Ibrahim Alkatout
Liselotte Mettler
Editors

Hysterectomy



A Comprehensive Surgical Approach

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Ibrahim Alkatout • Liselotte Mettler
Editors

With the Assistance of Dawn Rüther

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Dedicated to all patients placing their trust in us.

Foreword 1

The most common gynecological surgeries performed in the world are hysterectomies which date back to ancient time and were mainly associated with noncancerous conditions. The Italian anatomist Berengario da Carpi of Bologna carried out the first authenticated vaginal hysterectomy in 1507. In Manchester, England, Charles Clay performed the first recorded abdominal hysterectomy in 1843, and in 1853, by accident Walter Burnham performed the first successful abdominal hysterectomy in Lowell, Manchester. The early hysterectomies, either vaginal or abdominal, were performed without anesthesia, and with a fatality rate ranging from 70 to 90 %. In the absence of an alternative management of cervical cancer, the radical hysterectomy was introduced. The first radical hysterectomy was performed by John Clark at Johns Hopkins in 1985, and in 1898, Ernst Wertheim of Vienna performed the first extended radical hysterectomy. The more radical extension of vaginal hysterectomy was developed by Karl Schuchardt of Gottingen, and in 1901, Friedrich Schauta described radical vaginal hysterectomy in detail. With the advent of antiseptics, anesthesia, antibiotics, blood transfusion, new technologies, and advances in surgical techniques, by the 1940s, total abdominal hysterectomy had become the norm, and hysterectomy had become a safer surgical procedure for women worldwide. The fatality rate dropped significantly.

As science and technology advanced, Kurt Semm, in Kiel, Germany, in 1984, was the first to describe a technique for laparoscopic assistance in vaginal hysterectomy, thereby laying the foundation for all endoscopic procedures. Laparoscopic hysterectomy is increasingly performed in many countries in the world; however, conservative and less invasive operative managements, such as hysteroscopic surgery and the application of ulipristal acetate, may reduce the traditional indications for hysterectomy. The limitations of conventional laparoscopy and advances in robotic surgery have led to the increased use of robotic techniques in hysterectomy. Diaz-Arrastia reported the first series of successful robotic laparoscopic hysterectomies in 2002, and surgeries using robotic techniques for hysterectomy are now rapidly expanding.

The indication and performance of hysterectomies in general have changed with the change in techniques and procedures and have been adapted to the request of women to retain their uterus; therefore, the need for a comprehensive textbook on hysterectomy to improve the knowledge, skills, and competencies of surgeons has become very evident.

Ibrahim Alkatout and Liselotte Mettler have compiled the very first comprehensive medical textbook of its kind, *Hysterectomy*: *A Comprehensive Surgical Approach*, dealing with all surgical techniques of hysterectomy (vaginal, abdominal, laparoscopic, and robotic-assisted) and their extended operations, such as lymphadenectomy and omentectomy, with excellent illustrations. This textbook contains 132 chapters contributed by over 100 renowned international authors. This book is an important addition to the literature on hysterectomy techniques, accessible to gynecologists worldwide, and thereby contributing towards the global improvement of healthcare for women.

I believe this textbook will be very valuable and find extensive use in developed and developing countries. I am honored and privileged to write this foreword.

Windhoek, Namibia

Prof. Quazi Monirul Islam, MBBS, MPH, FRCOG
WHO Representative to Namibia

Foreword 2

Hysterectomy ranks among the most frequently performed procedures in gynecology. Since modern surgical techniques have allowed the reduction of intra- and postoperative complications to a considerable degree, it has become a well-established option in the treatment of a wide variety of conditions, including cancers of the reproductive system, certain types of endometriosis and adenomyosis, uterus myomatosus, chronic pelvic pain, or uncontrollable bleeding.

The range of procedures used is broad, not only in regard to surgical techniques – laparoscopic, robotic-assisted, vaginal, abdominal – but also in regard to the extent of the surgery, depending on which organs are included, in addition to the uterus itself, e.g., the cervix, the vagina or parts of it, the parametrium, the lymph nodes, the fallopian tubes, the ovaries, or the omentum.

With its comprehensive overview of all surgical techniques and its illustrated step-by-step descriptions, this book will provide not only a valuable decision aid for surgeons in their choice of method but also a training guide for surgeons at every level of education and experience. It can be considered an additional advantage that this book also covers anatomical and diagnostic aspects of hysterectomy, including questions of when hysterectomy is indicated.

This book is the successor to Liselotte Mettler's *Manual of New Hysterectomy Techniques* (2007), an indispensable handbook on vaginal and laparoscopic hysterectomy. This new volume, edited by a team, Ibrahim Alkatout and Liselotte Mettler, benefits in a similar way from the high standards of the Kiel School of Gynaecological Surgery, of which Liselotte Mettler is one of the distinguished protagonists. Along with Kurt Semm, she initiated the "minimally invasive revolution" of laparoscopic hysterectomy, thus establishing the foundation of today's procedures in the field.

This book's widened scope, now including all available techniques, diagnostic guidance, and in-depth background information, puts itself forward as a standard reference in the field of gynecological medicine.

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Foreword 3

It is with great pleasure that I write a forward for this book edited by Ibrahim Alkatout and Liselotte Mettler. Liselotte Mettler has lived on the cutting edge of advanced laparoscopic surgery from its beginning, and by beginning, I mean 1985 when we presented together at AAGL, known previously as a tubal ligation society. The next year, we were both teaching the advanced course at the AAGL. She has continuously worked as a leader to advance the surgical care of women and still does. She is active as a teacher worldwide, especially concerning hysterectomy, and was a founder of the Kiel School of Gynaecological Endoscopy, one of the first training centers in this specialty.

I have known and worked with Liselotte Mettler for over 30 years. Her work with Kurt Semm progressed along parallel paths with mine until we met in 1985–1986. Kurt and Lilo called me Mr. Electrosurgery at that time as Kurt used sutures for oophorectomy, while I pioneered the use of bipolar desiccation for large vessel hemostasis. It was then that Kurt told me, "If I learned to suture, I would be king." So I learned how to suture!

Somewhat lost in these discussions is that I started as a vaginal surgeon. Vaginal surgery was my passion! Abdominal mutilation was our common enemy. After 10 years of doing vaginal hysterectomy surgery with the occasional use of the laparoscope for salpingo-oophorectomy, I began to do the whole operation using laparoscopic visualization with desiccation of both the uterine arteries and the ovarian arteries in 1988. Laparoscopic supracervical hysterectomy came soon thereafter by Kurt and Lilo.

Now, Lilo and her associates from the Kiel School of Gynaecological Endoscopy have put everything about hysterectomy together with this textbook describing different techniques in a relatively comprehensive manner. I must admit that my favorites are both the vaginal and the laparoscopic approaches. So, I look forward to reading those sections to determine if the difference between a colpotomy and a culdotomy has been finally resolved.

I believe that this is a much-needed textbook, and I am sure that most gynecologists will benefit from reading it.

Harry Reich, MD, FACOG, FRCOG
Pioneer in the Development of Laparoscopic Hysterectomy, Shavertown, PA, USA

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Foreword 4

Hysterectomy is the most common major surgical procedure in modern gynecology. In the USA alone, approximately 600,000 hysterectomies are performed each year. All gynecologists will, at some stage of their training, learn how to perform the hysterectomy procedure independently. What is so special about a hysterectomy, compared to most other surgical procedures, is that there is such a variation of methods and surgical routes for this surgery. More than 90 % of all hysterectomy procedures are performed for benign indications. Thus, there are special needs concerning safety, efficiency, and cost-effectiveness in relation to this nonvital, quality of life-enhancing surgery.

A hysterectomy procedure can take anytime from 15 min to several hours. However, a hysterectomy that spans several hours may be as rewarding for the patient and the surgeon as a quick hysterectomy. I personally have probably performed the longest hysterectomy procedure. In a series of nine abdominal total hysterectomies that took place in 2013, the surgical duration was between 10.5 and 13 h. What is also so special is that these nine abdominal hysterectomies were performed to increase the quality of life of another woman and not the operated woman herself.

My co-surgeon, Pernilla Dahm-Kähler, and I performed the surgery through a midline incision and apart from the uterus also long extensive vascular pedicles, including the uterine and internal iliac arteries and veins, were harvested. The hysterectomy specimen was flushed and cooled ex vivo, before transplantation into the pelvis of the recipient (in most cases the daughter). Up until today, five healthy babies have been born from these transplanted uteri, and three out of these five recent mothers also grew themselves inside the same uterus as their babies.

Dr. Dahm-Kähler and I would never have been able to conduct these successful hysterectomies and uterus transplantations without a structured training in several different hysterectomy procedures during our early years of surgical training and more importantly, without the parallel acquisition of a great understanding of the anatomy of the pelvis. All these important aspects are covered in this comprehensive book. Another important point is that a prolonged duration of surgery does not necessarily equate with inadequate surgical skills. During my early training, I would closely record the time and would not be satisfied by a long duration of a seemingly easy hysterectomy. Today, I try to teach the residents in training that they should strive for minimal bleeding and follow the natural anatomic layers to minimize the tissue damage and thereby shorten the recovery time of the patient.

The editors, Ibrahim Alkatout and Liselotte Mettler, have been able to recruit a large number of absolute top clinicians/scientists in the field of gynecology and surgical hysterectomy to contribute chapters to this book. The impressive list of authors guarantees the readers not only up-to-date information on each aspect of hysterectomy but also that the opinions and surgical tips have passed the critical eyes of world-renowned doctors in academic medicine. Notably, this book covers not only the surgical techniques of all various hysterectomy procedures but also the important aspects of indications and presurgical diagnostics.

I am convinced that *Hysterectomy: A Comprehensive Surgical Approach* will become one of the classic books in the field of gynecology.

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Preface

This comprehensive surgical approach to hysterectomy rests on the pillars erected by the great masters in our specialty. The first hysterectomy was performed as a vaginal hysterectomy and dates back to ancient times. The procedure was performed in the time of Soranus of Ephesus, 120 years after the birth of Christ. There were many reports of its use in the Middle Ages, nearly always for the extirpation of an inverted uterus, and the patients rarely survived. Hysterectomy became safer with the introduction of anesthesia, antibiotics and antisepsis, blood transfusions, and intravenous therapy. During the 1930s, Richardson introduced the total abdominal hysterectomy to avoid serosanguinous discharge from the cervical remnant and the risk of cervical carcinoma developing in the stump.

Apart from this innovation, and the transverse abdominal incision introduced by Johannes Pfannenstiel of Kiel in the 1900s, there was little advance in hysterectomy techniques until the advent of endoscopic surgery and the performance of the first laparoscopic hysterectomy by Kurt Semm in Kiel in 1984 and Harry Reich in Kingston, Pennsylvania, in 1988. With his never-ending dedication to the teaching of laparoscopy, Kurt Semm stimulated his coworkers in Kiel and courageous followers around the world to move forward with laparoscopic total and radical hysterectomy.

Thoralf Schollmeyer was a pupil of Semm and head of the Kiel School of Gynaecological Endoscopy from 2007 until his early death at the age of 52 in 2014. He continues to inspire us and was the driving force behind the decision of the Kiel School to go ahead with the second edition of the *Manual of New Hysterectomy Techniques* (2007).

In this age of global communication, it is a great privilege to publish a specialist surgical book on hysterectomy which features the leading surgeons, researchers, and teachers as contributing authors. With the assistance of over 200 multidisciplinary authors, we have been able to compile a book that hopefully meets the requirements of a broad base of readers.

This book brings into balance theoretical background, clinical experience, and scientific findings in a readily comprehensible form with numerous illustrations and tables. For the beginner, this book could become a reliable companion, providing background information and assistance for all procedures associated with hysterectomy. This includes abdominal, vaginal, conventional laparoscopic, and robotic-assisted surgical procedures. But also the experienced surgeon will be able to broaden his spectrum and learn experimental and innovative surgical approaches as this is the first textbook on hysterectomy including traditional, up-to-date, and innovative surgical methods.

Additionally, the book contains a large proportion of interdisciplinary aspects, and we believe it will make a substantial contribution to meeting the growing requirements of interdisciplinary medical treatment. It offers related disciplines (especially general surgery and urology) the opportunity to describe the areas of common overlap and how these can be treated. This multidisciplinary approach is of advantage not only for gynecologists but also for general surgeons and urologists.

The wide range of the contents developed in the course of the conception of the book. Extended hysterectomy procedures cannot be separated from procedures on the internal genital organs or those involving the anatomical and functionally relevant surrounding area.

Finally, we would like to thank Joni Fraser for her continuous support and valuable assistance in preparing the book for production. Special thanks also go to Lizzy Raj, Julia Megginson, and Melissa Morton at Springer International Publishing for allowing us the freedom to design a book according to our ideas and supporting us in the realization of what turned out to be a mammoth project. Tribute is also due to the illustrators for their creative visual implementation of complex issues.

The editors are conscious of the privilege of having access to the most advanced treatment concepts of our time. In an unstable world, our foremost intention is to share the greatest good, the ability to cure one's fellow human beings.

Kiel, Germany, 2017 Ibrahim Alkatout and Liselotte Mettler

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Part I

Historical Background



The History of Hysterectomy

1

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Introduction: The Ancient Greek Understanding of Female Pelvic Anatomy

There was a certain mystique about female anatomy in ancient times so the Greeks believed that the uterus (hysteros) was the seat of the soul. The Pythagoreans believed that the uterus was bifid which almost implies a knowledge of embryology but probably arose from the fact that they were permitted to dissect animals but human dissection was forbidden. They hypothesised that the left uterine horn represented the west, or darkness, from which females were derived whereas the right side represented the east, or light, in which males developed. They believed that the uterus wandered around the abdominal cavity and that when the organ was displaced the poor woman developed signs of hysteria [1]. Such male orientated thinking persisted until the late nineteenth Century allowing gynaecologists to remove normal ovaries, popularised by the American Surgeon Robert Battey – for a range of dubious indications ranging from hysteria, menstrual madness, insanity and even nymphomania and masturbation [2]. Such a practice performed at a time when operative mortality was around 75 % represented the zenith of morality in the specialties of gynaecological surgery and psychiatry and was probably the greatest scandal in medical history [3].

The First Vaginal Hysterectomies

Although the history of vaginal hysterectomy is shrouded in the mists of antiquity there are reports of it having been performed 50 years before the birth of Christ by Themison of Athens [4, 5]. Most of our knowledge of surgery in Greek and Roman times is derived from *Gynaecology,* the oldest published work on obstetrics and gynaecology written by Soranus [6]. Soranus (Fig. 1.1) was born in Ephesus in Asia Minor, and being situated between India and Greece absorbed the early medical ideas of these two great cultures [7]. Ephesus, which has a well preserved stone amphitheatre, was originally a Greek city but is now situated in Turkey on the Aegean Sea north of Izmir.

Soranus received his medical training in Alexandria in Egypt and later worked in Rome during the reigns of Emperor Trajan (AD 98–117) and Emperor Hadrian (AD 117–138).

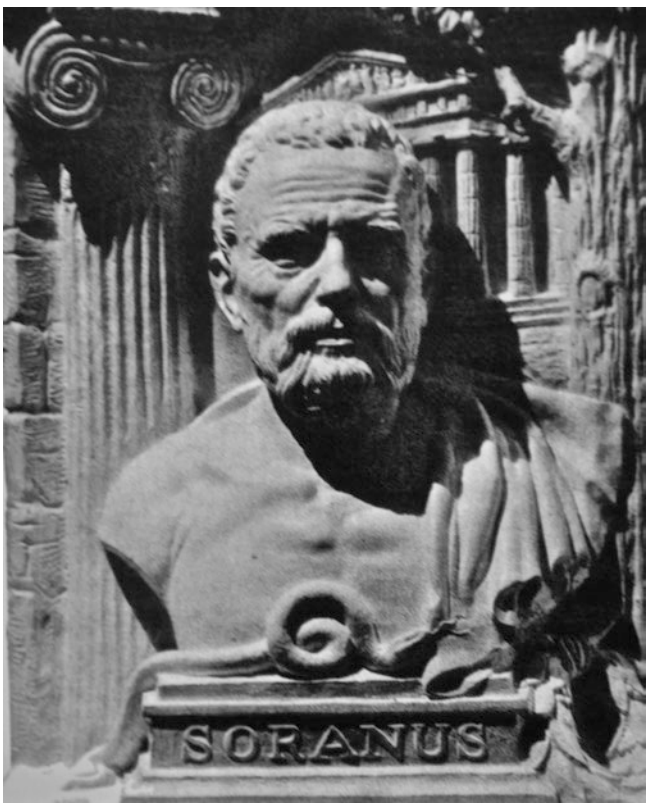


Fig. 1.1 Soranus of Ephesus (AD 98–138) who wrote the first textbook of Gynaecology and described a vaginal hysterectomy he performed (Photo: Dr. Chris Sutton taken at the Amphitheatre in Ephesus,Turkey)

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In his book *Gynaecology* there is a well documented case of a vaginal hysterectomy which explained in detail an operation performed by the author which involved the removal of an inverted uterus that had become gangrenous and had turned black in colour [8]. The ureters, and often the bladder, were part of these early surgical excisions and the patients invariably died [1, 9].

Nevertheless in the writing of the eleventh century Arabian physician, Alsaharavius he clearly states that if the uterus had prolapsed externally and could not be reinserted, then he advised his pupils that it should be surgically excised and it is unlikely that he would have advocated this practice if death was the inevitable result of such intervention.

There is another report from a Latin translation of a Hebrew text in 1287 that Abumeron Avenzoar (?1092–1162), generally regarded as the greatest Moslem physician of the Western Caliphate was the first to attempt total extirpation of the uterus [10].

The Middle Ages

In fact there are several reports of patients surviving vaginal hysterectomy in the Middle Ages, and these are referred to in medical writings in the sixteenth and seventeenth centuries. The first authenticated case was reported by Giacomo Berengario da Carpi who lived in Bologna, the site of one of the oldest medical schools in Europe. In 1507 he was reputed to have performed a partial vaginal hysterectomy and added that his father had also performed one in the same year [11].

Schenck of Grabenberg reported 26 cases during the early part of the seventeenth century and the operation was also performed by Andreas da Crusce in Italy in 1560 and by Valkaner of Nuremberg in Germany in 1675, when the patients appear to have survived [12]. Modern medical historians are somewhat sceptical about some of these early reports and, as usual, have largely ignored the contribution of the midwives of Europe who, from time to time, amputated prolapsed or inverted puerperal uteri. They have also overlooked an early example of self-help: Faith Howard, a 46 year old peasant woman who performed the operation on herself. This case was well documented and reported in 1670 by Percival Willoughby, an early male midwife and lifelong friend of William Harvey, who famously discovered the circulation of blood. Apparently, while she was carrying a heavy bucket of coal one day, Faith's uterus prolapsed completely and, frustrated by this frequent occurrence, she grabbed the offending organ, pulled as hard as possible and "cut the whole lot off with a short knife". In his report, Willoughby states that "there was a mighty bleeding which eventually stopped" and Faith lived on for many years after this "with water passing from her insensible day and night", obviously from a vesico-vaginal fistula [13, 14].

The famous French *accoucheur,* Jean- Louis Baudeloque , the inventor of the pelvimeter, introduced the technique of artificially prolapsing the uterus and then, in favourable cases cutting it off together with the adnexal organs and he performed 23 of these procedures over 10 years from 1800. He was a fervent supporter of Caesarean Section, as opposed to symphysiotomy, and his external pelvimeter was used to measure the diameter of the external conjugate to predict those women who were likely to have an obstructed labour. He attended the first confinement of Napoleon's wife, Empress Marie-Louise, and his reputation in Paris was such that he was called '*le grand Baudeloque'* [15].

It seems that the first vaginal hysterectomy on a non-puerperal uterus was an unfortunate accident. Dr. G.B.Paletta of Milan carried out the operation on 13 April 1812 assisted by an eminent Milanese surgeon Dr. D.B. Monteggia. He intended to amputate what he thought was a cervical cancer, but to his great surprise found that he had removed the entire uterus vaginally. Unfortunately the patient died 3 days later from peritonitis [7].

The First Elective Vaginal Hysterectomies

Most of these procedures were performed on puerperal uteri and were undertaken on an emergency basis, but the first planned elective hysterectomy was by Friedrich Osiander (1759–1822) of Gottingen in Lower Saxony in Germany just over two hundred years ago in 1801 who employed the vaginal approach. He did not report the case until he had operated on his ninth patient [16].

It is interesting to reflect that almost all women subjected to caesarean section at this time died from shock, haemorrhage or sepsis. In the early 1800's Ossiander wrote: "Before undertaking this procedure, one should allow the patient to draw up her will and grant her time to prepare herself for death" [15]. A rather extreme example of informed consent long before the modern epidemic of litigation might make this seem reasonable in certain circumstances.

The first deliberate planned vaginal hysterectomy for endometrial carcinoma was by Conrad Langenbeck (Fig. 1.2) who, interestingly, also came from Gottingen and was possibly the most distinguished surgeon of his time and the Surgeon-General of the Hanoverian army. He performed this operation in 1813 but did not report it until 4 years later [17].

Langenbeck, the inventor of the retractor that is familiar to all surgeons, was himself a surgeon of such supreme swiftness that he once amputated the shoulder of a wounded infantry officer whilst a colleague who had come to watch the procedure had turned around to take a pinch of snuff thereby totally missing the operation he had travelled far to observe [18, 19].

Having little precedent to follow, Langenbeck had to devise his own plan for the removal of the entire uterus. He



Fig. 1.2 Conrad Langenbeck from Gottingen, Lower Saxony, Germany: Surgeon General to the Hanoverian Army, who performed the first elective vaginal hysterectomy for endometrial cancer in 1813 (Reproduced with permission of Jaypee Brothers Medical Publishers, India)

performed a retroperitoneal dissection taking great care not to enter the peritoneal cavity. Towards the end of the procedure he encountered uncontrollable bleeding from the uterine artery and called upon his assistant, a Surgeon Commander afflicted with gout, to come and help but the gentleman was enormously overweight and could not rise from his chair. Langenbeck had no alternative but to compress the bleeding artery with his left thumb and forefinger and with his right hand he placed a ligature- carrying needle through the tissues behind the bleeding point and tied the ligature by grasping one end between his teeth and secured the pedicle with a one handed slip knot tied with his right hand. Following the procedure he could detect no opening into the peritoneal cavity and the patient made a surprising and uneventful recovery but after this extraordinary display of technical virtuosity, none of his colleagues believed that the operation had taken place since there was no visible scar. As is so often the case the operative specimen had been lost on the way to the pathology laboratory, the Surgeon Commander with gout died the following week and the patient herself was demented so was unable to provide reliable testimony. For the next 26 years Langenbeck was subjected to ridicule and the jibes of his colleagues and accused of being a liar and a charlatan and was only finally able to substantiate his claim when the patient died of senility and an autopsy showed that she had indeed had her uterus removed in its entirety [9].

The First Laparotomy: Christmas Day 1809

In order to put these events into historical perspective the vaginal hysterectomy for endometrial cancer performed by Conrad Langenbeck described above took place in 1813 at the time when Napoleon's *Grande Armée* was retreating from Moscow after the failure of his Russian Campaign. It was only 4 years before, on Christmas day 1809, that the human abdomen was deliberately opened for the first time in order to remove a diseased organ, in this case a massive ovarian cyst.

Until the beginning of the nineteenth Century there was no possible way of removing a large tumour because it was considered that surgical opening of the peritoneal cavity resulted in certain death. A little over 200 years ago an event took place which has had a momentous impact on our survival as individuals and as a species and yet it has been remembered by relatively few. That day saw the birth of operative abdominal surgery which has saved countless lives, yet it did not take place in one of the great University Teaching Hospitals but in the front parlour of the house of an American country doctor in the small frontier town of Danville in Kentucky [20, 21].

On the morning of Christmas Day 1809 the brave surgeon Ephraim McDowell (Fig. 1.3) performed the world's first elective laparotomy to remove a massive tumour from the equally brave patient, Jane Todd Crawford (Fig. 1.4) who had to withstand the horrific pain of a large abdominal incision without the benefit of an anaesthetic. The doctor was brave because the abdominal cavity had never been deliberately opened with a surgical knife before and it was widely accepted that such an intervention would inevitably result in death.

Legend has it that the townsfolk of Danville had gathered in the square outside his house on the morning of the operation and were erecting a gallows so that if Jane Todd Crawford died at the hands of the "dreadful doctor" he would be hanged in public [22].

The Father of Abdominal Surgery: Ephraim McDowell

McDowell's family were of mixed Irish and Scottish extraction and he was born in Rockbridge County, Virginia in 1771, the ninth of twelve children. When he was 13 years old the



Fig. 1.3 Ephraim McDowell (1771–1830): The Father of Abdominal Surgery. Performed the First Laparotomy on Christmas day 1809. Painting by P.W. Davenport in McDowell House. Note the three volumes on Surgery by John Bell, one of McDowell's teachers in Edinburgh (Photo: Chris Sutton with permission McDowell House and Museum, Danville, Kentucky)



Fig. 1.4 Jane Todd Crawford (1763–1842) From a painting of young Jane of unknown origin. McDowell House, Danville, Kentucky (Reproduced courtesy of McDowell House and Museum, Danville, Kentucky)

family moved to Danville, a frontier town that was the first capital of the State of Kentucky, where his father was appointed Judge of the small community of some "150 homes and some tolerably good buildings" [23]. The young Ephraim decided on a career in medicine early in his life and served as an apprentice to a family physician, Dr. Alexander Humphreys in Staunton, Virginia. When he was 22 he spent 2 years studying anatomy in Edinburgh under Alexander Munro and surgery under the tutelage of John Bell. For financial reasons he had to return home to Danville without earning a medical degree but even without the letters after his name the prestige of being educated at one of the most famous Medical Schools in the world ensured that he rapidly built up an extensive surgical practice and he came to be regarded as "the best doctor west of Philadelphia" [24] He was renowned for his swift amputations, hernia repairs and lithotomies and would typically operate in the homes of patients with family members gathered round to hold the unfortunate sufferer down. One of his patients was James Polk who, as a 14 year old boy had several bladder stones removed, and later became the eleventh president of the United States [25].

McDowell's fame spread locally among the frontier people because this was an area that was expanding rapidly after Dr. Thomas Walker had opened up the Wilderness Trail through the Cumberland Gap from Virginia into Kentucky accompanied by frontiersmen and Indian fighters such as Daniel Boone and Davy Crockett [21].

The Patient: Jane Todd-Crawford

Jane Todd-Crawford lived with her family of five children in a small log cabin in Motley's Glenn near Greensburg, Kentucky, some 60 miles from Danville and at the age of 44 she was thought to be carrying another child and was causing concern with the local doctors and midwives because she was 2 months beyond her due date and " she was afflicted with excrutiating pains similar to those of labour, which were incessant" [26]. The two attending physicians were in despair and had tried various potions and enemas used to induce labour and in desperation had even employed two midwives to jump up and down on her extremely distended abdomen. All this was to no avail and the poor woman had such a swollen abdomen that she could barely breathe and in desperation they decided to summon the "surgeon from Danville to assist with the delivery".

Although the journey from Danville to Greensburg can nowadays be easily accomplished in an hour or so using modern highways, in 1809 it required a lengthy and difficult journey on horseback, crossing many mountain ridges and fording deep rivers and when McDowell set out on this arduous journey the snow had already fallen deeply and there were added hazards from bands of skirmishing Indians, to say nothing of predatory wolf packs and bears. When he



Fig. 1.5 Massive ovarian cyst. When removed it weighed half of the weight of the patient (Photo: Chris Sutton. St. Luke's Hospital, Guildford)

arrived he quickly appraised the situation and saw that the swollen abdomen did, indeed, have the appearance of a pregnancy, possibly a multiple one, with a size that was indeed making it difficult for the patient to breathe.

Without recourse to sophisticated imaging techniques it is often difficult clinically to distinguish a massive fibroid from a large ovarian tumour (Fig. 1.5) or, indeed, from a term pregnancy [27]. Possibly because of his education in Edinburgh under the tutelage of the anatomist Alexander Monroe (Secundus), he performed a more thorough examination than had been performed by the local physicians and this included a vaginal examination where he found that the mass was inclined to one side and was mobile and his examining fingers felt a normal sized uterus and cervix which were pushed to the other side, all of which indicated that the mass was an "enlarged ovarium".

Clearly, he was very depressed by his findings and in an account written many years later to a medical student, Robert Thompson, he wrote "I told the lady that I could do her no good and candidly stated to her, her deplorable situation; informed her that John Bell, Hunter, Hay and A Wood, four of the first and most eminent surgeons in England and Scotland, had uniformly declared in their lectures that such was the danger of peritoneal inflammation that opening the abdomen to extract the tumour led to inevitable death."

She was clearly devastated by this pronouncement but told him that it was impossible to continue to live in her present situation since she was almost unable to breathe and felt that she would die anyway. He therefore continued "but, notwithstanding this, if she thought herself prepared to die, I would take the lump from her if she would come to Danville." He ended this account by stating simply "she appeared willing to undergo an experiment" [28]. This must surely be the first documented case in the world of informed consent.

The Operation on McDowell's Kitchen Table

Dr. McDowell returned to Danville expecting to hear no more from her because the journey with the increasing snowfall that winter was long and difficult and dangerous by horseback, but she was a tough frontier woman and a few days later appeared on his doorstep. Unfortunately the arduous journey had caused considerable bruising over the lower abdomen, where she had rested the enormous tumour on the pommel of her saddle. He therefore determined to wait for a few days before deciding to perform the operation and, being a deeply religious man, he timed the procedure to occur on the morning of Christmas Day when many of the townsfolk were in church so that they could bring the efforts of their combined prayers onto his endeavour. He was joined by his nephew, Dr. James McDowell, who had graduated a few months previously from the first Medical School in America, in Philadelphia, to join the practice as a partner and he did his best to dissuade his uncle from "the experiment". The kitchen table was dragged into the front room and Jane Todd Crawford was placed on her back on the table and tilted slightly to the right side (Fig. 1.6) and then "he removed all her dressing which might in any way impede the operation". He then offered up a prayer saying " Direct me, O God, in performing this operation, for I am but an instrument in thy hands, and am but thy servant, and if it is thy will, oh! spare this poor afflicted woman."

Many years later when he wrote about the procedure he described it as follows: "I made an incision about 3 inches from the rectus abdominus muscle on the left side, continuing the same 9" in length, parallel with the fibres of the above-named muscle, extending into the cavity of the abdomen. The tumour then appeared full in view but was so large that we could not take it away entire. We put a strong ligature around the fallopian tube near the uterus and then cut open



Fig. 1.6 The first laparotomy in the world on Christmas Day 1806 performed on the kitchen table in Ephraim McDowell's House in Danville, Kentucky. Painting by Dean Cornwell *" the Dawn of Abdominal Surgery"* (Reproduced courtesy of McDowell House and Museum, Danville, Kentucky)

the tumour, which was the ovarium and fimbrious part of the fallopian tube, very much enlarged. We took out 15 lbs of a dirty gelatinous-looking substance, after which we cut through the fallopian tube and extracted the sac, which weighed 7 lb and one-half. As soon as the external opening was made the intestines rushed out upon the table and so completely was the abdomen filled by the tumour that they could not be replaced during the operation which was terminated in about 25 minutes. We then turned her upon her left side so as to permit the blood to escape, after which we closed the external opening with the interrupted suture, leaving out at the lower end of the excision the ligature which surrounded the fallopian tube."

During the whole of this ghastly painful procedure Jane Todd-Crawford remained motionless and merely recited the Psalms in order to calm herself during her ordeal.

She stayed in McDowell's house and the bed in which she lay can still be seen because the entire house and gardens have been turned into a museum to commemorate this amazing feat of pioneering surgery. Several years ago the American College of Obstetricians and Gynaecologists donated the wooden door knocker from the front door of McDowell House to the Royal College of Obstetricians and Gynaecologists in London and it is still used to this day as a gavel on ceremonial occasions.

Ephraim McDowell visited Mrs. Crawford on a daily basis and on the 5th day he found her making her own bed and reprimanded her severely. She continued to make an excellent recovery and 25 days later she returned home in good health by the same route that she had come, which is now a long distance footpath named "The Jane Todd Crawford Trail".

The two of them never met again during their lives. Ephraim McDowell died at the age of 59 years of "an acute attack of inflammation of the stomach" which was probably appendicitis and long before the time when a laparotomy could be performed to remove the infected organ. Jane Todd Crawford outlived him and died at the age of 78 years and a picture of her in her old age (Fig. 1.7) shows her displaying a locket with the picture of Abraham Lincoln, who was born in a log cabin at Sinking Spring Farm very close to where she grew up in Greensburg County and to whom she was related as a cousin when he married one of her sisters who thus became America's First Lady as Mary Todd Lincoln.

The often repeated story that the townsfolk had gathered in the square outside his house and had erected a gallows to hang him in the event of Jane Todd Crawford dying during the operation is almost certainly anecdotal and untrue for several reasons. Firstly he was considered the most famous, knowledgeable, and skilful surgeon in that frontier area which probably had few doctors and he would have been treated with the greatest respect and unlikely to have been publicly hanged. Furthermore his father was the County Judge and his elder brother was the Sheriff of Danville who was sadly killed a few weeks later when he was involved, along with Davy Crockett and Daniel Boone, in a skirmish with a local Indian tribe at Blue Lick in Kentucky [21].



Fig. 1.7 Jane Todd Crawford. A daguerreotype of her as an old lady a few months before her death in 1842.She is holding a locket with a portrait of Abraham Lincoln, a distant relative by marriage to one of her cousins, who became America's First Lady as Mary Todd Lincoln (Photo: Chris Sutton with permission McDowell House and Museum, Danville, Kentucky)

The Ovariotomists: Pioneers of Ovarian Surgery

Unlike his modern counterparts, Ephraim McDowell did not immediately rush off to get this operation published and waited until he had performed two more successful operations on ovarian tumours in 1813 and 1816 before reporting it in a journal with a limited readership, "The Eclectic Repertory and Analytical Review of Philadelphia" [29]. Two years later he published two further cases in the same journal, one of whom survived, but the other died of peritonitis on the third post-operative day. During his lifetime he performed three further ovarian operations between 1822 and 1826. One involved merely drainage but the patient lived for a long time afterwards, the second underwent complete excision, but the third had to be abandoned because of extensive adhesions.

There were a further three that are mentioned in letters and on reading his descriptions it does seem that, although he styled himself as an ovarian surgeon, at least two of his cases were large pedunculated myomas [30, 31]. News of great surgical advances took a long time to percolate across the Atlantic and, even in America, McDowell's achievement was greeted with a certain amount of scepticism and even outright disbelief [32]. It was 14 years later that the first ovariotomy was carried out in Europe by John Lizars, a fellow student from Edinburgh, but the patient died and he then made three more successful attempts [33]. It appears that the Edinburgh Surgeon, J.Y.Simpson, the inventor of the anaesthetic agent chloroform was the first to introduce the word 'ovariotomy', a strange choice for the name of this operation in an age when most surgeons were reared in the classics and therefore etymologically correct [32]. The initial years of abdominal surgery were associated with an enormous mortality rate, mainly due to uncontrolled haemorrhage or peritonitis and sepsis but the few women that survived spawned a new generation of pioneering surgeons who finally realised that opening the human abdomen with a surgical incision did not result in certain death.

The World's First Abdominal Hysterectomy November 17th 1843

The greatest of the ovariotomists in Europe was Charles Clay of Manchester, in the North of England [34]. He studied at the Manchester Royal Infirmary and, like Ephraim McDowell received part of his medical education in Edinburgh. Like McDowell he also started in surgical practice in a small rural community, Ashton-under-Lyne under the shadow of the Pennine Hills in Cheshire. After 16 years he moved to the industrial city of Manchester where he established his surgical reputation. He was a member of the Reform Club and was a friend of my great grandfather, William Sutton, who was a successful businessman in this thriving Victorian metropolis. Charles Clay is shown in Fig. 1.8 at the peak of his surgical career, profoundly confident and appearing dapper with his top hat.

The first four of his ovariotomies survived but with the fifth he was not so lucky and this turned out to be the first abdominal hysterectomy recorded and it was a complete disaster. The operation was performed on 17 November 1843 in the first floor room above his Consulting Rooms in Piccadilly, the large square in the centre of Manchester. As was usual in those days he was accompanied by several



Fig. 1.8 Charles Clay (1801–1893) who performed the first successful abdominal hysterectomy in Europe on 2nd January 1863 (Copyright of the Rylands Library, University of Manchester, England)



Fig. 1.9 Massive fibroid exposed at laparotomy (Photo: Chris Sutton)

friends and medical students as spectators and since it was before the time of Pasteur or Lister no one wore masks or surgical gloves and the patient was given brandy and milk to alleviate the pain of the operation since this was a long time before anaesthesia was introduced by WRT Morton at the Massachusetts General Hospital in Boston in 1846 [35]. He was certain that he was dealing with a massive ovarian cyst so he made a long 60 cm surgical incision from the xiphisternum to the pubis. Unfortunately once the peritoneum was entered the patient coughed and the massive tumour was extruded (Fig. 1.9) and he realised to his horror that it was a huge fibroid and since the patient was now struggling and had to be forcibly restrained by the medical students and it was impossible to replace the hugely enlarged uterus back in the abdominal cavity he had no option but to proceed and performed a subtotal hysterectomy. By an extraordinary coincidence a few days later on the 21st of November, A M Heath who was also an ovarian surgeon in Manchester, found himself in a similar situation operating on a huge fibroid instead of an ovarian cyst. Unfortunately both patients died of a massive haemorrhage a few hours later [19].

The next year, Clay was more successful with a similar case but on this occasion he placed a ligature of Indian hemp around the supra-vaginal cervix to prevent haemorrhage from the uterine arteries. The patient lived for 15 days when she fell out of bed in a coma and never regained consciousness. Although this was tragic for the patient it was also sad for Clay since she had survived the critical post-operative period and not succumbed to sepsis which was the usual cause of death following a laparotomy.

From reading contemporary accounts of this woman's post-operative course it is difficult to determine the exact mode of death. She could have had a pulmonary embolus or she could have fallen out of bed in uraemic coma due to occlusion of both ureters by the ligature but popular Mancunian folklore suggests that she was dropped on the floor by a couple of incompetent porters whilst the nurses changed her bed linen. If this is true then her death was

entirely unrelated to the operation and Charles Clay could have claimed to have performed the first successful hysterectomy in the world [22, 36].

In fact it was not for a further 20 years that he attempted another hysterectomy and this time the patient survived. Interestingly he mentioned this almost as an aside during his important presentation to the Obstetrical Society of London in 1863 when he presented his experience of 395 ovariotomies with only 25 deaths [37].

The First Successful Abdominal Hysterectomy in the World

The first successful removal of a fibroid uterus was by Walter Burnham in Lowell, Massachusetts in 1853 [18, 38, 39]. The patient, a 42 year old woman, was referred to him by another physician who had observed a slowly growing abdominal mass over the previous 6 years that was without any other symptoms but had recently become persistently painful. Burnham diagnosed an ovarian cyst but told her there was no treatment available other than surgical removal and even '… this course of action could not be adopted without placing her life in imminent danger'. He advised her to seek a second opinion and ' also to consult her friends as to the propriety of running so great a risk' [15].

Nevertheless she elected to have the operation which took place on 25 June 1853 with two surgical assistants and in the presence of a large number of medical gentlemen as was often the case with these early surgical interventions. This operation took place in the early days of anaesthesia and the chloroform caused the patient to vomit so when he made a long midline incision from the sternum to the pubis, a large pedunculated fibroid attached to an enlarged fibroid uterus was extruded through the incision when in fact Burnham was anticipating a massive ovarian cyst. It proved impossible to replace the large fibroid and he had little choice but to proceed with a subtotal hysterectomy tying off both ovarian and uterine arteries. The patient recovered, apparently with the aid of brandy and opium, and the fact that the original diagnosis was incorrect should not detract from his achievement.

Early records of the first abdominal hysterectomies read like a disaster saga until Burnham produced the first survivor, but even in that instance the diagnosis was wrong (Table 1.1).

However, later the same year Gilman Kimball (Fig. 1.10) who, also resided in Lowell, carried out the first deliberate hysterectomy to remove a fibroid, and the patient survived the operation [40]. In this particular case the surgeon correctly diagnosed a large fibroid of about the size of a 6 month pregnancy but it was not the size that was the problem but the severe menorrhagia that was causing the loss of a large quantity of blood each month which had become life-threatening.

Table 1.1 A summary of the abdominal hysterectomies performed in the early years (1843–1863)

Date	Operator	Diagnosis	Outcome
1843	Clay	Ovarian tumour	Massive haemorrhage a few hours after the operation and died
1843	Heath	Ovarian tumour	Massive haemorrhage a few hours after the operation and died
1844	Clay	Ovarian tumour	Dropped on the floor on day 15 and died
1846	Bellinger	Fibroids	Haemorrhaged on day 5 and died
1853	Burnham	Ovarian tumour	Survived but diagnosis wrong
1853	Kimball	Fibroids	Survived and diagnosis correct
1863	Clay	Fibroids	Survived. First successful operation in Europe
1863	Koeberle	Fibroids	Survived

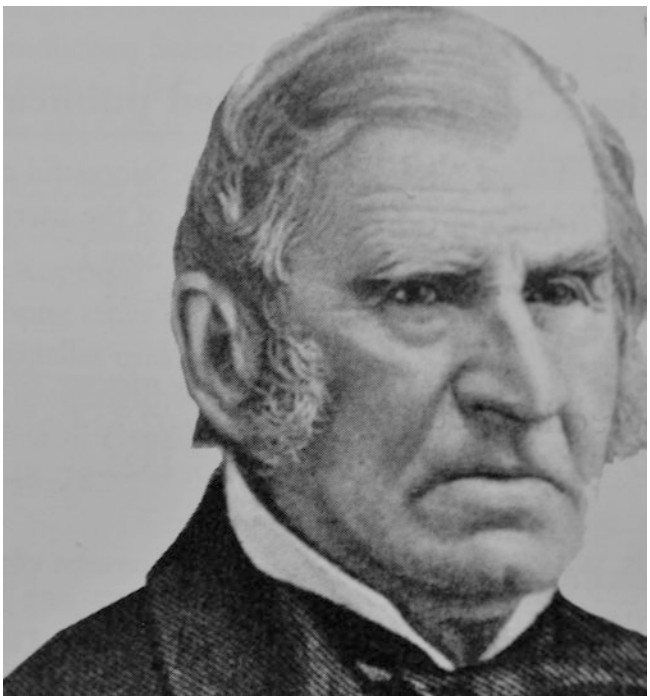


Fig. 1.10 Gilman Kimball (1804–1892) from Lowell, Massachusetts who performed the first successful hysterectomy in the world with the correct pre-operative diagnosis on 1 September 1853 (Reproduced with permission from RCOG Press, London)

During the consultation with her other physicians Kimball felt that ' Rather than give up the case as utterly hopeless, I would propose, as a last resort, the removal of the uterus itself …. Extraordinary and hazardous as this suggestion seemed, the feeling was unanimously and unhesitatingly expressed by everyone present at the consultation, that this

procedure offered the only possible chance of saving the patient from impending death. This conclusion was no sooner made known to the patient, than it was readily consented to – both she and her husband claiming that a chance of life by an operation however small that chance might be, was better than the certainty of a speedy death" [40].

They wasted no time and the same afternoon the patient was anaesthetized with chloroform and a relatively small incision was made through the linea alba directly over the most prominent part of the tumour. Kimball's plan was to perform a myomectomy and having reduced the size of the uterus to then proceed to sub-total hysterectomy. This is essentially what he achieved and the patient made a full and complete recovery, although the protruding ligatures were still causing inconvenience 8 months later.

It is interesting that these two surgeons came from a small town in rural Massachusetts and considering that hysterectomy is the second most common operation performed on women, second only to Caesarean Section, that enquiries I made at the tourist office last year as to where these operations actually took place lead nowhere and it seems that the burghers of that small town of Lowell are quite unaware of the fame that should be the just due of these two pioneering surgeons.

Walter Burnham was the son of a doctor and studied medicine under the tutelage of his father and graduated from the University of Vermont in 1829. He moved to Lowell in 1846 and carried out general and gynaecological surgery and was one of the early advocates of ovariotomy having performed 300 procedures in 30 years with a survival rate of 75 % which were excellent results for those times. His hysterectomy results were not so good and after the first survivor he performed a further 15 hysterectomies during the following 13 years but only two survived – the rest succumbing to sepsis, peritonitis, haemorrhage and exhaustion.

Walter Burnham was a member of the Massachusetts House of Representatives and was instrumental in securing the passage of the Anatomy Act in 1855,which authorised the medical profession to obtain bodies of dead paupers for dissection and anatomical research. During the American Civil War (1862–1870) he was surgeon to the Sixth Massachusetts Regiment of Volunteers. He died at his home in Lowell on 16 January 1883 at the age of 75 [41].

Gilman Kimball also served as a Brigade Surgeon in the American Civil War and was Medical Director to General Butler. Following his first successful operation at the Lowell Hospital he became Professor of Surgery at the Berkshire Medical Institute and the Vermont Medical College and was awarded an honorary MD at Yale College in Connecticut in 1856. In 1877 he was elected to Fellowship of the American Gynaecological Society and became President of that Society in1883. He died in his 88th year in 1892 [41].

The First Successful Abdominal Hysterectomy in Europe

Eugene Koeberle from Strasbourg was one of the greatest surgeons in Europe in the latter half of the nineteenth Century and the French usually claim that he performed the first successful hysterectomy in Europe. The operation was for fibroids and the diagnosis was correct and in order to obtain haemostasis he used a device of his own invention called a serre-noeud which was a wire loop tightened by a screw device (Fig. 1.11) that held the cervix like a clamp and allowed it to be exteriorised through the wound (Fig. 1.12). Eventually the avascular cervical stump necrosed and fell back into the pelvis [22]. This operation took place on 2 April 1863 and was certainly the first in Continental Europe but in his lecture to the Obstetrical Society of London Charles Clay had briefly mentioned a successful case of "the entire removal of the uterus and its appendages" which he had performed in Manchester a couple of months earlier on 3 January 1863 [37]. It would appear there-

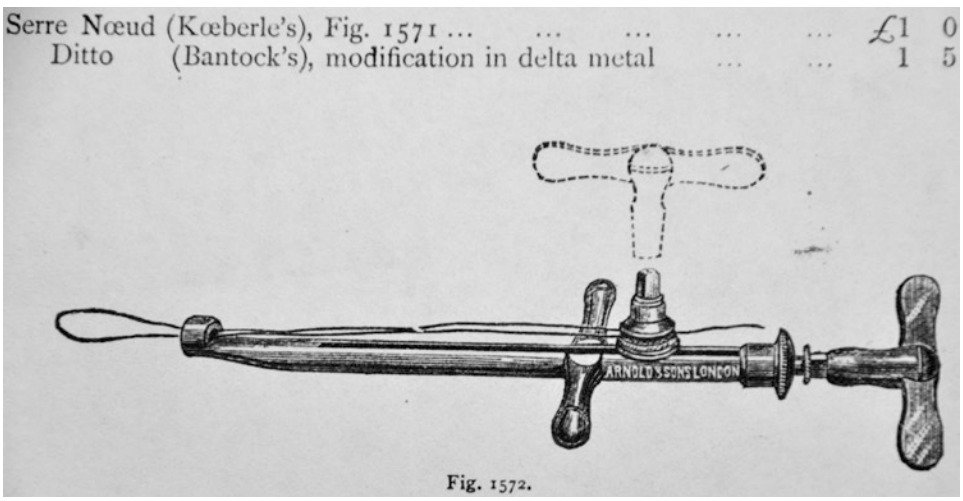


Fig. 1.11 The serre-noeud from a commercial catalogue of Arnold and Sons, Instrument Makers, London priced at £1 (1.38 Euros) (Photo by Chris Sutton. Company no longer in existence)

fore that the first successful hysterectomy in Europe was performed by an English surgeon albeit by only 3 months.

Anaesthesia was employed regularly and Lister had promulgated the theory of antisepsis and had devised a carbolic spray to prevent infection and peritonitis [42], although there is no actual reference in Clay's writings that he used these methods. In this particular case, which was deliberately undertaken to remove a uterine fibroid, he determined to cut through the cervix and not to open the vagina. The case is well authenticated by three doctors from Preston, Sheffield and Manchester, and immediately after the operation, Professor J Y Simpson, (Fig. 1.13) the inventor of chloroform,

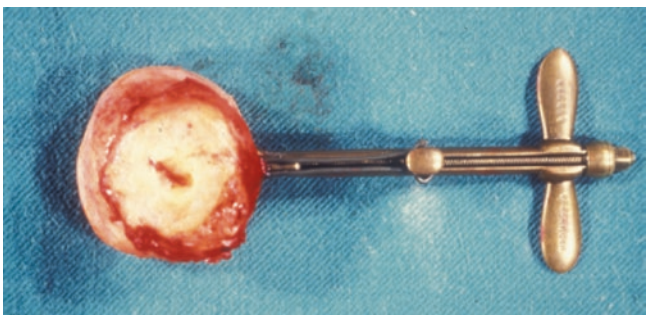


Fig. 1.12 The serre-noeud introduced by Koeberle of Strasbourg, who performed the first successful hysterectomy in continental Europe on 2nd April 1863 (Photo: Chris Sutton taken at St. Luke's Hospital, Guildford)



Fig. 1.13 James Young Simpson, Professor of Midwifery at the University of Edinburgh and inventor of chloroform and Simpson's Forceps (Photo: Chris Sutton from a contemporary portrait)

arrived unexpectedly from Edinburgh. He was greatly interested in the case and took the specimen back to Edinburgh from whence, some time later, he returned a description and a sketch, ending his letter with 'your case may turn out as a precedent for operative interference in some exceptional cases of large fibroids of the uterus and I congratulate you most sincerely on the happy recovery of your patient' [22].

James Young Simpson was the Professor of Midwifery in Edinburgh where he had enrolled in the University at the tender age of 14 initially to study the arts. He had difficulties with administering ether to patients in prolonged labour and sought an alternative solution by inventing chloroform [43] which could more easily be given as a small droplet inhaled on a handkerchief. He famously experimented on himself and his guests after a dinner party in his house, among them Matthew Duncan (of placenta fame) and George Keith, the brother of Thomas Keith (*vide infra*) and all the guests slid off their chairs and were found next morning soundly asleep on the floor.

He used it on many patients having prolonged painful labours and on children undergoing surgery but had to face criticism from religious objectors who quoted the Bible citing Genesis 3:16 '…. *in sorrow and suffering thou shal*t *bring forth children….'* With his wide knowledge of literature and the scriptures Simpson was able to quote back to them Genesis 2:21: ' *And the lord God caused a deep sleep to fall upon Adam, and as he slept he took one of his ribs and closed up the flesh instead thereof '* [44].

The criticism continued until Dr. John Snow successfully administered chloroform to Queen Victoria during the birth of Princess Charlotte and after this widely publicised regal event, ' *Chloroform à la Reine ',* the technique became widely accepted and for that and other contributions to Midwifery such as the design of Simpson's Forceps he was eventually made a Knight of the Realm [41].

Gynaecological Surgery in the Late Nineteenth Century

The initial mortality in these operations was extremely high since many of the early abdominal surgeons employed the long ligature hanging out of the lower part of the incision in order to allow the drainage of '*laudable pus'* from the peritoneal cavity, in much the same way as when they were amputating limbs in battlefield surgery. Charles Clay used the long ligature procedure throughout his career but Lawson Tait, (Fig. 1.14) of Birmingham, the first surgeon to successfully operate on an ectopic pregnancy, believed that if the ligature was short and the wound completely closed, the mortality rate would probably fall to 6 or 8 %. Such results were achieved by Isaac Baker Brown who cauterized the ligated ovarian pedicle before closure of the abdominal wound on 40 patients with

only four deaths. He was a Consultant Gynaecological Surgeon at London's greatest teaching hospital, St. Mary's Hospital in Paddington (Fig. 1.15) and sadly went the way of so many in the medical profession in the past. He somehow went off at a tangent and in 1865 published a paper on 'The cureability of some forms of insanity, epilepsy and hysteria by clitoridectomy' [45]. Unfortunately, he also advertised the success of this procedure and as a result he fell from grace and was expelled from the Obstetrical Society of London and died in obscurity [46]. Because of this, his technique of ovariotomy failed to be adopted and it fell to Thomas Keith, an apprentice of James Young Simpson, to rediscover this manoeuvre.

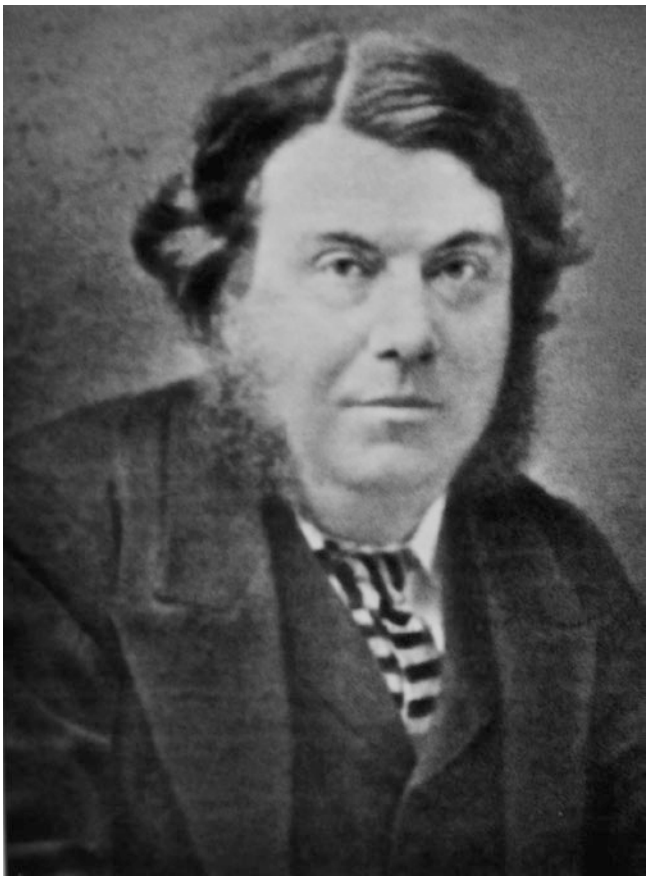


Fig. 1.14 Lawson Tait from Birmingham , an industrial city in the Midlands of England was one of the greatest surgeons of his generation and had a low mortality due to rigorous attention to cleanliness and aseptic principles (Figure reproduced courtesy of Jaypee Brothers Medical Publishers, India)

Dr. Keith Ends the Dark Period of Appallingly High Mortality

Thomas Keith was probably the greatest analytical surgeon in our speciality during the late nineteenth-century. He was a wild looking man, born in the Manse of St. Cyrus, near Montrose in the Scottish Borders and was a lifelong sufferer from cysteine stones for which he required many operations which probably accounts for his rather startling appearance (Fig. 1.16). Thomas Keith performed his first ovariotomy in September 1862, but his initial mortality was high. This was around the time that Lister was advocating antiseptic surgery, although Keith found that the carbolic spray did not help to reduce his operative mortality. He therefore turned his attention to the method of wound closure, abandoning the long ligature and exteriorized clamp that Koeberle and, later, Spencer Wells (Fig. 1.17) had popularized and instead cauterized the pedicle and dropped it into the peritoneal cavity, which he then drained.

He was also a vigorous opponent of the technique of blood-letting, and out of 156 cases reported only six deaths (3.8 % mortality). His hysterectomy results were no less impressive and by the time he left Edinburgh for London he had recorded 33 cases with only three deaths [22].

Appalling results were achieved by Spencer Wells, a society dilettante who considered himself the greatest

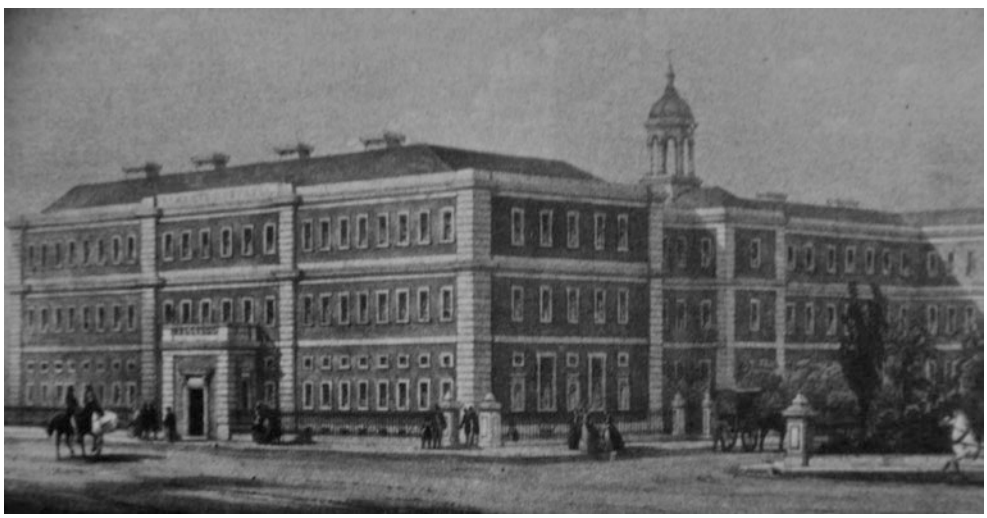


Fig. 1.15 The original St. Mary's Hospital, London in the nineteenth century. Where Isaac Baker Brown and Thomas Spencer Wells worked as Consultant Gynaecological Surgeons and the room on the corner of the second floor was the laboratory of Alexander Fleming where he discovered penicillin (Courtesy of the Archivist of St. Mary's Hospital, London)

gynaecological surgeon in Europe at that time and drove from hospital to hospital in London in his 'brougham and four silver grey horses' and produced results that were appalling and out of 40 hysterectomies performed for fibroids, there were 29 deaths–a mortality rate of 73 % [47].

His poor results were vigorously criticized in public by Charles Clay and he was joined in his disapproval by Lawson Tait, a rather aggressive Surgeon from Birmingham in the Midlands. Tait loathed Spencer Wells, and found that despite using the carbolic spray he still had a 38 % mortality with his first 50 ovariotomies. He then realized that it was not the spray that had given Keith his excellent results (indeed there is no evidence that Keith ever used it) but the intra-peritoneal method of dealing with the pedicle. He immediately adopted this technique, abandoned the carbolic spray and of his next 73 patients only two died – a remarkable achievement at that time. Lawson Tait also learned the value of cleanliness from both Lister and Keith that was unusual in those days, as no surgeons wore gloves and very few washed their hands before operating. He also preferred to operate in the home of the patient because hospitals at that time, and sadly now, are riddled with infection and before closing rinsed the abdominal and pelvic cavity with sterile water.

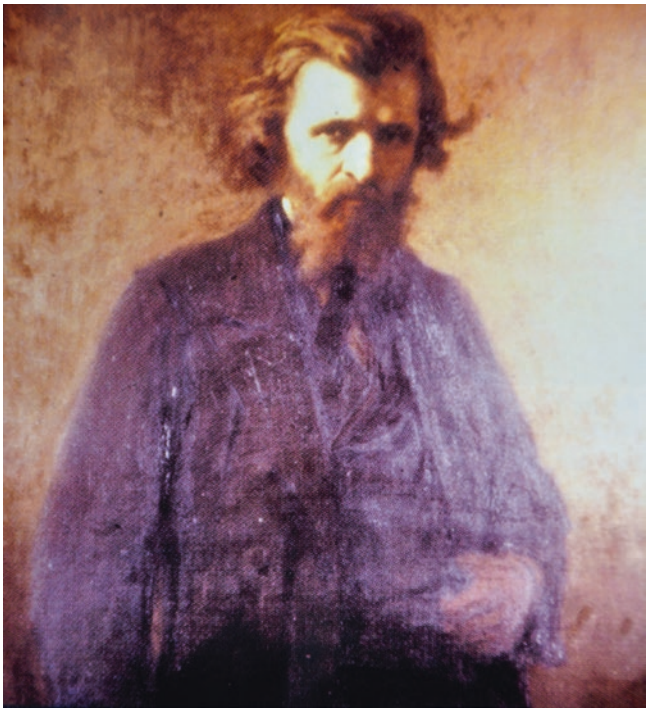


Fig. 1.16 Thomas Keith from Melrose, Scotland, who drastically reduced the mortality and morbidity of hysterectomy by his treatment of the cervical stump (Figure reproduced courtesy of Jaypee Brothers Medical Publishers, India)

Lawson Tait was a formidable character in the history of gynaecological surgery and was without doubt one of the most audacious and talented surgeons of his generation. He was aggressive and opinionated and successful and, as is often the case with large men of short stature, he was arrogant but often right. As can be seen from Fig. 1.14 his physical appearance was remarkably similar to that of Sir James Young Simpson (Fig. 1.13) with whom he lived after entering Edinburgh University at the tender age of 15 and also assisted him with his operations when still a teenager. Since Lawson Tait was born in Edinburgh in 1845 at the time of antidisestablishmentarianism when many clergymen were on strike against the idea of disestablishment of the church so no birth certificates were issued at this time thus fuelling speculation that Lawson Tait was the illegitimate son of JY Simpson [22].

Tait was prominent in the movement to start the Birmingham and Midland Hospital for Women and established many 'firsts' in gynaecological surgery including the first successful treatment of ectopic pregnancy in 1881, the first oophorectomy for sepsis, first bilateral oophorectomy for intractable menorrhagia as well as the removal of hepatic hydatid cysts and an appendicectomy in 1880.

Not only was he a gifted surgeon but he wrote more than 200 scientific papers and several books and also produced leading articles in the *Birmingham Morning News* and was

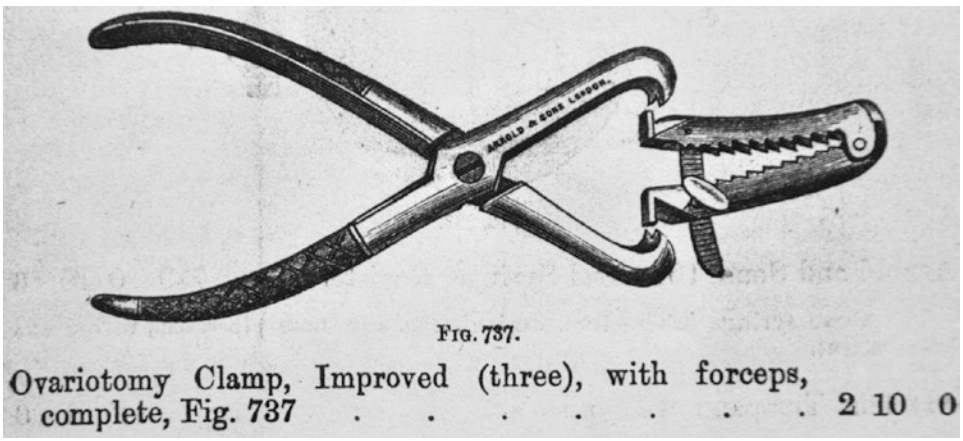


Fig. 1.17 The Spencer Wells Ovariotomy Clamp from a commercial catalogue of Arnold and Sons, Instrument Makers, London priced at £2.10 (2.80 Euros) (Photo by Chris Sutton. Company no longer in existence)



Fig. 1.18 Jules Pean, a renowned French gynaecological surgeon performing an early hysterectomy before a crowd of spectators in Paris. Note the absence of gloves and masks (Figure reproduced courtesy of Jaypee Brothers Medical Publishers, India)

elected to the Birmingham Town Council but was unsuccessful in his bid to be elected as a Member of Parliament. He founded and became the first President of the Medical Defence Union to counter the growing number of litigation cases against doctors. He was appointed Professor of Gynaecology at Queen's College in Birmingham and founded the British Gynaecological Society and was the first President in 1886.

He lived well and ate, drank and smoked excessively and was enormously successful and very wealthy owning two mansions and two luxury yachts and his own nursing home for his private patients. In the end this proved to be his undoing since he personally employed several nurses who were sexually attractive and it is alleged that three of them became pregnant by him and one of them cited him in a paternity case and at the same time he lost a libel case. Such behavior was not tolerated in times of strict Victorian prudery and his fall from grace was swift and coincided with declining health due to chronic pyelonephritis. He became anuric and died in Llandudno in North Wales after smoking his last cigar '… a very good Laranga - and the last I shall ever smoke'. Lawson Tait was cremated and his ashes laid in Warriston Cemetery, Edinburgh close to the grave of James Young Simpson [41].

The early hysterectomies were sociable affairs and it was considered good form to bring along friends, both medical and non-medical, to witness these momentous surgical events. Figure 1.18 shows the legendary French surgeon Jules Pean operating. There are a large number of onlookers, many wearing beards and Pean himself wears neither a mask nor surgical gloves. Since this operation occurs in a Paris Hospital the painter has been given a certain amount of artistic liberty in allowing the lovely French patient to display her *très jolie poitrines* whilst the anaesthetist, in keeping with modern practice, appears to be busy with the crossword puzzle.

Table 1.2 A summary of the hysterectomies performed for fibroids (1880–1884)

Operator	Date	Cases	Deaths	Mortality (%)
Lawson Tait	1882	30	10	33
Spencer Wells	1882	40	29	73
Koeberle	1882	19	10	52
Schroder	1884	100	32	32
Pean	1881	51	18	35
Keith	1883	25	2	8

Lawson Tait summed up the end of this rather dark era in gynaecological surgery as "the ovarian tumour was the battlefield whereupon the first abdominal engagements were fought. Whereas ovariotomy undoubtedly opened the gateway to abdominal surgery, Spencer Wells by his outmoded technique and resultant mortality of 73% for abdominal hysterectomies undoubtedly held back progress, because no one would submit women to such fearful risk unless life were already threatened. Dr Thomas Keith ended this dark period by showing us how to operate on the abdomen without fear and with little risk" [27]. (Table 1.2).

Refinements of Technique at the End of the Nineteenth Century

The latter years of the nineteenth century witnessed further development and technique for abdominal hysterectomy which was refined and standardised by Freund who performed the first successful abdominal hysterectomy for cervical cancer and was the first German surgeon to use Lister's Carbolic Spray [48]. Czerny following Langenbeck's original description, did the same for vaginal hysterectomy [49].

The first planned hysterectomy performed on a gravid uterus took place in 1876 and was performed by Porro from Milan in Italy [50].

In spite of advances in anaesthesia and antisepsis in the latter part of the nineteenth century the incidence of fatal haemorrhage and peritonitis remained high. Eduardo Porro (1842–1902) was an analytical surgeon who reviewed his own cases of contracted pelvis, mainly from rickets, and after experimental operations on pregnant rabbits and cadavers offered an alternative solution by removing the uterus after delivering the baby by caesarean section. He sutured

the cervical stump to the abdominal incision thus diverting the potentially septic contents of the cervix and vagina away from the peritoneal cavity. He performed this operation at his clinic for the first time on 21 May 1876 when he was presented with a rachitic primigravida in obstructed labour with a true conjugate of 4 cm and the woman survived and left hospital with her baby 6 weeks later [51].

For a time after his publication this approach found favour but later Ferdinand Kehrer and Max Sänger found that careful suture allowed the uterus to be reconstituted and allow for its conservation [52]. With the introduction of specially modified instrumentation, anaesthesia and antisepsis, the mortality rate for vaginal hysterectomy dropped precipitously and by 1886 was approximately 15 %; by 1890 it had reached 10 % and by 1910 it was as low as 2.5 %.

Unfortunately, abdominal hysterectomy lagged far behind and even as late as 1872 the mortality was so high that the procedure was formally condemned by the Academy of Medicine in Paris. In spite of this it was still performed though more often for fairly tenuous indications such as the relief of menstrual hysteria and 8 years after this pronouncement from Paris, TG Thomas reported on 365 consecutive cases with a mortality of 70 % [53].

In spite of these disastrous results, progress in abdominal hysterectomy was being made. Mikulicz abandoned the *serre-noeud* after using it for 13 years and instead placed triple ligatures on the broad ligaments and tied them off separately [53].

In 1878, Freund introduced techniques for packing off the intestines, ligating the major blood vessels and covering the cervical stump with peritoneum, which, in the same year, had been practised independently by both Schroeder and Spencer Wells.

In 1889 Lewis Stimpson had advocated the systematic ligation of the main ovarian and uterine vessels separately rather than tying off the entire broad ligament in one large ensnaring suture, and 3 years later Bare, of Philadelphia, the father of the modern subtotal hysterectomy, tied the uterine vessels 'outside of, but close to, the cervix'. He was also the first to advise gynaecological surgeons to 'take care' to avoid the ureter [54] then described an immaculate technique for subtotal hysterectomy little different from that employed today. Thus in the space of one decade, exterior fixation of the cervix by the *serre-noeud*, the Spencer Wells clamp or long ligature had been replaced by the intraperitoneal treatment of the cervical stump, which itself was modified and became extraperitoneal again, by covering the stump with pelvic peritoneum. These new techniques are reflected in the dramatic fall in mortality shown in the figures from the London teaching hospitals in 1896 and 1906 showing an impressive drop in mortality from 22 to 3.5 % [54] (Table 1.3).

Table 1.3 A summary of the abdominal hysterectomies performed for fibroids in London Teaching Hospitals (1896 and 1906)

	1896		1906	
Hospital	Cases	Deaths	Cases	Deaths
St Bartholomew's	7	3	26	4
St George's	1	0	8	0
St Thomas'	5	2	40	2
Middlesex	6	1	50	0
University College	3	0	21	1
Soho Hospital	1	0	60	1
St Mary's (Samaritan)	17	4	37	2
Chelsea	9	1	80	1
Total	49	11 (22 %)	322	11 (3.4 %)

Radical Hysterectomy for Cervical Cancer

Radical hysterectomy for cervical cancer was first performed by Dr. John G Clark of the Johns Hopkins Medical School in Baltimore in the United States of America who published details of two cases in which all of the parametra were removed [55]. The operation was refined by the addition of lymphadenectomy in certain cases and popularised by Ernst Wertheim (Fig. 1.19) the famous Austrian gynaecological cancer surgeon from Vienna, after whom the operation is now somewhat unfairly named [56]. Clark at the time was a 28 year old second year resident in gynaecology and had made a careful pathological study of cervical cancer and found that in most specimens that he examined the broad ligaments were cut too close to the uterus and too small a portion of the vagina had been removed [57].

Ernst Wertheim (1864–1920) was born in Graz in Austria and worked as assistant to Friedrich Schauta at the German University in Prague and later they moved to Professorial Chairs at the First and Second University Departments of Obstetrics and Gynaecology in Vienna, initially on an amicable basis but later disagreed due to the inability of Schauta's Radical Vaginal Hysterectomy to adequately remove the lymph nodes even though the vaginal approach was undoubtedly safer [58]. Even with the enlarged perineal relaxing incision introduced by Karl Schuchardt (1856–1901) who, like Ossiander and Langenbeck came from Gottingen, there was sufficient view to remove the parametrium but it was still not possible to remove all the involved lymph nodes [59]. Karl Schuchardt became a Professor at Stettin State Hospital but sadly died at the young age of 45 from sepsis following a surgical needle stick injury in the same way as Semmelweiss a few years later.

Ernst Wertheim performed his first radical abdominal hysterectomy and pelvic lymphadenectomy on Madame Rudd on 16th November 1898. He had carefully studied the



Fig. 1.19 Ernst Wertheim, Professor of the First Gynaecology Clinic of the University of Vienna, who ultimately performed 1300 radical hysterectomies with complete follow up (Photo courtesy of RCOG Press, London)

pathology and usual mode of lymphatic spread of cervical cancer and the procedure was based on an operation designed in 1878 by William Alexander Freund of Breslau who had carried out 66 radical operations with appalling results that included 55 deaths which occurred during the operation. These were mainly due to haemorrhage since this was before the introduction of blood transfusion since Landsteiner, from Vienna, only discovered the first four blood groups in 1900 [7].

The mortality rate in Wertheim's first 100 patients was high at 30 % [60] but as time went on his technique improved and when he had performed 500 radical hysterectomies the mortality rate had dropped to 19 % [61]. In those days there were no trained anaesthetists and patients died of shock due to the length of the procedures as well as blood loss and some were so feeble they were unable to bear the strain of the operation. In addition there were ureteric injuries, vesico-vaginal fistulas, pyelonephritis and recurrences. In those pre-antibiotic days there was still a high mortality from peritonitis and sepsis from the abdominal wound. It has to be said however that the infection rate could have been lowered had Wertheim adhered to some of the aseptic principles used by Keith and Lawson Tait because although surgical rubber gloves were available since 1900 Wertheim refused to wear them since he claimed they interfered with his sense of touch.

During his visit to London to deliver a lecture at the Royal College of Obstetricians and Gynaecologists a Consultant Gynaecologist from one of the poorer communities in the East End of London asked him to operate on a suitable patient with cervical cancer. Wertheim agreed and they set off for the hospital in their horse-drawn carriages and Wertheim examined the patient and later demonstrated his technique of radical hysterectomy. At one stage he needed an extra assistant and one of the junior doctors who was performing a post-mortem in the mortuary was summoned to come up to the operating theatre to help. As was the custom in England at the time the young doctor started to wash his hands prior to putting on a gown and surgical gloves but Wertheim admonished him and told him that was not necessary since he was needed immediately to assist in the surgery. The patient survived the operation but died 5 days later from peritoneal sepsis.

Ernst Wertheim was an expert skier and skater and once crossed the Alps in a hot-air balloon. He was prone to bouts of depression and was a difficult man to deal with and had an abrupt and defensive demeanour. He died at the age of 56, a victim of the pandemic of Spanish Influenza, and was buried in the Vienna City Cemetery next to the grave of Friedrich Schauta [41].

The Development of Hysterectomy in the Twentieth Century

As late as the mid-1940s the universal approach to hysterectomy was the subtotal procedure which involved retaining the cervix with the reduced chance of pelvic infection and ureteric injury but mainly, in the pre-antibiotic era, to reduce the chance of ascending infection and peritonitis, which was almost invariably fatal. Once the problem of ascending infection and peritonitis had been eradicated by the development of antibiotics, hysterectomy almost invariably included removal of the cervix.

The first total hysterectomy was performed by E.H. Richardson of the USA in 1929 [62]. His main concern in moving away from the traditional subtotal procedure, was to prevent the occurrence of cervical stump carcinoma, yet even in the days before cervical screening with Papanicolaou smears was available, the actual incidence of neoplastic change in retained cervical stumps was only 0.4 % in 6600 cases in the USA [63] and only 0.1 % in Finland [64]. As Thomas Lyons from Atlanta, Georgia, USA , a keen advocate

of laparoscopic subtotal hysterectomy has pointed out, this is similar to the rate of vaginal cancer following total abdominal hysterectomy and yet no one has seriously recommended the removal of the vagina at hysterectomy as prophylaxis against this [65].

During the past 100 years the introduction of antibiotics, intravenous therapy, anticoagulation, safe anaesthesia and blood transfusion has reduced the mortality for both vaginal and abdominal hysterectomy to around 0.1 %. There has also been a concomitant reduction in morbidity, reflected by a shorter hospital stay and the use of the transverse incision introduced by Johannes Pfannenstiel from Breslau in 1900 which gives a stronger and better cosmetic result [66]. Nevertheless, it took many years for this incision with its higher tensile strength making it less prone to wound dehiscence and incisional hernia, to gain universal acceptance.

Hermann Johann Pfannenstiel (1862–1909) received his medical degree from the University of Berlin and later moved to the Breslau Frauernklinic then to the University of Giessen and in 1907 became Chairman of the University Department of Obstetrics and Gynaecology at Kiel University where he remained until his premature death. Sadly Pfannenstiel died at the age of 47 following a needle-stick injury to the middle finger of his left hand sustained during the removal of a tubo-ovarian abscess [41].

Other famous surgeons including Karl Schuchardt, who was also from Breslau, had died at a relatively early age from similar injuries and it is salutatory to note that these injuries are not uncommon during various surgeries, and many doctors would have suffered a similar fate were it not for the revolutionary, but accidental, discovery of penicillin by Alexander Fleming at my own teaching hospital, St Marys Hospital in London.

Increased surgical skill and prowess from an apprenticeship type of training has ensured that the operation now is extremely safe with an incidence of ureteric injury of 0.2–0.5 % and a mortality of 0.12 % [67, 68].

The advent of prophylactic anticoagulants and antibiotics has further increased the safety of this procedure. Dicker et al. showed the superiority of vaginal hysterectomy (morbidity, 24.5 %) compared with abdominal hysterectomy (morbidity, 42.8 %). Although these statistics appear favourable to the vaginal approach they are, in fact, an eloquent testimony to the efficacy of prophylactic antibiotics, since those who had a vaginal hysterectomy had the benefit of these drugs, whereas those who had an abdominal hysterectomy did not [69].

Inevitably the increased safety of the operation with a mortality rate of approximately 12 per 10,000 led to an explosive increase in the number of hysterectomies performed so that it is now the second most common operation undertaken in the USA with over 650,000 being performed annually at a cost of approximately three billion dollars. With this increased safety the indications for the procedure had become wider, to the extent that up to 50 % of American women at the end of the past decade underwent hysterectomy [70]. Not only had the procedure become open to a certain amount of abuse, but technological advances, apart from endometrial ablation and embolization of fibroids, had largely by-passed hysterectomy and up until the mid part of twenty-ninth century, gynaecological surgery was in the doldrums.

The Modern Era: The Introduction of Laparoscopic Surgery

During the middle part of the twentieth century apart from a more conservative approach to the treatment of ovarian cysts and fibroids and the surgical refinements in instrumentation and technique introduced by tubal microsurgeons, few technical advances were made in gynaecological surgery.

A revolution in surgical technique could not occur until a different way of accessing the peritoneal cavity was invented and essentially this involved a method whereby the contents of the abdominal cavity could be visualised.

In 1901 Dr. Georg Kelling (Fig. 1.21) who was a Professor in Dresden in an address he gave to the German Biological



Fig. 1.20 Hans Christian Jacobaeus of Stockholm.The first person to perform laparoscopy on humans (Photo from the Archives of the Minimal Access Therapy Training Unit, Guildford, UK)

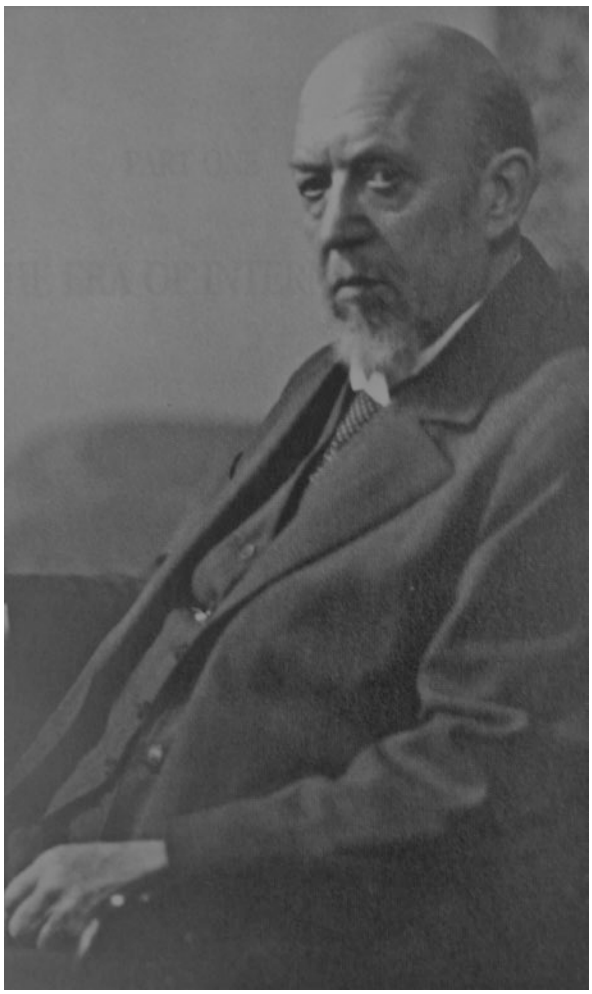


Fig. 1.21 Professor Dr. Georg Kelling (1866–1945) of Dresden, one of the "fathers of laparoscopy" (Photo by Chris Sutton from an original supplied by Prof. Dr. Liselotte Mettler)



Fig. 1.22 Dr. Raoul Palmer from Paris. Generally considered the " Father of Operative Laparoscopy" (Photo by kind permission of the late Mme Elizabeth Palmer)

and Medical Society in Hamburg described the visual examination of the stomach and oesophagus in the human and additionally the use of a cystoscope to visualise the viscera of a dog using air filtered through cotton wool to produce a pneumoperitoneum [71].

In that same year of 1901 von Ott from Saint Petersburg in Russia published a different technique of viewing the pelvis of a pregnant woman by way of culdoscopy through an incision in the posterior vaginal fornix and using as his light source reflected light from a head mirror. He called this technique Ventroscopy [72].

However the credit for the first true laparoscopy on a human goes to Hans Christian Jacobaeus (Fig. 1.20) from Stockholm who coined the term 'laparoscopy' and in 1910 described his technique for the inspection of the human peritoneal, thoracic and pericardial cavities [73]. Only 1 month later Kelling reported a series 45 laparoscopies and described the appearance of the liver, tumours and tuberculosis.

Laparoscopy became popular mainly with general physicians or internists for the diagnosis and treatment of tuberculosis and liver disease and to them must go the credit for the development of laparoscopy over the next 40 years [74].

This changed radically with the introduction of laparoscopic surgery by pioneers in Europe such as Raoul Palmer (Fig. 1.22) in Paris [75] and Hans Frangenheim in Konstanz [76] in the 1940s but such advances were hampered by the lack of communication across the Atlantic during the Second World War and the Americans, although using laparoscopy in the 1930's, had mysteriously reverted to culdoscopy for visualization of the pelvis. It required the publication of the first text book on this new technique in the English language in 1967 by Patrick Steptoe (Fig. 1.23) one of the pioneers of In-Vitro Fertilisation, working in a small district hospital in Oldham, near Manchester in Lancashire, to allow the widespread dissemination of this new technique to the English speaking world after he had learned the technique from Frangenheim and Palmer in Continental Europe [77].

Initially laparoscopy was used for diagnosis and relatively simple therapeutic procedures such as female sterilisation and puncture or fenestration of benign ovarian cysts but gradually became more sophisticated owing much to the



Fig. 1.23 Patrick Steptoe from Oldham, near Manchester, England, One of the pioneers of In-Vitro Fertilisation who wrote the first book in English on Laparoscopy (Photo supplied by the late Patrick Steptoe)

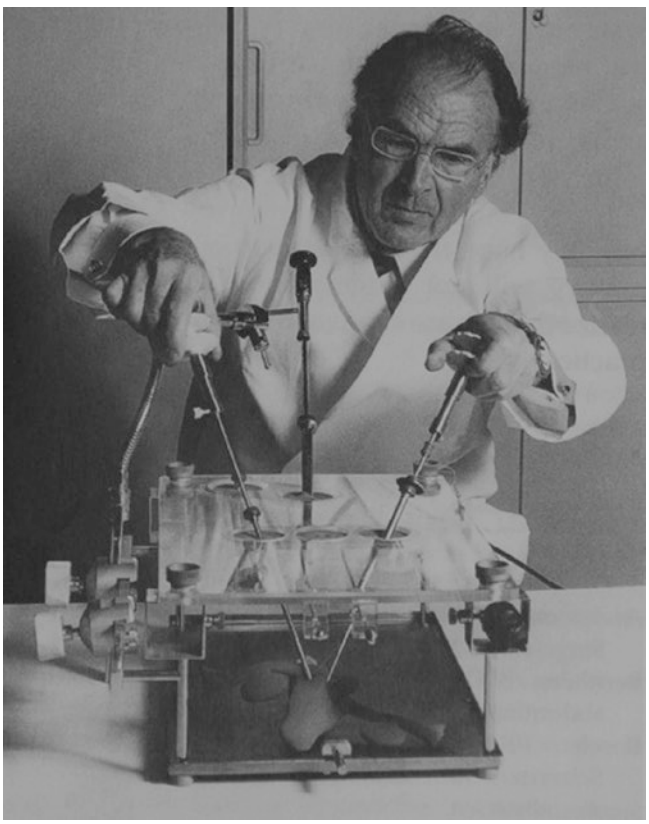


Fig. 1.24 Professor Kurt Semm from Kiel one of the great advocates and teachers of laparoscopic surgery and an inventor of much of the original equipment (Photo taken by Chris Sutton on a visit to the Minimal Access Therapy Training Unit in Guildford, UK)



Fig. 1.25 Professor Maurice Bruhat from the University of the Auvergne in Clermont Ferrand in France who performed the first laparoscopic removal of an ectopic pregnancy with Dr. Hubert Manhes (Photo given to Chris Sutton by the late Maurice Bruhat)

pioneering work of Professor Kurt Semm (Fig. 1.24) of Kiel University in Northern Germany who could claim to have performed the first Laparoscopic Hysterectomy using the CISH (Classic Intrafascial Supracervical Hysterectomy technique using the SEMM (Serrated Edged Macro Morcellator) [78, 79] although this would not be strictly classified as a total laparoscopic hysterectomy[80].

Professor Maurice Bruhat (Fig. 1.25) and Hubert Manhes and their gifted team from the University of Clermont Ferrand in the Auvergne in the Massif Central in France were a major influence on the development of laparoscopic surgery and were the first to treat ectopic pregnancy laparoscopically[81].

By the 1980s, minimally invasive surgery had become a reality but for a long time gynaecologists struggled with primitive equipment relying on advances in laser technology and electrosurgical devices to achieve cutting and coagulation. This was before the time of disposable instruments and self-sharpening scissors and it was necessary to return laparoscopic scissors to the factory and wait several weeks whilst they were sharpened.

The advent of laparoscopic cholecystectomy and its rapid uptake by our general surgical colleagues enabled industry to see the full potential of this new type of surgery and there were rapid developments in the quality of instrumentation and

sophistication in optics with the introduction of the rod lens system and external cold light source by Professor Harold Hopkins [82] of Reading University in the UK and later with the development of silicone chip cameras and high resolution television monitors to enable surgeons to operate comfortably and to usefully employ assistants to help with the operation.

In a remarkably short time these techniques were adopted universally to the extent that at least 80 % of gynaecological operations can now be performed using endoscopic techniques with several small incisions for the access of surgical instruments resulting in less pain, shorter hospital stays and rapid recovery compared with conventional laparotomy [83]. Nevertheless these techniques required special visual skills and hand-eye coordination which can not be achieved by all surgeons and the universal uptake of minimal access surgery, which was so confidently predicted in the 1990s, has not become a reality and conventional techniques are still employed by the majority of practicing gynaecological surgeons in the UK and USA although the adoption of this surgical revolution has been more successful in France and Germany.

Dr. Reich Performs the First Total Laparoscopic Hysterectomy

With the increasing skill of laparoscopic surgeons and the sophistication of the equipment laparoscopic operations became increasingly complex and it was only a matter of time before the first total laparoscopic hysterectomy was performed and this was in the Autumn of 1988 at the William Nesbit Memorial Hospital in Kingston, Pennsylvania by Dr.Harry Reich (Fig. 1.26). He published a description of this technique the following year [84].

The original operation proposed by Reich was an impressive display of technical virtuosity since the whole procedure was performed laparoscopically, including dissecting out part of the ureter and individually ligating and tying off the uterine artery and veins with extracorporeal sutures. He also performed the colpotomy incision laparoscopically in order to remove the uterus and repaired it with laparoscopic sutures. As a routine at the end of all advanced laparoscopic procedures he performs a cystoscopy, after injection of Methylene blue dye, to check that there had been no damage to the ureters.



Fig. 1.26 Dr. Harry Reich who performed the world's first Total Abdominal Hysterectomy at the William Nesbit Memorial Hospital, Kingston, Philadelphia in October, 1988 (Photo by Chris Sutton)

After the success of his first total laparoscopic hysterectomies he toured the United States demonstrating this new operation and then travelled the world, demonstrating it in the different countries that practiced laparoscopic surgery at that level. He performed the first demonstration in the UK in my own Department at the Royal Surrey Hospital in Guildford and I had the honour of being able to act as first assistant. The patient did extremely well and went home the following day with little pain and required only mild analgesics such a paracetamol and ibuprofen and was able to return to work 2 weeks after the operation. Nevertheless the procedure took five and a half hours occupying an entire morning operating session in which we would normally be expected to perform five or six laparoscopic operations of various types and difficulties.

At around this time I was performing about 35 laparoscopic operations per week whereas various American surgeons I had spoken to performed only 2–3 so clearly this procedure was more suited to a private based medical system than the socialised healthcare system operating in most European countries [85].

Laparoscopic hysterectomy was designed to replace abdominal hysterectomy and if a vaginal hysterectomy could be performed then that was clearly the minimal access procedure of choice. Nevertheless the original total laparoscopic hysterectomy (TLH) was too complicated and time consuming and required a very high level of laparoscopic skills so was soon replaced by many surgeons with the laparoscopic assisted vaginal hysterectomy (LAVH) whereby the upper pedicles were ligated, electrocoagulated or stapled while the remaining part of the operation was performed as a routine vaginal hysterectomy. It soon became evident that none of the laparoscopic part of the operation did anything to make the vaginal approach easier and because there is no descent until the utero-sacral and cardinal ligaments are transected. Most surgeons found that, with the limited access involved, the procedure became a very difficult vaginal hysterectomy. Cynics pointed out that this was in fact a complicated way of performing a vaginal hysterectomy, but it certainly had the advantage of honing vaginal surgical skills and allowed dissection of bowel adhesions laparoscopically, as well as the treatment of any existing endometriosis, particularly deep infiltrating endometriosis in the recto-vaginal septum, and the easier removal of ovaries where this was indicated.

It also had the advantage that the internal incision could be inspected at the completion of the procedure and any residual bleeding vessels could be sealed by bipolar diathermy ensuring at the end of the procedure the field was absolutely dry. Theoretically this had the advantage of preventing secondary haemorrhages occurring a few days later and preventing subsequent haematoma formation but in reality this was not always achieved.

Advances in instrumentation such as the ultrasonic scalpel, more effective techniques to coagulate large vessels using plasma kinetic energy and ingenious uterine manipulators and vaginal tubes to delineate the vaginal fornices have led some surgeons to persevere with the total laparoscopic approach and in recent years the time taken to perform these procedures has been considerably decreased but it remains a difficult procedure and one that can only really be performed by highly trained laparoscopic surgeons with a high level of skill.

These various criticisms led some laparoscopic surgeons to search for a simpler approach that could be universally employed by laparoscopic surgeons who had slightly lower skill levels or who were required by hospital administrators to perform the operation in a much shorter time and also discharge patients earlier, preferably on a day case basis. The simplest way to do this was to devise a simpler procedure that avoided any possibility of a secondary haemorrhage from the vaginal vault after the patient had left hospital and this meant performing a laparoscopic version of the outmoded subtotal hysterectomy.

Development of Laparoscopic Subtotal Hysterectomy and Introduction of New Laparoscopic Instrumentation for Hysterectomy

In 1993 Semm developed the intra-fascial laparoscopic supra-cervical hysterectomy with a technique of coring out the whole of the transformation zone and the central core of the uterus using a macro-morcellator with a serrated edge reamer turned manually in a clockwise direction to achieve cutting. The idea of this was to remove the entire transformation zone to avoid the subsequent development of cancer and also to decrease the chance of post-operative bleeding and monthly sero-sanguinous discharge [86, 87].

In 1991, we published our initial experience of supracervical laparoscopic hysterectomy and removal of the transformation zone using a modification of Semm's technique using the artificial sapphire tip of an ND-YAG laser (Laserscope, Cwmbran, UK) and endocoagulating the vaginal aspect of the cervical stump at the end of the procedure. Our technique also differed from the one described by Semm because he used sutures to secure the vascular pedicles whereas we used the Endo GIA 30 stapler (Autosuture Ltd., Ascot, UK) which was quick and effective and in those patients where it was not technically possible to secure the uterine vessels with the device, we used bipolar diathermy [88]. The mean operating time in our small series of eleven procedures was 111 min, with a mean blood loss of 185 ml. The mean duration of hospital stay was 3 days and the mean time to full recovery was 20 days and there were no complications. The reason for the long operating time was due to the fact that the SEMM (Serrated Edged Macro-Morcellator) was a manual device requiring long and arduous rotation and several of my Residents developed an occupational disease unique to laparoscopic surgical assistants – morcellator's thumb. This condition, which fortunately was only temporary, was due to injury to the peroneal nerve to the thumb causing numbness and hyperaesthesia in the skin distribution of that nerve.

Lyons [89] described a slightly different technique of laparoscopic supracervical hysterectomy also using the artificial sapphire tip of the ND-YAG laser but he did not merely coagulate the ascending branches of the uterine arteries, but actually included the main branch of the uterine artery and divided the utero-sacral ligaments making an inverted cone through the cervix, also removing the transformation zone but effectively leaving only the rim of the cervix. This was a slightly more radical procedure but almost certainly resulted in less long-term problems involving bleeding or serosanguinous discharge from the cervical stump [90, 91]. The team from UCH-Louvain in Brussels published a large series of 500 cases which also used the Nd:YAG laser to cut across the cervical stump but removed the transformation zone by a large loop electrosurgical excision in much the same way as that used for the removal of the transformation zone when treating cervical intra-epithelial neoplasia [92].

Further refinements have been made in recent years with the introduction of the Lap-Loop™ (Medsys, Gembloux, Belgium) invented by Jacques Dequesne in Lausanne [93]. whereby an electric wire loop is threaded around the cervix once the ascending branches of the uterine artery have been coagulated and cut and the bladder pushed down slightly. After making sure that there is no bowel close to the wire posteriorly, a 100–120 W cutting current is applied and the "noose" formed by the wire is slowly tightened as the heated wire slices through the tissue coagulating many small vessels and providing a very effective method of rapidly severing the cervix from the uterine fundus. In a study comparing the loop device with conventional methods (laparoscopic monopolar scissors or ultrasonic scalpel) the mean time for detaching the cervix from the fundus with the loop electrode was 6.6 min compared with 14.4 min in the control group [94].

Further advances have been made with more effective laparoscopic ligation instruments to effectively seal even large arteries and veins (Ligasure, Covidien Commercial Ltd., Gosport, UK; Enseal· Ethicon Endo-Surgery, Edinburgh, UK; Plasma Kinetic energy system, Olympus, KeyMed Ltd.,

Southend, UK; Gyrus International, Berkshire,UK) thus reducing the risk of secondary haemorrhage from major vessels and with the decreased operating time makes laparoscopic sub-total hysterectomy eminently suitable for day case surgery.

Some of these recently introduced electrosurgical devices that operate in a liquid field use the word plasma when describing their *modus operandi* but in reality use radiofrequency electrosurgery via specially designed bipolar electrode systems to seal vessels. Examples of this is the so-called PlasmaKinetic technology used in the Olympus (Gyrus ACMI) Plasma-Knife and the ArthroCareCoblation device, which only generates non-thermal plasma within the tiny bubbles formed in the fluid on the surface of their electrodes but in reality relies on basic electrosurgery for its tissue effect. Another new device, the Peak PlasmaBlade may generate a non-thermal plasma at the interface of the handpiece blade with the tissue or fluid medium in which it is used but, notwithstanding this, it is the rapid pulses of high-voltage energy that create the surgical effect [95]. All of these devices allow rapid sealing of large vessels and allow a new generation of gynaecological surgeons to dispense with the need for traditional sutures. It remains to be seen whether these new vessel sealing devices will have a wider application and increase the uptake of vaginal hysterectomy or if they are only used by laparoscopic surgeons because traditional abdominal and vaginal surgeons seem to have more faith in traditional sutures to seal vessels. Virtually all of these vessel sealing devices are single use only and add considerably to the cost of the procedure although they contribute to a shorter operating time.

The remaining problem is the removal of the detached fundus which can be via a colpotomy incision but this adds to the complexity and difficulty of the operation. High speed electromechanical morcellators such as the Gynecare X-Tract Ethicon Inc., Somerville, New Jersey) are not only very expensive but require considerable care and skill to operate and have been associated with serious accidents many of which have been fatal and will be described later.

Nevertheless in spite of these caveats laparoscopic subtotal hysterectomy (LSH) underwent a massive upsurge in popularity particularly in California where the rate increased from 6.9 to 20.8 % between 1997 and 2003 [96] and also in Scandinavia, particularly in relatively conservative countries such as Denmark when in a similar time frame it increased by 375 % so that 22 % of all hysterectomies were subtotal [97].

It is generally assumed that retaining the cervix enables a quicker procedure than TAH, and several laparoscopic series have confirmed this. If the cervix is retained, the surgeon needs only to secure the ascending branches of the uterine artery and vein, thus averting the need for dissection in the highly vascular tissue in the paravaginal area close to the ureter. It is claimed that STH is associated with fewer perioperative complications, in particular, hemorrhage because the main uterine artery is not ligated and the vaginal angles are left untouched.

In the 1980s a plethora of extravagant claims about other advantages of retaining the cervix had arisen, mainly from Finland, backed up by some poorly designed comparative clinical trials [98]. Among the claims of the advantages of STH over TAH are the reduced intra-operative complications, particularly ureteric injury, and no possibility of vault dehiscence but it was also claimed that there are fewer difficulties with post-operative bladder function, less subsequent pelvic floor complications and, particularly, less dyspareunia. It was also suggested that there was a considerable increase in sexual satisfaction, increased libido and better quality of orgasm and even an increased number of multiple orgasms. It was this latter suggestion that was seized on by the popular press and encouraged many women to come forward to seek this particular variety of hysterectomy if given the choice.

Although these claims seem compelling on superficial reading, we live in an age of evidence-based medicine largely due to the example shown by Dr. Archie Cochrane of Wales, and until recently these advantages have not been supported by adequate randomized controlled trials (RCTs) that have fulfilled the conditions required by the Cochrane Collaboration. However one study by St. George's Hospital in London [99] assessed urinary, bowel, and sexual function in great detail before surgery and at 6 and 12 month intervals afterwards with a series of carefully validated questionnaires. In addition, urinary function was determined with the use of twin-channel subtracted cystometrography and uroflowmetry, and definitions of urinary incontinence conformed to those of the International Continence Society.

There was no significant difference in any of the urinary symptoms between women who underwent TAH or STH. Urodynamic studies demonstrated a reduction in stress incontinence after surgery in both groups. Insofar as bowel symptoms were concerned the rates of constipation, hard stools, urgency, straining, use of laxatives, and incontinence of flatus were similar in the two groups after surgery.

Sexual function , which in the studies by Kilkku and colleagues [100] was greatly improved after STH, was remarkably similar in both groups in this study, which reasonably included only women who were sexually active at all three points in time: preoperatively and 6 and 12 months postoperatively. The frequency of intercourse, desire for intercourse, and initiation of intercourse did not differ significantly between the two groups; however, there was a significant increase in the frequency of intercourse in both groups (p 5.01). The type of surgery had a similar outcome insofar as frequency of orgasm, frequency of multiple orgasms, extent of vaginal lubrication, and rating of the sexual relationship with a partner. Deep dyspareunia was

reduced significantly in both groups at 6 and 12 months, whereas superficial dyspareunia decreased at 6 months but increased in both groups at 12 months, the reasons for which were not clear.

From the results of this carefully planned double-blind, randomized, prospective, controlled trial with adequate patient numbers and duration of follow-up, there was little to chose between the two types of abdominal hysterectomy other than the shorter operating time and decreased perioperative complications associated with subtotal abdominal hysterectomy. This brilliant study, published in arguably the most prestigious medical journal in the world, The New England Journal of Medicine, sadly did not include laparoscopic subtotal hysterectomy (LSH). We are therefore left to wonder whether its inclusion would have resulted in different conclusions, although it is clear from this study that abdominal hysterectomy, whether performed as a total or subtotal procedure, with the large painful scar associated with it and the prolonged recovery period, resulted in considerable patient satisfaction at 12 months of follow-up. It is a great shame that this otherwise excellent study which was conducted by urogynaecologists did not include an arm with laparoscopic subtotal hysterectomy because St. George's Hospital has some highly skilled laparoscopic surgeons who, I am sure, would have been happy to have taken part in this trial.

This was a great shame because the last time I did a thorough search of the literature I was only able to find one prospective randomized study comparing surgical complications and clinical outcomes after supracervical vs total laparoscopic hysterectomy in 141 patients followed up for 2 years, and that article was published only in Italian [101]. There were no statistically significant differences in the rates of complications, degree of symptom improvement, or activity limitation, although patients assigned to STH tended to have more hospital readmissions. Patients weighing more than 100 kg at study entry were more than twice as likely to be readmitted to the hospital during the 2 years of follow-up.

The Introduction of Robotic Laparoscopic Surgery

The most recent development in endoscopic hysterectomy is the development of hysterectomy techniques using robotic arms with wristed instruments rather than "straight sticks" with limited movements and a high fulcrum. This both exaggerates movement and requires the movement outside the body to be in the opposite direction as that inside the abdominal cavity, which is a primary reason for the learning curve in laparoscopic surgery. The wristed instruments powered by the robotic arms enable both a full range of movement and this movement can be slowed for fine manipulation. The only commercially available robotic systems the da Vinci S and the da Vinci SI (Intuitive Surgical, Inc., Sunnyvale, California) are equipped with a double optic, which gives the operator who works from a distant console, but not any of the observers, 3-dimensional vision, enabling much improved visualisation of the pelvis, which compensates for the loss of haptic feedback using the robotic arms. This is probably the main advantage of robotic surgery since it enables the operator to work with virtually no fatigue enabling several cases to be performed in one operating session. The wristed instruments, however, mean that the more recently available "safe" power sources such as the ultrasonic devices and bladed instruments are not available, and the only power sources are monopolar or bipolar diathermy, the latter now available with impedance feedback control. There have been several important publications that relate to the use of robotic techniques but they are primarily in surgery to treat malignant disease although recently increasingly they include benign disease particularly advanced stage endometriosis [102] and the thorny issue of cost effectiveness [103]. In this study from Lund in Sweden a randomized controlled trial (Canadian Task Force classification 1) of 122 women with a uterine size of less than 6 weeks who were scheduled to undergo minimally invasive hysterectomy for benign disease, who were not considered candidates for vaginal surgery, were assessed for hospital costs and short term clinical outcomes to compare laparoscopic hysterectomy with robot-assisted hysterectomy. All women underwent surgery as randomized and vaginal hysterectomy was possible in 41 % at a mean hospital cost of $4579 compared to $7509 for traditional laparoscopic hysterectomy and, surprisingly given that the robot is a pre-existing investment, the use of the robot only added $993 per case. If the calculation included the share of the purchase of the robot and maintenance this increased to $1607 extra per case but the robotic group had less blood loss and postoperative complications. The Robotic arms facilitate suturing in difficult situations such as the prostatic capsule in radical prostatectomy, and has been adopted in institutions that perform many of these procedures, predominantly by urologic oncologists. Case series have demonstrated that in appropriately skilled hands, radical hysterectomy performed using robotic techniques was comparable with laparotomy, and required significantly shorter time than laparoscopy, with equal lymph node harvest and significantly reduced blood loss and length of stay (2 days) [104].

Robotic hysterectomy to treat benign disease has now also become popular after the initial reports by Reynolds and Advincula of 16 consecutive patients with no conversions to laparotomy, a short hospital stay, and a complication rate comparable with routine laparoscopic (straight stick) surgery [103]. Their experience now includes patients with obliterated pelvic cul-de-sacs, six of whom have undergone hysterectomy with resection of the underlying disease safely and

with no conversions to laparotomy, which demonstrates that with the appropriate experience and training, robotic surgery is a useful tool for dealing with this associated disease [104].

An early limitation of robotic surgery was the need to dock the robot between the patient's legs, which meant that access to the vagina for uterine manipulation was difficult; however, this has been overcome by repositioning the robotic arms and docking the robot to the side of the patient where the surgeon would stand. The ports are relatively big, 8 mm for the robotic arm ports and 12 cm for the optical and accessory ports, and they need to be placed high in the abdomen, resulting in more obvious scarring.

Although robotic surgery is an exciting advance with great possibilities, it comes at considerable financial cost. The robot and optic cost $2 million, and limited-life reusable instruments cost $2000 each plus associated support costs. Despite the costs, there are now hundreds of units in place in the United States, and in the hands of enthusiasts, the techniques are gaining popularity in Europe and the United Kingdom.

The Choice of the Best Route for Hysterectomy

The last 80 years has witnessed a revolution in surgery from operations performed through a large painful abdominal incision with long hospital stays to minimal access procedures which are essentially the same operations but owing to the small incisions allow surgery often to be undertaken on a day care basis with much less pain and discomfort, rapid recovery and early return to work or domestic activity.

In this chapter I have described the amazingly brave interventions of pioneering surgeons when an abdominal incision was almost tantamount to a sentence of death and slowly seeing an improvement throughout the ages with the gradual reduction of associated morbidity and mortality until we final arrive in the modern era, when laparoscopic hysterectomy is performed to improve quality of life rather than to remove a threat to life as in former times. The sophistication of new instrumentation and optics together with the long training of the surgeon has ensured that the complication rate is low and technological progress is still continuing so that surgery can now be performed with the assistance of robots.

There has also been a steady progression from early reports from pioneers of each type of surgery and then a collected series by individual experts or teams from centres of excellence which have invariably given a favourable outcome for the procedure they are describing and finally a more evidence based approach with well constructed prospective comparative studies which, I feel sure, will be dealt with in detail in other chapters in this book. Some of these studies such as the excellent eVALuate Study have shown that when some of these procedures are put into general use the complication rate is inevitably higher than when a series is reported from an individual expert or centre of excellence [105]. Although this can result in unfair criticism from some quarters it is nevertheless essential that we face the obvious truth that the complication rate is likely to increase when the procedure is universally adopted but this is important when confronting the patient with the likelihood of complications associated with each type of procedure.

Much of this can be addressed by adequate training and experience but it must be realized that laparoscopic surgery requires special skills and excellent hand – eye coordination and this appears not to be available to all surgeons and it is essential that all surgical practitioners are aware of their own limitations. The ultimate choice of the type of hysterectomy to be chosen depends on a frank discussion between the patient and the doctor keeping the above factors in mind.

It is difficult to predict the future for however much increasing popularity seems to support a particular operation such was the case with laparoscopic subtotal hysterectomy in the past decade there was a severe setback when morcellation, which is a convenient way to rapidly remove the uterus after is has been severed from the cervix, has been associated with reports of dissemination of malignant material and, suddenly, the leader of the pack suffers a reversal of fortune until adequate ways are found to prevent this problem [106].

The ingenuity of doctors and scientists never ceases to amaze me and I remember some times ago being fascinated when seeing a video of an appendicectomy performed endoscopically by the passage of a multi channeled endoscope via the nose and entering the peritoneal cavity through a small incision in the stomach and finally removing the appendix without any abdominal incision and retrieving the specimen through the nose after repairing the small hole in the stomach. Thus a new chapter was born in this ongoing saga under the general title of Natural Orifice Endoscopic Surgery but gynaecologists should always remember that the vagina provides the natural orifice of our specialty and allows us to access the pelvis without painful abdominal incisions and in spite of all the advances that I have described it would appear that vaginal hysterectomy throughout the ages has remained the best, quickest and safest way of performing minimal access hysterectomy.

References

1. Lameras K. Galen and hippocrates. Athens: Papyrus; 1975.
2. Studd J. Ovariotomy for menstrual madness and premenstrual syndrome – 19th century history and lessons for current practice. Gynaecol Endocrinol. 2006;22(8):411–5.
3. Barker-Benfield GI. The horrors of the half-known life. London: Routledge; 2000.
4. Adler RE. Medical firsts: from Hippocrates to the human genome. Hobokin: Wiley; 2004.

5. Leonardo RA. History of gynecology. New York: Foben Press; 1944.
6. Temkin O (1956). Soranus' Gynaecology. (Translated). Baltimore: The Johns Hopkins University Press; 1991. Softshell Books edition.
7. O'Dowd MJ, Philipp EE. The history of obstetrics and gynaecology. Carnforth: Parthenon Press; 1994.
8. Soranus (of Ephesus). De arte obstetrician morbisque mulierum quae superaunt. Ex apogropho F.R. Dietze. Regimontii Pr: Graef et Unzer; 1838.
9. Senn N. The early history of vaginal hysterectomy. JAMA. 1895; 25:476–82.
10. Avenzoar A. L iber Teiser, sive rectification medication et reg*iminus.* J & G de Gregoriis, Venice.
11. Berengario da Carpi G. Commentaria cum amplissimis additionibus super anatomia Mundini., per H de Benedictus, Bononiae; 1521.
12. Benrubi GI. History of hysterectomy. J Fla Med Assoc. 1988; 75:533–42.
13. Sutton CJG. The history of vaginal hysterectomy. In: Sheth SS, editor. Vaginal hysterectomy, vol. 1. 2nd ed. New Delhi: Jaypee Publishers; 2014. p. 1–8.
14. Thornton JL, Want PC. William Harvey (1578 – 1657), 'Father of British Obstetrics', and his friend Percival Willughby (1596 – 1685). Br J Obst Gynaecol. 1978;85(4):241–5.
15. Baskett T. On the shoulders of giants. Eponyms in obstetrics and gynaecology. 1st ed. London: Butterworths; 1998.
16. Ricci JV. One hundred years of gynaecology 1800–1900. Philadelphia: Bakiston Company; 1945.
17. Langenbeck CJM. Geschichte einer von mir glucklich verichteten extirpation der ganger gebarrmutter. Bibliotyh Chir Opth Hannover. 1817;1:557–62.
18. Matthieu A. History of hysterectomy. West J Surg Obstet Gynecol. 1934;1(8):333–49.
19. Sutton CJG. Hysterectomy: a historical perspective. In: Wood C, Maher P, editors. Baillières clinical obstetrics and gynaecology, Hysterectomy, vol. 1. London: Bailliere Tindal; 1997. p. 1–23.
20. Ricci JV. Genealogy of gynaecology. Philadelphia: Blakiston; 1950. p. 350–2.
21. Gray L. The life and times of Ephraim McDowell. Louisville: VG Reid Printers; 1987.
22. Sutton CJG. The Royal College of Obstetricians and Gynaecologists historical lecture 1993. 150 years of hysterectomy: from Charles Clay to laparoscopic hysterectomy. Year Book of the Royal College of Obstetricians and Gynaecologists. London: RCOG Press; 1994.
23. Ellis H. Ephraim McDowell and the first elective successful laparotomy. Br J Hosp Med(Lond). 2009;70(2):107.
24. Tan SY, Wong C. Ephraim McDowell (1771 – 1830): pioneer of ovariotomy. Singapore Med J. 2005;46(1):4–5.
25. Graham S Jr D. Ephraim McDowell (1771 – 1830). The President's lithotomist. Invest Urol. 1981;19(3):216–7.
26. Bernhard CM. Presidential address: Dr. Ephraim McDowell: father of abdominal surgery. Am Surg. 1980;46(1):1–5.
27. Tait L. Diseases of the ovaries. New York: William Wood; 1883.
28. Othersen Jr HB. Ephraim McDowell: the qualities of a good surgeon. Ann Surg. 2004;239:648–50.
29. McDowell E. Initial observations on abdominal extirpation of tumours of the ovaria: a report of three cases. The Eclectic Repertory and Analytical Review of Philadelphia; 1819.
30. Sutton CJG: (2014). In: Reidy J, Hacking N, McLucas B, editors. Radiological interventions in obstetrics and gynaecology. Ch. 1; 3–16. Berlin: Springer.
31. Speert H. Obstetrics and gynaecology in America: a history. Baltimore: Waverly Press; 1980.
32. Morton LT. (1965). Garrison and Morton's medical Bibliography. Andre Deutsch London , 527–537.
33. Lizars J. Observations on extirpation of the ovaria with cases. Edinburgh Med Surg J. 1824. 22 October.
34. Bosdin Leech E. Some Manchester Medical Authors and their works. The Manchester University Medical School Gazette; 1956a, p. 102–6.
35. Fenster JM. Ether day: the strange tale of America's greatest medical discovery and the haunted men who made it. New York: Harper Collins; 2001.
36. Bosdin Leech E. Some Manchester Medical Authors and their Works. III – Charles Clay. The Manchester University Medical School Gazette; 1956b, p. 152–6.
37. Clay C. Observations on ovariotomy statistical and practical: also a successful case of entire removal of the uterus. Trans Obstet Soc London. 1863;5:58–74.
38. Burnham W. Extirpation of the uterus and ovaries for sarcomatous disease. Am Lancet. 1845:147–51.
39. Graham H. Eternal Eve. London: W Heinemann; 1950. p. 153–4.
40. Kimball G. Successful case of extirpation of the uterus. Boston Med Surg J. 1855;52:249–55.
41. Baskett TF. On the shoulders of giants. eponyms and names in obstetrics and gynaecology. 2nd ed. London: RCOG Press; 2008.
42. Lister J. On a new method of treating compound fractures, abscess, etc . with observations on the condition of suppuration. Lancet. 1867;1867:326–9.
43. Simpson JY. Discovery of a new anaesthetic agent, more effective than sulphuric ether. Lancet. 1847;2:549–51.
44. Simpson JY. Answer to the religious objections advanced against the employment of anaesthetic agents in midwifery and surgery. Sutherland and Knox: Edinburgh; 1857. p. 23–5.
45. Baker BI. On the curability of certain forms of insanity, epilepsy, catalepsy, and hysteria in females. J Obstet Soc. London 1866:107–11.
46. Fennel P. Treatment without consent. Law, Psychiatry and treatment of mentally disordered people since 1845. London: Taylor and Francis; 2002.
47. Shepherd JA. Spencer Wells. The life and work of a Victorian Surgeon. Edinburgh: E & S Livingstone; 1965.
48. Freund WA. Eine neue Methode der Exstirpation des ganzen uterus. Berlin Med Surg J. 1878;15:417–8.
49. Czerny V. Ueber die Ausrottung des Gebarmutterkrebses. WienMedWahrc. 1879;29:1171–4.
50. Porro E. Della amputazione utero-ovarica come complement di taglio cesareo. Ann Univ Med Chir (Milan). 1876;237:289–350.
51. Caffarato TM. Ricordo di Eduardo Porro nell'centenario del'suo operazione. Minerva Ginecol. 1976;28:1033–40.
52. Baskett TF. Hysterectomy: evolution and trends. Best Pract Res Clin Obstet Gynaecol. 2005;10:295–305.
53. Ricci JV. The development of gynaecological surgery and instruments. Philadelphia: Blackiston; 1949. p. 297–301.
54. Sutton CJG. The past present and future of hysterectomy. J Minim Inv Gynecol Surgery. 2010;17(4):421–35.
55. Clark JG. A more radical method of performing hysterectomy for cancer of the uterus. Johns Hopkins Hospital Bulletin. 1895;6: 120–4.
56. Wertheim E. Zur Frage der Radicaloperation beim Uteruskrebs. Arch Gynakol. 1900;61:627–68.
57. Webb MJ. Radical Hysterectomy. Baillieres Clin Obstet Gynaecol. 1997;11(1):149–66.
58. Schauta F. Die erweiterte vaginale totalexstirpation des Uterus bei Kollumkarzinom. Leipzig: J Safar; 1908.
59. Schuchardt K. Eine neue Methode der Gerbärmutterextirpation. Zentralbl Chir. 1893;20:1121–6.
60. Mikuta JJ. A history of the centennial of the first radical hysterectomy and its developer – Dr. John Goodrich Clark. J Pelvic Surg. 1995;1:3–7.
61. Wertheim E. The extended abdominal operation for carcinoma uteri. Am J Obstet. 1912;66:169–232.

62. Richardson EH. A simplified technique for abdominal panhysterectomy. Surg Gynaecol Obstet. 1929;48:248–51.
63. Cutler EC, Zolenger RM, editors. Atlas of surgical operations. 1949. New York: McMillan & Co.; 1949.
64. Kilkku P, Gronroos M, Rauramo L. Supravaginal uterine amputation with pre-operative electro coagulation of endocervical mucosa. Acta Obstetrica et Gynaecologica Scandinavica. 1985;64: 175–7.
65. Lyons TL. Laparoscopic supracervical hysterectomy using the contact Nd:YAG laser. Gynecol Endosc. 1993;2:79–81.
66. Pfannenstiel HJ. Uber die vortheile des suprasymphsaren Fascienquerschnitts fur die gynakogischen Koliotomein zugleich ein Beitrag zu der Indikationstellung der Operationswerge. Samml Klin Vortr Leipzig. 1900;268:1735–56.
67. Amirikiah M, Evans TN. Ten year review of hysterectomies: trends indications and risks. Am J Obstet Gynecol. 1979;124:431–7.
68. Daly JW, Higgins KA. Injury to the ureter during gynaecological procedures. Surgical Gynaecology and Obstetrics. 1988;167: 19–21.
69. Dicker RC, Greenspan JR, Strauss LT, et al. Complications of abdominal and vaginal hysterectomy among women of reproductive age in the United States. The collaborative review of sterilisation. Am J Obstet Gynecol. 1982;144:841–8.
70. Bachmann G. Hysterectomy: a critical review. J Reprod Med. 1990;35(9):839–62.
71. Kelling G. Uber oesophagoskopie, gastroskopie und koelioskopie. Munch Med Wochenschr. 1902;49:21–4.
72. Von Ott D. Die direkte Beleuchtung der Bauchhohle, der Harnblase, des Dickdarms und des Uterus zu diagnostischen Zwecken. Rev Med Tcheque (Prague). 1901;2:27.
73. Jacobaeus HC. Uber due Moglichkeit die Zystosco;ie bei Untersuchlung seroser Hohlungen anzerwerden. Munchen Medizinische Wochenschrift. 1910;57:2090–2.
74. Gordon AG, Taylor P. History and development of endoscopic surgery. In: Sutton C, Diamond M, editors. Endoscopic surgery for gynaecologists. 2nd ed Ch 1. London: W B Saunders; 1998. p. 1–8.
75. Palmer R. La coelioscopie gynécologique. Acad Chir. 1946;72: 363–8.
76. Frangenheim H. Die tuben sterilization unter sicht mit dem laparoscope. Gerbutsh Frauenheilk. 1964;24:470–3.
77. Steptoe PC. Laparoscopy in gynaecology. Edinburgh/London: Livingstone; 1967.
78. Semm K. Hysterectomy by pelviscopy: an alternative approach without colpotomy (CASH). In: Garry R, Reich H, editors. Laparoscopic hysterectomy. Oxford: Blackwell; 1993. p. 118–32.
79. Semm K O'Neill-Freys L. Conventional operative laparoscopy (pelviscopy). In: Sutton CJG, editors. Laparoscopic surgery*;* Baillière's Clinical Obstetrics and Gynaecology*;* Baillière Tindall, London. vol. 3: 3; 1989, p. 451–85.
80. Garry R, Reich H. Laparoscopic hysterectomy – definitions and indications. Gynaecol Endosc. 1994;4(2):77–9.
81. Bruhat MA, Manhes H, Mage G, Pouly JL. Treatment of ectopic pregnancy by means of laparoscopy. Fertil Steril. 1980;33:411–4.
82. Hopkins HH. Optical principles of the endoscope. In: Berci G, editor. Endoscopy. New York: Appleton-Century-Crofts; 1976. p. 3–27.
83. De Cherney AH. The leader of the band is tired. Fertil Steril. 1985;44:299–302.
84. Reich H, De Caprio J, McGlynn F. Laparoscopic hysterectomy. J Gynecol Surg. 1989;5(2):213–5.
85. Sutton CJG. Wither Hysterectomy? Curr opin gynaecol. 1994;6: 203–5.
86. Semm K. Hysterectomy via laparotomy or pelviscopy. a new CISH method without colpotomy. Geburtshilfe Frauenheilkd. 1991;51:996–1003.
87. Mettler L, Ahmed-Ebbiary N, Scollmeyer T. Laparoscopic hysterectomy: challenges and limitations. Min Invas Ther & Allied Technol. 2005;14:145–59.
88. Ewen SP, Sutton CJG. Initial experience with supra-cervical laparoscopic hysterectomy and removal of the transformation zone. Br J Obstet Gynaecol. 1994;101:225–8.
89. Lyons TL. Laparoscopic supra-cervical hysterectomy. A comparison of morbidity and mortality results with laparoscopic assisted vaginal hysterectomy. J Reprod Med. 1993;38:738–63.
90. Okara EO, Jones KD, Sutton CJG. Long term outcome following laparoscopic supracervical hysterectomy. Br J Obstet Gynaecol. 2001;108:1017–20.
91. Lieng M, Qvigstat E, Istre O, Langebrekke A, Ballard K. Long term outcomes following laparoscopic supracervical hysterectomy. Br J Obstet Gyanaecol. 2008;115:1605–10.
92. Donnez J, Nisolle N, Smets M, et al. Laparoscopic supracervical (subtotal) hysterectomy: a first series of 500 cases. Gynaecol Endosc. 1997;6:73–6.
93. Dequesne J, Schmidt N, Fryman R. A new electrosurgical loop technique for laparoscopic supra-cervical hysterectomy. Gynaecol Endosc. 1998;7:29–32.
94. Pasic R, Abdelmomen A, Levine R. Comparison of cervical detachment using monopolar lap loop ligature and conventional methods in laparoscopic supracervical hysterectomy. JSLS. 2006;10:226–30.
95. Sutton C, Abbott J. History of power sources in endoscopic surgery. J Minimally Invasive Gynecol. 1995;20(3):271–8.
96. Merrill RM. Hysterectomy surveillance in the United States: 1997 through 2005. Med Sci Monit. 2008;14:24–31.
97. Gimbel H, Settiness A, Tabor A. Hysterectomy for benign conditions in Denmark 1988 – 1998. Acta Obstet Gynecol Scand. 2001;80:267–72.
98. Kilkku P, Gonroos M, Hirvonen T, Rauramo L. Supravaginal uterine amputation vs hysterectomy: effect on libido and orgasm. Acta Obstet Gynaecol Scand. 1983;62:147–52.
99. Thakar R, Ayers S, Clarkson P, Stanton S, Manyonda I. Outcomes after total versus subtotal hysterectomy. N Engl J Med. 2002;347: 11318–24.
100. Morelli M, Noia R, Mocciaro R, et al. Laparoscopic supracervical hysterectomy versus laparoscopic total hysterectomy: a prospective randomized study. Minerva Gynecol. 2007;59:1–10.
101. Nezhat CR, Stevens A, Balassiano E, Soliemannjad BS. Robotic-assisted laparoscopy vs conventional laparoscopy for the treatment of advanced stage endometriosis. J Minim Invasive Gynecol. 2015;22:40–4.
102. Magrina JF, Kho R, Weaver L, Montero P, Magtibay P. Robotic radical hysterectomy: comparison with laparoscopy and laparotomy. Gynaecol Oncol. 2008;109:86–91.
103. Reynolds R, Advincula A. Robot-assisted laparoscopic hysterectomy technique and initial experience. Am J Surg. 2006;191:555–60.
104. Advincula A, Reynolds R. The use of robot-assisted laparoscopic hysterectomy in the patient with a scarred or obliterated anterior cul-de-sac. JSLS. 2005;9:287–91.
105. Garry R, Fountain J, Mason S, et al. The eVALuate study: two parallel randomised trials, one comparing laparoscopic with abdominal hysterectomy, the other comparing laparoscopic with vaginal hysterectomy. BMJ. 2004;328:129–33.
106. Brown J, Taylor K, Ramirez PT, et al. Laparoscopic supracervical hysterectomy with morcellation: should it stay or should it go? J Minim Invas Gynaecol. 2015;22:185–92.

History of Radical Hysterectomy

2

Karl Tamussino

At the end of the nineteenth century, cervical cancer was a scourge for which there was no early detection and no cure. In an era where the average life expectancy was about 50 years, cervical cancer was the most common cause of cancer death in women, as it still is today in parts of the world. "It is enough to make a physician's heart sink within him to make the diagnosis of cancer uteri," wrote Charles Meigs in [12], "for such a diagnostic is ipso facto a prognostic of death."

This dire state of affairs led to heroic efforts to remove uteri to cure cancer. The first abdominal removal of a cancerous uterus was apparently performed in 1878 by W. A. Freund in Breslau (Wroclaw, then Germany, now Poland). Three mass ligatures were placed on each side of the uterus. The ligatures contained the ovarian ligaments, the round ligaments, and the paracervical tissue. The last ligature was placed by "leading a suture from in front of the base of the ligamentum latum through the anterior lateral part of the vaginal fornix behind the base of the ligamentum latum into the pouch of Douglas" [7]. The patient went home 19 days after surgery. Sixty-six Freund operations performed by 1880 entailed 49 perioperative deaths (72 %) [3].

Surgeons worked to improve the Freund operation. In 1881 Linkenheld, an assistant of Freund's, noted that all the patients who survived the Freund operation developed a recurrence within two and a half years at the latest. He ascribed this to the fact that "in all these cases, the neoplasia exceeded the limits of the uterus and spread to the adjacent parametria, and that the operation had not removed all diseased tissue." Like surgeons who removed the tissue in the axilla of patients undergoing surgery for cancer of the breast, Linkenheld suggested "removing the parametria, of course avoiding injury to the ureters, under all circumstances." This entailed omitting the mass ligatures, since "they present a barrier to outward dissection. Instead, after circumcision of the portio, the uterus must be removed like a tumor, and the various vessels ligated individually. The parametria should then be removed bluntly, as is done in the removal of the axillary tissue" [10].

Consistent with the philosophy of extended mastectomy envisioned and advocated by William Halsted for women with breast cancer, surgeons continued to push the limits of parametrial excision. Brunet [1], in studies of Mackenrodt's surgical specimens, found that 60 % of those that were considered negative at palpation contained disease. Also, 42 % of the specimens showed spread to the upper third of the vagina. Increasing resection of the parametrial tissue soon led to the issue of the ureter [4, 20, 21]. The work of these surgeons built the foundation for what is today known and thought of as radical hysterectomy.

In the late 1890s, Ernst Wertheim (1864–1920) in Vienna began to standardize the operation that later came to bear his name. Wertheim was born and studied medicine in Graz, then moved to Vienna and Prague to train with Friedrich Schauta. He performed his first radical operation in 1898 and reported on the first 29 patients in 1900 [30]. His rationale was that simple removal of the uterus was providing poor results for patients with uterine cancer and that "to obtain better results – as for the surgical approach to cancers in other organs – in addition to the primary focus one should remove as much as possible of the surrounding tissue". This was the Halstedian vision applied to uterine cancer.

Wertheim's famous monograph describing 500 radical abdominal operations appeared in 1911 [31] and was soon translated into English [32]. The monograph is a monumental effort. It assiduously tabulates his first 500 patients, including their postoperative courses and outcomes. It provides detailed descriptions of the clinical findings. Descriptions such as "cauliflower like", "infiltration to the pelvic wall", "cervix replaced by neoplasia", "portio replaced by necrotic mass" are the rule. Obviously none of these were screening-detected lesions and many we today would not

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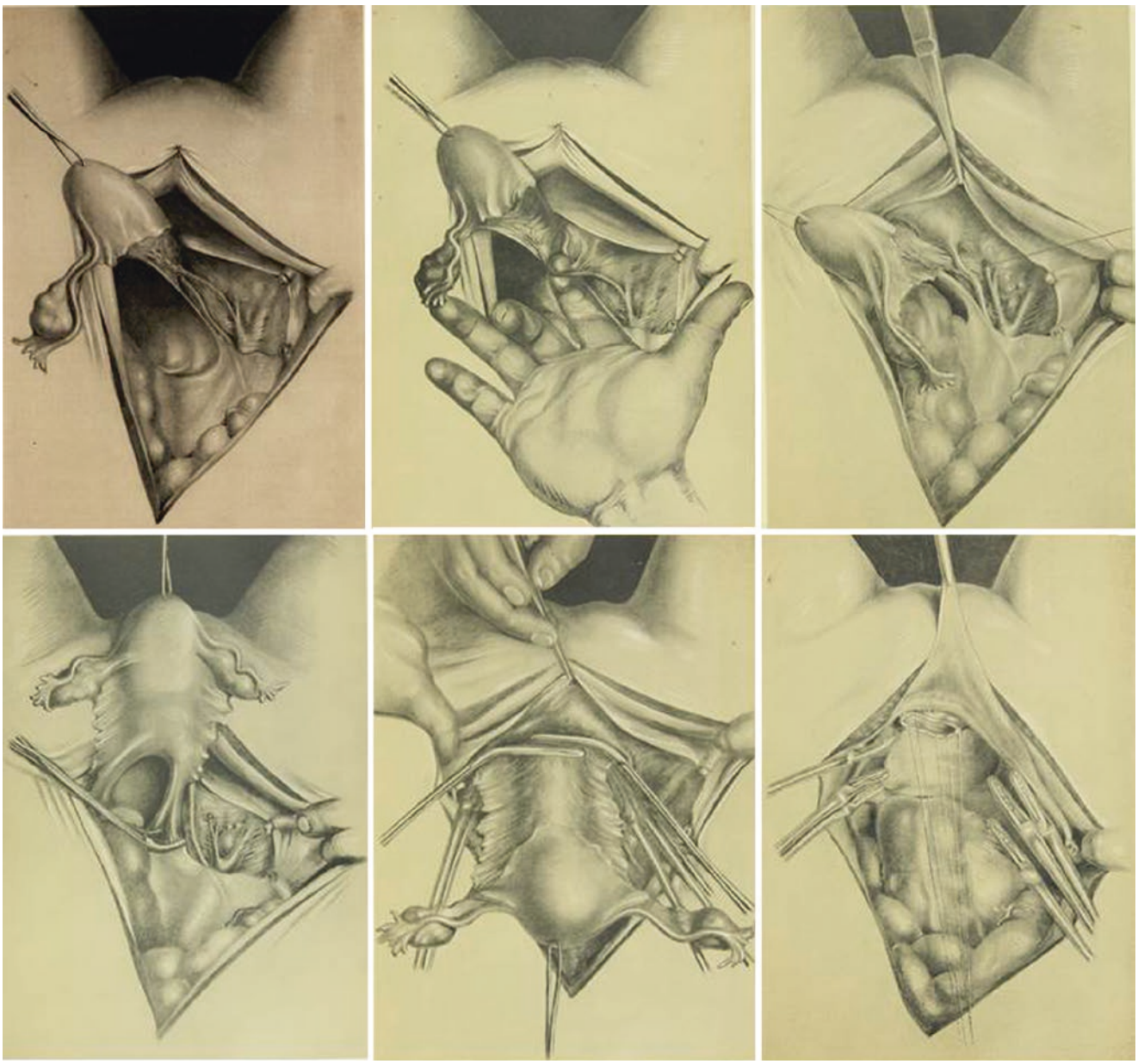


Fig. 2.1 Plates from Wertheim's original description of his extended hysterectomy (Wertheim [31])

consider for surgical treatment at all. The monograph lists the operating times (consistently under 2 h), the postoperative course (including 38 % mortality amongst the first 50 patients), and follow-up with information on time and site of recurrence.

Key steps of Wertheim's technique were digital separation of the leaves of the broad ligament, isolation of the ureter down to its entrance into the parametrium, a maneuver of poking the index finger through the parametrium along the ureter to isolate and ligate the uterine vessels, dissection of the bladder, dissection of the rectum, division of the parametria "from" the pelvic wall with specially designed clamps. Finally, the vagina was clamped and divided below the clamps to excise the specimen without contaminating the surgical field with malignant cells (Fig. 2.1).

Notably, Wertheim performed the hysterectomy first and then did a "search for and extirpation of enlarged lymph glands". Spaces were not systematically developed, and lymph nodes not removed systematically. Thus, a key feature of Wertheim's technique was that he did the hysterectomy first and then turned his attention to the lymph nodes, and then removed only enlarged nodes. Of course, issues regarding the indications for lymphadenectomy and which nodes to remove are still avidly debated for many cancers more than 100 years later.

Latzko and Schiffmann [9] in Vienna, like Peiser [17] before them but in contrast to Wertheim, began the operation

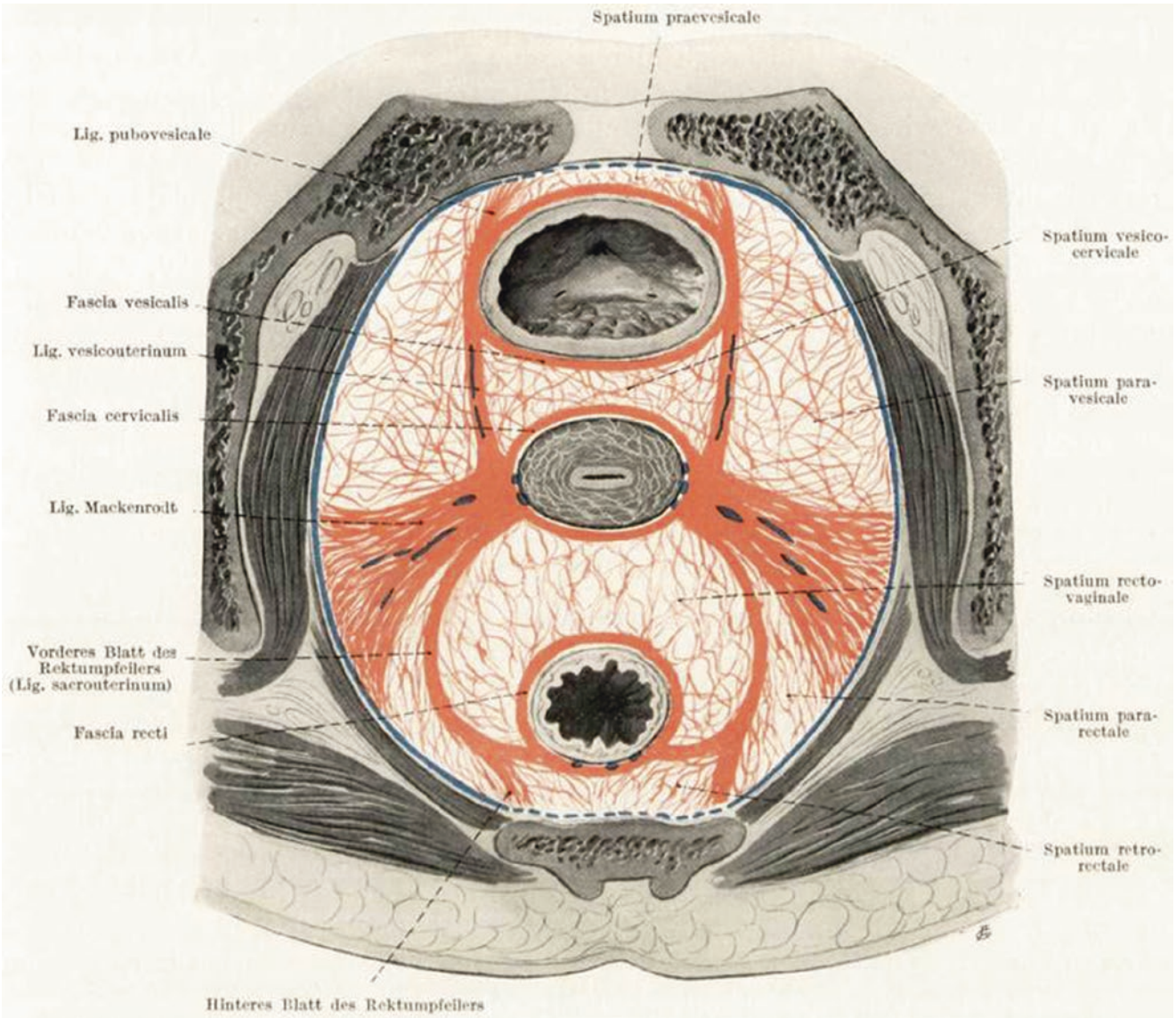


Fig. 2.2 Original schema of the potential spaces in the pelvis (Reprinted from Peham and Amreich [16], with permission from Elsevier)

with systematic lymphadenectomy. Thus, "the object of the operation was isolated according to the anatomic conditions." This was done by opening the paravesical and pararectal spaces (although these were not named) and freeing the ureter from its attendant tissue. The sacrouterine ligament was completely demonstrated and divided close to the sacrum. Isolating the specimen in this way made it possible to resect the parametrial tissue directly at the pelvic wall. By systematically removing lymph nodes before removing the uterus, and thereby "setting up" the operation, Latzko and Schiffmann [9] describe the radical hysterectomy much as we think of it today, but did not name the potential spaces they developed to set up the operation.

The schema with the names of the potential spaces in the pelvis that is the basis of today's surgical anatomy of the pelvis was first described by Peham and Amreich of Vienna in a classic textbook published in [15] (Fig. 2.2).

Lymphadenectomy was associated with radical hysterectomy from early on. The impulse came from anatomic studies by Wagner [29] and Cruveilhier [5] that had found involved nodes in more than 50 % of women who died of cervical cancer. Veit [28] and Mackenrodt [11] repeatedly found tumor deposits in the lymphatics of the parametrial tissue, even before the cervix was "completely infiltrated by tumor to its outer layers." Macroscopically normal parametrial tissue was therefore capable of containing tumor.

General surgeons were already working on removing all accessible regional lymph nodes (not just palpable nodes) in patients undergoing surgery for cancer. Schuchardt [25] stipulated this requirement for cancers of the uterus. In 1898,

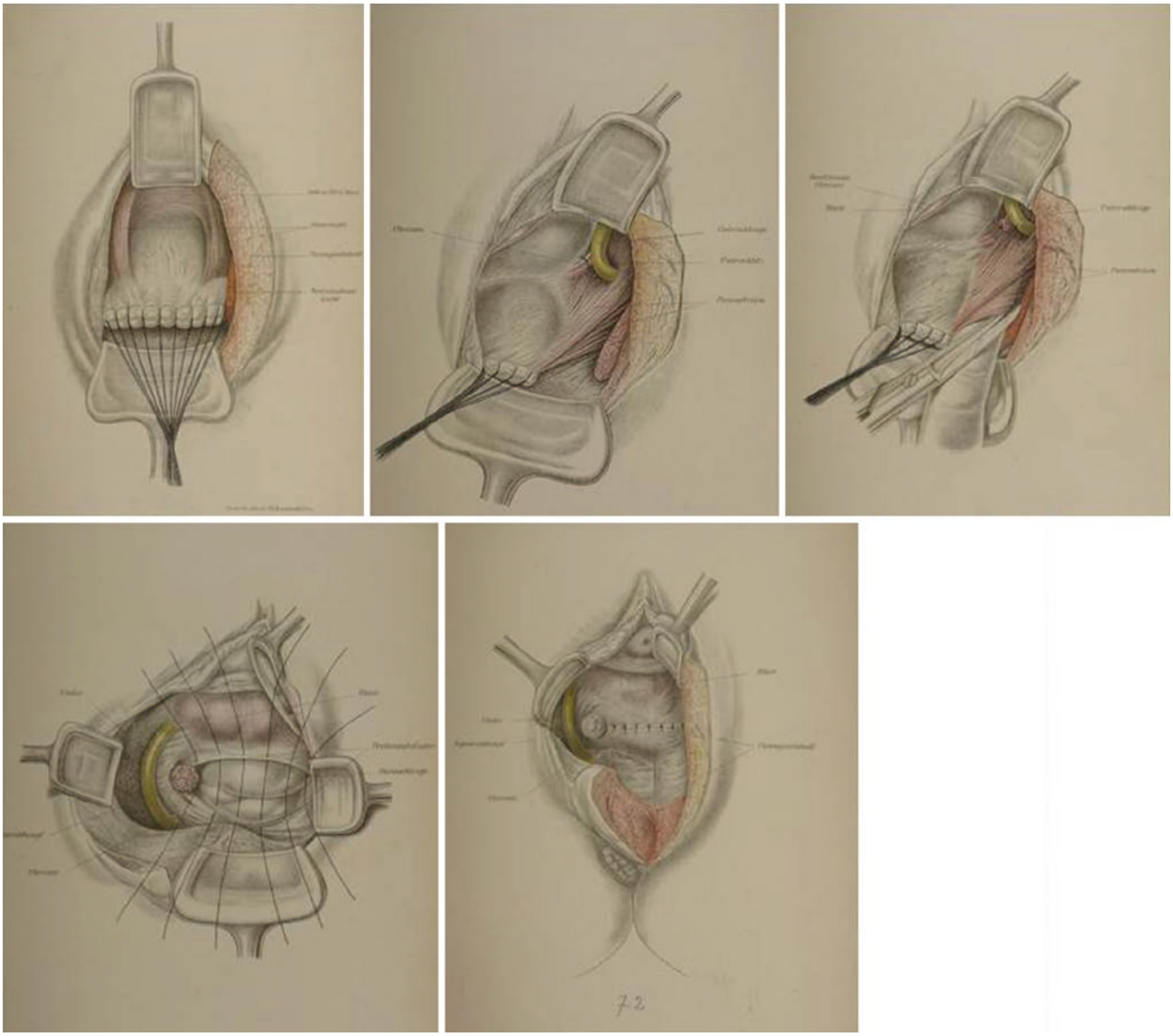


Fig. 2.3 Plates from Schauta's original description of extended vaginal hysterectomy (Schauta [22, 24])

Peiser published anatomical and clinical studies of the lymphatic system of the uterus. He saw a need for systematic lymphadenectomy by also removing the lymphatic channels between the cervix and the pelvic wall. This amounted to total excision of the parametrial tissue. Peiser's publication prompted Wertheim to make "a search for lymph nodes" part of his operation. Schauta [22–24], a proponent of radical vaginal hysterectomy, came out against the "needless search for glands," and stated that, at autopsy, nonenlarged and impalpable nodes could contain cancer. Thus, he unintentionally provided the rationale for systematic removal of the nodes. Latzko and Schiffmann [9] stated that searching for enlarged nodes was fundamentally different from their systematically rempoving node bearing tissue. This still holds true. In contrast to Wertheim, Latzko and Schiffmann performed lymphadenectomy at the beginning of the operation, thereby setting up the subsequent radical hysterectomy.

While Wertheim and others were pursuing an abdominal approach, Friedrich Schauta, Wertheim's erstwhile teacher, was working on the radical vaginal procedure first described by Schuchardt [25]. Schauta, also of Vienna, did for radical vaginal hysterectomy what Wertheim did for radical abdominal hysterectomy. In 1908 he published an assiduous and beautifully illustrated monograph with a list of 258 consecutive operations (Fig. 2.3). Like Wertheim, Schauta provides clinical descriptions, perioperative results and complications, and follow-up (25 % considered cured at 5 years).

Interestingly, Schauta and Wertheim were first teacher (Schauta) and student (Wertheim), later bitter rivals. Their dispute concerned the approach to radical hysterectomy

(vaginal vs. abdominal) and the issue of lymphadenectomy. Wertheim considered the removal of involved glands therapeutic, Schauta was not convinced. Of course, these arguments continue to the present day, and not just for cervical cancer. Both Schauta and Wertheim devote passages in their monographs to disparaging the other's approach. The tone is not friendly. It is ironic that the two rivals received honorary graves in the Vienna Zentralfriedhof, almost next to each other.

The exacting and self-critical work done by Schauta and Wertheim – with clinical descriptions, perioperative morbidity and mortality, and long-term outcome – also remind us that evidence-based surgery is not new.

Late in his life, in the late 1910s, Wertheim was despondent at the thought that his life's work on the treatment of cervical cancer was being made obsolete by the advent of radium treatment for this disease. Wertheim's last publication, which appeared in 1919, the year before he died, was a monograph on a vaginal, uterine-sparing operation for uterovaginal prolapse.

In the United States, Taussing [26] and Meigs [13] were influential in making lymphadenectomy a part of radical surgery for cervical cancer. An influential book edited by Joe V. Meigs of Boston, *Surgical Treatment of Cancer of the Cervix* [14], pulled together authors and the arguments for surgical treatment of cervical cancer and led to a renaissance of surgical treatment for this disease.

Improvements in surgical technique, anesthesiology, blood replacement, perioperative care and technology made possible longer and more complex operations. Pelvic exenterations were a further push to extend the reach of surgical treatment of cervical cancer. These were pioneered by Alexander Brunschwig (1901–1969) of New York [2]. These are complex operations with considerable complication rates and sequelae but continue to have a place in the surgical treatment of recurrent cervical cancer.

Differences in surgical approaches, anatomical concepts and terminologies have led to some confusion and attempts to classify what is understood under the term "radical" or "extended" hysterectomy. The classification put forth by Piver et al. in [18], which distinguished five classes of extended hysterectomy, has probably gained the most traction. Class I (which they called the the TeLinde modification) amounts to a standard total hysterectomy and was used for in situ and microinvasive carcinomas. Class II is a "moderately extended radical hysterectomy", with removal of the medial half of the cardinal ligament. A Class III procedure is the classic Latzko-Meigs concept with pelvic lymphadenectomy and excision of the cardinal ligaments at the pelvic wall, of the uterosacral ligaments at the sacrum, and of the upper half of the vagina. Class IV radical hysterectomy entails excision of three-fourths of the vagina and class V hysterectomy includes resection of involved areas of the ureter and bladder (but is short of exenteration). In Querleu and Morrow [19] developed a more detailed (and thus more complex) classification.

With the advent of cytologic screening after the Second World War, based on the work of George Papanicolaou, the spectrum of cervical cancers seen in developed shifted toward early, screening-detected lesions. Simultaneously, advances in radiation and chemoradiation therapy were made for the treatment of bulky or locally advanced disease. Accordingly, instead of continuously extending radicality, surgeons began to explore whether certain patients with smaller lesions could undergo less aggressive surgery and thus be spared morbidity. This was the basis for nerve-sparing radical hysterectomies [27], radical trachelectomies (with preservation of the uterus and thus of fertility) [6], and sentinel lymph node biopsy. Also, Japanese surgeons developed an anatomical approach to nerve-sparing radical hysterectomy that dates back to Okabayashi in the 1930s [8]. Evidence that small cervical cancers infrequently involve the parametrial tissue is the basis for an ongoing multinational randomized trial of simple vs. radical hysterectomy for early cervical cancer.

The story of radical history contains much of the history of gynecologic surgery and gynecologic oncology and reflects the enormous progress that has been made in combating what was once the leading cause of cancer death in women. The operation is fundamental to our understanding of the surgical anatomy of the pelvis. Wertheim need not have worried, the operation continues to evolve to serve the needs of women with cervical cancer.

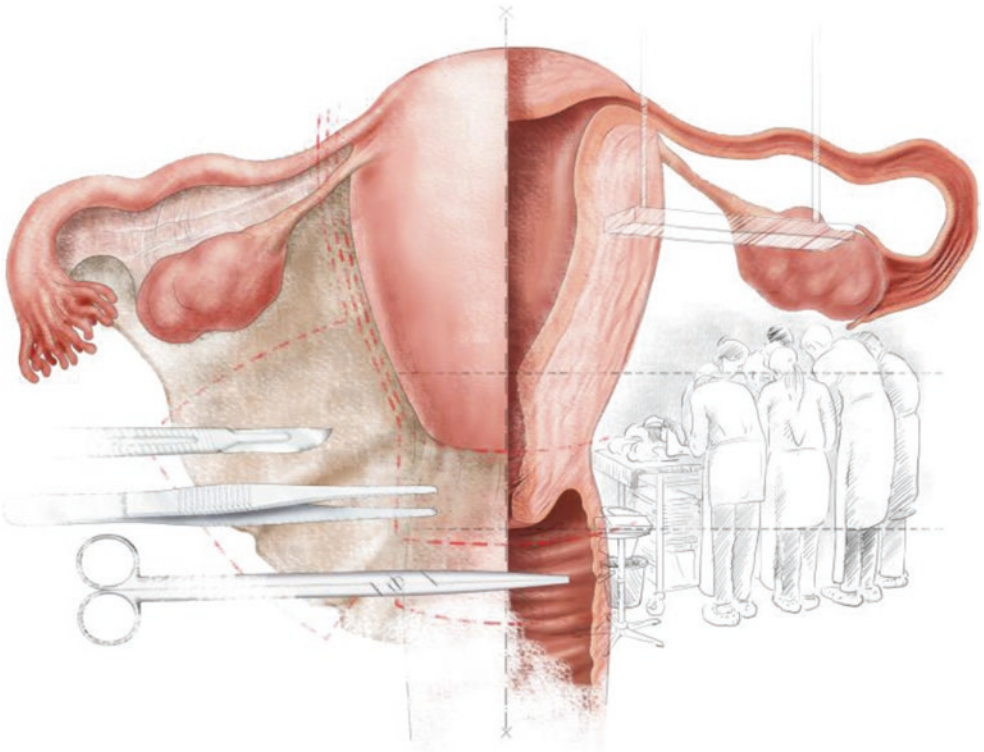
References

1. Brunet G. Ergebnisse der abdominalen Radikaloperation des Gebärmutterscheidenkrebses mittels Laparotomia hypogastrica. Z Geburtshilfe Gynäkol. 1905;56:1–87.
2. Brunschwig A. Total and anterior pelvic exenterations: report of results based on 315 operations. Surg Gynecol Obstet. 1954;99:324–30.
3. Burghardt E. Radical abdominal hysterectomy: historical background. In: Burghardt E, Webb MJ, Monaghan JM, Kindermann G, editors. Surgical gynecologic oncology. Stuttgart: Thieme; 1993. p. 275–6.
4. Clark JG. A more radical method of performing hysterectomy for cancer of the uterus. Bull Johns Hopkins Hosp. 1895;6:120.
5. Cruveilhier J. Traité d'anatomie descriptive. Paris: Bechet Jeune; 1834. p. 3.
6. Dargent D, Querleu D, Plante M, Reynolds K. Vaginal and laparoscopic vaginal surgery. Boca Raton: CRC Press; 2004.
7. Freund WA. Zu meiner Methode der totalen Uterus-Exstirpation. Z Gynäkol. 1878;2:265.
8. Fuji S, Takakura K, Matsumura N, Higuchi T, Yura S, Mandai M, Baba T, Yoshioka S. Anatomic identification and functional outcomes of the nerve sparing Okabayashi radical hysterectomy. Gynecol Oncol. 2007;107:4–13.
9. Latzko W, Schiffmann J. Klinisches und Anatomisches zur Radikaloperation des Gebärmutterkrebses. Zbl Gynäkol. 1919;34:689–705.

10. Linkenheld J. Zur Totalexstirpation des Uterus. Z Gynäkol. 1881; 5:169.
11. Mackenrodt A. Beitrag zur Verbesserung der Dauerresultate der Totalexstirpation bei Carcinoma uteri. Z Geburtshilfe Gynäkol. 1894;29:157.
12. Meigs CC. Woman, her diseases and remedies. Philadelphia: Lea and Blanchard; 1850.
13. Meigs JV. Wertheim operation for carcinoma of cervix. Am J Obstet Gynecol. 1945;49:542.
14. Meigs JV, editor. Surgical treatment of cancer of the cervix. New York: Grune & Stratton; 1954.
15. Peham H, Amreich J. Gynäkologische Operationslehre. Berlin: S. Karger; 1930 .766 pp
16. Peham H, Amreich J. Operative gynecology. Philadelphia: J.B. Lippincott; 1934 .779 pp.
17. Peiser E. Anatomische und klinische Untersuchungen über den Lymphapparat des Uterus mit besonderer Berücksichtigung der Totalexstirpation bei Carcinoma uteri. Z Geburtshilfe Gynäkol. 1898;39:259–78.
18. Piver MS, Rutledge F, Smith JP. Five classes of extended hysterectomy for women with cervical cancer. Obstet Gynecol. 1974;44:265–72.
19. Querleu D, Morrow CP. Classification of radical hysterectomy. Lancet Oncol. 2008;9:297–303.
20. Ries E. Eine neue Operationsmethode des Uteruscarcinoms. 1. Beitrag. Z Geburtshilfe Gynäkol. 1895;32:266.
21. Ries E. Modern treatment of cancer of the uterus. Chicago Med Rec. 1895;9:284.
22. Schauta F. Die Operation des Gebärmutterkrebses mittels des Schuchardt'schen Pravaginalschnittes. Monatschr f Geburtsh u Gynakol. 1902;15:133.
23. Schauta R. Die Operation des Gebärmutterkrebses mittels des Schuchardtschen Paravaginalschnittes. Monatsschr Geburtshilfe Gynäkol. 1902;15:133–52.
24. Schauta F. Die erweiterte vaginale Totalexstirpation des Uterus beim Kollumkarzinom. Vienna: Safar; 1908.
25. Schuchardt K. Eine neue Methode der Gebärmutterexstirpation. Zbl Chir. 1893;20:1121.
26. Taussig FJ. Iliac lymphadenectomy for group II cancer of the cervix. Am J Obstet Gynecol. 1943;45:733.
27. Trimbos JB, Maas CP, Deruiter MC, Peters AAW, Kenter GG. A nerve-sparing radical hysterectomy: guidelines and feasibility in Western patients. Int J Gynecol Cancer. 2001; 11:180.
28. Veit P. Operation bei fortgeschrittenem Gebärmutterkrebs. Dtsch Med Wochenschr. 1891;40.
29. Wagner N.. Gebärmutterkrebs. Eine pathologisch-anatomische Monographie. Leipzig. 1858.
30. Wertheim E. Zur Frage der Radikaloperation beim Uteruskrebs. Arch Gynäkol. 1900;61:627–68.
31. Wertheim E. Die erweiterte abdominale Operation bei Carcinoma colli uteri. Berlin: Urban and Schwarzenberg; 1911 .223 pp
32. Wertheim E. The extended abdominal operation for carcinoma uteri (based on 500 operative cases). Am J Obstet Dis Women Children. 1912;66:169–32.

Part II

Topographical Anatomy



Topographical Anatomy for Hysterectomy Procedures

3

Thilo Wedel

Compartments of the Female Pelvic Cavity

The female pelvic cavity is divided into an anterior, middle and posterior compartment (Fig. 3.1). In contrast to the male pelvic cavity which is confined to two compartments and contains parenchymatous organs (e.g. prostate and seminal glands), all three female compartments consist of hollow visceral organs resting upon the pelvic floor:

- Anterior compartment: urinary bladder and urethra
- Middle compartment: uterus with uterine adnexa and vagina
- Posterior compartment: rectum and anal canal

The peritoneum covers the organs contained in these pelvic compartments from above. While the urinary bladder and rectum are only partially lined by peritoneal serosa, almost the entire uterus and the complete adnexa including the ovaries and uterine tubes are wrapped by peritoneum and, thus, readily accessible by transperitoneal approach. The peritoneum reflects from the uterine body anteriorly on to the fundus of the urinary bladder forming the vesicouterine pouch delimited laterally by the vesicouterine folds and posteriorly on to the rectal wall forming the rectouterine pouch delimited laterally by the rectouterine folds. Except for the posterior vaginal fornix directly facing the rectouterine pouch, the vagina is located extraperitoneally. Both peritoneal pouches are often filled with small intestinal loops, sigmoid colon or greater omentum, thus requiring proper exposure by moving the content upwards.

The pelvic compartments are separated by septa mainly composed of connective tissue and intermingled smooth muscle tissue. Between the anterior vaginal wall and both the urinary bladder and urethra extends the vesico−/urethrovaginal septum, between the posterior vaginal wall and the anterior rectal wall extends the rectovaginal septum. The connective tissue septa are devoid of major blood vessels and serve as separating gliding layers between the three pelvic compartments reflecting the different ontogenetic origins of the urinary, genital and digestive tract. Thus, if surgical dissection follows these self-opening planes between the pelvic compartments, the uterovaginal complex can be readily delineated from the urinary bladder and urethra anteriorly and the anorectum posteriorly without relevant bleeding risk [1–3].

Female Pelvic Floor

The female pelvic floor (Fig. 3.2) is of larger dimension than in males displaying a wider urogenital opening, although its muscle strength is generally lower and its nerve supply less developed. These peculiar features allow vaginal delivery, but also predispose to an higher susceptibility for structural and functional insufficiency and pelvic organ prolapse.

The pelvic floor is composed of a pelvic diaphragm consisting of the levator ani muscle and a urogenital diaphragm comprising the transverse perineal muscles. The levator ani muscle corresponds to a flattened and funnel-shaped muscle closing most of the lower pelvic aperture. However, along the ventral midline openings are left for the urethra and vagina (urogenital hiatus) and the anal canal (anal hiatus).

The largest portion of the levator ani muscle are the ileococcygeal muscles extending from the pelvic side walls to a midline raphe. The rather thin muscle layer originates at the tendinous arc of the levator ani muscle formed by condensed

Note In regards to the nomenclature of anatomical structures, eponymes although commonly used in medical literature (e.g. Lee/Frankenhäuser ganglion, Poupart ligament, Mackenrodt ligament, Cooper ligament, Denonvillier fascia, Waldeyer fascia, Sampson artery, Richard fimbria, Latzko and Okabayashi spaces, etc.) are avoided to prevent confusions frequently resulting from misinterpretation of the historical descriptions.

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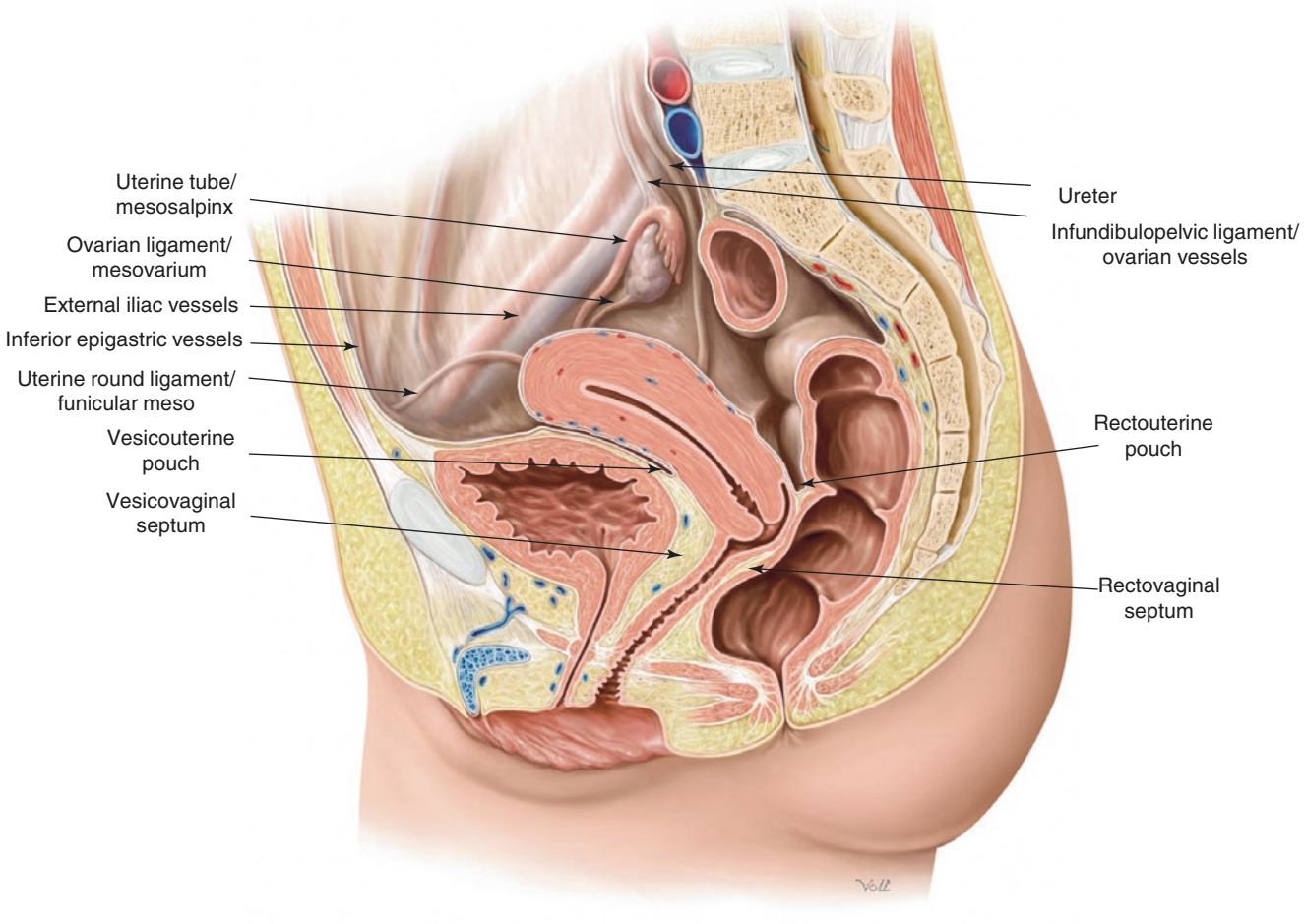


Fig. 3.1 Female pelvic cavity. Midsagittal section, view from left side (Reproduced from Schünke et al. [24])

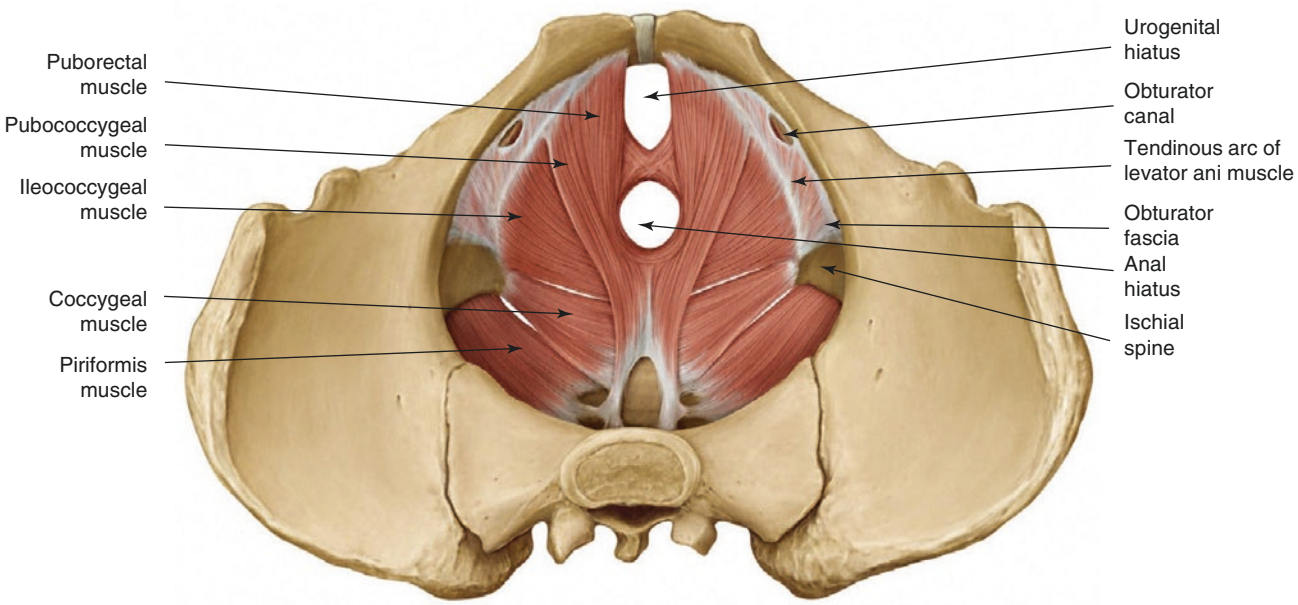


Fig. 3.2 Female pelvic floor. Cranial view. Content of pelvic cavity removed (Reproduced from Schünke et al. [24])

connective tissue of the obturator fascia ("white line"). The hammock-shaped pubococcygeal muscle originates from the pubic bone and extends towards the coccygeal bone, whereas the sling-shaped puborectal muscle bends arround the anal canal to produce the anorectal angle.

Innervation of the pelvic floor muscles is mainly provided by infralevatory branches of the pudendal nerve. In addition, also direct nerve branches the from sacral spinal nerves S3–S4 contribute and extend from the sacral concavity to reach the levator ani muscle from above. Thus, when exposing the pelvic floor muscle during extended deep lymphadenectomy, care must be taken to preserve these direct supralevatory nerve branches [1–3].

Uterus

The uterus (Fig. 3.3) is a pear-shaped hollow muscular organ of 7–9 cm length with its long axis nearly at right angle to that of the vagina (anteversion of uterine cervix plus anteflexion of uterine corpus) depending on the filling state of the urinary bladder. The anteroposteriorly flattened uterine corpus narrows caudally and continues into the cylindrical uterine cervix. The convex upper part of the uterine corpus is defined as the uterine fundus. On either side, a uterine cornu is formed to receive the uterine tube. Anterior to the uterine cornu inserts the uterine round ligament, posteroinferior to it attaches the ovarian ligament. The uterine cervix is 2–3 cm long, far less mobile than the uterine corpus due to its fixating ligaments and divided into a supravaginal and vaginal portion. Posteriorly the uterine cervix is covered by peritoneum, laterally it is in close relationship to the uterine arteries and the ureters flanking the uterine cervix at a distance of ca. 1–2 cm. The uterine cervical canal connects the uterine cavity with the vaginal lumen [3].

Uterine Adnexa

The uterine adnexa comprise the ovaries, ovarian tubes and ligaments adjacent to the uterus on both sides (Figs. 3.1 and 3.3). The ovaries lie in the ovarian fossae posterolateral to the uterus and medial to the external iliac vessels. They are attached to the uterus by the ovarian ligaments extending from the uterine pole of the ovary to the uterine cornu. The peritoneal fold raised by the ovarian ligament corresponds to the mesovarium containing the ovarian branch of the uterine artery (Figs. 3.5 and 3.8).

The tubal pole of the ovary is connected to the fimbriated end of the uterine tube. Between the tubal pole and the dorsolateral pelvic wall extends the infundibulopelvic ligament corresponding to a peritoneal fold raised by the ovar-

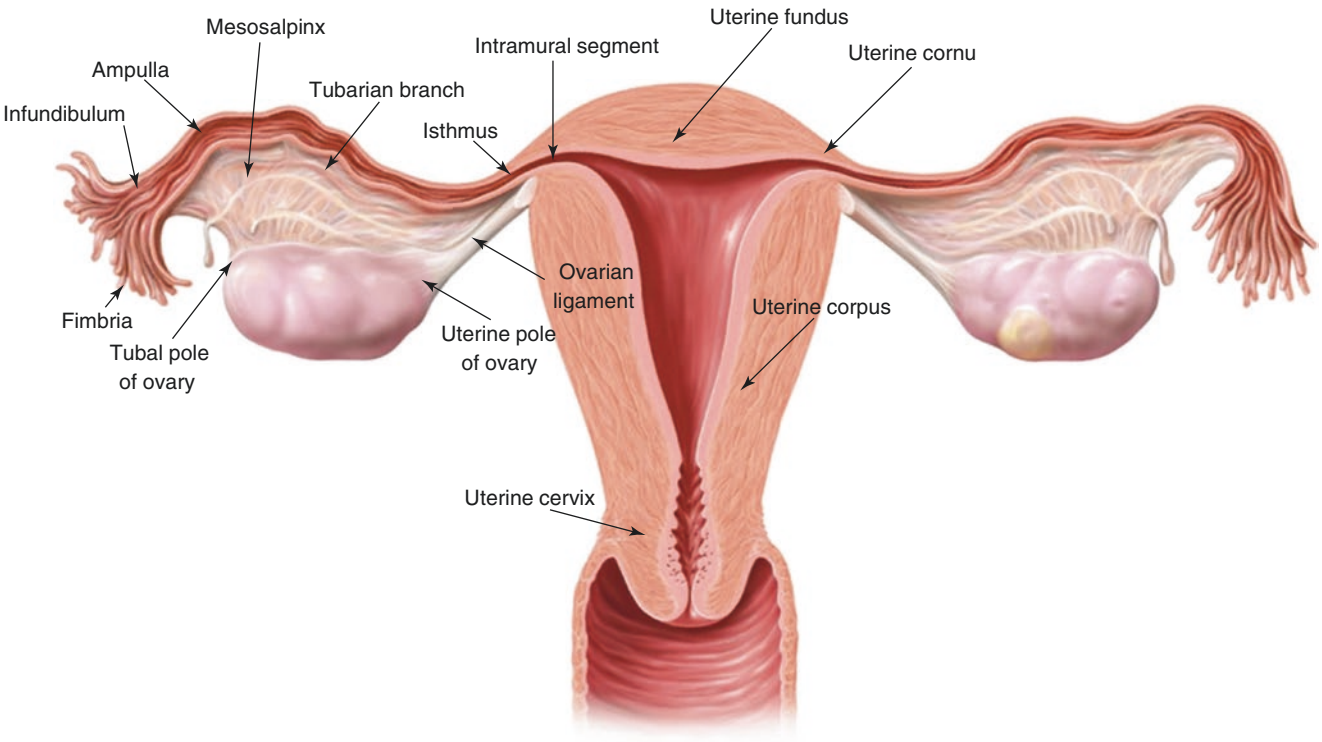


Fig. 3.3 Internal female genital organs. Frontal section, dorsal view. Broad ligament, parametrium and paracolpium removed (Reproduced from Schünke et al. [24])

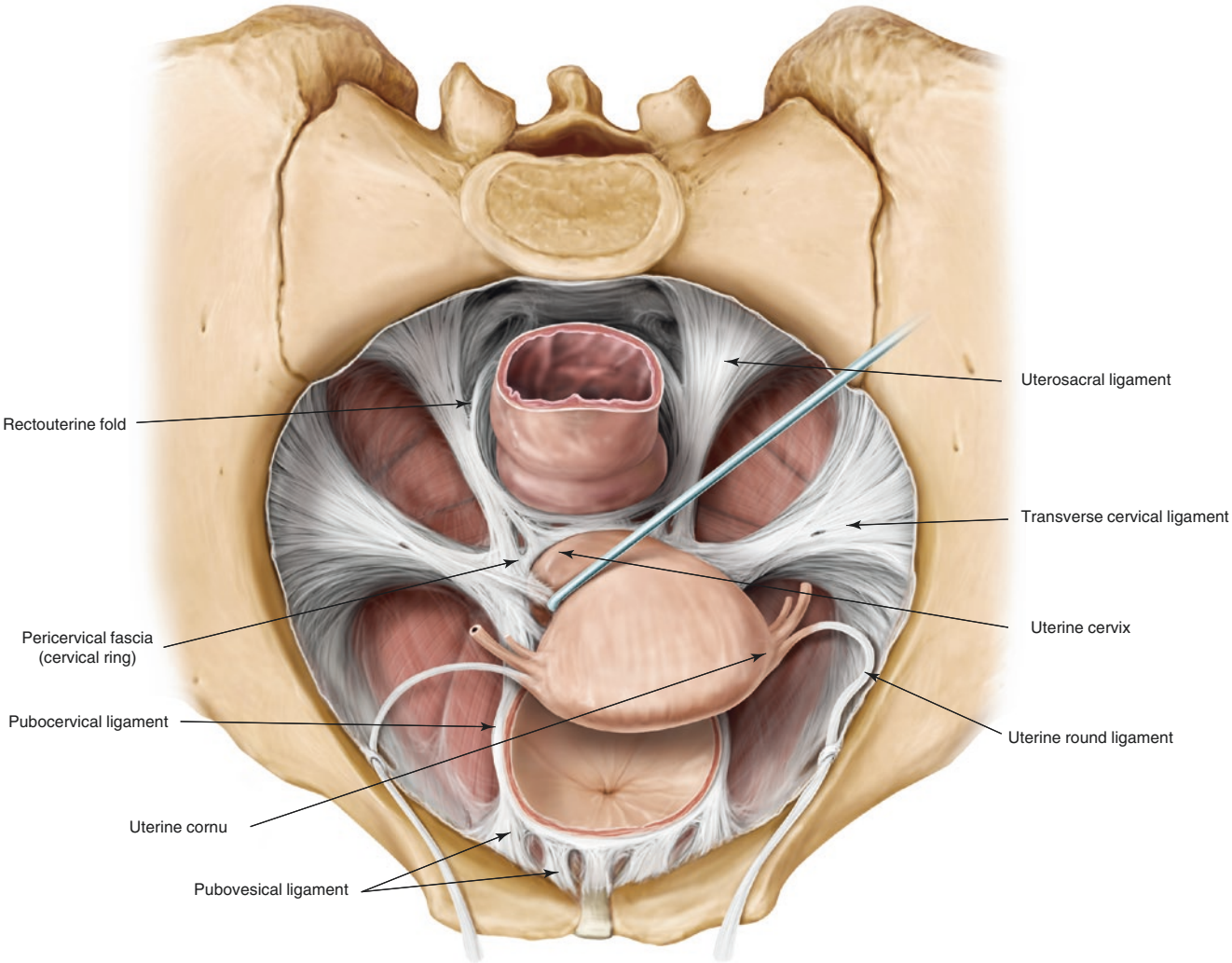


Fig. 3.4 Uterine ligaments. Cranial view. Rectum and urinary bladder are cut transversely, the uterus is shifted to the left side (Reproduced from Schünke et al. [24])

ian blood vessels. The synonym "suspensory ligament of the ovary" is inadequate, as the ovary is not substantially suspended by this peritoneal duplicature. When mobilizing the uterine adnexa, attention should be paid to the fact that the infundibulopelvic ligament together with the ovarian blood vessels cross the external iliac blood vessels ca. 1–2 cm anterolateral to the ureter. Moreover, due to its considerable intraperitoneal mobility the ovary may come into close proximity to both the external and internal iliac vessels and the ureter at the pelvic brim (Figs. 3.1, 3.5, 3.6, 3.9, and 3.7).

The uterine tube is ca. 9–11 cm long and connects the tubal pole of the ovary with the uterus. The infundibulum of the uterine tube is funnel-shaped and displays several fimbriae of which the ovarian fimbria is attached to the tubal pole of the ovary. The widened ampulla shows a luminal diameter of up to 10 mm and narrows at the isthmus to 0.1–0.5 mm. The uterine or intramural portion of the uterine tube is ca. 10 mm long and opens into the uterine cavity via the uterine os located at the uterine cornu. The peritoneal fold raised by the uterine tube corresponds to the mesosalpinx and contains the tubal branch of the uterine artery (Figs. 3.3, 3.5, and 3.8) [3].

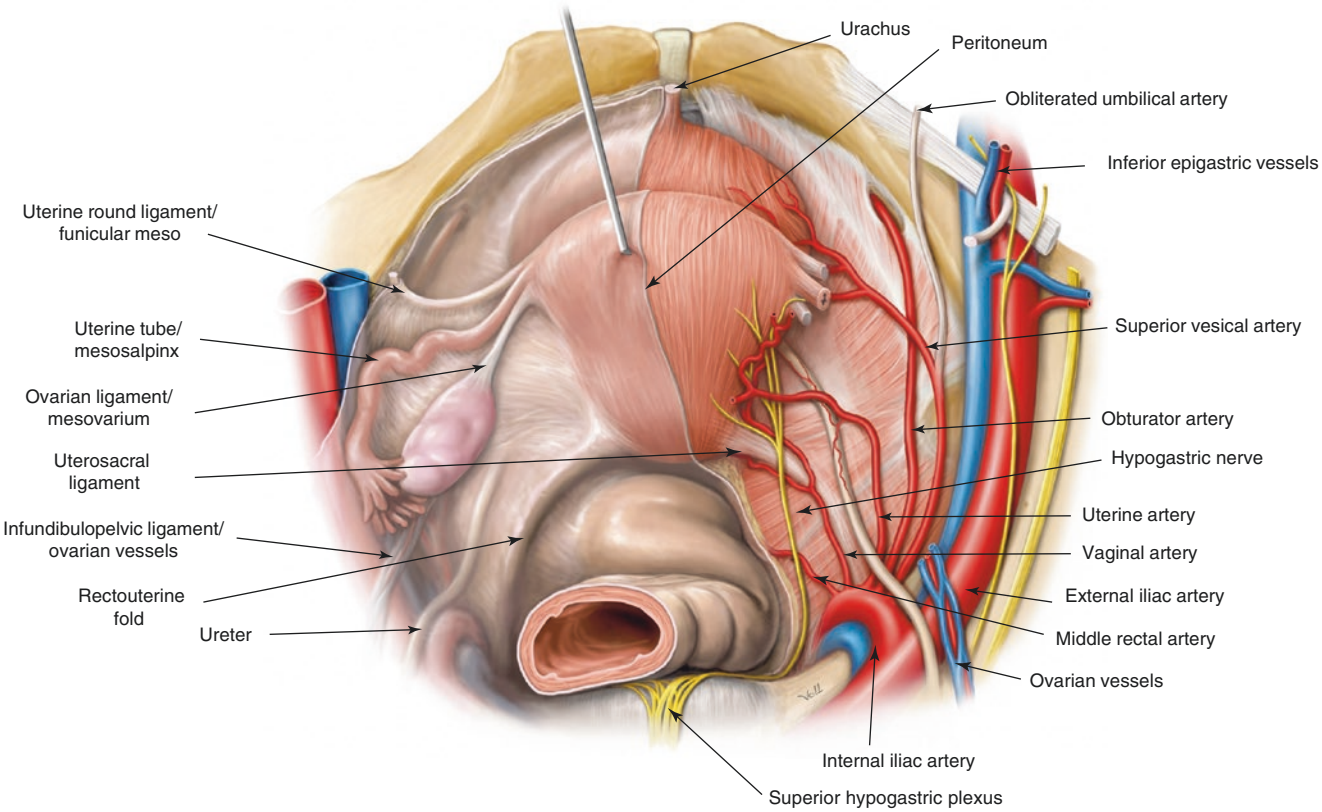


Fig. 3.5 Female pelvic cavity. Cranial view. The peritoneum, uterine adnexa and parametrial tissue are removed on the right side to expose the pelvic arteries and the ureter (Reproduced from Schünke et al. [24])

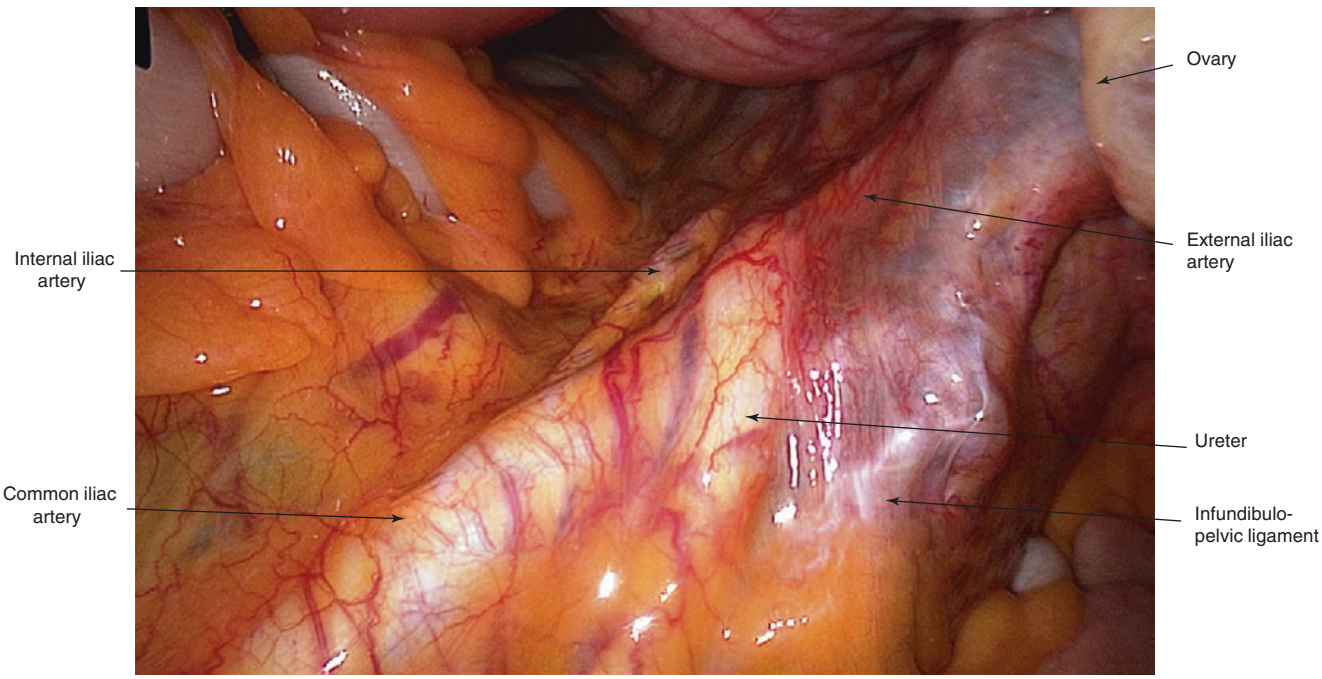


Fig. 3.6 Iliac vessels at the entrance into the right-sided female pelvis. Laparoscopic cranial view. The ureter crosses the pelvic brim running over the external iliac artery and medially to the infundibulopelvic ligament and the ovary

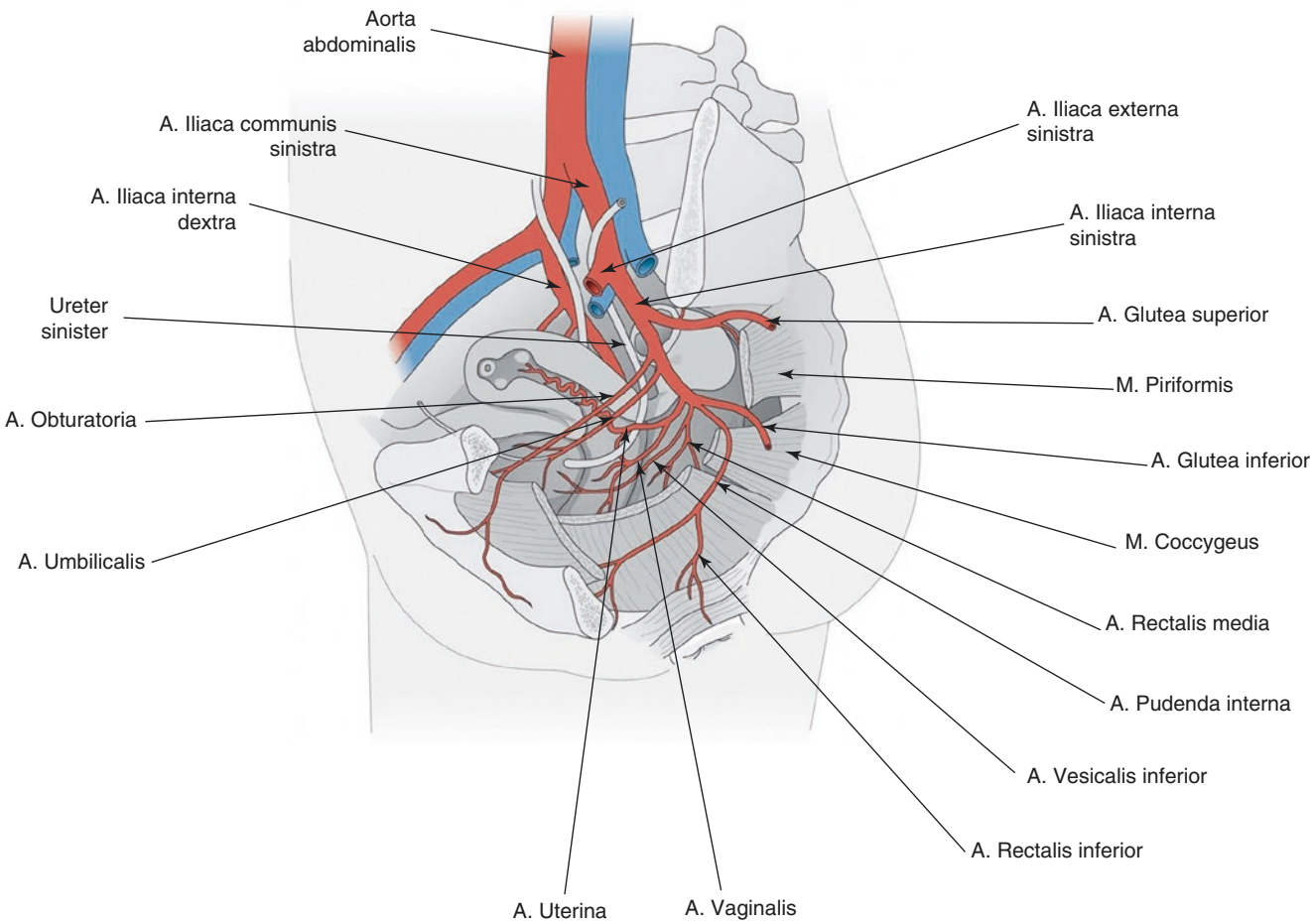


Fig. 3.7 Branches of the internal iliac artery in a female pelvis. Parasagittal section, view form left side. The left broad ligament is sectioned (Reproduced from Schünke et al. [24])

Uterine Ligaments, Parametrium and Mesometrium

Fixation of the uterovaginal complex is achieved on the one hand by the support of the pelvic floor (Fig. 3.2), on the other hand by uterine ligaments providing connections either to other pelvic organs or to the pelvic wall (Fig. 3.4). There is still an ongoing discussion about the exact tissue composition, topographic anatomy, functional relevance and terminology of these ligamentous, parauterine structures [1, 2, 4–7].

Broad Ligaments

The broad ligaments are named according to the fact that they provide a wide-stretched and ample connection between the middle pelvic compartment and the pelvic side walls. The peritoneal covering is lifted up by the broad ligaments and descends anteriorly to cover the paravesical space (anterior leaf) and posteriorly to cover the pararectal space (posterior leaf) on both sides. When viewed from above, the broad ligaments display three peritoneal folds on each side converging from different origins of the inner abdominal and pelvic walls towards the uterine cornu (Fig. 3.5):

- Funicular meso (anterior fold)
- Mesosalpinx (middle fold)
- Mesovarium (posterior fold)

The funicular meso corresponds to the peritoneal fold raised by the uterine round ligament extending from the uterine fundus below and lateral to the uterine cornu to the deep inguinal ring. The fibromuscular bands pass along the paravesical fossa and are accompanied by a branch from the uter-

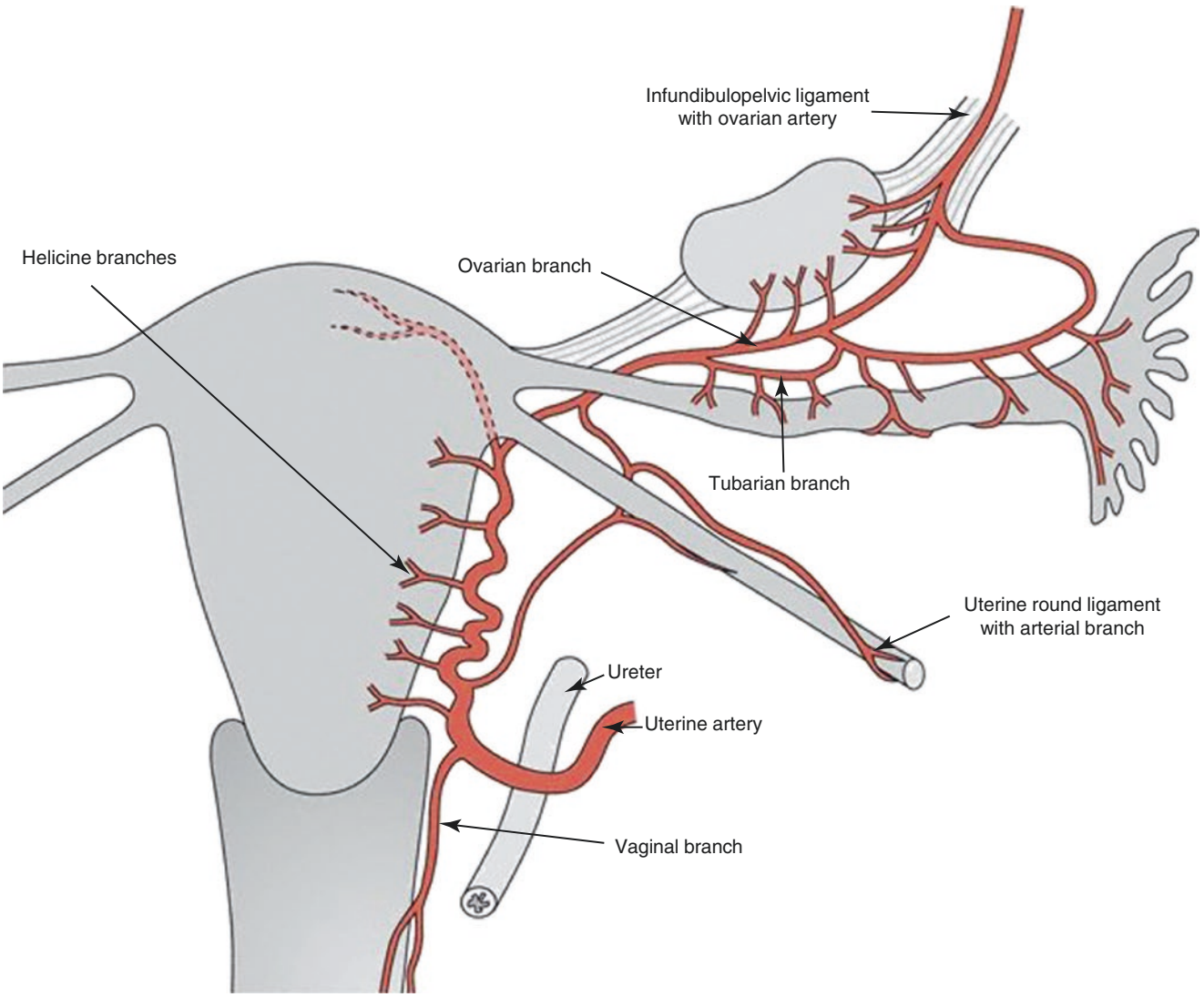


Fig. 3.8 Arterial supply of internal female organs. Ventral view. Branches of the left ovarian and uterine artery (Reproduced from Schünke et al. [24])

ine artery and lymphatic vessels draining to superficial inguinal lymph nodes. The mesovarium and mesosalpinx have been described previously (see section "Uterine Adnexa").

Parametrium and Transverse Cervical Ligaments

Beneath the peritoneal covering the broad ligaments consist of condensed connective tissue connecting the pelvic side walls with the uterus (parametrium) and the vagina (paracolpium) – comparable to those densifications of connective tissue extending lateral to the urinary bladder (paracystium) and rectum (paraproctium). The fibrous tissue contained within the parametrium/paracolpium corresponds to the transverse cervical ligaments (cardinal ligaments) which predominantly attach to the uterine cervix and vaginal fornix. Although composed of connective tissue providing a certain degree of mechanical suspension, the transverse cervical ligaments primarily resemble a mesentery-like structure serving as main routes of vascular, lymphatic and nervous supply of the uterus. The transverse cervical ligaments and parametrial tissue compartment are ca. 10 cm long and traversed by the ureter at its intermediate segment (Figs. 3.3, 3.4, 3.5, 3.10, 3.11, and 3.12) [4–6].

Uterosacral Ligaments

The uterosacral ligaments (Figs. 3.3, 3.4, and 3.5) attach to the uterine cervix and upper vagina and are often confluent with the uterine insertion site of the transverse cervical ligaments.

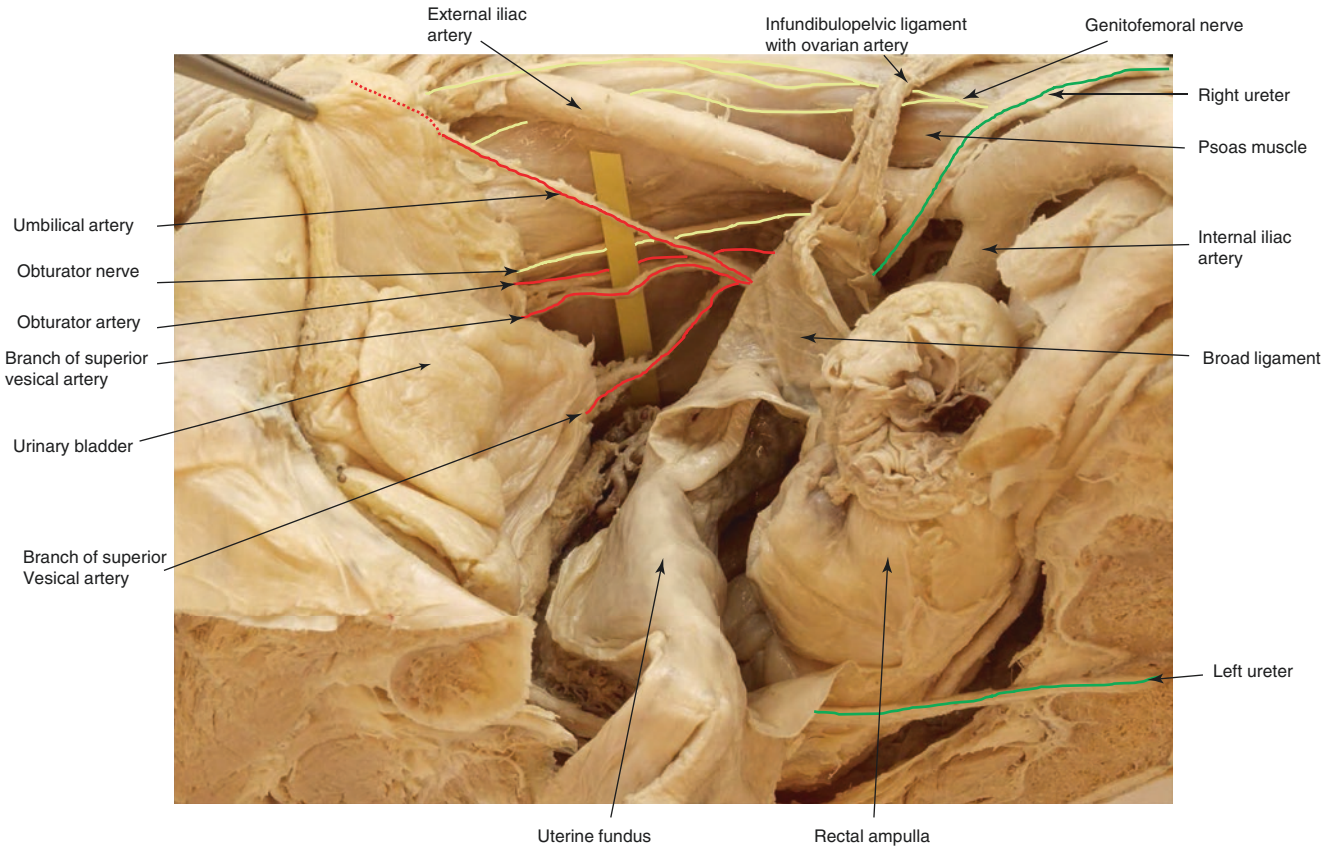


Fig. 3.9 Female right-sided hemipelvis. Parasagittal section, view from left side. The peritoneum is partially removed and incised, the anterior leaf of the right broad ligament is reflected dorsally, the urachus and the bladder roof are pulled upwards by a forceps, the obturator artery and nerve are marked by a yellow plastic strip. Arteries are highlighted by *red lines*, nerves by *yellow lines*, the ureter by *green line*. Formaldehyde-fixed specimen (same specimen also displayed in Fig. 3.10)

The fibrous bands extend dorsally along the rectal sidewalls to reach the sacrum. On their way to the sacrum they create the rectouterine folds and fan out before inserting at the sacral vertebrae S2–S4. The uterosacral ligaments serve as suspension of the uterine cervix and the vaginal tube ensuring the craniodorsal orientation of its long axis. In close proximity extend autonomic nerve fibers of the inferior hypogastric plexus passing immediately lateral to the uterosacral ligaments [4, 7–9].

Pubocervical Ligaments

The pubocervical ligaments (Fig. 3.4) connect the back side of the pubic bone with the uterine cervix. On their way to the uterus the pubocervical ligaments diverge around the urethra and bladder neck. In fact, all uterine ligaments – transverse cervical ligaments from both sides, uterosacral ligaments from behind, and pubocervical ligaments from front – insert at the uterine cervix. The insertion site is reinforced by a connective tissue condensation radially running around the uterine cervix termed cervical ring or pericervical fascia.

Mesometrium

The term mesometrium refers to the embryologically defined tissue compartment of the middle pelvic compartment that contains the neurovascular supply and major lymphatic drainage routes of the uterus – comparable to the mesorectum wrappend around the rectum in the posterior pelvic compartment. The mesometrium actually corresponds to the parametrial tissue, however further emphasizing its mesentery-like function provided by the lymphofatty tissue and accompanying uterine blood vessels and its clear delineation by fascial envelopes preventing early tumor transgression [6, 10].

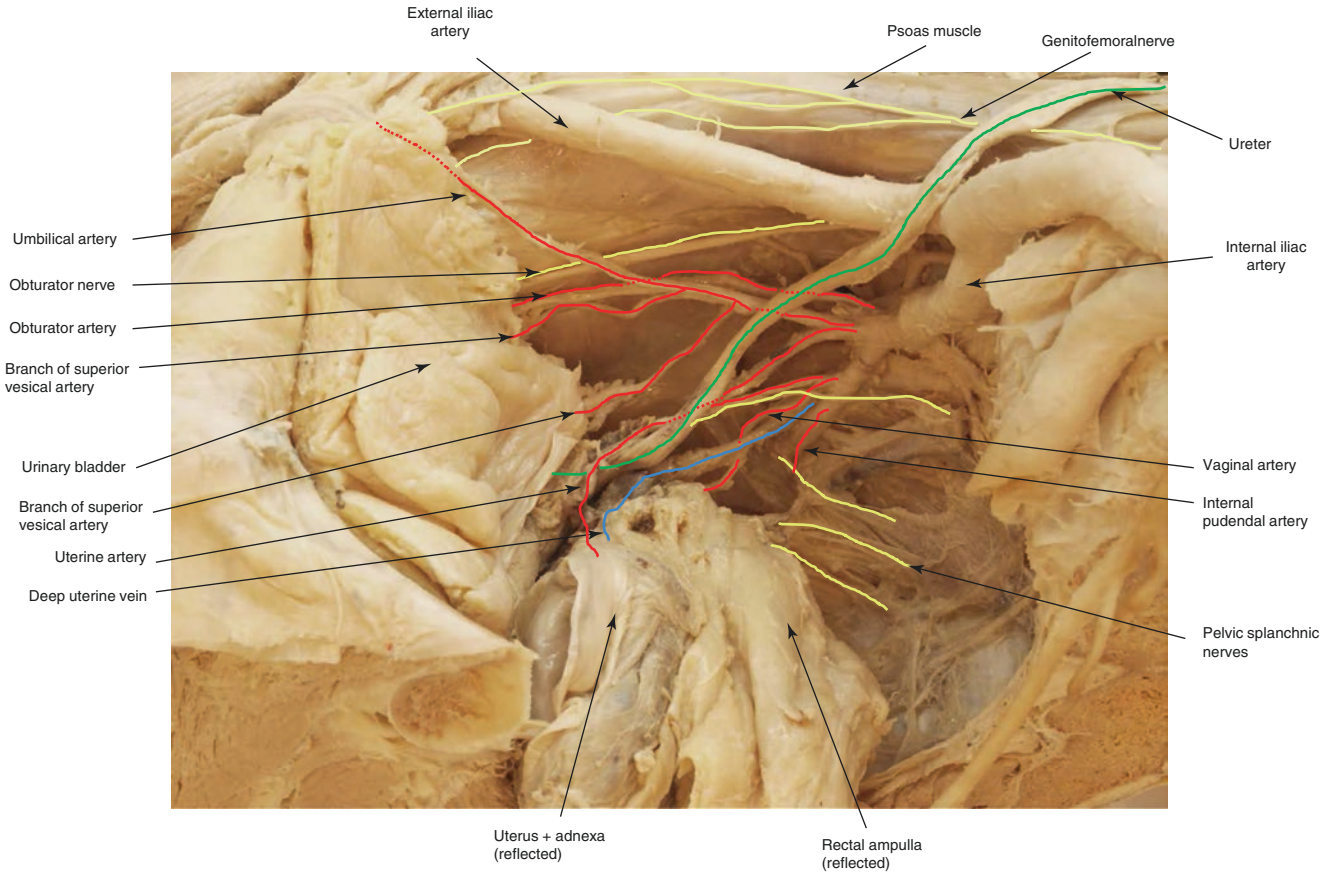


Fig. 3.10 Female right-sided hemipelvis. Parasagittal section, view from left side. The peritoneum is partially removed and incised, uterus and rectum are shifted to the left side to expose the blood vessels, nerves and ureter at the right pelvic sidewall. Arteries are highlighted by *red lines*, veins by *blue lines*, nerves by *yellow lines*, the ureter by *green line*. Formaldehyde-fixed specimen (same specimen also displayed in Fig. 3.9)

The clinical significance of the mesometrium has received special attention after the introduction of total mesometrial resection (TMME) for uterine cancer – in turn comparable to total mesorectal excision (TME) [11] carried for rectal cancer or complete mesocolic excision (CME) [12] recently introduced for colon cancer. All these surgical approaches are commonly based on the concept that tumor spread is initially confined to permissive ontogenetic compartments and its corresponding lymh node basins, so that complete removal of these embryologically defined packages will result in both optimal tumor control and low morbidity, if the resection margins are properly respected [10, 13, 14].

The uterine tubes, uterus and upper vagina are derivates of the paramesonephric ducts (Müllerian ducts). The distal fusion of the Müllerian ducts induces the development of the uterovaginal canal and the formation of the broad ligaments and the mesometrial tissue. According to Höckel the mesometrium can be subdivided into a vascular mesometrium containing the uterine vessels and surrounding lymphofatty tissue with mesometrial lymph nodes and a ligamentous mesometrium corresponding to the uterosacral ligaments and rectovaginal septum [10].

Blood Vessel Supply of Female Pelvic Viscera

The female pelvic viscera are mainly supplied by the internal iliac arteries (Figs. 3.5, 3.6, and 3.7) [3] The common iliac arteries originate at the aortic bifurcation in front of the left side of the fourth lumbar vertebra. They pass along the medial borders of the psoas major muscle without giving off branches and diverge into external and internal iliac arteries. Whereas the external iliac arteries follow the psoas major muscle until traversing the lacuna vasorum through the femoral ring to reach the lower limb, the internal iliac arteries descend into the pelvic cavity in posterocaudal direction over ca. 4 cm and then divide into an anterior and posterior trunk. To expose the inter-

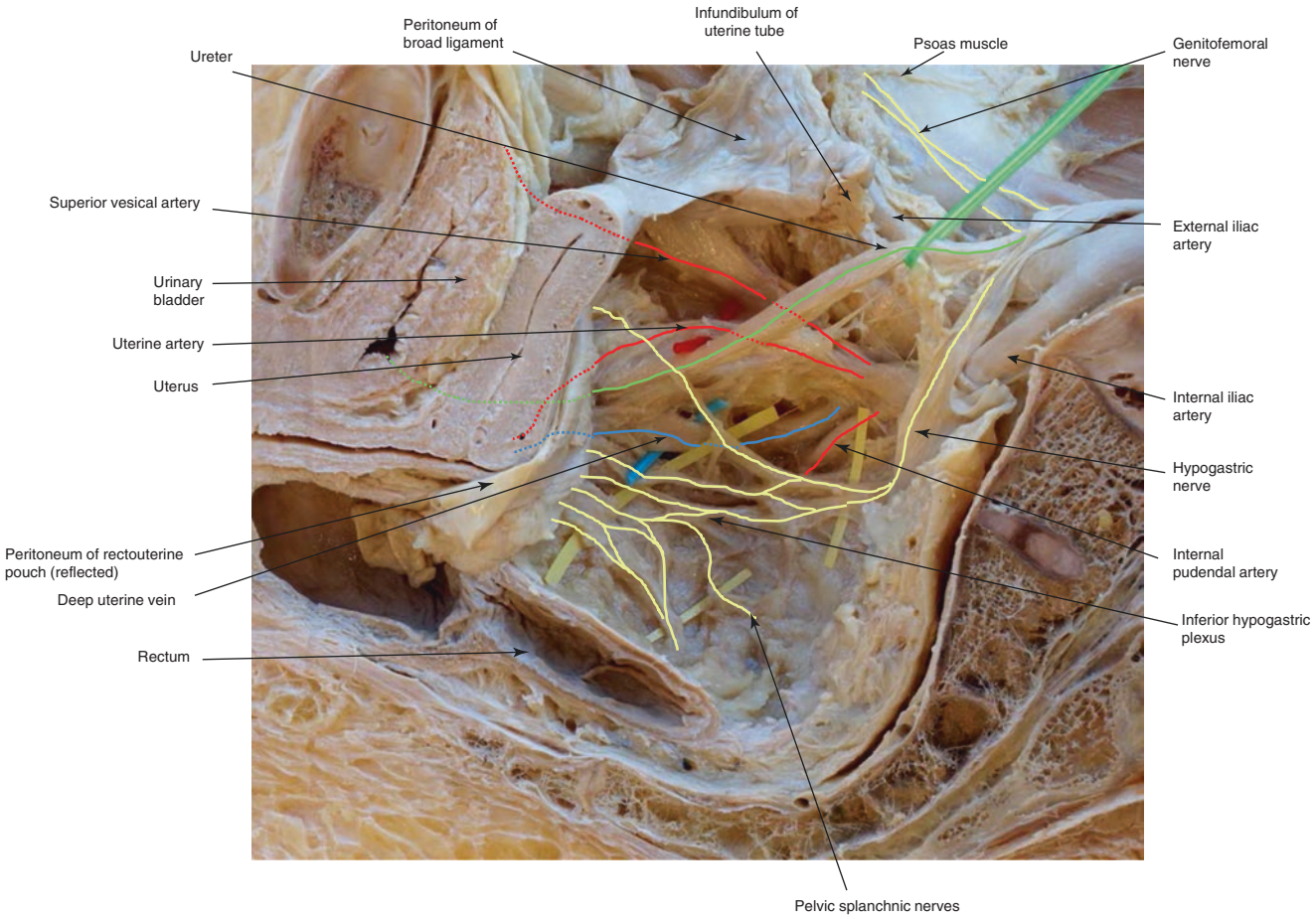


Fig. 3.11 Female right-sided hemipelvis. Midsagittal section, view from left side. The peritoneum is partially removed and shifted to the left side to expose the blood vessels, nerves and ureter at the right pelvic sidewall. The ureter is marked by a green vessel loop, the pelvic autonomic nerve plexus by yellow plastic strips, the uterine artery by a red plastic strip, the uterine vein by a blue plastic strip. In addition, arteries are highlighted by *red lines*, veins by *blue lines*, nerves by *yellow lines*, the ureter by *green line*. Formaldehyde-fixed specimen

nal iliac artery the adjacent and sometimes overlying infundibulopelvic ligament and ovary have to be shifted upwards. The common, external and internal iliac veins are located medially or dorsomedially to their arterial counterparts.

The anterior trunk or division of the internal iliac artery comprises the following branches:

Superior Vesical Artery

The superior vesical artery (Figs. 3.5, 3.7, 3.8, 3.9, 3.10, 3.11, and 3.12) is the first visceral branch and corresponds to the proximal, patent segment of the fetal umbilical artery. The artery follows the pelvic sidewall medially to the obturator vessels and nerve and craniolaterally to the urinary bladder. Before reaching the urinary bladder the superior vesical artery splits into various branches mostly for the vesical fundus and corpus but also for the distal ureter. The obliterated segment corresponds to the medial umbilical ligament ascending from the vesical fundus along the anterior abdominal wall to the umbilicus thereby forming the medial umbilical fold underneath the parietal peritoneum (Figs. 3.20 and 3.21). Gentle traction applied to the medial umbilical ligament allows easy identification of the superior vesical artery and usually thereby also of the uterine artery, as both arteries originate either from a common trunk or close to each other.

Uterine Artery

The uterine arteries supply (Figs. 3.5, 3.7, 3.8, 3.10, 3.11, 3.12, and 3.13) the entire uterus including the uterine tubes and uterine round ligaments and also the upper third of the vagina. The uterine artery originates from the internal iliac artery either as a separate branch or as a common trunk together with the superior vesical artery. Although the supe-

rior vesical and uterine arteries supply different pelvic compartments, vesicovaginal anastomoses are often observed, in particular regarding the corresponding veins.

The uterine artery runs through the parametrial tissue covered by the broad ligament towards the uterine cervix. The ureter crosses underneath the uterine artery ca. 1–2 cm lateral to the uterine cervix and lateral vaginal fornix and receives a supplying branch. Whereas in most of the cases one single uterine artery is present on each side, multiple uterine veins of different sizes can be observed which drain the uterine venous plexus. The uterine veins often do not directly follow the course of the uterine artery, but often pass underneath the ureter. The most caudally located vein is also termed deep uterine vein.

The main branch of the uterine artery ascends lateral to the uterus in meander-like course towards the uterine cornu where it gives off an ovarian branch running within the mesovar and a tubal branch running within the mesosalpinx. These branches establish anastomoses with the ovarian artery. An additional branch originates at the uterine cornu to follow and supply the uterine round ligament.

From the tortuous segment of the uterine artery multiple helicine branches enter in the uterine wall, divide into arcuate arteries and supply the myometrial and endometrial layers by giving off radial and spiral branches. The right and left uterine arteries establish extensive intramural anastomotic connections across the midline, so that the uterine blood supply is not seriously compromised after unilateral ligation. At the level of the uterine cervix branches descend to the vagina and anastomose with branches of the vaginal artery to form two longitudinal vessels. These vaginal azygos arteries run along the anterior and posterior vaginal wall.

Vaginal Artery

In addition to vaginal branches of the uterine artery one or more arteries originating from the internal iliac artery directly run to the vagina. These vaginal arteries (Figs. 3.5, 3.7, and 3.10) correspond to the inferior vesical artery in males and supply the vagina, vaginal vestibule as well as the vesical trigone and urethra.

Middle Rectal Artery

The last visceral branch of the internal iliac artery is the middle rectal artery (Figs. 3.5 and 3.7) running above the levator ani muscle within the lateral rectal pedicles together with autonomic nerve fibers of the rectal plexus to reach the rectal wall. However, in contrast to both the superior vesical and uterine arteries the middle rectal arteries are much smaller in size and inconstantly present, as the rectal blood supply is mainly provided by the more promiment superior rectal artery running within the mesorectum (Figs. 3.17 and 3.18).

Obturator Artery

The obturator artery (Figs. 3.5, 3.7, 3.9, 3.10, and 3.13) is one of the first branches of the internal iliac artery. However, it does not primarily supply the pelvic viscera, but leaves the pelvic cavity via the obturator canal to approach the adductor muscles of the medial thigh. In the pelvis the artery passes medially to the internal obturator muscle and caudally to the obturator nerve which converges with the obturator vascular pedicle at the entrance foramen of the obturator canal. At its proximal segment the obturator artery is located in close proximity both to the ureter and the ovary and it gives off iliac branches supplying the iliopsoas muscle. From the distal segment vesical branches may ramify and pass medially to the urinary bladder.

Frequently, an anastomotic connection between the obturator and inferior epigastric artery is provided by a pubic branch running across the pubic bone over the pectineal ligament (Figs. 3.13, 3.14, and 3.20). A prominent pubic branch is also termed corona mortis (“crown of death”), because in earlier times an inadvertent injury of this vessel during inguinal or femoral hernia repair has led to serious bleedings. In up to one third of cases the obturator artery does not originate from the internal iliac artery but from the inferior epigastric artery or even the external iliac artery sending an enlarged pubic branch directly towards the obturator canal. In any case, special attention should be payed to these vascular variations, when operating in the obturator fossa and paravesical space, e.g. for extended pelvic lymphadenectomy.

Internal Pudendal Artery

The internal pudendal artery (Figs. 3.7, 3.10, and 3.11) is one of the terminal branches of the anterior division of the internal iliac artery and supplies the perineal region, anal canal, external genital organs, and pelvic floor muscles. The artery descends laterally in front of the piriformis muscle and sacral nerve plexus roots, leaves the pelvis through the infrapiriform hiatus of the greater sciatic foramen and bends around the ischial spine to enter into the ischioanal fossa via the lesser sciatic foramen. The artery is accompanied medially by the internal pudendal vein and pudendal nerve. Branches of the internal pudendal artery include muscular branches for the pelvic and gluteal region, inferior rectal artery, perineal arteries, posterior labial branches, branches to the vestibular bulb and vaginal introitus, deep and dorsal artery of the clitoris.

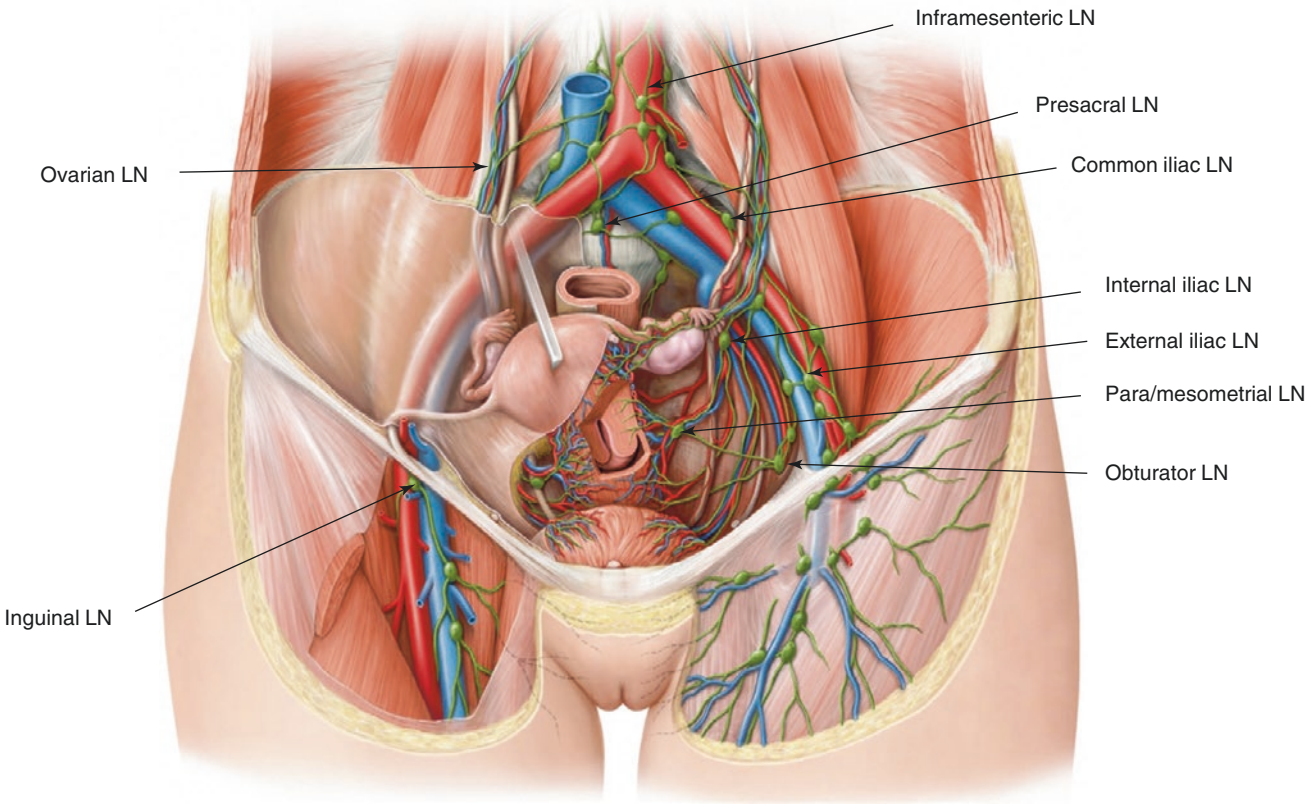


Fig. 3.12 Lymph nodes (LN) and lymphatic drainage of female genital organs. Ventral view. The uterus is shifted to the right side, the peritoneum is removed on the left side and above the aortic bifurcation (Reproduced from Schünke et al. [24])

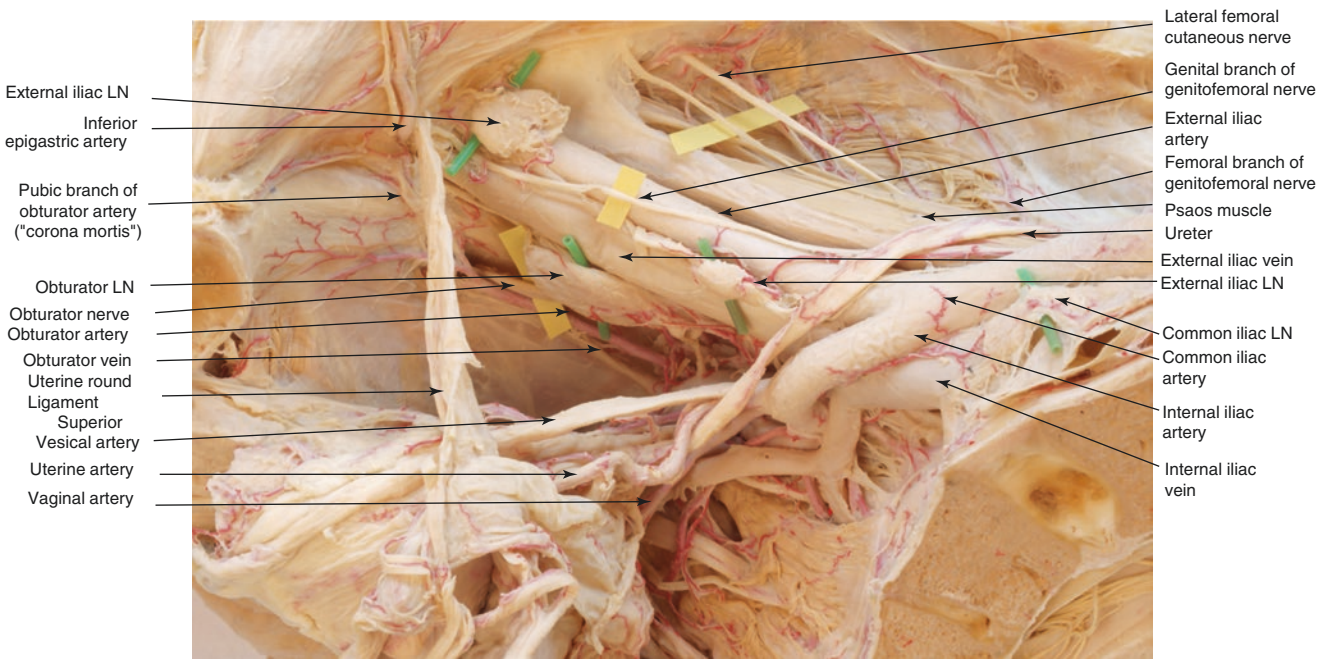


Fig. 3.13 Female right-sided hemipelvis, view from left side. The peritoneum is completely removed and the pelvic viscera are shifted to the left side to expose the blood vessels, nerves and ureter at the right pelvic sidewall. Lymph nodes (LN) are marked by green plastic tubes, nerves by yellow plastic strips. Formaldehyde-fixed specimen

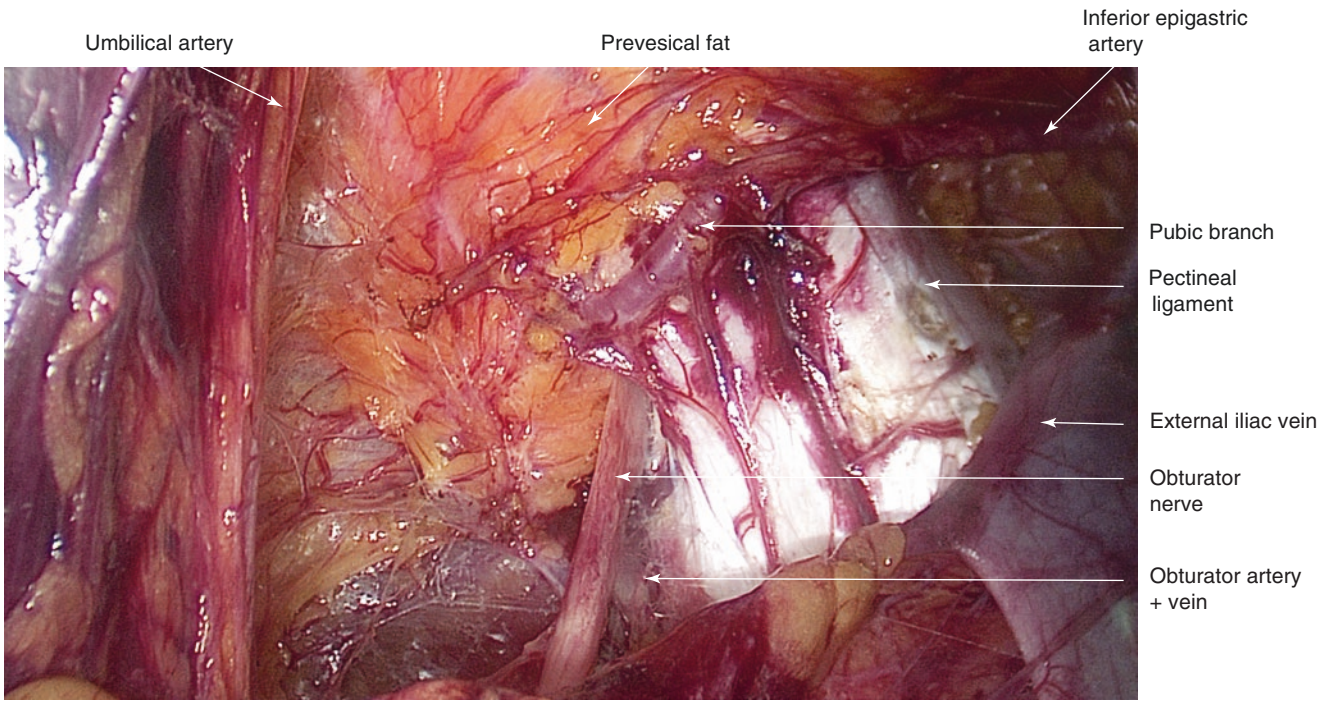


Fig. 3.14 Exposure of right-sided prevesical space and obturator fossa. Laparoscopic cranial view. A prominent pubic branch is visible crossing the pectineal ligament and the superior pubic ramus

Inferior Gluteal Artery

The inferior gluteal artery (Fig. 3.7) is the other terminal branch of the anterior division of the internal iliac artery, however often originating from a common stem together with the internal pudendal artery. It also decends anterior to the piriformis muscle and sacral nerve plexus, but then passes posteriorly between the ventral rami of the sacral spinal nerves and traverse the infrapiriform hiatus of the greater sciatic foramen to reach the gluteal and posterior femoral region.

The posterior trunk or division of the internal iliac artery comprises the following branches:

Iliolumbar Artery

The iliolumbar artery is the only ascending branch of the internal iliac artery passing posterior to the external iliac vessels and obturator nerve in front of the sacroiliac joint to reach the psoas muscle. The iliac and lumbar branches supply the muscles of the corresponding regions and establish anastomoses with the gluteal and deep circumflex iliac arteries.

Lateral Sacral Arteries

Usually a superior and inferior branch originate from the internal iliac artery, descend and approach the anterior sacral foramina to supply the sacral canal and dorsal sacral region. The lateral sacral arteries anastomose from both sides with the median sacral artery.

Superior Gluteal Artery

The superior gluteal artery (Fig. 3.7) corresponds to the terminal branch of the posterior division of the internal iliac artery. Immediately after its origin the large vessel traverses between the first ventral rami of the sacral spinal nerves to leave the pelvis via the suprapiriform hiatus of the greater sciatic foramen. Deep and superficial branches of the superior gluteal artery supply the gluteal and sacral region and anastomose with the inferior gluteal, deep circumflex iliac and circumflex femoral arteries.

Pelvic Veins

As a general rule, larger veins such as the common, external and internal iliac veins follow the course of their arterial counterparts. In most cases, the veins run medially or dorsomedially to the arteries. The same observation holds true for most of the parietal branches (e.g. obturator, pudendal, gluteal veins) of the internal iliac artery, whereas the visceral branches display different features: the urinary bladder, uterus and vagina are drained by venous plexus which are interconnected with each other and release the blood into multiple vesical, vaginal and uterine veins. These veins do

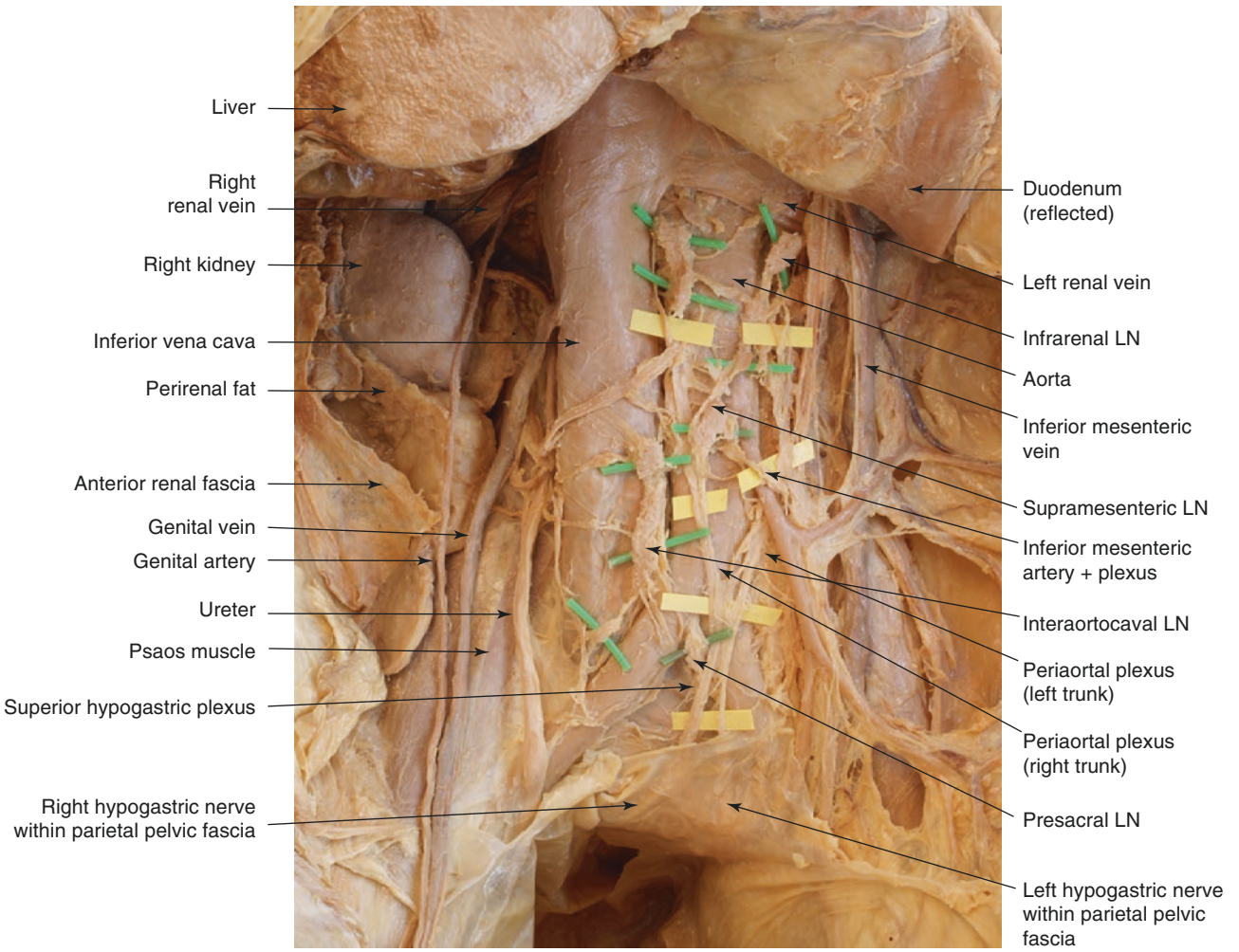


Fig. 3.15 Prevertebral and retroperitoneal region. Ventral view. The parietal peritoneum is removed down to the entrance into the pelvic cavity on both sides, the anterior renal fascia is removed on the left side. Lymph nodes (LN) are marked by green plastic tubes, nerves by yellow plastic strips. Formaldehyde-fixed specimen

not strictly accompany and parallel the arteries until they have entered into the internal iliac vein.

It has to be emphasized that during laparoscopic or roboter assisted surgery, pelvic veins often collapse due to the intraperitoneal pressure exerted by gas insufflation onto the thin venous walls. Thus, special care must be taken to clearly identify and respect the pelvic veins, because injury may occur inadvertently and lead to troublesome bleeding sometimes only evident after diminishing the intraperitoneal pressure.

Lymph Nodes and Lymphatic Drainage of the Uterus and Uterine Adnexa

In general, lymphatic drainage follows the blood supply of the corresponding organs and is realized by a network of rather thin-walled lymphatic vessels and lymph nodes grouped along the nutrient vascular branches and enveloped by fatty and loosely arranged connective tissue. As the arterial supply of the uterus and uterine adnexa originates from two sources (uterine and ovarian arteries), the main lymphatic drainage involves both pelvic and paraaortic routes and is therefore complex and multidirectional due to the peculiar ontogenetic anatomy of the female genital tract [3]. However, direct lymphatic drainage pathways into the anterior pelvic compartment via the vesicouterine ligaments or into the posterior compartment via the uterosacral ligaments could not be demonstrated [15, 16].

Lymphadenectomy is considered to be an integral component of the surgical treatment for uterine carcinoma. Due to the topographic complexity of lymphatic drainage and close proximity between lymph nodes and both blood vessels and nerves, pelvic and paraaortic lymph node dissection are challenging and often time consuming procedures. Therefore, profound anatomical knowledge of the different lymph node

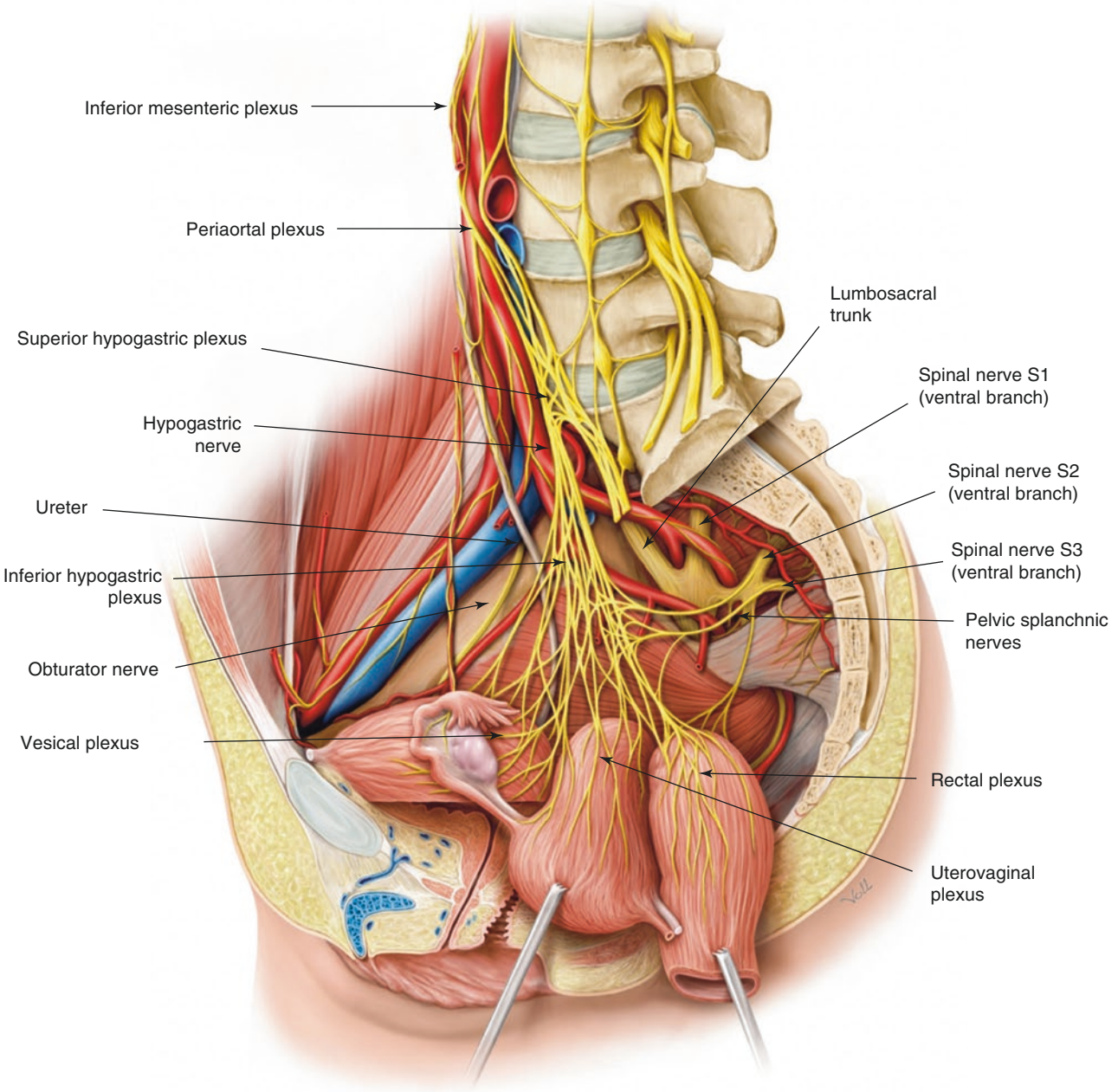


Fig. 3.16 Nerve supply of female pelvic viscera. Midsagittal section, view from left side. Uterus and rectum are shifted to the left side to expose the pelvic autonomic nerve plexus, (Reproduced from Schünke et al. [24])

regions is required to be familiar with the anatomical landmarks which help to identify and preserve structures at risk when removing the areolar fibrofatty tissue pads harbouring the relevant lymph nodes.

The pelvic lymphatic system is composed of parietal lymph nodes and trunks following the major pelvic blood vessels and of organ-related lymph nodes intercalated into the different mesenteries supplying the pelvic viscera. The following pelvic lymph node compartments or basins can be described: [13, 17, 18].

External Iliac Lymph Nodes

The external iliac lymph basin (Figs. 3.9, 3.10, 3.12, and 3.13) extends from the common iliac bifurcation down to the femoral ring along the psoas muscle. The medial border of the compartment is defined by the paravesical and obturator fossa. Lymph nodes may be further subdivided into a lateral group located between the external iliac vessels and the psoas muscle, an intermediate group between the artery and vein, and a medial group between the vein and the pelvic

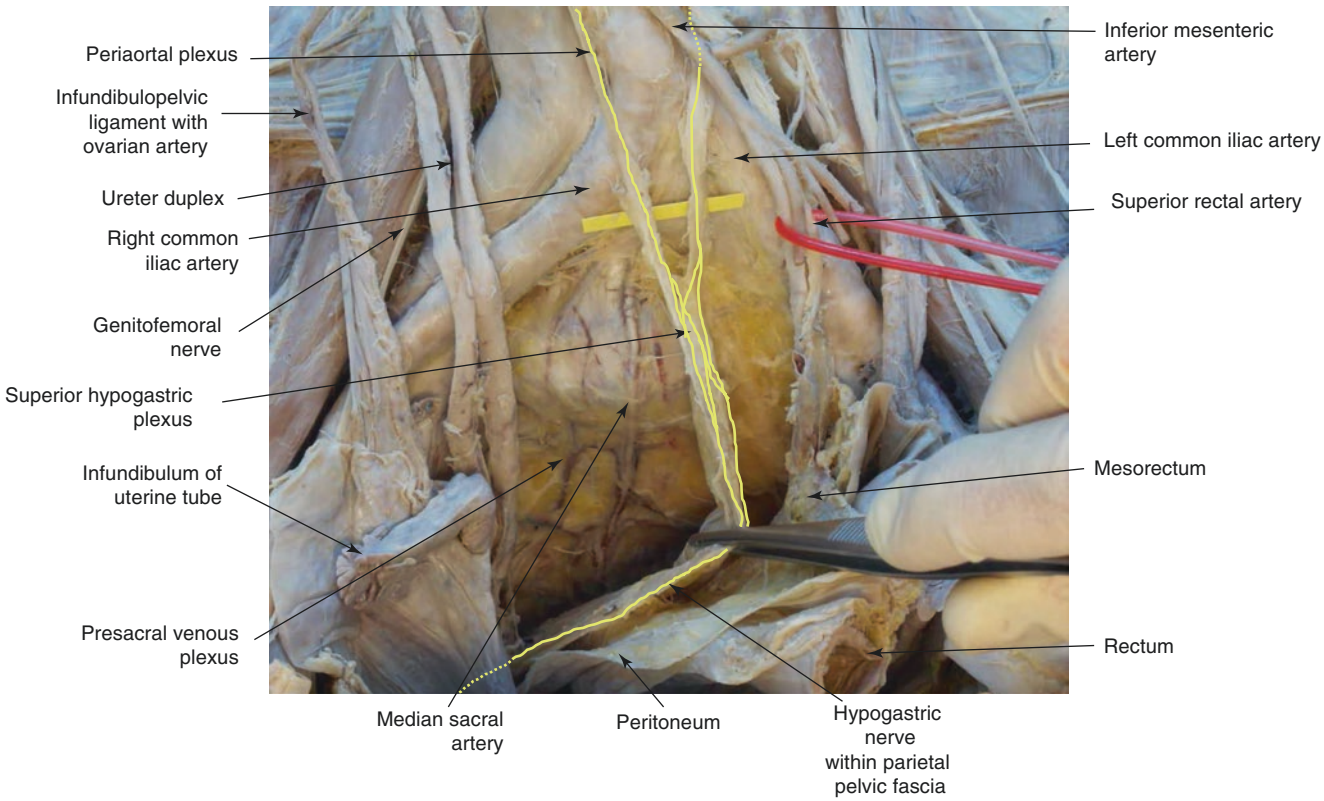


Fig. 3.17 Presacral region of a female pelvis. Ventral view. The peritoneum is removed, the rectum and mesorectum are shifted ventrally towards the left side, the pelvic parietal fascia is grasp by a forceps and also pushed ventrally to left side. The superior rectal artery is marked by a red vessel loop, the autonomic nerves are highlighted by *yellow lines* and plastric strip. Formaldehyde-fixed specimen

sidewall. Structures at risk during lymph node dissection are the external iliac vessels, in particular the vein when lifted up for harvesting medial lymph nodes, and the genitofemoral nerve when harvesting lymph nodes lateral to external iliac vessels. In some instances, minor branches originating from external iliac vessels to supply the psoas muscle may be torn and bleed during lymph node removal in this compartment.

Internal Iliac Lymph Nodes

Internal iliac lymph nodes (Figs. 3.10, 3.11, 3.12, and 3.13) follow the anterior and posterior trunk of the internal iliac artery and its corresponding branches, thus collecting lymphatic fluid from parietal/somatic structures, e.g. gluteal, perineal, sacral regions, as well as visceral organs, e.g. bladder, uterus, rectum. The compartment originates at the common iliac bifurcation and extends dorsally onto the piriformis muscle, caudally down to the levator ani muscle and ventrally to the origin of the visceral arterial branches for the urinary bladder and uterus. Most important for lymph node dissection is the direct vicinity of both the ureter and the delicate branches of the inferior hypogastric plexus approaching the internal iliac branches and lymph nodes from the medial side.

Common Iliac Lymph Nodes

The common iliac lymph nodes (Figs. 3.9, 3.10, 3.12, and 3.13) drain the external and internal iliac lymph nodes and follow the common iliac vessels towards the aortic bifurcation. Like the external iliac lymph nodes, they can be further subdivided into a lateral group facing the iliolumbar fossa, an intermediate group intercalated between the common iliac vessels adjacent to the lumbosacral trunk, and a medial group located along the pelvic brim underneath the common iliac vein. Structures at risk during lymph node dissection are the genitofemoral nerve on the lateral side, the lumbosacral trunk and obturator nerve at the dorsocaudal aspect and the ureter crossing the common iliac bifurcation.

Presacral Lymph Nodes

In front of the promontorium and underneath the aortic bifurcation the bilateral common iliac lymph routes drain into presacral lymph nodes (Figs. 3.12, 3.15, 3.16, 3.17, and 3.18), also termed promontory, midsacral or subaortic lymph nodes. The presacral compartment extends from the aortic bifurcation down to the end of the second sacral vertebra.

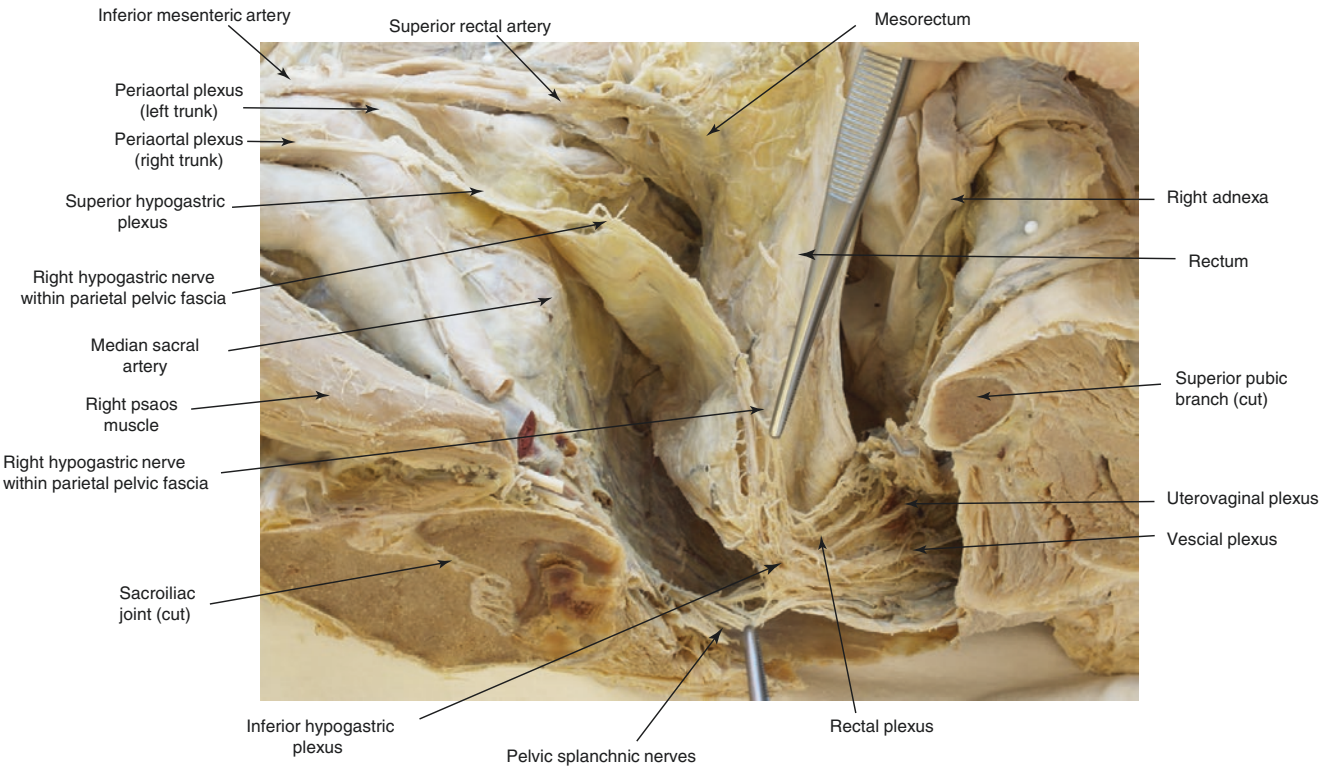


Fig. 3.18 Female left-sided hemipelvis. Parasagittal section, view from right side. The peritoneum is removed, the rectum and uterine adnexa are shifted ventrally, the forceps grasps the right hypogastric nerve embedded within the parietal pelvic fascia. Formaldehyde-fixed specimen with previous hysterectomy

Structures at risk during lymph node dissection are the median sacral artery and the presacral venous plexus as well as the thin-walled common iliac veins, in particular the left one due its exposed course running above the promontorium. Moreover, the promontorium region is crossed slightly left by the superior hypogastric plexus giving off the hypogastric nerves on both sides.

Obturator Lymph Nodes

The obturator lymph nodes (Figs. 3.9, 3.10, 3.12, 3.13, and 3.14) are distributed within the areolar fibrofatty tissue pad extending along the pelvic sidewall formed by the internal obturator muscle, the tendinous arcs of levator ani muscle and parietal pelvic fascia, and the levator ani muscle itself. The upper border is defined by the pelvic brim and the external iliac vessels, the dorsal border by the common iliac bifurcation, and the medial border by the visceral branches of the internal iliac artery. The obturator fossa is traversed by the neurovascular obturator pedicle composed of the obturator nerve recognizable by its pearl-white colour and the obturator artery and vein which join the nerve coming from below. The neurovascular obturator pedicle enters into the obturator canal beneath the superior pubic branch and frequently displays a pubic branch anastomosing with the inferior epigastric artery.

Lymph nodes in this compartment may be further subdivided into supraobturator (superficial) and infraobturator (deep) lymph nodes according to its position related to the obturator pedicle. Complete lymphadenectomy of the obturator fossa requires also subtle clearance of infraobturator nodes located below the obturator pedicle and along the upper surface of levator ani muscle. However, care must be taken not to injure the obturator pedicle itself as well as the neurovascular pedicles of the urinary bladder, in particular the vesical venous plexus.

Obturator and internal iliac lymph nodes may also be subsumed as paravisceral lymph nodes, as they are located adjacent to pelvic visceral organs which they drain – that is the urinary bladder and the uterus.

Parametrial/Mesometrial Lymph Nodes

Those lymph nodes located in close topographical vicinity to the uterus underneath the broad ligament (parametrium) and intercalated into the uterine mesentery (mesometrium)

correspond to the parametrial/mesometrial lymph nodes (Figs. 3.10, 3.11, and 3.12). They are embedded in areolar fibrofatty tissue and follow the branches of the uterine artery (vascular mesometrium). On the one hand, the aim of oncologic surgery is to completely remove these organ-related lymph nodes. On the other hand, the vesical neurovascular pedicles supplying the urinary bladder and the ureters crossing the parametrial compartment have to be preserved during lymphadenectomy of the parametrial/mesometrial tissue.

The paraaortic lymphatic system composed of the lumboaortic lymphatic chains extends beyond the pelvic lymph nodes and may be affected by lymphatic spread of tumors involving the uterine body and/or fundus and uterine adnexa. In these cases, lymphadenectomy should include removal of the lymph routes following the infundibulopelvic ligament and the ovarian vessels up to the paraaortic lymph basins. The following paraaortic lymh node compartments can be described:

Inframesenteric Lymph Nodes

Inframesenteric lymph nodes (Figs. 3.12 and 3.15) extend from the origin of the inferior mesenteric artery along the aorta and inferior vena cava down to the aortic and caval bifurcation. The lateral borders of this compartment are defined by the ureters running in front of the psoas muscles and undercrossing the ovarian vessels. On the left side, the ureter also undercrosses the root of the sigmoid mesocolon and the inferior mesenteric pedicle which has to be lifted up to achieve full exposure and protection of the ureter. The paraaortic lymph nodes are grouped into a readily discernible ventral chains including interaortocaval lymph nodes and less obvious dorsolateral chains. Thus, complete inframesenteric lymph node removal requires full exposure of both pericaval and periaortal tissue compartments.

However, dissection should be carried out carefully avoiding a too rigorous "cleaning" of the large prevertebral vessels to preserve or at least minimize the damage of the perivascular autonomic nervous network. Nerve fibers emerge from paravertebral sympathetic ganglia and form an aortic plexus composed of a left and right periaortal trunk with multiple interconnecting fibers crossing in front of the aortal wall. While the inferior mesenteric plexus follows the corresponding artery into the inferior mesenteric pedicle for the left and rectosigmoid colon, the superior hypogastric plexus descends in front of the aorta to divide in front of the promontorium into the left and right hypogastric nerves. Preservation of these autonomic nerve plexus is best achieved, when both the inferior mesenteric pedicle and superior hypogastric plexus are gently lifted up to gain access to the paraaortic lymph nodes. Care should also be taken to preserve the segmental lumbar arteries and veins and the small blood vessels approaching the ureter from the medial side.

Supramesenteric/Infrarenal Lymph Nodes

Supramesenteric lymph nodes (Fig. 3.15) include those lymph nodes of the paraaortic compartment located superior to the inferior mesenteric root and inferior to the left renal vein. Like in the inframesenteric compartment, supramesenteric lymph nodes are grouped around and in between the large vessels. Additionally, lymph nodes from the renal hilus drain into this compartment and autonomic nerve fibers derived from the aortic nerve plexus diverge to both sides to form the renal nerve plexus following the corresponding vessels (Fig. 3.12).

Autonomic Nerves of the Female Pelvis

As pointed out in the introduction, the challenge of oncologic surgery is twofold: aiming at the highest radicalness to ensure curative therapy and lowest loss of function to maintain quality of life after surgery. The latter one depends essentially on the preservation of those autonomic sympathetic and parasympathetic nerves mediating urogenital and anorectal functions [8, 9, 19–21].

Sympathetic nerves support the filling phase of the urinary bladder under resting conditions by relaxing the detrusor vesicae muscle and closing the internal urethral sphincter and bladder neck, thereby contributing to urinary continence. For controlled micturition, parasympathetic nerves suppress the sympathetic input and initiate contraction of the detrusor vesicae muscle and opening of the urethra and bladder neck. Thus, injury of the vesical nerve plexus may lead to both urinary incontinence and urinary bladder dysfunction.

Similar actions of autonomic nerves are also exerted for the control of anorectal function: While sympathetic nerves contribute to fecal continence by mediating internal anal sphincter contraction and rectal filling, parasympathetic nerves initiate defecation by relaxing the internal anal sphincter and enhancing rectal motility.

Moreover, both sympathetic and parasympathetic nerves are involved in regulating sexual functions. Sympathetic nerves mediate contraction of the musculature of the clitoris, vagina and uterus. Parasympathetic nerves are responsible for the lubrification of external genital organs and the filling of cavernous bodies thereby inducing swelling of the clitoris. Sexual dysfunctions due to surgically induced pelvic autonomic nerve injury are generally more evident in male patients, e.g. leading to erectile dysfunction and impaired ejaculation. However, the impact of autonomic nerve damage in female patients, such as inability to experience orgasm and insufficient lubrification, should not be underestimated.

The extent of autonomic nerve injury that will result in definite postoperative impairment of urinary and fecal continence as well as sexual functions remains unclear. The autonomic innervation of pelvic organs is characterized by its

functional redundancy, anatomically reflected by a bilateral organization of intrapelvic nerve plexus abundantly ramifying and connecting both sides with each other. Thus, partial or unilateral damage may be compensated by the remaining intact contralateral nervous input.

Sympathetic Nerves

The preganglionic sympathetic nerve fibers emerge from lower lumbar and upper sacral spinal cord segments and pass along the descending aorta on both sides as periaortal trunks. The periaortal nervous network fuses ventrolaterally to form the inferior mesenteric and superior hypogastric plexus. In front of the promontorium and slightly left to the midline the superior hypogastric plexus divides into the left and right hypogastric nerves. The hypogastric nerves often consist of various nerve bundles and are embedded within the parietal pelvic fascia extending in front of the sacral concavity. Gentle traction of the hypogastric nerve will lift up this fascial sheath in a tent-like fashion thereby illustrating its course along the pelvic side wall down to the inferior hypogastric plexus (Figs. 3.11, 3.15, 3.16, 3.17, and 3.18) [22].

Parasympathetic Nerves

Parasympathetic nerves derive from the sacral part of the parasympathetic nervous system residing in the sacral spinal cord. Together with ventral branches of the sacral spinal nerves S2–S4, these pelvic splanchnic nerves leave the ventral sacral foramina and pierce the parietal pelvic fascia on both sides to join the hypogastric nerves. The pelvic splanchnic nerves coming from dorsocaudally and the hypogastric nerves coming from dorsocranially converge to form the inferior hypogastric plexus (Figs. 3.10, 3.11, 3.16, and 3.18).

Inferior Hypogastric Plexus

The inferior hypogastric plexus is a mixed autonomic nerve plexus composed of both sympathetic and parasympathetic nerves. As this abundant nerve network provides the autonomic nerve supply to all pelvic viscera, the inferior hypogastric plexus is also termed pelvic plexus. In fact, several subgroups of delicate nerve fiber bundles diverge from the main plexus towards the different pelvic compartments to supply the corresponding organs: rectal plexus, uterovaginal plexus, vesical plexus.

Like the hypogastric and pelvic splanchnic nerves, the inferior hypogastric plexus is embedded within the parietal pelvic fascia covering the pelvic sidewalls. The nervous meshwork extends medially to the internal iliac artery and follows its branches to the pelvic organs. Posteriorly, the rectal plexus diverges at the level of the rectal ligaments/pedicles and enters into the rectal wall accompanied by the middle rectal artery. Anteriorly, the inferior hypogastric plexus widens in a fan-like manner and releases a lateral and medial trunk. The lateral trunk corresponds to the vesical plexus running to the bladder lateral and underneath the ureter. The nerve bundles follow the branches of the vesical artery and further ramify to innervate the distal ureter, urinary fundus and neck, and internal urethral sphincter. The medial trunk corresponds to the uterovaginal plexus passing to the uterine cervix and vagina medial and underneath the ureter. The nerve bundles follow the uterine artery after its intersection with the ureter and innervate the uterus and urinary bladder from both sides (Figs. 3.11, 3.16, and 3.18).

Ureter

Special attention should be paid to the topographic anatomy of the ureter [3, 23] due to its high vulnerability to intraoperative injury for the following reasons:

- considerably long course (25–30 cm) along the interface between the retro- und intraperitoneal space exhibiting segments susceptible to damage at virtually all levels.
- hampered identification caused by obesity, previous surgery or radiation, inflammatory or neoplastic events, scarce peristaltic movements.
- morphological appearance and size similar to vascular structures.
- relatively common congenital anomalies (e.g. ureter duplex, ureter fissus, crossed ureter, retrocaval ureter).

Abdominal Segment

The abdominal segment (Figs. 3.12, 3.15, and 3.16) extends from the renal pelvis to the pelvic brim in front of the psoas muscle. The course of the ureter may vary from a paravertebral position close to either the vena cava or aorta to a lateral position along the outer border of the psoas muscle. The ureter is crossed anteriorly by the ovarian vessels and posteriorly by the genitofemoral nerves. On the left side, the ureter additionally undercrosses the root of the sigmoid mesocolon and the inferior mesenteric pedicle. Inspite of the close proximity between the ureter and the digestive tract, both are clearly separated by the anterior renal fascia delimiting the intraperitoneal from the retroperitoneal organs to which the ureter belongs.

While the ovarian vessels extend further laterally to form the infundibulopelvic ligaments, the ureters run medially creating ureteric peritoneal folds. Thus, at the pelvic brim the

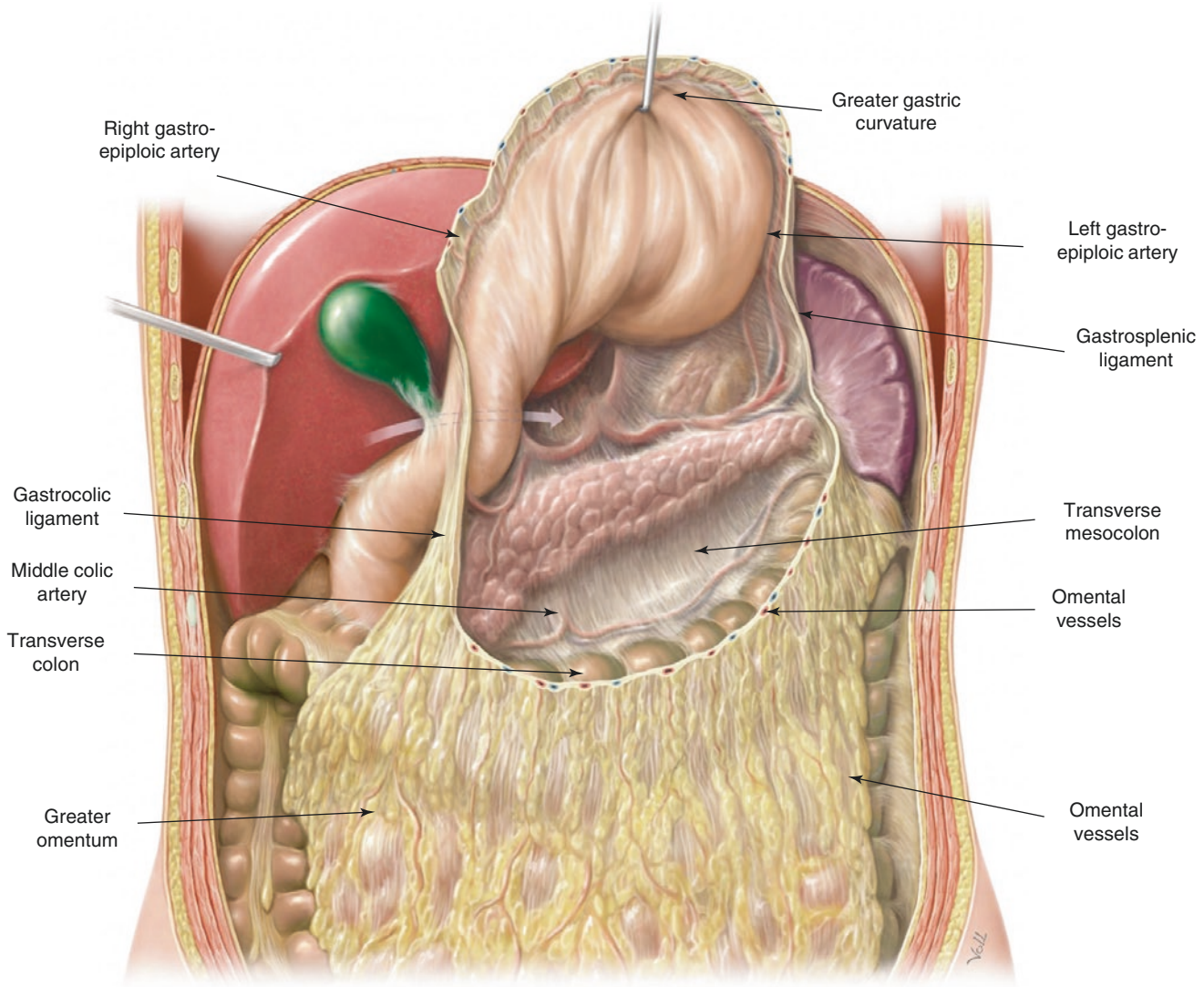


Fig. 3.19 Greater omentum. Ventral view. The gastrocolic ligament is partially cut, the stomach is flipped upwards to expose the lesser sac (Reproduced from Schünke et al. [24])

ureteric fold is closely related to and located medially to both the infundibulopelvic ligament and the ovary, so that care should be taken to protect the ureter underneath its peritoneal fold when mobilizing the uterine adnexa (Figs. 3.6, 3.9, 3.11, 3.12, and 3.17).

Pelvic Segment

In most cases the ureter enters the pelvic cavity anterior to the common iliac artery on the left side and anterior to the external iliac artery on the right side. The ureter further descends underneath the peritoneum and is related laterally to the branches of the internal iliac artery (obturator, superior vesical and uterine artery) and the obturator nerve and medially to the uterosacral ligament and its corresponding rectouterine fold as well as to the inferior hypogastric plexus.

Before the ureter reaches the urinary bladder via the vesicouterine ligament, the parametrium has to be traversed at the level of the uterine cervix (paracervix). The distance of the ureter from the uterine cervix and lateral vaginal fornix is ca. 1–2 cm. While the uterine artery bends medially to reach the uterine cervix, the ureter undercrosses the vessel in anterior oblique direction. As this area is a common site of ureter injury, the distance between the ureter and both the uterine cervix and artery can be enlarged by shifting the uterus to the contralateral side, e.g. by means of a uterus manipulator (Figs. 3.5, 3.8, 3.10, 3.11, 3.12, 3.13, and 3.17).

Blood Vessel and Nerve Supply

Due to its considerable length the ureter is supplied by various sources of blood vessels including branches from the aorta, renal, ovarian and internal iliac arteries. Of note is the observation that the nutrient arteries approach the abdominal segment from the medial side and the pelvic segment from the lateral side. Consequently, when mobilizing or dissecting the ureter, special care has to be taken to preserve the blood vessels at the medial side of the ureter above the pelvic brim and at its lateral side below the pelvic brim. Moreover, excessive denudation of the ureter over a long distance should be avoided to preserve the adventitial layer together with the mesoureter which contain an elaborated vascular plexus. Due to this intramural anastomotic system interruption of one blood supply can be compensated by the remaining vascular sources given that the periureteric tissue is left intact.

The autonomic innervation of the ureter mediates its peristaltic movements and pain perception. The nerve fibers derive from the aortic, superior and inferior hypogastric plexus. The distal ureter is innervated by nerve fibers originating from the lateral trunk of the inferior hypogastric plexus and running within the superior portion vesical plexus. To prevent bladder and sexual dysfunctions due to injury of the vesical plexus, manipulation of the distal ureter at the region of the vesicoureteric junction and vesical trigone should be avoided.

Greater Omentum

Both infragastric and infracolic omentectomy require knowledge of the topographic anatomy of the greater omentum (Fig. 3.19). Embryologically, the greater omentum is part of the dorsal mesogastrium which descends from the greater gastric curvature to cover the small intestinal loops and ascends back to reach the transverse colon and become adherent with the transverse mesocolon. The portion extending between the greater gastric curvature and the transverse colon is also termed the gastrocolic ligament. The gastrosplenic ligament corresponds to the continuation of the greater omentum at its left border connecting the stomach with the spleen. Although the greater omentum is fused to the transverse colon, both structures can be separated from each other by gently detaching the adherent peritoneal surfaces. Once the greater omentum has been released from the transverse colon or the gastrocolic ligament has been split, the omental bursa is opened.

At a distance of approximately 1–2 cm and parallel to the greater gastric curvature, the right and left gastroepiploic arteries run within the gastrocolic ligament and give off nutrient branches to the gastric wall. Descending branches of the gastroepiploic arc traverse the greater omentum to supply both the infragastric and infracolic parts.

The space between the peritoneal layers is usually filled with adipose tissue which may be massive in obese patients. On the other hand, the greater omentum may be thin, translucent or even congenitally absent. Beside fat storage the greater omentum functions as immuncompetent organ by means of its high content of macrophages and the ability to cover and thereby limit intraperitoneal inflammations [3].

Anterior Abdominal Wall

The topographic anatomy of the anterior abdominal wall (Figs. 3.20 and 3.21) [3] is particularly relevant, when multiple trocar incisions are applied in minimal invasive techniques bearing the risk of vascular, nerve or organ injuries. The abdominal wall is composed of the following layers:

- Skin
- Subcutaneous tissue
- Musculofascial layer
- Transversalis fascia
- Preperitoneal space
- Parietal peritoneum

Below the umbilicus the peritoneal layer displays five folds:

- 1 median umbilical fold (obliterated urachus)
- 2 medial umbilical folds (obliterated umbilical arteries)
- 2 lateral umbilical folds (inferior epigastric vessels)

The median umbilical fold is continuous with the urinary bladder fundus and sometimes stretches the urinary bladder cavity cranially which may lead to inadvertent injury of the urinary bladder wall during suprapubic trocar placement. The medial umbilical folds separate the supravesical from the medial inguinal fossae. Although the umbilical arteries are mostly obliterated, in some cases these vessels are still patent and may cause bleeding when the medial umbilical folds are perforated inadvertently by trocars.

While both the median and medial umbilical folds converge upwards to reach the umbilicus, the lateral umbilical folds pass laterally to the umbilicus behind the rectus abdominis muscle. The lateral umbilical folds extend between the medial and lateral inguinal fossae – the latter ones corresponding to the deep inguinal rings into which the uterine round ligaments enter. The inferior epigastric vessels originate medially to the deep inguinal ring and ascend under-

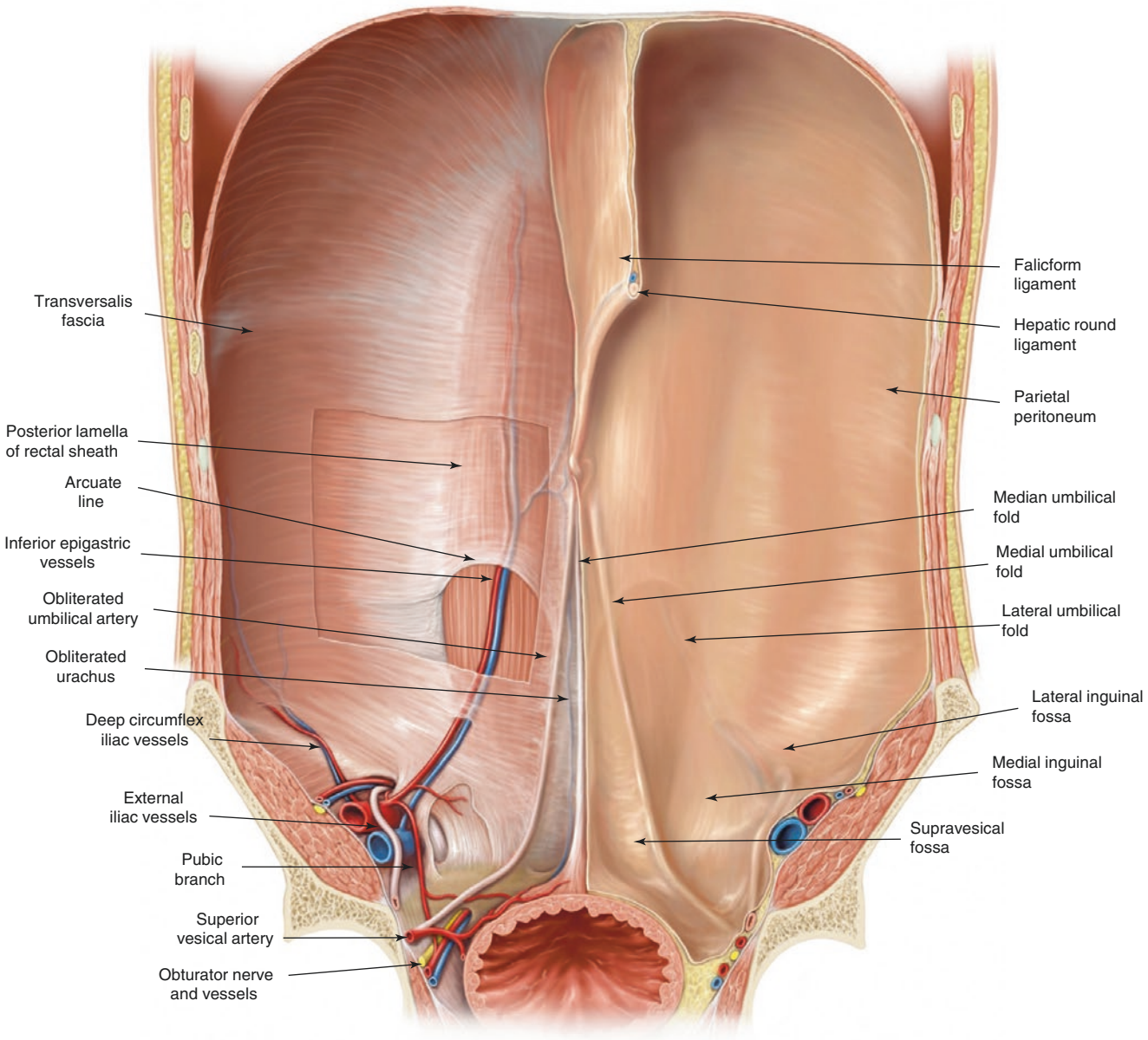


Fig. 3.20 Backside of the anterior abdominal wall. Frontal section, dorsal view. On the left side the peritoneum and part of the transversalis fascia are removed

neath the peritoneum and transversalis fascia to reach and enter into the rectus abdominis muscle. Frequently, the inferior epigastric vessels give off a pubic branch which passes along the femoral fossa and over the pectineal ligament to anastomose with the obturator vessels.

Whereas the transversalis fascia is ubiquitously present and most developed in the lower abdominen, the posterior lamella of the rectus sheath is only present in the upper addomen and fades out at the level of the arcuate line below the umbilicus. The preperitoneal space extends between the transversalis fascia and the parietal peritoneum and is filled by fat. In obese patients an increased content of adipose tissue may considerably thicken the preperitoneal space – which has to be considered during trocar placement to avoid unwanted insufflation of this tissue compartment.

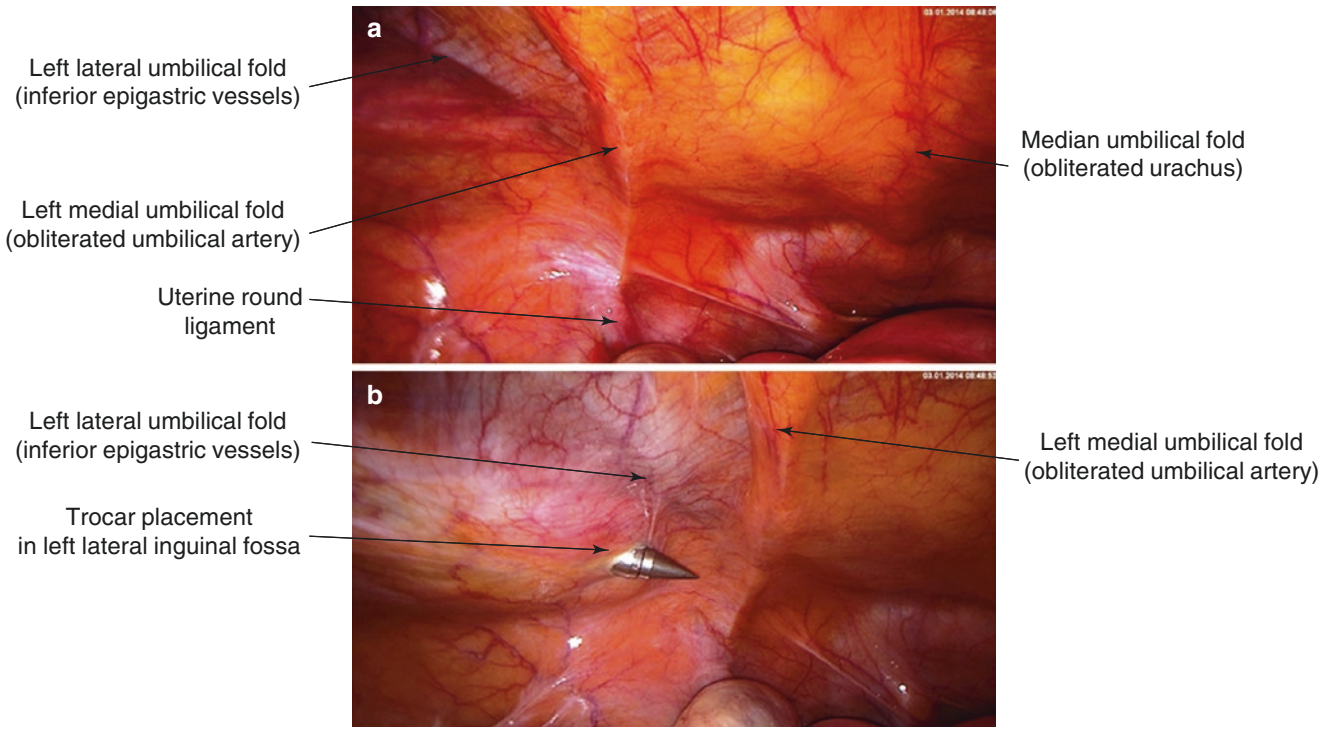


Fig. 3.21 Backside of the left anterior abdominal wall. Laparoscopic view. The three umbilical folds are discernible (**a**), the entry site of the trocar (**b**) is lateral to the lateral umbilical fold

References

1. Ashton-Miller JA, DeLancey JO. Functional anatomy of the female pelvic floor. Ann N Y Acad Sci. 2007;1101:266–96.
2. Fritsch H, Lienemann A, Brenner E, Ludwikowski B. Clinical anatomy of the pelvic floor. Adv Anat Embryol Cell Biol. 2004;175:III–X. 1–64.
3. SGH S, editor. Gray's anatomy: the anatomical basis of clinical practice. 40th ed. New York: Churchill Livingstone/Elsevier; 2008.
4. Ramanah R, Berger MB, Parratte BM, DeLancey JO. Anatomy and histology of apical support: a literature review concerning cardinal and uterosacral ligaments. Int Urogynecol J. 2012;23:1483–94.
5. Samaan A, Vu D, Haylen BT, Tse K. Cardinal ligament surgical anatomy: cardinal points at hysterectomy. Int Urogynecol J. 2014; 25:189–95.
6. Touboul C, Fauconnier A, Zareski E, Bouhanna P, Darai E. The lateral infraureteral parametrium: myth or reality? Am J Obstet Gynecol. 2008;199:242.e241–6.
7. Yabuki Y, Sasaki H, Hatakeyama N, Murakami G. Discrepancies between classic anatomy and modern gynecologic surgery on pelvic connective tissue structure: harmonization of those concepts by collaborative cadaver dissection. Am J Obstet Gynecol. 2005;193: 7–15.
8. Mauroy B, Demondion X, Bizet B, Claret A, Mestdagh P, Hurt C. The female inferior hypogastric (= pelvic) plexus: anatomical and radiological description of the plexus and its afferences–applications to pelvic surgery. Surg Radiol Anat. 2007;29:55–66.
9. Raspagliesi F, Ditto A, Fontanelli R, Solima E, Hanozet F, Zanaboni F, Kusamura S. Nerve-sparing radical hysterectomy: a surgical technique for preserving the autonomic hypogastric nerve. Gynecol Oncol. 2004;93:307–14.
10. Hockel M, Horn LC, Manthey N, Braumann UD, Wolf U, Teichmann G, Frauenschlager K, Dornhofer N, Einenkel J. Resection of the embryologically defined uterovaginal (mullerian) compartment and pelvic control in patients with cervical cancer: a prospective analysis. Lancet Oncol. 2009;10:683–92.
11. Heald RJ, Ryall RD. Recurrence and survival after total mesorectal excision for rectal cancer. Lancet. 1986;1:1479–82.
12. Hohenberger W, Weber K, Matzel K, Papadopoulos T, Merkel S. Standardized surgery for colonic cancer: complete mesocolic excision and central ligation–technical notes and outcome. Colorectal Dis. 2009;11:354–64. ; discussion 364–5.
13. Hockel M, Horn LC, Tetsch E, Einenkel J. Pattern analysis of regional spread and therapeutic lymph node dissection in cervical cancer based on ontogenetic anatomy. Gynecol Oncol. 2012;125:168–74.
14. Kimmig R, Wimberger P, Buderath P, Aktas B, Iannaccone A, Heubner M. Definition of compartment-based radical surgery in uterine cancer: radical hysterectomy in cervical cancer as 'total mesometrial resection (tmmr)' by m hockel translated to robotic surgery (rtmmr). World J Surg Oncol. 2013;11:211.
15. Ercoli A, Delmas V, Iannone V, Fagotti A, Fanfani F, Corrado G, Ferrandina G, Scambia G. The lymphatic drainage of the uterine cervix in adult fresh cadavers: anatomy and surgical implications. Eur J Surg Oncol. 2010;36:298–303.
16. Kraima AC, Derks M, Smit NN, Van Munsteren JC, Van der Velden J, Kenter GG, DeRuiter MC. Lymphatic drainage pathways from the cervix uteri: implications for radical hysterectomy? Gynecol Oncol. 2014;132:107–13.
17. Cibula D, Abu-Rustum NR. Pelvic lymphadenectomy in cervical cancer–surgical anatomy and proposal for a new classification system. Gynecol Oncol. 2010;116:33–7.

18. Kimmig R, Iannaccone A, Buderath P, Aktas B, Wimberger P, Heubner M. Definition of compartment based radical surgery in uterine cancer-part i: therapeutic pelvic and periaortic lymphadenectomy by michael hockel translated to robotic surgery. ISRN Obstet Gynecol. 2013;2013:297921.
19. Baader B, Herrmann M. Topography of the pelvic autonomic nervous system and its potential impact on surgical intervention in the pelvis. Clin Anat. 2003;16:119–30.
20. Park NY, Cho YL, Park IS, Lee YS. Laparoscopic pelvic anatomy of nerve-sparing radical hysterectomy. Clin Anat. 2010;23:186–91.
21. Stelzner S, Holm T, Moran BJ, Heald RJ, Witzigmann H, Zorenkov D, Wedel T. Deep pelvic anatomy revisited for a description of crucial steps in extralevator abdominoperineal excision for rectal cancer. Dis Colon rectum. 2011;54:947–57.
22. Runkel N, Reiser H. Nerve-oriented mesorectal excision (nome): autonomic nerves as landmarks for laparoscopic rectal resection. Int J Colorectal Dis. 2013;28:1367–75.
23. Frober R. Surgical anatomy of the ureter. BJU Int. 2007;100:949–65.
24. Schünke M, Schulte E, Schumacher U. Prometheus atlas of anatomy, vol. 2. Stuttgart: Thieme Publisher; 2015.

Part III

Imaging and Diagnostics



Clinical Diagnostics Before Hysterectomy

4

Stefan Rimbach

Introduction

Diagnostic measures before hysterectomy aim to ensure patients general perioperative safety with regard to risk management as well as to prepare accuracy, safety and success of the planned surgical procedure.

In order to be efficient, tools and extent of diagnostics should allow to

- prove the indication for hysterectomy
- assess general pre-operative risk (including co-morbidity and anaesthesiological factors)
- reveal individual (risk-) factors referring to
  - surgical procedure planning
  - individualized surgical strategy (e.g. interdisciplinary procedure)
  - ressource management (e.g. operating room time)
  - individualized perioperative management
- reveal/exclude unsuspected additional findings (e.g. adnexal masses)
- reveal/exclude unsuspected malignancy
- exclude contraindications
- save as a basis for patient information to achieve informed consent

Diagnostic Tools Overview

Basic (mandatory):

- anamnesis/patient history
- physical examination
- gynecological examination: inspection, palpation
- cervical cytology

Additional (optional):

- colposcopy
- vaginal ultrasonography (endometrium, intracavitary pathology, myometrium, myometrial pathology, adnexa, pouch of douglas
- renal sonography
- MRI
- (MR) urography

Laboratory investigations:

- according to institutional standard
- and to individual risk profile
- pregnancy test in premenopausal women

Patient History

Patient history comprises personal as well as family history. Familial disorders may influence surgical and perioperative planning. E.g. hereditary diseases of the blood coagulation system may be of utmost importance for perioperative thrombosis prevention, choice of anaesthesia and pain therapy as far as catheter methods are concerned, and for coagulation management during surgery; rare conditions such as HLRCC-syndrom (hereditary leiomyomatosis and renal cell carcinoma) predispose to malignancy such as sarcoma in case of presumed benign myoma. Personal patient history informs the surgeon about individual risks such as co-morbidity, previous surgery (e.g. leading to adhesions), medication influencing procedural planning (e.g. anti-coagulation), but also feasibility aspects for the planned hysterectomy (e.g. history of vaginal births vs cesarean sections influencing the route of hysterectomy in terms of vaginal vs abdominal approach). Menstrual history may not only lead to the hysterectomy indication itself in case of bleeding disorders, but also add information on the risk of malignancy in case of irregular bleeding. A typical history of dysmenorrhea may lead to the suspicion

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of endometriosis. Inquiring about bladder and intestinal function may reveal (pre-)existing incontinence problems and play a role for procedure planning as well as for the evaluation of potential post-surgical conditions or presumed complications. The same applies for anamnestic pain or neurological symptoms. Psycho-social aspects should not lack in a complete patient history.

Physical and Gynecological Examination

Gynecological examination including inspection and bimanual palpation allow to evaluate size, position and mobility of the uterus, as well as the adnexa, parametria and pouch of douglas.

Inspection of the vaginal fornix may e.g. reveal vaginal endometriosis (Fig. 4.1), malformations like a vaginal septum (Fig. 4.2) or raise suspicion of vaginal infection, usually rendering hysterectomy contraindicated until successfully treated.

In some instances, such as suspected endometriosis, rectovaginal palpation may additionally give informations on the rectovaginal septum . Palpation may be focally painful, reveal induration or resistance, caused at level of the sacro-uterine ligaments (Fig. 4.3) or the rectovaginal space (Fig. 4.4).

Size and mobility of the uterus as determined by palpation may decide about the surgical approach to hysterectomy or indicate further imaging such as MRI. In case of prolapse, inspection and palpation may allow differentiation between levels and compartments affected and different forms of cele formation. Depending on the clinical impression further functional testing such as urodynamics and ultrasound may be indicated.

Physical examination does also comprise inspection and palpation/percussion of the abdomen, the inguinal regions, back with renal beds and case depending the breast/thoracic area, extremities and head/neck area.



Fig. 4.1 Inspection of the vaginal fornix: blue spots as a sign of vaginal endometriosis

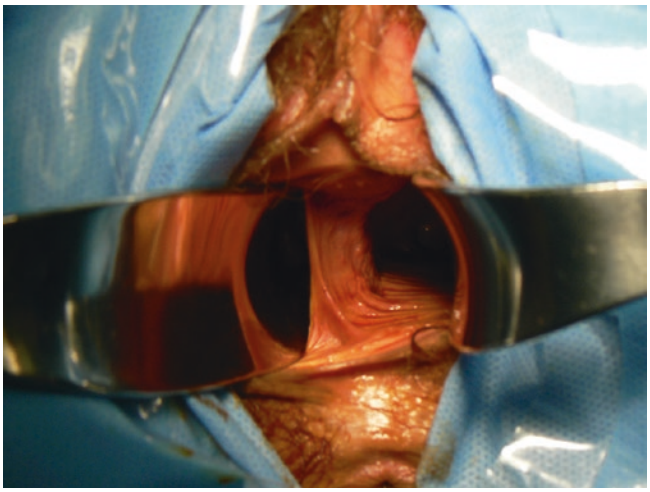


Fig. 4.2 Inspection of the vagina (foto taken during surgery): vaginal septum

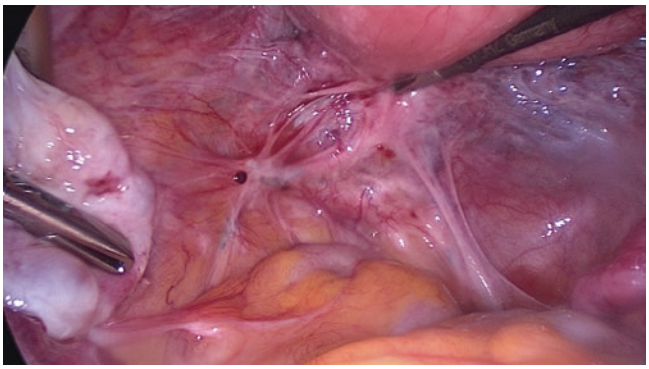


Fig. 4.3 Laparoscopic aspect of the palpatory painful and indurated sacro-uterine ligament on the left side affected by deep infiltrating endometriosis

Cervical Cytology and Colposcopy

Cervical cytology is important to exclude cervical pathology before hysterectomy, and colposcopy may add detailed information relevant to surgical strategies, e.g. when discussing total versus supracervical procedure. HPV-testing may also add helpful information.

Imaging Techniques: Ultrasonography and MRI

Vaginal sonography as an adjunct to clinical examination allows to double check clinical information on size and position of the uterus, but especially gives further insight to the structure of the endometrium and myometrium [1, 2]. Thus, intracavitary pathology such as polyps, submucous fibroids or irregular formations suspect for malignancy can be detected and hysterectomy indication adapted, or further

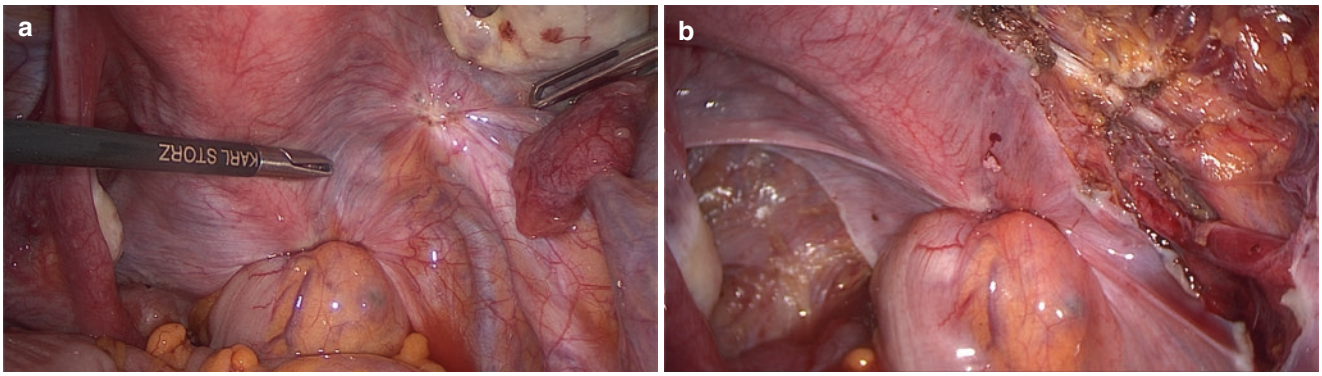


Fig. 4.4 Laparoscopic aspects (**a** = overview, **b** = close-up during preparation) of the palpatory painful and indurated recto-vaginal septum affected by a nodule of deep infiltrating endometriosis

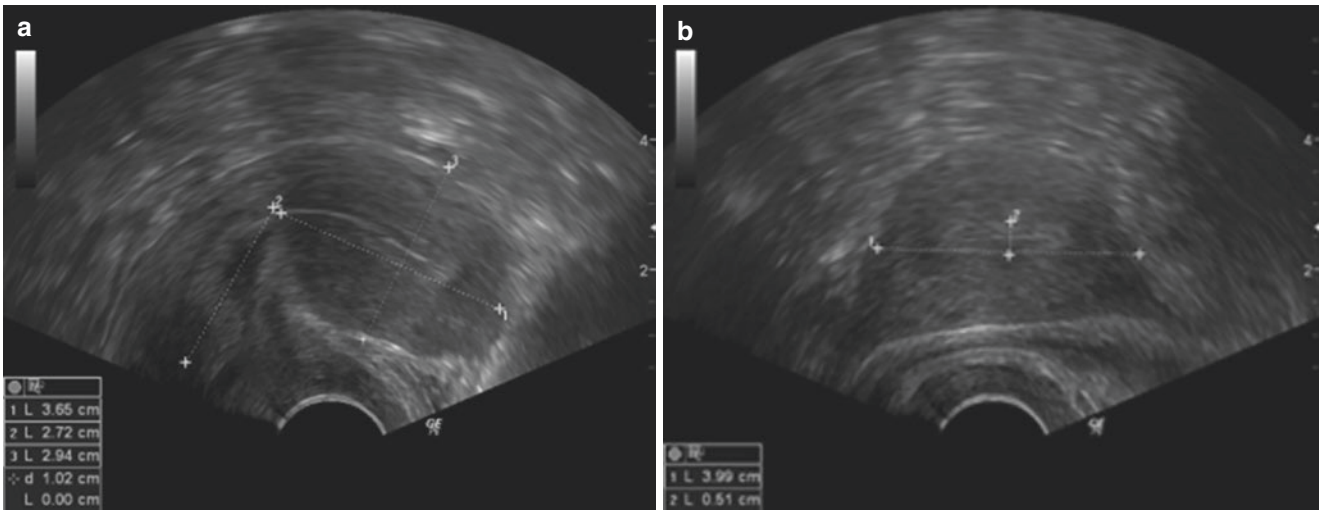


Fig. 4.5 (**a**, **b**) Preoperative vaginal sonography of a regular uterus

investigations such as hysteroscopy or endometrial biopsy scheduled prior to hysterectomy [3].

Figure 4.5 shows the vaginal-sonographic appearance of a uterus before hysterectomy (in this case for dysfunctional uterine bleeding). Detectable pathologies are absent. Size and position of the organ, endometrium and myometrium can be described.

Figures 4.6, 4.7, and 4.8 show examples of endometrial, myometrial and intracavitary pathology as can be detected and described by vaginal sonography.

With regard to additional findings such as endometriosis, ovarian tumors, ascites, sonographic investigation of the adnexa, pouch of douglas, and kidneys may be helpful. Examples are given in Figs. 4.9, 4.10, and 4.11, showing cystic adnexal tumors of tube and ovary.

MRI may play a role in diagnosing and staging endometrial tumors, e.g. in case of an endometrial carcinoma as shown in Fig. 4.12.

Large fibroids may be better visualized by MRI than sonography, if relevant to the projected surgery (Fig. 4.13). MRI may also add valuable informations to vaginal sonography and Doppler results when findings are suspicious for sarcoma [4–7], a question which is most relevant before hysterectomy when morcellation is discussed.

Ureteral compression with subsequent renal dilation may be detected by urography, which is advisable especially if obstruction is presumed or ureters shall be visualized by intraoperative preparation (Figs. 4.14 and 4.15). Postoperative control may be advisable when there was a risk of ureteral impairment during hysterectomy.

Laboratory Investigations

Laboratory investigations are done above all to exclude individual risks with regard to anaesthesia. Usually there exist institutional standards or individual risk profile requires serum specimens [8]. In order to exclude pregnancy, a serum or urinary test is performed in premenopausal women.

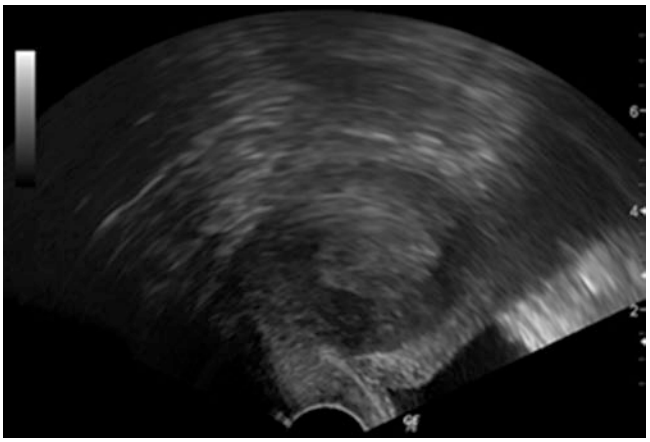


Fig. 4.6 Vaginal sonograpy: suspect endometrium, postmenopausal patient; histology: endometrioid adenocarcinoma

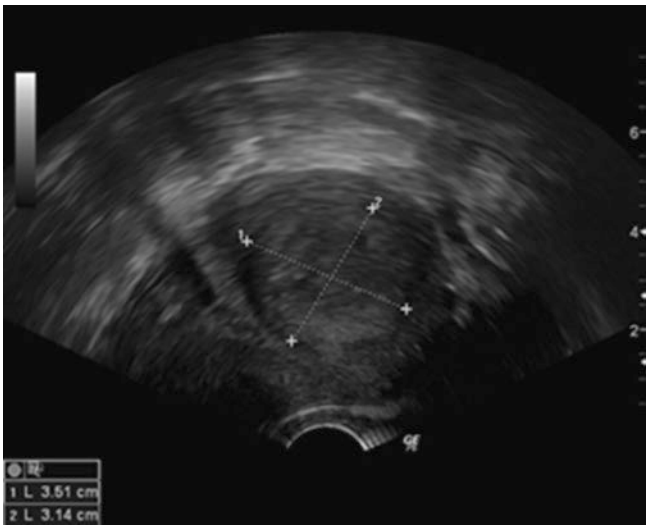


Fig. 4.7 Vaginal sonography: fundal fibroid 3.5 × 3.2 cm



Fig. 4.8 Menorrhagia because of dehiscent cesarean scar

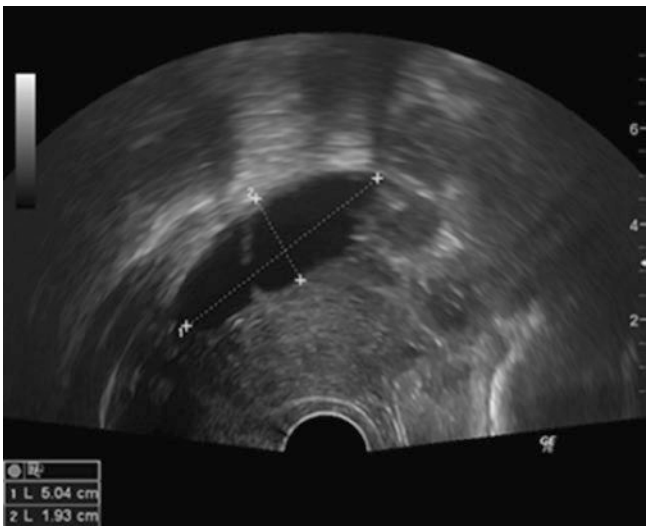


Fig. 4.9 Hydrosalpinx (right adnexa)

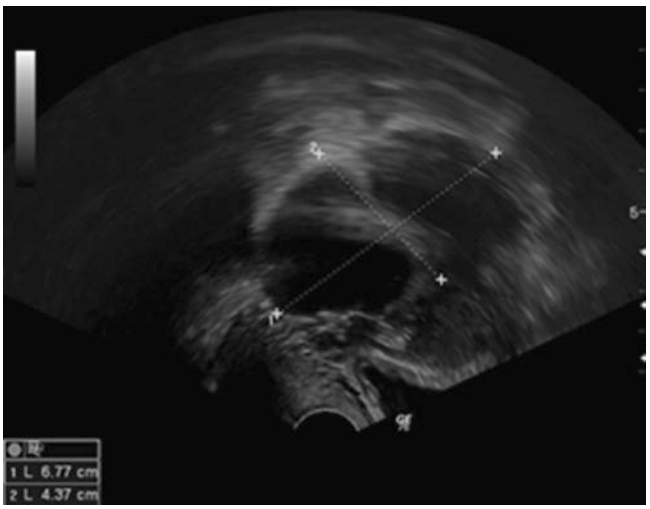


Fig. 4.10 Cystic adnexal mass of unclear dignity

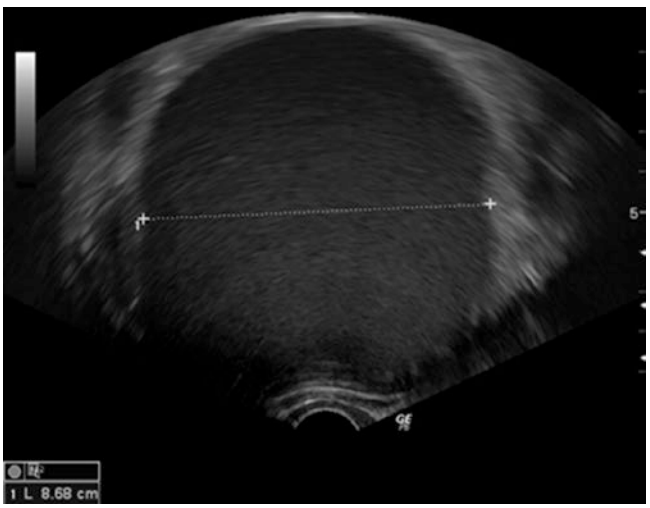


Fig. 4.11 Ovarian endometriosis

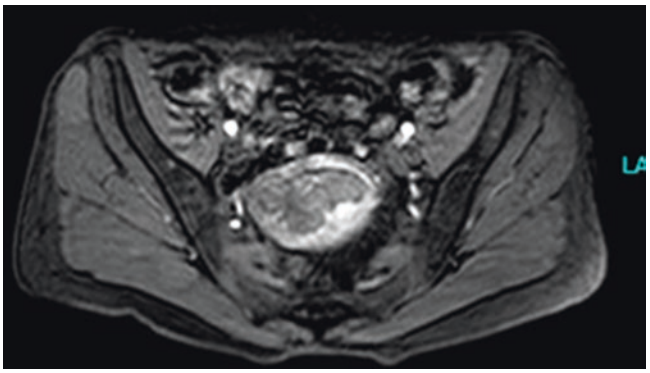


Fig. 4.12 Pelvic MRI: endometrial carcinoma

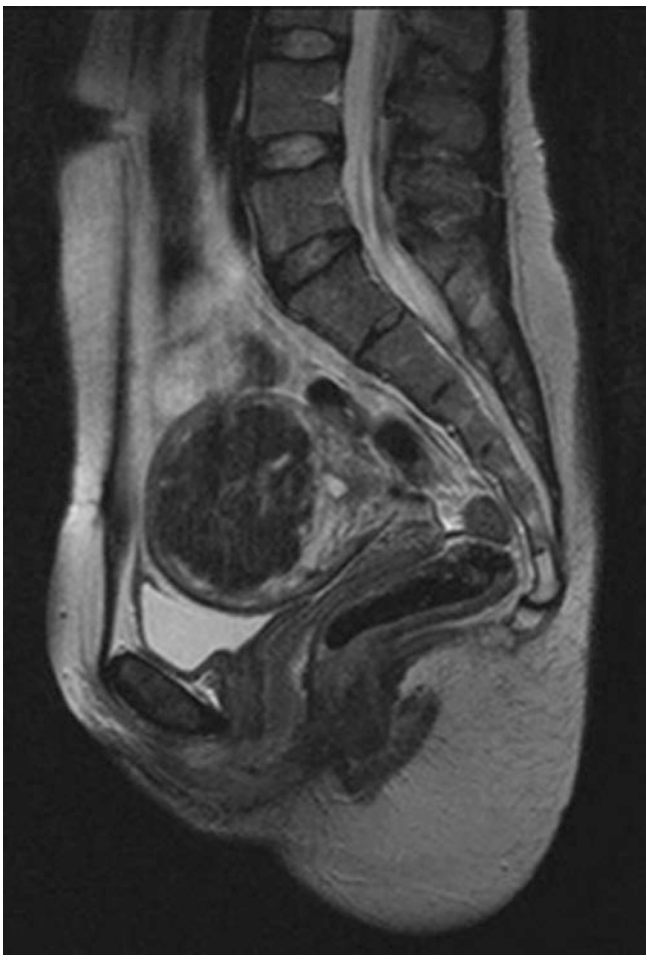


Fig. 4.13 MRI showing an uterus with a large intramural myoma

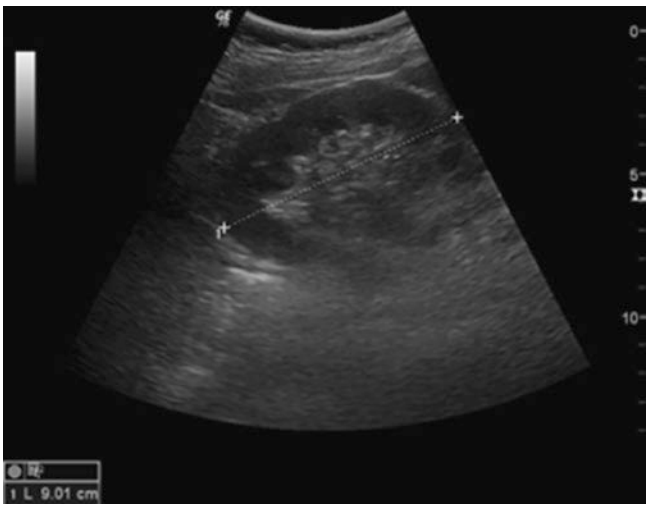


Fig. 4.14 Renal sonography

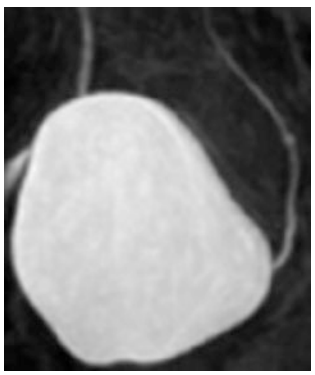


Fig. 4.15 MR-Urography

Conclusion

As a basis for clinical indication, counselling and decision making, patient history and physical examination are required when hysterectomy is considered. Cervical cytology seems mandatory in order to exclude or diagnose cervical dysplasia. Imaging serves as an adjunct to clinical examination. Vaginal sonography will be helpful and applied in most cases before hysterectomy. In selected circumstances, MRI may add valuable information. The necessity of laboratory investigations beyond a pregnancy test in fertile patients varies depending on the indication and co-morbidity of the individual patient. The results of clinical examinations before hysterectomy serve to verify the indication and exclude contraindications, minimize risks, and allow individualized procedure planning as well as adequate patient information in order to achieve informed consent.

References

1. Munro MG, Dickersin K, Clark MA, Langenberg P, Scherer RW, Frick KD. The Surgical Treatments Outcomes Project for Dysfunctional Uterine Bleeding: summary of an Agency for Health Research and Quality-sponsored randomized trial of endometrial ablation versus hysterectomy for women with heavy menstrual bleeding. Menopause. 2011;18(4):445–52.
2. Guideline NG. Diagnosis and treatment of endometrial carcinoma. (S2 k). 2010;Registry No. AWMF 032/034 (Band I):185–92.

3. Dijkhuizen FP, Mol BW, Brölmann HA, Heintz AP. The accuracy of endometrial sampling in the diagnosis of patients with endometrial carcinoma and hyperplasia: a meta-analysis. Cancer. 2000;89(8):1765–72.
4. Sato K, Yuasa N, Fujita M, Fukushima Y. Clinical application of diffusion-weighted imaging for preoperative differentiation between uterine leiomyoma and leiomyosarcoma. Am J Obstet Gynecol. 2014;210(4):368.e1–8. doi:10.1016/j.ajog.2013.12.028. Epub 2013 Dec 22.
5. Amant F, Coosemans A, Debiec-Rychter M, Timmerman D, Vergote I. Clinical management of uterine sarcomas. Lancet Oncol. 2009;10(12):1188–98. doi:10.1016/S1470-2045(09)70226-8. Review.
6. Beckmann MW, Juhasz-Böss I, Denschlag D, Gaß P, Dimpfl T, Harter P, Mallmann P, Renner SP, Rimbach S, Runnebaum I, Untch M, Brucker SY, Wallwiener D. Surgical Methods for the Treatment of Uterine Fibroids – Risk of Uterine Sarcoma and Problems of Morcellation: Position Paper of the DGGG. Geburtshilfe Frauenheilkd. 2015;75(2):148–64.
7. Brölmann H, Tanos V, Grimbizis G, Ind T, Philips K, van den Bosch T, Sawalhe S, van den Haak L, Jansen FW, Pijnenborg J, Taran FA, Brucker S, Wattiez A, Campo R, O'Donovan P, de Wilde RL. European Society of Gynaecological Endoscopy (ESGE) steering committee on fibroid morcellation. Options on fibroid morcellation: a literature review. Gynecol Surg. 2015;12(1):3–15. Epub 2015 Feb 7.
8. Geldner G ME, Wappler F et al. Präoperative Evaluation erwachsener Patienten vor elektiven, nicht kardiochirurgischen Eingriffen. http://www.dgaide/eev/EEV_2011_S_129-142pdf.

Ultrasound Imaging

5

Werner Dürr

Abbreviations

EMJ — Endometrial-myometrial junction [1]. Anatomically, an inner layer of myometrium surrounding the endometrium differentiated sonographically and by MRI from the other myometrium by lower echogenity (Figs. 5.2 and 5.3). This layer is also part of the endometrial-subendometrial unit "archimetra" [2], which evolutionary is an old part of the uterus. According to the theory of Leyendecker, the EMJ is of importance for uterine peristalsis by performing contractions and is believed to play a role in fertility and the development of adenomyosis and endometriosis [3].

Glass body — 3D glass-body rendering. Grey values in a transparent mode and color presentation together give a glass-like image of vascularization (Fig. 5.5). Color Doppler alone without grey values shows the vascularization without any surrounding tissue (Fig. 5.6).

Inversion mode — Image presentation of surfaces in a technically inverted way. Findings of low or no echogenity present echogenic (Fig. 5.7) whereas echogenic structures present low echogenic.

OmniView — Image presentation on the basis of a stored volume and a chosen plane of section.Used to render structures in planes not ordinarily visible in real time e.g. the uterus can be shown in a frontal scan in its whole length without its usual flexure, so to say "stretched" (Fig. 5.1).

TAS — Transabdominal sonography

TUI — Tomographic ultrasound imaging. Imaging of a sonographic finding in diverse, simultaneously presented parallel planes of section on the basis of a stored volume (Fig. 5.4)

TVS — Transvaginal sonography

US — Ultrasound

VCI — Volume contrast imaging. Image presentation in a certain selectable slice thickness for better contrast and suppression of artifacts on the basis of a special technique with assemblage of diverse, parallel scans of close vicinity and their following superposition with the effect of better discrimination between structures of different echogenity (Fig. 5.1).

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Introduction

Independent of the indication for hysterectomy, each operating surgeon will be highly interested in the detailed information on the uterus given by preoperative imaging methods, such as sonographic imaging.

To know what to expect enables the surgeon to define an adequate surgical management and prevents unexpected intraoperative findings. This is one of the most important reasons for preoperative sonographic imaging.

Especially transvaginal sonography (TVS), more so than transabdominal sonography (TAS), gives us the opportunity to closely approach the regions of interest within the minor pelvis. Because of the short distances within the minor pelvis, probes of high frequency with corresponding high resolution can be used to discover even very small uterine alterations.

Developments such as color Doppler and volume scan give additional diagnostic extensions and refinements.

As sonography is an imaging method, this chapter will be primarily image-based appropriate to the saying, "A good image tells more than a thousand words".

Normal Findings

It is important to know the normal sonographic appearance of the uterus (Figs. 5.8 and 5.9) to be able to identify uterine alterations as findings deviating from the norm. In addition to the classic B-mode sonography, other techniques, such as OmniView and VCI, are demonstrated in this section (see Fig. 5.1). Normal findings of the so-called EMJ are also demonstrated by images (Figs. 5.2 and 5.3).

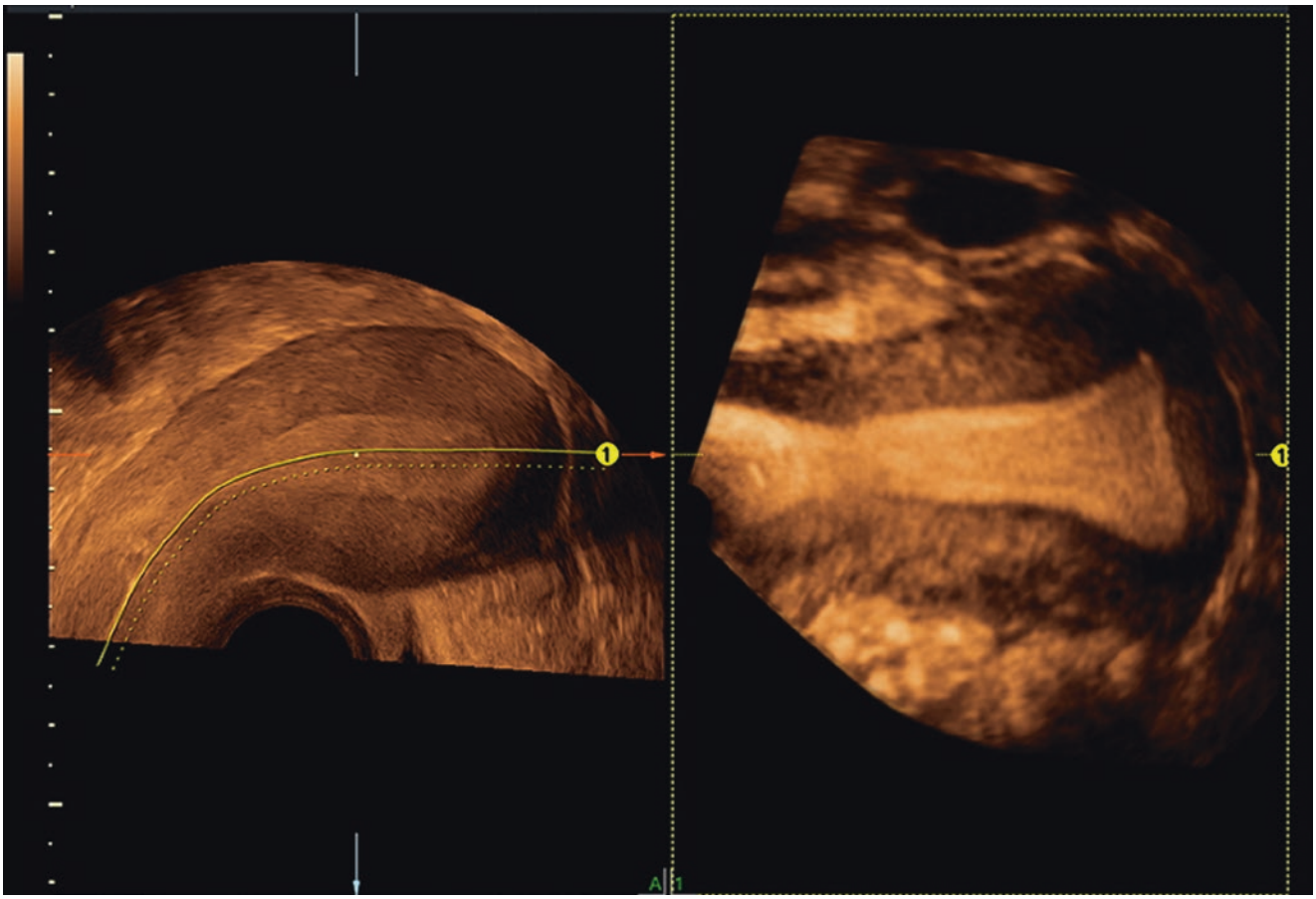


Fig. 5.1 To demonstrate OmniView and VCI technique, a frontal scan to present the uterus in its total length, so to speak "stretched" (*right image*). VCI technique is used to give a more plastic impression of the endometrium (*right image*) (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

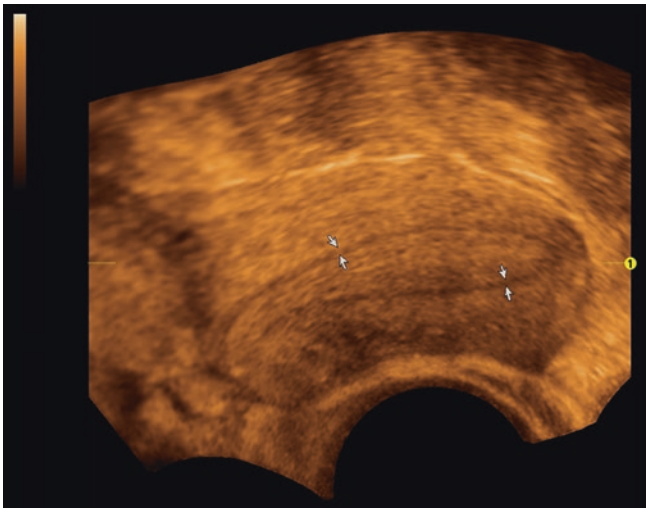


Fig. 5.2 This longitudinal scan in 3D technique shows an anteverted, anteflected, normal sized uterus with a remarkably clear and sharp demarcation, in comparison to endometrium and myometrium hypoechoic line (*arrows*) which represents the inner layer of myometrium, surrounding the endometrium. This endometrial-myometrial junction (EMJ) is of importance for uterine peristalsis by performing contractions and is believed to play a role in fertility and the development of adenomyosis and endometriosis [2–4]. It is unusual to see the EMJ as clear and demarcated as in this image (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

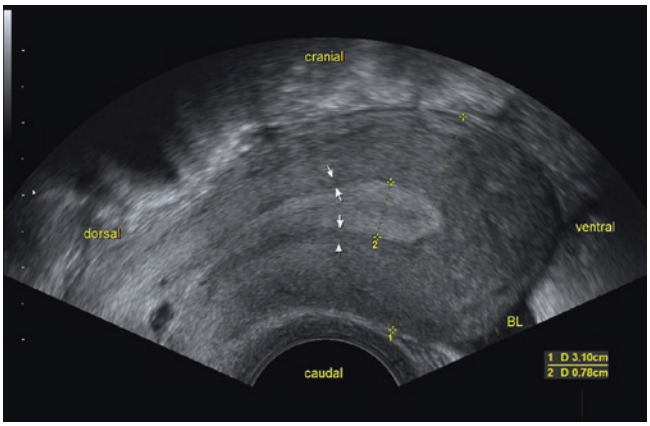


Fig. 5.3 This longitudinal scan shows an anteverted, anteflected, normal sized uterus with a fundal uterine wall thicker than expected, in comparison to the anterior and the posterior uterine wall. As an additional finding, a normal EMJ (*arrows*) (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

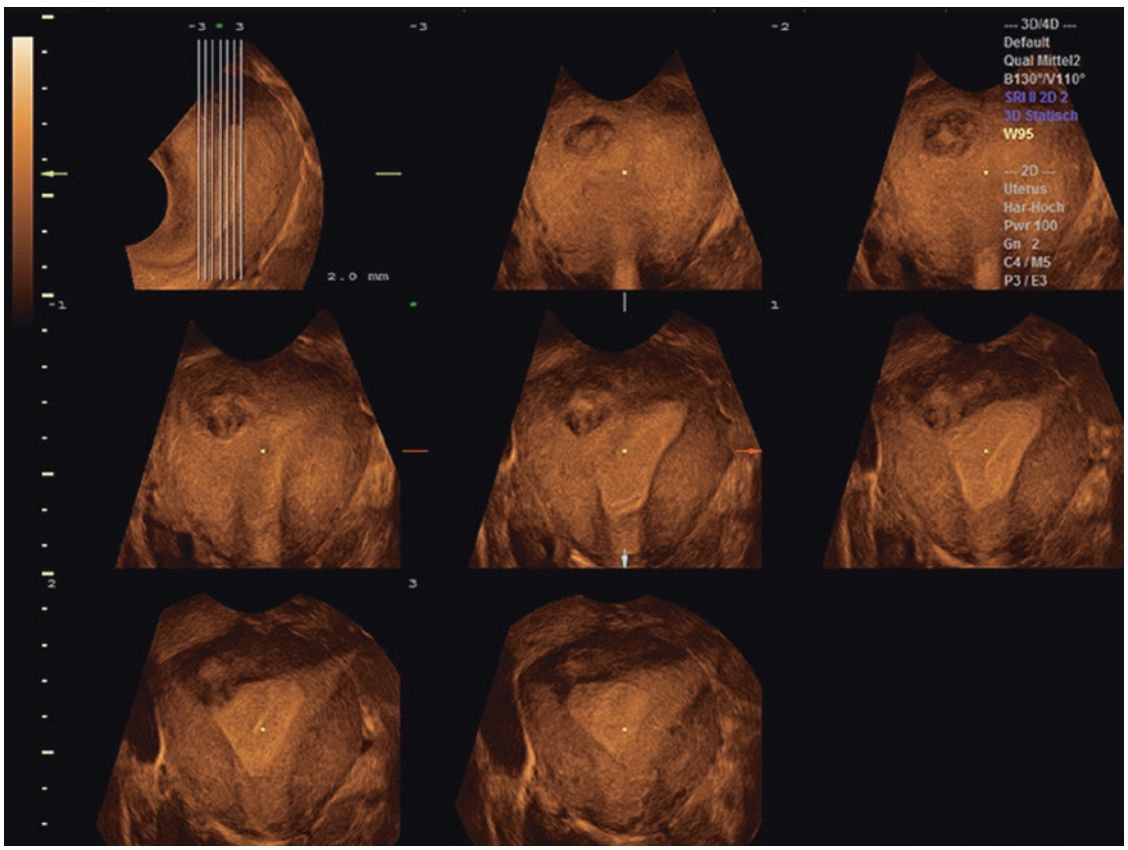


Fig. 5.4 A myoma, for example, as shown by Figs. 5.19, 5.20, and 5.21, can also be presented by a tomographic technique, such as TUI, as shown in this image (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

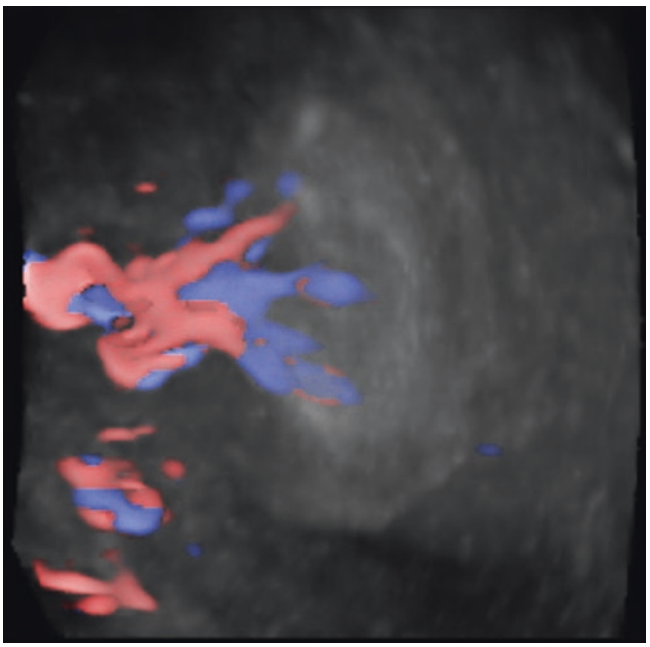


Fig. 5.5 3D color Doppler glass body modus shows impressively pedicle vessels and their branching as well as the diminuating echogenity of endometrial polyp, endometrium and myometrium

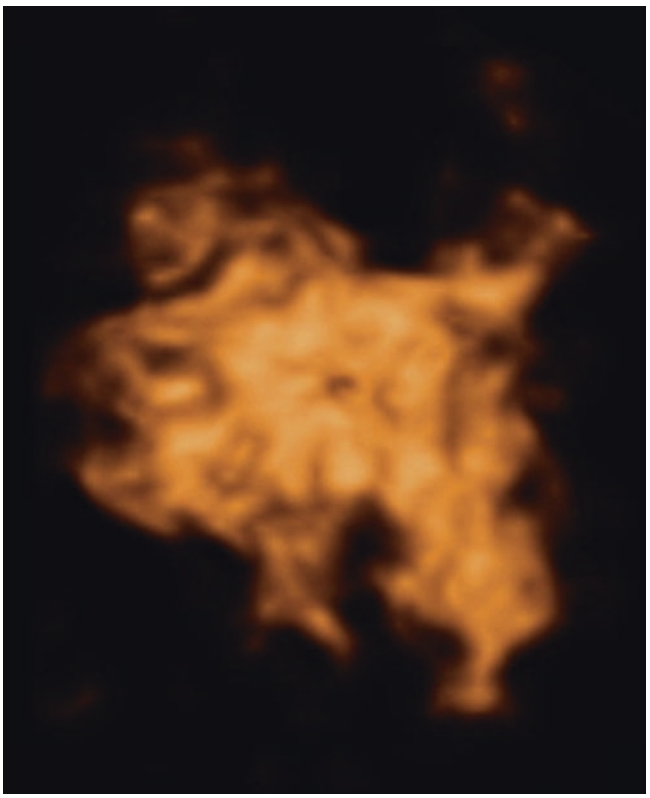


Fig. 5.7 3D presentation of a deep infiltrating endometriosis, inversion modus. The very irregular surface and the pedicle-like extensions give an impression of the highly aggressive potential of this kind of endometriosis and its suspected tendency to progress (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

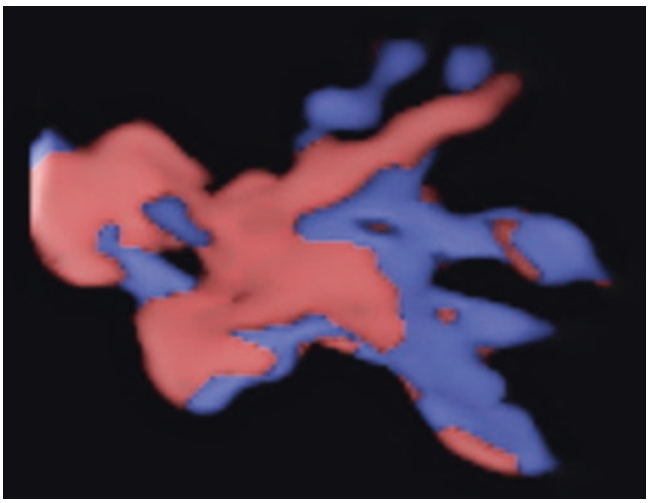


Fig. 5.6 Pure color Doppler without any surrounding tissue shows precisely the branching pedicle vessels (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

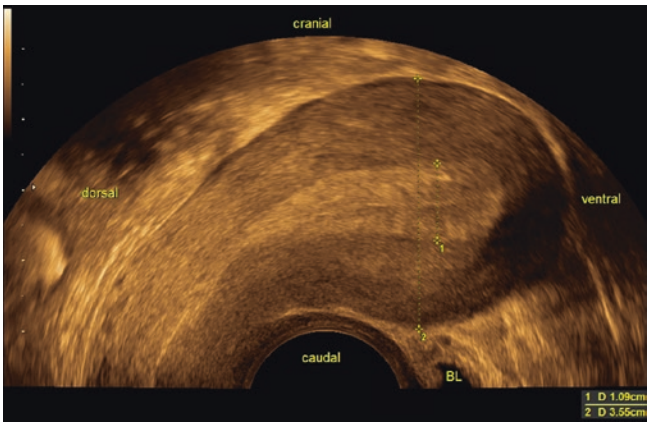


Fig. 5.8 Longitudinal scan of anteverted, anteflected, normal sized uterus with nearly homogeneous echodense endometrium typical for the progestogenic second phase of the cycle

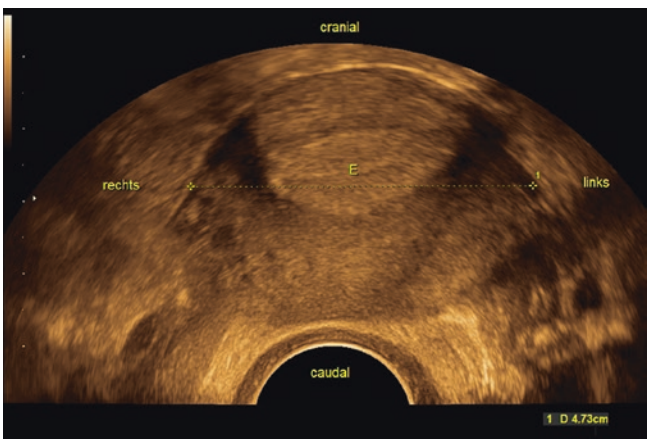


Fig. 5.9 The same uterus, transverse scan through the corpus uteri at its widest lateral extension. See above additionally Fig. 5.1 which demonstrates OmniView and VCI techniques (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

Congenital Uterine Anomalies

Some of these anomalies can easily be missed by US if only a longitudinal scan, showing a normal uterus, is performed. Once the investigator has documented a normal uterus he does not always think of a second one, such as a uterus duplex or bicornis or a septate uterus. By performing a transverse scan, it is hard to miss such uterine malformations. Within a few seconds the transverse scan reveals these anomalies, here for example an arcuate uterus (Figs. 5.10, 5.11, and 5.12), see also Fig. 5.3, and a septate uterus (Figs. 5.13 and 5.14). Additionally, an overview of uterine malformations is given by schematic drawings (Fig. 5.15).



Fig. 5.10 Additionally to Fig. 5.3 a longitudinal scan of the same uterus presenting the cervical part, showing the cervical channel with a small amount of (anechoic) mucus and, at the level of the internal os, a small retention cyst. The distance from internal to external os, here measured at 2.4 cm, corresponds to the cervical length. Close to, but distinct from the external uterine orifice, the dorsal vaginal wall can be seen, here indicated by the two measuring points which demonstrate the wall- thickness of 3.3 mm

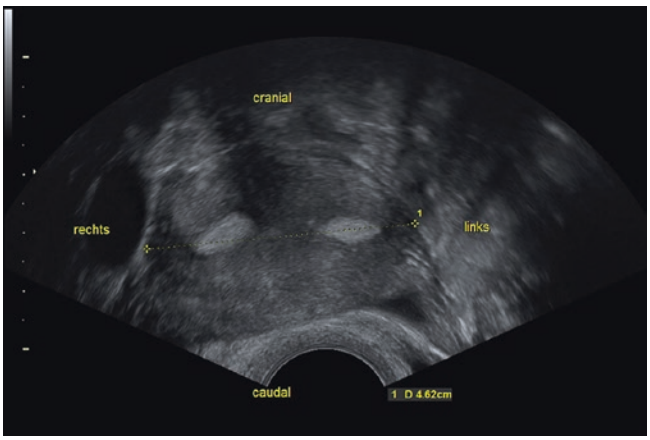


Fig. 5.11 Also additionally to Fig. 5.3 a transverse scan at the fundal region of the corpus uteri clearly showing two endometrial parts separated from each other

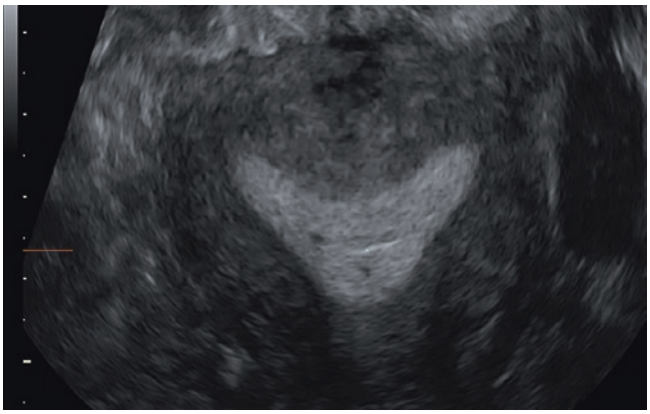


Fig. 5.12 Representation of the endometrium in the fundal region by 3D sonography indicates an arcuate uterus which explains the thicker than expected fundal uterine wall, see above Fig. 5.3 (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

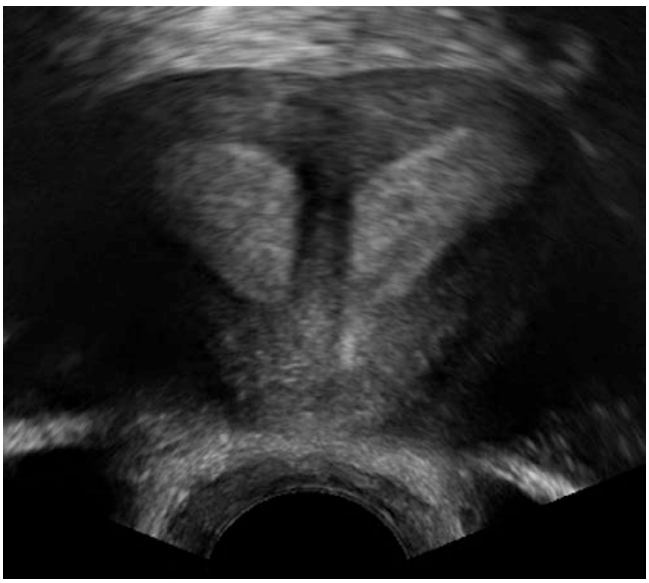


Fig. 5.13 Corpus uteri, transverse scan, showing two parts of endometrium separated from each other. Suspicion of a septate uterus becomes firmer by performing continuous transverse scans from the fundal to the cervical uterine region and reverse

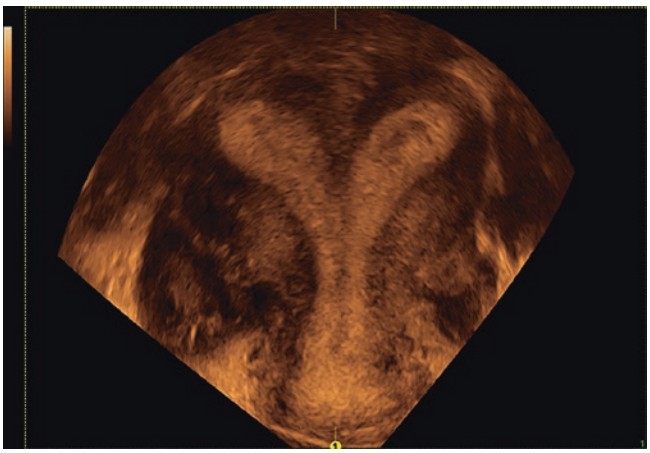


Fig. 5.14 Presentation of the whole uterus in its length by a frontal scan, using the 3D OmniView technique, impressively demonstrates the septate uterus (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

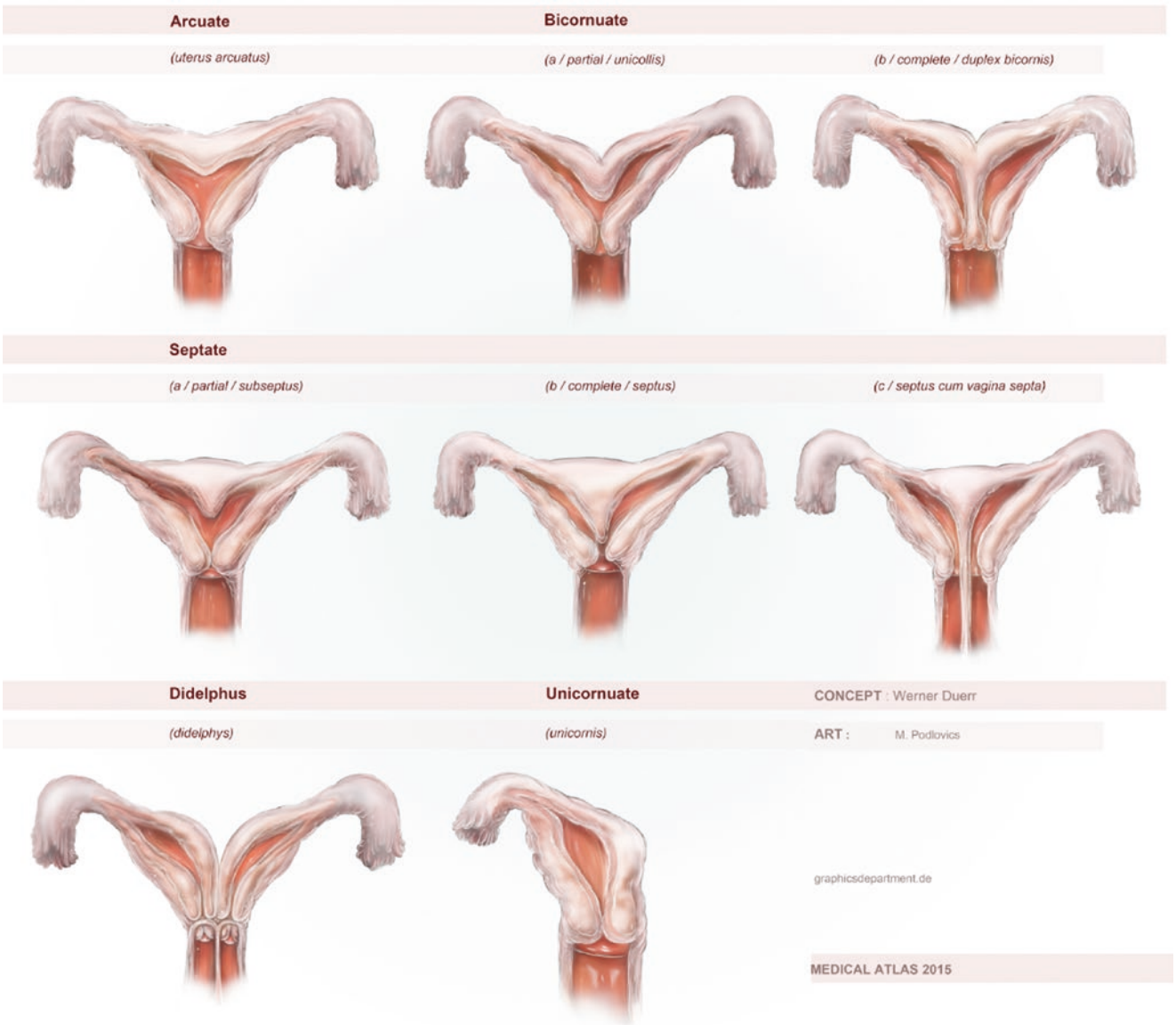


Fig. 5.15 An overview of uterine malformations by schematic drawings

Uterine Myomata

Uterine myomata are the most common benign uterine alterations.

Their location can be intramural, subserosal, submucosal, subserosal-intramural, submucosal-intramural (Fig. 5.16) and subserosal-intramural-submucosal (Figs. 5.17 and 5.18), however, all begin to develop within the uterine wall. Similar to congenital uterine malformations, small myomata, located laterally from the uterine midline, can be missed by TVS in a longitudinal scan whereas a transverse scan reveals the myoma within a few seconds. To prevent overlooking uterine myometrial or intracavitary alterations not located in the midline, it is necessary, or at least helpful, to perform not only a longitudinal but also a transverse scan. This is illustrated by images and additional information gained by 3D (Figs. 5.19, 5.20, 5.21, and 5.22) and TUI techniques, see Fig. 5.4.

To differentiate between myomata and other myometrial or intracavitary alterations, e.g. adenomyosis or endometrial polyps, the use of color Doppler is helpful because myomata usually present typical surrounding blood vessels feeding the myoma (Fig. 5.23). This is in contrast to the more diffuse vascularization of adenomyosis (Figs. 5.24 and 5.25) and the very characteristic vascular pedicle of mostly pedunculated endometrial polyps (Fig. 5.26).

Some examples of myomata and their vascularization are given by the images Figs. 5.16, 5.17, 5.18, 5.23, 5.27, and 5.28.

In some cases the differentiation between subserosal myoma and adnexal tumor can be very difficult by US (Fig. 5.29); however, this is very important with regard to the further diagnostic and therapeutic proceeding. If, using color Doppler, a vascular connection between the suspected adnexal tumor and the uterus is found, the diagnosis would be subserosal myoma (Fig. 5.30). If no vascular connection exists or can be found by color Doppler, further diagnostic and therapeutic steps have to be performed.

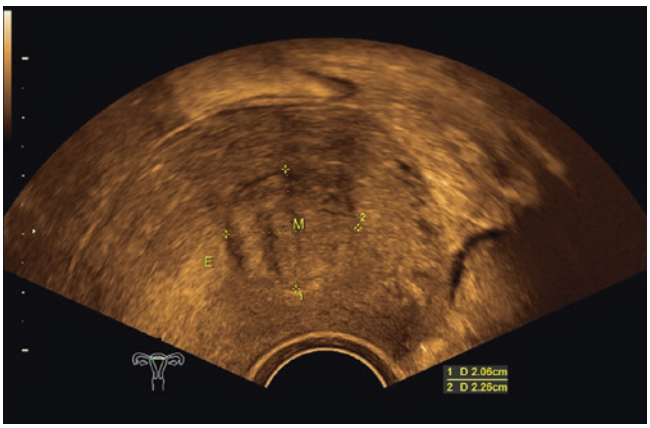


Fig. 5.16 Corpus uteri with a partial submucosal myoma left of the more echodense endometrium, transverse scan

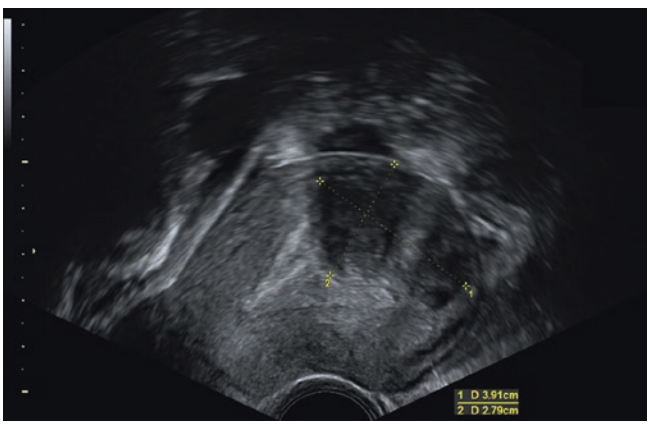


Fig. 5.17 Corpus uteri with a subserosal-intramural-submucosal myoma impressing the endometrium. This image shows the typical differences of echogenity between myometrium which is of middle echodensity, endometrium with its mostly higher echodensity and myoma which is usually hypoechoic in comparison to both

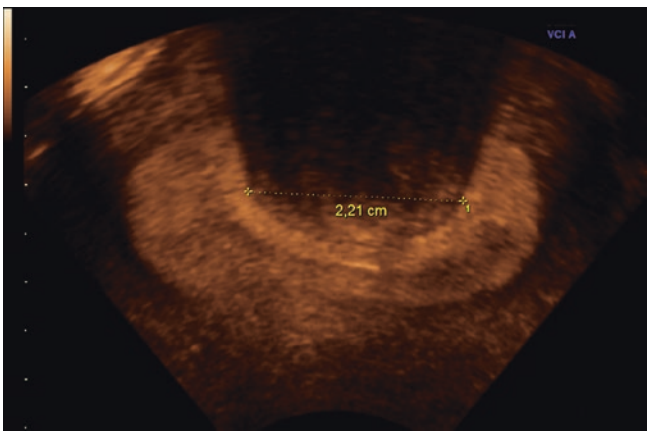


Fig. 5.18 Corpus uteri, transverse scan using 3D and VCI technique to show more impressively the relationship between endometrium and the submucosal part of the myoma

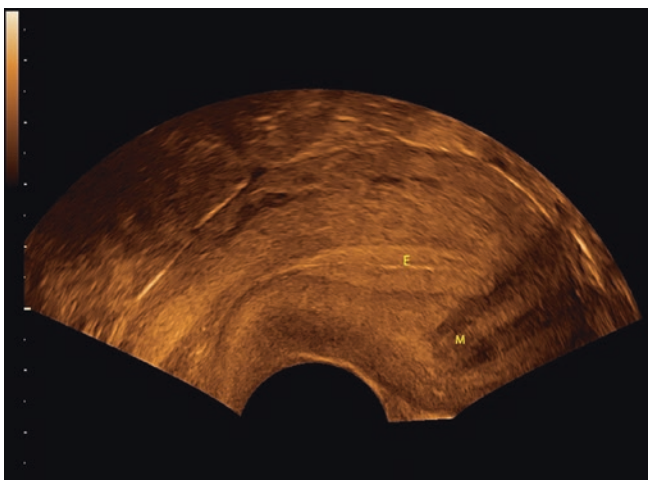


Fig. 5.19 Normal-sized, anteverted, anteflected uterus in a slightly oblique longitudinal scan, including the right paramedian anterior uterine wall, showing a small intramural myoma in the anterior uterine wall, right of the midline

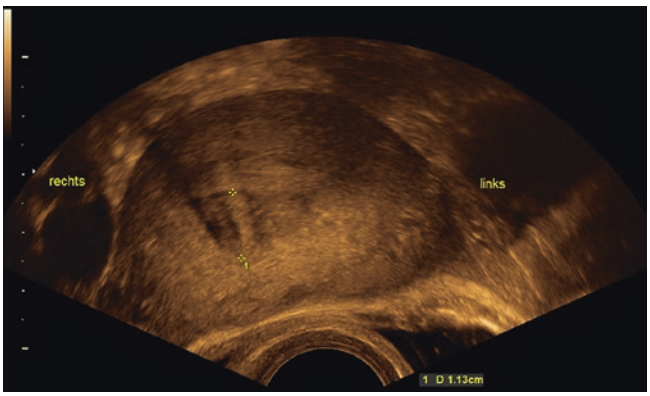


Fig. 5.20 The transverse scan reveals not only the intramural but also the submucosal location of the myoma on the right side

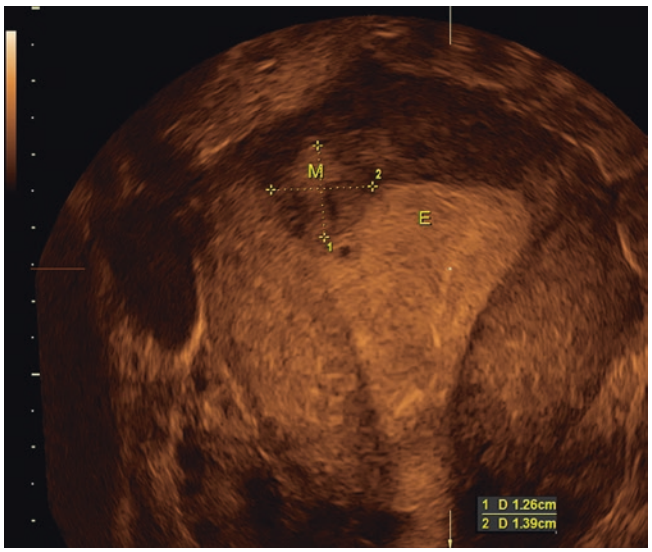


Fig. 5.21 The additional 3D image confirms the intramural and submucosal location of the myoma, at the right tubal angle with possible negative effects on the patency of the interstitial tubal part. Such detailed information is important, especially in cases of fertility disorder. See above also Fig. 5.4, showing the myoma presented by a tomographic technique, such as TUI

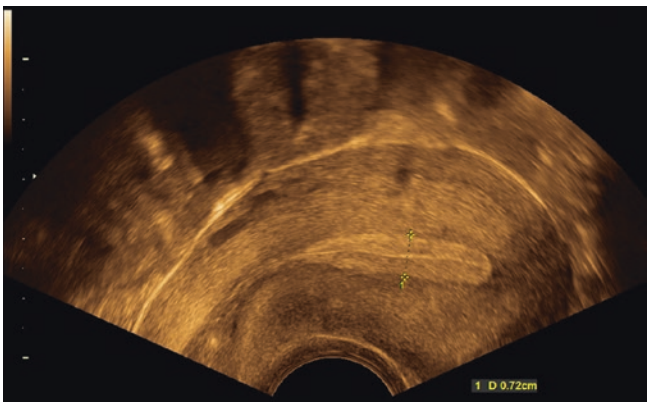


Fig. 5.22 Here, to demonstrate how easily this myoma could have been missed by TVS, a longitudinal scan exactly in the midline where the myoma cannot be seen. This emphasizes the necessity of a transverse scan in addition to the obligatory longitudinal scan when investigating the uterus by US (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

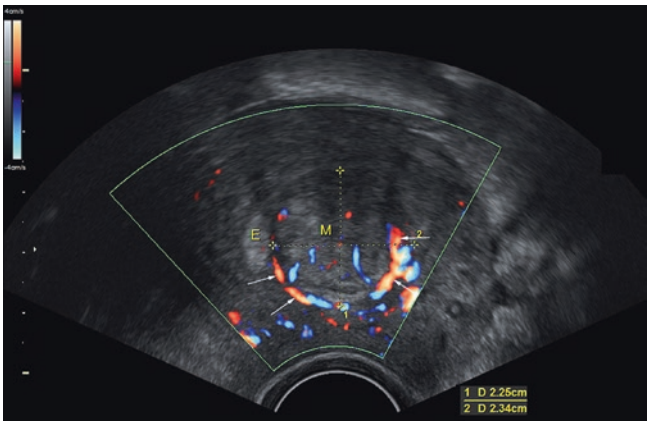


Fig. 5.23 Colour Doppler impressively shows the typical feeding vessels surrounding the myoma and some vessels entering the myoma. See above Fig. 5.16, which presents this myoma without colour Doppler (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

Endometrial Polyps

Endometrial polyps are to be found in the uterine cavity, seldom sessile, mostly pedunculated, possibly reaching into the cervical channel and presenting there. The echogenity of these polyps is usually higher than in the endometrium (Fig. 5.31). The differentiation from submucosal myoma is easy by color Doppler when the typical vessel in the vascular pedicle can be seen. This feeding vessel begins in the myometrium, crosses the EMJ and ends within the polyp, see Fig. 5.26. The branching of this feeding vessel within the polyp is shown by Fig. 5.32, see also Figs. 5.5 and 5.6.

Endometrial Hyperplasia

Endometrial hyperplasia is predominantly found in the adolescent and climacteric transitional phase when, because of anovulatoric cycles with corresponding progestagenic deficiency, usually as a result of follicular persistence, the endometrial proliferation, induced by ovarian estrogen, is not opposed sufficiently by progesterone and, therefore, no endometrial transformation with following regular menstrual discharge is

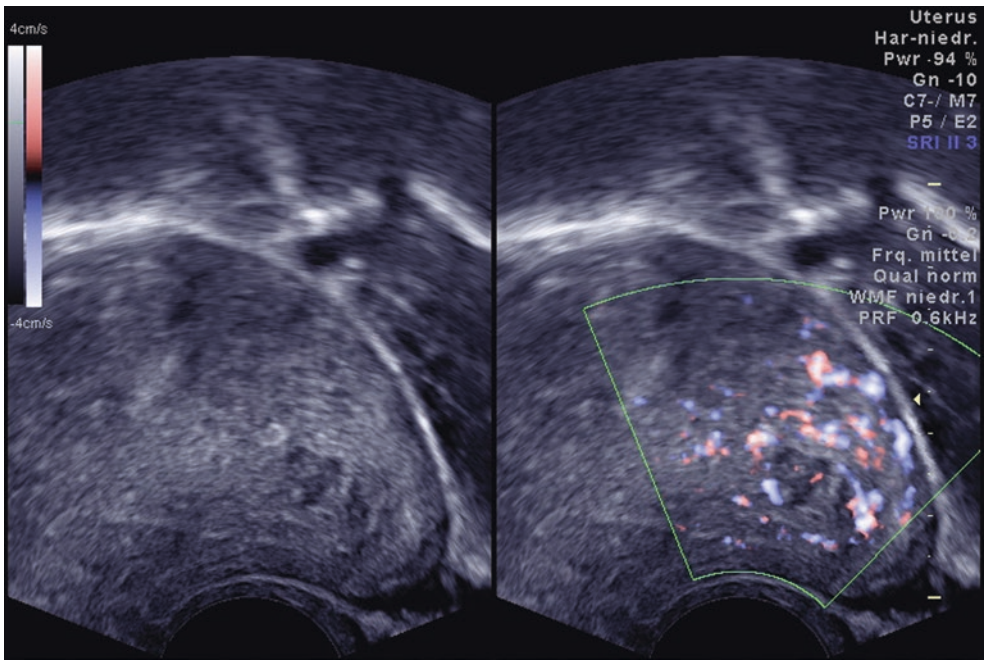


Fig. 5.24 Color Doppler shows a markedly higher and more irregular vascularization of the area affected by adenomyosis in comparison to the regular vascularization by preexisting vessels (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

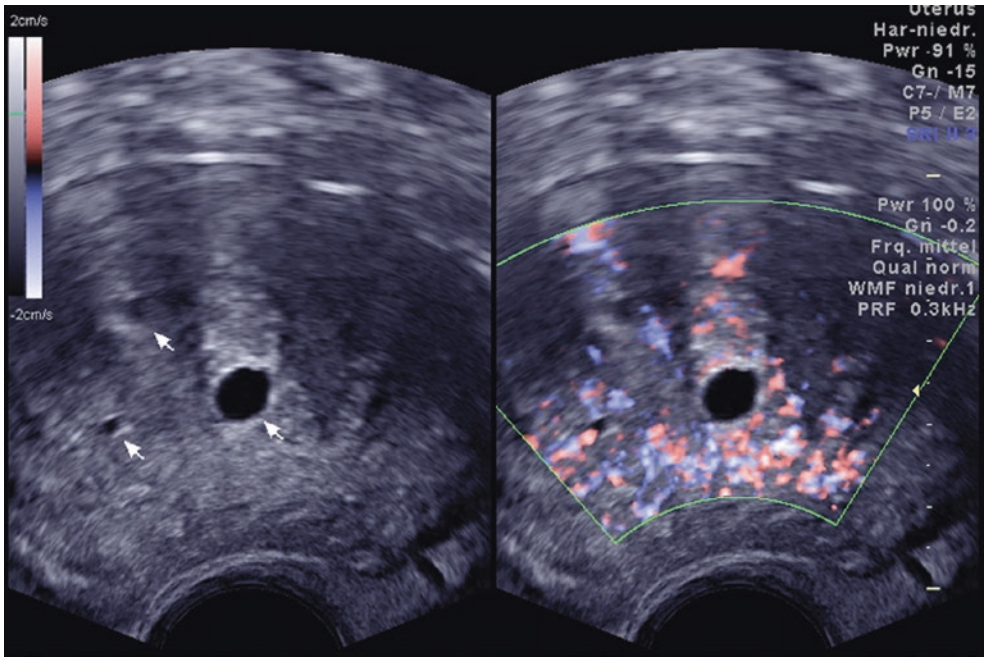


Fig. 5.25 In another area of the same uterus as shown by Fig. 5.72, cystic structures, surrounded by an echogenic endometrium-like margin, are to be found. Color Doppler shows a very marked and diffuse neovascularization in the cystic area as a sign of adenomyosis with a tendency to progress. It seems to be that streaky shadows indicate older processes and cystic findings more recent afflictions of adenomyosis (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

possible. Instead of this continuous bleedings occur as a result of highly proliferated endometrium which is no longer fed in its upper layers whereas proliferation continues.

High resolution TVS can show the typical microcysts within an endometrial hyperplasia, well known from the histological term "cystic glandular hyperplasia" (Fig. 5.33).

Endometrial hyperplasia can be treated with progestin to induce an endometrial transformation and withdrawal bleeding. This is an alternative to possible sequential curettages (Figs. 5.33, 5.34, and 5.35).

Endometrial Carcinoma

Endometrial carcinoma, the most common malignant gynecological tumor, can be detected and described in its extension by sonography, especially TVS, with the help of color Doppler. The sonographic finding is mostly an inhomogeneous intracavitary echo which shows an irregular vascularization, such as neovascularization typical for malignant tumors. The EMJ is penetrated by tumor vessels in areas where myometrial invasion has taken place (Figs. 5.36, 5.37, 5.38, 5.39, and 5.40).

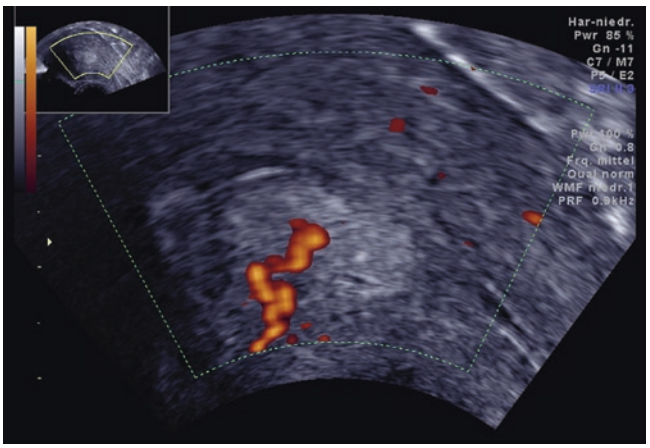


Fig. 5.26 Color Doppler demonstrates a well-defined feeding vessel crossing the EMJ, ending in an intracavitary echodense clearly demarcated mass. This pedicle vessel indicates an endometrial polyp and makes sure that indeed the finding is doubtless nothing else, no submucous myoma, no endometrial hyperplasia, for example

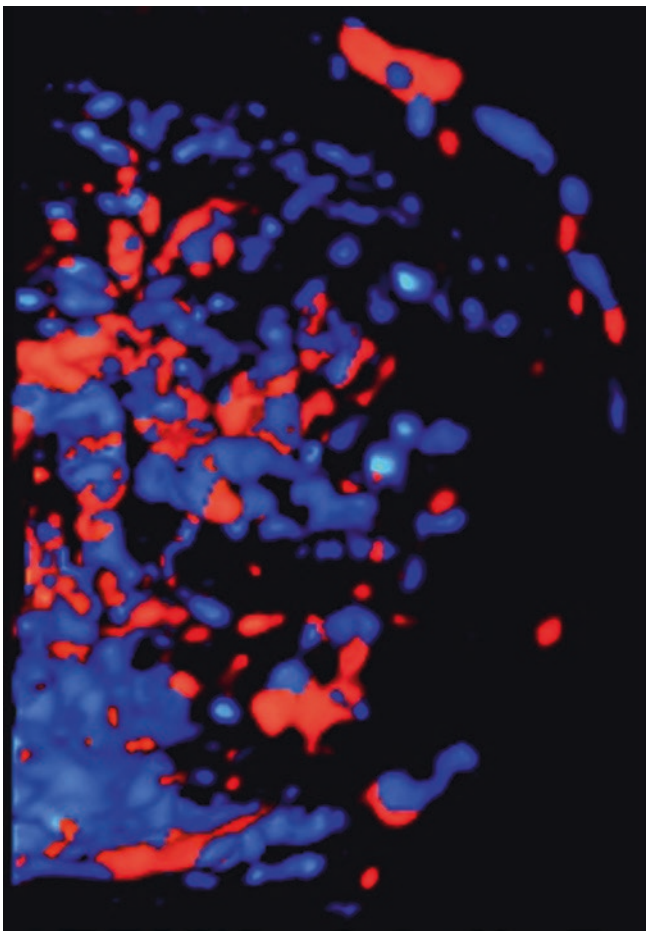


Fig. 5.28 3D color flow shows a very intense vascularization and perfusion of the myoma (see Figs. 5.17 and 5.18) as a possible sign of its tendency to grow. In this case the tendency was confirmed by comparison of the actual findings with the preceding findings (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

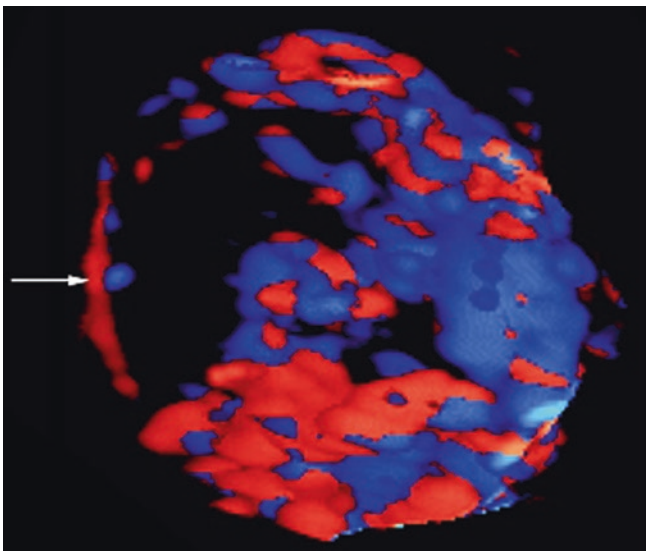


Fig. 5.27 3D color flow demonstrates, like an angiogram, the relatively intense vascularization of this myoma (see Figs. 5.16 and 5.23) as a possible expression of its tendency to grow (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

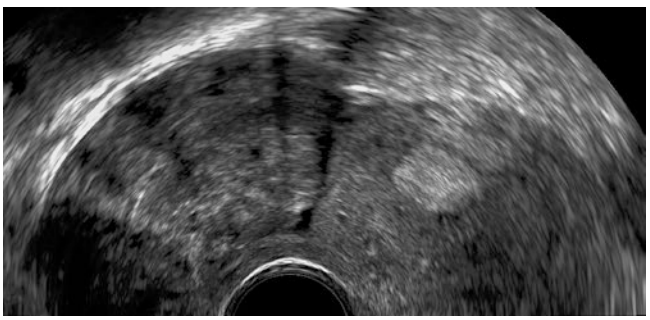


Fig. 5.29 A tumor-like mass in the right adnexal region, as large as the corpus uteri, seems to displace the corpus uteri (identifiable by the echogenic endometrium) from the midline to the left side. Echogenity and clear demarcation of this mass as well as its close vicinity to the corpus uteri give suspicion of a subserosal myoma

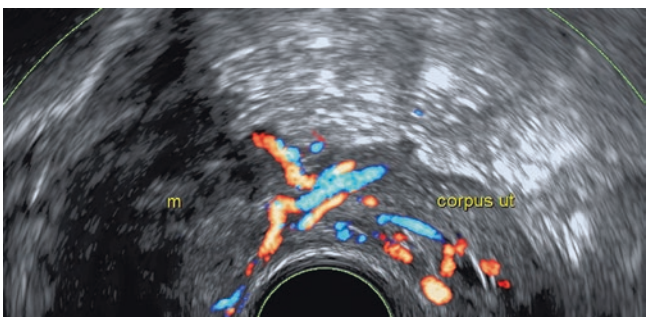


Fig. 5.30 Intensive search by color Doppler succeeded in showing not only a vascular connection between corpus uteri and tumor-like mass but also the typical feeding vessels surrounding the myoma, originating from the corpus uteri. Thus, the diagnosis subserosal myoma could be confirmed and a tumor, originating from the right adnexal region, was excluded (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

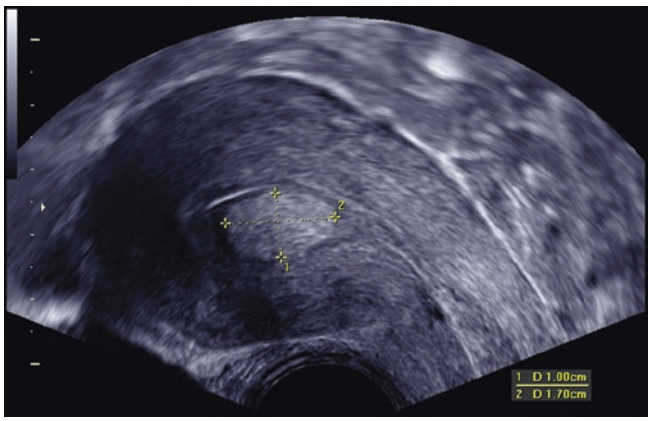


Fig. 5.31 Uterus in a longitudinal scan showing an intracavitary, echodense, clearly demarcated mass, at first sight resembling an endometrial polyp. Additional Color Doppler – see Fig. 5.26 – demonstrates a well-defined feeding vessel crossing the EMJ. This pedicle vessel indicates an endometrial polyp

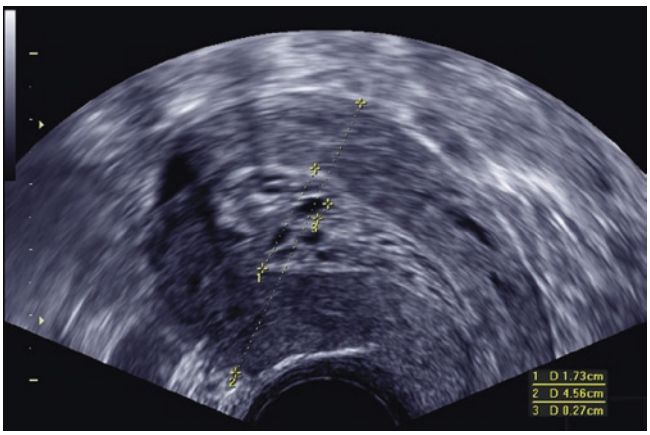


Fig. 5.33 Uterine longitudinal scan shows a microcystic intracavitary echo, thickness a.-p. 17.3 mm. In connection with an existing follicular persistence in a 47-year-old woman with continuous bleeding, this finding should be an endometrial hyperplasia

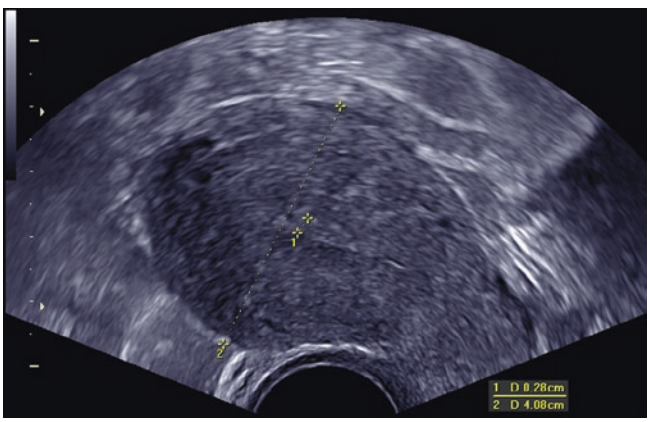


Fig. 5.35 Thus, as endometrial hyperplasia was expected on the basis of sonographic diagnostics in connection with anamnestic data, administration of an exogenous progesterone agent should therapeutically be at least as helpful as a curettage. The image demonstrates the uterine cavity as nearly empty after gestagen-induced transformation and following withdrawal bleeding (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

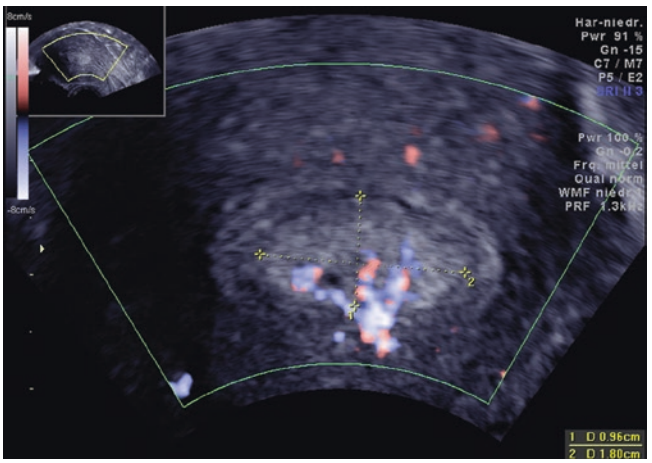


Fig. 5.32 The transverse scan shows a branching of the pedicle vessel within the endometrial polyp. See above additionally Figs. 5.5 and 5.6 which demonstrate sonographic-technical possibilities and are less part of the daily routine proceedings (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

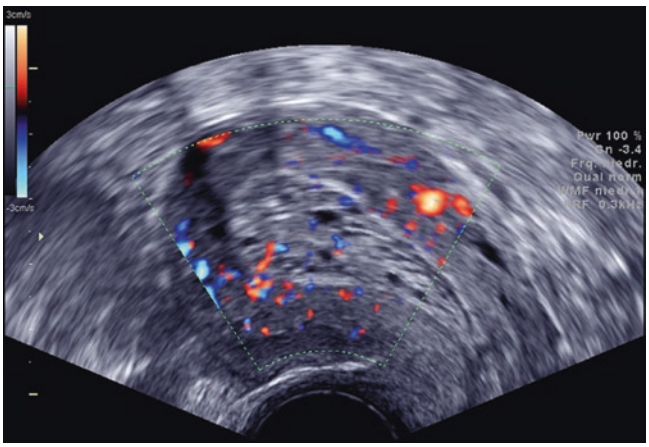


Fig. 5.34 To exclude an endometrial polyp, which looks very similar when of cystic-fibrous texture, color Doppler is used. Only a spiral artery-like vessel, no pedicular vessel typical for an endometrial polyp, can be found

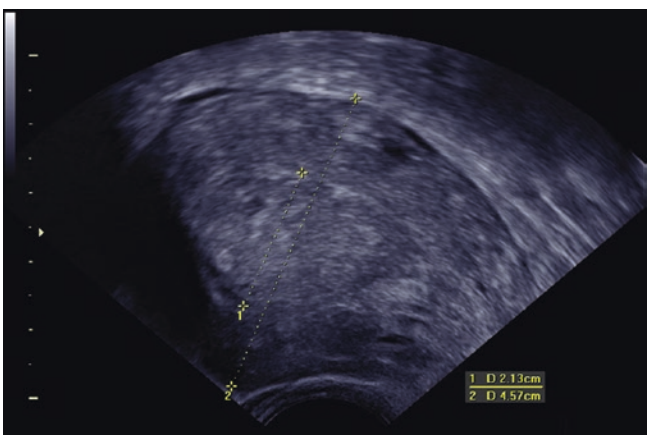


Fig. 5.36 Uterus of a 55-year-old woman with postmenopausal bleeding. The longitudinal scan shows a markedly thickened inhomogeneous endometrium of 21.3 mm which seems distinctly demarcated from the myometrium

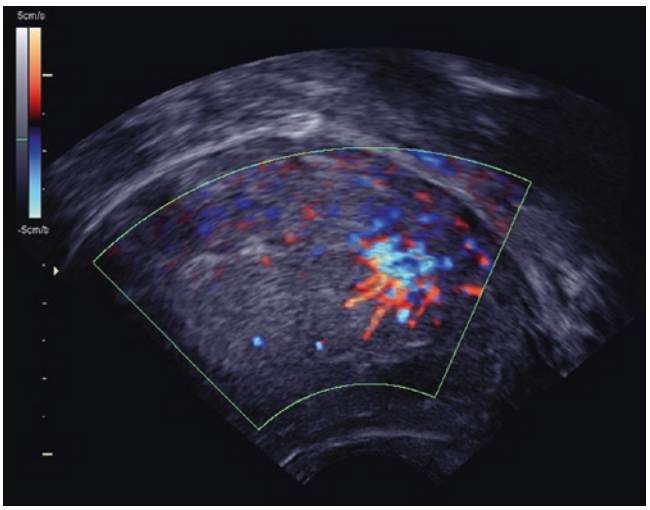


Fig. 5.37 Transverse scan in the fundal region of the corpus uteri. The color Doppler reveals on the left side a chaotic neovascularization typical for malignant growth, with vessels penetrating the EMJ in this zone of myometrial invasion

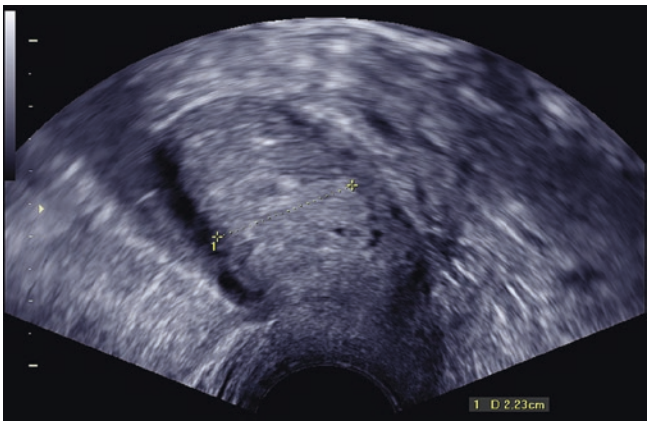


Fig. 5.39 Corpus uteri with endometrial cancer, longitudinal scan. The extension and respective myometrial invasion of the tumor can easily be estimated and measured when, as in this case, there is a clear demarcation by markedly different echogenities between tumor (higher echogenity) and the non-invaded myometrium (lower echogenity)

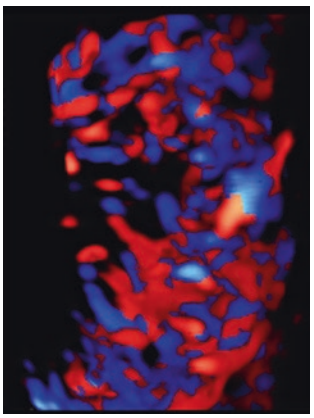


Fig. 5.38 3D color presentation of this zone confirms the tumor-suspicious neovascularization. Postoperative histological diagnosis: endometrial carcinoma pT1a (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

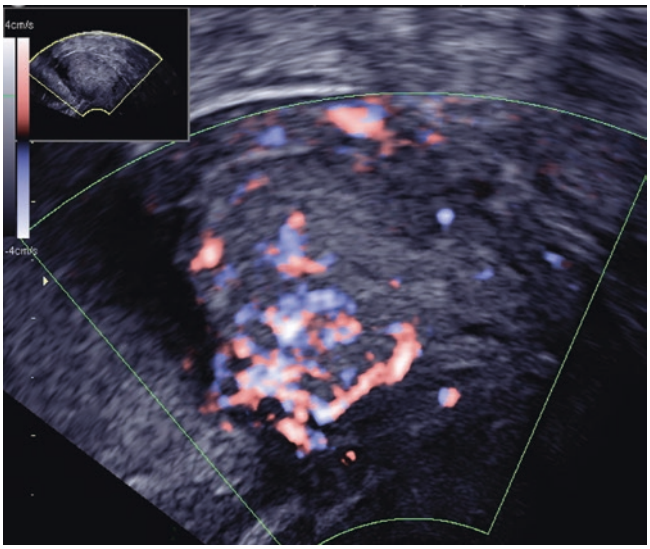


Fig. 5.40 Color Doppler shows the irregular vessels of a typical tumor neovascularization which involves the endometrium and the myometrium (Images by courtesy of Dr. Isabel Wallrafen)

Uterine Sarcoma

Uterine sarcoma, a very rare tumor, is often mistaken for a fast growing myoma. Color Doppler can be helpful to confirm the suspicion of malignancy when an extraordinarily high vascularization of tumor-like pattern is detected. Every fast-growing uterine tumor, even in the case of well-known myomata, warrants further evaluation for uterine sarcoma. Myomata do not exclude sarcoma; however, not all sarcomas grow markedly fast and not all sarcomas present the typical tumor neovascularization.

Other sonographic signs of malignancy could be central anechoic or low echogenic areas, caused by tumor-necrosis or hemorrhage; however, these findings are sonographically indistinguishable from very similar looking areas of central liquefaction in myomas without any additional malignancy.

In summary, we have no really reliable sonographic signs to diagnose or exclude uterine sarcomas preoperatively. Nevertheless, sonography with the help of color Doppler is and will most likely remain an important diagnostic tool in the preoperative differentiation of benign from malignant uterine mass.

If sonographically there is any suspicion of malignancy, morcellation should not be performed and no other uterine incision except for total hysterectomy to prevent, as far as possible, tumor tissue or cell dissemination.

In future, a risk score for uterine sarcomas, based not only on imaging parameters, but including all other known

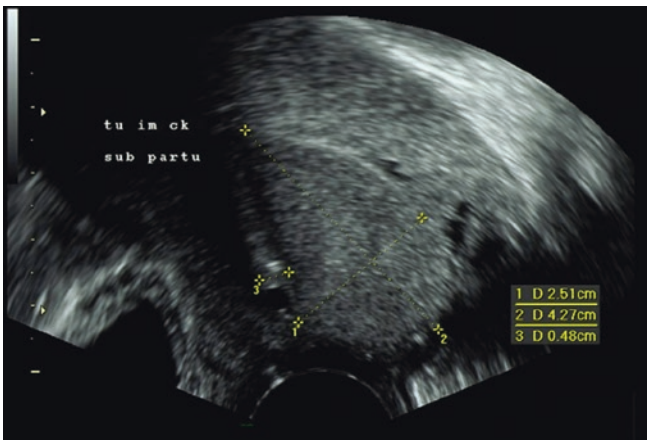


Fig. 5.41 Longitudinal scan of the uterine cervix showing a tumor in the cervical channel, seeming to be "sub partu"



Fig. 5.42 Color Doppler shows a remarkably high but totally irregular perfusion of this polyp-like tumor. Postoperative histological diagnosis: "leiomyosarcoma of low malignancy" (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

relevant risk factors, could be helpful in decreasing the number of coincidentally, intraoperatively or postoperatively, histologically found sarcomas, by increasing the number of preoperatively suspected and thus adequately operated tumors.

Examples of uterine sarcomas and their vascularization are given by the images Figs. 5.41, 5.42, 5.43, and 5.44.

Cervical Carcinoma

The diagnosis of cervical carcinoma is not the domain of sonography although more progredient tumors can be estimated sonographically (Figs. 5.45, 5.46, and 5.47). It has been successfully proven that early diagnosis of cervical cancer is still the domain of cytology and histology after biopsy.

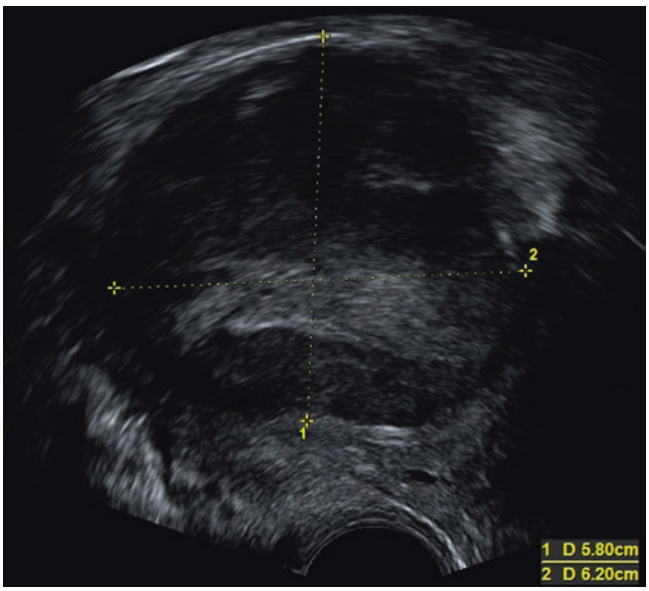


Fig. 5.43 Cross section of a previously known myoma which seems to have grown markedly since the last control some months ago

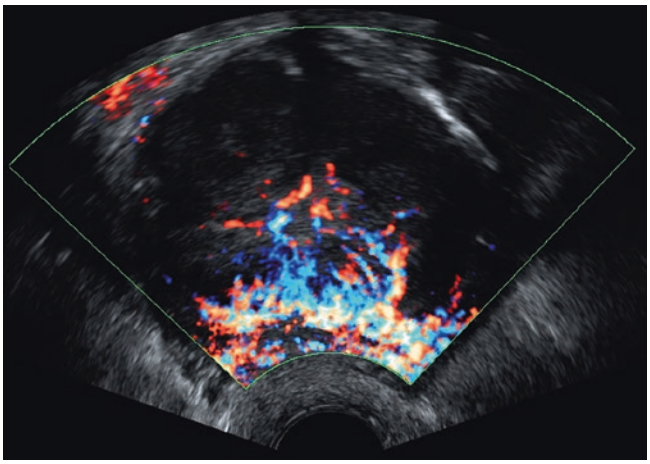


Fig. 5.44 Color Doppler reveals an extremely high vascularization with the pattern of typically chaotic tumor neovascularization. The postoperative histological diagnosis was uterine sarcoma.(Images by courtesy of Dr. Isabel Wallrafen)

Tamoxifen-Induced Intrauterine Alterations

Sonographically, uterine alterations under Tamoxifen treatment usually look like cystic intracavitary proliferations, but in reality are subendometrial extended cysts with atrophy of the endometrium. The uterine cavity is often totally smooth except when additional intracavitary proliferations, such as endometrial polyps, are present. The subendometrial cysts can differ in size from very small, similar to the microcysts in cystic glandular hyperplasia or cystic fibrous endometrial polyps, to relatively large, as shown in the image (Fig. 5.48).

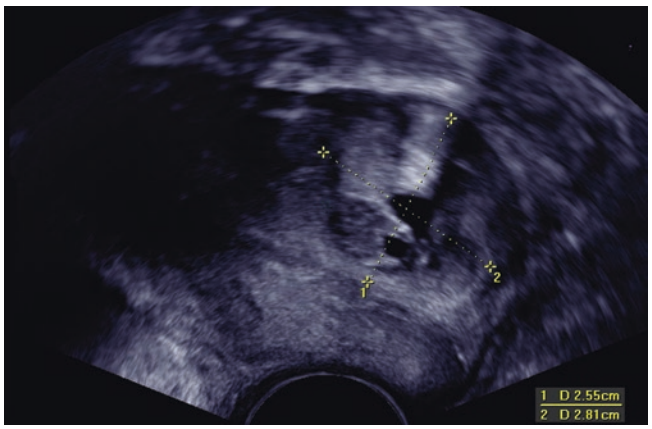


Fig. 5.45 In this image, left is anterior and right is posterior. The longitudinal scan of a cervix shows a clear, demarcated area in the posterior wall with different echogenities from echodense to anechoic. The described finding is also palpable as a strong knot similar to a cervical myoma. Diverse, previously known myomata are palpable as subserosal myomata originating from the uterine corpus

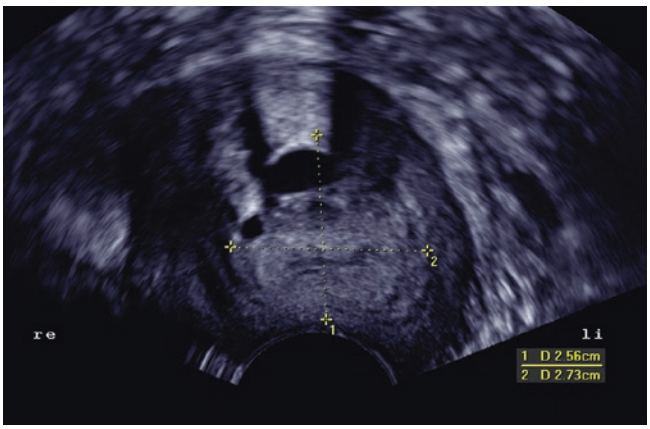
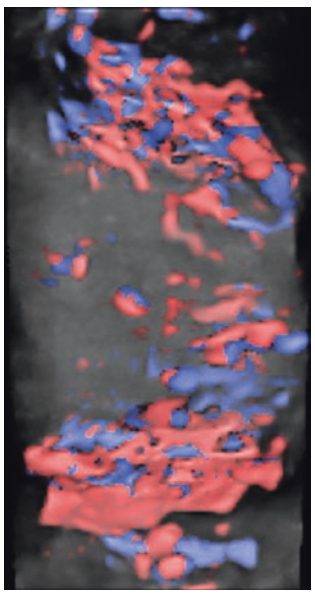


Fig. 5.46 Transverse scan demonstrates that the alteration also includes, but to a lower degree, the anterior cervical wall without direct connection to the cervical channel. The intact-looking circular layer of cervical endometrium around the cervical channel may correspond to an inconspicuous pap smear taken some months previously. Therefore, the differential diagnosis could tend more to a cervical myoma with zones of liquefaction rather than cervical carcinoma

Fig. 5.47 3D color Doppler in glass body modus reveals a very remarkable vascularization over the whole cervix with the pattern of typical tumor neovascularization, corresponding to a cervical carcinoma, as was histologically confirmed



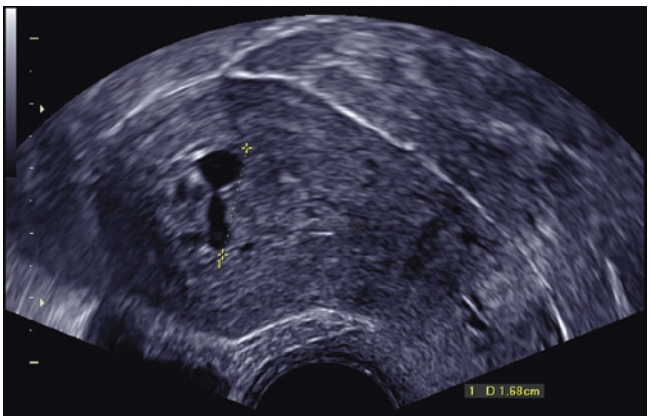


Fig. 5.48 Uterus in a longitudinal scan with intracavitary-looking cystic proliferations which in reality are typical subendometrial cysts under Tamoxifen treatment, whereas the endometrium is atrophic (Image by courtesy of Dr. Annette Philippi)

Intrauterine Fluid Collection (Serometra)

Intrauterine fluid collection presents sonographically as anechoic. Sonographically confirmed intrauterine fluid collection is often seen by chance in postmenopausal women with cervical stenosis (Fig. 5.49). In these cases no further treatment is necessary, provided there are no other intracavitary findings.

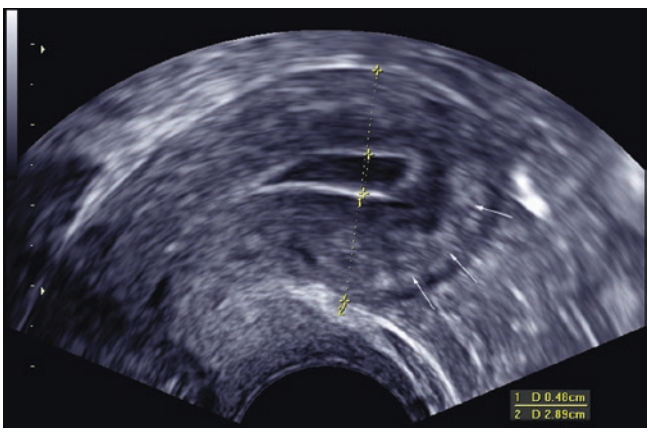


Fig. 5.49 Intrauterine fluid collection (Serometra) in a 75-year-old woman. Noticeable is not only the small amount of intracavitary serous liquidity but also the hyperechoic zones in the outer myometrial region (*arrows*) as a sign of atheromatous alterations in the arcade arteries (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

Hematometra

Hematometra refers to a uterus with an intracavitary accumulation of blood. The causes for this condition vary and must be clarified. The intracavitary echo is homogenous because of the corpuscular contents of blood and, as to be expected, intracavitary vascularization will not be found (Figs. 5.50 and 5.51).

Pyometra presents sonographically very similar to hematometra.

Adherent Placental Remnants

Remnants of pregnancy can remain intrauterine after delivery and after abortion. Sonographic controls can be helpful to detect and remove them, if necessary. Remaining placental tissue has the potential for malignant degeneration and must be removed (Fig. 5.52).

The leading sign of a vital and therefore potentially dangerous placental remnant is vascularization within the sonographic finding. Vessels can be seen crossing the EMJ, usually reaching deep into the myometrium (Figs. 5.52 and 5.53). This is not found in blood clots. Another sign of a remaining "vital" placental remnant is possible hormonal activity. Both signs, vascularization and hormonal activity, can easily be assessed, the one by color Doppler, the other by serodiagnosis of HCG.

If, to prevent possible uterine damage, expectant management with regard to a possible spontaneous resolving of the suspected placental remnant is chosen, sonographic and serodiagnostic short time controls are strongly indicated. If there is no rapid decrease in vascularization and especially in HCG-values, operative removal has to be performed sooner rather than later.

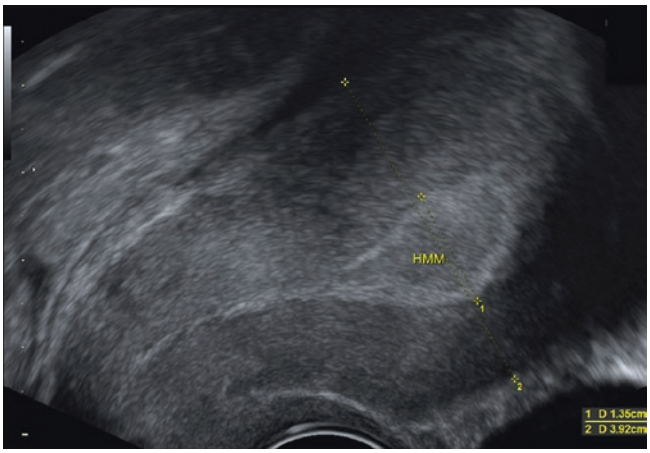


Fig. 5.50 Hematometra after spontaneous abortion. Homogenous intracavitary echo as a sign of liquid, not yet clotted blood

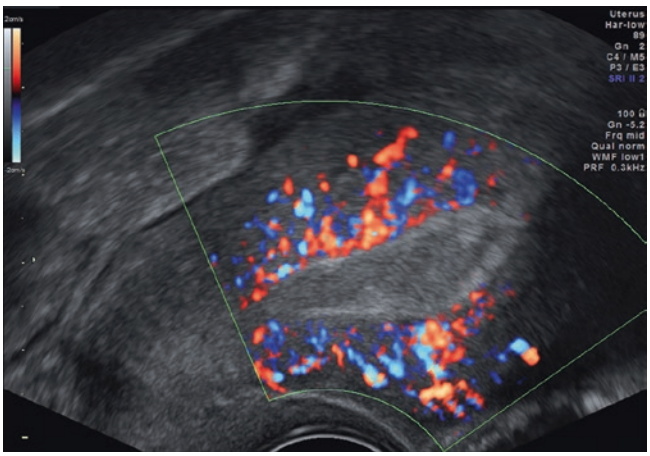


Fig. 5.51 Color Doppler shows, as expected, no intracavitary vascularization. The increased myometrial and subendometrial vascularization ends exactly at the wall of the uterine cavity (Images from of Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

Intrauterine Adhesions

Intrauterine adhesions can develop after intrauterine surgery, e.g. curettage, and can be a cause of infertility. They disrupt the EMJ and present sonographically as endometrial defects (Figs. 5.54, 5.55, 5.56, 5.57, 5.58, and 5.59).

Subendometrial Fibrosis

Subendometrial fibrosis can occur after intrauterine surgery, such as a curettage, and seems to be without significant effect on endometrial function. Sonographically subendometrial fibrosis presents as echogenic foci in the basal endometrium [1] (Fig. 5.60).

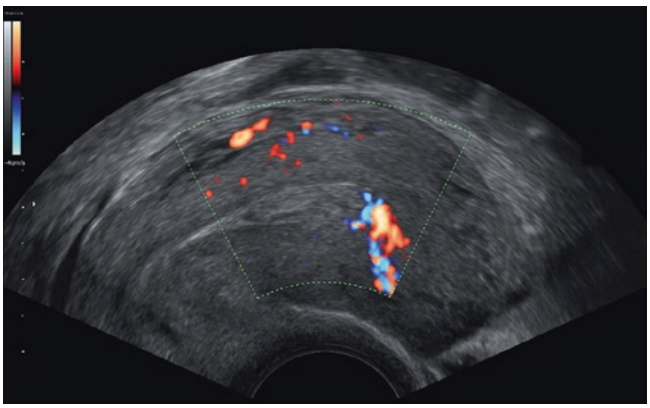


Fig. 5.52 Uterus was scanned because of continuous bleeding 3 months after spontaneous abortion. An intracavitary, spindle-like mass with a very marked vascularization in the fundal part crosses the EMJ and reaches deep into the myometrium

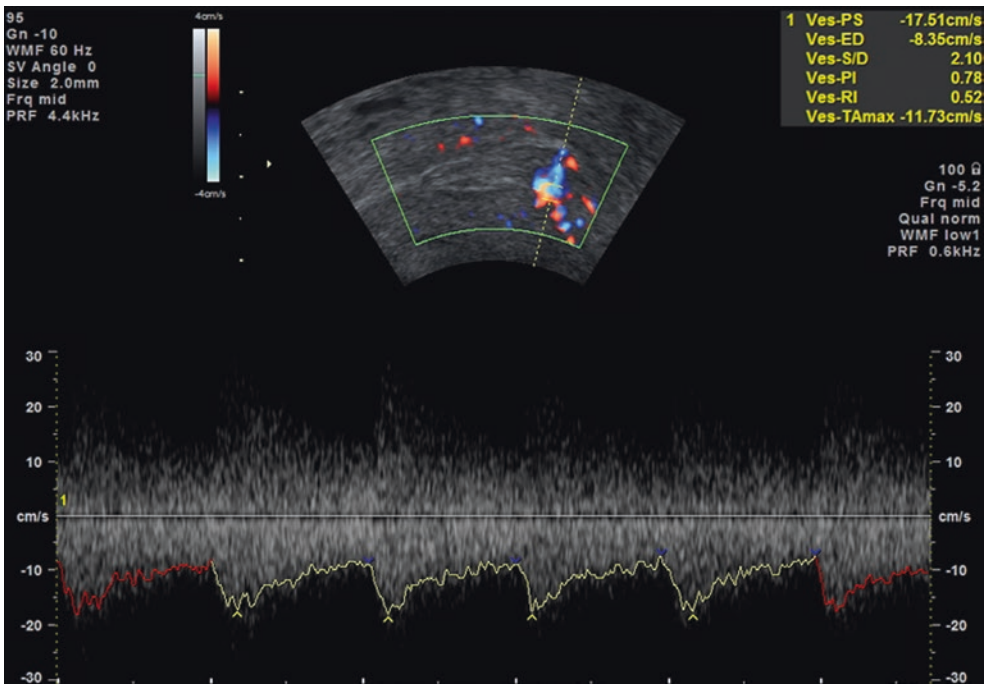


Fig. 5.53 Spectral Doppler shows the typical low impedance of neovascularization. This, in connection with the color flow image and the anamnestic information, leads to the suspicion of hormonal active "vital" placental remnants. Corresponding to this suspicion, beta-HCG was 720 mIE/ml and the histologically confirmed diagnosis after curettage: "regressive altered abortion material with partial mole-like degeneration of the villi. In the presented material no signs of malignant growth." (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

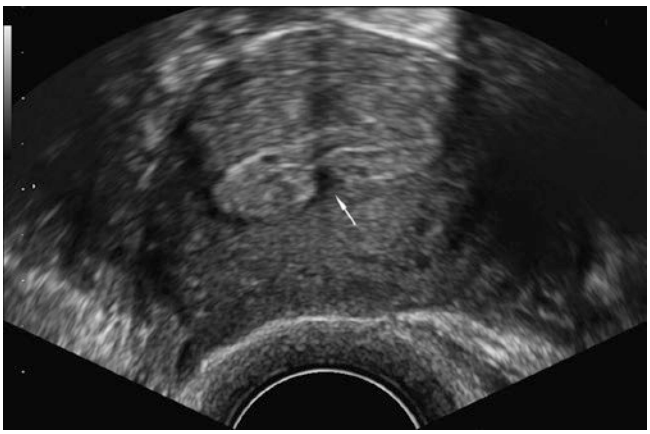


Fig. 5.54 The image shows an endometrial defect (*arrow*) with focal interruption of the EMJ, typical for intrauterine adhesion

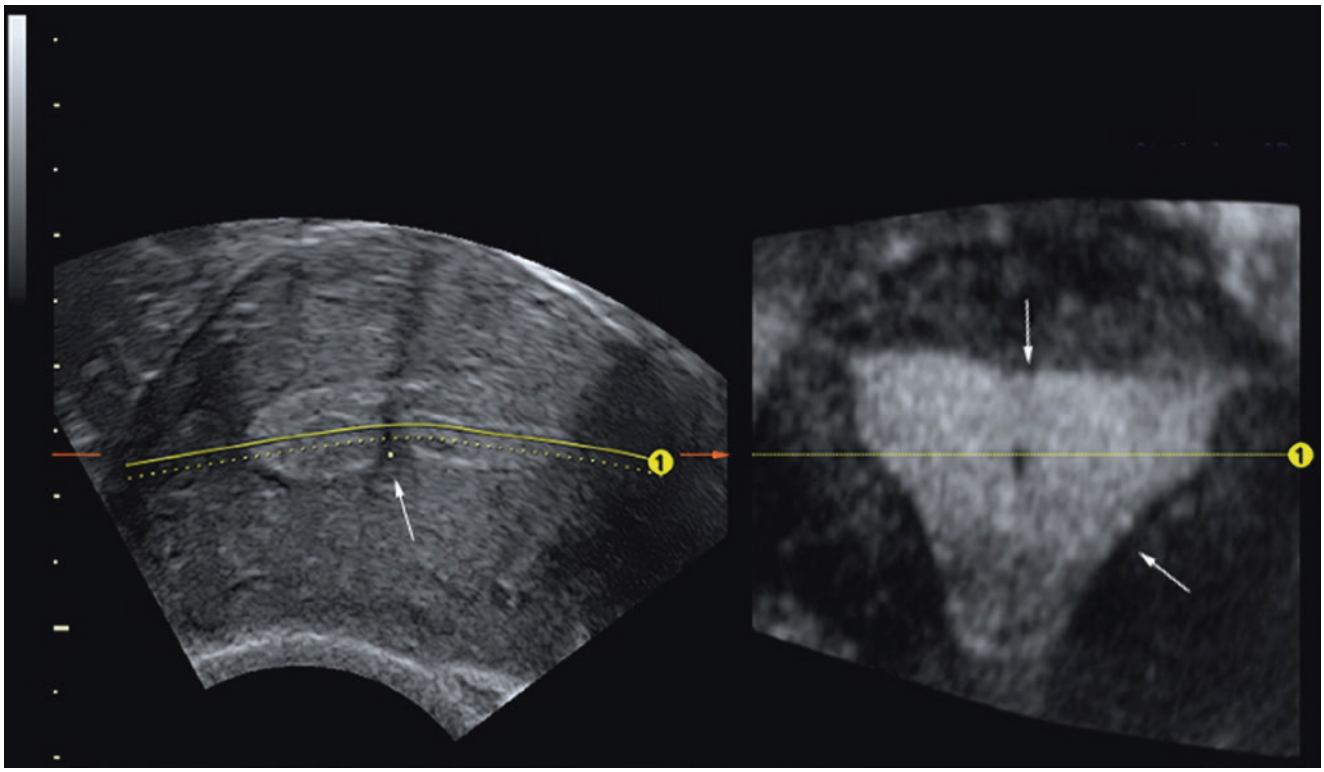


Fig. 5.55 Frontal scan by 3D OmniView technique for better localization and presentation of the very thinly marked adhesion

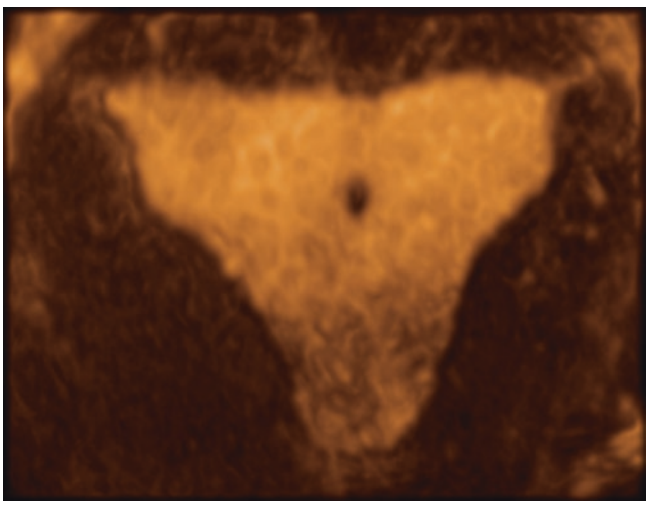


Fig. 5.56 The same frontal scan augmented and colored for better optical perception. Supplementary case history: state after curettage because of abortion (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

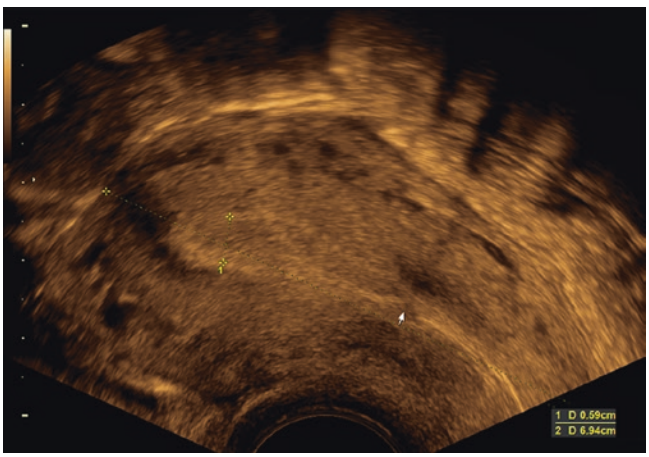


Fig. 5.57 A second example of an endometrial defect with focal interruption of the EMJ, located in the lower part of the uterine cavity (*arrow*), suspicious for intrauterine adhesion

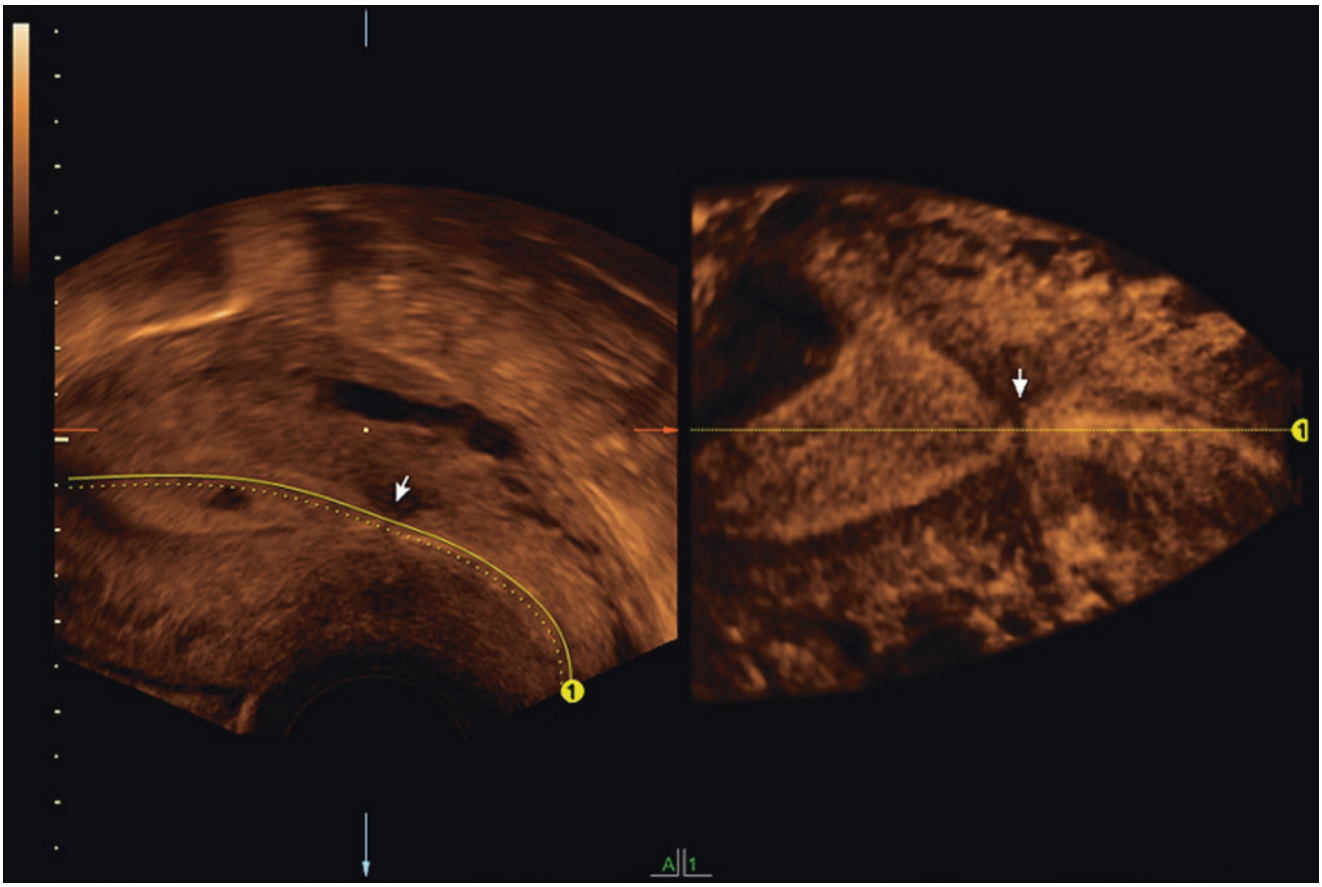


Fig. 5.58 Frontal scan by 3D OmniView technique shows the suspected adhesion (*arrow*) better than a 2D scan

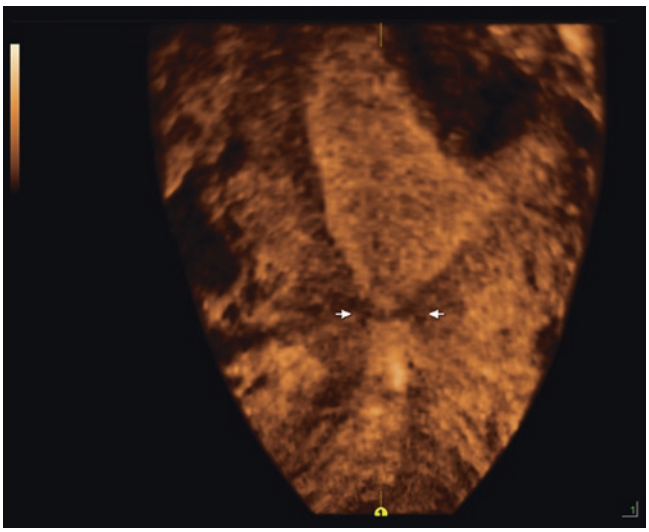


Fig. 5.59 The same frontal scan augmented and turned in the usual position for frontal scans impressively shows the endometrial interruption at the expected level (*arrows*). Supplementary case history: At this level (*arrows*) a strong, impenetrable obstacle was found when a sounding test was made before insertion of an intrauterine contraceptive device. These findings are to be seen in connection with a state after curettage due to retained pregnancy remnants (Images by courtesy of Dr. Isabel Wallrafen)

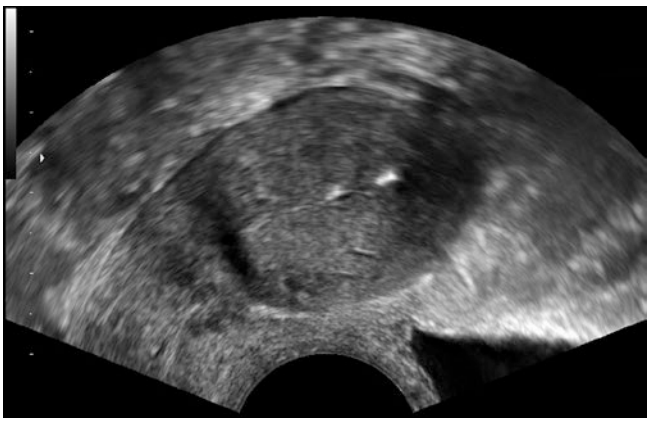


Fig. 5.60 Uterus with two echogenic foci as signs of subendometrial fibrosis (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

Cesarean Section Scar

Cesarean scars are usually found in the lower uterine segment of the anterior uterine wall and present sonographically as a structure of low echo density reaching from the uterine serosa to the endometrium, interrupting the endometrial-myometrial continuity (Fig. 5.61).

Scar defects (dehiscences, niches) of smaller and larger size (Figs. 5.62, 5.63, and 5.64) are common sonographic findings after cesarean section. Different authors have published different findings on the prevalence of scar defects, but agree that the defects occur not seldom but more or less frequently. For example, O. Vikhareva Osser et al. found scar defects "in 61 % (66/108), 81 % (35/43) and 100 % (11/11) of the women who had undergone one, two and at least three cesarean sections" [4].

The larger the defect the greater is the loss of myometrial thickness at the level of the scar defect, with possible negative effects on the stability of the anterior uterine wall during pregnancy. But, quite astonishingly, even in more advanced pregnancies, where sonographically the remaining myometrium at the defect is found to be very thin (Fig. 5.64), its stability is usually better than expected. Nevertheless, uterine rupture is possible and sequential sonographic surveillance is obligatory.

Another consequence of scar defects, depending on their extension and shape, can be the retaining of menstrual blood and therefore irregular bleedings.

But the most severe aspect of cesarean scar defects are cesarean scar pregnancies (CSP) with the high risk of developing placental attachment disorders, such as placenta accreta, increta, and especially percreta.

These developments could be due to the loss of normal endometrium at the level of the scar with its interrupted EMJ. "The loss of functional endometrium results in inadequate decidualization at the scar site; the absence of decidua is considered to be the main factor explaining the propensity of trophoblast to penetrate deep into myometrium, beyond the EMJ, when future pregnancies are implanted into a deficient cesarean scar" [5].

As cases of CSP are described with placental implantation "on" the scar as well as cases with placental implantation "in" the niche of a defect scar [6], it seems that not only scar defects but also scars without (sonographically visible) defects are a risk for CSP.

Because of the high risk of CSP developing the above-mentioned severe placental disorders with all their severe consequences of blood loss, loss of uterus and fertility, all pregnant patients with previous cesarean section should have an early first trimester TVS, preferably between 6 and 8 weeks (p.m.), to localize the gestational sac and placental insertion. If a CSP is found, the patient should be counseled in detail "to enable

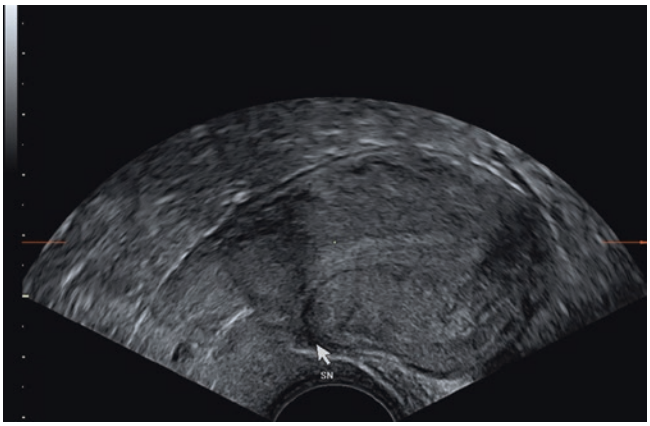


Fig. 5.61 Typical cesarean scar in the anterior wall of the lower uterine segment (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

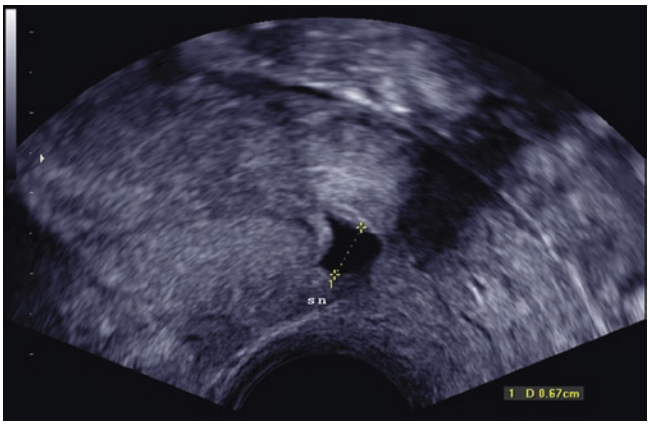


Fig. 5.62 Longitudinal scan of the lower part of the uterus (in this image, left is anterior and right is posterior). Cesarean scar defect filled with anechoic fluid, no pregnancy (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

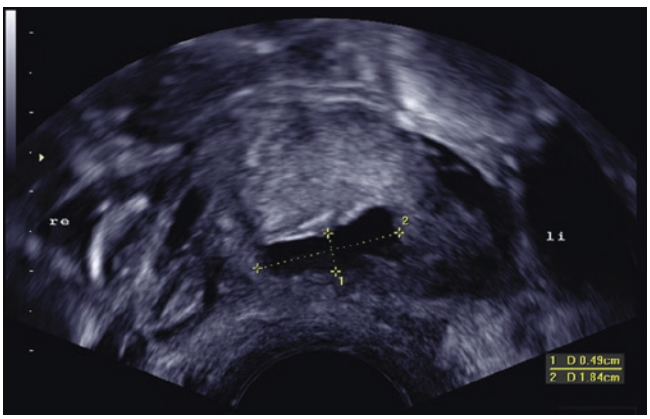


Fig. 5.63 The same case: transversal scan at the level of the scar defect (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

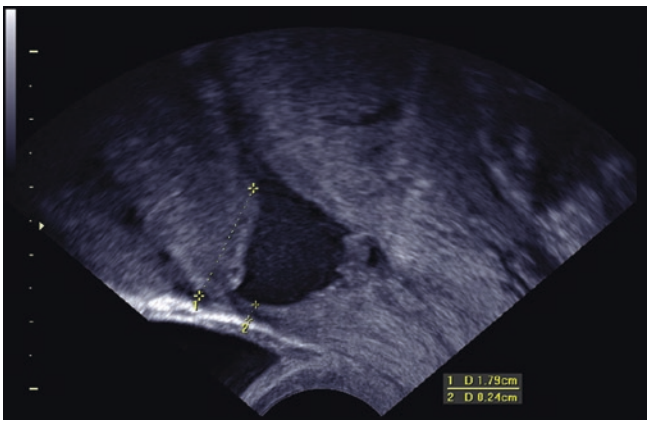


Fig. 5.64 A different case. Longitudinal scan of the lower part of the uterus (in this image, left is anterior and right is posterior). Cesarean scar defect during pregnancy at 26 weeks. The defect is much extended and sharply delineated by amniotic fluid. The remaining myometrial thickness at the scar level is very thin, only 2.4 mm compared to the normal thickness of 17.9 mm at this level (measurements within the image). The course of this pregnancy with sequential sonographic controls was finally terminated by cesarean re-re-section at 36 weeks. The intraoperatively found anterior uterine wall at the level of the cesarean scar was paper-thin but not ruptured. The newborn baby was in good condition (Image from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

her to make an informed choice between first trimester termination and continuation of the pregnancy, with its risk of premature delivery and loss of uterus and fertility " [6]. In this connection, it is well worth reading the article of Timor-Tritsch et al. with its very instructive images of cesarean scar pregnancies and their development in the course of pregnancy [6].

Intrauterine Ectopic Pregnancy

Ectopic pregnancies can be implanted not only extrauterine but also ectopic within the uterus, which is a life-threatening condition and a challenge for therapeutic treatment (Figs. 5.65 and 5.66).

Intrauterine Contraceptive Devices

The position of these devices within the uterus can easily be documented by 2D-sonography and more accurately by 3D sonography (Figs. 5.67,5.68, 5.69, and 5.70).

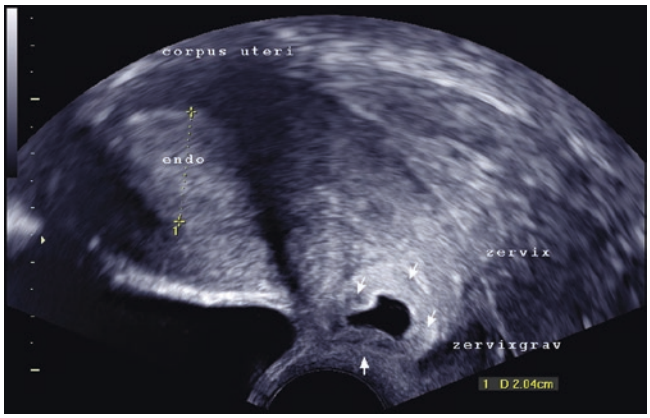


Fig. 5.65 In this longitudinal scan the anterior uterine wall is on the left side of the image. Within the anterior cervical wall a round, in comparison to the surrounding myometrium, more echodense area with a central liquid zone can be seen

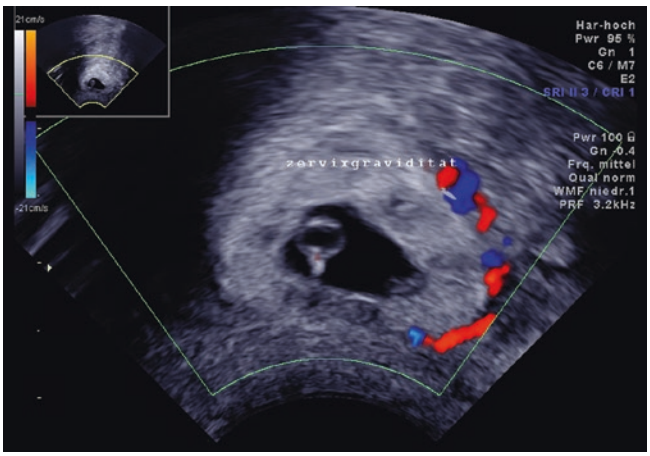


Fig. 5.66 Color Doppler and augmentation show the finding of a vital early pregnancy with the typical neovascularization around the trophoblast (Images by courtesy of Drs. Sibylle Haase and Isabel Wallrafen)



Fig. 5.67 As far as can be estimated by 2D sonography, the image shows a correctly positioned intracavitary IUD. The marked echo indicates a copper-armed IUD

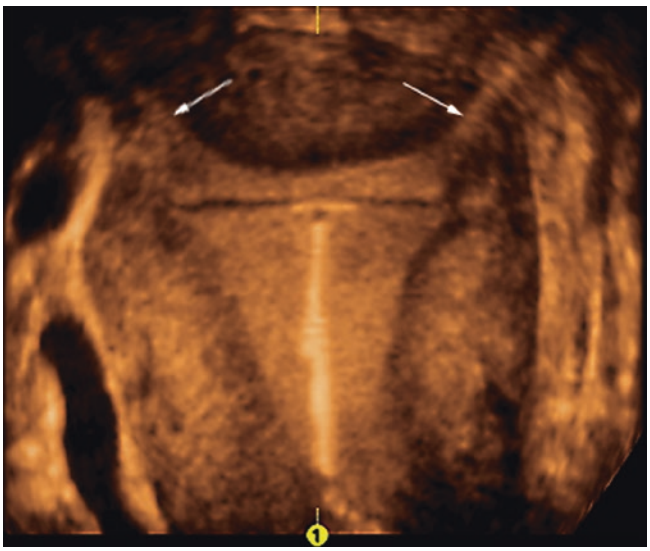


Fig. 5.68 The frontal scan by the 3D OmniView technique demonstrates the correctly extended side arms of this "Copper-T" IUD (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

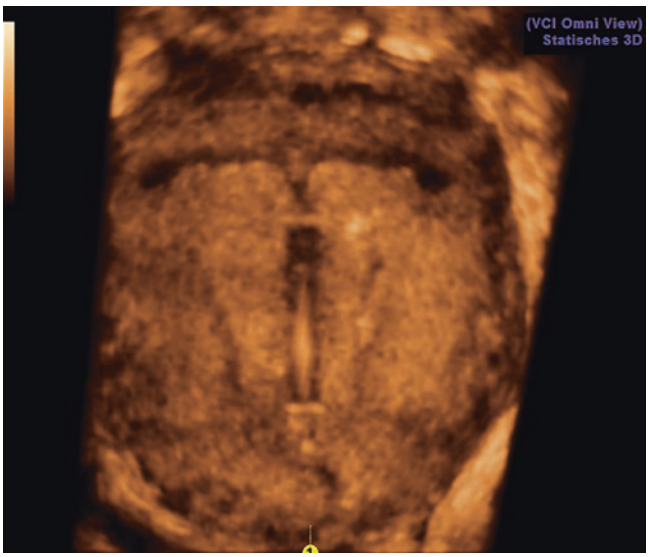


Fig. 5.70 The frontal scan by the 3D OmniView technique demonstrates the correctly extended side arms of the levonorgestrel-bearing IUD Mirena (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

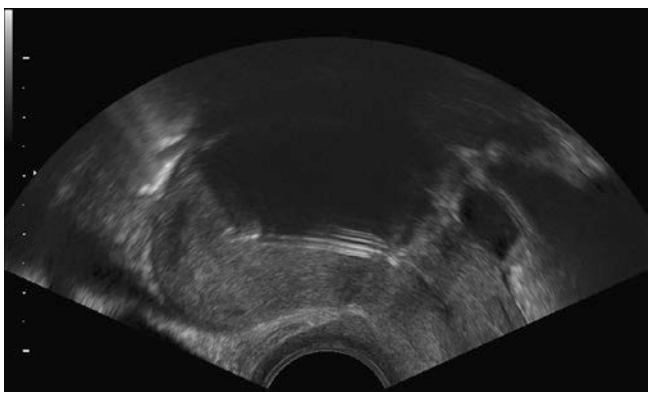


Fig. 5.69 As far as can be estimated by 2D sonography, the image shows a correctly positioned intracavitary IUD. The very marked shadowing behind the IUD indicates a gestagen-delivering IUD

Adenomyosis Uteri Interna or Endometriosis Interna

Adenomyosis is a uterine disease, caused by protrusion of vital endometrium from the basal layer into the myometrium, forming focal or widespread alterations within the myometrium on the other side of the EMJ. This disease is characterized by endometrial glands and stroma, surrounded by hypertrophic myometrium. Each focus can be seen as a "mini-uterus" within the uterus.

According to the theory of Leyendecker, autotraumatization of the uterus, caused by hyperperistalsis and dysperistalsis of the EMJ (archimetra) with consecutive increase of intrauterine pressure, leads to the dislocation of basal endometrium [3]. If basal endometrium fragments settle within the myometrium, the term adenomyosis uteri interna or endometriosis uteri interna is used. If the fragments enter the cavum uteri and from there by retrograde menstruation the peritoneal cavity and settle there, the term endometriosis externa is used.

A common trait of adenomyosis (interna) and endometriosis (externa) is an "infiltrative expansion of the archimetra" into the surrounding uterine wall. Consequently, a disease of the archimetra, that is a disease of the uterus, is the primary phenomenon and "endometriosis of the peritoneal cavity is not an obligatory secondary phenomenon" (Leyendecker).

So much for the shortened theory of Leyendecker.

The spreading of adenomyosis can be focal or multifocal diffuse, with a more infiltrative expansion which, contrary to myomata, shows no clear demarcation from the surrounding tissue. In contrast to myomata the vascularization (angiogenesis) is increased more within the affected area and less around this area. Calcifications are not found within adenomyosis.

A very easy and immediately recognizable sonographic sign of adenomyosis, even with older or low grade ultrasound equipment, is a marked asymmetry between the non or less affected and the more affected uterine wall (Fig. 5.71), provided that the asymmetry is not caused by myomata.

Streaky shadowing within the affected areas, caused by marked differences in sonographic impedances, indicates the older, advanced processes (Fig. 5.72) whereas cystic, clear demarcated adenomyotic islands indicate the more recent processes, see above Fig. 5.25.

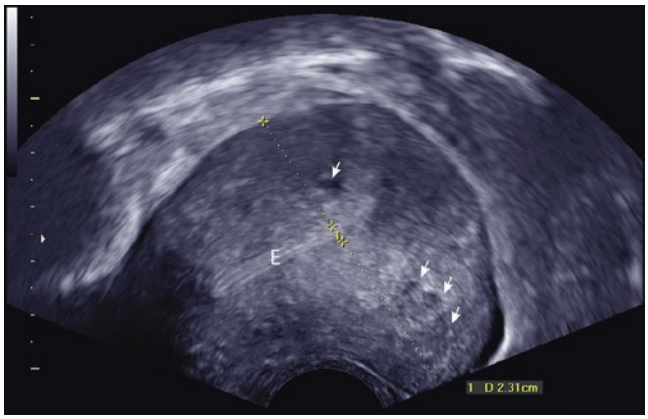


Fig. 5.71 This longitudinal scan demonstrates the common finding of a uterine asymmetry in a case of adenomyosis. "*E*" in the image indicates the mid uterus. One uterine wall contains more adenomyotic foci (*arrows*) than the other, with only one focus (*arrow*), and therefore is markedly thicker. This sign of asymmetric uterine walls can easily be assessed even by low grade US equipment. See above also Fig. 5.24 Color Doppler shows a markedly higher and more irregular vascularization of the affected area in comparison to the regular vascularization by preexisting vessels (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

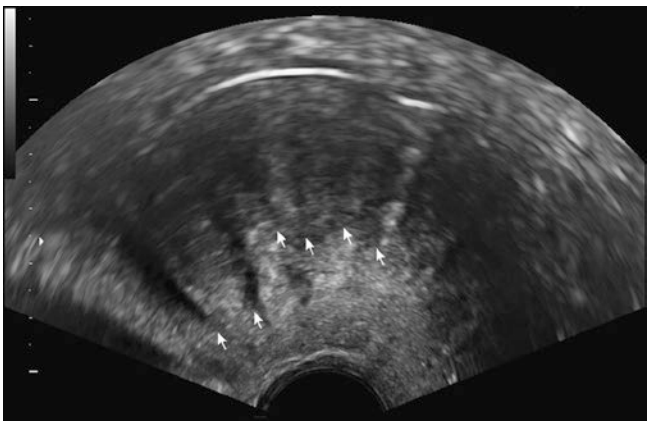


Fig. 5.72 In this longitudinal scan streaky shadowing indicates a widespread adenomyosis. See above also Fig. 5.25: In another area of the same uterus cystic structures, surrounded by an echogenic endometrium-like margin, are to be found. Color Doppler shows a very marked and diffuse neovascularization in the cystic area as a sign of adenomyosis with a tendency to progress. It seems to be that streaky shadows indicate older processes and cystic findings more recent afflictions of adenomyosis (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

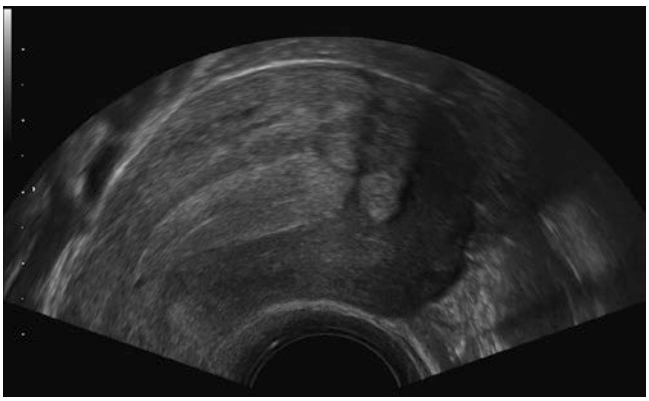
In some cases it can be difficult to differentiate between signs of adenomyosis and myomata when they do not present the signs in a typical manner and especially when both adenomyosis and myomata are present.

The symptoms and consequences of adenomyosis vary, depending on the progression of the disease, from very heavy dysmenorrhea, algopareunia, continuous pain, sterility, to a more or less symptomless course of the disease with normal or only slightly reduced fertility.

Therapeutically medical treatment can be attempted in the form of drugs often given in cases of endometriosis (externa), but it is not really effective. More promising seems to be the intrauterine application of levonorgestrel by means of the intrauterine device Mirena (Schering).

Hysterectomy is the surgical choice for reliably removing all foci. However, if fertility should be conserved as far as possible, organ-preserving methods with excision or electric coagulation of the foci could be considered, depending on the extent of the disease.

Adenomyosis is a very common disease and is detected increasingly more by high resolution TVS in the hands of well-trained investigators whereas in earlier times diagnosis was usually made by chance, histologically.



Flg. 5.73 The longitudinal scan shows two adenomyotic foci close to the endometrium

The examples of adenomyosis presented here (Figs. 5.71, 5.72, 5.73, 5.74, 5.75, 5.76, and 5.77), and see above Figs. 5.24 and 5.25, demonstrate the high value of TVS and color Doppler in the diagnosis and assessment of this disease. In addition to this today's primary tools, MRI can be necessary for special demands, such as "mapping" before surgical treatment.

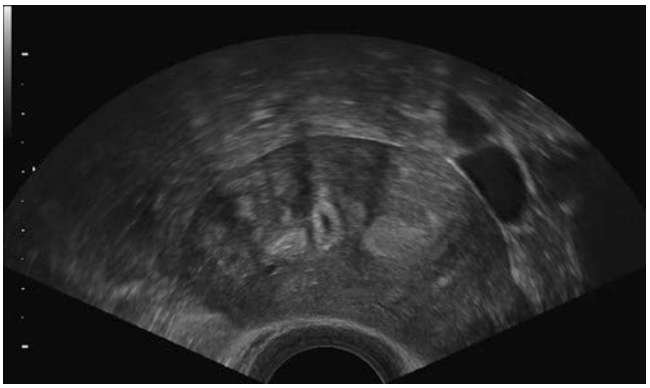


Fig. 5.74 The transverse scan in the fundal region shows some larger and many smaller adenomyotic foci which are more distant from the endometrial part where protrusion into the myometrium has begun

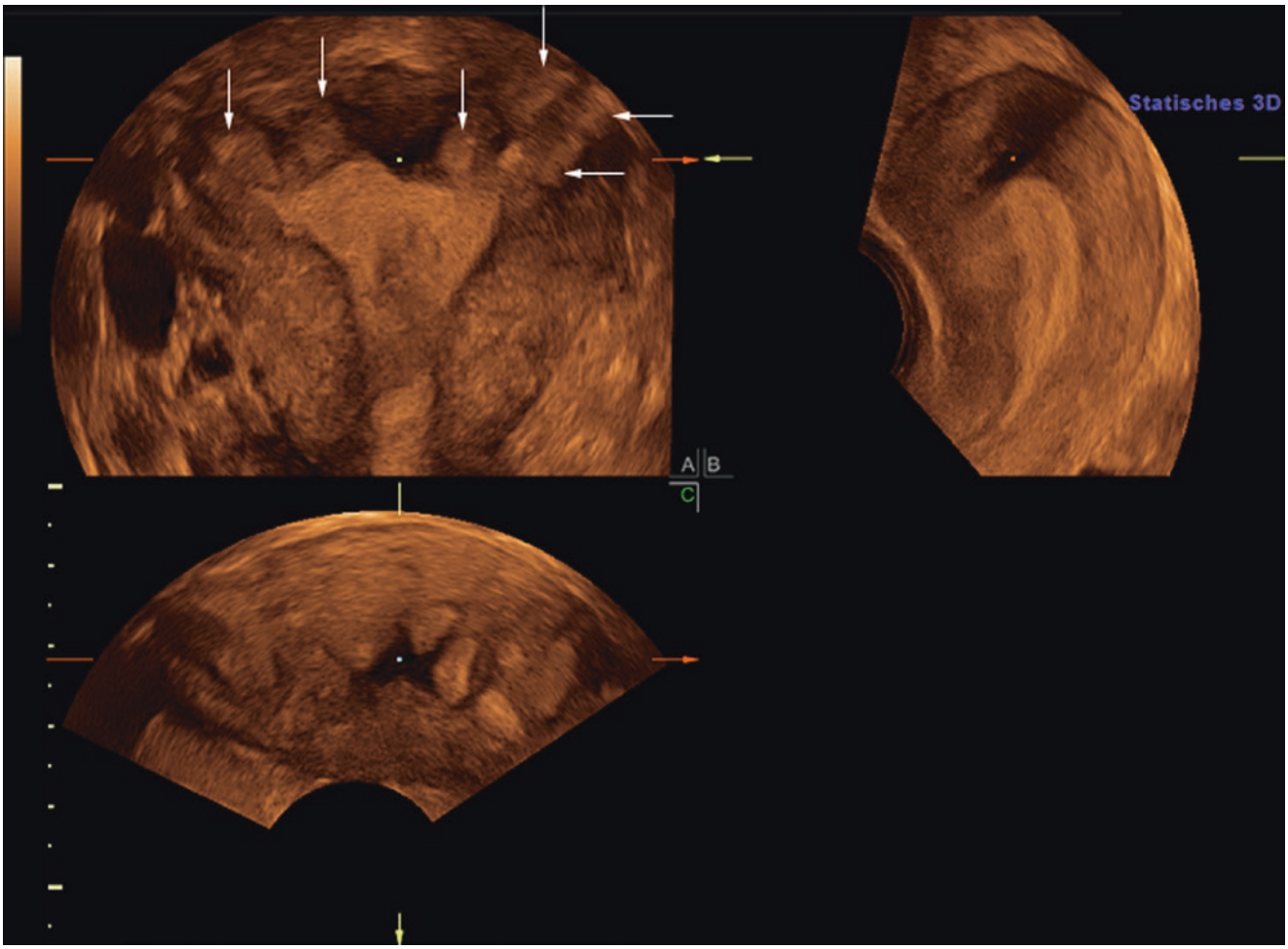


Fig. 5.75 The 3D frontal scan shows multiple adenomyotic foci (*arrows*) which obviously started from the fundal endometrium, as is often found in cases of adenomyosis

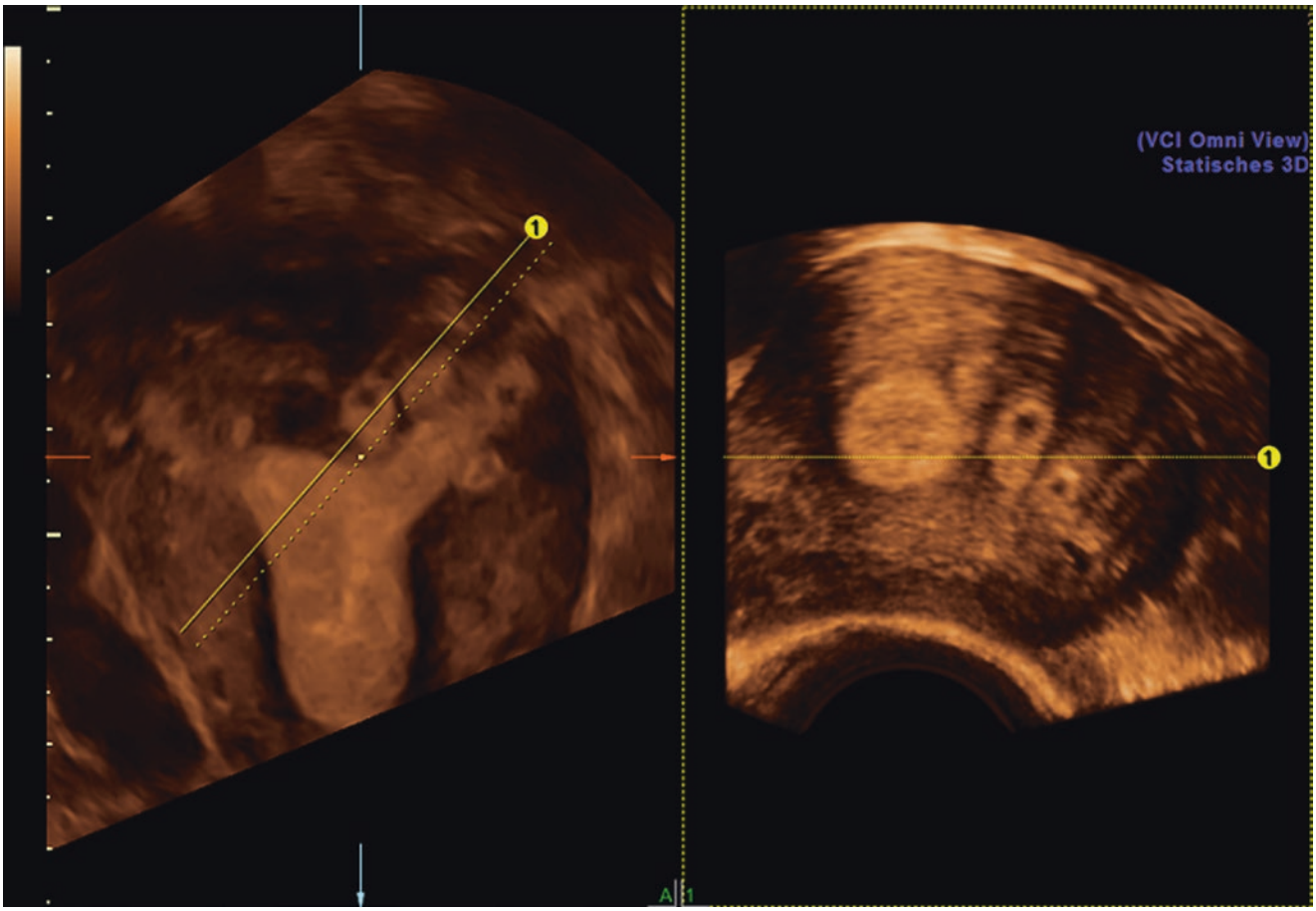


Fig. 5.76 The frontal scan on the left side of the image shows the EMJ as a low echogenous seam surrounding the middle and lower part of the endometrium. In the fundal region the EMJ is no longer visible because of multiple adenomyotic activities with their partially destroying effect on the EMJ. On the right part of the image endometrium and adenomyotic islands are presented more vividly by using OmniView and VCI techniques. The chosen plane of section is indicated by the line 1

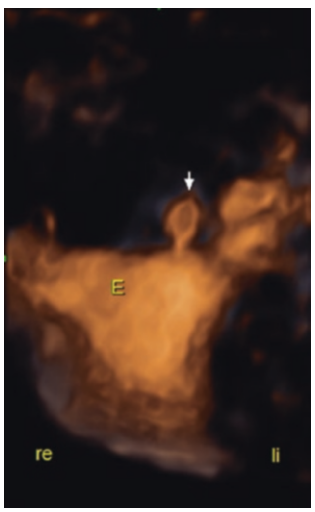


Fig. 5.77 This frontal scan in the fundal region demonstrates an adenomyotic focus in the early phase of development, still connected to the endometrium (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

Deep Infiltrating Endometriosis or Adenomyosis Externa

Deep infiltrating endometriosis, described by Donnez et al. [7] as a form of "adenomyosis" invading deep into the rectovaginal space, affects the bowel wall in the rectosigmoid area, the uterus with its ligaments and the paraprocticum. Sonographically, the nodular alteration can be shown as a low echogenic, relatively clear demarcated structure between the cervical part of the uterus and the anterior rectal wall that is invaded in its muscular part (Fig. 5.78), see also Figs. 5.79, 5.80, 5.81, 5.82, and 5.83. To improve the surgical management, the extension of deep infiltrating endometriosis should be assessed by TVS before surgical treatment.

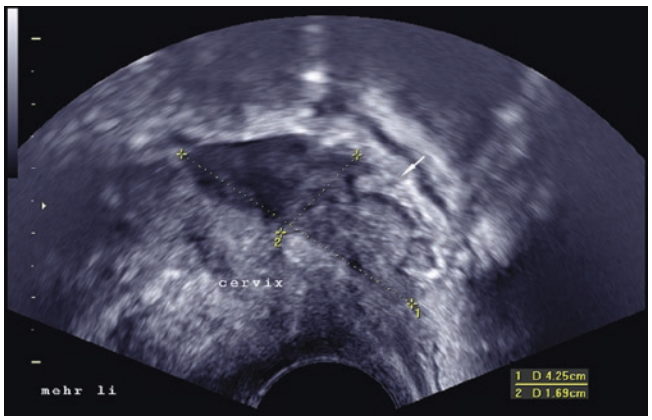


Fig. 5.78 Longitudinal cervical scan, left paramedian. In this and the following images, left is anterior and right is posterior. A retrocervical, rectovaginal deep endometriosis is shown sonographically as a relatively clear, demarcated structure of low echogenity, extended between the posterior cervical wall and the vicinal bowel (rectum) which is infiltrated in its frontal muscular wall. The non-affected mucosal part of the bowel is indicated by high echogenity (*arrow*). Measurements within the image

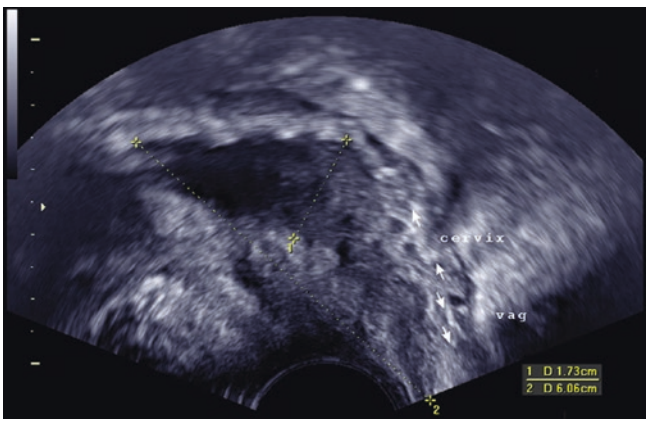


Fig. 5.79 The wide spread of the endometriosis towards the vagina is indicated by two *arrows* and towards the *cervix* by one *arrow*. Measurements within the image

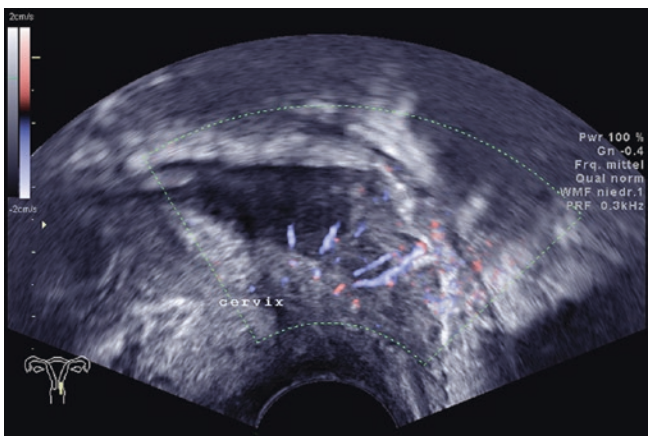


Fig. 5.80 Color Doppler shows vascularization as a possible sign of "vitality" and a tendency to progress

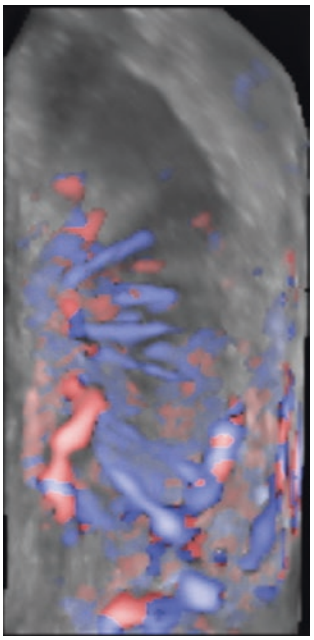


Fig. 5.81 Vascularization demonstrated by color Doppler glass body mode

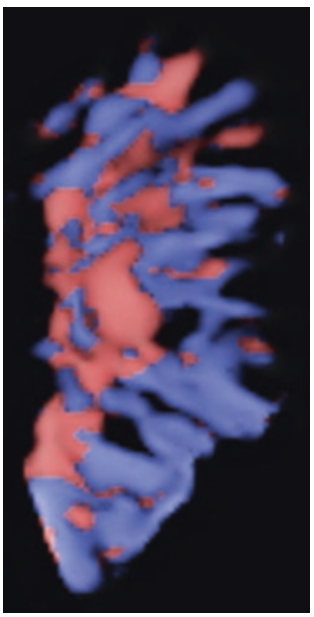


Fig. 5.82 Vascularization demonstrated by solely color, without any surrounding tissue. See above also Fig. 5.7 3D presentation of the endometriosis, inversion modus: The very irregular surface and the pedicle-like extensions give an impression of the highly aggressive potential of this kind of endometriosis and its suspected tendency to progress (Images from Dürr, Transvaginale Sonographie in der Gynäkologie, De Gruyter, 2nd Edition, 2015)

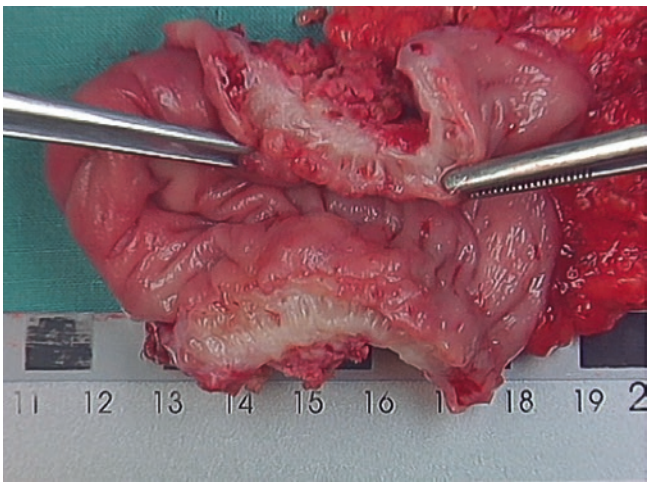


Fig. 5.83 The postoperative image shows the opened endometriotic node, extended in the anterior muscular part of the rectum (Courtesy of Prof. Dr. J. Keckstein)

References

Book

Dürr, W: Transvaginale Sonographie in der Gynäkologie. De Gruyter, 2. Auflage 2015.

Journal Articles

1. Naftalin J, Jurkovic D. Editorial.The endometrial- myometrial junction: a fresh look at a busy crossing. Ultrasound Obstet Gynecol. 2009;34:1–11.
2. Leyendecker G, Kunz G, Noe M, Herbertz M, Mall G. Endometriosis: a dysfunction and desease of the archimetra. Hum Reprod Update. 1998;4:752–62.
3. Leyendecker, G, Herbertz M, Kunz, G. Neue Aspecte zur Pathogenese von Endometriose und Adenomyose. Frauenarzt 43. 2002 Nr.3 297–307.
4. Vikhareva Osser O, Jokubkiene O, Valentin L. High prevalence of defects in Cesarean section scars at transvaginal ultrasound examination. Ultrasound Obstet Gynecol. 2009;34:90–7.
5. Ben-Nagi J, Helmy D, Ofili-Yebovi J, Jazbek J, Sawyer E, Yurkovic D. Reproductive outcomes of women with a previous history of Caesarean scar ectopic pregnancies. Hum Reprod. 2007;22:2012–5. Cited out of (1).
6. Timor-Tritsch IE, Monteagudo A, Cali G, Vintzileos A, Viscarello R, Al-Khan A, Zamudio S, Mayberry P, Cordoba MM, Dar P. Caesarean scar pregnancy is a precursor of morbidly adherent placenta. Ultrasound Obstet Gynecol. 2014;44:346–53. doi:10.1002/uog. 13426.
7. Donnez J, Nissole M, Smets M, et al. Rectovaginal septum adenomyotic nodule: a distinct entity: a series of 460 cases. In: Sutton C, Diamond M, editors. Endoscopic surgery for gynecologists. 2nd ed. London: WB Saunders; 1998. p. 357–62.

Radio-Imaging for Benign Uterine Disease

6

Céline D. Alt-Radke

Introduction

Magnetic Resonance Imaging (MRI)

Native high-resolution T2-weighted images (T2WI) are essential for morphological differentiation of pelvic organ tissue (Fig. 6.1). Contrast-enhanced T1-weighted images (T1WI) give important additional information in almost every problem and should be therefore routinely performed [1–6]. However, kidney functions (kreatinine) should be checked before the intravenous application of contrast media. As intravenous MR contrast agent is gadolinium (Gd)-based, thyroid function is therefore not required to be checked. In recent years, diffusion weighted imaging (DWI) gains more and more attention. This imaging technique was designed to depict alterations in thermally induced random (Brownian) motion of water molecules within tissues and the degree of this motion is known as diffusion [7]. DWI can be performed quickly, without the necessity of contrast i.v. The technique yields qualitative and quantitative information about tissue cellularity and cellular membrane integrity. High cellularity and cell membrane integrity restrict water mobility and therefore diffusion, as seen e.g. in tumors. During MR-performance, diffusion sensitivity can easily be varied by changing the *b* value used during image acquisition [7]. Quantitative analysis of diffusion may be performed by obtaining and mapping apparent diffusion coefficient (ADC) values [7].

For the evaluation of inflammation or fistulas, T2WI with fat saturation are helpful, especially with patients where no contrast media application is possible. For the differentiation between hemorrhage or lipid contents, a native T1-weighted sequence without and with fat saturation is helpful. For lymph node detection, a native T1-weighted sequence or proton-weighted (PD) sequence is helpful (Table 6.1) [8].

Computed Tomography (CT)

With a multidetector CT (MDCT) the examination of a region of interest can be performed in axial plane in a short examination time with submillimeter resolution. The row data can be postprocessed in any plane with approximately the same resolution. It should be noticed that intravenous contrast application is essential for soft tissue contrast because even CT in venous phase has less tissue contrast compared to native MRI (Figs. 6.2, 6.3, and 6.4) [9]. Before performing contrast enhanced CT (CECT), kidney function (kreatinine) and thyroid function (TSH, fT3, fT4) should be checked to be with normal values.

Leiomyoma

Leiomyomas have a pseudo-capsule, are almost clearly defined and can be located submucosal (growth intraluminal), intramural or subserous (growth to the outside), yet can also be pedunculated. More localisations are cervical, vaginal or intraligamental [10]. Usually, the diagnosis is based on the clinical-vaginal examination and ultrasound. In case of myomas large in size or number, a high-resolution MRI of the pelvis may be helpful for the planning of an individual therapy (hysterectomy, myomectomy, open versus laparoscopic surgery, uterine artery embolisation, MR guided focused ultrasound) or the distinction between benign or malignant appearance (Fig. 6.5). Depending on their content,

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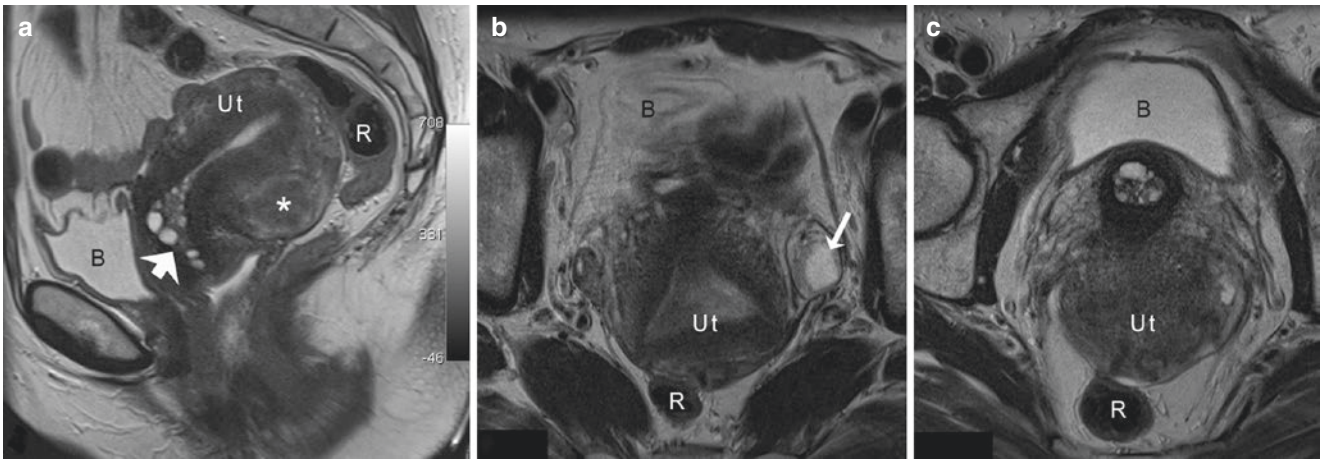
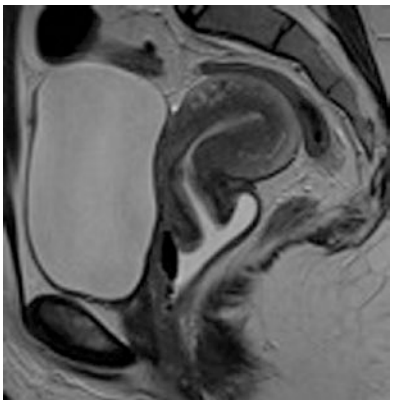
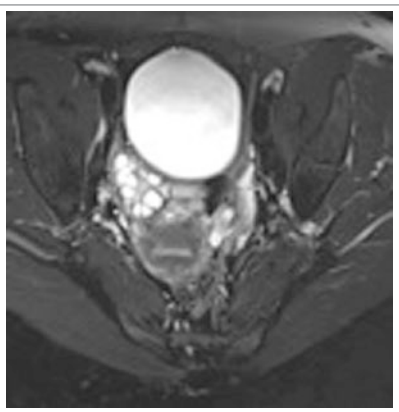


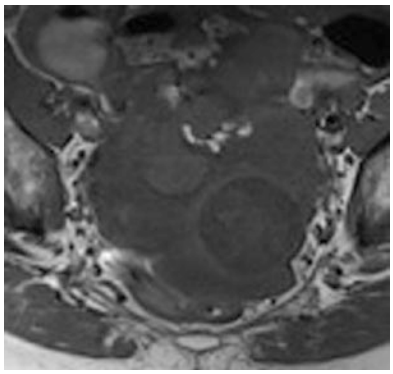
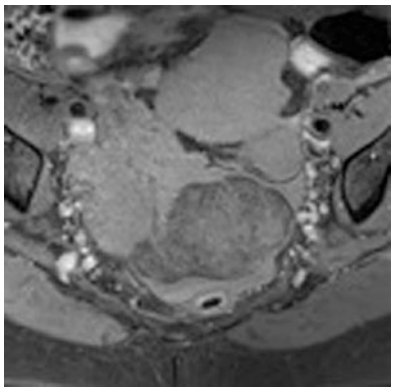
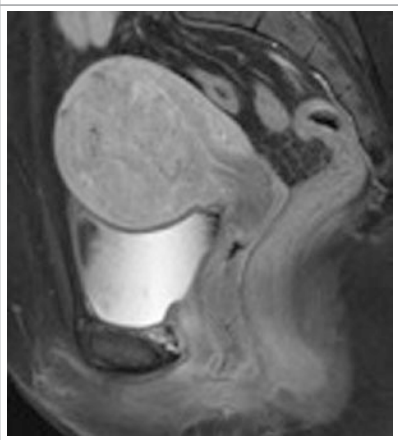
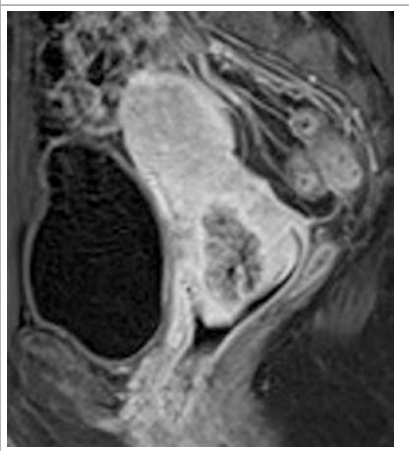
Fig. 6.1 Information given by native T2-weighted MRI of the female pelvis: (**a**) on sagittal plane, the uterus presents retroflected with a normal three-layer appearance and an intramural leiomyoma of the posterior wall (*asterisk*). The cervix contains nabothian cysts (*arrowhead*). (**b**) On T2-weighted transverse oblique plane to the cervix, additional information can be given for the left ovary containing a corpus luteum cyst (*arrow*). (**c**) On T2-weighted transverse plane oblique to the cervix, the hypointense stromal ring of the cervix presents intact, the cervical cavity presents with nabothian cysts. *Ut* uterus, *B* bladder, *R* rectum

Table 6.1 Common MR-sequences used for female pelvic imaging

	Sequence	Specification	Example	
1	High resolution T2WI	Morphology of pelvic organs		[Table 6.2 image 1]
2	T2WI with fat saturation	Oedema, inflammation, fistula		[Table 6.2 image 2]

(continued)

Table 6.1 (continued)

	Sequence	Specification	Example	
3	T1WI native/with fat saturation	Lymph nodes/ differentiation between lipids or hemorrhage		
4	DWI (diffusion weighted imaging)	Diffusion restriction in inflammation, differentiation between benign to malignant lesions		[Table 6.2 image 3.1 and 3.2 are above] [Table 6.2 image 4 here] [Table 6.2 image 5.1 and 5.2 are below]
5	DCE (dynamic contrast enhanced)	Evaluation of tissues in arterial and venous phase, vascularisation, hyperemia		

T2WI T2-weighted imaging, *T1WI* T1- weighted imaging

myomas are shown with different signal behaviour in MRI [10]. A non-degeneratively changed (fibrous) leiomyoma is rich in fibrous tissue, round to ovally shaped, clearly defined and circumscribed, and is hypointense in T1WI and highly hypointense in T2WI in comparison to the myometrium. After application of contrast media i.v., signal behaviour tends to be non-homogenous. Often, a pseudo-capsule can be detected [3, 11]. Due to inlaid calcifications or hyaline, fat or liquid contents, degenerated leiomyomas show heterogenous signal behaviour as early in as in native sequences (Figs. 6.6, 6.7, and 6.8) [11]. If myomas are classified as secondary findings in CT-examinations, they commonly show early enhancement in the arterial phase and are more likely to be hypodense in the late phase. Depending on their size, myomas are homogenous (small myomas) or heterogenous (large myomas) (Fig. 6.4). Ring-shaped calcifications, which can be more easily discerned in CT than in MRI, are often part of myomas. Hyperdense foci in CT may point to hemorrhage, whereas hypodense areas may be a sign of necrosis or infection (Figs. 6.8 and 6.9).

Possible differential diagnoses for leiomyomas are polyps (if submucous myoma) (Fig. 6.10), adenomyosis (if intramu-

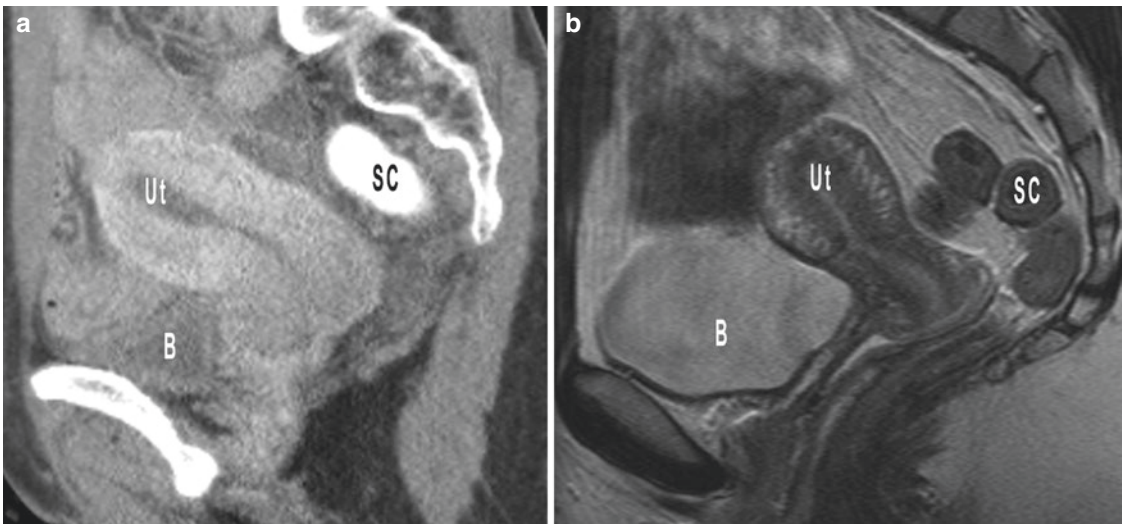
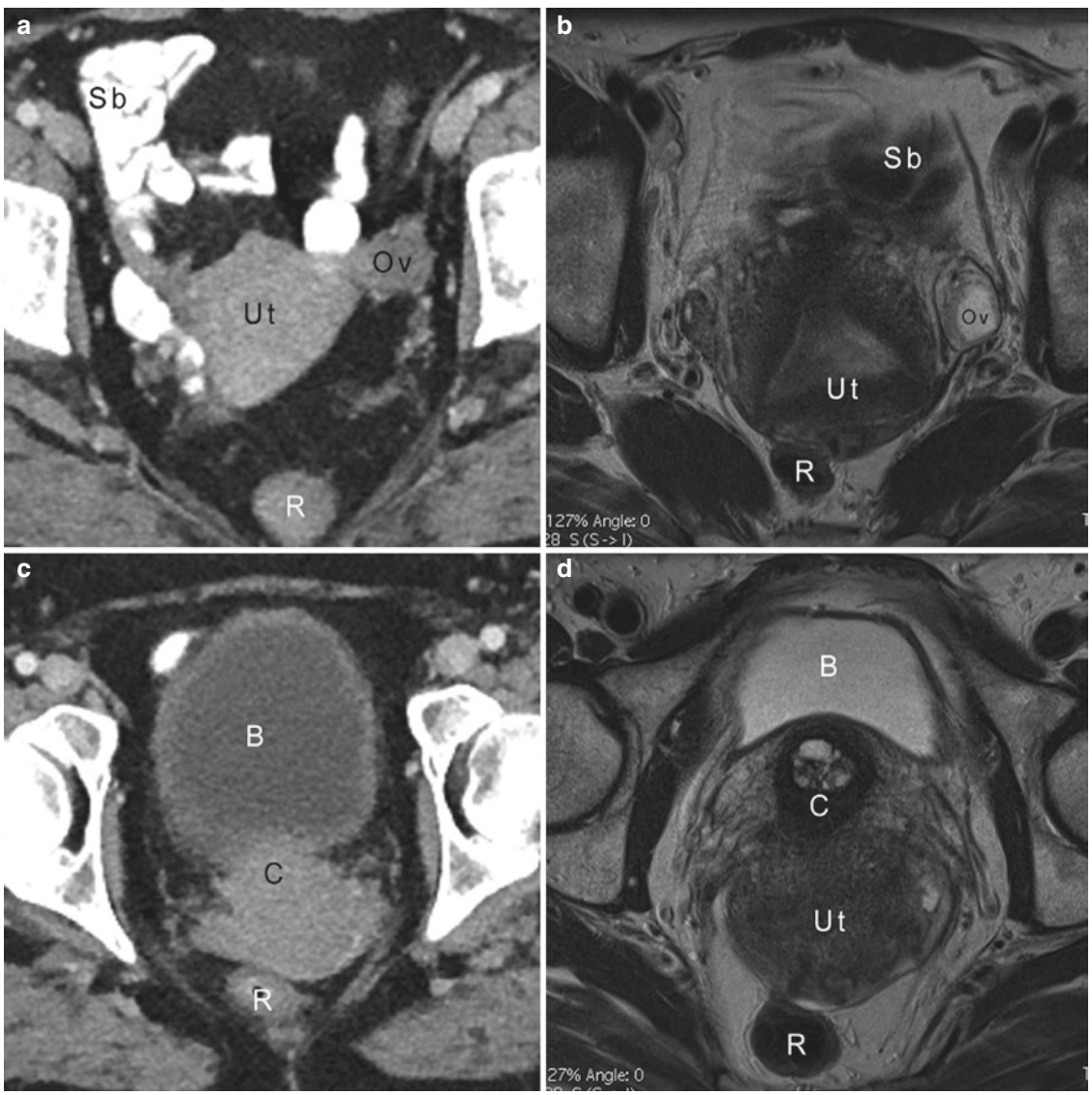


Fig. 6.2 Two patients presenting with sagittal images of the entire pelvis. (**a**) contrast enhanced CT gives an overview of the pelvic organs but lacks of good morphological differentiation. (**b**) High resolution T2 weighted image on MRI presents with a high soft tissue contrast and allows differentiation of different tissues, e.g. the differentiation between endometrium, junctional zone, myometrium and perimetrium. *B* bladder, *Ut* uterus, *SC* sigmoid colon



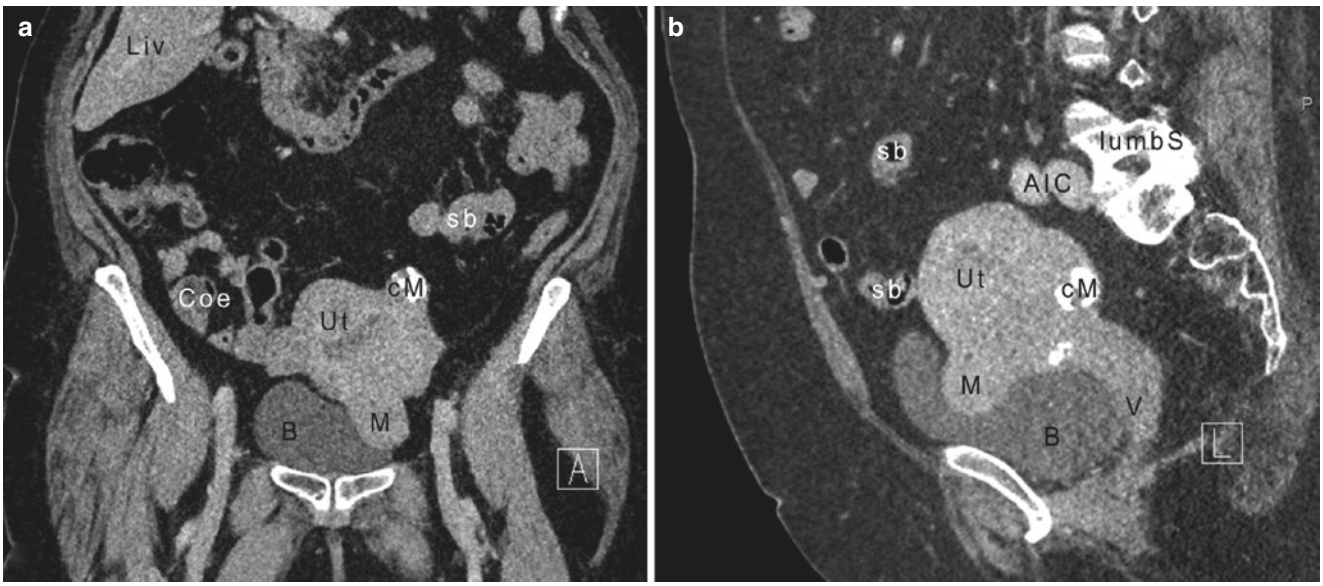


Fig. 6.4 Contrast enhanced CT performed for another indication. As a secondary finding, the woman presents with uterus myomatosus, partially calcified. Image on coronal (**a**) and sagittal (**b**) plane for anatomical landmarks. *Ut* uterus, *M* myoma, *cM* calcified myoma, *V* vagina; *B* bladder, *R* rectum, *Liv* liver, *sb* small bowel, *Coe* coecum, *AIC* common iliac arteries, *lumbS* lumbar spine

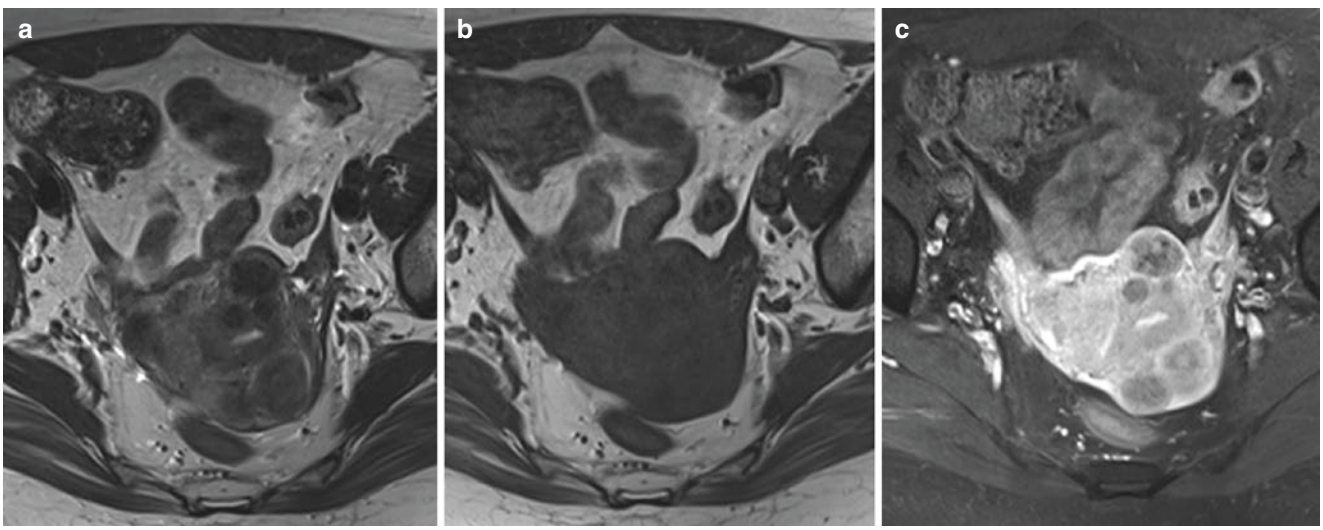


Fig. 6.5 Patient presenting with symptomatic uterus myomatosus. Without cross sectional imaging, the clear differentiation between degenerated/non degenerated leiomyoma, the number and localisation and the differentiation to small bowel loops, respectively, may be challenging with ultrasound alone. These images at transversal plane show the uterus myomatosus with at least 6 leiomyomas at this slice on (**a**) T2WI (**b**) native T1WI and (**c**) after contrast i.v

Fig. 6.3 Comparison of contrast enhanced CT (*left*) to native MRI of the female pelvis (*right*). The excellent soft tissue contrast of MRI without radiation gives more detailed information of the female pelvis as CT is able to. Therefore, whenever possible, MRI with an adopted gyne protocol should be performed instead of CT. *Ut* Uterus, *Ov* ovary; *C* cervix, *B* bladder, *Sb* small bowel, *R* rectum

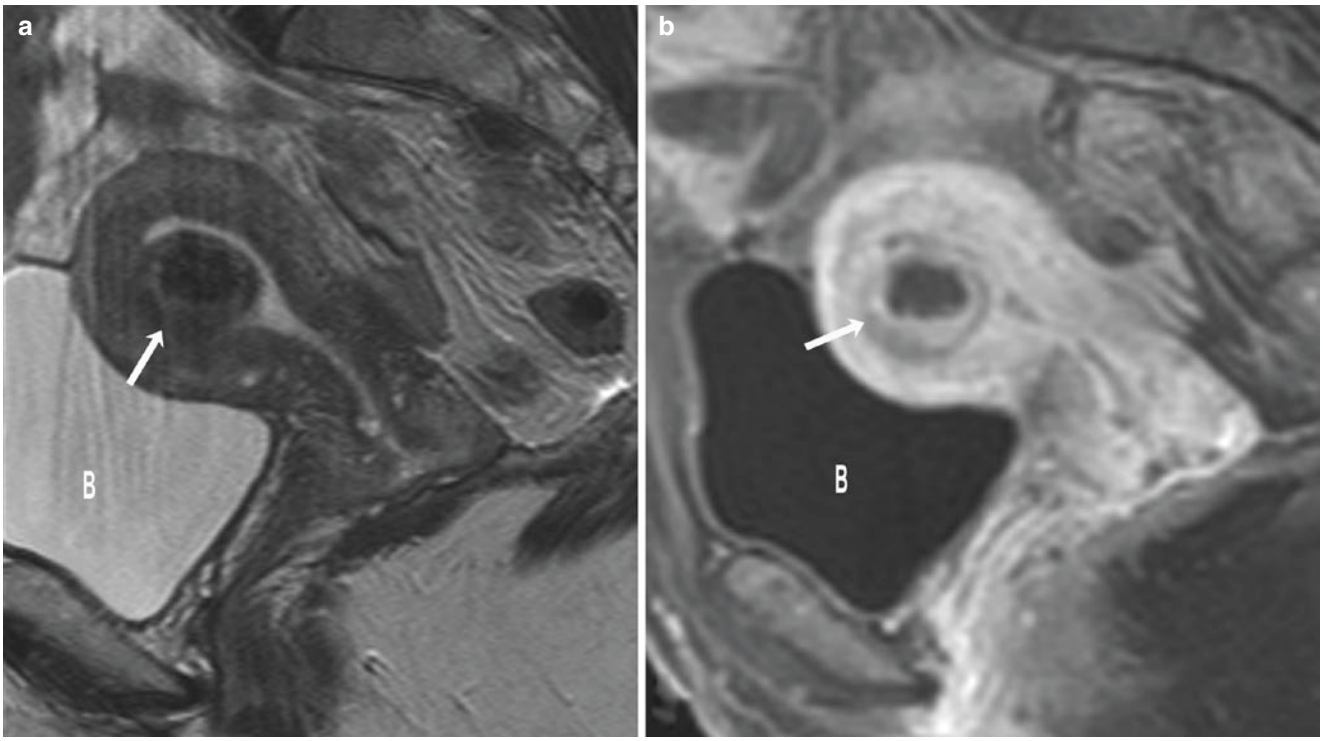


Fig. 6.6 Presentation of a submucous leiomyoma of the anterior wall of the uterine corpus with a wide based connection to the endometrium (*arrow*). (**a**) It presents with a hypointense center with an isointense ring shape on T2WI. (**b**) After application of contrast i.v., the center of the leiomyoma remains hypointense, possibly due to calcifications. *B* bladder

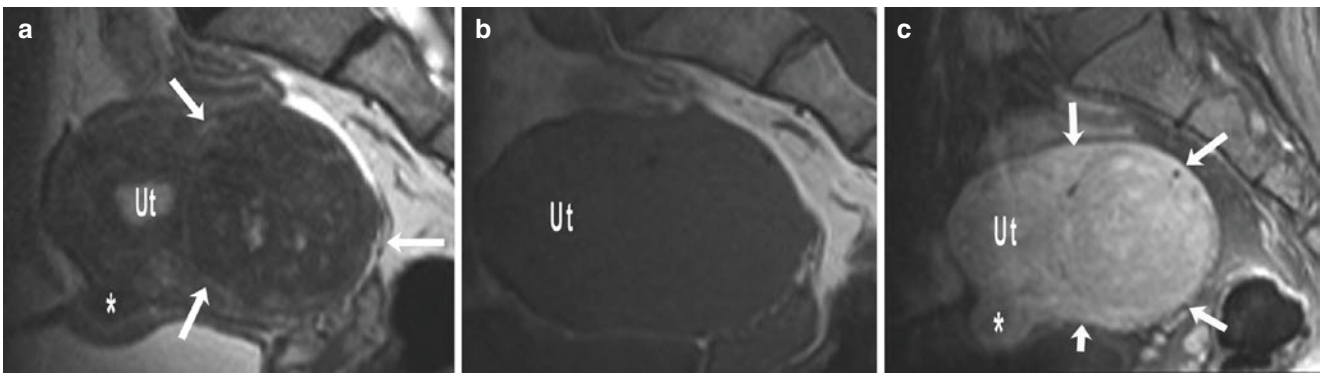


Fig. 6.7 Huge subserous non-degenerated leiomyoma of the uterus (*arrows*). (**a**) The leiomyoma is hypointense with some minor hyperintense spots at T2WI. (**b**) It presents with the same signal intensity as the myometrium at native T1WI. (**c**) It enhances homogenously after contrast i.v., comparable to the myometrium. Additionally, the claw sign is present (the serosa surrounds of the fibroid). There is a small second subserous leiomyoma at the anterior wall (*asterisk*). *Ut* uterus

Fig. 6.10 Presentation of an endometrial polyp on contrast enhanced CT scan (**a**) and MRI (**b**). (**a**) On CT scan, a homogenously enhancing lesion, located at uterine cavity is present (*arrow*). A clear identification cannot be made between submucous myoma, hemorrhage or polyp, histopathologically proven as endometrial polyp. (**b**) T2-weighted MRI presents with a well circumscribed hypointense lesion at the hyperintense uterine cavity with a small peduncle to the endometrium (*arrow*). Clear identification of a polyp can be made, histopathologically proven. Secondary finding is a follicle cyst right sided with partial hemorrhage

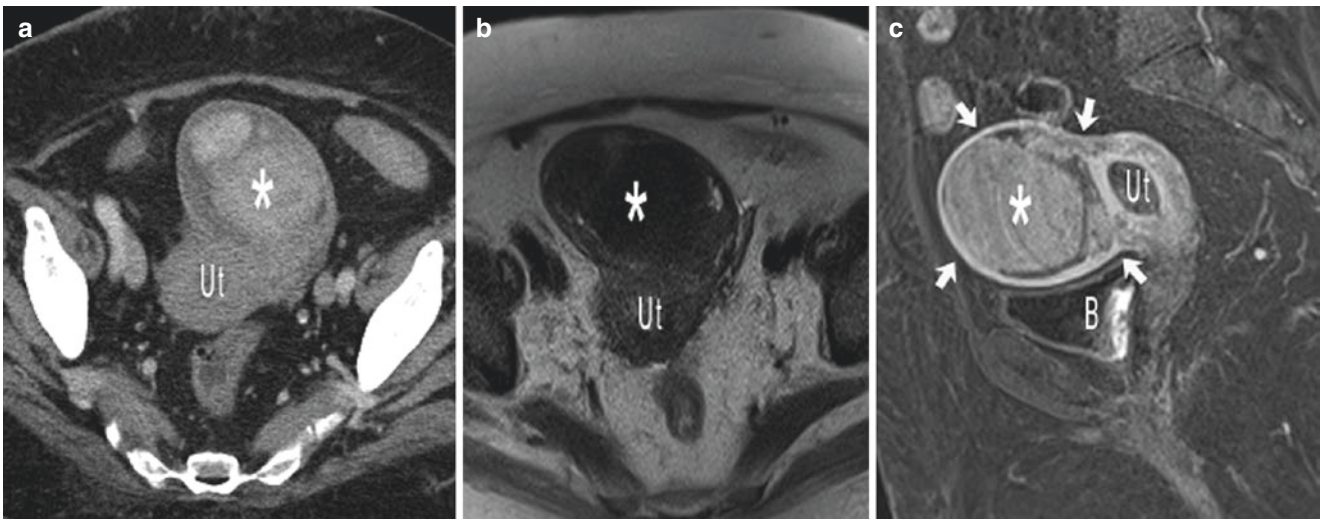


Fig. 6.8 (**a**) CT scan of the pelvis presents with a mass like lesion of the uterus with heterogenous densities (*asterisk*). (**b**) MRI in the same patient shows this mass as hypointense on T2WI associated with the uterus and well defined margins (*asterisk*). (**c**) application of contrast i.v. shows the typical claw-sign for subserous leiomyoma (*arrows*). This result was histopathologically proven. *B* bladder, *Ut* uterus

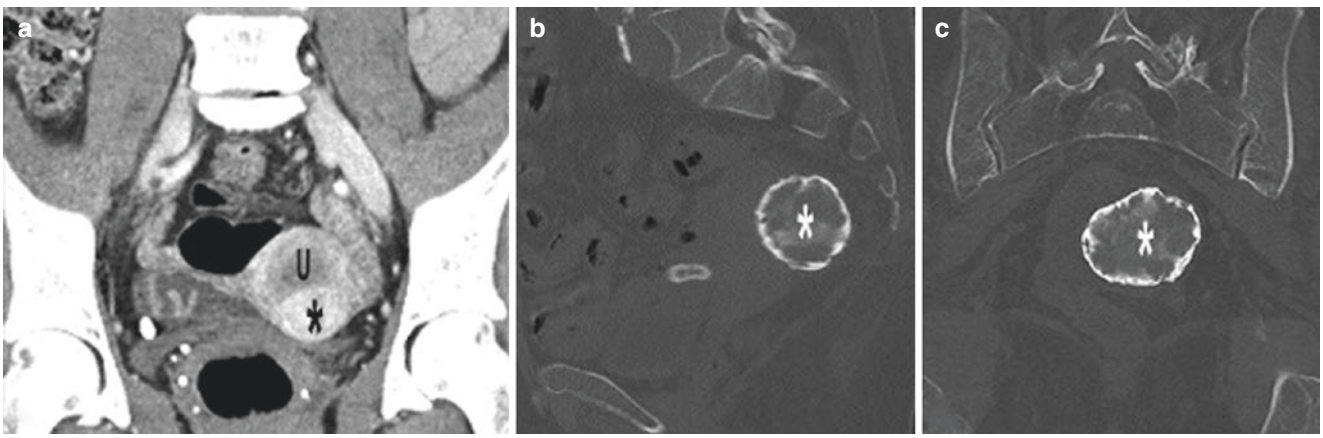


Fig. 6.9 (**a**) Presentation of a subserous non degenerated leiomyoma of the uterus at CT at venous phase (*asterisk*). The lesion is slightly more hyperdense than the myometrium. The uterine cavity presents as hypointense (*U*). Tissue contrast is reduced compared to MRI. (**b**) and (**c**) Degenerated myoma with ring-shape calcifications in another patient as a secondary finding on CT in sagittal and coronal plane (*asterisk*). Using the bone window, calcifications are best seen. This leiomyoma is located directly presacral and may be a cause for unspecific lower lumbar pain

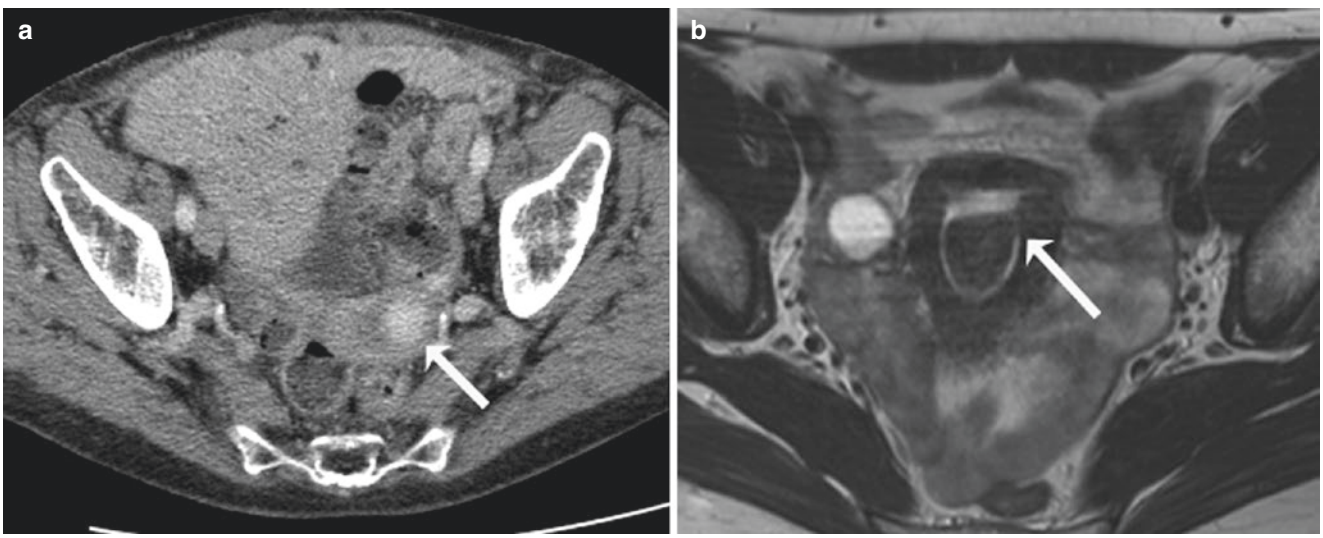


Table 6.2 Cross sectional imaging modalities for female pelvic pathologies

	Native MRI	CE MRI	Native CT	CECT	PET/CT	Specification of disease
1	+	+	–	(+)	–	Localisation, number, morphology, possible suspicious areals (early focal enhancement)
2	+	+	–	–	–	Differentiation and detection of adnexal, uterine or subperitoneal manifestations
3	+	–	–	–	–	Evaluation of entire pelvis with dynamic sequences during valsalva maneuver
4	+	+	–	(+)	–	Visualisation of fistulas and their origin/entry/re-entry better detection with rectal and/or vaginal filling with ultrasound gel MRI modality of choice for fistulas, CECT only if use of MRI is limited due to contraindications
5	+	+	–	+	+	CE MRI of the pelvis including the level of the renal veins for local staging and lymph node detection CECT of the abdomen and thorax for pretreatment staging in advanced stages CECT of the pelvis only if MRI is impossible to perform (e.g. pacemaker, implants) CE MRI for local recurrence PET/CT for diffuse or occult metastases
6	+	+	–	+	+	CE MRI of the pelvis including the level of the renal veins for local staging and lymph node detection CECT of the chest and abdomen for pretreatment staging in advanced stages CECT of the pelvis only if MRI is impossible to perform (e.g. pacemaker, implants) CE MRI for local recurrence PET/CT for diffuse or occult metastases

CE contrast enhanced, *MRI* Magnetic Resonance Imaging, *CECT* Contrast Enhanced Computed Tomography, *PET* Positron Emission Tomography

ral ill-defined myoma), uterine sarcoma (especially in fast growing intramural myoma), leiomyosarcoma of the cervix or vagina, ovarian fibroma or ovarian cancer (if subserous or pedunculated myoma). If local tumor differentiation is required, MRI of the pelvis is the imaging modality of choice (Table 6.2).

Endometriosis

MRI is recommended in cases with suspicion for subperitoneal endometrioses or in cases with unclear dysmenorrhoea and suspicion for adenomyosis [12–14].

Subperitoneal Implants of Endometriosis

Suberitoneal implants from endometriosis may be detected with MRI from at least 7 mm in diameter. Endometrial implants are hypointense in native T1WI and T2WI images. Sometimes T1WI hyperintense spots may be present in between the implant [12, 15]. If endometriosis is implanted in the abdominal wall, detection is made with a T1WI sequence with fat saturation. Angulation of the MR-sequences to the uterine corpus is essential for correct visualisation of the sacrouterine ligament, the torus uterinus and the fornix vaginae. Slice thickness should not exceed 3–4 mm for detection of small implants [16]. There is no indication for CT performance in endometriosis [17].

Adenomyoma/Adenomyosis Uteri

The adenomyoma and the adenomyosis uteri are two special forms of subperitoneal endometriosis and are located in the myometrium or the junctional zone of the uterus. Areas of endometriosis found within a myoma are defined as adenomyoma. The adenomyoma is almost ovally shaped and slightly blurred around its border with the surrounding myometrium when compared to an intramural leiomyoma. The signal intensity is comparable between both forms of myomas (Figs. 6.11 and 6.12) [11].

One distinguishing feature may be the fact that in adenomyoma, the junctional zone is commonly an integral part of the lesion, whereas in leiomyoma, even a small myometrial layer is notable close to the junctional zone.

An adenomyosis uteri is characterised by haphazardly scattered endometrial tissue within the uterus wall (Fig. 6.9). Using ultrasound, the adenomyosis uteri often represents heterogenous and includes microcysts. The accuracy using ultrasound was reported by Bazot et al. with 88 % and a sensitivity of 65 %, a specificity of 97.5 %, a PPV of 93 % and a NPV of 89 % when combining transvaginal and transabdominal ultrasound in patients without

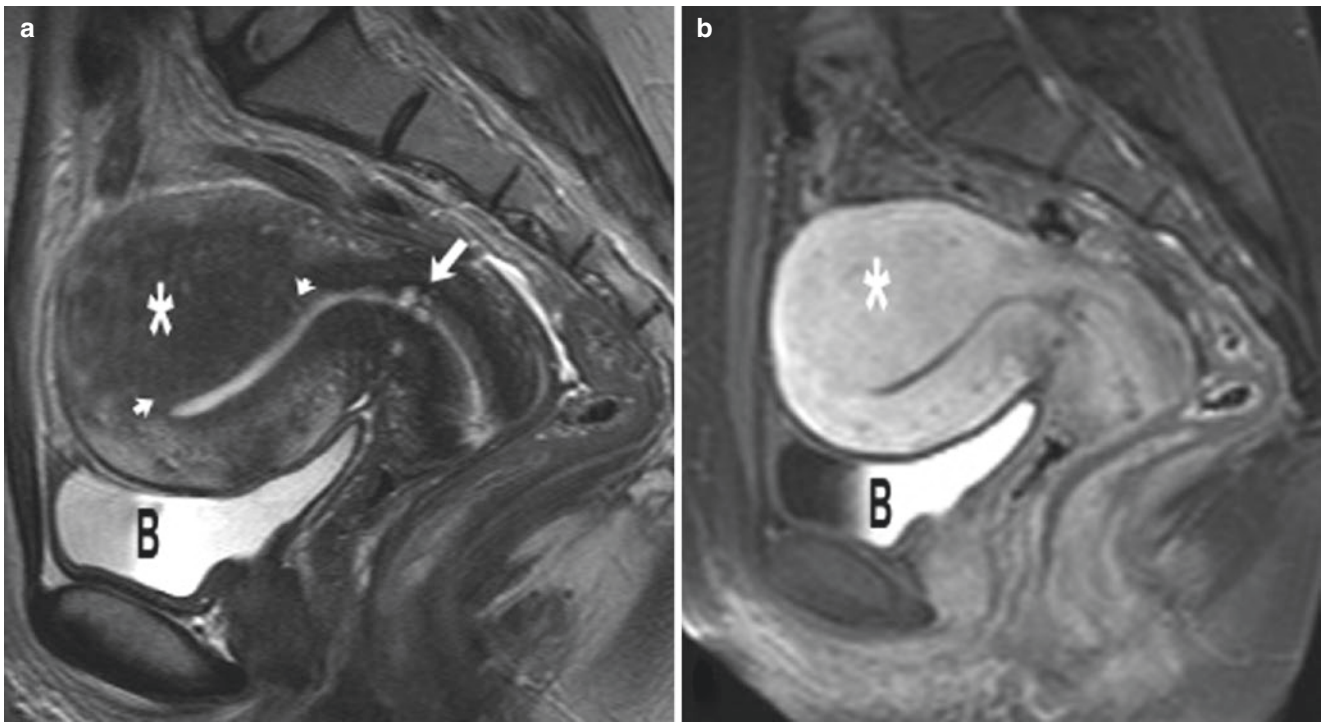


Fig. 6.11 Presentation of an adenomyoma in the posterior uterine wall with slightly blurry margins to surrounding myometrium (*asterisk*). Additionally, the adjacent junctional zone is not well defined (*arrowheads*). In the anterior wall there are several hyperintense spots, which are typical for diffuse adenomyosis. Small nabothian cysts as secondary findings (*arrow*). *B* bladder

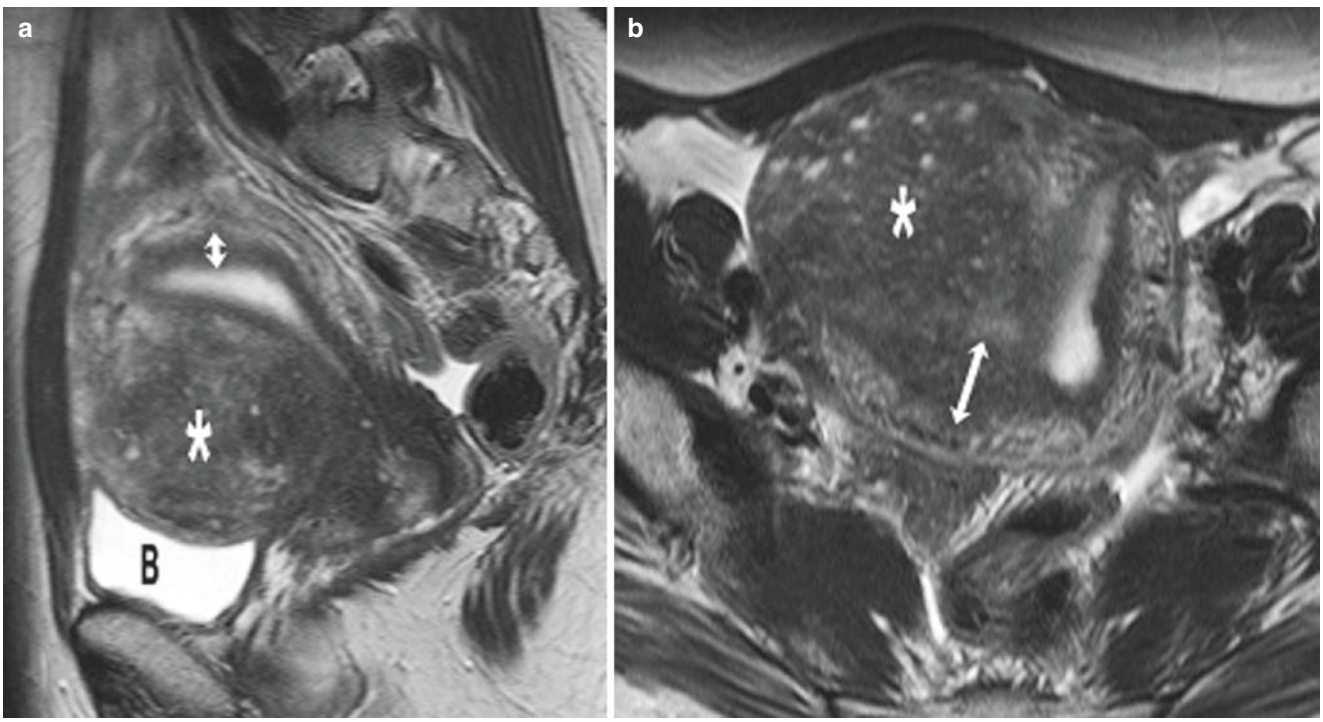


Fig. 6.12 (**a**) Presentation of an adenomyoma in the anterior uterine wall on T2WI on sagittal plane with slightly blurry margins to surrounding myometrium and several hyperintense spots. (**b**) The junctional zone is thin despite of a focal thickening at the posterior wall (*distance arrows*). This finding is typical for focal adenomyosis. *B* bladder



Fig. 6.13 Presentation of diffuse adenomyosis with heterogenous signal intensity of the myometrium and a thickened junctional zone with hyperintense spots on T2WI. Retroflected uterus. *B* bladder, *R* rectum

associated uterine disorders [18]. However, in patients with accompanied uterine disorders, e.g. leiomyomas, or with an enlarged uterus, ultrasound is limited in correct diagnosis of adenomyosis [18]. In those cases, MRI is able to visualize the uterine corpus on its whole extent and free of superimposition [19].

Using MRI, an adenomyosis characteristically shows a thickened junctional zone of more than 12 mm (the norm being max. 5 mm), hyperintense spots on T1WI and microcysts (Fig. 6.13). The accuracy using MRI was reported to be 87.5 % with a sensitivity of 77.5 %, a specificity of 92.5 %, a PPV of 84 % and a NPV of 89 % [18]. Typically, a discrepancy between the anterior and posterior wall of the uterine corpus can also be detected [20]. Differential diagnoses for adenomyoma are leiomyoma or uterine sarcoma. A study by Moghadam et al. evaluated the predictive value of an preoperative MRI in differentiating between leiomyoma and adenomyosis compared with pathologic findings in 153 women, suggesting that pelvic MRI is highly specific in the diagnosis of adenomyosis with 91 % and highly sensitive for leiomyomas with 94 % [19].

Fistulas

Vaginal fistulas may commonly occur after surgery (e.g. hysterectomy), radiation therapy or with the background of (chronic) inflammatory disease. Surgical reconstruction of such fistulas may be challenging, wherefore the detection and exact location of the fistula is crucial for therapy planning. With thin sliced T2-weighted or PD-images with fat saturation angulated to the vaginal cavity, the fistula presents hyperintense and is commonly well delineable to the surrounding tissue (Table 6.1). Patient's preparation with vaginal and rectal filling with ultrasound gel helps to better identify the origin of the fistula (Figs. 6.14 and 6.15). CT is mostly unable to detect small fistulas, why indication is usually not authorized.

Symptomatic Pelvic Floor Dysfunction

The prevalence of pelvic organ prolapse in developing countries is reported to be around 19.7 % [21]. Vaginal childbirth was demonstrated to be a predictor for levator ani trauma and an increased prevalence of pelvic floor dysfunction (PFD) even in younger, parous women [22–26]. Affected women may suffer from an abnormal frequency and urgency of emptying of the bladder, organ protrusion, pelvic pain or from dyspareunia, as well as from urinary or fecal incontinence [27–30]. To evaluate the pelvic floor structures and its integrity, MRI with high resolution T2 weighted images are performed at rest. This is best done in three planes [31–34]. The dynamic MR scans are performed during straining or defecation in the sagittal plane to evaluate pelvic organ prolapse (POP) and concordant PFD. The radiological report should give standardized measurements of pelvic organ prolapse, as well as a quantitative description of the pelvic organ position at rest and during straining or evacuation (Figs. 6.16, 6.17, 6.18, and 6.19) [35]. This precise description gives an impression of an individual woman's pelvic support in addition to an accurate, observer-independend, site-specific observation of the stability or progression of prolapse over time. Similar judgments are made regarding the outcome of surgical repair of prolapse, without interpreting the data using a grading system [36]. It was shown that the visualization of pelvic organ mobility, the detection of all involved structures and the extent of POP, detached from a grading system based on maximal prolapse values, might have more impact for intraindividual evaluation [37].

Dynamic MRI has benefits especially in regard to women suffering from re-prolapse after surgical repair and in the

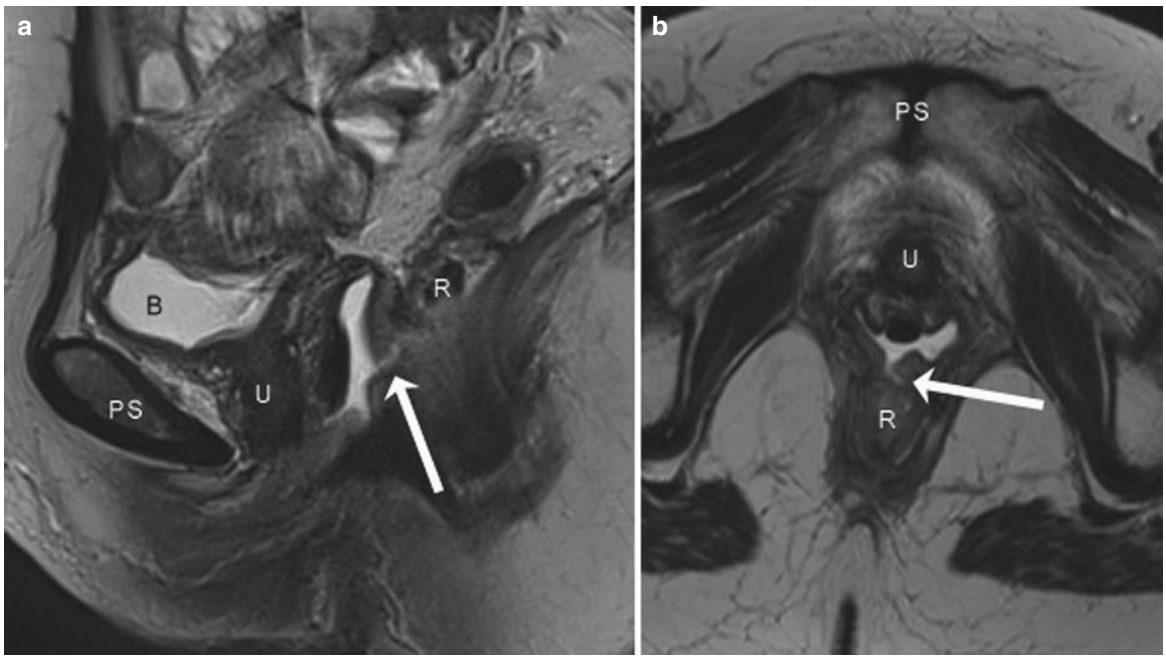


Fig. 6.14 Recto-vaginal fistula on high-resolution T2-weighted images. (**a**) on sagittal plane, the vaginal vault is filled and distended with ultrasonic gel. The fistula to the rectum with its angled form is also filled with gel, why detection is easy (*arrow*). (**b**) On transverse plane, the fistula starts at the posterior vaginal wall at 6 o'clock (*arrow*). At this level, the rectal wall is still intact. The entry to the rectum is located above (see (**a**)). *PS* pubic symphysis, *B* bladder, *U* urethra, *R* rectum

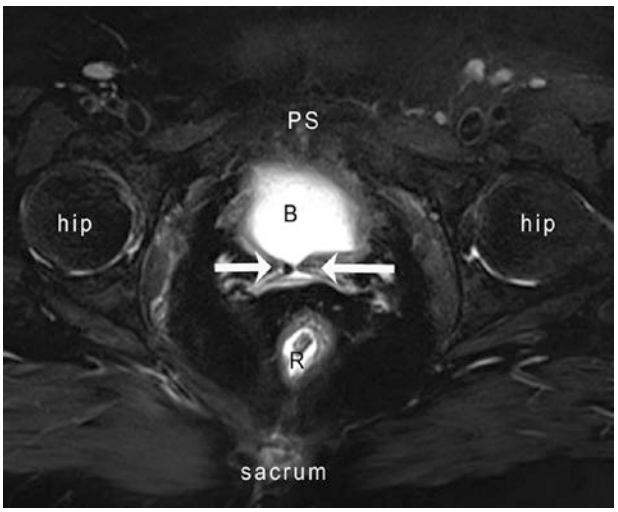


Fig. 6.15 Patient with vesico-vaginal fistula. T2-weighted images on transverse plane with fat saturation easily detect the fistula due to the high contrast of urine in the bladder and the vaginal filling with ultrasonic gel (*arrows*). The rectum was also filled with ultrasonic gel. *PS* pubic symphysis, *B* bladder, *R* rectum

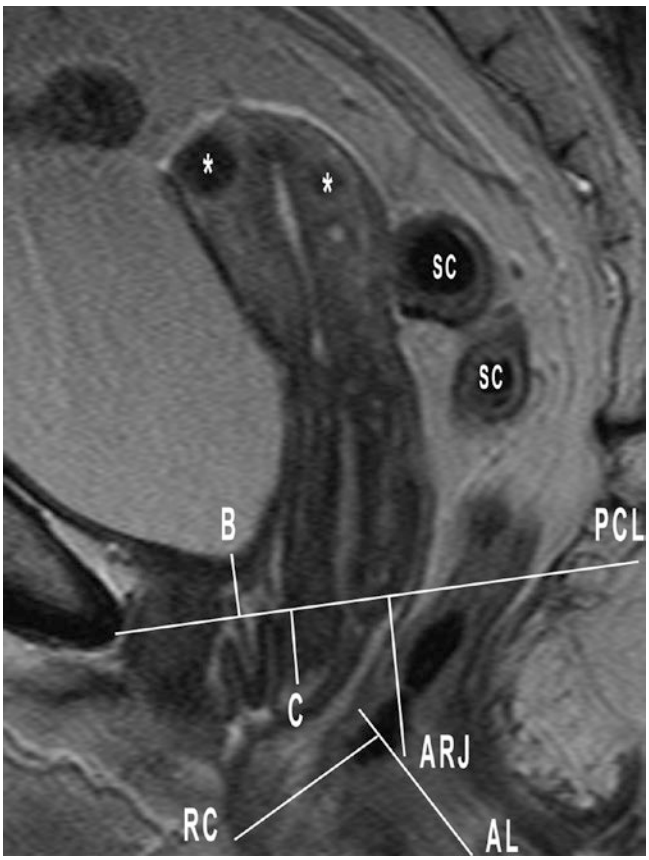


Fig. 6.16 T2WI on sagittal plane at rest in a 62 year old female. Even at rest, a partial uterine prolapse (*C*), a small rectal descent (*ARJ*) and a small rectocele (*RC*) can be noted. The bladder base (*B*) is above the reference line (*PCL*). Two small intramural leiomyomas are seen at T2WI on sagittal plane (*asterisk*). *AL* anal line (reference line for rectoceles), *SC* sigmoid colon, *ARJ* anorectal junction

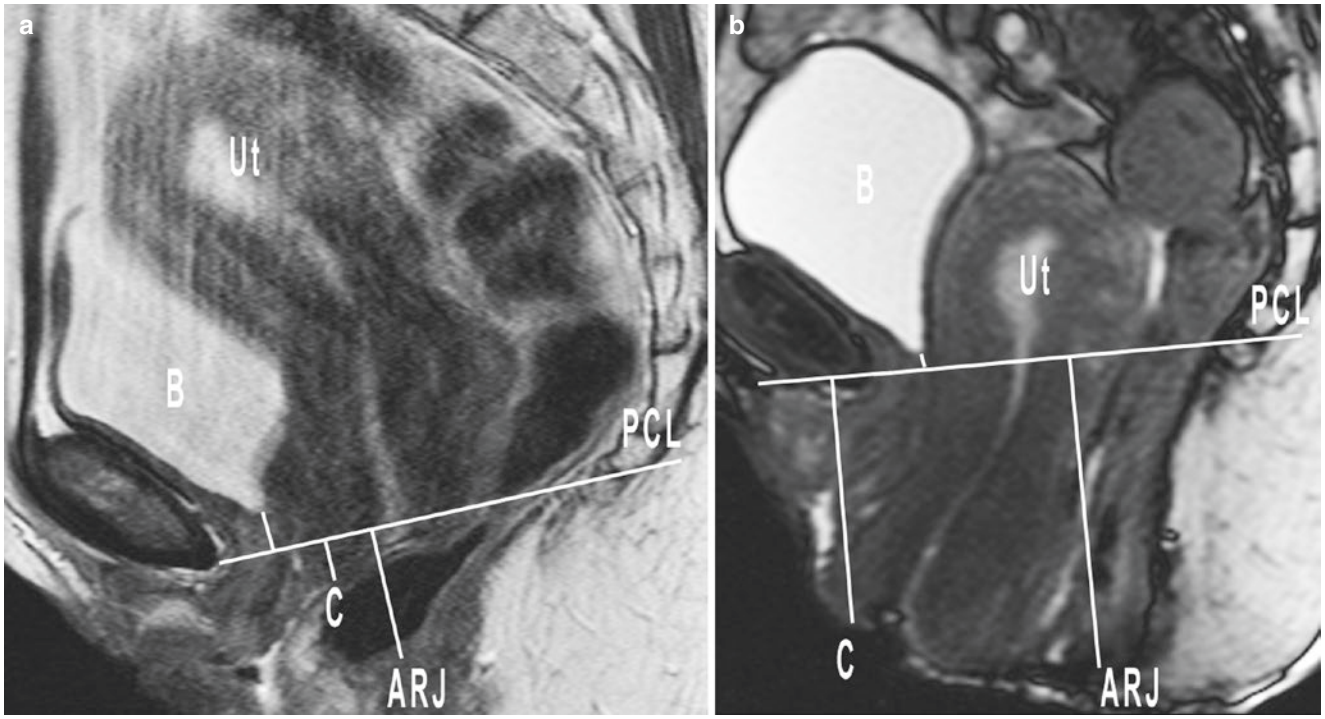


Fig. 6.17 (**a**) T2WI on sagittal plane at rest presenting with small descent of the cervix and a small rectal descent (*ARJ*). (**b**) During maximum strain presentation of a partial uterine prolapse and a severe rectal descent. The bladder is moved ventrally to the pubic symphysis. No bladder descent due to lack of hiatal space. *PCL* pubococcygeal line, *B* bladder, *Ut* uterus, *C* cervix, *ARJ* anorectal junction

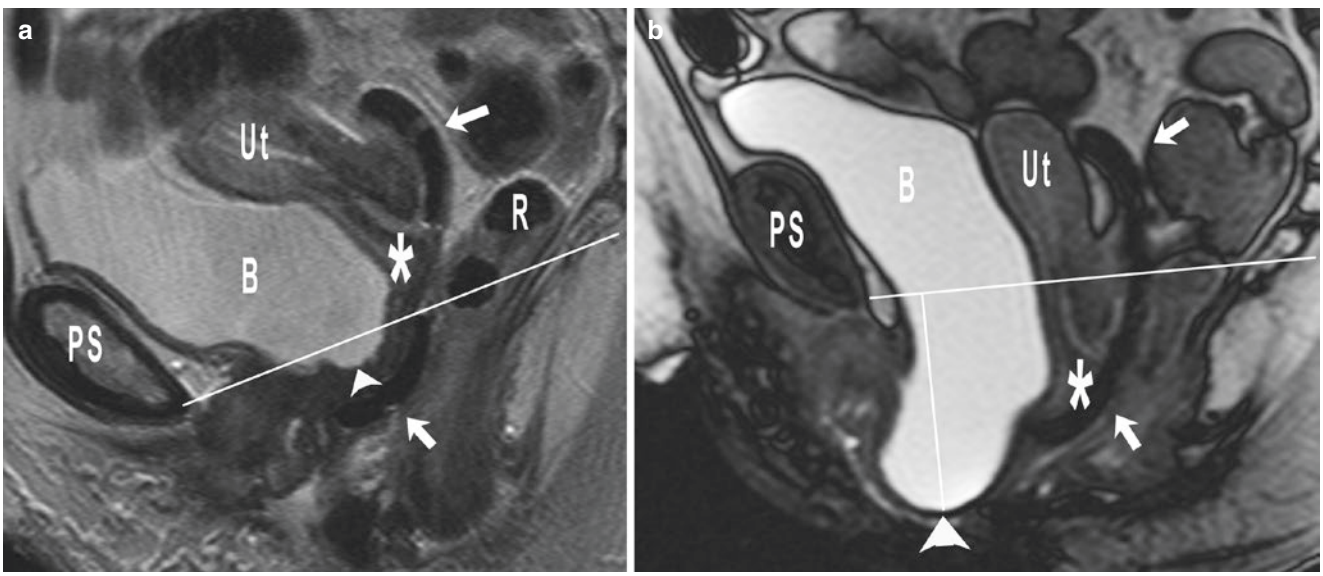


Fig. 6.18 (**a**) T2 W sagittal image at rest showing a moderately filled bladder with the bladder base slightly below the reference line (PCL). The uterus and cervix are also located above the reference line, supported by a pessary (*arrows*). (**b**) During maximum strain, the bladder base, as well as the cervix descent below the reference line, irrespective of the pessary presenting with a distraction cystocele (lateral defect of the endopelvic fascia) (*arrowhead*) and a partial uterine prolapse (*asterisk*). Additionally, hypermobility of the urethra is present (*thin arrows*). *B* bladder, *Ut* uterus, *PS* pubic symphysis

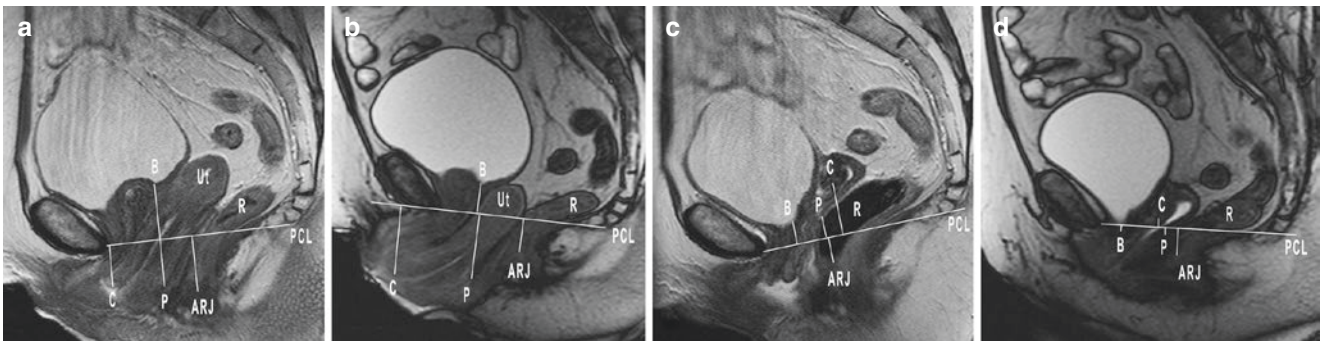


Fig. 6.19 Dynamic MRI of the pelvic floor (**a**) at rest and (**b**) during maximum strain before treatment presenting with partial uterine prolapse (*C*), peritoneocele (*P*) and rectal descent (*R*). Dynamic MRI of the pelvic floor 12 weeks after total mesh repair surgery combined with supracervical hysterectomy (**c**) at rest and (**d**) during maximum strain presenting reconstructed pelvic floor without pelvic organ descent. *B* bladder base, *C* cervix, *P* pouch of Douglas, *ARJ* anorectal angle, *PCL* pubococcygeus line

increasing sensitivity of findings in symptomatic women after surgery without findings during clinical examination [38]. MRI is able to detect the mechanisms responsible for topographic changes, which cannot be fully reached by the POP-Q system only, but are frequently needed to determine the steps necessary for successful surgical repair [39–42]. Therefore, MRI needs more attention before planned surgical repair to identify all involved compartments in POP and to detect incidental pathologic conditions in order. This is done to minimize the risk of incomplete surgical repair or recurrence [26, 27, 43, 44]. CT has no indication in evaluating POP [45].

References

1. Balleyguier C, Sala E, Da Cunha T, et al. Staging of uterine cervical cancer with MRI: guidelines of the European Society of Urogenital Radiology. Eur Radiol. 2011;21:1102–10.
2. Kinkel K, Forstner R, Danza FM, et al. Staging of endometrial cancer with MRI: guidelines of the European Society of Urogenital Imaging. Eur Radiol. 2009;19:1565–74.
3. Kirchhoff S. MR Vagina, Uterus, Adnexe. In: Scheffel H, Alkadhi H, Boss A, Merkle E, editors. Praxisbuch MRT Abdomen und Becken. Berlin: Springer; 2012. p. 181–94.
4. Thomassin-Naggara I, Darai E, Bazot M. Gynecological pelvic infection: what is the role of imaging? Diagn Interv Imaging. 2012;93:491–9.
5. Brocker KA, Alt CD, Eichbaum M, et al. Imaging of female pelvic malignancies regarding MRI, CT, and PET/CT: part 1. Strahlenther Onkol. 2011;187:611–8.
6. Sala E, Rockall AG, Freeman SJ, et al. The added role of MR imaging in treatment stratification of patients with gynecologic malignancies: what the radiologist needs to know. Radiology. 2013;266:717–40.
7. Pano B, Sebastia C, Bunesch L, et al. Pathways of lymphatic spread in male urogenital pelvic malignancies. Radiographics. 2011;31:135–60.
8. Scheidler J. Bildgebende Diagnostik der inneren weiblichen Genitalorgane – Adnexe. In: Adams S, Nicolas V, Freyschmidt J, editors. Urogenitaltrakt, Retroperitoneum, Mamma. Berlin/Heidelberg: Springer; 2004. p. 221–40.
9. Horton KM, Sheth S, Corl F, et al. Multidetector row CT: principles and clinical applications. Crit Rev Comput Tomogr. 2002;43:143–81.
10. Kröncke T. Benign Uterine Lesions. In: Hamm B, Forstner R, editors. MRI and CT of the Female Pelvis. Berlin/Heidelberg/New York: Springer; 2007. p. 61–100.
11. Alt C, Gebauer G. Uterus. In: Hallscheidt P, Haferkamp A, editors. Urogenitale Bildgebung. Berlin/Heidelberg: Springer; 2011. p. 232–301.
12. Bazot M, Darai E, Hourani R, et al. Deep pelvic endometriosis: MR imaging for diagnosis and prediction of extension of disease. Radiology. 2004;232:379–89.
13. Del Frate C, Girometti R, Pittino M, et al. Deep retroperitoneal pelvic endometriosis: MR imaging appearance with laparoscopic correlation. Radiographics. 2006;26:1705–18.
14. Schindler A. Epidemiologie, Pathogenese und Diagnostik der Endometriose. Journal für Fertilität und Reproduktion. 2007;17:22–7.
15. Bazot M, Gasner A, Ballester M, et al. Value of thin-section oblique axial T2-weighted magnetic resonance images to assess uterosacral ligament endometriosis. Hum Reprod. 2011;26:346–53.
16. Kinkel K, Frei KA, Balleyguier C, et al. Diagnosis of endometriosis with imaging: a review. Eur Radiol. 2006;16:285–98.
17. Radeleff B. Ovarien. In: Hallscheidt P, Haferkamp A, editors. Urogenitale Bildgebung. Berlin/Heidelberg: Springer; 2011. p. 303–46.
18. Bazot M, Cortez A, Darai E, et al. Ultrasonography compared with magnetic resonance imaging for the diagnosis of adenomyosis: correlation with histopathology. Hum Reprod. 2001;16:2427–33.
19. Moghadam R, Lathi RB, Shahmohamady B, et al. Predictive value of magnetic resonance imaging in differentiating between leiomyoma and adenomyosis. JSLS. 2006;10:216–9.
20. CG R. Magnetic resonance imaging of the female pelvis. Fundamentals of body MRI. Philadelphia: Elsevier Saunders; 2012. p. 261–368.
21. Walker GJ, Gunasekera P. Pelvic organ prolapse and incontinence in developing countries: review of prevalence and risk factors. Int Urogynecol J. 2011;22:127–35.
22. DeLancey JO, Kearney R, Chou Q, et al. The appearance of levator ani muscle abnormalities in magnetic resonance images after vaginal delivery. Obstet Gynecol. 2003;101:46–53.
23. Lanzarone V, Dietz HP. Three-dimensional ultrasound imaging of the levator hiatus in late pregnancy and associations with delivery outcomes. Aust N Z J Obstet Gynaecol. 2007;47:176–80.
24. Mant J, Painter R, Vessey M. Epidemiology of genital prolapse: observations from the Oxford Family Planning Association Study. Br J Obstet Gynaecol. 1997;104:579–85.

25. Rortveit G, Subak LL, Thom DH, et al. Urinary incontinence, fecal incontinence and pelvic organ prolapse in a population-based, racially diverse cohort: prevalence and risk factors. Female Pelvic Med Reconstr Surg. 2010;16:278–83.
26. Nygaard I, Barber MD, Burgio KL, et al. Prevalence of symptomatic pelvic floor disorders in US women. JAMA. 2008;300:1311–6.
27. Boyadzhyan L, Raman SS, Raz S. Role of static and dynamic MR imaging in surgical pelvic floor dysfunction. Radiographics. 2008;28:949–67.
28. Harris TA, Bent AE. Genital prolapse with and without urinary incontinence. J Reprod Med. 1990;35:792–8.
29. Petros P. The female pelvic floor : function, dysfunction, and management according to the integral theory:subtitle. 2nd ed. Heidelberg: Springer; 2007.
30. Rush CB, Entman SS. Pelvic organ prolapse and stress urinary incontinence. Med Clin North Am. 1995;79:1473–9.
31. Alt CD, Hampel F, Hallscheidt P, et al. 3 T MRI-based measurements for the integrity of the female pelvic floor in 25 healthy nulliparous women. NeurourolUrodyn. 2014;35(2):218–23.
32. El Sayed RF, El Mashed S, Farag A, et al. Pelvic floor dysfunction: assessment with combined analysis of static and dynamic MR imaging findings. Radiology. 2008;248:518–30.
33. Hoyte L, Schierlitz L, Zou K, et al. Two- and 3-dimensional MRI comparison of levator ani structure, volume, and integrity in women with stress incontinence and prolapse. Am J Obstet Gynecol. 2001;185:11–9.
34. Tunn R, Goldammer K, Neymeyer J, et al. MRI morphology of the levator ani muscle, endopelvic fascia, and urethra in women with stress urinary incontinence. Eur J Obstet Gynecol Reprod Biol. 2006;126:239–45.
35. El Sayed RF, Alt CD, et al. Magnetic resonance imaging of pelvic floor dysfunction - joint recommendations of the ESUR and ESGAR Pelvic Floor Working Group. Eur Radiol. 2016. [Epub ahead of print] DOI:10.1007/s00330-016-4471-7.
36. Bump RC, Mattiasson A, Bo K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. Am J Obstet Gynecol. 1996;175:10–7.
37. Alt CD, Brocker KA, Lenz F, et al. MRI findings before and after prolapse surgery. Acta Radiol. 2014;55:495–504.
38. Goodrich MA, Webb MJ, King BF, et al. Magnetic resonance imaging of pelvic floor relaxation: dynamic analysis and evaluation of patients before and after surgical repair. Obstet Gynecol. 1993;82:883–91.
39. Altringer WE, Saclarides TJ, Dominguez JM, et al. Four-contrast defecography: pelvic "floor-oscopy". Dis Colon rectum. 1995;38:695–9.
40. Broekhuis SR, Futterer JJ, Barentsz JO, et al. A systematic review of clinical studies on dynamic magnetic resonance imaging of pelvic organ prolapse: the use of reference lines and anatomical landmarks. Int Urogynecol J Pelvic Floor Dysfunct. 2009;20:721–9.
41. Hock D, Lombard R, Jehaes C, et al. Colpocystodefecography. Dis Colon rectum. 1993;36:1015–21.
42. Kelvin FM, Maglinte DD, Hornback JA, et al. Pelvic prolapse: assessment with evacuation proctography (defecography). Radiology. 1992;184:547–51.
43. Olsen AL, Smith VJ, Bergstrom JO, et al. Epidemiology of surgically managed pelvic organ prolapse and urinary incontinence. Obstet Gynecol. 1997;89:501–6.
44. Rentsch M, Paetzel C, Lenhart M, et al. Dynamic magnetic resonance imaging defecography: a diagnostic alternative in the assessment of pelvic floor disorders in proctology. Dis Colon rectum. 2001;44:999–1007.
45. Alt C, Lenz F, Haferkamp A. Beckenbodendysfunktion der Frau. In: Hallscheidt P, Haferkamp A, editors. Urogenitale Bildgebung. Berlin/Heidelberg: Springer; 2011. p. 399–441.

Radio-Imaging for Malignant Uterine Disease

7

Céline D. Alt-Radke

Introduction

Magnetic Resonance Imaging (MRI)

Native high-resolution T2-weighted images (T2WI) are essential for morphological differentiation of pelvic organ tissue. Contrast-enhanced T1-weighted images (CE T1WI) give important additional information in almost every problem and should be therefore routinely performed [1, 3, 6–9]. However, kidney functions (kreatinine) should be checked before the intravenous application of contrast media. In recent years, diffusion weighted imaging gains more and more attention. This imaging technique was designed to depict alterations in thermally induced random (Brownian) motion of water molecules within tissues and the degree of this motion is known as diffusion [5]. Diffusion-weighted MR imaging (DWI) can be performed quickly, without the necessity of contrast i.v. The technique yields qualitative and quantitative information about cellularity and cellular membrane integrity. High cellularity and cell membrane integrity restrict water mobility and therefore diffusion, as seen e.g. in tumors. During MR-performance, diffusion sensitivity can easily be varied by changing the *b* value used during image acquisition [5]. For gynecologic malignancies, b-values up to 800–1000 are recommended for local tumor staging and the evaluation of lymph node affection [10–12]. Quantitative analysis of diffusion may be performed by obtaining and mapping apparent diffusion coefficient (ADC) values [5]. This technique can be performed in patients with contraindication for contrast i.v., which is of great benefit for further evaluation in case of tumorous. For lymph node detection, a native T1WI sequence or proton-weighted (PD) sequence is helpful [13].

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Computed Tomography (CT)

With a multidetector CT (MDCT) the examination of a region of interest can be performed in axial plane in a short examination time with submillimeter resolution. The row data can be postprocessed in any plane with approximately the same resolution. It should be noticed that intravenous contrast application is essential for soft tissue contrast because even CT in venous phase has less tissue contrast compared to native MRI (see Fig. 6.1) [14]. Before performing contrast enhanced CT (CECT), kidney function (kreatinine) and thyroid function (TSH, fT3, fT4) should be checked to be with normal values.

Endometrial Cancer

Regardless of hormone status, the normal endometrium is always hyperintense in native T2w images, the junctional zone is hypointense and the outer myometrium is of moderate signal intensity [15]. Endometrial cancer is moderately hyperintense in T2WI. However, small tumors can be isointense in regard to the endometrium and may be therefore difficult to detect. CE T1WI sequence with fat saturation is therefore recommended, as the tumor then represents hypointense compared to the myometrium (best delineation approx. 2 min after contrast media injection i.v.) (Figs. 7.1, 7.2, and 7.3) [1].

Diffusion weighted images may also be helpful for tumor detection, as this shows a stronger signal decrease in ADC map than the surrounding normal myometrium [12]. The lack of the fat layer between organs (best seen in the native T1WI), as well as a thickened bladder or rectal wall, are an indicator for a beginning infiltration of the bladder or the rectal mucosa [1]. Staging is done using UICC-criteria (Union Internationale Contre le Cancer), the most recent version dating to 2010 [2, 16].

A CT-examination is not used for local staging. However, it is used for radiation planning or for complete staging for

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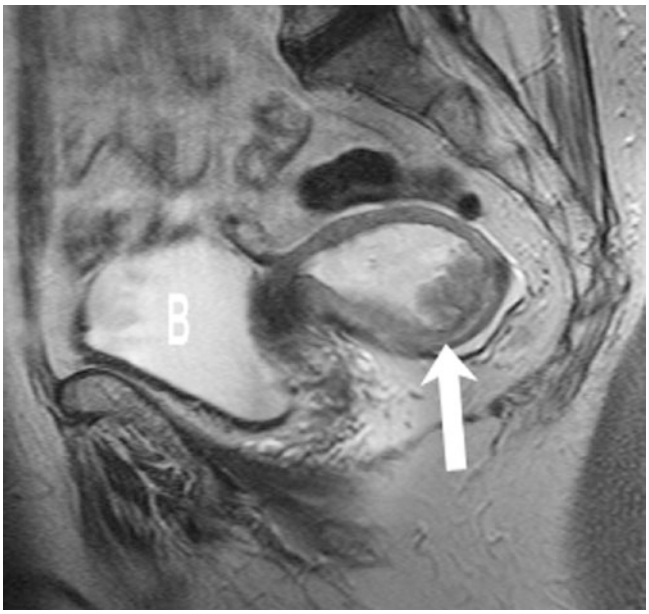


Fig. 7.1 Histopathologically proven early stage endometrial cancer in a retroflected uterus with mucos retention in the uterine cavity. There is no infiltration of the myometrium, as there is a clear demarcation on T2WI of the hypointense junctional zone between the intraluminal endometrial mass and the myometrium (*arrow*). T-Stage T1a. *B* bladder

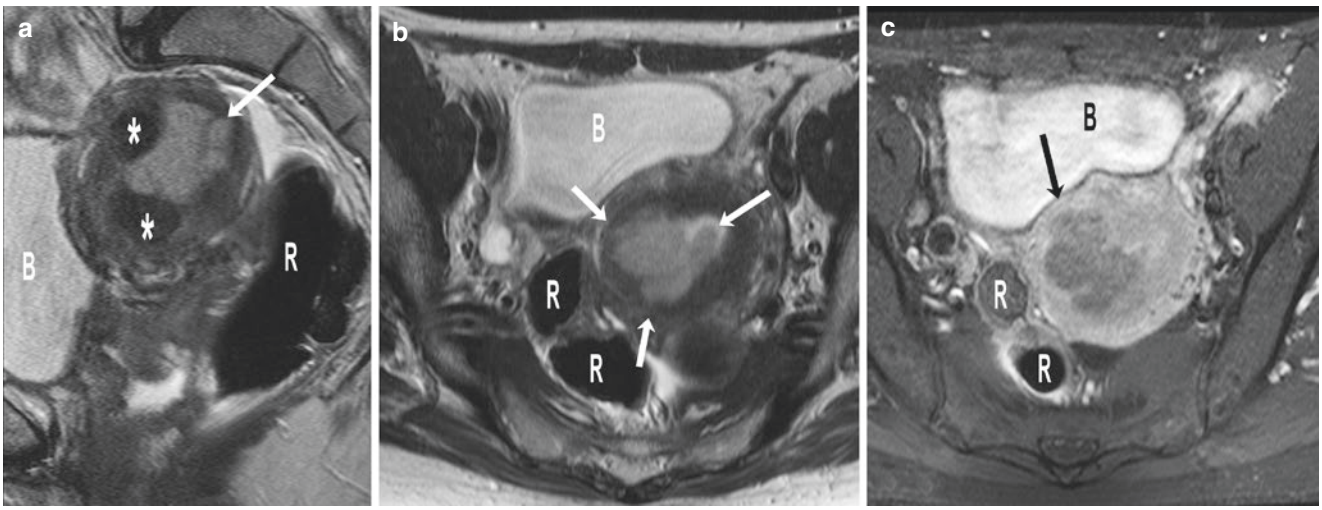


Fig. 7.2 Uterus myomatosus (*asterisk*) with the presence of an hyperintense endometrial mass (*arrow*), biopsy proven endometrial cancer. (**a**) The endometrial cancer is hyperintense on T2WI. (**b**) It presents hypointense after application of contrast i.v. Myometrial invasion is partly more than 50 %, defined on T2WI images on transversal oblique plane and was verified after contrast i.v. with hypointense demarcation of the tumor compared to surrounding myometrium on transversal oblique plane (*arrows*). T-stage T1b. This result was histopathologically proven. *B* bladder, *R* rectum

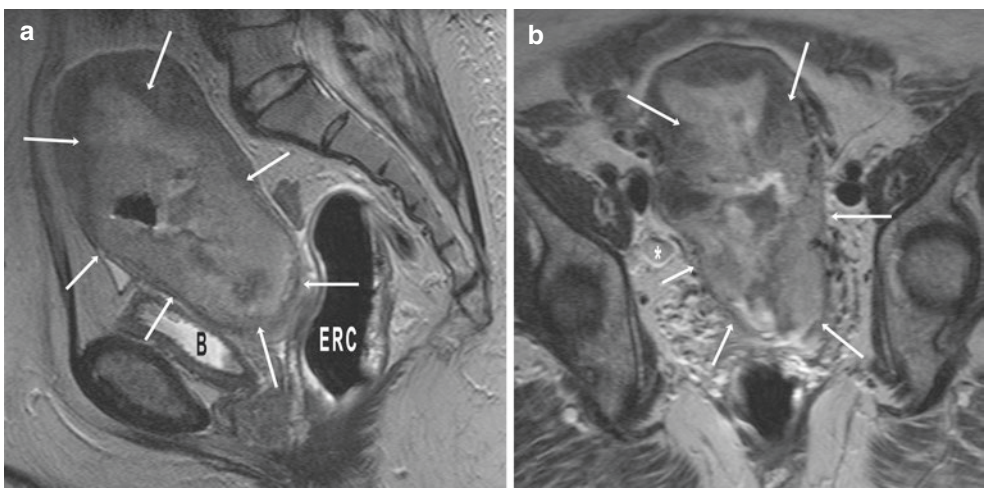


Fig. 7.3 (**a**) Locally advanced endometrial cancer (*arrows*) with infiltration of the cervix. The serosa is intact. No vaginal infiltration. T-stage T2. (**b**) One lymph node at the right pelvic sidewall is suspicious for metastatic affection (*asterisk*). N-stage N1. This result was histopathologically proven

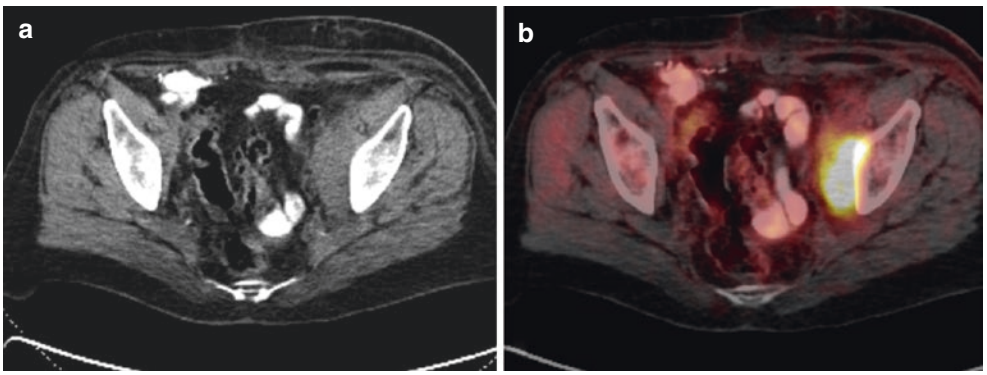


Fig. 7.4 PET/CT scan of a patient with suspected recurrence of endometrial cancer. (**a**) CT scan gives the anatomical overview. (**b**) PET presents with the pathological tracer uptake (*yellow*). Metastasis was found at the left pelvic side wall. Without any other manifestation of occult or visible metastases, the patient underwent radiation therapy

distant metastases (especially pulmonary, hepar, retroperitoneal lymph nodes). If CECT is performed for another indication, an endometrial cancer represents as a hypodense mass in the endometrial cavity. The evaluation of the depth of myometrial infiltration with CECT is made more difficult due to the low contrast of soft tissue as sensitivity is only around 58–61 %. If the cervix is heterogenous and thickened, suspicion of infiltration must be filed. If a tumor expands beyond the serosa a blurred reticular streaking can be expected. A bladder or rectum infiltration is to be presumed when the fat layer is missing. When solid tissue expansions in the lumen can be proven, an infiltration is the case [17]. The PET/CT has a standing in the diagnosis of distal metastases and in the diagnosis of recurrent disease (Fig. 7.4) [1].

Cervical Cancer

The decision for primary surgery or primary combined chemoradiation or brachytherapy, respectively, is based in particular on tumor size and the discovery of an infiltration of the parametrium [6]. With the expansion of cervical cancer along the parametrium to the pelvic wall or to the lower third of the vagina, the probability of positive paraaortal or inguinal lymph nodes grows. Metastases in the liver, the lungs or bones could exist in the advanced tumor stages. For this reason, a complete cross-sectional imaging based staging including MRI of the pelvis and CT of the body and chest is recommended before treatment. Ultrasound is often not sufficient for a complete evaluation of a local finding. However, this technique is used to exclude hydronephrosis or liver metastases.

In MRI, the mucosa of the normal cervix represents hyperintensive in the native T2WI, whereas the cervical stroma is hypointense [15]. Cervical cancer represents hyperintensive in the native T2WI in relation to the hypointense stroma tissue (Fig. 7.5). If the cervical stromal ring appears intact on T2WI on transverse oblique plane, parametrial invasion is present in 0–6 % of cases [20]. In a large meta-analysis by Rigon et al., the authors found an overall sensitivity of 66 % and a specificity of 84 % for detection of parametrial invasion in 1341 patients using 1.5 T MRI [21]. In rare cases, the tumor is isointense to the surrounding tissue in the T2WI or too small in diameter, as this may be residual tumor tissue after curettage. In these cases, DWI or CE T1WI with fat saturation is relevant for tumor detection (Fig. 7.6) [6]. There is a signal decrease on ADC map and a hypointense signal in early phase after application of contrast i.v. in T1WI with fat saturation compared to surrounding tissue. Best delineation will be reached 15–30 s after contrast injection. In late phase, however, the tumor represents hyperintense compared to uterine myometrium. Dynamic contrast enhanced sequences are therefore recommended (Figs. 7.7, 7.8, 7.9, 7.10, 7.11, and 7.12) [18, 19].

The staging for cervical cancer is done according to UICC-criteria (Union Internationale Contre le Cancer), the most recent version dating to 2010 [2, 16].

While the intravenous application of contrast i.v. can be forgone during primary detection as the tumor is easily detectable in the native T2WI in most cases, such an application is compulsive for therapy control after brachytherapy, after combined chemoradiation or after surgery to differentiate between a residual tumor or scar-like changes [6].

The CT is not necessary for primary diagnosis but is used for planning radiation or detecting distal mestastases (lungs, liver, bones) or peripheral lymph node metastases [3]. In case of a contrast media-enhanced CT, cervical cancer usually represents as a thickening of non-centric cervical tissue with a diameter of more than 3.5 cm (Fig. 7.13) [17]. Parametrial involvement is probable if cervical borders are blurry, thickened and spiculated (Fig. 7.14) [19]. An infiltration of the bladder or rectal wall represents in an irregular

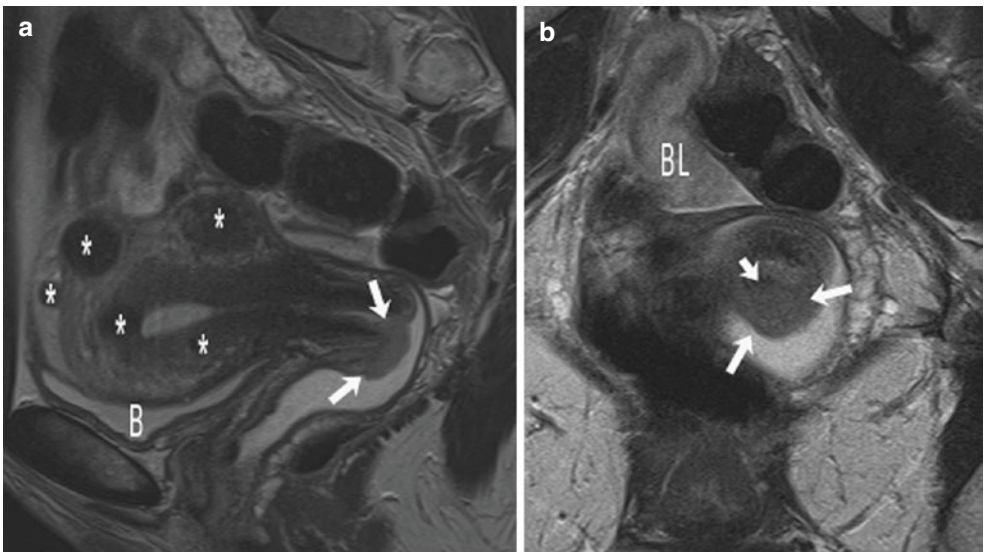


Fig. 7.5 (**a**) T2WI on midsagittal plane. Vaginal filling with ultrasound gel distends the vaginal cavity and gives a better demarcation of the cervical structures and the vaginal fornices. Due to this preparation, the dome-shaped mass of the anterior cervical lip is well visible and tumor extent can be easily detect (*arrows*). As a secondary finding, uterine corpus presents with 5 leiomyomas (submucosal – transmural – subserosal) (*asterisk*). (**b**) Transversal oblique plane of the cervix shows the circumscribed tumor extent (*arrows*). Cervical cancer at T-stage T1b1, histopathologically proven. *B* bladder, *BL* bowel loops

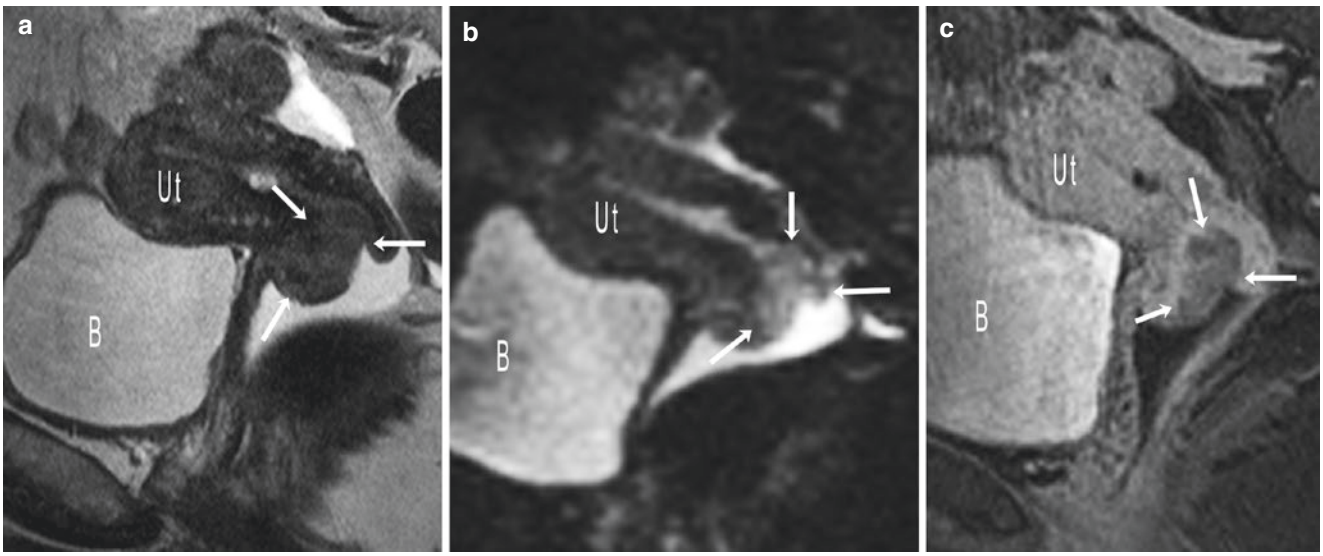


Fig. 7.6 Biopsy proven cervical cancer. MRI performed for pretherapeutic staging. (**a**) T2 WI presents a mass like lesion of the cervix originating from the anterior cervical lip (*arrows*). In this case, the tumor is not well delineated on T2WI and functional imaging techniques like diffusion weighted imaging or dynamic contrast enhanced images are helpful. (**b**) Diffusion weighted imaging with a *b*-value of 800 shows high signal intense tumor, well delineatable from surrounding tissue (*arrows*). (**c**) after application of contrast i.v. the tumor delineates as hypointense compared to surrounding tissue (*arrows*). *B* bladder, *Ut* uterus

thickening of the wall or a solid tumor that extends into the cavity and is probably present, if the fat layer is missing (Fig. 7.15) [17].

The PET/CT has a standing with locally advanced cervical cancer, especially for the detection of morphological, at first glance seemingly harmless lymph node metastases [22].

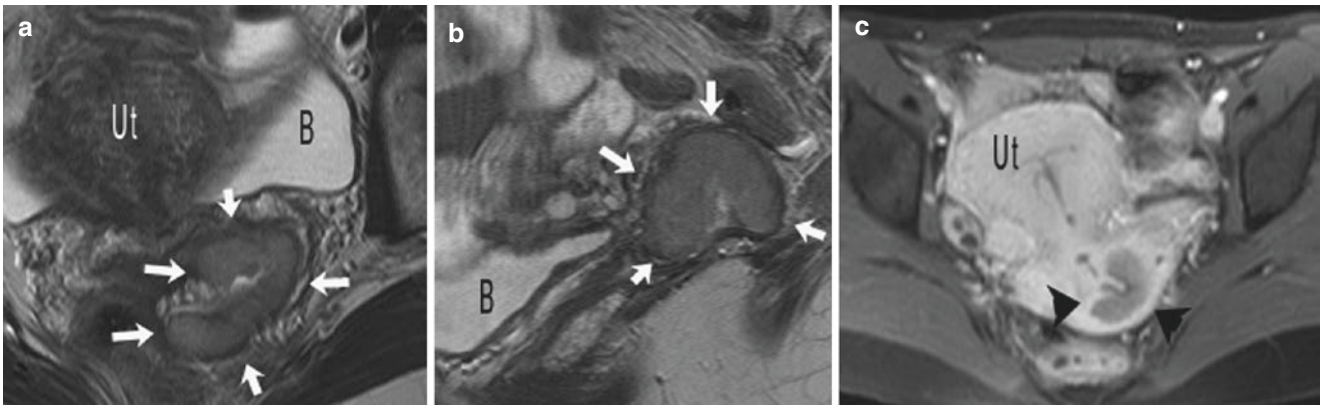


Fig. 7.7 Horseshoe-like mass of the cervix with well defined margins and a maximum diameter of >4 cm presented on (**a**) transversal oblique and (**b**) sagittal plane. (**c**) After application of contrast i.v. the tumor demasks hypointense to the surrounding cervical stroma (*black arrow head*). The cervical stroma ring is not interrupted, no infiltration of adjacent structures. T-stage T1b2, histopathologically proven. *B* bladder, *Ut* uterus

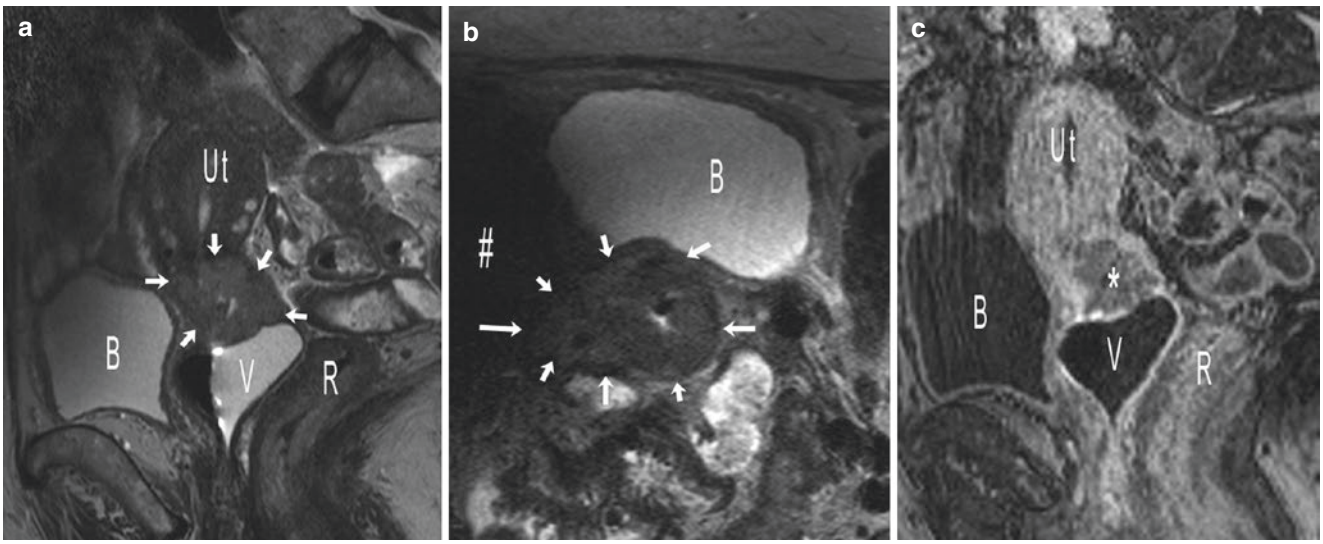


Fig. 7.8 Histopathologically proven cervical cancer. (**a**) T2WI on sagittal plane with vaginal filling with ultrasound gel. This preparation better delineates the cervical cancer with moderate hyperintense signal intensity (*arrows*). The vaginal fornix becomes infiltrated. (**b**) The cervical carcinoma invades the right parametrium, whereas the cervical stroma is still well delineated to the left parametrium on transversal oblique sequences (*arrows*). (**c**) Hypointense demarcation of the carcinoma after application of contrast i.v. (*asterisk*). *B* bladder, *V* vagina, *Ut* uterus, *R* rectum, *#* artefact due to endoprothesis of the right hip

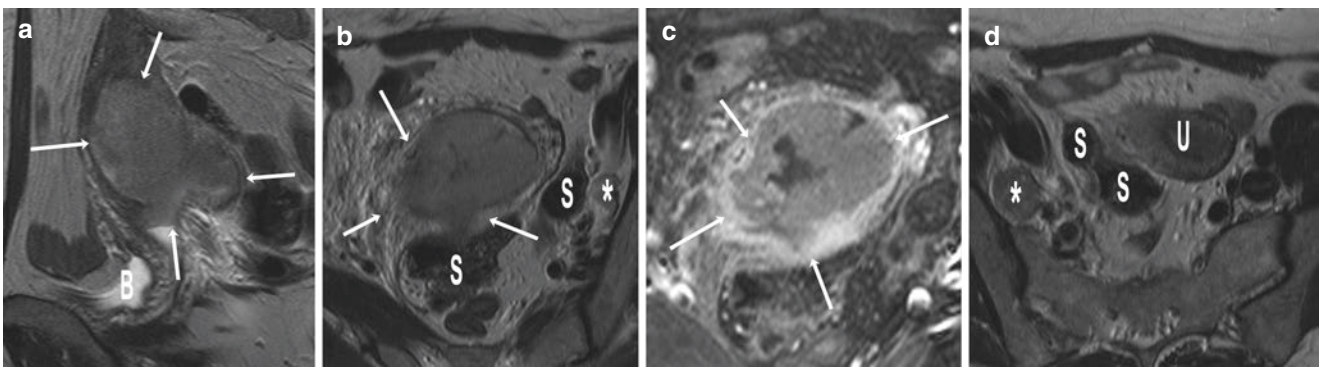


Fig. 7.9 Biopsy proven cervical cancer with invasion into the uterine corpus and the proximal vagina (*arrows*) on T2WI on sagittal plane. (**b**) Invasion into the right parametrium on T2WI on transversal oblique plane. (**c**) After application of contrast i.v. the carcinoma presents hypointense to surrounding tissue with central necrotic parts. T-Stage T2b. (**d**) Additionally, a large lymph node metastasis iliacal right sided is present (*asterisk*). N-stage N1. This result was histopathologically proven. *S* sigmoid colon, *U* uterus

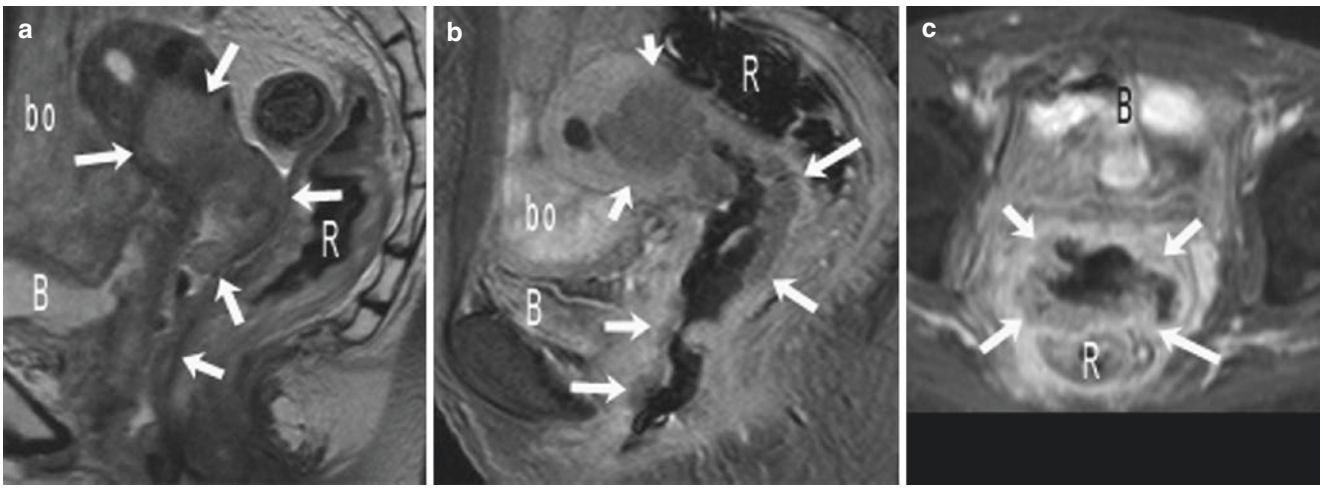


Fig. 7.10 Biopsy proven cervical cancer. (**a**) MRI with T2WI on sagittal plane shows infiltration of the uterine corpus and the vaginal wall until the lower third (*arrows*). (**b**) After contrast i.v. the tumor presents as hypointense (*arrows*). (**c**) CE T1WI on transversal oblique plane shows an intact layer to anterior rectal wall. T-stage T3a. This patient underwent primary chemoreadiation therapy. *B* bladder, *R* rectum, *bo* bowel

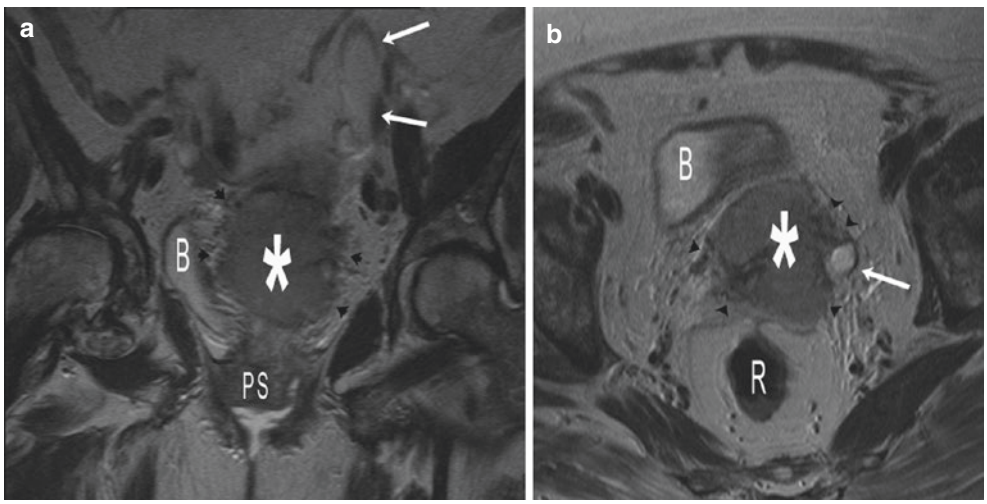


Fig. 7.11 Biopsy proven cervical cancer (*asterisk*). (**a**) The T2WI on coronal oblique plane shows a dilated left ureter (*arrows*). (**b**) On T2WI on transversal oblique plane invasion of the parametrium bilaterally with impression of the left distal ureter is present (*arrow*). T-stage T3b. This patient underwent splint implantation into the ureter bilaterally and underwent primary chemoradiation therapy. *B* bladder, *R* rectum, *PS* pubic symphysis

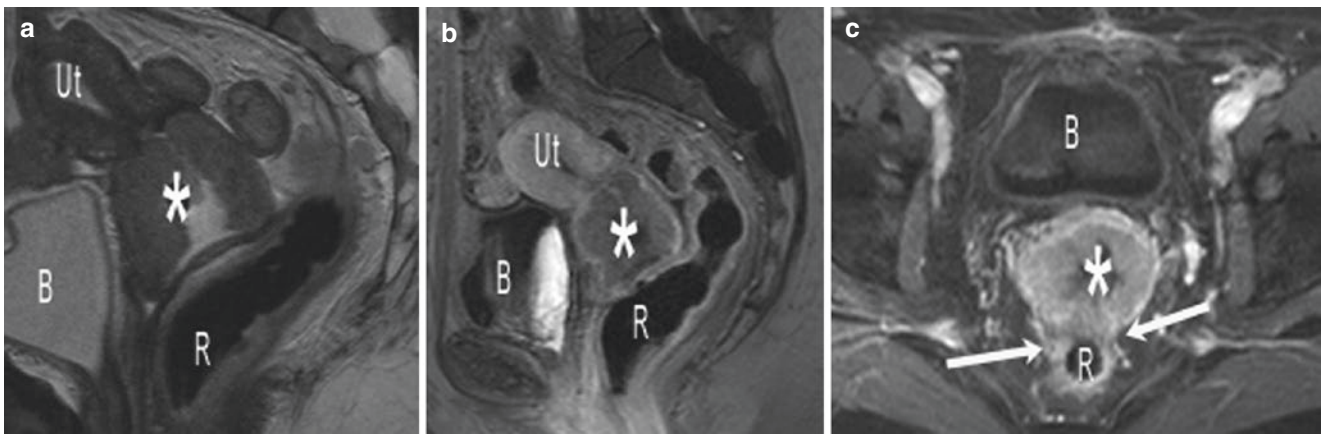


Fig. 7.12 (**a**) Cervical cancer (*asterisk*) on sagittal plane with infiltration of the isthmus uteri. (**b**) Better tumor demarcation after contrast i.v. suggesting local tumor disease. (**c**) On transversal oblique plane, however, the tumor (*asterisk*) invades the anterior rectal wall (*arrows*). T-stage T4. This result was proven by rectoscopy. The patient underwent primary chemoradiation therapy. *B* bladder, *Ut* uterus, *R* rectum

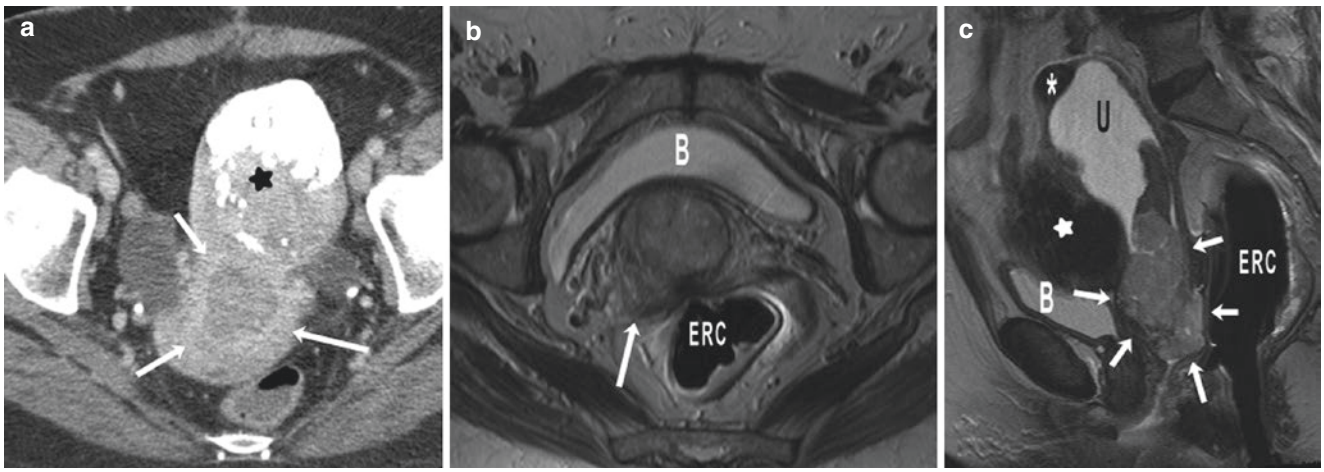


Fig. 7.13 (**a**) Axial CT scan at venous phase shows an enlarged cervix with centrally hypointense area (*arrows*). A subserous leiomyoma with calcifications is located ventrally (*star*). (**b**) MRI of the same patient shows cervical mass with infiltration of the right parametrium on transversal oblique plane (*arrow*). *B* bladder, *ERC* endorectal coil. (**c**) On sagittal plane, invasion of the uterine corpus and the upper third of the vagina is visible (*arrows*). The fat layer between the bladder and the rectum wall is present. Cervical carcinoma at T-stage T2b, histopathologically proven. The calcified leiomyoma presents as hypointense on T2WI (*star*). There is a small subserous leiomyoma at the fundus (*asterisk*). *B* bladder, *ERC* endorectal coil, *U* uterus

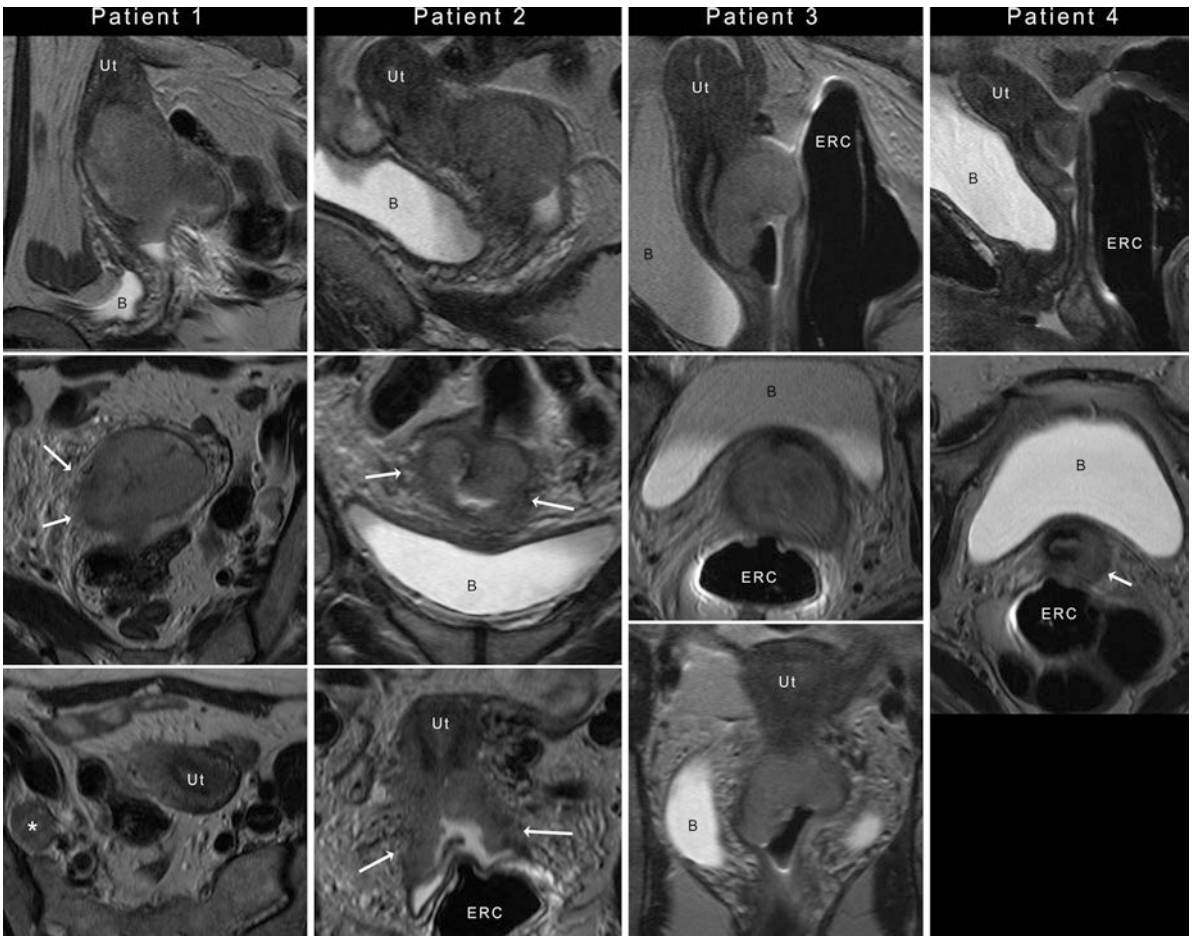


Fig. 7.14 Four patients with histopathologically proven cervical cancer stage T2b. Patient 1: Cervical cancer with infiltration into the uterine corpus, the proximal anterior vaginal fornix and the right parametrium (*arrows*). Patient 2: Cervical cancer with invasion of the vaginal fornix and bilateral parametrial invasion (*arrows*). Patient 3: Cervical cancer originating from the posterior cervical lip. The stromal ring is only intact ventrally, whereas the margins to the parametrium are blurry bilaterall. Patient 4: Cervical cancer with invasion into the left parametrium (*arrow*). The hypointense cervical stromal ring is well delineated at the right side. *B* Bladder; *Ut* uterus; *ERC* endorectal coil

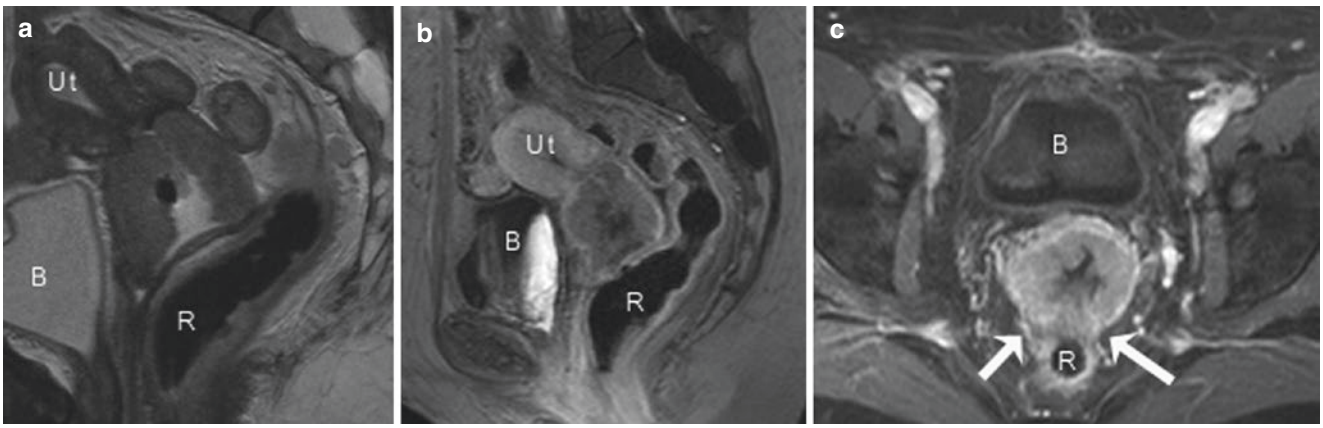


Fig. 7.15 (**a**, **b**) Patient presenting with a pseudo-well described cervical cancer on sagittal plane. (**c**) On transverse oblique plane to the cervical cavity, the wide based invasion of the upper part of the anterior rectal wall is visible (*arrows*). *B* bladder, *R* rectum, *Ut* uterus

Uterine Sarcoma

Uterine sarcoma can be classified into three histological subtypes: leiomyosarcoma (commonly myometrial origin), endometrial stromal sarcoma, *and* adenosarcoma (commonly endometrial origin) [16]. The transvaginal ultrasound is used as the primary standard image modality. In addition to this, MRI offers relevant additional informationen about tumor expansion. The CECT provides an overview of the infiltrated surrounding structures, distant metastases, ascites or peritoneal implants (Figs. 7.16 and 7.17) [23]. The PET/CT offers promising possibilities for staging, grading and therapy control for sarcomas [24]. All in all, differentiating between leiomyoma and leiomyosarcoma is challenging by using MRI. Apart from a fast growth, a large heterogenous tumor, hypervascular foci or central necrotic components can be indicators [25, 26]. Endometrial stromal sarcoma commonly represents an infiltrative mass with cystic parts. The endometrium as well as the myometrium is involved (Figs. 7.18 and 7.19).

Leiomyosarcoma, however, is mostly shown through heterogenous signal intensity with a fuzzy boundary. Commonly, at least 50 % are hyperintense on T2WI, with additional hyperintensities on T1WI (Fig. 7.20). On CECT, the uterus commonly presents as a heterogeneous mass with ill defined boundaries and irregular central zones, commonly due to necrosis (Fig. 7.21).

The adenosarcoma is often defined as a large, multiseptated, cystic mass with heterogenous solid components in the uterine cavity. The solid components are mostly hypointense in the native T2WI, which represent with strong contrast enhancement in CE T1WI [27]. Adenosarcoma may also presents as a large polypoid mass occupying the endometrial cavity, possibly protruding into the vaginal cavity (Fig. 7.22) [28]. Staging is done according to UICC-criteria (Union Internationale Contre le Cancer), the most recent version dating to 2010 [16].



Fig. 7.16 Histopathological proven uterine sarcoma, which can be depict with CECT as a inhomogenous mass with impression of the bladder and the uterine corpus right sided (*white arrows*). The right ureter is dilated (*black arrowhead*) due to tumor impression. The right kidney presents with concecutive hydronephrosis °IV (*asterisk*) with already narrow width of the parenchyma

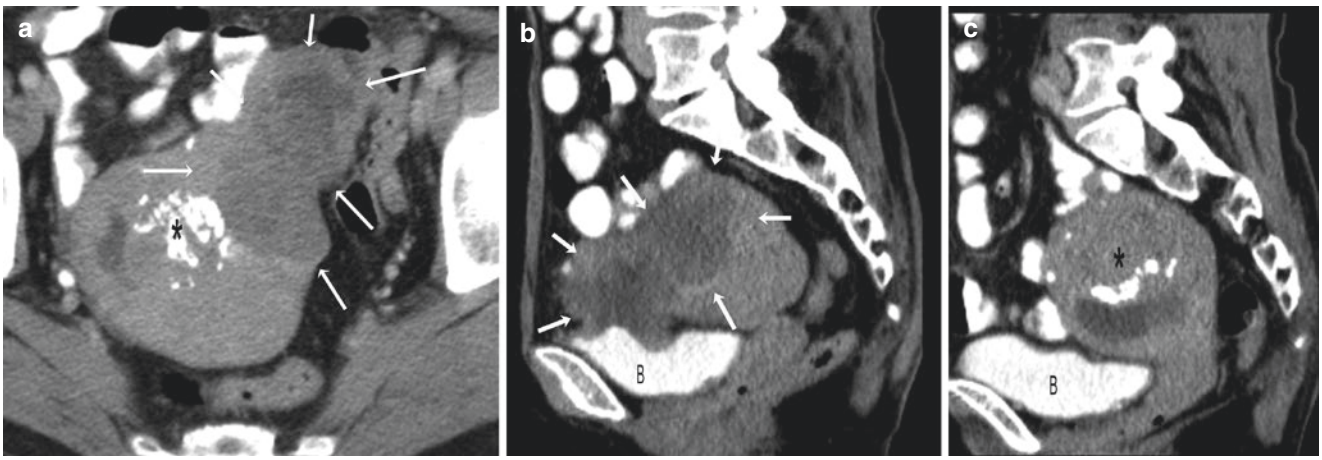


Fig. 7.17 Contrast enhanced CT with positive contrast of the small bowel loops. (**a**) On axial plane uterine calcifications (*black asterisk*) and a hypodense mass ventrally (*arrows*) is present. (**b**, **c**) On sagittal plane in two different slices presenting the hypodense mass (*arrows*) and the calcifications (*black asterisk*). Histologically proven as uterine sarcoma ventrally and a degenerated leiomyoma with calcifications. *B* bladder

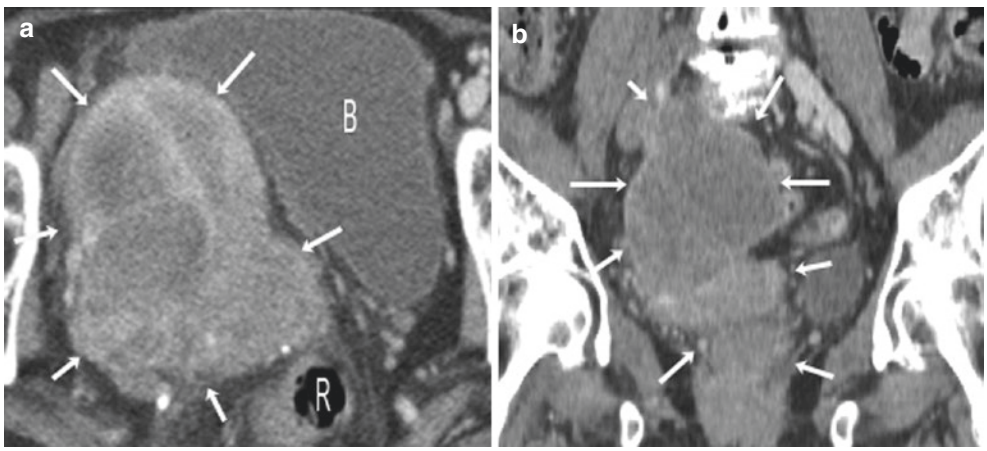


Fig. 7.18 On contrast enhanced CT in venous phase (**a** axial, **b** coronal), the uterus presented as oedematous, with ill defined margins and with a heterogenous density (*arrows*). Histopathological proven as endometrial stromal sarcoma. *B* bladder, *R* rectum

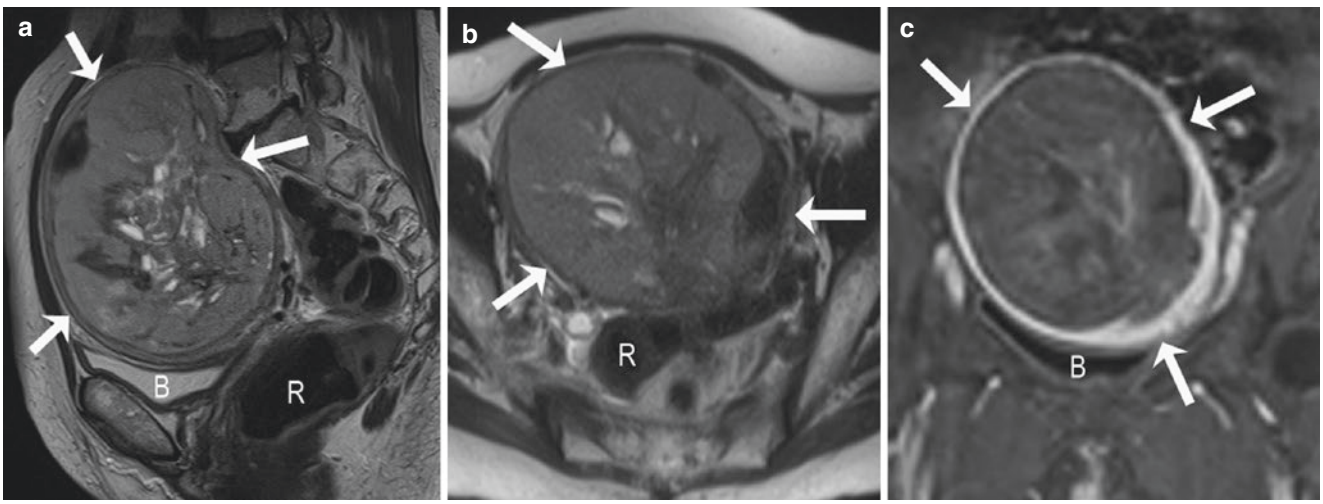


Fig. 7.19 Patient with medical history of uterus myomatosus underwent MRI before planned hysterectomy. (**a**) T2WI image on sagittal plane presents a huge and heterogenous, but well circumscribed, mass in the uterine cavity (*arrows*). (**b**) Even on transverse plane, the mass seems to be well circumscribed with a pseudo-capsule (*arrows*). (**c**) Contrast-enhanced MRI on transverse plane shows the enhanced myometrium (*arrows*) and the heterogenous hypointense mass in the uterine cavity. Histopathological result was endometrial stromal sarcoma. *B* bladder; *R* rectum

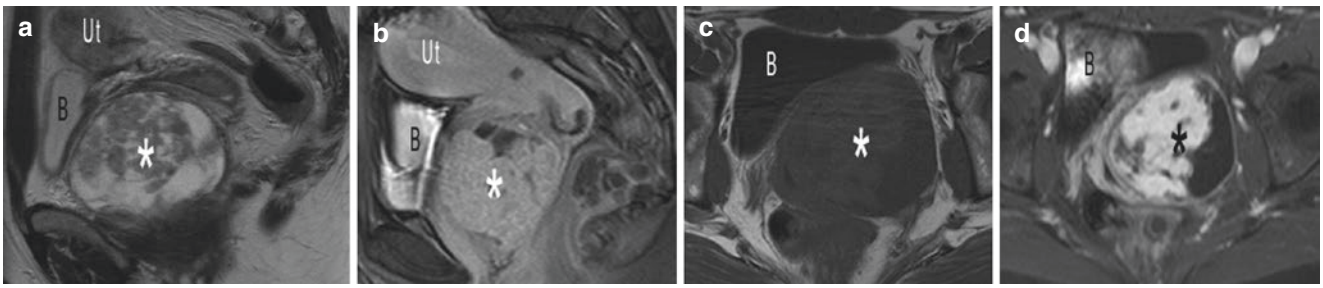


Fig. 7.20 (**a**) Huge inhomogenous mass in entire pelvis with septa and different signal intensities at T2WI (*asterisk*). (**b**) CE T1WI on sagittal plane shows homogenous enhancement of the solid parts of the mass (*asterisk*). The vagina is distended. (**c**) The mass presents as hypointense on native T1WI (*asterisk*). (**d**) On dynamic contrast enhanced images, the mass presents with hypervascular areas on arterial phase (*asterisk*). Histopathologically proven as leiomyosarcoma of the uterus. *B* bladder, *Ut* uterus

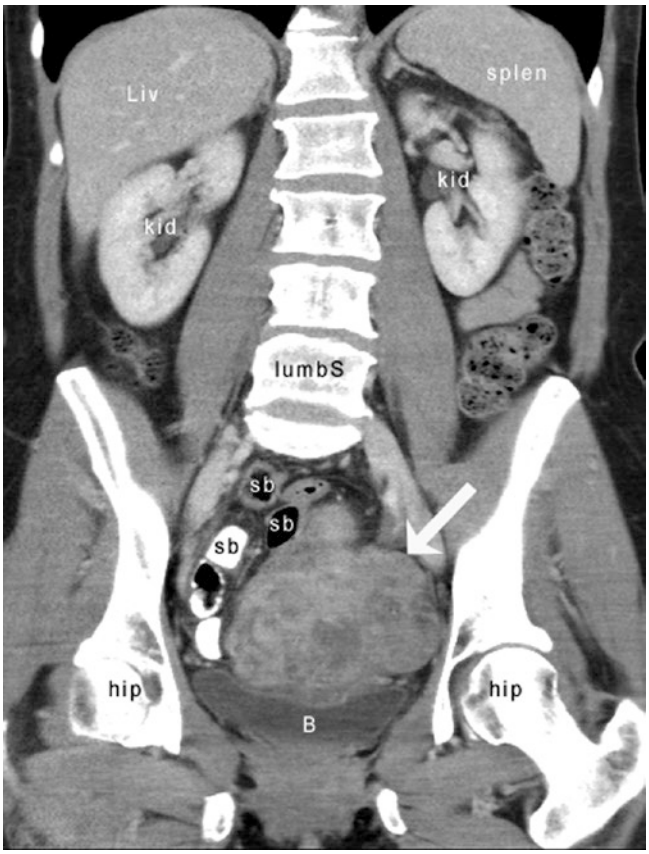


Fig. 7.21 Contrast enhanced CT scan in coronal plane. The entire pelvis presents with a huge heterogeneous mass (*arrow*) impressing the bladder. Hypointense central areas suggest central necrosis. The tumor was histopathologically confirmed as leiomyosarcoma of the uterus. *B* bladder, *sb* small bowel, *Liv* liver, *kid* kidney, *lumbS* lumbar spine

Uterine Lymphoma

Non-Hodgkin-lymphoma of the uterus and the cervix are very rare (<1 %) and may affect women between the ages of 20–80 [29].

Local tumor detection can be undertaken by using ultrasound. However, in some case the entire extent of the lymphoma cannot be depicted, so cross sectional image modality may be useful. If there is already a clinically based suspicion of a tumor extent beyond the small pelvis, a CECT of the abdomen for therapy planning and for follow-up examinations should be initiated (Fig. 7.23) [30]. For the visualisation of local findings, contrast enhanced MRI of the pelvis ought to be the image modality of choice. Using MRI, uterine lymphomas are mostly visible as homogenous, hyperintense masses in native T2WI, without a clear differentiation to the surrounding tissue and with a strong enhancement after contrast application [31].

Recurrent Tumor Disease

Recurrence of endometrial cancer after primary surgery mostly occur within the first 2 years. Metastases can be found as solid mass within the vagina and the parametrium or as lymph node metastases (Fig. 7.24). Recurrence of endometrial cancer after primary radiation therapy can often be found within the uterus or the ovaries [32]. For local recurrence, MRI is the cross sectional imaging modality of choice, however, if there is suspicion for distant metastases, CECT gives a better overview and is commonly performed for the chest and the body in one examination (Fig. 7.25).

Recurrence of a cervical cancer is seen in approx. 10–42 % of primary surgically treated patients. They often show as a solid mass at the vaginal vault, but can also manifest themselves within the vagina, the parametrium, the pelvic wall or the bones (Figs. 7.26, 7.27, and 7.28) [17, 32]. If there is a clinicial suspicion of tumor recurrence in the entire pelvis, contrast enhanced MRI for detection and diagnosis of its extent is relevant. The differentiation to scar tissue is especially important. Scar tissue as well as residual tumor tissue shows as moderately hyperintense in native T2WI. For differentiation, the CE T1WI is used: scar tissue is hypointense due to missing enhancement, inflamed/ tumorous tissue mostly absorbs contrast media and represents hyperintense (Fig. 7.29) [19]. It is to be mentioned however, that differentiation may be challenging in between the first 6 month due to contrast enhancement of fibrous scar tissue [19].

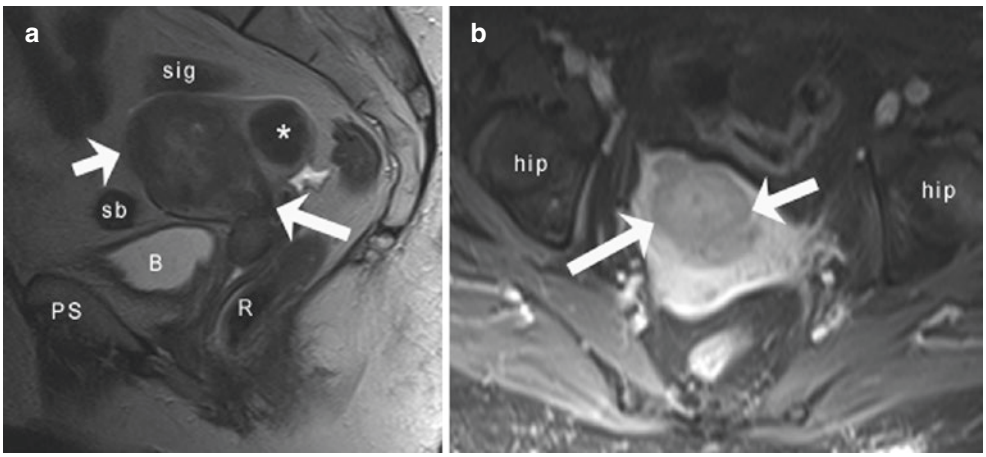


Fig. 7.22 MRI of a women with histopathologically proven adenosarcoma of the uterus. (**a**) On T2WI image on sagittal plane the uterine cavity is filled with a solid mass (*arrows*), the serosa is slightly interrupted at the fundus. Secondary finding is a subserous leiomyoma (*asterisk*). (**b**) On CE T1WI images with fat saturation on transverse oblique plane, the mass presents with a relatively homogeneous contrast enhancement (*arrows*), although the surrounding myometrium presents with a stronger enhancement. *PS* pubic symphysis, *B* bladder, *R* rectum, *sb* small bowel, *sig* sigmoid colon



Fig. 7.23 (**a**) On contrast enhanced CT (venous phase) on coronal plane, a large pelvic mass with homogenous density is present (*black arrows*). The distal ureter is bilaterally impressed, why the ureter is bilaterally splinted (*white arrows*). The renal pelvis is slightly dilatated due to the reflux through the splints in supine position during the examination. (**b**) The mass invades the bladder wall and the rectal wall (*white arrow heads*). Histologically proven as diffuse large-cell B-cell lymphoma. *B* bladder, *R* rectum

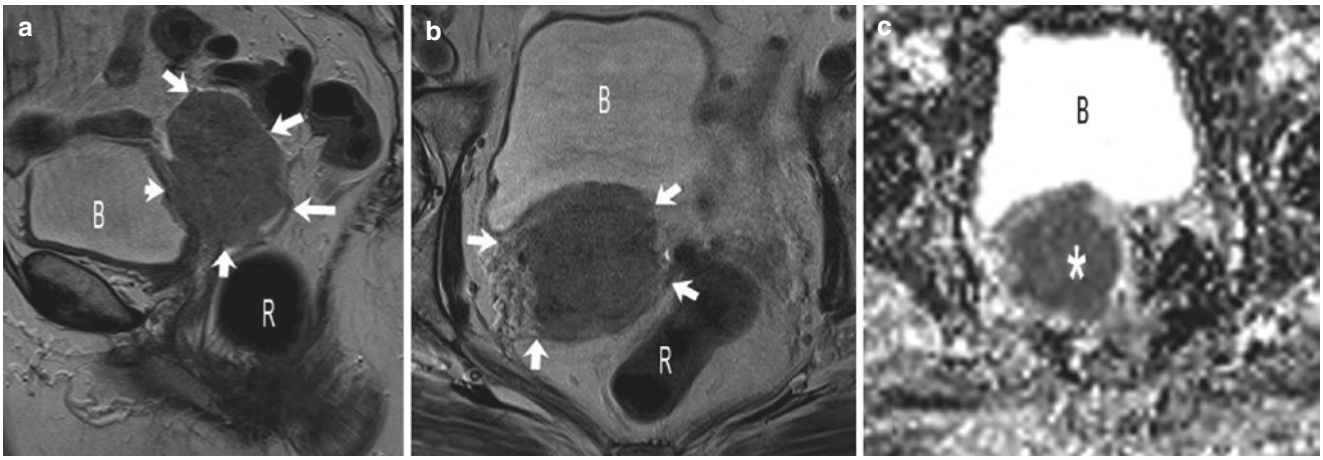


Fig. 7.24 Histologically proven recurrence of endometrial cancer. (**a**) T2WI on sagittal plane presenting with a huge mass at the vaginal vault (*arrows*). (**b**) T2WI on transversal oblique plane presents without infiltration of adjacent structures (*arrows*). (**c**) Diffusion weighted imaging shows restriction in tumor tissue (*asterisk*), delineating well the tumor margins. Tumor is close to the bladder wall, but no transmural invasion. *B* bladder, *R* rectum

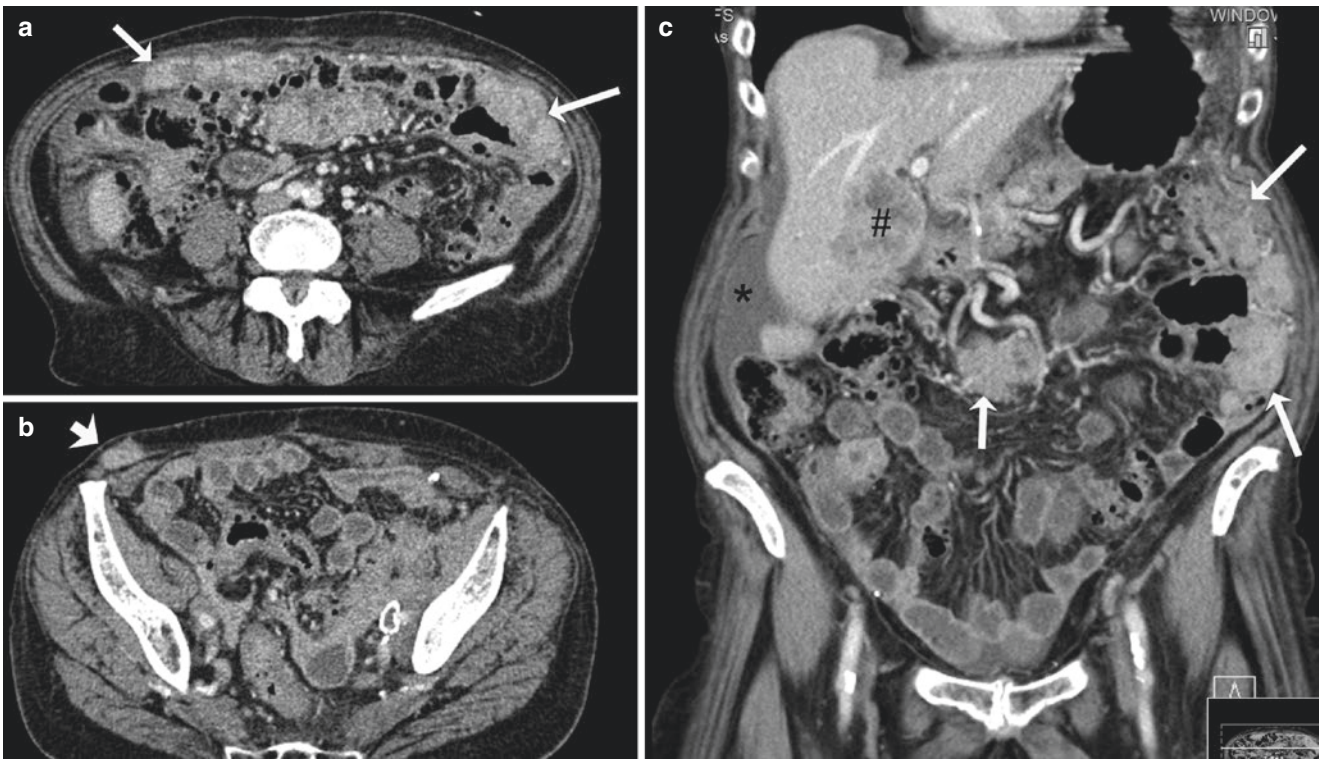


Fig. 7.25 Patient with recurrence of endometrial cancer. (**a**, **b**) Contrast enhanced CT scan on axial plane in different planes detects multiple peritoneal implants (*arrows*) and a cutaneous metastasis (*arrowhead*). (**c**) The coronal reconstruction of the same patient additionally shows a huge liver metastasis (#) and ascites (*)



Fig. 7.26 Histologically proven recurrence of cervical cancer after hysterectomy, located between the vaginal vault and the bladder wall (*arrow*). The tumor presents slightly hyperintense on T2WI. *B* bladder, *V* vagina, *R* rectum, *PS* pubic symphysis, *sbl* small bowel loops

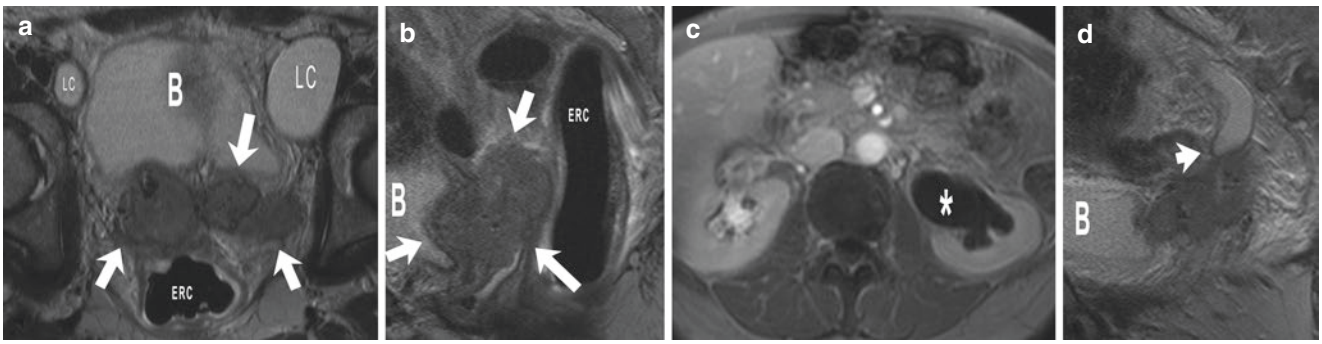


Fig. 7.27 Case of a patient after hysterectomy 4 month ago due to cervical cancer T2b N1 (same patient as in Fig. 7.21). (**a**) In entire pelvis, one solid lesion at the vaginal vault and two solid lesions close by are present, hyperintense on T2WI (*arrows*). The bilaterally inguinal oval cystic-like lesions correspond to lymphoceles (LC). (**b**) The vaginal vault mass is well delineated between the bladder wall and the rectal wall (*arrows*). (**c**) Hydronephrosis of the left kidney (*asterisk*). (**d**) The left distal ureter is compressed by the mass (*arrowhead*). *B* bladder, *ERC* endorectal coil

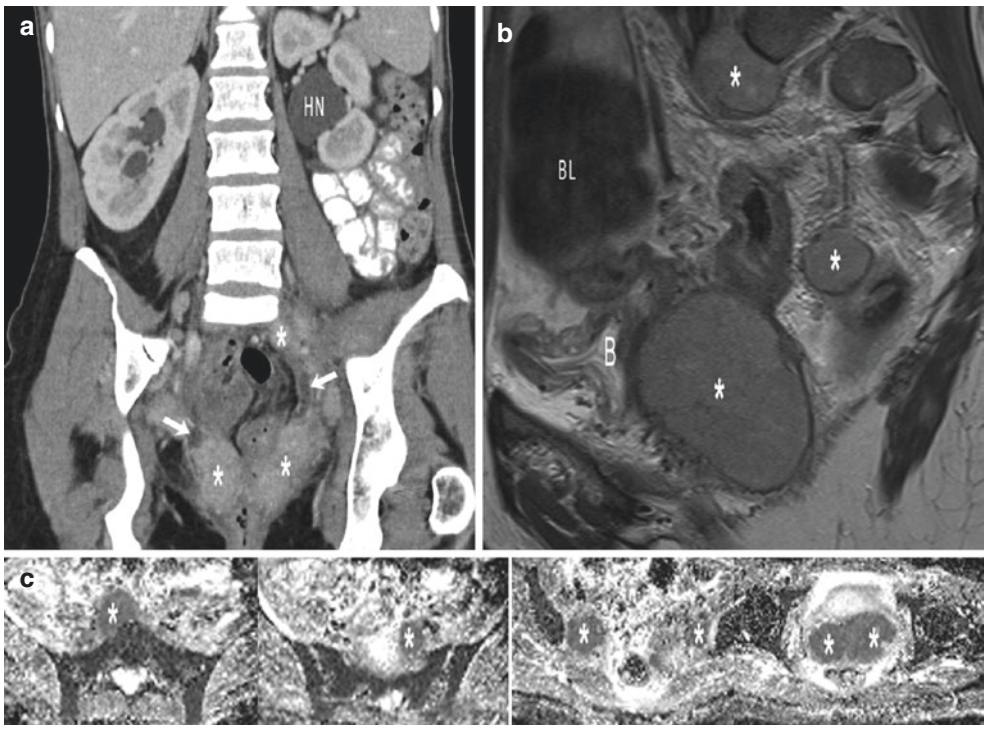


Fig. 7.28 Histologically proven recurrence of cervical cancer. (**a**) On contrast enhanced CT scan in coronal plane, hyperdense masses are present in entire pelvis as well as at the level of the aortal bifurcation (*asterisk*). The ureter is dilatated bilaterally (*arrows*) with concecutive hydronephrosis (HN). (**b**) On T2WI on sagittal plane, the masses are slightly hyperintense and well defined (*asterisk*). (**c**) Diffusion weighted imaging on axial plane on severeal slices present with multiple diffusion restriction tissues, defining tumor recurrence (*asterisk*). *B* bladder

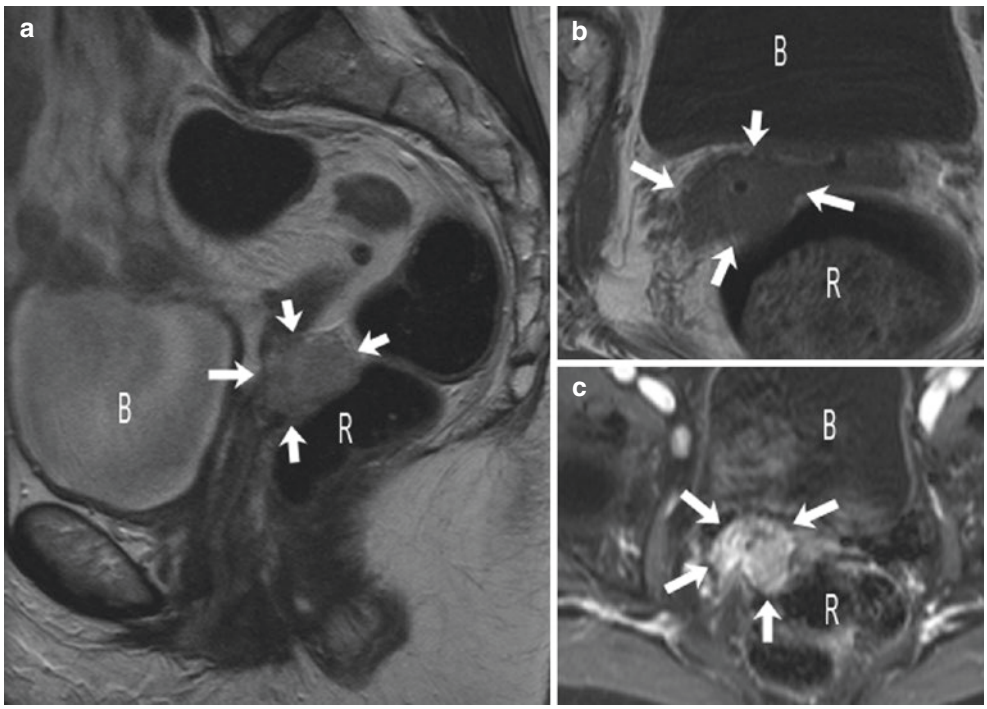


Fig. 7.29 (**a**) On T2WI on sagital plane a hyperintense mass at the vaginal vault is present (*arrows*), histopathologically proven as recurrence from cervical cancer. (**b**) On native T1WI on transversal plane, the mass is hypointense with slightly blurry margins (*arrows*). (**c**) After contrast i.v. the mass shows increased contrast enhancement (*arrows*). No infiltration into surrounding structures. *B* bladder, *R* rectum

References

1. Kinkel K, Forstner R, Danza FM, et al. Staging of endometrial cancer with MRI: guidelines of the European Society of Urogenital Imaging. Eur Radiol. 2009;19:1565–74.
2. Pecorelli S. Revised FIGO staging for carcinoma of the vulva, cervix, and endometrium. Int J Gynaecol Obstet. 2009;105:103–4.
3. Brocker KA, Alt CD, Eichbaum M, et al. Imaging of female pelvic malignancies regarding MRI, CT, and PET/CT: part 1. Strahlenther Onkol. 2011;187:611–8.
4. Colombo N, Van Gorp T, Parma G, et al. Ovarian cancer. Crit Rev Oncol Hematol. 2006;60:159–79.
5. Pano B, Sebastia C, Bunesch L, et al. Pathways of lymphatic spread in male urogenital pelvic malignancies. Radiographics. 2011;31:135–60.
6. Balleyguier C, Sala E, Da Cunha T, et al. Staging of uterine cervical cancer with MRI: guidelines of the European Society of Urogenital Radiology. Eur Radiol. 2011;21:1102–10.
7. Kirchhoff S. MR Vagina, Uterus, Adnexe. In: Scheffel H, Alkadhi H, Boss A, Merkle E, editors. Praxisbuch MRT Abdomen und Becken. Berlin: Springer; 2012. p. 181–94.
8. Thomassin-Naggara I, Darai E, Bazot M. Gynecological pelvic infection: what is the role of imaging? Diagn Interv Imaging. 2012;93:491–9.
9. Sala E, Rockall AG, Freeman SJ, et al. The added role of MR imaging in treatment stratification of patients with gynecologic malignancies: what the radiologist needs to know. Radiology. 2013;266:717–40.
10. Beddy P, Moyle P, Kataoka M, et al. Evaluation of depth of myometrial invasion and overall staging in endometrial cancer: comparison of diffusion-weighted and dynamic contrast-enhanced MR imaging. Radiology. 2012;262:530–7.
11. Forstner R, Sala E, Kinkel K, et al. ESUR guidelines: ovarian cancer staging and follow-up. Eur Radiol. 2010;20:2773–80.
12. Shen SH, Chiou YY, Wang JH, et al. Diffusion-weighted single-shot echo-planar imaging with parallel technique in assessment of endometrial cancer. AJR Am J Roentgenol. 2008;190:481–8.
13. Scheidler J. Bildgebende Diagnostik der inneren weiblichen Genitalorgane – Adnexe. In: Adams S, Nicolas V, Freyschmidt J, editors. Urogenitaltrakt, Retroperitoneum, Mamma. Berlin/Heidelberg: Springer; 2004. p. 221–40.
14. Horton KM, Sheth S, Corl F, et al. Multidetector row CT: principles and clinical applications. Crit Rev Comput Tomogr. 2002;43:143–81.
15. Sala E, Hricak H. Female pelvis. In: Reiser MFHH, Semmler W, editors. Magnetic Resonance Tomography. Berlin/Heidelberg: Springer; 2008. p. 964–97.
16. Wittekind C, Meyer H-J. International Union against Cancer. TNM Klassifikation maligner Tumoren. 7. Aufl. Weinheim: Wiley-Blackwell; 2010.
17. Brant W. Pelvis. In: Webb W, Brant W, Major N, editors. Fundamentals of Body CT. Philadelphia: Saunders; 2006. p. 355–76.
18. Naganawa S, Sato C, Kumada H, et al. Apparent diffusion coefficient in cervical cancer of the uterus: comparison with the normal uterine cervix. Eur Radiol. 2005;15:71–8.
19. Zaspel U, Hamm B. Cervical cancer. In: Hamm B, Forstner R, editors. MRI and CT of the female pelvis. Berlin/Heidelberg: Springer; 2007. p. 121–80.
20. Sala E, Wakely S, Senior E, et al. MRI of malignant neoplasms of the uterine corpus and cervix. AJR Am J Roentgenol. 2007;188:1577–87.
21. Rigon G, Vallone C, Starita A, et al. Diagnostic accuracy of MRI in primary cervical cancer. Open J Radiol. 2012;2:14–21.
22. Pandharipande PV, Choy G, del Carmen MG, et al. MRI and PET/CT for triaging stage IB clinically operable cervical cancer to appropriate therapy: decision analysis to assess patient outcomes. AJR Am J Roentgenol. 2009;192:802–14.
23. Kortmann B, Reimer T, Gerber B, et al. Concurrent radiochemotherapy of locally recurrent or advanced sarcomas of the uterus. Strahlenther Onkol. 2006;182:318–24.
24. Benz MR, Tchekmedyian N, Eilber FC, et al. Utilization of positron emission tomography in the management of patients with sarcoma. Curr Opin Oncol. 2009;21:345–51.
25. Roth CG. Magnetic resonance imaging of the female pelvis. Fundamentals of body MRI. Philadelphia: Elsevier Saunders; 2012. p. 261–368.
26. Sumi A, Terasaki H, Sanada S, et al. Assessment of MR imaging as a tool to differentiate between the major histological types of uterine sarcomas. Magn Reson Med Sci. 2015;14(4):295–304.
27. Nucci MR, Oliva E. Gynecologic pathology. Edinburgh: Churchill Livingstone; 2009.
28. Takeuchi M, Matsuzaki K, Yoshida S, et al. Adenosarcoma of the uterus: magnetic resonance imaging characteristics. Clin Imaging. 2009;33:244–7.
29. Griffin N, Grant LA, Sala E. Magnetic resonance imaging of vaginal and vulval pathology. Eur Radiol. 2008;18:1269–80.
30. Tateishi U, Terauchi T, Inoue T, et al. Nodal status of malignant lymphoma in pelvic and retroperitoneal lymphatic pathways: PET/CT. Abdom Imaging. 2010;35:232–40.
31. Kim YS, Koh BH, Cho OK, et al. MR imaging of primary uterine lymphoma. Abdom Imaging. 1997;22:441–4.
32. Jonat W, Bauerschlag D, Schem C, et al. Gut- und bösartige gynäkologische Tumoren. In: Diedrich K, Holzgreve W, Jonat W, Schneider K-T, Schultze-Mosgau A, Weiss J, editors. Gynäkologie und Geburtshilfe. Berlin/Heidelberg: Springer; 2007. p. 211–98.

Interventional Diagnostics Before Hysterectomy

8

Sergio Haimovich

Office Hysteroscopy

It was in 1980 when Hamou, considered the father of modern hysteroscopy, designed the first microcolpohysteroscope, offering a new combination of hysteroscopy and microscopy. His device allowed for multiple magnifications (X1, X20, X60, and X150) for cellular exploration and it presented new diagnostic opportunities (Fig. 8.1).

Introduction of bipolar system 'Gynecare Versa Point' by Ethicon Inc. in 1997 was the turning point of modern office hysteroscopy. This technology enabled to increase spectrum of intrauterine surgical procedures by means of thin miniaturized instruments without both anesthesia and dilatation of cervix at outpatient clinics. It was de beginning of the "see and treat" concept that is applied in the hysteroscopy units now a day.

The office setting hysteroscopy is becoming prevalent based among others in the convenient and efficiency of the procedure for both the physician and patient. An additional benefit of office-based hysteroscopy has been suggested by Lindheim et al. [1], who more than a decade ago, noted the cost saving per case of at least 50 % when compared with the hospital equivalent. The approach with vaginoscopy or "no touch" technique, without using speculum, tenaculum or even anesthesia is another well tolerated advantage of office hysteroscopy and patients reported just little discomfort [2].

Hysteroscopy is currently considered the best technique for investigating the uterine cavity [3, 4]. Several comparative studies between hysteroscopy and histology have demonstrated that hysteroscopy has a very high diagnostic accuracy for most intrauterine abnormalities [4] and for endometrial cancer [5, 6].

In 2002 Clark and coworkers in a systematic review concluded that diagnostic accuracy of hysteroscopy is high for endometrial cancer but only moderate for endometrial disease (cancer or hyperplasia) [7].



Fig. 8.1 Hamou microcolpohysteroscope

Indication for Office Hysteroscopy

When is a diagnostic hysteroscopy indicated? There are different clinical conditions as abnormal uterine bleeding (AUB). AUB is the most common indication in women over 45 years old.

Based on suspicious images especially by transvaginal ultrasound (TVUS) but also by CT or MRI, the endometrial pathology can be divided to focal (polyps and myoma) or diffuse (hyperplasia with or without cytological atypia and adenocarcinoma) (Table 8.1).

Any image of suspected endometrial cavity occupation by focal or diffused pathology is an indication for performing a diagnostic hysteroscopy.

When diffuse endometrial pathology is suspected (thickened endometrium image) the first choice is to obtain tissue sample by using a Pipelle. It has a low false positive rate but the false negative rate can be over 20 %, for this reason a diagnostic hysteroscopy is indicated after a negative result [8].

The similarity in morphological appearance of endometrial atypia hyperplasia (EAH) and well-differentiated

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Table 8.1 Hysteroscopy indications

Clinical features	Images of suspected uterine occupation
Post-menopausal bleeding	Focal (polyp/myoma)
Abnormal Uterine Bleeding	Non Focal – Endometrial Thickness >5 mm (Hyperplasia/ Adenocarcinoma)

endometrial carcinoma represents a major challenge to histopathologists. When a diagnosis of atypical hyperplasia is made, there is a risk of concomitant invasive carcinoma in the uterus. This discrepancy between endometrial specimens and hysterectomy specimens on histopathological examination has been found in several reports, with 7–50 % of women with endometrial hyperplasia with cytological atypia reported to have concomitant carcinoma in subsequent hysterectomy specimens [9–14].

On biopsy specimens, the distinction between well-differentiated carcinomas and atypical hyperplasias, on the basis of distortion of glands architecture and cytologic atypia, is neither simple nor reproducible even by experienced pathologists [15]. On Figs. 8.2 and 8.3, it is possible to see the great difficulty to differentiate between Hyperplasia and Adenocarcinoma.

We define the pathology that will end in a hysterectomy as High Risk Endometrial Pathology, this group includes:

1. Adenocarcinoma on a polyp (AP)
2. Endometrial adenocarcinoma (EA)
3. Endometrial atypical hyperplasia (EAH).

Except in EA were the hysteroscopy has a great grade of accuracy with histopathology, both in AP and EHA many times hysteroscopic images are no so easy to interpret.

The hysteroscopic appearance of an endometrial carcinoma is quite typical, and this visual diagnosis is generally based on the presence of a gross distortion of endometrial cavity, because of focal or extensive nodular, polypoid, papillary or mixed patterns of neoplastic growth. Focal necrosis, friable consistency, and atypical vessels are other features almost invariably associated with endometrial cancer and easily detected by hysteroscopic inspection (Fig. 8.4).

High-risk polyps are presented in postmenopausal women as an image of more than 10 mm and symptomatic (bleeding or spotting). It is important to perform a complete hysteroscopic dissection of the polyp and no to leave any tissue including the pedicle, sometimes adenocarcinoma can be find in the polyp's base.

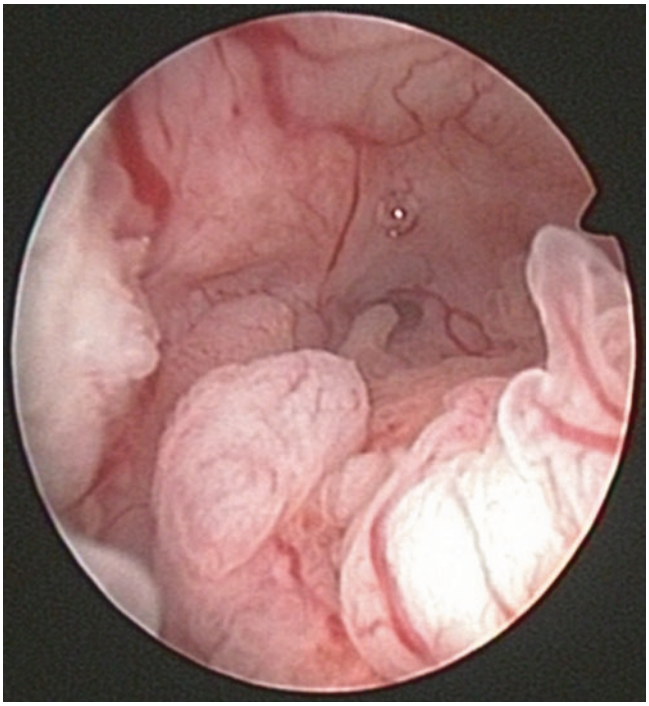


Fig. 8.2 Complex hyperplasia (Courtesy of Dr. Luis Alonso)

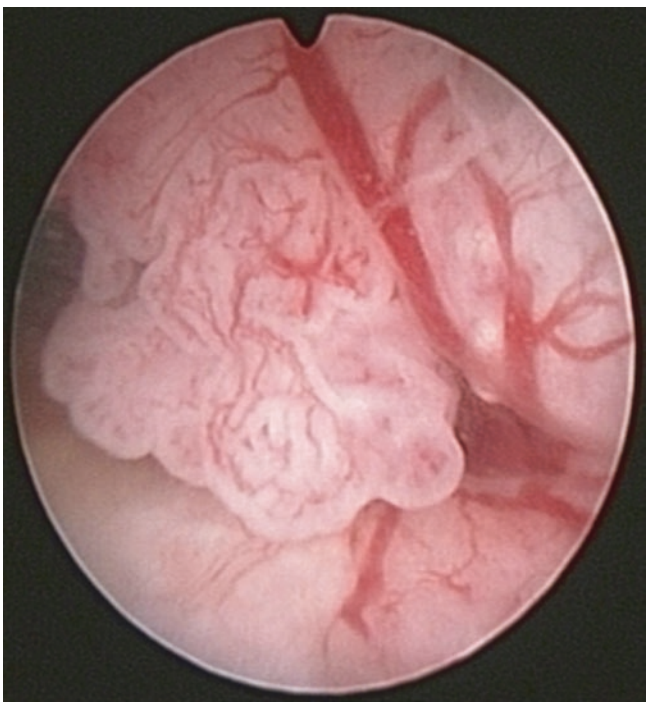


Fig. 8.3 Well-differentiated adenocarcinoma (Courtesy of Dr. Luis Alonso)

Narrow Band Imaging (NBI) and Hysteroscopy

An element that helps in the diagnosis of endometrial high-risk pathology when applied during hysteroscopy is the narrow-band imaging (NBI). This technology is a real-time, on-demand endoscopic imaging technique designed to enhance visualization of the vascular network and surface texture of the mucosa in an effort to improve tissue characterization, differentiation, and diagnosis [16] (Fig. 8.5).

Enhancement of particular mucosal features with NBI is achieved by observation of light transmission at selected wavelengths (or colors) because the interaction of particular tissue structures with light is wavelength dependent.

Selective light transmittance is accomplished by optical filtering of white light (WL) in NBI. The use of a band of light of 415 nm, blue light, correspond to the peak light absorption of hemoglobin, and this enables NBI to make the organization of blood vessels on the surface of the analyzed structures clearer and sharper with respect to observation with WL. Narrow-band blue light displays superficial capillary networks, offering an extremely high-contrast image of the tissue surface.

NBI has a very good correlation with histology especially in the difficult cases like atypical hyperplasia. Lasmar et al. have reported that the sensitivities of hysteroscopy for endometrial hyperplasia (EMH) and endometrial carcinoma are 56.3 and 80.0 %, respectively [17].

In the last years many authors have published their results in the use of NBI during hysteroscopy showing an improvement in the diagnostic sensitivity for atypical endometrial hyperplasia or endometrial carcinoma, compared with conventional hysteroscopy [18–20]. With NBI helps a variety of atypical blood vessels were observed in the mucosa of endometrial malignant lesions, including vessels with expanded, tortuous, and zigzagged shapes; variable diameter; inflectional, interrupted, papillary shapes; and sea anemone shapes. The visualization of this patterns helps in the orientation of high-risk endometrial pathology [18].

Figure 8.6 shows the enhancement of the capillary vascularization with NBI compared with WL in a case of EHA shows the difference between WL and NBI on a polyp's pedicle.

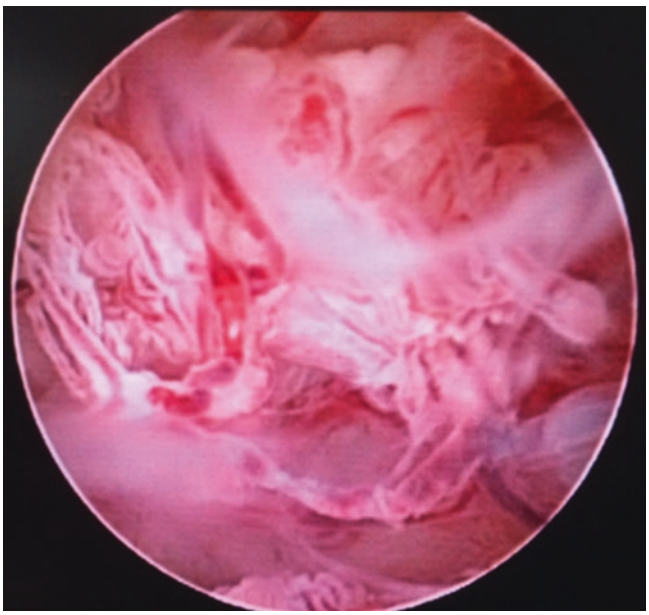


Fig. 8.4 Endometrial adenocarcinoma

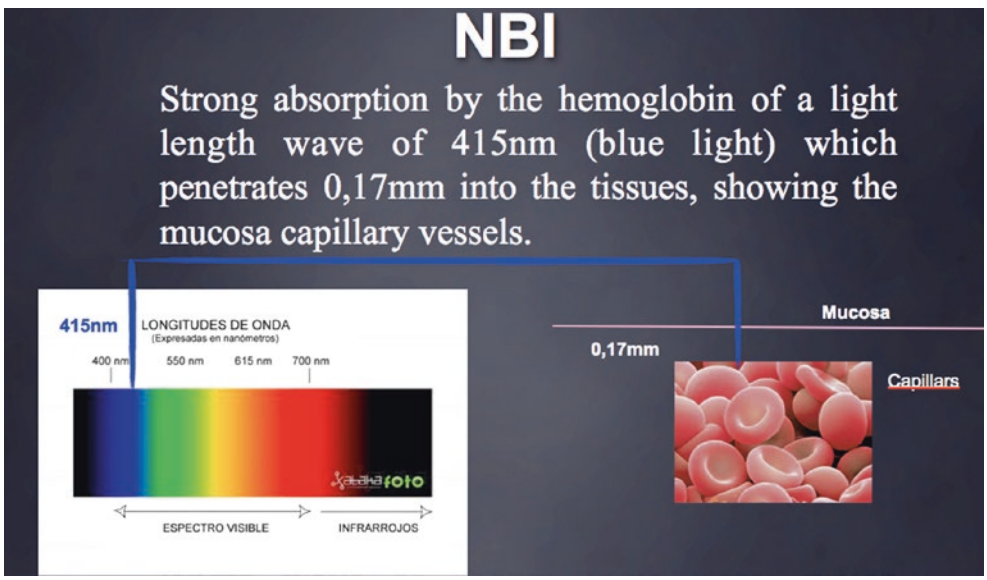


Fig. 8.5 NBI

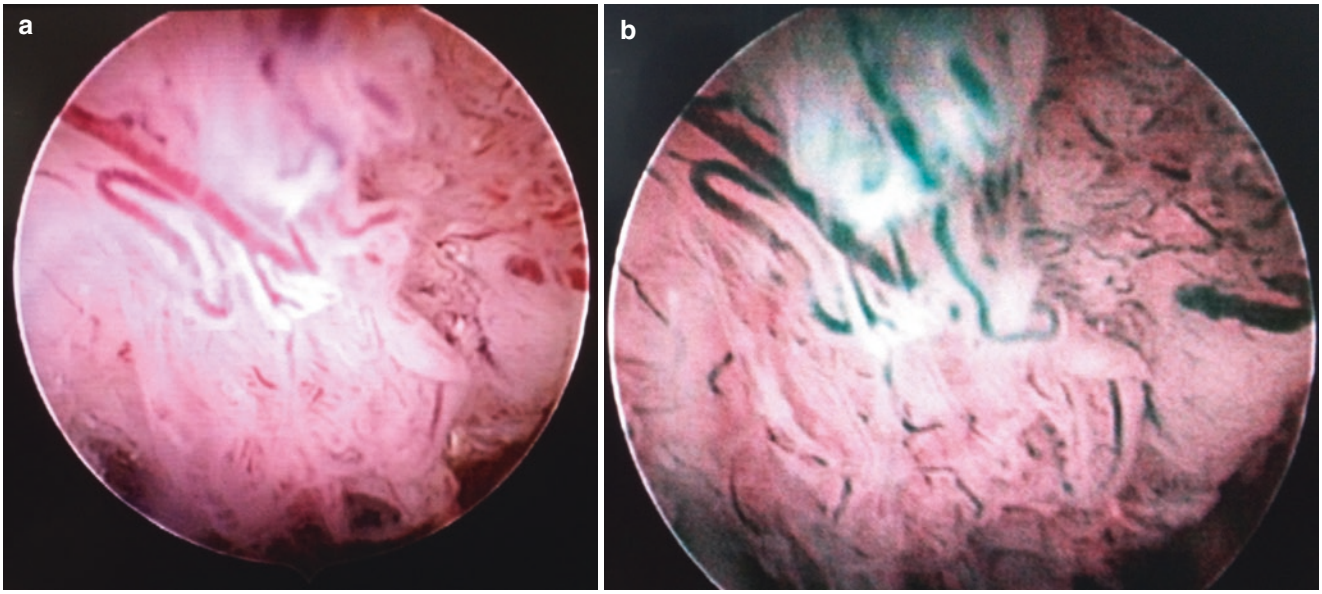


Fig. 8.6 Hyperplasia with atypia: (**a**) WL versus (**b**) NBI

Hysteroscopy and Endometrial Cancer

As seen in this chapter endometrial sampling for histopathology examination is essential to diagnose endometrial cancer. Hysteroscopy provides an accurate evaluation of the endometrial cavity and allows directed sampling of suspected lesion.

However, there have been concerns that endometrial cells could be flushed into the fallopian tubes and the peritoneal cavity. It is a controversial subject with no enough evidence in order to achieve a clear conclusion.

In one study, Vilos at al found that hysteroscopy did not adversely affect the 5-year survival and the long-term prognosis in 14 women with endometrial cancer [21].

Polyzos et al. in a Meta-Analysis [22] estimated the risk for disease upstaging associated with the hysteroscopic procedure before surgery in women with endometrial cancer. The outcomes considered were the incidence of malignant cells in peritoneal washings before hysterectomy, incidence of tumour upstaging due solely to the presence of a positive peritoneal cytological feature in patients with apparent clinical early-stage disease limited to the uterus; overall survival, disease-free survival, and disease recurrence.

The results showed that hysteroscopy in patients with endometrial cancer resulted in statistically significant higher endometrial cancer cell seeding within the peritoneal cavity [OR: 1.78; (95 % CI, 1.13–2.79)]. Sensitivity analysis including only trials in which hysteroscopy with isotonic sodium chloride was used showed a further increased risk [OR, 2.89; (95 % CI, 1.48–5.64)], as well as sensitivity analysis including only trials in which inflated distension medium pressure reached or exerted 100 mmHg [OR 3.23; (95 % CI, 0.94–11.09)].

Also a statistically significant higher tumour upstaging was found when hysteroscopy was performed in patients with disease limited to the uterus compared with no hysteroscopy [OR, 2.61; (95 % CI, 1.47–4.63)]. Data regarding overall survival and disease recurrence supported the notion that no significant difference for the prognostic outcomes tested was observed.

The possible risk of the spreading into the abdominal cavity of neoplasic cells should not limit the use of hysteroscopy in favor of blind techniques (LEVEL OF EVIDENCE II, STRENGH OF THE RECOMMENDATION A).

In order to minimize the small risk of cancer dissemination, hysteroscopy should be performed with an intrauterine pressure of less than 80 mmHg, and the duration of the procedure should be as short as possible.

Prognosis Value of Diagnostic Hysteroscopy

The staging of endometrial cancer by hysteroscopy has not demonstrated its utility. In 1988, Cronjé et al. found no differences between dilatation curettage and hysteroscopy in pre surgical staging of endometrial adenocarcinoma [23].

Cervical involvement may vary between free tumor cells in the endocervical canal and endometrial infiltration of the endocervix. Cervical involvement is important to determinate staging, prognosis, and adjuvant treatment [24].

The prevalence of cervical involvement in endometrial cancer is between 10 and 20 % [25].

Panoramic hysteroscopy is the best procedure for excluding cervical involvement from endometrial cancer [26]. Moreover, as hysteroscopy enables us to estimate the extent of the cancerous spread within the uterine cavity, it could indirectly be predictive of tumoral size.

The cervical spreads is shown by irregularly eroded endocervical lining, well-marked coarse undulation of cervical mucosa, and endocervical exophytic growth of tissue displaying vascular atypia consistent with tumor growth were the hallmarks defining the spread of endometrial neoplasia to the endocervical canal.

In a group of 87 women with endometrial cancer, Villegas et al. found with a predictive positive value of hysteroscopy in the detection of cervical cancer was of 80 %, concluding that Hysteroscopy is a useful method for assessing cervical invasion in endometrial carcinoma, as it allows direct visual inspection of the uterine cavity and guided biopsies [27].

Hysteroscopy is the best and probably the only diagnostic tool for a preoperative estimation of the extent of endometrial lining involvement from endometrial carcinoma [28, 29].

Although unproven, a direct relationship between the extention of endometrial spread detected hysteroscopically and tumor volume appears rational. Morrow and Curtin's suggested in their work [30] that 50 % endocavity tumor spreading assessed by hysteroscopic view can be assumed as a reliable cutoff for selecting patients at high risk of metastatic disease.

References

1. Lindheim SR, Kavic S, Shulman SV, Sauer MV. Operative hysteroscopy in the office setting. J Am Assoc Gynecol Laparosc. 2000;7:65–9.
2. Bettocchi S, Ceci O, Nappi L, et al. Operative hysteroscopy without anesthesia: analysis of 4863 cases performed with mechanical instruments. J Am Assoc Gynecol Laparosc. 2004;11:59–61.
3. Balasch J. Investigation of the infertile couple: investigation of the infertile couple in the era of assisted reproductive technology: a time for reappraisal. Hum Reprod. 2000;15:2251–7.
4. Brand A. Diagnosis of endometrial cancer in women with abnormal uterine bleeding. J SOGC. 2000;86:1–3.
5. Chambers JT, Chambers SK. Endometrial sampling: when? Where? Why? With what? Clin Obstet Gynecol. 1992;35:28–39.
6. Creasman WT. Endometrial cancer: incidence, prognostic factors, diagnosis, and treatment. Semin Oncol. 1997;24 :S1–140–50.
7. Clark TJ, Voit D, Gupta JK, Hyde C, Song F, Khan KS. Accuracy of hysteroscopy in the diagnosis of endometrial cancer and hyperplasia: a systematic quantitative review. JAMA. 2002;288:1610–21.
8. Farrell T, Jones N, Owen P, Baird A. The significance of an "insufficient" Pipelle sample in the investigation of postmenopausal bleeding. Acta Obstet Gynecol Scand. 1999;78:810–2.
9. Valenzuela P, Sanz JM, Keller J. Atypical endometrial hyperplasia: grounds for possible misdiagnosis of endometrial adenocarcinoma. Gynecol Obstet Invest. 2003;56:163–7.
10. Trimble CL, Kauderer J, Zaino R, Silverberg S, Lim PC, Burke JJ, et al. Concurrent endometrial carcinoma in women with a biopsy diagnosis of atypical endometrial hyperplasia: a Gynecologyc Oncology Group study. Cancer. 2006;106:812–9.
11. Schutter J, Wright Jr TC. Prevalence of underlying adenocarcinoma in women with atypical endometrial hyperplasia. Int J Gynecol Pathol. 2005;24:313–8.
12. Garuti G, Mirra M, Luerti M. Hysteroscopic view in atypical endometrial hyperplasias: a correlation with pathologic findings on hysterectomy specimens. J Minim Invasive Gynecol. 2006;13:325–30.
13. Bilgin T, Ozuysal S, Ozan H, Atakan T. Coexisting endometrial cancer in patients with a preoperative diagnosis of atypical endometrial hyperplasia. J Obtet Gynaecol Res. 2004;30:205–9.
14. Daud S, Jalil S, Griffin M, Ewies A. Endometrial hyperplasia – the dilemma of management remains: a retrospective observational study of 280 women. Eur J Obstet Gynecol Repro Biol. 2011;159:172–5.
15. Kendall BS, Ronnett BM, Isacson C, Cho KR, Hedrick L, Diener-West M, et al. Reproducibility of the diagnosis of endometrial hyperplasia, atypical hyperplasia, and well differentiated carcinoma. Am J Surg Pathol. 1998;22:1012–7.
16. Vincent BD, Fraig M. A pilot study of narrow-band imaging compared to white light bronchoscopy for evaluation of normal airways and premalignant and malignant airways disease. Chest. 2007;131:1794–9.
17. Lasmar RB, Barrozo PR, De Oliveira MA, Coutinho ES, Dias R. Validation of hysteroscopic view in cases of endometrial hyperplasia and cancer in patients with abnormal uterine bleeding. J Minim Invasive Gynecol. 2006;13:409–12.
18. Kisu I, Banno K, Kobayashi Y, Ono A, Masuda K, Ueki A, Nomura H, Hirasawa A, Abe T, Kouyama K, Susumo N, Aoki D. Flexible hysteroscopy with narrow band imaging (NBI) for endoscopic diagnosis of malignant endometrial lesions. Int J Oncol. 2011;38:613–8.
19. Surico D, Vigone A, Bonvini D, Tinelli R, Leo L, Surico N. Narrow-band imaging in diagnosis of endometrial cancer and hyperplasia: a new option? J Minim Invasive Gynecol. 2010;17:620–5.
20. Cicinelli E, Tinelli R, Colafiglio G, Pastore A, Mastrolia S, Lepera A, Clevin L. Reliability of narrow-band imaging (NBI) hysteroscopy: a comparative study. Fertil Steril. 2010;94(6):2303–7.
21. Vilos G, Edris F, Al-Mubarak A, Ettler H, Hollett-Caines J, Abu-Rafea B. Hysteroscopic surgery does not adversely affect the long-term prognosis of women with endometrial adenocarcinoma. J Minim Invasive Gynecol. 2007;14(2):205–10.
22. Polyzos NP, Mauri D, Tsioras S, Messini CI, Valachis A, Messinis IE. Intraperitoneal dissemination of endometrial cancer cells after hysteroscopy: a systematic review and meta-analysis. Int J Gynecol Cancer. 2010;20:261–7.
23. Cronje HS, Deale CJC. Staging of endometrial cancer by hysteroscopy. S Afr Med J. 1988;73:716–7.
24. Garuti G, De Giorgi O, Sambruni I, Cellani F, Luerti M. Prognostic significance of hysteroscopic imaging in endometrioid endometrial adenocarcinoma. Gynecol Oncol. 2001;81:408–13.
25. Leminen A, Forss M, Lehtovirta P. Endometrial adenocarcinoma with clinical evidence of cervical involvement: accuracy of diagnostic procedures, clinical course, and prognostic factors. Acta Obstet Gynecol Scand. 1995;74:61–6.
26. Toky T, Oka K, Nakayama K, Oguchi O, Fujii S. A comparative study of pre-operative procedures to assess cervical invasión by endometrial carcinoma. Br J Obstet Gynaecol. 1998;105:512–6.
27. Villegas I, Andía D, Rui-Wamba MJ, De la Rosa JH, Marqués M. Utility of hysteroscopy in the presurgical diagnosis of cervical invasion in endometrial carcinoma. Prog Obstet Ginecol. 2004;47(12):548–53.
28. Sugimoto O. Diagnostic hysteroscopy. In: Coppleson M, Monaghan JM, Morrow CP, Tattersall MHN, editors. Gynecologic oncology, fundamental principles and clinical practice, vol. 1. 2nd ed. New York: Churchill Livingstone; 1992. p. 341–56.
29. Taddei GL, Mancini D, Scarselli G, Tantini C, Bargelli G. Can hysteroscopic evaluation of endometrial carcinoma influence therapeutic treatment? Ann N Y Acad Sci. 1994;734:482–7.
30. Morrow CP, Curtin JP. Management of uterine neoplasia. In: Morrow CP, Curtin JP, De La Osa EL, editors. Gynecologic cancer surgery. New York: Churchill Livingstone; 1996. p. 569–625.

Part IV

Extended Aspects Regarding Indications and Contraindications



Evidence Based Review of Hysterectomy and Sexuality

9

Farah Lone

Sexuality and Prevalence of Female Sexual Dysfunction

Sexuality, its expression and intimacy remains important throughout the lifespan of a woman, and hence needs to be well understood in health as well as in illness. Sexuality contributes to some of the most complex aspects of human behaviour. Sexual dysfunction is more prevalent in women than men (43 vs 31 %).

Prevalence studies of female sexual dysfunction (FSD) are confounded by a lack of consistent methodology. Classification and determination of FSD are complicated by variability in levels of normal sexual function and the importance of sexual function to individuals and cultural beliefs. Community studies indicate that the prevalence of female sexual dysfunction ranges from 25 to 63 %. An important population-based study, a sub study of the National Health and Social Life Survey, was conducted in 1992 [1]. It provides a probability sample among 1749 women and 1410 men living in the USA, aged 18–59 years, and is based on face-to-face interviews conducted by trained interviewers. The population was matched for age, education level and marital status. Following are the ranges of dysfunctions across the age groups:

- Lack of interest in sex: 27–32 %
- Unable to achieve orgasm: 22–28 %
- Pain during sex: 8–21 %
- Sex not pleasurable: 17–27 %

Comparable prevalence rates were calculated by Hayes et al. from 11 published prevalence studies that included assessment of all FSDs [2]. Similar results have been reported by another population-based telephone survey of women aged 30–70 years to ascertain prevalence of FSD [3] using the validated Profile of Female Sexual Function and Personal Distress Scale instruments [3].

Women's sexuality can be associated with personal, physical, social and cultural factors. Therefore sexual problems may be associated with significant distress including a low self-esteem, a reduction in life satisfaction and a decline in the quality of the relationship with her partner [4, 5].

It is estimated that more than 600,000 hysterectomies (an average of more than one per minute) are performed in the United States per annum [6]. Amongst other concerns with hysterectomy, is the possible effect of the surgery on woman's sexual response. In the United Kingdom 33–46 % of women report decreased sexual response after hysterectomy with oophorectomy. Although sexual problems are highly prevalent, a very small proportion of women consult a physician.

Indications for Hysterectomy

These include benign conditions such as menometrorrhagia, uterine fibroids (leiomyoma), adenomyosis, endometriosis, pelvic pain and for actual and possible malignancies.

Types of Hysterectomy

- Total (i.e., removal of uterus and cervix)
- Subtotal (supracervical i.e., removal of uterus), with or without unilateral or bilateral oophorectomy.

Surgical Routes for Hysterectomy

- Abdominal
- Vaginal
- Endoscopic (including robotic).

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Reasons for Decreased Sexual Response

Various reasons have been described for reduction in sexual response following a hysterectomy, including hormonal changes, psychological factors, and anatomical factors.

Hormonal Changes

Common hormones produced by the ovaries include estrogen, progesterone and testosterone. Women who have had bilateral oophorectomy lose most of their ability to produce the hormones estrogen and progesterone, and lose about half of their ability to produce testosterone, and subsequently enter what is known as "surgical menopause" (as opposed to normal menopause, which occurs naturally in women as part of the aging process). In natural menopause the ovaries generally continue to produce low levels of hormones, especially androgens, even after menopause. These symptoms are commonly addressed through hormone therapy, utilizing various forms of estrogen, testosterone, progesterone or a combination.

There is paucity of consistent evidence to draw a conclusion as to the effect on sexuality of oophorectomy with or without hormone replacement therapy (HRT). Almost half the papers do not specify whether HRT was administered, other papers report that some of the women in their study received oophorectomy, and some received HRT, but contingent relationships are not specified between hysterectomy with or without oophorectomy and its impact on sexuality. However, the available data shows no significant difference in changes in women's perception of their sexual functioning has been reported before and after hysterectomy based on whether the women had their ovaries conserved or removed, with or without receiving hormone replacement therapy [7].

Psychological Factors

A wide range of psychological characteristics influence sexual function after hysterectomy.

Psychological factors with a negative impact on sexuality after hysterectomy [8–11]*:*

- Preoperative psychiatric morbidity
- Depression
- Unsatisfactory preoperative sexual relations with poor outcome

Psychological factors with a positive impact on sexuality after hysterectomy [9, 11, 12]*:*

- Frequency of coitus
- Frequency of desire
- Orgasmic response
- A healthy relationship with a partner
- Good general health of both partners
- Being stress free

Therefore those women who retained an overall desire for sexual activity, and were presumably affected by negative symptoms might be expected to experience an improvement in their sexual function after hysterectomy.

Anatomical Factors

Anatomical factors include:

(a) The lack of the uterine contractions which in some women are an important aspect of orgasm.

(b) Scar tissue preventing expansion of vagina, which may make intercourse difficult.

(c) Scarring or nerve damage causing discomfort and interference with feeling sexual pleasure.

(d) Reduced quantity of tissue resulting in diminished vasocongestion may reduce sexual arousal and the probability of multiple orgasms, and also the disruption of vaginal blood flow, local nerve supply and anatomical relationships, which could have a negative effect on overall pelvic floor function [13–16].

In addition to these factors, the pathology for which the hysterectomy is performed may differentially affect sexual response. It has been reported that women who had a hysterectomy due to endometriosis reported more difficulty and less satisfaction with orgasm than women who had a hysterectomy for other reasons. There is considerable evidence that simple abdominal hysterectomy does not have an adverse affect on pelvic organ function (bladder, bowel and sexual) [17].

Evidence-Based Review of Effects of Hysterectomy on Sexuality

Hysterectomy is the most frequently performed gynecological operation. Therefore, the myths regarding hysterectomy need to be dispelled and women requiring hysterectomy should be counseled using the best available evidence.

Simple Hysterectomy {Total Abdominal (TAH), Subtotal Abdominal (STAH) and Vaginal Hysterectomy (VH)}

Farrell and Kieser performed a systematic review of sexuality after hysterectomy and found that research in this area was largely retrospective without the use of validated outcome measures [18]. Most studies showed either no change or enhancement of sexuality following

hysterectomy. Theoretically hysterectomy should increase sexual pleasure by removing the fear of pregnancy, relieving dyspareunia and uterine disease particularly cancer. Roussis et al. [19] performed a retrospective study to assess the patient's own appraisal of their sexual responsiveness after hysterectomy (61 TAH, 22 STAH, 42 VH) and found that sexuality did not diminish after any type of hysterectomy. Alexander et al. [20] performed a prospective randomised trial comparing hysterectomy with endometrial ablation using validated measures of psychological and sexual function both pre and postoperatively. They found no difference in post operative sexuality after 12 months. Differences in libido and sexual sensitivity following various types of hysterectomies have been evaluated by Wierrani et al. [21] and found no difference at 12 months follow-up. Galyer et al. compared sexual function in women who had undergone TAH with those who had VH and found no difference in sexual desire postoperatively [22]. Roovers et al. in a prospective study over 6 months, found a reduction in sexual problems VH, TAH or STAH [23]. A large prospective study (the Maryland Women's Health study) which enrolled 1299 women who were interviewed with validated questionnaire preoperatively and at 6, 12, 18 and 24 months after hysterectomy for benign condition and found significant increase in frequency of sexual activity, a decrease in dyspareunia and a reduction in low libido [16]. Overall this study found substantial improvements in sexual function after hysterectomy.

It has been hypothesised that the disturbance of innervation of cervix and upper vagina after total hysterectomy interferes with lubrication and orgasm. Other factors that might contribute to sexual problems include a reduction in cervical mucus and vaginal shortening [24]. However Weber et al. do not agree with these views [25]. Kilkku et al. highlighted the influence of anatomical changes by comparing coital frequency, dyspareunia, libido and frequency of orgasm before and at 6 weeks, 6 months and 1 year in 105 women with TAH and 107 with STAH [26, 27]. Both groups showed an equal but slight reduction in coital frequency and dyspareunia with statistically significant deterioration after STAH. The frequency of orgasm was significantly reduced in TAH group but not in STAH group. However two randomised studies by Thakar et al. [28] and Zobbe et al. [29] found no difference in frequency of intercourse or orgasm between TAH and STAH. However there was a significant increase in frequency of intercourse [30] and decrease in dyspareunia [30, 31] after hysterectomy.

Current evidence suggests that dyspareunia reduces after hysterectomy. Sexual function does not usually deteriorate after a simple hysterectomy although a few women may develop sexual problems. There does not appear to be a difference in sexual function in women who have STAH and TAH.

Radical Hysterectomy (RH)

Women after surgery for genital cancer have to deal with not only the fear and anxiety generated by the diagnosis, treatment and prognosis, but also with the constant fear of recurrence. These women are often unaware of the consequences of the operation on sexual function. Although there is extensive evidence in the literature that shows adverse sexual functioning after treatment for cervical cancer [32–34], most studies report on heterogeneous groups of patients undergoing surgery, radiotherapy or both [35]. Primary or adjuvant radiotherapy has been reported to result in more severe sexual difficulties than hysterectomy alone [33, 36]. Patients treated with radical hysterectomy alone seem to regain their full sexual capacity and satisfaction more frequently [37]. Bergman et al. compared 256 women who had been treated for early cervical cancer and 350 controls [36]. They found that treatment of cervical cancer caused changes in vaginal anatomy and had negative effect on sexual function. These changes included decreased lubrication and reduction in perceived vaginal length and elasticity during intercourse. However the difference in the two groups with respect to frequency of intercourse, orgasmic frequency and pleasure were small. Grumann et al. prospectively compared 18 patients with stage 1B cervical cancer undergoing RH with 20 women undergoing hysterectomy for a benign cause-over 8 months using standardised questionnaires [37]. The cancer patients showed slightly better sexual function preoperatively than the other group but this deteriorated with time. Sexual function among patients with benign disease showed steady improvement indicating that RH for stage 1B cervical cancer is not associated with major disruption in sexual function. However this study had a small sample size so must be interpreted with caution. A large prospective study comparing 173 patients who had RH with age-matched controls indicated that RH had a persistent and negative impact on patients' sexual function, whereas majority of vaginal problems disappear over time [38]. Maas et al. objectively assessed sexual arousal in women who had RH (n = 12), TAH (n = 12) and 17 age-matched controls by measuring vaginal blood flow during sexual arousal using erotic films [39]. The authors suggested that although RH appears to be associated with a disturbed blood flow after sexual response, larger studies are needed for confirmation.

Overall, however, while RH affects some aspects of female sexuality, the majority appears to be transient and may be influenced by other overriding issues related to the diagnosis of cancer.

Laparoscopic Hysterectomy

A prospective case control study found no alteration of sexual function in premenopausal women undergoing either conventional or single port laparoscopically assisted

Table 9.1 Effects of hysterectomy, summary of 40 papers, 1952–2013

Effect	Increase	Decrease	No change	Variable	Undesirable effect on:
Dyspareunia	0	14	4	0	22
Vaginal lubrication	2	1	8	0	10
Libido	5	3	17	0	20
Orgasm frequency	2	4	9	0	12
Orgasm intensity	2	0	5	1	5
Sexual function	4	3	4	0	4
Sexual activity	4	1	18	3	14

vaginal hysterectomy [40]. Serati et al. found that laparoscopic radical hysterectomy did not show any benefit on women's sexuality over the open abdominal surgery for cervical cancer [41].

With recent advances in robotic surgery, this modality has been used for hysterectomy (benign and radical). Laparoscopic robotic-assisted radical hysterectomy with nerve sparing technique for bowel and bladder is proposed to be an attractive surgical approach for early invasive cervical cancer. However, effect on sexuality has not been studied to date and needs further exploration [42].

Kupperman et al. [43] conducted a randomized trial of 135women (67 TAH and 68 STAH) for benign conditions with a 2 year follow up. Sexual functioning and quality of life variables were measured with a telephone and clinic interviews. Both groups reported improvement in most measures of sexual functioning. The study by Thakar et al. [44] of 279 women (146 TAH and 133 STAH) was the only double-blind RCT. Each woman was followed for 1 year. A short-form, previously validated 36-question health survey (SF-36) and psychological outcome measure (GHQ: general health questionnaire) were used preoperatively and at 6 and 12 months postoperatively (0–100 scale). No statistical difference was found between the 2 groups before and after surgery. The frequency of intercourse, desire for intercourse, orgasm, and initiation of intercourse did not differ significantly between the groups. There was also a significant increase in the frequency of intercourse in both groups after surgery ($P = 0.01$). Deep dyspareunia was reduced significantly in both groups (46.2–6.6 % STAH and 39.3–14.3 % TAH) at 12 months ($P < 0.001$), but there was no statistical difference between groups. Zobbe et al. [29] conducted a randomized trial of 319 women (158 TAH and 161 SCH) with a one year follow-up and found no statistical difference between the 2 intervention groups regarding frequency of sexual desire, intercourse, masturbation, and orgasm, as well as quality of orgasm, vaginal lubrication, or satisfaction with sexual life ($P > 0.05$). Dyspareunia decreased significantly in both groups (89 women pre surgery and 22 post surgery $P = 0.009$). A multivariate logistic regression analysis identified preoperative satisfaction with sexual life, good relationship with partner, chronic disease, and use of hormone therapy as significant predictors of postoperative satisfaction with sexual life. Flory et al. [45] conducted a randomized trial of 63 women (32 LAVH and 31 laparoscopic subtotal hysterectomy) with a 7 month follow up. There were no differences in sexual functioning overall ($P > 0.05$).

Table 9.1 gives a summary of findings reported in the papers regarding the variably reported outcomes of hysterectomy. Any individual study reporting on at least some women who experienced deleterious effects after hysterectomy, whether or not statistically significant, was included in the last column of the table – "Undesirable Effects On:" It is important to identify and report incidence of deleterious effects of hysterectomy on any individuals. Since very few papers elaborated on these deleterious effects, we could not distinguish whether the women who, for example, experienced dyspareunia after hysterectomy developed this condition after the surgery or if the condition was present preoperatively but not treated with surgery.

Conclusion

The research on the effect of hysterectomy on sexual function that has been performed to date is not conclusive. There are discrepancies in the literature as to whether hysterectomy improves or attenuates sexuality. Hysterectomy may alleviate the discomfort of pain and bleeding, resulting in positive psychological factors such as elimination of anxiety over unwanted pregnancy and cancer risk. Symptom relief may have led to increased sexual enjoyment and increased orgasm frequency. While women report an improvement of sexual functioning after hysterectomy, this may be the result of the relief of symptoms (such as vaginal bleeding and dyspareunia) from the uterus, some women develop sexual dysfunction as a result of hysterectomy. More research is needed to clarify the issue of the effect of hysterectomy on sexual response.

Tips for the Reader

It is imperative that sexual function/dysfunction should be addressed in counseling women undergoing hysterectomy. The evaluation process for women with sexual dysfunction includes identification of the dysfunction, patient education

and modification of reversible factors. The history should include a sexual function history, medical history and psychosocial history. The examination should include both an external and internal physical exam. A multidisciplinary approach with involvement of gynaecologist, vulval pain specialist and a psychosexual counselor should be used, where indicated.

Treatment for physical causes may include the use of vaginal estrogen pessaries especially in presence of vaginal atrophy. Testosterone therapy also converts to estrogen so women in transition from peri-menopause to menopause who have vasomotor symptoms (hot flashes, night sweats) and low androgens may need to take additional estrogen in conjunction with androgens. Other treatments include Dehydroepiandrosterone (DHEA), which may result in enhanced androstenedione and testosterone levels and improvement of sexual symptoms including better Female Sexual Function Index (FSFI) and Sexual Dysfunction Score (SDS). Considering the low incidence of the adverse effect of hysterectomy on sexual function psychosexual counseling and therapy is an integral part of treatment of patients with sexual problems after hysterectomy.

References

1. Laumann EO, Paik A, Rosen RC. Sexual dysfunction in the United States: prevalence and predictors. JAMA. 1999;281(6):537–44.
2. Hayes RD, Bennett CM, Fairley CK, et al. What can prevalence studies tell us about female sexual difficulty and dysfunction? J Sex Med. 2006;3:589–95.
3. West SL, D'Aloisio AA, Agans RP, et al. Prevalence of low sexual desire and hypoactive sexual desire disorder in a nationally representative sample of US women. Arch Intern Med. 2008;168:1441–9.
4. DeRogatis LR, Graziottin A, Bitzer J, et al. Clinically relevant changes in sexual desire, satisfying sexual activity and personal distress as measured by the profile of female sexual function, sexual activity log, and personal distress scale in postmenopausal women with hypoactive sexual desire disorder. J Sex Med. 2009;6:175–83.
5. Dennerstein L, Guthrie JR, Hayes RD, DeRogatis LR, Lehert P. Sexual function, dysfunction, and sexual distress in a prospective, population-based sample of mid-aged, Australian-born women. J Sex Med. 2008;5:2291–9.
6. Whiteman MK, Hillis SD, Jamieson DJ, et al. Inpatient hysterectomy surveillance in the United States, 2000–2004. Am J Obstet Gynecol. 2008;198:31–7.
7. Bhattacharya S, Mollison J, Pinion S, et al. A comparison of bladder and ovarian function two years following hysterectomy or endometrial ablation. BJOG. 1996;103:898–903.
8. Lalinec-Michaud M, Engelsmann F. Psychological profile of depressed women undergoing hysterectomy. J Psychosom Obstet Gynecol. 1988;8:53–66.
9. Rhodes JC, Kjerulff K, Langenberg PW, Guzinski GM. Hysterectomy and sexual functioning. JAMA. 1999;282:1934–41.
10. Dennerstein L, Wood C, Burrows GD. Sexual responses following hysterectomy and oophorectomy. Obstet Gynaecol. 1977;49:92–6.
11. Helstorm L, Lundberg PO, Sorborm D, Backstorm T. Sexuality after hysterectomy: factor analysis of women's sexual lives before and after subtotal hysterectomy. Obstet Gynaecol. 1995;74:142–6.
12. Darling CA, McKay-Smith YM. Understanding hysterectomies: sexual satisfaction and quality of life. J Sex Res. 1993;30:324–35.
13. Langer R, Neuman M, Ron-el R, et al. The effect of total abdominal hysterectomy on bladder function in asymptomatic women. Obstet Gynecol. 1989;74:205–7.
14. Carlson KJ, Miller BA, Fowler Jr FJ. The Maine Women's Health Study I. Outcomes of hysterectomy. Obstet Gynecol. 1994;83:556–65.
15. Kjerulff KH, Langenberg PW, Greenaway L, Uman J, Harvey LA. Urinary incontinence and hysterectomy in a large prospective cohort study in American women. J Urol. 2002;167:2088–92.
16. Griffith-Jones MD, Jarvis GJ, McNamara HM. Adverse urinary symptoms after total abdominal hysterectomy—fact or fiction? Br J Urol. 1991;67:295–7.
17. Thakar R. Dispelling the myth-does hysterectomy cause pelvic organ dysfunction. BJOG. 2004;111:20–3.
18. Farrell SA, Kieser K. Sexuality after hysterectomy. Am J Obstet Gynaecol. 2000;95:1045–51.
19. Roussis NP, Waltrous L, Kerr A, et al. Sexual response in the patient after hysterectomy: total abdominal versus supracervical versus vaginal procedure. Am J Obstet Gynaecol. 2004;190:1427–8.
20. Alexander AD, Naji AA, Pinion SB, et al. A randomised trial of hysterectomy versus endometrial ablation for dysfunctional uterine bleeding: psychiatric and psychosocial outcome. Br Med J. 1996;312:280–312.
21. Wierrani F, Huber M, Grin W, et al. Prospective libido and genital sexual sensitivity following various forms of hysterectomy. J Gynecol Surg. 1995;11:127–32.
22. Galyer KT, Conaglen HM, Hare A, Conaglen JV. The effect of gynecological surgery on sexual desire. J Sex Marital Ther. 1999;25:81–8.
23. Roovers JWR, Van der Bom JG, Van der Vaat CH, Heintz PM. Hysterectomy and sexual wellbeing: prospective observational study of vaginal hysterectomy, subtotal abdominal hysterectomy and total abdominal hysterectomy. Br Med J. 2003;327:774–7.
24. Jewett JF. Vaginal length and incidence of dyspareunia following total abdominal hysterectomy. Am J Obstet Gynaecol. 1952;63:400–7.
25. Weber AM, Walters MD, Piedmonte MR. Sexual function and vaginal anatomy in women before and after surgery for pelvic organ prolapse and urinary incontinence. Am J Obstet Gynaecol. 2000;182:1610–5.
26. Kilkku P, Gronoos M, Hirovnen T, Rauramo L. Supravaginal uterine amputation versus hysterectomy: effects on libido and orgasm. Acta Obstet Gynecol Scand. 1983;62:147–52.
27. Kilkku P. Supravaginal uterine amputation versus hysterectomy: effects on coital frequency and dyspareunia. Acta Obstet Gynecol Scand. 1983;62:141–5.
28. Thakar R, Ayers S, Clarkson P, Stanton S, Manyonda I. Outcomes after total versus subtotal abdominal hysterectomy. N Engl J Med. 2002;347:1318–25.
29. Zobbe V, Gimbel H, Anderson BM, et al. Sexuality after total and subtotal hysterectomy. Acta Obstet Gynecol Scand. 2004;83:191–6.
30. Van der Wiel HBM, Weijmar Schultz WCM, Hallensleben A, et al. Sexual functioning following treatment of cervical cancer. Eur J Gynecol Oncol. 1988;9:275–81.
31. Schover LR, Fife M, Gershenson DM. Sexual dysfunction and treatment of early stage cervical cancer. Cancer. 1989;63:204–12.
32. Horton B. Sexual outcomes arising from diagnosis and treatment of cervical cancer and cervical intraepithelial neoplasia: a review of literature. J Sex Marital Ther. 1991;6:29–39.
33. Weijmar Schultz WCM, Bransfield DD, Van der Wiel HBM. Sexual functioning following female genital cancer treatment: a critical

review of methods of investigation and results. J Sex Marital Ther. 1992;7:29–64.
34. Siebel MM, Freeman MG, Graves WL. Carcinoma of the cervix and sexual function. Obstet Gynecol. 1980;55:484–7.
35. Thranov I, Klee M. Sexuality amongst gynaecologic cancer patients–a cross-sectional study. Gynecol Oncol. 1994;52:14–9.
36. Bergmark K, Avall-Lundqvist E, Dickman PW, et al. Vaginal changes and sexuality in women with a history of cervical cancer. N Engl J Med. 1999;340:1383–9.
37. Grumann M, Robertson R, Hacker NF, Sommer G. Sexual functioning in patients following radical hysterectomy for stage 1B cancer of the cervix. Int J Gynecol Cancer. 2001;11:372–80.
38. Jensen PT, Groenvold M, Klee MC, et al. Does radical hysterectomy have an impact on sexual function in early stage cervical cancer patients? Int J Gynecol Cancer. 2003;13:22.
39. Maas CP, ter Kuile MM, Laan E, et al. Objective assessment of sexual arousal in women with a history of hysterectomy. BJOG. 2004;111:456–62.
40. Lee JH, Choi JS, Hong JH, Joo KJ, Kim BY. Does conventional or single port laparoscopically assisted hysterectomy affect female sexual function? Acta Obstet Gynecol Scand. 2011;90(12):1410–5.
41. Serati M, Salvatore S, Uccella S, Laterza RM, Cromi A, Ghezzi F, Bolis P. Sexual function after radical hysterectomy for early-stage cervical cancer: is there a difference between laparoscopy and laparotomy? J Sex Med. 2009;6(9):2516–22.
42. Gil-lbanez B, Diaz-Feijoo B, Perez-Benavente A, Puig-Puig O, Franco-Camps S, Centeno C, Xercavins J, Gil-Moreno A. Nerve sparing technique in robotic-assisted radical hysterectomy: results. Int J Med Robot 2013. doi: 10.1002/rcs 1480. Epub.
43. Kuppermann M, Summitt Jr RL, Varner RE, McNeeley SG, Goodman-Gruen D, Learman LA, et al. and Total or Supracervical Hysterectomy Research GroupSexual functioning after total compared with supracervical hysterectomy: a randomized trial. Obstet Gynecol. 2005;105(6):1309–18.
44. Thakar R, Ayers S, Georgakapolou A, Clarkson P, Stanton S, Manyonda I. Hysterectomy improves quality of life and decreases psychiatric symptoms: a prospective and randomised comparison of total versus subtotal hysterectomy. BJOG. 2004;111(10):1115–20.
45. Flory N, Bissonnette F, Amsel RT, Binik YM. The psychosocial outcomes of total and subtotal hysterectomy: a randomized controlled trial. J Sex Med. 2006;3(3):483–91.

Guidelines and Recommendations of Scientific Societies and Associations for Hysterectomy

10

Klaus Neis and Felix Neis

Hysterectomy represents the second most performed surgery in gynecology after the Cesarean Section. In Germany there are 100,000 hysterectomies performed a year in case of benign indication. 27 % of these are prolapse surgeries. Thus, there remain 75,000 hysterectomies due to benign diagnostic findings in 2012 [1]. Worldwide most of the hysterectomies of this group are performed abdominally. Only in Germany, Austria and Switzerland a lower rate could be found. As in the USA 64 % of the hysterectomies are performed abdominally, in Canada 60 %, Austria 29.6 %, Switzerland 26.0 % and in Germany 17.5 % [2].

At the beginning of the 90s, when the laparoscopic surgery has been introduced for hysterectomy, the aim was to reduce the number of abdominal hysterectomies. In individual hospitals which decided to specialize in this field, this could be realized in an impressive way. [3]. Regarding however the national statistics this development has only lead to moderate adjustments [4]. For example declined the rate of abdominal hysterectomy in the USA from 66.1 % in 2003 [4] to 54.2 % in 2010 [5].

Two Cochrane Analysis, in which the different methods of hysterectomy have been evaluated, showed however that the vaginal hysterectomy is the method of the lowest rate of complications, the lowest blood loss and also the shortest time of surgery. Additionally, cost analyses demonstrate that the vaginal hysterectomy represents the most economical method by far in the whole range of hysterectomies [6, 7].

In Germany the rate of vaginal hysterectomies lies at about 50 %, in Austria at 46.2 %, in Switzerland at 41 %. In the USA the rate of vaginal hysterectomies lies at only 20 % [8–11].

In 2009 this had been the reason for the American College of Obstetricians and Gynecologists (ACOG) to publish a statement, in which the vaginal hysterectomy was recommended as first option. In cases where a vaginal hysterectomy seems not to be viable the possibility of laparoscopic hysterectomy should be investigated. If both options are unviable then there is given an indication for abdominal hysterectomy [12].

Analogously there is also the recommendation of the AAGL (American Association of Gynecologic Laparoscopists) of 2011. In the meantime a working group in the AAGL is established where colleagues with special interests in vaginal surgeries are united [13].

Meanwhile also the insurance companies suggest that the vaginal hysterectomy should be the method of first choice. They justify their suggestion as they want to offer their insurants the method of least complications. The fact, that this method is the most economical one at the same time, may probably be also an important point for an insurance company.

In 2010, a group under the auspices of K.J. Neis and K. Schwerdtfeger has been authorized by the German Society of Gynecology and Obstetrics (Deutsche Gesellschaft für Gynäkologie und Geburtshilfe e.V. ‚DGGG) to develop in Germany a guideline for indication and methodology of hysterectomy. The guideline was compiled by 24 scientifically and clinically operating colleagues and was available in 2012. It reflects the situation in Germany, Austria and Switzerland, where the vaginal hysterectomy is preferred traditionally and where today the laparoscopic surgeries are integrated to the greatest possible extent into the range of surgeries for hysterectomy.

When compiling the individual chapters it became more and more clear, that also the alternative methods as hysteroscopy, the systemic und local hormone therapy or Uterine artery embolization (UAE) are all effectible. However, the most satisfied women are to be found in the group of patients who underwent a hysterectomy (Table 10.1).

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Table 10.1 Comparison of satisfaction rates of women who underwent hysterectomy, endometrial ablation or the levonorgestrel-releasing intrauterine system (LNG-IUS)

	Hysterectomy	Endometrial ablation	LNG-IUS
Control of bleeding symptoms	+++	++(+)	++
Rate of reinterventions within 5 years	<5 %	10–36 %	42 %
Quality of life	++++	+++(+)	+++
Chance of success Length of uterine cavity >8 cm	+++	+	+

+ = degree of satisfaction

Due to the highly sociopolitical importance the board of DGGG had decided to subordinate these already compiled statements to an evidence analysis. This analysis had been executed by Dr. M. Nothacker, an employee of AWMF (Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften e.V.) especially skilled in this field.

The evidence, which includes the present literature until 12/2014, leads fortunately to the same results and recommendations as the primary 2 k-guideline. Thus, all predications, recommendations and statements are supported objectively. Accordingly, the guideline was upgraded to the highest scientific level S3.

The full text of the German guideline and the report of evidence, inclusive the list of authors, is available at http://www.awmf.org/leitlinien/detail/ll/015-070.html.

The recommendations of this guideline concerning the preference of the methods are:

Evidence Based Recommendations

Evidence Grade **1a**	*Recommendation Grade* **A**	*Consensus Level* **+++**

If possible the vaginal hysterectomy shall be preferred to the abdominal hysterectomy.

Evidence Grade **1a**	*Recommendation Grade* **B**	*Consensus Level* **+++**

If the vaginal hysterectomy is not viable, the possibility of a laparoscopic hysterectomy shall be investigated.

Evidence Grade **1a**	Recommendation *Grade* **0**	*Consensus Level* **+++**

The LASH can be performed alternatively to the abdominal hysterectomy as well as to the vaginal hysterectomy.

Consensus Based Statement

Expert Consensus	*Consensus Level* **+++**

However, the recorded data does not allow at present to differ exactly between the various laparoscopic techniques.

Consensus Based Recommendation

Expert Consensus	*Consensus Level* **+++**

The abdominal hysterectomy should only be performed in case of special indication.

Quality of Life

The patient's question, whether the disorders impairing her quality of life will really be improved by hysterectomy, represent a very central point within the medical counseling.

There exist numerous investigations to this question and all of them show the result that quality of life will be considerably improved after hysterectomy [14–16].

Thus, an evidence based recommendation could be compiled:

Evidence Grade **1a**	Recommendation Grade **B**	*Consensus Level* **+++**

The patients should be informed that they can expect predominantly an improvement of quality of life and sexuality after an indicated hysterectomy compared to their pre-operative situation.

Alternatives to Hysterectomy and Counseling

When evaluating the different operative and non-operative alternatives to hysterectomy it can be stated that all of them are effective at the end. Though, due to the fact that the uterus is conserved, the alternative methods naturally have a risk of recurrence respectively a failure rate which then requires after all in lots of cases still a hysterectomy.

Thus, the hysterectomy is at least the most effective method to eliminate the disorders.

Independent of this, in each individual case it has to be examined whether the medically most reasonable method is also the best method for the patient.

So, the latent desire to have children independent of the age represents always a contra indication against hysterectomy. The same is valid for women who occupied their uterus with very important personal feelings. For those the loss of the uterus may be technically the perfect solution, but emotionally they would suffer.

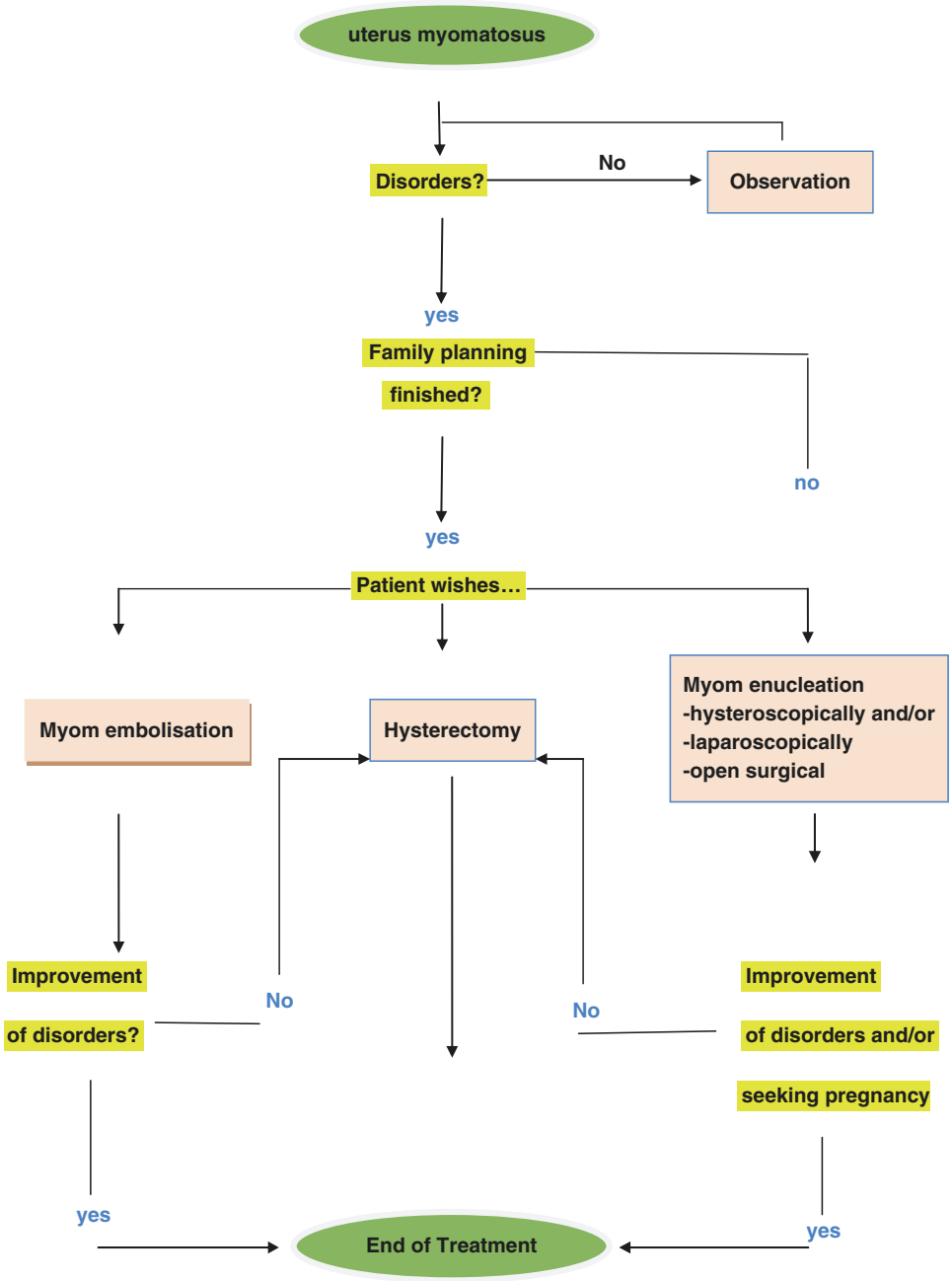


Fig. 10.1 Algorithm: alternatives to hysterectomy

Those women have to be identified and selected within an intensive talk before surgery. In order to guarantee that a complete and highly-qualified counseling is made it is recommended to follow the algorithms compiled by the guideline group (for example, uterus myomatosus shown in Fig. 10.1). That way the patient can realize at a glance the complete range of her possibilities.

The discussion of the individual steps, explaining the advantages and disadvantages of the different possibilities, require however a special education in the field of hysterectomy and its alternatives. As also the alternatives have indications and contra-indications and the probability that the success hoped for is different due to various medical findings and varying anamnesis, the consultant physician should have qualified for this field by advanced training.

It is the aim of the counseling, that on one side transparency is shown, but on the other side, the evidence situation of the individual contemplable methods has to be presented that way that the woman knowing her different possibilities is able to choose that therapy option of which she believes it suits the best to her and her situation of life.

The experience shows that women who are used to take responsibility in their lives are also able to take a decision

quickly, or that they already have made a decision for themselves based on their own research before the counseling.

Even in those cases the patient should be informed again in order to assure that really all aspects were considered for the decision making.

Hesitant women are never to be urged in one or another direction. If there is no imminent danger, as e.g. an anemiating bleeding disorder, the woman can take the time to deal in detail with her disorders and her psychological strain.

Frequently, she will seek medical advice also somewhere else, where she hopefully will be advised just as qualified, transparent, evident and impartial.

When comparing the possibilities we have today with those given 100 years before, as the hysterectomy has been a surgery with high mortality and morbidity and which therefore only has been performed in exactly justified individual cases, with the broad range which we have today as well in the field of hysterectomy as in the field of uterus conserving alternatives, so it is possible today to offer each woman an effective method individually specific to her, so that she can regain the lost quality of life.

The woman always should decide by herself which way to go. In our opinion, with a qualified patient information each woman independent of the primary educational level is able to make her own decision at the end with which she is satisfied also years thereafter.

In summary it can be stated that at present there is generated one standard worldwide concerning the method of hysterectomy. The first option is and will be the vaginal hysterectomy. The second option represents the laparoscopic surgeries which differ decreasingly in their complication rate, so that it is recommended here to choose the method which can be performed best by the surgeon. Then, there are only a few indications remaining for the abdominal hysterectomy. In the meantime, the organ conserving alternatives also have a fixed significance. Their presentation is an essential part of the patient information today.

References

1. Institut A. Bundesauswertung 2012. https://www.sqgde/downloads/Bundesauswertungen/2012/bu_Gesamt_15N1-GYN-OP_2012pdf. 2012.
2. Obstetrics GotGSoGa. Indication and technics of hysterectomy for benigne diseases. AWMF Registry No 015/077, March 2015. 2015. http://www.awmf.org/leitlinien/detail/ll/015-070.html.
3. Brandner P, Neis KJ. The significance of laparoscopically-assisted vaginal hysterectomy–LAVH. Zentralbl Gynakol. 1995;117(12):620–4.
4. Wu JM, Wechter ME, Geller EJ, Nguyen TV, Visco AG. Hysterectomy rates in the United States, 2003. Obstet Gynecol. 2007;110(5):1091–5.
5. Wright JD, Herzog TJ, Tsui J, Ananth CV, Lewin SN, Lu YS, et al. Nationwide trends in the performance of inpatient hysterectomy in the United States. Obstet Gynecol. 2013;122(2 Pt 1):233–41.
6. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2009;3:CD003677.
7. Aarts JW, Nieboer TE, Johnson N, Tavender E, Garry R, Mol BW, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2015;8:Cd003677.
8. Gesundheit A. http://www.statistik.at/web-de/suchergerniss/index.htlm. Zugriff: 1022012.
9. (ASF) ASF. http://www.sevisa.ch/. Zugriff: 27102014. 2010.
10. Jacobson TZ, Duffy JM, Barlow D, Koninckx PR, Garry R. Laparoscopic surgery for pelvic pain associated with endometriosis. Cochrane Database Syst Rev. 2009;4:CD001300.
11. Merrill RM. Hysterectomy surveillance in de United States, 1997 through 2005. Med Sci Monit Int Med J Exp Clin Res. 2008;14(1):CR24–31.
12. ACOG Committee Opinion No. 444: choosing the route of hysterectomy for benign disease. Obstet Gynecol. 2009;114(5):1156–8.
13. Worldwide AAMIG. AAGL position statement: route of hysterectomy to treat benign uterine disease. J Minim Invasive Gynecol. 2011;18(1):1–3.
14. Kuppermann M, Varner RE, Summitt Jr RL, Learman LA, Ireland C, Vittinghoff E, et al. Effect of hysterectomy vs medical treatment on health-related quality of life and sexual functioning: the medicine or surgery (Ms) randomized trial. JAMA. 2004;291(12):1447–55.
15. Varner RE, Ireland CC, Summitt Jr RL, Richter HE, Learman LA, Vittinghoff E, et al. Medicine or Surgery (Ms): a randomized clinical trial comparing hysterectomy and medical treatment in premenopausal women with abnormal uterine bleeding. Control Clin Trials. 2004;25(1):104–18.
16. Radosa JC, Meyberg-Solomayer G, Kastl C, Radosa CG, Mavrova R, Graber S, et al. Influences of different hysterectomy techniques on patients' postoperative sexual function and quality of life. J Sex Med. 2014;11(9):2342–50.

Choosing the Correct Hysterectomy Technique

11

Linda-Dalal J. Shiber and Resad Pasic

Introduction

In 2009, a systematic review of all randomized control trials comparing surgical approach to hysterectomy for benign disease was published. The objective of this review was to determine the 'most beneficial and least harmful surgical approach to hysterectomy' [1]. The conclusion was that, based on cumulative outcomes of time to recovery, complication rates and length of hospital stay, vaginal hysterectomy should be performed preferentially to abdominal hysterectomy and, when vaginal hysterectomy is not possible, laparoscopic approaches should be considered over the abdominal route.

Existing data clearly indicates that vaginal approach to hysterectomy is associated with fewer complications, faster recovery and lower healthcare costs than abdominal hysterectomy and shorter operative time than laparoscopic hysterectomy (Table 11.1) [1, 2]. Comparisons between vaginal hysterectomy and laparoscopic hysterectomy typically indicate longer operative time with the laparoscopic approach. Some studies have suggested increased complication rates with laparoscopic hysterectomy, namely urinary tract injury [2, 3]. Others have found no significant increase in such complications [4, 5].

Position statements from the American College of Obstetricians and Gynecologists (ACOG) and the American Association of Gynecologic Laparoscopists (AAGL) echo the above recommendations [6, 7]. The concept seems simple-i.e., vaginal hysterectomy is preferable, followed by laparoscopic approach, followed by laparotomy. In reality, however, selecting the route for hysterectomy is a complex task that requires consideration of patient preference, surgical indications, patient characteristics, available resources/procedural costs and surgeon skills and limitations. Perhaps the better way to address this chapter is to ask the question–how do we identify women who are *not* candidates for vaginal hysterectomy? And, of these women, how do we choose who undergoes abdominal hysterectomy over laparoscopic hysterectomy?

Note: For the purpose of this discussion, robotic-assisted laparoscopy will be considered to be within the category of laparoscopic techniques unless otherwise specified.

Operative Indication

In benign gynecologic practice, the most common indication for hysterectomy is symptomatic uterine fibroids, followed by abnormal uterine bleeding. A plethora of other indications exist, including pelvic organ prolapse, endometriosis, pelvic pain and prophylaxis against reproductive system cancers in high-risk women [8].

Selecting the surgical route for hysterectomy is intimately linked with the indication for surgery (Fig. 11.1). The surgical management of gynecologic malignancies is beyond the scope of this chapter and will be considered separately.

For women who present with pelvic pain symptoms or a definite indication for adnexectomy, it is most reasonable to offer a surgical approach that allows a systematic inspection of the pelvic peritoneum, the abdominal contents and the adnexa. Vaginal hysterectomy does not provide a reliable or global survey of the pelvis in these women and does not consistently allow for identification and resection of disease such as endometriotic lesions, adnexal masses or other abnormalities that may contribute to pelvic pain. Though underpowered, a 2004 study found that despite the inherent advantages of vaginal hysterectomy in many women, laparoscopic route to hysterectomy was associated with a higher incidence of detecting unexpected pathology [9]. Certainly, for women who seek hysterectomy for pain

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Table 11.1 Advantages and limitations of surgical approaches to hysterectomy[1, 6]

	Vaginal	Laparoscopic	Robotic	Abdominal
Advantages	Shorter recovery time[a] Shorter operating time[b] Most cost-effective	Shorter recovery time[a] Facilitates global evaluation of pelvis Less blood loss[a] Less infectious morbidity[a]	Improved ergonomics Facilitates ease of suturing Shorter recovery time[a]	Default approach for massive uteri, disseminated malignancy
Limitations	Uteri >12 week size Cannot reliably evaluate for extra-uterine disease	May be associated with higher incidence urinary tract injury[a] Longer operating time[a] Uteri >24 week. size	Least cost-effective	Longer recovery time[c] Higher incidence of febrile morbidity[c] Higher blood loss[b]

[a]As compared with abdominal hysterectomy
[b]As compared with laparoscopic hysterectomy
[c]As compared with laparoscopic and vaginal hysterectomy

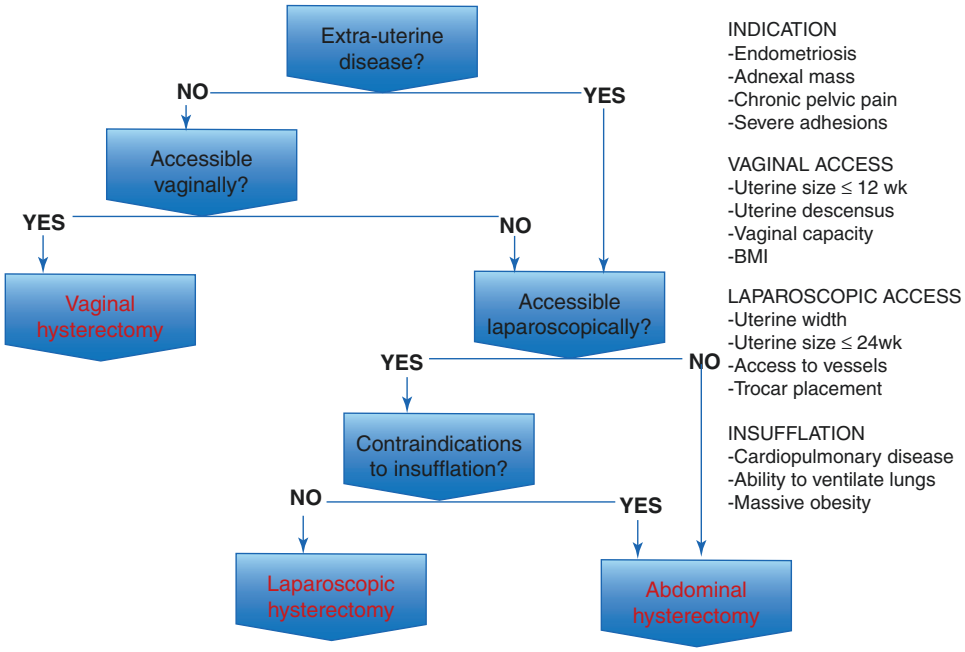


Fig. 11.1 Choosing the route of hysterectomy

symptoms, it is imperative that inspection of the abdominopelvic contents occurs. This should preferentially occur via laparoscopy rather than laparotomy. Though salpingo-oophorectomy is often performed at the time of vaginal hysterectomy, there is no guarantee that adnexal structures will be visible or mobilized from below. Again, in a patient who has adnexal pathology or desires risk-reducing BSO, the laparoscopic approach is most reliable and appropriate.

Concomitant, planned procedures must also be considered when selecting the route of hysterectomy. In women with pelvic organ prolapse who are candidates for vaginal repair, the vaginal route to hysterectomy is most logical. However, in women who require sacro-colpopexy, a laparoscopic or robotic route is preferable to laparotomy.

Co-morbid Conditions: Obesity and Cardiopulmonary Disease

As the obese patient population grows, surgical complication rates and post-operative morbidity increase. It is important to offer these high-risk patients a minimally invasive approach to hysterectomy [10, 11]. Obese patients may have poorer wound healing with higher rates of wound infection and postoperative complications such as venous thromboembolic events. Providing surgical options that minimize hospital stay and immobility is key. Abdominal hysterectomy should therefore be avoided in most scenarios. In a parous patient without indication for abdominopelvic survey and with a uterus of feasible size, vaginal hysterectomy is preferable.

Devices such as the vaginal Bookwalter retractor may aid with visualization and completion of surgery.

If vaginal access is not possible, if the patient suffers from pelvic pain or if the uterus is very enlarged, laparoscopic approaches to hysterectomy are ideal and offer equivalent benefits. However, it is important to counsel the super obese patient considering a laparoscopic or robotic hysterectomy that steep Trendelenburg position and abdominal insufflation may not be tolerated, resulting in laparotomy.

The role of robotic-assisted laparoscopic hysterectomy in the obese patient remains unclear. Anecdotally, the robot may aid with minimizing surgeon fatigue and optimizing visualization during minimally invasive hysterectomy and is certainly preferable to laparotomy in terms of decreasing hospital stay [12]. Randomized control trials comparing surgical outcomes for robotic hysterectomy to laparoscopic and vaginal hysterectomy in obese women are not currently available. One study comparing surgical outcomes of robotic hysterectomy in morbidly obese (body mass index (BMI) > 35) patients versus patients with BMI < 35 found equivalent outcomes but increased operative time for these heavier patients [13]. Regarding the general population, a recent Cochrane systematic review found limited evidence that robotic assisted laparoscopy affords benefit in benign disease [14] and it is well accepted that the robotic approach is more costly [15, 16].

Patients with certain types of heart failure or severe pulmonary conditions such as chronic obstructive pulmonary disease and obstructive sleep apnea may not tolerate the increased intra-peritoneal pressures created by carbon dioxide insufflation during laparoscopy. Deep trendelenburg position, necessary for pelvic surgery in these patients, may not be possible either. Depending on the co-morbid condition present, evaluation of pulmonary and cardiac function is necessary prior to surgery. Consultation with cardiology, pulmonology and anesthesia services is of great importance to surgical planning. These patients should be offered vaginal hysterectomy if possible, but unfortunately may require laparotomy for safe completion of surgery (Fig. 11.1).

Surgical History

In women with multiple abdominal surgeries, adhesion formation is common. Levrant et al. found the incidence of adhesions to be 59 % in women with a prior vertical midline incision versus 28 % in women with a prior Pfannenstiel incision [17]. In women with multiple laparotomies or prior pelvic infections, the likelihood of pelvic and anterior abdominal wall adhesions involving bowel increases. This may preclude safe vaginal hysterectomy. In addition, with the increased rates of cesarean sections in the US and certain other countries, severe vesicouterine adhesions may be present, making bladder dissection from below challenging and dangerous. Although one prior cesarean delivery is certainly not a contraindication to vaginal hysterectomy, clinical judgement must be used. In a patient who is high risk for severe pelvic adhesions, the laparoscopic route to hysterectomy is recommended and laparotomy may ultimately be required to complete the procedure safely.

Parity, Pelvis, Uterine Size

The obstetrician within every gynecologic surgeon must consider the anatomic feasibility of removing the uterus vaginally. When considering vaginal hysterectomy, it is important to assess the vaginal capacity, the uterine size and degree of uterine descensus [18]. For experienced vaginal surgeons, the upper limit of uterine size when considering vaginal route to hysterectomy may approach 16–18 week size. However, in an era when the typical OB/GYN resident is finishing training with fewer vaginal hysterectomies, this is neither a safe nor acceptable parameter. Typically, for uteri larger than 10–12 week size, a laparoscopic or robotic approach allows easier visualization of upper pedicles and even the uterine vasculature. For very large uteri or even uteri >12 week size with an inexperienced laparoscopic surgeon, the abdominal route to hysterectomy may be indicated. In women with rapidly growing fibroids or strong suspicion for malignancy, laparotomy is indicated.

In addition to uterine size, consideration of the shape of the uterus and mapping of fibroids is imperative to surgical planning. For women who have large lower uterine segment fibroids precluding peritoneal access from below, vaginal hysterectomy may not be possible.

Nulliparity and limitations posed by the bony pelvis (i.e., narrow pubic arch) are other important considerations when assessing candidacy for vaginal hysterectomy. Vaginal hysterectomy may be challenging in these women as descensus may not be present and visualization may be very difficult. An important point, however, is that if the patient is otherwise an appropriate candidate for TVH, it may be appropriate to attempt vaginal surgery with preoperative counseling that a laparoscopic approach may be necessary if that fails.

Surgeon Skills/Strengths/Limitation

Despite recommendations set forth by professional societies, it is important to critically assess one's surgical skill set prior to consenting a patient for a particular route of hysterectomy. For surgeons who are inexperienced in *any* approach, the rate of complications and intra/post-operative morbidity increases exponentially for that approach despite purported benefits [18–20].

Decreasing surgical numbers during residency training and a paucity of hysterectomy cases per year of practice have contributed to continued, widespread use of the abdominal route for benign hysterectomy, even in women who would be candidates for TVH or TLH in more experienced hands [21–23]. Surgeons who identify a candidate for MIS hysterectomy but who do not possess the skill set to perform such procedures should actively seek consultation from surgical specialists who can provide optimal hysterectomy care for their patients.

Cost Considerations, Resources

With regard to healthcare costs, vaginal hysterectomy is the most cost-effective approach with robotic hysterectomy accruing the highest costs, both in operating room time and equipment/maintenance, etc. [14–16, 24–27]. In a world recognizing the importance of evidence-based, cost-conscious and high-quality healthcare, the use of expensive robotic technology in benign gynecology is not justifiable.

Patient Preference

Ultimately, after clinical considerations have been outlined and the objective risks and benefits of each approach to hysterectomy detailed to the patient, her informed opinion regarding which technique she prefers must be taken into consideration.

With recent debates in the United States on tissue extraction, many women are declining even vaginal morcellation of tissue and requesting laparotomy. Some women concerned for cosmesis allow this to govern their decision regarding surgery. One study surveyed 100 women and found that the majority preferred a suprapubic mini-laparotomy incision or single-site laparoscopy incisions over laparoscopic, pfannenstiel and robotic incisions [28]. In addition, despite data that has suggested supracervical hysterectomy affords no long-term benefit to sexual function or post-operative outcomes and quality of life [29, 30], some women desire to retain the cervix and this request must be honored in the medically appropriate patient.

In conclusion, selecting the route of hysterectomy for benign gynecologic disease is a complex task that requires consideration of patient preference, surgical indications, patient characteristics, available resources/procedural costs and surgeon skills and limitations. As existing data on surgical outcomes, benefits, limitations and costs continues to evolve, it is important to incorporate these new findings in the patient counseling process.

References

1. TE N, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, van Voorst S, BW M, KB K. Surgical approach to hysterectomy for benign disease. Cochrane Database Syst Rev. 2009;3:CD003677. doi:10.1002/14651858.CD003677.pub4.
2. Johnson N, Barlow D, Lethaby A, et al. Methods of hysterectomy: systematic review and meta-analysis of randomized controlled trials. BMJ. 2005;330:1478.
3. Drahonovsky et al. A prospective randomized comparison of vaginal hysterectomy, laparoscopically assisted vaginal hysterectomy and total laparoscopic hysterectomy in women with benign uterine disease. Eur J Obstet Gynecol Reprod Biol. 2010;148(2):172–6. doi:10.1016/j.ejogrb.2009.10.019. Epub 2009 Nov 18
4. Gendy R, Walsh CA, Walsh SR, Karantanis E. Vaginal hysterectomy versus total laparoscopic hysterectomy for benign disease: a metanalysis of randomized controlled trials. Am J Obstet Gynecol. 2011;204(5):388.e1–8. doi:10.1016/j.ajog.2010.12.059. Epub 2011 Mar 4
5. Donnez O, Donnez J. A series of 400 laparoscopic hysterectomies for benign disease: a single centre, single surgeon prospective study of complications confirming previous retrospective study. BJOG. 2010;117:752–5.
6. Choosing the route of hysterectomy for benign disease. ACOG Committee Opinion No. 444. American College of Obstetricians and Gynecologists. Obstet Gynecol. 2009; 114:1156–8.
7. Route of hysterectomy to treat benign uterine disease. AAGL position statement, American Association of Gynecologic Laparoscopists. J Minim Invasive Gynecol. 2011;18: 1–3. doi:10.1016/j.jmig.2010.10.001.
8. Walters M, Barber M. Hysterectomy for benign disease. Philadelphia: Saunders Elsevier ; 2010.http://www.clinicalkey.com.au/dura/browse/bookChapter/3-s2.0-C20090388534
9. Garry et al. EVALUATE hysterectomy trial: a multicentre randomised trial comparing abdominal, vaginal and laparoscopic methods of hysterectomy. Health Technol Assess. 2004;8(26):1–154.
10. Siedhoff MT et al. Effect of extreme obesity on outcomes in laparoscopic hysterectomy. J Minim Invasive Gynecol. 2012;19(6):701–7. doi:10.1016/j.jmig.2012.07.005.
11. Scheib SA et al. Laparoscopy in the morbidly obese: physiologic considerations and surgical techniques to optimize success. J Minim Invasive Gynecol. 2014;21(2):182–95. doi:10.1016/j.jmig.2013.09.009. Epub 2013 Oct 4
12. Silasi DA et al. Robotic versus abdominal hysterectomy for very large uteri. JSLS. 2013;17(3):400–6. doi:10.4293/108680813X13693422521755.
13. Eddib A et al. Influence of morbid obesity on surgical outcomes in robotic-assisted gynecologic surgery. J Gynecol Surg. 2014;30(2):81–6.

14. Liu H et al. WITHDRAWN: Robotic surgery for benign gynecological disease. Cochrane Database Syst Rev 2014;(12):CD008978. [Epub ahead of print]
15. Rosero EB et al. Comparison of robotic and laparoscopic hysterectomy for benign gynecologic disease. Obstet Gynecol. 2013;122(4):778–86. doi:10.1097/AOG.0b013e3182a4ee4d.
16. Wright JD et al. An economic analysis of robotically assisted hysterectomy. Obstet Gynecol. 2014;123(5):1038–48. doi:10.1097/AOG.0000000000000244.
17. Levrant SG et al. Anterior abdominal wall adhesions after laparotomy or laparoscopy. J Am Assoc Gynecol Laparosc. 1997;4(3):353–6.
18. Skinner BD, Delancey JO. Selecting the route for hysterectomy: a structured approach. Contemporary OB/GYN. 2013;58(8):p24.
19. Rogo-Gupta LJ et al. The effect of surgeon volume on outcomes and resource use for vaginal hysterectomy. Obstet Gynecol. 2010;116(6):1341–7. doi:10.1097/AOG.0b013e3181fca8c5.
20. Boyd LR et al. Effect of surgical volume on route of hysterectomy and short-term morbidity. Obstet Gynecol. 2010 Oct;116(4):909–15. doi:10.1097/AOG.0b013e3181f395d9.
21. Burkett D et al. Assessing current trends in resident hysterectomy training. Female Pelvic Med Reconstr Surg. 2011;17(5):210–4. doi:10.1097/SPV.0b013e3182309a22.
22. Kenton K et al. How well are we training residents in female pelvic medicine and reconstructive surgery? Am J Obstet Gynecol. 2008;198(5):567.e1–4. doi:10.1016/j.ajog.2008.01.045. Epub 2008 Mar 20
23. Moen M et al. Considerations to improve the evidence-based use of vaginal hysterectomy in benign gynecology. Obstet Gynecol. 2014;124(3):585–8. doi:10.1097/AOG.0000000000000398.
24. Barbash GI, Glied SA. New technology and health care costs: the case of robot-assisted surgery. N Engl J Med. 2010;363:701–4.
25. Pasic R, Rizzo J, Fang H, et al. Comparing robot-assisted with conventional laparoscopic hysterectomy: Impact on cost and clinical outcomes. J Minim Invasive Gynecol. 2010;6:730–8.
26. Robotic-assisted laparoscopic surgery in benign gynecology. AAGL position statement, American Association of Gynecologic Laparoscopists. J Minim Invasive Gynecol. 2013;20: 2–9.
27. Davaratna S et al. Hospital costs of total vaginal hysterectomy compared with other minimally invasive hysterectomy. Am J Obstet Gynecol. 2014;210(2):120.e1–6. doi:10.1016/j.ajog.2013.09.028. Epub 2013 Sep 20
28. Goebal K, Goldberg JM. Women's preference of cosmetic results after gynecologic surgery. J Minim Invasive Gynecol. 2014;21(1):64–7. doi:10.1016/j.jmig.2013.05.004.
29. Lethaby et al. Total versus subtotal hysterectomy for benign gynaecological conditions. Cochrane Database Syst Rev. 2006;2:CD004993. (Evidence I)
30. AAGL practice report: practice guidelines for laparoscopic subtotal/supracervical hysterectomy(LSH). American Association of Gynecologic Laparoscopists. J Minim Invasive Gynecol. 2014;21(1):9–16. doi: 10.1016/j.jmig.2013.08.001. Epub 2013 Aug 15.

Indications for Salpingectomy

12

Roberta Venturella

Anatomical and Functional Considerations

The uterine tubes (Fallopian Tubes, FT) are two hollow muscle-mucosal organs, about 10–12 cm long, divided into three portions: the intramural, the isthmic and the ampullary ones. This last portion terminates in an enlarged end, called infundibulum, with some protrusions called fimbriae. The ovarian fimbria, in particular, is connected through the mesosalpinx to the ovary. The tubal ostium, laterally, is the site where the tubal canal meets the pelvic cavity, while the uterine opening of the FT is the entrance into the uterine cavity, the utero-tubal junction (Fig. 12.1).

As the cervix and endometrium, also the FT are derived from the müllerian ducts. The wall of the tube has a mucous layer and a muscle one, thicker in the medial part of the tube. The contraction of the muscle bundles allows the tubes having their own peristaltic motility. The mucosal layer is covered with cells, some of which ciliated, that determine a bidirectional internal movement of fluids and cells, both to the uterus and towards the pelvis. The production of cilia on these cells is increased by Estrogens. Scattered between the ciliated cells are secretory cells, which contain apical granules and produce the tubular fluid. The number of these cells is increased by Progesterone, while Estrogens increase their secretory activity. The tubal fluid contains nutrients as lipids and glycogen for spermatozoa, oocytes, and zygotes and also promote capacitation of the sperm.

After ovulation, physiologically, the oocyte is caught by the fimbriated end and travels to the ampulla of the uterine tube where the sperm are met and fertilization occurs. The fertilized ovum, now a zygote, comes towards the uterus thanks to the activity of tubal cilia and muscle. After four to five days the embryo reachs the uterine cavity and on about the sixth day implants on the wall of the fundus of the uterus.

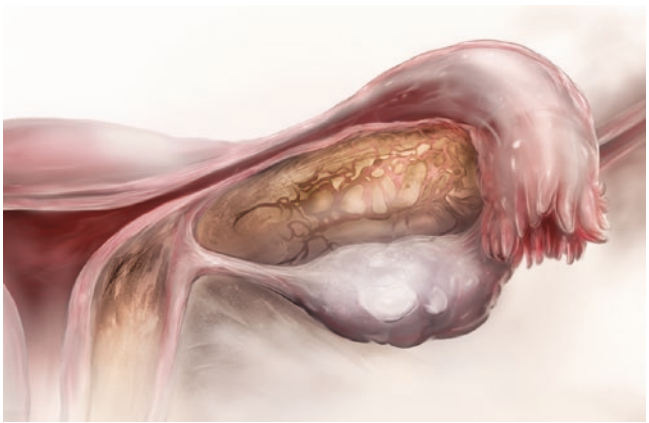


Fig. 12.1 Normal tubal anatomy

Given their bidirectional motility, moreover, the FT are able to let cells, pathogens, blood and substances from the vagina, the cervix and the endometrium to reach the abdomino-pelvic cavity.

Benign Tubal Pathologies as Indication to Salpingectomy

Inflammatory diseases are the most important tubal disorders, due to their frequency and their consequences, sometimes serious [1].

FT indeed, placed between the uterus and ovaries, are frequently infected by one of these two organs. The communication with the peritoneal cavity, moreover, exposes the tube also to any abdominal infection. Appendicitis is a frequent source of descending infection. Rarely, the tubal infection is transmitted by blood, as in the case of tuberculous salpingitis.

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More often, the infectious processes ascending from the lower genital tract extend to the tube and reach the peritoneal cavity, leading to Pelvic Inflammatory Disease (PID) [1].

The narrow tubal lumen undergoes important consequences in case of inflammation. The mucosal edema can completely occlude the utero-tubal junction, preventing drainage of inflammatory secretions in the uterine cavity. This causes the onset of acute salpingitis, in which the tube is red, swollen, tortuous, with thickened wall and the lumen filled with pus. The progress of each salpingitis is very slow. Exceptionally acute inflammation can heal spontaneously and the restoration of tubal anatomy and function occurs. Usually, however, the infection becomes chronic and causes permanent tubal occlusion (Fig. 12.2). The tube becomes more dilated, takes the form of a sausage and is filled with pus, leukocytes or plasma-cells (pyosalpinx). The drainage of this infected tube into abdominal cavity can cause the insurgence of peritonitis.

The purulent content may gradually melt turning into a serous or sero-hematic fluid (hydrosalpinx or hematosalpinx). This conditions can remain asymptomatic for a long time, and the diagnosis is often difficult or accidental. When salpingitis becomes chronic, the peritoneal adhesions surrounding the tube and ovaries distort the course of the FT and cause infertility.

In tubal factor infertility, when the cause is bilateral hydrosalpinx, in vitro fertilization (IVF) is now considering the first option rather than attempting to restore tubal function [2]. The hydrosalpinges themselves, however, adversely affect IVF outcomes, reducing the implantation rate and increasing the risk of miscarriage [3]. Among the pathogenic mechanisms proposed, embryotoxic effects, mechanical flushing and changes in endometrial receptivity are the most shared by reproductive gynecologists [3]. The hydrosalpinx fluid, indeed, is able to reach the uterine cavity, in which embryos try to implant, and exerts a toxic effect on this delicate phase of pregnancy.



Fig. 12.2 Hysterosalpingografic image suggestive of right hydrosalpinx

Laparoscopic salpingectomy has been demonstrated to be an effective option for avoiding this negative reproductive interference, improving pregnancy rates and removing the risk of PID and ectopic pregnancies. Whenever laparoscopy is not recommended due to the presence of dense pelvic adhesions, hysteroscopic insertion of device seems a very effective option for management of hydrosalpinx before IVF [4].

Recently, a systematic review and meta-analysis of studies comparing the pregnancy outcomes in hydrosalpinx patients treated with salpingectomy versus those treated with proximal tubal occlusion prior to IVF has been published [5]. In this study, comparable responses to controlled ovarian hyperstimulation and pregnancy outcome were observed between groups, demonstrating that salpingectomy does not worsen reproductive prognosis of patients in which excisional surgery is chosen.

Hydrosalpinx is also the most frequent (35.5 %) complication of the blind-ended remnants of the FT in patients undergoing hysterectomy with tubal preservation [6]. Others pathologies that may emerge from retained FT are tube prolapse, torsion, PID, benign and malignant Fallopian Tube tumors.

Other frequent causes of peritoneal adhesions, responsible of anatomical and functional FT alterations, are previous pelvic and abdominal surgeries, especially if performed by laparotomy. Caesarean sections, surgeries for uterine myomas or ovarian cysts, but especially the presence of peritoneal or ovarian endometriosis are well-known risk factors for tubal alterations and occlusion.

Many variables have to be considered when counseling patients with tubal alterations regarding corrective surgery or direct IVF. The chronological and ovarian age of the woman, the site and extent of tubal pathology, the semen analysis of the male partner, the presence of other infertility factors (such as ovarian endometriosis), the experience of the surgeon and the quality and success rate of the referring IVF center are the most important. Given the costs and benefits associated to both surgery and IVF, the ideal candidate for surgical tubal restoration is probably a young woman, with no other infertility factors, a partner with a normal semen analysis and a tubal anatomy amenable to repair. Conversely, patients with extensive omolateral dense peritubal adhesions from endometriosis and/or dilated tubes (>3 cm) with thick fibrotic walls have poor prognosis: in all these cases the tube is usually damaged beyond repair and omolateral salpingectomy is indicated when pregnancy can be achieved by spontaneous attempts. In patients with tubal factor infertility, however, IVF has a higher pregnancy rate per cycle and this

information need to be discussed with the patient to provide assistance in her decision making.

The second most frequent benign condition affecting the FT is the ectopic pregnancy (EP). Between 1 and 2 % of live births in developed countries, and as high as 4 % of pregnancies involving assisted reproductive technology [7] are complicated by EP, in which the embryo is implanted outside the uterine cavity.

At least 93 % of ectopic pregnancies are located in a FT (Fig. 12.3) [8]. Of these, 75 % are located in the ampullar portion, 13 % are located in the isthmus, and 12 % in the fimbriae [7] but ectopic implantation can also occur in the cervix, ovaries, and abdomen.

EP can be a life-threatening condition as it is responsible for 6 % of maternal deaths during the first trimester of pregnancy [8].

In a typical tubal pregnancy, the embryo adheres to the lining of the FT and burrows into the tubal wall. Commonly, it invades vessels and causes intratubal bleeding, which may discharges the implanted embryo out of the tube as a tubal abortion. Sometimes this bleeding might be heavy enough to threaten the life of the woman, even if, in developed countries, this event is today luckily rare.

Identified risk factors for EP include: PID, infertility, use of an intrauterine device (IUD), previous exposure to toxicants, tubal or intrauterine surgery (e.g. D&C), smoking, previous EP, and tubal ligation [9].

Fertility following EP is dependent from several factors, the most important of which is a prior history of infertility [10]. The treatment choice seems not to play a great role. A recent randomized study concluded that the rates of intrauterine pregnancy two years after treatment of EP are approximately 64 % with excisional surgery, 67 % with methotrexate, and 70 % with conservative surgery (salpingotomy) [11].

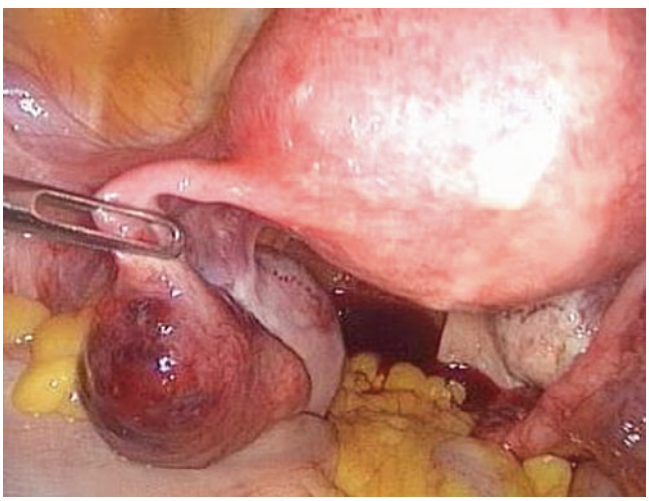


Fig. 12.3 Laparoscopic view of a left tubal ectopic pregnancy

In 2014, in a new open-label, multicentre, international, randomised controlled trial, women aged 18 years and older with a laparoscopically confirmed tubal pregnancy and a healthy contralateral tube were randomly assigned to receive salpingotomy or salpingectomy [12]. In this study, the cumulative ongoing pregnancy rate was 60.7 % after salpingotomy and 56.2 % after salpingectomy (difference not significant between groups). Persistent trophoblast, however, occurred more frequently in the salpingotomy group than in the salpingectomy group (7 % vs < 1 %). Repeat ectopic pregnancy occurred in 8 % of women in the salpingotomy group and 5 % of those in the salpingectomy group. The number of ongoing pregnancies after ovulation induction, intrauterine insemination, or IVF did not differ significantly between the groups.

Meta-analysis of data substantiated the results of the trial so that authors concluded that in women with a tubal EP and a healthy contralateral tube, salpingotomy does not significantly improve fertility prospects compared with salpingectomy.

Malignant and Pre-neoplastic Tubal Pathologies as Indication to Salpingectomy

Historically, primitive tumors of the FT were described as rare [13]. In women with advanced peritoneal carcinoma, the involvement of the ovary usually hides and incorporates the fallopian tube, drawing the attention of surgeons and pathologists and resulting in a diagnosis of ovarian primary carcinoma. In those cases, however, salpingectomy is only a little part of the more radical surgical procedure that is total hysterectomy plus bilateral salpingo-oophorectomy, with pelvic and aortic lymph node dissection when indicated.

Recently, however, morphologic, immune-histochemical and molecular studies [14, 15] have led to the development of a new theory on the pathogenesis of Epithelial Ovarian Carcinomas (EOCs) based on a dualistic model of carcinogenesis [15], which identifies type II neoplasia (high-grade serous (HGSC), high-grade endometrioid, malignant mixed mesodermal tumours and undifferentiated carcinomas) as cancers typically genetically unstable, aggressive and presented in advanced stages [15]. Among these, HGSC is the most common Ovarian Cancer (OC), responsible for the higher death rate among the others types.

Interestingly, the new proposed theory shifts the early events of carcinogenesis to the FT instead of the ovary [15], suggesting that types II tumors derive from the epithelium of the Fallopian tube, whereas clear cell and endometrioid tumors derive from endometrial tissue that migrate to the ovary by retrograde menstruation [14].

These observations have been mainly collected from women carrying BRCA1/2 mutations and undergoing

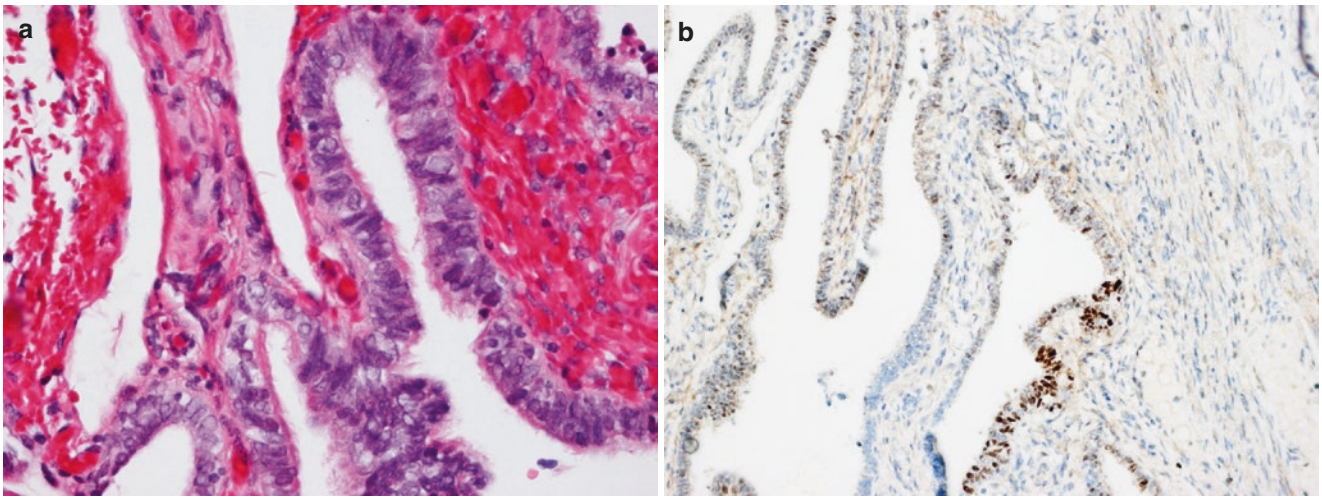


Fig. 12.4 Histologic view of a serous intraepithelial tubal cancer (STIC). In this H&E staining, (**a**) the STIC cells show polymorphic nuclei and a multilayer epithelium, compared with normal tubal epithelium (**b**), in which a distinct transition from normal tubal epithelium to p53 positive STIC (p53 immunohistochemistry) is also shown

prophylactic salpingo-oophorectomy, in which most of the incidentally diagnosed in situ carcinomas or intraepithelial precursors of cancers (STIC) were detected not in the ovary but in the fimbrial end of the FT [16–18] (Fig. 12.4). STIC were also subsequently diagnosed in many women not carrying BRCA mutations, thanks to an extended protocol of pathologic examination of the Fallopian Tubes (SEE-FIM) of patients operated for sporadic HGSC [19–22].

Based on these evidences, prophylactic bilateral salpingectomy (PBS) without ovariectomy has been proposed as a new preventive approach to reduce the risk of sporadic neoplasia [23, 24] in women at population risk of ovarian cancer (i.e. those not carrying BRCA 1/2 mutations) [25], without exposing these patients to the adverse effects of iatrogenic premature menopause.

Even if opinions vary regarding short and long term outcomes of PBS [26, 27], consistent preliminary data demonstrated its safety both in term of ovarian reserve preservation and surgical complication [28, 29]; moreover, several authors have shown a significant reduction in OC risk among women with previous bilateral salpingectomy compared to tubal preservation [30, 31] or unilateral salpingectomy [31].

Therefore, a 2011 position paper by the Society of Gynaecologic Oncology of Canada [25] encouraged physicians to discuss the risks and benefits of PBS at the time of hysterectomy or tubal ligation with women at population risk for OC and this recommendation has been confirmed in 2015 by the American College of Obstetricians and Gynaecologists [32].

The advantage of PBS has been estimated also in term of cost-effectiveness. A recent analysis on PBS (elective salpingectomy at hysterectomy or instead of tubal ligation), showed as salpingectomy with hysterectomy for benign conditions will reduce ovarian cancer risk at acceptable cost and is a cost-effective alternative to tubal ligation for sterilization [33].

Concerning BRCA women, current recommendations include bilateral salpingo- oophorectomy (PBSO) by the age of 40 years or on completion of childbearing to reduce their risk of both ovarian and breast cancers. In these women, indeed, PBS might reduce risk of OC and premature death secondary to cardiovascular disease, but it would not reduce breast cancer risk; conversely, PBSO is able to decrease the risk of OC and breast cancer by approximately 80–90 % and 50 %, respectively.

Permanent Contraception as Indication to Salpingectomy

Surgical sterilization is the most used method worldwide [34] involving 8.1 % of the 15-to 49-year-old married women in developed countries, and 22.3 % of women of reproductive age in less-developed countries [35].

Surgical sterilization it is often achieved by resection (i.e. during a Caesarean section) or laparoscopic coagulation of the isthmic portion of the FT. The remnant segment of the transected tube, however, frequently exhibits histological modifications that let unsuccessful the micro-reanastomotic procedures [36]; the most successful contraception, moreover, is recognized to be obtained by total salpingectomy [37].

For those of women(1–2 %) who revise the previous decision for sterilization for any reason, it was demonstrated that the best method to obtain a pregnancy would be IVF [38], so that bilateral salpingectomy doesn't have any disadvantages

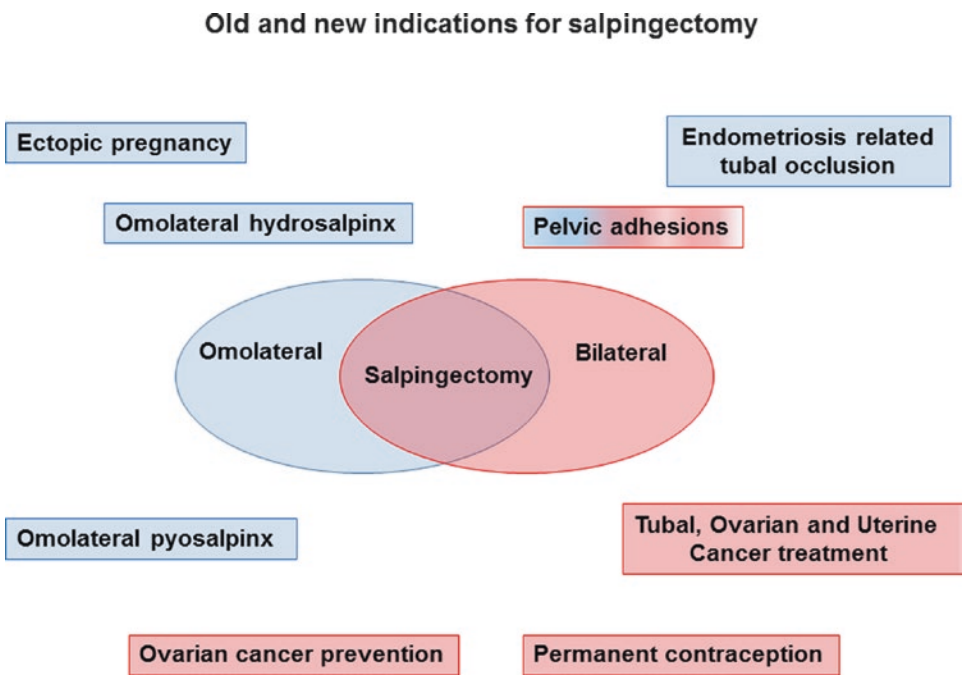


Fig. 12.5 Old and new indication for salpingectomy

in this population of women, while tubal preservation with subsequent tubal disease, definitively impair the implantation of transferred embryos [39].

Hysteroscopic sterilization was recently introduced as an attempt to provide a less invasive but similarly effective alternative to the abdominal approach. Current methodologies, unfortunately, have limitations that make the procedure less promising than expected [40].

Considering the new theory on OC pathogenesis, even if also tubal ligation seems to reduce the risk of EOC of 33 % both in no-BRCA1 [41] and BRCA1 carriers [42, 43], recent data demonstrated that excisional tubal sterilization confers greater risk reduction (64 %) than other methods [44], thus representing the more advisable sterilization procedure to be adopted in the clinical practice.

Bilateral salpingectomy, indeed, would offer to those women requesting for permanent contraception not only the absolute prevention of intrauterine pregnancies and the almost complete elimination of tubal pregnancies, but also protection against EOCs, further providing the chance to assess, along the years, the efficacy of this risk-reducing procedure [35] (Fig. 12.5).

References

1. RCOG Green-top Guideline No. 32, Management of acute pelvic inflammatory disease. Nov 2008.
2. Johnson N, van Voorst S, Sowter MC, Strandell A, Mol BW. Surgical treatment for tubal disease in women due to undergo in vitro fertilisation. Cochrane Database Syst Rev. 2010:1.
3. Matorras R, Rabanal A, Prieto B, Diez S, Brouard I, Mendoza R, Exposito A. Hysteroscopic hydrosalpinx occlusion with Essure device in IVF patients when salpingectomy or laparoscopy is contraindicated. Eur J Obstet Gynecol Reprod Biol. 2013;169:54–9.
4. D'Arpe S, Franceschetti S, Caccetta J, Pietrangeli D, Muzii L, Panici PB. Management of hydrosalpinx before IVF: a literature review. J Obstet Gynaecol. 2014;1:1–4.
5. Zhang Y, Sun Y, Guo Y, Li TC, Duan H. Salpingectomy and proximal tubal occlusion for hydrosalpinx prior to in vitro fertilization: a meta-analysis of randomized controlled trials. Obstet Gynecol Surv. 2015;70:33–8.
6. Repasy I, Lendvai V, Koppan A, Bodis J, Koppan M. Effect of the removal of the Fallopian tube during hysterectomy on ovarian survival: the orphan ovary syndrome. Eur J Obstet Gynecol Reprod Biol. 2009;144:64–7.
7. Kirk E, Bottomley C, Bourne T. Diagnosing ectopic pregnancy and current concepts in the management of pregnancy of unknown location. Hum Reprod Update. 2014;20:250–61.
8. Crochet JR, Bastian LA, Chireau MV. Does this woman have an ectopic pregnancy?: the rational clinical examination systematic review. JAMA. 2013;309:1722–9.
9. Farquhar CM. Ectopic pregnancy. Lancet. 2005;366:583–91.
10. Tulandi T, Tan SL. Advances in reproductive endocrinology and infertility: current trends and developments. UK: Informa Healthcare; 2002. p. 240.
11. Fernandez H, Capmas P, Lucot JP, Resch B, Panel P, Bouyer J. Fertility after ectopic pregnancy: the DEMETER randomized trial. Hum Reprod. 2013;28:1247–53.
12. Mol F, van Mello NM, Strandell A, Strandell K, Jurkovic D, et al. Salpingotomy versus salpingectomy in women with tubal pregnancy (ESEP study): an open-label, multicentre, randomised controlled trial. Lancet. 2014;383:1483–9.
13. Tone AA, Salvador S, Finlayson SJ, Tinker AV, Kwon JS, Lee CH, et al. The role of the fallopian tube in ovarian cancer. Clin Adv Hematol Oncol. 2012;10:296–306.
14. Kurman RJ, Shih IM. The origin and pathogenesis of epithelial ovarian cancer: a proposed unifying theory. Am J Surg Pathol. 2010;34:433–43.
15. Kurman RJ, Shih IM. Molecular pathogenesis and extraovarian origin of epithelial ovarian cancer–shifting the paradigm. Hum Pathol. 2011;42:918–31.

16. Crum CP, Drapkin R, Kindelberger D, Medeiros F, Miron A, Lee Y. Lessons from BRCA: the tubal fimbria emerges as an origin for pelvic serous cancer. Clin Med Res. 2007;5:35–44.
17. Manchanda R, Abdelraheim A, Johnson M, Rosenthal A, Benjamin E, Brunell C, Burnell M, Side L, Gessler S, Saridogan E, et al. Outcome of risk-reducing salpingo-oophorectomy in BRCA carriers and women of unknown mutation status. BJOG. 2011;118:814–24.
18. Powell CB, Chen LM, McLennan J, Crawford B, Zaloudek C, Rabban JT, et al. Risk-reducing salpingo-oophorectomy (RRSO) in BRCA mutation carriers: experience with a consecutive series of 111 patients using a standardized surgicalpathological protocol. Int J Gynecol Cancer. 2011;21:846–51.
19. Crum CP, McKeon FD, Xian W. BRCA, the oviduct, and the space and time continuum of pelvic serous carcinogenesis. Int J Gynecol Cancer. 2012;22:S29–34.
20. Salvador S, Rempel A, Soslow RA, Gilks B, Hunsman D, Miller D. Chromosomal instability in fallopian tube precursor lesions of serous carcinoma and frequent monoclonality of synchronous ovarian and fallopian tube mucosal serous carcinoma. Gynecol Oncol. 2008;110:408–17.
21. Wiegand KC, Shah SP, Al-Agha OM, Zhao Y, Tse K, Zeng T, et al. ARID1A mutations in endometriosis-associated ovarian carcinomas. N Engl J Med. 2010;363:1532–43.
22. Medeiros F, Muto MG, Lee Y, et al. The tubal fimbria is a preferred site for early adenocarcinoma in women with familial ovarian cancer syndrome. Am J Surg Pathol. 2006;30:230–6.
23. Parker WH, Broder MS, Chang E, Feskanich D, Farquhar C, Liu Z, et al. Ovarian conservation at the time of hysterectomy and long-term health outcomes in the nurses' health study. Obstet Gynecol. 2009;113:1027–37.
24. McAlpine JN, Hanley GE, Woo MM, Tone AA, Rozenberg N, Swenerton KD, et al.; Ovarian Cancer Research Program of British Columbia. Opportunistic salpingectomy: uptake, risks, and complications of a regional initiative for ovarian cancer prevention. Am J Obstet Gynecol 2014;210:471.e1-471.11.
25. The Society of Gynecologic Oncology of Canada. GOC statement regarding salpingectomy and ovarian cancer prevention. Sep 2011.
26. Thiel J. It sounded like a good idea at the time. J Obstet Gynaecol Can. 2012;34:611–2.
27. Tone A, McAlpine J, Finlayson S, Gilks CB, Heywood M, Huntsman D, et al. It sounded like a good idea at the time. J Obstet Gynaecol Can. 2012;34:1127–30.
28. Morelli M, Venturella R, Mocciaro R, Di Cello A, Rania E, Lico D, et al. Prophylactic salpingectomy in premenopausal low-risk women for ovarian cancer: primum non nocere. Gynecol Oncol. 2013;129:448–51.
29. Reade CJ, Finlayson S, McAlpine J, Tone AA, Fung-Kee-Fung M, Ferguson SE. Risk-reducing salpingectomy in Canada: a survey of obstetrician-Gynaecologists. J Obstet Gynaecol Can. 2013;35:627–34.
30. Zhou B, Sun QM, Cong RH, Gu HJ, Tang NP, Yang L, et al. Hormone replacement therapy and ovarian cancer risk: a meta-analysis. Gynecol Oncol. 2008;108:641–51.
31. Falconer H, Yin L, Grönberg H, Altman D. Ovarian cancer risk after salpingectomy: a nationwide population-based study. J Natl Cancer Inst. 2015;27:107.
32. Committee on Gynecologic Practice. ACOG Committee opinion no. 620. Salpingectomy for ovarian cancer prevention. Obstet Gynecol. 2015;125:279–81.
33. Kwon JS, McAlpine JN, Hanley GE, Finlayson SJ, Cohen T, Miller DM, et al. Costs and benefits of opportunistic salpingectomy as an ovarian cancer prevention strategy. Obstet Gynecol. 2015;125:338–45.
34. http://www.un.org/esa/population/publications/contraceptive2005/2005_World_Contraceptive_files/WallChart_WCU2005.pdf.
35. Dietl J, Wischhusen J, Hauslert SFM. The post-reproductive Fallopian tube: better removed? Hum Reprod. 2011;11:2918–24.
36. Stock RJ. Histopathologic changes in fallopian tubes subsequent to sterilization procedures. Int J Gynecol Pathol. 1983;2:13–27.
37. Bartz D, Greenberg JA. Sterilization in the United States. Rev Obstet Gynecol. 2008;1:23–32.
38. Boeckxstaens A, Devroey P, Collins J, et al. Getting pregnant after tubal sterilization: surgical reversal or IVF? Hum Reprod. 2007;22:2660–4.
39. Cakmak H, Taylor HS. Implantation failure: molecular mechanisms and clinical treatment. Hum Reprod Update. 2011;17:242–53.
40. Creinin MD, Zite N. Female tubal sterilization: the time has come to routinely consider removal. Obstet Gynecol. 2014;124:596–9.
41. Cibula D, Widschwendter M, Majek O, Dusek L. Tubal ligation and the risk of ovarian cancer: review and meta-analysis. Hum Reprod Update. 2011;17:55–67.
42. Antoniou AC, Rookus M, Andrieu N, Brohet R, Chang-Claude J, Peock S, et al. Reproductive and hormonal factors, and ovarian cancer risk for BRCA1 and BRCA2 mutation carriers: results from the International BRCA1/2 Carrier Cohort Study. Cancer Epidemiol Biomarkers Prev. 2009;18:601–10.
43. Narod SA, Sun P, Ghadirian P, Lynch H, Isaacs C, Garber J, et al. Tubal ligation and risk of ovarian cancer in carriers of BRCA1 or BRCA2 mutations: a case-control study. Lancet. 2001;357:1467–70.
44. Lessard-Anderson CR, Handlogten KS, Molitor RJ, Dowdy SC, Cliby WA, Weaver AL, et al. Effect of tubal sterilization technique on risk of serous epithelial ovarian and primary peritoneal carcinoma. Gynecol Oncol. 2014;135:423–7.

Indications for Oophorectomy and Adnexectomy

13

William H. Parker

The continued hormonal function of the ovaries after menopause has been well established and the current understanding of the health-related long-term effects of removal of the ovaries has effected a change in the indications for oophorectomy. While adnexectomy is presently indicated for women with an adnexal mass suspicious for cancer, increased risk of ovarian/tubal cancer due to genetic mutations, or for some women with severe symptomatic endometriosis, conservation of the ovaries should be considered for most other women without these conditions.

Benefits of Ovarian Conservation

Prophylactic oophorectomy in order to prevent the subsequent development of ovarian cancer was first proposed in the 1970s. This proposal leads to approximately 250,000 US women having normal ovaries removed at the time of hysterectomy for benign disease every year.

However, endocrine studies first performed in the 1970s and subsequently confirmed, showed that the ovaries continue to produce androgens which are converted to estrone throughout a woman's lifetime [1, 2]. Studies showing the potential benefits of endogenous estrogen exposure on long-term women's health outcomes led to a 2005 Markov model constructed from previously published studies [3]. This model suggested that the health benefits of ovarian conservation outweighed the very small risk of ovarian cancer.

In 2013, an analysis of the Nurses' Health Study cohort examined health outcomes after 28 years of follow-up for 16,873 (56.3 %) women who had a hysterectomy with bilateral oophorectomy for benign disease and 13,113 (43.7 %) women who had a hysterectomy with ovarian conservation [4]. Although oophorectomy was associated with a much lower mortality from ovarian cancer, less than 1 % of the women with ovarian conservation died of ovarian cancer. In contrast, more women who had bilateral oophorectomy died from lung cancer (HR = 1.32), colorectal cancer (HR = 1.56), total cancers (HR = 1.18) and coronary heart disease (HR = 1.26) when compared with women who had ovarian conservation. Importantly, at no age was oophorectomy associated with an increased survival.

Studies from the Mayo Clinic had similar findings ; women who had bilateral oophorectomy before age 45 had a 44 % increased risk of cardiovascular mortality [5]. Other Mayo studies showed higher risks of anxiety/depression, dementia/cognitive impairment and Parkinsonism in women who had their ovaries removed [6]. In addition, after oophorectomy about 90 % of premenopausal women will have vasomotor symptoms and many women will also experience mood changes, a decline in well-being, a decrease in sexual desire, sleep disturbances, and headaches [7, 8]. Additionally, vaginal dryness, painful intercourse, bladder dysfunction, and symptoms of depression may occur [9, 10].

In both the NHS and Mayo studies, these detrimental effects on health outcomes were not seen in women who took estrogen following oophorectomy. Therefore, some gynecologists have suggested that oophorectomy be performed at the time of hysterectomy for benign disease and these women be given prescriptions for menopausal hormone therapy and statins to ward off harmful cardiovascular effects. But studies show that within 5 years of a first prescription, only 17 % of women continue to take estrogen and fewer than 18 % are still taking statins [11]. And, these numbers are overstated since they do not include women who never see a doctor, see a doctor but don't get a prescription or women who get a first prescription but never fill it. Consequently, removing ovaries and prescribing medication to prevent the health consequences is not likely to be effective.

Medical ethics suggests that prophylactic procedures should follow two guidelines: there is a reasonable expectation that the procedure will result in a net benefit to the patient; and, without the intervention the individual would be

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at high risk of developing the disease. Therefore, the evidence suggests that removal of healthy ovaries does not meet the definition of a prophylactic intervention. Therefore, prophylactic oophorectomy, in women at average risk of ovarian cancer, should be approached with caution.

Tubal Cancer and Salpingectomy

Recently, the origin of "epithelial ovarian cancer" has been questioned. Interestingly, the ovary contains no epithelial cells and metaplasia of surface mullerian cells to epithelial cells has been hypothethized to explain the types of epithelial ovarian cancer: serous, mucinous and endometriod. Recently, with careful pathologic analysis of ovaries and tubes removed from BRCA positive women, precursor lesions called serous tubal intra-epithelial cancer (STIC) have been found in the fallopian tubes, but no such precursor lesions have been found in the ovary. STIC lesions have the same p53 mutations found in high-grade serous "ovarian" cancers. The more indolent and treatable Stage I low grade cancers, found rarely inside the ovary do not have these p53 mutations. Astonishingly, the deadly form of ovarian cancer does not come from the ovary; most aggressive "ovarian" cancers are, in fact, tubal cancers [12].

Bilateral salpingectomy has been proposed as an alternative to oophorectomy, as it removes the source of aggressive cancers but conserves functioning ovaries. Interestingly, a recent study found that women having hysterectomy and salpingectomy had similar sonographically measured antral follicle counts, mean ovarian diameters and similar blood levels of AMH and FSH. Therefore, it appears that the ovaries function normally after salpingectomy. Based on all of the evidence, and following the lead of the Society of Gynecologic Oncologists of Canada, the Society of Gynecologic Oncologists recently published practice guidelines suggesting that for women at average risk for ovarian cancer, salpingectomy should be considered at the time of hysterectomy, in lieu of tubal ligation, and also at the time of other pelvic surgery (after completion of childbearing) [13]. This strategy is being closely studied in Canada.

It appears that there is now a convergence of ideas: aggressive "ovarian" cancer appears to be "tubal" cancer and salpingectomy may prevent many of these horrible deaths; oophorectomy has adverse long-term health consequences for women and ovarian conservation should be encouraged.

Oophorectomy Not Indicated for Most Ovarian Cysts

Benign ovarian cysts are a common finding in women. In asymptomatic women aged 25–40, 8 % are found to have ovarian cysts larger than 2.5 cm [1] and a study of women age 50 or older found 18 % had unilocular cysts less than 10 cm. However, most ovarian cysts will resolve, even in post-menopausal women. The University of Kentucky Ovarian Cancer Screening Program monitored 39,337 women with baseline and subsequent transvaginal ultrasonography over 25 years of follow-up [14]. Abnormal sonograms were found in 6807 women (17.3 %) over this time. Ovarian cysts were commonly found: in premenopausal women the prevalence was 34.9 % and the incidence was 15.3 %; in postmenopausal women the prevalence was 17.0 % and the incidence was 8.2 %. For the group having an initial abnormal transvaginal sonogram, 63.2 % resolved on subsequent sonograms. The abnormal findings were classified: unilocular cysts (11.5 %), cysts with septations (9.8 %), cysts with solid areas (7.1 %), and solid masses (1.8 %). Surgery was performed on 557 women with the findings of 472 benign cysts and 85 ovarian malignancies. Serial sonography found that many ovarian abnormalities resolved, even if the initial appearance is complex, solid, or bilateral. Cysts considered low risk for malignancy (unilocular and cysts with septations) had a median time to resolution of 12 months. Interestingly, cysts considered higher risk for malignancy (cysts with solid areas or predominantly solid masses) had a shorter median time to resolution – 2 months. Although many cysts resolved in less than 6–12 months, some cysts took longer and, when documented to be stable, these cysts were then followed on an annual basis. However, after 6–12 weeks, cysts that increased in complexity or size were more likely to be malignant and the authors recommended surgery [15]. Using this strategy of serial sonographic monitoring was associated with a positive predictive value of 25 %. Therefore, the authors recommended avoiding a single sonographic abnormality as the sole indication for surgery and they recommended using serial sonograms to reduce false-positive results and unnecessary surgery.

When evaluating women with an adnexal mass, it is a good idea to view the images yourself. Many radiologists use the descriptive term "complex" to denote any cyst other than entirely clear simple cysts. However, "complex" cysts include many benign etiologies: dermoid cysts, endometriomas, hemorrhagic cysts and cystadenomas. Very young women are at risk for developing germ cell tumors, which may produce BHCG or Alpha feto-protein, so these tumor markers should also be considered. Tumor markers, such as CA-125, are rarely helpful in determining the management of cysts in premenopausal women since the chance of a false positive is about 70 %. Endometriosis, functional cysts, fibroids or adenomyosis, cyclic elevations associated with the menstrual cycle, pelvic infection and pregnancy, all common conditions in premenopausal women, have all been associated with abnormally high CA-125 values. Also, 50 % of women with stage I ovarian cancer will have a negative test. Therefore, this test should be avoided in premenopausal women.

Careful scrutiny of the images and serial sonography will often be indicated and, at times, other imaging studies can often help determine the most likely diagnosis and help guide management. Suspected dermoid cysts can often be confirmed by limited CT scan, when fat (sebaceous material), teeth or bone is seen within the ovary. If a hemorrhagic cyst is present, a follow-up sonogram about two weeks later may show either a smaller cyst or changes in the internal echoes consistent with organizing clot.

One study showed that surgery for adnexal masses found during cancer screening does not decrease the death rate from ovarian cancer and subjects some women to the risks of unnecessary surgery. The Prostate, Lung, Colorectal and Ovarian (PLCO) Cancer Screening Randomized Controlled Trial randomized 78,216 women ages 55–74 to a study group screened with annual CA-125 and transvaginal ultrasonography and a control group who received usual medical care [16]. The women were followed for 11–13 years and managed based on the findings.

In the study group, 212 women were found to have ovarian cancer and 118 women died from ovarian cancer (3.1 per 10,000 person-years); in the usual care group 176 women were found to have ovarian cancer and 100 women died from ovarian cancer (2.6 per 10,000 person-years). The risk of death was statistically no higher in the screened group (mortality RR, 1.18; 95 % CI, 0.82–1.71). However, 3285 women had false-positive screening results and 1080 of these women underwent oophorectomy for the findings. Importantly, 163 of these women (15 %) had at least one serious complication occur as the result of unnecessary surgery for an adnexal mass.

Detorsion Rather than Adnexectomy for Adnexal Torsion

Especially in pre-menopausal women, detorsion of the adnexa even in apparently severely injured ovaries can be accomplished with good recovery of ovarian follicles and hormonal function. The not infrequent black-blue appearance of a torsed adnexa results from venous and lymphatic stasis, but some blood supply continues from the ovarian or uterine artery [17]. Some studies suggest that time from the onset of pain to de-torsion best predicts viability of the ovary. One study found evidence of necrosis on microscopy only after 48 h following the onset of pelvic pain [18]. Eighteen young women, ages 23–35, undergoing in-vitro fertilization and ovarian stimulation, were studied with sonography following detorsion of the adnexa [19]. There was no difference in mean antral follicle counts when the de-torsed ovary was compared with the contra-lateral ovary at 6 months following surgery.

Due to the edema caused by torsion, some authors recommend detorsion of the ovary and postoperative follow-up with serial ultrasounds to determine cyst resolution [20]. Cystectomy at time of detorsion may be difficult due to the edema and loss of tissue planes. Additionally, one study found that in 3 of 4 women treated with cystectomy at the time of de-torsion, loss of ovarian function was found in follow-up sonograms 6 months later [21].

However, if the cyst is not removed, there is risk of re-torsion and need for another operation. One study found higher rates of recurrence among 40 women managed with detorsion or detorsion and cyst aspiration, compared with detorsion with cystectomy or salpingo-oophorectomy [22] Malignancy is present in 2 % of women with adnexal torsion, and oophorectomy should be considered in postmenopausal women. However, in pre- menopausal women, detorsion and ovarian conservation should be strongly considered.

When Adnexectomy Is Warranted

Oophorectomy is indicated when the mass is considered suspicious for a neoplastic lesion. Criteria for suspicious lesions include a high initial morphology index, increasing size or complexity on serial sonography over a 6–12 week time period, or an elevated CA-125 in a postmenopausal woman. The University of Kentucky developed a morphology index (MI) in a cohort of post-menopausal women, which can be helpful in predicting the likelihood of malignancy for ovarian tumors (Fig. 13.1) [15].

The MI calculates a score between 0 and 10, using sonographically determined volume and morphologic complexity, with complexity having twice the weight of volume. A score of 0–4 implies that the cyst is likely benign; 5–10 implies that the cyst is likely malignant. Eighty-five percent of all cancers had a MI score ≥ 5. Of the 38,983 women in the study cohort, 472 women had surgery and 74 women were found to have ovarian cancer. The risk of malignancy based on the calculated MI was: MI = 5 (3 %); MI = 6 (3.7 %); MI = 7 (12.6 %); MI = 8 (26.7 %); MI = 9 (27.8 %); and, MI = 10 (33.3 %).

The best predictive values for malignancy were achieved with serial sonographic evaluation at 6–12 week intervals. The mean increase in MI for tumors found to be malignant was 1.6 per month. Women who were found to have benign tumors at surgery had a mean decrease of the MI of −0.3 per month. Tumors that resolved over time had a mean decrease MI of −1.0 compared to tumors subjected to surgery.

This study is very helpful to show that most ovarian tumors, even those with morphologic complexity, resolve over time. However, tumors that have an increase in MI over time should be considered for surgical exploration, oophorectomy, frozen section and surgical staging if malignancy is found.

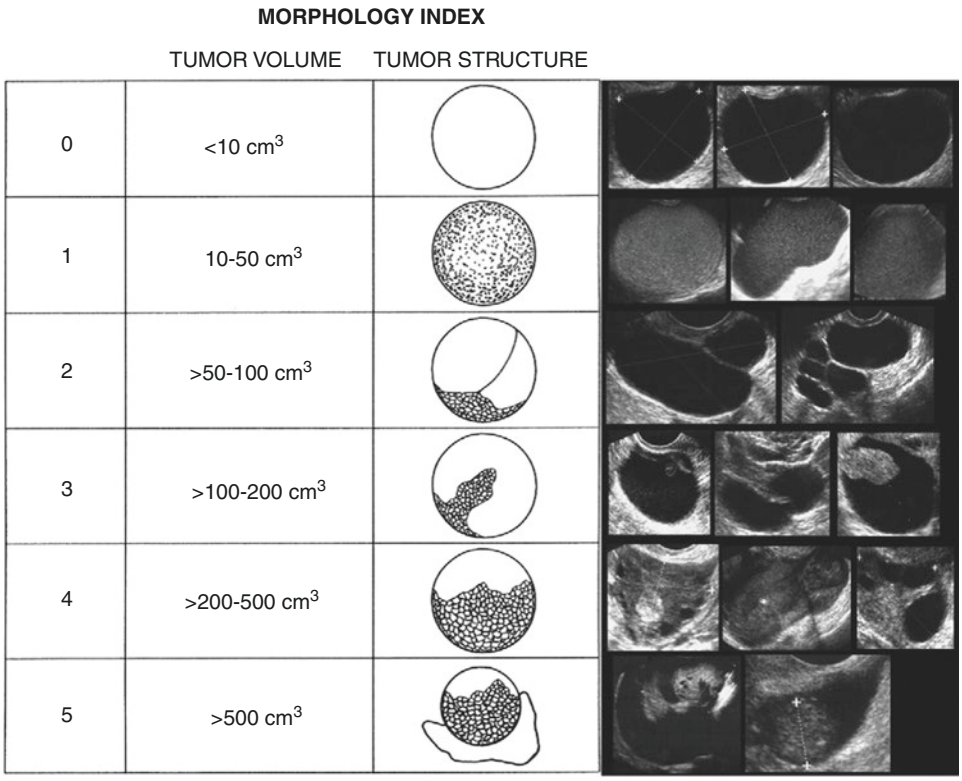


Fig. 13.1 Morphology index (Reprinted from Elder et al. [15] Copyright 2014, with permission from Elsevier)

Risk-Reducing Adnexectomy for BRCA, Lynch

Women with BRCA 1 have 40 % risk of having ovarian cancer in their lifetime and BRCA 2 confers a 20 % lifetime risk. Women with a BRCA 1 mutation have an increased risk of ovarian/tubal cancer as early as age 35, and 2–3 % of these women will develop ovarian cancer by age 40. The risk of women with the BRCA2 mutation developing ovarian/tubal cancer occurs about one decade later [23]. Women with Lynch Syndrome, especially those with the MSH2 gene, have a lifetime risk of ovarian cancer of 33 % and they also have a 40–60 % risk of developing endometrial cancer.

In a BRCA positive woman, oophorectomy, or more correctly, adnexectomy, reduces the risks of ovarian/tubal cancer to less than 3 %. Current recommendations suggest adnexectomy at the completion of child-bearing or: for BRCA 1, before age 35–40; for BRCA 2, before age 50; for Lynch Syndrome, adnexectomy and hysterectomy before age 40 [24].

Endometriosis and Oophorectomy

For women with severe, symptomatic endometriosis unresponsive to conservative management, bilateral oophorectomy concurrent with hysterectomy may decrease recurrent or persistent symptoms and the need for reoperation [25]. One study of women with symptomatic endometriosis compared outcomes between women who had a hysterectomy with ovarian conservation and women who had a hysterectomy with concurrent bilateral oophorectomy [26]. For the women who had ovarian conservation, 18/29 (62 %) had recurrent pain and 9/29 (31 %) required reoperation. For the women who had both ovaries removed, 11/109 (10 %) had recurrent pain and 4/109 (4 %) required reoperation.

Another study of women with endometriosis found that of the 47 women who had a hysterectomy with ovarian conservation, 9 (19 %) required further surgery over the 7 years of follow-up [27]. Of the 50 women who had a hysterectomy with bilateral oophorectomy, only 4 (8 %) required reoperation. Preservation of both ovaries doubled the risk of reoperation regardless of the patient's age. Nevertheless, given the problems associated with early menopause, the authors recommended that for women younger than 40 years, hysterectomy with ovarian conservation should be considered.

Large Masses

Some women may be symptomatic from larger cysts, or they may not be comfortable with, or available for, close follow-up. For these women, surgery may be indicated. There is some evidence for removal of endometriomas, that ovarian function decreases after removal of cysts >4 cm when compared with cystectomy for cysts smaller than 4 cm [28]. However, a review of the literature found no studies showing

loss of ovarian function related to the size of cyst removed. It may be prudent to conserve ovarian tissue even in large cysts clearly thought to be benign.

Summary

Oophorectomy is associated with decreased long-term health outcomes and ovarian conservation should be considered in many woman having pelvic surgery. Salpingectomy may be the procedure of choice for "ovarian/tubal" cancer prophylaxis. Oophorectomy is indicated for women with an adnexal mass that is suspicious for malignancy or for a mass that increases in size or complexity when monitored with serial sonography. Adnexal torsion can usually be treated with detorsion rather than adnexectomy. Oophorectomy decreases the likelihood of repeat surgery in women with severe, symptomatic endometriosis, but ovarian conservation should be considered in those women who are younger than age 40, since conservation avoids early surgical menopause.

References

1. Judd H, Judd G, Lucas W, Yen S. Endocrine function of the postmentopausal ovary: concentration of androgens and estrogens in ovarian and peripheral vein blood. J Clin Endocrinl Metab. 1974;39:1020–4.
2. Fogle R, Stanczyk F, Zhang X, Paulson R. Ovarian androgen production in postmenopausal women. J Clin Endocrinol Metab. 2007;92:3040–3.
3. Parker W, Broder M, Liu Z, Shoupe D, Farquhar C, Berek J. Ovarian conservation at the time of hysterectomy for benign disease. Obstet Gynecol. 2005;106:219–26.
4. Parker WH, Feskanich D, Broder MS, Chang E, Shoupe D, Farquhar CM, Berek JS, Manson JE. Long-term mortality associated with oophorectomy compared with ovarian conservation in the nurses' health study. Obstet Gynecol. 2013;121:709–16.
5. Rocca W, Grossardt B, de Andrade M, Malkasian G, Melton J. Survival patterns after oophorectomy in premenopausal women: a population-based cohort study. Lancet Oncol. 2006;7:821–8.
6. Rocca W, Bower J, Maraganore D, Ahlskog J, Grossardt B, de Andrade M, Melton L. Increased risk of cognitive impairment or dementia in women who underwent oophorectomy before menopause. Neurology. 2007;69:1074–83.
7. Nathorst-Böös J, von Schoultz B, Carlström K. Elective ovarian removal and estrogen replacement therapy–effects on sexual life, psychological well-being and androgen status. J Psychosom Obstet Gynaecol. 1993;14(4):283–93.
8. Elit L, Esplen MJ, Butler K, Narod S. Quality of life and psychosexual adjustment after prophylactic oophorectomy for a family history of ovarian cancer. Fam Cancer. 2001;1(3–4):149–56.
9. Bachmann GA, Nevadunsky NS. Diagnosis and treatment of atrophic vaginitis. Am Fam Physician. 2000;61(10):3090–6.
10. Shifren JL, Avis NE. Surgical menopause: effects on psychological well-being and sexuality. Menopause. 2007;14(3 Pt 2):586–91.
11. Buist DS, Newton KM, Miglioretti DL, Beverly K, Connelly MT, Andrade S, et al. Hormone therapy prescribing patterns in the United States. Obstet Gynecol. 2004;104:1042–50.
12. Kurman RJ, Shih IM. The origin and pathogenesis of epithelial ovarian cancer: a proposed unifying theory. Am J Surg Pathol. 2010;34:433–43.
13. SGO clinical practice statement: salpingectomy for ovarian cancer prevention, November 2013. Available at: https://www.sgo.org/clinical-practice/guidelines/sgo-clinical-practice-statement-salpingectomy-for-ovarian-cancer-prevention. Accessed 3/8/2015.
14. Pavlik EJ, Ueland FR, Miller RW, Ubellacker JM, DeSimone CP, Elder J, Hoff J, Baldwin L, Kryscio RJ, van Nagell Jr JR. Frequency and disposition of ovarian abnormalities followed with serial transvaginal ultrasonography. Obstet Gynecol. 2013;122:210–7.
15. Elder JW, Pavlik EJ, Long A, Miller RW, DeSimone CP, Hoff JT, Ueland WR, Kryscio RJ, van Nagell Jr JR, FR U. Serial ultrasonographic evaluation of ovarian abnormalities with a morphology index. Gynecol Oncol. 2014;135:8–12.
16. SS B, Partridge E, Black A, et al. Effect of screening on ovarian cancer mortality: the Prostate, Lung, Colorectal and Ovarian (PLCO) Cancer Screening Randomized Controlled Trial. JAMA. 2011;305:2295–303.
17. Oelsner G, Shashar D. Adnexal torsion. Clin Obstet Gynecol. 2006;49:459–63.
18. Chen M, Chen CD, Yang YS. Torsion of the previously normal uterine adnexa. Evaluation of the correlation between the pathological changes and the clinical characteristics. Acta Obstet Gynecol Scand. 2001;80:58–61.
19. Bozdag G, Demir B, Calis PT, Zengin D, Dilbaz B. The impact of adnexal torsion on antral follicle count when compared with contralateral ovary. J Minim Invasive Gynecol. 2014;21:632–5.
20. Cohen SB, Wattiez A, Seidman DS, Goldenberg M, Admon D, Mashiach S, Oelsner G. Laparoscopy versus laparotomy for detorsion and sparing of twisted ischemic adnexa. JSLS. 2003;7:295–9.
21. Cohen SB, Oelsner G, Seidman DS, Admon D, Mashiach S, Goldenberg M. Laparoscopic detorsion allows sparing of the twisted ischemic adnexa. J Am Assoc Gynecol Laparosc. 1999;6:139–43.
22. Pansky M, Smorgick N, Herman A, Schneider D, Halperin R. Torsion of normal adnexa in postmenarchal women and risk of recurrence. Obstet Gynecol. 2007;109:355–9.
23. Boyd J, Sonoda Y, Federici MG, et al. Clinicopathologic features of BRCA-linked and sporadic ovarian cancer. JAMA. 2000;283:2260–5.
24. GA MC, EL E. Hereditary cancer syndromes with high risk of endometrial and ovarian cancer: surgical options for personalized care. J Surg Oncol. 2015;111:118–24.
25. Vercellini P, Barbara G, Abbiati A, Somigliana E, Viganò P, Fedele L. Repetitive surgery for recurrent symptomatic endometriosis: what to do? Eur J Obstet Gynecol Reprod Biol. 2009;146:15–21.
26. Namnoum AB, Hickman TN, Goodman SB, Gehlbach DL, Rock JA. Incidence of symptom recurrence after hysterectomy for endometriosis. Fertil Steril. 1995;64(5):898–902.
27. Shakiba K, Bena JF, McGill KM, Minger J, Falcone T. Surgical treatment of endometriosis: a 7-year follow-up on the requirement for further surgery. Obstet Gynecol. 2008;111(6):1285–92.
28. Tang Y, SL C, Chen X, YX H, DS Y, Guo W, HY Z, XH Y. Ovarian damage after laparoscopic endometrioma excision might be related to the size of cyst. Fertil Steril. 2013;100:464–9.

Uterine Sarcomas and Atypical Smooth-Muscle Tumors: Clinic, Diagnostics and Appropriate Surgical Therapy

14

Günter Köhler and Marek T. Zygmunt

Abbreviations

AAGL	American Association of Gynecologic Laparoscopists
AS	Adenosarcoma
BSO	Bilateral salpingo-oophorectomy
CT	Computed tomography
DD	Differential diagnosis
DGGG	Deutsche Gesellschaft für Gynäkologie und Geburtshilfe e. V. (German Society for Gynecology and Obstetrics)
DKSM	Deutsches klinisches Kompetenzzentrum für genitale Sarkome und Mischtumoren (German Clinical Center of Excellence for Genital Sarcomas and Mixed Tumors)
ER	Estrogen receptors
ESN	Endometrial stromal nodule
ESTECLE	Endometrial stromal tumor with sex cord-like elements
GCIG	Gynecologic Cancer InterGroup
HE	Hysterectomy
HR	Hormone receptor
HG-ESS	High-grade endometrial stromal sarcoma
HSC	Hysteroscopy
LG-ESS	Low-grade endometrial stromal sarcoma
LM	Leiomyoma
LMS	Leiomyosarcoma
LN	Lymph node
LNE	Lymphadenectomy
LSC	Laparoscopy
M/10 HPF	Mitoses per 10 high-power fields
MI	Mitotic index
Mo	Months
MRT	Magnetic resonance tomography
NCCN	National Comprehensive Cancer Network
NPV	Negative predictive value
OS	Overall survival
Pat.	Patients
PECom	Perivascular epithelioid cell tumor
RFI	Relapse free interval
PFS	Progression free survival
PPV	Positive predictive value
PR	Progesterone receptor
RI	Resistance index in Doppler sonography
SEER	Surveillance, Epidemiology and End Results
SI	Signal intensity
SO	Sarcomatous overgrowth
STUMP	Smooth muscle tumor of uncertain malignant potential, atypical
T1/T2 W	T1 or T2-weighting in MRT imaging
T1 WC	T1-weighted contrast-MRT
TVS	Transvaginal sonography
TZN	Tumor cell necrosis
UTROSCT	Uterine tumors resembling ovarian sex cord/stromal tumors
UUS	Undifferentiated uterine sarcoma
WOP	Weeks of pregnancy

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Leiomyosarcoma

Epidemiology, Etiology, Pathogenesis, Staging

In Germany and Norway, LMSs constitute 47 [143] resp. 68 % [2] of all uterine sarcomas. The annual incidence rate is 0.55/100,000 among white women and 0.92/100,000 for black women [283]. In northern Europe, with around 0.4 cases/100,000 women of all age groups, the highest incidence rates could be observed among women aged between 45 and 59 [155]. The median and mean ages of disease onset are 53

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Table 14.1 Staging for uterine leiomyosarcomas and stromal sarcomas, according to FIGO and UICC 2009 [291]

TNM	FIGO	Definition
T1	I	Tumor limited to uterus
T1a	IA	Tumor 5 cm or less in largest dimension
T1b	IB	Tumor >5 cm
T2	II	Tumor extends beyond the uterus to the lesser pelvis
T2a	IIA	Adnexal involvement
T2b	IIB	Involvement of other pelvic tissues/structures
T3	III	Tumor invades abdominal tissues
T3a	IIIA	One site
T3b	IIIB	>one site
N1	IIIC	Metastasis to pelvic and/or para-aortic lymph nodes
T4	IVA	Tumor invades bladder and/or rectum
M1	IVB	Distant metastasis

and 54 years, respectively (min. 31, max. 90 years) [143]. Other sources point to a median age of 48–57 years [2, 6, 116, 168, 231, 223, 247]. According to data from the German Clinical Center of Excellence for Genital Sarcomas and Mixed Tumors (Deutsches klinisches Kompetenzzentrum für genitale Sarkome und Mischtumoren, DKSM), 64.9 % of women are postmenopausal and 64.0 % are aged older than 50 [143] (Table 14.8). Only 5 to 13 % of LMSs primarily originate in the cervix, tubal LMS are the exception [23, 124, 143]. Medical histories have increasingly revealed a previous exposure to tamoxifen [298].

LMSs arise primarily in the wall of the uterus. Progression of an LMS from an LM is regarded as the exception, and is in fact widely rejected due to the differing gene expression profiles of LMs and LMSs [230, 290]. On the basis of genetics and morphology, it appears highly probable that a smooth muscle tumor of uncertain malignant potential (STUMP) can progress into an LMS [193, 194]. This is further suggested by the fact that the median and mean ages for STUMPs are 5 years lower [143] and that these tumors can also metastasize as LMS (see subchapter STUMP). LMS-growth is regarded as being estrogen-independent (see also prognostic factors).

New binding FIGO-staging [83, 264] for uterine LMSs and stromal sarcomas was released in 2009 (Table 14.1). Current staging takes tumor size into consideration as well as the fact that LMSs can also primarily develop in the cervix, which need not necessarily imply a higher stage or justify a different course of therapy.

Macroscopical and Microscopical Findings

LMSs are mostly intramural. They initially displace the cavum, then break into it and fill it with tumor masses which can subsequently protrude into the vagina via the cervix. Myometrial invasion can be so comprehensive that the myometrium is only covered by the serosa (Figs. 14.1a–f and 14.3a). It is not uncommon for the serosa to rupture. Tumor size ranges between 0.7 and 30 cm, and in 50 % of cases the tumor is solitary [143]. The presence of multiple "myomas" bears the general risk that an LMS may not be recognized as such. In 94 % of such cases, however, the LMS constitutes the largest "LM" [143]. Gross appearance and the cut surface can be strongly reminiscent of an LM (Fig. 14.2a, b). However, the whorled structure that is typical for LMs is missing in most cases (Figs. 14.3a, b and 14.4a). The tumor usually has a rosy, yellowish or grayish-white, "dirty" color. The macroscopic appearance can be markedly pleomorphous, with numerous haemorrhagia, decomposed greenish-yellowish necrotic tissue, and blood-filled cysts (Figs. 14.1d, 14.3a, b, and 14.4a). What usually results is a noticeably soft consistency. In actual fact, what appear to be "capsules" in fact virtually always consist of compressed tumor tissue (Fig. 14.4a). Thus the margins to surrounding tissue are usually poorly defined. The soft consistency of the tumors and the absence of a capsule frequently result in intraoperative tumor perforations (Fig. 14.4b, c). Accordingly, unlike LMs, LMSs cannot be enucleated or abraded ("shelled-out"). Ultimately, the spectrum of gross macroscopic appearance ranges from myoma-like aspects to almost entirely decomposed tumors. Epithelioid LMSs can barely be differentiated from typical LMSs on gross observation. Myxoid LMSs, by contrast, have a more or less gelatinous, shiny surface (Fig. 14.3a, b).

At the microscopic level, LMSs are categorized into spindle cell, epithelioid, and myxoid types [201]. Spindle cell LMSs are much more common than the other variants. They usually have a high degree of cellularity and consist of intersecting bundles of spindle cells and/or pleomorphic cells with eosinophilic cytoplasm. However, cell count is not relevant when seeking to categorize an LMS as such. Destructive myometrial invasion is common. The presence of vascular invasions is characteristic and can be found in 30–34 % of non-epithelioid and non-myxoid LMSs [2, 61]. The decisive

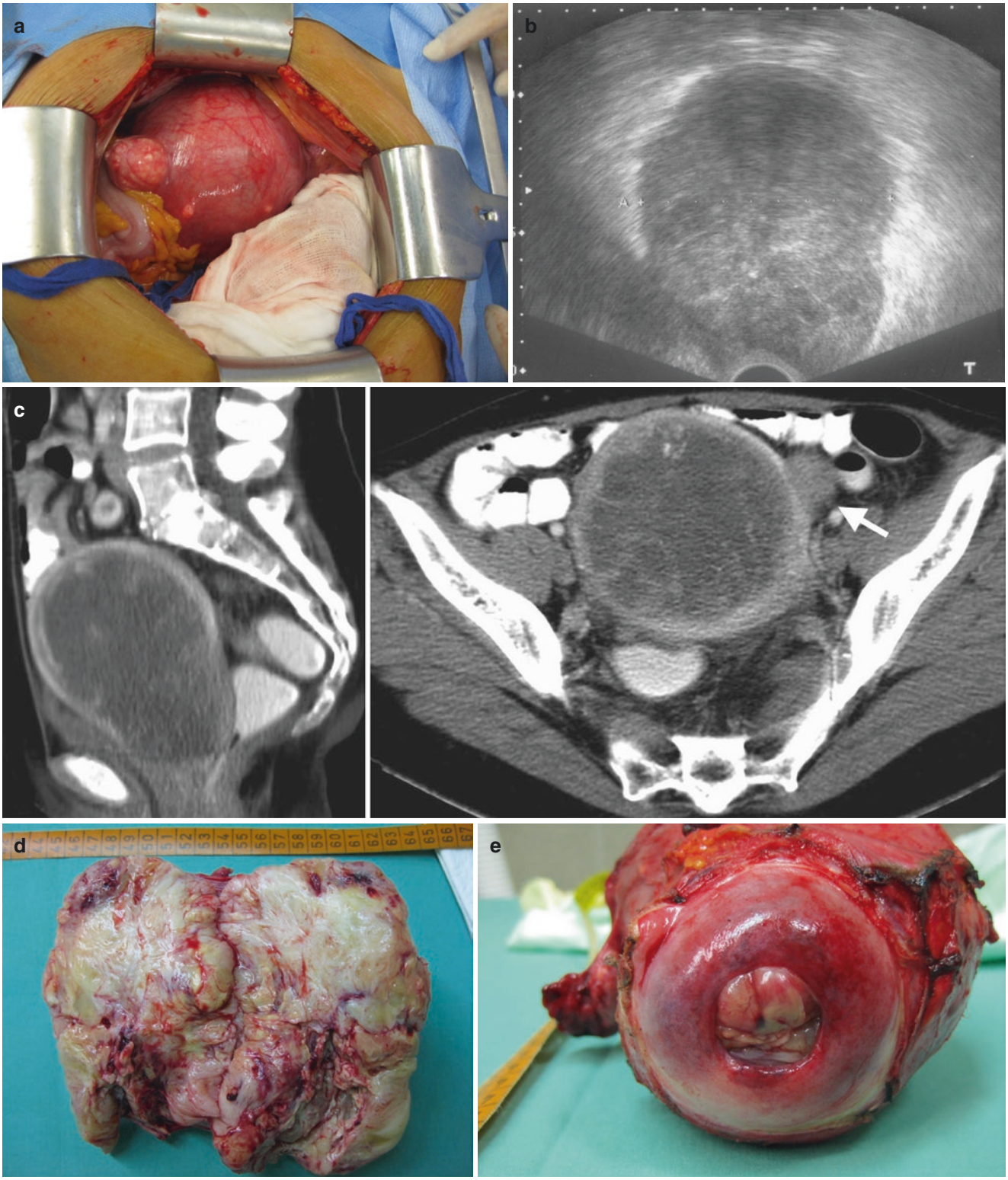


Fig. 14.1 Leiomyosarcoma. (**a**) Looking at the left of the uterine fundus, an LMS has visibly grown into the abdominal cavity, but still remains covered by the serosa; (**b**) in axial sonography, the uterine structures have disappeared and the LMS is practically only surrounded by the serosa; (**c**) both sagittal (*left*) and axial (*right*) CT clearly show that the distinguishability between different tissue layers has been entirely compromised by hypodense tumor masses that are pervaded by enhancing septa. The protrusion of the tumor into the cavity as described under A is clearly visible in the axial CT image (*arrow*); (**d**) macroscopic observation of the opened uterus served to confirm the findings from imaging diagnostics; (**e**) the strong pressure generated by its rapid rate of growth caused the tumor depicted in A–D to protrude through and from the cervix; (**f**) this monstrous cervical LMS appeared to be an LM both clinically and in LSC (With permission of Köhler et al. [145], Fig. 1.2–1a–f)

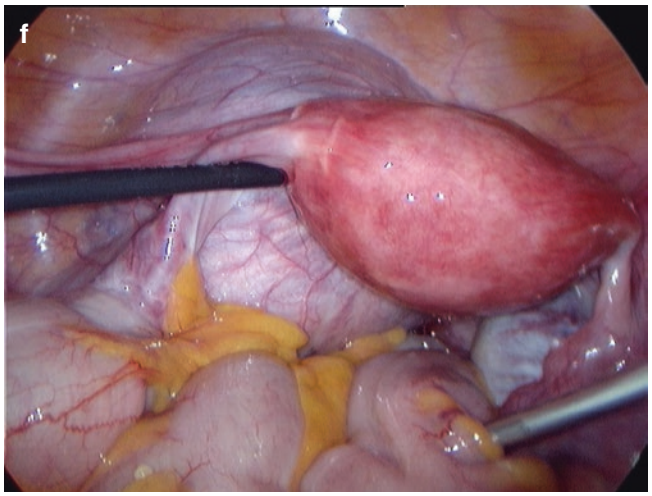


Fig. 14.1 (continued)

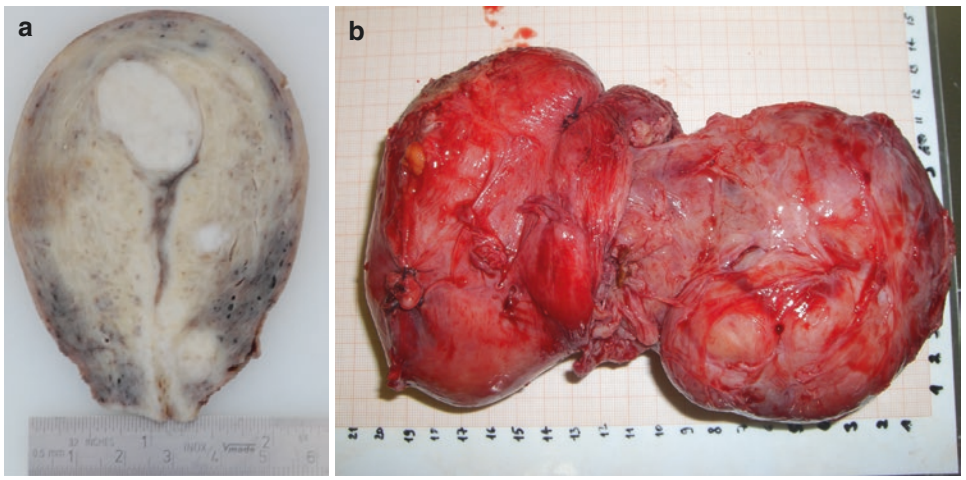


Fig. 14.2 Leiomyosarcoma. (**a**) This LMS, incidentally detected post-operatively following supracervical HE, was the largest of four lesions. The three smaller tumors were ordinary LMs that barely differed from LMS on gross observation; (**b**) even during supracervical HE, this monstrous LMS gave the impression of being an LM (With permission of Köhler et al. [145], Fig. 1.2–2a, b)

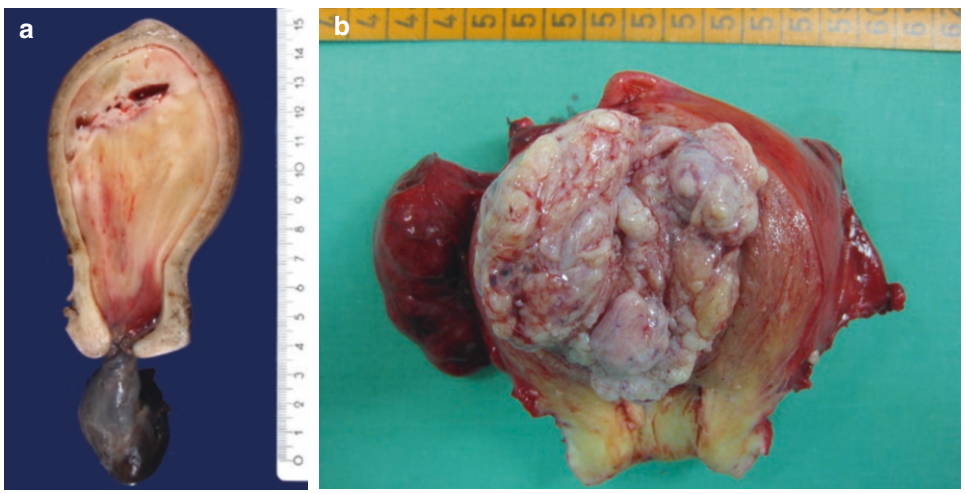


Fig. 14.3 Leiomyosarcoma. (**a**) The very smooth, almost hyaline cut surface, featuring several hemorrhages and cysts, is already a first macroscopic characteristic suggestive of myxoid LMS; (**b**) what is particularly noteworthy about these myxoid LMSs, besides their visible degree of macroscopical pleomorphism, is their hyaline, greasy appearance (With permission of Köhler et al. [145], Fig. 1.2–4a, b)

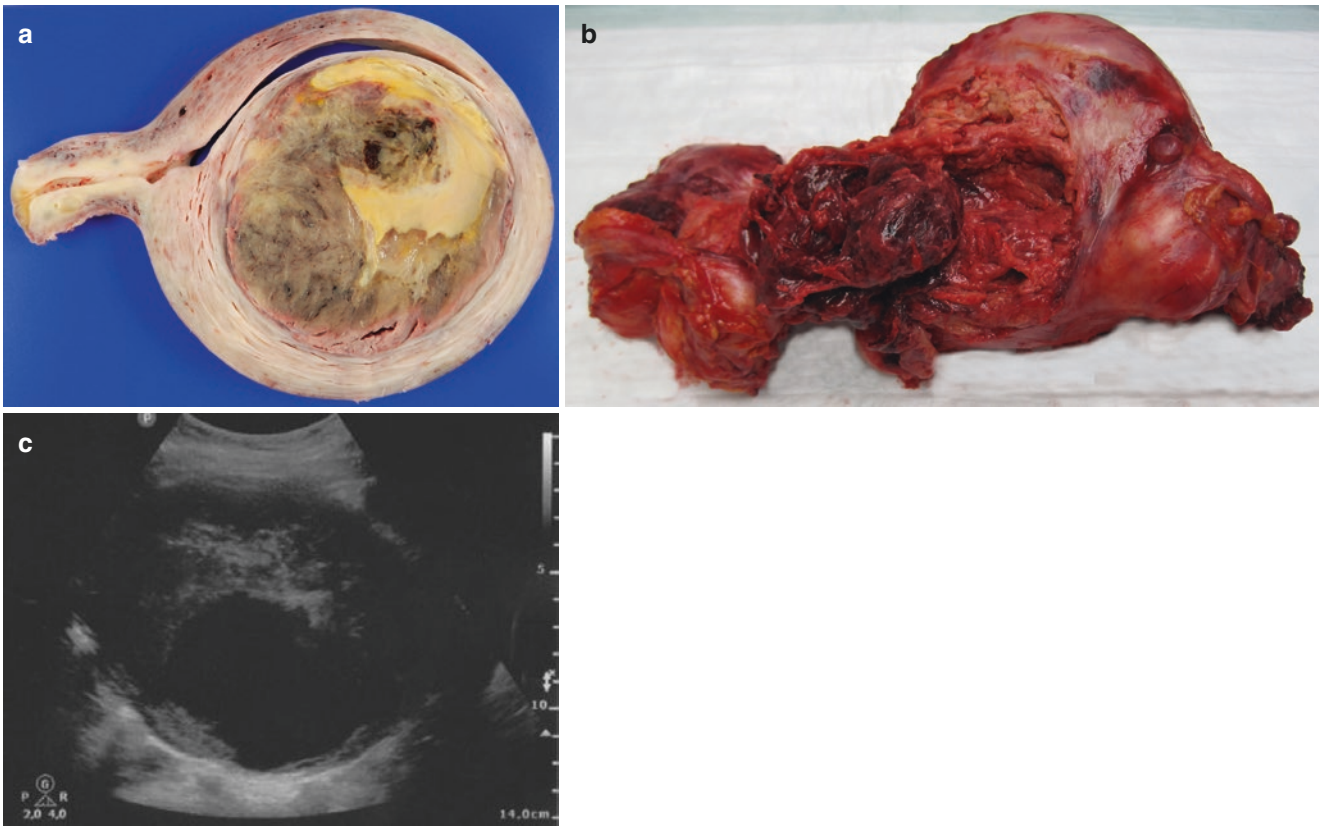


Fig. 14.4 Leiomyosarcoma. (**a**) The LMS is contained within the myometrium and has strongly distended the cavum, however without having broken through or ruptured it. The "capsule" is in fact merely a pseudo-capsule that consists of a mixture of myometrial and tumor tissue that directly merges into the tumor. The *yellow* areas are necroses; (**b**) this LMS was extremely soft, hemorrhagic, and was located immediately beneath the serosa. The attempt to lift the uterus from the pelvis by hand was already enough to cause perforation to the tumor; (**c**) sonography of the same tumor clearly shows that the cystic necrotic tumor was covered only by the serosa (With permission of Köhler et al. [145], Fig. 1.2–12, 1.2–2d, e)

3 factors for classifying a lesion as an LMS are: the presence of TCN, mitotic activity, and nuclear and cytologic atypia [28, 57, 207, 282].

TCN (synonyms: geographic or coagulative necrosis) usually occurs multifocally and is characterized by irregular, well-defined margins to surrounding vital tissue. Differentiating TCN from hyaline necrosis, which also frequently occurs in LMSs, can be challenging. Necroses for which such a clear differentiation is not possible are termed uncertain necroses or questionable TCNs.

MI constitutes the second diagnostic pillar and is measured as the mean number of mitoses per 10 HPF. Mitoses usually occur in so-called "hot spots" (i.e. areas with the most mitoses). Only measuring MI in randomly selected areas of the tumor should thus be avoided, a recommendation that can often not be fulfilled when opting for punch biopsy.

Significant diffuse or multifocal moderate-to-severe nuclear and cellular atypia provide the third diagnostic criterion for LMSs. .

In order to come to the diagnosis "LMS", at least 2 of the following characteristics must be fulfilled:

- TCN;
- an MI of ≥10 M/10 HPF (significantly lower in epithelioid and myxoid LMS);
- significant diffuse or multifocal moderate-to-severe atypia.

Where TCNs have been identified beyond doubt and there is any degree of mitotic activity, i. e. any MI, the diagnosis must be LMS, even in the absence of nuclear and cellular atypia. If the typical necroses are absent, then the MI must be ≥10 M/10 HPF and, additionally (!), there must also be diffuse or multifocal moderate-to-severe atypia in order to allow the tumor to be classified as LMS. Even when the diagnosis is already clear on the basis of the necroses and atypia, the MI should nonetheless always be noted so as to be able to determine prognosis according to the overall survival probability prediction tool for LMSs [308].

ER-expression is positive in 63 % of LMS patients, while the PRs are positive in 50 %; 29 % of tumors are negative in terms of both ER and PR-expression [112]. Other sources have measured positive ER and PR-expression in 20–60 % of LMSs. However, receptors were said to be focally localized in the majority of cases [5, 34, 204].

Myogenic markers, such as desmin and H-caldesmon, are normally well-expressed. LMSs show diffuse moderate Ki-67 (or MIB-1) staining and a moderate-to-strong expression of p53 and p16 [50, 61, 213]. The tumor suppressor protein p16 was in fact immunologically substantiated in 100 % of LMSs [50, 190]. The particulars of the very rare epithelioid and myxoid LMSs are described in great detail in the respective specialist literature [145].

No consensually accepted grading for uterine LMSs currently exists. Current UICC-TNM-classification provides no grading for uterine sarcomas [212, 291].

A re-evaluation of LMSs revealed that one third of lesions that had previously been classified as low-grade LMSs were in fact STUMPs [99] (s. a. section on STUMP). In a further study [287], only 31 % of low-grade LMSs actually fulfilled the LMS criteria.

Symptoms, Clinical Presentation, Clinical Diagnostics, Imaging, Differential Diagnosis

Abnormal vaginal bleeding is the most important symptom of LMS, present in 43–53 % of cases. It occurs as abnormal bleeding in form of intermenstrual bleeding and/or heavy, and/or prolonged, and/or irregular and postmenopausal bleeding [143, 168]. Hemorrhaging is observed in 54 % of postmenopausal women [143]. Compared to endometrial carcinoma and AS originating in the endometrium, in LMS and LG-ESS patients, such bleeding only occurs once the tumor has broken into the cavum. Uterine or lower abdominal pains as well as increased urinary urgency without any signs of bladder inflammation have also been observed [143, 168]. Overall, 86 % of patients show symptoms or report complaints of any sort in the course of tumor development. Symptoms that are independent of a patient's menstrual cycle are, in most cases, a result of the high rate of tumor growth. Said growth also causes the cervix to dilate (accompanied by labor-like pains) and tumor masses to protrude out of the cervical canal. An "LM" is particularly suspicious of being sarcoma when the tumor has developed *de novo* or grown during postmenopause, and when such patients' first symptoms or abnormal bleedings occur postmenopausally. Symptoms normally arise relatively late, with the consequence that the tumors have often already grown to a considerable size by the time they are initially diagnosed (see above and Table 14.8).

Continued LM growth or persistently symptomatic LMs within 12 Mo of embolization, high frequency ultrasound therapy, cryoablation, electromyolisis, or treatment with GnRH-analogues are all factors suggestive of an LMS [85, 101, 117, 191, 215, 289]. A lack of regression following embolization and/or the recurrence of vaginal bleeding are first signs for a primary misdiagnosis [43].

Gynecological examination reveals a relatively soft tumor in the majority of cases. This noticeable "softness" is also frequently stated as an intraoperative finding (Tables 14.4 and 14.11). LMSs have median and mean diameters of 8.0 cm and 9.5 cm, respectively [143]. According to other sources, 67–74 % of LMSs are >5 cm and 25–34.3 % are >10 cm in size [2, 234] (s. a. last section). The data from the DKSM [143] are presented in Table 14.8. The true significance of rapid uterine or myometrial growth for properly diagnosing LMSs has long been, and remains, a highly debated issue. One essential facet of this problem is that there are at least four definitions of what actually constitutes "rapid growth" [21, 41, 219, 222]. This overall lack of certainty needs to be borne in mind if one wishes to draw on rapid growth as a factor for discriminating between LMSs and LMs. Ultimately, one will have to rely on the expertise of the attending gynecologist. Rapid uterine growth was observed in 36 % of LMSs in the materials of the DKSM [143]. A recent report states, albeit anecdotally and without providing exact figures, that LMSs are strongly associated with a rapid increase in tumor size [130]. The issue of rapid growth, pertaining in particular to the differentiation between LMSs and LMs, is discussed below under DD.

Performing an HSC in combination with fractional curettage is indicated when patients present with abnormal uterine or postmenopausal bleeding. However, since LMSs remain in the myometrium for a relatively long time, they are correctly recognized as such on the basis of the curettage specimen in only 25 % of cases (i.e. a false-negative rate of 75 %) [143]. Curettage is thus not indicated when there is no abnormal uterine bleeding and where intracavitary sonography yields no suspicious findings – current NCCN-guidelines deem curettage inappropriate in such cases [191]. In postmenopausal patients, or patients who are premenopausal with suspicious clinical and/or sonographic findings, and who complain of uterine bleeding, unsuspicious findings resulting from analysis of curettage tissue specimens should not be blindly trusted or assumed to be correct. Likewise, the results from HSC could lead to an LMS being mistaken for an LM. Dilated, irregular and crossed vessels with diameter fluctuations could be suggestive of a malignancy and thus give rise to performing a deeper hysteroscopical biopsy and/or more intensive diagnostics.

It often only becomes evident intraoperatively – usually following morcellation – that a removed LM exhibits further unusual or uncharacteristic features, for instance serous or

hemorrhagic cysts and/or decomposing or necrotic tissue in the absence of a capsule (Fig. 14.4a–c, Table 14.11).

Diagnoses reached via frozen section are correct in only 19–28 % of cases [251], though it should be pointed out that these data are somewhat dated. The occurrence of mitoses, TCN and atypia in so-called "hot spots" further exacerbates these insecurities. Myomectomies are also known to have yielded misdiagnoses [263]. The difficult DD between benign, semi-malignant and malignant smooth muscle (!) tumors makes pathologico-anatomical diagnostics based on tissue removed via morcellation particularly challenging. The intraoperative findings presented in Table 14.11 however, provide clinicians with important pointers suggestive of a potentially non-ordinary LM.

While there are no specific tumor markers for LMSs, they do produce LDH and its isoenzymes. LDH-levels are known to have been elevated in up to 80 % of LMSs, but also in STUMPs and occasionally in LMs and degenerated LMs [103, 250]. According to DKSM data, even in recurring or metastasized LMSs, the LDH-values reach pathological levels in about 50 % of cases [143]. LDH-values are not suitable for screening due to their relatively low sensitivity. Notwithstanding, they can indeed be helpful in the context of differential diagnosis, if clinical assessment and symptoms are unclear or inconclusive and/or imaging reveals suspicious findings [58, 103, 187].

Sonography nearly always reveals findings suggestive of an LMS. What makes sonography so valuable is that it serves to provide results that point to an LMS even when clinical diagnostics do not. Such findings make further diagnostic measures necessary, or at the very least require the therapeutic approach opted for to be re-evaluated. Currently, 47 % of LMSs sonographically present and are subsequently described as unclear tumors (though not LM). A further 30 % appear to be suspicious LMs in sonography, while only 10 % are described as sarcomas [143]. In other sources, 30 % of LMSs are classified as unsuspicious findings following sonography, while 45 % are deemed abnormal [251]. As also applies to morphological diagnostics, in general, the largest mass should always be subjected to particularly close examination. The combination (!) of clear rapid tumor growth between successive sonographic examinations with an age of >45 years or present clinical symptoms is suggestive of a malignant or semi-malignant tumor. Solitary tumors with a diameter of ≥5–8 cm are generally to be suspected to be LMSs (see also flow chart) [143]. LMSs occur as solitary tumors ≥8 cm in 56.5 % of cases, compared to 9.1 % among LMs [143].

Changed echogenicity compared to myometrium is an important factor suggestive of an LMS or a malignant mesenchymal tumor. Furthermore, characteristic sonographic findings include: derounded tumors with, in part, bizarre and poorly defined margins to the myometrium; irregular cystic structures with and without hemorrhagic content; necroses. The septa between the cysts usually differ in thickness. The necroses and/or cystic structures usually have bizarre margins. This also applies to the interfaces between zones of differing echogenicity. In particular, numerous central and peripheral hypoechoic spaces can be observed in the tumor that usually reflect abundant vascularity, but also small cysts and necroses. The vessels can often be identified relatively easily due to their narrow hyperechoic rim. They reflect the presence of central hypervascularity, a typical characteristic of all uterine sarcomas. Tumors are highly suspicious of being malignant if they have ruptured the serosa and protrude through it (Figs. 14.1b, 14.4c, and 14.5c, d). Transvaginal sonography should be supplemented with transabdominal sonography in cases in which the former cannot sufficiently visualize the tumor due to its size.

Suspicious or unclear/ambiguous sonographic findings should be followed up by a Doppler examination, unless a primary total HE is already planned. Doppler- or color Doppler sonography usually reveal elevated levels of peripheral and intratumoral vascularity (Fig. 14.5b) [78, 225]. While LMSs are characterized by irregular or incidental vascularity, in LMs the vessels are predominantly peripheral and in a circular pattern. Vascularization of the septa between the cystic regions is also typical for LMSs [75]. A sensitivity of 88, a specificity of 96 and a PPV of 44 % are achieved when only the presence of marked central vascularity in LMSs is considered. The combination of a solitary intramural lesion, a diameter of >8 cm, central vascularity, and the presence of cystic areas is associated with a specificity of 99 % and a PPV of 57 %, albeit with a low sensitivity of 50 % [75]. Central vascularity can also be absent and thus promote a misdiagnosis as an LM. The RI can provide important information suggestive of sarcoma. The mean RI in cases of LM is 0.58, which is lower than in normal myometrium and in adenomyosis (mean: 0.67). RI in LMSs, with a mean of 0.31, is significantly lower than in LMs [161]. Another study has revealed that the median RIs in LMs (0.59) and LMSs (0.49) do not differ to any degree of statistical significance. The authors, however, go on to state that this could be a consequence of the small number of LMS-cases included in their study [19]. Overall, RI is highest in the myometrium, lower in LMs and at its lowest (relatively) in sarcomas. Setting a cut-off value of 0.4 for the RI is reported as being highly appropriate for distinguishing between benign and malignant lesions, i. e. for diagnosing malignant smooth muscle tumors, with a sensitivity of 90.9 and a specificity of 99.8 % (PPV 71.4 %, NPV 99.96 %) [160, 162, 225]. Applying an RI cut-off value of 0.5 yields a detection rate for LMSs of 67 %, with a false-positive rate of 11.8 % [270]. In principle, it is legitimate to assume that an RI < 0.4 is associated with a malignancy, while an RI > 0.7 is reliably suggestive of a benign condition. Further clarification via

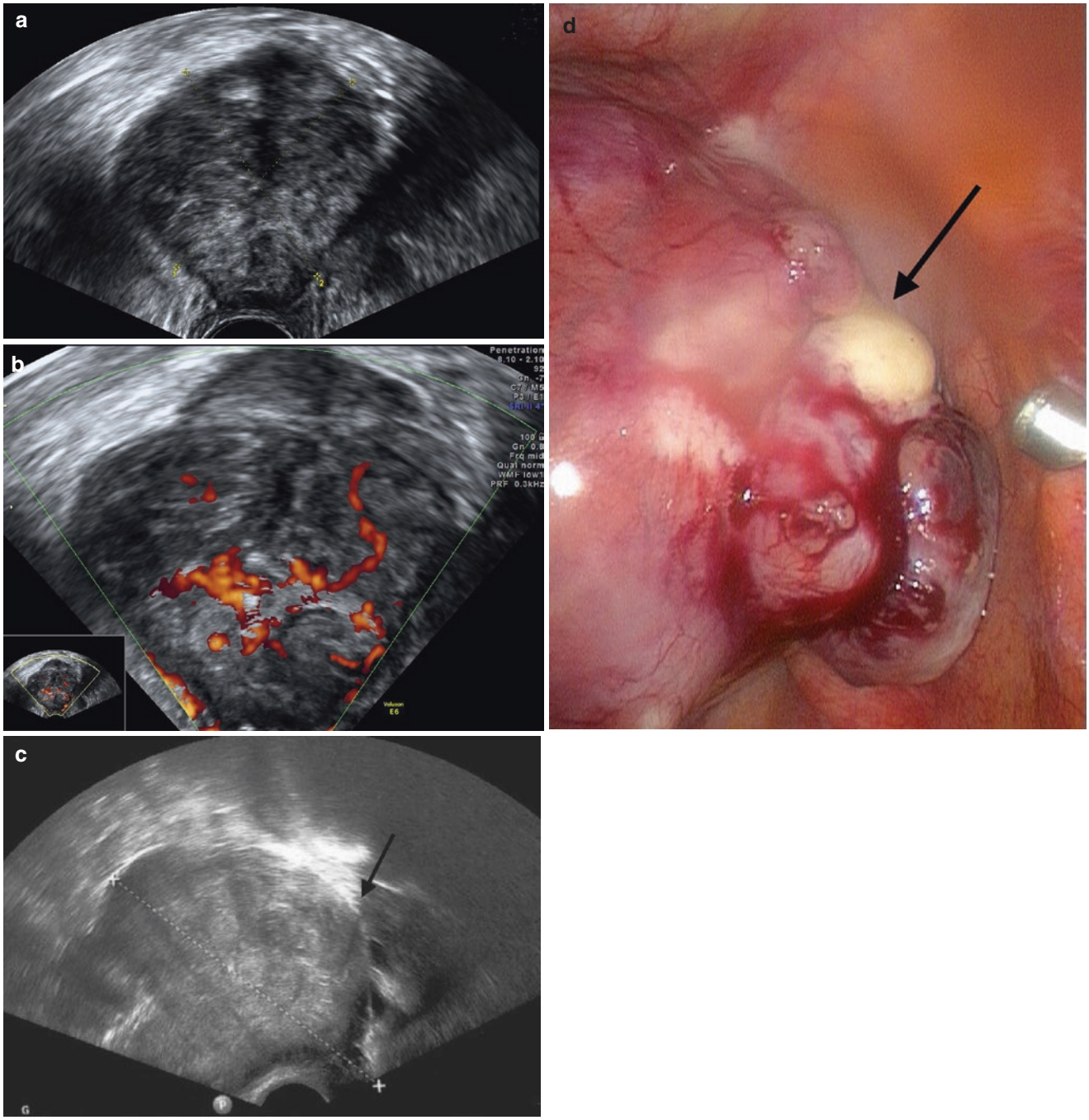


Fig. 14.5 Leiomyosarcoma. (**a**) This ultrasound image bears numerous characteristics that are suggestive of a malignant mesenchymal tumor; (**b**) color Doppler sonography confirmed this suspicion by showing up strong irregular vascularization that in part corresponded to the signal voids; (**c**) tumor with unobtrusively heterogeneous echogenicity that has broken through the serosa in the fundus region; (**d**) endoscopy confirmed that the tumor had broken through the serosa (*arrow*). The visible *yellow* mass was in fact necrotic tissue. The signal voids apparently correspond to the widened atypical vessels that are clearly visible on gross observation (With permission of Köhler et al. [145], Fig. 1.2–8d, e, 1.2–7i, j)

MRT should be sought in doubtful or questionable cases. Typical sonographic characteristics of LMSs are summarized in Table 14.2. The more criteria that are fulfilled, the greater the risk of a malignant mesenchymal tumor or another uterine sarcoma. Even if only one such criterion is fulfilled, diagnostics must be conducted in strict accordance with the flowchart depicted in Fig. 14.22, and/or any planned organ-preserving/sparing surgical procedures or interventional measures should be dispensed with. This equally applies when sonographic findings are unclear or difficult to assess.

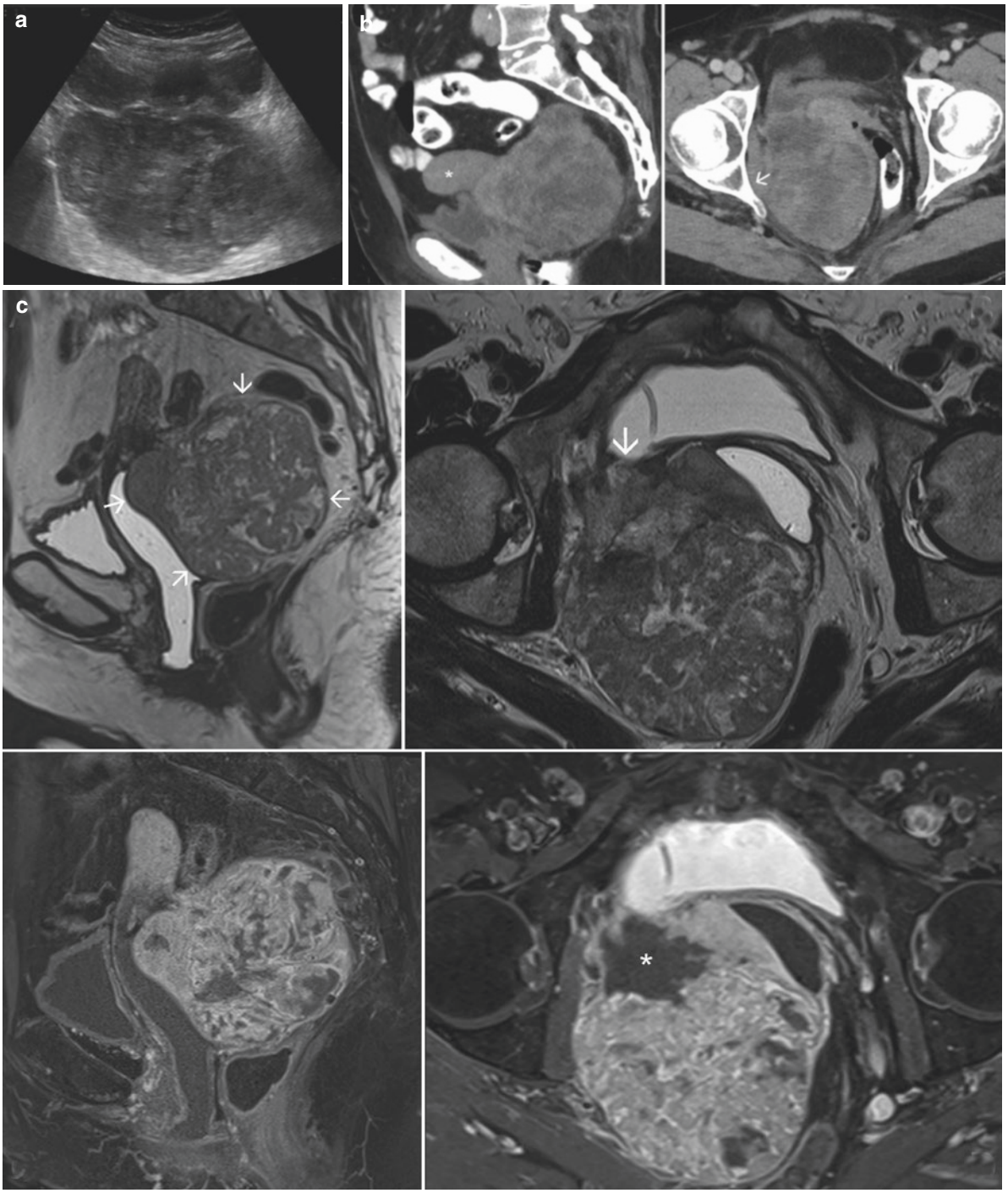


Fig. 14.6 Leiomyosarcoma. Sonographic (**a**), CECT (**b**) and MRT-image (**c**) of a large cervical LMS; (**a**) abdominal sonography shows a tumor with heterogeneous echogenicity that apparently contains numerous necroses with bizarre margins; (**b**) sagittal (*left*) and axial (*right*) CT findings of a large heterogeneously dense tumor in the Douglas that borders the pelvic wall on the patient's right (*arrow*). The corpus uteri (*asterisk*) is anteflected. Most of the hypodense areas are necroses with irregular margins, which corresponds with the findings from sonography and MRI; (**c**) in sagittal and axial T2 W-MRT (*left* and *right*, *top*), the LMS (boundaries marked with *small arrows*) appears as an inhomogeneous hypointense mass that is interspersed with hyperintense areas. A fistula to the bladder (*vertical arrow*) has already developed. Below the *arrow*, a predominantly hyperintense necrosis is recognizable. In sagittal and axial T1 W-MR images (*left* and *right*, *bottom*), upon application of the contrast agent and fat suppression, the LMS shows clearly inhomogeneous enhancement with several non-enhancing tumor necroses (*asterisk*). The latter correspond to the hyperintense mass revealed in T2 W (*top right*) and to the hypodense areas shown in axial CECT (With permission of Köhler et al. [145], Fig. 1.2–10a–c)

Table 14.2 Sonographic characteristics of uterine leiomyosarcomas

Boundaries to the myometrium are poorly defined, derounded, often bizarre or with pointed, tapered extensions
Tumor has clear heterogeneous echogenicity with larger areas of strong hyperechogenicity
Patchy or predominating hypo- to anechoic regions across the entire tumor
Margins between areas of differing echogenicity are derounded, often bizarre or with pointed, tapered extensions
Serosa reached or ruptured
Marked peripheral and irregular central hypervascularity
Central vascularity plus cystic sections plus tumor >8 cm
RI < 0.4

Köhler et al. [145]

Table 14.3 Characteristics of leiomyosarcomas in MRI

T1 W	Tumor with intermediate SI or low (cystic necroses in particular) SI, scattered areas of high SI (hemorrhages in particular)
T2 W	SI primarily intermediate, with heterogeneous hypo- (hemorrhages) and hyperintense SI, some sections with very high SI (necroses, cysts)
T1 WC	Tumor with heterogeneous enhancement
	Weaker enhancement than the homogeneously enhancing myometrium
	Necroses and cysts show no enhancement, often irregular margins

Köhler et al. [145]

Analogous to MRT, determining the LDH-value can be a useful means for further narrowing down the diagnostic options in cases of suspicious sonographic findings as well. It is, therefore, essential that, whenever an LM is suspected, sonography be performed prior to any projected surgical or interventional therapeutic measures – both as a means of preventing inappropriate therapy, and also on grounds of legal certainty.

Expanding imaging diagnostics to include MRT is indicated when sonography and Doppler sonography plus LDH-testing cannot provide sufficient clarification, but organ-sparing surgery and/or morcellation or interventional measures (embolization, high-frequency ultrasound destruction) are planned (see Fig. 14.22). A CT would be inadequate for resolving such issues, but could be a sensible option for determining disease spread when an LMS has been histologically verified (Fig. 14.6b). Taking into consideration that performing an LNE has yet to be scientifically proven as beneficial for almost all types of genital sarcoma, resorting to imaging diagnostics to determine nodal status is generally questionable. One study revealed a sensitivity and specificity of 40–60 % and 80–90 %, respectively, for pelvic LN involvement [296]. The values for para-aortic metastases were 43 % and 91 %, respectively.

MRI (Table 14.3) is better suited than CT for assessing the resectability of locally spread tumors, in particular in relation to neighboring organs, due to its high level of tissue resolution. In terms of LN-involvement, the same statements apply as have already been made regarding CT. 7.5 % of MRT-findings pertaining to LMSs are classified as normal findings, while 30 % are abnormal findings. No clear specification is made for the remaining 62.5 % of LMSs [247].

In T2-weighted MRT images, a high SI, irregular tumor structures, and cystic and necrotic areas (high SI) in combination with ill-defined tumor margins generally are important signs for a malignancy. An SI of >50 % in T2-weighted images together with the mere presence of high SI in T1-weighted MRT images and non-enhancing signal voids in T1 WC are strongly suggestive of a STUMP or an LMS. There have been accounts of LMSs showing homogeneous hypointense SI in T1 W [259, 285]. In T1 WC MRT with gadolinium, LMSs exhibited rapid contrast agent enhancement within 20–90 s, while LMs and the myometrium showed a delayed and gradual enhancement [103]. The necroses and cysts, with their irregular margins, do not enhance (Fig. 14.6c). Degenerated LMs and STUMPs can exhibit similar behavior in MRT [118].

The highest degree of diagnostic accuracy is achieved when there is a combination of the following findings: >50 % high SI on T2 W images plus hyperintense areas on T1 W images and well-defined areas of non-enhancement on T1 WC images [59, 277]. Respective findings also apply to STUMPs, however [277]. Despite the characteristic MRT images with their high specificity, and due to the low sensitivity of all of the findings, no statistically significant objective criteria exist that are associated with the presence or absence of an LMS or a STUMP. Combining the most important criteria [59] with sonography offers a sensitivity of 17–56 % and a specificity of 80–100 % for correctly identifying an LMS, which constitutes a far superior likelihood than can be achieved using purely clinical methods. Performing additional LDH-testing can serve to substantially narrow down the possible diagnoses. Combining MRT findings with elevated LDH-values is said to have a

sensitivity of 100 % for diagnosing LMSs. In one study [103], the specificity, PPV, and NPV as well as diagnostic accuracy associated with stand-alone MRI diagnostics were 93.1 %, 52.6 %, 100 % and 93.1 %, respectively. Combining MRI with LDH-testing served to raise all four of these figures to 100 %. It is important to note, however, that, in more than 50 % of LMSs, the LDH-values are within the normal range [143].

Degenerated LMs are the most important diagnostic pitfall, both clinically and in the context of imaging diagnostics. Differentiating between malignant tumors with cystic structures and degenerated LMs is somewhat simplified by the fact that, in the case of the latter, the cysts are located in an otherwise unsuspicious myometrial environment, exceptionally have bizarre margins, and women with degenerated LMs tend to be younger [230]. Cellular LMs can bear marked similarity to LMSs, both in T2 W and T1 WC images [199].

Performing an FDG-PET-CT can be indicated in exceptional cases (f. ex. in the case of an urgent desire to preserve fertility) when uncertain MRT results leave a need for further clarification [70]. PET-CT is said to have a diagnostic accuracy of 100 % when combined with LDH-testing [200]. There is currently no scientific justification for performing primary PET-CT [235].

Currently, the most substantial problem with LMSs lies in the fact that they are frequently not recognized as such, both before and during surgery, and that 51–68 % of LMSs are operated on under the indication of LM [143, 247]. LM is thus the most important and significant DD for LMS. The median age of women with LMs is 35.5 years at the time of initial presentation [38]. Decisively, however, the median age of women at the time at which LM-surgery is indicated is 45 years, according to the results from two DKSM working groups [143]. LMs are thus subjected to surgery 6–8 years earlier than LMSs are. LMs are predominantly associated with cycle-related pains (dysmenorrhea or hypermenorrhea and menorrhagia), while LMS-patients are more likely to complain of cycle-unrelated symptoms. Symptoms like *de novo* urinary urgency without signs of bladder inflammation or sensations of pressure are generally characteristic of larger tumors. Accompanying symptoms are somewhat more common in LMS than in LM patients. These findings notwithstanding, 14–31 % of LMS-patients show no clinical symptoms [143]. For contrast, 4–80 % of women with LMs are symptom-free [64, 199].

LMSs have median and mean diameters of 8.0 cm and 9.5 cm, respectively. A more detailed breakdown reveals that 85.6 % are ≥5 cm, 55.6 % are ≥8 cm, and 38.5 % are ≥10 cm in their largest dimension [143]. By contrast, according to two separate DKSM-analyses, only 55.2 % resp. 16.9 % of LMs have diameters of ≥5 cm to ≥8 cm [143] (Table 14.8). A further study [64] revealed a respective share of 13.5 % for the latter. A tumor size of ≥5 cm, and even more so tumors with a diameter of ≥8 cm, can be regarded as a criterion for differentiating LMSs from LMs.

According to DKSM-data, LMSs occur as solitary tumors in 50 % of cases [143]. Two separate DKSM studies have shown that 40.1 % of LMs are solitary lesions [143]. On its own, the fact that the tumor is solitary is insufficient for safely differentiating an LM from an LMS. When the two differentiation criteria "diameter ≥8 cm" and "solitary tumor" are combined, however, the differences in frequency become more apparent: while 9.1 % of LMs fulfill both criteria, the respective share among LMSs is significantly greater, at 25.5 % [143]. A solitary tumor with a diameter of ≥8 cm should thus be interpreted as being suggestive of LMS. The aforementioned data are considered in the diagnostics flowchart for preventing inappropriate surgery below (Fig. 14.22).

Two DKSM working groups revealed that 13.3 % of ordinary LMs and 26.0 % of LMSs exhibited rapid growth [143]. Other sources have observed rapid growth in up to 31 % of LMs [64]. In one prospective study, 26.7 % of LMs showed volume gains of 30 % within 1 year. In 26 % of those cases, a 30 % increase in volume was observed within just 3 Mo. There were no accounts of an LMS developing in that study. Interestingly, short-term growth spurts were less common or extensive in LMs that had a diameter of 5 cm or more at the time of initial observation [21, 64]. A further DKSM-analysis revealed that 13.3 % of LMs with a diameter of ≥5 cm exhibited rapid growth, compared to 26.0 % of LMSs. In a further prospective study, 34 % of LMs were rapidly growing. The study also revealed that the rapidity of growth declined dramatically as age increased – rapid LM growth in women aged 45 and above was the exception in the study [222]. It is currently contested whether rapid uterus growth in premenopausal women without accompanying symptoms should be regarded as a warning sign [64]. Besides the fact that LMSs exhibit rapid growth twice as frequently as LMs do, the DKSM-results and studies mentioned above [21, 222] also imply, however, that an LMS should be seriously considered in cases in which tumors with an initial diameter of ≥5 cm exhibit rapid growth and/or when there is rapid tumor growth in women aged 45 and above. At least one of the symptoms stated at the beginning of this section was present in 68 % of LMSs that exhibited rapid growth [143]. Reversely, this also implies that 32 % of patients with rapidly growing LMSs do not complain of any symptoms. According to a further study, asymptomatic, rapidly growing LMs up to a size of 16 WOP with and without rapid growth do not require any special measures to be taken – tumors beyond that size should be subjected to more intensive examination [78]. The clinical criteria that can be suggestive of an LMS as well as other uterine sarcomas are presented in Tables 14.4 and 14.8, and are also considered in the diagnostic flowchart (Fig. 14.22) below.

Table 14.4. Risk factors, symptoms, and clinical findings of uterine sarcomas in particular leiomyosarcoma suitable as selection criteria for preventing or excluding inappropriate sarcoma operations under the indication of a leiomyoma

Tamoxifen exposure
Suspicious sonography in particular in combination with elevated LDH-values
Newly occurring or growing "myoma" in women ≥50 years in particular during postmenopause
"Myoma" turns symptomatic postmenopausally (in particular bleeding)
Tumor diameter ≥8 cm in particular in solitary tumors
Myoma growth under medication therapy
Rapid growth from a starting diameter of ≥5 cm and/or with newly arising symptoms and/or aged >45 years
Myoma with abnormal uterine bleeding (beyond menses)
Very soft tumor

Modified from Köhler et al. [145]

Determining the GDF-15 factor and the unspecific N/L--ratio can be helpful in diagnostically differentiating an LMS from an LM [141, 284].

Both during and after surgery, an LMS need not necessarily be macroscopically discernible as such from other LMs alongside which it has developed. In 94.4 % of cases in which LMSs and LMs occur simultaneously, the former constitutes the largest lesion [143], the soft consistency of which is usually another factor strongly suggestive of it being an LMS. LMs are relatively solid and rough, and show a whorled structure on the cut surface. They have well-defined margins compared to LMSs and a discernible pseudo-capsule is present, out of which they can normally be easily enucleated.

STUMPs constitute the biggest challenge for DD at the histological level. They are difficult to discern – clinically, pathoanatomically and in imaging – from both LMSs and LMs. TCN, MI, and atypia are the pivotal histologic differentiation criteria. The particularities in this regard are discussed in the section on STUMPs. For more detail pertaining to histological appearance in the context of DD, reference should be had to the specialist literature [144]. The same applies to information on the diagnostic differentiation of LMSs from PEComs (perivascular epithelioid cell tumors) [152].

If the results from all imaging and laboratory-chemical options as well as curettage and HSC (where necessary due to abnormal uterine bleeding) provide no clarification, and the patient insists on a conservative strategy, a transcervical punch biopsy can be performed under ultrasound guidance. Experiences with this approach have been surprisingly positive. In one study, transcervical punch biopsies were taken from 453 women whose tumors were LMS-suspicious (high SI in T1/2 W MRT and/or high LDH-values and/or rapidly growing tumor with threefold gain in volume within 1 year) [135]. Among 372 eligible cases, only 7 sarcomas were found. In no case in which histologic examination revealed no suspicious findings (atypia, mitoses, TCN, infiltrations, vascular invasions, epithelioid or myxoid components) was an LMS subsequently revealed in the further course. Examinations performed on 312 women showed that a transcervical punch biopsy under ultrasound guidance is in fact less burdensome for/on patients than curettage [136]. Nonetheless, false-negative results need to be reckoned with, for spindle-cell sarcomas in particular [96]. One reason for this is because mitoses, atypia, and necroses can in fact be concentrated in so-called "hot spots". There is a real risk of missing these hot spots using punch biopsy, so that, essentially, only positive findings can be truly relied on. There are reports that measuring the CD34 and Ki-67 indexes can serve to minimize that risk [300]. The authors defined a case as positive when the measured Ki-67 index was ≥ 15 % [300]. Nonetheless, the Ki-67 index does not constitute a histological criterion for correctly diagnosing an LMS as such (!) (see section on STUMP). Due to the stated problems, biopsy should not be performed at the time of definitive surgery. The described problems and pitfalls notwithstanding, in a further study, the results from performing sonography-assisted trans- or intraabdominal needle biopsies (18-gauge needle) on suspicious lesions with high SI in T2-weighted images were greatly beneficial. Malignant tumors were found in 12 of 63 cases (19 %) (11 LMSs, one LG-ESS). Among the remaining 81 % (n = 51) that were classed as benign, surgery revealed only one LG-ESS. The other 50 lesions were LMs, 27 of which were surgically removed. The remaining 23 tumors exhibited no signs of malignancy in a median follow-up period of 32 Mo. The results are a specificity of 100 % and a sensitivity of 91.7 %, with positive and negative predictive values of 100 and 96.2 %, respectively [276]. The positive morphological results notwithstanding, the risks associated with intraabdominal (!) biopsy suffice to regard the procedure as a counter-indication. The high growth-related pressure within the tumor, that, in turn, is thus frequently pressed up against the serosa (Fig. 14.1a–d), can cause tumor cells to ooze out of the puncture point and subsequently disseminate within the abdominal cavity. Furthermore, tumor perforation cannot be ruled out (Fig. 14.4b, c). These risks are knowingly condoned when intraperitoneal biopsy is performed, and can be avoided by instead opting for a transcervical punch biopsy.

Clinical Course and Prognostic Factors Relevant to Therapy

With reference to the current staging system, median OS for stages I, II, III and IV is 75, 66, 34 and 20 Mo, respectively [232], while mean OS is 45.2, 28.1, 37.6 and 34.3 Mo, respectively [176].

Disease stage is regarded as the most significant prognostic factor, independent of patient age [6, 93]. 42.6–55 % of patients have stage I disease, 4–4.3 % have stage II, 11–12.1 % have stage III, and 30–40.9 % have stage IV disease at initial presentation [232, 233]. Tumor size is also a strong independent prognostic factor in multivariate analysis [2, 95, 232]. According to recent data, stage I disease has a 3 and 5 year OS of 64 % and 38 %, respectively, while OS remains stable at around 30 % in patients with stage II–IV disease. The median time to recurrence is 19.7 Mo across all stages [93].

An MI beyond 20 M/10 HPF is related to a significantly shorter RFI [182]. For instance, 5-year OS for patients with an MI of 6–10 is 60 %, and 23 % for an MI of >20/10 HPF [2]. More recent findings suggest that, in multivariate analysis, an MI of 12 M/10 HPF and above is already significantly associated with a higher rate of recurrence [93]. Ki-67 expression is said to have no influence on recurrence, i. e. it is of no predictive value [93].

Overall, the following pathoanatomical characteristics are said to be associated with poorer survival: size ≥5 cm, unclear gross margins, an MI of >20 M/10 HPF, epithelioid or myxoid components, extensive TCNs, diffuse severe atypia, lymphatic invasion, p53 positivity, and an absence of ER and PR-expression [57].

Most recent analyses suggest that the number of M/10 HPF alone (<25 vs. ≥25 M/10 HPF) constitutes the most important predictive factor for OS [233]. MI and tumor size as well as patient age and the presence of extrauterine spread are the most important factors in calculating prognostic scores according to Zivanovic [308]. The lymphocyte/monocyte ratio, a new independent prognostic variable for soft tissue sarcomas, including LMSs, is significantly associated with RFI and tumor-specific OS in both uni- and multivariate analyses. Preoperative values < 2.85 are associated with an inferior prognosis [271].

LMSs predominantly metastasize hematogenously, while lymphogenous spread plays only a subordinate role. LMSs have a propensity to metastasize to the lungs (65 %) and the liver (23 %) [233]. Overall, 56 % of disease recurrences involved hematogenous metastases, while pelvic metastases were found in only 7 % of cases [182]. According to other sources, up to 31 % of recurrences are solely distant metastases; 73 % are distant metastases plus pelvic recurrences [89].

Metastases to the ovaries occur in only 3.5 % of cases of stage I disease [187], and are almost always observed in connection with further extrauterine spread [57, 100, 168]. At the time of primary diagnosis, no metastases could be found in the ovaries of 202 DKSM-cases of LMSs of all stages [143]. It has yet to be proven that not performing a BSO has a negative impact on prognosis [106]. According to a case-control study [98] and a SEER-analysis [134], whether the ovaries are removed or left during premenopause has no effect on prognosis. A further study has shown that performing a BSO in fact has negative effects on disease-specific survival [95, 98]. This is in line with data that suggest that patients aged up to 55 years have a more promising prognosis than older women [95, 123], and that OS progressively worsens from age 55 onwards [6]. Other studies suggest that ER and PR-expression are not correlated with patient age, stage of disease, vascular invasion, and relapse rate, and have no influence on PFI and OS [33, 61, 93].

In a SEER-analysis, all lymph node-positive patients had stage IIIB or stage IV disease [134]. Nodal positivity was observed in 6.6 % of stage I–IV cases; positive LNs without extrauterine spread were observed in only 3.5 % [168, 182]. In a sample of 884 LMSs of all stages, positive LNs were found in only 3.3 % of cases. Similarly, nodal involvement was found in only 4 % of all LMS-cases included in the DKSM material database [143]. In all of these cases, positive LNs were accompanied by simultaneous extrauterine involvement. Positive LNs were not found in any of the cases of cervical LMS [24]. Accordingly, it has yet to be proven that performing an LNE has beneficial effects on RFI and OS [4, 60, 134, 154, 156]. This is in line with the findings that the number of distant metastases clearly exceeds the number of pelvic recurrences, that LN-involvement is usually accompanied by other extrauterine spread, and that recurrences are common despite patients being lymph node-negative.

The increased demand for conservative modes of treatment has been accompanied by parallel rise in the frequency of reports of surgical procedures being performed that are inadequate/inappropriate for LMSs [1, 87, 117, 201, 215, 226, 289]. An analysis of retroperitoneal sarcomas, including LMSs, identified R1/R2 resections and tumor ruptures as significant independent predictors for worsened OS [37]. These data can be regarded as surrogate evidence for the negative impact of tumor injury occurring in the course of surgical procedures that are inappropriate for uterine sarcomas. A negative impact on patient prognosis should always be expected whenever an LMS is subjected to morcellation [72, 223]. First studies have shown that morcellation only results in a slight increase in the rate of disease recurrence without any measurable impact on OS [197]. Three further studies have revealed a significantly shorter RFI for LMS and LG-ESS patients subjected to morcellation, as well as shorter OS among LMS patients, even though the women were younger and the tumors were smaller than in women who

underwent appropriate surgery [97, 199, 217, 225, 254]. A recent analysis compared the effects of morcellation and total abdominal HE on patient prognosis [97]. The study revealed a four-fold reduction in RFI when morcellation was performed (10.9 vs. 39.6 Mo for total abdominal HE) accompanied by a doubling of mortality risk. Endoscopic follow-up examinations of LG-ESS, STUMP and LMS patients who underwent morcellation revealed intraperitoneal tumor dissemination in 64 % of cases that occurred within 3 Mo in 43 % of cases, and that had not been present at the time of primary surgery. Follow-ups on 2 LMS patients originally subjected to conservative morcellation revealed that extensive metastasization had occurred within one Mo [104]. 75 % of LMS patients in whom there was peritoneal dissemination following morcellation succumbed to their disease within 8.4–40.3 Mo [210, 254]. The causal connection between morcellation and a shorter RFI is further supported by the fact that, in these cases, locoregional and intraabdominal recurrences were considerably more frequent than in LMS-patients who underwent appropriate surgical procedures [188, 217]. A recent meta-analysis covering morcellated vs. non-morcellated LMSs revealed an odds-ratio of 3.16 for all recurrences, 4.11 for intraabdominal recurrences and 2.42 for the death rate. The cumulative extraabdominal relapse rate was not elevated [35]. The higher relapse risk associated with endoscopic morcellation [217] might be due to changes in pathophysiological conditions during LSC. Experimental studies appear to be supportive of this assumption [221]. Another reason is seen in the use of electric morcellators during LSC that apparently propel tumor cells into the abdominal cavity [68, 247]. That would certainly help to explain why tumor cell dissemination seems to occur less frequently when a scalpel or other cutting instrument is used during open surgery. At 0.16–1.18 %, the very low rate of port-site metastases for endoscopic gynecologic carcinoma surgery [179, 185, 307] thus does not necessarily speak against there being an elevated risk of recurrence in performing endoscopic morcellation or the enucleation of sarcomas. What is more, intraperitoneal tumor implants cannot be equated to port-site metastases and, overall, sarcomas and carcinomas behave differently in general. However, the risk of port-site metastases is nonetheless regarded as also being elevated in cases of gynecologic high-risk neoplasms. In such cases, robot-assisted LSC should be avoided [179]. In the meantime, the AAGL and the FDA have issued warnings against using electric morcellators [1, 80].

Besides morcellation, tumor injury and positive surgical margins <1 mm are further independent risk factors that have been significantly associated with local disease recurrence and poorer OS. According to one study [292], local recurrence was in fact 5.6-fold more likely. For these reasons, tumor enucleation, too, is to be viewed critically from a prognostic perspective. There is generally no indication for performing tumor enucleation on LMS patients [74]. LMSs have no capsule, or rather appear to have a pseudo-capsule consisting of compressed tumor tissue, making it inevitable that only R1 (or at least RX) resection margins can be achieved. A recent study revealed a significant RFI-reduction compared to total abdominal HE (8.2 Mo for myomectomies, vs. 46.6 Mo for total abdominal HE) [130].

There is the risk that intravascular or myometrial infiltrations remain in the uterine stump following laparoscopic and abdominal supracervical HEs. Therefore, from a clinical perspective, even when R0-resection margins have been described, an RX-situation should always be assumed. Early disease recurrences within 3 Mo of such operations have been reported [14]. The situation appears to be similar when the uterus is injured with a sharp instrument. In fact, supracervical HE and other uterus disruptions resulted in a 2.8-fold increase in mortality-risk with simultaneous decreases in RFI and OS [223]. In the DKSM-sample, the rate of relapse after inappropriate operations (any form of tumor and uterus injury) is 28.3 %, compared to 27.7 % among patients subjected to appropriate surgical procedures. It needs to be noted, though, that the women who underwent appropriate surgery (n = 101), with a mean age of 55 years and an average tumor diameter of 9 cm, had a poorer primary prognosis than the patients who were subjected to inadequate surgical procedures (mean age of 47 years, tumor diameter of 6.5 cm) [143].

Two studies [246, 260] have shown that death due to LMS was more common in endoscopic HE with morcellation versus open abdominal HE. However, estimated overall (!) deaths were lower in the former. The authors state that the risk of LMS morcellation is balanced by complications that are associated with laparotomy, including death. Better quality of life and lower costs were further highlighted as advantages of endoscopic procedures. Such statements interfere with efforts to avoid inadequate LMS surgery, and to improve diagnostics for these tumors.

Surgical Therapy and Problems

The prognostic data unambiguously show that uterine sarcomas have to be resected in a manner that doubtlessly leaves R0 resection margins and that causes no injury to the tumor whatsoever. What this implies for uterine LMSs is that such tumors have to be removed together with their compartment “uterus” without injuring or damaging it. Total HE without injuring the uterus is thus to be regarded as the standard surgical procedure for LMSs, too [113, 172]. There is no indication for a primarily vaginal approach due to the risk of causing injury to the uterus that this procedure entails, as well as the lack of possibilities for exploring the abdominal

cavity. When opting for laparoscopically assisted vaginal HE or total endoscopic HE, neither the tumor nor the uterus are allowed to sustain injury. There are no data to confirm that performing such surgeries without injuring the uterus leads to less-promising results than would be achieved via open surgery. Intrauterine manipulators should not be used when endoscopic procedures are performed. In the USA and in Germany, 89.4 resp. 64 % of LMS patients undergo total abdominal or total laparoscopic HE [143, 233]. Since supracervical HEs always go hand in hand with injuries to the uterus (potential opening of microscopic invasion routes), they must be classified as inappropriate operations, not least because – as endoscopic procedures – they are virtually always performed in connection with morcellation. The prognostic consequences that could potentially result have been described in the subsection on prognosis. According to the current NCCN-guidelines, the GCIG consensus, the AAGL-recommendations, and the position paper of the German Society for Gynecology and Obstetrics (Deutsche Gesellschaft für Gynäkologie und Geburtshilfe, DGGG), morcellation should always be avoided when an LMS is suspected [1, 27, 113, 202].

Due to the impact that tumor and uterus injuries have on prognosis [204, 217, 223], intraabdominal *in vivo* excisional and punch biopsies as well as tumor enucleation (see prognosis) should not be performed when an LMS is suspected.

Based on the prognostic analyses (see prognosis), there is no indication for performing a BSO on LMSs that are confined to the uterus when the ovaries are unsuspicious from a clinical standpoint. Likewise, a BSO is not necessary according to the ESMO-guidelines [74]. The NCCN-guidelines and the current GCIG consensus [113, 202] state that a BSO can be performed on an individualized, i.e. case-specific basis, bearing in mind the age of the patient. The AAGL [1] recommends a BSO for premenopausal women who do not wish to preserve fertility, albeit without providing any scientific justification. The Japanese guidelines, too, do not back up their recommendation to perform a BSO with any scientific evidence [201]. Whether or not a BSO is indicated is thus dependent on the will of the patient, her menopausal status and the surgical conditions. Overall, in Germany, a BSO is performed on 67 % of LMS patients [143], in the USA this applies to 99.2 % [233]. The fact that at least 50 % of LMS-patients are postmenopausal could also help, at least in part, to explain the high frequency to which BSOs are performed.

According to the current NCCN-, ESMO- and Japanese guidelines as well as the GCIG-consensus, an LNE is not routinely necessary [74, 113, 201]. This takes into consideration that, currently, it has yet to be proven that performing an LNE would have any effect on RFI and OS (see also prognosis) [4, 60, 95, 134, 154, 156]. Furthermore, whether the LNs test positively or negatively does not allow for any further therapeutic consequences to be deduced. There has thus yet been no indication for routinely performing systematic and selective LNEs on patients with LMSs for some time now [91, 134]. Nor is an LNE recommended for cervical LMSs [24]. It remains unproven whether performing a selective LNE on enlarged or suspicious nodes offers any benefits [113], but such course of action can nonetheless be taken according to the GCIG-consensus [113]. Regional LNE does not fall within the surgical spectrum envisaged for retroperitoneal soft tissue sarcomas and LMSs [37, 85, 106]. Nonetheless, LNE in some form is performed in 27–30 % of LMS patients [143, 231, 233].

Omentectomy is not indicated unless there is omental disease involvement [202]. In the DKSM materials, omentectomies accounted for 13 % of 158 LMS-operations, and omental involvement was identified in 15.2 % of those cases. However, in all of those cases, said involvement was accompanied by other extrauterine spread [143]. Cytological smear testing of the abdominal cavity has no implications for therapy, as the resulting findings have not yet been proven to be of prognostic significance.

The poor overall prognosis (!) and the aforementioned risks (see prognosis) associated with certain surgical methods and procedures serve as a counter-indication against performing tumor extirpation on lesions that have been identified as LMSs. The RX-resection as the overriding problem with which tumor extirpation mostly because of the missing capsule (Fig. 14.4a–c) is associated cannot be remedied by using an extraction bag. The same applies to morcellating the tumor inside an extraction bag. A critical review of the literature reveals that a significant share of the conservative operations that resulted in favorable outcomes was in fact performed on so-called low-grade LMSs, that are in fact mainly classified as STUMPs nowadays [170, 248]. The promising courses and outcomes thus need to be treated and interpreted with caution. Should identified LMSs nonetheless be subjected to tumor extirpation in absolutely exceptional cases, the tumor should be no larger than 5 cm and R0 resection margins must be achieved without doubt. Overall, subjecting an LMS to conservative surgery is currently regarded as an inappropriate measure [91]. Should a patient who has been correctly diagnosed with an LMS wish to preserve her fertility and thus insist on conservative surgery, she must be insistently informed that such surgery will further worsen an already very poor overall prognosis, and follow-up LSC (see below) as well as total HE once the desire for fertility-preservation ceases (i.e. upon child birth) should be urgently recommended.

For the risks associated with incidentally inappropriate surgery, see the final section below.

If an LMS is diagnosed post-operatively following conservative primary surgical procedures, including supracervical HE, the residual uterus/cervix as well as all tumor masses

should be fully resected in any case [1, 27, 202], notwithstanding that having undergone inappropriate primary surgery will have already increased the risk of recurrence. The possibility of residual tumors remaining in the uterus and/or its lymphatic vessels is the primary motivation behind this course of action. In one study, 15 % of re-operated patients were upstaged [72]. Drawing on the experiences reported by the DKSM and more recent literature [143, 210], in these cases, the tumor stage was not primarily incorrectly assessed – rather, new tumor residuals or occurrences had arisen/developed. In a total of 12 DKSM-cases involving LMSs and LG-ESSs, metastases that had previously not been detectable were identified in the 2–4 weeks following primary surgery [143]. It is thus urgently recommended that patients who undergo morcellations or "myoma enucleations" be subjected to endoscopic follow-up or re-operation/completion surgery within 3 to 6 Mo [202, 210, 254]. The AAGL, too, recommends re-operation or LSC as means for follow-up, and to remove any suspicious tissue [1]. Where the aforementioned measures are not performed, following-up via imaging techniques is strongly advised [177, 202].

The surgical management of advanced LMSs applies to all LMSs that have spread beyond the uterus. Locally advanced LMSs are predominantly accompanied by dissemination to the abdominal cavity. Simultaneous distant metastasization, in particular to the lungs, is also common. If the LMS is confined to the pelvis or the abdominal cavity, and no distant metastatic disease is present, then maximal debulking should be aspired to. Aggressive cytoreduction can apparently serve to prolong survival even when only R1-resection margins have been achieved [66]. It is also possible to perform intra- and extraperitoneal interventions (the latter in the lung in particular) when conditions are favorable [169]. Absence of clinical post-operative residual disease was associated with a significantly improved RFI as well as improved OS. While the benefits for OS were not statistically significant, the median OS in such cases was still a remarkable 31.9 Mo [169]. Currently, in light of the few applicable chemotherapeutic agents available, and their poor response rates and very short PFIs, subjecting patients with advanced disease to remedial surgery should be the therapeutic strategy of choice. Accordingly, the current NCCN-guidelines and the GCIG-consensus [113, 202] both strongly prioritize the surgical resection of all metastases, depending on their resectability and the extent of disease. Where metastasization is extensive, a palliative HE is always indicated if uterine bleeding cannot be controlled by other means [113].

Follow-up and aftercare should entail gynecological and general examinations that are clinically guided by the presenting symptoms. Follow-up examinations should be conducted every 3 Mo for the first 2 years, every 6 Mo in the following 3 years, and every 12 Mo thereafter. The current NCCN-guidelines make a 2A–recommendation to consider running a CT on the thorax, the abdomen, and the pelvis at these follow-up examinations. MRI or PET and further diagnostic procedures should be reserved for when there are suspicious findings or when patients show clinical symptoms [202]. It remains unclear, however, what course of action should be taken when imaging diagnostics yield positive findings in symptom-free patients. Benefits for survival resulting from complex laboratory-chemical and instrument examinations have yet to be scientifically substantiated. Clinical examination should always be combined with vaginal sonography, and abdominal sonography where deemed necessary. This applies in particular to cases in which patients have undergone primary surgical procedures that are associated with increased risk of locoregional disease recurrence.

There are no indications for adjuvant or postoperative chemo- and/or radiation therapy. More detailed information, including data pertaining to the therapeutic approach for metastases, should be taken from the specialist literature [145].

Atypical Smooth Muscle Tumors (Smooth Muscle Tumors with Uncertain Malignant Potential, STUMP)

Epidemiology, Etiology, Pathogenesis

The term "atypical smooth muscle tumor" has come to be increasingly used in place of the term STUMP. Current WHO-classification [212] defines a STUMP as a smooth muscle tumor with characteristics that clearly preclude a diagnosis as an LMS, while at the same time not fulfilling the criteria for being classified as an LM or one of its variants. The common characteristic of these heterogeneous tumors (that are too rare to be able to definitively predict their behavior) is their metastatic potential, which is very low, and much lower than that of an LMS. The current nomenclature "atypical smooth muscle tumor" includes such tumors that had previously been termed 'atypical LM'.

STUMPs are observed in women with a mean age of 35 to 42 years, in an age range from 25 to 77 years [227, 277]. According to DKSM data, the median and mean ages are 46 and 44.9 years, respectively [143]. Thus, they occur roughly 7–9 years earlier than LMSs and can consequently be regarded as a kind of precursor or forerunner. In clear contrast to LMSs, only 20 % of women with STUMPs are postmenopausal and 28 % are $\geq$ 50 years old. Calculations conducted by two DKSM working groups revealed in summary that STUMPs account for 0.153 % (6 of 3920, 1:653) women who underwent any form of LM surgery (*14334*). Atypical LMs differ from LMs in that they can have proven chromosome-p1-deletions, which are suggestive of an independent etiology [53].

Macroscopic and Microscopic Appearance

According to DKSM data, STUMPs have median and mean diameters of 6 resp. 6.8 cm [143]. STUMPs are occasionally observed side by side with LMSs [164]. Cutting open the surgical specimen often reveals macroscopic characteristics that differ from those of ordinary LMs, for instance the absence of the whorled structure, and a more fleshy gross appearance. Necroses, hemorrhages and cystic sections can be present (Fig. 14.7a, b). It sometimes occurs that final diagnosis as a STUMP is only reached upon specimen re-examination on the occasion of a patient presenting with disease recurrence.

The histological criteria for categorizing an atypical smooth muscle tumor as such are the MI, the presence of cellular and nuclear atypia, and an absence of clear TCN (s. section on LMS). The lack of unambiguous TCN is the most important histological difference to an LMS. TCN needs to be distinguished from so-called hyaline (infarct-like) necrosis, which occurs relatively frequently in normal LMs as a spontaneous regression phenomenon. Necroses that cannot be reliably categorized as either TCN or hyaline necrosis are termed questionable or uncertain necroses, and constitute an important criterion for diagnostically classifying a STUMP as such.

According to the current WHO-classification [212], lesions are to be classified as atypical smooth muscle tumors or STUMPs if they fulfill the following histological characteristics [28, 57, 119, 120, 121, 212]:

- MI of > 15 M/10 HPF without TCNs and without atypia,
- focal/multifocal moderate to severe atypia with an MI of 3–5 M/10 HPF,
- diffuse moderate to severe atypia with an MI of 2–9 M/10 HPF,
- uncertain necroses or isolated/sporadic TCNs without mitoses and without atypia.

Opinion is divided on TCN in this context. While some hold the view that only uncertain necroses are eligible as a criterion [181, 207], others state that it is also sufficient if there are isolated/sporadic necroses coupled with no more than a low MI and mild atypia [62, 212]. The presence of multiple TCNs that have been reliably identified as such, however, is a criterion that clearly points towards LMS. Histologically, around 20 % of STUMPs exhibit hyaline necroses [181]. Hyaline necroses and areas of edema showed more frequently in atypical LMs treated prior with hormonal therapy. Microscopic examination demonstrated that 46 of 51 cases had pushing margins, i.e. margins penetrating the myometrium [181].

In one study, 100 % of atypical LMs exhibited strong PR-expression, and 10 of 13 tumors had moderate to strong ER-expression [269]. In other studies, ER and PR-expression tested positive in around 50 resp. 70–100 % of cases [34, 192, 305]. Measured ER-expression levels closely resemble those of LMSs and differ significantly from levels found in ordinary LMs. By contrast, PR expression is significantly higher than is the case in LMSs. These findings underline the special position that STUMP holds between LM and LMS, and serve to clarify the importance

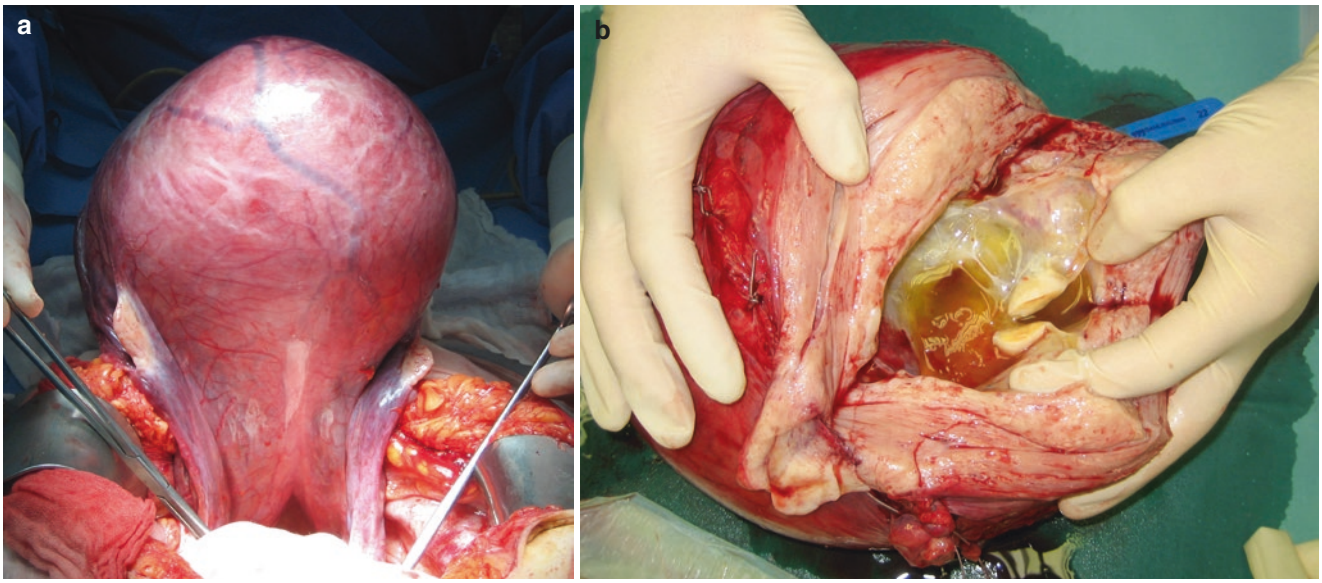


Fig. 14.7 Atypical smooth-muscle tumor (STUMP). AB: this 52 y.o. patient is a prime example for the fact that these tumors have often already grown to quite a size at the time of primary diagnosis. Compared to ordinary LMs, they are usually softer, less fascicular, and often inhomogeneously colored. Additional gelatinous components and cystic structures are not uncommon. (With permission of Köhler et al. [144], Fig. 1.1–15a, b)

of PR-expression as a factor for differentiating a STUMP from an LMS.

The Ki67-index of atypical LMs fluctuates between 0 and 25 % (mean 2 %). Since LMSs have a Ki67-index of between 6 and 50 % (mean: 25 %), said index can only be used with caution as a means for differentiating between LM and LMS. 84.6 resp. 38.5 % of atypical LMs show a strong immune reaction to p16 and p53 [269]. A further study [50] revealed a mediate-to-strong diffuse p16 staining pattern in 100 % of LMSs and STUMPs (WHO-classification pre-2014). STUMPs with diffuse p16 staining and TCN should be classified as LMSs [18, 142]. Diffuse p16 and/or p53 staining is regarded as the most important indicator for an increased risk of recurrence [57]. Overall, drawing a line and differentiating between STUMPs and LMSs is remarkably difficult. For more detailed information, also on the extremely rare myxoid and epithelioid STUMPs, reference should be had to the specialist literature [144].

Symptoms, Clinical Presentation, Diagnostics, Imaging, Differential Diagnosis

The symptomatology associated with STUMPs largely corresponds to that of ordinary LMs, and also that of LMSs, featuring heavy menstrual and prolonged bleeding, menorrhagia, dysmenorrhea, and premenstrual pains. The same can be said of their clinical presentation. STUMPs often exhibit a rapid rate of growth, in young women in particular [143]. Postmenopausal LM-growth points to a STUMP or an LMS. Lack of remission following treatment with GnRH-analogues or UPA, or continued LM-growth, are also suspicious. On palpation, STUMPs often feel softer than ordinary LMs, a finding that is reported almost without exception in surgery reports [143]. During surgery in which the tumor remains *in situ* or is not cut open, the differences to ordinary LMs are often only implied, or are not even visible and discernible at all. In opened tumors, however, hemorrhaging, gross necroses, or cystic areas are not uncommon. When in doubt, a frozen section can be performed. However, such practice can often not provide definitive clarification if not accompanied by immunohistochemical testing. The problems and difficulties that frozen section procedures entail are referred to in the chapters on LMS and LG-ESS. What can be said at this point is that frozen section procedures should only be performed on fully excised tumors (excisional biopsy), since otherwise, as with morcellation, tumor cell conveyance is virtually unavoidable.

STUMPs have a polymorphic sonographic appearance that can be similar to that of ordinary/degenerated LMs and LMSs. Heterogeneous echogenicity and the presence of anechoic regions, in the form of cysts and necroses that are usually an expression of cystic degeneration or hyaline necroses, could be suggestive of a STUMP (Fig. 14.8a) [180]. Narrow anechogenic areas usually correspond to dilated vessels. STUMPs thus cannot be differentiated from ordinary, degenerated and cellular LMs or from LMSs solely on the basis of cystic structures being present. However, the presence of bizarre margins between the individual echogenic and anechoic regions constitutes an important criterion for differentiating STUMPs from LMs. Doppler sonography reveals that STUMPs have a significantly higher degree of central vascularity than both cellular LMs and ordinary LMs (Fig. 14.8b) [75]. STUMPs have an RI between those of

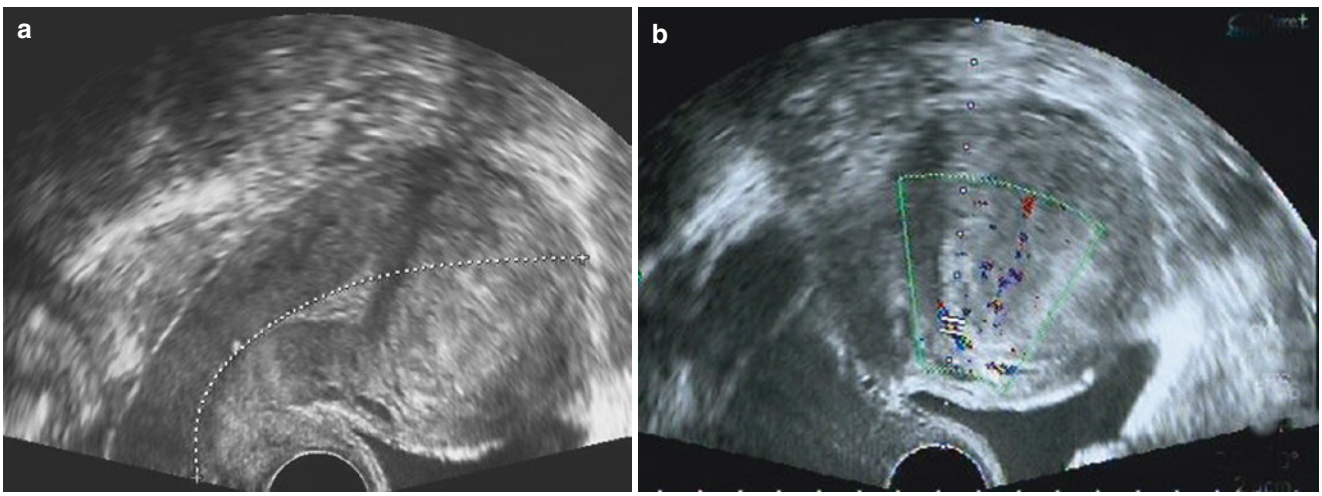


Fig. 14.8 Atypical smooth-muscle tumor (STUMP). (**a**) Closer observation of this predominantly hyperechoic tumor shows margins between the different echogenicities that are bizarre in part. The anechoic voids just above the bladder, with their hyperechoic margins, correspond to dilated vessels, as confirmed in Doppler sonography (B); (**b**) color Doppler sonography of the same tumor also reveals the tumor's central but weak vascularization that in turn speaks less likely for an LMS. The RI of 0.58 lies between those of ordinary LMs and LMSs (With permission of Köhler et al. [144], Fig. 1.1–18a, b)

Table 14.5 Variants of leiomyomas and smooth muscle tumors of uncertain malignant potential

Variant	Tumor cell necroses	Mitotic rate/10 HPF	Atypia or other criteria
Cellular leiomyoma[a]	Missing	<4	Missing or light, but cellular
Leiomyoma with bizarre nuclei	Missing	Missing or low	Bizarre cells and nuclei diffuse p16 and/or p53 staining possible [2]
Mitotically active leiomyoma	Missing	≥5 (10) and ≤15	Missing
Atypical smooth muscle tumor (STUMP [4])	Few present or questionable [3]	none	None
	Missing	>15	Missing
	Missing	3–5	Moderate to severe, focal or multifocal
	Missing	2–9	Moderate to severe, diffuse

Modified from Köhler et al. [144]

[a]Particularly when chromosome p1-deletions are positive, cellular leiomyomas exhibit the prognostic behavior of STUMPs [2], classification as STUMP when there is diffuse p16 and/or p53 staining [3], when hyaline necroses and TCN cannot be clearly discerned from one another [4], elevated risk of recurrence for all STUMPs in case of diffuse p16 and p53 expression

LMs and LMSs in most cases (0.4–0.7). More detailed particularities are described in the chapter on LMSs.

CT does not allow for a specific diagnosis to be reached. As is also the case with LMs, for STUMPs, in many cases T2 W MRI reveals a homogeneous hypointense mass [257, 277]. Differentiation from an ordinary LM is not possible in such cases. However, as is the case with LMS, T2 Ws can also reveal hyperintense tumor sections or cysts. The non-enhancing cystic regions and necroses within the enhancing tumor are easily discernible in T1 WC images. A clear differentiation from an LMS is often not possible [257, 277]. Despite remaining uncertainties, the probability of identifying an LMS or a STUMP is very high (with an accuracy of 87 %, a sensitivity of 72.7 %, and a specificity of 100 %), if >50 % of the tumor has a high SI in T2 W images, smaller sections have a high SI in T1 W images, and several non-enhancing pockets are recognizable in T1 WC images.

In terms of DD, the greatest histological challenges are posed by cases that are borderline between STUMP and LMS. Due to the frequent localization of mitoses, atypia, and necroses in so-called 'hot spots', results from frozen section examinations that are suggestive of a STUMP are to be deemed uncertain unless there is a clear and unambiguous LMS-diagnosis. Moreover, MI is elevated during progestin therapy and pregnancy. The pathologist must be provided with such information where present, so as to prevent false diagnoses that otherwise have been avoidable. Analyzing mast cell count in the tumor can be helpful for differentiating between a STUMP and an LMS. Mast cell counts are significantly lower in LMSs than in cellular and atypical LMs [214, 297]. The cut-off value is 16 mast cells per HPF [214], with a sensitivity of 100 % and a specificity of 96 % [214]. In uncertain cases, p16 expression should be taken into account – where p16 expression is diffuse, then a diagnosis of LMS should rather be opted for [18]. According to a different source, immunohistochemically determining p16, p53, and Ki67-indexes is not suitable for differentiating between LMSs and STUMPs. It should be borne in mind that p16-expression does not constitute an independent diagnostic criterion for LMSs. Histologically differentiating STUMPs from mitotically active LMs, from LMs with bizarre nuclei, as well as from cellular LMs can be challenging (Table 14.5). Differentiating the very rare epithelioid and myxoid STUMPs from the respective LM and LMS variants is particularly difficult. For more detail, reference should be had to the specialist literature [144].

Clinical Course, Prognostic Factors Relevant for Therapy

As a general rule, the different STUMP variants are all benign lesions. Recurrence and metastasis usually occur within the uterus, the pelvis, the abdominal cavity, the retroperitoneal region, the lung, the liver, in the bones, and the LNs. Distant metastases usually occur in the lungs [31, 108, 227]. There have also been accounts of metastasis in the deep soft tissue of the neck, the posterior mediastinum, and the paravertebral region [51, 245]. Interestingly, with a mean age of 34 years, women with recurring disease are roughly 10 years younger than women without recurrence [108, 119]. There are only few morphological criteria that serve to predict the risk of disease recurrence and the sites of recurrence and metastasis. There have been accounts of recurrences of atypical LMs with entirely absent MI or an MI < 2 M/10 HPF. From an immunohistochemical and molecular genetic perspective, diffuse immunoreactivity for p16 and/or p53 is regarded as a strong predictive factor for recurrence or metastasis in STUMPs [18, 50, 119, 121]. Even the presence of only minimal TCN is apparently associated with an elevated risk of disease recurrence [10], though it should be noted that, in these cases, the differences to LMSs are not stark or overly blatant. Estrogen and progesterone receptor expression are of no prognostic significance [31, 34].

According to different sources, the rate of recurrence in STUMPs is between 7.7 and 26.7 % [108, 121, 224, 270], and thus markedly lower than for LMSs. Another study comes to the conclusion that recurrences and metastases occur after a mean period of 46.9 Mo (15–108 Mo). Median OS in these cases was 63.9 Mo (40–108 Mo) [121]. Even after 20 years, the risk of recurrence cannot be entirely ruled out. The majority of disease-specific deaths occur 6–11 years after diagnosis [99]. Accordingly, the disease-specific 5, 10, and 15-year survival rates are 100, 88, and 81 %, respectively [99]. A considerable share of STUMPs also recurs and metastasizes as LMSs [10, 107, 108, 227, 258]. Of the 12 STUMPs in the DKSM material that developed metastases, 42 % did so as STUMP, while in the remaining 58 % disease metastasized as LMS [143]. Given the current data situation, the transformation of a STUMP into an LMS should be deemed a serious possibility, not least because STUMPs generally provide the necessary genetic and microbiological preconditions.

Recurrences and metastases only seem to occur following conservative "myoma therapies" and abdominal or endoscopic supracervical HE (Fig. 14.9) [3, 31, 258, 269]. It cannot be safely deduced from the merely occasional accounts of recurrences occurring following total HE that a morcellation was not performed in those cases [108, 181]. Performing morcellation on smooth muscle tumors has increasingly come to constitute a special risk factor, not least due to the danger of spreading cellular tumor material. There have been accounts of STUMP-recurrences occurring within only a few weeks [143]. The problems associated with morcellation are addressed in detail in the chapter on LMSs. In order to prevent morcellation being performed on the wrong object, when clinical and sonographic findings are suspicious, more intensive diagnostics should be conducted, in particular prior to organ-sparing surgery. Due to the numerous clinical and sonographic commonalities between STUMPs and LMSs, the diagnostics-flow chart (Fig. 14.22) presented in the chapter "risk and prevention of inadequate surgery" should be consulted as a decision-making aid.

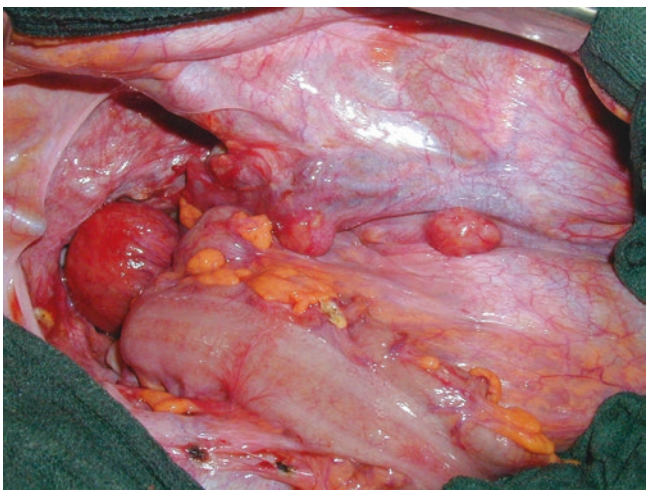


Fig. 14.9 Atypical smooth-muscle tumor (STUMP). Peritoneal metastases of an atypical smooth muscle tumor that was incidentally discovered post-operatively following endoscopic supracervical HE with morcellation, 22 months after primary surgery (With permission of Köhler et al. [144], Fig. 1.1–20a)

Overall, total HE without injuring the tumor is the best method for preventing recurrence. In 3 of 51 cases (34 HE, 17 myomectomies), subsequent HE resp. Myomectomy revealed two atypical LMs in the residual uterus and one atypical LM in the retroperitoneum. Interestingly, in the latter case, the recurrent tumor had been preceded by a total HE, probably in combination with laparoscopic morcellation [181]. It in fact currently remains difficult to assess whether performing laparoscopic myomectomy on STUMPs results in more intrauterine recurrent disease than in ordinary LMs [181]. The cumulative risk of intrauterine recurrence following laparoscopic myomectomy of ordinary LMs is at around 51 % [203]. This rate is possibly no lower than that for recurrence following myomectomies performed on STUMP patients. What is decisive, though, is that recurring tumors and metastases of STUMPs need to be assessed differently than LMs in terms of whether or not they are malignant, and that transformation into an LMS is a possibility that should be reckoned with.

Surgical Therapy and Problems

According to the current literature, total HE is the standard surgical procedure for STUMPs [181]. Surgery should be performed without injuring the tumor (morcellation, sharp clamping). There is no indication for a systematic and/or selective LNE. Recurrences are known to occur both in cases in which a BSO has been performed, as well as in such in which it has not [31]. One analysis found that having undergone BSO has no influence on the rate of disease recurrence [108]. Data pertaining to LMSs suggest that a BSO has no influence on the further course of disease [134]. A case has been reported in which a STUMP patient developed LMS metastases following a supracervical abdominal HE with BSO [258]. BSO can thus be indicated on the basis of the patient's wishes, her menopausal status, or other circumstances that give rise to an independent indication for such surgery. There is no indication for performing a BSO *ex post*.

Where a STUMP has been diagnosed, in exceptional cases – for instance where the patient has an urgent and pressing desire to have children [121] – conservative uterus-sparing surgery can be considered [181]. In doing so, the tumor must not be injured during resection, and the cut must be made outside the pseudocapsule in tissue that is definitely

disease-free. Since disease recurrences and metastases almost exclusively occur after conservative procedures, patients must be insistently informed of the increased risk of recurrence and the danger of a possible transformation into an LMS. It is strongly recommended that patients undergo a total HE once their desire to have children has been fulfilled, i.e. following pregnancy and childbirth [121].

Whether or not a subsequent HE should be recommended upon the incidental finding of an R0-enucleated STUMP can be decided based on the immune reaction to p16 and p53, as well as the presence of coagulative or questionable necroses. From a pathological-anatomical perspective, it is urgently advised to perform the HE in all cases in which there is no certainty of tumor benignity (f. ex. questionable necroses, size, atypia, the presence of any mitotic activity) [207]. Whether or not performing a gasless endoscopic myomectomy in STUMP patients, as is recommended by some authors [274], should indeed be regarded as innocuous in terms of recurrence risk, remains unproven and rather unlikely. R1/2 resections should be followed by a follow-up resection, or even better by HE.

Cases of very early post-surgery tumor dissemination following morcellation of a STUMP have been reported [210]. The recent literature [198, 210, 254] recommends a follow-up LSC within 3–6 months of performed myomectomy, morcellation/tumor injury, and unclear resection margins, unless a subsequent total HE is planned [210, 254]. Possible tumor deposits should be R0 resected in the course of these procedures. Total HE is indicated for cases in which patients have no desire to preserve fertility.

Due to the problems associated with determining and specifying the MI, as well as the possibility of overlooking a STUMP or (in the worst case) an LMS as a consequence thereof, conservative surgery should rather not be considered for lesions classified as myxoid or epithelioid LMs or STUMPs. For more detail, reference should be had to the specialist literature [144].

Clinical aftercare should be designed according to the symptoms shown and can be roughly adapted to aftercare for LMS patients. There are no indications for post-operative chemo, hormone, or radiation therapy. There are no known contraindications for hormone replacement therapy.

Low-Grade Endometrial Stromal Sarcomas (LG-ESS)

Epidemiology, Etiology, Pathogenesis, Staging

In Germany and Norway, LG-ESSs account for 26.9 resp. 20 % of all uterine sarcomas, excluding carcinosarcomas [2, 143]. Incidence of LG-ESSs in Southern and Northern Europe is at around 0.23 resp. 0.3 cases/100,000 women [155, 186]. According to various sources, the age of affected women ranges from 15 to 96 years. Median age is 42–52 years; 50 % to 88 % of LG-ESSs arise prior to menopause [20, 47, 299]. The age range in Germany is 18–80 years according to DKSM-data [143], median age is 46 years, and only 18 % of presenting women are postmenopausal.

LG-ESSs exhibit t(7;17) translocations and consecutive fusions of the JAZF1- and SUZ12- (previously: JJAZ1) genes as well as t(6;7) translocations (JAZF1/SUZ12-gene fusion), which are typical genetic abnormalities [206]. t(7;17)(p15;q21) translocation is an early genetic aberration in the development of LG-ESSs. Interestingly, this translocation can also be observed in LG-ESSs that exhibit a focal smooth-muscle differentiation, which allows the conclusion that such tumors originate from a pluripotential mesenchymal precursor cell (progenitor cell) [32, 206, 211]. Identical genetic aberrations are also found in so-called endometrial stromal nodules (ESN), which are regarded as a precursor of LG-ESSs [157].

ER, PR, and aromatase expression as well as association with pregnancy and endometriosis allow the assumption that estrogens are involved in the etiology, pathogenesis, and progression of LG-ESSs [236–241]. Previous or ongoing tamoxifen or toremifen therapy is regarded as another etiological factor [15, 111, 115].

Since 2009, FIGO-staging and UICC-TNM-classification for stromal sarcomas and LMSs have applied (Table 14.1) [83, 217, 264].

Macroscopic and Microscopic Findings

LG-ESSs predominantly have the appearance of an intramural nodulated tumor with strong similarities to an LM or the rare ESNs. LG-ESSs can expand into the cavum and protrude through the cervix when growth persists (Fig. 14.10a–c). They have a median size of 5.5 to 5–8 cm [94, 143]. Compared to LMs, LG-ESSs almost always have a softer consistency. Like with LMs, the cut surface may exhibit whorled structures, but is usually significantly smoother. Like ESNs, the opened tumor often has a yellowish to tan-yellow, sometimes light reddish appearance. On gross examination, intramural tumors can appear well circumscribed and can displace the surrounding myometrium and endometrium. Compressed tumor and surrounding tissue can form a kind of pseudocapsule (Fig. 14.11). Macroscopically visible finger-, worm- or tongue-like infiltrations, when present, are a typical gross characteristic.

Cystic structures, necroses, and focal hemorrhages are present to varying degrees (Fig. 14.13a). LG-ESSs can also exhibit a less common growth pattern in which diffuse myometrial infiltration forces the myometrium apart/separates it. In such cases, the wall of the uterus appears enlarged and

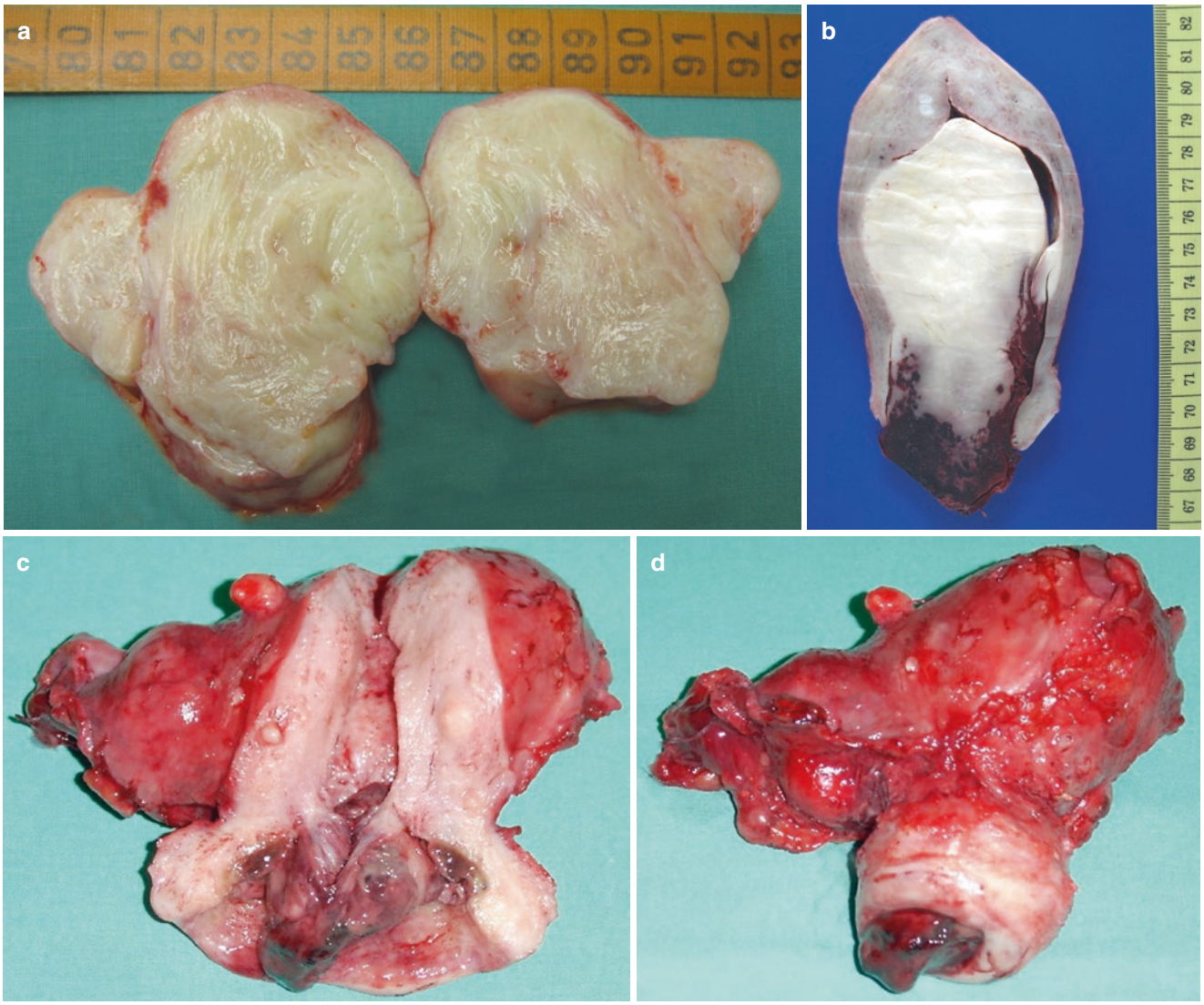


Fig. 14.10 Low-grade endometrial stromal sarcoma. (**a**) Knotty tumor that can barely be macroscopically discerned from an LM; (**b**) large smooth formalin-fixated LG-ESS that had filled out the entire cavum uteri; (**c**, **d**): pedunculated tumor macroscopically similar to an LM that is protruding from and through the cervix (With permission of Köhler et al. [147], Fig. 2.2–1a–d)

thickened, with a certain degree of nodulation. LG-ESSs occasionally also originate primarily in the cervix.

Overall, an LG-ESS consists of cells that are reminiscent of endometrial stroma in the proliferation phase. The cells cannot be morphologically discerned from ESNs. Microscopically, LG-ESSs are characterized by opulent small uniform cells with oval nuclei, small or absent nucleoli, scant cytoplasm, and poorly defined cytoplasm boundaries. Significant atypia are absent by definition [195]. Accordingly, the microscopic appearance is monotonous and bland. Necroses and hemorrhages also occur in LG-ESSs [286]. The MI does not correlate with diagnosis and prognosis, and is usually measured at around <5 M/10 HPF, but can also exceed 10 M/10 HPF. Atypical mitoses are rare, and true TCNs hardly ever occur. The vessels most closely resemble uniformly distributed endometrial spiral arteries. Lymphatic and blood vessel invasion are observed in 19.1–26.6 [20, 143] resp. 30.8 % of cases [143].



Fig. 14.11 Low-grade endometrial stromal sarcoma. Cut-open LG-ESS specimen with what appears to be a capsule – in the left of the image – that gradually diminishes (or fades) towards the cut base and crosses over into infiltration on the opposite side that is clearly visible on gross observation (With permission of Köhler et al. [147])

LG-ESSs typically have a strong expression of ER and PR (in 71–95 % of cases) [22, 54, 118, 237]. Missing ER and PR-expressions have been reported, albeit with ER being negative more frequently than PR [286, 299]. LG-ESSs can contain aromatases and can thus synthesize estrogens themselves [237]. CD10 expression is characteristical of LG-ESSs, though not specific to them.

Symptoms, Clinical Presentation, Diagnostics, Imaging, Differential Diagnosis

In about 70 % of cases, LG-ESS is an incidental finding during or after HE that is performed on the basis of an LM diagnosis [20, 143, 247, 299]. Forty-eight to seventy-two percent of all patients present with abnormal uterine bleeding in form of intermenstral bleeding and/or heavy und prolonged menstrual, or postmenopausal bleeding. Abnormal uterine bleeding, while it may be absent in some patients, thus constitutes the most common symptom [20, 143, 299]. Tumor growth causes diffuse enlargement of the uterus and is linked with lower abdominal pains in around 20 % of cases. Feelings of satiation and pressure are also occasionally reported [143, 299]. Palpation reveals a noticeably soft, fleshy consistency and/or a lumpy surface on the (usually enlarged) uterus or the palpated "LM". A soft consistency is generally to be taken as suggestive of a malignant or semi-malignant mesenchymal tumor. On average, LG-ESSs are said not to be larger than ordinary LMs [59]. Among the DKSM materials [143], and according to a further source, the median size of LG-ESSs is 5.5 resp. 5.8 cm [94, 143]. Data from a further study revealed a mean tumor size of 6.2 cm (0.3–18 cm), with 58.8 % being ≤5 cm [20]. Rapid growth of an "LM" or a rapidly growing uterus during pubescence is not a common clinical finding in women with LG-ESSs, and is observed in only 6.5 % of cases [20]. By contrast, 30 % of all ordinary LMs occurring during pubescence are rapidly growing tumors [64]. Compared to LMSs and UUSs, symptoms associated with rapid tumor growth, like lower abdominal pains and uresiesthesis, are rather less common in LG-ESS patients. Nonetheless, uterine growth or "myoma growth", especially when postmenopausal, is to be regarded as strongly suggestive of a malignant or semi-malignant mesenchymal uterine tumor.

It is essential that conventional clinico-gynecological examination be accompanied by sonographic examination. Abnormal and postmenopausal uterine bleeding most commonly suggest that the LG-ESS has developed into the cavum of the uterus. Hysteroscopy and fractional curettage are always indicated in such cases. The hysteroscopic appearance shall bear similarity either to a pedunculated LM or a polypoid tumor. Since LG-ESSs are frequently located intramurally, curettage will yield unsuspicious findings or a wrong diagnosis in 50–59 % of cases [23, 143, 269]. It is thus unavoidable that hysteroscopy and/or curettage result in misdiagnoses, a typical diagnostic pitfall.

Analogous to gross appearance, sonography, too, predominantly reveals LG-ESSs within the myometrium. Depending on the extent and depth of infiltration, the tumor margins appear either well-defined or poorly defined/irregular in sonography. According to the literature, solid lesions are generally homogeneously or heterogeneously hypoechoic or intermediately echoic [139, 165, 281]. Hypoechogenicity can correspond to that found in LMs and can apply to the entire tumor. There are also accounts of masses being isoechogenic to the myometrium [44]. Differentiation from an LM can be particularly difficult in such cases. A heterogeneous echogenicity, with anechoic regions and strongly hypoechogenic sections separated by washy or bizarre margins, is most commonly encountered, as is also confirmed by DKSM research [143]. LG-ESSs usually clearly displace the hyperechoic endometrium. Growth of the tumor into the cavum usually interrupts the endometrial layer [165]. It is often the case that anechoic clefts or small cysts are visible, either solitary or spread across the entire tumor, that in part correspond to dilated vessels [122], cystic areas, or necroses. The vessels usually have very small hyperechoic edges (Figs. 14.12a, and 14.13b). A diffuse heterogeneous echogenic thickening of the myometrium with partially nodular components is not an uncommon sonographic correlate for diffusely growing LG-ESSs [139, 242].

Between 68 % and 71 % of cases, sonography yields a diagnosis of LM [143, 265], with substantial consequences for surgery indication and surgical procedure (see also the section on risk and prevention of inadequate surgery). Only 18 % of findings are described as malignant tumors, and overall, 17.9 % are classified as suspicious tumors [143].

In Doppler sonography, LG-ESSs show a strong degree of irregularly and focally distributed vascularity in combination with a low RI of 0.21–0.42 and a PI of 0.2–0.49 [46, 49, 126, 139, 162, 242]. The RI cut-off value of 0.4, with a sensitivity of 90.9 % and a specificity of 99.8 %, is largely adequate for differentiating between benign and malignant lesions, or for classifying a tumor as highly suspicious. In Doppler sonography, visible cysts are surrounded by numerous vessels (Fig. 14.12b) [259]. These findings, however, are by no means unique or specific to LG-ESSs, and in fact also apply to other sarcomas. Nonetheless, they serve as a useful criterion for distinguishing malignant lesions from LMs [153]. It can occasionally so occur that color Doppler sonography provides a visual appearance typical of an LM. Should the suspicion of a malignant mesenchymal tumor prevail in light of the patient's medical history and the clinical findings, and should the patient desire organ-preserving/sparing surgery, then adherence to the diagnostic flowchart (Fig. 14.22) (sec-

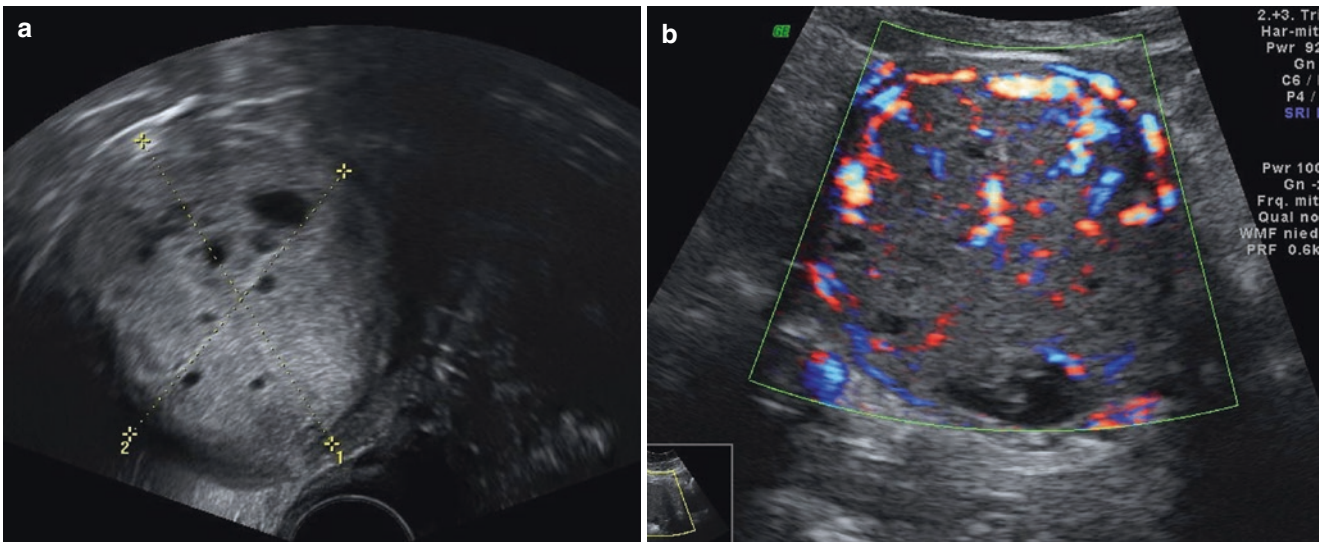


Fig. 14.12 Low-grade endometrial stromal sarcoma. (**a**) Gray scale sonography showing a tumor with heterogeneous echogenicity containing numerous anechoic spaces and gaps. The larger anechoic spaces most likely correspond to necroses with bizarre margins; (**b**) color Doppler sonography revealed that many of the anechoic gaps corresponded to vessels. The strong degree of irregular central vascularity is suggestive of a malignancy (With permission of Köhler et al. [147], Fig. 2.2–9c, d)

tion: risk and prevention of inadequate surgery) is strongly indicated.

Regarding CT, the same applies as previously described for LMSs.

In the majority of cases, MRT images show LG-ESSs as lesions within the myometrium (Fig. 14.13c, d). T1-weighted images typically show a predominantly heterogeneous SI that is hypo- to isointense (and occasionally hyperintense) compared to the myometrium. Signal-free regions are usually necroses or cystic areas that show no enhancement in T1 WC images, but strong hyperintense enhancement in T2 W images. In T1 and T2-weighted images, the tumor is delimited from the surrounding areas by a hypointense layer or rim that can be interrupted by tumor infiltrations. Enhancement in T1 WC-images is predominantly intense (occasionally mild) and heterogeneous (occasionally also homogeneous). Here, too, there is a recognizable band of enhancement that is weaker compared to the rest of the tumor and the myometrium, and that corresponds to the hypointense margin visualized in T1/2 W MRI images. T2-weighted images show a recognizably homogeneous or heterogeneous, sometimes intermediate SI that is higher than that of the myometrium and the skeletal muscles. Cystic structures that appear hypointense in T1 W imaging, but show no enhancement in T1 WC images, are strongly hyperintense in T2 W [88, 259]. In tumors with myometrial involvement, i. e. muscle infiltration/invasion, preserved bundles of muscle fibers are recognizable as bands of low signal intensity (hypointense) within the myometrium in T2-weighted images. This imaging feature is regarded as one of the most important criteria suggestive of an LG-ESS (Table 14.6) [138, 158, 242, 257, 259, 281].

The definitively benign ESN is the most important macroscopic and microscopic DD for LG-ESSs. ESNs and LG-ESSs have identical cytological pictures, so that they only really differ in that, in case of the former, there is no lymphovascular, vascular, or myometrial invasion [268]. Differentiating between ESNs and LG-ESSs on the basis of the tissue specimens gathered via curettage or morcellation without bordering neighboring tissue can thus be very difficult, or even impossible. The attending clinician must be aware of this problem and, where such cases arise, bear the real possibility of an LG-ESS in mind and inform the patient of that possibility and what it implies.

Since LG-ESSs bear great similarity to LMs, both clinically and macroscopically, and predominantly occur prior to menopause, successfully differentiating them from LMs is of particular importance. Accordingly, LG-ESSs are operated under the indication of an LM in 69–78 % of cases [20, 143, 216, 247, 299]. Thus, the majority of LG-ESSs are incidentally diagnosed as such either during or post-surgery. The risk of encountering an LMS or an LG-ESS during HE, regardless of the indication on the basis of which it is performed, is addressed in detail in the section on the risk and prevention of inadequate surgery.

Successfully histologically differentiating LG-ESSs from cellular LMs is by far the greatest differential diagnostic challenge, since both tumors express ER and PR as well as SMA and desmin (the latter albeit rarely among LG-ESSs). Measuring CD10 expression (which, unfortunately, is not seldom positive in LMs and LMSs), especially in combination with H-Caldesmon-expression, can be helpful in this regard [178, 306]. The attending clinician must be aware of the fact that successfully differentiating

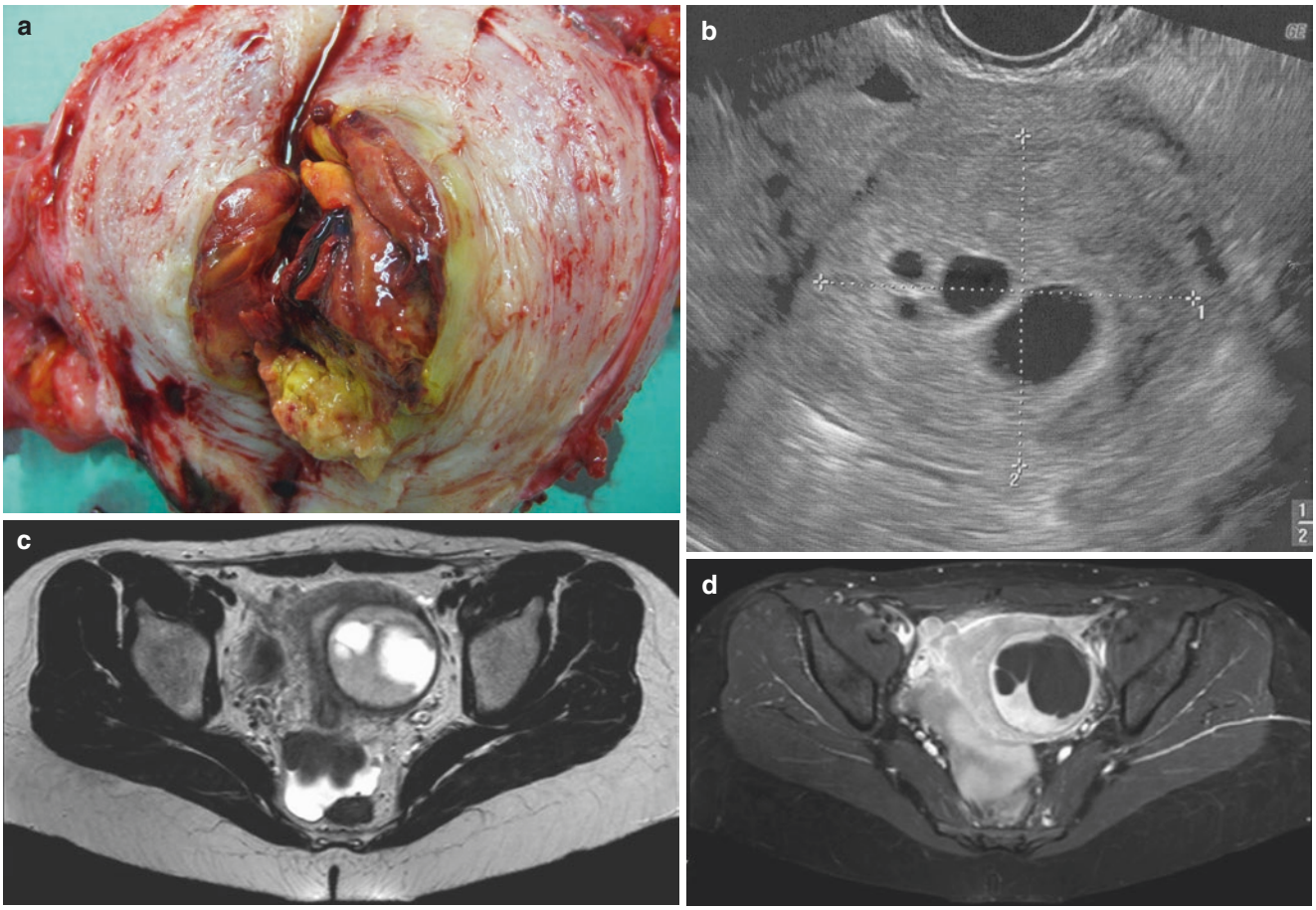


Fig. 14.13 Low-grade endometrial stromal sarcoma. (**a**) Intramurally located LG-ESS with predominantly necrotic (*yellow color*) and cystic components; (**b**) the necrotic and cystic regions of the same tumor showed as anechoic areas in abdominal sonography; (**c**) results from axial T2 W MRI correlated very well to the sonographic findings. The necroses showed typically high levels of signal intensity. The LG-ESS is intramurally located and has visibly displaced the endometrium and the cavum. The typical intratumoral hypointense bands are only barely discernible; (**d**) T1 W contrast-MRI with fat suppression confirmed the necroses as such – they showed no enhancement and showed up as signal free sections. The hypodense rim at the margins is recognizable in all of these images (With permission of Köhler et al. [147], Fig. 2.2–3a, 2.2–11a, c, e)

Table 14.6 Characteristics of low-grade endometrial stromal sarcomas in MRI

T1 W	Tumor with intermediate SI and low (necroses, cysts) SI, scattered areas with high SI (hemorrhages in particular), hypointense rim
T2 W	Predominantly intermediate to hyperintense SI with intratumoral hypointense bands, in part sections with very high SI (necroses, cysts), hypointense rim
T1 WC	intensive homogeneous enhancement, up to heterogeneous enhancement compared to the homogeneously enhancing myometrium
	Rim with weaker enhancement compared to tumor and myometrium
	hyperintense necroses and cysts show no enhancement in T2 W

From Köhler et al. [147]

LG-ESSs from cellular LMs on the basis of frozen section specimens without accompanying immunohistochemical testing can be difficult to impossible. Any diagnosis of a cellular LM that is based solely on photo-optical observation of the biopsy or curettage specimen, and without immunohistochemical testing, should be subjected to critical scrutiny.

Clinical Course and Prognostic Factors Relevant to Therapy

Stage of disease is also the most important prognostic factor for LG-ESSs [6, 94]. Prognosis for tumors >10 cm is apparently no worse than for such that are 5.1–10 cm in size [2, 94]. Prognosis worsens as age progresses [20, 47, 94, 256]

and is significantly less promising in postmenopausal than in premenopausal women. Drawing on numerous accounts, the median time to first recurrence is 36–130 Mo for Stage I, 3 years for Stage I/II and only 9 Mo for stages III/IV (FIGO pre 2009) [7, 48, 129, 140]. Nonetheless, the occurrence of late relapses after more than 10–30 years is distinctive. SEER-data (FIGO pre-2009), calculated for a sample of 356 cases, have revealed a 5-year OS of 96 % for stages I and II, 89 % for stages III and IV, and 92 % for stages I–IV [256]. Two larger retrospective studies measured a 10-year-OS of 87.1–95.8 % and a 10-year RFI of 49.6–52.1 % [20, 299]. LG-ESSs can thus be considered tumors with a relatively promising prognosis. Even relapsed LG-ESSs remain local for a long time and only develop distant metastases relatively late.

Positive pelvic and/or para-aortic LNs are found in 2.6–17 % of women with stage I-IV disease [143, 162, 299] and in 10 % [69] of cases in which the LG-ESS is confined to the uterus. According to SEER-data [256], LNs test positive in 7 % of cases (mean number of removed LNs: 12; 63 % of stage I/II tumors, acc. to FIGO pre-2009). It is thus apparent that positive LNs do not correlate to distant metastasis and disease recurrence in the context of LG-ESSs that are confined to the uterus, while, however, being linked to simultaneous extrauterine spread in the majority of cases [69]. Whether performing an LNE has any effect on prognosis remains unproven. A SEER-analysis compared 100 women who underwent an LNE with 283 patients who did not, and revealed no differences in terms of OS [256]. Benefits could not even be identified for cases in which LNs tested positive. Further SEER-analyses covering 310 and 1010 LG-ESSs, respectively, as well as a smaller and a larger retrospective study, all came to the unanimous conclusion that undergoing an LNE effects no change in OS [11, 20, 25, 94, 261, 299]. Recurrences occurred entirely locoregionally in 40–42 % of cases, albeit without any marked preference for the draining lymphovascular spaces or nodes [20, 143]. The remaining 60 % of cases were comprised of intraabdominal recurrences, distant metastases, or a combination of all forms of dissemination [140]. Distant metastasization occurs to the lungs in particular, though bone metastases have also been reported in isolated cases [20, 299].

Metastatic dissemination to the ovaries is known to occur – in the DKSM-materials, such spread, without involvement of other organs, occurs in 2.4 % of cases [143, 302]. Adnexal involvement has been observed in 9.5 % of cases, and almost uniformly goes hand in hand with further extrauterine dissemination [69]. Despite the fact that HRs usually test positive, the benefits of performing a BSO for both OS and disease-free survival are highly contested. Retrospective studies suggest that sparing the ovaries in premenopausal women increases the risk of recurrence without having any effect on OS [11, 20, 26, 29, 129, 174, 299]. One study determined a median RFI of 5 years for patients who did not undergo BSO, compared to 2 years when the ovaries were left *in situ* [73]. A more recent study concludes that ovarian preservation constitutes a "high-level risk factor" for recurrence [82]. What stands out in this study, besides the relatively small sample size (61 with vs. 7 without BSO), is the relatively low median age of women who did (35.4 years) or did not (43 years) undergo a BSO. Since the surgical methods applied are not described anywhere in the study, it is rather likely that organ-sparing surgical techniques were performed in these cases that in turn are associated with an increased risk of recurrence. In two further studies, leaving the ovaries *in situ* was associated with an increased rate of recurrence (87.5–95.5 resp. 27.4–59.6 %) and a shorter RFI however without being statistically significant [20, 299]. In one of these studies, however, almost without exception, the women on whom BSO was not performed underwent a myomectomy [20]. In practice, the ovaries remain *in situ* significantly more often when conservative surgery is performed [20, 143, 216]. The actual effects of a BSO on RFI thus remain unclear. However, in all analyses stated, myomectomy and sparing the ovaries, notwithstanding the shorter RFI had no influence on OS [20]. Other studies observed identical OS and RFI both with and without BSO being performed [140, 174, 218]. The relatively extensive SEER-data also suggest that leaving the ovaries *in situ* in premenopausal women has no negative effects on OS [122, 256]. Despite their inherent bias, all larger retrospective studies [140, 174, 256] allude that retaining the ovaries is relatively unobjectionable. However, the ovaries are still removed in 46.5–49.4 % of all cases [143, 299]. Overall, and in summary, to date, evidence has yet to be presented that leaving the ovaries *in situ* has a negative effect on patients' OS. However, a potentially elevated risk of recurrence cannot be ruled out entirely.

The surgical techniques applied have a crucial influence on prognosis. The fact that 69–78 % of LS-ESSs are operated under the primary diagnosis of an LM [20, 143, 216, 247, 299] subsequently results in a large number of inadequate surgical procedures being performed. At present, in Germany, 23 % of all women with an LG-ESS undergo tumor enucleation, and laparoscopic or abdominal supracervical HE is performed in 13.2 % of cases. 42 % of the different surgical procedures include morcellation [143]. Other sources report that myomectomies are performed in 12.4 % of cases, all of which are connected with foregoing a BSO [20]. In 0.28 % of cases in which morcellation was performed under the diagnosis of an LM, an LG-ESS was revealed as an incidental finding [71]. Since LG-ESSs, like LMSs, do not have a capsule or pseudocapsule, every enucleation poses a high risk of achieving only R1-resection margins (at the very least RX-resection margins). Accordingly, tumor extirpation bears a significantly higher

risk of recurrence (78.9 %) than total HE (25.4 %). Resection margins that are not definitely tumor free are equally associated with increased rates of recurrence. Not one patient remained relapse-free within the five years following tumor enucleation, however without differences in terms of OS [20]. There have been multiple accounts of (sometimes extensive) intraperitoneal deposits being observed within 1–3 Mo of endoscopic morcellation or tumor enucleation [65, 143, 221, 223]. A further study compared outcomes of LG-ESS patients who underwent morcellation during abdominal tumor enucleation, total abdominal HE, or a laparoscopy-assisted vaginal HE with outcomes of patients on whom total abdominal HE was performed without morcellation [216]. The results show that both 5-year PFS and abdominopelvic PFS were significantly poorer in the group of morcellation patients, of whom the majority had undergone endoscopic procedures. The problems pertaining to elevated risk of recurrence following morcellation are elaborated in greater detail in the chapter on LMSs.

Generally, laparoscopic or abdominal supracervical HE bears the danger of residual intravascular or myometrial infiltrations in the uterine stump. Moreover, in practice, supracervical laparoscopic HE is virtually always performed in connection with morcellation. Even if an R1-resection cannot be observed, from a clinical perspective, an RX-situation should be assumed. There have been accounts of early tumor deposits occurring within three months of such procedures being performed (Fig. 14.14a, b) [143]. Any form of supracervical HE should thus be classified as inadequate procedure until proven otherwise. An increased risk of tumor cell spillage should apparently also be assumed even if the uterus has only been damaged with a sharp instrument. Therefore, the uterus must not be subjected to any clawing with sharp instruments whenever an LG-ESS has been unambiguously identified as such or is even suspected. DKSM-data reveal a median time to first recurrence of 17 and 7 Mo following adequate and inadequate operations, respectively [143].

In summary, tumor enucleation and/or R1-resection are regarded as independent risk factors for locoregional and intraabdominal disease recurrence, but have no influence on OS. The fact that OS remains unaffected, in contrast to the encountered reduction in RFI, can evidently be accounted for by the good level of surgical tumor control achieved in 63.6 % of LG-ESS recurrences [20] and can help to explain the high response rates to HT that have been known to last for several years in some cases. To date, no cases have been reported in which LG-ESS patients with local recurrence have succumbed to their disease [20].

The negative prognostic impact of BSOs performed during adequate (!) surgical procedures, as is claimed by some authors (see above), remains highly questionable.

No valid, reliable RFI or OS-related data exist to date that militate against operating LG-ESSs endoscopically, so long as tumors and/or the uterus remain uninjured in the process.

Surgical Therapy and Problems

Total HE and BSO without causing injury to the tumor and/or the uterus is the generally accepted standard for patients with LG-ESSs. Opting for a primarily vaginal approach is

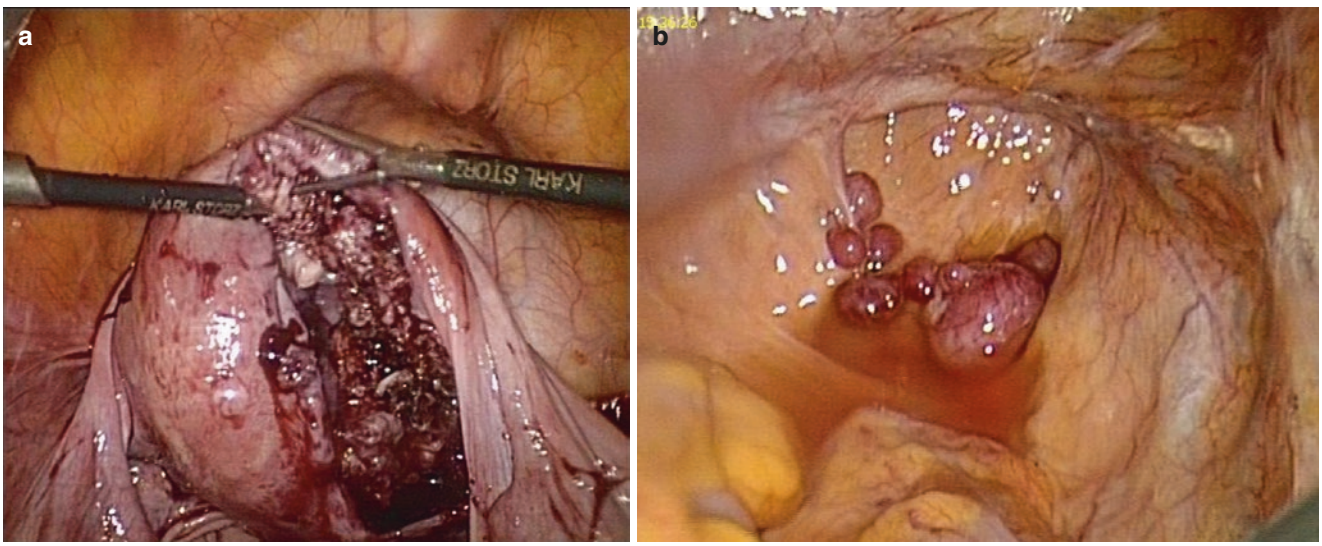


Fig. 14.14 Low-grade endometrial stromal sarcoma. Despite the presence of suspicious results from imaging diagnostics, the patient insisted on undergoing endoscopic myoma enucleation; (**a**) the shown tumor had no capsule, and cutting open the wall of the uterus caused it to immediately expand (or virtually "jump") out of its "bed"; (**b**) despite having undergone subsequent HE with BSO, within a short period of time the patient developed comprehensive local recurrence (With permission of Köhler et al. [147], Fig. 2.2–12a, d)

not indicated due to the risk of damaging the uterus and the lack of possibilities for abdominal exploration. Laparoscopy-assisted vaginal HE must be performed without injuring the tumor or the uterus. Subjecting an intact uterus retrieved via laparoscopy-assisted HE to vaginal morcellation inside a vaginally inserted protective pouch/endobag can be an acceptable solution for achieving this [79].

The benefits of a BSO are contested and have been described in great detail in the subchapter on prognosis. In light of the rarity of isolated ovarian metastases, a respective surgical procedure need not be necessarily justified when the ovaries are unsuspicious on gross examination. According to the current NCCN-recommendations and the GCIG-consensus, decisions for or against a BSO can be made on a case-specific basis dependent on the patient's reproductive age and/or desire to preserve fertility [12, 202]. The ESMO-guidelines – while not making a respective recommendation – merely draw attention to the fact that BSOs are performed in practice *per se* [74]. Taking all data pertaining to prognostic consequences together, preserving the ovaries cannot be deemed erroneous practice, and subsequent i.e. later extirpation can be foregone if the LG-ESS was subjected to adequate primary surgery. Patients should be informed of the potentially increased risk of recurrence, albeit without any consequences for OS, when deciding whether or not the ovaries should be preserved. The consensus [11, 29, 81, 82, 91, 174] that had existed previously, namely that a BSO is indicated for premenopausal women due to the high levels of HR-expression found in LG-ESSs, can no longer be sustained. A BSO is nonetheless performed in 71.2–78.4 % of cases [20, 94]. In Germany, the respective rate is 47 % [143].

There are recommendations for performing at least selective pelvic and para-aortic LNE in patients with enlarged LNs so long as such course of action can reasonably be expected of them [196]. Such a recommendation, however, cannot be made on the basis of the recurrence and metastasization patterns described in the subsection on prognosis above. The NCCN-guidelines no longer make any mention of performing LNE alongside total HE with or without BSO [202]. Likewise, the ESMO-guidelines and the GCIG-consensus do not recommend systematic LNE, as such course of action has yet to be proven to be beneficial [12, 74]. The aforementioned publications do, however, suggest that LNs that appear enlarged, either clinically or via imaging diagnostics, be subjected to cytoreductive resection (debulking). The NCCN-recommendation is somewhat confusing, since it assumes in its commentary that surgical staging be performed in accordance with staging for endometrial carcinoma. A holistic observation of all the available data reveals that, currently, the scientific basis is insufficient to support an indication for conducting systematic LNE. Accordingly, systematic LNE cannot be defined as standard practice. Moreover, the findings currently have no ramifications for the further course of therapy, even when the LNs are positive. This does not mandatorily preclude that clinically suspicious LNs can be resected in the absence of evidence that doing so bears any benefits. However, an LNE is nonetheless performed in 26.4–39.5 % of cases [20, 94, 143, 299].

There is no indication for an omentectomy if the omentum appears tumor-free, i.e. there is no omental involvement, on gross examination.

Taking all available data into account, there is no indication that patients with LG-ESSs should undergo an organ-preserving extirpation. One exception could be cases in which young women, upon extensive elucidation, wish to preserve fertility and their physical ability to have children [67, 267]. In such cases, the tumor must be R0-resected. As the pseudo-capsule usually consists of compressed tumor material (Fig. 14.14a), it not seldom occurs that the tumor is damaged or injured during surgery.

A subsequent pregnancy will obviously have a negative impact on prognosis and further exacerbate the risk of recurrence that is already elevated due to having undergone inadequate primary surgery. Patients must be unequivocally informed of these circumstances. Reference should be had to the respective specialist literature [309] for more detailed information.

The problem of inadequate surgery and means of preventing it, which apply in equal measure to both LG-ESSs and LMSs, are discussed at length in the chapter "risk and prevention of inadequate surgery", together with the diagnostic flow-chart (Fig. 14.22).

As is also the case for LMSs, surgical procedures that preserve or spare organs either wholly or partially should be followed up by total HE or a resection of the residual uterus. Additional BSO is recommended in these cases. Such course of action also corresponds to current recommendations of the AAGL, the DGGG and the NCCN [1, 27, 72, 202, 254]. Should the patient decline such course of action, then at the very least an endoscopic follow-up examination/countercheck should be sought within 3–6 months [198] (see also section on LMS), and postoperative hormone therapy should be given serious consideration [1, 254].

Taking the patient's general state of health and overall condition into account, maximal debulking should be performed in cases of LG-ESSs that have spread in the pelvis and abdominal cavity. Systematic LNE is not indicated and thus not deemed sensible [91, 202]. No data are available to underline that performing a selective LNE on enlarged LNs when an intraabdominal R0-resection has been achieved is in fact beneficial. Overall, as is also the case for soft tissue sarcomas, having 'no macroscopic tumor-burden' and 'clear resection margins' are regarded as the most important prognostic factors [13, 114, 205]. Even for LG-ESS patients who have undergone surgery on metastases and/or

disease recurrences with or without gross residual tumor burden, the 5-year PFS rates were 65 % and 100 %, respectively [20]. The available data, therefore, suggest that maximal debulking is the gold standard to be aspired to in cases of advanced disease. The same results might also be achieved with HT. Since recurrences remain in the abdomen for a long time and remissions are known to occur years later, even after an R1-resection with subsequent HT [20, 143], surgical intervention should always be prioritized.

Aftercare corresponds to what has been described for LMSs. Regarding indications for a thorax CT in the context of LG-ESS, both the implications of radiation exposure and the relative rarity of lung metastases need to be taken into consideration. There are no indications for adjuvant or postoperative chemo- and/or radiation therapy. Particularities in this regard, as well as more details pertaining to the necessity for postoperative hormone therapy following inadequate operations, can be found in the specialist literature [147].

High-Grade Endometrial Stromal Sarcoma and Undifferentiated Uterine Sarcoma

Epidemiology, Etiology, Pathogenesis, Staging

HG-ESSs and UUSs need to be clearly pathogenetically, morphologically, clinically, and prognostically distinguished from LG-ESSs. The data situation pertaining to HG-ESSs and UUSs is extremely poor, particularly in terms of the therapeutic approach to be followed. Recommendations are mainly based on individual case reports and retrospective studies with relatively small sample sizes and often include all stages of disease. HG-ESSs and UUSs account for 10.1 % and 3.7 %, respectively, of all uterine sarcomas [143]. Women with HG-ESSs and UUSs have a median age of 58 and 63 years, respectively, and are thus noticeably older than LG-ESS patients [143]. These tumors thus occur in postmenopausal women in the majority of cases.

HG-ESSs and LG-ESSs both derive from the endometrial stroma [57, 163, 212]. This commonality notwithstanding, they are nonetheless pathogenetically independent of one another. A fusion of the YWHAE and NUTM2 genes (YWHAE-FAM22), a result of chromosomal translocation of t(10;17) (q22;p13), can be found in HG-ESSs. In LG-ESSs, by contrast, JAZF1-SUZ12 is the most characteristic gene fusion (see the section on LG-ESS) [105, 166, 167]. The fact that HG-ESSs and LG-ESSs exhibit differing fusion genes suggests that an HG-ESS does not usually develop from an LG-ESS [252]. The principal difference between HG-ESSs and UUSs lies in the fact that the cytological criteria of the former resemble endometrial stroma *to any degree* [252]. These cytological criteria as well as the fusion genes found in LG-ESSs and HG-ESSs are absent in UUSs [105, 160, 163, 166]. In contrast, UUSs exhibit complex chromosomal aberrations, with gains on 2q, 4q, 6q, 7p, 9q, and 20q, and losses/deletions on 3q, 10p, 14q [109]. UUSs generally exhibit no specific type of differentiation, and their histogenesis remains unclear [212]. UUSs thus constitute an independent type of neoplasm. There have been accounts of cases in which HG-ESSs and UUSs have developed from or alongside an LG-ESS [90, 133, 160, 212]. Significant associations between HG-ESSs/UUSs and tamoxifen therapy are considerably rarer than is the case for LG-ESSs and LMSs [111, 255].

FIGO-staging and UICC-TNM-classification correspond to those provided for LMSs (Table 14.1).

Macroscopic and Microscopic Appearance

Gross examination of HG-ESSs/UUSs often reveals polypous fleshy masses in the cavity of the uterus that are yellowish, yellowish-gray, or grayish-white in color, and which are characterized by hemorrhages and necroses as well as extensive myometrial invasion in some cases. Decomposed necrotic masses can make up up to 90 % of the tumor. HG-ESSs/UUSs generally exhibit rapid growth, quickly fill the entire uterine cavity, and are associated with a rapid increase in the size of the uterus. The borders of the uterus are often exceeded within a very short period of time (Figs. 14.15a–c, 14.16a, and 14.17a). Due to their rapid growth rate, HG-ESSs already have mean and median diameters of 8.0 cm and 7.5 cm, respectively, at the time of initial diagnosis (min.: 1.7 cm; max.: 15 cm) [143]. UUSs have mean and median sizes of 12.2 cm and 11 cm (min.: 2.6 cm; max.: 24 cm), respectively [143]. The fact that UUSs are generally larger at the time of initial diagnosis strongly underlines their higher degree of malignancy compared to HG-ESSs. The low-grade component of HG-ESSs can sometimes be easy to discern on gross observation, and bears resemblance to the low-grade component found in LG-ESS [252].

HG-ESSs and UUSs are highly pleomorphic and thus can already be clearly discerned from the more knotty, nodal, and uniform LG-ESSs on the basis of gross macroscopic appearance.

Within HG-ESSs, there is a coexistence of areas of low-grade structures with a close resemblance to LG-ESS on the one hand, and (usually predominating) high-grade areas on the other. The low-grade component is characterized by uniform low-grade spindle cells with visible cytological connections to the endometrial stroma, and finger or worm-like (permeative) myometrial infiltrations. The high-grade areas, in contrast, exhibit higher degrees of nuclear atypia, ample TCNs, a usually clearly elevated MI (>10 M/10 HPF), lymphovascular invasions, and destruc-



Fig. 14.15 Undifferentiated uterine sarcoma. (**a**) Necrotic tissue accounts for almost 90 % of the depicted UUS. The immense pressure generated by strong tumor growth has distended the cervix; (**b**) in this case, the uterine cavity is completely filled by a predominantly necrotic UUS that has prolapsed through the cervix. Moreover, metastases were found on the peritoneum of the bladder and in the left adnex; (**c**) due to their extremely rapid rate of growth, UUSs are often found to have perforated the wall of the uterus (With permission of Köhler et al. [148], Fig. 2.3–1a–c)

tive myometrial invasions. This coexistence of differing cytological criteria is also associated with variations in CD10-, ER-, and PR-expressions within the tumor [160, 207, 212, 252]. Diffuse and strong CD10-, ER-, and PR-expression can be found in the low-grade component in particular. It is thus by all means appropriate to conduct HR testing at least in HG-ESSs with a view to potential HT. By contrast, the high-grade component is characterized by ER-, PR-, and CD10-negativity [252]. These findings correlate with diffuse and strong cyclin D1-positivity. Cyclin D1 is regarded as a marker for the fusion gene YWHAE-FAM22 [163, 166] that is only found in the high-grade component of HG-ESSs. While this fusion gene may not be traceable in some cases, it nonetheless remains an important characteristic of HG-ESSs that does not or only in a few exceptions occur in LG-ESSs or UUSs. Overall, the simultaneous presence of positive, negative or heterogeneous ER-, PR-, CD10-, and cyclin D1-expression, and of the YWHAE-FAM22 and JAZF1 and JJAZ1 fusion genes shows that both HG-ESSs and LG-ESSs derive from

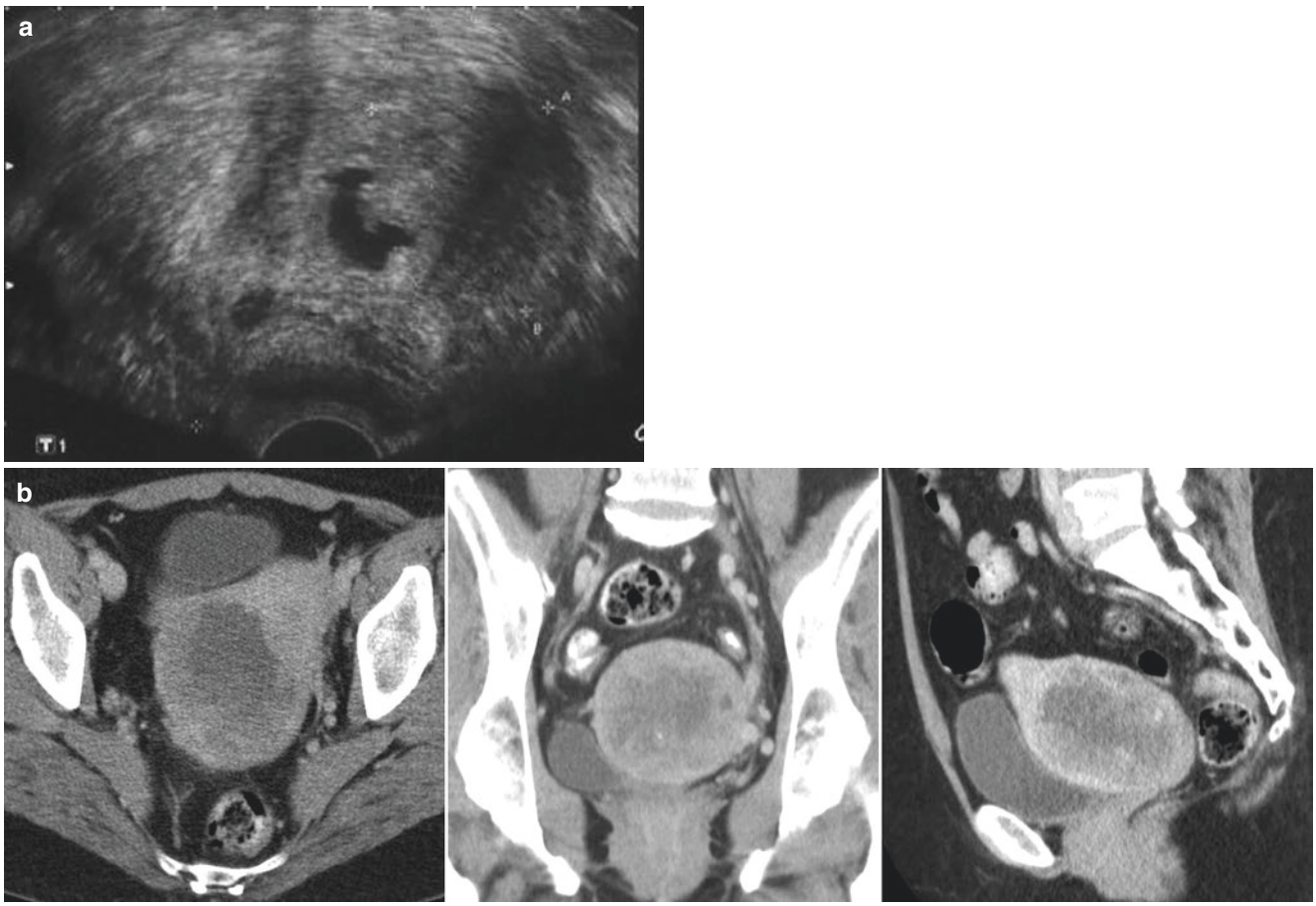


Fig. 14.16 Undifferentiated uterine sarcoma. (**a**) This UUS shows heterogeneous echogenicity in axial sonography, with the exception of some signal voids that correspond to necroses. The tumor fills out the entire cavum. The narrow hyerechoic endometrial rim that is primarily indicated in the right half of the image serves to visibly delimit the UUS from its surroundings there. Said demarcation decreases and is gradually lost as we move to the opposite side of the image; (**b**) the tumor enhances homogeneously in the axial CECT image (*left*) which, analogous to the sonographic findings, recognizably shows that the tumor margins are not clear and sharp throughout. The extent to which the notably enlarged uterus has been infiltrated becomes clear in the coronal (*center*) and sagittal (*right*) planes. Enhancement was heterogeneous in these images. The remainder of the myometrium has been compressed and reduced to a narrow seam (With permission of Köhler et al. [148], Fig. 2.3–6a, b)

the endometrial stroma. The observation that an HG-ESS is reminiscent of or bears resemblance to the endometrial stroma in any way is a decisive diagnostic factor that clearly delineates such neoplasms from UUSs [252].

UUSs exhibit such extensive dedifferentiation that it can often no longer be discerned that (or whether) they originated from the endometrial stroma or the myometrium. The cells are characterized by clear aneuploidy, marked cellular and nuclear pleomorphism including prominent nucleoli and bizarre polynuclear giant cells, and no specific type of differentiation. Expansive foci of coagulative necrosis and high rates of often atypical mitoses are typical characteristics of UUSs [160, 212, 304]. The MI usually clearly exceeds 10 M/10 HPF. Destructive myometrial invasion is already visible on gross observation. Furthermore, early and extensive lymphovascular and blood vessel invasion is observed in 47 % and 48 % of cases, respectively [143]. UUSs exhibit no (or occasionally weak) HR- and CD10-expression [61, 125, 160, 212]. Desmin, SMA, or cytokeratins have also been traced in UUSs in some cases [160, 278]. P53-positivity is detected in 57 % of UUSs [125]. Ultimately, immunohistochemical analyses of UUSs are very unreliable, as these dedifferentiated tumors have already lost their reactivity to numerous antigens [295]. Taken together, the evidence underlines that, unlike LG-ESSs and HG-ESSs, and bar a few exceptional cases, UUSs do not derive from the endometrial stroma.

The most evident commonality between UUSs and HG-ESSs is the fact that both are highly aggressive neoplasms.

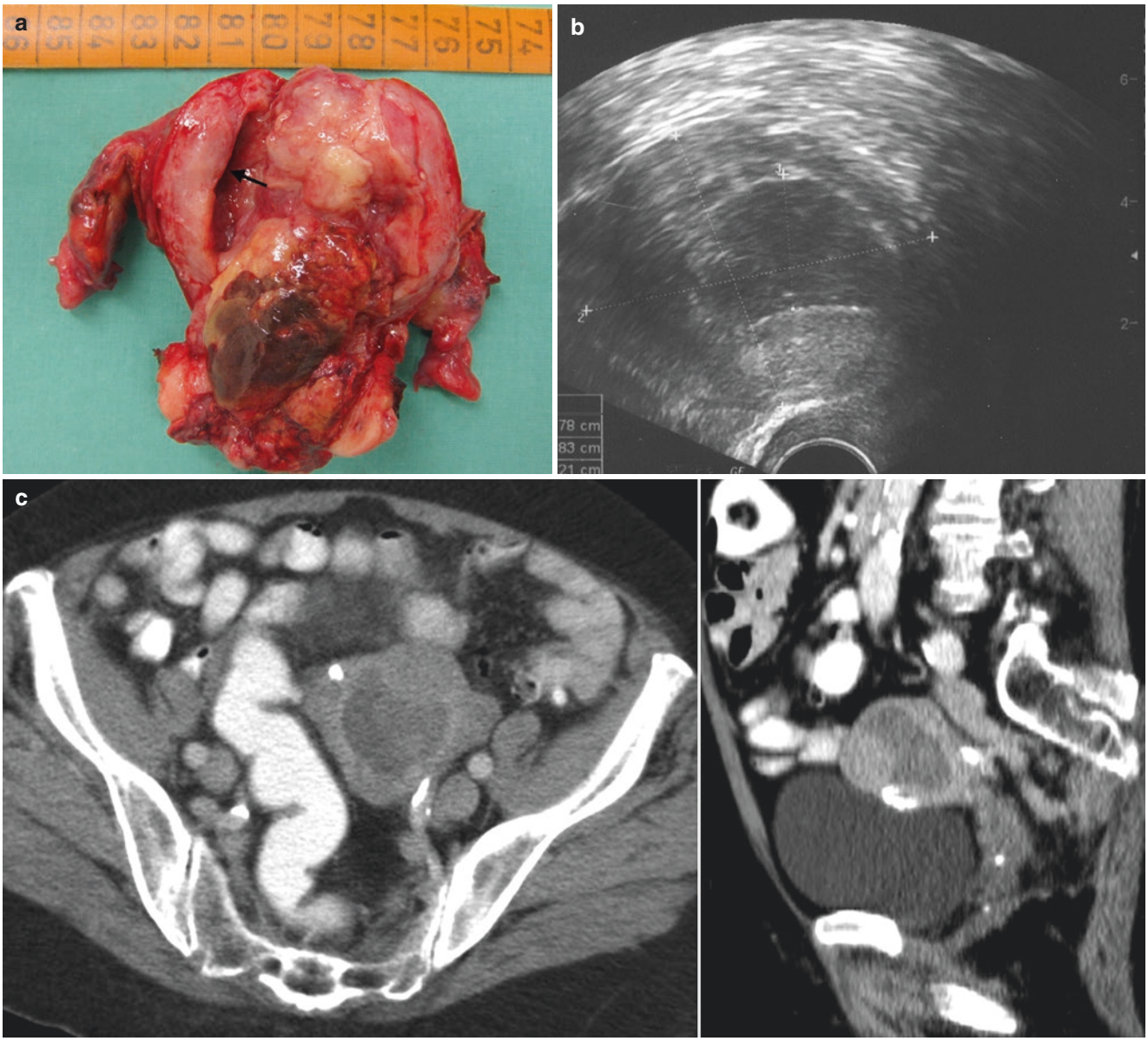


Fig. 14.17 High-grade endometrial stromal sarcoma. (**a**) Macroscopic appearance of an HG-ESS that originated in the anterior wall of the fundus and subsequently filled out the entire cavum. The endometrium is still visibly intact (*arrow*); (**b**) in sonography, the heterogeneous, predominantly hypoechoic HG-ESS is recognizably located within the endometrial hyperechoic band. The image also shows that the tumor interupts the endometrial band towards the fundus (*left side* of the image). The visible round finding with an echogenicity even lower than that of the surrounding tumor tissue, with dull interior echoes, most likely corresponds to a pathological-anatomically verified necrosis; (**c**) axial and sagittal CECT images show that the HG-ESS – with an enhancement weaker than that of the endometrium and the myometrium – is mostly located in the distended cavum of the uterus. As a secondary finding, an LM can be seen in the anterior wall of the uterus. This LM is also clearly visible when observing the macroscopic specimen (With permission of Köhler et al. [148], Fig. 2.3–17a, b, d)

Symptoms, Clinical Presentation, Clinical Diagnostics, Imaging, Differential Diagnosis

Postmenopausal bleeding is the pivotal symptom of HG-ESSs/USSs. Premenopausal women usually present with abnormal uterine or irregular menstrual bleeding. Rapid tumor growth results in marked, usually irregular enlargement of the uterus, and is usually associated with lower abdominal pains and uresiesthesis. Postmenopausal growth of the uterus is generally an observation that serves to arouse suspicion of sarcoma. HG-ESSs/USSs have a predominantly soft consistency. The rapid growth of the tumor can cause tumor masses to protrude from the cervix at a very early stage (Fig. 14.15a, b). Distant metastatic disease occurs very early. It is thus not seldom the case that HG-ESSs/UUSs are primarily discovered upon detection of their metastases.

Diagnostics largely correspond to the procedure followed for LMSs. Since up to 90 % of the tumor can consist of necrotic tissue, it can so occur that performing multiple curettages still fails to yield any actual tumor tissue. HG-ESSs/UUSs or malignant neoplasms are correctly diagnosed as such on the basis of curettage specimen analysis in only 35–65 % of cases [143, 278]. As metastatic spread to the abdominal cavity and the lungs is already present in up to 52 % of cases at the time of primary diagnosis [278], the pelvis, the abdomen, and the thorax should be subjected to imaging-based staging using CT or MRI after receipt of the histological diagnosis.

The sonographic picture correlates with the tumor's polymorphous gross appearance, characterized by decomposing tumor tissue, necroses, cysts, and dilated vessels alongside solid areas with high cell counts. Sonography, too, shows that the tumor usually fills the entire cavity of the uterus with clearly discernible myometrial invasion. As long as the tumor is predominantly located in the cavum, the endometrium is usually recognizable as a thin hyperechoic layer or band. It can be punctured or interrupted by the tumor in one or numerous locations, and is known to have been entirely consumed in some cases. Both HG-ESSs and UUSs are almost exclusively heterogeneously echogenic and are predominated by areas of hypoechoicity in the majority of cases. Tumors can also be predominantly hyperechoic in some cases. Anechoic areas, resembling larger cysts or wide seams/clefts, can be found in both the hypoechoic and the hyperechoic areas of virtually all such tumors. Narrow seams or signal voids often resemble vessels, while large hypoechoic areas resemble necroses or cystic structures. The borders between the hyperechoic and hypoechoic areas are virtually always derounded, with, in part, bizarrely frayed, ragged margins (Figs. 14.16a and 14.17b).

As is also the case for the other types of uterine sarcoma, Doppler sonography shows a highly hypervascular tumor, with an RI of 0.27 [208]. Despite noticeable conspicuous features, 56 % of HG-ESSs are assessed in sonography as being LMs, and 34.6 % are also subjected to surgery under that indication [143]. While 26.1 % of UUSs are operated on under the indication of an LM, to date, no UUSs are reported to have been sonographically classified as an LM [143].

CT is not suitable for precisely diagnosing or classifying HG-ESSs/UUSs, but is a useful method for staging diagnostics (Figs. 14.16b and 14.17c). Only very few data are available pertaining to the MRI-characteristics of these tumors. The absence of low SI in T2-weighted images (100 %), an inhomogeneous SI in T1-weighted images (88 %), and the presence of necroses (69 %) have the highest sensitivities in this regard, with respective specificities of 26, 42, and 98 %. There have been accounts in which adjacent regions of both high and low SI within the same tumor have been described [259]. Necroses and hemorrhagic areas are more common than in LG-ESSs, and the hypointense bands with low SI, that are typical of LG-ESSs, are absent in T2-weighted images [111, 158, 234]. Numerous signal voids can be observed within the areas of myometrial involvement that reflect the hypervascular nature of the tumors [158, 259]. There are accounts of normal myometrium having a clearly stronger enhancement than tumor tissue in T1C-weighted images [272]. There are also reports of iso- or hyperintense contrast enhancement compared with normal myometrium that can help in differentiating from endometrial carcinomas [249].

While both LG-ESSs and LMSs are primarily intramurally localised, clinical and imaging diagnostics usually reveal that HG-ESSs/UUSs are predominantly located within the cavity. In contrast to LG-ESSs, HG-ESSs/UUSs have a noticeably pleomorphic macroscopic appearance, with numerous necroses and hemorrhages that are not seldom accompanied by a pyometra.

HG-ESSs and UUSs do differ in terms of their microscopic appearance. In contrast to HG-ESSs, most UUSs exhibit no specific type of differentiation, both cytologically and immunohistochemically. HG-ESSs can be differentiated from UUSs by measuring cyclin-D1, CD10, and possibly ER- and PR-expression, all of which are negative in UUSs. Histologically discerning HG-ESSs/UUSs from LG-ESSs is usually unproblematic. Complications can arise when doing so solely on the basis of tissue specimens gathered via curettage or biopsy, since HG-ESSs can contain focal areas consisting of LG-ESS. Special attention needs to be devoted to identifying possible epithelial structures during microscopic examination so as not to overlook an AS or a carcinosarcoma.

Clinical Course, Prognostic Factors Relevant for Therapy

Both HG-ESSs and UUSs have a substantially poorer prognosis than LG-ESSs [163, 166]. Prognosis for HG-ESS/UUS worsens as patient age increases, and is especially unfavorable for women of particularly advanced aged [6, 47, 94]. Stage of disease is the most important prognostic factor [6]. Fifty-two to seventy-two percent of cases already exhibit primary involvement of the abdominal cavity [183, 278]. Overall, UUSs have an even worse prognosis than HG-ESSs [105, 160, 228]. Twenty percent of HG-ESS patients present with stage IA disease at the time of initial diagnosis, compared to only 12 % of UUS patients [143]. Moreover, among UUS patients, 32 resp. 28 % presented with FIGO-stage IVa resp. IVb disease at the time of initial diagnosis. For HG-ESS patients, the rate was 10 % both for stage IVa and stage IVb.

Metastases predominantly occur in the lung, the abdomen, the liver, and sometimes in the bones [183, 278]. There

is significant variation in the data pertaining to regional LN involvement. An analysis of stage I-IV primary HG-ESSs and UUSs revealed positive pelvic and para-aortic LNs in 18 % resp. 15 % of cases [163]. A further study revealed an incidence of pelvic and/or para-aortic LN involvement of 44.4 % [183]. SEER-data [47], covering 143 patients with stage I-IV disease, revealed positive LNs in 18 % of cases, with a mean number of 12 removed LNs. Within the DKSM sample, positive LNs were found in 25 % of UUSs and only 7.7 % of HG-ESSs [143]. Positive LNs are a clear sign of a particularly poor prognosis. This evidently has to do with the fact that positive LNs are virtually always found in patients in whom disease has also spread to other extrauterine sites [183]. In light of research findings, according to which extrapelvic metastases with simultaneous pelvic disease recurrence are found in 75 % of cases [91], and isolated distant metastases occur in 67 % of cases [143], survival appears to be mainly determined by extrapelvic sites of recurrence or metastasization [183]. The ineffectiveness of LNE is thus primarily footed in the fact that disease is frequently already so extensive at the time of primary diagnosis. Accordingly, despite their intrinsic bias, the few available retrospective studies, including the SEER-data, have been unable to verify that performing an LNE on HG-ESS/UUS patients has any beneficial effects on survival [94, 154, 185, 256].

Removing or preserving the ovaries has no influence on survival, neither for HG-ESSs nor for UUSs [94, 257].

Median RFI and OS for all cases is 5–11 resp. 11.8 Mo [129, 143, 163]. Among other factors, the median RFI is strongly dependent on the type of surgery performed – 8 Mo for cases of adequate surgery, and 3 Mo for inadequate operations [143]. In contrast to LG-ESS, R2-resection margins, in particular, are associated with an extremely negative prognosis [163, 183]. It more than seldom occurs that recurrences become clinically evident within only a few weeks of primary diagnosis [278].

Surgical Therapy and Problems

Total abdominal HE with BSO is regarded as the generally accepted surgical standard for HG-ESSs/UUSs. Since steroid receptor expression is nearly always negative in UUSs, resection of the adnexa is not absolutely necessary in premenopausal women. Given that HG-ESSs and UUSs are said to metastasize to the ovaries rather frequently [302], performing a BSO by all means seems to be appropriate. However, it remains scientifically unproven that performing such surgery offers any benefits in cases in which the ovaries are clinically tumor-free. The current NCCN-guidelines, accordingly, state that decisions to leave the ovaries *in situ* should be made on an individualized case-by-case basis that takes reproductive age into account [202]. Clinically tumor-free ovaries need not be removed, according to the ESMO-guidelines [74]. HG-ESSs that express ER- and/or PR-positivity should be subjected to surgical therapy as described for LG-ESSs.

Since the number of extrapelvic recurrences and distant metastases clearly exceeds the incidence of local disease recurrence, the degree to which performing a systematic LNE can be deemed appropriate is both questionable and strongly debated (see prognosis for details). Isolated LN-metastases only rarely occur postoperatively [183, 278]. LNE has not been included as a surgical measure in the current NCCN-guidelines [202], and well-researched reviews [91] as well as the current ESMO-guidelines do not recommend it [74]. The Japanese guidelines state that pelvic and para-aortic LNE can nonetheless be considered, but simultaneously draw attention to the absence of scientifically proven therapeutic benefits [201]. The aforementioned guidelines go on to state that LNs can be resected in order to reduce tumor burden when they are radiologically or clinically suspicious. The GCIG-consensus does not recommend performing a systematic LNE unless there is a radiological or clinical suspicion of nodal involvement [220]. However, no statement is made in the guidelines as to the benefits of such practice.

Overall, all forms of LNE currently lack an adequate and sufficing scientific evidence base and thus cannot be defined as standard practice. Where this procedure is nonetheless opted for, it must be borne in mind that no therapeutic consequences can be deduced from the findings resulting from said course of action, even in cases of LN-positivity.

The risks associated with tumor enucleation, supracervical HE, and injuring the uterus or the tumor are addressed in detail in the sections on LMSs and LG-ESSs. 35.7 % of HG-ESSs and 36.4 % of UUSs are subjected to inadequate surgical procedures. While these rates are lower than those measured for LG-ESSs, from a prognostic perspective, they are still too high [143]. Adhering to the diagnostics flowchart (Fig. 14.22) presented in the section “risks and prevention of inadequate surgery” can contribute significantly to preventing inadequate operations being performed, as the criteria described there equally apply to HG-ESSs/UUSs.

HG-ESSs/UUSs that have invaded the abdominal cavity (stage III) should be subjected to maximal cytoreductive surgery. According to retrospective studies pertaining to all uterine sarcomas, and a retrospective study on HG-ESSs/UUSs [163], maximal debulking is evidently associated with improved survival. Complete macroscopic resection was achieved in 60–86 % of patients, though it should be noted that these figures also include intestinal resections [183, 272]. However, due to the fact that these tumors are highly malignant, rapid progression is still identified in 61 % of cases despite having achieved complete gross (R0) resection [278]. Overall, free resection margins are regarded as the most important prognostic factor [205]. Compared to

incomplete macroscopic resection, maximal cytoreduction is associated with significantly improved OS [183]. Some studies suggest that cytoreductive surgery generally has no influence on OS [280]. According to the current NCCN-2A-recommendations and the Japanese guidelines, the decision to surgically resect all tumor tissue can be made on an individualized i.e. case-specific basis, depending on symptoms, extent of disease, and resectability [201, 202]. The GCIG-consensus [220] points out that debulking apparently (though not significantly) improves OS, albeit without making a formal recommendation to that end. An LNE is deemed inappropriate when there is evidence of extrauterine disease [202]. Selective resection of affected enlarged LNs could be appropriate, if it has also been achieved that the patient is intrabdominally tumor free. Overall, the available data pertaining to such cases are very slim at best.

Regarding aftercare, reference should be had to what is stated for LMSs. There is no indication for adjuvant/postoperative chemo- and/or radiotherapy. For more detailed information, reference should be had to the specialist literature [148].

Adenosarcoma

Epidemiology, Etiology, Pathogenesis, Staging

AS is a mixed tumor that consists of a benign epithelial and a malignant mesenchymal (stromal) component. ASs occur with and without SO (sarcomatous overgrowth, see below). Due to the rarity of this variety of tumor, there are currently no "evidence based" therapeutic strategies. The NCCN-guidelines for uterine sarcomas make no reference to ASs. Studies that are devoted solely to ASs are, without exception, retrospective case studies with relatively small sample sizes on average.

When carcinosarcomas are excluded, ASs account for 8.9 % of all uterine sarcomas [143]. More detailed information pertaining to AS prevalence rates are generally non-existent. The majority of AS-patients are aged 50–70 years, with a median age of 54–58 years [45]. Patients covered in the DKSM material database are aged between 22 and 82 years (mean: 55.6, median: 56 years) [143]. There are clear age differences between AS-patients with and without SO: according to the literature, the median age of patients without SO is 58 years (29–87 years), compared to 67 years [38–94] among patients with SO [24]. According to DKSM-data, the median ages are 56 and 55 years, respectively [143]. ASs thus occur in postmenopausal women in the majority of cases.

Uterine ASs develop in the endometrium in more than 90 % of cases. ASs that originate in the myometrium are likely to have developed from an adenomyosis [102, 209]. There are accounts of ASs primarily originating in the cervix [24, 184]. Likewise, cases in which ASs have developed from adenofibromas are long known to exist. AS-patients often exhibit a previous medical history of cervical or corporal polyps. It is likely that ASs or adenofibromas were not primarily recognized as such in these cases. There are multiple reports pertaining to the existence of a connection between AS and tamoxifen exposure [17, 52, 56, 77, 127].

Since 2009, new binding FIGO-staging and UICC-classifications [83, 264] have been in place for ASs that differ from those provided for pure uterine sarcomas (Table 14.7), and that take into consideration the fact that ASs generally originate in the endometrium in 90 % of cases.

Macroscopic and Microscopic Appearance

ASs are usually polypoid or papillary, often broad-based pedunculated masses that frequently fill the endometrial cavity (Figs. 14.18a, b and 14.21a, c, e). ASs can grow to a considerable size. Diameters of up to 20 cm have been described in the literature [92]. In most cases, the tumor forces the myometrium apart. Myometrial infiltration only rarely occurs in cases of ASs without SO. ASs contain epithelial

Table 14.7 FIGO staging for adenosarcomas [291]

I	**Tumor limited to uterus**
IA	Tumor limited to endometrium/endocervix with no myometrial invasion
IB	Less than or equal to half myometrial invasion
IC	More than half myometrial invasion
II	**Tumor extends to the pelvis**
IIA	Adnexal involvement
IIB	Tumor extends to extrauterine pelvic tissue
III	**Tumor invades abdominal tissues**
IIIA	One site/organ
IIIB	> one site/organ
IIIC	Metastasis to pelvic and/or para-aortic lymph nodes
IV	**Tumor invades bladder and/or rectum and/or distant metastasis**
IVA	Tumor invades bladder and/or rectum
IVB	Distant metastasis

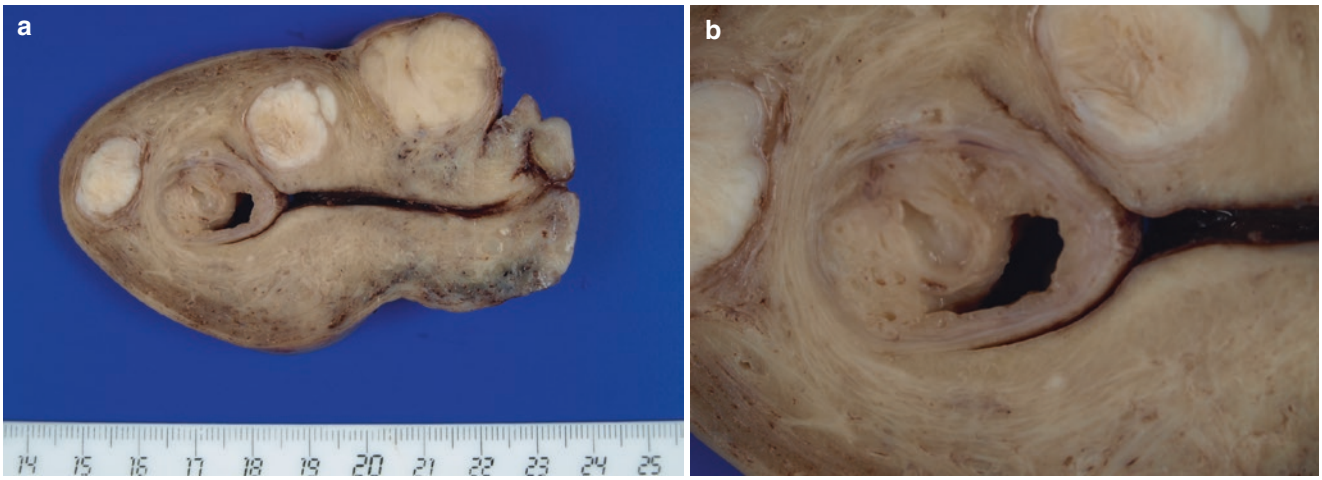


Fig. 14.18 Adenosarcoma. (**a**) An AS alongside several LMs in the fundus of the uterus; (**b**) it becomes apparent upon magnification that the AS developed from the endometrium and subsequently advanced into the cavum like a broad-based polyp. Numerous smaller and larger cysts are recognizable within tumor. They usually correspond to dilated endometrial glands and can be easily visualized via imaging diagnostics (With permission of Köhler et al. [153], Fig. 3.2–1a, b)

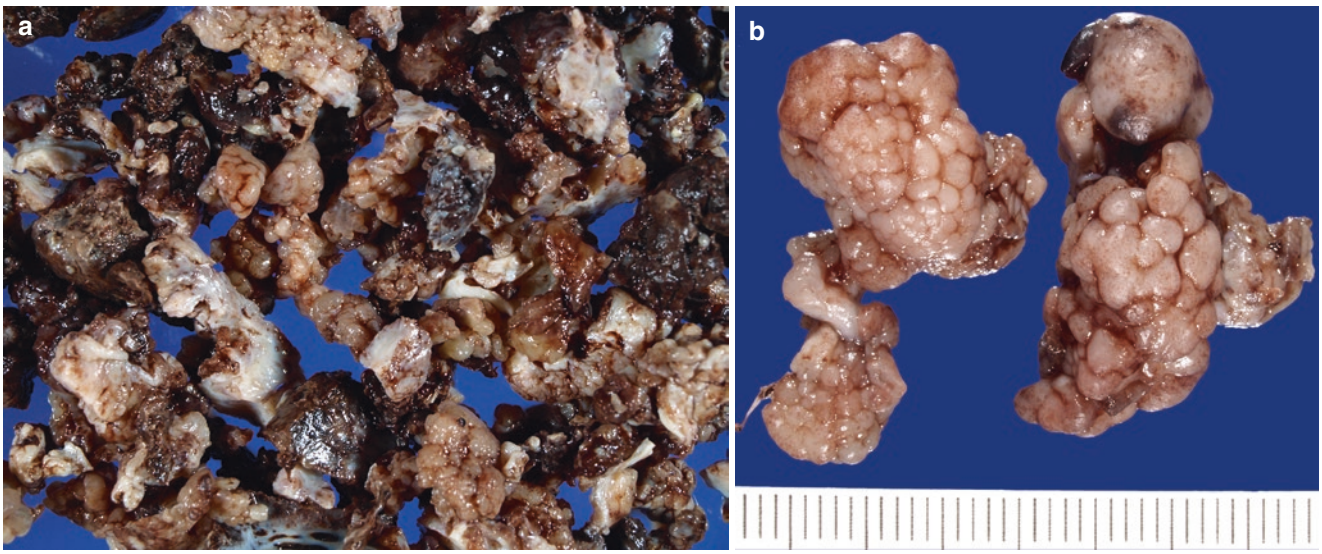


Fig. 14.19 Adenosarcoma without sarcomatous overgrowth. (**a**, **b**) The AS specimens obtained via curettage have a noticeable grape-like appearance that becomes even more apparent when magnified (**b**) (With permission of Köhler et al. [153], Fig. 3.2–2a, b)

cysts that vary in size and that effect a spongy appearance on the cut surface. Grape-shaped tumor masses are also typical in this context (Fig. 14.19a, b). The yellowish to brownish, pink or white to gray tumor is usually also macroscopically well differentiated from the myometrium. Outside the cystic areas, the tumor can be of a solid or fleshy, but also a soft and gelatinous consistency. Grossly visible necroses and hemorrhages can be observed in roughly one quarter of all cases.

An AS is classified as homologous when the sarcomatous component is of uterine origin (endometrial stroma, myometrium, connective tissue, vessels). Said component is comprised of an LG-ESS, an HG-ESS, a UUS, or an LMS in the vast majority of such cases. Roughly 75–80 % of ASs are homologous tumors [55, 92]. By contrast, an AS is heterologous if the sarcomatous component derives from extrauterine tissue. In those cases, the mesenchymal component usually consists of rhabdomyosarcoma or chondrosarcoma, or osteosarcoma, liposarcoma, or another form of sarcoma in rarer cases.

Classification of ASs into tumors with or without SO is of considerable clinical and prognostic importance. An AS is classified as having SO when more than 25 % of the tumor volume is composed of pure (i. e. epithelium-free) sarcoma [178]. AS without SO is regarded as the “classical” or “typical” variant of AS. Unfortunately, numerous studies and publications make no precise distinction between these two

AS-variants. A look at the histological appearance of ASs reveals an eye-catching phylloid, leaf-like, or papillary growth pattern. Epithelium-lined clefts and cysts of varying size, combined with papillary protrusions of cellular stroma into these cysts, serve to generate this appearance.

The epithelium is distributed across the entire tumor, usually in the form of benign glandular isles, however without fostering an impression of infiltration. In most cases, the epithelium is atrophic/inactive or resembles the normal phase of proliferation. The presence of malignant epithelial cells is indicative of carcinosarcoma.

The characteristic abounding, collar-like growth of stroma cells around the benign glands has resulted in the coining of the term "cuffing", a phenomenon that is strongly suggestive of an AS both in diagnostics and DD. The fact that ASs are closely related to adenofibromas is also more than apparent at the microscopic level. Prime criteria for distinguishing ASs from adenofibromas are: an MI ≥ 2 M/10 HPF, marked stromal hypercellularity with periglandular or subepithelial stroma cell congestions (collar, cuff), and significant stromal cell atypia. The mitotic rate is usually between 2–4 M/10 HPF. However, the mean mitotic rate across the whole tumor is only 2.2 M/10 HPF [266]. Nuclear atypia are predominantly mild-to-moderate. The majority of ASs without SO are confined to the cavity of the uterus or to the endometrium. Myometrial invasions are rare and non-destructive. They occurre in roughly 20 % (16–42 %) of cases, and usually reach only a few millimeters deep [55, 92]. Lymphovascular invasion is reported in only 7 % of cases [131]. Analogous to LG-ESSs, ASs without SO are characterized by high levels of HR-expression: in one study, ER- resp. PR-positivity were measured in the epithelial component of 85 resp. 65 %, while the stromal component was ER- resp. PR-positive in 80 resp. 60 % of cases. Both ER- and PR-positivity were detected in 90 % of cases [8]. Analogous to LG-ESSs, CD10 expression tests positively in 81–100 % of ASs without SO. Moreover, immunohistochemical testing has verified a smooth muscle differentiation in numerous cases (smooth muscle actin, desmin) [8, 189, 266]. Overall, ASs without SO and LG-ESSs share numerous morphological and immunophenotypical commonalities.

ASs with SO differ from the aforementioned typical or classic ASs in numerous aspects. The literature suggests a rather wide range of frequency, from 8 to 60 % of all ASs. The majority of studies narrow their share down to 20 to 48 % [45, 55, 92, 131, 178, 253, 266, 279]. 35.1 % of all ASs in the DKSM-materials exhibited SO [143]. While no significant differences between ASs with and without SO are discernible in the epithelial component of the tumor, the sarcomatous component of ASs with SO usually consists of an HG-ESS, a UUS, or another high-grade sarcoma, for instance rhabdomyosarcoma or angiosarcoma. With an MI of up to 115 M/10 HPF and a mean MI of 13.5 M/10 HPF, the number of mitoses is significantly higher in ASs with SO compared to ASs without SO [55, 92, 266]. Myometrial invasion is observed in 53–60 % of cases [92, 159] and often borders on the serosa. Lymphovascular invasion is verified in up to 24 % of cases. Hemorrhaging, necroses, and heterologous components are much more frequent in this neoplasm than in its counterpart without SO [131]. Analogous to HG-ESSs and UUSs, and in contrast to LG-ESSs, ER- and PR-expression are very low or non-existent. The epithelial component has shown ER- and PR-positivity in 50 % resp. 25 %, while the stromal component has shown ER-positivity in 0 % and PR-positivity in only 0–12 % of cases [9, 92]. CD10-expression is positively measured in the sarcomatous component of no more than 28 % of ASs with SO [8, 92, 255].

Symptoms, Clinical Presentation, Clinical Diagnostics, Imaging, Differential Diagnosis

Since ASs originate in the endometrium or the cervix, abnormal vaginal bleeding or postmenopausal bleeding are the most commonly presenting symptoms. Overall, the symptoms correspond to those of endometrial carcinomas. Like for the other uterine sarcomas, a broad-based, usually polypoid tumor protruding from the cervix is a commonly reported finding (Fig. 14.20a–c). Especially in very young patients, such tumors usually turn out to be cervical ASs. Lower abdominal pain is a frequent symptom resulting from rapid tumor growth, which in turn causes the uterus to expand and/or the cervix to dilate. Performing an HSC and/or fractional curettage is indicated when patients present with abnormal/postmenopausal bleeding (Fig. 14.20c, d). ASs can primarily originate in the myometrium; however, this is only rarely known to have occurred. Notwithstanding, in such cases, the AS might not be traceable in tissue specimens retrieved via curettage.

Since ASs originate in the endometrium in more than 90 % of cases, in contrast to both LG-ESSs and LMSs, sonography, too, shows that they are limited to the endometrium or primarily centrally located. The tumor often fills the endometrial cavity. In contrast to polyps, which constitute an important DD for ASs, sonography reveals a broad-based connection to the endometrium almost without exception.

The AS has a higher echogenicity than the surrounding myometrium and is thus well differentiated from it. ASs are heterogeneously echogenic in the majority of cases [273] and thus essentially correspond the echogenic texture of the endometrium [52]. Analogous to the macroscopic and microscopic appearance that is characterized by cystically dilated glands, sonography, too, reveals an internal structure that comprises numerous anechoic areas that represent said

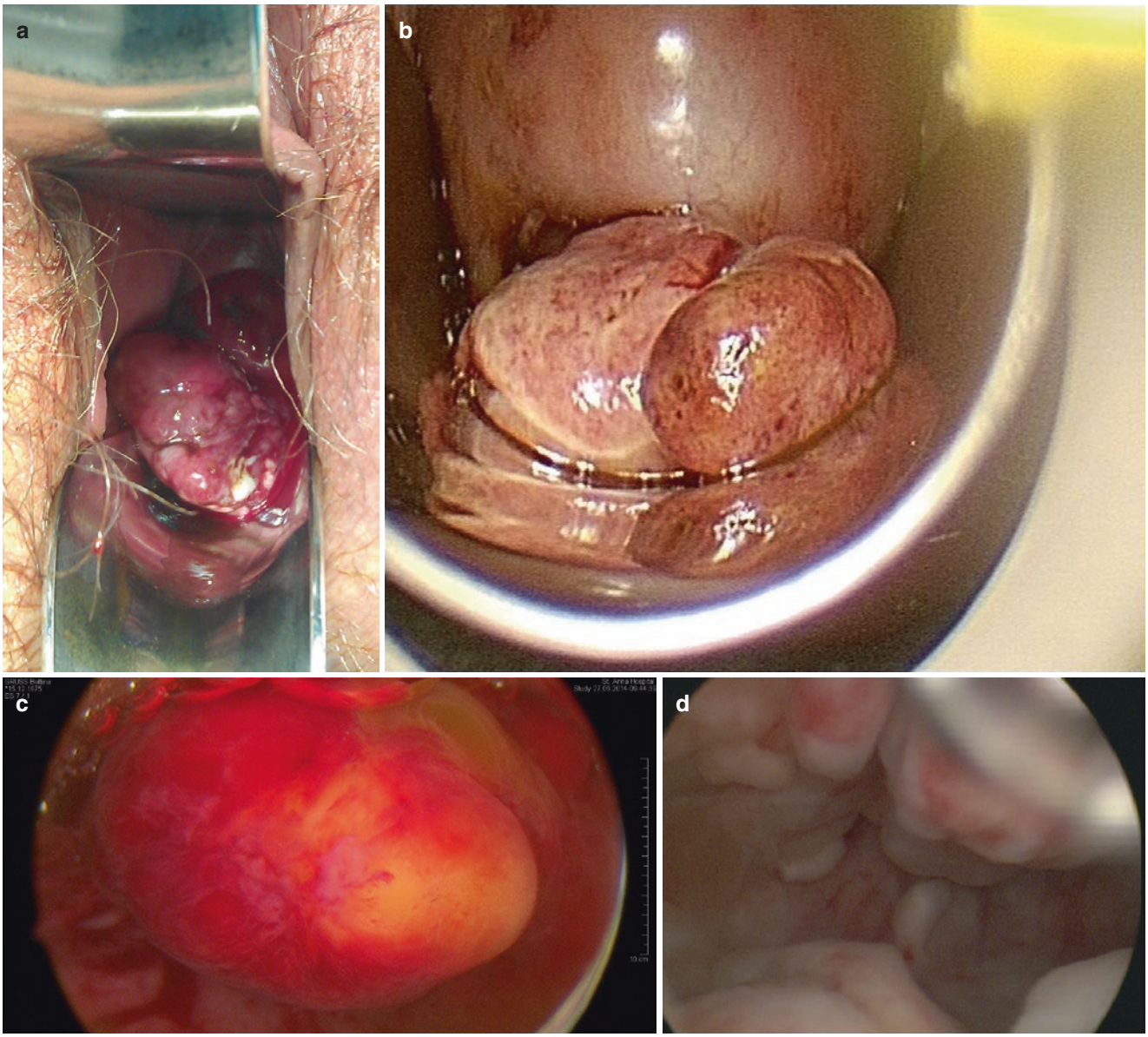


Fig. 14.20 Adenosarcoma with and without sarcomatous overgrowth. (**a**) AS without SO that has prolapsed into the vagina, the cystic-polypoid structure is clearly recognizable on close observation; (**b**) two polyps removed via hysteroscopic resection that turned out to be AS with SO. The presence of only very few barely discernible cysts is a typical feature; (**c**) hysteroscopic finding of a relatively smooth intracavitary tumor the macroscopic observation of which yielded no suspicions of AS; (**d**) typical HSC-image depicting grape-like AS without SO in a 21 y.o. patient (With permission of Köhler et al. [153], Fig. 3.2–6a–d)

glands [52]. The resulting respective visual appearance is of seminal importance for arriving at the proper diagnosis. The phylloid growth pattern can also be clearly recognizable in fortunate cases (Fig. 14.21a). Nonetheless, the location of these tumors within the cavity and their predominantly hyperechogenic texture make them difficult to differentiate from carcinosarcomas and endometrial carcinomas.

Doppler-sonographic criteria correspond to those for LG-ESSs and LMSs, characterized in particular by strong irregular central vascularity. One marked difference, however, lies in the fact that, in ASs, the numerous differently sized cysts are easily recognizable alongside the visible vessels (Fig. 14.21b).

CT is not suitable for precisely diagnosing or classifying tumors, but is a useful method for spread-related diagnostics and staging. However, the presence of numerous intratumoral cysts with a density equal to that of water (Hounsfield-unit 0) could be suggestive of an AS (Fig. 14.21c). T1 W MR-images reveal a heterogeneous tumor with intermediate SI that is usually isointense to the myometrium. Hemorrhagic areas are characterized by areas of high SI, while the (usually numerous) cystic areas of varying size have low SI on

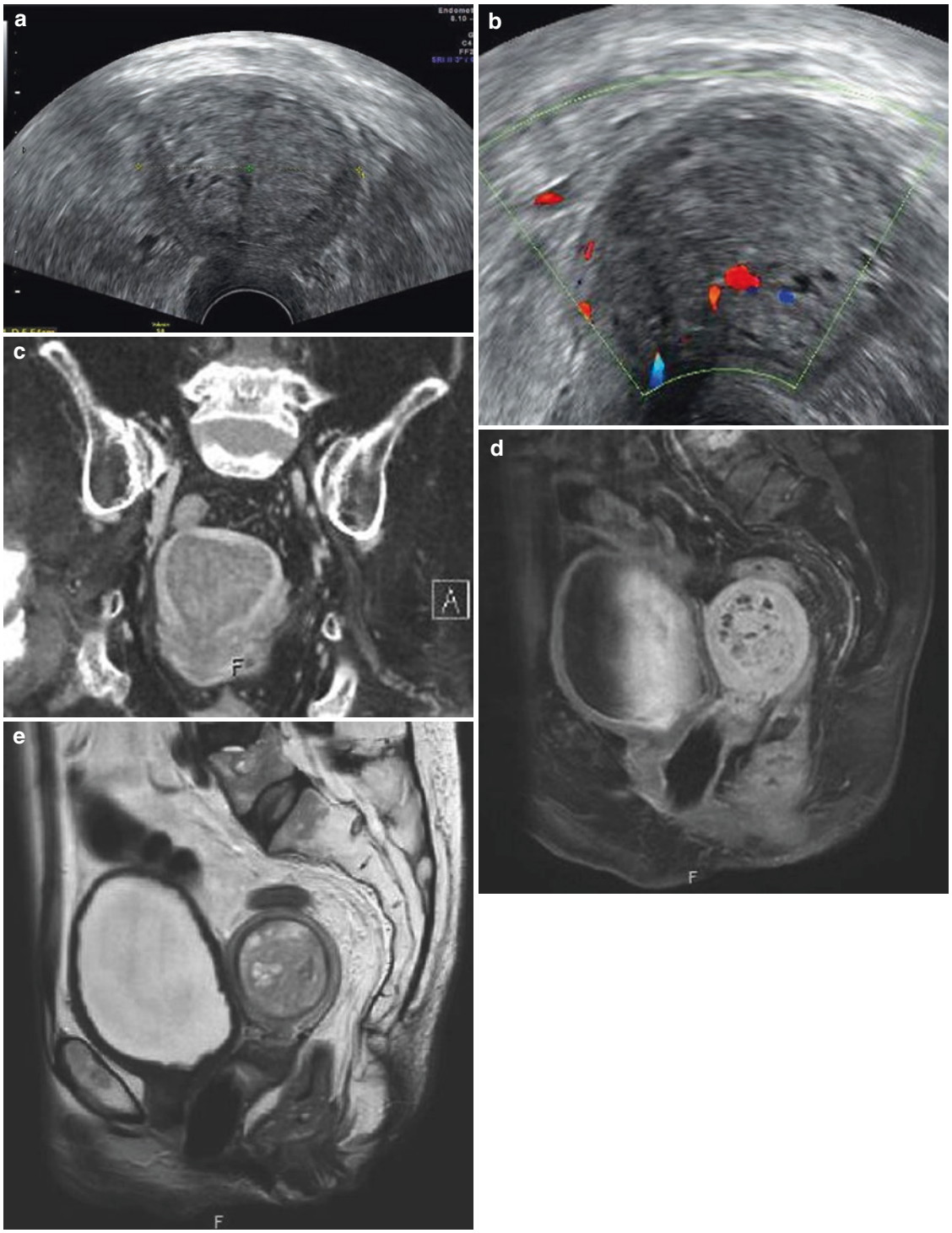


Fig. 14.21 Adenosarcoma without sarcomatous overgrowth. (**a**) Gray-scale sonography of an AS without SO with a mesenchymal component resembling LG-ESS shows a tumor with irregular bizarre margins that is hyperechoic to normal myometrium, that fills the entire cavum, and that has inflitrated the myometrium in multiple locations. Numerous anechoic areas are visible that correspond to vessels and dilated endometrial glands; (**b**) color Doppler sonography reveals some of these anechoic spaces to be dilated vessels; (**c**) the findings from CECT correspond to those from sonography, the non-enhancing areas correspond to dilated glands; infiltrations of the more hyperdense myometrium are clearly recognizable; (**d**) AS shows a similar enhancement to normal myometrium in T1 W-contrast MRT with fat suppression. As is also the case in T2 W, here, too, there is a discernible margin (albeit with a lesser degree of hypointensity at the bottom of the tumor) that is interrupted in several places (as is also recognizable in **e**). The non-enhancing hypointense sections correspond to the hyperintense areas in T2 W; (**e**) analogous to LG-ESS, this T2 W images show a clear hypointense rim or margin that is breached in the lower part of the uterus, where it most likely corresponds to myometrial infiltration. The strongly hyperintense sections predominantly correspond to the greatly dilated, fluid-filled glands (With permission of Köhler et al. [153], Fig. 6–8a–d, f)

T1-weighted images [52, 301]. ASs have heterogeneous SI on T2 W-images with hypointense, intermediate, and hyperintense areas. The multitudinous hyperintense regions represent the cystic components, while the areas of low-to-intermediate SI correspond to the solid components of the tumor [272, 273, 275, 281]. Clustered cystic components with strong SI are regarded as a key finding. The tumor components that are hypointense in T2 W-images show a strong enhancement in T1 WC images [272]. There are accounts of cases in which the myometrium has a stronger enhancement than the tumor, which makes tumor invasions easy to recognize, as well as of SIs that appear isointense compared to the myometrium [301]. The enhancing solid tumor components, as well as the enhancing septa between the non-enhancing cystic areas, often generate a lattice- or truss-like overall visual impression [52, 275, 301] (Fig. 14.21d, e).

It is barely possible to grossly differentiate an AS from endometrial carcinoma, carcinosarcoma, adenofibroma, stromal sarcomas as well as from large necrotic endometrial polyps solely on the basis of macroscopic observation of the resected and opened uterus. Real polyps usually have a tapered, gradually narrowing stem and a generally smooth appearance. ASs, by contrast, usually have a broad-based connection to the corpus or the cervix. Multitudinous cystic structures or a grape-like appearance are suggestive of an AS, but are also characteristics of botryoid rhabdomyosarcoma.

Adenofibroma constitutes the most difficult and challenging DD, since the histological transition from adenofibroma to adenosarcoma is a continuous, gradual one [55, 92]. ASs without SO are generally difficult to differentiate from LG-ESSs, since these two tumor types are largely identical in terms of their morphology and immunophenotypic profiles [266]. In particular, basing diagnostic decisions and conclusions on a relatively small amount of tissue, for example such stemming from a frozen section or curettage, bears numerous trap doors and much room for potential misinterpretation. In such cases, the specimens might omit the epithelial components or facilitate them being overlooked, thus making misdiagnoses as pure sarcomas more likely. Within the DKSM-materials, on the basis of the curettage specimens alone, 17.6 % of all ASs were primarily diagnosed as purely homologous or heterologous sarcomas (LG-ESS, HG-ESS, UUS, LMS, rhabdomyosarcoma) [143]. Final diagnosis is thus frequently only reached upon examination of the surgical specimen.

Clinical Course, Prognostic Factors Relevant for Therapy

Generally speaking, stage of disease is the most important prognostic factor for both AS-types [2]. There is apparently no correlation between MI-levels and rates of recurrence [131]. Deep myometrial invasion and lymphovascular invasion are regarded as predictors of recurrence and metastasis [92, 131].

According to DKSM findings and the majority of other studies, metastatic spread to the ovaries is not observed at the time of primary diagnosis [16, 30, 143, 279]. One further study reported ovarian involvement at the time of primary therapy in 8 % of cases. Metastases were not visible on gross observation in 2 of 5 cases [45].

Only limited data are available pertaining to the rate to which LNs test positive in cases of AS with and without SO. According to one study covering 262 cases of AS, nodal metastases were found in only 3.1 % of cases of AS (all stages) with and without SO [16]. A further study [45] identified positive LNs in only one case of AS with SO, accompanied by further extrauterine spread. Within the DKSM materials, LN-metastases could be verified for 33 % of ASs with SO and 11 % of ASs without SO. Interestingly, recurrences only occurred in patients with negative LNs. 25 % of distant metastases occurred in patients with positive LNs, while the LNs of the remaining 75 % of patients who developed distant metastatic disease tested negative [143]. Accordingly, the prognostic value of positive LNs is indeed questionable. Data stemming from some smaller research series suggest that performing an LNE may well serve to reduce the number of pelvic recurrences [244, 280]. These findings notwithstanding, according to SEER-data, performing an LNE does not seem to affect OS beneficially, even in cases of positive lymph node metastasis [256]. Further retrospective studies, too, have confirmed that, to date, performing an LNE apparently serves to provide no benefits in terms of OS [30, 154].

The typical (classical) AS-variant – AS without SO – is associated with a relatively favorable prognosis (analogous to LG-ESS) and is often cited as a tumor with low malignant potential [92, 131, 228, 293]. In actual fact, up to 96 % of AS patients initially present with stage I disease [30]. Tumor growth is relatively slow and recurrences usually occur in the form of late recurrences in the vagina, the lesser pelvis, and the abdomen. Reported rates of recurrence range from 7–14 % [30, 55, 131, 279]. Distant metastasis has been described in up to 50 % of cases [30], with a median time to recurrence of 21.3 Mo (10.4–60.9 Mo) [30].

Presence of SO is significantly statistically associated with less favorable OS and is regarded as an independent prognostic determinant *per se* [42, 92, 288]. Thirty to forty percent of ASs with OS are already at an advanced stage of disease at the time of initial diagnosis [30, 159]. Overall, rapid tumor growth and early recurrence and/or metastasization should be expected when SO is present. Recurrence rates for ASs with SO have been measured at 44–80 % [30, 55, 131, 279] and distant metastases occur in up to 90 % of cases [30]. In 30 % of cases overall, lung metastases arise

without local recurrences or metastases in the abdominal cavity [30]. The risk of recurrence is roughly 3.2 times higher than for classic ASs [131]. The median period of time until the occurrence of first tumor recurrence is 21.3 Mo (2.1–87.8 Mo) [30]. Overall, the presence of SO and/or predominantly myometrial invasion as well as lymphovascular invasion are regarded as the most reliable histological predictors for recurrence of AS [45, 110, 266].

Taking both AS variants together, the time period until first recurrence is around 3.4–5 years; 38–40 % of first recurrences occur after 5 years or more. There are accounts of dramatic courses in which tumors recurred within just 2 weeks [76]. Isolated recurrences in the vagina and the pelvis are observed in 33 % and 28 % of cases, respectively. Roughly 38 % of recurrences occur in the abdomen and the pelvis with and without distant metastases. By contrast, isolated (!) distant metastases are observed in only 5–9 % of all AS patients. Hematogenous metastatic spread is rather the exception and practically only occurs in AS-patients with SO [55, 303]. A recent analysis [45] measured a median RFI and a median OS of 29.4 resp. 55.4 Mo for ASs with SO, compared to 105.9 resp. 112.4 Mo for ASs without SO. Among stage I disease patients, 77 % with SO and 22 % of patients without SO showed recurrence. The difference was statistically significant.

Thus, ASs with SO and ASs without SO differ significantly in terms of their prognosis. The former exhibits clinical and prognostic behavior and characteristics more reminiscent of HG-ESSs and other high-grade sarcomas, while the latter more closely resembles LG-ESSs from a clinical and prognostic perspective.

Surgical Therapy and Problems

Since ASs are rare malignancies, there are currently no therapeutic studies that are devoted solely to this form of tumor. Accordingly, there are no recommendations that fulfill the criteria for "evidence based medicine". The NCCN-guidelines [202] contain no provisions pertaining to ASs. The situation is even more unsatisfactory if one differentiates between ASs with and without SO. Therapeutic decision-making is made somewhat easier, however, by the fact that ASs and stromal sarcomas share certain clinical, microscopic, biochemical, and prognostic commonalities [266]: AS without SO is more reminiscent of LG-ESS, while AS with SO more closely resembles HG-ESS or other high-grade sarcomas, not least because, in ASs, prognosis is primarily influenced by or dependent on the mesenchymal component. Procedure should or can thus be guided by the procedure applied to the sarcomas to which the different AS variants bear close resemblance [86, 266, 288]. One exception is when the sarcomatous component consists of a rhabdomyosarcoma, in which case the tumor should not be approached as if it were a rhabdomyosarcoma, but instead analogous to the other high-grade sarcomas.

In accordance with the current NCCN-guidelines for LG-ESSs and HG-ESSs and the GCIG-consensus [86, 202], total HE without injuring the uterus with accompanying BSO is regarded as the adequate surgical approach to be applied, and thus as accepted standard practice. There is no indication for performing total vaginal HE when an AS has been diagnosed, due to the risk of injuring the uterus and the fact that this procedure does not allow for abdominal exploration. Laparoscopically assisted vaginal HE or total laparoscopic HE, when opted for, must be performed without causing injury to the uterus.

The SEER-analyses and the lack of scientific evidence notwithstanding, there is nonetheless consensus among several studies that a BSO is more likely indicated when the tumor expresses HR positivity [11, 29, 91, 174]. The data, when taken together, suggest that preserving the adnexa is at least a possibility, i.e. that a subsequent extirpation can be forgone. According to the NCCN-guidelines, in referring to LG-ESS, decisions for or against performing a BSO can be made on an individualized basis under consideration of patients' reproductive age or desire for fertility preservation [202]. This statement is supported by the current GCIG-consensus [86]. Patients with HR-positive ASs should, however, be informed of the potentially elevated risk of recurrence that is associated with ovarian preservation. Said risk obviously only applies to uterus-preserving surgical procedures. This issue is discussed in more detail in the section on LG-ESSs. Since ASs with SO are usually HR-negative, a BSO is not indicated when the ovaries are unsuspicious.

It is currently contested whether or not performing an LNE is necessary [131], not least because the share of cases with nodal involvement is low (see prognosis). In the current NCCN-guidelines, LNE has been removed from the recommendations for all uterine sarcomas [202]. Likewise, according to the current GCIG-consensus, the benefits of an LNE have yet to be scientifically proven. Routinely performing a systematic LNE is thus not recommended [86]. However, the guidelines do indeed recommend the removal of all metastatic masses, which can be interpreted as a recommendation for performing selective LNE on enlarged LNs on an individualized basis. It needs to be reiterated that the preceding statement is not supported by evidence-based data, and that it has yet to be scientifically proven to any degree that performing any form of LNE is beneficial for prognosis.

In summary, systematic LNE or LN-sampling currently lack a sufficing and adequate scientific basis, and can thus not be defined as standard practice [45, 86, 91, 256]. Sampling enlarged LNs is currently deemed a justifiable compromise. If an LNE of any type is opted for, it must be borne in mind that no therapeutic consequences can be

deduced from the findings resulting from said course of action, even when the LNs test positive. Overall, therefore, not performing an LNE cannot be regarded as erroneous practice.

Stand-alone tumor extirpation, any form of morcellation, and any form of supracervical HE all constitute inadequate surgical procedures for ASs. As also applies for LG-ESSs, HG-ESSs, UUSs, and LMSs, a negative impact on the prognosis has to be expected when such procedures are performed [72]. However, 19 % of all ASs are still operated on under the indication of an LM [143]. The problems connected with and arising from inadequate surgical procedures, including morcellation in particular, are elaborated in detail in the section on LMS, while strategies for preventing inadequate surgery are discussed in the section on "risk and prevention of inadequate surgery" using a diagnostic flowchart (Fig. 14.22).

Local resection appears to be an option in exceptional cases of young women who urgently desire fertility-preservation and in whom the AS without SO is conveniently located within and confined to the uterus [55, 110, 184, 267]. It is necessary that R0-resection margins are achieved beyond doubt. One study revealed that one patient who underwent curettage alone, and two patients who underwent supracervical HE, had no recurrences [30]. According to two further studies [42, 84], among 7 adolescents who underwent organ-sparing surgery for cervical ASs, 5 developed recurrences. Conservative procedures are best suited for pedunculated tumors confined to the endometrium, under the condition that R0-resection is achieved [110]. In general, organ-sparing surgery, including supracervical HE, should nonetheless be classified as inadequate procedure and should thus not be recommended by physicians. Should the patient insist on such surgery, she must be thoroughly informed of the implications of such course of action, not least because preserving the ovaries when an HR-positive AS has been subjected to inadequate surgery could potentially promote recurrence (as also applies to LG-ESSs). A case has been reported in which adnexal preservation was not accompanied by recurrence in the follow-up period [184].

ASs that have spread within the pelvis and the abdominal cavity should be subjected to maximal cytoreductive surgery. Retrospective studies, albeit referring to all uterine sarcomas, suggest that such procedure is associated with improved OS [91]. There is an account of a patient with an AS with SO that had spread to and within the pelvis, who underwent a total of three cytoreductive operations following total HE with BSO plus cytoreduction plus hyperthermic intraperitoneal CHT with 50 mg/m^2 melphalan. The patient was still alive with disease after 55 months [128]. However, it remains unclear in this case whether hyperthermic CHT actually had any effects. Drawing on findings relating to LG-ESSs, it can be assumed that performing maximal cytoreductive surgery in cases of ASs without SO allows improvements in OS to be expected [280]. "Removal of all tumor" and "free resection margins" are deemed the most important prognostic factors [205]. For ASs with SO, analogous to HG-ESSs, due to the absence of effective alternatives, maximal cytoreductive surgery should also be considered. According to the current NCCN-2A-recommendations (that refer to all uterine sarcomas), the decision to surgically resect all tumor tissue can be made on an individualized i.e. case-specific basis, depending on symptoms, extent of disease, and resectability. LNE is deemed inadequate where there is extrauterine spread [202]. There are currently no data available pertaining to the potential benefits of performing a selective LNE, even when R0 resection margins have been achieved.

More extensive surgical procedures, for example exenterations, are generally rejected on the grounds of the substantial complications that can arise and in light of the poor prognosis with which sarcomas with exception of LG-ESS are generally associated. Pelvic exenteration should only be considered in exceptional cases, in which R0-resection (i.e. resection with clear margins) can be achieved and the patient is young and in a good general state of health [137].

Aftercare should be managed in accordance to what has been stated for LMSs and LG-ESSs. There is no indication for adjuvant/postoperative chemo- and/or radiotherapy. For detailed information in this regard, as well as for information pertaining to potential postoperative HT in cases of HR-positive ASs that have been subjected to inadequate surgical procedures, reference should be had to the specialist literature [153].

Other Uterine Sarcomas and Rare Mesenchymal Tumors

Angiosarcomas and liposarcomas also occasionally occur in the uterus. Regarding the different variants of liposarcoma, only the dedifferentiated, myxoid-round cell, and pleomorphic variants are known to occur in the uterus, while well-differentiated liposarcoma does not. Liposarcomas stand out for their imaging characteristics in particular. The tumor component containing adipocytes is typically hyperechoic in sonography. The lipogenic components show hyperintense SI in T1 and T2-weighted MR images. By contrast, fat suppression results in a complete loss of signal intensity. Combining the findings from these two imaging methods is expedient for diagnosing liposarcomas or lipogenic tumors. Analogous to LMSs, angiosarcomas and liposarcomas are treated with total HE without injuring the uterus. No adjuvant therapeutic measures have yet been established in practice.

There are also occasional accounts of embryonic, alveolar, and pleomorphic rhabdomyosarcomas occurring in the uterus in adult women (1.8 % of DKSM cases, 143). While the surgical management of pleomorphic rhabdomyosarcomas resembles that of LMSs, performing surgical therapy with and without LNE on the other two variants constitutes only one aspect of a multimodal therapeutic strategy that – depending on which of the pre-defined risk groups is at hand in the individual case – usually includes radiotherapy and chemotherapy. Particularities pertaining to PEComs (perivascular epithelioid cell tumors), endometrial stromal tumors with sex cord-like elements (ESTSCLEs), and uterine tumors resembling ovarian sex cord/stromal tumors (UTROSCTs) can be found in the specialist literature [146, 149–152].

Risk and Prevention of Inadequate Surgery

The central problem for diagnosing and adequately treating uterine sarcomas is that, in many cases, they are incidental or unexpected diagnoses that are reached intra- or postoperatively. Due to the frequent absence of specific symptoms, but also due to clinical, sonographic, and anamnestic clues or risk factors being overlooked, 68 % of all LG-ESSs and 51 % of all LMSs in the DKSM-materials were operated under the indication of an LM [143]. Unfortunately, the same applies to 19 %, 26 %, and 35 % of ASs, UUSs, and HG-ESSs, respectively (Table 14.8) [143].

The likelihood of encountering an LMS or an LG-ESS in the course of or following HE, regardless of the indication under which it was performed, is 0.14 % (LMS: 0.07 %; LG-ESS: 0.07 %) [132]. Among patients operated on under the indication of an LM, the risk is 0.23 % (LMS 0.08, LG-ESS 0.15 %) [171, 219]. Other studies have reported likelihoods of 0.09 % [263] and 0.39 % [262] for encountering unexpected LMSs during or following sole LM-enucleation. In 1.2 % of cases, LM-morcellation (1091 instances) reveals unexpected LMSs (0.09 %), LG-ESSs (0.09 %), or STUMPSs [243]. However, the risk of incidentally diagnosing an LMS in patients subjected to HE for symptomatic LMs is substantially higher, at 0.49 %, and increases from 0.2 % at age 36 to 1.4 % beyond the age of 50, and 1.7 % from the age of 62 [172]. Further analyses report a 0.22 % likelihood of discovering an occult LMS or LG-ESS on morcellated specimens taken under any indication [104]. The aforementioned data are, however, all based on relatively small samples. A more recent and extensive study of 41,777 women who underwent a myomectomy with or without power morcellation revealed an 0.18 % chance of encountering occult uterine sarcomas and (!) endometrial carcinomas (codified as ICD-9-codes 179 and 182). This corresponds to 1 tumor per 550 cases. The ratio changes to 1 tumor per 161 cases in women aged 50 and older. The rate for patients who underwent power morcellation was 0.09 % [294].

In a recent German analysis, the rate of all occult sarcoma (LMS and LG-ESS) among 10,731 women who underwent supracervical laparoscopic HE was 1:1788 (LMS 1:5365, LG-ESS 1:2683) [36]. Two separate analyses were conducted by cooperation partners of the DKSM [143] in 2015. The first (143) revealed an 0.22 % chance (1:455) of incidental uterine sarcoma (1 LMS, 6 LG-ESS, 1 AS), but only an 0.027 chance (1:3703) of LMS in 3717 women who underwent any form of LM surgery. The second study (143) revealed a risk of 0.06 % (1:1666) of finding occult uterine sarcomas (LMS, LG-ESS, carcinosarcoma) among 31,227 patients who were subjected to LM-surgery. This risk was significantly higher among postmenopausal women (1:100). The risk for LMS and LG-ESS was 0.05 % (1:2000) and 0,006 % (1:16,666), respectively. A review of the available literature suggests that the prevalence of unexpected sarcomas in cases of suspected LM is roughly 0.14 % (1:700) [40]. Taking the more recent German studies with their larger respective cohorts into consideration, it is justifiable to assume that the prevalence rate is closer to 1:1000 for all uterine sarcomas and from 1300 up to 1:5000 for LMS. In an up-to date meta-analysis [229], 134 studies (without the German analysis (31)) were analyzed, covering 30,193 women in whom fibroid related indications were the primary reason for an HE or a myomectomy. The analyses of 64 prospective studies revealed an estimated prevalence of LMS of 0.12 per 1000 surgeries (1:8300). When restricted to the retrospective analyses, the estimated prevalence was 0.57 per 1000 surgeries (1:1700). Meta-analyses of all 134 studies estimated prevalence to be 0.57 per 1000 surgeries (approximately 1 LMS for every 2000 procedures). The latter is similar to the results of the DKSM-study [143].

In the DKSM database [143], of the LMS patients who were operated on under the indication of an LM, 5 % were subjected to myoma enucleation, 27 % underwent morcellation, and a total of 66 % received inadequate surgery (all techniques that cause injury to the tumor and/or the uterus, including supracervical abdominal or endoscopic HE). The figures are significantly higher for LG-ESSs, at 23 %, 41 %, and 70 %, respectively. What this implies in terms of patient prognosis has already been elaborated in detail in the respective subsections. The situation is similar for uterine ASs, HG-ESSs, and UUSs, albeit with significantly smaller shares of these tumors being operated on under the indication of an LM (Table 14.8). Pre-therapeutic and intraoperative selection thus requires vast improvement, and more thought and consideration need to be devoted to indications for surgery. The fact that the risk of 1 sarcoma per 1000 LM-operations is rather low by comparison should not serve to distract from that need.

The AAGL [1] recommends that morcellation should only be considered when appropriate examinations of the myome-

Table 14.8 Epidemiological and clinical characteristics and primary indication for surgery of 1132 uterine sarcomas and 3920 leiomyomas covered by the Doctoral Research Group (Promotions- und Forschungsgruppe) of the DKSM [143]

	Med. age years	≥50 years %	Postmeno-pause %	Med. tumor Ø cm	Tumor Ø ≥5 cm %	Tumor Ø ≥8 cm %	OP-indication LM %
LM	44	16.1	3.4	5.0	55.2	16.9	100
STUMP	46	28,0	20.0	6	68.4	36.8	92
LG-ESS	46	25.0	17.9	5.5	64.5	24.2	68
AS	56	64.3	61.9	5.5	54.3	27.8	19
LMS	53	66.1	62.5	8.0	85.6	60.2	51
HG-ESS	58	80.4	73.3	7.5	90.0	36.6	35
UUS	63	84.0	80.7	11	83.3	72.2	26

Table 14.9 Clinical criteria and differences between Leiomyoma (n = 3920) and leiomyosarcoma (n = 224) according to the data from the DKSM, all criteria $p < 0.001$ [143]

Clinical criteria	Myoma %	Leiomyosarcoma %
age ≥50 years	15.9	66.1
Postmenopause	3,3	62.5
Additional bleeding in premenopause	4,3	41.6
Bleeding in postmenopause	22	45
Suspicious sonography	5.3	88.4
Suspicious sonography in tumor ≥5 cm	3.6	40.5
Rapid growth	16.9	42.2
Rapid growth with symptoms	8.7	17.3
Rapid growth in tumor ≥5 cm	13.4	26.7
Rapid growth ≥45 years	9.4	24
Diameter ≥8 cm	16.7	60.2
Diameter ≥8 cm and solitary	9,1	28.0

trium, the cervix, and the endometrium have revealed no suspicious findings. When the pre-operative findings are suggestive of a malignancy and/or the patient is postmenopausal, alternative measures, including laparotomy, should be opted for. At the same time, morcellation should not be performed when examinations have revealed malignant or premalignant findings. This view is also reflected in the most recent recommendations of the DGGG as well as the current NCCN-guidelines [27, 202]. Whenever electric morcellation is being seriously considered, the specific risks associated with performing the procedure on benign (!) LMs (for instance provocation of a disseminated peritoneal leiomyomatosis or benign metastasizing LM) need to be explicitly discussed with the patient. Particularities pertaining to these clinical situations should be sought in the specialist literature [145].

Consistently having regard to the anamnestic, clinical, and sonographic criteria and risk factors that are suggestive of uterine sarcoma (Tables 14.2, 14.4, 14.8, and 14.9), while consistently adhering to a respective diagnostic flowchart (Fig. 14.22) prior to every LM-operation, can rather easily serve to protect uterine sarcoma patients from being subjected to inappropriate therapeutic procedures in the majority of cases.

In women aged 50 and older, the chance of encountering unexpected uterine sarcomas during LM-surgery is 0.62 % (1:116). The risk increases to 3.4 % in patients aged ≥60 years (1:29). In contrast, for women aged <40 years, the likelihood is only 0.04 % [293]. Overall, about 66 % of LMSs occur in women aged 50 and above, and about 62 % are found in postmenopausal patients [8, 9] [143]. Currently, 64.2 % of all LMSs are subjected to inappropriate surgical treatment [143]. If one were to exclude all women aged 50 and above as well as all postmenopausal patients from inappropriate surgery or advise against undergoing such surgery, as is recommended by the AAGL [1], then such inappropriate surgery would be prevented in well more than 50 % of LMS-cases. For ASs, HG-ESSs, and UUSs, the proportion of patients aged ≥50 is 64.3 %, 80.4 %, and 84 % (!), respectively (see Table 14.8). In order to better protect LG-ESS patients from being subjected to inadequate surgery, it is sensible to set the upper age threshold for organ-sparing surgery to 50 years, not least because LG-ESS patients have a median age of 46 years and only 18 % of these tumors occur postmenopausally (see also the section on LG-ESS).

For premenopausal patients (even better, patients aged <50) who desire organ sparing surgery (including supracervical HE), following anamnesis and clinical examination, selection must be based on the results from sonographic examination (and from curettage and HSC in cases of abnor-

mal bleeding). Should gray-scale sonography reveal findings that are suspicious of sarcoma (Table 14.2) or other suggestive findings (Tables 14.4, 14.8, and 14.9), then total HE without injuring the uterus should be the primary surgical course of action. Otherwise, further diagnostic measures are necessary.

According to the data from the DKSM [143] factors (Table 14.9) suggestive of sarcoma are, in particular, rapid tumor growth in women aged ≥45 years (24 % in LMS and 9.4 % in LM) and/or in combination with newly arising symptoms (17.3 % in LMS and 8.7 % in LM). Of all LMs ≥5 cm 13.4 % exhibit rapid growth, compared to 26.7 % of LMSs of the same size. Tumors with a diameter of ≥8 cm (60.2 % in LMS, 16.7 % in LMs) are particularly suspicious of being sarcomas, especially when they are solitary tumors or are noticeably soft. Only 9.1 % of ordinary LMs are solitary tumors with a diameter of ≥8 cm, while 28.0 % of LMSs fulfill these criteria. So the fact that LMSs have a median diameter of 8.0 cm would in itself serve to avoid inadequate surgery for at least 50 % of all LMSs, regardless of patient age, symptoms and rapid growth (Table 14.9).

Lowering the threshold for critical tumor size from 8 to 5 cm would be particularly helpful from the perspective of advanced diagnostics. Doing so would bring more than 50 % of all LG-ESSs and ASs within the remit of the selection criteria, bearing in mind that LG-ESSs and ASs have a median diameter of 5.5 cm at the time of initial presentation. The share of LMSs that would thus be covered by the criteria would be 85.6 %. Moreover, in the DKSM database, 69.2 % of LG-ESSs that were described as LMs in clinical examination and/or sonography and that were subsequently operated on as such were ≥5 cm in diameter, and 87.5 % of them were morcellated [143]. Expanding the diagnostic criteria to include all tumors with diameters of ≥5 cm would have been extraordinarily helpful in these cases. While changing the diagnostic criteria to this end would indeed entail that a larger proportion of

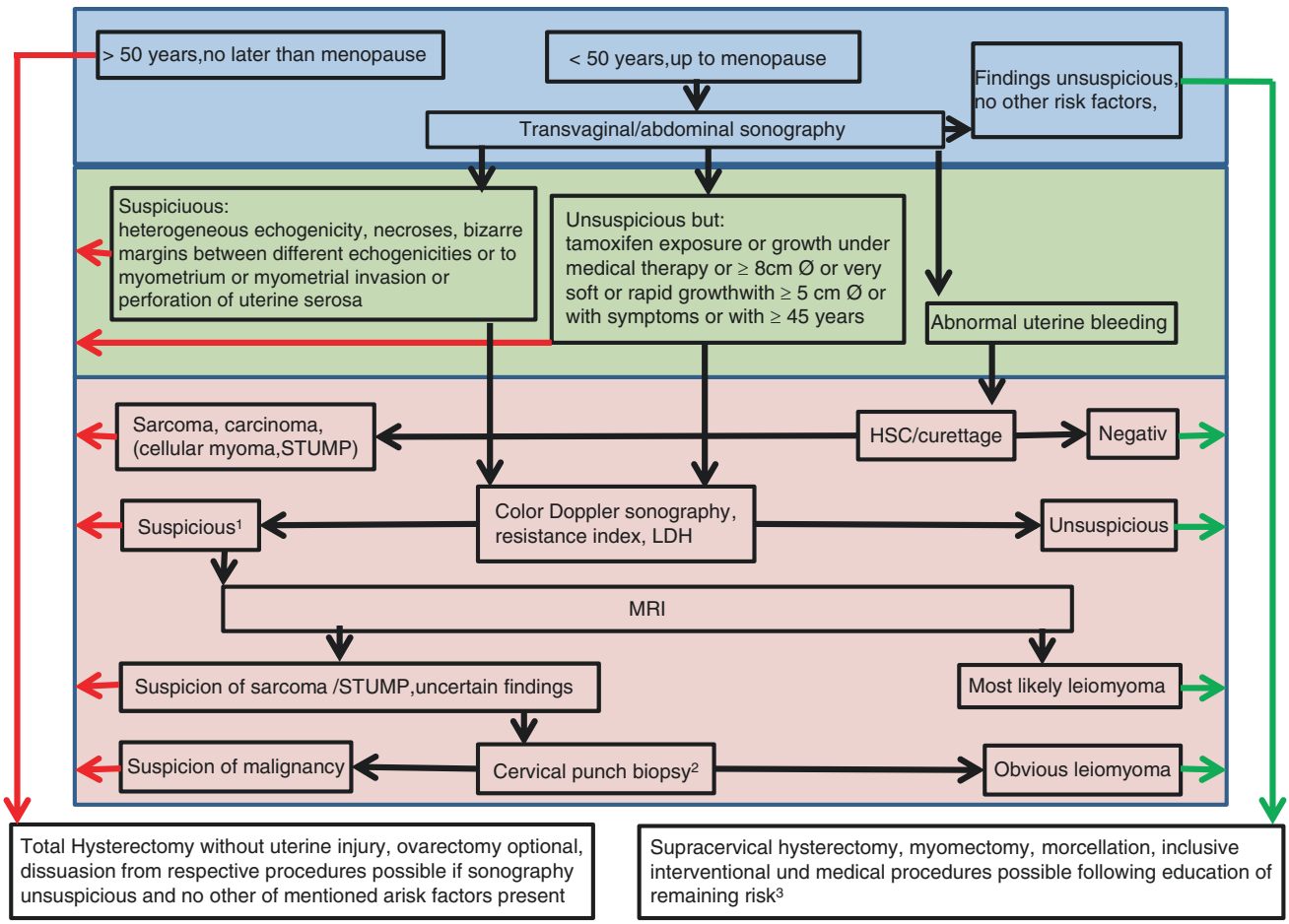


Fig. 14.22 Flowchart for preventing inappropriate surgery being performed on uterine sarcomas operated on under the assumption of a leiomyoma (With permission of Köhler et al. [144], Fig. 1.2–13)

Table 14.10 Results of the flowchart, if used prior to surgical procedure according to the data from the DKSM [143]

	LMS	Proven risk factors	
Surgical procedure	n	n	%
Inadequate surgery	129	122	94.6
Adequate surgery	72	71	98.6

patients would be subjected to Doppler sonography, at the same time, it would also imply that inappropriate surgical procedures could be prevented for up to 85.6 % of LMS, 83.3 %, of UUS and 90 % of HG-ESS patients. However, adapting the diagnostic criteria in the flowchart below to include tumors with a diameter of ≥5 cm with (apparently) unsuspicious results from gray-scale sonography inevitably has a negative impact on sensitivity, as 55.2 % of regular LMs and have a diameter of ≥5 (LMS in 85.6 %) (Table 14.8) [143].

The resulting decrease in sensitivity notwithstanding, tumors with a diameter of ≥5 cm should be included in the scope of expanded diagnostic criteria so as to improve diagnostic security and accuracy.

A medical history of exposure to tamoxifen is also among the risk factors that need to be clarified prior to performing surgery (see pathogenesis for all uterine sarcomas).

Should a patient request surgery that is either entirely or partially organ-sparing, even though one or more risk factors for a sarcoma are fulfilled (Table 14.4), then subsequent diagnostic measures must be initiated. Besides performing curettage and/or HSC in cases of abnormal vaginal bleeding, the patient should undergo a Doppler sonography examination, ideally in combination with LDH-testing. Both of these measures have been discussed in detail in the respective subchapters on the different sarcoma types. Where results from these procedures are likewise suspicious or pathological, and the patient continues (!) to request conservative surgery, an MRT examination should be performed. If the MRT results (for details, see the respective subsections) are suspicious or unclear, especially in combination with elevated LDH-levels (reference value × 1.2), and the patient continues to reject total HE in the course of which the uterus would not sustain injury, then performing a transcervical punch biopsy is the last available option. The potential pitfalls and risks associated with this procedure have been elaborated in detail in the differential diagnosis subsection for LMSs.

Overall, the diagnostic flowchart (Fig. 14.22) generally implies that sonographic examination has been performed prior to any LM-operation. Routinely subjecting patients with anamnestically, clinically, and sonographically unsuspicious LMs to curettage and/or HSC, color Doppler sonography, and/or MRT is not necessary according to the current state of information. Nonetheless, even when the flowchart is applied, incidental discoveries of uterine sarcomas and STUMPs cannot be entirely ruled out. Patients must be informed of this remaining risk.

Even in cases with ordinary LM patients must be informed of the fact that performing enucleation or morcellation can increase the risk of disseminated peritoneal leiomyomatosis and benign metastasizing LM.

When considering interventional therapy (embolization, ultrasound-guided destruction) for LM-patients, it must be borne in mind that the object on which such therapy is to be performed might well be inappropriate for such course of action [226]. However, in the DKSM-sample, embolizations accounted for only 1.2 % of all primary LMS-operations [143]. In contrast to older publications [63], more recent analyses and meta-analyses on LM-embolization lack any reference to potential sarcoma risk. Attending physicians should, however, not interpret this state of affairs as absolving them from the need to inform their patients of this risk, nor from taking further respective diagnostic steps to minimize it.

5.4 % of the 129 inadequate LMS surgeries covered in the DKSM materials [143] exhibited none of the risk factors described above (Table 14.9 and Fig. 14.22). Consequently, 94.6 % of these operations could have been prevented by referring to the flow chart (Table 14.10). Among the 72 adequate LMS operations performed, only 1.4 % of LMSs would have been missed as a consequence of adhering to the diagnostic chart. This (albeit minor) difference can be explained by the fact that total HE without injury to the uterus was often performed in cases in which an LMS had already been primarily diagnosed or suspected. In a further study [175] 4791 patients were referred to surgery under the indication of an LM. Among them, a total of 26 LMSs (1:183) were discovered. 20 LMSs could be successfully identified as such and referred to adequate surgery on the basis of diagnostics (curettage) or arising clinical suspicions of malignancy (tumor size). Only 6 cases (1:799) thus remained undetected. Ultimately, the share of LMSs that are detected incidentally during or following LM operations can be decreased dramatically if suspected LMs are subjected to more critical assessment prior to surgery.

This notwithstanding, an analysis conducted by the cooperation partners of the DKSM [143] revealed that, among 3920 ordinary LMs, 1739 (44.4 %) exhibited at least one of the risk factors stated above. However, only those patients who decline primary total HE need to be subjected to further diagnostics (yes when HSC/curettage and/or color Doppler sonography yield findings).

Therefore, seeking to prevent subjecting uterine sarcomas to inadequate surgery under the indication of an LM would not entail much effort, not least because, in its flow chart, the

Table 14.11 Descriptive accounts of uterine sarcomas, rendered either intraoperatively or immediately following surgery, based on 804 DKSM-surgical reports [143]

Intraoperative
Tumor very soft
Tumor primarily ruptured
Tumor extremely fragile (ruptures upon slight pressure)
Protrusion/outpour of hemorrhagic, marrowy, cauliflower-like, degrading or liquefied material upon cutting/dissection
Resected, opened tumor
If present, pseudo-capsule consists mostly of compressed tumor tissue
Hemorrhagic tumor, cystic structures, necrotic components
Entirely or partially gray, greenish-gray, dirty, intense yellow color
Very smooth cut surface, either partially or overall

ESGE [40] already regards color Doppler sonography as a precondition for conservative myoma surgery.

The performance of inappropriate modes of surgery on patients with sarcoma types not covered in the flowchart can nonetheless be prevented, if the attending physicians bear the factors suggestive of sarcomas (Table 14.11) in mind both during and immediately after surgery. The surgical approach should be reconsidered and/or a frozen section should be performed in respectively appropriate cases. The problems and pitfalls associated with frozen section procedures have to be taken into consideration (see LMS).

When findings are deemed unsuspicious according to the flowchart, and no intraoperative suspicions arise, there is currently no sound reason to deviate from tried and tested interventional and conservative surgical procedures for LMs, or to refrain from performing endoscopic procedures or morcellation where necessary. Notwithstanding, the patient must nonetheless be informed of the risks associated with morcellation (disseminated peritoneal leiomyomatosis and benign metastasizing LM). Electric morcellation should currently not be resorted to due to the large number of unresolved questions pertaining to the procedure. In their flowchart, the European Society of Gynaecological Endoscopy prioritizes performing a Doppler sonography examination as the primary method for verifying indications for surgery, a demand that is currently unrealistic context. The aforementioned chart [40] also demonstrates a number of other weaknesses and unclear, in part ambiguous wordings.

A real LMS risk score will be published soon by the DKSM.

Conclusions

LMs shall not be subjected to surgery without prior sonographic examination

Consistent application of the diagnostics flowchart

Consistent consideration of suspicious findings arising intraoperatively

Patients to be informed that, despite appropriate diagnostics, additional surgical procedures could be necessary if a finding of a malignancy arises

Patients to be informed that performing enucleation or morcellation on unsuspicious, ordinary LMs can result in disseminated peritoneal leiomyomatosis or a benign metastasizing LM.

References

1. AAGL Advancing Minimally Invasive Gynecology Worldwide. AAGL practice report: morcellation during uterine tissue extraction. J Minim Invasive Gynecol. 2014;21:517–30.
2. Abeler VM, Røyne O, Thoresen S, Danielsen HE, Nesland JM, Kristensen GB. Uterine sarcomas in Norway. A histopathological and prognostic survey of a total population from 1970 to 2000 including 419 patients. Histopathology. 2009;54:355–564.
3. Abu-Rustum N, Curtin JP, Burt M, Jones WB. Regression of uterine low-grade smooth-muscle tumors metastatic to the lung after oophorectomy. Obstet Gynecol. 1997;89:850–2.
4. Akahira J, Tokunaga H, Toyoshima M, Takano T, Nagase S, Yoshinaga K, Tase T, Wada Y, Ito K, Niikura H, Yamada H, Sato A, Sasano H, Yaegashi N. Prognosis and prognostic factors of carcinosarcoma, endometrial stromal sarcoma and uterine leiomyosarcoma: a comparison with uterine endometrial adenocarcinoma. Oncology. 2006;71:333–40.
5. Akhan SE, Yavuz E, Tecer A, Iyibozkurt CA, Topuz S, Tuzlali S, Bengisu E, Berkman S. The expression of Ki-67, p53, estrogen and progesterone receptors affecting survival in uterine leiomyosarcomas. A clinicopathologic study. Gynecol Oncol. 2005;99:36–42.
6. Albrektsen G, Heuch I, Wik E, Salvesen HB. Prognostic impact of parity in 493 uterine sarcoma patients. Int J Gynecol Cancer. 2009;19:1062–7.
7. Amant F, Moerman P, Cadron I, Neven P, Berteloot P, Vergote I. The diagnostic problem of endometrial stromal sarcoma: report on 6 cases. Gynecol Oncol. 2003;90:37–43.
8. Amant F, Steenkiste E, Schurmans K, Verbist L, Abeler VM, Tulunay G, Jonge E de, Massuger L, Moermann P, Vergote I. Immunhistochemical expression of CD10 antigen in uterine adenosarcoma. Int J Gynecol Cancer 2004; 14: 1118–1121
9. Amant F, Schurmans K, Steenkiste E, Verbist L, Abeler VM, Tulunay G, Jonge E de, Massuger L, Moermann P, Vergote I. Immunhistochemical determination of estrogen and progesterone receptor positivity in uterine adenosarcoma. Gynecol Oncol 2004; 93: 680–685
10. Amant F, Moerman P, Vergote I. Report of an unusual problematic uterine smooth muscle neoplasm, emphasizing the prognostic

importance of coagulative tumor cell necrosis. Int J Gynecol Cancer. 2005;15:1210–2.
11. Amant F, De Knijf A, Van Calster B, Leunen K, Neven P, Berteloot P, Vergote I, Van Huffel S, Moerman P. Clinical study investigating the role of lymphadenectomy, surgical castration, and adjuvant hormonal treatment in endometrial stromal sarcoma. Br J Cancer. 2007;97:1194–9.
12. Amant F, Floquet A, Friedlander M, Kristensen G, Mahner S, Nam EJ, Powell MA, Ray-Coquard I, Siddiqui N, Sykes P, Westermann AM, Seddon B. Gynecological Cancer InterGroup consensus review for endometrial stromal sarcoma. Int J Gynecol Cancer. 2014;24(Suppl 3):S67–72.
13. Anaya DA, Lev DC, Pollock RE. The role of surgical margin status in retroperitoneal sarcoma. J Surg Oncol. 2008;98:607–10.
14. Anderson TM, McMahon JJ, Nwogu CE, Pombo MW, Urschel JD, Driscoll DL, Lele SB. Pulmonary resection in metastatic uterine and cervical malignancies. Gynecol Oncol. 2001;83:472–6.
15. Arenas M, Rovirosa A, Hernández V, Ordi J, Jorcano S, Mellado B, Biete A. Uterine sarcomas in breast cancer patients treated with tamoxifen. Int J Gynecol Cancer. 2006;16:861–5.
16. Arend R, Bagaria M, Lewin SN, Sun X, Deutsch I, Burke WM, Herzog TJ, Wright JD. Long-term outcome and natural history of uterine adenosarcomas. Gynecol Oncol. 2010;119:305–8.
17. Arici DS, Aker H, Yildiz E, Tasyurt A. Mullerian adenosarcoma of the uterus associated with tamoxifen therapy. Arch Gynecol Obstet. 2000;164:105–7.
18. Atkins KA, Arronte N, Darus CJ, Rice LW. The Use of p16 in enhancing the histologic classification of uterine smooth muscle tumors. Am J Surg Pathol. 2008;32:98–102.
19. Aviram R, Ochshorn Y, Markovitch O, Fishman A, Cohen I, Altaras MM, Tepper R. Uterine sarcomas versus leiomyomas: gray-scale and Doppler sonographic findings. J Clin Ultrasound. 2005;33:10–3.
20. Bai H, Yang J, Cao D, Huang H, Xiang Y, Wu M, Cui Q, Chen J, Lang J, Shen K. Ovary and uterus-sparing procedures for low-grade endometrial stromal sarcoma: a retrospective study of 153 cases. Gynecol Oncol Gynecol Oncol. 2014;132:654–60.
21. Baird DD, Garrett TA, Laughlin SK, Davis B, Semelka RC, Peddada SD. Short-term change in growth of uterine leiomyoma: tumor growth spurts. Fertil Steril. 2011;95:242–6.
22. Balleine RL, Earls PJ, Webster LR, Mote PA, deFazio A, Harnett PR, Clarke CL. Expression of progesterone receptor A and B isoforms in low-grade endometrial stromal sarcoma. Int J Gynecol Pathol. 2004;23:138–44.
23. Bansal N, Herzog TJ, Burke W, Cohen CJ, Wright JD. The utility of preoperative endometrial sampling for the detection of uterine sarcomas. Gynecol Oncol. 2008;110:43–8.
24. Bansal S, Lewin SN, Burke WM, Deutsch I, Sun X, Herzog TJ, Wright JD. Sarcoma of the cervix: natural history and outcomes. Gynecol Oncol. 2010;118:134–8.
25. Barney B, Tward JD, Skidmore T, Gaffney DK. Does radiotherapy or lymphadenectomy improve survival in endometrial stromal sarcoma? Int J Gynecol Cancer. 2009;19:1232–8.
26. Beck TL, Singhal PK, Ehrenberg HM, Rose PG, Lele SB, Krivak TC, McBee Jr WC. Endometrial stromal sarcoma: analysis of recurrence following adjuvant treatment. Gynecol Oncol. 2012;125:141–4.
27. Beckmann MW, Juhasz-Böss I, Denschlag D, Gaß P, Dimpfl T, Harter P, Mallmann P, Renner SP, Rimbach S, Runnebaum I, Untch M, Brucker SY, Wallwiener D. Surgical methods for the treatment of uterine fibroids – risk of uterine sarcoma and problems of morcellation: position paper of the DGGG. Geburtshilfe Frauenheilkd. 2015;75:148–64.
28. Bell SW, Kempson RL, Hendrickson MR. Problematic uterine smooth muscle neoplasms. a clinicopathologic study of 213 cases. Am J Surg Pathol. 1994;18:535–58.
29. Berchuk A, Rubin SC, Hoskins WJ, Saigo PE, Pierce VK, JL Jr L. Treatment of endometrial stromal tumors. Gynecol Oncol. 1990;71:60–5.
30. Bernard B, Clarke BA, Malowany JI, McAlpine J, Lee CH, Atenafu EG, Ferguson S, Mackay H. Uterine adenosarcomas: a dual-institution update on staging, prognosis and survival. Gynecol Oncol. 2013;131:634–9.
31. Berretta R, Rolla M, Merisio C, Goirdano G, Nardelli GB. Uterine smooth muscle tumor of uncertain malignant potential: a three-case report. Int J Gynecol Cancer. 2007;18:1108–31.
32. Blom R, Malmström H, Guerrieri C. Endometrial stromal sarcoma of the uterus: a clinicopathologic, DNA flow cytometric, p53, and mdm-2 analysis of 17 cases. Int J Gynecol Cancer. 1999;9:98–104.
33. Bodner K, Bodner-Adler B, Kimberger O, Czerwenka K, Leodolter S, Mayerhofer K. Estrogen and progesterone receptor expression in patients with uterine leiomyosarcoma and correlation with different clinicopathological parameters. Anticancer Res. 2003;23:729–32.
34. Bodner K, Bodner-Adler B, Kimberger O, Czerwenka K, Mayerhofer K. Estrogen and progesterone receptor expression in patients with uterine smooth muscle tumors. Fertil Steril. 2004;81:1062–6.
35. Bogani G, Cliby WA, Aletti GD. Impact of morcellation on survival outcomes of patients with unexpected uterine leiomyosarcoma: a systematic review and meta-analysis. Gynecol Oncol. 2015;137:167–72.
36. Bojahr B, De Wilde RL, Tchartchian G. Malignancy rate of 10,731 uteri morcellated during laparoscopic supracervical hysterectomy (LASH). Arch Gynecol Obstet. 2015; doi:10.1007/s00404-015-3696-z.
37. Bonvalot S, Rivoire M, Castaing M, Stoeckle E, Le Cesne A, Blay JY, Laplanche A. Primary retroperitoneal sarcomas: a multivariate analysis of surgical factors associated with local control. J Clin Oncol. 2009;27:31–7.
38. Borah BJ, Nicholson WK, Bradley L, Stewart EA. The impact of uterine leiomyomas: a national survey of affected women. Am J Obstet Gynecol. 2013;209:319.e1–319.
39. Bradley LD. Uterine fibroid embolization: a viable alternative to hysterectomy. Am J Obstet Gynecol. 2009;201:127–35.
40. Brölmann H, Tanos V, Grimbizis G, Ind T, Philips K, van den Bosch T, Sawalhe T, van den Haak L, Jansen FW, Pijnenborg J, Taran FA, Brucker S, Wattiez A, Campo R, O'Donovan P, de Wilde RL, On behalf of the European Society of Gynaecological Endoscopy (ESGE) Steering Committee on Fibroid Morcellation. Options on fibroid morcellation: a literature review. Gynecol Surg. 2015;12:3–15.
41. Buttram V, Reiter R. Uterine leiomyomata: etiology, symptomatology, and management. Fertil Steril. 1981;36:433–45.
42. Buyukkurt S, Guzel AB, Gumurdulu D, Vardar MA, Zeren H, Sucu M. Mullerian adenosarcoma of the uterine cervix in an adolescent girl. J Pediatr Adolesc Gynecol. 2010;23:e13–5.
43. Buzaglo K, Bruchim I, Lau SK, Ferenczy A, Tulandi T, Gotlieb WH. Sarcoma post-embolization for presumed uterine fibrosis. Gynecol Oncol. 2008;108:244–7.
44. Cacciatore B, Lehtovirta P, Wahlström T, Ylöstalo P. Ultrasound findings in uterine mixed müllerian sarcomas and endometrial stromal sarcomas. Gynecol Oncol. 1989;35:290–3.
45. Carroll A, Ramirez PT, Westin SN, Soliman PT, Munsell MF, Nick AM, Schmeler KM, Klopp AH, Fleming ND. Uterine adenosarcoma: an analysis on management, outcomes, and risk factors for recurrence. Gynecol Oncol. 2014;135:455–61.

46. Carter J, Perrone T, Carson LF, Carlson J, Twiggs LB. Uterine malignancy predicted by transvaginal sonography and color flow Doppler ultrasonography. J Clin Ultrasound. 1993;21:405–8.
47. Chan JK, Kawar NM, Shin JY, Osann K, Chen L, Powell C, Kapp S. Endometrial stromal sarcoma: a population based analysis. Br J Cancer. 2008;99:1210–5.
48. Chang KL, Crabtree GS, Lim-Tan SK, Kempson RL, Hendrickson R. Primary uterine endometrial stromal neoplasms. A clinicopathologic study of 117 cases. Am J Surg Pathol. 1990;14:415–38.
49. Chen CD, Huang CC, Wu CC, Tseng GC, Lee CN, Lin GJ, Hsieh CY, Hsieh FJ. Sonographic characteristics in low-grade endometrial stromal sarcoma: a report of two cases. J Ultrasound Med. 1995;14:165–8.
50. Chen L, Yang B. Immunohistochemical analysis of p16, p53, and Ki-67 expression in uterine smooth muscle tumors. Int J Gynecol Pathol. 2008;27:326–32.
51. Cho KR, Woodruff JD, Epstein JI. Leiomyoma of the uterus with multiple extrauterine smooth muscle tumors: a case report suggesting multifocal origin. Hum Pathol. 1989;20:80–3.
52. Chourmouzi D, Boulogianni G, Zarampoukas T, Drevelengas A. Sonography and MRI of tamoxifen-associated müllerian adenosarcoma of the uterus. AJR Am J Roentgenol. 2003;181:1673–5.
53. Christacos NC, Quade BJ, Dal Cin P, Morton CC. Uterine leiomyomata with deletions of Ip represent a distinct cytogenetic subgroup associated with unusual histologic features. Genes Chromosom Cancer. 2006;45:304–12.
54. Chu MC, Mor G, Lim C, Zheng W, Parkash V, Schwartz PE. Low-grade endometrial stroma sarcoma: hormonal aspects. Gynecol Oncol. 2003;90:170–6.
55. Clement P, Scully R. Mullerian adenosarcoma of the uterus: a clinico-pathologic analysis of 100 cases with areview of the literature. Hum Pathol. 1990;21:363–81.
56. Clement PB, Oliva E, Young RH. Mullerian adenosarcoma of the uterine corpus associated with tamoxifen therapy: a report of six cases and a review of tamoxifen-associated endometrial lesions. Int J Gynecol Pathol. 1996;15:222–9.
57. Clement PB, Young RH. Atlas of gynecologic surgical pathology. 3rd ed. Saunders Elsevier; 2014.
58. Coley HM, Lewandowicz G, Sargent JM, Verrill MW. Chemosensitivity testing of fresh and continuous tumor cell cultures using lactate dehydrogenase. Anticancer Res. 1997;17:231–6.
59. Cornfeld D, Israel G, Martel M, Weinreb J, Schwartz P, McCarthy S. MRI appearance of mesenchymal tumors of the uterus. Eur J Radiol. 2010;74:241–9.
60. Dafopoulos A, Tsikouras P, Dimitraki M, Galazios G, Liberis V, Maroulis G, Teichmann AT. The role of lymphadenectomy in uterine leiomyosarcoma: review of the literature and recommendations for the standard surgical procedure. Arch Gynecol Obstet. 2010;282:293–300.
61. D'Angelo E, Spagnoli LG, Prat J. Comparative clinicopathologic and immunohistochemical analysis of uterine sarcomas diagnosed using the World Health Organization classification system. Hum Pathol. 2009;40:1571–85.
62. D'Angelo E, Quade BJ, Prat J. Uterine smooth muscle tumors. In: Mutter GL, Prat J, editors. Pathology of the female reproductive tract. 3rd ed. Churchill-Livingstone Elsevier; 2014. p. 402–24.
63. David M, Warschewske G, Hengst S, Ehrenstein T. Die uteruserhaltende Myombehandlung. Frauenarzt. 2003;44:1164–76.
64. David M, Krätschell R, Stupin JH. Welches Myomwachstum ist normal? Frauenarzt. 2013;54:1162–7.
65. Della Badia C, Karini H. Endometrial stromal sarcoma diagnosed after uterine morcellation in laparoscopic supracervical hysterectomy. Minim Invasive Gynecol. 2010;17:791–3.
66. Dinh TA, Oliva EA, Fuller Jr AF, Lee H, Goodman A. The treatment of uterine leiomyosarcoma. Results from a 10-year experience (1990–1999) at the Massachusetts General Hospital. Gynecol Oncol. 2004;92:648–65.
67. Dong R, Mao H, Zhang P. Conservative management of endometrial stromal sarcoma at stage III: a case report. Oncol Lett. 2014;8:1234–6.
68. Donnez O, Squifflet J, Leconte I, Jadoul P, Donnez J. Posthysterectomy pelvic adenomyotic masses observed in 8 cases out of a series of 1405 laparoscopic subtotal hysterectomies. J Minim Invasive Gynecol. 2007;14:156–60.
69. Dos Santos L, Garg K, Diaz JP, Soslow RA, Hensley ML, Alektiar KM, Barakat RR, Leitao MM. Incidence of adnexal and lymph node metastases in endometrial stromal sarcoma. J Clin Oncol. 2009;27(Suppl):Abstr. 5589.
70. Eary JF, Conrad EU. Imaging in sarcoma. J Nucl Med. 2011;52:1903–13.
71. Ehdaivand S, Simon RA, Sung CJ, Steinhoff MM, Lawrence WD, Quddus MR. Incidental gynecologic neoplasms in morcellated uterine specimens: a case series with follow-up. Hum Pathol. 2014;45:2311–7.
72. Einstein MH, Barakat RR, Chi DS, Sonoda Y, Alektiar KM, Hensley ML, Abu-Rustum NR. Management of uterine malignancy found incidentally after supracervical hysterectomy or uterine morcellation for presumed benign disease. Int J Gynecol Cancer. 2008;10:1065–70.
73. El Maalouf G, Duvillard P, Rey A, Morice P, Haie-Meder C, Lhommé C, Pautier P. Clinical features, recurrence patterns and treatment in endometrial stromal sarcomas: a thirty-year single-institution experience. J Clin Oncol. 2008;26(Suppl 15):Abstr 10574.
74. ESMO/European Sarcoma Network Working Group. Soft tissue and visceral sarcomas: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2012;23(Suppl 7):vii 92–9.
75. Exacoustos C, Romanini ME, Amadio A, Amoroso C, Szabolcs B, Zupi E, Arduini D. Can gray-scale and color Doppler sonography differentiate between uterine leiomyosarcoma and leiomyoma? J Clin Ultrasound. 2007;35:449–57.
76. Farhat MH, Hobeika EM, Moumneh G, Nassar AH. Uterine mullerian adenosarcoma with sarcomatous overgrowth fatal recurrence within two weeks of diagnosis: a case report. Med Case Reports. 2007;25:103.
77. Farhat F, Fakhruddine NA. A case of synchronous relapse of breast cancer and uterine müllerian adenosarcoma post tamoxifen in a premenopausal woman. Eur J Gynaecol Oncol. 2008;29:95–7.
78. Farquhar C, Arroll B, Ekeroma A, Fentiman G, Lethaby A, Rademaker L, Roberts H, Sadler L, Strid J, Working Party of the New Zealand Guidelines Group. An evidence-based guideline for the management of uterine fibroids. Aust N Z J Obstet Gynaecol. 2001;41:125–40.
79. Favero G, Anton C, Silva e Silva A, Ribeiro A, MP A, Miglino G, EC B, JP C. Vaginal morcellation: a new strategy for large gynecological malignant tumor extraction: a pilot study. Gynecol Oncol. 2012;126:443–7.
80. FDA – SOURCES: April 17, 2014, U.S. Food and Drug Administration news briefing with William Maisel, M.D., M.P.H., deputy director for science and chief scientist, Center for Devices and Radiological Health; March 17, 2014, The New York Times; Dec. 24, 2013, Wall Street Journal.
81. Feng W, Hua K, Malpica A, Zhou X, Baak JP. Stages I to II WHO 2003-defined low-grade endometrial stromal sarcoma: how much primary therapy is needed and how little is enough? Int J Gynecol Cancer. 2013;23:488–93.

82. Feng W, Hua K, Gudlaugsson E, Yu Y, Zhou X, Baak JP. Prognostic indicators in WHO 2003 low-grade endometrial stromal sarcoma. Histopathology. 2013;62:675–87.
83. FIGO Committee on Gynecologic Oncology: FIGO staging for uterine sarcomas. Int J Gynecol Obstet. 2009;104:179.
84. Fleming NA, Hopkins L, de Nanassy J, Senterman M, Black AY. Mullerian adenosarcoma of the cervix in a 10-year-old girl: case report and review of the literature. J Pediatr Adolesc Gynecol. 2009;22:45–51.
85. Fong Y, Coit DG, Woodruff JM, Brennan MF. Lymph node metastasis from soft tissue sarcoma in adults. Analysis of data from a prospective database of 1772 sarcoma patients. Ann Surg. 1993;217:72–7.
86. Friedlander ML, Covens A, Glasspool RM, Hilpert F, Kristensen G, Kwon S, Selle F, Small W, Witteveen E, Russell P. Gynecologic Cancer InterGroup (GCIG) consensus review for mullerian adenosarcoma of the female genital tract. Int J Gynecol Cancer. 2014;24(9 Suppl 3):S78–82.
87. Fukunishi H, Funaki K, Ikuma K, Kaji Y, Sugimura K, Kitazawa R, Kitazawa S. Unsuspected uterine leiomyosarcoma: magnetic resonance imaging findings before and after focused ultrasound surgery. Int J Gynecol Cancer. 2007;17:724–8.
88. Furukawa R, Akahane M, Yamada H, Kiryu S, Sato J, Komatsu S, Inoh S, Yoshioka N, Maeda E, Takazawa Y, Ohtomo K. Endometrial stromal sarcoma located in the myometrium with a low-intensity rim on T2-weighted images: report of three cases and literature review. J Magn Reson Imaging. 2010;31:975–9.
89. Gadducci A, Landoni F, Sartori E, Zola P, Maggino T, Lissoni A, Bazzurini L, Arisio R, Romagnolo C, Cristofani R. Uterine leiomyosarcoma: analysis of treatment failures and survival. Gynecol Oncol. 1996;62:25–32.
90. Gadducci A, Sartori E, Landoni F, Zola P, Maggino T, Urgesi A, Lissoni A, Losa G, Fanucchi A. Endometrial stromal sarcoma: analysis of treatment failures and survival. Gynecol Oncol. 1996;63:247–53.
91. Gadducci A, Cosio S, Romanini A, Genazzani AR. The management of patients with uterine sarcoma: a debated clinical challenge. Crit Rev Oncol Hematol. 2008;65:129–42.
92. Gallardo A, Prat J. Mullerian adenosarcoma: a clinicopathologic and immunohistochemical study of 55 cases challenging the existence of adenofibroma. Am J Surg Pathol. 2009;33:278–88.
93. Garcia C, Kubat JS, Fulton RS, Anthony AT, Combs M, Powell CB, Littell RD. Clinical outcomes and prognostic markers in uterine leiomyosarcoma: a population-based cohort. Int J Gynecol Cancer. 2015;25:622–8.
94. Garg G, Shah JP, Toy EP, Bryant CS, Kumar S, Morris RT. Stage IA vs. IB endometrial stromal sarcoma: does the new staging system predict survival? Gynecol Oncol. 2010;118:8–13.
95. Garg G, Shah JP, Liu JR, Bryant CS, Kumar S, Munkarah A, Morris RT. Validation of tumor size as staging variable in the revised International Federation of Gynecology and Obstetrics stage I leiomyosarcoma: a population-based study. Int J Gynecol Cancer. 2010;20:1201–6.
96. Geisinger, K. R., Abdul-Karim, F. W. Fine needle aspiration bopsy of soft tissue tumors. In: Weiss SW, Goldblum JR, editors. Enzinger and Weiss's soft tissue tumors. 5th ed. Philadelphia: Mosby Elsevier; 2008. p. 103–117.
97. George S, Barysauskas C, Serrano C, et al. Retrospective cohort study evaluating the impact of intraperitoneal morcellation on outcomes of localized uterine leiomyosarcoma. Cancer. 2014;120:3154–8.
98. Giuntoli RL, Metzinger DS, DiMarco CS, Cha SS, Sloan JA, Keeney GL, Gostout BS. Retrospective review of 208 patients with leiomyosarcoma of the uterus: prognostic indicators, surgical management, and adjuvant therapy. Gynecol Oncol. 2003;89:460–9.
99. Giuntoli RL, Gostout BS, DiMarco CS, Metzinger DS, Keeney GL. Diagnostic criteria for uterine smooth muscle tumors: leiomyoma variants associated with malignant behavior. J Reprod Med. 2007;52:1001–10.
100. Goff BA, Rice LW, Fleischhacker D, Muntz HG, Falkenberry SS, Nikrui N, Fuller AF. Uterine leiomyosarcoma and endometrial stromal sarcoma: lymph node metastases and sites of recurrences. Gynecol Oncol. 1993;50:105–9.
101. Goldberg J, Burd I, Price FV, Worthington-Kirsch R. Leiomyosarcoma in a premenopausal patient after uterine artery embolization. Am J Obstet Gynecol. 2004;191:1733–5.
102. Gollard R, Kosty M, Bordin G, Wax A, Lacey C. Two unusual presentations of müllerian adenosarcoma: case reports, literature review, and treatment considerations. Gynecol Oncol. 1995;59:412–22.
103. Goto A, Takeuchi S, Sugimura K, Maruo T. Usefulness of Gd-DTPA contrast-enhanced dynamic MRI and serum determination of LDH and its isozymes in the differential diagnosis of leiomyosarcoma from degenerated leiomyoma of the uterus. Int J Gynecol Cancer. 2002;12:354–61.
104. Graebe K, Garcia-Soto A, Aziz M, Valarezo V, Heller PB, Tchabo N, Tobias DH, Salamon C, Ramieri J, Dise C, Slomovitz BM. Incidental power morcellation of malignancy: a retrospective cohort study. Gynecol Oncol. 2015;136:274–7.
105. Gremel G, Liew M, Hamzei F, Hardell E, Selling J, Ghaderi M, Stemme S, Pontén F, Carlson JW. A prognosis based classification of undifferentiated uterine sarcomas: identification of mitotic index, hormone receptors and YWHAE-FAM22 translocation status as predictors of survival. Int J Cancer. 2014; doi:10.1002/ijc.29141.
106. Gronchi A, Lo Vullo S, Fiore M, Mussi C, Stacchiotti S, Collini P, Lozza L, Pennacchioli E, Mariani L, Casali PG. Aggressive surgical policies in a retrospectively reviewed single-institution case series of retroperitoneal soft tissue sarcoma patients. J Clin Oncol. 2009;27:24–30.
107. Guntupalli SR, Anderson ML, Milam MR, Bodurka D, Ramirez PT. Clinical outcomes of smooth muscle tumors of uncertain malignant potential. Gynecol Oncol. 2008;108:94–5.
108. Guntupalli SR, Ramirez PT, Anderson ML, Milam MR, Bodurka DC, Malpica A. Uterine smooth muscle tumor of uncertain malignant potential: a retrospective analysis. Gynecol Oncol. 2009;11:324–6.
109. Halbwedl I, Ullmann R, Kremser ML, Man YG, Isadi-Moud N, Lax S, Denk H, Popper HH, Tavassoli FA, Moinfar F. Chromosomal alterations in low-grade endometrial stromal sarcoma and undifferentiated endometrial sarcoma as detected by comparative genomic hybridization. Gynecol Oncol. 2005;97:582–7.
110. Han XY, Xiang Y, Guo LN, Shen K, Wan XR, Huang HF, Pan LY. Clinicopathological analysis of mullerian adenosarcoma of the uterus. Chin Med J. 2010;123:756–9.
111. Hayasaka K, Morita K, Saitoh T, Tanaka Y. Uterine adenofibroma and endometrial stromal sarcoma associated with tamoxifen therapy: MR findings. Comput Med Imaging Graph. 2006;30:315–8.
112. Hensley ML, Wathen JK, Maki RG, Araujo DM, Sutton G, Priebat DA, George S, Soslow RA, Baker LH. Adjuvant therapy for high-grade, uterus-limited leiomyosarcoma: results of a phase 2 trial (SARC005). Cancer. 2013;119:1555–61.
113. Hensley ML, Barrette BA, Baumann K, Gaffney D, Hamilton AL, Kim JW, Maenpaa JU, Pautier P, Siddiqui NA, Westermann AM, Ray-Coquard I. Gynecologic Cancer InterGroup (GCIG) consensus review: uterine and ovarian leiomyosarcomas. Int J Gynecol Cancer. 2014;24(9 Suppl 3):S61–6.
114. Hohenberger P, Kasper B, Ahrar K. Surgical management and minimally invasive approaches for the treatment of metastatic sarcoma. Am Soc Clin Oncol Educ Book. 2013;33:457–64.

115. Homer L, Muller M, Dupré PF, Lucas B, Pradier OJ. Uterine sarcoma associated with tamoxifen use after breast cancer: review of the pathogenesis. Gynecol Obstet Biol Reprod. 2009;38:629–33.
116. Iasonos A, Keung EZ, Zivanovic O, Mancari R, Peiretti M, Nucci M, George S, Colombo N, Carinelli S, Hensley ML, Raut CP. External validation of a prognostic nomogram for overall survival in women with uterine leiomyosarcoma. Cancer. 2013;119:1816–22.
117. Iihara K, Hirano K, Fujioka Y, Sakamoto A. Leiomyosarcoma with dedifferentiation in a premenopausal patient discovered after uterine artery embolization. Pathol Int. 2007;57:681–7.
118. Ioffe YJ, Li AJ, Walsh CS, Karlan BY, Leuchter R, Forscher C, Cass I. Hormone receptor expression in uterine sarcomas: prognostic and therapeutic roles. Gynecol Oncol. 2009;115:466–71.
119. Ip PP, Cheung AN, Clement PB. Uterine smooth muscle tumors of uncertain malignant potential (STUMP): a clinicopathologic analysis of 16 cases. Am J Surg Pathol. 2009;33:992–1005.
120. Ip PP, Tse KY, Tam KF. Uterine smooth muscle tumors other than the ordinary leiomyomas and leiomyosarcomas: a review of selected variants with emphasis on recent advances and unusual morphology that may cause concern for malignancy. Adv Anat Pathol. 2010;17:91–112.
121. Ip PP, Cheung AN. Pathology of uterine leiomyosarcomas and smooth muscle tumours of uncertain malignant potential. Best Pract Res Clin Obstet Gynaecol. 2011;25:691–704.
122. Jaakkola S, Lyytinen HK, Pukkala E, Ylikorkala O. Use of estradiol-progestin therapy associates with increased risk for uterine sarcomas. Gynecol Oncol. 2011;122:260–3.
123. Jacobs VR, Zemzoum I, Kremer M, Gottschalk N, Baumgärtner AK, Krol J, Kiechle M. Primary metastatic leiomyosarcoma of the fallopian tube: a rare case report. Onkologie. 2010;33:49–52.
124. Jacoby AF, Fuller AF Jr, Thor AD, Muntz HG. Primary leiomyosarcoma of the fallopian tube. Gynecol Oncol. 1993;51:404–7.
125. Jakate K, Azimi F, Ali RH, Lee CH, Clarke BA, Rasty G, Shaw PA, Melnyk N, Huntsman DG, Laframboise S, Rouzbahman M. Endometrial sarcomas: an immunohistochemical and JAZF1 re-arrangement study in low-grade and undifferentiated tumors. Mod Pathol. 2013;26:95–105.
126. Jayakrishnan K, Koshy AK, Manjula P, Nair AM, Ramachandran A, Kattoor J. Endometrial stromal sarcoma mimicking a myoma. Fertil Steril. 2009;92:1744–6.
127. Jessop FA, Roberts PF. Müllerian adenosarcoma of the uterus in association with tamoxifen therapy. Histopathology. 2000;36:91–2.
128. Jimenez WA, Sardi A, Nieroda C, Gushchin V. Cytoreductive surgery and hyperthermic intraperitoneal chemotherapy in the management of recurrent high-grade uterine sarcoma with peritoneal dissemination. Am J Obstet Gynecol. 2014;210:259.e1–8. doi:10.1016/j.ajog.2013.11.002.
129. Jin Y, Pan L, Wang X, Dai Z, Huang H, Guo L, Shen K, Lian L. Clinical characteristics of endometrial stromal sarcoma from an academic medical hospital in China. Int J Gynecol Cancer. 2010;20:1535–9.
130. Judson IR, Miah AB. Uterine sarcoma dissemination during myomectomy: if not "acceptable collateral damage," is it possible to mitigate the risk? Cancer. 2014;120(20):3100–2. doi:10.1002/cncr.28841.
131. Kaku T, Silverberg SG, Major FJ, Miller A, Fetter B, Brady MF. Adenosarcoma of the uterus: a Gynecologic Oncology Group clinicopathologic study of 31 cases. Int J Gynecol Pathol. 1992;11:75–88.
132. Kamikabeya TS, Etchebehere RM, Nomelini RS, Murta EF. Gynecological malignant neoplasias diagnosed after hysterectomy performed for leiomyoma in a university hospital. Eur J Gynaecol Oncol. 2010;31:651–3.
133. Kanda M, Sonoyama A, Hirano H, Kizaki T, Ohara N. Transition of low-grade to high-grade endometrial stromal sarcoma: a case report. Eur J Gynaecol Oncol. 2013;34:358–61.
134. Kapp DS, Shin JY, Chan JK. Prognostic factors and survival in 1396 patients with uterine leiomyosarcomas. Emphasis on impact of lymphadenectomy and oophorectomy. Cancer. 2008;112:820–30.
135. Kawamura N, Ichimura T, Ito F, Shibata S, Takahashi K, Tsujimura A, Ishiko O, Haba T, Wakasa K, Ogita S. Transcervical needle biopsy for the differential diagnosis between uterine sarcoma and leiomyoma. Cancer. 2002;94:1713–20.
136. Kawamura N, Ichimura T, Takahashi K, Tsujimura A, Ishiko O, Ogita S. Transcervical needle biopsy of uterine myoma-like tumors using an automatic biopsy gun. Fertil Steril. 2002;77:1060–4.
137. Khoury-Collado F, Einstein MH, Bochner BH, Alektiar KM, Sonoda Y, Abu-Rustum NR, Brown CL, Gardner GJ, Barakat RR, Chi DS. Pelvic exenteration with curative intent for recurrent uterine malignancies. Gynecol Oncol. 2012;124:42–7.
138. Kido A, Togashi K, Koyama T, Yamaoka T, Fujiwara T, Fujii S. Diffusely enlarged uterus: evaluation with MR imaging. Radiographics. 2003;23:1423–39.
139. Kim JA, Lee MS, Choi JS. Sonographic findings of uterine endometrial stromal sarcoma. Korean J Radiol. 2006;7:281–6.
140. Kim WY, Lee JW, Choi CH, Kang H, Kim TJ, Kim GB, Lee JH, Bae DS. Low grade endometrial stromal sarcoma: a single center's experience with 22 cases. Int J Gynecol Cancer. 2008;18:1084–9.
141. Kim HS, Han KH, Chung HH, Kim JW, Park NH, Song YS, Kang SB. Neutrophil to lymphocyte ratio for preoperative diagnosis of uterine sarcomas: a case-matched comparison. Eur J Surg Oncol. 2010;36:691–8.
142. Kobayashi H, Uekuri C, Akasaka J, Ito F, Shigemitsu A, Koike N, Shigetomi H. The biology of uterine sarcomas: A review and update. Mol Clin Oncol. 2013;1:599–609.
143. Köhler G, Belau, A, Dennis K, Evert K, Evert M, Hesse J, Hegenscheid K, Lehnhoff H, Krichbaum J, Kühnast M, Lehr A, Linke L, Marcinek A, Müller S, Schalitz S, Simon J, Spring P, Ständer C, Trojnarska S, Witte N, Zygmunt M. Deutsches klinisches Kompetenzzentrum für genitale Sarkome und Mischtumoren an der Universitätsmedizin Greifswald (DKSM) und Kooperationspartner – Institut für Pathologie Univ.-Klinikum Greifswald/Regensburg, VAAO Deutschland und Frauenklinik Frankfurt/Sachsenhausen. Datenbank und Promotions- und Forschungsgruppe genitale Sarkome, Greifswald 2016, http://www2.medizin.uni-greifswald.de/gyn/forschung/dksm/.
144. Köhler G, Evert K, Zygmunt M, Evert M. Glattmuskuläre Tumoren – Varianten des Leiomyoms (Angio- u. Lipoleiomyom, kotyledonoides u. zellreiches Leiomyom, Leiomyom mit bizarren Kernen, mitotisch aktives, epitheloides u. myxoides Leiomyom), glattmuskuläre Tumoren mit unsicherem malignem Potential (atypische glattmuskuläre Tumoren), disseminierte peritoneale Leiomyomatose, benignes metastasierendes Leiomyom, intravenöse Leiomyomatose. In: Köhler G, Evert M, Evert K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 1 Glattmuskuläre und stromale Tumoren. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 1–114.
145. Köhler G, Evert K, Zygmunt M, Evert M. Das Leiomyosarkom. In: Köhler G, Evert M, Evert K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 1 Glattmuskuläre und stromale Tumoren. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 115–225.
146. Köhler G, Evert K, Zygmunt M, Evert M. Stromale Tumoren – Endometriale Stromatumoren – Endometrialer Stromaknoten, endometrialer Stromatumor mit keimstrangähnlichen Elementen (ESTSCLE), uterine tumor resembling ovarian sex-cord tumor (UTROSCT) und ähnliche Tumoren. In: Köhler G, Evert M, Evert

K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 1 Glattmuskuläre und stromale Tumoren. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 226–49.
147. Köhler G, Evert K, Zygmunt M, Evert M. Low-grade endometriales Stromasarkom. In: Köhler G, Evert M, Evert K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 1 Glattmuskuläre und stromale Tumoren. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 250–313.
148. Köhler G, Evert K, Zygmunt M, Evert M. High-grade endometriales Stromasarkom und undifferenziertes uterines Sarkom. In: Köhler G, Evert M, Evert K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 1 Glattmuskuläre und stromale Tumoren. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 314–53.
149. Köhler G, Evert K, Zygmunt M, Evert M. Angiosarkom. In: Köhler G, Evert M, Evert K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 2 Andere seltene Sarkome, Mischtumoren, genitale Sarkome und Schwangerschaft. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 1–27.
150. Köhler G, Evert K, Zygmunt M, Evert M. Liposarkome. In: Köhler G, Evert M, Evert K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 2 Andere seltene Sarkome, Mischtumoren, genitale Sarkome und Schwangerschaft. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 28–60.
151. Köhler G, Evert K, Zygmunt M, Evert M. Rhabdomyosarkome. In: Köhler G, Evert M, Evert K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 2 Andere seltene Sarkome, Mischtumoren, genitale Sarkome und Schwangerschaft. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 61–112.
152. Köhler G, Evert K, Zygmunt M, Evert M. Perivaskulärer Epitheloidzelltumor (PECom). In: Köhler G, Evert M, Evert K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 2 Andere seltene Sarkome, Mischtumoren, genitale Sarkome und Schwangerschaft. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 113–38.
153. Köhler G, Evert K, Zygmunt M, Evert M. Adenosarkom. In: Köhler G, Evert M, Evert K, Zygmunt M. Sarkome des weiblichen Genitale, Bd. 2 Andere seltene Sarkome, Mischtumoren, genitale Sarkome und Schwangerschaft. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 151–212. (a) Köhler G, Evert K, Zygmunt M, Evert M. Adenosarcoma. In: Köhler G, Evert M, Evert K, Zygmunt M. Sarcoma of the female genitalia, Volume 2: Other rare sarcomas, mixed tumors, genital sarcomas and pregnancy. Berlin/Boston: Walter de Gruyter GmbH; 2016 (in press).
154. Koivisto-Korander R, Butzow R, Koivisto AM, Leminen A. Clinical outcome and prognostic factors in 100 cases of uterine sarcoma: experience in Helsinki University Central Hospital 1990–2001. Gynecol Oncol. 2008;11:74–81.
155. Koivisto-Korander R, Martinsen JI, Weiderpass E, Leminen A, Pukkala E. Incidence of uterine leiomyosarcoma and endometrial stromal sarcoma in Nordic countries: results from NORDCAN and NOCCA databases. Maturitas. 2012;72:56–60.
156. Kokawa K, Nishiyama K, Ikeuchi M, Ihara Y, Akamatsu N, Enomoto T, Ishiko O, Motoyama S, Fujii S, Umesaki N. Clinical outcomes of uterine sarcomas: results from 14 years worth of experience in the kinki district in Japan (1990–2003). Int J Gynecol Cancer. 2006;16:1358–63.
157. Koontz JI, Soreng AL, Nucci M, Kuo FC, Pauwels P, van Den Berghe H, Dal Cin P, Fletcher JA, Sklar J. Frequent fusion of the JAZF1 and JJAZ1 genes in endometrial stromal tumors. Proc Natl Acad Sci U S A. 2001;98:6348–53.
158. Koyama T, Togashi K, Konishi I, Kobayashi H, Ueda H, Kataoka ML, Kobayashi H, Itoh T, Higuchi T, Fujii S, Konishi J. MR imaging of endometrial stromal sarcoma: correlation with pathologic findings. Am J Roentgenol. 1999;173:767–72.
159. Krivak TC, Seidman JD, McBroom JW, MacKoul PJ, Aye LM, Rose GS. Uterine adenosarcoma with sarcomatous overgrowth versus uterine carcinosarcoma: comparison of treatment and survival. Gynecol Oncol. 2001;83:89–94.
160. Kurihara S, Oda Y, Ohishi Y, Iwasa A, Takahira T, Kaneki E, Kobayashi H, Wake N, Tsuneyoshi M. Endometrial stromal sarcomas and related high-grade sarcomas: immunohistochemical and molecular genetic study of 31 cases. Am J Surg Pathol. 2008;32:1228–38.
161. Kurjak A, Zalud I. The characterization of uterine tumors by transvaginal color Doppler. Ultrasound Obstet Gynecol. 1991;1:50–2.
162. Kurjak A, Kupesic S, Shalan H, Jukic S, Kosuta D, Ilijas M. Uterine sarcoma: a report of 10 cases studied by transvaginal color and pulsed Doppler sonography. Gynecol Oncol. 1995;59:342–6.
163. Leath III CA, Huh WK, Hyde Jr J, Cohn DE, Resnick KE, Taylor NP, Powell MA, Mutch DG, Bradley WH, Geller MA, Argenta PA, Gold MA. A multi-institutional review of outcomes of endometrial stromal sarcoma. Gynecol Oncol. 2007;105:630–4.
164. Lee WY, Tzeng CC, Chou CY. Uterine leiomyosarcomas coexistent with cellular and atypical leiomyomata in a young woman during the treatment with luteinizing hormone-releasing hormone agonist. Gynecol Oncol. 1994;52:74–9.
165. Lee J. Sonohysterography. In: Kim SH, editor. Radiology illustrated gynecologic imaging. 2nd ed. Berlin/Heidelberg: Springer; 2012. p. 1149–81.
166. Lee CH, Mariño-Enriquez A, Ou W, Zhu M, Ali RH, Chiang S, Amant F, Gilks CB, van de Rijn M, Oliva E, Debiec-Rychter M, Dal Cin P, Fletcher JA, Nucci MR. The clinicopathologic features of YWHAE-FAM22 endometrial stromal sarcomas: a histologically high-grade and clinically aggressive tumor. Am J Surg Pathol. 2012;36:641–53.
167. Lee CH, Ali RH, Rouzbahman M, Marino-Enriquez A, Zhu M, Guo X, Brunner AL, Chiang S, Leung S, Nelnyk N, Huntsman DG, Blake Gilks C, Nielsen TO, Dal Cin P, van de Rijn M, Oliva E, Fletcher JA, Nucci MR. Cyclin D1 as a diagnostic immunomarker for endometrial stromal sarcoma with YWHAE-FAM22 rearrangement. Am J Surg Pathol. 2012;36:1562–70.
168. Leitao MM, Sonoda Y, Brennan MF, Barakat RR, Chi DS. Incidence of lymph node and ovarian metastases in leiomyosarcoma of the uterus. Gynecol Oncol. 2003;91:209–12.
169. Leitao Jr MM, Zivanovic O, Chi DS, Hensley ML, O'Cearbhaill R, Soslow RA, Barakat RR. Surgical cytoreduction in patients with metastatic uterine leiomyosarcoma at the time of initial diagnosis. Gynecol Oncol. 2012;125:409–13.
170. Lerman H, Bar-On S, Helpman L, Even-Sapir E, Grisaru D. Estrogen-dependent variations in 18F-fluorodeoxyglucose uptake in uterine leiomyomas. Int J Gynecol Cancer. 2012;22:1187–91.
171. Leung F, Terzibachian JJ, Gay C, Chung Fat B, Aouar Z, Lassabe C, Maillet R, Riethmuller D. Hysterectomies performed for presumed leiomyomas: should the fear of leiomyosarcoma make us apprehend non laparotomic surgical routes? Gynecol Obstet Fertil. 2009;37:109–14.
172. Leung F, Terzibachian JJ. Re: "The impact of tumor morcellation during surgery on the prognosis of patients with apparently early uterine leiomyosarcoma". Gynecol Oncol. 2012;124:172–3.
173. Li A, Giuntoli R, Drake RSY, Rojas F, Barbuto D, Klipfel N, Edmonds P, Miller D, Karlan B. Ovarian preservation in stage I low-grade endometrial stromal sarcoma. Obstet Gynecol. 2005;106:1304–8.
174. Li N, Wu LY, Zhang HT, An JS, Li XG, Ma SK. Treatment options in stage I endometrial stromal sarcoma: a retrospective analysis of 53 cases. Gynecol Oncol. 2008;108:306–11.
175. Lieng M, Berner E, Busund B. Risk of morcellation of uterine leiomyosarcomas in laparoscopic supracervical hysterectomy and laparoscopic myomectomy, a retrospective trial including 4791 women. J Minim Invasive Gynecol. 2015;22:410–4. doi:10.1016/j.jmig.2014.10.022.

176. Lim D, Wang WL, Lee CH, Dodge T, Gilks B, Oliva E. Old versus new FIGO staging systems in predicting overall survival in patients with uterine leiomyosarcoma: a study of 86 cases. Gynecol Oncol. 2013;128:322–6.
177. Lissoni A, Cormio G, Bonazzi C, Perego P, Lomonocio S, Gabriele A, Bratina G. Fertility sparing surgery in uterine leiomyosarcoma. Gynecol Oncol. 1998;70:348–50.
178. Löning T. Funktionelle Morphologie und Pathologie des Myometriums. In: Löning T, Riethdorf L, Hrsg. Pathologie der weiblichen Genitalorgane III – Pathologie des Uterus der Vagina und Vulva. Berlin/Heidelberg/New York: Springer; 2001. p. 652–704.
179. Lönnerfors C, Bossmar T, Persson J. Port-site metastases following robot-assisted laparoscopic surgery for gynecological malignancies. Acta Obstet Gynecol Scand. 2013;92:1361–8.
180. Lousse JC, Jourct M, Marbaix E, Fellah L, Squifflet J, Donne J. Suspicious myometrial mass on ultrasonography and MRIdoes not necessarily mean a sarcoma on histology. Gynecol Surg. 2010;7:263–5.
181. Ly A, Mills AM, McKenney JK, Balzer BL, Kempson RL, Hendrickson MR, Longacre TA. Atypical leiomyomas of the uterus: a clinicopathologic study of 51 cases. Am J Surg Pathol. 2013;37:643–9.
182. Major F, Blessing J, Silverberg S, Morrow P, Creasman W, Curry JL, Yordan E, Brady MF. Prognostic factors in early stage uterine sarcoma: a Gynecologic Oncology study. Cancer. 1993;71:1702–9.
183. Malouf GG, Lhommé C, Duvillard P, Morice P, Haie-Meder C, Pautier P. Prognostic factors and outcome of undifferentiated endometrial sarcoma treated by multimodal therapy. Int J Gynaecol Obstet. 2013;122:57–61.
184. Manoharan M, Azmi MA, Soosay G, Mould T, Weekes AR. Mullerian adenosarcoma of uterine cervix: report of three cases and review of literature. Gynecol Oncol. 2007;105:256–60.
185. Martínez A, Querleu D, Leblanc E, Narducci F, Ferron G. Low incidence of port-site metastases after laparoscopic staging of uterine cancer. Gynecol Oncol. 2010;118:145–50.
186. Mastrangelo G, Coindre JM, Ducimetière F, Dei Tos AP, Fadda E, Blay JY, Buja A, Fedeli U, Cegolon L, Frasson A, Anchère-Vince D, Montesco C, Ray-Coquard I, Riccardo RC. Incidence of soft tissue sarcoma and beyond. A population-based prospective study in 3 European regions. Cancer. 2012;118:5339–48.
187. Matsuda M, Ichimura T, Kasai M, Murakami M, Kawamura N, Hayashi T, Sumi T. Preoperative diagnosis of usual leiomyoma, atypical leiomyoma, and leiomyosarcoma. Sarcoma. 2014;2014:498682. doi:10.1155/2014/498682.
188. Menge F, Hartmann E, Mathew M, Kasper B, Hohenberger P. The impact of operative techniques to the onset of peritoneal tumor dissemination in parients with uterine Leiomyosarcomas. 18th Annual Meeting of Connective Tissue Oncology Society 2013; Paper 010.
189. Mikami Y, Hata S, Kiyokawa T, Manabe T. Expression of CD10 in malignant müllerian mixed tumors and adenosarcomas: an immunohistochemical study. Mod Pathol. 2002;15:923–30.
190. Mills AM, Ly A, Balzer BL, Hendrickson MR, Kempson RL, McKenney JK, Longacre TA. Cell cycle regulatory markers in uterine atypical leiomyoma and leiomyosarcoma: immunohistochemical study of 68 cases with clinical follow-up. Am J Surg Pathol. 2013;37:634–42.
191. Milman D, Zalel Y, Biran H, Open M, Caspi B, Hagay Z, Dgani R. Unsuspected uterine leiomyosarcoma discovered during treatment with a gonadotropin-releasing hormone analogue: a case report and literature review. Eur J Obstet Gynecol Reprod Biol. 1998;76:237–40.
192. Mittal K, Demopoulos RI. MIB-1 (Ki-67), p53, estrogen receptor, and progesterone receptor expression in uterine smooth muscle tumors. Hum Pathol. 2001;32:984–7.
193. Mittal K, Joutovsky A. Areas with benign morphologic and immunohistochemical features are associated with some uterine leiomyosarcomas. Gynecol Oncol. 2007;104:362–5.
194. Mittal KR, Chen F, Wei JJ, Rijhvani K, Kurvathi R, Streck D, Dermody J, Toruner GA. Molecular and immunohistochemical evidence for the origin of uterine leiomyosarcomas from associated leiomyoma and symplastic leiomyoma-like areas. Mod Pathol. 2009;22:1303–11.
195. Moinfar F, Azodi M, Tavassoli FA. Uterine sarcomas. Pathology. 2007;39:55–71.
196. Morice P, Rodrigues A, Pautier P, Rey A, Camatte S, Atallah D, Pomel C, Lhommé C, Haie-Meder C, Duvillard P, Castaigne D. Chirurgie des sarcomas utérins: revue de la littérature et recommandations sur la prise en charge chirurgicale. Surgical procedures for uterine sarcoma. Gynecol Obstet Fertil. 2003;31:147–50.
197. Morice P, Rodriguez A, Rey A, Pautier P, Atallah D, Genestie C, Pomel C, Lhommé C, Haie-Meder C, Duvillard P, Castaigne D. Prognostic value of initial surgical procedure for patients with uterine sarcoma: analysis of 123 patients. Eur J Gynaecol Oncol. 2003;24:237–40.
198. Mowers EL, Skinner B, McLean K, Reynolds RK. Effects of morcellation of uterine smooth muscle tumor of uncertain malignant potential and endometrial stromal sarcoma: case series and recommendations for clinical practice. J Minim Invasive Gynecol. 2015;22:601–6. doi:10.1016/j.jmig.2015.01.007.
199. Murase E, Siegelman ES, Outwater EK, Perez-Jaffe LA, Tureck RW. Uterine leiomyomas: histopathologic features, MR imaging findings, differential diagnosis, and treatment. Radiographics. 1999;19:1179–97.
200. Naqamatsu A, Umesaki N, Li L, Tanaka T. Use of 18F-fluorodeoxyglucose positron emission tomography for diagnosis of uterine sarcomas. Oncol Rep. 2010;23:1069–76.
201. Nagase S, Katabuchi H, Hiura M, Sakuragi N, Aoki Y, Kigawa J, Saito T, Hachisuga T, Ito K, Uno T, Katsumata N, Komiyama S, Susumu N, Emoto M, Kobayashi H, Metoki H, Konishi I, Ochiai K, Mikami M, Sugiyama T, Mukai M, Sagae S, Hoshiai H, Aoki D, Ohmichi M, Yoshikawa H, Iwasaka T, Udagawa Y, Yaegashi N, Japan Society of Gynecologic Oncology. Evidence-based guidelines for treatment of uterine body neoplasm in Japan: Japan Society of Gynecologic Oncology (JSGO) 2009 edition. Int J Clin Oncol. 2010;15:531–42.
202. National Comprehensive Cancer Network: NCCN Practice Guidelines in Oncology – Uterine neoplasms – Version 1.2016. www.nccn.org.
203. Nezhat FR, Roemisch M, Nezhat CH, et al. Recurrence rate after laparoscopic myomectomy. J Am Assoc Gynecol Laparosc. 1998;5:237–40.
204. Ngan HY, Fisher C, Blake P, Shepherd JH. Vaginal sarcoma: the Royal Marsden experience. Int J Gynecol Cancer. 1994;4:337–41.
205. Nordal R, Kristensen GB, Kaern J, Stenwig A, Pettersen EO, Tropé CG. The prognostic significance of surgery, tumor size, malignancy grade, menopausal status, and DNA ploidy in endometrial stromal sarcoma. Gynecol Oncol. 1996;62:254–9.
206. Nucci MR, Harburger D, Koontz J, Dal Cin P, Sklar J. Molecular analysis of the JAZF1-JJAZ1 gene fusion by RT-PCR and fluorescence in situ hybridization in endometrial stromal neoplasms. Am J Surg Pathol. 2007;31:65–70.
207. Nucci MR, Quade BJ. Uterine mesenchymal tumors. In: Crum CP, Nucci MR, Lee KR, editors. Diagnostic gynecologic and obstetric pathology. 2nd ed. Philadelphia: Elsevier Saunders; 2011. p. 582–639.
208. Numa F, Umayahara K, Ogata H, Nawata S, Sakaguchi Y, Emoto T, Kawasaki K, Hirakawa H, Sase M, Oga A, Kato H. De novo uterine sarcoma with good response to neo-adjuvant chemotherapy. Int J Gynecol Cancer. 2003;13:364–7.

209. Oda Y, Nakanishi I, Tateiwa T. Intramural müllerian adenosarcoma of the uterus with adenomyosis. Arch Pathol Lab Med. 1984;108:798–801.
210. Oduyebo T, Rauh-Hain AJ, Meserve EE, Seidman MA, Hinchcliff E, George S, Quade B, Nucci MR, Del Carmen MG, Muto MG. The value of re-exploration in patients with inadvertently morcellated uterine sarcoma. Gynecol Oncol. 2014;132:360–5.
211. Oliva E, de Leval L, Soslow RA, Herens C. High frequency of JAZF1-JJAZ1 gene fusion in endometrial stromal tumors with smooth muscle differentiation by interphase FISH detection. Am J Surg Pathol. 2007;31:277–84.
212. Oliva E, Caracangiu ML, Carinelli SG, Ip P, Loening T, Longacre TA, Nucci MR, Prat J, Zaloudek CJ. Tumours of the uterine corpus. Mesenchymal tumors. In: Kurman RJ, Carcangiu ML, Herrington CS, Young RH, editors. WHO classification of tumors of female reproductive organs. 4th ed. Lyon: IARC; 2014. p. 135–52.
213. O'Neill CJO, McBride HA, Connolly LE, McCluggage WG. Uterine leiomyosarcomas are characterized by high p16, p53 and MIB1 expression in comparison with usual leiomyomas, leiomyoma variants and smooth muscle tumours of uncertain malignant potential. Histopathology. 2007;50:851–8.
214. Orii A, Mori A, Zhai YL, Toki T, Nikaido T, Fujii S. Mast cells in smooth muscle tumors of the uterus. Int J Gynecol Pathol. 1998;17:336–42.
215. Papadia A, Salom EM, Fulcheri E, Ragni N. Uterine sarcoma occurring in a premenopausal patient after uterine artery embolization: a case report and review of the literature. Gynecol Oncol. 2007;104:260–3.
216. Park JY, Kim DY, Kim JH, Kim YM, Kim YT, Nam JH. The impact of tumor morcellation during surgery on the outcomes of patients with apparently early low-grade endometrial stromal sarcoma of the uterus. Ann Surg Oncol. 2011;18:3453–61.
217. Park JY, Park SK, Kim DY, Kim JH, Kim YM, Kim YT, Nam JH. The impact of tumor morcellation during surgery on the prognosis of patients with apparently early uterine leiomyosarcoma. Gynecol Oncol. 2011;122:255–9.
218. Park JY, Kim KR, Nam JH. Immunohistochemical analysis for therapeutic targets and prognostic markers in low-grade endometrial stromal sarcoma. Int J Gynecol Cancer. 2013;23:81–9.
219. Parker WH, Fu YS, Berek JS. Uterine sarcomas in patients operated for presumed leiomyoma and rapidly growing leiomyoma. Obstet Gynecol. 1994;83:414–8.
220. Pautier P, Nam EJ, Provencher DM, Hamilton AL, Mangili G, Siddiqui NA, Westermann AM, Reed NS, Harter P, Ray-Coquard I. Gynecologic Cancer InterGroup (GCIG) consensus review for high-grade undifferentiated sarcomas of the uterus. Int J Gynecol Cancer. 2014;24(9 Suppl 3):S73–7.
221. Pavlakis K, Messini I, Papadimitriou CA, Zagouri F, Yiannou P, Mavrelos D, Panoskaltis T. Tumor dissemination after laparoscopic surgery for an unsuspected endometrial stromal tumor. Eur J Gynaecol Oncol. 2011;32:362–3.
222. Peddada SD, Laughlin SK, Miner K, Guyon JP, Haneke K, Vahdat HL, Semelka RC, Kowalik A, Armao D, Davis B, Baird DD. Growth of uterine leiomyomata among premenopausal black and white women. Proc Natl Acad Sci U S A. 2008;105:19887–92.
223. Perri T, Korach J, Sadetzki S, Oberman B, Fridman E, Ben-Baruch G. Uterine leiomyosarcoma: does the primary surgical procedure matter? Int J Gynecol Cancer. 2009;19:257–60.
224. Peters 3rd WA, Howard DR, Andersen WA, Figge DC. Uterine smooth-muscle tumors of uncertain malignant potential. Obstet Gynecol. 1994;83:1015–20.
225. Plasvsic SK, Patham B, Honemeyer U, Kurjak A. Uterine lesions: advances in ultrasound diagnosis. In. Kurjak A, Chervenak FA, editors. Donald School Textbook of ultrasound in obstetrics and gynecology. 3rd ed. New Delhi/Panama City/London: Jaypee Brothers Medical Publishers LTD; 2011. p. 770–787.
226. Posy HE, Elkas JC, Yemelyanova AV, Diaz-Montes TP, Bristow RE, Giuntoli RL. Metastatic leiomyosarcoma diagnosed after uterine artery embolization. Eur J Gynaecol Oncol. 2009;30:199–202.
227. Pothuri B, Kehoe M, Wright T, Herzog T. Clinical outcome of atypical uterine smooth muscle tumors. ASCO Annual Meeting 2006; Abstr. 15028.
228. Prat J. FIGO staging for uterine sarcomas. Int J Gynecol Obstet. 2009;104:177–8.
229. Pritts EA, Vanness DJ, Berek JS, Parker W, Feinberg R, Feinberg J, Olive DL. The prevalence of occult leiomyosarcoma at surgery for presumed uterine fibroids: a meta-analysis. Gynecol Surg. 2015;12:165–77.
230. Protopapas A, Milingos S, Markaki S, Loutradis D, Haidopoulos D, Sotiropoulou M, Antsaklis A. Cystic uterine tumors. Gynecol Obstet Investig. 2008;65:275–80.
231. Quade BJ, Wang TY, Sornberger K, Dal Cin P, Mutter GL, Morton CC. Molecular pathogenesis of uterine smooth muscle tumors from transcriptional profiling. Genes Chromosom Cancer. 2004;40:97–108.
232. Rauh-Hain JA, Oduyebo T, Diver EJ, Guseh SH, George S, Muto MG, del Carmen MG. Uterine leiomyosarcoma: an updated series. Int J Gynecol Cancer. 2013;23:1036–43.
233. Rauh-Hain JA, Hinchcliff EM, Oduyebo T, Worley Jr MJ, Andrade CA, Schorge JO, George S, Muto MG, Del Carmen MG. Clinical outcomes of women with recurrent or persistent uterine leiomyosarcoma. Int J Gynecol Cancer. 2014;24:1434–40.
234. Raut CP, Nucci MR, Wang Q, Manola J, Bertagnolli MM, Demetri GD, Morgan JA, Muto MG, Fletcher CD, George S. Predictive value of FIGO and AJCC staging systems in patients with uterine leiomyosarcoma. Eur J Cancer. 2009;45:2818–24.
235. Reed NS. The management of uterine sarcomas. Clin Oncol. 2008;20:470–8.
236. Reich O, Regauer S, Urdl W, Lahousen M, Winter R. Expression of oestrogen and progesterone receptors in low-grade endometrial stromal sarcomas. Br J Cancer. 2000;82:1030–4.
237. Reich O, Regauer S. Aromatase expression in low-grade endometrial stromal sarcoma. An immunohistochemical study. Mod Pathol. 2004;17:104–8.
238. Reich O, Regauer S. Survey of adjuvant hormone therapy in patients after endometrial stromal sarcoma. Eur J Gynaecol Oncol. 2006;27:150–2.
239. Reich O, Regauer S. Hormonal therapy in endometrial stromale sarcoma. Curr Opin Oncol. 2007;19:347–52.
240. Reich O, Regauer S, Scharf S. High levels of xenoestrogens in patients with low-grade endometrial stromal sarcoma–report of two cases. Eur J Gynaecol Oncol. 2010;31:105–6.
241. Reich O, Regauer S, Tempfer C, Schneeberger C, Huber J. Polymorphism 1558 C > T in the aromatase gene (CYP19A1) in low-grade endometrial stromal sarcoma. Eur J Gynaecol Oncol. 2011;32:626–7.
242. Reinhold C, Zand KR. Endometrial stromal sarcoma. In: Hricak HH, Akin O, Sala E, Ascher SM, Levine D, Reinhold C, editors. Diagnostic imaging gynecology. Amyrsis; 2007. p. 2–162–6.
243. Rha SE, Byun JY, Jung SE, Lee SL, Cho SM, Hwang SS, Lee HG, Namkoong SE, Lee JM. CT and MRI of uterine sarcomas and their mimickers. Am J Roentgenol. 2003;181:1369–74.
244. Riopel J, Plante M, Renaud MC, Roy M, Têtu B. Lymph node metastases in low-grade endometrial stromal sarcoma. Gynecol Oncol. 2005;96:402–6.
245. Rivera JA, Christopoulos S, Small D, Trifiro M. Hormonal manipulation of benign metastasizing leiomyomas: report of two cases and review of the literature. J Clin Endocrinol Metab. 2004;89:3183–8.

246. Rutstein SE, Siedhoff MT, Geller EJ, Doll KM, Wu JM, Clarke-Pearson DL, Wheeler SB. Cost-effectiveness of laparoscopic hysterectomy with morcellation compared to abdominal hysterectomy for presumed fibroids. J Minim Invasive Gynecol. 2015;13. pii: S1553–4650(15)01618–0. doi:10.1016/j.jmig.2015.09.025.
247. Sagae S, Yamashita K, Ishioka S, Nishioka Y, Terasawa K, Mori M, Yamashiro K, Kanemoto T, Kudo R. Preoperative diagnosis and treatment results in 106 patients with uterine sarcoma in Hokkaido, Japan. Oncology. 2004;67:33–9.
248. Salman MC, Guler OT, Kucukali T, Karaman N, Ayhan A. Fertility-saving surgery for low-grade uterine leiomyosarcoma with subsequent pregnancy. Int J Gynaecol Obstet. 2007;98:160–1.
249. Santos P, Cunha TM. Uterine sarcomas: clinical presentation and MRI features. Diagn Interv Radiol. 2015;21:4–9. doi:10.5152/dir.2014.14053.
250. Sato K, Yuasa N, Fujita M, Fukushima Y. Clinical application of diffusion-weighted imaging for preoperative differentiation between uterine leiomyoma and leiomyosarcoma. Am J Obstet Gynecol. 2014;210:368.e1–8.
251. Schwartz LB, Diamond MP, Schwartz PE. Leiomyosarcomas: clinical presentation. Am J Obstet Gynecol. 1993;168:180–3.
252. Sciallis AP, Bedroske PP, Schoolmeester JK, Sukov WR, Keeney GL, Hodge JC, Bell DA. High-grade Endometrial Stromal Sarcomas: a clinicopathologic study of a group of tumors with heterogenous morphologic and genetic features. Am J Surg Pathol. 2014;38:1161–72.
253. Seidman JD, Wasserman CS, Aye LM, MacKoul PJ, O'Leary TJ. Cluster of uterine mullerian adenosarcoma in the Washington, DC metropolitan area with high incidence of sarcomatous overgrowth. Am J Surg Pathol. 1999;23:809–14.
254. Seidman MA, Oduyebo T, Muto MG, Crum CP, Nucci MR, Quade BJ. Peritoneal dissemination complicating morcellation of uterine mesenchymal neoplasms. PLoS One. 2012;7(11):e50058. doi:10.1371/journal.pone.0050058.
255. Sesti F, Patrizi L, Ermini B, Palmieri G, Orlandi A, Piccione E. High-grade endometrial stromal sarcoma after tamoxifen therapy for breast cancer. Gynecol Obstet Investig. 2005;60:117–20.
256. Shah JP, Bryant CS, Kumar S, Ali-Fehmi R, Malone JM, Morris RT. Lymphadenectomy and ovarian preservation in low grade endometrial stromal sarcoma. Obstet Gynecol. 2008;112:1102–8.
257. Shah SH, Jagannathan JP, Krajewski K, O'Regan KN, George S, Ramaiya NH. Uterine sarcomas: then and now. Am J Roentgenol. 2012;199:213–23.
258. Shapiro A, Ferenczy A, Turcotte R, Bruchim I, Gotlieb WH. Uterine smooth-muscle tumor of uncertain malignant potential metastasizing to the humerus as a high-grade leiomyosarcoma. Gynecol Oncol. 2004;94:818–20.
259. Shin YR, Rha SE. Miscellaneous tumors of the uterus. In: Kim SH, editor. Radiology illustrated gynecologic imaging. 2nd ed. Berlin/Heidelberg; Springer; 2012. p. 249–97.
260. Siedhoff MT, Wheeler SB, Rutstein SE, Geller EJ, Doll KM, Wu JM, Clarke-Pearson DL. Laparoscopic hysterectomy with morcellation vs abdominal hysterectomy for presumed fibroid tumors in premenopausal women: a decision analysis. Am J Obstet Gynecol. 2015;212:591.e1–8. doi:10.1016/j.ajog.2015.03.006.
261. Signorelli M, Fruscio R, Dell'Anna T, Buda A, Giuliani D, Ceppi L, Milani R. Lymphadenectomy in uterine low-grade endometrial stromal sarcoma: an analysis of 19 cases and a literature review. Int J Gynecol Cancer. 2010;20:1363–6.
262. Sinha R, Hegde A, Mahajan C, Dubey N, Sundaram MJ. Laparoscopic myomectomy: do size, number, and location of the myomas form limiting factors for laparoscopic myomectomy? J Minim Invasive Gynecol. 2008;15:292–300.
263. Sizzi O, Rossetti A, Malzoni M, Minelli L, La Grotta F, Soranna L, Panunzi S, Spagnolo R, Imperato F, Landi S, Fiaccamento A, Stola E. Italian multicenter study on complications of laparoscopic myomectomy. J Minim Invasive Gynecol. 2007;14:453–62.
264. Sobin LH, Gospadarowicz MK, Wittekind CH, editors. TMN classification of malignant tumours. 7th ed. Weinheim: Wiley; 2010.
265. Somoye G, Lawton H, Havenga S. Endometrial stromal sarcoma: experience from a district hospital and literature review. Eur J Gynaecol Oncol. 2009;30:664–7.
266. Soslow RA, Ali A, Oliva E. Mullerian adenosarcomas: an immunophenotypic analysis of 35 cases. Am J Surg Pathol. 2008;32:1013–21.
267. Stadsvold JL, Molpus KL, Baker JJ, Michael K, Remmenga SW. Conservative management of a myxoid endometrial stromal sarcoma in a 16-year old nulliparous woman. Gynecol Oncol. 2005;99:243–5.
268. Stemme S, Ghaderi M, Carlson JW. Diagnosis of endometrial stromal tumors: a clinicopathologic study of 25 biopsy specimens with identification of problematic areas. Am J Clin Pathol. 2014;141:133–9.
269. Sung CO, Ahn G, Song SY, Choi YL, Bae DS. Atypical leiomyomas of the uterus with long-term follow-up after myomectomy with immunohistochemical analysis for pl6, INK4A, p53, Ki-67, estrogen receptors, and progesterone receptors. Int J Gynecol Pathol. 2009;280:529–34.
270. Szabó I, Szánthó A, Csabay L, Csapó Z, Szirmai K, Papp Z. Color Doppler ultrasonography in the differentiation of uterine sarcomas from uterine leiomyomas. Eur J Gynaecol Oncol. 2002;23:29–4.
271. Szkandera J, Gerger A, Liegl-Atzwanger B, Absenger G, Stotz M, Friesenbichler J, Trajanoski S, Stojakovic T, Eberhard K, Leithner A, Pichler M. The lymphocyte/monocyte ratio predicts poor clinical outcome and improves the predictive accuracy in patients with soft tissue sarcomas. Int J Cancer. 2014;135:362–70.
272. Szklaruk J, Tamm EP, Choi H, Varavithya V. MR imaging of common and uncommon large pelvic masses. Radiographics. 2003;23:403–24.
273. Taga S, Sawada M, Nagai A, Yamamoto D, Hayase R. A case of adenosarcoma of the uterus. Case Rep Obstet Gynecol. 2014;Article ID 342187:4. http://dx.doi.org/10.1155/2014/J42187.
274. Takeda A, Imoto S, Mori M, Nakamura H. Successful pregnancy outcome after laparoscopic-assisted excision of a bizarre leiomyoma: a case report. J Med Case Rep. 2011;5:344.
275. Takeuchi M, Matsuzaki K, Yoshida S, Kudo E, Bando Y, Hasebe H, Kamada M, Nishitani H. Adenosarcoma of the uterus: magnetic resonance imaging characteristics. Clin Imaging. 2009;33:244–7.
276. Tamura R, Kashima K, Asatani M, Nishino K, Nishikawa N, Sekine M, Serikawa T, Enomoto T. Preoperative ultrasound-guided needle biopsy of 63 uterine tumors having high signal intensity upon T2-weighted magnetic resonance imaging. Int J Gynecol Cancer. 2014;24:1042–7.
277. Tanaka YO, Nishida M, Tsunoda H, Okamoto Y, Yoshikawa H. Smooth muscle tumors of uncertain malignant potential and leiomyosarcomas of the uterus: MR findings. J Magn Reson Imaging. 2004;20:998–1007.
278. Tanner EJ, Garg K, Leitao Jr MM, Soslow RA, Hensley ML. High grade undifferentiated uterine sarcoma: surgery, treatment, and survival outcomes. Gynecol Oncol. 2012;127:27–31.
279. Tanner EJ, Toussaint T, Leitao Jr MM, Hensley ML, Soslow RA, Gardner GJ, Jewell EL. Management of uterine adenosarcomas with and without sarcomatous overgrowth. Gynecol Oncol. 2013;129:140–4.
280. Thomas MB, Keeney GL, Podratz KC, Dowdy SC. Endometrial stromal sarcoma: treatment and patterns of recurrence. Int J Gynecol Cancer. 2009;19:253–6.

281. Tirumani SH, Ojili V, Shanbhogue AK, Fasih N, Ryan JG, Reinhold C. Current concepts in the imaging of uterine sarcoma. Abdom Imaging. 2013;38:397–411.
282. Toledo G, Oliva E. Smooth muscle tumors of the uterus. Arch Pathol Lab Med. 2008;132:595–605.
283. Toro JR, Travis LB, Wu HJ, Zhu K, Fletcher CD, Devesa SS. Incidence patterns of soft tissue sarcomas, regardless of primary site, in the surveillance, epidemiology and end results program, 1978-2001: an analysis of 26,758 cases. Int J Cancer. 2006;119:2922–30.
284. Trovik J, Salvesen HB, Cuppens T, Amant F, Staff AC. Growth differentiation factor-15 as biomarker in uterine sarcomas. Int J Gynecol Cancer. 2014;24:252–9.
285. Umesaki N, Tanaka T, Miyama M, Ogita S, Kawabe J, Okamura T, Koyama K, Ochi H. Positron emission tomography using 2-[(18)F] fluoro-2-deoxy-D-glucose in the diagnosis of uterine leiomyosarcoma: a case report. Clin Imaging. 2001;25:203–5.
286. Vera AA, Guadarrama MB. Endometrial stromal sarcoma: clinicopathological and immunophenotype study of 18 cases. Ann Diagn Pathol. 2011;15:312–7.
287. Veras E, Zivanovic O, Jacks L, Chiappetta D, Hensley M, Soslow R. "Low-grade leiomyosarcoma" and late-recurring smooth muscle tumors of the uterus: a heterogenous collection of frequently misdiagnosed tumors associated with an overall favorable prognosis relative to conventional uterine leiomyosarcomas. Am J Surg Pathol. 2011;35:1626–37.
288. Verschraegen CF, Vasuratna A, Edwards C, Freedman R, Kudelka AP, Tornos C, Kavanagh JJ. Clinicopathologic analysis of mullerian adenosarcoma: the M.D. Anderson Cancer Center experience. Oncol Rep. 1998;5:939–44.
289. Vilos GA, Hollett-Caines J, Abu-Rafea B, Allen HH, Inculet R, Kirk ME. Leiomyosarcoma diagnosed six years after laparoscopic electromyolysis. J Obstet Gynaecol Can. 2008;30:500–4.
290. Walker CL, Stewart EA. Uterine fibroids: the elephant in the room. Science. 2005;308:1589–92.
291. Wittekind C, Comptom CC, Brierley J, Sobin LH. TNM-supplement – a commentary on uniform use. 4th ed. Genf: UICC and Wiley; 2012.
292. Wong P, Han K, Sykes J, Catton C, Laframboise S, Fyles A, Manchul L, Levin W, Milosevic M. Postoperative radiotherapy improves local control and survival in patients with uterine leiomyosarcomas. Radiat Oncol. 2013;8:128.
293. Wright JD, Seshan VE, Shah M, Schiff PB, Burke WM, Cohen CJ, Herzog TJ. The role of radiation in improving survival for early-stage carcinosarcoma and leiomyosarcoma. Am J Obstet Gynecol. 2008;199:536.e1–8.
294. Wright JD, Tergas AI, Cui R, Burke WM, Hou JY, Ananth CV, Chen L, Richards C, Neugut AI, Hershman DL. Use of electric power morcellation and prevalence of underlying cancer in women who undergo myomectomy. JAMA Oncol. doi:10.1001/jamaoncol.20l4.206, Published online February 19, 2015.
295. Xue WC, Cheung AN. Endometrial stromal sarcoma of uterus. Best Pract Res Clin Obstet Gynaecol. 2011;25:719–32.
296. Yang WT, Lam WW, Yu MY, Cheung TH, Metreweli C. Comparison of dynamic helical CT and dynamic MR imaging in the evaluation of pelvic lymph nodes in cervical carcinoma. Am J Roentgenol. 2000;75:759–66.
297. Yavuz E, Güllüoğlu MG, Akbaş N, Tuzlali S, Ilhan R, Iplikçi A, Akhan SE. The values of intratumoral mast cell count and Ki-67 immunoreactivity index in differential diagnosis of uterine smooth muscle neoplasms. Pathol Int. 2001;51:938–41.
298. Yildirim Y, Inal MM, Sanci M, Yildirim YK, Mit T, Polat M, Tinar S. Development of uterine sarcoma after tamoxifen treatment for breast cancer: report of four cases. Int J Gynecol Cancer. 2005;15:1239–42.
299. Yoon A, Park JY, Park JY, Lee YY, Kim TJ, Choi CH, Bae DS, Kim BG, Lee JW, Nam JH. Prognostic factors and outcomes in endometrial stromal sarcoma with the 2009 FIGO staging system: a multicenter review of 114 cases. Gynecol Oncol. 2014;132:70–5.
300. Yoshida C, Ichimura T, Kawamura N, Nakano A, Kasai M, Sumi T, Ishiko O. A scoring system for histopathologic and immunohistochemical evaluations of uterine leiomyosarcomas. Oncol Rep. 2009;22:725–31.
301. Yoshizako T, Wada A, Kitagaki H, Ishikawa N, Miyazaki K. MR imaging of uterine adenosarcoma: case report and literature review. Magn Reson Med Sci. 2011;10:251–4.
302. Young RH, Scully RE. Sarcomas metastatic to the ovary: a report of 21 cases. Int J Gynecol Pathol. 1990;9:231–51.
303. Zaloudek CJ, Norris HJ. Adenofibroma and adenosarcoma of the uterus: a clinicopathologic study of 35 cases. Cancer. 1981;15:354–66.
304. Zaloudek C, Hendrickson MR, Soslow RA. Mesenchymal tumors of the uterus. In: Kurman RJ, Ellenson RH, Ronnett M, editors. Blaustein's pathology of the female tract. 6th ed. New York/Dodrecht/Heidelberg/London: Springer; 2011. p. 453–527.
305. Zhai YL, Kobayashi Y, Mori A, Orii A, Nikaido T, Konishi I, Fujii S. Expression of steroid receptors, Ki-67, and p53 in uterine leiomyosarcomas. Int J Gynecol Pathol. 1999;18:20–8.
306. Zhu XQ, Shi YF, Cheng XD, Zhao CL, Wu YZ. Immunohistochemical markers in differential diagnosis of endometrial stromal sarcoma and cellular leiomyoma. Gynecol Oncol. 2004;92:71–9.
307. Zivanovic O, Sonoda Y, Diaz JP, Levine DA, Brown CL, Chi DS, Barakat RR, Abu-Rustum NR. The rate of port-site metastases after 2251 laparoscopic procedures in women with underlying malignant disease. Gynecol Oncol. 2008;111:431–7.
308. Zivanovic O, Jacks LM, Iasonos A, Leitao Jr MM, Soslow RA, Veras E, Chi DS, Abu-Rustum NR, Barakat RR, Brennan MF, Hensley ML. A nomogram to predict postresection 5-year overall survival for patients with uterine leiomyosarcoma. Cancer. 2012;118:660–9.
309. Zygmunt M, Evert M, Evert K, Köhler G. Fertilität und Schwangerschaft bei Varianten des Leiomyoms, glattmuskulären Tumoren mit unsicherem malignen Potential, stromalen Tumoren, genitalen Sarkomen, PEComen und Mischtumoren. In: Köhler G, Evert M, Evert K, Zygmunt M, editors. Sarkome des weiblichen Genitale, Bd. 2 Andere seltene Sarkome, Mischtumoren, genitale Sarkome und Schwangerschaft. Berlin/Boston: Walter de Gruyter GmbH; 2016. p. 286–327.

List of Image Sources

Amberger M et al. Röntgenpraxis Trier, Trier 13CD.
Erler MA. GMP für Pathologie Krech/Christians Osnabrück/Rheine, Rheine. 2A.
Evert M, Evert K. Universitätsmedizin Greifswald, Institut für Pathologie, Greifswald. 3A, 4A, 10B, 18AB, 19AB.
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Kärner Ch, Leinen K. Gemeinschaftspraxis – Frauenärztinnen, Konz. 13B.
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Köhler G, Zygmunt M. Universitätsmedizin Greifswald, Klinik Frauenheilkunde und Geburtshilfe, Greifswald. 1ADE, 3B, 7AB, 10ACD, 13A, 15ABC, 17AB, 22.
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Uterine Morcellation

15

Courtney J. Steller and Charles E. Miller

Minimally invasive surgical techniques have been proven to lead to decreased post operative pain, decreased morbidity, and faster recovery times when compared to open abdominal procedures [1]. According to committee opinions from ACOG and the AAGL, the preferred route for hysterectomy is a minimally invasive approach, including a laparoscopic or vaginal approach when feasible [2]. Fibroids are the most common indication for a hysterectomy (40.7 %) [3] which in turn makes specimen removal difficult as the specimen size is often larger than the abdominal or vaginal incisions made during surgery. As stated by Wright et al., patients who are nulliparous or have a large uterine size are at higher risk of requiring alternate methods of specimen removal such as morcellation [4]. Morcellation is defined as "division and removal in small pieces" in the Merriam-Webster dictionary. In addition, a similar challenge arises when removing tissue in the absence of a colpotomy, as in a supracervical hysterectomy or myomectomy.

History

Dr. Kurt Semm in Kiel, Germany originally developed a solution to the problem of specimen removal when he introduced a hand held manual morcellator in 1973. This hand-activated morcellator was produced by WISAP and resulted in a procedure that was very time consuming, arduous and painful for the surgeon. In order to avoid these issues, he developed a battery driven power morcellator in 1984 which was called the S.E.M.M. (serrated-edge macro morcellator). Then, in 1991 this was replaced by a completely electrically driven power morcellator [5]. This new S.E.M.M. worked by punching out tissue cylinders up to 1.5 cm in diameter. If used together with a myoma drill, large holes could be punched into the specimen, making them easily removable [6].

Dr. Rolf A. Steiner out of Zurich, Switzerland developed the first power morcellator, which was FDA approved in 1995. Utilizing a rotating knife driven by an electric micro-engine and controlled via foot pedal, the function was, again, to cut tissue in cylinder-shaped pieces. The cutting cylinder, which was 13 mm in diameter and 25 cm long, was placed in a 14 mm trocar sleeve and protruded a few millimeters past the sleeve of the trocar into the abdomen. Outside the abdomen was a gearbox, by which the electrical micro-engine produced the turning motion. A 10 mm grasping forceps was used through the cutting cylinder to grasp the tissue and a rubber ring ensured an airtight seal. In his paper, Steiner stated that the transmission of power was sufficient to cut almost any type of tissue. He originally performed this technique with uterine fibroids or ovaries, reporting 11 successful cases with mean specimen removal times of 6.5 min for fibroids and 4.5 min for ovaries, as compared to the "conventional technique" which he reported at 30 min [7].

Carter JE, et al. published a time and cost analysis of power vs. manual morcellation in 1997. He demonstrated that electromechanical morcellation reduced the average time for extraction of specimen <100 g by 15 min and of specimen weighing 401–500 g by 150 min. This also led to a significant cost reduction despite the more expensive nature of the electromechanical morcellators [8]. Electromechanical ("power") morcellators began to gain significant popularity and several new developments and models were created.

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Modern Morcellators

The general engineering of the modern electromechanical morcellator is similar to that described by Steiner. The ideal morcellator is easy to handle, ergonomic, maintains pneumoperitoneum, and enables constant visualization of the rotating knife with minimal operator effort [9].

The Morcellator Knife was developed in 2000. It was a classic lancet with an interchangeable blade that was inserted through at 10 mm trocar and used to cut a specimen as it was held between two forceps. A posterior culdotomy was made to remove the small pieces of the specimen [10]. The Sawalhe morcellator, developed by Karl Storz, modified the Steiner model and enabled removal morcellated tissue from the abdominal cavity via the sleeve, obviating the need for a posterior culdotomy that was necessary with the Morcellator Knife [9].

Karl Storz then developed an even more competitive morcellator in 2007 called the Rotocut G1 morcellator (Fig. 15.1). In comparison to the existing Sawalhe model in a study published in 2007, the Rotocut G1 device accomplished significantly shorter morcellation time, operative time and duration of anesthesia. It also created fewer and longer pieces of tissue due to a more effective power output and drive transmission. In this model, the generator is located in the hand piece and is activated by a foot pedal.

The Gynecare Morcellex tissue morcellator developed by Ethicon, Inc. is another popular power morcellator (Fig. 15.2). Unlike the Rotocut G1, the Gynecare Morcellex does not require a foot pedal. In 2009, a randomized controlled trial was initiated to compare the two popular models, the Gynecare Morcellex and the Rotocut G1. There was no statistical difference between the two groups in regards to operative time, morcellation time, weight of excised pieces, blood loss/blood transfusion, intra or post operative complications, post operative pain, hospitalization or time to return to full activity. The two morcellators were evaluated by the surgeon using a VAS score ranging from 0 (low handling, easy) to 10 (high handling, difficult). There was a significant difference in ease of use, with the Gynecare Morcellex having a higher handling score (average 7.0 for supracervical hysterectomy and 7.2 for myomectomy). Also noted in this study, since the Rotocut G1 morcellator is reusable, it was more cost effective in large volume hospitals where laparoscopy is performed routinely. However, in hospitals where laparoscopy is not performed routinely, the Gynecare Morcellex was more cost-effective since more than 30 laparoscopic procedures requiring morcellation are needed to reach the cost of the Rotocut G1 [11]. The Gynecare Morcellex was voluntarily withdrawn from the market by Johnson and Johnson in late July, 2014 after a statement discouraging the use of power morcellators was released by the FDA. See "Updated FDA Recommendations under Complications" for further details.

There is also a morcellator currently on the market developed by Olympus Gyrus that uses purely bipolar technology and does not have a bladed system. The device, known as the PKS PlasmaSORD (Solid Organ Removal Device), utilizes bipolar energy to morcellate the tissue instead of sharp blades (Fig. 15.3). Theoretically, this creates fewer tissue fragments. It connects to a standard bipolar generator (Fig. 15.4), requires minimal set up, is lightweight and is ergonomical. There have been reports of successful morcellation

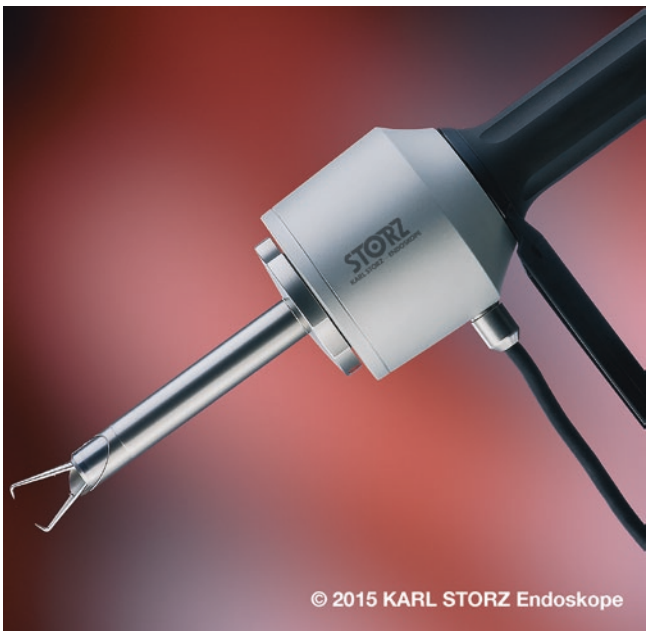


Fig. 15.1 Rotocut G1 Morcellator by Karl Storz (©2015 Photo Courtesy of KARL STORZ Endoscopy-America, Inc.)



Fig. 15.2 MORCELLEX SIGMA™ Tissue Morcellator System, manufactured by Ethicon US, LLC



Fig. 15.3 PKS PlasmaSORD Bipolar Morcellator by Olympus



Fig. 15.4 Bipolar Generator Box used with the PKS PlasmaSORD Morcellator

Table 15.1 Types of morcellators

Date introduced	Date discontinued	Manufacturer	Make	Diameter (mm)	Blade speed (rpm)	Disposable/Reusable	Motor	Activation
Feb-00	Jul-14	Ethicon, Inc.	Gynecare X-Tract	12	125–1000	Disposable	Generator box	Foot
Jul-06	2013	Ethicon, Inc.	Gynecare Morcellex	15	125–1000	Disposable	Generator box	Hand or foot
2013	Jul-14	Ethicon, Inc.	Morcellex Sigma	15	125–1000	Disposable	Generator box	Hand
Jul-06	n/a	Karl Storz	Rotocut G1	12 or 15	0–1200	Disposable blade	Hand piece	Foot
May-08	n/a	Olympus	PKS Plasma SORD	15	n/a	Disposable	**Bipolar generator box	Foot
Jun-09	n/a	Richard Wolf	Morce Power Plus	12, 15, 20	100–1000	Reusable	Generator box	Foot
Mar-11	n/a	Blue Endo	MOREsolution	12.5, 15, 20	100–800	Reusable	Generator box	Hand or foot
Mar-11	n/a	LiNA Medical	Xcise	15	1000	Completely disposable	Hand piece, cordless	Hand

of large uteri using this device [12] but few studies have been performed comparing this bipolar technology with the standard bladed technique. Reported injuries have been related to limited visualization due to electrosurgical smoke and skin burns due to the bipolar system [13].

A comparison of these and other current models of morcellators is listed in Table 15.1.

Use

The use of most power morcellators is similar amongst manufacturers. Figure 15.5 shows the various pieces of the Storz Rotocut G1 Morcellator. The technique is historically done with the power morcellator placed in the abdominal wall. First, the largest trocar is removed from the abdominal wall. The incision is extended to the appropriate diameter, usually by dilators, under direct visualization. Once the appropriate diameter is reached, the morcellator cannula with obturator is inserted through this incision under direct visualization (Fig. 15.6). The obturator is removed and the blade is placed into the cannula (Fig. 15.7). A grasper, usually a 10 mm-diameter tenaculum or spoon, is then inserted through this cannula/blade and the tissue to be morcellated is grasped (Fig. 15.8). The cannula should contain a seal in order to maintain pneumoperitoneum. The tissue is brought up flush with the morcellator blade. Care should be taken to bring the specimen to the morcellator, not the morcellator to the specimen. The motor is then activated and the blade rotates while an upward force is exerted by the surgeon to allow the blade



Fig. 15.5 Separate pieces of the Rotocut G1 Morcellator. Pieces include (from left to right): obturator, sleeve (12 or 15 mm), blade, motor with power cord, motor valve, blade handle, sealing cap, and tenaculum (©2015 Photo Courtesy of KARL STORZ Endoscopy-America, Inc.)

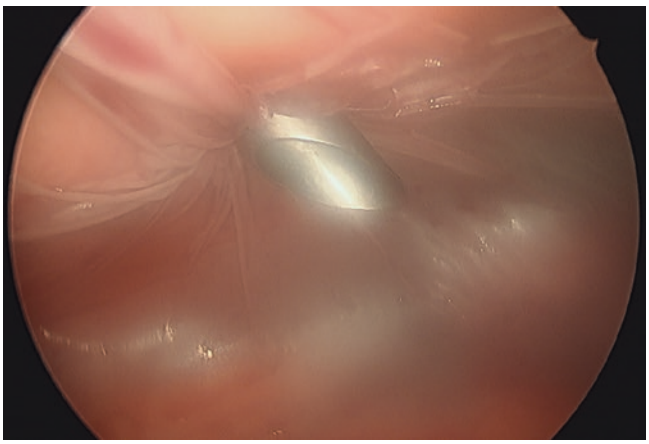


Fig. 15.6 The morcellator cannula inside the abdomen. Dilate the incision to the appropriate size prior to placement. Take care to have the long arm of the cannula bevel anterior

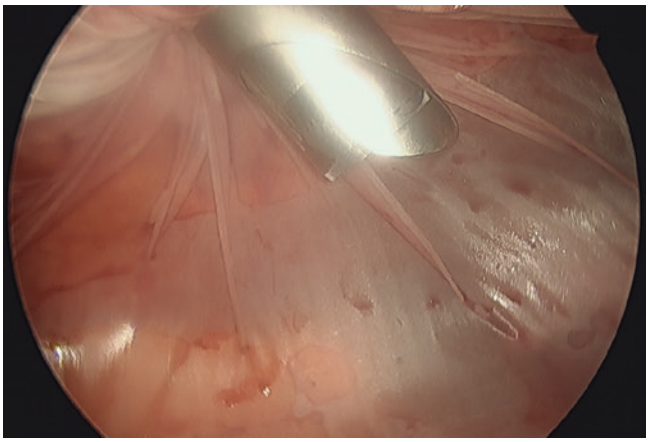


Fig. 15.7 The morcellator blade is now inserted through the cannula. Always aim towards the pelvis



Fig. 15.8 Using the Rotocut G1 Morcellator: one hand holds the morcellator steady while the other hand uses the tenaculum to grasp the tissue. This hand then pulls the tissue against the blade, the blade is activated, and morcellation ensues (©2015 Photo Courtesy of KARL STORZ Endoscopy-America, Inc.)

to cut through the tissue. This action cuts the tissue into cylindrical strips and allows for its removal through the cannula. The long arm of the bevel of the cannula should be anterior to allow a "coring" of the tissue, like peeling an apple [14]. The blade should be pointed away from the abdominal organs toward the pelvis with the cannula close to the abdominal wall (Fig. 15.9). When the tissue breaks, the activation of the morcellator should be stopped until a new piece of tissue is grasped. This is repeated until the entire specimen is able to be removed. Visualization should be maintained throughout the entire procedure and the end of the blade should be constantly seen by the surgeon. During this process, small pieces of the tissue may be separated from the specimen and dispersed throughout the abdominal cavity (Fig. 15.10). Careful inspection of the cavity should be performed and all small pieces removed prior to terminating the morcellation procedure. Small pieces should be removed by a spoon rather than a tenaculum [14].

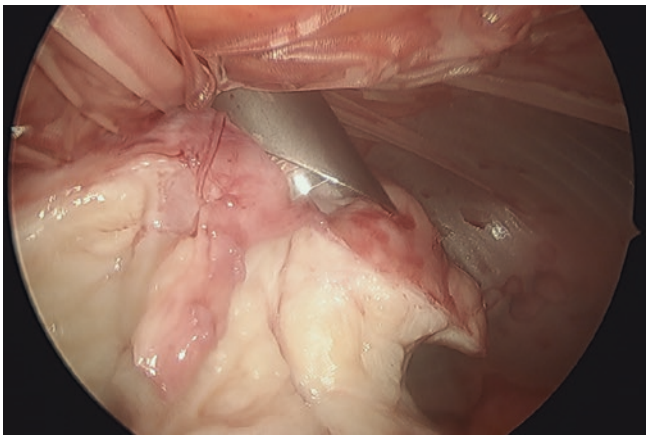


Fig. 15.9 Morcellating the specimen. Grasp specimen with a tenaculum or spoon and pull towards the morcellator until flush against morcellator. Point morcellator towards the pelvis. Pull back on the specimen while activating the blade. Use a "coring" technique to morcellate

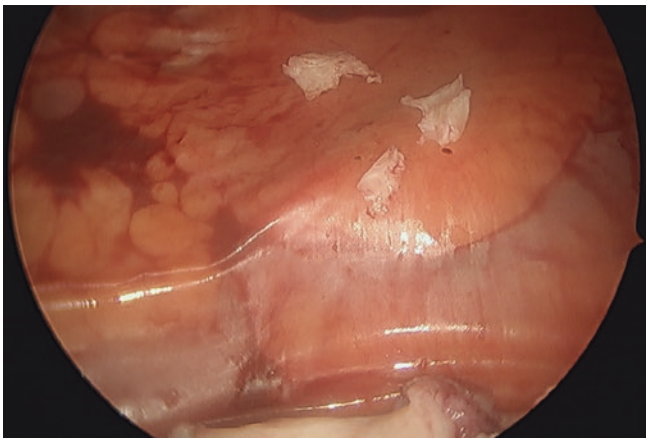


Fig. 15.10 Small fragments of tissue that may be dispersed after morcellation. Take care to remove all small pieces

Transcervical Morcellation

Morcellation has also been described using a transcervical approach after a supracervical hysterectomy. The steps are essentially the same; however, instead of extending an abdominal wall incision by dilation, the cervical canal is dilated until the morcellator cannula can be inserted. A longer cannula and blade must be used to traverse the vaginal canal. Morcellation is then completed in the same manner and the dilated cervical so may be closed using a single stitch laparoscopically. This technique allows the surgeon to avoid making a large abdominal wall incision and thus decreases the risk of future herniation. This technique was first reported in the literature by Rosenblatt et al. in 2010 [15].

At our institution, we have successfully performed transcervical morcellation after supracervical hysterectomy in several patients. We utilize the 12 mm Rotocut G1 Morcellator with the extra-long cannula. However, we have recently abandoned this method in order to routinely utilize contained in-bag morcellation which, at this time, can only be performed trans-abdominally and trans-vaginally. See "Updated FDA Recommendations under Complications" and "Contained Morcellation" for more details.

Manual Morcellation

An alternative form of morcellation can be performed by hand. This historically is performed vaginally, using a scalpel or scissors to cut a large specimen into smaller, retrievable pieces. It can also be performed abdominally through a small incision. In a study published in 2006 by Wang, et al., extraction of uterine myomas by culdotomy with hand morcellation vs. power morcellation was compared. The time for specimen removal with power morcellation was significantly less and there were no differences in myoma weight, size, number removed, blood loss or post-operative stay and no major complications occurred [16].

Complications

As morcellators have become more common place in laparoscopic surgery, morcellator-related injuries have also increased. These injuries range from direct surgical risks resulting in immediate complications to sequelae of morcellated tissue fragments and morcellation of undiagnosed malignancy resulting in more long term complications.

Immediate Complications

Immediate complications inherent in morcellation are generally caused by the sharp blade that is placed in the abdomen. Several advances have been made to decrease the incidence of these injuries, such as improved visualization of the blade due to a beveled trocar, completely covered blades and improved maintenance of pneumoperitonum. Some morcellators, such as Xcise, have different settings allowing the blade to protrude by different lengths. Despite these advances, adverse events can still occur. Milad et al. performed a systematic review using a literature search and a search of the FDA Medical Device Reporting (MDR) and Manufacturer and User Facility Device Experience (MAUDE) databases to determine the frequency of immediate morcellator injuries from 1992 to 2012 [13]. This study examined morcellation after hysterectomy, myomectomy, nephrectomy, splenectomy, and "other." He found a total of 55 complications, specifically including injuries to the small

and large bowels (n = 31), vascular system (n = 27), kidney (n = 3), ureter (n = 3), bladder (n = 1) and diaphragm (n = 1). Most (66 %) of these injuries were identified intraoperatively. Six patients died of morcellator related complications. No single manufacturer was solely associated with visceral or vascular injuries. The most common contributing factor for the injuries was lack of surgeon experience (n = 16) followed by lack of visualization (n = 4) and device malfunction (n = 4). Therefore, it is imperative that surgeons planning on performing power morcellation undergo training to gain experience and understand how to use, put together, operate and troubleshoot the device they plan to use. Other tips to reduce the surgical risk of morcellator use include:

1. Use the beveled tip of the morcellator anteriorly to allow an "apple peeling" technique.
2. Make sure, prior to activating the morcellator, that only the specimen is grasped and that the specimen is away from underlying bowel which may incidentally be grasped.
3. Only morcellate when the blade tip is visible
4. Never bring the morcellator to the specimen; instead, bring the specimen to the morcellator.
5. Always ensure adequate visualization is obtained prior to morcellation.

Long-Term Complications

Long term complications of morcellation include retained or parasitic tissue, leiomyomatosis or dissemination of undiagnosed malignancy. The term "iatrogenic parasitic myoma" has been developed to describe the formation of new myomas that are not attached to the uterus presenting after uterine or myoma morcellation. This is thought to occur when fragments of myomas are left behind following morcellation and become implanted in normal tissue in the abdominal cavity. The morcellated fragments are then able to grow via neovascularization from the peritoneum or adjacent tissue. Although Donnez et al. estimated the incidence to be 0.57 % of subtotal hysterectomies, the true incidence of retained uterine fragments is unknown. There are several case reports and literature reviews documenting the development of iatrogenic parasitic myomas but the numbers are too low to justify any substantial conclusions or to determine the incidence. In 2010, Larrain et al. reported a series of four cases of parasitic myomas diagnosed after prior morcellation at their institution. They also reviewed the literature, revealing 14 different reported cases or series of iatrogenic parasitic myomas at that time [17]. In 2011, Cucinella et al. reviewed four cases of parasitic myomas over a three year study period, giving an incidence of 0.9 % in their institution [18]. Finally, in 2012, a review out of Scandinavia reported three cases of parasitic myomas between 2004–2011, making their reported incidence of parasitic myomas only 0.12 % [19]. These lesions are usually confined to the pelvis, especially in the paravesical, pararectal, and rectovaginal spaces [18, 20, 21] however, reports exist of parasitic myomas found in the upper abdomen, anterior abdominal wall and port sites as well [9, 22–25]. Symptoms of parasitic myomas are not specific and patients are often asymptomatic. Palpable masses have also been described, as well as pelvic pain dyspareunia and abnormal vaginal bleeding [17, 26]. Treatment is surgical removal.

Disseminated peritoneal leiomyomatosis is another condition that has been reported after morcellation of leiomyoma. It is a rare hormonally dependent condition in which multiple nodules stud the pelvic and peritoneal surfaces, often giving the appearance of metastatic ovarian or peritoneal carcinoma [27]. There are approximately 150 cases reported in the literature since the first report in 1952 [28, 29]. Complete or partial smooth muscle differentiation in the absence of cytologic atypia is seen on morphologic, immunohistochemical evaluation. It is generally a benign condition but there are rare reports of malignant transformation. Patients can be asymptomatic and therefore, the condition is often diagnosed incidentally. However, abdominopelvic pain or palpable masses, dysmenorrhea, menorrhagia and intestinal obstruction have all been reported as presenting symptoms. If suspected, surgical exploration is indicated for diagnostic and therapeutic purposes with removal of the masses. This has been successfully reported by the laparoscopic approach [30]. Recent reports of successful treatment with GnRH agonists [31] or aromatase inhibitors [32] are documented as well.

Iatrogenic endometriosis has been reported to occur after uterine morcellation, but not all of the literature is consistent. A case report by Sepilian demonstrated widespread endometriosis and symptoms of cyclic pelvic pain six months following morcellation after a supracervical hysterectomy performed for uterine fibroids with an absence of endometriosis [33]. Implants have also been reported in the abdomen, pelvis and port sites [33–35]. One proposed theory is that viable endometrial tissue can seed the pelvis and peritoneum during hysterectomy and uterine morcellation. This would lead to implantation and proliferation of this endometrial tissue, leading to endometriosis formation. Other possible causes include retrograde flow from remaining endometrial tissue in a cervical stump or the presence of endometriosis that was not visualized on initial procedure [33, 36]. However, a case control study reported by Schuster et al. showed no difference (p = 0.998, n = 464) in new-onset endometriosis in patients after hysterectomy with morcellation compared to hysterectomy without morcellation [36]. Therefore, despite some case reports, uterine morcellation does not seem to increase the risk of a subsequent diagnosis of endometriosis.

In a systematic review analyzing 66 patients between 1990 and 2014 who underwent reoperation after morcellation during laparoscopic hysterectomy or myomectomy, the most common reason for reoperation was parasitic leiomyomata (33.3 %). The majority of the reoperations were due to new clinical symptoms, 60 % in the myomectomy group and 60 % in the hysterectomy group. The remaining reoperations were performed due to unsuspected malignancy, and the majority of these malignancies were leiomyosarcomas (24 %) [37].

Disseminated Malignancy

The biggest concern in regards to dissemination of tissue during morcellation is the inadvertent dissemination of malignancy.

Endometrial Adenocarcinoma

Morcellation of endometrial adenocarcinoma can cause cancerous tissue to be spread throughout the abdomen and lead to possible upstaging of an existing malignancy. Morcellation of endometrial adenocarcinoma can usually be avoided by appropriate pre-operative evaluation with endometrial biopsy or dilation and curettage; however, this is not always accurate. In symptomatic patients with confirmed endometrial malignancies, cancer detection rates are as high as 95 % with office based endometrial biopsy. However, in women undergoing hysterectomy without these symptoms, office sampling is much less effective [38]. In addition, curettage may be preferred over biopsy for endometrial sampling in certain situations. Studies have shown a discrepancy of 10–16 % in histologic diagnosis with endometrial biopsy or curettage when compared to hysterectomy [39]. A recent study out of Europe showed a concordance rate of only 62 % and 67 % of endometrial biopsy and curettage (respectively) when compared to hysterectomy [40].

Although the exact guidelines vary by source, it is always necessary to undergo appropriate preoperative evaluation. In patients with abnormal uterine bleeding, endometrial evaluation with ultrasound and endometrial biopsy should always be performed. If the endometrial lining is thickened, sonohysterogram should be considered to evaluate for polyps or intracavitary fibroids. Abnormally thickened endometrium is defined as thickness > 4 mm in post-menopausal women or >5 mm on days 3–5 of the menstrual cycle of a pre-menopausal women. If, after sonohysterogram and biopsy, there is no evidence of intracavatary pathology and the biopsy is negative, uterine curettage may be warranted. In patients without abnormal uterine bleeding, ultrasound should still be performed for operative planning. Although there are no strict guidelines, it may be beneficial to proceed with endometrial sampling for abnormally thickened endometrium in these patients as well, especially when morcellation is anticipated. In our practice, we perform a routine hysterosonogram and endometrial biopsy prior to any case that may undergo uterine or fibroid morcellation regardless of their presenting symptoms.

Yet, even with appropriate pre-operative evaluation, an endometrial cancer can remain undetected and inadvertent morcellation and dissemination of malignancy can, rarely, occur. In a study evaluating 708 women undergoing hysterectomy for pelvic organ prolapse (i.e. benign disease), five patients had pathologic diagnosis of endometrial cancer (0.6 %) and 4/5 of these cases had normal preoperative screening [41]. Finally, a case report out of Duke University Medical Center in 2013 describes a case where laparoscopic hysterectomy was performed with morcellation after an endometrial curettage with frozen section was negative for malignancy. The morcellated specimen was evaluated by pathology and was also found to be negative for malignancy. Fourteen months later, the patient had left lower quadrant pain and a persistent cough and was found to have evidence of metastatic disease on PET-CT. Biopsy showed grade three endometrioid adenocarcinoma. The differential included unrecognized malignancy at the time of initial hysterectomy or malignant transformation of retained endometrial tissue or endometriosis after morcellation [42]. Despite these anecdotal examples, it is imperative to undergo strict and standardized pre-operative evaluation with all patients, especially when uterine morcellation is planned.

Other Tumors

Case reports of rare undiagnosed tumors that were morcellated have been reported as well. Upstaging of these tumors is possible, but due to low number, no incidence can be determined. In a case series out of the University of Pennsylvania, a series of 101 patients undergoing laparoscopic hysterectomy with morcellation was reviewed. In this series, one case was noted to have an atypical trophoblastic nodule with necrosis and myometrial infiltration, suspected to represent epithelioid trophoblastic tumor [43]. A case reported out of Drexel University revealed morcellation of a low-grade endometrial stromal sarcoma after laparoscopic supracervical hysterectomy for abnormal uterine bleeding. This patient had a benign pre-operative dilation and curettage. She was transferred to a gynecologic oncologist who performed a laparotomy, bilateral salpingo-oophorectomy and removal of the cervical stump as well as debulking of extensive sarcoma throughout the pelvis that was not seen on initial laparoscopy. The authors concluded that morcellation of the tissue likely accelerated the spread of the disease [44]. It must be recognized that these are anecdotal cases. While in discussion with patients, the risks must be noted but it should

be recognized that the likelihood of morcellation of these tumors is rare, especially if age stratification is recognized and the patient is properly evaluated.

Leiomyosarcoma

Of greatest concern is the inadvertent morcellation of a leiomyosarcoma. Leiomyosarcoma is the most common malignant nonepithelial tumor of the uterus [45] representing 1–2 % of all uterine malignancies [46]. It is an aggressive malignancy with 5-year survival rate of 18.8–65 %. It typically affects women in the perimenopausal years with a median age of 52 years and is very rare in women below the age of 40. Leiomyosarcoma presents as a solitary, fleshy and necrotic intramural tumor [47] in patients noting uterine enlargement, pain, a sensation of pressure, abnormal uterine bleeding or a lower abdominal mass. The classic sign of this malignancy is a rapidly growing uterus; however, because it is uncommon, only 0.23 % of patients with this finding will have leiomyosarcoma [48]. Preoperative diagnosis is challenging because the symptoms and the clinical appearance associated with leiomyosarcoma are nearly identical to benign leiomyoma. MRI with diffusion-weighted imaging and PET/CT with F-FDG have both been evaluated in the pre-operative diagnosis of leiomyosarcoma [49, 50]; however, neither has been sufficiently proven to offer accurate diagnosis. Utilizing serum lactate dehydrogenase (LDH) and its isoenzymes, especially isozyme type 3, has also been utilized to distinguish leiomyosarcoma from benign leiomyoma and is a promising technique. The correlation was first seen in a series of 1886 patients who underwent hysterectomy for uterine myomas, 7 of which were found to have leiomyosarcoma. Three of these 7 patients had an elevated LDH and these 3 patients had tumors with worse prognostic factors [51]. In a follow up study evaluating 10 patients with leiomyosarcoma and 130 patients with degenerated leiomyoma, all patients with leiomyosarcoma had elevated total LDH and LDH isozyme type 3. When LDH was combined with MRI, the specificity, positive predictive value and negative predictive value were all 100 % in this particular study [52].

Despite these findings, there is no formal recommendation to use specific labs or imaging to pre-operatively diagnose leiomyosarcoma. At this time the only way to accurately distinguish a leiomyosarcoma from a benign leiomyoma is through histologic evaluation with leiomyosarcomas revealing coagulative tumor cell necrosis, moderate to severe cytologic atypia and numerous mitotic figures [47]. However, in our practice we will utilize serum LDH and/or MRI based on individual patient findings. We do not obtain them on all patients with fibroids; however, if a patient is at an increased risk for a leiomyosarcoma, we may consider using these diagnostic modalities. High risk patients include perimenopausal patients with any sized fibroid, a fibroid that is rapidly growing or has been present for an unknown amount of time, or a fibroid that looks suspicious on ultrasonography. Of note, in the few patients in our practice that had elevated LDH and LDH3 levels pre-operatively, the final pathology was benign.

An updated series on uterine leiomyosarcomas was published in 2013. In 198 patients with leiomyosarcomas over 10 years the presenting symptoms varied. Eight percent were incidental, 29 % of patients had menorrhagia or abnormal uterine bleeding, 25 % had pelvic pain, 17 % had postmenopausal bleeding, 19 % had abdominal fullness and 4 % had an unknown presenting symptom. Of the patients who had preoperative endometrial sampling, only 46 % were suggestive of leiomyosarcoma. The mean tumor size was 10 cm. The median disease free survival and median overall survival for women with stage 1 were 37 and 75 months, stage 2 were 23 and 66 months, stage 3 were 10 and 34 months and stage 4 were 3 and 20 months respectively [46].

There are currently nine studies in the literature on unsuspected leiomyosarcomas in patients who had a hysterectomy or myomectomy for presumed benign disease [52]. The rate of leiomyosarcoma in these studies ranges from 0 to 0.49 % with the average being 0.18 % [53]. The FDA recently released a statement quoting the incidence to be 1 per 350 or 0.29 % [54]. This incidence has been challenged by Elizabeth Pritts, et al. at the FDA meeting. Her more extensive evaluation of the literature was correlated to a much lower risk of leiomyosarcoma.

Morcellating these unsuspected malignancies can result in upstaging and a worse prognosis [55, 56]. In a comparison of 56 patients with LMS, 25 with and 31 without morcellation, tumor morcellation was significantly associated with poorer disease free survival ($p = 0.043$), higher stage (I vs. II, $p = 0.037$) and poorer overall survival (0.040). It was also found that the percentage of patients with abdominopelvic dissemination was significantly greater in patients with tumor morcellation (44 % vs. 12.9 %) [55]. Of course, one must always question whether the patients were originally staged adequately. In a review out of Sloan Kettering, four patients who underwent completion operations after laparoscopic morcellation of an unknown malignancy were evaluated. One patient had uterine endometrioid cancer and three had uterine leiomyosarcomas. Two of the three leiomyosarcoma patients were upstaged from stage one to stage three. The patient with uterine endometrioid cancer with stage 1B disease was not upstaged at reoperation [56]. Another retrospective study of 58 patients, 19 of whom underwent morcellation, showed a significant increase in the risk of abdominal/pelvic recurrences and shorter median recurrence-free survival in patients with unsuspected leiomyosarcomas who underwent intraperitoneal morcellation [57]. Oduyebo et al. reviewed 21 patients with the diagnosis of leiomyosarcoma or uterine smooth muscle tumors of uncertain malignant potential (STUMP) after morcellation. Twelve of these

patients had re-exploration surgery and 28.5 % of the leiomyosarcoma patients and 25 % of the STUMP patients had findings of disseminated intraperitoneal disease [58]. Yet, despite these reports, this data is still limited and controversial. In a systematic review of six studies, data seemed to be highly biased and of poor quality, resulting in the author's conclusion that there is no reliable evidence that morcellation significantly results in tumor upstaging or in poorer patient outcome. There is also no evidence from these studies that power morcellation affects patient outcomes differently than any other type of morcellation, or even simple myomectomy [59]. Finally, in a decision-tree analysis using base-case estimates, a lower overall mortality rate is seen with laparoscopic hysterectomy with morcellation versus abdominal hysterectomy for the treatment of presumed fibroid uterus in premenopausal women. Although there were more deaths from leiomyosarcoma after laparoscopic hysterectomy, there were more hysterectomy-related deaths with abdominal hysterectomy as well as higher rates of transfusion, infection, thromboembolism and hernia [60].

Updated FDA Recommendations

Due to these controversial findings and reports, the FDA put out a statement discouraging the use of power morcellators, citing safety concerns, mostly the inadvertent dissemination for occult uterine cancer in patients undergoing hysterectomy and myomectomy for presumed leiomyomata. They state that morcellation is contraindicated in peri- or postmenopausal women or in anyone where an alternative form of specimen removal can be performed [54]. According to the SGO, morcellation is contraindicated in the presence of a documented or highly suspected malignancy and may be inadvisable in premalignant conditions or risk-reducing surgery. They quote other options to intracorporeal morcellation including removing the uterus through a mini-laparotomy or morcellating the uterus inside a laparoscopic bag [61]. The AAGL states that when comparing the risks involved in open hysterectomy versus those of power morcellation, gynecologists should improve but not abandon power morcellation, and that power morcellation with appropriate informed consent should remain available to appropriately screened, low risk women [62].

Contained Morcellation

Due to these recent reports, the method of morcellating in a laparoscopic specimen retrieval bag has been proposed. Cohen et al. released a feasibility study in September 2014 reporting 73 successful cases of morcellation of uteri or myomas with and insufflated bag. There were no complications in this report and no visual evidence of tissue dissemination outside of the isolation bag. The bag used in this case was developed by one of the authors specifically for this use [63].

At our institution, we have performed contained in-bag morcellation since May 2014. We use the EcoSac230 bag made by Espiner (Fig. 15.11). Our standard technique is as follows: the bag is inserted through the umbilical port (Fig. 15.12) and the specimen placed inside (Fig. 15.13). The cinched bag edge is pulled out through a 15 mm umbilical incision (Fig. 15.14) and a 12–15 mm trocar is replaced into the bag through the pulled-up bag edge (Fig. 15.15). The bag is insufflated to 25 mmHg allowing a bladed lateral trocar to be placed through the bag (Fig. 15.17). Ideally, this trocar should have balloon on the end, which is then inflated and pulled against the abdominal wall to prevent leakage of insufflation or tissue (Fig. 15.16). The 5 mm laparoscope is used through the lateral port for visualization. The umbilical trocar is removed and the morcellator is placed through this incision into the bag under direct visualization (Fig. 15.18).



Fig. 15.11 The Espiner EcoSac230 bag



Fig. 15.12 Inserting the Espiner EcoSac 230 bag through the umbilical port



Fig. 15.13 Specimen placed inside Espiner EcoSac230 bag. The bag is ultimately cinched closed and pulled up through the umbilical incision

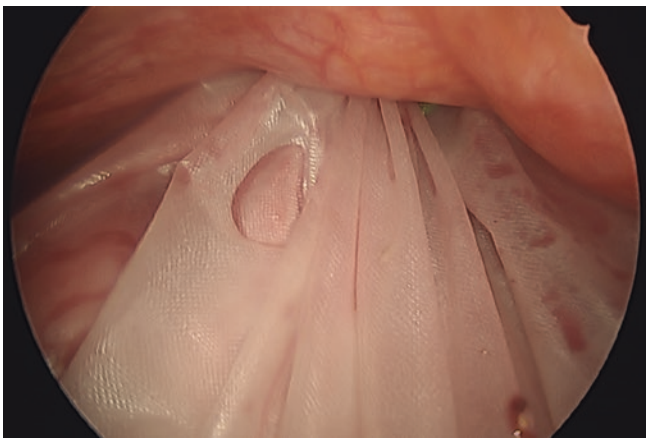


Fig. 15.14 The bag is cinched closed and pulled up through the umbilical incision

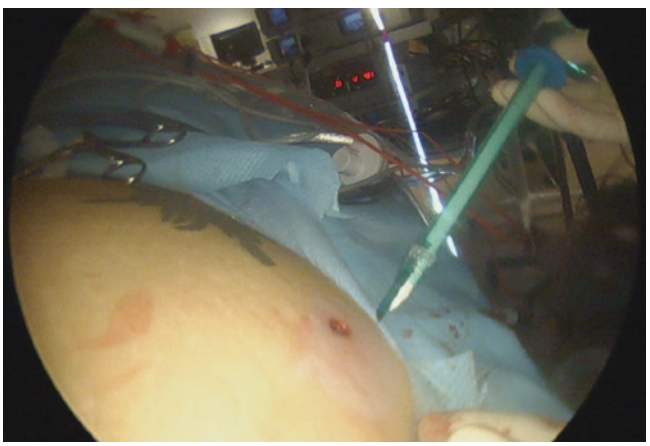


Fig. 15.16 A lateral trocar is placed inside EcoSac230 bag after bag is insufflated to 25 mmHg. This trocar should be bladed to allow adequate puncture of the bag. This is inserted under direct visualization through the umbilical trocar prior to placement of the morcellator

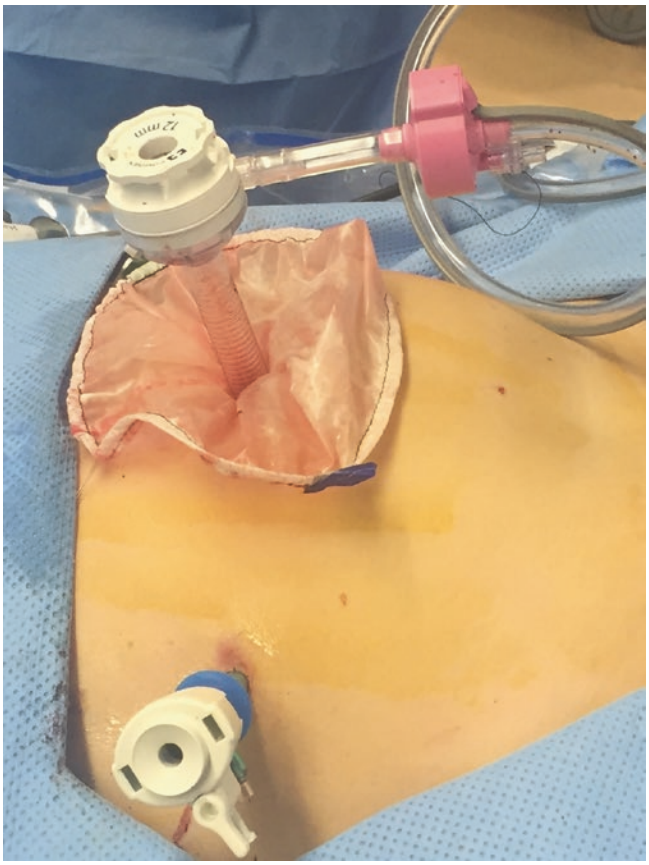


Fig. 15.15 The umbilical trocar is replaced into the bag through the pulled-up bag edge. Insufflation is then attached to this trocar and the bag is insufflated to 15 mmHg

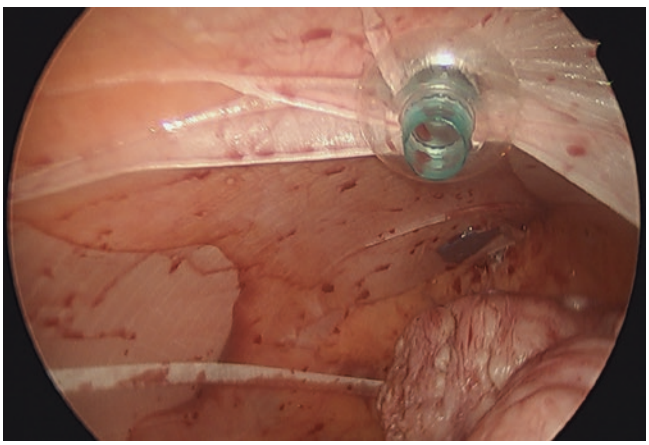


Fig. 15.17 The lateral trocar seen through the bag. The balloon on the end of the lateral trocar is inflated and pulled against the abdominal wall to prevent leakage. This trocar is now used for the laparoscope



Fig. 15.18 The umbilical trocar is removed and replaced with the morcellator. The morcellator is placed through the umbilical incision into the bag. This is done under direct visualization using the laparoscope in the lateral port

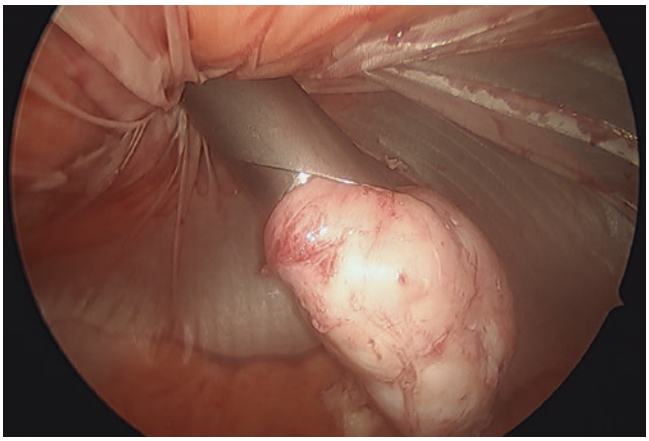


Fig. 15.19 Morcellation occurring with the Storz Rotocut G1 Morcellator. The 5 mm laparoscope is utilized for visualization from the lateral trocar

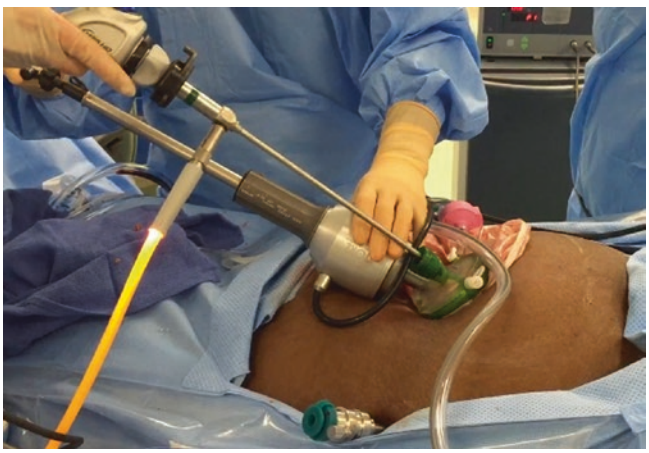


Fig. 15.20 Abdominal set-up of the GelPOINT Mini Advanced Access Platform with the 5 mm laparoscope and the Storz Rotocut G1 Morcellator

Morcellation is then performed through the umbilical incision (Fig. 15.19). We have successfully used this technique in over 90 patients, 27 % of which have been hysterectomies. Our average specimen weight was 288 g, with the largest specimen weighing 2134 g, proving the efficacy of this technique even with larger specimen.

In order to avoid puncturing the bag with a lateral trocar, we have developed another technique of contained in-bag morcellation utilizing the GelPOINT Mini Advanced Access Platform made by Applied Medical. This technique allows the EcoSac230 bag and the laparoscope to both be inserted through the GelPOINT platform simultaneously. It necessitates a slightly larger umbilical incision of 25 mm to allow insertion of the Platform, but prevents the creation of an extra hole in the bag for laparoscopic visualization (Fig. 15.20).

Other institutions are using previously manufactured specimen retrieval bags with insufflation for morcellation under direct visualization. Many studies regarding this new method of morcellation are currently in progress across the country. There are also new specimen bags being developed specifically for this purpose which are under investigation. No FDA approval on the use of specimen retrieval bags for morcellation has been obtained at this point.

Patient Counseling/Informed Consent

When considering morcellation in conjunction with hysterectomy, it is prudent to provide adequate patient counseling. The discussion with the patient should be open, honest and all questions should be answered. The technique of morcellation should be described as well as the reason for performing morcellation. It is important to discuss the risk of underlying malignancy tailored to the individual patient. In appropriate patients, the reasoning behind pre-operative evaluation can be reviewed. It is imperative to include the risk of leiomyosarcoma in this discussion. It should be

noted that the precise incidence of this malignancy is unknown but a risk estimate of 1/350 is quoted by the FDA [54]. The aggressive nature of the tumor as well as the possibility of upstaging due to morcellation leading to a worse prognosis should be reviewed. It may also be beneficial to discuss the recent decision-tree analysis concluding that there are fewer predicted overall deaths with laparoscopic hysterectomy with morcellation compared with abdominal hysterectomy [60]. The possibility of dissemination of benign tissue to should be included in the discussion as well. Once this discussion is complete, any methods to avoid complications involving uterine malignancy should be reviewed. This includes the possibility of morcellation in a bag. The patient should be aware that there is no literature proving the efficacy of contained morcellation at this time, but there are many studies in progress. If vaginal morcellation is feasible, this can be offered to the patient as well. The patient should also be offered an alternative to morcellation, which would be to create a mini-laparotomy, laparotomy or colpotomy to remove the specimen. The size the incision can vary based on the size of the specimen. With any larger incision, the patient should be aware that her recovery time will be longer, pain will be greater, and she will have a higher risk of infection and other morbidities. Once this discussion is complete, specific consent forms allowing for uterine morcellation should be reviewed and signed with the patient [64].

Conclusion and Recommendations

In conclusion, morcellation is an effective way of removing a large specimen via a minimally invasive approach. Manual morcellation can be performed vaginally, through a culdotomy or abdominally but is often time consuming and laborious for the surgeon. Power morcellation may improve surgeon ergonomics and spare time; however, it has controversial complications. Proper visualization of the blade and surrounding tissues should be employed at all times. Care should be taken to remove all morcellated fragments from the abdomen. When possible, the use of a laparoscopic bag may be beneficial during power morcellation to avoid dissemination of tissue. Other techniques to reduce complications include handing the tissue to the tenaculum as opposed to reaching with the tenaculum, using an atraumatic "spoon" forceps when retrieving small fragments, keeping the longer portion of the beveled sleeve more anterior and being sure to consistently maintain sufficient pneumoperitoneum [13]. Appropriate pre-operative work up is essential when planning on potential morcellation in order to exclude pre-existing uterine malignancy. If malignancy is found incidentally after morcellation, the patient should be immediately referred to a gynecologic oncologist [52]. Finally, patient counseling and education is prudent when planning on utilizing the benefits of morcellation. Informed consent should always be addressed and any patient concerns or questions should be attended to in detail. Most importantly, surgeons should always have proper training and sufficient surgical experience prior to entering a case with the potential need for power morcellation.

References

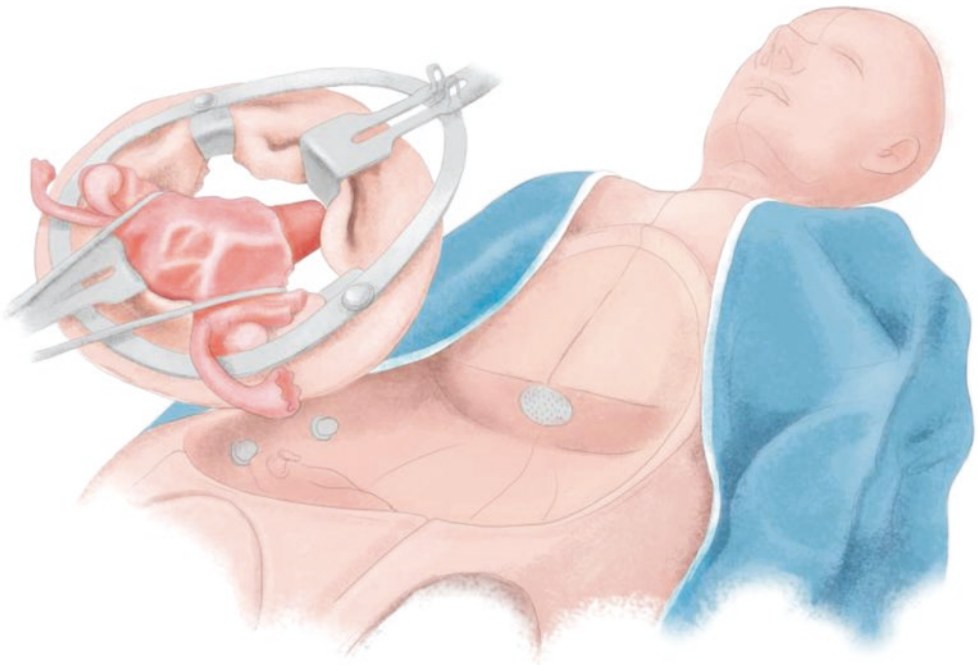
1. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2009;3:CD003677.
2. American College of Obstetrics and Gynecology. Choosing the route of hysterectomy for benign disease. ACOG Committee Opinion Number 444, Nov 2009.
3. Whiteman MK, Hillis SD, Jamieson DJ, et al. Inpatient hysterectomy surveillance in the United States, 2000–2004. Am J Obstet Gynecol. 2008;198:34.e1–7.
4. Wright JD, Herzog TJ, Tsui J, et al. Nationwide trends in the performance of inpatient hysterectomy in the United States. Obstet Gynecol. 2013;122(2 pt 1):233–41.
5. Mettler, Liselotte. Letter to the author. 14 May 2015 TS.
6. Semm K. Morcellement and suturing using pelviscopy: not a problem any more [in German]. Geburtshilfe Frauenheilkd. 1991;51:843–6.
7. Steiner RA, Wight E, Tadir Y, Haller U. Electrical cutting device for laparoscopic removal of tissue from the abdominal cavity. Obstet Gynecol. 1993;81:471–4.
8. Carter JE, McCarus SD. Laparoscopic myomectomy. time and cost analysis of power vs. manual morcellation. J Reprod Med. 1997;42:383–8.
9. Brucker S, Solomayer E, Zubke W, et al. A newly developed morcellator creates a new dimension in minimally invasive surgery. J Minim Invasive Gynecol. 2007;14:233–9.
10. De Grandi P, Chardonnens E, Gerber S. The morcellator knife: a new laparoscopic instrument for supracervical hysterectomy and morcellation. Obstet Gynecol. 2000;95(5):777–8.
11. Zullo F, Falbo A, Iuliano A, et al. Randomized controlled study comparing the Gynecare Morcellex and Rotocut G1 tissue morcellators. J Minim Invasive Gynecol. 2010;17(2):192–9.
12. Walid MS, Heaton RL. A large fibroid uterus removed with a bipolar morcellator. Proc Obstet Gynecol. 2011;1(3):11.
13. Milad MP, Milad EA. Laparoscopic morcellator-related complications. J Minim Invasive Gynecol. 2014;21:486–91.
14. Streicher L. A gynecologist's guide to laparoscopic morcellation. Female Patient. 2010;35:26–35.
15. Rosenblatt PL, Makai G, DiSciullo AJ. Laparoscopic supracervical hysterectomy with transcervical morcellation. J Minim Invasive Gynecol. 2010;17:331–6.
16. Wang CJ, Yuen LT, Lee CL, Kay N, Soong YK. A prospective comparison of morcellator and culdotomy for extracting of uterine myomas laparoscopically in nullipara. J Minim Invasive Gynecol. 2006;13(5):463–6.
17. Larrain D, Rabischong B, Khoo CK, et al. "Iatrogenic" parasitic myomas: unusual late complication of laparoscopic morcellation procedures. J Minim Invasive Gynecol. 2010;17(6):719–24.
18. Cucinella G, Granese R, Calagna G, Somigliana E, Perino A. Parasitic myomas after laparoscopic surgery: an emerging

complication in the use of morcellator? Description of four cases. Fertil Steril. 2011;96:e90–6.
19. Leren V, Langebrekke A, Qvigstad E. Parasitic leiomyomas after laparoscopic surgery with morcellation. Acta Obstet Gynecol Scand. 2012;91:1233–6.
20. Donnez O, Squifflet J, Leconte I, Jadoul P, Donnez J. Posthysterectomy pelvic adenomyotic masses observed in 8 cases out of a series of 1405 laparoscopic subtotal hysterectomies. J Minim Invasive Gynecol. 2007;14(2):156–60.
21. Kho KA, Nezhat C. Parasitic myomas. Obstet Gyencol. 2009;114:611–5.
22. Moon HS, Koo JS, Park SH, et al. Parasitic leiomyoma in the abdominal wall after laparoscopic myomectomy. Fertil Steril. 2008;90:e1–2.
23. Hutchins Jr FL, Reinoehl EM. Retained myoma after laparoscopic supracervical hysterectomy with morcellation. J Am Assoc Gynecol Laparosc. 1998;5:293–5.
24. Paul PG, Koshy AK. Multiple peritoneal parasitic myomas after laparoscopic myomectomy and morcellation. Fertil Steril. 2006;85:492–3.
25. Ostrzenski A. Uterine leiomyoma particle growing in an abdominal wall incision after laparoscopic retrieval. Obstet Gynecol. 1997;89:853–4.
26. Takeda A, Mori M, Sakai K, et al. Parasitic peritoneal leiomyomatosis diagnosed 6 years after laparoscopic myomectomy with electric tissue morcellation: report of a case and review of the literature. J Minim Invasive Gynecol. 2007;14(6):770–5.
27. Hardman 3rd WJ, Majmudar B. Leiomyomatosis peritonealis disseminate: clinicopathologic analysis of five cases. South Med J. 1996;89(3):291–4.
28. Bisceglia M, Galliani C, Pizzolitto S, et al. Selected case from the Arkadi M. Rywlin International Pathology Slide Series: Leiomyomatosis peritonealis disseminata: report of 3 cases with extensive review of the literature. Adv Anat Pathol. 2014;21(3):201–15.
29. Al-Talib A, Tulandi T. Pathophysiology and possible iatrogenic cause of leiomyomatosis peritonealis disseminate. Gynecol Obstet Invest. 2010;69(4):239–44.
30. Takeda A, Mori M, Sakai K. Parasitic peritoneal leiomyomatosis diagnosed 6 years after laparoscopic myomectomy with electric tissue morcellation: report of a case and review of the literature. J Minim Invasive Gynecol. 2007;14:770–5.
31. Hales HA, Peterson CM, Jones KP, et al. Leiomyomatosis peritonealis disseminate treated with a gonadotropin-releasing hormone agonist. a case report. Am J Obstet Gynecol. 1992;167:515–6.
32. Takeda T, Masuhara K, Kamiura S. Successful management of a leiomyomatosis peritonealis disseminate with an aromatase inhibitor. Obstet Gynecol. 2008;112(2 pt2):491–3.
33. Sepilian V, Della BC. Iatrogenic endometriosis caused by uterine morcellation during a supracervical hysterectomy. Obstet Gynecol. 2003;102:1125–7.
34. Brown RL. Iatrogenic endometriosis caused by uterine morcellation during a supracervical hysterectomy. Obstet Gynecol. 2004;103:583. , author reply 583–84.
35. Decenzo JA. Iatrogenic endometriosis caused by uterine morcellation during a supracervical hysterectomy. Obstet Gynecol. 2004;103:583.
36. Schuster MW, Wheller TL, Richter HE. Endometriosis after laparoscopic supracervical hysterectomy with uterine morcellation: a case control study. J Minim Invasive Gynecol. 2012;19(2):183–7.
37. Pereira N, Buchanan T, Wishall K, et al. Electric morcellation-related reoperations after laparoscopic myomectomy and nonmyomectomy procedures. J Minim Invasive Gynecol. 2014;S1553-4650(14):01292–8.
38. American Association of Gynecologic Laparoscopists. AAGL practice report: Morcellation during uterine tissue extraction. J Minim Invasive Gynecol. 2014;21(4):517–30.
39. Katz VL, Lentz GM, Lobo RA, Gershenson DM. Comprehensive gynecology. 5th ed. Philadelphia: Mosby; 2007.
40. Gungorduk K, Asicioglu O, Ertas IE, et al. Comparison of the histopathological diagnoses of preoperative dilation and curettage and Pipelle biopsy. Eur J Gynaecol Oncol. 2014;35(5):539–43.
41. Ramm O, Gleason JL, Segal S, Antosh DD, Kenton KS. Utility of preoperative endometrial assessment in asymptomatic women undergoing hysterectomy for pelvic floor dysfunction. In Urogynecol J. 2012;23(7):913–7.
42. Turner T, Secord AA, Lowery WJ, Sfakianos G, Lee PS. Metastatic adenocarcinoma after laparoscopic supracervical hysterectomy with morcellation: a case report. Gynecol Oncol Case Rep. 2013;5:19–21.
43. Hagemann IS, Hagemann AR, LiVolsi VA, Montone KT, Chu CS. Risk of occult malignancy in morcellated hysterectomy: a case series. Int J Gynecol Pathol. 2011;30:476–83.
44. Della Badia C, Karini H. Endometrial stromal sarcoma diagnosed after uterine morcellation in laparoscopic supracervical hysterectomy. J Minim Invasive Gynecol. 2010;17:791–3.
45. Silverberg SG. Leiomyosarcoma of the uterus. a clinicopathologic study. Obstet Gynecol. 1971 Oct;38(4):613–28.
46. Rauh-Hain JA, Oduyebo T, Diver E, et al. Uterine Leiomyosarcoma: an updated series. Int J Gyencol Cancer. 2013;23(6):1036–43.
47. Berek JS, Hacker NF. Gynecologic oncology. 5th ed. Philadelphia: Lippincott Williams & Wilkens; 2010.
48. Rose PG. Cancer of the uterine corpus. Precis: an update in obstetrics and gynecology. Oncology. 3rd ed. Washington, DC: The American College of Obstetricians and Gynecologists; 2008.
49. Sato K, Yuasa N, Fujita M, et al. Clinical application of diffusion-weighted imaging for preoperative differentiation between uterine leiomyoma and leiomyosarcoma. Am J Obstet Gynecol. 2014;210(4):368.e1–8.
50. Kitajima K, Murakami K, Kaji Y, et al. Spectrum of FDG PET/CT findings of uterine tumors. AJR Am J Roentgenol. 2010;195(30):737–43.
51. Seki K, Hoshihara T, Nagata I. Leiomyosarcoma of the uterus: ultrasonography and serum lactate dehydrogenase level. Gynecol Obstet Invest. 1992;33:114–8.
52. Goto A, Takeuchi S, Sugimura K, Maruo T. Usefulness of Gd-DTPA contrast-enhanced dynamic MRI and serus determination of LDH and its isozymes in the differential diagnosis of leiomyosarcoma from degenerated leiomyoma of the uterus. Int J Gynecol Cancer. 2002;12(4):354–61.
53. Stine JE, Clarke-Pearson DL, Gehrig PA. Uterine morcellation at the time of hysterectomy: techniques, risks, and recommendations. Obstet and Gynecol Surv. 2014;69(7):415–25.
54. US Food and Drug Administration. Laparoscopic uterine power morcellation in hysterectomy and myomectomy: FDA safety communication. Nov 2014.
55. Park JY, Park SK, Kim DY, Kim JH, Kim YM, Kim YT, et al. The impact of tumor morcellation during surgery on the prognosis of patients with apparently early uterine leiomyosarcoma. Gynecol Oncol. 2011;122:255–9.
56. Einstein MH, Barakat RR, Chi DS, Sonoda Y, Alektiar KM, Hensley ML, et al. Management of uterine malignancy found incidentally after supracervical hysterectomy or uterine morcellation for presumed benign disease. Int J Gynecol Cancer. 2008;18:1065–70.
57. George S, Barysauskas C, Serrano C, Oduyebo T, JA R-H, et al. Retrospective cohort study evaluating the impact of intraperitoneal morcellation on outcomes of localized uterine leiomyosarcoma. Cancer. 2014;120(20):3154–8. [Epub ahead of print].

58. Oduyebo T, Rauh-Hain AJ, Meserve EE, et al. The value of re-exploration in patients with inadvertently morcellated uterine sarcoma. Gynecol Oncol. 2014;132:360–5.
59. Pritts EA, Parker WH, Brown J, Ollive DL. Outcome of occult uterine leiomyosarcoma after surgery for presumed uterine fibroids: a systematic review. J Minim Invasive Gynecol. 2014;2 [epub ahead of print].
60. Siedhoff MT, Wheeler SB, Rutstein SE, et al. Laparoscopic hysterectomy with morcellation vs abdominal hysterectomy for presumed fibroid tumors in premenopausal women: a decision analysis. Am J Obstet Gynecol. 2015;212:591.
61. SGO Position Statement: Morcellation. Dec 2013. https://www.sgo.org/newsroom/position-statements-2/morcellation. Accessed 10/2014.
62. Brown, Jubilee and board of trustees. AAGL statement to the FDA on power morcellation. 2014. www.aagl.org.
63. Cohen SL, Einarsson JI, Wang KC, Brown D, Boruta D, Scheib SA, Fader AN, Shibley T. Contained power morcellation within an insufflated isolation bag. Obstet Gynecol. 2014 Sep;124(3):491–7.
64. American College of Obstetricians and Gynecologists. Power morcellation and occult malignancy in gynecologic surgery. A Special Report. May 2014.

Part V

Surgical Education and Training



Learning by Doing: How to Teach Hysterectomy

16

Carolin Spüntrup, Marc Banerjee, and Elmar Spüntrup

The Hippocratic oath reminds since more than 2000 years to heal patients to the best of knowledge and to impart knowledge to the next generation. Over centuries history showed that individual ethically and morally understanding as well as motivation for education are adapted to external factors – advantaged by base motives as personal professional advancement or the uncritical acceptance of specific ideologies. Dreadful experiments using living human being were performed and legitimated by the pretended scientific benefit.

Following the ideals medicines should hold for: Medical knowledge is common knowledge – it should be denied neither patients nor younger colleagues. Medical education of younger colleagues must be carried out in an ethically and morally acceptable way and always with the focus on the benefit of patients.

Introduction

For century's surgical education based on a learning-by-doing apprenticeship model using a high patient volume to teach the residency step by step certain surgical skills under various levels of supervision. Mistakes and costs resulting from the trainee's learning curve were accepted by the society [1].

Today a couple of factors limit this traditional model: surgical procedures have become more complex and specified resulting in a reduced patient volume for certain operation morally and ethical aspects came into focus, the acceptance of the society concerning medical mistakes has changed and finally financial aspects especially concerning operation time, complication rate as well as time and costs for a surgical education came more into focus of both, society as well as surgeons (Fig. 16.1) [1].

Several studies analysed the influence of repetition of specific interventions to iatrogenic injury and found an association between number of repetitions and declining injury rate (Fig. 16.2). But also other associations were found correlating to repetition such as operative time, operative result etc. This indicates that repetition is a central factor for the surgeons learning curve and how complex and multifactorial the process of operative learning is.

Considering these factors it seemed likely to establish a new surgical education system which includes a repetitive step by step education of complex operations under ethical, morally and financially more acceptable conditions.

Educational Concepts

The idea to update the traditional apprenticeship-model is not new. Over the past century several proposals were reported how to innovate the traditional system [2]. The American Bord of surgeons complained in 1916 that the traditional apprenticeship model does not result in a broad and well-grounded surgical education respectively the operative quality [3]. To improve surgical education, some American universities introduced surgical education programs including refresher courses in anatomy, pathology, biochemistry and skill training using cadavers and animals before residents performed operations in real patients [3].

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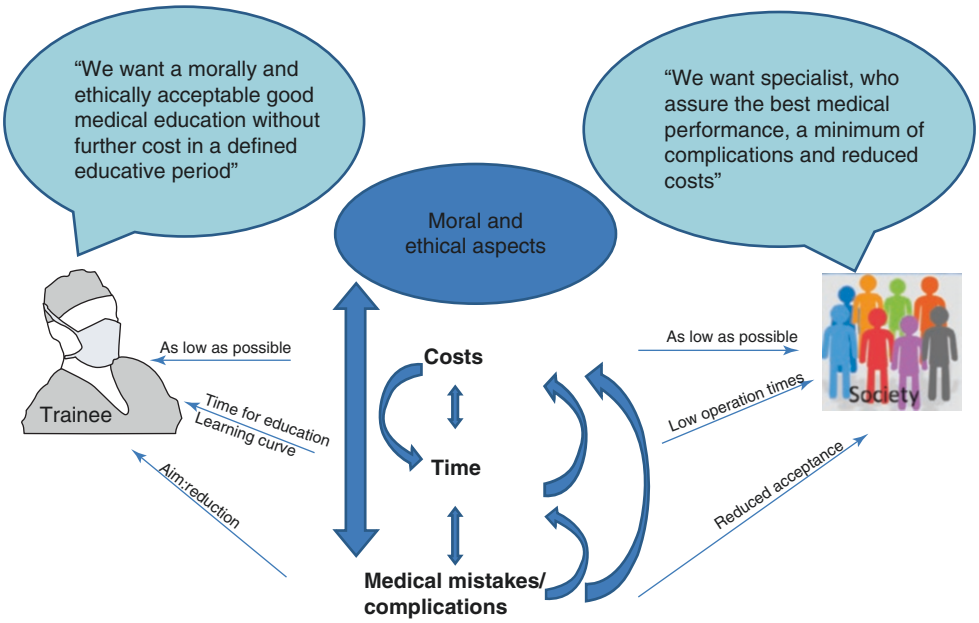


Fig. 16.1 The dilemma of surgical education

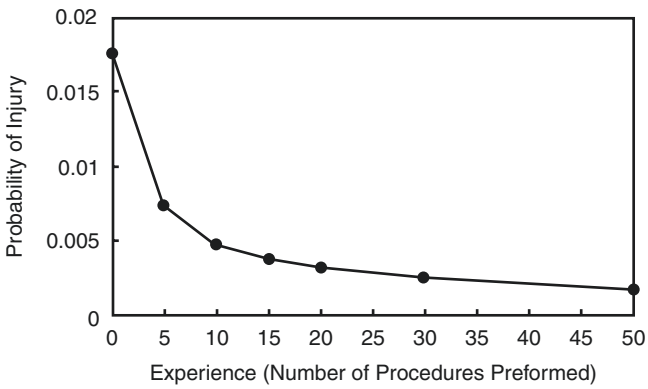


Fig. 16.2 Typical example for the decline of a learning curve. Instead of probability of injury also time for the performance of a specific task could be chosen (compare Fig. 16.4a) (From Rogers et al. [25])

With regard to the success of simulated training for pilots, surgical training in a simulated environment came more into focus and is meanwhile one of the central parts of innovative surgical trainings-models [4, 5]. In pilot trainings difficult situations, e.g. a clear defined storm of certain intensity hits the airplane and induces some damages. The pilot trainee learns how to handle this situation in a simulated, not life threatening environment. By repetition he will develop mental schemes and he will also increase psychic stability to manage these extreme situations in case of real occurrence. Modern findings of behavioral cognitive sciences describe a couple of modifications which can be used as variances to reach specific aims in such pilot trainings-schedules [6]. Theoretically similar schemes could be adopted for a surgeon to handle different situations e.g. the step-by-step training of a routine hysterectomy or a complication occurring during a hysterectomy. Technically it is already possible to simulate a couple of difficult intraoperative situations with some of the existing trainers presented later. In reality for a resident it is still not a routine to train such situations on a simulator [4, 5]. The main difference between education of pilots and surgeons is that pilots *must* undergo trainings units while surgeons do it optional. This is reflected in the fact that airlines bear the expenses for pilot training while surgeons often have to come up themselves for the costs. Surgical admission boards mostly do not demand a participation in simulated training to reach a certain educational level. The associated high costs for the trainees as well as the volunteer status of simulator training are probably reasons why still no widespread educational concept has been accomplished.

Behavioral Sciences and Surgical Training

Behavioral sciences analyzed the complexity of learning in several fields and defined specific terms for learning processes [7]. From a behavioral point of view experts are characterized by cognition in a certain field. Cognition itself is composed of several factors: perception, attention, information processing, information storage (including organization), and then retrieval from long-term memory at the appropriate time as "knowledge" which helps the individual make their decision [5, 8].

Gallagher emphasizes the value of attention for surgical learning [5]. Attention of an experienced surgeon will focus the intraoperative progress searching the best way of operation to minimize the individual patients risks and possible complications while the novices attention is focused –depending on his educational level- on basics, such as anatomical orientation or guiding his instruments etc. [5]. It has been proposed that simulators can help to reach the point where many of the psychomotor skills (e.g. hand-eye coordination) and spatial orientation have been automated. This process is called "shap-

ing" in a behavioral sciences sense. It generates new resources of attention for the trainee [5] and allows the trainee to focus more on learning of the operation steps itself or the management of complications [4, 5]. Figure 16.3 outlines behavioral aspects focusing the aims of surgical learning, the pathways of internalizing and mediums to optimize the processes.

Manual Dexterity

Teachers often subjectively report on talented surgical trainees and it must be contributed that even in the eyes of experienced surgeons some colleagues stick out by performing difficult procedures with a phenomenal ease. Talent in its usual sense meaning a pre-existing manual dexterity seems to be useful but not a precondition to become a good surgeon [4, 5]. For endoscopic knotting and suture techniques it was found that the influence of concomitant factors which might influence the talent of manual dexterity is of less importance (Fig. 16.4a, b) [9]. Only during the first five procedures individuals, who trained their bimanual dexterity before (e.g. by playing guitar, knitting or former endoscopic experience for more than 10 h) but were novices concerning self-performed endoscopic operations, had a significant advantage concerning knotting times. Learning curve improved most remarkably during the first five procedures. Afterwards a kind of steady state is reached without a further significant improvement of knotting time for the individual surgeon and an adaption of knotting times between all individuals is found (Fig. 16.4a, b) [9]. Thus it is proposed

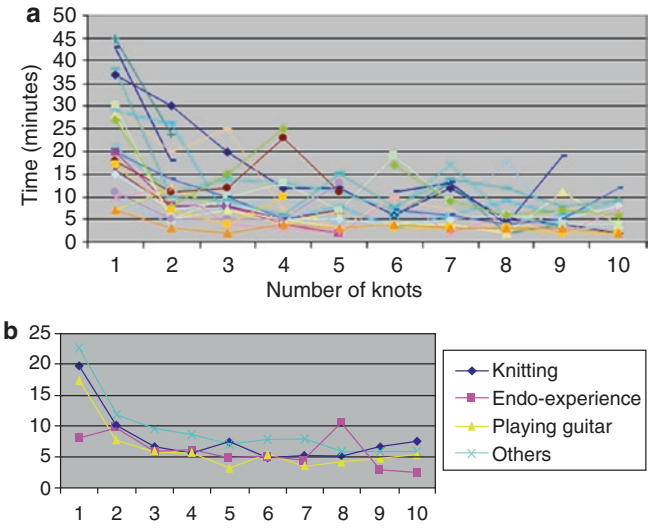


Fig. 16.4 (**a**) Repetions and times of the first 10 knots of novices (each *color lines* one novice). (**b**) Novices, who played guitar, had experience in endoscopic assistance or knitted started on a faster niveau of time for each knot. These findings adapted after 5 knots

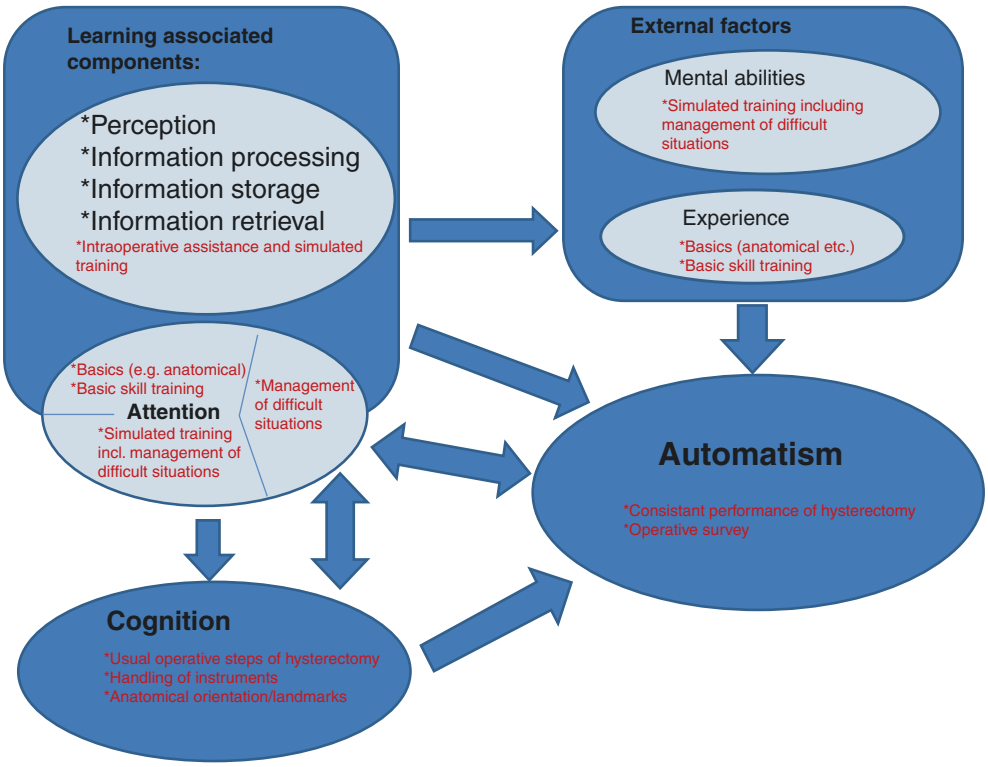


Fig. 16.3 Behavioral aspects of endoscopic learning. In a behavioral sense of learning, automatisms for a specific tasks are the designated learning aim. Several components influence the generation of automatisms. The graphic summarizes the influence of superior components (*black, bold face*), subitems (*black*) and related endocsopical trainings levels (*red*). Attention is a central point for developing automatisms and the focus of attention changes in correlation to the trainees educative level

that surgical manual dexterity concerning knotting is not a specific talent. It can be improved after a few repetitions and interindividual differences will adapt over time.

Gallager and Satana [10] reported about three trials on a virtual reality trainer comparing the surgical skills of novices (no experiences), juniors (10–100 operations) and experts (more than 100 operations). Also in this study surgical basic skills adapted after three trials, but novices and experts showed a very different behavior concerning the instrumental activity: while the experts used electrocoagulation rather conservative and situate adapted, the novices ignored alerts concerning thermic damages and did not change their behavior during the trials. Juniors tried to reduce the use of electrocoagulation after repeated alert [10].

Surgical Trainings-Aims

In accordance to these findings it has been estimated that the performance of a skillfull operation depends in 75 % percent in decision making and only in 25 % in manual dexterity [11]. Correct decisions require a good intraoperative survey and are compound by an excellent fact knowledge and other factors which are summarized under the behavioral scientific term "cognition". This weighting of the factor "decision making" changes former concepts of surgical skill training. Former concepts separated theoretical knowledge and practical skill training depending on individual trainings level. Theoretical knowledge included the theoretical knowledge of anatomic landmark, operative steps etc. The education of practical skills concentrated in exercises for the hand-eye coordination. Not before the performance of operations in living patients both components were united. Newer trainings programs allow focusing on the togetherness of components, fact knowledge and practical training [4, 5, 11, 12]. They respect the complete field that influences intraoperative decisions. Theoretical and practical aspects of operations are thus more joined even on an early educative level (Fig. 16.5).

Accordingly new trainings aims base on a entirety concept focusing both, operation specific practical knowledge (manual dexterity, guidance of instruments, intraoperative details etc.) and theoretical knowledge (anatomical, pathological, bio-

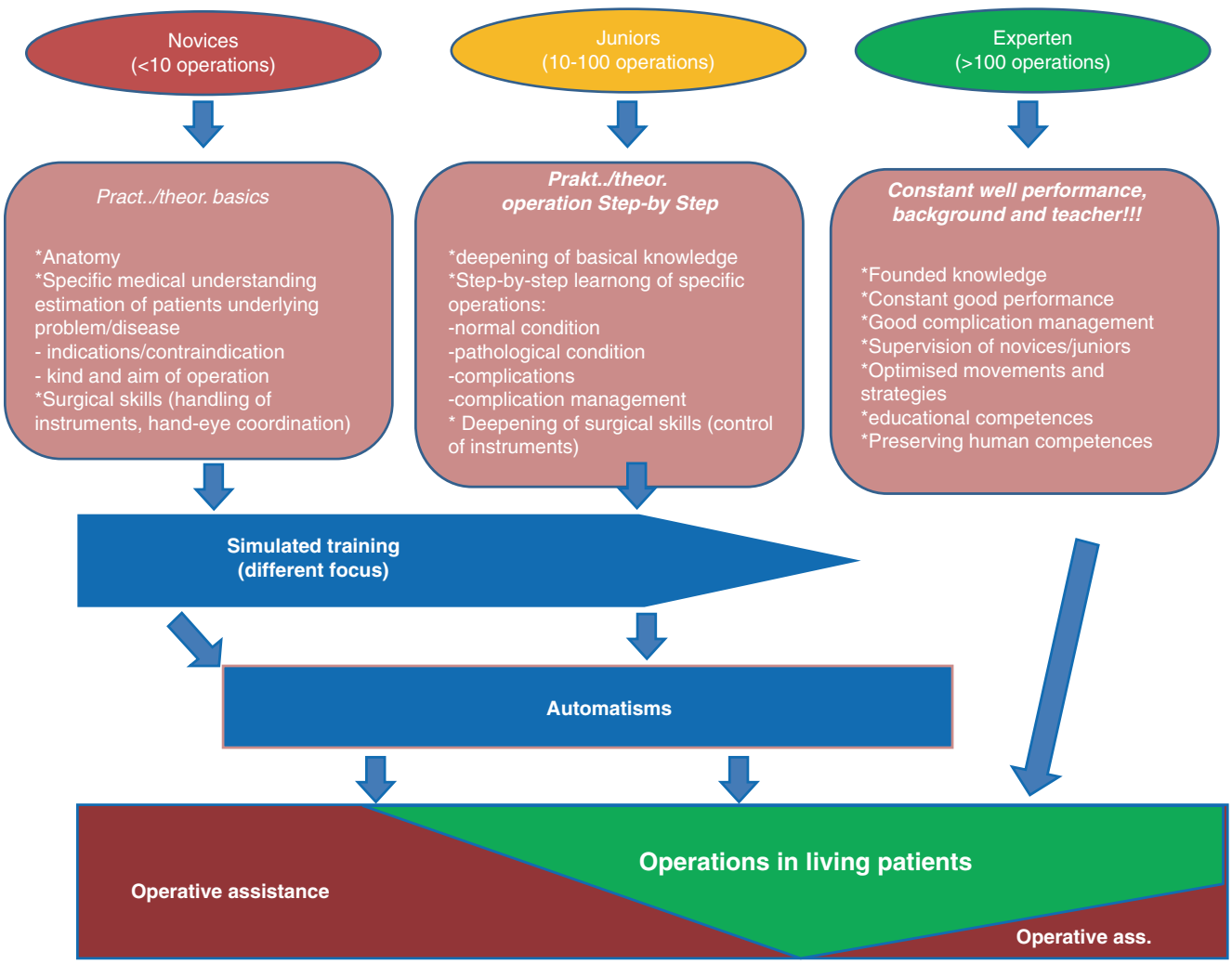


Fig. 16.5 Learning aims of novices, juniors and experts. Simulated training (with different trainings aims) decreases with rising trainings level and generation of automatisms

chemisty, theoretical knowledge on procedure etc). Trainings aims are correlated to the individual trainings level [2, 12–14]. The tripartitude into novices, juniors and experts is a recurrent classification in literature and seems suitable to summarize trainings aims for an entirety concept (Fig. 16.5) [5, 10, 13].

Novices are unexperienced in all respects. For novices trainings aims are the implementation of automatisms concerning basics: anatomical basics, intraoperative anatomical orientation, handling of the surgical instruments, understanding of the aim of the surgical procedure (that means why is the procedure done, how is it done and what is the final aim) [5, 10, 13].

Juniors are low experienced with a beginning survey on operative procedures. Defined subordinated targets can be accomplished. The trainings aims of juniors are the implementation of automatisms concerning the single steps of a certain operative procedure, internalizing specific subordinate targets and the control of instruments. With an increasing experience on the way to become an expert, juniors will also learn automatisms concerning pathological situation, complications and other difficult intraoperative situations [5, 10, 13].

Experts (more than 100 procedures) featured automatisms for operative basics, have a founded knowledge and internalized pathways for many intraoperative situations. Intraoperative movements and activities are optimized, with a clear defined final aim and several sub-ordinate targets, knowing and respecting the consequences of each movement and activity. In case of complications the expert acts more calm and stringent in order to return to the "normal" operative pathway. For the definition of trainings aim the priority aim should be to reach this expert level with optimized and constant performance as well as a reduction of errors [4, 5]. The aims of experts are finally to optimize the education of novices and juniors as well as to supervise operation in real patients and help in case of problems (Figs. 16.5 and 16.6) [4, 5, 12, 13].

Associated Factors for an Optimized Training and Opportunities for Efficiency Control

Concerning an optimized trainings scheme for the ideal implementation of trainings aims the distributed short interval training has been described as more effective than single long sessions. According to behavioral sciences the cognitively implementation of surgical skills is better consolidated, if an interval between training is realized [5, 15]. In practice this means that e.g. a splitted overnight training (afternoon session on one day and morning session on the next day) is more effective than a complete one day training (morning session and afternoon session on the same day).

Feedback mechanisms and similar control respectively test tools visualizing the success of simulated training seem to be useful. The trainee gets information whether he has reached the accomplished trainings aims. Depending on the system mistakes are pointed instantly and can be reduced by repeated training [8, 11].

Test systems additionally provide a good tool for the trainers to assess whether the trainee is able to reach the next level. This can be also used for the award of a certificate. Trainees who verify their ability of successful performance of a specific operation before they start performing supervised operations in real patients will reduce operation time and complication rate in an ethical acceptable way [1, 4, 5, 15]. For the daily routine this could ease the disposition of operators and maybe also benefits the mutual trust between patient and surgeon.

Several predictors have been tested as control systems for the estimation of learning success in simulated trainers. Time is not only influenced by experience but also by quality and is therefore as a single item not a good predictor [5, 16]. The number of required repetitions for a specific task is also not a good predictor. Basically surgical skills are reproductive acceptable after about three repetitions. Concerning more

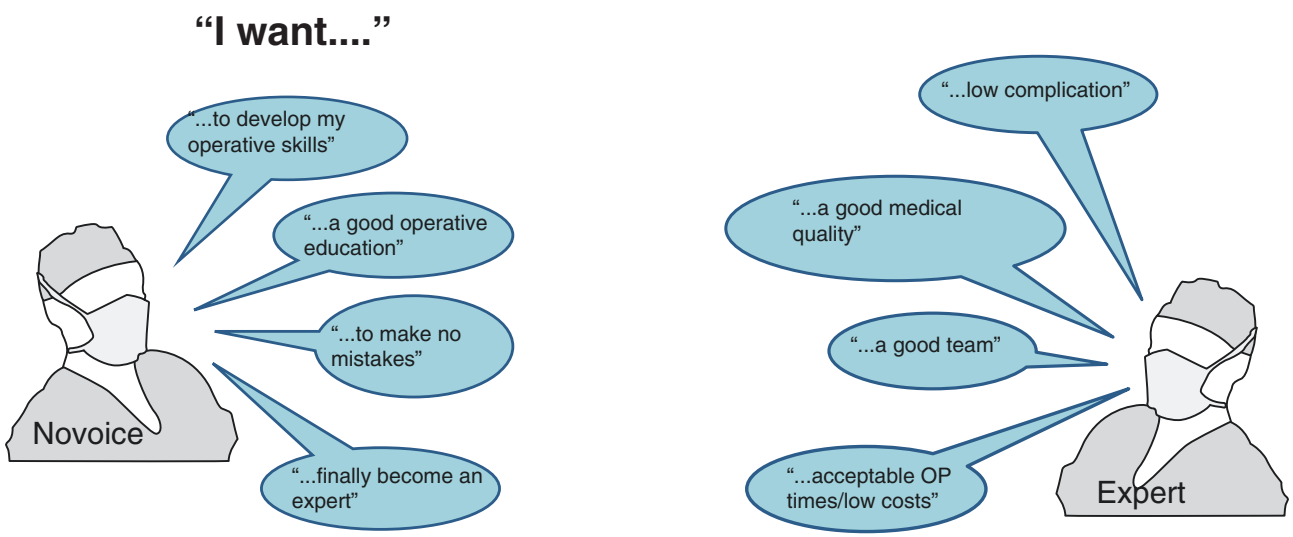


Fig. 16.6 Claims on surgical education from different points of view (pict.: pixabay)

complex tasks (e.g. a complete operative procedure with the need of a more distinguished efficiency control) the number of necessary repetitions depends on the individual trainee and does not reflect the quality of performance in detail. For those complex tasks the achievement of a certain degree of proficiency including a constantly well performance or the evaluation of relevant single items including mistakes is provided to be more useful [5, 13, 17]. Several factors such as the relation between time and accuracy or knowledge and manual dexterity influence the operative result. These factors are difficult to estimate objectively. For that reason predictors ideally should be measurable in any way. For the objective assessment of technical skills performance the economy of hand movements using an electromagnetically tracking system (ICSAD) [18] seems to be appropriate to differ between very experienced surgeons and less experienced surgeons. The system can be also used for open approaches. Other control instruments use more metric systems to objectify the trainee's performance, e.g. measuring the difference between the ideal puncture of a suture and the actual puncture. In combination with other factors (time etc.) a points-based system can be used for evaluation.

Trainings Concepts for Hysterectomy

In accordance to former surgical training systems and respecting behavioral findings concerning cognition, the adoption of an educational system with three levels (surgical basics, practical training on simulators and final education schedules in real patients) seems suitable [5]. The three levels are overlapping and respect the different start levels of trainees [novice, juniors (non-experienced and experienced), expert].

In detail the implementation of levels for a structured hysterectomy education comprises:

Surgical Basics

This educational stadium should be hallmarked by the aims of deepening anatomical, topographical and pathological knowledge of the pelvis minor and adjacent structures, an understanding of biochemical processes, knowledge about correct indications/contraindication for a hysterectomy including judicial consequences, basically management of complications (kind of possible complications, perception of complications, adequate therapy of complications, strategies to avoid complications) and a broad knowledge about the postoperative sequence in general. This stadium should be more than only a recapitulation of students-knowledge. Especially anatomical and topographical knowledge should be specifically considered under the operative aspect, e.g. using certain structures as landmarks, acquire a 3-dimensional idea of the course of the ureter and other structures etc. These aims can be reached by practical assistance and hospitation during operations and indications, refreshing the literature including modern opportunities such as videos, video animations etc. and participation in special courses. Hand eye-coordination and first steps in instruments handling can be improved by the use of simulators.

The stadium of *surgical basics* will have its maximum learning effect during the first years of residency but in fact learning effect of this stadium will attend throughout a doctor's life with a lower intensity and changing focus than during the first few years of surgical education.

Simulated Hysterectomy

Modern surgical simulators can be used to achieve more or less the following trainings aims:

- improvement of manual dexterity (also concerning single steps, e.g. suture of the vagina)
- continuing enlarging experience and fact knowledge (active use of the basic knowledge of stadium I, e.g. concerning the course of the ureter or identification of leading structures)
- induction of schemes and strategies for the solution of difficult situations by repeated hysterectomies in a not life threatening surrounding (e.g. how to handle intraligamental myoma etc.)
- accomplishing the steady state of the learning curve concerning hysterectomy before continuing stadium three
- improvement of operative survey including the knowledge to make quick and correct decisions
- making correct valuations of intraoperative findings (e.g. the valuation of endometriosis)
- finding strategies concerning prevention respectively management of iatrogenic complications
- performing examinations to verify certain levels of certification

It becomes feasible that the differentiation into novice and junior is important for the trainings aims of this level. Simulators are an effective tool for both group, but with a different focus. While the novice can improve his knowledge concerning intraoperative anatomical orientation, control on the surgical instruments, understanding of the aim of the surgical procedure (that means why is the procedure done, how is it done and what is the final aim), juniors will deepen their

skills concerning the implementation of automatisms concerning the single steps of a certain operative procedure, pathological situation, complications and other difficult intraoperative situations.

Most hospitals possess on box trainers so trainees have the opportunity to learn certain steps such as knotting/ suturing as well as the handling in general. Anatomical models of the pelvis are also often available and partly even integrated in the box- trainers. These trainings tools allow an advanced anatomical and topographical education. The complete imitation of hysterectomies, ideally with a simulated sick uterus (e.g. uterus myomatosus), will be more a subject of courses in specialized training centers, but at present the costs of such courses must be mostly beared by the trainee himself. It is of high importance, that – according to the pilot training- these specified courses focus on clear defined education aims which can be realistically achieved by the trainee during the course. Otherwise courses will only lead to a certificate- without a real surgical use to the trainee or finally to the patient!

The participation of courses in such institutions should be integrated part of this stadium. Several courses concerning hysterectomy are available focusing on different educational aims, e.g. deepening hysterectomy-specific anatomical and topographical knowledge (human cadaver courses), training of hysterectomy steps in general (hysterectomy of living porcs), advanced training of hysterectomy with simulation of different uterine diseases (intraligamental myoma, large uterus myomatosus, endometriosis etc.; Realsimulator), test instruments for estimation of surgical skill level (computer assisted systems). The different trainings systems will be précised later.

Training in Patients

In this educational stadium the trainee will continue his surgical hysterectomy education in real patients. In contrast to the traditional system the trainee will start making hysterectomies on a higher education level. That means that he has reached already a certain steady state of his learning curve and his attention can be focused on the essentials of hysterectomy. Combined with the supervision of an experienced surgeon a preferably simple hysterectomy (normal weighted patients without expected adhesions or complications) can be chosen. In case of any complication the experienced surgeon can either guide the trainee throughout the operation or can take over the hysterectomy. According to trainings-degree supervision by an experienced surgeon can be reduced step by step and degree of difficulty of the sick uterus can be elevated step by step until the trainee has reached a level to take the full responsibility even for expected difficult hysterectomies.

Training Systems

Several training modules are available today and it is difficult to get an overview about all existing systems. According to Munro et al., the division into organic (that means human cadavers or animals) and inorganic trainers (others) is adopted here and complemented by combined organic/inorganic trainers [1].

Most trainings systems have been developed for unspecific surgical intervention such as hand-eye- coordination or suturing techniques. With a new focus on surgical survey and the induction of automatisms for intraoperative decision making as trainings aims, the simulation of complete operations seems useful. Such high complex training systems have been developed for open abdominal, vaginal or endoscopical approach opportunities and offer theoretically a couple of interventional possibilities [19, 20]. These training systems partly allow the performance of “complete” operative procedures, such as access to operative field, specific operations and reconstruction of abdominal/vaginal wall. In practice these simulators are very expensive and most of the patented simulators obviously have not been produced in a broad mass.

Other simulators consist on vessels as well as on nerve simulations, so even defined complications are possible. The operative procedure itself is mostly simulated by the use of animal organs. For the simulation of surgical operations porcine gall bladder or porcine intestine are common used trainings-objects [1, 4, 5]. Porcine gall bladder and adjacent structures allow a realistic simulation of gall bladder extirpation including preparation of bile duct etc. Porcine guts system is favorited as trainings –tool for a couple of surgical interventions (resections, enteroanastomosis, use of staplers, suturing and knotting, endoscopic resections etc.) [1, 4, 5]. Simulators which allow the use of animal organs offer special equipment for fixation of the focused structures.

As the organic simulators are associated with some disadvantages (unpleasant odor, explanation of organs, no planned pathologies) during the last decades inorganic trainings moduls came more into focus. Concerning hysterectomy such simulators are still rare.

In the following section we give an overview over the existing training systems, which can be used to improve surgical skills regarding hysterectomy. Also a short interpretation is given for which purpose or trainings aim the presented systems are fitting (Table 16.1).

Table 16.1 Characteristics of different endoscopic trainings and education levels

	Anatomical/pathological details	HE simulation	Hand eye coordination	Infectious	Ethical vote	costs	Proportion HE: trainee	Planned Pathologies	Tests for certificates
Human Cadavers	Very good	+ (o,e,v)	+	Risk	(Agreement of patient)	++	1:3	Not planned	No
Living pigs	Partly comparable	+ (o,e)	+	Low risk	Yes	+++	1:3	Not planned	No
Box trainers	Not at all	–	+	Low risk	No	(+)	–	–	Yes
Advanced Trainers	Partly comparable - good	+ (o,e)	+	No	No	++	1:1	Partly yes	Partly yes
VRT	Very good if programmed	+ (e)	+	No	No	++++	1:1	Yes	Yes
Real Simulator	Good	+ (o,e)	+	Very low risk	No	++	1:1	Yes	Yes

Organic Trainers

Organic simulators are in common human cadavers or animals.

Human cadavers have been used as a teaching tool for centuries. Learning aims of hysterectomy courses using human cadavers are focusing on a recapitulation and deepening of anatomical and topographical details around the operated field on the one hand and the possibility of performing the steps of a hysterectomy on the other hand. The simulation of a hysterectomy is possible in all variations (vaginal, open abdominal, endoscopical, supracervical or complete etc.). Operative access is comparable to living patients. In general two to three persons learn on one human cadaver. Therefor not all trainees will perform a complete hysterectomy during the courses. A vascular perfusion of the cadaver to imitate blood flow is in most cases not realized. Nevertheless coagulation, ligation, sutures, morcellations , incisions and other steps, which are important during hysterectomy are similar to a real hysterectomy. Pathologies in the operative field can be used as a welcome special challenge during the course, but they cannot be planned.

Formaldehyde-based fixation techniques are not appropriate due to the rigid consistency of pelvic organs and abdominal wall and, thus, have to be replaced either by alternative fixation methods or the use of fresh frozen cadavers. Fixation procedures providing good conditions to perform open abdominal or laparoscopic procedures include embalming techniques based on ethanol-glycerin or Thiel fixation [21, 22]. Although the tissue properties (e.g. color, water content, consistency, mobility) still differ from the in-vivo situation, virtually all surgical procedures including the use of electrocautery and ultrasound devices are feasible applying these alternative fixation methods. Decision making, acquire operative survey, guidance of assistance as well as single steps (appropriate use of coagulation, preparation, sutures, hand eye-coordination etc.) are trainings aims which can be learned using this setting. Disadvantages of the use of human cadavers are the risk of transferring certain infections during the procedure and the partly unpleasant odor. The transvaginal access is sometimes limited either by natural factors as the higher age at the time of death (associated with narrow and thin walled vagina) or by a certain disgust of the trainees.

Simulation on Animals

Animals, either living or death, were used for medical learning and education purposes since antiquity. Claudius Galenus performed a couple of sections in different animals (e.g. neurolysis in pigs, study of organs in elephants).

For hysterectomy trainings the uterus of pigs seems to be most qualified, as the size and adjacent structures are tolerably comparable to real patients. Operations on living pigs allow a perfusion of the uterus, which makes the operation more realistic. Haptic, color, admittance (at least open abdominal or endoscopic) are similar to operations in real patients. All intraoperative steps including admittance, complete steps of hysterectomy and closing the admittance are possible.

Decision making, acquire operative survey, guidance of assistance as well as single steps (appropriate use of coagulation, preparation, sutures, hand eye-coordination etc.) are trainings aims which can be learned using this system. In living pigs the trainee gets a comparable intraoperative feedback concerning his operative behavior (e.g. via the anesthesist etc).

Limiting factors are the necessity of a positive ethical votum for each course and the high costs of each pig. In living pigs for ethical reasons pigs must get a general anesthesia. In most courses two to three trainees will operate one pig, so not all participants will operate a complete hysterectomy themselves. In general, animals will die after operation. Pathologies cannot be planned. Anatomic and topographic details are only partly comparable to human beings. The risk of zoonosis exists, but is small.

Inorganic Trainers

Inorganic trainers can be divided into classical box trainers, advanced trainers and virtual reality systems (VRT) with the subgroup of robotic assisted VRT's. Most inorganic trainers refer more to the endoscopic approach, but also allow at least an open abdominal access. Some trainers are even equipped with a vagina.

Box Trainers (Fig. 16.7)

Classical box trainers are characterized by a kind of box covered by an exchangeable layer, which simulates the abdominal wall. The box includes possibilities for fixation of artificial layers, structures or even simulated organs. Box trainers are widespread trainings tool and are available in most hospitals. In general they are not associated to a certain operative field. Thus trainee can learn basic steps such as admittance, hand-eye coordination, instrument handling or knotting and suture techniques.



Fig. 16.7 Box Trainer and fitting inlay for hand-eye coordination and suture -knitting skills (By courtesy of Erler-Zimmer)

Advanced Trainers

Advanced (endoscopic) trainers allow the fixation of operative inlays for specific operations. Some endoscopic advanced trainers are additionally equipped with USB connections to overcome the problem of optical system. Genuine endoscopes are no longer necessary to learn on the simulator but it is possible to adapt the integrated camera e.g. to the own computer or laptop. Often a mannequin form is chosen with openings on the upper or lower abdomen. Access ports are either determined or can be chosen free on a complete flexible abdominal wall. Operative inlays consist on all important structures and landmarks which are necessary for specific operations. Inlays are rather expensive, but often two or three organs with pathologies (uterus, ovarian cyst, ectopic tubal pregnancy) are simulated. After operation(s) inlays must be rejected. They can be changed easily and are fixed by a kind of click-in system. They are made completely from inorganic material. This lightens storage.

Concerning hysterectomy very less simulators have been described using artificial tissue (e.g. a kind of special foam) to simulate organs and structures. Hysterectomy steps including preparation, cutting, sutures etc. are realistically possible to a certain degree. Some systems allow even the simulation of pathologies such as myoma etc.

Decision making, acquire operative survey, guidance of assistance as well as single steps (preparation, sutures, hand eye-coordination etc.) are trainings aims which can be learned using this system. The use of additional training success tool gives the trainee feedback concerning his operative behavior and allows also evaluating the success of learning.

Disadvantage of the systems is that they are not aligned for electrocoagulation or HF surgery. No coagulation of prefunded vessels or electric surgery procedures on tissue (monopolar cutting, sealing etc.) is possible. Additionally the systems are rather expensive for the daily clinical use and therefor more useful in courses.

Virtual Reality Trainers (Fig. 16.8)

During the last decade for endoscopic procedures a new generation of computed based simulator has been introduced. Simplified virtual reality trainers are comparable to a wii system, using detectors and microprocessors to convert the surgeon instruments movement into an imaginative movement on the monitor. The underlying imaginative computerized matrix is very realistic and bases on real happened cases.

In first systems sometimes leaps in time or mistakes in converting the surgeons movements occurred which were meanwhile reduced.

Virtual reality trainers have a large potential, as already every operation and complication can be simulated. Additionally operations can be performed only by the trainee without the need of assistance. Additionally specific hand eye coordination tools are available.

All procedures which are necessary during hysterectomy such as preparation, cutting, sutures, electrocoagulation, monopolar cutting, sealing etc. are theoretically possible, but must be implemented by the codes.

Decision making, acquire operative survey and single steps (appropriate use of coagulation, preparation, sutures, hand eye-coordination etc.) are trainings aims which can be learned using this system. The use of additional training success tool gives the trainee feedback concerning his operative behavior and allows also evaluating the success of learning.

A great problem is the lack of haptic. The development of a haptical feeling is a relevant factor for a trainee. Newer systems implemented codes for a kind of haptical feeling but there is still no solution to copy the original feeling in all situations during the operation.

A further disadvantage is that the coded systems only allow defined steps of the trainee. That means, that the system answers with a programmed displacement activity in



Fig. 16.8 Virtual Reality Systems: (**a**) LapSim® Haptic System, (**b**) LapSim® Non-Haptic System, (**c**) LapSim® virtual hysterectomy., LapSim® Laparoscopic Trainer (Source: LapSim®)

case of movements of the trainee, which have not been programmed. So an accidental injury of a gut during a hysterectomy is not possible and the gut evades, if the simulated operation has not been coded for the complication "injury of guts".

The fact that in some systems no further assistance is necessary seems to be positive on the first sight. Regarding the trainings aim of intraoperative survey it must be contributed that also the guidance of an intraoperative assistance is a relevant factor and should be trained.

Further disadvantages are the high costs for the systems, which are reasoned in the developing cost for the different tools.

Summarizing virtual reality trainers are at present not seen in the first line of simulated training for novices. They are rather used as control instruments of trainings success in specialized courses. If all "teething troubles" including the lack of haptic will be overcome and a really broad spectrum of intraoperative courses including spontaneous induced complications can be realistically simulated, this system could be the surgical counterpart of simulators for pilots.

Integrated Virtual Reality Trainers in Robotic Assisted Surgical Systems

During the last decade robotic assisted surgical systems have been introduced also for hysterectomy. The robotic assisted surgical systems are in general featured with an integrated virtual reality trainer. These "robotic" VRT's focus on the one hand in general skill training and on the other hand on a training to optimize the use of all function which are provided by the robotic system.

Moglia et al. published in 2015 a review comparing the different VRT's of robotic systems concerning general skill training and skill transfer to robotic operation.

They found in all analysed systems a realistic simulation, which made the tool usable and useful for the trainee, but trainings tools are not standardized at all [23]. Robotic VRT's are a useful tool for bimanual wristed manipulation, camera control, master clutching to manage hand position, use of third instrument arm, activating energy sources, appropriate depth perception, and awareness of forces applied by instruments for surgeons who intend to use robotic systems [24].

Concerning the items of general skill training and especially on simulated hysterectomy no additional facts than those of VRT's have been reported.

Combined Organic/Inorganic Trainers (Fig. 16.9)

Combined trainers are characterized by the combination of advantages of organic trainers such as the possibility of electrocoagulation or perfusion with advantages of inorganic trainers such as reproducible simulation of pathological conditions. By the combination of both components the realistic simulation of a couple of operative steps is optimized and l a realistic haptic is given [15]. Additional hand-eye-coordination tools are available.

In a certain way box trainers with the fixation possibility for organic parts of animals can be considered as precursor of combined trainers but the characteristic difference is that pathologies cannot be planned and that they are not exactly reproducible. In a real combined trainer organic structures are not used in its entity but only components of organic origin are processed to create reproducible artificial pathological organs. According to bionic sciences characteristics of organic material is analysed and useful components for each operative step are composed until a fully functional simulation of a certain operation is created. The organic parts are often by-products of vegetable, meat or fish processing.

The Gynecological Real Simulator (GRS) system is a combined trainings tool for frequent gynecological operations (hysterectomy, ovarian surgery, endoscopic descensus surgery and anti-incontinence procedures). The unit consists of three parts:

1. The Gynecological Real Simulator
2. Pelvic models
3. Operation-specific inlays

The Real Simulator imitates a female torso. It consists of a closable opening on the lower abdomen, a vaginal opening and smaller holes for connection of equipment (e.g. perfusion). Endoscopic equipment is introduced via four defined areas on the classical introduction places. The pelvic models are scaled to the GRS and are fixed by bolted connections. Pelvic models are specific for the simulation of defined operations so different pelvic models are available (hysterectomy model, ovarian cyst model, descensus model, anterior compartment model). An additional basic-skills model is available, using classical tools for hand eye-coordination and handling of instruments .

Pelvic models consist of all structures which are important landmarks for the specific operations. Depending on the trainings aim learning success tools as well as perfusion or the possibility for the use of electrocoagulative instruments are possible.

The operative area of the pelvic models is recessed for the according inlays and provides fixation mechanisms for the inlays. The inlays are the centerpiece of the simulated operations. They simulate specific operations as realistic as possible, can be changed easily by a click-in system and are thrown away after operation.

For a simulation of a hysterectomy using the GRS system additional to the GRS a hysterectomy model and appendant inlays are necessary. The hysterectomy model consists on the pelvic bone ring, a flexible pelvic floor, sigma and rectum, bladder, ovaries, tubes, Ligg. Suspensorium, ureters, fatty tissue and peritoneum. All structures are hardly inflammable and are resistant to a certain level of transmitted heat resulting by the use of common electrosurgical instruments. The model itself can be cleaned with water and a mild cleaning agent.

The hysterectomy inlays can be fixed easily by a click-in system. Perfusion lines must be connected. If monopolar instruments are intended to use, a neutral electrode must be fixed on the inlay. Different hysterectomy inlays with an increasing degree of difficulty are available (normal uterus, uterus with intraligamental myoma, large uterus myomatosus, attached gut/endometriosis). All inlays of one category (e.g. large uterus myomatosus) are exact reproducable. Hysterectomy inlays allow all relevant operative steps including preparation, coagulation, monopolar cuts, use of slings, sealing, morcellation, sutures etc. and are thrown away after operation. Decision making, acquire operative survey, guidance of assistance as well as single steps



Fig. 16.9 Combined System, Real Simulator (GRS): (**a**) Closed Real Simulator System; (**b**) Opened Real Simulator System with adapted pelvic model; (**c**–**g**) Hysterectomy inlay during a trainings session. (**c**) artificial hysterectomy trainings inlay, (**d**) dissection of round ligament, (**e**) separation of broad ligament layers and preparation, (**f**) exposure of uterine vessels, (**g**) dissected uterine vessels (after coagulation, not shown) (Courtesy of Pelvic School Saaarbuecken)

(appropriate use of coagulation, preparation, sutures, hand eye-coordination etc.) are trainings aims which can be learned using this system. The use of additional training success tool gives the trainee feedback concerning his operative behavior and allows also evaluating the success of learning.

Disadvantages are the necessity of unfreezing inlays before use. Connection of vessels, neutral etc. is associated with a lead time of about 15 min.

Outlook

An educational concept for hysterectomy basing on three levels (surgical basics-simulated training-hysterectomy in patients) seems suitable and complies ethical and morally requirements. It allows trainees to graduate their individual educational niveau and helps defining trainings aims which should be focused next. Concerning simulated training, trainings aims should be clearly defined in order to choose the optimal simulated trainer for the focused aim. The financial aspect of simulated training cannot be resolved finally. The costs of simulated training are high and correlate to the technical and scientifically effort. A structured education, at least for the second level, in trainings-centers seems more appropriate than an individual, self-ministered training in each hospital. Maybe the wide spread implementation of structured trainings-programs will help to come closer to a conceptual medical counterpart of pilot training.

Tools for learning success as a basis e.g. for a hysterectomy certificate are an interesting vision. A certificate verifying a defined trainings level as precondition for operation in real patients would give patients who undergo hysterectomy the feeling of security and could simplify the clinical daily routine for trainees and trainers.

References

1. Munro MG. Surgical simulation: where have we come from? Where are we now? Where are we going? J Minim Invasive Gynecol. 2012;19(3):272–83.
2. Fried GM, Feldmann LS, Vassiliou MC, Fraser SA, Stanbridge D, Ghitulescu G, Andrew CG. Proving the value of simulation in laparoscopic surgery. Ann Surg. 2004;240:518–25.
3. Smyth CM. Graduate surgical training in America. Ann Surg. 1945;121(6):793–802.
4. Gallagher AG, Lederman AB, McGlade K, Satava RM, Smith CD. Discriminative validity of the Minimally Invasive Surgical Trainer in Virtual Reality (MIST-VR) using criteria levels based on expert performance. Surg Endosc. 2004;18(4):660–5.
5. Gallagher AG, Ritter EM, Champion H, Higgins G, Fried MP, Moses G, Smith CD, Satava RM. Virtual reality simulation for the operating room: proficiency-based training as a paradigm shift in surgical skill training. Ann Surg. 2005;241(2):364–72.
6. www.faa.gov/regulations_policies/handbooks_manuals/aviation/risk_management_handbook/media/rmh_ch02.pdf
7. Fitts FM, Posner MI. Human performance. Belmont: Brooks/Cole Publishing Co; 1967.
8. Esysenck M, Keane M. Cognitive psychology: a student handbook. Hove: Erlbaum; 1995.
9. Banerjee C, Cosentino M, Hatzmann W, Noé KG. Endoscopic intracorporal knotting and suture techniques: talent or experience? Gyn Surg. 2010;7:16_4.
10. Gallagher A, Satava R. Virtual reality as a metric for the assessment of laparoscopic psychomotor skills: learning curves and reliability measures. Surg Endosc. 2002;16:1746–52.
11. Spencer F. Teaching and measuring surgical techniques: the technical evaluation of competence. Bull Am Coll Surg. 1978:9–12.
12. Hier und heute Reportage 2010 (“nähkurs für ärzte”).
13. Ritter E, McClusky D, Gallagher A, et al. Objective psychomotor skills assessment of experienced and novice flexible endoscopists with a virtual reality simulator. J Gastrointest Surg. 2003;7:871–8.
14. Club TSS. The learning curve for laparoscopic cholecystectomy. Am J Surg. 1995;170:55–9.
15. Spüntrup C, Noé GK, Spüntrup E. Lernprogramme in der Gynäkologie: learning by doing – aber bitte erst am Modell. Der Frauenarzt. 2012;53(10):952–7.
16. Hanna G, Frank T, Cuschieri A. Objective assessment of endoscopic knot quality. Am J Surg. 1997;174:410–3.
17. Gallagher A, Richie K, McClure N, et al. Objective psychomotor skills assessment of experienced, junior, and novice laparoscopists with virtual reality. World J Surg. 2001;25:1478–83.
18. Darzi A, Smith S, Taffinder N. Assessing operative skill. BMJ. 1999;318:887.
19. Patent Henrickson D. Bellezzo F. US 2014/0072941 A1, Mar 13, 2014.
20. Patent WO 2011/046606 A1 (MIYAZAKI DOUGLAS W US) 21. Apr 2011 (2011–04-21).
21. Hammer N, Löffler S, Feja C, Sandrock M, Schmidt W, Bechmann I, Steinke H. Ethanol-glycerin fixation with thymol conservation: a potential alternative to formaldehyde and phenol embalming. Anat Sci Educ. 2012;5(4):225–33.
22. Hammer N, Löffler S, Bechmann I, Steinke H, Hädrich C, Feja C. Comparison of modified thiel embalming and ethanol-glycerin fixation in an anatomy environment: potentials and limitations of two complementary techniques. Anat Sci Educ. 2015;8(1):74–85.
23. Moglia A, Ferrari V, Morelli L, Ferrari M, Mosca F, Cuschieri A. A systematic review of virtual reality simulators for robot-assisted surgery. Eur Urol. 2015;69(6):1065–80. doi:10.1016/j.eururo.2015.09.021. S0302-2838(15)00929-X. [Epub ahead of print].
24. Liu M, Curet M. A review of training research and virtual reality simulators for the da Vinci surgical system. Teach Learn Med. 2015;27(1):12–26.
25. Rogers DA, Elstein AS, Bordage G. Improving continuing medical education for surgical techniques: applying the lessons learned in the first decade of minimal access surgery. Ann Surg. 2001;233:159–66.

Communicative and Ethical Aspects of the Doctor-Patient Relationship in Extreme Situations

17

Ibrahim Alkatout

Introduction

A doctor's actions constitute the very core of the medical profession. A doctor's actions are, by their very nature, unique, unrepeatable, and irrevocable. The element of irreversibility and constant contact with the patient's biological existence impose an enormous burden of responsibility on the doctor's actions [1]. The residual lack of safety and uncertainty, which cannot be eliminated despite most recent discoveries in medical science and technology, still make it almost impossible for the doctor to guarantee the success he/she intends to achieve [2]. The general purpose of a doctor's actions is to cure an ill person. This includes the prevention of disease as well as its cure, the patient's rehabilitation, palliation, the diagnostic procedures required for these measures, and their consequence, which is the treatment [2]. In order to ensure that the treatment addresses the specific disease as well as the patient's right to individual care, the patient must be viewed in his/her entirety at all times. A successful doctor-patient relationship can be learned and applied in all fields of medicine.

The Doctor-Patient Relationship Is the Basis of All Fields of Interaction

A positively perceived and productive relationship between the doctor and the patient is primarily based on the following three basic attitudes: *empathy* (sensitivity), *congruence* (authenticity) and absolute (unconditional) *esteem* [3].

Assuming that the diseased patient is a self-determined individual, his/her autonomy is in no way reduced by the loss of his/her physical integrity. The doctor and the patient are partners with equal rights; each of them has specific competences and responsibilities.

Empathy

Empathy may be defined as understanding the emotional and cognitive processes of another, the ability to recognize a person's conflicts, feelings and attitudes, and be able to experience the emotions of another [4].

The doctor should, in lieu of the patient, be able to put the latter's feelings into words and determine the patient's needs, which the patient himself/herself may not yet be fully aware of. These processes occur at the emotional and intuitive level in the form of empathy, as well as the cognitive level in the form of comprehension. The therapist's ability to identify himself/herself with the patient for a limited period of time enables the therapist to share the patient's experience. Gestures, facial expression, body posture, the speed of talking, the tone of voice, and other features of non-verbal communication trigger empathy in the interacting partner [5]. Thus, empathy is also an attempt to understand the reasons for another's actions and opinions, based on the latter's view of the world and horizon of experience (Fig. 17.1) [6].

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Fig. 17.1 Authentic empathic setting in preoperative counseling based on congruence and esteem

Congruence (Authenticity)

Congruence (authenticity) refers to the therapist's attitude: he/she is entirely sincere towards the patient, without any deception of himself/herself or the patient. The doctor is aware of his feelings at all times and can communicate these to the patient if necessary [4].

Thus, the doctor-patient relationship incorporates the therapist's authentic communication towards the patient. Authenticity refers to everything the doctor feels and experiences, those parts of his/her feelings and experiences he/she is aware of, and those parts he/she eventually communicates. Thus the therapist is able to access his own thoughts and feelings towards the client and the therapy situation [7]. The therapy principle of authenticity makes it necessary for the doctor to render his identity (which differs from that of the patient) transparent to the patient, answer questions sincerely, and seek opportunities to face the patient and communicate with him/her [7, 8].

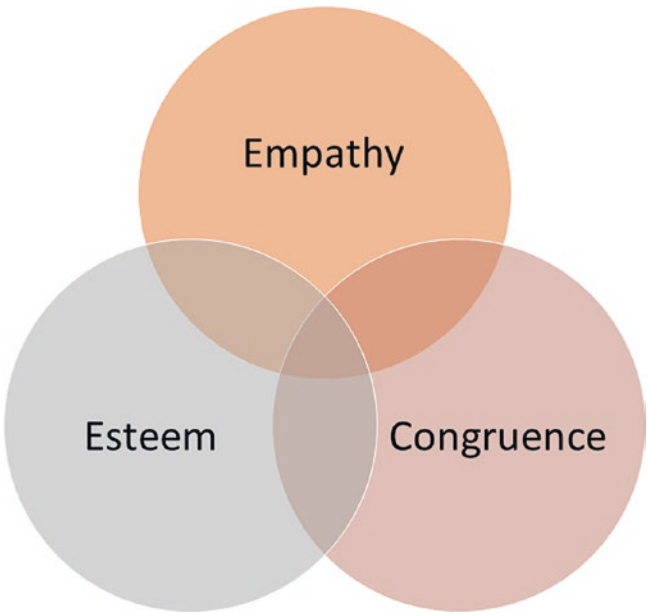


Fig. 17.2 The doctor-patient relationship is the basis of all fields of interaction. It is founded on the three cornerstones of empathy (sensitivity), congruence (authenticity), and absolute (unconditional) esteem

Unconditional Positive Esteem (Unreserved Acceptance)

A relationship of unconditional positive esteem is marked by trust, appreciation and respect; these qualities form the foundation of the doctor-patient relationship [8].

The patient is welcomed and accepted, independent of what he/she says and how he/she behaves at the present time. This unrestricted acceptance is incompatible with an attitude expressing judgment, dislike or disapproval, or even a selectively expressed esteem of another (depending on the contents of the conversation). Unconditional acceptance consolidates the therapeutic relationship, promotes one's experience of self-respect, and mobilizes the patient's own resources. The doctor focuses his entire attention on the patient and confirms the patient's ambitions by acknowledgement, encouragement, and expressions of solidarity and concern. The patient's communication is accepted exactly as expressed by the patient, and is not questioned further [8]. This gives the patient the certainty he/she needs in order to fully experience his/her feelings at the moment, although the therapist is still obliged to align his/her experience to his/her values [5] (Fig. 17.2).

Creating the Doctor-Patient Relationship

The doctor's professional rule of conduct has existed since the antique ages of medicine: *primum non nocere* (above all, you should do no harm).[1] The principle of *Nonmaleficience* or prevention of damage is, in addition to the *patient's autonomy*, the *patient's wellbeing* and *justice*, one of the four ethical guiding principles of decision-making by a doctor. The art of ethical judgement is derived from a balance of these four basic principles: dispensing with harmful interventions (*primum non nocere),* respecting the patient's self-determined decision (*voluntas aegroti*), ensuring that any medical measures serve the preservation and improvement of the patient's mental and physical health (*benevolence)*; and being just in one's actions (*fairness*) [9, 10]. The four principles incorporate a number of explicit, implicit and potential standards, which may contradict each other in many ways but result in a coherentistic approach in terms of application [9, 11, 12].

Self-Determined Decision (The Patient's Autonomy)

The term autonomy is derived from the Greek words *autos* (self) and *nomos* (law, rule), and means self-legislation or self-determination. It was initially used to express the self-determination and self-government of independent city states of the antique period. Kant regarded the autonomy of practical reason as the commitment of human will – driven by the legitimate categorical imperative – to assign greater importance to unconditional obligation than to primordial intentions.

Preconditions for autonomous decisions are the following:

1. *Awareness*: Being able to understand the issue in question
2. *Competence*: The ability to inspect, judge, and make decisions; in other words, to be competent
3. *Freedom*: To make one's decision without the controlling influence of another, and also implement one's decision.

In the medical context, autonomy is the ability to act freely in regard of one's own mental and physical matters. The contrary term *heteronomy* refers to dependence and external determination. Promotion and restoration of one's ability to exercise self-determinism is one of the major goals of medical action [13]. Respect for autonomy, in its minimal form, is expressed as respect for the basic rights of the patient. The relationship between the doctor and the patient must ensure asymmetry between action and suffering on the one hand, and symmetry of self-determinism and freedom of action on the other [14]. The doctor-patient relationship is outlined in three basic models: (1) *Paternalistic model*, (2) *Contractual or Client Model*, and (3) *Partnership model*. External influences exist due to secularization, economization, and technological developments in medicine on the one hand, and the changing values of our pluralistic society on the other. The diverse and variable *models of relationship* differ especially in regard of the criterion of trust and the actual degree of patient autonomy in the respective interaction. We are concerned with the communication requirements to be fulfilled by the doctor [15, 16].

Techniques of Conducting a Doctor's Conversation with the Patient from the Viewpoint of Autonomy

The core aspects of a successful conversation conducted by the doctor with the patient include, above all, active listening, determining the structure of the conversation, as well as identifying and resolving difficult patterns of interaction.

1. Active listening. Techniques of active listening are summarized in Table 17.1.
2. Determining the structure of the conversation. *Transparency* is a basic instrument for structuring the conversation and adhering to the time frame. This includes transparency of the elements of the conversation, such as providing information about the steps of the treatment, the necessary medical informatioin, and informing the patient as to why a step is being performed. The transparency of basic conditions includes informing the patient about potential disorders and the time frame of the conversation. Transparency concerning the individual phases of the conversation enables the patient to differentiate between doctor-centered and patient-centered sections of the conversation.

The conversation can be reflected on and corrected through *metacommunicative statements*. Metacommunicative statements concern the content of the conversation, the style of conversation, the positions of those conducting the conversation, and problems in the doctor-patient relationship.

3. Identifying and resolving complex patterns of interaction. Harmonious communication patterns are oriented to the anticipated reactions of one's counterpart. This calls for a

[1]The dictum is attributed to the Roman physician Scribonius Largus, court physician of the emperor Tiberius Claudius Nero Caesar Drusus who ruled Rome around 50 A.D. A similar phrase is also found in the Corpus Hippocraticum (Epidemics, Book I, Section XI).

Table 17.1 Techniques of active listening

Active listening	
Let the patient finish speaking	The first few minutes form the basis of the relationship. Active listening is encouraging and delivers valuable information
Ask open questions	Open questions yield comprehensive information, clarify associations, and provide background data beyond the actual facts of the case
Inquire	Problems of comprehension can be addressed immediately
Balance pros and cons	Helps to determine the patient's priorities or encourages him to think about them. Especially by explaining why a step is being given preferences
Pause	Short pauses (about 3 s) have a relieving effect. The patient thinks of data he/she had ignored until now
Encourage the patient to speak further	Echoing or nonverbal communication (nodding, eye contact, body facing the patient) signalizes one's presence
Paraphrase (repeat)	Focus on those parts of the patient's statements that are most significant (verbal accompaniment) and thus open new perspectives
Summarize what has been said	Agreement between the doctor and the patient by expressing longer portions of the conversation in one's own words
Reflect emotions	Address emotions verbally in the form of a suggestion

high degree of flexibility and thorough knowledge of role expectations. Interaction may be disrupted by inadequate social competence, fixation on oneself, or distorted perception of social behavior.

Individual Requirements of the Doctor in a Patient-Centered Doctor-Patient Relationship

A successful doctor-patient relationship is the foundation of any successful treatment and the breeding ground for sustained satisfaction in the professional existence of a doctor.

The action-guiding *obligations of a doctor* include the willingness to take responsibility, confidentiality, and authenticity. Action-guiding *virtues of a doctor* are patience, empathy, compassion, and the willingness to help. Finally, one needs to work out what the various optional decisions mean in terms of obligations towards third parties. In this context one needs to consider the patient's family members and close friends, as well as the entire community of the insured person [17].

Very urgent decisions and chronic diseases are the easiest to handle from the ethical point of view. In highly acute situations, such as emergencies, the responsibility of decisions is still handed over to the doctor without considering the patient's opinion (accepted paternalism). In this setting the patient is informed of the bare essentials, without disregarding the his/her right of self-determination. Even when the patient's ability to help himself/herself is on the decline and the patient needs help and care to an increasing extent, as in old age frailty and/or cognitive impairment, his/her modified autonomy should be accompanied by a high degree of empathy on the part of the doctor concerning the putative will of the patient. Chronic diseases differ from this approach in that a satisfactory outcome of care and the required degree of compliance can only be achieved cooperatively by the doctor and the patient. The less urgent the decision is, the more responsibility one may assign to the patient; in this setting decisions can be made in accordance with the *shared decision-making model* (Fig. 17.3) [18]. The degree of autonomy depends on the momentary and general condition of the individual patient (such as the patient's mental condition, degree of intellectual differentiation, severity of symptoms, severity of disease), and must be adapted to the current situation. The patient's values (estimation of the disease, will, concept of life) should be viewed along with the values of his environment (the patient's living environment, the treatment team) and the values of society (implicit values, institutionalized values). Even if the patient's living values are clear, there may be ambiguity concerning what is meaningful, appropriate, and beneficial for the patient.

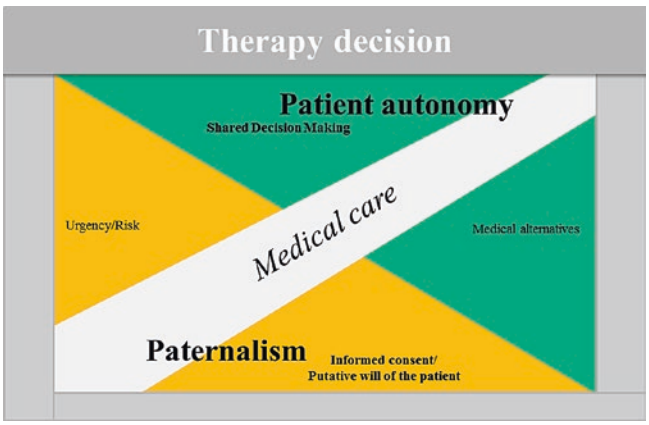


Fig. 17.3 Reciprocal flow diagram of paternalism and Informed Consent on the one hand, and patient autonomy and Shared Decision Making on the other. Dependent variables are medically equivalent alternatives and the medical urgency or risk for the patient. Medical care should respect the patient's wellbeing as well as his/her will

In many medical situations, the relationship between the doctor and the patient remains no more than an idealized behavior pattern. Many situations are rendered complex by the indefinite prognosis of acute diseases, especially when the initiated maximal therapy has not been successful and the doctor contemplates a change in the goals of treatment. However, particularly such extreme situations call for mastery over, and the application of, medico- ethical principles.

Borderline Situations in Dealing with Aged Patients and Those with Cognitive Impairment (Dementia)

The rising number of aged patients and those with cognitive impairment (dementia) permits complete patient autonomy in a very small number of cases. However, demographic developments necessitate the establishment of applicable concepts that will do justice to the altered spectrum of morbidity, which includes a rise in chronic diseases and multimorbid conditions. When coordinating the medical reports and other collected data with the individual patient's value system and also when considering the available resources in a specific case, the treatment team needs to employ a high degree of empathy and respect for the patient's autonomy. Again, it may be necessary to re-check and ensure congruency between the medical approach and the patient's concept of living, and make the respective putative decisions anew [19, 20].

Borderline Situations in Dealing with Psychiatric Patients, Young Children, and Mentally Challenged Persons

According to the principle of autonomy, young children, psychiatric patients and less gifted persons also have the right to be informed comprehensively. On the other hand, a comprehensive explanation may involve potential harm or delay in all three groups. Therefore, in the patient's interest many decisions about him/her are made on his/her behalf. When making serious decisions one must integrate the patient to the greatest possible degree. Consulting and including family members and caregivers is especially relevant in these situations. Showing empathy and sympathy for the patient and the family, answering questions, and explaining the medical treatment are highly valued aspects in this setting [21].

The Doctor-Patient Relationship in Oncology

Tumor patients are typical candidates for patient-centered doctor-patient communication. Cancer patients need a great deal of information about their disease, its consequences, and the available options. In many cases, the treating doctor and the patient share an intensive and long-term relationship. Therapy decisions are of long duration and have far-reaching consequences on the patient's quality of life and the prognosis of his/her disease. The doctor's task and responsibilities in providing medical assistance for cancer patients involves, to a much greater extent now than ever before, inviting the patient's active participation in decisions regarding treatment [22].

In 1819 Goethe wrote in *West-Östlichen Diwan (West-Eastern Divan)*: "What I thank Allah most for? That he has made a division between suffering and knowing. Any ill person would be desperate if he knew the disease as thoroughly as the doctor does".[2]

Slevin et al. were able to show that, in apparently hopeless situations, cancer patients are much more willing to undergo stressful chemotherapy with minimal chances of cure than the medical personnel in charge of their treatment would be willing to subject them to such treatment. Also with regard to the prolongation of overall survival and the improvement of quality of life, the acceptance threshold of severe side effects is highly underestimated (Table 17.2) [23]. Although many ill persons will accept a stressful treatment that prolongs their lives by a few months or provides brief symptomatic relief, some patients refuse to undergo a stressful therapy although the prognosis of their disease may be quite favorable [24]. Achievement of the goals of therapy, in this case, is not dependent on the effects or the efficacy of therapeutic measures alone, but is subject to a positive evaluation of the treatment by the patient [25].

Patient-centered medicine includes the ability to deliver bad news. Communications about impending death and statements about the significance of a disease or death are major challenges for the doctor and the patient. Empathy, congruence, and unrestrained respect for the patient when delivering bad news have culminated, for instance, in the SPIKES protocol described by Baile (Table 17.3) [26].

Questions to establish one's estimation of the patient's perception include, for instance, "What do you know about your medical situation so far?" or "What is your understanding of the reasons we wish to do the investigation?"

Table 17.2 The threshold likelihood (in percentage) of cure, prolongation of life, or symptomatic relief: the point from which patients are willing to accept chemotherapy associated with severe side effects and complications. This survey was conducted among cancer patients as well as a group of doctors and nursing staff [23]

	Patient	Therapist
Chances of cure	1 %	10–50 %
Prolongation of life	12 months	12–60 months
Alleviation of symptoms	10 %	50–70 %

[2]In: Johann Wolfgang von Goethe: *West-Östlicher Diwan*, Frankfurt am Main 1999, page 47.

Table 17.3 The SPIKES model. A six-step protocol for delivering bad news. This is a tool for obtaining information about the patient's current level of knowledge. He/she can also be informed about medical facts, depending on his/her need for information, support can be expressed, and suitable options can be rendered accessible. Finally, a treatment plan can be drafted in cooperation with the patient

S P I K E S	Steps	Contents
S	1. Setting up the interview	Arrange for some privacy Involve significant others Sit down Avoid interruptions
P	2. Assessing the patient's perception	Open questions to assess the patient's current perception (avoid misunderstandings early)
I	3. Obtaining the patient's invitation	Assess the patient's willingness to receive bad news Mention that the patient can speak to the doctor at a later point in time
K	4. Giving knowledge and information	Warning before delivering bad news Optimizing communication
E	5. Addressing the patient's emotions with empathic responses	Empathic statements express support
S	6. Strategy and Summary	Depends on level of wellbeing Discuss the next steps

To better estimate the ability of one's counterpart to receive bad news, it may be useful to ask questions like "How would you like me to give the information about the test results? Would you like me to give you all the information or sketch out the results and spend more time discussing the treatment plan?" To warn the patient before delivering bad news, one could try to steer the conversation, "Unfortunately I've got some bad news to tell you…" or "I'm sorry to tell you that …". While speaking to the patient, it would be advisable to make repeated and active attempts to optimize the conversation. This includes alignment of one's language to the patient's vocabulary and omitting specialized medical terms. Excessive directness should be avoided, and the required or desired information should be given in small units. The level of communication can be further improved by avoiding phrases like "There's nothing more we can do for you." Empathic statements in these exceptional situations express support. Specifically, the patient is helped when emotions are registered, named, and identified (such as grief, anger or shock). The patient is also helped when the doctor signalizes that the patient may express himself/herself. Agreeing upon a plan of treatment simultaneously makes the patient feel that his/her wishes are being taken into account; it also avoids misunderstanding, uncertainty and anxiety (Fig. 17.4).

The Doctor-Patient Relationship in Obstetrics from the Invasive Point of View

Obstetrics and prenatal medicine constitute an equally important part of our spectrum of activities. In contrast to gynecology, the doctor is called upon to bear responsibilities beyond the patient's scope of action. High-risk pregnancies have risen greatly in the last few years because of improved procedures in reproduction medicine. Maternal diseases may become consolidated or be exacerbated during pregnancy. The increasing complexity of this subject calls for interdisciplinary management and imposes the highest medico-ethical demands on our specialty.

In addition to the medico-ethical questions of the mother, the demands of the unborn child also must be taken into account. A crucial aspect of decision-making when dealing with the unborn child is the moral status an embryo must achieve in order to be granted specific rights – such as the right to live – as a practical subject. The fundamental rights granted to nascent life and the consequent legal protection that goes with these can be described in different ways [27].

1. *The species argument*: All members of the biological species known as *Homo sapiens* and, in fact, only this species, are entitled to human dignity and the comprehensive legal and moral protection that go with it.
2. *Potentiality argument*: The potential of entire human development is present in the primary cells. An embryo, which normally develops into a human being, is therefore worthy of protection and possesses the same moral characteristics as the fully developed human being.
3. *Identity argument*: The human embryo/fetus has the same rights as the persons they will become in the normal course of life, because the two are basically identical. The identity of the developed individual results from the composite of cells he/she evolves from.
4. *Continuity argument*: The process of development that starts with nidation is a continuous process with no sharp divisions and therefore does not permit any specific demarcation of the stages of development. Despite the

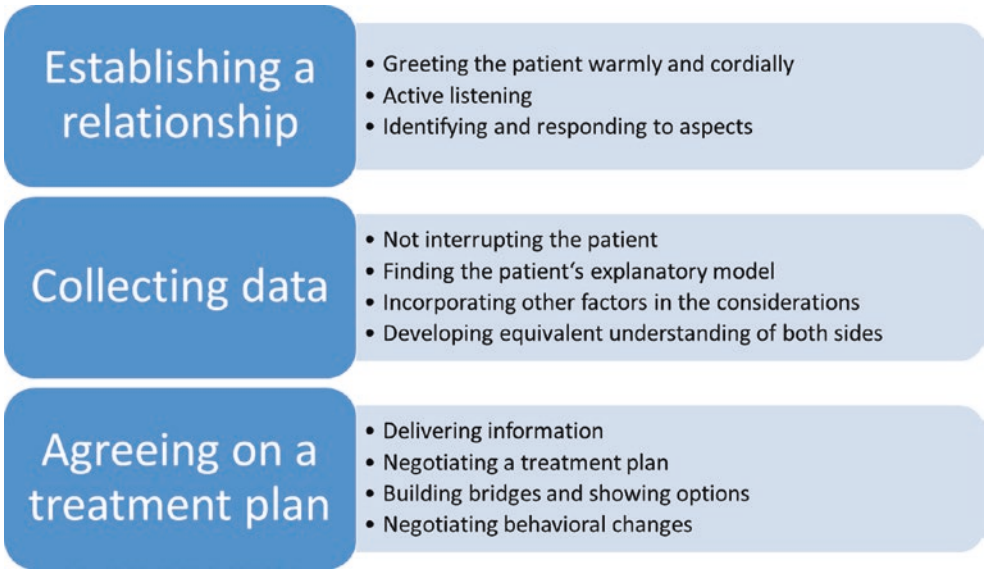


Fig. 17.4 Three functions of a doctor's consultation

continuity of human development from the very start, one can identifiy various stages of development whose demarcations, however, are blurred.

Fetomaternal conflicts result from the need to set priorities regarding the wellbeing of the expectant mother or the future child. Once the moral and ethical status of both parents and their right of self-determination have been established, it will be necessary to register the moral and ethical status of the unborn child. Any decision in favor of one would be accompanied by neglect of the other. Equal treatment of the interests and possessions of the unborn child and the future parents is practically impossible. Once the individuality of the embryo starts to take shape – which would be at the time of insemination or later – the individual possesses complete human dignity and must be protected accordingly. From this time on, the existence of the human being and his/her individuality is determined by the uniqueness of his/her genetic material. Based on the ethical principle of autonomy, one is obliged to justify any hindrance to self-determined life and protect the value of freedom. However, embryos and fetuses are unable to make competent decisions and are therefore incapable of moral, independent, and autonomous action or decisions – which, however, are essential for the self-determined decision-making process. Therefore, *competent representatives* have to make decisions on their behalf. The representative also has to align the child's value system with general ethical considerations in order to make appropriate decisions in keeping with the presumed life concept of the unborn child. Thus, a person who makes decisions for others is especially obliged to adhere to ethical principles, standards and criteria.

Given these facts, many prenatal diagnostic and obstetric situations pose a dilemma because it is impossible to act in the interests of the embryo or fetus as well as the expectant mother, not do them any harm, preserve their autonomy, and behave in a just manner. The options of action from the medico-ethical point of view would be quite clear if the unborn child's right to live would be ranked secondary to the expectant mother's. These questions are not, by any means, conclusively clarified at the present time.

Since parents are those who have to live with their decisions in favor of one of the courses of action and its respective dramatic consequences, they should be given all of the tools that enable them to make a sustainable decision. These include, in addition to the medical information provided by an interdisciplinary team of doctors (obstetrics, human genetics, prenatal diagnosis, neonatology, pediatrics), information about further decision-making aids and about tools for coping with the conflict-ridden situation.

Endangerment of the Doctor-Patient Relationship

The atmosphere of trust created by both of these parties is currently at risk of being lost forever. Three factors are worthy of mention in this regard. *Increasing anonymity* is a result of increasingly complex infrastructures. The patient is compelled to surrender his relationship with his treating physician and share his existence as an ill person as well as his doctor (a confidant) with the entire institution. *Juridification*, by which the doctor-patient relationship is subject to an increasing degree of legal control. The third source of uncertainty is *probabilization*. Statements about the disease process can only be made with certain degrees of probability.

Industrialization and the enhancement of efficiency in the health care system through measurable performance have, in

many instances, reduced non-measurable medical services to a minimum. Higher-level optimization processes, technocracy and bureaucracy are culminating in an unsurmountable pressure of time, which is partly offset by specialized medical services such as those of psychologists, specialized nursing staff, or social workers.

Conclusions and Future Perspectives for Medical Practice

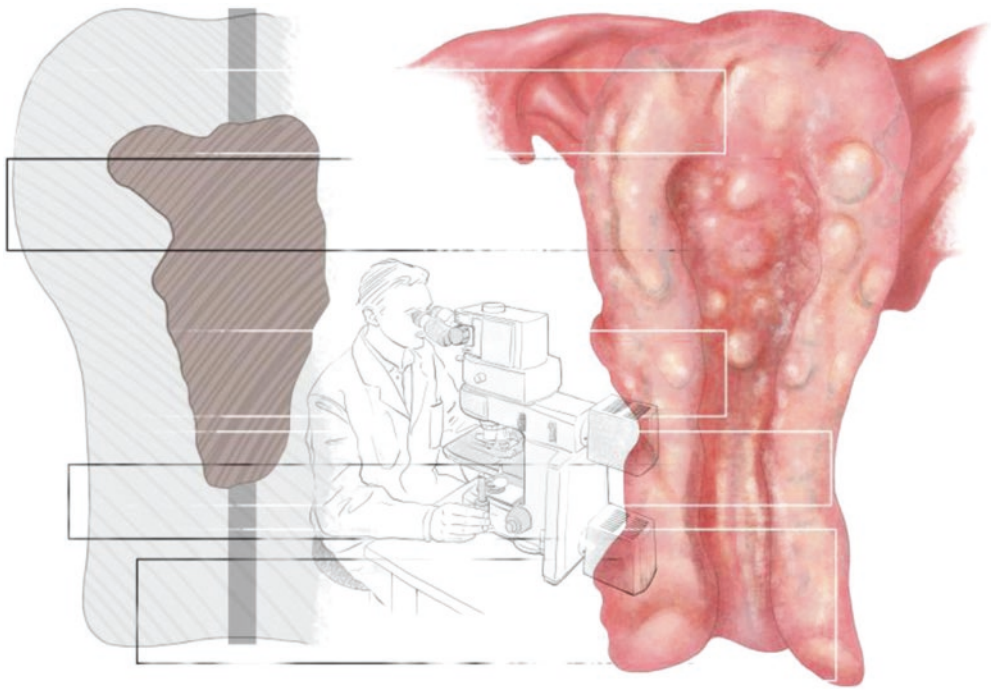
Decision-making in medical treatment is an individual process founded on ethics and can only be rendered possible by a well-functioning doctor-patient relationship. A prerequisite for the latter is communication based on empathy, congruence, and unconditional esteem. With a foundation of this nature, the patient and the doctor will be able to strive for the patient's wellbeing while preserving the patient's autonomy, avoid damage or injustice, and tread a common pathway, ideally as partners, which would lead to sustained satisfaction – also from the doctor's point of view – and render the two extremes of paternalism and contractual action unnecessary. In the majority of situations, the basic demands of the two parties must be weighed against each other and may not be achieved simultaneously. In the joint process of decision-making, it will be necessary to strike a compromise between the respective non-negotiable principles.

References

1. Wieland W. Strukturwandel der Medizin und ärztliche Ethik – philosophische Überlegungen zu Grundfragen einer praktischen Wissenschaft. Heidelberg: Universitätsverlag; 1986.
2. Gethmann CF. Gesundheit nach Maß? Eine transdisziplinäre Studie zu den Grundlagen eines dauerhaften Gesundheitssystems. Berlin: Akademie Verlag GmbH; 2004.
3. Rogers CR. Therapeut und Klient: Grundlagen der Gesprächspsychotherapie. 20th ed. Frankfurt: Fischer Verlag; 1983.
4. Mittelstraß J. Enzyklopädie: Philosophie und Wissenschaftstheorie . Stuttgart: J.B. Metzler Verlag; 2004.Special Edition ed
5. Argyle M. Körpersprache und Kommunikation: Das Handbuch zur nonverbalen Kommunikation. 9th ed. Junfermann Verlag: Paderborn; 2005.
6. Geisler LS. Patient autonomy–a critical concept analysis. Dtsch Med Wochenschr. 2004;129(9):453–6.
7. Rogers CR. Entwicklung der Persönlichkeit. 13 th ed. Stuttgart: Klett-Cotta; 1996.
8. Finke J. Gesprächspsychotherapie – Grundlagen und spezifische Anwendungen. 3rd ed. Stuttgart: Georg Thieme Verlag; 2004.
9. Beauchamp TL, Childress JF. Principles of Biomedical Ethics. 6th ed. New York, Oxford: Oxford University Press; 2009.
10. Smith CM. Origin and uses of primum non nocere–above all, do no harm! J Clin Pharmacol. 2005;45(4):371–7.
11. Schöne-Seifert B. Medizinethik. In: Nida-Rümelin J, editor. Angewandte Ethik. Die Bereichsethiken und ihre theoretische Fundierung. Ein Handbuch. 2nd ed. Stuttgart: Alfred Kröner Verlag; 2005. p. 690–803.
12. Alkatout I, Rummer A. Intrauterines Lebensrecht von Zwillingen mit ungleichen Überlebenschancen – Kommentar zum Fall. Ethik in der Medizin. 2011;23(3):233–4.
13. Gabl C, Jox RJ. Paternalism and autonomy–no contradiction. Wien Med Wochenschr. 2008;158(23–24):642–9.
14. Marckmann G, Bormuth M. Arzt-Patient-Verhältnis und Informiertes Einverständnis. In: Wiesing U, editor. Ethik in der Medizin. Ein Reader. Stuttgart: Philipp Reclam; 2000. p. 76–85.
15. Krones T, Richter G. Physicians' responsibility: doctor-patient relationship. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. 2008;51(8):818–26.
16. von Engelhardt D. Ethik in der Onkologie – Dem kranken Menschen gerecht werden. Im Focus Onkologie. 2006;09:65–8.
17. Marckmann G, Mayer F. Ethische Fallbesprechungen in der Onkologie – Grundlagen einer prinzipienorientierten Falldiskussion. Der Onkologe. 2009;10(15):980–8.
18. Krones T, Richter G. Die Arzt-Patient-Beziehung. In: Schulz S, Seigleder K, Fangerau H, NW P, editors. Geschichte, Theorie und Ethik der Medizin. Frankfurt am Main: Suhrkamp Verlag; 2006. p. 94–117.
19. Wolf E, Lahrmann H. The seriously affected stroke patient who is not able to communicate – treatment to the best of one's knowledge and ethical principles. Wien Med Wochenschr. 2014;164(9–10):195–200.
20. Meran JG. Palliative care and quality of life as therapy goal. Wien Med Wochenschr. 2012;162(1–2):1–2.
21. Espinel AG, Shah RK, Beach MC, Boss EF. What parents say about their child's surgeon: parent-reported experiences with pediatric surgical physicians. JAMA Otolaryngol Head Neck Surg. 2014;140(5):397–402.
22. Hahn J, Mandraka F, Fröhlich G. Ethische Aspekte in der Therapie kritisch kranker Tumorpatienten. Intensivmedizin und Notfallmedizin. 2007;44(7):416–28.
23. Slevin ML, Stubbs L, Plant HJ, Wilson P, Gregory WM, Armes PJ, et al. Attitudes to chemotherapy: comparing views of patients with cancer with those of doctors, nurses, and general public. BMJ. 1990;300(6737):1458–60.
24. Silvestri G, Pritchard R, Welch HG. Preferences for chemotherapy in patients with advanced non-small cell lung cancer: descriptive study based on scripted interviews. BMJ. 1998;317(7161):771–5.
25. Krones CJ, Willis S, Steinau G, Schumpelick V. Current patient perceptions of the physician. Chirurg. 2006;77(8):718–24.
26. Baile WF, Buckman R, Lenzi R, Glober G, Beale EA, Kudelka AP. SPIKES-A six-step protocol for delivering bad news: application to the patient with cancer. Oncologist. 2000;5(4):302–11.
27. Schulz S. Person oder Keim? Der moralische Status des Ungeborenen in der Geschichte der Abtreibungsdiskussion. In: Schulz S, Seigleder K, Fangerau H, NW P, editors. Geschichte, Theorie und Ethik der Medizin. Frankfurt am Main: Suhrkamp Verlag; 2006. p. 303–15.

Part VI

Macroscopic and Microscopic Pathological Aspects



Processing and Histopathological Workup of Hysterectomy Specimens

18

Lars-Christian Horn and Anne K. Höhn

Introduction

The challenges of histopathology have been changed dramatically during the last years. The pathologist nowadays is a diagnostic oncologist and in the majority of the cases the management of patients is influenced by the histopathology report so, the surgical pathologist performs a "background treatment" of the patient.

The histopathologic report is one cornerstone and within the majority of cases the basement of quality control and decision making for adjuvant treatment and guides the selection of appropriate approach in additional treatment, especially in patients suffering malignant disease.

The gross description of a resection specimen is one important, if not the most important, part in several cases of the entire surgical pathology report.

The following chapter describes an approach of gross examination and the method of reporting the pathologic findings for benign and malignant gynaecologic diseases within hysterectomies, guided by the clinical principles of patient management, focussing on a concise report to guide the decision makings in multidisciplinary meetings.

Crosstalk Between Clinicians and Treating Pathologists

The surgical pathology report gives the final diagnosis and includes specific information about the success of surgical treatment and just in case about prognosis and treatment. So, the "treating pathologist" must have sufficient familiarity with the management of obstetric and gynaecologic disorders to assure that the report, as its major focus, communicates the clinically relevant information [143].

But, the quality of the histopathological report is mainly influenced by the available clinical information. Some important points of interaction between the clinicians and the surgical pathologist should be addressed.

The gynaecologic surgeon has seen the situation and the disease in vivo in conjunction with several anatomic landmarks. These landmarks cannot be reconstructed by the pathologist within the laboratory. So, it is absolutely necessary that the gynaecologist communicates important intraoperative findings on the requisition sheet. For proper orientation of the specimen in the lab, a marking of relevant structures/landmarks/resection margins on focus on the resection specimen (e.g. by sutures) is mandatory. Especially in complex resection specimens, special requirements of the gynaecologic surgeon, special intraoperative findings and a proper orientation of the specimen will directly influence how the pathologist will handle and process the specimen postoperatively at the cutting room. This is also the case during intraoperative frozen section analysis.

Intraoperative frozen section examination of a specimen should guide the operation procedure by evaluation the status of resection margins and the extent of the disease. Unnecessary frozen sections should be avoided to cut the costs and save manpower. It should be recognised that frozen section analysis present a preliminary method and is not as good as permanent sections from any tissue [37, 47]. The overall accuracy of frozen section analysis has tested and proved on numerous occasions, both in university and community hospitals with good results [121, 144]. A review, sponsored by the College of American Pathologists covering over 90,000 frozen sections, performed at 461 institutions showed a concordance rate with permanent sections of 98.6 % [144]. Given limited sampling, frequent paucity of clinical information and the various artifacts introduced by the freezing process, the technique is remarkable accurate but not perfect. So, the diagnosis of frozen section examina-

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tion might be changed after examination of the whole specimen by permanent slides.

The surgical specimen will be examined and described at the cutting room. For frozen section analyses and the selection of tissue blocks for the histopathologic examination the tissue will be sliced and dissected. During the cutting of the specimen it will be distorted and a complete reconstruction in context with all structures removed will be impossible.

The examined tissue will be stored for several weeks. Then, the tissue will be discarded under the line of legal regulations. So, there is no way to return to the specimen for re-examination and/or additional embedding of tissue after that time. This means for the clinician to contact your pathologist as early as possible if there are any questions regarding the specimen and its histopathological report.

Proper fixation of surgical specimens is an absolutely prerequisite for adequate handling and processing of the tissue. Improper fixation causes problems in cutting the paraffin blocks, sadly influences the quality of H&E-staining (Fig. 18.1a, b) and may cause false-negative or false-positive results in immunohistochemical staining (Fig. 18.1d, e; [98, 140]). Improper fixation may also cause problems in molecularpathologic analyses [98, 120]. Formalin-based fixatives are most commonly used today. For proper fixation 10 % buffered formalin should be used. The relationship between specimen size and the amount of formalin used should be 1:10.

In therapeutic resections a larger amount of tissue will be resected within each individual specimen. The formalin-based fixation works by the penetration of the formalin in the tissue from the periphery to its centre with a speed of ~0.1 cm per hour [29]. So, a minimum of about 12 h for medium sized specimens (simple hysterectomy) and a minimum of 24 h for larger specimens (e.g. radical hysterectomies, exenteration specimens) will be needed for proper fixation. The processing of the specimen and its histopathological interpretation (without additional immunohistochemical stains) needs about 24–48 h. This timeline (Fig. 18.2) should be kept in mind by the clinician for proper information of the patient. In complex therapeutic resections, some information will be available earlier as the result from frozen section examination (e.g. status of the resection margins, dignity of the lesion). Additionally, some patients will need intensive or intermediate-care after operation procedure. So, in almost all cases with extended gynaecologic surgery there will be no need to rush up the pathologist. The major points of the crosstalk between pathologists and clinicians are summarised in Table 18.1.

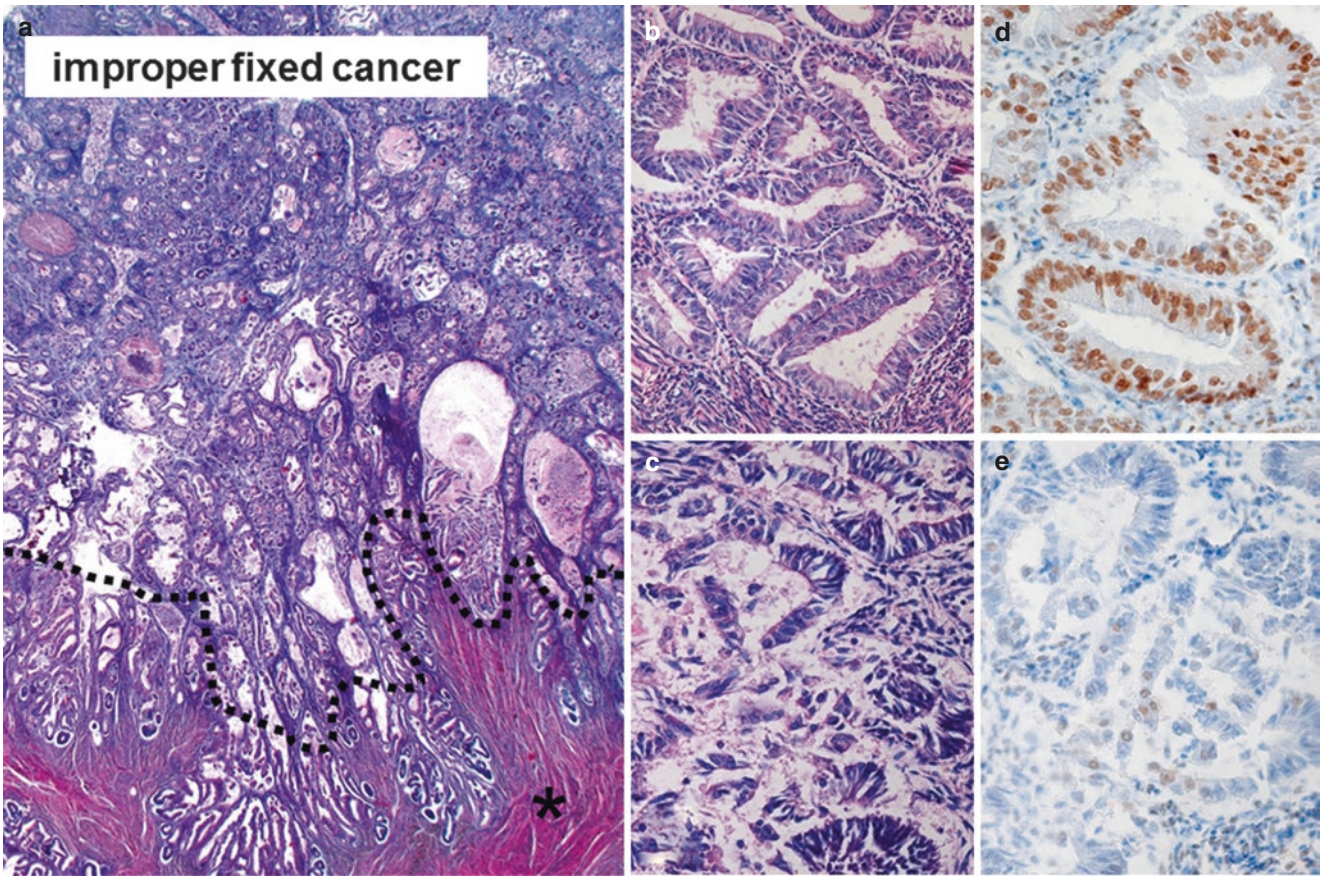


Fig. 18.1 Impact of fixation on morphology. (**a**) Poorly fixed endometrioid adenocarcinoma within a hysterectomy specimen above the dotted line. The cancer below the *dotted line* in proximity to myometrium (*asterix*) is well fixed. (**b**, **c**) Well fixed cancer and improper fixed cancer; the latter one represents with fragmented glands. (**d**, **e**) well defined immunohistochemical staining of the proper fixed cancer cell nuclei (**d**) and invalid staining for estrogen receptor within the poorly fixed tumor cells (**e**)

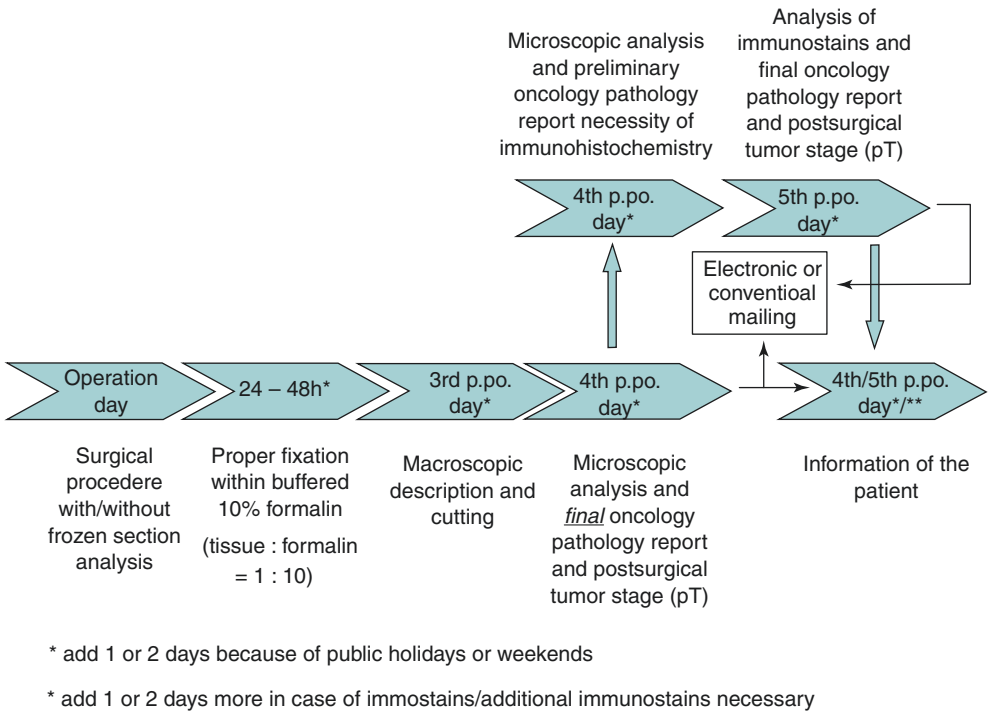


Fig. 18.2 Approximative timeline for building the final pathology oncology report for hysterectomy specimens

Table 18.1 Major points within the dialog between the gynaecologic surgeon and the gynaecologic surgical pathologist (for details see text)

Needs from the clinician	Why needed by the pathologist
1. **Anamnestic/clinical data**	
Anamnestic data about malignancies	Proper interpretation of the findings,
	Proper selection of immunohistochemical stains
If available, tumor markers should be given on the requisition sheet	Proper interpretation of the findings,
	Proper selection of immunohistochemical stains
Technique used in surgical approach	Proper interpretation and description of the specimen, quality control of surgical management and pathological workup
Special intraoperative findings should be communicated on the requisition sheet	Proper orientation and handling of the specimen
Relevant structures/landmarks/resection margins should be marked by sutures	Proper orientation and handling of the specimen
Contact your pathologist as early as possible in case of questions or re-orders	In-time re-examination and re-cutting, before the tissue is discarded
2. **Frozen section (FS) examination**	
Prevent "unnecessary" frozen sections	Prevention of tissue destruction
	Prevent loss of diagnostic relevant tissue
Guide FS analyses by marking the relevant resection margins by sutures and ask clear questions on requisition sheet	Reducing the stress level of the pathologist
	Reducing the time necessary for FS
	Reducing the number of FS-blocks
3. **Pre-analytic variables**	
Use of 10 % buffered formalin for fixation	Improved quality of (immuno-) stains and moleculas analyser
Adequate relation between tissue and formaline 1:10	Improved quality of (immuno-) stains and moleculas analyser
Give adequate time-line for the fixation, processing and histopathologic interpretation of complex surgical specimens	Proper quality of staining and interpretation

Table 18.2 Issues for frozen section examination in endometrial cancer and its relative risk for lymph node involvement [5, 147, 183]

Feature	Relative increase for lymph node involvement
Invasion of the outer half of the myometrium	5×
Involvement of the cervical stroma	4×
Ovarian/adnexal involvement	4×
Grade 3 endometrioid carcinoma	3×
Serous/clear cell histology	3×

General Aspects of Cutup for Pathologists

The techniques of the cutup of resection specimens, i.e. its gross description and cutting and processing, should be guided by the needs of the clinician for patients management and recommendation of national guidelines and recommendations of several societies ([7, 17, 38, 88, 96, 107]; see Table 18.2).

A good gross description enables the examining/re-examining pathologist but also the gynaecologic surgeon to reconstruct an image which corresponds to the treated lesion. Several general key points can be determined for good medical practice in surgical pathology [17, 63, 143]:

- appropriate gross description and selection of paraffin blocks for histopathology requires a full understanding of what should be in the final report for each specimen type and why,
- opening sentence of gross description should indicate how the tissue is received (fresh or inadequate/adequate fixed),
- it should be mentioned if the specimen received intact or if there are some incisions made by the gynaecologic surgeon,
- sutures for marking the specimens should be mentioned,
- the weight and three dimensional measurement should be given,
- gross description should be given in an orderly fashion, focussing on the primary lesion,
- descriptions should be full but economical in words and space,
- elaborate descriptions of normal anatomy of adjacent, uninvolved anatomy should be avoided,
- obvious lesions should be described using diagnostic terms, not by prosaic texts,
- gross description should focus on the site and the extent of the lesion,
- the main lesion should be described in detail by giving its three-dimensional size, the presence of its borders to adjacent tissue (its contour) and organs, its consistency and colour, the presence/absence of necroses and haemorrhage, its presence of the cutting surface,
- application of ink is useful for the identification of margins that lack natural margins (i.e. surgical resection margins),
- inking should be sparingly and blot-dry to prevent spill-over or running,
- the reporting of the status of the resection margins is mandatory,
- the reporting of the metric distance between the infiltrating edge of the tumor and adjacent resection margin is mandatory,
- in complex cases or specimens with inadequate orientation drawings or photographs may be helpful for adequate interpretation,
- photographic documentation of complex specimens or those with rare disease is helpful and mandatory in our digital world,
- the number of blocks embedded should be given to document how many tissue has been processed
- the use of adequate section codes is mandatory.

Resection Margins and Inking

The determination of resection margins is mandatory for the management of the patients, for prognostic evaluation and for quality control of gynaecologic surgical treatment.

The status of all resection margins of a lesion should be given in the gross description with the metric distance between the lesion and the margin. All close margins (e.g., margins <1 cm) should be examined histologically.

Application of ink is necessary to identify surgical resection margins on histological slides (Fig. 18.3). The use of multiple colours may be helpful, but it is also adequate to use only one colour. At the authors department we have good experiences to use writing correction fluid if only one colour is needed for inking. In our opinion it represents a good practicable, cheap and easiely handling tool. The correction fluid appears white on macroscopy but black on histology Fig. 18.3a–g). Sometime it is helpful to dry up the specimen before inking using a tissue towel. The application of the ink should avoid a spill-over of the ink and an inadvertently covering of the lesion. The use of perpendicular sections is favoured by the authors rather than the use of

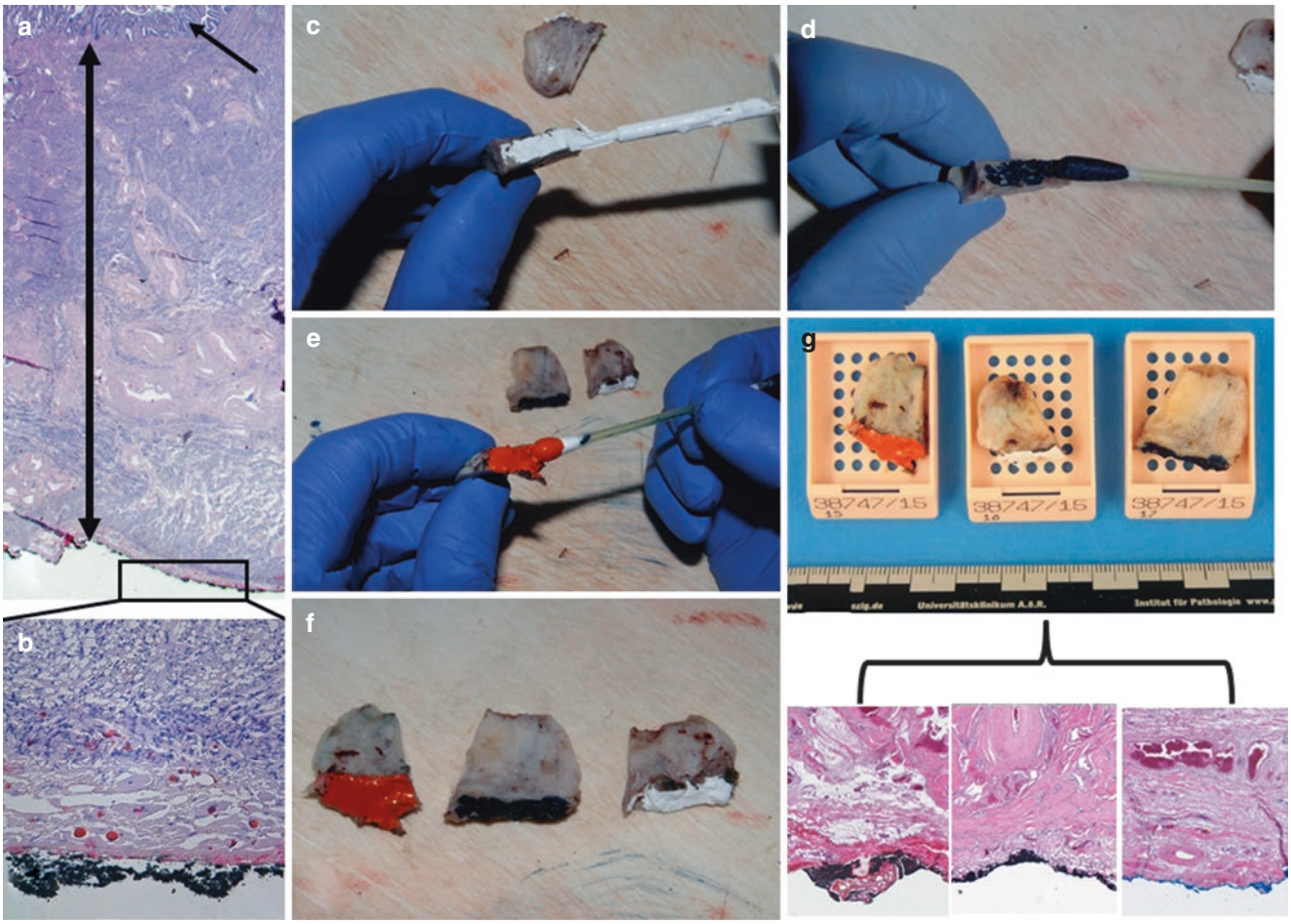


Fig. 18.3 Inking of hysterectomy specimens. (**a**, **b**) Inking of the serosal surface with correction fluid of a hysterectomy specimen with endometrioid endometrial cancer (*arrow*) indicating the distance from the serosal surface (*double headed arrow*). The serosal surface appears black inkend on the microscope. (**b**–**g**) Inking of the anterior resection margin of radical hysterectomy specimens by different colours (for details please see text)

sections parallel to the margins. But in special cases transverse sections fits. Although the number of blocks might be higher, the use of perpendicular sections allows the exact measurement of the distance to the margin.

During frozen section examination but also on permanent sections, the interpretation of the resection margins may be difficult because of cautering artifacts.

Frozen Section Analyses

Frozen section examination of a specimen may be necessary to evaluate the dignity of a uterine lesion (rarely), the extent of a lesion, its relation to the resection margins or to guide the extension of the surgical approach intraoperatively.

For adequate evaluation of the specimens the requirements and questions of the gynaecologic surgeon directly guide the pathologist how to handle the specimen [37, 47]. It is very helpful to contact the surgeon by phone call if there are missing/unclear marking sutures within the specimen or if it is unclear why the specimen was sent for frozen section analyses *before* any cutting of the tissue. To avoid misinterpretation of histological findings the pathologist should get in dialogue with the surgeon, rather than with the anaesthesiologist and/or the operation room nurses or technicians.

For special issues regarding the handling and reporting of hysterectomy specimens sent for frozen section, see Chap. starting at line 312.

Fixation of the Specimen

Well fixed specimens allow an easier handling and cutting of the tissue and produce better results in H&E-staining and immunohistochemical examination (Fig. 18.1).

Especially in exenteration specimens a complete or partial opening of resected bladder or bowel followed by tamponation using tissue towels (preferred by the authors, because of easier handling) or cellulose may be helpful. At the authors experiences a minimum fixation time of (radical) hysterectomies is about 24 h and of exenteration specimens 48 h. Large specimens might be cross-sectioned at intervals of about 1–2 cm. If there is a need to speed up the examination, the specimen may be fixed in an adequate amount of formalin and heating it up (at ~40 °C) in an incubator. The time depends of the size from the specimen. In the author opinion, (radical) hysterectomy specimen may heated up for about 6–8 h without any damage of the tissue.

Number of Sections Required

Judging what number of blocks required to optimally examine a specimen is one of the more controversial subjects in gynaecological pathology [143].

In the authors opinion, each resection margin and each resected structure should be documented by histologic slides. In case of smaller anatomic structures resected two identical ones (i.e. anterior and posterior vaginal margin) can be blocked into one cassette and one of the tissue slices (e.g. the anterior one) can be marked by ink. The relationship of a lesion to its adjacent structures as well as its resection margins should be documented. During the cutting of the specimen it should be determined which cut brings the most information on the histologic slide within one block. In lesions with known difficulties in histologic diagnosis and/or high intratumoral heterogeneity (e.g. MMMTs, leiomyosarcomas, endometrial stromal sarcomas, carcinomas after previous radio-(chemo-)therapy), a more extensive embedding is recommended.

Definition Relevant Parameters for Tumor Staging

The diagnosis of *lymphovascular space involvement (LVSI)* requires the demonstration of tumor cells (single cells or groups) within channels that are unequivocal lined with endothelium (Fig. 18.4a, e; [182]). It has been stated within the TNM-supplement of the UICC that if spaces around tumor cell nests caused by shrinkage during tissue processing and spaces which cannot clearly defined as lymphatic vessels should be classified as no LVSI (i.e. L0; [182]). The use of immunohistochemical stains (e.g. D2-40) to indentify LVSI is not being recommended for routine use.

The most recent TNM-supplement has defined (venous) *vessel invasion* if there is a tumor invasion within the vessels wall. It is not necessarily require demonstration of tumor cells in the lumen of the vessels (Fig. 18.3b; [182]).

Perineural involvement (PNI) has been defined as the detection of malignant cells in the perineural space of nerves, regardless if the nerve itself is infiltrated by the tumor and regardless of the extension of the involvement of the perineural tissue (Fig. 18.4c, d; [68, 72, 101, 116]).

Isolated tumor cells (ITC) are single tumor cells or small clusters of cells not more than 0.2 mm in greatest extent that can be detected by routine H&E-staining or immunohistochemically (Fig. 18.4f; [182]). ITC do not typically show evidence of metastatic activity (e.g. proliferation or stromal reaction) or penetration of lymphatic sinus walls [182]. The use of immunistochemistry to detect ITC cannot be recommended in routine workup. The presence of ITC within lymph nodes should not categorised as pN1 but as pN0(i+) if the ITC were morphologically identified (H&E or by immunohistochemistry) and as pN0(mol+) if they were diagnoses by non-morphologic techniques (e.g. DNA-cytometry or molecular techniques; [182]).

Micrometastases within lymph nodes are defined as tumor cell deposits larger than or equal 0.2 mm but not larger than 0.2 cm (Fig. 18.4g; [182]). The TNM/UICC suggest the use of pN1(mi) within the tumor classification [159, 182]. For easier communication, the authors prefer the use of pN1mic for the designation of micrometastases within lymph nodes according to the earlier TNM-classification in breast cancer.

Frozen Section Analyses of Hysterectomy Specimens

Frozen section diagnosis (FS) will guide the gynaecologic surgeon to perform lymph node dissection, the removal of additional tissue to complete the resection of possibly tumor burden tissue or to perform other surgical staging procedures (e.g. peritoneal biopsies, omentectomy etc.).

There are different approaches and indications for intraoperative frozen section analyses for hysterectomy specimens [26]. Some of them are dependent from the surgical philosophy and individual experience of the surgeon [190]. Within the authors institution there is a wide range of intraoperative treatment of the patient by the pathologist. The distribution of FS-examination during a 5-year period is illustrated in Fig. 18.5.

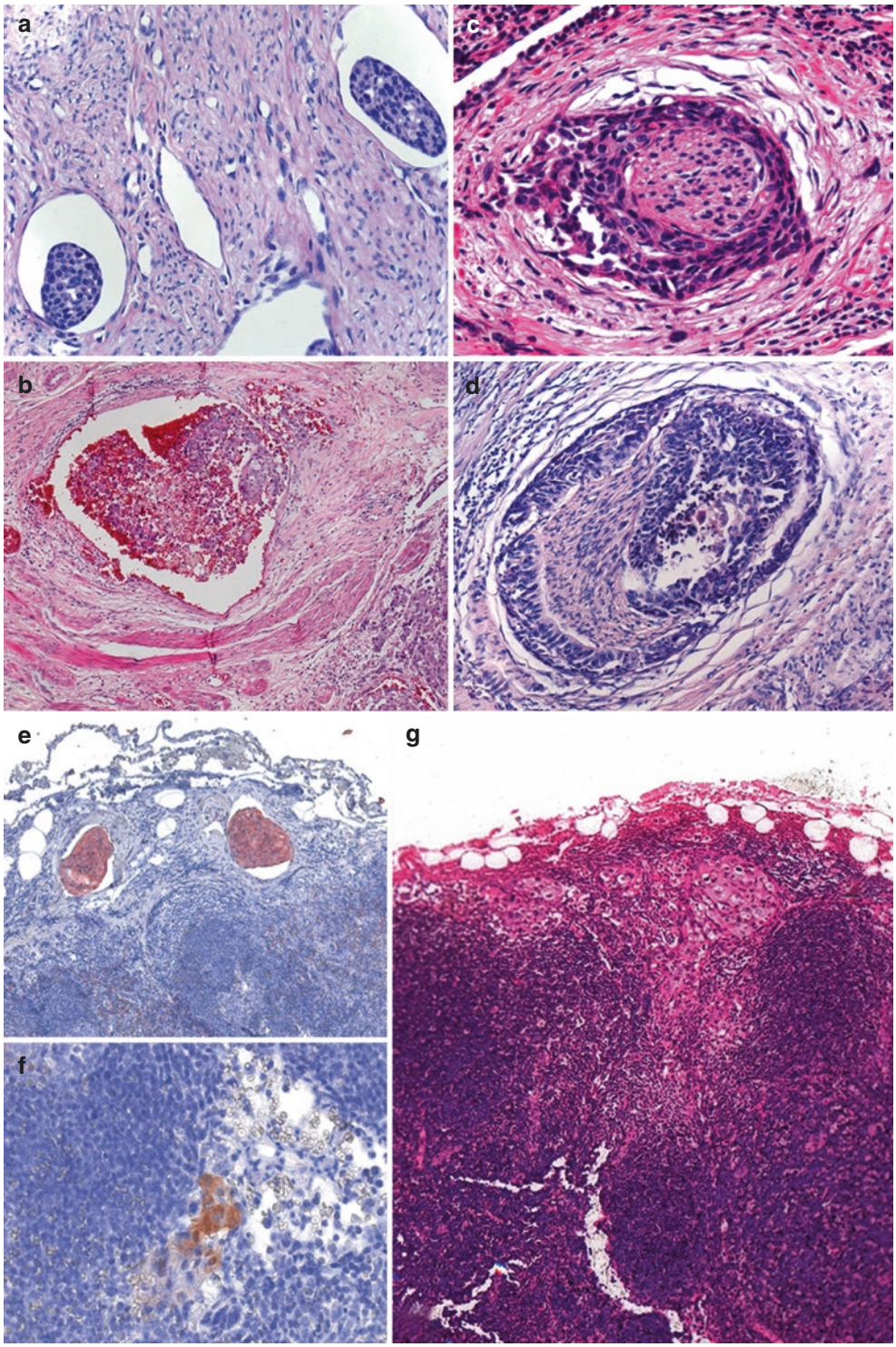


Fig. 18.4 Histopathologic parameters for staging of uterine cancers. (**a**) Lymphovascular space involvement by a squamous cell carcinoma within lymphatic vessels, lined by a single layer of endothelial cells (H&E staining). (**b**) Venous infiltration by a squamous cell carcinoma, note the erythrocytes admixed with tumor cells (H&E staining). (**c**, **d**) Perineural involvement by a squamous cell (**c**) and poorly differentiated adenocarcinoma of the uterine cervix (**d**). (**e**) lymphovascular space involvement within the capsule of a pelvic lymph node by squamous cell carcinoma which will categorised as L1 and not as lymph node metastasis (immunostain for cytokeratines; AE 1/3). (**f**) Isolated tumor cells of a squamous cell carcinoma within a pelvic lymph node (immunostain for p16). (**g**) Micrometastasis of a squamous cell carcinoma within a pelvic lymph node (H&E staining)

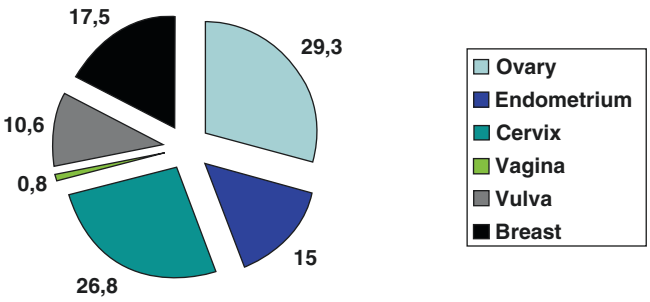


Fig. 18.5 Percentage of requested frozen section analysis from gynaecologic oncology during a 5-year period [74]. Within 7,921 frozen sections, 17.5 % (N = 1.368) were requested by gynecologic oncologic surgeons

Frozen Section in Endometrial Cancer, Malignant Mixed Müllerian Tumors (MMMT) and Atypical Endometrial Hyperplasia

FS-examination in hysterectomies is done to document the extent of the tumor which will directly impact patient's surgical management. The issues for FS-examination in endometrial cancer and its relative risk for lymph node involvement is summarised in Table 18.2.

Within the majority of cases the assessment of the depth of invasion represents the leading question [5, 42, 83, 146, 162] in endometrial cancer surgery. If the involvement of endocervical stroma represents a prognostic factor is still under discussion [132, 187], but its recognition mandatory for staging.

To determine the extent of the endometrial cancer the serosal surface and adnexal tissue should inspected. The ovaries should be incised along its long axis and all suspicious findings should be examined by histology. The uterus should be opened (by scissor at 12-o'clock position or bivalved at 3-o'clock and 9-o'clock position). Then the tumor and its adjacent myometrium should be sliced and the deepest point of infiltration should be frozen, ideally as full thickness or in a manner to preserve the overall depth and total thickness measurements [143, 183]. The macroscopic only evaluation of the depth of invasion may be problematic [33, 50, 97, 138]. Within the authors opinion macroscopic only evaluation may result in an underestimation of the depth of invasion especially in cases of endometrioid cancer representing microcystic, elongated, fragmented glands (MELF) pattern of invasion [40, 125], in case of endometrioid carcinoma with minimal deviation growth pattern [2, 76, 79, 92, 104, 126] as well as in cases of serous endometrial cancer with glandular pattern [11, 76] where the diagnosis was not made on the curetting. So, the depth of invasion should be proofed by histologic examination of FS in all cases [138]. One example of minimal deviation carcinoma is illustrated in Fig. 18.6.

The gross assessment of myometrial invasion is no better than 70 % [44, 50] and increases up to 90 % by histologic examination [86, 134, 146, 162, 173].

The differentiation between myometrial invasion and involvement of an endometriosis by endometrial adenocarcinoma may be challenging [5, 55, 83]. Helpful features distinguishing involvement of an endometriosis versus true myometrial invasion are discussed in the paragraps of cut-up of hysterectomies with uterine cancer and MMMT at page 1021.

Areas for suspicion of endocervical involvement should also be frozen to determine endocervical stromal invasion. The involvement of endocervical glands has no longer impact for staging. Although, there is still a debate about the necessity of radical hysterectomy in endometrial cancer with endocervical stromal invasion (stage pT2; [132, 167]), this feature should be examined and reported during frozen section examination also [112, 187].

The evaluation of the tumor grade by intraoperative biopsy has a reported sensitivity and a specificity of 40 % and 98 %, respectively [86, 134, 146]. A recommendation may be to report the grade at frozen section if there is an upgrade of the tumor [162].

The determination of the histologic subtype, mainly the distinction between type 1 and type 2 endometrial cancers should base on the histology of the curetting specimen, if there is a previously undiagnosed serous/clear cell cancer on frozen section the diagnosis should be given to the clinician [162].

Malignant mixed Müllerian tumors (MMMT) represent high grade carcinomas of the uterus [61] and will be treated by hysterectomy with bilateral salpingo-oophorectomy and pelvic and para-aortic lymphonodectomy [157]. So, intraoperative evaluation is of no impact.

A significant number of women diagnosed with atypical endometrial hyperplasia on endometrial curetting will be diagnosed with endometrial cancer on the hysterectomy specimen [71]. So, in individual cases there may be an indication for frozen section on hysterectomies with previously diagnosed endometrial hyperplasia [169, 171]. There may be some challenges within the diagnosis of low grade endometrioid endometrial cancers [141], high risk cancers are efficiently identified in frozen section [123, 141].

Frozen section analysis of lymph nodes in endometrial cancer may result in a discrepancy betwenn frozen and permanent section in 7–13 % [87, 175].

Frozen Section Radical Hysterectomies for Cervical Cancer

Frozen section analyses may be indicated in radical trachelectomy to determine the status of endocervical margins [20, 49, 122].

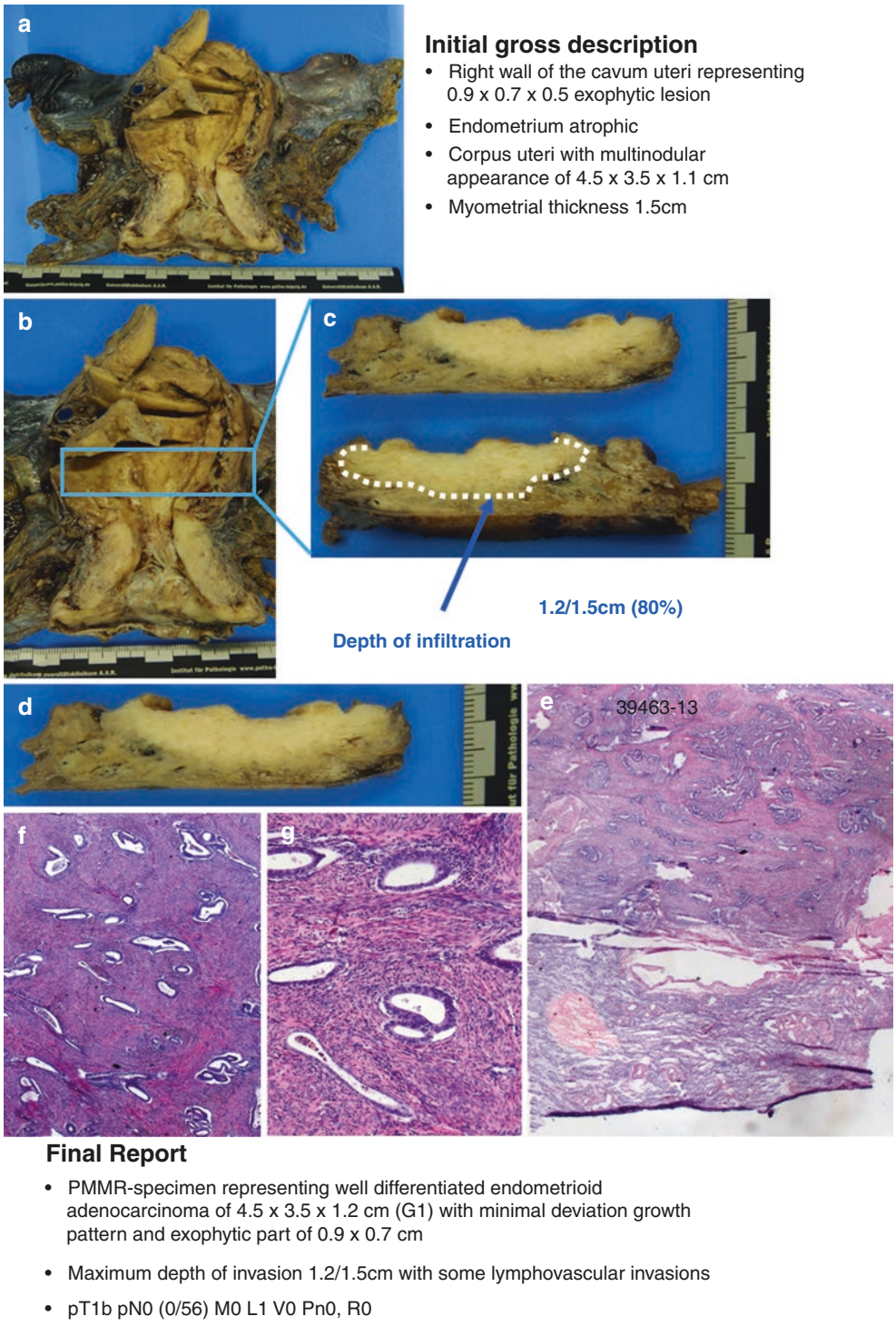


Fig. 18.6 PMMR specimen of endometrial cancer with well differentiated endometrioid adenocarcinoma with minimal deviation growth pattern. The initial gross description indicated a 0.9 cm exophytic tumor in maximal dimension. But frozen section analysis revealed a deeply invasive tumor with maximal depth of invasion of 1.2 into the myometrium which represented a maximal thickness of 1.5 cm. Final tumor size of 4.5 × 3.5 × 1.2 cm

But intraoperative examination of radical hysterectomy for cervical cancer is rarely requested within most institutions [9]. At the authors institution, that procedure was requested in all cases representing 26.8 % of all frozen section analyses for gynaecologic malignancies [73]. Routinely, the vaginal resection margin was examined by tangential sections. In cases with close posterior or anterior resection margins (i.e. in direction to the mesorectum and urinary bladder) and in cases with close margins at mesometrial (parametrial) infiltration the margins are examined using perpendicular sectioning. Recognising the concept of ontogenetic anatomy of the female genital tract [58] and the concept of therapeutic lymphonodectomy [56], routinely we examine the hysterectomy specimen for corpus involvement

by the cervical tumor macroscopically. In suspicious cases the leading edge of the cervical tumor in direction to the uterine corpus will be examined by frozen section histologically. In case of corpus involvement the lymph node dissection will be expanded to the para-aortic nodes, even in cases in which the first-line pelvic nodes were without metastatic deposits on previous frozen section examination.

The examination of lymph nodes in cervical cancer may be challenging and an inaccuracy up to 33 % has been reported [12, 41, 48]. These numbers are very high in the authors opinion. But these high rates are caused by the examination of sentinel nodes and under recognition of micrometastases. In case of macrometastases the accuracy rates will be higher.

Frozen Section Hysterectomies for Mesenchymal Tumors of the Uterus

Frozen section for mesenchymal tumors of the uterus is rarely requested [5, 9, 49, 97, 122, 183]. So, here is limited information in the literature addressing the practical issues commonly encountered regarding intraoperative frozen section of uterine mesenchymal lesions [10].

The depth of myometrial involvement of endometrial stromal sarcoma may be determined by frozen section analysis but has no direct impact of surgical procedure. Some leiomyosarcoma may be diagnosed by frozen section but it is impossible to separate between low grade spindle cell leimoysarcomas from smooth muscle tumors of uncertain malignant potential (STUMP) or highly cellular leiomyomas with mitotic activity [77] as well as between myxoid leiomyomas and myxoid leiomyosarcomas. The same diagnostic dilemma exists within the differential diagnosis of endometrial stromal nodules and low-grade endometrial stromal sarcomas (LG-ESS) as well as for the differential between high-grade endometrial stromal sarcomas (HG-ESS) and undifferentiated uterine sarcomas (UUS). Because of the limitations of the diagnostic safety and its impact on surgery frozen section examination of uterine sarcomas is not indicated within the majority of cases [46, 135].

There are case reports about frozen section examination of biopsies obtained from mesenchymal uterine lesions before laparoscopic morcellation procedure [172].

Handling of Hysterectomy Specimens for Final Cutup

Hysterectomy in Benign Diseases (Figs. 18.7 and 18.8)

There are several causes for hysterectomy in benign diseases. Cutting and examination of uteri removed for functional diseases is one of the most performed procedures in gynaecologic surgery [160]. This includes hysterectomy for decensus uteri, leiomyomas, pelvic discomfort in case of endometriosis/adenomyosis, persistent dysfunctional and/or postmenopausal bleeding and endometrial hyperplasia. A special indication is the risk-reducing (elective or prophylactic) hysterectomy in women at risk of hereditary endometrial cancer [89]. For a detailed description, see page 612.

Hysterectomy in Uterine Prolapse, Persistent Dysfunctional Bleeding and Pelvic Dyscomfort

There are some general aspects of the gross description of any hysterectomy specimen, regardless of the background disease for surgery which are summarised in Tables 18.3 and 18.4.

For normal appearing cervix one section of the anterior and one of the posterior lips fits. The sections are adequate if the squamo-columnar junction (transition zone) is included, because it represents the preferred location of CIN or ACIS [54, 119]. If the uterus is small, both sections can be embedded in one block and one lip (e.g., the anterior one) may be inked.

For examination of the endometrium in premenopausal women two sections, one of the anterior and one of the posterior parts of the fundus uteri is adequate. If the endometrium is atrophic and the woman is postmenopausal, one section is adequate. The section of the endometrium should represent a full thickness section, including the endometrium, adjacent myometrium and the uterine serosa, if not too thick.

The number of sections should be increased if there is a dysfunctional bleeding up to four. Alternatively, wedge sections can be performed by cutting small peaces of the endometrium and the immediately adjoining myometrium putting them in one cassette [143].

From any suspicious lesion within the uterine serosa and the myometrium, one block should be embedded.

The details of histopathology report are listed in Table 18.4.

Hysterectomy in Endometrial Hyperplasia

General aspects of gross description and parameters of the histopathology report are summarised in Table 18.3.

Uteri removed with the previous histopathology of endometrial hyperplasia require more extensive sampling of the myometrium to state residual disease and to exclude / diagnose endometrial carcinoma.

About six sections, three of the anterior and three of the posterior parts of the fundus uteri is have been recommended [143] to detect small well differentiated endometrial cancer [154]. The section of the endometrium should represent a full thickness section. Alternatively, wedge sections can be performed by cutting small peaces of the endometrium and the immediately adjoining myometrium putting them in one cassette [143]. The preferred site of embedding is the macroscopically thickened endometrium.

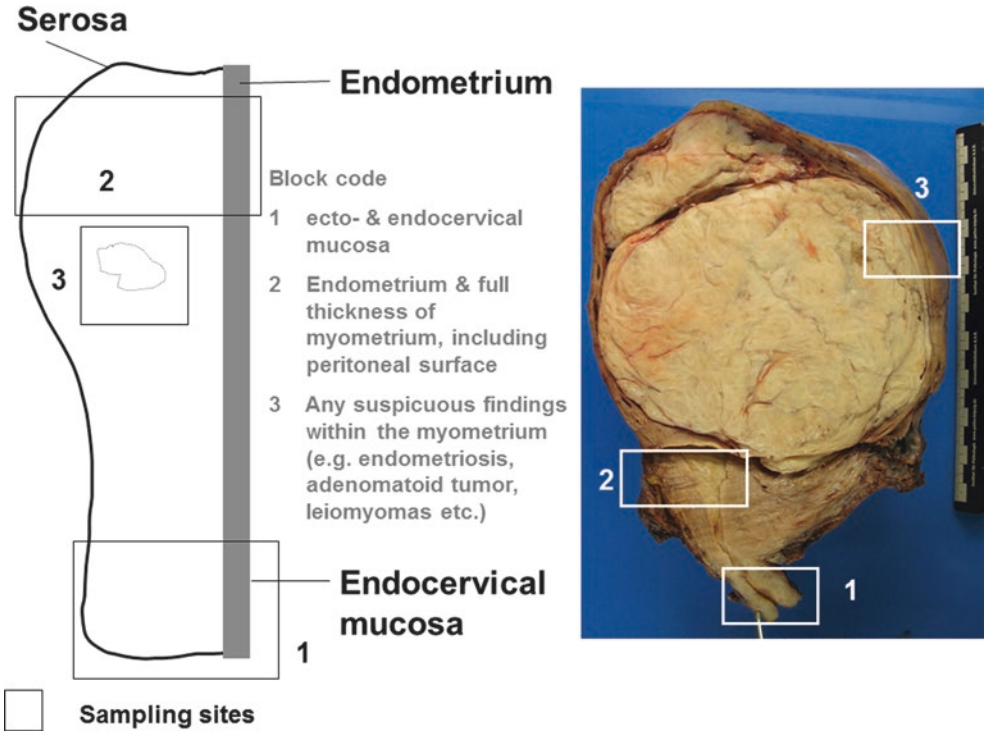


Fig. 18.7 Handling of a hysterectomy specimen for benign disease (see text)

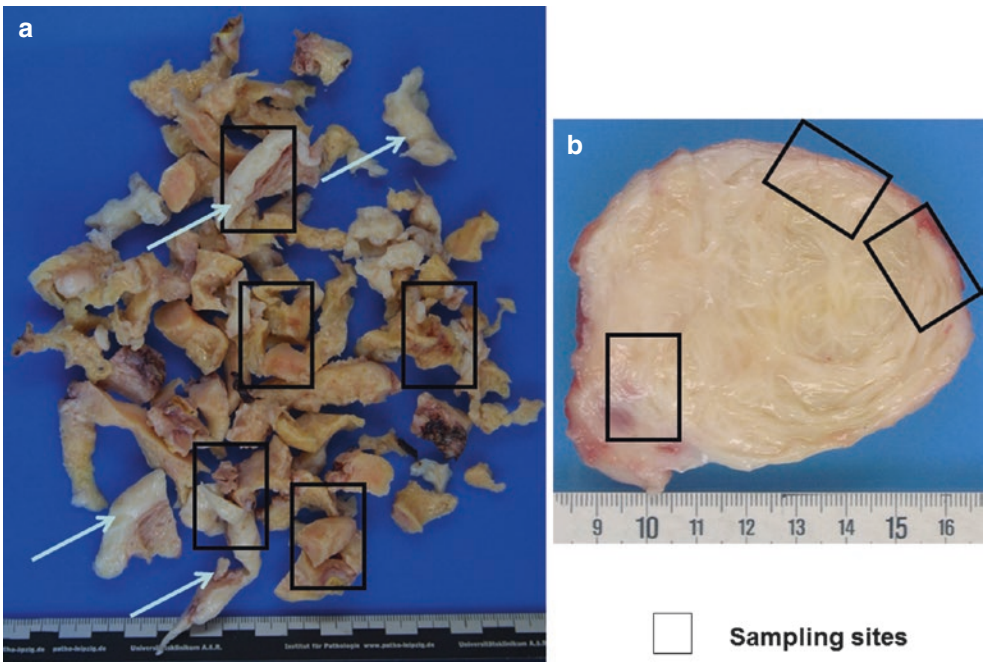


Fig. 18.8 Morcellated uterus and myomectomy. (**a**) Fragments resulted from morcellation during LASH-procedure with fragments of a leimoyma (*arrow*). (**b**) Myomectomy specimen with smooth outline of the leiomyoma with fasciculas (whirled) cutting surface, no necroses, no hemorrhage. Quadrats indicate embedding sites

Table 18.3 General aspects for the cutup of hysterectomy specimens [17, 62, 69, 88, 95, 143, 145]

List which specimens received (uterus alone, with one/two adnexae, tubes only etc.)
Indicate, how the tissue is received (fresh or inadequate/adequate fixed)
Note if the specimen is received intact or in parts or if it is morcellated
Note any defects on the uterine surface
Note if there are sutures made by the clinician to reconstruct the specimen
Make a proper orientation of the uterus
If the adnexae are present: the ovaries lay posteriorily to the Fallopian tubes
The posterior surface of the uterus is covered by a larger area of the peritoneum and extends farther down (in direction of cul-de-sac)
Give the appearance of the uterine surface (serosa)
The posterior part is of special interest
state if the surface is smooth or if there are peritoneal adhesions
State if there is rough surface or some discolorations
Look for small cysts (peritoneal cysts or endosalpingiosis) or probably implants of ovarian borderline tumor
State if there is a vaginal cuff present or not
State if mesometrial/parametrial tissue is present
State if ovarian ligament and/or infundibulum pelvicum is present
Weight the specimen
Give the size of each resected structure in three dimensions
State the performance of the ectocervical surface
Measure the thickness of the normal appearing myometrium
State if the cutting surface of the myometrium is abnormal
Irregular thickening, whirled appearance, cysts, haemorrhages
State the appearance of the endometrium and measure it
State if the endometrium is atrophic, polypoid, irregularly shaped or haemorrhagic
Record the location, shape (sessile or polypoid) and size of any polyps
State if there are abnormal findings within the myometrium (leiomyomata, endometriosis etc.)

Table 18.4 Details of the histopathology report within a hysterectomyspecimen without previously determined malignant disease [62, 69, 95, 143]

List the findings of ecto- and endocervix
List the findings of the endometrium
Atrophic/cyst-atrophic endometrium
Different phases of proliferation and secretion of the endometrium
Changes caused by hormones (oral contraceptives, HRT, selective progesterone receptor modulators, IUD etc.)
Any inflammatory changes
Presence of disordered proliferation/endometrial hyperplasia
List the findings of the myometrium
Leiomyomas, endometriosis/adenomyosis etc.

In case of atypical endometrial hyperplasia a careful examination is required to exclude well differentiated endometrioid adenocarcinoma.

The histopathologic report should give the kind of endometrial hyperplasia according to the most recent WHO-classification [186].

Hysterectomy in Precancerous Lesions or Microinvasive Carcinoma of the Cervix

Precancerous lesion of the cervix includes those deriving from the squamous epithelium (CIN-lesions, [165]) and from the endocervical columnar epithelium (adenocarcinoma in situ; AIS; [179]), some proceed to microinvasive carcinomas.

In the majority of cases there is a history of previous conisation. In hysterectomy specimens with the previous diagnosis of precancerous lesion of the cervix the transformation zone should be embedded completely.

The cervix should be amputated about 1.5 cm above the external os and should be processed similarly to a cone. Radial sectioning in a clockwise manner is the preferred method [17, 61, 62, 69, 88, 143]. Serially blocks should be submitted. Some authors prefer the submission of one sliced specimen within one cassette (e.g. cassette with number 1

indicates 1:00 o'clock). But, in the authors opinion and of others [143] it is also possible to put three sliced specimen in one cassette (e.g. cassette with number 1 indicates 1:00 to 3:00 o'clock and so on). Especially in case of previously diagnosed AIS one additional block of the endocervical mucosa immediate to the complete embedded transition zone is required.

The complete embedding of the transition zone is recommended if previous conisation was performed within the last six months. If it was up to 12 months previously, the embedding of the transition zone performing one block from the 12:00; 3:00; 6:00 and 9:00 o'clock position may be adequate. Perhaps the slices from 12:00 and 6:00 as well as from 3:00 and 6:00 may be processed together and one slice (e.g. 12:00) may be inked. Is there a history of previous CIN/AIS or conisation of >12 months, the cervix should be handled as described in the chapter Hysterectomy in Benign disease at page 435.

The performance of step sectioning (three sections with an interval of 200 µm; [7]) will be required in cases in which the diagnosis was made only be colposcopic guided biopsy or endocervical curetting without previous conisation to exclude microinvasive carcinoma and to document the extension of the lesion. (Secondary) step sectioning is also required when a precancerous lesion is microscopically suspicious for microinvasion. In all other cases up-front step sectioning is not indicated.

General aspects of gross description and parameters of the histopathology report are summarised in Tables 18.3 and 18.4.

The histopathologic report should state the precancerous/micro-invasive lesion according to the most recent WHO-classification [165, 179] and the status (perhaps distance) to the distal (ectocervical/vaginal/ circumferential) resection margin should be given.

Risk-Reducing Hysterectomy in Hereditary Cancer Syndromes

A special condition is the risk-reducing (elective or prophylactic) hysterectomy in women with hereditary cancer syndromes or familial history of endometrial cancer [15, 89, 90, 102, 148].

In those cases the endometrium should carefully examined [27, 80]. As in endometrial hyperplasia, embedding of about six sections, three of the anterior and three of the posterior parts of the fundus uteri is recommended. In some cases complete examination of the endometrium, especially of the lower uterine segment may be required [34]. The section of the endometrium in any grossly visible tumor should represent a full thickness section. Without grossly evident tumor, wedge sections can be performed by cutting small peaces of the endometrium and the immediately adjoining myometrium putting them in one cassette [143].

Some endometrial malignancy in women with HNPCC-(Lynch-) syndrome, occur within the isthmus uteri (lower uterine segment; [11, 27, 139]), so about three additional blocks are recommended to cover the isthmic endometrium. Some authors recommend complete embedding [34].

Colonic adenocarcinoma is the most common malignancy in hereditary nonpolyposis colon cancer (HNPCC; Lynch syndrome). However, endometrial carcinoma may develop before colon carcinoma in ~50 % of women with HNPCC [18, 177, 178]. There may be some features associated with HNPCC-related endometrial carcinoma i.e. age 50 year or younger, personal/family cancer pedigree that meets Bethesda guideline criteria, presence of MMR-associated tumor morphology (poorly differentiated endometrioid carcinoma, presence of high peri-/intratumoral lymphocytes; i.e. ≥40/10 HPF; [27, 152]), or location in the lower uterine segment [11]. In these cases, testing for defective DNA mismatch repair genes (MSH1, MLH2, MLH6, and PMS2) may be performed by immunohistochemistry [27]. Loss of MSH2 expression indicates Lynch syndrome and MSH6 is related to MSH2. HNPCC-related endometrial carcinoma is predominantly associated with MSH2 mutations, and MLH6 mutations in particular [18, 177, 178]. PMS2 loss is often associated with loss of MLH1 and is only independently meaningful if MLH1 is intact. More recently, a first-line testing for defective MMR-genes, followed by methylation testing was suggested for all endometrial cancer patients younger than 60-years of age [14, 43, 139] and by some authors for all newly diagnosed endometrial cancers [118].

The histopathologic report should give the endometrial pathology according to the most recent WHO-classification [186].

Hysterectomy for Leiomyomas and Endometriosis/Adenomyosis (Figs. 18.7 and 18.9)

In *uteri removed for leiomyomas*, the number and its location of the leiomyomas should be recorded. Their minimal and maximal size should be given. It should be stated if the myoma distorts the endometrium or protrudes into the isthmus uteri. These conditions may represent the cause for dysfunctional bleeding or may mimic endometrial polyp clinically and on ultrasound.

Each leiomyoma should be sectioned and examined grossly. If the cutting surface obtaining represents a white, fasciculas, well circumscribed appearance, obtaining one block with the surrounding myometrium will be adequate. If the lesion is >5 cm in largest dimension or represents some necroses or haemorrhagic foci or a softening of its consistence, one block per 1–2 cm largest diameter should be taken in context with the surrounding myometrium.

General aspects of gross description and parameters of the histopathology report are summarised in Tables 18.3 and 18.4.

Two conditions may clinically simulate uterine leiomyomas. For endometriosis/adenomyosis see the paragraph below. Another smooth muscle proliferation with unusual growth pattern represents the (diffuse) myometrial hypertrophia. *Myometrial hypertrophy* is a condition in which the myometrium is thickened and the uterus is (in the majority of cases) symmetrically enlarged without any microscopically abnormalities and without present and most recent pregnancy. This condition is not well defined. The weight of an uterus decreases after menopause and is influenced by the number of previous pregnancies. A weight of >130 g for nulliparous women, >210 g for parity 1–3 and >250 g for parity for and above 4 has been defined as myometrial hypertrophia [93]. Another, less plausible, definition indicates a weight of >200 g with a myometrial thickness of >2 cm [170].

Sometimes the clinicians perform a *myomectomy*. The tissue received should be weighted and measured in three dimensions. Each tissue should be transacted and examined grossly. The embedding of multiple slices in one cassette, altogether of two cassettes fits. Sometimes tiny surrounding tissue is grossly visible and the cuts should cover the transition of the lesion to its surrounding tissue (Fig. 18.8b). If the lesion is >5 cm or present with suspicious findings (see above), additional embedding is required.

The histopathologic report should recognise the criteria for the diagnostic of mesenchymal lesions of the uterus and their terminology of most recent WHO-classification [129].

Within the English literature the *endometriosis uteri* is termed adenomyosis. It is defined as the ectopic presence of endometrial glands surrounded by stroma within the myometrium beyond the histological interface with the endometrium (Fig. 18.9a). No commonly accepted diagnostic criteria of uterine endometriosis exist. On practical purpose the endometriosis should represent more than the field width of an intermediate magnification (i.e. deeper than the microscopic field seen using 10× objective and 10× ocular lenses, within a conventionally configured microscope, or 0.2–0.3 cm below the endometrial (myometrial interface) [128]. Consequently the diagnosis of uterine endometriosis is made on a hysterectomy specimen and not on currettings. Endometriosis uteri may provoke some diagnostic challenges within the clinicians because it may be associated with non-specific signs, may be asymptomatic or may mimic uterine tumors. On histology the endometriotic glands and its surrounding stroma may display the same range of changes seen within the endometrium. Especially on postmenopausal women the glands may disappear (so called gland poor or stromal endometriosis; Fig. 18.9b). Larger foci of stromal endometriosis must be separated from uterine stromal nodule and low-grade endometrial stromal sarcomas [21].

Within a serious number of cases the diagnosin of endometriosis uteri is incidental on microscopy. By careful examination a circumscribed whirling of the myometrium may occur (Fig. 18.9c). Some uterine endometrioses may be tumorlike and may clinically as well as macroscopically mimic leiomyomas (e.g. provoking pelvic discomfort, tumorlike appearance, bleeding disorders). On histology the endometriotic foci are surrounded by a reactive proliferation of the myometrium (Fig. 18.9d, e; representing a "real" adenomyosis of the uterus). Tumorlike uterine endometriosis may mimic low-grade endometrial stromal sarcomas with glandular features [111].

Hysterectomy with Morcellated Uterus

There may be an increased frequency of operation procedures resulting in the fragmentation and morcellation of the uterus (as laparoscopic assisted supracervical hysterectomy; LASH) especially in heavily adipose women [13, 52].

In a serious number of cases it is difficult to get an orientation within the fragmented tissue to identify the endometrium. The preoperative use of methylene blue [136] may simplify macroscopic identification of the endometrium.

The risk of incident malignancies after morcellated hysterectomy ranges between 0.2 and 1 % [36, 51, 53, 149] but may increase with increasing age of the women treated [184].

The tissue received should be weighted and measured in three dimensions as well as examined carefully. From any suspicious findings/discolorations tissue should be processed. Four cassettes, containing two to three tissue slices may be submitted for histopathologic examination. Other authors prefer the embedding of one block per cm largest dimension of the fragmented tissue (D. Mayr, personal communication 2015). From all tissue with any discoloration or different consistency additional embedding is required. The endometrium should be identified. In case of lesions suspicious for leiomyoma, the lesion and the adjacent myometrium should be embedded (Fig. 18.8a). In case of incident malignancies, unclear smooth muscle proliferations or missing endometrium, additional embedding is required.

Hysterectomy with Macroinvasive Cervical Cancer

Trachelectomy (Fig. 18.10)

The specimen should be weighted and measured in three dimensions. The presence and its size of adjacent mesome-

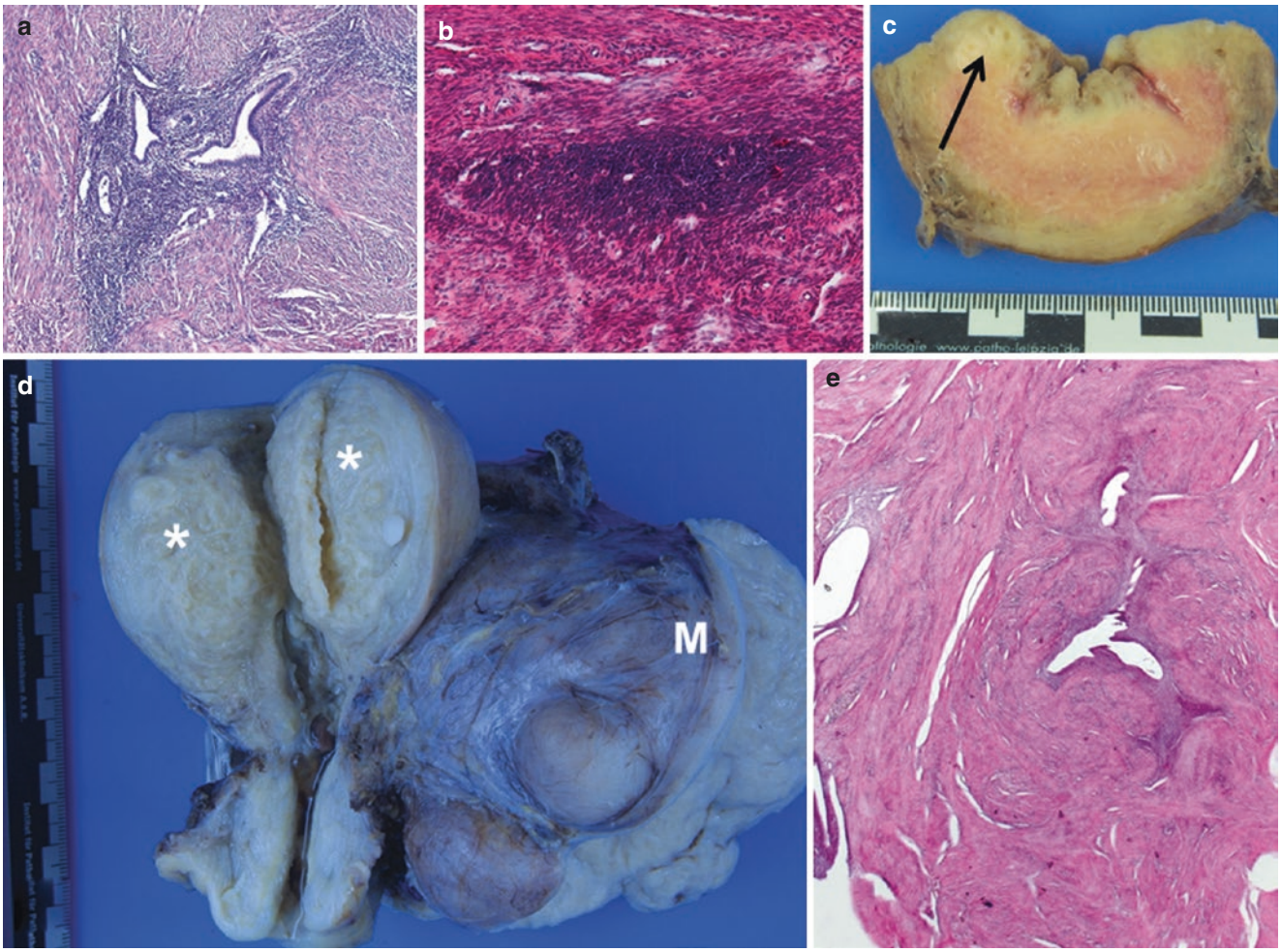


Fig. 18.9 Endometriosis affecting hysterectomy specimen. (**a**) Typical histologic appearance of uterine endometriosis representing endometrial glands and surrounding stroma within the myometrium. (**b**) So called gland poor (or stromal) endometriosis representing solely endometrial stroma without glands within uterine myometrium. (**c**) Macroscopic appearance of small endometriosis (*arrow*). (**d**, **e**) Tumorlike endometriosis within uterine corpus (*stars*), the endometrial glands are surrounded by circular reactive proliferation of smooth muscle fibers of the myometrium, representing an adenomyosis uteri. *M* uterine leiomyoma

trial/parametrial tissue should be given. The length of the vaginal cuff, if present, should be given, separately for its anterior and posterior part. The appearance of the ectocervix and external os should be stated (smooth, erosions, ulcerated, funnel-shaped etc.). The presence of lymph nodes within mesometrial/parametrial tissue should be stated and its size given.

The distal vaginal resection margin should be embedded separately or inked. The proximal endocervical resection margin should be examined separately as well. If present and not removed by previous conisation, the size of the cervical tumor should be given in three dimensions. Its distance to the resection margins (distal/ectocervical, proximal/endocervical, anterior and posterior) should be stated as the involvement of mesometrial/parametrial tissue.

The transformation zone should be embedded completely. Radial sectioning in a clockwise manner is the preferred method. Serially blocks should be submitted preferring the submission of one sliced specimen within one cassette (e.g. cassette with number 1 indicates 1:00 o'clock). The adjacent endocervical tissue should be processed completely as is for the mesometrial/parametrial tissue. The resection margin of the mesometrial/parametrial tissue may be inked.

A synopsis of histopathologic oncology report is summarised in Table 18.5.

The tumor typing and staging should be performed according to the most recent WHO- and TNM-classification [159, 165, 179].

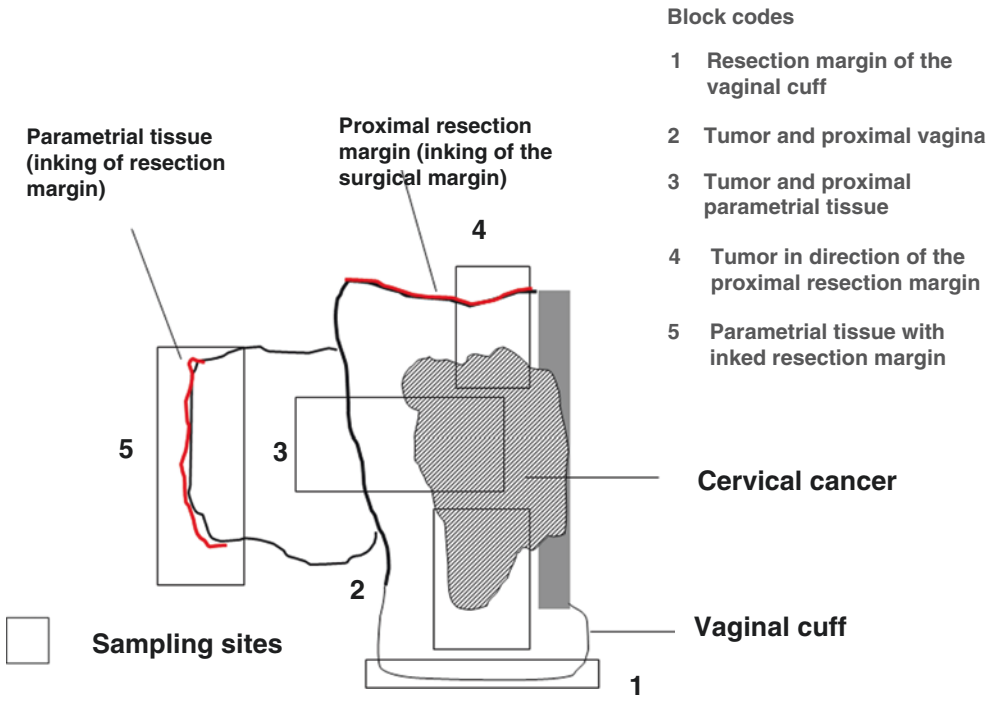


Fig. 18.10 Schematic sectioning of a radical trachelectomy specimen with cervical carcinoma and block codes (for details see text; adopted from Horn et al. 60)

Radical Hysterectomy (Figs. 18.11, 18.12, and 18.13)

Radical hysterectomy will be performed for macroinvasive cervical carcinoma [142, 176] or in some cases with endometrial carcinoma/MMMT with cervical stromal involvement.

General aspects of gross description and parameters of the histopathology report are summarised in Table 18.3.

The final oncology pathology report should recognise the most recent WHO-classification [165, 179] for tumor typing the TNM-classification [159] for staging.

The gross description in radical hysterectomy needs the documentation of the location of the tumor, its three dimensional measurement and its relation to the vaginal cuff (if present) and the resected mesometrial/parametrial tissue as well as the involvement of the corpus uteri. The exact anatomic location of the cervical tumor should be stated (e.g. anterior or posterior lip, ecto- or endocervix; the authors prefer to give an "o'clock location" on localised tumors or to state circular involvement of the transition zone).

The three dimensional size of the resected mesometrial/parametrial tissue should be given. Within specimens resulted from the surgical TMMR-technique the macroscopic description should be separate between the ligamental and vascular part of the mesometrial tissue (Figs. 18.11 and 18.13). By the way, almost all lymph nodes within the mesometrial tissue are located within its vascular part (Fig. 18.11).

The circumferential distal vaginal margin should be embedded separately, one block covering the margin between 9:00 and 3:00 (anterior margin) and one covering the margin between 3:00 and 9:00 (posterior margin) in a tangential manner. Sections of the tumor need to demonstrate the depth of invasion into the cervical stroma, its relationship to the vaginal cuff, the mesometrial/parametrial tissue and the distance to the resection margins. Each section should be perpendicular (if possible) and full thickness and should include the maximum amount of tissue that will fit into the cassette. One block should document the distance to the anterior and posterior resection margin of the cervix uteri.

Since there is a low intratumoral heterogeneity in cervical carcinomas [8, 109], two blocks each from the anterior and posterior part of the cervical stroma is adequate. Especially in larger tumors and/or deep cervical stromal invasion, careful embedding of the transition zone between the cervical stroma and the adjacent mesometrial/parametrial tissue is mandatory. After transecting the resected mesometrial/parametrial tissue, the transition zone to the endocervical stroma should be embedded using perpendicular sections. In the authors institution, in small tumors where there is macroscopically no evidence for mesometrial/parametrial invasion one block from the right and left side will be embedded. In larger tumors or grossly suspicion of mesometrial/parametrial involvement two blocks from each side will be processed.

The transected mesometrial/parametrial tissue will be processed completely to evaluate lymphovascular space or perineural involvement, discontinuity of tumor spread and the detection of small lymph nodes. The mesometrial/para-

Table 18.5 Synopsis of the features within the final oncologic histopathology report of cancer of the cervix uteri [7, 17, 62, 69, 88, 95, 143, 145]

Histopathologic tumor type (WHO)[a]
Grading (WHO)
Tumor regression after previous radio (chemo-) therapy
Absence/presence of lymphovascular and blood vessel (venous) involvement (L- and V-status)
Absence/presence of perineural invasion (Pn-status)
Tumor stage (TNM)
Tumor size and depth of invasion in microinvasive disease (pT1a1 and pT1a2)
Tumor size in three dimensions in macroinvasive disease (≥pT1b1)
Relative depth of invasion within (endo-) cervical stroma (pT1b and pT2a)
Presence/localisation and extension of vaginal invasion
Presence/localisation and extension of mesometrial/parametrial invasion
Minimal distance to the resection margins
R-classification (UICC)
Status of the adnexae

[a]it is important to note that (small cell) neuroendocrine carcinomas of the uterine cervix represent a poor prognosis [6, 185] and that up to 33% of these tumors represent a non-neuroendocrine component [64]. Because mixed neuroendocrine/non-neuroendocrine carcinomas represent decreased survival [64], the percentage of the neuroendocrine component of the whole tumor should be stated within the report [7]

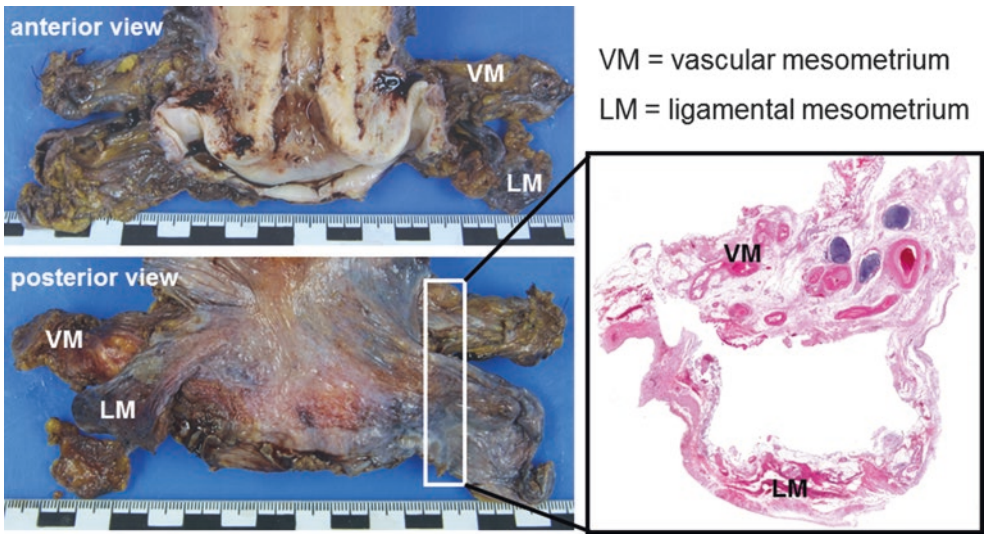


Fig. 18.11 TMMR-specimen (previously opened by scissor at 12 o'clock) representing vascular and ligamental mesometrium using perpendicular section for embedding (see text). Within the vascular mesometrium small lymph nodes are present

metrial tissue will be virtually separated in its proximal (near the uterus), medial and distal third and processed each within one (ore more) cassette. If small lymph nodes are grossly visible, step sections (three sections with an interval of 200 µm) are performed.

Because there may be an increased risk of (para-aortic) lymph node spread [117] and higher frequency of ovarian metastases [81] in cases representing invasion of the uterine corpus this feature should be documented. In each case of macroscopically suspected corpus infiltration (especially in larger tumors), one or two blocks from the cranial end of the tumor into the direction to the corpus uteri should be embedded. Although, involvement of the corpus uteri has no impact on staging at time, that feature should be given within the pathology report, perhaps stating if the infiltration occurs at endometrial or myometrial level or both.

In cases with previous conisation and grossly no visible tumor within the radical hysterectomy specimen, the distal part of the cervix should be embedded completely as described in the chapter about Hysterectomy in Precancerous Lesions or Microinvasive Carcinoma of the Cervix at page 560. The transition zone between the endocervical stroma and the mesometrial/parametrial tissue should be handled as described above.

Based on ontogenetic rather than functional anatomy, new surgical approaches of radical hysterectomy in uterine cervical cancer, known as TMMR-technique [56, 57], has been described. A more radical approach represents the extended mesometrial resection (EMMR; [56]). In EMMR additional

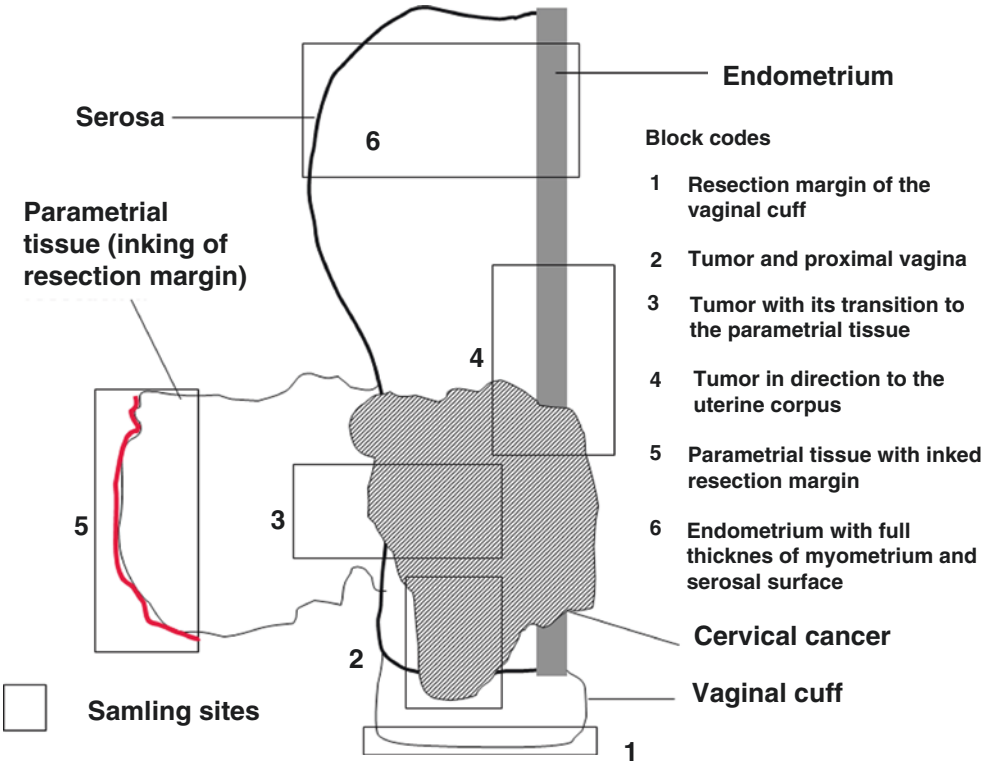


Fig. 18.12 Schematic sectioning of a radical hysterectomy specimen with cervical carcinoma and block codes (for details see text and Table 18.5)

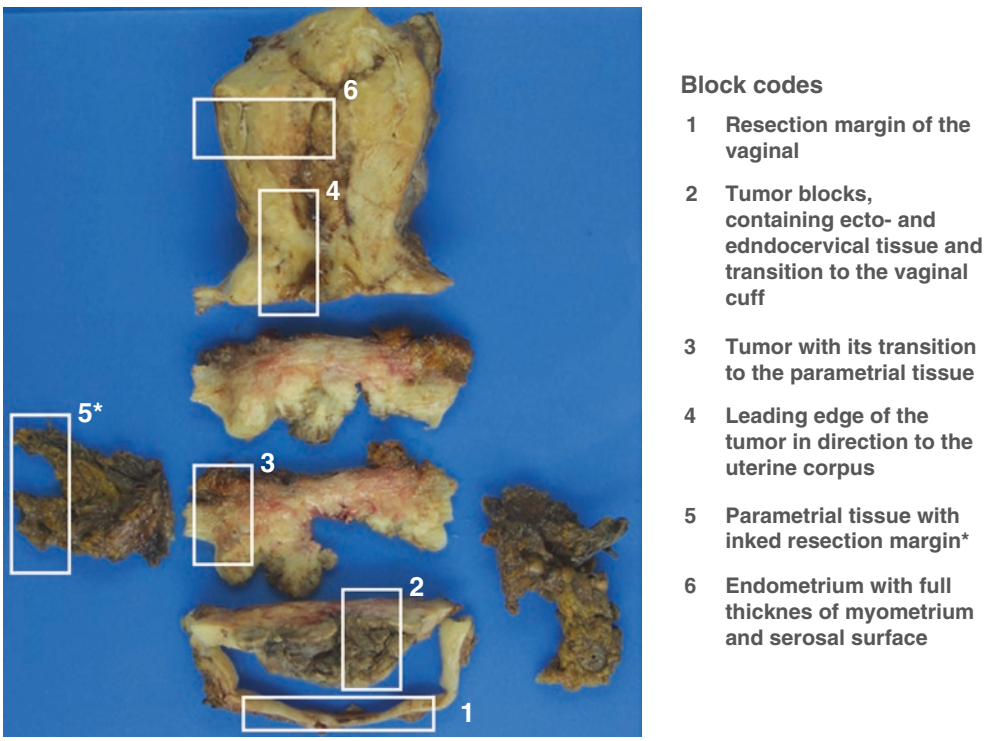


Fig. 18.13 Sectioning of a TMMR-specimen with cervical cancer. For more information please see text (*For detailed handling of the mesometrial tissue please see Fig. 18.11)

pelvic tissue, suspected to be involved by the tumor clinically or on radiologic findings will be removed (Fig. 18.14). This includes for example lipo-fibrous tissue surrounding the ureter (mesoureter) or the resection of the ureter itself and/or the dorso-lateral parts of the urinary bladder (meso of the urinary bladder). This tissue is sometimes incorporated within the mesometrial tissue and may be hard to be identified on macroscopic description and dissection. So, detailed information from the gynaecologic surgeon is mandatory which tissue was removed during EMMR-operation

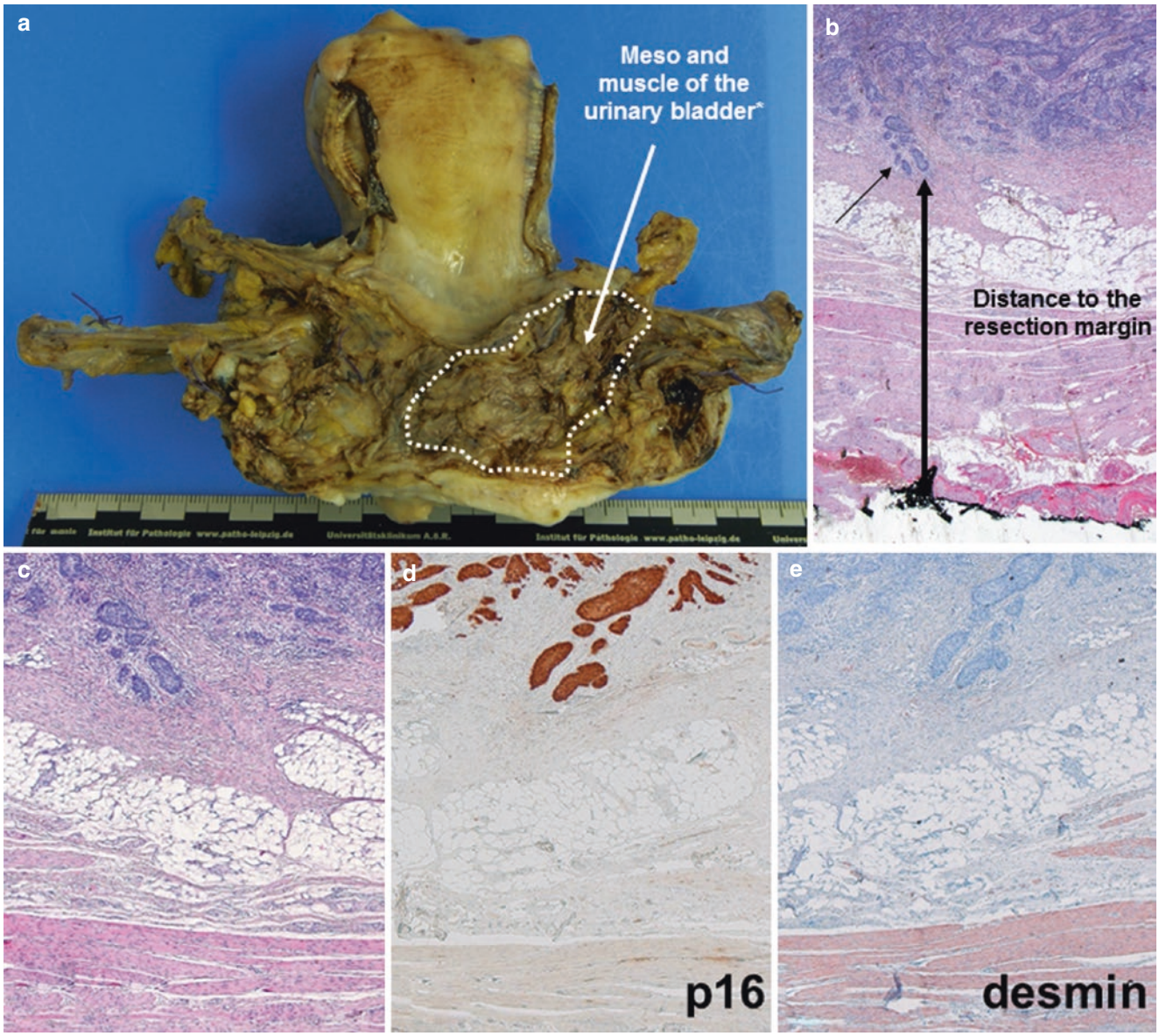


Fig. 18.14 Extended mesometrial resection (EMMR). (**a**) Anterior view of EMMR specimen, encircled the additional removed tissue containing the fatty tissue surrounding the dorsal part of the urinary bladder (bladder's meso) and some outer lines of smooth muscle of the bladders wall, (**b**) microscopic view representing squamous cell carcinoma infiltrating the bladder's meso (*small arrow*), note the peritumoral desmoplastic stromal response surrounding the leading edge of the tumor. *The thick double headed arrow* indicates the distance to the inked resection margin, (**c**–**e**) higher magnification from (**b**) featuring the infiltration of the bladder's meso by the tumor which stained positive for p16, no infiltration of the bladder's muscle which is stained positive for desmin in (**e**)

procedure. The size of that additionally resected tissue should be incorporated in the measurement at gross description and its resection margins should carefully be examined. Sometimes individual components are only detected by histologic examination (Fig. 18.14c–e). The presence or absence of tumor infiltration and its distances should be given in the oncologic pathology report to exactly document the tumor spread within the pelvis and to correlate the pathologic findings with the clinical and radiologic ones.

In cases with radical hysterectomy after neoadjuvant radio- (chemo-) therapy, and grossly no visible tumor within the radical hysterectomy specimen, the distal part of the cervix should be embedded completely as described in the chapter about Hysterectomy in Precancerous Lesions or Microinvasive Carcinoma of the Cervix at page 560. The transition zone between the endocervical stroma and the mesometrial/parametrial tissue should be handled as described above.

The tumor typing and staging should be performed according to the most resent WHO- and TNM-classification [159, 165, 179].

A synopsis of histopathologic oncology report is summarised in Table 18.5.

There may be a prognostic effect of the distance to the anterior and posterior resection margins in patients with were treated by radical hysterectomy using the Wertheim-Meigs-technique [39, 106], but not in patients who were treated by TMMR-technique [59]. Regardless of the used surgical approach, the (metric) distance to the margins should be given in the pathology report. In small tumors the distance can be determined macroscopically, but in large tumors or close resection margins it should be determined histologically using a liner after marking on the slide or in even much more closer margins using an ocular micrometre (Fig. 18.15).

Despite there is no established regression grading system in cervical carcinomas [189] after neoadjuvant radio-(chemo-) therapy, the histopathological report should state if there are any therapeutic effects or not.

Regardless if there is a mesometrial/parametrial involvement, infiltration of the vaginal cuff should be given in the final report with its extension, localisation and distance to the resection margin.

Microscopically, there is no clear transition between the endocervical stroma and the mesometrial/parametrial tissue [94, 131]. But, if tumor is seen outside the endocervical stroma with infiltrative growth within the fibrous paracervical tissue, mesometrial/parametrial involvement should be diagnosed (Fig. 18.16). There is no doubt that the presence of tumor between large vessels and/or fatty tissue it represents stage pT2b. Some authors suggest that the infiltration of paracervical (fibrous) tissue and that of mesometrial tissue with invasion of fatty tissue represents two different ontogenetic tumor stages (oT-stage; [56]).

Metastatic involvement of mesometrial/parametrial lymph nodes represent lymph node involvement and should be staged as pN1 and not as stage pT2b.

There is no doubt that deep cervical stromal invasion represents a prognostic factor but, different studies have used different cut-off points for defining deep infiltrative growth, ranging from >25 to >75 % [28, 84, 91, 191]. Within the German guidelines for the diagnosis and treatment of carcinoma of the uterine cervix, deep stromal invasion was defined very recently as infiltration of >66 % [7]. Depth of invasion is measured from the level of the cervical mucosa up to the deepest point of invasion. The relative depth on invasion is calculated by the relationship between the deepest point of invasion and the full thickness of the cervical wall (see Fig. 18.17). The presence of lymphovascular space involvement outside the deepest point of tumor stromal infiltration will not alter the depth of invasion and should be diagnosed as L1.

There may be a prognostic impact of different patterns of invasion in squamous cell carcinoma of the uterine cervix ([64, 67]; Fig. 18.18). For adenocarcinomas a prognostic relevant 3-tired pattern of invasion has been described [31]. Pattern A represents an infiltrative growth of well-demarced well or moderate differentiated glands with rounded contours, frequently forming groups of glands or cribriform pattern, without lymphovascular space involvement, desmoplastic stromal reaction and without single cell invasion. Pattern B is characterised by early destructive stromal invasion arising from glands with pattern A-like features, with or without lymphovascular space involvement, whereas pattern C shows destructive invasion. It may be recommended to add the pattern of invasion within the histology report.

In case of radical hysterectomy after previous conisation and availability of the histopathology report of the conisation a final (maximal) tumor size should be calculated by summarising both sizes [7].

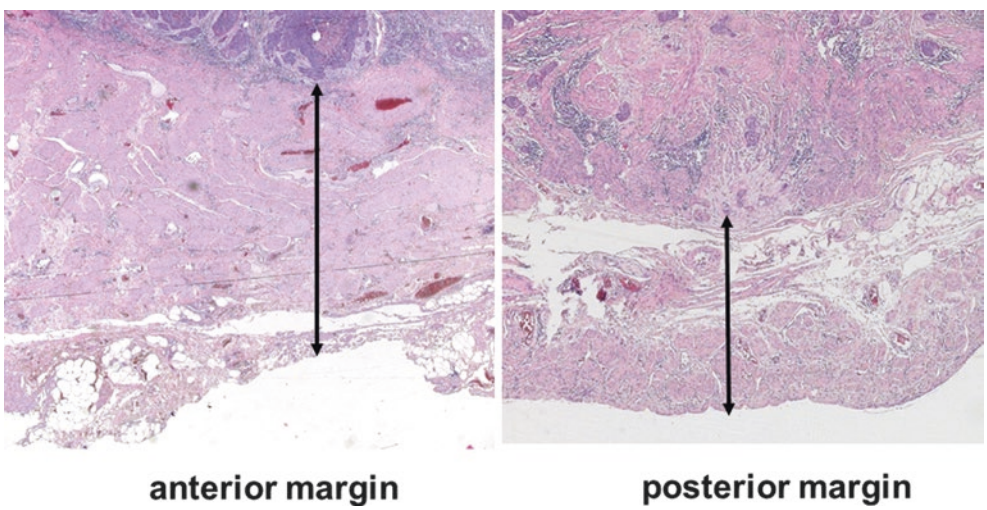


Fig. 18.15 Distances to the anterior and posterior resection margin of a TMMR-specimen with squamous cell carcinoma

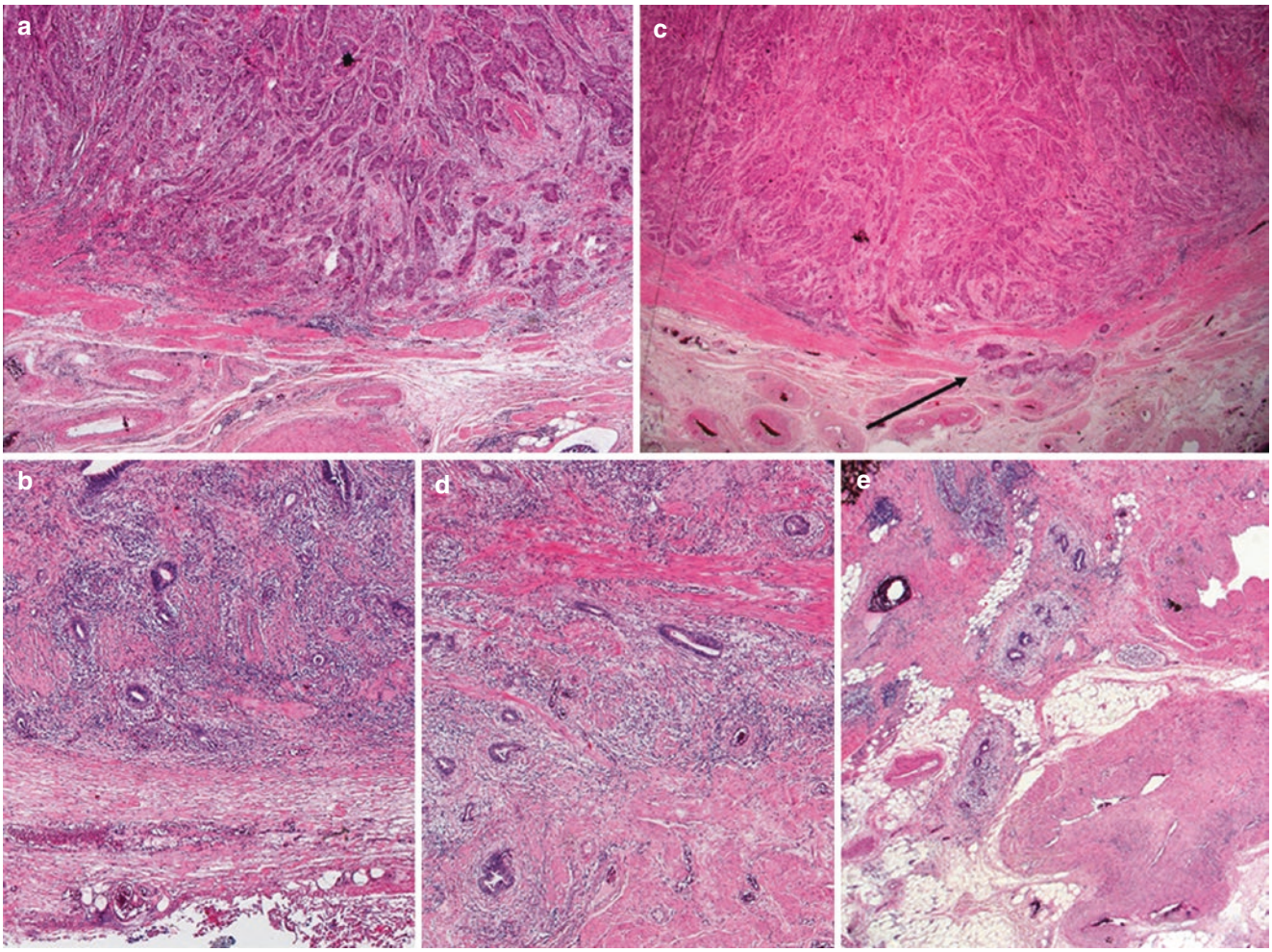


Fig. 18.16 Different patterns of parametrial (mesometrial) invasion by squamous cell carcinoma, indicating pT2b tumors. (**a**, **b**) complete infiltration of the cervical stroma (deep stromal invasion), tumor confined to the cervix, indicating pT1b tumor. (**c**) Very early infiltration outside the endocervical stroma, representing early pT2b tumor. (**d**) Infiltration of the fibrous tissue very close to the endocervical stroma, so called paracervical tissue (Höckel et al. 2014), which represents a part of parametrial (meosmetrial) tissue. (**e**) Infiltration of the fatty tissue of the parametrium (mesometrium)

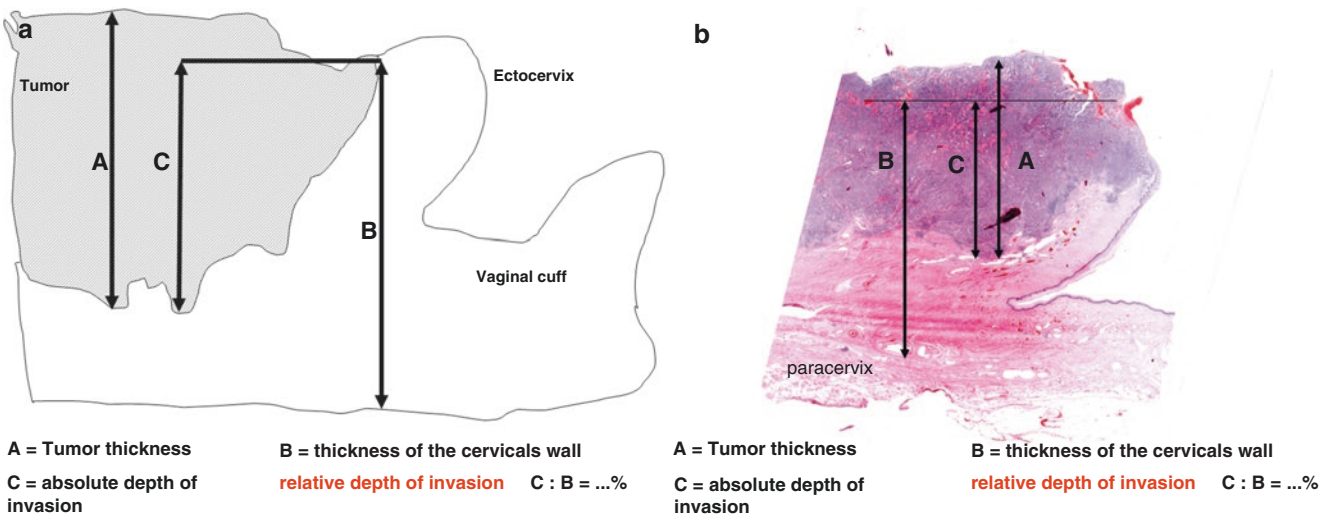


Fig. 18.17 Measurement of the depth of invasion for cervical carcinoma. Deep stromal invasion has been defined by the German guidelines as infiltration of >66 % of the endocervical stroma [7]. (**a**) Scheme for the measurement of absolute and relative depth of invasion. (**b**) Histologic scan containing the proximal part of the vaginal cuff, endo- and ectocervical transition (i.e. transformation zone) and full thickness of tumor and cervical wall

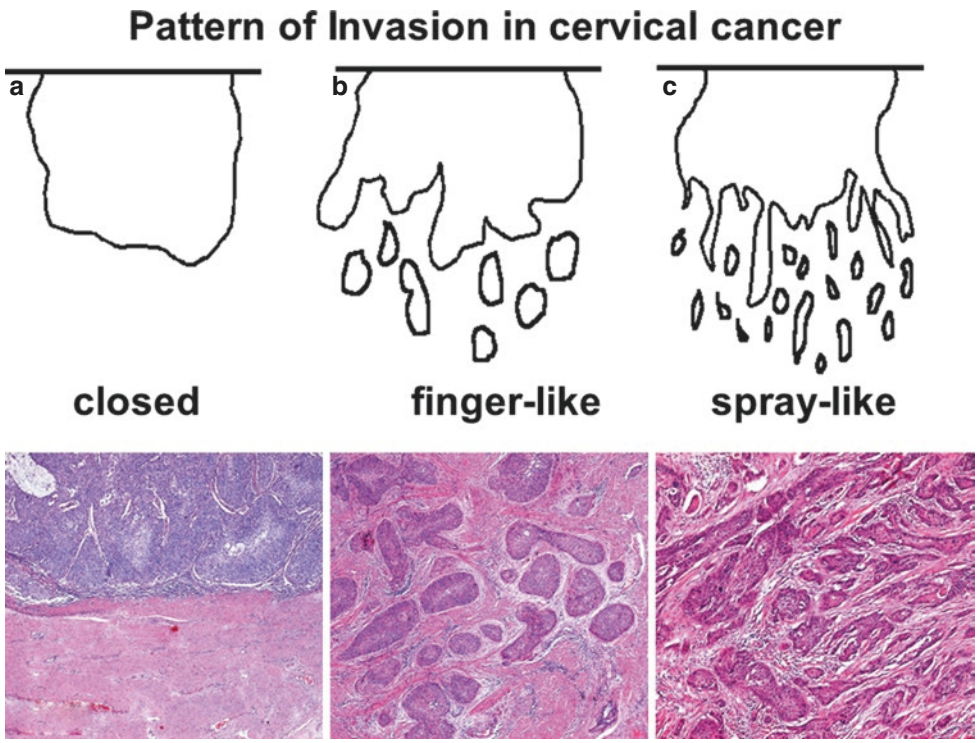


Fig. 18.18 Pattern of invasion of squamous cell carcinoma of the uterine cervix: Schematic description of the modified three-level scoring system for the description of the different types of infiltrative growth [64]. Histologic pictures of the different types of infiltrative growth: (**a**) closed pattern of invasion with cohesive tumor growth with well-delineated infiltrating borders and "pushing" margins, (**b**) finger-like pattern of invasion with trabecular tumor growth in solid cords and tumor cell nests, (**c**) spray-like pattern of invasion with tumor growth in small groups of infiltrating cells and high tumor cell dissociation

There is one major unclear topic within the staging of uterine cervical cancer [55]. The involvement of the Fallopian tube, ovary or adjacent mesoadnexal tissue ("adnexal involvement") is not recognised within the TNM-/FIGO-system [70, 159]. There are only limited studies dealing with the prognostic impact of that topic [78, 81, 153]. So, the impact of "adnexal involvement" is quite unclear at time. In the authors opinion, adnexal involvement represents a feature of local advanced disease and poor prognostic outcome [81] within uterine cervical carcinoma and should be stated as distant metastatic disease, categorised as pM1 OTH.

Hysterectomy with Endometrial Carcinoma and Malignant Mixed Müllerian Tumors (MMMT) (Figs. 18.19, 18.20, 18.21, 18.22, 18.23, and 18.24)

The term *endometrial* designs a lesion which is located within the endometrium. It says nothing about a special histopathological type and its clinical behaviour. Whereas the term *endometrioid* defines a lesion which is histopathologically similar to the morphology of endometrial glands (of the proliferative endometrium). So, an endometrioid endometrial adenocarcinoma means an adenocarcinoma within the endometrium representing a glandular morphology which is similar to the non-neoplastic glands of the endometrium (the adenocarcinoma looks alike normal glands of the endometrium).

According to recent research results MMMTs represent a special morphologic type of endometrial cancer [103, 114]. Consequently, the staging should be performed according to endometrial cancer [159].

The gross description of the endometrial tumor must include the exact anatomic location of the tumor (isthmus uteri (lower uterine segment), or where it is located within the corpus (anterior, posterior wall, dome), its three dimensional measurement and its relation to the cervix uteri as well as its shape (polypoid, sessile, diffuse). Sometimes the length of the vaginal cuff will be important. So, the length (or its absence) of the vaginal cuff should be given, separately for its anterior and posterior part. Some authors state the distance of the tumor to the internal/external cervical os.

For prognostic purposes, staging and adjuvant treatment, the size of the lesion, its depth of invasion within the myometrium and cervical involvement is very important [15, 16].

The cervix uteri should be sampled by one block from anterior and one from the posterior lip [127]. Regardless of macroscopic involvement of the cervix uteri or not, the endocervix should be sampled by (one) perpendicular section (Fig. 18.19). For adequate sampling some authors recommend embedding of several blocks [166]. In some cases,

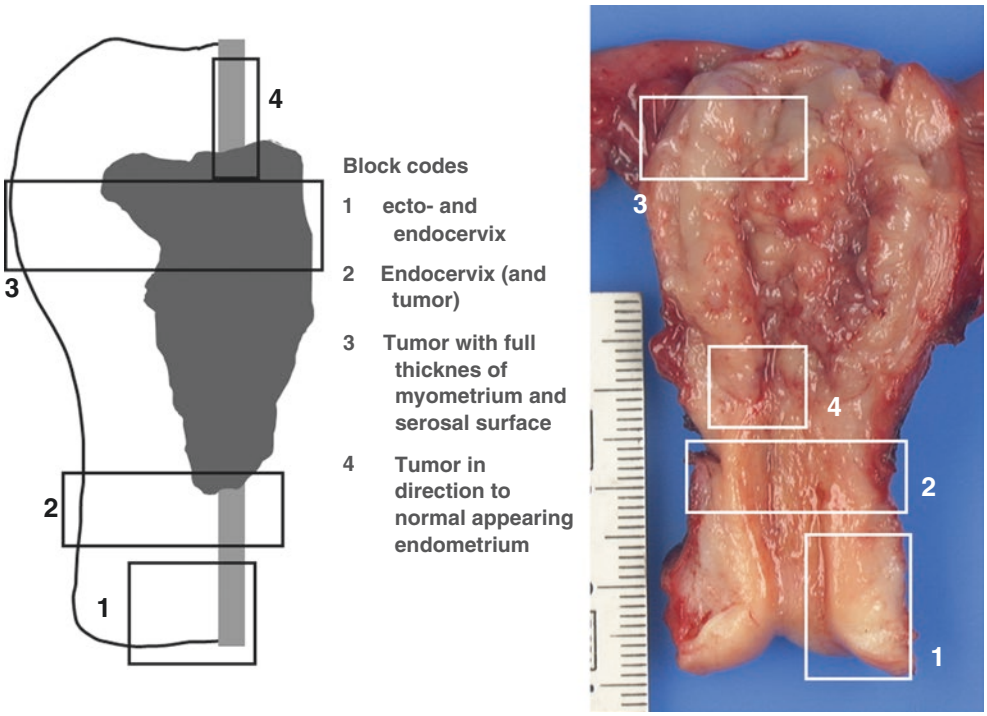


Fig. 18.19 Schematic sectioning of a hysterectomy specimen with endometrial carcinoma and block codes (for details see text and Tables 18.6 and 18.7)

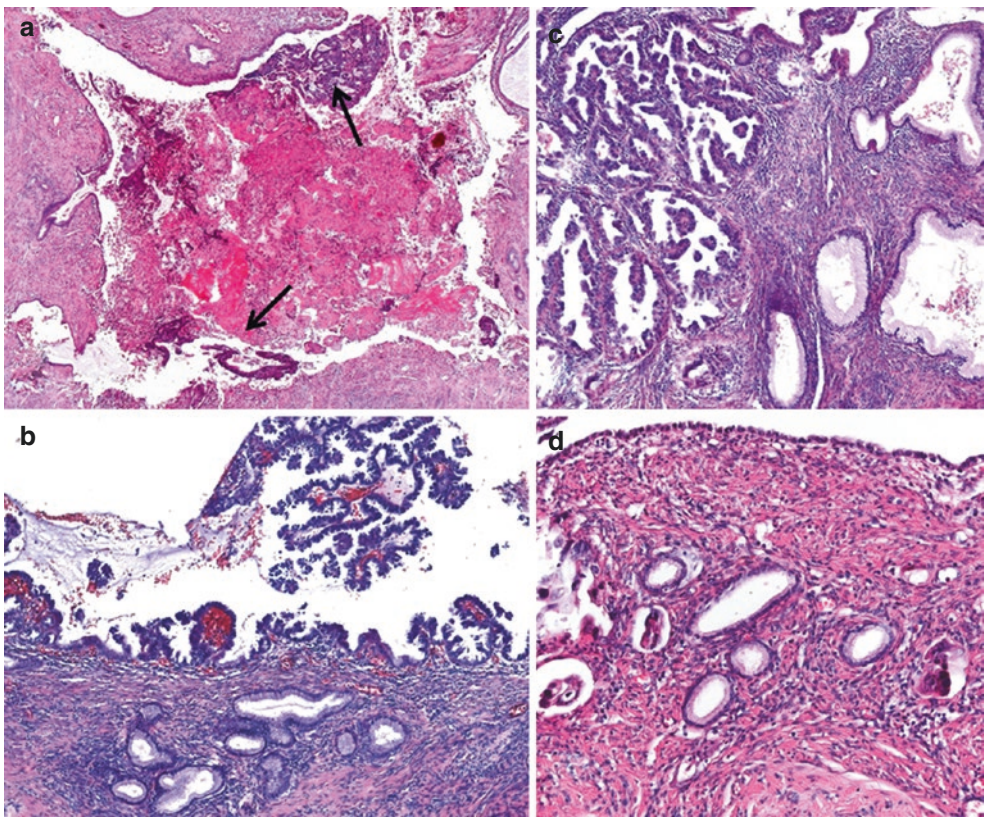


Fig. 18.20 Different patterns of cervical involvement by an endometrial carcinoma (**a**–**c** adopted from: Horn et al. 2011 [70]): (**a**) dislocated tissue of a well differentiated endometrioid ECX (*arrows*) within the cervical channel during irregular bleeding. (**b**) Involvement of endocervical glands by a serous endometrial carcinoma. Note the dislocated glands within the cervical channel (*arrows*) (**c**) infiltration of the cervical stroma by a serous endometrial carcinoma. (**d**) Lymphovascular space involvement of the endocervical stroma by a serous endometrial carcinoma

especially in those with serous endometrial carcinoma, lymphovascular space involvement (LVSI) or occult (microscopic) involvement of the endocervical stroma may occur (Fig. 18.20d). The presence of LVSI represents no "invasion" of the endocervical stroma and should not stated as pT2-tumor, but should be separately mentioned within the report and categorised as L1 [159]. Involvement of the endocervical glands (Fig. 18.20b) by the endometrial carcinoma has no longer impact on staging, whereas the invasion of the endocervical stroma has [132, 159]. The assessment of cervical involvement in endometrial carcinoma may cause some diagnostic problems but there is at most a fair-to-good agreement among specialist gynaecologic pathologists [112]. The determination and reporting of the depth of cervical stromal involvement is facultative at time (but may be asked by the clinicians), because it has no impact on treatment decisions and prognosis.

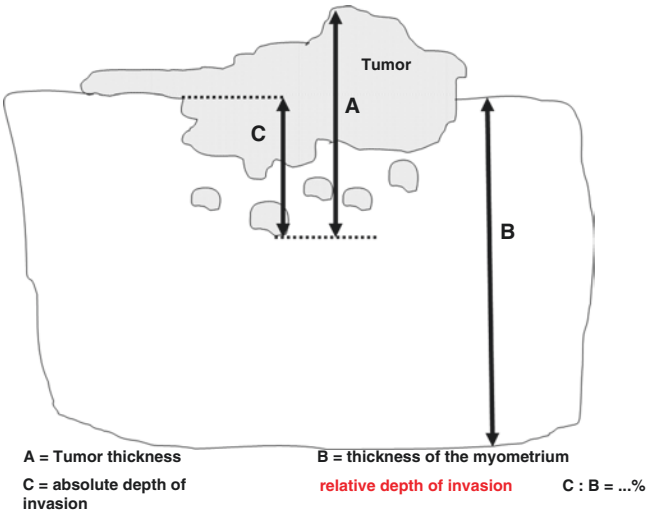


Fig. 18.21 Scheme for the measurement of the depth of invasion for endometrial cancer (Adopted from Robboy et al. [143]).

Within previously diagnosed pure endometrioid or serous endometrial cancer on fractional curetting one block per 2 cm largest tumor dimension is adequate. In mixed endometrioid/serous cancer (or other mixed histologic types, e.g. neuroendocrine carcinoma) and in MMMTs one block per 1 cm largest tumor dimension is recommended.

If there is no grossly visible tumor at the hysterectomy specimen extensive embedding as described for endometrial hyperplasia with embedding of about six sections, three of the anterior and three of the posterior parts of the fundus uteri [143] is recommended. Alternatively, wedge sections

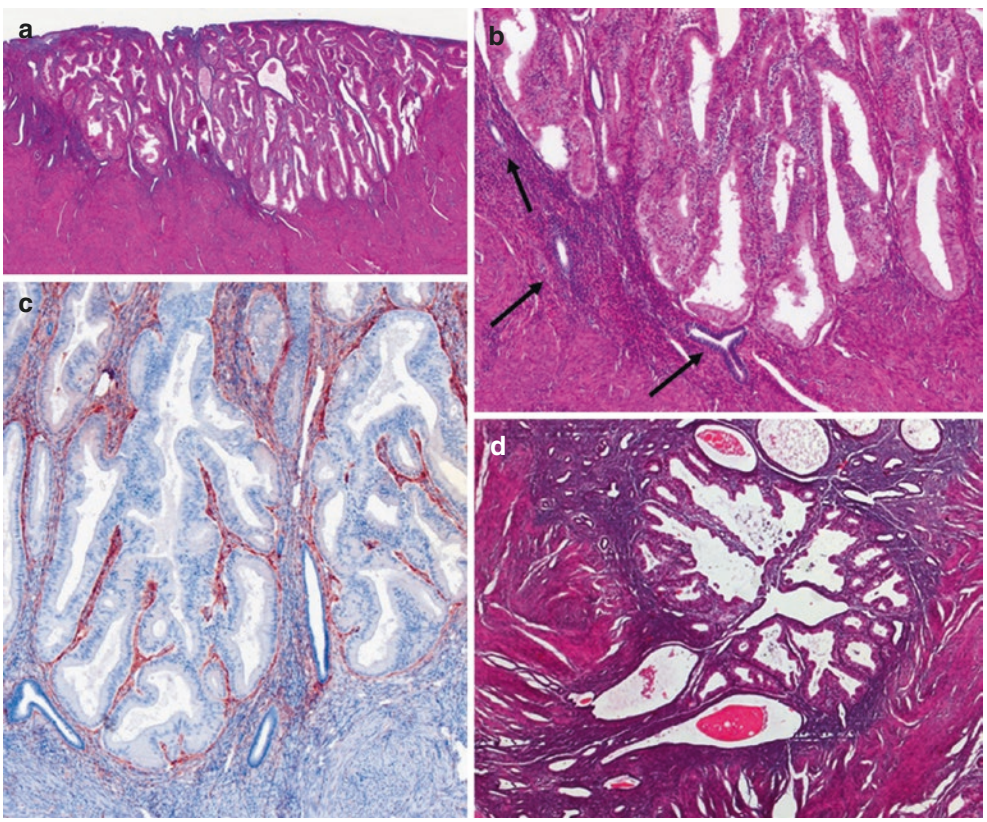


Fig. 18.22 Endometrioid endometrial adenocarcinoma. (**a**) Small well differentiated carcinoma within hysterectomy specimen. (**b**) Tumor glands protruding in direction to the myometrium. Note benign glands at the base of the tumor (*arrows*) as an morphologic feature that the carcinoma is confined to the endometrium. (**c**) Tumor glands are surrounded by a small rim of endometrial stroma cells, highlighted by CD 10 immunostaining (*brown colour*). **(d)** Endometrioid adenocarcinoma involving an endometriosis (see text)

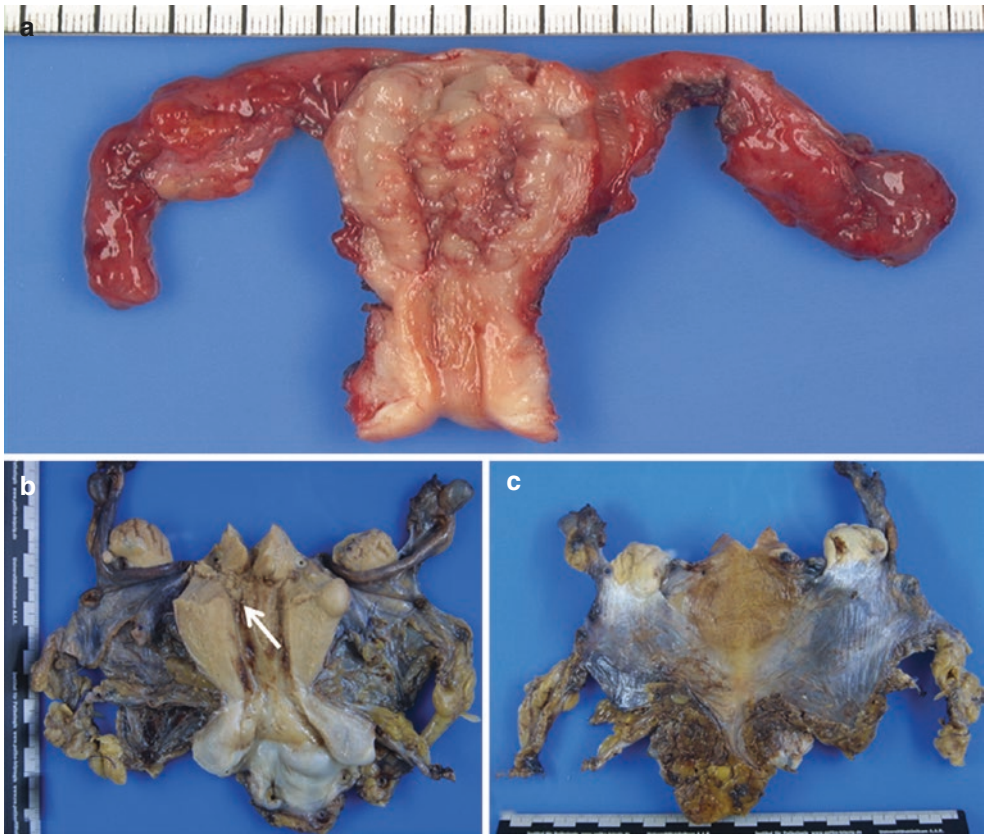


Fig. 18.23 Hysterectomy specimens with endometrial carcinoma. (**a**) Simple hysterectomy with bilateral salpingo-oophorectomy with an endometrial cancer within the corpus uteri representing myometrial infiltration up to the outer third of the myometrium. (**b**, **c**) Anterior and posterior view of a endometrial carcinoma at the right tubal insertion within the uterine corpus (*arrow*) in a PMMR-Specimen (please see text)

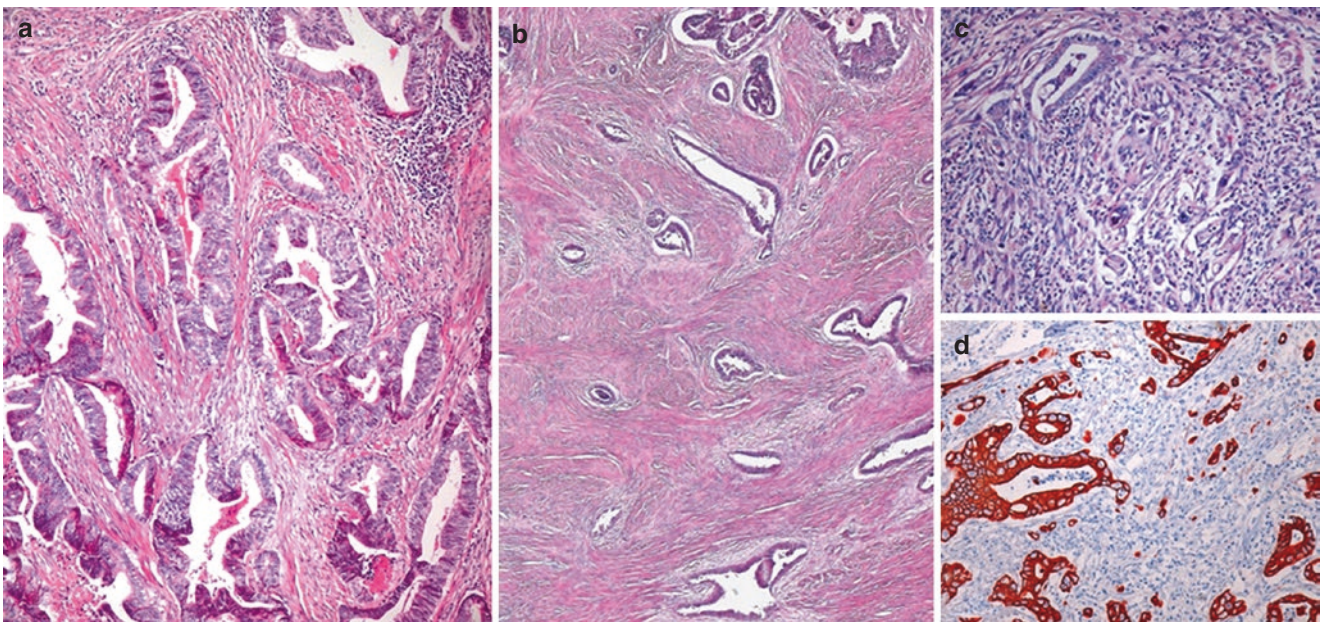


Fig. 18.24 Different patterns of invasion of endometrial adenocarcinoma. (**a**) Conventional pattern of myometrial invasion by a well differentiated endometrioid adenocarcinoma. (**b**) Minimal deviation pattern of myometrial invasion [62, 69]. (**c**, **d**) MELF-pattern of invasion, representing infiltrative growth of microcystic, elongated, fragmented glands (MELF), fragmented glands; highlighted in (**d**) by CK 18 immunostaining

can be performed by cutting small peaces of the endometrium and the immediately adjoining myometrium putting them in one cassette [143]. If there is no residual tumor seen (i.e. *vanishing endometrial cancer*; [3, 35]), complete embedding of the endometrium is recommended using wedge sections.

According to the WHO-classification [186], the term mixed carcinoma should only be used when two or more distinctive subtypes of endometrial carcinoma are identified, each representing more than 5 % of the tumor. When a carcinoma is classified as "mixed," the major and minor types and their relative proportions should be specified and the different percentages should be given in the pathology report.

It should be noted that for mixed endometrioid and serous carcinomas, studies have found variable results regarding tumor behaviour based on percentage of the serous component. Some studies have found that tumors with >25 % serous component behave like pure serous carcinomas [181], whereas other studies have shown that tumors with <10 % serous component also behave like pure serous carcinomas [100].

The depth of invasion should be noted grossly and the embedded tissue should document the area with maximal tumor invasion. The final depth on invasion should be calculated using the histological slides. The depth of invasion should be measured from the level of the adjacent endometrium up to the deepest point of tumor infiltration. If there is an exophytic growth of the tumor, the adjacent endometrium should be identified and an imaginary line should be drawn from that level through the tumor [143]. The distance below that line up to the deepest point of direct tumor infiltration represents the depth on invasion. This distance plus the distance above that line up to the surface of the tumor represent its thickness (Fig. 18.21). Any lymphovascular invasion below the infiltrating tumor front does not alter the depth of invasion and should be categorised as L1. The fact of LVSI below the infiltrating tumor edge should be transferred to the clinician.

Very rarely, *endometrial carcinoma* arises *within an uterine endometriosis* [85]. There, the depth of invasion should be calculated from the most superficial endometrial gland of that endometriosis up to the most distant tumor edge.

Determination of depth of invasion may be challenging [4]. There is no sharp border between the normal endometrium and myometrium, rather than a serrating/interdigitating appearance [55]. Infiltrating glands of endometrial cancer represent in a direct contact to the myometrium, sometimes surrounded by a tiny desmoplastic change (sometimes highlighted by van Gieson stain), but are not surrounded by normal endometrial ands and/or endometrial stroma. The latter one may be highlighted by CD 10-immunohistochemistry (Fig. 18.22a–c).

Involvement of endometriosis by endometrioid adenocarcinoma (Fig. 18.22d) is a known mimicker of myometrial infiltration and may occur in ~25 % of the cases. There is no adverse prognostic impact of that feature. The following features may be useful distinguishing involvement of an endometriosis versus true myometrial invasion [5, 55]:

- presence of benign and endometrial glands adjacent to the carcinoma,
- benign endometrial glands admixed within the carcinoma
- lack of desmoplastic stromal response,
- lack of inflammatory response,
- rounded appearance of the lesion with smooth border on low power.

It has been reported that there is the same thickness of the anterior and posterior wall of the uterus [180] so, the uninvolved myometrium from the opposite wall can be used as reference value determining myometrial thickness.

In contrast to simple hysterectomy for endometrial cancer (or radical hysterectomy in FIGO-stage II disease), women may be treated by peritoneal mesometrial resection (PMMR; Fig. 18.23b, c; [82]; in the chapter about Hysterectomy in Precancerous Lesions or Microinvasive Carcinoma of the Cervix at page 560).

There are some different patterns of invasion within endometrial carcinomas (Fig. 18.24). Beside the classic pattern of growth, an adenoma malignum-like pattern has been described [79].

The so called MELF-pattern of invasion, representing infiltrative growth of microcystic, elongated, fragmented glands (MELF), surrounded by peritumoral desmoplastic stromal response [125] may represent an indicator for high epithelial-mesenchymal transition [164] and has recently been discussed as prognostic factor [40]. So, the different types of invasive growth should be stated within the histopathological report.

There is one major unclear topic within the staging of endometrial cancer and MMMTs, which has been discussed previously [55, 68, 72, 137, 188].

Within the current issue of FIGO/TNM-classification, stage pT3a disease is defined as "tumor invades uterine serous and/or adnexa (direct extension or metastasis) and/or cancer cells in ascites or peritoneal washings" [70, 159]. There is no clear statement how the term adnexal involvement is defined. Tumor deposits within the Fallopian tube and the ovary with histologically proven stromal invasion represents adnexal involvement as is in case of adnexal meso-infiltration (see Fig. 18.25).

The recently recognised intramucosal spread of endometrial and non-gynaecologic cancers to the Fallopians tubal

mucosa [163] also represents adnexal involvement (Fig. 18.25e). But, what is about the presence of LVSI within the meso-salpinx, mes-ovarium, the Fallopian tube and the ovarian stroma?

In our opinion LVSI at that location represents biologically stage pT3a-disease [68, 72]. But under staging purposes, LVSI within the adnexal structures must be categorised as L1 rather than as stage pT3a-disease [159, 182]. The histopathologic report should give the clinician detailed information about the localisation of LVSI and the patterns in case of adnexal involvement.

Because the adnexal involvement may be grossly not evident in a serious number of cases [68, 72], careful examination of adnexal tissue is recommended. The majority of patients with ECX are postmenopausal and the ovaries are usually small and atrophic, so extensive/complete embedding may not be time and/or cost consuming. As suggested by others [156], and under recognition of our above mentioned results, we would recommend complete processing of macroscopic inconspicuous adnexae, regardless of the histologic type of ECX. Within the cutting of the ovary we prefer sectioning along the short axis of the ovary with embedding of the adjacent mesovarian tissue [62, 69] and for handling of the Fallopian tube we adopted the protocol which is currently used for the handling of the tubes in prophylactic adnexectomies from women with BRCA mutations (so called SEE-FIM-protocol; [115, 151]).

A direct invasion or metastatic spread into the parametrial tissue and/or vagina will be staged as pT3b [159]. The presence of LVSI represents no "metastatic spread" and should

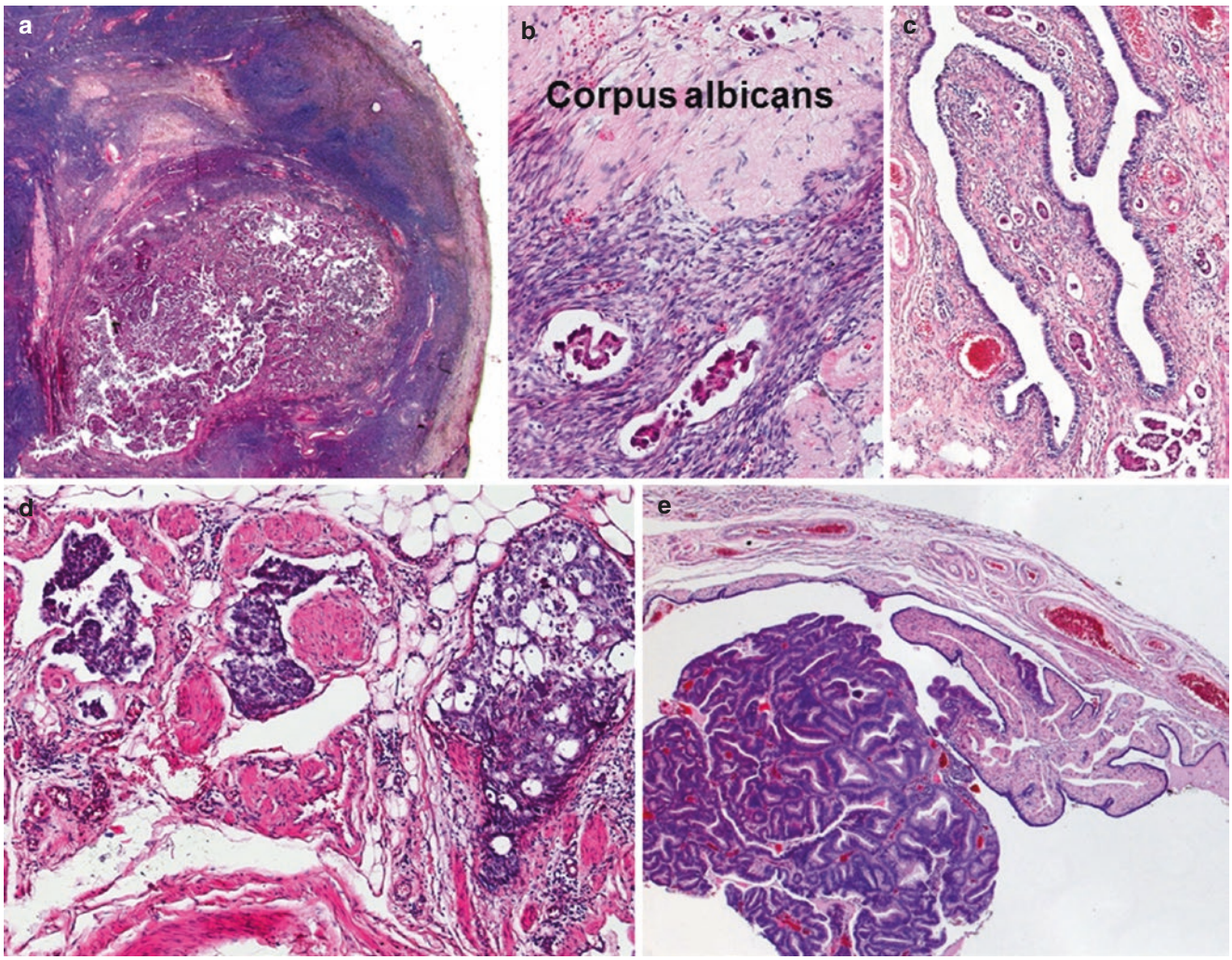


Fig. 18.25 Different patterns of adnexal involvement by endometrial carcinoma [70]. (**a**) Metastasis to the ovarian stroma of an adenosquamous carcinoma of the endometrium. (**b**) lymphovascular space involvement of the ovarian stroma by a serous endometrial carcinoma. (**c**) lymphovascular space involvement of the Fallopian's tubal mucosa by a serous endometrial cancer. (**d**) lymphovascular space involvement of mesoadnexal tissue by a poorly differentiated endometrioid cancer. (**e**) Intramucosal spread to the Fallopina stube mucosa by an endometrioid endometrial adenocarcinoma

Table 18.6 Synopsis of the features within the final oncologic histopathology report of endometrial cancer and malignant Müllerian mixed tumors (MMMT) of the uterus [17, 62, 69, 110, 124, 145, 155]

Histopathologic tumor type (WHO)[a]
Grading (WHO/FIGO)
Absence/presence of lymphovascular and blood vessel (venous) involvement (L- and V-status)
Absence/presence of perineural invasion (Pn-status)
Tumor stage (TNM)
Tumor size and depth of invasion into the myometrium
Tumor size in three dimensions in macroinvasive disease
Presence of (endo-) cervical stromal invasion
Presence/localisation and extension of mesometrial/parametrial invasion
Minimal distance to the resection margins
R-classification (UICC)
Status of the adnexae

[a]the WHO-classification [186] defines mixed carcinomas as tumors where two or more distinctive subtypes are identified, each representing more than 5 % of the tumor. Some studies have found that mixed serous cancer with even >10 % or >25 % of serous component represent adverse outcome [100, 181]. So, each percentage of serous component should be given within the pathology report

not be stated as pT3b-tumor, but should be separately mentioned within the pathology report and categorised as L1 [159].

An unclear issue by definition is the categorisation of the presence of lymph node metastases within the parametrial tissue in endometrial cancer. Lymph node metastases at that location represent metastatic involvement and according to the TNM-classification it represents a pT3b tumor. But, parametrial lymph nodes are defined as regional lymph nodes in endometrial cancer. So, the question appears, if the parametrial nodes are involved should they counted as pN1 as well? Uninvolved parametrial nodes should be counted within the overall number of resected regional nodes.

General aspects of gross description and parameters of the histopathology report are summarised in Tables 18.3 and 18.6.

The final oncology pathology report should recognise the most recent WHO-classification [186] for tumor typing the TNM-classification for staging [159].

Hysterectomy with Uterine Sarcomas

The majority of uterine sarcomas occur within the corpus uteri.

So, the cervix uteri should be sampled by one block from anterior and one from the posterior lip. In case of gross involvement of the endocervix, it should be sampled by perpendicular section(s). To ensure correct diagnosis, extensive sampling i.e. one paraffine block per 1 cm largest tumor dimension should be performed [110, 133, 168]. To cover different morphologic features within the tumor it is helpful to obtain different blocks from different locations with embedding the edges of hemorrhagic and necrotic foci or those with different colours and edges of the lesion protruding in the adjacent myometrium [110, 130, 133].

At time, there is no grading for leimoysarcomas in the WHO classification [129]. Some clinical oncologists urge their pathologist to give a grading for these tumors. In those cases the grading system of the Fédération Nationale des Centres de Lutte Contre le Cancer [23, 24, 30] i.e. FNCLCC-grading system should be adopted.

General aspects of gross description and parameters of the histopathology report are summarised in Tables 18.3 and 18.7.

The final oncology pathology report should recognise the most recent WHO-classification [129] for tumor typing the TNM-classification for staging [159].

Handling of Lymphonodectomy Specimens in Uterine Malignancies (Figs. 18.3 and 18.26)

In uterine cancer and MMMT regional lymph node involvement represents the locoregional spread.

It should be documented (three dimensional measuring) how many tissue was sent for each defined location of lymph node resection. Careful dissection of the specimen is necessary with submission of all visible and palpable lymph nodes. The embedding of the whole lymph node up a maxi-

Table 18.7 Synopsis of the features within the final oncologic histopathology report of uterine sarcomas [22, 26, 77, 110, 133, 168]

Histopathologic tumor type (WHO)
Grading (WHO) of endometrial stromal sarcomas[a]
Tumor regression after previous treatment (including hormonal treatment)
Absence/presence of lymphovascular and blood vessel (venous) involvement (L- and V-status)
Absence/presence of perineural invasion (Pn-status)
Tumor stage (TNM)
Tumor size in three dimensions
Depth of invasion within the myometrium
Presence/localisation and extension of extrauterine infiltration
Minimal distance to the resection margins
R-classification (UICC)

[a]The WHO-classification separate endometrial stromal tumor in low-grade and high-grade enodmetrial stromal tumors and separate them from undifferentiated uterine sarcomas (UUS)

mum dimension of 0.3 cm without slicing has been recommended [63]. Larger nodes should be bivalved along its longest axis and processed completely as well [63, 75, 96, 145].

If the gross lymph node number is small and the remaining soft tissue is small, it may be worthwhile to entirely submit the tissue from that special location for histopathologic analysis [143]. Extensive or complete embedding of the soft tissue resulting from lymph node resection may reassure the clinician that a thorough examination of the tissue has been performed. The use of so called clearing techniques may increase the number of detected nodes [1]. But in case of careful handling of the removed tissue during lymph node resection, clearing techniques cannot being recommended by the authors and others [145] for gynaecologic malignancies.

The performance of step sections (e.g. three step sections with an interval of 200 μm) may increase the detection of small metastases [75, 96].

Isolated tumor cells (ITC) within a lymph node are single tumor cells or small tumor cell clusters not more than 0.2 mm in greatest dimension that can be detected on routine H&E-staining or using immunohistochemistry [182]. To the best of our knowledge, there are no studies regarding prognostic impact of ITC for cervical and endometrial cancer at time. Two reports are dealing with "low volume lymphe node involvement" in patients with cervical carcinoma [19, 161]. In these studies there are no definitions of ITC and micrometastases according to the UICC and AJCC definitions and cases with ITC and micrometastases were not seprated within statistical evaluation. So the question of the prognostic impact of ITC in cervical carcinoma is still unanswered. In the author opinion, the presence of ITC should be reported to the clinician, because that feature indicates the capability for lymphovascuar spread of the given tumor.

The same issues must be stated for the presence of lymphovascular involvement within the fatty tissue surrounding the lymph nodes and within the Vasa afferentia of the lymph nodes in the lymph nodes capsule (Fig. 18.26a, e). Both features are categorised within the L-category of the TNM-system but not as lymph node involvement (N-category).

Micrometastases within lymph nodes are defined by the UICC as the presence of tumor cell deposits larger than 0.2 mm, but not exceeding 0.2 cm ([182]; Figs. 18.4g and 18.26b). This definition was adopted for cervical carcinoma by the last version of the German National guidelines for the diagnosis and treatment of cervical cancer [7] and will be adopted within the next issue of the guidelines for endometrial cancer.

There are some studies which reported the prognostic impact of micrometastases (pN1mic) for cervical carcinomas [45, 65, 66, 99, 105]. Within one study patients with pN1mic have had a poor prognostic outcome than node negative patients but an improved one when it was compared to those with macrometastatic disease [65, 66].

Extracapsular extension of the metastatic deposits into the perinodal fatty tissue (i.e. extracapsular extension; ECS; Fig. 18.26f, g) is an established prognostic factor for vulvar cancer and that feature is included in the N-categorisation within the TNM-system. For carcinoma of the uterine cervix it has been reported that ECS may be of prognostic impact as well [62, 69, 108]. So, that feature may be included within the pathology report of removed lymph nodes representing with metastases of any gynecologic malignancy.

A synopsis of histopathologic report of lymphonodectomy specimens is summarised in Table 18.8.

Block codes

1 Ectocervix

2 Endocervix (and placenta)

3 Myometrium and chorionis membrane

4 Umbilical cord#

5 Amnion membrane

6 Placenta and implatation site within the myometrium

7 Placenta and implantation site with thinned myometrium

8 Placenta and thinned uterine wall within the lower uterine segment

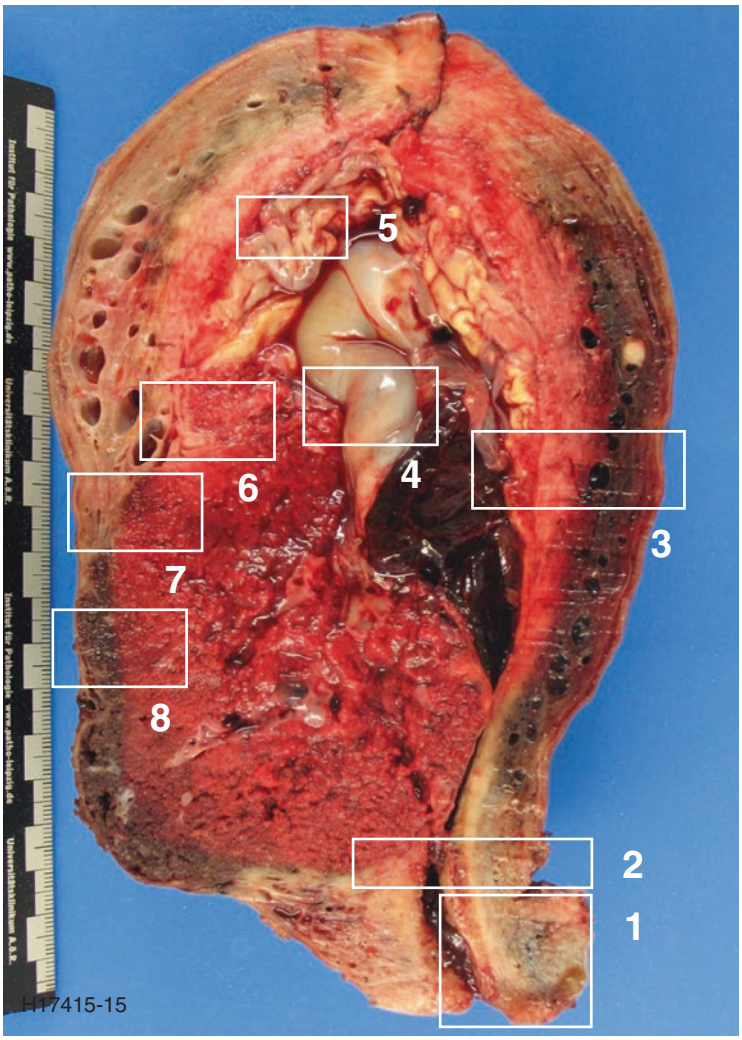


Fig. 18.26 Frontal cut of an hysterectomy with placenta praevia with block code for tissue embedding

Table 18.8 Synopsis of the features within the final histopathology report for removed lymph nodes [63, 96, 143, 145]

Give the location and the dimension of the removed tissue for lymphonodectomy
Give the number of removed/examined nodes per location
Give the number of positive nodes in relation to the number of removed/examined nodes (e.g. 4/13 right pelvic nodes or 0/15 para-aortic nodes)
Largest dimension of nodal metastatic deposit per location
Absence of presence of extracapsular spread of the metastatic deposits per location
Presence or absence of lymphovascular space involvement within the fatty tissue surrounding the lymph node
After pre-operative chemotherapy and/or radiotherapy, regressive changes should be roprted

Handling Omentectomy Specimens

Omentectomy represents a routine part of staging surgery in type 2 endometrial carcinomas (serous and clear-cell carcinomas) and in some cases of malignant mixed Müllerian tumors as well as in selected cases of endometrioid adenocarcinoma.

Macroscopically three dimensions of the omentum should be provided in the pathology report to document the size. This may be useful in certain scenarios to direct the need for further surgery. Additionally, the size may be also helpful to determine the extent of sampling for histologic examination. Any unusual gross findings should be noted and proofed by tissue embedding.

At time, there are no standardized guidelines for sampling omental specimens in gynecologic malignancies. Interestingly, omental sampling is not mentioned within the recommendations of the College of American Pathologists (CAP) and the International Collaboration on Cancer Reporting (ICCR) within their protocols for endometrial malignancies.

The following suggestions are based mainly on studies of ovarian malignancies.

In a *grossly involved omentum*, submitting 1 block for histologic examination is probably sufficient [32, 174].

For *grossly negative omental specimens* the sampling methods vary within different studies.

For ovarian borderline tumors, a meticulously gross examination with an embedding of at least 1 section per 2 cm of maximum dimension was suggested [150]. Usubütün et al. [174] recommended one section per 2–3 cm of maximum omental diameter in cases with ovarian or endometrial cancer. Another studie suggest 1 block for every 67 mm of maximal dimension of omentum in ovarian neoplasms [32]. A recent study reported an estimated sensitivity of 82 % by an examination of 5 blocks and of 95 % by 10 blocks performing a theoretical model ("*in silico*")for optimal sampling of grossly normal omentum in various gynecologic malignancies [158]. In real life studies, the examination of 3–5 blocks was suggested as representative in cases with gynecologic malignancies [158, 174]. The CAP-protocol for ovarian neoplasms generally recommend to take 5–10 sections (a section means a tissue sample transferred to the embedding cassette) from the omentum [25] which may blocked in about 5 paraffine blocks.

For practical purposes in the author opinion, the recommendation for omental sampling of the ICCR for primary ovarian, Fallopian tube and peritoneal cancer [113] should be adopted for endometrial cancer. There, the embedding of 4–6 blocks in cases where the omentum is grossly negative is recommended.

Within pathology report, the size of the largest tumour deposit should be recorded. It should also be reported the presence of omental lymph nodes with or without metastatic deposits. Omental lymph nodes represent not regional lymph nodes in endometrial cancer by the definition of the TNM. So, omental lymph node involvement represents stage T3/FIGO III disease. Any additional findings (e.g. inflammatory change, mesothelial hyperplasia, scaring) should be noted as well.

References

1. Abassi-Ghadi N, Boshier PR, Goldin R, Hanna GB. Techniques to increase lymph node harvest from gastrointestinal cancer specimens: a systematic review and meta-analysis. Histopathology. 2012;61(4):531–42.
2. Abiko K, Baba T, Ogawa M, Mikami Y, Koyama T, Mandai M, Konishi I. Minimal deviation mucinous adenocarcinoma ('adenoma malignum') of the uterine corpus. Pathol Int. 2010;60(1):42–7.
3. Ahmed QF, Gattoc L, Al-Wahab Z, Abdulfatah E, Ruterbusch JJ, Cote M, Bandyopadhyay S, Morris RT, Ali-Fehmi R. Vanishing endometrial cancer in hysterectomy specimens: a myth or a fact. Am J Surg Pathol. 2015;39(2):221–6.
4. Ali A, Black D, Soslow RA. Difficulties in assessing the depth of myometrial invasion in endometrial carcinoma. Int J Gynecol Pathol. 2007;26:115–23.
5. Argani P, Cimino-Mathews A. Intraoperative frozen sections. Diagnostic pitfalls. New York: demosMedical; 2014. p. 255–8.
6. Atienza-Amores M, Guerini-Rocco E, Soslow RA, Park KJ, Weigelt B. Small cell carcinoma of the gynecologic tract: a multifaceted spectrum of lesions. Gynecol Oncol. 2014;134(2):410–8.
7. AWMF. S3-Leitlinie Diagnostik, Therapie und Nachsorge der Patientin mit Zervixkarzinom. Langversion; 2014. http://www.awmf.org/uploads/tx_szleitlinien/032-033OL1_S3_Zervixkarzinom_2014-10.pdf.
8. Bachtiary B, Boutros PC, Pintilie M, Shi W, Bastianutto C, Li JH, Schwock J, Zhang W, Penn LZ, Jurisica I, Fyles A, Liu FF. Gene expression profiling in cervical cancer: an exploration of intratumor heterogeneity. Clin Cancer Res. 2006;12(19):5632–40.

9. Baker P, Oliva E. A practical approach to intraoperative consultation in gynecological pathology. Int J Gynecol Pathol. 2008;27(3):353–65.
10. Bartosch C, Exposito MI, Lopes JM. Low-grade endometrial stromal sarcoma and undifferentiated endometrial sarcoma: a comparative analysis emphasizing the importance of distinguishing between these two groups. Int J Surg Pathol. 2010; 18(4):286–91.
11. Bartosch C, Manuel Lopes J, Oliva E. Endometrial carcinomas: a review emphasizing overlapping and distinctive morphological and immunohistochemical features. Adv Anat Pathol. 2011;18(6):415–37.
12. Bjornsson BL, Nelson BE, Reale FR, Rose PG. Accuracy of frozen section for lymph node metastasis in patients undergoing radical hysterectomy for carcinoma of the cervix. Gynecol Oncol. 1993;51(1):50–3.
13. Bojahr B, Tchartchian G, Ohlinger R. Laparoscopic supracervical hysterectomy: a retrospective analysis of 1000 cases. JSLS. 2009;13(2):129–34.
14. Buchanan DD, Tan YY, Walsh MD, Clendenning M, Metcalf AM, Ferguson K, Arnold ST, Thompson BA, Lose FA, Parsons MT, Walters RJ, Pearson SA, Cummings M, Oehler MK, Blomfield PB, Quinn MA, Kirk JA, Stewart CJ, Obermair A, Young JP, Webb PM, Spurdle AB. Tumor mismatch repair immunohistochemistry and DNA MLH1 methylation testing of patients with endometrial cancer diagnosed at age younger than 60 years optimizes triage for population-level germline mismatch repair gene mutation testing. J Clin Oncol. 2014;32(2):90–100.
15. Burke WM, SGO Clinical Practice Endometrial Cancer Working Group, Orr J, Leitao M, Salom E, Gehrig P, Olawaiye AB, Brewer M, Boruta D, Villella J, Herzog T, Abu Shahin F, Society of Gynecologic Oncology Clinical Practice Committee. Endmetrial cancer: a review and current management strategies: part I. Gynecol Oncol. 2014;134(2):385–92.
16. Burke WM, SGO Clinical Practice Endometrial Cancer Working Group, Orr J, Leitao M, Salom E, Gehrig P, Olawaiye AB, Brewer M, Boruta D, Herzog TJ, Shahin FA, Society of Gynecologic Oncology Clinical Practice Committee. Endometrial cancer: a review and current management strategies: part II. Gynecol Oncol. 2014 Aug;134(2):393–402.
17. CAP. College of American Pathologists. 2011. http://www.cap.org/apps/docs/committees/cancer/cancer_protocols/2011/Cervix_11protocol.pdf.
18. Charames GS, Millar AL, Pal T, Narod S, Bapat B. Do MSH6 mutations contribute to double primary cancers of the colorectum and endometrium? Hum Genet. 2000;107:623–9.
19. Cibula D, Abu-Rustum NR, Dusek L, Zikán M, Zaal A, Sevcik L, Kenter GG, Querleu D, Jach R, Bats AS, Dyduch G, Graf P, Klat J, Lacheta J, Meijer CJ, Mery E, Verheijen R, Zweemer RP. Prognostic significance of low volume sentinel lymph node disease in early-stage cervical cancer. Gynecol Oncol. 2012;124(3):496–501.
20. Cibula D, Sláma J, Svárovský J, Fischerova D, Freitag P, Zikán M, Pinkavová I, Pavlista D, Dundr P, Hill M. Abdominal radical trachelectomy in fertility-sparing treatment of early-stage cervical cancer. Int J Gynecol Cancer. 2009;19(8):1407–11.
21. Clement PB. The pathology of endometriosis: a survey of the many faces of a common disease emphasizing diagnostic pitfalls and unusual and newly appreciated aspects. Adv Anat Pathol. 2007;14(4):241–60.
22. Clement PB. The pathology of uterine smooth muscle tumors and mixed endometrial stromal-smooth muscle tumors: a selective review with emphasis on recent advances. Int J Gynecol Pathol. 2000;19:39–55.
23. Coindre JM. Grading and staging of sarcoma. In: CDM F, Bridge JA, PCW H, Mertens F, editors. WHO classification of tumours of soft tissue and bone. Lyon: IARC Press; 2013. p. 17–8.
24. Coindre JM. Grading of soft tissue sarcomas: review and update. Arch Pathol Lab Med. 2006;130(10):1448–53.
25. CAP: College of American Pathologists. Protocol for the examination of specimens from patients with carcinoma of the ovary. 2015. http://www.cap.org/web/oracle/webcenter/portalapp/pages/search-results.jspx?searchTerms=hysterectomy+omentectomy+peritoneal+biopsies+specify&_adf.ctrl-state=263oqd8k1_21&_afrLoop=629838432981632.
26. Coffey D, Kaplan AL, Ramzy I. Intraoperative consultation in gynecologic pathology. Arch Pathol Lab Med. 2005;129:1544–57.
27. Conklin CMJ, Longacre TA. Lynch syndrome in endometrial carcinoma: a sentinel diagnosis. Pathol Case Rev. 2014;19:78–84.
28. Delgado G, Bundy B, Zaino R, Sevin BU, Creasman WT, Major F. Prospective surgical-pathological study of disease-free interval in patients with stage IB squamous cell carcinoma of the cervix: a Gynecologic Oncology Group study. Gynecol Oncol. 1990;38(3):352–7.
29. Dempster WT. Rates of penetration of fixing fluids. Am J Anat. 1960;107:59–72.
30. Deyrup AT, Weiss SW. Grading of soft tissue sarcomas: the challenge of providing precise information in an imprecise world. Histopathology. 2006;48(1):42–50.
31. Diaz De Vivar A, Roma AA, Park KJ, Alvarado-Cabrero I, Rasty G, Chanona-Vilchis JG, Mikami Y, Hong SR, Arville B, Teramoto N, Ali-Fehmi R, Rutgers JK, Tabassum F, Barbuto D, Aguilera-Barrantes I, Shaye-Brown A, Daya D, Silva EG. Invasive endocervical adenocarcinoma: proposal for a new pattern-based classification system with significant clinical implications: a multi-institutional study. Int J Gynecol Pathol. 2013;32(6):592–601.
32. Doig T, Monaghan H. Sampling the omentum in ovarian neoplasia: when one block is enough. Int J Gynecol Cancer. 2006;16:36–40.
33. Doering DL, Barnhill DR, Weiser EB, et al. Intraoperative evaluation of depth of myometrial invasion in stage I endometrial adenocarcinoma. Obstet Gynecol. 1989;74:930–3.
34. Downes MR, Allo G, McCluggage WG, Sy K, Ferguson SE, Aronson M, Pollett A, Gallinger S, Bilbily E, Shaw P, Clarke BA. Review of findings in prophylactic gynaecological specimens in Lynch syndrome with literature review and recommendations for grossing. Histopathology. 2014;65(2):228–39.
35. Dubé V, Macdonald D, Allingham-Hawkins DJ, Kamel-Reid S, Colgan TJ. Vanishing endometrial carcinoma. Int J Gynecol Pathol. 2007;26(3):271–7.
36. Ehdaivand S, Simon RA, Sung CJ, Steinhoff MM, Lawrence WD, Quddus MR. Incidental gynecologic neoplasms in morcellated uterine specimens: a case series with follow-up. Hum Pathol. 2014;45(11):2311–7.
37. El-Bahrawy M, Ganesan R. Frozen section in gynaecology: uses and limitations. Arch Gynecol Obstet. 2014;289(6):1165–70.
38. Emons G, Mallmann P, members of the Uterus Commission of AGO. Recommendations for the diagnosis and treatment of endometrial caner, update 2013. Geburtshilfe Frauenheilk. 2014;74:244–7.
39. Estape RE, Angioli R, Madrigal M, Janicek M, Gomez C, Penalver M, Averette H. Close vaginal margins as a prognostic factor after radical hysterectomy. Gynecol Oncol. 1998;68(3):229–32.
40. Euscher E, Fox P, Bassett R, Al-Ghawi H, Ali-Fehmi R, Barbuto D, Djordjevic B, Frauenhoffer E, Kim I, Hong SR, Montiel D, Moschiano E, Roma A, Silva E, Malpica A. The pattern of myometrial invasion as a predictor of lymph node metastasis or extrauterine disease in low-grade endometrial carcinoma. Am J Surg Pathol. 2013;37(11):1728–36.
41. Fader AN, Edwards RP, Cost M, Kanbour-Shakir A, Kelley JL, Schwartz B, Sukumvanich P, Comerci J, Sumkin J, Elishaev E, Rohan LC. Sentinel lymph node biopsy in early-stage cervical cancer: utility of intraoperative versus postoperative assessment. Gynecol Oncol. 2008;111(1):13–7.

42. Fanning J, Tsukada Y, Piver MS. Intraoperative frozen section diagnosis of depth of myometrial invasion in endometrial adenocarcinoma. Gynecol Oncol. 1990;37:47–50.
43. Ferguson SE, Aronson M, Pollett A, Eiriksson LR, Oza AM, Gallinger S, Lerner-Ellis J, Alvandi Z, Bernardini MQ, MacKay HJ, Mojtahedi G, Tone AA, Massey C, Clarke BA. Performance characteristics of screening strategies for Lynch syndrome in unselected women with newly diagnosed endometrial cancer who have undergone universal germline mutation testing. Cancer. 2014; 120(24):3932–9.
44. Franchi M, Ghezzi F, Melpignano M, Cherchi PL, Scarabelli C, Apolloni C, Zanaboni F. Clinical value of intraoperative gross examination in endometrial cancer. Gynecol Oncol. 2000;76(3): 357–61.
45. Fregnani JH, Latorre MR, Novik PR, Lopes A, Soares FA. Assessment of pelvic lymph node micrometastatic disease in stages IB and IIA of carcinoma of the uterine cervix. Int J Gynecol Cancer. 2006;16:1188–94.
46. Friedlander ML, Covens A, Glasspool RM, Hilpert F, Kristensen G, Kwon S, Selle F, Small W, Witteveen E, Russell P. Gynecologic Cancer InterGroup (GCIG) consensus review for mullerian adenosarcoma of the female genital tract. Int J Gynecol Cancer. 2014;24(9 Suppl 3):S78–82.
47. Ganesan R, Brown LJ, Kehoe S, McCluggage WG, El-Bahrawy MA. The role of frozen sections in gynaecological oncology: survey of practice in the United Kingdom. Eur J Obstet Gynecol Reprod Biol. 2013;166(2):204–8.
48. Garg G, Shah JP, Toy EP, Field JB, Bryant CS, Liu JR, Morris RT. Intra-operative detection of nodal metastasis in early stage cervical cancer: a survey of the practice patterns of SGO members. Gynecol Oncol. 2011;121(1):143–7.
49. Ghaemmaghami F, Behnamfar F, Ensani F. Intraoperative frozen sections for assessment of female cancers. Asian Pac J Cancer Prev. 2007;8(4):635–9.
50. Goff BA, Rice LW. Assessment of depth of myometrial invasion in endometrial adenocarcinoma. Gynecol Oncol. 1990;38(1):46–8.
51. Graebe K, Garcia-Soto A, Aziz M, Valarezo V, Heller PB, Tchabo N, Tobias DH, Salamon C, Ramieri J, Dise C, Slomovitz BM. Incidental power morcellation of malignancy: a retrospective cohort study. Gynecol Oncol. 2015;136(2):274–7.
52. Grosse-Drieling D, Schlutius JC, Altgassen C, Kelling K, Theben J. Laparoscopic supracervical hysterectomy (LASH), a retrospective study of 1,584 cases regarding intra- and perioperative complications. Arch Gynecol Obstet. 2012;285(5):1391–6.
53. Hagemann IS, Hagemann AR, LiVolsi VA, Montone KT, Chu CS. Risk of occult malignancy in morcellated hysterectomy: a case series. Int J Gynecol Pathol. 2011;30(5):476–83.
54. Herfs M, Yamamoto Y, Laury A, Wang X, Nucci MR, McLaughlin-Drubin ME, Münger K, Feldman S, McKeon FD, Xian W, Crum CP. A discrete population of squamocolumnar junction cells implicated in the pathogenesis of cervical cancer. Proc Natl Acad Sci U S A. 2012;109(26):10516–21.
55. Hirschowitz L, Nucci M, Zaino RJ. Problematic issues in the staging of endometrial, cervical and vulval carcinomas. Histopathology. 2013;62(1):176–202.
56. Höckel M, Hentschel B, Horn LC. Association between developmental steps in the organogenesis of the uterine cervix and locoregional progression of cervical cancer: a prospective clinicopathological analysis. Lancet Oncol. 2014;15(4):445–56.
57. Höckel M, Horn LC, Hentschel B, Höckel S, Naumann G. Total mesometrial resection: high resolution nerve-sparing radical hysterectomy based on developmentally defined surgical anatomy. Int J Gynecol Cancer. 2003;13(6):791–803.
58. Höckel M, Horn LC, Illig R, Dornhöfer N, Fritsch H. Ontogenetic anatomy of the distal vagina: relevance for local tumor spread and implications for cancer surgery. Gynecol Oncol. 2011;122(2):313–8.
59. Höckel M, Horn LC. The puzzle of close surgical margins is not puzzling. Gynecol Oncol. 2013;130(1):224–5.
60. Horn LC, Beckmann MW, Follmann M, Koch MC, Mallmann P, Marnitz S, Schmidt D. 3-Leitlinie Diagnostik und Therapie des Zervixkarzinoms – Anforderungen an die Pathologie. Pathologe. 2015, im Druck.
61. Horn LC, Dallacker M, Bilek K. Carcinosarcomas (malignant mixed Mullerian tumors) of the uterus. Morphology, pathogenetic aspects and prognostic factors. Pathologe. 2009;30(4):292–301.
62. Horn LC, Einenkel J, Höckel M, Kölbl H, Kommoss F, Lax SF, Reich O, Riethdorf L, Schmidt D. Pathoanatomical preparation and reporting for dysplasias and cancers of the cervix uteri: cervical biopsy, conization, radical hysterectomy and exenteration. Pathologe. 2007;28(4):249–60.
63. Horn LC, Einenkel J, Höckel M, Kölbl H, Kommoss F, Lax SF, Riethdorf L, Schnürch HG, Schmidt D. Recommendations for the handling and oncologic pathology report of lymph node specimens submitted for evaluation of metastatic disease in gynecologic malignancies. Pathologe. 2005;26(4):266–72.
64. Horn LC, Fischer U, Raptis G, Bilek K, Hentschel B, Richter CE, Braumann UD, Einenkel J. Pattern of invasion is of prognostic value in surgically treated cervical cancer patients. Gynecol Oncol. 2006;103(3):906–11.
65. Horn LC, Hentschel B, Fischer U, Peter D, Bilek K. Detection of micrometastases in pelvic lymph nodes in patients with carcinoma of the cervix uteri using step sectioning: Frequency, topographic distribution and prognostic impact. Gynecol Oncol. 2008;111(2):276–81.
66. Horn LC, Hentschel B, Galle D, Bilek K. Extracapsular extension of pelvic lymph node metastases is of prognostic value in carcinoma of the cervix uteri. Gynecol Oncol. 2008;108(1):63–7.
67. Horn LC, Hommel N, Roschlau U, Bilek K, Hentschel B, Einenkel J. Peritumoral stromal remodeling, pattern of invasion and expression of c-met/HGF in advanced squamous cell carcinoma of the cervix uteri, FIGO stages III and IV. Eur J Obstet Gynecol Reprod Biol. 2012;163(1):76–80.
68. Horn LC, Meinel A, Fischer U, Bilek K, Hentschel B. Perineural invasion in carcinoma of the cervix uteri–prognostic impact. J Cancer Res Clin Oncol. 2010;136(10):1557–62.
69. Horn LC, Meinel A, Handzel R, Einenkel J. Histopathology of endometrial hyperplasia and endometrial carcinoma: an update. Ann Diagn Pathol. 2007;11:297–311.
70. Horn LC, Schierle K, Schmidt D, Ulrich U, Liebmann A, Wittekind C. Current TNM/FIGO classification for cervical and endometrial cancer as well as malignant mixed müllerian tumors. Facts and background. Pathologe. 2011;32(3):239–43.
71. Horn LC, Schnurrbusch U, Bilek K, Hentschel B, Einenkel J. Risk of progression in complex and atypical endometrial hyperplasia: clinicopathologic analysis in cases with and without progestogen treatment. Int J Gynecol Cancer. 2004;14(2):348–53.
72. Horn LC, Trost M, Bilek K. Staging of endometrial carcinoma: aspects of ovarian and cervical involvement. Int J Gynecol Pathol. 2010;29(1):63–6.
73. Horn LC, Wagner S. Frozen section analysis of vulvectomy specimens: results of a 5-year study period. Int J Gynecol Pathol. 2010;29(2):165–72.
74. Horn LC, Klostermann K. Precancerous lesions of the uterine cervix: morphology and molecular pathology. Pathologe. 2011;32(Suppl 2):242–54.
75. Hunt JL, Baloch ZW, LiVolsi VA. Sentinel lymph node evaluation for tumor metastasis. Semin Diagn Pathol. 2002;19(4):263–77.
76. Ioffe OB. Recent developments and selected diagnostic problems in carcinomas of the endometrium. Am J Clin Pathol. 2005;124(Suppl):S42–51.
77. Ip PP, Cheung AN. Pathology of uterine leiomyosarcomas and smooth muscle tumours of uncertain malignant potential. Best Pract Res Clin Abstet Gynaecol. 2011;25(6):691–704.

78. Jaiman S, Surampudi K, Gundabattula SR, Garg D. Bilateral ovarian metastatic squamous cell carcinoma arising from the uterine cervix and eluding the Mullerian mucosa. Diagn Pathol. 2014; 9:109.
79. Kalyanasundaram K, Ganesan R, Perunovic B, McCluggage WG. Diffusely infiltrating endometrial carcinomas with no stromal response: report of a series, including cases with cervical and ovarian involvement and emphasis on the potential for misdiagnosis. Int J Surg Pathol. 2010;18(2):138–43.
80. Karamurzin Y, Soslow RA, Garg K. Histologic evaluation of prophylactic hysterectomy and oophorectomy in Lynch syndrome. Am J Surg Pathol. 2013;37(4):579–85.
81. Kato T, Watari H, Takeda M, Hosaka M, Mitamura T, Kobayashi N, Sudo S, Kaneuchi M, Kudo M, Sakuragi N. Multivariate prognostic analysis of adenocarcinoma of the uterine cervix treated with radical hysterectomy and systematic lymphadenectomy. J Gynecol Oncol. 2013;24(3):222–8.
82. Kimmig R, Aktas B, Buderath P, Wimberger P, Iannaccone A, Heubner M. Definition of compartment-based radical surgery in uterine cancer: modified radical hysterectomy in intermediate/high-risk endometrial cancer using peritoneal mesometrial resection (PMMR) by M Höckel translated to robotic surgery. World J Surg Oncol. 2013;11:198.
83. Kir G, Kir M, Cetiner H, Karateke A, Gurbuz A. Diagnostic problems on frozen section examination of myometrial invasion in patients with endometrial carcinoma with special emphasis on the pitfalls of deep adenomyosis with carcinomatous involvement. Eur J Gynaecol Oncol. 2004;25(2):211–4.
84. Kodama J, Kusumoto T, Nakamura K, Seki N, Hongo A, Hiramatsu Y. Factors associated with parametrial involvement in stage IB1 cervical cancer and identification of patients suitable for less radical surgery. Gynecol Oncol. 2011;122(3):491–4.
85. Koshiyama M, Suzuki A, Ozawa M, Fujita K, Sakakibara A, Kawamura M, Takahashi S, Fujii H, Hirano T, Okagaki A, Nagano T, Ban C. Adenocarcinomas arising from uterine adenomyosis: a report of four cases. Int J Gynecol Pathol. 2002;21(3): 239–45.
86. Kucera E, Kainz C, Reinthaller A, Sliutz G, Leodolter S, Kucera H, Breitenecker G. Accuracy of intraoperative frozen-section diagnosis in stage I endometrial adenocarcinoma. Gynecol Obstst Invest. 2000;49(1):62–6.
87. Kumar S, Bandyopadhyay S, Semaan A, Shah JP, Mahdi H, Morris R, Munkarah A, Ali-Fehmi R. The role of frozen section in surgical staging of low risk endometrial cancer. PLoS One. 2011;6(9): e21912.
88. Kurman RJ, Amin MB, Members of the Cancer Committee, College of American Pathologists. Protocol for the examination of specimens from patients with carcinomas of the cervix. A basis for checklists. Arch Pathol Lab Med. 1999;123:55–61.
89. Lachiewicz MP, Kravochuck SE, O'Malley MM, Heald B, Church JM, Kalady MF, Drake RD. Prevalence of occult gynecologic malignancy at the time of risk reducing and nonprophylactic surgery in patients with Lynch syndrome. Gynecol Oncol. 2014;132(2):434–7.
90. Lancaster JM, Powell CB, Chen LM, Richardson DL, SGO Clinical Practice Committee. Society of Gynecologic Oncology statement on risk assessment for inherited gynecologic cancer predispositions. Gynecol Oncol. 2015;136(1):3–7.
91. Landoni F, Maneo A, Colombo A, Placa F, Milani R, Perego P, Favini G, Ferri L, Mangioni C. Randomised study of radical surgery versus radiotherapy for stage IB-IIA cervical cancer. Lancet. 1997;350:535–40.
92. Landry D, Mai KT, Senterman MK, Perkins DG, Yazdi HM, Veinot JP, Thomas J. Endometrioid adenocarcinoma of the uterus with a minimal deviation invasive pattern. Histopathology. 2003;42(1):77–82.
93. Langlois PL. The size of the normal uterus. J Reprod Med. 1970;4(6):220–8.
94. Langreder W. Das Parametrium. In: Schröder R (Hrsg). Zwanglose Abhandlungen auf dem Gebiete der Frauenheilkunde. Band 18, Leipzig: Thieme; 1955.
95. Lawrence WD, Abdul-Karim FW, Crum C, Fu YS for the Association of Directors of Anatomic and Surgical Pathology. Recommendations for the reporting of surgical specimens containing uterine cervical neoplasms. Hum Pathol. 2000;31:1194–8.
96. Lawrence WD, Association of Directors of Anatomic and Surgical Pathology. ADASP recommendations for processing and reporting of lymph node specimens submitted for evaluation of metastatic disease. Virchows Arch. 2001;439(5):601–3.
97. Lax S, Tamussino K, Prein K, Lang P. Intraoperative frozen sections in diseases of the female genital tract. Pathologe. 2012;33(5):430–40.
98. Lee AH, Key HP, Bell JA, Kumah P, Hodi Z, Ellis IO. The effect of delay in fixation on HER2 expression in invasive carcinoma of the breast assessed with immunohistochemistry and in situ hybridisation. J Clin Pathol. 2014;67:573–5.
99. Lentz SE, Muderspach LI, Felix JC, Ye W, Groshen S, Amezuca CA. Identification of mircometastases in histologically negative nodes of early-stage cervical cancer patients. Obstet Gynecol. 2004;103:1204–10.
100. Lim P, Al Kushi A, Gilks B, Wong F, Aquino-Parsons C. Early stage papillary serous carcinoma of the endometrium: effect of adjuvant whole abdominal radiotherapy and pathologic parameters on outcome. Cancer. 2001;91:752–7.
101. Liebig C, Ayala G, Wilks JA, Berger DH, Albo D. Perineural invasion in cancer: a review of the literature. Cancer. 2009;115: 3379–91.
102. Lindor NM, Petersen GM, Hadley DW, Kinney AY, Miesfeldt S, Lu KH, Lynch P, Burke W, Press N. Recommendations for the care of individuals with an inherited predisposition to Lynch syndrome: a systematic review. JAMA. 2006;296(12):1507–17.
103. Lopez-Garcia MA, Palacios J. Pathologic and molecular features of uterine carcinosarcomas. Semin Diagn Pathol. 2010;27(4):274–86.
104. Mai KT, Perkins DG, Yazdi HM, Thomas J. Endometrioid carcinoma of the endometrium with an invasive component of minimal deviation carcinoma. Hum Pathol. 2002;33(8):856–8.
105. Marchiole P, Buenerd A, Benchaib M, Nezhat K, Dargent D, Mathevet P. Clinical significance of lympho vascular space involvement and lymph node micrometastases in early-stage cervical cancer: a retrospective case-control surgico-pathological study. Gynecol Oncol. 2005;97:727–32.
106. McCann GA, Taege SK, Boutsicaris CE, Phillips GS, Eisenhauer EL, Fowler JM, O'Malley DM, Copeland LJ, Cohn DE, Salani R. The impact of close surgical margins after radical hysterectomy for early-stage cervical cancer. Gynecol Oncol. 2013;128(1):44–8.
107. McCluggage WG, Colgan T, Duggan M, Hacker NF, Mulvany N, Otis C, Wilkinson N, Zaino RJ, Hirschowitz L. Dataset for reporting of endometrial carcinomas: recommendations from the International Collaboration on Cancer Reporting (ICCR) between United Kingdom, United States, Canada, and Australasia. Int J Gynaecol Pathol. 2012;32:45–65.
108. Metindir J, Bilir Dilek G. Evaluation of prognostic significance in extracapsular spread of pelvic lymph node metastasis in patients with cervical cancer. Eur J Gynaecol Oncol. 2008;29(5):476–8.
109. Kidd EA, Grigsby PW. Intratumoral metabolic heterogeneity of cervical cancer. Clin Cancer Res. 2008;14(16):5236–41.
110. McCluggage WG, Fisher C, Hirschowitz L for the Roayl College of Pathologists. Dataset for histological reporting of uterine sarcomas. 2014. http://www.rcpath.org/publications-media/publications/datasets/uterine-sarcomas.

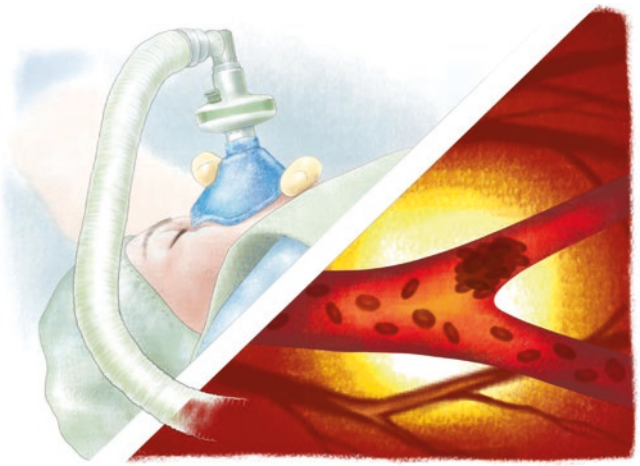
111. McCluggage WG, Ganesan R, Herrington CS. Endometrial stromal sarcomas with extensive endometrioid glandular differentiation: report of a series with emphasis on the potential for misdiagnosis and discussion of the differential diagnosis. Histopathology. 2009;54(3):365–73.
112. McCluggage WG, Hirschowitz L, Wilson GE, Oliva E, Soslow RA, Zaino RJ. Significant variation in the assessment of cervical involvement in endometrial carcinoma: an interobserver variation study. Am J Surg Pathol. 2011;35(2):289–94.
113. McCluggage WG, Judge MJ, Clarke BA, Davidson B, Gilks CB, Hollema H, Ledermann JA, Matias-Guiu X, Mikami Y, Stewart CJR, Vang R, Hirschowitz L. Dataset for reporting of ovary, fallopian tube and primary peritoneal carcinoma: recommendations from the International Collaboration on Cancer Reporting (ICCR). Mod Pathol. 2015;28(8):1101–22.
114. McCluggage WG. Malignant biphasic uterine tumours: carcinosarcomas or metaplastic carcinomas? J Clin Pathol. 2002;55(5):321–5.
115. Medeiros F, Muto MG, Lee Y, Elvin JA, Callahan MJ, Feltmate C, Garber JE, Cramer DW, Crum CP. The tubal fimbria is a preferred site for early adenocarcinoma in women with familial ovarian cancer syndrome. Am J Surg Pathol. 2006;30:230–6.
116. Meinel A, Fischer U, Bilek K, Hentschel B, Horn LC. Morphological parameters associated with perineural invasion (PNI) in carcinoma of the cervix uteri. Int J Surg Pathol. 2011;19(2):159–63.
117. Mileshkin L, Paramanathan A, Kondalsamy-Chennakesavan S, Bernshaw D, Khaw P, Narayan K. Smokers with cervix cancer have more uterine corpus invasive disease and an increased risk of recurrence after treatment with chemoradiation. Int J Gynecol Cancer. 2014;24(7):1286–91.
118. Mills AM, Liou S, Ford JM, Berek JS, Pai RK, Longacre TA. Lynch syndrome screening should be considered for all patients with newly diagnosed endometrial cancer. Am J Surg Pathol. 2014;38(11):1501–9.
119. Mirkovic J, Howitt BE, Roncarati P, Demoulin S, Suarez-Carmona M, Hubert P, McKeon FD, Xian W, Li A, Delvenne P, Crum CP, Herfs M. Carcinogenic HPV infection in the cervical squamocolumnar junction. J Pathol. 2015;236(3):265–71.
120. Moatamed NA, Nanjangud G, Pucci R, Lowe A, Shintaku IP, Shapourifar-Tehrani S, Rao N, Lu DY, Apple SK. Effect of ischemic time, fixation time, and fixative type on HER2/neu immunohistochemical and fluorescence in situ hybridization results in breast cancer. Am J Clin Pathol. 2011;136(5):754–61.
121. Montag AG. The frozen section: historical background, technique and quality assurance. In: Taxy JB, Husain AN, Montag AG, editors. Biopsy interpretation: the frozen section. Philadelphia/Baltimore/New York/London/Buenos Aires/Hong Kong/Sydney/Tokyo: Wolters Kluwer/Lippincott Williams & Wilkin; 2014. p. 1–15.
122. Moodley M, Bramdev A. Frozen section: its role in gynaecological oncology. J Obstet Gynaecol. 2005;25(7):629–34.
123. Morotti M, Menada MV, Moioli M, Sala P, Maffeo I, Abete L, Fulcheri E, Menoni S, Venturini P, Papadia A. Frozen section pathology at time of hysterectomy accurately predicts endometrial cancer in patients with preoperative diagnosis of atypical endometrial hyperplasia. Gynecol Oncol. 2012;125(3):536–40.
124. Movahedi-Lankarani S, Gilks CB, Soslow R, Oliva E, Members of the Cancer Committee, College of American Pathologists. Protocol for the examination of specimens from patients with carcinoma of the endometrium. http://www.cap.org/apps/docs/committees/cancer/cancer_protocols/2011/Endometrium_11protocol.doc.
125. Murray SK, Young RH, Scully RE. Unusual epithelial and stromal changes in myoinvasive endometrioid adenocarcinoma: a study of their frequency, associated diagnostic problems, and prognostic significance. Int J Gynecol Pathol. 2003;22(4):324–33.
126. Nakao Y, Yamasaki F, Yokoyama M, Aihara S, Yasunaga M, Iwasaka T. Minimal deviation endometrioid adenocarcinoma of the endometrium and its MRI findings. Eur J Gynaecol Oncol. 2014;35(2):185–7.
127. Nayar AG, Cross PA, Bulmer JN, Deen S, El-Sherif A. Comparison of examination of the entire uterine cervix with routine cervical sampling in hysterectomy specimens from women with endometrial cancer. J Clin Pathol. 2008;61(5):621–2.
128. Nucci MR, Quade BJ. Uterine mesenchymal tumors. In: Crum CP, Lee KR, editors. Diagnostic gynecologic and obstetric pathology. Philadelphia: Elsevier; 2006. p. 655–7.
129. Oliva E, Carcangiu ML, Carinelli SG, Ip P, Loening T, Longacre TA, Nucci MR, Prat J, Zaloudek CJ. Mesenchymal tumors of the uterine corpus. In: Kurman RJ, Carcangiou ML, Herrington S, Young RH, editors. WHO classification of tumours of femal reproductive organs. Lyon: IARC Press; 2014. p. 135–48.
130. Oliva E. Cellar mesenchymal tumors of the uterus: a review emphasizing recent observations. Int J Gynecol Pathol. 2014;33(4):374–84.
131. Ober KG, Huhn FO. Die Ausbreitung des Cervixkrebses auf die Parametrien und die Lymphknoten der Beckenwand. Arch Gynäkol. 1962;197:262–90.
132. Orezzoli JP, Sioletic S, Olawaiye A, Oliva E, del Carmen MG. Stage II endometrioid adenocarcinoma of the endometrium: clinical implications of cervical stromal invasion. Gynecol Oncol. 2009;113(3):316–23.
133. Otis CN, Ocampo AC, Nucci MR, McCluggage WG, For the Members of the Cancer Committee, College of American Pathologists. Protocol for the examination of specimens from patients with sarcoma of the uterus. http://www.cap.org/apps/docs/committees/cancer/cancer_protocols/2013/UterineSarcomaProtocol_3000.pdf.
134. Ozturk E, Dikensoy E, Balat O, Ugur MG, Aydin A. Intraoperative frozen section is essential for assessment of myometrial invasion but not for histologic grade confirmation in endometrial cancer: a ten-year experience. Arch Gynaecol Obstet. 2012;285(5):1415–9.
135. Pautier P, Nam EJ, Provencher DM, Hamilton AL, Mangili G, Siddiqui NA, Westermann AM, Reed NS, Harter P, Ray-Coquard I. Gynecologic Cancer InterGroup (GCIG) consensus review for high-grade undifferentiated sarcomas of the uterus. Int J Gynecol Cancer. 2014;24(9 Suppl 3):S73–7.
136. Pavlakis K, Vrekoussis T, Pistofidis G, Gavresea T, Panoskaltsis T. Methylene blue: how to visualize the endometrium in uterine morcellation material. Int J Gynecol Pathol. 2014;33(2):135–9.
137. Prat J. Prognostic parameters of endometrial carcinoma. Hum Pathol. 2004;35:649–62.
138. Quinlivan JA, Petersen RW, Nicklin JL. Accuracy of frozen section for the operative management of endometrial cancer. BJOG. 2001;108(8):798–803.
139. Rabban JT, Calkins SM, Karnezis AN, Grenert JP, Blanco A, Crawford B, Chen LM. Association of tumor morphology with mismatch-repair protein status in older endometrial cancer patients: implications for universal versus selective screening strategies for Lynch syndrome. Am J Surg Pathol. 2014;38(6):793–800.
140. Rakha EA, Pinder SE, Bartlett JM, Ibrahim M, Starczynski J, Carder PJ, Provenzano E, Hanby A, Hales S, Lee AH, Ellis IO, National Coordinating Committee for Breast Pathology. Updated UK Recommendations for HER2 assessment in breast cancer. J Clin Pathol. 2015;68(2):93–9.
141. Rakha E, Wong SC, Soomro I, Chaudry Z, Sharma A, Deen S, Chan S, Abu J, Nunns D, Williamson K, McGregor A, Hammond R, Brown L. Clinical outcome of atypical endometrial hyperplasia diagnosed on an endometrial biopsy: institutional experience and review of literature. Am J Surg Pathol. 2012;36(11):1683–90.

142. Rob L, Robova H, Chmel R, Komar M, Halaska M, Skapa P. Surgical options in early cervical cancer. Int J Hyperthermia. 2012;28:489–500.
143. Robboy SJ, Mutter GL, Shako-Levy R, Bean SM, Prat J, Bentley RC, Russel P. Cutup – gross description and processing of specimens. In: Robboy SJ, Mutter GL, Prat J, Bentley RC, Russel P, Anderson MC, editors. Robboy's pathology of the female reproductive tract. Edinburgh/London/New York/Oxford/Philadelphia/St. Louis/Sydney/Toronto: Elsevier; 2009. p. 979–91.
144. Rosai J. Foreword. In: Argani P, Cimino-Mathews A, editors. Intraoperative frozen sections. Diagnostic pitfalls. New York: demosMedical; 2014. p. XIII–XV.
145. Rosai J, editor. Rosai and Ackerman's surgical pathology. Edinburgh/London/New York/Oxford/Philadelphia/St. Louis/Sydney/Toronto: Elsevier; 2011. p. 2553–4, 2579–83, 2633–6.
146. Sanjuán A, Cobo T, Pahisa J, Escaramís G, Ordi J, Ayuso JR, Garcia S, Hernández S, Torné A, Martínez Román S, Lejárcegui JA, Vanrell JA. Preoperative and intraoperative assessment of myometrial invasion and histologic grade in endometrial cancer: role of magnetic resonance imaging and frozen section. Int J Gynecol Cancer. 2006;16(1):385–90.
147. Savelli L, Testa AC, Mabrouk M, Zannoni L, Ludovisi M, Seracchioli R, Scambia G, De Iaco P. A prospective blinded comparison of the accuracy of transvaginal sonography and frozen section in the assessment of myometrial invasion in endometrial cancer. Gynecol Oncol. 2012;124(3):549–52.
148. Schmeler KM, Lynch HT, Chen LM, Munsell MF, Soliman PT, Clark MB, Daniels MS, White KG, Boyd-Rogers SG, Conrad PG, Yang KY, Rubin MM, Sun CC, Slomovitz BM, Gershenson DM, Lu KH. Prophylactic surgery to reduce the risk of gynecologic cancers in the Lynch syndrome. N Engl J Med. 2006;354(3):261–9.
149. Seidman MA, Oduyebo T, Muto MG, Crum CP, Nucci MR, Quade BJ. Peritoneal dissemination complicating morcellation of uterine mesenchymal neoplasms. PLoS One. 2012;7(11):e50058.
150. Seidman JD, Soslow RA, Vang R, Berman JJ, Stoler MH, Sherman ME, Oliva E, Kajdacsy-Balla A, Berman DM, Copeland LJ. Borderline ovarian tumors: diverse contemporary viewpoints on terminology and diagnostic criteria with illustrative images. Hum Pathol. 2004;35(8):918–33.
151. SGO. Society of Gynecologic Oncologists Clinical Practice Committee statement on prohpylactic Salpingo-oophorectomy. Gynecol Oncol. 2005;98:179–81.
152. Shia J, Black D, Hummer AJ, Boyd J, Soslow RA. Routinely assessed morphological features correlate with microsatellite instability status in endometrial cancer. Hum Pathol. 2008;39(1):116–25.
153. Shimada M, Kigawa J, Nishimura R, Yamaguchi S, Kuzuya K, Nakanishi T, Suzuki M, Kita T, Iwasaka T, Terakawa N. Ovarian metastasis in carcinoma of the uterine cervix. Gynecol Oncol. 2006;101(2):234–7.
154. Shutter J, Wright TC Jr. Prevalence of underlying adenocarcinoma in women with atypical endometrial hyperplasia. Int J Gynecol Pathol. 2005;24(4):313–8.
155. Silverberg SG. Protocol for the examination of specimens from patients with carcinomas of the endometrium: a basis for checklists. Cancer Committee, College of American Pathologists. Arch Pathol Lab Med. 1999;123(1):28–32.
156. Silverberg SG. The endometrium. Pathologic principles and pitfalls. Arch Pathol Lab Med. 2007;131:372–82.
157. Singh R. Review literature on uterine carcinosarcoma. J Cancer Res Ther. 2014;10(3):461–8.
158. Skala SL, Hagemann IS. Optimal sampling of grossly normal omentum in staging of gynecologic malignancies. Int J Gynecol Pathol. 2015;34(3):281–7.
159. Sobin LH, Gospodarowicz MK, Wittekind C. TNM-classification of malignant tumors. 7th ed. London: Wiley-Blackwell; 2009.
160. Stang A, Merrill RM, Kuss O. Hysterectomy in Germany: a DRG-based nationwide analysis, 2005–2006. Dtsch Arztebl Int. 2011;108(30):508–14.
161. Stany MP, Stone PJ, Felix JC, Amezcua CA, Groshen S, Ye W, Kyser KL, Howard RS, Zahn CM, Muderspach LI, Lentz SE, Chernofsky MR. Lymph node micrometastases in early-stage cervical cancer are not predictive of survival. Int J Gynecol Pathol. 2015;34(4):379–84.
162. Stephan JM, Hansen J, Samuelson M, McDonald M, Chin Y, Bender D, Reyes HD, Button A, Goodheart MJ. Intra-operative frozen section results reliably predict final pathology in endometrial cancer. Gynecol Oncol. 2014;133(3):499–505.
163. Stewart CJ, Leung YC, Whitehouse A. Fallopian tube metastases of non-gynaecological origin: a series of 20 cases emphasizing patterns of involvement including intra-epithelial spread. Histopathology. 2012;60(6B):E106–14.
164. Stewart CJ, Little L. Immunophenotypic features of MELF pattern invasion in endometrial adenocarcinoma: evidence for epithelial-mesenchymal transition. Histopathology. 2009;55(1):91–101.
165. Stoler M, Bergeron C, Colgan TJ, Ferency AS, Herrington CS, Kim KR, Loening T, Schneider A, Sherman ME, Wilbur DC, Wright T. In: Kurman RJ, Carcangiou ML, Herrington S, Young RH, editors. WHO classification of tumours of femal reproductive organs. Lyon: IARC Press; 2014. p.172–82.
166. Syed S, Reed N, Millan D. Adequacy of cervical sampling in hysterectomy specimens for endometrial cancer. Ann Diagn Pathol. 2015;19(2):43–4.
167. Takano M, Ochi H, Takei Y, Miyamoto M, Hasumi Y, Kaneta Y, Nakamura K, Kurosaki A, Satoh T, Fujiwara H, Nagao S, Furuya K, Yokota H, Ito K, Minegishi T, Yoshikawa H, Fujiwara K, Suzuki M. Surgery for endometrial cancers with suspected cervical involvement: is radical hysterectomy needed (a GOTIC study)? Br J Cancer. 2013;109(7):1760–5.
168. Toledo G, Oliva E. Smooth muscle tumors of the uterus: a practical approach. Arch Pathol Lab Med. 2008;132(4):595–605.
169. Torres ML, Weaver AL, Kumar S, Uccella S, Famuyide AO, Cliby WA, Dowdy SC, Gostout BS, Mariani A. Risk factors for developing endometrial cancer after benign endometrial sampling. Obstet Gynecol. 2012;120(5):998–1004.
170. Traiman P, Saldiva P, Haiashi A, Franco M. Criteria for the diagnosis of diffuse uterine myohypertrophy. Int J Gynaecol Obstet. 1996;54(1):31–6.
171. Trimble CL, Method M, Leitao M, Lu K, Ioffe O, Hampton M, Higgins R, Zaino R, Mutter GL, Society of Gynecologic Oncology Clinical Practice Committee. Management of endometrial precancers. Obstet Gynecol. 2012;120(5):1160–75.
172. Tulandi T, Ferenczy A. Biopsy of uterine leiomyomata and frozen sections before laparoscopic morcellation. J Minim Invasive Gynecol. 2014;21(5):963–6.
173. Turan T, Oguz E, Unlubilgin E, Tulunay G, Boran N, Demir OF, Kose MF. Accuracy of frozen-section examination for myometrial invasion and grade in endometrial cancer. Eur J Obstet Gynecol Reprod Biol. 2013;167(1):90–5.
174. Usubütün A, Ozseker HS, Himmetoglu C, Balci S, Ayhan A. Omentectomy for gynecologic cancer: how much sampling is adequate for microscopic examination? Arch Pathol Lab Med. 2007;131(10):1578–81.
175. Vidal F, Rafii A. Lymph node assessment in endometrial cancer: towards personalized medicine. Obstet Gynecol Int. 2013;2013:892465.
176. Wagner AE, Pappas L, Ghia AJ, Gaffney DK. Impact of tumor size on survival in cancer of the cervix and validation of stage IIA1 and IIA2 subdivisions. Gynecol Oncol. 2013;129:517–21.

177. Watson P, Vasen HF, Mecklin JP, Järvinen H, Lynch HT. The risk of endometrial cancer in hereditary nonpolyposis colorectal cancer. Am J Med. 1994;96:516–20.
178. Wijnen J, de Leeuw W, Vasen H, et al. Familial endometrial cancer in female carriers of MSH6 germline mutations. Nat Genet. 1999;23:142–4.
179. Wilbur DC, Colgan TJ, Ferenczy AS, Hisrchowitz L, Loening T, McCluggage WG, Mikami Y, Park KJ, Ronnett BM, Schneider A, Soslow R, Wells M, Wright T. In: Kurman RJ, Carcangiou ML, Herrington S, Young RH, editors. WHO classification of tumours of femal reproductive organs. Lyon: IARC Press; 2014. p. 183–94.
180. Williams JW, Hirschowitz L. Assessment of uterine wall thickness and position of the vascular plexus in the deep myometrium: implications for the measurement of depth of myometrial invasion of endometrial carcinomas. Int J Gynecol Pathol. 2006; 25(1):59–64.
181. Williams KE, Waters ED, Woolas RP, Hammond IG, McCartney AJ. Mixed serous endometrioid carcinoma of the uterus: pathologic and cytopathologic analysis of a high-risk endometrial carcinoma. Int J Gynecol Cancer. 1994;4:7–18.
182. Wittekind C, Compton CC, Brierley J, Sobin LH. TNM-supplement. A commentary on uniform use. Oxford: Wiley-Blackwell; 2012. p. 9–11, 21–2.
183. Wolsky RJ, Montag AG. Female genital tract. In: Taxy JB, Husain AN, Montag AG, editors. Biopsy interpretation: the frozen section. Philadelphia/Baltimore/New York/London/Buenos Aires/Hong Kong/Sydney/Tokyo: Wolters Kluwer/Lippincott Williams & Wilkin; 2014. p. 69–88.
184. Wright JD, Tergas AI, Burke WM, Cui RR, Ananth CV, Chen L, Hershman DL. Uterine pathology in women undergoing minimally invasive hysterectomy using morcellation. JAMA. 2014;312(12):1253–5.
185. Yin ZM, Yu AJ, Wu MJ, Zhu JQ, Zhang X, Chen JH, Yuan SH, Yu H. Prognostic factors and treatment comparison in small cell neuroendocrine cervical carcinoma. Eur J Gynaecol Oncol. 2014;35(3):259–63.
186. Zaino R, Carinellei SG, Ellenson LH, Eng C, Katabuchi H, Konishi I, Lax S, Matis-Guiu X, Mutter GL, Peters WA, Sherman ME, Shih IM, Soslow R. Stewart CJR. In: Kurman RJ, Carcangiou ML, Herrington S, Young RH, editors. WHO classification of tumours of femal reproductive organs. Lyon: IARC Press; 2014. p. 121–34.
187. Zaino RJ, Abendroth C, Yemelyanova A, Oliva E, Lim D, Soslow R, Delair D, Hagemann IS, Montone K, Zhu J. Endocervical involvement in endometrial adenocarcinoma is not prognostically significant and the pathologic assessment of the pattern of involvement is not reproducible. Gynecol Oncol. 2013;128(1):83–7.
188. Zaino RJ. FIGO staging of endometrial adenocarcinoma: a critical review and proposal. Int J Gynecol Pathol. 2009;28:1–9.
189. Zannoni GF, Vellone VG, Carbone A. Morphological effects of radiochemotherapy on cervical carcinoma: a morphological study of 50 cases of hysterectomy specimens after neoadjuvant treatment. Int J Gynecol Pathol. 2008;27(2):274–81.
190. Zarbo RJ, Schmidt WA, Bachner P, Howanitz PJ, Meier FA, Schifman RB, Boone DJ, Herron RM Jr. Indications and immediate patient outcomes of pathology intraoperative consultations. College of American Pathologists/Centers for Disease Control and Prevention Outcomes Working Group Study. Arch Pathol Lab Med. 1996;120(1):19–25.
191. Zaino RJ, Ward S, Delgado G, Bungy B, Gore H, Fetter G, Ganjei P, Frauenhoffer E. Histopathological predictors of the behavior of surgically treated stage Ib squamous cell carcinoma of the cervix. Cancer. 1992;69:1750–8.

Part VII

Specific Hematological and Anesthesiological Aspects



19 Perioperative Management of Antithrombotic Therapy in the Periprocedural Period of Patients Undergoing Hysterectomy

Verena Limperger, Florian Langer, Rolf Mesters, Ralf Ulrich Trappe, and Ulrike Nowak-Göttl

Introduction

The use of oral anticoagulants (OAC) especially Vitamin-K-antagonists (VKA) and antiplatelet agents (AA) (ASA, Clopidogrel, Prasugrel, Ticagrelor) alone or combined is necessary to prevent or treat thromboembolic diseases. Patients with the indication for a long-term therapy with OAC, for example with chronic atrial fibrillation, artificial cardiac valve or after thromboembolic events, or patients with the indication for treatment with AA for example after a stroke, TIA, myocardial infarct, implantation of a bare-metal-stent (BMS) or drug-eluting-stent (DES), need in case of surgical interventions a bridging with medication with a short half-time [1, 3, 5–9, 14, 21, 23, 25].

This review covers the recent published recommendations and guidelines related to elective hysterectomies in patients taking an OAC or AA. These recommendations are based on a few randomized trials with limited data only [8, 9, 34, 35]; therefore is the evidence level of these recommendations grade "2C" [1, 3, 5–9, 12, 14, 18, 21, 23, 25, 38]: In contrast with recommendation grade "1″ are these [7]; it is comparable with "we suggest, that". The impact of study quality is divided into A, B and C, where as "C" is weaker than "A" or "B".

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Preoperative Evaluation

In every patient taking an oral anticoagulant (Table 19.1) or antiplatelet agent (Table 19.2) the risk of the bleeding versus the risk for thromboembolic events must be evaluated at least two to three weeks prior to an elective surgical intervention: The risk of bleeding in terms of hysterectomy is fairly low but stays in contrast to the medium risk for thromboembolic events [7, 21]. Table 19.3 shows the yearly risk for thromboembolic recurrence after withdrawal of the oral anticoagulant or antiplatelet agent therapy.

The risk of bleeding is a summary of the patients inherited and acquired risk factors. A standardized bleeding questionnaire is the best way to identify the individual bleeding risk [16, 18, 26, 27]. This includes the record of the oral anticoagulant or antiplatelet agent taken as well as the documentation of potentially taken co-medication and of acquired diseases which can affect the hemostasis [13]: This includes the liver as the most important organ for the synthesis of coagulation factors, the kidneys as organs for the elimination of heparin and the direct oral anticoagulants [DOACs] und possibly hemostatic changes due to hemato-oncological diseases. In addition to that is it possible that for example cardiac diseases can lead to an acquired von Willebrand's disease [42].

Drugs, that for example can increase the effect of OACs, are androgen steroids, anabolic drugs, antacids, antibiotics, antidepressants, ß-inhibitors, gout medication, insulin, cholesterol lowering medication and thyroid hormones.

Conclusion: in every patient using an anticoagulant the risk of bleeding versus the risk for thromboembolism has to be evaluated.

The risk for thromboembolism in patients with inherited thrombophilia depends on the risk factor (Tables 19.4 and 19.5).

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Table 19.1 Oral or parenteral anticoagulant agents

Agent	Half-time	Target enzyme	Antidote
VKA: Phenprocoumon Warfarin Acenocoumarol	6 days 35–45 h 6,6 h	VK-depending y-carboxylation	Vitamin K1 oral/iv PPSB
Heparins: UFH LMWH Fondaparinux	30–60 min 3–7 h 17–21 h	AT-depending serine proteinase	Protamine –[a]
Dabigatran	11–14 h	Thrombin	Idarucizumab –[a]
Rivaroxaban	7–13 h	Factor Xa	Andexanet alfa & Ciraparantag –[a]
Apixaban	8–18 h	Factor Xa	Andexanet alfa & Ciraparantag –[a]
Edoxaban	10–14 h	Factor Xa	Andexanet alfa & Ciraparantag –[a]

Abbreviations: *AT* Antithrombin, *LMWH* low molecular weight Heparin, *UFH* unfractionated Heparin, *VK* Vitamin K, *VKA* Vitamin-K-Antagonist, *PPSB* Prothrombin complex concentrate

[a]General procedures for hemostasis: mechanical compression/ sealing the source of bleeding, volume replacement, if necessary infusion of erythrocyte concentrates, platelet concentrate, plasma, PPSB, rFVIIa, tranexamic acid [20 mg/kg body weight: 31,39]. The use of dialysis (Dabigatran) or the administration of active coal may be useful in case of overdose of DOACs

Table 19.2 Antiplatelet agents

Agent	Half-time	Target enzyme	Antidote
Acetylsalicylic acid [ASA]	15–30 min	COX-1; COX-2	–[a]
Clopidogrel	8 h [with loading-dose shorter]	$P2Y_{12}$ ADP receptor-irreversible	–[a]
Ticlopidin [is rarely used]	24–36 h	$P2Y_{12}$ ADP receptor-irreversible	–[a]
Prasugrel	7 h	$P2Y_{12}$ ADP receptor -irreversible	–[a]
Ticagrelor	7 h	$P2Y_{12}$ ADP receptor-reversible	–[a]
Cangrelor	2–5 min	$P2Y_{12}$ ADP receptor-reversible	
GPIIb-IIIa antagonists: Abciximab[b] Eptifibatide Tirofiban	10–30 min 150 min 1,8 h	Fibrinogen- receptor (GPIIb-IIIa)	platelet concentrate[a] Hemodialysis

[a]General procedures for hemostasis: mechanical compression/sealing the source of bleeding, volume replacement, if necessary infusion of erythrocyte concentrates, platelet concentrate, plasma, PPSB, rFVIIa, tranexamic acid [16–18, 20–22, 31, 39]. In case of platelet disorders due to ASA platelet concentrates can be combined with DDAVP i.v. [20, 22, 32, 38]

[b]Caution: not eligible for "bridging", because the effect on the receptor is too long

Table 19.3 Risk of arterial / venous thromboembolism in case of interruption of the OAC/AA therapy

High risk of thrombosis [circa 10 % per year]	Medium risk of thrombosis [4–10 % per year]	Low risk of thrombosis [<4 % per year]
Artificial heart valves	Biological heart valves [first 3 months]	Biological heart valves [>3 months]
Atrial fibrillation with fresh stroke/TIA or CHADS2 score[a]> 5	Atrial fibrillation & CHADS2 score[a] 3–4 without stroke / TIA	Atrial Fibrillation & CHADS2 score [a] 0–2 without stroke/TIA
BMS [<4 weeks]	BMS [4 weeks; – 12 months][b]	BMS [>12 months][b]
DES [<6 months]	DES [6–24 months][b]	DES [>24 months][b]
MI [<6 weeks] rheumatic valvular disease	MI [6 weeks – 12 months]	MI [>12 months]
Venous thromboembolism [<3 months]	Venous thromboembolism [3–12 months]	Venous thromboembolism [>12 months]
Severe thrombophilia[antiphospholipid syndrome, antithrombin, protein C- / S- deficiency]	Recurrent venous thromboembolism	
	Active malignancy	

Abbreviations: *BMS* Bare-metal-Stent, *DES* Drug-eluting-Stent; *MI* heart attack, *TIA* transient ischemic attack

[a]$CHADS_2$: heart failure, hypertension, age > 75 years, diabetes mellitus, stroke or TIA

[b]Recent studies come to the conclusion that the antiplatelet therapy can be discontinued in case of BMS the dual after 3 months and in case of new DES often already after 6 weeks [11, 16]

Table 19.4 Risk of thromboembolism in various interventions

High risk of thrombosis	Medium risk of thrombosis	Low risk of thrombosis
Arthroplasty	Upper limb & other interventions lower extremity	Visceral surgery, **gynecology**, urology [<30 min]
Hip fractures	visceral surgery, **gynecology**, urology [>30 min]	Metal removal
Large abdominal surgery	surgery of lung, chest wall, mediastinum	juxtaarticular surgeries without immobilization
Tumor surgery	Varicosis surgery	
	Vascular surgery	

Table 19.5 Relative risk [RR] of inherited thrombophilia on venous thromboembolism in family studies [43]

Risk factor	Prevalence [%]	RR of first venous thrombosis
Antithrombin deficiency	0.02	5–10
Protein C deficiency	0.2	4–6.5
Protein S deficiency	0.03–0.13	1–10
Faktor V Leiden/APC-Resistance	3.0–7.0	3–5
Prothrombin G20210A	0.7–4.0	2–3
High factor VIII	10	5

Venous thromboembolism is a multifactorial disorder. Antithrombin-, protein C- protein S- deficiency are high risk factors for the onset of venous thromboembolism. In contrast, factor V Leiden, the prothrombin mutation G20210A and elevated factor VIII levels are discussed as common but mild risk factors of thromboembolism. Combinations between established prothrombotic risk factors increase the risk of thrombosis [19, 43].

In patients with or without a history a venous thromboembolism and inherited thrombophilia the updated Chest guidelines and the German AWMF Guidelines suggest a prophylaxis in risk situations for thrombosis. The dosage has to be determined on an individual basis, inter alia depending on the body weight [7, 33].

Perioperative Management: Vitamin K-Antagonists

The median risk for thromboembolism is the most common situation in the daily praxis, so is the risk of hysterectomy for thromboembolism: the current guidelines for the perioperative management focus the expecting bleeding tendency in this case. In case of intervention with a high risk for bleeding an interruption of the OAC can be taken place without a bridging, in case of a low bleeding tendency a bridging with UFH or LMWH can be taken place depending the half-time of the OAC [1, 3, 5–7, 9, 14, 21, 23, 25, 40].

(i). low bleeding risk & median thromboembolic risk: is there a minor bleeding risk due to the scheduled intervention, in most cases the oral anticoagulation can be taken unmodified or can be reduced in its intensity.

(ii). medium to high bleeding risk & medium thromboembolic risk: when the intervention causes a medium to high bleeding risk the anticoagulant therapy can be paused for a short period.

(iii). high bleeding risk & high thromboembolic risk: when the intervention causes a high bleeding und thromboembolic risk the change of a vitamin K antagonist to UFH [limited renal function] or LMWH is necessary. In this cases the VKA is paused approximately 7 days [Phenprocoumon] respectively 5 days [Warfarin] prior to the scheduled intervention or if the INR is below its therapeutic level [INR < 2] and UFH or LMWH is used for bridging. If there will be high thromboembolic risk a therapeutic heparin use should be aimed: For UFH an aPTT prolongation of 1.5–2 times the standard is intended, for LMWH the dose which is recommended by their manufacturers for the acute treatment of deep vein thrombosis or pulmonary embolism should be selected.

There are only a few comparative studies for UHF and LMWH for bridging therapy [9, 9]. These show no difference in bleeding and the occurrence of thromboembolic complications, however, the length of hospital stay was significantly shorter with LMWH and hence more cost-effective.

For (iii) applies, in cases of severe renal insufficiency [creatinine clearance <30 ml/min] the heparin therapy should be carried out with UFH [7, 21], in other cases, LMWH can be used. In the current 9th guideline of the "American College of Chest Physicians" it is recommended, that stop UFH 6–8 h and LMWH 24 h before the procedure and to start the therapy again after 24–48 h depending on postoperative bleeding tendency [7]. In early resuming heparin therapy a reduced dose of LMWH or a heparin is discussed without a bolus of UFH.

The reuptake of OAC depends on the risk of bleeding of the performed surgery and should be done at the earliest from 1 to 2 days post-surgery, the parallel heparinization should be continued up to a reproducible INR > 2 [7, 21, 25].

Unlike in elective surgeries the management in emergency cases cannot be planned: The effect of the OAC must be lifted as soon as possible. To do this the administration of vitamin K1 10 mg iv [effectiveness within 24 h] or the substitution of vitamin K-dependent coagulation factors [PPSB: 4-factor concentrate] which work within minutes can be performed. If there is a life-threatening bleeding under OAC vitamin K1 and PPSB ca be administered simultaneously.

When bridging with a parenteral anticoagulant the INR, aPTT and anti-Factor Xa activity should be measured in addition to the clinical evaluation of the bleeding preoperatively. During the postoperative period the blood count, prothrombin time according to thromboplastin time and aPTT should be determined to evaluate the bleeding tendency before reuptake.

To summarize: the current recommendations for the perioperative management are based on the expected risk of bleeding. For planned interventions with high risk of bleeding the interruption of OAC without bridging may be considered. At a low risk of bleeding a bridging therapy with UFH or LMWH can be applied after discontinuation of OAC.

Perioperative Management: Platelet Inhibition Therapy

The use of medication with reversible and irreversible inhibition of platelets (Table 19.2) is indicated for primary and secondary prevention of atherothrombosis-related cerebrovascular and cardiovascular diseases. This includes for example stroke, TIA, myocardial infarction, interventional radiological procedures such as PTCA with or without implantation of bare-metal stents [BMS] or drug-eluting stents [DES], radiofrequency ablation, and peripheral arterial thromboembolic diseases. Platelet-inhibitory substances are used either as monotherapy [primary prophylaxis or long-term therapy] or as a temporary combination therapy for example in high risk patients after stenting. In this group of patients is the annual recurrence risk of atherothrombotic occlusion or stent thrombosis after discontinuation of a AA therapy within 6 months after a implantation of a BMS and up to 12 months after using a DES is high to very high. According to the current guidelines elective procedures should not carried out or planned in this period, vice versa, a stent implantation should be performed only after an urgent surgical intervention has taken place [7, 16–18, 20–22, 32]. Recent publications show a broad consensus that the dual platelet inhibition may be often finished after 3 months when using a BMS and when using a novel DES already after 6 weeks [12, 17].

The assessment of periprocedural bleeding risk (Table 19.3) is similar to the assessment taking an OAC [35]. At medium to high risk of bleeding the cardiovascular risk determines the procedures for non cardiosurgical necessary interventions [5, 7, 21].

(i). *Low risk of bleeding and high cardiovascular risk: Is the risk of bleeding through the planned intervention low, the AA therapy can be continued unchanged in most cases.*
(ii). *Medium to high risk of bleeding and high cardiovascular risk: aspirin in these patients should not be paused but continued [if the intervention cannot be moved].*
(iii). High risk of bleeding and high cardiovascular risk: if a surgery is urgent and not unmovable, the short-term interruption of the AA therapy by administration of platelet concentrates and the use of a short-acting GPIIb-IIIa antagonists iv can be performed.
(iv). *Medium to high risk of bleeding and low cardiovascular risk: an interruption of the AA medication is justifiable.*

ASA, [common dose 100 mg per day] can be discontinued 5 days before the planned intervention, clopidogrel or ticagrelor should be paused 5 days and prasugrel 7 days in advance [16–18].

In aspirin-induced bleeding, DDAVP can be administered i.v. [0.3–0.4 mg/kg] in consideration of the contraindications for DDAVP in combination of platelet concentrates administration [18, 20, 22, 32, 38]: in 2014 the EMA approval has been extended in this indication for DDAVP administration.

After interruption of an AA therapy to the procedure can be applied in analogy for OAC, approximately 24 h following surgery the reuptake of the AA therapy can be scheduled. ASA is effective within minutes; Clopidogrel reaches its full effect without saturation after about 7 days.

For high-risk patients who have to undergo a necessary intervention, a bridging with a short-acting GPIIb-IIIa antagonists iv [Eptifibatide, Tirofiban: 29] is possible in addition to the short-term interruption of AA therapy with platelet concentrates.

In patients with renal impairment Eptifibatide is the GPIIb-IIIa inhibitor of choice. First experiences on the short-term bridging therapy with reversible direct P2Y12 inhibitor Cangrelor are available [1], but this substance is not yet approved in Germany.

When bridging an AA therapy in addition to the clinical evaluation of the bleeding measurements of blood count, thromboplastin time and aPTT should be performed preoperatively and postoperative. In addition, preoperative and possibly in the inpatient period of time the measurement of the residual platelet function by appropriate test methods might be helpful.

To summarize: the risk of recurrence of stent thrombosis after (too) early discontinuation of AA therapy after implantation of a BMS or DES is high [−please consider

manufacturer's instructions and current guidelines-]. Generally, elective surgery should not be performed during this period. ASA may be discontinued 5 days before the planned intervention, Clopidogrel or Ticagrelor should be discontinued 5 days and Prasugrel should be paused 7 days in advance.

Perioperative Management: Direct Oral Anticoagulants

Among the class of DOACs the class of thrombin inhibitors and factor Xa inhibitors are combined [2, 15, 31]. Dabigatran is a thrombin inhibitor, Rivaroxaban, Apixaban and Edoxaban are factor Xa inhibitors. Both classes are used in fixed dosage without laboratory control both for primary prevention as well as in therapeutic indications.

The audited dosage for the treatment of deep vein thrombosis will be for Dabigatran 2 × 150 mg daily after the initial use of UFH, LMWH or Fondaparinux for at least 5 days, for Rivaroxaban in the first three weeks 2 × 15 mg followed by 1 × 20 mg daily, for Apixaban initial 2 × 10 mg daily for 7 days and then 2 × 5 mg and 60 mg once daily for Edoxaban after initial administration of UFH, LMWH or Fondaparinux for at least 5 days. In atrial fibrillation, the standard dose of Dabigatran is 150 mg 2 × daily, 1 × 20 mg daily of Rivaroxaban, 2 × 5 mg per day for Apixaban and 60 mg once daily for Edoxaban (regarding dosage recommendations, for example in renal impairment, we refer to the prescribing information respectively) [4, 31].

For DOACs no bridging therapy in the perioperative period is usually required due to the short half-lives because the necessary treatment interruption can be achieved by simply omitting before surgery [23, 24]. Peak levels are reached after oral administration of Dabigatran after 1.5–2 h, for Rivaroxaban 2–4 h, for Apixaban after 3–4 h and for Edoxaban after 1–2 h [2, 4, 25].

For Dabigatran discontinuation is recommended 2 days before a standard intervention in normal renal function, mild and moderate renal impairment a break of 3–4 days should be discussed [21]. For Rivaroxaban a break usually ranges from of at least 24 h before planned surgery, Apixaban and Edoxaban should be discontinued 24–48 h before the planned surgery [4, 21].

If the time of last intake is unclear and urgently required intervention with high bleeding tendency is a determination by modified thrombin time possible for Dabigatran and an anti-factor Xa determination for Rivaroxaban, Apixaban and Edoxaban possible [11, 15, 28, 41]: It this context it should be noted that the respective anti-factor Xa test for the DOAC-substance must be calibrated. In addition, it should be mentioned that a Rivaroxaban-sensitive thromboplastin time (for example Neoplastin reagent) for detecting the effect of Rivaroxaban is also suitable [15].

In contrast to therapy with OAC the DOACs achieve at point of restart with DOACs in the original dose an immediate anticoagulant effect, it is recommended to start these drug classes again only after a secure clinical exclusion of postoperative bleeding tendency or to reduce the starting dose of both agents [21]. If necessary, the administration of UFH or LMWH should post-operatively initially carried out (in the first 48–72 h), as there is no experience for the post-operative administration of DOACs outside of VTE prophylaxis in hip and knee replacement surgery. If oral drug absorption should not be possible for a long time postoperatively a thromboembolic prophylaxis is to be ensured with for example UFH or LMWH.

Finally, we have to point out that DOACs do not represent a medication to bridge a therapy with OAC or AA.

To summarize: Dabigatran is discontinued in normal renal function 2 days before a standard procedure, Rivaroxaban should be discontinued at least 24 h in advance and Apixaban and Edoxaban 24–48 h before. DOACs are no medication for a bridging therapy with OAC or AA.

Future Prospects

Further prospective and randomized trials and meta-analyzes of randomized studies are needed to be able to pronounce recommendations on a higher evidence level in the future. These studies should be based on a harmonized definition and evaluation criteria for study endpoints and bridging therapies [10, 29, 30, 36, 37].

Conclusions for Clinical Practice

Current recommendations for bridging a chronic OAK or AA-therapy are still based on not sufficient data and therefore are subject to uncertainty, so that in each patient the bleeding and thromboembolic risk must be weighed against each other.

With a medium risk of thromboembolism, such as during the hysterectomy**,** the individual bleeding risk of the planned intervention determines the bridging therapy:

Is the risk of bleeding due to the planned intervention low, the OAK / AA therapy can be continued unchanged or be slightly reduced in intensity in most cases.

Is risk of thrombosis low in case of a medium to high risk of bleeding, antiplatelet therapy can be paused temporarily.

At high risk of bleeding and thromboembolism, a change of OAC to UFH [impaired renal function] or LMWH is required.

The AA-therapy can be bridged with cases of a high risk of bleeding and thromboembolism with platelet concentrates and short-acting GPIIb-IIIa antagonists [Eptifibatide, Tirofiban].

Patients using a direct oral anticoagulant [Dabigatran, Rivaroxaban, Apixaban, Edoxaban] need an intermission

of therapy prior to the planned intervention depending the individual half-time of the specific medication and the individually renal function. These patients do not need a bridging with heparins.

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References

1. Angiolillo DJ, Firstenberg MS, Price MJ, et al. Bridging antiplatelet therapy with cangrelor in patients undergoing cardiac surgery. A randomized controlled trial. JAMA. 2012;307:265–74.
2. Baglin T. Clinical use of new oral anticoagulant drugs: dabigatran and rivaroxaban. Br J Haematol. 2013;163:160–7.
3. BRIDGE study investigators. Bridging anticoagulation. Is it needed when warfarin is interrupted around the time of a surgery or procedure – cardiology patient page. Circulation. 2012;125:e496–8.
4. Chan L, Pisano M. Edoxaban (savaysa): a factor xa inhibitor. P T. 2015;40:651–95.
5. Dimitrova G, Tulman DB, Bergese SD. Perioperative management of antiplatelet therapy in patients with drug-eluting stents. HSR Proc Intensive Care Cardiovas Anesth. 2012;4:153–67.
6. Douketis JD. Perioperative management of patients who are receiving warfarin therapy: an evidence-based and practical approach. Blood. 2011;117:5044–9.
7. Douketis JD, Spyropoulos AC, Spencer FA, American College of Chest Surgeons, et al. Perioperative management of anticoagulant therapy: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines [erratum appears in Chest 2012;141(4):1129]. Chest. 2012;141(Suppl 2):e326S–50S.
8. Hammerstingl C, Schmitz A, Fimmers R, Omran H. Bridging of chronic oral anticoagulation with enoxaparin in patients with atrial fibrillation: results from the prospective BRAVE registry. Cardiovasc Ther. 2009;27:230–8.
9. Halbritter KM, Wawer A, Beyer J, Oettler W, Schellong SM. Bridging anticoagulation for patients on long-term vitamin-K-antagonists. A prospective registry of 311 episodes. J Thromb Haemost. 2005;3:2823–5.
10. Healey J, Eiklboom J, Douketis J, et al. Periprocedural bleeding and thromboembolic events with dabigatran compared with warfarin – results from the randomised evaluation of long-term anticoagulation therapy (RE-LY) randomised trial. Circulation. 2012;126:343–8.
11. Hillarp A, Baghaei F, Fagerberg BI, et al. Effects of the oral, direct factor Xa inhibitor rivaroxaban on commonly used coagulation assays. J Thromb Haemost. 2011;9:133–9.
12. Lip GY, Huber K, Andreotti F, et al. Management of antithrombotic therapy in atrial fibrillation patients presenting with acute coronary syndrome and/or undergoing percutaneous coronary intervention/stenting. Thromb Haemost. 2010;103:13–28.
13. Joist JH, George JN. Hemostatic abnormalities in liver and renal disease. In: RW C, Hirsh J, VJ M, et al., editors. Hemostasis and thrombosis. Basic principals and clinical practice. Philadelphia: Lippincott, Williams & Wilkins; 2004. p. 955–73.
14. Kearon C, Hirsh J. Management of anticoagulation before and after elective surgery. N Engl J Med. 1997;336:1506–11.
15. Koscielny J, Beyer-Westendorf J, von Heymann C, et al. Risk of bleeding and haemorrhagic complication with rivaroxaban-periprocedural management of haemostasis – Konsensus. Hamostaseologie. 2012;32(4):287–93.
16. Koscielny J, Rutkauskaite E. Preinterventional change in the clotting medication. Viszeralmedizin (Gastrointestinal Medicine and Surgery). 2013;29:1–13.
17. Korte W, Cattaneo M, PG C, et al. Perioperative management of antiplatelet therapy in patients with coronary artery disease: joint position paper by members of the working group on Perioperative Haemostasis of the Society on Thrombosis and Haemostasis Research (GTH), the working group on Perioperative Coagulation of the Austrian Society for Anesthesiology, Resuscitation and Intensive Care (ÖGARI) and the Working Group Thrombosis of the European Society for Cardiology (ESC). Thromb Haemost. 2011;105(5):743–9.
18. Kozek-Langenecker S, Afshari A, Albaladejo P, et al. Management of severe perioperative bleeding: guidelines from the European Society of Anaesthesiology. Eur J Anaesthesiol. 2013;30:270–382.
19. Lijfering WM, J.-L B, Veeger N, et al. Selective testing for thrombophilia in patients with first venous thrombosis: results from a retrospective family cohort study on absolute thrombotic risk for currently known thrombophilic defects in 2479 relatives. Blood. 2009;113(21):5314–22.
20. Mannucci PM. Desmopressin (DDAVP) in the treatment of bleeding disorders: the first 20 years. Blood. 1997;90:2515–21.
21. Ortel TL. Perioperative management of patients on chronic antithrombotic therapy. Hematology. 2012;529-535
22. Levi M, Eerenberg E, Kamphuisen PW. Bleeding risk and reversal strategies for old and new anticoagulants and antiplatelet agents. J Thromb Haemost. 2011;9:1705–12.
23. Levy JH, Faraoni D, Spring JL, Douketis JD, Samama CM. Managing new oral anticoagulants in the perioperative and intensive care unit setting. Anesthesiology. 2013;118:1466–74.
24. Patel M, Mahaffey K, Garg J, et al. Rivaroxaban versus warfarin in nonvalvular atrial fibrillation. N Engl J Med. 2011;365:883–91.
25. Patel JP, Arya R. The current status of bridging anticoagulation. Br J Haematol. 2013; doi:10.1111/bjh.12644.
26. Pfanner G, Koscielny J, Pernerstorfer T, et al. Die präoperative Blutungsanamnese. Empfehlungen der Arbeitsgruppe perioperative Gerinnung (AGPG) der Österreichischen Gesellschaft für Anästhesiologie, Reanimation und Intensivmedizin (ÖGARI). Anaesthesist. 2007;56(6):604–11. [in German]
27. Rodeghiero F, Tosetto A, Abshire T, Arnold DM, Coller B, James P, Neunert C, Lillicrap D. ISTH/SSC bleeding assessment tool: a standardized questionnaire and a proposal for a new bleeding score for inherited bleeding disorders. J Thromb Haemost. 2010;8:2063–5. on behalf of the ISTH/SSC Joint VWF and Perinatal/ Pediatric Haemostasis Subcommittees Working Group: http://www.wfh.org/en/resources/bleeding-assessment-tool-isth-batt
28. Samama MM, Contant G, Spiro TE, et al. Evaluation of the anti-factor Xa chromogenic assay for the measurement of rivaroxaban plasma concentrations using calibrators and controls. Thromb Haemost. 2012;107:379–87.
29. Savonitto S, D'Urbano M, Caracciolo M, et al. Urgent surgery in patients with a recently implanted coronary drug-eluting stent: a phase II study of 'bridging' antiplatelet therapy with tirofiban during temporary withdrawal of clopidogrel. Br J Anaesth. 2010;104:285–91.
30. Schulman S, Kearon C, on behalf of the subcommittee on control of anticoagulation of the Scientific and Standardization committee of the International Society on Thrombosis and Haemostasis. Definition of major bleeding in clinical investigations of antihemostatic medicinal products in non-surgical patients. Scientific and Standardization Committee Communication. J Thromb Haemost. 2005;3:692–4.
31. Schellong SM, Haas S. Perioperative Thromboseprophylaxe – Neue orale Antikoagulanzien und ihre Anwendung. Anästhesiol Intensivmed Notfallmed Schmerzther. 2012;47:266–72. [in German]
32. S3 – Leitlinie Polytrauma/Schwerverletzten-Behandlung. Deutsche Gesellschaft für Unfallchirurgie. AWMF (Arbeitskreis wissen-

schaftlicher medizinischer Fachgesellschaften) – Register Nr. 012/019: 1–445. [in German].
33. S3 – Leitlinie Prophylaxe der venösen Thromboembolie (VTE). AWMF (Arbeitskreis wissenschaftlicher medizinischer Fachgesellschaften) – Register Nr. 003/001: 1–243. [in German].
34. Siegal D, Yudin J, Kaatz S, Douketis J, Lim W, Spyropoulos AC. Periprocedural heparin bridging in patients receiving vitamin K antagonists: systematic review and meta-analysis of bleeding and thromboembolic rates. Circulation. 2012;126:1630–9.
35. Sørensen R, Hansen ML, Abildstrom SZ, et al. Risk of bleeding in patients with acute myocardial infarction treated with different combinations of aspirin, clopidogrel, and vitamin K antagonists in Denmark: a retrospective analysis of nationwide registry data. Lancet. 2009;374(9706):1967–74.
36. Spyropoulos AC, Albaladejo P, Godier A, et al. Periprocedural antiplatelet therapy: recommendations for standardized reporting in patients on antiplatelet therapy: communication from the SSC of the ISTH. J Thromb Haemost. 2013 Aug;11(8): 1593–156.
37. Spyropoulos A, Douketis JD, Gerotziafas G, Kaatz S, Ortel TL, Schulman S, on behalf of the subcommittee on control of anticoagulation of the SSC of the ISTH. Periprocedural antithrombotic and bridging therapy: recommendations for standardized reporting in patients with arterial indications for chronic oral anticoagulant therapy. J Thromb Haemost. 2012;10:692–4.
38. The Society of Thoracic Surgeons Blood Conservation Guideline Task Force, The Society of Cardiovascular Anesthesiologists Special Task Force on Blood Transfusion. Perioperative blood transfusion and blood conservation in cardiac surgery: the Society of Thoracic Surgeons and The Society of Cardiovascular Anesthesiologists clinical practice guideline. Ann Thorac Surg. 2007;83(Suppl):S27–86.
39. Thiele T, Sumnig A, Hron G, et al. Platelet transfusion for reversal of dual antiplatelet therapy in patients requiring urgent surgery: a pilot study. J Thromb Haemost. 2012;10:968–71.
40. Ufer M. Comparative pharmacokinetics of vitamin K antagonists: warfarin, phenprocoumon and acenocoumarol. Clin Pharmacokinet. 2005;4412:1227–46.
41. van Ryn J, Tangier J, Haertter S, et al. Dabigatran etexilate—a novel, reversible, oral direct thrombin inhibitor: Interpretation of coagulation assays and reversal of anticoagulant activity. Thromb Haemost. 2010;103:1116–27.
42. Vincentelli A, Susen S, le Turneau E, et al. Acquired von Willebrand syndrome in aortic stenosis. N Engl J Med. 2003;349:343–49.
43. Vossen CY, Conard J, Fontcuberta J, et al. Familial thrombophilia and lifetime risk of venous thrombosis. J Thromb Haemost. 2004;2:1526–32.

Anaesthesia in Gynaecology

20

Michael Sonntagbauer

Abbreviations

5HT3	5-hydroxytriptamine
ATP	Adenosine triphosphate
CO	Cardiac output
CO_2	Carbon dioxide
COPD	Chronic obstructive pulmonary disease
CS	Compartment syndrome
FRC	Functional residual capacity
GnRH	Gonadotropin-releasing hormone
HSC	Hysteroscopy
IAP	Intra-abdominal pressure
IOH	Intra-operative hypotension
IUP	Intra-uterine pressure
K+	Potassium
MAP	Mean arterial pressure
MOV	Multiple organ failure
MV	Minute volume
NK1	Neurokinin 1
Na+	Sodium
PACU	Post anaesthesia care unit
Pinsp	Pressure, inspiratoric
PONV	Postoperative nausea and vomiting
RAAS	Renin-angiotensin-aldosterone system
RR	Respiratory rate
SIRS	Systemic inflammatory response syndrome
TUR	Trans-urethral resection
VC	Vital capacity

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Gynaecologists and anaesthesiologists are both at the patient's service when performing gynaecological procedures.

In order to achieve the best possible outcome concerning patient safety and comfort and to establish a smooth course in the operating theatre and a good environment for performing surgery it is necessary to maintain an on-going communication and teamwork between gynaecologists and anaesthesiologists. Both sides have to be aware of each other's specific needs and problems.

Therefore this book, which is addressed to operating gynaecologists includes a chapter emphasizing on anaesthesiological difficulties of vaginal procedures, laparotomy, laparoscopy and robotic assisted gynaecological surgery.

General Considerations of Gynaecological Anaesthesia

Gynaecological procedures are often perceived as mutilating by patients. Therefore a high level of fear has to be expected and considered by all involved disciplines. The first contact between anaesthesiologist and patient usually takes place at the pre-operative assessment. The main objective here is the evaluation of cardiopulmonary risk factors and the completion of additionally necessary diagnostic investigations. Especially when dealing with multimorbid patients or invasive surgery an interdisciplinary perioperative risk evaluation is important. By taking account of the patient's wishes the anaesthesiologist chooses a certain technique. The pre--operative assessment needs to be discussed with the patient. All information as well as the patient's consent are documented. The patient is informed about fasting times and administration of her own medication. Furthermore the anaesthesiologist should try to reduce the patient's fears during the conversation. The pre-operative administration of anxiolytic medication is an integral component for achieving this goal.

An outpatient surgical procedure is only permitted if the procedural and patient-related requirements are fulfilled. The patient's status should be passed on to the anaesthesiological

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department prior to their assessment. Thereby possible contraindications can be detected and an inpatient treatment can be planned if necessary.

Postoperative Nausea and Vomiting

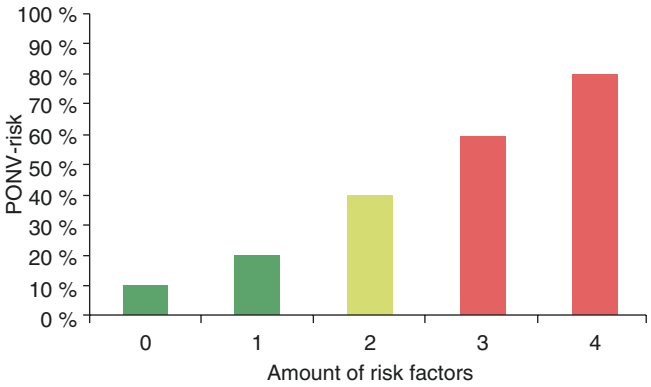
One of the most common complications after anaesthesia is the occurrence of PONV. The general incidence is about 30 % [1–3]. In gynaecological surgery the incidence is even two to three times higher and lies at ca. 80 % [4]. Even though the exact pathogenesis of PONV remains unknown it was possible to identify numerous significant independent risk factors by analysis of large cohort studies. In addition to patient-specific risk factors anaesthesia- and surgery-related risk factors should be determined (Table 20.1). Surgical risk factors include "gynaecological surgery "as well as" laparoscopy" [3, 5] underlining the gynaecology-specific relevance of PONV for the anaesthesiological care. The patient's discomfort due to PONV is one of the most common reasons for poor patient satisfaction rating in the postoperative period [6]. Given the possibility to allocate a certain amount of money to prevent all postoperative complications, patients would spend one third and also the largest amount to avoid PONV [7]. Persistent PONV can lead to a prolonged stay in the postoperative care unit [3] and unanticipated hospital admission which results in a significant increase of overall health care costs [8, 9]. To address these findings risk scores are used to objectify the patient's individual baseline risk for PONV. Simplified PONV risk scores with a sensitivity and specificity of about 70 % [1, 2, 10] are equally precise in predicting PONV as compared to more complex approaches and may significantly reduce the rate of PONV (Fig. 20.1); Nowadays they are part of everyday practice at most institutions. Prevention and treatment of PONV may be achieved by altering the anaesthesiological approach and by applicating antiemetic drugs (Table 20.1).

Positioning

Lithotomy position is commonly used during gynaecological interventions. It allows the best access to the perineum. An additional advantage is the extra space between the patient's legs for an assistant surgeon during abdominal procedures without restricting the operator's mobility.

When placing patients in lithotomy position awareness for nerve injuries caused by intraoperative positioning is crucial.

Femoral neuropathy may occur due to distinctive angulation of the femoral nerve beneath the unyielding inguinal ligament. Sciatic nerve function may be compromised since



Risk factors	Points
Female sex	1
Non-smoker	1
History of PONV	1
Postoperative opioids	1
Sum =	0 ... 4

Fig. 20.1 Risk score for PONV in adults. Simplified risk score from Apfel et al. [1] to predict the patient's risk for PONV. *PONV* postoperative nausea and vomiting

Table 20.1 Risk factors for PONV as well as options for prophylaxis and treatment of PONV in adults [1]

Risk factors for PONV in adults	Options for prophylaxis/treatment of PONV in adults
Female sex	Propofol anaesthesia
History of PONV or motion sickness	Regional anaesthesia
Nonsmoking	Dexamethasone
Younger age	$5HT_3$ antagonists
General versus regional anaesthesia	Dimenhydrinate
Use of volatile anaesthetics and nitrous oxide	NK_1 receptor antagonists
Postoperative opioids	Propofol subhypnotic dose infusion or Propofol in PACU (rescue-only)
Duration of anaesthesia	Scopolamine
Type of surgery (cholecystectomy, laparoscopic, gynaecological)	Non pharmacological: acupuncture
	Perphenazine
	Droperidol/Haloperidol

PONV postoperative nausea and vomiting, *PACU* post-anaesthesia care unit, *5HT3* 5-hydroxytryptamine, *NK1* neurokinin-1

it is fixed at the sciatic notch and extreme positioning, especially external rotation may lead to stretch injury. The common peroneal nerve is susceptible to compression injury due to its superficial course near the lateral fibular head.

Excessive hip flexion (>90°), abduction (>45°) and external hip rotation should be avoided. Maximum abduction is reached when the contralateral shoulder is in line with thigh, knee and heel of the patient.

Special care must be taken if the patient's mobility in the knee and hip joint is limited (e.g. condition after hip replacement). In these cases it is advisable to perform positioning while the patient is still awake.

Nerve injury of the brachial plexus may occur when shoulder padding is used during Trendelenburg position to prevent sliding of the patient. The neural structures of the brachial plexus pass the cervical intervertebral foramina, the interscalene triangle and run between the clavicle and the first rib to the axilla. Potential compression along the way can be caused by soft tissue as well as bony structures when pressure is applied. The contact point of shoulder padding should be at the acromioclavicular joint. Abduction of the arm increases the risk of nerve injury and should never exceed 90° [11].

Less common is the development of a compartment syndrome (CS) during lithotomy position. The incidence of CS lies around 1:3500 during gynaecological procedures. Since delayed diagnosis and treatment may result in catastrophic consequences for the patient this rather rare complication will be further discussed in this chapter. The occurrence of CS in a previously healthy leg is also described as "well-leg-compartment-syndrome".

The arterio-venous pressure gradient theory is the most accepted theory today for description of the pathophysiology of CS [12]. This hypothesis states that capillary perfusion is only assured when the arterial pressure transcends the venous pressure.

During lithotomy position increased external pressure on the calf, the weight of the calf itself in the positioning devise and venous obstruction due to kinking of the veins will increase venous pressure.

Arterial pressure may be decreased by elevation of the lower extremity, anaesthesia-related hypotension or hypovolemia due to haemorrhage [13]. This constellation especially during long-lasting lithotomy position can result in a reduction of capillary perfusion beyond tissue viability. Ischemia itself and post ischemia reperfusion injury can cause increased endothelial permeability due to liberation of inflammatory mediators with a leakage of fluid into the interstitial space. The resulting edema within the non-expandable compartment causes further reduction of arterial and increase of venous pressure and is ultimately the start of a vicious circle (Fig. 20.2).

If necrosis occurs the function of the extremity can be compromised and amputation may be the only option. In the case of cell death rhabdomyolisis, kidney failure, hyperkalaemia and acidosis can lead to multiple organ failure and death.

So far it was not possible to identify any independent risk factors for CS. However, increased body mass index (BMI) and peripheral arterial disease have been considered to predispose an individual to be affected by CS. From what is known duration and extent of lithotomy position seems to be

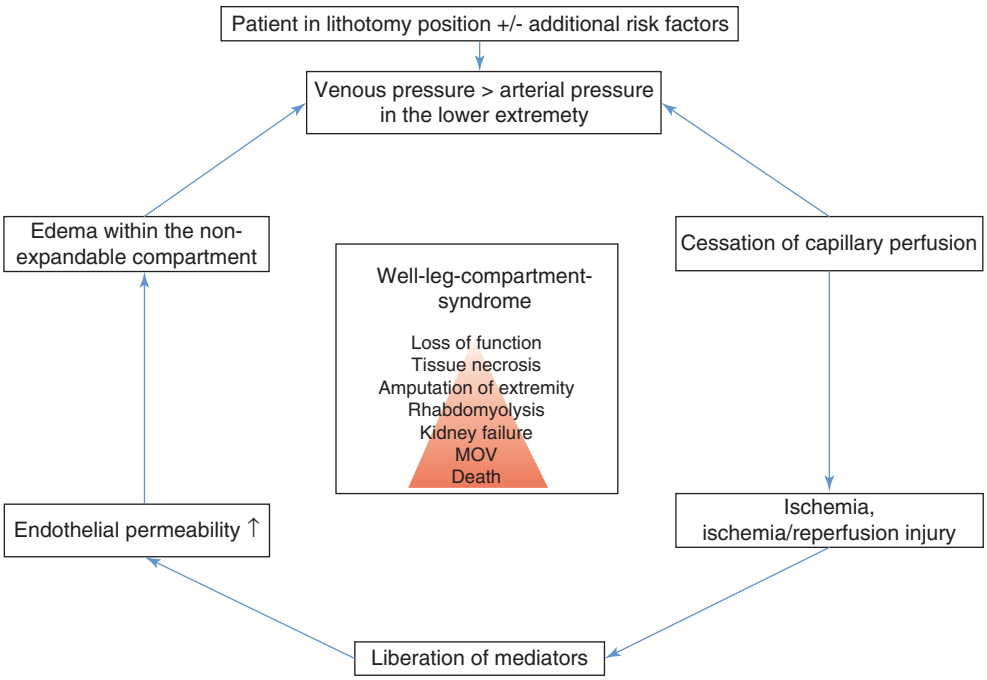


Fig. 20.2 Vicious cycle of the development of well-leg-compartment-syndrome. *MOV* Multiple organ failure

the major cornerstone in the development of CS [14]. Seventy percent of CS occur after more than 5 h [15] spent in lithotomy position (which also means that 30 % occur before that). So far evidence-based recommendations for preventing CS have not been established [15].

At some institutions preventive measures have been implemented. It remains unclear whether one of these measures or their combination can achieve the desired impact (Table 20.2).

Treatment of CS is achieved by pressure release through fasciotomy of the affected compartment [16]. To reduce edema and ischemia/reperfusion injury intravenous mannitol can be considered as a treatment option [17].

CS is primarily a clinical diagnosis. Leg pain, that is not otherwise explainable and is intensified by passive stretch and paraesthesia have to be interpreted as alarming symptoms and should be recognized.

Although large reviews could find no correlation it has been controversially discussed if diagnosis of CS may be delayed due to the use of epidural anaesthesia [18, 19]. Strong breakthrough pain has to be expected even if sufficient epidural anaesthesia is in place [20–22].

Vaginal (Access-) Surgery

The majority of vaginal procedures are less invasive. Due to short duration and limited tissue trauma many of these interventions are performed as outpatient surgery. For the anaesthesiological management the use of short-acting substances is preferred to ensure a prompt dismissal while the patient is objectively and subjectively at comfort. Postoperative nausea and vomiting can lead to prolonged observation time in the post anaesthesia care unit and unexpected admissions. Therefore adequate prophylaxis and treatment of PONV is advised.

If lack of contraindications is assured (e.g. gastro--oesophageal reflux) the airway can be secured with supraglottic devices. Thereby the use of muscle relaxants can be avoided and the risk of prolonged respiratory assistance due to overdosing or overhang can be minimized.

During short procedures an on-going communication between gynaecologist and anaesthesiologist is necessary to assure a well scheduled and adequate depth of anaesthesia. Hereby a smooth process in the operating theatre with little delay can be achieved.

Possible complications during vaginal procedures can develop when surgical manipulation leads to vagal reaction. In most cases interruption of that manipulation is sufficient as a causal treatment although cardiac arrest may occur [23].

For surgical procedures with a duration of 1–2 h or patient-specific factors (e.g. COPD) spinal anaesthesia may be an alternative technique if steep Trendelenburg position is not required. Respectful and considerate interaction with the conscious patient and an appropriate conversation and noise level need to be regarded. Spinal anaesthesia per se is not a contraindication for outpatient surgery.

Fluid Overload Syndrome

Diagnosis and treatment of intra-uterine pathologies requires distension of the uterus. Today fluid distending media are predominantly used. Distension of the endometrial cavity is only feasible if the distending media is applied with a certain pressure. Systemic absorption may cause “fluid overload syndrome”. Heart failure and lung edema can develop due to sudden exposure to additional preload. Pathogenesis and clinical appearance are similar to TUR-syndrome known from urological surgery.

In diagnostic hysteroscopy the anticipated risk for systemic absorption is low due to the lack of vessel transection since media has no opportunity to enter systemic circulation. Consequently the risk increases if resection (e.g. of a myoma) is performed and tissue is traumatised.

While mechanical instruments may be an alternative for resection in some cases, most hysteroscopic resectoscopies are performed using monopolar or bipolar electrosurgical instru-

Table 20.2 Potential risk factors of CS and potential strategies for preventing CS during lithotomy position

Potential risk factors of CS during lithotomy position	Potential strategies for preventing CS during lithotomy position
Extreme lithotomy position	Avoidance of lithotomy position whenever there is no need for perineal and vaginal access
Trendelenburg position	Intraoperative modification of position of lower extremity
Long duration of lithotomy position and head down tilt	Intraoperative warming of lower extremity
Intraoperative hypotension/hypovolemia	Avoidance of hypotension
Hypothermia	Minimization of time in lithotomy−/Trendelenburg position
High extent of flexion in knee- and hip joints	Avoidance of high degree of lithotomy−/Trendelenburg position
External pressure due to positioning support material	Adequate substitution of fluid loss
Patient-specific risk factors	Intermittent compression of lower extremity
Misinterpretation of clinical symptoms	Awareness of clinical symptoms

CS compartment syndrome

ments. Monopolar cauterisation requires completion of an electrical circuit between the surgical instrument and the remotely located dispersive electrode to achieve a thermal effect. If such instruments are used in the presence of conductive particles (e.g. ions in saline) dispersion prevents the completion of the electrical circuit and therefore the surgical effect.

This explains the requirement of electrolyte-free and hypotonic distension media if monopolar electrocauterisation is used. If these hypotonic fluids find their way into the systemic circulation of the patient not only fluid overload may occur, but also hypotonic haemodilution. Resulting hyponatremia and osmotic imbalances can lead to cerebral edema with symptoms as seizures, coma or death [24, 25].

Premenopausal women are at increased risk of neurological complications due to sodium-potassium adenosine triphosphatase (NA^+/K^+- ATPase) "pump"-inhibition by female sex steroids, most likely oestrogens [26]. Preoperative GnRH-agonist administration may therefore be considered [27].

The risk of neurological complication using electrolyte--free distending media has led to the development of bipolar electrosurgical instruments that can be used even in complex hysteroscopic surgery [28, 29]. The electrical circuit is completed at the tip of the instrument. The presence of charged particles is therefore required and electrolyte-containing media (e.g. normal saline) is used.

To prevent neurological complications during hysteroscopy it is recommended to avoid hypotonic distending media whenever possible. The uterine cavity distension pressure should be the lowest pressure necessary to distend the uterine cavity and ideally should be maintained below the mean arterial pressure (MAP) especially with regard to long--lasting procedures.

Input and output of distending solution should be accurately monitored, since differences may indicate increased absorption or fluid loss due to accidental uterus perforation.

When using hypotonic distending media not more than 1000 mL should be absorbed. For elderly patients and others with comorbid conditions including compromised cardiovascular systems, a maximum fluid deficit of 750 mL is recommended.

In case of use of high-viscosity distending media, the maximum infused volume should be maintained below 500 mL in healthy patients, and below 300 mL if risk factors are present.

The maximum limit for isotonic media remains unclear, but absorption volumes of more than 2500 mL even in healthy patients should be prevented.

Preoperatively gynaecologist and anaesthesiologist should agree upon a maximum deficit volume with respect to the distending media used, the planned procedure and patient-specific risk factors. If that limit is exceeded during surgery termination has to be considered. If absorption of hypotonic solution is suspected, immediate measurement of plasma electrolytes and osmolality is indicated [30].

Some authors propagate intra-cervical injection of a dilute vasopressin solution to reduce distending media absorption during resectoscopy [31, 32]. This approach should be communicated with the anaesthesiologist, since absorption of large systemic doses have resulted in cardiovascular collapse, myocardial infarction and death [33].

Treatment options for manifest fluid overload syndrome include supportive intensive care, use of diuretics and substitution with sodium-containing solution. Special care must be taken when correcting severe hyponatremia, since pontine myelinolysis can occur (Fig. 20.3).

Laparoscopy

In recent centuries laparoscopy has become the standard technique for numerous gynaecological procedures. Advantageous for the anaesthesiologist are less haemorrhage, less postoperative pain and an improved lung function that results in a shorter hospital stay [34]. Especially overweight patients and patients with significant cardiopulmonary comorbidities benefit from laparoscopy.

However insufflation of carbon dioxide (CO_2) in order to establish and maintain pneumoperitoneum causes relevant changes in haemodynamics, lung function and the acid-base balance. Other organ systems like liver and kidney function may be altered as well.

Pulmonary Difficulties During Laparoscopy

CO_2 best satisfies the characteristics demanded from a gas used for pneumoperitoneum insufflation. It is non-flammable, inexpensive and easily expelled from the body, the latter because CO_2 is readily soluble. Therefore the risk for embolism is low but insufflation of CO_2 into the peritoneal cavity causes increased blood levels. To prevent development of hypercarbia and following acidosis the anaesthesiologist needs to alter ventilator settings. An increased respiratory rate (RR) and inspiratory pressures (P_{insp}) generate the necessary elevation of respiratory minute volume (MV).

$$\text{Pneumoperitoneum} \rightarrow CO_2 \uparrow \rightarrow MV \uparrow \left(RR \uparrow \text{ and } P_{insp} \uparrow\right)$$

Increased inspiratory pressures are also required due to the pneumoperitoneum itself. Increased intra-abdominal pressure will shift the diaphragm cranial. Therefore higher pressure settings are required to maintain a certain tidal volume. Thus pulmonary compliance decreases. Also functional residual capacity and vital capacity decline following pneumoperitoneum. The use of Trendelenburg

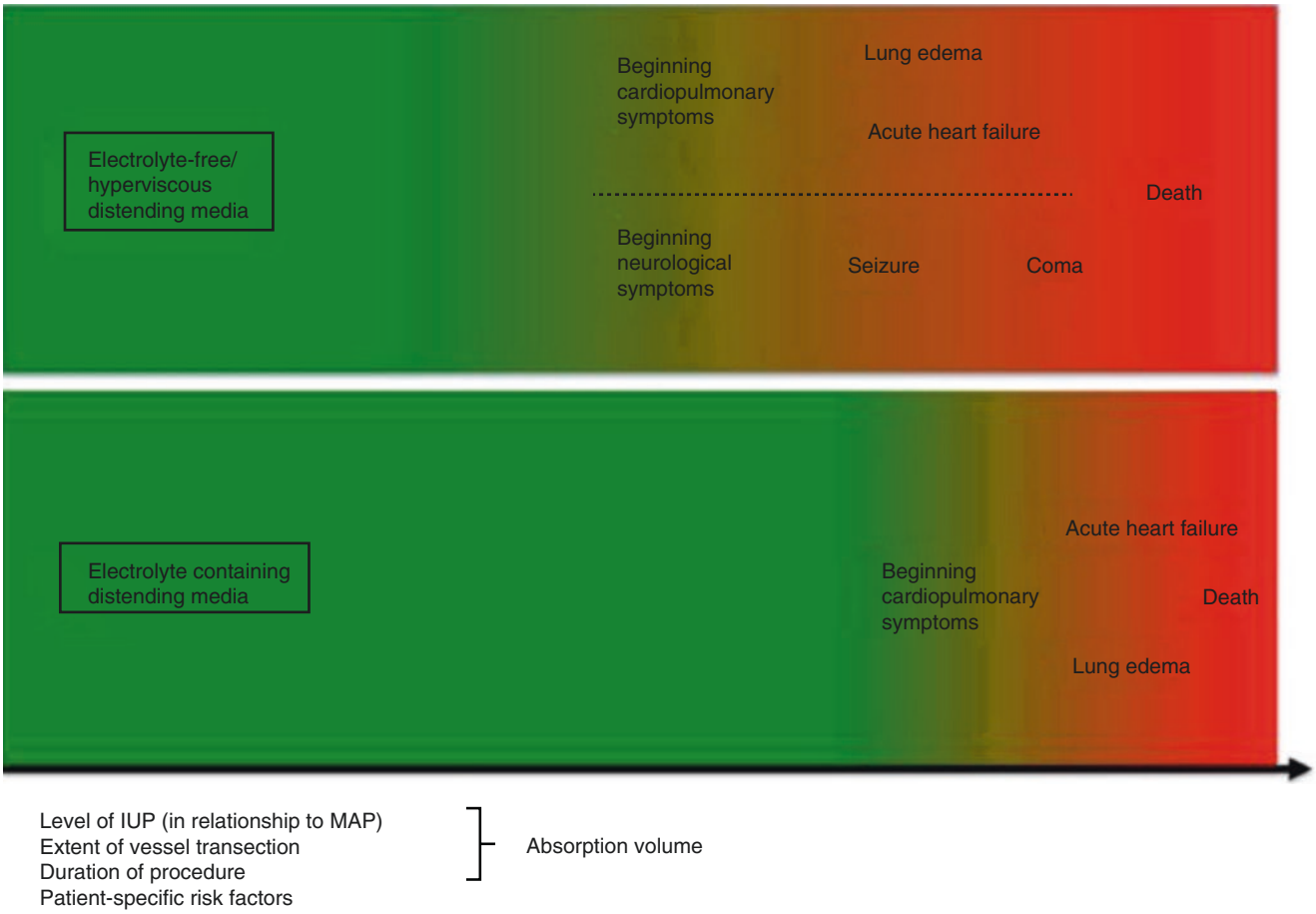


Fig. 20.3 Risk for complications using electrolyte-containing and electrolyte-free/hyperviscous distending media in hysteroscopic procedures. *IUP* intra-uterine pressure, *MAP* mean arterial pressure

position intensifies diaphragm transfer with its pulmonary consequences.

$$\text{Pneumoperitoneum} \rightarrow \text{cranial shift of the diaphragm} \rightarrow \text{compliance} \downarrow \rightarrow P_{insp} \uparrow$$

Increased inspiratory pressure leads to increased intra-thoracic pressure that directly affect the vessels of the pulmonary circuit resulting in decreased lung perfusion. Additionally the development of atelectasis leads to a reduction of lung tissue taking part in gas exchange. Consequently ventilation/perfusion ratio will be decreased inducing a deterioration of CO_2 elimination and an oxygenation deficiency.

$$P_{insp} \uparrow \rightarrow \text{intra-thoracic pressure} \uparrow \rightarrow \text{ventilation / perfusion mismatch} \uparrow \leftarrow \text{atelectasis} \uparrow$$

Summarizing, pneumoperitoneum results in increased levels of CO_2 in the blood. At the same time decreasing pulmonary compliance and an increasing ventilation/perfusion mismatch lead to reduced performance of the pulmonary system, which is supposed to eliminate CO_2. It needs to be kept in mind that the anaesthesiologist can hardly improve the pulmonary system itself during laparoscopy/Trendelenburg position. To avoid acidosis the invasiveness of ventilator settings needs to be increased which may eventually harm the patient.

For the patient's safety the gynaecologist therefore needs to be informed by the anaesthesiologist if excessive acidosis and/or oxygenation deficiency develop. Since pneumoperitoneum is the main cornerstone for pulmonary exacerbation during laparoscopic surgery reduction of intra-abdominal pressure and Trendelenburg position is the adequate de-escalation strategy. If the pulmonary status remains critical the termination of the procedure has to be taken into account.

Subcutaneous Emphysema During Laparoscopy

In rare cases the insufflation gas extends beyond the peritoneum causing subcutaneous emphysema. Extension of insufflated gas may directly harm the patient if extravasation occurs within the mediastinum. Swelling of the larynx region may result in dyspnoea and stridor after extubation.

Pneumothorax caused by extension of insufflated gas through diaphragmatic congenital channels into the pleural cavities has been reported [35–37].

While minor extravasations of gas can only be detected by radiological imaging distinctive manifestations may be palpated as crepitations.

CO_2 extension beyond peritoneal cavity
→ direct harm due to gas expansion

Extension of CO_2 beyond the peritoneal cavity impairs integrity of pneumoperitoneum required by the operator. To maintain the predetermined pressure set point the insufflator increases the gas flow rate resulting in an increased overall exposure with CO_2. CO_2 is therefore not only absorbed from the peritoneal cavity but also the surrounding tissue. Severe, long-lasting acidosis may develop.

Excessive hypercarbia requires invasive respirator settings with high tidal volumes and inspiratory pressures that may also harm the patient.

Hypercarbia beyond extubation requires increased work of breathing. Exhaustion may result in CO_2 narcosis and possible reintubation.

It is therefore recommended to not only monitor pressure and flow rate but also the total CO_2 volume during laparoscopy in order to detect loss of gas [38].

CO_2 extension beyond peritoneal cavity → pressure of pneumoperitoneum ↓→ flow rate of insufflator ↑→ total exposition to CO_2 ↑→ absorption ↑→ acidosis ↑→ escalation of ventilatory support

The incidence of subcutaneous emphysema varies with regard to the extent of extravasation. Grossly detectable subcutaneous emphysema can be found in 0.43–2.3% [38]. Postoperative computed tomography scans showed subcutaneous emphysema in 56 % 24 h after laparoscopy [39]. Mediastinal emphysema was detectable in 20 % after laparoscopy using x-ray imaging [40–43].

High intra-abdominal pressure leads to increased incidence of subcutaneous emphysema, especially during long-lasting procedures. Each increase in pressure is transmitted against the inner abdominal wall and transmitted to tissues, resulting in decreased perfusion, hypoxia, increased gas absorption, and increased likelihood of tissue dissection and subcutaneous emphysema. Even though intra-abdominal pressures between 0 and 20 mmHg are considered as safe, the use of pressures between 12 and 14 mmHg is recommended.

Locations of increased vulnerability of CO_2 escape are the insertion sites of the trocars. Gas extension beyond the peritoneal cavity increases with the amount and size of the trocars used. Due to their length surgical instruments act as lever arms and the force applied is multiplied at the fulcrum, which in case of laparoscopy is the boundary between the trocars and the tissue surrounding it. Shear forces may cause trauma and eventually lead to dissection of tissue and loss of CO_2. Knowledge of this fact is particularly crucial when performing robotic assisted surgery since the surgeon lacks haptic feedback from the tissue [38].

Cardiocirculatory Difficulties During Laparoscopy

Prediction of cardiocirculatory reactions during laparoscopy is difficult due to complex processes, since both, pneumoperitoneum and Trendelenburg position cause a cardiocirculatory response.

Pneumoperitoneum affects circulation through increased intra-abdominal pressure and acidosis resulting from CO_2 absorption.

IAP < 15 mmHg causes mobilization of pooled venous blood and increases cardiac preload and cardiac output. If IAP exceeds 15 mmHg the contrary has to be expected. Increased pressure is directly transmitted to the vessel walls and causes compression resulting in reduced venous return. At the same time the arterial system is affected and systemic vascular resistance increases. Decreased CO and elevated MAP may be witnessed [44].

Mesenterial and renal perfusion decreases during pneumoperitoneum, causing activation of renin-angiotensin-aldosterone system (RAAS) and thus liberation of catecholamines.

Acidosis resulting from hypercarbia causes sympathetic activation while severe acidosis decreases left ventricular function [45].

As mentioned above pneumoperitoneum is associated with increased inspiratory pressures that compromise venous return. Trendelenburg position may partly revoke these effects due to orthostatic effects. Possible tachycardia and hypertension due to a lack of analgesia as well as cardiocirculatory effective medication taken by the patient may alter cardiocirculatory response as well.

Therefore implementation of pneumoperitoneum and changes in patient position should occur gently, especially in patients with cardiopulmonary comorbidities, to allow circulation to adapt.

Introduction of the veress-needle, trocars and establishing pneumoperitoneum may cause vagal reactions that can lead to bradycardia and asystole even in healthy individuals [44].

Similar symptoms can occur through manipulation on uterus and adnexa [23].

Additional Considerations During Laparoscopic Surgery

CO_2 absorption and Trendelenburg position may cause an increase in cerebral blood flow, which can result in cerebral edema and increased intracranial pressure especially during long-lasting procedures. If cerebral edema is suspected prolonged ventilatory support in anti-Trendelenburg position and treatment with mannitol should be considered. Pre-existing increased intracranial pressure is a contraindication for laparoscopy [46].

Intra-ocular pressure may also increase during pneumoperitoneum. Vision loss after long-lasting laparoscopy in steep Trendelenburg position is a rare but catastrophic complication [47, 48]. In patients with glaucoma ophthalmologic assessment is advised.

Elevated intra-abdominal pressure during laparoscopy increases the risk for aspiration. The airway is therefore secured via endotracheal tube. Intra-gastric pressure is resolved using a gastric tube.

The anaesthesiologist must be aware that inadvertent one-sided intubation and consequent hypoxemia is a distinct possibility during laparoscopic surgery because of the Trendelenburg position, which with the raised IAP, lifts the diaphragm and carina, while the endotracheal tube remains fixed at its proximal end. This complication can easily be detected by auscultating the patient and then resolved.

Restricted Access in emergency situations to the patient's airway, intravenous lines and thorax for possible resuscitation during laparoscopy has to be considered.

Gas Embolism

With implementation of pneumoperitoneum, immediate gas embolism may occur, and in very rare cases it may lead to severe cardiovascular failure, decreased pulmonary blood flow, and death. Since CO_2 is readily soluble this complication is extremely rare during laparoscopy. Contamination of the abdominal cavity with room air needs to be prevented because the contained oxygen can maintain combustion and nitrogen could cause embolism due to its poor solubility. If embolism occurs pulmonary circulation is generally affected causing an increased vascular resistance. Sudden elevation of right hearted afterload may cause right heart failure. Transfer to arterial circulation (patent foramen ovale) can result in end organ failure, especially stroke. The clinical manifestations of embolism generally include a sudden increase followed by a rapid reduction in end-tidal CO_2, tachycardia and hypotension. If suspected the patient should be brought in head down/left-side tilt (durant maneuver) to prevent further embolism of the pulmonary circulation. Gas embolism can be detected sonographically and a central venous line can be used to evacuate emboli via aspiration (Fig. 20.4).

Robotic Surgery

Improved precision and three-dimensional display allows execution of even complex gynaecological procedures in minimal invasive technique. Further dissemination of robotic assisted surgery in the years to come can be expected.

For anaesthesiologists the evolution of laparoscopy to robotic assisted surgery can be a challenge.

The considerations for laparoscopy are even more valid for the robotic approach. Essential problems include patient positioning, duration of the procedures and limited access to the patient.

Patient positioning is crucial in robotic assisted surgery since after docking of the robot no further movement of the patient is permitted. Patient movement while the robot is docked can cause serious injury at the insertion site of the trocars, which is why adequate muscle relaxation is critical for success. To achieve optimal circumstances to perform surgery the patient is positioned in steep (up to 45°) Trendelenburg position. Especially in overweight patients undesired sliding and intraoperative neuropathic injury can only be prevented if positioning is performed meticulously prior to robot docking using shoulder braces, antiskid foam material and vacuum mattresses etc.

The creation of pneumoperitoneum is associated with the earlier mentioned problems as hypercarbia, decreased pulmonary compliance, ventilation/perfusion mismatch and interference with venous return and systemic vascular resistance.

Intravenous lines should be introduced on both sides of the upper extremity to compensate for loss since access (for further puncturing) after robot docking may be restricted. Preoperative communication between gynaecologist and anaesthesiologist is essential to plan anaesthesiological management with regard to extent and duration of the procedure [49, 50]. Moreover the anaesthesiologist evaluates the indication for arterial line and central venous catheter considering the patient's comorbidities.

If the bulky robot is draped and docked access to the patient's thorax is limited. In emergency situation chest compressions or cardiac defibrillation can only be executed once the robotic arms have been removed. That way the resuscitation can be initiated immediately. Removal of the trocars and the robot itself has to be done subsequently to allow access to the entire patient. Reaction time in emergency situations during robotic assisted surgery can be improved with simulator training [51].

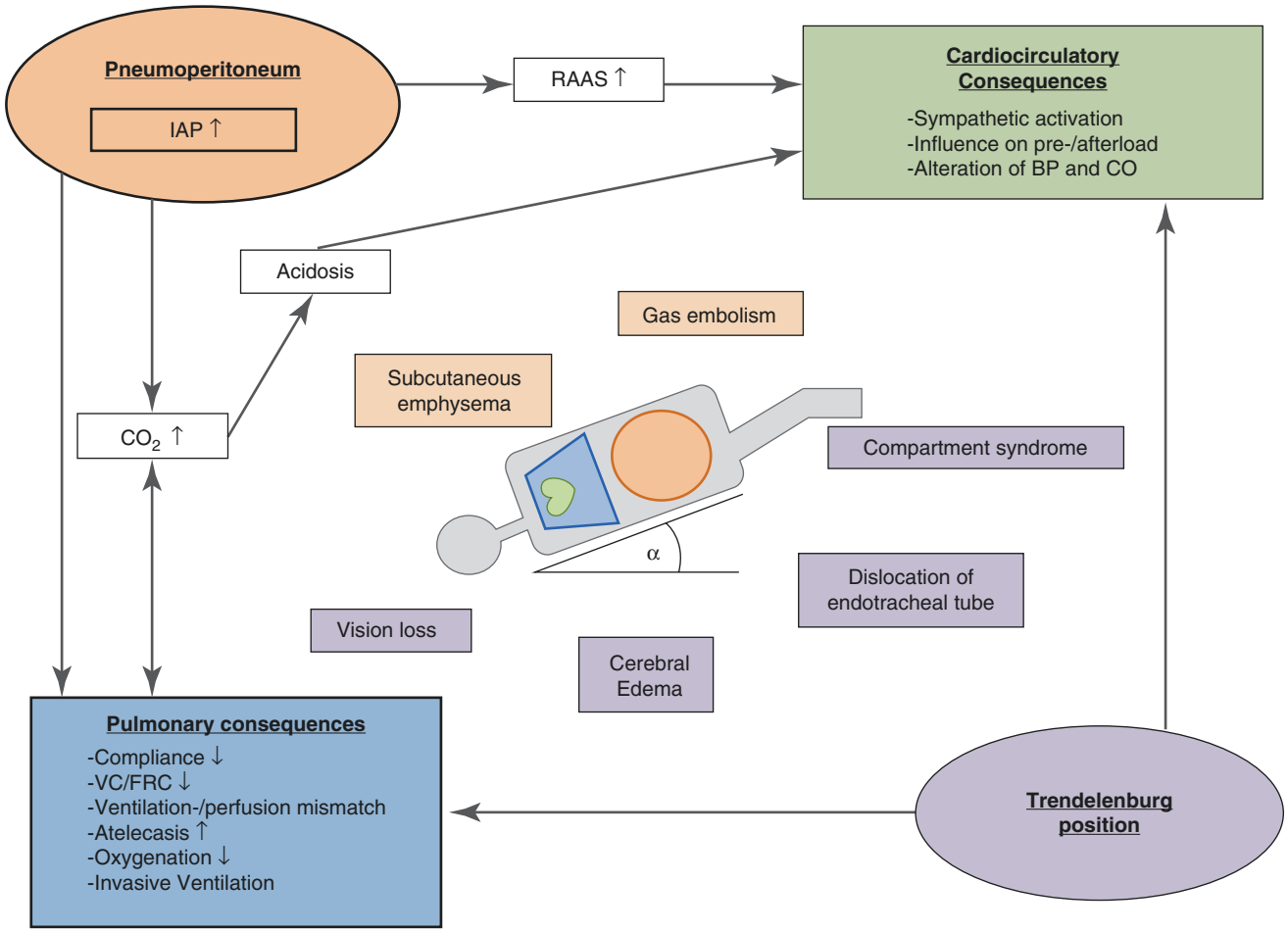


Fig. 20.4 (Patho-) Physiological alterations and complications during laparoscopy/robotic assisted surgery. The complications are coloured corresponding to the leading risk factor. CO_2 Carbon dioxide, *CO* Cardiac output, *IAP* intra-abdominal pressure, *FRC* Functional residual capacity, *RAAS* Renin-angiotensin-aldosterone system, *BP* Blood pressure, *VC* Vital capacity, *α* angle (extent) of Trendelenburg position

Resuscitation

Remove the arms of the robot → start chest compressions / defibrillation → remove all trocars from the robot → remove the robot

The long duration of most robotic assisted procedures intensifies the effects of pneumoperitoneum and patient position (also see Fig. 20.4). Therefore all issues discussed above concerning laparoscopy need to be considered during robotic assisted surgery in particular. That includes:

- Pulmonary difficulties (including risk of subcutaneous emphysema)
- Cardiocirculatory difficulties
- Risk of cerebral edema and increased intra-ocular pressure
- Risk of nerve injuries and compartment syndrome
- Risk of aspiration due to increased intra-abdominal pressure
- Risk of one-sided intubation
- Restricted access

Also general factors of long-lasting surgery as fluid loss, hypothermia and haemorrhage need to be anticipated by the anaesthesiologist.

Laparotomy

Despite the advances in laparoscopic techniques oncologic surgery in gynaecology is today mostly performed via laparotomy.

Oncologic patients more often present in poor general condition and are older than the usual gynaecologic cohort. Preoperative tumor-associated anaemia is common. Large intra-abdominal masses and the presence of ascites may increase intra-abdominal pressure and risk for aspiration.

Compared to laparoscopy tissue trauma during laparotomy is more severe. Therefore vast, long-lasting procedures may promote the development of systemic inflammatory response syndrome (SIRS). The liberation of mediators causes increased capillary permeability, endothelial dysfunction and impaired cardiac function.

The anaestheseological management relies on the knowledge of anticipated blood loss, duration and patient-specific risk factors. Particularly for the operative setting it has to be considered if vasopressors or postoperative parenteral nutrition are required. Extravasation of vasopressors (e.g. norepinephrine and epinephrine) can propagate cell damage by inducing venous and arterial vasospasms and causing disruption to vein wall integrity. Parenteral nutrition is a hypertonic agent that can cause tissue damage by shifting the equilibrium between intracellular and extracellular fluid. Intracellular fluid is forced out of cells and into the interstitial space, causing direct cell damage. Extravasation of these substances may lead to significant tissue damage, skin sloughing, and dermal necrosis with following infection and even amputation [52–54]. Therefore central venous line placement is advisable whenever there is a high probability that these substances need to be administered perioperatively. When evaluating the indication for central venous line placement possible adverse effects like pneumothorax, central-line associated bloodstream infections, thrombosis, misplacement and arrhythmias need to be considered.

While measurement of central venous pressure is no longer recommended for controlling volume management, central venous oxygenation may pose essential information regarding the patient's circulation [55].

Introduction of an arterial line should be performed for vast, long-lasting surgery or in patients with cardiopulmonary comorbidities. It allows the continuous and exact monitoring of blood pressure and the analysis of the arterial blood gases may give additional information on the patient's volume and respiratory status.

To decrease the risk of hypothermia the patient's temperature is monitored and convective warming systems and preheated infusion solution are used. In the case of severe hypothermia adapting the room temperature in the operating theatre can be considered.

Adequate muscle relaxation during abdominal surgery improves conditions to perform surgery by decreasing tone of skeletal muscle of the abdominal wall and the diaphragm. Muscle relaxants decrease transmission of nerve impulses at the site of neuromuscular junction. Therefore the muscle itself will be susceptible to direct electrical stimulation even after a muscle relaxant has been administered. The clinical effect of muscle relaxants is commonly monitored by acceleromyography (quality of muscle response after repeated nerve stimulation). Smooth muscle cell function and therefore intestinal motility is not affected by muscle relaxants.

The introduction of an epidural catheter is an important tool to shorten the time of recovery, manage pain and improve postoperative lung function. Nevertheless epidural haematoma with the risk of persisting paraplegia has an incidence between 1:3000 and 1:6000 [56–58] and therefore is far more common than previously suspected. The placement is performed prior to the operation while the patient is still awake in order to detect paraesthesia during catheter introduction and possible misplacement of the catheter into the subarachnoid space. The patient's wish, pre-existing anti--coagulant medication and possible patient-specific risk factors need to be evaluated in a risk benefit assessment prior to operation. The recent implementation of newer anticoagulants has to be considered with regard to timing of puncture and removal of epidural catheters (Table 20.3). A monotherapy with acetylsalicylic acid is not a contraindication for epidural puncture. While the epidural catheter is in place an anaesthesiologist and/or pain nurse will consult the patient at least once daily to asses adequate pain relieve and to detect signs for infection or neurological abnormalities. Usually the catheter is removed once sufficient analgesia without epidural infusion has been assured. When removing an epidural catheter intake of anticoagulant medication needs to be considered (Table 20.3).

For abdominal surgery intravenous lidocaine infusion poses a possible option to reduce perioperative pain and to improve recovery of postoperative bowel function [59]. Analgesic [60], anti-hyperalgesic [61] and anti-inflammatory effects [60, 62] characterize intravenous lidocaine. Increased postoperative sedation and the occurrence of cardiac arrhythmias may be possible side effects [63].

Vast oncologic surgery is associated with a high risk for haemorrhage and distinctive fluid shifts. Thus compatible erythrocyte concentrate needs to be provided. It has to be considered that transfusion of erythrocyte concentrate poses an independent risk factor for infection and sepsis [64], multiple organ failure [65] and death [66]. This reflects in more restrictive transfusion recommendations. Due to early presentation prior to surgery existing anaemia can be detected and possibly treated. Hereby the patient's red blood cell count and haemoglobin concentration can be optimized and mortality may be decreased [67–69].

If acute profuse bleeding (e.g. due to vessel transection) occurs during surgery basic physiology (Ohm's law) teaches that during hypertension will cause an increased blood loss due to an increased pressure gradient (pressure within the vessel vs. surrounding (atmospheric) pressure). Not only because the bleeding itself is stronger but also because haemostasis may be impeded due to clot disruption [70].

Therefore lower blood pressure via intraoperative controlled hypotension may be advantageous during acute bleeding and possibly reduce transfusion rate and blood loss. However intraoperative hypotension (IOH) is one of the

Table 20.3 Recommended time intervals prior to and after epidural catheter placement and removal [78]

Substance	Half-life period	Interval prior to placement/removal	Interval after placement/removal
Heparin, unfractionated (prophylaxis)	1, 5–2 h	4 h	1 h
Heparin, unfractionated (therapeutic)	2–3 h	i.v. 4–6 h s.c. 8–12 h	1 h
Low molecular weight heparin (prophylaxis)	4–6 h[a]	12 h	4 h
Low molecular weight heparin (therapeutic)		24 h	4 h
Fondaparinux (1 × 2.5 mg/day)	15–20 h[a]	36–42 h	6–12 h
Danaparaoid (2 × 750 I.E./day)	22–24 h[a]	48 h	3–4 h
Hirudinea Desirudin Bivalirudin	120 min[a] 25 min[a]	8–10 h 4 h	6 h 8 h
Argatroban (prophylaxis)[b]	35–45 min	4 h	5–7 h
Dabigatran (max. 1 × 150–220 mg/day)	14–17 h[a]	28–34 h	6 h
Dabigatran (max. 2 × 150 mg/day)	14–17 h[a]	56–85 h	6 h
Rivaroxaban (1 × 10 mg/day)	11–13 h[a]	22–26 h	4–5.5 h
Rivaroxaban (2 × 15 mg/day, 1 × 20 mg/day)	11–13 h[a]	44–65 h	4–5.5 h
Apixaban (2 × 2.5 mg/day)	10–15 h[a]	26–30 h	5–7 h
Apixaban (2 × 5 mg/day)	10–15 h[a]	40–75 h	5–7 h
Vitamin k antagonists	Days	INR < 1.4	After removal
Acetylsalicylic acid (100 mg/day)[c]	Life span of thrombocytes	None	None
Clopidogrel Ticlopidin	Life span of thrombocytes	7–10 days	After removal
Prasugrel	Life span of thrombocytes	7–10 days	6 h
Ticagrelor	7–8.5 h	5 days	6 h
Abciximab	12–24 h	Contraindication for puncture/48 h prior to removal	8 h

[a]Half-life period depends on renal function
[b]Half-life period depends on liver function
[c]Treatment with acetylsalicylic acid requires disruption of other anticoagulants for 4–5 half-life periods, while acetylsalicylic acid may be continued

most important concerns associated with the occurrence of postoperative myocardial ischemia and infarction, acute kidney failure and stroke (watershed infarcts) [71, 72].

IOH still lacks exact definition and needs to be considered a dynamic phenomenon depending on patient specific risk factors such as comorbidity, age and surgical factors. Therefore intraoperative controlled hypotension should not be based on fixed, arbitrarily chosen thresholds but needs to be adapted (extent and duration of IOH) according to the clinical setting [71–73].

Perioperative coagulopathy may occur during gynaecologic surgery and necessitate substitution of coagulant factors. Coagulopathy in the operative setting often is initiated due to blood loss and dilution but remains a multifactorial disorder involving:

- Abnormalities of basic physiological conditions (e.g. temperature, pH, ionized calcium),
- Disorders of primary haemostasis (pre-existing or acquired),
- Abnormalities of blood plasma (clotting-factor deficits) or
- Complex coagulopathies (hyperfibrinolysis, disseminated intravascular coagulation).

Detection of perioperative coagulopathies and the monitoring of their treatment are difficult tasks and an on-going field of research [74–77].

While "classical" routine testing of blood coagulation (INR, aPTT) is limited in terms reflecting the complexity of bleeding disorders, point-of-care (POC) testing (e.g. aggregometric or viscoelastic testing) may potentially reveal additional information on the underlying coagulopathy and help guide the use of allogeneic blood products, clotting-factor concentrates and other hemotherapeutic agents.

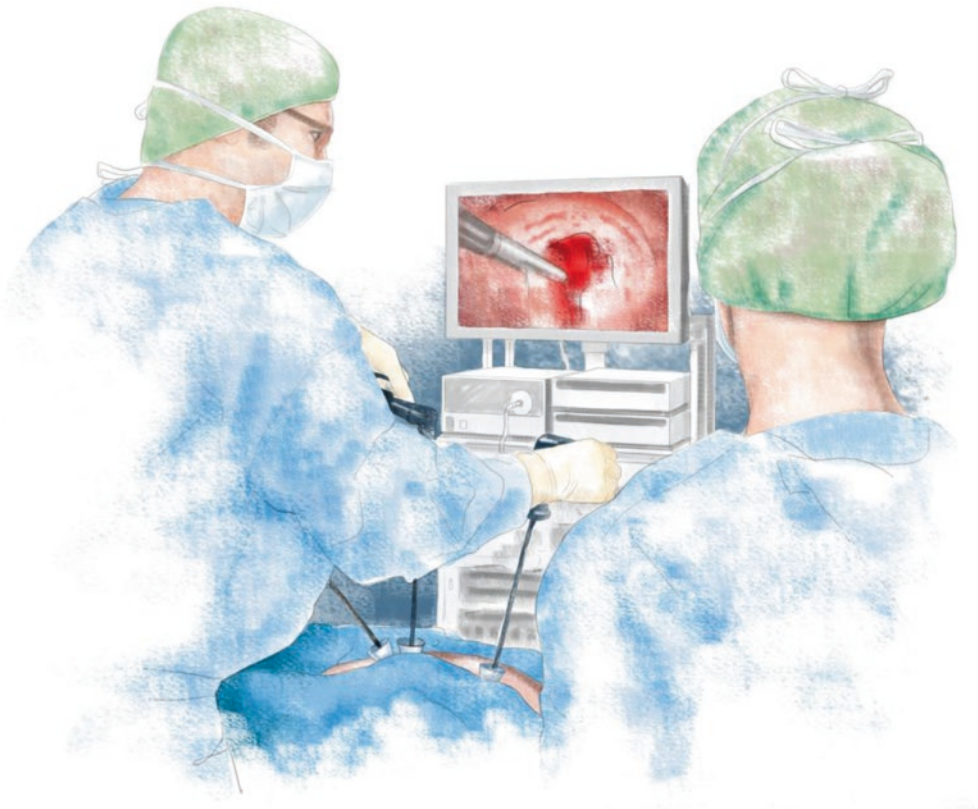
References

1. Apfel CC, Laara E, Koivuranta M, Greim CA, Roewer N. A simplified risk score for predicting postoperative nausea and vomiting: conclusions from cross-validations between two centers. Anesthesiology. 1999;91:693–700.
2. Koivuranta M, Laara E, Snare L, Alahuhta S. A survey of postoperative nausea and vomiting. Anaesthesia. 1997;52:443–9.
3. Sinclair DR, Chung F, Mezei G. Can postoperative nausea and vomiting be predicted? Anesthesiology. 1999;91:109–18.
4. Apfel CC, Heidrich FM, Jukar-Rao S, Jalota L, Hornuss C, Whelan RP, et al. Evidence-based analysis of risk factors for postoperative nausea and vomiting. Br J Anaesth. 2012;109:742–53.
5. Apfel CC, Kranke P, Eberhart LH. Comparison of surgical site and patient's history with a simplified risk score for the prediction of postoperative nausea and vomiting. Anaesthesia. 2004;59:1078–82.
6. Myles PS, Williams DL, Hendrata M, Anderson H, Weeks AM. Patient satisfaction after anaesthesia and surgery: results of a prospective survey of 10,811 patients. Br J Anaesth. 2000;84:6–10.
7. Macario A, Weinger M, Carney S, Kim A. Which clinical anesthesia outcomes are important to avoid? The perspective of patients. Anesth Analg. 1999;89:652–8.
8. Fortier J, Chung F, Su J. Unanticipated admission after ambulatory surgery–a prospective study. Can J Anaesth. 1998;45:612–9.
9. Hill RP, Lubarsky DA, Phillips-Bute B, Fortney JT, Creed MR, Glass PS, et al. Cost-effectiveness of prophylactic antiemetic therapy with ondansetron, droperidol, or placebo. Anesthesiology. 2000;92:958–67.
10. Eberhart LH, Geldner G, Kranke P, Morin AM, Schauffelen A, Treiber H, et al. The development and validation of a risk score to predict the probability of postoperative vomiting in pediatric patients. Anesth Analg. 2004;99:1630–7. table of contents.
11. Recommendations for the prevention of positioning injuries during gynecologic operations. Guideline of the German Society of Gynecology and Obstetrics (AWMF Registry No. 015/077) [Internet]. 2015. Available from: http://www.awmf.org/leitlinien/detail/ll/015-077.html.
12. Vollmar B, Westermann S, Menger MD. Microvascular response to compartment syndrome-like external pressure elevation: an in vivo fluorescence microscopic study in the hamster striated muscle. J Trauma. 1999;46:91–6.
13. Matsen FA, Krugmire RB, King RV. Nicolas Andry Award. Increased tissue pressure and its effects on muscle oxygenation in level and elevated human limbs. Clin Orthop Relat Res. 1979;144:311–20.
14. Anema JG, Morey AF, McAninch JW, Mario LA, Wessells H. Complications related to the high lithotomy position during urethral reconstruction. J Urol. 2000;164:360–3.
15. Bauer EC, Koch N, Janni W, Bender HG, Fleisch MC. Compartment syndrome after gynecologic operations: evidence from case reports and reviews. Eur J Obstet Gynecol Reprod Biol. 2014;173:7–12.
16. Matsen FA, Winquist RA, Krugmire RB. Diagnosis and management of compartmental syndromes. J Bone Joint Surg Am. 1980;62:286–91.
17. Shah DM, Bock DE, Darling RC, Chang BB, Kupinski AM, Leather RP. Beneficial effects of hypertonic mannitol in acute ischemia–reperfusion injuries in humans. Cardiovasc Surg. 1996;4:97–100.
18. Johnson DJ, Chalkiadis GA. Does epidural analgesia delay the diagnosis of lower limb compartment syndrome in children? Paediatr Anaesth. 2009;19:83–91.
19. Mar GJ, Barrington MJ, McGuirk BR. Acute compartment syndrome of the lower limb and the effect of postoperative analgesia on diagnosis. Br J Anaesth. 2009;102:3–11.
20. Cohen SA, Hurt WG. Compartment syndrome associated with lithotomy position and intermittent compression stockings. Obstet Gynecol. 2001;97:832–3.
21. Montgomery CJ, Ready LB. Epidural opioid analgesia does not obscure diagnosis of compartment syndrome resulting from prolonged lithotomy position. Anesthesiology. 1991;75:541–3.
22. Radosa JC, Radosa MP, Sutterlin M. Acute lower limb compartment syndrome after Cesarean section: a case report. J Med Case Reports. 2011;5:161.
23. Sprung J, Abdelmalak B, Schoenwald PK. Recurrent complete heart block in a healthy patient during laparoscopic electrocauterization of the fallopian tube. Anesthesiology. 1998;88:1401–3.
24. Arieff AI. Hyponatremia associated with permanent brain damage. Adv Intern Med. 1987;32:325–44.
25. Istre O, Bjoennes J, Naess R, Hornbaek K, Forman A. Postoperative cerebral oedema after transcervical endometrial resection and uterine irrigation with 1.5 % glycine. Lancet. 1994;344:1187–9.
26. Ayus JC, Wheeler JM, Arieff AI. Postoperative hyponatremic encephalopathy in menstruant women. Ann Intern Med. 1992;117:891–7.
27. Taskin O, Buhur A, Birincioglu M, Burak F, Atmaca R, Yilmaz I, et al. Endometrial Na+, K + −ATPase pump function and vasopressin levels during hysteroscopic surgery in patients pretreated with GnRH agonist. J Am Assoc Gynecol Laparosc. 1998;5:119–24.
28. Berg A, Sandvik L, Langebrekke A, Istre O. A randomized trial comparing monopolar electrodes using glycine 1.5 % with two different types of bipolar electrodes (TCRis, Versapoint) using saline, in hysteroscopic surgery. Fertil Steril. 2009;91:1273–8.
29. Darwish AM, Hassan ZZ, Attia AM, Abdelraheem SS, Ahmed YM. Biological effects of distension media in bipolar versus monopolar resectoscopic myomectomy: a randomized trial. J Obstet Gynaecol Res. 2010;36:810–7.
30. Munro MG, Storz K, Abbott JA, Falcone T, Jacobs VR, Muzii L, et al. AAGL Practice Report: Practice Guidelines for the Management of Hysteroscopic Distending Media: (Replaces Hysteroscopic Fluid Monitoring Guidelines. J Am Assoc Gynecol Laparosc. 2000;7:167–168.). J Minim Invasive Gynecol. 2013;20:137–48.
31. Corson SL, Brooks PG, Serden SP, Batzer FR, Gocial B. Effects of vasopressin administration during hysteroscopic surgery. J Reprod Med. 1994;39:419–23.
32. Phillips DR, Nathanson HG, Milim SJ, Haselkorn JS, Khapra A, Ross PL. The effect of dilute vasopressin solution on blood loss during operative hysteroscopy: a randomized controlled trial. Obstet Gynecol. 1996;88:761–6.
33. Martin JD, Shenk LG. Intraoperative myocardial infarction after paracervical vasopressin infiltration. Anesth Analg. 1994;79:1201–2.
34. Gonzalez R, Smith CD, McClusky DA, Ramaswamy A, Branum GD, Hunter JG, et al. Laparoscopic approach reduces likelihood of perioperative complications in patients undergoing adrenalectomy. Am Surg. 2004;70:668–74.
35. Batra MS, Driscoll JJ, Coburn WA, Marks WM. Evanescent nitrous oxide pneumothorax after laparoscopy. Anesth Analg. 1983;62:1121–3.
36. Fitzgerald SD, Andrus CH, Baudendistel LJ, Dahms TE, Kaminski DL. Hypercarbia during carbon dioxide pneumoperitoneum. Am J Surg. 1992;163:186–90.
37. Sharma KC, Kabinoff G, Ducheine Y, Tierney J, Brandstetter RD. Laparoscopic surgery and its potential for medical complications. Heart Lung. 1997;26:52–64. quiz 65–7.
38. Ott DE. Subcutaneous emphysema–beyond the pneumoperitoneum. JSLS. 2014;18:1–7.
39. McAllister JD, D'Altorio RA, Snyder A. CT findings after uncomplicated percutaneous laparoscopic cholecystectomy. J Comput Assist Tomogr. 1991;15:770–2.
40. Celik H, Cremins A, Jones KA, Harmanli O. Massive subcutaneous emphysema in robotic sacrocolpopexy. JSLS. 2013;17:245–8.

41. Herati AS, Andonian S, Rais-Bahrami S, Atalla MA, Srinivasan AK, Richstone L, et al. Use of the valveless trocar system reduces carbon dioxide absorption during laparoscopy when compared with standard trocars. Urology. 2011;77:1126–32.
42. Waisbren SJ, Herz BL, Ducheine Y, Yang HK, Karanfilian RG. Iatrogenic "respiratory acidosis" during laparoscopic preperitoneal hernia repair. J Laparoendosc Surg. 1996;6:181–3.
43. Wolf JS, Monk TG, McDougall EM, McClennan BL, Clayman RV. The extraperitoneal approach and subcutaneous emphysema are associated with greater absorption of carbon dioxide during laparoscopic renal surgery. J Urol. 1995;154:959–63.
44. Gerges FJ, Kanazi GE, Jabbour-Khoury SI. Anesthesia for laparoscopy: a review. J Clin Anesth. 2006;18:67–78.
45. Rasmussen JP, Dauchot PJ, DePalma RG, Sorensen B, Regula G, Anton AH, et al. Cardiac function and hypercarbia. Arch Surg. 1978;113:1196–200.
46. Bloomfield GL, Ridings PC, Blocher CR, Marmarou A, Sugerman HJ. Effects of increased intra-abdominal pressure upon intracranial and cerebral perfusion pressure before and after volume expansion. J Trauma. 1996;40:936–41. discussion 941–3.
47. Awad H, Santilli S, Ohr M, Roth A, Yan W, Fernandez S, et al. The effects of steep Trendelenburg positioning on intraocular pressure during robotic radical prostatectomy. Anesth Analg. 2009;109:473–8.
48. Molloy BL. Implications for postoperative visual loss: steep trendelenburg position and effects on intraocular pressure. AANA J. 2011;79:115–21.
49. Kaye AD, Vadivelu N, Ahuja N, Mitra S, Silasi D, Urman RD. Anesthetic considerations in robotic-assisted gynecologic surgery. Ochsner J. 2013;13:517–24.
50. Lee JR. Anesthetic considerations for robotic surgery. Korean J Anesthesiol. 2014;66:3–11.
51. Huser AS, Muller D, Brunkhorst V, Kannisto P, Musch M, Kropfl D, et al. Simulated life-threatening emergency during robot-assisted surgery. J Endourol. 2014;28:717–21.
52. Overgaard CB, Dzavik V. Inotropes and vasopressors: review of physiology and clinical use in cardiovascular disease. Circulation. 2008;118:1047–56.
53. Tran DQH, Finlayson RJ. Use of stellate ganglion block to salvage an ischemic hand caused by the extravasation of vasopressors. Reg Anesth Pain Med. 2005;30:405–8.
54. Le A, Patel S. Extravasation of noncytotoxic drugs: a review of the literature. Ann Pharmacother. 2014;48(7):870–86.
55. Marik PE, Cavallazzi R. Does the central venous pressure predict fluid responsiveness? An updated meta-analysis and a plea for some common sense. Crit Care Med. 2013;41:1774–81.
56. Cook TM, Counsell D, Wildsmith JA. Major complications of central neuraxial block: report on the Third National Audit Project of the Royal College of Anaesthetists. Br J Anaesth. 2009;102:179–90.
57. Moen V, Dahlgren N, Irestedt L. Severe neurological complications after central neuraxial blockades in Sweden 1990–1999. Anesthesiology. 2004;101:950–9.
58. Volk T, Wolf A, Van Aken H, Burkle H, Wiebalck A, Steinfeldt T. Incidence of spinal haematoma after epidural puncture: analysis from the German network for safety in regional anaesthesia. Eur J Anaesthesiol. 2012;29:170–6.
59. Vigneault L, Turgeon AF, Cote D, Lauzier F, Zarychanski R, Moore L, et al. Perioperative intravenous lidocaine infusion for postoperative pain control: a meta-analysis of randomized controlled trials. Can J Anaesth. 2011;58:22–37.
60. Lauretti GR. Mechanisms of analgesia of intravenous lidocaine. Rev Bras Anestesiol. 2008;58:280–6.
61. Koppert W, Ostermeier N, Sittl R, Weidner C, Schmelz M. Low--dose lidocaine reduces secondary hyperalgesia by a central mode of action. Pain. 2000;85:217–24.
62. Hollmann MW, Durieux ME. Local anesthetics and the inflammatory response: a new therapeutic indication? Anesthesiology. 2000;93:858–75.
63. McCarthy GC, Megalla SA, Habib AS. Impact of intravenous lidocaine infusion on postoperative analgesia and recovery from surgery: a systematic review of randomized controlled trials. Drugs. 2010;70:1149–63.
64. Bernard AC, Davenport DL, Chang PK, Vaughan TB, Zwischenberger JB. Intraoperative transfusion of 1 U to 2 U packed red blood cells is associated with increased 30-day mortality, surgical-site infection, pneumonia, and sepsis in general surgery patients. J Am Coll Surg. 2009;208:931–7. 937.e1–2; discussion 938–9.
65. Vincent JL, Baron JF, Reinhart K, Gattinoni L, Thijs L, Webb A, et al. Anemia and blood transfusion in critically ill patients. JAMA. 2002;288:1499–507.
66. Musallam KM, Tamim HM, Richards T, Spahn DR, Rosendaal FR, Habbal A, et al. Preoperative anaemia and postoperative outcomes in non-cardiac surgery: a retrospective cohort study. Lancet. 2011;378:1396–407.
67. Gombotz H, Hofmann A. Patient Blood Management : three pillar strategy to improve outcome through avoidance of allogeneic blood products. Anaesthesist. 2013;62:519–27.
68. Goodnough LT, Maniatis A, Earnshaw P, Benoni G, Beris P, Bisbe E, et al. Detection, evaluation, and management of preoperative anaemia in the elective orthopaedic surgical patient: NATA guidelines. Br J Anaesth. 2011;106:13–22.
69. Fischer DP, Zacharowski KD, Meybohm P. Savoring every drop – vampire or mosquito? Crit Care. 2014;18:306.
70. Sondeen JL, Coppes VG, Holcomb JB. Blood pressure at which rebleeding occurs after resuscitation in swine with aortic injury. J Trauma. 2003;54:S110–7.
71. Bijker JB, Gelb AW. Review article: the role of hypotension in perioperative stroke. Can J Anaesth. 2013;60:159–67.
72. Bijker JB, van Klei WA, Kappen TH, van Wolfswinkel L, Moons KGM, Kalkman CJ. Incidence of intraoperative hypotension as a function of the chosen definition: literature definitions applied to a retrospective cohort using automated data collection. Anesthesiology. 2007;107:213–20.
73. Walsh M, Devereaux PJ, Garg AX, Kurz A, Turan A, Rodseth RN, et al. Relationship between intraoperative mean arterial pressure and clinical outcomes after noncardiac surgery: toward an empirical definition of hypotension. Anesthesiology. 2013;119:507–15.
74. Weber CF, Zacharowski K, Meybohm P, Adam EH, Hofer S, Brun K, et al. Hemotherapy algorithms for coagulopathic cardiac surgery patients. Clin Lab. 2014;60:1059–63.
75. Weber CF, Zacharowski K. Perioperative point of care coagulation testing. Dtsch Arztebl Int. 2012;109:369–75.
76. Kozek-Langenecker S. Management of massive operative blood loss. Minerva Anestesiol. 2007;73:401–15.
77. Ganter MT, Hofer CK. Coagulation monitoring: current techniques and clinical use of viscoelastic point-of-care coagulation devices. Anesth Analg. 2008;106:1366–75.
78. Waurik K, Riess H, Van Aken H, Kessler P, Gogarten W, Volk T. Regional anaesthesia and thromboembolism prophylaxis/anticoagulation 3. Revised recommendations of the German Society of Anaesthesiology and Intensive Care Medicine [Internet]. 2014. Available from: http://www.awmf.org/uploads/tx_szleitlinien/001-005l_S1_R%C3%BCckenmarksnahe_Regionalan%C3%A4sthesie_Thromboembolieprophylaxe_2015-01.pdf.

Part VIII

Laparoscopic Hysterectomy and Extended Procedures for Benign and Malignant Indications



Indications and Contraindications for Laparoscopic Hysterectomy

21

Helder Ferreira and António Braga

Introduction

Hysterectomy is one of the most common surgical procedures performed worldwide. Laparoscopic hysterectomy (LH) ultimate aim is to reduce morbidity and mortality of abdominal hysterectomy (AH) to the levels seen with vaginal hysterectomy (VH) and minimise the rate of AH. Many advantages are referred to laparoscopy like the image magnification offering better visualization of anatomical structures and disease identification. It allows improved access to retroperitoneal spaces due to CO_2 pneumo-dissection. The vessels, ureter, and nerves can be better recognized. When LH is compared with AH, the laparoscopic approach is associated with less blood loss, fewer transfusions, less post-operative pain, shorter hospital stay, decrease risk of wound infection, better quality of life and lower levels of disability [1–12] (Table 21.1).

In 2015, Cochrane published a meta-analysis of 47 randomizes controlled trials with the aim to determine the most appropriate type of hysterectomy for gynaecologic nonmalignant conditions [13]. This study concluded that there are no differences between laparoscopic and vaginal hysterectomies in time to return to normal activities, duration of hospital stay and the rate of conversion to laparotomy. This study also concluded that the incidence of pelvic hematoma, vaginal cuff infection, urinary tract or respiratory infections, and venous thromboembolism were similar for these two types of hysterectomies [13]. There was a higher rate of bladder and ureteral injuries in total laparoscopic hysterectomy (TLH) in comparison with total abdominal hysterectomy (TAH), but similar to total vaginal hysterectomy (TVH) [13].

Classically, the operative time is higher with TLH when compared with TAH or TVH. However, with an increment of surgical experience and expertise, the operative time, as well as the conversion rate to laparotomy or the incidence of major complications is significantly reduced [14, 15].

In spite of these, according to the American College of Obstetricians and Gynaecologists 2009 Committee Opinion[16] and American Association of Gynecologic Laparoscopists [17] TVH is the overall preferred approach when feasible. Factors that influence the surgical approach in hysterectomy include vagina and uterus size and shape, the mobility and accessibility of uterus, the extension of extra uterine disease when present, the need for concurrent procedures and the surgical team experience.

Table 21.1 Advantages of laparoscopic hysterectomy *versus* abdominal hysterectomy

Less blood loss
Fewer transfusions
Less post-operative pain
Shorter hospital stay
Decreased risk of wound infection
Better quality of life
Lower levels of disability

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Indications

TLH indications are similar to those for TAH. Usual indications include leiomyomata (Figs. 21.1 and 21.2), pelvic organ prolapse, abnormal uterine bleeding, adnexal pathology (Fig. 21.3), chronic pelvic pain and endometriosis (Fig. 21.4) [18]. TLH may also be indicated for resection and debulking of both malignant and premalignant disease, especially endometrial and cervical cancer, as noted by extensive case series in the gynaecologic oncologic literature (Table 21.2).

Laparoscopic approach to hysterectomy may be indicated when vaginal access is complicated by a narrow subpubic arch, a nulliparous pelvis, a large uterus (16-week size is usually the upper limit for a TVH) [19] when uterine mobilization is compromised by adhesions or by multiple or large leiomyomas [18].

In case of a very large uterus, it is more feasible to perform transitory uterine arteries clamping using a laparoscopic approach than a vaginal or abdominal access. The need of concomitant procedures and the necessity to explore the pelvis is also an indication for the laparoscopic approach (e.g. endometriosis, pelvic inflammatory disease).

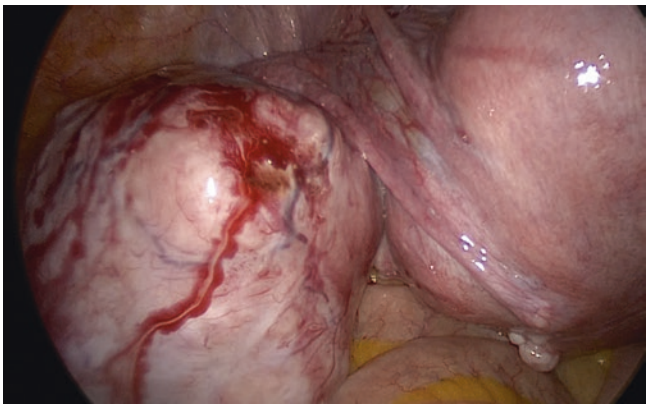


Fig. 21.1 Uterine leiomyomas

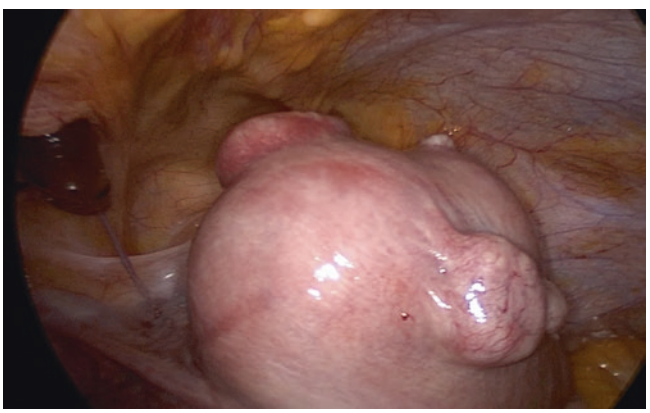


Fig. 21.2 Uterine leiomyomas

An old argument against the use of TLH was the procedure cost. A meta-analysis of 12 randomized controlled studies compared the cost of TLH against the TAH. The total direct costs for the laparoscopic approach were slightly higher, whereas the total indirect cost for TLH was half of TAH. This study concluded that the shorter hospital stay and decreased morbidity in the laparoscopic group compensates for the increased operating cost compared to the laparotomic route [20] (Fig. 21.5).

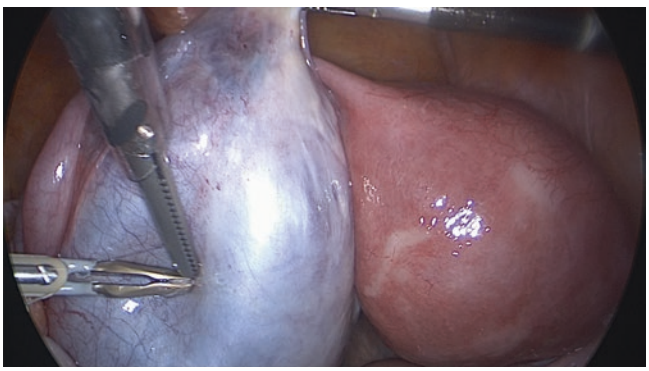


Fig. 21.3 Adnexal cystic mass

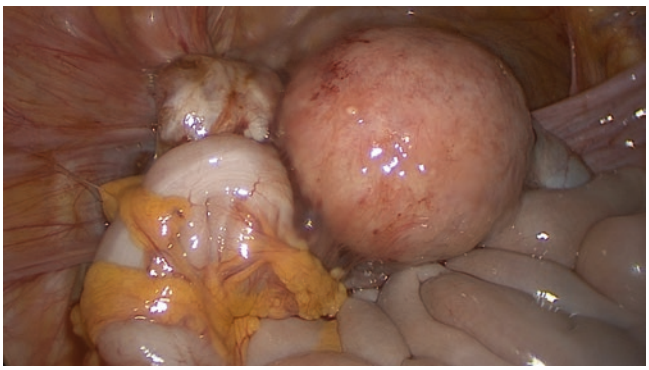


Fig. 21.4 Pelvic endometriosis

Table 21.2 Indications for total laparoscopic hysterectomy

Benign indications	Adenomyosis
	Chronic pelvic pain
	Dysfunctional uterine bleeding
	Endometriosis
	Leiomyoma
	Pelvic organ prolapse
Premalignant indications	Adnexial mass
	Cervical intraepithelial neoplasia
	Endometrial hyperplasia
Malignant indications	Cervical cancer
	Endometrial Cancer

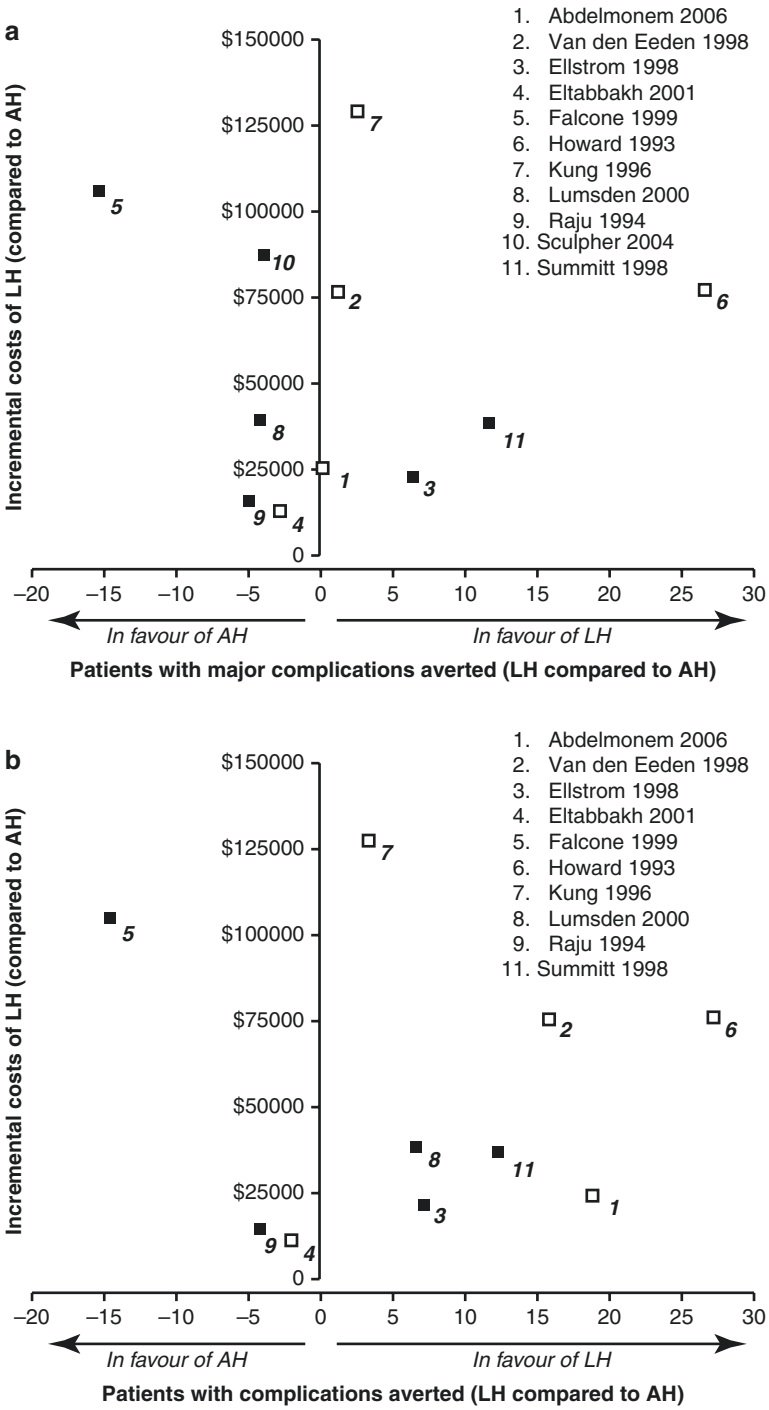


Fig. 21.5 Incremental costs and effects for patients with major complications (**a**) and all complications (**b**) per 100 patients. ■ RC T, □ CCT (From Bijen et al. [20])

Contraindications

There are no absolute contraindications for laparoscopic hysterectomy with the exception to the anaesthetic contraindication to perform the pneumoperitoneum. The experience of the surgical team and the patient's pelvic anatomy are the most important factors. The presence of severe adhesive disease, obstructive uterus or leiomyoma or any other anatomic limitation that prevent a safe entry or adequate working space remain the leading contraindication for the laparoscopic route. LH is also not advised for the diagnosis and treatment of a suspicious pelvic mass that cannot be removed intact through, for example, a culdotomy incision or into an impermeable sack. This is important because, in the presence of a malignant lesion, spillage may change the surgical stage of an ovarian cancer or an uterine sarcoma [21].

Risk factors for conversion to laparotomy include an elevated body mass index, increased uterine width greater than 10 cm, lateral or lower uterine segment fibroids over 5 cm, and previous adhesion-forming abdominopelvic surgery [14]. Previous abdominal scars, especially midline incisions, increase the risk of abdominal adhesions. This can make abdominal entry and surgery more difficult, leading to a major incidence of bowel lesions and conversion to a laparotomic approach [14] (Table 21.3).

Considerations

Remarkably, the most relevant contraindication for laparoscopic hysterectomy is the lack of expertise of the surgical team. In some countries, the rate of TLH increased very quickly at the beginning but, because many surgeons have not received a proper education, many complications happened and the number of minimally invasive procedures decreased. Fortunately, in the recent years, more and better educational programs have allowed a significant increase in TLH offering much superior outcomes in comparison to classic laparotomic approach.

If the surgeon respects the rules, the risk of complications is really low. The placement of the patient in a correct position (Fig. 21.6), the use of correct instrumentation (Figs. 21.7 and 21.8) and trocars positioning (Fig. 21.9) are factors of paramount importance. The key of the success to perform a laparoscopic hysterectomy is to follow the standard steps (Figs. 21.10, 21.11, 21.12, 21.13, 21.14, 21.15, 21.16, 21.17, 21.18, 21.19, 21.20, 21.21, 21.22, 21.23, 21.24, 21.25, and 21.26).

Table 21.3 Contraindications for total laparoscopic hysterectomy

Absolute	Anaesthetic contraindication for pneumoperitoneum confection
	Lack of laparoscopic surgery experience
	Lack of adequate equipment
Relative	Obstructive uterus or leiomyoma
	Severe adhesive disease
	Suspicious pelvic mass that cannot be removed intact



Fig. 21.6 Patient correct positioning



Fig. 21.7 Uterine manipulator

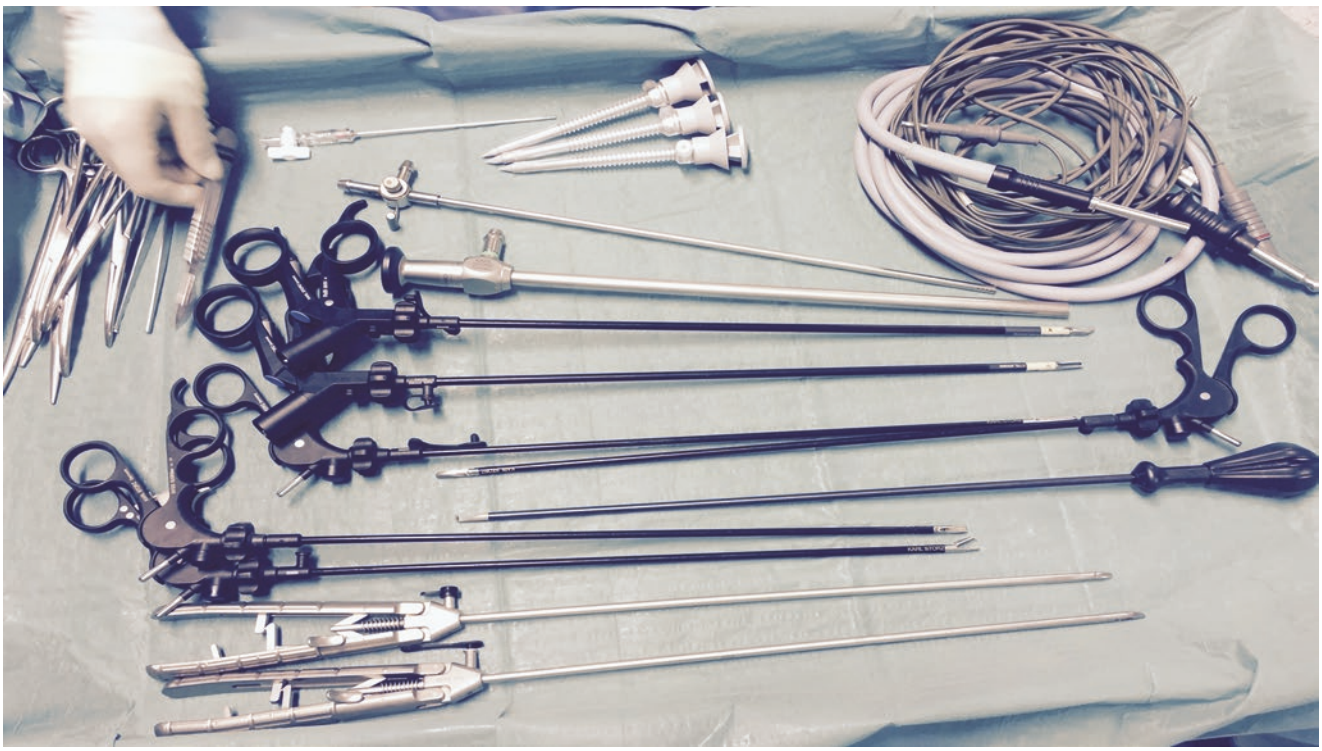


Fig. 21.8 Instruments set for laparoscopic hysterectomy

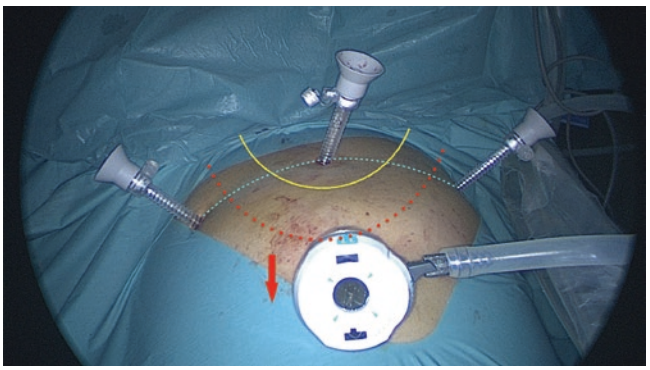


Fig. 21.9 Trocars positioning: in case of a big uterus (*red line*), optical trocar should be placed upwards (*arrow*) and the supra pubic ancillary trocar should be placed on the umbilical area

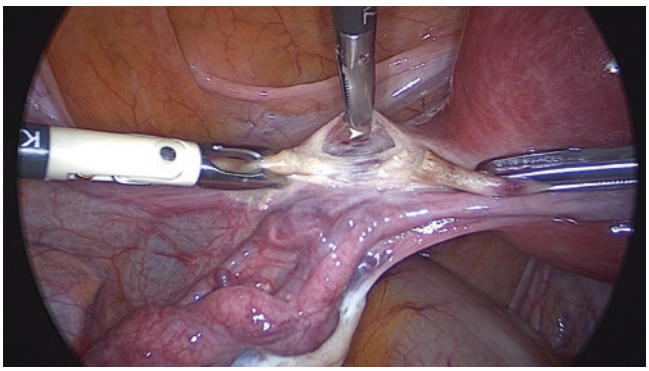


Fig. 21.13 ➤ Opening the broad ligament

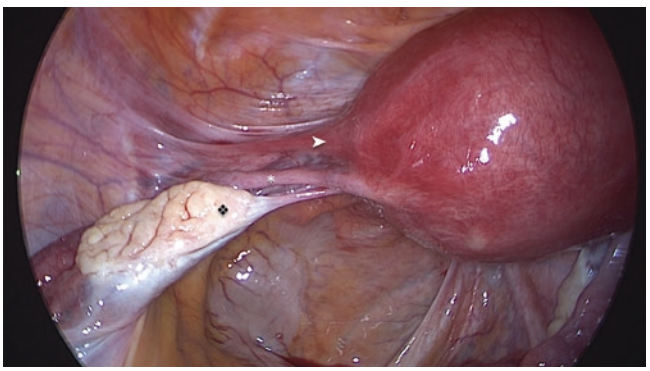


Fig. 21.10 ➤Round ligament, * fallopium tube, ❖ ovary

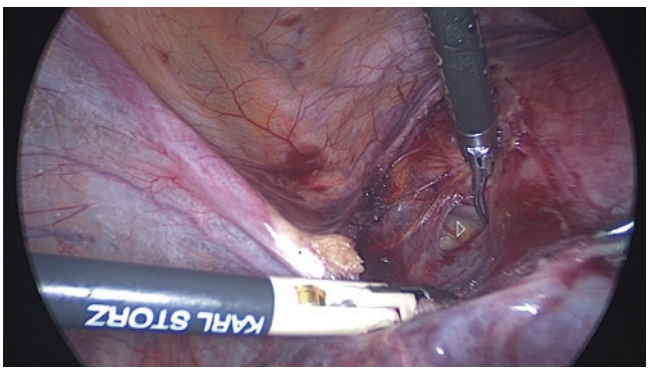


Fig. 21.14 ▹ Fenestration of broad ligament

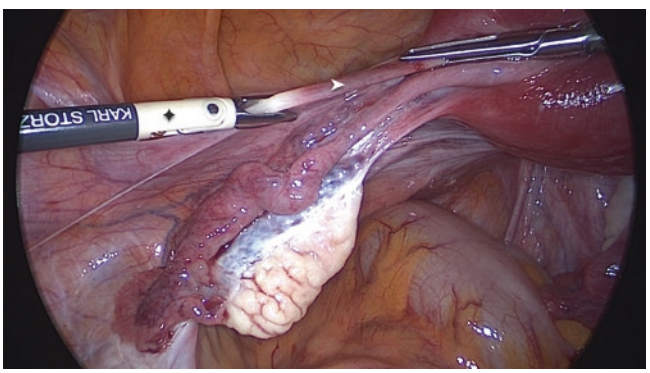


Fig. 21.11 ➤Round ligament

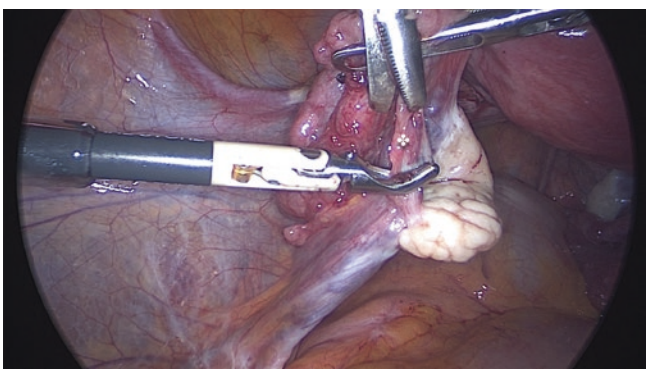


Fig. 21.15 ✣ Coagulation and section of salpingo-ovarian ligament

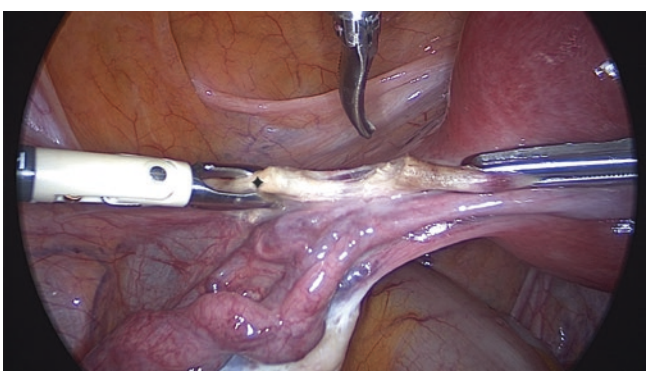


Fig. 21.12 ✦ Rotating bipolar grasper

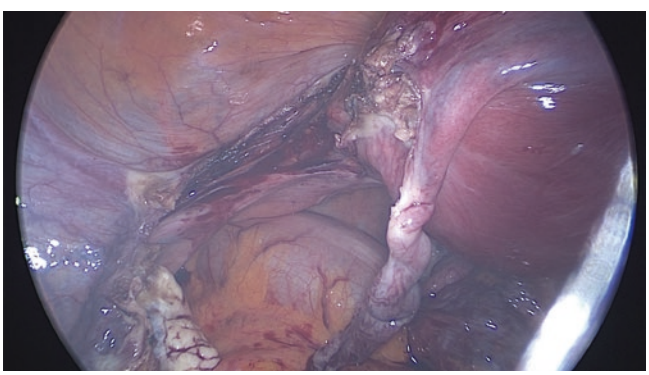


Fig. 21.16 Uterus with left salpinx

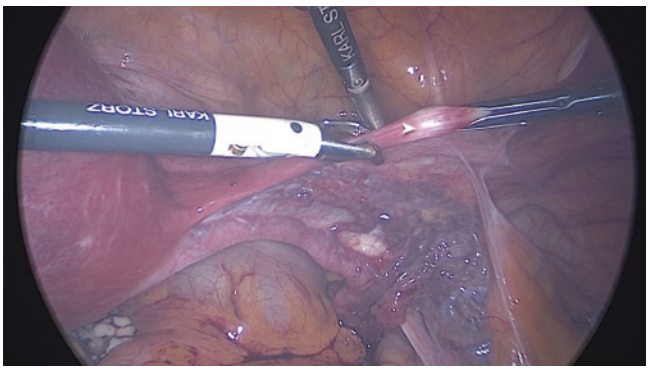


Fig. 21.17 ➤ Right round ligament

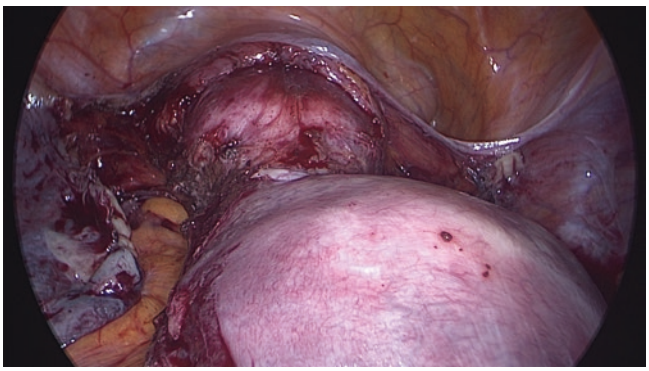


Fig. 21.21 Uterine artery coagulation using a bipolar rotating grasper

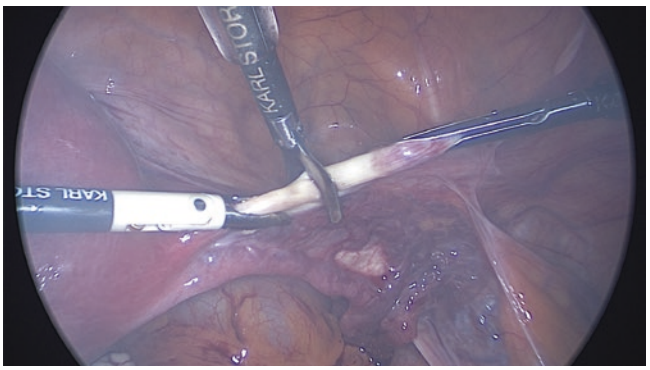


Fig. 21.18 Coagulation and section of right round ligament

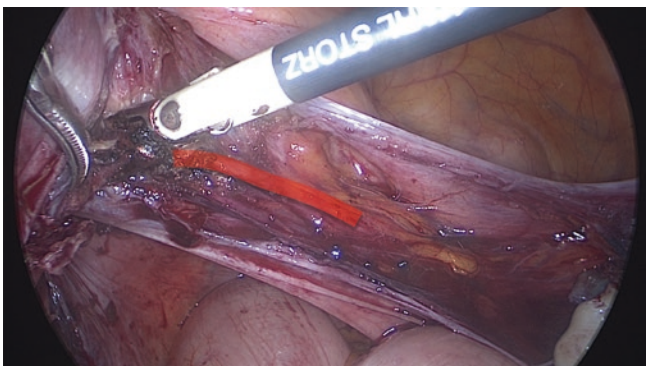


Fig. 21.22 Dissection of the bladder away from the anterior vagina along the vesicovaginal space

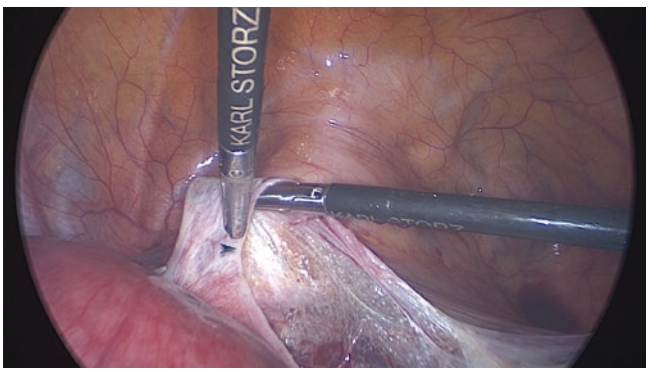


Fig. 21.19 Cutting the peritoneum over the vesico-uterine space

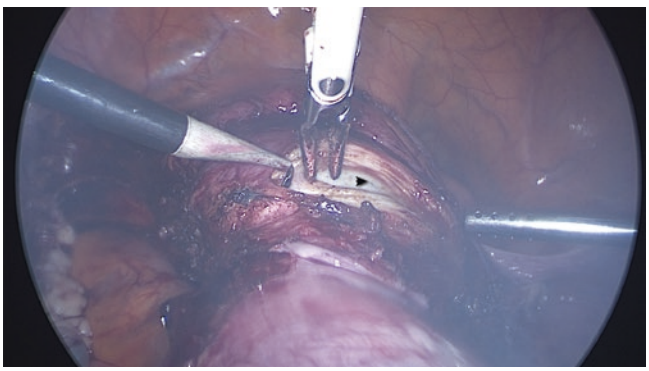


Fig. 21.23 Opening the vaginal cuff using a monopolar hook and a bipolar grasper

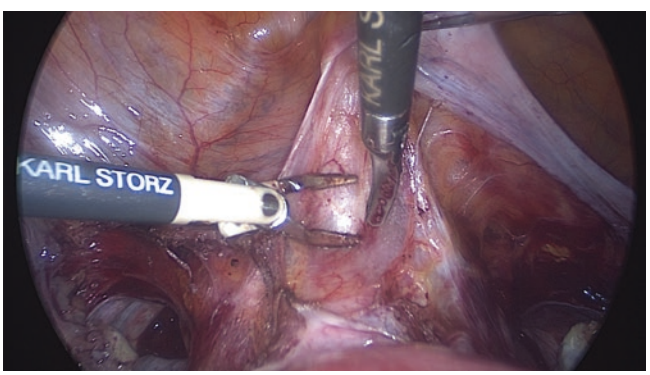


Fig. 21.20 Dissection of vesico-vaginal space

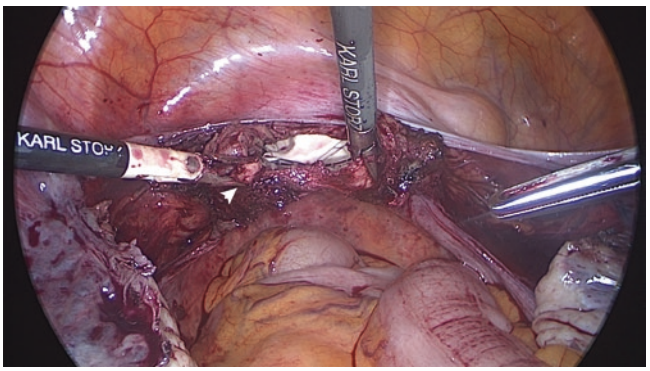


Fig. 21.24 Coagulation of vaginal cuff using a bipolar grasper (ROBI® WATTIEZ Grasping Forceps)

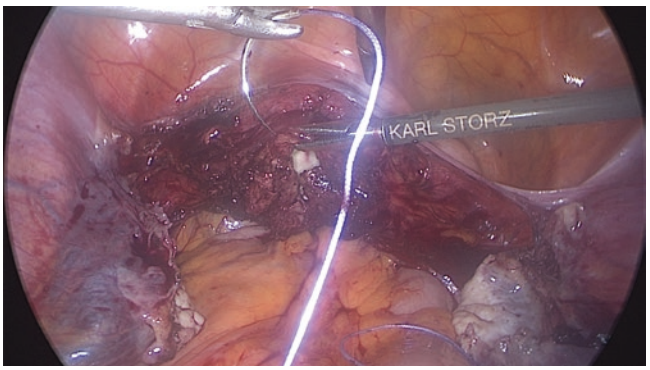


Fig. 21.25 Vaginal cuff closure using an intra-corporeal absorbable suture

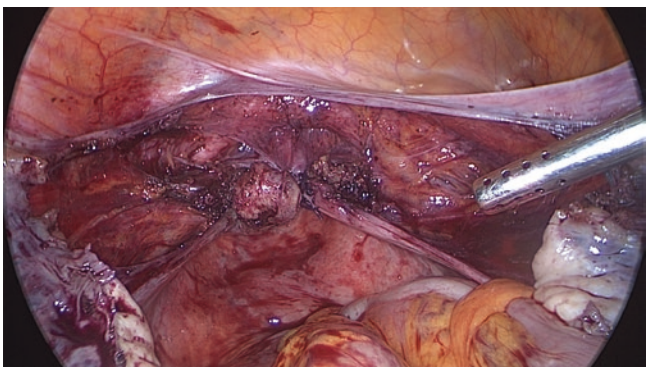


Fig. 21.26 Vaginal cuff closure approximating both uterosacral ligaments and pubocervical fascia

Conclusion

Surely, the old paradigm "big surgeon means big incisions" has absolutely changed. Laparoscopic hysterectomy is noticeably favorable for patients in whom vaginal surgery is contraindicated or cannot be done. We go towards a concept that the best surgeon performs the smallest incisions.

References

1. Garry R et al. The eVALuate study: two parallel randomised trials, one comparing laparoscopic with abdominal hysterectomy, the other comparing laparoscopic with vaginal hysterectomy. BMJ. 2004;328(7432):129.
2. Nezhat F et al. Laparoscopic versus abdominal hysterectomy. J Reprod Med. 1992;37(3):247–50.
3. Phipps JH, John M, Nayak S. Comparison of laparoscopically assisted vaginal hysterectomy and bilateral salpingo-oophorectomy with conventional abdominal hysterectomy and bilateral salpingo-oophorectomy. Br J Obstet Gynaecol. 1993;100(7):698–700.
4. Raju KS, Auld BJ. A randomised prospective study of laparoscopic vaginal hysterectomy versus abdominal hysterectomy each with bilateral salpingo-oophorectomy. Br J Obstet Gynaecol. 1994; 101(12):1068–71.
5. Olsson JH, Ellstrom M, Hahlin M. A randomised prospective trial comparing laparoscopic and abdominal hysterectomy. Br J Obstet Gynaecol. 1996;103(4):345–50.
6. Langebrekke A et al. Abdominal hysterectomy should not be considered as a primary method for uterine removal. A prospective randomised study of 100 patients referred to hysterectomy. Acta Obstet Gynecol Scand. 1996;75(4):404–7.
7. Marana R et al. Laparoscopically assisted vaginal hysterectomy versus total abdominal hysterectomy: a prospective, randomized, multicenter study. Am J Obstet Gynecol. 1999;180(2 Pt 1):270–5.
8. Falcone T, Paraiso MF, Mascha E. Prospective randomized clinical trial of laparoscopically assisted vaginal hysterectomy versus total abdominal hysterectomy. Am J Obstet Gynecol. 1999;180(4): 955–62.
9. Ferrari MM et al. Identifying the indications for laparoscopically assisted vaginal hysterectomy: a prospective, randomised comparison with abdominal hysterectomy in patients with symptomatic uterine fibroids. BJOG. 2000;107(5):620–5.
10. Lumsden MA et al. A randomised comparison and economic evaluation of laparoscopic-assisted hysterectomy and abdominal hysterectomy. BJOG. 2000;107(11):1386–91.
11. Schutz K et al. Prospective randomized comparison of laparoscopic-assisted vaginal hysterectomy (LAVH) with abdominal hysterectomy (AH) for the treatment of the uterus weighing >200 g. Surg Endosc. 2002;16(1):121–5.
12. Walsh CA et al. Total abdominal hysterectomy versus total laparoscopic hysterectomy for benign disease: a meta-analysis. Eur J Obstet Gynecol Reprod Biol. 2009;144(1):3–7.
13. Aarts JW et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2015;12(8):CD003677. doi: 10.1002/14651858.CD003677.pub5.
14. Wattiez A, Cohen SB, Selvaggi L. Laparoscopic hysterectomy. Curr Opin Obstet Gynecol. 2002;14(4):417–22.
15. Ghezzi F et al. Postoperative pain after laparoscopic and vaginal hysterectomy for benign gynecologic disease: a randomized trial. Am J Obstet Gynecol. 2010;203(2):118 e1–8.
16. ACOG Committee Opinion No. 444: choosing the route of hysterectomy for benign disease. Obstet Gynecol. 2009;114(5):1156–8.
17. A.A.M.I.G. Worldwide. AAGL position statement: route of hysterectomy to treat benign uterine disease. J Minim Invasive Gynecol. 2011;18(1):1–3.
18. Walters MD. Choosing a route of hysterectomy for benign disease. Uptodate. 2015.
19. Shiota M et al. Indication for laparoscopically assisted vaginal hysterectomy. JSLS. 2011;15(3):343–5.
20. Bijen CB et al. Costs and effects of abdominal versus laparoscopic hysterectomy: systematic review of controlled trials. PLoS One. 2009;4(10):e7340.
21. Reich H. Laparoscopic hysterectomy. Surg Laparosc Endosc. 1992; 2(1):85–8.

Preparation (Medical History, Surgical Set-Up, Antibiotics, Anticoagulants)

22

Magdalena Zalewski and Mohamed Elessawy

Introduction

Hysterectomy is the most frequently performed major gynaecologic surgical procedure [1, 2]. The overall rate of hysterectomy in Germany in the period 2005–2006 was 362.9 (295.0 for benign diseases of the genital tract and 44.0 for primary malignant tumors of the genital tract) per 100,000 person-years. Hysterectomy rates varied considerably across federal states: the rate for benign disease was lowest in Hamburg (213.8 per 100,000 women per year) and highest in Mecklenburg–West Pomerania (361.9 per 100,000 women per year) [3]. The CDC (Centers for Disease Control and Prevention) reported that in the USA the hysterectomy rate in 2000–2004 was 5.4/1000 per year [4].

Hysterectomies are preformed abdominally, vaginally, or with laparoscopic or robotic assistance. When choosing the route of hysterectomy, the physician should take into consideration the safest and most cost-effective route to fulfil all needs of the patient. The surgeon's decision is based on the patient's wishes and the route preferred by the surgeon. The art of surgery has developed and changed with the advancement of technology so that nowadays hysterectomy nowadays is mostly performed as a minimal invasive operation, accounting for nearly 60 % of all hysterectomy operations [5].

The preparation of the patient is a crucial factor towards obtaining the best surgical results. It should include the preparation of the tissues to encourage healing and bowel preparation to optimize the endoscopic space. In this chapter we will discuss our experience in preparing patients for laparoscopic hysterectomy.

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Medical History

Taking a detailed medical history is the first step towards planning and successfully achieving a safe surgery.

Our patients complete a standardized questionnaire sheet covering their personal data and medical history. A Pap smear test is important before deciding to perform a supracervical hysterectomy.

Special consideration is given to patients with an oncological history in their families. Ongoing treatment for a breast cancer patient or a high-risk tumour patient might influence our decision to perform prophylactic adnectomy during the hysterectomy procedure.

Additional consideration must be given to prolapse and incontinence, which account for up to 14 % of indications for hysterectomy, in order to plan the best operative route for hysterectomy with corrective fixation surgery [5].

A detailed surgical history revealing the number of vaginal deliveries, laparotomies and cesarean section is important for deciding the route and the preparation for the hysterectomy operation.

Cesarean section is the most commonly performed surgery in obstetrics, and its incidence is increasing with rates as high as 17–31 % in some countries [6]. Estimates of the prevalence of cesarean delivery on maternal request range from 1–18 % of all caesarean deliveries worldwide, and <−1 to 3 % of all cesarean deliveries in the United States [7]. In certain cases, resulting scar formation may lead to adhesions and pain in many patients and possible difficulties at a later hysterectomy operation. In addition, cesarean scar dehiscence can be a risk for perforation during insertion of the uterine manipulator at total laparoscopic hysterectomy (Fig. 22.1).

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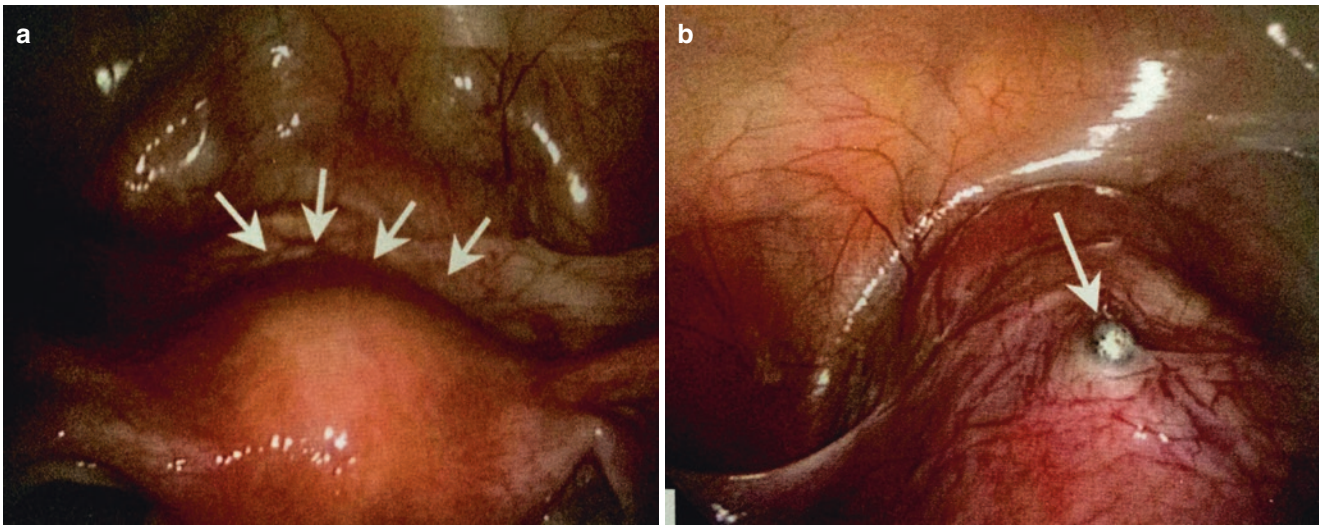


Fig. 22.1 Shows that cesarean scar dehiscence can be a risk for perforation during insertion of the uterine manipulator at total laparoscopic hysterectomy (**a**). Shows that the inseration of utrine manipulator should be carefully inserted to avoid perforation of the thin uterine wall by cesarean scar dehiscence (**b**)

In the literature, there is little information on the ability of MRI findings to detect cesarean scar dehiscence. Ultrasonographic evaluation of the anterior uterine wall is mandatory to evaluate the thickness of the lower uterine segment in the case of previous cesarean section.

It is well known that previous operations can result in the development of postoperative adhesions, which are a natural consequence of tissue trauma. This leads to an inclusion entity of adhesiolysis which is usually associated with a higher risk of complications. A review of the PubMed library shows that the correlation between a preoperative risk score and the complication incidence at the time of hysterectomy has not been sufficiently examined. At the Kiel University Department of Obstetrics and Gynecology, Germany, the estimated risk has been examined in comparison with the incidence of the intraoperative and post-operative complications. The data were statistically evaluated to investigate the relationship between the occurrence of the complication and the preoperative score at the time of the hysterectomy. For the preoperative score, patients who had undergone a previous laparoscopy were assigned 1 point; those who had undergone a previous Pfannenstiel laparotomy were assigned 2 points; those who had undergone 1 cesarean delivery were assigned 3 points; those who had undergone 2 cesarean deliveries were assigned 4 points; those who had undergone 3 cesarean deliveries were assigned 5 points; and those with no previous operations were assigned 0 points.

Of the intraoperative complications recorded 28.6 % of patients had a preoperative score more than 1, of the major postoperative complications recorded 33.3 % had a preoperative score more than 1 and of the minor postoperative complications recorded 25 % of patients had a preoperative score more than 1 [8]. Patients with a history of previous operations have to be informed of the risk of adhesions which can lead to a prolongation of the operative procedure to achieve a sufficient adhesiolysis and a longer hospital stay.

Gilmour et al. found from studies without routine cystoscopy that combined ureter and bladder injury rates varied according to the complexity of the surgery, ranging from less than 1 injury per 1000 for subtotal hysterectomy with or without bilateral salpingo-oophorectomy to as many as 13 injuries per 1000 surgeries for laparoscopic hysterectomy with or without bilateral salpingo-oophorectomy and for other gynecologic and urogynecologic surgeries [9].

Preoperative Evaluation and Treatment

Preoperative detection and evaluation differs according to the symptoms, needs of the patient and the indication for hysterectomy. The six most common reasons for performing a hysterectomy in the period 2002–2010 at the Kiel university hospital were uterine myoma (65.19 %), adenomyosis (11.21 %), dysfunctional uterine bleeding (12.99 %), endometriosis (5.03 %), hyperplasia of the endometrium of the cervix (1.99 %) and total uterine prolapse (14.79 %) [5].

This data is comparable to national data. In Germany the main reasons for performing a hysterectomy were uterine myoma (60.7 %), uterine prolapse (27.9 %), bleeding disorders (25.2 %), hyperplasia (2.9 %) and endometriosis (15.1 %).

The preoperative work-up should include: the measurement of preoperative haemoglobin levels and an abdominal and transvaginal ultrasonography. A blood count and serum ferritin test provide information on the necessity of administering oral iron, particularly in patients with menometrorrhagia. The correction of sideropenic anemia by giving oral iron is essential to reduce the risk of a blood transfusion.

Ultrasonography should include the measurement of the entire uterus (length, depth and width) and the number, size and location of myomas. Such information may play an important role in the determination of the operative strategy.

Magnetic resonance imaging is mandatory when the ultrasound examination is difficult to analyse and in cases of associated adnexal pathology. We follow the concept of obtaining the required information with minimum exploration for both psychological and economic reasons.

Ulipristal acetate (UPA) significantly reduces uterine fibroid volume, reduces menstrual blood loss and improves quality of life without serious adverse events. UPA is a selective progesterone receptor modulator (SPRM) blocking most progestational effects with a reduced antiglucocorticoid activity [10]. Gonadotropin-releasing hormone agonists (GnRH) cause myoma shrinkage by reducing the circulating oestrogen levels [11].

A vaginal preparation with 0.05 mg oestrogen is the standard dose recommended for regeneration of the vagina; however, preparations with 0.03 mg are currently in use and are usually administered for one to three weeks. With the absence of sufficient feedback a vaginal oestrogen preparation is sometimes prescribed for at least one month prior to surgery to improve the vaginal cell regeneration and proliferation of tissues. This enables a better healing in the case of additional vaginal corrective surgery for prolapse patients. Recent studies suggest that hormone replacement therapy decreases the risk of recurrence of breast cancer [12].

Informed Consent

No intervention can be undertaken without the patient's voluntary consent. For consent to be valid, the patient must be considered competent. In the setting of informed consent, competence or capacity means that the patient has the mental ability to understand problems and make decisions about accepting or rejecting medical treatments that are offered (Table 22.1).

Table 22.1 Informed consent – important topics

Personal discussion about the recommended therapy and the alternatives
Making clear the necessity and the urgency
Possible risks
Making sure the patient understands everything (especially foreign patients)
Provision of sufficient time for an informed decision (day before surgery)
Consent must be voluntary

Bowel Preparation

We aim to empty the bowel to facilitate pushing the loops of the bowel out of the way and flattening them so as to enlarge the operating space. Preparation starts with a standard low residue diet which the patient is required to follow for 5 days prior to the operation. Two days before the operation, the bowel is emptied by administering a laxative solution such as Xprep. Finally, the day before the operation, the lower bowel should be cleaned with an enema. It is important to follow this chronological order to avoid any loss from the anus onto the table, which would give rise to a high risk infection.

Antibiotics

The United States Centers for Disease Control and Prevention (CDC) has published an internationally accepted definition of surgical site infection (SSI). The term SSI is defined as an infection of the skin or the subcutaneous tissue of the incision within 30 days of an operative procedure. Antimicrobial prophylaxis can help to avoid SSI.

The decision for an antimicrobial prophylaxis in a surgical procedure is based on risk stratification for the onset of SSI. The stratification of wounds (clean, clean-contaminated, contaminated, dirty wounds) is the most important factor in this decision. The hysterectomy is defined as a surgery with a clean-contaminated wound and therefore there is a risk of infection during the performed surgery.

However, several additional risk-factors are known to increase the risk of SSI (AWMF-Leitlinie: Perioperative Antibiotikaprophylaxe; Recommendations of the "Paul-Ehrlich-Gesellschaft für Chemotherapie e.V."):

- patient age,
- comorbidities (especially diabetes and immunosuppression),
- obesity,
- nicotine or drug abuse,

Table 22.2 The effect of perioperative antibiotic prophylaxis in different kinds of hysterectomy

Kind of hysterectomy and antibiotic prophylaxis	Number of patients [n]	Number of infections [n (%)]
Abdominal hysterectomy		
Combination	532	31 (5.8)
Cefuroxime	405	28 (6.9)
Metronidazole	178	27 (15.2)
Laparoscopic hysterectomy		
Combination	806	50 (6.2)
Cefuroxime	645	37 (5.7)
Metronidazole	90	13 (14.4)
Vaginal hysterectomy		
Combination	914	35 (3.8)
Cefuroxime	969	38 (3.9)
Metronidazole	250	31 (12.4)

- preoperative infections,
- length of surgery (more than 2 h),
- blood transfusion,
- hypothermia,
- previous radiotherapy,
- previous surgery.

In general SSI occurs less often in laparoscopic surgery than in abdominal surgery [13]. We expect any SSI in abdominal hysterectomy in 10.5 %, and in laparoscopic hysterectomy in 9.0 % of patients.

Nevertheless, a hysterectomy is an indication for an antibiotic prophylaxis, independent of the surgical approach used (abdominal, vaginal, laparoscopic or robotic). The preferred regimen is a single intravenous dose of a second-generation cephalosporin, possibly combined with metronidazole.

In 2013 a prospective study from Finland with 5279 patients compared the effect of perioperative antibiotic prophylaxis in different kinds of hysterectomy. Data on 1115 abdominal hysterectomies (AH), 1541 laparoscopic hysterectomies (LH), and 2133 vaginal hysterectomies (VH) were analysed. The patients received cefuroxime alone, metronidazole alone or a combination of both (Table 22.2).

The results revealed that adding metronidazole to a prophylaxis with cefuroxime did not show any statistically significant additional advantage. A prophylaxis with metronidazole alone led to more infections after surgery [14].

The correct timing of antimicrobial prophylaxis plays a crucial role for an effective prophylaxis. The ideal moment for the first application is 30–60 min before incision. An application more than 60 min before incision significantly increases the risk of SSI. For surgical procedures shorter than 2 h a single shot therapy is sufficient. Longer procedures require a repetition of the prophylaxis. Timing of repeated administration depends on the half-life of the chosen antimicrobial agent. A repetition is needed after 2 half-life periods (half-life of cefuroxime: 70 min; half-life of metronidazole: 7 h). In general, there is no need for continuing the prophylaxis after the end of the procedure.

Anticoagulants

In case of a permanent therapy with anticoagulants some considerations should be made before planning a hysterectomy. Coumarin derivatives should be paused for an operation. A bridging with low molecular weight heparin is recommended. A normalisation of the INR is expected four to seven days later. Rivaroxaban should be paused 24 h before starting the operation. A monitoring is possible by measuring anti-Factor Xa activity. The taking of acetylsalicylic acid should be continued if it is taken for secondary prevention and can be paused if taken for primary prevention. In these cases an interval of seven days is necessary until the platelet aggregation is no longer affected.

Installation and Disinfection

After the induction of anaesthesia, the patient is placed on her back with legs apart and half bent. The buttocks must protrude a few centimetres from the edge of the table to allow uterine manipulation. This position creates three operating spaces: one occupied by the surgeon, another one on the right occupied by the first assistant and a third one between the legs for the second assistant (Fig. 22.2).

The patient's arm is placed alongside her body to avoid any brachial injury.

A warming system can be used to avoid any chilling of the patient. The abdomen, perineum and vagina are prepared with a suitable bactericidal solution and a Foley catheter is inserted.

Conclusion

A laparoscopic hysterectomy can be a long and difficult operation; therefore, the optimal preparation of the patient is of prime ergonomic and economic importance (Table 22.3).

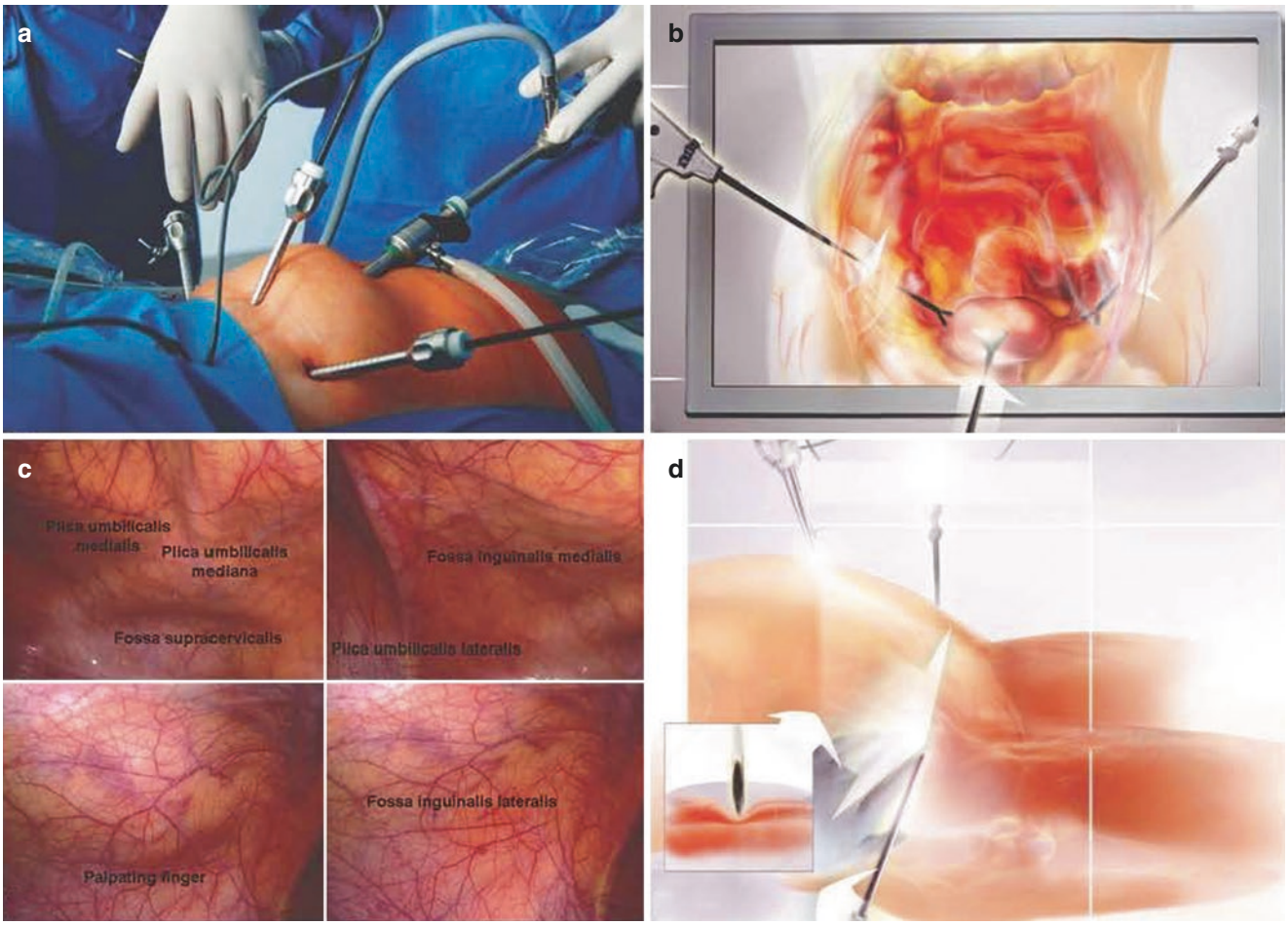


Fig. 22.2 Position of trocars and positions occupied by operating team

Table 22.3 Summary – preparation of a hysterectomy via laparoscopy

Medical history, previous cancers in family medical history
Gynecological examination and ultrasonography
Pap smear
→Indication for hysterectomy via laparoscopy
Informed consent
Anesthesiological preparation
Blood test (haemoglobin, pregnancy test (if patient is fertile)
Bowel preparation
Perioperative antimicrobial prophylaxis (cefuroxime ± metronidazole)

References

1. Altgassen C, Michels W, Schneider A. Learning laparoscopic-assisted hysterectomy. Obstet Gynecol. 2004;104(2):308–13.
2. Briese V., Ulfig N., and Mylonas I., Die vaginale Hysterektomie, in Gynäkologe. 2002. p. 116–124.
3. Stang A, Merrill RM, Kuss O. Prevalence-corrected hysterectomy rates by age and indication in Germany 2005–2006. Arch Gynecol Obstet. 2012;286(5):1193–200.
4. Whiteman MK et al. Inpatient hysterectomy surveillance in the United States, 2000–2004. Am J Obstet Gynecol. 2008;198(1):34 e1–7.
5. Schollmeyer T et al. Hysterectomy trends over a 9-year period in an endoscopic teaching center. Int J Gynaecol Obstet(The Official Organ of the International Federation of Gynaecology and Obstetrics). 2014;126(1):45–9.
6. Seffah JD. Re-laparotomy after Cesarean section. Int J Gynaecol Obstet(The Official Organ of the International Federation of Gynaecology and Obstetrics). 2005;88(3):253–7.
7. MacDorman MF, Menacker F, Declercq E. Cesarean birth in the United States: epidemiology, trends, and outcomes. Clin Perinatol. 2008;35(2):293–307.
8. Elessawy M et al. Arch Gynecol Obstet 2015;292:127. doi:10.1007/s00404-014-3594-9
9. Gilmour DT, Das S, Flowerdew G. Rates of urinary tract injury from gynecologic surgery and the role of intraoperative cystoscopy. Obstet Gynecol. 2006;107(6):1366–72.
10. Zalewski MM, Felix Z, Joseph N. Update of conservative systemic treatment of uterine fibroids. Curr Obstet Gynekol Rep. 2014;3:191–5.

11. Friedman AJ et al. A randomized, placebo-controlled, double-blind study evaluating the efficacy of leuprolide acetate depot in the treatment of uterine leiomyomata. Fertil Steril. 1989;51(2):251–6.
12. Fahlen M et al. Hormone replacement therapy after breast cancer: 10 year follow up of the Stockholm randomised trial. Eur J Cancer. 2013;49(1):52–9.
13. Mahdi H et al. Predictors of surgical site infection in women undergoing hysterectomy for benign gynecologic disease: a multicenter analysis using the national surgical quality improvement program data. J Minim Invasive Gynecol. 2014;21(5):901–9.
14. Brummer TH et al. Antibiotic prophylaxis for hysterectomy, a prospective cohort study: cefuroxime, metronidazole, or both? BJOG. 2013;120(10):1269–76.

Instrumentation Systems, Apparatus and Materials in Hysterectomy

23

Liselotte Mettler, Ibrahim Alkatout, and Artin Ternamian

Introduction

Instruments and apparatus for laparoscopic hysterectomy have been developed over the last 30 years for interventions with multiple ports as well as for single port surgery. Different set of instruments are necessary for subtotal and total laparoscopic hysterectomy and radical hysterectomies. This chapter is divided into.

1. History.
2. General systems for adhesion prevention, mesh, sutures, stables, glue, drains, rinsing solutions and suction.
3. Instrument systems and apparatus for laparoscopic hysterectomies.

All equipment as used in gynecological and general laparoscopic surgery is assembled on instrument trolleys, so called smart carts, which are available as rolling carts or on special platforms hanging down from the ceiling. Panoramic operating room endoscopic settings such as OR1 TM Neo (Karl Storz GmbH, Tuttlingen) or the Endoalpha by Olympus (Olympus Europa SE & CO.KG, Hamburg) or the Stryker unit with SDC Ultra as digital documentation system form the basis to position the necessary equipment for easy use of the surgeon.

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The idea of warming and humidifying the CO_2 gas to avoid damage to the peritoneum has been propagated by Douglas Ott and Philippe Koninckx. The HumiGard TM of Fisher & Paykel Healthcare (Auckland, New Zealand) provides heated, humidified and filtered gas to a patient at a predetermined temperature.

Today, every CO_2 pneu automatic provides up to 37 °C heated CO_2, gas which is controlled by a pressure regulator and within the machine by applying the Quadro-test. In the Quadro-test, the volume of gas flowing through the Veress needle during insufflation, intra-abdominal pressure, total volume and preset filling pressure are measured. Cold light is provided by xenon lamps. The video camera systems are equipped with three-chip camera or HD-cameras and can be used for laparoscopy as well as hysteroscopy. High-resolution video monitors guarantee optimal picture quality. The technological development allows the use of larger monitors in HD quality that facilitate a relaxed working atmosphere for the surgeon.

A realistic, true to life 3D picture is possible due to various technological elements such as digital simulation, a second camera system or the use of shutter lens. Digital devices for the video camera control the picture quality and facilitate automatic white balancing. The Karl Storz company already offers the TRICAM 3D imaging system that allows the surgeon to view crisp, dear image through a pair of lightweight polarizing glasses. Their ENDOCAMELEON laparoscope provides a viewing angle that can be adjusted continuously between 0 and 120° (Fig. 23.1a).

The Olympus 3D system allows a direct vision through the ENDOEYE FLEX 3D, a deflectable tip 3D laparoscope. This tool allows for 100° angulation in 4 directions while the image on the screen is maintaining a fixed horizon. The dual-lens design of the ENOEYE FLEX 3D and the high-density image sensors for high-definition 3D images give a focus-free view (Fig. 23.1b).

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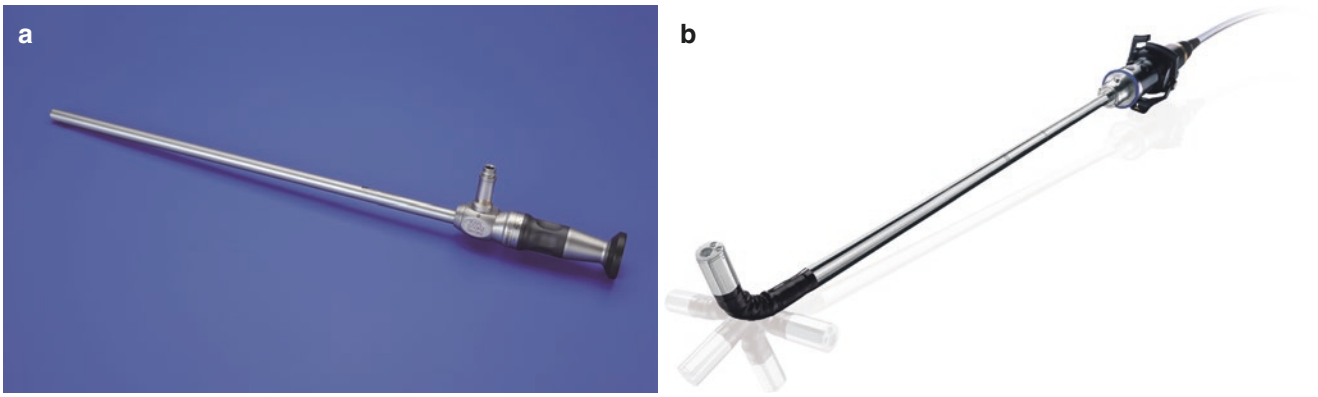


Fig. 23.1 (**a**) Endocameleon laparoscope 0–120° angle (**b**) Endoeye Flex 3 D laparoscope system

History

Although the origin of endoscopy can be found already in a reference of the Babylonian Talmud. Endoscopic surgery has mainly be developed by the use of Bozzini's light guide and the rigid optic system developed by Max Nizze as cystoscope. We consider Georg Kelling, (1866–1945) of Dresden, who added his experience in oral air insufflation as the father of endoscopic surgery. The knowledge of gastric and esophageal endoscopy of air insufflation where the foundation of future trials for the diagnostic and therapeutic examination of enclosed body cavities.

Subtotal hysterectomy by laparotomy, total hysterectomy by laparotomy and vaginal hysterectomy dominated till 1980 the field for this gynecologic surgical procedure. In relation to the development of save instruments and apparatus to be used in endoscopic surgical procedures the desire to perform laparoscopic hysterectomy was noticed worldwide in the groups of many gynecologic endoscopic surgeons. In Kiel we applied laparoscopic assistance to vaginal hysterectomy, first published by Kurt Semm in 1984, routinely in difficult vaginal hysterectomies [1]. In those days the aggression towards laparoscopy as surgical procedure was still very pronounced. We did not dare in Kiel to even talk about laparoscopic hysterectomy in our own department although we freed the uterus from the pelvic side wall in many occasions and then extracted the uterus through the vagina, because everybody already blamed us as irresponsible surgeons. This procedure was later described as laparoscopic vaginal hysterectomy (LAVH). We did not dissect the uterine vessels laparoscopically in those early years.

As worldwide accepted, however, the first laparoscopic hysterectomy was performed by Harry Reich in the 1989 in the William Nesbitt Memorial Hospital in Kingston, Pennsylvania, U.S.A. [2]. Simultaneously Kurt Semm developed the laparoscopic subtotal hysterectomy and performed on Sept.07, 1989 on a Saturday afternoon in Kiel the first then called "Classic Intrafascial Subtotal Hysterectomy" (CISH), which was first published in 1993 [3]. In the same years Jaques Donnez, 1993 and Thomas Lyons, 1993 published their approaches of laparoscopic subtotal hysterectomy. Over the consecutive years till today various modifications and classifications of laparoscopic hysterectomies for benign indications have been described. Radical hysterectomies using laparoscopy date back to the early experience of Daniel Dargent 1986 [4] and have only been performed worldwide on a larger scale in the twenty first century.

General Systems, Adhesion Prevention, Mesh, Sutures, Staples, Glue, Drains, Rising Solutions and Suction)

Generators and Set-Ups

All essential equipment for laparoscopic hysterectomy is assembled on equipment trolleys which are integrated into the panoramic operating rooms. Panoramic viewing possibilities and integrating commanding functions for all operating procedures and documentation are given today by many companies set-ups. An equipment trolley always contains the following apparatus: CO_2 insufflation unit with the possibility of producing heated and humidified gas, endoscopic camera, light sources (cold light is provided by Xenon lamps), suction and irrigation pumps, electrical energy systems, documentation systems. These systems are compatible with third party devices such as operating room lights, energy units, lasers and thermofusion systems. Higher solution video monitors guarantee optimal picture quality. The technical development allows the use of larger monitors in HD quality on flexible arms that fascilitate to position them into a relaxed working atmosphere for the surgeon. A realistic, nearly true to live 3D picuture, various technical elements such as digital simulation, a second camera system or the use of shutter lenses, are engaged. Digital devices for the video camera control the picture quality and facilitate automatic white balancing.

Adhesion Prevention

Adhesions during surgery are primarily defined as a condition in which bodily tissues that are normally separate grow together.

A fibrous band of scar tissue that binds together normally separates anatomical structures (Fig. 23.2). In this chapter, we want to stress the impact of adhesions as defined above as the most common post-surgical complication.

Adhesion formation is influenced by various factors. It starts with a trauma to the peritoneum or any other body site when rapidly fibrin de-position occurs. In peritoneal healing for example there is a balance between fibrin deposition and fibrinolysis. Any impairment of this process leads to increased fibrin deposition, the formation of fibrin strands and stable adhesions may be formed. The incidence of intraperitoneal adhesions in patients following general abdominal or gynecological surgery ranges from 63 to 97 % [5, 6]. The overall risk of hospital readmission related to adhesions following either laparoscopic or open surgery is similar [7]. Although the majority of patients remain asymptomatic, a considerable number experience serious complications, including bowel obstruction [8], female secondary infertility [9] and re-operative complications [10]. The presence of adhesions from previous surgery significantly increases the length of time required in subsequent surgical procedures, adversely affecting the workloads of surgical teams [11]. Certain surgical procedures carry a greater risk of adhesion-related complications. Surgical procedures on the ovary and fallopian tube were shown to have the highest risk of adhesion-related readmission (48.1 % and 41.2 % of women readmitted, respectively) [12]. For laparoscopic myomectomy this increases to 41 in every 100 procedures [13]. In one study, the number of adhesion-related readmissions increased steadily over a ten-year period, with 16 % occurring within the first year after the initial surgical procedure [12]. Some studies have also shown that adhesion-related complications can occur ten years after the initial surgical procedure [6].

Let us introduce into this discussion first an overview on the most common anti adhesion agents, which can be divided into two groups: "Site specific Agents" and compare them with the "broad coverage fluid agents".

Site-Specific Agents: Membranes

Mechanical barriers Interceed® (Gynecare, Ethicon, a Johnson & Johnson Company, Sommerville, NJ, USA): Interceed® is an oxidized regenerated cellulose membrane placed over a suture or a deperitonealised area. No sutures are required to keep Interceed® in place; slight moistening after positioning a single layer will make it adhere to the injured site, where it is absorbed within 4 weeks. Interceed® has been shown to be effective in various studies, and significantly reduces adhesion formation even in severe endometriosis [14].

Seprafilm® (Genzyme, Cambridge, MA, USA) Seprafilm®: is a hyaluronate-carboxymethyl cellulose membrane, which is placed over a suture or an injured area without stitches and remains in place for 7 days. In contrast to Interceed® no loss of efficacy in the presence of blood has

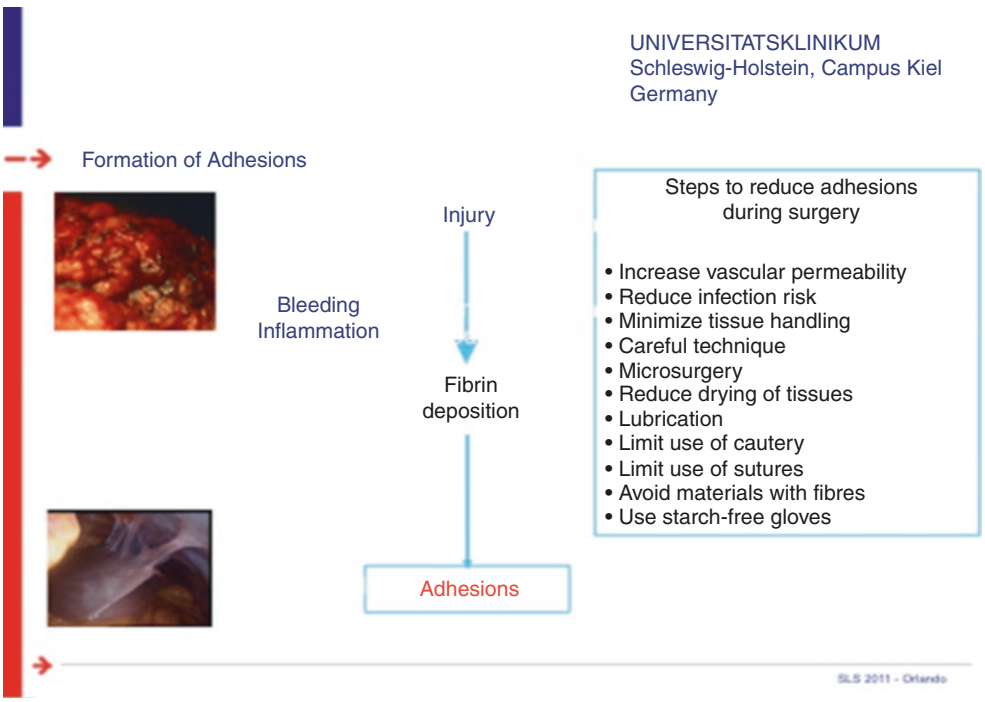


Fig. 23.2 Formation of adhesions from injury to adhesions

been reported. Several studies have demonstrated the efficacy of Seprafilm® mainly in general surgery, especially bowel surgery [15].

Gel barriers:SprayShield/Spray Gel® (Covidien Bio-Surgery, Waltham, MA, USA): SprayShield® is a synthetic polyethylene glycol solution which is sprayed over the affected area where it remains for approximately 5–7 days. After that period, it is degraded and absorbed. It consists of two components that react immediately on contact with the tissue to form an adherent layer. One of the components contains a blue food colourant, so there is an intraoperative visualization of where SprayShield® was used [16, 17]. In the case of myomectomy a reduction of adhesion formation was demonstrated for SprayGel® in a multi-center randomized controlled trial.

Intercoat®/Oxiplex/AP (FzioMed, Inc., San Luis Ob-ispo, CA, USA): Intercoat® is an absorbable gel composed of polyethylene oxide and sodium carboxymethyl cellulose. Functioning as a mechanical barrier during the healing process, Intercoat® is applied as a single layer at the end of the procedures.

HYA CORP ENDOGEL (BIO SCIENCE, GERMANY) is an absorbable sterile, transparent, high viscous gel produced by condensation of hyaluronic acid, which is one of the main components of human connective tissue. It adheres to tissue surfaces and to the abdominal wall and is effective as an anti-adhesion barrier substance on the local level. The development of Hyacorp Endogel is based on a composition of a substance that already exists for treating and filling tissue defects (Hyacorp Body Con-touring MLF 1).

Hyalobarrier Gel® (Fidia Advanced Biopolymers, Abano Terme, Italy): Hyalobarrier gel is a highly viscous autocrosslinked hyaluronate used to separate organs and tissues after surgery. The use of hyaluronic acid agents may decrease adhesion formation and prevent the deterioration of preexisting adhesions [18]. CoSeal® (Baxter Healthcare Corporation, Deerfield, IL, USA).

CoSeal® is a resorbable hydrogel consisting of two polyethylene glycol polymer solutions which are mixed together when applied during surgery. The technology is similar to that seen with SprayShield® but in CoSeal® the polyethylene glycol esters have a different isomer structure. CoSeal® is long available for preventing adhesions in cardiac surgery where its efficacy has already been proved. First researches in women undergoing myomectomy demonstrated safety and efficacy of CoSeal® in abdominopelvic surgery [19].

Broad-Coverage Fluid Agents

Adept® (Icodextrin 4 % solution; Baxter Healthcare, Deerfield, II, USA): Adept® is a clear solution containing icodextrin at a concentration of 4 %. Icodextrin is an a 1–4-linked glucose polymer and is responsible for the longer absorption time of Adept® compared to the previously used crystalloid instillates like saline solution or lactated Ringer's solution, which is rapidly resorbed by the peritoneum and therefore not suitable for adhesion prevention. At the end of a procedure, 1.000 ml of Adept® is instilled into the abdominal cavity. Instillates separate the injured tissue by hydroflotation and should stay in the abdominal cavity during the first days after surgery.

In laparoscopic hysterectomies out of the available pellet of adhesion prevention strategies we advise at present time the application of a site specific barrier either on hyaluronic acid basis (HyaCorp Endo Gel – Bioscience or Hyalobarrier – Nordic Pharma) and in case a large peritoneal defect results as broad liquid barrier Icodextrine – 4 % – adept – Baxter.

Meshes

There are many new kits on the market that involve the placement of the same nylon-like mesh in the TVT but instead used in large sheets between the bladder and the vagina and the rectum and the vagina to reinforce prolapse repair. There is no long term information on these techniques. Therefore we will hold off promoting or criticizing these techniques until there is adequate information available. As these materials are permanent, there is always a benefit in waiting to see the long term complications before jumping on the bandwagon of laparoscopic mesh application in sacro colpopexy or the new technique of prolapse surgery pectopexy after laparoscopic hysterectomy, as the long term complications may include mesh erosion into the vagina, bladder or rectum, painful intercourse, infection or bleeding etc.

Sutures

Ligatures and suturing techniques are besides all the modern coagulation advances many times still necessary for safe surgery in hysterectomy. Therefore we would like to give some basic ideas on hemostasis by loop ligatures, endosutures with extra corporeal knotting technique and endosutures with intra corporeal knotting technique.

Haemostasis by Endosuture with Extra Corporal Knot Tying

In many cases, it is convenient to ligate vascular bundles, adhesion bundles and similar structures with sling ligatures. Timewise it is worthwhile to tie the vascular omental and intestinal adhesions before cutting because searching for

bleeders later can be time consuming and associated with much blood loss. Primarily, an 80 cm long Ethi-Endoligature ® with a plastic knot pusher by Ethicon is used as a ligature. As an endosuture, it has a 3 cm long and 0,8 mm thick needle. The endosuture with extracorporeal knotting has a 2.5 and 3.5 cm long sharp needle as well as a 2.5 cm round needle. It is supplied with a suture applicator and a 3 mm trocar by Autosuture. After taking a purse string suture, the needle is cut; extracorporeal knots are formed and pushed down in the usual way with the plastic pusher (Figs. 23.3, 23.4, 23.5, 23.6 and 23.7). To push the knot, the applicator is pulled up. When it is pushed again into the 5 mm trocar, the plastic tube pushes the knot into the abdominal cavity. The loop is tightened under vision and the wound edges are adapted, e.g. the wound edges of the vaginal cuff. Cutting scissors are inserted in place of the 5 mm needle holder to cut the thread. The thread must be long enough to be able to form extracorporeal knots outside.

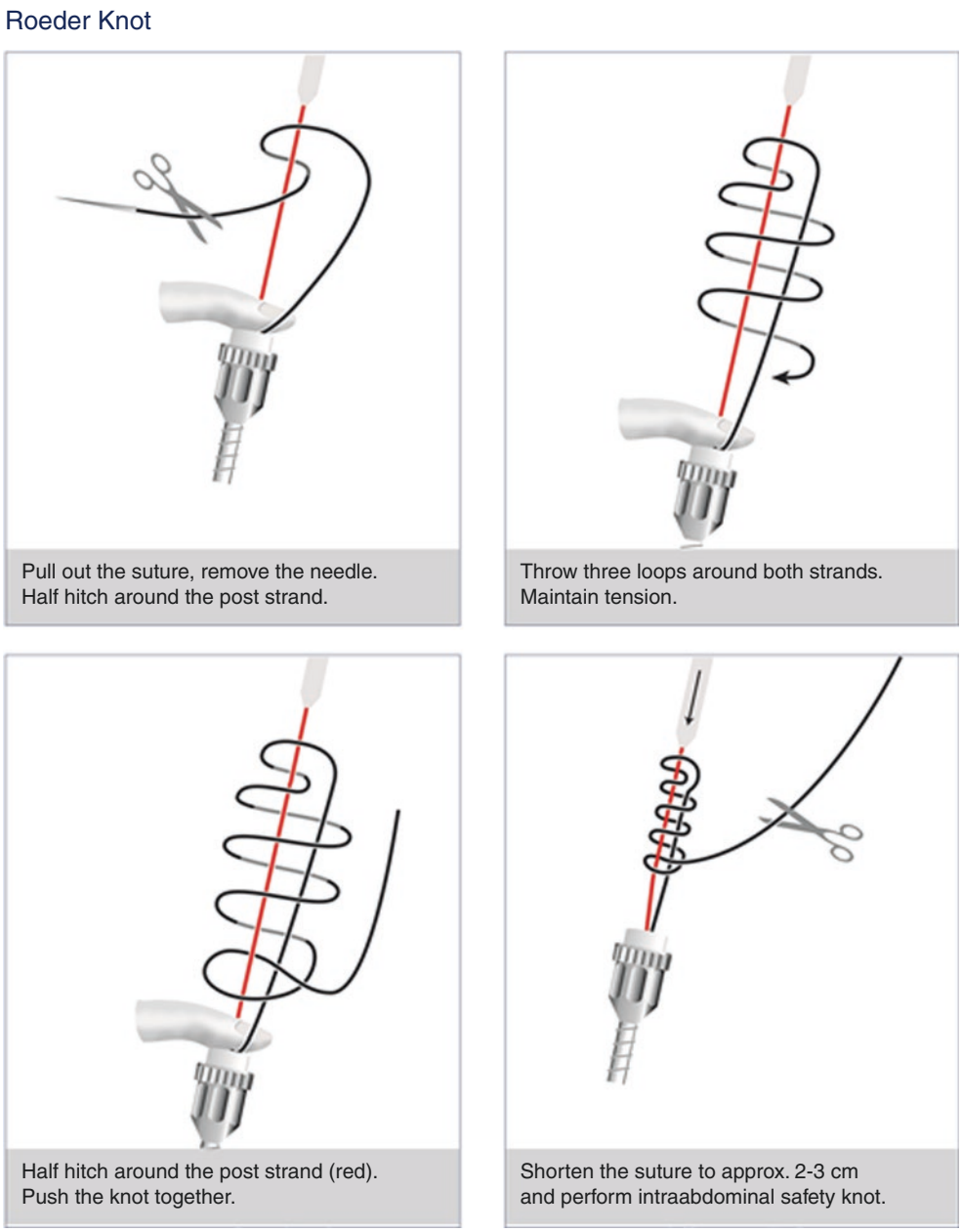
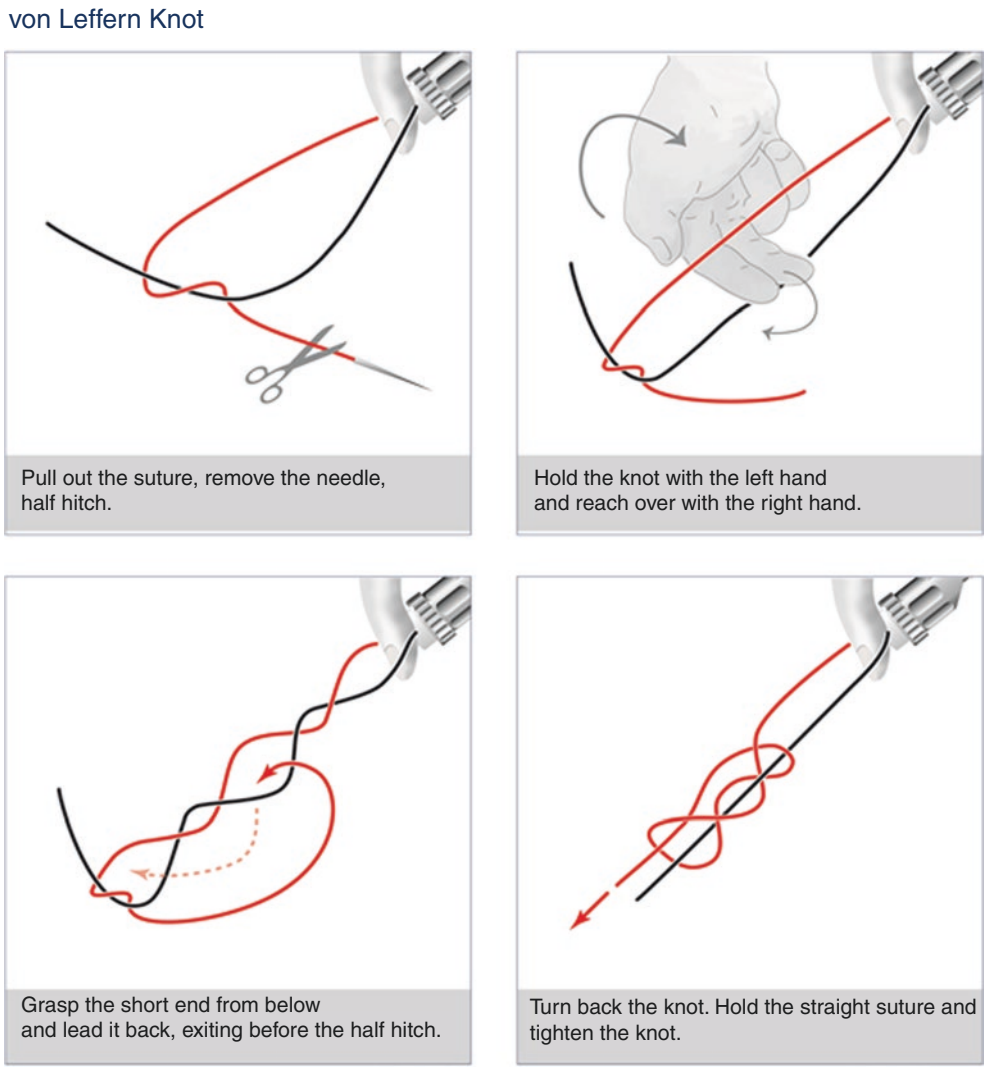


Fig. 23.3 Roeder Knot

Fig. 23.4 von Leffern Knot



Hemostasis by Endosuture with Intracorporeal Knotting

For intracorporeal knotting, a straight or curved needle with different suture calibers is used. For microsurgical interventions, such as end-to-end anastomosis of the tube, 4–0 to 6–0 sutures are used otherwise 1–0 is adequate for vaginal cuff suture. The long-end of a thread, originally knotted extracorporeally, is wrapped around the needle holder twice while the needle holder is aiming for the short-end of the tread to perform an additional, intracorporeal safety knot (Fig. 23.8). Among many other intracorporeal suturings, the baseball suture is specially suitable to compress wounds, e.g. after enucleation of myomas.

Due to this technique of suturing, the size of the wound is minimized and along with it the risk of immediate and later bleeding. In addition, the occurrence of adhesions is reduced since the wound is closed toward the surrounding tissue. Stitching and tying of the whole uterine vessel bundle requires good knowledge of anatomy.

Hemostasis by Suture and Tying Knot with Half Hitch

The Clark knot pusher is used for this procedure. With the extracorporeal thread, a half-hitch is formed and the knot is then pushed down with the knot pusher.

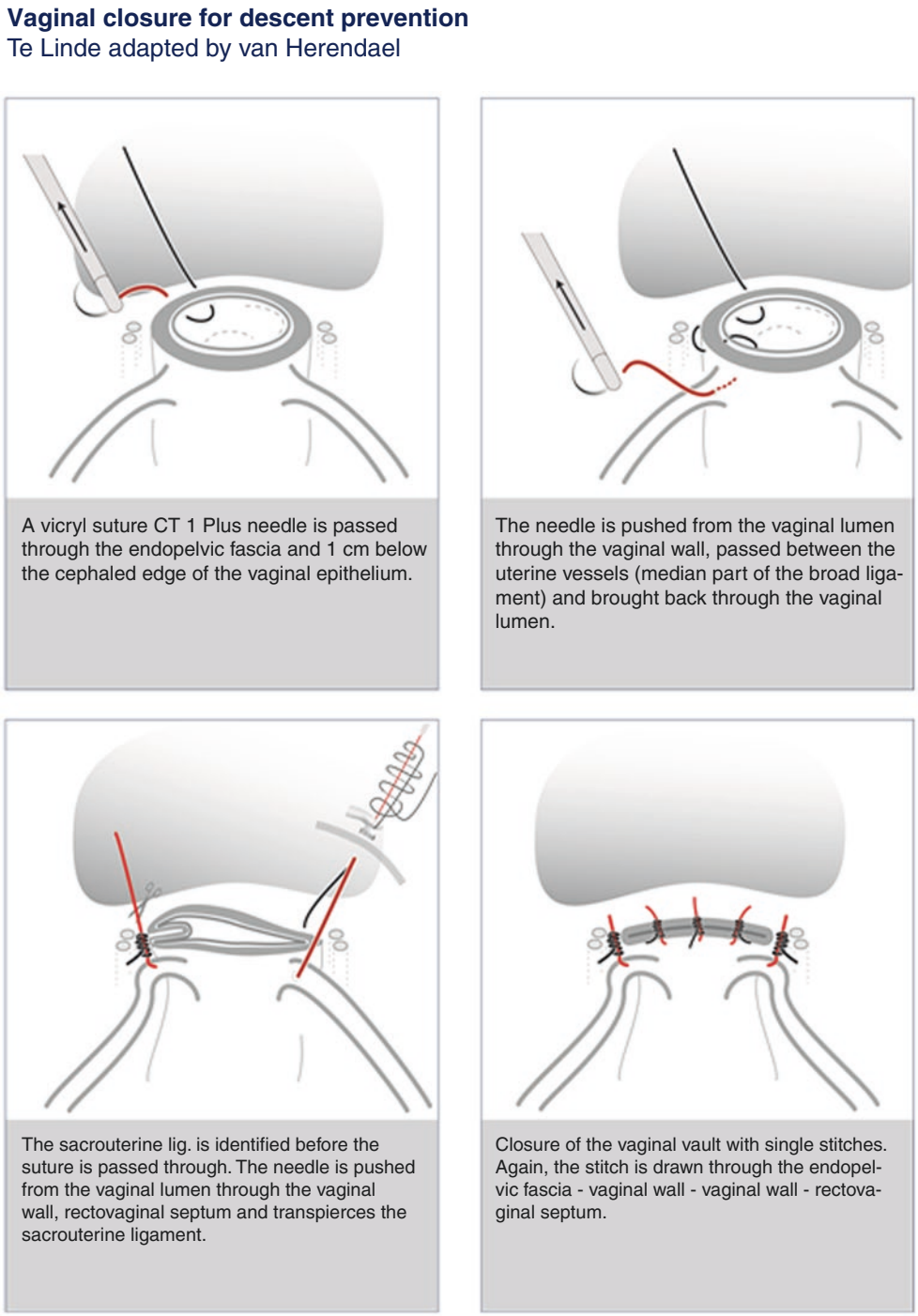


Fig. 23.5 Vaginal closure for descent prevention

Staples and Stapling Instruments

A safe way for vessel occlusion at laparoscopic hysterectomies is provided by "ENDO GIA" These ENDO GIA's are available with straight and curved tips. The unique Endo GIA™ Curved Tip Reload with Tri-Staple™ Technology of COVIDIEN is a stapler designed with a curved tip at the distal end of the anvil to provide enhanced visibility and maneuverability around target tissues and vessels.

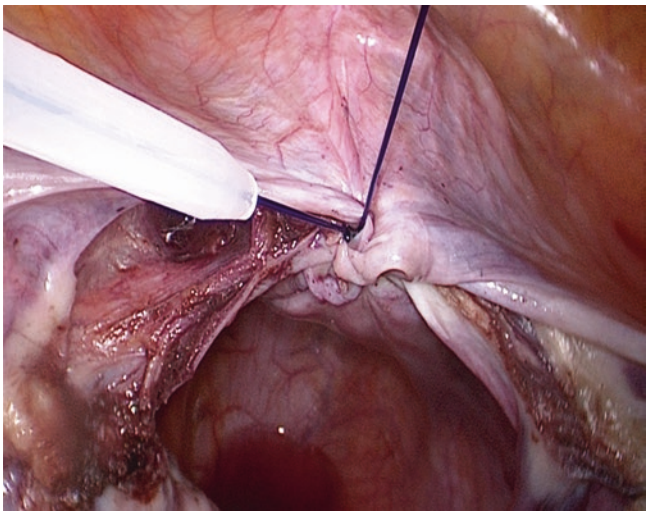


Fig. 23.6 After having formed the knot extracorporally, it is pushed down with the plastic knot pusher

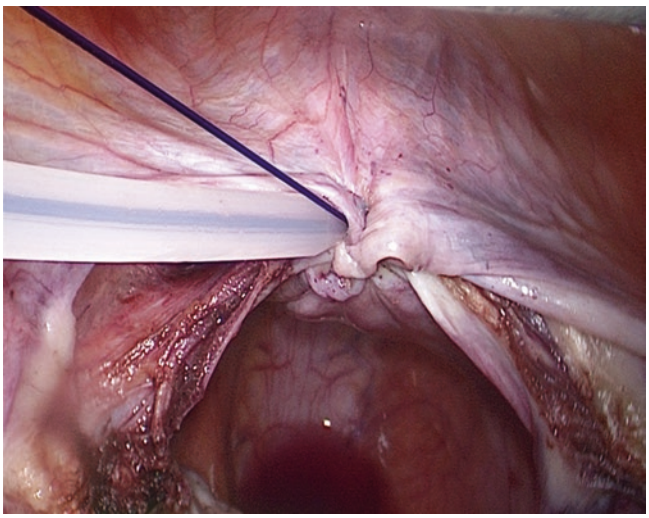


Fig. 23.7 To tighten the knot, the other end of the thread is held with some tension while the knot pusher is pressed onto the knot firmly

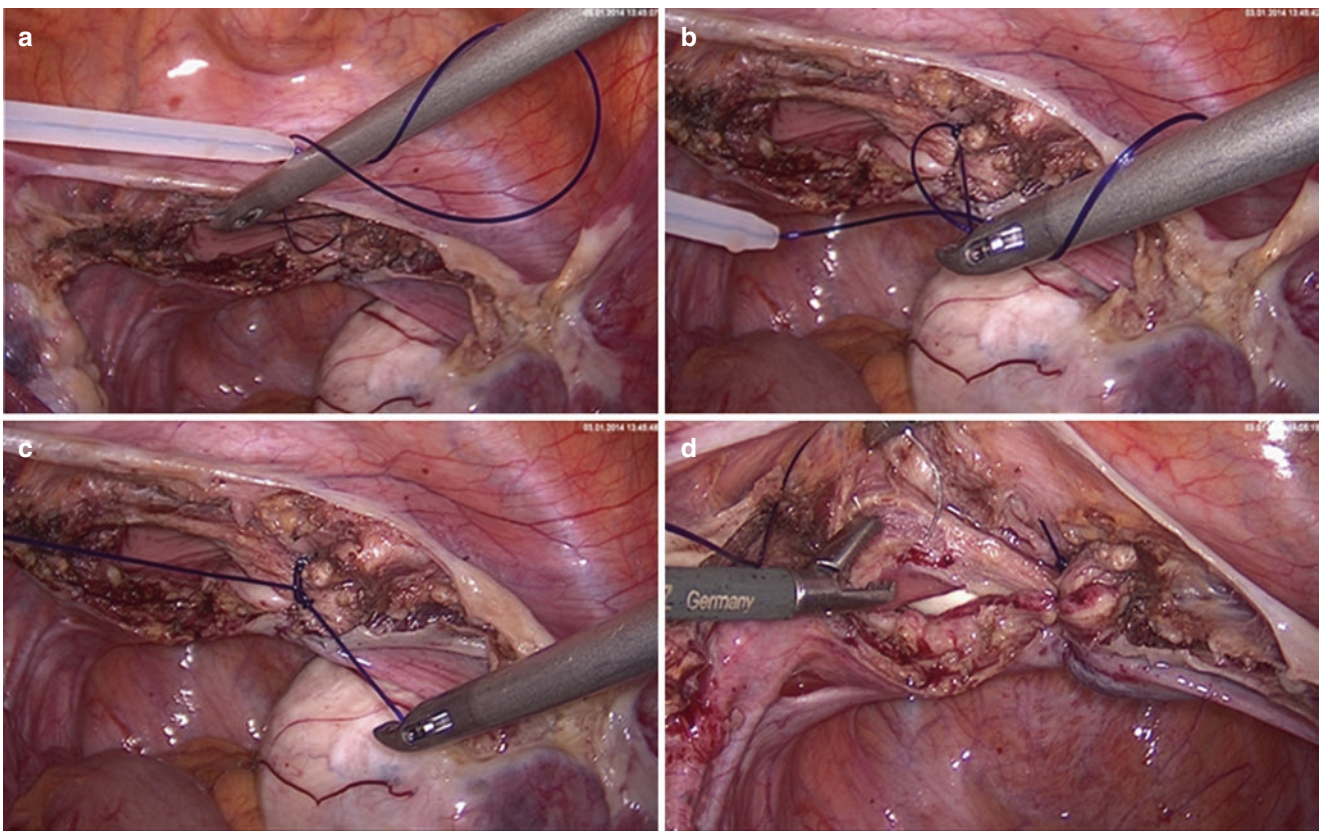


Fig. 23.8 Intracorporal knot to give final tension

Tissue Glues

A variety of adhesive substances can be applied locally during laparoscopic hysterectomy for hemostasis or wound closure. The main classes of tissue adhesives are cyanoacrylate glues, fibrin glue, and thrombin. Cyanoacrylate glues are widely used in GI endoscopy for control of bleeding from gastric varices and, to a much lesser degree, for hemostasis of bleeding peptic ulceration and for closure of fistulas and anastomotic leaks. Fibrin glue (fibrinogen and thrombin) and thrombin have been used extensively in all surgical

disciplines for tissue adhesion; suture support; hemostasis; wound care; and the sealing of body cavities, including the subarachnoid space;

Biosurgical agents designed to promote tissue adhesion and hemostasis are being increasingly employed also in hysterectomies. Fibrin sealant is the most widely utilized biosurgical product. Gelatin matrix thrombin has proven to be an efficacious hemostatic agent. Bovine serum albumin-glutaraldehyde is a new promising tissue glue.

TachoSil of Takeda represents a new fibrine sealant with excellent thermostatic possibilities. It contains fibrinogen and thrombin as a dried coating on the surface of a collagen matrix. In contactwith physiological fluids, e.g. blood, lymph or physiological saline solution the components of the coating dissolve and partly diffuse into the wound surface. This is followed by the fibrinogen-thrombin reaction.

which initiates the last phase of physiological blood coagulation.

Instrument Systems and Apparatus for Laparoscopic Hysterectomies

Conventional Laparoscopy

Of the multitude of laparoscopic instruments known today for hysterectomies, we describe here only a selected few which are absolutely necessary and which should be available in duplicate or triplicate on the instrument trolley. Multiple use instruments for cutting, grasping, dissection, pushing, traction, coagulation, irrigation and suction are very helpful.

Instruments for Perforation

- The **Veress needle** is blindly introduced into the abdomen after lifting the anterior abdomen wall [20]. Trocars of 3 mm, 7 mm, 10 mm, 12 mm, 15 mm, 20 mm, 24 mm diameter are used for guiding the endoscopes and operative instruments, irrigation, coagulation and during employment of needle holders and morcellators.
- The simple **automatic flap valves** can leak because of soiling with blood or tissue particles. Therefore they are to be used for single use only. **Trumpet valves** are stable, but must be always opened and closed. They hinder the introduction of needles and thread.
- **Endoscopic lenses** must be frequently washed and removed because of soiling during the operation. Therefore, for such trocars we reluctantly use automatic valve, but prefer trumpet valve.
- **Primary trocars** can be inserted by the Z-puncture technique to prevent dehiscence of aponeurosis and late prolapse of the omentum. The decision, however, depends on the surgeon. We recommend conical and pyramidal trocars. Pyramidal trocars carry the advantage of a sharp cutting edge Optiview^{R} by Ethicon (Ethicon Endo-Surgery, Cincinnati, USA) , Visiport^{R} by Covidien (Mansfield, MA, USA) and XCel by Ethicon (Fig. 23.9) offer **insertion under vision**. At present, only 10–11 mm trocars are available through which the 10 mm laparoscope can be passed under direct vision.
- **Optical Veress needles** can be inserted under vision but one looks still through a plastic layer. The insertion under vision can be done below left costal margin also; a suitable trocar can inserted through the umbilicus under vision.
- The linear **expansion trocars** help controlled widening of a narrow canal by serial dilatation
- The **Endo-Tip** is the only trocar to be inserted under direct vision (Fig. 23.10)



Fig. 23.9 XCeltrocar by Ethicon for entry under vision

Dilatation Instruments

It is possible to dilate up to 10 mm, 12 mm, 15 mm and 20 mm through an introduced rod and a suitable 5 mm threaded trocar.

Holding, Grasping Instruments and Screws

Various types of traumatic and atraumatic forceps are used as endoscopic grasping tools for laparoscopic hysterectomies. They are in 5–20 mm sizes. In 10 mm size we recommend the big toothed forceps and lymph node holding forceps to hold the tissues firmly. The 10 mm swab holding forceps are suitable for holding tissues lightly and for pushing. The 5 and 10 mm swab holders are used in tissue dissection. The 5 and 10 mm myoma screw may be used for traction of the uterus. The handles of the Robi instruments of the Karl Storz company are easier and more ergonomic to use than older roundgrip handle versions. Olympus offers with its HICURA line (Fig. 23.11) a new generation of laparoscopic hand instruments consisting of a wide range of product offerings of different lengths, shafts, handles, and jaws to accommodate surgeon's needs. The adapted handle design for grasping and dissection forceps has new ergonomic handles availbale in two sizes, developed with the goal to improve handling and safety of the instruments).

Cutting Instruments

Five millimeter curved scissors and the 5 mm and the 11 mm saw-toothed scissors as well as different micro knives with changeable disposable blades are available. Mostly, curved scissors are used, but round scissors with electric connection are frequently employed because of their extreme safety. The latter one is often used as a disposable instrument.

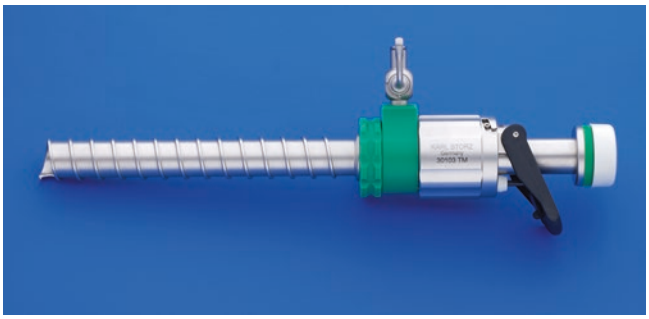


Fig. 23.10 Endo-tip by Ternamian (Karl Storz) for smooth laparoscopic entry under direct vision



Fig. 23.11 HICURA line laparoscopic instruments

Suction and Irrigation Instruments

The suction irrigation devices of Karl Storz, Olympus, Wolf etc. are well known.

The suction cannula is used either with an open tip or with a perforated tip. Large volumes of fluids are aspirated with these suction irrigation cannulas (Fig. 23.12). They are set at an irrigation pressure of up to 300 mmHg and an aspiration force of up to 1 bar. The normal suction force is maximum 800 mbar; irrigation pressure is 300 mmHg. With extra-long (50 cm) suction irrigation tubes, it is possible to suck even under the dome of diaphragm from the pelvic region. Many disposable systems are also available.

Morcellation Instruments

The development of morcellation instruments was slow. In ovarian resection and enucleation of myoma, the tissue was cut with scissors and knives, depending on the size. The specimen can be removed either with big toothed forceps or a big sponge holding forceps directly through the 11 or 15 mm trocar with conical end. However, the so-called motor drive morcellators in 10 mm, 15 mm and 20 mm diameters are electrically powered and function well. The tissue is slowly cut electrically, nearly shaved from the surface, and pulled into the trocar sleeve. It is particularly suitable for horizontal operations as in vertical use a laceration of bowel or vessels can easily occur. Karl Storz produces the Steiner morcellator®, the Rotocut and a new development, the Sawalhe II Supercut morcellator, all with a tissue protection shield (Figs. 23.13 and 23.14). Single-use devices are available from various companies such as the PKS PlasmaSORD by Olympus. In bag morcellation is more and more being developed to prevent tissue particles being left in the abdominal cavity. Sarcomas should, of course, not be morcelllated and be recognized prior to hysterectomy and morcellation.

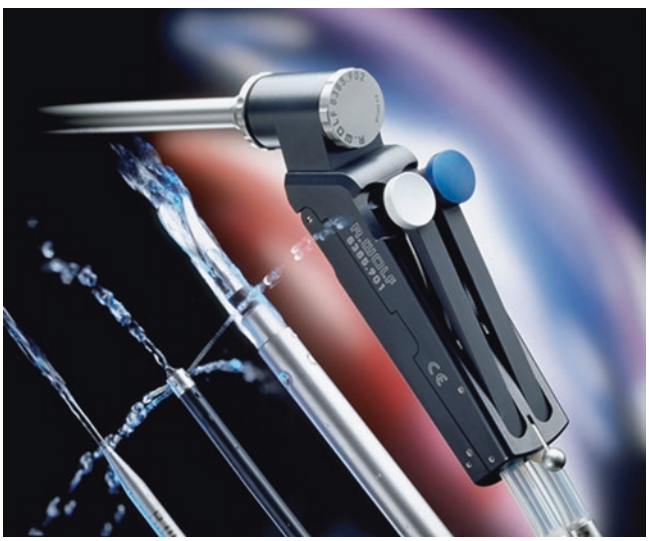


Fig. 23.12 Suction irrigation system (R. Wolf, Knittlingen, Germany)

Many companies have disposable morcellators. The WISAP electric morcellator was the first on the international market. Alternatively, the surgical specimen from the abdominal cavity is put in an endobag (small plastic bags) with forceps. Morcellation is only advised at present for benign specimens. However, I foresee the transformation of fibroid-like material into powder, which can then be aspirated and examined by the molecular geneticist- pathologist for malignancy. In case of uterine tissue this would mean to detect mutations in these carcinosarcomas that are found in about 1–4 per thousand in myomas. Of course any hysterectomy is preceded by careful imaging with ultrasound and often MRI, where bulky polyploid masses with heterogeneous appearance and increased vascularity, lacking calcifications would lead the surgeon to avoid morcellation.

However, after the Boston case of a non-recognition of a sarcoma at morcellation, was published over all public media everyone became more careful not to spread tissue at morcellation. Morcellation in bags became available and some companies have retracted their morcellation devices.



Fig. 23.13 ROTOCUT GI (Karl Storz), morcellation tool with protectivshield, available in 2 sizes (12 and 15 mm)



Fig. 23.14 SAWALHE II SUPERCUT Morcellator (Karl Storz)

Instruments for Hemostasis

Instruments for tying the blood vessels such as the Roeder loop, the endoligature or the endosutures with extra or intracorporeal knotting are widely known. Needle holders for straight, curved or Ski needles must be available in different variations.

For hemostasis, endocoagulation, heat denaturation at 100–120 °C, bipolar coagulation in various forms (see section on energy sources in this chapter) and monopolar needle, melting hook, high frequency scissors or other instruments are suitable [21]. For localized ischemia a vasopressin derivative in a dilution of 1–100 is injected subcapsular with an applicator.

Gynaecologists prefer suturing and coagulation devices. However, clips and stapling devices, which are more frequently used by general surgeons, are also used for fixing meshes, for pelvic floor surgery, lymphadenectomy and hysterectomy in our field. Both Ethicon, a Johnson & Johnson company (New Bunswick, NJ, USA), and Covidien have fascinating devices on the market. Let me just mention here Covidien's new Endo Clip Applicator III (5 mm) with easy to be situated clips and a digital clip counter as well as the Ultra Handle Group (Fig. 23.15a, b) and the Endo GIA™ Stapler (Fig. 23.16).

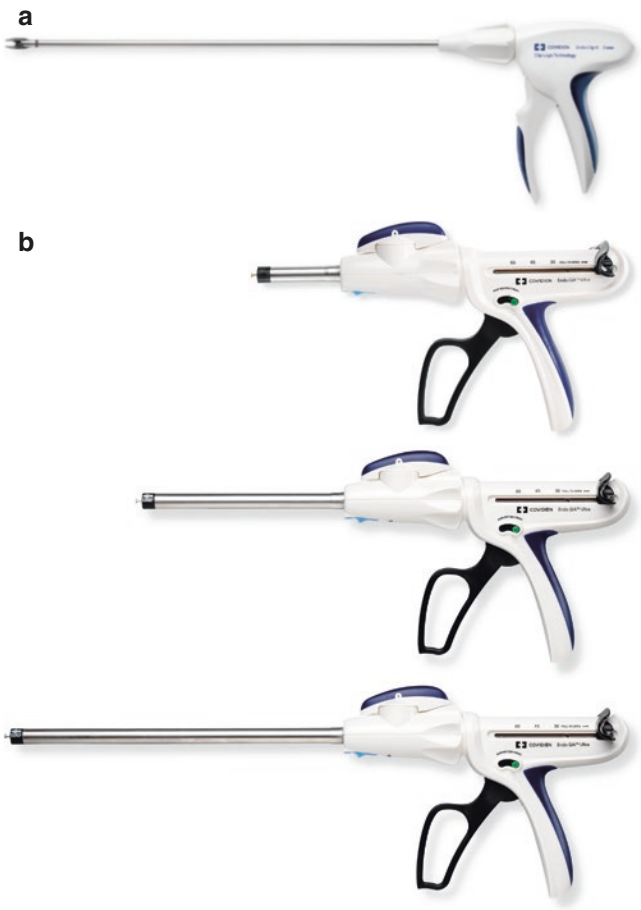


Fig. 23.15 (**a**) Endo-Clip (Covidien) (**b**) Handle Group (Covidien)

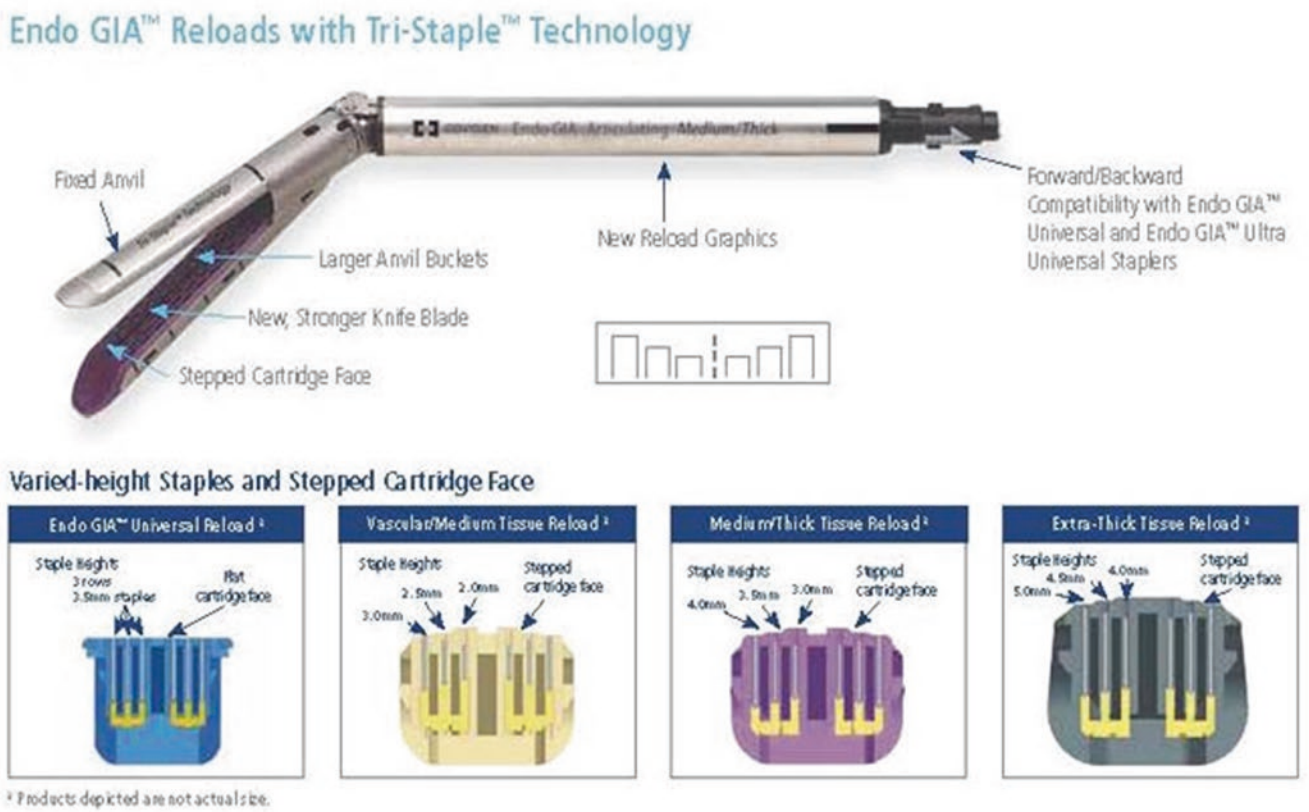


Fig. 23.16 Endo GIA™ Reloads with Tri-Staple™ Technology (Covidien)

Instruments for Clamping Large Vessels, Emergency Needle

Emergency instruments and usual clamps used in routine gynecological operations should not be used for clamping the vessels. Vascular clamps must be readily available. Large vessel injury must be immediately explored by laparotomy and the bleeding vessel clamped. If a vessel in the anterior abdominal wall is injured (epigastric artery), it is advisable to ligate it at an appropriate place with a large emergency needle.

Instruments for Drainage

The Robinson drainage is suitable for abdominal drainage. It works on a gravity basis and as a rule can be left in situ over 24 h.

Instruments for Uterine Manipulation

Vacuum intracervical probes in the standard three sizes allow only partial movement of the uterus and facilitate tubal chrompertubation.

Various instruments for intra uterine manipulation make it possible to move the uterus in side-to-side, ante and retroflexion as well as rotation movements and sometimes allow the possibility of chromopertubation. Uterine manipulation is required in endometriosis of the pouch of Douglas, for hysterectomies, in bladder dome endometriosis and for enucleation of myoma. The ACE (Abdominal Cavity Expander) serves to elevate the anterior abdominal wall in cases with adhesions. Further versions of this principle are used in the gasless laparoscopy, e.g. as Laparolift®.

The Hohl, the Mangeshikar and the Donnez intra–uterine manipulators or mobilizers as well as the Koninckx uterine twister are all produced by Karl Storz and have a cup with a well palpable and visible border to visualize the resection level between vagina and cervix for all cases of TLH (Total Laparoscopic Hysterectomy) (Fig. 23.17). This facilitates the intracervical approach of TLH; however, they are not to be used for the extracervical approach and in oncologic cases of hysterectomy. Many companies have disposable manipulators.

Lenses and Endoscopes

Scopes are available in rigid and flexible systems (Figs. 23.18 and 23.19). The rigid system is based on Hopkins's experience with a rod lens system, which results in good resolution and depth of focus ratio [22]. Flexible endoscopes are based on the use of optical fibre bundles. The rigid laparoscopes are in 3–11 mm sizes, e.g. the arthroscope with a 14° angle. Most of the rigid endoscopes are directly connected to the telescope through the camera coupling system. The picture is enlarged so that it looks even bigger on the monitor. In flexible endoscopes, the bundle of fibres is also enlarged. The standard laparoscopes are rigid instruments



Fig. 23.17 Intrauterine manipulators produced by Karl Storz according to Koninckx, Clermont-Ferrand, Mangeshikar, Hohl, Donnez and Tintara

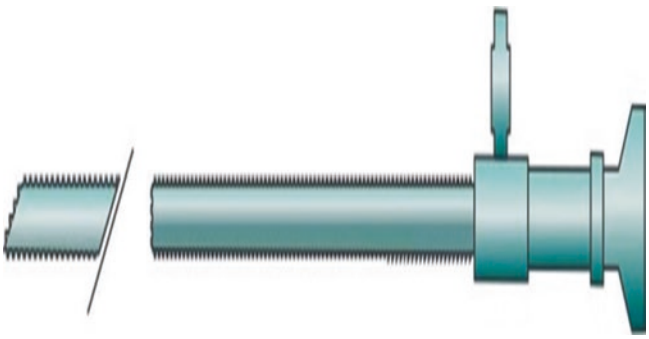


Fig. 23.18 Rigid standard laparoscope (10 mm) with 0° and 30° optic

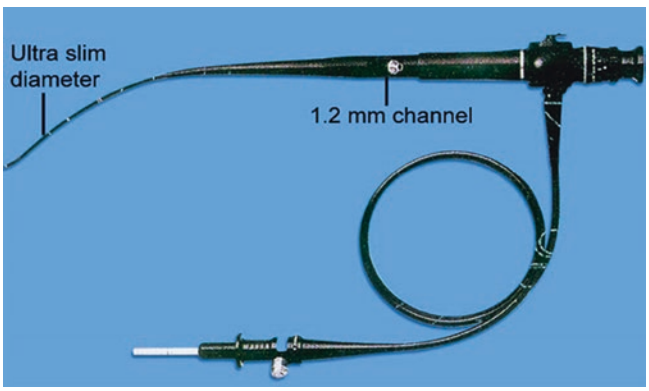


Fig. 23.19 Flexible endoscope

with a 0° lens. The 30° lens has the advantage of a wide panoramic view. With the Endo-Cameleon (Karl Storz) a 120° panoramic view is possible (Fig. 23.1).

Each camera has two components: head and control. A 35 mm coupling system yields a much more enlarged picture than a 28 mm coupler. A direct coupling transmits the picture directly to the camera.

Olympus offers different endoscopes with the chip on the tip of the optic the observation light passes through fewer lenses than on a rigid scope. This allows brighter and sharper images than when the camera is attached to the head of the optic. The ENDOEYE concept includes a range of 5 mm and 10 mmm scopes with advanced optical design that expands the clinical possibilities laparoscopic surgery. The images are smooth and clear, with reproduction so accurate that details and colours remain sharp and true to life. The ENDOEYE FLEX has a flexible tip which can be bend up to 100° in four directions. This means the relevant organs and tissues can be thoroughly examined head-on, from above and from behind (Fig. 23.20).

Energy Systems for Laparoscopic Subtotal, Total and Radical hysterectomies (Electrosurgery and Thermofusion)

Electro section, i.e. cutting of tissue between the active electrode and the tissue where an electrical arc is generated, takes place above 200 °C. During coagulation and desiccation the tissue is heated slowly. It results in denaturation, evaporation of water and secondary hemostasis. The argon beam coagulator is a monopolar electrosurgical instrument. In principle, non-combustible argon gas (4 L/min) across an electrode cannula acts as a bridge for electrical current to burn the tissue superficially (up to 5 mm depth) [23]. As the gas is easier to ionize than air, electrical arcs develop up to 1 cm above the tissue surface. In monopolar electrosurgery, high-density current is used at the active electrode that is conducted to the patient on touching. In bipolar electro surgery, two small electrodes of same size are used which lie close to each other and function as active passive electrodes.

While the use of thermal hemostasis goes back to the glowing iron, according to Paquelin, the development of safe high frequency current techniques took 40 years. The application of the laser technique, ultrasonic cutting and coagulation techniques and the local thermal effects, such as thermocoagulation, take place in the range of 80–120 °C. Suturing and clip techniques are handled in next chapter.

We differentiate between fulguration and coagulation in high frequency hemostasis. In fulguration, electromagnetic oscillations across an air bridge produce radio frequency between the tip of the electrode and the surface of the organ, i.e. they come in direct contact. The generated heat is limited to tissue surface, i.e. the area visible through the scope. By coagulation we mean the heating of the tissues until intracellular water boils under the influence of high frequency current.



Fig. 23.20 (**a**) EndoEYE video laparoscopes (Olympus) as Endoeyerigid (**b**) EndoEye video laparoscopes (Olympus) as Endoeyeflex

In addition to the technique used for fulguration and for coagulation, the most important technique in medicine and endoscopic surgery is the **electrotomy,** the cutting of tissue with the so-called electrical knife or the electrical loop.

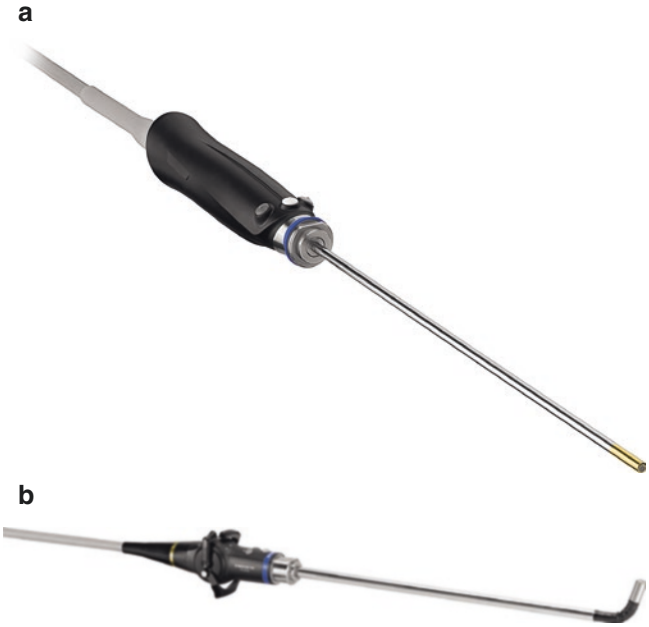


Fig. 23.21 (**a**) BiCision coagulation and cutting forceps (Erbe) (**b**) Erbe Gynaecological Workstation VIO 300 D

At present even with high frequency instruments there is no blind and uncontrolled burning because of the electrical system control. Therefore, we use monopolar current for cutting and bipolar instruments when coagulation is required before cutting big vessels in endoscopic surgery. Most of the systems have an autostop, so that only the required tissue is denatured. It is not set for a very big coagulation zone. Bi-Clamp for vaginal and open surgery and BiCision (Fig. 23.21a) for laparoscopic surgery are the thermofusion devices of Erbe Elektromedizin GmbH (Tübingen, Germany). Their effect is electronically controlled thermofusion and the mechanical separation of tissue.

The electrocoagulation system of Erbe (Fig. 23.21) uses an additional argon beamer, controlled by a foot switch, which facilitates linear coagulation by switching on the argon gas. This gynecological workstation with the high frequency module VIO 300 D can be connected to any monopolar or bipolar coagulation device. It contains several modules, such as the argon plasma coagulation (APC 2) and the smoke plume evacuator (IES 2). The Erbe electro surgical unit (ESU) has a color monitor display that provides the user with an on-screen tutorial as well as settings and operational information. The unit has various cutting and coagulation modes with defined effect levels to provide the physician flexibility in interventional applications (i.e. its ability to generate HF current). The system has automatic start and stop features. The equipment is programmable and various accessories (e.g. footswitches, hand instruments, etc.) as well as modes may be assigned to perform specific functions. Upon activation, the energy



Fig. 23.22 LigaSure (Covidien), bipolar vessel sealing system, 10 mm (Atlas) and 5 mm



Fig. 23.23 LigaSure (Covidien) jaw providing a combination of pressure and energy to create vessel fusion

delivered (in watts) from the ESU to the tissue is displayed on the display screen.

Bipolar vessel sealing, also described as thermofusion, combined with pressure between the branches of the instruments, is a new, easy to use technique that has been picked up by many companies in the production of disposable instruments with integrated cutting devices such as LigaSure (Covidien) (Figs. 23.22 and 23.23).

The BOWA ARC 400 electrosurgical unit is a multifunctional generator for all surgical specialities. Two monopolar and three bipolar instruments can be used with the generator, and, ARC 400 offers specific setting for gynaecology as for every other supported speciality. Monopolar and bipolar resections for hysteroscopic treatments:

- Laparoscopic interventions

LIGATION and Coagulation: Permanent sealing of vessels and tissue bundles with BOWA LIGATION instruments for laparoscopic procedures with BOWA ERGO 310D and NightKNIFE instruments and open surgical applications with BOWA TissueSeal PLUS.

The Nightknife (BOWA-electronic GmbH, Gomaringen, Germany) (Fig. 23.24) is a bipolar vessel sealing device. The instrument incorporates atraumatic tips for secure dissecting and sealing. The integrated cutting system saves changing instruments for tissue separation. The Ergo 310 D knife 5 mm in diameter integrates the sealing and cutting function likewise

- A special mode for BOWA MetraLOOP, a special laparoscopic instrument for the fast and secure removal of the uterus (LSH surgeries). SimCoag mode offers the possibility for two surgeons to activate monopolar or bipolar instruments simultaneously.
- In combination with the ARC PLUS argon unit, electrosurgical system offers Argon plasma coagulation and argon enhanced cutting. The ionized Argon beam offers homogeneous superficial coagulations which is perfectly suitable for e.g. endometriosis treatments.

To support the surgeon's work, the ARC 400 has a very user-friendly design concept.

- COMFORT instruments are automatically detected during insertion by the Plug'n Cut COMFORT function of the generator. The specific settings of the instrument are preselected and the operation can be carried out immediately.
- The intuitive touch display makes settings easy and the layout of the interface allows the user to always know which socket is being set at the moment.
- The EASY neutral electrode monitoring system increases patient safety in monopolar applications by deactivation and alarm in case of insufficient contact between the neutral electrode and the patient.

Additionally, the system can be equipped with the SHE SHA smoke evacuation system, which helps to protect health of the OR-team by evacuating surgical smoke.

The PKS HALO Cutting Forceps by Olympus are ergonomically designed forceps that allow easy operator use, serrated jaws enable strong grasping, better dissecting, reliable coagulation and cutting. PK Technology is an impedance feedback controlled, advanced bipolar vessel



Fig. 23.24 Nightknife (BOWA-electronic) in 5 and 10 mm versions (**a**)Ergo 310 D knife, (**b**) Ergo 310 D, (**c**) open jaws, (**d**) ARC 400 Gynecology/ligation monitor, (**e**) ARC 400 Gynecology plugncut.

sealing system that allows tissue and device tip to cool during the 'energy off' phase, minimizing sticking and charring (Fig. 23.25).

By means of the smart electrode technology, the ENSEAL sealing instrument (Ethicon Endo-Surgery,) permits simultaneous sealing and the possibility of tissue separation, including vessels up to 7 mm (Fig. 23.26). The tip of the instrument has either a 5 mm round tip or a 3 mm slightly curved tip enabling tissue preparation and sealing.

Laser

Laser beam is often described as "light that heals." Laser is acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. Fox established the first surgical laser in 1960. Bruhat and his colleagues in 1979 and Tadir and colleagues in 1996 introduced CO_2 laser in laparoscopy. Today, there are enthusiasts of laser surgery and enthusiasts of electro surgery. Light energy is amplified to generate increased coherent electromagnetic radiation. Here we mention the three forms of laser used in endoscopic surgery:

- CO_2-laser
- Nd: YAG-laser
- KTP-lasers

The Neodymium: Yttrium-Aluminium-Garnet (Nd: YAG-) laser, the Argon laser and KTP- (Potassium-Titanium-phosphate-) laser are used for cutting and coagulation. All the tissue effects are produced because of the continuous or pulsing thermodynamic conversion of light in thermal energy. Because of the 15° refraction of the laser beam after arising from the fiber bundle, the effect can be achieved only up to 2 cm from the tip of the fibers. In 1996 Wallwiener et al. introduced laser treatment in the reproductive surgery [24].

Harmonic Scalpel – Ultrasonic Energy

The harmonic scalpel is an ultrasonically activated laparoscopic instrument that uses mechanical energy to cut and coagulate tissues. Today, the harmonic scalpel can be used as 5–10 mm cutting blades and scissors. Activation of the titanium blade takes place by a piezoelectric crystal with a frequency of 55,500/s in the hand set. The cutting and coagulation effects are comparable to that of the CO_2-laser [25]. The lateral thermal damage is less than by high frequency coagulation. Burning and carbonization of tissues are not observed.

The advantages of ultrasound energy in surgical endoscopic instruments produced by Ethicon Endo-Surgery

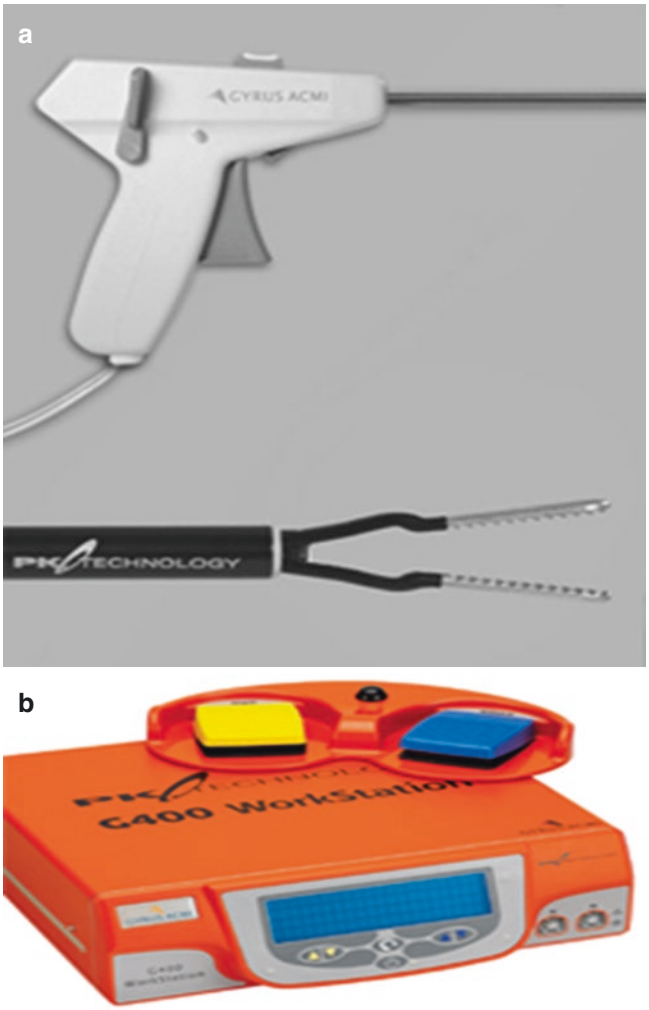


Fig. 23.25 (**a**) Gyrus PK integrated vessel sealing and cutting system (Olympus) (**b**) Gyrus PK control unit (Olympus)



Fig. 23.26 ENSEAL sealing instrument (Ethicon Endo-Surgery)

and Olympus are well known today and highly appreciated. As an example let us focus on the harmonic ace of Ethicon (Fig. 23.27) which with its specific control unit (Fig. 23.28) allows a shorter and a longer effect of sealing and cutting. The mechanical energy works with low temperatures, small lateral damage and minimal desiccation of the tissue.



Fig. 23.27 Harmonic Ace forceps (Ethicon)

The THUNDERBEAT by Olympus is the world's first integrated hand instrument that delivers the benefits of both advanced bipolar and ultrasonic energy in a single device. This unique integration of energy modalities combines proven safety of secure haemostasis from advanced bipolar energy with the speed and precision of ultrasonic dissection (Fig. 23.29).

The different harmonic instruments on the market today, such as harmonic shears, forceps and cutting rings, are applied for adhesiolysis as well as any type of adenexectomy, ovarectomy and hysterectomy. It remains up to the surgeon whether he uses them in combination with other sealing instruments or bipolar coagulation.

Summary of Specific Instruments to Be Used in Total Laparoscopic Hysterectomies (TLH)

All the above mentioned instruments are excellent tools to be used for TLH. There are 2 ways of applying traction and contra-traction for the operative field either by using an intrauterine manipulator in uteri up to a certain size or using traction with a myoma screw, introduced from the lateral ports, a principle widely applied in "Radical hysterectomies" in cases of malignancies. The absolutely necessary instruments for TLH, with or without adnexectomies are detailed in Fig. 23.30.

Summary of Specific Instruments to Be Used in Subtotal Hysterectomies (SLH)

Subtotal hysterectomy, as CISH (Classic Intrafascial Supracervical Hysterectomy) or LSH (Laparoscopic Assisted Supracervical Hysterectomy), is facilitated by the use of an electric loop produced by LiNA Medical ApS, Glostrup,



Fig. 23.28 Harmonic Ace control unit (Ethicon)

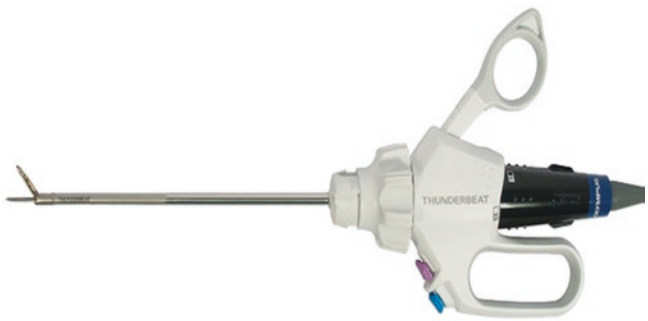


Fig. 23.29 Thunderbeat (Olmypus)

Denmark (Fig. 23.31) as the LiNA Loop and the Storz Loop. With this electric cutting look the cervix is separated from the uterine body. It is of utmost importance not to touch any bowel loops during the activation of the cutting part of the loop.

The PKS BiLL by Olympus is currently the only available bipolar loop for more safety for your patients and fast cutting of the uterus during LSH procedures. With immediate ignition and dry and fast cutting, the PKS BiLL allows for shorter procedure times. The big diamond-shaped loop opens up automatically in the abdomen and is easy and convenient for the surgeon to place even in enlarged uteri (Fig. 23.32). Figure 23.33 details the most necessary instruments for SLH today.

Micro Endoscopy

By rigorously following the concept of minimally invasive access for hysteroscopy and laparoscopy through advances in instrument designing, today optic systems measuring only about 1.8–2 mm including the trocar surrounding



Fig. 23.30 Instrument set for Total Laparoscopic Hysterectomy (TLH)

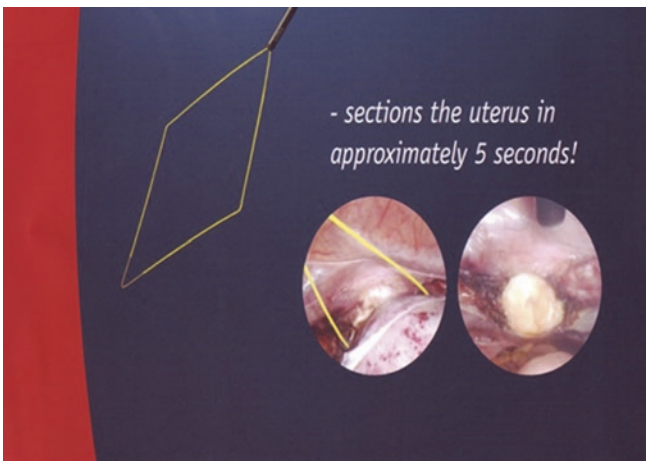


Fig. 23.31 LiNA Loop at Subtotal Hysterectomy (SLH)



Fig. 23.32 Bipolar cutting loop for SLH (Billbipolar)

them are available. Phase optic and lens optic system with diameter between 1.2 and 2 mm are offered by instrument manufacturers. Common to both of them is that the laparoscope can be passed through the Veress needle or the sleeve. Additional trocar insertion after gas insufflation is therefore superfluous. However, compared to the standard 5 and 10 mm optics, even the most satisfactory of the mini-systems shows deficient lighting efficiency. The instrument trocars are also available in correspondingly small diameters.

The merits of minimal operative trauma and the avoidance of umbilical trocar insertion done by inserting the laparoscope through the Veress cannula in minilaparoscopies used to have disadvantages, such as the mechanical fragility of the minilaparoscopes and difficult operative sites with a restricted view. Today new optics and stabile instruments have virtually eliminated these disadvantages. Therefore, a set of minilaparoscopic instruments must always be available for use in certain surgical interventions. The small diameter of the mini-instruments contributes towards reducing trauma and pain in children and in smaller surgical procedures.

For TLH and SLH in small uteri microendoscopic instruments can be used. However, there should be no limitation to combine the procedure by using conventional laparoscopic instruments, as well.

Single Port or Single Entry Laparoscopy (SEL)

Laparoscopy in the 1940s started with the angled laparoscope (optic and one working channel) of Raoul Palmer in France as SEL. Laparoscopy at that time was mainly used for diagnostic purposes and for sterilizations. Kurt Semm in Germany further developed the procedure into operative laparoscopy by using multiple entries and instruments.



Fig. 23.33 Instrument set for Subtotal Laparoscopic Hysterectomy (SLH)

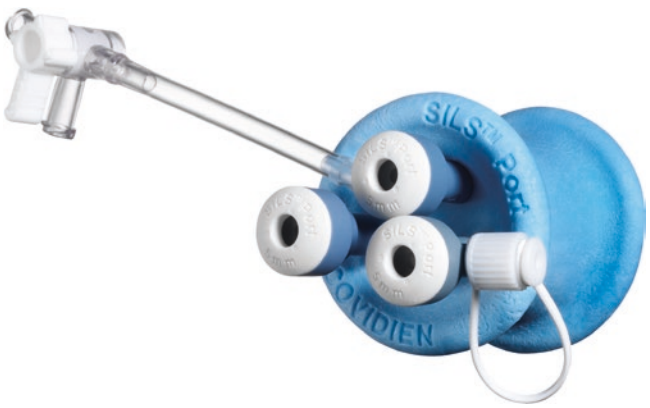


Fig. 23.34 SILS (Covidien) Port New



Fig. 23.35 LESS - Laparo-Endoscopic Single-Site Tri-Port Surgery (Olympus)

With the improved technology of today, SEL takes the idea of the early laparoscopy to new horizons. Of the multitude of SEL ports available, let us mention two disposable and one reusable:

1. The SILS port (Covidien) (Fig. 23.34) is a disposable port. Here a silicone port is introduced into the abdominal cavity using a classical curved grasper with a beak of 5–6 cm. The surgeon has the choice of two ports of five mm and one allowing for a large barrel instrument of 10–12 mm or one with four 5 mm ports. The SILS, with the possibility to introduce larger instruments, is suitable for hysterectomies.
2. Another disposable port is the LESS QuadPort + (Fig. 23.35) of Olympus which contains duckbill valves and requires no gel for insertion. Instruments of 5, 10, 12 and 15 mm can be introduced easily for ergonomic surgery. The 5 mm LESS EndoEYE video-laparoscopes provide excellent visualization and help to avoid instrument clashing. Specialized curved HiQ+ LESS instruments allow internal triangulation and mimic traditional laparoscopy



Fig. 23.36 LESS System with EndoEYE and curved instruments (Olympus)

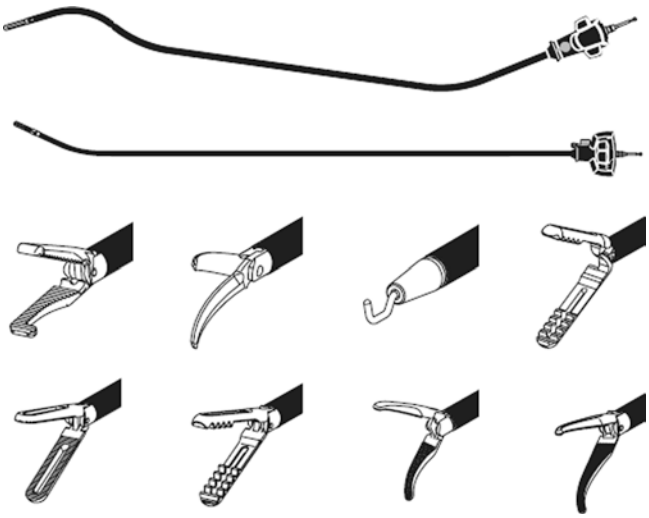


Fig. 23.37 Seven variations of LESS curved instruments (Olympus)

(Figs. 23.36 and 23.37). As a reusable port we use the XCONE (Fig. 23.38) of Karl Storz. This system is operational in the abdomen with 3–5 entry channels, one allowing large barrel instruments. Usually the 3 or 5 mm optic is placed into the middle entry and at least one curved instrument on the left or right side. The ENDOCONE® (Fig. 23.39) is a special access system developed by the general surgeon Cuschieri in which seven instruments can be introduced simultaneously.



Fig. 23.38 XCONE (Karl Storz)

Developments are ongoing as can be seen by the ETHOS Surgical Platform™ (Ethos Surgical, Beaverton, USA), on which the surgeon is postured over the midline of the patient with optimal port triangulation options. New instruments and apparatus are continuously being appraised. They assist the surgeon but do not replace his knowledge and have always to be critically evaluated and studied before they are applied.

For TLH and SLH at Single Port Laparoscopy an intrauterine manipulator is essential to be used in combination with the following necessary instruments: Graspers, coagulation devices, scissors, electro loop and morcellator.

In summary conventional laparoscopic hysterectomies with single and multiple port entries are easy to be performed with modern gyne-endoscopic instrument and apparatus.



Fig. 23.39 ENDOCONE® (Karl Storz) according to CUSCHIERI

References

1. Semm K, editor. Operationslehre für endoskopische Abdominal-Chirurgie. Stuttgart, New York: Schattauer; 1984.
2. Reich H, De Caprio J, F. MG. Laparoscopic hysterectomy. J Gynecol Surg. 1989;5:213–6.
3. Semm K. CISH (pelviscopic intrafascial hysterectomy–without colpotomy), TUMA (total uterine mucosa ablation) and IVH (intrafascial vaginal hysterectomy). Gynakologe. 1993;26(6):378–84.
4. Dargent D, Audra P, Miellet CC. Better use of POR 8. Presse Med. 1986;15(23):1106.
5. Weibel MA, Majno G. Peritoneal adhesions and their relation to abdominal surgery. A postmortem study. Am J Surg. 1973;126(3):345–53.
6. Menzies D, Ellis H. Intestinal obstruction from adhesions–how big is the problem? Ann R Coll Surg Engl. 1990;72(1):60–3.
7. Hawthorn RJS, Lower A, Clark D, Knight AD, Crowe AM. Adhesion-related readmissions following gynaecological laparoscopy in Scotland, an epidemiological study of 24,046 patients. Reviews in Gynaecological Practice. 2003;3:1.
8. Beck DE, Opelka FG, Bailey HR, Rauh SM, Pashos CL. Incidence of small-bowel obstruction and adhesiolysis after open colorectal and general surgery. Dis Colon rectum. 1999;42(2):241–8.
9. Hershlag A, Diamond MP, DeCherney AH. Adhesiolysis. Clin Obstet Gynecol. 1991;34(2):395–402.
10. Holmdahl L, Risberg B. Adhesions: prevention and complications in general surgery. Eur J Surg. 1997;163(3):169–74.
11. Beck DE, Ferguson MA, Opelka FG, Fleshman JW, Gervaz P, Wexner SD. Effect of previous surgery on abdominal opening time. Dis Colon rectum. 2000;43(12):1749–53.
12. Lower AM, Hawthorn RJ, Ellis H, O'Brien F, Buchan S, Crowe AM. The impact of adhesions on hospital readmissions over ten years after 8849 open gynaecological operations: an assessment from the Surgical and Clinical Adhesions Research Study. BJOG. 2000;107(7):855–62.
13. Dubuisson JB, Fauconnier A, Chapron C, Kreiker G, Norgaard C. Second look after laparoscopic myomectomy. Hum Reprod. 1998;13(8):2102–6.
14. Sekiba K. Use of Interceed(TC7) absorbable adhesion barrier to reduce postoperative adhesion reformation in infertility and endometriosis surgery. The Obstetrics and Gynecology Adhesion Prevention Committee. Obstet Gynecol. 1992;79(4):518–22.
15. Vrijland WW, Tseng LN, Eijkman HJ, Hop WC, Jakimowicz JJ, Leguit P, et al. Fewer intraperitoneal adhesions with use of hyaluronic acid-carboxymethylcellulose membrane: a randomized clinical trial. Ann Surg. 2002;235(2):193–9.
16. Mettler L, Audebert A, Lehmann-Willenbrock E, Schive-Peterhansl K, Jacobs VR. A randomized, prospective, controlled, multicenter clinical trial of a sprayable, site-specific adhesion barrier system in patients undergoing myomectomy. Fertil Steril. 2004 Aug;82(2):398–404.
17. Ferland R, Campbell PK. Pre-clinical evaluation of a next-generation spray adhesion barrier for multiple site adhesion protection. Surg Technol Int. 2009;18:137–43.
18. Metwally M, Watson A, Lilford R, Vandekerckhove P. Fluid and pharmacological agents for adhesion prevention after gynaecological surgery. Cochrane Database Syst Rev. 2006;2:CD001298.
19. Mettler L, Hucke J, Bojahr B, Tinneberg HR, Leyland N, Avelar R. A safety and efficacy study of a resorbable hydrogel for reduction of post-operative adhesions following myomectomy. Hum Reprod. 2008 May;23(5):1093–100.
20. Veress J. Neues Instrument zur Ausführung von Brust oder Bauchpunktionen und Pneumothoraxbehandlung. Dtsch Med Wschr. 1938;41:1480.
21. Semm K. Die moderne Endoskopie in der Frauenheilkunde. Frauenarzt. 1972;13:300–7.
22. Hopkins HH. On the diffraction theory of optical images. Proc Roy Soc A. 1953;217:408–15.
23. Brill AI. Energy systems for operative laparoscopy. J Am Assoc Gynecol Laparosc. 1998;5(4):333–45. quiz 47–9
24. Wallwiener D, Maleika A, Rimbach S, Homann G, Rabe T, Gauwerky J, et al. The value of laparoscopic and laser-assisted techniques in reconstruction of distal fallopian tube pathology. Zentralbl Gynakol. 1996;118(2):66–72.
25. Schemmel M, Haefner HK, Selvaggi SM, Warren JS, Termin CS, Hurd WW. Comparison of the ultrasonic scalpel to CO2 laser and electrosurgery in terms of tissue injury and adhesion formation in a rabbit model. Fertil Steril. 1997;67(2):382–6.

Uterine Manipulators for Total Laparoscopic Hysterectomy

24

Prashant Mangeshikar and Abhishek P. Mangeshikar

Introduction

With the advent of development of laparoscopic hysterectomy, improving the ease by which the surgery is done, the need to develop the ideal uterine manipulator became necessary. Each new uterine manipulator improved the shortcomings of its predecessor. This chapter will address the significant benefits and shortcomings of the manipulators invented thus far.

Laparoscopic Hysterectomy is in present time, the standard practice of hysterectomy in experienced hands for diseased uteri where vaginal hysterectomy is not possible. Described by Harry Reich, initially as a LAVH procedure (Laparoscopic Assisted Vaginal Hysterectomy) and later as a Total Laparoscopic Hysterectomy (TLH) operation, the operation like all laparoscopic surgeries requires good and optimal surgical exposure. Optimal exposure of the operative field is of prime importance during Laparoscopic Hysterectomy. Despite the advent of high definition cameras, superior optics and newer light sources, complications can occur if optimal exposure is not available at laparoscopy.

Manipulation of the uterus during LH is essential to provide maximal exposure with minimal access. Though manipulation of the uterus is possible by using a laparoscopic myoma screw, it is not as effective in comparison to the multiple functions provided by the uterine manipulator. In addition, the use of the myoma screw blocks an accessory portal, immobilizing one instrument and one hand which is no longer available for help. The use of the myoma screw may not be able to provide uterine access in all the possible views. This would require shifting the fixation of the myoma screw in the uterus in multiple positions. Bleeding can ensue as a result of screwing and unscrewing the myoma screw from the uterus necessitating arrest of bleeding from the fixation sites in the body of the uterus.

The role of uterine manipulators at Laparoscopic Hysterectomy has been well described and established by numerous studies as a safe and effective way to handle the uterus during laparoscopic hysterectomy. This enables the surgeon to develop spaces along the lines of cleavage, facilitating safe dissection and avoiding unnecessary complications.

The ideal uterine manipulator should have the following characteristics:

1. Inexpensive
2. Safe and nonconductive of electricity
3. Quick assembly and disassembly
4. Reusable
5. Have a wide range of movement and mobilize the uterus in different axis.
6. Easy placement and removal within the uterus
7. No complications arising from its use.
8. Maintain the pneumoperitoneum following the circumcision of the vagina.
9. Should not break down into pieces or fragment during surgery
10. Special functions

According to Gamal Eltabbakh [1], a uterine manipulator should perform the following functions:

1. Raise the uterus cephalad bringing it closer to the laparoscopic instruments.
2. Manipulating the uterus, thereby keep the side to be operated upon, on a stretch.
3. Increase the distance between the uterus and the ureters, bladder and rectum preventing any injury or damage to these vital organs

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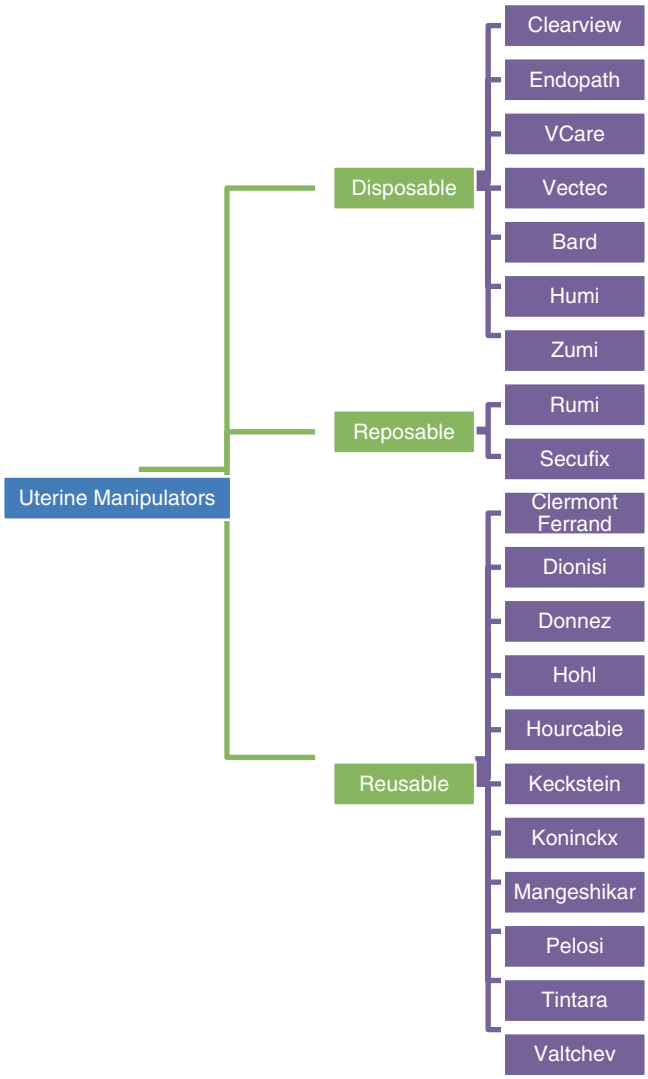


Fig. 24.1 List of Uterine manipulators for Total Laparoscopic Hysterectomy

4. Facilitate identification of the utero-vesical fold of peritoneum, cul-de-sac, and the vaginal cuff at the cervico-vaginal junction.
5. Enable the delivery of the uterus via the vagina once it is free.
6. Maintain the pneumoperitoneum following the circumcision of the vagina.

The uterine manipulator is termed as "The FIFTH Hand in the Pelvis" where in the vaginal assistant is manipulating the uterus via the indwelling instrument: the uterine manipulator. Numerous uterine manipulators have been designed by different authors across the world with the aim to facilitate maximal access during LH as shown in Fig. 24.1.

Clearview Manipulator

The Clearview Manipulator previously known as the Endopath uterine manipulator is a disposable device with ease of handling and assembly with the following characteristics:

1. Allows the uterine manipulation with an inbuilt inflatable balloon in the AP and lateral axis and elevation without the need of a vaginal assistant.
2. In view of the fact that even though it allows 210° of movement in the AP axis, it is not suitable for the TLH operation since it does not allow dextro- and laevo-rotation of the uterus, does not delineate the vagina and also does not maintain the pneumoperitoneum.
3. Two cases of uterine perforation during dilation of cervix due to cervical stenosis reported. Two cases of the Clearview manipulator breaking down into small pieces retained within the patient were reported.

VCare Uterine Manipulator

The VCare Uterine Manipulator is a disposable lightweight device with the following characteristics:

1. It has a wide range of motion (AP, lateral and elevation).
2. It allows easy handling and assembly with an inflatable intrauterine balloon device.
3. Though it offers good vaginal delineation and well maintains the pneumoperitoneum, it is not suitable for TLH in large uteri.
4. Disintegration of the VCare and laceration of the vaginal have been reported as also one case of melting of the cervical cup.

Vectec Manipulator

The Vectec manipulator is an ultra light, inexpensive disposable instrument available either with suction or a screw device to hold the uterus during manipulation.

Rumi Manipulator

The RUMI system consist of the Rumi Manipulator, the Koh cervical cup, and the Koh Colpo-pneumo–occluder, that facilitates 140° degree movement in the AP axis, lateral movements and elevation in the cephaled direction. The indwelling balloon facilitates the manipulation. The injury

rate for 0.2 % for ureter and 0.4 % for bladder, and 1 % for the vagina. Two patients had uterine rupture due to hyperinflation of the intra uterine balloon of the Rumi. In another series the Koh cup was found 14 months after the operative procedure. Following other reports of the disintegration of the instruments, parts being left behind, and vaginal wall laceration, the RUMI has been updated to the RUMI II system.

Clermont Ferrand Manipulator

The Clermont Ferrand Manipulator is a reusable device offering movements in the AP axis, lateral movements and elevation in the cephalad direction (Fig. 24.2). Though it is versatile, it is considered difficult to assemble.

However it does not allow levo –and dextro rotation unlike the Mangeshikar uterine manipulator.

Donnez Uterine Manipulator

The Donnez Uterine Manipulator is a reusable device, lightweight in design. It is not a self retaining instrument (Fig. 24.3). The working insert at the distal end of the manipulator facilitate the positioning of the cervix and is available in three sizes as also the caps which delineate the vagina and seal the gas during opening of the vagina. However, though the inherent design is good for small to moderately enlarged uteri, it has limitations in the range of movement as also with variations in the length of the cervix and associated vaginal prolapse.



Fig. 24.2 Clermont Ferrand Manipulator

Dionisi Uterine Manipulator

The Dionisi uterine manipulator is a reusable device, which is inserted into the uterine cavity: the distal insert being in a closed position (Fig. 24.4). The rotatory wheel at the proximal end is rotated to open up the distal working insert once in proper position. The distal working inserts are available in three different sizes depending upon the size of the uterus for the hysterectomy. The inherent design does not allow the various ranges of movement unlike the Mangeshikar Uterine manipulator. Further there are no vaginal delineating caps available with this instrument.

Hohl Uterine Manipulator

The Hohl uterine manipulator is a reusable device, which is tightly screwed into the cervical canal using spiral inserts (Fig. 24.5). The working inserts, available in different lengths (60 mm, 80 mm, 100 mm) allows this device to be used for uteri of varying sizes. The ceramic caps in varying sizes are available to match the size of the portio. The caps provide optimal presentation over the fornix during circumcision of



Fig. 24.3 Donnez Uterine Manipulator



Fig. 24.4 Dionisi Uterine Manipulator

the vagina. Whilst the manipulator provides a wide range of movement of the uterus rotation of the uterus around its axis is not possible.

Keckstein Uterine Manipulator

The Keckstein uterine manipulator is a reusable lightweight device that enables the uterus to be manipulated with maximum mobility: 95° anteflexion and 30° retroflexion (Fig. 24.6). The movable spiral insert facilitates the movement of the uterus whilst the screw mechanism into the cervix fixes the manipulator. Whilst the Keckstein manipulator allows dorsal, ventral and lateral movements, it cannot rotate the uterus around its axis. This versatile device is provided with caps to present the vagina during the hysterectomy procedure and also to prevent loss of pneumoperitoneum. The shallow fixed height of the cap could be a limiting factor for the identification of the cervico-vaginal junction unlike the Mangeshikar Uterine mobilisar, considering the length of the cervix and associated vaginal descent.

Mangeshikar Uterine Mobilizar

The Mangeshikar Uterine Mobilizar was developed by the primary author with the idea of maximizing uterine manipulation in multiple axis or directions to facilitate excellent exposure for surgical dissection during the total lapaoscopic hysterectomy and colpotomy (Fig. 24.7).



Fig. 24.5 Hohl Uterine Manipulator



Fig. 24.6 Keckstein Uterine Manipulator

The Mangeshikar Uterine Mobilizar consists of two main components (Fig. 24.8):

1. The central assembly
2. Vaginal Fornix Presenter

The central assembly comprises of:

1. A reusable insert, which is housed in an outer stainless steel tube, has at its distal central end a fixation device for the intrauterine steel element (IUE) (Fig. 24.9) and two built in single toothed tenaculum (Fig. 24.10). At its



Fig. 24.7 Mangeshikar Uterine Mobilizar



Fig. 24.8 Different parts of Mangeshikar Uterine Mobilizar



Fig. 24.9 Distal end of MUM with Intrauterine element (IUE)

proximal end, the insert fits snugly into the handle of the manipulator that has a locking device to fix the tenacula into the cervix.

2. The Vaginal Delineating Cup / Vaginal Fornix Presenter (VDC) is made of reusable medical grade PVC (Fig. 24.11). The VDC has a cup at its distal end and houses a tricuspid valve apparatus at the proximal end. It has a locking device within its handle. Once positioned inside the vagina to expose the cervicovaginal junction, it can be locked in place with the inbuilt handle so that the assistant does not have to be concerned with the persistent pushing and handing of the VFP. The cup has a ceramic lip and is flat and not beveled. The standard supplied cup is available in three fixed sizes 30, 35 and 40 mms. Outer diameter.

The Mangeshikar Uterine Mobilizar has no disposable elements and is made up of stainless steel and medical grade PVC that is steam autoclavable.

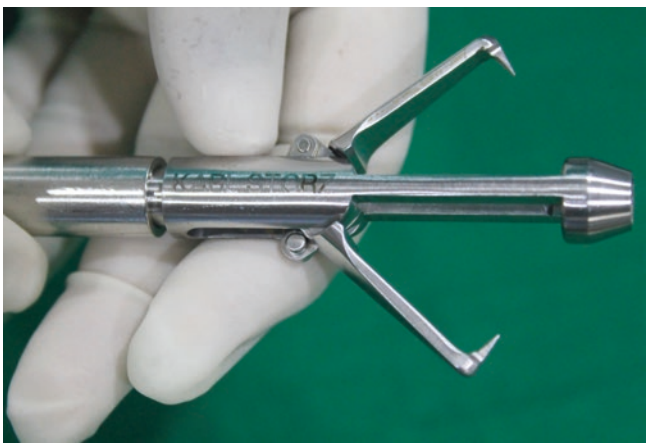


Fig. 24.10 Distal end of MUM showing inbuilt tenaculum



Fig. 24.11 Vaginal Delineating cups with Handle

Operative Steps:

1. With the patient positioned in a modified lithotomy position under general anesthesia, with an indwelling catheter in the Bladder after draping under aseptic precautions, an Assessment is made under anesthesia to determine the uterine size, mobility and the Utero-cervical Length.
2. The cervix is held with a vulsellum at the anterior lip and dilated to 10 Hegar.
3. The uterocervical length (UCL) is determined in cms. With the hysterometer / uterine sound and the appropriate intrauterine element is selected. The length of the element in cms. Is etched at its base as a Number e.g. 8, 9 etc. The correct IUE chosen reduces the risk of uterine perforation and trauma.
4. The MUM is assembled with the appropriate IUE and the vaginal tube Fig. 24.12). The VDC is selected depending upon the width of the vagina and the diameter of the cervix.

After removing the Mangeshikar Uterine Mobilisar from its sterilizing box, the instrument is assembled choosing the appropriate:

A. Intra Uterine Element according to the Utero-cervical length in cms. The appropriate IUE is identified by a Numeral etched at its base e.g. 8, 9, 10 etc.
B. Vaginal Delineating Cup, which is selected depending upon the width of the vagina and the diameter of the cervix (Fig. 24.13).



Fig. 24.12 MUM is assembled with the appropriate IUE



Fig. 24.13 Fixing the Vaginal Delineating Cup to the Handle



Fig. 24.14 Close-up view of the final assembly of MUM at the distal end

5. Holding the anterior lip of the cervix with vulsellum, the MUM is introduced safely into the uterus with the appropriate IUE and VDC and the two in-built tenacula grasp the cervix securely at 3 and 9 o'clock position (Fig. 24.14). Rotating the proximal knob on the handle in an anti-clockwise manner opens the tenacula.

Precautions are taken to ensure that the vagina is not included in the grip. The steel rotating knob on the handle is rotated in a clockwise direction to secure the grip of the tenacula of the MUM on the cervix avoiding any injury to the vagina or the bladder. The vulsellum on the ant lip of the cervix is now removed.

6. The MUM is now ready for use. Traditionally, the vaginal tube is not inserted into the vagina at the beginning of the TLH. In cases of previous C-section, one may insert the tube at the very beginning of the operation to facilitate bladder dissection as the tube acts as a platform on which safe dissection of the bladder fascia and the adhesions can be performed.

Note:

1. The MUM Mobilizes the Uterus in FOUR directions:
   a. Cephalad
   b. Lateral
   c. Anterior and posterior
   d. Levo-rotation and Dextro-rotation on the shaft of MUM
2. By pushing the uterus cephalad, the MUM lifts the uterus out of the pelvis into the abdomen and increases the space between the uterus and the lateral wall of the pelvis.
3. The lateral movements of the uterus by the MUM provide maximal exposure and access to the round ligament, the tube and ovary as well as the broad ligament with all its structures. Further, with the lateral push provided by the MUM, maximal access is available for dealing with the uterine vessels and the ureter (Fig. 24.15). The lateral mobilization by the Mum increases the distance between the uterine vessels and the ureter providing safety to the ureter from injury.
4. The MUM can antevert and retrovert the uterus to gain access to the lower part of the uterus in cases of fibroids blocking straight vision. In addition, the cul-de-sac can be well identified with the MUM and the vaginal tube being pushed deep into the depth of the vagina.
5. The secure grip by the tenacula on the cervix enables the MUM to rotate the uterus around its axis thus bringing the uterine vessels anteriorly at 1 and 11 o'clock position while the ureters remain at their normal 3 and 9 o'clock positions. This provides a safe and clear view of the uterine vessels and the ureter Fig. 24.16). The tenacula grip the cervix and this in addition ensures that uterine perforation due to the instrument will not occur during introduction and surgery.

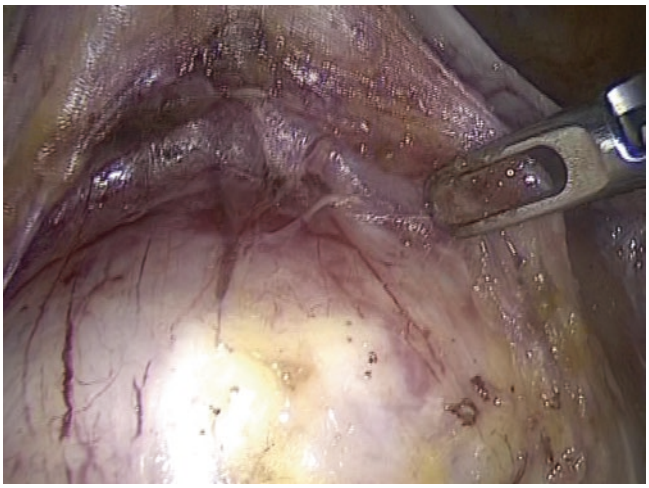


Fig. 24.15 Exposure of Vagina and Bladder dissection

The Mangeshikar Uterine Manipulator aims to be the IDEAL Uterine Manipulator due to its characteristics (Figs. 24.17, 24.18, 24.19, 24.20, 24.21 and 24.22):

1. Lightweight
2. Reusable

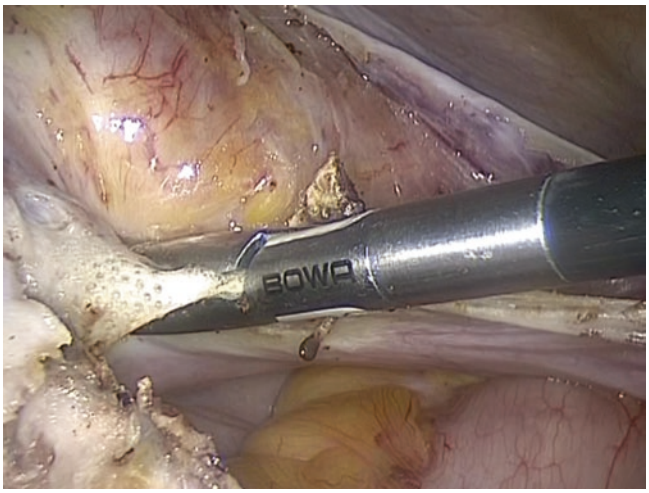


Fig. 24.16 Exposure of Uterine vessels using MUM

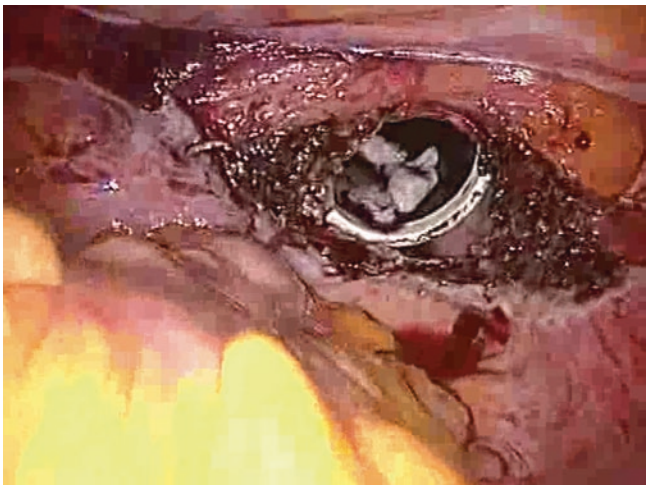


Fig. 24.17 Easy Retrieval of Morcellated tissue via Vaginal Cup

3. Multifunctional
4. Robust
5. For varying uterine sizes
6. Safe
7. Easy to Assemble and Disassemble
8. Easy to Clean and Sterilize
9. Vehicle for Sutures and Needles and Passover Clip
10. Displaces Cervix away from ureters
11. Displaces Bladder Anteriorly and Rectum posteriorly
12. Defines Dissecting plane for Colpotomy
13. Receptacle for sterile gauze pieces
14. Exposes the vaginal edges during laparoscopic closure of the vagina
15. Receptacle for the morcellated tissue remnants, uterine tissue, tubes and ovaries.

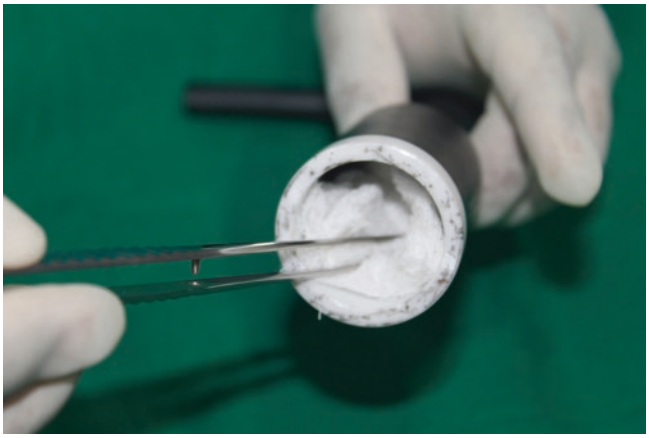


Fig. 24.18 Vaginal Delineating Cup: Storage of gauze piece for mopping the surgical area

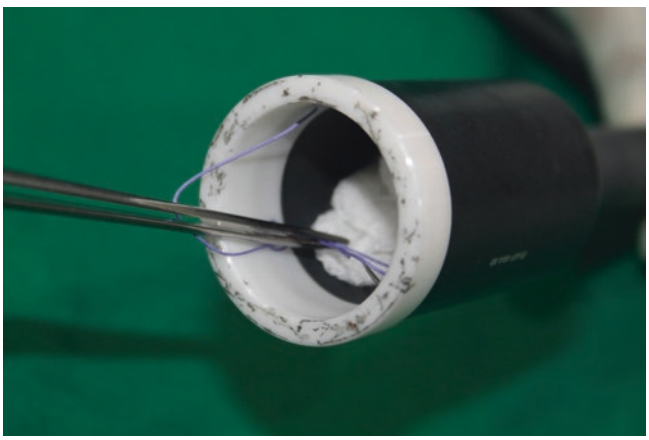


Fig. 24.19 Vaginal Delineating Cup: Storage of Needle with Suture

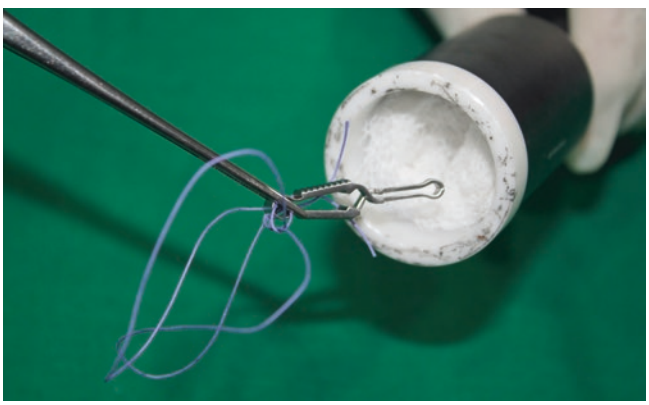


Fig. 24.20 Vaginal Delineating Cup: Storage of Possover Clip

16. Prevents loss and Maintains pneumoperitoneum during circumcision of the vagina as well as during laparoscopic closure of the vagina.

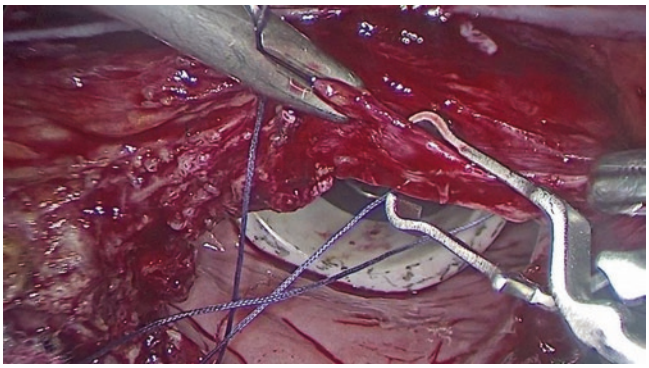


Fig. 24.21 Possover Clip being applied laparoscopically on anterior vaginal wall

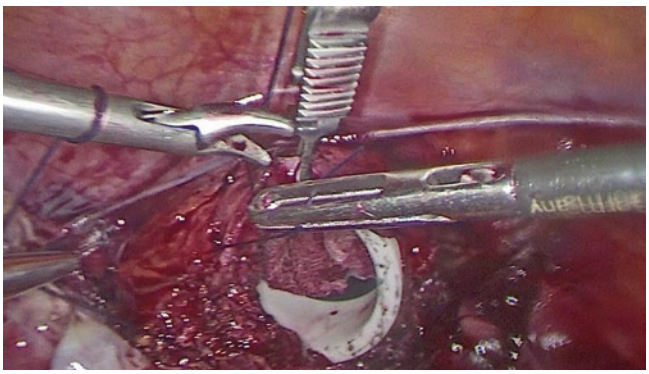


Fig. 24.22 Possover Clip holding anterior vaginal wall providing optimal exposure for easy closure of vagina

Tintara Uterine Manipulator

The Tintara Uterine Manipulator is a lightweight reusable device (Fig. 24.23). It is held in position with the vulsellum on the cervix and allows elevation of the uterus in a cephalad direction and anteflexion upto 90°. It is suitable for LASH (Laparoscopic Supracervical Hysterectomy) and not for Total Laparoscopic Hysterectomy.

Complications

Complications with the use of Uterine Manipulators at Laparoscopic Hysterectomy include:

1. Cervical Tears and Lacerations
2. Vaginal Lacerations
3. Perforation of the uterus during introduction and usage
4. Laceration of Uterine vessels and colporrhexis
5. Bleeding: Intraperitoneal or retroperitoneal.
6. Perforation of Bladder/Bowel/Rectum
7. Breakdown of the Uterine manipulator within the uterus

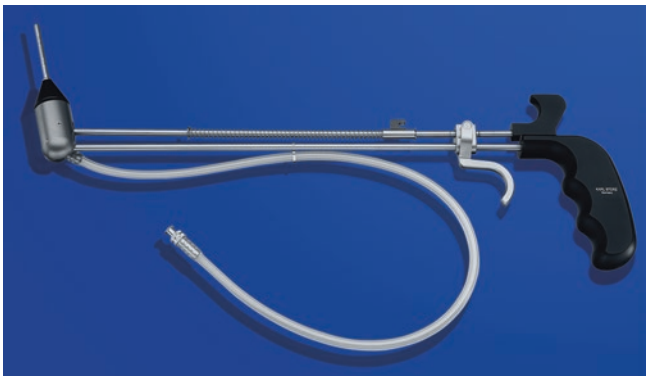


Fig. 24.23 Tintara Uterine Manipulator

Complications are more likely to occur in postmenopausal women or nulliparous women or women who have had no vaginal delivery. The stenotic cervix and the retroverted uterus predispose to complications. Complications can be avoided by proper insertion of the manipulator under laparoscopic visualization.

Ali Akdemir and Teksin Cirpan [2] reported a case of iatrogenic uterine perforation and sigmoid colon penetration caused by the Hohl uterine manipulator during TLH, which required conversion to laparotomy. A prospective study involving 1432 patients undergoing TLH using the Hohl manipulator reported 1 ureter and 8 bladder injuries [3].

The use of uterine manipulators during laparoscopic hysterectomy for endometrial cancer has been a cause of concern that the instrument may push the malignant cells intraperitoneally upstaging the cancer as a retrospective study by Sonoda etal [4] (2001) suggested a higher incidence of 1988 FIGO Stage IIIa (positive peritoneal cytology) among women treated by LAVH. However a prospective study by Eltabbakh and Mount [5] found no such difference in a prospective study in 42 women with endometrial carcinoma who underwent Laparoscopic Hysterectomy using uterine manipulators.

A relatively higher positive peritoneal cytology was found in women who had laparotomy compared to laparoscopy in a study by Walker et al. involving 2616 women with endometrial cancer [6]. These patients were randomly selected for surgery either by laparotomy or by laparoscopy involving different uterine manipulators.

References

1. Eltabbakh GH. Uterine manipulation in laparoscopic hysterectomy. The Female Patient. 2010;35:18–23.
2. Akdemir A, Cirpan T. Iatrogenic uterine perforation and bowel penetration using a Hohlmanipulator: a case report. Int J Surg Case Rep. 2014;5:271–3.

3. Hohl MK, Hauser N. Safe total intrafascial laparoscopic (TAIL) hysterectomy: a prospective cohort study. Gynecol Surg. 2010;7: 231–9.
4. Sonoda Y, Zerbe M, Smith A, Lin O, Barakat RR, Hoskins WJ. High incidence of positive peritoneal cytology in low-risk endometrial cancer treated by laparoscopically assisted vaginal hysterectomy. Gynecol Oncol. 2001;80(3):378–82.
5. Eltabbakh GH, Mount SL. Laparoscopic surgery does not increase the positive peritoneal cytology among women with endometrial carcinoma. Gynecol Oncol. 2006;100(2):361–4.
6. Walker JL, Piedmonte MR, Spirtos NM, et al. Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer. Gynecologic Oncology Group Study LAP2. J Clin Oncol. 2009;27(32):5331–6.

Diagnostic Laparoscopy and Final Site Recognition

25

Julia Serno

With diagnostic or exploratory laparoscopy a direct inspection of intraabdominal organs is possible. Primary access to the intraperitoneal cavity is usually accomplished through the umbilicus, either by direct trocar insertion (open laparoscopy) or by Veress needle placement. This is the most worrisome step in laparoscopic surgery as the surgeon has at this point no knowledge of intraperitoneal adhesions. There is no clear consensus as to the optimal method of entry into the peritoneal cavity [1]. In the open technique, a small subumbilical laparotomy is performed. Skin, rectus sheath, and peritoneum are then incised under direct vision followed by the insertion of a blunt trocar. After that a pneumoperitoneum is created [2]. The closed laparoscopic entry with the use of a Veress needle for insufflation followed by the blind insertion of a trocar is the most common approach used by gynecologists worldwide [3]. A nasogastric or orogastric tube should be placed in order to decompress the stomach prior to insertion of the Veress needle [4]. During the insertion of the needle two "clicks" can be felt, the first corresponds to the piercing of the anterior rectus sheath, the second to the piercing of the posterior rectus sheath and the peritoneum. An intraabdominal pressure of 20–25 mmHg should be administered to elevate the anterior abdominal wall for safety before inserting the first trocar. After the insertion of the first trocar, a scope is introduced to confirm the correct entry into the abdomen without CO_2 insufflation. Once safe entry into the peritoneal cavity is obtained, the pressure can be reduced to the working pressure (10–12 mmHg). All secondary ports should be introduced under vision. Transillumination of the abdominal wall with the endoscope can help identify superficial abdominal wall vessels. Moreover, the anterior surface of the peritoneal cavity should be inspected to locate and avoid injury to the epigastric vessels.

Patients who have had abdominal incisions which extended to or through the umbilicus have a higher risk for bowel adhesions to the anterior abdominal wall area. In this case it is recommended to place the Veress needle in the left upper quadrant (Palmer's Point). Raoul Palmer described this point as being "3 cm below the middle of the left costal margin" [5]. Thus, the risk of bowl injuries can be reduced [6].

The trocar placement depends on surgical indications, organ pathology, adhesions and adipose tissue distribution. A traditional trocar placement for many benign gynecologic surgeries is demonstrated in Fig. 25.1. Two 5 mm ports are inserted on the right and left side of the lower abdomen. In non-obese women with a normal sized uterus, hysterectomy can be performed using this trocar placement.

In more difficult cases additional trocars can be added for example on the right and left side of the umbilicus. With

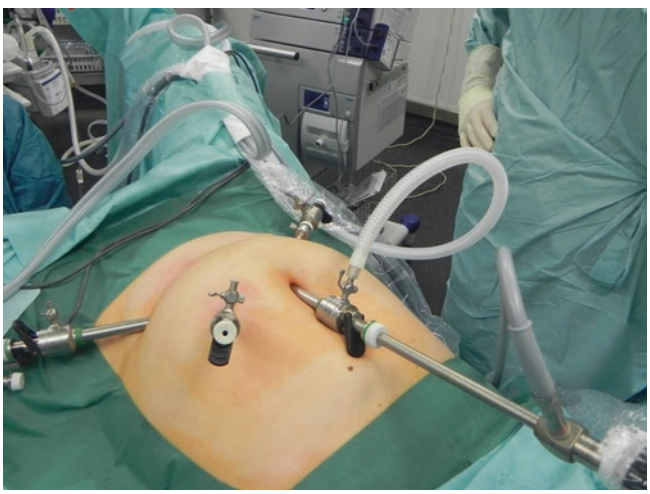


Fig. 25.1 The traditional trocar placement with two trocars on the right and left side of the lower abdomen is complemented by a trocar in the paraumbilical region

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Fig. 25.2 Trocar placement for laparoscopic radical hysterectomy

large uteri or in oncological hysterectomies trocars are generally placed more superior (see Fig. 25.2).

During the course of diagnostic laparoscopy all visible peritoneal surfaces are inspected. The first step is to rule out any injuries that might have been caused by the Veress needle or by the blind insertion of the first trocar. After that the laparoscope can be turned and the upper abdominal organs are displayed (liver, stomach, spleen). After moving the patient in Trendelenburg position two graspers can be used to move the small bowel in the upper abdomen. Thus, a good vision of the pelvic organs is obtained. In case of suspected malignancy any free fluid should be aspirated or normal saline is instilled and then aspirated for cytologic examination [7]. In case of lower abdominal pain it is essential to check the appendix and sigma for signs of inflammation. To rule out unknown endometriosis the most common sites of involvement should be inspected, including the ovaries, the posterior cul-de-sac, the broad ligaments, the uterosacral ligaments, the recto sigmoid colon, the bladder and the distal ureters.

Final Site Recognition

At the end of every laparoscopic surgery the most common complications of laparoscopic surgery should be checked and ruled out (see Table 25.1). Gastrointestinal trauma may occur during the creation of the pneumoperitoneum or during the operative portion of laparoscopy [8]. Both types of injuries are more frequent in cases of previous surgery with present adhesions of the bowel [9]. One simple step to prevent delay in diagnosis is to view the initial trocar site through an alternative port if there is concern about anterior wall adhesions. The bowel close to the operating site should be checked for thermal injuries. Superficial thermal injuries to the bowel can often be repaired by a laparoscopic guided purse-string suture placed beyond the thermally affected

Table 25.1 Checklist final site recognition

Check for thermal injuries (bowel, bladder, ureter)
Check for pneumaturia or hematuria
Consider bladder installation of indigo carmine or methylene blue dye
Remove trocars under vision
Reduce the intra-abdominal pressure and check for (venous) bleeding

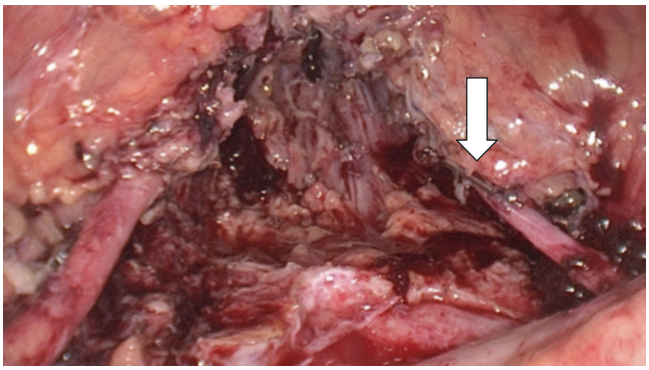


Fig. 25.3 Final site after radical hysterectomy. The veins in the uretric tunnel have been clipped (*arrow*) to avoid thermal damage

tissues. Thus, late onset perforation of the bowel with the risk of sepsis, multi-organ failure and even death can be prevented.

Significant bladder injuries usually result from the placement of a lower midline trocar. The surgeon should check the urine catheter for pneumaturia or hematuria which is a sign for potential bladder injury If a bladder injury is suspected, installation of indigo carmine or methylene blue dye into the bladder may help identify the site of injury. When an injury is noted, laparoscopic suture repair can be used to close the defect ([8], [10]).

Ureteral injury is a serious complication of laparoscopy and unfortunately, in most patients may not be diagnosed at the time of surgery. If injury is identified or suspected intraoperative ureteral stenting may be considered. For intraoperative prevention of ureteral injuries a thorough knowledge of the anatomy is mandatory. Using cautery or any kind of energy source close to the ureter should be avoided. Control of hemorrhage in the area of the ureters should be performed with surgical clips whenever possible (see Fig. 25.3).

All trocars should be removed under vision and it is good practice to inspect all secondary trocar sites for active bleeding before the laparoscope is finally withdrawn. The inspection should be carried out when the intra-abdominal pressure has been lowered, because the pneumoperitoneum can tamponade venous bleeding and by lowering the pressure, these vessels can be identified. In case of injuries to the epigastric vessels blood can be seen dripping down the trocar into the abdomen or haematoma formation can be detected around the trocar site. Minimal bleeding can often be controlled by coagulation of the parietal peritoneum above and below the

trocar. A Foley catheter can be passed through the trocar site and used as a tamponade. For moderate to severe bleeding, full thickness abdominal wall sutures can be placed under laparoscopic control both above and below the trocar site using a long and straight needle.

In case of minimal bleeding close to the rectum or the ureter the use of topical haemostatic agents can be considered. Several topical haemostatic agents are currently available in a range of configurations. They improve primary haemostasis, stimulate fibrin formation or inhibit fibrinolysis. Sometimes the procoagulant substance is combined with a vehicle such as collagen matrix.

References

1. Ahmad G, O'Flynn H, Duffy JM, Phillips K, Watson A. Laparoscopic entry techniques. Cochrane Database Syst Rev. 2012;2:CD006583.
2. Pierre F, Chapron C. Complications of laparoscopy: an inquiry about closed versus open-entry technique. Am J Obstet Gynecol. 2005;192(4):1352–3.
3. Jansen FW, Kolkman W, Bakkum EA, de Kroon CD, Trimbos-Kemper TC, Trimbos JB. Complications of laparoscopy: an inquiry about closed- versus open-entry technique. Am J Obstet Gynecol. 2004;190(3):634–8.
4. Agarwala N, Liu CY. Safe entry techniques during laparoscopy: left upper quadrant entry using the ninth intercostal space–a review of 918 procedures. J Minim Invasive Gynecol. 2005;12(1):55–61.
5. Palmer R. Safety in laparoscopy. J Reprod Med. 1974;13(1):1–5.
6. Childers JM, Brzechffa PR, Surwit EA. Laparoscopy using the left upper quadrant as the primary trocar site. Gynecol Oncol. 1993;50(2):221–5.
7. Mettler L, Jacobs V, Brandenburg K, Jonat W, Semm K. Laparoscopic management of 641 adnexal tumors in Kiel, Germany. J Am Assoc Gynecol Laparosc. 2001;8(1):74–82.
8. Ulker K, Anuk T, Bozkurt M, Karasu Y. Large bowel injuries during gynecological laparoscopy. World J Clin Cases. 2014;2(12):846–51.
9. van Goor H. Consequences and complications of peritoneal adhesions. Colorectal Dis. 2007;9(Suppl 2):25–34.
10. Worley MJ, Slomovitz BM, Ramirez PT. Complications of laparoscopy in benign and oncologic gynecological surgery. Rev Obstet Gynecol. 2009;2(3):169–75.

General Aspects and Their Handling: Adhesions

26

Andreas Hackethal, Jörg Engel, Hans-Rudolf Tinneberg, and Sebastian F.M. Häusler

Introduction

Intraabdominal adhesions severely increase the risk of injuries to bladder, omentum, ureter or vessels followed by major blood loss. An enterotomie occurs in 20 % of cases followed by an impaired patient outcome [1]. Elis found, that one third of patients with intraperitoneal operations are readmitted an average of 2.1 times for a disorder directly or possibly related to adhesions, or for repeat surgery that could potentially be complicated by adhesions [2]. Additionally, adhesions are responsible for 65–75 % of small bowel obstructions which could be life threatening and evoke further need of subsequent surgical intervention [2–7]. Therefore, intraabdominal adhesions have a severe impact on the quality of life of many patients. Nevertheless, social and healthcare system associated impacts as well as the increasing burden of medicolegal claims linked to intraperitoneal adhesions and their consequences are often underestimated.

Adhesions result from wound healing processes after peritoneal injury (Fig. 26.1). Since early publications over 100 years ago, a variety of factors influencing mesothelial healing and adhesion formation as well as factors preventing adhesion formation have been discussed and identified [8–13].

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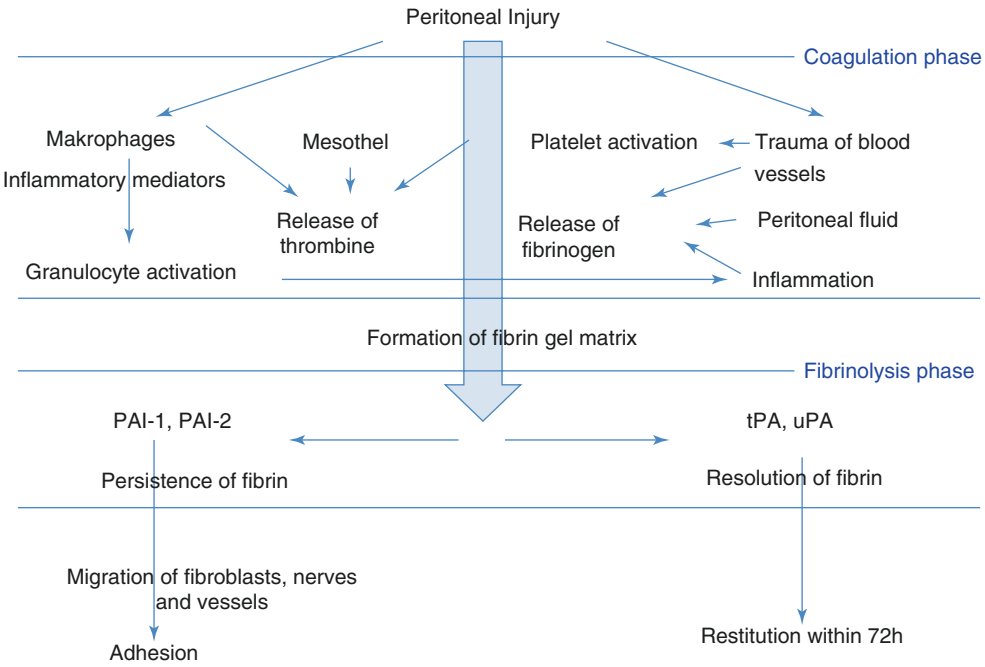


Fig. 26.1 Summary of cellular and humoral responses after peritoneal injury (With permission from Brüggmann et al. [14])

Anticipation, Diagnosis and Considerations of Preoperative Intraabdominal Adhesions

To minimize the risk of adhesion related complications during abdominal entry, one of the key steps is awareness of adhesions and identification of patients with potential intraabdominal adhesions preoperatively. Hence, patients with previous abdominal trauma, histories of pelvic inflammatory or other chronic diseases warrant special attention.

Epidemiologic studies describe postoperative adhesion formation in 50–100 % of surgical patients [4, 15]. The adhesion prevention in gynecological surgery guideline by the Society of Obstetricians and Gynecologists of Canada (SOGC) summarizes in a statement that the risk of adhesion increases with the total number of abdominal and pelvic surgeries performed on one patient [16]. It is well known, that operative laparotomies result in more adhesions than operative laparoscopic approaches [17]. Additionally, adhesions were found more frequently after vertical midline incisions than after transverse suprapubic incisions (59 % vs. 29 %) [17]. Sepilian et al. identified umbilical adhesions after previous laparoscopy in 21 % [18].

The incidence of intraabdominal adhesions after gynecological surgeries is difficult to estimate. Apart from surgeons' experiences, studies with evaluation of adhesion-related complications might help to delineate the incidence.

Within three surveys amongst German, British and European gynecologists regarding their awareness and perceptions of adhesions and adhesion-related consequences, the respondents thought surgeries for endometriosis, adhesiolysis and myomectomy to highest likely be associated with adhesion formation [19–21]. However, the highest rate of readmission to hospital after open gynecological surgery was found after prior adnexal surgery [22]. Additionally, adhesion-related small bowel obstruction after hysterectomy was found to be a significant cause of re-admission to hospital within a Canadian retrospective study [23]. Muffly et al. found 17 small bowel obstructions (SBO) in 3229 hysterectomies within a retrospective analysis. SBOs were identified after abdominal hysterectomy in 9 of 17 (53 %), vaginal hysterectomies in 5/17 (29.4 %) and laparoscopic hysterectomies in 3/17 (17.6 %). The authors claim, that despite the clinical tendency there were no statistical significant differences within the surgical approaches [24].

It is a well-established fact that intra-abdominal adhesions and intra-operative complications increase with successive number of cesarean sections [25, 26]. In regards to adhesion prevention, a recent Cochrane analysis reviewed closure of the peritoneum versus non-closure of the peritoneum [27]. Data of 17,276 women does not support the additional operative time and suture material to close the peritoneum, since the evidence on adhesion formation was limited and inconsistent [27].

Furthermore, intraabdominal adhesions are often found in women with previous pelvic inflammatory disease and suspected or diagnosed endometriosis. Intraabdominal adhesions cause 15–20 % of female infertility and the most common morphologic changes seen in women with chronic abdominal pain are pelvic adhesions [28–30].

Additional to patient history and symptoms, the per vaginal examination might raise the suspicion for pelvic adhesions. Palpation of a fixed pelvic organs or a frozen pelvis, in absence

of other causes, may reflect pelvic adhesions. Demco analyzed pain scores of nature and location of adhesion during awake laparoscopy in 30 women. On a visual analogue scale, the highest pain was associated with filmy adhesions that allowed movement between two structures. Fixed adhesions that did not allow movement had the lowest pain scores [31].

To date, only sparse data exist on non-invasive imaging techniques to identify intraabdominal adhesions. However, certain real-time or functional imaging modalities can delineate intraabdominal adhesions. A literature review published in 2010 found 16 studies on transabdominal ultrasonography and cine-MRI which identified adhesions using visceral slide with accuracy of 76 % and 92 %, respectively [32]. The authors conclude that all but one study were biased by not being blinded and they suggest further double-blinded comparative studies to validate the results [32]. Seow and colleagues found a sensitivity of 90 and specificity of 100 % using three-dimensional transvaginal ultrasonography and level of CA12–5 to detect pelvic adhesions preoperatively [33]. More recently, Reid et al. reported on the transvaginal sonographic sliding sign and Kikuchi et al. evaluated the usefulness of the MRI jelly method to predict obliteration of the pouch of Douglas [34, 35]. A positive sign, signalizing no pouch of Douglas obliteration, is shown by gentle pressure with the transvaginal ultrasonography probe. In this case, the anterior rectum glides over the posterior vaginal wall and part of the cervix and the rectosigmoid glides over the posterior uterine wall [34]. Kikuchi et al. used ultrasonography jelly within vagina and rectum during MRI and found an increased sensitivity and specificity in identifying an obliterated pouch of Douglas [35]. However, both imaging modalities could not visualize filmy adhesions and adnexal adhesions.

As stated above, intraabdominal adhesions are a common finding during surgery and lead to a significant higher complications rate. In light of this, an adequate preoperative consent about possible adhesions and their consequences should be mandatory. Rajab et al. evaluated 200 surgical consent forms from 6 hospitals for the documented risk of adhesions related complications, which was only stated in 8.5 % of consent forms [36]. Similar results were found in two nationwide Dutch surveys. Only 5.2 % of Gynecologists and 9.8 % of General Surgeons reported to routinely include adhesion-related morbidity in the informed consent [37, 38]. In spite of the implications of adhesion-related complications, a standardized consent form was developed to educate patients adequately and document this process [39].

Apart from adequate preoperative patient consent, different presurgical measures have been examined to reduce potential adhesion related complications. Seow et al. suggested mechanical bowel preparation to decrease intraabdominal bowel volume and surgical complications [33]. More important are surgical steps during abdominal entry. Here, the site of entry should be adopted if previous laparotomies or laparoscopies have been performed or large pelvic masses are present. The Palmers point entry, 2 cm below the costal margin at midclavicular line left upper quadrant, can be considered as a safe entry approach, if no left upper quadrant abdominal surgery was performed previously [40, 41]. Additionally, a direct optical entry (DOE) was less time consuming and associated with less blood loss compared to an open entry [42]. Though the authors claim no statistical significance, the number of bowel and vascular injuries was 1/86 (1,2 %) in the DOE group compared to 10/82 (12,2 %) in the open entry group [42].

Surgical Management of Intraabdominal Adhesions

As intraabdominal adhesions result from wound healing, every attempt to lyse or dissect adhesions will likely re-form new adhesions. Data suggests the de novo-formation or reformation in 55–100 % of patients [43, 44]. Consequently, it is a valid question whether performing a full adhesiolysis during surgery should be mandatory, or whether exclusively the lysis of symptomatic or potentially symptomatic adhesions should be recommended. Studies from surveys underline, that Gynecologists agree, adhesiolysis should be performed in symptomatic patients [19, 21].

If patients lack symptoms and have no impairment of their quality of life, adhesions should not be treated [5]. However, in symptomatic patients, it is debatable whether to perform an adhesiolysis during diagnostic laparoscopy or not, as the impact of adhesiolysis cannot be predicted confidently. A well-recognized randomized controlled multicenter trial of laparoscopic adhesiolysis in chronic abdominal pain patients showed no significant differences in follow-up pain scores for patients with only diagnostic laparoscopy and those with performed adhesiolysis [45]. It is noteworthy, that patients with bowel obstructing adhesions were excluded in this study. In contrast, other studies have shown chronic abdominopelvic pain improvement rates after laparoscopic adhesiolysis of up to 84 % [46, 47].

Additionally, infertile patients with adnexal adhesions benefit from adhesiolysis. The pregnancy rate were 32 % after 12 month and 45 % after 24 month in the treated group compared with 15 % after 12 month and 16 % after 24 month in women left untreated [48].

It remains common sense that not the question of how many adhesions have been lysed, but rather, which adhesions have been lysed impacts on patients well-being.

Surgical adhesiolysis can be performed in various ways: sharp dissection with scissors with or without bipolar diathermy, with monopolar diathermy, with laser dissection or

blunt by traction and counter traction. In general, the latter is the most important step in adhesiolysis. Especially in laparoscopic surgery it is of outmost importance to define the adhesions and involved structures to minimize the risk of organ injury before dissection. We usually use traction and counter traction with a 3D movement of the adhesion to better define the involved structures and define the starting point of adhesiolysis. Studies evaluating the impact on the tissue and reformation of adhesions using these different approaches are lacking.

Strategies to Reduce Adhesions Reformation

The medical professional's awareness of intraabdominal adhesion formation is the key for adhesion reduction or prophylaxis. Therefore, numerous articles and statements concerning the burden of adhesions and strategies for prevention have been published especially within the last few years. The Practice Committee of the American Society for Reproductive Medicine (ASRM) with the Society of Reproductive Surgeons (SRS) published a committee statement concerning pathogenesis, consequences and control of peritoneal adhesions in gynecologic surgery [49]. The Society of Obstetricians and Gynecologists Canada (SOGC) summarized recommendations of adhesion prevention in Gynecology in a guideline published in 2010 [16]. On behalf of the European Society for Gynecological Endoscopy (ESGE), a consensus paper has been published to guide gynecologists in "state of the art" handling of adhesions and to fulfill their duty of patient care [50, 51].

Additionally, a recent Cochrane review analyzed Cochrane data on adhesion prevention agents for gynecological surgery [13].

Apart from individual patient characteristics and the impact of surgical procedures on adhesion formation, the main focus of adhesion prophylaxis comprises surgical technique and barrier methods.

Recognizing that no prevention of adhesions is possible, most authors agree that their formation can be reduced with good surgical practice to minimize tissue trauma and diminished placement of foreign materials in the peritoneal cavity [14, 15, 49, 50, 52, 53]. It is understood, that good surgical technique comprises gentle tissue handling, meticulous hemostasis, excision of necrotic tissue, minimizing ischemia and desiccation, the use of fine, nonreactive suture materials and prevention of foreign body reaction and infection (Table 26.1) [14, 16, 49].

Table 26.1 Good surgical practice [14]

Gentle tissue handling
Meticulous hemostasis
Excision of necrotic tissue
Minimizing ischemia and desiccation
Use of fine, non-reactive sutures
Prevention of foreign body reaction
Prevention of infection

An experimental study by Kraemer et al. analyzed different surgical trauma and their impact on inducing peritoneal adhesions in rats [54]. Brushing of the parietal peritoneum and bipolar coagulation of the peritoneum were the least adhesiogenic trauma. Highest rates of adhesions were found after traumatizing with electrocoagulation of the peritoneum and defect closure with Vicryl sutures [54].

Surgical separation of wound sites, i.e., transient ovariopexy in surgical excision of severe endometriosis, is helpful in reducing adhesion formation and improving fertility outcomes [55, 56]. Interestingly, a recent systematic review and meta-analysis concludes however, that the two main adhesion-related outcomes, small bowel obstruction and infertility, are not reduced by less-invasive techniques or introducing less foreign bodies [57].

Reducing peritoneal adhesions is attempted by various strategies. Pharmacological, mechanical and other adhesion prevention strategies are summarized in Table 26.2.

In recent decades, the armamentarium of commercially available anti-adhesion products has increased. Generally, anti-adhesion agents aim to either reduce the inflammatory response after surgery or act as direct or indirect physical barrier on surgical sites. Reduction of inflammatory response, as example, might be achieved by Non-steroidal antirheumatics or steroids, physical barrier by modified hyaluronic acid or modified cellulose.

Surveys examining the awareness for intraabdominal adhesions in health care practitioners underline that there is uncertainty in the treatment and prophylactic strategies in dealing with adhesions [10, 19, 55].

The American Society for Reproductive Medicine concludes that FDA-approved surgical barriers have been demonstrated effective for reducing postoperative adhesions, but not having an impact on clinical symptoms [49]. The European field guideline for gynecological surgery states, that the implementation of good surgical practice, together with the adoption of adhesion-reduction agents, is paramount to reduce adhesion formation [12]. The Society of Gynecologists and Obstetricians Canada recommends that surgeons could consider using an adhesion barrier for patients who are at high risk of forming clinically significant adhesions [16].

A recent Cochrane review analyzed previous Cochrane reviews on adhesion prevention agents for gynaecological surgery and concludes that there is insufficient evidence to draw any conclusions about the effectiveness and safety of anti-adhesion agents in gynaecological surgery, due to the lack of data on pelvic pain, fertility outcomes, quality of life or safety [13].

Table 26.2 Different pharmacological, mechanical, and other adhesion prevention strategies [10, 56, 57]

Pharmacologic	Ileus prophylactics	*Exogenic tissue*
Anticoagulation	Plication of the intestines (Noble)	Amnotic membrane
Dicumarol	Plication of the mesentery	Fish bladder
Heparin	Intestinal catheter	Gel Photopolymerization
Hirudin	**Suface isolation**	Gore Tex
Oxalate	*Insufflation*	Rubber- and Plastic film
Citrate	Pneumoperitoneum	Bowine peritoneum
Fibrinolysis	*Instillation*	Polytetrafluoroethylene membrane
Actase	Agar	Silk
Chymotrysin	Albumin	Silver- and Gold films
Hyaluronidase	Amnotic fluid	Cellulose and Gelatine films
Calcium antagonists	Chymus	Oxygenized cellulose
Papain	Dextran	*Others*
Pepsin	Ironhyaluronidase gel Intergel	Allopurinol
Plasminogen activator	Electrolyt fluids	Aprotinin
Protoporphyrin	Gelatine	Chinese herbs
Streptokinase	Vitreous body fluid	Fibrin glue
Typsin	Gycot	Infrasound
Urokinase	Honey	Moor mud wrap
Reduction of fibrosis	Sodium Hyaluronate/ Carboxymethylcellulose	Peristaltics
Anti histaminics	Hydroxyethylstark	Progesterone
Cochicin	Lanoline	Prostacycline
Non steroidal antirheumatics	Olive oile	Superoxiddismutase
Steroids	Paraffine	Tetrachlorodecaoxide
Vitamin E	Phosphatdicholine	**Others**
Cytostatics	Polysiloxan	Ultrasound to stimulate motility
Antibiotics	Polyvinylpyrrolidon	Iron turnings to stimulate bowel motility by external magnets
Antiseptics	Silicone	
Procinetics	Vaseline	
Cisapride	*Autolouge tissue*	
Neostigmine	Bladder	
	Omentum	
	Peritoneum	
	Mesenchymal stem cells	

Conclusion

Intraabdominal adhesions are the most common complication of abdominopelvic surgery. Surgeons' awareness is crucial and should include an adequate preoperative patient counsel. Apart from good surgical practice and continuous education on new surgical strategies to reduce adhesions, results of anti-adhesion products in randomized trials are difficult to obtain and interpretation may be influenced by various factors. It is understood, that not the number of adhesions within the abdomen but rather the clinical impact of adhesions on the patients well-being plays the important role. Though the scientific results of adhesion reduction are promising, the regular use of these agents in clinical practice is mostly uncommon and health care providers mostly do not refund the cost of anti-adhesion products adequately.

Strategies to identify adhesions with clinical impact and classifications of adhesions at the beginning and the end of surgery could eventually help to generate more robust data to define useful adhesion reduction strategies with and without agents.

References

1. Van Der Krabben AA, Dijkstra FR, Nieuwenhuijzen M, et al. Morbidity and mortality of inadvertent enterotomy during adhesiotomy. Br J Surg. 2000;87:467–71.
2. Ellis H, Moran BJ, Thompson JN, et al. Adhesion-related readmissions after abdominal pelvic surgery: a retrospective cohort study. Lancet. 1999;353:1476–80.
3. Mavros MN, Velmahos GC, Lee J, et al. Morbidity related to concomitant adhesions in abdominal surgery. J Surg Res. 2014;192:286–92.

4. GS dZ. Contemporary adhesion prevention. Fertil Steril. 1994;61: 219–35.
5. Menzies D, Ellis H. Intestinal obstruction from adhesions: How big is the problem? Ann R Coll Surg Engl. 1990;72:60–3.
6. Operative Laparoscopy Study Group. Postoperative adhesion development after operative laparoscopy: evaluation at early second-look procedures. Fertil Steril. 1991;55:700–4.
7. Monk BJ, Berman ML, Monitz FJ. Adhesions after extensive gynecologic surgery: clinical significance, etiology and prevention. Am J Obstet Gynecol. 1994;170:1396–403.
8. Dembowski T. Über die Ursachen der peritonealen Adhäsionen nach chirurgischen Eingriffen mit Rücksicht auf die Frage des Ileus nach Laparotomien. Langenbecks Arch Chir. 1889;37:745.
9. Uhlmann C. Ueber das Auftreten peritonealer Adhäsionen nach Laparotomien, mit besonderer Berücksichtigung des Verhaätnisses zwischen trockener und feuchter Asepsis. Arch Gynecol Obstet. 1897;54:384–411.
10. Grund D. Neue Möglichkeiten zur Reduzierung von postoperativen Adhäsionen. Eine vergleichende tierexperimentelle Studie mit abriebarmen Bauchtüchern und Perfluorcarvon PF 5080. 2004, Promotion Charite – Universitätsmedizin Berlin.
11. Durron JJ. Postoperative intraperitoneal adhesion pathophysiology. Colorectal Dis. 2007;9(Suppl 2):14–24.
12. DeWilde RL, Brölmann H, Koninckx PR, The Anti-Adhesions in Gynecology Expert Panel (ANGEL), et al. Prevention of adhesions in gynaecological surgery: the 2012 European field guideline. Gynecol Surg. 2012;9:365–8.
13. Hindocha A, Beere L, Dias S, et al. Adhesion prevention agents for gynaecological surgery: an overview of Cochrane reviews. Cochrane Database Syst Rev. 2015;1:CD011254.
14. Brüggmann D, Tchartchian G, Wallwiener M, Münstedt K, Tinneberg H-R, Hackethal A. Intra-abdominal adhesions: definition, origin, significance in surgical practice, and treatment options. Dtsch Arztebl Int. 2010;107:769–75.
15. Liakakos T, Thomakos N, Fine PM, Dervenis C, Young RL. Peritoneal adhesions: etiology, pathophysiology, and clinical significance. Dig Surg. 2001;18:260–73.
16. Robertson D, Lefebvre G, Leyland N, et al. Adhesion prevention in gynaecological surgery. J Obstet Gynaecol Can. 2010;32:598–608.
17. Levrant SG, Bieber EJ, Barnes RB. Anterior abdominal wall adhesions after laparotomy or laparoscopy. J Am Assoc Gynecol Laparosc. 1997;4:353–6.
18. Sepilian V, Ku L, Wong H, et al. Prevalence of intraabdominal ahdesions in women with previous laparoscopy. JSLS. 2007;11:| 41–4.
19. Hackethal A, Sick C, Brueggmann D, et al. Awareness and perception of intraabdominal adhesions and related consequences. Survey of gynaecologists in German hospitals. Eur J Obstet Gynecol Reprod Biol. 2010;150:180–9.
20. Trew G, Cooke I, Lower A, McVeigh E. Post-operative abdominal adhesions – awareness of UK gynaecologists – a survey of members of the Royal College of Obstetricians and Gynaecologists. Gynecol Surg. 2009;6:25–37.
21. Wallwiener M, Koninckx PR, Hackethal A, for The Anti-Adhesions in Gynecology Expert Panel (ANGEL), et al. A European survey on awareness of post-surgical adhesions among gynaecological surgeons. Gynecol Surg. 2014;11:105–12.
22. Lower AM, Hawthorn RJ, Ellis H, et al. The impact of adhesions on hospital readmissions over ten years after 8849 open gynaecological operations: an assessment from the Surgical and Clinical Adhesions Research Study. BJOG. 2000;107:855–62.
23. Al-Sunaidi M, Tulandi T. Adhesion-related bowel obstruction after hysterectomy for benign conditions. Obstet Gynecol. 2006;108: 1162–6.
24. Muffly TM, Ridgeway B, Abbott S, et al. Small bowel obstruction after hysterectomy to treat benign disease. J Minim Invasive Gynecol. 2012;19:615–9.
25. Zia S, Rafique M. Intra-operative domplications increase with successive number of cesarean sections: myth or fact? Obstet Gynecol Sci. 2014;57:187–92.
26. Özcan S, Karayalcin R, Kanat PM. Multiple repeat cesarean delivery is associated with increase maternal morbidity irrespective of placenta accreta. Eur Rev Med Pharmacol Sci. 2015;19:1959–63.
27. Bamigboye AA, Hofmeyr GJ. Closure versus non-closure of the peritoneum at caesarean section: short- and long-term outcomes. Cochrane Database Syst Rev. 2014;8:CD000163.
28. Aziz. Laparoscopic evaluation of female factors in infertility. J Coll Physicians Surg Pak. 2010;20:649–52.
29. Luijendijk RW, de Lange DC, Wauters CC, et al. Foreign material in postoperative adhesions. Ann Surg. 1996;223:242–8.
30. Duffy DM, GS dZ. Adhesion controversies: pelvic pain as a cause of adhesions, crystalloids in preventing them. J Reprod Med. 1996;41:19–26.
31. Demco L. Pain mapping of adhesions. J Am Assoc Gynecol Laparosc. 2004;11:181–3.
32. Zinther NB, Fedder J, Friis-Andersen H. Noninvasive detection and mapping of intraabdominal adhesions: a review of the current literature. Surg Endosc. 2010;24:2681–6.
33. Seow KM, Lin YH, Hsieh BC, et al. Transvaginal three-dimensional ultrasonography combined with serum CA 125 level for the diagnosis of pelvic adhesions before laparoscopic surgery. J Am Assoc Gynecol Laparosc. 2003;10:320–6.
34. Reid S, Lu C, Hardy N, et al. Office gel sonovaginography for the prediction of posterior deep infiltrating endometriosis: a multicenter prospective observational study. Ultrasound Obstet Gynecol. 2014;44:710–8.
35. Kikuchi I, Kuwatsuru R, Yamazaki K, et al. Evaluation of the usefulness of the MRI jelly method for diagnosing complete cul-de-sac obliteration. Biomed Res Int. 2014;2014 Article ID 437962, 7 pages
36. Rajab TK, Wallwiener M, Talukdar S, Kraemer B. Adhesion-related complications are common, but rarely discussed in preoperative consent: a multicenter study. World J Surg. 2009;33:748–50.
37. Meuleman T, Schreinemacher MH, van Goor H. Adhesion awareness: a nationwide survey of gynaecologists. Eur J Obstet Gynecol Reprod Biol. 2013;169:353–9.
38. Schreinemacher MH, ten Broek RP, Bakkum EA, et al. Adhesion awareness: a national survey of surgeons. World J Surg. 2010;34: 2805–12.
39. Hirschelmann A, Wallwiender CW, Wallwiender M, et al. Is patient education about adhesions a requirement in abdominopelvic surgery? Geburtshilfe Frauenheilkd. 2012;72:299–304.
40. Granata M, Tsimpanakos I, Moeity F, Magos A. Are we underutilizing Palmer's point entry in gynecologic laparoscopy? Fertil Steril. 2010;94:2716–9.
41. Aust TR, Salma IK, Rowlands DJ. Direct optical entry through Palmer's point: a new technique for those at risk of entry-related trauma at laparoscopy. General Surg. 2009;7:315–7.
42. Tinelli A, Malvasi A, Guido M, et al. Laparoscopy entry in patients with previous abdominal and pelvic surgery. Surg Innov. 2011;18: 201–5.
43. Diamond MP, Daniell JF, Feste J, et al. Adhesion reformation and de novo adhesion formation after reproductive pelvic surgery. Fertil Steril. 1987;47:864–6.
44. Diamond MP, Freeman ML. Clinical implications of postsurgical adhesions. Hum Reprod Update. 2001;7:567–76.
45. Swank DJ, Swank-Bordewijk SC, Hop WC, et al. Laparoscopic adhesiolysis in patients with chronic abdominal pain: a blinded randomised controlled multi- centre trial. Lancet. 2003;361:1247–51.
46. YC C, Reading I, Bailey S, Sadek K, Ledger W, TC L. Should women with chronic pelvic pain have adhesiolysis? BMC Womens Health. 2014;14:36.
47. Schietroma M, Carlei F, Altilia F, et al. The role of laparoscopic adhesiolysis in chronic abdominal pain. Minerva Chir. 2001;56:461–5.

48. Tulandi T, Collins JA, Burrows E, et al. Treatment-dependent and treatment- independent pregnancy among women with periadnexal adhesions. Am J Obstet Gynecol. 1990;162:354–7.
49. Practice Committee of American Society for Reproductive Medicine with Society of Reproductive Surgeons. Pathogenesis, consequences, and control of peritoneal adhesions in gynecologic surgery: a committee opinion. Fertil Steril. 2013;99:1550–5.
50. DeWilde RL, Bakkum EA, Brölmann H, et al. Consensus recommendations on adhesions (version 2014) for the ESGE Adhesions Research Working Group (European Society for Gynecological Endoscopy): an expert opinion. Arch Gynecol Obstet. 2014;290: 581–2.
51. DeWilde RL, Trew G, on behalf of the Expert Adhesions Working Party of the European Society of Gynaecological Endoscopy (ESGE). Postoperative abdom- inal adhesions and their prevention in gynaecological surgery. Expert consen- sus position. Gynecol Surg. 2007;4:161–8.
52. Brochhausen C, Schmitt VH, Planck CN, et al. Current strategies and future perspectives for intraperitoneal adhesion prevention. J Gastrointest Surg. 2012;16:1256–74.
53. Hellebrekers BW, Kooistra T. Pathogenesis of postoperative adhesion formation. Br J Surg. 2011;98:1503–16.
54. Kraemer B, Wallwiener C, Rajab TK, et al. Standardised models for inducing experimental peritoneal adhesions in female rats. Biomed Res Int. 2014;2014:435056. doi:10.1155/2014/435056. Epub 2014 Apr 8
55. Carbonnel M et al. Efficacy of transient abdominal ovariopexy in patients with severe endometriosis. Euro J Obstet Gyneco Reprod Biol. 2011;155:183–7.
56. Ouahba J, Madelenat P, Poncelet C. Transient abdominal ovariopexy for adhesion prevention in patients who underwent surgery for severe pelvic endometriosis. Fertil Steril. 2004;82: 1407–11.
57. Ten Broek RP, Issa Y, van Santbrink EJ, et al. Burden of adhesions in abdominal and pelvic surgery: systematic review and meta-analysis. BMJ. 2013;347:f5588.
58. Hackethal A, Sick C, Szalay G, et al. Intra-abdominal adhesion formation: does surgical approach matter? Questionnaire survey of South Asian surgeons and literature review. J Obstet Gynaecol Res. 2011;37:1382–90.
59. Risberg B. Adhesions: preventive strategies. Eur J Surg Suppl. 1997;577:32–9.
60. Treutner KH, Schumpelick V. Adhäsionsprophylaxe. Wunsch und Wirklichkeit Chirurg. 2000;71:510–7.

Comorbidities

27

Ralf Rothmund

Clinical Comorbidity

It can generally be said that a laparoscopic or vaginal approach should be chosen where possible in the presence of serious concomitant disorders, since the intraoperative and postoperative stresses especially are relatively minor compared to those of open surgery. Convalescence usually proves to be correspondingly quick and straightforward.

The duration of surgery, as well as the intra- and postoperative complication rates, increase in obese patients compared to groups of patients of normal weight [1, 2]. The duration of surgery increases further in cases of extreme obesity, as does the risk of severe complications. It is these patients who particularly benefit from a laparoscopic approach [3] when a vaginal hysterectomy is not technically feasible [4, 5].

The technique of the surgical intervention itself remains unchanged in patients with severe obesity; however, the placement of the first trocar is extremely important in these patients. The risk of preperitoneal insufflation is higher in obese patients especially if a Veress-needle is used for insufflation. Therefore, the use of a trocar that enables the insertion of the optic device before CO_2 insufflation is recommended (see Table 27.1). While the surgical technique of hysterectomy in patients with obesity unchanged remains compared to normal weight patients, the surgeon is often constrained to operate with a reduced insufflational pressure and consequently a limited view of the neighbouring structures. In patients with severe obesity the combination of Trendelenburg-positioning and high intraabdominal pressure leads to a higher ventilation pressure. The surgeon is thus forced to work with lower intrabdominal pressure (10–12 mmHg) in order to enable a sufficient ventilation pressure (see Table 27.1). If the respiratory capacity of the patient is further limited by additional factors (e.g. COPD) a laparoscopic approach becomes impossible in some cases [6]. Hence, a COPD might become a limiting factor for the laparoscopic hysterectomy if sufficient intraoperative ventilation is not possible. In contrast, the presence of hypertension, a diagnose that often confounds with obesity, is managed perioperatively by the anaesthesiologist and has no direct implications for laparoscopic hysterectomy (see Table 27.1).

Obesity and diabetes are important risk factors for the development of postoperative infections and sepsis after abdominal hysterectomy. However, the risk of developing postoperative infection or sepsis after a laparoscopic hysterectomy is not increased for obese patients compared to patients of normal weight [7–10].

Table 27.1 Appropriate risk and management

Risk Factor	Intraoperative management	Postoperative management
Obesity	Adaption of the entrance technique (e.g. go without Veress-needle) Lower insufflational pressure	Venous thromboembolism prophylaxis
Chronic obstructive pulmonary disease	Lower insufflational pressure	Monitoring of the lung function
Hypertension	Regulation of blood pressure	Regulation of blood pressure
Diabetes	Monitoring of blood sugar	Monitoring of blood sugar Possible antibiotic prophylaxis in case of coexisting obesity
Deep infiltrating endometriosis	Adaption of preparation technique (e.g. retroperitoneal entrance in analogy to radical hysterectomy; nerve sparing technique) Surgery in dedicated centres	Monitoring of bladder and bowel function

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In several studies, obesity was associated with a longer duration of surgery; however the intra- and postoperative complication rates were not increased [11–15].

Thromboembolism occurs less commonly after laparoscopic hysterectomy than after abdominal hysterectomy. It can therefore be concluded that a laparoscopic approach should be chosen where possible if there are risk factors for the development of thromboembolism, naturally in accordance with thromboprophylaxis guidelines [16].

Comorbidities such as obesity, smoking and diabetes do not increase the risk of vaginal cuff dehiscence [17].

Coexistence of Deep Infiltrating Endometriosis or Frozen Pelvis
(See Figs. 27.1, 27.2 and 27.3)

Vaginal cuff dehiscence occurs more commonly where there is coexisting deep infiltrating endometriosis [18]. The presence of deep infiltrating endometriosis, especially in the retrovaginal fascia or the parametrial area, makes laparoscopic hysterectomy considerably more difficult. It is then necessary to adapt surgical dissection along the lines of a radical hysterectomy (see Table 27.1). Careful dissection of the ureters and distancing of the rectum from the posterior vaginal wall to avoid injury to the ureters or minimise the risk of fistula development between the rectum and vagina are particularly important in these cases. These procedures, with their significantly increased level of complexity, should only be performed in suitably qualified centres wherever possible.

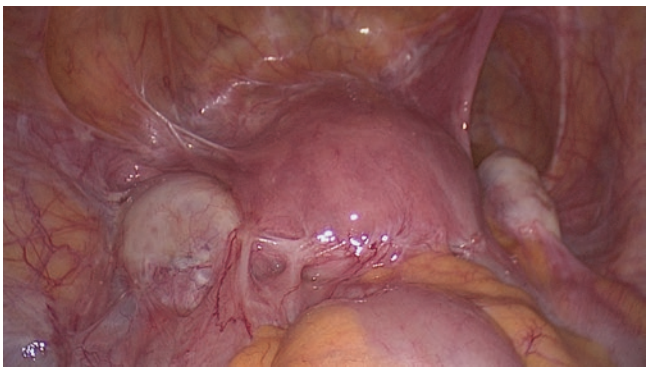


Fig. 27.1 Patient with frozen pelvis and deep infiltrating endometriosis in the rectovaginal fascia with severe dysmenorrhoea undergoing TLH

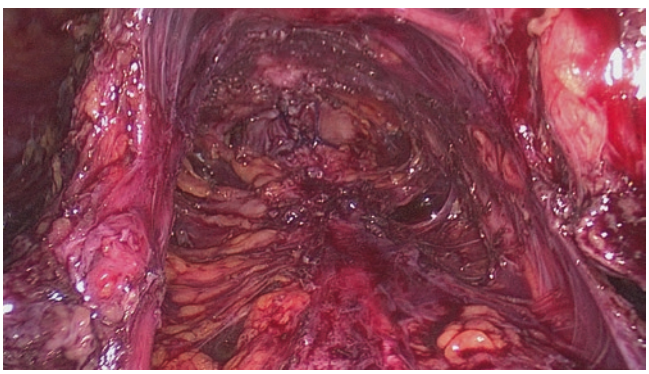


Fig. 27.2 Surgical dissection and excision of the endometriosis in the rectovaginal fascia before displacement of the uterus

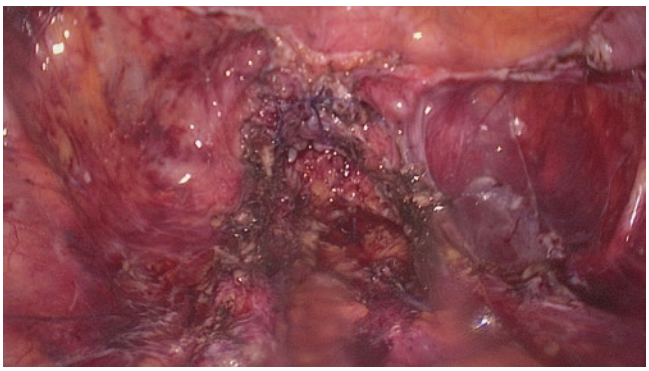


Fig. 27.3 End result: Rectum clearly distanced from the vaginal cuff to avoid fistula development

References

1. Morgan-Ortiz F, Soto-Pineda JM, López-Zepeda MA, Peraza-Garay FJ. Effect of body mass index on clinical outcomes of patients undergoing total laparoscopic hysterectomy. Int J Gynaecol Obstet. 2013;120(1):61–4.
2. McMahon MD, Scott DM, Saks E, Tower A, Raker CA, Matteson KA. Impact of obesity on outcomes of hysterectomy. J Minim Invasive Gynecol. 2014;21(2):259–65.
3. Siedhoff MT, Carey ET, Findley AD, Riggins LE, Garrett JM, Steege JF. Effect of extreme obesity on outcomes in laparoscopic hysterectomy. J Minim Invasive Gynecol. 2012;19(6):701–7.
4. Matthews KJ, Brock E, Cohen SA, Chelmow D. Hysterectomy in obese patients: special considerations. Clin Obstet Gynecol. 2014;57(1):106–14.
5. Committee on Gynecologic Practice. Committee opinion no. 619: gynecologic surgery in the obese woman. Obstet Gynecol. 2015; 125(1):274–8.
6. Afors K, Centini G, Murtada R, Castellano J, Meza C, Wattiez A. Obesity in laparoscopic surgery. Best Pract Res Clin Obstet Gynaecol. 2015;29(4):554–64.
7. Mahdi H, Goodrich S, Lockhart D, DeBernardo R, Moslemi-Kebria M. Predictors of surgical site infection in women undergoing hysterectomy for benign gynecologic disease: a multicenter analysis using the national surgical quality improvement program data. J Minim Invasive Gynecol. 2014;21(5):901–9.
8. Mikhail E, Miladinovic B, Finan M. The relationship between obesity and trends of the routes of hysterectomy for benign indications. Obstet Gynecol. 2014;123(Suppl 1):126S.
9. Mikhail E, Scott L, Imudia AN, Hart S. Total laparoscopic hysterectomy in the obese patient. Surg Technol Int. 2014;25:167–74.
10. Shah DK, Vitonis AF, Missmer SA. Association of body mass index and morbidity after abdominal, vaginal, and laparoscopic hysterectomy. Obstet Gynecol. 2015;125(3):589–98.

11. Hanwright PJ, Mioton LM, Thomassee MS, Bilimoria KY, Van Arsdale J, Brill E, Kim JY. Risk profiles and outcomes of total laparoscopic hysterectomy compared with laparoscopically assisted vaginalhysterectomy. Obstet Gynecol. 2013;121(4):781–7.
12. Kondo W, Bourdel N, Marengo F, Botchorishvili R, Pouly JL, Jardon K, Rabischong B, Mage G, Canis M. What's the impact of the obesity on the safety of laparoscopic hysterectomy techniques? J Laparoendosc Adv Surg Tech A. 2012;22(10):949–53.
13. Mueller A, Thiel F, Lermann J, Oppelt P, Beckmann MW, Renner SP. Feasibility and safety of total laparoscopic hysterectomy (TLH) using the Hohl instrument in nonobese and obesewomen. J Obstet Gynaecol Res. 2010;36(1):159–64.
14. Guraslan H, Senturk MB, Dogan K, Guraslan B, Babaoglu B, L. Y. Total Laparoscopic Hysterectomy in Obese and Morbidly Obese Women. Gynecol Obstet Invest. 2015;79(3):184–8. [Epub ahead of print]
15. Wallwiener M, Taran FA, Rothmund R, Kasperkowiak A, Auwärter G, Ganz A, Kraemer B, Abele H, Schönfisch B, Isaacson KB, et al. Laparoscopic supracervical hysterectomy (LSH) versus total laparoscopic hysterectomy (TLH): an implementation study in 1,952 patients with an analysis of risk factors for conversion to laparotomy and complications, and of procedure-specific re-operations. Arch Gynecol Obstet. 2013;288(6):1329–39.
16. Barber EL, Neubauer NL, Gossett DR. Risk of venous thromboembolism in abdominal versus minimally invasive hysterectomy for benign conditions. Am J Obstet Gynecol. 2014;212(5):609.e1–7. pii: S0002-9378(14)02407-7
17. Leggieri C, Bertin M, Dalla Toffola A, Fagherazzi S, Vitagliano A, Conte L. Laparoscopic hysterectomy: really so risky to a vaginal cuff dehiscence? Clin Exp Obstet Gynecol. 2014;41(3):300–3.
18. Patzkowsky KE, As-Sanie S, Smorgick N, Song AH, Advincula AP. Perioperative outcomes of robotic versus laparoscopic hysterectomy for benign disease. JSLS. 2013;17(1):100–6.

General Surgery Conditions and Techniques for Gyne-Endoscopic Surgeons

28

John E. Morrison

Abdominal and Pelvic Wall: Hernias

The abdominal wall from the umbilicus superiorly to the symphysis pubis inferiorly and laterally to the iliac crests is an area that can be the site of abnormalities that are encountered either upon entering the abdominal cavity or be identified during the performance of laparoscopic procedures. The different techniques used to enter the abdomen are not within the scope of this chapter, but some of these abnormalities when encountered in the abdominal wall may make safe access a challenge.

The most commonly performed surgical procedure by general surgeons is hernia repair. Approximately 800,000 inguinal hernia repairs and over 200,000 incisional hernia repairs are performed yearly in the US. Primary hernias occur most commonly in the anterior abdominal wall either at the umbilicus or in the inguinal canal. They also may be present lateral to the rectus sheath at the linea semicircularis, the Spigelian Hernia however this is an uncommon type of defect.

The diagnosis of small incisional or inguinal hernias may be difficult preoperatively particularly if the patient is obese or the defect is small, and their presence may not be certain until insufflation is achieved.

Large hernias on the other hand are usually diagnosed preoperatively through a thorough physical exam, or by preoperative imaging, however in the morbidly obese patients this can be a difficult task. When an incisional hernia is suspected, CT scan of the abdomen and pelvis without contrast is the most sensitive imaging exam for hernia defects and is routinely performed to assess the size and number of defects in order to better plan operative repair and safe access into the abdomen.

The treatment of hernias differs depending on the symptoms, location, size and etiology so their diagnosis, location and size are crucial to planning appropriate care.

Umbilical Hernias

Primary umbilical hernias are usually diagnosed preoperatively and may be symptomatic particularly when small. If abdominal entry is planned through the umbilicus, an open (Hasson) technique is preferred because the fascial defect is already present and can be easily closed when exiting the abdominal cavity. Direct entry through the umbilicus when a hernia defect is present can be a very dangerous task, as omentum or bowel can easily be included in the hernia defect and as such can be injured with the Veress needle or visual port entry device. It is not uncommon for adhesions to form at the hernia site even without prior surgery so caution is advised. See Fig. 28.1.

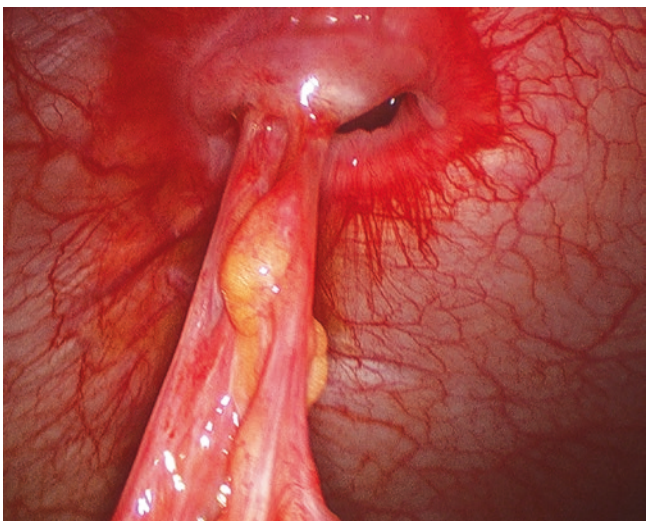


Fig. 28.1 Primary umbilical hernia with adhesions in a patient that has not had previous surgery

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Defects 2 cm or less in diameter are closed primarily with permanent suture and do not require mesh reinforcement. The suture chosen is usually a permanent material, polypropylene, or polyester, size 0, and the fascial edges approximated using simple or mattress suture techniques.

If the patient has had an umbilical hernia repaired previously and it is recurrent, then the defect is usually closed utilizing a reinforcing synthetic mesh material. There are several devices available which are designed specifically for these repairs. One such design is C-QUR V-Patch manufactured by Atrium corp. (Fig. 28.2) which is a circular polypropylene mesh coated with omega 3 fatty acid and is placed in the defect then sutured lateral to the fascial edges making certain that the mesh extends at least 3 cm from the fascial edge in all directions. The defect is then closed primarily over the reinforcing mesh.

Any mesh placed intrabdominally should have a barrier substance on the surface of the mesh coming in contact with the underlying bowel in order to reduce adhesions to these structures. Several products exist that have absorbable material incorporated onto the mesh to provide this barrier. If the reinforcing mesh is placed extraperitoneally then barrier material is not necessary.

Tips

Primary umbilical hernias 2 cm or less, close primarily with permanent suture.



Fig. 28.2 Circular polypropylene mesh with barrier coating manufactured by Atrium Corp

Recurrent umbilical hernias or larger than 2 cm: repair with mesh reinforcement.

Mesh should extend at least 3–5 cm from the fascial edge.

Entry into abdomen through umbilical hernia: open technique is safest.

Incisional Hernias

Patients that have had any prior abdominal surgery are potential candidates for incisional hernias. There are approximately 250,000 incisional hernia repairs performed in the US yearly [1]. If the patient is found to have an incisional hernia, then the surgeon can usually anticipate more than one defect being present in the incision. The majority of incisional hernia defects are asymptomatic when they are small <1 cm Defects between 2 cm and 6 cm usually are symptomatic, and are repaired using a reinforcing synthetic material when they are encountered. There is no difference in treatment of incisional hernias with regards to their location in the abdominal wall whether above or below the umbilicus.

Large defects in the fascia are most often identified on physical exam but the most sensitive method again for diagnosis and measurement of the defect is a CT scan of the abdomen and pelvis.

Primary repair of incisional hernias without reinforcement of mesh has an unacceptably high recurrence rate [2]. The choices for reinforcement material are either synthetic or biologic. There are certain conditions where the biologic grafts have distinct advantages over synthetic materials but discussion of this topic is out of the scope of this chapter.

Most 2–8 cm incisional hernia defects currently are repaired using the laparoscopic approach. The repair most commonly utilized is referred to as a "bridge" repair where the defect is covered by mesh and the fascial edges are not reapproximated. The fascial defect may be primarily approximated and then covered with mesh but this technique is used less commonly. In both instances a reinforcing material is used.

When an incisional hernia defect is encountered during an "open" procedure, the fascia is closed primarily with suture, either permanent or long lasting absorbable suture, with synthetic mesh reinforcement. The synthetic mesh can be placed either (1) under the abdominal wall on the peritoneal surface in which instance the material should have an adhesive barrier, or (2) Between the posterior rectus fascia and anterior rectus muscle and fascia (retro rectus) or (3) as an onlay where the mesh is simply anchored to the abdominal wall covering the reapproximated midline incision and extending laterally at least 5–8 cm from the midline. The onlay method is the easiest and safest approach. See Fig. 28.3.

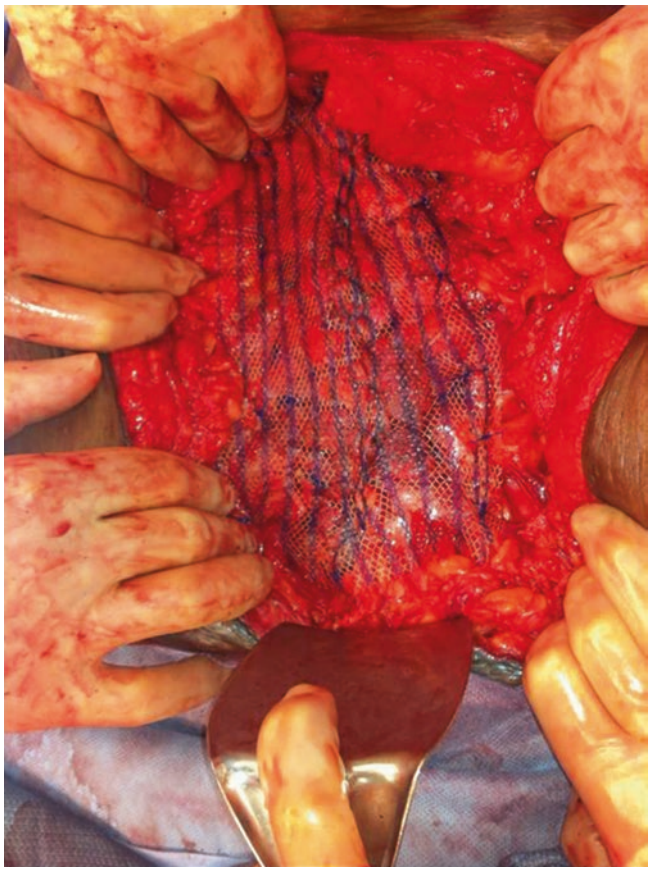


Fig. 28.3 Light weight polypropylene mesh lying over fascial closure

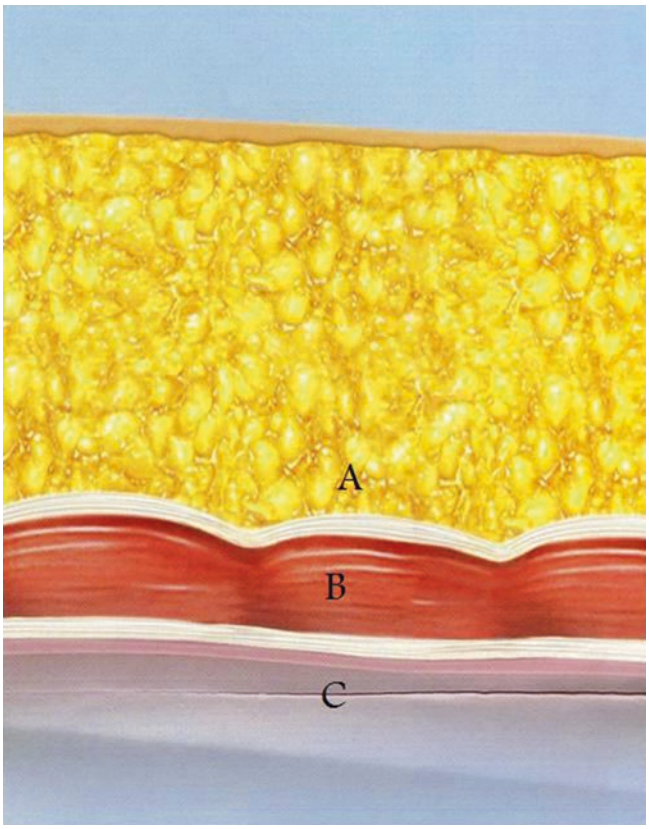


Fig. 28.4 Diagram of abdominal wall: (**A**) area where onlay graft is placed (**B**) area where retrorectus mesh placement occurs (**C**) area where underlay mesh placed and laparoscopic mesh placed

Figure 28.4 demonstrates commonly used sites for mesh placement. A: is where an onlay graft is placed. B: is where an inlay graft is placed. It usually lies between the fascia and muscle layers of the abdominal wall. C: is an underlay. Site C is the site where placement of laparoscopic mesh is usually performed.

Synthetic Materials Used for Repair

The materials used in these repairs must have certain properties:

First: the material must have the strength to tolerate pressures that are generated in the abdominal and pelvic cavity.

There are several studies currently ongoing that are addressing the most accurate way of determining the actual pressures generated in the abdominal and pelvic cavities and thus what strength characteristics the synthetic material must have in order to maintain an adequate repair. Over the past several years the density and structure of the synthetic mesh material used has undergone significant change. The main change is one of thinner, lighter weight materials with large pore structure for flexibility and easy incorporation into the abdominal wall tissues.

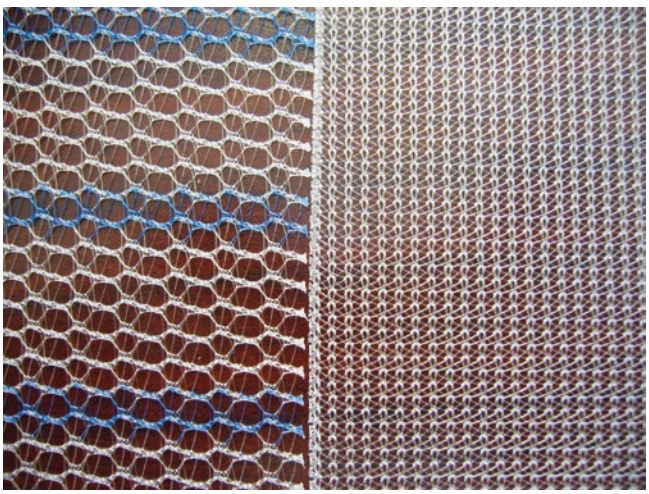


Fig. 28.5 Lightweight polypropylene mesh on left. Medium weight polypropylene mesh on right

Figure 28.5 demonstrates the two most commonly used polypropylene mesh types. The mesh on the left is a light weight mesh and the material on the right of the figure is a medium weight material. The differences are a combination of pore size and weight of the material used. The trend now

is to utilize lighter weight materials however in large incisional hernia repairs tearing of this lightweight mesh is being seen with more frequency and there may be a return to using medium or heavier weight materials.

Second characteristic is that the material must adhere securely to the abdominal wall. The material is anchored either with suture or tacking devices or a combination of the two. The anchoring devices assist in preventing slippage of the material while it is being incorporated onto the abdominal wall. Depending on the physical properties of the material used, the mesh elicits a reaction that results in scar formation around the material that also assists in incorporation of the material into the abdominal wall and adding to the strength of the repair.

Third characteristic and one of the most important characteristics is that the material must possess a property that reduces adherence to the bowel and any underlying structures. The mesh must have secured onto it a barrier device that helps reduce adherence to the underlying bowel if it is placed intraperitoneally. Synthetic mesh placed into the abdominal cavity without any barrier carries a risk of erosion into the bowel or any other structure it comes in contact with and thus fistula formation. If this does occur then the synthetic mesh must be removed and the fistula closed. Replacement of the mesh by synthetic materials in this situation is not recommended and a biologic material is usually needed.

Fourth characterisitc is that the material should elicit a minimal inflammatory or immunologic response. Research is ongoing in this area and materials are constantly being tested and refined to reduce this reaction.



Fig. 28.6 Polypropylene mesh with barrier incorporated onto mesh for intraabdominal placement



Fig. 28.7 Microporous PTFE mesh for intraabdominal repair

Materials for Repair

The most frequently utilized synthetic material in hernia repairs is polypropylene mesh. Figure 28.6 is an example of a coated polypropylene mesh used for hernia repair when the mesh is placed intraabdominally.

Polypropylene has been used for decades and because surgeons have a long experience and great familiarity with it, it is the preferred mesh material. Because of the hydrophilic nature of the material it does result in the formation of a fibrous capsule which can become firm over time and a source for pain but with reduction of polypropylene mesh weight, this phenomenon is becoming less of a problem.

PTFE (polytetrafluorethylene) is another material utilized in hernia repair in the abdomen. It has properties of minimal adherence to surrounding tissues, and flexibility, but because of its propensity for nonadherance, other materials must be incorporated into the mesh in order to make it adhere to the anterior abdominal wall. Otherwise the material is not incorporated and the repair not secured. Figure 28.7 is an example of a PTFE mesh used for hernia repair.

The PTFE mesh is a micro porous material, so seroma formation above the mesh and below the overlying skin and subcutaneous tissue after bridge repair is not uncommon. These seromas usually are asymptomatic and over time resolve, however if they become infected or symptomatic they can be drained percutaneousely or if mature excised after adequate incorporation of the underlying mesh has occurred. Seroma formation is not uncommon after any bridge type repair regardless of the material used. See Fig. 28.8.

When PTFE material is used for repair if an overlying seroma or the material itself becomes infected, it must be removed. The pore size is such that bacteria are able to enter the mesh but neutrophils cannot so the resulting infection cannot be cleared without mesh removal.

All grafts contract over time, but PTFE grafts do contract the most when compared to other synthetic materials, so this characteristic must be taken into consideration when placing the material and ensuring adequate overlapping of the defect [3].

Polyester mesh is also utilized for hernia repair but less frequently. The material is a woven braided polyester fiber that incorporates into the surrounding tissues well. This material has been used for decades in the manufacture of vascular grafts, so its use has a long history in surgery and thus experience with this material is large. It is a hydrophilic material so

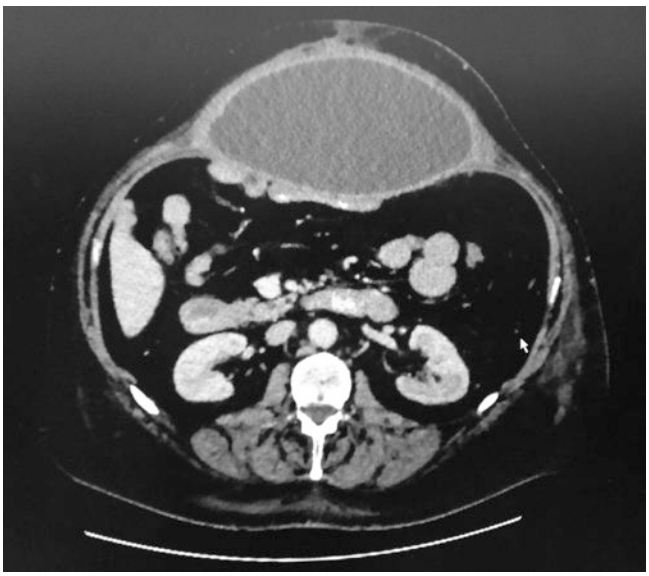


Fig. 28.8 Seroma over mesh under skin of abdominal wall

it does not elicit the intense fibrotic reaction that polypropylene does, but as with any braided material if it does become contaminated with bacteria or infected, it is difficult to clear of bacteria so it may require excision if this does occur.

When and How for Incisional Hernia Repairs?

Defects 2 cm or less may be repaired primarily with permanent suture material as in umbilical hernia repair.

Hernia defects >8 cm may require mobilization of anterior abdominal wall fascial layers with reinforcement by synthetic or biologic material in order to reapproximate the midline fascial edges and restore a dynamic abdominal wall.

To accomplish this there are a number of options which include relaxing incisions in the external oblique muscle bilaterally or in the posterior rectus fascia and transverse abdominal muscle layers in order to mobilize the fascia to get the midline fascial edges together. Discussion of this type of repair is out of the scope of this chapter and these large defects should be **referred** for definitive repair either before gynecologic procedures are performed or preferably repaired at the time of gynecologic surgery by a General Surgeon or Plastic Surgeon familiar with these type of repairs.

The treatment of choice for repair of incisional hernia defects from 2 cm to 6 cm currently is via laparoscopy and is usually performed at the end of other surgical procedures. The mesh should overlap the defect by at least 3 cm preferably up to 5 cm or more on all edges and be anchored to the abdominal wall. If during the primary operative procedure the bowel is entered, gross contamination with infected material is encountered or the vagina or bladder are entered, and an incisional hernia repair is considered, then the use of synthetic mesh is discouraged and biologic graft used in its place. Biologic grafts may be used in a bridge repair or as a reinforcing material to primary closure but there are no good studies to gauge its long-term success and these materials are very expensive.

Procedure for Repair of Incisional Hernia

All contents in the hernia defect must be reduced into the abdominal cavity and the surrounding fascial edges cleared of overlying tissue, bowel and fat in order to ensure adequate incorporation of mesh into the abdominal wall fascia. Figure 28.9 demonstrates a defect prepared for repair.

The material chosen for repair must have an adequate size in order to overlap all aspects of the defect by 5 cm or more and have a barrier for reduction of adhesions.

If the defect is large and a large piece of mesh is needed for coverage, sutures are placed at the four quadrants of the mesh; the sutures are retrieved through the abdominal wall to align the mesh adequately over the defect for final anchoring of the mesh. These sutures can be used to primarily anchor the mesh to the abdominal wall. Figures 28.10 and 28.11 demonstrate the mesh with anchoring sutures and retrieval of the sutures through the abdominal wall.

The mesh is then anchored to the abdominal wall with either suture, or tacking devices or a combination of the two. Particular attention is addressed to the edges of the mesh in order to ensure that adequate anchoring of the mesh has taken place and the possibility of bowel herniation between the mesh and abdominal wall tacks does not take place. Figure 28.12 demonstrates anchoring of the mesh with a permanent tacking device.

Abdominal binders are usually placed on the patient immediately postoperatively to give support to the abdominal wall and reduce pain. It is recommended that the patients wear such devices for 6 weeks or more after surgery.

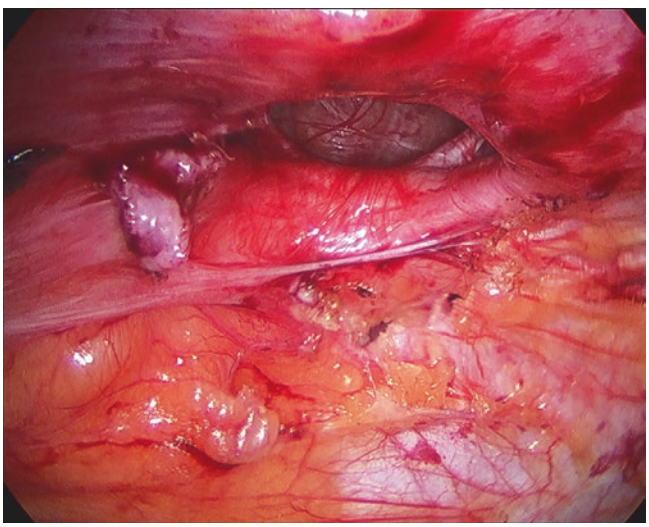


Fig. 28.9 Incisional hernia with adhesions, bowel and fat cleared for placement of mesh on fascia and peritoneum

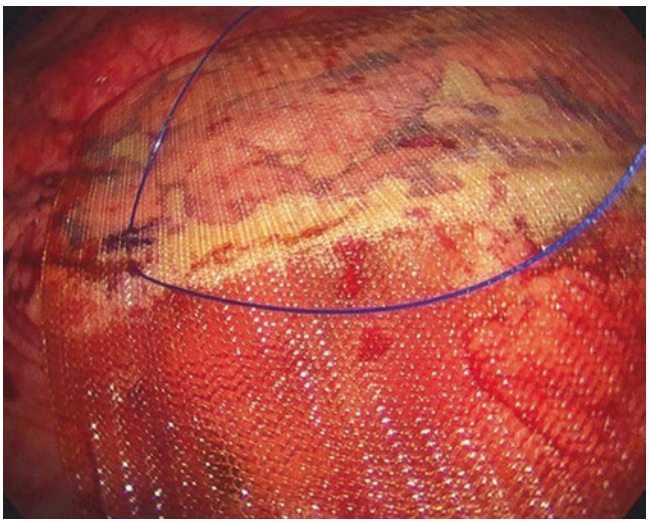


Fig. 28.10 Mesh intraabdominally with suture loop for placement

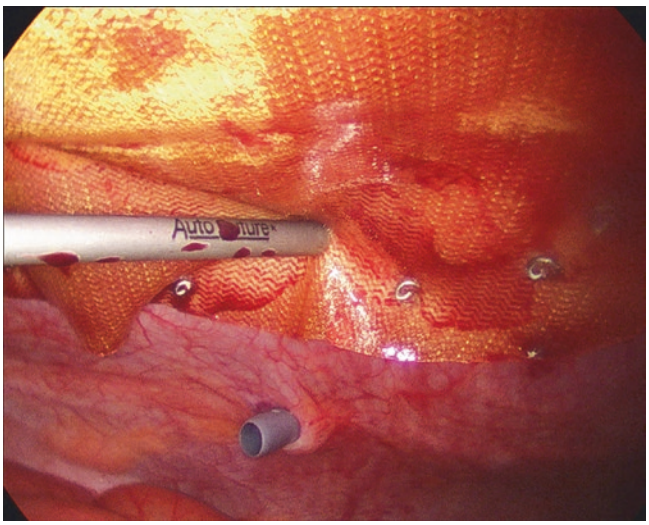


Fig. 28.12 Permanent tacking device securing mesh to fascia

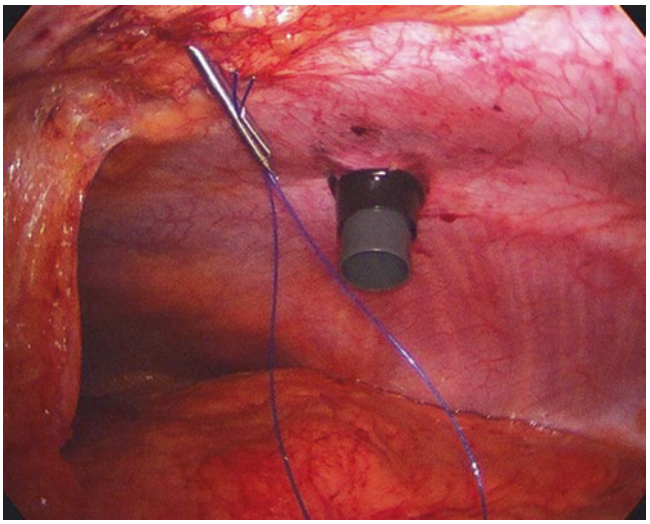


Fig. 28.11 Grasping suture loop to bring mesh under hernia defect for anchoring

Results with laparoscopic bridge repair of incisional hernias have been very good with comparable low recurrence rates when compared to open repair, but with higher major intraoperative complication rates when compared to open repair. Patients do return to normal activities sooner, have less pain and hospital stay is shorter [4].

Special Considerations After Hernia Repair

If a patient has had prior hernia repair utilizing mesh, then special consideration must be given for safe entry into the abdomen. Despite the application and incorporation of adhesive barriers into the mesh, or even if the mesh is completely covered by peritoneum, the presence of adherent bowel or omentum to the mesh and particularly to the edge of the mesh should be expected.

Entry into the abdominal cavity can be accomplished in these instances either by remote entry i.e. Palmer's Point in the left upper quadrant or other sites outside of the prior surgical field. Entry can also be accomplished through the mesh itself. If a laparoscopic procedure is planned, then open (Hasson) technique is recommended either directly through the mesh utilizing careful blunt dissection of adherent bowel and omentum away from the mesh as the abdominal cavity is entered or at a remote site lateral to the prior incision. Extreme care must be taken around the edges of the mesh as this is the area most involved with adhesion formation. Figure 28.13 demonstrates adhesions at the edge of a previously placed mesh.

Once the procedure is completed, upon closure of the incision if it was made through the mesh, the closure should be accomplished with permanent suture.

Repair of complex incisional wall hernia defects may involve the use of biologic grafts intraabdominally or with an onlay over the anterior fascia. The biologic materials used currently consist of an acellular matrix of collagen and come in a variety of substances. The matrix is infiltrated with fibroblasts over time and the hosts' native collagen incorporated into the matrix resulting in a thick scar. In complex hernia repairs, if a biologic graft is used internally, opening directly through the material is recommended with the same considerations and precautions being taken as recommended with opening through synthetic material for abdominal entry.

As discussed above, complex hernia repairs are being performed with primary closure and with combinations of onlay mesh, inlay (between the layers of the abdominal wall) and underlay mesh. It is strongly recommended that the surgeon obtain prior operative notes in order to be familiar with the repair performed so entry into the abdomen can be accomplished safely. A prior knowledge of where the mesh was placed helps makes this possible.

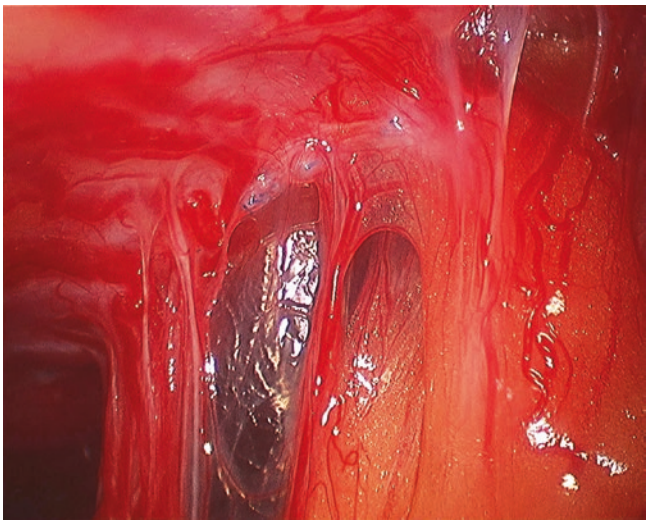


Fig. 28.13 Dense vascular adhesions seen at the lateral border of previously placed mesh

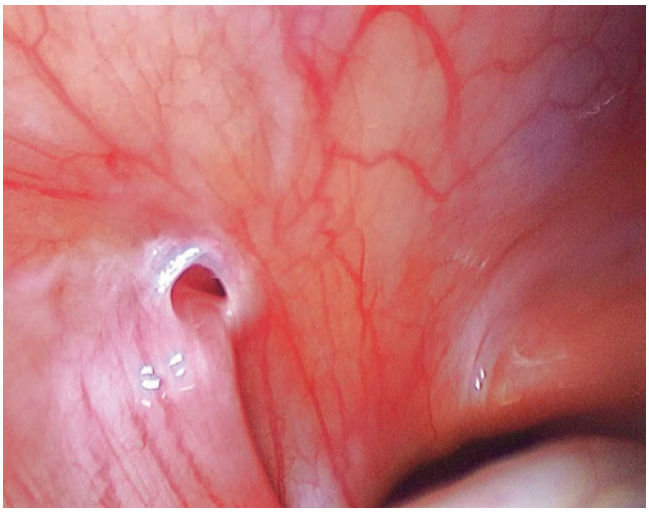


Fig. 28.14 Small indirect hernia on the left inguinal area with round ligament in defect

Tips

2 cm or less defects: close primarily with nonabsorbable suture.

2–8 cm defects: Laparoscopic bridge repair with synthetic material with adhesive barrier. Anchor to the abdominal wall with tacking device and overlap fascial edges 5 cm.

2–8 cm defects: Open repair, reapproximate the fascial edges and incorporate synthetic mesh reinforcement either intrabdominally, subfascial or overlay the midline closure.

Defects larger than 8 cm usually require a more complex repair for closure of the midline fascia and should be performed in conjunction with surgeons familiar with these repair techniques.

When entering the abdomen after prior incisional hernia repair with mesh, enter either through the center of the mesh with caution or at distant point and avoid the edges.

Know beforehand what type of repair was performed on the patient prior to entry to help anticipate when the mesh will be encountered in opening.

Inguinal Hernias

Inguinal hernia defects, when seen during laparoscopy are located in the pelvic side walls lateral to the obliterated umbilical veins. The two most common types of inguinal defects are direct and indirect hernias. Direct defects are medial to the inferior epigastric vessels and indirect defects are lateral to these vessels. The indirect defects can also be identified by the presence of the round ligament in or medial to the defect. Figure 28.14 is an example of a small asymptomatic indirect inguinal hernia and does not require repair.

Symptoms of inguinal hernia include: swelling or bulge in the inguinal floor usually superior to the inguinal ligament. It may or may not be associated with pain. Pain in the area of the inguinal ligament may be the only symptom or sign of a hernia. Inguinal hernias are more difficult to diagnose in females as compared to males. The dilemma is when the hernia is identified at the time of surgery what needs to be done?

Tip

If an inguinal defect is identified and the patient is asymptomatic i.e. the patient does not have inguinal pain, then the defect is noted, the patient is informed but repair is not necessary.

When a single symptomatic inguinal hernia defect is discovered, the choice of repair technique is controversial among surgeons. Patients with a single inguinal hernia are still most commonly repaired using standard open technique. In single surgeon series, the recurrence rate with laparoscopic repair is comparable to open repair and pain scores much better [5]. In large studies, results with laparoscopic repair show slightly higher recurrence rate, but pain scores and return to normal activity was better in the laparoscopic group versus open [6, 7].

Cost must be taken into consideration when choosing a repair, but when evaluated, there is little difference in operating room costs but there can be large differences in facility reimbursement [8].

The laparoscopic repair of inguinal hernias can be either performed entirely preperitoneal or transperitoneal. The principles of the repair and results are similar for both techniques. The anatomy of the inguinal canal and pelvic floor is constant, predictable and familiar to the gynecologic surgeon that performs anterior vaginal wall repairs or vesico-urethral neck suspensions such as Burch procedure. This is the same space routinely dissected and entered in a laparoscopic inguinal hernia repair (Video 28.1).

In either repair, the peritoneum is dissected from the lower pelvic and inguinal floor exposing the inguinal canal, iliac vessels, pubic tubercle, femoral canal and lateral inguinal side wall. It is important to completely reduce the hernia

contents into the preperitoneal space. Simply closing the peritoneal defect is inadequate for repair; the inguinal floor must be reinforced with synthetic materials.

The mesh dimensions should be 10 cm by 15 cm in order to adequately cover, the inguinal floor and all potential defects. If polypropylene mesh is used, then this material should be anchored to the inguinal floor. Care must be taken when anchoring the mesh to avoid the major vascular and neural structures that are in the dissection site as injury to these structures is possible.

Anchoring of mesh should only be performed medial to the inferior epigastric vessels on the anterior lower abdominal wall and into the symphysis pubis and Cooper's ligament. Tacking devices should not be utilized in the lateral pelvic side wall as the genitofemoral and ilioinguinal nerves are present and can be easily trapped causing significant postoperative pain.

If polyester mesh is used for repair, because of the hydrophilic nature of the material, the mesh adheres to the underlying tissues well and does not need to be tacked if the repair is performed in a preperitoneal fashion. Results with this type of repair are very good and as such problems with tacking are avoided. Figure 28.15 demonstrates coverage of the inguinal floor with mesh at the end of a repair.

Femoral hernias are more common in females than males and may be a source of chronic pelvic or lower abdominal pain.

Femoral hernia is difficult to diagnose preoperatively. Symptoms usually include pain radiating down the inner aspect of the thigh and or under the inguinal ligament with no palpable mass or bulge. Frequently the first sign that a femoral hernia is present is acute incarceration. The repair of femoral hernia defects can be accomplished either by open or laparoscopic techniques, but the laparoscopic approach affords excellent exposure and allows accurate placement of a single layer of mesh that adequately covers the femoral and inguinal canals creating a very good repair.

The contents of a femoral hernia must be carefully reduced into the preperitoneal space in order to adequately identify the femoral canal structures and complete the repair. Again, if polypropylene mesh is utilized it should be anchored to the pelvis taking precautions as noted previously to avoid major vascular or neural injuries (Video 28.2).

Special Considerations in Inguinal Hernias

Techniques for laparoscopic inguinal hernia repair have evolved over the past 15 years. In the 1990's plug type repair was common, where a mesh plug usually consisting of polypropylene material was simply placed into the defect. This type of repair resulted in significant pain at the repair site because of scarring and contraction of the material, and as a result, this procedure currently is rarely used. Patients that have had this type of repair may present with significant pain with no external palpable "mass" and removal of the mesh plug is usually required for relief. Figure 28.16 is an example of a plug type repair in a patient that presented with pain several years later.



Fig. 28.15 Mesh placed over inguinal floor encircling the round ligament and covering the hernia defect

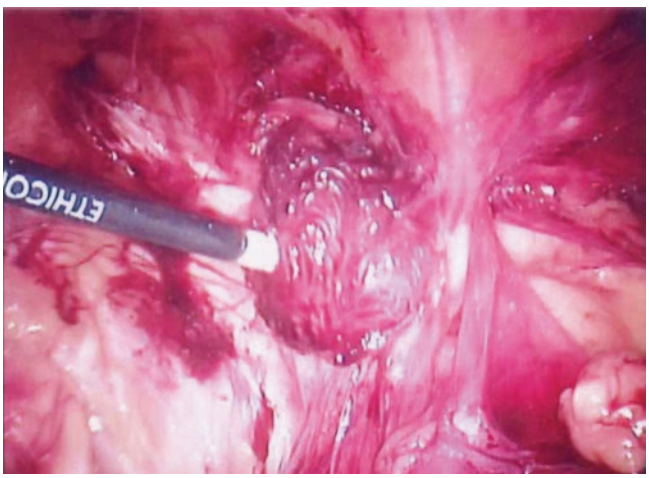


Fig. 28.16 Previously placed mesh plug in inguinal hernia defect

The plug repairs when performed currently utilize an absorbable material primarily or are in combination with open repair systems that utilize lower weight permanent synthetic materials. Figure 28.17 is an example of an absorbable material currently used in plug repairs. The material is Bio-A; manufactured by Gore corporation. This material provides a substrate for collagen deposition by the host resulting in an adequate support for the repair.

Tips

Asymptomatic inguinal hernias found at the time of surgery: Note and inform the patient of their presence but they do not require repair.

Femoral hernias may be a source of pelvic pain: symptoms are: radiating pain to the inner thigh and pain



Fig. 28.17 Bio-A absorbable hernia plug manufactured by Gore Corp. used in plug hernia repair

in the groin below the inguinal ligament. If a femoral hernia is found it should be repaired as incarceration is common.

Previous repairs with plug type materials may be a source of chronic pain: diagnosis can be made by prior history of surgery and imaging of the inguinal floor. Resolution of pain usually requires removal of the material.

Single symptomatic inguinal hernias are usually repaired with open technique.

Bilateral or recurrent inguinal hernias usually are repaired with laparoscopic technique.

In patients who have had a prior laparoscopic inguinal hernia repair, the retropubic space will be very difficult to enter due to adherence of the mesh material to the underlying structures.

Internal Hernias

An internal hernia is an opening between any two adjacent structures in the abdominal cavity that has the potential for abdominal contents to protrude through creating a site for obstruction. These hernias are very difficult to diagnose preoperatively and can also be a source of chronic lower abdominal or pelvic pain. They most commonly present with incarceration and bowel obstruction as the first presenting symptom.

Internal hernias are usually the result of prior surgery and adhesive disease. When bowel resection with anastomosis or gastric bypass is performed and the mesenteric defect is not sufficiently closed then this site may be the location of an internal hernia.

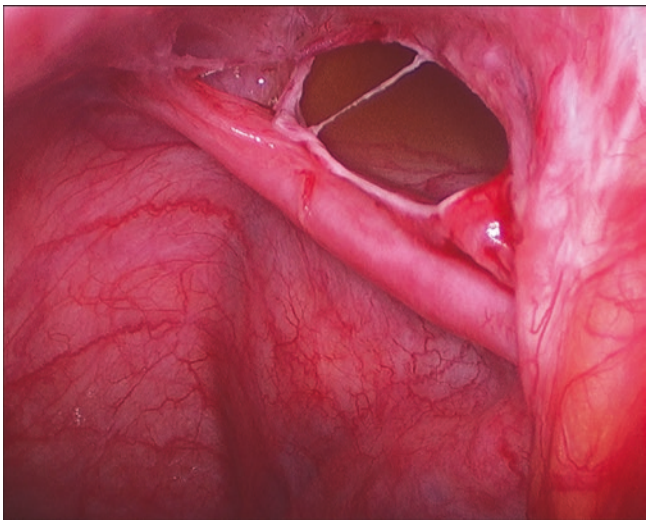


Fig. 28.18 Reduced internal hernia defect in left pelvic side wall

Figure 28.18 demonstrates such an internal hernia where adhesions created a small defect and bowel became entrapped and obstructed. The prior operation that resulted in this defect was a caesarian section with scarring between the uterus, anterior abdominal wall and lateral pelvic side wall.

When an internal hernia is diagnosed it needs to be either fixed by primary closure of the defect or the defect opened widely so the bowel cannot become incarcerated because the potential for complications is high.

Tips

When an internal hernia defect is encountered, it should be either closed completely or opened completely to prevent incarceration of bowel.

Visceral Pathologies

In the true pelvis, the rectosigmoid and the appendix are common sources of pathology. It is important to be able to recognize common conditions affecting these structures that may mimic gynecologic conditions, and be aware of the treatment for these processes. The small bowel also visits the pelvis and conditions that involve this organ may also mimic gynecologic pathologies.

Colon

The most common condition involving the colon in the West that may mimic gynecologic pathology is diverticular disease. Patients with acute hemorrhage or perforation as a result of their diverticular disease usually are referred directly to General Surgery for care; however chronic pain from diverticulosis or low grade diverticulitis may be difficult to distinguish from a gynecologic etiology.

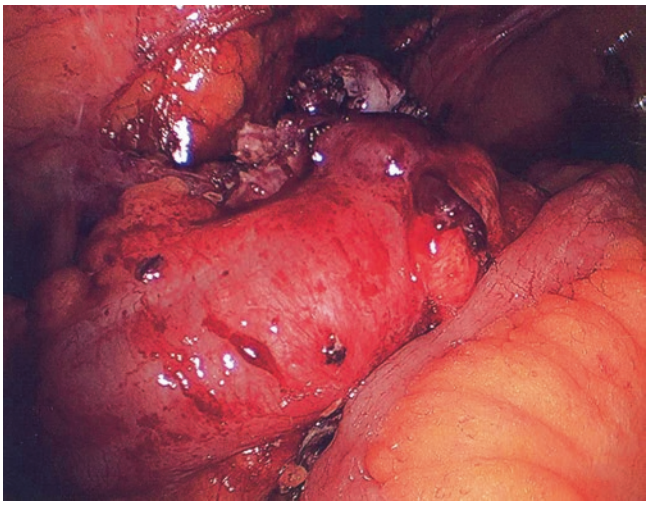


Fig. 28.19 Acute sigmoid diverticulitis with normal appearing bowel in the right lower aspect of the picture

The sigmoid colon is the region of the colon that is most commonly involved with symptomatic diverticuli and the pain is usually present in the left lower quadrant, but may be suprapubic or even in the right lower quadrant.

On inspection and manipulation of the involved colon during laparoscopy, the bowel wall is usually thickened and has lost its normal pliability. In patients that have chronic diverticular disease there are usually adhesions adjacent to the involved segment as a result of repeated bouts of inflammation. See Fig. 28.19.

Diverticuli may actually be seen protruding through the muscular wall of the colon aiding in diagnosis.

Once the GYN surgeon has ruled out any gynecologic pathology and the findings suggest diverticular disease whether it be chronic or acute, no further surgical intervention is necessary. Treatment consists of dietary fiber increase with or without intravenous or oral antibiotics depending on whether an acute process is present or not.

When a patient is explored for pelvic inflammatory disease or presumed tuboovarian abscess, one of the differentials is a contained diverticular perforation with abscess formation. When this is encountered, the segment of involved colon **does not require resection** (except in free perforation and peritonitis where a resection and diverting colostomy may be necessary). The abscess can be drained laparoscopically and a drain left in the abscess cavity.

Malignancies may also perforate however this is less common than in diverticular disease and these patients commonly manifest symptoms of bowel obstruction and as such are usually seen by General Surgeons prior to this happening.

Frequently when operating in the pelvis, congenital "adhesions" are encountered between the sigmoid colon, cecum and the abdominal wall or pelvic side wall. When these structures are noted, if they do not interfere with the planned procedure they are usually left in place and not taken down. The potential problem with mobilizing these structures (sigmoid and cecum) too vigorously is the possibility of volvulus, or twisting of the bowel. So as a rule of thumb, if it is not interfering with the planned procedure leave these support bands in place.

Tips

Diverticular disease of the sigmoid whether it is chronic or acute without perforation; does not require resection. Note and inform the patient.

Perforation with abscess formation: drain the abscess; leave a drain in the cavity, no resection is required.

Appendix

The use of pelvic ultrasound and or CT scan to accurately diagnose appendicitis has been on the rise recently but these have sometimes been unreliable tools to include or exclude the diagnosis, so the use of laparoscopy particularly in the female patient is becoming more frequent when the diagnosis is uncertain. The benefits of laparoscopic appendectomy when compared to open appendectomy are still being hotly debated in the General surgery literature [9]. The majority of appendectomies performed in the US are currently being done laparoscopically. The main advantage being reduction in wound infection rate when compared to open techniques.

The surgical technique used by GI Surgeons for appendectomy most commonly involves utilizing a linear stapling device. These instruments provide a quick simple technique for removal of the appendix; however they are expensive, and may not be readily available so other methods for dissection and removal should be in the surgeons' armamentarium. The technique for appendectomy will be described in stepwise detail.

Procedure Appendectomy

First the appendix must be mobilized from any retroperitoneal or lateral pelvic attachments. This step is important in order to have adequate access to the mesentery of the appendix and avoid injury to retroperitoneal structures, cecum or the ileocecal valve during removal.

Next, a small window is created in the mesoappendix at the base of the appendix. This can be done bluntly using dissectors or energy sources.

Once this is accomplished, the third step is either ligation of the mesoappendix or appendix base. The choice of which one of these structures is to be ligated first is dependent on the anatomy and ease of visualization. Control can also be accomplished using a linear stapling device. The appendix base is usually transected using the 3.5 or 2.8 mm staple depth. The choice depends on whether the base of the appen-

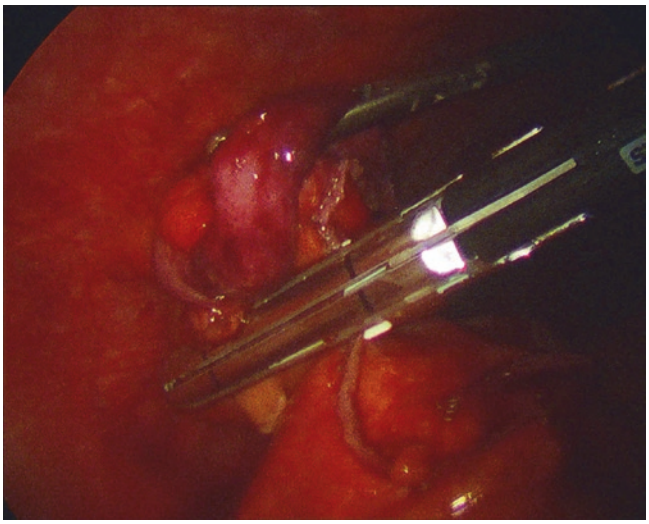


Fig. 28.20 Stapler being applied to the base of the appendix

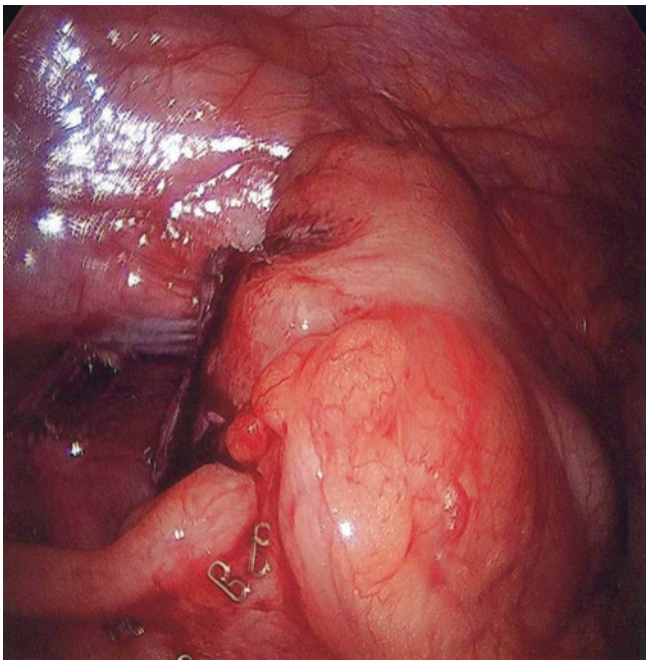


Fig. 28.21 Stapled appendix base to the left and normal cecum to the right of the picture

dix is inflamed or normal. The vascular pedicle is divided using the 2.8 mm staple load. Figure 28.20 shows placement of the stapling device and Fig. 28.21 shows the appendix base after stapling.

Simple ligation of the appendix base or its vascular pedicle using 0-silk or other suture offers good control prior to transection of these structures. This method is much more cost effective when compared to stapling devices. Video 28.3 demonstrates ligation of the appendix base with suture.

After the base of the appendix or mesoappendix is ligated and transected, an Endoloop may be applied for extra security. Video 28.4 shows the transaction of the appendix base after ligation.

In instances where the appendix is necrotic at its base, the stapler has its best utility. The proximal staple line should cross normal cecal wall in order to insure viable tissue is left in the staple line. Stapling across a necrotic appendix can result in delayed perforation and peritonitis since there is no viable tissue left in the staple line.

When the primary ligation method is utilized, and the base of the appendix is necrotic, the appendix base should be inverted into the cecum utilizing either a Z stitch or purse string seromuscular stitch of 2-0 or 3-0 suture. Historically silk suture has been used however an absorbable suture may be utilized but the crucial point is that the tissue in question be closed and inverted with normal viable tissue overlying it.

Special Considerations

In instances where the appendix has perforated and an abscess is encountered which may be the case in exploration for suspected tuboovarian abscess, then just as for diverticular abscess, the surgeon should drain the abscess, leave a drain in the abscess cavity and end the procedure. The appendix does not need to be removed at that time but this can be done at a later date usually several months later if indicated.

In patients with chronic lower abdominal or pelvic pain who are undergoing laparoscopy and the appendix is still present, it is recommended that the appendix be removed. In several studies, relief of pain after appendectomy even without obvious gross pathology shows benefit [10, 11].

Tips

Appendectomy should be performed in patients with pelvic pain when the organ is still present and appears grossly normal.

Appendectomy can easily be accomplished utilizing a stapling device, 3.5 or 2.8 mm load for the appendix base and 2.8 mm size for the mesentery.

Suture ligation using 0-silk or other suture material is as effective as stapling and more cost effective. Pretied loops can also be used to control the appendix base and mesentery base.

In perforation and abscess formation, drain the abscess, do not remove the appendix and leave a drain in the cavity.

Small Bowel

Small bowel pathology is much less common than either colon or appendix pathology, however conditions do exist that may be found during exploration that mimic pelvic pathology.



Fig. 28.22 Meckel's diverticulum

Meckel's diverticulum is a true diverticulum that classically is located 2 ft from the ileocecal valve and can be a source of chronic pain. The appearance is typically that of an antimesenteric diverticulum with its own blood supply originating from the mesentery.

Figure 28.22 shows a typical Meckel's diverticulum.

The diverticulum can harbor gastric mucosa that can lead to GI bleeding and also perforation. Bowel obstruction from intussusception also has been described. So when these structures are encountered they are usually removed.

Resection with a linear stapling device 3.5 mm size staple load, placed at the base of the Meckel's diverticulum so as not to compromise the remaining bowel lumen is recommended. Resection utilizing simple excision with two layer suture closure may be used if the surgeon is adept with laparoscopic resection and suturing techniques.

Tips

When Meckel's Diverticulum is found it should be removed.

GIST or gastrointestinal stromal tumors can be found in the small bowel and have the same gross appearance as leiomyomas. Figure 28.23 is that of a small bowel GIST preoperatively mimicking a leiomyoma.

GIST tumors are most commonly found in the stomach 60% with 30% incidence in the large and small bowel. They can be intraluminal or extraluminal with a pedunculated base which can lead to misdiagnosis via imaging as originating from the uterus or ovary. Figure 28.24 shows the appearance on CT of the lesion in Fig. 28.23.

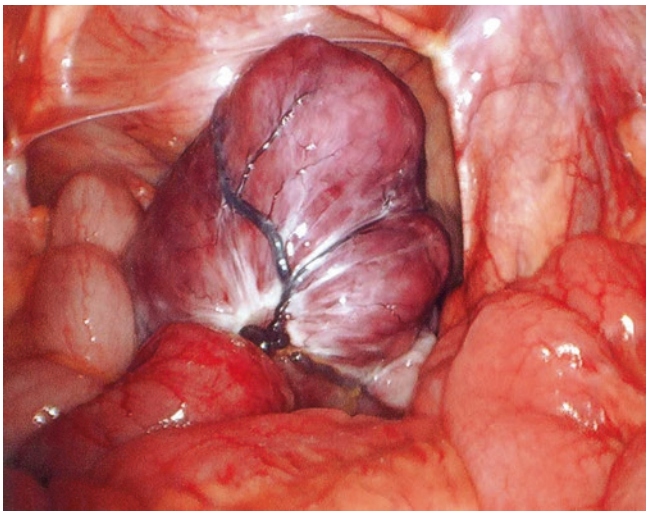


Fig. 28.23 Pedunculated GIST tumor of the small bowel resembling leiomyoma



Fig. 28.24 CT scan of the pelvis demonstrating the GIST tumor in Fig. 28.23

These tumors do have a malignant potential and so when encountered they should be removed. Despite their malignant potential, removal of GIST lesions requires only clear resection margins and a formal nodal dissection is not necessary. Lesions greater than 5 cm or with >5 mitoses per high power field should be referred for consideration for adjuvant chemotherapy.

Because these tumors resemble leiomyomas the urge to morcellate should be avoided when they are removed. They should be removed from the abdomen intact by extending the incision or utilizing a specimen retrieval bag device.

Tips

GIST tumors grossly resemble leiomyomas and as such may be mistaken for gynecologic pathology. When found, they should

be removed intact, not morcellated, and no formal cancer nodal dissection is necessary. The bowel margins should be clear.

Regional enteritis or Crohn's Disease can also cause pelvic or lower abdominal pain. The gross appearance is similar to that seen with chronic diverticular disease with marked thickening of the bowel wall, loss of pliability and the characteristic mesenteric creeping fat may be present.

Without any acute problems or complications of the patient's disease (perforation, obstruction), the involved segment does not need to be removed and in fact it is recommended that the involved bowel be left in place. Medical therapy is the mainstay of treatment with surgery being left only for complications such as perforation, stricture, obstruction or fistula formation.

Tips

Crohn's disease when encountered should be noted with no resection recommended except only for complications such as perforation, obstruction, stricture or fistula formation.

Special Considerations in Encountering Bowel, Injuries

In the course of dissection particularly when adhesive disease is encountered, occasionally injury to the bowel wall is noted. Avoidance of injury is the key. The use of any energy source to release bowel from the abdominal wall is to be discouraged and when used, should be performed only with extreme caution.

Use of scissors without cautery is the preferred method. When very loose adhesions are encountered, the bowel may be gently pushed from the abdominal wall with the convex side of the instrument. Figure 28.25 demonstrates the recommended position of the scissors.

This helps reduce chance of an unseen injury by the tip of the scissors on the bowel.

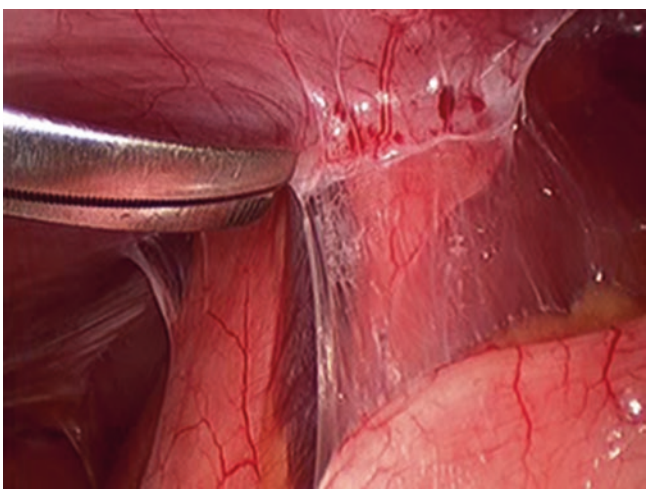


Fig. 28.25 Fibrinous adhesions between the bowel and anterior abdominal wall

Small bowel and colon are encountered frequently in the pelvis during surgery, despite placing the patient in Trendelenberg position. These structures must be mobilized from the pelvis in order to achieve adequate visualization. When grasping the bowel, a method recommended to help reduce the possibility of injury, is that the bowel be grasped gently with an instrument with a large surface area and at an angle parallel to the mesentery (Fig. 28.26) or grasp the mesentery directly (Fig. 28.27).

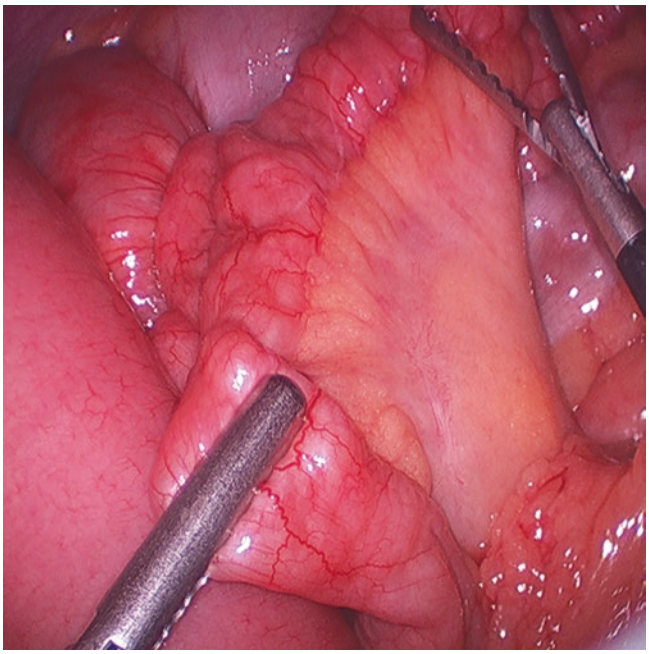


Fig. 28.26 Grasping the bowel with broad based instrument at a 0 degree angle

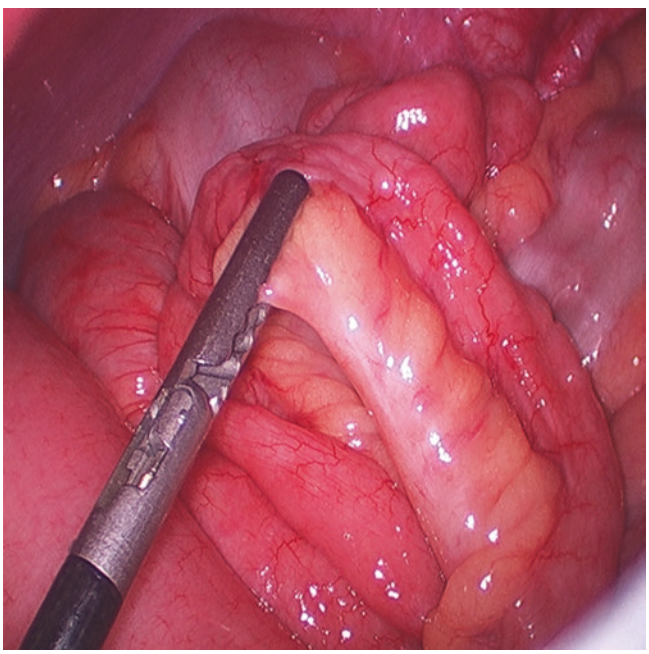


Fig. 28.27 Grasping the mesentery of the bowel avoiding the bowel wall completely

The larger surfaced area grasper disperses the force generated by the grasper and by grasping the mesentery the bowel itself is avoided thus reducing the risk of injury. The amount of force generated at the tip of laparoscopic instruments has been measured at up to 1500 kPa which is equal to a human bite so excessive force on the instrument can be transferred to the bowel and must be avoided [12].

Extra care must be taken when the bowel is inflamed or diseased as this makes the possibility of injury more likely.

When to Repair Bowel Wall Injuries?

1. If the mucosa is entered or visible, then primary repair is mandatory. Repair is accomplished either in one or two layers. Suture size used may be 4–0 or 3–0 and may be permanent or absorbable suture. The critical aspect of the repair is that the mucosa be completely inverted.
2. When the muscular wall is damaged and mucosa is visible but not injured, see Fig. 28.28, it is still recommended that the bowel wall be repaired. Again either a two or one layer closure is used.
3. When muscular wall is damaged and no mucosa is visible, depending on the length of injury, the bowel wall may not need to be repaired. The decision is surgeon dependant but any injury over 1 cm in size should be reinforced.
4. Serosal injuries do not need to be repaired. See Fig. 28.29

Tips

Full thickness bowel wall injuries need to be repaired either with two layer or one layer technique making certain that mucosa is adequately inverted and or covered with viable tissue.

Muscular wall injury should be repaired depending on degree and size. When in doubt: repair.

Serosal injuries do not require repair.

Grasp bowel carefully with large surface area instruments.

Other Topics

Endometriosis may involve organs other than the uterus or ovaries and this can include bowel particularly the rectosigmoid. Figure 28.30 demonstrates an endometriotic plaque in the Pouch of Douglas.

In order to adequately treat and relieve the patient from their symptoms, complete resection of the involved area is usually required.

When endometriosis involves the colon or rectum, the endometriotic nodule can usually be completely resected without having to perform a formal segmental resection [13]. Anticipation of the need to resect part of the large bowel is usually noted preoperatively and if necessary a general surgeon can be called to assist, however a well trained laparoscopic surgeon competent in suturing can also treat the involved bowel.

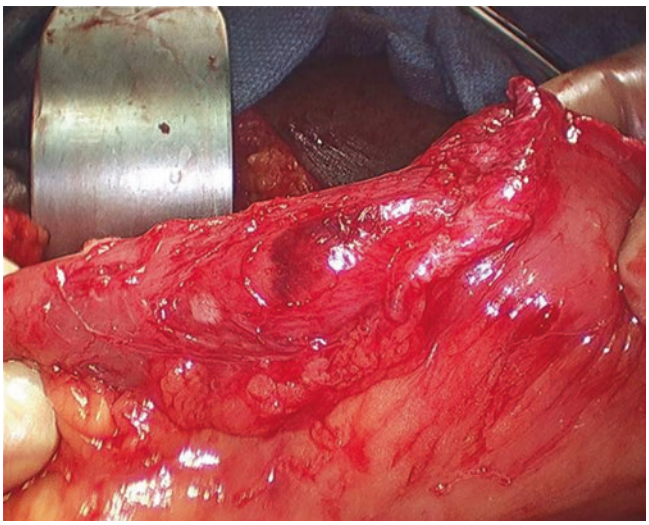


Fig. 28.28 Bowel wall injury with intact mucosa, disrupted serosa and both muscular walls requiring repair

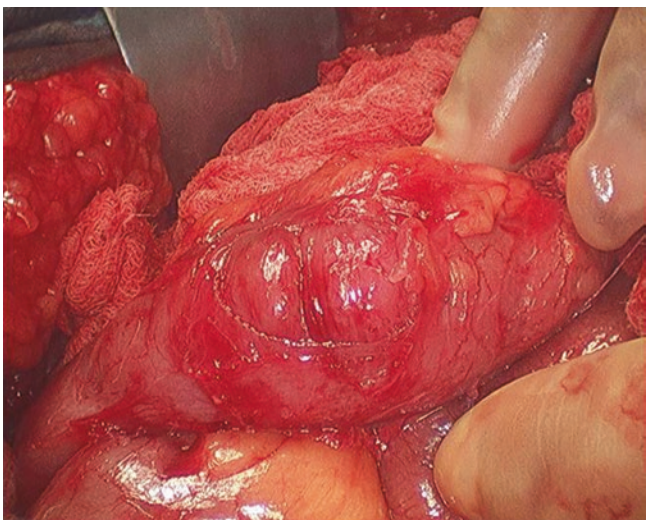


Fig. 28.29 Serosal injury with intact muscular layers not requiring repair



Fig. 28.30 Endometriosis involving the anterior wall of the rectum and posterior wall of the vagina

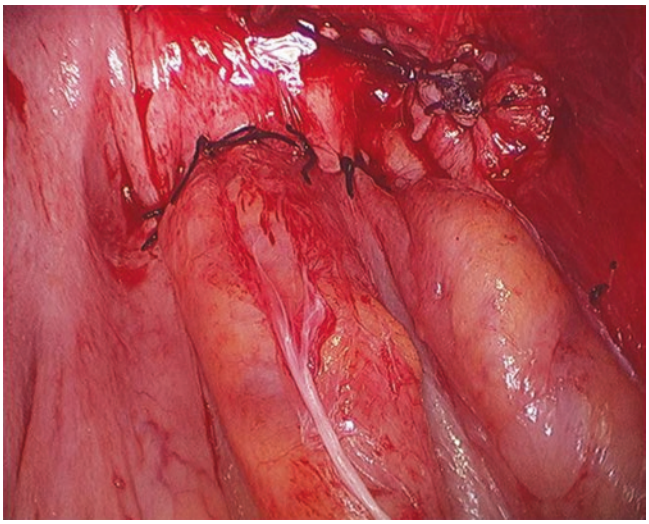


Fig. 28.31 Repair of the rectal wall closed in transverse fashion

If the nodule requires full thickness resection of the bowel wall and closure would not result in compromise of bowel lumen, (usually 50% or less of the bowel wall circumference) then primary repair in a two layer manner is appropriate. The first inverting layer is usually an absorbable suture (chromic or polyglactin) 4-0 or 3-0 size. The injury should be closed so as not to compromise the lumen of the bowel so closure in a transverse fashion rather than longitudinal with interrupted suture is best. See Fig. 28.31.

The second layer may be either absorbable or permanent and is usually either 4-0 or 3-0 size.

The ultimate success of closure depends on standard well recognized principals of general surgery. The first being a tension-free repair and the second being adequate blood supply.

If the rectum and not the sigmoid colon is involved, because of the lack of serosa, the anastomosis is at higher risk of leak since there is no serosa to aid in sealing of the anastomosis, so it is recommended that in these instances, the use of anti-adhesive agents be avoided. The successful sealing of an anastomosis in this circumstance is very dependent on adherence from surrounding tissues, so adhesions in this instance are crucial to good outcome.

Tips

When endometriosis is encountered involving the bowel, it usually can be removed by local excision and primary closure.

Two layer closure without tension and adequate blood supply to the remaining tissues is standard.

When rectum is involved, antiadhesive barrier products should be avoided.

The same management principles apply in a situation where the distal colon or rectum is injured during surgery or entry. The injury is usually repaired in a two layer fashion. If the defect is small, then a one layer closure is adequate as long as the bowel mucosa is inverted. The need for creation of a colostomy is extremely rare when the injury is recognized early and closed primarily.

When bowel resection is anticipated preoperatively, usually the patients are placed on mechanical bowel prep. There is good evidence that when patients have not had bowel prep and subsequently underwent resection when compared to patients that did have a bowel prep and underwent resection with anastomosis, there was no difference in leak rate, abscess formation or complication such as wound infection [14]. The long held notion that all patients that are to undergo bowel surgery need to be on a mechanical prep is now questioned.

In special cases where an entire segment of bowel needs to be removed, the availability of circular staplers has made creation of a low colonic anastomosis simpler. There are certain principles that need to be understood when using these devices. First is that there should be no tension on the anastomosis and staple line. The proximal bowel should easily reach into the pelvis without tension. The descending colon or splenic flexure may need to be mobilized in order to reach the distal sigmoid or rectal stump; if this is needed then care must be taken that the blood supply is not compromised in the process as this is the second important factor in a successful anastomosis.

Choosing staple size is very important. Lower colon anastamosis using a circular stapler should be performed with a 28 mm diameter stapler or larger. Figure 28.32 shows a stapling device manufactured by Covidien Corporation. The anvil and stapler are demonstrated.

Using a stapler smaller than 28 mm usually will lead to stricture. If the proximal bowel lumen is small the staple anvil may be placed in a side fashion forming an end-to-side anastamosis and thus creating an adequately large lumen.

In placing the anvil in the proximal bowel, the bowel should be closed firmly around the anvil post so that when the stapler is closed and fired no bowel wall is extruded from the side of the stapler resulting in a compromised anastomosis.



Fig. 28.32 EEA stapler manufactured by Covidien Corp. showing the anvil and stapler

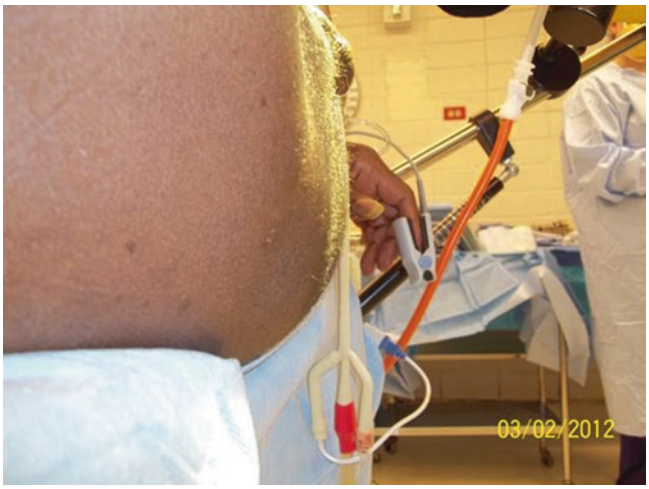


Fig. 28.33 The patient's buttocks extending past the end of the operating table

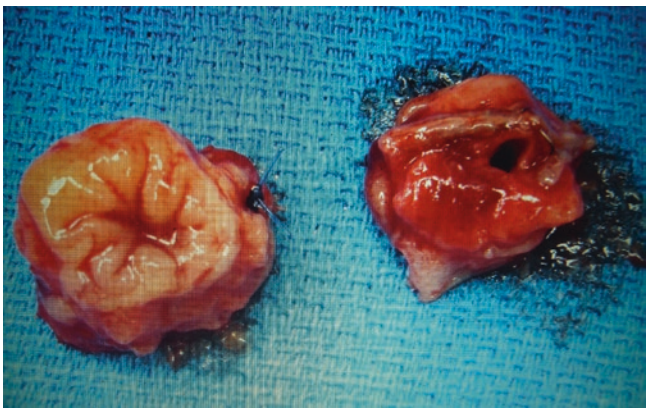


Fig. 28.34 Circular staple tissue donuts from the proximal and distal bowel

In placing the stapling device transanaly, it is very important that the patient's lower buttocks and perineum extend past the edge of the operating table. This allows adequate angling of the stapler into the rectum and first part of the sigmoid. This is absolutely crucial to successful docking and firing of the stapler. See Fig. 28.33.

Once the stapler and anvil are docked, the stapler fired, and removed, the confirmation of two intact tissue "doughnuts" (see Fig. 28.34) and a secure anastomosis via colonoscopy or insufflation using proctoscopy or other device with submersion leak testing should be performed. In the instance of a questionable staple line, the anastomosis site can be reinforced with an inverting stitch or redone. Drains are not usually placed.

Tips

Mechanical bowel prep is not mandatory in colon surgery.

Closure of colon after partial resection or injury should be in two layer fashion.

Circular stapling devices should be 28 mm or greater in diameter when used for anastomosis after segmental resection.

In closure of rectal injury or resection, avoid anti-adhesive materials.

Colostomies are rarely needed when the bowel is injured during surgery; primary repair is preferred.

General surgical conditions can mimic gynecologic disease and may be encountered in the course of surgery for GYN conditions. It is important to be able to recognize, diagnose and have knowledge of treatment for these conditions in order to have good surgical outcomes.

References

1. Millennium Research Group. U.S. markets for soft tissue repair 2009. Toronto: Millennium Research Group, Inc; 2008.
2. Luijendijk RW, Hop WK, van den Tol MP, de Lange DC, Braaksma MM, Ijzermans JN, et al. A comparison of suture repair with mesh repair of incisional hernia. N Engl J Med. 2000;343:392–8.
3. Jonas J. The problem with mesh shrinkage in laparoscopic incisional hernia repair. Zentralbl Chir. 2009;134(3):209–13.
4. Olmi S, Scaini A, Cesana GC, Erba L, Croce E. Laparoscopic versus open incisional hernia repair: an open randomized controlled study. Surg Endosc. 2007;21(4):555–9.
5. Morrison J, Jacobs V. Laparoscopic preperitoneal inguinal hernia repair using preformed polyester mesh without fixation: prospective study with one year follow up results in a rural setting. Surg Laparosc Endosc Percutan Tech. 2008;18(1):33–9.
6. McCormack K, Scott NW, Go PM, Ross S, Grant AM; EU Hernia Trialists Collaboration. Laparoscopic techniques versus open techniques for inguinal hernia repairs. Cochrane Database Syst Rev. 2003;(1):CD001785.
7. Neumayn L, Giobbie-Hurder MS, Jonasson O, Fitzgibbons R, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. N Engl J Med. 2004;350(18):1819–27.
8. Jacobs V, Morrison J. Comparison of institutional costs for laparoscopic preperitoneal inguinal hernia versus open repair and its reimbursement in an ambulatory surgery center. Surg Laparosc Endosc Percutan Tech. 2008;18(1):70–4.
9. Kathkouda N, Mason R, Towfigh S. Laparoscopic versus open appendectomy a prospective randomized double-blind study. Ann Surg. 2005;242(3):439–50.
10. Lyons T, Winer WK, Woo A. Appendectomy in patients undergoing laparoscopic surgery for pelvic pain. J Am Assoc Gynecol Laparosc. 2001;8(4):542–4.
11. Agarwala N, Liu CY. Laparoscopic appendectomy. J Am Assoc Gynecol Laparosc. 2003;10(2):166–8.
12. Cartmill JA, Shakeshaft AJ, Walsh WR, Martin CJ. High pressures are generated at the tip of laparoscopic graspers. Aust N Z J Surg. 1999;69(2):127–30.
13. Roman H, Rozsnayi F, Puscasiu L, Resch B, Belhiba H, Lefebure B, Scotte M, et al. Complications associated with two laparoscopic procedures used in management of rectal endometriosis. JSLS. 2010;14:169–77.
14. Zmora O, Mahajna A, Bar-Zakai B, Rosin D, Hershko D. Colon and rectal surgery without mechanical bowel preparation a randomized prospective trial. Ann Surg. 2003;237(3):363–7.

Fibroids in Laparoscopic Hysterectomy

29

Xiaofeng Zhao, Lu Huang, and Sheng Xu

Abbreviations

B	Bladder
C	Cervix
CL	Cardinal ligament
CVG	Cervico-vesical gap
FT	Fallopian tube
O	Ovary
OV	Ovarian vessels
R	Rectum
RL	Round ligament
SV	small venae
U	Uterus
UA	Uterine artery
UL	Uterosacral ligament
UOL	Utero-ovarian ligament
UOV	Utero-ovarian vessels
UUL	Umbilicourethralligament
UV	Uterine veins
UVB	Uterine veins bleeding
UVF	Utero-vesical fold
UVS	Uterinevessels
V	Vagina
VCL	Vesico-cervical ligament
VIE	Vena iliaca externa

Uterine fibroids are the most common gynecologic benign tumors. Depending on different symptoms, options for management of uterine fibroids include follow-up observation, medication, surgery or embolization.

Laparoscopic hysterectomy is the most frequently performed minimally invasive procedure for treatment of fibroids. It is applied to patients with indications of surgery but with no desire for fertility or reservation of uterus. It is divided into complete laparoscopic hysterectomy and laparoscopic-assisted vaginal hysterectomy. According to resection range, hysterectomy can be total or supracervical.

With the development of laparoscopic technology and accumulation of surgical experiences, almost all the laparoscopic hysterectomy due to fibroids can be performed successfully, including conditions of large uterus, severe adhesion or specially located fibroids [1–5]. But supracervical hysterectomy or hysterectomy of a large uterus requires power morcellation to facilitate removal, which links to an increased risk of disseminating occult malignancy into the abdominal and peritoneal cavities, and it has become a main concern and reason for restriction of laparoscopic hysterectomy [6–10].

Most of hysterectomies for fibroids can be completed safely by laparoscopy. The crucial part of laparoscopic hysterectomy is safely processing the uterine vessels [11]. The vessels supplied the uterus mainly come from two sources, one is the uterine artery and vein, the other is the anastomoses branch of utero-ovary vessels. The uterus becomes ischemic after devascularization of the two sites and then resection won't be difficult. Core of the whole procedure is to reveal the two groups of vessels precisely and bloodlessly, followed by transfixion or electro-coagulation. Large uteri, cervical fibroids or fibroids located in the lower segment of the uterus may greatly increase the difficulty of devascularization [12]. We will analyze the procedure of laparoscopic hysterectomy step by step.

Appropriate exposure and operating space are the precondition for laparoscopic hysterectomy. To achieve better exposure and operating space, the use of a uterine manipulator and placement of trocars are important. A uterine manipulator should push up the uterus to expose cervico-vesical fold, and provide a good motion range. The placement of trocars is one of the most critical factors for a successful operation. On the basis of anatomical characteristics, the cervix is a relatively fixed point, while the uterus is a partially

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free organ with relatively bilateral mobility, so three trocars are generally most favorable for hysterectomy. More trocars make no contribution to exposure of anatomic and operative view. The first port-site is for laparoscopic lens. For uteri smaller than the size of 18 weeks gestation, the first port-site is usually at umbilicus point. For bigger uteri, upper umbilicus point is chosen, but often lower than the umbilico-xiphoid midpoint. The left and right port-sites are operating sites, commonly near the anterior axillary line, 2 cm higher than the utero-ovarian ligaments. One side of port-site is for operating and the other side is to help exposure during the procedure. Proper rotation of the uterus helps exposure. Rotate the uterus clockwise when deal with the left side. Rotate anti-clockwise when go to the right.

We first deal with the anastomoses branch of utero-ovarian vessels, which are surrounded by the round ligament, utero-ovarian ligament and fallopian tube (see Fig. 29.1). For uteri that are not too large, a uterine manipulator can help exposure. For large uteri, the effect of uterine manipulator is limited, and grasping forceps are needed to grasp the point where the round ligament connects the uterus, pull and rotate the uterus to one side so that the operative side can be exposed. For patients whose ligaments are thick, transection of fallopian tube, round ligament and utero-ovarian ligament is done before devascularization. For patients with thin ligaments, do the devascularization directly. Transection of these structures should be done 1 cm away from the uterus to avoid injury of vessels on the lateral uterine wall. Then open the broad ligament, dissect the anterior and posterior leaf (see Fig. 29.2). Usually there are only small vessels and loose connective tissue within the broad ligament. Be careful not to injury the uterine vessels which are closed to the lateral uterine wall. Now a uterine manipulator is necessary to push the uterus up to help expose, meanwhile the contra-lateral grasping forceps continue pulling and assist rotation. Open the anterior leaf of the broad ligament up to the cervix, continue to open the utero-vesical fold. Open the posterior leaf of the broad ligament to where the utero-sacral ligament attaches to the cervix. Avoid tear and bleeding of the small veins, electro-coagulate timely to keep the wound bloodless and the operative view clear.

The contra-lateral side is done with the same rule.

With the broad ligaments done, we need to push up the uterus as far as possible, and pin the anterior uterine wall by forceps, thus reveal the cervico-vesical gap, and open the utero-vesical fold and bilateral vesico-cervical ligaments (see Fig. 29.3). Find the correct cervico-vesical gap, reflect the bladder downwards carefully not to cause any bleeding. For supracervical hysterectomy, reflect the ladder just enough to do the devascularization. For total hysterectomy, the bladder has to be reflected down to 1 cm below the upper end of the vagina. It is crucial to reflect the bladder downwards before devascularization, so that the vessels can be processed successfully without injury of the bladder and ureters.

Continue to dissect the peripheral structure of cervical vessels after the bladder is reflected down (see Fig. 29.4). There is often one uterine artery surrounded by several uterine veins. Uterine veins are wide and thin-walled, easy to be damaged, and not easy to electro-coagulate. Once big uterine vein bleeding occurs, clamp the bleeding point and push away the bladder with caution to make space for transfixion. When cervical vessels are dissected, suture the uterine vessels below the isthmus, or electro-coagulate and transect. Desiccation of a vessel should be of a certain width in order to avoid bleeding after transection and blurring of the operative view.

After devascularization, go further to next steps according to total or supracervical hysterectomy.

For supracervical hysterectomy, withdraw the uterine manipulator and remove the uterus by morcellation (see Fig. 29.5). The cervix stump is scissored into a wedge shape, coagulated by electrotome and interruptedly sutured, usually by three stitches. The middle stitch must be deep to the base of the wedge, upper end of the cervical canal, in case of possible postoperative bleeding.

For total hysterectomy, after devascularization, transect the cardinal ligament to the cervico-vaginal fornix junction through the space between uterine vessels and the cervix, then resect the uterus circumferentially off the vaginal fornix, aided by the cup of uterine manipulator , extract the uterine corpus through vagina(see Fig. 29.6). To find the space between uterine vessels and the cervix correctly is vital to prevent bleeding.

Close the vaginal cuff after hysterectomy by interrupted or running suture. Pay special attention to the suture of bilateral utero-sacral ends.

At last, irrigate the pelvic cavity, stanch thoroughly, and examine the ureters, bladder, rectum and other pelvic organs, finish the operation.

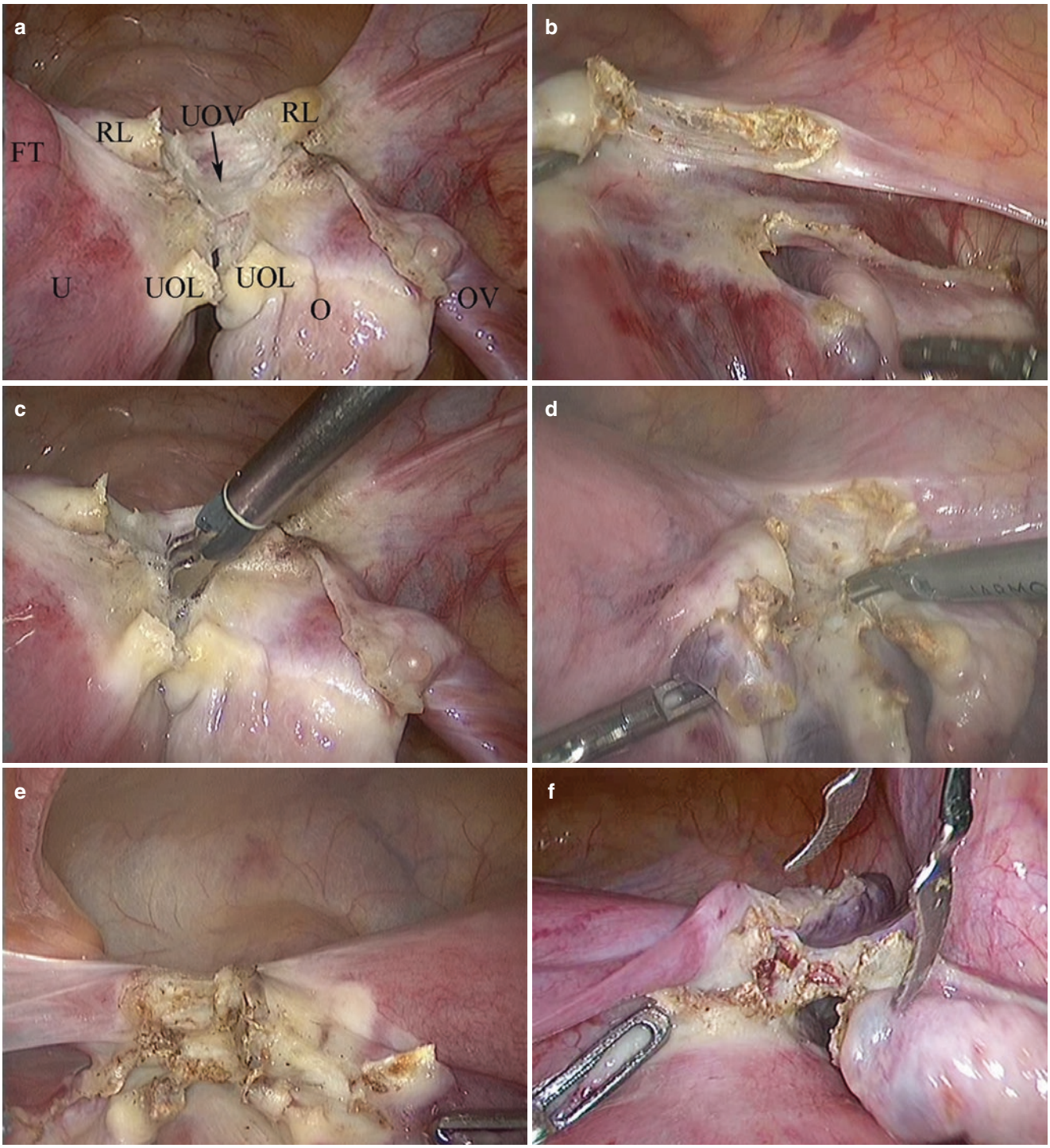


Fig. 29.1 Utero-ovarian vessels and surrounded structures. The anastomoses branch of utero-ovarian vessels, which are surrounded by the round ligament, utero-ovarian ligament and fallopian tube. Round ligament, utero-ovarian ligament and fallopian tube are usually done before devascularization. For patients with thin ligaments, do the devascularization directly. Transection of these structures should be done 1 cm away from the uterus to avoid injury of vessels on the lateral uterine wall. (**a**) Divide the surrounding structure and expose the anastomoses branch of utero-ovarian vessels. (**b**) The round ligament is transected 1 cm away from the uterus. (**c**) electrocoagulation of the anastomoses branch of utero-ovarian vessels. (**d**) Transection of the anastomoses branch of utero-ovarian vessels by ultrasound knife. (**e**) Transect the surrounding structure and expose the anastomoses branch of left ovarian vessel. (**f**) The round ligament and utero-ovarian ligament that surround the anastomoses branch of utero-ovarian vessels are thin, so directly electro-coagulate them. **Abbreviations**: *FT* FallopianTube, *RL* Round Ligament, *UOV* Utero-ovarian Vessels, *OV* Ovarian Vessels, *U* Uterus, *O* Ovary, *UOL* Utero-ovarian Ligament

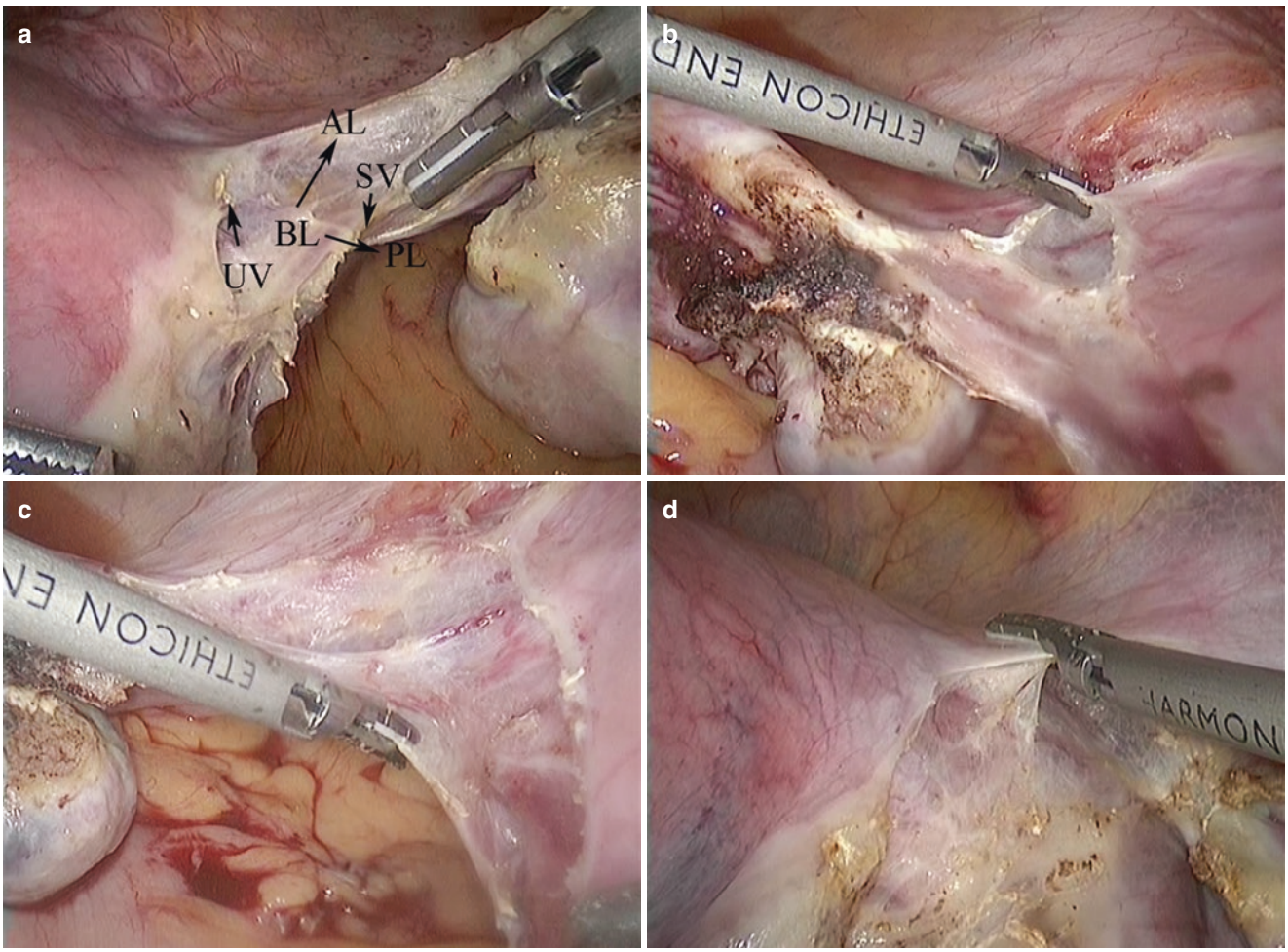


Fig. 29.2 To dissect the broad ligament. To open the broad ligament, dissect the anterior and posterior leaf respectively. Usually there are only small vessels and loose connective tissue within the broad ligament. Be careful not to injure the uterine vessels which are close to the lateral uterine wall. Now a uterine manipulator is necessary to push the uterus up to help expose, meanwhile the contra-lateral grasping forceps continue pulling and assist rotation. (**a**) Open the anterior and posterior leaf of the broad ligament, and small veins can be seen. (**b**) Open the anterior leaf of the left broad ligament to where the utero-vesical fold is, (**c**) Open the anterior and posterior leaf of the left broad ligament;2–4 a uterine with the lower segment enlarged. (**d**) Carefully open the anterior leaf of the broad ligament close to the uterus. (**e**) A uterine with the lower segment enlarged. Carefully open the posterior leaf of the broad ligament close to the uterus. (**f**) Open the anterior and posterior leaf of the broad ligament in a large uterus, and umbilico-vesical ligament, external iliac vein and thick uterine veins can be seen. (**g**) Myoma of the left lower segment of uterine wall. Pull it to right and rotate clockwise, and open the anterior leaf of the broad ligament to the front of the cervix. (**h**) Myoma of the left lower segment of uterine wall. Pull it to right and rotate clockwise, and open the posterior leaf of the broad ligament to the utero-sacral ligaments. **Abbreviations**: *U* Uterus, *UV* Uterine Veins, *VIE* Vena Iliaca Externa, *UUL* Umbilicourethralligament, *AF* Anterior Feaf, *PF* Posterior Feaf, *SV* Small Venae

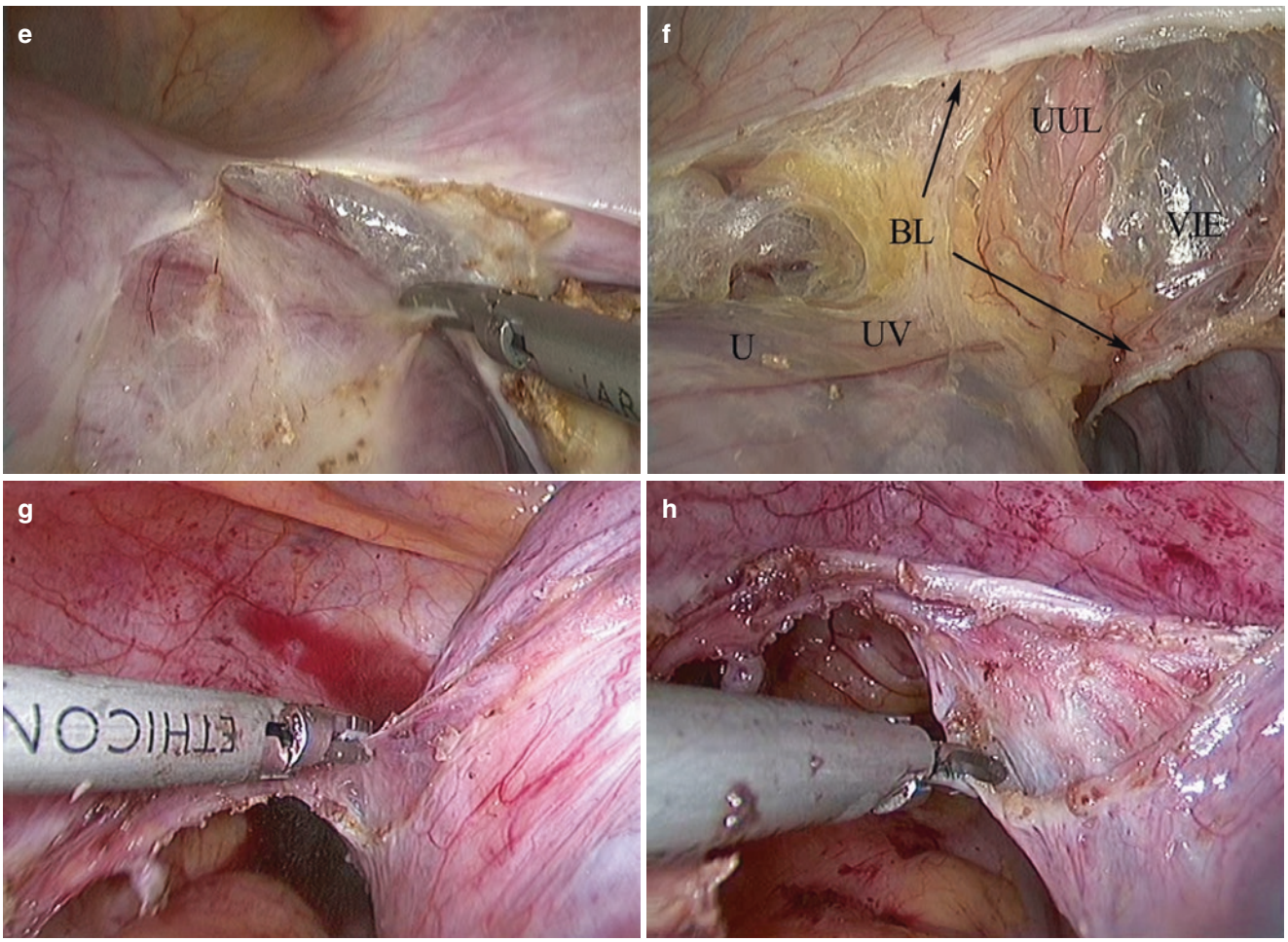


Fig. 29.2 (continued)

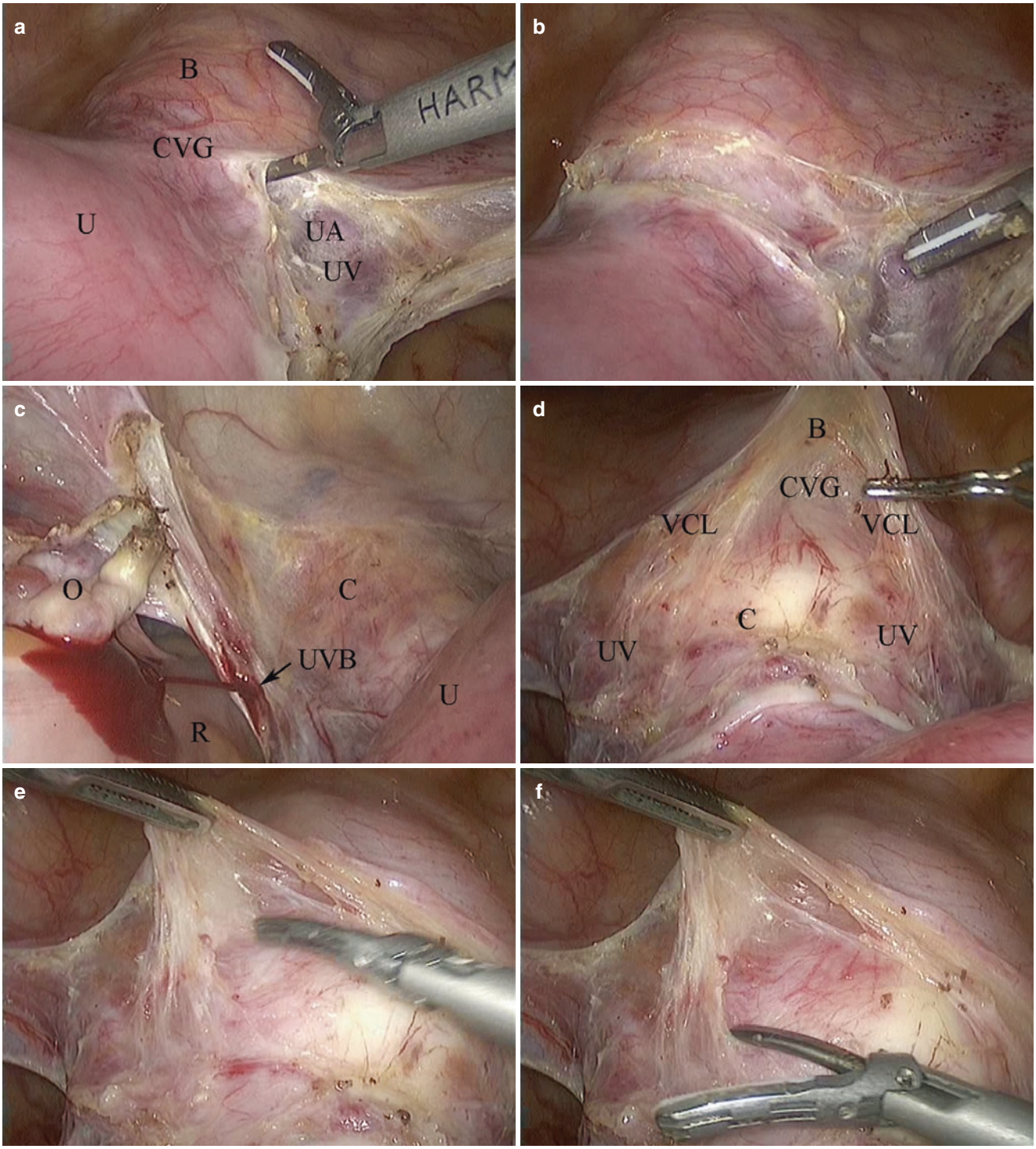


Fig. 29.3 To open the utero-vesical fold and reflect the bladder downwards. Open the anterior leaf of the broad ligament up to cervix; continue to open the utero-vesical fold. Open the posterior leaf of the broad ligament to where the utero-sacral ligament attaches to the cervix. Avoid tear and bleeding of the small veins, electro-coagulate timely to keep the wound bloodless and the operative view clear. The contralateral side is done with the same rule. With the broad ligaments done, we need to push up the uterus as far as possible, and pin the anterior uterine wall by forceps, thus reveal the cervico-vesical gap, and open the utero-vesical fold and bilateral vesico-cervical ligaments. Find the correct cervico-vesical gap, reflect the bladder downwards carefully not to cause any bleeding. For supracervical hysterectomy, reflect the ladder just enough to do the devascularization. For total hysterectomy, the bladder has to be reflected down to 1 cm below the upper end of the vagina. It is crucial to reflect the bladder downwards before devascularization, so that the vessels can be processed successfully without injury of the bladder and ureters. (**a**–**b**) Open the utero-vesical fold. (**c**) Small veins are torn and bleeding during uterine manipulation. (**d**–**f**) Reflect the bladder downwards and transect the vesico-cervical ligaments. (**g**–**h**) Open the utero-vesical fold of a large uterus. (**i**–**j**) Open the utero-vesical fold and reflect the bladder downwards in a patient who used to receive a caesarean section. Pay attention to find the correct cervico-vesical gap.*U* Uterus, *UV* UterineVeins, *UA* Uterine Artery, *UVS* Uterine Vessels, *VIE* Vena Iliaca Externa, *B* Bladder, *C* Cervix, *R* Rectum, *UVB* Uterine Veins Bleeding, *CVG* Cervico-vesical Gap, *VCL* Vesico-cervical Ligament, *SV* Small Venae

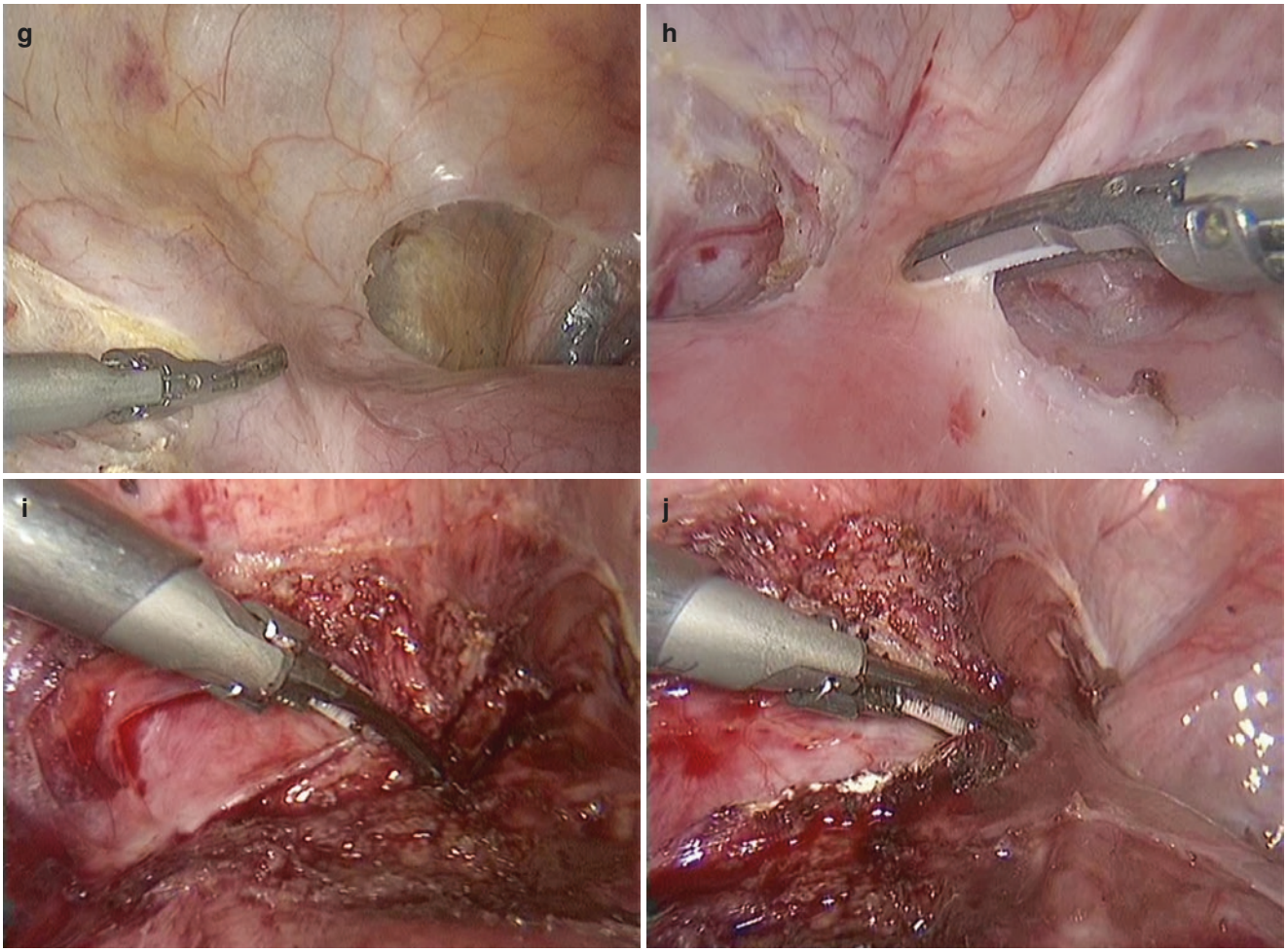


Fig. 29.3 (continued)

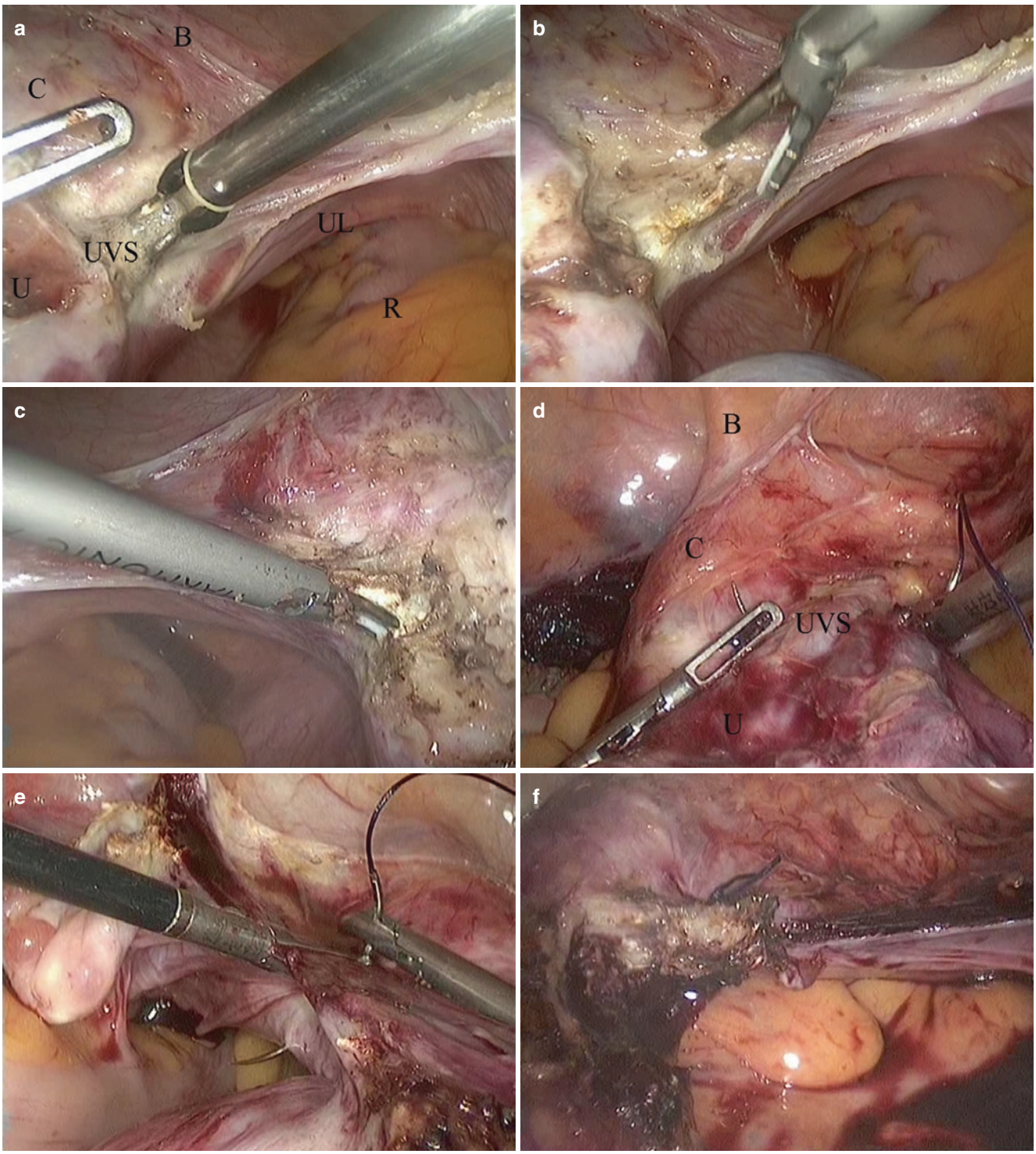


Fig. 29.4 To dissect the uterine vessels and devascularization. Continue to dissect the peripheral structure of cervical vessels after the bladder is reflected down. There is often one uterine artery surrounded by several uterine veins. Uterine veins are wide and thin-walled, easy to be damaged, and not easy to electro-coagulate. Once big uterine vein bleeding occurs, clamp the bleeding point and push away the bladder with caution to make space for transfixion. When cervical vessels are dissected, suture the uterine vessels below the isthmus, or electro-coagulate and transect. Desiccation of a vessel should be of a certain width in order to avoid bleeding after transection and blurring of the operative view. (**a**) Open the anterior and posterior leaf of the broad ligament and the utero-vesical fold, reflect the bladder downwards and electro-coagulate the right uterine vessel. (**b**) Transection of the right uterine vessel by ultrasound knife. (**c**) The left uterine vessel is done by the same way. (**d**) Transfixion of the right uterine vessel. (**e**) Transfixion of the left uterine vessel. (**f**) Electro-coagulate and transect the uterine vessel 1–2 cm above the transfixion point. **Abbreviation**: *U* Uterus, *UVS* Uterinevessels, *U*L Uterosacral ligament, *B* Bladder, *C* Cervix, *R* Rectum

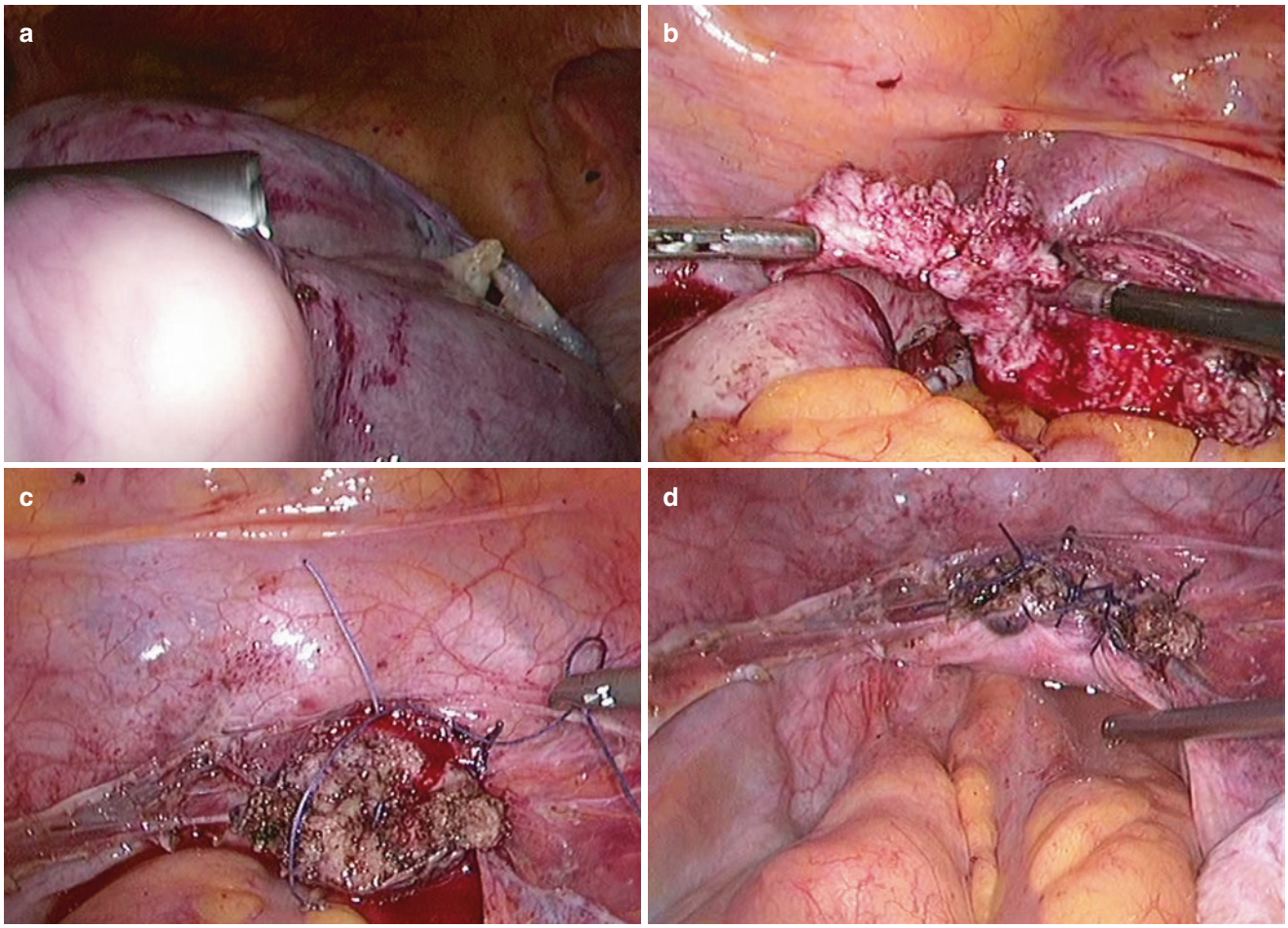


Fig. 29.5 Morcellation and closing cervix stump for supracervical hysterectomy. After devascularization, go further to next steps according to total or supracervical hysterectomy. For supracervical hysterectomy, withdraw the uterine manipulator and remove the uterus by morcellation. The cervix stump is scissored into a wedge shape, coagulated by electrotome and interruptedly sutured, usually by three stitches. The middle stitch must be deep to the base of the wedge, upper end of the cervical canal, in case of possible postoperative bleeding. (**a**) After devascularization, remove the uterus by morcellation. (**b**) Scissoring of The cervix stump in supracervical hysterectomy. (**c**) Coagulate by electrotome and interruptedly suture the cervix stump with 1–0 absorbable line. (**d**) Suture of the cervix stump is done

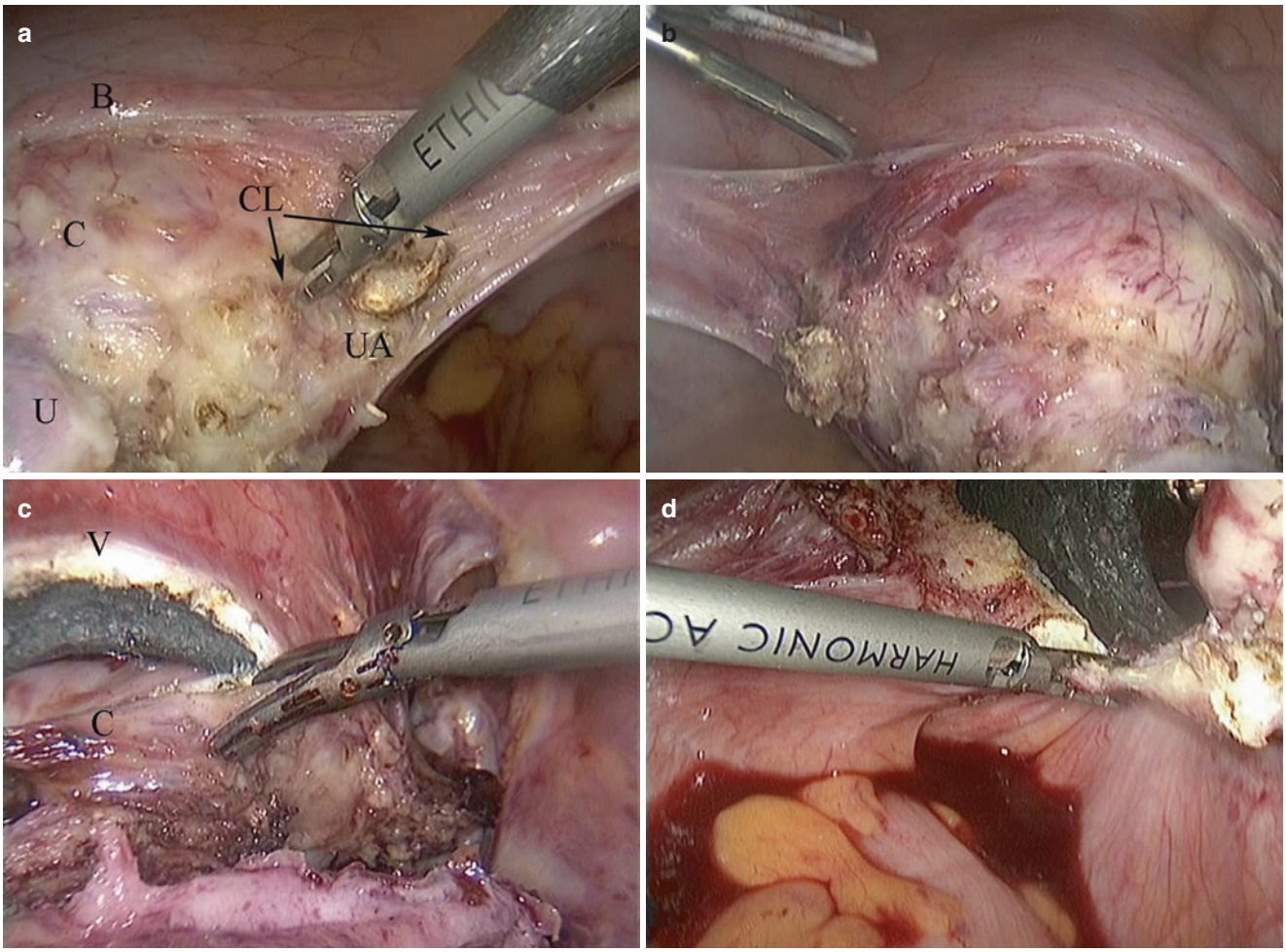


Fig. 29.6 Total hysterectomy. For total hysterectomy, after devascularization, transect the cardinal ligament to the cervico-vaginal fornix junction through the space between uterine vessels and the cervix, then resect the uterus circumferentially off the vaginal fornix, aided by the cup of uterine manipulator, extract the uterine corpus through vagina. To find the space between uterine vessels and the cervix correctly is vital to prevent bleeding. Close the vaginal cuff after hysterectomy by interrupted or running suture. Pay special attention to the suture of bilateral utero-sacral ends. (**a**, **b**) For total hysterectomy, after devascularization, transect the cardinal ligament by ultrasound knife to the cervico-vaginal fornix junction through the space between uterine vessels and the cervix; (**c**, **d**) use a ultrasound knife or unipolar electrotome to resect the uterus circumferentially off the vaginal fornix, aided by the cup of uterine manipulator, and remove through the vagina; (**e**) the vaginal cuff after hysterectomy; (**f**) Close the vaginal cuff by running suture, and Pay attention to the suture of bilateral utero-sacral ends. (**g**) The hysterectomy and closure of the vaginal cuff is done. **Abbreviations**: *U* Uterus, *UL* Uterosacral ligament, *B* Bladder, *C* Cervix, *R* Rectum, *V* Vagina, *CL* Cardinal ligament, *UA* Uterine artery, *UVS* Uterine vessels

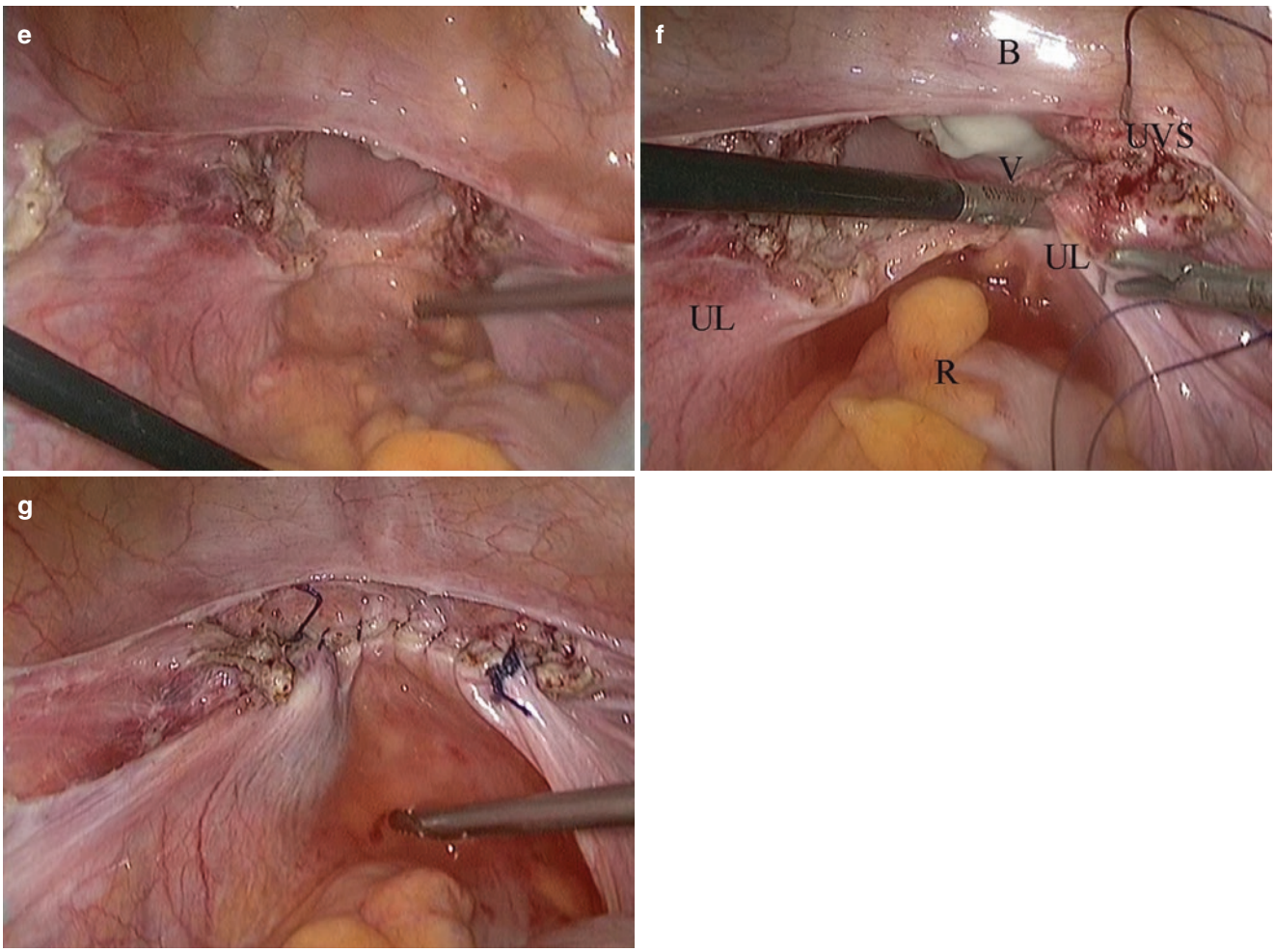


Fig. 29.6 (continued)

References

1. McPherson K, Metcalfe MA, Herbert A, et al. Severe complications of hysterectomy: the VALUE study. BJOG. 2004;111(7):688–94.
2. O'Hanlan KA, McCutcheon SP, McCutcheon JG. Laparoscopic hysterectomy: impact of uterine size. J Minim Invasive Gynecol. 2011;18(1):85–91.
3. Demir RH, Marchand GJ. Safe laparoscopic removal of a 3200 gram fibroid uterus. JSLS (Journal of the Society of Laparoendoscopic Surgeons/Society of Laparoendoscopic Surgeons). 2010;14(4):600–2.
4. Walid MS, Heaton RL. Total laparoscopic hysterectomy for uteri over one kilogram. JSLS (Journal of the Society of Laparoendoscopic Surgeons/Society of Laparoendoscopic Surgeons). 2010;14(2):178–82.
5. Zeng W, Chen L, Du W, Hu J, Fang X, Zhao X. Laparoscopic hysterectomy of large uteri using three-trocar technique. Int J Clin Exp Med. 2015;8(4):6319–26.
6. AAGL Advancing Minimally Invasive Gynecology Worldwide. AAGL practice report: Morcellation during uterine tissue extraction. J Minim Invasive Gynecol. 2014;21(4):517–30.
7. Brown J. AAGL advancing minimally invasive gynecology worldwide: statement to the FDA on power morcellation. J Minim Invasive Gynecol. 2014;21(6):970–1.
8. Senapati S, Tu FF, Magrina JF. Power morcellators: a review of current practice and assessment of risk. Am J Obstet Gynecol. 2015;212(1):18–23.
9. Hampton T. Use of morcellation to remove fibroids scrutinized at FDA hearings. JAMA. 2014;312(6):588.
10. Stephenson J. FDA warns against procedure used in removing fibroids. JAMA. 2014;311(19):1956.
11. Aust T, Reyftmann L, Rosen D, Cario G, Chou D. Anterior approach to laparoscopic uterine artery ligation. J Minim Invasive Gynecol. 2011;18(6):792–5.
12. Manoucheri E, Cohen SL, Sandberg EM, Kibel AS, Einarsson J. Ureteral injury in laparoscopic gynecologic surgery. Rev Obstet Gynecol. 2012;5(2):106–11.

Symptomatic Fibroids as Main Indication for Laparoscopic Hysterectomy and Their Handling

30

Liselotte Mettler and Ibrahim Alkatout

Introduction

One of the multiple treatment possibilities for myomas considering all laparoscopic surgical, medical or interventional techniques is total laparoscopic hysterectomy (TLH) or subtotal laparoscopic hysterectomy (SLH). As SLH is a much less invasive procedure, a good number of patients with myomas can consider a subtotal approach. However, only a total laparoscopic hysterectomy (TLH) can offer 100 % protection from new fibroid formation, later sarcoma formation, uncontrolled bleedings, cervical and endometrial cancer or any other problems arising from the uterus.

In spite of numerous theories, the etiology of fibroid formation remains unclear. While a genetic disposition must be given, as Africans have a much higher frequency of multiple myomas than Caucasians certain up- and down-regulations in the genes of patients with and without myomas have been described. However, as yet no clear guidelines for the prevention of fibroids are available. Hereditary leioyomatosis and renal cell carcinoma syndrome is a rare syndrome involving fibroids. Individuals with the gene that leads to both fibroids and skin leiomyomas have an increased risk of developing a rare case of kidney cell cancer (papillary renal cell carcinoma).

Understanding which genes are involved in fibroids does not automatically tell us why fibroids develop or how to control them. From our understanding of fibroid behavior, we would guess that genes involved in estrogen or progesterone production, metabolism or action are involved. Unfortunately, science is seldom that straightforward. Most guesses regarding these "candidate genes" turn out to be wrong and much research is still required to find out how these genes lead to disease. There are also small variations, called polymorphisms, in genes that may play a role in influencing the risk of fibroids. Both polymorphisms and mutations are changes in the sequence of genes, but the difference is in the degree of change. A mutation makes a major change in the gene that leads to a change in the protein the gene is coding for. For example, it can change the amino acid from alanine to glycine or cause the protein to be prematurely cut off.

The Genetics of Fibroids, Genotype, Phenotype

The discovery of the structure of DNA (desoxyribonucleic acid) by Watson and Crick revolutionized biology and medicine. They discovered that DNA carries the code for life in a ladder-like structure. Today, it is known that the genes from a single person take up the space of 400,000 times the distance from the earth to the moon or 1000 times the distance from the earth to the sun = 150 billion kilometers [1–3].

Before going further, it is important to define the terms genotype and phenotype. The genotype is the pattern of genes that you inherit. For example, with eye color, brown is a dominant color and is represented by a "B". Blue is a recessive trait and represented by a "b". Therefore, a person can have "BB", "bb", or "Bb" as genotypes for eye color. Each person gets two copies of the gene, one originally from his or her mother and the other from his or her father. The dominant gene will always dominate; it has the power to trump a recessive trait. Phenotype is the physical manifestation, or end result, of the genotype. Although there are three different genotypes (BB, bb, or Bb), there are only two phenotypes: brown eyes and blue eyes. People with the "BB" or the "Bb" genotype have brown eyes because brown is the dominant trait; only the people with the "bb" genotype have blue eyes.

We believe that fibroids are a common phenotype that represents many different underlying genotypes. In other words, in our view, fibroids can arise through multiple

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different pathways. In this case, "Bb" might represent two different genes that code for the estrogen receptor beta which influences the action of estrogen on fibroid tissue. A "B" gene may make the fibroid more sensitive to this hormone and therefore more likely to grow. In addition, probably multiple genes influence fibroids so that in addition to "Bb" we may also have "Pp" for progesterone receptors, "Ff" for fibrotic factors, and so on. This information would be most helpful in advancing treatment as women who carry a high risk of recurrent fibroids and have completed their family planning might choose to have a hysterectomy because of the higher chance of their having an additional surgery. We currently have some clinical information (based on physicians' clinical experience with many patients) to predict prognosis for recurrence after myomectomy, but our clinical information for alternative forms of treatment options is limited.

Evidence for the Role of Genes in Fibroid Development and Growth

Studies of women with fibroids suggest several reasons to suspect that genes play a role in fibroid formation. The first is that both women in a pair of identical twins are twice as likely to have had a fibroid-related hysterectomy as both women in a pair of fraternal (non identical) twins. Identical twins share 100 % of their genes, while fraternal twins share only 50 % of their genes. This suggests that the genes that identical twins share make them more likely to form fibroids, since both are identical and non identical twins have equal exposure to environmental factors. This difference between identical and fraternal twins has been observed in a general population of women undergoing hysterectomy and a population of women with fibroids leading to hysterectomy [4, 5].

There is also evidence that women who have close relatives, such as a mother or sister, with fibroids are much more likely to have fibroids themselves [6, 7]. This propensity is called familial aggregation. Just as with breast cancer, if you have many relatives affected by fibroids, your risk of disease is likely to be increased.

Molecular Genetics and Genome-Wide Scan for Fibroid Genes

Finally, in the age of molecular genetics, we can scan markers across the complete sets of DNA, or genomes, of many people to find genetic variations associated with a particular disease. This process is called a genome-wide scan. This is a common approach to finding genes in complex diseases, such as diabetes, asthma and heart disease. With a genome-wide scan, women who are sisters and both have fibroids (an affected sibling pair) are recruited to participate in the study. Their DNA is studied for common genes. If hundreds of women are studied, each region of every chromosome can be examined, and it can be determined which genes are shared by the sisters who share the fibroid phenotype but are different in many other respects. This approach often produces novel genes that were not previously thought to be involved in the disease process [8–11].

Microscopic Facts and Fibroid Viability

Fibroids are composed primarily of smooth muscle cells. The uterus, stomach and bladder are all organs made of smooth muscle. Smooth muscles cells are arranged so that the organ can stretch, instead of being arranged in rigid units like the cells in skeletal muscle in arms and legs that are designed to "pull" in a particular direction. In women with fibroids, tissue from the endometrium typically looks normal under the microscope. Sometimes, however, in submucosal fibroids there is an unusual type of uterine lining that does not have the normal glandular structure. The presence of this abnormality, called aglandular functionalis (functional endometrium with no glands), in women having bleeding disorders is sometimes a clinical clue for their doctors to look more closely for a submucosal fibroid [12]. A second pattern of endometrium, termed chronic endometritis, can also suggest that there may be a submucosal fibroid, although this pattern can also be associated with other problems, such as retained products of conception and various infections of the uterus. Hysterectomy is not the only solution for treating fibroids; distinctions in size, position, and appearance have to be taken into account when deciding upon the best treatment option. If we understand these issues, we may be able to tell why some women have severe bleeding and other women with a similarly sized fibroid have no problem.

Costs of Fibroids

In fact, accurately capturing all the costs attributable to uterine fibroids will help us move toward more, and more effective, innovative therapies. When deciding whether or not to launch a new concept, companies typically look at the amount currently spent for other treatments. The economics of fibroids has chiefly been discussed in terms of the health care costs of hysterectomy. This in itself is a huge amount of money. According to a recent estimate, in the United States, more than $2 billion dollars are spent every year on hospitalization costs due to uterine fibroids alone [13]. Additionally, one study estimates that the health care costs due to uterine fibroids are more than $ 4600 per woman per year [14].

When you incorporate all the costs of fibroids, however, the way of treatment becomes even more significant. Let us consider what costs arise

- The costs of myomectomy, uterine artery embolization (UAE), and other minimally invasive therapies
- The costs of birth control pills and other hormonal treatments to control bleeding
- The costs of tampons, pads, and the adult diapers many women require to contain the bleeding
- The costs of alternative and complementary therapies
- The cost of doing nothing (for many women this means missing work or working less productively during their period).

Reasons for Hysterectomies in Fibroid Patients

Why should a patient have a hysterectomy today when so many alterative treatment possibilities are available? Firstly, up to a certain size of the enlarged uterus, laparoscopic subtotal hysterectomy completely solves the problem and if women want to eliminate every risk of recurrent fibroids, hysterectomy is their only choice. Hysterectomy also solves coexisting problems, such as adenomyosis, endometriosis and endometrial polyps or cervical dysplasia, and there is no danger of ever leaving a sarcoma or carcinoma behind.

Review of All Uterine-Preserving Treatment Possibilities for Fibroids

The surgical treatment of fibroids can be differentiated between less invasive and more invasive surgical techniques. Time and type of treatment have to be chosen individually and are dependent on the patient and the treating gynecologist (Tables 30.1 and 30.2).

Table 30.1 Uterine fibroids or myomatous uterus

Asymptomatic	Symptomatic
Conservative treatment	Operative treatment
No acute need for action	Acute need for action
Medical therapy	Primary operative treatment
Expectant management	Delayed operative treatment with medical pre-treatment

Expectant Management

Wait-and-see is a possibility if patients are asymptomatic, decline medical or surgical treatment or have contraindications to any kind of treatment. However, existing data describe the possibility that fibroids can shrink substantially either by optimizing endocrinological disorders, such as hypothyroidism, or during the postpartum period [15, 16].

To pursue the idea of expectant management, the pelvic mass must definitely be classified as a fibroid and differentiated from an ovarian mass. The complete blood count (CBC) should be normal, especially in patients with severe symptoms, such as menorrhagia or hypermenorrhea. The women must also be informed that the risk of miscarriage, premature labor and delivery, abnormal fetal position and placental abruption is increased during pregnancies with uterine fibroids [17].

Medical Therapy

The benefit of medical treatment in the management of women with symptomatic fibroids is still difficult to prove. Medical therapy can provide adequate symptom relief, especially in cases where hypermenorrhea is the leading problem. The benefit of symptom improvement decreases in long-term treatment periods so that more than 50 % undergo surgery within two years [18].

Nevertheless, there has been a shift in traditional thinking that medical treatment of fibroids is solely based on the manipulation of steroid hormones. A deeper analysis and understanding of specific genes or pathways associated with leiomyomatosis may open new possibilities for prevention and medical treatment [19].

Primarily as a preoperative treatment to decrease heavy bleedings in patients with fibroids, hormonal treatment with selective progesterone modulators, such as ulipristal acetate 5–10 mg daily, have become widely used over the last 2 years [20–22].

Alternative Treatment Methods

If the patient does not want to undergo surgery or there are contraindications to surgery, there are alternative procedures:

Table 30.2 Treatment options for uterine fibroids

Alternative	Surgical						
Uterine artery Embolization	Myomectomy				Hysterectomy		
High intensity focused ultrasound	Hysteroscopic	Laparoscopic	Abdomical	Robotic assisted	Vaginal	Laparoscopic	Abdominal
Miscellaneous methods (myoma coagulation, myolysis)						Supracervical	
						Total	

Uterine Artery Embolization (UAE): This minimally invasive therapeutical option allows an occlusion of the specific arteries supplying blood to the fibroids. A catheter is introduced via the femoral artery under local anesthesia and particles are injected to block the blood flow to the fibroid. This can be an effective treatment option if the uterus should not be removed, surgery is contraindicated and family planning is completed. It results in myoma shrinkage of up to 46 %. Nevertheless, there is still a significant rate of postinterventional complications [23, 24].

Magnetic Resonance-guided focused UltraSound (MgRf-US): This is a more recent treatment method for uterine fibroids in premenopausal women. Again, the patients should have completed their family planning. In this noninvasive thermo ablative technique multiple waves of ultrasound energy are converged on a small volume of tissue, resulting in maximal thermal destruction. The limiting factors are size, vascularity and access [25, 26].

Uterine-Preserving Surgical Treatment of Fibroids

The surgical removal of fibroids is still the main pillar in the treatment of leiomyomas. Hysterectomy is the only definitive solution and can be performed as supracervical or total hysterectomy. Myomectomy performed by hysteroscopy, conventional laparoscopy or laparoscopy with robotic assistance and by the open or vaginal approach are alternative surgical methods.

Indications for surgical therapy of uterine fibroids are:

1. Abnormal uterine bleeding disorders (hypermenorrhea, dysmenorrhea, menorrhagia- and metrorrhagia)
2. Bulk-related symptoms
3. Primary or secondary infertility and recurrent pregnancy loss.

Counseling and Informed Consent

Patients undergoing an operative procedure have to be informed of the risks and potential complications as well as alternative operating methods. Counseling before surgery should include discussion of the entry technique and the associated risks: injury of the bowel, urinary tract, blood vessels, omentum and other surrounding organs and, at a later date, wound infection, adhesion-associated pain and hernia formation.

Counseling needs to integrate the individual risk dependent on the BMI of the patient. Depending on the medical history, it is important to consider anatomical malformations, number of vaginal births, midline abdominal incisions, a history of peritonitis or inflammatory bowel disease [27].

Myomectomy

Myomectomy is a surgical treatment option for women who have not completed their family planning or who wish to retain their uterus for any other reasons. The enucleation of fibroids by any method is an effective therapy for bleeding disorders or displacement pressure in the pelvis. Nevertheless, the risk of recurrence remains after myomectomy. Furthermore, if any other pathologies might be causative or only co-causative for the symptoms (such as adenomyosis uteri), these problems will persist [28]. Complications arising at myoma enucleations and pregnancy-related complications have been investigated extensively. All operating possibilities, especially laparoscopic versus laparotomic, but recently also laparoscopic versus robotic-assisted myomectomy have been evaluated. Uterine rupture or uterine dehiscence is rare and occurs in less than 1 % of laparoscopic cases and even less seldom in robotic-assisted and laparotomic cases. Careful patient selection and preparation, as well as suture techniques, appear to be the most important variables for myomectomy in women of reproductive age [29, 30]. Uteri with multiple fibroids have an increased number of uterine arterioles and venules. Therefore, myomectomy can lead to a significant blood loss and corresponding arrangements should be made [31].

Hysteroscopic Myomectomy

Submucosal fibroids have their origin in myometrial cells underneath the endometrium and represent about 15–20 % of all fibroids. Before the establishment of hysteroscopy as a minimally invasive and effective treatment method, these myomas were removed by hysterotomy or even hysterectomy. Increased surgical training, improvement of technology and the widespread use of hysteroscopic myomectomy have made it a safe, fast, effective and cheap method of fibroid resection while preserving the uterus [32].

Patient selection concentrates on intracavitary submucous and some intramural fibroids. More than 50 % of the fibroid circumference needs to be protruding into the uterine cavity. Deep myometrial leiomyomas require advanced operative skills and have an increased risk for perioperative complications and incomplete resection. The depth of myometrial penetration correlates with the volume of distension fluid absorbed [33, 34]. Few data are available on the size of myoma that prevents the use of the hysteroscopic approach. The European Society of Hysteroscopy suggests to limit the myoma size to 4 cm but the few existing data report a significant increase of complications in fibroids that are >3 cm. Surgical skills determine the size and number of myomas that can be resected [35].

Prior to hysteroscopy, knowledge of the patient's medical history is important e.g. history of caesarean section or any other reason to expect an anatomical disorder. A vaginal ultrasound scan must be performed to precisely determine the uterus location, size and all cervical and uterine pathologies [36]. If available and feasible, fluid hystero-sonography should be performed to better differentiate the relationship of leiomyoma to the endometrial cavity and the myometrium. No prophylactic antibiotic is required to prevent surgical site infection.

The first step is the dilation of the cervical channel with Hegar dilators up to Hegar 9. The most commonly used instrument for fibroid resection is the monopolar or bipolar wire loop. Using a monopolar device the fluid medium must be non-electrolytic, using a bipolar device the fluid medium is isotonic [37]. A continuous flow allows the clearance of blood out of the uterine cavity to improve visualization. Furthermore, the resected pieces can be retracted. Nevertheless, the surface of the myoma and the time needed for resection increase the risk of excessive fluid absorption [38].

The resectoscope is inserted through the cervix into the uterine cavity and after distension with fluid the uterine cavity is carefully inspected. The monopolar resectoscope requires a cutting current of 60–120 W. Bipolar resectoscopes offer the possibility of simultaneous cut and coagulation. The wire loop passes easily through the tissue. The incision starts at the highest point of the myoma. Only in pedunculated fibroids might the incision cut the peduncle first. The loop is then moved towards the surgeon using the spring mechanism and simultaneously the entire resectoscope is gently pulled backwards. The wire loop must be in view of the surgeon during the whole procedure. This motion is repeated until the whole myoma has been resected and the surrounding myometrium (depth) and endometrium (side) can be differentiated. All resected specimen is sent to the pathologist. In cases of heavy bleeding and reduced vision the endometrium and the cutting surface have to be reinspected. These areas can be desiccated with the coagulating current.

The resected area will be recovered by the surrounding endometrium during the following weeks. The complication rate is low (0.8–2.6 %) [38, 39]. Complications that can occur, especially after extensive resection, are uterine perforation or excessive fluid absorption. Absorption of distension fluid might result in hyponatremia or volume overload [40]. The recurrence rate is about 20 % in a follow-up period of more than 3 years [35] .

Laparoscopic Myomectomy

With the improvement of laparoscopic techniques and skills myomectomy can be performed laparoscopically in most women. The laparoscopic approach is usually used for intramural or subserosal fibroids. The main advantage compared to abdominal myomectomy is decreased morbidity and a shorter recovery period. Nevertheless, laparoscopic myomectomy is limited by surgical expertise and especially laparoscopic suturing skills [41, 42]. Selection criteria for laparoscopic myomectomy are location, size and number of fibroids. Nevertheless, these characteristics are variable in relation to the surgical expertise. Preoperative imaging is performed by vaginal ultrasound to assess the precise features of the leiomyomas [31, 36, 43, 44].

Laparoscopic myomectomy starts with the usual placement of ports and trocars. After placement of the initial port in the umbilicus or higher up in the midline, depending on the size of the fibroids, 2–3 ancillary trocars are placed in the lower abdomen about 2 cm medial of each iliac crest and possibly in the midline [31, 45, 46]. Myomectomy can lead to severe bleeding that will complicate the procedure due to reduced vision. Vessel bleeding is controlled by bipolar electrosurgical power tools. Intraoperative bleeding can be reduced using vasopressin or other vasoconstrictors. Vasopressin is diluted (e.g. 20 units in 100 ml of saline) and injected into the planned uterine incision site. Vasopressin constricts the smooth muscle in the walls of capillaries, small arterioles and venules. Nevertheless, due to side effects the surgeon should pull back the plunger of the syringe before insertion to check that the needle is not inserted intravascularly [47–49]. Alternatively, misoprostol can be administered vaginally about one hour before surgery to reduce blood loss [50].

The uterine incision is preferably made vertically as this allows a more ergonomic suturing of the defect. The incision is performed with a monopolar hook directly over the fibroid and carried through deeply until the entire myoma tissue has been reached (Figs. 30.1, 30.2, 30.3, 30.4, 30.5 and 30.6).

After exposure of the myoma, it is grasped with a tenaculum or sharp forceps and traction and countertraction are applied. The removal of the myoma can easily be performed with blunt and sharp dissecting devices. Capsular vessels should be coagulated before complete removal of the myoma as coagulation becomes more difficult if traction is unsuccessful and bipolar coagulation occurs in the remaining myometrium wall. Subsequent to removal, the myoma is morcellated with an electromechanical device under direct vision and at a safe distance to all structures, such as the small bowel, to avoid inadvertent injury. The myoma tissue is removed and sent for pathologic evaluation. The uterine defect is closed with delayed absorbable sutures in one or two layers, depending upon the depth of the myometrial defect. It is important that the suture starts at the deepest point to avoid any cavity that might lead to a weak uterine wall. Furthermore, we tie the knot extracorporally so that the knot can be pushed into the deep layers with full strength (Fig. 30.7).

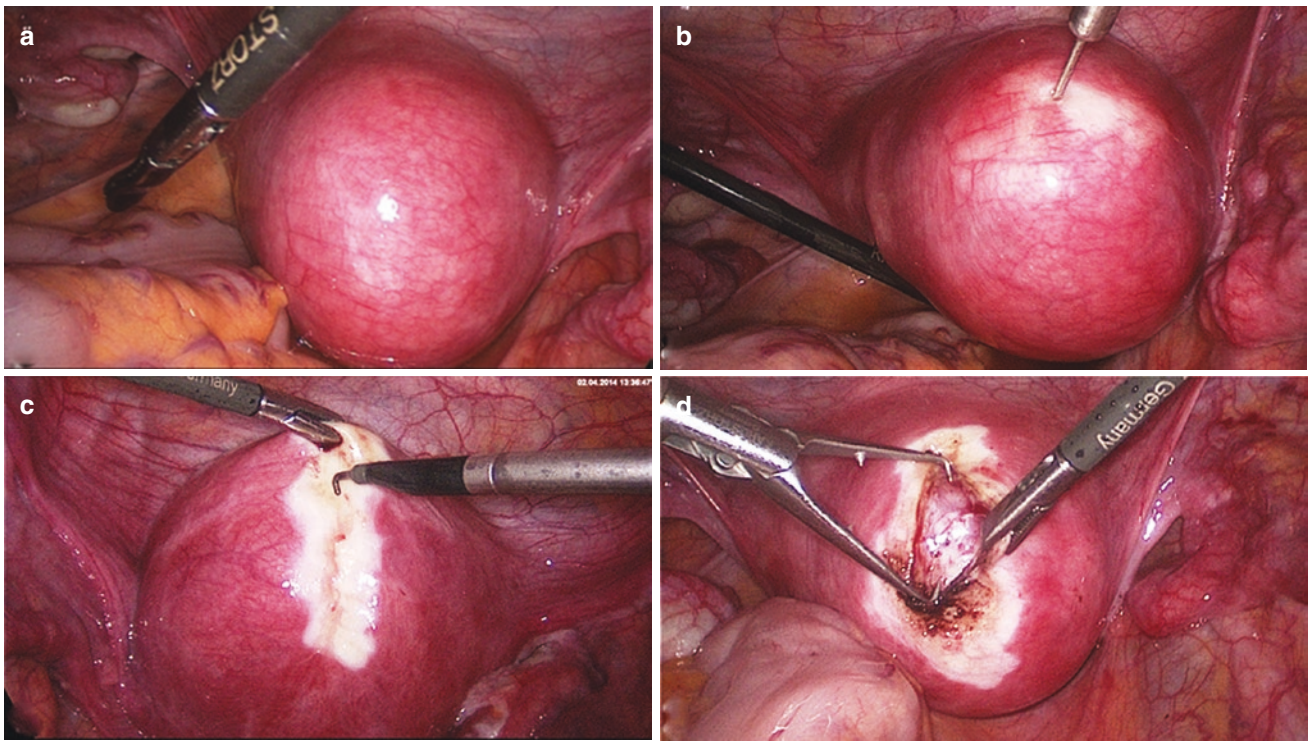


Fig. 30.1 Laparoscopic myoma enucleation. (**a**) Situs of a fundal/anterior wall fibroid. (**b**) Prophylactic hemostasis with 1:100 diluted vasopressin solution (Gylcilpressin) in separate wells. The injection intends to separate the pseudocapsule from the fibroid and reduces bleedings. (**c**) Bipolar superficial coagulation of the longitudinal incision strip and opening of the uterine wall with the monopolar hook or needle up to the fibroid surface. (**d**) Grasping of the fibroid and beginning of the enucleation. The pseudocapsule remains within the uterine wall and is pushed off bluntly

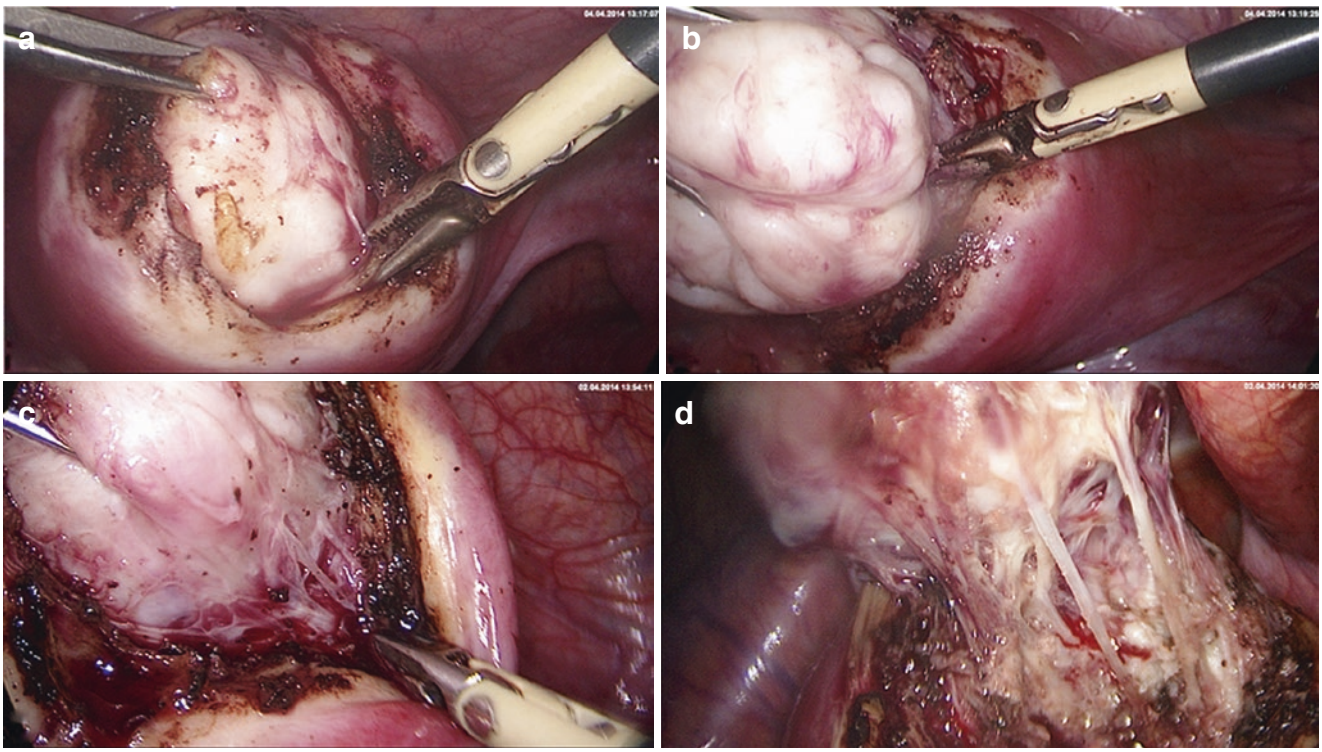


Fig. 30.2 Laparoscopic myoma enucleation. (**a**) Traction of the fibroid with a tenaculum and blunt delineation from the capsule. (**b**) Focal bipolar coagulation of basic vessels. (**c**) Continuous enucleation of the fibroid under traction and specific coagulation of capsule vessels containing fibers. (**d**) Magnification of remaining capsule fibers to be coagulated and cut

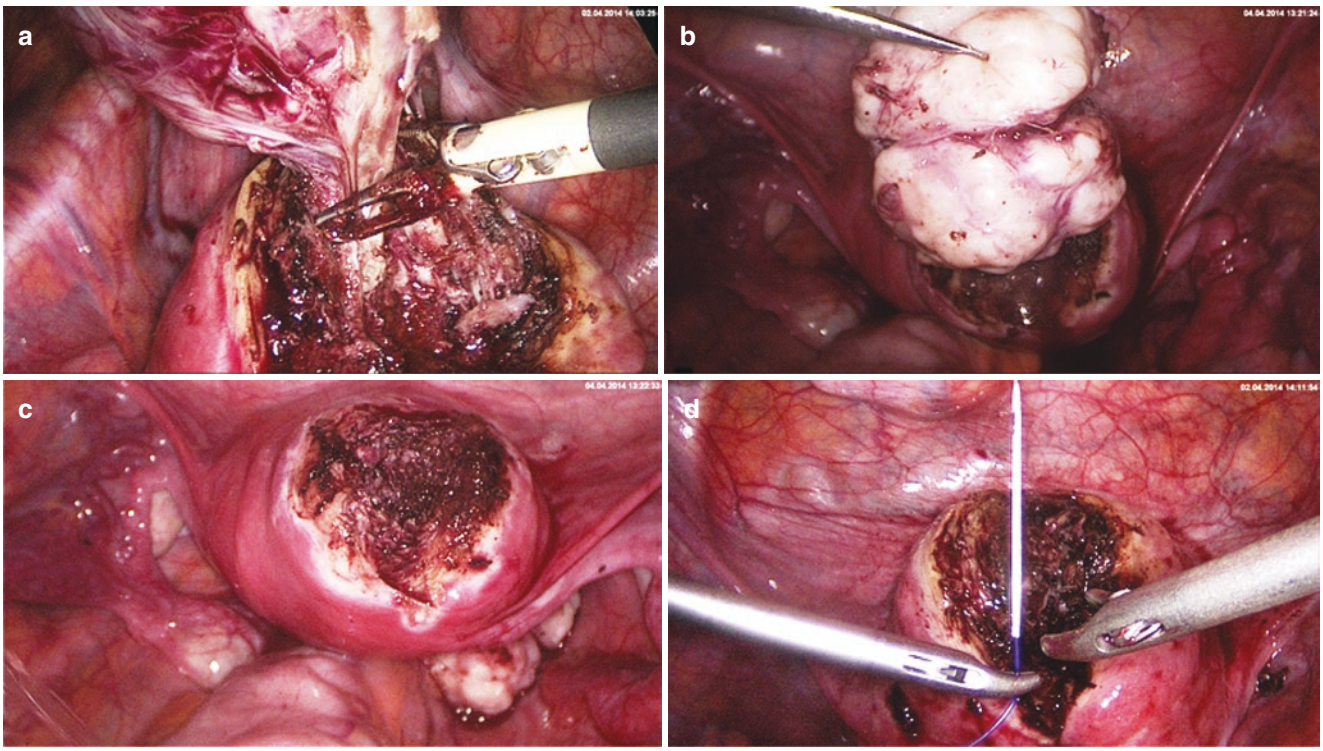


Fig. 30.3 Laparoscopic myoma enucleation. (**a**) Final coagulation of the capsule vessels. (**b**) Double belly fibroid after complete enucleation. (**c**) Minimal coagulation of bleeding vessels under suction and irrigation. (**d**) Approximation of wound edges with either straight or round, sharp needle and a monofilar late-absorbable suture

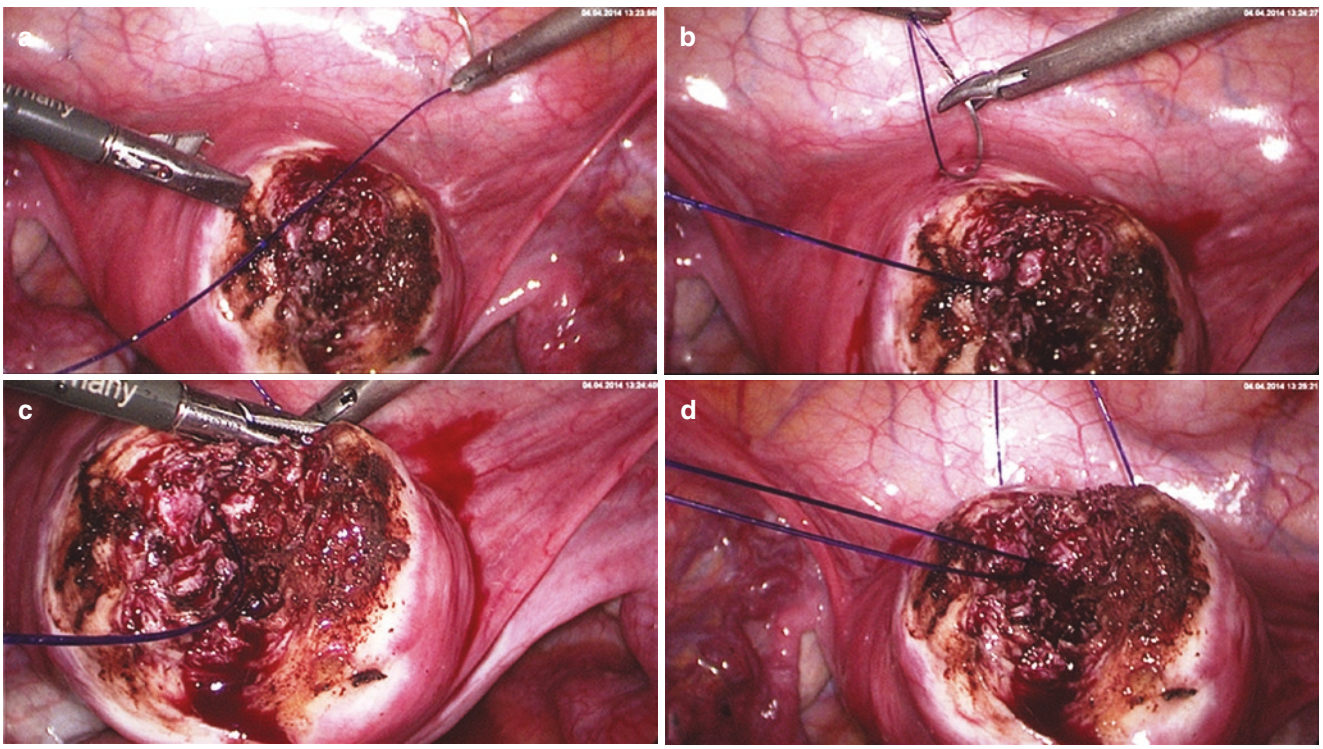


Fig. 30.4 Laparoscopic myoma enucleation. (**a**) Advantage of round needle stitch. The wound angle is elevated safely and completely by elevation with a Manhes forceps. Deeper layers of the myometrium can be grasped more easily using a round needle. (**b**) Needle exit and simplified regrasping with the right needle holder. (**c**) Final stitch to invert the knot. (**d**) Extirpation of the needle and completion of the extracorporeal knot and preparation to push down the extracorporeal knot

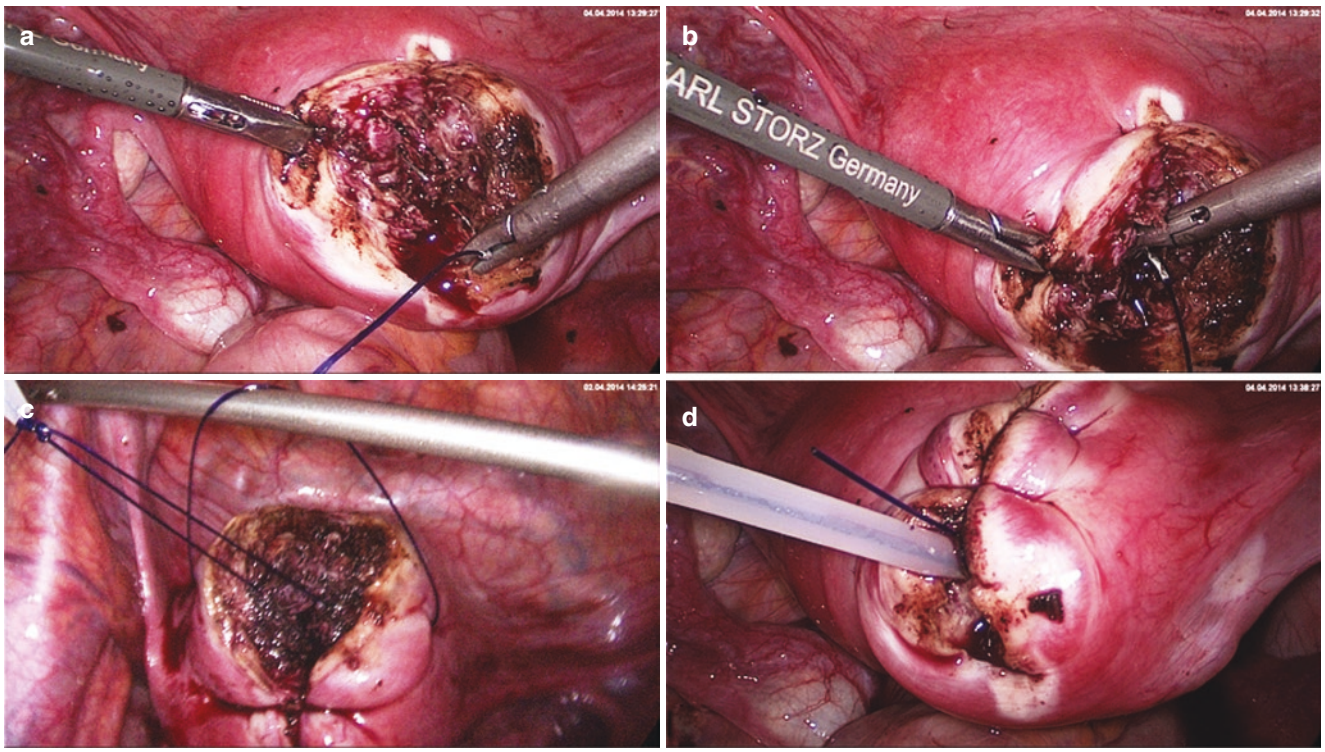


Fig. 30.5 Performance of the extracorporeal "von Leffern" knot. (**a**) Pulling out the suture, removing the needle, half hitch. (**b**) Holding the knot with the left hand and reaching over with the right hand. (**c**) Grasping the short end from below and leading it back, exiting before the half hitch. (**d**) Turning back the knot. Holding the straight suture and tightening the knot

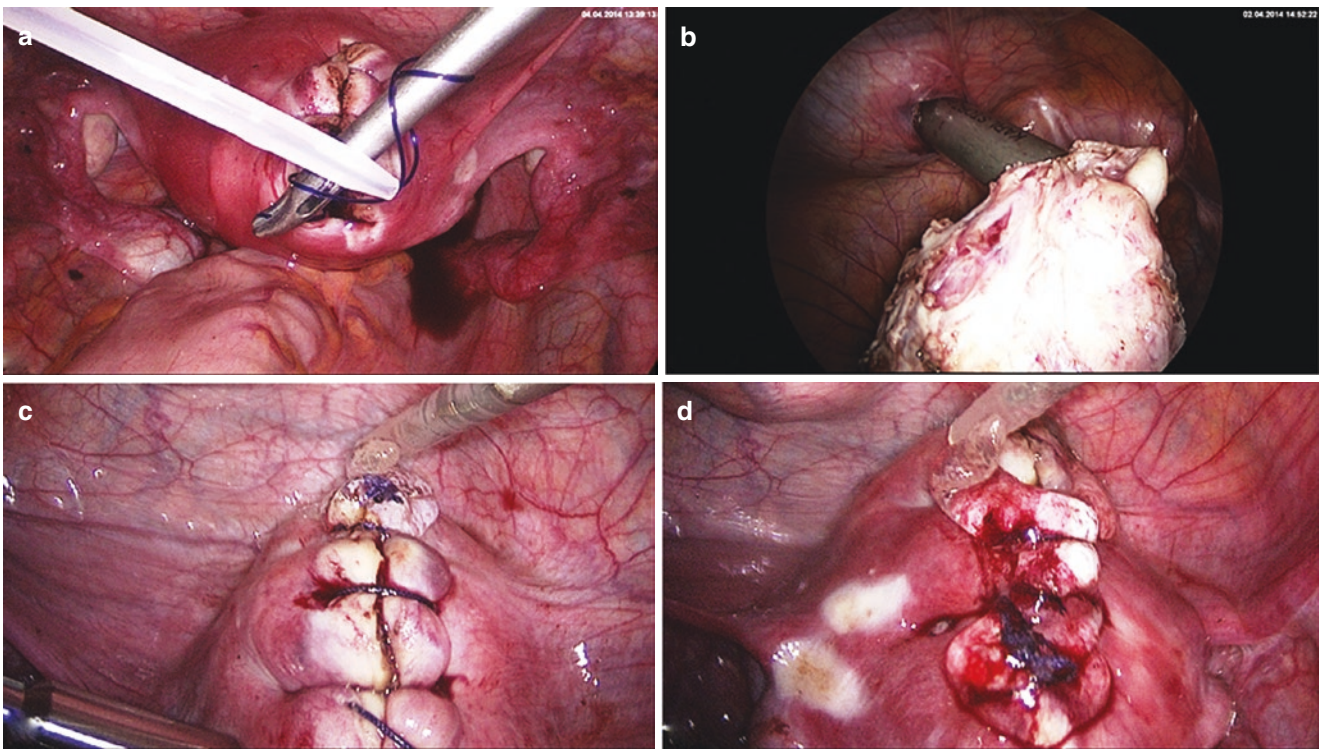


Fig. 30.6 Laparoscopic myoma enucleation. (**a**) Second single stitch starting as deep as possible in the uterine wound. (**b**) Exit of the needle on the left wound margin (just next to the Manhes forceps). (**c**) Completion of the stitch and preparation of the extracorporeal von Leffern knot. The needle holder elevates the thread to avoid tearing of the uterine wall while pulling through the monofilar thread (PDS). (**d**) The extracorporeal knot is pushed down with a plastic push-rod and deposited deep in the wound minimizing the external suture part

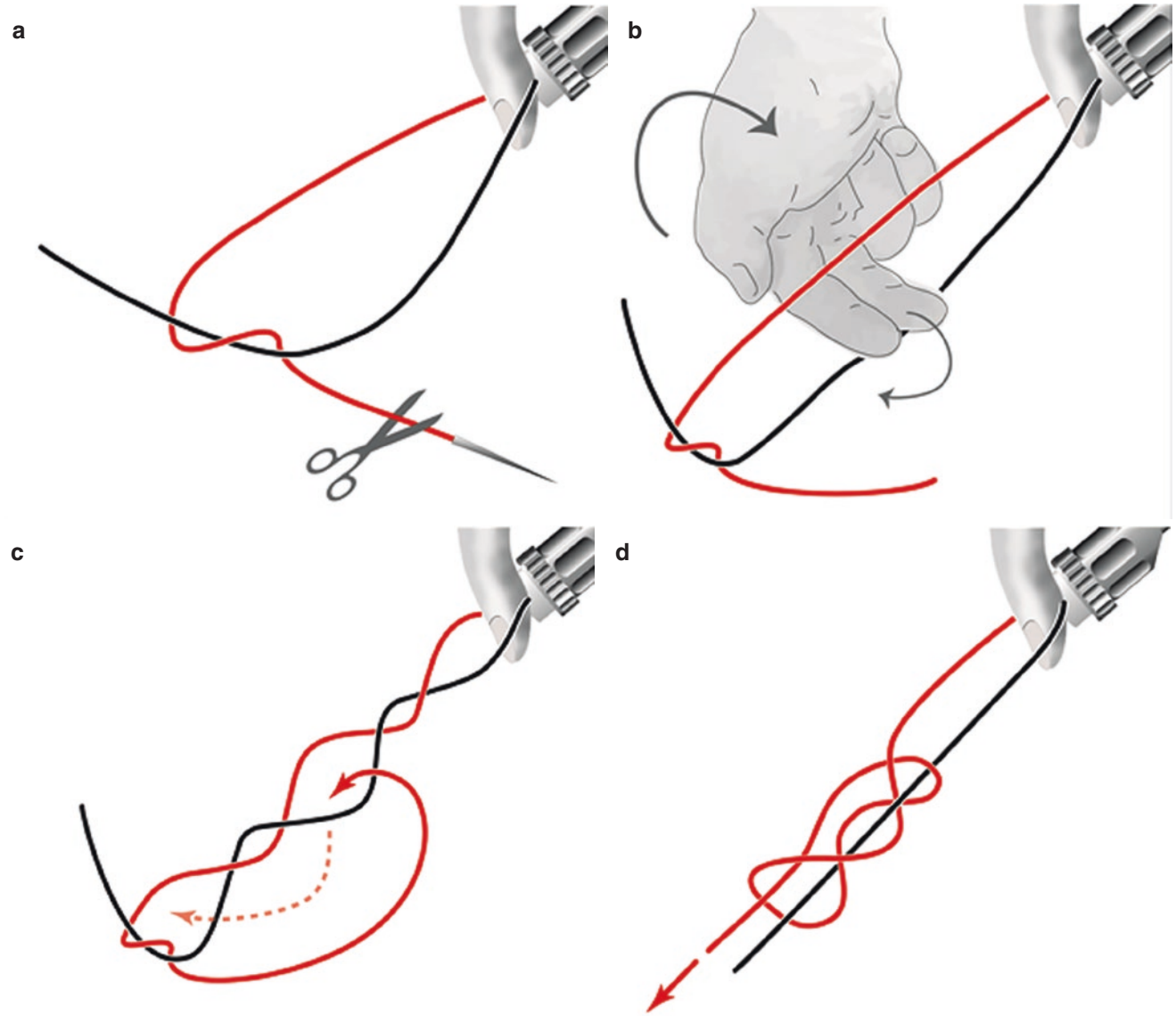


Fig. 30.7 Laparoscopic myoma enucleation. (**a**) Intracorporeal safety knot of the knot performed extracorporeally. (**b**) Morcellation of the fibroid with the Rotocut morcellator (Storz) in an apple-peeling manner. (**c**) Final situs showing the extracorporeal sutures to adapt the uterine wound edges. (**d**) Application of Hyalo Barrier (Nordic Pharma) for adhesion prevention

Alternatively, barbed sutures, such as V-lock, can be used to tighten the tissue or a third ancillary trocar can be inserted to hold the suture tight. The security of the uterine closure has bearing on the risk of uterine rupture in subsequent pregnancy. Different kinds of adhesion prevention barriers can be applied (Fig. 30.8) [51–53]. Women should wait at least 4–6 months before attempting to conceive [54].

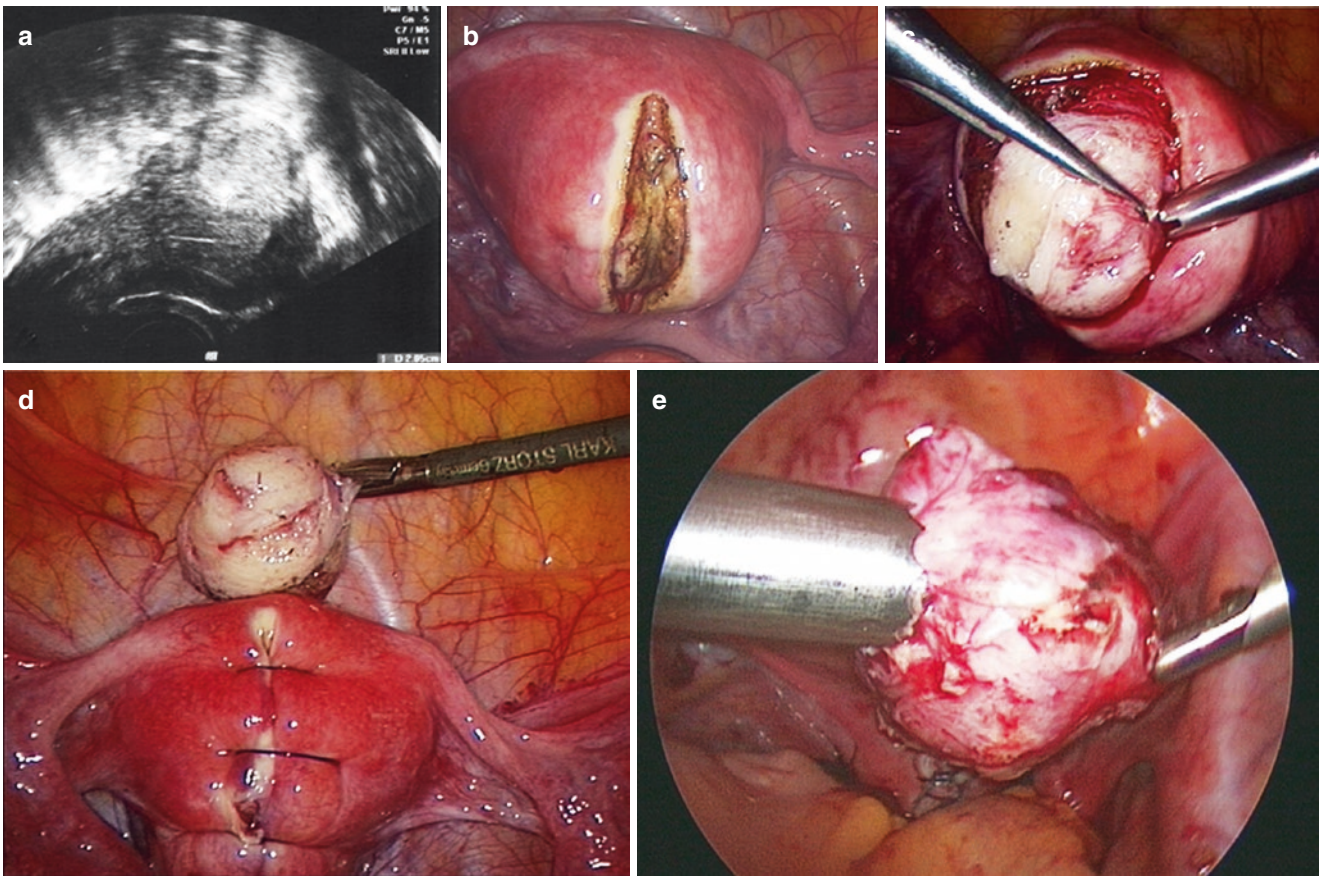


Fig. 30.8 (**a**) Transvaginal ultrasound shows a 3.5 cm intramural myoma in the back wall of the uterus. (**b**) Intraoperative uterotomy just above the myoma after injection of vasopressin. The uterotomy includes the myometrium and the myoma capsule and is done with a monopolar needle. All different tissue layers can be differentiated (**c**) Intraoperative sight of the myoma and its surrounding vascularized capsule. (**d**) Reconstruction of the uterine wall after excision of the tumor. (**e**) Removal of the myoma by morcellation

Abdominal Myomectomy

Abdominal or open myomectomy has its origin in the early 1900s as a uterus-preserving procedure. Today, it is mostly performed for women with intramural or subserosal myomas and less frequently for submucosal localization. Since the introduction of endoscopic procedures, the indication for abdominal myomectomy has become rare. It becomes an option if hysteroscopic or laparoscopic myomectomy is not feasible or if a laparotomy is required for any other reason. The indication to exclude uterine sarcomas has to be taken very strictly; however, uterine sarcoma is a very rare malignancy and the rate of sarcoma after clinical diagnosis of myoma is very low. The risk of severe complications in association with open surgery is higher than with hysteroscopic or laparoscopic moymectomy. Prophylactic antibiotics should be given for any abdominal fibroid operation [55, 56]. After the Pfannenstil incision either a vertical or transverse uterine incision is performed [57]. The myoma enucleation is performed by traction on the myometrial edges, e.g. with Allis clamps. After exposure of the fibroid it can be extirpated. The pseudocapsule is typically dissected bluntly. The uterine defects are closed with sutures in in several layers to reapproximate the tissue and achieve haemostasis without excessive bipolar coagulation.

Robotic Myomectomy

Robot-assisted laparoscopic myomectomy is a relatively new approach. The advantages of robotic surgery are three-dimensional imaging, mechanical improvement, including 7 ° of freedom for each instrument, stabilization of the instruments within the surgical field and improved ergonomics for the surgeon. Technical difficulties are decreased as suturing is easier than during conventional laparoscopy; however, there are few data comparing robot-assisted with conventional laparoscopic myomectomy [58–60]. The advantages compared to abdominal myomectomy are decreased blood loss and shorter recovery time. Nevertheless,

operation duration and operating costs are much higher than for conventional procedures. Furthermore, robotic devices are large and bulky. Robotic surgery is limited by the lack of tactile feedback and additional team training is necessary to minimize the risk of mechanical failure [61]. To date, no advantage compared to conventional laparoscopy could be demonstrated regarding blood loss or operative duration. A more secure myometrial closure has not yet been proven [59]. In obese patients robot-assisted surgery might be beneficial [62].

Hysterectomy as Treatment for Myomas

As fibroids are also the most common indication for hysterectomy (30 % of hysterectomies in white and 50 % of hysterectomies in black women), specific focus is given to hysterectomies within this chapter. The decision for a hysterectomy in a multifibroid uterus depends on the wish of the patient, her health status, whether childbearing has been completed and on the combined decision with the doctor. Only if the patient suffers from metrorrhagia does the disorder need to be examined pre-operatively in more detail as this may be a sign of endometrial cancer or sarcoma. Nevertheless, the combined evaluation of MRI and tumor makers pre-operatively leads to a more specific diagnosis of rapidly growing uterine masses or adnexas in the case of a leiomyomatous uterus or adnexal tumors. Only in cases where malignancy is not suspected is a simple TLH or SLH recommended, otherwise an oncological approach has to be selected. Hysterectomy as TLH or SLH is recommended for the following indications:

- Acute hemorrhage with non-response to other therapies
- Completion of family planning and current or increased future risk of other diseases, such as cervical intraepithelial neoplasia, endometrial hyperplasia or an increased risk of uterine or ovarian cancer. Precondition for the indication for hysterectomy is that these risks can be eliminated or decreased by hysterectomy.
- Failure of previous treatment.
- Completion of family planning and significant symptoms (e.g. multiple fibroids or adenomyosis) and the desire for a definitive solution.

The main advantage of hysterectomy over all other therapeutical possibilities is the definitive solution in eliminating all existing symptoms and the risk of recurrence. Nevertheless, the advantage of a definitive solution that allows freedom from future problems can be an obstacle if family planning has not been completed or the patient has a personal inhibition against the removal of the central genital female organ [63]. These issues must be discussed in advance with the patient before the decision for a hysterectomy is taken. Furthermore, for a solitary submucous, subserous, pedunculated or intramural myoma, the complication rate of a hysterectomy has to be compared with the complication rate of a myomectomy. The operational risks have to be compared to the operational risks of hysteroscopy, laparoscopic fibroid enucleation or conservative management. With the advances in cervical cancer screening the prevention of future cervical or uterine pathologies is no longer a relevant indication for hysterectomy. The decision must be tailored to meet the needs of each individual patient.

Laparoscopic hysterectomy was first introduced in 1989 with the aim of reducing the morbidity and mortality of abdominal hysterectomy to the level reached with vaginal hysterectomy. Laparoscopic assistance for vaginal hysterectomy can be of advantage if there is a need for adhesiolysis, a need to treat endometriosis simultaneously, a need to treat large leiomyomas and to ensure an easier and safer adnexectomy. If feasible, vaginal hysterectomy allows a more rapid and less painful recovery than open or laparoscopic surgery and is much cheaper [64].

Should Ovaries and/or Fallopian Tubes Be Removed or Left in Place at Hysterectomy?

Ovaries

Generally, the ovaries are not removed when a hysterectomy is performed for uterine fibroids. Removing the uterus alone will cure the bleeding and the size-related symptoms caused by the fibroids. When treating fibroids it is not necessary to remove the ovaries or fallopian tubes as is sometimes the case when treating other diseases, such as endometriosis or gynecologic cancers.

Many physicians were taught that at a set age (which varies between 35 and 50) women should be told that removal of the ovaries is recommended as part of the surgery, with the speculation of “while we are there, we may as well.” The general teaching has been that ovaries do not have any function after menopause and the risk of ovarian cancer increases with increasing age, so removing the ovaries near the time of menopause was a no-lose proposition. This was especially true if hormone replacement therapy could be used to help younger women transition to the time when they would naturally go through menopause.

However, more recent research suggests that although after menopause the ovaries produce little estradiol (the major estrogen in premenopausal women), they produce a tremendous amount of androgens (usually thought of as male hormones) [65]. It is thought that these androgens may be important in maintaining mood and sex drive [66–68]. In

addition, the risks of hormone replacement have become clearer, and many women choose to use hormones following menopause [69, 70]. Most women are aware of the research from the Women's Health Initiative demonstrating significant complications with postmenopausal hormone replacement therapy. However, it is not widely known that the risks are lower for women without a uterus, who are able to take estrogen alone [70]. Recently the association of premature loss of ovarian function and the increasing risk of heart disease has also been investigated [71].

Considering all these factors, there are good reasons to retain the ovaries if possible. The major reason to remove them at the time of fibroid surgery is if the woman has a high risk of ovarian cancer.

Fallopian Tubes

According to new research presented at the Annual Clinical Meeting of The American College of Obstetricians and Gynecologists in 2013, bilateral salpingectomy at hysterectomy, with preservation of the ovaries, is considered a safe way of potentially reducing the development of ovarian serous carcinoma, the most common type of ovarian cancer. Increasing evidence points toward the fallopian tubes as the origin of this type of cancer. Removing the fallopian tubes does not cause the onset of menopause, as does the removal of the ovaries.

Prophylactic removal of the fallopian tubes during hysterectomy or sterilization would rule out any subsequent tubal pathology, such as hydrosalpinx, which is observed in up to 30 % of women after hysterectomy. Moreover, this intervention is likely to offer considerable protection against later tumor development, even if the ovaries are retained. Thus, we recommend that any hysterectomy should be combined with salpingectomy. Women undergoing hysterectomy with retained fallopian tubes or sterilization have at least a doubled risk of subsequent salpingectomy. Removal of the fallopian tubes at hysterectomy should therefore be recommended [72, 73].

For this reason, once the reproductive function is completed the tubes of a female of reproductive age should be removed while the ovaries should remain to support the female wellbeing. Beyond the reproductive age, tubes should always be removed with the uterus while ovaries, as previously discussed, are routinely removed only above the age of 65 years.

Abdominal Hysterectomy

As the indication for abdominal hysterectomy in benign diseases has become very rare, it is not discussed in this article [74].

Vaginal Hysterectomy

Before beginning a vaginal hysterectomy, a bimanual pelvic examination is performed to assess uterine mobility and descent and to exclude unsuspected pathology of the adnexa. Only then can a final decision be made whether to proceed with a vaginal or abdominal approach. The operation starts with entry into the cul-de-sac or the vesico vaginal fold. Here we describe the posterior peritoneal opening. The uterosacral ligaments are identified and clamped, including the lower portion of the cardinal ligaments. In the next step the vesicovaginal space is opened and after identification of the peritoneal fold it is cut and the cardinal ligaments are ligated, including the uterine vessels. Most adnexa can be removed by grasping the ovary and clamping the infundibulopelvic ligament. The uterus can then be enucleated stepwise from the remaining peritoneal fold at a safe distance from the bladder. The peritoneum can either be closed or left open and the vaginal epithelium is reapproximated in either a vertical or a horizontal manner. A myomatous uterus has to be morcellated in a circular manner. Sometimes it is necessary to enucleate large solitary myomas or perform intramyometrial coring, especially in cases of diffusely enlarged uteri [75, 76].

Subtotal Laparoscopic Hysterectomy (SLH)

The supracervical (subtotal) hysterectomy was first described by Semm in 1990 and in another technique by Lyons. The operative technique is similar to the total laparoscopic hysterectomy. Only after occluding the ascending branch of the uterine artery is the uterine corpus resected as a reverse conus down to the endocervical canal [77]. For SLH and TLH the trocar placements are the same as for laparoscopic myomectomy and depend on the size of the uterus (see above). There is no need to perform ureterolysis at the beginning of the operation as the ureter is at a safe distance if the suturing line is kept strictly at the uterine wall. The infundibulopelvic ligament and the round ligament are divided from the pelvic side wall and, if the adnexa are to remain in situ, division of the adnexa from the uterus is performed. The broad ligament is then opened, dissected and each leaf separately coagulated. The bladder is separated from the uterus by opening the vesicouterine ligament and pushing the bladder downwards for about 1–2 cm. This is followed by presentation of the ramus ascendens of the uterine artery and division of the uterine pedicles with the same stepwise dissection of the left adnexa. A thorough inspection of the cervix then takes place. The cervix is separated from the uterus with the help of the electric cutting loop or any other cutting instrument. This is followed by coagulation of the cervical canal and closure of the peritoneum over the remaining cer-

vical stump for infection and adhesion prevention. However, the peritoneum can also be left open, according to surgeon preference. Afterwards, morcellation of the uterine body is performed and, if the adnexa are also resected, they should be put into an endo bag for extraction.

As morcellation techniques are described in detail in other chapters of the book, the importance of this technique is not dealt with here.

Total Laparoscopic Hysterectomy (TLH)

LSH should be avoided if adenomyosis uteri is suspected because part of the endometrial glands remain in the cervical and paracervical channel. These can cause an early recurrence or persistence of the symptoms although the few existing data offer no direct confirmation of this view [78, 79].

The surgical steps are identical to the LSH, the only difference being that a uterine manipulator is placed in the vagina before the operation. After separation of the bladder from the uterus, the bladder is pushed and dissected down 2–3 cm to clearly visualize the rim of the cervical cup. In cases of post-caesarean section, a gentle, blunt and intermediate sharp dissection has to be carried out. After the uterus has been lateralized by pushing up the manipulator, the uterine artery and vein with collateral vessels are completely coagulated near the cervix and dissected. The vagina is resected from the cervix with the monopolar hook by firmly stretching the manipulator cranially and carefully performing an intrafascial dissection leaving the sacrouterine ligaments almost completely in place. This is in accordance with the CISH technique introduced by Kurt Semm [80]. The uterus is then retracted through the vagina while still fixed to the manipulator. If the uterus is too large, it has to be morcellated either intraabdominally or transvaginally. The vagina is closed with 2 corner sutures and 1 or 2 sutures in between the corner sutures. The sacrouterine ligaments and the middle portion of the vagina are stitched and elevated by the corner sutures to prevent vaginal prolapse or enterocele formation at a later time. Peritonealization and drainage are not required.

With the improvement of endoscopic surgery and above all the improvement in endoscopic suturing laparoscopic-assisted vaginal hysterectomy has become obsolete, especially as this technique does not include a suspension of the cardinal and sacrouterine ligaments.

Conclusions

Treatment options for uterine leiomyomas vary. The choice of treatment should be made on an individual basis taking into account the following factors: the patient's level of suffering due to bleeding disorders or displacement-caused pain, the status of family planning and the patient's preferences regarding the different treatment options.

In *asymptomatic women* expectant management is suggested except for hydronephrosis caused by displacement or hysteroscopically resectable submucous fibroids in women who pursue pregnancy.

In *postmenopausal women* without hormonal therapy fibroids usually shrink and become asymptomatic. Therefore, expectant management is the method of choice. However, sarcoma should be excluded if a new or an enlarging pelvic mass occurs in a postmenopausal woman. Surgical treatment is the option of choice if the leiomyomas are symptomatic. If there are contraindications to operative procedures or hysterectomy is declined by the patient for personal reasons, any of the alternative treatment options can be considered (medical, embolization or guided ultrasound).

In *premenopausal women* appropriate submucosal leiomyomas should be resected hysteroscopically if the women wish to preserve their childbearing potential and/or they are symptomatic (e.g. bleeding, miscarriage). Intramural and subserosal leiomyomas in women who wish to preserve their fertility can be removed laparoscopically. Nevertheless, an appropriate surgical technique and advanced laparoscopic skills are necessary. If this cannot be guaranteed, abdominal myomectomy has to be recommended or referral to a laparoscopic center to maximize the possibility and safety of pregnancy after uterine reconstruction. The risk of uterine rupture in pregnancy following myomectomy needs to be discussed with the patient.

Robotic assistance makes laparoscopic suturing easier and offers surgery with 3 dimensional vision; however, costs are still high. Further developments in robotic assistance, including force feedback, will catch more of our attention in the future.

For *women who have completed their family planning,* hysterectomy is the definitive procedure for relief of symptoms and prevention of recurrence of fibroid-related problems. With increasing experience in laparoscopic hysterectomies, the risk of side effects has become manageable. In relation to the compliance and individuality of the patient, a suitable solution can be either laparoscopic supracervical or total laparoscopic hysterectomy.

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References

1. Watson JD, Crick FH. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid. Nature. 1953;171(4356):737–8.
2. Watson JD, Crick FH. Genetical implications of the structure of deoxyribonucleic acid. Nature. 1953;171(4361):964–7.
3. Spektrum der Wissenschaft.

4. Treloar SA et al. Pathways to hysterectomy: insights from longitudinal twin research. Am J Obstet Gynecol. 1992;167(1):82–8.
5. Snieder H, MacGregor AJ, Spector TD. Genes control the cessation of a woman's reproductive life: a twin study of hysterectomy and age at menopause. J Clin Endocrinol Metab. 1998;83(6):1875–80.
6. Vikhlyaeva EM, Khodzhaeva ZS, Fantschenko ND. Familial predisposition to uterine leiomyomas. Int J Gynaecol Obstet. 1995;51(2):127–31.
7. Van Voorhis BJ, Romitti PA, Jones MP. Family history as a risk factor for development of uterine leiomyomas. Results of a pilot study. J Reprod Med. 2002;47(8):663–9.
8. Al-Hendy A, Salama SA. Catechol-O-methyltransferase polymorphism is associated with increased uterine leiomyoma risk in different ethnic groups. J Soc Gynecol Investig. 2006;13(2):136–44.
9. Tsibris JC et al. Insights from gene arrays on the development and growth regulation of uterine leiomyomata. Fertil Steril. 2002;78(1):114–21.
10. Wang H et al. Distinctive proliferative phase differences in gene expression in human myometrium and leiomyomata. Fertil Steril. 2003;80(2):266–76.
11. Gross K, Morton C, Stewart E. Finding genes for uterine fibroids. Obstet Gynecol. 2000;95(4 Suppl 1):60.
12. Patterson-Keels LM et al. Morphologic assessment of endometrium overlying submucosal leiomyomas. J Reprod Med. 1994;39(8):579–84.
13. Flynn M et al. Health care resource use for uterine fibroid tumors in the United States. Am J Obstet Gynecol. 2006;195(4):955–64.
14. Hartmann KE et al. Annual costs associated with diagnosis of uterine leiomyomata. Obstet Gynecol. 2006;108(4):930–7.
15. Peddada SD et al. Growth of uterine leiomyomata among premenopausal black and white women. Proc Natl Acad Sci U S A. 2008;105(50):19887–92.
16. Laughlin SK, Hartmann KE, Baird DD. Postpartum factors and natural fibroid regression. Am J Obstet Gynecol. 2011;204(6):496 e1–6.
17. Zaima A, Ash A. Fibroid in pregnancy: characteristics, complications, and management. Postgrad Med J. 2011;87(1034):819–28.
18. Marjoribanks J, Lethaby A, Farquhar C. Surgery versus medical therapy for heavy menstrual bleeding. Cochrane Database Syst Rev. 2006;2:CD003855.
19. Al-Hendy A et al. Gene therapy of uterine leiomyomas: adenovirus-mediated expression of dominant negative estrogen receptor inhibits tumor growth in nude mice. Am J Obstet Gynecol. 2004;191(5):1621–31.
20. Donnez J et al. Ulipristal acetate versus placebo for fibroid treatment before surgery. N Engl J Med. 2012;366(5):409–20.
21. Donnez J et al. Long-term treatment of uterine fibroids with ulipristal acetate. Fertil Steril. 2014;101(6):1565–73. e1–18.
22. Donnez J et al. Efficacy and safety of repeated use of ulipristal acetate in uterine fibroids. Fertil Steril. 2015;103(2):519–27. e3.
23. Edwards RD et al. Uterine-artery embolization versus surgery for symptomatic uterine fibroids. N Engl J Med. 2007;356(4):360–70.
24. van der Kooij SM et al. Uterine artery embolization versus surgery in the treatment of symptomatic fibroids: a systematic review and metaanalysis. Am J Obstet Gynecol. 2011;205(4):317 e1–18.
25. Kim HS et al. MR-guided high-intensity focused ultrasound treatment for symptomatic uterine leiomyomata: long-term outcomes. Acad Radiol. 2011;18(8):970–6.
26. Funaki K, Fukunishi H, Sawada K. Clinical outcomes of magnetic resonance-guided focused ultrasound surgery for uterine myomas: 24-month follow-up. Ultrasound Obstet Gynecol. 2009;34(5):584–9.
27. RCoOa G. Preventing entry-related gynaecological laparoscopic injuries. RCOG Green-top Guideline. 2008;49:1–10.
28. Wallach EE, Vlahos NF. Uterine myomas: an overview of development, clinical features, and management. Obstet Gynecol. 2004;104(2):393–406.
29. Kim MS et al. Obstetric outcomes after uterine myomectomy: laparoscopic versus laparotomic approach. Obstet Gynecol Sci. 2013;56(6):375–81.
30. Lonnerfors C, Persson J. Pregnancy following robot-assisted laparoscopic myomectomy in women with deep intramural myomas. Acta Obstet Gynecol Scand. 2011;90(9):972–7.
31. Mettler L et al. Complications of uterine fibroids and their management, surgical management of fibroids, laparoscopy and hysteroscopy versus hysterectomy, haemorrhage, adhesions, and complications. Obstet Gynecol Int. 2012;2012:791248.
32. Di Spiezio Sardo A et al. Hysteroscopic myomectomy: a comprehensive review of surgical techniques. Hum Reprod Update. 2008;14(2):101–19.
33. Emanuel MH et al. An analysis of fluid loss during transcervical resection of submucous myomas. Fertil Steril. 1997;68(5):881–6.
34. Wamsteker K, Emanuel MH, de Kruif JH. Transcervical hysteroscopic resection of submucous fibroids for abnormal uterine bleeding: results regarding the degree of intramural extension. Obstet Gynecol. 1993;82(5):736–40.
35. Hart R, Molnar BG, Magos A. Long term follow up of hysteroscopic myomectomy assessed by survival analysis. Br J Obstet Gynaecol. 1999;106(7):700–5.
36. Mettler L et al. Imaging in gynecologic surgery. Womens Health (Lond Engl). 2011;7(2):239–48. quiz 249–50.
37. Varma R et al. Hysteroscopic myomectomy for menorrhagia using Versascope bipolar system: efficacy and prognostic factors at a minimum of one year follow up. Eur J Obstet Gynecol Reprod Biol. 2009;142(2):154–9.
38. Loffer FD et al. Hysteroscopic fluid monitoring guidelines. The ad hoc committee on hysteroscopic training guidelines of the American Association of Gynecologic Laparoscopists. J Am Assoc Gynecol Laparosc. 2000;7(1):167–8.
39. Jansen FW et al. Complications of hysteroscopy: a prospective, multicenter study. Obstet Gynecol. 2000;96(2):266–70.
40. Propst AM et al. Complications of hysteroscopic surgery: predicting patients at risk. Obstet Gynecol. 2000;96(4):517–20.
41. Parker WH, Rodi IA. Patient selection for laparoscopic myomectomy. J Am Assoc Gynecol Laparosc. 1994;2(1):23–6.
42. Lefebvre G et al. The management of uterine leiomyomas. J Obstet Gynaecol Can. 2003;25(5):396–418. quiz 419–22.
43. Alkatout I et al. Precarious preoperative diagnostics and hints for the laparoscopic excision of uterine adenomatoid tumors: two exemplary cases and literature review. Fertil Steril. 2011;95(3):1119 e5–8.
44. Dueholm M et al. Accuracy of magnetic resonance imaging and transvaginal ultrasonography in the diagnosis, mapping, and measurement of uterine myomas. Am J Obstet Gynecol. 2002;186(3):409–15.
45. Alkatout I et al. Principles and safety measures of electrosurgery in laparoscopy. JSLS. 2012;16(1):130–9.
46. Alkatout I et al. Organ-preserving management of ovarian pregnancies by laparoscopic approach. Fertil Steril. 2011;95(8):2467–70. e1–2.
47. Kongnyuy EJ, Wiysonge CS. Interventions to reduce haemorrhage during myomectomy for fibroids. Cochrane Database Syst Rev. 2011;11:CD005355.
48. Zhao F et al. Evaluation of loop ligation of larger myoma pseudocapsule combined with vasopressin on laparoscopic myomectomy. Fertil Steril. 2010;95(2):762–6.
49. Tinelli A et al. Impact of surgical approach on blood loss during intracapsular myomectomy. Minim Invasive Ther Allied Technol. 2013;23(2):87–95.
50. Celik H, Sapmaz E. Use of a single preoperative dose of misoprostol is efficacious for patients who undergo abdominal myomectomy. Fertil Steril. 2003;79(5):1207–10.
51. Mettler L et al. Cross-linked sodium hyaluronate, an anti-adhesion barrier gel in gynaecological endoscopic surgery. Minim Invasive Ther Allied Technol. 2013;22(5):260–5.

52. Mettler L, Schollmeyer T, Alkatout I. Adhesions during and after surgical procedures, their prevention and impact on women's health. Womens Health (Lond Engl). 2012;8(5):495–8.
53. Tulandi T, Murray C, Guralnick M. Adhesion formation and reproductive outcome after myomectomy and second-look laparoscopy. Obstet Gynecol. 1993;82(2):213–5.
54. Tsuji S et al. MRI evaluation of the uterine structure after myomectomy. Gynecol Obstet Invest. 2006;61(2):106–10.
55. D'Angelo E, Prat J. Uterine sarcomas: a review. Gynecol Oncol. 2009;116(1):131–9.
56. Mukhopadhaya N, De Silva C, Manyonda IT. Conventional myomectomy. Best Pract Res Clin Obstet Gynaecol. 2008;22(4): 677–705.
57. Discepola F et al. Analysis of arterial blood vessels surrounding the myoma: relevance to myomectomy. Obstet Gynecol. 2007;110(6): 1301–3.
58. Pundir J et al. Robotic-assisted laparoscopic vs abdominal and laparoscopic myomectomy: systematic review and meta-analysis. J Minim Invasive Gynecol. 2013;20(3):335–45.
59. Barakat EE et al. Robotic-assisted, laparoscopic, and abdominal myomectomy: a comparison of surgical outcomes. Obstet Gynecol. 2011;117(2 Pt 1):256–65.
60. Mettler L et al. The past, present and future of minimally invasive endoscopy in gynecology: a review and speculative outlook. Minim Invasive Ther Allied Technol. 2013;22(4):210–26.
61. Schollmeyer T et al. Roboterchirurgie in der Gynäkologie. Gynakologe. 2011;44(3):196–201.
62. George A, Eisenstein D, Wegienka G. Analysis of the impact of body mass index on the surgical outcomes after robot-assisted laparoscopic myomectomy. J Minim Invasive Gynecol. 2009;16(6):730–3.
63. Falcone T, Parker WH. Surgical management of leiomyomas for fertility or uterine preservation. Obstet Gynecol. 2013;121(4): 856–68.
64. Garry R et al. EVALUATE hysterectomy trial: a multicentre randomised trial comparing abdominal, vaginal and laparoscopic methods of hysterectomy. Health Technol Assess. 2004;8(26): 1–154.
65. Adashi EY. The climacteric ovary as a functional gonadotropin-driven androgen-producing gland. Fertil Steril. 1994;62(1):20–7.
66. Shifren JL. The role of androgens in female sexual dysfunction. Mayo Clin Proc. 2004;79(4 Suppl):S19–24.
67. Buster JE et al. Testosterone patch for low sexual desire in surgically menopausal women: a randomized trial. Obstet Gynecol. 2005;105(5 Pt 1):944–52.
68. Nyunt A et al. Androgen status in healthy premenopausal women with loss of libido. J Sex Marital Ther. 2005;31(1):73–80.
69. Manson JE et al. Estrogen plus progestin and the risk of coronary heart disease. N Engl J Med. 2003;349(6):523–34.
70. Anderson GL et al. Effects of conjugated equine estrogen in postmenopausal women with hysterectomy: the Women's Health Initiative randomized controlled trial. JAMA. 2004;291(14): 1701–12.
71. Parker WH et al. Ovarian conservation at the time of hysterectomy for benign disease. Obstet Gynecol. 2005;106(2):219–26.
72. Dietl J, Wischhusen J, Hausler SF. The post-reproductive Fallopian tube: better removed? Hum Reprod. 2011;26(11):2918–24.
73. Guldberg R et al. Salpingectomy as standard at hysterectomy? A Danish cohort study, 1977–2010. BMJ Open. 2013;3(6):e002845.
74. AAMIG W. AAGL position statement: Robotic-assisted laparoscopic surgery in benign gynecology. J Minim Invasive Gynecol. 2013;20(1):2–9.
75. Meeks GR, Harris RL. Surgical approach to hysterectomy: abdominal, laparoscopy-assisted, or vaginal. Clin Obstet Gynecol. 1997; 40(4):886–94.
76. Mazdisnian F et al. Vaginal hysterectomy by uterine morcellation: an efficient, non-morbid procedure. Obstet Gynecol. 1995;86(1): 60–4.
77. Jenkins TR. Laparoscopic supracervical hysterectomy. Am J Obstet Gynecol. 2004;191(6):1875–84.
78. Berner E et al. Pelvic pain and patient satisfaction after laparoscopic supracervical hysterectomy: prospective trial. J Minim Invasive Gynecol. 2013;21(3):406–11.
79. Alkatout I et al. Combined surgical and hormone therapy for endometriosis is the most effective treatment: prospective, randomized, controlled trial. J Minim Invasive Gynecol. 2013;20(4):473–81.
80. Semm K. Hysterectomy via laparotomy or pelviscopy. A new CASH method without colpotomy. Geburtshilfe Frauenheilkd. 1991;51(12):996–1003.

Uterine-Preserving Operative Therapy of Uterus Myomatosus

31

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Introduction

Uterine fibroids (also known as leiomyomas or myomas) (Fig. 31.1) are the most common benign tumors of the genital organs in women of childbearing age. They could have negative impact on reproductive system and can be single, but are more often multiple, causing significant morbidity, and impairment of the quality of life [1, 2]. According to the literature, 40–60 % of all hysterectomies are performed for the presence of myomas. Myomas are the most common indication for hysterectomy in the USA and Australia [3, 4]. The first who described myomas was Matthew Baille in 1793 [5]. Myomas consist mainly of smooth muscle cells containing different amounts of fibrous tissue [5].

During its growth, myoma determines compression on the surrounding structures (myometrium and endometrium),

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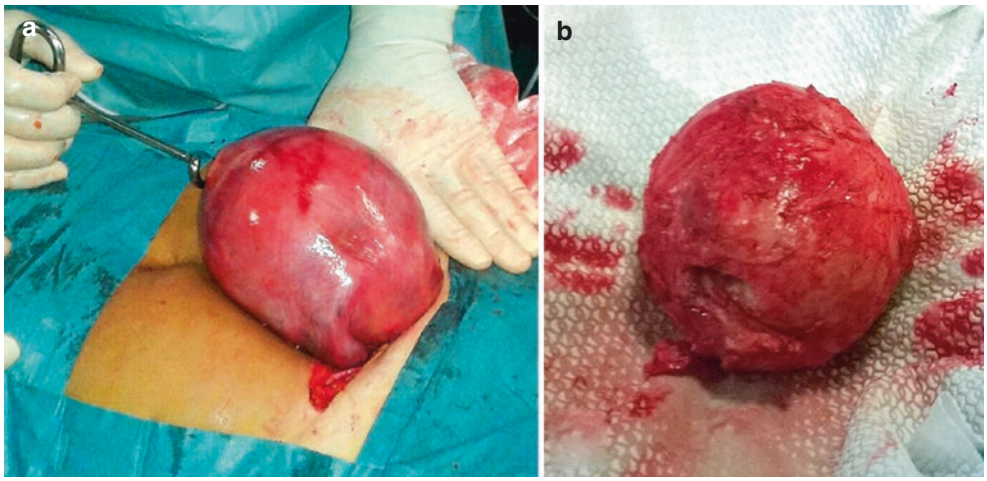


Fig. 31.1 To the left, a uterus removed from the abdomen by suprapubic transverse laparotomy; the uterus is deformed by large intramural myoma of the fundal-body of about 12 cm of diameter (*H*). On the right shows the enucleated myoma myomectomy by laparotomy (**b**)

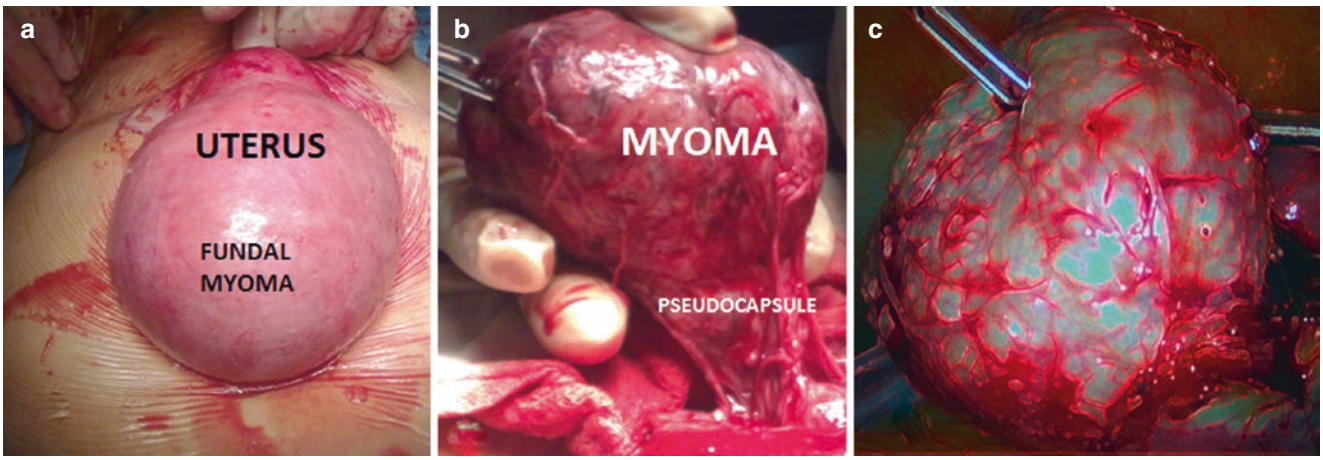


Fig. 31.2 On the left, the picture shows a uterus removed by laparotomy, deformed by a fundal fibroid 7 cm in diameter (**a**); at the center, the image shows a laparotomic myomectomy, with fibroid extraction and highlighting myoma pseudocapsule (**b**); to the right, a myoma with overhanging trace of the myoma pseudocapsule on the fibroid surface (**c**)

causing the progressive formation of a sort of pseudocapsule, rich of collagen fibers, neurofibers and blood vessels (Fig. 31.2).

Occasionally, the pseudocapsule surface is interrupted by bridges of collagen fibers and vessels that anchor the myoma to the myometrium. This causes the formation of a clear cleavage plane between myoma and pseudocapsule, and between pseudocapsule and the surrounding myometrium. This pseudocapsule causes a displacement and not destructive action on the myometrium, maintaining the integrity and contractility of uterine structure [6, 7].

Literature data has show that between 5.4 and 77 % of women have myomas; this wide range depends on the study population or on the diagnostic techniques applied to myoma detection [8].

Ultrasound studies documented that myoma prevalence is lower in Europe than in the United States, probably because of racial differences [9, 10]. In 65–70 % of cases, fibroids are multiple and can be found in various uterine locations. Most frequently they are within the wall of the uterus (Fig. 31.3) where they can expand in the myometrium (intramural leiomyoma), beneath the endometrium, simulating a polyp (submucosal leiomyoma), beneath the serosal surface (subserosal leiomyoma), within the broad ligament, simulating an adnexal neoplasia (intraligamentous leiomyoma) or under the uterine isthmus, called cervical leiomyoma (Fig. 31.4) [8].

The compression of the endometrium causes atrophy and erosion with bleeding. Subserosal leiomyomata (Fig. 31.5) can be pedunculated (Fig. 31.5) and in some cases can separate from the uterus and create a new vascular peduncle with another nearby organ (parasitic leiomyoma) [6–8].

They are well circumscribed, firm, and grey-white and with a whorled cut surface (Fig. 31.6). They may degenerate, especially in pregnancy, and become soft with a yellowish hue in necrosis or a reddish color due to hemorrhaging [8].

Myomas have been in 70 % of cases after hysterectomy, and multiple myomas have been present in more than 80 % of cases [11].

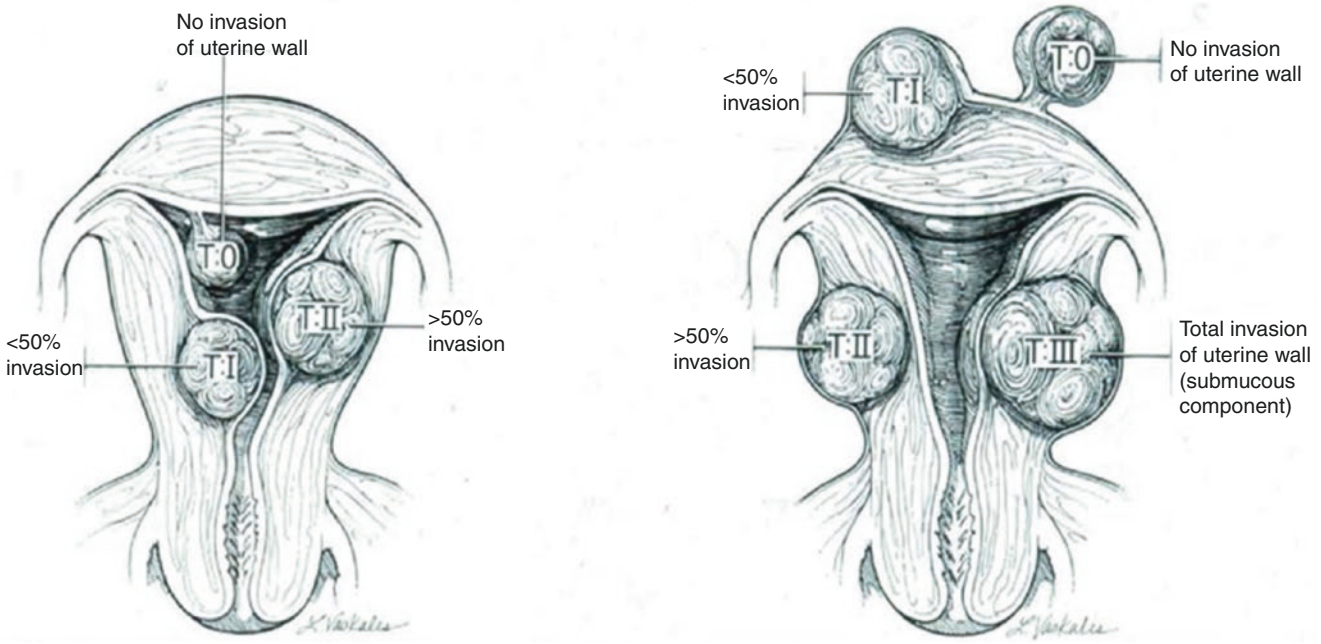


Fig. 31.3 Schematic representation of various invasions of the uterine wall by submucous myomas, on the left. Myomas impinging and penetrating the uterine wall from the periphery of the uterus, on the right (Image taken from: Butram and Reiter [163])

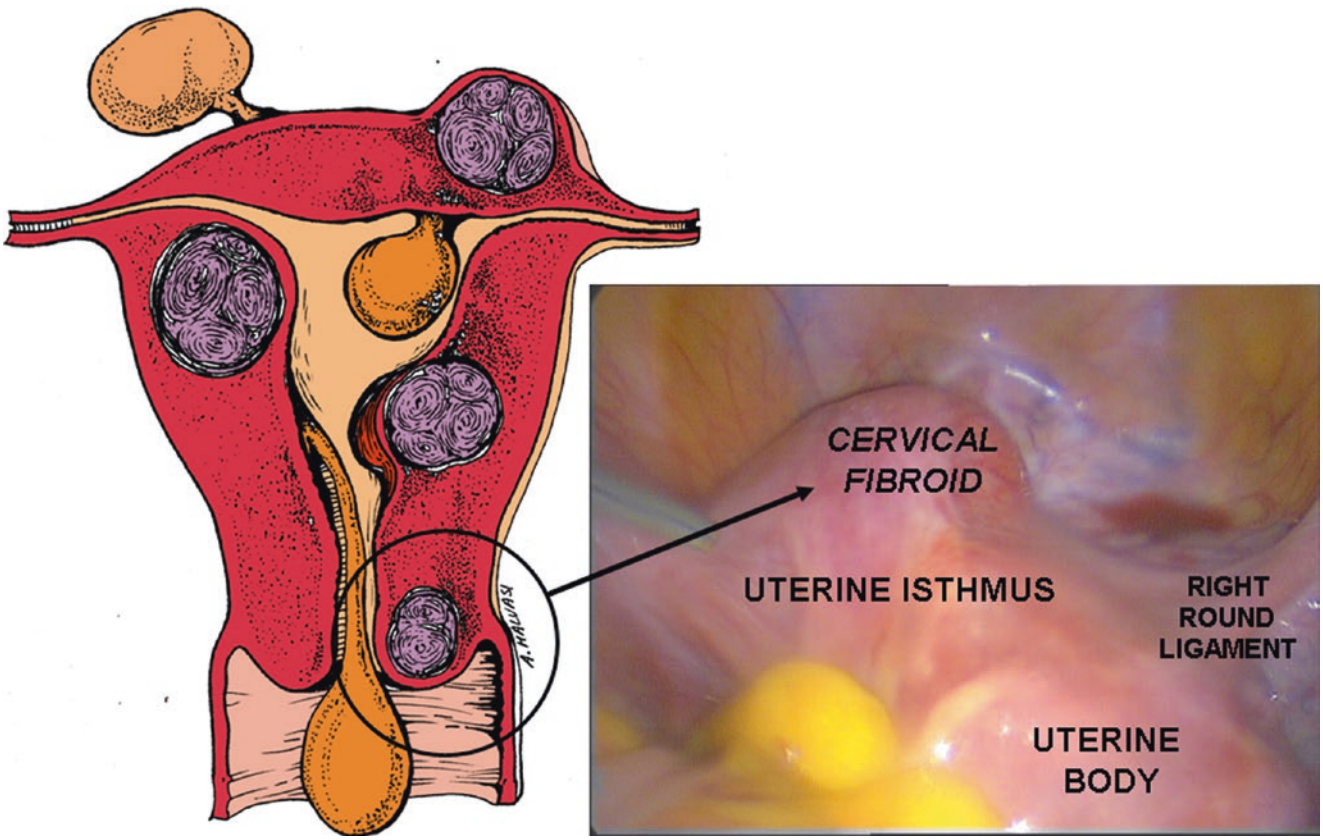


Fig. 31.4 On the left, a schematic representation of the fibroids' location; to the right, the laparoscopic image highlights an anterior cervical uterine myoma, under the uterine isthmus

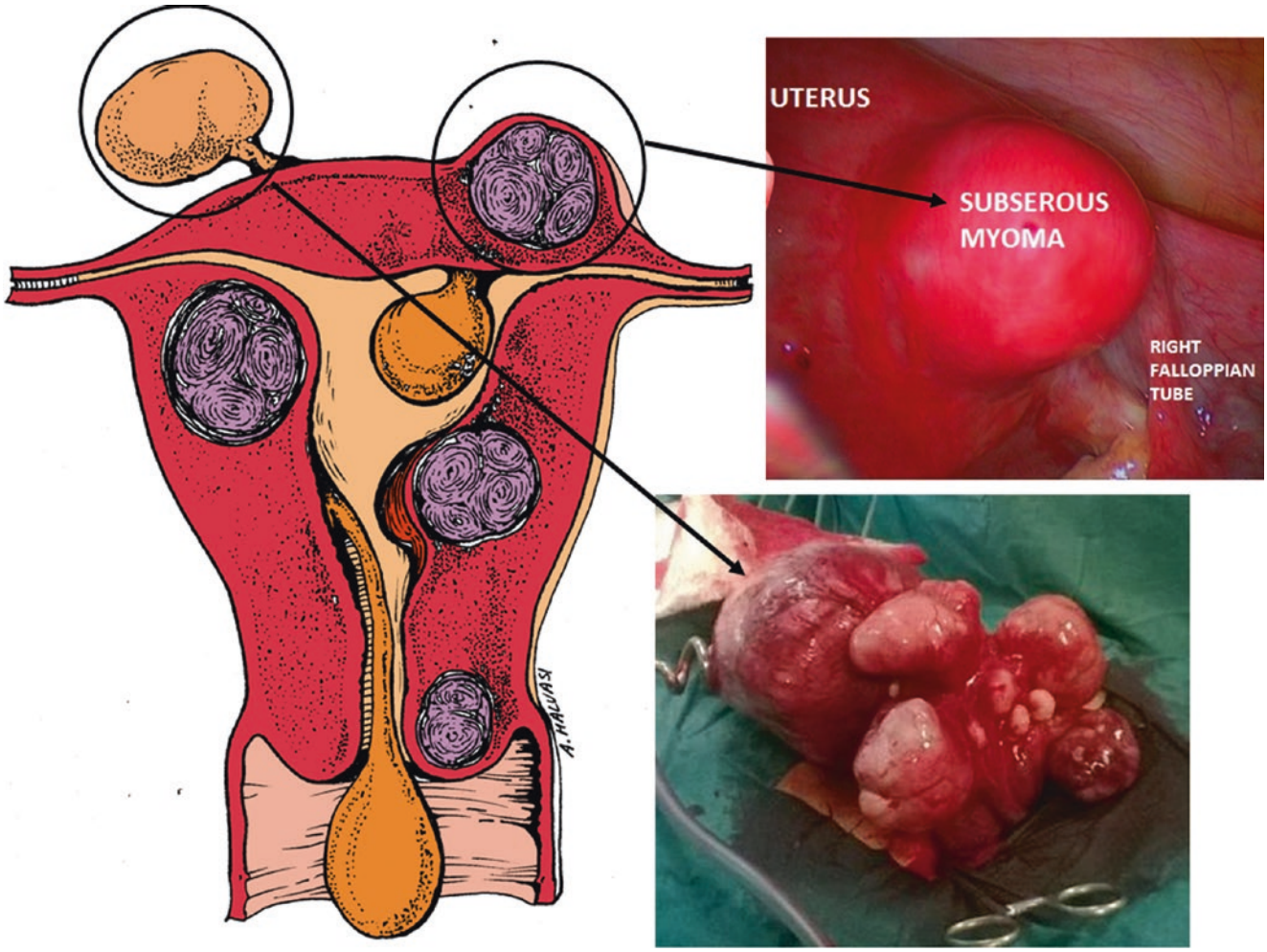


Fig. 31.5 On the left, a representation of fibroids location; on the right, at the top, a laparoscopic image showing a subserosal myoma on uterine body, near right fallopian tube. On the right, below, a laparotomic image showing a myomatosic uterus with several pedunculated fibroids



Fig. 31.6 The picture shows a uterus with a large number of myomas, anteriorly dissected from the bottom up to the cervix: fibroids appear well circumscribed, firm, *grey-white* and with a whorled cut surface

Previous epidemiological studies, focusing mostly on symptomatic women, have largely underestimated myoma prevalence [5, 10–12].

Over the past two decades, epidemiological studies have become more accurate, since they investigate a wide range of general population and use advanced non invasive imaging techniques, such as accurate 3D–4D ultrasound screening [1, 10].

Thus, Laughlin et al. [12], demonstrated the prevalence of myomas in 10.7 % of women in the first trimester of pregnancy (Fig. 31.7), which is lower than previously reported.

Some of the data on epidemiologic factors associated with myoma risk are well defined, while the others are not yet fully understood [10].

Documented predispositions in myoma formation and development include: age, race, body mass index (BMI), as well as heritage, reproductive factors, sex hormones, obesity, lifestyle (including diet, caffeine and alcohol consumption, smoking, physical activity and stress), environmental and other pathologies (as hypertension and infection) [1, 10–14].

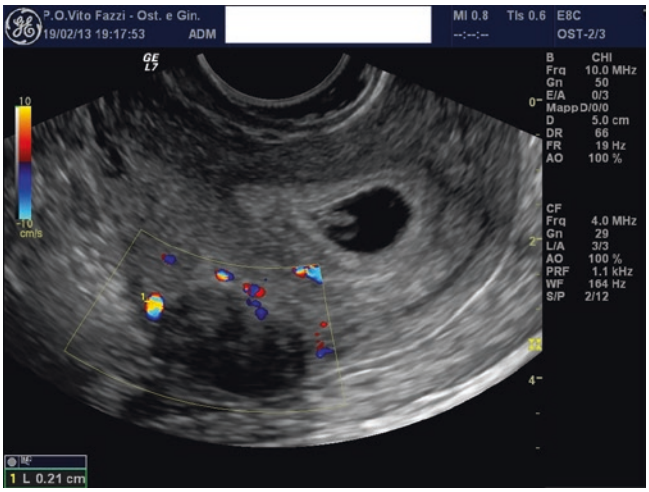


Fig. 31.7 A traditional transvaginal ultrasonographic image by 2D and Doppler ultrasound probe, showing a posterior subserous myoma and a gestational sac with within the embryo of 6 weeks

Clinical Presentation of the Fibroids

Uterine myomas may be present for years in some women without any symptoms and diagnosed incidentally, during routine gynecological examination or investigation for other illness [15, 16]. In other cases, they are an important cause of morbidity and may result in the need for multiple surgical procedures [16–18].

It is believed that the only 20–50 % of women with uterine fibroids have symptoms. The reasons why some myomas are symptomatic and some not, have not been yet full understood [19], although size, localization and number of fibroids are factors affecting the symptoms [19, 20]. Sometimes women with the fundus uteri reaching the umbilicus do not report any problems, except for the enlargement of the abdomen and the increase in body weight (Fig. 31.8) [19]. It is also unproven that women with multiple fibroids (Fig. 31.9) tend to have more symptoms, compared with those who have only one fibroid [19].



Fig. 31.8 The picture shows, on the right, a 46 years' women on the surgical table with a significant abdomen enlargement; the patients referred just an increase in body weight and poor clinical symptoms; On the right, the laparotomic hysterectomy with a uterus deformed by a huge myoma of 3.5 kg in weight

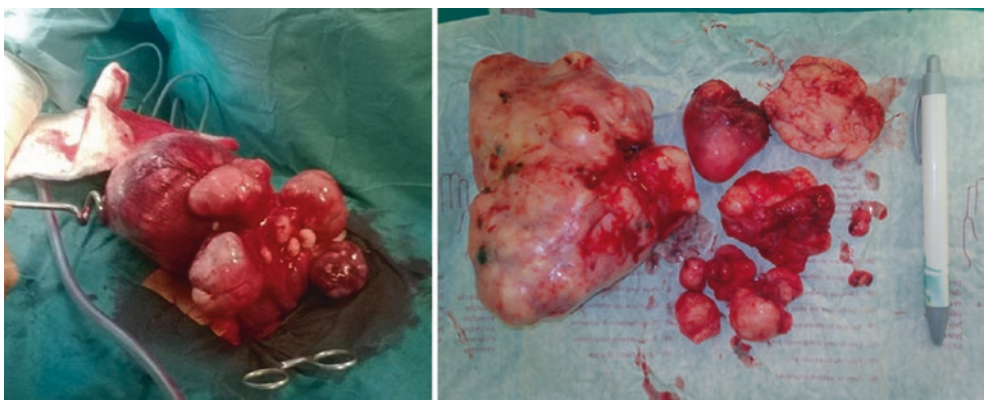


Fig. 31.9 On the left, the picture shows a uterus, deformed by many fibroids, located over the abdomen during a laparotomic myomectomy; on the right, the 11 enucleated myomas

Symptomatic fibroids usually occur in women in their thirties and forties, although they can occur, as well, in other age groups [21, 22]. In 62 % of women affected by uterine fibroids are symptomatic [20].

The most common presenting symptoms of uterine fibroids are: bleeding (menometrorrhagia, metrorrhagia or intermenstrual bleeding), pain, symptoms of compression of adjacent organs, change of the abdomen wall outline and infertility [16, 21, 23].

The Problem of Suspected Fibroid Malignant Alterations

Malignant alteration of uterine fibroids occurs mainly in postmenopausal women and is rarely asymptomatic. The main presenting symptoms of uterine leiomyosarcomas are abnormal vaginal bleeding, pain in the lower abdomen and a pelvic or abdominal mass [40]. In the past, if sudden growth of uterine fibroids is observed, especially after menopause, malignancy should be suspected and these tumors should be surgically removed. Recent evidences indicate that in premenopausal women, "rapid uterine growth" almost never indicates presence of uterine sarcoma [24].

Parker and colleagues examined 1332 women who had undergone a hysterectomy for uterine fibroids as the sole indication for surgery. Only 1 patient out of 371 women operated on for a "'myoma fast-growing" had proved to be a leiomyosarcoma. When the surgeons had judged that the myoma was at "rapid growth", defined as an increase of uterine volume as a womb of 6 weeks of pregnancy in 1 year of observation, none of the 198 patients who had this diagnosis was later shown to a uterine sarcoma at histological examination. Two of these women had instead endometrial stromal sarcoma. A patient of 30 years in the group of patients candidates for hysterectomy showed a normal uterus 22 months before; to gynecological presurgical, had a very large size of the uterus, such as a uterus of 16 weeks. After surgery, histological examination was shown a leiomyosarcoma. None of the 198 patients who had the criteria of "rapidly growing myoma" had a leiomyosarcoma, a mixed mesodermal tumor, or endometrial stromal sarcoma. None of the 17 postmenopausal women admitted for rapid uterine growth proved to be a sarcoma [25].

The uterine leiomyosarcoma (Fig. 31.10) is a very rare condition, has an incidence ranging from 0.5 to 3.3 per 100,000 women per year, with a further incidence of sarcomas in women with myomas at rapid growth of 0.27 % [26].

The transformation of leiomyomas in leiomyosarcoma is very rare [27].

Indisputable scientific data strongly suggest that uterine leiomyosarcomas are solitary lesions and are not commonly found in association with uterine myomas. If there is malignant transformation of uterine leiomyomas, is a rare event. The hypothesis that a uterine leiomyosarcoma derived from a myoma or are the result of malignant transformation of benign leiomyomas is never demonstrated [28].

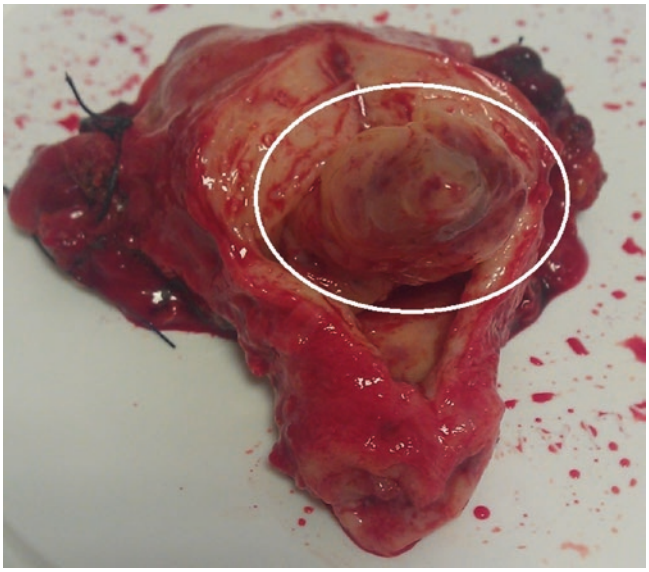


Fig. 31.10 A section uterus by pathologist with, in the white ring, a protruding single leiomyosarcoma of 4 cm, occupying almost the uterine cavity

There is no scientifically validated screening instrument that allow to diagnoses a sarcoma, since the diagnosis of sarcoma is purely histological and sometimes mixed with areas of benign myoma. In fact, to perform a diagnosis of leiomyosarcoma is not easy, even on extemporaneous histological examination. In most medical centers, the frozen section is not the histological technique for the final diagnosis. From one to three slides of a so-called "fibroid" can be routinely assessed when examining the frozen sections. It is more common than you think wrong or missing the diagnosis of uterine leiomyosarcoma in the frozen section [29, 30].

The Histopathology of Myomas

Histologically, the tumor is made up of cells similar to that of the contiguous endometrium (elongated, eosinophilic cytoplasm with central, blunt-ended, pale elongated nucleus, sometimes with clumped chromatin. The cells form whirling fascicles interlaced at right angles. This arrangement clearly distinguishes the leiomyoma (Fig. 31.11) from the surrounding myometrium, which shows a more regular pattern of the muscle fibers (Fig. 31.12). Furthermore, a large number of tumors show a clear border with the myometrium, even forming a valley, exaggerated by fixation artifact, with the

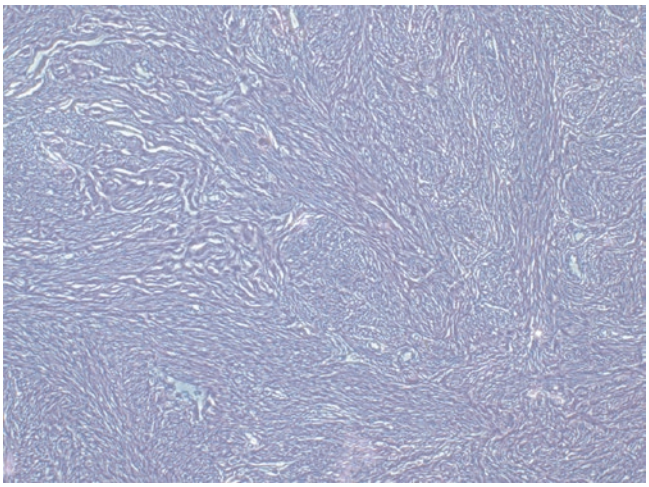


Fig. 31.11 A uterine leiomyoma composed by bundles of spindle cells, similar to those present in the myometrial wall: only the whirling and irregular arrangement of the cellular bundles distinguish the neoplastic proliferation

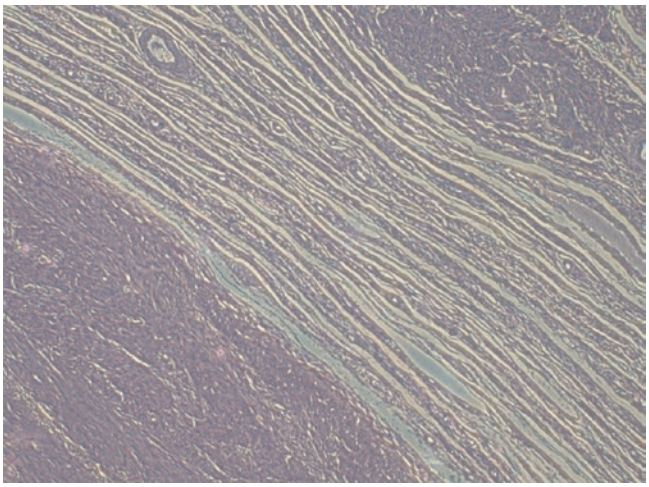


Fig. 31.13 At the center of the image shows a bundle of muscle fibers, collagen tissue and blood vessels are surrounded by extracellular matrix; this is what is known as a myoma pseudocapsule

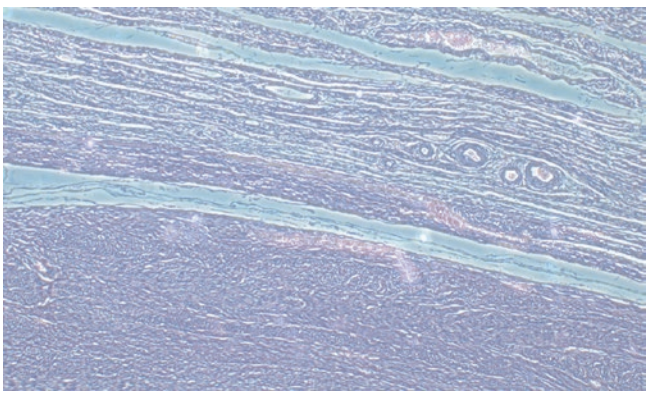


Fig. 31.12 The myometrium (in the *lower part*) surrounding myoma (in the *upper part*) shows a more regular pattern of the muscle fibers

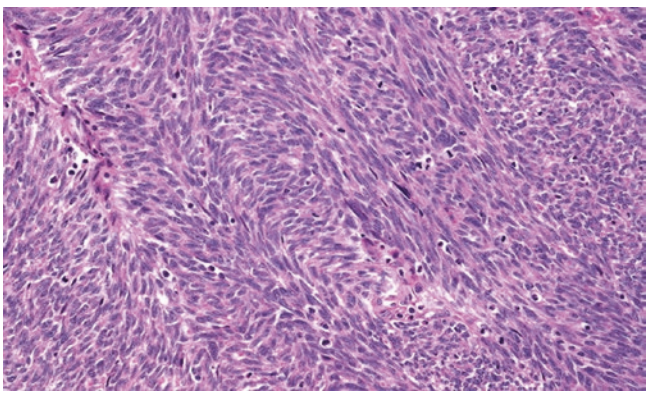


Fig. 31.14 A leiomyosarcoma: other than "tumor cell necrosis", it is detecting the presence of moderate-severe atypia and a mitotic index over 10/10HPF

formation of a ring of compressed myometrial cells, the pseudocapsule. In conservative myomectomy the surgeon exploits this valley to allow an easy excision of the tumor from the uterine wall. This interstitial space is formed from a variable amount of connective tissue (increasing with age and the menopausal state), possible edema and many blood vessels of different caliber, and it is called myoma pseudocapsule (Fig. 31.13).

Leiomyomata variants have differences that can be macroscopic or histological and thereby pose a serious problem of differential diagnosis with leiomyosarcoma.

First of all, there can be "infarct-type" necrosis or hyaline necrosis according to Bell et al. [31], characterized by areas of seemingly coagulative necrosis separated from the rest of the tumor by rings of fibrous or granulation tissue. This type of necrosis must not be confused with "tumor cell necrosis" observed in leiomyosarcoma where the cells are frequently necrotic, there is no separation from the surrounding tumor and often there are clumps of the residue of neoplastic cells surrounding residual vascular structures, commonly known as ghost outlines.

The differential diagnosis with leiomyosarcoma supposes, other than "tumor cell necrosis", the presence of moderate-severe atypia and a mitotic index over 10/10HPF: according to the Bell criteria of Bell [31] the presence of two out of three of these parameters is enough to diagnose leiomyosarcoma (Fig. 31.14). Immunohistochemistry does not bring any further advantages to the differential diagnosis. The borders of the tumor often infiltrate the near myometrium without the presence of the pseudocapsule observed in benign leiomyomata. Clearly malignant tumors express more p16, p21 and p53 immunoreactivity, but this is not helpful in single cases [32].

The expression of Ki 67 is also higher in leiomyosarcomas: in our experience Ki 67 is constantly higher than 40 %,

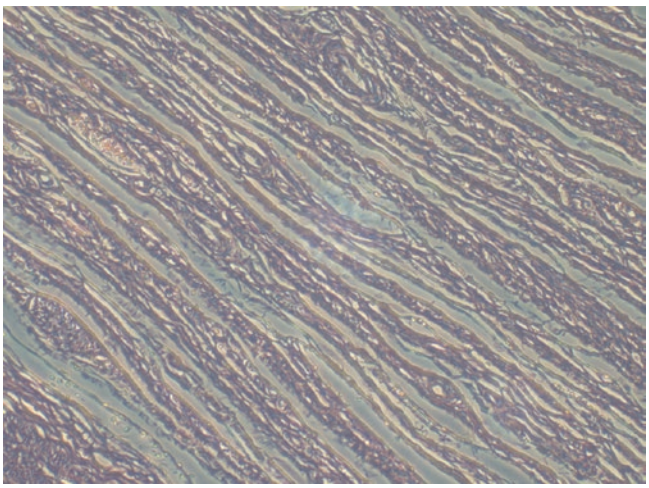


Fig. 31.15 The myometrium surrounding fibroid produce a sort of pseudocapsule, for ischemic phenomena, constituted by a network of: collagen fibers, extracellular matrix, neurofibers and blood vessels, as a separate fibroneurovascular tissue

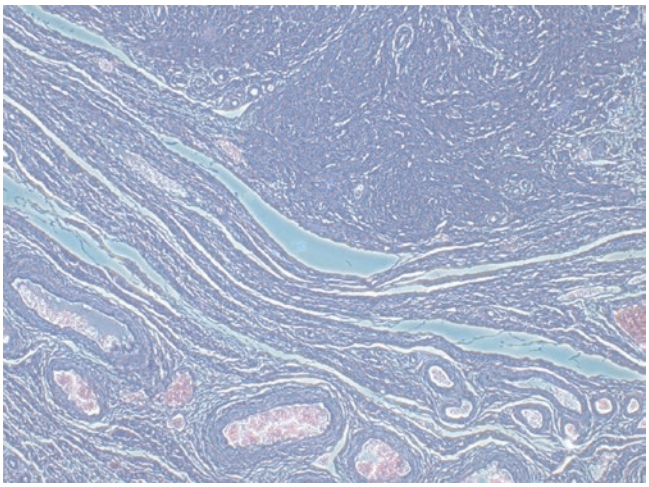


Fig. 31.16 A microscopic section showing the myoma pseudocapsule surface occasionally interrupted by collagen fibers and vessels that anchors the fibroid to myometrium

while in leiomyomata it is always less than 10 %. Necrosis can also be observed beneath the endometrium in tumors that grow into the uterine cavity which ulcerate and bleed, and therefore the necrotic cells are found together with inflammatory infiltrates. Other degenerative changes, more of less common, are: *hyaline transformation* of the stroma, leading to the wide substitution of the tumor, *dystrophic calcification* for a calcium salt deposition in the interstitial stroma (more common in menopausal women), a *hydropic degeneration* that can lead even to the formation of pseudocysts full of clear liquid.

A rarer but important type of change is myxoid degeneration of the fibroid when a gelatinous material is formed and the leiomuscolar cells can appear star-shaped and immersed in a slightly basophile stroma. Here the margins of the tumor must be closely examined as well circumscribed and the mitotic index is an essential point. A myxoid leiomyosarcoma, besides invading the surrounding myometrium, displays evident mitotic figures with only 2 per 10 HPF necessary to presume a malignant behavior. During pregnancy, leiomyomata can undergo necrosis and suffer bleeding (red degeneration), depending on the hormonal situation. Similar degeneration has been seen in hormonal therapy with estroprogestins. GnRH – analogue therapy causes a high degree of cellularity of the tumor which can confuse the pathologist when analyzing the mitotic figures. The increase in cellularity is apparently an effect linked to cell atrophy which reduces the cytoplasm thickness with closer nuclei, often with densely packed chromatin. As we discussed in a previous paper, the arteries we have described alterations of the inner wall agree with the proliferation of muscle cells and distortion or restriction of the lumen [33].

Analyzing leiomyomas composition, they are stiff tumors characterized by an excessive deposition of disordered extracellular matrix (ECM) components, particularly collagen I, III, and IV, proteoglycans, and fibronectin [34]. Matrix metalloproteinases (MMPs) are implicated in leiomyoma remodeling with a higher activity of MMP-2 in leiomyomas than in surrounding myometrium [35], separating by the myoma pseudocapsule.

During its growth, fibroid causes compressive phenomena on the surrounding myometrium, which for ischemic phenomena, seems to produce a sort of pseudocapsule, constituted by a surrounding network of collagen fibers, neurofibers and blood vessels, as a separate fibroneurovascular tissue (Fig. 31.15) [6].

Occasionally the pseudocapsule surface is interrupted by collagen fibers and vessels that anchor the fibroid to myometrium, well represented in microscopic sections (Fig. 31.16). It allows a constitution of a macroscopically clear cleavage plane between fibroid and the pseudocapsule, and between the pseudocapsule and the surrounding myometrium (Fig. 31.17) [36]. The pseudocapsule allows to fibroid only a displacement action (but not destructive) on myometrium, retaining the integrity and contractility of uterine structure [37]. We will discuss the importance of this small structure in the context of the myometrium, for the purpose anatomical, pathophysiological and reproductive systems.

Anatomy of Fibroid Pseudocapsule

Microscopically, the pseudocapsule seems to be as a continuous layer between the fibroid and surrounding myometrium and is made of a thickening of collagen fibers and blood

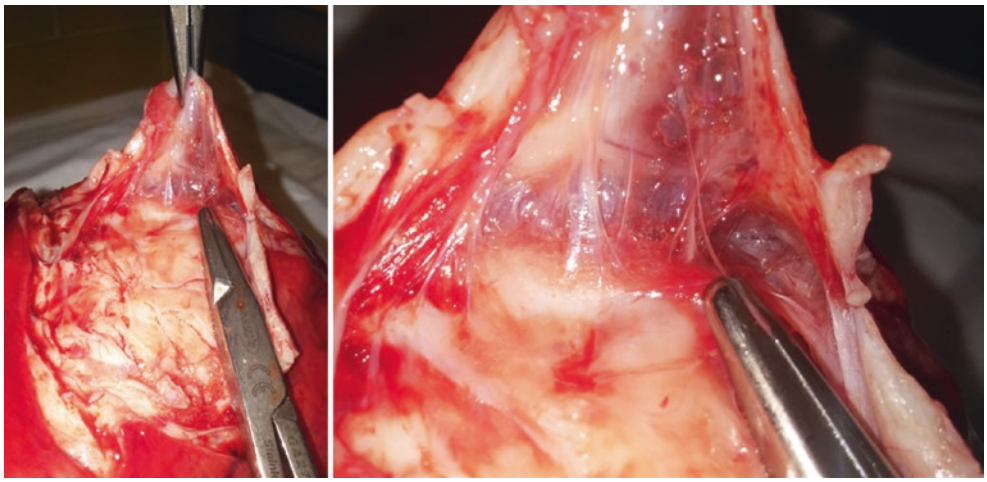


Fig. 31.17 Anatomical section of uterus with intramural myoma detecting myoma pseudocapsule: on the left the clamp shows a clear cleavage plane between fibroid and the pseudocapsule; on the right a surgical image magnification showing the small fibrovascular bridges connecting the pseudocapsule to the fibroid

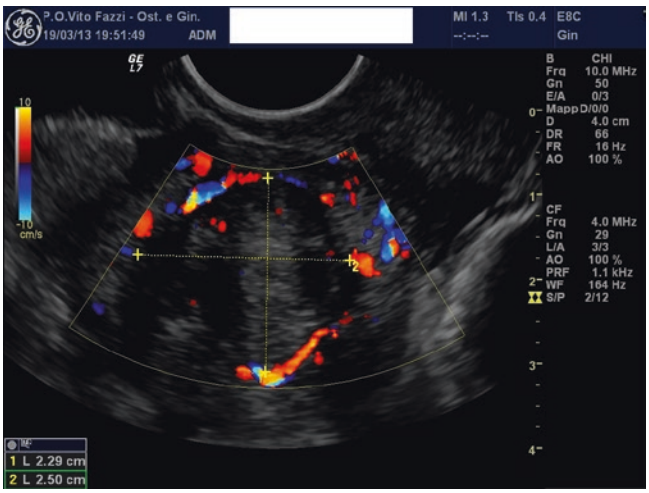


Fig. 31.18 A uterine section by transvaginal ultrasound scan: the pseudocapsule forms a vascular ring around fibroid, sonographically called "ring of fire" by echo-color Doppler, separating myoma from the surrounding myometrium

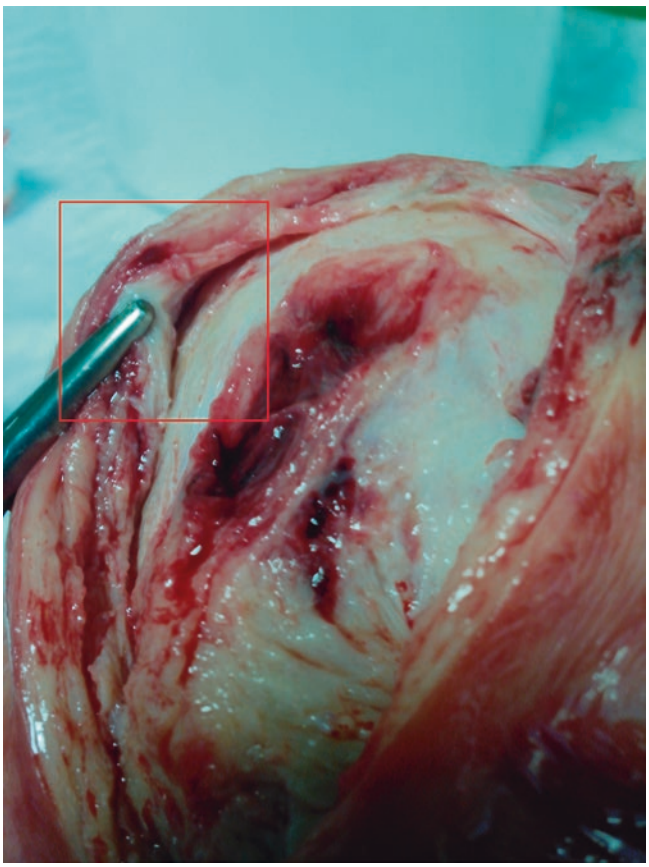


Fig. 31.19 Anatomic section of uterus with intramural myoma showing, in the *red box*, the cleavage plane to identify and to respect during a myomectomy, between fibroid and pseudocapsule

vessels that form a vascular ring, sonographically called "ring of fire" by echo-color Doppler: the pseudocapsule is separated from the surrounding myometrium, sonographically forming a hyperechogenic ring that surrounds and defines myoma (Fig. 31.18) [18]. To help with understanding of the micro-neuroanatomy of the fibroid peripheral area, we should get close with the story of pseudocapsule entity. An anatomical textbook, published at the end of last century, asserted: "*myoma shows a nodular aspect, a round image, well circumscribed, to enucleate even if they miss a pseudocapsule*" [6]. These authors confirmed the existence of the fibroid pseudocapsule and cleavage plane to identify and to respect during a myomectomy (Fig. 31.19) [6]. The first paper that described a fibrovascular system over a fibroid as "a mass of proliferating arteries" was in 1944 [38] and then, Farrer-Brown in 1970 [39] and Awataguchi in 1982 [40] found a fibrovascular plexus around the periphery of the fibroid. Lately, Casey et al. reported significantly higher microvasculature density in the surrounding myometrium in large fibroids; the author discovered that the vascular capsule

was a substantial feature of all fibroids, excluding those smaller, and that it reaches the highest density of blood vessels in large tumors [41].

Pathologists examined the relationship between ultrasound and histological findings of the fibroids vascular capsule in the last century, in a series of women using Gn-RH analogues in preoperative treatment before myomectomy [42–44].

Walocha et al. [45] performed a microstructural evaluation of the fibroid pseudocapsule and found that the density of blood vessels increases around myoma. As the fibroid grows, new blood vessels penetrate the tumor from its periphery where "the vascular capsule" network is formed. Some of the vessels in the pseudocapsule connect at the base of the myoma and form a little foot which often bleeds during an extra-capsular myomectomy. These authors analyzed the fibroid vascular system using corrosion casting combined with scanning electron microscopy and affirmed that the pre-existing blood vessels undergo in regression and new vessels invade the tumor from the periphery during the development of myomas. Myoma pseudocapsule originates from small vessels entering the tumor from the periphery, forming a "vascular network" around the myoma, with flattened veins compressed by the tumor [45]. Forssman et al. reported the vascular capsule surrounding myoma of 2 cm of diameter and found that the inner aspect of the capsule contained large vessels that invade the capsule from the periphery [46]. Wei et al. already demonstrated that in large uterine fibroids, the most biologically active zone is the region next to the periphery with a higher level of gene expression, a higher density of blood vessels, a higher proliferative rate, and a lower level of hyaline degeneration [47]. Finally, a preliminary study showed neurotransmitters into the myoma pseudocapsule [48], outline some neuro-biological properties of this structure [49], since the vascular structure has a proper characteristic, similar to cancers [50].

The Ratio of Uterine-Preserving Operative Therapy of Uterus Myomatosus

Uterine fibroid is a multifactorial and still enigmatic pathology. Traditional studies were associated to molecular and genetic investigations, detecting an important role in fibroids' growth and development, with cytogenetic anomalies observed in about 40 % of patients [34, 35]. Starting from the data on myoma and its pseudocapsule mentioned below, we focused our investigations on the morphological and biomolecular properties of myoma pseudocapsule, explaining the ration of uterine-preserving operative therapy.

Uterine Myoma Pseudocapsule Analisysed by Trasmission Electron Microscopy

In such study, we investigated the ultra-structure of myoma pseudocapsule by transmission electron microscopy analysis, to best detail the pseudocapsule structure and its involvement in fibroid growth and removal [51]. In two Universities affiliated Hospitals, ten women with a mean age of 36.7, underwent single laparoscopic intracapsular myomectomy (removing fibroid form its pseudocapsule). The selected patients requested myomectomy for the following associated symptoms: pelvic pain, menorrhagia, and growth of myomatic nodules, verified by ultrasound, with increasing symptoms. Exclusion enrolling criteria for the investigation were: previous uterine surgery (excluding caesarean section), pre-surgical treatment with GnRH-analogues, history of gynecological malignancy and primary sub fertility. Exclusion criteria for preoperative GnRH-analogue treatment was due to reported increased risk of recurrence, a possible delay in the diagnosis of leiomyosarcoma, a risk of massive hemorrhage from degeneration, a greater difficulty in finding the cleavage plane, and a greater extent of hyalinization phenomena [52, 53]. In the study setting, all fibroids were selected through standardized transvaginal ultrasound: all patients had subserous and/or intramural fibroids and transvaginal ultrasound clearly evidenced the fibroid pseudocapsule. The myomas' sizes were between 5 and 8 cm; the 4–9 cm limit was selected by surgeons to avoid longer operation time and pointless uterine trauma for smaller fibroids. To give homogeneity to the intracapsular laparoscopical myomectomy, the authors excluded pedunculated, cervical and intra-ligamentary myomas – because they are extra-myometrium., and suboptimal for authors' purpose. Patients underwent a standardized technique [7, 54] (Fig. 31.20): hysterotomy, pseudocapsule incision, extracting the myoma by stretching and uterine suturing. Samples were taken by scissors from the surface of the pseudocapsule as soon as good hemostasis was reached. Ten myoma pseudocapsule biopsy specimens of approximately 5 mm in depth, which included full thickness of the surrounding myometrium, were collected and processed for transmission electron microscopy (TEM). In semi thin sections the cells are fusiform with a centrally located nucleus. Inflammatory infiltration has not been detected in any section. At the electron microscopy level the cells have the features of the smooth muscle cells. They show nucleus with rounded end, often folded (concertina fashion), notched or with many invaginations. The cytoplasm is packed with thin (about 6 nm thick) filaments; between filaments fusiform dense bodies are interspersed. There are few organelles like mitochondria, glycogen particles and sparse elements of endoplasmic reticulum. Abundant micropinocytotic vesicles

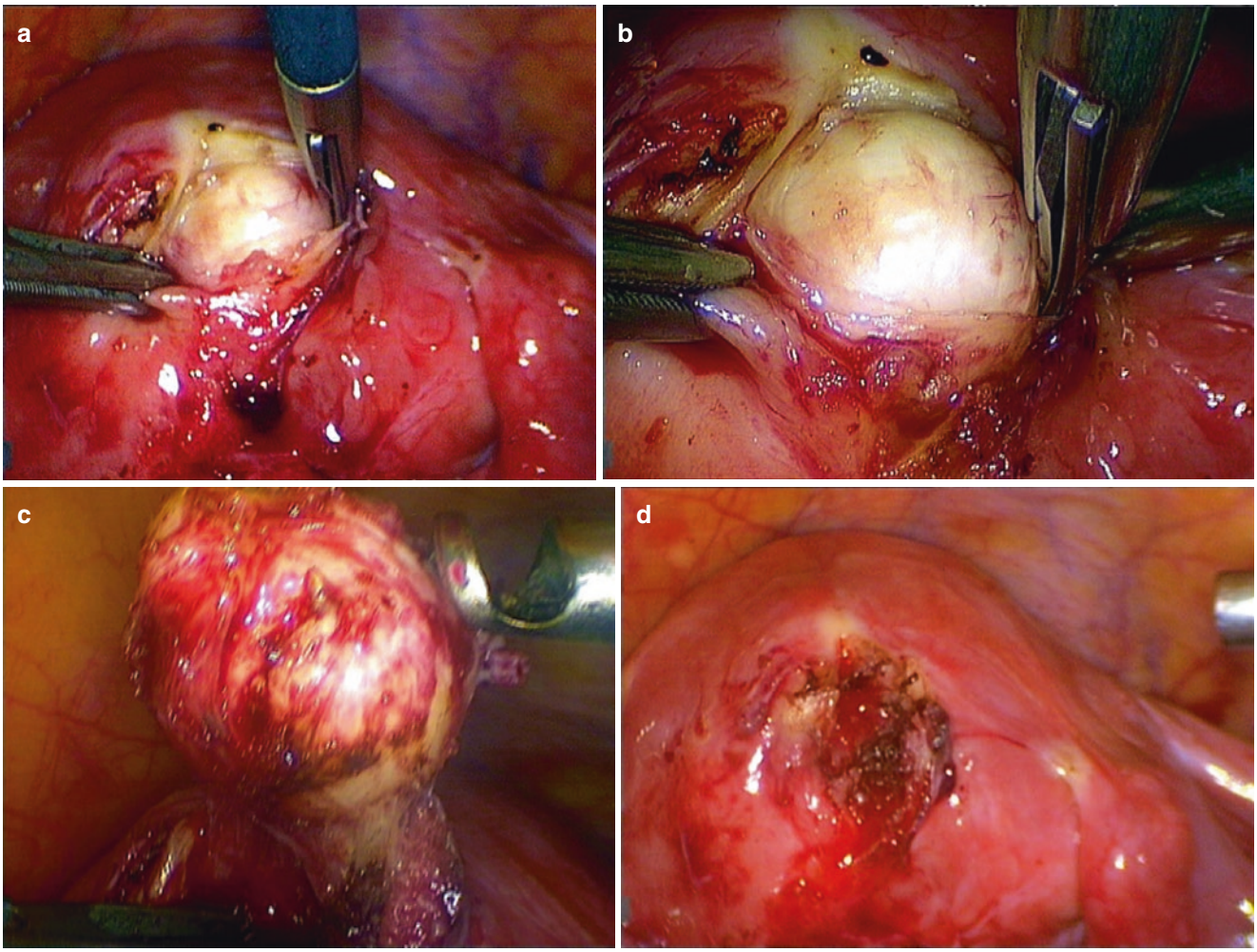


Fig. 31.20 The image shows a laparoscopic intracapsular myomectomy: (**a**) a womb incision over myoma; (**b**) the myoma enucleation by intracapsular technique; (**c**) myoma removal from uterus; (**d**) the minimal uterine bleeding after pseudocapsule sparing

are also present. The cells are surrounded by a thin but distinct basal lamina. The results of this study showed that at the electron microscopy level, the pseudocapsule cells had the features of the smooth muscle cells, as in myometrium. Basing on these findings, myoma pseudocapsule should be a part of myometrium who compresses leiomyoma, being a structure different from leiomyoma. Anatomically, fibroids arise from the uterine myometrium and typically are comprised of fascicles of smooth muscle cells with abundant pink cytoplasm and uniform spindle-shaped nuclei. Fibroids show a monoclonal proliferation of smooth muscle cells with isolated mitoses, minimal atypical nuclei, and an absence of coagulative necrosis and pseudocyst formation. In this investigation, authors investigated the ultra-structure of myoma pseudocapsule by transmission electron microscopy analysis, to best detail the pseudocapsule structure and its involvement in fibroid growth and removal.

Neurotransmitters in Myoma Pseudocapsule

Other investigations [55, 56] showed the presence of neurotrasmitters in myoma pseudocapsule. These studies confirmed the preliminary evidence that pseudocapsules contain neuropeptides together with their related fibers, as a neurovascular bundle, containing a vascular network rich in neurotransmitters like a neurovascular bundle [48, 49].

In the first paper [55], we evaluated the presence of neuropeptide tyrosine (NPY) in pseudocapsule of intramural, corporal, and fundal UMs, as well as in the normal myometrium. In addition, the presence of neurotensin (NT) associated with uterine contraction, and protein gene product 9.5 (PGP 9.5) as marker for uterine innervation, were both evaluated in the same tissues of NPY, in 75 women scheduled for single or multiple myomectomies. The indications for myomectomy were: severe pelvic pain, heavy menorrhagia not

responding to conservative treatment, or uncontrolled growth of UMs, as verified by repeated ultrasound. Among the patients, 67 women agreed to sign an informed consent for surgery; pregnancy was ruled out by a β-human chorionic gonadotropin test. All women were Caucasians. The exclusion criteria were: no previous myomectomy or cesarean sections, treatment with gonadotropin-releasing hormone (GnRH) analogs, to avoid eventual influence on results [52, 53] and a history of gynecological tumors. All fibroids were diagnosed using standardized transabdominal and transvaginal ultrasound myoma mapping by expert clinicians. The UMs' location were classified depending on their positions and the ultrasound data were recorded for postsurgical evaluations. Investigated UMs were single or multiple, and were located in the fundus uteri and in the corpus. Pedunculated, subserous, cervico-isthmic, and intraligamentary UMs were excluded. All myomectomies were performed by laparotomy or laparoscopy, depending on their dimensions and the surgeon's preference. The diameters of the UMs were between 4 and −9 cm of diameter. All women were administered a standard prophylactic antibiotic dose of 2 g Cefazolin intravenously. All operations were performed under general anesthesia with endotracheal intubation. All surgical procedures were performed by experienced gynecologists or senior residents who had paramount experience in removing UMs from within the pseudocapsule, as evidence-based data have shown [7, 54]. Once the UM removing and the UM pseudocapsule (PUM) spared on normal myometrium (NM), the surgeons sampled full thickness specimens that included the PUM as well as the surrounding NM from the fundus of the uterus (FU) and the uterine body (UB). These samples were approximately 20 mm in depth, obtained using scissors and were collected in peers, but separately. All samples were sent to the laboratory in a dry-ice container for histological and immunofluorescent analyses. A quantitative analysis of images (QAI) was performed on slides and on microphotographs using a the Quantimet Analyzer (Quantimet 500 Leica Microsystems Imaging Solutions Ltd., Cambridge, UK), equipped with specific software for a detailed evaluation. The densities of NT, NPY, and PGP 9.5 fibers were calculated using a Quantimet Leitz image analyzer that measures the following parameters: (1) detection of NT, NPY, and PGP 9.5 nerve containing fibers counted in 10 fields randomly chosen; (2) the percentage of total area occupied by those fields; (3) the number of observed varicosities; (4) the number of intersections of the nerve fibers; and (5) the total perimeter of NT, NPY, and PGP 9.5 structures in proportion to an average value (100 for each field). Morphometric quantification of the density of each type of nerve fiber was performed on photographs of stained samples using the Quantimet Leica 2000 image analyzer by a single pathologist. The software provided with the analyzer counts and expresses these fluorescent areas in "Conventional Units" or C.U. [48], i.e., as percentages of area occupied by a single type of nerve fiber related to the total observed area. By adding these values (single type of nerve fiber), it is possible to evaluate the sum of the areas occupied by the different types of nerve fibers. The software also calculates the average values and translates them to a single value with a standard deviation, which is reported on the instrument display as the "standard error of the mean (SEM)." Other details about the experimental procedures used for morphometric quantification by the Quantimet Leica are reported in the Anon manual of methods [36]. Statistical analysis of the data was based on the results obtained by the image analyzer software; and the data were averaged to obtain a median value per case. The means ± SEMs were then calculated and reported for each nerve fiber group. Repeated immunofluorescent controls were prepared and the differences were calculated by using Student's *t*-test. A P-value <0.05 was considered statistically significant.

Morphometric quantification of the neurotransmitters was performed on photographs using quantitative image analysis of 67 specimens. Fibers containing neuropeptides were not significantly higher in PUMs than in NM of FUs: 4 ± 0.2 C.U. for NT, 1 ± 0.5 C.U. for NPY, 4 ± 0.3 C.U. for PGP 9.5 in PUMs vs. 3 ± 0.9 C.U. for NT, 2 ± 0.1 C.U. for NPY, 3 ± 0.4 C.U. for PGP 9.5 in NM. Statistical evaluation did not report any significant difference (Table 31.1).

Nerve fibers containing the neurotransmitters increased slightly but not significantly in UBs with respect to FUs, with, 5 ± 0.3 C.U. for NT, 7 ± 0.2 C.U. for NPY, 6 ± 0.5 C.U. for PGP 9.5 in UBs vs. 4 ± 0.9 C.U. for NT, 6 ± 0.8 C.U. for NPY, 5 ± 0.7 C.U. for PGP 9.5 in FUs ($p > 0.05$). Also in such case, statistical evaluation did not report any significant difference among FU and UB neuropeptide concentration (Table 31.2).

Our results showed that NT, NPY, and PGP 9.5 neurofibers are almost equally present in PUF as in NM of a nonpregnant uterus. As all of these neuropeptides are present in the uterine muscle and can affect muscle contractility, uterine peristalsis and muscular healing. A myomectomy respecting the pseudocapsule neurofibers should facilitate smooth muscle scarring and promote restoration of normal uterine peristalsis with a possible positive influence on fertility.

In the second investigation, we compared the quantitative distributions of OXY and ENK in nerve fibers of fibroid pseudocapsules, sampled from uterine fundal, corporal and isthmo-cervical regions. We included 64 women in the study protocol: a well-designed non-randomization controlled trial (Level of evidence: II-1). The following were the inclusion criteria: a large uterus with symptomatic myomas, a myomatous uterus with severe pelvic pain, and menorrhagia, that was not controlled by conservative treatment, or uncontrolled growth of myomas revealed by dynamic ultrasound examinations. The main exclusion criterion was pregnancy,

Table 31.1 Distribution of the neurotensin (NT), the neuropeptide tyrosine (NPY) and the protein gene product 9.5 (PGP 9.5) nerve fibers in uterine fibroid pseudocapsule and in normal myometrium

	Fibroid pseudocapsule	**Normal myometrium**	***P* value**
Neurotensin (NT)	4 ± 0.2 C.U.	3 ± 0.9 C.U.	P > 0.05
	Fibroid pseudocapsule	**Normal myometrium**	**P value**
Neuropeptide Tyrosine (NPY)	1 ± 0.5 C.U.	2 ± 0.1 C.U.	P > 0.05
	Fibroid pseudocapsule	**Normal myometrium**	**P value**
Protein Gene Product 9.5 (PGP 9.5)	4 ± 0.3 C.U.	3 ± 0.4 C.U.	P > 0.05

Table 31.2 Distribution of the neurotensin (NT), the neuropeptide tyrosine (NPY) and the protein gene product 9.5 (PGP 9.5) nerve fibers in uterine fibroid pseudocapsule of uterine body and fundus uteri

	Fibroid pseudocapsule of uterine body	**Fibroid pseudocapsule of fundus uteri**	**P value**
Neurotensin (NT)	5 ± 0.3 C.U.	4 ± 0.9 C.U.	P > 0.05
	Fibroid pseudocapsule of uterine body	**Fibroid pseudocapsule of fundus uteri**	**P value**
Neuropeptide Tyrosine (NPY)	7 ± 0.2 C.U.	6 ± 0.8 C.U.	P > 0.05
	Fibroid pseudocapsule of uterine body	**Fibroid pseudocapsule of fundus uteri**	**P value**
Protein Gene Product 9.5 (PGP 9.5)	6 ± 0.5 C.U.	5 ± 0.7 C.U.	P > 0.05

as confirmed by the betaHCG test, performed prior to surgery and women not belonging to the Caucasian group were excluded. Other exclusion criteria included: (1) uterine scarring from previous surgeries (including cesarean section), (2) a treatment history of gonadotropin-releasing hormone (GnRH) analogues, and (3) a history of gynecological tumors. Treatment with GnRH analogues was seen as an exclusion criterion due to their reported association with an increased risk of recurrent myomas, delays in leiomyosarcoma diagnosis, and massive hemorrhages due to difficulties in entering the cleavage plane at a greater extent of hyalinization [52, 53]. Patients with pedunculated, submucous, and intraligamentary fibroids were excluded because of the risk of a distinctly uncommon pseudocapsule that engages the surrounding myometrium following presurgical ultrasound [18] performed by expert clinicians to determine the presence of the ultrasound screen, a white ring surrounding the fibroids, indicated by Doppler sonography as a "ring of fire". The study was designed to include patients of both the single and the multiple fibroid with more than two myomas. Total laparotomic hysterectomies were performed under general anesthesia with endotracheal intubation by experienced gynecologists or senior residents. During surgery, cefazolin (2.0 g) was intravenously administrated as a preventive antibiotic therapy. Following hysterectomy, 3 full-thickness specimens (2 cm wide × 2 cm deep) were acquired from the fundus uteri, corpus, and cervix using a sterile scalpel, referred to Gray's Anatomy Book for the classification of the uterine segments [57].

Separate samples from an identical uterine specimen were collected in peers. The full-thickness specimens contained part of the myoma with its fibroid pseudocapsule and the surrounding myometrium. In patients with multiple myomas, tissues were resected from each site. All tissues were histological examined, prior to analyze them by polyclonal antibodies for the ENK and OXT immunohistochemical assays. Further evaluation of specimens was performed blindly processing samples by their numbers and pathologist was not informed about origin of evaluated samples. The distribution (density) of each type of nerve fiber was performed on digital images of stained samples using a Quantimet Leica 2000 image analyzer (Leica Microsystems Cambridge Ltd., Cambridge, UK) by a single pathologist. The software with the Quantimet Leica 2000 image analyzer enables the counting and expression of fluorescent areas in conventional units (CU) [48], which is the percentage of the area occupied by a single type of nerve fiber relative to the observed area. By adding these values (single nerve fiber types) it is possible to evaluate the sum of the areas occupied by different types of nerve fibers. The software also calculates the average values and translates them into a single value with the standard deviation displayed on the instrument. The density of ENK and OXT fibers was calculated by quantitative analysis using the Quantimet Leica 2000 image analyzer. Results were averaged to obtain a median value per sample and analyzed using one-way analysis of variance (ANOVA) with Bonferroni correction for multiple comparisons of normally distributed data set of 3 groups. Statistical calculations were performed with MedCalc software (version 11.4.1.0). Data are displayed as the mean (m) and standard deviation (SD) overall. Values of $P < 0.01$ were considered statistically significant.

We tested null (Ho) and alternative (Ha) hypotheses for both ENK and OXT positive nerve fibers to distinguish distribution differences of neuropeptides in pseudocapsules depending on localization of fibroids in different uterine regions, i.e., μHo: fundal=corporal=isthmian-cervical region; μHa: fundal≠corporal≠isthmian-cervical region.

Table 31.3 The distribution of neuropeptides enkephalin (ENK) – and oxytocin (OXT) -positive nerve fibers in uterine fibroids pseudocapsules of the uterine fundal, corporal, and isthmian–cervical regions

Parameters	Uterine regions			*Total P*-value
	Fundal	Corporal	Isthmian–cervical	
Number of patients	19 (33.3 %)	18 (31.5 %)	20 (35.2 %)	57 (100.0 %)-
Number of fibroids	22 (33.8 %)	23 (35.4 %)	20 (30.8 %)	65 (100.0 %)
ENK-positive nerve fibers (CU)	0	0	94 ± 0.7	0.01
OXT-positive nerve fibers (CU)	6.3 ± 0.8	15.0 ± 1.4	72.1 ± 5.1	0.01

Sixty-four women were consecutively assessed for eligibility, seven women were excluded and, finally, the study included 57 patients with myomas and hysterectomy. The patients were 36.4 ± 3.6 years old with the body mass index – 23.8 ± 2.5, and the parity index – 1.4 ± 0.3. Analysis of localization of myomas during surgery demonstrated, that in 18 patients myomas were located in restricted uterine regions such as in 5 patients (8.7 %) – in the fundus, in 7 patients (12.2 %) – in the corpus and in 6 patients (10.5 %) – in the isthmian–cervical region, whereas in 39 patients distribution of myomas was expanded with combination of two or all three regions (Table 31.3).

So, in 10 patients (17.5 %) fibroids were found in both fundus and corpus of uteri, in 12 patients (21 %) – in the fundus and isthmian–cervical region, in 13 patients (22.8 %) – in the corpus and isthmian–cervical region and in 4 patients (7 %) – in all 3 regions. Subsequently we obtained samples for ENK and OXT assays in total from 65 fibroid pseudocapsules obtained from 57 removed uteri. Among these, 22 (33.8 %) samples of fibroid pseudocapsules were obtained from fundus, 23 (35.4 %) – from corpus and 20 (30.8 %) – from isthmian-cervix region. Distribution of fibroid pseudocapsule nerve fibers containing ENK and OXT was identified by immunohistochemistry and quantified by morphometric evaluation in relevant number of samples for valid statistical analysis. An absence of ENK-positive nerve fibers was seen in the uterine fundus and corpus fibroid pseudocapsules, whereas ENK values of up to 94 ± 0.7 CU were observed in the nerve fibers in fibroid pseudocapsules obtained from the isthmian–cervical region. OXT-positive fibers were present in fibroid pseudocapsules of all uterine regions. However, density of OXT-positive fibers was comparatively lower in the fundus (6.3 ± 0.8 CU) and at a slightly increased number in the corpus (15.0 ± 1.4 CU), whereas the distribution of OXT-positive fibers was significantly higher in the isthmian–cervical region (72.1 ± 5.1 CU) ($p < 0.01$).

Thus, the uterine cervix, contains a wide amount of immunoreactive nerve fibers filled with a great number of neuropeptides, neurotransmitters play a crucial role in the regulation of woman's sexual and reproductive functions as the central neuronal structure orchestrating the functions of the female tract organs by accepting/activating and passing signals between the central nervous system and all genital tract structures. A high density of ENK and OXT in nerve fibers in the isthmian–cervical region fibroid pseudocapsules highlights the importance of this region for female reproductive and sexual functions, and pregnancy-related complications. The present findings are important to discern the pathophysiology of the female reproductive system and sexual disorders manifesting after surgical procedures in the cervix, including complications during pregnancy and delivery (i.e., miscarriage and cervical dystocia during labor). the uterine cervix, containing a wide amount of immunoreactive nerve fibers filled with a great number of neuropeptides, neurotransmitters play a crucial role in the regulation of woman's sexual and reproductive functions as the central neuronal structure orchestrating the functions of the female tract organs by accepting/activating and passing signals between the central nervous system and all genital tract structures. A high density of ENK and OXT in nerve fibers in the isthmian–cervical region fibroid pseudocapsules highlights the importance of this region for female reproductive and sexual functions, and pregnancy-related complications. The present findings are important to discern the pathophysiology of the female reproductive system and sexual disorders manifesting after surgical procedures in the cervix, including complications during pregnancy and delivery (i.e., miscarriage and cervical dystocia during labor).

Our and literature data confirmed that pseudocapsules contain many neuropeptides and neurotransmitters [48, 49, 55, 56, 58], physiologically active. Moreover, these substances may play a significant role in wound healing and innervation repair [18, 59, 60], and may be essential for reproductive [61–63] and sexual function [64, 65]. Indeed, the lower urinary tract neuropeptide–receptor systems may represent a potential target for therapeutic interventions [66, 67].

The Gentical Analysis of Pseudocapsule

Another of my investigations stated that biochemical growth factors evaluated in the pseudocapsule vessels cause intense angiogenesis in pseudocapsule, probably promoted by the fibroids [68]. The angiogenesis of the myoma pseudocapsule likely leads to the formation of a "protective" vascular

capsule responsible for the supply of blood to the growing tumor [69]. However, studies demonstrated a dysregulation of various growth factors and their receptors in uterine myomas [40, 69]. In fact, a research on gene expression analysis in uterine leiomyoma pseudocapsule revealed an angiogenic profile in pseudocapsule [68]. In this investigation we performed, by quantitative real-time RT-PCR method (qRT-PCR), a gene expression analysis of pseudocapsule (PC), matching it with the same analysis in uterine leiomyoma (UL) and uterine myometrium (UM), evaluating the expression levels of IGF-2, used as tumoral marker, and COL4A2, CYR61/CCN1, CTGF/CCN2, VEGF-A and vWF, known to be involved in angiogenic processes. A group of 18 patients underwent laparoscopic myomectomy pseudocapsule sparing. Patients were selected on the basis of their symptoms as pain or pressure, menstrual disorders, large and growing myomas, infertility or reproductive dysfunction. The number, size and location of ULs were assessed for all patients: 11 women had subserous UL (61.1 %) whereas 7 women had intramural UL (38.9 %); ULs were single in 10 patients (55.5 %) and multiple in 8 patients (44.4 %) with the dominant fibroid measured between 3 and 12 cm in diameter. Patients with suspected adenomyosis or adenomyoma were excluded. Pedunculated, small and submucous ULs were also excluded. Preoperative treatment with gonadotropin releasing hormone analogues (GnRHa), known to induce distortion of the UL pseudocapsule [50, 53], has also been considered as an exclusion indication for the purposes of this study. As all women were to be subjected to intracapsular myomectomy, the protocol was primarily explained to the patients and full written consent to operation and protocol was obtained prior surgery. Pre-surgical trans-vaginal (TV) ultrasound (US) was performed to determine the presence of the UL-PC as a white ring surrounding the UL. Laparoscopic myomectomy by intracapsular technique (LIM) was performed as mentioned above [7, 54]. Tissues sampling from the fibroids were taken approximately 20 mm in depth, including full thickness of the UL, UL-PC and the surrounding UM; samples of UL-PC were taken by scissors from its surface, as soon as good hemostasis was reached, while UM tissues were biopsied at 2 cm distance from UL. All samples were orientated as surgeons proceed in case of cervical conization. All samples were collected and stored in saline solution, then sent to the genetic laboratory for successive analysis. To examine the molecular characteristics of PC, the expression levels of CYR61/CCN1, CTGF/CCN2, COL4A2, VEGF-A, vWF, endoglin/CD105 and IGF-2 genes were analyzed in eighteen matched PC, UM and UL specimens. The last gene was chosen because known to be a tumor proliferation marker in UL pathology, the others were selected for their involvement in angiogenesis. mRNA levels were measured by quantitative RT-PCR and corrected against the housekeeping GADPH gene. Normalized data were reported by the medians and interquartile ranges and the degree of variability among the three tissues was statistically determined. The IGF-2 expression varied significantly among the three tissues ($p = 0.0011$ by Kruskal-Wallis test). In particular, it was significantly higher in UL (0.0165 relative units mean) compared to UM (0.0028 relative units mean; $p = 0.033$ by Mann-Whitney test) and PC (0.0026 relative units mean; $p = 0.032$ by Mann-Whitney test). The difference between UM and PC was not significant ($p = 0.916$ by Mann-Whitney test). Expression levels analysis of endoglin/CD105 revealed a significant difference among the three tissues ($p = 0.016$ by Kruskal-Wallis test). In particular there was a significant over-expression in PC (0.031 relative units mean) with respect to both UL (0.013 relative units mean, $p = 0.020$ by Mann-Whitney test) and UM (0.008 relative units mean; $p = 0.021$ by Mann-Whitney test). The difference between UL and UM was not significant ($p = 0.23$ by Mann-Whitney test). Both CYR61 and CTGF showed a significant degree of variability among the three tissues in our samples ($p = 0.044$ and $p = 0.021$ respectively by Kruskal-Wallis test). The down-regulation of CYR61 gene in UL (0.0278 relative units mean) with respect to UM (0.0588 relative units mean) was statistically significant ($p = 0.032$ by Mann-Whitney test), while difference with respect to PC (0.0479 relative units mean) doesn't reach significance ($p = 0.067$ by Mann-Whitney test). The difference between UM and PC was no significant as well ($p = 0.92$ by Mann-Whitney test). The down-regulation of CTGF in UL (0.0049 relative units mean) with respect to UM (0.0121 relative units mean) was significant ($p = 0.006$ by Mann-Whitney test), while no significant differences were found in the CTGF mRNA level between UL and PC (0.0111 relative units mean; $p = 0.090$ by Mann-Whitney test) and between PC and UM ($p = 0.15$ by Mann-Whitney test). Similarly, COL4A2 expression is significantly different across the three tissues ($p = 0.018$ by Kruskal-Wallis test). Moreover in this case, COL4A2 was expressed at significant higher in UL (2313 relative units mean) than in UM (1157 relative units mean, with $p = 0.007$ by Mann-Whitney test) while difference with PC (1658 relative units mean) was not significant ($p = 0.137$ by Mann-Whitney test).

The difference between UM and PC was not significant too ($p = 0.154$ by Mann-Whitney test).

VEGF-A and vWF mRNA levels showed no significant differences across the three tissues ($p = 0.73$ and $p = 0.24$ respectively by Kruskal-Wallis test).

The study' results clearly indicated that the pseudocapsule is a structure anatomically distinguishable from the myometrium and the surrounding fibroid, displaying a significant and specific gene expression profile. The pseudocapsule, as the fibroid, exhibited a significantly reduced expression of the IGF-2 gene, known to be a tumor growth marker, if compared to the fibroid, suggesting that it has a

non-fibroid origin and that it has a structural continuity with myometrium. The pseudocapsule also showed a statistical relevant over-expression of the endoglin/CD105 gene, when compared to the myometrium and to the fibroid. Based on these evidences, the over-expression of the endoglin gene, rather than of other angiogenic genes, seemed to indicate the presence of an active angiogenesis correlated with reparative process in the pseudocapsule. All together these data clearly depicted the pseudocapsule as a site of intense angiogenesis linked to the endoglin activation rather than other angiogenic factors such as VEGF-A or vWF. The presence of an active angiogenesis is concordant with the histological studies that describe a parallel array of extremely dense capillaries in the pseudocapsule and in the adjacent myometrium, that are absent in fibroid. This can define the structural and functional features of pseudocapsule that could explain its possible roles in the uterine regenerative process [68].

Although the reported investigations conformed the myometrial origin of pseudocapsule, it has never been established its biological genesis. Thus authors analyzed the nature of this uterine structure by defining the mutational state of Mediator Complex Subunit 12 (MED12) gene, known to be mutated in more that 70 % of fibroids [70], in leiomyoma pseudocapsule by a genetic investigation [71].

MED12 gene encode for a component of the Mediator Complex, which act as a transcription factor involved in general and specific gene regulation. Mutations in MED12 gene could [70] be involved in the overall gene de-regulation commonly observed in fibroids and, as a consequence, in its genesis and evolution [72].

In our prospective, non-randomized, observational study (level of evidence II-2), samples of uterine leiomyomas (ULs) and corresponding uterine myometrium (UM) and PC were collected from 36 females who underwent at laparoscopic myomectomy by the intracapsular technique mentioned above [7, 54]. Patient selection was based upon the following criteria: pain or pressure symptoms, ULs causing infertility or reproductive dysfunction, large and growing UFs, or menstrual disorders. Women taking oral contraceptives, GnRH analogues or other hormonal therapies were not included in this study. Additional exclusion criteria as abnormal uterine bleeding, endometrial hyperplasia, uterine polyps, cervical intraepithelial neoplasia, uterine or cervical cancer, and confirmed or suspected primary adnexal pathology were additionally applied according to the presurgical US examinations, by bidimensional (2D) power Doppler ultrasound (PDU) studies, performed in the first 10 days of menstrual cycle, either with a Logic 7 Pro US system (GE-Kretz, Zipf, Austria), an IU 22 xMATRIX US system (Philips Healthcare, Eindhoven, the Netherlands), or a Voluson 730 US system (GE-Kretz, Zipf, Austria) equipped with a 3.8–5.2 MHz transvaginal transducer. All machines had a standard US setting of Doppler and gray scale, provided by companies. Presurgical vaginal US was performed by 2 well-trained physicians with similar expertise to determine the number, size, and location of any fibroid together with the pseudocapsule, which presents as a white ring surrounding the fibroid and is often colored as a "ring of fire" by Doppler scans. LIM was performed using a standardized method previously described. During the operation, the surgeons sampled specimens for analysis. Tissues sampled from the fibroids were taken to approximately 20 mm in depth, including the full thickness of the UL, the UL-PC interface and the surrounding UM; samples of the PC were obtained using scissors as soon as good hemostasis was achieved, while the UM tissues were biopsied at a distance of 2 cm from the UL. The samples were transported to the laboratory for subsequent analysis.

The patients' ages ranged from 32 to 45 years, with an average of 38.5 years. Twenty females had subserous ULs (55.6 %), 16 females had intramural ULs (44.4 %), 15 had single ULs (41.7 %), and 21 had multiple ULs (58.3 %). Authors investigated MED12 gene mutational state by PCR on genomic DNA followed by direct sequencing from each of the 36 ULs collected and their corresponding PCs. Since up to now most mutations in ULs have been found in intervening sequence (IVS) I and in exon 2 of MED12 gene, we focused our analysis on this portion of the gene. We identified specific already known missense mutation in 12 ULs and different deletions never described before in other 6 ULs (data not shown). We extended the analysis to the corresponding pseudocapsules and we find that none of the pseudocapsules associated to a mutated UL show the corresponding mutation. The same wild type profile was obtained by sequencing of the genomic DNA extracted from randomly selected UMs. To the best of our knowledge, we showed, for the first time, the non tumor origin of the PC, by analyzing the mutational state of the MED12 gene. Mutations in MED12 gene could be involved in the overall gene de-regulation commonly observed in fibroids and, as a consequence, in its genesis and evolution. We confirm the high frequency (18 out of 36) of mutations in MED12 gene among our set of fibroids; then we extend the analysis to the corresponding PCs and we find that each PC show a wild type sequence profile, even when associated to a MED12-mutated UL.

This data clearly indicate the non-tumor origin of the PC and a genomic profile comparable to that of the adjacent healthy myometrium, whose MED12 sequence always results as wild type too. The gene expression profile of PC is well distinguishable from that of the fibroid, as well: in particular it exhibits lower IGF-2 and higher endoglin/CD105 transcript levels when compared to the UL [68]. Since IGF-2 overexpression is known to be a specific leiomyoma marker, this data seem to support the non-tumor origin of PC; by the

other side, the high expression level of endoglin gene, involved in neo-angiogenic processes and wound healing [73, 74], could explain the regenerative processes observed at the scar site, after a myomectomy performed by pseudocapsule sparing.

Another genetic investigation [75] involved the analysis of insulin-like growth factor II (IGF-2) and collagen type IV alpha 2 (COL4A2) expression levels in the same set of ULs. To assess whether the MED12 mutational state affects the gene expression profile in UL, we analyzed, using quantitative real-time PCR, the expression of IGF-2 and COL4A2 in our set of ULs. These genes were selected for this investigation because they are known to be up-regulated in UL when compared to matching myometrium. On the basis of the different mutational status, the UL samples were divided into three groups: group A consisted of samples without MED12 mutations, group B consisted of samples exhibiting deletions in the MED12 gene, and group C consisted of samples harboring missense mutations. Firstly, we defined IGF-2 and COL4A2 expression level in UM: we observed that the health tissues always express low level of both genes without any statistical variation depending on the corresponding UL's state ($p = 0.84$ by Kruskal–Wallis test). As a consequence, having ascertained that expression levels in ULs are not influenced by basal levels of expression in the corresponding UMs, we were able to compare the three groups of ULs, directly considering the mRNA relative units of expression of IGF-2 and COL4A2. The analysis of the IGF-2 expression level revealed a significant difference among the groups ($p = 0.0004$ by Kruskal–Wallis test). In particular, the mean relative expression units were significantly higher as assessed by the Mann-Whitney tests in group C (0.017 units mean) compared with group A (0.004 units mean, $p = 0.0004$) and group B (0.003 units mean, $p = 0.002$). The difference between groups A and B was not statistically significant ($p = 0.76$ by the Mann-Whitney test). These data demonstrated a specific correlation between missense mutations in exon 2 of the MED12 gene and IGF-2 overexpression. Conversely, the COL4A2 mRNA levels, although resulted higher in ULs when compared to those expressed by the corresponding UMs, showed no significant differences among the three groups of samples ($p = 0.132$ by Kruskal–Wallis test).

Concluding, the study interestingly revealed that only those with MED12-missense mutations expressed significantly higher levels of the IGF-2 gene. Otherwise, the MED12 gene status does not appear to affect the expression levels of the COL4A2 gene. On the basis of this finding, we suggest that the MED12 status stratified the ULs into two mutually exclusive pathways of leiomyoma genesis with IGF-2 overexpression and the absence of IGF-2 activation. The occurrence of IGF-2 overexpression could be therapeutically targeted in uterine myomas for the non-surgical myoma treatment.

Finally, since pseudocapsule is also genetically different from myoma, all pharmacological and hormonal commonly proposed treatments to prevent the growth of myomas, such as aromatase inhibitor, progestins and anti-progestins, estrogens, Selective Progestin Receptor Modulators (SPRMs), Selective Estrogen Receptor Modulators (SERMs) and GnRH, i.e., should not act on the pseudocapsule as acting on the myoma.

Uterine Myoma Pseudocapsule Analysed by Ultrasound and Histology

Fibroid pseudocapsule sizes, although its biological importance, is often underestimated by surgeons because of difficulties in visualizing the pseudocapsule during laparotomy or laparoscopy so as the pseudocapsule thickness was never morphologically measured in a study. The aim of our study was to measure the myoma pseudocapsule by a feasible and reproducible method, the gynecological ultrasound (US), comparing the thickness with histology according to fibroid location within the uterine wall.

We also hypothesized that pseudocapsule thickness depended on fibroid location within the uterine wall, whether near the endometrial cavity (FEC), intramural (IMF), or subserosal (SSF), and that the pseudocapsule thickness will be equivalent by US and histological measurement. Therefore, we planned to measure in a study [76] the presurgical fibroid pseudocapsule thickness by US and the histological features following hysterectomy in patients undergoing hysterectomy for symptomatic uterine fibroids. Thus, we organized a prospective cohort trial investigating pseudocapsule thickness using US and histology on a total, 90 women with large (from 6 cm in diameter), growing, symptomatic (pain, pressure, or menstrual) fibroids scheduled for hysterectomy. All procedures were conducted in accordance with the guidelines of the Helsinki Declaration on human experimentation. All patients had a heavy menstrual cycle and provided written, informed, and signed consent for the hysterectomy and anonymous use of information concerning fibroid pseudocapsules for research purposes. The following exclusion criteria were applied: abnormal uterine bleeding, endometrial hyperplasia, uterine polyps, cervical intraepithelial neoplasia, uterine or cervical cancer, and confirmed or suspected primary adnexal pathology. The following exclusion criteria were additionally applied according to the presurgical US examinations in order to maintain the homogeneity of fibroid pseudocapsule thickness: adenomyosis or adenomyoma and isthmic-cervical, intraligamentary, or pedunculated fibroids to give analytic homogeneity. Following presurgical US screening, 15 women were excluded and 75 patients were enrolled for further investigation. Bi-dimensional (2D) power Doppler

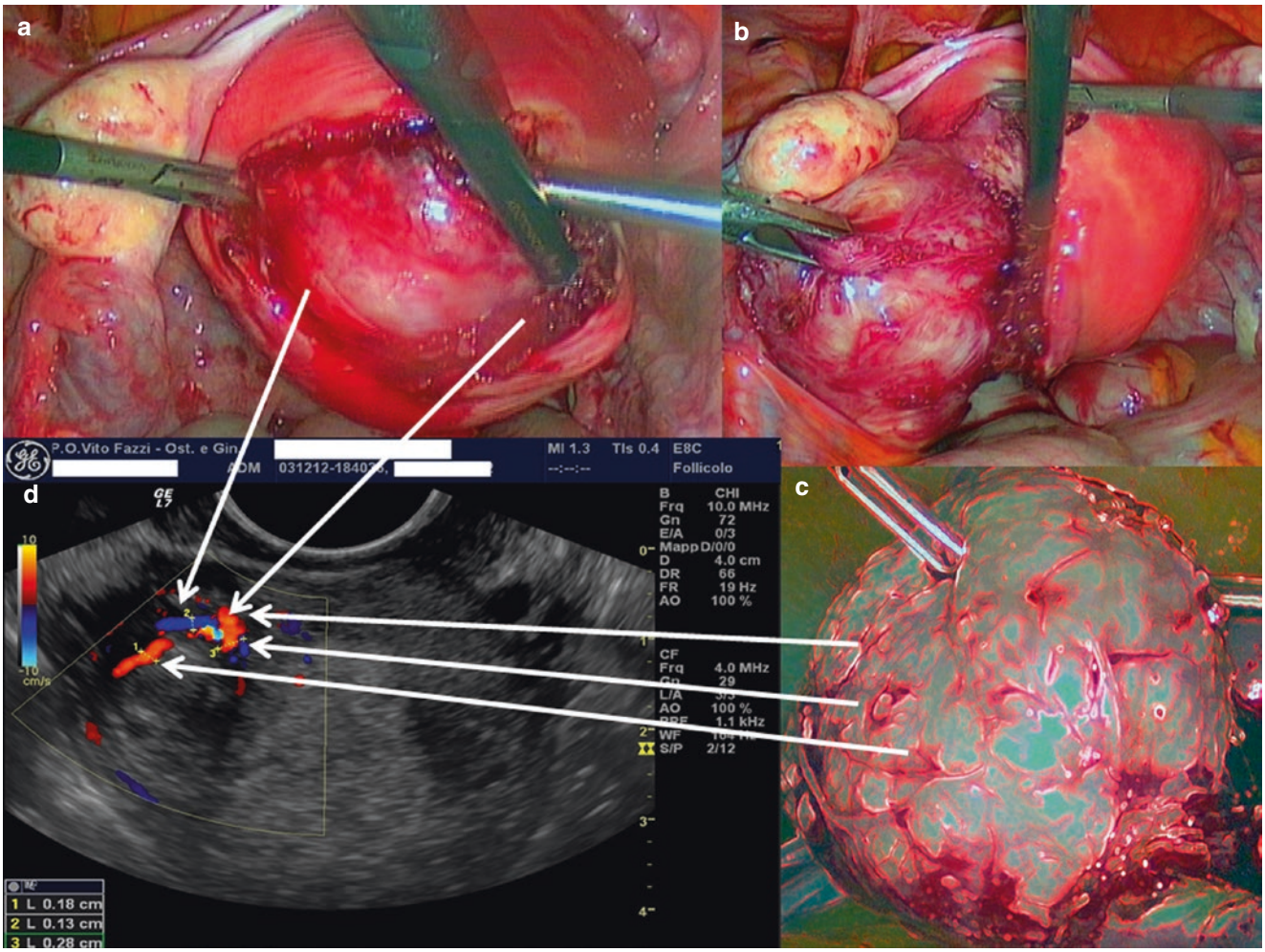


Fig. 31.21 Clockwise, starting from top left: the technique of fibroid enucleation with pseudocapsule sparing (**a**–**c**). White arrows indicate the pseudocapsule saved during fibroid enucleation, which appears finely covered by a thin fibrovascular matrix (neurovascular bundle). This is joined in the ultrasound image (**d**) to highlight the ring of fire during presurgical evaluation

ultrasound (PDU) studies were conducted in the first ten days of menstrual cycle, either with a Logic 7 Pro US system (GE-Kretz, Zipf, Austria), an IU 22 xMATRIX US system (Philips Healthcare, Eindhoven, The Netherlands), or a Voluson 730 US system (GE-Kretz, Zipf, Austria) equipped with a 3.8–5.2 MHz transvaginal transducer. All machines had a standard US setting of Doppler and gray scale, provided by Companies. Presurgical vaginal US was performed by two well trained physicians with similar expertise to determine the number, size, and location of any fibroid [27], together with the pseudocapsule, which presents as a white ring surrounding the fibroid and is often colored as a "ring of fire" by Doppler scans (Fig. 31.21). The fibroid pseudocapsule thickness was measured by transvaginal 2D-PDU in a clockwise manner in the longitudinal and transversal planes (Fig. 31.22), with 4 measurements: superior–inferior and lateral–lateral; measuring the thickness of two measurements, clinicians added the measurements and split for two, getting the average thickness of the myoma pseudocapsule. The US scanner cursor was placed at the thickest point between the 2 layers on the anterior and posterior pseudocapsule walls, both as regards to the white ring of fire on 2D-PDU. To analyze the fibroid location and pseudocapsule thickness, the uterus was artificially divided in a transverse plane to record each fibroid's location compared to pseudocapsule thickness. In order to strictly standardize the fibroid location in the uterus, we used the leiomyoma subclassification system of Wamsteker et al. (currently used by International Federation of Gynecology and Obstetrics), identifying subserosal fibroids (n° 6 and 5 by Wamsteker classification), intramural fibroids (n° 4), and fibroids near endometrial cavity (n° 3) [18]. All the collected thickness parameters were mapped and recorded. Total hysterectomies were performed either via laparotomy or laparoscopy in the first ten days of menstrual cycle, and the excised uterus was immediately sent to the pathology department

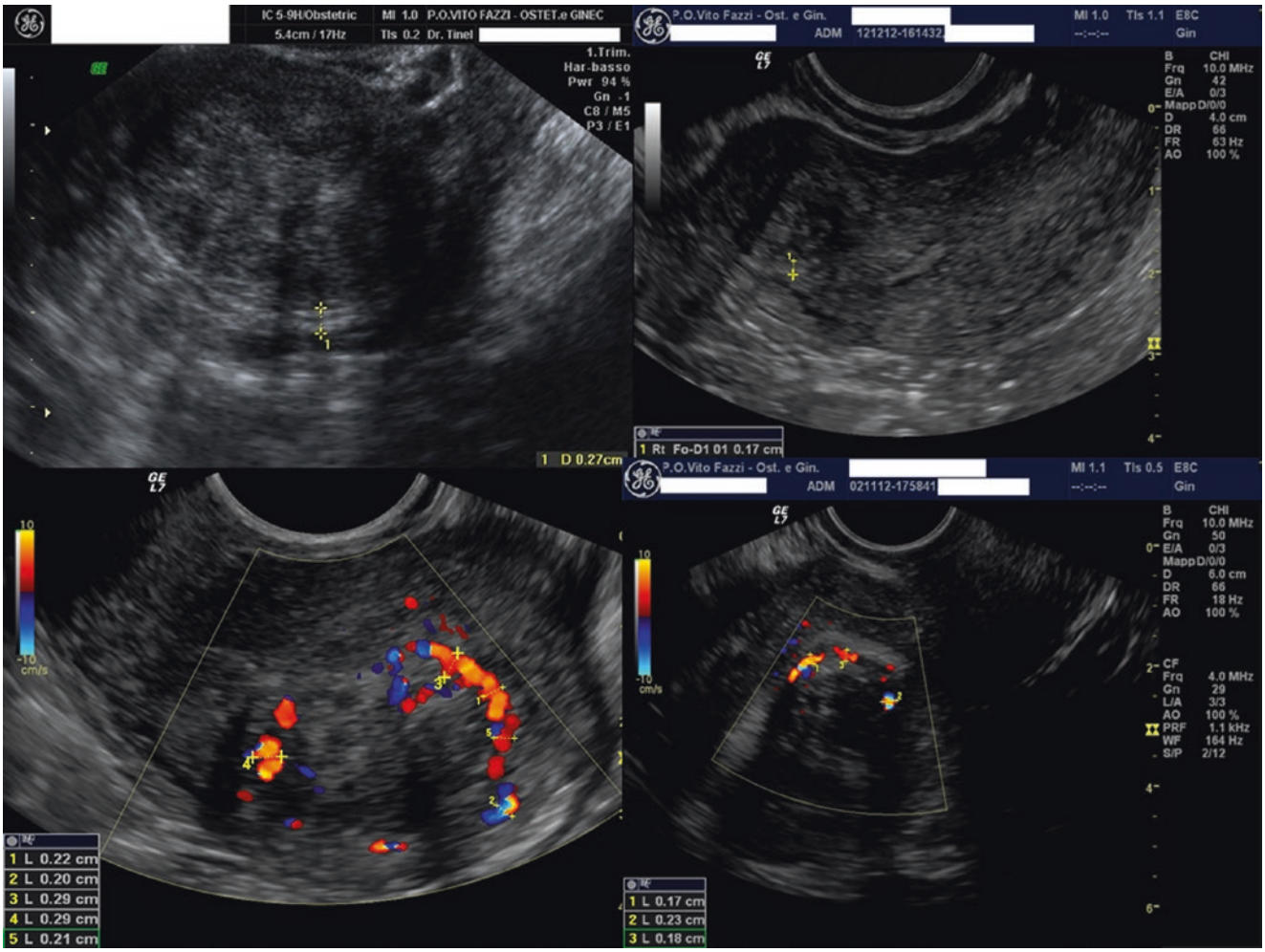


Fig. 31.22 Clockwise, starting from top left: 4 presurgical vaginal ultrasound images demonstrating the presence of the pseudocapsule as a white ring surrounding the fibroid (2 images in the *box above*) or colored as a "ring of fire" by a Doppler scan (in the *box below*)

for macroscopic and histological examination by expert pathologists, already involved in other studies on myoma pseudocapsules. Four fibroid-pseudocapsule–myometrium specimens measuring 2 × 2 cm (superior–inferior and lateral–lateral) were obtained. All specimens were numbered and fixed, before being embedded in paraffin wax for cross-sectional sagittal slices. The sections were obtained at 7-μm intervals and placed on a glass slide for Hematoxylin and Eosin staining. The fibroid-pseudocapsule–myometrium specimen borders were analyzed on each side using conventional light microscopy (10× to 40× magnification) to detail the pseudocapsule thickness.

Pathologists measured the thickness of two measurements, and then they added the measurements and split for two, getting the average thickness of the myoma pseudocapsule for histological evaluation. Artifacts were considered with the correct plane of cleavage of the fibroid from the myometrium. Finally, all US and histological data were matched by an independent researcher for comparison.

All measures are calculated as means ± Standard Deviation (Ultrasound and Histology or U&H). Both variables are normally distributed, because Q-Q plots approximate a diagonal straight line, not showed into the paper. A small difference in the skewness and in the Kurtosis between the two samples (U&H measurements) was observed. Pseudocapsule thicknesses were analyzed by one-way analysis of variance (ANOVA) with Tukey's multiple comparisons and post hoc paired t-test on US and histological measurements. Cut-off levels were defined with receiver operating characteristic (ROC) curves was used to predict sensitivity and specificity. Differences between ultrasonographic and histological pseudocapsule measurements were assessed by Bland Altman method. The nonparametric Kruskal–Wallis test was used to compare US and histological measurements (3 groups of matched measurements). A p value of $P < 0.05$ was considered statistically significant. Analyses were conducted with the statistical package for the Social Sciences Version 12.0 (SPSS, Inc., Chicago, IL, USA)

and JMP 8 for ANOVA and Kruskal-Wallis. The following hypotheses were tested: H1- Pseudocapsule thickness differs according to fibroid location within the uterine wall sites, i.e., FEC, IMF, and SSF; H2 – Pseudocapsule thickness differs according to the examination technique employed; in this case, either US or histology. All P values are 2 – tailed.

The mean age of the 75 patients was 47 years (range 43–51). Past obstetric history was as follows: 24 %, 41 %, and 35 % had a parity of 1, 2, and ≥3, respectively. Previous delivery was vaginal in 69 % and by cesarean section in 31 %. Past surgical histories included cholecystectomy (12 %), appendectomy (25 %), ovarian cysts (27 %), and surgery for pelvic pain and adhesions (21 %). Multiple past surgeries were recorded for 22 % of the cases. None of the patients reported prior surgical complications. In total, 108 fibroids were sampled, of which 53 were from the uterine body and 55 were from the fundus. The fibroids were subdivided according to their location within the uterine wall into subserosal (n = 57), intramural (n = 33), and near the endometrial cavity (n = 18). There was no significant difference in the mean or median diameter of the fibroid in each location. The first hypothesis (H1) was analyzed by one-way ANOVA, and it was determined that significant differences in pseudocapsule thickness depended on fibroid location within the uterine wall (FEC, IMF, or SSF), independent of measurement technique ($P < 0.001$). The FEC pseudocapsule walls measured by US were considerably thicker than the IMF ($P < 0.001$) and SSF ($P < 0.001$) pseudocapsule walls: 2.64 ± 0.28, 1.70 ± 0.14, and 0.95 ± 0.33 mm, respectively. The thickness measured by histological examination was 2.79 ± 0.25, 1.72 ± 0.21, and 1.03 ± 0.4 mm, respectively. In turn, the IMF pseudocapsule walls were thicker than the SSF pseudocapsule walls ($P < 0.001$). The results were further analyzed for the second hypothesis (H2), to determine whether US pseudocapsule measurements are comparable with histological measurements. Our measurements revealed a high correlation (correlation coefficient: 0.963) and significance level ($P = 0.001$) using paired sample t-tests. Only IMF pseudocapsule measurements showed similarity between the histological and US methods ($P = 0.625$). Conversely, a significant difference was observed between measurements in FEC ($P = 0.001$) and SSF ($P = 0.014$) locations. Overall, a difference was observed between US and histological measurements ($P = 0.0001$) (paired sample t-test). A clear cut-off was observed between FEC pseudocapsule and all other pseudocapsule measurements, i.e., at 2 mm, the difference was significant ($P = 0.001$). The area under the curve (AUC) was 1 for US measurement and 0.999 for histological measurement. ROC analysis revealed that a cut off value of 2 mm provided almost 100 % sensitivity and specificity for diagnosing a FEC, in this limited sample. Overall Bland Altman limit of agreement analysis revealed that histological measurements tended to be slightly higher than ultrasonographic measurements. However, for 95 % of all cases this difference represented a small range. From a clinical standpoint this difference is unlikely to be significant. The pseudocapsule of fibroids is considerably thicker near the endometrial cavity when compared those of both intramural and subserosal fibroids. Since fibroids closest to the endometrial cavity are the most involved in fertility and infertility and fibroid pseudocapsule is considerably thicker near the endometrial cavity, it is possible to hypothesize an involvement of FP of fibroid near on endometrium, since FP contains many neuropeptides and neurotransmitters that are physiologically active, even if this data may take on a broader meaning in a study on a larger number of patients.

Another investigation [18] evaluated the uterine scar healing after laparoscopic myomectomy, monitored by traditional 2D ultrasound (US) and Doppler velocimetry, in 149 women underwent laparoscopic intracapsular myomectomy (LIM). The indications and surgical techniques were evaluated to consider the benefits and limitations of LIM. The procedures used in the present study were in accordance with guidelines of the Helsinki Declaration on human experimentation. The study protocol was carefully explained to the patients before they entered the study and written consent for operation was obtained. Patient selection was based upon the following criteria: pain or pressure symptoms, UFs causing infertility or reproductive dysfunction, large and growing UFs, or menstrual disorders. Regarding menstrual disorders, the authors used similar criteria established by an international consensus that determined normal limits for menstrual parameters in the mid-reproductive years: excessively frequent menses (each < 25 days), irregular menses (cycle-to-cycle variation greater than 20 days), excessive duration of flow (prolonged 6–8 days) and high volume of monthly blood loss [77]. Presurgical vaginal ultrasound (US) was performed by expert clinician to determine the presence of the pseudocapsule as a white ring surrounding the UF, colored by Doppler as a "ring of fire". The number, size and location of UFs were assessed and patients with suspected adenomyosis or adenomyoma were excluded. All 2D-PDU studies were performed either with a Logic 7 Pro US system (GE-Kretz, Zipf, Austria) or IU 22 xMATRIX US system (Philips Healthcare, Eindhoven, The Netherlands) or with a Voluson 730 US system (GE-Kretz, Zipf, Austria), each equipped with a 3.8–5.2 MHz transvaginal transducer. The uterus and the UF were measured in two planes, sagittal and coronal and all the data were recorded. The Resistance Index (RI) was calculated from the flow velocity waveform of the uterine arteries, at their ascending branch. Magnetic resonance imaging was not used to diagnose fibroids due to expense and time. All UFs were subserous or intramural, single or multiple, and the dominant fibroid measured between 5 and 9 cm in diameter. The study excluded women with UFs that were pedun-

culated, small (<3 cm in diameter) or submucous. Preoperative evaluation included office hysteroscopy to exclude submucus UFs and other uterine abnormalities. We used the UF classification system of Wamsteker to describe fibroid location, as usually done. Preoperative treatment with GnRH analogues was performed in rare cases, to avoid distortion of the UF pseudocapsule [52, 53, 78]. All patients received prophylactic Cefazolin 2 g I.V prior to laparoscopy and an intrauterine manipulator was used. Laparoscopic myomectomy was performed under general anesthesia by endotracheal intubation with a standardized four port approach: one port for the laparoscope and three lower quadrant ancillary ports (one suprapubic central 10 mm port and two lateral 5 mm ports). The 10 mm central suprapubic port was often changed to 15–20 mm for the introduction of the morcellator at the end of the procedure. Laparoscopic myomectomy by the intracapsular technique was performed without injection of an ischemic solution, as vasopressin, into the myometrium [7]. Its use could mask the musculature vascularization by collapsing vessels, making difficult the selective and gentle pseudocapsule vessel hemostasis during LIM and favouring subsequent intra-myometrial hematomas. Authors used the US to monitor the scar size and the muscular healing following LIM, detailed as following for consistency in the study. The visceral peritoneum was incised in the midline longitudinal plane with monopolar scissors or a crochet needle electrode, quickly proceeding into the myometrium to reach the right plane to detect the fibroid below. Once the pseudocapsule was identified, it was exposed by a Johannes or Manhes clamp or by an irrigator cannula to provide a panoramic laparoscopic view of the pseudocapsule. The pseudocapsule was opened with a longitudinal cut using monopolar scissors or a crochet needle to expose the UF surface. Then the fibroid was secured by a myoma screw or Collins laparoscopic forceps to provide the traction necessary for gentle enucleation, and inserting the irrigator cannula into the space between the UF pseudocapsule and fibroid for assistance. Hemostasis of the small vessels was selectively achieved using a low energy bipolar clamp or by monopolar crochet, to free the base of the UF and the connective bridges from the pseudocapsule, with minimal trauma, minimal blood loss, and pseudocapsule sparing. In cases of deep intramural UFs, chromopertubation was applied via a cervical cannula not only to check tubal patency but also to facilitate the direct recognition of an inadvertently opened uterine cavity. The myometrium was closed in a single (for subserous) or double layer (for intramural) with 1/0 Vicryl (polyglactine; Ethicon, USA), including overlying serosa, with a round CT-1 curved needle, using intra or extracorporeal knots. In sub-serosal myomectomies (types 5 and 6), the edges of the uterine defect were approximated with introflexing U-inverted stitches (myometrium/serosa-serosa/myometrium direction) at 1 cm increments (a baseball-type suture). Interrupted closure or a traditional unidirectional running suture was chosen by the surgeon. Deep intramural UFs (types 2–5 and 3) were closed in two-layers using introflexing baseball-type sutures. If the uterine cavities were accidentally opened during UF enucleation, 2–3 single or continuous sutures were used to close the edge of the uterine cavity. UFs were morcellated with a reusable Rotocut G1 morcellator (Karl Storz GmbH & Co. KG, Germany) or by a Gynecare Morcellex tissue morcellator (Ethicon, Inc., Somerville, NJ, USA). Patients were re-evaluated by transvaginal US on days 1, 7, 30 and 45 after surgery. The myometrial scar pattern was compared to the previous myometrial area occupied by the UF. The scar diameter was measured by placing callipers on the outer edge of the echogenic, heterogeneous, and ill-defined area to determine the healing pattern of the uterine scar after LIM [79–82]. Moreover, authors measured the RI of the uterine arteries at their ascending branch during each US examination. The myometrial area of the scar was calculated as the percentage of the preoperative UF diameter. The parameters were analyzed by an independent statistician using the Student's t-test for paired samples. A significant p-value was considered as $p < 0.05$.

One hundred and thirty-six operated patients completed the study and the follow up. The mean age of our population was 37.2 ± 3.6 years (range 33–40 years), mean BMI was 22.9 ± 2.5 and mean parity was 1.3 ± 0.7. The primary preoperative indications included pelvic pain in 24 %, menorrhagia or metrorrhagia in 23 %, a large growing UF in 13 %, and infertility in 40 %. The size of UFs was 5–6 cm diameter in 35 women (25.7 %), 6–7 cm in 37 (27.2 %), 7–8 cm in 34 (25 %), and 8–9 cm in 30 women (22.1 %). UF were subserosal in 48 women (35.2 %) and intramural in 88 (64.8 %). Of the 136 women, 82 had a single fibroid (60.2 %): 29 subserous (35.3 %) and 53 intramural (64.7 %). Fifty-four had multiple UFs (39.7 %): 19 subserous (35.2 %) and 35 intramural (64.8 %). Of the 48 subserosal fibroids, 29 were type 5 (60.4 %) and 19 were type 6 (39.6 %), with no type 7. Of the 88 intramural UF, 21 were transmural types 2-5 (23.8 %), 38 were type 3 (43.1 %) and 29 were type 4 (33.1 %). Single intracapsular myomectomy was performed for intramural fibroids in 7 women with UF types 2–5 (33.3 %), 16 with type 3 (42.1 %) and 17 with type 4 (58.6 %), and for subserous fibroids in 16 patients with type 5 (55.1 %) and 11 with type 6 (57.8 %). Multiple intracapsular myomectomy was performed for intramural fibroids in 14 women with UF type 2–5 (66.7 %), 22 with type 3 (57.9 %) and 12 with type 4 (41.4 %), and for subserous fibroids in 13 patients with UF type 5 (44.9 %) and 8 with type 6 (42.2 %). Two women (1.4 %) were pre-treated with 3.75 mg leuprolide acetate for 3 months before surgery to shrink the UFs. During surgery, a monopolar crochet needle was used to cut the connective bridges of the pseudocapsule from the surrounding myome-

trium in 59 women (43.4 %), and bipolar clamp scissors (30 W energy) were used in the remaining 77 (56.6 %). The uterine cavity was entered during myomectomy in 2 women with a single UF (2.4 %) and in 5 with multiple UFs (9.2 %). All laparoscopies were successful without conversion to laparotomy.

On the first and 7th post-operative days, the US pattern of uterine scar area was represented by a highly echogenic area having an-ill defined heterogeneous myometrial texture; from day 30–45 the image shifted to a normal echogenic myometrial texture. There was a progressive reduction of uterine scar. The scar after LIM was 78 % of the previous UF diameter on the first day, 61 % on 7th day, and 19 % on the 30th day, and disappeared (<4 %) on the 45th day. The progressive reduction in size of US pattern of uterine scar area was significant ($p < 0.05$). There was no correlation with the size of the fibroid and the relative reduction in the scar diameter, either on days 1 or 45. There was an increase of the RI value of the ipsilateral uterine arteries from 0.57 of the preoperative day (range 0.45–0.69) to 0.65 on the first postoperative day (range 0.59–0.73). This difference was statistically significant ($p < 0.05$). After 1 week the RI was always elevated to 0.83 (range 0.74–0.92), then the RI decreased to 0.71 (range 0.59–0.83) at the 30th post operative day and to 0.61 (range 0.50–0.72) at the 45th post operative day. All of these comparisons were statistically significant ($p < 0.05$). During the postoperative US evaluations, the authors noted the persistence of small linear hyperechoic points, the stitches of polyglactine that have an absorption time of 50–60 days. No important fluid-filled areas were seen. The authors found a few small anechoic areas < 5 mm at the site of LIM on the first day, and two patients had an anechoic area of 1–2 cm at the myomectomy site (1.5 %), possibly indicating the presence of a hematoma.

Basing on these results, the myometrial area of the scar after LIM can be followed by 2D US and Doppler velocimetry, a non-invasive, safe method to check uterine perfusion, postoperative hematoma and disechogenic, heterogeneous, or an ill-defined scar area, all unfavourable signs for myometrial scarring. Moreover, Doppler transvaginal monitoring, evaluating PI and RI of the uterine arteries at their ascending branch, could identify patients with altered PI and RI parameters, possible markers of impaired wound healing.

The Potential Impact of Pseudocapsule Sparing on Muscular Healing

Uterine muscle is an amazing tissue, specialized to generate force but for that function to be well-served, muscle must be a precisely organized and excitable tissue, in function to pregnancy, labor and delivery. It also shows an impressive ability to adapt to changing functional demands during fetal growth, and provides a major site for energy storage for labor.

Uterine myometrial repair and regeneration that follow surgical injury, as myomectomy, requires that muscle first re-establish homeostasis following the damaging perturbation and then restore the normal structural and functional capacities of the fully differentiated tissue. Restoration of muscle structure and function is a key, early feature in successful repair and regeneration of muscle. However, muscle membrane damage itself can initiate signalling processes that activate muscle regeneration. The synthesis and release of signalling molecules that are activated by muscle fibers subjected to membrane damage can induce the activation and attraction of a diverse population of cells that promote muscle regeneration and growth [83]. Following acute muscle injury, the sequence of muscle injury-repair-regeneration leads to full functional recovery with days to weeks of the initial damage [84].

A vital process in the regeneration of an injured muscle is the vascularization of the injured area. The restoration of vascular supply to the injured area is the first sign of regeneration and a prerequisite for the subsequent morphological and functional recovery of the injured muscle. The new capillaries sprout from the surviving trunks of the blood vessels toward the centre of the injured area to provide the area with an adequate supply of oxygen, subsequently enabling aerobic energy metabolism for the regenerating myofibers [85].

In such regenerative process, there is also the involvement of neuropeptides and neurotransmitters, extremely important in wound healing. In fact, there is evidence that the nervous system and its neurotransmitters, such as Substance P (SP), Vasoactive Intestinal Peptide (VIP), neuropeptide Y (NPY), Oxytocin, Vasopressin (VP), PGP9.5, calcitonin gene-related peptide (CGRP), growth hormone-releasing hormone (GHRH), play a role in mediating inflammation and healing [83, 85–87].

Referring to uterine musculature scar physiology, these peptides sparing enhances a correct healing of a hysterotomy. Most of these neuropeptides have been highlighted in the pseudocapsule, as evidenced [48, 49, 55, 56].

As the neuropeptides are transported to the tissues by the neurovascular network, the myoma pseudocapsule, as neurovascular bundle [49], is therefore a structure rich of neuropeptides. Pseudocapsule vessels were also studied by a preliminary three-dimensional mathematical model [50], who showed an increase vascular tortuosity, disarray, an abnormal branching and the presence of "cul-de-sac" pseudocapsule vessels. All of these features are similar to malignant neoplastic tissue vessels features, present in malignant tumors. It was not possible to clarify if the pseudocapsule vasculature network could be sustained by mechanical and inflammatory effects of myoma on myometrium, or pro-

duced by a sort of neoangiogenesis "neoplastic-type", due to the fibroid growth or even to a muscle and tissue healing process, such as a neurovascular preparative reaction of female body to a fibroid expulsion (pedunculated fibroids), necrosis or degeneration, allowing a normal uterine restoration [88].

In human body, difficulties in obtaining serial samples of the hysterotomic scar during myomectomy or cesarean section, are a major barrier to our understanding of the events involved in the post-myomectomy and post-cesarean section remodelling processes of the uterine wound. They can be only monitored by ultrasound or MRI [18].

However, irrespective of the ultimate result, wound healing is a dynamic, interactive process involving neuromediators, angiogenetic factors, neuropeptides, blood cells, extracellular matrix, and parenchymal cells that follows three complex and overlapping phases: inflammation, tissue formation, and tissue remodelling [89].

And the biochemical growth factors evaluated in the pseudocapsule vessels cause intense angiogenesis in pseudocapsule, probably promoted by the fibroids [68].

Anyway, the biological genesis of myoma pseudocapsule sustains the necessity either to better analyze hormonal and pharmacological impacts of drugs on pseudocapsule (based on reducing fibroid growth without compromise pseudocapsule properties), or to remodelling the presurgical uterine fibroid therapy and the post-surgical follow up, in order to preserve uterine functionality, as much as possible.

Translation of Scientific Research on Myoma Pseudocapsule on Medical and Surgical Practice

Since the ultimate goal of scientific research is the application in clinical practice, I tried to translate the studies on the myoma pseudocapsule in surgical practice of reproductive surgery. Fibroids can cause clinical symptoms and myomectomy can significantly improve symptoms and quality of life and, in some clinical situations, improve reproductive outcomes in aged women, who delay childbirth into their 30s and 40s, when the incidence of fibroids is significantly increased. So far, reproductive surgery was supported by a large number of publications that have discussed the benefits of myomectomy. However, very few articles have evaluated, per se, the rationale of the surgical technique, explaining all the steps of the scientific techniques. And this is what I tried to do I explain the rationale for the removal of myomas starting with the preservation of its pseudocapsule, rich of neurotrasmitters and vessels, a neurovascular bundle containing neuropeptides and related fibers surrounding prostate [88].

The idea of a neurovascular bundle surrounding a myoma, inside pseudocapsule, derives from a multidisciplinary discussion among gynecologists and urologists, on analogies of myoma pseudocapsule with the prostate capsule. Based on the purpose of reducing the probability of impotence associated prostate cancer treatment, urologist generally must preserve neurovascular bundles surrounds prostate. Anatomically, the neurovascular bundles are situated on the peripheral to the prostate.

The prostatic neurovascular bundle provide both somatic and autonomic innervations to the continence mechanism. The excision of neurovascular bundle causes more incontinence and impotency than when the neurovascular bundles are preserved [49, 88]. In order to spare the prostatic neurovascular bundles, laparoscopic or robotic assisted prostatectomy are both useful [90], since the magnification facilitates a more gentle dissection with less traction and careful dissection [91].

Although these nerves are microscopic [92], their anatomic location can be evaluated intraoperatively through the use of the capsular vessels as a landmark. An opening in the levator fascia is performed by sharp incision along the anterolateral surface of the prostate starting at the base of the prostate and proceeding toward the apex. This manoeuvre releases the bundle laterally, thus making it easier to make the next step, where the bundle is released posteriorly at the apex. Once the superficial fascia has been released, the site of the neurovascular bundles can be identified by the presence of a thin "groove" on the posterolateral edge of the prostate. The interfascial plane (i.e., between the levator and prostatic fascia) is developed gently using blunt dissection with a fine curved dissector and a gentle diathermocoagulation. Dissection continues in close approximation to the surface of the prostatic fascia in efforts to optimize quantitative cavernous nerve preservation. If bleeding occurs from periprostatic vessels, insufflation pressure can be in the meanwhile increased and pressure applied to the source of bleeding with hemostatic gauze. Hemostasis with high wattage diathermocoagulation or ultrasonic heat energy should be always avoided during dissection near the neurovascular bundles, as these energy sources have been shown to be injurious to cavernous nerve function in the canine model [93].

On the bases of these findings about the importance of the prostatic capsule and the important and physiologic role of nerve-sparing techniques for prostatectomy, and comparing this structure to the fibroid pseudocapsule, the knowledge of peripheral neurovascular bundle of the uterine leiomyoma was challenged and revisited by me and my colleagues (Fig. 31.23).

In fact, literature showed the possibility to perform myomectomy by removing the fibroid from its surrounding structure, the fibroid pseudocapsule [94, 95], I called "intracapsular myomectomy" [7, 79]. It performs by stretching and extracting fibroid directly from the surrounding fibromuscular skeleton, breaking up the fibrous bridges.

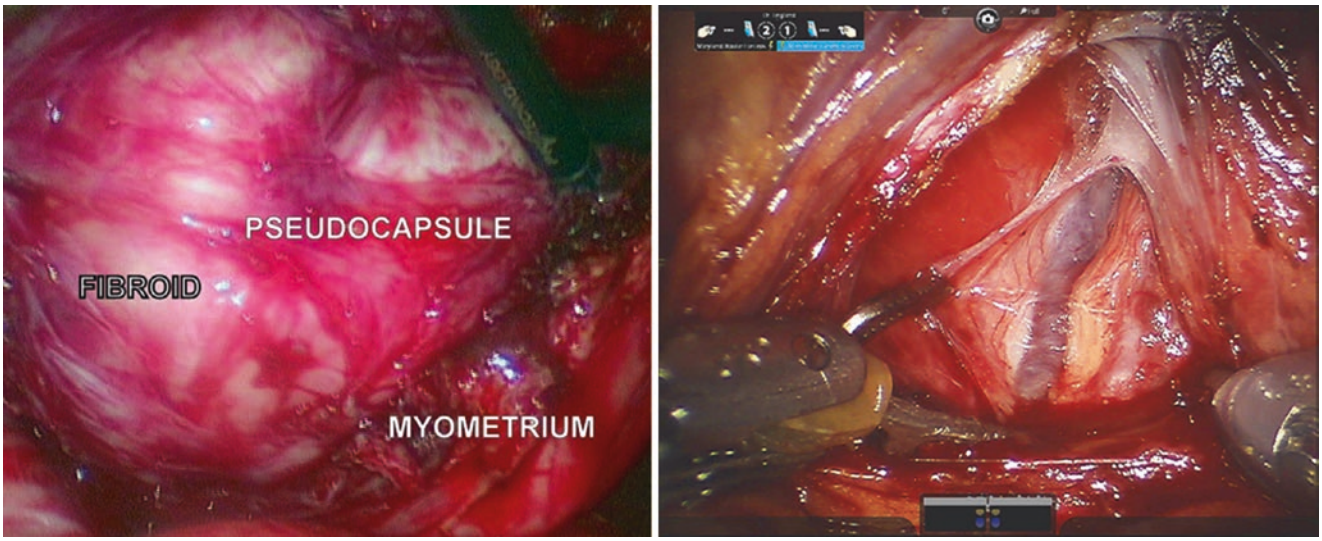


Fig. 31.23 A parallelism between laparoscopic myomectomy sparing pseudocapsule (*on the left*) and radical robotic prostatectomy sparing prostatic vein and neurovascular bundle (*on the right*)

The general myomectomy dogma is that "each surgical fibroid enucleating needs to be gently performed to enhance a correct healing process of the uterine musculature and to facilitate successively the correct uterine musculature anatomical-functional restoring".

So, the main principle of myomectomy is to perform all manipulations as precisely and bloodlessly as possible, and the new surgical technique of intracapsular myomectomy meets this requirement. Nevertheless, the impact of surgical myomectomy differs depending on the technique used [96]. The laparotomic myomectomy is different from the laparoscopic technique, also with same intracapsular method: the laparoscopic access route proved to be the most beneficial. The advantages of the laparoscopic approach are the significantly reduced parameters of both intra- and post-surgical blood loss, decreased bladder pain after Foley removal, the lower number of patients requiring pain relief medication and the shorter hospital stay. In addition, laparoscopic intracapsular myomectomy resulted in slightly improved short-term outcomes in relation to postoperative fever, myometrium scar hematomas, ileus and antibiotic treatment compared to open surgery. Finally, the laparoscopic myomectomy has a favourable impact on blood loss by intracapsular method, aiming to preserve musculature under hysterotomy. The CO2 insufflation can influence blood loss during intracapsular myomectomy, as the increased intraperitoneal pressure can lead to the occlusion of the small blood vessels and capillaries of the pseudocapsule. This effect, combined with less traumatic endoscopic micro-manipulations, could result in beneficial outcomes of surgery. To better clarify these results, I remember that my intracapsular myomectomy was standardized and published [7, 79].

Laparoscopic myomectomies are performed under general anesthesia by endotracheal intubation with a standardized four port approach: one port for the laparoscope and three lower quadrant ancillary ports (one suprapubic central 10 mm port and two lateral 5 mm ports). The 10 mm central suprapubic port is often changed to 15–20 mm for the introduction of the morcellator at the end of the procedure. All patients receive an intrauterine manipulator prior to laparoscopy, to better mobilize uterus. Intracapsular laparoscopic myomectomy of sub mucous and intramural fibroids is generally performed without injection of ischemic solution into the myometrium. The visceral peritoneum is incised in the midline longitudinal plane, by monopolar scissors or crochet needle electrode, proceeding in depth into myometrium to reach the right plane under myometrium, to detect myoma pseudocapsule with the fibroid below.

Once identified the myoma pseudocapsule, it is well exposed by atraumatic clamp or by irrigator cannula, to provide a panoramic laparoscopic view of pseudocapsule of all subserous-intramural leiomyomas. Then surgeon affects the pseudocapsule by a longitudinal cut, performed by monopolar scissors or Hook electrode at low wattage (30 W), to expose the myoma surface. Then fibroid is hooked by a myoma screw or Collins laparoscopic forceps to perform the traction necessary for its gentle enucleating, helping by irrigator cannula to be inserted in the space under myoma pseudocapsule and fibroid. Hemostasis of the small vessels bleeding is selectively achieved by a low wattage bipolar clamp or by Hook electrode or monopolar scissors, always at 30 W, to free the base of the myoma and the connective bridges from the pseudocapsule. In such way, complete minimal traumatic fibroid removal from its pseudocapsule was accomplished with a minimal blood loss and pseudocapsule sparing. In case of pseudo-pedunculated myomas, the pedicle is coagulated by bipolar

forceps and cut by laparoscopic scissors or cut after placement of loops or staples, without suturing. In cases of deep intramural myomas, chromopertubation is always applied via a cervical cannula not only to check tubal patency but also to facilitate the direct recognition of an inadvertently opened uterine cavity.

The myometrium closuring is performed by a single (for subserous fibroids) or double layer (for intramurals), including overlying serosa, with a round CT-1 curved needle, using intra or extracorporeal knots. In sub-serosal myomectomies, the edges of the uterine defect were approximated with introflexing U-inverted stitches (myometrium/serosa-serosa/myometrium direction) with intra myometrial knot, at 1 cm increments from the edge of the incision (as a "baseball-type" suture). The closure was by surgeon choice: interrupted closure or traditional unidirectional running suture, stared at the end of one of hysterotomic sides.

Deep intramural fibroids required a two-layer myometrial closure with introflexing sutures, ever by a "baseball-type" suture. If the uterine cavity was accidentally opened during fibroid enucleating, 2–3 deep myometrial single or continuous sutures were applied on the uterine cavity edges. After hysterorrhaphy, fibroids are usually morcellated.

Thus, during myomectomy, as reported by literature [88], the fibroid pseudocapsule neurovascular bundle needs to be always protected, avoiding destructive surgical proceedings such as extensive and high wattage diathermocoagulation (> 30 W) or excessive tissue manipulating or trauma. This method of myomectomy maximally respects the fibroid pseudocapsule neurovascular bundle, rich of neurofibers involved in the correct successive scar healing. The iatrogenic myoma pseudocapsule damage should therefore alter the successive neurotransmitters' function in myometrial repair, with negative effect on uterine healing. Thus, the surgical sequels of an uncorrected myomectomy with pseudocapsule damaging should be: a reduction in neurofibers' presence at hysterotomic site, a deterioration of uterine musculature healing, and a deficit either of myometrial neurotransmission or of muscular impulse and contractility, with final reduced uterine musculature functionality.

The Intracapsular Cesarean Myomectomy

This type of technique to perform a myomectomy sparing pseudocapsule can also be reproduced in another very complex and risky operation: the cesarean myomectomy.

Uterine myomas are observed these days more frequently in pregnancy with an estimated incidence of 2–4 %, because many women are delaying childbearing until their late thirties or the beginning of their forties, the time of greatest risk for myoma growth [97, 98]. Uterine myomas are commonly encountered in women older than 30 years [99] and their growth is directly related to exposure to the circulating estrogens levels. The prevalence of leiomyomas among pregnant women ranges from 0.1 to 3.9 % [99–104]. The effective rate of uterine myomas in pregnancy is unknown; however, they are associated with numerous pregnancy-related maternal and fetal complications like spontaneous abortion, preterm labor, placental abruption, post partum hemorrhage and high rate of cesarean deliveries [99, 105].

Complications in pregnancy, labor and delivery occur almost twice as frequently among women diagnosed with uterine myomas than in those without [99–103]. The literature suggests a high rate of cesarean deliveries in women with myomas up to 39.95 % [106].

Thus, any surgical procedure performed on or around the uterus has the potential of causing severe hemorrhage and, for this reason, uterine myomectomy during cesarean section has consistently been discouraged, in the past years, as a high-risk procedure.

On the contrary, resection of an intramural myoma is inadvisable and contraindicated during cesarean section by some obstetric textbooks [107, 108], due to the risk of profuse uncontrolled bleeding that could lead to hysterectomy.

So, after the development of my well detailed and published technique [7, 18, 79], the intracapsular myomectomy, successfully performed during laparoscopy in non pregnant women with single or multiple fibroids, the authors decided to study their methods of myomas removal during CS, exploring its outcomes (Fig. 31.24).

Thus I prospectively evaluated the surgical outcome of intracapsular myomectomy during CS by a case-control study on 68 patients who underwent intracapsular cesarean myomectomy, compared with a control group of 72 patients with myomatosic pregnant uterus who underwent cesarean section without myomectomy [109].

All operations were ever performed by CS by Stark's method, under regional anesthesia. A routine intracapsular cesarean myomectomy was then done for all anterior fibroids: cervical, body, or fundal, using the same cesarean incision where possible, or utilizing other incisions, when necessary. Each intracapsular cesarean myomectomy was performed after LUS closure. A linear incision was made over the uterine serosa direct to myoma by a scalpel or a monopolar electro-scalpel at low voltage (≤ 30 W), gradually until opening the pseudocapsule, enabling to enter the relatively bloodless plan between the pseudocapsule and its myoma. Once the surface of the myoma was reached and its fibre bridges separated, the myoma was hooked and extracted from its capsule, also by traction and pushing down the capsule using a sharp Metzenbaum scissors. The hemostasis during intracapsular cesarean myomectomy was always reached by gentle low voltage coagulation (≤ 30 W) of pseudocapsule vessels, with minimal blood loss. Generally, 10 I.U. of intravenous oxytocin drip was given as a standard to

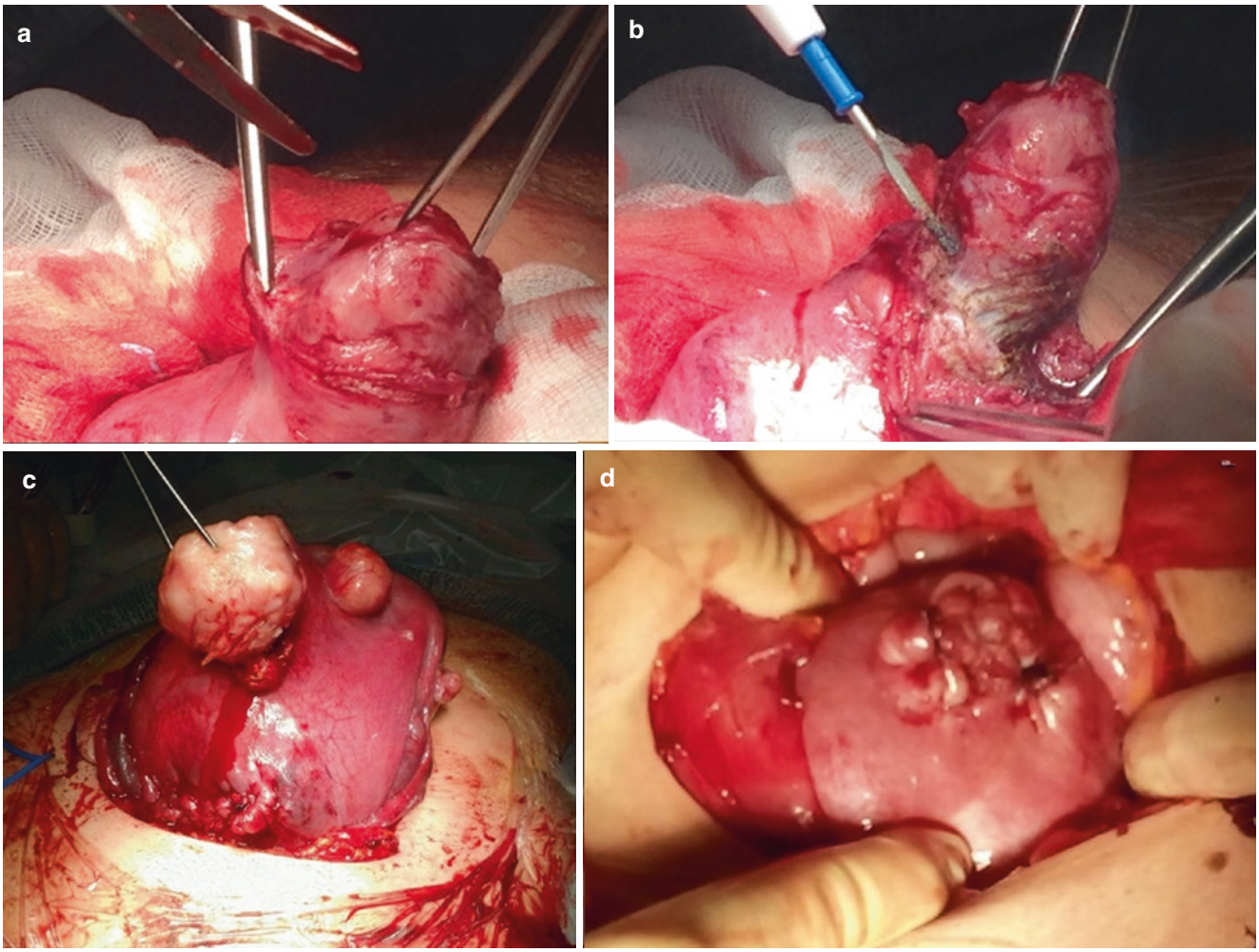


Fig. 31.24 Intracapsular cesarean myomectomy: (**a**) pregnant uterine incision after hysterorrhaphy and myoma pseudocapsule exposure by scissors; (**b**) gentle myoma dissection from myometrium; (**c**) myoma enucleating; (**d**) suture of uterine wall after myoma enucleation

all patients to control bleeding, after enucleating of the fibroid. For myomas located near LUS, we temporarily changed operation' steps: after completion of the CS, an interlocked suture is temporarily placed on the edge of the cesarean uterine incision without closure. Then we performed intracapsular cesarean myomectomies from the edge of the cesarean incision. This also facilitates working from within the uterine cavity or from the outer part of the uterus without significant bleeding from the CS incision. After that, in case of other myomas far from LUS, surgeons made a new incision above the myoma in instances where they were located in a site remote from the CS incision. Suturing of the fibroid base was routinely performed by using two layers of interrupted absorbable sutures (1–0 calibre vicryl) and a baseball-type suture was used for the serosa, using a continuous absorbable suture (2– 0 or 3–0 calibres vicryl), as a third layer. Pelvic irrigation was done with saline solution. Postoperatively, the oxytocin infusion was continued for 12–24 h in parallel with normal saline infusion. Seventy-two control subjects were randomly selected among pregnant women with myomas undergoing CS without myomectomy, at the same Institutions and during the same period, and CS' indications were: breech presentation, more than one previous CS, CS on demand. These women did not receive cesarean myomectomy since they refuse this operations and both myomectomy and control groups were similar in terms of characteristics without any statistical differences.

Most of the removed myomas were subserous or intramural: 48 subserous, 14 intramural and 6 pedunculated. Of these, 12 had multiple sites myomas (17,6 %), but we try to use always the same hysterotomy for neighbours fibroids.

Sites of myomas' removal were: fundal in 37 women (54.4 %), corporal in 22 (32.3 %) and around the lower uterine segment in 9 women (18.7 %), where we temporarily changed operation' steps just in 5 women. The average myoma' size was 8 cm (1.5–20), in 40 women, with 8 myomas measuring 4–6 cm, 14 myomas between 10 and 12 cm and > 13 cm in 6 patients. Differences in blood chemistry

and surgical outcome in intracapsular cesarean myomectomy were not statistically significant ($p > 0.05$). Concerning the post-operative course, 5 patients had postpartum fever of 38.8 °C, on average, for two consecutive days after surgery (7.3 %); the blood culture didn't show any bacteria and patients were treated by large spectrum antibiotics. The average duration of hospitalization of intracapsular cesarean myomectomies was 5 days, with six patients requiring more than 5 days of hospital stay (8,8 %); these five patients felt too weak to be discharged, so they preferred to stay in the hospital an extra day.

There was no correlation between complications or duration of hospital stay and patient age, gravidity, parity or indication for CS. None of the patients underwent repeated surgery after intracapsular cesarean myomectomy and no hysterectomy was required after intracapsular cesarean myomectomy. My data show no difference between intracapsular cesarean myomectomy group and control group, in term of pre and post-operative hemoglobin values, mean change in hemoglobin values, incidence of intraoperative hemorrhage, frequency of blood transfusion and of post-operative fever. The only two parameters that affect negatively the group submitted to intracapsular cesarean myomectomy are the duration of operation and the length of hospital stay.

Since obstetricians often confronted with fibroids while performing CS and face the dilemma of how they should be managed, considering the cost-benefit of our study, authors affirmed that intracapsular cesarean myomectomy procedure can be performed with some confidence, without affecting adversely the postoperative course and clinical outcomes.

Hysteroscopic Intracapsular Myomectomy: The Cold Loop Technique

The advent of surgical endoscopy in clinical practice has led to a conservative approach to uterine fibroids, especially for women who want to have children. To date, surgical hysteroscopy is considered an effective and safe treatment for submucous myomas [110]. Hysteroscopic myomectomy is currently the most widely used minimally invasive surgical procedure for the treatment of submucous myomas [111]. Despite its widespread use and ease of implementation, several complications have been reported, some of which are particularly serious [112–115].

Different techniques have been described in the hysteroscopic treatment of submucous myomas, but cold loop myomectomy, ideally performed in a single surgical procedure, seems to be the most effective and safe treatment for G1–G2 myomas [111]. It is an effective method providing greater safety for patients and reducing surgical risks [116].

The technique, conceived by Mazzon and firstly described in 1995 [117], was developed in order to preserve the muscular fibres in the myometrium and ensures the complete removal of the myoma. Indeed, the cold loop technique allows to apply the surgical principles utilized in laparotomic and laparoscopic myomectomy [7, 88, 118] to the hysteroscopic setting.

The importance of pseudocapsule in treating myomas was stressed and a hysteroscopic procedure taking advantage from such anatomic structure was specifically designed. The enucleation of myoma within its pseudocapsule not only ensured a reduced blood loss but it also allowed a complete treatment of the intramural part of myoma. Indeed, since the beginning of hysteroscopy, the intramural extension of myomas represented a challenge for the surgeons, as it influences the possibility to complete the myomectomy in a single-step procedure [111, 119], while increasing the risk for intraoperative complications and repeated surgeries [111, 115, 120]. In case of distention media warning level reached, it is recommended to interrupt the procedure in order to avoid clinical intravasation syndrome, and a second surgery should be scheduled [121].

To ensure a blunt dissection of the fibro-connetival bridges, which anchor the myoma to the pseudocapsule, mechanical loops have been designed (Mazzon's cold loops®, Karl Storz Tuttlingen, Germany). These new instruments allows to avoid the recourse to coagulation or cutting combined with coagulation. In this way the thermal damage of surrounding myometrium and dramatic intraoperative complications, as uterine electrical loop perforation, are theoretically eliminated.

Furthermore, using the cold loop technique, the infiltration of the myoma into the myometrium, which has always been considered a major difficulty in hysteroscopic myomectomy, especially when associated with multiple myomas [111, 120], does not play an important role. Indeed, it makes the intramural extension of the fibroids an intracavitary lesion that is easy to treat.

Before the surgical act, an accurate preoperative diagnostic investigation should be done. A good surgery starts with a good diagnosis. Firstly, to assess the number and size of myomas and the extent of their intramural development, an ultrasonographic evaluation should be carried out in all the patients.

Particular attention must be paid to the measurement of the free myometrial margin (FMM), the thickness of the myometrium between the myoma and the perimetrium, because a reduced FMM is a major risk factor for uterine perforation. In order to avoid such complication, the FMM should be at least 1 cm, nevertheless, even few millimetres of FMM may be considered safe by an expert hysteroscopist. Indeed, it has been shown that this is a dynamic parameter during surgery and tends to progressively grow during the removal of the myoma [122].

However, even in case of uterine perforation, the cold loop allows to avoid the dramatic consequence due to the thermal loop [123–125].

Secondly, a diagnostic hysteroscopy is mandatory for the preoperative evaluation. The knowledge of the number, the position of myomas relatively to the uterine wall, the endometrium thickness, the presence of other intracavitary pathologies and the size of the uterine cavity, may influence the favourable outcome of the hysteroscopic myomectomy. Moreover only with the diagnostic hysteroscopy is possible to really categorize the grading of myoma, according to the classification proposed by Wamsteker [119]. Such classification, officially adopted by the European Society of Gynaecological Endoscopy organizes the myomas based on the intramural development:

- **G0**: completely endocavitary, pedunculated myoma, with no intramural extension;
- **G1**: submucous myoma with less than 50 % intramural extension;
- **G2**: submucous myoma with more than 50 % intramural extension.

Recently, multiple variables and not only the degree of myometrial penetration were considered in the "STEPW classification" proposed by Lasmar et al. [121], to more accurately predict a complete or an incomplete removal of the myoma in one-step procedure before treatment [126].

In addition to the intramural extension, the STEPW classification considered the size, topography, and extension of the base myomas in relation to the uterine wall. The five parameters of STEPW are as follows [121]:

1. Size: the largest diameter found by any of the imaging methods. When the nodule measures ≥2 cm, it is given a score of 0; if it is 2.1–5 cm, it gets a score of 1; and if it measures >5 cm, it gets a score of 2.
2. Topography: defined by the third of the uterine cavity where the fibroid is situated. If it is in the lower third, the score is 0; if in the middle third, the score is 1; and if in the upper third, the score is 2.
3. Extension of the base of the myoma: when the fibroid covers one third or less of the wall, it is given a score of 0; when the base of the nodule occupies between one and two thirds of the wall, the score is 1; and when it affects more than two thirds of the wall, the score is 2.
4. Penetration of the nodule into the myometrium: when the fibroid is completely within the uterine cavity it is given a score of 0; if it has its larger part in the uterine cavity it is given a score of 1; and when it has its larger part in the myometrium it is given a score of 2.
5. Wall: when the fibroid is on the lateral wall, 1 extra point is added regardless of the third that is affected.

In case of a score from 5 to 6, the GnRH analogue (GnRHa) preoperative treatment was suggested by the Authors.

The role of GnRHa before hysteroscopic myomectomy is still controversial in the scientific literature. Concerning the hysteroscopic myomectomy, although some papers reported longer surgical times with GnRHa [127], Muzii in a RCT [128] showed a shorter duration of the procedure. On the contrary, Mavrelos advised against the use of GnRHa before myomectomy as any benefit in such treatment was not identified [53]. A recent meta-analysis [129], including the only 2 available RCT [53, 128], concluded that GnRHa "may improve some outcomes but there is insufficient evidence to support their routine use prior to hysteroscopic resection of submucous fibroids". In order to clarify this issue, randomized controlled trials investigating the efficacy of GnRHa pre-treatment in hysteroscopic myomectomy, especially with cold loop technique, are needed.

Considering the scientific evidence available on the usefulness of the GnRHa therapy before laparoscopic or hysteroscopic myomectomy [129, 130] and based on our experience, we are able to affirm that, waiting for more consistent data, the GnRHa pre-treatment in cold loop myomectomy should be reserved only to the patients with severe anaemia.

At the end of the diagnostic (ultrasonographic and hysteroscopic) evaluation, the surgeon should gain sufficient information about the possibility to perform the procedure in one or two-step.

At the beginning of the cold loop hysteroscopic myomectomy, a dilation of the cervix is carried out.

In the event that dilation proves difficult with this technique, the resectoscope is inserted into the cervical canal to visualize the direction and to complete the dilation.

No drugs should be used for cervical dilation.

Slicing of the Intracavitary Component of the Myoma

The intracavitary component of the myoma is progressively removed up to the surface of the endometrium using the conventional slicing technique (Fig. 31.25). During this phase, an electric loop powered by a 100 W monopolar current in pure cutting mode should be used. When the cleavage plane between the myoma and myometrium is identified, the slicing is stopped.

Enucleation of the Intramural Component of the Myoma

The electric cutting loop is subsequently replaced with a cold loop, which is inserted into the cleavage plane and repeatedly applied along the surface of the myoma (Fig. 31.26). In this way the connective fibers anchoring the myoma to the myometrium are disconnected by blunt dissection (Fig. 31.26). Using the cold loop, the damage of myometrial fibers around the myoma is minimal. The muscle bundles are spared any surgical trauma owing to the thermal damage of electrical cutting.

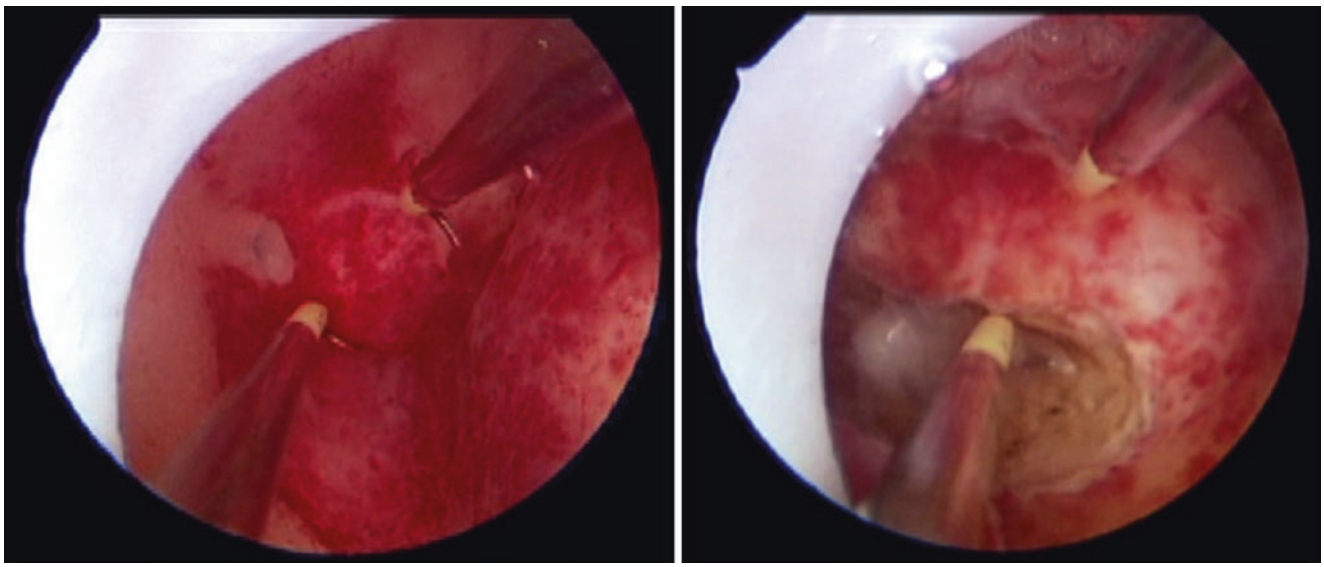


Fig. 31.25 The intracavitary component of the myoma is progressively removed up to the surface of the endometrium using the conventional slicing technique

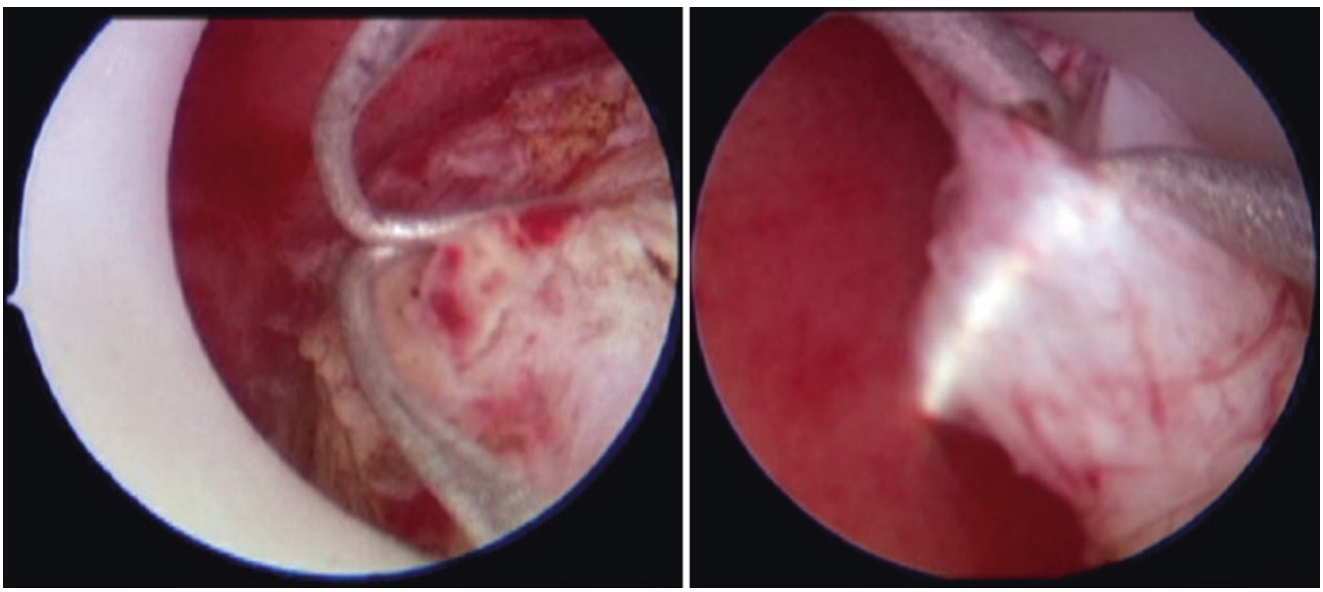


Fig. 31.26 The cold loop is inserted into the cleavage plane and repeatedly applied along the surface of the myoma

Slicing of the Intramural Component of the Myoma

After detachment, the intramural part of the myoma becomes an endocavitary neoformation and is safely removed by slicing as previously described, without damaging the surrounding myometrium (Fig. 31.27). During the slicing phase, the cutting action is always directed from the notch of the myoma towards the uterine cavity and never in the opposite direction: this is done to avoid thermal damage and the risk of accidentally cutting the myometrium around the notch (where the uterine wall is thinnest), or uterine perforation caused by the thermal loop. The electric loop is never used under the endometrial lining.

Control of Uterine Cavity Integrity

The integrity of the cavity and the absence of residual fragments are verified at the end of the procedure, to avoid the risk of inflammation and intracavitary synechiae (Fig. 31.28).

If the surgical procedure is interrupted due to excessive absorption of the distension liquid or other complications, thus the myomas are not totally removed, an additional resectoscopic procedure is scheduled.

The cold loop hysteroscopic myomectomy is usually performed using a 9 mm resectoscope with 0° optical system (HOPKINSII® Karl Storz Tuttlingen, Germany) and glycine 1.5 % for distension of the uterine cavity. For safety reasons,

coagulation or blended waveforms are never used: this is also to avoid significant thermal damage deriving from coagulation.

To prevent the risk of clinical intravasation syndrome, the surgeon is constantly informed of the volumetric difference between the inflow and outflow fluid: the surgical procedure must be interrupted when absorption reached 1000 cm^3. The absorption of distending media should be continuously monitored along with the serum sodium level (arterial blood gas analysis). In accordance with the scientific literature [131–133], the critical value limit that we suggest to observe is 125 mEq/l.

Antibiotic prophylaxis should be only administered to patients with specific indications (e.g. cardiac valvulopathies).

According to Hamou who firstly suggested the importance and the usefulness of diagnostic hysteroscopic follow up because of the possibility to directly treat any postoperative adherence [134], 2 months after surgery a diagnostic hysteroscopy should be carried out. Intrauterine adhesions may impair many important reproductive aspects such as menstruation, normal fertility and pregnancy, being able to cause recurrent pregnancy loss, placenta accreta and intrauterine growth restriction. For these reasons, such synechiae have to be considered as a new pathology and not only as a complication or collateral effect correlated to the surgical treatment. According to the American Fertility Society criteria [135], the light synechiae can be easily treated during the endoscopic follow-up using the tip of the hysteroscope.

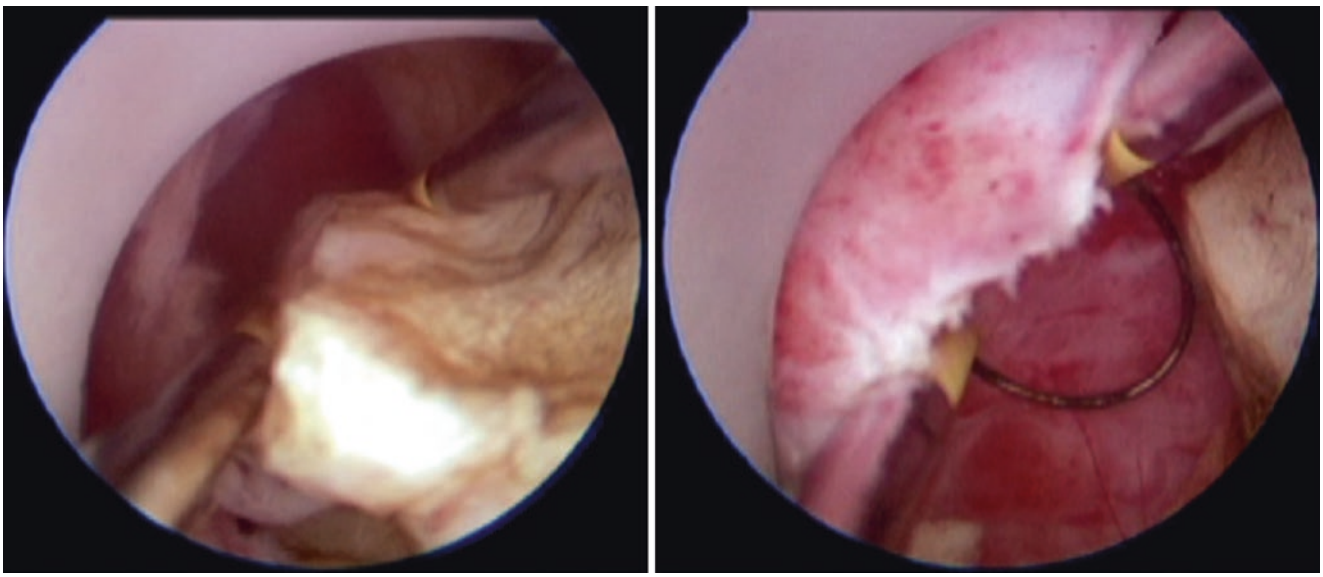


Fig. 31.27 The intramural part of the myoma is now an endocavitary neoformation and is safely removed by slicing, without damaging the surrounding myometrium

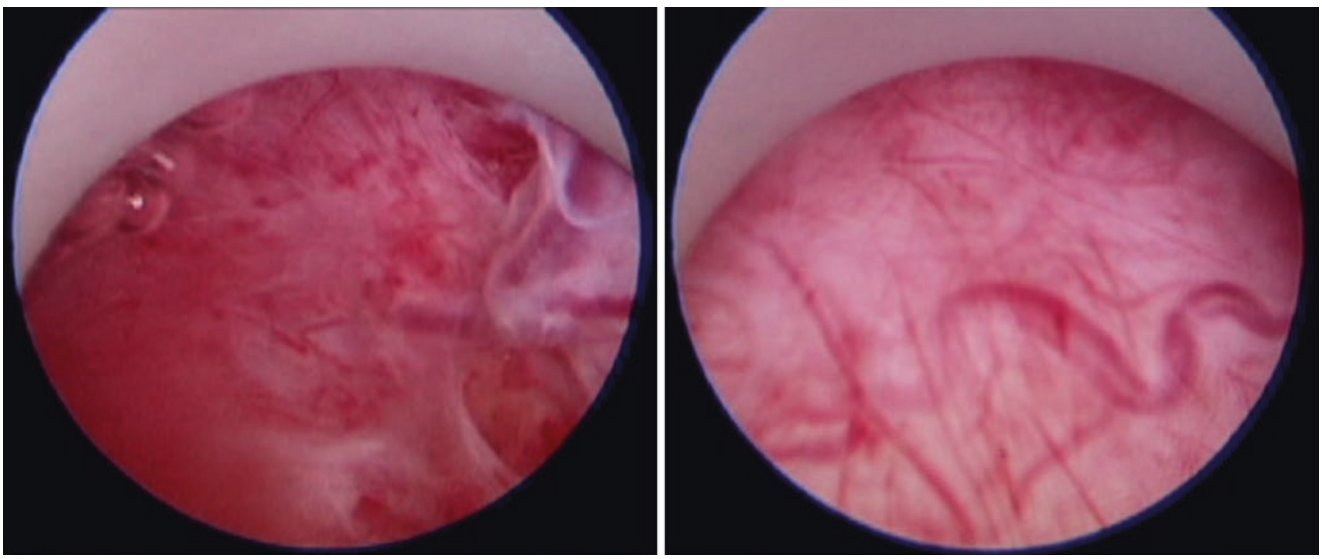


Fig. 31.28 The integrity of the fovea and the absence of sectioned residual fragments are verified at the end of the procedure

Synechiae of the uterine cavity represent the most common post-operative complication following resectoscopic myomectomy [136], and are related to the healing following the removal of myomas or to a possible perforation of the uterine wall [134]. Despite the frequency of this episode, there are few examples available in literature that describe its prevalence [137–140]. Some authors have suggested the use of anti-adherence liquid mixtures, or intrauterine devices aimed at preventing synechiae after resectoscopy [139, 141]. However, other authors have studied the influence of different types of electric energy used during myomectomy and their effect on the formation of adherences [138].

Taskin et al., in a prospective randomised study, reported a rate of synechiae of 31.3 % following resectoscopic myomectomy of a single myoma, reaching a rate of 45.5 % in case of multiple myomas [136]. In 2008 Yang et al. published a study where was reported a rate of 1.5 % in case of the resection of single myoma and a rate of 78 % in case of myomas located one in front of the other. In both groups of patients an IUD after the surgery was placed. The authors remarked the importance of diagnostic hysteroscopy within 2 weeks after the resectoscopic surgical treatment, with the aim to easily treat light intrauterine adherences [140].

In 2014, the results of a retrospective study conducted on a group of 688 patients with one or more G1–G2 myomas showed that the cold loop hysteroscopic myomectomy is a safe and effective procedure capable of ensuring a low prevalence of intrauterine synechiae [116].

The rate of adhesions reported 2 months after resectoscopic myomectomy was approximately 4 %, of which only 0.29 % were represented by fibrous synechiae, even in case of multiple myomas enucleated. The occurrence of synechiae in patients in whom 2 myomas were removed was almost the same as in those with a single myoma treated (4.48 % and 3.22 %, respectively). However, differently from expected, post-surgical synechiae were not found in the group of patients in which more than 2 myomas were removed.

The low rate of adherences can be ascribed to the non-use of electricity in coagulation mode (characterised by a higher thermic damage) and conversely to the use of the cold loop, preventing electric energy, whichever the type (monopolar or bipolar), from getting in contact with the myometrium of the uterine wall and inducing thermic damage which may increase the appearance of synechiae. Moreover, 8 cases of intraoperative complications were reported in in the same series (1.16 %). Furthermore the low rate of complications, such as perforations and the complete absence of damage to the entire layer of the uterine wall caused by thermal loop, might have a positive influence in the low rate of the post-surgical synechiae registered [116]. Moreover, no cases of uterine rupture in subsequent pregnancies were recorded. Several cases have been reported in the literature, some of which with dramatic consequence [142–144]. The possible negative effects on fertility and on pregnancies outcome due to the use of intraoperative monopolar or bipolar coagulation has been already described. The damage of surrounding healthy myometrium is considered as the major risk factor for uterine rupture in pregnancy after laparoscopic myomectomy [143].

In conclusion, it is therefore possible to affirm that the cold loop hysteroscopic myomectomy is a safe and feasible procedure, ensuring the respect of pseudocapsule and of surrounding healthy myometrium. Such technique allows to limit the blood loss during surgery, the damage to healthy myometrium fibers and is associated with a low rate of intraoperative complications. Moreover the rate of adhesions seems to be lower in comparison with the reported literature [18, 116]. These issues are of great importance for fertility patients and the surgeons should pay more attention in pseudocapsule preserving.

Translational Research and Virtual Biomodeling for Personalized Management of Patients with Uterine Myoma: Future Perspectives

Computational simulations of pelvic organs' topographic anatomy is a perspective direction of the translational biomodeling research aimed to design personalized approaches of minimally invasive restorations of women's reproductive health.

Uterine myoma is a common disease with serious consequences for women's well-being by causing such problems as infertility, recurrent miscarriages, dyspareunia, pelvic pain, bowel and bladder dysfunctions, dysmenorrhea, as well as irregular and excessive bleedings are associated with anemia. It is well known that uterine myoma is the most common indication for surgical procedures such as myomectomy and hysterectomy making this condition as an enormous healthcare concern with considerable healthcare expenditures.

From this view it is logical to design a special mathematical tool for preliminary patient-specific structural virtual analysis. It may help to come up with decision on the type of optimal treatment strategy. A mathematical biomodeling would become essential part of patient management. This approach will help to choose conservative or surgical intervention options which will be planned together with patients by demonstrating them virtual events are related with disease and its different treatment options as well as possible risks and beneficial outcomes.

We developed semi-automatic algorithm for constructing personalized virtual 3D anatomical model of uterine myoma which was based on MRI data set of a particular subject as well as on the medical applications of our previous mathematical model-system entitled "Personalized anatomical meshing of human body with applications" [145]. In order to design our semi-automatic technology we have used following algorithms and methods. The medical image segmentation is performed using user-guided active contour segmentation

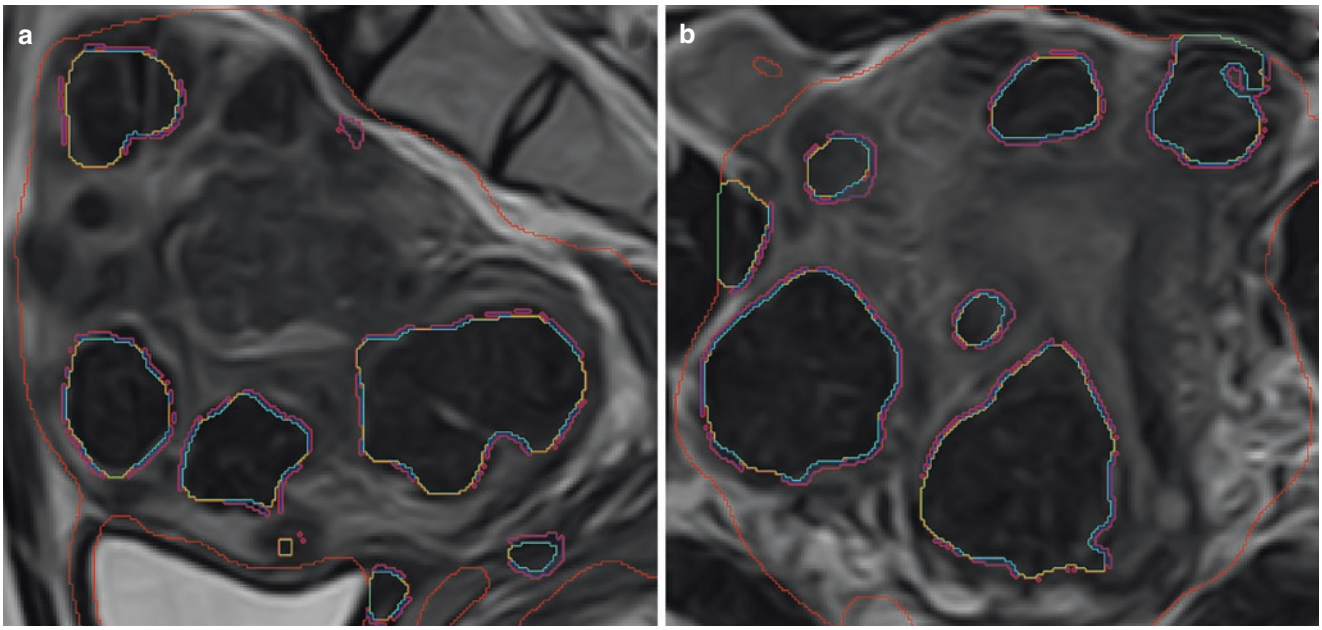


Fig. 31.29 MRI based 2D analysis of myoma pseudocapsule inner and outer boundaries: (**a**) sagittal plane; (**b**) transverse plane

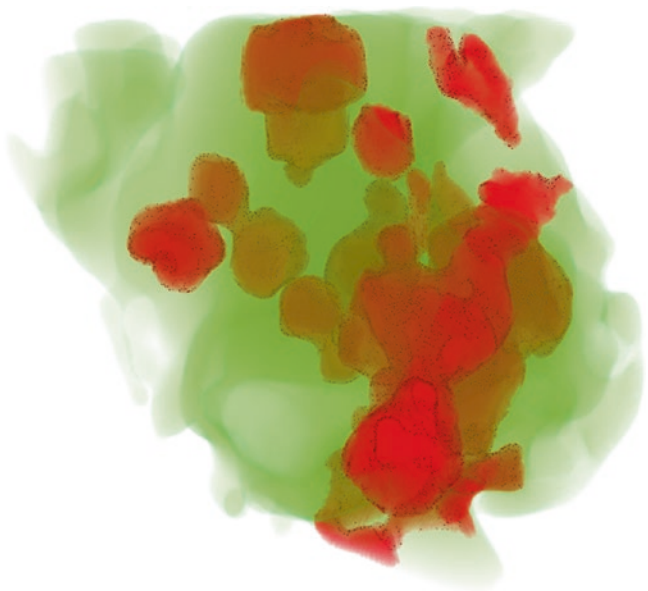


Fig. 31.30 3D reconstruction of multiple large uterine myoma case

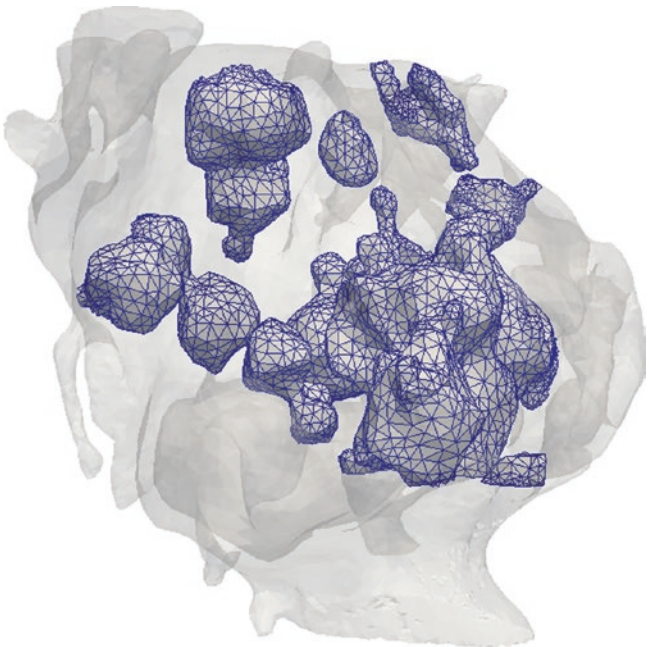


Fig. 31.31 3D computation mesh generated for segmentation results

[146] with supervised random forest classification from ITK-SNAP segmentation software [147]. The inner and outer boundaries of fibroid pseudocapsule can be determined at this stage (Fig. 31.29). Several post-processing algorithms were applied for filling remaining gaps between tissues and final segmented data smoothing. These algorithms are based on Gaussian smoothing, connected-component labelling and mathematical morphology operations: erosion, dilation, opening and closing [148]. As a result, a 3D model of multiple uterine fibroids is produced (Fig. 31.30). This post-processing step is essential for generation of valid mesh, which is suitable for future finite element modelling.

The following algorithms were used for mesh generation: a marching cubes algorithm for surface reconstruction [149]; surface triangulation, smoothing and coarsening techniques [150, 151]; 3D Delaunay triangulation algorithm from the CGAL-Mesh library [152], allowing specific mesh size for each model material; advancing front technique for volume mesh generation [153, 154].



Fig. 31.32 The image shows a 32 years' old patients with multiple fibroids searching pregnancy; the operation was by laparotomic intracapsular multiple myomectomy and uterus reconstruction sparing myoma pseudocapsule

The essential post-processing mesh cosmetics step is applied using Ani3D library [155] in order to increase mesh quality. Preliminary results of our biomodeling cooperation are presented as computational mesh suitable for further computational simulations (A virtual model of multiple fibroids in patient with large uterine myoma) (Fig. 31.31).

In future 3D model will allow us to conduct non invasive virtual topographic anatomical analysis of the individual features of uterine fibroids including number and size of fibroids and their location in the uterine wall (subserosal, intramural, submucosal and pedunculated myomas) as well as in different uterine regions (fundal, corporal and isthmian–cervical) in order to design a personalized management strategy and optimized treatment choice.

Our biomodeling researches will cover wide range of topics are related with uterine topographic anatomy and uterine myoma, such as a mathematical model of fibroid pseudocapsule [156], virtual mechanical soft tissue computational simulations of uterine scar after myomectomy [157] and a virtual 3D model of uterine scar after caesarean section [158], as well as an original concept of angiogenesis initiation and vascular network development during uterine fibroid formation and growth [159].

Conclusions

The morphological and molecular research we conducted on the myoma pseudocapsule produced many interesting scientific results. The fibroid deforms the surrounding myometrium as it grows, giving rise to a dense fibroneurovascular pseudocapsule, rich of neurotrasmitters and growth factors, with a proper angiogenic profile. The discovery of the richness of the fibroneurovascular structure in neurotransmitters and morphological analysis of the pseudocapsule made it possible to translate the results in reproductive surgery and the whole topic of fertility and clinical practice, even for giant fibroids (Fig. 31.32) and during pregnancy (Fig. 31.33). My evidences on the presence of dedicate angiogenesis, neurofibers and neuropeptides in few millimetre structure, the pseudocapsule, suggested to preserve as much as possible such

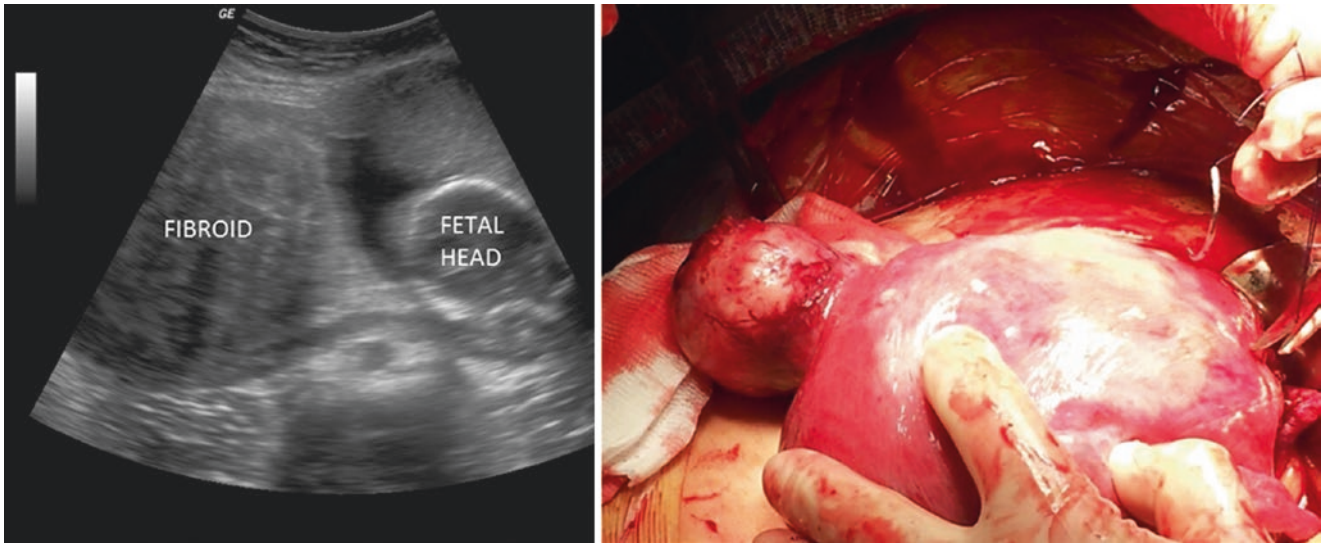


Fig. 31.33 A patient with a subserous fibroid of 4 cm of diameter located near lower uterine segment: on the left, the ultrasonographic image, on the right the image before a cesarean intracapsular myomectomy, after hysterorraphy

structure, during myomectomy. Pseudocapsule sparing during myomectomy should preserve myometrium integrity peripheral to fibroid site, enhancing myometrial healing after myomectomy. Moreover, intracapsular myomectomy, via traditional laparotomy, laparoscopy or hysteroscopy, should favour reproductive outcomes [160] and normal labor and delivery, for less bleeding [13], better neurovascular bundle sparing [88], and postoperative adhesions reduction [37, 116]. So the mix of intracapsular myomectomy and pseudocapsule-sparing by endoscopic "microsurgical" magnification, can be reproduced in all myomectomies, as a safe and feasible minimally invasive technique [7, 18, 54, 116, 161, 162].

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References

1. Tomasik P, Bomba-Opon D, Krupniewski L, Palczewski P, Wielgos M. Evaluation of uterine myomas during pregnancy using magnetic resonance imaging. Neuro Endocrinol Lett. 2014;35(4):262–4.
2. Downes E, Sikirica V, Gilabert-Estelles J, Bolge SC, Dodd SL, Maroulis C, et al. The burden of uterine fibroids in five European countries. Eur J Obstet Gynecol Reprod Biol. 2010;152(1):96–102.
3. Baskett TF. Hysterectomy: evolution and trends. Best Pract Res Clin Obstet Gynaecol. 2005;19(3):295–305.
4. Fleischer R, Weston GC, Vollenhoven BJ, Rogers PA. Pathophysiology of fibroid disease: angiogenesis and regulation of smooth muscle proliferation. Best Pract Res Obstet Gynaecol. 2008;22(4):603–14.
5. Okolo S. Incidence, aetiology and epidemiology of uterine fibroids. Best Pract Res Obstet Gynaecol. 2008;22(4):571–88.
6. Tinelli A, Malvasi A, Rahimi S, Negro R, Cavallotti C, Vergara D, Vittori G, Mettler L. Myoma pseudocapsule: a distinct endocrino-anatomical entity in gynecological surgery. Gynecol Endocrinol. 2009;25(10):661–7.
7. Tinelli A, Hurst BS, Hudelist G, Tsin DA, Stark M, Mettler L, Guido M, Malvasi A. Laparoscopic myomectomy focusing on the myoma pseudocapsule: technical and outcome reports. Hum Reprod. 2012;27(2):427–35.
8. Evans P, Brunsell S. Uterine fibroid tumors: diagnosis and treatment. Am Fam Physician. 2007;75(10):1503–8.
9. Somigliana E, Vercellini P, Daguati R, Pasin R, De Giorgi O, Crosignani PG. Fibroids and female reproduction: a critical analysis of the evidence. Hum Reprod Update. 2007;13(5):465–76.
10. Wise LA, Laughlin-Tommaso SK. Uterine leiomyomata. In: Goldman MB, Troisi R, Rexrode KM, editors. Women and health. San Diego: Academic; 2013. p. 285–306.
11. Graff-Radford J, Jones DT, Pruthi RK, Flemming KD. A neurological complication of a uterine fibroid. Neurocrit Care. 2013;18(1):93–5.
12. Wise LA, Palmer JR, Harlow BL, Spiegelman D, Stewart EA, Adams-Campbell LL, et al. Reproductive factors, hormonal contraception and risk of uterine leiomyomata in African-American women: a prospective study. Am J Epidemiol. 2004;159(2):113–23.
13. Laughlin SK, Baird DD, Savitz DA, Herring AH, Hartmann KE. Prevalence of uterine leiomyomas in the first trimester of pregnancy. Obstet Gynecol. 2009;113(3):630–5.
14. Wise LA, Ruiz-Narvaez EA, Palmer JR, Cozier YC, Tandon A, Patterson N, et al. African ancestry and genetic risk for uterine leiomyomata. Am J Epidemiol. 2012;176(12):1159–68.
15. Okogbo FO, Ezechi OC, Loto OM, Ezeobi PM. Uterine leiomyomata in South Western Nigeria: a clinical study of presentations and management outcome. Afr Health Sci. 2011;11(2):271–8.
16. Gupta S, Jose J, Mayonda I. Clinical presentation of fibroids. Best Pract Res Clin Obstet Gynaecol. 2008;22(4):615–26.
17. Sparić R, Hudelist G, Berisavac M, Gudović A, Buzadžić S. Hysterectomy throughout history. Acta Chir Iugosl. 2011;58(4):9–14.
18. Tinelli A, Hurst SB, Mettler L, Tsin AD, Pellegrino M, Nicolardi G, Dell'Edera D, Malvasi A. Ultrasound evaluation of uterine healing after laparoscopic intracapsular myomectomy: an observational study. Hum Reprod. 2012;27(9):2664–70.

19. Divakar H. Asymptomatic uterine fibroids. Best Pract Res Clin Obstet Gynaecol. 2008;22(4):643–54.
20. Cramer SF, Patel A. The frequency of uterine leiomyomas. Am J Clin Pathol. 1990;94(4):435–8.
21. Ezeama C, Ikechebelu J, Obiechina NJ, Ezeama N. Clinical presentation of uterine fibroids in Nnewi, Nigeria: a 5-year review. Ann Med Health Sci Res. 2012;2(2):114–8.
22. Stewart EA. Uterine fibroids. Lancet. 2001;357(9252):293–8.
23. Kwon DH, Song JE, Yoon KR, Lee KY. The safety of cesarean myomectomy in women with large myomas. Obstet Gynecol Sci. 2014;57(5):367–72.
24. Barlin JN, Giuntoli 2nd RL. Management of uterine leiomyosarcoma: an update. Exp Rev Obstet Gynecol. 2009;4(5):509–20.
25. Parker WH, Fu YS, Berek JS. Uterine sarcoma in patients operated on for presumed leiomyoma and rapidly growing leiomyoma. Obstet Gynecol. 1994;83(3):414–8.
26. Hyman DM, Grisham RN, Hensley ML. Management of advanced uterine leiomyosarcoma. Curr Opin Oncol. 2014;26(4):422–7.
27. Indraccolo U, Luchetti G, Indraccolo SR. Malignant transformation of uterine leiomyomata. Eur J Gynaecol Oncol. 2008;29(5): 543–4.
28. Mayerhofer K, Obermair A, Windbichler G, Petru E, Kaider A, Hefler L, et al. Leiomyosarcoma of the uterus: a clinicopathologic multicenter study of 71 cases. Gynecol Oncol. 1999;74(2): 196–201.
29. Leibsohn S, d'Ablaing G, Mishell Jr DR, Schalaerth JB. Leiomyosarcoma in a series of hysterectomies performed for presumed uterine leiomyomas. Am J Obstet Gynecol. 1990;162(4): 968–76.
30. Gockley AA, Rauh-Hain JA, Del Carmen MG. Uterine leiomyosarcoma: a review article. Int J Gynecol Cancer. 2014;24(9): 1538–42.
31. Bell SW, Kempson RL, Hendrickson MR. Problematic uterine smooth muscle neoplasms: a clinicopathologic study of 213 cases. Am J Surg Pathol. 1994;18:535–58.
32. Kobayashi H, Uekuri C, Akasaka J, Ito F, Shigemitsu A, Koike N, Shigetomi H. The biology of uterine sarcomas: a review and update. Mol Clin Oncol. 2013;1(4):599–609.
33. Resta L, Sanguedolce F, Orsini G, Laricchia L, Piscitelli D, Fiore MG. Morphometric and histological evaluation of GnRH agonists or progestational agents-treated uterine leiomyomas. Pathologica. 2004;96:35–41.
34. Sozen I, Arici A. Interactions of cytokines, growth factors, and the extracellular matrix in the cellular biology of uterine leiomyomata. Fertil Steril. 2002;78(1):1–12.
35. Bogusiewicz M, Stryjecka-Zimmer M, Postawski K, et al. Activity of matrix metalloproteinase-2 and -9 and contents of their tissue inhibitors in uterine leiomyoma and corresponding myometrium. Gynecol Endocrinol. 2007;23(9):541–6.
36. Tinelli A, Malvasi A, Cavallotti C, Dell'Edera D, Tsin DA, Stark M, Mettler L. The management of fibroids based on immunohistochemical studies of their pseudocapsules. Expert Opin Ther Targets. 2011 Nov;15(11):1241–7.
37. Tinelli A, Malvasi A, Guido M, Tsin DA, Hudelist G, Hurst B, Stark M, Mettler L. Adhesion formation after intracapsular myomectomy with or without adhesion barrier. Fertil Steril. 2011;95(5): 1780–5.
38. Faulkner RL. The blood vessels of the myomatous uteri. Am J Obstet Gynaecol. 1944;47:185–97.
39. Farrer-Brown G, Beilby JOW, Tarbit MH. The vascular patterns in myomatous uteri. J Obstet Gynaecol. 1970;77:967–75.
40. Awataguchi K. Studies on the angioarchitecture of uterine myoma. Nippon Ika Daigaku Zasshi. 1982;49:225–32.
41. Casey R, Rogers PA, Vollenhoven BJ. An immunohystochemical analysis of fibroid vasculature. Hum Reprod. 2000;15(7): 1469–75.
42. Campo S, Garcea N. Laparoscopic myomectomy in premenopausal women with and without preoperative treatment using gonadotrophin-releasing hormone analogues. Hum Reprod. 1999;14:44–8.
43. Lethaby A, Vollenhoven B, Sowter M. Pre-operative Gn-RH analogue therapy before hysterectomy or myomectomy for uterine fibroids. Cochrane Database Syst Rev. 2001;2:CD000547.
44. Pinkerton JV. Pharmacological therapy for abnormal uterine bleeding. Menopause. 2011;18(4):459–67.
45. Walocha JA, Litwin JA, Miodonski A. Vascular system of intramural leiomyomata revealed by corrosion casting and scanning electron microscopy. Hum Reprod. 2003;18:1088–93.
46. Forssman L. Blood flow in myomatous uteri as measured by intraarterial 133-Xenon. Acta Obstet Gynecol Scand. 1976;55:21–4.
47. Wei JJ, Zhang XM, Chiriboga L, Yee H, Perle MA, Mittal K. Spatial differences in biologic activity of large uterine leiomyomata. Fertil Steril. 2006;85:179–87.
48. Malvasi A, Tinelli A, Cavallotti C, Morroni M, Tsin DA, Nezhat C, et al. Distribution of substance P (SP) and vasoactive intestinal peptide (VIP) in pseudocapsules of uterine fibroids. Peptides. 2011;32:327–32.
49. Mettler L, Tinelli A, Hurst BS, Teigland CM, Sammur W, Dell'Edera D, Negro R, Gustapane S, Malvasi A. Neurovascular bundle in fibroid pseudocapsule and its neuroendocrinologic implications. Expert Rev Endocrinol Metab. 2011;6(5):715–22.
50. Malvasi A, Tinelli A, Rahimi S, D'agnese G, Rotoni C, Dell'Edera D, Tsin DA, Cavallotti C. A three-dimensional morphological reconstruction of uterine leiomyoma pseudocapsule vasculature by the allen-cahn mathematical model. Biomed Pharmacother. 2011;65(5):359–63.
51. Malvasi A, Cavallotti C, Morroni M, Lorenzi T, Dell'Edera D, Nicolardi G, Tinelli A. Uterine fibroid pseudocapsule studied by transmission electron microscopy. Eur J Obstet Gynecol Reprod Biol. 2012;162(2):187–91.
52. De Falco M, Staibano S, Mascolo M, Mignogna C, Improda L, Ciociola F, Carbone IF, Di Lieto A. Leiomyoma pseudocapsule after pre-surgical treatment with gonadotropin releasing hormone agonists: relationship between clinical features and immunohistochemical changes. Eur J Obstet Gynecol Reprod Biol. 2009;144:44–7.
53. Mavrelos D, Ben-Nagi J, Davies A, Lee C, Salim R, Jurkovic D. The value of pre-operative treatment with gnrh analogues in women with submucous fibroids: a double-blind, placebo-controlled randomized trial. Hum Reprod. 2010;25:2264–9.
54. Tinelli A, Malvasi A, Cavallotti C, Hudelist G, Tsin DA, Schollmeyer T, Bojahr B, Mettler L. Single and multiple intracapsular laparoscopic myomectomy. an institutional experience. J Laparoendosc Adv Surg Tech A. 2010;20(8):705–11.
55. Malvasi A, Cavallotti C, Nicolardi G, Pellegrino M, Dell'edera D, Vergara D, et al. NT, NPY and PGP 9.5 presence in myometrium and in fibroid pseudocapsule and their possible impact on muscular physiology. Gynecol Endocrinol. 2013;29:177–81.
56. Malvasi A, Cavallotti C, Nicolardi G, Pellegrino M, Vergara D, Greco M, et al. The opioid neuropeptides in uterine fibroid pseudocapsules: a putative association with cervical integrity in human reproduction. Gynecol Endocrinol. 2013;29:982–8.
57. Gray's Anatomy. The uterus. In: The anatomical basis of clinical practice. 40th ed., ISBN:978-0-443-06684-9. Churchill-Livingstone, Elsevier, USA; 2008. p. 710–4.
58. Sun Y, Zhu L, Huang X, Zhou C, Zhang X. Immunohistochemical localization of nerve fibers in the pseudocapsule of fibroids. Eur J Histochem. 2014;58(2):2249.
59. Delgado AV, McManus AT, Chambers JP. Exogenous administration of Substance P enhances wound healing in a novel skin-injury model. Exp Biol Med (Maywood). 2005;230:271–80.
60. Jiang MH, Chung E, Chi GF, Ahn W, Lim JE, Hong HS, et al. Substance P induces M2-type macrophages after spinal cord injury. Neuroreport. 2012;23:786–92.

61. Collins JJ, Usip S, McCarson KE, Papka RE. Sensory nerves and neuropeptides in uterine cervical ripening. Peptides. 2002;23: 167–83.
62. Tingaker BK, Ekman-Ordeberg G, Facer P, Irestedt L, Anand P. Influence of pregnancy and labor on the occurrence of nerve fibers expressing the capsaicin receptor TRPV1 in human corpus and cervix uteri. Reprod Biol Endocrinol. 2008;6:8.
63. Tingaker BK, Ekman-Ordeberg G, Forsgren S. Presence of sensory nerve corpuscles in the human corpus and cervix uteri during pregnancy and labor as revealed by immunohistochemistry. Reprod Biol Endocrinol. 2006;4:45.
64. Cormio L, Gesualdo L, Maiorano E, Bettocchi C, Palumbo F, Traficante A, et al. Vasoactive intestinal polypeptide (VIP) is not an androgen-dependent neuromediator of penile erection. Int J Impot Res. 2005;17:23–6.
65. Rodríguez R, Pozuelo JM, Martín R, Arriazu R, Santamaria L. Stereological quantification of nerve fibers immunoreactive to PGP 9.5, NPY, and VIP in rat prostate during postnatal development. J Androl. 2005;26:197–204.
66. Arms L, Vizzard MA. Neuropeptides in lower urinary tract function. Handb Exp Pharmacol. 2011;202:395–423.
67. Merrill L, Girard B, Arms L, Guertin P, Vizzard MA. Neuropeptide/ Receptor expression and plasticity in micturition pathways. Curr Pharm Des. 2013;19:4411–22.
68. Di Tommaso S, Massari S, Malvasi A, Bozzetti MP, Tinelli A. Gene expression analysis reveals an angiogenic profile in uterine leiomyoma pseudocapsule. Mol Hum Reprod. 2013;19(6):380–7.
69. Stewart EA, Nowak RA. Leiomyoma-related bleeding: a classic hypothesis updated for the molecular era. Hum Reprod Update. 1996;2(4):295–306.
70. Bulun SE. Uterine fibroids. N Engl J Med. 2013;369:1344–55.
71. Di Tommaso S, Massari S, Malvasi A, Vergara D, Maffia M, Greco M, Tinelli A. Selective genetic analysis of myoma pseudocapsule and potential biological impact on uterine fibroid medical therapy. Expert Opin Ther Targets. 2015 Jan;19(1):7–12.
72. Mäkinen N, Mehine M, Tolvanen J, et al. MED12, the mediator complex subunit 12 gene, is mutated at high frequency in uterine leiomyomas. Science. 2011;334:252–5.
73. Dallas NA, Samuel S, Xia L, et al. Endoglin (CD105): a marker of tumor vasculature and potential target for therapy. Clin Cancer Res. 2008;14:1931–7.
74. Valluru M, Brown NJ, Cross SS, et al. Blood vessel characterization in human dermal wound repair and scarring. Br J Dermatol. 2011;165:221–4.
75. Di Tommaso S, Tinelli A, Malvasi A, Massari S. Missense mutations in exon 2 of the MED12 gene are involved in IGF-2 overexpression in uterine leiomyoma. Mol Hum Reprod. 2014;20(10):1009–15.
76. Tinelli A, Mynbaev OA, Mettler L, Hurst BS, Pellegrino M, Nicolardi G, Kosmas I, Malvasi A. A combined ultrasound and histologic approach for analysis of uterine fibroid pseudocapsule thickness. Reprod Sci. 2014;21(9):1177–86.
77. Fraser IS, Critchley HO, Munro MG, Broder M, Writing Group for this Menstrual Agreement Process. A process designed to lead to international agreement on terminologies and definitions used to describe abnormalities of menstrual bleeding. Fertil Steril. 2007;87(3):466–76.
78. Mettler L, Schollmeyer T, Tinelli A, Malvasi A, Alkatout I. Complications of uterine fibroids and their management, surgical management of fibroids, laparoscopy and hysteroscopy versus hysterectomy, haemorrhage, adhesions and complications. Obstet Gynecol Int. 2012;2012:791248.
79. Darwish AM, Nasr AM, El-Nashar DA. Evaluation of postmyomectomy uterine scar. J Clin Ultrasound. 2005;33(4):181–6.
80. Seinera P, Gaglioti P, Volpi E, Cau MA, Todros T. Ultrasound evaluation of uterine wound healing following laparoscopic myomectomy: preliminary results. Hum Reprod. 1999;14(10):2460–3.
81. Beyth Y, Jaffe R, Goldberger S. Uterine remodelling following conservative myomectomy. Ultrasonographic evaluation. Acta Obstet Gynecol Scand. 1992;71(8):632–5.
82. Pun TC, Chau MT, Lam C, Tang G, Leong L. Sonographic evaluation of the myomectomy 'scars'. Acta Obstet Gynecol Scand. 1998;77(2):218–21.
83. Hanna KR, Katz AJ. An update on wound healing and the nervous system. Ann Plast Surg. 2011;67(1):49–52.
84. Tidball JG. Mechanisms of muscle injury, repair, and regeneration. Compr Physiol. 2011;1(4):2029–62.
85. Järvinen TA, Järvinen TL, Kääriäinen M, Kalimo H, Järvinen M. Muscle injuries: biology and treatment. Am J Sports Med. 2005;33(5):745–64.
86. Henderson J, Terenghi G, Ferguson MW. The reinnervation and revascularisation pattern of scarless murine fetal wounds. J Anat. 2011;218(6):660–7.
87. Gouin JP, Carter CS, Pournajafi-Nazarloo H, Glaser R, Malarkey WB, Loving TJ, Stowell J, Kiecolt-Glaser JK. Marital behavior, oxytocin, vasopressin, and wound healing. Psychoneuroendocrinology. 2010;35(7):1082–90.
88. Tinelli A, Malvasi A, Hurst BS, Tsin DA, Davila F, Dominguez G, Dell'Edera D, Cavallotti C, Negro R, Gustapane S, Teigland CM, Mettler L. Surgical management of neurovascular bundle in uterine fibroids pseudocapsule. JSLS. 2012;16:119–29.
89. Vikhareva Osser O, Valentin L. Risk factors for incomplete healing of the uterine incision after caesarean section. BJOG. 2010; 117(9):1119–26.
90. Han M, Kim C, Mozer P, Schäfer F, Badaan S, Vigaru B, Tseng K, Petrisor D, Trock B, Stoianovici D. Tandem-robot assisted laparoscopic radical prostatectomy to improve the neurovascular bundle visualization: a feasibility study. Urology. 2011;77(2): 502–6.
91. Walz J, Burnett AL, Costello AJ, Eastham JA, Graefen M, Guillonneau B, Menon M, Montorsi F, Myers RP, Rocco B, Villers A. A critical analysis of the current knowledge of surgical anatomy related to optimization of cancer control and preservation of continence and erection in candidates for radical prostatectomy. Eur Urol. 2010;57(2):179–92.
92. Lee SE, Hong SK, Han JH, Han BK, Yu JH, Jeong SJ, Byun SS, Lee HJ. Significance of neurovascular bundle formation observed on preoperative magnetic resonance imaging regarding postoperative erectile function after nerve-sparing radical retropubic prostatectomy. Urology. 2007;69(3):510–4.
93. Ong AM, Su LM, Varkarakis I, Inagaki T, Link RE, Bhayani SB, Patriciu A, Crain B, Walsh PC. Nerve sparing radical prostatectomy: effects of hemostatic energy sources on the recovery of cavernous nerve function in a canine model. J Urol. 2004;172 (4 Pt 1):1318–22.
94. Hurst BS. Uterine fibroids. In: Stadtmauer LA, Tur-Kaspa I, editors. Ultrasound imaging in reproductive medicine. New York: Springer; 2014 . p. 117–31.Chapter 10
95. Falcone T, Parker WH. Surgical management of leiomyomas for fertility or uterine preservation. Obstet Gynecol. 2013;121(4): 856–68.
96. Tinelli A, Mettler L, Malvasi A, Hurst B, Catherino W, Mynbaev OA, Guido M, Alkatout I, Schollmeyer T. Impact of surgical approach on blood loss during intracapsular myomectomy. Minim Invasive Ther Allied Technol. 2014;23(2):87–95.
97. Novak ER, Woodruff JD. Myoma and other benign tumours of the uterus, Novaks' gynecologic and obstetric pathology with clinical and endocrine relations. Philadelphia: WB Saunders; 1979. p. 795–801.
98. Ouyang DW. Obstetric complications of fibroids. Obstet Gynecol Clin North Am. 2006;33:153–69.
99. Song D, Zhang W, Chames MC, Guo J. Myomectomy during cesarean delivery. Int J Gynaecol Obstet. 2013;121(3):208–13.

100. Rice JP, Kay HH, Mahony BS. The clinical significance of uterine leiomyomas in pregnancy. Am J Obstet Gynecol. 1989; 160:1212–6.
101. Exacoustos C, Rosati P. Ultrasound diagnosis of uterine myomas and complications in pregnancy. Obstet Gynecol. 1993;82:97–101.
102. Katz VL, Dotters DJ, Droegemueller W. Complications of uterine leiomyomas in pregnancy. Obstet Gynecol. 1989;73:593–6.
103. Incebiyik A, Hilali NG, Camuzcuoglu A, Vural M, Camuzcuoglu H. Myomectomy during caesarean: a retrospective evaluation of 16 cases. Arch Gynecol Obstet. 2014;289(3):569–73.
104. Hasan F, Arumugam K, Sivanesaratnam V. Uterine leiomyomata in pregnancy. Int J Gynaecol Obstet. 1991;34:45–8.
105. Vergani P, Locatelli A, Ghidini A, Andreani M, Sala F, Pezzullo JC. Large uterine leiomyomata and risk of cesarean delivery. Obstet Gynecol. 2007;109:410–4.
106. Coronado GD, Marshall LM, Schwartz SM. Complications in pregnancy, labor, and delivery with uterine leiomyomas: a population-based study. Obstet Gynecol. 2000;95:764–9.
107. Cunningham FG, Leveno KL, Bloom SL, Hauth JC, Gilstrap III LC, Wenstrom KD, editors. Abnormalities of the reproductive tract. In Williams obstetrics. 22st ed. New York: Mcgraw-Hill Medical Publishing Division; 2005.
108. Ludmir J, Stubblefield PG. Surgical procedures in pregnancy. In: Gabbe SG, Niebyl JR, Simpson JL, editors. Gabbe: obstetrics-normal and problem pregnancies. 4th ed. New York: Churchill Livingstone, Inc.; 2002. p. 613.
109. Tinelli A, Malvasi A, Mynbaev OA, Barbera A, Perrone E, Guido M, Kosmas I, Stark M. The surgical outcome of intracapsular cesarean myomectomy. A match control study. J Matern Fetal Neonatal Med. 2014;27(1):66–71.
110. Neuwirth RS, Amin HK. Excision of submucus fibroids with hysteroscopic control. Am J Obstet Gynecol. 1976;126:95–9.
111. Di Spiezio Sardo A, Mazzon I, Bramante S, Bettocchi S, Bifulco G, Guida M, Nappi C. Hysteroscopic myomectomy: a comprehensive review of surgical techniques. Hum Reprod Update. 2008;14:101–19.
112. Jedeikin R, Olsfanger D, Kessler I. Disseminated intravascular coagulopathy and adult respiratory distress syndrome: life-threatening complications of hysteroscopy. Am J Obstet Gynecol. 1990;162:44–5.
113. Sullivan B, Kenney P, Seibel M. Hysteroscopic resection of fibroid with thermal injury to sigmoid. Obstet Gynecol. 1992;80:546–7.
114. Howe RS. Third-trimester uterine rupture following hysteroscopic uterine perforation. Obstet Gynecol. 1993;81:827–9.
115. Murakami T, Tamura M, Ozawa Y, Suzuki H, Terada Y, Okamura K. Safe techniques in surgery for hysteroscopic myomectomy. J Obstet Gynaecol Res. 2005 Jun;31(3):216–23.
116. Mazzon I, Favilli A, Cocco P, Grasso M, Horvath S, Bini V, Di Renzo GC, Gerli S. Does cold loop hysteroscopic myomectomy reduce intrauterine adhesions? A retrospective study. Fertil Steril. 2014;101:294–298.e3.
117. Mazzon I. Nuova tecnica per la miomectomia isteroscopica: enucleazione con ansa fredda. In: Cittadini E, Perino A, Angiolillo M, Minelli L, editors. Testo-Atlante di Chirurgia Endoscopica Ginecologica. Palermo: COFESE; 1995 .chapt XXXIIIb
118. Zhao X, Zeng W, Chen L, Chen L, Du W, Yan X. Laparoscopic myomectomy using "cold" surgical instruments for uterine corpus leiomyoma: a preliminary report. Cell Biochem Biophys. 2014;72:141–6. [Epub ahead of print]
119. Wamsteker K, Emanuel MH, de Kruif JH. Transcervical hysteroscopic resection of submucous fibroids for abnormal uterine bleeding: results regarding the degree of intramural extension. Obstet Gynecol. 1993;82:736–40.
120. Emanuel MH, Wamsteker K, Hart AA, Metz G, Lammes FB. Long-term results of hysteroscopic myomectomy for abnormal uterine bleeding. Obstet Gynecol. 1999;93:743–8.
121. Lasmar RB, Barrozo PR, Dias R, Oliveira MA. Submucous myomas: a new presurgical classification to evaluate the viability of hysteroscopic surgical treatment-preliminary report. J Minim Invasive Gynecol. 2005;12:308–11.
122. Casadio P, Youssef AM, Spagnolo E, Rizzo MA, Talamo MR, De Angelis D, Marra E, Ghi T, Savelli L, Farina A, Pelusi G, Mazzon I. Should the myometrial free margin still be considered a limiting factor for hysteroscopic resection of submucous fibroids? A possible answer to an old question. Fertil Steril. 2011;95:1764–8.e1.
123. Jansen FW, Vredevoogd CB, van Ulzen K, Hermans J, Trimbos JB, Trimbos-Kemper TC. Complications of hysteroscopy: a prospective, multicenter study. Obstet Gynecol. 2000;96:266–70.
124. Hallez JP. Single-stage total hysteroscopic myomectomies: indications, techniques, and results. Fertil Steril. 1995;63:703–8.
125. Aydeniz B, Gruber IV, Schauf B, Kurek R, Meyer A, Wallwiener D. A multicenter survey of complications associated with 21,676 operative hysteroscopies. Eur J Obstet Gynecol Reprod Biol. 2002;104:160–4.
126. Lasmar RB, Xinmei Z, Indman PD, Celeste RK, Di Spiezio Sardo A. Feasibility of a new system of classification of submucous myomas: a multicenter study. Fertil Steril. 2011;95:2073–7.
127. Campo S, Campo V, Gambadauro P. Short-term and long-term results of resectoscopic myomectomy with and without pretreatment with GnRH analogs in premenopausal women. Acta Obstet Gynecol Scand. 2005;84:756–60.
128. Muzii L, Boni T, Bellati F, Marana R, Ruggiero A, Zullo MA, Angioli R, Panici PB. GnRH analogue treatment before hysteroscopic resection of submucous myomas: a prospective, randomized, multicenter study. Fertil Steril. 2010;94:1496–9.
129. Kamath MS, Kalampokas EE, Kalampokas TE. Use of GnRH analogues pre-operatively for hysteroscopic resection of submucous fibroids: a systematic review and meta-analysis. Eur J Obstet Gynecol Reprod Biol. 2014;177:11–8.
130. Fedele L, Vercellini P, Bianchi S, Brioschi D, Dorta M. Treatment with GnRH agonists before myomectomy and the risk of short-term myoma recurrence. Br J Obstet Gynaecol. 1990;97:393–6.
131. Propst AM, Liberman RF, Harlow BL, Ginsburg ES. Complications of hysteroscopic surgery: predicting patients at risk. Obstet Gynecol. 2000;96:517–20.
132. Shveiky D, Rojansky N, Revel A, Benshushan A, Laufer N, Shushan A. Complications of hysteroscopic surgery: "beyond the learning curve". J Minim Invasive Gynecol. 2007;14:218–22.
133. Paschopoulos M, Polyzos NP, Lavasidis LG, Vrekoussis T, Dalkalitsis N, Paraskevaidis E. Safety issues of hysteroscopic surgery. Ann N Y Acad Sci. 2006;1092:229–34.
134. Hamou J. Uterine adhesions. In: Hamou JE, Patrick JT, John JS, editors. Hysteroscopy and microhysteroscopy: text and atlas. New York: Appleton & Lange; 1991. p. 139–50.
135. The American Fertility Society classifications of adnexal adhesions, distal tubal occlusion, tubal occlusion secondary to tubal ligation, tubal pregnancies, müllerian anomalies and intrauterine adhesions. Fertil Steril. 1988;49:944–55.
136. Taskin O, Sadik S, Onoglu A, Gokdeniz R, Erturan E, Burak F, Wheeler JM. Role of endometrial suppression on the frequency of intrauterine adhesions after resectoscopic surgery. J Am Assoc Gynecol Laparosc. 2000;7:351–4.
137. Shokeir TA, Fawzy M, Tatongy M. The nature of intrauterine adhesions following reproductive hysteroscopic surgery as determined by early and late follow-up hysteroscopy: clinical implications. Arch Gynecol Obstet. 2008;277:423–7.
138. Touboul C, Fernandez H, Deffieux X, Berry R, Frydman R, Gervaise A. Uterine synechiae after bipolar hysteroscopic resection of submucosal myomas in patients with infertility. Fertil Steril. 2009;92:1690–3.
139. Guida M, Acunzo G, Di Spiezio Sardo A, Bifulco G, Piccoli R, Pellicano M, Cerrota G, Cirillo D, Nappi C. Effectiveness of

auto-crosslinked hyaluronic acid gel in the prevention of intrauterine adhesions after hysteroscopic surgery: a prospective, randomized, controlled study. Hum Reprod. 2004;19:1461–4.
140. Yang JH, Chen MJ, Wu MY, Chao KH, Ho HN, Yang YS. Office hysteroscopic early lysis of intrauterine adhesion after transcervical resection of multiple apposing submucous myomas. Fertil Steril. 2008;89:1254–9.
141. Metwally M, Watson A, Lilford R, Vandekerckhove P. Fluid and pharmacological agents for adhesion prevention after gynaecological surgery. Cochrane Database Syst Rev. 2006;2: CD001298.
142. Gerli S, Baiocchi G, Favilli A, Di Renzo GC. New treatment option for early spontaneous rupture of a postmyomectomy gravid uterus. Fertil Steril. 2011;96:e97–8.
143. Parker WH, Einarsson J, Istre O, Dubuisson JB. Risk factors for uterine rupture after laparoscopic myomectomy. J Minim Invasive Gynecol. 2010;17:551–4.
144. Pistofidis G, Makrakis E, Balinakos P, Dimitriou E, Bardis N, Anaf V. Report of 7 uterine rupture cases after laparoscopic myomectomy: update of the literature. J Minim Invasive Gynecol. 2012;19:762–7.
145. Vassilevski Y, Danilov A, Ivanov Y, Simakov S, Gamilov T. Personalized anatomical meshing of human body with applications. In book Modeling the heart and the circulatory system. vol 14. Cham, Switzerland: Springer; 2015., p. 221–36.
146. Yushkevich PA, Piven J, Hazlett HC, Smith RG, Ho S, Gee JC, Gerig G. User-guided 3D active contour segmentation of anatomical structures: significantly improved efficiency and reliability. Neuroimage. 2006;31(3):1116–28.
147. ITK-SNAP Medical Image Segmentation Tool. http://itksnap.org/.
148. Convert3D Tool. http://itksnap.org/c3d/.
149. Wu Z, Sullivan JM. Multiple material marching cubes algorithm. Int J Numer Meth Eng. 2003;58:189–207.
150. Taubin G. A signal processing approach to fair surface design. In book Proceedings of the 22nd Annual Conf. on Comp. Graphics and Interactive Techniques, ACM, New York;1995. p. 351–8.
151. Vassilevski YuV, Vershinin AV, Danilov AA, Plenkin AV. Tetrahedral mesh generation in domains defined in CAD systems. In book Matrix methods and technology for solving large problems. Moscow: Institute of Numerical Mathematics, 2005; 21–32, (in Russian).
152. Rineau L, Yvinec M. A generic software design for Delaunay refinement meshing. Comp Geom Theory Appl. 2007;38:100–10.
153. Danilov AA. Unstructured tetrahedral mesh generation technology. Comp Math Math Phys. 2010;50:139–56.
154. Frey P, George PL. Mesh generation: application to finite elements. Paris/Oxford: Hermes Science; 2000.
155. Advanced Numerical Instruments 3D. http://sourceforge.net/projects/ani3d.
156. Danilov AA, Simakov SS, Vassilevski YV, Malvasi A, Ishchenko AI, Kovaleva AM, Mynbaev OA, Tinelli A. A mathematical model of myoma pseudocapsule. The NESA Days 2015. 18–20 September 2015. Berlin, Germany.
157. Danilov AA, Salamatova VYu, Simakov SS, Tinelli A, Malvasi A, Mynbaev OA, Mal'kov PG, Ishchenko AI, Kovaleva AM, Vassilevski YuV. Virtual mechanical soft tissue computational simulations of uterine scar after myomectomy. The NESA Days 2015. 18–20 September 2015. Berlin, Germany.
158. Babenko TI, Danilov AA, Simakov SS, Ryzhkov VV, Kovalev MI, Danilova NV, Mal'kov PG, Mynbaev OA. A virtual 3D model of uterine scar after caesarean section. V International conference on biotechnology and pharmaceutics 'PhystechBIO'. 29–30 April 2015. Moscow Institute of Physics and Technology, Dolgoprudny, Russia.
159. Mynbaev OA, Simakov SS, Danilov AA, Kolobov AV, Mal'kov PG, Polyakov YuV, Kovalev MI, Ishchenko AIL, Tinelli A, Malvasi A, Melerzanov AV, Vassilevski YuV. Angiogenesis initiation and vascular network development during uterine fibroid formation and growth. V International conference on biotechnology and pharmaceutics 'PhystechBIO'. 29–30 April 2015. Moscow Institute of Physics and Technology, Dolgoprudny, Russia.
160. Mazzon I, Favilli A, Grasso M, Morricone D, Di Renzo GC, Gerli S. Is 'cold loop' hysteroscopic myomectomy a better option for reproduction in women with diffuse uterine leiomyomatosis? A case report of successful repeated pregnancies. J Obstet Gynaecol Res. 2014; doi:10.1111/jog.12548. [Epub ahead of print]
161. Camanni M, Bonino L, Delpiano EM, Ferrero B, Migliaretti G, Deltetto F. Hysteroscopic management of large symptomatic submucous uterine myomas. J Minim Invasive Gynecol. 2010;17:59–65.
162. Leone FP, Calabrese S, Marciante C, Cetin I, Ferrazzi E. Feasibility and long-term efficacy of hysteroscopic myomectomy for myomas with intramural development by the use of non-electrical "cold" loops. Gynecol Surg. 2012;9:155–61.
163. Butram VC, Reiter RC. Uterine Leiomyomata: etiology, symptomatology and management. Fertil Steril. 1981;36:433–45.

Laparoscopic Subtotal Hysterectomy (LSH)

32

Bernd Bojahr and Garri Tchartchian

Introduction

Various benign gynecological conditions including dysfunctional uterine bleeding, meno-metrorrhagia due to endometrial hyperplasia, fibroids, diffuse myomatosis, adenomyosis, endometriosis, pressure symptoms related to bowel or bladder function, large uterine fibroids, and treatment of excessive menstrual loss not responding to medical therapy [1–3] are indicative for a laparoscopic hysterectomy. For nonmalignant conditions LSH represents an alternative to total hysterectomy, with a low level of intraoperative and postoperative morbidity [4].

The difference between a subtotal, or supracervical hysterectomy and a total hysterectomy is as follows:

The total hysterectomy removes the entire uterus, including the cervix, whereas in the subtotal or supracervical hysterectomy the excision of the body of the uterus is performed, at or below the level of the isthmus, and conserves the cervix.

Leaving the cervix intact laparoscopically is easier to perform on a technical level, making the Laparoscopic subtotal hysterectomy (LSH) favorable over a total laparoscopic hysterectomy (TLH). With the LSH technique the two pitfalls of TLH, uterine vessel haemorrhage and ureteric injury, can be avoided. The risk of cervical cancer can also be reduced by coring out the entire transformation zone and endocervical canal.

Other advantages can be seen in reports that LSH results in lower levels of sexual, bladder and bowel dysfunction and offers superior protection of the integrity of the pelvic floor compared to total hysterectomy [5–7]. In developed industrial countries there is an increasing uptake rate of LSH [8, 9].

Although laparoscopic surgery is well accepted by gynaecologists worldwide, laparoscopic hysterectomy in Germany is still only performed by a few specialists as it is a highly skilled technique. At the "Klinik für MIC" (a hospital specialized in minimally invasive surgery) in Berlin, Germany, the surgeons are leading experts in laparoscopic subtotal hysterectomy. Between 1998 to December 2014 11,598 LSH procedures were performed there 909 of these extirpated uteri had a weight of more than 500 g and the largest removed uterus had a weight of 4065 g.

This article will describe and illustrate in detail the surgical technique of LSH and will comment on complications, as well as providing some tips and suggestions for implementation.

Surgical Procedure

After bladder catheterism and vaginal disinfection, the patient is placed in a horizontal position, with stretched legs (Fig. 32.1). Positioned on the left side of the patient are the surgeon, the assistant and the surgical nurse, along with instrument tables, facing the monitors and endoscopic tower on the right side of the patient the electronic equipment is set up (Fig. 32.2). No uterus manipulators are needed. A CO_2 pneumoperitoneum to an intra-abdominal pressure of 15 mmHg is established utilizing a Veress needle, placed through an incision in the inferior umbilical fossa. A 5-mm trocar is used for the laparoscopy with 30 ° optics.

Tip When the situs is obscure, and especially in the case of large multimodal myomatous uteri, the excellent image quality provided by the new digital 3-ship camera (STORZ), and the benefits of the 30° telescope can be much appreciated.

The patient is then placed in Trendelenberg position, a maximum (steep) position. Two more 5 mm puncture sites in the lower abdomen are required (Fig. 32.3), the location of which depends on the size of the uterus.

Two additional trocars are introduced left and right lateral to the epigastric vessels in the region of the pubic hair line in cases of a normal sized uterus. The larger the uterus, the further

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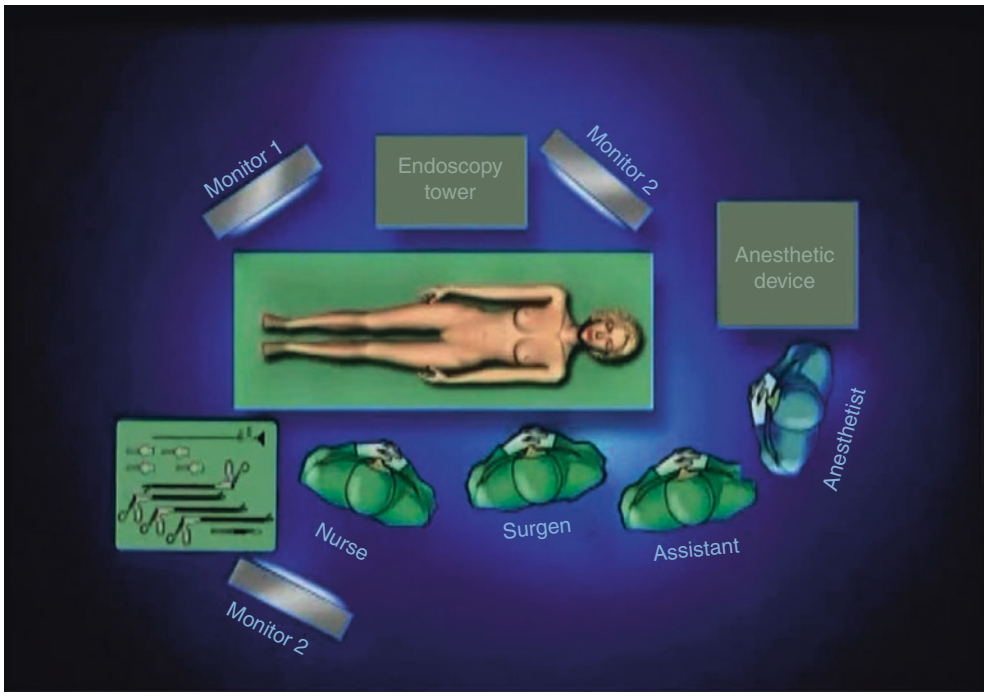


Fig. 32.1 Patient positioning and OR Equipment at MIC Klinik in Berlin

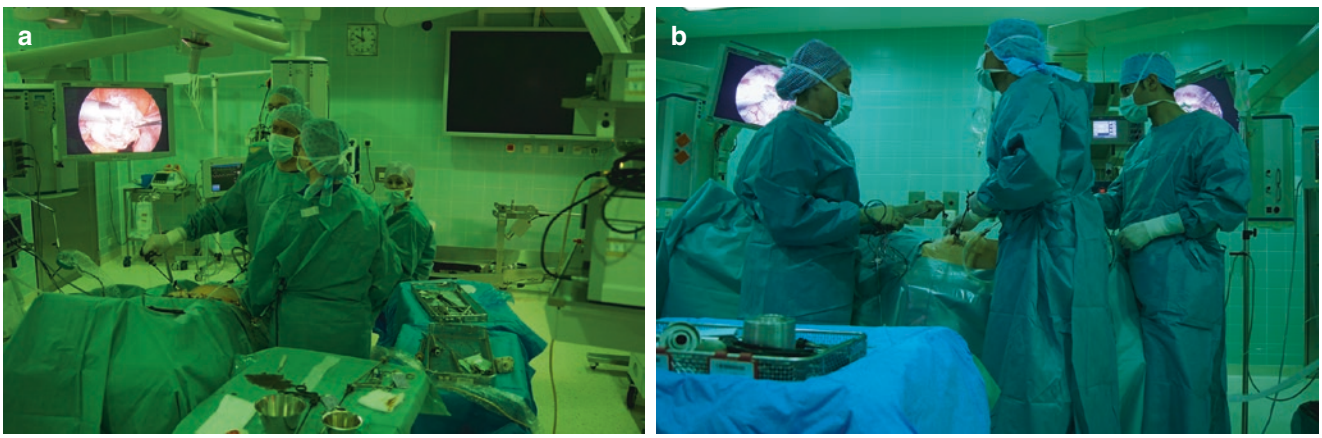


Fig. 32.2 The surgeon, the assistant, the scrub nurse and the instrument table are positioned on the left side of the patient (**a**, **b**)



Fig. 32.3 Trocar placement for a LASH (normal sized uterus)

above the symphysis pubis the lateral trocars need to be positioned. In the case of uterus extension as far as the umbilicus, insufflation is performed on the left, below the costal arch with trocar introduction there or in the umbilicus. Correspondingly higher, additional trocars are positioned according to the size of the uterus, to enable the adnexa to be dissected (Fig. 32.4).

Tip With a large myomatous uterus (Fig. 32.5), localization of the two trocars in the lower abdomen depends on the size of the uterus. They are then usually placed two to three centimeters above the pubic hair border. A fourth trocar should be introduced on the left below the costal arch or above the umbilicus to obtain a better overview of the uterus. From

there, visualization can be performed with the telescope (Fig. 32.6). The uterus can then be pressed to the right or left using a palpation probe, so as to remove the adnexa laterally. With such large findings, good visualization of the anatomic structures with the 30 ° telescope is essential to avoid unnecessary bleeding.

The only additional re-usable instruments needed for LSH include a bipolar coagulation clamp, Metzenbaum scissors, three various grasping forceps, a needle holder, a unipolar hook, and a suction-irrigation system.

The round ligaments, the fallopian tubes and the ovarian ligaments are coagulated using bipolar forceps for mobilization of the uterus (Fig. 32.7) and subsequently dissected using endoscopic Metzenbaum scissors (Fig. 32.8).

Tip Mobilization of the uterus can also be performed with the ultracision harmonic scalpel. Less frequent instrument changing is required. But also the use of ultracision instruments, monopolar scissors and unipolar loops for the dissection of the corpus uteri has been described [10–12]. Safety,

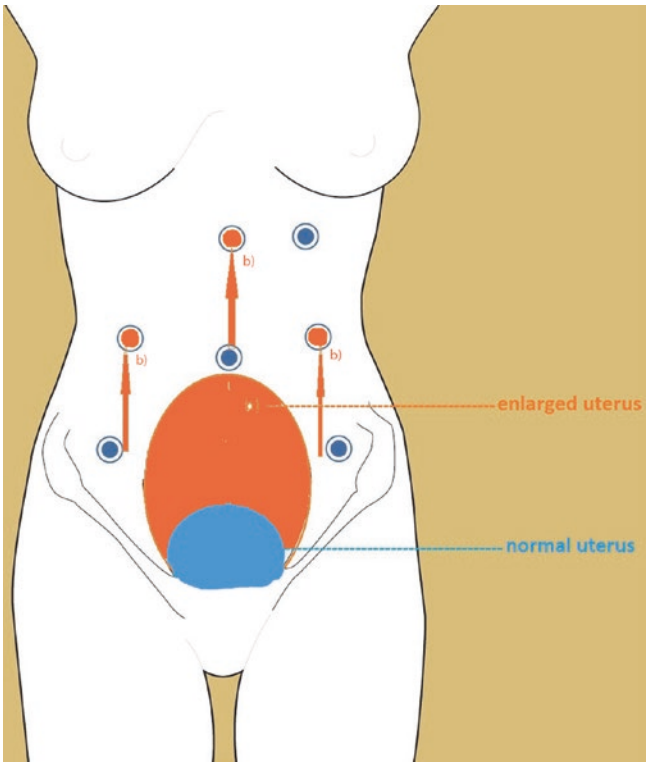


Fig. 32.4 Variations of trocar placement in cases of enlarged uteri

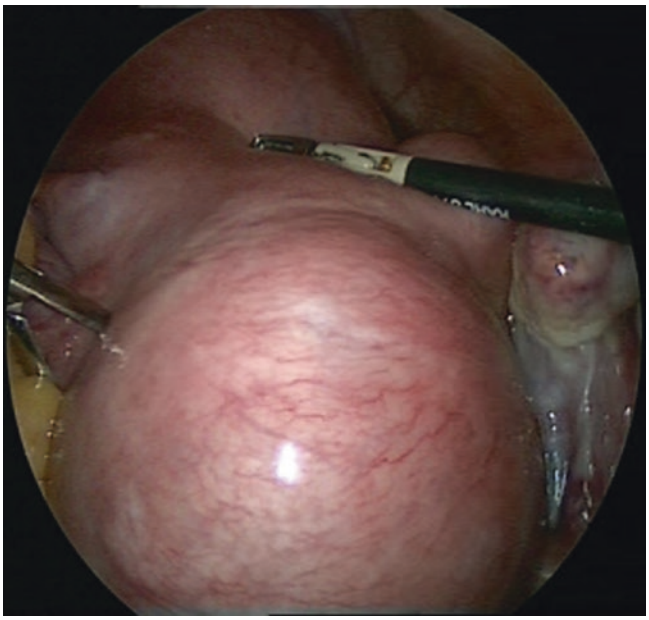


Fig. 32.6 1107 gm Uterus – View from inside

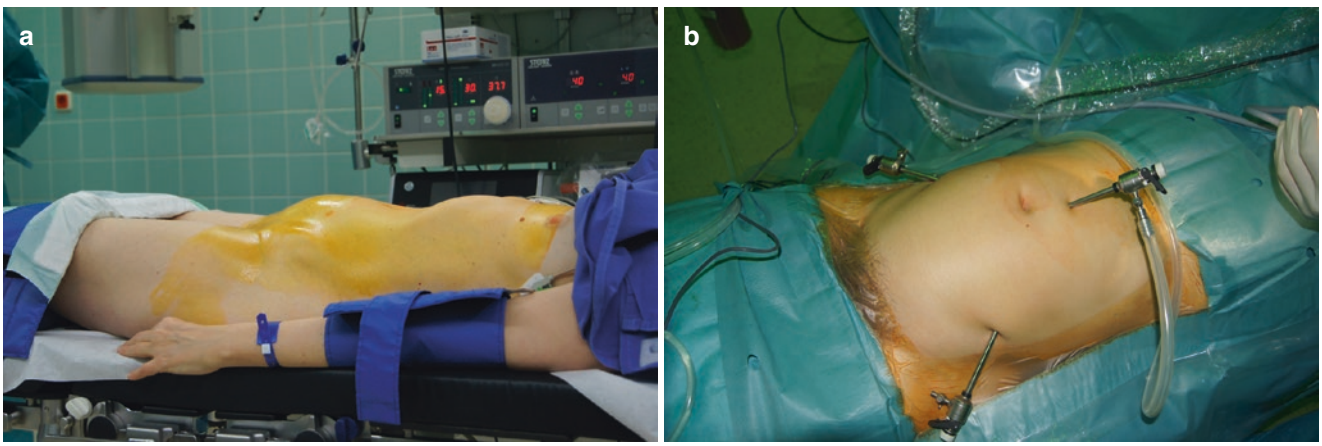


Fig. 32.5 1107 gm Uterus – (**a**) View from outside , (**b**) Trocar placement

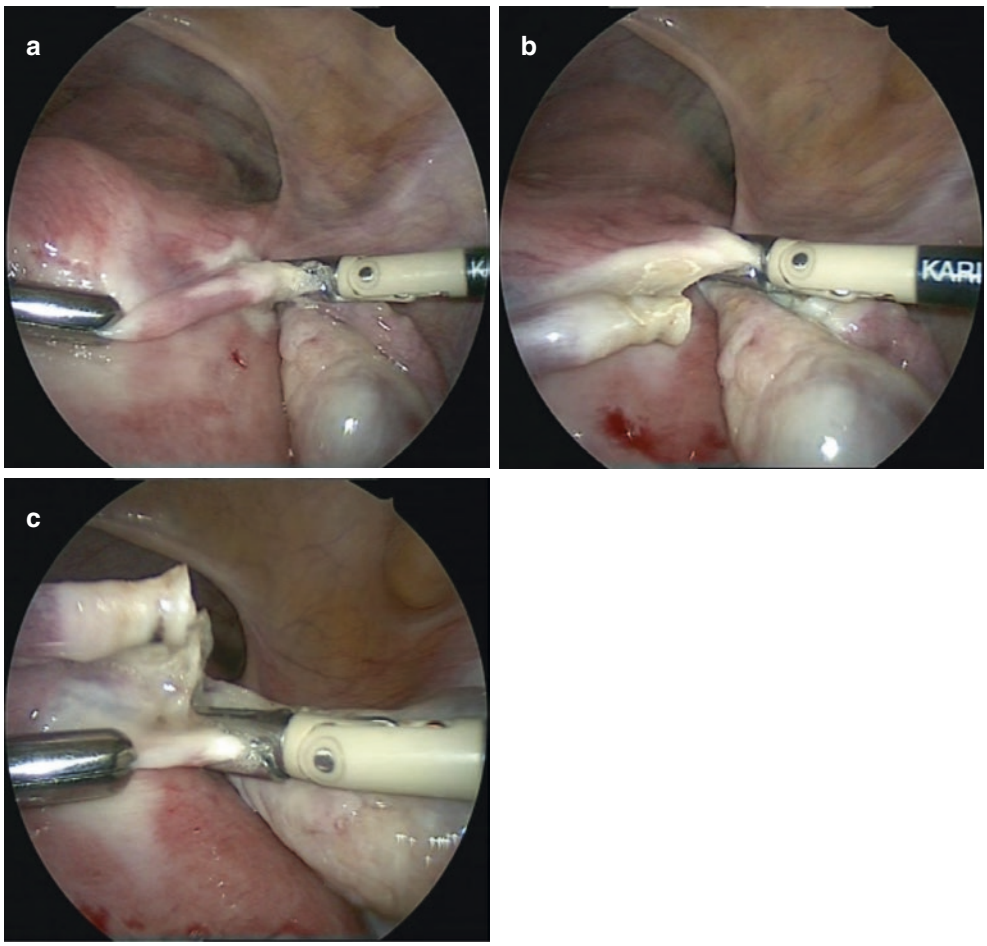


Fig. 32.7 (**a**–**c**) – Bipolar coagulation of the fallopian tube, the round ligament and the ovarian ligament.

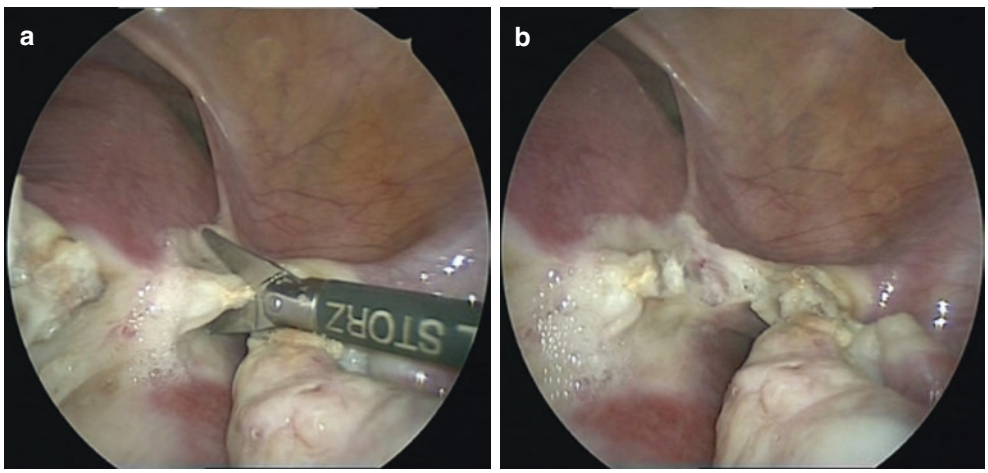


Fig. 32.8 Dissection of the round ligament, fallopian tube and ovarian ligament from the right side with a pair of scissors (**a**) – after the dissection (**b**)

precision of the cut, and shortage of operating time are definite advantages of the unipolar loop are [10].

Tip In the case of intraligamentous myomas the essential requirements are, on the one hand, sufficient hemostasis and, on the other hand, that dissection is always close up against the myoma. The majority of myomas can be mobilized with a blunt instrument. It is necessary for the ureter to be visualized during and after the removal if the myomas extend as far as the pelvic wall. To ensure that the symptoms complained of before the operation do not persist afterwards if endometriosis foci are present, irrespective of whether they are located in the Douglas, in the area of the round ligaments or in the area of the bladder peritoneum, it is important to also resect these foci completely.

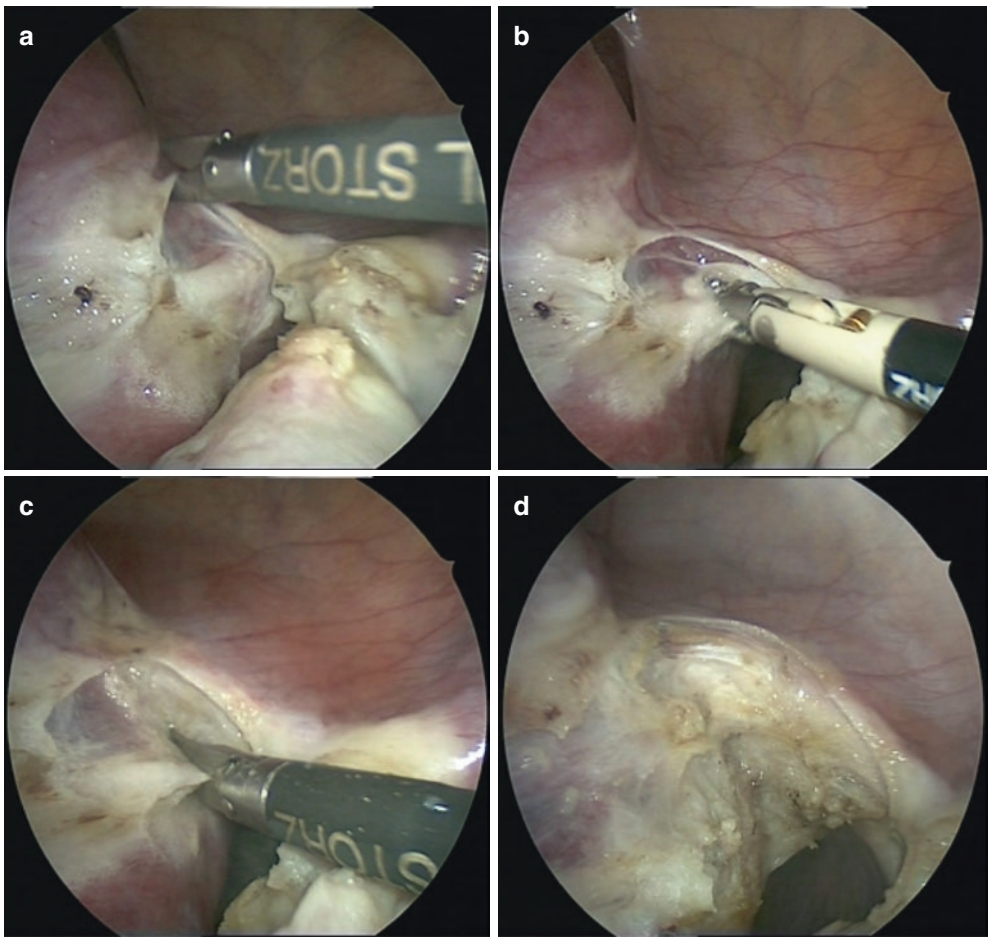


Fig. 32.9 Identification and skeletonization, bipolar coagulation and dissection of uterine vessels on the right side (**a**–**d**)

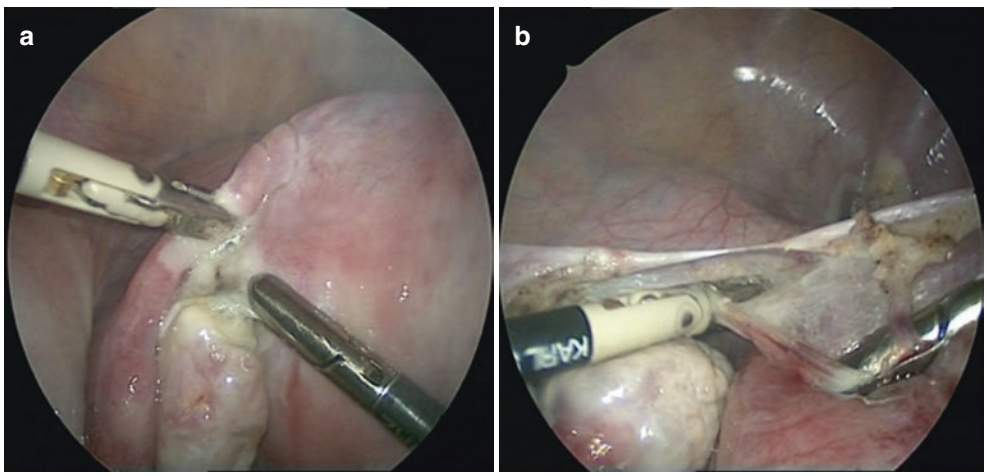


Fig. 32.10 Bipolar coagulation and dissection of round ligament, fallopian tube and ovarian ligament from left side (**a**, **b**)

After identification and skeletonization of the uterine vessels, bleeding is controlled by bipolar coagulation and the vessels dissected using Metzenbaum scissors on the right side (Fig. 32.9).

Grasping forceps are used to pull the uterus to the contralateral side. After separation of the uterus from the ovaries and fallopian tubes and dissection through the round ligaments on the left side (Fig. 32.10) the uterine vessels will be also coagulated and dissected (Fig. 32.11) and a bipolar coagulation zone is placed on the bladder peritoneum for the delineation of the planned direction of incision to open the bladder peritoneum (Fig. 32.12). Once the bladder peritoneum has been separated from the dissected round ligaments using scissors, it can be opened and the bladder pushed slightly caudally. It is not necessary to push away the bladder as it is in total hysterectomy. This is because dissection of the

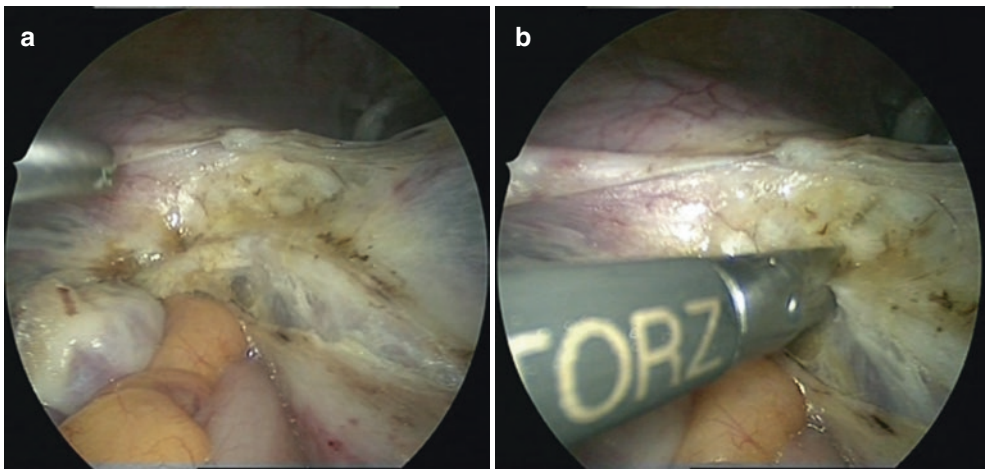


Fig. 32.11 Identification and skeletonization, bipolar coagulation and dissection of uterine vessels on the left side (**a**, **b**)

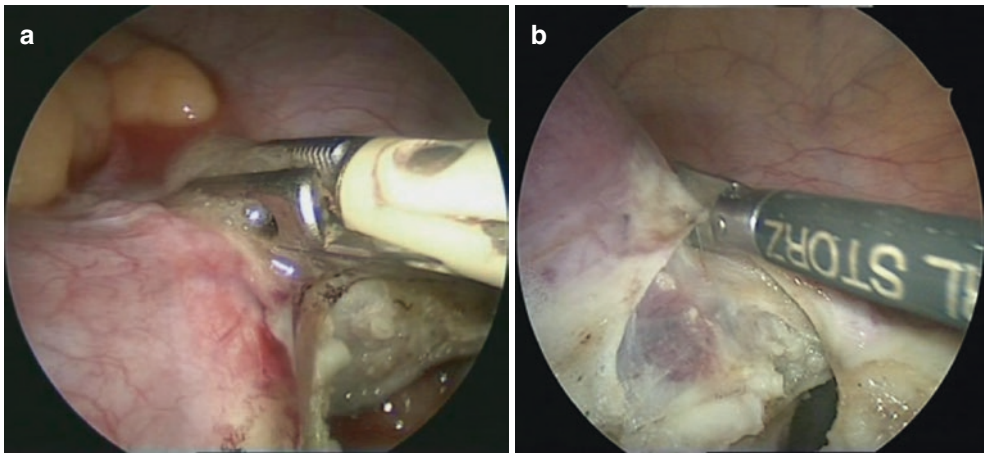


Fig. 32.12 A Coagulation zone is made on the bladder peritoneum (**a**) – Undermining and opening of the bladder peritoneum (**b**)

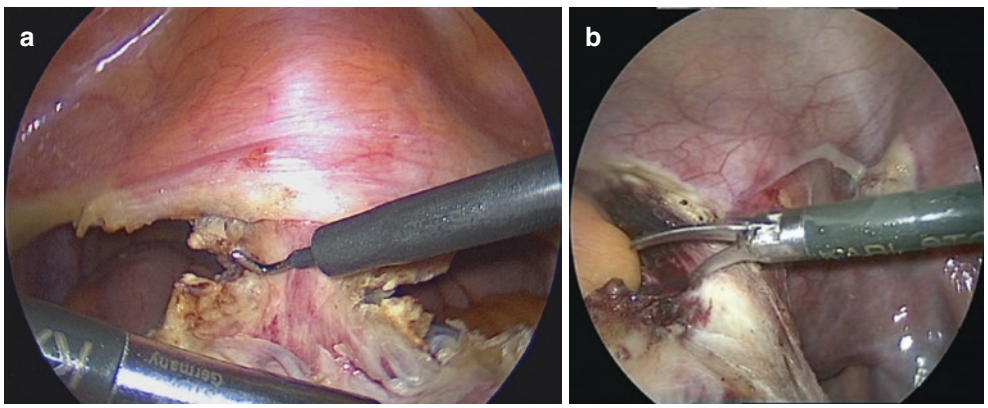


Fig. 32.13 Transection of corpus uteri with unipolar hook (**a**) or with a pair of scissors (**b**)

uterine body with a unipolar hook or with a pair of scissors (Fig. 32.13) is done in the upper third, cranial to where the uterosacral ligaments leave the cervix. If dissection starts from the left side, the uterus is held against the anterior wall using grasping forceps and pulled in cranial direction.

Due to the traction of the uterus to the opposite side (where the dissection is to be performed) space can be created to identify the uterine vessels in the cervical area and the ureter. If coagulation and dissection of the uterine vessels is performed close to the cervix, we do not visualize the ureter. In cases of cervical myomas, even traction of the uterus to the contralateral side is very helpful for visualizing the ureter.

The dissection is done step by step starting from the right using the unipolar hook. In this phase of surgery the surgeon needs clear vision to prevent injuries of adjacent organs; the development of excessive smoke can be prevented by actuating

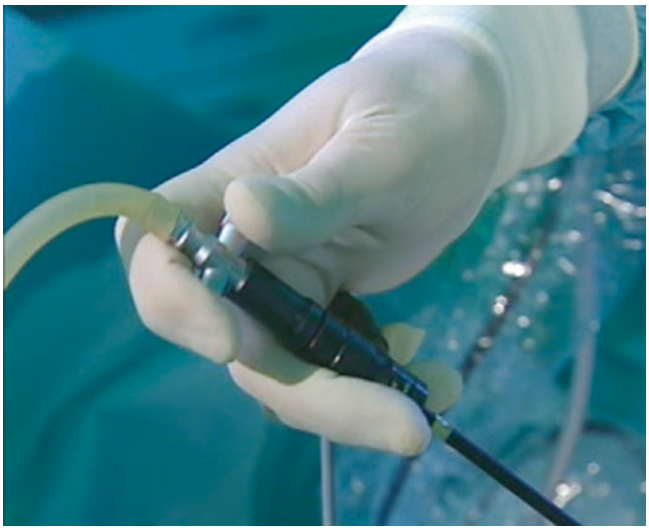


Fig. 32.14 Suction device connected to the unipolar hook

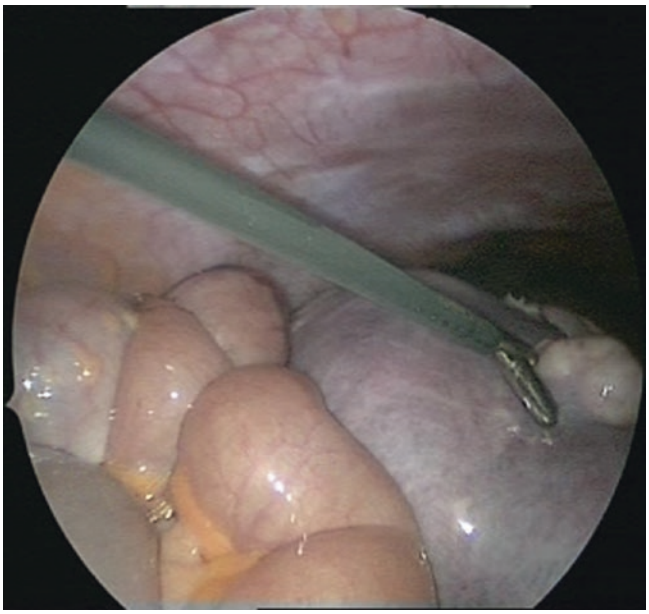


Fig. 32.15 Positionning of the transected corpus in the right-hand mesogastrium

the suction on the hook (Fig. 32.14). The dissected body of the uterus is positioned in the right-hand mesogastrium to enable haemostasis in the wound area (Fig. 32.15), followed by bipolar coagulation of the cervical canal (Fig. 32.16) after efficient haemostasis (Fig. 32.17) in the area of the cervix stump.

Tip The cervix can be held from the left using grasping forceps while searching for the entrance into the cervical canal with the palpation probe or bipolar forceps if identification of the cervical canal is difficult. Coagulation is performed by opening and simultaneously rotating the damp in the cervical canal.



Fig. 32.16 Bipolar coagulation of the cervical canal

A vicryl thread shortened to approximately instrument length is used for peritonealisation of the cervical stump. Under vision, the round needle is introduced through the 5 mm incision (Fig. 32.18). The cervix stump is then covered with peritoneum using a continuous purse-string suture, including both uterosacral ligaments (Fig. 32.19). Following the preparation of a triple knot, the peritoneum is pulled together, with a fourth knot to secure the suture (Fig. 32.20).

The incision is widened to 10–20 mm in the left-hand lower abdomen to remove the uterus. Following injection of a local anaesthetic beneath the wound area of the left-hand incision, an electric morcellator (STORZ® or WISAP®) (Fig. 32.21) is introduced under direct vision. The uterus is then gripped from the left and pulled into the morcellator, which is activated by hand or via foot pedal. It is of utmost importance to keep the sharp rotating blade continuously in vision at the centre of the laparoscopic image to avoid injuries (Fig. 32.22). To remove a large section of tissue in a single piece, it is helpful to assist the process of morcellation with the right-handed grasping forceps so that the blade is always visible on the surface of the uterus (Fig. 32.23). Morcellation is therefore performed around the exterior of the uterus. The uterus is effectively peeled like a potato.

Tip It is particularly important to ensure a good overview during morcellation, and in the case of large uteri a 20 mm morcellator can also be used. This leads to a considerably shorter operation, as the sections of uterus removed in this way are far larger.

Remaining smaller pieces of the uterus or the myoma are retrieved using 10 mm spoon grasping forceps after removal of the uterus (Figs. 32.24 and 32.25).

The operation is completed with lavage and a final checking of the cervical stump (Fig. 32.26). The peritoneum in the area of 15 or 20 mm incisions is closed from the inside using bipolar coagulation. To avoid incision hernias Closure of the fasciae is also necessary. The skin is then closed using single-button sutures. The final position for a normal sized uterus shows 5 mm incisions in the umbilicus and on the right side of the lower abdomen, and a 15 mm incision on the left (Fig. 32.27). If the uterus is noticeably enlarged, an additional 5 mm and a 20 mm incision for the morcellation may become necessary.

Laparoscopic combined hysterectomy (LACH) with "change over technique" – this is a special surgical tech-

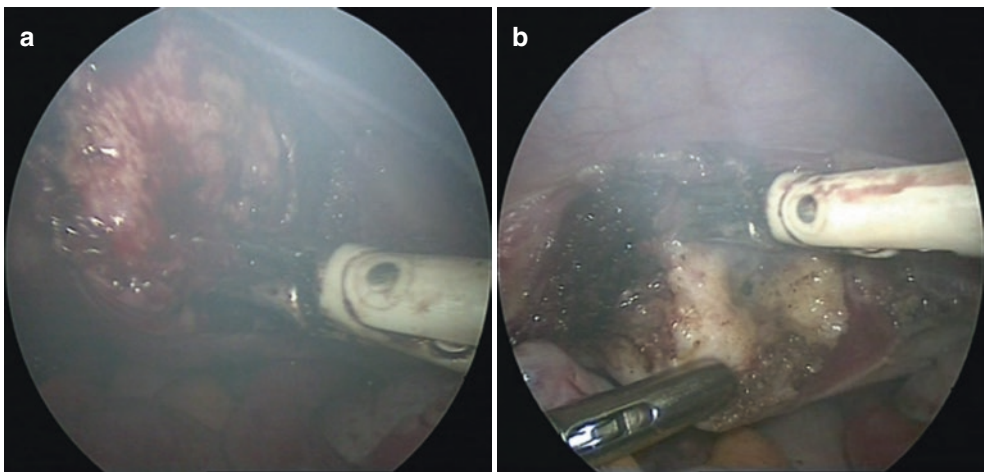


Fig. 32.17 Hemostasis in the area of the cervical stump (**a**, **b**)

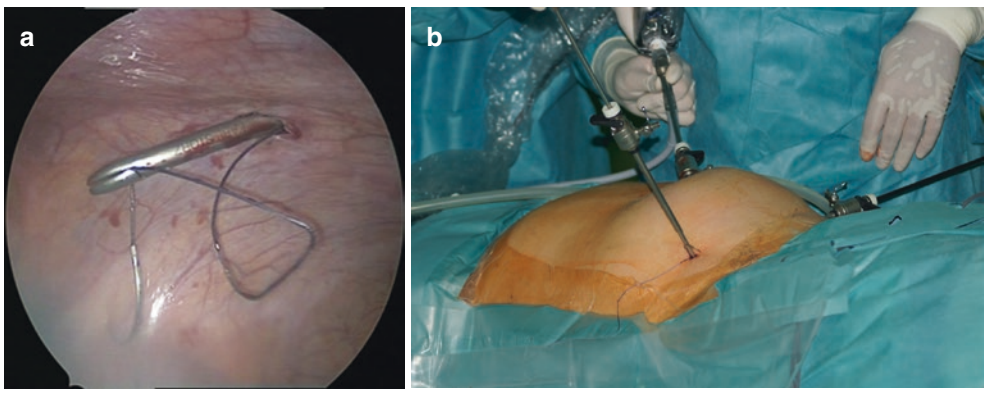


Fig. 32.18 Introduction of a round needle (endoscopic view and view from outside **a**, **b**)

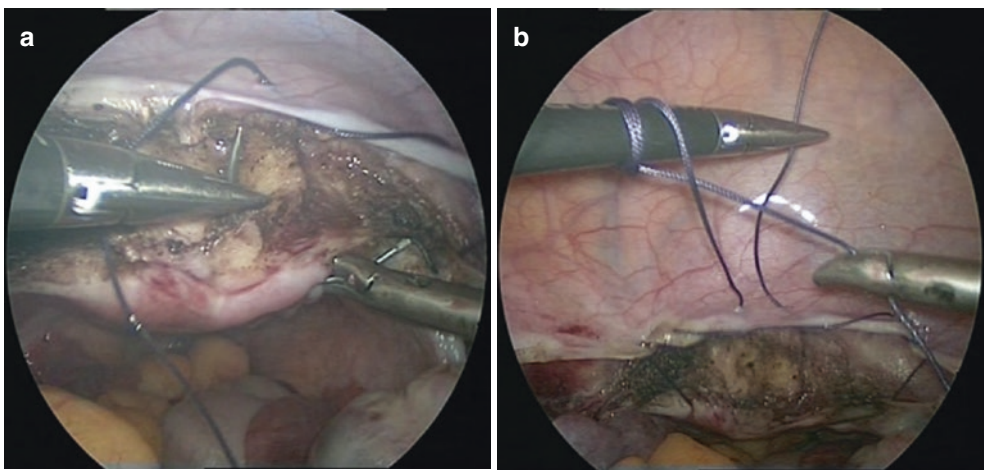


Fig. 32.19 Continuous purse-string suture (**a**, **b**)

nique for the removal of a very large uterus [13, 14]. Here, the uterine corpus is abscised and morcellated laparoscopically. For this, the above mentioned "change over technique" is applied, where the operation-team changes from one side of the patient to the other (Figs. 32.28 and 32.29). The "change over technique" can also be used in LSH given a difficult-case-uterus. The specialty of the "change over technique" lies in the fact that for successful abscission of the uterine corpus in case of very large uterine myomata, the surgeon begins operating on the left side of the uterus, respectively on the left side of the parametrium. After sealing and cutting off the left parametrium and the vascular bundle, the surgeon and the assistant move to the right side of the patient and now operate on the right side of the uterus.

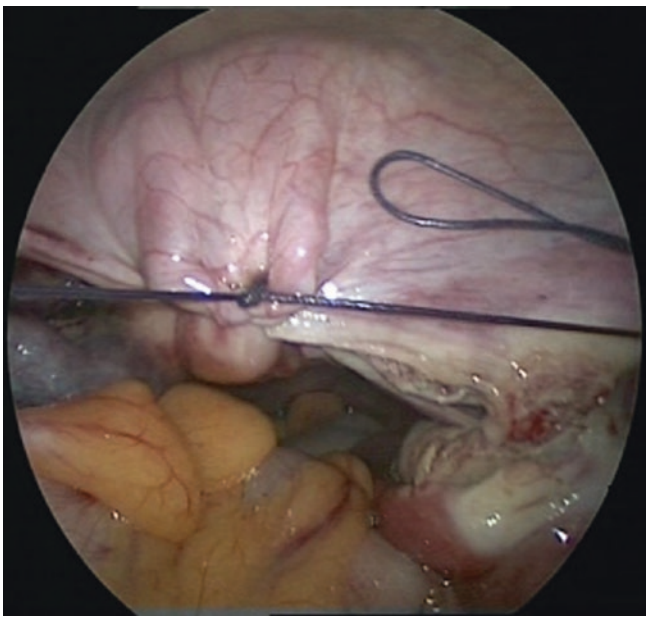


Fig. 32.20 Peritonealization of the cervical stump

Tip Doubtlessly, an umbilical entry of the optical trocar into the epigastrium is possible. However, we always recommend using Palmer's point for the camera trocar on the left side. For the right optical trocar, we use the exact symmetrical counterpoint on the right side. Surgery is always carried out using 5 mm 30 ° optics made by the Karl Storz company. Next, the patient is placed in maximum Trendelenburg position. For the first phase the surgery on the left side we place two more working trocars on the left axillary line of the abdomen, leaving a space of about 8–10 cm between them [14].

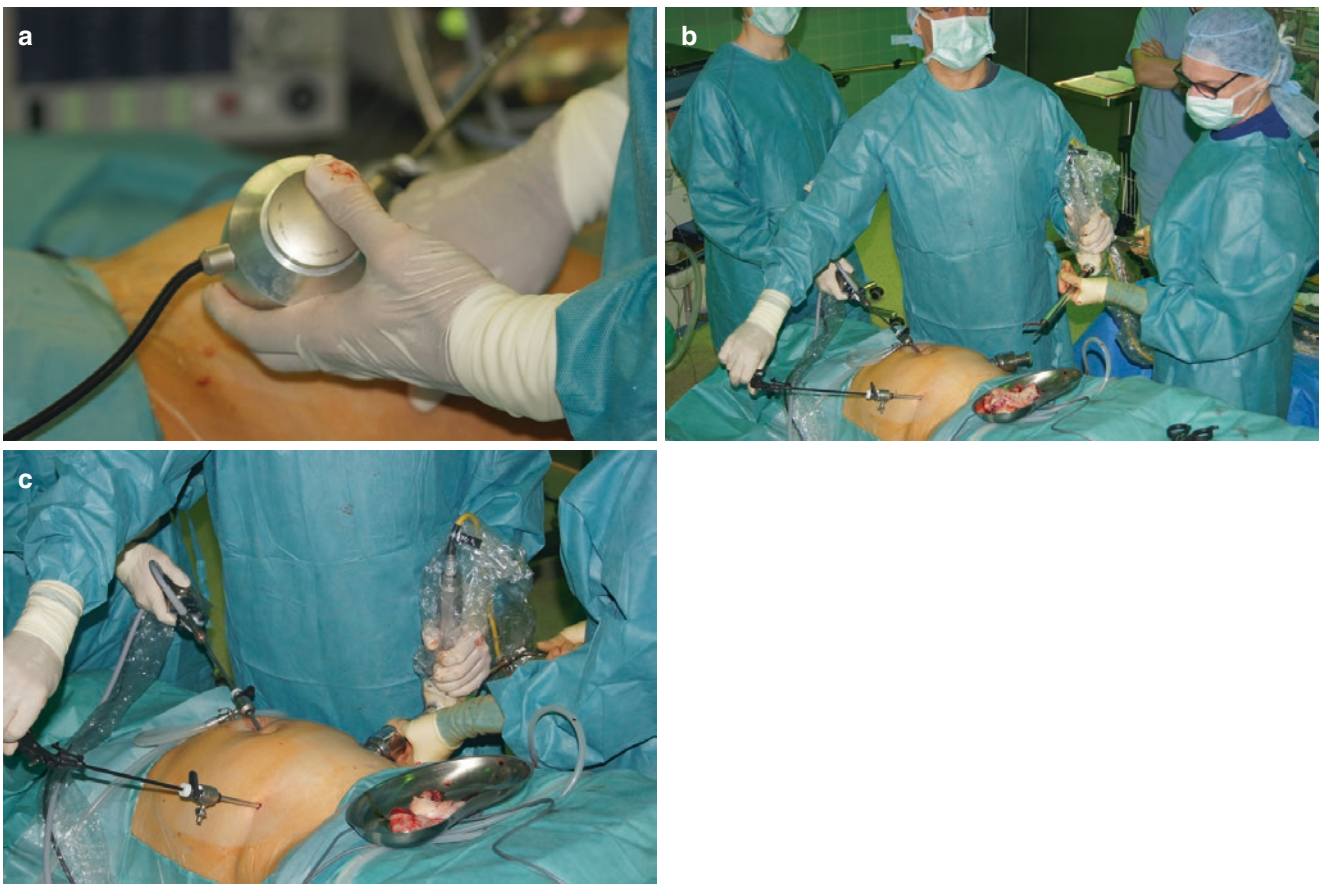


Fig. 32.21 Introduction of a 15 mm Rotocut electric morcellator (Storz) (**a**) or a 20 mm WISAP morcellator (**b**, **c**)

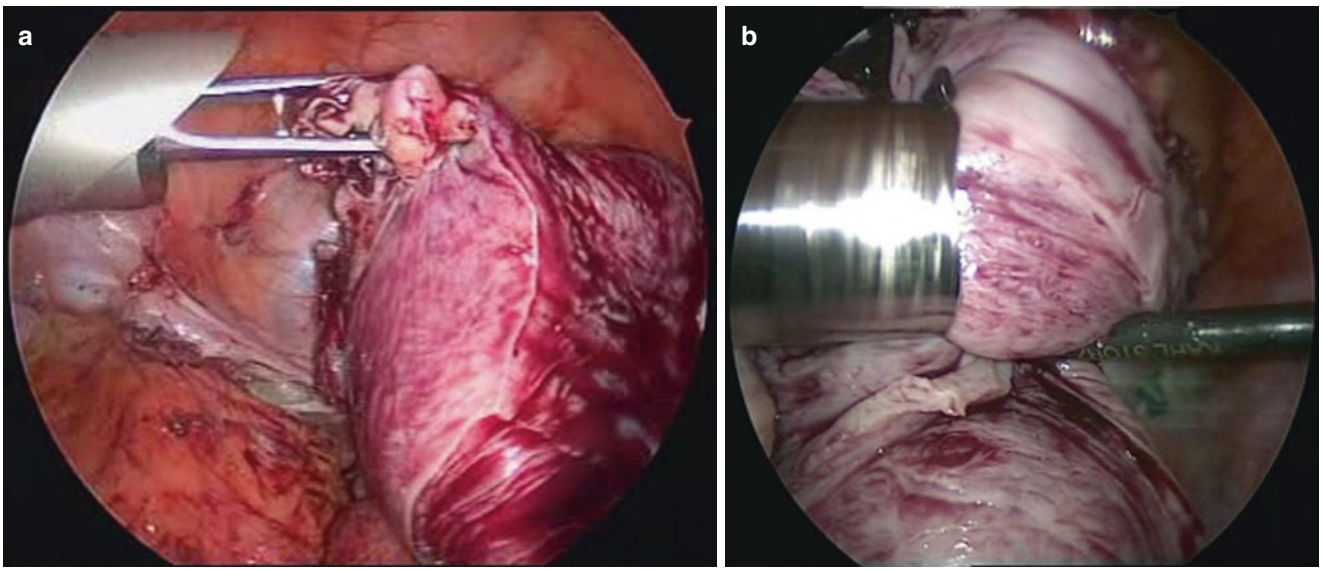


Fig. 32.22 The sharp rotating blade of the morcellator is visible during morcellation (**a** – Rotocut electric morcellator (Storz), **b** – WISAP electric morcellator)

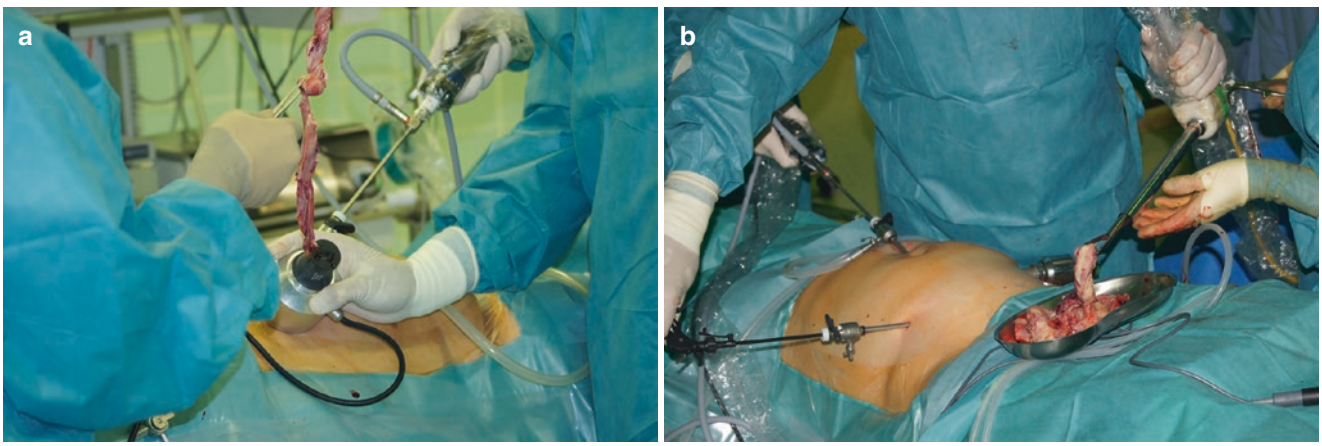


Fig. 32.23 Morcellation - View from outside (**a** – with the Rotocut electric morcellator (Storz), **b** – with the WISAP electric morcellator)

Tip The lower working trocar should be placed at about the height of the uterotubal junction.

After parameterization on the left side is conducted, the second optical trocar is placed in a position symmetrical to the Palmer's point area on the right costal arch under laparoscopic observation for the second phase of the "change over technique". The surgeon and his assistant change their position to the right side of the patient and the operation is resumed from the right. Leaving space of 8–10 cm between them, two further working trocars are placed along the right axillary line.

Complications

Reported complication rates in literature for all different hysterectomy procedures vary tremendously. It appears that complication rates in general are reduced using endoscopic techniques. Complication rates for abdominal hysterectomies are between 13.1 and 48 % [15–17] and for vaginal hysterectomies between 2 and 27.7 % [15, 17–19]. Complication rates for LSH are lower (0–4.35 %) than for TLH (0–18%) [4, 9, 19–23 34].

Compared to vaginal and abdominal hysterectomies, major complications (e.g. haemorrhage, vesicoperitoneal fistula, ureteral injury, rectal perforation or fistula) are more common after laparoscopic hysterectomies, as shown in multicenter studies [24], however the comparison to total laparoscopic hysterectomy shows that LSH has a lower major complication rate [25].

We reported intraoperative and postoperative complication rates of LSH of 0.2 % and 1.2 %, respectively, and a conversion rate of 0.82 % [4], which are similar to the low rates of conversion (0.7 %) and of intraoperative complication (0.1 %) in a second study [26]. Lyons [27] reports low rates

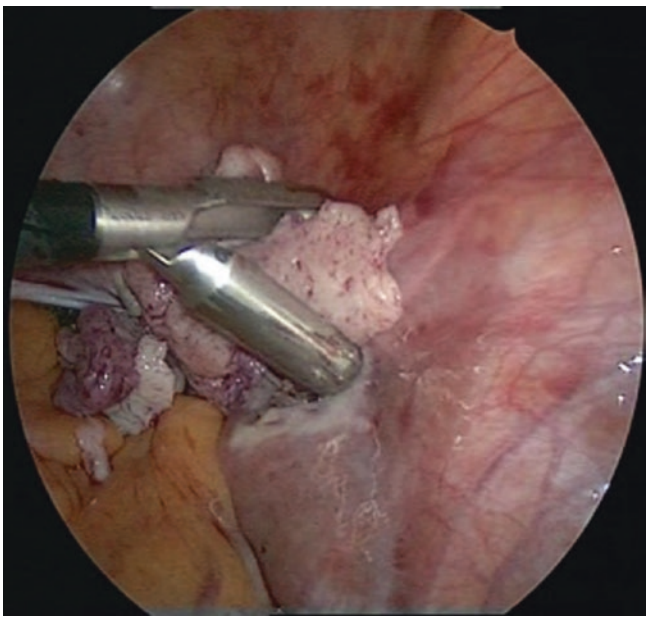


Fig. 32.24 Removal of smaller pieces using a 10 mm spoon grasping forceps

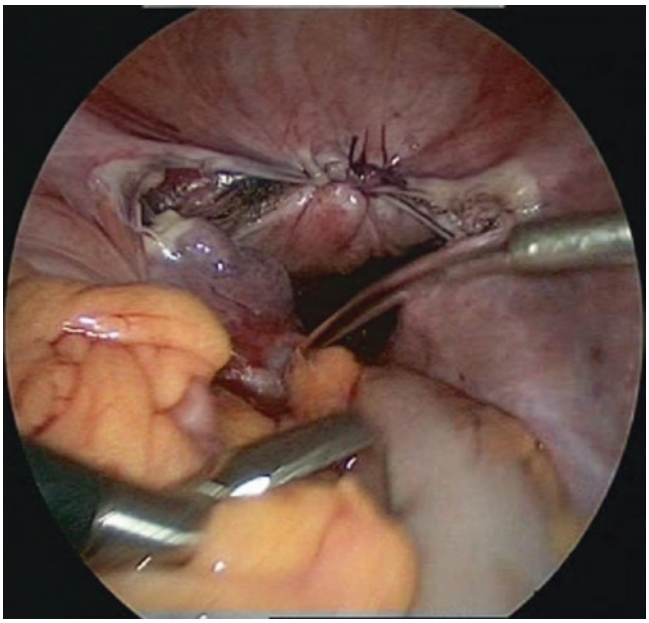


Fig. 32.26 Rinsing of the abdomen



Fig. 32.25 Morcellated pieces of a 1107 g uterus

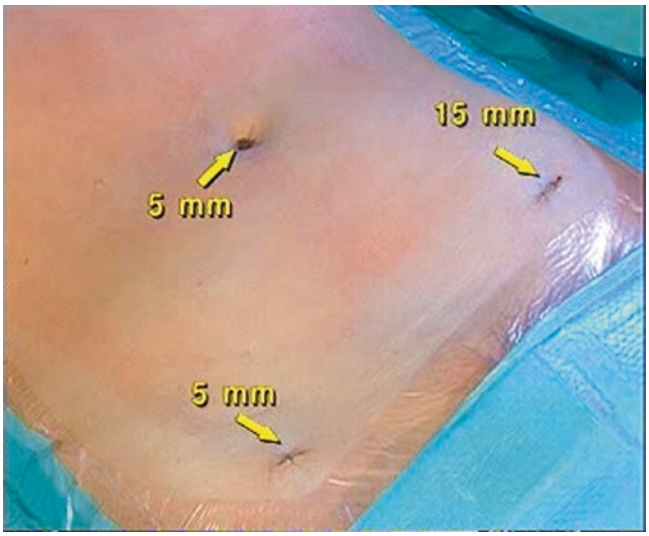


Fig. 32.27 Final abdominal situs

of blood transfusion (0 %), and reoperation (0.001 %), out of 1500 procedures, including patients with severe adhesive disease and severe endometriosis.

The majority of complications associated with a hysterectomy involve injuries to the urinary tract. One multicenter study showed highest complication rates of injury to the urinary tract for TLH (2.26 %) compared to abdominal (0.17 %) and vaginal hysterectomy (0.04 %) [28]. The risk of injury to the ureter or bladder during TLH increases as the bladder is dissected off the vaginal tissue [29]. Because the dissection ends superior to the bladder and ureter during LSH, the risk of direct damage to the ureter and bladder is presumably decreased [28, 30, 31]. Four retrospective studies have reported urinary tract (ureteral) injury rates of less than 1 % out of a total of more than 30,000 laparoscopic hysterectomies [4, 32, 33, 35].

Minor complication rates occurring after LSH are lower (0.25–1.35 %), including bladder incision (0.1–0.25 %), iatrogenic adenomyosis (0–0.56 %) and ileus (0.5 %) [11, 24, 25, 31, 33].

There are several reasons for the conversion of laparoscopic hysterectomies. Uterine size, weight and lack of mobility are clearly limiting factors for laparoscopic surgery, resulting in limited vision available during laparoscopy and higher rates of conversion [26]. Other risk factors are previous gynecological operations [4]. the close proximity of myomas to the cervix or the lateral wall of the pelvis has also made conversion necessary [26], technical difficulties caused

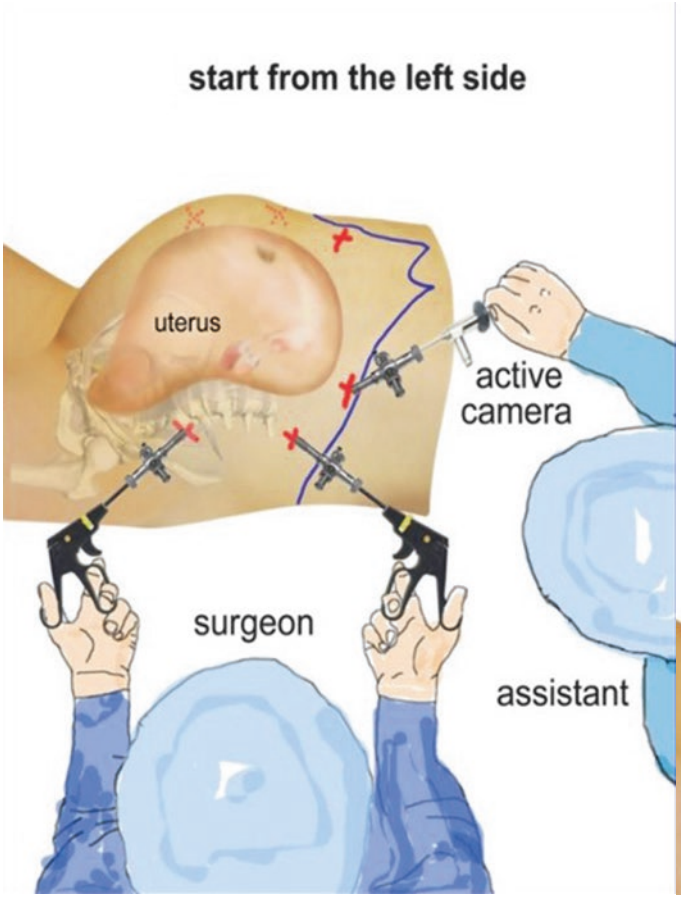


Fig. 32.28 Change Over Technique – Start of parameterization on the left side

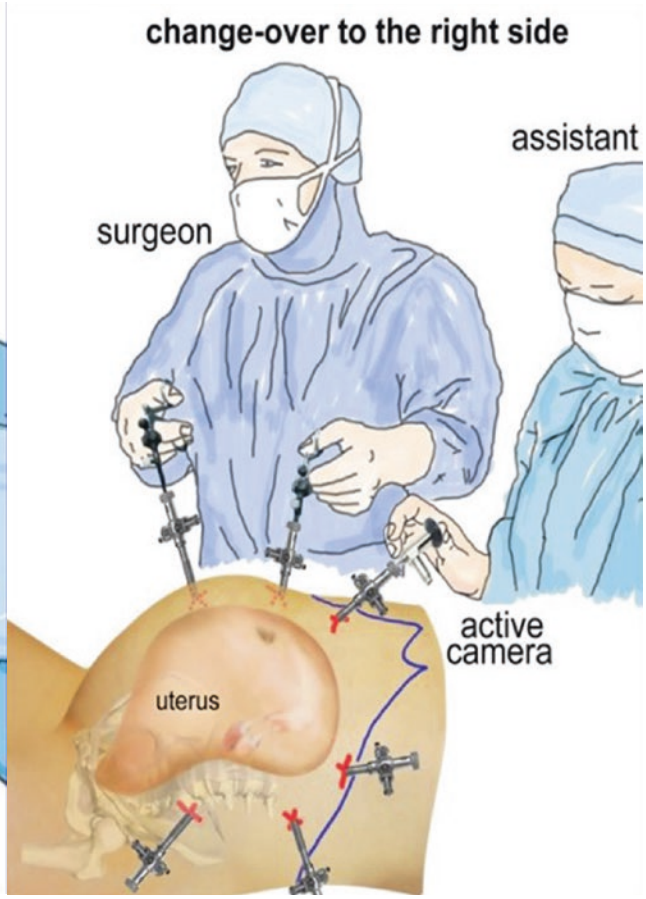


Fig. 32.29 Change Over Technique – Operation team changes side. Continuation of parameterization on the right side

by adhesions, difficulty in controlling intraoperative bleeding, or the repair of a complication [33]. Endometriosis is a major challenge to the surgeon [36], and should be completely resected, as further surgery might otherwise become necessary [37].

Further interventions needed due to postoperative complications include postoperative abdominal pain due to adhesions [4]. Other causes of postoperative complications are infections of the cervical stump and of the incision sites [4]. Conservative treatment with antibiotics is indicated.

Remnants of uterine myoma left in the abdominal cavity after morcellation [38] can be rare postoperative complications leading to unclear persisting abdominal pain.

Performed by skilled, experienced surgeons, laparoscopic hysterectomy is a safe procedure resulting in very low rates of complication [35]. Various studies have shown that low complication rates correspond to the level of experience of the surgeons involved, whereas high complication rates observed in other studies are not the result of the technique itself but rather lack of experience. The laparoscopic technique requires a high level of expertise with a learning curve of 30 operations to significantly decrease operating time and complication rates [39].

Conclusion

Minimal morbidity and an equally low complication rate are typically associated with LSH. The majority of complications associated with a hysterectomy are bladder and ureteral lesions and vaginal stump infections. These risks can be reduced significantly as the cervix is conserved, which is reflected in lower surgical morbidity and fewer postoperative complications.

The rate of postoperative complications is lower, hospital stays are shorter, patients recover more quickly and return to normal activity and work after a shorter convalescence compared to abdominal or vaginal hysterectomy. The procedure therefore appears to be beneficial to

patients [37, 40–43]. In addition, a comparison to total laparoscopic hysterectomy shows that LSH has a remarkably lower major complication rate [25]. Furthermore, the use of reusable laparoscopic instruments reduces the total cost of the procedure [44].

References

1. Hucke J, DeBruyne F, Wangsatimur BR, Campo RL. Surgical hysteroscopy. Gynäkologie. 1993;26:338–45.
2. Mettler L. Endoskopische Abdominalchirurgie in der Gynäkologie. Stuttgart: Schattauer; 2002.
3. Semm K. Total ablation of uterine mucosa (TUMA) – CURT instead of endometrium ablation. Geburtshilfe Frauenheilkd. 1992;52:773–7.
4. Bojahr B, Raatz D, Schonleber G, Abri C, Ohlinger R. Perioperative complication rate in 1706 patients after a standardized laparoscopic supracervical hysterectomy technique. J Minim Invasive Gynecol. 2006;13:183–9.
5. Kilkku P, Grönroos M, Hirvonen T, Rauramo L. Supravaginal uterine amputation vs. hysterectomy. Effects on libido and orgasm. Acta Obstet Gynecol Scand. 1983;62(2):147–52.
6. Thomas B, Magos A. Subtotal hysterectomy and myomectomy – Vaginally. Best Pract Res Clin Obstet Gynaecol. 2010;25(2):133–52. doi:10.1016/j.bpobgyn.2010.11.003.
7. Vervest HA, de Jonge M K, TM V, JW B, AA H. Micturition symptoms and urinary incontinence after non-radical hysterectomy. Acta Obstet Gynecol Scand. 1988;67(2):141–6.
8. Gimbel H. Total or subtotal hysterectomy for benign uterine disease? A meta-analysis. Acta Obstet Gynecol Scand. 2007;86:133–44.
9. Learman LA, Summit Jr RL, Varner RE, et al. A randomized comparison of total or supracervical hysterectomy: surgical complications and clinical outcomes. Obstet Gynecol. 2003;102:453–62.
10. Pasic R, Abdelmonem A, Levine R. Comparison of cervical detachment using monopolar lap loop ligature and conventional methods in laparoscopic supracervical hysterectomy. JSLS. 2006;10:226–30.
11. Donnez O, Jadoul P, Squifflet J, Donnez J. A series of 3190 laparoscopic hysterectomies for benign disease from 1990 to 2006: evaluation of complications compared with vaginal and abdominal procedures. BJOG. 2009;116:492–500.
12. Giep BN, Giep HN, Hubert HB. Comparison of minimally invasive surgical approaches for hysterectomy at a community hospital: robotic-assisted laparoscopic hysterectomy, laparoscopic-assisted vaginal hysterectomy and laparoscopic supracervical hysterectomy. J Robot Surg. 2010;4(3):167–75.
13. Tchartchian G, Dietzel J, Bojahr B, et al. No more abdominal hysterectomy for myomata using a new minimally-invasice technique. Int J Surg Case Rep. 2010;1(1):7–8.
14. Tchartchian G. Laparoscopic combined hysterectomy using the "Change Over Technique" for very large uterine myomata. In: Schollmeyer T, Mettler L, Rüther D, Alkatout I, editors. Practical manual for laparoscopic and hysteroscopic gynecological surgery. 2nd ed. New Delhi: Jaypee Brothers Medical Publishers; 2013. p. 337–41.
15. Dicker RC, Greenspan JR, Strauss LT, et al. Complications of abdominal and vaginal hysterectomy among women of reproductive age in the United States. The Collaborative Review of Sterilization. Am J Obstet Gynecol. 1982;144(7):841–8.
16. Härkki-Siren P, Sjöberg J. Evaluation and the learning curve of the first one hundred laparoscopic hysterectomies. Acta Obstet Gynecol Scand. 1995;74(8):638–41.
17. Wang PH, Lee WL, Yuan CC, et al. Major complications of operative and diagnostic laparoscopy for gynecologic disease. J Am Assoc Gynecol Laparosc. 2001;8(1):68–73.
18. Daraï E, Soriano D, Kimata P, et al. Vaginal hysterectomy for enlarged uteri, with or without laparoscopic assistance: randomized study. Obstet Gynecol. 2001;97(5 Pt 1):712–6.
19. Sarmini OR, Lefholz K, Froeschke HP. A comparison of laparoscopic supracervical hysterectomy and total abdominal hysterectomy outcomes. J Minim Invasive Gynecol. 2005;12:121–4.
20. Buchele B. Retrospective analysis of 195 laparoscopic supracervical hysterectomies. J Am Assoc Gynecol Laparosc. 2004;11(suppl):S22.
21. Fiaccavento A, Landi S, Barbieri F, et al. Total laparoscopic hysterectomy in cases of very large uteri: a retrospective comparative study. J Minim Invasive Gynecol. 2007;14:559–63.
22. Hoffman CP, Kennedy J, Borschel L, et al. Laparoscopic hysterectomy: the Kaiser Permanente San Diego experience. J Minim Invasive Gynecol. 2005;12:16–24.
23. Johnson N, Barlow D, Lethaby A, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2006;19:CD003677.
24. Garry R, Fountain J, Mason S, Hawe J, Napp V, Abbott J, et al. The eVALuate study: two parallel randomized trials, one comparing laparoscopic with abdominal hysterectomy, the other comparing laparoscopic with vaginal hysterectomy. BMJ. 2004;328:1229–36.
25. Cipullo L, De Paoli S, Fasolino L, Fasolino A. Laparoscopic supracervical Hysterectomy Compared to Total Hysterectomy. JSLS. 2009;13:370–5.
26. Bojahr B, Tchartchian G, Ohlinger R. Laparoscopic Supracervical Hysterectomy: a Retrospective Analysis of 1000 Cases. JSLS. 2009;13:129–34.
27. Lyons TL. Laparoscopic supracervical versus total hysterectomy. J Minim Invasive Gynecol. 2007;14:275–7.
28. Härkki-Siren P, Sjöberg J, Tiitinen A. Urinary tract injuries after hysterectomy. Obstet Gynecol. 1998;9:113–8.
29. Jelovsek JE, Chiung C, Chen G, et al. Incidence of lower urinary tract injury at the time of total laparoscopic hysterectomy. JSLS. 2007;11:422–7.
30. Johns A. Supracervical versus total hysterectomy. Clin Obstet Gynecol. 1997;40:903–13.
31. Richards SR, Simpkins S. Laparoscopic supracervical hysterectomy versus laparoscopic-assisted vaginal hysterectomy. J Am Assor Gynecol Laparosc. 1995;2:431–5.
32. Brummer TH, Seppälä TT, Härkki PS. National learning curve for laparoscopic hysterectomy and trends in hysterectomy in Finland 2000–2005. Hum Reprod. 2008;23:840–5.
33. Harmanli OH, Tunitsky E, Esin S. A comparison of short-term outcomes between laparoscopic supracervical and total hysterectomy. Am J Obstet Gynecol. 2009;201:536.e1–7.
34. Karaman Y, Bingol M, Günenc Z. Prevention of complications in laparoscopic hysterectomy: experience with 1120 cases performed by a single surgeon. J Minim Invasive Gynecol. 2007;14:78–84.
35. Donnez O, Donnez J. A series of 400 laparoscopic hysterectomies for benign disease: a single centre, single surgeon prospective study of complications confirming previous retrospective study. BJOG. 2010;117:752–5.
36. Lyons TL, Adolph AJ, Winer WK. Laparoscopic supracervical hysterectomy for the large uterus. J Am Assoc Gynecol Laparosc. 2004;11(2):170–4.
37. Okaro EO, Jones KD, Sutton C. Long term outcome following laparoscopic supracervical hysterectomy. BJOG. 2001;108:1017–20.
38. Hutchins FLJ, Reinoehl EM. Retained myoma after laparoscopic supracervical hysterectomy with morcellation. J Am Assoc Gynecol Laparosc. 1998;5:293–5.
39. Ghomi A, Littman P, Prasad A, Einarsson JI. Assessing the learning curve for laparoscopic supracervical hysterectomy. JSLS. 2007;11(2):190–4.

40. Lyons TL. Laparoscopic supracervical hysterectomy. Obstet Gynecol Clin North Am. 2000;27:441–50.
41. Mettler L, Semm K, Lehmann-Willenbrock L, Shah A, et al. Comparative evaluation of classical intrafascial-supracervical hysterectomy (CISH) with transuterine mucosal resection as performed by pelviscopy and laparotomy – our first 200 cases. Surg Endosc. 1995;33:448–53.
42. Mettler L. Long-term results in the treatment of menorrhagia and hypermenorrhea with a thermal balloon endometrial ablation technique. JSLS. 2002;6:305–9.
43. Reich H, McGlynn F, Sekal L. Total laparoscopic hysterectomy. Gynecol Endosc. 1993;2:59–63.
44. Mettler L, Ahmed-Ebbiary N, Schollmeyer T. Laparoscopic hysterectomy: Challenges and limitations. Minim Invasive Ther Allied Technol. 2005;14(3):145–59.

Laparoscopic Supracervical Hysterectomy for Large Uteri

33

Funlayo Odejinmi and Reeba Oliver

Introduction

Routes of Hysterectomy

The routes of hysterectomy have evolved since ancient times. The first vaginal hysterectomy was performed by Soranus of Ephesus around AD 120 and employment of the vaginal route to remove the uterus continued through the medieval times. The next advance in an alternative route occurred in 1843 when Charles Clay performed the first abdominal hysterectomy in Manchester, England [1]. It was only in 1988 after the advent of modern endoscopic techniques, did the route of hysterectomies evolve again. Harry Reich performed the first laparoscopic hysterectomy in Pennsylvania [1]. Since then, the challenge has always been to push the boundaries of endoscopic surgery to achieve removal of the uterus for all women within the remits of surgical safety.

Once the decision is undertaken that a woman needs a hysterectomy, the route of the hysterectomy is the next debatable issue that is taken into consideration. The decision about the route depends on the patient characteristics, indication for hysterectomy, extrauterine pathology and size of the uterus. Recent reviews comparing routes of hysterectomy suggest that vaginal hysterectomy is the preferred route for hysterectomy for benign conditions and where vaginal hysterectomy is not possible, laparoscopic hysterectomy may avoid the need for an abdominal procedure necessitating a laparotomy [2].

Many perceived barriers to laparoscopic hysterectomy have been identified. The size of the uterus is considered to be a limiting factor to performing most hysterectomies endoscopically. Traditionally the large uterus was exclusively extirpated by the abdominal route, often by a midline incision [3] with the associated risk of infective complications [4].

For the vaginal route, randomised trials have shown that large uteri can be removed vaginallywith no added complications and reduced length of hospital stay [5]. This however requires a higher level of expertise, and even then uterine size has often been cited as a limiting factor and increases the rate of conversion to laparotomy particularly when the vagina is narrow. The use of GnRH analogues to reduce the size of the uterus to allow for vaginal hysterectomy has been advocated [6]. However, the use of GnRH analogues can be associated with unwanted side effects. Thus where vaginal hysterectomy is not possible, and if possible, the laparoscopic approach should be used in order tos avoid abdominal hysterectomy. Randomized trials have shown the benefits of laparoscopic hysterectomy over open abdominal hysterectomy [7].

With the advent of new modern alternatives to the management of menorrhagia such as endometrial ablations and Mirena IUS, most hysterectomies are no longer on “normal sized” uteri. However for the large uterus whatever route is used, uterine size remains a bastion to conquer for the generalist gynaecologist and is often a reason for conversion to abdominal hysterectomy.

Supracervical Hysterectomy

The laparoscopic supracervical hysterectomy (LSH) has become a well-established and proven safe procedure [8] since first described by Semm [9]. It has evolved into an alternative to other forms of hysterectomy, with good short and long term outcomes [10] and patient satisfaction [11]. In some countries up to 40 % of hysterectomies are now performed supracervically [12]. In the absence of the need to remove the cervix for the normal sized uterus it has been shown that the LSH is associated with shorter operating time, less blood loss and less postoperative febrile episodes [13, 14].

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Although LSH enables the removal of a large uterus laparoscopically with the obvious patient benefits, it has not been without its detractors. There is a perceived risk of developing cervical cancer in the residual cervix necessitating further surgery. But in developed countries where there is cervical screening, the risk of cervical cancer is very low if women do not default from screening programmes. Thus if there is no clinical reason to remove the cervix, LSH with its advantages is an alternative to laparotomy especially in women with high BMI. Again there is the potential risk of leiomyosarcoma. This risk is associated with the morcellation process with the morcellation process. Despite this, current evidence suggests that LSH is a safe and appropriate procedure for the management of benign gynaecological disease. Emphasis should be placed on patient information to aid an informed decision and further diagnostic assessments to allow earlier detection of occult malignancy (see unexpected malignancy).

There are no studies that have looked at long term outcome of women who have had LSH for large uteri. In women with normal uteri, though quality of life in the short term may be better when compared to TLH there is a slightly increased risk of stump haematoma, which can be overcome by careful haemostasis and laparoscopically over-sewing the cervical stump.

In the long term there is an increased risk of spotting. In the series by Tchartchain and colleagues looking at vaginal spotting after LSH they found that vaginal bleeding post procedure can result in a decrease in quality of life. However for myomatous uteri there was no statistical difference in patient satisfaction when compared to women who had LSH for other indications [15]. In the series by Lieng and colleagues 7 % of their cohort went on to have removal of the cervical stump for continued bleeding [16]. The size of the uteri in their cohort was however not specified.

With the advancement of technologies; better laparoscopes, optical systems, endoscopic instruments, vessel sealing technologies and tissue morcellation, it has become possible to push the boundaries of laparoscopic supracervical hysterectomy (LSH). It is now possible not only to perform this procedure in the large uterus but also in the larger patient [17]. Most observational studies demonstrate that LSH for the large uterus is not only feasible but offers a procedure with no added morbidity or complications with good patient satisfaction.

The Large Uterus

There are inconsistencies in literature as what constitutes a large uterus. The uterus was considered large at 280 g but this was the definition used for cut-off for vaginal hysterectomy [18]. With a laparoscope and full visualization of the pelvis a large uterus can be defined as one that extends to or beyond the true pelvis, thus extending above the sacral promontory. In an average sized woman this landmark will extend midway between the pubic symphysis and the umbilicus, equivalent to a 20 week sized fetus or weigh 500 g (Fig. 33.1).

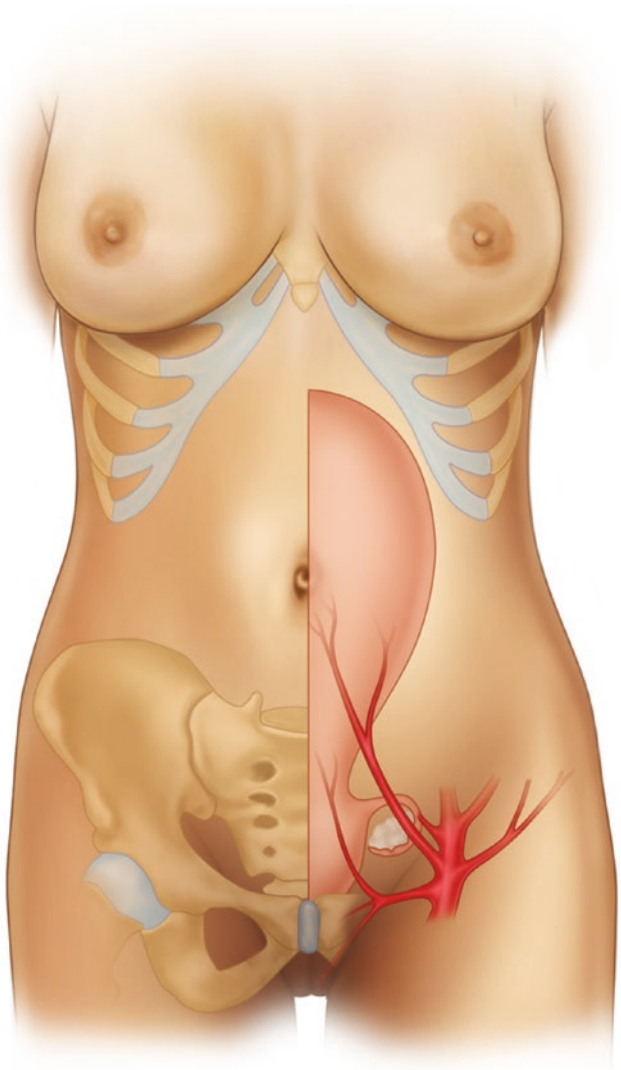


Fig. 33.1 Schematic diagram of a large uterus. Figure 33.1 shows the position of the enlarged uterus in relation to the bony pelvis (Courtesy of Catherine Woodman, BA (Hons))

LSH in Uterus Over 500 g: The Evidence

There have been no randomised studies with outcomes comparing LSH in women with uteri over 500 g with other forms of hysterectomy, thus outcomes can only be extrapolated from observational studies.

In the earliest large series on LSH for large uteri reported by Lyons and colleagues, 67 % of women had uteri larger than 500 g [19]. Alperin and colleagues later published a series of 333 women with uteri larger than 500 g who underwent LSH for large uteri and compared the outcome

with 113 women who underwent total laparoscopic hysterectomy (TLH) for uteri larger than 500 g (mean weight 786 g) and found that LSH was associated with a significantly lower operating time than TLH in this group of patients. Additionally, their conversion rate was low and not related to uterine size [3].

In the series by Maclaran et al. where 33 women had a uterine weight of over 600 g, there were no conversions to laparotomy. They found that a combination of elevated BMI and enlarged uterus resulted in 94 % increase in blood loss and 66 % increase in operation duration compared to those with normal weight and uterine size less than 300 g [20]. But in spite of the above, there were no increase in hospital stay or morbidity. Hussain and colleagues in a series of 88 patients undergoing laparoscopic hysterectomy found that with the larger uterus there is significantly more blood loss and longer operating time. Most of the operative time was put down to the added time needed for morcellation. However there was no difference in the length of stay of the patients [17].

In the series of 1584 women by Grosse-Dreiling et al. though there is no data on the sizes of the uteri, the overall conversion rate was 0.88 %. Of the 14 patients that needed conversion to laparotomy, 3 had uteri greater than 850 g and conversions were due to uncontrollable bleeding attributed to uterine size. Uterine size alone contributed to only 20 % of the conversions [21].

In the series of 1000 LSH procedures reported by Bojahr and colleagues of which 68 had uteri weighing 500 g or more, there were 4 conversions in patients with increased uterine weight. The average uterine weight in this group was 976 g, the lightest uterus was 750 g, and the heaviest was 1185 g. The authors note that the conversion to laparotomy was not due to the size alone but the lack of uterine mobility, closeness of myomas to the cervix or the lateral wall of the pelvis [22]. This group again reported on a series of 1952 LSH procedures of which 8.6 % weighed more than 500 g. In this series the overall conversion rate was 0.82 % with 71 % of those conversions due to access related to uterine size [23].

Twijnstra and colleagues reviewing the literature on laparoscopic hysterectomy conversion rates, found that LSH can reduce conversion rates compared to TLH 3 fold, but uteri weighing 500 g or more could increase conversion rates 30 fold [24]. With the large uterus it could be argued that size *per se* is not the limiting factor but rather the shape of the uterus as it is in the TLH procedure [25]. The difficulty in completing the procedure is dependent on the limited pelvic space and the often tortuous and enlarged uterine vessels. Another major factor is the distortion of anatomy caused by uterine fibroids, with conversions to laparotomy being influenced by lower segment or broad ligament fibroids [3]. The mobility of the uterus is also often limited [26]. Access to the cervix and or uterine arteries can be restricted by the presence of fibroids and the approach will depend on the exact location of the fibroids in relation to these structures. Thus irrespective of the definition used, the most important factor in performing a supracervical hysterectomy for the large uterus is access to the uterine vessels and the cervix in order to transect it at the isthmus. Nimaroff and colleagues advised a combined technique of laparoscopic supracervical amputation followed by trachelectomy to enable laparoscopic removal of large uteri weighing more than 450 g [27].

Optimizing the Surgical Outcome

Whatever the route or type of hysterectomy the ideal procedure is one that allows for the procedure to be completed successfully with the least morbidity, fewest complications, allows early recovery and has good patient satisfaction.

Patient Selection

It is thus important that patients are chosen carefully in order to meet these objectives. For the large uterus and in the large patient, recent literature dictates that not only is this a safe procedure and feasible, but it also has good outcomes and satisfaction rates. There have been no studies looking at selection and pre-operative criteria for large uteri for LSH. There have been studies to predict the weight of the uterus using ultrasound or MRI (Fig. 33.2) and comparing this to bimanual examination of the uterus [28]. And though formulae have been developed

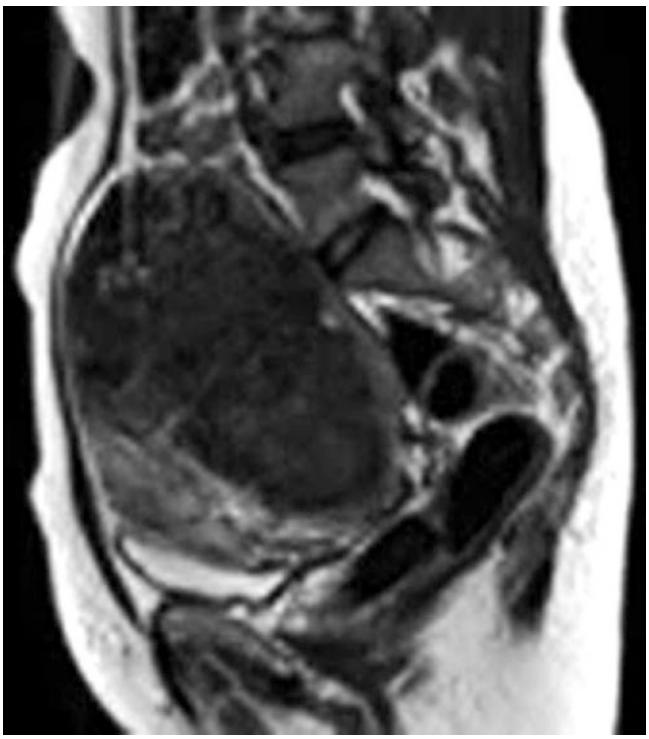


Fig. 33.2 MRI scan of a large fibroid. Figure 33.2 shows a MRI scan of a large fibroid uterus extending out of the true pelvis

to help with the prediction [29], and can be helpful in the evaluation and counseling of the patient as long as there is space to insert the laparoscope beyond the upper margin of the uterus, there is always the possibility of being able to perform the procedure laparoscopically [26].

Counseling the Patient

As with all gynaecological procedures adequate counseling of the patient prior to procedure is necessary. The LSH is associated with reduced hospital stay compared to other forms of hysterectomy and earlier recovery and resumption of intercourse [19]. However, long term sequellae such as spotting and the need for further intervention is increased with subtotal hysterectomy [11].

Though there are no specific studies looking at these issues specifically for large uteri, counseling should also be along the lines of LSH for normal uteri.

There is also the issue of morcellation and the risk of upgrading occult leiomyosarcoma that needs to be discussed with the patients. Clear and written guidelines need to be provided.

Theatre Set Up

The theatre set up is essentially the same as for a standard LSH. It is important that all members of staff are aware of their roles and those responsible for use of modern energy sources are aware of how to trouble-shoot when things go wrong.

As with all forms of laparoscopic surgery that can take over 2 h there is a need to ensure that the patient is warm and adequate anticoagulation measures are taken to prevent thrombosis. The patient will be in the Trendelenberg position for a considerable amount of time and on occasions the angle needed may be quite steep, measures should be used to prevent the patient slipping caudally and to prevent nerve injury.

Patient Habitus

The ideal habitus for a patient for LSH would be one with a "roomy" pelvis that allows visualization of the sides of the uterus and pedicles. There is an increase in obesity in society and this need to be taken into consideration. Performing LSH on the larger patient is not only feasible but safe [17]. Although with the larger patient there is an increased operating time and blood loss [20], this however does not affect the length of hospital stay post operation.

Surgical Technique

The surgical technique of LSH in a large uterus follows that of routine LSH, but with certain modifications to accommodate the distortion in size, shape and lack of access.

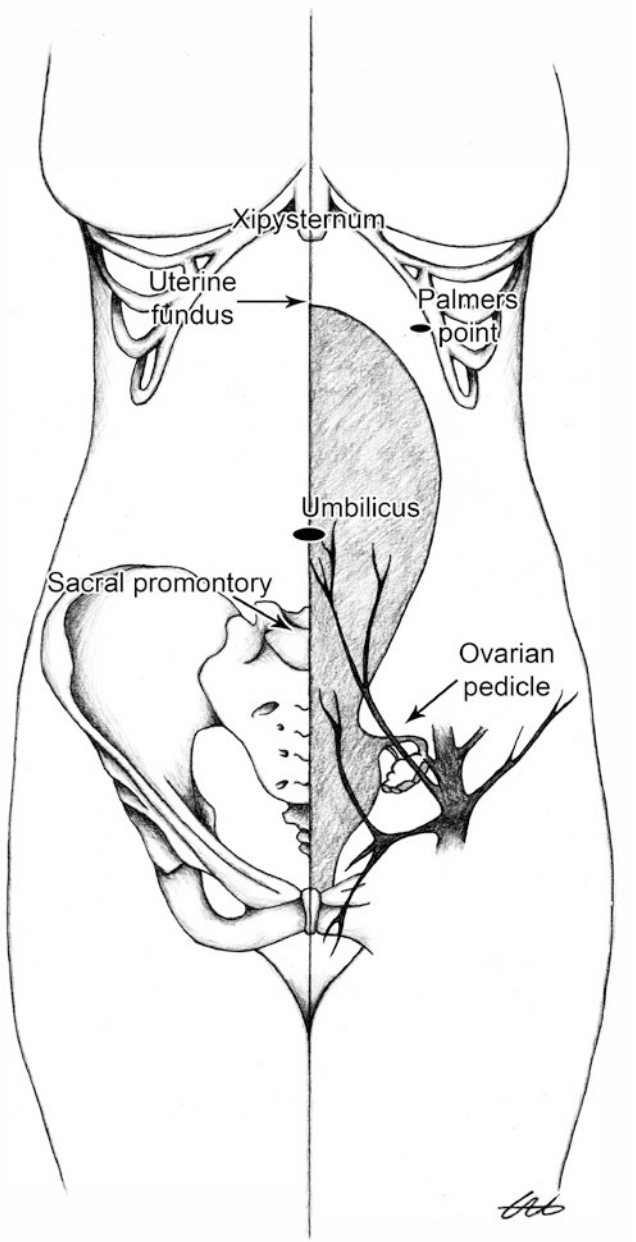


Fig. 33.3 Anterior abdominal landmarks. Figure 33.3 shows the important laparoscopic landmarks of the anterior abdominal wall (Courtesy of Catherine Woodman, BA (Hons))

Land Marks

It is pertinent to be aware of the anatomical landmarks of the whole of the abdominal cavity as the enlarged uterus could rise up to the xiphisternum. Additionally the primary trocar site might have to be varied due to the uterus taking up most of the central abdominal space, and other sites such as the Palmer's point will have to be used (Fig. 33.3). The most important land mark irrespective of the entry point is the ability to visualize both the sides of the uterus below the ovarian pedicles and the neck of the cervix anteriorly and posteriorly.

LSH of a Tall Globular Uterus

The tall globular uterus, as is usually seen with a fundal fibroid, usually does not limit access to the pedicles. The procedure is usually straightforward and follows the routine steps of a LSH (Fig. 33.4).

The procedure begins with placing the ports to allow visualization of the fundus of the uterus as well as the anterior and posterior pouches. This is usually achieved by good manipulation to lift the bulk of the uterus out of the pelvis, and using instruments placed in other available ports for traction and counter traction. It should be remembered that due to the myomas, the uterus may be rotated off its natural axis and therefore every effort should be made to restore this axis as this will allow for exposure of the pedicles.

Because of possible distortion of anatomy which ever pedicle is cephalad, and accessible should be dealt with first followed by the others in descending order until the uterine vessels become visible. Maintenance of strict haemostasis during the preparation and transection of the pedicles is the key to success.

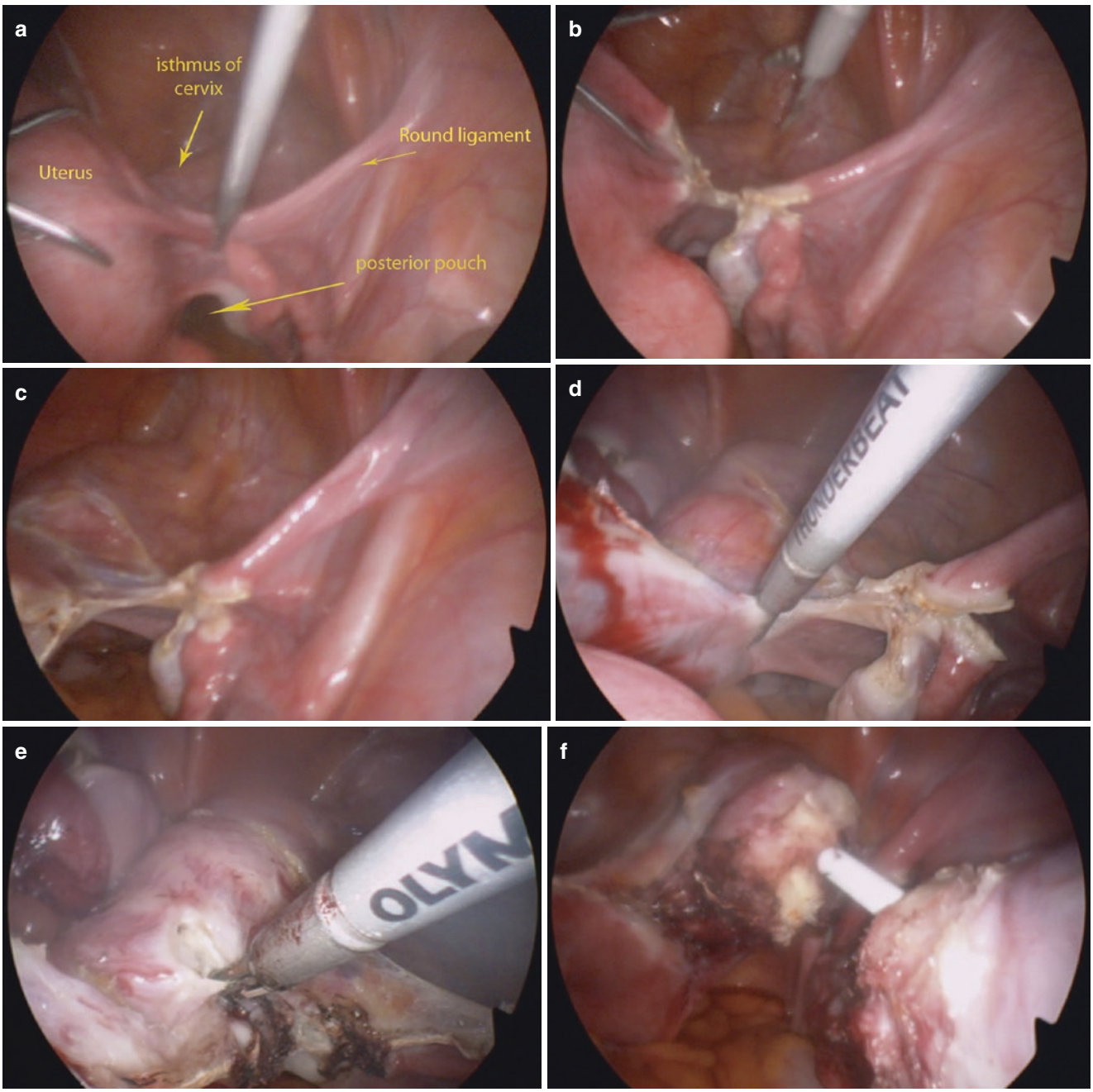


Fig. 33.4 Sequence steps for lash. (**a**) Transection of the broad ligament. (**b**) Transection of the ovarian ligament. (**c**) Skeletisation of the uterine vasculature. (**d**) Transection of the uterine vasculature. (**e**) Transection of the cervix and (**f**) Complete transection of the cervix

Once the adnexal pedicles have been dealt with the bladder flap is then developed to enable the bladder to be dissected and pushed caudally. Care should be taken again if there are uterine fibroids in the lower segment as they may obscure the upper limit of the bladder leading to bladder injury during dissection. The same is true with the presence of adhesions which may be as a result of previous/multiple caesarean sections. Once the bladder flap is developed and the uterine pedicles are exposed the uterine vessels are coagulated and transected either with the use of traditional bipolar instruments and scissors, or with more modern energy sources. It should be remembered that the vessels can be large and multiple thus whilst coagulated it is best not to have the vessels under tension. Where possible the vessels should be approached perpendicular to angle of the uterus as this will prevent shearing during the process of coagulation and transection.

The next step is transection of the cervix as with normal sized uteri. This can be achieved by the use of preformed loops, however it may be difficult to place the loop around and over the fundus of the uterus due to uterine bulk. If this is the case energy sources with a cutting modality can be used to transect the cervix.

Surgical Challenges

Performing a LSH for a large distorted uterus is a very challenging procedure. The technical challenges are specific and can be overcome with the right techniques.

Surgical Challenges for Performing LSH for Large Uteri

The surgical challenges can be summarized as follows:

Distortion due to enlarged uterine size
Distortion due to altered uterine shape
Restricted uterine mobility and limitation of access to structures

Distortion Due to Enlarged Uterine Size

Such a distortion, as it is mostly in the fundus due to fundal fibroids or a uterus enlarged without anatomical distortion as seen in adenomyosis, should afford relatively easy access to the uterine pedicles and to the uterocervical angle for transaction (Fig. 33.5).

Distortion Due to Altered Uterine Shape

Frequently the surgical challenge would be a uterus which is not enlarged in the cranio-caudal axis, but is distorted due to fibroids in the lower segment (Fig. 33.6). Such procedures are technically more challenging and might necessitate myomectomy prior to LSH to facilitate access.

Restricted Uterine Mobility and Limitation of Access

Access to the uterine sides, especially at the utero-cervical junction is paramount as without which the surgery cannot be successfully completed.

Figure 33.7 illustrates the loss of space and limited access which has been restored with good uterine manipulation.

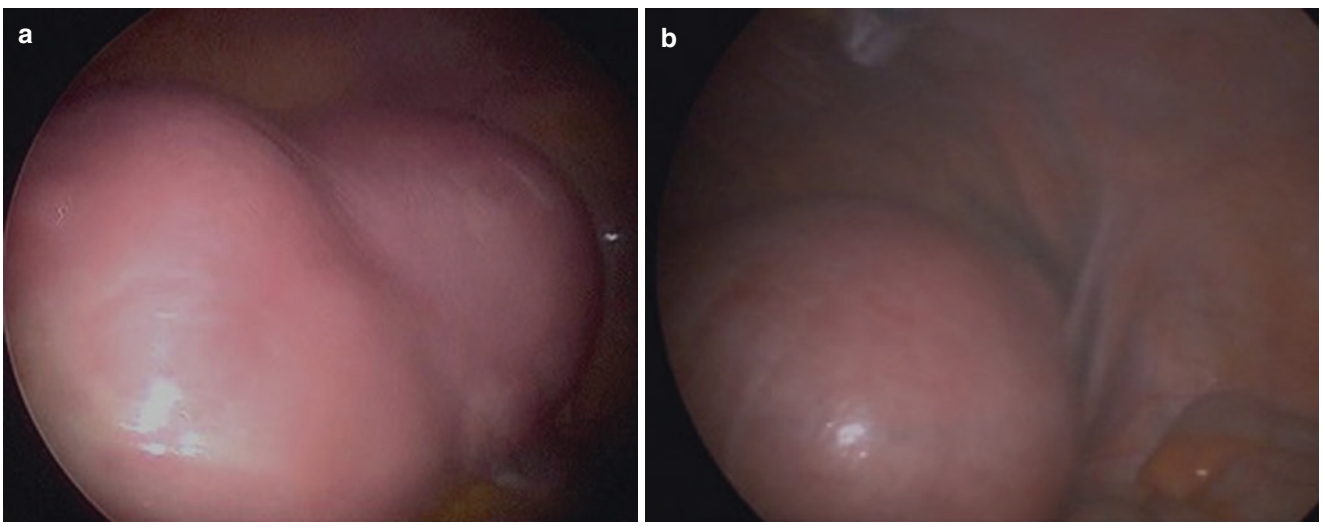


Fig. 33.5 Fundal/non distorted expansion of the uterus. (**a**) Shows uterine enlargement due to adenomyosis and (**b**) shows expansion of the uterine fundus due to fibroids

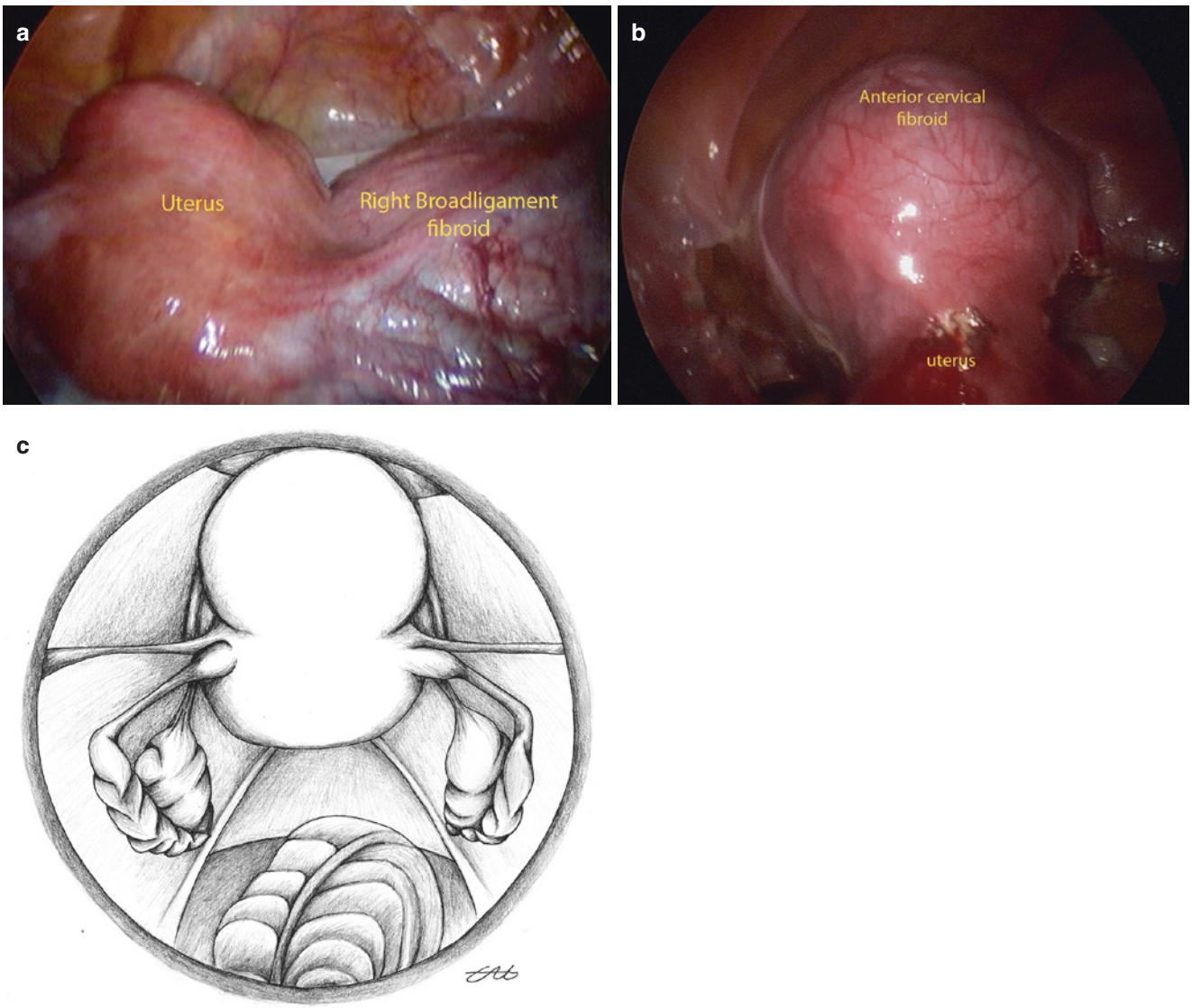


Fig. 33.6 Distortion of the lower segment of the uterus. (**a**) Shows the lower segment of the uterus distorted due to a large broad ligament fibroid and (**b**) shows expansion of the lower segment due to a large cervical fibroid. (**c**) Shows the schematic diagram of the anterior fibroid ((**c**) Courtesy of Catherine Woodman, BA (Hons))

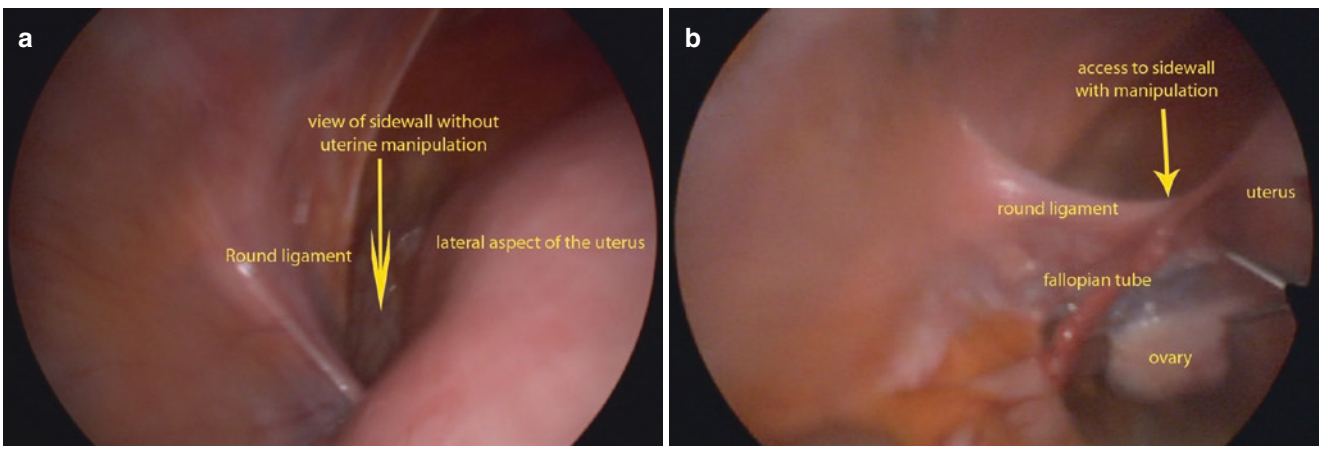


Fig. 33.7 Limited access to side wall structures due to the enlarged uterus. (**a**) Shows the restricted view of the side wall and (**b**) shows the posterior aspect of same uterus with good manipulation

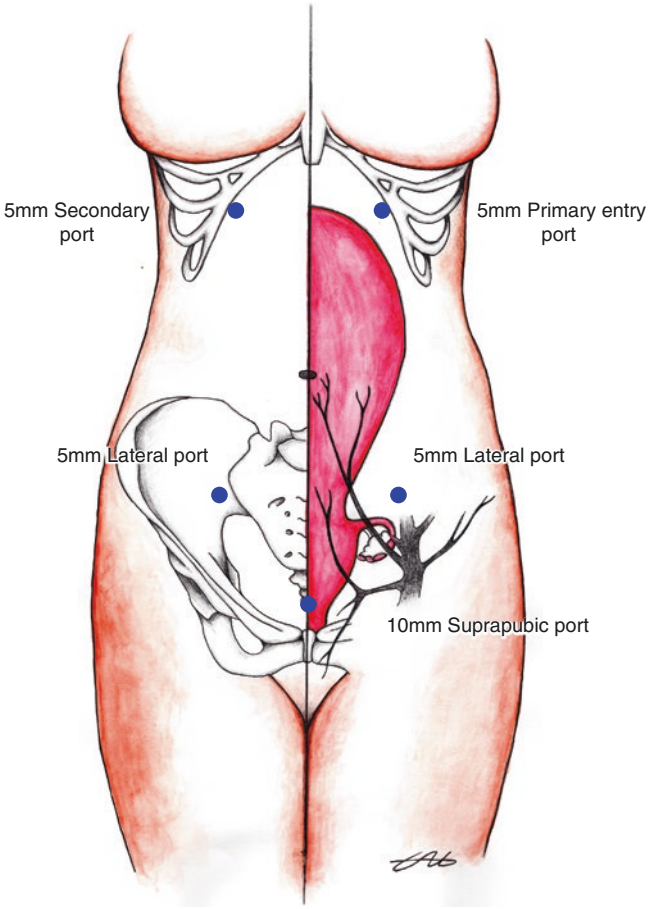


Fig. 33.8 Sites of potential port placements on the anterior abdominal wall. Figure 33.8 shows the possible port sites and the hazards to avoid (Courtesy of Catherine Woodman, BA (Hons))

Overcoming the Surgical Challenges

Most of the limitations for operating laparoscopically on the large uterus can be overcome by good surgical technique, the ability to suture laparoscopically and the use of modern sealing devices.

Port Placement and Utilization and Ergonometrics

In order to perform this procedure it is important to be able to visualize the pelvis (Fig. 33.8). Some surgeons place the entry port above the level of the uterus in the midline [30], this however does not provide complete visualization of both sides of the uterus and runs the risk of injury to the uterus. Shahid and colleagues describe a modified 5-port technique with the first port placed at palmers point and a second 5 mm trocar is placed in the contralateral hypochondrium. Two further ports are inserted in both iliac fossa above the ovarian pedicles. With this technique, though the operating time was longer for uteri greater than 500 g, it did not add to the length of stay of the patients (<500 g = 65 min, >500 g = 103 min, $P = 0.007$) [26].

Others have used 7 trocars with 10 mm tocars above the Bikini line. Though this technique provides adequate access it can have adverse cosmetic results and result in patient dissatisfaction [30, 31]. Some surgeons use a 30 ° laparoscope which provide better visibility into the pelvis [21].

Even when the primary trocar is inserted away from the top of the uterus it is important to remember that surgery is not always limited to that view. On occasion even where visualization of the uterine and ovarian pedicles may seem impossible from the palmers point view rotating to other ports may provide visibility to the pelvic side walls (Fig. 33.9). Thus a handy surgical tip would be to rotate the laparoscope through the different ports to find the best view for execution of the procedure.

Vessel Sealing

Traditionally bipolar technology was used to seal vessels. Currently with the explosion of technology in this area, there is an array of devices including ultrasound devices such as the harmonic scalpel and Ace™ (gynaecare) or Lotus™ (SRA Developments). Though these technologies seal vessels there is a limit to vessel size of about 7 mm and vessels for large uteri often exceed this limit. Hence care needs to be taken to adjust the devices accordingly. There are also "intelligent" sealing devices such as the Thunderbeat™ (Olympus Europa SE & CO) which combine ultrasound and bipolar technology. The Ligasure™ device (Covidien) can also be used with good effect. As these devices seal and cut they have the advantage of decreasing the need to use multiple instruments.

Though these devices can also transect the cervix, once the cervix has been prepared for transection, where available the Laploop™ (Roberts Surgical) or the preformed Linaloop™ (Lina medical) can be used.

Myomectomy Prior to LSH

If there are fibroids obstructing the access to the uterine vessels, then performing a laparoscopic myomectomy may be helpful to aid exposure (Fig. 33.10). It should be remembered that in countries where it is available, the use of Pitressin™ may help with haemostasis. Where it is not other methods of reducing haemostasis during myomectomy may be used [32]. Provided there is adequate space a myomectomy screw may also be used to aid traction and counter traction.

When access to the uterus is limited by the presence of fibroids obstructing vital structures, the decision would be either to perform the laparoscopic supracervical hysterectomy with the fibroids *in situ* or to remove the fibroids to obtain access to the uterine arteries and or the cervix.

Extrapolating from data comparing laparoscopic hysterectomy outcomes with those of myomectomy for the management of uterine fibroids, myomectomy prior to LSH may be associated with increased blood loss [33]. It is thus useful to use techniques to prevent blood loss during myomectomy if this approach is taken. Matsuoka and colleagues describe techniques to perform cervical myomectomy [34]. These techniques can be used to perform cervical myomectomy prior to performing a LSH. Broad ligament fibroids can also be

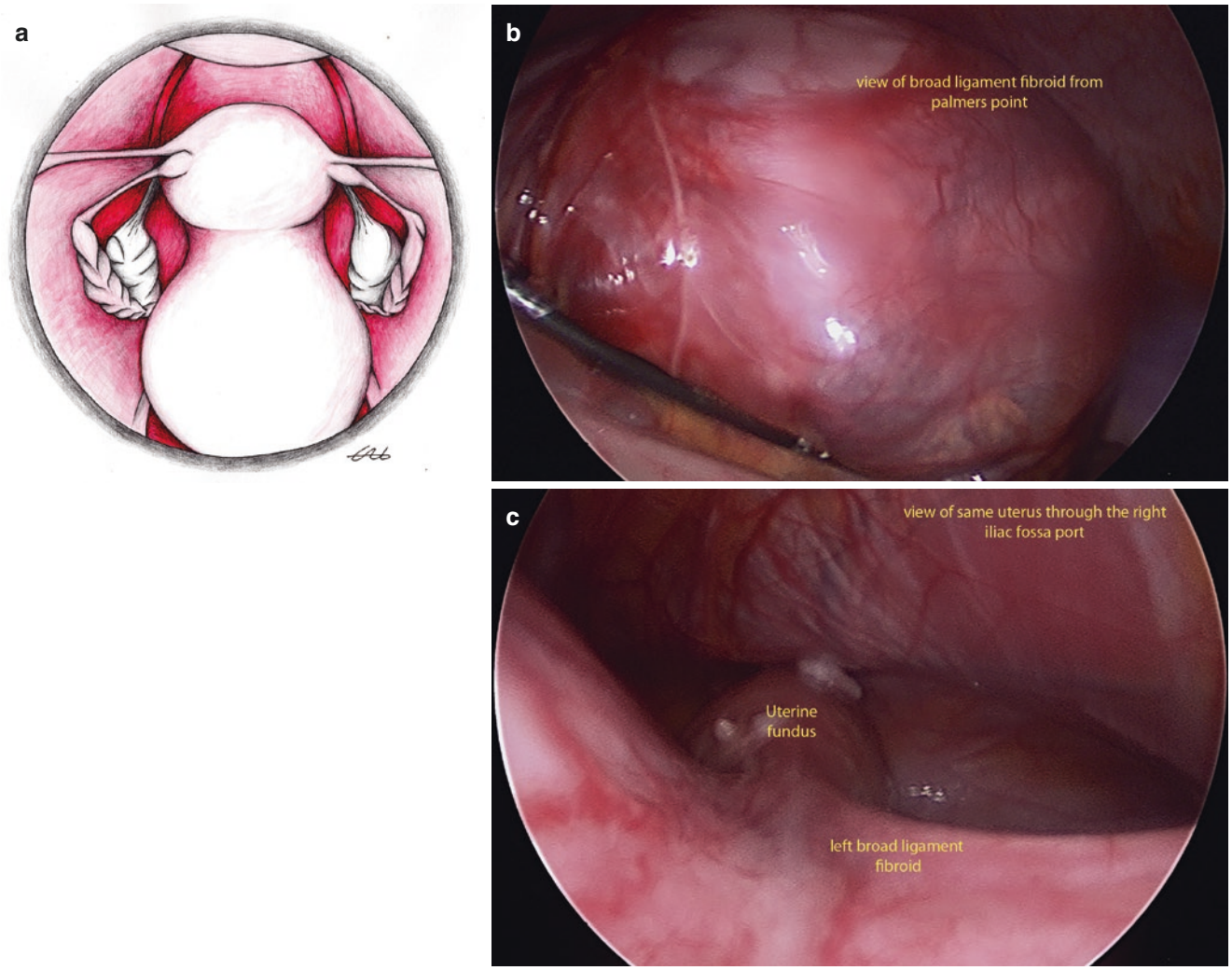


Fig. 33.9 Better identification of anatomy by varying the ports (**a**) shows the schematic diagram of a posterior fundal fibroid. (**b**) Shows view of large uterus from palmers point with fundal 10 cm fibroid and anterior 6 cm fibroid. (**c**) Shows better identification of anatomy with the view from the right lateral port showing the uterus and a broad ligament fibroid ((**a**) Courtesy of Catherine Woodman, BA (Hons))

removed safely with good surgical technique and port placement providing adequate exposure and vision [33, 35, 36].

Retroperitoneal Approach to Hysterectomy

In order to reduce bleeding the retroperitoneal approach to the uterine artery may be used [37]. This allows for the uterine artery to be coagulated and transected at its origin. Roman and colleagues applied this approach to 18 patients undergoing TLH with a mean uterine weight of 540 g [38]. Once the uterus is devascularised, multiple myomectomy may then be performed before the remainder of the procedure is performed. However this is often difficult if there is a broad ligament fibroid obscuring access to the pelvic sidewall (Fig. 33.11). In such cases the broad ligament fibroid will need to be removed before proceeding with the hysterectomy.

Use of Manipulators and Patient Positioning

There are numerous uterine manipulators on the market that facilitate the movement of the uterus. Most have a pivot and do not rely on the habitus of the patient. The important function when performing LSH for the large uterus would be the ability of the manipulator to move the uterus out of the pelvis exposing the posterior and anterior as well as the lateral aspects for the cervix. With low-lying fibroids this aids visualization of the contents of the lesser pelvis (see Fig. 33.7).

Raised Body Mass Index

Though studies have shown that LSH is feasible and safe in patients of high BMI [17], raised BMI has been shown to have adverse outcome on hysterectomy, though not so much for laparoscopic hysterectomy [39]. Paradoxically, it can be easier to perform LSH for the large uterus in larger patients. This is because of the ratio of uterine size to the available space within the patient. There is limited access and visibility when operating on the smaller patient, and this may lead to damage to adjacent organs [20].

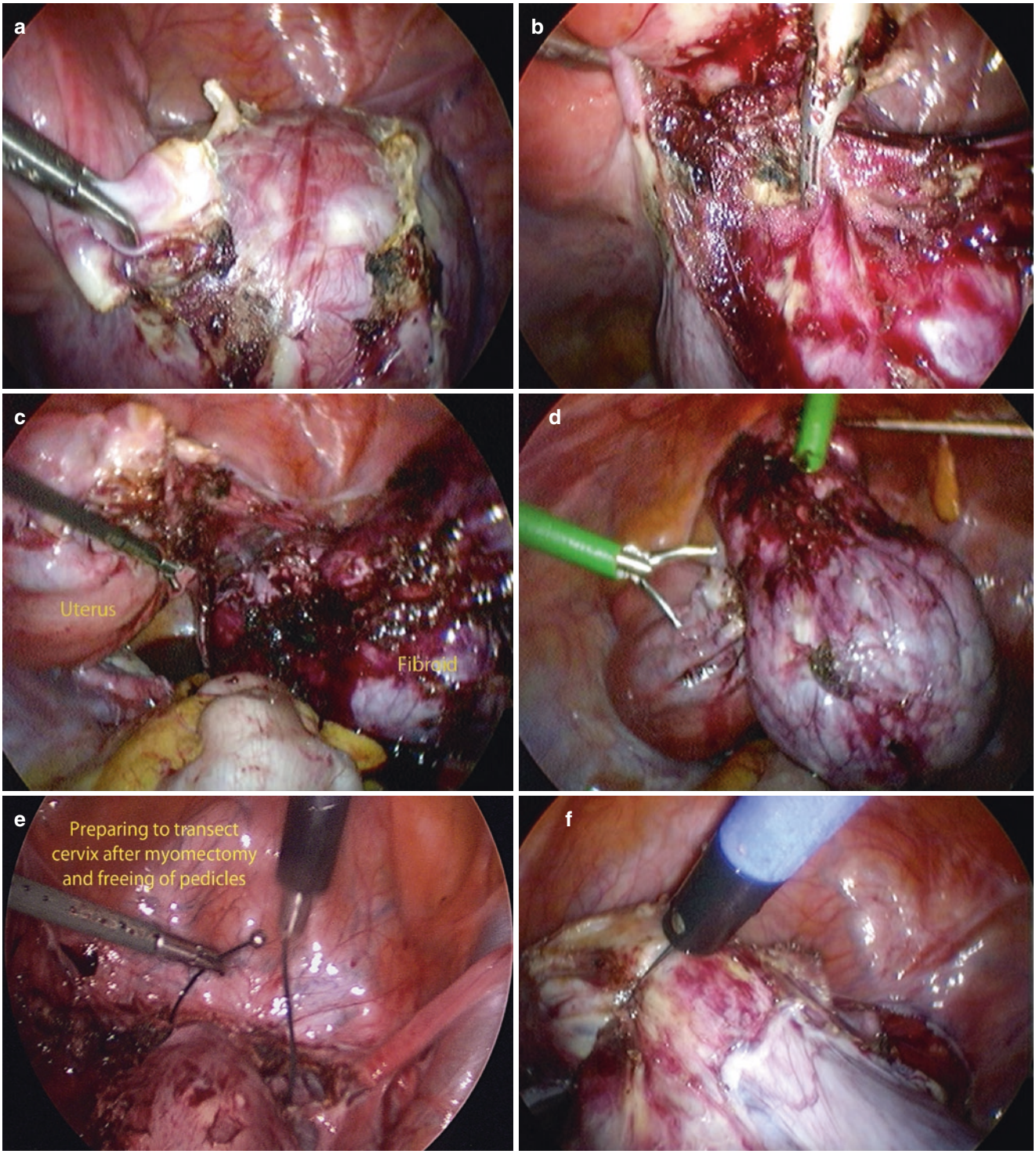


Fig. 33.10 Myomectomy being performed of the fundal 10 cm fibroid and anterior 6 cm fibroid shown in Fig. 33.8, prior to the LSH. (**a**) Reflection of the peritoneum off the anterior cervix, pushing the bladder caudally. (**b**) Use of the harmonic scalpel to separate the fibroid from its attachment to the uterus. (**c**) Demonstration of the fibroid separated from the uterus. (**d**) Fibroid separated from both the uterus and enucleated from the broad ligament. (**e**) Application of the "lap loop" to transect the cervix from the body of the uterus. (**f**) Transecting the cervix



Fig. 33.11 Schematic diagram of a broad ligament fibroid (Courtesy of Catherine Woodman, BA (Hons))

Complications

General Complications

Most studies concur that there is no difference in the complication rate between LSH and TLH. A 16 year study of 3190 laparoscopic hysterectomies by Donnez et al. showed that in experienced hands, laparoscopic hysterectomy is not associated with any increase in major complication rates [40]. Both minor complications (fever >38.5 °C, bladder damage) and major complications (haemorrhage, vesicoperitoneal fistula, ureteral injury, rectal perforation or fistula) have been observed. In the LSH group, the minor complication rate was 0.99 % and the major complication rate 0.37 %. In the TLH group, the minor complication rate was 1.14 % and the major complication rate 0.51 % [40]. Bojahr et al. in their series of 1706 patients found five (0.3 %) intraoperative (three bladder injuries, one ureter injury, and one severe intraoperative bleed) and 20 (1.2 %) postoperative complications [23].

Specific Complications

All the above complications are seen generally in all laparoscopic hysterectomies whether it is done as total hysterectomy or subtotal. There are only a few complications which are specific to the supracervical procedure. Laparoscopic hysterectomy has been associated with higher rates of urinary tract injuries, compared with abdominal hysterectomy (OR 2.61,95 % CI 1.22–5.60) [41, 42, 43]. Later studies performed by Karaman et al. and Bojahr et al. found a lower complication rate (between 0 and 1.4 %) [8, 23].

Bladder Injury

Bladder injury is a complication that can occur in the presence of cervical myoma. It usually occurs as a result of the bladder being stretched over the anterior cervical fibroid [20] a contributory factor in this series was low BMI alluding to poor access. In the series by Grosse-Drieling et al., 2 of the patients had uteri measuring 540 and 595 g and one had a contributory factor of previous surgery [21]. Even though bladder injury appears with cervical myomas, these complications are usually recognized at the time of surgery. The injury can be sutured laparoscopically and have no long-term sequellae. At the end of such procedures even if the complication is unsuspected during the laparoscopy, the catheter bag should be examined before the procedure is completed. If it is found to be inflated this could signify occult bladder injury and further investigations should be carried out to identify the same. The complication of bladder injury at LSH is not unique with large uteri. Donnez and colleagues in a series of 3190 laparoscopic hysterectomies of which 1613 were supracervical had a cystotomy rate of 0.25 % in women with uterine size less than 17 weeks. In this cohort there were also more iatrogenic cystotomies in the total hysterectomy group (0.38 %) [40]. A recent meta-analysis looks at the use for universal cystoscopy at gynaecological surgery to detect urinary tract injury. However though it increases the detection rate intra-operatively it does not decrease the postoperative detection rate [44]. In all the case series reporting on urinary tract injury during LSH for large uteri most injuries were detected intraoperatively. The one reported injury detected postoperatively was managed by catheterisation and allowed to heal spontaneously. For the use of routine cystoscopy to be cost effective it has been estimated that the prevalence of injury would have to be 2 % at laparoscopic hysterectomy [45].

The main recommendation in avoiding bladder injury is being cognisant of limited space particularly in the smaller patient with fibroids in the lower segment, and where patients have had previous surgery. When operating on such patients it is important to look in the catheter bag. If it is inflated with gas, like a balloon it is important to look for the bladder injury and repair the bladder using a 2/0 vicyl suture or equivalent in layers. The patient does not necessarily need to stay in hospital till the catheter is removed. It is our practice to keep the catheter in situ for 7–10 days, the patient is taught how to use a leg bag and discharged home on prophylactic

antibiotics. The patient then returns for a cystogram and if the bladder is intact, the catheter is removed and if all is well the patient returns home.

Unexpected Malignancy

Laparoscopic morcellation has enabled the removal of large uteri without necessitating the removal of the cervix. But due to the potential for dissemination of occult uterine cancers the American Association of Gynecologic Laparoscopists (AAGL) stated that, in case of known or suspected uterine malignancy, morcellation is contraindicated [46]. Additionally the Food and Drug Administration (FDA) recently issued a statement discouraging the use of electromechanical morcellation for hysterectomy and myomectomy in most women with uterine myoma [47]. Arkenbout et al. recently assessed the basic "physiology" of the morcellation process and tissue spread and found that LSH and laparoscopic hysterectomy procedures may be at higher risk for tissue scatter than TLH [48].

Bojahret al. analysed data of 10,731 patients who underwent a standardized LSH surgery with electric power morcellation. In total, six sarcomas (0.06 %) and eight endometrial cancers (0.07 %) were documented. This amounts to a very low uterine malignancy rate of 0.13 % [49].

When analysing the risk of malignancy it used to be thought that rapid growth of the uterus is an indication for possibility of malignancy. However, Parker et al. looked at 198 women who had published definition of rapidly growing myoma and none of his cohort on histology were found to have leiomyosarcoma [50]. If there is any suspicion of malignancy the patient should be referred to an oncologist for appropriate investigation and management rather than have a LSH. Pertinent investigations would include LDH estimations and MRI [49]. Thus currently the consensus opinion is not to lose the obvious advantages of a laparoscopic procedure by deferring to an open procedure, but to rely on preoperative diagnosis and clear patient counseling [51].

Conclusion

With the advent of conservative methods of management of normal sized uteri and the evidence skewed towards minimally invasive hysterectomies, it is important that gynaecologists who offer care to women requiring hysterectomy are able to perform LSH for large uteri.

We have outlined the surgical precepts to be followed to achieve a successful outcome. In order to be able to perform the procedure effectively it is imperative to select patients after appropriate pre-operative investigations and consent procedure. It is also imperative for the surgeon to have a good knowledge of anatomy, instruments and modern energy sources and endoscopic skills necessary to achieve a successful outcome.

References

1. Sutton C. Hysterectomy: a historical perspective. Baillieres Clin Obstet Gynaecol. 1997;11(1):1–22.
2. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, van Voorst S, Mol BW, Kluivers KB. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2009;3:CD003677. doi:10.1002/14651858.CD003677.
3. Alperin M, Kivnick S, Poon KY. Outpatient laparoscopic hysterectomy for large uteri. J Minim Invasive Gynecol. 2012;19(6):689–94. doi:10.1016/j.jmig.2012.06.007.
4. Park SH, Cho HY, Kim HB. Factors determining conversion to laparotomy in patients undergoing total laparoscopic hysterectomy. Gynecol Obstet Invest. 2011;71(3):193–7. doi:10.1159/000317520. Epub 2010 Dec 15.
5. Benassi L, Rossi T, Kaihura CT, Ricci L, Bedocchi L, Galanti B, Vadora E. Abdominal or vaginal hysterectomy for enlarged uteri: a randomized clinical trial. Am J Obstet Gynecol. 2002;187(6):1561–5.
6. Lethaby A, Vollenhoven B, Sowter M.Pre-operative GnRH analogue therapy before hysterectomy or myomectomy for uterine fibroids Cochrane Database Syst Rev 2001;(2):CD000547.
7. Ferrari MM, Berlanda N, Mezzopane R, Ragusa G, Cavallo M, Pardi G. Identifying the indications for laparoscopically assisted vaginal hysterectomy: a prospective, randomised comparison with abdominal hysterectomy in patients with symptomatic uterine fibroids. BJOG. 2000;107(5):620–5.
8. Karaman Y, Bingol B, Günenç Z. Prevention of complications in laparoscopic hysterectomy: experience with 1120 cases performed by a single surgeon. J Minim Invasive Gynecol. 2007;14(1):78–84.
9. Semm K. Hysterectomy via laparotomy or pelviscopy. A new CASH method without colpotomy. Geburtshilfe Frauenheilkd. 1991;51(12):996–1003.
10. Berner E, Qvigstad E, Myrvold AK, Lieng M. Pain reduction after total laparoscopic hysterectomy and laparoscopic supracervical hysterectomy among women with dysmenorrhoea: a randomised controlled trial. BJOG. 2015;122(8):1102–11. doi:10.1111/1471-0528.13362. Epub 2015 Apr 19.
11. Lieng M, Lømo AB, Qvigstad E. Long-term outcomes following laparoscopic and abdominal supracervical hysterectomies. Obstet Gynecol Int. 2010;2010:989127. doi:10.1155/2010/989127. Epub 2010 Mar 14.
12. Garry R. The place of subtotal/supracervical hysterectomy in current practice. BJOG. 2008;115(13):1597–600. doi:10.1111/j.1471-0528.2008.01956.x.
13. Lyons TL. Laparoscopicsupracervical hysterectomy. A comparison of morbidity and mortality results with laparoscopically assisted vaginal hysterectomy. J Reprod Med. 1993;38(10):763–7.
14. Lethaby A, Mukhopadhyay A, Naik R. Total versus subtotal hysterectomy for benign gynaecologicalconditions. Cochrane Database Syst Rev. 2012;4:CD004993. doi:10.1002/14651858.CD004993.pub3.
15. Tchartchian G, Gardanis K, Bojahr B, de Wilde L. Postoperative patient satisfaction after laparoscopic supracervical hysterectomy. JSLS. 2013;17:107–10.

16. Lieng M, Qvigstad E, Istre O, Langebrekke A, Ballard K. Long-term outcomes following laparoscopicsupracervical hysterectomy. BJOG. 2008;115:1605–10.
17. Hussain M, Odejinmi F. Laparoscopic supracervicalhysterectomy:impact of body mass index and uterineweight. Gynecol Surg. 2012;9:351–5. doi:10.1007/s10397-011-0721-5.
18. Darai E, Soriano D, Kimata P, et al. Vaginal hysterectomy for enlarged uteri, with or without laparoscopic assistance: randomised study. Obstet Gynecol. 2001;97:712–6.
19. Lyons TL, Adolph AJ, Winer WK. Laparoscopic supracervical hysterectomy for the large uterus. J Am Assoc Gynecol Laparosc. 2004;11(2):170–4.
20. Maclaran K, Agarwal N, Odejinmi F. Perioperative outcomes in laparoscopic hysterectomy: identifying surgical risk factors. Gynecol Surg. 2015;13:75. doi:10.1007/s10397-015-0914-4.
21. Grosse-Drieling D, Schlutius JC, Altgassen C, Kelling K. ThebenJ. Laparoscopicsupracervical hysterectomy (LSH), a retrospective study of 1,584 cases regarding intra- and perioperative complications. Arch Gynecol Obstet. 2012;285(5):1391–6. doi:10.1007/s00404-011-2170-9. Epub 2011 Dec 16.
22. Bojahr B, Tchartchian G, Ohlinger R. Laparoscopic supracervical hysterectomy: a retrospective analysis of 1000 cases. JSLS. 2009;13(2):129–34.
23. Bojahr B, Raatz D, Schonleber G, Abri C, Ohlinger R. Perioperative complication rate in 1706 patients after a standardized laparoscopic supracervical hysterectomy technique. J Minim Invasive Gynecol. 2006;13:183–9.
24. Twijnstra AR, Blikkendaal MD, van Zwet EW, Jansen FW. Clinical relevance of conversion rate and its evaluation in laparoscopic hysterectomy. J Minim Invasive Gynecol. 2013;20(1):64–72. doi:10.1016/j.jmig.2012.09.006.
25. Leonard F, Chopin N, Borghese B, Fotso A, Foulot H, Coste J, Mignon A, Chapron C. Total laparoscopic hysterectomy: preoperative risk factors for conversion to laparotomy. J Minim Invasive Gynecol. 2005;12(4):312–7.
26. Shahid A, Sankaran S, Odejinmi F. Laparoscopic subtotal hysterectomy for large uteri using modified five port technique. Arch Gynecol Obstet. 2011;283(1):79–81. doi:10.1007/s00404-009-1322-7. Epub 2009 Dec 19.
27. Nimaroff ML, Dimino M, Maloney S. Laparoscopic-assisted vaginal hysterectomy of large myomatous uteri with supracervical amputation followed by trachelectomy. J Am Assoc Gynecol Laparosc. 1996;3(4):585–7.
28. Stoelinga B, Huirne J, Heymans MW, Reekers JA, Ankum WM, Hehenkamp WJ. The estimated volume of the fibroid uterus: a comparison of ultrasound and bimanual examination versus volume at MRI or hysterectomy. Eur J Obstet Gynecol Reprod Biol. 2015;184:89–96. doi:10.1016/j.ejogrb.2014.11.011. Epub 2014 Nov 20.
29. Kung FT, Chang SY. The relationship between ultrasonic volume and actual weight of pathologic uterus. Gynecol Obstet Invest. 1996;42(1):35–8.
30. Lee YS. Benefits of high epigastric port placement for removing the very large uterus. J Am AssocGynecol Laparosc. 2001;8(3):425–8.
31. Wattiez A, Soriano D, Fiaccavento A, Canis M, Botchorishvili R, Pouly J, Mage G, Bruhat MA. Total laparoscopic hysterectomy for very enlarged uteri. J Am Assoc Gynecol Laparosc. 2002;9(2):125–30.
32. Kongnyuy EJ, Wiysonge CS. Interventions to reduce haemorrhage during myomectomy for fibroids. Cochrane Database Syst Rev. 2014;8:CD005355. doi:10.1002/14651858.CD005355.pub5.
33. Odejinmi F, Maclaran K. AgarwalN.Laparoscopic treatment of uterine fibroids: a comparison of peri-operative outcomes in laparoscopic hysterectomy and myomectomy. Arch Gynecol Obstet. 2015;291(3):579–84. doi:10.1007/s00404-014-3434-y. Epub 2014 Sep 13.
34. Matsuoka S, Kikuchi I, Kitade M, Kumakiri J, Kuroda K, Tokita S, Kuroda M, Takeda S. Strategy for laparoscopic cervical myomectomy. J Minim Invasive Gynecol. 2010;17(3):301–5. doi:10.1016/j.jmig.2009.12.020. Epub 2010 Mar 19.
35. Tariq S, Miskry TS, Kindinger LM, Setchell TE. Broad ligament fibroids—a radiological and surgical challenge. Gynecol Surg. 2014;11:19–22.
36. Chandrasekaran D, Agarwal N, Oliver R, Odejinmi F. Evaluation of laparoscopic myomectomy for the management of broad ligament fibroids. Poster presentation. ESGE 2015, ES24-0515. Gynecol Surg. 2015;12(Suppl 1):S1–S494.
37. Gol M, Kizilyar A. EminogluM.Laparoscopic hysterectomy with retroperitoneal uterine artery sealing using LigaSure: Gazi hospital experience. Arch Gynecol Obstet. 2007;276(4):311–4. Epub 2007 Mar 20.
38. Roman H, Zanati J, Friederich L, Resch B, Lena E, Marpeau L. Laparoscopic hysterectomy of large uteri with uterine artery coagulation at its origin. JSLS. 2008;12(1):25–9.
39. Bohlin KS, Ankardal M, Stjerndahl JH, Lindkvist H, Milsom I. Influence of the modifiable life-style factors body mass index and smoking on the outcome of hysterectomy. Acta Obstet Gynecol Scand. 2015;95(1):65–73. doi:10.1111/aogs.12794.
40. Donnez O, Jadoul P, Squifflet J, Donnez J. A series of 3190 laparoscopic hysterectomies for benign disease from 1990 to 2006: evaluation of complications compared with vaginal and abdominal procedures. BJOG. 2009;116:492–500. doi:10.1111/j.1471-0528.2008.01966.x. Epub 2008 Nov 11.
41. Johnson N, Barlow D, Lethaby A, Tavender E, Curr L, Garry R. Methodsof hysterectomy: systematic review and meta-analysis of randomizedcontrolled trials. BMJ. 2005;330:1478.
42. Johnson N, Barlow D, Lethaby A, Tavender E, Curr L, Garry R. Surgicalapproach to hysterectomy for benign gynaecological disease (Review). Cochrane Database Syst Rev. 2006;3:CD003677.
43. Garry R, Fountain J, Mason S, Hawe J, Napp V, Abbott J, et al. TheeVALuate study: two parallel randomized trials, one comparing-laparoscopic with abdominal hysterectomy, the other comparinglaparoscopic with vaginal hysterectomy. BMJ. 2004;328:1229–36.
44. Teeluckdharry B, Gilmour D, Flowerdew G. Urinary tract injury at benign gynecologic surgery and the tole of cystoscopy: a systematic review and meta-analysis. Obstet Gynecol. 2015;126(6):1161–9. doi:10.1097/AOG.0000000000001096.
45. Fischer J. Just Do It!: Routine Cystoscopy Should Be Done at the Time of Gynecologic Surgery. Obstet Gynecol. 2015;126(6):1136–7. - Volume Publish Ahead of Print - doi:10.1097/AOG.0000000000001169.
46. AAGL Advancing Minimally Invasive Gynecology Worldwide. AAGL position statement: route of hysterectomy to treatbenign uterine disease. J Minim Invasive Gynecol. 2011;18(1):1–3.
47. U.S. Food and Drug Administration (2014) Laparoscopic uterine-powermorcellation in hysterectomy and myomectomy: FDA. Safety communication: http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm393576.htm. Accessed 22 May 2014. DOI 10.1007/s10397-013-0826-0.
48. Arkenbout EA, van den Haak L, Driessen SR, Thurkow AL, Jansen FW. Assessing basic "physiology" of the morcellation process and tissue spread: a time-action analysis. J Minim Invasive Gynecol. 2015;22(2):255–60.
49. Bojahr B, De Wilde RL, Tchartchian G. Malignancy rate of 10,731 uteri morcellated during laparoscopic supracervical hysterectomy (LSH). Arch Gynecol Obstet. 2015;292(3):665–72. doi:10.1007/s00404-015-3696-z. Epub 2015 Mar 28.
50. Parker W, Fu Y, Berek J. Uterine sarcoma in patients operated on for presumed leiomyoma and rapidly growing leiomyoma. Obstet Gynecol. 1994;84(3):414–8.
51. Odejinmi F, Agarwal N, Maclaran K, Oliver R. Should we abandon all conservative treatments for uterine fibroids? The problem with leiomyosarcomas. Womens Health (Lond). 2015;11(2):151–9. doi:10.2217/whe.14.71.

Cervical Stump Extirpation

34

Peter Oppelt

There are both benign and also malignant indications for extirpation of the cervical stump. Techniques of oncological surgery do not form part of this section.

The most frequent indication for cervical stump extirpation is persistent bleeding from the cervical canal, which is reported in the literature as occurring in 0.9–25 % of cases after laparoscopy-assisted supracervical hysterectomy (LASH). Preoperative menorrhagia and endometriosis (adenomyosis tissue in the cervix) appear to be risk factors for persistent bleeding after LASH (Table 34.1) [1–8]. Bipolar coagulation of the cervical stump to ablate any residual endometrial tissue is also regarded differently by various authors [6, 8, 9].

When there is persistent bleeding, only extirpation of the stump may remain as a last resort in some cases. Before such an intervention, however, a recent Pap smear is important in order to exclude cervical cancer.

Two primary surgical options are available:

Vaginal Approach

This is particularly appropriate if the patient has already had a spontaneous vaginal delivery and the cervical stump is sufficiently deep within the vagina.

Laparoscopic Procedure

Laparoscopic cervical stump extirpation is appropriate particularly in nulliparous patients or patients with suspected endometriosis. The length of the cervix should be measured using ultrasound preoperatively. Thanks to the various types of manipulator that are available, it is much easier to perform this operation nowadays. The following surgical steps are carried out using the Hohl uterine manipulator (Storz):

1. A working insert is normally screwed onto the spiral cap. As the cervix has a residual length of around 40 mm, the end of the instrument might break through and possibly injure adherent structures (Fig. 34.1). It is therefore advisable to dispense with the working insert and to rotate the spiral cap (if possible always using the largest one, for better holding) directly into the cervical stump (Fig. 34.2).
2. The best-fitting cover is placed.
3. Laparoscopic inspection of the cervical stump is carried out (Fig. 34.3).

Table 34.1 Contraindications for LASH

Contraindications
Endometriosis recto-vaginal septum
Adenomyosis
Cervical myoma
Dysplasia of the cervix
Malignancy

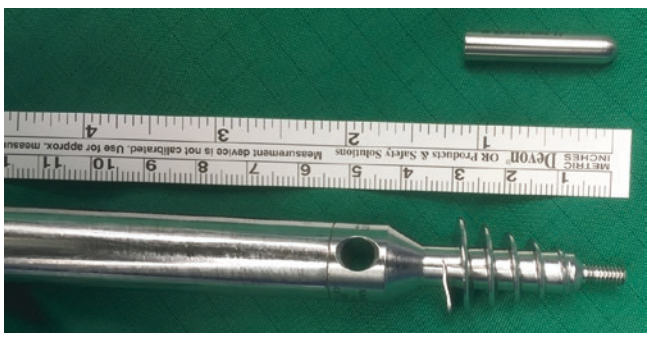


Fig. 34.1 Spiral cab of the "Hohl uterine manipulator2 (don't use the blunt tip on the spiral cab to avoid to break through)

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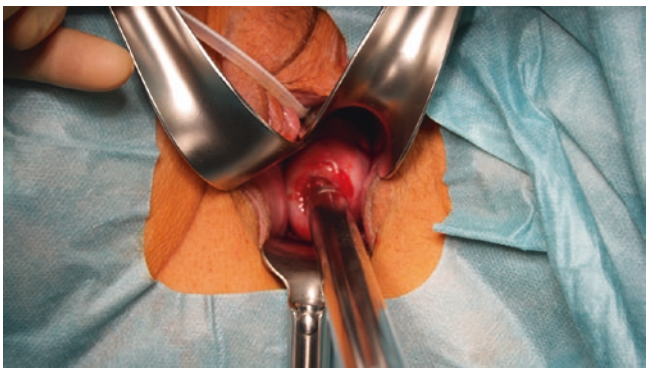


Fig. 34.2 The spiral cab is inserted into the cervical stump

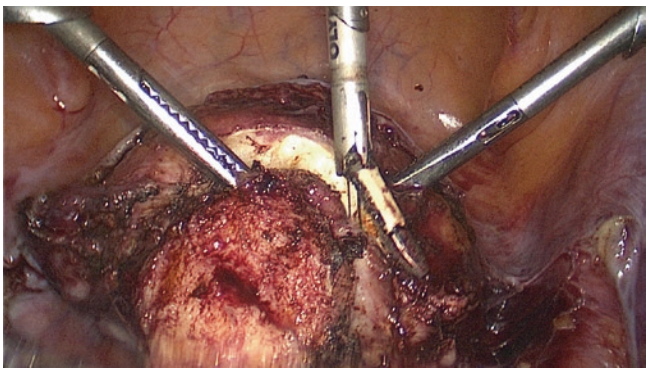


Fig. 34.5 Remove of the cervical stump from the vaginal wall

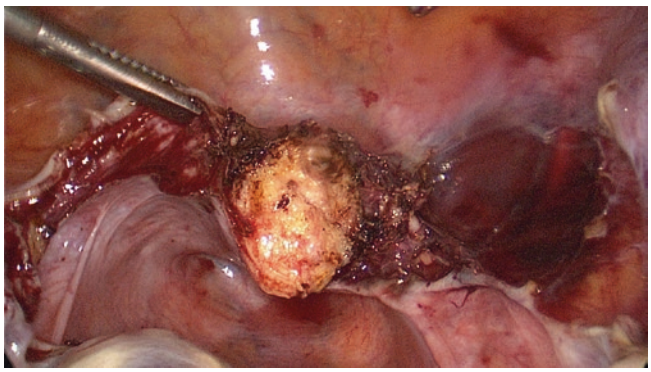


Fig. 34.3 Laparoscopic image of the stump

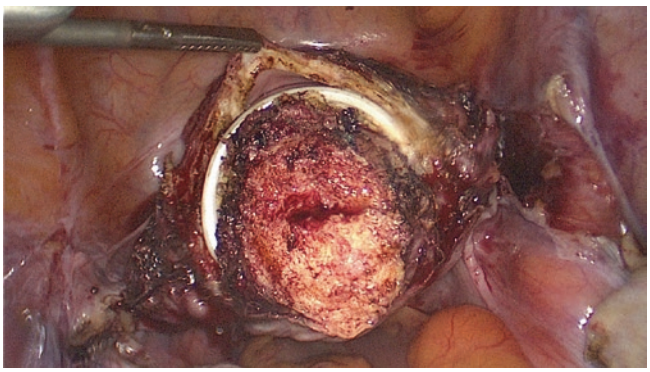


Fig. 34.6 Image of the cap during separation

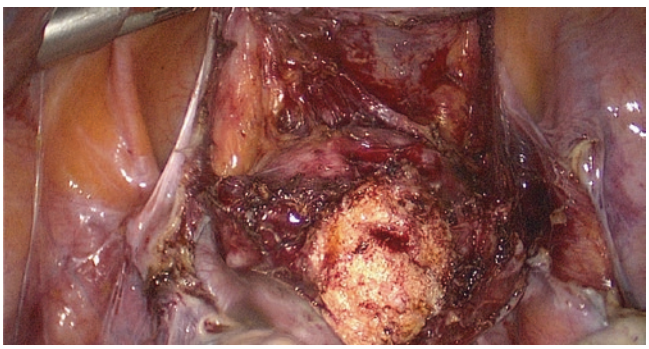


Fig. 34.4 Laparoscopic image of the stump after bladder preparation

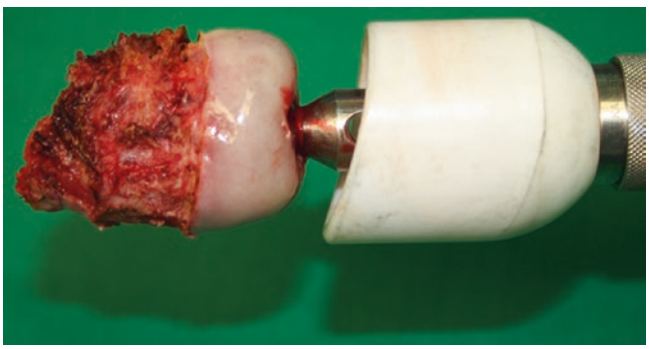


Fig. 34.7 Final operation preparation

4. Tension is applied to the vaginal walls (the manipulator should *always* be inserted straight first of all, and moved to the side under tension; it should never lead directly towards an ovarian fossa. This allows optimal tension to be applied to the vaginal wall, with an optimal distance from the ureters.)
5. An incision is made into the peritoneum and the bladder is pushed away (Fig. 34.4). (In case of an not clear situ, fill up the bladder with 200 ml saline. Push the manipulator straight in. Under this setup, the identification of the structure should be more clearly in an difficult situs).
6. The cervix is released from the parametrial ligaments up to the level of the cap of the uterine manipulator (Fig. 34.5).
7. Since there is no affiliation provided for Peter Oppelt in the chapter opening page, we have taken the affiliation from the Contributor list in the front matter. Please confirm if this is fine. If necessary, coagulation of the cervical part of the uterine artery bilaterally.
8. Separation of the cervical stump at the edge of the manipulator cap with Ultracision / monopolar needle) (Figs. 34.6 and 34.7).
9. Closure of the vagina with endoscopic or transvaginal sutures.

References

1. Morrison JE, Jacobs VR. 437 classic intrafascial supracervical hysterectomies in 8 years. J Am Assoc Gynecol Laparosc. 2001; 8(4):558–67.
2. Kim DH, Bae DH, Hur M, Kim SH. Comparison of classic intrafascial supracervical hysterectomy with total laparoscopic and laparoscopic-assisted vaginal hysterectomy. J Am Assoc Gynecol Laparosc. 1998;5(3):253–60.
3. Gimbel H, Zobbe V, Andersen BM, Filtenborg T, Gluud C, Tabor A. Randomised controlled trial of total compared with subtotal hysterectomy with one-year follow up results. BJOGInt J Obstet Gynaecol. 2003;110(12):1088–98.
4. Van der Stege JG, Van Beek JJ. Problems related to the cervical stump at follow-up in laparoscopic supracervical hysterectomy. JSLSJ Soc Laparoendosc Surg. 1999;3(1):5–7.
5. van Wijngaarden WJ, Filshie GM. Laparoscopic supracervical hysterectomy with Filshie clips. J Am Assoc Gynecol Laparosc. 2001;8(1):137–42.
6. Nouri K, Demmel M, Greilberger U, Fischer E-M, Seemann R, Egarter C, Ott J. Prospective cohort study and meta-analysis of cyclic bleeding after laparoscopic supracervical hysterectomy. Int J Gynecol Obstet. 2013;122(2):124–7.
7. Jenkins TR. Laparoscopic supracervical hysterectomy. Am J Obstet Gynecol. 2004;191(6):1875–84.
8. Ghomi A, Hantes J, Lotze EC. Incidence of cyclical bleeding after laparoscopic supracervical hysterectomy. J Minim Invasive Gynecol. 2005;12(3):201–5.
9. Sasaki KJ, Cholkeri-Singh A, Sulo S, Miller CE. Persistent bleeding after laparoscopic supracervical hysterectomy. JSLSJ Soc Laparoendosc Surg. 2014;18(4):e2014. doi:10.4293/JSLS.2014.002064.

Total Laparoscopic Hysterectomy for the Small and Normal-Sized Uterus

35

Ibrahim Alkatout

Introduction

Hysterectomy is one of the most frequently performed operations in gynecological surgery. International gynecological societies recommend vaginal hysterectomy as the most acceptable technique. However, operative endoscopic methods have gained widespread acceptance in the last two decades, and play a much more important role than the traditional approaches of abdominal and vaginal hysterectomy. With regard to hysterectomies performed for benign disease, the number of abdominal hysterectomies is decreasing, the number of vaginal hysterectomies varies, but laparoscopic and robotic-assisted laparoscopic procedures are on the increase [1]; the trend is visible throughout the world (Fig. 35.1) [2].

The most frequent indications for hysterectomy are uterine leiomyomas (Figs. 35.2, 35.3, 35.4, 35.5, 35.6 and 35.7), adenomyosis (Figs. 35.8, 35.9, 35.10 and 35.11), adenomyoma (Fig. 35.12), diffuse endometriosis (Figs. 35.13, 35.14, 35.15, 35.16, 35.17 and 35.18), uterine prolapse, and therapy-resistant idiopathic bleeding abnormalities. These constitute 60 % and more of the indications for hysterectomy [3]. Alternative therapeutic strategies, such as uterine artery embolization or focused ultrasound therapy have been developed in Germany [4] and other countries [5] over the last ten years. Conservative operative management and the introduction of ulipristalacetate have reduced the number of hysterectomies. Hysterectomy rates depend not only on the indication but also on the age group, family planning, and the centers at which the patients are treated. The indications for hysterectomy in general have now been adapted to the patients' wish to retain their uterus [6, 7]. Hysterectomy is also performed for malignant diseases of the inner genital organs (endometrium or cervix, ovaries and fallopian tube). Endoscopic surgery is only performed for endometrium and cervical cancer. Table 35.1 summarizes the indications for hysterectomy.

Once the decision to perform a hysterectomy has been made, the physician and patient must decide whether the procedure will be performed abdominally, vaginally, or with laparoscopic or robotic assistance [8–10]. Each of these approaches has its advantages and disadvantages, which must be explained to the patient (Fig. 35.19). The surgeon's familiarity with the technique and the economic resources of the hospital are also important considerations (Table 35.2).

The foremost advantage of endoscopic treatment is the fact that the surgeon is able to address other intraabdominal comorbidities simultaneously, such as endometriosis or severe adenomyosis in the adjacent organs (sacrouterine ligaments, cardinal ligament, bladder and/or bowel), as well as adhesions. Although uterine-preserving operative strategies are still controversially discussed and the results are not consistently promising, the only reliable treatment for adenomyosis is total hysterectomy. Since the disease is confined to the uterus, the ovaries can be preserved.

In many cases, conservative medical or conservative surgical treatment signifies undertreatment of the patient, who may then need surgery later on. Subtotal hysterectomy is a compromise that meets the requirements of patients, society and doctors. It is the least invasive approach of hysterectomy. However, the patient must provide her informed consent regarding the disadvantages of the remaining cervix. Only a laparoscopic total hysterectomy (LTH) provides complete protection from renewed fibroids, prevents subsequent carcinoma of the cervix or sarcoma, cell spilling when cutting the corpus and during morcellation, uncontrolled bleeding, and other problems arising from the uterus. The persistence or recurrence of adenomyosis-related symptoms in subtotal hysterectomy continues to be a subject of debate.

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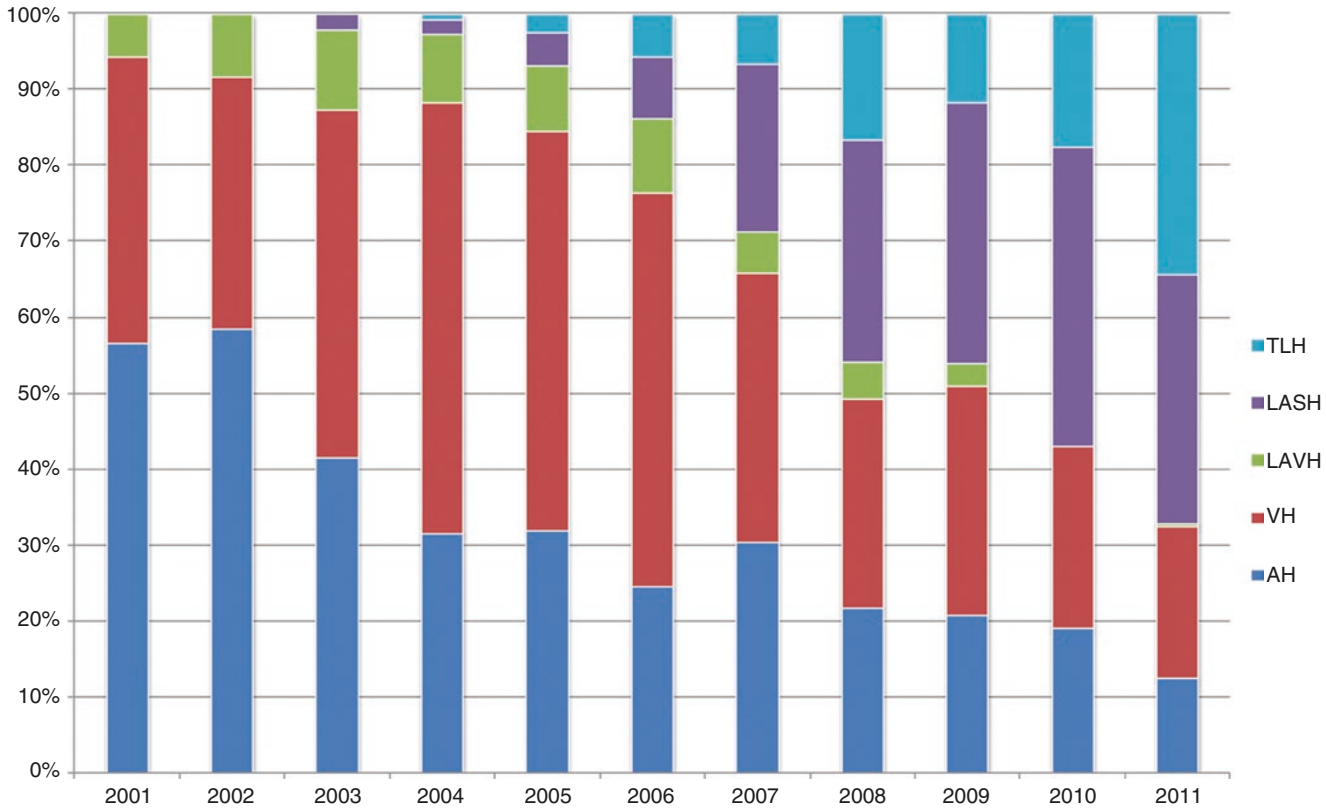


Fig. 35.1 Development of surgical techniques from 2002 to 2010 at the department of obstetrics and gynecology, University of Kiel, Germany. Abbreviations: *AH* abdominal hysterectomy, *LAVH* laparoscopically assisted vaginal hysterectomy, *LSH* laparoscopic supracervical hysterectomy, *TLH* total laparoscopic hysterectomy, *VH* vaginal hysterectomy

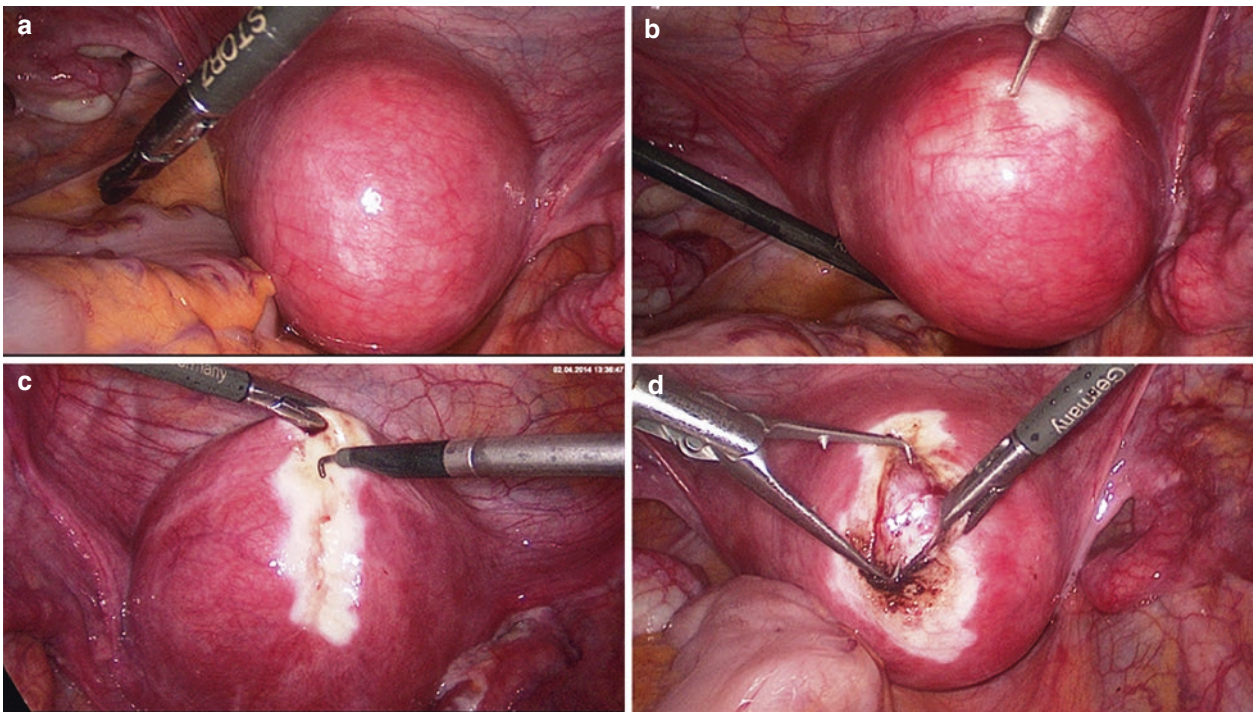


Fig. 35.2 Laparoscopic myoma enucleation. (**a**) Situs of a fundal/anterior wall fibroid. (**b**) Prophylactic hemostasis with 1:100 diluted vasopressin solution (Gylcylpressin) in separate wells between the superficial and healthy tissue of the myometrium, and the capsule/fibroid surface. The purpose of the injection is to separate the pseudocapsule from the fibroid and reduce bleeding. (**c**) Bipolar superficial coagulation of the longitudinal incision strip and opening the uterine wall above the myoma with a monopolar hook or needle until one reaches the myoma. (**d**) Grasping the fibroid and starting the enucleation. The pseudocapsule remains within the uterine wall and is pushed off bluntly

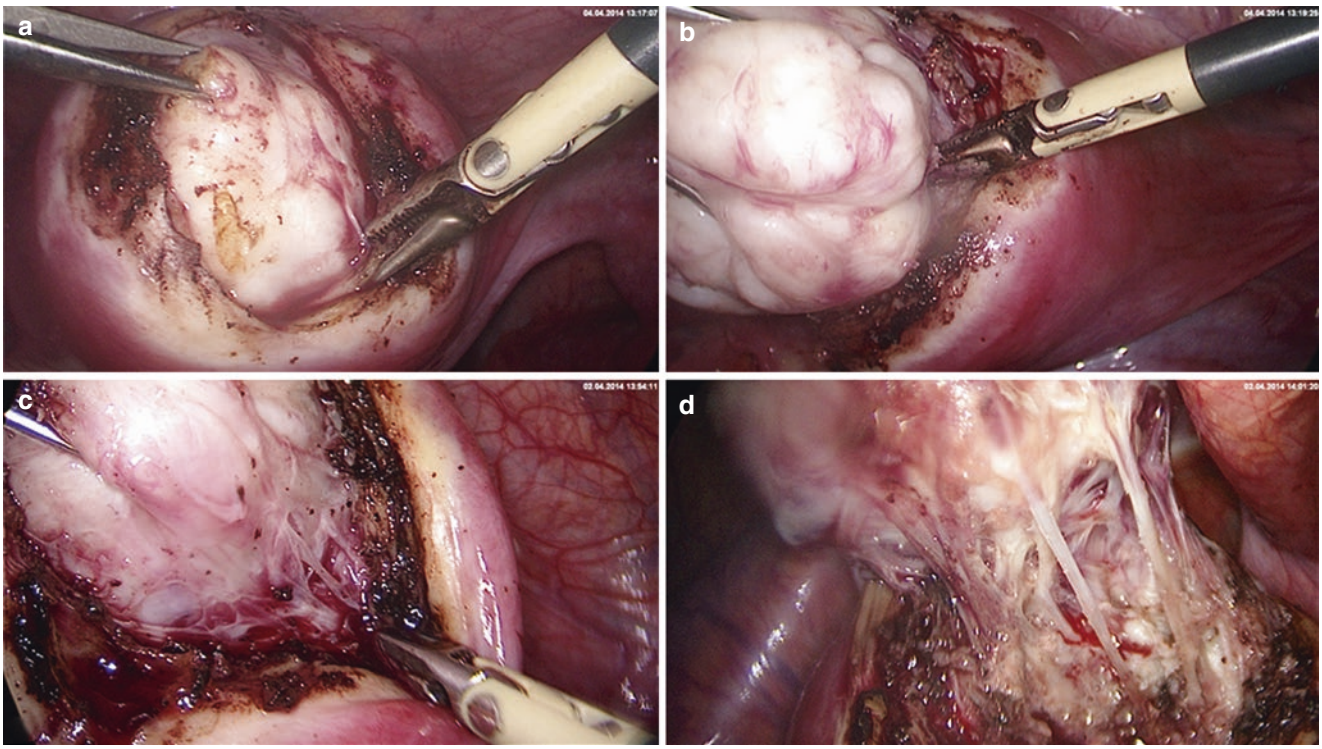


Fig. 35.3 Laparoscopic myoma enucleation. (**a**) Traction of the fibroid with a tenaculum and blunt demarcation from the capsule. (**b**) Focal bipolar coagulation of basic vessels. (**c**) Continuous enucleation of the fibroid under traction and specific coagulation of capsule fibers containing vessels. (**d**) Magnification of the remaining capsule fibers to be coagulated and cut

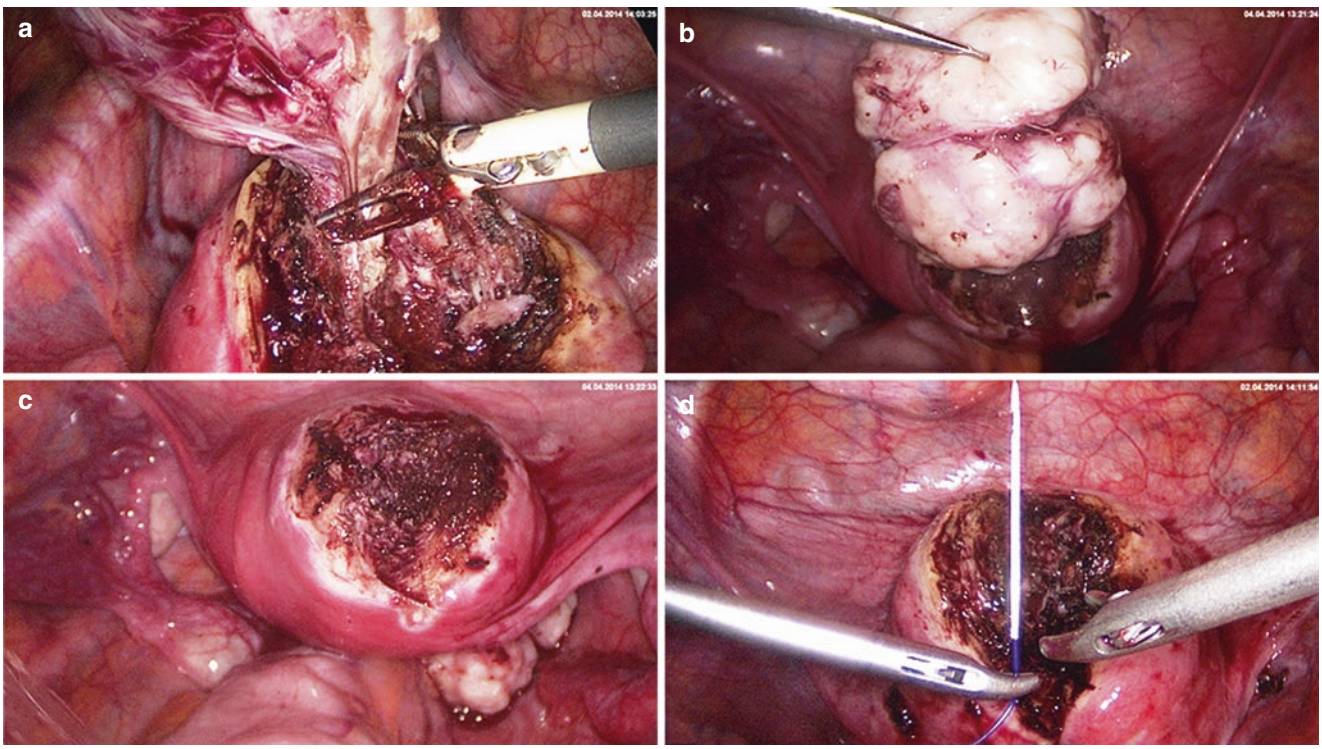


Fig. 35.4 Laparoscopic myoma enucleation. (**a**) Final coagulation of the capsule vessels. (**b**) Double belly fibroid after complete enucleation. (**c**) Minimal coagulation of bleeding vessels under suction and irrigation. (**d**) Approximation of the wound edges with a straight or round sharp needle and a monofilar late-absorbable suture

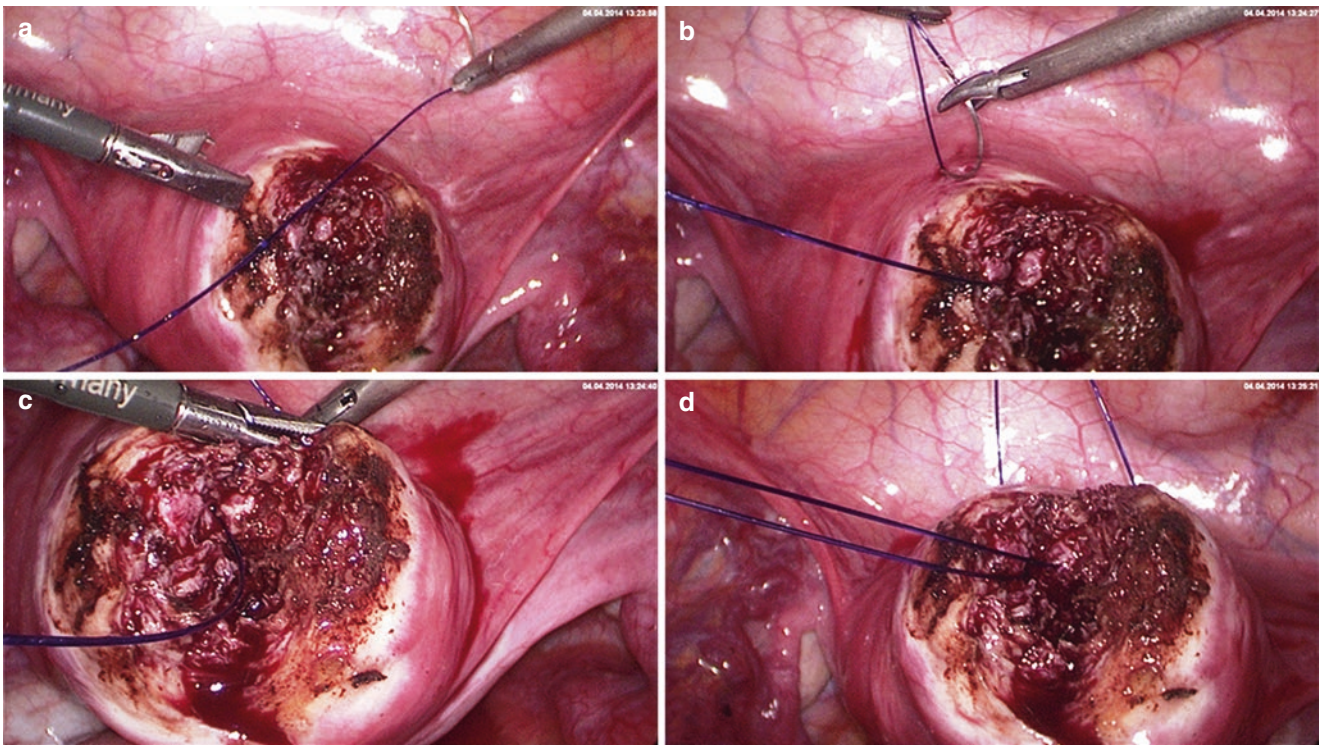


Fig. 35.5 Laparoscopic myoma enucleation. (**a**) Advantages of a circular needle stitch: (**a**) the wound angle is elevated safely and completely when raised with a Manhes forceps, (**b**) deeper layers of the myometrium can be grasped more easily with a circular needle. (**b**) Needle exit and simplified re-grasping with the right needle holder. (**c**) Final stitch to invert the knot. (**d**) Extirpation of the needle, completing the extracorporeal knot, and preparing to push down the extracorporeal knot

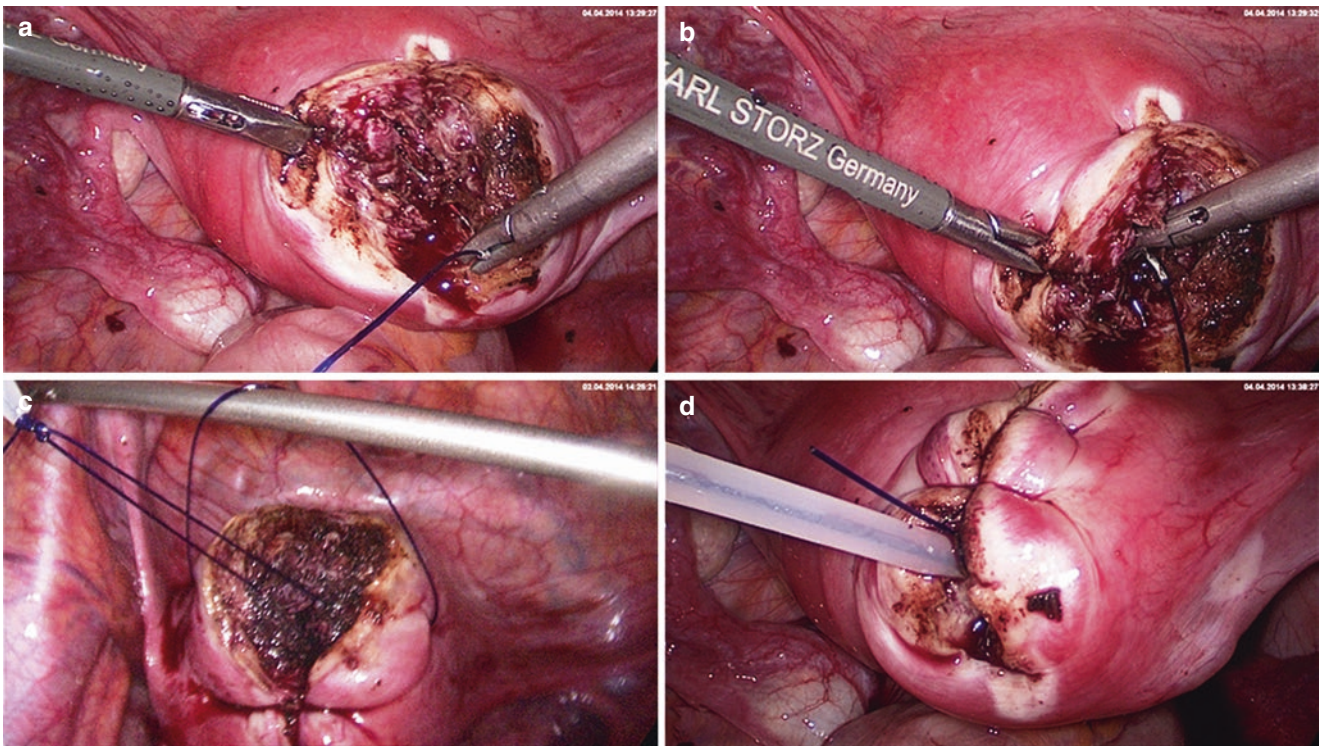


Fig. 35.6 The extracorporeal "von Leffern" knot. (**a**) Pulling out the suture, removing the needle, half hitch. (**b**) Holding the knot with the left hand and reaching over with the right hand. (**c**) Grasping the short end from below and leading it back, exiting before the half hitch. (**d**) Turning back the knot. Holding the straight suture and tightening the knot

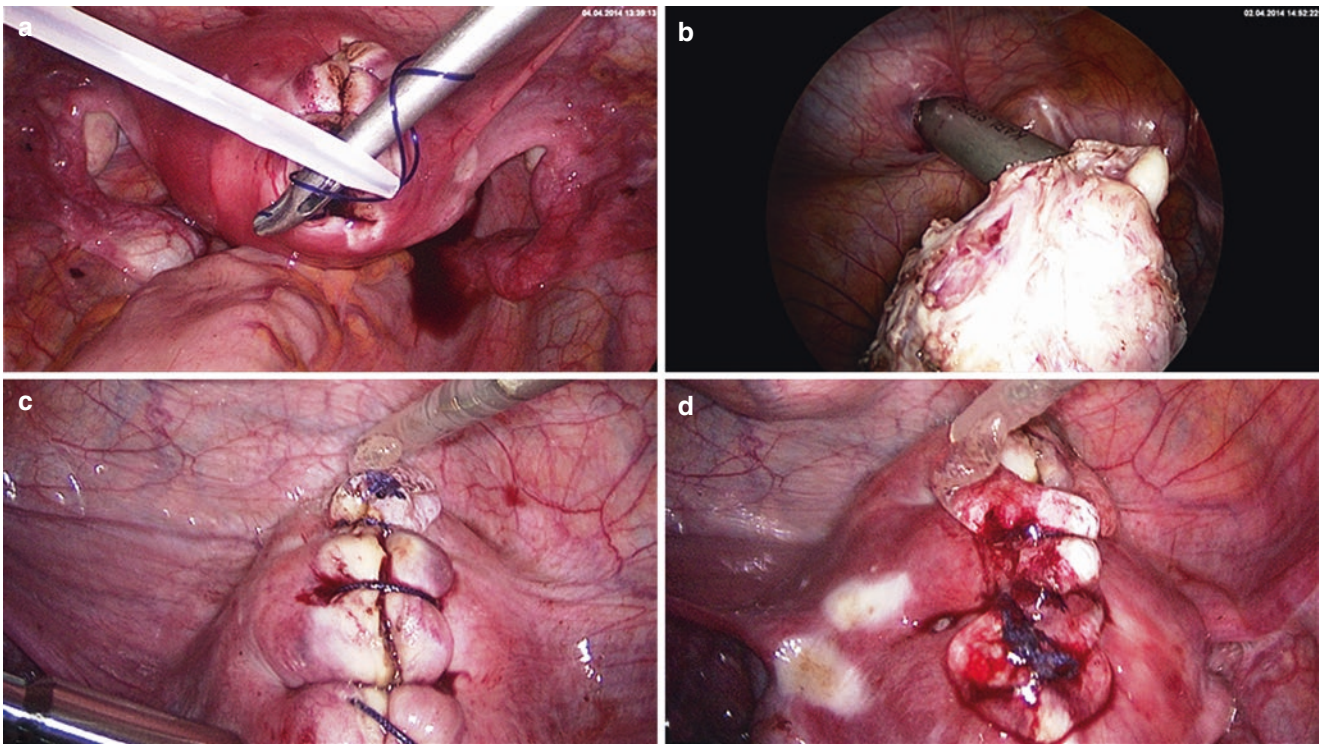


Fig. 35.7 Laparoscopic myoma enucleation. (**a**) Second single suture starting as deep as possible in the uterine wound. (**b**) The needle exits on the left wound margin (immediately adjacent to the Manhes forceps). (**c**) Completing the stitch and preparing the extracorporeal von Leffern knot. The needle holder elevates the thread to avoid tearing the uterine wall when pulling the monofilar thread (PDS). (**d**) Pushing down the extracorporeal knot with a plastic pushrod into the depth of the wound to dump the knot, thus minimizing the size of the external part of the suture

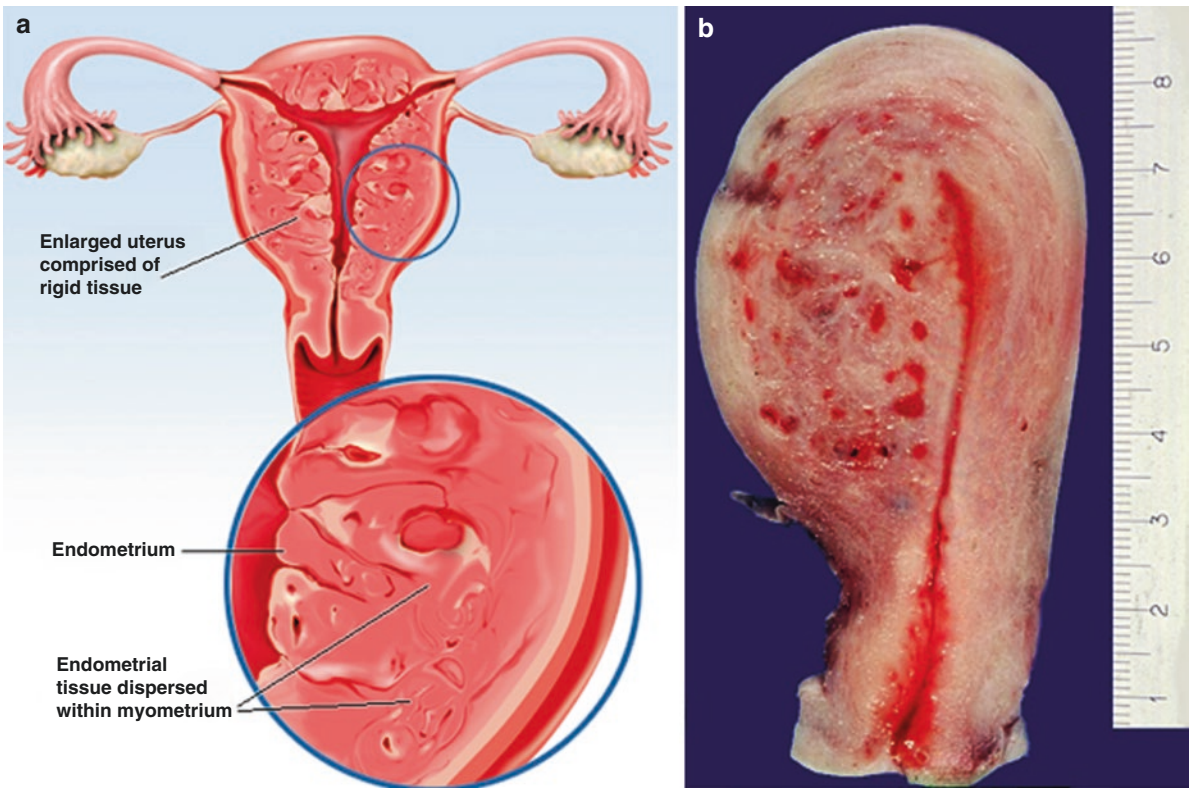


Fig. 35.8 (**a**) Schematic illustration of an enlarged uterus with adenomyosis. Endometriosis glands are dispersed within the myometrium. (**b**) Anatomical specimen in a sagittal cut. The posterior wall is much thicker than the anterior wall, with endometriosis glands spread diffusely in the myometrium wall

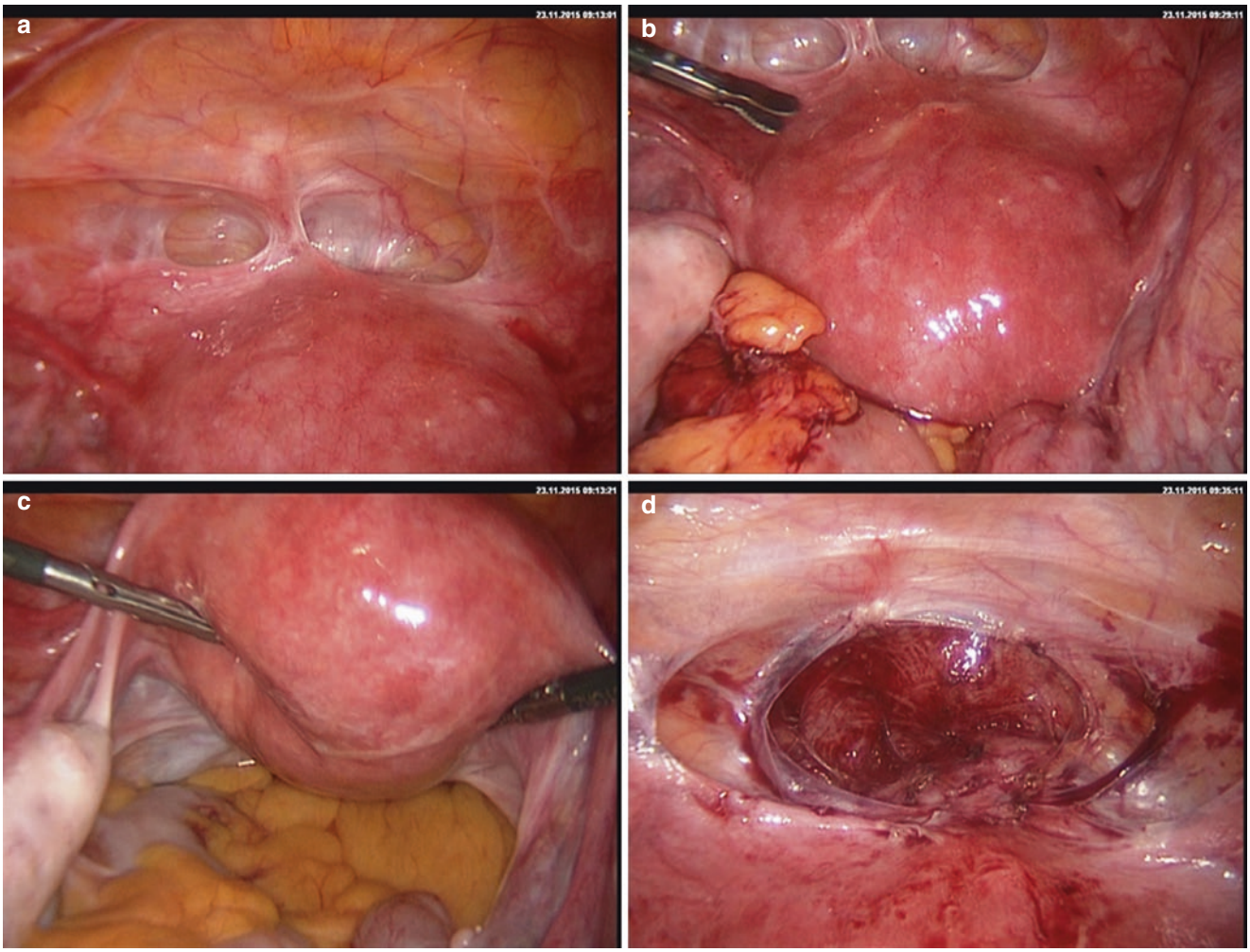


Fig. 35.9 (**a**) Overview of the laparoscopic situs of a patient with severe dysmenorrhea. The uterus is enlarged and soft (**a–c**). The anterior wall is connected to the bladder peritoneum by multiple adhesions. (**d**) After adhesiolysis one has the impression that the adenomyosis has grown through the uterine wall into the adjoining bladder

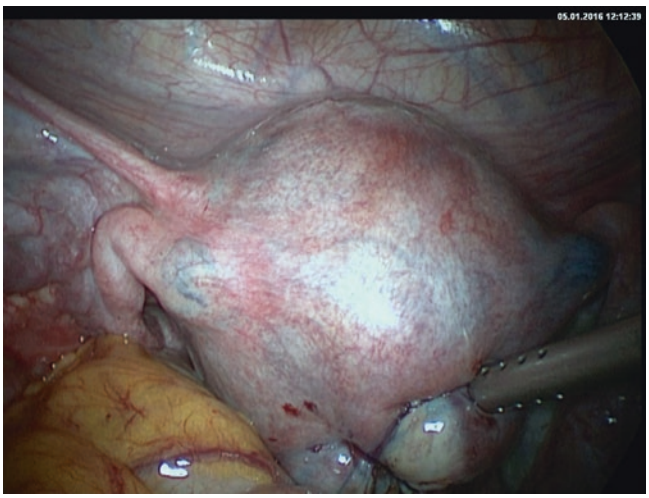


Fig. 35.10 Patient with severe dysmenorrhea and dyspareunia. The injection of blue dye exposes the intramural vessels, which seem to be massively increased. This picture is also typical of adenomyosis of the uterus

Total Versus Subtotal (Supracervical)

Independent of the surgical technique (subtotal or total hysterectomy), endoscopic surgery is a desirable goal. Some women wish to retain their cervix, believing that it may affect their sexual satisfaction after hysterectomy. Removal of the cervix is known to cause excessive neurologic and anatomic disruption, thereby leading to greater surgical and postoperative morbidity, vaginal shortening, subsequent vault prolapse, abnormal cuff granulations, and a propensity for fallopian tube prolapse. These issues were addressed in a systematic review of three randomized trials focused on total versus subtotal hysterectomy for benign gynecological conditions. The conclusions were as follows [11]:

- No difference was noted in rates of incontinence, constipation, or measures of sexual function (sexual satisfaction, dyspareunia).

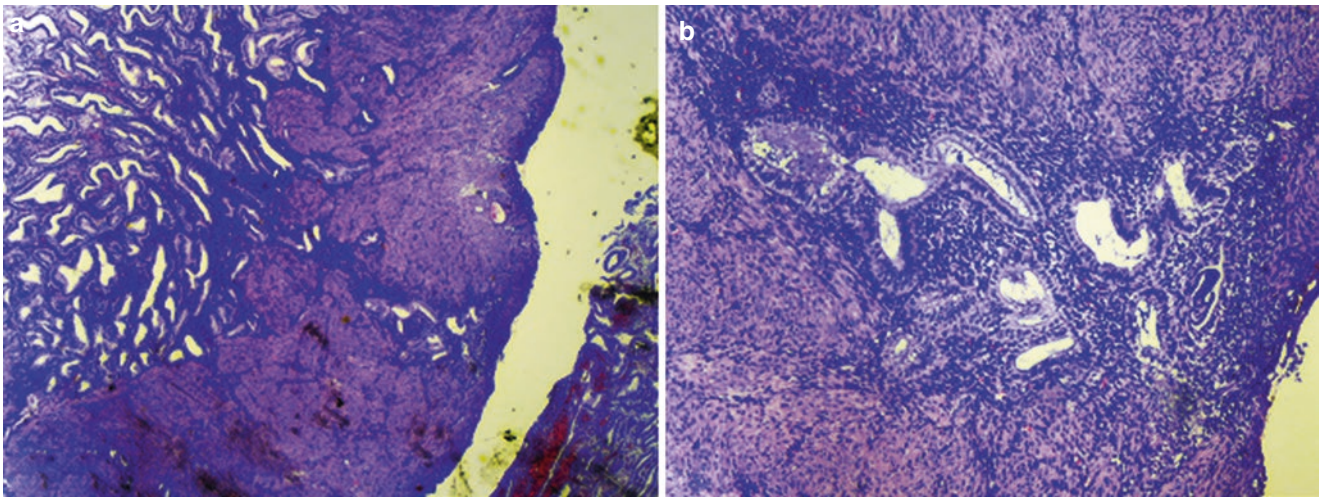


Fig. 35.11 (**a**) Low magnification of a piece of ablated endometrium with the adjoining myometrium tissue in the early secretion phase.(**b**) Islets of endometrium glands in the myometrium stroma with no connection to the uterine cavity. Obviously, the endometrium is fully involved in the endocrine cycle

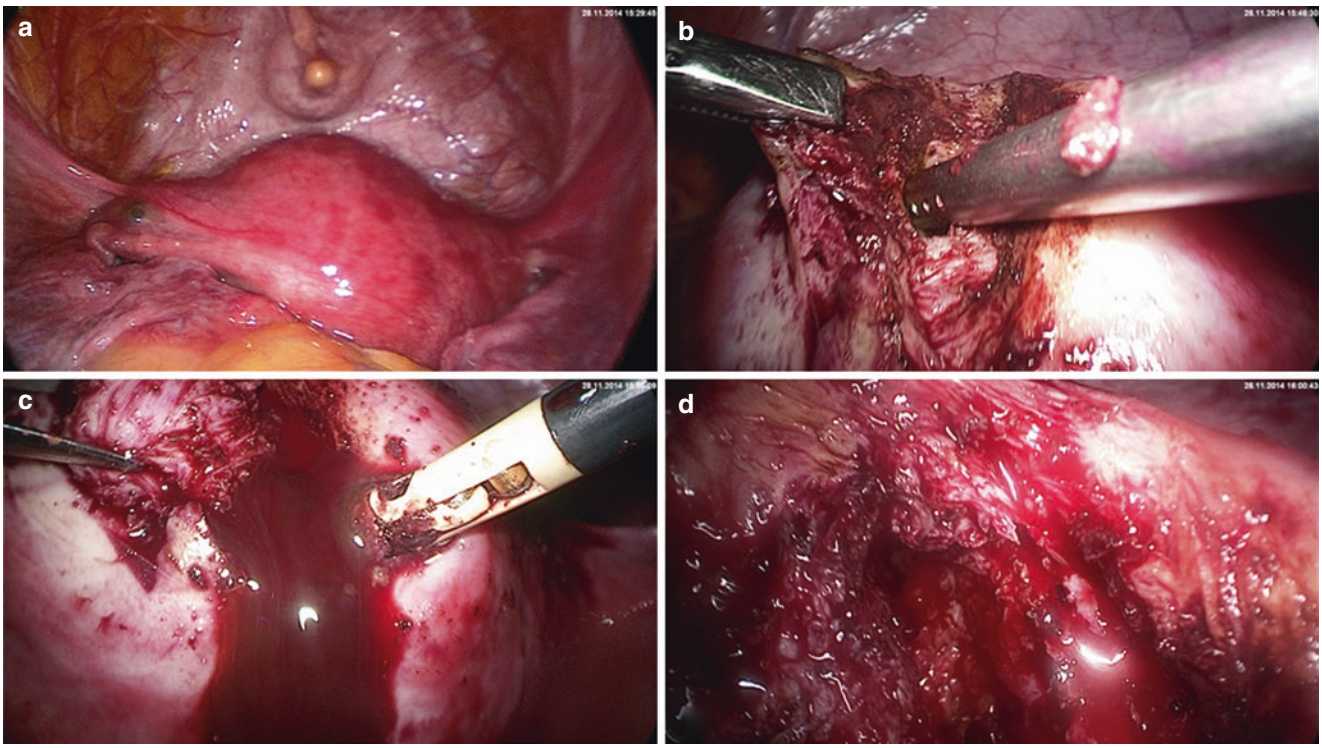


Fig. 35.12 (**a**) Overview of an asymmetrical uterus; endometriosis is suspected at the left tube and a central space-occupying lesion is seen. (**b**) Opening the central intramural lesion, which was suspected to be a fibroid.(**c**) Chocolate-like fluid after entering the adenomyoma. (**d**) On the magnification even the wall layers, including the mid-endometrium tissue can be seen

- The duration of surgery and the quantity of blood loss during surgery were significantly less during subtotal hysterectomy compared with total hysterectomy. However, there was no difference in the likelihood of the patient needing a transfusion.
- Febrile morbidity was less likely and ongoing cyclic vaginal bleeding one year after surgery more likely after subtotal hysterectomy.
- No difference was noted in the rates of other complications, recovery from surgery, or readmission rates.

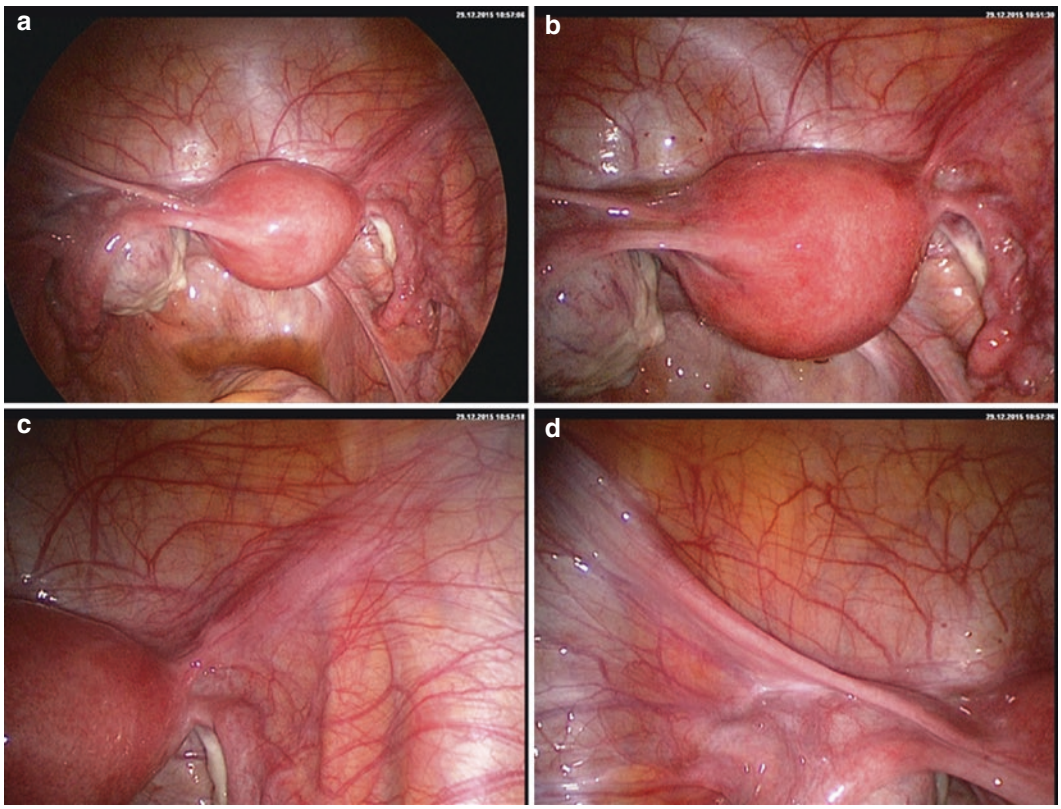


Fig. 35.13 Laparoscopic overview of a patient with dysmenorrhea.(**a**, **b**) An enlarged and irregular uterus with hypervascularization of the serosa. The chronic disease has caused an asymmetry of the round ligaments. (**c**) The right side is much shorter than (**d**) the left side

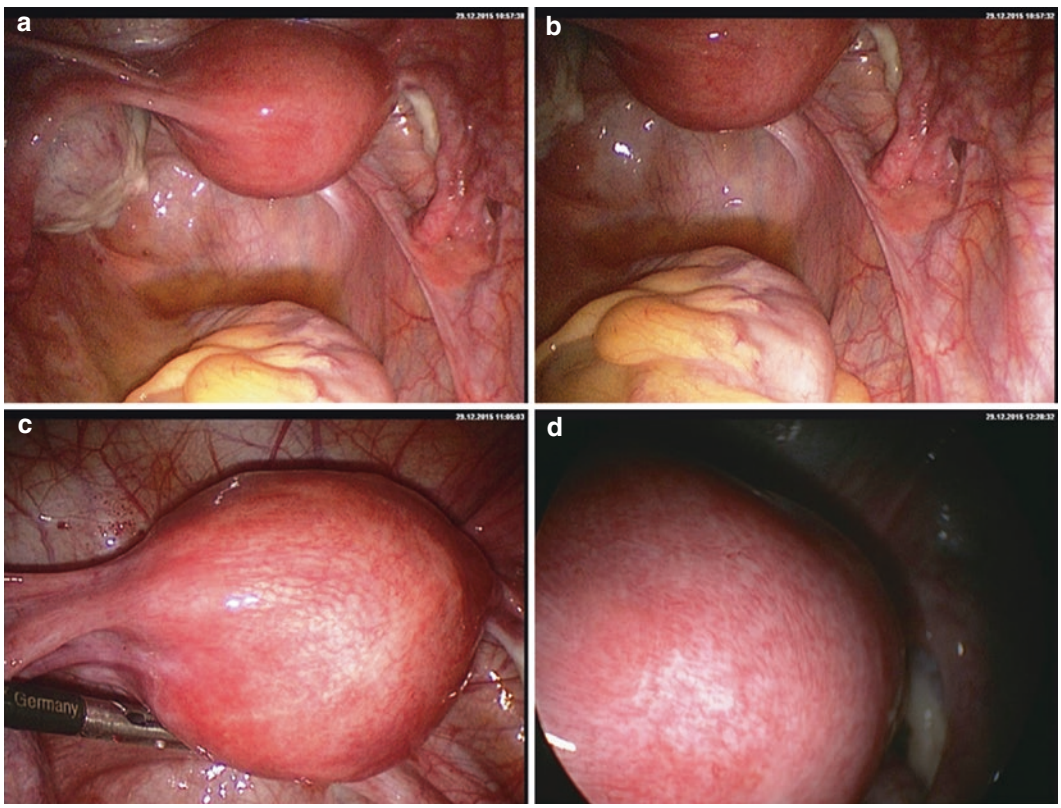


Fig. 35.14 (**a**, **c**) The uterus appears to be less mobile but somehow fixed in the pelvis. (**b**) The peritoneum above the ureter is under tension and can be demarcated from the sacrouterine ligament.(**c**, **d**) The surface of the uterus is hypervascularized; the outflow of the tubes seems to be steep

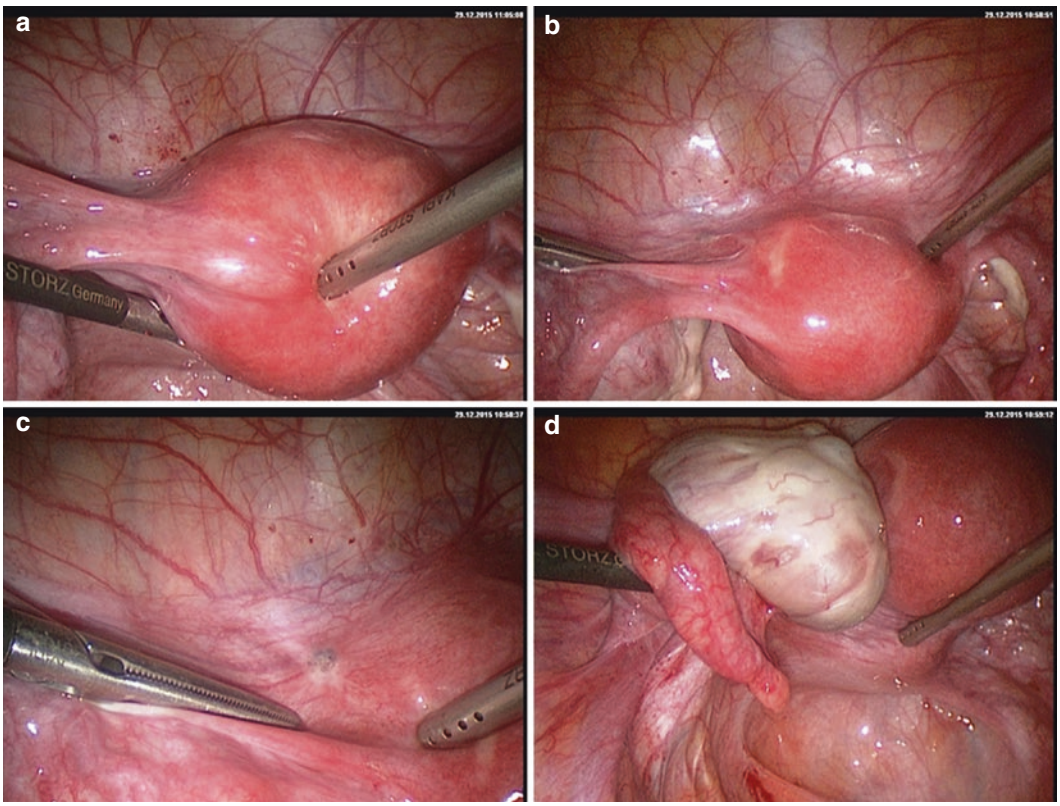


Fig. 35.15 (**a**, **b**) Palpating the uterus with a blunt instrument shows that its consistency is less soft; it is tight but hypervascular.(**c**) Endometriotic nodule on the lower uterine anterior wall.(**d**) Fixed and enlarged cystic left ovary in the ovarian fossa. The ureter can be demarcated behind the peritoneum and is lifted to the fixed area

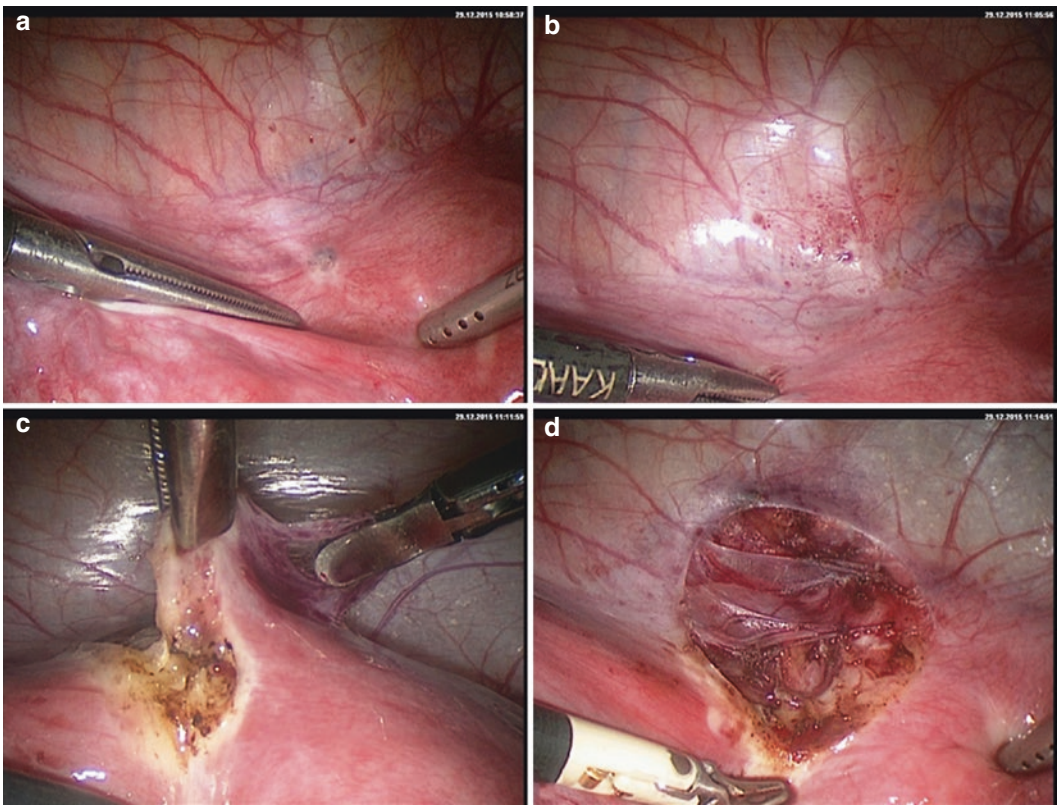


Fig. 35.16 (**a–d**) Excision of the endometriotic nodule of the lower anterior uterine wall.(**b**) Even the adjacent bladder peritoneum appears to be superficially affected because it is hypervascularized and fragile

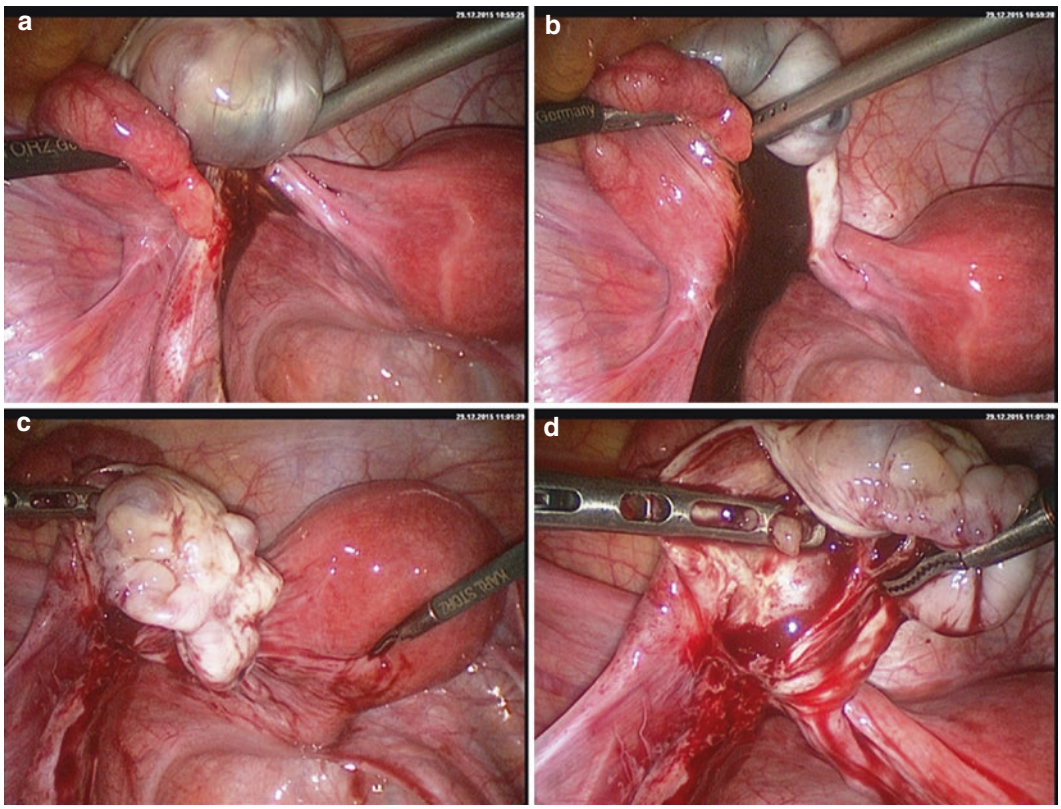


Fig. 35.17 (**a**, **b**) Lifting the ovary out of the ovarian fossa and releasing it from its peritoneal adhesion leads to opening of the endometrioma. (**c**, **d**) The depths of the ovarian fossa are affected by disease, as proven by the demarcation of the peritoneal nodule. These nodules are usually connected to the cardinal ligament or the sacrouterine ligament

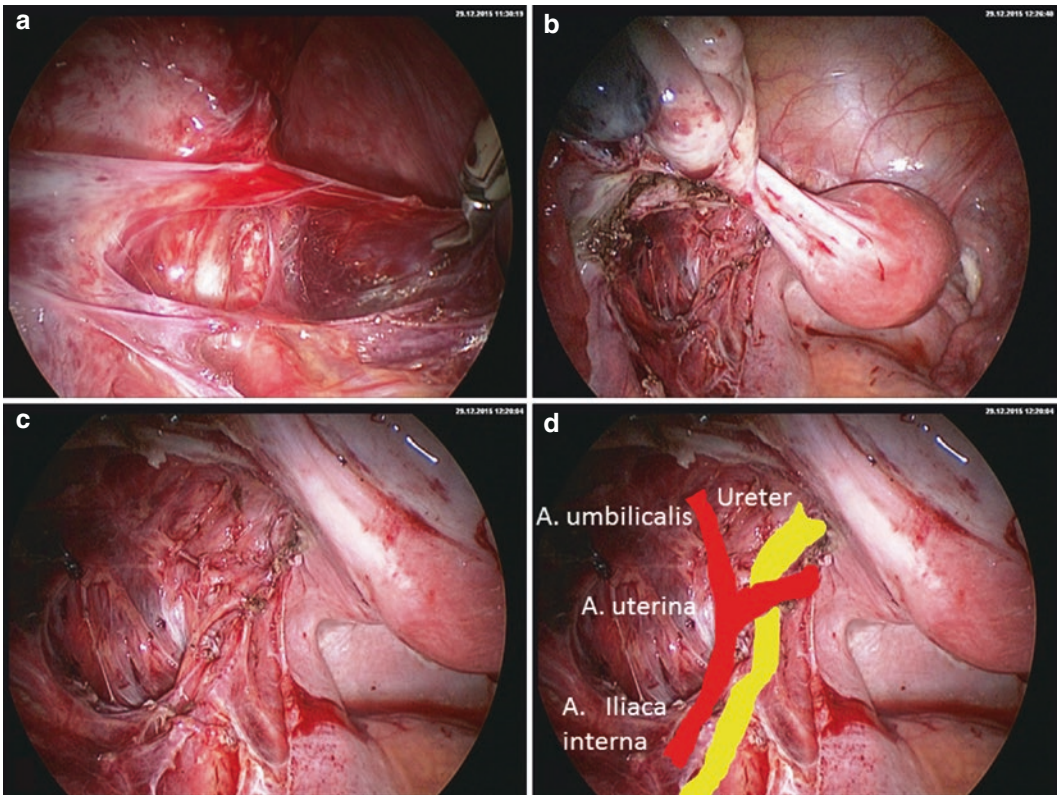


Fig. 35.18 Opening the peritoneal wall for resection of the symptomatic endometriotic nodule. (**a–d**) The ureter and vessels of the pelvic wall can be separated bluntly from the peritoneum and the endometriotic nodule. The ureter or the vessels themselves are very rarely affected. If they are, the condition calls for special surgical treatment

Table 35.1 The five major diagnostic categories that constitute indications for hysterectomy are the following

Uterine leiomyomas
Endometriosis and adenomyosis uteri
Pelvic organ prolapse
Pelvic pain or infection (other than endometriosis): pelvic inflammatory disease, adhesions
Abnormal uterine bleeding of known and unknown origin
Malignant and premalignant disease



Fig. 35.19 Truly empathetic preoperative counseling must include congruence and respect for the patient

Table 35.2 Vaginal versus abdominal versus laparoscopic hysterectomy. The robotic-assisted laparoscopic hysterectomy is included in the category of laparoscopic hysterectomies

Vaginal hysterectomy compared to abdominal hysterectomy	
Advantages	Shorter hospitalization (mean difference 1 day, 95 % CI 0.7–1.2)
	More rapid return to normal activities (mean difference 9.5 days, 95 % CI 6.4–12.6)
	Fewer infections or fever (OR 0.42, 95 % CI 0.21–0.83)
	Possibility of regional anesthesia
Disadvantages	No simultaneous surgery of comorbidities
	More difficulties in simultaneous adnexal surgery
Laparoscopic hysterectomy compared to abdominal hysterectomy	
Advantages	Less blood loss (mean difference 45.3 ml, 95 % CI 17.9–72.7)
	Shorter hospital stay (mean difference 2 days, 95 % CI 1.9–2.2)
	More rapid return to normal activities (mean difference 13.6 days, 95 % CI 11.8–15.4)
	Fewer wound infections or fever (OR 0.32, 95 % CI 0.12–0.85)
Disadvantages	Longer operating times (mean difference 10.6 min, 95 % CI 7.4–13.8)
	More urinary tract injuries (OR 2.61, 95 % CI 1.22–5.60)
Laparoscopic hysterectomy compared to vaginal hysterectomy	
Advantages	Simultaneous surgery for comorbidities
	Almost independent of the preoperative assessment
Disadvantages	Similar outcomes except longer operating times (mean difference 41.5 min, 95 % CI 33.7–49.4)
	More expensive

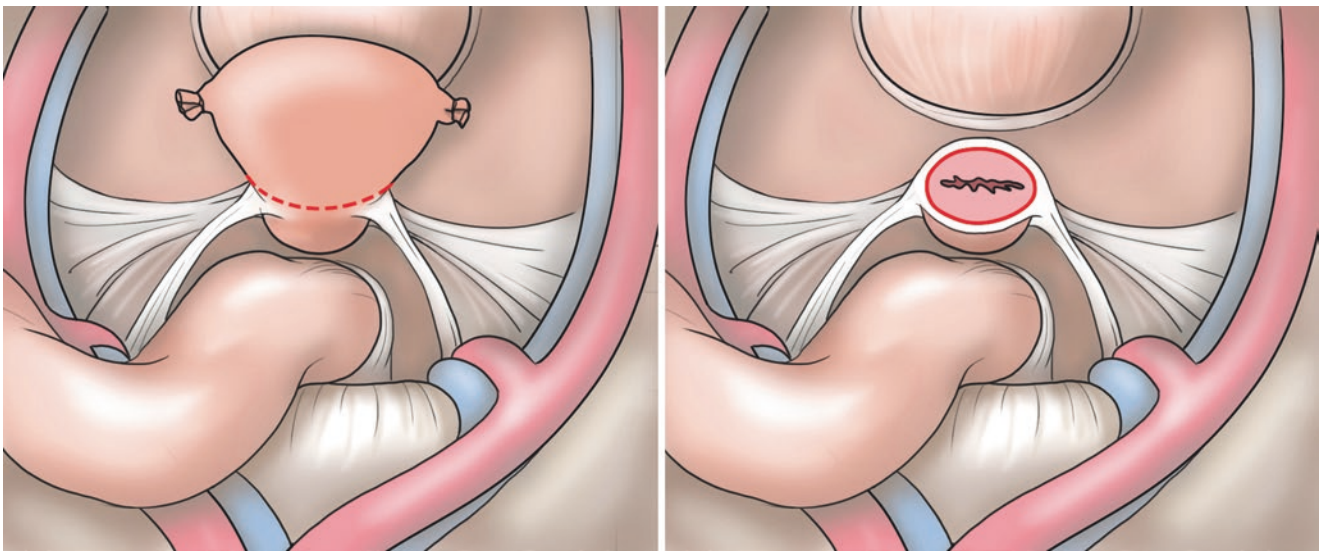


Fig. 35.20 Schematic illustration of subtotal or supracervical hysterectomy with the remaining cervical stump. The sacrouterine ligaments and the cardinal ligament remain untouched. The medial compartment is not opened

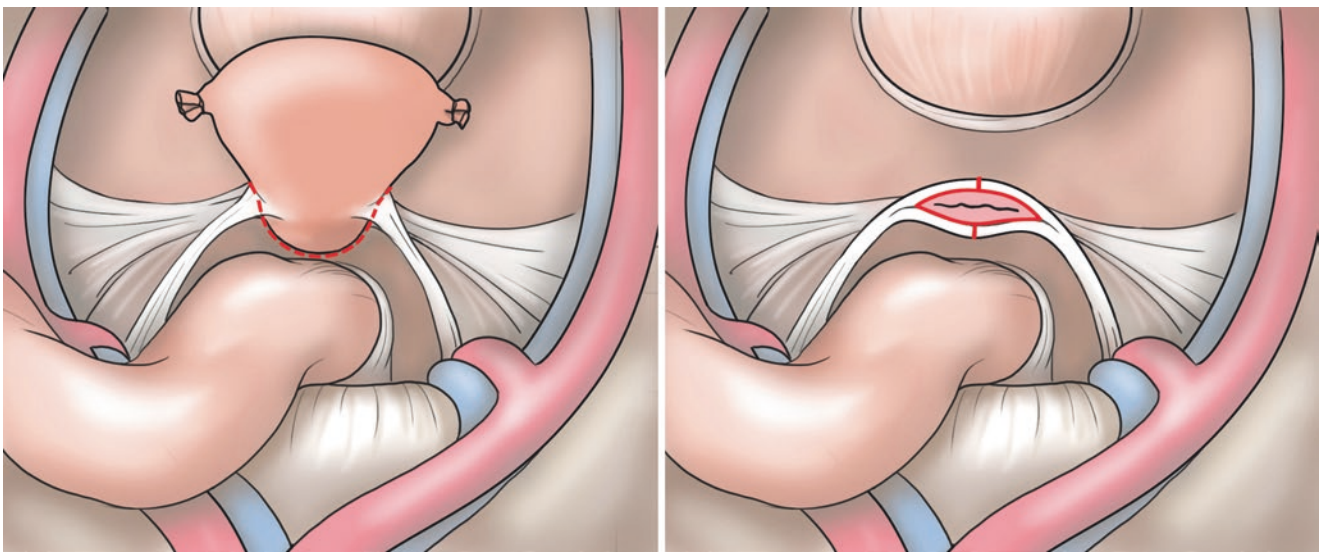


Fig. 35.21 In comparison, in laparoscopic total hysterectomy the middle compartment is opened and the cervix is enucleated out of its bed. In intrafascial hysterectomy the surrounding ligaments remain intact and the vaginal stump is retained

In the short-term, randomized trials have shown that preservation or removal of the cervix does not affect the rate of subsequent pelvic organ prolapse.

The anatomical and therefore functional advantage of the cervix being left in place is that the cardinal and uterosacral ligaments remain in place (Figs. 35.20, 35.21, 35.22, 35.23 and 35.24).

The advantages of supracervical hysterectomy compared to abdominal hysterectomy include shorter operating times and a shorter length of hospital stay when performed laparoscopically. Furthermore, patients who undergo subtotal hysterectomy are able to withstand loads earlier because there is no risk of vaginal cuff dehiscence [12]. Some studies have reported a shorter recovery period following subtotal hysterectomy, but this finding is not supported by data from randomized trials. In a prospective cohort study, supracervical hysterectomy was associated with greater improvement in short-term quality of life scores than total hysterectomy, but no difference was registered in postoperative pain or return to activities of daily living [13]. There may also be fewer injuries to the urinary tract because dissection is not performed as close to the cervix or as deep into the pelvis as in total hysterectomy. However, clinical trials designed to demonstrate this clinical observation have not been performed yet.

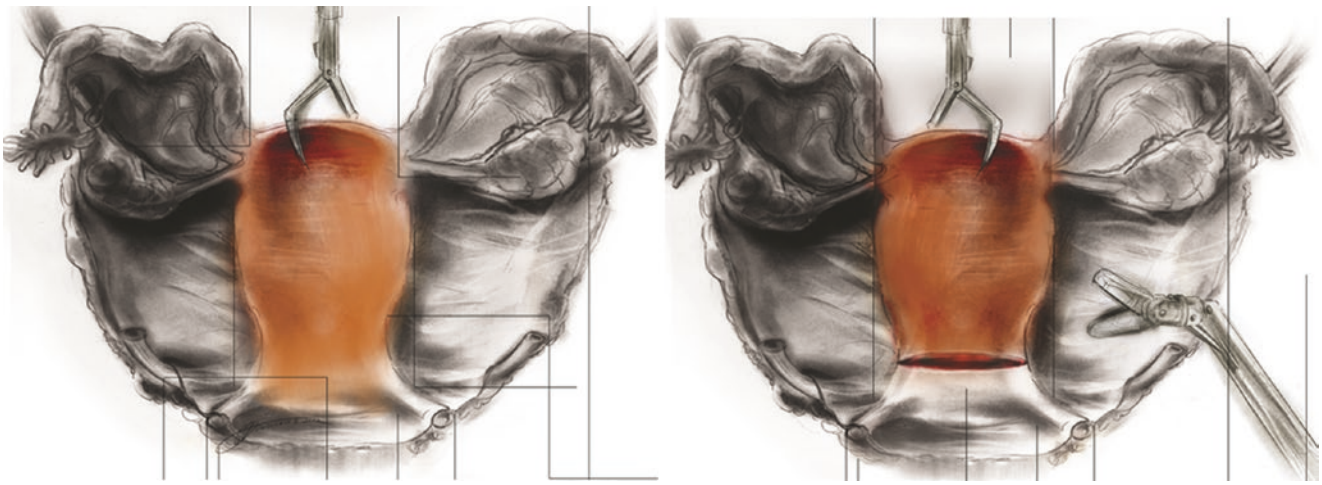


Fig. 35.22 Overview of subtotal and total hysterectomy with reference to the surrounding tissue. The sacrouterine ligaments are omitted in both procedures

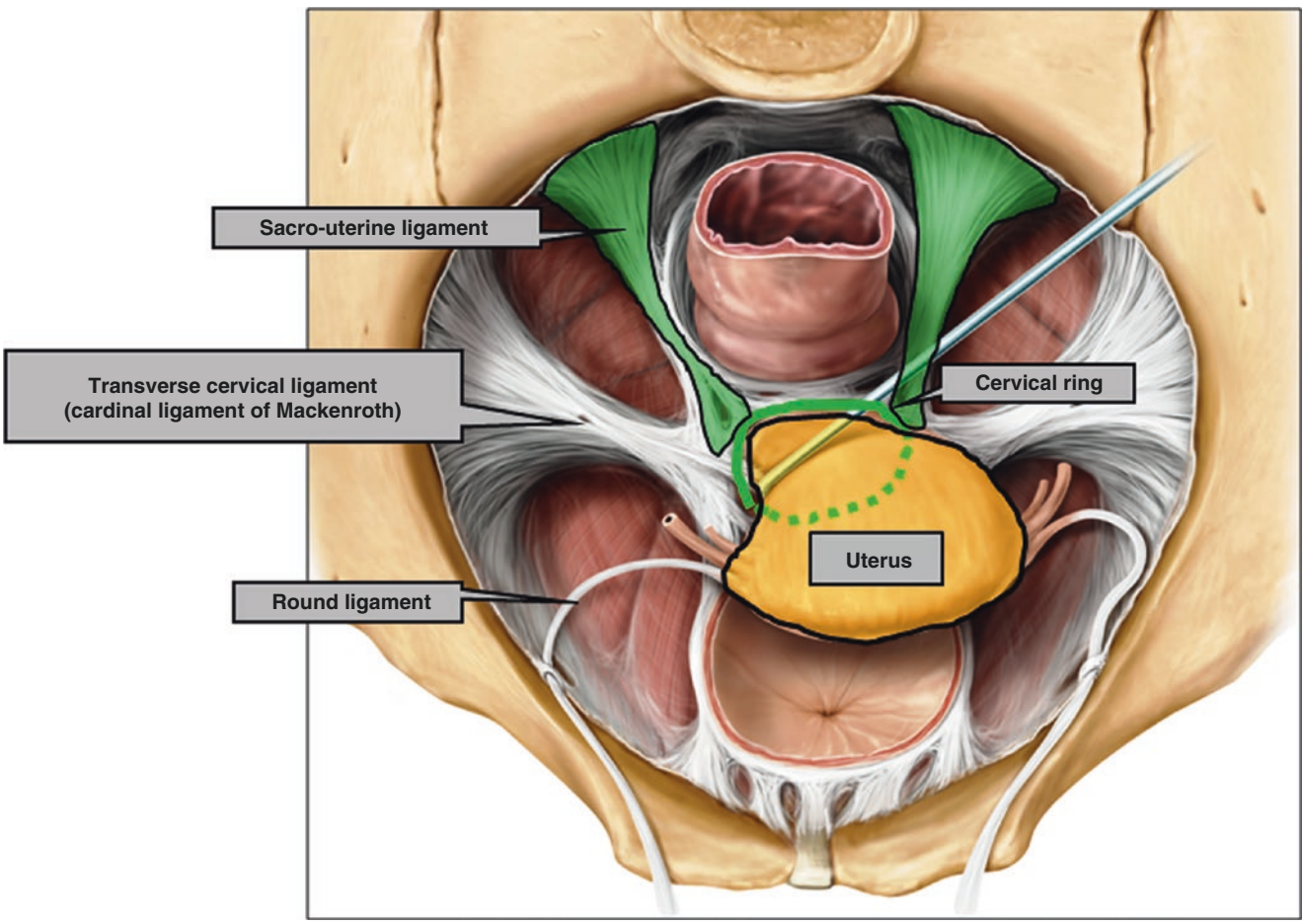


Fig. 35.23 Imaginary transverse plane showing the three compartments and the cervical ring, which is removed in total laparoscopic hysterectomy. The anatomical structure must be reconstructed when closing the vaginal cuff

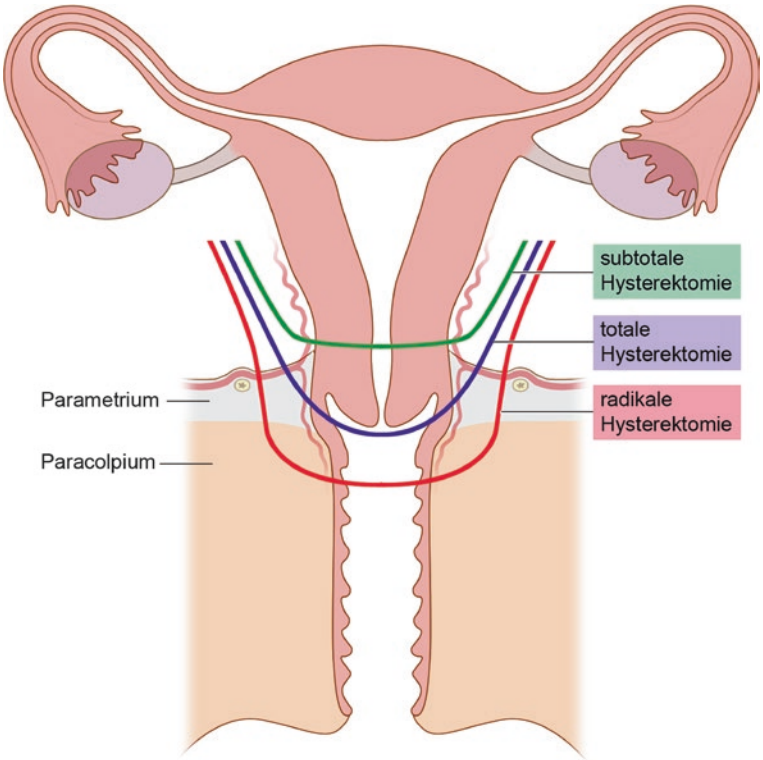


Fig. 35.24 Schematic illustration of the resection line in subtotal, total, and radical laparoscopic hysterectomy. Only the ascending branch of the uterine artery needs to be coagulated and cut with the uterine manipulator in benign cases. When adhering closely to this operative technique, the ureter is located at a safe distance from the coagulation zone (about 2 cm). All radical procedures are associated with a high degree of risk

Other differences include post-hysterectomy body image and health status. Women who underwent subtotal hysterectomy reported a significantly better body image and health-related quality of life than those who underwent total hysterectomy. Both groups reported an improvement in sexual satisfaction [14].

The only absolute contraindication for subtotal hysterectomy is a malignant or premalignant condition of the uterine corpus or cervix.

Extensive endometriosis is a relative contraindication because these women may experience persistent dyspareunia when the cervix is retained. The significance of adenomyosis has been underestimated so far. The uterus is morcellated in the abdomen. If the morcellated uterus is not collected in a bag, adenomyosis may spread into the abdominal cavity. The patient may experience persistent pain in the central segment of the lower abdomen. In laparoscopic supracervical hysterectomy (LSH), the involvement of the cervix or the retrocervical/precervical space is ignored. Very often the sacrouterine ligaments or the lateral cardinal ligaments leading to the ovarian fossa are also affected. In these cases, either the adenomyosis has grown through the uterine wall into the adjacent organs or there is concomitant endometriosis. To rule out all causes of symptoms, it would be advisable to remove all visible endometriosis-associated pathologies. LTH, if performed correctly, is associated with very few additional risks or side effects. Therefore, in cases of adenomyosis of the uterus we explain the situation to the patient in detail and advise LTH [personal statement]. Arguments in favor of LTH include fewer cases of urinary incontinence, less prolapse and cervical stump problems. However, subtotal hysterectomy is performed faster in most cases and seems to be associated with fewer intraoperative and postoperative complications. We lack convincing data concerning the advantages of simultaneous removal of the cervix; the cervix is very rarely involved in the disease [15, 16].

Elective supracervical hysterectomy should be preceded by cervical cytology confirming the absence of cervical intraepithelial neoplasia (PAP smear). Women who have had a supracervical hysterectomy should be screened for cervical cancer according to standard guidelines for their age and risk status. In patients with abnormal uterine bleeding (especially metrorrhagia), endometrial cancer or any type of sarcoma should be ruled out prior to performing a supracervical hysterectomy.

Sometimes the cervix needs to be removed later as a separate procedure. This approach is associated with frequent damage to the bowel and the bladder because the anatomical spaces cannot be exposed clearly and adhesions are common. However, the approach is readily accepted because primary surgery is associated with fewer risks than subsequent procedures. Patients who wish to minimize the likelihood of subsequent surgery may prefer a laparoscopic total hysterectomy (LTH).

Will the Fallopian Tubes and/or Ovaries Be Removed in a Hysterectomy?

Based on the existing data concerning the prevention of ovarian cancer and fallopian tube disorders, we recommend a simultaneous salpingectomy after appropriate counseling.

Notwithstanding the above facts, the number of pelvic floor corrections has increased very markedly throughout the world in recent years. This is a consequence of demographic changes. In 2000, 34.8 million women (12.7 %) in the USA were 65 years or older. By 2030 this number will have risen to 70.3 million (20 %). Similar demographic changes are anticipated in Germany [17]. In 2011, women above the age of 65 years accounted for 20 % of the total population; the percentage will rise to 35 % by 2060. This development will be less striking in other European countries, the United Kingdom, France, the Netherlands and Sweden [17]. The rate of pelvic organ prolapse (POP) repair in women aged 65 years and above is 30–50 % [18];among women older than 80 years it is still 11 % [19].

The reported rates of post-hysterectomy prolapse vary. The cumulative risk has been reported to be 1 % at three years after hysterectomy, and about 15 % fifteen years later. The risk is 5.5-fold higher when hysterectomy is performed for a descensus. Incidence rates of 46 % have been reported elsewhere [19–22]. Apart from the risk of a pre-existing descensus, vaginal deliveries and age are discussed as reasons for the risk doubling with each advancing decade of life [23]. Obviously, the rate of descent also depends on the applied surgical technique and measures for the prevention of descensus [24].

Total laparoscopic hysterectomy involves removal of the uterus and the cervix. The entire procedure is performed laparoscopically. The specimen can usually be removed through the vaginal vault. Laparoscopic-assisted vaginal hysterectomy (LAVH) has been entirely replaced by the endoscopic technique, which has become a standard procedure since the learning curve for laparoscopic suturing is now favorable. Taking into account the advantages of endoscopic surgery (shorter hospital stay, faster recovery, better cosmetic result and fewer infections), the question arises as to whether the risk of post-hysterectomy prolapse after LSH can be reduced by preserving the existing structures of the pelvic floor in the middle compartment or reconstructing them. In cases of pre-existing defects, LTH provides sufficient fixation of the pelvic floor and thus minimizes the risk of a post-hysterectomy prolapse. Mesh implants such as those used for sacrocolpopexy may be employed in both procedures simultaneously.

Our multimodality concept of laparoscopic intrafascial hysterectomy is aimed at the removal of all concomitant pathologies that might also be responsible for the patient's symptomatic condition, and simultaneously reducing the risk of post-hysterectomy prolapse:

1. Removal of all concomitant pathologies, such as adhesions or endometriosis spots, and demarcating the extent of adenomyosis.
2. Intrafascial hysterectomy with preservation of existing ligaments, yet opening the medial compartment when performing total laparoscopic hysterectomy:
   (a) Technique 1: Primary uterine artery clipping/ligation
   (b) Technique 2: Classic intrafascial hysterectomy
3. A technique of stable fixation of the vaginal stump

Development of Laparoscopic Hysterectomy Techniques and Instruments

The popularity of laparoscopic hysterectomy rose gradually after Harry Reich's initial publication of the procedure [25, 26]. A number of approaches evolved, such as laparoscopically assisted vaginal hysterectomy (LAVH), laparoscopic supracervical hysterectomy (LSH), total laparoscopic hysterectomy, and laparoscopic intrafascial hysterectomy (LTH). LTH had a steep learning curve and was initially associated with rather high complication rates [5]. The development of new instruments and consistent training improved the situation. The introduction of the intrauterine manipulator helped to develop the classic intrafascial concept which, today, is the aim of every gynecological surgeon performing total laparoscopic hysterectomy. Hohl used Kurt Semm's procedure of classic intrafascial supracervical hysterectomy (CISH) [27] and developed it further with the use of his manipulator [28]. The majority of the available manipulators are well accepted because they are easy to handle, reusable, and durable. The uterus can be moved in all directions while the elliptical long tip of the manipulator eases out vaginal and paravaginal tissue intraabdominally. The manipulator can be pushed straight towards the field of operation, especially when cutting the uterus off the vagina with the monopolar hook and targeting the tip of the manipulator.

The large majority of manipulators are provided with a ceramic cap that creates a flat surface to work on. Consequently, dissection of the bladder is usually not necessary. It should be noted that the use of the manipulator for bladder dissection is useful and safe even after a cesarean section. The application of the manipulator imitates the classical movements during abdominal hysterectomy; the ureters are kept out of the field of operation. The cap allows intrafascial hysterectomy, which preserves the ligaments and avoids vaginal shortening. The smooth cutting edge is useful for vaginal occlusion (Fig. 35.25).



Fig. 35.25 (**a**) Hohl manipulator (Storz). (**b**) Dionisi uterine manipulator (Storz). (**c**) Mangeshikar uterine manipulator (Storz). (**d**) RfQ uterine manipulator. (**e**) Clermont-Ferrand uterine manipulator (Storz). (**f**) Braun uterine manipulator. (**g**) Koninckx uterine manipulator (Storz). (**h**) Tintara uterine manipulator (Storz). (**i**) Donnez uterine manipulator (Storz)

Points to be considered:

- Monopolar electricity can be used on the ceramic cap. Bipolar current causes a larger defect, bearing the risk of subsequent wound healing problems and vaginal cuff dehiscence. The fact that ultrasound is liable to destroy this apparatus must be taken into account when using ultrasound for dissection during hysterectomy.
- Intrafascial hysterectomy involves a much smaller opening to the vagina and preserves the circular ligaments. Large uteruses may need to be morcellated. Extended endometriosis or adenomyosis may involve the circular ligaments, which then have to be removed [28].

The other instruments may be of the disposable or reusable type. Disposable tissue sealing instruments are faster and need not be replaced frequently. However, the instruments are costly and fusion of the layers of tissue results in a less clear overview of the anatomical structures. Bipolar forceps are essential. Extracorporeal sutures (PDS 1.0) are helpful, although intracorporeal sutures (Vicryl) are sufficient for vaginal closure. The monopolar hook facilitates the removal of endometriotic spots and the uterus from the manipulator, but can be replaced by bipolar forceps and scissors. In cases of a large uterus, the tenaculum can be used to lift out the uterus; a morcellator avoids troublesome comminution of the uterus.

Preoperative Considerations and Preparation

When severe endometriosis (Fig. 35.26) is suspected on vaginal examination (Fig. 35.27) and the ultrasound scan is correlated with the patient's medical history, it will be necessary to perform further diagnostic investigations such as MRI, cystoscopy, rectoscopy, or endosonography (Figs. 35.28 and 35.29). Radical interdisciplinary surgery can then be planned and performed (Figs. 35.30, 35.31 and 35.32).

A hysterectomy must always be accompanied by antibiotic protection, such as a second-generation cephalosporin. In cases of suspected bowel involvement, a single

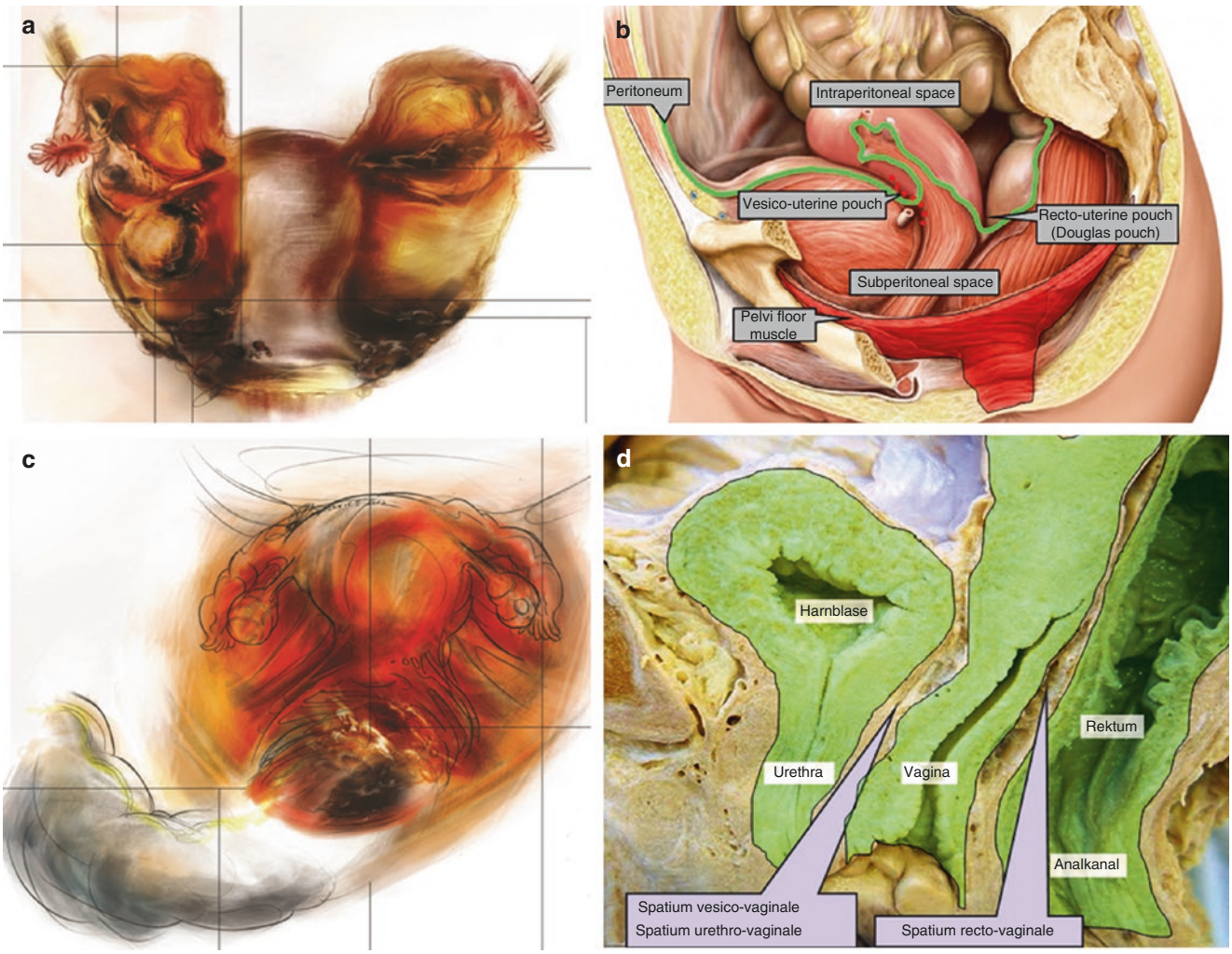


Fig. 35.26 (**a**) Severe endometriosis in relation to anatomical landmarks (**b–d**)

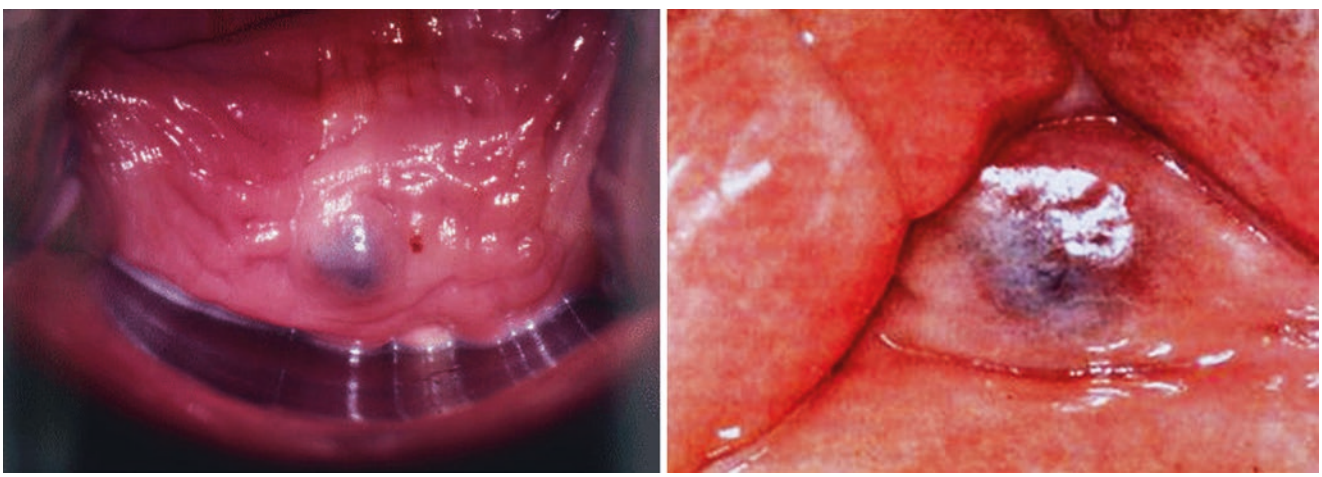


Fig. 35.27 Vaginal photograph of a small endometriotic nodule in the dorsal vaginal wall and another patient with severe deep infiltrating endometriosis involving the vagina

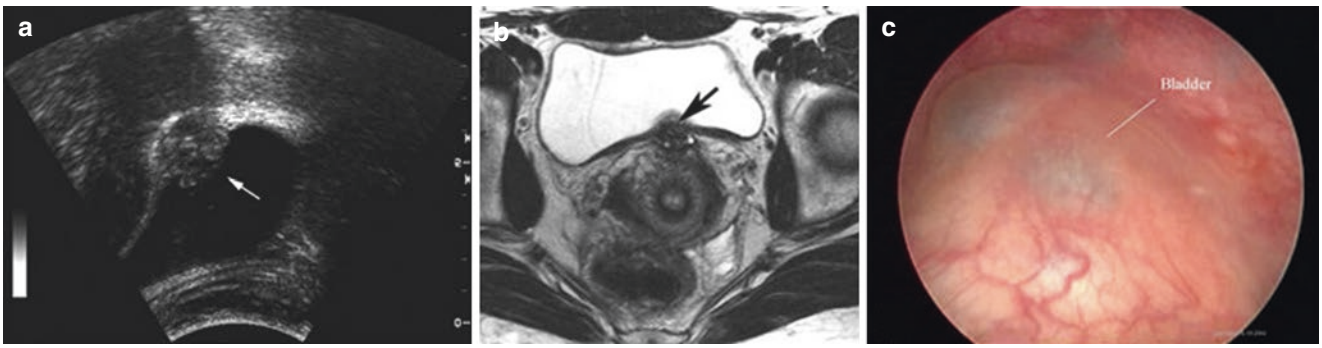


Fig. 35.28 (**a**) Vaginal ultrasound of a solitary nodule between the anterior wall of the uterus and the bladder (vesicovaginal space). (**b**) MRI scan and (**c**) cystoscopy of the same patient

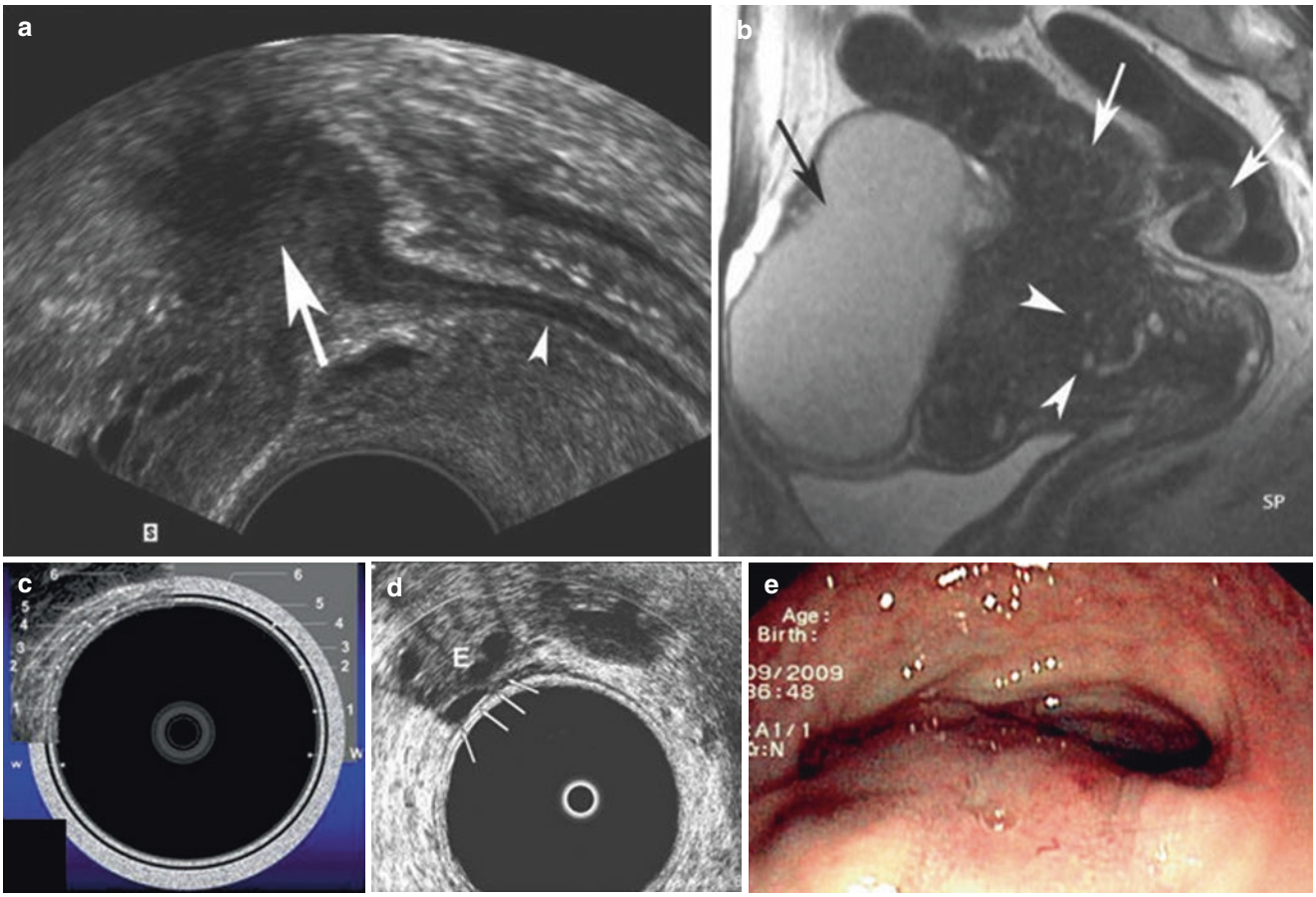


Fig. 35.29 (**a**) Vaginal ultrasound of a solitary nodule between the lower back wall of the uterus/cervix and the rectum (rectovaginal space). (**b**) MRI scan, (**c–d**) endosonography, and (**e**) rectoscopy

shot of metronidazole is also essential. The antibiotic should be applied about 30 min before the start of the operation.

The instruments consist of trocars, a uterine manipulator (for LTH only), needle holders and sutures. Additionally one needs an instrument for coagulation, graspers, scissors, window forceps and a suction irrigation unit. If a robotic set-up is available, the instruments must be adjusted accordingly. A thermofusion device with an integrated knife is optional.

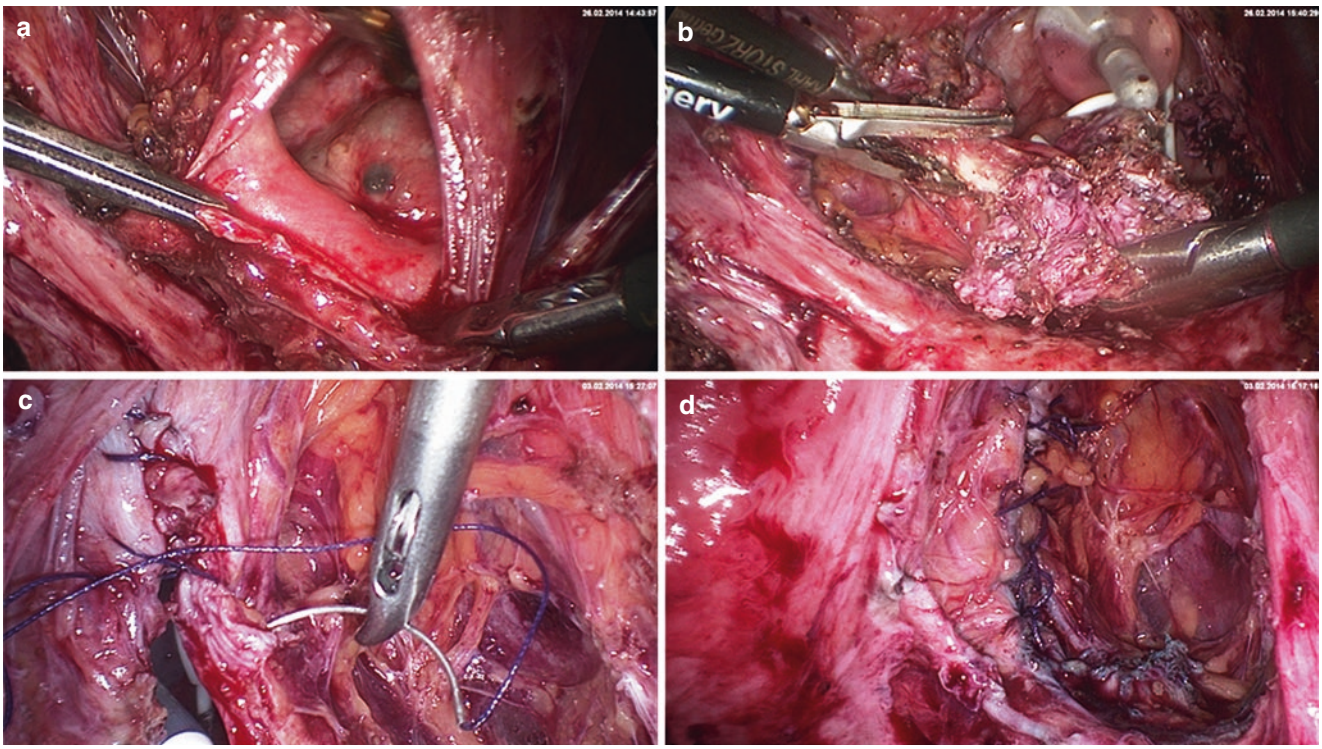


Fig. 35.30 Resection of a solitary nodule in bladder endometriosis. (**a**) The nodule is seen after opening the bladder. Two double J-catheters are placed in both ureters so that (**b**) the nodule can be cut out with an energy device. (**c**, **d**) Closure of the bladder in two layers

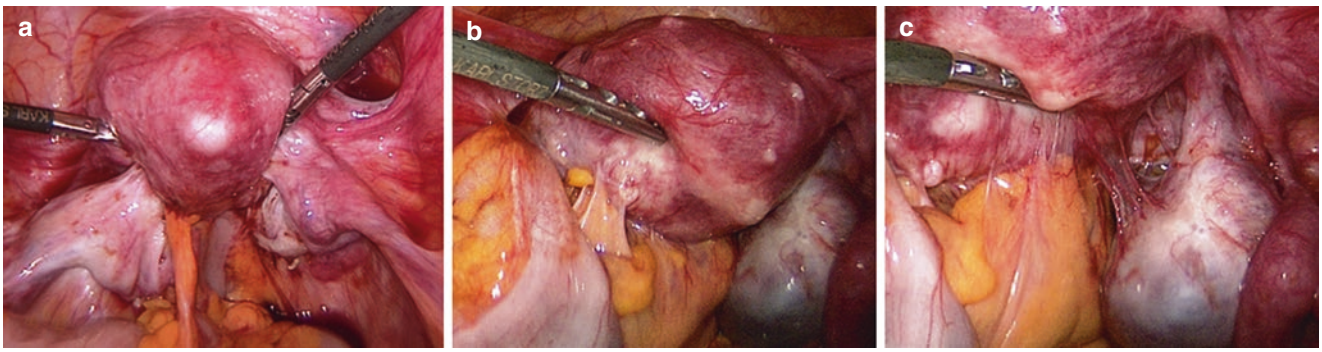


Fig. 35.31 (**a–c**) Overview of severe deep infiltrating endometriosis associated with adenomyosis of the uterus, affecting the lower sigmoid colon/rectum

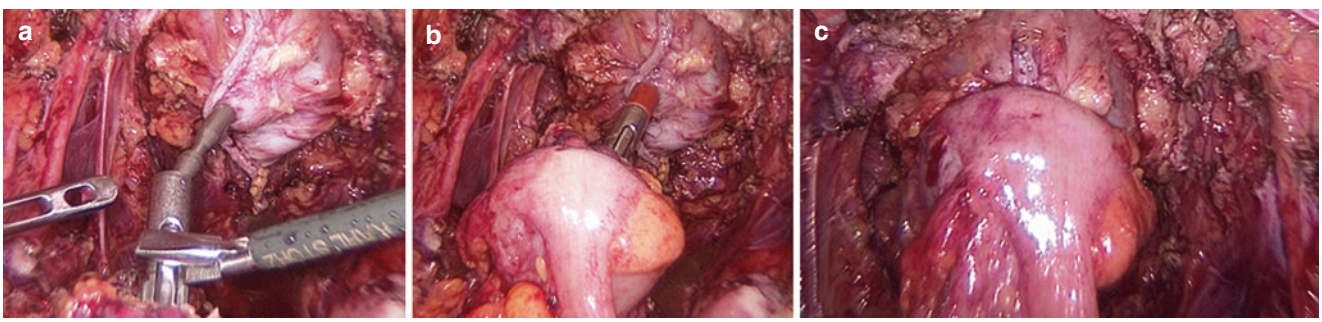


Fig. 35.32 (**a–c**) Endoscopic re-anastomosis can be performed after partial bowel resection

Prerequisites

Obesity or comorbidities, a large uterus or a uterus with multiple myomas is no contra-indication for a laparoscopic procedure. However, in these cases the preoperative assessment and the anesthesia procedure must be discussed with the patient in advance. The trocars may need to be placed higher in the abdominal wall and the surgeon may need more than the usual two ancillary trocars. In cases of a large uterus, the need for morcellation and its risks must be explained to the patient.

Intrafascial Hysterectomy with Preservation of Existing Structures.

Operative Steps of Total Laparoscopic Hysterectomy (LTH)

Step 1

A vaginal examination in anesthesia is performed before using the manipulator. When no further vaginal or rectal pathologies are found, the manipulator is inserted.

Step 2

Port placement

The first step of the operation is placement of the uterine manipulator (Fig. 35.25) [29].

A number of entry techniques are available; direct entry under sight has become very popular in the last few years. Nevertheless, the traditional entry technique described by Kurt Semm and Liselotte Mettler from the University Hospitals Schleswig-Holstein, Kiel, in the 1980s, and still used at the Kiel School of Gynecological Endoscopy is shown here.

Optic Trocar

Veress needle technique and CO_2 gas

To insert the Veress needle, the operating table needs to be in horizontal position. The Trendelenburg tilt is carried out after creating a pneumoperitoneum. The most common site of entry for the Veress needle is the umbilical area. As the wall layers are thinnest at this level, a deep incision will ensure access to the peritoneal cavity. Before incising the skin it would be advisable to palpate the course of the aorta and identify the iliac bifurcation. This will permit inspection and palpation of the abdomen in order to detect any unusual masses (Figs. 35.33, 35.34 and 35.35) [30].

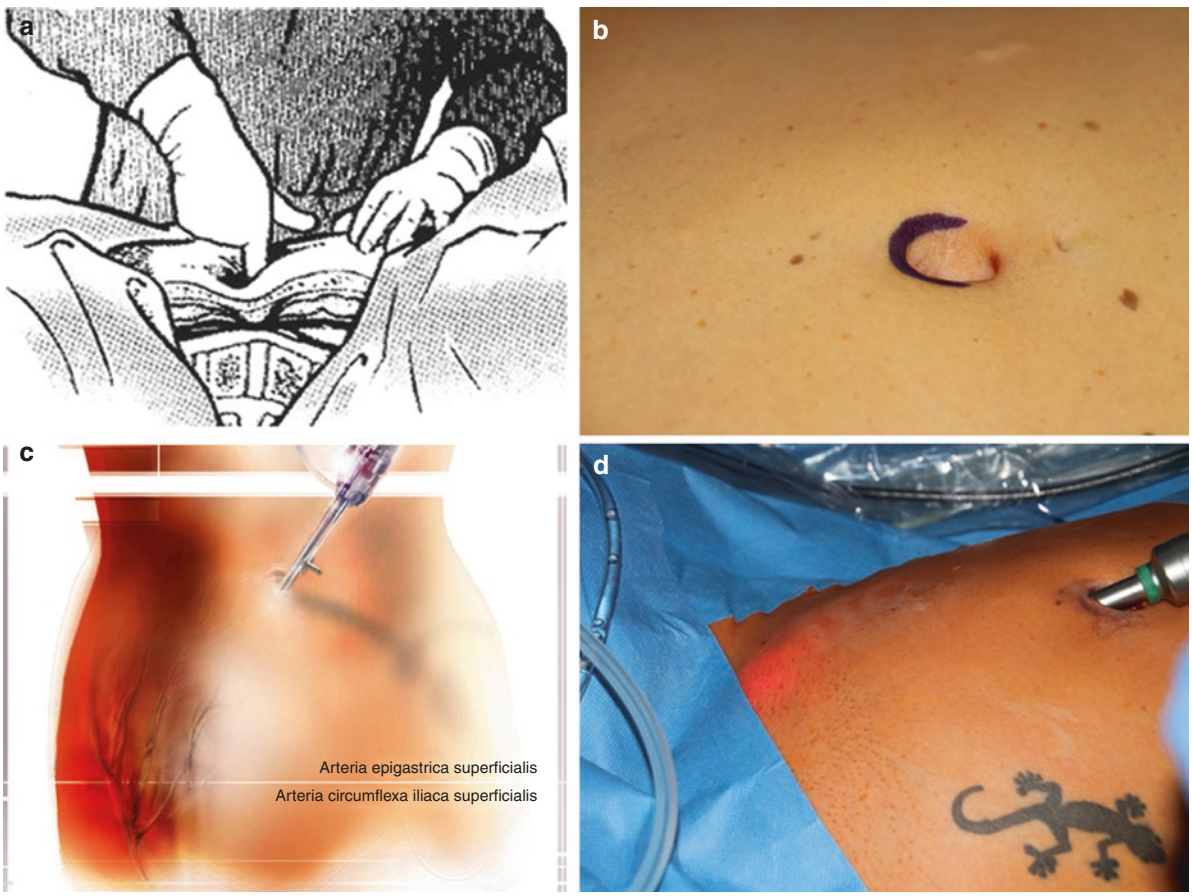


Fig. 35.33 (**a**) Typical point of palpation in the subumbilical region. The fingertip is pointing to the promontory.Subumbilical incision and local palpation reveal the short distance from the skin to the spine (**b–d**). Diaphanoscopy illuminates the region of insertion of the ancillary trocars while demarcating the superficial epigastric artery and the superficial circumflex iliac artery

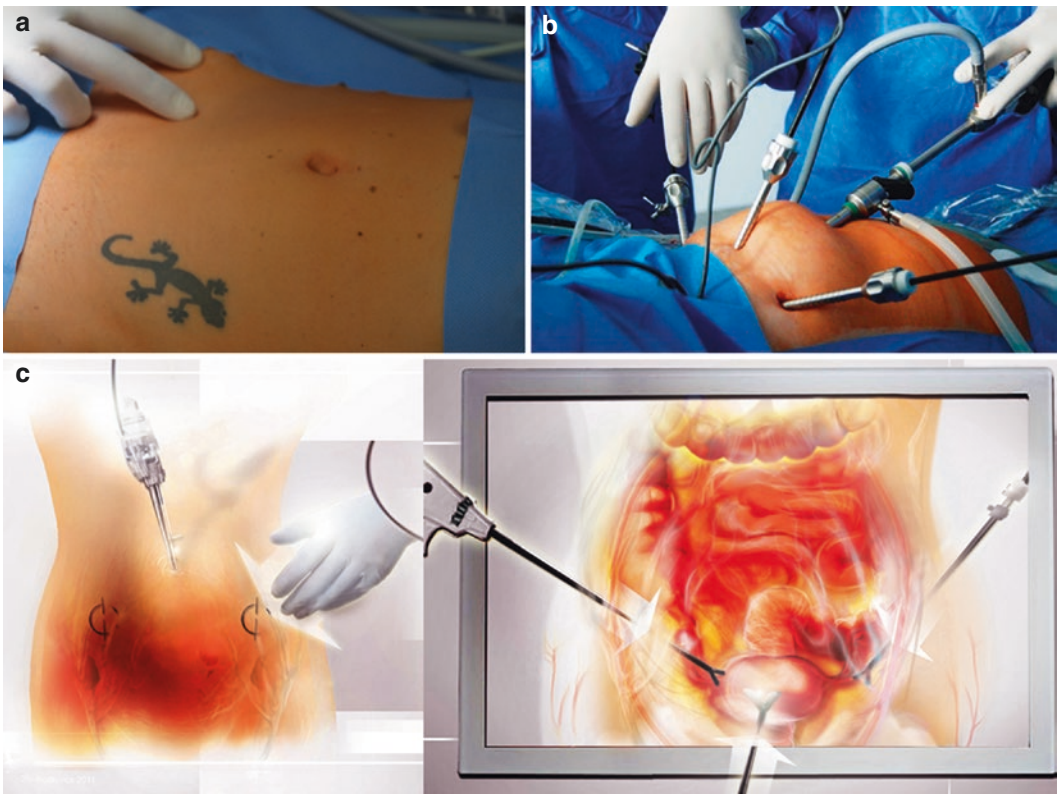


Fig. 35.34 (**a**, **c**) Point of insertion from the outside (two thumbs medial to the anterior superior spine), at a 90 ° angle to the surface, with penetration of all layers of the abdominal wall. Trocar insertion site lateral to the lateral umbilical fold. (**b**, **d**) Overview after insertion of the laparoscope and 3 ancillary trocars

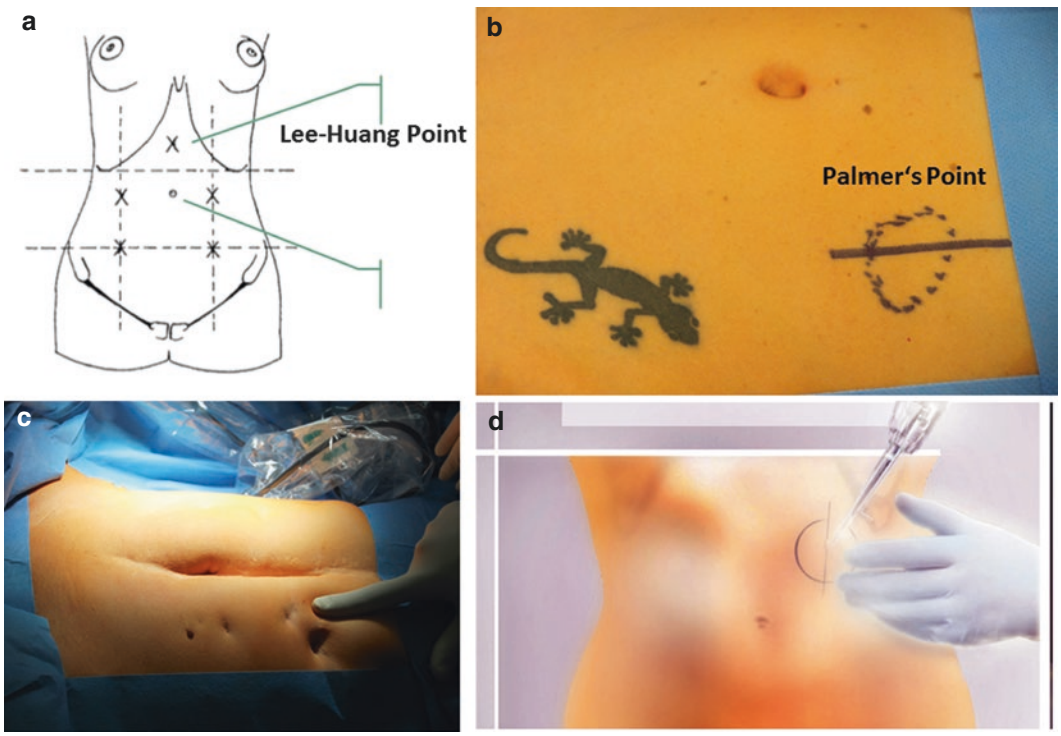


Fig. 35.35 Alternative entry site showing (**a**), in cases of a large uterus, especially at or above the level of the umbilicus, the Lee-Huang point. This point is recommended for video-assisted laparoscopy or in cases of anticipated adhesions in the region of Palmer's point (**c**). (**b**–**d**) Palmer's point is situated in the midclavicular line, about 3 cm below the costal margin

The Veress needle must be tested to ensure that the valve springs, and that gas flow is between 6 and 8 mmHg. In this position the insertion of the primary instrument at a 45° angle toward the uterus involves the least risk of damaging the major vessels coursing downward retroperitoneally. The abdominal wall should be lifted before inserting the instrument. In obese patients the insertion angle is close to 90°, whereas in slim patients the angle is close to 45°. If the first attempt fails, a second attempt is made before selecting an alternative entry site. Before placing the Veress needle, a number of safety checks should be performed in order to minimize the risk of complications:

Usually *two clicks* are heard: the first after perforation of the muscle fascia and the second after perforation of the peritoneum. Proper needle placement is ensured by keeping the Veress needle between the thumb and the index finger. *Aspiration test*: Injection of 5–10 ml of physiological saline solution results in negative aspiration when the Veress needle is correctly placed and yields a blood-tinged aspirate, or one with intestinal contents when the needle is placed in a blood vessel or the intestine. *Hanging drop test and "fluid in flow"*: With the Veress needle placed in the abdominal cavity, lifting the abdominal wall creates negative intraabdominal pressure. A drop of water is then placed on the open end of the Veress needle. If the needle is correctly positioned, the water will move down the shaft.

Any movement of the needle after placement must be avoided as this may convert a small needlepoint injury into a complex and threatening tear. After ensuring that the Veress needle has been positioned correctly, the insufflation is started. Once adequate gas flow and pressure have been achieved, the influx can be raised so that 2–3 l of CO_2 gas can be insufflated per minute until 3–6 l have been insufflated, depending on the patient's size and obesity. After an insufflation volume of about 300 ml, percussion of the liver region will confirm the *loss of liver dullness*, which is a reliable sign of proper positioning of the Veress needle and the creation of a pneumoperitoneum. Abdominal pressure should then be increased to 20–25 mmHg before inserting the primary trocar because this maximizes the distension of the abdominal wall from all underlying structures (Fig. 35.36) [27].

The optic trocar is inserted in two steps. In the first step, a 5-mm optic trocar and the laparoscope are inserted to confirm the pneumoperitoneum and the absence of local adhesions. Dilation to 10 mm is achieved in the second step, either under sight or blindly, thus ensuring optimum visibility during the operation.

Step 1: Entry is performed by a Z *technique*in the following manner: After proceeding forward with the trocar forward to about 1.5 cm, the tip is moved to about 1.5 cm to the right at a 90° angle. The abdominal wall is lifted in the same

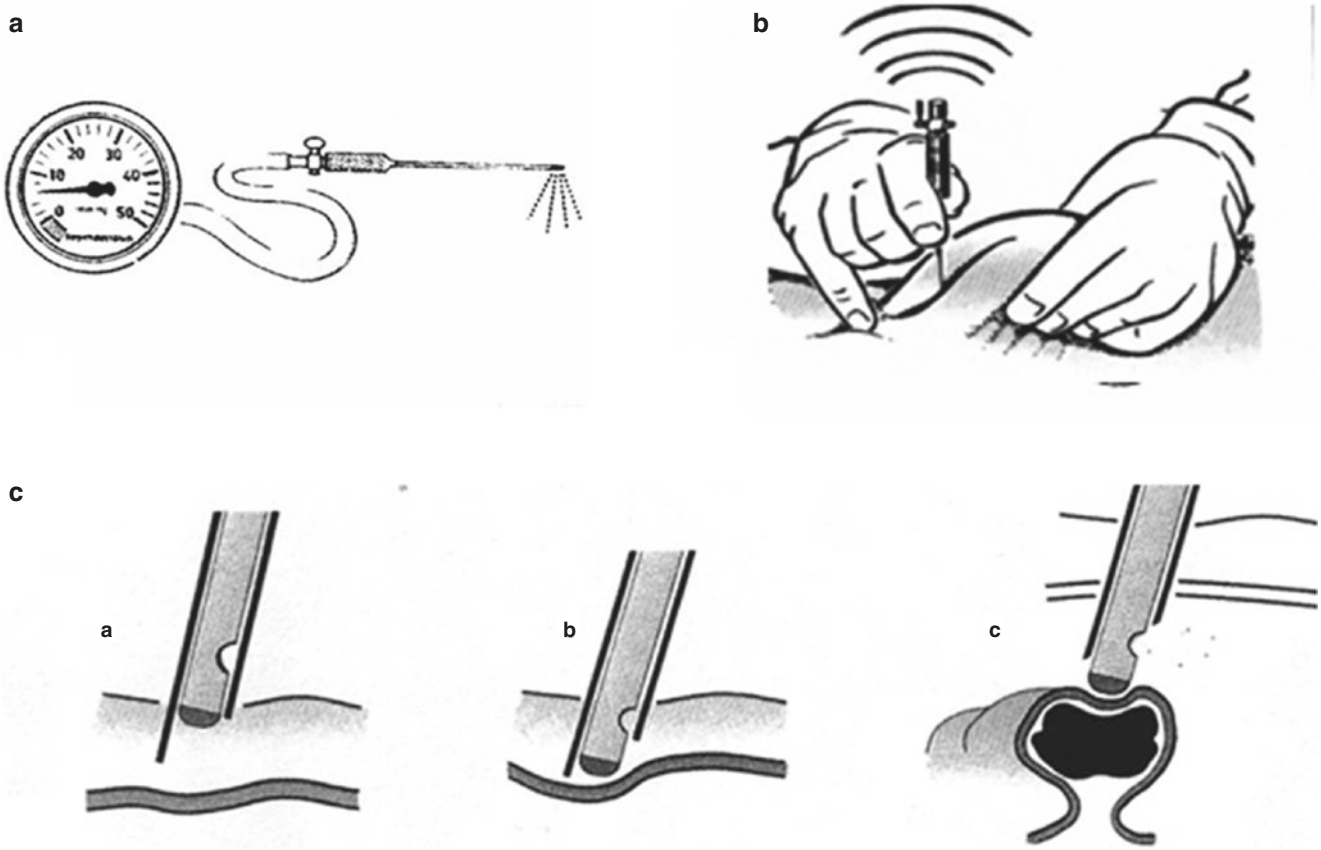


Fig. 35.36 (**a**) Veress needle and its insertion. The pressure going through the needle is measured. (**b**) The safety mechanism avoids damage or injury to the bowel or vessels. By lifting the abdominal wall the distance to the structures below (bowel and vessels) is increased. (**c**) Perforation of the outer skin is performed by the sharp tip of the needle. While running through soft tissue the blunt tip jumps forward by means of a spring mechanism. The same mechanism prevents bowel injury after penetrating the peritoneum

manner as when inserting the Veress needle, and the trocar is screwed with the dominant hand straight into the abdominal wall at a 90° angle, towards the hollow of the sacrum.

Correct placement of the trocar is indicated by a hissing sound when gas escapes through the open valve of the trocar. The obturator is then removed and the trocar is held in place. Before dilating to 10 mm, a 5-mm laparoscope is introduced and rotated through 360° to check visually for any bleeding, intraabdominal abnormality, or adherent bowel loops. If the surgeon suspects adherence of the bowel in the umbilical region, the primary trocar site must be visualized from a secondary port site, such as the lower abdominal wall, with a 5-mm laparoscope.

Step 2: A blunt palpation probe is placed in the 5-mm trocar; the shaft is pulled over the palpation probe and taken out. A 10-mm trocar is then screwed into the abdominal cavity [27].

Subcostal Insufflation Technique (Palmer's Point or Lee Huang Point)

No entry technique is entirely devoid of the risk of gas embolism or injury to vessels, intestines, or the urinary tract. Palmer's point is the safest laparoscopic entry point because it is least likely to be affected by adhesions.

For all patients with a significantly higher risk of adhesion, a history of abdominal surgery including cesarean section, a large fibroid uterus, umbilical hernia, large ovarian cysts, preperitoneal gas insufflation or failed umbilical entry, Palmer described in 1974 an abdominal entry point in the midclavicular line, about 3 cm below the costal margin. Palmer's point can be used for the Veress needle as well as for small trocars. In case adhesions are suspected in the subcostal region on the left side, the Lee Huang point in the midline is a suitable alternative (Fig. 35.35) [27].

Ancillary Trocars

All ancillary trocars must be inserted with an intraabdominal pressure of 15–20 mmHg under direct vision. The inferior epigastric vessels are visualized laparoscopically whereas the superficial vessels can be visualized by diaphanoscopy.

Once the tip of the trocar has pierced the peritoneum, it should be angulated in the direction of the uterine fundus under visual control until the port is placed correctly and the sharp tip can be removed.

Before inserting any ancillary trocars, the patient is moved into the Trendelenburg position. Premature Trendelenburg positioning may increase the risk of retroperitoneal vascular injury because the iliac vessels are located exactly in the axis of a preconceived 45° insertion angle, especially in slim patients with minimal retroperitoneal fat. The number of ancillary trocars is variable; all of them must be inserted under direct vision. If two working trocars are needed, they should be placed in the lower quadrant above the pubic hairline lateral to the deep epigastric vessels from the interior view. From the exterior view the trocars are placed two fingers medial to the anterior superior iliac spine. Two major superficial vessels - the superficial epigastric artery and the superficial circumflex iliac artery - must be avoided. These vessels can be visualized by diaphanoscopy. When a third ancillary trocar is required, the suprapubic midline is the most common site. Diaphanoscopy cannot be relied upon to locate the deep vessels, especially in obese patients (Figs. 35.37 and 35.38).

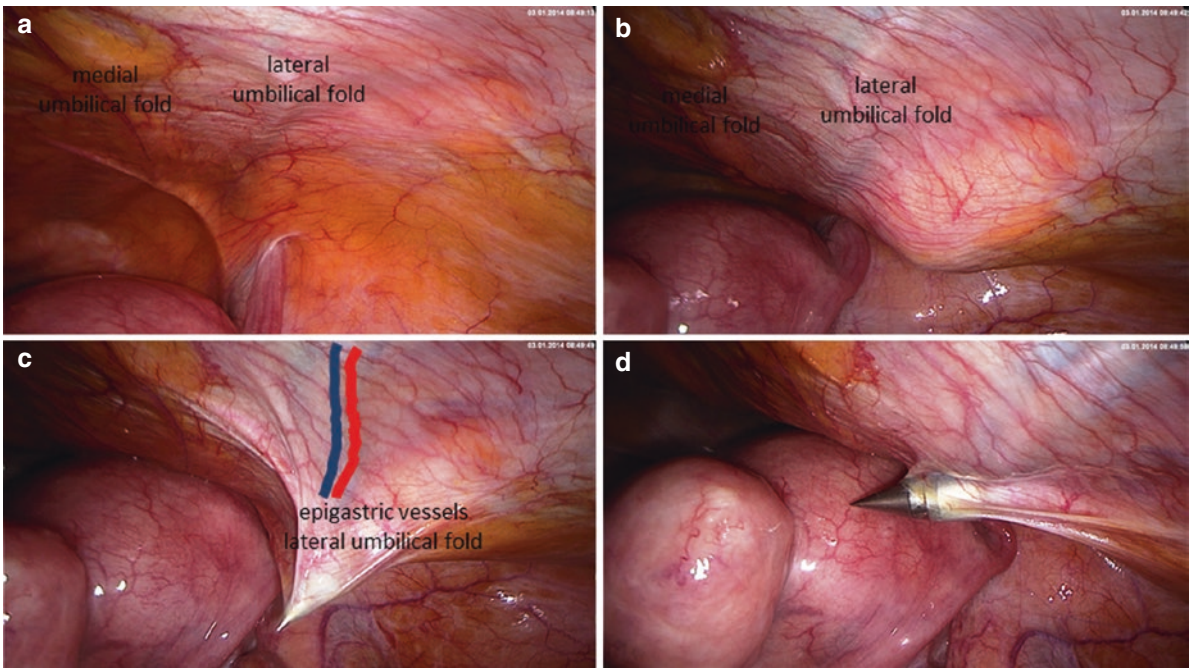


Fig. 35.37 Secondary trocar placement, entry in the right lower abdomen. (**a**) The three different plicae are visualized. (**b**) The palpating finger is showing the area lateral to the lateral umbilical fold. (**c**) Entry of the sharp ancillary trocar lateral to the lateral umbilical fold. (**d**) Once the peritoneum has been penetrated, the trocar points to the fundus of the uterus in order to avoid injury to the major vessels and the bowel

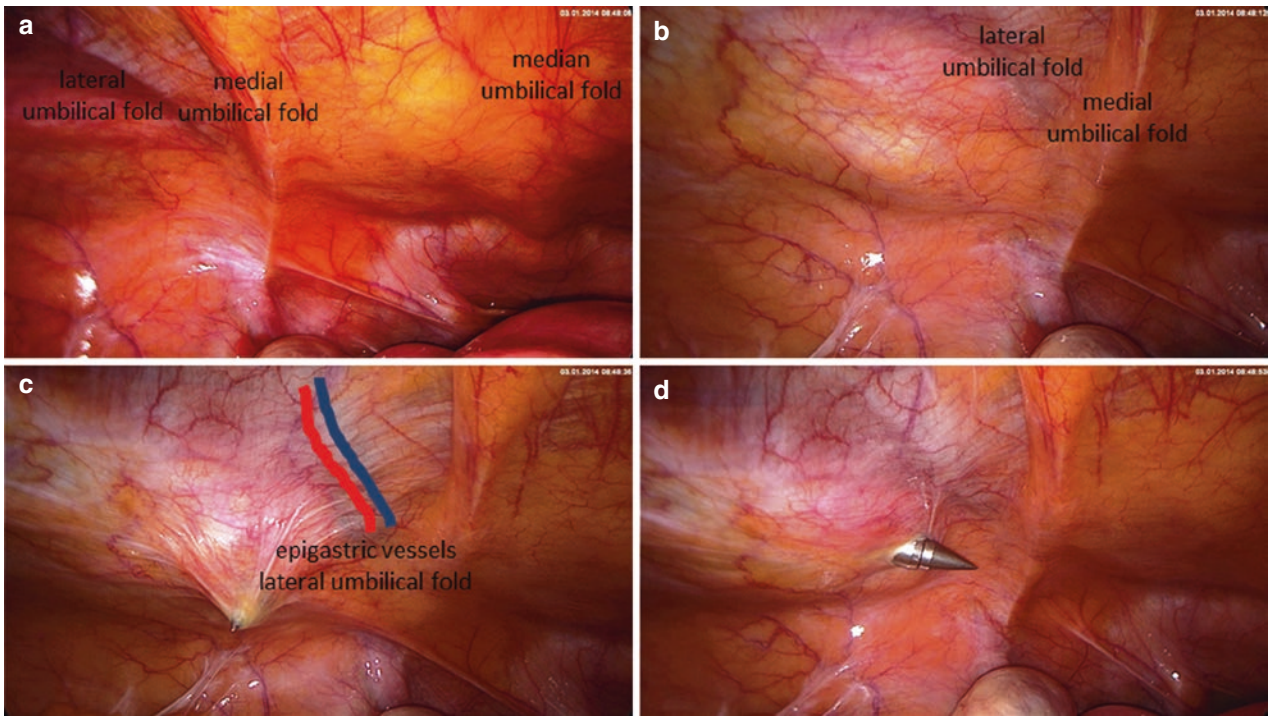


Fig. 35.38 Secondary trocar placement, entry in the left lower abdomen.(**a**) The three plicae are visualized. (**b**) The palpating finger is showing the area lateral to the lateral umbilical fold. (**c**) Entry of the sharp ancillary trocar lateral to the lateral umbilical fold. (**d**) Once the peritoneum has been penetrated, the trocar points to the fundus of the uterus in order to avoid injury to the major vessels and the bowel

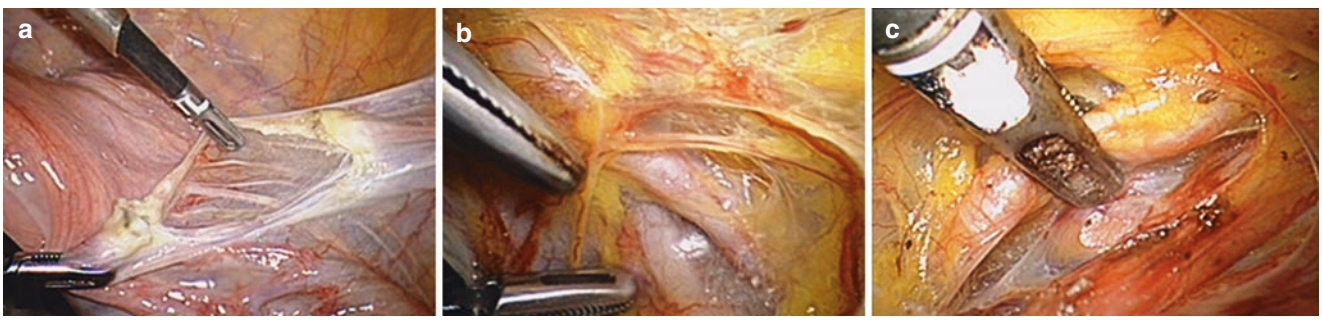


Fig. 35.39 Technique 1: The first step consists of opening the anterior leaf of the broad ligament (**a**). The round ligament is kept intact. The lower crossing of the ureter and the uterine artery are identified (**b**); the uterine artery can be coagulated directly after its point of departure from the internal iliac artery (**c**)

Finger-tapping from the outside can be used to verify correction positioning of the trocar. A small skin incision should be performed before the trocar sleeve is inserted. The trocars must be inserted by the shortest route at a 90° angle to the skin surface so that the risk of injuring structures on the way to the abdominal wall is minimized. When inserting a trocar in the midline, the Foley catheter must be identified in order to avoid accidental bladder perforation [27, 31].

Step 3

Surgical Steps

Resection of endometriosis

The primary sept in hysterectomy is removal of all visible endometriosis spots. These may be superficial and easy to excise (Figs. 35.15 and 35.16), or adherent to more delicate structures and difficult to eliminate (Figs. 35.17 and 35.18).

Laparoscopic Total Hysterectomy (LTH)

In patients being operated on for surgical staging, the surgeon will be able to assess the abdomen, pelvis, obtain pelvic washings, perform salpingo-oophorectomy, lymph node dissection, tissue biopsies and omentectomy in addition to laparoscopic hysterectomy.

(Technique 1: Primary uterine artery ligation)

The next step is to coagulate and separate the round ligament near the pelvic side wall (Fig. 35.39a). The peritoneum is then incised further. The anterior leaf of the broad ligament is opened to the bladder fold and the bladder is pushed

downwards. The posterior leaf of the broad ligament is visualized and the ureters are lateralized. The retroperitoneal space is then exposed, the course of the ureters demonstrated, and the site of exit of the uterine artery from the iliac artery visualized (Fig. 35.39b). The crossing point of the uterine artery and the ureter is exposed and the uterine artery coagulated (Fig. 35.39c). The bladder pillar is identified, coagulated, and separated. This is followed by separation of the ovary and the tube from the uterus. If the adnexa – after ensuring a sufficient distance from the ureters – are to be dissected along with the uterus, the infundibulopelvic ligament should be coagulated and the mesosalpinx and mesovarium dissected in the direction of fenestration. The fenestration is a useful point of orientation to safeguard the ureter [32–34] .

(Technique 2: Classic intrafascial hysterectomy):

Surgical Steps

3.1 Inspection of the pelvis, tracing the ureters and planning theoperation (Figs. 35.40 and 35.41)
3.2 Start on the right side. Push the uterus in the opposite direction when separating the adnexa or the ligaments from the pelvic sidewall, with the assistance of the intrauterine manipulator or by traction (Figs. 35.42 and 35.43).
3.3 Division of the infundibulopelvic ligament and round ligament from the pelvic sidewall or, when the adnexa are retained, separation of the adnexa from the uterus (Figs. 35.44, 35.45, 35.46, 35.47 and 35.48).
3.4 Dissection of the broad ligament: The broad ligament is opened and each leaf coagulated separately (Figs. 35.49, 35.50 and 35.51). This is not possible when a sealing and cutting instrument is used, because the two leaves of the broad ligament are sealed together. The direction of exposure is as close to the uterus as possible but as distant as necessary, thus avoiding exposure close to the sidewall and the ureter (Fig. 35.52).
3.5 Separation of the bladder from the uterus by opening the vesicouterine ligament and pushing the bladder downward by about 1–2 cm (Fig. 35.51b and c).

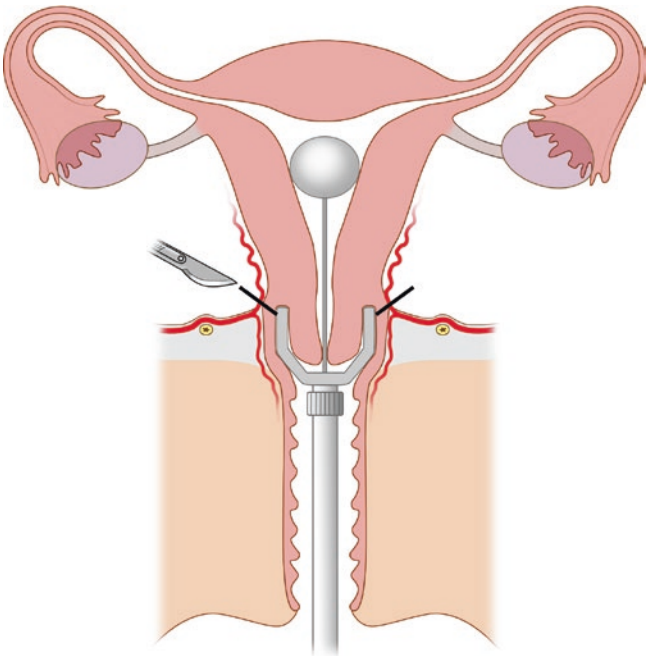


Fig. 35.41 Schematic illustration of the resection line in total laparoscopic hysterectomy. Only the ascending branch of the uterine artery needs to be coagulated and cut on the uterine manipulator. When adhering closely to this operative technique, the ureter is located at a safe distance from the coagulation zone (about 2 cm)

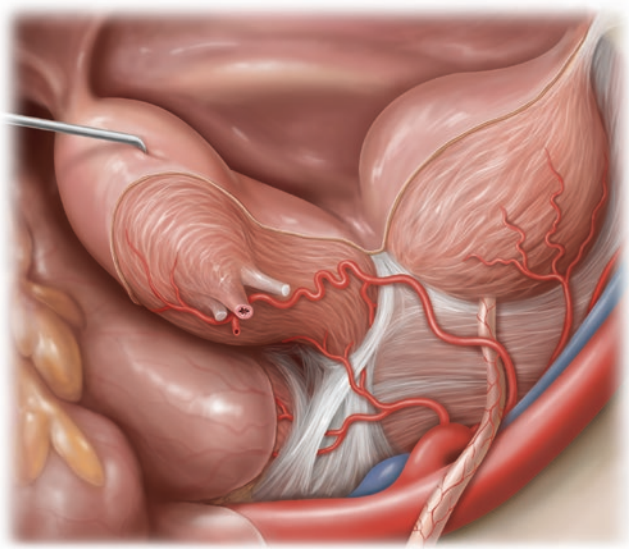


Fig. 35.40 Anatomical illustration showing the relation of the uterine vessel to the ureter in the pelvic wall, compared to its location close to the uterus. The helical course of the ascending branch of the uterine artery can be easily followed. The uterus, bladder and rectum are embedded in a ligament-based pelvic floor

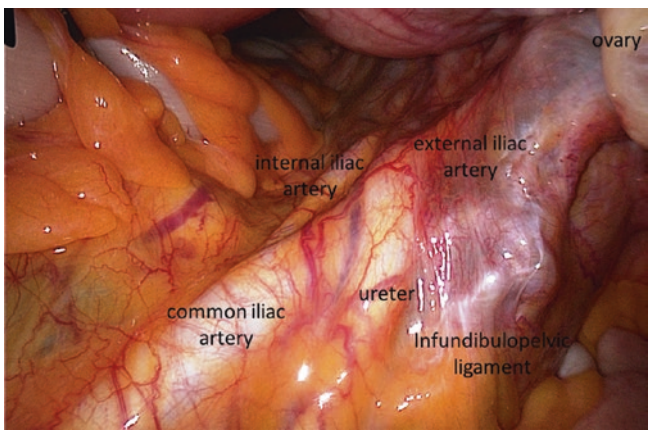


Fig. 35.42 Preliminary inspection of the uterus and the surrounding organs. The lower pelvis as well as the ligaments, vessels and the ureter can be differentiated in relation to the uterus. In slim patients the crossing of the ureter and the common iliac artery can be seen. The infundibulopelvic ligament is identified and held towards the lateral wall in order to obtain a better view of the field of surgery

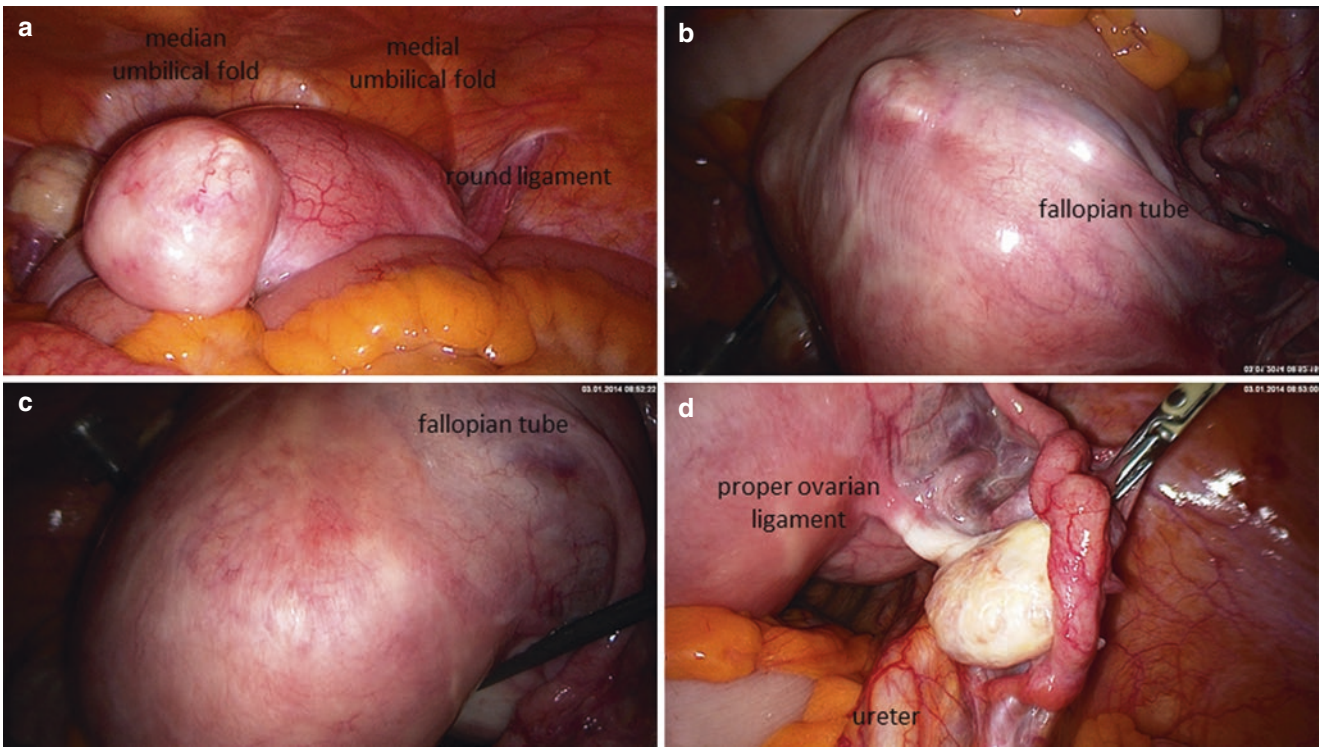


Fig. 35.43 (**a**) Reconstruction of the anatomy of the right pelvic wall. (**b**) Only the fallopian tube is visible at first glance on the right side. (**c**) After mobilization of the uterus a large fibroid on the back wall can be seen. (**d**) The bifurcation of the common iliac artery and the crossing of the ureter are clearly visible. The infundibulopelvic ligament and the ovarian vessels are situated lateral to the ureter. The infundibulopelvic ligament might be fixed to the bowel (especially on the left side) and cause difficulties when exposing the adnexa

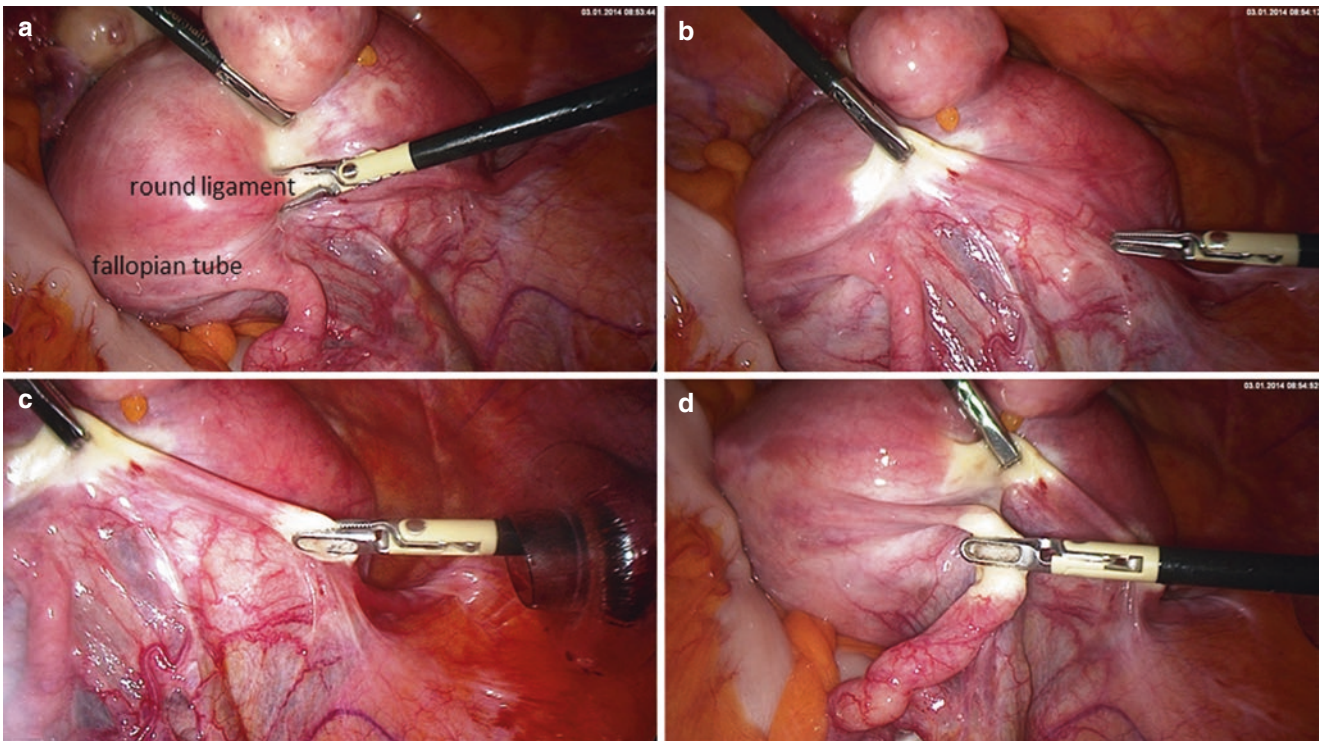


Fig. 35.44 Stepwise bipolar coagulation of the right tube and the right round ligament. (**a–b**) The round ligament is coagulated so that a sharp instrument can be used to pull the tissue without causing bleeding that might impede vision. (**c**) In benign cases the round ligament can be cut close to the uterus, in malignant cases the round ligament is cut very laterally. (**d**) This allows complete inspection of the tube and it can selectively be coagulated and cut

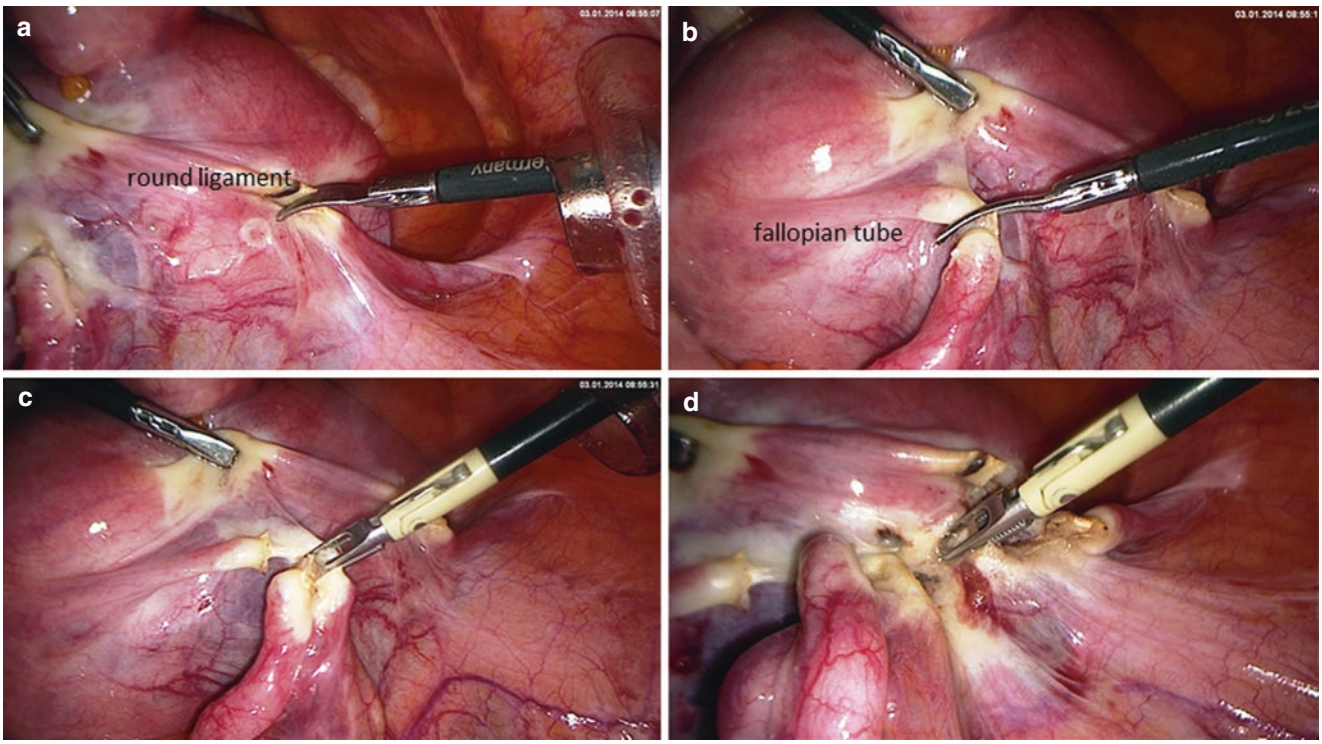


Fig. 35.45 Stepwise dissection of the right tube and the round ligament.(**a**, **b**) The curved scissors are held with the tip away from the uterine wall. (**c**, **d**) After dissecting the fallopian tube, the vessels running underneath must be coagulated before further cutting

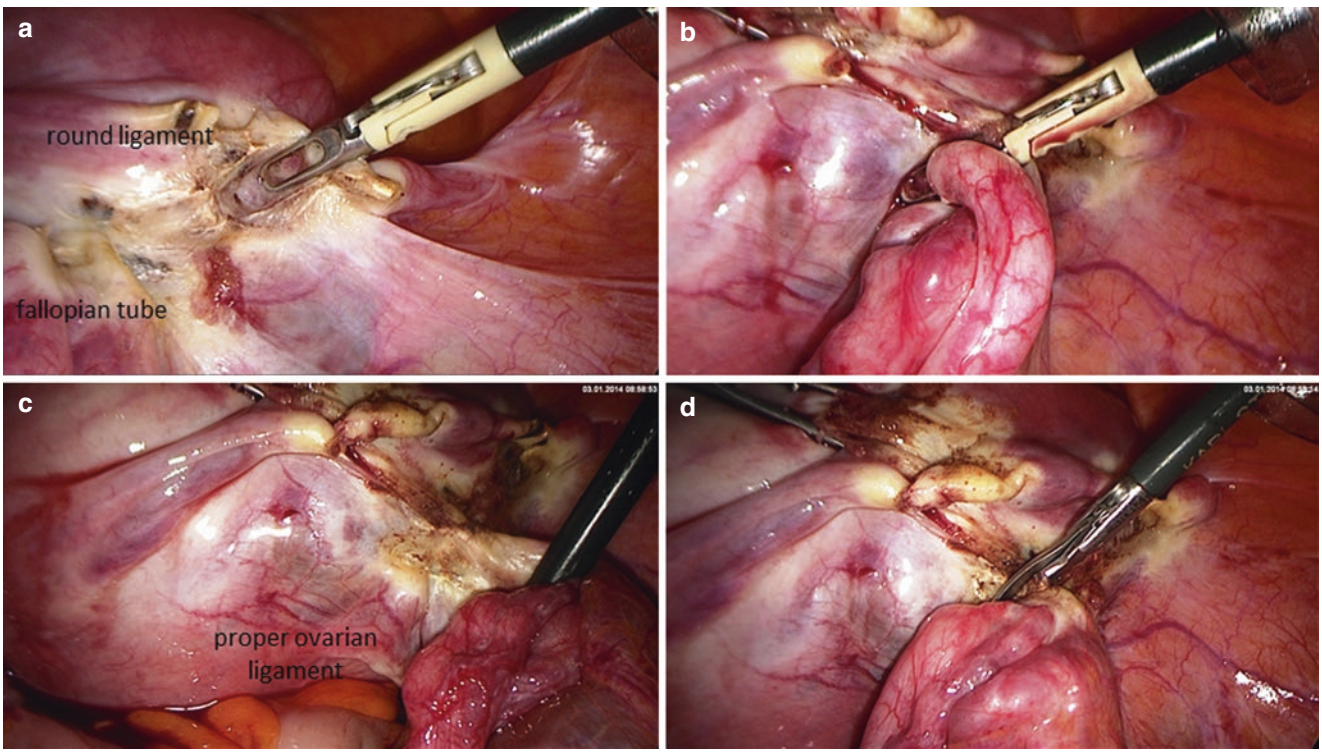


Fig. 35.46 Continuous stepwise dissection and exposure for opening the broad ligament. With traction on tissue, the line of exposure can be easily demarcated (**a**, **c**). Coagulation involves the entire tissue, but the cutting line strictly omits the uterine wall (**b**, **d**). Cutting the tube at this stage provides a better overview for exposure in the following steps. The tube can be removed easily after the hysterectomy

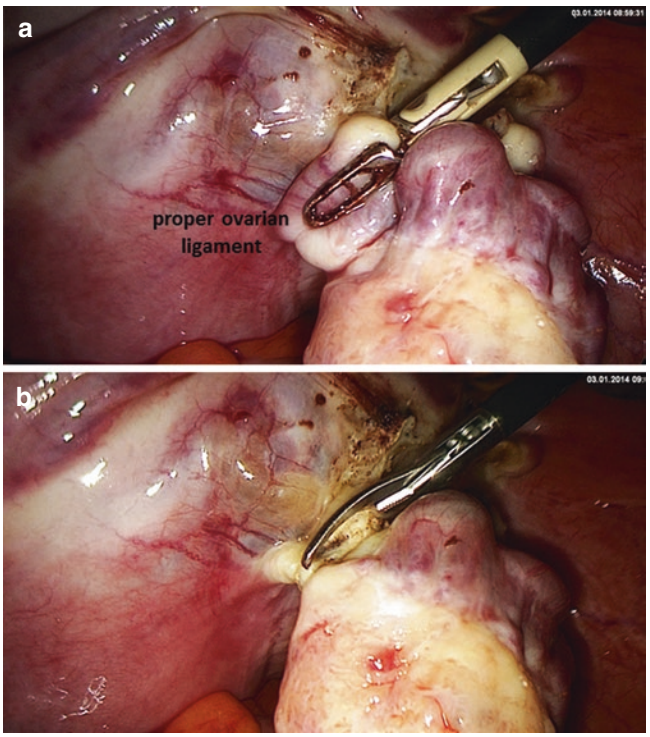


Fig. 35.47 (**a**) Coagulation of the proper ovarian ligament and (**b**) dissection without involving the uterine or the ovarian wall

3.6 Presentation of the ascending branch of the uterine artery and separation of the uterine pedicles (Fig. 35.53).

3.7 Identical stepwise dissection of the left adnexa (Figs. 35.54 and 35.55), opening of the bladder peritoneum and broad ligament (Fig. 35.56), and dissection of the uterine vessels (Figs. 35.57 and 35.58) on the left side. A thorough inspection of the cervix is performed.

3.8 After separation of the bladder from the uterus, the bladder is pushed and dissected down by 2–3 cm to clearly visualize the rim of the cervical cap. In cases of post-cesarean section, a careful, gentle and nearly blunt dissection should be performed (Figs. 35.59, 35.60 and 35.61).

3.9 While lateralizing the ureter by pushing the manipulator upward, the uterine artery and vein with its collaterals are fully coagulated near the cervix and dissected.

The key steps of pushing the bladder down from the anterior vaginal fornix prior to incision and distancing the ureters from the uterine vessels at the cervical/vaginal level can be safely performed by stretching the manipulator firmly cranially, to the contralateral side of the exposure.

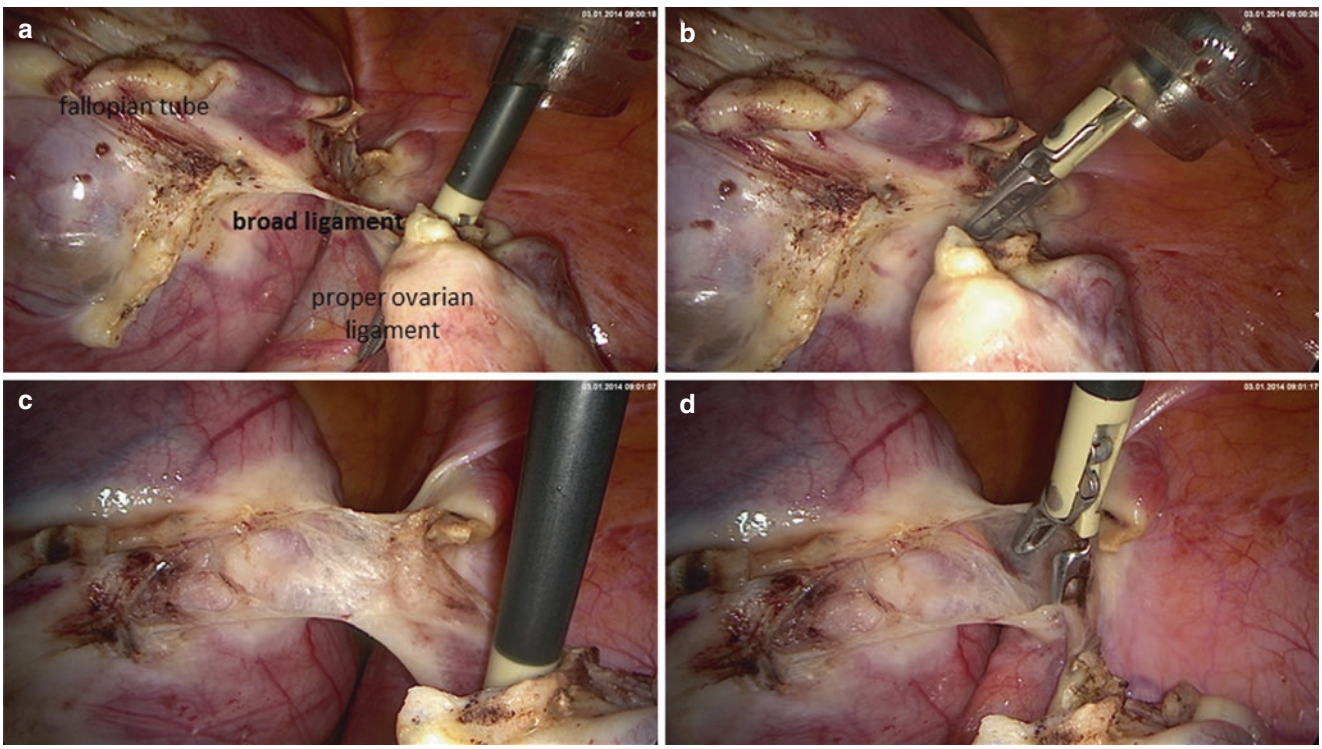


Fig. 35.48 Dissection of the proper ovarian ligament and opening the broad ligament.(**a**) After the proper ovarian ligament has been dissected, the adnexa falls to the lateral aspect. (**b–d**) The broad ligament can then be identified and separated into its two leaves

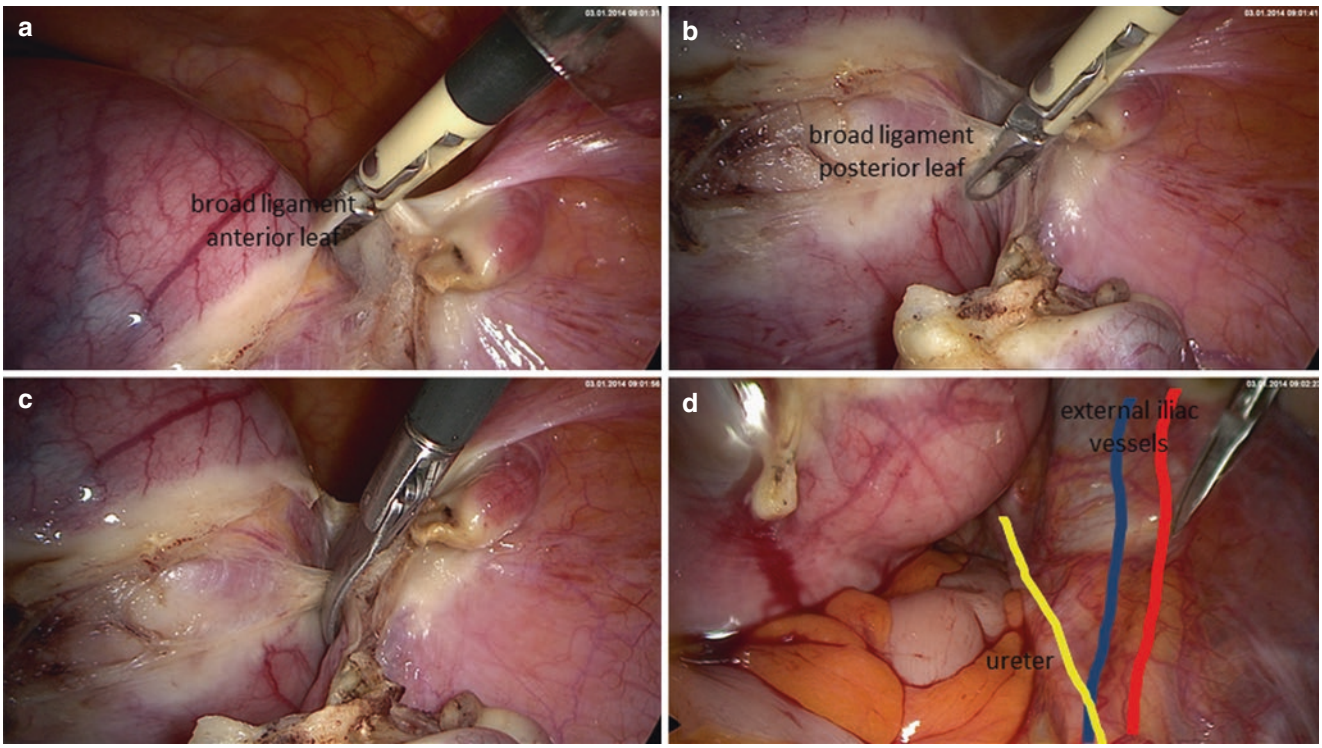


Fig. 35.49 Separation of the anterior and posterior leaf of the broad ligament (**a–**c) in relation to the ureter and the pelvic vessels (**d**).(**a-c**) The broad ligament is coagulated and dissected as close to the uterus as possible without affecting the uterine artery. As the two leaves are separated, the ascending branch of the uterine artery can be visualized easily and omitted. The tip of the scissors is directed strictly away from the uterine wall using the curved blade

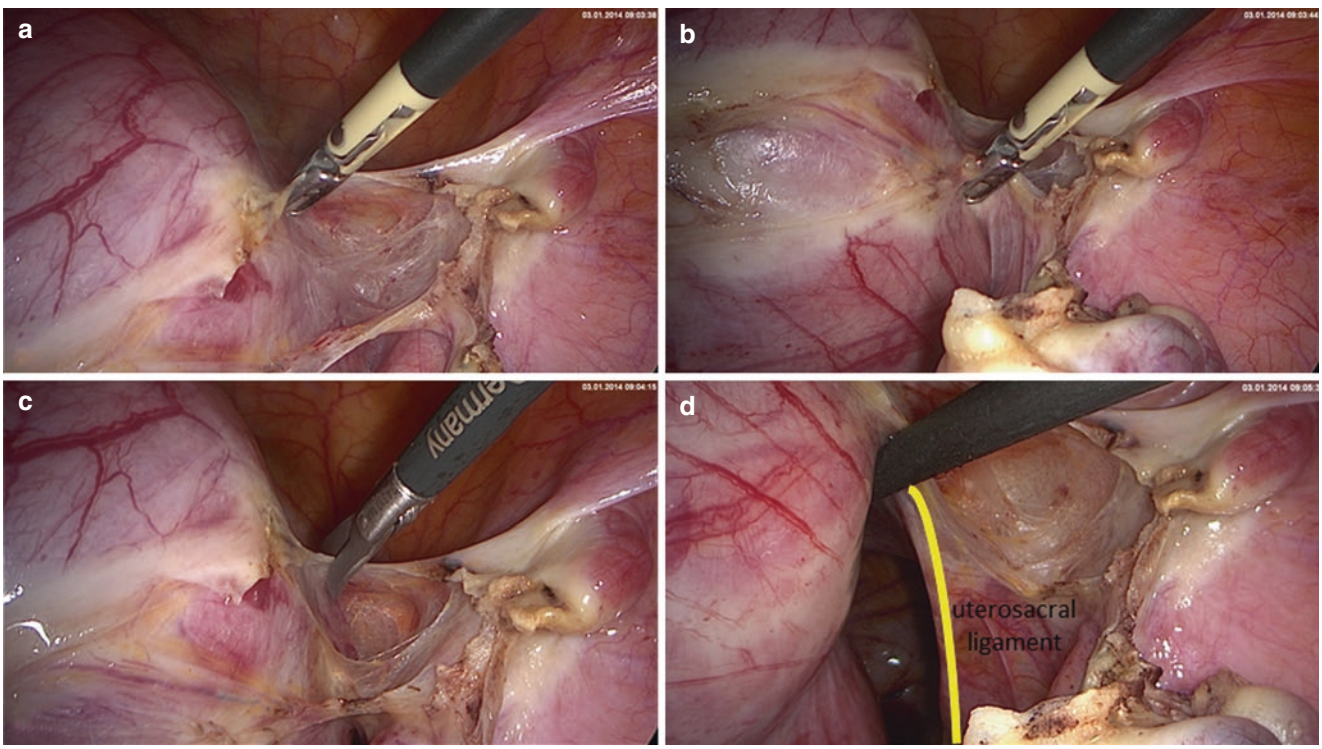


Fig. 35.50 Final separation of the leaves of the broad ligament close to the pelvic floor (**a–c**) and the sacrouterine ligament (**d**). The uterus is pushed to the left side; the bladder peritoneum is close by. (**d**) By blunt manipulation the course of the sacrouterine ligament can be visualized; the line of coagulation should omit this part

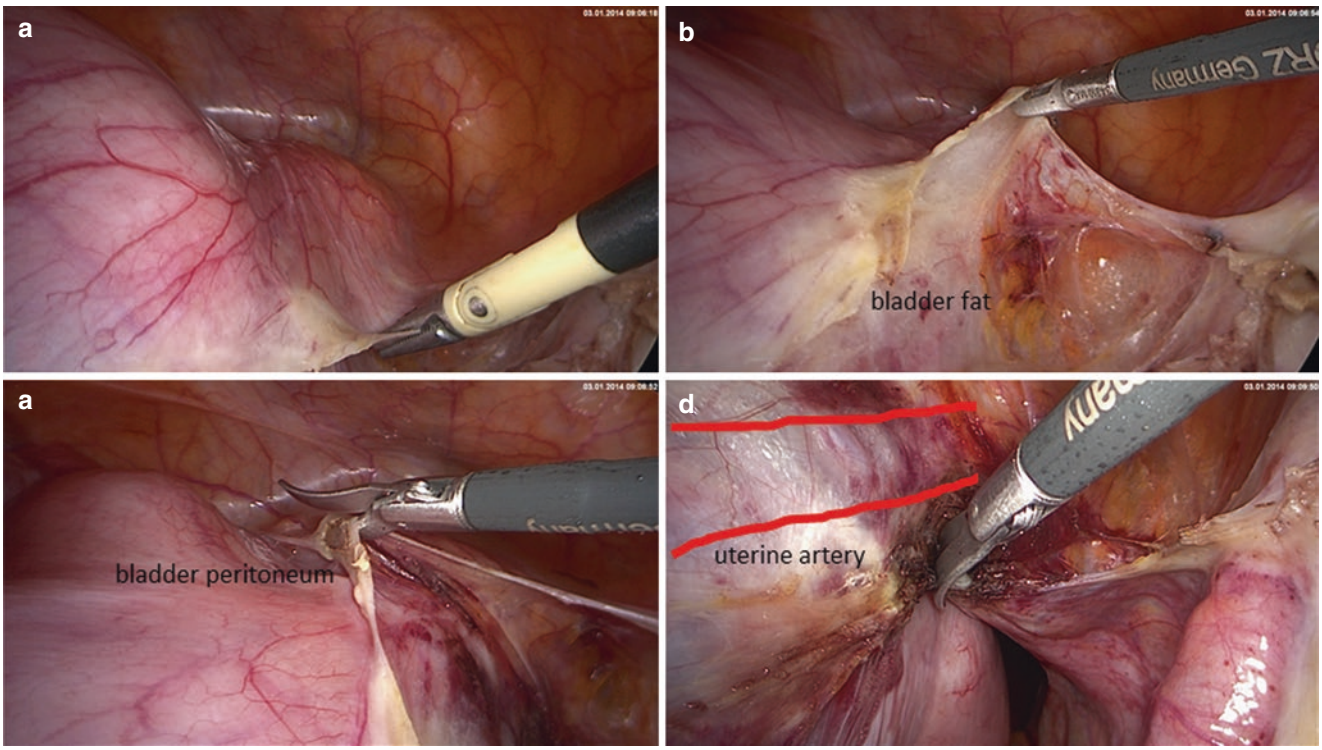


Fig. 35.51 Opening the bladder peritoneum from the right side (**a**–**c**). The beginning of the bladder peritoneum can be easily demarcated; the cutting line should be neither above this zone nor too far into the caudal aspect. Gas enters the created space and shows the beginning of the bladder pillar. The uterine vessel bundle (**d**) is freed by coagulating and dissecting above and below it. The ureter is at a safe distance lateral to this area of exposure

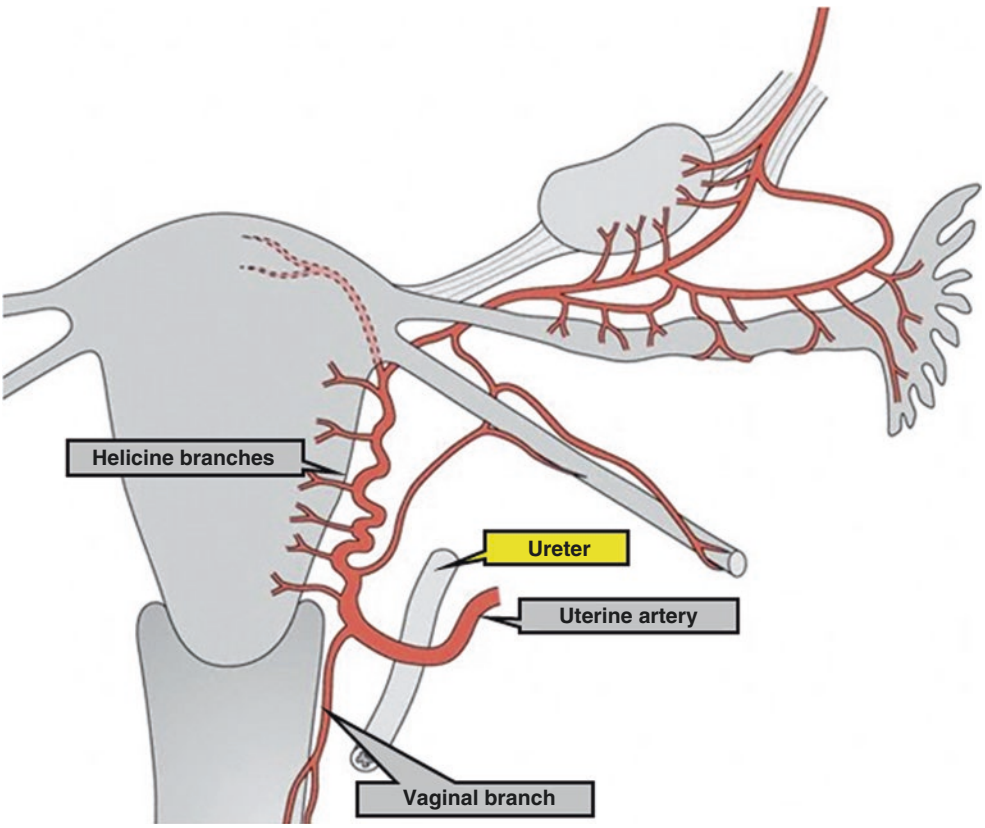


Fig. 35.52 Anatomical schematic illustration showing the spiral structure of the ascending uterine artery. Exposure too close to the uterus may cause arterial bleeding, which can only be stopped after complete coagulation of the uterine artery on the opposite side. The field of surgery would be greatly disturbed by antegrade or retrograde bleeding. The ureter is close to the surgical field only in the lowest part. Pushing the uterus away lateralizes the ureter and moves it to the side

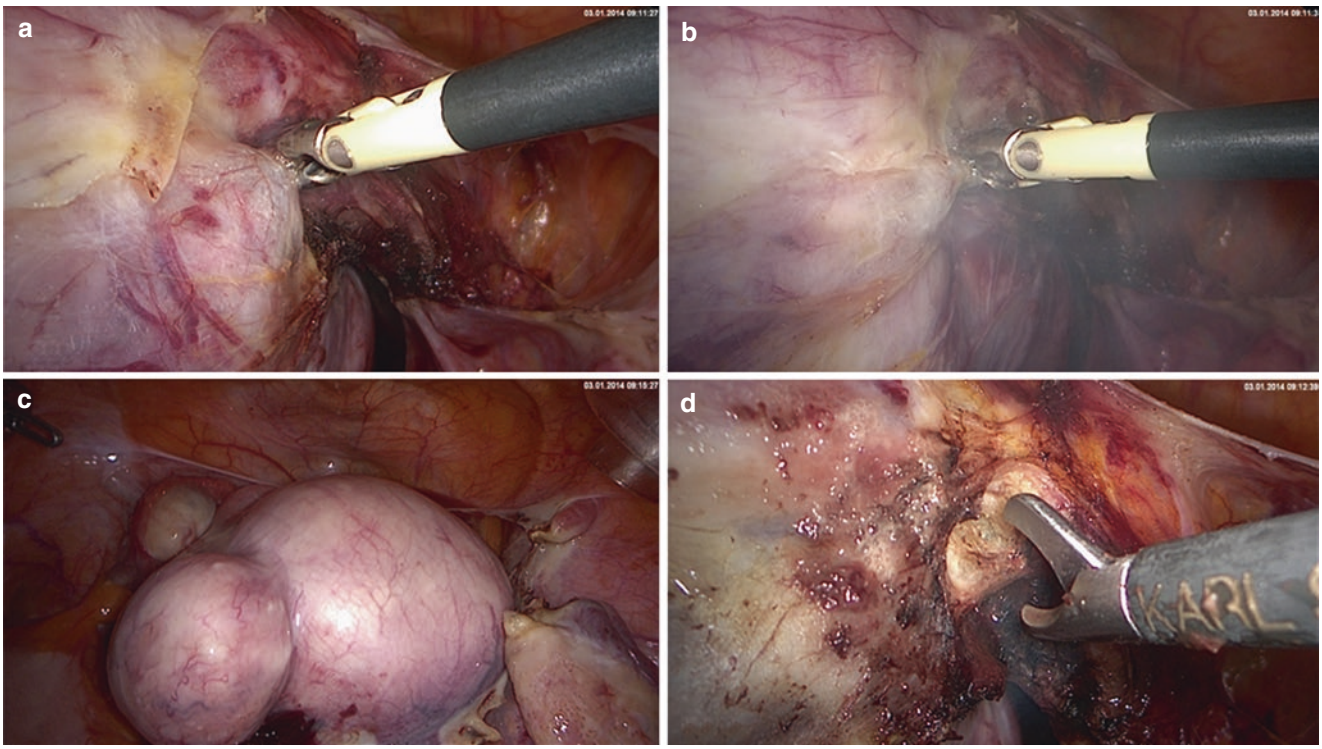


Fig. 35.53 (**a**) Bipolar coagulation and dissection of the uterine vessels. (**b**) The area of coagulation must include the upper part of the artery to avoid retrograde bleeding after dissecting the vessel. (**c**): The color of the uterus changes to whitish/grey. (**d**): A deeper cut can be avoided by using the hook scissors; the uterine artery is dissected in two steps. This allows further coagulation of the tissue lying just behind the artery and avoids cumbersome venous bleeding

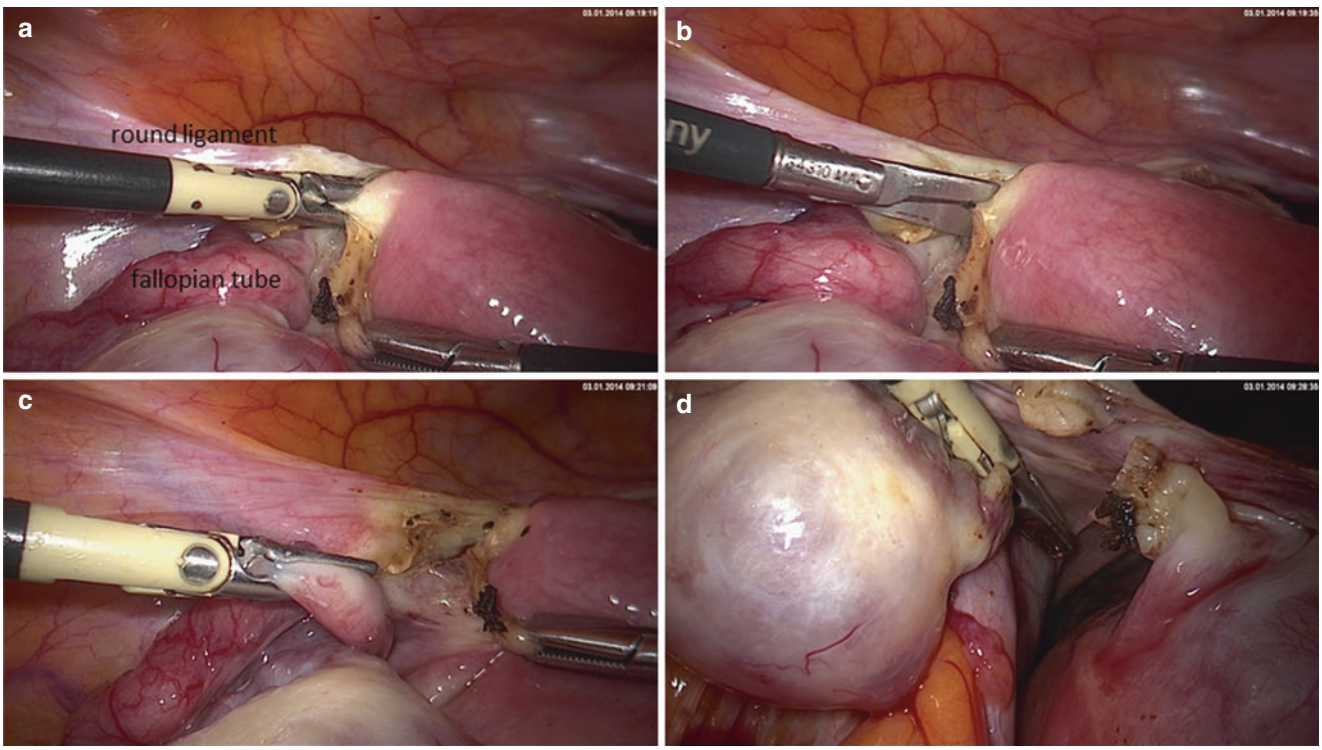


Fig. 35.54 Stepwise coagulation and dissection of the left round ligament and tube (**a**–**c**) and the ovarian ligament (**d**).(**a**, **b**): The curved scissors are held with the tip away from the uterine wall. (**c**, **d**): After dissecting the fallopian tube, the vessels coursing below must be coagulated before further cutting. (**d**): By blunt manipulation the course of the sacrouterine ligament and the uterus can be visualized in patients with lateral myomas. The line of coagulation should omit this part

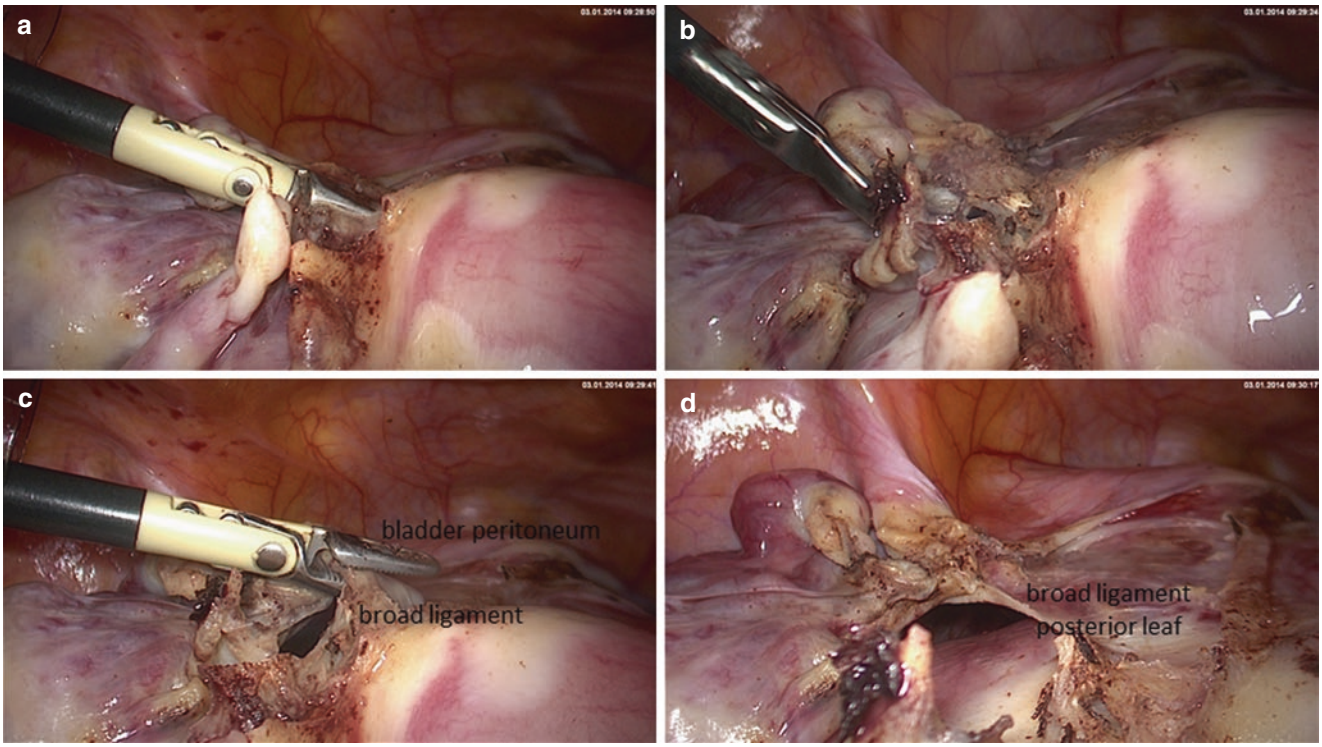


Fig. 35.55 (**a**) Dissection of the bladder peritoneum as well as the anterior and posterior leaf of the broad ligament on the left side. (**b**) Blunt manipulation shows the exact anatomical path of the left adnexa avoiding the wrong surgical route. (**c**) Coagulation is performed as close as possible to the uterus. (**d**) The bladder peritoneum has already been opened from the right side and the posterior leaf of the broad ligament serves as an anatomic landmark for the uterine vessels

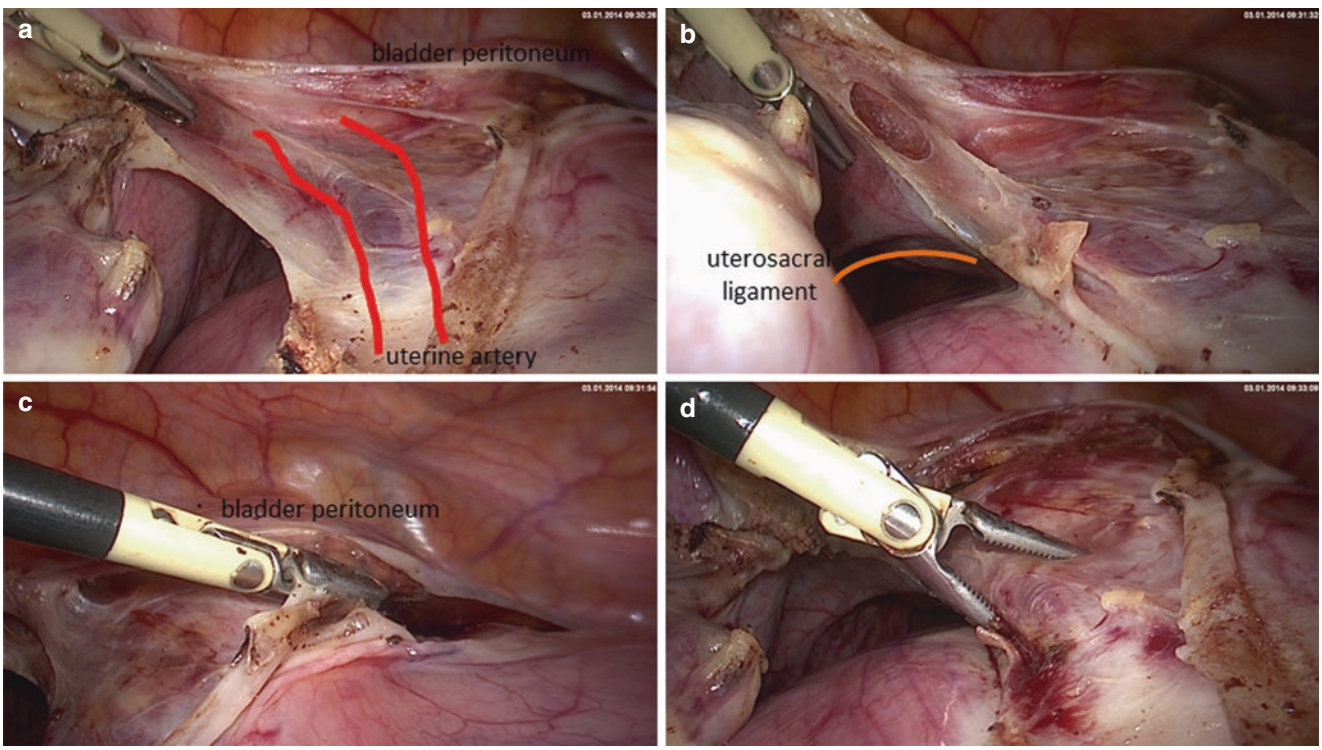


Fig. 35.56 Further opening of the bladder peritoneum and the broad ligament (**a**–**c**), and commencement of coagulation of the left uterine vessels (**d**). The uterine artery functions as an anatomic landmark leading downward (**a**). An intermediate glance at the back of the uterus shows that the cutting edge is above the conjunction of the sacrouterine ligaments

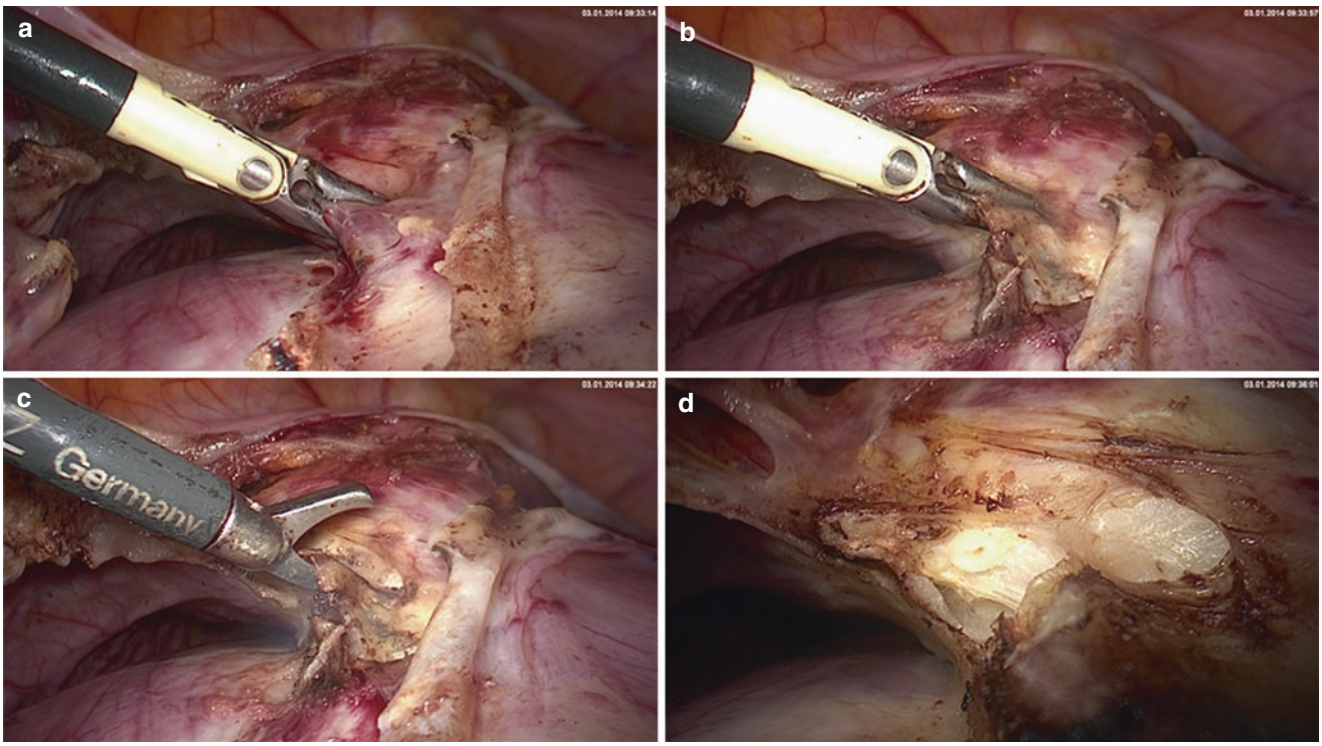


Fig. 35.57 Bipolar coagulation and separation of the uterine vessels on the left side. (**a**) The area of coagulation should include the upper parts of the artery to avoid any retrograde bleeding after dissection of the vessel (**b**). The color of the uterus changes to whitish/grey. (**c**–**d**): A deeper cut can be avoided by using the hook scissors; the uterine artery is dissected in two steps. This allows further coagulation of the tissue lying just behind the artery and avoids cumbersome venous bleeding

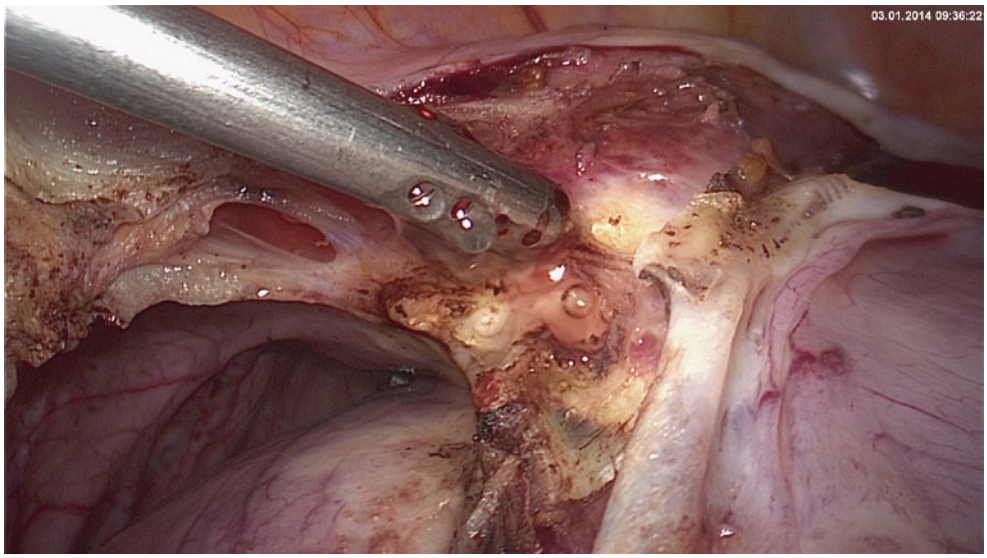


Fig. 35.58 Visualization of the separated left uterine pedicles. A few drops of physiological saline solution render the bipolar coagulation more effective because of better electrolyte flow, especially when the field of operation is very dry

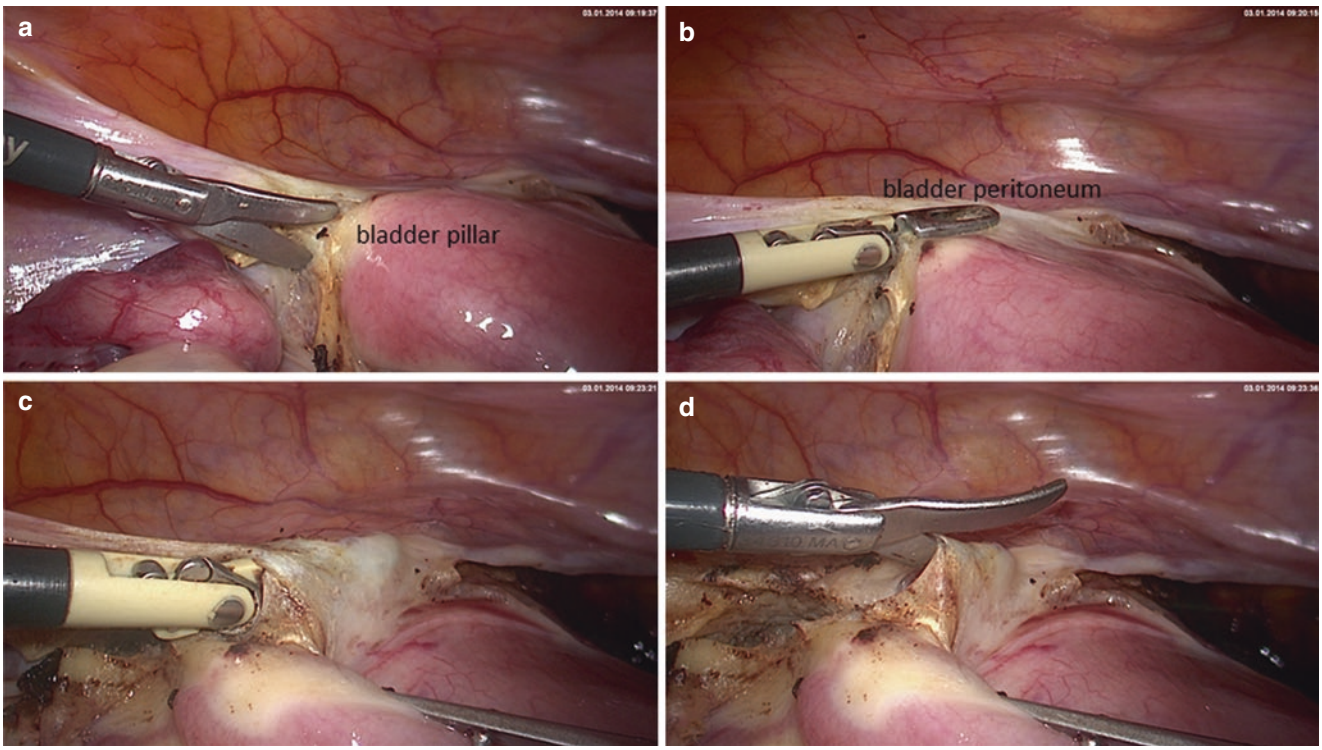


Fig. 35.59 (**a**) Final dissection of the bladder pillar and the bladder peritoneum (**b**) from left to right, (**c**) allowing the CO_2 distension medium to show the way. (**d**) The bladder is pushed safely downward from the field of operation and the peritoneal line of the vesicouterine fold is easily recognized

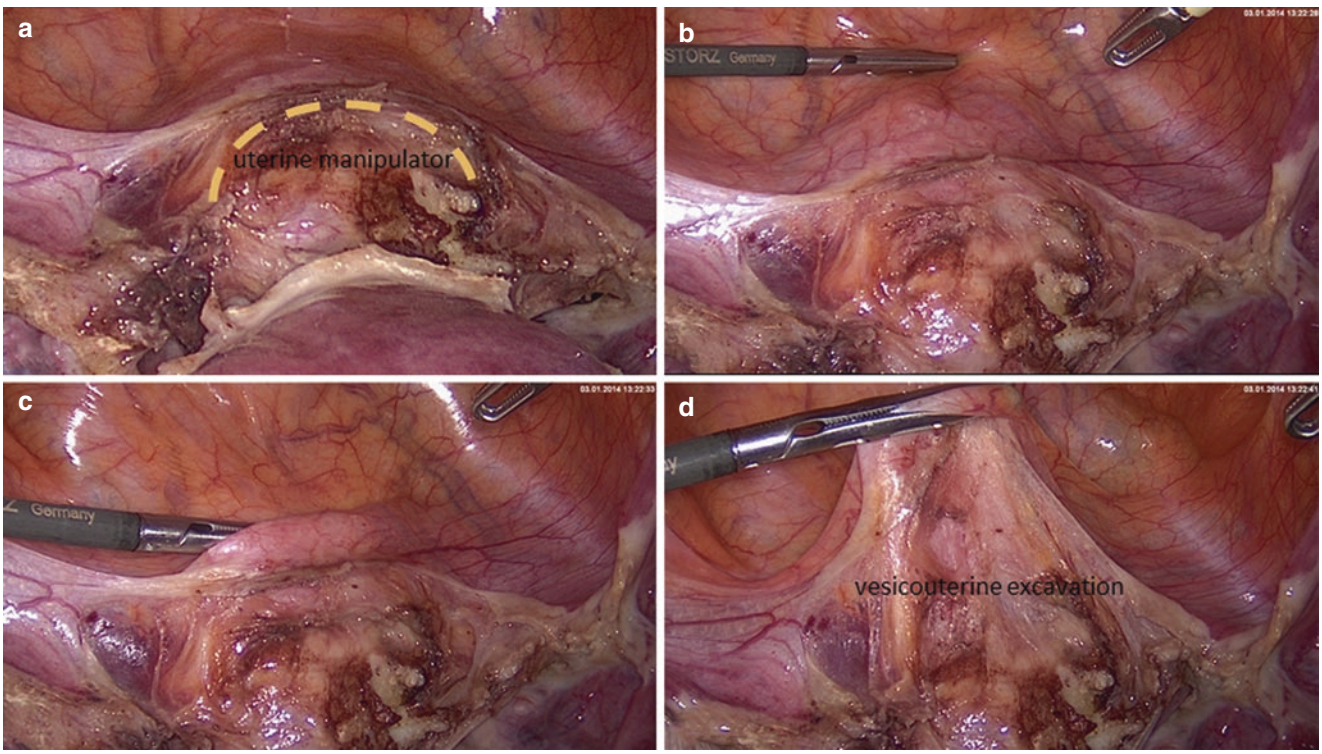


Fig. 35.60 Visualization of the intrauterine manipulator, if inserted (**a**). (**b**, **c**): The bladder cannot be identified immediately in all cases and is safely avoided. The bladder can be localized exactly when a blunt instrument is used to push the suspected bladder towards the cervix from the balloon of the Foley catheter. (**d**) Once the bladder has been identified, it is elevated. Vesicouterine excavation can be used to push the bladder further downward

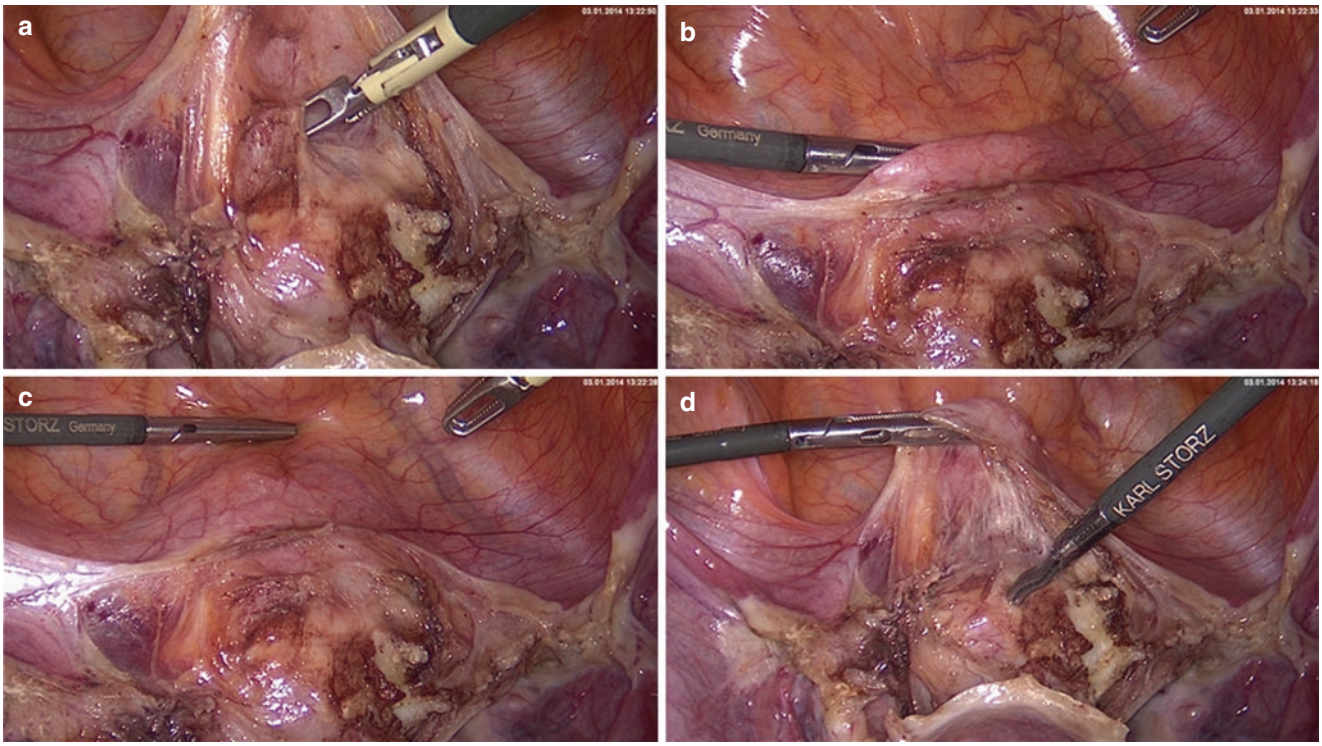


Fig. 35.61 (**a**) Minimal dissection of the bladder peritoneum by about 1 cm for LSH and 2-3cm for LTH, by opening the vesicouterine excavation. (**b**) This is easier when a manipulator is inside the vagina and the cervix is pushed upward. The anatomical landmarks of the bladder are hard to find. Therefore it is easier if the whole organ is pushed upwards and (**c**) back, thereby displaying the anatomical borders. (**d**) The step can also be performed by traction alone. Once the vesicouterine space has been opened, exposure is easily achieved with a blunt instrument while avoiding bleeding

Step 4

4.1 In laparoscopic supracervical hysterectomy, resection of the uterine corpus is performed at this stage of surgery. The steps of exposure are very similar until this point, except for the fact that there is no need for a manipulator and elevation of the uterus is achieved by traction. The corpus of the uterus is cut with a monopolar loop and the cervical channel coagulated to prevent spotting. The cervical channel should be closed because of the risk of ascending infection. Simultaneously, the cervix can be suspended using a strong monofilament suture with extracorporeal knotting (Figs. 35.62 and 35.63).

4.2 Resection of the vagina from the cervix with the monopolar hook by stretching the manipulator firmly cranially. Intrafascial dissection is performed, leaving the sacrouterine ligaments almost completely in place (Figs. 35.64, 35.65 and 35.66).

The uterus is then extracted through the vagina or positioned in the vagina to prevent loss of intraabdominal pressure while still fixed to the manipulator (Fig. 35.67). A large uterus must be morcellated either intraabdominally or transvaginally. In cases of a large benign uterus, visible myomas can be enucleated or the large uterus cut into several smaller pieces which are then extracted through the vagina. As a result, the incision in the lower abdomen need not exceed 5 mm and postoperative pain or the risk of hernia is minimized. Alternatively, a 10–12-mm electromorcellator is used to dissect the material, which is then extracted through the abdominal wall. The cutting edge of the morcellator must always be visible during morcellation. Evidence of the absence of any malignancy must be obtained earlier by appropriate preoperative diagnostic investigation. The patient must be informed in advance about the fact that the uterus, depending on its volume, may need to be morcellated.

Step 5 (Classical Closure)

After removing the uterus, the vaginal cuff and the peritoneum are closed with two Vicryl 0 Z-sutures, or with a running suture with or without separate knotting of the lateral edges. Suturing may be performed intraabdominally or extraabdominally. This simple and economical concept can be adapted to almost all techniques of open surgery.

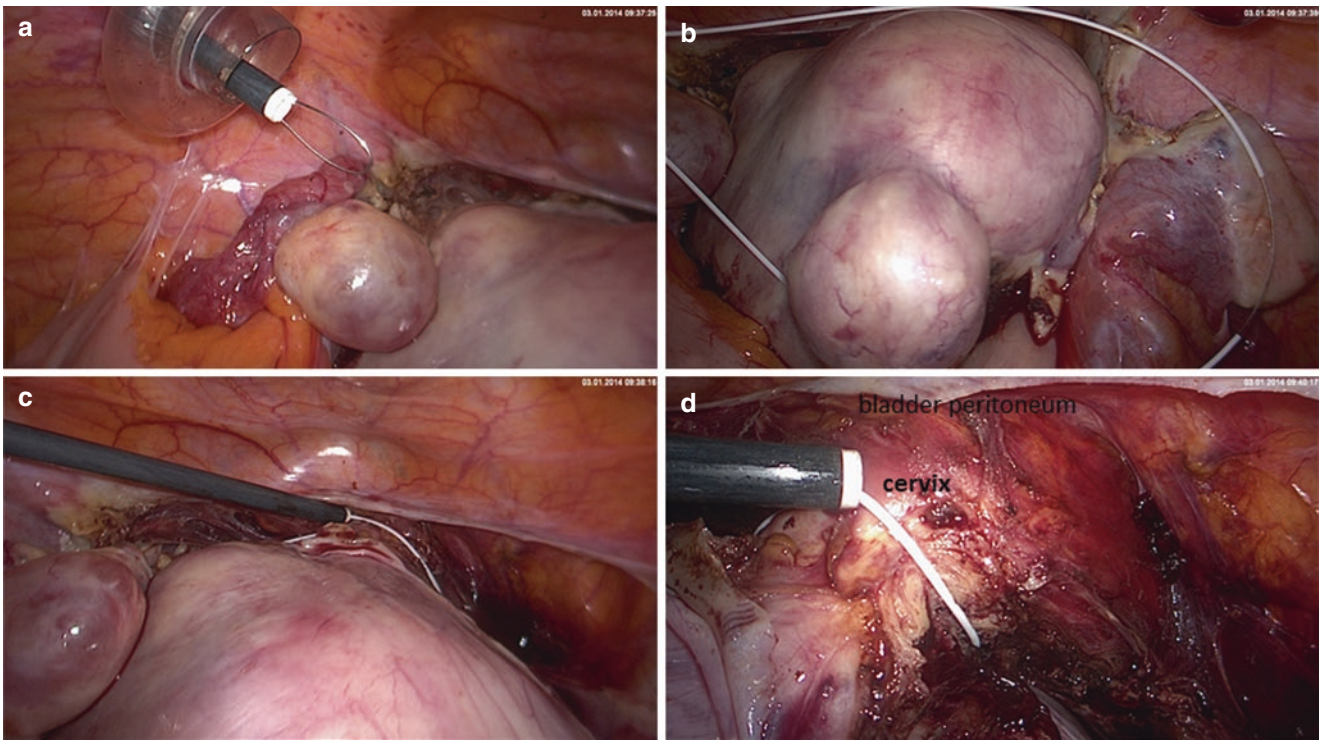


Fig. 35.62 (**a**) Introduction of a monopolar cutting loop for the cervix and (**b**) exact placement prior to activation. (**c**) The whitish uterus is lifted over the loop and (**d**) the loop is tightened gently. Correct placement between the stumps of the uterine artery and above the conjunction of the sacrouterine ligaments is checked

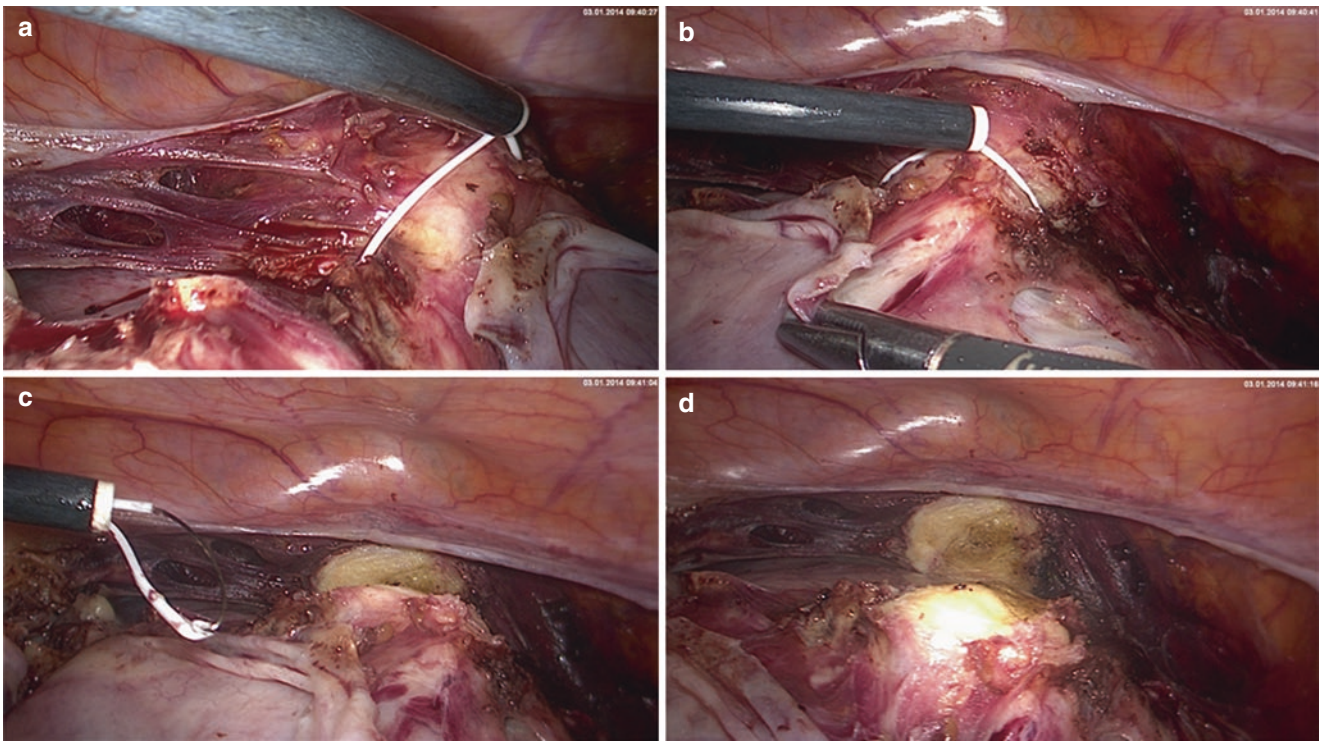


Fig. 35.63 Resection of the uterine corpus from the cervix after placing the cutting loop with the cutting point on the posterior cervix (**a**, **b**). Correct placement between the stumps of the uterine artery and above the conjunction of the sacrouterine ligaments is monitored. Dissection of the cervix and the uterus is performed (**c**, **d**), in this case LSH by monopolar current only in the non-isolated field. When cutting, the uterine corpus is pulled upward to achieve a retrograde conus (**b**, **d**)

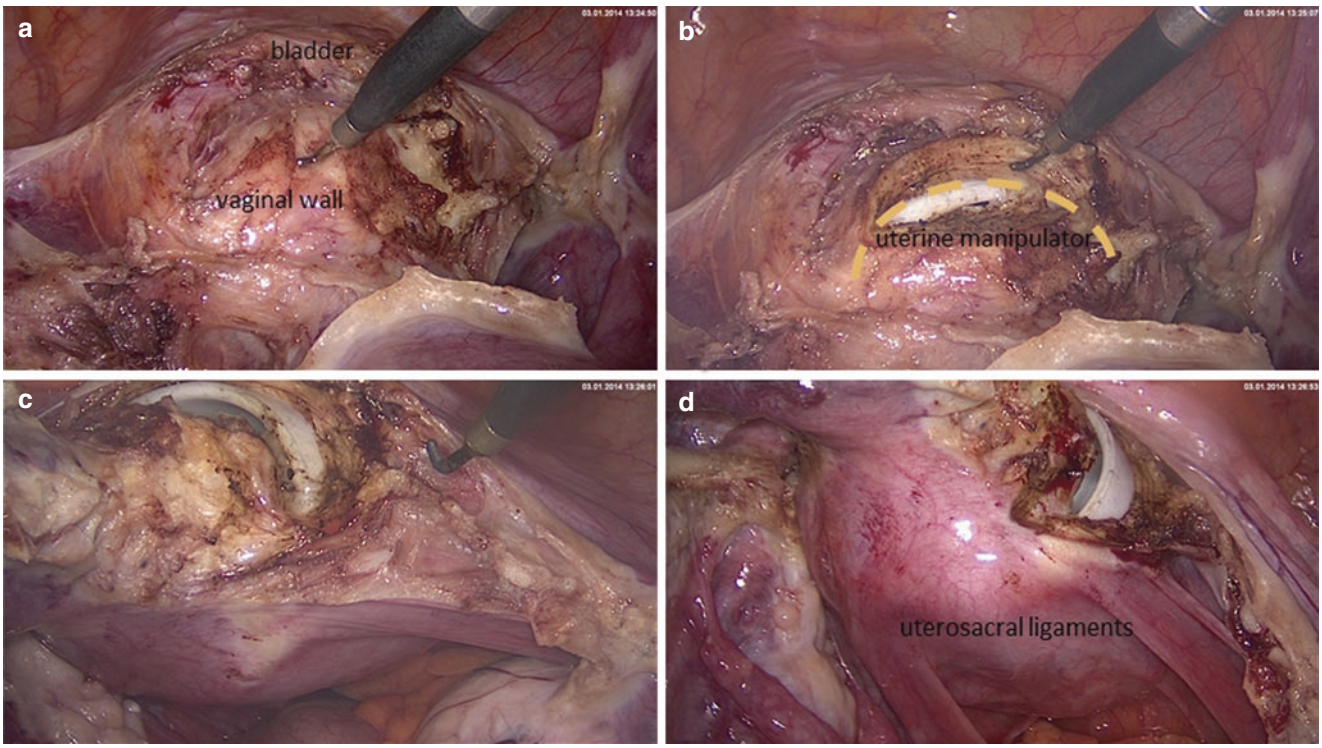


Fig. 35.64 In this case of LTH, the distance between the vagina and the bladder is increased because of exposure of the bladder peritoneum (**a**). The intrauterine manipulator is firmly placed in the abdomen and dissection of the uterus from the vagina is performed in a stepwise manner (**b**–**d**). The conjunction of the sacrouterine ligaments is left in place

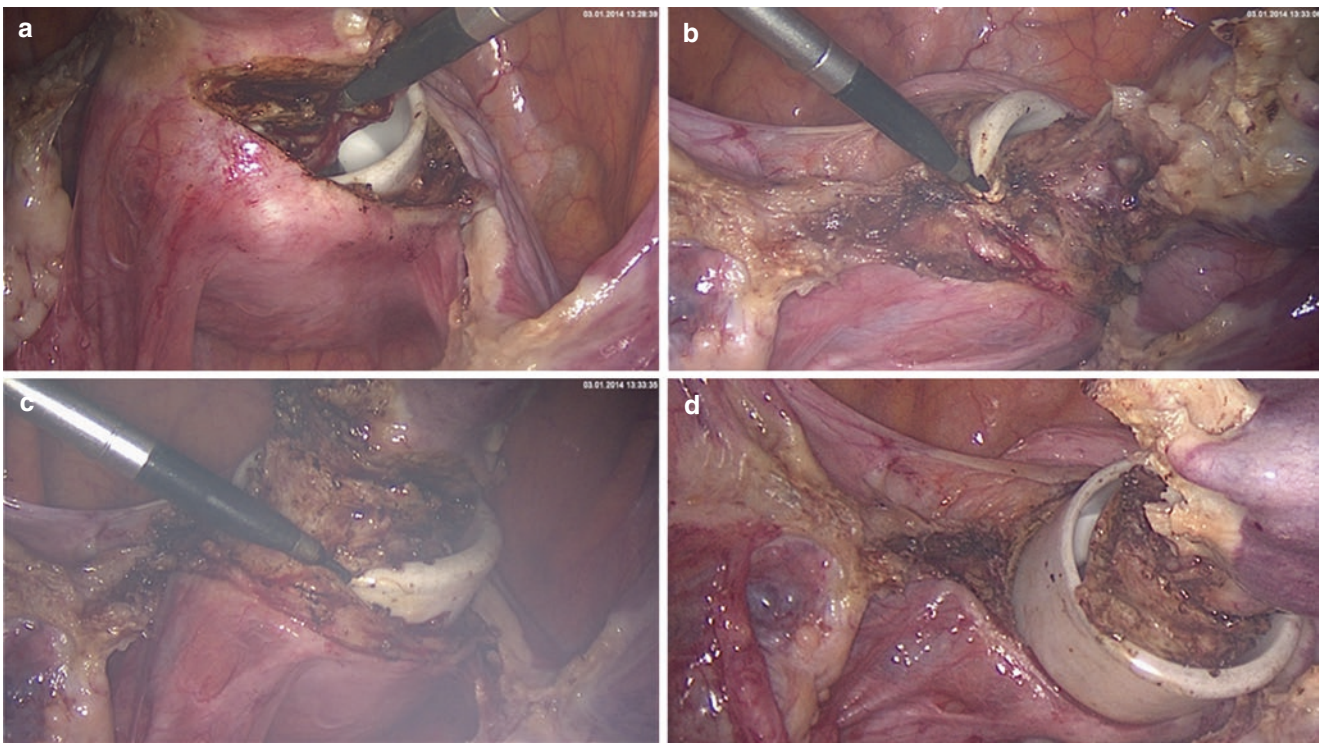


Fig. 35.65 Completion of the dissection of the vagina from the cervix (**a**–**c**) and commencement of retraction of the uterine cervix, still grasped by the manipulator forceps, transvaginally. Excessive lens fogging caused by the monopolar current and the sharpness of the monopolar hook make it necessary to perform precise exposure under full vision. This can be done during simultaneous retraction/manipulation with the use of the 30 ° optic device. (**d**) The surgeon's vision may worsen immediately when CO2 gas leaks through the colpotomy. Visibility may then become extremely poor and the use of monopolar energy hazardous

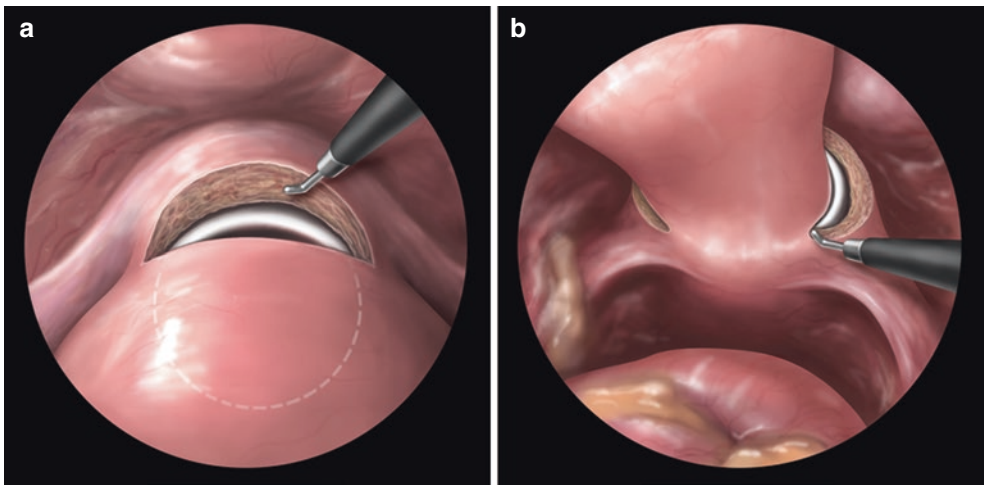


Fig. 35.66 Schematic illustration of uterine dissection. (**a**) Colpotomy is usually started in the anterior part, on the palpable manipulator cap. (**b**) The intrafascial hysterectomy can be completed with the sacrouterine ligaments in view

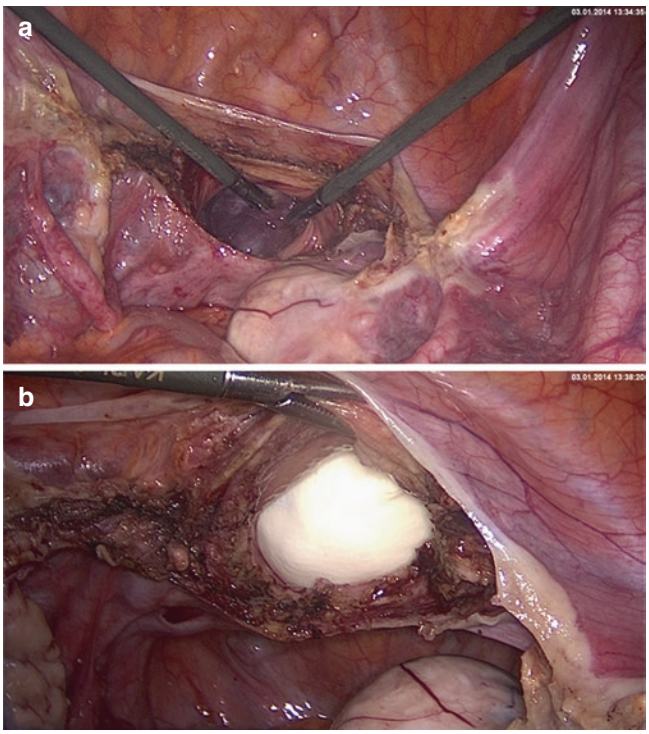


Fig. 35.67 Retraction of uterus through the vagina (**a**).Introduction of a cotton swab-filled glove transvaginally to hinder breakdown of the CO_2 pneumoperitoneum (**b**)

Step 5(Alternative Closure Technique Emphasizing Prolapse Prevention)

A Technique for Stable Fixation of the Vaginal or Cervical Stump

Vaginal closure with Te Linde suturing technique modified by Schollmeyer

Hysterectomy is known to be associated with a high risk of pelvic organ prolapse; the risk is especially high among multiparous women. This may necessitate pelvic organ prolapse surgery. Given the current high life expectancy of women, organ prolapse may pose a problem in later life and also difficulties in surgical repair (thrombosis, embolism, and infection) [35].

The suturing technique of Te Linde, known from abdominal hysterectomy for the closure of the vagina, was modified for laparoscopic use by Bruno van Herendael and further modified by Thoralf Schollmeyer [36, 37].

5.1 Cautious coagulation of the vaginal edge [38] is followed by suturing of the vagina. Coagulation should be performed very carefully to avoid postoperative necrosis of the vaginal stump. Slight residual bleeding is addressed by sutures incorporating the complete vaginal wall. The uterus is either still in the vagina or a glove filled with swabs is placed in the vagina to avoid loss of the pneumoperitoneum. Usually a curved needle and PDS 1–0 is used for single knot suturing, with extracorporeal knots and intracorporeal safety knots. Alternatively, sledneedles or even straight needles can be used for easy handling in and out of the 5-mm trocars.

PDS 1–0 extracorporeal knots are used for the following reasons:

1. The monofilament thread slides easily through the tissue and does not cause additional damage.
2. The monofilament PDS material minimizes the risk of vaginal stump infection.
3. The long half-life of the suture material minimizes the risk of vaginal stump dehiscence [38].
4. Extracorporeal knots provide additional strength.

Optionally, both sacrouterine ligaments may be attached to the posterior vaginal wall to prevent vaginal prolapse (McCall culdoplasty).

5.2 Corner sutures

The peri-cervical ring is pierced by performing a suture in the right vaginal corner, followed by the corresponding vaginal epithelium. The sutures are made at a distance from the urinary bladder to minimize the risk of bladder laceration (Figs. 35.68 and 35.69).

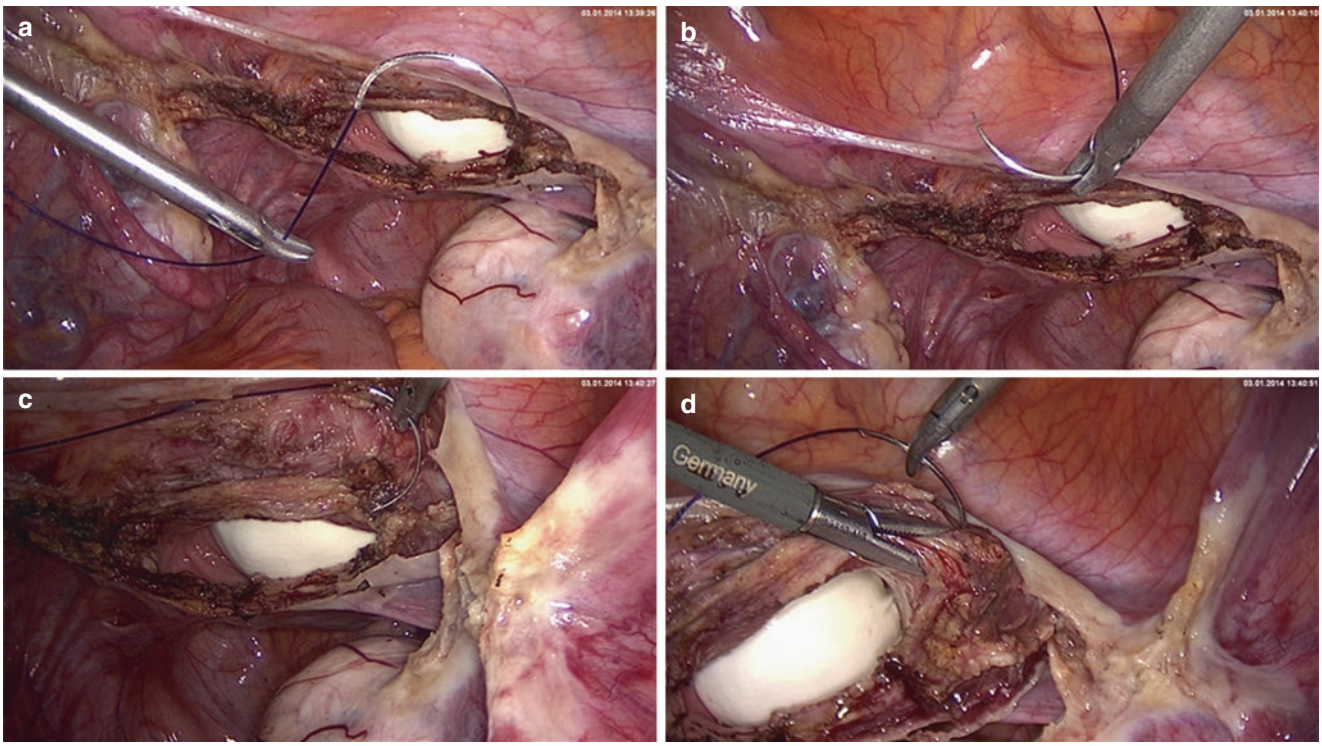


Fig. 35.68 LTH: Right corner suture uniting the anterior and posterior vaginal wall, the posterior peritoneum, and the right sacrouterine ligament. The bladder can be omitted under sight. (**a**) Insertion of the needle and (**b**) positioning of the needle in the needle holder. (**c**) The disadvantages of conventional laparoscopy need to be overcome by surgical quality. (**d**) The forceps must be sharp in order to securely grab the vaginal epithelium. When the suture incorporates the vaginal wall alone and omits the epithelium, there is a high likelihood of postoperative granulomas

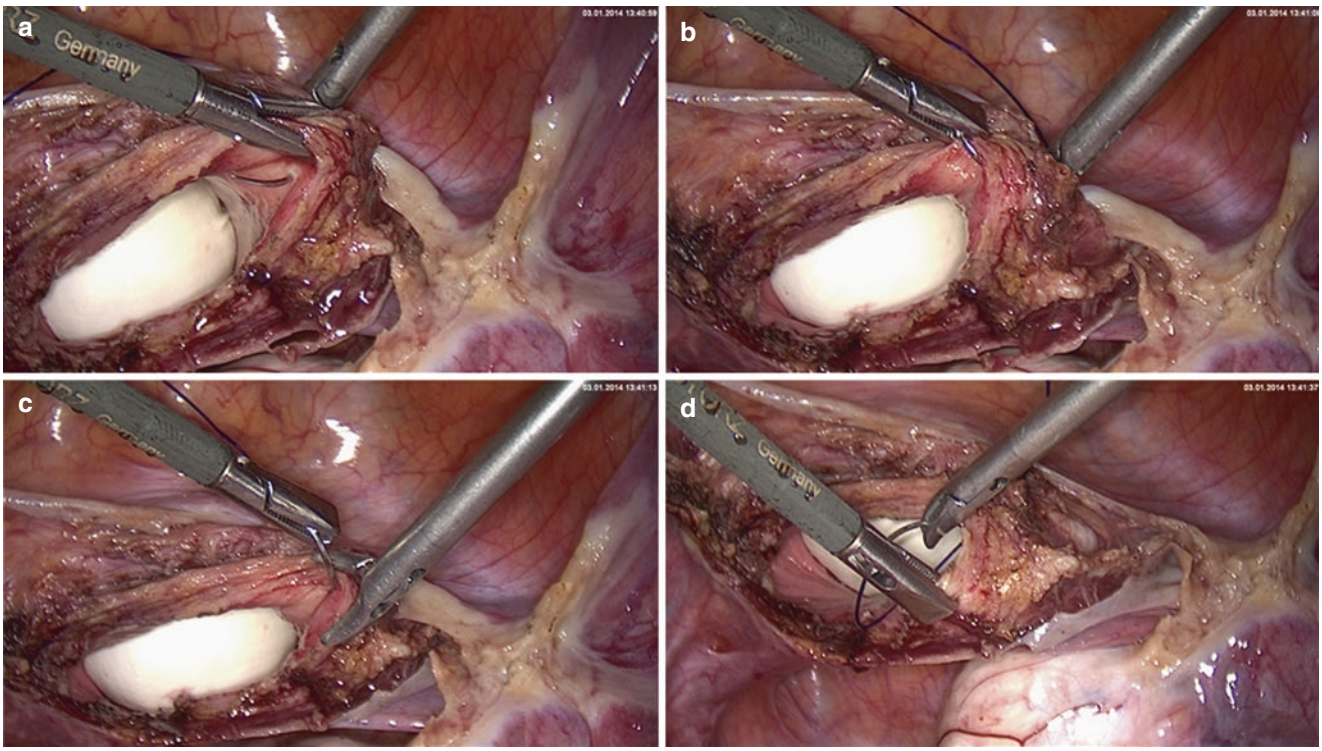


Fig. 35.69 LTH: (**a**) Continuation of the right corner suture. (**b**) The 30° optic device helps to look into the vagina from below when rotating and (**c**) picking up the needle (**d**) from above. The strong paravaginal tissue is grasped in large units

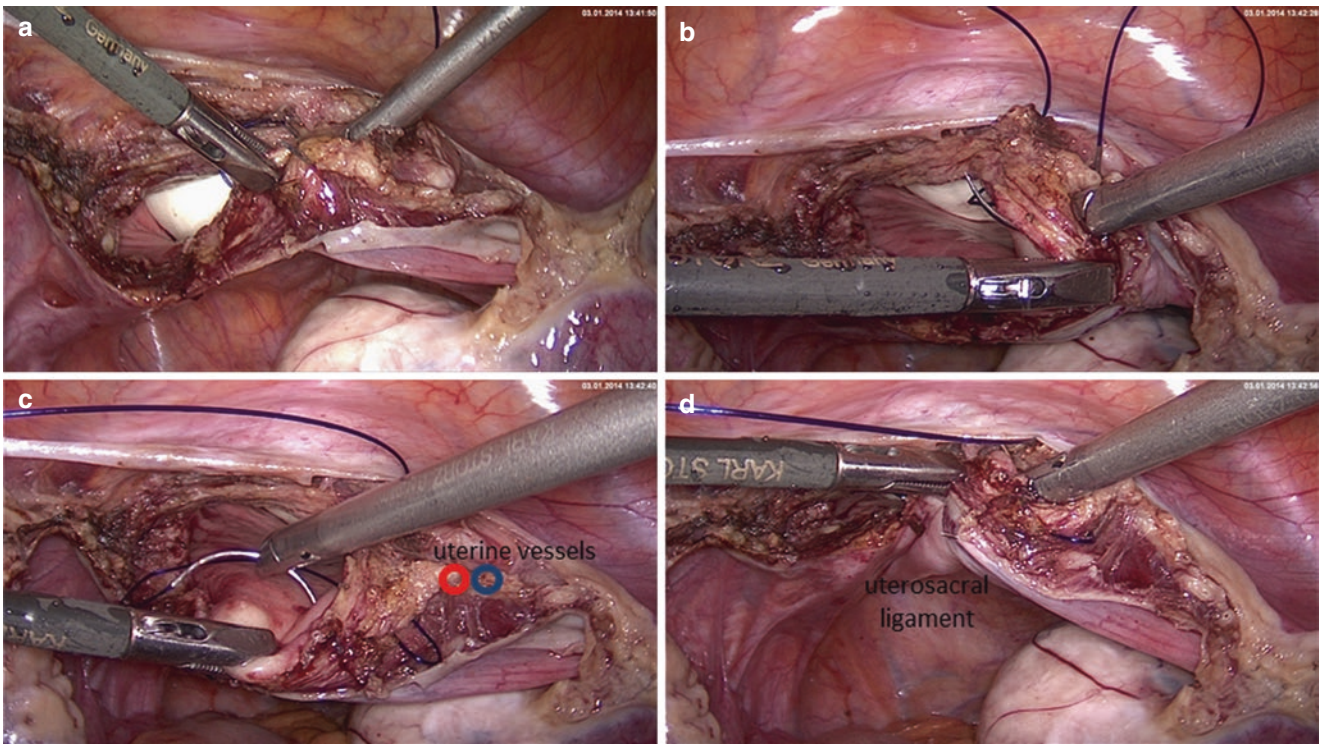


Fig. 35.70 LTH: (**a**) Continuation of the right corner suture while (**b**) leaving out the vessels to the side, (**c**) performing an omega suture (according to Schollmeyer), (**d**) and then grabbing the right sacrouterine ligament. The vessel stumps are omitted and lateralized. When using this type of suture, the vessels are compressed mechanically

5.3 In the second step, the needle is passed through the medial aspect of the cardinal ligament in front of the uterine vessels (Fig. 35.70). The second step involves the structures supporting vaginal wall suspension. Extracorporeal knotting with the placement of a deep and strong monofilament suture allows the surgeon to grasp a large quantity of tissue and smoothly glide through the tissue without causing damage (Figs. 35.71, 35.72 and 35.73).

5.4 Subsequent back-stitching of the vagina is followed by passing the needle through the vaginal epithelium and then, in the third step, through the sacrouterine ligament. The last step may be omitted when the ligament is stitched again once or twice to shorten it. In cases of pre-existing descent, this is absolutely essential.

The needle can now be withdrawn and the suture is completed with an extracorporeal Roeder knot, secured by 2–3 intracorporeal knots (Fig. 35.74). This procedure is repeated on the contralateral side and ensures that all parts of the endopelvic fascia (vesicouterine, cardinal and sacrouterine ligaments) are connected (Figs. 35.75, 35.76 and 35.77).

Step 6

Vaginal Closure

The remaining vaginal opening in the middle can now be closed with two U- or Z-sutures. These ensure both vertical and horizontal compression of the tissue, and minimize the risk of a vaginal stump hematoma. Neither peritonealization nor drainage is necessary (Figs. 35.78 and 35.79). Physiological reperitonealization occurs during the first two weeks after the operation. Any additional peritoneal suturing might cause encapsulation of seroma or hematoma and increase the likelihood of postoperative infection as well as pain. If still inside, the uterus or the swab-filled glove is now taken out of the vagina. Figure 35.80 provides an overview of the procedure.

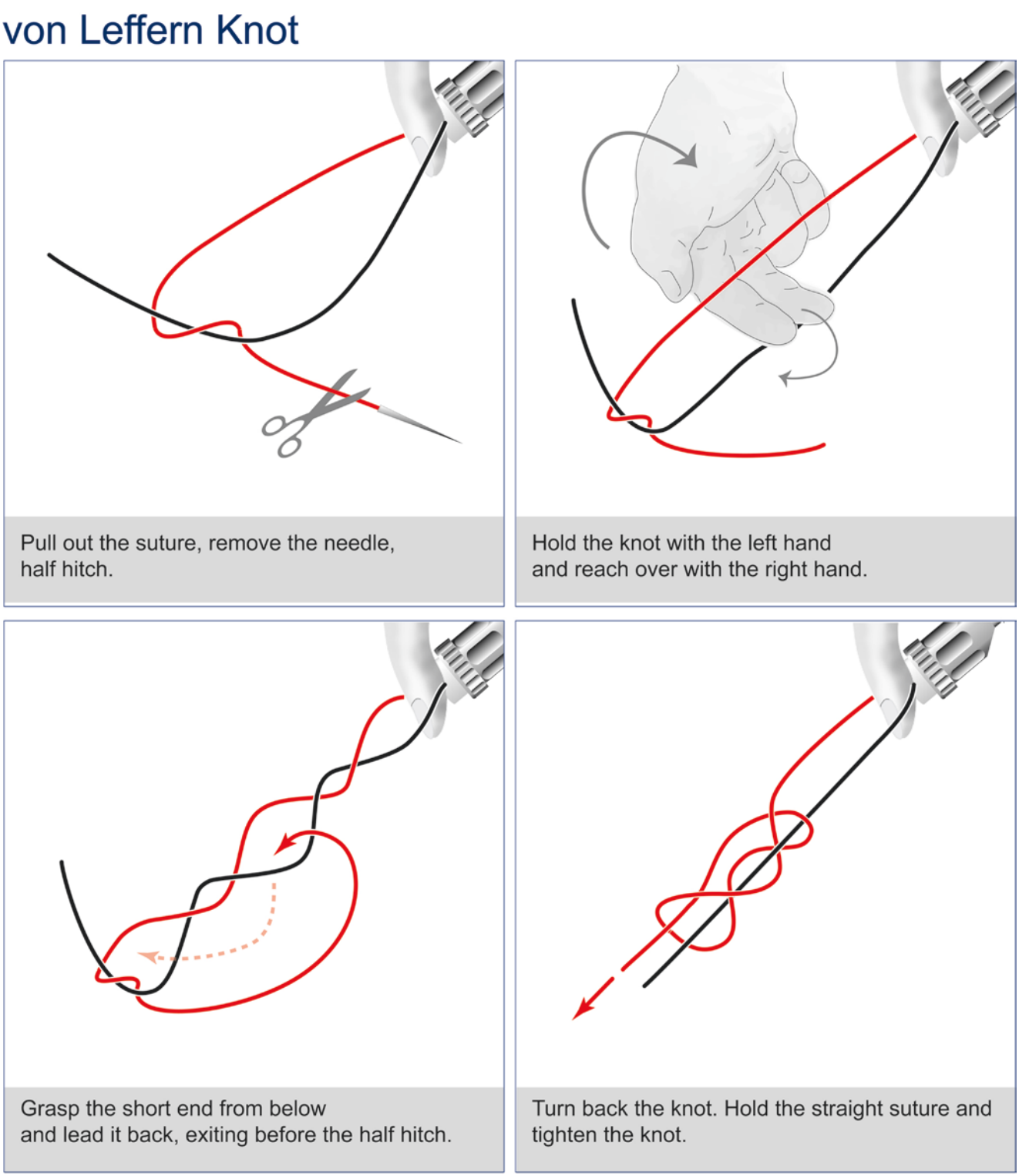


Fig. 35.71 LSH: Finalizing the extracorporeal knot of the PDS suture by using the "von Leffern knot"

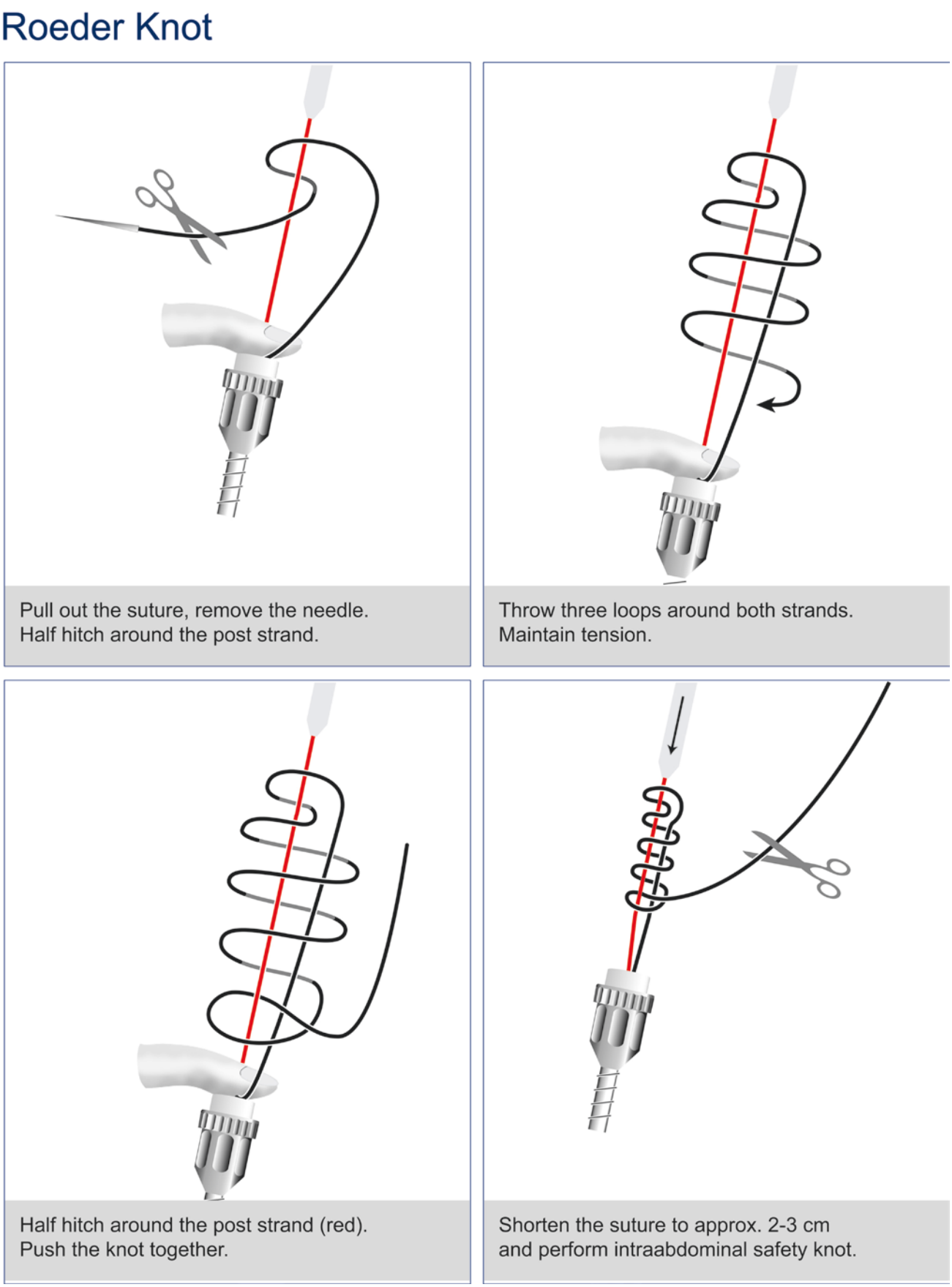


Fig. 35.72 "The Roeder" knot

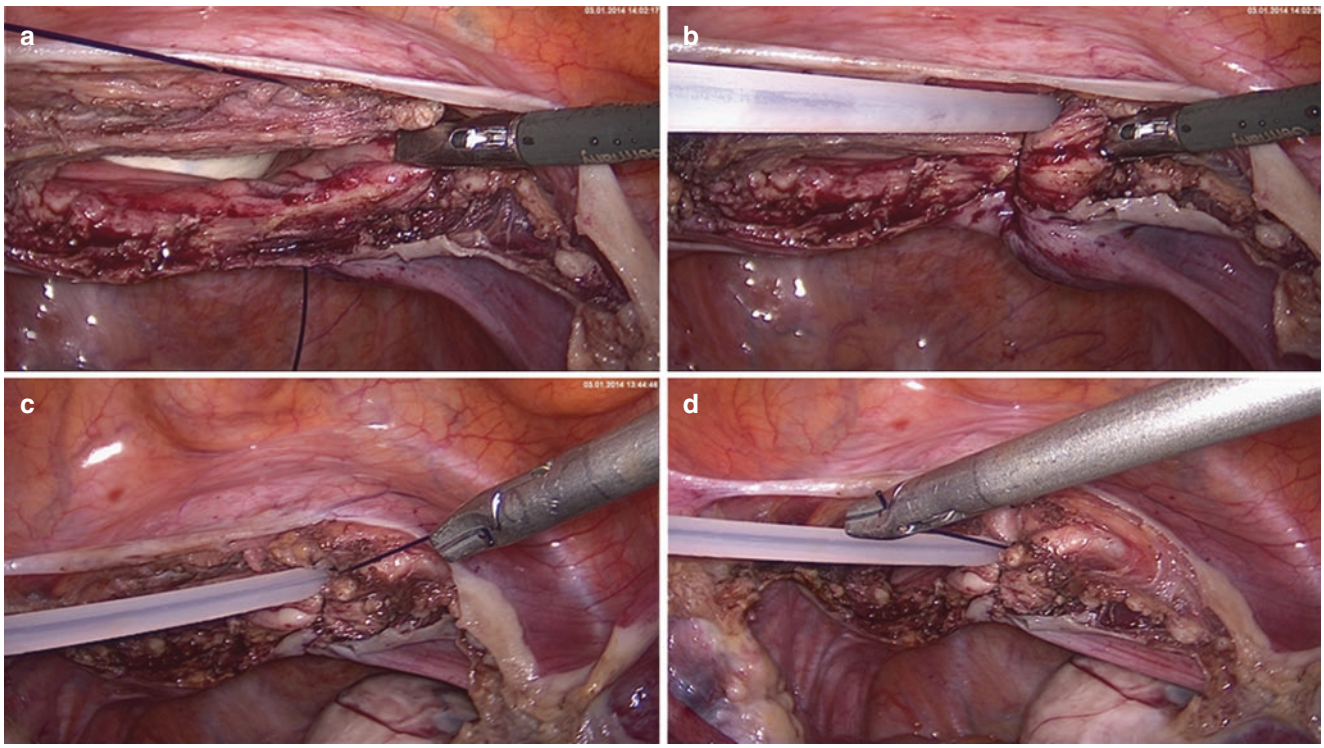


Fig. 35.73 LTH: (**a**) Completion of the extracorporeal "Roeder" or "von Leffern" knot by pushing it down with a plastic pushrod (**b**–**d**). The edge is pulled into the abdomen to avoid disturbance of intravaginal sensitivity

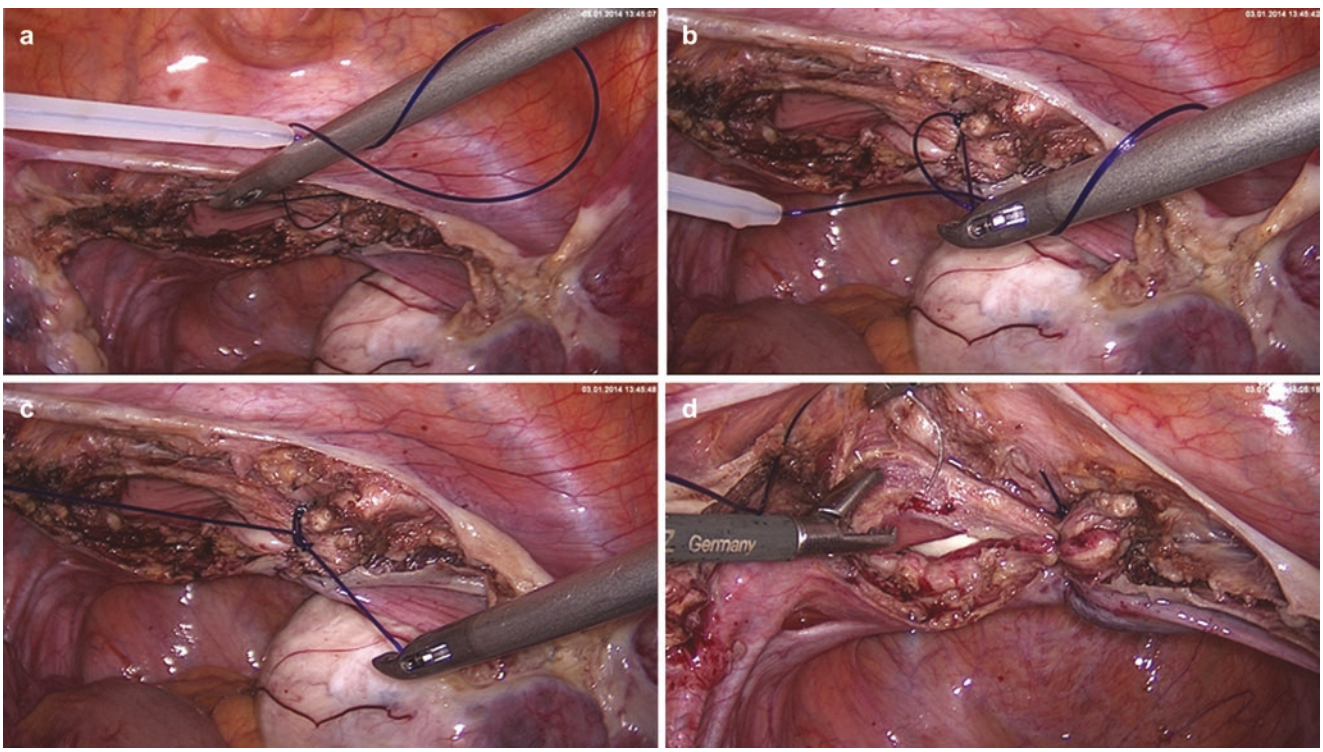


Fig. 35.74 LTH: (**a**) Performance of an intracorporeal safety knot (**b**) by placing the right corner stitch (**c**) and tightening of the threads. Here, it can be clearly visualized that extracorporeal knotting allows the surgeon to push the knot deeper into the tissue than intracorporeal knotting. (**d**) The same knot is performed on the left side, both edges are dry and everted

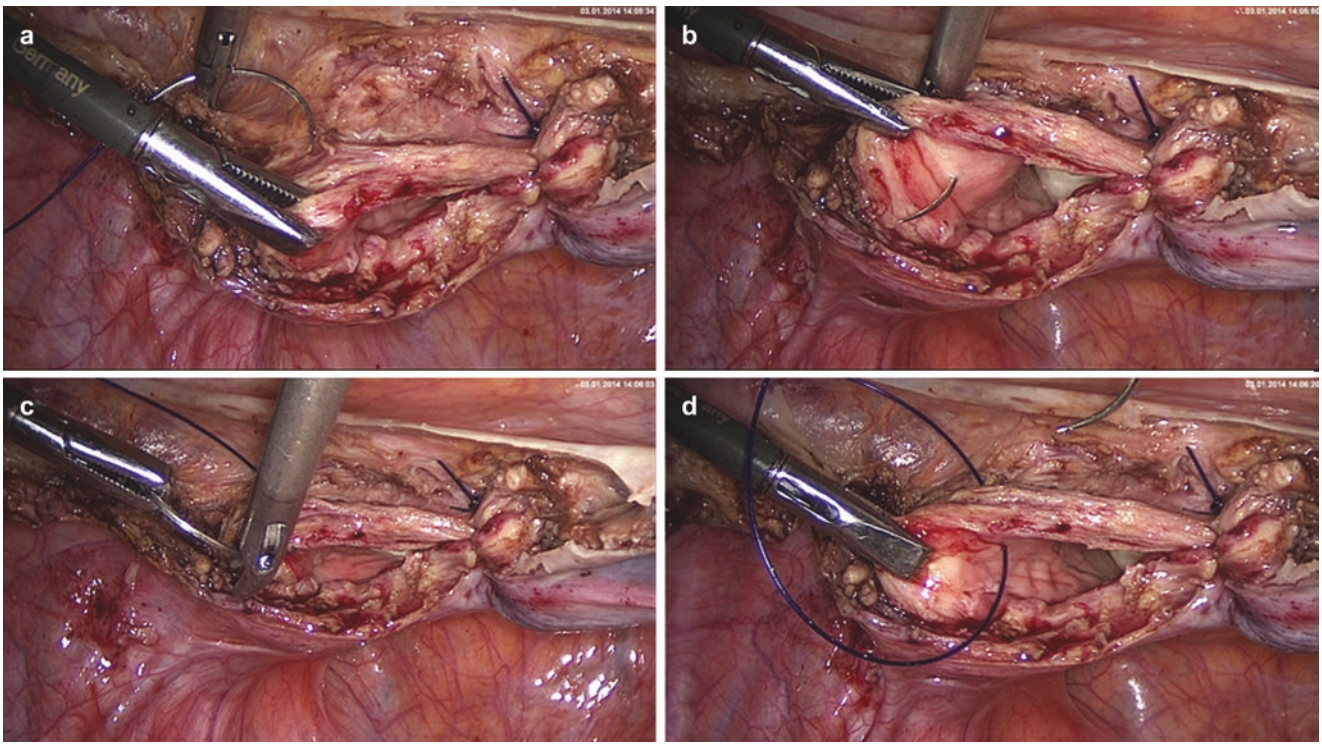


Fig. 35.75 LTH: (**a**) Left corner suture uniting the anterior and posterior vaginal wall, the posterior peritoneum, and the left sacrouterine ligament. The bladder can be omitted under sight. After positioning of the needle, (**b**) paracolpium and epithelium are grabbed and perforated by the needle. (**c**) The grasper of the left hand holds the needle and (**d**) the needle holder only rotates once it has touched the tissue, thereby avoiding tearing of the tissue. The forceps must be sharp in order to securely grasp the vaginal epithelium. When the suture incorporates the vaginal wall alone and omits the epithelium, there will be a high likelihood of postoperative granuloma or bleeding

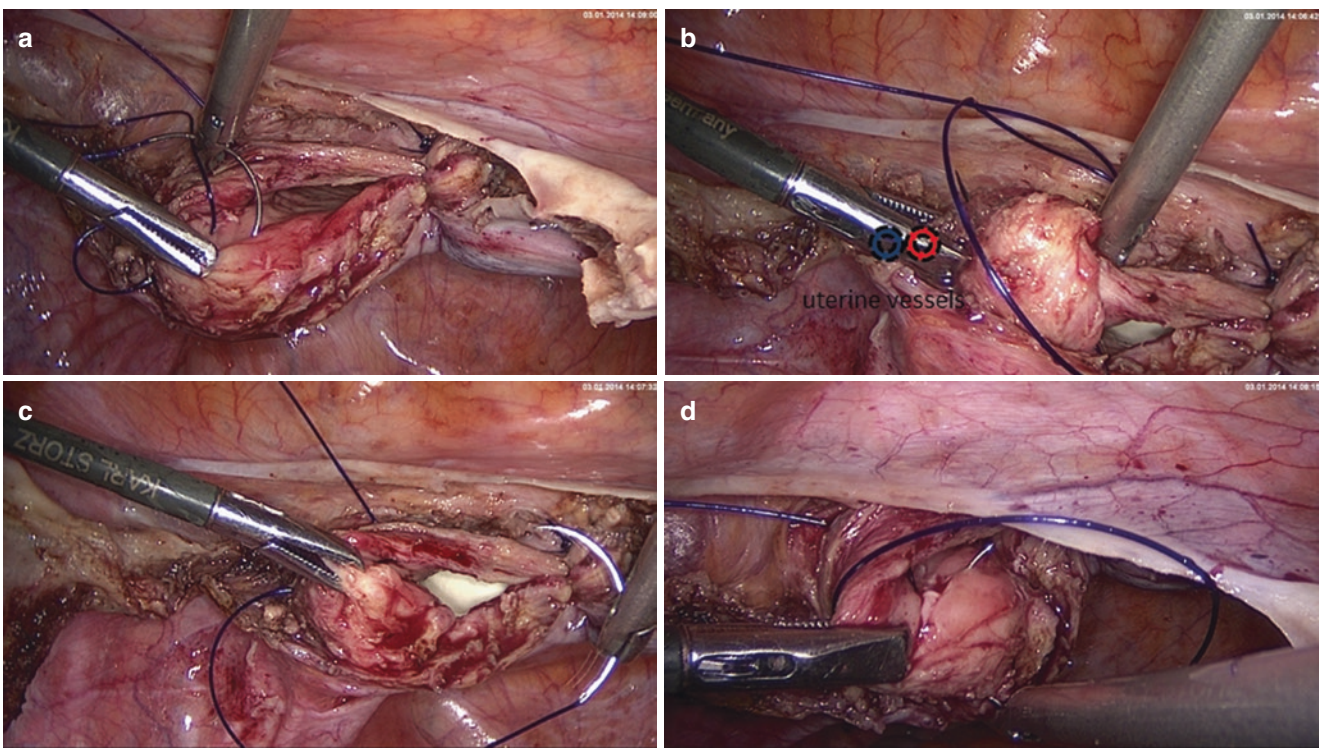


Fig. 35.76 LTH: Continuation of the left corner suture. (**a**) Grabbing and perforation of the dorsal vaginal wall with the needle, (**b**) avoiding the laterally positioned vessels (**c**–**d**) in an omega fashion. When using this type of suture, the vessel stump is omitted and compressed mechanically. Approximately 1 cm of the vaginal wall should be included in the suture

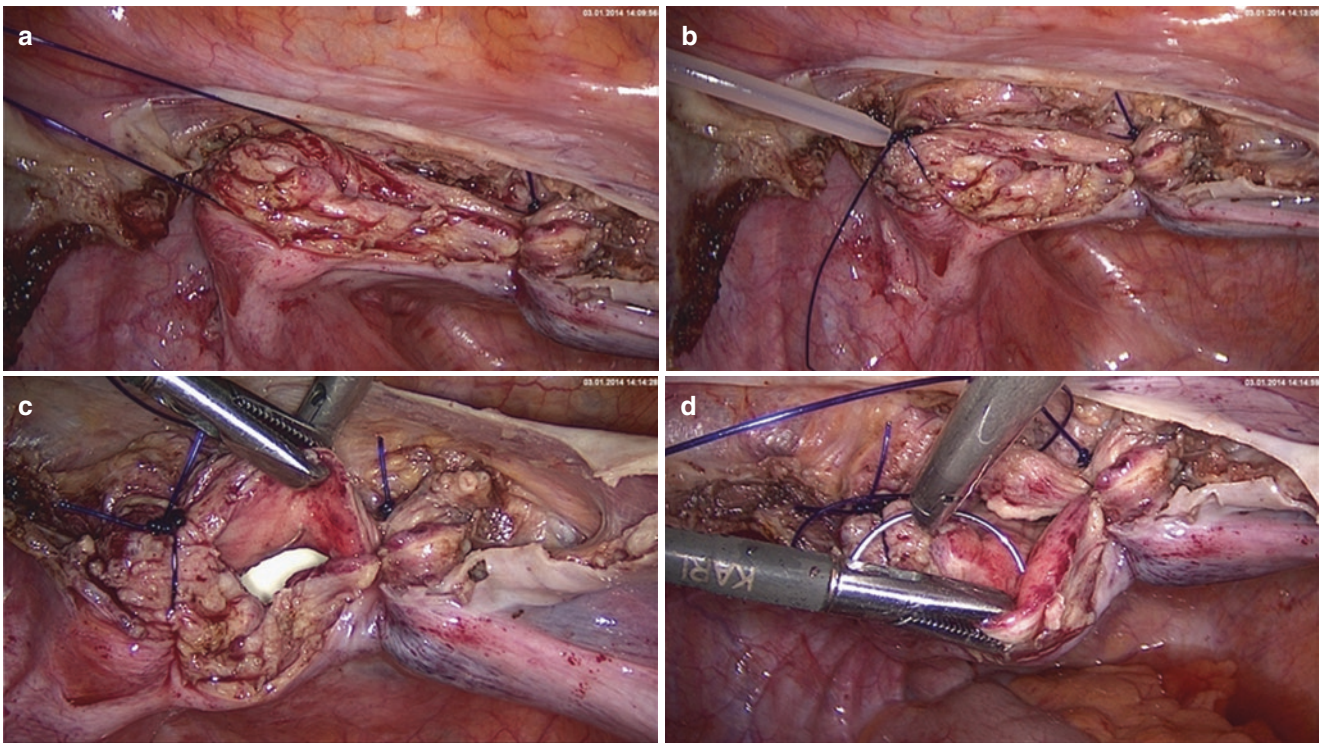


Fig. 35.77 LTH: Completion of the left corner suture.The extracorporeal knot is pushed down by the pushrod (**a**–**c**). Commencement of a U-stitch or a Z-stitch in the middle (**d**). When the vaginal cuff is not entirely dry, it will be easier to close the edges first. A large part of the bleeding then stops automatically and further coagulation will not be necessary. Severe coagulation on the vaginal wall might increase the risk of vaginal stump infection or dehiscence

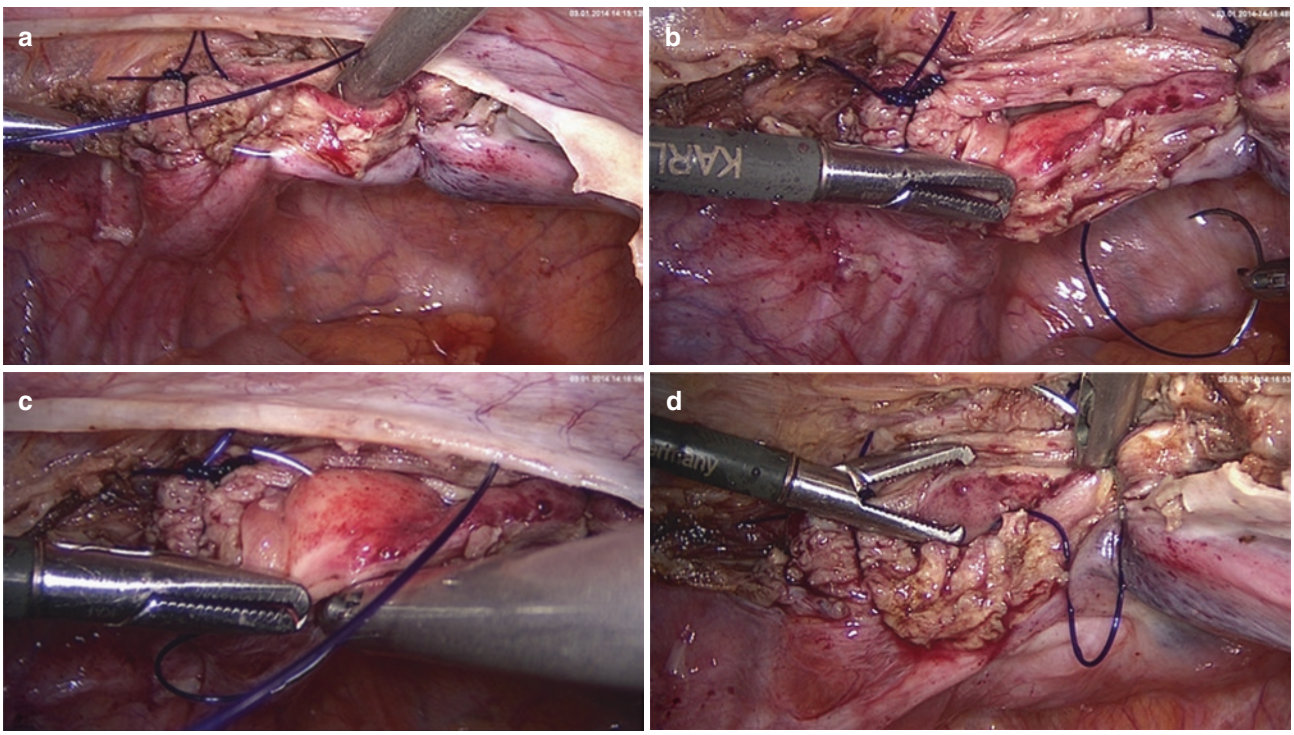


Fig. 35.78 LTH: Final closure of the remaining vaginal opening with (**a**) a U-suture or a Z-suture. (**b**) Grabbing the anterior and posterior wall and (**c**) going straight back. (**d**) The left hand correctly positions the tissue which is to be grabbed, as is necessary in conventional laparoscopy. When using the U-suture, the suture end should reach the bladder to prevent bowel damage

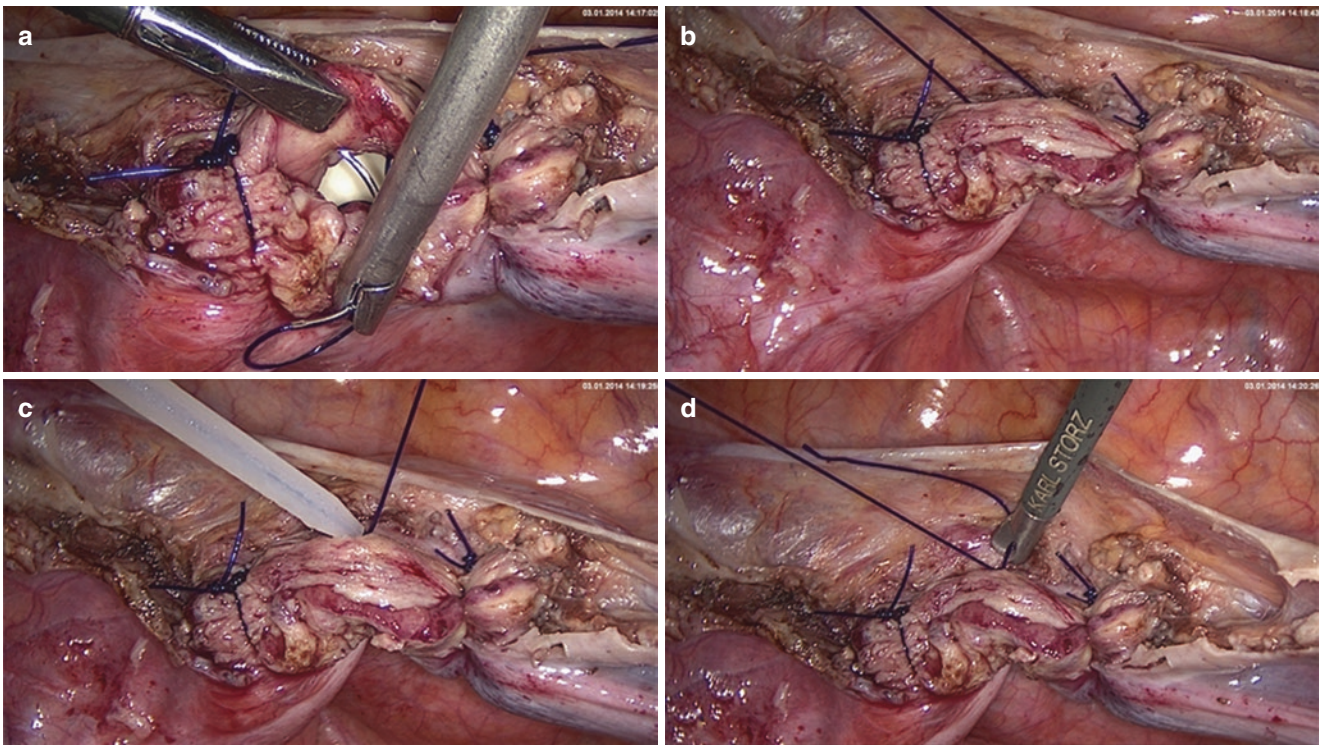
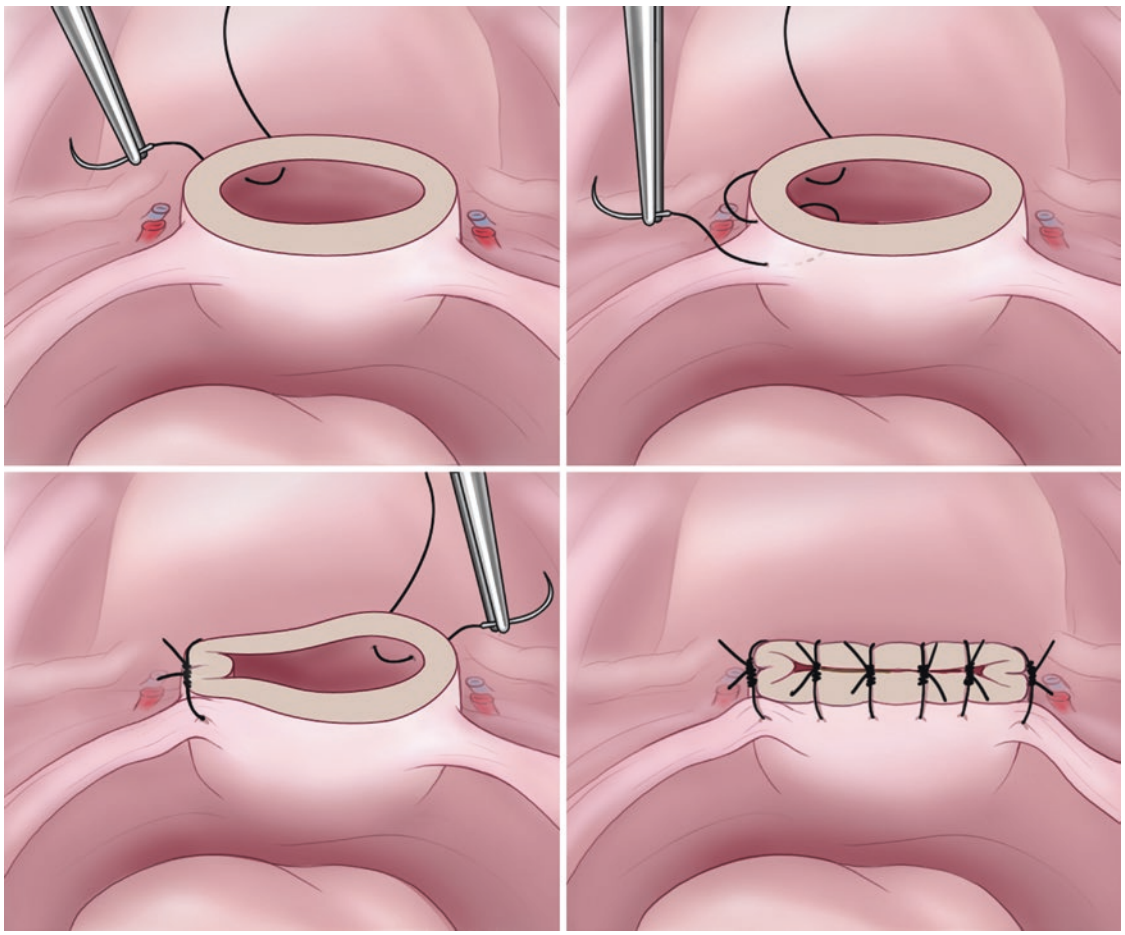


Fig. 35.79 LTH: (**a**) Completion of the central suture with a U-stitch or a Z-stitch. (**b**) Both threads of the U-stitch are pulled out anteriorily and (**c**) after extracorpoeral knotting (**d**) the thread can be shortened. There is no need for extracorporeal suturing because the suture is set ideally and the tissue mass is adequate



Laparoscopic Subtotal Hysterectomy

In laparoscopic supracervical hysterectomy, resection of the uterine corpus is performed at this stage of surgery. The preceding steps are very similar except for the fact that a manipulator is not needed because the uterus is elevated by traction. The corpus of the uterus is cut with a monopolar loop and the cervical channel is coagulated to prevent spotting. The cervical channel should be closed because of the high risk of ascending infection. Simultaneously, the cervix can be suspended with a strong monofilament suture and extracorporeal knotting. The remaining uterine corpus needs to be morcellated intraabdominally (Figs. 35.81, 35.82, 35.83, 35.84, 35.85 and 35.86).

Figure 35.87 shows the outcome of supracervical and total hysterectomy.

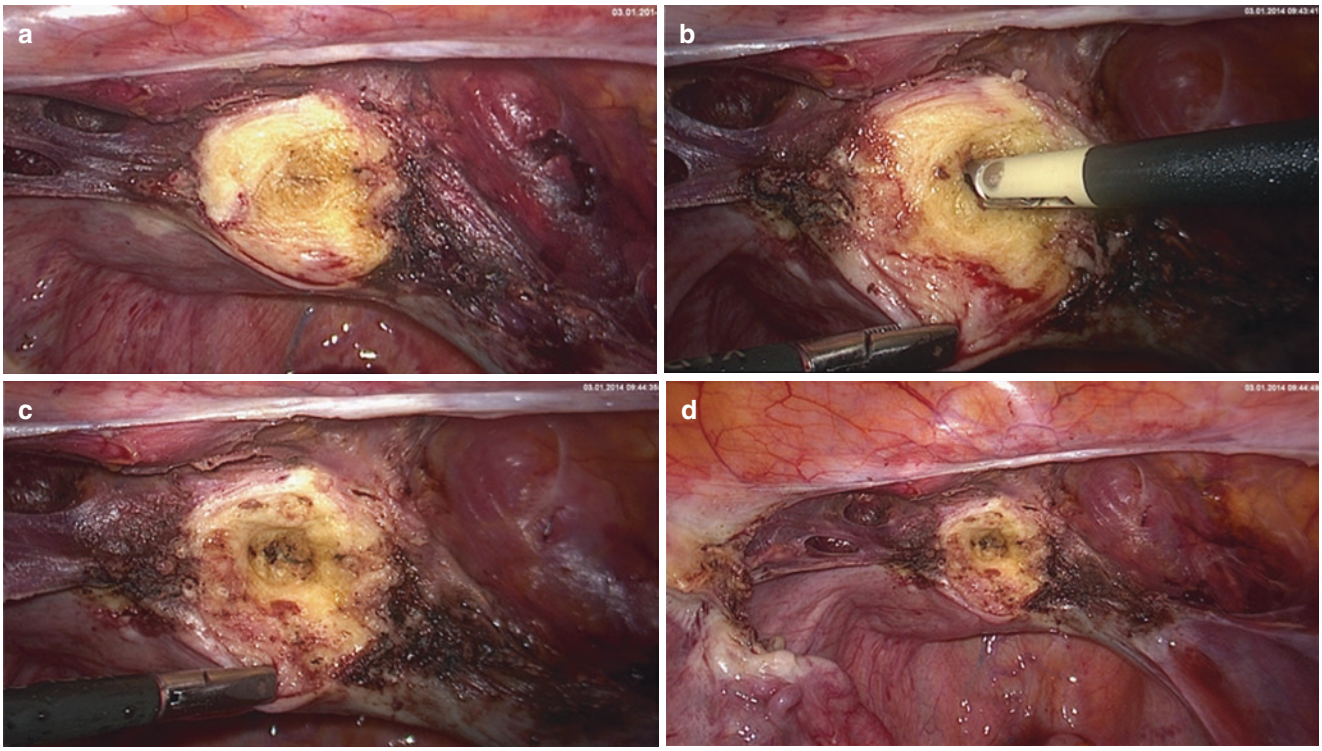


Fig. 35.81 The remaining cervical stump. Especially in cases of bleeding disorders, adenomyosis of the uterus or endometriosis, extended coagulation of the remaining cervical channel should be performed (**a–c**). By pulling the uterus upward when cutting the cervix, resection if performed in the shape of an inverse cone (**d**)

Fig. 35.80 Schematic illustration of vaginal closure after LTH modified by Schollmeyer. A suture is passed through the endopelvic fascia, 1 cm below the cephalad edge of the vaginal epithelium. The needle is pushed from the vaginal lumen through the vaginal wall, passed between the uterine vessels (median part of the broad ligament), and returned through the vaginal lumen. The sacrouterine ligament is identified before the suture is passed through. The needle is pushed from the vaginal lumen through the vaginal wall and the rectovaginal septum, and pierces the sacrouterine ligament. Closure of the vaginal vault with single stiches, U-stiches or Z-stitches. The stitch is drawn through the endopelvic fascia and the vaginal wall, and then out of the vaginal wall and the endopelvic fascia

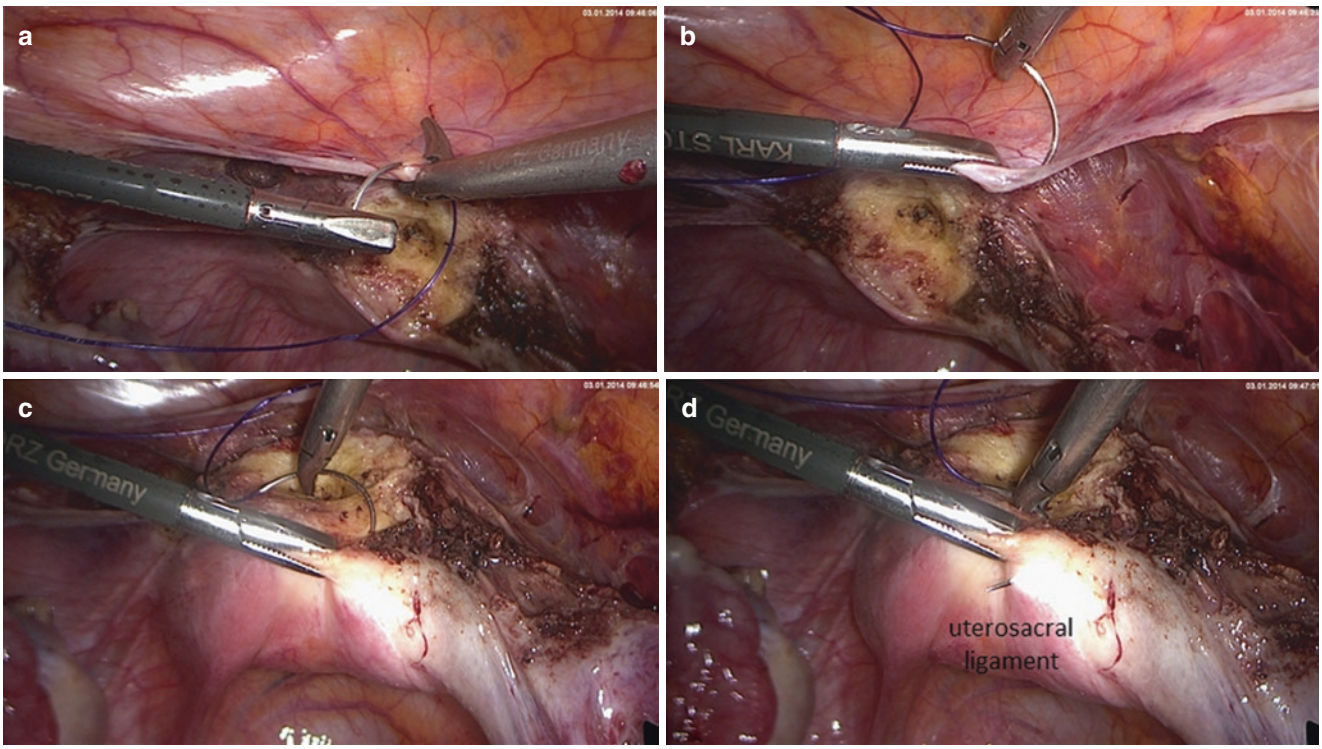


Fig. 35.82 LSH: (**a–d**) As the conjunction of the sacrouterine ligaments has been omitted, the two ligaments are grabbed and included in the suture to achieve cervical suspension (**a**). Connection of the bladder peritoneum to the posterior peritoneum by means of a purse-string suture

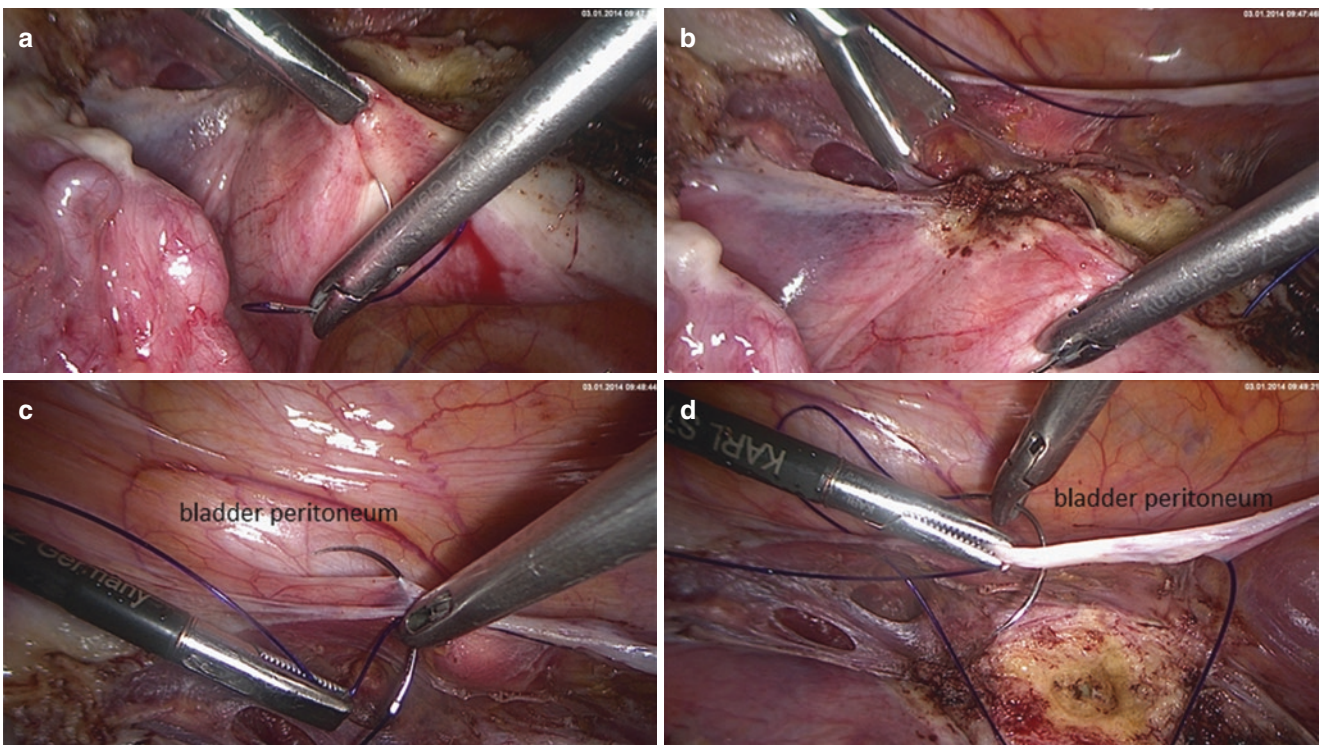


Fig. 35.83 (**a–b**) The sacrouterine ligaments can be identified and included in the closure of the cervical stump.(**c–d**) As the bladder has been slightly exposed during the procedure, there is now enough tissue to functionally close the cervical channel

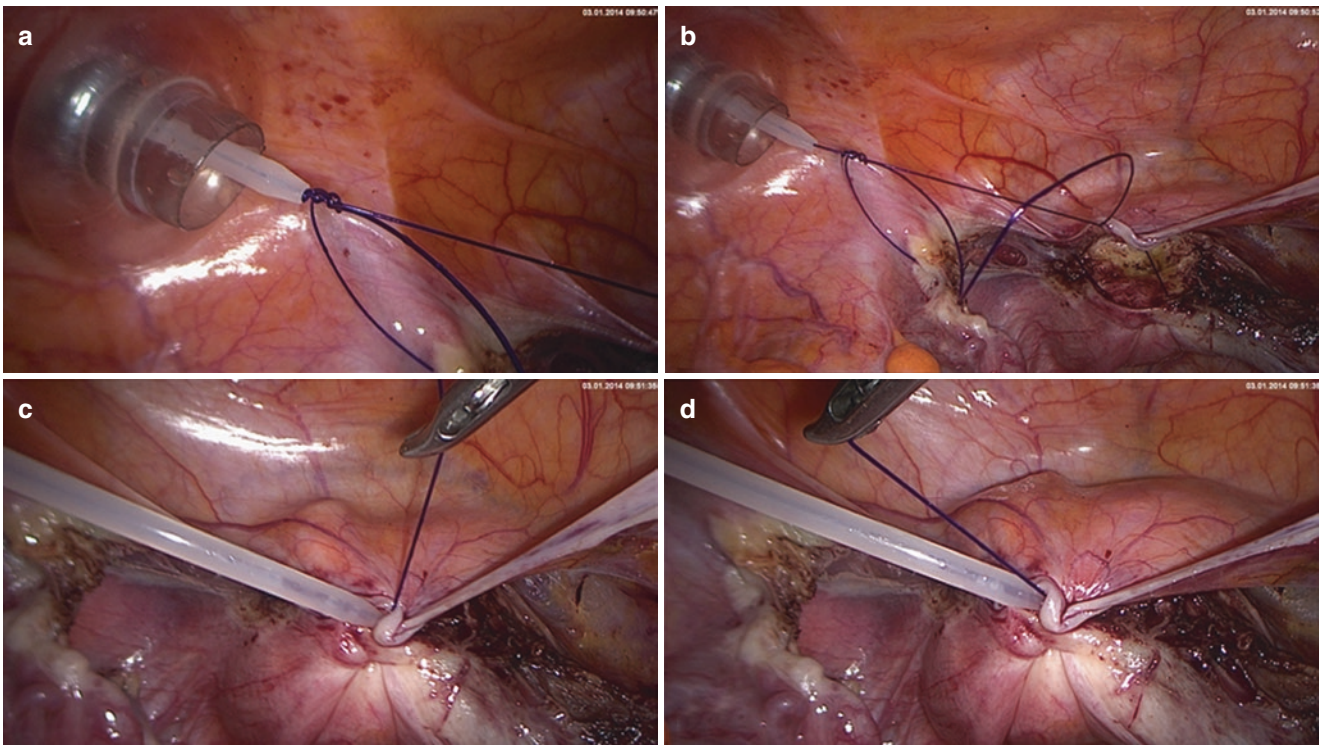


Fig. 35.84 When using the extracorporeal knot, the peritoneum closes the cervical channel functionally and this leads to cervical suspension. (**a**) The extracorporeally performed knot is (**b**) pushed inside. (**c**) Placement on the cervical stump and (**d**) tightening. The omitted sides still permit drainage if necessary

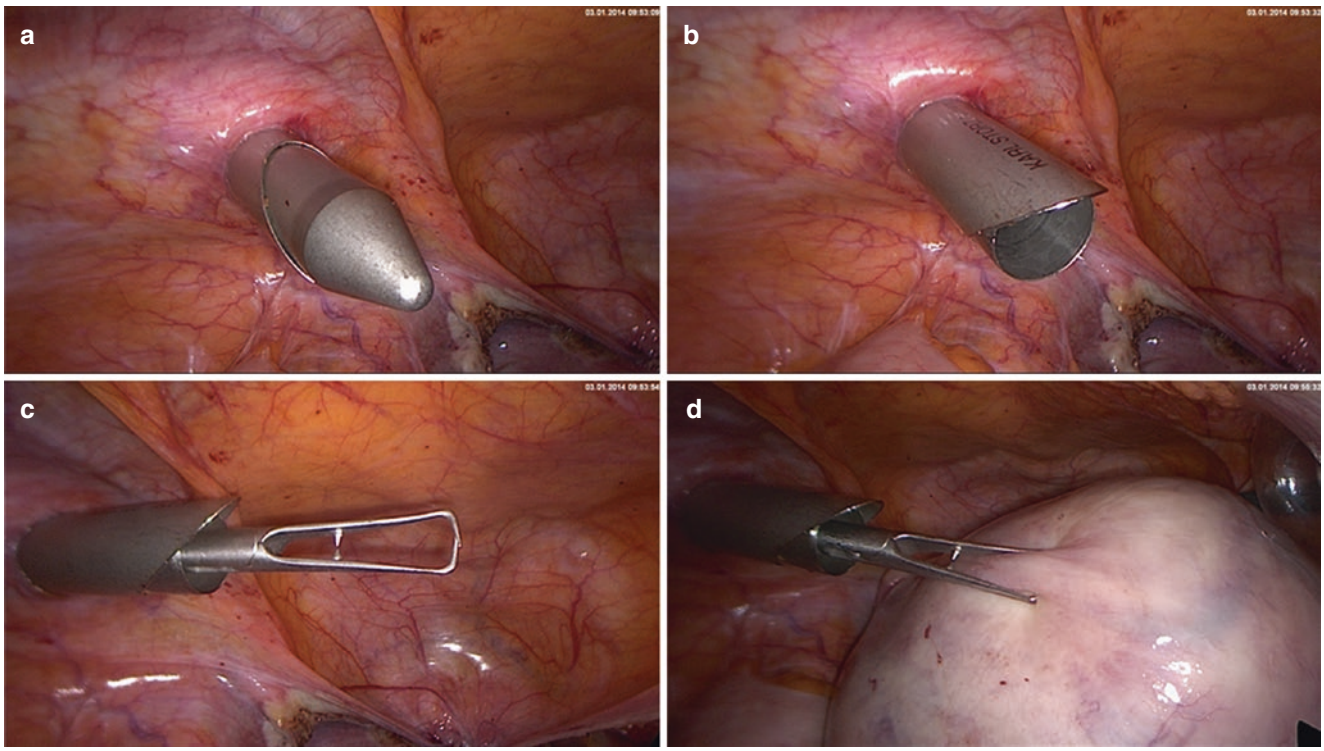


Fig. 35.85 (**a–d**) Introduction of the Roto-Cut morcellator, which is available in diameters of 12 and 15 mm. The knife should be protected by the shield and the tenaculum should be used under direct vision, regardless of the size of the uterus

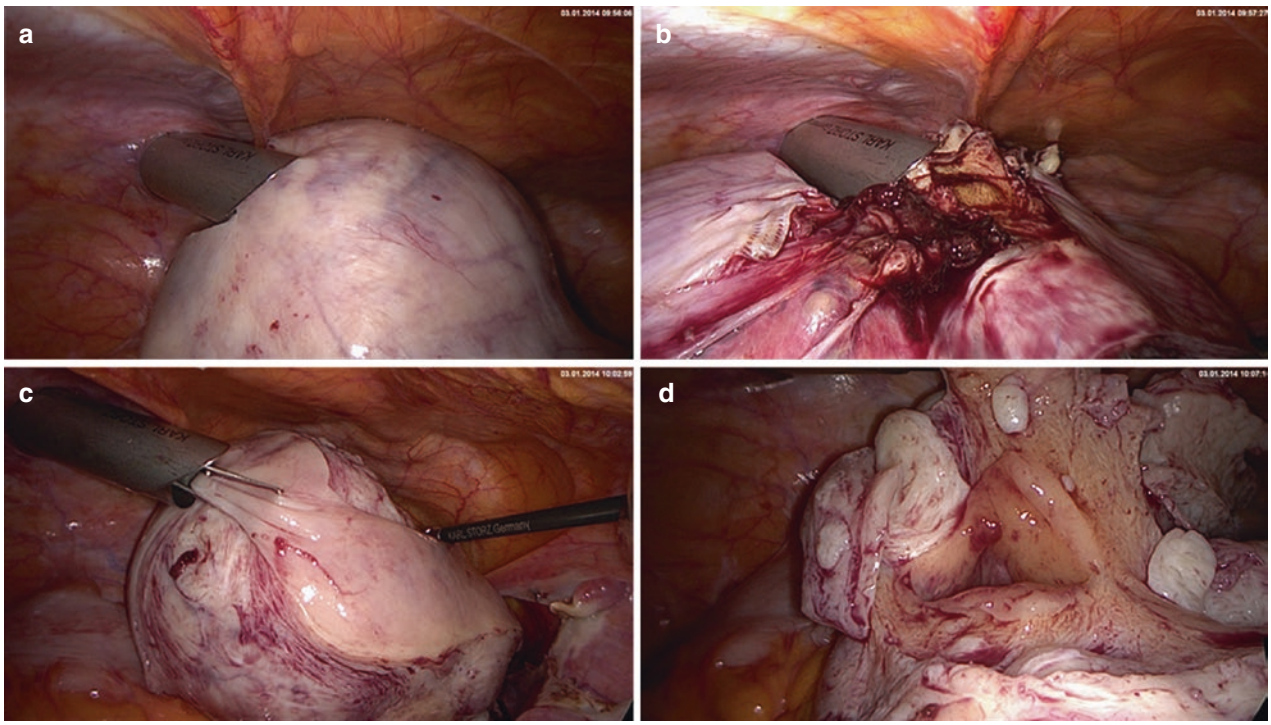


Fig. 35.86 LSH: (**a**) Morcellation of the myomatous uterus (850 g) under (**b**) continuous observation of the rotating cutting edge and (**c**) the protective shield of the morcellator**.** The protective shield should be directed upward to the abdominal wall in order to avoid cutting the vessels of the abdominal wall. Nevertheless, the lower part, especially the small bowel, must be exposed and kept out of the field of operation. (**d**) The surgeon must be patient and observant in order to avoid cutting into the bowel, which is one of the major complications in the LSH procedure

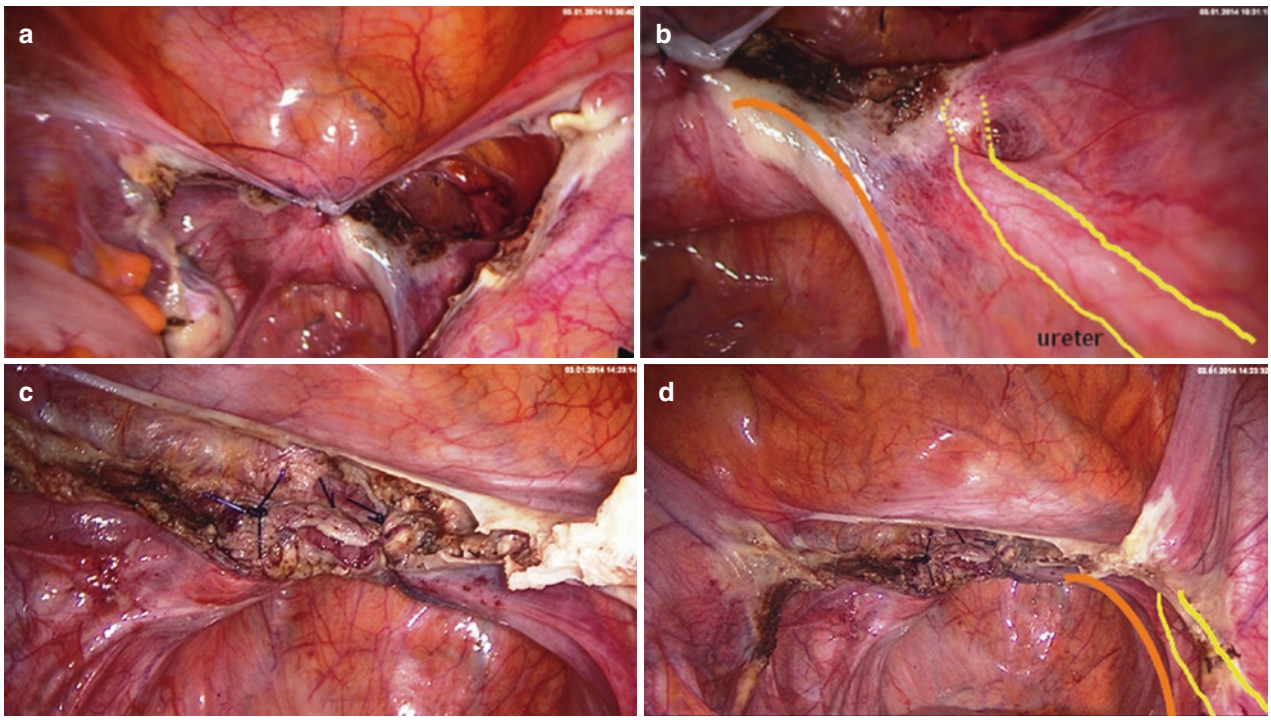


Fig. 35.87 (**a**, **b**) Final situs after LASH. The cervical channel is covered by peritoneum and both sacrouterine ligaments are under slight tension, thus fixing the middle compartment and the cervical ring. (**c**, **d**) Final situs after LTH. Closure of vaginal stump has been performed; the sacrouterine ligaments have been elevated by 2 corner sutures. The peritoneum closes the cervical channel, and drainage can be effected on both sides. Both sacrouterine ligaments are under slight tension, thus ensuring colposuspension. Reperitonealization will occur approximately 2 weeks after the operation. The PDS suture allows safe closure and healing of the vaginal cuff because absorption occurs only after about 6 months. The sacrouterine ligaments and the ureter can be clearly identified. Since the anatomy of the ureter has not been affected, opening of the retroperitoneum and its visualization are not necessary

Special Situations

The traditional technique of laparoscopic hysterectomy must be modified in cases of severe adhesions or concomitant deep infiltrating endometriosis. The surgical steps are quite similar to those for oncologic surgery; radical pelvic exposure is essential (Figs. 35.17, 35.18, and 35.40). After adhesiolysis, which may be very extensive in severe endometriosis or adenomyosis, the retroperitoneum is opened (Figs. 35.52, 35.88 and 35.89). The ureter and major vessels are localized, and the crossover of the uterine artery is visualized and exposed (Fig. 35.89). In some cases, clipping of the uterine artery just behind its point of departure from the internal iliac artery (Figs. 35.90, 35.91, 35.92 and 35.93) is useful for the following reasons:

1. More distal preparation and skeletonization of the uterine artery may be difficult or even impossible.
2. Endometriotic scars and nodules are liable to modify the anatomy of the region. This may lead to unexpected bleeding, especially in cases of a larger uterus. Clipping of the initial portion of the uterine artery will minimize intraoperative bleeding.

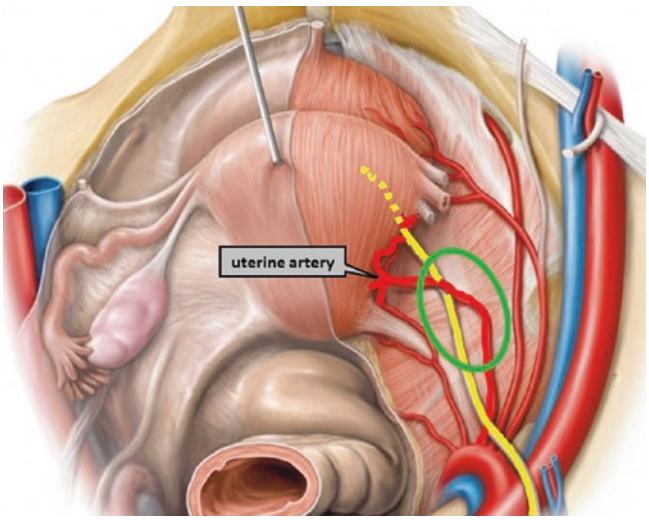


Fig. 35.88 Any uterine pathology may cause major difficulties in exposing the lateral uterine wall and the ascending branch of the uterine artery. Furthermore, all radical hysterectomies include the parametrium and imply a distal resection margin. This might make it necessary to expose the retroperitoneum and localize the departure of the uterine artery from the internal iliac artery

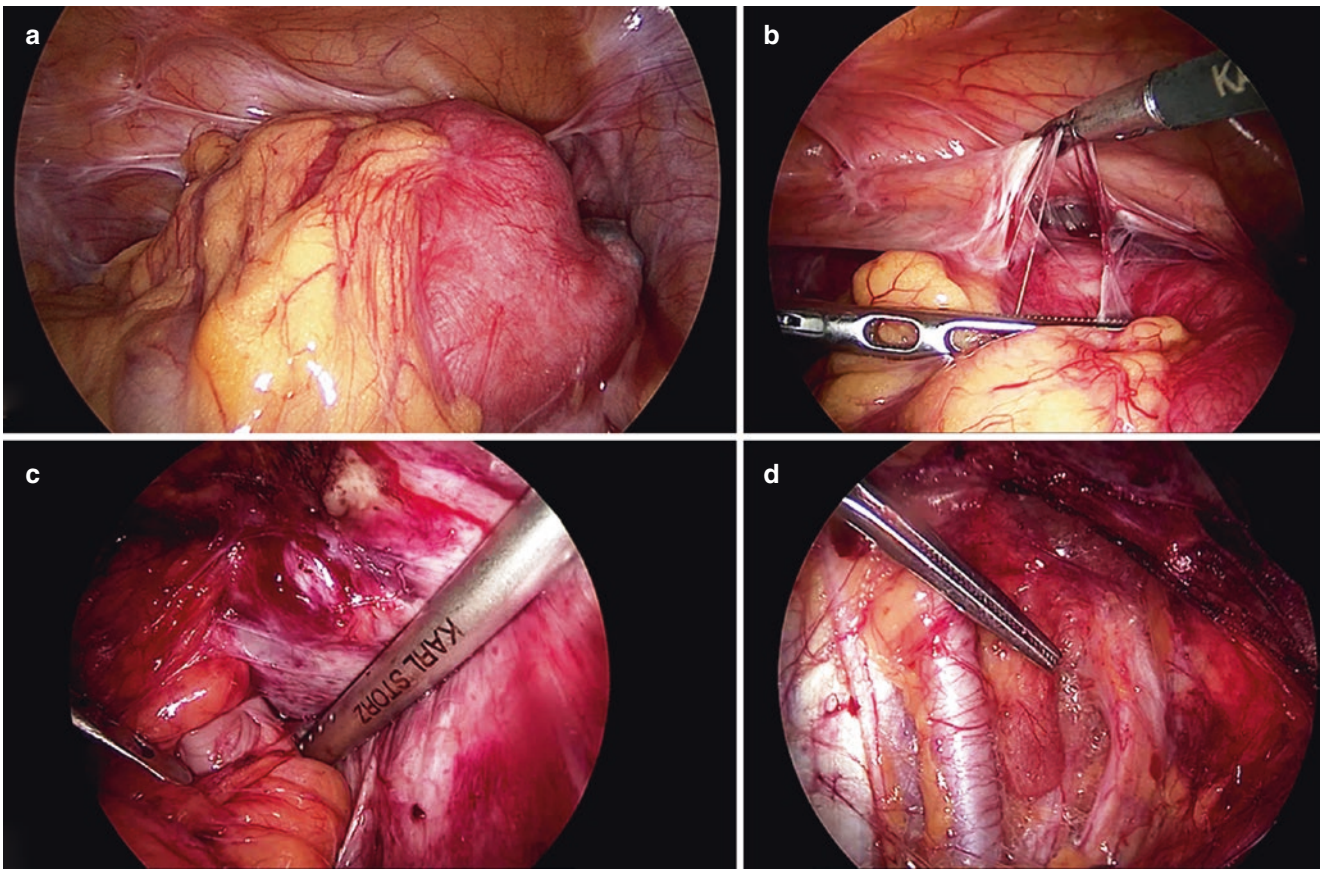


Fig. 35.89 A case of severe adenomyosis of the uterus with subsequent adhesions of the bowel (**a**) and the bladder (**b**) peritoneum. Access to the lateral aspect of the uterus is closed (**c**); retroperitoneal access is necessary (**d**)

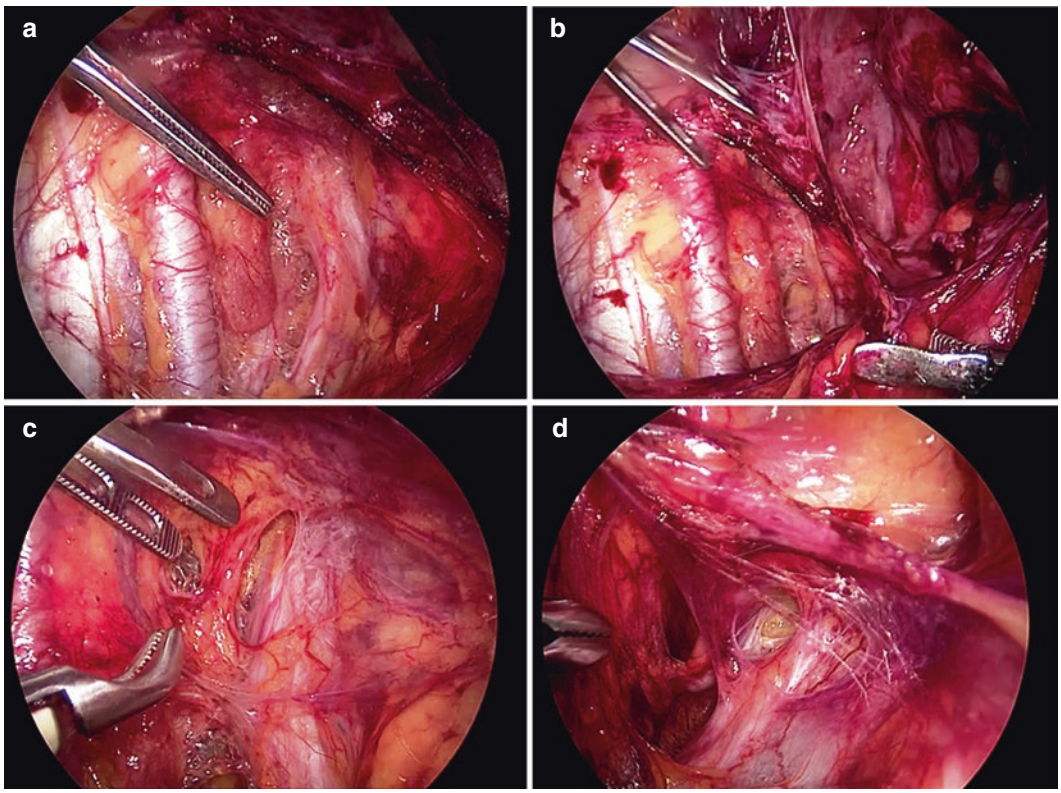


Fig. 35.90 (**a**) After localization of the external iliac artery, the ureter is usually found adherent to the peritoneum. A major lymph node lies in between.(**b**) Opening of the pararectal and (**c**) the paravesical fossa. (**d**) The crossing point of the uterine artery is demarcated, and the ureter is left in its adventitia to avoid skeletonizing and denudation

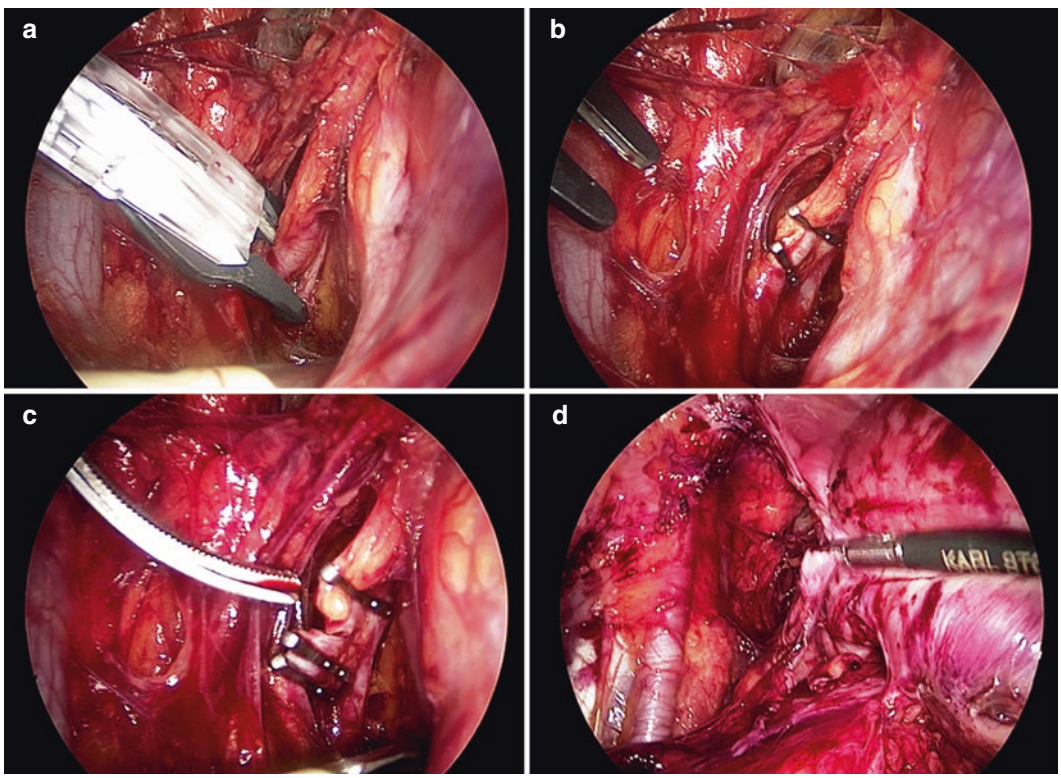


Fig. 35.91 (**a–b**) Clips can be inserted and the artery can be closed and cut (**c**)**.** (**c**) The uterine vein (deep) is seen just beneath the cut artery.(**d**) Overview of the exposed situs. To the right you see the uncolored uterus after closure of both arteries

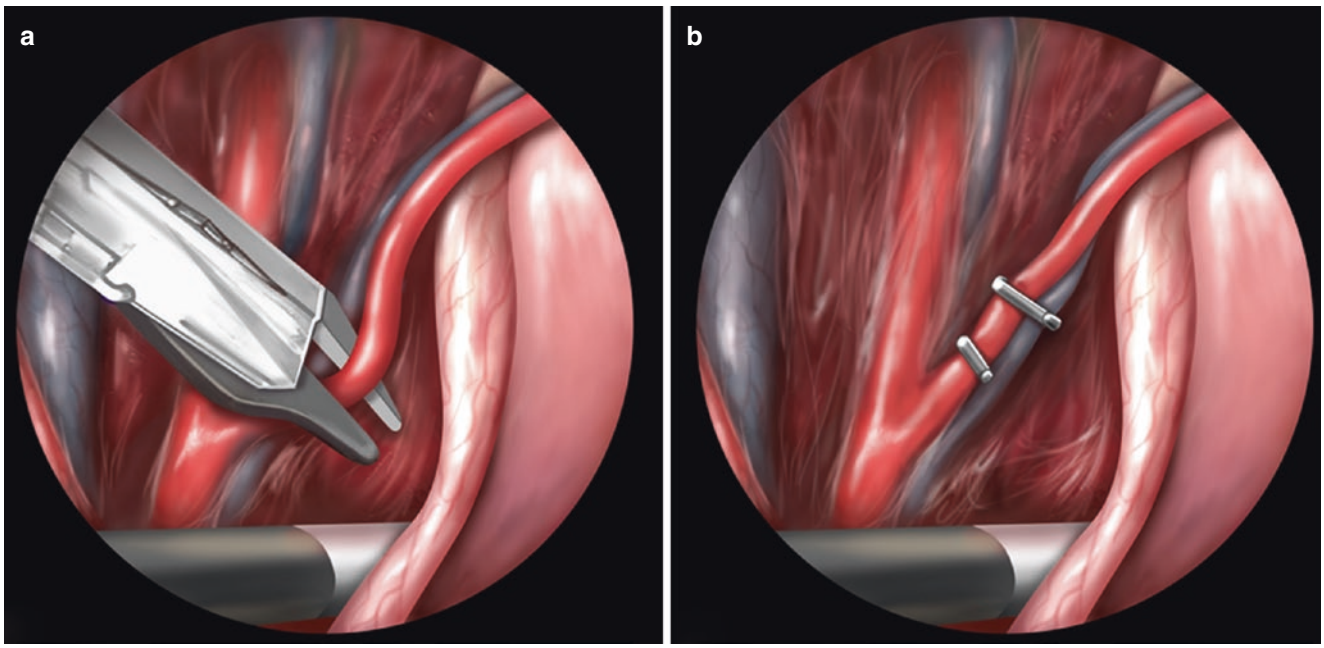


Fig. 35.92 (**a–b**) Schematic illustration of the retroperitoneal area where the ureter is undercrossing the uterine artery. The uterine vain is usually divided into a superficial part and a deep part. Clips can be set after medializing the ureter

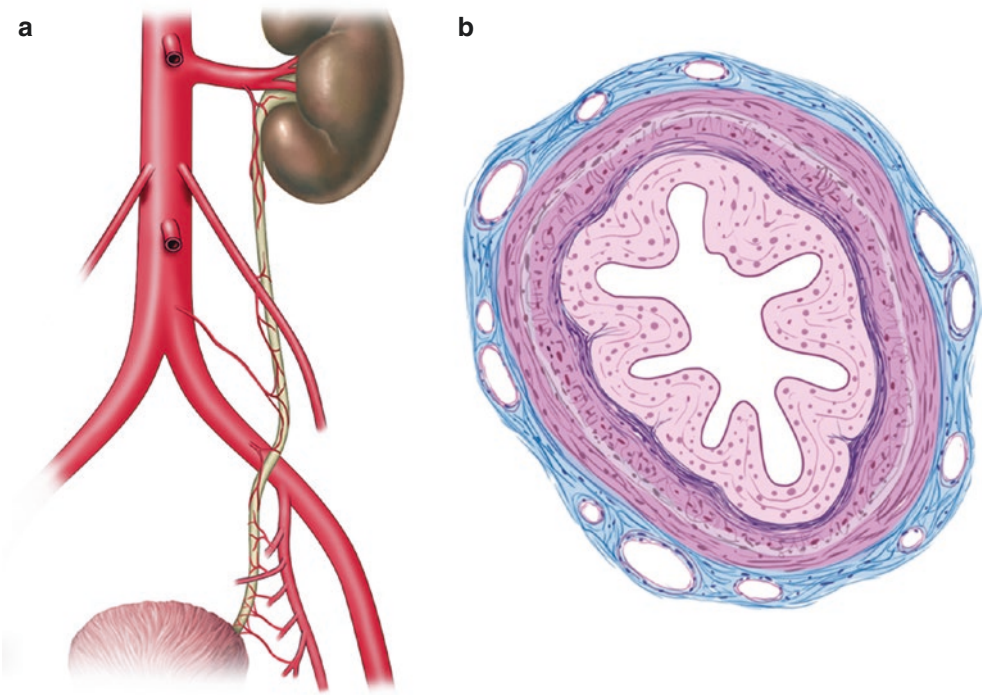


Fig. 35.93 The anatomy of the ureter provides crucial information.(**a**) Vascularization is effected from the upper part: the renal artery, the ovarian artery, and the aorta. In the lower part the ureter is supplied by lateral vessels: the iliac vessels and the uterine artery. Blunt dissection causes minor bleeding at the respective location.(**b**) The histological cross-section shows that vascular supply is located in the adventitia. Therefore, electricity or manipulation causing destruction of the adventitia may lead to secondary fistulas and/or leakage

3. The proximity of the uterine artery to the ureter and the thermal spread of bipolar instruments may cause secondary coagulation defects of the ureter, which can be avoided by using vessel clips.

At the end of the procedure the abdominal cavity is irrigated with physiological saline solution and drained. Usually no drains are left in situ (Fig. 35.89).

We established this suture technique because it provides stable fixation of the vaginal end in addition to other safety advantages:

1. As the suture is applied parallel to the urethra, kinking of the ureters is avoided. The thread is led through the medial part of the cardinal ligament, along the anterior-posterior access.

2. Compression of small vessels between the vaginal wall and uterine artery within the cardinal ligament minimizes the risk of bleeding.
3. Despite good suspension there is no relevant displacement of the vaginal access dorsally, which might increase the risk of a cystocele.

Post-hysterectomy Inspection

The pedicles, bladder, ureters and bowel must be inspected under continuous irrigation with Ringer's lactate or Adept (Baxter). Ureter movement is no proof of integrity. In cases of suspected damage to the ureter or kinking of the ureter while closing the vagina, the ureter must be visualized by opening the retroperitoneum and ureterolysis performed until the ureter enters the parametria (Fig. 35.93). Alternatively, methylene blue can be injected. If no dye is seen intraabdominally, severe damage is unlikely. In critical cases the integrity of the ureter can be proven by performing an intravenous pyelogram two to three days after the operation.

Postoperative Management

The urinary catheter is removed; it remains in place only in specific cases. A postoperative cystoscopy is performed in cases of severe endometriosis or adhesions in the upper part of the bladder. Early ambulation a few hours after surgery is good practice. Clear fluids can be ingested 6 h post-surgery, followed by a light diet. Thromboprophylaxis (mechanical and medical) must be used in appropriate cases. The patient can be discharged after 8–12 h. A postoperative ultrasound scan of the renal pelvis should be performed. Ordinary light activities are permitted and the patient may return to work after 4–5 days. Sexual activity, intensive sports and heavy work should be avoided for 6–8 weeks.

Anticipated Problems

Vital symptoms, pain and temperature must be carefully monitored during the first 8 h. A patient who is discharged early must be given a phone number she may call in case of distress or pain. The insertion of a drain is not necessary. Fever, early pain, abdominal distension, delirium, decreased urine output, the shock index and hypotension must be recognized and attended to immediately, as these may be signs of complications.

Summary and Conclusions

In addition to the well-known laparoscopic techniques for myomectomy and hysteroscopic techniques for submucous fibroidectomy, laparoscopic subtotal and total hysterectomy are surgical options for the treatment of multiple fibroids. The surgical procedure is decided upon jointly by the patient and the doctor. The individual steps described in this chapter help the gynecological surgeon to perform a satisfactory operation and eliminate the onerous burden of multiple fibroids in patients who have completed planning their families.

Conclusion

1. The transformation of classic intrafascial hysterectomy into laparoscopic hysterectomy, or even total atraumatic intrafascial laparoscopic hysterectomy (TAIL), is the first step for the prevention of a descensus. The uterine manipulator and the structured procedure have made laparoscopic hysterectomy a much safer option [28].
2. In a comparison of various methods to avoid prolapse during vaginal hysterectomy, McCall culdoplasty proved to be the most effective technique in the short term and after three years [39]. A similar procedure is used for abdominal hysterectomy [40, 41]. The method was modified by Harry Reich and adapted for laparoscopic procedures. One of its disadvantages is the unification of two lateral sutures in the midline, which results in an unphysiological narrowing of the apical pole of the vagina. As transposition of the ureters bears the risk of kinking it would be advisable to use van Herendael's modified suture technique, which avoids this risk [37].

References

1. Kovac SR. Route of hysterectomy: an evidence-based approach. Clin Obstet Gynecol. 2014;57(1):58–71.
2. Schollmeyer T et al. Hysterectomy trends over a 9-year period in an endoscopic teaching center. Int J Gynaecol Obstet. 2014;126(1):45–9.
3. Lefebvre G et al. SOGC clinical guidelines. Hysterectomy. J Obstet Gynaecol Can. 2002;24(1):37–61. quiz 74–6.
4. Stang A, Merrill RM, Kuss O. Hysterectomy in Germany: a DRG-based nationwide analysis, 2005–2006. Dtsch Arztebl Int. 2011;108(30):508–14.
5. Brummer TH, Seppala TT, Harkki PS. National learning curve for laparoscopic hysterectomy and trends in hysterectomy in Finland 2000–2005. Hum Reprod. 2008;23(4):840–5.
6. Prevention, C.f.D.C.a., Women's reproductive health: hysterectomy fact sheet, D.o.R. Health, Editor. 2009: 1600 Clifton Rd. Atlanta, GA 30333, USA.
7. Hanstede MM et al. Regional and temporal variation in hysterectomy rates and surgical routes for benign diseases in the Netherlands. Acta Obstet Gynecol Scand. 2012;91(2):220–5.
8. Alkatout I et al. Precarious preoperative diagnostics and hints for the laparoscopic excision of uterine adenomatoid tumors: two exemplary cases and literature review. Fertil Steril. 2011;95(3):1119 e5–8.
9. Alkatout I et al. Principles and safety measures of electrosurgery in laparoscopy. JSLS. 2012;16(1):130–9.
10. Hughes E, et al., Ovulation suppression for endometriosis.Cochrane Database Syst Rev. 2007;(3): p. CD000155.

11. Lethaby A, V Ivanova, NP Johnson. Total versus subtotal hysterectomy for benign gynaecological conditions.Cochrane Database Syst Rev. 2006;(2): p. CD004993.
12. Thakar R et al. Outcomes after total versus subtotal abdominal hysterectomy. N Engl J Med. 2002;347(17):1318–25.
13. Gorlero F et al. Hysterectomy and women satisfaction: total versus subtotal technique. Arch Gynecol Obstet. 2008;278(5):405–10.
14. Roovers JP et al. Hysterectomy and sexual wellbeing: prospective observational study of vaginal hysterectomy, subtotal abdominal hysterectomy, and total abdominal hysterectomy. BMJ. 2003; 327(7418):774–8.
15. Ascher-Walsh CJ et al. Location of adenomyosis in total hysterectomy specimens. J Am Assoc Gynecol Laparosc. 2003;10(3): 360–2.
16. Sarmini OR, Lefholz K, Froeschke HP. A comparison of laparoscopic supracervical hysterectomy and total abdominal hysterectomy outcomes. J Minim Invasive Gynecol. 2005;12(2):121–4.
17. BMI, Demography Report: Report of the German federal government on the demographic situation and future development of the country 2011, German Federal Ministry of the Interior.
18. Nygaard I, Bradley C, Brandt D. Pelvic organ prolapse in older women: prevalence and risk factors. Obstet Gynecol. 2004; 104(3):489–97.
19. Olsen AL et al. Epidemiology of surgically managed pelvic organ prolapse and urinary incontinence. Obstet Gynecol. 1997;89(4): 501–6.
20. Symmonds RE, Pratt JH. Vaginal prolapse following hysterectomy. Am J Obstet Gynecol. 1960;79:899–909.
21. Toozs-Hobson P, Boos K, Cardozo L. Management of vaginal vault prolapse. Br J Obstet Gynaecol. 1998;105(1):13–7.
22. Marchionni M et al. True incidence of vaginal vault prolapse. Thirteen years of experience. J Reprod Med. 1999;44(8):679–84.
23. Swift SE, Pound T, Dias JK. Case-control study of etiologic factors in the development of severe pelvic organ prolapse. Int Urogynecol J Pelvic Floor Dysfunct. 2001;12(3):187–92.
24. Elessawy M et al. The incidence of complications by hysterectomy for benign disease in correlation to an assumed preoperative score. Arch Gynecol Obstet. 2014;292(1):127–33.
25. Reich H. Laparoscopic oophorectomy and salpingo-oophorectomy in the treatment of benign tubo-ovarian disease. Int J Fertil. 1987;32(3):233–6.
26. Mettler L et al. Comparative evaluation of classical intrafascial-supracervical hysterectomy (CISH) with transuterine mucosal resection as performed by pelviscopy and laparotomy–our first 200 cases. Surg Endosc. 1995;9(4):418–23.
27. Semm K. Hysterectomy via laparotomy or pelviscopy. A new CASH method without colpotomy. Geburtshilfe Frauenheilkd. 1991;51(12):996–1003.
28. Hohl MK, Hauser N. Safe total intrafascial laparoscopic (TAIL) hysterectomy: a prospective cohort study. Gynecol Surg. 2010; 7(3):231–9.
29. Schüssler B, Scheidel P, Hohl MK. Hysterektomie update. Frauenheilkunde aktuell. 2008;3:4–12.
30. Veress J. Neues Instrument zur Ausführung von Brust- und Bauchpunktionen und Pneumothoraxbehandlung. Dtsch Med Wochenschr. 1938;64:1480–1.
31. Alkatout I et al. Abdominal anatomy in the context of port placement and trocars. J Turk Ger Gynecol Assoc. 2015;16(4):241–51.
32. Kramer L. Mixed reviews on removing fallopian tubes to prevent ovarian cancer. CMAJ. 2013;185(9):E391–2.
33. Kurman RJ, Shih Ie M. Molecular pathogenesis and extraovarian origin of epithelial ovarian cancer–shifting the paradigm. Hum Pathol. 2011;42(7):918–31.
34. Caceres A, McCarus SD. Fallopian tube prolapse after total laparoscopic hysterectomy. Obstet Gynecol. 2008;112(2 Pt 2):494–5.
35. Altman D et al. Pelvic organ prolapse surgery following hysterectomy on benign indications. Am J Obstet Gynecol. 2008;198(5):572 e1–6.
36. Thompson JD, Warshaw J. Hysterectomy. In: Rock JA, Thompson JD, editors. Te Linde's Operative Gynecology. Philadelphia-New York: Lippincott Raven; 1996. p. 771–854.
37. van Herendael B. Strategies to prevent vaginal vault descent during hysterectomy. In: Mettler L, editor. Manual of new hysterectomy techniques. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2007. p. 82–5.
38. Hur HC et al. Incidence and patient characteristics of vaginal cuff dehiscence after different modes of hysterectomies. J Minim Invasive Gynecol. 2007;14(3):311–7.
39. Cruikshank SH, Kovac SR. Randomized comparison of three surgical methods used at the time of vaginal hysterectomy to prevent posterior enterocele. Am J Obstet Gynecol. 1999;180(4):859–65.
40. Wall LL. A technique for modified McCall culdeplasty at the time of abdominal hysterectomy. J Am Coll Surg. 1994;178(5):507–9.
41. Ostrzenski A. A new, simplified posterior culdoplasty and vaginal vault suspension during abdominal hysterectomy. Int J Gynaecol Obstet. 1995;49(1):25–34.

Total Laparoscopic Hysterectomy in Patients with Bulky Uterus

36

Guenter K. Noé and Michael Anapolski

A big uterus can pose a serious challenge to a gynecologic surgeon in case a total laparoscopic hysterectomy (TLH) is to be performed. Although the basic anatomy of the lesser pelvis does not vary depending on the uterine size, the operative site can present some differences in these patients. Due to the sample size, there is less space in the pelvis and often in the abdominal cavity. This feature restricts the overview and renders more difficult the identification of such anatomical structures as the ureter. If the uterus fills the entire lesser pelvis not only a fast identification and isolation of uterine vessels in the paracervical region is not possible, but also a ligation of the uterine artery leaving the anterior brunch of the hypogastric artery is hardly conceivable. At the same time, the close proximity of the uterus to pelvic walls means a higher risk of an injury to the ureter since its course cannot be easily identified as long as the uterus occludes the field of view. Caused by the uterine size the pedicles of the supplying vessels can often be found in unusual positions (e.g. on the ventral side of the uterus). Due to the larger vessel diameter than in a normal specimen, a bleeding from a uterine artery or vein may result in a serious impairment of the visibility and also lead to a major blood loss. Since the minor branches of the uterine vein can reach the size of a regular normal size uterine vein, they may be mistaken for its major branch. The above mentioned features underline the importance of the correct identification of the supplying vessels prior to their ligation.

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Even if the laparoscopic procedure reaches a high level of difficulty, it allows a direct visualization of anatomical structures prior to and during their dissection. This is an important advantage compared to the vaginal approach. Another advantage is the possibility to perform an intrafascial hysterectomy via the laparoscopic route. For hysterectomies scheduled for benign conditions, we prefer this method to conserve as much ligamental and nervous tissue as possible. The intrafascial hysterectomy reduces also the risk of a ureteric injury [1]. This surgical procedure is as a rule possible also in patients with large sized uteri.

The usual preparation sequence of a TLH is a downward dissection that starts in the adnexal region and proceeds towards the uterine vessels. This strategy is not always possible with large uteri since the parauterine and paracervical region may become accessible only after mobilization of the uterus. Such situations require good surgical skills in view of the fact that the usual procedure has to be modified in order to adjust to the situs. We prefer to start with the "easy" side first and proceed to the other side after the uterus gained some mobility. It may be also necessary to switch to the other side before the preparation on the first side is completed. For example, we might dissect the adnexal pedicles on both sides prior to carry on with the dissection on the right side in order to mobilize the uterus and obtain enough space to access the parauterine region. In some cases of bulky uteri, the only accessible region is the anterior aspect of the cervix. Under such circumstances, the dissection should begin here by opening the peritoneal fold. The loose connective tissue in this area can often be pushed away and dissected bluntly towards the lateral aspect of the cervix allowing the access to the uterine vessels. In such cases, the access to the adnexa might be possible only in a retrograde way.

For regular TLH, we usually use an umbilical optic trocar and two working ports – in the left lower abdomen and in the suprasymphysary area. The uterine manipulator is usually handled by the operating nurse. For bulky uteri, we place an additional trocar in the right lower abdomen. The

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uterine manipulator can be controlled by an additional person since the operating nurse should avoid any distractions in order to allow a rapid reaction to eventual bleedings. To simplify the preparation and fasten the course of surgery we prefer to use combination instruments, allowing to seal and dissect the tissue without changing the device. Depending on the degree of difficulty, such tools may significantly shorten the time requirement, although the most part of them are designed for a single use and lead hence to higher operative costs.

Although a TLH can be performed in a freehand mode, we prefer the use of a manipulator with a cervical cup. In difficult situations, such as with a bulky uterus, this device helps to increase the distance to bladder and ureter during the dissection process. Different types of manipulators are available on the market with different additional functions and degrees of freedom. We prefer to use manipulators without a uterine spike because it restricts the ability to move the uterus manually within the abdominal cavity.

In a case of a "regular" intrafascial TLH, there is no particular need to expose the ureter in its entire course. With a bulky uterus, the visualization of the ureter prior to and during the dissection is rarely possible, so that it might be reasonable to perform it at least after the uterus removal. If any doubts exist – e.g. in case the dissection was carried out in a close proximity of the ureter – a placement of a ureteric stent should be considered. If a hydronephrosis is known before the surgery, a ureteric stent should be inserted prior to the intervention. To exclude a thermal injury – e.g. a stricture of the ureter – an intravenous pyelogram or a CT-scan can be conducted in the postoperative course. One should bear in mind, that such changes take some time to develop and unsuspicious results might be false negative in case the examination was carried out shortly after the surgery.

Although the closure of the vaginal vault can be performed by a vaginal approach, good endoscopic suturing skills are essential for a TLH since an additional ligation of major uterine vessels might be necessary. We usually perform a continuous endoscopic suturing of the vagina using absorbable material.

As a rule, the uterus can be extracted vaginally after a regular TLH. In case of a bulky uterus, the vaginal route is often not an option to remove the specimen in toto. Under the given conditions, tissue extraction is a serious issue since previously undetected malignancy, premalignant conditions and myoma tissue might be disseminated in the abdominal cavity during power morcellation [2–5]. To address this concern, some authors proposed to carry out a manual vaginal morcellation [6]. Another option is a laparoscopic power morcellation inside an endobag [7–9]. Different devices were developed by the industry recently, but the exact quantification of the risk reduction for spread of uterine sarcoma, endometrial cancer, smooth muscle tumor of uncertain malignant potential (STUMP) and parasitic myoma is not yet available at present.

Technique

A big Uterus is not only defined by weight but also by the volume relatively to the volume of the intra-abdominal space. The problem for the surgeon is primary the lack of space to move and the reduced field of view. Different strategies are suggested as mentioned above.

To obtain a good overview many authors recommend to position the optic trocar 2–4 cm above the umbilicus. According to the position different access-port placements are known (Figs. 36.1, 36.2, and 36.3).

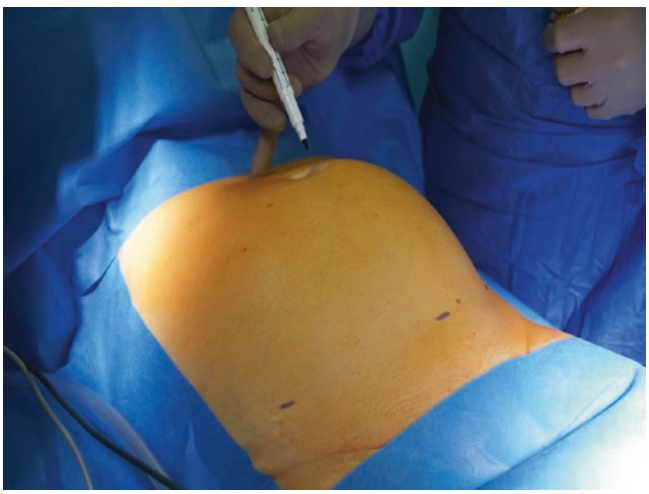


Fig. 36.1 Standard port-position

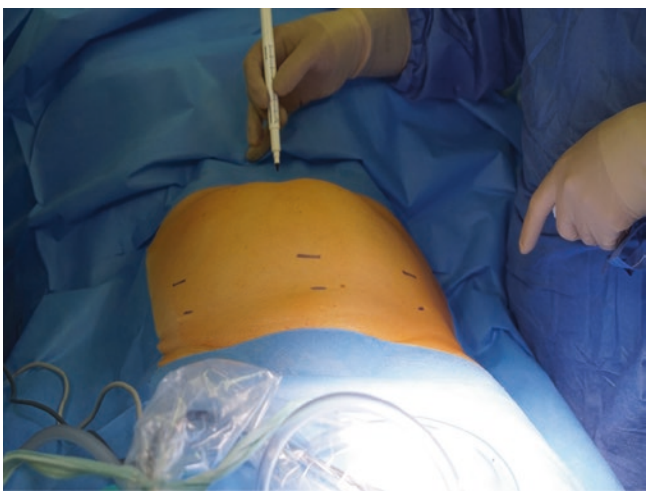


Fig. 36.2 Standard and elevated port-position

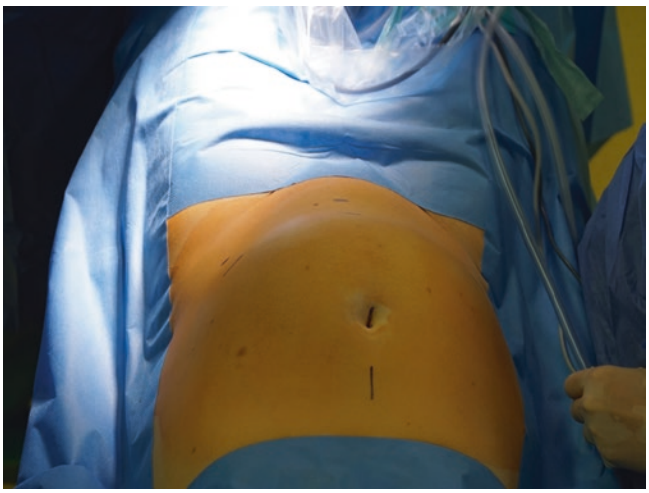


Fig. 36.3 Umbilical and high optic entrance

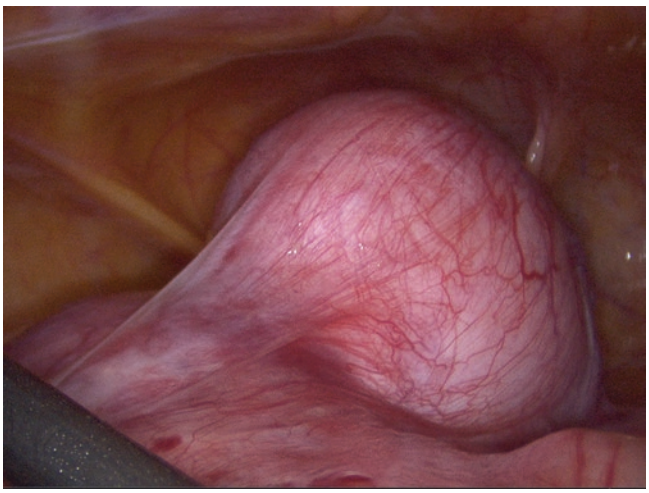


Fig. 36.4 2300 g uterus (all pictures taken on this uterus)

Indeed the higher positioning provides better view and better access to the higher tissue like the adnexa. On the other hand the angel to reach the uterine vessels gets more and more unfavorable the higher the placement of the port is proceeded.

At the end the success or the feasibility of the surgery is related to the access to the blood supply of the uterus. As we describe an approach for uterus 1000 g and more, the access to the uterine origin branch is not possible, the surgeon is forced to get access to the entering branch of the uterine arteries near the cervix from the anterior area. In this region a lot of vessels can be found as well as the ureter is close and the lack of tissue traction can increase the risk of damage.

To have an optimal angle the authors prefer the direct access and place the trocars in a usual setting (Fig. 36.1). One Optic-trocar and three working-port are placed.

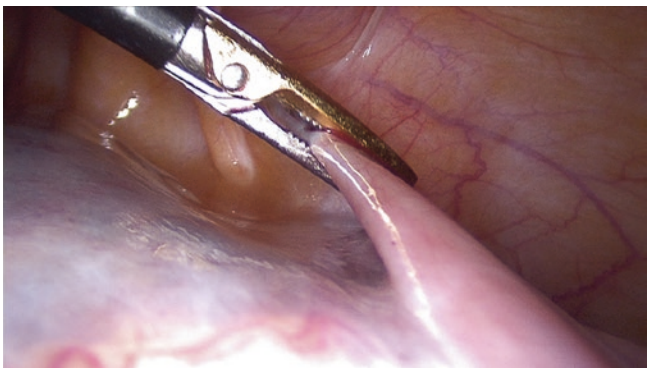


Fig. 36.5 Right round ligament

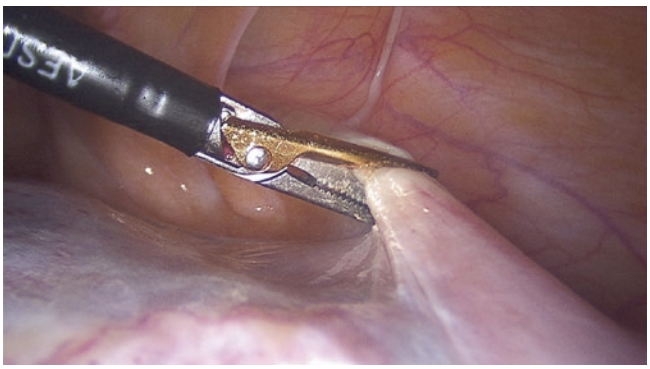


Fig. 36.6 Coagulation and cutting round ligament

Step 1

Visualizing the situation and exposure of the anatomy.

Step 2

Decision:

Is it possible to move the uterus laterally?

Will it be possible to move the uterus cranially after releasing from the round ligaments and the cardinal ligaments?

If these question cannot be answered positively an open procedure should be chosen.

Step 3

Identifying the Round Ligaments and the Peritoneal Border-Line to the Anterior Uterine Wall

The use of a combined instrument (coagulation/sealing/preparation and cutting) is the best advantage in this situation. Unnecessary movements by changing the instruments has to

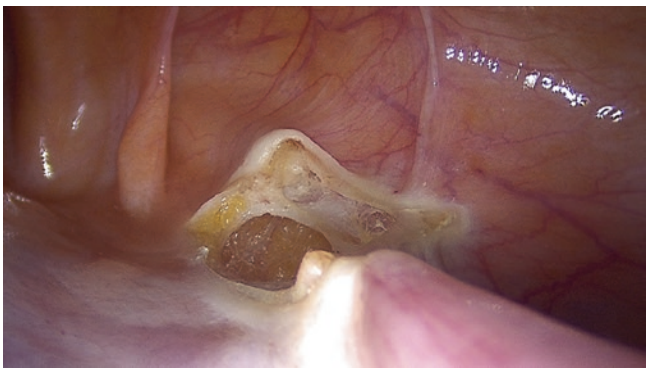


Fig. 36.7 Extension of the ligament

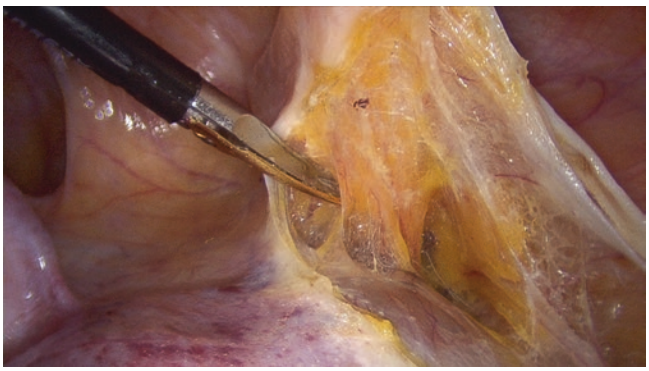


Fig. 36.9 Preparation downwards to the bladder

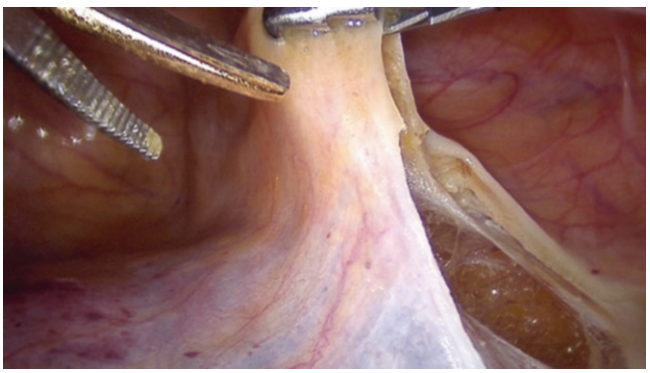


Fig. 36.8 Under traction the CO_2 Gas can stream into the retro-peritoneal space

be avoided. It depends on the experience of the surgeon which device is used. We prefer a bipolar combination instrument which provides the possibility to coagulate and cut as well as perpetrate separately.

In a field with poor visibility it is important to do the preparation as dry as possible.

To have the chance to move the uterus we first cut the round ligaments (Figs. 36.4, 36.5, 36.6, and 36.7). The lateral as possible to have a proper access to the retro-peritoneal space is important.

Step 4

Preparation of the peritoneum for identifying the uterine blood supply and get the uterus moved out of the pelvis (Figs. 36.8, 36.9, 36.10, 36.11, 36.12, 36.13, 36.14, and 36.15).

The preparation should be performed in small steps to avoid the rupture of the vein plexus in the lower part of the retro-peritoneal region. We use the gas for the dilution of the spaces and try to prepare as bluntly as possible.

Step 5

Identifying the Vessel Supply

As the access to the deep branch of the uterine artery is not possible by the bulky uterus, it is necessary to approach the vessels from anterior. To avoid bleedings from the accompanying veins a precise clearing of the margins is useful (Figs. 36.16, 36.17, and 36.18).

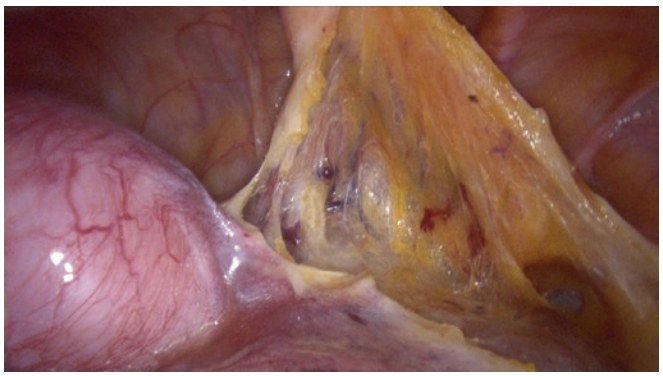
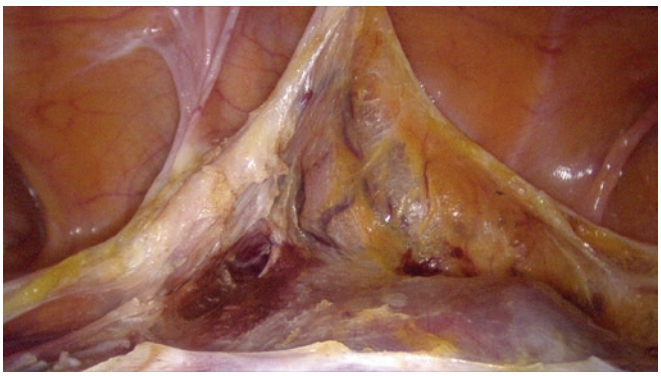
A clear and broad sealing of the artery to avoid reverse bleedings from the uterus is important as these bleeding reduce massively the field of view for the rest of the surgery (Fig. 36.19).

Step 6

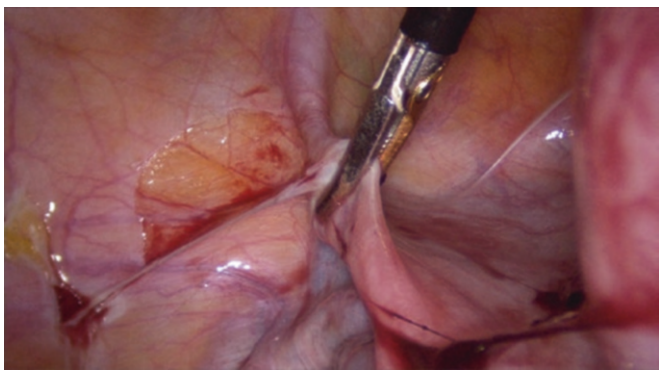
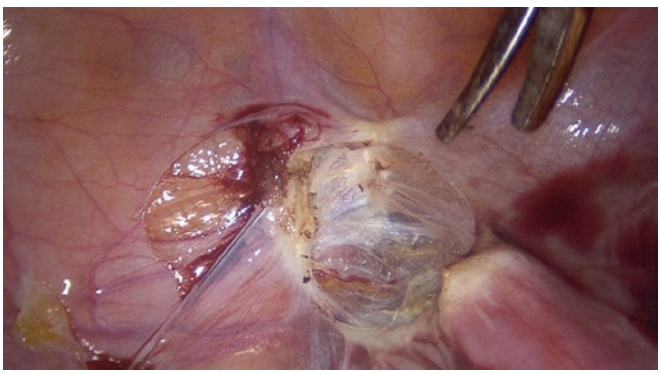
Approaching the Adnexa (Figs. 36.20, 36.21, 36.22, 36.23, 36.24, and 36.25)

In case of large uterus the access to the adnexa is performed reverse. First the position of the ovary and the tube has to be verified. The protruding masses can make the identification very difficult and the correct direction of the preparation has to be controlled step by step.

The second surgeon can hold the uterus to the contralateral side as far as the tissue allows. Then the first surgeon approaches the tube and the ovarian ligament retroperitoneal.

Figs. 36.10 and 36.11 Preparation of the bladder. The identification of the cervix can be difficult as often the cervix is consumed by fibroids

Figs. 36.12 and 36.13 Right round ligament preparation

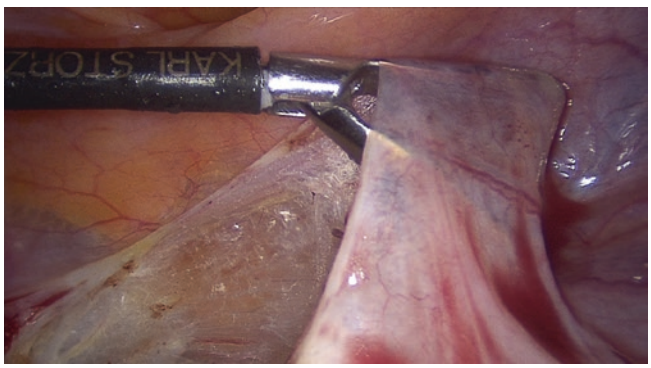
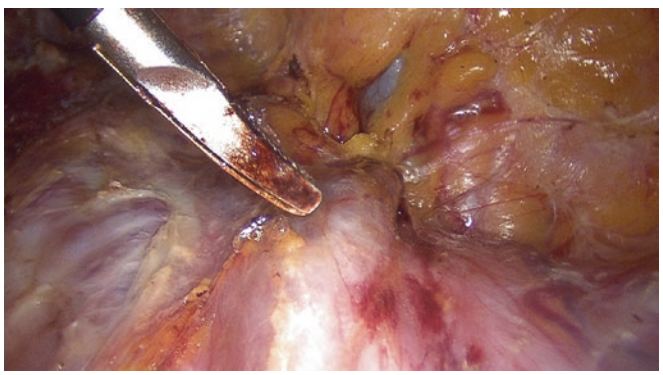
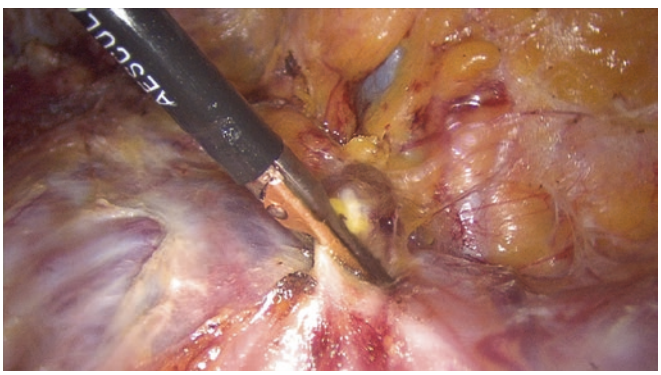


Fig. 36.14 Traction and tunneling the peritoneum to complete the anterior preparation



Fig. 36.15 Exposure bulky, lateral wall

Figs. 36.16 and 36.17 Right uterine artery/exposure and preparation

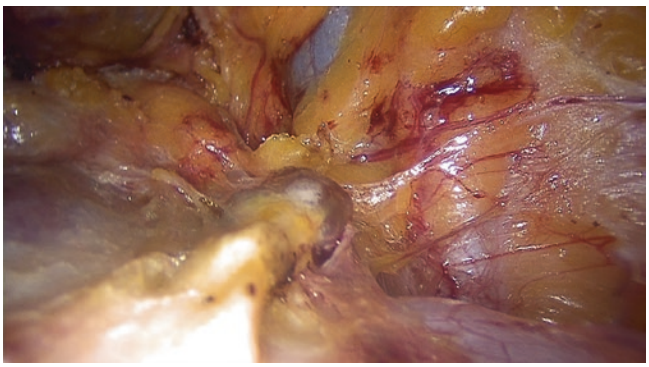


Fig. 36.18 Vain exposure

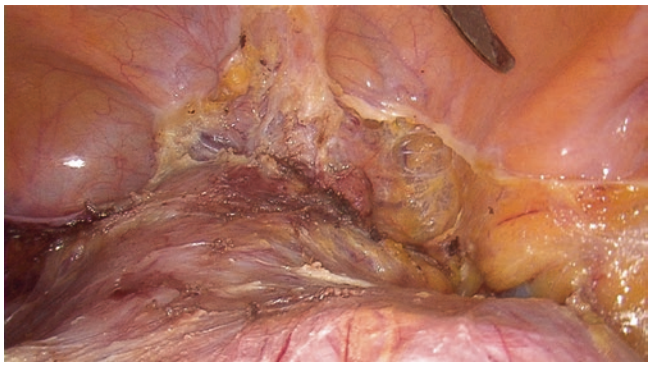
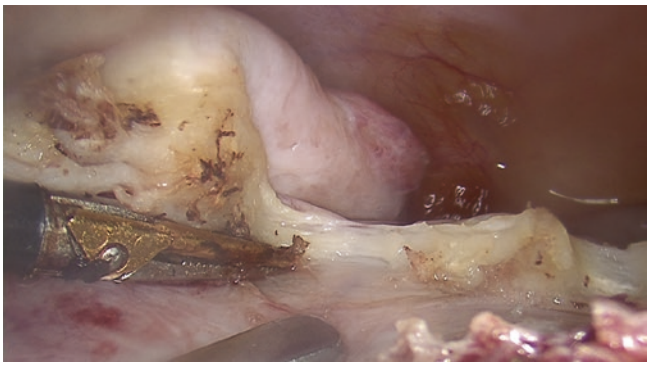


Fig. 36.19 Field after dissecting the artery





Figs. 36.21 and 36.22 Close preparation to the uterus in small steps

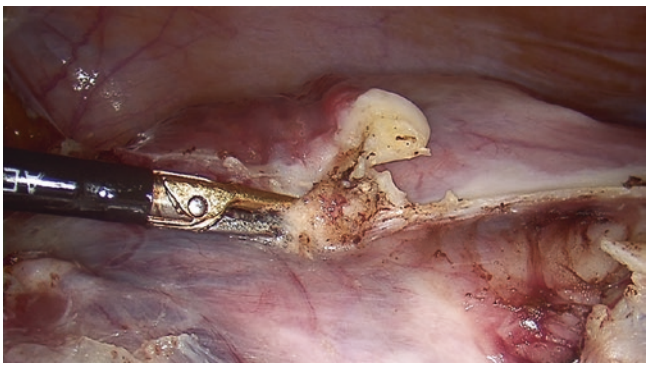


Fig. 36.20 Fallopian tube

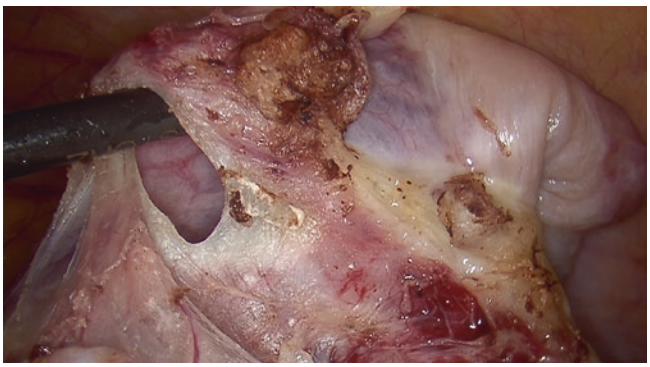


Fig. 36.23 Identification of the proper ovarian ligament

Step 7

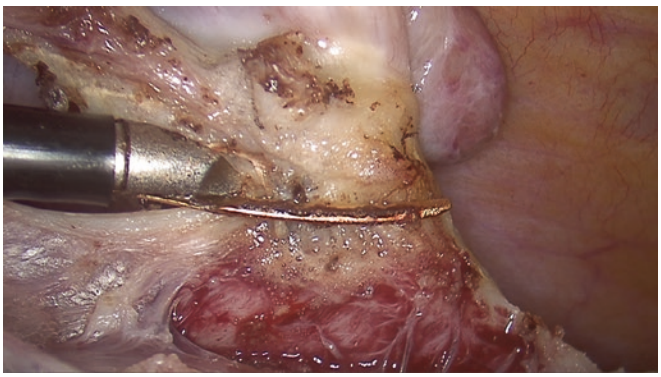
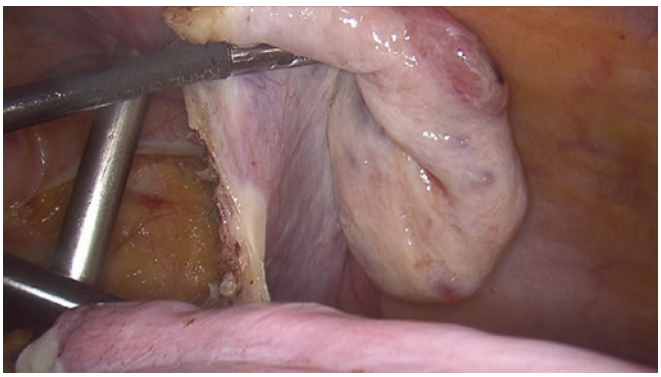
Clearing the Margins and Exposure of the Para-Cervical Tissue (Figs. 36.26, 36.27, 36.28, 36.29, and 36.30)

Step 8

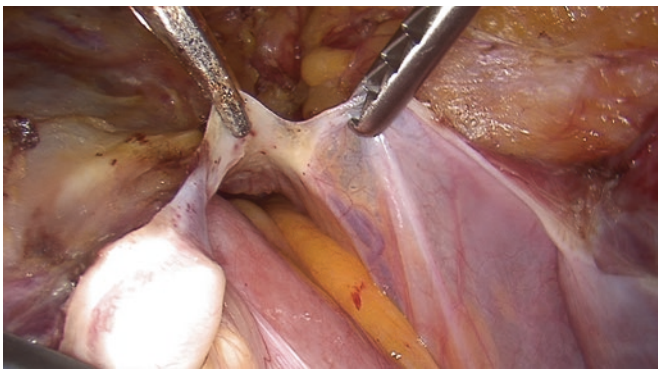
Exposure and Preparation of the Cervix (Figs. 37.31 and 37.32)

Upon transitioning of the uterine arteries the uterus can be cut off from the cervix to have an optimal surgical field. This provides the access to the utero-sacral ligaments and they can be spared by an intra-facial dissection. If the pushing up of the uterus is performable optimal, the preparation of the para-cervical tissue is possible and can be done with or without a vaginal adapter.

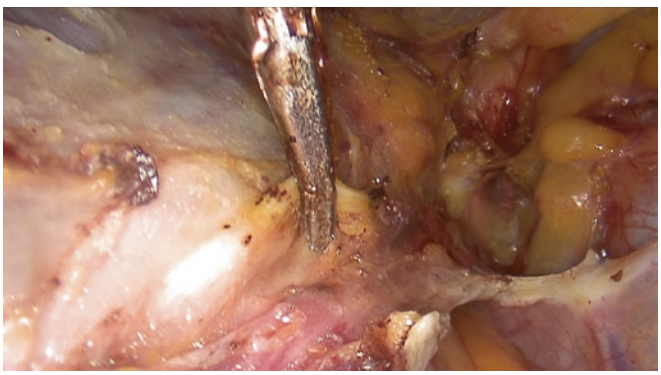
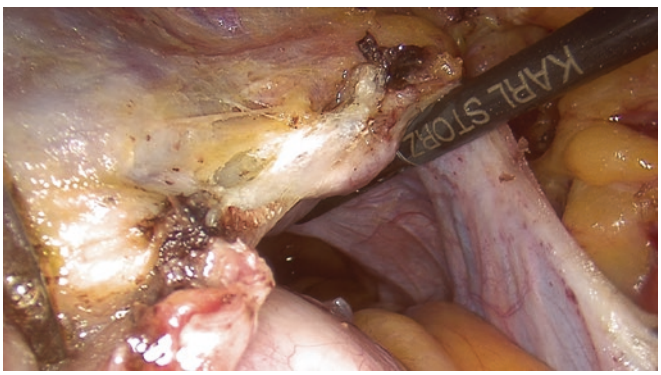
The TLH or LSH of large uterus is only performable by the use of morcellation. At the moment a uterus larger then 1000 g cannot be morcellated in an enclosed setting. For specimen from 300 to 1000 g we use a bag with three closable access openings to control the morcellation by two hands. It is possible to perform morcellation with only a morcellator in the bag if the tissue is small. It is advantageous to have a helping hand for specimen larger then 300 g controlling the movement of the tissue and provide an optimal view on the rotating knife.

Figs. 36.24 and 36.25 Cutting the proper ligament (*right*)

Figs. 36.26 and 36.27 Step by step preparation of the broad ligament

Figs. 36.28 and 36.29 Complete exposure of the right pedicel

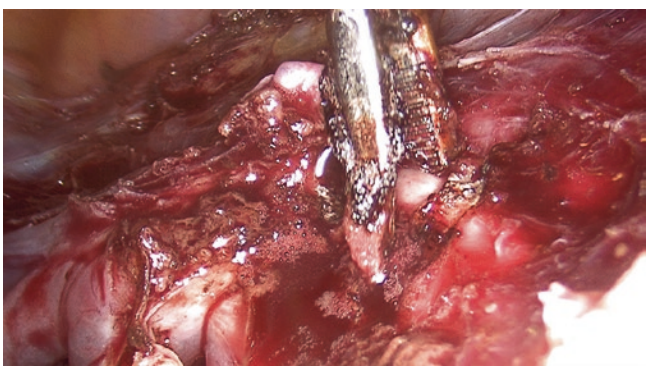


Fig. 36.30 Left uterine artery

As the access openings of the bag are closable we can prevent loosing spillage while extracting the bag after morcellation.

Two liter polyurethane bag with three closable access openings provides a good manageability of large tissue and a proper orientation by the transparency of the polyurethane (Figs. 36.33, 36.34, 36.35, and 36.36).

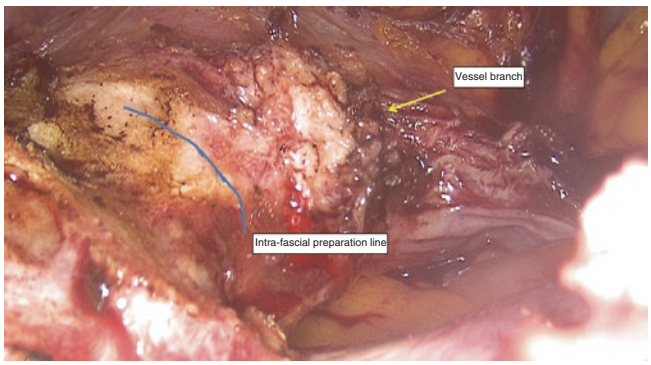


Fig. 37.31 Preparation of the right intra-facial space

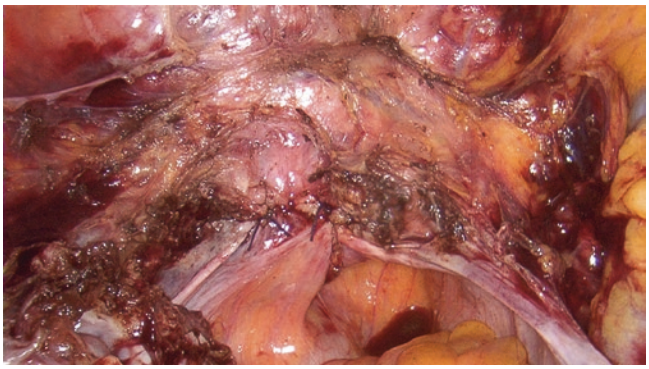


Fig. 37.32 Situs after closing the vagina by a running suture

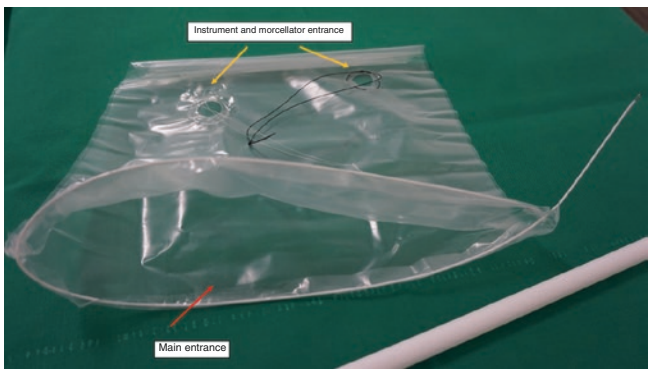


Fig. 36.33 Closable polyurethane bag







Figs. 36.34, 36.35, and 36.36 Closure of the access port and bag after extraction

References

1. Hohl MK, Hauser N. Safe total intrafascial laparoscopic (TAIL) hysterectomy: a prospective cohort study. Gynecol Surg. 2010;7:231–9.
2. Available at: http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm393576.htm. Accessed 21 Feb 2015.
3. Brown J. AAGL advancing minimally invasive gynecology worldwide: statement to the FDA on power morcellation. J Minim Invasive Gynecol. 2014;21:970–1.
4. Brown J, Taylor K, Ramirez PT, Sun C, Holman LL, Cone SM, Irwin J, Frumovitz M. Laparoscopic supracervical hysterectomy with morcellation: should it stay or should it go? J Minim Invasive Gynecol. 2015;22:185–92.
5. Nezhat C, Kho K. Iatrogenic myomas: new class of myomas? J Minim Invasive Gynecol. 2010;17:544–50.
6. Montella F, Riboni F, Cosma S, Dealberti D, Prigione S, Pisani C, Rovetta E. A safe method of vaginal longitudinal morcellation of bulky uterus with endometrial cancer in a bag at laparoscopy. Surg Endosc. 2014;28:1949–53.
7. Cholkeri-Singh A, Miller CE. Power morcellation in a specimen bag. J Minim Invasive Gynecol. 2015;22:160.
8. Cohen SL, Einarsson JI, Wang KC, Brown D, Boruta D, Scheib SA, Fader AN, Shibley T. Contained power morcellation within an insufflated isolation bag. Obstet Gynecol. 2014;124:491–7.
9. Harmanli O. Contained power morcellation within an insufflated isolation bag. Obstet Gynecol. 2015;125:229.

Total Laparoscopic Hysterectomy for the Patient with Concomitant Pelvic Organ

37

Shanti I. Mohling, Robert S. Furr, and C.Y. Liu

Pelvic organ prolapse significantly impacts the lives of women throughout the world. Nearly half of women worldwide will suffer from pelvic organ prolapse (POP) in their lifetimes [1]. Prolapse may be devastating as it affects many aspects of daily life including the ability to work, to exercise and to remain continent of urine and stool. It can affect self-esteem and sexual health. While conservative treatment options exist, and should be considered, surgical repair remains a viable option. Indications for surgery include failed conservative management with a pessary or physical therapy, failure or complications of a prior surgery for pelvic prolapse, and patient choice.

Hysterectomy with concomitant repair of pelvic organ prolapse may be performed laparoscopically or robotically, both of which afford excellent visualization of the operative field, thereby resulting in precise repair of pelvic floor defects and improved surgical outcomes. With fewer operative complications and minimal postoperative pain and discomfort, the patient enjoys a shorter recovery period and earlier return to normal activity.

Treatment of Pelvic Organ Prolapse at the Time of Hysterectomy

The primary goal of surgical treatment of POP at the time of hysterectomy is to reconstruct and to restore the integrity of endopelvic fascia. Ultimately, the aim is to restore normal vaginal length, vaginal axis and vaginal support. Because the general principles and detailed surgical techniques of endoscopic hysterectomy for various indications have been described elsewhere in the atlas, this chapter aims to describe the specific techniques of laparoscopic hysterectomy that are unique to the anatomical distortions secondary to POP. This chapter will also be devoted specifically to the concomitant laparoscopic treatment of POP at the time of hysterectomy. Finally, the technique of uterosacral vaginal vault suspension at the time of laparoscopic hysterectomy may also be applicable in the prevention of vaginal vault prolapse.

Anatomic Considerations

Pericervical Ring

The cervix is encircled by thick visceral connective tissue called the pericervical ring. This is the cornerstone of vaginal apical support. The pericervical ring is the convergence of the anterior pubocervical fascia, the posterior rectovaginal septum and the uterosacral ligaments [2]. The pericervical ring constitutes the strongest connective tissue between the ischial spines and is located in the narrowest diameter of the female pelvis. Defects in any of these three components as they converge create varying forms of pelvic prolapse [3]. The location of the ischial spines relative to the structures of the pericervical ring are the most important factors to be considered in reconstructive surgery for pelvic organ prolapse (Fig. 37.1).

Ischial Spine

The ischial spine is a triangular bony eminence projecting from the dorsal border of the ischium. It serves as an attachment point for the sacrospinous ligament, the coccygeus and levator ani muscles, and the pelvic fascia. The space between the ischial spines is the narrowest diameter in the female pelvis and contains the strongest connective tissue.

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Fig. 37.1 A schematic of reconstructed Pericervical Ring after hysterectomy demonstrating the convergence of pubocervical fascia, the rectovaginal septum and the uterosacral ligament at the level of ischial spine

Pelvic Ureter

During hysterectomy with co-existing POP, one must be keenly aware of the potential for anatomic deviation in the course of the ureter. In the patient without prolapse, the pelvic ureter follows the internal iliac artery, traverses downward from the bifurcation, passes under the uterine artery at the level of the ischial spine, and then turns forward and medially over the anterior lateral vaginal fornix to enter the posterolateral wall of the bladder. At the "knee" of the ureter, the distance between the ureter and the cervix is approximately 1.5–2 cm, however, as the ureter curves forward over the anterior vaginal fornix, this distance can become even smaller, especially with co-existing prolapse.

The surgeon must be vigilant and have a clear idea of the location of the ureter while performing desiccation or ligation of the uterine vessels and while performing the anterior and lateral aspect of colpotomy during hysterectomy. In the setting of utero-vaginal prolapse (especially in the case of chronic uterovaginal prolapse with elongated cervix), anterior enterocele, and cystocele the course of the ureter between the "knee" and the bladder may be displaced, medially or anteriorly. In this area, the ureter can easily be damaged through ligation, thermal injury, transection, or impingement during hysterectomy and during the repair of prolapse.

Uterosacral Ligaments

Many gynecologists hold a traditional concept of the uterosacral ligament believing that it spans from the back of the cervico-vaginal junction curving posteriorly to reach the anterior and lateral aspects of the sacrum. The surgical anatomy of the uterosacral ligament may appear to be readily identified as a dense, strong band of connective tissue medial and posterior to the ischial spine. However, cadaveric and histological studies have generally demonstrated an absence of actual condensed ligamentous structure.

In 2004, Umek and DeLancey used MRI to demonstrate the origin and insertion points of the uterosacral ligament on 61 asymptomatic women. Their study revealed that more than 82 % of uterosacral ligaments actually inserted into the sacrospinous ligament and coccygeus muscle, while only 7 % inserted onto the sacrum [4]. Again, in 2012, DeLancey's group, at the University of Michigan, used dynamic MRI to track the uterosacral ligament on 20 nulliparous women. They found that in 73 % of them, the uterosacral ligaments actually inserted into the sacrospinous ligament and coccygeus muscle. Only 21 % of them had insertions into the presacral fascia. No direct attachment to the sacrum was identified [5]. Therefore, the primary insertion site of the uterosacral ligament is the sacrospinous ligament or coccygeus muscle at the level of the pericervical ring, which holds the cervix and apex of vagina in their normal anatomic position.

Vaginal Tube and Enterocele

Prolapse is the end result of the detachment of endopelvic fascia from its surrounding connective tissue support. Pathophysiologically, prolapse is a condition of herniation – a fascial separation that occurs within the vaginal tube. From a surgical perspective, the vagina is a fibromuscular tube that is completely encapsulated by endopelvic fascia. Anteriorly, this is the pubocervical fascia; posteriorly, the rectovaginal septum, and; superiorly, the uterosacro-cardinal ligament complex. This fibromuscular vaginal tube is lined by vaginal epithelium. Biomechanically, the endopelvic fascia cannot be stretched or attenuated. Thus, it breaks, or separates, under chronic pressure while vaginal epithelium and pelvic peritoneum can be stretched endlessly under pressure.

Fascial separations occurring within the vaginal wall result in pelvic peritoneum having direct contact with vaginal epithelium. Under pressure, both will stretch and protrude, bulging into the vagina forming a hernia sac, or enterocele. Separation between the pubocervical fascia and pericervical ring produces an anterior enterocele. Similarly, a separation in the connective tissue of the rectovaginal septum and

pericervical ring presents as a posterior enterocele. Procidentia results from circumferential separation at the pericervical ring together with disintegration of the uterosacral ligament attachments (Table 37.1).

Surgical Considerations

Surgical reconstruction and restoration of the integrity of the pericervical ring will correct a majority of prolapses. In pelvic reconstructive surgery, one must first restore the integrity of the fibromuscular vaginal tube by reattaching the pubocervical fascia to the rectovaginal septum after hysterectomy or by attaching them both to the cervix if the uterus is to be preserved. Next, the apex of the vagina, or the cervix, is suspended to the proximal part of the uterosacral ligaments at the level of the ischial spine. In most cases, this will restore the normal vaginal length and vaginal axis. The latter step can also be accomplished by reattaching the apex of the vagina or the cervix to the sacrospinous ligament, or by performing a sacrocolpopexy with mesh graft. Literature strongly suggests that without proper suspension of the apex of vagina or cervix to the level of the ischial spine, all attempts at prolapse repair will ultimately fail [6].

Because pelvic floor defects are true herniations in pelvic floor fascia, the detached fascia needs to be reconstructed and repairs should be performed using non-absorbable monofilament sutures. In our center, we currently perform laparoscopic uterosacral ligament vault suspension using non-absorbable monofilament suture and laparoscopic or robotic sacrocolpopexy with large pore monofilament polypropylene synthetic mesh. We reserve the use of synthetic mesh for cases of severe prolapse in which the fascia is severely damaged or the patient has had recurrent symptomatic prolapse with failed previous surgical repair.

Following apical suspension, a vaginal examination is performed to ensure that the depth of the vagina has been restored. Frequent intraoperative vaginal examinations, with simultaneous laparoscopic observation, are performed to confirm appropriate correction of anterior and posterior vaginal wall prolapse. In some cases, after the appropriate reconstruction and restoration of the pericervical ring, an anterior or posterior defect will persist. This warrants further reconstruction with either a retropubic paravaginal repair, a midline cystocele repair or vaginal posterior colporrhaphy with perineorrhaphy.

Pre-operative Patient Counseling

If a graft material or non-absorbable synthetic mesh is being considered, the patient must be thoroughly informed and counseled regarding the risks and possible complications associated with the use of these materials. Risks of mesh include erosion into the vagina, dyspareunia, bowel obstruction, infection and pelvic pain. The patient must sign a comprehensive consent prior to surgery.

Additional counseling should include discussion on the possible but rare occurrences of postoperative urinary, bowel and sexual dysfunction. Expected long-term outcomes based on available data should be discussed in detail with the patient. The authors firmly believe that verbalized understanding by the patient of known failure rates, potential complications and potential for *de novo* stress incontinence or urge incontinence can help prevent false expectations and ultimately lead to greater patient satisfaction.

Preoperative Evaluation

A thorough medical history and prolapse history (including urinary, gastrointestinal, and sexual histories) must be carefully taken and recorded in the patient's file prior to surgery. The patient must be examined in both erect and supine position to map out pelvic floor defects in detail. The Pelvic Organ Prolapse Quantification (POP-Q) system is used to quantify, describe, and stage pelvic support. Urinary incontinence must be assessed in the erect and supine positions with and without reduction of prolapse. Assessment of urethral mobility, simple office cystometrics and post void residual are generally adequate for evaluation. A randomized trial, in 2012, demonstrated that for patients with history of uncomplicated, demonstrable stress urinary incontinence, preoperative evaluation in the office alone was not inferior to performing urodynamic testing. This was based on outcomes at one year [7]. In our practice, urodynamic studies are reserved for those with complicated symptoms.

Table 37.1 Fascial separations occurring within the vaginal wall result in pelvic organ prolapse. This table lists traditional nomenclature and pairs it with the precise fascial defect as related to the pericervical ring

Organ prolapse	Anatomical defect
Anterior compartment (anterior enterocele)	Separation of pubocervical fascia from pericervical ring
Posterior compartment (posterior enterocele)	Separation of rectovaginal septum from pericervical ring
Complete procidentia	Separation of the anterior and posterior fascia from the uterosacral ligament attachments and the pericervical ring

Operative Procedures

Patient Positioning

The patient is placed on a non-slip foam pad in the dorsolithotomy position with both legs well supported, as steep Trendelenberg will be maintained throughout most of the procedure. The arms are carefully tucked alongside the body. Attention is taken to ensure that the brachial plexus is not under untoward strain. Padding is placed on all pressure points including the occiput, to prevent neurovascular and ischemic compression injury. The surgeon should have unobstructed access to the perineum and vagina for the use of a vaginal or uterine manipulator, rectal probe and performance of vaginal examination during the surgery. Nasogastric or orogastric tube should be in position prior to subcostal insertion of a Veress needle or trocar to avoid injury to the stomach.

A Foley catheter is always placed at the onset of the surgery.

Placement of Uterine Manipulator

An effective uterine mobilizer capable of uterine anteversion, retroversion and lateral motion is essential. Many options exist for this purpose. A manipulator with a colpotomizing cup is helpful, but not imperative. If the surgeon prefers a non-disposable approach, instruments readily available in any gynecologic procedure tray may be used. In our center, for years we successfully used a simple technique: A single-toothed tenaculum is secured to the anterior lip of the cervix and a uterine sound is placed within the uterus to the fundus. A second tenaculum is placed on the posterior lip of the cervix and subsequently the three instruments are secured tightly together using sterile rubber bands.

Creation of Pneumoperitoneum

Establishing pneumoperitoneum may be one of the most critical steps in the performance of laparoscopic surgery. Many techniques exist with or without the use of a Veress needle, yet no technique has been demonstrated to be superior. In our practice, a Veress needle is usually inserted in the middle of the umbilicus or in the left upper quadrant, a fingerbreadth beneath the costal margin at the mid-clavicular line (Palmer's Point). Saline test or "hanging drop test" confirms ideal placement. Opening pressures for CO_2 gas should be under 10 mmHg, or extraperitoneal placement may have occurred. The patient should be in a flat position during initial placement of the Veress needle. The insufflator pressure may be initially set to 20 mmHg for placement of the trocars, but it should be reduced to 14–15 mmHg for duration of the procedure.

Trocar Placement

Five trocars are inserted after the pneumoperitoneum: a 10 mm umbilical trocar and four 5 mm secondary trocars. A 10 mm laparoscope is used and is inserted through the umbilical trocar sleeve and the patient is placed in steep Trendelenberg position. Two 5 mm trocars are placed lateral to the deep inferior epigastric vessels in the lower abdomen and two 5 mm trocars are placed lateral to the abdominal rectus muscles at or slightly below the umbilical level (Fig. 37.2). The bowels are pushed back to the upper abdomen.

Laparoscopic Hysterectomy and Repair of Concomitant POP

Step 1

Ureteral Identification and Dissection

In the setting of pelvic organ prolapse, the course of the ureter may be distorted. Inspection and exposure of the ureters bilaterally should be accomplished primarily and prior to hysterectomy and any reparative procedures. The transperitoneal approach to ureteral dissection is used in the majority of cases. For those patients who are obese or who have complicated pelvic pathology, a retroperitoneal approach may be necessary.

Transperitoneal Exposure of the Ureters

The ureters on both sides are visualized through the laparoscope (Fig. 37.3). To expose and dissect the ureters, an atraumatic grasper is held open against the peritoneum just above the ureter at the level of the pelvic brim. The peritoneum is incised just below the ureter (Fig. 37.4). A grasper is used to bluntly separate the peritoneum away from the ureter

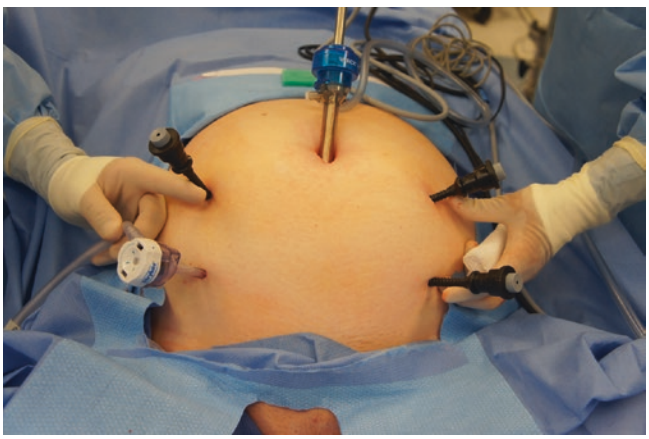


Fig. 37.2 The authors utilize four working 5 mm ports plus a 10 mm umbilical port for the laparoscope

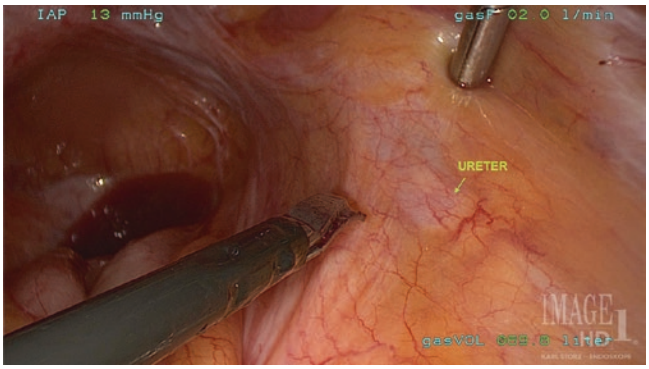


Fig. 37.3 The right ureter is visible coursing beneath the peritoneum. Transperitoneal dissection of the ureter begins by opening the peritoneum just beneath the ureter

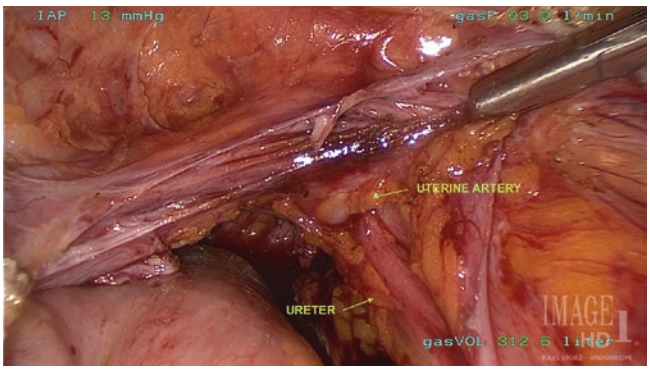


Fig. 37.5 The ureter should be exposed to the level at which it passes beneath the uterine artery. Here the ureter is seen passing just beneath the uterine artery

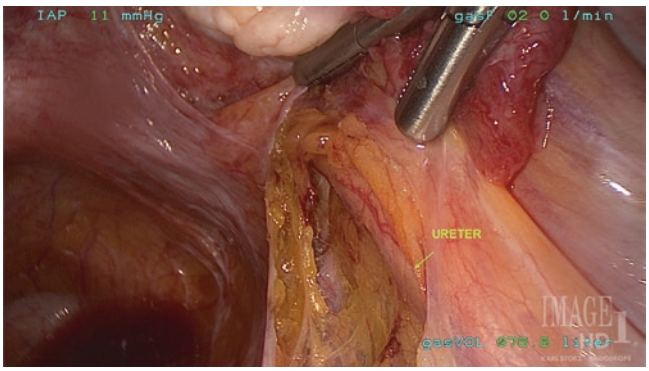


Fig. 37.4 Transperitoneal exposure of the ureter: ureteral exposure is accomplished by opening the peritoneum overlying the ureter. Atraumatic graspers are used to bluntly separate the tissue overlying the ureters and provide counter-traction as the surgeon opens the peritoneum

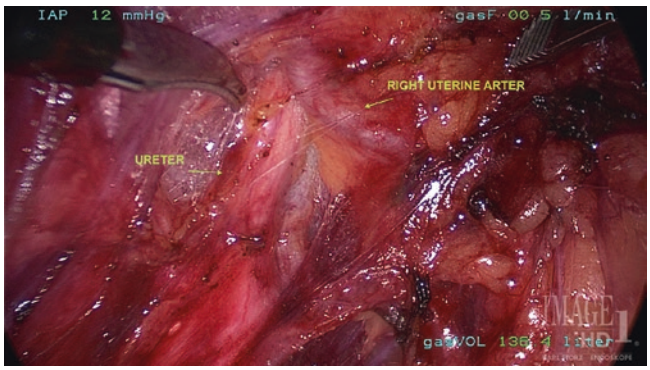


Fig. 37.6 In some patients, habitus or pelvic pathology will dictate the need to expose the ureter by opening the retroperitoneum. This may be accomplished by entering the peritoneum longitudinally, lateral to the infundibulopelvic ligament and medial to the external iliac artery

and a relaxing peritoneal incision is performed. The ureter is exposed to the level where it passes under the uterine artery (Fig. 37.5). This dissection prevents the ureter from becoming tethered, as adjacent tissues are plicated. The procedure is duplicated on the opposite side. It is important to expose the ureters prior to performing the hysterectomy and prolapse support procedures, as visualization of the ureters may become more difficult with retroperitoneal CO_2 gas infiltration, swelling and bleeding.

Retroperitoneal Dissection to Expose the Ureters

Exposure may be accomplished by opening the peritoneum longitudinally between the external iliac artery and the infundibulopelvic ligament (Figs. 37.6 and 37.7). Dissection is carried down posteriorly to the infundibulopelvic ligament to expose the ureter and internal iliac artery (Figs. 37.8, 37.9, and 37.10). Exposure of the ureter should continue until the uterine artery is seen crossing over the ureter (Fig. 37.11). The space between the ureter (medially) and the internal iliac artery (laterally) can be entered posteriorly with ease and is fairly avascular.

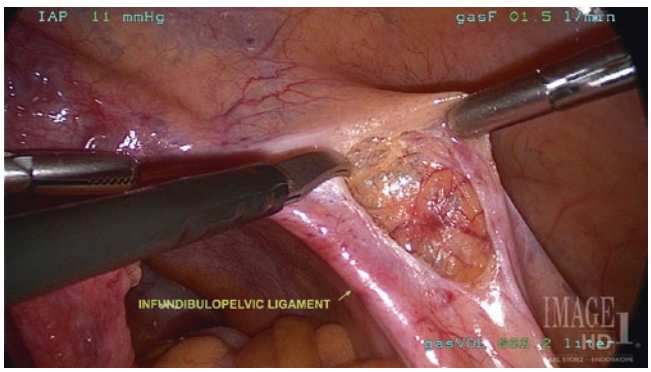


Fig. 37.7 The retroperitoneal space is opened on the right, beginning lateral to the infundibulopelvic ligament

Step 2

Exposure of the Rectovaginal Septum

Regardless of whether the prolapse repair will be performed with mesh or suture, it is crucial to expose and identify the pubocervical fascia and rectovaginal septum before completing the hysterectomy.

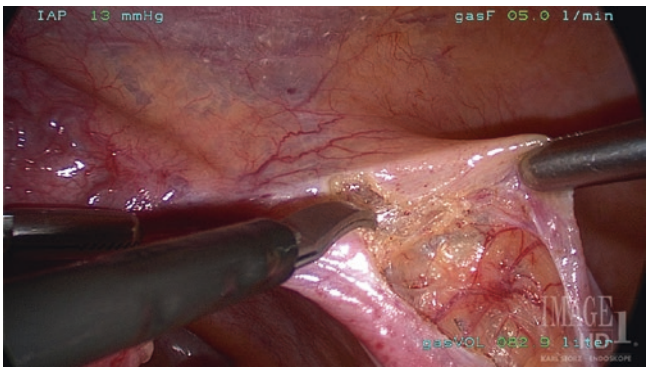


Fig. 37.8 The peritoneal incision is extended caudally

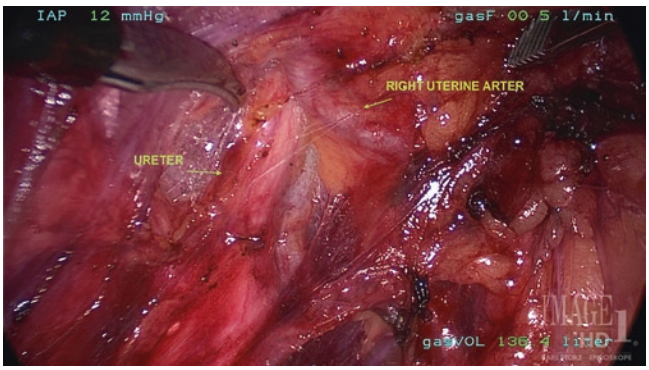


Fig. 37.11 Exposure of the ureter should continue until the uterine artery is seen crossing over the ureter

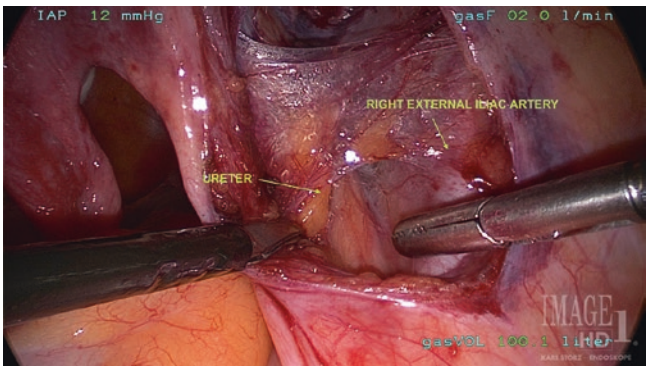


Fig. 37.9 The ureter is identified medial to the external iliac artery

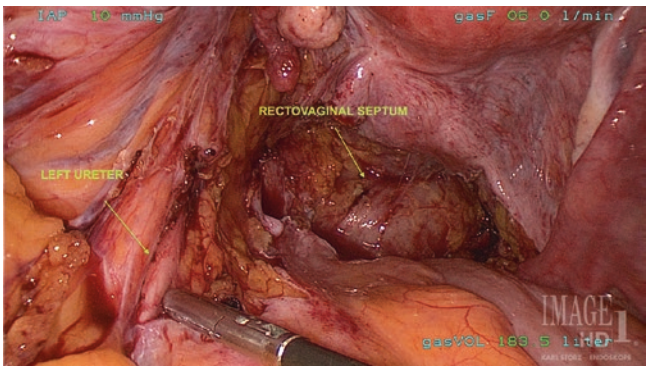


Fig. 37.12 The rectovaginal septum is exposed with simultaneous visualization of the left ureter shown here

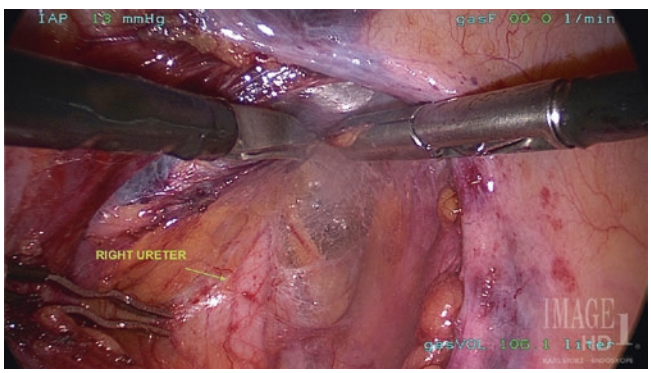


Fig. 37.10 The dissection is continued along the course of the ureter, moving caudally

The assistant, using the uterine manipulator, pushes the uterus anteriorly and superiorly. A rectal probe is helpful in preventing injury of the rectum during the dissection and will facilitate the identification of both the pararectal and rectovaginal spaces. First, the rectal probe is placed and the rectum is deviated toward the patient's left side. A longitudinal incision is made in the peritoneum overlying the right pararectal space, and this is extended caudally toward the rectovaginal space. The rectovaginal space is entered on the right side. The same procedure is then performed on the left side with the rectum deviated by the rectal probe to the right during the dissection. The rectal probe can be removed after the rectovaginal space is successfully exposed.

The rectovaginal space is dissected caudally until the rectovaginal septum can be clearly identified (Fig. 37.12). The rectovaginal septum may be confirmed by placing the surgeon's fingers inside the vagina, while simultaneously grasping the rectovaginal septum laparoscopically and forcefully pulling on it. The fingers in the vagina can feel that the entire posterior vaginal wall is being pulled up. In the case of more severe prolapse, the rectovaginal septum will sometimes be found quite low within the space.

Step 3

Exposure of Pubocervical Fascia

To expose the pubocervical fascia, the bladder must be dissected off of the anterior vaginal wall. A transverse incision is made just below the vesicouterine peritoneal fold (Fig. 37.13). To avoid bladder injury during the dissection, after the vesicocervical space is entered, the bladder is grasped with an atraumatic grasping forceps, lifted up and pushed caudally by the

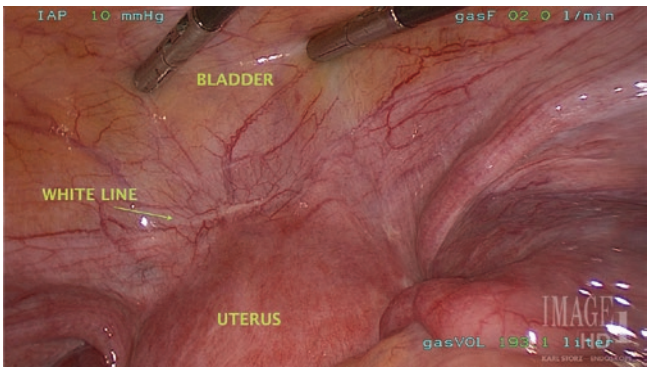


Fig. 37.13 The vesico-uterine peritoneum is seen here with a clearly defined "white line", which lies at the junction between the bladder peritoneum and anterior broad ligament, below which the surgeon will find an ideal plane for creating the bladder flap and exposing the pubocervical fascia

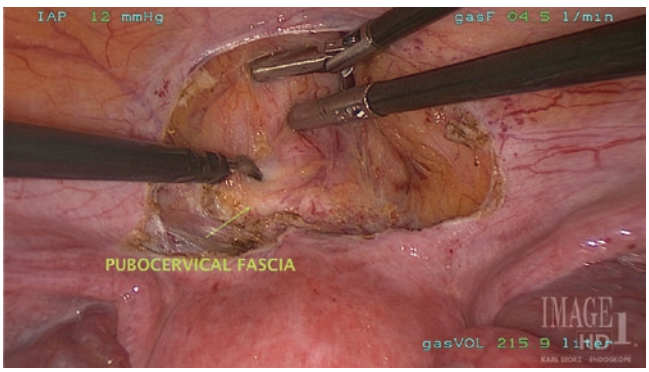


Fig. 37.14 The vesico-uterine peritoneum is entered sharply and dissected to expose the pubocervical fascia

assistant (Fig. 37.14). The vesico-cervical and vesico-vaginal space can then be easily entered and dissected bloodlessly. If excessive bleeding is encountered during the dissection, the possibility of having entered the wrong plane or having caused a bladder injury should be assessed. If it is difficult to distinguish the bladder from the adjacent planes of tissue, the bladder may be backfilled with 200–250 cc of sterile saline to aid in identification of planes. This is done by instilling the bladder with normal saline, through the Foley catheter, and clamping it. The clamp is released once the dissection is completed.

The pubocervical fascia is identified and confirmed by grasping and pulling the fascia laparoscopically while simultaneously placing the surgeon's fingers inside the vagina to appreciate the anterior vaginal wall being pulled upward during laparoscopic traction on the fascia. In the case of a large transverse defect, when the pubocervical fascia has detached from the cervix, it may be found very low in the vagina. This anterior fascia will be incorporated with the rectovaginal septum, in closing the vaginal cuff, to re-establish the integrity of the vaginal tube. When the apex is then attached to the proximal uterosacral ligaments, the pericervical ring is restored.

Step 4

Hysterectomy

Coexisting pelvic organ prolapse presents a unique challenge during hysterectomy, particularly due to the frequent occurrence of an elongated cervix. A study published by DeLancey et al, from 2012, evaluated women with and without prolapse by pelvic MRI. They demonstrated that in 40% of women with prolapse the cervix was elongated [8]. This elongation of the cervix causes displacement and distortion of the course of the ureter. Thus, special care must be taken to visualize the ureter during the ligation and division of the uterine vessels.

Securing the Uterine Vessels

The posterior and anterior leaves of the broad ligament are skeletonized revealing the uterine vessels. The uterine vessels are skeletonized, coagulated and transected being mindful that the ureter passes just lateral and inferior at this point. In lieu of using electrosurgical techniques, we frequently suture ligate the uterine vessels to avoid the potential for thermal injury to the ureter (Fig. 37.15). Following removal of the uterus, often the startling proximity of the ureter to the uterine artery stump may be readily appreciated.

Colpotomy

Most modern uterine manipulators incorporate a colpotomizer cup or ring which simplifies entry into the top of the vagina and enhances ureteral protection by lateralizing these structures. The circumferential colpotomy is performed along the ring or cup (Fig. 37.16), however, in the presence of prolapse, we routinely open the anterior and posterior vaginal fornix first, followed by lateral colpotomy very close to cervix to further reduce the incidence of ureteral injury and to preserve vaginal length. The assistant should maintain cephalad pressure with the manipulator further decreasing the risk of ureteral injury.

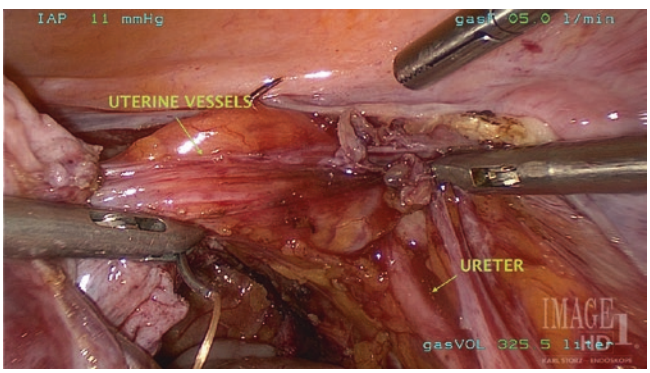


Fig. 37.15 The right uterine vessels have been skeletonized and are suture ligated using extracorporeal knot technique. Note the fully identified and visualized right ureter passing just beneath the uterine artery lateral to the ligation

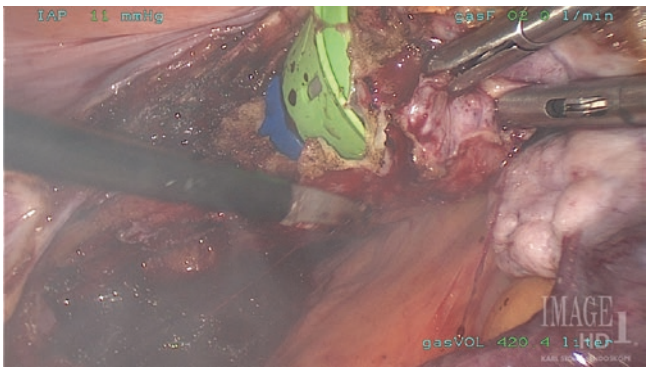


Fig. 37.16 Circumferential colpotomy is performed with the vaginal cuff opened as close to the cervix as possible to preserve vaginal length

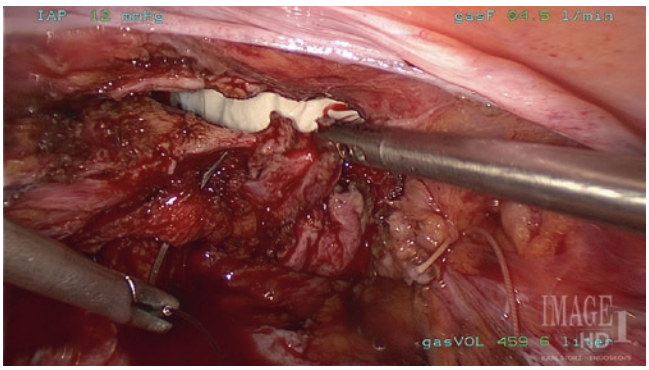


Fig. 37.17 The vaginal cuff is closed using an absorbable monofilament suture. Each bite includes vaginal epithelium and at least 1.5 cm of pubocervical and rectovaginal fascia. Note the presence of a glove in the vagina to maintain pnemoperitoneum

The uterus and adnexa are delivered through the vagina. Rarely, in the case of prolapse, would the uterus be too large to fit through the vagina. Under those exceptions, it will need to be removed using a bag and morcelation or other technique of surgeon preference. Controversy regarding morcelation is outside the scope of this chapter. A vaginal occlusion device is placed in the vagina to maintain pneumoperitoneum throughout the remainder of the procedure or until the cuff is closed.

Step 5

Cuff Closure with Enterocele Repair

For those patients with enterocele, a two-layer closure of the vaginal cuff is performed. The first layer is to close the vaginal epithelium with 3-0 or 2-0 absorbable monofilament sutures followed by a second layer to reapproximate the pubocervical fascia and rectovaginal septum with permanent non-absorbable sutures. Special care must be taken to include adequate fascial tissue in the suture bites.

This step will repair the enterocele and restore the integrity of vaginal fibromuscular tube.

Cuff Closure Without Presence of Enterocele

Closure of the cuff should always re-approximate the rectovaginal septum and the pubocervical fascia. For those patients without enterocele, the vaginal cuff can be closed laparoscopically using a monofilament absorbable suture (Fig. 37.17). Large bites are incorporated that include pubocervical fascia, rectovaginal septum and both anterior and posterior vaginal epithelium (Fig. 37.18). We advocate taking suture bites of at least 1–1.5 cm of tissue for the vaginal cuff closure. Due to the magnifying effect of the laparoscopic view, the surgeon can have a false perception of the amount of tissue included while suturing. Small vaginal cuff suture bites and inadequate hemostasis are the leading causes of postoperative vaginal cuff bleeding and dehiscence.

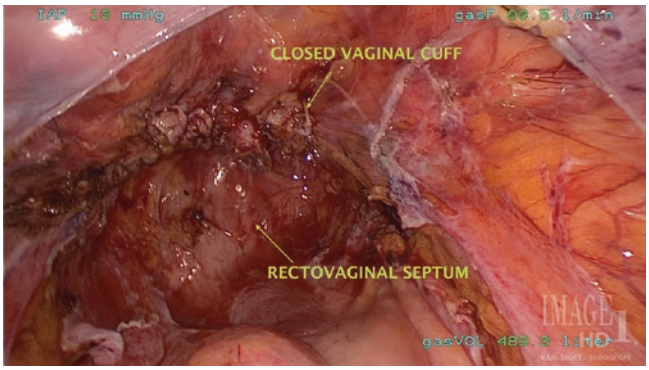


Fig. 37.18 The vaginal cuff is seen fully closed. The right ureter can also be visualized

Step 6

Vaginal Apical Suspension

Uterosacral ligament vaginal vault suspension is performed to re-suspend the apex of the vagina to the level of the ischial spine—the normal anatomical position of the vaginal apex (Fig. 37.19).

To determine the location of the ischial spine, the surgeon places two fingers inside the vagina, palpating the ischial spine, while simultaneously viewing laparoscopically the exact location of the ischial spine from above. A rectal probe can be used to deviate the rectum away from each side of the operative field as the surgeon incorporates the uterosacral ligament complex of tissue at the level of the ischial spine. Using a large-diameter permanent, non-absorbable suture, a deep bite is placed at the point about 1.5–2 cm medial and posterior to the ischial spine (Fig. 37.20). The surgeon should confirm that this stitch truly incorporates the uterosacral ligament by lifting it. It should be a substantial bite that can tolerate significant traction (Fig. 37.21). While elevating the tissue, a second, deeper, bite is taken (Fig. 37.22). This suture is then plicated to the lateral part of the vaginal cuff on the

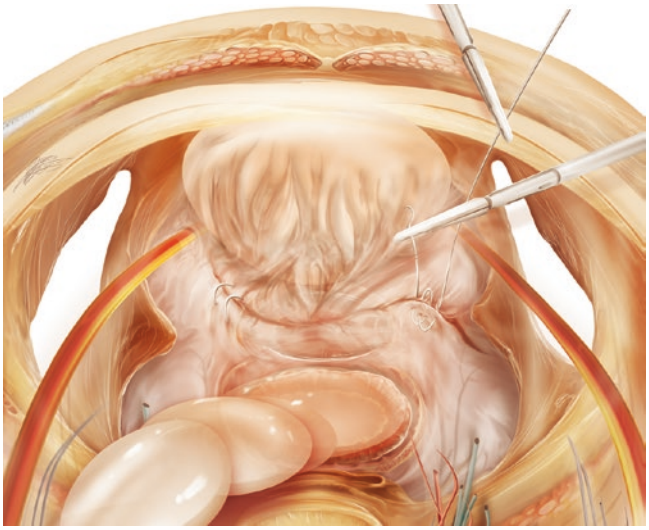


Fig. 37.19 A large permanent suture is used to secure a substantial figure-of-eight bite of tissue at the level of the ischial spine

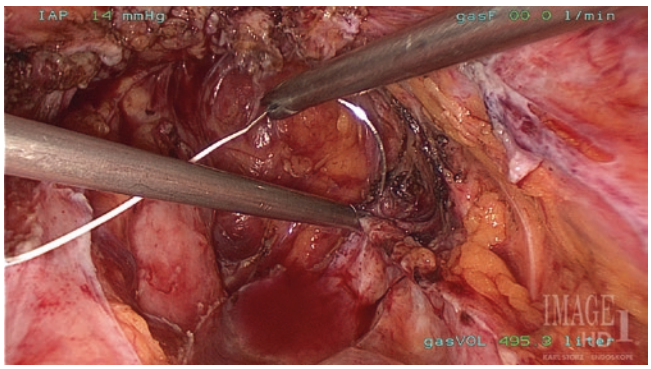


Fig. 37.20 Using two fingers transvaginally, the landmarks of the ischial spines are first identified before placing the first suture. Large suture bites are taken 1.5–2 cm medial and posterior to the ischial spine

ipisilateral side with a sizeable bite of rectovaginal septum and pubocervical fascia (Figs. 37.23, 37.24, and 37.25).

The same procedure is performed bilaterally (Figs. 37.26 and 37.27). Both sutures are tied with extracorporeal knot technique without undue tension (Fig. 37.28). With too much tension there is a higher risk of postoperative pain and discomfort with failure of the suspension.

Care must be taken not to leave any suture gaps. If suture gaps are evident, a second stitch with the same suture material is used to close the gaps (Figs. 37.29, 37.30, and 37.31).

Typically, we use CV-0 Gore-Tex (Gore Medical, Flagstaff, AZ) suture or Number 1 Ethibond (Ethicon) suture for laparoscopic uterosacral ligament vaginal vault suspension, with good result. These sutures should not enter the vaginal canal. Vaginal exposure of those permanent nonabsorbable sutures will lead to development of annoying foreign body granulation tissue, vaginal bleeding and possible infection.

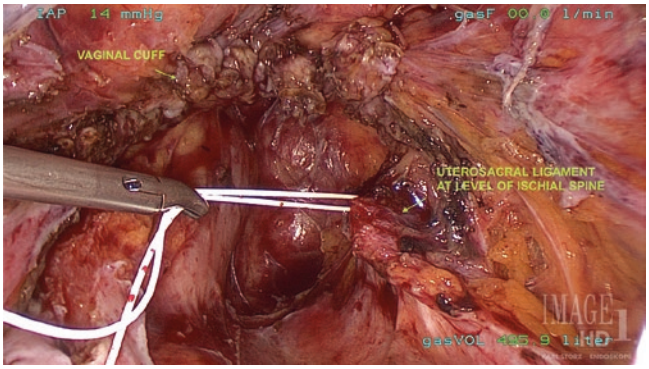


Fig. 37.21 The first bite on the uterosacral ligament at the level of the ischial spines is pulled with enough tension to ensure the strength and depth of tissue is adequate. This elevation will assure an ideal placement of the second bite

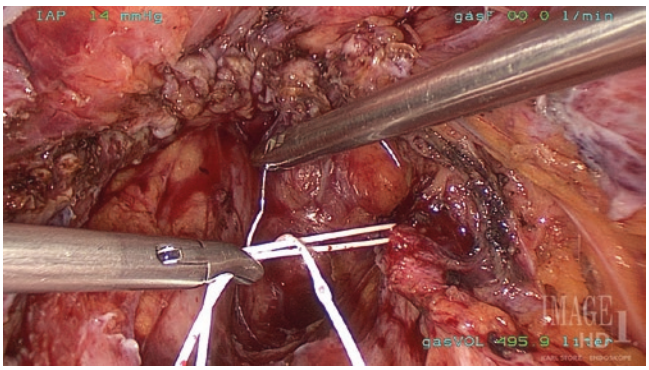


Fig. 37.22 The first suture is lifted and a much larger second bite with the same suture is taken at the same location, that is 1.5–2 cm medial and posterior to the ischial spine

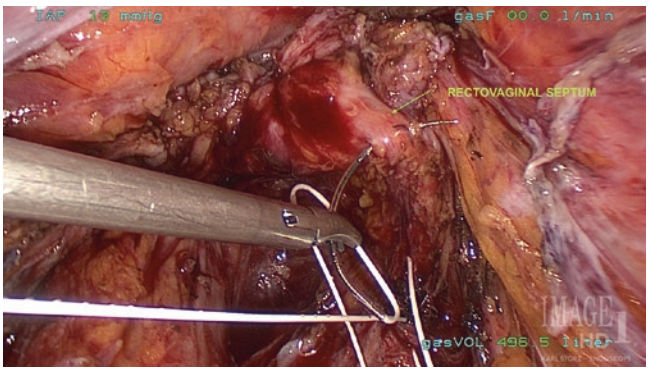


Fig. 37.23 The uterosacral ligament is plicated to the lateral apex of the vagina, incorporating the rectovaginal septum. The uterosacral ligament suture is then continued, plicating it with a large bite of rectovaginal septum close to the closed vaginal cuff. This same suture will continue through the lateral portion of the vaginal cuff, incorporating a large bite of pubocervical fascia just anteriorly above the vaginal cuff

Sacrocolpopexy

The purpose of using mesh in abdominal, robotic or laparoscopic sacrocolpopexy is to replace the failed endopelvic fascia. The risks of mesh are well documented and include

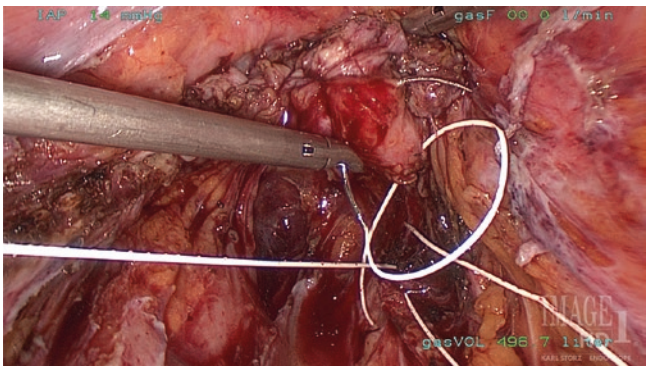


Fig. 37.24 A second bite secures the rectovaginal septum. Occasionally, two bites of rectovaginal septum posteriorly may be taken in cases with more severe prolapse

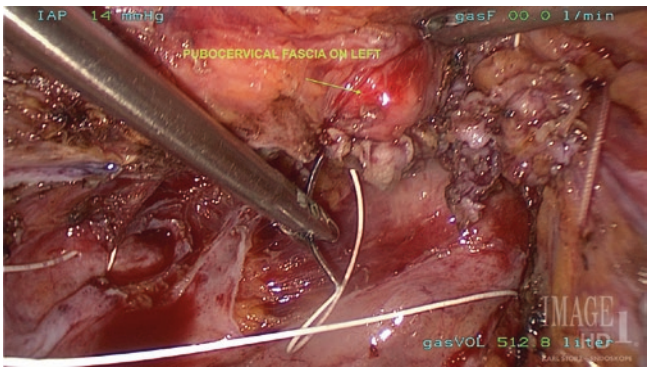


Fig. 37.27 The left uterosacral ligament is plicated to the ipisilateral rectovaginal septum, vaginal apex, and here incorporating the left aspect of the pubocervical fascia

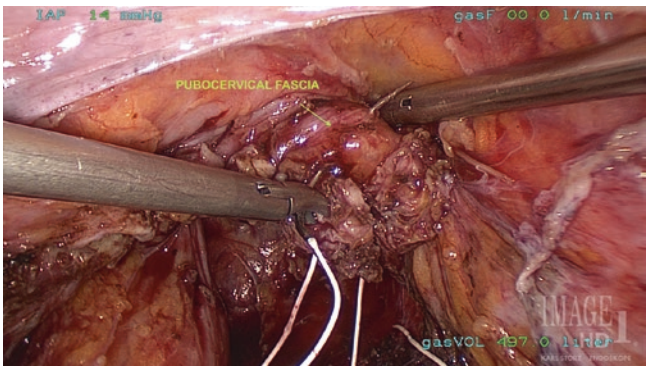


Fig. 37.25 The large bite of pubocervical fascia is incorporated and sutured with the same ipsilateral uterosacral ligament suture

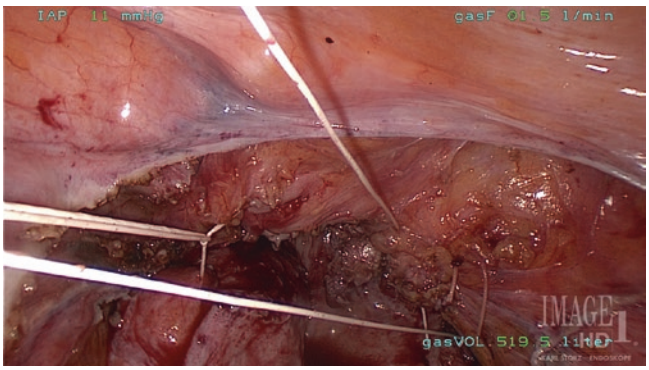


Fig. 37.28 Bilateral uterosacral ligament sutures are seen suspending the apex of the vaginal cuff

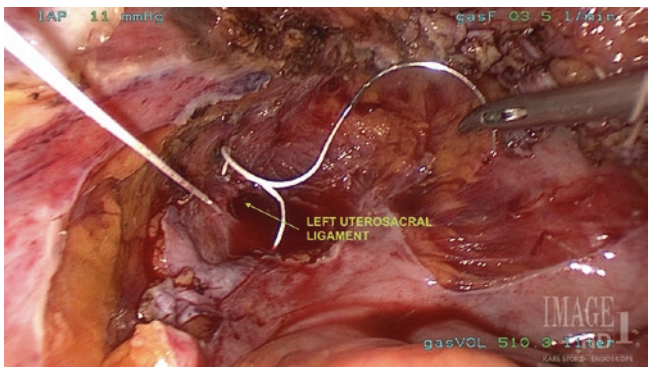


Fig. 37.26 The left uterosacral ligament is secured at the level of the ischial spines

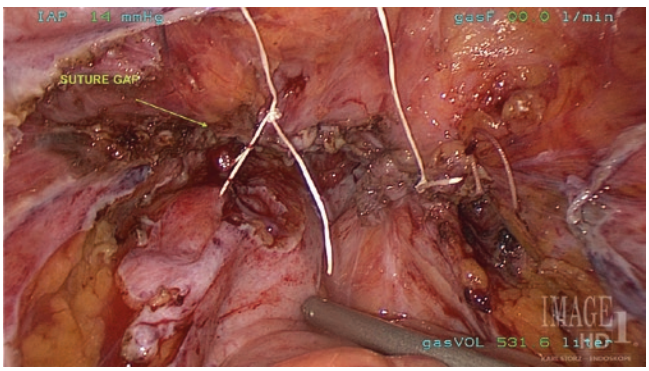


Fig. 37.29 This image demonstrates the gap in the initial suspension stitch on the left. This will be closed using a second suture of the same material. This is shown to illustrate that all suspension sutures are, and must be tied without undue tension

infection, erosion, pain, contraction of the scar and dyspareunia. Multiple studies have demonstrated that some types of mesh are superior to others and it is clear that large pore polypropylene mesh carries the lowest risk of infection, while the ePTFE mesh confers a fourfold increased risk of complications. Concomitant total hysterectomy and smoking increase the risk of mesh complications and are modifiable factors [9].

If a sacrocolpopexy has been planned, a supracervical hysterectomy should be performed, unless contraindicated [9]. Supracervical hysterectomy can easily be accomplished after both uterine vessels are secured and divided. Most menopausal uteri can be placed in a bag and easily removed by slightly extending the fascial incision of the largest laparoscopic or

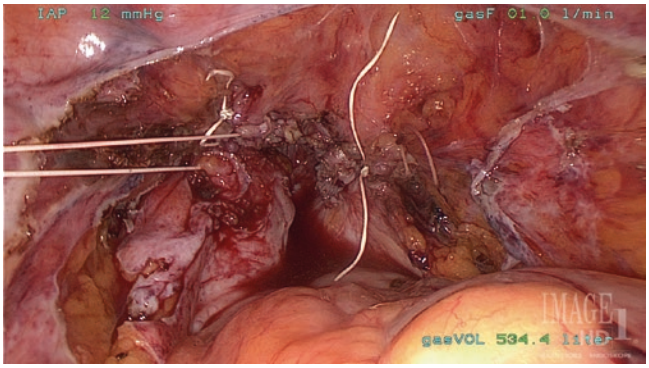


Fig. 37.30 Note how the second suture closes the gap without creating undue tension on the suspension

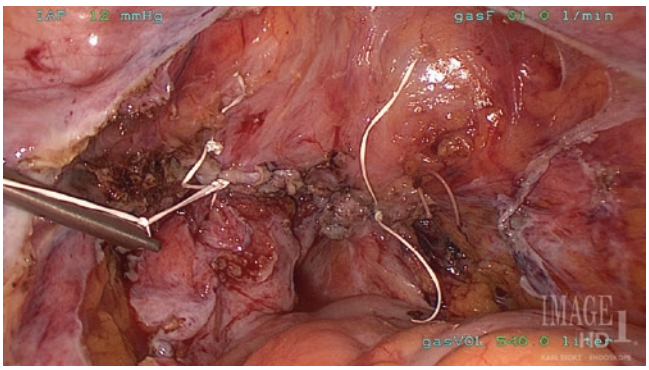


Fig. 37.31 Here we see the completion of the uterosacral ligament suspension and the re-establishment of the pericervical ring

robotic port. For larger uteri, safe extraction techniques have been described and are beyond the scope of this chapter.

The sigmoid colon is deviated to the patient's left side with the use of a rectal probe. A longitudinal incision is made on the peritoneum overlying the sacral promontory. The incision should be medial to the ureter and common iliac vessels and lateral to the descending sigmoid colon. Careful dissection is carried out along the right side of S-1 and S-2 to expose the anterior longitudinal ligament of the sacrum. Special care must be paid not to injure the middle and lateral sacral vessels in this area. Using a 30° laparoscope will facilitate this dissection. The peritoneal incision is extended caudally to join the longitudinal incision over the right pararectal space, which continues down to the rectovaginal space (see Step 2 above).

If a commercially available Y shaped synthetic mesh is used (Type 1, totally macroporous, Polypropylene mesh), the arms should be trimmed appropriately to fit the exposed fascia. The anterior arm of the mesh is sutured to the previously exposed pubocervical fascia and anterior cervix and the posterior arm of the mesh is sutured to the rectovaginal septum and posterior cervix with 2-0 polypropylene sutures. We typically place one to three rows of three interrupted sutures anteriorly and posteriorly with two on the endopelvic fascia and one on the cervix. An assistant gently pushes the cervix or vaginal vault superiorly, with a vaginal probe until the apex is at the level of the ischial spines. The stem of the Y- mesh is sutured to the anterior longitudinal ligament of the sacrum with two interrupted, non-absorbable sutures. The mesh must be placed snuggly, but without undue tension. Reperitonization with absorbable suture to cover the mesh must also be performed to prevent the rare complication of bowel obstruction secondary to bowel adhesions to the synthetic mesh.

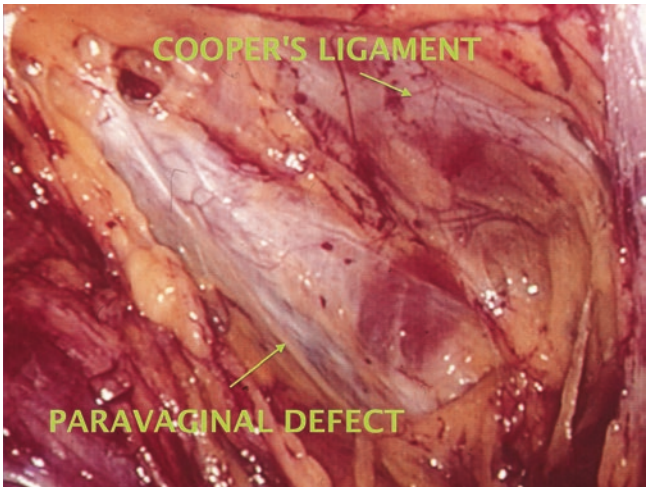


Fig. 37.32 A paravaginal defect can be appreciated in this photo. A paravaginal defect may be responsible for a persistent anterior compartment defect following apical suspension

Step 7

Re-evaluation of Pelvic Floor Support

A thorough and systematic vaginal examination must be performed at this time to re-evaluate the pelvic floor support. The apical support and vaginal length, the anterior and posterior vaginal wall support and the status of the perineal body must be carefully evaluated. All of the remaining defects should be corrected.

1. Prolapse of the vaginal apex or cervix.
   (i). The apex of the vagina or cervix must be at the level of the ischial spines.
   (ii). Additional uterosacral ligament suspension sutures should be placed if the apex is not at the level of the ischial spines.
   (iii). In the case of sacrocolpopexy, tighten the mesh to bring the apex of the vagina or cervix up to the level of the ischial spines to restore the normal vaginal length.
2. Persistent anterior vaginal wall defect (Fig. 37.32).

   More than 80% of cystoceles are due to a paravaginal defect and the majority of paravaginal defects will be cor-

rected after the apex of the vagina is restored to its normal position at the level of ischial spine. Therefore, if the anterior wall vaginal defect persists following suspension, one must consider the following three possibilities:

(i). Inadequate or incomplete repair of anterior enterocele.

Re-evaluate the closure of vaginal cuff, to ensure that the pubocervical fascia is well attached to the rectovaginal septum and that the cuff is suspended to the proximal part of the uterosacral ligament at the level of the ischial spine. (Repeat Steps 5 and 6).

(ii). Patient has an extended paravaginal defect.

The retropubic space is entered and dissected laparoscopically, and if paravaginal defect (unilateral or bilateral) is detected, the defect is then repaired by reattaching the pubocervical fascia to the arcus tendineus fascia of pelvis with interrupted stitches using permanent non-absorbable sutures [10].

(iii). Presence of a midline defect: An anterior vaginal colporrhaphy should be performed.

3. Persistent posterior vaginal wall defect.

(i). Inadequate or incomplete repair of posterior enterocele. Repeat Steps 5 and 6 to evaluate the cuff closure and vault suspension.

(ii). Rectovaginal septum is detached from the perineal body or the perineal body has been torn or damaged: A vaginal posterior colporrhaphy and perineorrhaphy should be performed.

Step 8

Post Procedure Cystoscopy

Following every laparoscopic hysterectomy and repair of pelvic prolapse, cystoscopy is performed to confirm patency of the ureters and to ascertain no injury to the bladder has occurred. If needed, various agents can be employed to facilitate appreciation of ureteral patency such as indigo carmine, given intravenously at the end of the procedure, or phenazopyridine, given before the case. If bilateral ureteral patency is not observed, then steps must be taken to systematically diagnose the source of the obstruction and resolve the problem. Specific techniques for diagnosing and correcting ureteral injury/obstruction after pelvic reconstructive surgery depend on operator experience and vary by institutional privilege and are thus beyond the scope of this chapter.

Once bilateral ureteral patency is confirmed, a Foley catheter may be left in place until the next post-operative day. A voiding trial may be performed if indicated following removal of the catheter. For patients who fail the voiding trial, the Foley catheter is replaced and they are seen in the office 48 h later for removal of the Foley catheter and a repeat void trial. A suprapubic catheter may alternatively be used.

Conclusion

Coexisting pelvic organ prolapse presents a unique challenge during hysterectomy. Laparoscopic hysterectomy with concomitant surgery for pelvic organ prolapse is effective and minimally invasive. Laparoscopy provides the surgeon with excellent visualization and allows for simultaneous manual examination through the vagina to verify and define the details of repair in a manner not possible through open or robotic procedures.

References

1. Subak LL et al. Cost of pelvic organ prolapse surgery in the United States. Obstet Gynecol. 2001;98(4):646–51.
2. Sprague ML, Furr RS, Rich JS, Liu CY. Treatment of apical prolapse by laparoscopy. In: Bustos-Lopez H, editor. Cirugía Endoscopica en Ginecólogía: Laparoscopia e Histeroscopia. Mexico City: Editorial Médica Panamericana; 2011. p. 177–82.
3. Lin LL, Phelps JY, Liu CY. Laparoscopic vaginal vault suspension using uterosacral ligaments: a review of 133 cases. J Minim Invasive Gynecol. 2005;12:216–20.
4. Umek WH, Morgan DM, Ashton-Miller JA, DeLancey JOL. Quantitative analysis of uterosacral ligament origin and insertion points by magnetic resonance imaging. Obstet Gynecol. 2004; 103(3):447–51.
5. Ramanah R, DeLancey JO, et al. See it in 3D!: researchers examined structural links between the cardinal and uterosacral ligaments. Am J Obstet Gynecol. 2012;207(5):437.e7. doi:10.1016/j.ajog.2012.08.036. Epub 2012 Sep 7.
6. Sprague ML, Furr RS, Liu CY. Laparoscopic surgery for uterine and vaginal vault prolapse. Textbook of gynecological and obstetrical surgery. 2 ed. Ankara: Besevler; 2009.
7. Nager CW, Brubaker L, Litman HJ, et al. A randomized trial of urodynamic testing before stress-incontinence surgery. N Engl J Med. 2012;366:1987.
8. Berger MB, DeLancey JO. Is cervical elongation associated with pelvic organ prolapse? Int Urogynecol J. 2012;23(8):1095–103.
9. Cundiff GW, Varner E, Visco AG, Zyczynski HM, Nager CW, Norton PA, Schaffer J, Brown MB, Brubaker L. Risk factors for mesh/suture erosion following sacral colpopexy. Am J Obstet Gynecol. 2008;199:688.
10. Liu CY. Laparoscopic cystocele repair: paravaginal suspension. In: Liu CY, editor. Laparoscopic hysterectomy and pelvic floor reconstruction. Cambridge: Blackwell; 1996.

Laparoscopic Assisted Vaginal Hysterectomy in Prolapse Situations

38

Hsin-Hong Kuo and Chyi-Long Lee

Introduction

Dr. Harry Reich reported first laparoscopic hysterectomy in 1989, which confirmed the possibility of laparoscopic hysterectomy being employed as a replacement of the vast majority of traditional abdominal hysterectomies.

There are some subdivisions of laparoscopic hysterectomy, which are defined on the basis of the level of laparoscopic operation used to achieve the dissection of the uterus. Total laparoscopic hysterectomy (TLH) involves entire laparoscopic excision of the uterus including laparoscopic closure of the vaginal dome. Laparoscopic assisted vaginal hysterectomy (LAVH) consists of laparoscopic dissection down to the uterine arteries with or without transection of which, and the remainder procedures, including the specimen retrieval, performed through a vaginal approach. For women with prolapse pelvis, the relatively wide vagina route forms a preferable access for vaginal dissection and specimen retrieval. For whom with advanced prolapse uterus, vaginal hysterectomy could be indicated without abdominal wound. The procedures of LAVH are explained steps by steps in the following description. Laparoscopic sacrocolpopexy is an option for the patients with stage two to four uterovaginal prolapses.

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LAVH Technique- Laparoscopic Dissecting

General anesthesia is required. The patient is placed in the dorsolithotomy Trendelenburg position with both legs protected by elastic bandages. A Foley catheter is inserted for constant urinary drainage. Pelvic examination under anesthesia checks the top of the fundus and makes decision regarding the position of first trocar insertion to have wide surgical view and operating space. A uterine manipulator, generally a setting of Cohen cannula and tenaculum, is placed into the uterus. The axis of the tip of Cohen cannula should be parallel to the axis of uterus to avoid uterine perforating damage while cephalad pushing.

The selection of the size, number and positions of the trocars depend on the circumstanced and surgeon's preferences. But generally speaking, the videolaparoscopy is performed with a midline 10 mm principal trocar introduced through the umbilicus. The ancillary cannulas are placed under laparoscopic visualization: one 5 mm cannula in the right lower quadrant lateral to the inferior epigastric arteries, and one 5 mm cannula in the left lower quadrant. The third 5 mm cannula can be placed in the left or right upper quadrant between the telescope and lateral ports. Once the cannula placement is completed, the patient is placed in a steep Trendelenburg position to allow the bowel out of the pelvis and adhesions are lysed as necessary.

For the case with large uterus, especially at or above the level of the umbilicus, the Lee-Huang point (Fig. 38.1) is recommended for videolaparoscopy.

It locates between the xiphoid process and the umbilicus, which provide a sufficient view of the operative field and adequate space for unimpaired motion of the surgeon's instruments.

The operation begins with the coagulation and dissection of bilateral round ligaments: the anterior leaves of the broad ligaments are opened and incised using unipolar or bipolar electrosurgery to the point of the vesico-uterine pouch (Fig. 38.2a–d). If the tubes and ovaries are to be conserved, the ovarian ligament and the proximal end of tubes are coagulated

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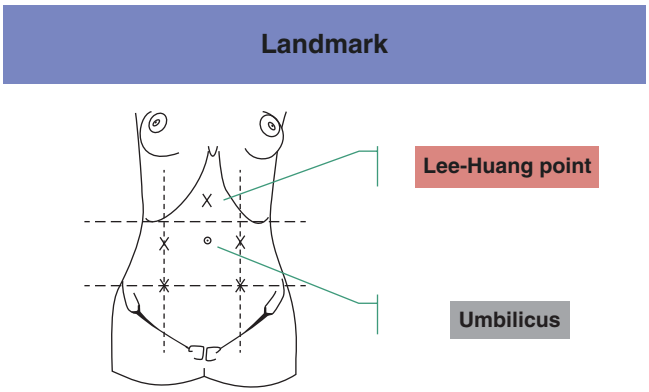


Fig. 38.1 Landmark for Lee-Huang point

and dissected (Fig. 38.3a, b). If the tubes and the ovaries are to be removed with the uterus, the infundibulopelvic (IP) portion of the broad ligament is coagulated and dissected. Before this step, a peritoneal window is created to prevent ureteral damage (Fig. 38.4a–d). The ureter is usually easy to recognize at the level of the pelvic brim, and its peristalsis distinguishes ureter from the pulsating artery. While the IP is elevated gently, the created window is identified in the medial leaf of the broad ligament between the ureter and the IP. The IP is then divided by monopolar and bipolar device. The opening of the medial (or posterior) leaf of the broad ligament can be extended, parallel to the lateral side of the uterus, to the point of origin of the uterosacral ligaments behind the cervix (Fig. 38.5a, b). The ureter should be

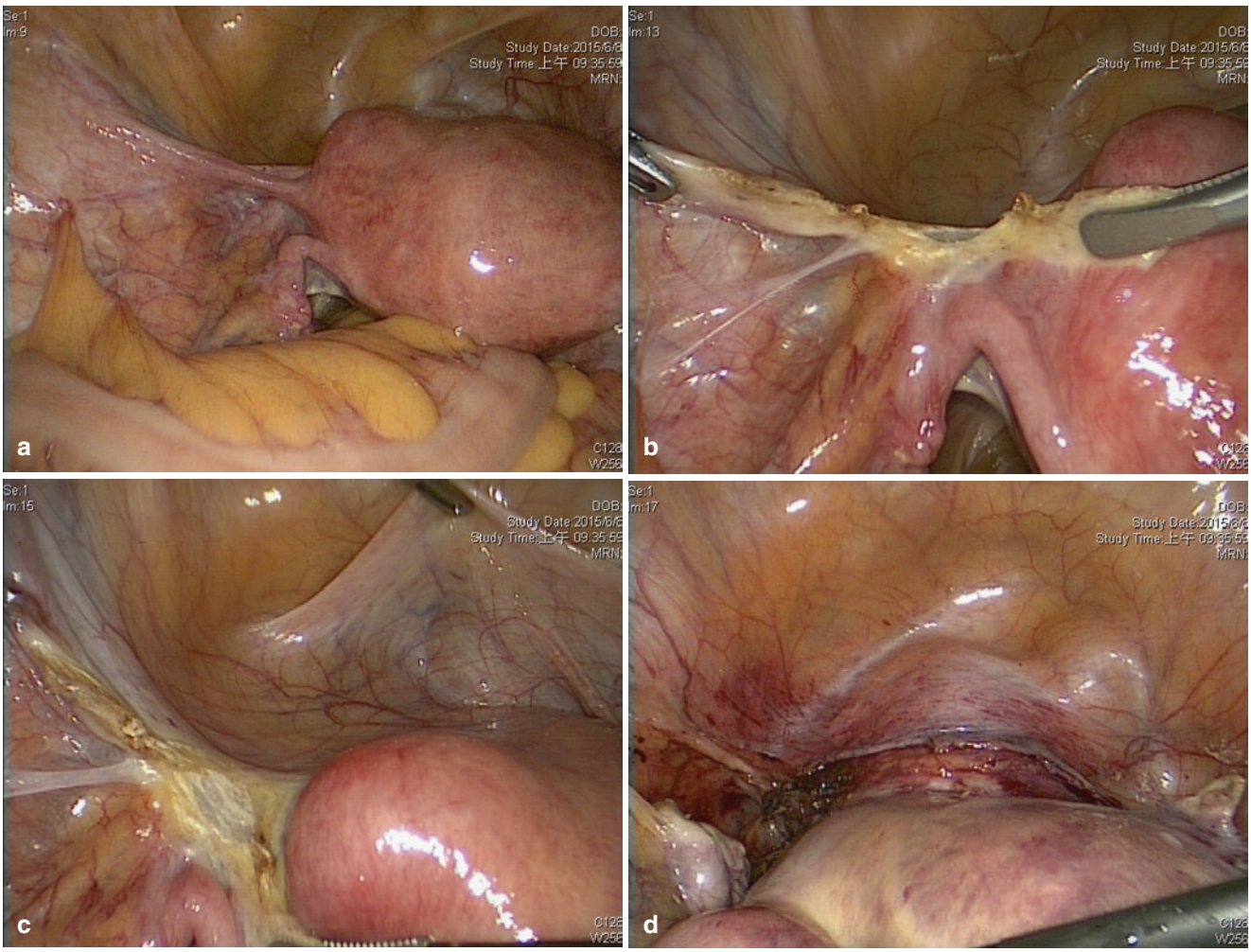


Fig. 38.2 (**a**) Before dissecting the round ligament. (**b**) Dissecting left round ligament with bipolar and unipolary Electrosurgery (**c**) Left round ligament has been dissected. The grasper holds the serosal of bladder. The vesico-uterine pouch locates in the junction between the held serosa and the low uterine corpus. (**d**) The vesico-uterine pouch has been exposed. (**e**) Left leaf of the broad ligament has been exposed. (**f**) A case with history of Cesarean Section. The vesico-uterine pouch is covered by the scarring tissue. (**g**) The dissecting plane is close to the uterus as possible. (**h**) Exposure of bilateral anterior leaves of the broad ligaments and the vesico-uterine pouch. Photos courtesy of Chyi-Long Lee and Kuan-Gen Huang

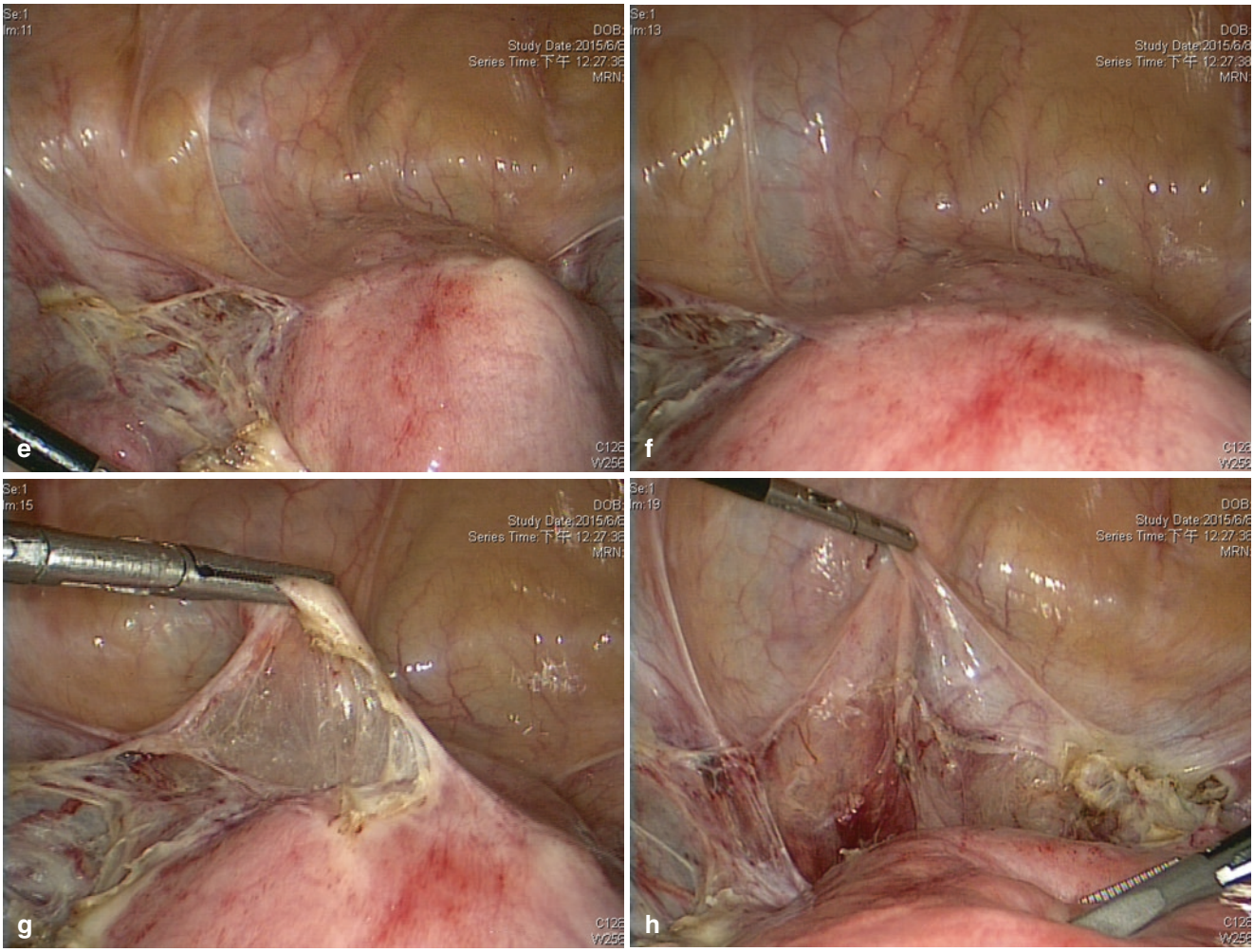


Fig. 38.2 (continued)

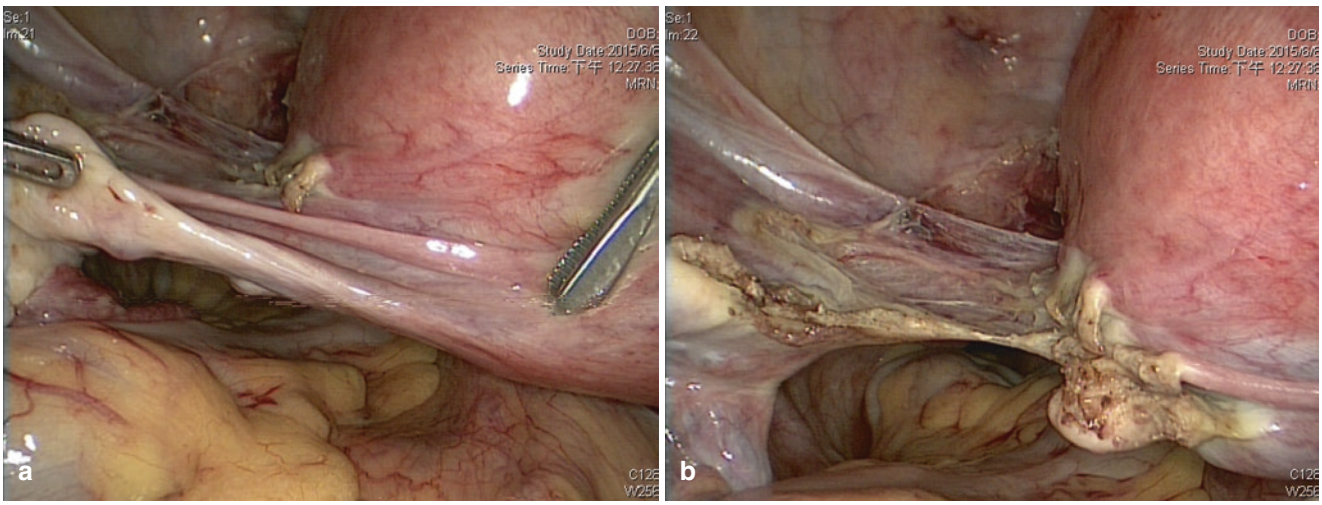


Fig. 38.3 (**a**) Before dissecting left tube and ovarian ligament, (**b**) after dissecting left tube and ovarian ligament. Photos courtesy of Chyi-Long Lee and Kuan-Gen Huang

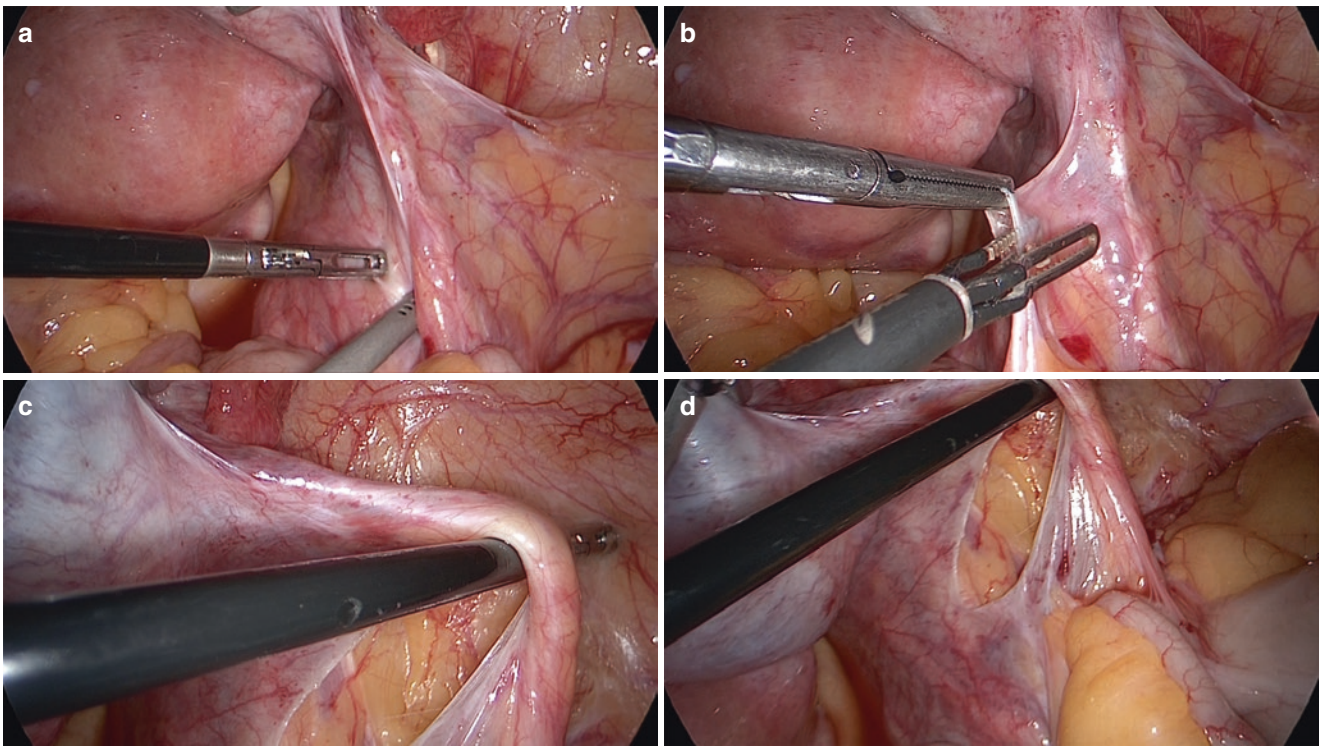


Fig. 38.4 (**a**) The grasper lies between the ureter and the IP (infundibulopelvic) ligament. (**b**) Opening the window between the ureter and the IP ligament. (**c**) The dissecting window for salpingo-oophrectomy. (**d**) The window lies between the ureter and the IP ligament. Photos courtesy of Chyi-Long Lee and Kuan-Gen Huang

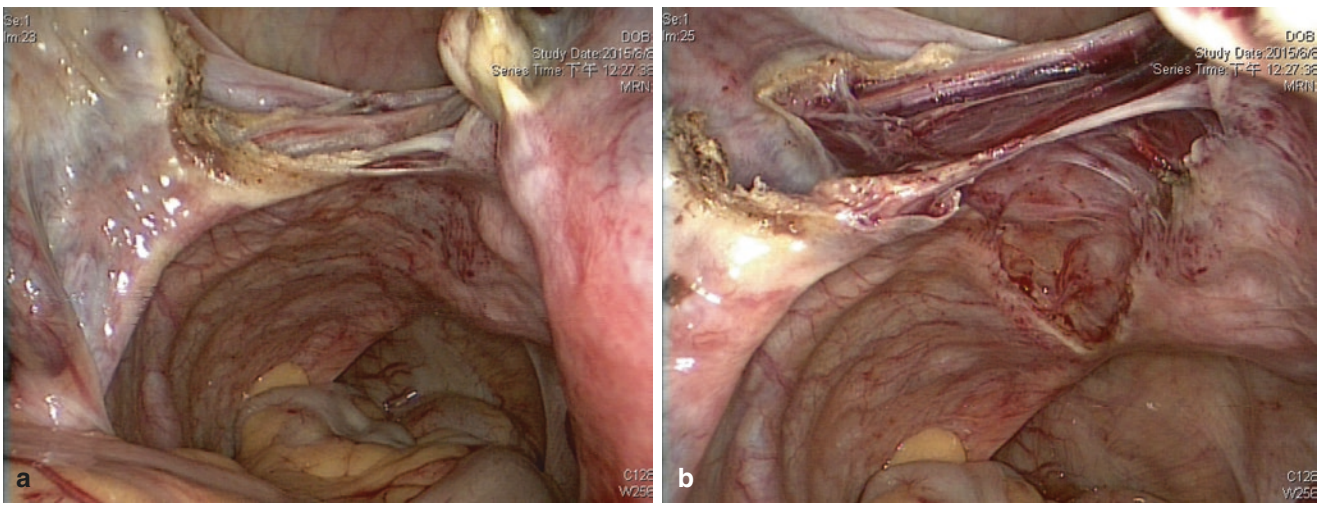


Fig. 38.5 (**a**) The opening of the medial leaf of the broad ligament is seen after the ovarian ligament, tube and round ligament have been dissected. (**b**) The peritoneum is extended, parallel to the lateral side of the uterus, to the point of the uterosacral ligaments

identified medial to the cutting edge of the medial (or posterior) leaf. The same procedure is repeated on another side.

The parametrium is coagulated (or dissected) along the uterus by bipolar and monopolar electrosurgery to the level of the uterine artery near uterine isthmus. Ureteral injury usually happens in this step and some tips should be pointed out. Firstly, the secondary assistant should keep the tension of cephalad by pushing the manipulator to keep the ureter away from the dissecting plane (Fig. 38.6a). Secondary, the principal of the dissecting plane is closely alone with the lateral side of the uterus but its also depends on the level of uterus. The plane near the fundus should be away from the

uterus to prevent injury to the ascending branch of the uterine artery (Fig. 38.6b). At the level near uterine isthmus, the plane should just adjacent to the uterus due to the distance between ureter and uterine artery less then 1 cm (Fig. 38.6c, d). The risk of thermal damage of the ureter could be minimized if the safe margin is maximized. Third, some studies reports the incidence of the ureter injuries is prone to occur contralateral to the surgeon side, especially in the case of big uterus. The big uterus leads to difficult manipulating and may prevent the dissecting direction parallel to the lateral side of uterus but toward to the sidewall (Fig. 38.6e, f). In this situation, the surgeon is recommended to shift to the opposite (first assistant) side and the dissecting plane is naturally parallel to the lateral side of uterus (Fig. 38.6g–j).

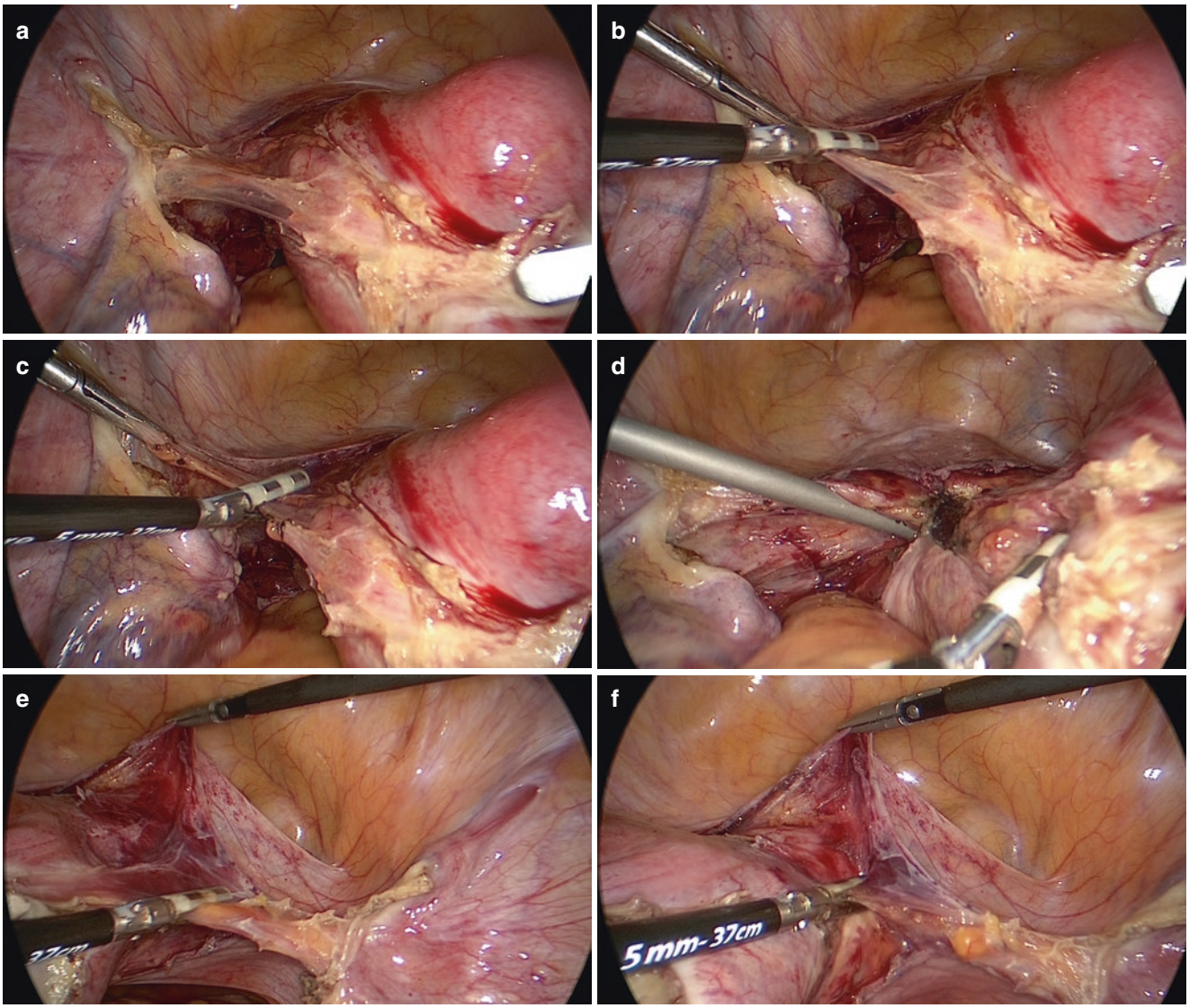


Fig. 38.6 (**a**) The uterus is push cephalad and opposite to the dissecting plane to allow wide operating space and prevent ureteral injury. (**b**) The proximal dissecting plane is away from the uterus. (**c**) During dissecting, the plane is closing to the uterus gradually. (**d**) At the level of isthmus, the dissecting plane should close the uterus. (**e**) In the assistant side, the dissecting plane is toward to the sidewall. (**f**) The surgeon should correct the dissecting plane along with the uterine sidewall. (**g**) Operating in the assistant side, the dissecting plane toward to the uterus, not the pelvic sidewall. (**h**) Through the operating in the assistant side, the uterine artery is dissected with any thermal effect in the pelvic sidewall. (**i**) Before coagulation or dissection of bilateral uterine arteries. A pink uterine corpus. (**j**) The ischemic change of the uterine corpus after the coagulation or dissection of the uterine arteries. Photos courtesy of Chyi-Long Lee and Kuan-Gen Huang

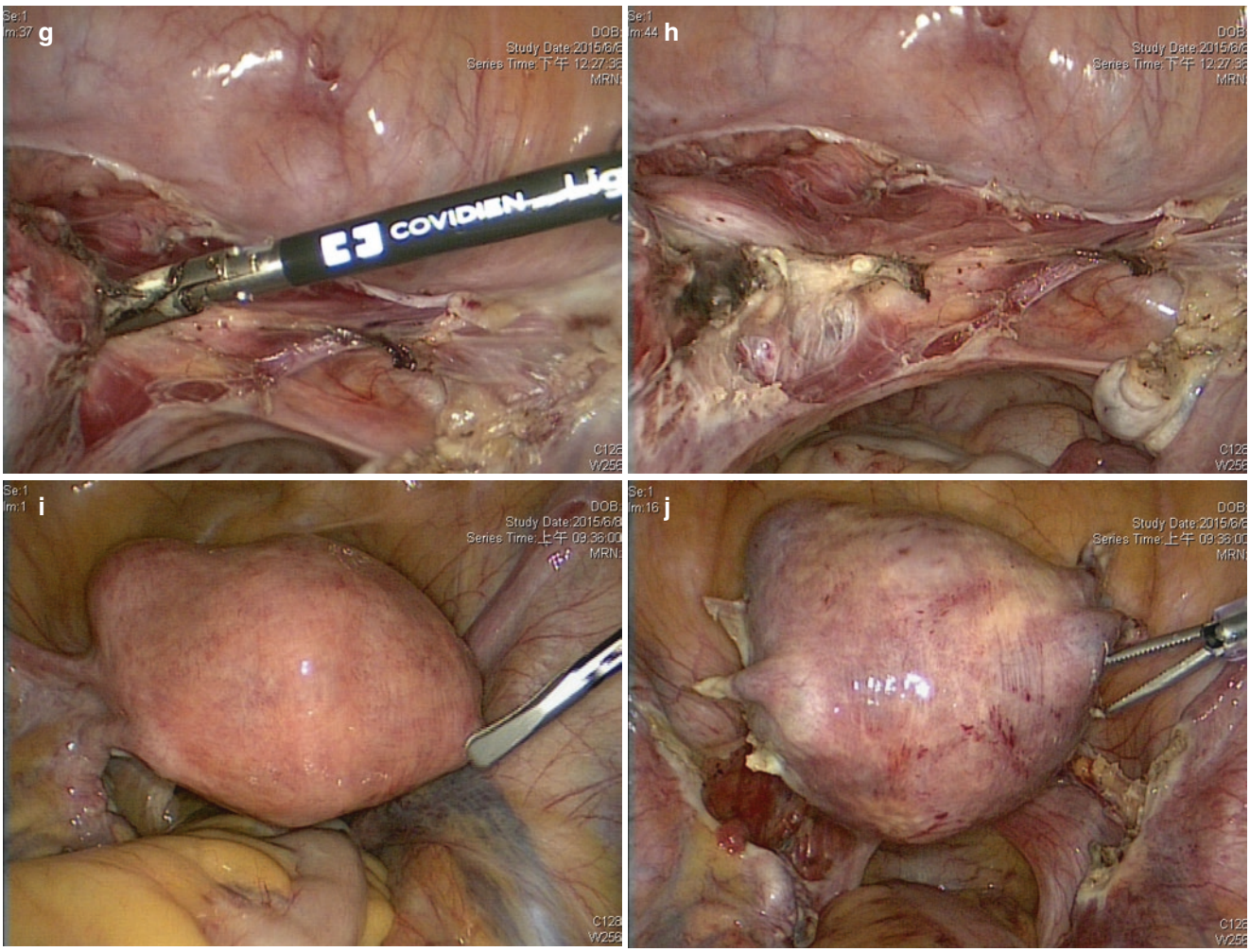


Fig. 38.6 (continued)

The bilateral incision of anterior leaf of the broad ligaments unites in the vesico-uterine pouch. To facilitate dissecting the bladder, a simple method is introduced: the folding gauze clamped by a ring forceps is inserted above the tenaculum (into the anterior fornix) to guide the vesico-uterine pouch and by the gentle pushing of the suction irrigation gear against on the assisted gauzed, separation of the uterus and anterior bladder flap can be easily achieved (Fig. 38.7 a–c). This mechanical procedure is superior to the electro-dissecting to prevent postoperative paralyzing of the bladder. An anterior colpotomy is performed by using monopolar cautery at the level about 1 cm below the cervicovaginal junction. This procedure can be easily evaluated by the exposure of the assisted gauze (Fig. 38.7d). A posterior colpotomy can also be repeated by means of the assisted gauze and unipolar incision method (Fig. 38.7e–g).

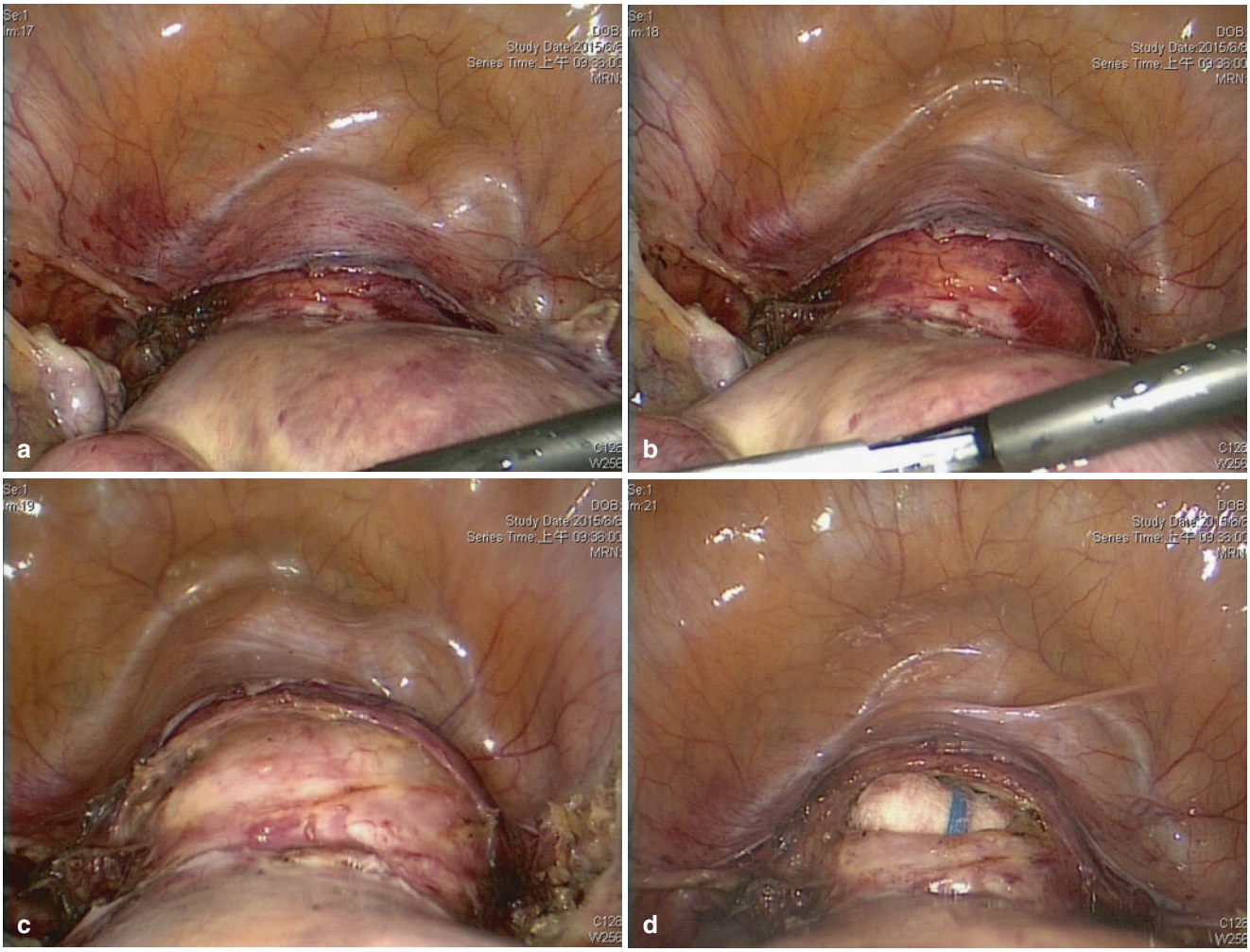


Fig. 38.7 (**a**) Before the assistance of the folding gauze. (**b**) The folding gauze is pushed to the anterior fornix to guide the dissecting of the vesico-uterine pouch. (**c**) The bladder has been dissected away from the vesico-uterine pouch. (**d**) The gauze is exposed. (**e**) Before the assistance of the folding gauze in the posterior fornix. (**f**) The folding gauze is pushed to the posterior fornix. (**g**) The gauze is exposed; the opening of the posterior colpotomy has been finished through abdominal approach. Photos courtesy of Chyi-Long Lee and Kuan-Gen Huang

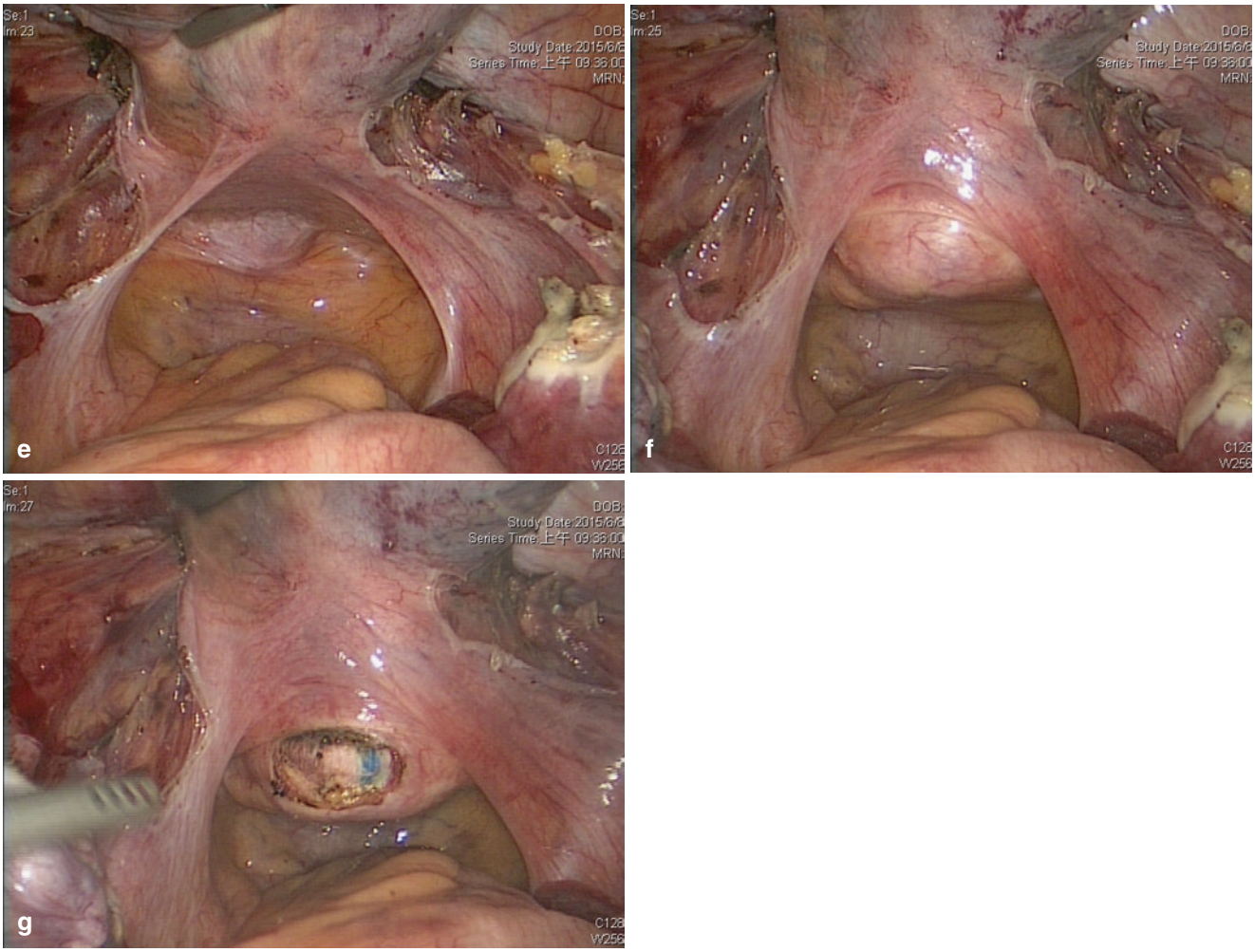


Fig. 38.7 (continued)

LAVH Technique- Vaginal Dissecting

With tractions placed on the uterine cervix by tenaculum, the openings of anterior and posterior colpotomy are extended and the wound retractor maintains the spaces. The bilateral uterosacral ligaments and uterine arteries are clamped by surgical clamp and dissected as the procedures of vaginal hysterectomy (Fig. 38.8a). The detached uterus is removed by manual peeling morcellation (Fig. 38.8b). The vaginal cuff is closed vaginally using a running, non-locking stitch of 2-0 absorbable sutures.

LAVH Technique- Laparoscopic Hemostasis

After the closure of the vaginal cuff, pneumoperitoneum is re-established and the vaginal cuff, bilateral stumps of adnexa and any rough surface are inspected to ensure hemostasis (Fig. 38.9a–h). The peritoneal cavity is irrigated and lavaged until a blood less condition is achieved.

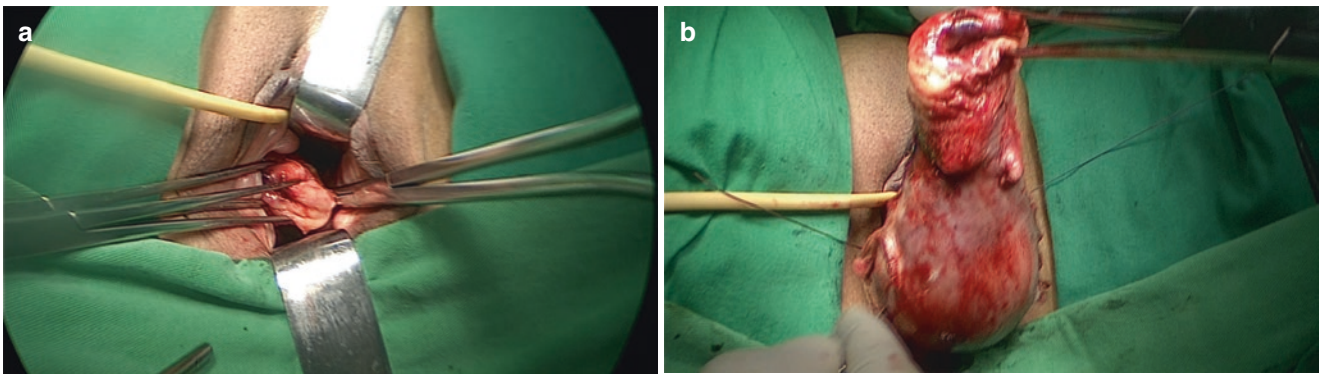


Fig. 38.8 (**a**) The uterosacral ligament is clamped as the procedures of vaginal hysterectomy. (**b**) The specimen is removed through vagina. Photos courtesy of Chyi-Long Lee and Kuan-Gen Huang

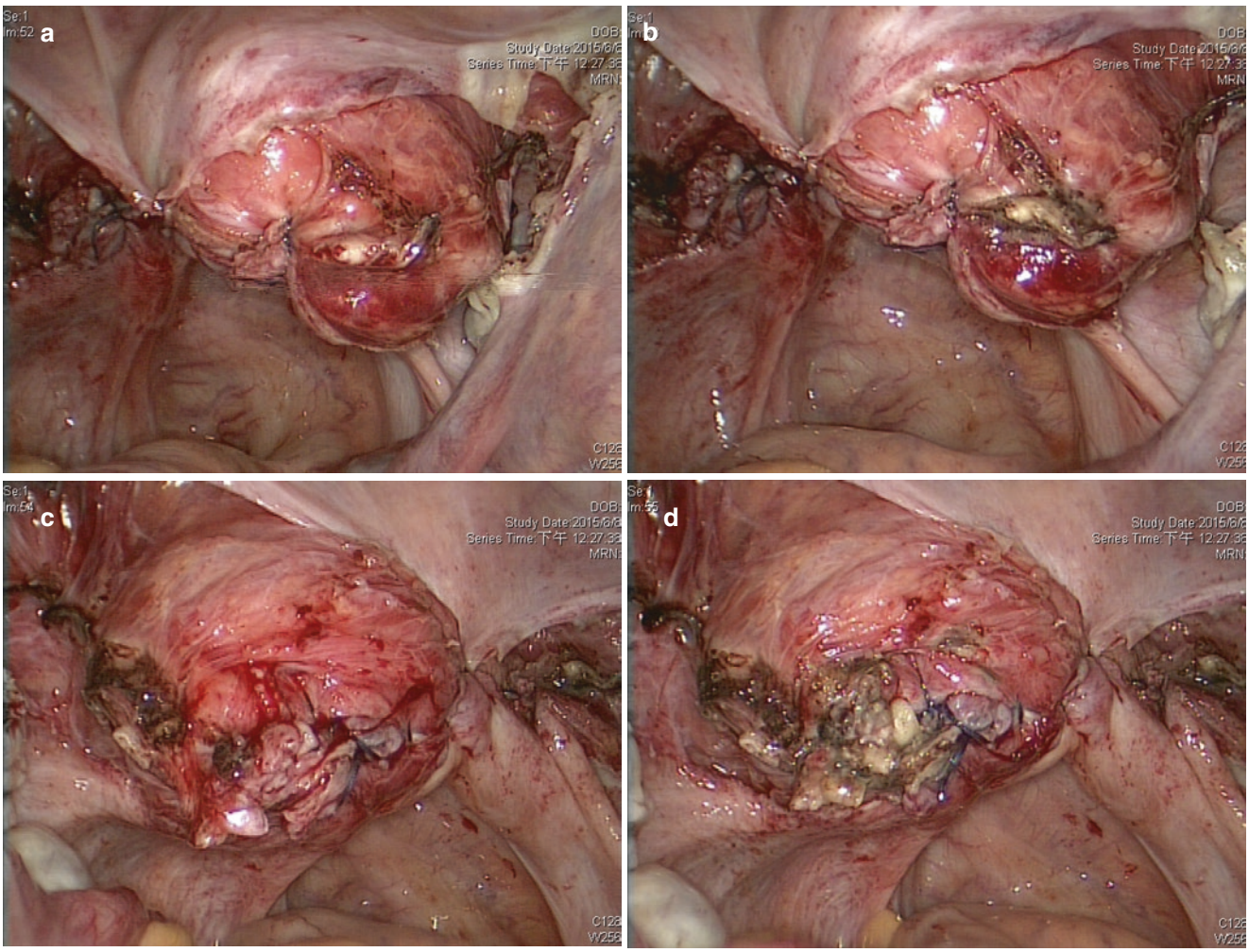


Fig. 38.9 (**a**) Under the assistance of the folding gauze, the right stump of the uterine artery is identified. (**b**) Routine coagulation is made for the distal end of the stump to prevent it bleeding while extubation (increase abdominal pressure). (**c**) Same maneuver (exposure) in the left side. (**d**) Same maneuver (routine coagulation) in the left side. (**e**) Final inspection. (**f**) Well hemostasis of left adnexa. (**g**) Well hemostasis of right adnexa. Photos courtesy of Chyi-Long Lee and Kuan-Gen Huang

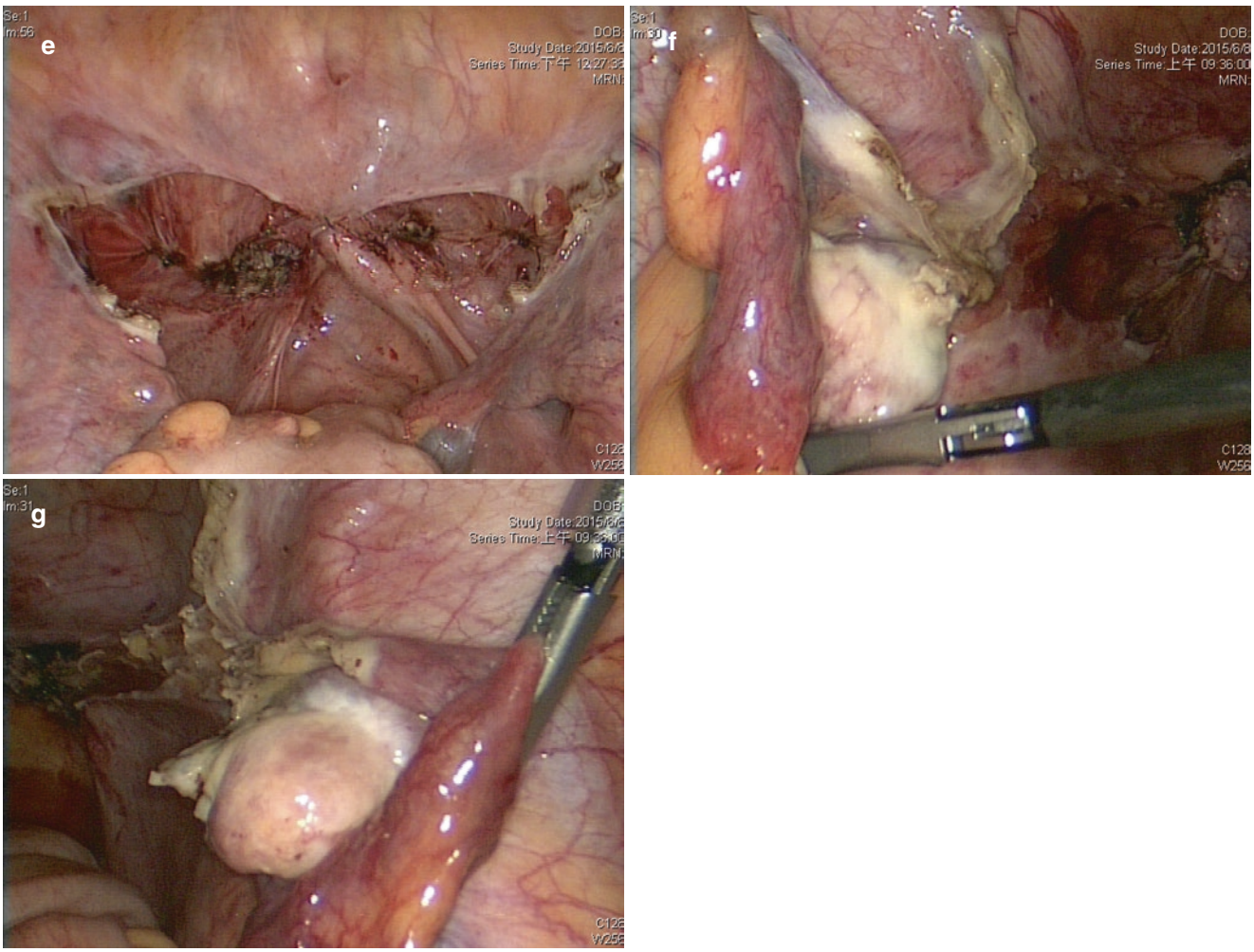


Fig. 38.9 (continued)

Optional Laparoscopic Sacro-colpopexy

The peritoneum superficial to the sacral promontory is incised and an avascular plane in the anterior longitudinal ligament is identified using blunt dissection (Fig. 38.10a, b). This peritoneal window, right of the midline, medial to the right ureter is dissected and continued down to the right uterosacral ligament (Fig. 38.10c, d). The polypropylene mesh is trimmed according to the estimated length between the vaginal vault and the sacral promontory. The distal end is fixed to the vaginal vault exposed by the assistant using the folding gauze (Fig. 38.10e, f). The proximal end of the mesh is interrupted sutured and anchored to the avascular plane in the longitudinal ligament with a total of two non-absorbable sutures (Fig. 38.10g). The exposed peritoneum is approximated with absorbable suture to retroperitoneally cover the mesh (Fig. 38.10h).

LAVH Technique- Routine Cystoscopy

A rigid 70° routine cystoscopy is then performed. Under a direct visualization, the ureteral jets proved the patent of bilateral ureter and the integrity of bladder ruled the penetrating suture materials out (Fig. 38.11a–c).

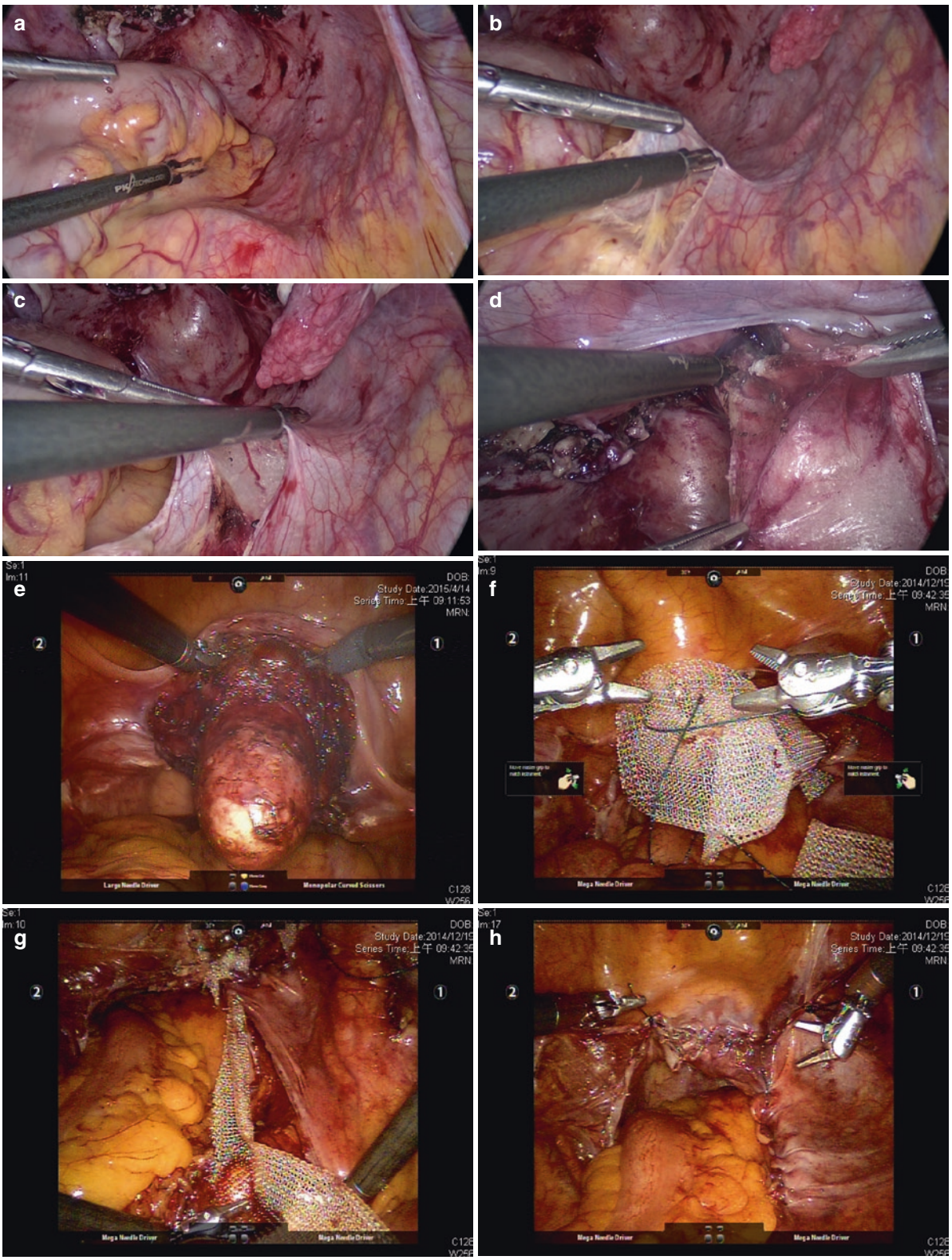


Fig. 38.10 (**a**) The opening of right ureteral orifice. The patent is documented by the urine flow. (**a**) The peritoneum superficial to the sacral promontory. (**b**) The landmark of the bladder dome is air bubble. (**b**) The opening window of the peritoneum superficial to the sacral promontory. The white anterior longitudinal ligament is visualized. (**c**) A papillary lesion is noted in the routine cystoscopy. The biopsy reveals the high grade papillary urothelial carcinoma in the bladder. (**c**) The peritoneal window is extended, right of the midline, medial to the right ureter. (**d**) The peritoneal window is continued to the right uterosacral ligament. (**e**) The vaginal vault exposed by the assistant. (**f**) The distal end of the mesh is fixed to the vaginal vault. (**g**) The proximal end is going to be anchored to the anterior longitudinal ligament. (**h**) A final inspection after approximation of the peritoneum through Robotic camera

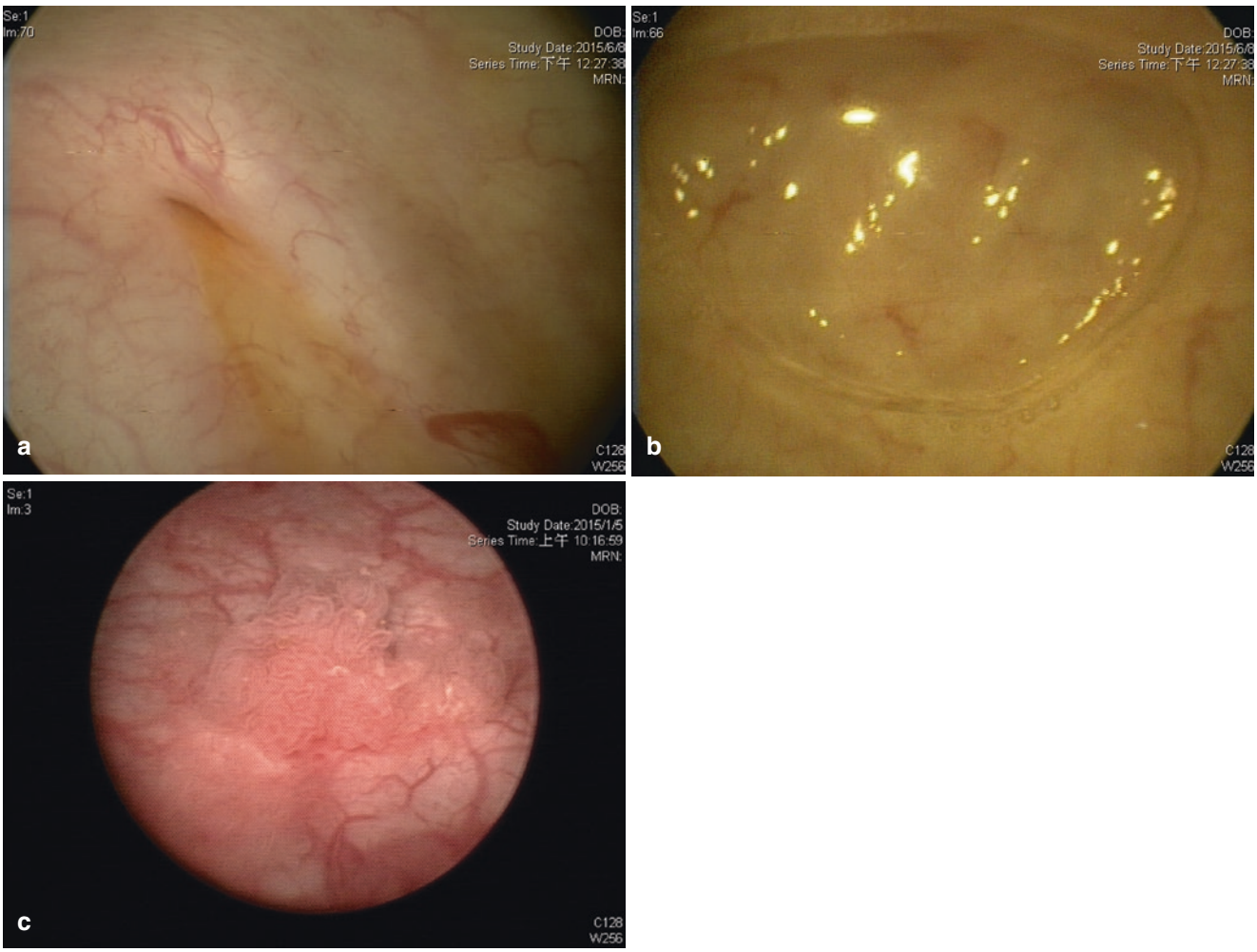


Fig. 38.11 (**a**) The opening of right ureteral orifice. The patent is documented by the urine flow. (**b**) The landmark of the bladder dome is air bubble. (**c**) A papillary lesion is noted in the routine cystoscopy. The biopsy reveals the high grade papillary urothelial carcinoma in the bladder

Radical Hysterectomy and Pelvic Lymphadenectomy (French School)

39

Gabriele Centini, Rodrigo P. Fernandes, Karolina Afors, Rouba Murtada, Marco Fabián Puga, and Arnaud Wattiez

Introduction

The first large series on radical or extended hysterectomy were published in the beginning of the twentieth century by Wertheim [1] in Austria, and later by Okabayashi [2] in Japan and Meigs [3] in the United States.

Since these publications different procedures and classifications have been proposed but none have spread worldwide. The most commonly used classification in the past decade has been the Piver-Smith classification published in 1974 [4].

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The Piver classification has been criticized on different levels: the description of the five classes was not based on reproducible anatomical landmarks, the boundary between classes was unclear, class I was in fact not a radical hysterectomy and the introduction of a more conservative surgical approach rendered class V excessive in its radicality with regards to the vagina making it obsolete. Moreover, this classification was developed in the United States before the nerve-sparing approach was introduced and adopted into clinical practice and as such is not included in this classification.

For a long time it seemed adequate, however, over time with recent changes in the surgical management of cervical cancer this classification has become outdated. This is largely attributed to the development of endoscopic techniques providing a more detailed knowledge of the anatomy of the parametrium, leading to the development of a new revised classification by Querleu and Morrow in 2008 [5].

The term radical hysterectomy encompassed various techniques based on different anatomical nomenclatures. A common classification was necessary for surgeons to establish a standardised treatment protocol, compare outcomes, as well as for communication and teaching purposes.

Laparoscopy in gynaecological oncology was first introduced in the late 80´s and the well-known benefits of laparoscopy such as early postoperative discharge, pain reduction and faster recovery were already well established for benign surgery [6, 7]. These benefits are particularly relevant for cancer patients, reducing the possibility of thromboembolic events and improving postoperative recovery, allowing patients to begin adjuvant therapy more quickly. In addition, due to the enhanced vision and precision permitted by this technique, laparoscopy progressively demonstrated being not only a safe alternative to laparotomy, but also the preferred route for staging procedures such as lymphadenectomy. After few years of experience, laparoscopy has been extensively adopted for a wide range of gynaecological oncology procedures [8]. Currently extensive data has demonstrated equivocal safety and post-operative outcomes for

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laparoscopic oncological procedures, whilst sustaining the benefits of minimally invasive surgery.

There is no doubt that more radical and longer procedures are inevitably associated with complications and morbidities, irrespective of the route used. Of major concern in lymphadenectomy is major bleeding originating in the rich vascular pelvic network. Injury to other surrounding structures such as ureters and nerves although infrequent, can lead to potential complications. In addition, postoperative lymphocele can occur due to the extensive dissection of pelvic lymphatic chains [3, 9].

A comprehensive knowledge of the anatomy, in addition, to a thorough and standardized technique is key in preventing such complications. Pelvic lymphadenectomy (PL) is a stepwise technique where the benefits of laparoscopy can be integrated into surgical practice. However, adequate training is mandatory to master the technique and optimize its use.

In the last few decades efforts have been made to diminish lymphadenectomy complications. Studies have guided surgeons towards a more minimally invasive extraction of lymph nodes: the sentinel node. These nodes can be mapped during laparoscopy by techniques of lymphoscyntigraphy and blue dye test injected in the cervix of the uterus at 3 and 9 o'clock position. Detection of the nodes can be visual or with use of probes depending on the technique used for mapping. Results showed a higher rate of lymphatic drainage to the iliac and obturative nodes [10, 11].

Radical Hysterectomy: A New Classification

All previous classifications were based on a non-standardized anatomical terminology according to the originating school or country. The first step towards a new classification was the standardization of anatomical terms with fixed landmarks in the parametrium clearly defined.

The lateral attachment of the cervix was named "paracervix", incorporating the previously subdivided paracolpium and parametrium, and replacing other terms such as cardinal ligament, Mackenrodt's ligament or parametrium.

The lateral attachments of the bladder and rectum were respectively named lateral ligament of the bladder and rectum. Furthermore, basing itself on anatomical studies, the new classification introduced the two concepts of a nerve-sparing approach to radical hysterectomy, and paracervical lymphadenectomy.

These concepts derived from cadaveric studies demonstrating that the paracervix can be divided into two parts according to types of connective tissue: the medial part, extending from the cervix to the hypogastric artery, is made of dense connective tissue with vessels, nerves, and lymph nodes that should be resected during surgery, whilst the lateral part is node bearing fatty tissue that can be easily isolated from surrounding structures.

This cleavage allows the surgeon to increase the radicality without increasing the morbidity.

Nerve Sparing Approach

The nerve sparing approach was initially developed to reduce the rate of postoperative bladder, bowel and sexual dysfunction caused by damage done to the nerves during a radical hysterectomy procedure and was rapidly demonstrated to be effective.

Surgical experience and cadaveric anatomy studies identified three main surgical steps at high risk of nerve injury during a radical hysterectomy: the resection of the uterosacral ligament, the resection of the paracervix and the resection of the bladder pillars.

The uterosacral ligament, or lateral ligament of the rectum, is in close relation to the hypogastric nerve and the inferior hypogastric plexus making its resection a critical step for potential nerve injuries.

The hypogastric nerve, mainly made of sympathetic fibers, is born from the superior hypogastric plexus at the level of the promontorium, follows an immediately subperitoneal course and joins the inferior hypogastric plexus at the dorsal and lateral part of the pelvis.

In its final third, just before joining the inferior hypogastric plexus, it crosses the ureter while coming from a dorsomedial direction.

At that level and for a few centimeters, the ureter lies close to the lateral ligament of the rectum and is identified and reclined when developing the Okabayshi space (Fig. 39.1).

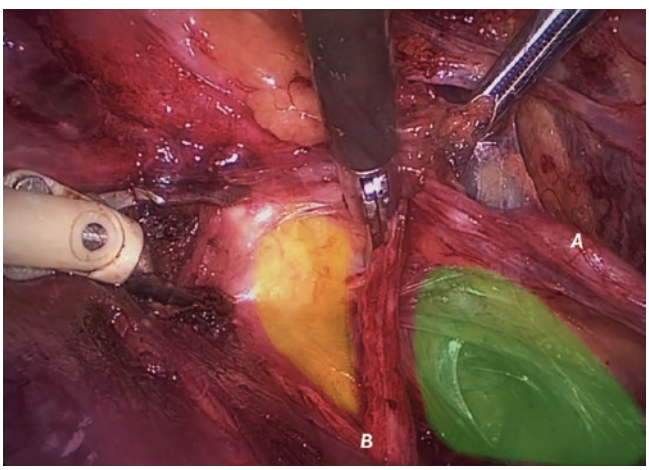


Fig. 39.1 The picture shows the paracervix on the right side after the dissection of the pararectal fossa at the level of the ureteral channel. *A* Uterine artery and paracervix; *B* ureter. *Yellow*: okabayashi space; *Green*: latsko space

The hypogastric nerve and the pelvic splanchnic nerves arising from the sacral roots S2–S4 are brought together to form the inferior hypogastric plexus that lays on the dorsal and lateral part of the pararectal fossa.

This plexus gives branches to the pelvic organs and crosses the paracervix just under the deep uterine vein, which then can be considered a landmark for the sparing of the neural part of the paracervix.

Lastly, a careful dissection needs to be performed when approaching the lateral ligament of the bladder, which is a critical area not only with regards to innervation but also in the proximity of the ureter.

The anatomy of the anterior part of the then called cardinal ligament has been described in details by Fuji as a structure formed by two layers of connective tissue dorsal and ventral to the ureter. According to this description the nerve fibers running to the bladder from the inferior hypogastric plexus pass in the lateral part of this ligament.

In order to spare the lateral part of the lateral ligament of the bladder the fourth space of Yabuki needs to be developed.

Landmarks and Classes

The new classification is based on three fixed and reproducible landmarks: the ureter, the uterine artery and the pelvic sidewall (Fig. 39.2).

These anatomical structures are used to define the four main classes while the deep uterine vein is the landmark used to define two sub-classes, with and without nerve sparing approach.

The four classes are defined according to lateral, anterior, posterior and vaginal extension of the resection as well as in depth of the paracervix. As for the bladder and rectal ligaments the authors considered these structures too short and without clear landmarks and did not define intermediate levels of resection between the cervix and adjacent organs.

Type A is the previously defined extrafascial hysterectomy whereby the paracervix is transsected halfway between the ureter and the cervix and the lateral ligaments of bladder and rectum are resected at the level of the cervix, and less than 1 cm of vagina is removed. This procedure insures the *in toto* removal of the cervix.

Type B is divided into B1 and B2 according to the addition of a paracervical lymphadenectomy. This type of resection was previously known as "modified radical hysterectomy" and its lateral limit is the ureteric tunnel. The ureter is unroofed and at least 1 cm of vagina is resected. The purpose of this procedure is to enlarge the resection of the paracervix while leaving untouched its neural portion, under the deep uterine vein.

Type C is the resection of the uterosacral ligament at the level of the rectum and the vesico-uterine ligament at the level of the bladder. The ureter is mobilized completely and 15–20 mm of vagina starting at the level of the tumor or the cervix is resected.

Performing such an enlarged hysterectomy, the nerve supply to the bladder is threatened and whether it is preserved or not leads to the creation of two sub-classes.

Type C1 is a nerve sparing approach where dissection remains above (ventral to) the deep uterine vein while Type C2 extends resection beyond this landmark and includes the neural portion of the paracervix (Fig. 39.3).

Type D1 is the resection of the entire paracervix, extending to the level of the pelvic sidewall, along with the hypogastric vessels, exposing the roots of the sciatic nerve. Type D2 is D1 with the resection of adjacent fascial or muscular structures



Fig. 39.2 Landmarks in radical hysterectomy. Paracervix after the dissection of the pelvic spaces (*right side*). *Green*: ureter; *Red*: uterine and hypogastric arteries; *Yellow*: pelvic side wall

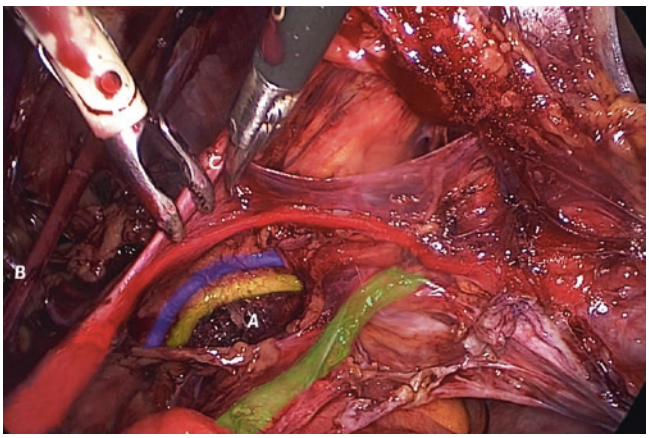


Fig. 39.3 Posterior view of the paracervix on the left side after the dissection. *A* Latsko space; *B* Left obturator nerve; *C* unbilical artery; *Red*: Uterine artery; *Blue*: deep uterine vein; *Yellow*: vaginal artery; *Green*: ureter

The Technique

Radical hysterectomy is one of the most anatomical procedures in gynaecological surgery, as it requires all anatomical spaces of the pelvis to be developed.

In most cases, there is no anatomical distortion and a wide dissection can be performed, guided by reproducible anatomical landmarks.

The procedure begins with the dissection of the lateral spaces of the pelvis in order to identify and isolate the paracervix.

The round ligament is coagulated and sectioned at the level of the umbilical artery and the anterior leaf of the broad ligament is divided. In order to perform this step, an instrument is inserted under the anterior peritoneal leaf until it reaches the uterus and then lifted, exposing the reflection line between peritoneum and uterine serosa. The peritoneum is divided under the point marked with a thin white line between the bladder and the cervix.

The opening reaches caudally the bladder and cranially the psoas muscle exposing the lateral spaces of the pelvis.

The paravesical fossa is divided into its medial and lateral parts using the obliterated umbilical artery as a landmark. The dissection is first carried laterally to the umbilical artery and progresses in a cranio-caudal direction, exposing the obturator area with its homonymous vessels and nerve.

The development of anatomical planes is helped by infiltration of CO_2 into the areolar tissue that fills the spaces, in between the landmarks.

Moving medially between the umbilical artery and the bladder, the medial part of the paravesical fossa is developed, with special care to avoid injury to the superior vesical artery. It arises from the umbilical artery, bringing blood supply to the bladder and is the only artery to cross this space (Fig. 39.4).

The medial part of the paravesical fossa is developed in its dorsal aspect to find the paracervix that marks the limit with the pararectal fossa.

This dissection allows the surgeon to identify the uterine artery and with it the cranial limit of the paracervix.

Following the uterine artery in a ventro-dorsal direction the surgeon enters the Latsko space located laterally to the ureter and dorsally to the paracervix.

A partial ureterolysis is then performed after developing the Okabayashi space, medially to the ureter. During this step, the hypogastric nerve is identified, coursing immediately under the peritoneum and crossing the ureter in its lower third to join the inferior hypogastric plexus (Fig. 39.5).

In thin patients the nerve is easy to identify on the right side as its path is often represented by a peritoneal fold, running from the promontorium through the pararectal fossa, between the ureter and the uterosacral ligament. To the left it is covered by the mesosigmoid.

The dissection then continues into the central spaces, whereby the rectovaginal and vesicovaginal spaces are developed.

To enter the posterior (dorsal) space the assistant grabs the rectum and pulls it in a dorsocranial direction exposing the spaces and the surgeon cuts the peritoneum 1–2 cm under the reflection line of the torus uterinus, below the level of insertion of the uterosacral ligaments.

The procedure continues with the development of the vesicouterine plane. To perform this dissection safely the assistant grabs the bladder and pulls ventrally, removing the bladder from the field, exposing the correct tissue plane (Fig. 39.6).

The right plane is at the level of the pubocervical fascia that is usually visible.

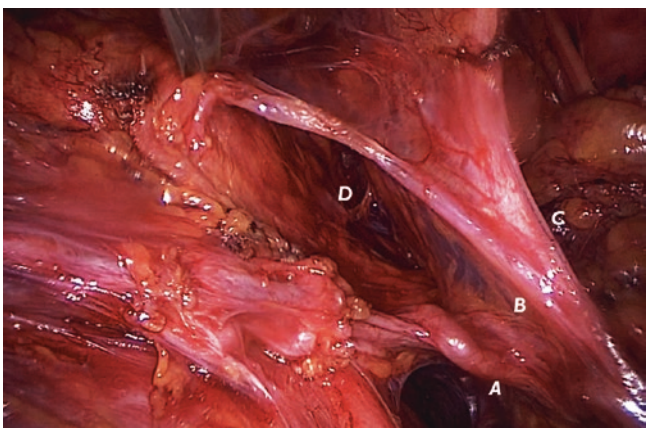


Fig. 39.4 View of the paravesical fossa. *A* Uterine artery; *B* superior vesical artery; *C* umbilical artery; *D* medial part of the paravesical fossa

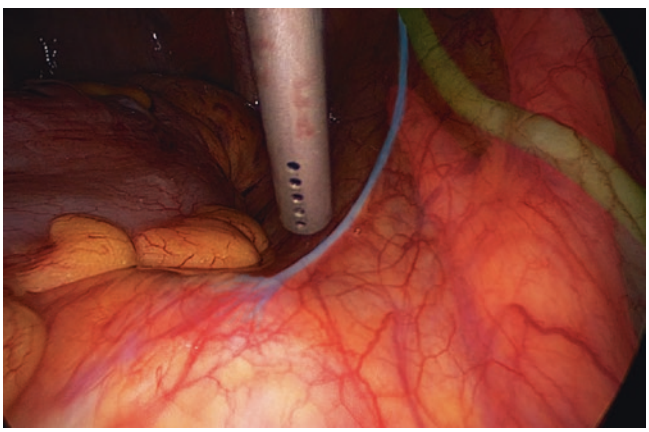


Fig. 39.5 The picture shows the relationship between ureter, iliac vessels and hypogastric nerve. On the right side the ureter cross the external iliac artery and the hypogastric nerve pass under the ureter arising from the promontorium. *Red*: Biforcation of the common iliac artery; *Green*: ureter; *Blue*: hypogastric nerve

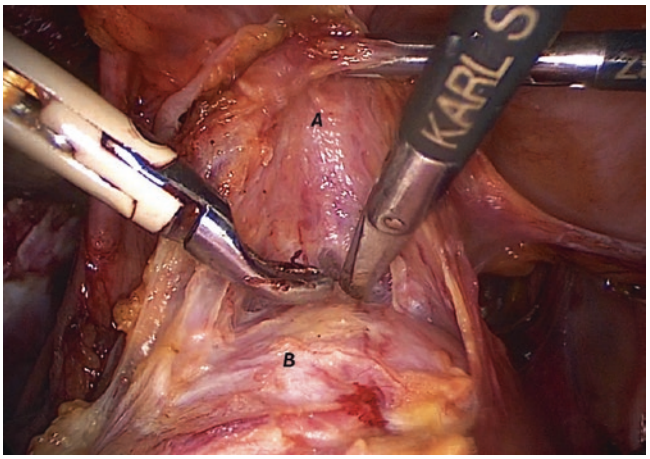


Fig. 39.6 Dissection of the vesicovaginal septum. The assistant lift up the bladder to expose the dissection plane. *A* Bladder; *B* vagina

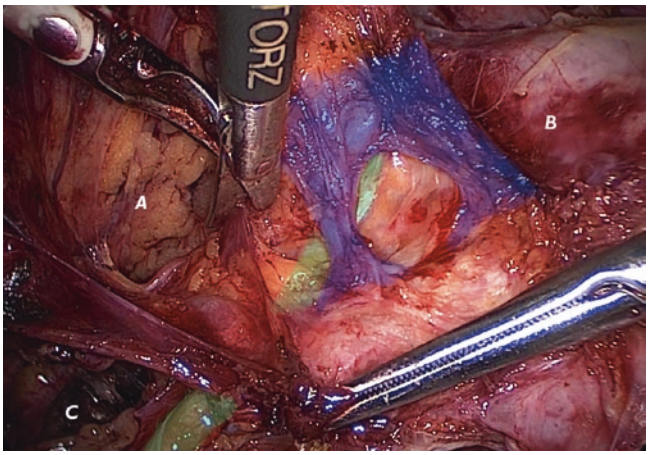


Fig. 39.7 The picture shows the relationship between the superficial layer of the vesicouterin ligament and the ureter (*left side*). This ligament can be divided in i a medial and lateral part. *A* medial part of the paravesical fossa; *B* vesicovaginal plane; *C* pararectal space; *Green*: ureter; *Blue*: superficial layer of the vesicuterine ligament

The development of the vesicouterine space, after the previously developed medial part of the paravesical fossa, isolates the lateral ligament of the bladder.

The dissection of this ligament is one of the most challenging steps of the procedure because of the close proximity of the ureter and the nerve bundles coming from the inferior hypogastric plexus that innervates the bladder.

The anatomy of this lateral ligament of the bladder has recently been found to be more complex than previously thought, with a detailed description reported in Japanese publications in the last decade.

The vesicouterine ligament is in fact made of two different layers, passing over and under the ureter. The superficial layer is made only of connective tissue and small vessels while the deep layer contains the nerve supply to the bladder.

The understanding of the anatomical relationship between the ureter, nerves and the paracervix is crucial to performing a safe procedure (Fig. 39.7).

The ureter crosses the paracervix, coursing in a dorsoventral and craniocaudal direction, passing under the uterine artery and above the deep uterine vein, through the ureteric tunnel. It then turns medially to join the bladder passing between the two layers of the vesicouterine ligament.

To dissect the intraligamentary part of the ureter and at the same time spare the bladder nerve branches, the fourth space of Yabuki is found. This space can be developed dissecting medially to the ureter once passed the superficial layer of the vesicouterine ligament (Fig. 39.8).

Doing so the surgeon can spare the deep layer of the vesicouterine ligament with the branches of the inferior hypogastric plexus arising from the paracervix under the deep uterine vein.

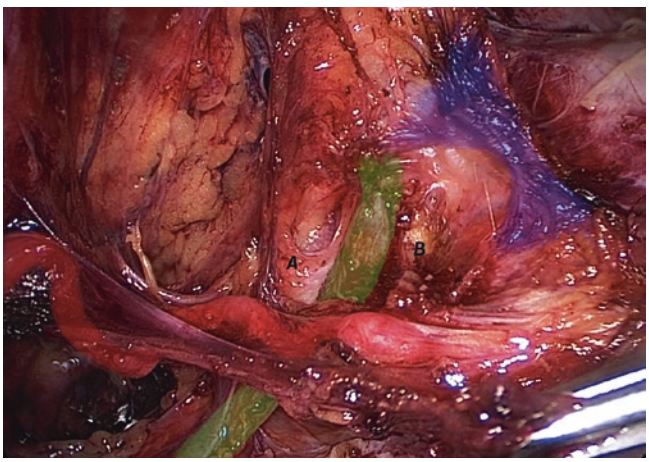


Fig. 39.8 Position of the ureter in the anterior paracervix after the section of the medial part of the ligament. The Yabuky space is located medially to the ureter at the level of the inferior layer of the vesicouterine ligament. *A* Inferior layer of the vesicouterine ligament; *B* yabuky space; *Green*: ureter; *Blue* superficial layer of the vesicouterine ligament; *Red*: uterine artery

Lymphadenectomy

The basic principle consists of identifying the anatomical landmarks by wide dissection of the retroperitoneal space. This is followed by, collection of nodes respecting the anatomical structures. In our technique, the dissection is performed by means of a bipolar forceps and scissors. Nevertheless, other types of energy can be used, notably mechanical energy sources (such as ultrasound) due to the high impedance of the fatty tissue.

Three lymphatic chains are systematically resected during the PL: external iliac, interiliac and obturative. The limits

of the pelvic dissection are: Cephalad: iliac vessels bifurcation, lateral: genito femoral nerve. Medial: ureter. Caudal: Circumflex iliac vein.

Adequate exposure is achieved by means of trendelenburg maneuver, uterine manipulator and in some cases organ suspension. The procedure starts with division of the round ligament. The anterior layer of the broad ligament is incised largely in both directions, caudally towards the cervix and cephalad over the psoas muscle. The retroperitoneum is exposed allowing the CO_2 gas to enter the connective tissue facilitating dissection and producing the so-called "bubble effect". The paravesical space (PVS) is then carefully developed using traction and counter traction. Haemostasis should be maintained and is important to reduce contaminating the operative field. The umbilical artery is identified in the middle of the PVS, an important landmark that should be preserved. The connective tissue between the Umbilical artery (UA) and the bladder can then be dissected (Fig. 39.9). Nevertheless, frequently the UA can be left attached to the lateral wall of the bladder and considered as part of the medial limit of the PVS. The pectineal ligament is identified and corresponds to the ventral limit of the space. The dissection is continued deeply until the levator ani muscles are reached. The obturator muscle and fascia with the obturator nerve and vessels run on the lateral aspect of the PVS. Dorsally the dissection continues until the paracervix. Afterwards the pararectal space or Latzko space is developed between the ureter and the internal iliac artery. Once the anatomical landmarks are identified, fatpad resection becomes straightforward.

The lateral aspect of the dissection consists of detaching the nodes from the external iliac vessels. The most lateral aspect of the nodes lies over the genito femoral nerve. By pulling the fatty tissue medially, the nerve can be completely isolated with minimal damage. Continuing with the same medial traction the nodes are separated from the superficial aspect of the external iliac vessels by using selective coagulation. Dissection of the nodes from the external iliac vein is one of the most dangerous steps. In contrast to the artery, traction over the vein leads its walls to collapse making it difficult to identify its limits. Another dangerous step is during anterior dissection of the nodes from the external iliac vein. A branch denominated the *Corona Mortis,* connecting the external vessel to the obturator vein can be frequently found (Fig. 39.10). Variations such as artery to artery and vein to artery shunts have been described. This communication can be sacrificed if needed, but should be performed at a considerable distance from the external iliac vein to avoid injuries of the external iliac vein.

Part of the dissection requires the surgeon to medialize the external iliac vessels, a gesture that should be performed cautiously at all times. The assistant can hold the vessels allowing the surgeon to work close to the lumbosacral fossa. Node dissection at this point should be careful and precise. Branches originating from the external iliac vessels directly into the muscles and foramens of the pelvis can retract and bleed if cut without proper coagulation. After separating the nodes from the external vessels attention should be paid to the deeper limits of the lymph node dissection: the obturator nerve.

The obturator nerve originates on the deepest aspect of the lumbosacral fossa, over the lumbosacral trunk and comprises the lower aspect of the pelvic lymphadenectomy (Fig. 39.11). It leaves the pelvis through the obturator foramen and it is completely surrounded by nodes and fatty tissue demanding greater attention of the surgeon to avoid complete transection. Gentle traction of the nodes is sufficient to isolate them from the nerve.

In cases when surgery is performed together with hysterectomy, the fat pad can be left in place until the end of the surgery and then removed through the vagina. The use of endoscopic bags is highly recommended when removing

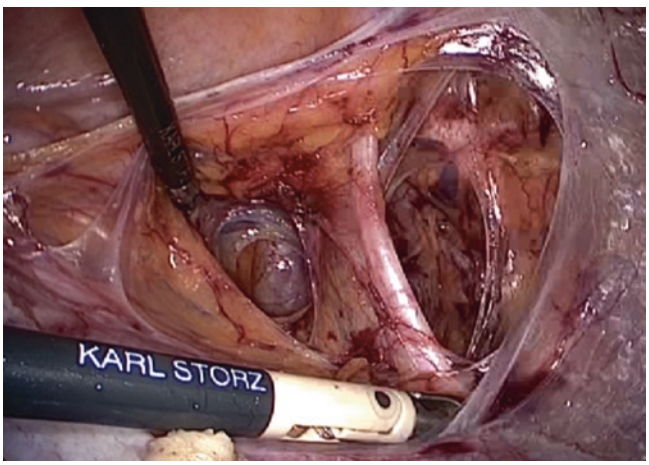


Fig. 39.9 the picture shows the paravesical fossa after the dissection of its both lateral and medial part using the umbilical artery as landmark (*right side*)

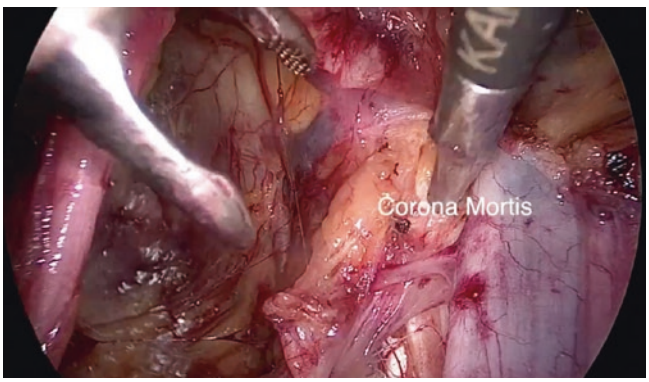


Fig. 39.10 The figure shows the origin of the corona mortis from the external iliac vein (*right side*)

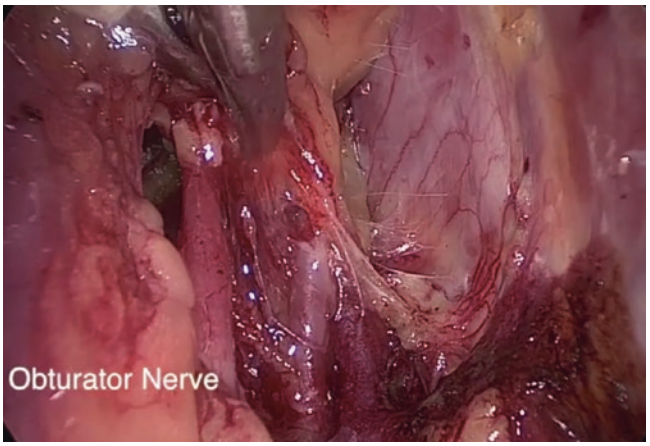


Fig. 39.11 The figure shows the obturator fossa on the right side along with its homonymous nerve artery and vein after the iliac vessels are reclaimed medially

nodes, particularly when they are enlarged or suspicious. In addition, in cases when the vagina is not opened (i.e., traquelectomy and PL, or PL for restaging) the use of bags is mandatory.

Lately surgery has moved towards more minimally invasive procedures and laparoscopy has played a considerable role within this field. Together with the benefits of sentinel node mapping, minimally invasive surgery has further improved outcomes compared to the early introduction of laparoscopy in oncology.

References

1. Wertheim E. The extended abdominal operation for carcinoma uteri (based on 500 operative cases). Am J Obstet Dis Women Child. 1912;66:169–232.
2. Okabayashi H. Radical abdominal hysterectomy for cancer of the cervix uteri. Surg Gynecol Obstet. 1921;33:335–41.
3. Meigs JV. Carcinoma of the cervix – the Wertheim operation. Surg Gynecol Obstet. 1944;78:195–8.
4. Piver MS, Rutledge F, Smith JP. Five classes of extended hysterectomy for women with cervical cancer. Obstet Gynecol. 1974;44:265–72.
5. Querleu D, Morrow CP. Classification of radical hysterectomy. Lancet Oncol. 2008;9(3):297–303.
6. Querleu D, Leblanc E, Castelain B. Laparoscopic pelvic lymphadenectomy in the staging of early carcinoma of the cervix. Am J Obstet Gynecol Elsevier. 1991;164(2):579–81.
7. Nezhat CR, Burrell MO, Nezhat FR, Benigno BB, Welander CE. Laparoscopic radical hysterectomy with paraaortic and pelvic node dissection. YMOB. 1992;166(3):864–5.
8. Köhler C, Klemm P, Schau A, Possover M, Krause N, Tozzi R, et al. Introduction of transperitoneal lymphadenectomy in a gynecologic oncology center: analysis of 650 laparoscopic pelvic and/or paraaortic transperitoneal lymphadenectomies. Gynecol Oncol. 2004;95(1):52–61.
9. Cartron G, Leblanc E, Ferron G, Martel P, Narducci F, Querleu D. Complications des lymphadénectomies cœlioscopiques en oncologie gynécologique : 1102 interventions chez 915 patientes. Gynécol Obstét Fertilité. 2005;33(5):304–14.
10. Abu-Rustum NR, Khoury-Collado F, Gemignani ML. Techniques of sentinel lymph node identification for early-stage cervical and uterine cancer. Gynecol Oncol Elsevier Inc. 2008;111(S):S44–50.
11. Abu-Rustum NR, Khoury-Collado F, Pandit-Taskar N, Soslow RA, Dao F, Sonoda Y, et al. Sentinel lymph node mapping for grade 1 endometrial cancer: Is it the answer to the surgical staging dilemma? Gynecol Oncol Elsevier Inc. 2009;113(2):163–9.

Laparoscopic Radical Hysterectomy with Pelvic Lymphadenectomy (Spanish School)

40

Antonio Gil-Moreno, Sabina Salicrú, Berta Diaz-Feijoo, and Blanca Gil-Ibáñez

Background

In less than two decades, the advent of laparoscopic surgery has definitely contributed to modifying the management of patients with gynecologic cancer. This minimally invasive surgery plays an important role in the basic aspects of gynecologic oncology: diagnosis, staging, and treatment of malignant tumors. All these tasks involve a learning phase for surgeons and a phase of diffusion of these techniques. In cases of cervical and ovarian neoplasms, laparoscopic procedures are technically more difficult and for this reason should be performed by highly specialized teams.

Laparoscopic lymphadenectomy occupies an important place as a diagnostic and staging method in cervical cancer. The first transperitoneal pelvic lymphadenectomies in the management of cervical cancer were originally reported on by Querleu et al. in 1991 [1]. In 1992, Querleu in France and Childers in the United States described transperitoneal paraaortic lymphadenectomy, and in 1995, Dargent showed that extraperitoneal laparoscopy can also be performed at this level [2]. Nowadays, systematic pelvic lymphadenectomy may be substituted by detection and analysis of the sentinel node.

The first laparoscopic hysterectomy for benign diseases was published in 1989 by Reich et al. [3]. Subsequently, laparoscopy was preferentially used in gynecologic oncology to convert radical abdominal hysterectomy into radical vaginal hysterectomy [4–6]. In 1990, Canis et al. [7] and in 1992, Nezhat et al. [8] described for the first time radical hysterectomy performed using the laparoscopic route. During the 90's various clinical series with a limited number of patients showed the possibility of performing radical resections with lymphadenectomy using the laparoscopic approach [9–13]. Different groups have published their experiences showing the feasibility and safety of the procedure and suggesting that prognosis or survival is not adversely affected by the procedure. However, there are few publications on the morbidity and long-term survival of laparoscopic radical hysterectomy.

Terminology

The term radical hysterectomy implies resection of a vaginal cuff and paracervical tissues besides the uterus. Pelvic lymphadenectomy also constitutes a part of the surgical procedure for early invasive cervical cancer, although it is not included in the current International Federation of Gynecology and Obstetrics (FIGO) staging classification [14]. The operation can be more or less radical according to the tumor size and involvement of paracervical tissue or of the vaginal tissue. Extension to the pelvic wall is performed through the paracervix, usually with involvement of lymph vessels and lymph nodes at this level.

In 1974, Piver et al. [15] pointed out that the term radical hysterectomy involves 'many different operations' and described five classes of extended hysterectomies that have been later summarized or adapted to the two types of radical hysterectomies: proximal, modified or Piver type II hysterectomy (resection of the medial paracervix proximal to the ureters and medial section of uterosacral ligaments) and distal or Piver type III/IV hysterectomy (distal resection of the paracervix at the level of the pelvic wall and removal of the uterosacral ligaments) (see Table 40.1).

In 2008, Querleu and Morrow [16] (Q-M) proposed a new classification of radical hysterectomy based on the lateral extent of resection. Four types of radical hysterectomy (A-D) were described, adding when necessary a few subtypes that look at nerve preservation and paracervical

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Table 40.1 Types of radical hysterectomy

Querleu/Morrow type (2008/2011) [16, 17]	EORTC type (Piver 1974) [15]
Type A The fascia of the cervix and lower uterine segment is removed with the uterus	**Type I** Extrafascial hysterectomy
Type B Removes the cervix, proximal vagina, and parametrial and paracervical tissue The radicality of this operation can be improved by lymph-node dissection of the lateral part of the paracervix. Thus defining two subtypes: B1 and B2, with additional removal of the lateral paracervical lymph nodes.	**Type II** Modified radical hysterectomy
Type C Requires greater resection of the parametria The issue of nerve preservation is crucial. Two subcategories are defined: **C1 with nerve preservation** Uterosacral ligaments were transected after separation of both hypogastric nerves. The paracervix tissue was transected up to the deep uterine vein. The inferior hypogastric plexus with the splanchnic nerves are identified systematically . Then the bladder branches of the pelvic plexus were identified and preserved in the lateral ligament of the bladder **C2 with a complete parametrial resection** The paracervix is transected completely, including the part caudal to the deep uterine vein	**Type III** Radical hysterectomy
Type D Differs from type C2 in a feature additional ultraradical procedures, mostly indicated at the time of pelvic exenteration. Excision extends to the pelvic sidewall D1 is resection of the entire paracervix at the pelvic sidewall along with the hypogastric vessels, exposing the roots of the sciatic nerve D2 is D1 plus resection of the entire paracervix with the hypogastric vessels and adjacent fascial or muscular structures	**Type IV** Radical hysterectomy
	Type V **Pelvic Exanteration**

lymphadenectomy. Lymph node dissection was considered separately and four areas or levels were defined according to corresponding arterial anatomy and radicality of the procedure: level 1, external and internal iliac; level 2, common iliac (including presacral); level 3, aortic infra-mesenteric; and level 4, aortic infrarenal. In addition, it can be adapted to the different types of surgical approaches and is useful for open abdominal, laparoscopic or robotic, and vaginal routes.

More recently, in 2011, Cibula et al. proposed a classification system based on the proposal published by Querleu and Morrow but specifying anatomical landmarks for all types of radical hysterectomy in three dimensions [17].

Types of Radical Hysterectomy (Querleu-Morrow Classification Plus Cibula et al.)

Type A

This type corresponds to the extrafascial hysterectomy, which guarantees full removal of the pericervical tissue up to the attachment of the vaginal fornices. The paracervix is transected medial to the ureter, but lateral to the cervix. The uterosacral and vesicouterine ligaments are not transected at a distance from the uterus. Vaginal resection is generally at a minimum, routinely less than 10 mm, without removal of the vaginal part of the paracervix (paracolpos). The autonomic nerves remain fully preserved.

Type B

This type corresponds to the modified or proximal radical hysterectomy. Partial resection of the uterosacral and vesicouterine ligaments is a standard part. The ureter is only unroofed, dissected from the cervix and displaced laterally, permiting transaction of the paracervix at the level of the ureteral tunel. The nerve supply to the bladder is not treated because the paracervix is not resected caudal to the uterine vein, thereby nerve supply is conserved. At least 10 mm of the vagina from the cervix or tumour is resected.

The radicality of this operation can be improved without increasing postoperative morbidity by lymph-node dissection of the lateral part of the paracervix, thus defining two subtypes: B1 (as described); and B2, with additional removal of the lateral paracervical lymph nodes.

Type C

Type C corresponds to variants of classical radical hysterectomy. This type is transection of the uterosacral ligament at

the rectum and vesicouterine ligament at the bladder. The ureter is mobilised completely. 15–20 mm of vagina from the tumour or cervix and the corresponding paracolpos is resected routinely. The Q–M classification system distinguishes between a type C1 procedure, which corresponds to the nerve-sparing modification, and the type C2, which aims for a complete parametrial resection.

In type C1, the uterosacral ligaments were transected after separation of both hypogastric nerves and ureters. The paracervix tissue was transected up to the deep uterine vein. The inferior hypogastric plexus with the splanchnic nerves are identified systematically and preserved (Fig. 40.1). Then the bladder branches of the pelvic plexus were identified and preserved in the lateral ligament of the bladder (Fig. 40.2).

In the C2 type, the paracervix is transected completely, including the part caudal to the deep uterine vein (Fig. 40.3).

Type D

Type D1 is resection of the entire paracervix at the pelvic sidewall along with the hypogastric vessels, exposing the roots of the sciatic nerve. There is total resection of the vessels of the lateral part of the paracervix. Type D2 is D1 plus resection of the entire paracervix with the hypogastric vessels and adjacent fascial or muscular structures. This resection corresponds to the LEER (laterally extended endopelvic resection) procedure.

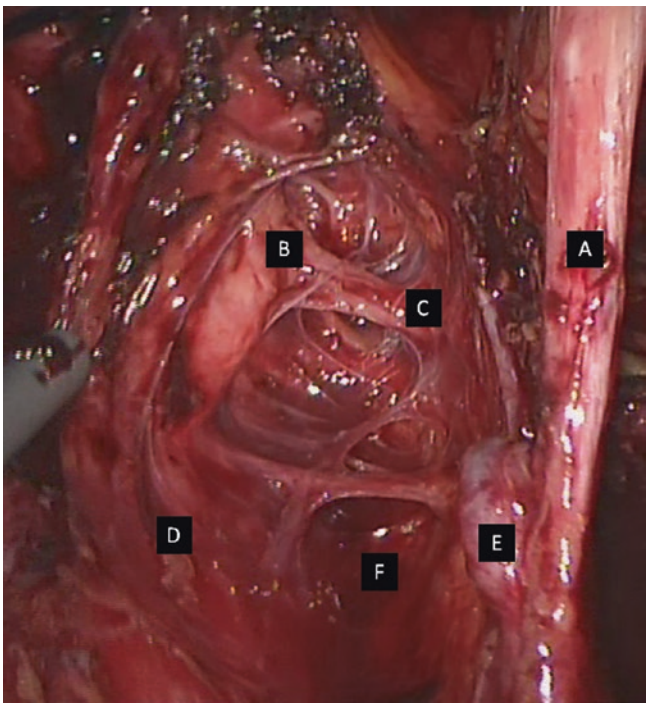


Fig. 40.1 The inferior hypogastric plexus (IHP) has been mobilized laterally from the right uterosacral ligament. The pelvic splanchnic nerves are seen joining the IHP in a perpendicular fashion. *A* Superior vesical artery *B* Inferior hypogastric plexus *C* Pelvic splanchnic nerve *D* Hypogastric nerve *E* Uterine artery *F* Pararectal space

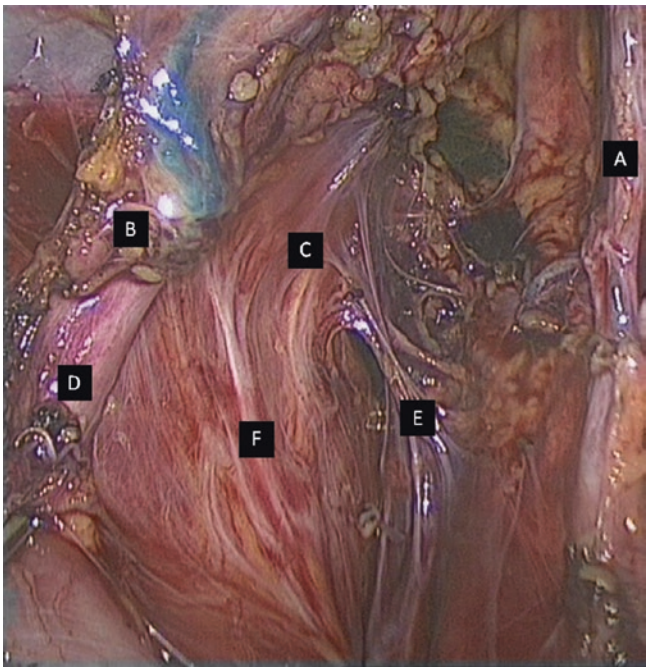


Fig. 40.2 Pelvic autonomic nerves, right side (radical hysterectomy type *C1*). *A* Superior vesical artery *B* Transected uterine artery *C* Inferior hypogastric plexus *D* Ureter *E* Pelvic splanchnic nerve *F* Hypogastric nerve

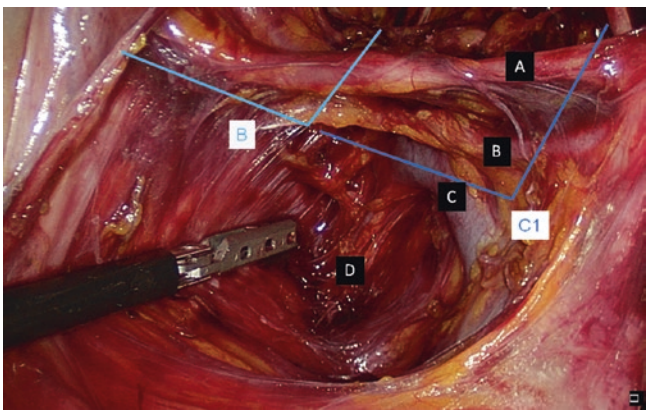


Fig. 40.3 Resection lines on the paracervix for radical hysterectomy type *B* and *C1*. *A* Uterine artery *B* Uterine vein *C* Deep uterine vein *D* Pararectal space

Surgical Procedure Step by Step [18]

Combined general and epidural anesthesia can be used. Patients should undergo bowel preparation and perioperative antibiotics (2 gr of cefazolin intravenously) and low-molecular-weight enoxaparin (40 mg/24 h subcutaneously) should be administered. A uterine manipulator is used. A four-trocar

transperitoneal approach is normally used. The laparoscope is introduced through an 11-mm umbilical trocar with a direct-puncture technique (or open technique using a Hasson trocar), and three other trocars are inserted with the patient in the 25–30-degree Trendelenburg position. Two accessory 12 and 5-mm trocars are then placed under direct visualization in the iliac fossas, and one 5-mm accessory trocar is placed at the midline between the umbilicus and the left subcostal margin (Fig. 40.4).

The abdominal cavity is inspected, and the retroperitoneal spaces are opened. The paravesical, pararectal, rectovaginal, and vesicovaginal spaces are developed, thereby delineating the uterosacral ligaments and the parametria (Fig. 40.5).

The pelvic lymph nodes are divided into external iliac, internal iliac or hypogastric, obturator, common iliac and presacral. External iliac nodes are superior and lateral to the external iliac vessels, from the deep iliac circumflex artery to the bifurcation of the common iliac artery. The internal iliac nodes are at the top and side of the internal iliac artery. The obturator nodes are in the obturator fossa below the external iliac vein and above the obturator nerve. Common iliac nodes extend from the bifurcation of the common iliac vessels to the bifurcation of the aorta. Presacral nodes are located below the bifurcation of the aorta and over the left common iliac vein. Lymphs located outside these anatomical areas are usually not involved in the lymphatic spread of uterine malignancies, so their systematic dissection is not justified.

Systematic bilateral pelvic lymphadenectomy is performed with blunt dissection and monopolar/bipolar coagulation from the common iliac artery to the inferior boundary of the circumflex iliac vein. On special occasions we use sealing vessels. Common, internal and external iliac nodes, as well as obturator and presacral lymph nodes, are removed (Fig. 40.6).

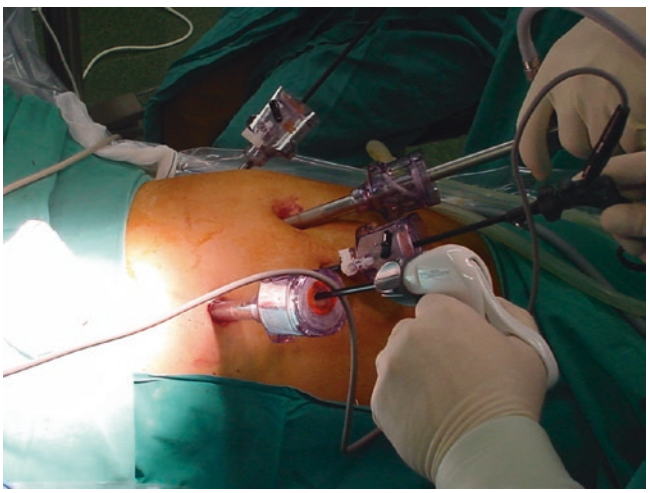


Fig. 40.4 Details of the four-trocar approach

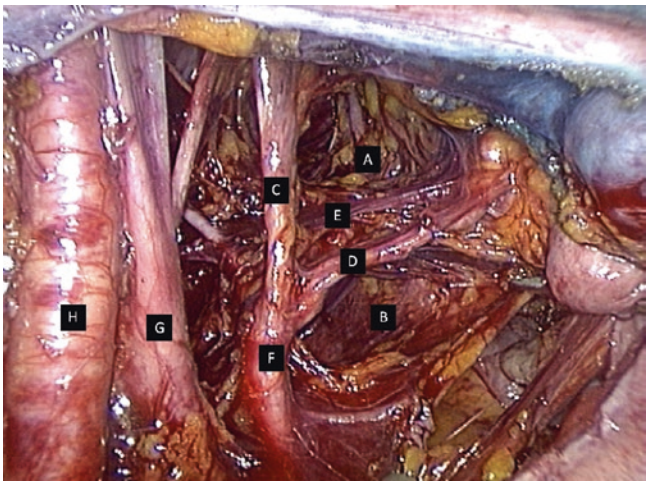


Fig. 40.5 Dissection of the uterine vessels (*left side*). *A* Paravesical space *B* pararectal space *C* superior vesical artery *D* uterine artery *E* uterine vein *F* internal iliac artery *G* external iliac vein *H* external iliac artery

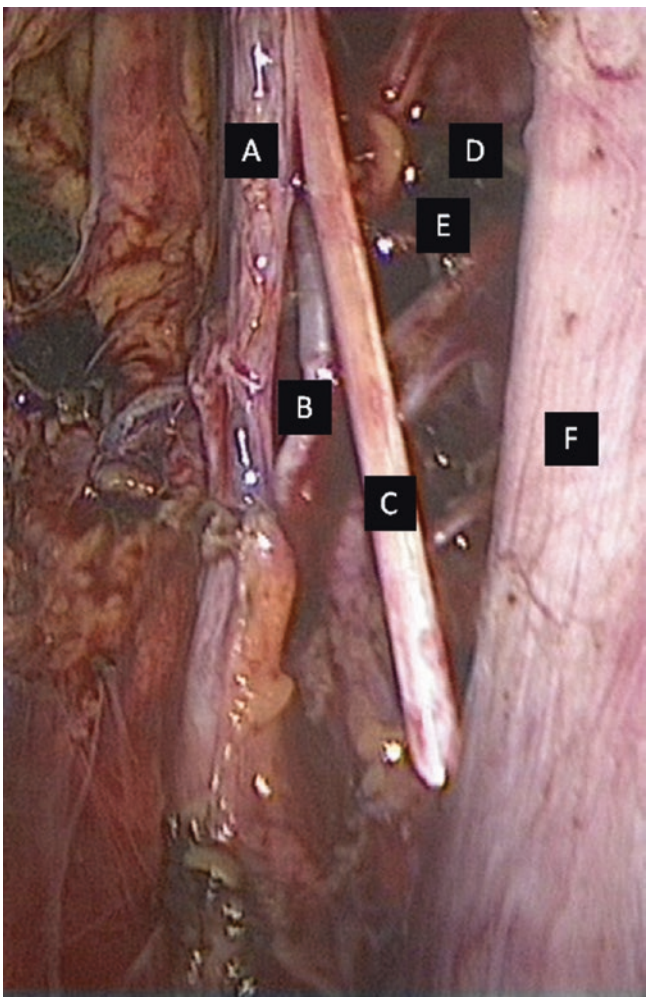


Fig. 40.6 Pelvic lymphadenectomy (*right side*). *A* Superior vesical artery *B* Obturator vein *C* Obturator nerve *D* Intern obturator muscle *E* Obturator fossa *F* External iliac vein

Uterine vessels are identified and cut at their origin from the hypogastric vessels. The uterosacral ligaments are transected after separation of both hypogastric nerves and ureters. The paracervix tissue is transected up to the deep uterine vein (Fig. 40.7).

Dissection of the ureteral tunnel, urinary bladder, and ureteral separation is accomplished with monopolar coagulation using a blunt dissector and with the aid of sealing vessels (Fig. 40.8).

Resection of the proximal paracervical tissues is performed with sealing vessels or monopolar/bipolar coagulation. At the point where the vaginal fornices are encountered bilaterally, the vagina is transected with monopolar coagulation, and the specimen is removed vaginally (Fig. 40.9)

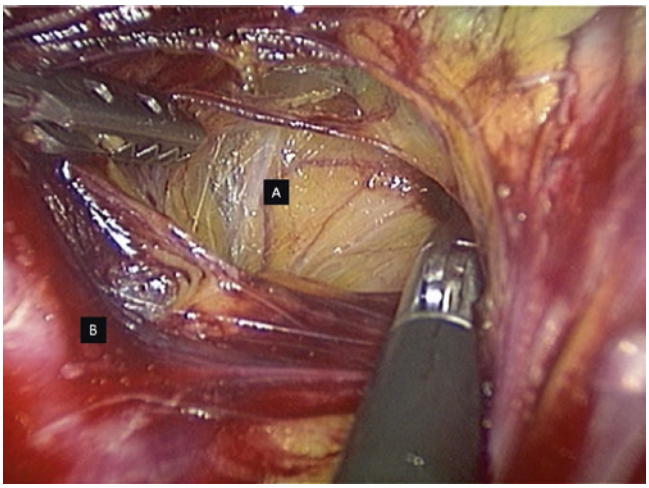


Fig. 40.7 Hypogastric nerves in uterosacral ligament, 2 cm under the ureter. *A* Hypogastric nerve *B* Ureter

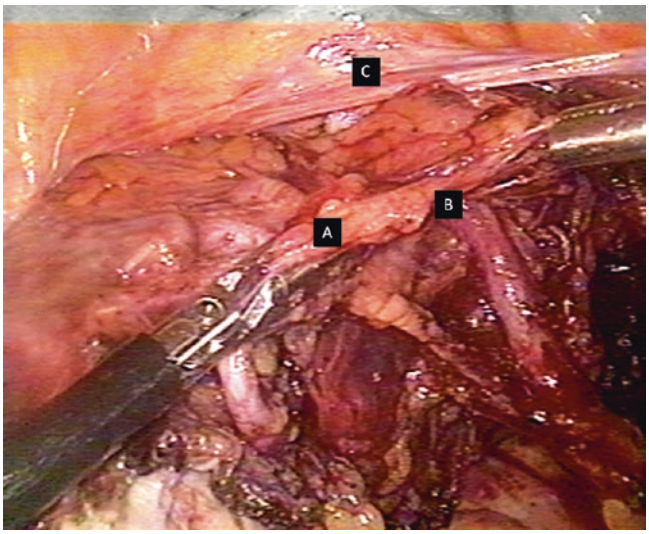


Fig. 40.8 Dissection of the left ureteral tunnel (vesicouterine ligament). *A* Ureter *B* vesicouterine ligament *C* Bladder

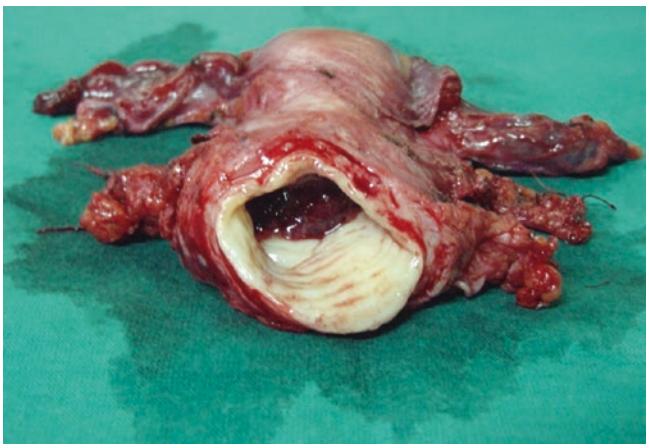


Fig. 40.9 Surgical specimen after total laparoscopic radical hysterectomy (type C1-nerve sparing)

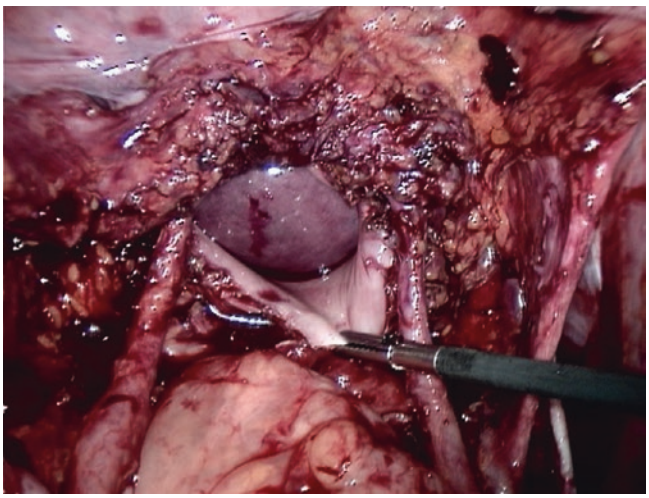


Fig. 40.10 Vaginal cuff before suture through the laparoscopic route

The vaginal cuff is then closed laparoscopically with 2-0 polyglactin continuous sutures. After completing the vaginal procedure, we check for hemostasis and intact ureters, and the peritoneal cavity is thoroughly irrigated and lavaged (Fig. 40.10).

Laparoscopy Radical Hysterectomy Compared with Laparotomy

There have been several studies in the last 10 years in which laparoscopy and laparotomy radical hysterectomy with pelvic lymphadenectomy for the treatment of early invasive Cervical Cancer have been compared.

Duration of Operation

As shown in Tables 40.2 and 40.3, duration of a laparoscopic radical hysterectomy type C operation ranged from 196 min

Table 40.2 Comparative studies of radical hysterectomy by the laparoscopic and the conventional laparotomy route in early invasive cervical cancer

First author, year (References)	Study group	Number patients	FIGO stage	Details	Operative time, min mean	Blood loss, mL, mean	Pelvic nodes mean	Length of stay, days, mean
Lin (2003) [19]	Laparoscopy	10	IA2-IB1 < 2 cm	Type B. Completed vaginally	159	250	16.8	4.1
	Laparotomy	39	IB < 2 cm	Type B	165.7	611.5 P < 0.01		8.3 P < 0.01
Abu-Rustum (2003) [20]	Laparoscopy	19	IA1-IB1 < 2 cm	Without vaginal surgery	371	301	25.5	4.5
	Laparotomy	195	IA1-IB1		295 P < 0.01	639 P < 0.01	30.7	9.7 P < 0.01
Zakashansky (2007) [21]	Laparoscopy	30	IA1-IIA ≤ 4 cm	Case-control study. Completed vaginally. Advanced laparoscopic training program	318.5	200	31	3.8
	Laparotomy	30	IA1-IIA ≤ 4 cm	NA	242.5 P < 0.01	520 P < 0.01	21.8 P < 0.01	5.6 P < 0.01
Li (2007) [22]	Laparoscopy	90	IB1-AII ≤ 5 cm	Type C. Vaginal suture through the vaginal route	263	370	21.3	13.8
	Laparotomy	35	IB1-AII ≤ 5 cm	Type C	217 P = 0.001	455	18.8	13.7
Frumovitz (2007) [23, 24]	Laparoscopy	35	IA1-IB1	Type C. Without vaginal surgery	344	319	14	2
	Laparotomy	44	IA1-IB1	Type C	307 P = 0.03	548 P = 0.009	19 P =0.001	5 P < 0.001
Díaz-Feijoo (2008) [25]	Laparoscopy	20	IA2-IIA < 4 cm	Sentinel node detection	272	400	19.0	4.9
	Laparotomy	30	IA2-IIA < 4 cm	Sentinel node detection	240 P = 0.001	623 P = 0.001	21.6	10.7 P = 0.001
Malzoni (2009) [26]	Laparoscopy	65	IA1 (n =5, vascular invasion), IA2 (n= 21), Ib1 (n = 39, < 4 cm)	Type II (n = 14), type III (n = 51), paraaortic lymphadenectomy (n = 8)	196	55	23.5	4
	Laparotomy	62	IA1 (n = 3 vascular invasion), IA2 (n=39), Ib1 (n = 39 < 4 cm)	Type II (n = 13), type III (n = 49), paraaortic lymphadenectomy (n = 7)	152 P < 0.01	145 P < 0.01	25 P < 0.01	7 P < 0.01
Ditto (2015) [27]	Laparoscopy	60	IA2-IB1 < 2 cm	Type B	215.9	50	25.4	4
	Laparotomy	60	IA2-IB1 < 2 cm	Type B	175 P < 0.001	200 P < 0.001	34.6 P < 0.001	6 P < 0.001

in the series of Malzoni [26] to 344 min in the study of Frumovitz [23, 24]. Other groups reporting short operative times are Li et al. [22] and Diaz-Feijoo et al. [25], in which procedures were totally performed using the laparoscopic route.

In a clinical series of 12 patients undergoing laparoscopic radical hysterectomy and lymphadenectomy with intraoperative detection of the sentinel node, Gil-Moreno et al. [28] reported a mean time of 271 min, which is shorter than results published in other series in which the technique of sentinel node detection was not included in the procedure. This study includes patients operated on from March 2001. In the same year, the same group [18], published their experience with laparoscopic radical hysterectomy and pelvis lymphadenectomy in which 27 patients were described (with detection of the sentinel node in 10) and the mean operative time was 285 min. However, patients in this study were included from September 1999, so it can be deduced that the technique of intraoperative sentinel node detection was not

Table 40.3 Comparative studies of radical hysterectomy by the laparoscopic and the conventional laparotomy route in early invasive cervical cancer: complications and follow-up

First author, year (References)	Study group	Complications		Follow-up months
		Intraoperative	Postoperative	
Lin (2003) [19]	Laparoscopy	No	No	11 (1–24)
	Laparotomy	No	No	NA
Abu-Rustum (2003) [20]	Laparoscopy	2 conversions (parametrial bleeding 1, adhesions 1 1 ureteral stent migration replaced at surgery	1 fever of unknown origin 1 transfusion	NA
	Laparotomy	41 transfusions 5 bladder injuries (2.6 %) 5 iliac vein injuries (2.6 %) 1 ureteral lesion (0.5 %)	26 surgical wound infection 25 pelvic/hematoma infections 15 bowel occlusion 13 ileus 4 urinary tract infection 3 bacteremias/sepsis 1 pneumonia 1 *Clostridium difficile* infection 1 deep venous thrombosis 7 lymphedemas	NA
Zakashansky (2007) [21]	Laparoscopy	2 bladder injury	2 *Clostridium difficile* colitis 1 pulmonary thromboembolism 1 deep venous thrombosis 1 ileus 1 bladder dysfunction at 3 weeks	20
	Laparotomy	5 transfusions 1 inferior vena cava injury, small bowel omentum injury	1 thrombosis 1 ileus 1 small bowel occlusion 2 bladder dysfunction at 3 weeks 3 sensory disturbance 2 pyelonephritis	20
Li (2007) [22]	Laparoscopy	2 conversions (iliac vein lesion 1, bladder lesion 1) 4 iliac vein lesions 4 bladder injuries	29 bladder dysfuncton 1 uterocecal fistula 1 vesicovaginal fistula 1 bowel occlusion 4 lymphoceles	26 10 lost to follow-up 13.7 % recurrences 10 % mortality
	Laparotomy	1 iliac vein lesion 2 ureteral lesions	10 urinary retention 1 bowel occlusion 2 lymphocysts 1 dehiscence scar	26 5 lost to follow-up 12 % recurrences 8 % mortality
Frumovitz (2007) [23, 24]	Laparoscopy	11 % transfusions 2 conversions (injury iliac veins 2) 1 lesion inferior epigastric vessels 1 bladder injury	18 % infections 45 % transient bladder dysfunction 3 readmissions (1 fever unknown origin,1 pulmonary embolism, 1 pyelonephritis)	7.2 Recurrence 1
	Laparotomy	15 % transfusions 1 bladder injury	53 % infectious morbidity 31 % transient bladder dysfunction 4 readmissions (fever unknown origin 1, wound celulitis 1, pelvic abscess 1, pulmonary embolism 1)	15.2 Recurrences 2

(continued)

Table 40.3 (continued)

First author, year (References)	Study group	Complications		Follow-up months
		Intraoperative	Postoperative	
Díaz-Feijoo (2008) [25]	Laparoscopy	1 conversion (technical failure) 1 transfusion (5 %) 2 technical failures	Early 0 %, late 20 % 2 urinary incontinence (TVT tape) 3 vaginal suture dehiscence	23.3 100 % survival
	Laparotomy	5 transfusions (16.7 %) 1 disseminated intravascular coagulation (1 death) 1 ureter section	Early 13.3 % 1 urinary tract infection 2 abdominal wall hematomas 1 abdominal wall abscess Late 3.3 % 1 urinary incontinence (TVT tape)	34.6 90 % survival Deaths 3 (recurrent disease 2)
Malzoni (2009) [26]	Laparoscopy	1 bladder injury 2 subcutaneous emphysema	17 bladder dysfunction 1 ureterovaginal fistula 20 lymphorrhea vaginal scar 6 fever episodes	52.5 Vaginal recurrences 5 91 % survival
	Laparotomy	1 bladder injury	19 bladder dysfunction 8 fever episodes 17 lymphorrhea vaginal scar	71.5 Vaginal recurrences 4 93.6 % survival
Ditto (2015) [27]	Laparoscopy	1 bladder injury	1 haemoperitoneum requiring open abdominal surgery 1 uretero-vaginal fistula 2 % urinary retention	31 Recurrences 3 % Death of disease 2 %
	Laparotomy	No	1 lymphocele 1vesico-vaginal fistula 3 % urinary retention	48.7 Recurrences 8 % Death of disease 5 %

initiated until the learning curve of radical hysterectomy with pelvic lymphadenectomy was accomplished.

Regarding the experience of the surgical team and the learning curve for this type of laparoscopic surgery, the study of Pomel et al. [29] provides interesting data. In a group of 50 patients, a mean operative time of 258 min (range 114–540 min, 39 radical hysterectomies type C and 11 type B) was reported. The operative time was not significantly different in patients with and without previous surgery, preoperative brachytherapy or even in relation to body mass index. But the effect of the learning curve was evident. In the first 25 patients, the mean operative time was 290 min, whereas for the last 25 patients, the mean time was 226 min ($P = 0.01$). Moreover, in the last ten patients, the mean operative time decreased to 135 min (range 114–180 min).

In 1995, Sedlacek et al. [30], compared a series of 14 patients undergoing laparoscopic radical hysterectomy type III with lymphadenectomy *vs* the historical group of patients treated in the past 3 years using the laparotomic route, showing a duration of operation of 7 h for the laparoscopy group and 4 h for the laparotomy group, although neither the influence of the surgical experience or the learning curve was considered. Lin [19] published preliminary findings of a prospective and non-randomized study. In the laparoscopic group of ten patients, the mean operative time was 159 min *vs* 165.7 min in the open surgery group (39 patients). It should be noted that the type of hysterectomy was a radical hysterectomy type B and that the procedure was completed by the vaginal route but the surgical time in the two approaches was the same. Abu-Rustum et al. [20] in 2003, carried out a retrospective comparative study of 19 patients undergoing laparoscopic radical hysterectomy with pelvic lymphadenectomy with argon beam coagulation (there were two conversions to open laparotomy, the operative times of which were not included) *vs* a historical cohort of 195 patients who underwent standard laparotomy over an 11-year period. The mean operative time was 296 min in the historical cohort and 371 in the laparoscopy group ($P < 0.01$), but again the learning curve should be taken into account.

Frumovitz and co-workers [23, 24] from the University of Texas M.D. Anderson Cancer Center compared 35 patients operated using the laparoscopic route (two conversions to open laparotomy) with 54 patients undergoing hysterectomy by laparotomy. Surgical times were significantly longer for the laparoscopic group (344 min *vs* 307 min, $P = 0.03$). The authors had two different explanations. Firstly, the learning curve because this was a new technique for the surgical team, and secondly, by the fact that the institution is a teaching center both for gynecologists that want to become specialists in gynecologic oncology and residents that participate in all surgeries. These surgical times are similar to those reported on in the Memorial Sloan-Kettering Cancer Center [20], which is also a university-affiliated hospital. The group of Zakashansky and Nezhat [21] published the results of a

case-control study in which 30 laparoscopically-operated patients (the procedure was completed by the vaginal route) were compared with 30 patients operated via laparotomy, emphasizing that the study was performed in a teaching center (with a teaching program for advanced laparoscopic procedures). This is an interesting study because it shows the curve of surgical time by academic year, showing a plateau of 310 min that was not able to be reduced with the experience of the surgeons. When the experience in a teaching program was analyzed, there was an increase in the mean operative time for the laparoscopic procedure *vs* the open route in radical hysterectomies performed by the same alumni. The duration of operation is slightly longer as compared with the same procedure performed by expert surgeons in other series, and approximately coincides with data from other studies of hospitals teaching these procedures [20, 31]. Li et al. [22] compared a group of 90 patients undergoing laparoscopic hysterectomy with suture of the vaginal cuff vaginally with 35 patients operated using the conventional laparotomy approach. The mean surgical time was 263 min *vs* 217 min, respectively ($P = 0.001$). The difference in favor of the laparotomy group was attributed to the learning curve since the duration of operation decreased significantly from 281 min for the first 48 patients to 244 for the last 45 patients ($P = 0.009$).

In 2008, Díaz-Feijoo et al. [25] reported the results of a retrospective non randomized study in which 50 consecutive patients with FIGO stage IA_2, IB_1, and AII disease less than 4 cm underwent radical hysterectomy and lymphadenectomy with intraoperative sentinel lymph node biopsy. The operation was performed entirely by laparoscopy in 20 patients and using the conventional abdominal route in 30. The mean duration of operation was 272.5 min and 240 min. for the laparoscopic and laparotomy groups, respectively ($P = 0.001$).

All studies are consistent with a longer duration of operation for the laparoscopic approach, although the operative time decreases with the surgeon's experience and when the learning curve has been surpassed. However, the laparoscopic technique involves some steps, such as extraction of the lymph nodes using a bag device and insertion of the uterine manipulator and other laparoscopic instruments which increase the overall operating time.

Intraoperative Blood Loss

A review of the different series published in the literature revealed a mean intraoperative blood loss of 200 mL (see Table 40.2). The learning curve is important to decrease blood loss at the time of surgery. Blood loss in the laparoscopic technique is minimized by a better visualization of the small vessels through magnification of the current optical systems, which allows a careful hemostasis of the operative field [24].

In the first case described by Nezhat et al. [8] in 1992, the estimated blood loss was 30 mL, and in the case reported by Jobling and Wood [32] in 1993, the amount of blood loss was 100 mL. These blood losses were very small bearing in mind the long operating time (420 and 460 min, respectively) and given that procedures were completed by the vaginal route. It is probable that hemostasis was carefully controlled.

When the laparoscopy and the laparotomy routes are compared (Table 40.2), all the studies reported a significantly lower blood loss in the laparoscopic route. Although the significant difference in blood loss (in ml.) may not be clinically important. The clinically important difference is the transfusion rate. Historically, 40–80 % of patients undergoing radical hysterectomy via abdominal laparotomy received blood transfusion.

In the study of Pomel et al. [29] (50 patients) only one patient required blood transfusion in the laparoscopic arm. In the study of Zakashansky et al. [21] published in 2007 (30 patients, procedure completed through the vaginal route), no transfusions were reported. In the study of Malzoni et al. [26], the estimated blood loss was 55 mL and no transfusions were needed. In the study of Díaz-Feijoo et al. [25], the mean blood loss was 623 mL in the laparotomy group and 400 mL in the laparoscopy group ($P = 0.001$). Five patients in the laparotomy group required blood transfusion compared with one patient in the laparoscopy group. In relation to the learning curve, in the largest series of laparoscopic radical hysterectomies lower rates of blood transfusion are generally reported. In the study of Spirtos et al. [33] of 78 patients, the transfusion rate was 1.3 % and in the study of Pomel et al. [29] 2 %.

Pelvic Nodes

The number of pelvic nodes obtained in the different studies published in the literature ranges from 7 to 41. In the largest series, the mean number of nodes removed in the laparoscopic route is around 20 (23.5 in the study of Malzoni et al. [26] with 65 patients, 21.3 in the study of Li et al. [22] with 90 patients and 25.5 in the study of AbuRustum et al. [20] with 197 patients). In other studies, the mean number of lymph nodes obtained is smaller (16.8 in the study of Lin et al. [19] with ten patients) or greater such as 31 in the study of Zakashansky et al. [21] with 30 patients (Table 40.2).

Abu-Rustum et al. [20], reported a mean of 25.5 nodes in the laparoscopic group *vs* 30.7 in the laparotomy group, although significant differences were not found. Malzoni et al. [26] also observed a higher number of nodes obtained in open surgery (25.2) than in laparoscopic surgery (23.5), including a difference in the number of aortic nodes in favor of laparotomy. In the study of Frumovitz et al. [23], a mean of 19 pelvic nodes were obtained during abdominal radical hysterectomy compared with 14 during total laparoscopic radical hysterectomy ($P = 0.001$). However, in the study of Li et al. [22] the mean number of nodes obtained was similar (21.3 laparoscopy *vs* 18.8 laparotomy), whereas Zakashansky

et al. [21] showed a significantly higher number in laparoscopic radical hysterectomy than in open abdominal surgery (31 *vs* 21.8, P = 0.01) (Table 40.2).

The decision to perform laparoscopic lymphadenectomy depends on the experience and protocols of each working group. There are, currently, controversial opinions regarding the posibility of comparing the results obtained for each of the different techniques, due to the absence of comparative prospective randomized studies on the effectiveness of each and influence on survival in each type of genital neoplasia.

However, there is not a consensus on the minimal number of nodes which should be removed at the time of a systematic pelvic lymphadenectomy or even if the lymphadenectomy has a therapeutic effect in cervical cancer. With this objective, Suprasert *et al.* [34]retrospectively included 826 patients who were divided into four groups according to the number of nodes removed (with at least 11 pelvic nodes removed). They concluded that the number of removed pelvic nodes was not associated with 5-year disease-free survival nor when stratified by nodal status. These results are opposite to those from the study of Shah et al. [35] who analyzed 5522 women included in the SEER. It concluded that among node-negative women, survival is improved when a greater number of lymph nodes are removed suggesting that the extent of lymphadenectomy in node negative patient influences survival. This could be explained because a greater number of removed nodes could give a better way to detect metastasis or to extract micrometastasis.

Sentinel Lymp Node (SLN)

The sentinel lymph node is defined as the first draining lymph node of an anatomical region, so that a histologically negative sentinel lymph node would predict the absence of tumor metastases in the other non-sentinel lymph nodes. In cervical carcinoma patients, lymph node status is a major prognostic factor and is a decision criterion for adjuvant therapy. In patients with early cervical cancer, pelvic or paraaortic lymph node metastases are detected in only 8 % of women with stage IA2 and in 26 % of women with stage IIA no bulky [36].Thus, many of these patients derive no benefit from pelvic lymphadenectomy. SLN dissections have been associated with decreased short-term and long-term morbidity when compared with complete lymph node dissection such as lymphedema [37]. We should remember that 34.5 % of patients with lymphadenectomy for a gynecological cancer will develop symptomatic linfocysts and 11.4 % a lower-limb lymphedema [38]. Eiriksson and Covens reviewed the reports published on 2333 patients with early cervical cancer and sentinel node dissection. The sensibility was 98.2 % and the predictive negative value was 99.6 %. They suggested that it may be possible that systematic lymphadenectomy can be substituted by detection and analysis of the sentinel node as many groups are making nowadays [39]. The study

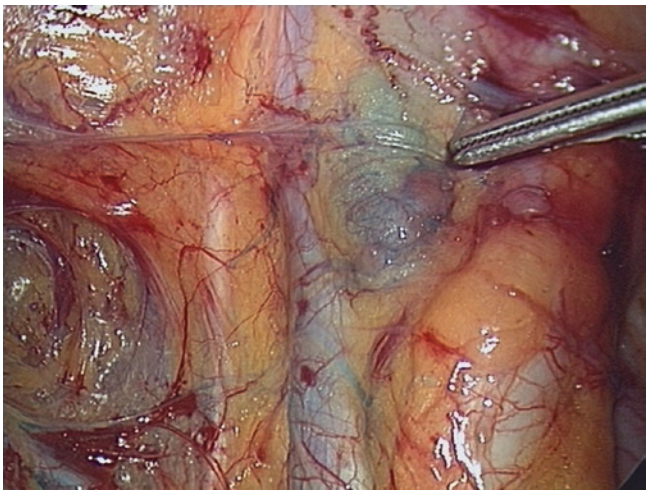


Fig. 40.11 Identification of a blue-positive sentinel lymph node

published by Gil-Moreno et al. in 2005 showed the feasibility of the combination of laparoscopic intraoperative sentinel node mapping and laparoscopic radical surgery in the context of minimally invasive surgery for the management of patients with early cervical cancer [18]. Intraoperative detection of sentinel lymph node status may have significant implications from a clinical management point of view. If the node is positive for tumor metastasis, a radical hysterectomy could be omitted, and adjuvant chemoradiation is commonly given (Fig. 40.11) [40].

Intraoperative Complications

Intraoperative complications reported on in the different studies are shown in Table 40.3. Conversion to open surgery has been mostly described in association with vascular injuries [10, 20, 22, 23, 33, 41], bladder injuries [9, 20, 27, 33], pelvic adhesions [9, 20], large uterus [9], or difficulties in maintaining the pneumoperitoneum for technical reasons [18, 25, 33].

Vascular injuries during laparoscopic procedures, including trocar injury at the start of the procedure [23] is one of the most common complications requiring immediate conversion to open surgery and/or blood transfusion, with the external and internal iliac veins [20, 22, 23, 41, 42] and vascular lesions of the abdominal wall being the most frequent. Blood transfusion at the time of surgery or in the immediate postoperative period is also a common complication. Although in the majority of studies higher blood losses are usually reported for conventional laparotomy [20, 21, 23, 25]. A case of secondary hemorrhage requiring relaparoscopy has been also reported [42]. A venotomy of the inferior vena cava during lymph node dissection in the laparotomy group was described by Zakashansky et al. [21].

Intraoperative injuries of the bladder (mostly repaired during the laparoscopic procedure) [23, 27, 29, 31, 33, 41, 42]

and less frequently of the ureters [9, 29, 30, 41, 42] (sometimes documented in the postoperative period) [42] are relatively frequent intraoperative complications. In a review of intraoperative urinary tract lesions in laparoscopic surgery (50 patients) and open surgery (48 patients), no statistically significant differences were observed [43].

Other less frequent intraoperative complications include intestinal damage [41, 42] ,a case of pneumomediastinum immediately following surgery [31], and hypercapnia [41].

In one large serie of laparoscopic radical hysterectomy and lymphadenectomy procedures for invasive cervical carcinoma that included 317 patients, Xu et al. [41] examined complications and analyzed factors associated with conversion to an open surgical procedure. The overall conversion rate was 1.3 % (n = 4). Major and minor intraoperative complications occurred in 4.4 % (n = 14) of the patients. Seven patients had vessel injuries, five of which were repaired or treated laparoscopically. One left external iliac vein required laparotomy, and one patient underwent laparotomy to control bleeding sites. Operative cystotomies occurred in five patients, which were repaired laparoscopically. Two patients underwent laparotomy because of hypercapnia and colon injury. The authors emphasized that these complications were developed in the first 50 laparoscopic procedures, and after those, no intestinal or vascular injuries occurred.

In the majority of studies in which the laparoscopic procedure and open surgery has been compared (see Table 40.3), differences in the rate of intraoperative complications were not found except in the study of Zakashansky et al. [21] regarding the number of patients requiring blood transfusion. Some studies even showed a trend towards a higher number of complications in the laparotomy group [21, 25]. In the laparotomy group in the study of Díaz-Feijoo et al. [25], ureteral injury occurred in one patient and disseminated intravascular coagulation in another. In the laparoscopy group, conversion to open surgery was necessary in one patient.

Postoperative Complications

Postoperative complications are also summarized in Table 40.3. Most relate to infections [12, 20, 21, 23, 28, 29, 33, 42] and bladder dysfunction, as classically reported after radical hysterectomy [12, 18, 21–23, 25, 28, 29, 32, 33, 41, 42]. Voiding difficulties, sometimes requiring intermittent catheterization, may occur between 2 weeks and 6 months postoperatively.

Infectious morbidity is mainly related to urinary tract infection, pelvic abscesses, and abscesses of the vaginal cuff, as well as some cases of fever of unknown origin. Cases of urologic-related sepsis have also been described. Frumovitz et al. [23] showed a higher percentage of postoperative infections in patients undergoing open surgery (53 %) than in those treated laparoscopically (18 %).

Ureterovaginal fistulas and to a lesser extent vesicovaginal fistulas, are also reported on in many studies [12, 22, 29–31, 41, 42, 44]. Surgical repair was necessary in most cases, although some patients have been treated conservatively [44]. In the study of Uccella et al. [43], the rate of postoperative urological complication was similar in laparoscopic and open surgery.

Other uncommon complications include deep venous thrombosis [21, 33, 41], which was reported as the cause of fatal and nonfatal pulmonary thromboembolism [21, 23, 31]. Early mobilization of the patients is highly recommended for the prophylaxis of deep venous thrombosis and pulmonary embolism. However, embolism of the right external iliac artery is a rare postoperative complication of laparoscopic radical hysterectomy [41].

In the study of Díaz-Feijoo et al. [25], 3 months after radical hysterectomy, vagina cuff separation with bowel prolapse after the first sexual intercourse (successfully repaired vaginally)was reported on in three patients in the laparoscopy group. Similar cases have been also described by other authors [29, 31, 44].

Lymphocele is a relatively common complication [22, 31, 33, 41], although most cases are asymptomatic and no treatment is required. Symptomatic lymphocele may be treated by percutaneous puncture, guided by ultrasound or compute tomography. Other complications described in the studies are lymphedema of the lower extremities [12, 41], transient sensory disturbances [29, 41], and colitis caused by *Clostridium difficile* reported both in laparoscopy surgery [21] and in open surgery [20].

Length of Hospital Stay and Costs

Laparoscopic surgery is usually associated with a short hospital stay, ranging between 1 day [31] and 13.8 days [22], although in most studies the mean length of stay varies between 2 and 5 days [8, 13, 18–21, 23–26, 31–33, 44]. (Table 40.2). Studies in which laparoscopy and laparotomy approaches were compared, length of hospitalization was usually shorter for the laparoscopic procedure [11, 19–21, 23, 25, 27] partly, due to early postoperative intestinal motility. In the study of Li et al. [22] there were differences in the bowel recovery time between the open surgery group (2.4 days) and the laparoscopy group (1.96 days) (P = 0.025). Advantages of the laparoscopic procedure include early mobilization and lower pain intensity. On the other hand, Li et al. reported similar lengths of hospital stay for the laparoscopic and open abdominal surgery groups (13.8 *vs* 13.7 days) and argued that patients wanted to be discharged after complete recovery. Moreover, differences in health care delivery systems and culture may account for a large variation in the average hospital stay. Also insurance companies may not be concerned about the duration of hospital stay in cancer patients.

In 1994, Sedlacek et al. [11] estimated the cost of laparoscopic radical hysterectomy as $12,594 in comparison with $12,905 of the open procedure. Reduced costs of laparoscopy were especially associated with a shorter hospital stay.

Outcome and Recurrence

A few cases of port-site metastasis have been reported [42, 44]. Preventive measures include irrigation of port sites with cytotoxic agents, careful tumor manipulation, and use of extraction bags for any suspicious tissue.

Definitive data regarding differences in overall survival, disease-free survival, and recurrence between the laparoscopic approach and conventional open surgery are lacking. Comparative studies of both procedures include small series of patients with relatively short duration of follow-up (Table 40.3). In the study of Li et al. [22], after a mean follow-up of 26 months, the overall mortality in the laparoscopy group was 10 % *vs* 8 % in the laparotomy group, and there was a recurrence rate of 13.7 % and 12 %, respectively. In the study of Frumovitz et al. [23], one recurrence in the laparoscopy group (n = 35) after a mean follow-up of 7.2 months and two recurrences in the laparotomy group (n = 44) after a mean follow-up of 15.2 months was reported. In the series of Díaz-Feijoo et al. [25], the disease-free survival was 100 % in the laparoscopy group after a follow-up of 23.3 months and 86.7 % in the laparotomy group after a mean follow-up of 34.6 months, with an overall survival of 90 %. In the study of Ditto et al. [27] in 2015, the recurrence rate was 3 % in the laparoscopic arm (31 months of follow up) and 8 % in the laparotomy arm (48.7 months of follow up).

Further studies, particularly prospective randomizes studies, with larger study samples and longer follow-up periods are needed to assess the outcome of patients with early-stage cervical cancer undergoing radical hysterectomy with pelvic lymphadenectomy through the laparoscopic approach or conventional open surgery.

Conclusions

In comparison with the conventional abdominal laparotomy, the laparoscopy approach is associated with a lower surgical morbidity in terms of intraoperative blood loss, shorter hospital stay and early resumption of daily activities with an increase in quality of life [25]. Recent advances in laparoscopic instruments simplify training and improve outcomes. Probably magnification yields a better surgical field and shorten operative times by enabling better hemostasis with less tissue damage and easier manipulation. With advances in surgical robotics [45–50], continuation of these trends can be anticipated.

Evidence presented here shows that laparoscopic radical hysterectomy with endoscopic pelvic lymphadenectomy is a safe surgical option in the treatment and staging of early invasive cervical cancer regarding the surgical technique, surgical risk, intraoperative bleeding, perioperative and postoperative complications, and patient's recovery. A decrease in operative time as more procedures are performed and surgeons become more familiar with the procedure may be expected. The laparoscopic technique is more expensive than laparotomy due primarily to laparoscopic instrumentation but the disadvantage of cost is counterbalanced by shorter hospital stay, prompt postoperative recovery, and early resumption of daily activities [11, 30].

In our opinion, minimally invasive surgery (conventional laparoscopy or robotically assisted) should be the standard approach for the surgical treatment of patients with early cervical cancer.

References

1. Querleu D, Leblanc E, Castelain B. Laparoscopic pelvic lymphadenectomy in the staging of early carcinoma of the cervix. Am J Obstet Gynecol. 1991;164:579–81.
2. Leblanc E, Querleu D, Castelain B, et al. Bilan de la cœliochirurgie en oncologie gynécologique en 2000. Bull Cancer. 2000;87:76–85.
3. Reich H, DeCaprio J, McGlynn F. Laparoscopic hysterectomy. J Gynecol Surg. 1989;5:213–6.
4. Dargent D, Mathevet P. Hystérectomie élargie laparoscopico-vaginale. J Gynecol Obstet Biol Reprod (Paris). 1992;21:709–10.
5. Querleu D. Hystérectomies élargies de Schauta-Amreich et Schauta-Stoeckel assistées par cœlioscopie. J Gynecol Obstet Biol Reprod. 1992;20:747–8.
6. Querleu D. Laparoscopically assisted radical vaginal hysterectomy. Gynecol Oncol. 1993;51:248–54.
7. Canis M, Mage G, Wattiez A, JL P, Manhes H, MA B. La chirurgie endoscopique a-t-elle une place dans la chirurgie radicale du cancer du col utérin? J Gynecol Obstet Biol Reprod (Paris). 1990;19:921.
8. Nezhat CR, Burrell MO, Nezhat FR, Benigno BB, Welander CE. Laparoscopic radical hysterectomy with paraaortic and pelvic node dissection. Am J Obstet Gynecol. 1992;166:864–5.
9. Canis M, Mage G, Pouly JL, et al. Laparoscopic radical hysterectomy for cervical cancer. Baillieres Clin Obstet Gynaecol. 1995;9:675–89.
10. Hsieh YY, Lin WC, Chang CC, Yeh LS, Hsu TY, Tsai HD. Laparoscopic radical hysterectomy with low paraaortic, subaortic and pelvic lymphadenectomy. Results of short-term follow-up. J Reprod Med. 1998;43:528–34.
11. Sedlacek TV, Campion MJ, Hutchins RA, Reich H. Laparoscopic radical hysterectomy: a preliminary report [abstract]. J Am Assoc Gynecol Laparosc. 1994;1(Part 2):s32.
12. Kim DH, Moon JS. Laparoscopic radical hysterectomy with pelvic lymphadenectomy for early, invasive cervical carcinoma. J Am Assoc Gynecol Laparosc. 1998;5:411–7.
13. Spirtos NM, Schlaerth JB, Kimball RE, Leiphart VM, Ballon SC. Laparoscopic radical hysterectomy (type III) with aortic and pelvic lymphadenectomy. Am J Obstet Gynecol. 1996;174:1763–7.
14. Mutch DG. The new FIGO staging system for cancers of vulva, cervix, endometrium and sarcomas. Gynecol Oncol. 2009;115:325–8.
15. Piver MS, Rutledge F, Smith JP. Five classes of extended hysterectomy for women with cervical cancer. Obstet Gynecol. 1974;44:265–72.
16. Querleu D, Morrow CP. Classification of radical hysterectomy. Lancet Oncol. 2008;9:297–303.

17. Cibula D, Abu-Rustum NR, Benedetti-Panici P, Köhler C, Raspagliesi F, Querleu D, Morrow CP. New classification system of radical hysterectomy: emphasis on a three-dimensional anatomic template for parametrial resection. Gynecol Oncol. 2011;122:264–8.
18. Gil-Moreno A, Puig O, Pérez-Benevente MA, et al. Total laparoscopic radical hysterectomy (type II-III) with pelvic lymphadenectomy in early invasive cervical cancer. J Minim Invasive Gynecol. 2005;12:113–20.
19. Lin YS. Preliminary results of laparoscopic modified radical hysterectomy in early invasive cervical cancer. J Am Assoc Gynecol Laparosc. 2003;10:80–4.
20. Abu-Rustum NR, Gemignani ML, Moore K, et al. Total laparoscopic radical hysterectomy with pelvic lymphadenectomy using the argon-beam coagulator: pilot data and comparison to laparotomy. Gynecol Oncol. 2003;91:402–9.
21. Zakashansky K, Chuang L, Gretz H, Nagarsheth NP, Rahaman J, Nezhat FR. A case-controlled study of total laparoscopic radical hysterectomy with pelvic lymphadenectomy versus radical abdominal hysterectomy in a fellowship training program. Int J Gynecol Cancer. 2007;17:1075–82.
22. Li G, Yan X, Shang H, Wang G, Chen L, Han Y. A comparison of laparoscopic radical hysterectomy and pelvis lymphadenectomy and laparotomy in the treatment of Ib-IIa cervical cancer. Gynecol Oncol. 2007;105:176–80.
23. Frumovitz M, dos Reis R, Sun CC, et al. Comparison of total laparoscopic and abdominal radical hysterectomy for patients with early-stage cervical cancer. Obstet Gynecol. 2007;110:96–102.
24. Frumovitz M, Ramirez PT. Total laparoscopic radical hysterectomy: surgical technique and instrumentation. Gynecol Oncol. 2007;104(Suppl):13–6.
25. Díaz-Feijoó B, Gil-Moreno A, Pérez-Benavente A, Morchón S, Martínez-Palones JM, Xercavins J. Sentinel lymph node identification and radical hysterectomy with lymphadenectomy in early stage cervical cancer: laparoscopy versus laparotomy. J Minim Invasive Gynecol. 2008;15:531–7.
26. Malzoni M, Tinelli R, Cosentino F, Fusco A, Malzoni C. Total laparoscopic radical hysterectomy versus abdominal radical hysterectomy with lymphadenectomy in patients with early cervical cancer: our experience. Ann Surg Oncol. 2009;16:1316–23.
27. Ditto A, Martinelli F, Bogani G, Gasparri ML, Di Donato V, Zanaboni F, Lorusso D, Raspagliesi F. Implementation of laparoscopic approach for type B radical hysterectomy: a comparison with open surgical operations. Eur J Surg Oncol. 2015;41:34–9.
28. Gil-Moreno A, Díaz-Feijoo B, Roca I, et al. Total laparoscopic radical hysterectomy with intraoperative sentinel node identification in patients with early invasive cervical cancer. Gynecol Oncol. 2005;96:187–93.
29. Pomel C, Atallah D, Le Bouedec G, et al. Laparoscopic radical hysterectomy for invasive cervical cancer: 8-year experience of a pilot study. Gynecol Oncol. 2003;91:534–9.
30. Sedlacek TV, Campion MJ, Reich H, Sedlacek T. Laparoscopic radical hysterectomy: a feasibility study. Gynecol Oncol. 1995;56:126 (abstract 65).
31. Ramirez PT, Slomovitz BM, Soliman PT, Coleman RL, Levenback C. Total laparoscopic radical hysterectomy and lymphadenectomy: The MD Anderson Cancer Center experience. Gynecol Oncol. 2006;102:252–5.
32. Jobling T, Wood C. Laparoscopic modified radical hysterectomy and lymphadenectomy simulating open operation for stage 1A2 cervical carcinoma. Aust N Z J Obstet Gynaecol. 1993;33:400–3.
33. Spirtos NM, Eisenkop SM, Schlaerth JB, Ballon SC. Laparoscopic radical hysterectomy (type III) with aortic and pelvic lymphadenectomy in patients with stage I cervical cancer: Surgical morbidity and intermediate follow-up. Am J Obstet Gynecol. 2002;187:340–8.
34. Suprasert P, Charoenkwan K, Khunamornpong S. Pelvic node removal and disease-free survival in cervical cancer patients treated with radical hysterectomy and pelvic lymphadenectomy. Int J Gynecol Obstet. 2012;116:43–6.
35. Shah M, Lewin SN, Deutsch I, et al. Therapeutic role of lymphadenectomy for cervical cancer. Cancer. 2011;117:310–7.
36. Benedet JL, Odicino F, Maisonneuve P, Beller U, Creasman WT, Heintz AP, Ngan HY, Sideri M, Pecorelli S. Carcinoma of the cervix uteri. J Epidemiol Biostat. 2001;6:7–43.
37. Robison K, Holman LL, Moore RG. Update on sentinel lymph node evaluation in gynecologic malignancies. Curr Opin Obstet Gynecol. 2011;23(1):8–12.
38. Achouri A, Huchon C, Bats AS, Bensaid C, Nos C, Lécuru F. Complications of lymphadenectomy for gynecologic cancer. Eur J Surg Oncol (EJSO). 2013;39(1):81–6.
39. Eiriksson L, Covens A. Sentinel lymph node mapping in cervical cancer: the future? BJOG Int J Obstet Gynaecol. 2012;119(2): 129–33.
40. Lambaudie E, Collinet P, Narducci F, Sonoda Y, Papageorgiou T, Carpentier P, Leblanc E, Querleu D. Laparoscopic identification of sentinel lymph nodes in early stage cervical cancer: prospective study using a combination of patent blue dye injection and technetium radiocolloid injection. Gynecol Oncol. 2003;89:84–7.
41. Xu H, Chen Y, Li Y, Zhang Q, Wang D, Liang Z. Complications of laparoscopic radical hysterectomy and lymphadenectomy for invasive cervical cancer: experience base on 317 procedures. Surg Endosc. 2007;21:960–4.
42. Puntambekar SP, Palep RJ, Puntambekar SS, et al. Laparoscopic total radical hysterectomy by the Pune technique: our experience of 248 cases. J Minim Invasive Gynecol. 2007;14:682–9.
43. Uccella S, Laterza R, Ciravolo G, et al. A comparison of urinary complications following total laparoscopic radical hysterectomy and laparoscopic pelvic lymphadenectomy to open abdominal surgery. Gynecol Oncol. 2007;107:S147–9.
44. Pellegrino A, Vizza E, Fruscio R, et al. Total laparoscopic radical hysterectomy and pelvic lymphadenectomy in patients with Ib1 stage cervical cancer: analysis of surgical and oncological outcome. EJSO. 2009;35:98–103.
45. Wexner SD, Bergamaschi R, Lacy A, et al. The current status of robotic pelvic surgery: results of a multinational interdisciplinary consensus conference. Surg Endosc. 2009;23:438–43.
46. Sert BM, Abeler VM. Robotic-assisted laparoscopic radical hysterectomy (Piver type III) with pelvic node dissection—case report. Eur J Gynaecol Oncol. 2006;27:531–3.
47. Magrina JF, Zanagnolo VL. Robotic surgery for cervical cancer. Yonsei Med J. 2008;49:879–85.
48. Ramirez PT, Soliman PT, Schmeler KM, dos Reis R, Frumovitz M. Laparoscopic and robotic techniques for radical hysterectomy in patients with early-stage cervical cancer. Gynecol Oncol. 2008;110:S21–4.
49. Nezhat FR, Datta MS, Liu C, Chuang L, Zakashansky K. Robotic radical hysterectomy versus total laparoscopic radical hysterectomy with pelvic lymphadenectomy for treatment of early cervical cancer. JSLS. 2008;12:227–37.
50. Gil-Ibáñez B, Díaz-Feijoo B, Pérez-Benavente A, Puig-Puig O, Franco-Camps S, Centeno C, Xercavins J, Gil-Moreno A. Nerve sparing technique in robotic-assisted radical hysterectomy: results. Int J Med Robot. 2013;9(3):339–44.

Total Laparoscopic Nerve-Sparing Radical Hysterectomy

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Introduction

Total laparoscopic radical hysterectomy for cervical carcinoma is currently an accepted surgical procedure not only because of its technical feasibility, but also because of its favorable oncologic outcome [1–6]. However, bladder dysfunction after a laparoscopic radical hysterectomy is likely to decrease the patient's quality of life because of the physical and mental stress that accompany post-operative disorders. The main cause is damage to the pelvic nerve plexus (inferior hypogastric plexus) and its vesical branches during this procedure. These nerve circuits are important for neurogenic bladder control [7–9].

Total laparoscopic nerve-sparing radical hysterectomy has been developed recently for early stage cervical carcinoma using a previously established technical procedure.. The principal features of this technique can be summarized by describing the procedure as one in which the hypogastric nerves, instead of the pelvic nerve plexus and its vesical branches, are preserved at several steps during a classical radical hysterectomy [10, 11]. Consequently, the hypogastric nerves are regarded as the main anatomical landmark of the nerve-sparing radical hysterectomy because they act as the upper limit of the pelvic nerve plexus and the vesical branches.

In this chapter, step-by-step surgical instructions for total laparoscopic nerve-sparing radical hysterectomy are described (with a special focus on the nerve-sparing techniques) and our original research regarding the correlations between the preserved pelvic nerve networks and bladder functions after total laparoscopic nerve sparing radical hysterectomy are introduced.

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Surgical Procedures

Creation of the Vaginal Cuff

Prior to laparoscopic (LAP) surgery, a vaginal cuff is created (Fig. 41.1). In LAP surgery, an excision of suitable length of the vagina (2 cm from the tumor) is quite difficult due to the loss of tactile sensation; therefore, the creation of a vaginal cuff is essential for an accurate excision of the vagina. Moreover, the creation of a vaginal cuff is also quite useful to prevent the spillage of cancer cells during LAP surgery.

The patient is placed in the lithotomy position. First, 12–15 sutures are placed circumferentially approximately 2 cm from the tumor, and the sutures are pulled to reveal the incision line. Adrenaline at a dilution of 1:1,000,000 is injected into the incision line to reduce bleeding. The vaginal mucosa is then incised circumferentially using electrocautery and the vaginal cuff is doubly closed in a continuous fashion. When the margin of the tumor is difficult to determine, visual inspection with the Schiller test is essential.

Positioning of the Patient and Configuration of the Trocars

The patient is placed in the mild lithotomy position. The legs of the patient are extended slightly and the patent is tilted about 10 ° (Fig. 41.2a). A 12-mm trocar is placed in the umbilicus for a camera port and three 5-mm trocars for forceps are placed as in Fig. 41.2b. A 5-mm extra-long trocar (150 mm length) is placed at the posterior vaginal fornix, and a forceps placed through this port is used as a uterine manipulator. A 1-0 vicryl suture is placed around the uterine body and the uterus is manipulated by a pulling-and-pushing technique of the 1-0 vicryl suture with forceps through the vaginal trocar. In our procedure, a vaginal cuff is created prior to the LAP surgery, thus overcoming the problem of using a uterine manipulator (Fig. 41.2c).

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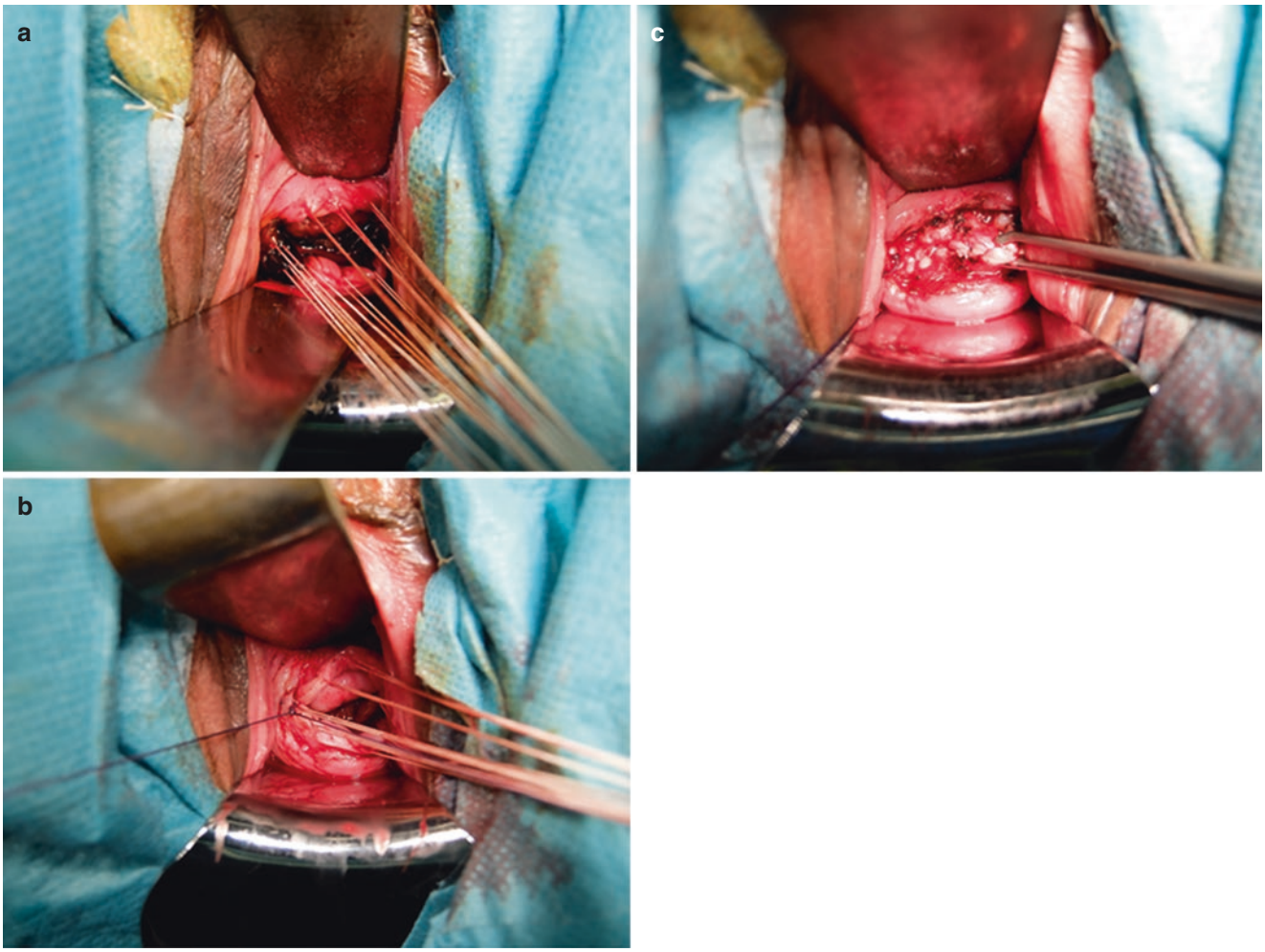


Fig. 41.1 Creation of the vaginal cuff. (**a**) 12–15 sutures are placed circumferentially approximately 2 cm from the tumor. (In this case, Schiller test is performed). (**b**) Incision of vaginal mucosa is made around the sutures and the vaginal cuff closure is started. (**c**) Vaginal cuff closure is completed

Pelvic Lymphadenectomy

Pelvic lymphadenectomy is started by opening the pelvic sidewall triangle, which is the area between the round ligament, the infundibulopelvic ligament, and the external iliac vessels. At first, a wide opening of the pararectal space and paravesical space is developed allowing the exposure of the cardinal ligament between these spaces. These spaces are avascular spaces; therefore, a blunt dissection is sufficient for development. In order to maintain a good surgical view around the paravesical space (and obturator fossa), we suspend an umbilical ligament to the abdominal wall (Fig. 41.3 1).

Next, the space between the psoas muscle and the external iliac vessels is developed widely in order to expose the obturator nerve and vessels (Fig. 41.3 2). The lymphofatty tissue is easily dissected from the obturator nerve and vessels using a blunt dissection technique and the upper end of the lymphofatty tissue (around the common iliac lesion) is clipped and transected (Fig. 41.3 3). The clipping of the cut end of lymph node is particularly important to prevent lymphocele after the surgery. Following the transection of the upper end, the lymphofatty tissue is easily stripped off the external and internal iliac vessels en block (Fig. 41.3 4–6).

For a total laparoscopic nerve-sparing radical hysterectomy, the complete exposure of the pelvic nerve networks (hypogastric nerves, pelvic splanchnic nerves, pelvic nerve plexus, and their vesical branches) is essential; and in order to achieve complete exposure it is very important to perform lymphadenectomy adjacent to the internal iliac region.

After developing a wide pararectal space, the hypogastric nerves can be observed easily along the lateral sides of the mesorectum. The lymph node tissue around the internal iliac region is removed completely; then, the S2–3 roots are identifiable beneath the fascia of the piriformis muscle. Additionally the pelvic splanchnic nerves, which join the pelvic nerve plexus, are visible as visceral branches originating

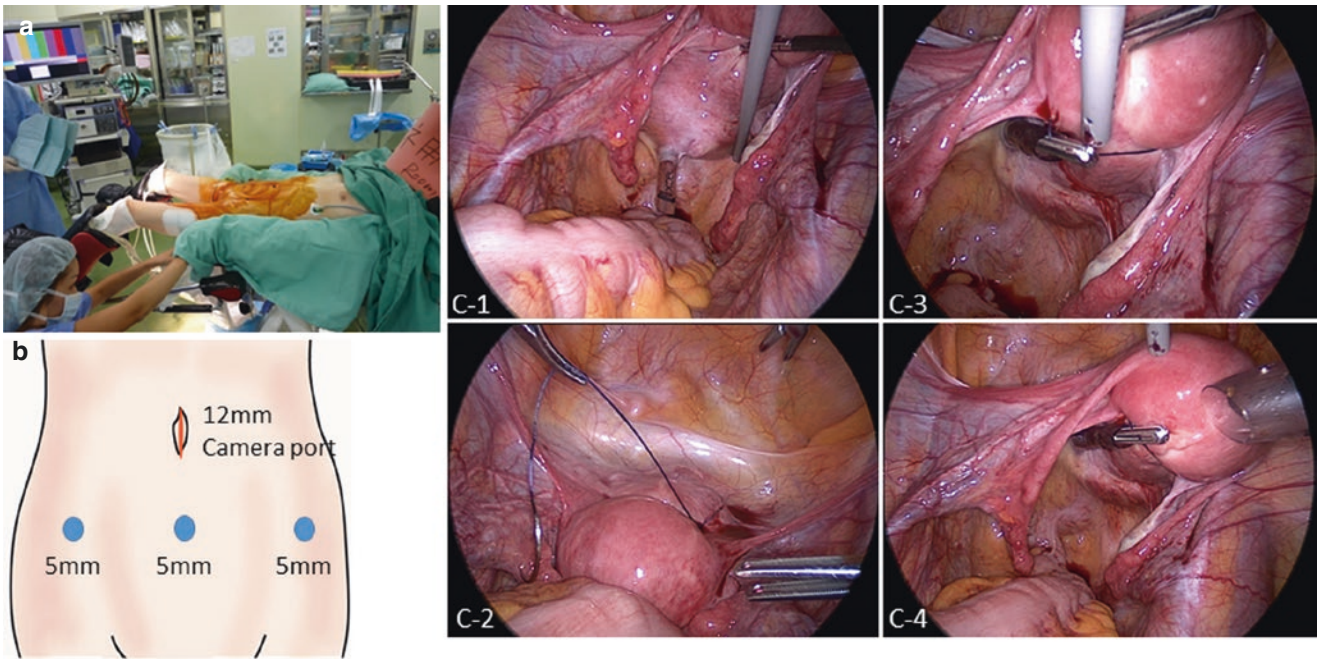


Fig. 41.2 Positioning of the patient and configuration of the trocars. (**a**) patient position, (**b**) trocar position, (**c**) A vaginal additional port. (*C-1*) An extra long trocar is placed at the posterior vaginal fornix. (*C-2*) 1-0 vicryl is placed around the uterine body. (*C-3,4*) This vicryl is grasped by the forceps through this port, and the uterus can be mobilized by this forceps like an uterine manipulator

from the S2–3 roots after the lymph node tissue around the cardinal ligament is meticulously removed (Fig. 41.4). After all lymph nodes are harvested, the nodes are removed with a plastic bag to prevent the scattering of the specimen.

The Transection of Upper Ligaments

The infundibulopelvic ligament or the adnexal ligament (if the patient wants to preserve her ovaries) is desiccated and transected. The round ligament is also desiccated and divided.

The Dissection of the Bladder

The bladder peritoneum is incised using a monopolar knife and the bladder is dissected from the cervix. When the bladder is lifted ventrally enough, an avascular area between the bladder and the cervix can be visualized, and then the dissection of the bladder can easily be performed.

The Transection of the Uterine Artery and the Unroofing of the Ureter

The uterine artery has already been isolated at the pelvic lymphadenectomy step described above; therefore, the transection of the uterine artery is easily performed using a hemoclip. Lifting the end of the uterine artery medially, a branch to the bladder (middle vesical artery) is isolated. After transecting this branch, the uterine artery can be isolated from the ureter completely, and the ureter tunnel can be developed median of the ureter. The bladder pillar is dissected meticulously thus allowing a small vessel to be isolated (cervico-vesical vessels). After transecting these cervico-vesical vessels, the unroofing of the ureter is accomplished.

Steps 4–6 are identical to those of total laparoscopic radical hysterectomy (non nerve-sparing techniques); therefore please refer to the relevant chapter for further details.

The Transection of the Cardinal Ligament

At the pelvic lymphadenectomy step described above, the lymph node of the cardinal ligament is removed; therefore, the vessels and nerves around the cardinal ligament are already isolated at this point. In nerve-sparing procedure described here, only the deep uterine vein is clipped and transected at the pelvic sidewall, and the stump of the deep uterine vein is scraped up to the level of the hypogastric nerves (i.e., the upper end of pelvic nerve networks).

The Transection of the Posterior Layer of the Vesico-Uterine Ligament

This step is essential for the preservation of the vesical branches of the pelvic nerve networks. At the posterior layer of the vesico-uterine ligament, the vesical vessels, nerves, and

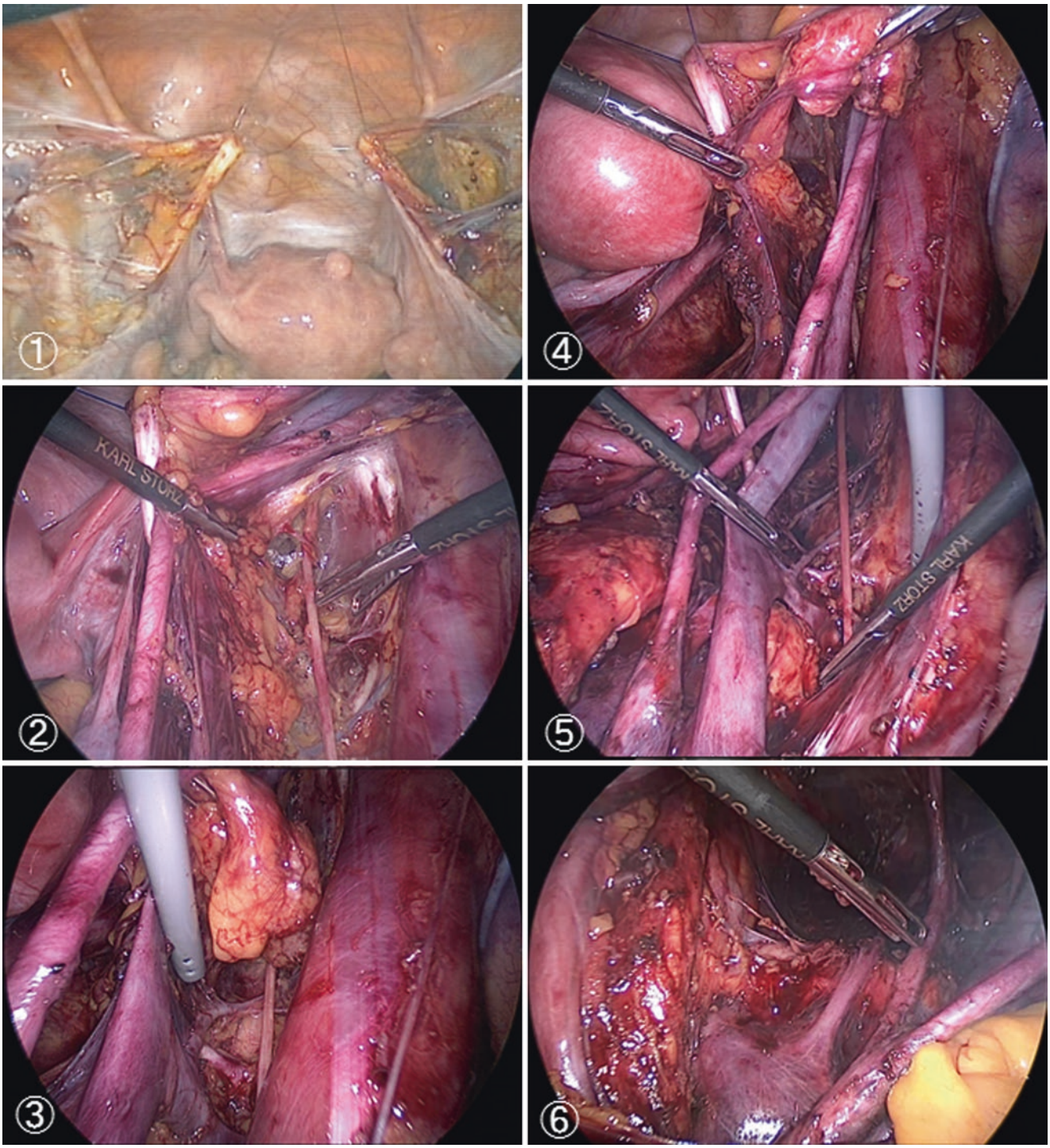


Fig. 41.3 Pelvic lymphadenectomy. (*1*) The umbilical ligament is suspended to the abdominal wall to maintain the good surgical view. (*2*) The space between the psoas muscle and the external iliac vessels is developed widely until the obturator nerve and vessels are exposed. (*3*) The upper end of the lymphofatty tissue(around the common iliac lesion) is clipped and transected. (*4*) Pelvic lymphnode is removed en block. (*5*, *6*) Final view of pelvic lymphadenectomy

adipose tissue are packed by a membrane, therefore a meticulous dissection or "demembranation" is required to expose the two or three vesical veins, which flow into the deep uterine vein; these veins are clipped and transected. The remnant after the transection of these vesical vessels at the posterior layer of the vesico-uterine ligament contains the vesical branches of the pelvic nerve networks. For complete preservation of the function of vesical branches, it is essential to

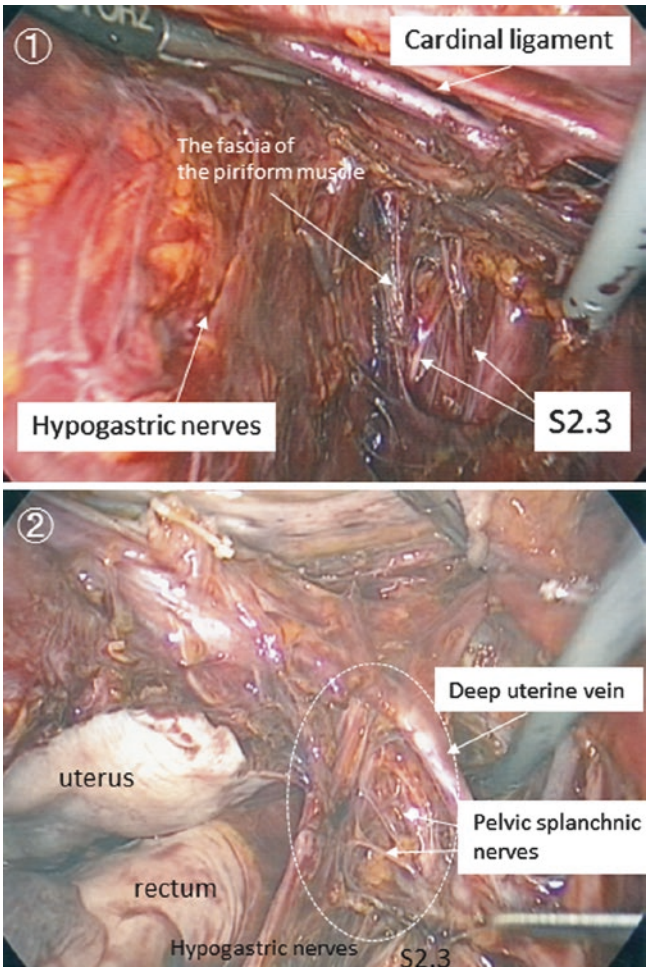


Fig. 41.4 Complete exposure of pelvic nerve networks. (*1*) The lymph node tissue around the internal iliac region is removed completely, then the S2–3 roots are identifiable beneath the fascia of the piriform muscle. (*2*) The complete structure of pelvic nerve plexus is marked by a dotted circle. They are consisted by hypogastric nerves and pelvic splanchnic nerves

prevent thermal injury; therefore, the vesical veins are transected using clips and scissors (Fig. 41.5 1–4).

Transection of the Paracolpium and Sacrouterine Ligament

The Douglas peritoneum is incised and the rectum is dissected until the posterior vaginal wall is exposed. Sometimes, the vaginal wall is opened at this stage because the vaginal cuff has already been created. After dissecting the rectum, the sacrouterine ligament can be exposed. To preserve the pelvic nerve networks, the uterosacral ligament and paracolpium tissue are transected just above the hypogastric nerves.

At this stage, the paracolpium tissue is sutured and ligated to reduce the usage of the energy device and to prevent thermal injury (Fig. 41.5a).

Transection of the Vagina

A vaginal pipe is inserted to extend the vaginal wall. The vaginal cuff has already been created at the first step of this surgery, thus after the transection of rectovaginal ligament, the vaginal wall can easily be transected.

Closure of the Vagina

The specimen is retrieved vaginally. To prevent the scattering of cancer cells, a plastic bag is used for the retrieval of the specimen (Fig. 41.6). The vaginal stump is closed using a 1-0 vicryl interrupted suture. The central part of the peritoneum is closed using a 2-0 vicryl suture, and the lateral part is opened to reduce the occurrence of lymphocyst following the surgery. The drainage tube is placed at the Douglas space.

Figure 41.7 shows the final view of the total laparoscopic nerve-sparing radical hysterectomy for stage Ib2 cervical cancer.

Discussion

Bladder function following conventional total laparoscopic nerve-sparing radical hysterectomy is quite good. However, the degree of radicality of this procedure is insufficient in some cases. Therefore, the applicability of this procedure is expected to be limited to early stage cervical carcinoma [12]. For intermediate-stage or advanced-stage cervical carcinoma, a more radical procedure is necessary. In such cases, nerve-sparing techniques have never been applied. However, in some intermediate-risk cervical carcinoma cases, non-nerve-sparing radical hysterectomy tends to result in overtreatment. We suggest that a different nerve-sparing technique be applied for these cases.

The pelvic nerve plexus appears as a mesh and consists mainly of hypogastric nerves and pelvic splanchnic nerves. The hypogastric nerves are located at the ventral edge and pelvic splanchnic nerves are located at the dorsal edge of the pelvic nerve plexus [13]. Therefore, the pelvic nerve plexus has a somewhat definable anatomical width. In this case, it is possible to apply a different nerve sparing technique, which would likely consist of a more radical procedure than conventional nerve-sparing radical hysterectomy.

To accomplish the innovative nerve sparing technique described here, the complete exposure of the pelvic nerve plexus is necessary. As explained above, the complete exposure of pelvic nerve networks is possible and enables to control the degree of radicality to the point where the uterosacral ligament and paracolpium tissue can be transected. Furthermore, laparoscopic radical hysterectomies can be

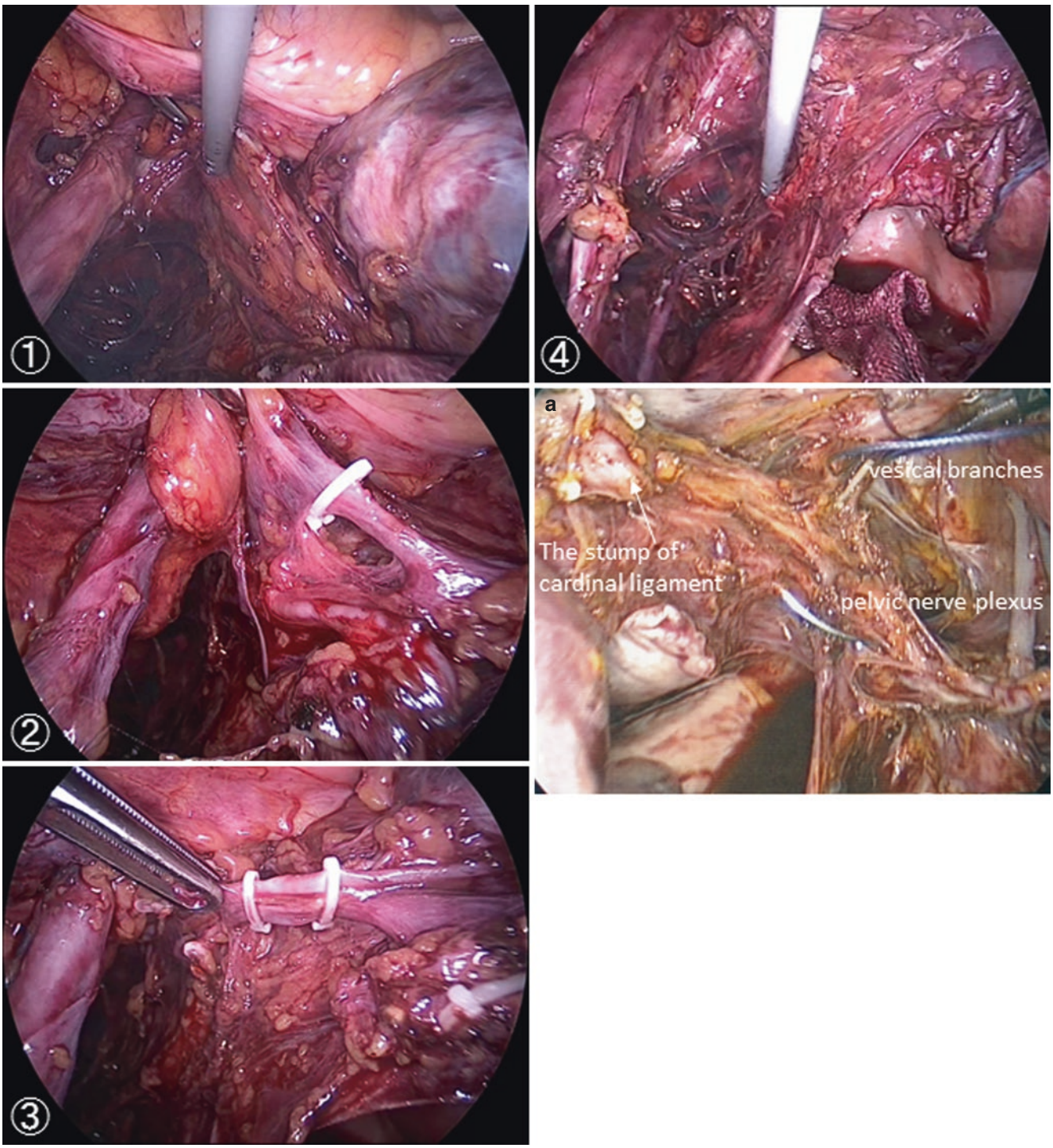


Fig. 41.5 Transection of posterior layer of vesico-uterine ligament and paracolpium tissue. ① The posterior layer of vesico-uterine ligament of left side. Veins, nerves and adipose tissue are packed by a membrane.②③ "Demembranation" expose two or three vesical veins. They are isolated and transected one by one.④ After transection of the posterior layer of vesico-uterine ligament, pelvic nerve networks are exposed. (**a**) To preserved the pelvic nerve networks, the uterosacral ligament and paracolpium tissue are transected just above the hypogastric nerves. At this stage, we suture and ligate the paracolpium tissue to reduce the usage of energy device and to prevent thermal injury

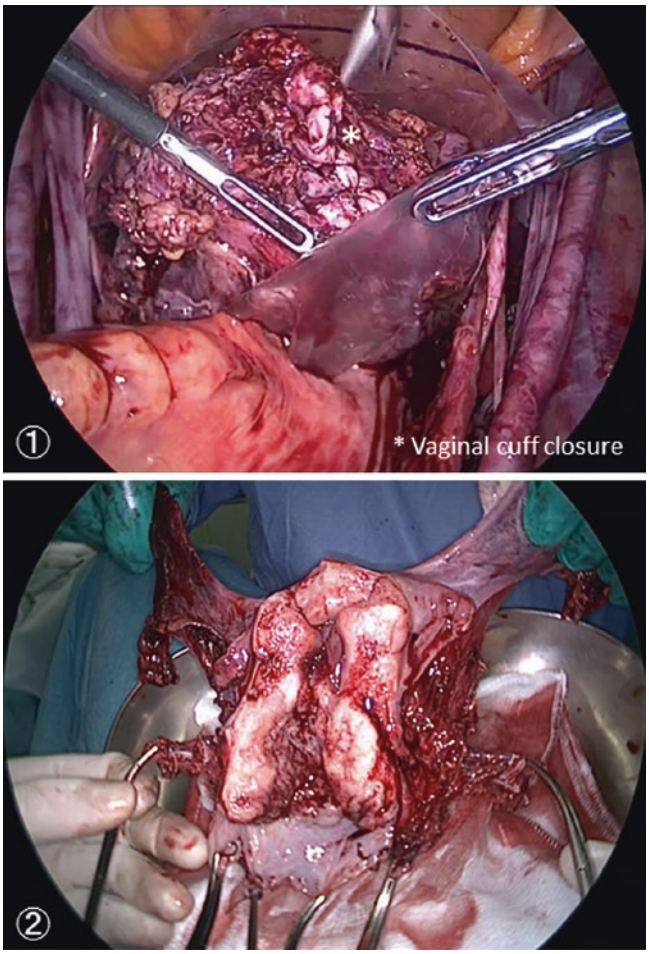


Fig. 41.6 The specimen of total laparoscopic nerve-sparing radical hysterectomy. ① To prevent the scattering of the cancer cells, a plastic bag is used for the retrieval of the specimen. ② This case is stage Ib2 cervical cancer, tumor size is 5 cm, and histological type is SCC. After the retrieval of the specimen, a vaginal cuff is opened to check the surgical margin

categorized into three types depending on the status of the preserved nerve network. The uterosacral ligament and the paracolpium tissue are transected above the hypogastric nerves for the conventional nerve-sparing procedure (group A), between the hypogastric nerves and pelvic splanchnic nerves for the radical nerve-sparing procedure (group B), or below the pelvic splanchnic nerves in the case of nerve-sacrificed radical hysterectomy (group C). We performed 27 cases belonging to group A, 13 cases to group B and 13 cases to group C (Fig. 41.8). Bladder function after these procedures was evaluated using urodynamic studies. Finally, we identified a correlation between the preserved pelvic nerve networks and bladder function after laparoscopic nerve-sparing radical hysterectomy.

Several studies have conducted urodynamic analyses after radical hysterectomy, but no consensus on these procedures has been reached, perhaps because around 80 % of patients with cervical carcinoma already had some degree of bladder dysfunction before the procedure was performed. It is therefore extremely difficult to evaluate the effects of nerve sparing techniques accurately [14]. In this study, we defined our original index (Function Ratio) to control for the scattering of data from urodynamic studies before surgical procedures. Urodynamic studies have many parameters, and among these parameters, the detrusor contraction pressure at maximum flow (PdetQmax) has been chosen to evaluate the motor function of the bladder, and the first desire to void (FDV) to evaluate sensory function, these are defined as:

Function Ratio (FDV) = FDV pre-operative / FDV post-operative.

Function Ratio (PdetQmax) = PdetQmax post-operative / PdetQmax pre-operative.

In fact, the PdetQmax is expected to be proportional to bladder function, and the FDV is expected to be inversely proportional to bladder function. Therefore, the function ratio formulas (FDV, PdetQmax) differ.

Ralph et al. reported that bladder function after radical hysterectomy could improve within 12 months after surgery [15]. Therefore, we analyzed data at 12 months after the operation to ascertain the correlation between the preserved pelvic nerve networks and bladder function after laparoscopic nerve-sparing radical hysterectomy (Fig. 41.9).

Based on the results of this study, it is possible to suggest that the distributions of sensory nerves and motor nerves differ. The sensory nerve is distributed predominantly at the lower (dorsal) half of the pelvic nerve networks. Thus, the sensory functions of group A and B are statistically equivalent, and the sensory function of group C is significantly lower than that of group A or B.

In contrast, the motor nerve is distributed predominantly at the upper (ventral) half of the pelvic nerve networks. Hence, the motor function of group A was significantly more preserved compared to that of either group B or C. The motor functions of groups B and C were damaged to same extent, and thus showed no mutually significant difference. Through this study, we conclude that various types of total laparoscopic nerve-sparing radical hysterectomy are technically feasible, and the sensory and motor functions of the bladder following the operation can be tailored depending on the patient's risk of cervical cancer.

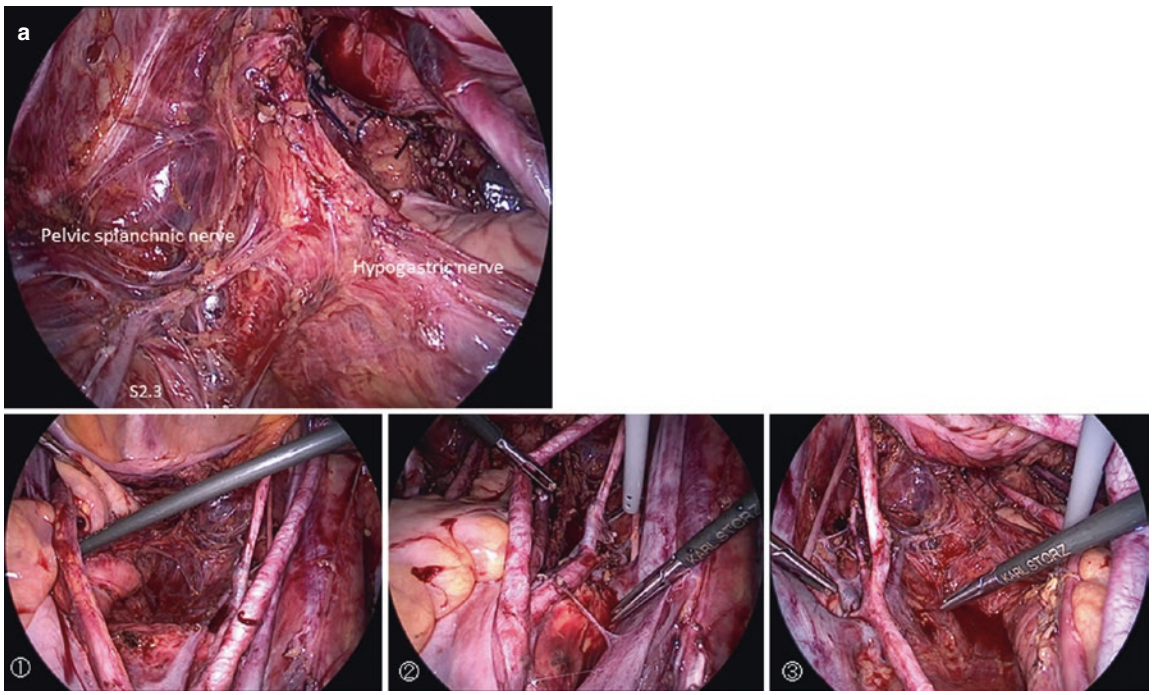


Fig. 41.7 The final view of total laparoscopic nerve-sparing radical hysterectomy for stage Ib2 cervical cancer. (**a**) The status of the preserved nerve networks of left side. ①,② right side ③ left side

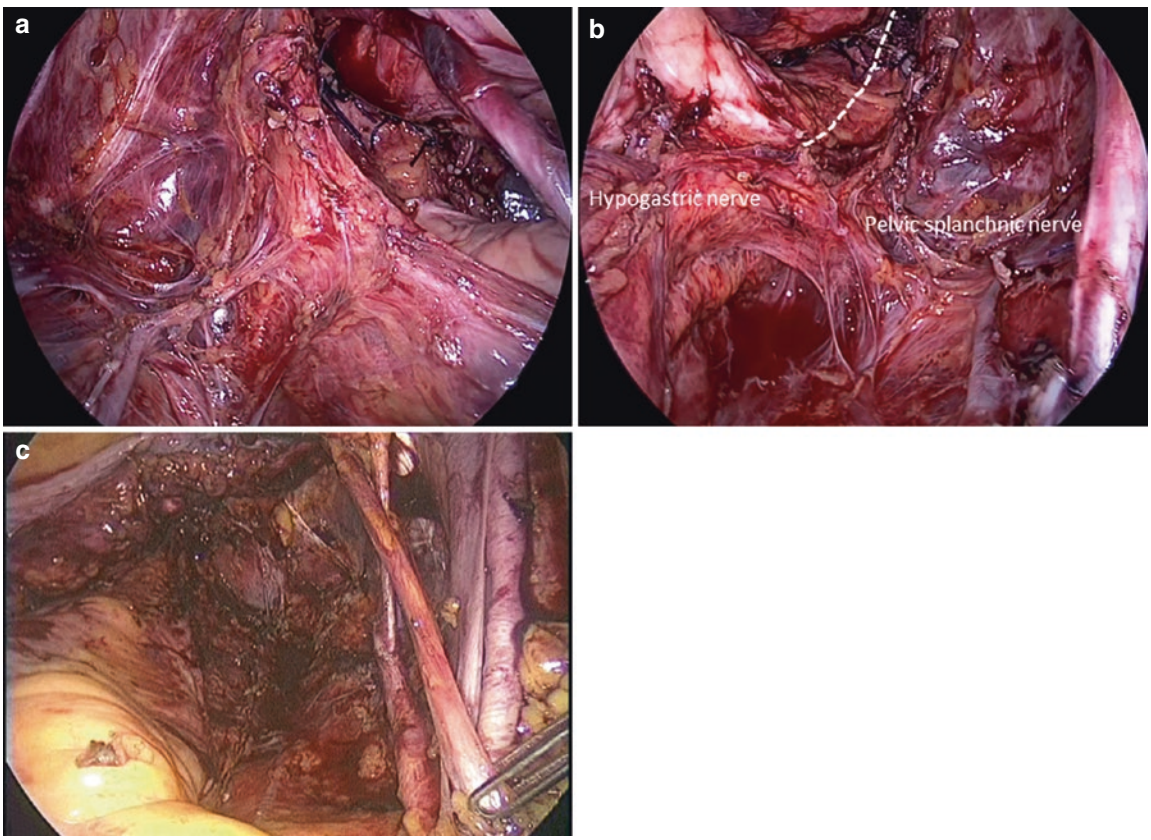


Fig. 41.8 The classification of total laparoscopic nerve-sparing radical hysterectomy. (**a**) Group A. (**b**) Group B (The *dotted line* shows the cutting line of Group A). (**c**) Group C. Patients with mixed pelvic nerve system sparing status (e.g., the right side is categorized into group A, and the left side is categorized into group C) were excluded from this study

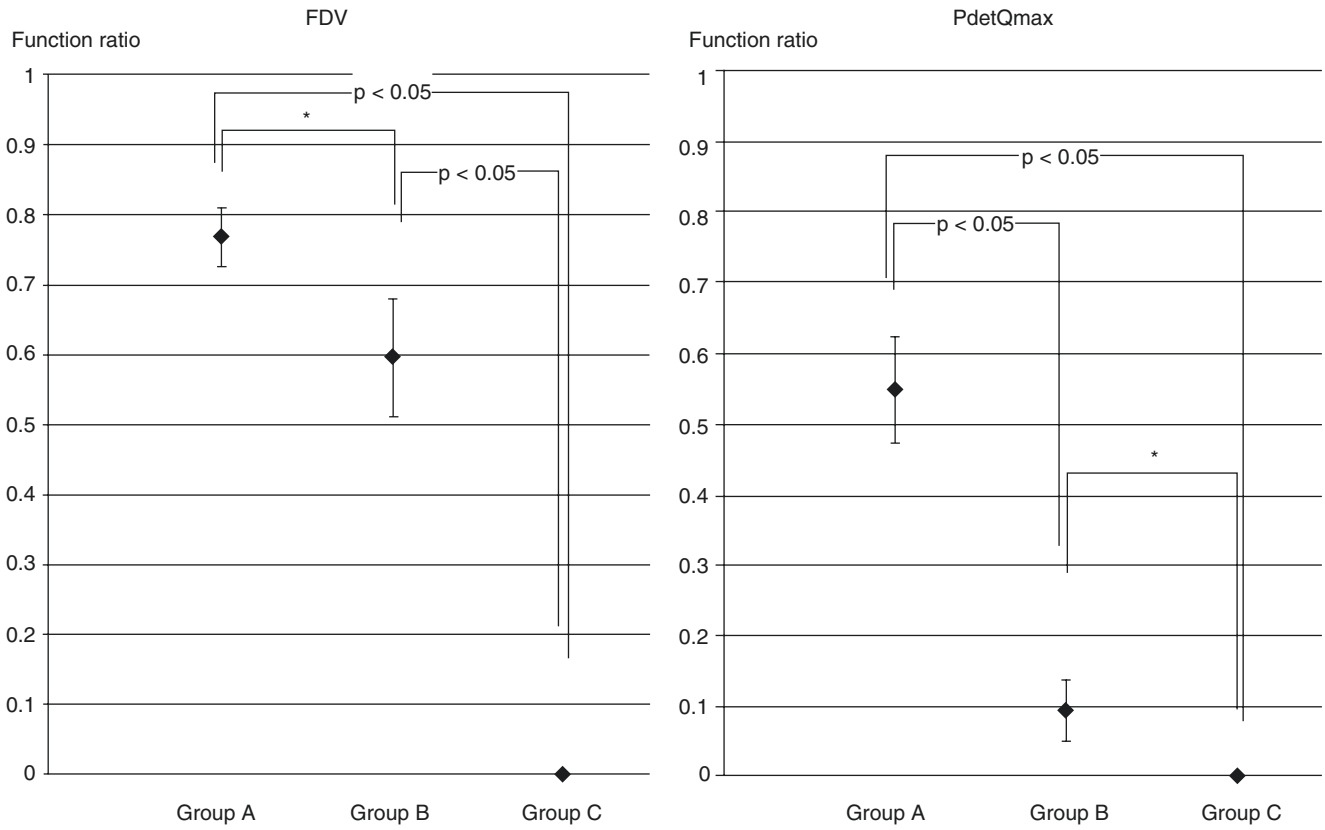


Fig. 41.9 The bladder function of each group at 12 month intervals after the operation

References

1. Malzoni M, Tinelli R, Cosentino F, Fusco A, Malzoni C. Total laparoscopic radical hysterectomy versus abdominal radical hysterectomy with lymphadenectomy in patients with early cervical cancer: our experience. Ann Surg Oncol. 2009;16(5):1316–23.
2. Li G, Yan X, Shang H, Wang G, Chen L, Han Y. A comparison of laparoscopic radical hysterectomy and pelvic lymphadenectomy and laparotomy in the treatment of Ib-IIa cervical cancer. Gynecol Oncol. 2007;105(1):176–80.
3. Taylor SE, McBee Jr WC, Richard SD, Edwards RP. Radical hysterectomy for early stage cervical cancer: laparoscopy versus laparotomy. JSLS. 2011;15(2):213–7.
4. Lee EJ, Kang H, Kim DH. A comparative study of laparoscopic radical hysterectomy with radical abdominal hysterectomy for early-stage cervical cancer: a long-term follow-up study. Eur J Obstet Gynecol Reprod Biol. 2011;156(1):83–6.
5. Sobiczewski P, Bidzinski M, Derlatka P, Panek G, Danska-Bidzinska A, Gmyrek L, et al. Early cervical cancer managed by laparoscopy and conventional surgery: comparison of treatment results. Int J Gynecol Cancer. 2009;19(8):1390–5.
6. Nam JH, Park JY, Kim DY, Kim JH, Kim YM, Kim YT. Laparoscopic versus open radical hysterectomy in early-stage cervical cancer: long-term survival outcomes in a matched cohort study. Ann Oncol. 2012;23(4):903–11.
7. Glahn BE. The neurogenic factor in vesical dysfunction following radical hysterectomy for carcinoma of the cervix. Scand J Urol Nephrol. 1970;4(2):107–16.
8. Seski JC, Diokno AC. Bladder dysfunction after radical abdominal hysterectomy. Am J Obstet Gynecol. 1977;128(6):643–51.
9. Fishman IJ, Shabsigh R, Kaplan AL. Lower urinary tract dysfunction after radical hysterectomy for carcinoma of cervix. Urology. 1986;28(6):462–8.
10. Kavallaris A, Hornemann A, Chalvatzas N, Luedders D, Diedrich K, Bohlmann MK. Laparoscopic nerve-sparing radical hysterectomy: description of the technique and patients' outcome. Gynecol Oncol. 2010;119(2):198–201.
11. Liang Z, Chen Y, Xu H, Li Y, Wang D. Laparoscopic nerve-sparing radical hysterectomy with fascia space dissection technique for cervical cancer: description of technique and outcomes. Gynecol Oncol. 2010;119(2):202–7.
12. Park NY, Chong GO, Hong DG, Cho YL, Park IS, Lee YS. Oncologic results and surgical morbidity of laparoscopic nerve-sparing radical hysterectomy in the treatment of FIGO stage IB cervical cancer: long-term follow-up. Int J Gynecol Cancer. 2011;21(2):355–62.
13. Yamaguchi K, Kobayashi M, Kato T, Akita K. Origins and distribution of nerves to the female urinary bladder: new anatomical findings in the sex differences. Clin Anat. 2011;24(7):880–5.
14. Lin HH, Yu HJ, Sheu BC, Huang SC. Importance of urodynamic study before radical hysterectomy for cervical cancer. Gynecol Oncol. 2001;81(2):270–2.
15. Ralph G, Tamussino K, Lichtenegger W. Urological complications after radical abdominal hysterectomy for cervical cancer. Baillieres Clin Obstet Gynaecol. 1988;2(4):943–52.

Modified Nerve-Sparing Radical-Like Hysterectomy for Deep Infiltrating Endometriosis

42

Stefano Uccella, Jvan Casarin, and Fabio Ghezzi

Introduction

Endometriosis is a common disease characterized by the presence of ectopic endometrial glands and stroma outside the uterine cavity. This heterotopic tissue has the same cyclic estrogen-dependent changes of the eutopic endometrium, according to the various phases of the menstrual cycle.

Endometriosis typically affects young women in their fertile age, being extremely uncommon before menarche and after menopause. The real incidence of this condition is a matter of debate and it is probably underestimated, due to the possible presence of asymptomatic, clinically silent lesions. A large population-based study has shown that this disease affects approximately 11 % of premenopausal women [1]. The average age at diagnosis ranges from 25 to 30 years [2], and it has been estimated that the incidence raises up to 50 % among infertile females [3].

The main symptoms and signs of endometriosis include chronic pelvic pain, dysmenorrhea, dyspareunia, and infertility. The disease can be potentially ubiquitous, but its preferential location is obviously the pelvis. Three different forms of disease have been historically described, according to the site and invasiveness of the implants: peritoneal disease, ovarian endometriomas and deep infiltrating endometriosis (DIE) [4].

In its deeply invasive form, endometriosis grows mainly in the retroperitoneum, and has the potential to infiltrate organs and structures, including the recto-vaginal septum, the lateral parametria (also known as cardinal ligaments or lateral paracervix), the utero-sacral ligaments, the rectosigmoid, the ureters and the bladder. The clinical presentation of DIE is usually characterized by severe chronic pelvic pain, neurologic pain, dyschezia, dysuria, and deep dyspareunia. These symptoms have obvious debilitating consequences on the health and quality of life of reproductive age women.

Complete surgical excision of infiltrative endometriotic lesions by laparoscopy is possible and offers good long-term symptomatic relief, especially in case of failure of pharmacological treatment [5–10].

However, it must be kept in mind that the common locations of DIE are in contiguity with several autonomic nervous structures that exert their control on the function of many pelvic organs. In particular, the pelvic sympathetic and parasympathetic neural pathways (which run through the pelvic ligaments) regulate rectal, bladder, and sexual physiologic activities. Eradication of DIE may therefore disrupt neural fibers, and consequently impair (sometimes definitively) the autonomic control of important vegetative functions.

Rationale for Nerve Sparing

The anatomic proximity of DIE and pelvic autonomic nerves is witnessed by preliminary data from a recent study [11], which show that patients affected by endometriosis involving the recto-vaginal septum and the utero-sacral ligaments have a very high (>90 %) probability of a pre-operative urodynamic diagnosis of detrusor overactivity, even in the absence of bladder symptoms. These results corroborate the observation that pelvic sympathetic and parasympathetic nerves may be encapsulated or at least involved by endometriotic lesions [12]. As a consequence, preservation of neural structures and vegetative functions appears difficult, and may not always be possible at the time of radical surgery for DIE.

However (when neural fibers are not already disrupted pre-operatively), a deep and thorough anatomical knowledge about the routes of the neurogenic control of the pelvis is crucial to try to preserve as much as possible the inervation of the bladder, the rectum and the vagina.

The nerve-sparing approach to hysterectomy for deep infiltrating endometriosis implies the identification and meticulous isolation of the nerves and neural fibers that run

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in the pelvic ligaments, in order to separate them from the DIE lesions that must be removed [13].

Unfortunately, while the majority of the knowledge on nerve supply to the pelvis relies on anatomical studies on cadavers, the identification of nervous fibers is much more difficult in the operating room.

Autonomic Innervation of the Pelvis [14]

Orthosympathetic Nerves

The efferent orthosympathetic nervous fibers that reach the pelvis take their origin from the inferior thoracic and the superior lumbar (L1-L2) segments of the spine. These descendent branches are accompanied by afferent, ascendant fibers from the same innervated regions and organs.

The first structure contributing to the orthosympathetic innervation of the pelvis, is the inferior mesenteric plexus (IMP). This is a plexyphorm net of sympathetic fibers, covering the aorta from the origin of the inferior mesenteric artery until the promontorium of the sacral bone. At its inferior boundary, the IMP joins with the superior hypogastric plexus (SHP), which is a triangular-shaped net of sympathetic fibers lying in the presacral, retro-rectal space, just in front of the promontorium.

The inferior part of the SHP gives origin to the right and left hypogastric nerves (HN), which first descend laterally to the mesorectum, then they lie in the lateral part of the uterosacral ligament, following the ureteral course in a dorsal and caudal position. The tissue below the ureter is named "mesoureter" and should be preserved during dissection, since it contains not only the hypogastric nerves, but also the majority of the parasympathetic neural supply to the pelvis (Fig. 42.1).

Parasympathetic Nerves

The parasympathetic innervation of the pelvic viscera, the bladder and urethra, the rectosigmoid and anal canal and the vagina is supplied by the pelvic splancnic nerves (PSN). These tiny neural branches take origin from the anterior rami of the sacral roots between S2 and S4. Lateral to the mesorectum and approximately 3–4 cm laterally and 2–4 cm caudally from the pouch of Douglas, a variable number of parasympathetic PSNs (3–5) pierce the parietal endopelvic fascial sheet covering the ventral aspect of the piriformis muscle. After running in the posterior-lateral aspect of the uterosacral ligaments, below the level of the orthosympathetic routes, the PSNs join the HNs, forming the mixed (orthosympathetic and parasympathetic) inferior hypogastric plexus, also known as pelvic plexus (Fig. 42.2).

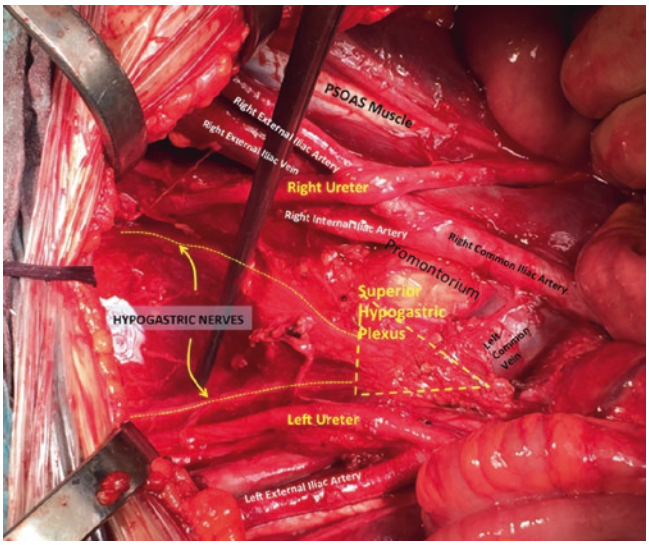


Fig. 42.1 The inferior mesenteric, the superior hypogastric plexus (with its triangular shape) and the two hypogastric nerves running to the pelvis bilaterally

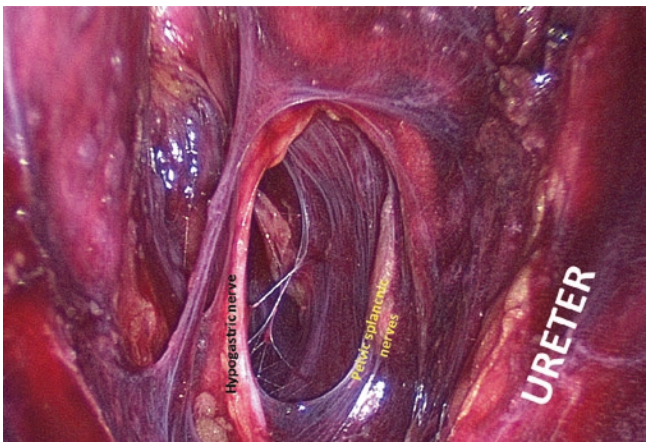


Fig. 42.2 The right inferior hypogastric plexus (also called "pelvic plexus") with its mixed (orthosympathetic and parasympathetic) fibers. The right ureter is lateralized, to expose the hypogastric nerve and the pelvic splancnic nerves, forming the plexus

Pelvic Plexus, Rectal, Bladder and Vaginal Neural Branches

The pelvic plexus is a pyramid-shaped plexus which is bilaterally located between the posterolateral vaginal fornix and the rectum, ventrally and caudally to the lateral rectal ligaments. This neural network receives ortho- and parasympathetic fibers both descending from the spine and ascending from the pelvic organs. From this anatomical structure, several fine neural branches reach the pelvic organs, mainly following the ligaments and supporting structures of the organs innervated. In particular, neural fibers reach the uterus and

the vagina through the parametria and paracolpia; anteriorly, ascending fibers deliver their neural supply to the bladder, running in the vesico-uterine ligaments (bladder branches); posteriorly, the innervation of the recto-sigmoid is delivered by fibers contained in the lateral rectal ligaments (also known as rectal wings).

The deep uterine vein is considered as the limit dividing the vascular part of the parametria (above its level), from their neural portion (below the deep uterine vein), where the pelvic plexus is located. To perform a nerve-sparing procedure that preserves the pelvic plexus, the deep uterine vein is to be identified, and resection should not exceed inferiorly this crucial anatomical landmark.

Pelvic Surgical Spaces for Radical Hysterectomy (Fig. 42.3)

In the pelvis, different anatomical spaces have been described. The knowledge of these regions is of paramount importance to obtain a safe and radical dissection of several oncological and non-oncological diseases in gynecology. In particular, we can recognize two median spaces (the Retzius space in front of the bladder and the presacral retrorectal space behind the rectum), and eight lateral spaces (the median and lateral paravesical and pararectal spaces) bilaterally, for a total of ten different and relatively avascular areas. To perform a radical hysterectomy, the paravesical and pararectal fossae have to be dissected. These virtual spaces must be carefully opened and developed by the surgeon, to make the anatomic landmarks clearer and also to allow a nerve-sparing procedure.

Paravesical Space

The boundaries of the paravesical space are the bladder and the upper part of the vagina, medially, and the obturator internus muscle, the obturator nerve, artery and vein (just beneath the bony arcuate ridge of the ileum), laterally.

This space is created by dissecting, both in dorsal and caudal direction, the loose connective tissue under the peritoneum, laterally to the bladder, until the levator ani muscle is reached. At this level, the external iliac vessels and the obturator nodes made up the lateral wall, while the bladder constitutes the medial landmark.

A useful tip to perform a safe and efficient dissection, is to identify the umbilical obliterated artery, and to develop the tissue laterally to it in a caudal direction. During the development of this space, surgeons have always to look for accessory obturator arteries and veins, which are often present in this area, in order not to damage them during dissection, in particular they have to pay attention to a anastomotic vein between the external iliac vein and the obturator vein, which in surgical jargon is called *corona mortis*.

The longitudinal course of the ureter is the reference for dividing the paravesical space in two different areas, the medial (also known as Yabuki's space) and the lateral paravesical fossa (Fig. 42.4).

Pararectal Space

The pararectal space is a potential space, lateral to the rectum. Dissection of this area usually starts with the development of the retroperitoneum medial to the internal iliac vessels. It is a triangular-shaped space, with an anterior base, represented by

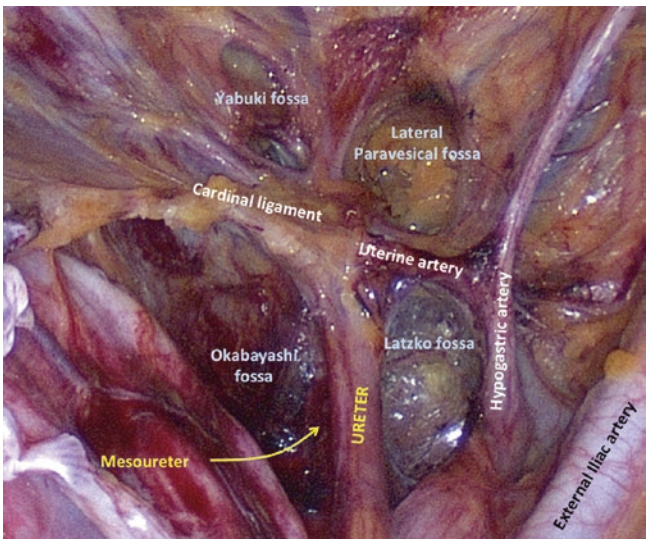


Fig. 42.3 The right paravesical and pararectal spaces, with the course of the ureter and mesoureter, the cardinal ligament and parametrium

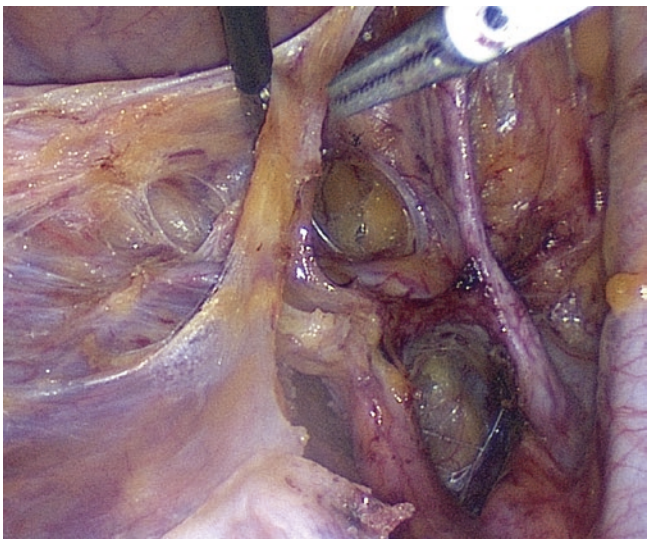


Fig. 42.4 The right lateral and medial paravesical spaces

the cardinal ligament; the medial border is represented by the vagina anteriorly, the peritoneum of the posterior sheet of the broad ligament superiorly, the utero-sacral ligament inferiorly and the rectum posteriorly; the lateral boundary corresponds to the internal iliac artery and vein with their collaterals. The ureter and the mesoureter divide the lateral aspect of the pararectal space (the so-called Latzko's fossa) from its medial aspect (Okabayashi's fossa) (Fig. 42.5).

The identification and development of the paravesical and pararectal spaces with their medial and lateral aspects is the first step to correctly identify the main anatomical structures in the pelvis and to perform a nerve-sparing radical hysterectomy, for both malignancies and endometriosis. Once the ureter with the mesoureter, the internal and external iliac vessels, the cardinal ligament with the uterine artery and veins and the utero-sacral ligament have been identified, the neural fibers of the hypogastric nerves, of the pelvic splancnic nerves and of the pelvic plexus can be localized and possibly spared, if not involved by the disease (Fig. 42.3).

Pre-operative Assessment

Preoperatively, all women should undergo a thorough gynecological examination, including complete medical and surgical history, bimanual visit, pelvic transvaginal and transabdominal ultrasound, to rule out the presence and exact location of the endometriotic lesions, and their relationships with the pelvic organs. In order to evaluate the extent of possible bowel, bladder and ureteral involvement and to better plan the correct surgical approach, pelvic and abdominal MRI with contrast medium may be useful. The administration of colon water distension during MRI is a possible adjunction that allows better visualization of the presence and depth of bowel wall infiltration. Ultrasound scan of the urinary tract may be useful, in order to recognize and quantify the possible presence of hydronephrosis, ureteral dilatation or bladder nodules. Anterograde pyleography is not performed on a routine basis at our department.

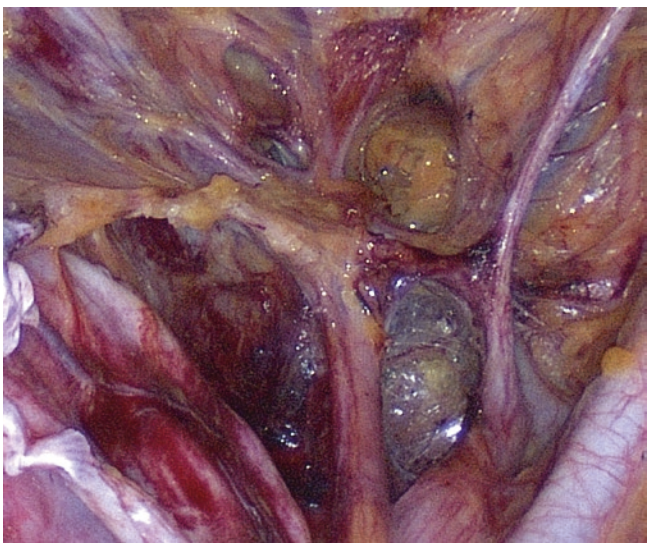


Fig. 42.5 The right lateral and medial pararectal spaces

Women receive one dose of prophylactic antibiotic 1 h before the intervention; antithrombotic prophylaxis is administered with low–molecular-weight heparin (7 days) and compression stockings (until full mobilization). Bowel preparation is not administered on a routine basis, unless bowel resection is planned.

Due to the intrinsic risks of this type of procedures, consisting in difficult recognition and isolation of the anatomical structures, and in the presence of dense adhesions and firm fibrotic nodules that complicate dissection of the surgical planes, pre-operative work-out should include the recognition of the most difficult cases of severe deep infiltrating endometriosis, in order to organize a surgical team of operators with extensive experience in both laparoscopic and open gynecological and intestinal procedures.

Instruments

The list of instruments for laparoscopic modified nerve-sparing radical-like hysterectomy in case of deep endometriosis should include:

- a uterine manipulator (we preferentially use a Rumi uterine manipulator used in conjunction with a Koh cup colpotomizer, [Koh Colpotomizer System; Cooper Surgical, Trimbull, CT]) to allow a safe dissection of the vesico-uterine fold, the delineation of the vaginal fornices and the lateralization of the ureters, obtained by cranial pressure on the instrument.
- Four 5-mm trocars, inserted one through the umbilicus and three suprapubically.
- A 0-degrees laparoscope.
- Scissors.
- Traumatic (Manes forceps) and atraumatic (Matkovic) graspers.
- Bipolar forceps.
- Monopolar hook or spatula.
- A suction-irrigation-system.

The entire procedure may be accomplished with reusable instruments. Only in very particular cases, a disposable combined coagulating/cutting device may be useful.

Surgical Technique

The patient must lie supine in lithotomic position. General endotracheal anesthesia is performed, and during the procedure, Trendelenburg position is maintained, to allow cranial

displacement of the bowel loops and optimal exposure of the pelvic organs. The uterine manipulator is positioned vaginally. A Veress needle is inserted in the abdominal cavity and CO_2 is insufflated. After creation of the pneumoperitoneum (10–15 mmHg pressure), a 5-mm trocar is inserted transumbilically for the laparoscope. Under direct visualization, three 5-mm ancillary trocars are positioned suprapubically: one at the level of the midline and two laterally to the epigastric arteries in the left and right lower abdominal quadrants, respectively. The entire abdominal cavity is then inspected.

The third operator, sitting between the legs of the patient, helps the first operator by mobilizing the uterus with the uterine manipulator.

In cases of severe deep infiltrating endometriosis, the pelvis is almost invariably "frozen" by dense adhesions. As a consequence, the procedure starts with meticulous adhesiolysis and adnexal surgery (cystectomy, stripping of endometriomas), if needed. One of the most important rules while performing surgery for DIE is to try to work in healthy tissue, surrounding the disease.

Development of the anatomical spaces is started coagulating and sectioning the round ligament, while the assistant grasps it and pulls it medially to obtain adequate countertraction and exposure. The anterior leaf of the broad ligament is coagulated with bipolar forceps and sectioned, starting from the round ligament up to the vesicouterine fold.

The retroperitoneum is then entered as follows: an incision is made on the peritoneum lateral and parallel to the infundibulopelvic ligamnents and the ureter is identified lateral to the ovarian vessels, when it crosses the iliac bifurcation and enters the pelvis at the level of the pelvic brim.

The lateral pararectal space is dissected medial to the internal iliac artery, and the uterine vessels are identified at their origin from the hypogastric artery and vein. The Okabayashi fossa is then developed by opening the virtual space between the ureter (laterally) and the peritoneum (medially), the cardinal ligament and uterine artery (anteriorly) and the rectum (posteriorly). While moving caudally in the dissection, the medial, fibrous part of the utero-sacral ligament should be separated by its lateral aspect, which contains the neural fibers of the hypogastric nerves and pelvic splancnic nerves. Once the Okabayashi and Latzko fossae have been prepared, the ureter is isolated and the mesoureter is identified and preserved, in order to spare the nervous fibers (hypogastric nerve, pelvic splancnic nerves and pelvic plexus) running in it (Fig. 42.6). If ureteral endometriosis is present, ureterolysis should be accomplished, with the intent of shaving and preserving the ureter whenever possible [5, 7]. Particular attention should be paid during isolation of the ureter to avoid damage to its peri-adventitial vessels, that provide blood supply to this organ, in order to prevent ischemic necrosis and consequent fistulas.

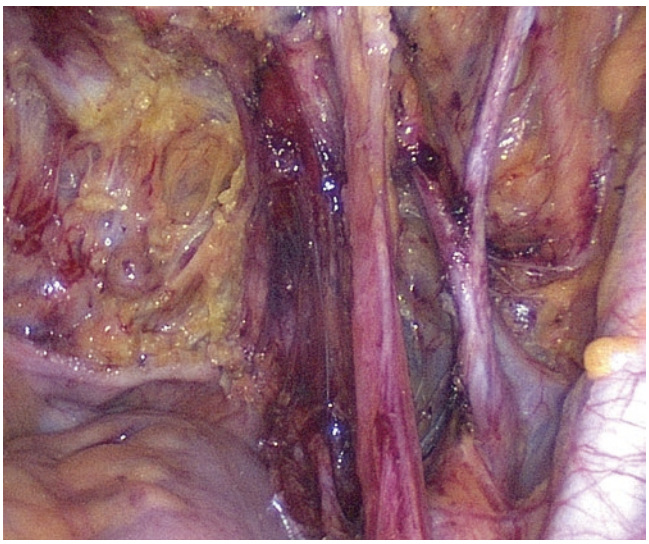


Fig. 42.6 The right ureter and the mesoureter isolated during a modified radical-like hysterectomy for deep endometriosis (the nervous fibers of the hypogastric nerves, pelvic splancnic nerves and pelvic plexus have been identified and spared)

The vesico-vaginal space is dissected and the space of Yabuki is developed only in case of vesical nodules or when the upper part of the anterior vaginal wall has to be removed.

In case of adnexectomy, coagulation and section of the infundibulopelvic ligament is accomplished. If the ovaries have to be preserved, coagulation and section is performed at the level of the tube and utero-ovarian ligament. The posterior leaf of the broad ligament is then opened, down to the level of the uterosacral ligaments.

When the cardinal ligament is involved, partial or total sacrifice of the uterine artery and/or some branches of the internal iliac artery may be necessary before its resection. Resection of the involved cardinal ligament is performed at this time, tailoring the radicality on the basis of the extension of the disease and the anatomical conditions of the patient.

If possible, isolation and preservation of the uterine vessels at the intersection with the ureter is performed. The dissection must never be extended below the level of the deep uterine vein (the border between the vascular portion and the neural portion of the parametrium), in order to spare the hypogastric nerves and the pelvic plexus, unless massive infiltration by the endometriotic process is present below this level.

When a rectovaginal nodule is present, the virtual space between the rectum and the vagina must be opened, starting from the medial pararectal spaces. The decision as to whether bowel resection is necessary, has to be taken on the basis of the percentage of infiltration of the recto-sigmoid wall by the endometriotic lesion. In case of bowel preservation, rectal shaving is accomplished and the nodule is mobilized from the anterior surface of the rectum, leaving it attached to the posterior vaginal wall.

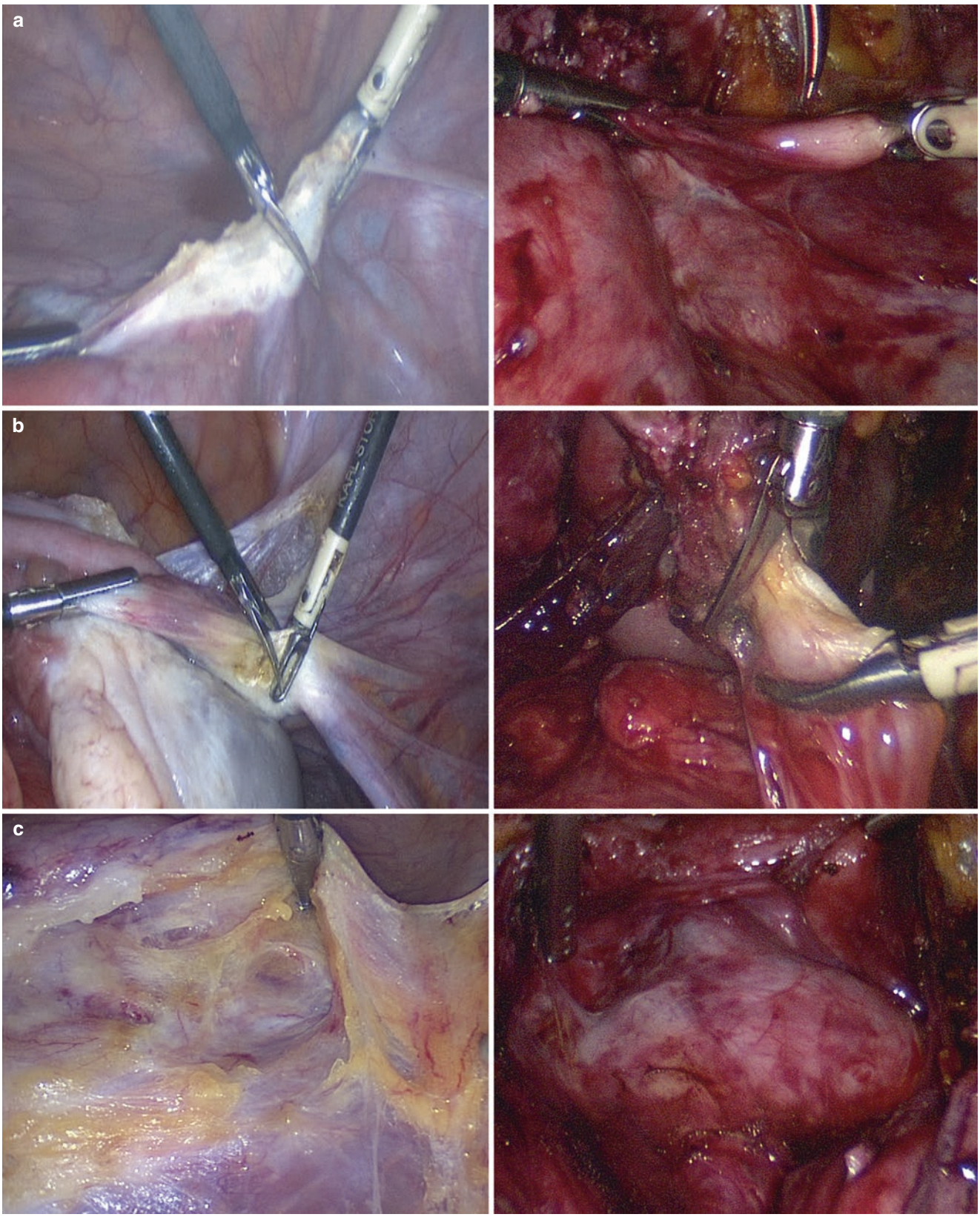


Fig. 42.7 (**a**) Coagulation and section of the round ligament; (**b**) Coagulation and section of the infundibulo-pelvic ligament; (**c**) Development of the vesical flap. Comparison between women without (*left*) and with (*right*) endometriosis. The recognition and dissection of the anatomical structures is more difficult in case of DIE

All the steps described are performed in the same way on both sides.

Once the uterus has been completely detached from its supporting structures, and complete dissection and isolation of the endometriotic process has been accomplished, colpotomy is performed using a monopolar spatula or hook. A colpo-pneumo-occluder inserted through the vagina before the procedure, is useful to prevent loss of pneumoperitoneum during this step of the procedure. Supplementary hemostasis of the vaginal vault with a bipolar forceps could be needed in cases of bleeding during colpotomy.

The extraction is usually performed *en-bloc* through the vagina; in some cases, transvaginal morcellation with cold knife could be necessary.

Once the specimen is extracted, the vaginal vault can be closed by continuous suture either transvaginally or endoscopically [15].

Before trocar extraction, an additional control of the hemostasis should be performed.

Figure 42.7 describes some of the steps of radical hysterectomy, highlighting the differences and the difficulties in the correct recognition of the anatomical structures in patients with vs. without endometriosis.

Post-operative Course

Although the common perception of the operators involved in this type of surgery is that hysterectomy for deep infiltrating endometriosis is associated with a higher likelihood of complications, compared to simple hysterectomy for benign gynecological conditions, the literature is devoid of clear information regarding this specific issue.

Normal post-operative management should include monitoring of the most common post-operative complications. A brief list of specific adverse events possibly related to modified-radical hysterectomy for deep endometriosis include: bladder and ureteral lesions/fistula (usually occurring 7–21 days after surgery), bowel perforation, and urinary, sexual or anal dysfunction, due to failure of nerve-sparing and denervation of the organs involved.

Summary of Key Steps for Modified Nerve-Sparing Approach to Radical Hysterectomy for Deep Infiltrating Endometriosis

- Opening of the retroperitoneum and development of the pararectal and paravesical spaces.
- Isolation of the ureter with preservation of the meso-ureter (in order to spare the hypogastric nerves, the pelvic splancnic nerves and the pelvic plexus).
- Separation of the lateral aspect of the utero-sacral ligament (containing the nervous fibers running to and from the pelvis), from its medial fibrous part, which may be transected, according to the extension of the endometriotic lesion.
- Avoid transection of the cardinal ligament below the level of the deep uterine vein (if possible), in order to preserve the mixed orthosympathetic and parasympathetic pelvic plexus.
- Try to work in healthy tissue surrounding the disease.

References

1. Buck Louis GM, Hediger ML, Peterson CM, Croughan M, Sundaram R, Stanford J, et al. Incidence of endometriosis by study population and diagnostic method: the ENDO study. Fertil Steril. 2011;96:360–5.
2. Giudice LC, Kao LC. Endometriosis. Lancet. 2004;364(9447):1789–99.
3. Dunselman GA, Vermeulen N, Becker C, Calhaz-Jorge C, D'Hooghe T, De Bie B, European Society of Human Reproduction and Embryology, et al. ESHRE guideline: management of women with endometriosis. Hum Reprod. 2014;29:400–12.
4. Nisolle M, Donnez J. Peritoneal endometriosis, ovarian endometriosis, and adenomyotic nodules of the rectovaginal septum are three different entities. Fertil Steril. 1997;68:585–96.
5. Uccella S, Cromi A, Casarin J, Bogani G, Pinelli C, Serati M, Ghezzi F. Laparoscopy for ureteral endometriosis: surgical details, long-term follow-up, and fertility outcomes. Fertil Steril. 2014;102:160–6. e2
6. Ghezzi F, Cromi A, Ciravolo G, Rampinelli F, Braga M, Boni L. A new laparoscopic-transvaginal technique for rectosigmoid resection in patients with endometriosis. Fertil Steril. 2008;90:1964–8.
7. Ghezzi F, Cromi A, Bergamini V, Bolis P. Management of ureteral endometriosis: areas of controversy. Curr Opin Obstet Gynecol. 2007;19:319–24.
8. Redwine DB, Sharpe DR. Laparoscopic segmental resection of the sigmoid colon. J Laparoendosc Surg. 1991;1:217–20.
9. Redwine DB, Wright JT. Laparoscopic treatment of complete obliteration of the cul-de-sac associated with endometriosis: long-term follow-up of en bloc resection. Fertil Steril. 2001;76:358–65.
10. Landi S, Ceccaroni M, Perutelli A, Allodi C, Barbieri F, Fiaccavento A, Ruffo G, McVeigh E, Zanolla L, Minelli L. Laparoscopic nerve-sparing complete excision of deep endometriosis: is it feasible? Hum Reprod. 2006;21:774–81.
11. Serati M, Cattoni E, Braga A, Uccella S, Cromi A, Ghezzi F. Deep endometriosis and bladder and detrusor functions in women without urinary symptoms: a pilot study through an unexplored world. Fertil Steril. 2013;100:1332–6.
12. Anaf V, Simon P, El Nakadi I, Fayt I, Buxant F, Simonart T, et al. Relationship between endometriotic foci and nerves in rectovaginal endometriotic nodules. Hum Reprod. 2000;15:1744–50.
13. Ceccaroni M, Clarizia R, Bruni F, D'Urso E, Gagliardi ML, Roviglione G, Minelli L, Ruffo G. Nerve-sparing laparoscopic

eradication of deep endometriosis with segmental rectal and parametrial resection: the Negrar method. A single-center, prospective, clinical trial. Surg Endosc. 2012;26:2029–45.
14. Ceccaroni M, Fanfani F, Ercoli A, Scambia G. Innervazione viscerale e somatica della pelvi femminile. Testo-Atlante di Anatomia Chirurgica. Roma: CIC Ed. Internazionali; 2006.
15. Uccella S, Ceccaroni M, Cromi A, Malzoni M, Berretta R, De Iaco P, Roviglione G, Bogani G, Minelli L, Ghezzi F. Vaginal cuff dehiscence in a series of 12,398 hysterectomies: effect of different types of colpotomy and vaginal closure. Obstet Gynecol. 2012; 120:516–23.

Laparoscopic Total Mesometrial Resection (L-TMMR)

43

Vito Chiantera, Alessandro Lucidi, and Giuseppe Vizzielli

Oncological Philosophy

Abdominal radical hysterectomy and pelvic lymph node dissection as introduced by Wertheim and Meigs [1–2] first in the beginning of the century is still regarded as "gold standard" in the surgical treatment of the uterine cervix carcinoma, FIGO stages IA2-IB and IIA. The resection of the parametrial and paracervical tissues proposed by the.

conventional radical hysterectomy is based on a "centrifugal diffusion" from the center of the tumor on the direction of the parametrial (dorsal, lateral and ventral) highways.

This imply a classic functional and ligament-focused view of the surgical anatomy.

Local spread of an invasive tumor is currently regarded as an isotropic process of tissue infiltration, irrespective of anatomic boundaries. Malignant solid tumors are thought to permeate locally by invasion of the interstitium or intravasion of lymphatic and venous channels and perineural spread. The conventional oncological surgical practice derived from these concept is a "wide tumor excision" as removal of the malignant tumor with a metrically defined radial margin of macroscopically and microscopically tumor-free tissue. However, despite histopathology confirmed resection within clear margins (R0), local recurrence rate (LRR) in cervical cancer patients still occurs in 10–25 % of the patients [3].

As consequence the clinical results obtained are favorable for small tumor, vascular space negative and free pelvic nodes remaining the necessity of adding adjuvant chemoradiation therapy in patients with histopathology high-risk features.

Those high and intermediate risk patients requiring adjuvant treatment may exceed 50 % in current series with moderate and severe treatment-related morbidity reported for a big percentage of them [4].

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Hockel theory is based on the concept that local tumor spreads not completely random but follows for a long period of the malignant progression into a permissive compartment morphologically deduced from the embryologic development of the affected organ. Although tumor propagation increase within that compartment during the malignant progression the neoplasm respects the compartment borders for a long period of progression. Only very late adjacent compartments deriving from different embryological origins are invaded and even in these late stages a hierarchy of embryological kinship is maintained.

The logic consequence of this developmental view is a *"Compartment Resection"* as a new principle of radical surgery for local tumor control aiming to a high local tumor control rate without additional post operative radiation.

Höckel et al. first investigated embryonic development of the female reproductive tract with respect to embryological different compartments [5–8] and were able to define three different primordial tissue complexes from cranial to caudal:

- The paramesonephric–mesonephric–Müllerian tubercle complex
- The deep urogenital sinus (UGS) vaginal plate complex
- The superficial UGS-genital folds and tubercle

The pelvic viscera-parietal compartments deduced from the embryonic development define the following pelvic parietal lymph-node basins:

- External iliac
- Paravisceral (i.e.: anterior internal iliac, supraobturator and infraobturator, presciatic)
- Common iliac (including the superior gluteal)
- Presacral (i.e.: posterior internal iliac, aortic, and caval bifurcation)

The high rate of local tumor control following Total Mesometrial Resection (TMMR) without any subsequent

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adjuvant radiotherapy in patients with early cervical cancer is impressive [9, 10]. Part of this outcome is achieved with a ultra radical pelvic lymphadenectomy (tLNE), called *"therapeutic lymphadenectomy"*, this differs from the classic staging pelvic LNE where the nodes are removed with the idea to obtain a precise hysto-patological information in order to individualize the adjuvant treatment.

In this version of the pelvic lymphadenectomy the aim of the procedure is to remove every macro or micro metastasis in order to "sterilize" the lateral pelvic surgical field and avoid any necessity of adjuvant treatment. To obtain this a ultra-radical dissection is performed with removing of the external iliac, the superficial obturator and the deep obturator nodes as well as the deep gluteal, pre ischiatic (at the level of the ischial spine), pre sacral (ventrally to the lateral sacral fascia), and internal iliac nodes [10].

Following this theory, the proposed uterovaginal (Müllerian) compartment, identified by bottom-up sectional anatomy as the final differentiation product of the Müllerian structures, as described in previous published data by Höckel et al. [8] are:

(a) The cranial part of the compartment located intraperitoneal that consists of the Fallopian tubes, the mesosalpinx, the uterine corpus with the broad ligament where the latter corresponds to the peritoneal mesometrium
(b) The sub-peritoneal part of the Müllerian compartment (i.e.: the subperitoneal mesometrium) tapers off with bilateral wings made up of dorso-laterally directed supply tissue with the uterine vaginal arteries and veins, lymphatic drainage, and a few lymph nodes (referred to as vascular mesometrium), and dorsally directed suspensory and fatty tissue fused to the anterior and lateral mesorectum continuous with the endopelvic fascia overlying the coccygeus muscles (referred to as ligamentous mesometrium).

Due to the systematic and complete resection of those compartments Hockel achieved impressive results: with a median follow-up of 41 months only three pelvic, two pelvic/distant and five distant recurrences were recorded. A recurrence-free survival of 94 % (95 % CI 91–98) and overall survival of 96 % (93–99) was noticed.

Even more, with the absence of any adjuvant radiation therapy applied to those patients a very low treatment-related morbidity as much as 9 % was reported.

Although it has been questioned whether the confirmation of these findings could change the classification of radical hysterectomy and the indication for adjuvant radiotherapy in early stage cervical cancer [11], various authors have recently described the TMMR as an attractive therapeutic option for the management of this subset of patients [12–15].

The TMMR as a open surgical technique is perfectly standardized and systematic described, Kimmig et al. showed that the principle of compartment based surgery combined with therapeutic lymphadenectomy (tLNE) as described by M. Höckel can systematically be translated to minimally invasive robotic procedures (rTMMR and rtLNE). The method appeared to be feasible and safe. Although the mean follow-up time (18 months) was limited, the number of patients was small and there was some "lack of homogeneity" in the patients' sample composition (six patients at FIGO stage IA and three patients who had prior radiotherapy), it should be noticed that there were no loco-regional tumor recurrence during the observation period.

We have recently reported in a large prospective multicentric experience that compartment based surgery performed as Total Mesometrial Resection combined with therapeutic lymphadenectomy can systematically be translated to laparoscopic procedure (L-TMMR) [16]. Combining the information gained in this two minimal invasive study and despite the limited number of patients or the short follow-up, it should be noticed that altogether only two (2.8 %) early loco-regional tumor recurrences were observed, thus suggesting that LTMMR and R-TMMR techniques may be safe with respect to local tumor control and should be considered at least equivalent to open surgery in term of radicalness.

More in depth, regarding to specific endoscopic surgical procedures, it should be underlined that, exposure of the tumor into the surgical field must strictly be avoided in order to diminishing the risks for a vaginal cuff recurrence and intraperitoneal tumor dissemination.

Regarding the operating time of L-TMMR, it should be noted that it was longer than other series of radical hysterectomy previously published according to the Querleu–Morrow classification [17].

Moreover, especially two steps of the TMMR are particularly demanding if performed laparoscopically: the natural complex eradication of some lymph node stations by laparoscopy (i.e. in the lumbosacral fossa) and the difficulty to obtain the right traction simultaneously both on the uterus, the rectum and the mesometrium in order to complete the dorsal part of the operation. Thus the difference with open surgery in exposing the posterior compartment cannot be neglected. On the other hand, the shorter operating time compared with the historical series by Höckel [5–8] performed by open technique, supports the idea that laparoscopic procedures are time-sparing compared to open technique, especially if performed by a surgical team with a deep experience in the endoscopic approach. Moreover, the two severe postoperative complications reported in the urinary tract and the sole vascular compartment damage are in line with an initial experience on this endoscopic surgical procedure and suggest next future improvements with the increasing of the specific surgical experience. In addition, the low grade post-operative autonomic urinary complications (9.8 %) reported could be justified considering that the L-TMMR technique spares the

pelvic nerves that supply the bladder both in the sympathetic and parasympathetic system.

Finally, laparoscopical as well as robotic approach, allowing to finely prepare and completely remove compartment-associated tissue without injuring adjacent structures by respecting the filmy septa at the compartment borders, enables to develop and dissect structures with higher "optical" accuracy than open technique. In our previous experience, laparoscopic elective dissection of the bladder and rectal splanchnic pelvic nerves and consequently, development of a parasympathetic nerve-sparing technique were technically feasible [18]. We believe that this L-TMMR technique is not inferior in terms of *"nerve sparing"* than the previous described laparoscopic approach.

Moreover, compared with the conventional open technique in the L-TMMR patients a notable reduction in global postoperative functional morbidity was demonstrated.

As next step we have compared, with a double-institution case-control study, peri-operative outcomes of R-TMMR and L-TMMR in early stage cervical cancer patients [19]. The few differences registered in this study did not seem clinically relevant, thus making the two procedures comparable, in terms of operative time, estimated blood loss and conversion or complication's rate.

Surgical Procedure

The objective of this chapter is to describe step-by-step the L-TMMR, a modified surgical technique according to the compartment theory based on ontogenetic anatomy proposed by Hockel. The laparoscopic procedure is performed in the modified dorsolithotomy position under endotracheal general anesthesia. A Veress needle is inserted through the umbilicus and the abdomen is insufflated. After pneumoperitoneum and insertion of the laparoscope through an umbilical 10 mm trocar, three suprapubic 5 mm trocars are introduced for ancillary instruments.

Step 1 An initial vaginal step was performed with *"vaginal manchette"* creation in order to encapsulate tumor lesion and reduce tumor spread during uterine manipulation, according to previous published data [20]. To preserve pneumoperitoneum, a wet surgical towel is placed into the vagina caudally to the performed manchette (Fig. 43.1).

Tips

The dissection of vescico-vaginal and retto-vaginal septum should be performed without opening of the peritoneum.

Step 2 Exploration of pelvic and abdominal intraperitoneal structures. With the exception of the recto-sigmoid colon, all bowel organs are retracted ventrally and placed in the right upper abdomen. The abdominal retroperitoneum is opened by incising peritoneum at the psoas muscle parallel to the infundibulopelvic ligaments.

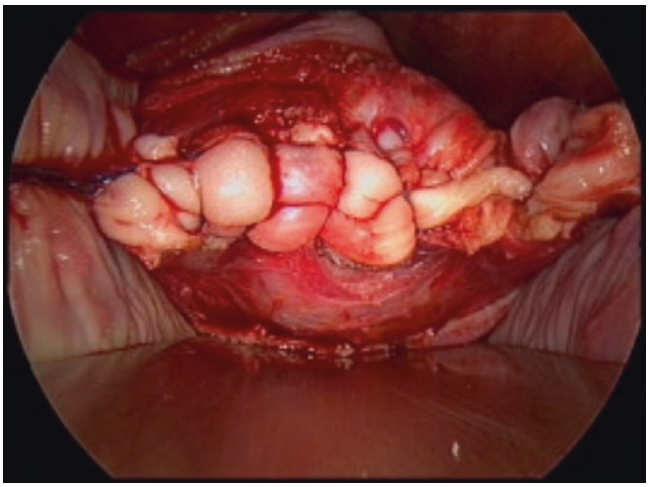


Fig. 43.1 Creation of tumor-adapted vaginal manchette

Step 3 Exposition of the urogenital mesentery developing anteriorly the paravisceral space with the umbilical artery and the lamina vesicalis dissected from the pelvic wall and tractioned medially

Step 4 Therapeutic systematic pelvic lymphadenectomy [tLNE] according to Höckel is performed and lymph-nodes are examined under frozen section [10]. The parietal nodes of the anterior pelvic compartments (external, internal iliac and obturator) are removed by completely stripping the external and internal iliac artery and vein. The deep pelvic lymph nodes are also removed exposing the proximal sciatic nerves and the lumbar rami of the sacral plexus and removing the paravisceral fat pads up to the sciatic spine (Figs. 43.2 and 43.3). Para-aortic lymph-node dissection is performed in any FIGO stage just in case of pre-operative radiological suspicious or with pelvic positive nodes at frozen section.

Step 5 The infundibulopelvic ligament is coagulated and cut in case of adenocarcinoma histology. In order to obtain more space in the pelvis the uterus–ovarian ligament is cut with separation of the adnexa from the uterus. The adnexa are placed in a bag outside the pelvis and are retained later. Otherwise if conservation of the adnexa were planned, the adnexa are separated form the uterus and dislocated in the upper abdomen at the level of the paracolic spaces on both side. In this case the whole *"peritoneal mesometrium"* (Falloppian tube, mesosalpinx and part of the broad ligament) is accurately dissected and removed separately.

Step 6 The peritoneum is incised again at the level of the right promontorium. The sigmoid colon is mobilized contra-

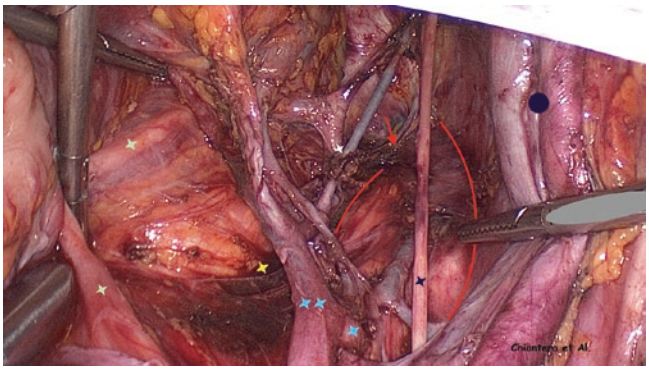


Fig. 43.2 Therapeutic Lymphadenectomy. *Light Green Stars*: right ureter. *Yellow star*: latzko pararectal space. *Double light blue stars*: internal iliac artery. *Single light blue star*: gluteal artery. *White star*: obturator vessels. *Blue star*: right obturator nerve. *Blue circle*: external iliac artery and vein. *Red lines*: borders of the sciatic nerve and sacral plexus. *Red arrow*: sacrospinal ligament

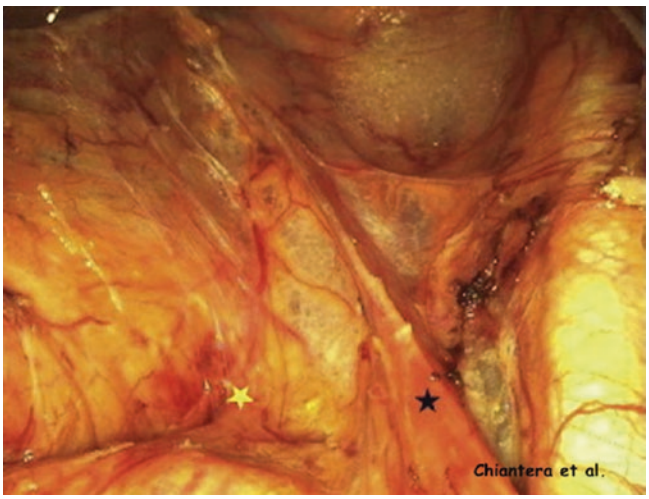


Fig. 43.4 Opening the Parasacral space on the right side and identifying the course of the right hypogastric nerve. *Black star*: right ureter. *Yellow star*: right hypogastric nerve

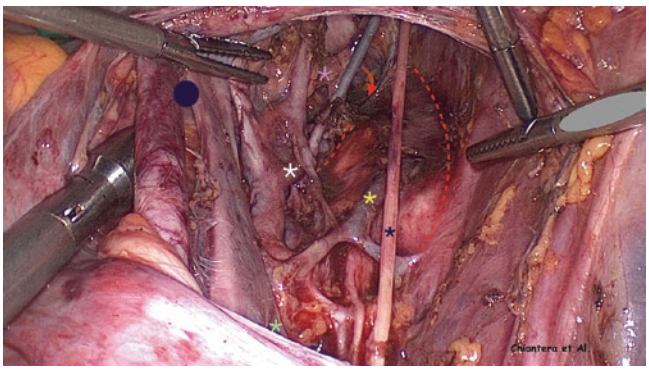


Fig. 43.3 Therapeutic Lymphadenectomy. *Blue circle*: external iliac artery and vein. *White star*: common trunk for the pudendal vein and obturator vessels. *Purple star*: bturator vessels. *Yellow star*: inferior gluteal vein. *Blue stars*: obturator nerve. *Green star*: superior gluteal vein. *Red arrow*: sacrospinal ligament. *Red dotted lines*: borders of the sciatic nerve and sacral plexus

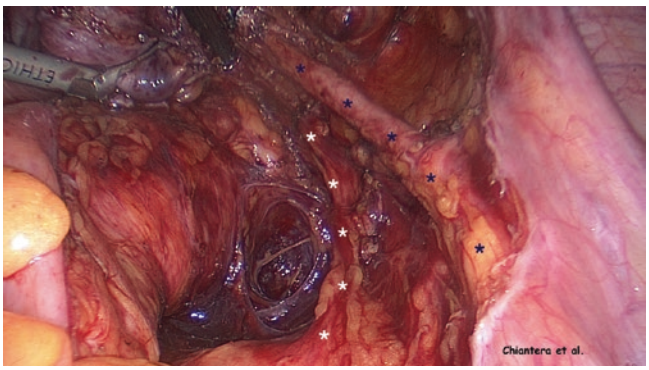


Fig. 43.5 Following the right hypogastric nerve the caudal and dorsal part of the parasacral space is developed up to the lateral border of the dorsal mesometrium.
Black stars: right ureter. *White stars*: right hypogastric nerve

lateral and the hypogastric plexus is identified just caudal the aortic bifurcation. The superior hypogastric plexus is identified at this level and the origin of the two hypogastric nerves is underlined (Fig. 43.4).

Tips

If difficult occurs in the identification of the superior hypogastric plexus the dissection can be further cranially developed up the the level of the aortic bifurcation where the dense tissue of the plexus is easier to identify.

Step 7 Development of the right pre-sacral fossa dorsally the Waldeyer's fascia and ventrally the parietal sacral fascia. Identification and isolation of the right hypogastric nerve adhering medially to the mesorectum (Fig. 43.5).

Step 8 The hypogastric nerve is lateralized in order to completely expose the ligamentous mesometrium. This maneuver is carried out down to the level where the pelvic splanchnic nerves join the right hypogastric nerves to form the right inferior hypogastric plexus.

The proximal inferior hypogastric plexus is mobilized from the lateral surface of the dense subperitoneal connective tissue which encases the rectum enabling the transection of the latter without nerve damage (Figs. 43.6, 43.7, 43.8 and 43.9).

Step 9 A complete uterus anti-version is obtained with the assistant instrument positioned behind the cervix. The Douglas peritoneum is now incised and the recto-vaginal septum is developed up to the level were the previous vaginal dissection was carried. Once the correct traction is obtained and the hypogastric nerves are lateralized, the ligamentum

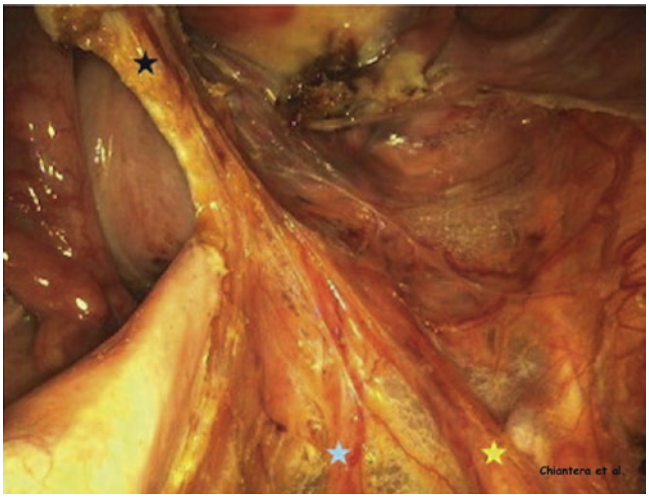


Fig. 43.6 The right hypogastric nerve is lateralized and divided from the posterior mesometrium. Thus the cranial aspect of the dorsal mesometrium is developed. *Black star*: mesometrium. *Yellow star*: right ureter. *Light blue star*: right hypogastric nerve

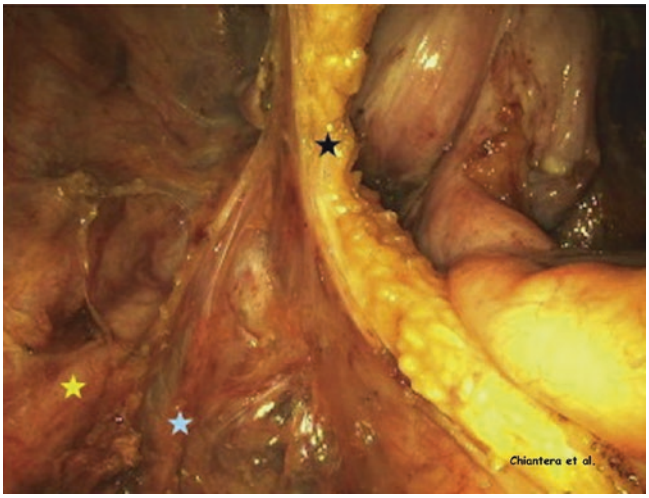


Fig. 43.8 Further lateralization of the left hypogastric nerve from the dorsal mesometrium. *Black star*: mesometrium. *Yellow star*: left ureter. *Light blue star*: left hypogastric nerve

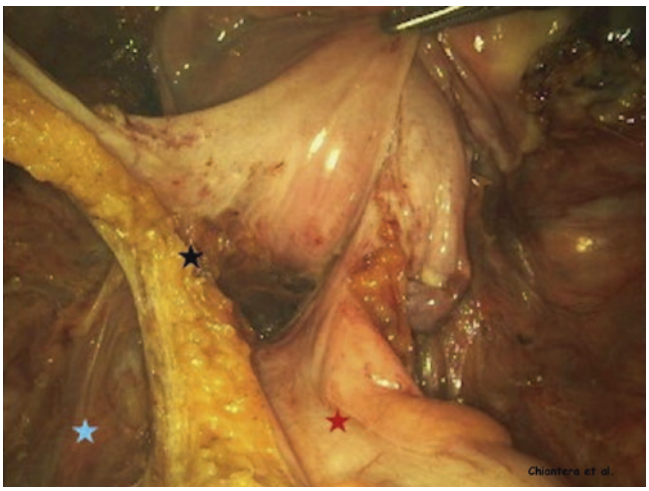


Fig. 43.7 On the left side the same preparation is carried out, the rectovaginal space is cranially dissected at this point. *Black star*: Mesometrium. *Red star*: Rectum. *Light blue star*: right hypogastric nerve

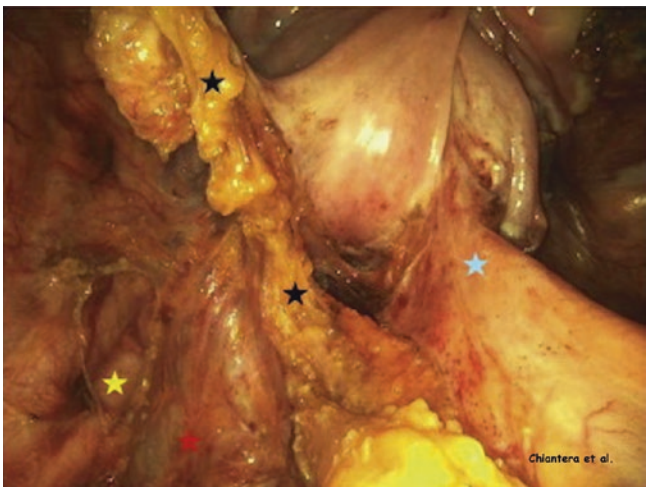


Fig. 43.9 The cranial and caudal part of the dorsal mesometrium is completely divided from the right hypogastric nerve. *Black stars*: cranial and caudal mesometrium. *Yellow star*: left ureter. *Red star*: left hypogastric nerve. *Light blue star*: Rectum

mesometrium. Is transected directly at the level of the anterior surface of the rectum (Fig. 43.10).

Tips

If necessary the rectum is pulled cranial-contralateral and suspended with a suture transfixed into the abdominal wall. Alternatively, the uterus can be suspended ventrally to the abdominal wall with two transfix suture and the assistant can pull the rectum at the level of the promontorium. One of this option is often required in order to obtain the necessary traction thus miming the exposure of the two posterior wings containing the posterior mesometrium as made by laparotomy.

Step 10 The dorsal part of the operation is now concluded (Fig. 43.11), proceeding ventrally the ureter is exposed and its route is completely exhibited until the cross with the uterine vessels (Fig. 43.12).

Step 11 Incision of peritoneum at the level of the vescicouterine septum with separation of bladder from the anterior cervix and the proximal vagina up to the level of the previous vaginal preparation.

Tips

The vescico uterine septum should be prepared just in his medial aspect in order not to detach the anterior mesometrium from the vescical fascia that has to be keep untouched

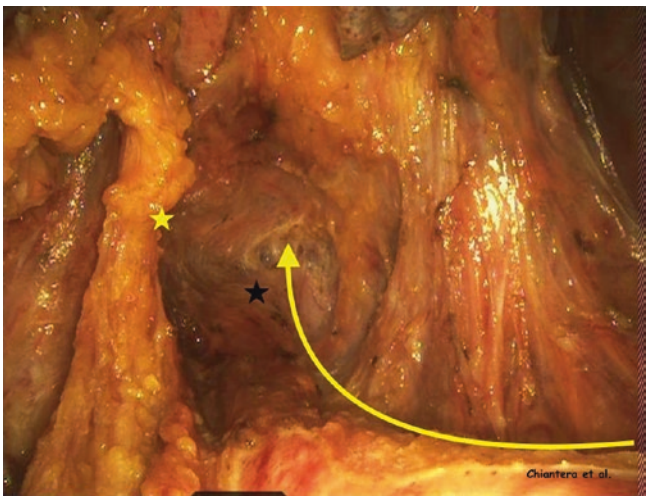


Fig. 43.10 Caudal preparation of the rectovaginal space up to the level of the dorsal vagina, this deep preparation allows a compete explosion of the caudal mesometrium. *Black star*: rectum. *Yellow star*: mesometrium. *Yellow arrow*: line resection of the mesometrium

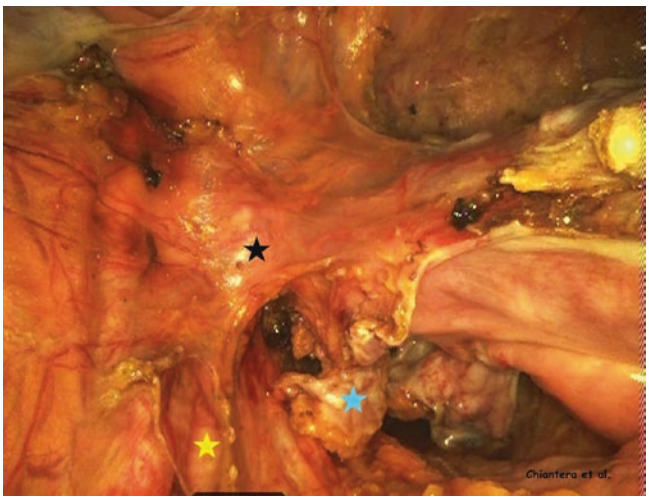


Fig. 43.12 Left vascular mesometrial preparation. *Yellow star*: ureter. *Black star*: vascular mesometrium. *Light blue star*: posterior mesometrium



Fig. 43.11 Right side at the end of the dorsal parametrectomy with cranial and caudal mesometrial preparation. Anatomical relations between the ureter, the right nerve and the dorsal mesometrium. *Blue circle*: divided Mesometrium. *Yellow star*: dorsal aspect of the Parasacral space. *Blue star*: sacral promontorium. *Yellow dotted line*: hypogastric nerve and plexus. *Blue dotted line*: right ureter

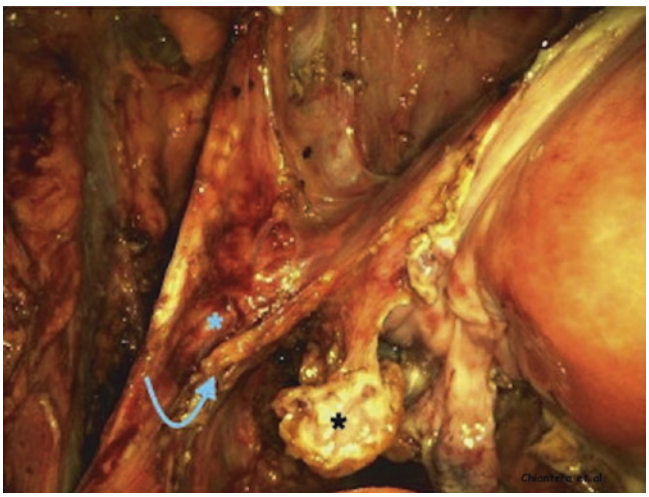


Fig. 43.13 Left vascular mesometrial preparation. *Light blue star*: left ureter. *Light blue arrow*: left vascular mesometrium. *Black star*: posterior mesometrium

until the sharp preparation of the space between the mesometrium and the lateral bladder is completed.

Step 12 The umbilical artery together with the superior bladder mesentery is separated from the anterior mesometrium with sharp dissection in order to isolate the lateral meometrium from the anterior one (Figs. 43.13 and 43.14).

Tips

Differently from the "classic" radical hysterectomy neither the lateral pararectal fossa after Latzko neither the medial one after Okabayashi are developed.

Step 13 The uterine arteries and veins are now coagulated and cut at their origins, this allow the vascular mesometrium to be flipped medially. The lateral mesometrium is mobilized from its origin at the site of the already transected uterine artery and vein(s) towards the uterus beyond the superior surface of the ureter (Figs. 43.15 and 43.16).



Fig. 43.14 Left vascular mesometrial preparation. *Light blue star*: left uterine artery. *Black arrow*: left ureter. *Yellow star*: ureteral tunnel



Fig. 43.16 Left vascular mesometrial preparation after the flipping. *Black arrow*: left ureter. *Yellow star*: rolled vascular mesometrium

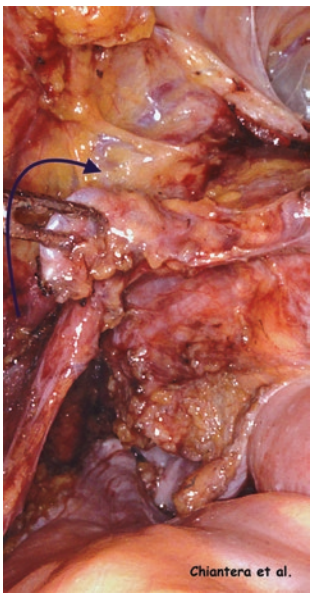


Fig. 43.15 Left vascular mesometrial preparation. Flipping of the vascular mesometrium above the ureter

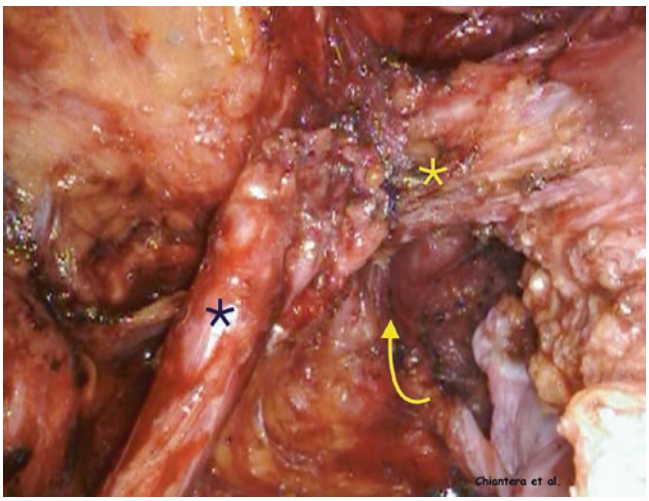


Fig. 43.17 Left vascular mesometrial preparation. Dividing the paravaginal tissue medially to the hypogastric nerve and plexus. *Blue Star: Ureter*, *Yellow Star*: paravaginal tissue, *Yellow arrow*: direction of the hypogastric nerve and plexus

Tips

The mesoureter has to be divided at the level of the lateral mesometrium in order to permit the medial rotation of the uterine artery and vein above and behind the ureter.

Step 14 The operation proceeds now in the anterior compartment. The vescico-vaginal venous plexus together with the dense subperitoneal connective tissue above the prevesical segment of the ureter is coagulated and divided. After cutting the remaining dorsal attachments the ureter can be completely mobilized laterally together with the dorsal part of the dense vescico caginal tissue containing the bladder branch of the pelvic parasympathetic nerve (Fig. 43.17).

Step 15 The paracolpium placed immediately lateral the initial "manchette" is transected connecting the anterior vescico-vaginal space with the posterior retto-vaginal one (Fig. 43.18).

Step 16 The TMMR-specimen is removed through the vagina and the vaginal stump is closed with laparoscopical sutures (Fig. 43.19).

According to Höckel approach no adjuvant radiotherapy should be indicated; although patients with lymph-node

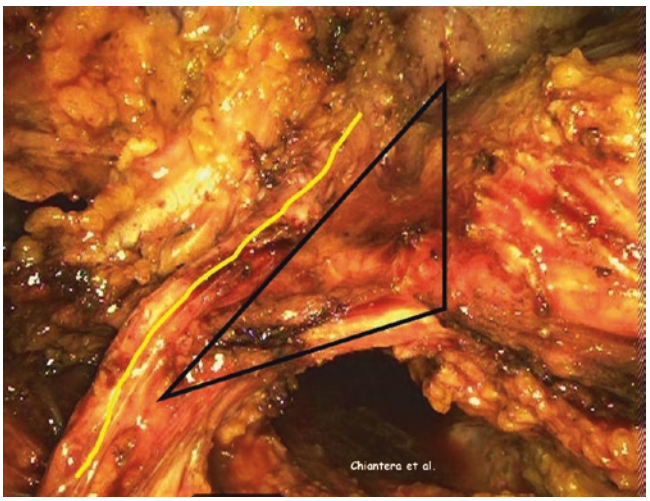


Fig. 43.18 Left vascular mesometrial preparation. Dividing the paravaginal tissue medially to the hypogastric nerve and plexus. *Yellow line*: left ureter. *Black triangle*: left paravaginal tissue

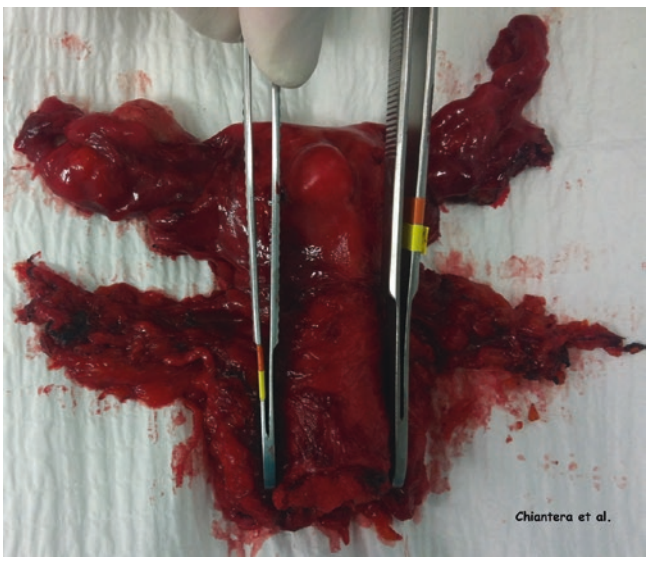


Fig. 43.19 The TMMR surgical specimen with the two of the four "wings"

metastases should be suggested to receive adjuvant chemotherapy with 75 mg/m^2 cisplatin for up to six 3-week cycles, because it had been demonstrated that adjuvant chemotherapy after conventional radical hysterectomy also reduced the incidence of distant metastases in patients with pN1 tumors [21].

Patients should be enrolled in a follow-up program of assessments at 3-month intervals for the first 2 years after surgery, and should be assessed at 6-month intervals thereafter.

It has to be acknowledged that the level of evidence supporting the oncological role of TMMR is still low. The introduction of the ontological surgery in the standard treatment of cervical cancer will probably need more support from the scientific community and further prospective randomized data. However, although the role of TMMR in cervical cancer remains to be definitively established, compelling data from retrospective and prospective series support its role in this clinical setting [11–15]. In conclusion, further larger prospective studies are needed in order to confirm these promising results and to compare this results to the outcome of the classical radical hysterectomy as well as to better define the laparoscopic surgical steps and the subsequent oncological outcome of patients undergoing TMMR compared to a classical open surgical approach.

References

1. Wertheim E. The extended abdominal operation for carcinoma uteri (based on 500 operative cases). Am J Obstet Dis Women Child. 1912;66:169–232.
2. Meigs VJ. Radical hysterectomy with bilateral pelvic lymph node dissections. A report of 100 patients operated on five or more years ago. Am J Obstet Gynecol. 1951;62:854–70.
3. Höckel M, Dornhöfer N. The hydra phenomenon of cancer: why tumors recur locally after microscopically complete resection. Cancer Res. 2005;65:2997–3002.
4. Waggoner SE. Cervical cancer. Lancet. 2003;361:2217–25.
5. Höckel M, Horn LC, Hentschel B, Höckel S, Naumann G. Total mesometrial resection: high resolution nerve-sparing radical hysterectomy based on developmentally defined surgical anatomy. Int J Gynecol Cancer. 2003;13:791–803.
6. Höckel M, Horn LC, Fritsch H. Association between the mesenchymal compartment of uterovaginal organogenesis and local tumour spread in state 1B–2B cervical carcinoma: a prospective study. Lancet Oncol. 2005;6:751–6.
7. Höckel M. Do we need a new classification for radical hysterectomy? Insights in surgical anatomy and local tumor spread from human embryology. Gynecol Oncol. 2007;1:106–12.
8. Höckel M, Horn LC, Manthey N, Braumann UD, Wolf U, Teichmann G, Frauenschläger K, Dornhöfer N, Einenkel J. Resection of the embryologically defined uterovaginal (Müllerian) compartment and pelvic control in patients with cervical cancer: a prospective analysis. Lancet Oncol. 2009;10:683–92.
9. Höckel M, Kahn T, Einenkel J, Manthey N, Braumann U-D, Hildebrandt G, Leo C, Hentschel B, Vaupel P, Horn L-C. Local spread of cervical cancer revisited: a clinical and pathological pattern analysis. Gynecol Oncol. 2010;117:401–8.
10. Höckel M, Horn L-C, Tetsch E, Einenkel J. Pattern analysis of regional spread and therapeutic lymph node dissection in cervical cancer based on ontogenetic anatomy. Gynecol Oncol. 2012;125:168–74.
11. Höckel M. Cancer permeates locally within ontogenetic compartments: clinical evidence and implications for cancer surgery. Future Oncol. 2012;8:29–36.
12. Manjunath AP, Girija S. Embryologically based resection of cervical cancers: a new concept of surgical radicality. J Obstet Gynaecol India. 2012;62(1):5–14.
13. Kimmig R. Robotic surgery for cervical cancer. Endoscopic total mesometrial resection and therapeutic lymphadenectomy [Robotic surgery beim Zervixkarzinom. Endoskopische total emesometriale Resektion und therapeutische Lymphonodektomie]. Gynakologe. 2012;45:707–11.

14. Kimmig R, Iannaccone A, Buderath P, Aktas B, Wimberger P, Heubner M. Definition of compartment-based radical surgery in uterine cancer — part I. Therapeutic pelvic and periaortic lymphadenectomy byMichael Höckel translated to robotic surgery (rtLNE). ISRNObstetGynecol.2013;2013:297921.doi:10.1155/2013/297921.
15. Höckel M, Hentschel B, Horn LC. Association between developmental steps in the organogenesis of the uterine cervix and locoregional progression of cervical cancer: a prospective clinicopathological analysis. Lancet Oncol. 2014;15(4):445–56.
16. Chiantera V, Vizzielli G, Lucidi A, Gallotta V, Petrillo M, Legge F, Fagotti A, Sehouli J, Scambia G, Muallem MZ. Laparoscopic radical hysterectomy in cervical cancer as total mesometrial resection (L-TMMR): a multicentric experience. Gynecol Oncol. 2015;139(1):47–51. pii: S0090-8258(15)30071-8
17. Kruijdenberg CB, van den Einden LC, Hendriks JC, Zusterzeel PL, Bekkers RL. Robot-assisted versus total laparoscopic radical hysterectomy in early cervical cancer, a review. Gynecol Oncol. 2011;120(3):334–9.
18. Possover M, Quakernack J, Chiantera V. The LANN technique to reduce postoperative functionalmorbidity in laparoscopic radical pelvic surgery. J Am Coll Surg. 2005;201(6):913–7.
19. Vizzielli G, Lucidi A, Gallotta V, Petrillo M, Dessole M, Fagotti A, Costantini B, Scambia G, Chiantera V. Robotic total mesometrial resection (R-TMMR) *vs.* Laparoscopic total mesometrial resection (L-TMMR) in early cervical cancer: a case-control study. J Minim Invasive Gynecol. 2016;23(5):804–9. In Press
20. Gottschalk E, Lanowska M, Chiantera V, Marnitz S, Schneider A, Brink-Spalink V, Hasenbein K, Koehler C. Vaginal-assisted laparoscopic radical hysterectomy: rationale, technique, results. JSLS. 2011;15(4):451–9.
21. Peters WA, Liu PY, Barrett RJ, et al. Concurrent chemotherapy and pelvic radiation therapy compared with pelvic radiation alone as adjuvant therapy after radical surgery in high-risk early-stage cancer of the cervix. J Clin Oncol. 2000;18:1606–13.

Laparoscopic Radical Hysterectomy for Malignant Indications: Laparoscopic Trachelectomy

44

Vito Chiantera, Alessandro Lucidi, and Marco Petrillo

Cervical cancer is the third most common female cancer and the fourth leading cause of female cancer death worldwide [1]. Approximately 15 % of all cervical cancers are diagnosed in women under the age of 40 years who wish to preserve their fertility [2, 3]. For these reasons, although radical hysterectomy with lymph node dissection represents the standard treatment for early-stage cervical cancer, alternative surgical approaches able to spare reproductive organs have been developed.

In this context, vaginal radical trachelectomy (VRT) with laparoscopic lymphadenectomy represents the gold standard for fertility sparing surgery in early stage cervical cancer patients. This surgical technique was firstly described by Dargent [4] in the 1980s, and to date more than 1000 cases of VRT have been published, with a global pregnancy rate (total number of women who conceived of all who retained fertility) of 24 % [5], and a relapse and death rate of 4.2 % and 2.9 %; respectively [6].

Radical trachelectomy is a surgical procedure in which is removed the cervix with parametria, the upper part of the vagina and pelvic lymph nodes.

Criteria used to select candidates for radical vaginal hysterectomy are:

1. Confirmed invasive cervical cancer: squamous, adenocarcinoma, or adenosquamous
2. FIGO stage IA1 with lymphovascular space involvement, FIGO IA2 L0 or L1 V0 to IB1 L0 or L1 V0
3. Desire to preserve fertility
4. Lesion size < 2 cm
5. No previous history of infertility
6. Limited endocervical involvement at colposcopy (R0 resection possible with surgical margin >5 mm)
7. Estimated length of remaining cervix >1 cm
8. Post-conization adequate resolution of acute inflammation required (usually a 6-week interval between conization and RT)
9. Negative pelvic lymph node status

In this context, although VRT still represents the best surgical approach, only in selected cases laparoscopic radical trachelectomy (LRT) may offer specific advantages.

It has been considered that the age of first pregnancy is progressively increasing; therefore the vast majority of women receiving fertility sparing surgery are nulliparous at the time of surgery.

In these cases, RVT can be technically complex, and the laparoscopic route can be a more reliable strategy. Moreover, LRT represents an alternative to RVT for several gynecologic oncologists who are not proficient in vaginal radical surgery.

In addition, LRT ensures an easier identification of the uterine artery and the hypogastric nerve compared with the vaginal approach, thus allowing a more precious dissection of the parametrium. Therefore, using the laparoscopic route surgeons can better tailor the width of parametrium resection compared with the vaginal approach. In this context, it has to be considered that a novel surgical technique, the total mesometrial resection (TMMR) has been recently proposed as an affective therapeutic strategy in early stage cervical cancer patients [7], with recently published evidences suggesting the feasibility of laparoscopic TMMR [8]. Therefore, LRT may represent an attracting strategy in order to remove mesometrium according with Hockel technique which is not applicable with the vaginal approach.

For these reasons, LRT may be considered in women with tumor dimension > 2 cm receiving fertility sparing surgery which may require a wider parametrial resection. In these

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cases, LRT may be considered only in the context of controlled clinical trials in which a fertility sparing surgical treatment is proposed after neoadjuvant chemotherapy [9]. In this regard, too many case reports and retrospective studies have been presented in literature proposing abdominal trachelectomy as surgical option for patients with tumor dimension >2 cm [10].

In conclusion, we have to point out that for tumor >2 cm LTR may be considered only in the context of controlled clinical trials and at the same time we have to remember that even in patients with tumor dimension <2 cm the real advantage of LRT compared to VRT must be proved necessarily and exclusively through a randomized prospective clinical trial.

In this context, it has to be emphasized that to safely complete LRT is mandatory to perform vaginal manchette to avoid intraperitoneal diffusion of cancer cells during specimen's removal after surgery. We believe that to cure women diagnosed with cervical cancer by fertility-preserving surgery, correct indication and oncologic precautions are more important than the type of approach. During surgical procedures the tumor may be inadvertently manipulated and the tumor cells may have been mobilized [11]. Although it has not yet been demonstrated worsening oncological outcome in cases in which vaginal cuff closure is not performed we consider this procedure essential more so in patients receiving LRT. Indeed, in these cases uterine cervix is exposed in the abdominal cavity to be transected allowing not only a vaginal tumor cell contamination (as for standard radical hysterectomy) but also an intraabdominal tumor spread.

Looking at the literature, a recent review including 485 abdominal radical trachelectomies reported a relapse and death rates of 3.8 % and 2.9 %, respectively [5]; which appears comparable with the results reported for VRT. In particular focusing on the laparoscopic approach, 140 LRT have been described in the literatures (Table 44.1). The operative outcomes are summarized in Table 44.2. The analysis of combined data demonstrates a low average intraoperative complication rate of 0.7 % with an incidence of postoperative complications around 6.4 %. The most common intraoperative complication is represented by the injury of uterine artery occurring during pelvic lymphadenectomy. On the other hand, the most frequent post-operative complications are represented by cervical stenosis, and bladder hypotonia due to the surgical-related damage of the sympathetic and parasympathetic branches of the pelvic autonomic nerve system.

Rates of conversions to laparotomy or secondary surgeries for parametrial bleeding, blood vessel injury, lymphocele, suprapubic, or vulvar hematoma range between 0 %

Table 44.1 Patient characteristics of total laparoscopic radical trachelectomy for early-stage cervical cancer in published studies

Characteristics	Lee et al. [12]	Cibula et al. [13]	Park et al. [14]	Park et al. [15]	Martin et al. [16]	Lu et al. [17]	Ebisawa et al. [18]	Kucukmetin et al. [19]
Number of patient	2	1	4	55	9	25	56	11
Age, years	32	36	29	32	32	29	32	28
Stage, n. patients								
Ia2			1	2	2	10	4	
Ib1	2	1	3	53	7	15	52	11
IIa								
Histologic subtype, n. patients								
Squamous cell carcinoma	2	1	4	42	6	25	42	5
Adenocarcinoma				13	3		12	6
Other							2	

Table 44.2 Operative outcomes after total laparoscopic radical trachelectomy for early-stage cervical cancer in published studies

Characteristics	Lee et al. [12]	Cibula et al. [13]	Park et al. [14]	Park et al. [15]	Martin et al. [16]	Lu et al. [17]	Ebisawa et al. [18]	Kucukmetin et al. [19]
Number of patient	2	1	4	55	9	25	56	11
EBL, ml	650	250	185	NA	NA	120	300	85
Operative Time, min	353	250	250	NA	270	232	349	320
Hospital stay, day	13	6	NA	NA	5.2	3.3	17.5	4
FU, months	11	4	34	NA	28	66	60	9
Intraoperative complication	Injured vessel	No	No	No	No	No	No	NA
Post-operative complications	Bladder hypotonia	No	No	No	No	Voiding dysfunction	Cervical stenosis	NA

and 9 %. Postoperative complications such as dysmenorrhea (24 %), dyspareunia (20 %), menstrual abnormalities (17 %), excessive vaginal discharge (14 %), recurrent candidiasis (14 %), bladder hypotonia (4–16 %), vulvar edema (12 %), lymphocele (3–11 %), chronic pelvic pain (10 %), isthmic stenosis (10 %), amenorrhea (7 %), vulvar hematoma (7 %), suprapubic hematoma (4 %), lymphedema (3 %), urinary tract infection (2 %), and femoro-cutaneous nerve palsy (1 %) are reported.

Focusing on oncologic outcome, the tumour recurrence rate reported with LRT is 2.9 %, which appears superimposable or even lower compared with data reported for VRT (4.2–5.3 %), and abdominal radical trachelectomy (3.8 %) [5, 20]. Furthermore, the risk of recurrence does not seem to be greater after LRT for adenocarcinoma compared with squamous cell carcinoma (2.8 vs. 2.9 %), thus suggesting that tumor histotype does not represent a contraindication to the use of the laparoscopic route.

The obstetric outcomes after LRT for early-stage cervical cancer in the available literature are presented in Table 44.3. Overall, 59 patients attempted to conceive after LRT, and 46 patients successful deliveries were recorded, with a pregnancy rate of 78 % (46/59). Seventeen miscarriages, 14 preterm births and 11 term births have been described. On the other hand, the pregnancy rate in patients attempting to conceive after VRT is 52.8 % [5, 21], thus suggesting that the pregnancy rate after LRT is not lower compared with VRT. Similarly, the pregnancy loss rate is superimposable between vaginal and laparoscopic approach, accounting for 24 % [5, 21]. Unfortunately, regardless of the used surgical strategy, the pregnancy loss rates are significantly higher than that of the general population (12 %) [22]. The preterm birth rate of patients who gave birth after vaginal or abdominal radical trachelectomy is 24.7 %, and 38.7 % respectively. The preterm birth rate after LRT was 24 % in all the published studies, which appears again higher than general population, but superimposable with the vaginal approach [23]. Further investigations are required to establish definitive guideline for preterm birth prevention following radical trachelectomy.

Surgical Procedure

The surgical procedure is similar to that for laparoscopic nerve-sparing radical hysterectomy as described by Querleu [24]. In this chapter we describe our surgical modified technique according to the compartment theory besed on ontogenetic anatomy proposed by Hockel. The laparoscopic procedure is performed in the modified dorsolithotomy position under endotracheal general anesthesia. A Veress needle is inserted through the umbilicus and the abdomen is insufflated. After pneumoperitoneum and insertion of the laparoscope through an umbilical 10 mm trocar, three suprapubic 5 mm trocars are introduced for ancillary instruments.

Step 1 Preserving the integrity of the round ligament, the retroperitoneal space is entered along the lateral pelvic wall, thereby exposing the common iliac, external iliac, internal iliac and umbilical arteries. The pelvic visceroparietal ground plan is exposed by dissecting the areolar fibrous tissue to create a "paravisceral space" down to the pubo- and iliococcygeus muscles and a "presacral space" to the ventral margin of the inferior hypogastric plexus separated by the urogenital mesentery. Laterally to the external iliac vessels the obturator and lumbosacral fossa are developed. We proceed with the identification of the obturator nerves, the lumbosacral trunc, the gluteal vessels and the sciatic nerve. The lymph node dissection include the external and internal iliac nodes and the superficial and deep obturator nodes. We extend the radicality of our lymphadenectomy to the gluteal and pre-ischiatic nodes according to the therapeutic lymphadenectomy described by Hockel (Fig. 44.1) [7]. Lymph nodes are extracted in endoscopic bags through

Table 44.3 Obstetric outcomes after total laparoscopic radical trachelectomy for early-stage cervical cancer in published studies

Characteristics	Lee et al. [12]	Cibula et al. [13]	Park et al. [14]	Park et al. [15]	Martin et al. [16]	Lu et al. [17]	Ebisawa et al. [18]	Kucukmetin et al. [19]
Number of patient	2	1	4	55	9	25	56	11
Attempted to conceive, n. patients	NA	NA	NA	18	4	12	25	NA
Pregnancies, n. patients	NA	NA	NA	14	2	9	21	0
Miscarriages, n. patients	NA	NA	NA	4	0	3	10	0
Preterm birth, n. patients	NA	NA	NA	6	0	1	7	0
Term birth, n. patients	NA	NA	NA	4	1	3	3	0
Ongoing pregnancy, n. patients	NA	NA	NA	0	1	2	1	0

the 10-mm sheath for perioperative histological examination. If the lymph nodes are negative, the procedure is continued.

Tip The pararectal fossa during this step is not developed to avoid uterine artery injury during lymphadenectomy. We proceed with this step later when we have a complete exposition of the pelvic retroperitoneum.

Step 2 A vaginal step is performed with vaginal "manchette" creation (Fig. 44.2a, b) in order to encapsulate tumor lesion and reduce tumor spread during uterine manipulation, according to previous published data [25]. The vescico-vaginal and recto-vaginal septum are opened without peritoneal incision.

Tip A sterile gauze is placed inside the developed septum for a easier identification of the developed space during laparoscopy. A sterile glove with a gauze inside are placed into the vagina to prevent gas loss during laparoscopy.

Step 3 The development of the medial and lateral pararectal space is then performed (Fig. 44.3). The lateral pararectal fossa (Latzko's fossa) is developed until the plan of uterine vein.

Tip Differently from what we have previously reported for radical hysterectomy [26] the parasympathetic nerves plan is not reached and the sacral fascia remains intact along the surface of the sacral root.

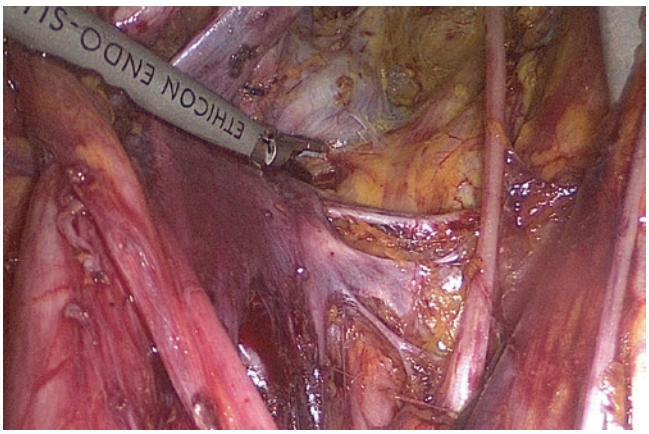


Fig. 44.1 Pelvic side wall after radical lymphadenectomy according to Hockel

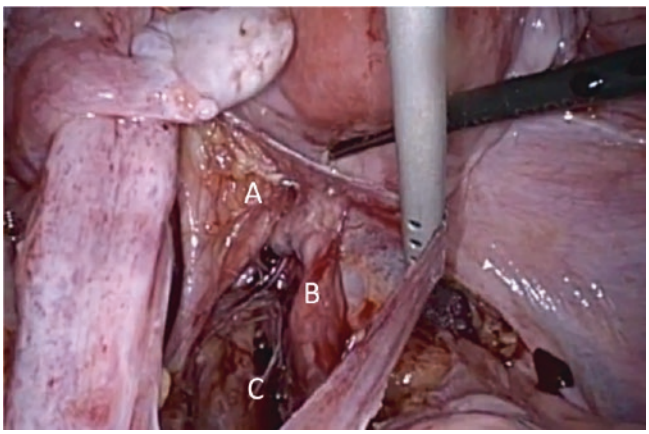


Fig. 44.3 Uterine artery (*A*); Ureter (*B*), Pararectal space (*C*)

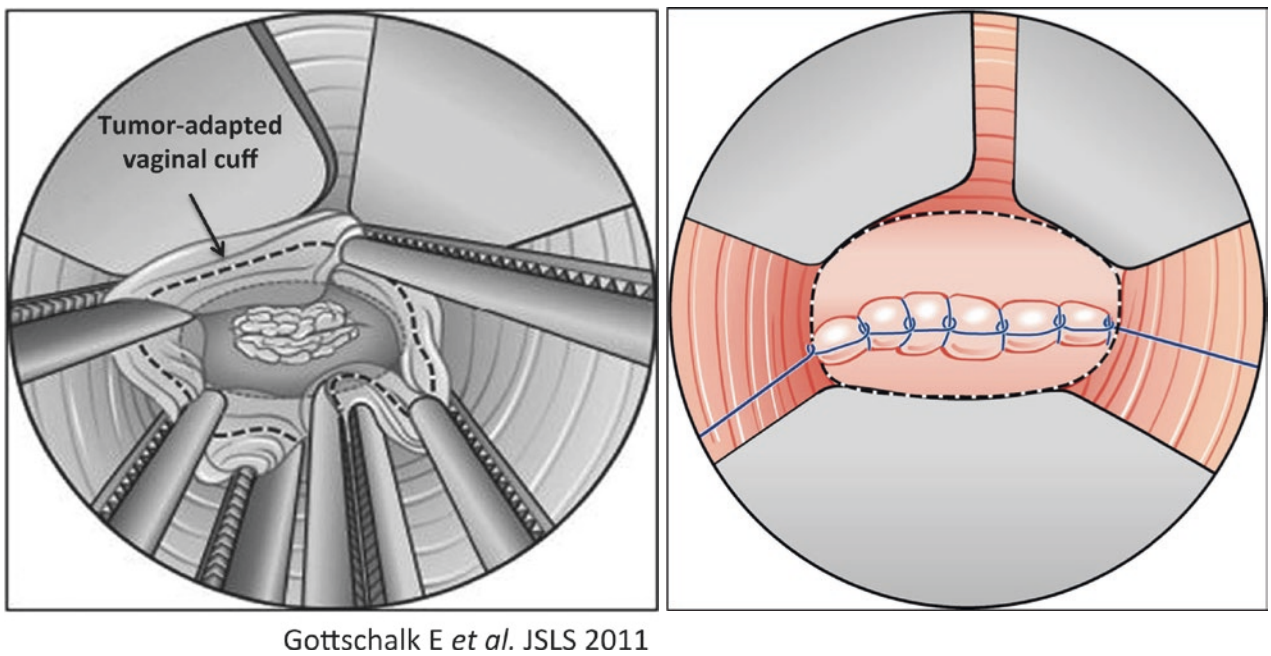


Fig. 44.2 Vaginal manchette

Step 4 The superior hypogastric plexus is isolated at the level of the sacral promontory and the right hypogastric nerve is identified (Fig. 44.4) with the development of the parasacral fossa.

Step 5 A peritoneal incision on the left side is performed at the level of the common iliac artery. The hypogastric plexus and the left hypogastric nerve are identified and the parasacral fossa is developed with reunification on the contralateral space (Fig. 44.5).

Tip At this point the rectum should be cranially pulled. We generally anchored it to the abdominal wall by placing a stitch on the rectal tenia.

Step 6 Hypogastric nerves are bilaterally lateralized and the peritoneum is transected medially to the ureter until the posterior mesometrium (Fig. 44.6) which is then transected at the level of the vaginal manchette (Fig. 44.7).

Tip Before the mesometrial transection Douglas peritoneum should be opened in order to identify the gauze previously positioned during the vaginal step.

Step 7 The pelvic ureter is separated from the broad ligament to the crossing of the uterine artery, and the hypogastric nerve is identified in the space created between the broad ligament and the mesoureter (Fig. 44.8).

Step 8 The uterine vessels and ureters are identified bilaterally (Fig. 44.9). The ascending and descending branches of

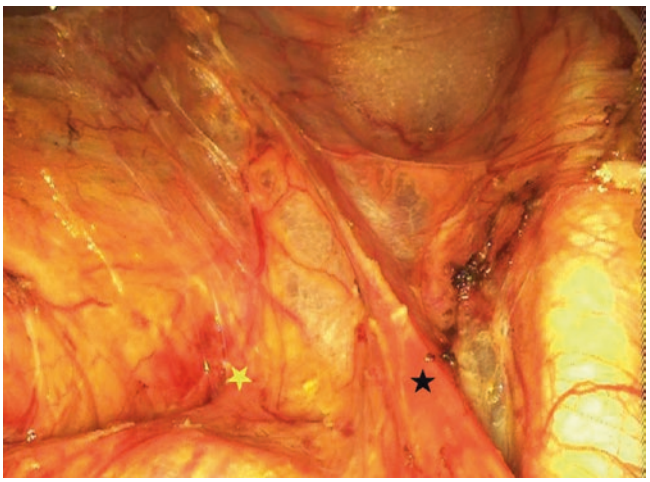


Fig. 44.4 *Black star*: right ureter. *Yellow star*: right hypogastric nerve

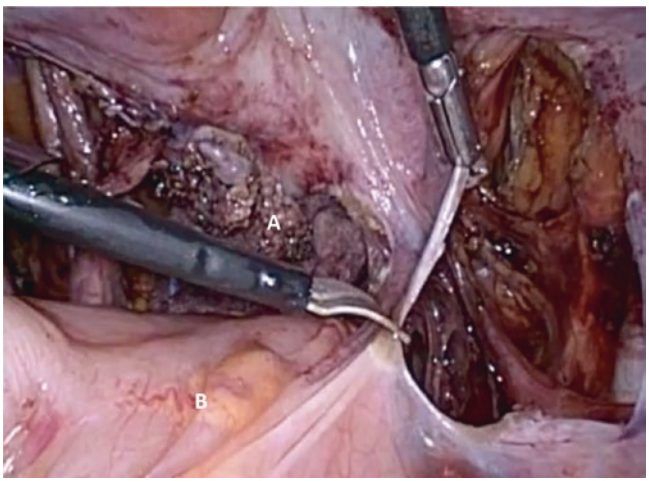


Fig. 44.6 Douglas (*A*); Rectum (*B*)

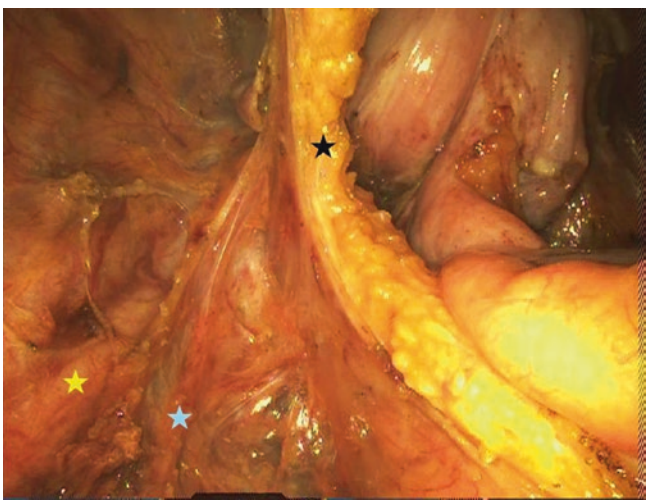


Fig. 44.5 *Black star*: mesometrium. *Yellow star*: left ureter. *Light blue star*: left hypogastric nerve

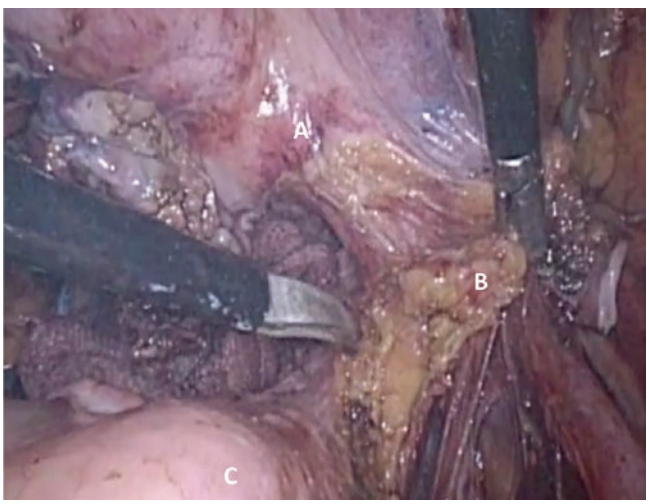


Fig. 44.7 Cervix (*A*); Mesometrium (*B*); Rectum (*C*)

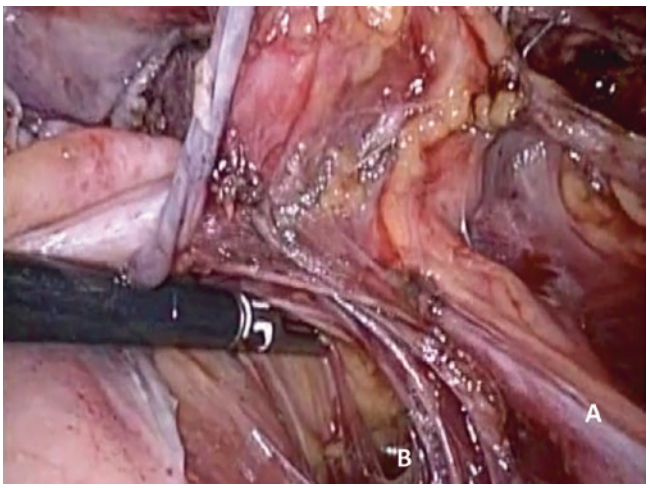


Fig. 44.8 Ureter (*A*); Hypogastric plexus (*B*)

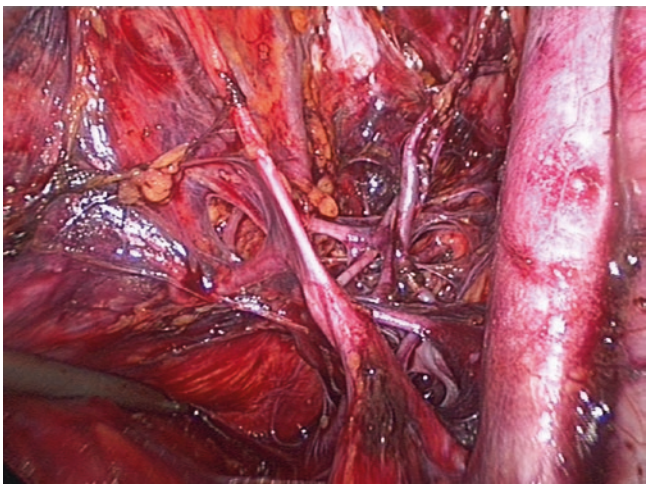


Fig. 44.10 Right lateral parametrium and paravescical space

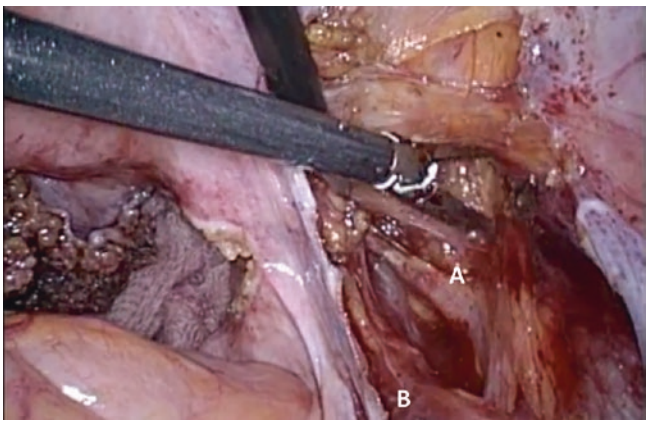


Fig. 44.9 Uterine artery (*A*); Ureter (*B*)

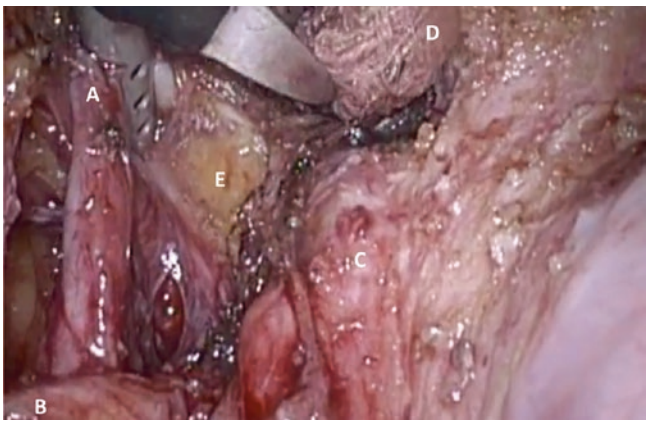


Fig. 44.11 Ureter (*A*); Uterine artery (*B*); Cervix (*C*); Vagina (*D*); Vescico-uterine ligament (*E*)

uterine artery are identified and in our technique uterine artery with both branches is preserved till to final cervical resection from the uterine corpus. The lateral parametrium is resected below (dorsally) the uterine artery (Fig. 44.10). The uterine vein is sectioned at the origin and then the parametrium is rotated below the ureter.

Tip In contrast to our classic radical hysterectomy where the mesouretere remains intact and the parametrium (including uterine artery) is rotated above and medially to the ureter, we prefer to dissect the mesouretere sliding the parametrium (with the uterine artery intact) below ureter.

Step 9 The vescico-vaginal space is opened with the identification of the gauze previously positioned during vaginal step (Fig 44.11).

Tip The two bladder corners are pulled ventrally positioning two stitches through the abdominal wall.

Step 10 The dissection of vescicouterine ligament is performed defining a section plane between the cervix (medially) and the terminal ureter (externally) with the bladder positioned ventraly and the uterine artery dorsally (Fig. 44.11).

Step 11 The uretere is isolated caudally to the uterine artery, surrounded by a rubber strip and anchored to the abdominal wall (Fig. 44.12). In this way we create a kneeling of the uretere caudally to the uterine artery.

Step 12 The infraureteral anterior parametrium, the anterior and lateral paracolpium are transected dorsally to the pulled ureter (Fig. 44.13).

Tip At this point the anterior (vescico-vaginale), lateral and posterior (recto-vaginal) spaces are in communication and the cervix remains pegged to the posterior paracolpium.

Step 13 The remaining paracolpium (Fig. 44.14) is transected caudally to the vaginal manchette.

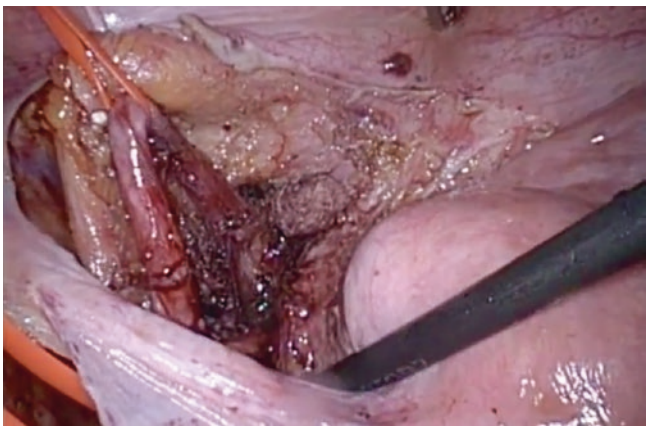


Fig. 44.12 Anchored ureter

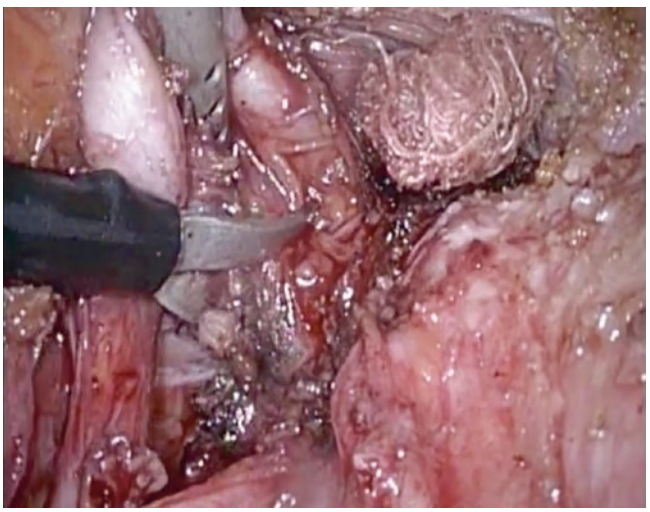


Fig. 44.13 Infraureteral anterior parametrium

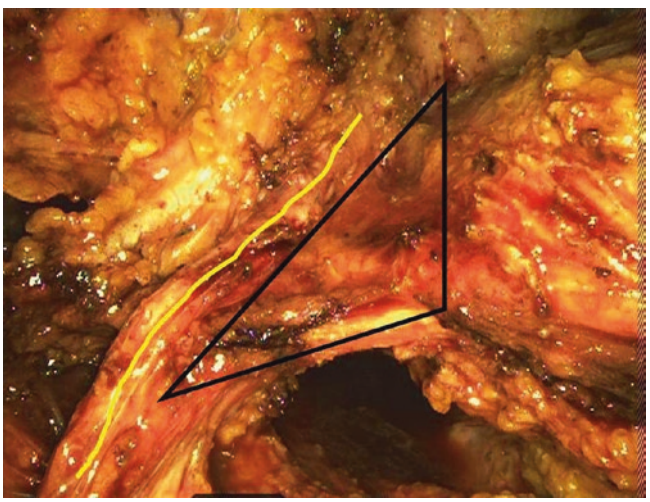


Fig. 44.14 *Yellow line*: left ureter. *Black triangle*: left paracolpium

Step 14 All these steps are performed bilaterally.

Tip The uterus at this point is held in place by the round ligaments, the uterine arteries and the pelvic infundibula.

Step 15 The vaginal manchette is rotated ventrally in order to expose the isthmus (Fig. 44.15).

Step 11 The descending branch of uterine artery is coagulated, whereas the ascending branch is preserved, then the cervix is then transected approximately few millimetres below the insertion of the uterine artery (Fig. 44.16). The excised cervix is marked and sent for frozen section for the evaluation of surgical margins.

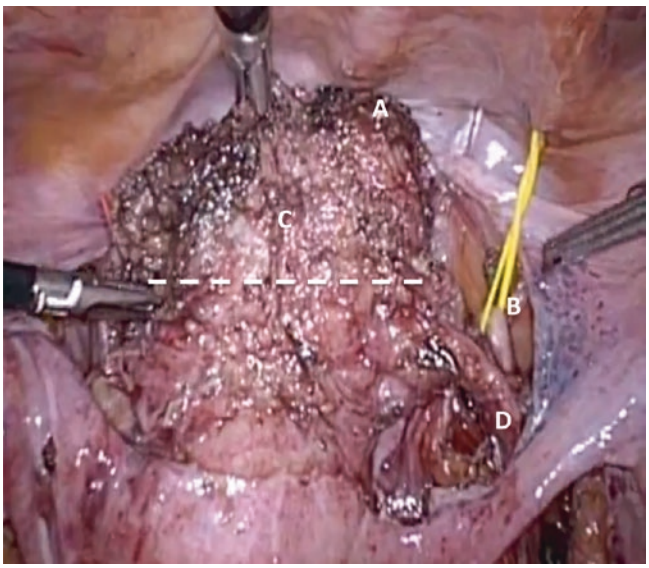


Fig. 44.15 Vaginal manchette (*A*); Ureter (*B*); Cervix (*C*); Uterine artery (*D*)

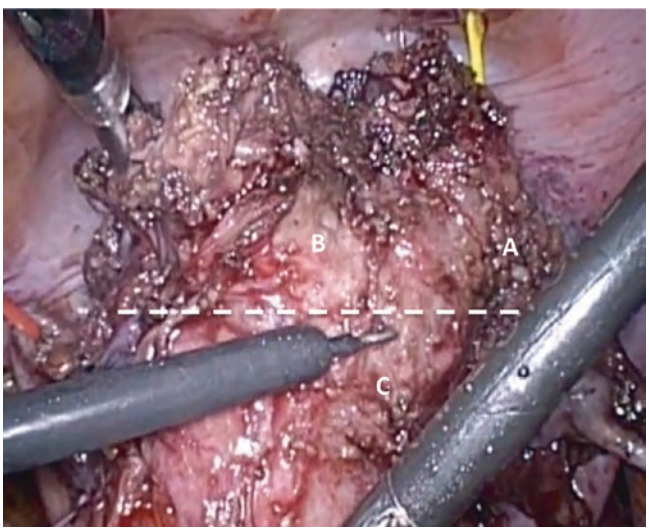


Fig. 44.16 Parametrium (*A*); Cervix (*B*); Isthmus (*C*)

Step 12 Reanastomosis of the uterine corpus and upper vagina is then laparoscopically performed and eight separated stiches are placed (Fig. 44.17).

Step 13 The specimen is sent for extemporaneous histological examination in order to evaluate the the margins of resection (Fig. 44.18).

A Foley catheter is always placed in the isthmus at the end of the surgical procedure.

After LVT, we recommended contraception with oral contraceptives for 6–12 months in patients with squamous cell carcinoma. Patients with adenocarcinomas were recommended non-hormonal contraception. During pregnancy following LVT, we recommended regular visits in short intervals such as in risk pregnancies. Cervical length was assessed on every visit or at least every 2 weeks. In the event of cervical shortening or funnel building, we recommended the Saling procedure between weeks 12 and 14. We recommended examining microbiologic vaginal smears every second week to detect vaginal infection as soon as possible. We advised women to check their vaginal pH twice a week starting in the second trimester. If a patient showed signs of cervical insufficiency, we recommended bed rest and hospitalization. We recommended routinely administering steroid and antibiotic prophylaxis before the 34th week to prevent acute respiratory distress syndrome and premature rupture of membranes (PROM) in patients with cervical insufficiency or suspicious microbiologic smears.

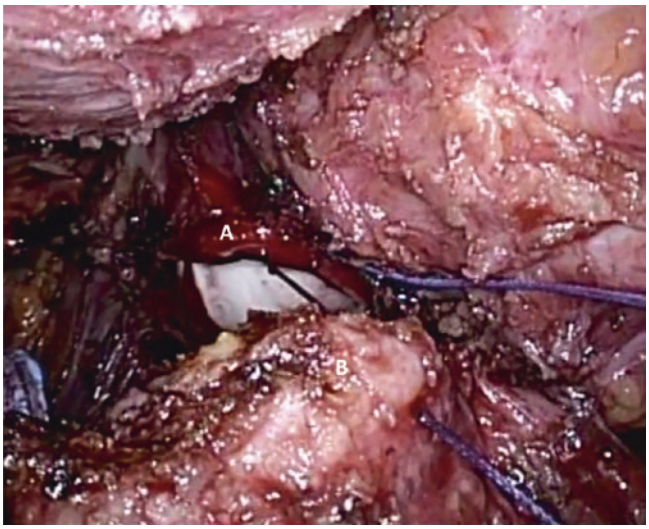


Fig. 44.17 Vagina (*A*); Uterine corpus (*B*)

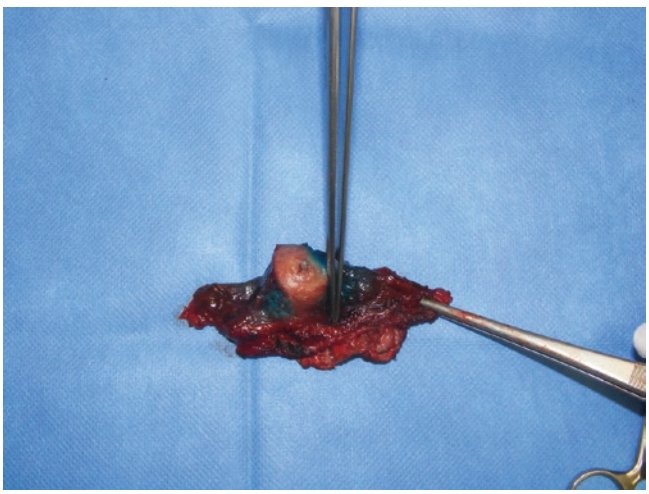


Fig. 44.18 Final surgical specimen

LRT does appear to be a well tolerated treatment for carefully selected patients. The advantages of minimally invasive approaches are visual enhancement, more precise dissection, less blood loss, fewer complications and shorter recovery time. The review of the literature indicates that pregnancy rates are high; however, preterm birth is common. LRT allows a more precious dissection of the parametrium and a wider parametrial resection; however "not always bigger means better". Therefore, VRT remains the gold standard, and LRT should be considered only in the context of clinical trial as an additional surgical approach for selected cases. In tertiary referral centers both surgical techniques must be available to properly tailor surgical management.

References

1. Jemal A, Bray F, Center MM, et al. Global cancer statistics. CA Cancer J Clin. 2011;61:69–90.
2. Rebecca S, Elizabeth W, Otis B, et al. Cancer statistics, 2011: the impact of eliminating socioeconomic and radical disparities on premature cancer death. CA Cancer J Clin. 2011;61:212–36.
3. Covens A, Rosen B, Murphy J, et al. Changes in the demographics and perioperative care of stage IA(2)/IB(1) cervical cancer over the past 16 years. Gynecol Oncol. 2001;81:133–7.
4. Dargent D, Brun L, Roy M. Trachelectomy broaden. An alternative to radical hysterectomy in the treatment of invasive cancers developed on the outer surface of the uterine cervix [in French]. J Obstet Gynecol. 1994;2:292–5.
5. Pareja R, Rendon GJ, Sanz-Lomana CM, Monzon O, Ramirez PT. Surgical, oncological, and obstetrical outcomes after abdominal radical trachelectomy – a systematic literature review. Gynecol Oncol. 2013;131:77–82.
6. Diaz JP, Sonoda Y, Leitao MM, Zivanovic O, Brown CL, Chi DS, et al. Oncologic outcome of fertility-sparing radical trachelectomy versus radical hysterectomy for stage IB1 cervical carcinoma. Gynecol Oncol. 2008;111:255–60.
7. Höckel M, Horn LC, Manthey N, Braumann UD, Wolf U, Teichmann G, Frauenschläger K, Dornhöfer N, Einenkel J. Resection of the embryologically defined uterovaginal (Müllerian) compartment and pelvic control in patients with cervical cancer: a prospective analysis. Lancet Oncol. 2009 Jul;10(7):683–92.
8. Chiantera V, Vizzielli G, Lucidi A, Gallotta V, Petrillo M, Legge F, Fagotti A, Sehouli J, Scambia G, Muallem MZ. Laparoscopic

radical hysterectomy in cervical cancer as total mesometrial resection (L-TMMR): a multicentric experience. Gynecol Oncol. 2015;139(1):47–51. pii: S0090-8258(15)30071-8.
9. Vercellino GF, Piek JM, Schneider A, Köhler C, Mangler M, Speiser D, Chiantera V. Laparoscopic lymph node dissection should be performed before fertility preserving treatment of patients with cervical cancer. Gynecol Oncol. 2012;126(3):325–9.
10. Pareja R, Rendón GJ, Vasquez M, Echeverri L, Sanz-Lomana CM, Ramirez PT. Immediate radical trachelectomy versus neoadjuvant chemotherapy followed by conservative surgery for patients with stage IB1 cervical cancer with tumors 2 cm or larger: a literature review and analysis of oncological and obstetrical outcomes. Gynecol Oncol. 2015;137(3):574–80.
11. Schneider A, Köhler C. Locoregional recurrence after laparoscopic radical trachelectomy: the vaginal cuff must be closed to avoid tumor cell contamination of the peritoneal cavity. Int J Gynecol Cancer. 2015;25(4):550.
12. Lee CL, Huang KG, Wang CJ, et al. Laparoscopic radical trachelectomy for stage Ib1 cervical cancer. J Am Assoc Gynecol Laparosc. 2003;10:11–115.
13. Cibula D, Ungar L, Palfalvi L, et al. Laparoscopic abdominal radical trachelectomy. Gynecol Oncol. 2005;97:707–9.
14. Park NY, Chong GO, Cho YL, et al. Total laparoscopic nerve-sparing radical trachelectomy. J Laparoendosc Adv Surg Tech. 2009;19:53–8.
15. Park JY, Kim DY, Suh DS, et al. Reproductive outcomes after laparoscopic radical trachelectomy for early-stage cervical cancer. J Gynecol Oncol. 2014;25:9–13.
16. Martin A, Torrent A. Laparoscopic nerve-sparing radical trachelectomy: surgical technique and outcome. J Minim Invasive Gynecol. 2010;17:37–41.
17. Lu Q, Zhang Y, Liu C, et al. Total laparoscopic radical trachelectomy in the treatment of early squamous cell cervical cancer: a retrospective study with 8-year follow-up. Gynecol Oncol. 2013;130:275–9.
18. Ebisawa K, Takano M, Fukuda M, et al. Obstetrics outcomes of patients undergoing total laparoscopic radical trachelectomy for early stage cervical cancer. Gynecol Oncol. 2013;131:83–6.
19. Kucukmetin A, Biliatis I, Ratnavelu N, et al. Laparoscopic radical trachelectomy is an alternative to laparotomy with improved perioperative outcomes in patients with early-stage cervical cancer. Int J Gynecol Cancer. 2014;24:135–40.
20. Martinez A, Poilblanc M, Ferron G, et al. Fertility-preserving, surgical procedures, techniques. Best Pract Res Clin Obstet Gynecol. 2012;26:407–24.
21. Geisler JP, Orr CJ, Manahan KJ. Robotically assisted total laparoscopic radical trachelectomy for fertility sparing in stage IB1 adenosarcoma of the cervix. J Laparoendosc Adv Surg Tech A. 2008;18:727–9.
22. Regan L, Braude PR, Trembath PL. Influence of past reproductive performance on risk of spontaneous abortion. BMJ. 1989;299:541–5.
23. Preterm birth. In: Cunningham FG, Gant NF, Leveno KJ, et al., editors. Williams obstetrics. 21st ed. New York: McGraw-Hill; 2001. p. 689–727.
24. Querleu D. Laparoscopic radical hysterectomy. Am J Obstet Gynecol. 1993;168:1643–5.
25. Gottschalk E, Lanowska M, Chiantera V, Marnitz S, Schneider A, Brink-Spalink V, Hasenbein K, Koehler C. Vaginal-assisted laparoscopic radical hysterectomy: rationale, technique, results. JSLS. 2011;15(4):451–9.
26. Koehler C, Gottschalk E, Chiantera V, Marnitz S, Hasenbein K, Schneider A. From laparoscopic assisted radical vaginal hysterectomy to vaginal assisted laparoscopic radical hysterectomy. BJOG. 2012;119(2):254–62.

45 Laparoscopic Radical Hysterectomy with Anterior and Posterior Exenteration – Gynecological Perspectives

Shailesh P. Puntambekar, Yamini M. Gadkari, Vikrant C. Sharma, Suyash S. Naval, Seema S. Puntambekar, and Natasha U. Singbal

Introduction

Uterine malignancies are a common cause of cancer death amongst women. The incidence has risen in the recent years because of increasing awareness and screening [1, 2]. Radical hysterectomy continues to be the most common surgical approach in treatment of an early stage carcinoma of the cervix and endometrium.

The role of laparoscopy in this setting is to offer all the benefits of a minimally invasive approach, while maintaining equivocal oncological outcomes of an open approach. Since the first radical hysterectomy performed by Clark in 1895 and the Wertheim's technique of radical hysterectomy in 1898 [2], the radical hysterectomy has evolved into a simpler procedure and the surgical approach has evolved over a period of time into a highly specialized and minimally invasive modality. With technological advances we now can perform the radical hysterectomy with minimally invasive techniques like laparoscopy and robotics [3].

Here the author describes his "Pune technique" of laparoscopic radical hysterectomy with operative steps which are standardized. This makes this technique universally acceptable as it is easily duplicable [3].

Advantages of laparoscopic surgery are shorter hospital stay, less postoperative pain, quicker postoperative recovery, cosmetically better, enables the patient to start adjuvant treatment as early as possible. Hence, the acceptance of minimally access surgery in the recent years has increased [2, 3].

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Laparoscopic Radical Hysterectomy [2, 3]

Indications

1. Cervical cancer stage IA2 to stage IIA2
2. Endometrial cancer stage II

Preoperative radiation therapy is not a contra-indication for the laparoscopic procedure.

Contraindications

1. Evidence of peritoneal carcinomatosis or distant metastatic disease
2. Evidence of grossly involved lymph nodes

Preoperative

Liquid diet a day prior to the surgery.

Mechanical Bowel Preparation: Polyethylene glycol night before the operative to clear the bowels so as to keep them away from the operative field.

Enema and bowel wash should be avoided as this leads to dilatation of sigmoid colon.

Anaesthesia

Combined regional and general anaesthesia. The regional anaesthesia acts by blocking the sympathetic activity, contracts the small bowel and keeps it away from the operative field.

Patient Position

Patient is placed in modified Lloyd Davis position. A bolster is placed at the level of the anterior superior iliac spine which

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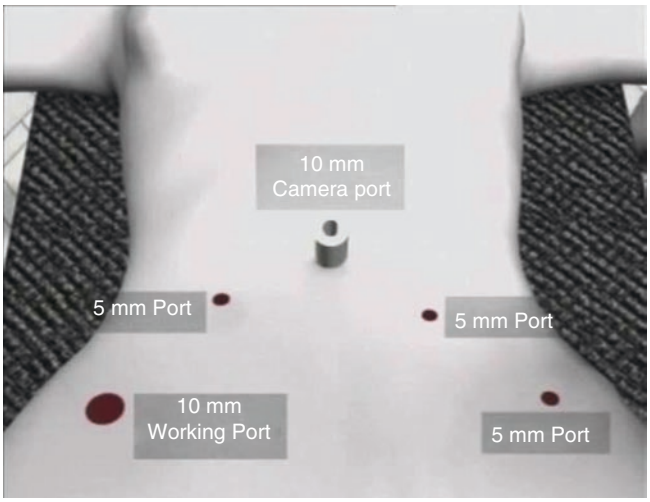


Fig. 45.1 Port positions

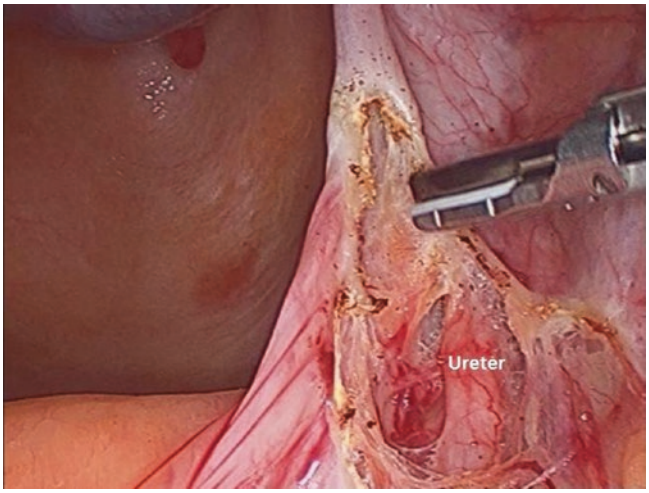


Fig. 45.2 Opening of peritoneum at the level of sacral promontory to expose ureter

causes elevation of the pelvis and results in a drop of the intestines cephalad. A gauze piece is kept in the vagina to prevent the loss of pneumoperitoneum after colpotomy.

Port Positions (Fig. 45.1)

A total of five ports are used.

A 10 mm camera port at the umbilicus.

A 10 mm working port at the Mcburney's point on the right side.

A 5 mm port pararectally (at rectus muscle margin) at the midclavicular line at the level of the umbilicus.

A set of two 5 mm ports are inserted as a mirror image of right side on the left side.

The surgeon stands on the right side, the assistant surgeon on the left side and the camera surgeon also stands on the left side, at the head end.

Procedure

The uterus is manipulated with a myoma screw in cervical malignancy. The myoma screw is introduced from the 5 mm left pararectal port and inserted into the fundus.The uterus is manipulated with a tenaculum in cases of endometrial malignancy.

Step 1: Posterior U- Cut

Uterus is anteverted. The rectum is retracted towards the left side. The right ureter is identified underneath the peritoneum at the level of sacral promontory. The peritoneum is opened medial to infundibulopelvic ligament with the help of harmonic shears to expose the ureter (Fig. 45.2). This cut is extended downwards into the Pouch of Douglas upto the level of uterosacral ligament

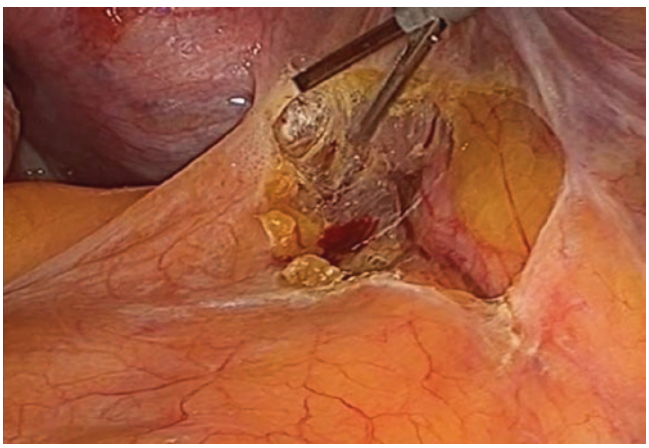


Fig. 45.3 Extending the peritoneal cut towards the Pouch of Douglas

(Fig. 45.3).The ureter should be on the lateral side and constantly under vision. The same steps are repeated on the left side and both the peritoneal cuts are joined in the Pouch of Douglas forming the posterior U- cut (Fig. 45.4**).**

Step 2: Dissection of Rectovaginal Space (Fig. 45.5)

The peritoneum in the Pouch of Douglas is pulled cephalad and the rectum is dissected off the posterior vaginal wall by remaining in between the two layers of Denonvillier's fascia. The plane between the fat and the posterior vaginal wall is dissected keeping in mind the dictum **"the fat belongs to rectum".**

Step 3: Dissection of Pararectal Space

The left ureter is retracted medially, and the posterior leaf of the broad ligament above the ureter is cut. A window is made in the anterior leaf of broad ligament. The ureter is now retracted

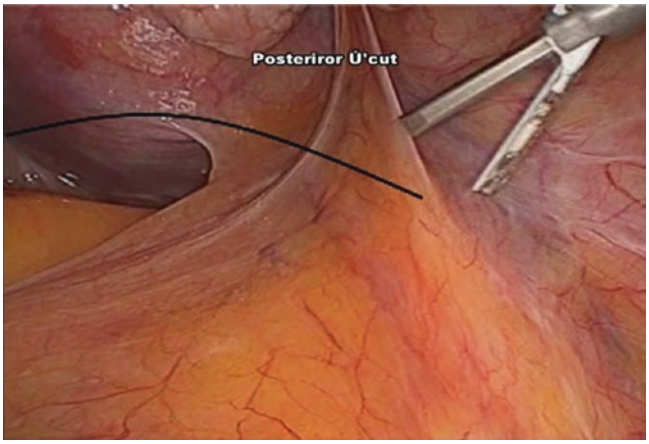


Fig. 45.4 Posterior U-cut

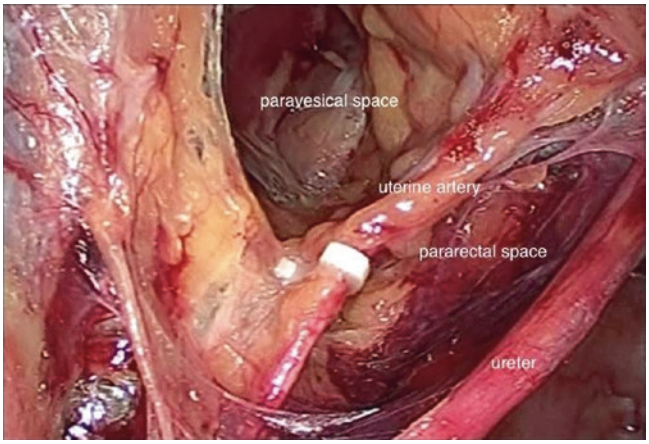


Fig. 45.6 Left pararectal space

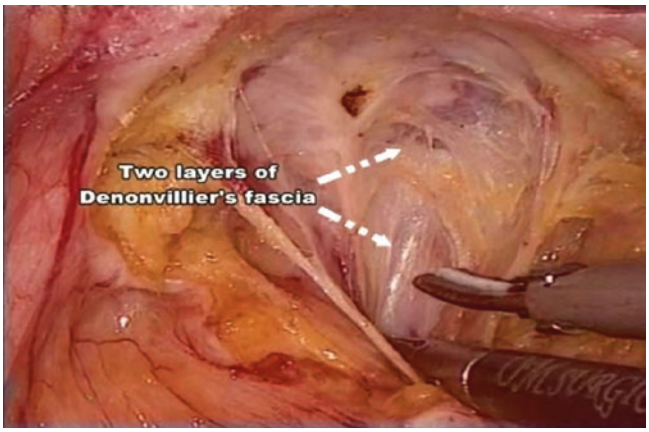


Fig. 45.5 Dissection of rectovaginal space

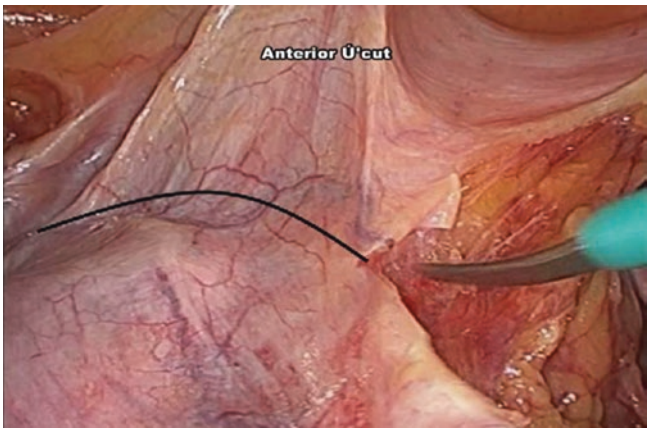


Fig. 45.7 Anterior U-cut

medially and the pararectal space is opened by remaining parallel and lateral to the ureter. The internal iliac artery forms the lateral boundary of this space and is then visualised. The only structure which crosses the pararectal space transversely is the uterine artery (Fig. 45.6). The space anterior to the uterine artery and medial to the obliterated hypogastric artery is dissected. The dissection is continued caudally by remaining parallel to the uterine artery to open the paravesical space upto the levator ani muscle. The uterine vein is seen below the ureter. The ureter always lies in the fork formed by the uterine artery anteriorly and the uterine vein posteriorly. Both the artery and the vein are individually clipped or ligated and then cut. This allows the visualization of the uterosacrals and the mackenrodt's ligament from their origin. The ureter is now retracted upwards and laterally and these ligaments are cut either with the harmonic or ligasure, as laterally as possible. The paracolpos which is continuation with the mackenrodt's ligaments is thus reached. This is divided up to the levator ani muscle. Similar steps are repeated on the right side.

Step 4: Anterior U- Cut

The uterus is retroverted. The peritoneum over the uterovesical fold is cut starting from the round ligament on right side to the left side forming the anterior U- cut (Fig. 45.7)**.**The bladder is dissected off the uterus and cervix by remaining below the fat and above the pubocervicovesical fascia.The dictum used is **"fat belongs to the bladder"**(Fig. 45.8). The peritoneal cut is further extended up to the infundibulopelvic ligaments.

Step 5: Dissection of Ureteric Tunnel (Fig. 45.9)

The uterus is pulled to the left. The right ureter is traced along its entire course towards the bladder. The bladder peritoneum is held and the bladder is retracted upwards by the assistant. The cervicovesical ligaments, also known as the ureteric tunnel, is dissected with the help of Maryland's forceps (Fig. 45.10).There are two veins in the anterior cervicovesical ligament which is clipped and then cut. Similarly the posterior cervicovesical ligament is also clipped and cut. The

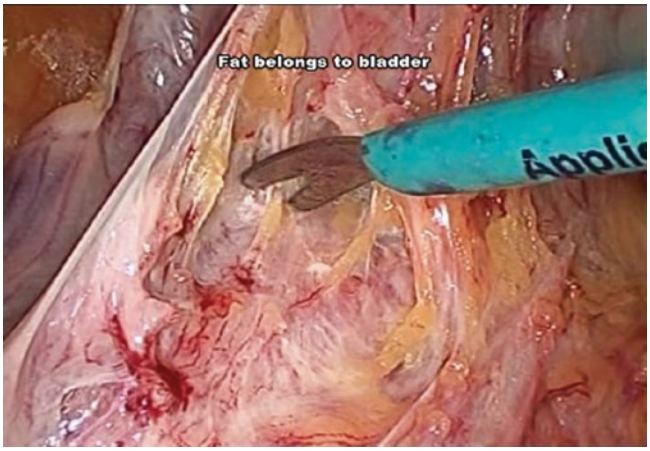


Fig. 45.8 Bladder dissection

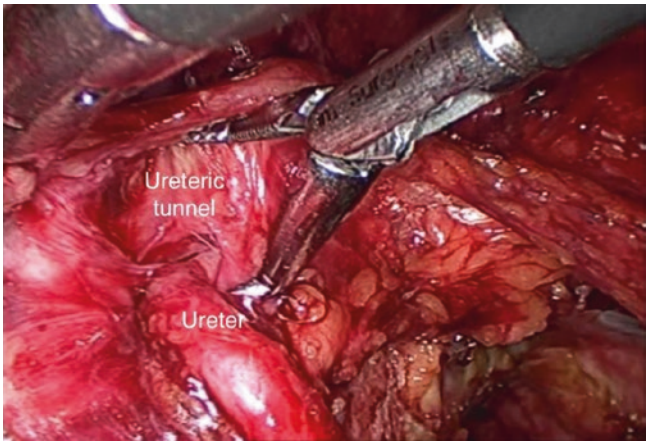


Fig. 45.10 Ureteric tunnel

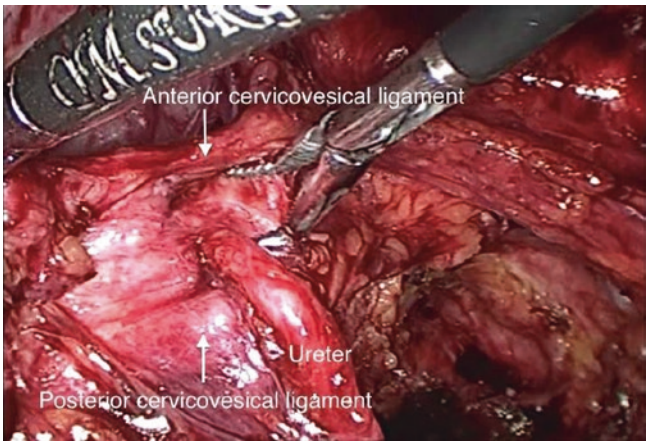


Fig. 45.9 Anterior and posterior cervicovesical ligament

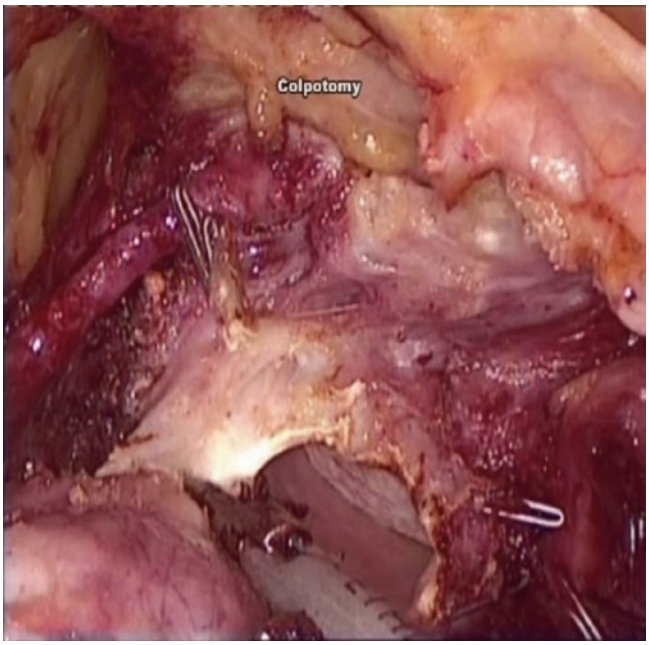


Fig. 45.11 Colpotomy

strands of endopelvic fascia which hold the ureter are cut on the medial side which further lateralises the ureter. The ureter can be seen upto its entry into the bladder. The bladder is pushed further down to achieve a good vaginal cuff, below the growth. The paracolpos is then cut as laterally as possible. These steps ensure that we can obtain maximum amount of paracolpos and the vaginal margin. The same steps are repeated on the left side making the trigonal area visible. Colpotomy is done above this level with the help of harmonic shears (Fig. 45.11). The infundibulopelvic ligaments are then cut and the entire specimen is separated and placed in an endobag.

Step 6: Lymph Node Dissection (Fig. 45.12)

The lymph node dissection is started at the bifurcation of common iliac artery (Fig. 45.13). All the fibrofatty tissue along the external iliac vein and artery is dissected, remaining in a direction parallel to the vessels upto the iliac bone which forms the lateral limit of the dissection. The medial limit is formed by the internal iliac artery and the lower limit is the obturator nerve (Fig. 45.14).Similar dissection is done on the opposite side. The entire nodal tissue obtained is put in the endobag (Fig. 45.15). The endobag is removed vaginally. Haemostatsis is achieved. Vault is closed with continuous locking intracorporeal suturing with vicryl 2–0, which is introduced through the 10 mm working port. Wound is irrigated with normal saline. It is not necessary to use any intra-abdominal drain. The ports are removed under vision and the port sites closed.

The Specimen This technique achieves a Pivers Type III [4]/ Querleu and Morrow [5] Type C Radical Hysterectomy,

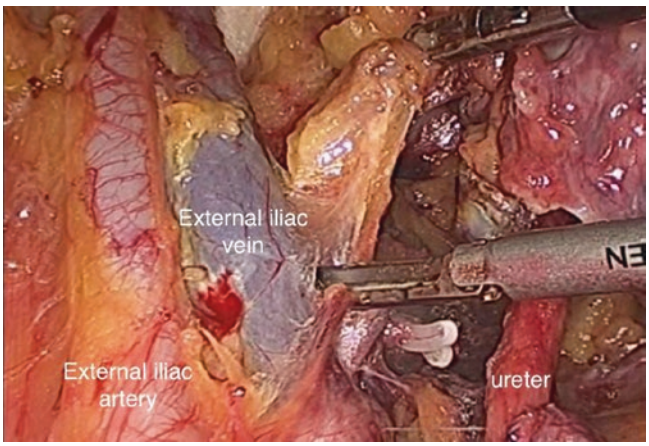


Fig. 45.12 Ilioobturator lymph node dissection

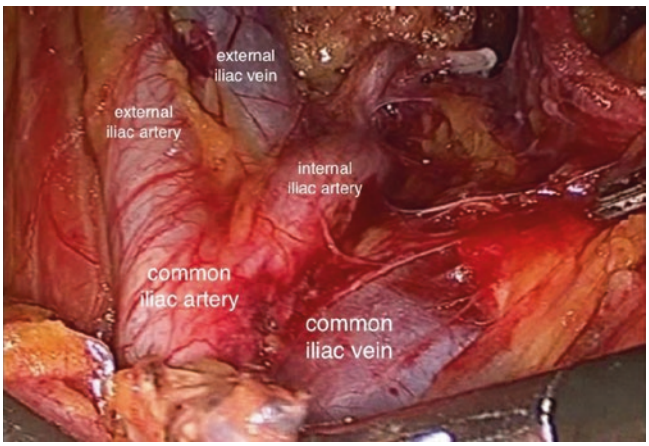


Fig. 45.13 Lymph node dissection of common iliac region

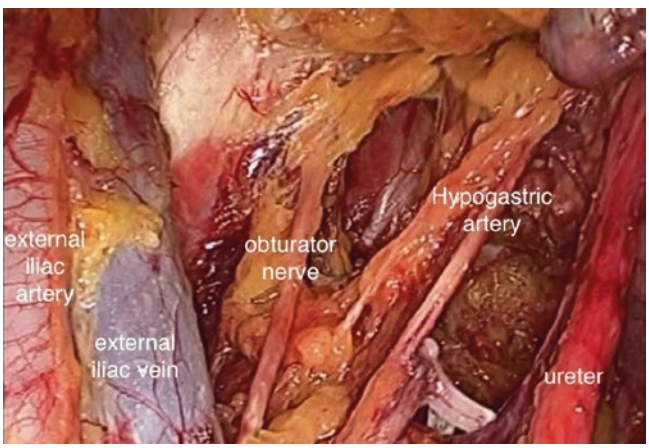


Fig. 45.14 Ilioobturator lymph node dissection

with a paracervical clearance of more than 3 cms, distal vaginal margin of more than 3–3.5 cms, nodal yield of 14–30 nodes**.**

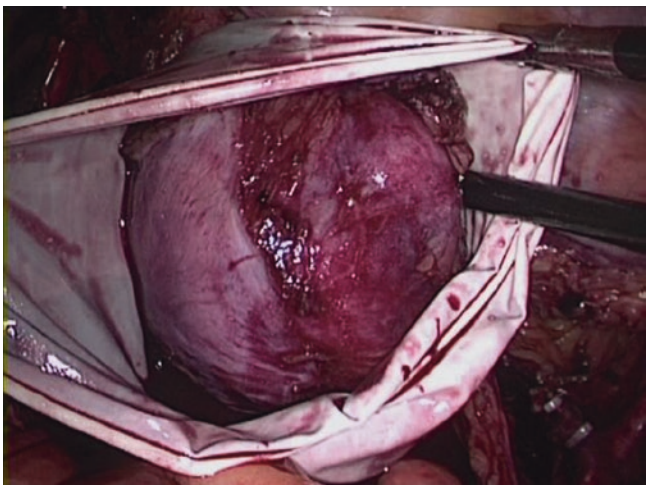


Fig. 45.15 Specimen delivery in endobag

Complications

Haemorrhage
Bladder injury
Ureteric injury
Bowel injury
Fistulas

Laparoscopic Nerve Sparing Radical Hysterectomy [6, 7]

The main disadvantage of laproscopic radical hysterectomy is the bladder dysfunction. This is caused due to autonomic nerve disruption with loss of anatomical bladder neck support and over distension of the bladder. A nerve sparing radical hysterectomy is involves the preservation of superior and inferior hypogastric and the pelvic splanchnic plexus, thus overcoming the complication of bladder dysfunction.

The procedure is the similar as that of laparoscopic radical hysterectomy. The hypogastric plexus lies lateral to the uterosacral ligaments. Thus the dissection at the level of uteroscarals is done carefully. The nerves are identified lateral to the uterosacrals and medial to the ureter.

The branches of the hypogastric nerve going to the uterus are identified in the connective tissue just posterolateral to the vagina and these branches are selectively cut and the nerve plane is lateralized on the posterior side. The bladder branch of the inferior hypogastric plexus is spared by lateralizing the nerve plane and the ureter. The posterior leaf of the vesicouterine ligament contains vesical veins that drain into the deep uterine veins which are individually clipped and cut. The bladder branch that passes just below the inferior vesical vein is also spared. The uterine and cervical branches

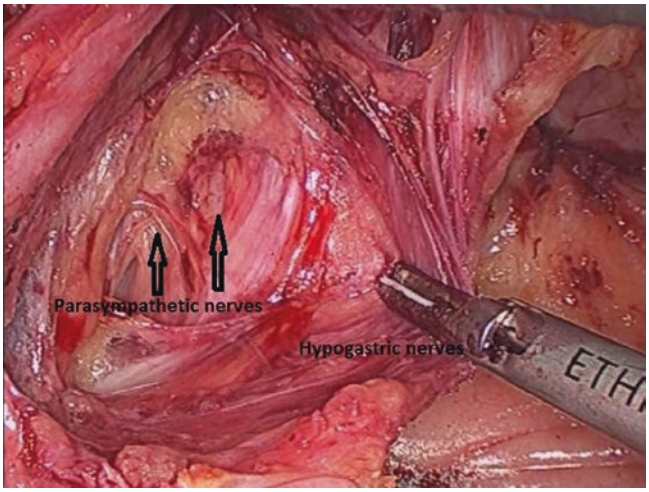


Fig. 45.16 Inferior hypogastric plexus

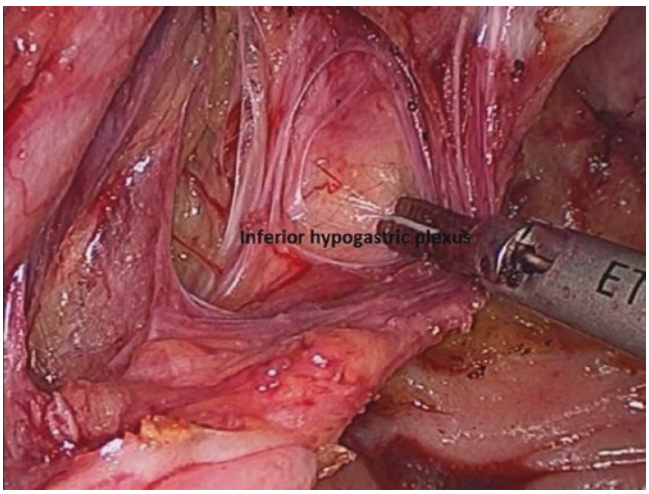


Fig. 45.17 Inferior hypogastric plexus

of the inferior hypogastric plexus in the anterior part are also selectively cut (Figs. 45.16 and 45.17).

The key structure in a nerve sparing radical hysterectomy is the uterine vein. The uterine vein should be cauterised and cut medial to the ureter in order to preserve the nerves.During colpotomy the nerve is lateral to ureter whereas in the initial stages of the dissection the hypogastric nerve and inferior hypogastric plexus were anatomically posteromedial to the ureter. The rest of the procedure is completed in the same way as the laparoscopic radical hysterectomy explained earlier.

Postoperatively the Foley's catheter is removes after 48 h. If urinary retention occurs Foley's catheterization is done again and patient is reassessed every 7 days.

Anterior Exenteration

Currently anterior exenteration is used as one of the modality for treatment of locally advanced cancers of the cervix.The anterior exenteration includes the removal of bladder, lower ureters, perivesical stump, uterus, ovaries and ilioobturator and iliac lymph nodes [8].

The following criteria should be used to decide the operability [9]:

1. Histological documentation of cancer in the palpable mass.
2. Absence of tumour extension to parametrium or pelvic sidewalls.
3. No involvement of the rectum by the growth.
4. Absence of gross pelvic or para aortic lymph node enlargement.
5. No peritoneal implants or bowel involvement.
6. No evidence of distant metastasis.

The absolute contraindications for surgery are:

1. Unilateral or bilateral pedal edema.
2. Sciatica or bone pain.
3. Poor medical condition.

Preoperative Workup

1. Computed tomography of the abdomen and pelvis
2. Chest radiography
3. Liver function tests
4. Cystoscopy

Procedure [10, 11, 12]

Anaesthesia, patient position and port positions are same as laparoscopic radical hysterectomy.

Steps 1 ,2, 3 remain the same as at radical hysterectomy (Fig. 45.18).

Step 4

The anterior dissection is begun by cutting right round ligament and then the anterior leaf of the broad ligament is cut. The peritoneum medial to the obliterated hypogastric artery is cut and the peritoneal cut is extended to the anterior abdominal wall, to separate the bladder from the anterior abdominal wall. Similar steps repeated on the left side.

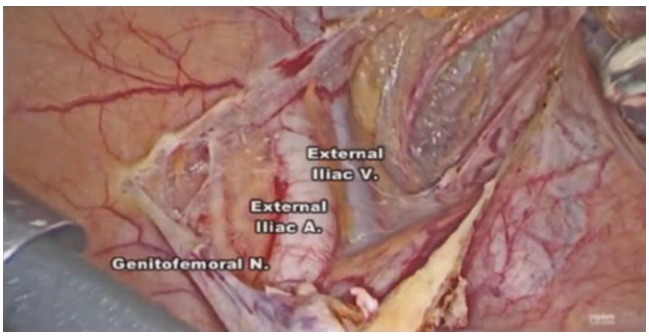


Fig. 45.18 External iliac vessels

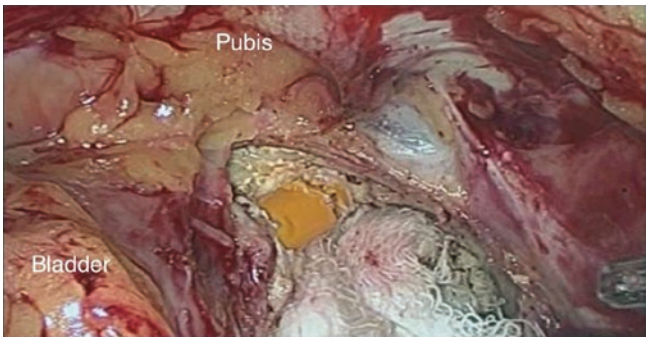


Fig. 45.20 Urethra being cut

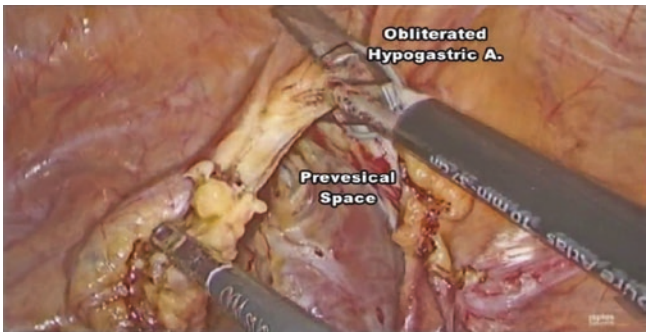


Fig. 45.19 Prevesical space

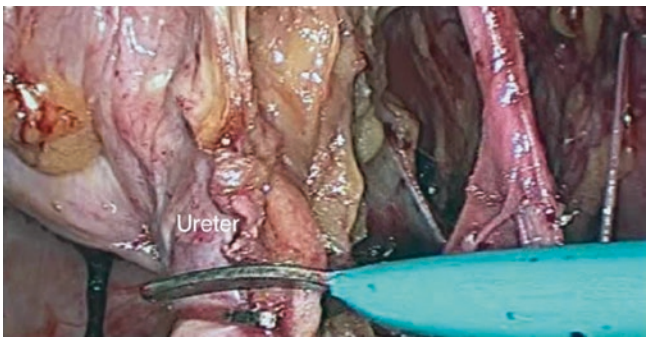


Fig. 45.21 Ureter being clipped and cut

Step 5

The bladder is then brought down from the anterior abdominal wall to enter the retro-pubic space i.e. the Cave of Retzius (Fig. 45.19) The tissue which is anterior and lateral to the urethra and vagina is cut. The urethra is accessed anteriorly (Fig. 45.20). The posterior urethral wall and the anterior vaginal wall are cut. A good length of vagina below the growth is exposed. The aim is to have a distal vaginal cuff of 3 cms.

Step 6

Colpotomy is done. Ilio obturator nodal dissection is done on both the sides and the tissue put in an endobag. Specimen is removed vaginally.

The type of urinary diversion plays an important role in the quality of life.

The various type of urinary diversions which can be done are

- ileal conduit
- ureterosigmoidostomy
- orthotropic illeal neo bladders
- Indiana pouch.

Ureterosigmoidostomy and ileal conduit can be done entirely laparoscopically while Indiana pouch and neo bladder have to be done by opening the abdomen. Here the author describes the ureterosigmoid anastomosis.

Step 7

The right ureter is cut (Fig. 45.21) and transfixed to the sigmoid colon anteriorly over the taenia coli. The end of the suture is held up for better visualization. A cut is made on the ureter which is fashioned into a fish mouth. A cut is also made on the sigmoid, anteriorly overlying the taenia coli (Fig. 45.22). A proximal full thickness stitch is taken, outside-in on colon and is continued inside-out on ureter. Infant feeding tube no. 5 or 6 is inserted in it, to act as a stent across the anastomosis (Fig. 45.23). It is proximally put into the ureter upto the renal pelvis. A note is made of the presence of flowing urine in the tube, to confirm proper placement. It is distally inserted into the opening made in the sigmoid colon. Once the stent is in place, the ureter edges are sutured with a 3:0 vicryl continuous suture. A full thickness continuous suture is taken on one side of the anastomosis, going from proximal to distal. The same suture is taken around and continued from distal to proximal end on the opposite side of the anastomosis. Right edge of ureterosigmoid anastomosis is sutured (Fig. 45.24). The suture is brought around from below the ureter, to be tied to its tail on the left side. A transfixation suture (hypnotic) is taken. The excess tip of ureter is trimmed. The left ureter is brought under the colon and then to the right side.

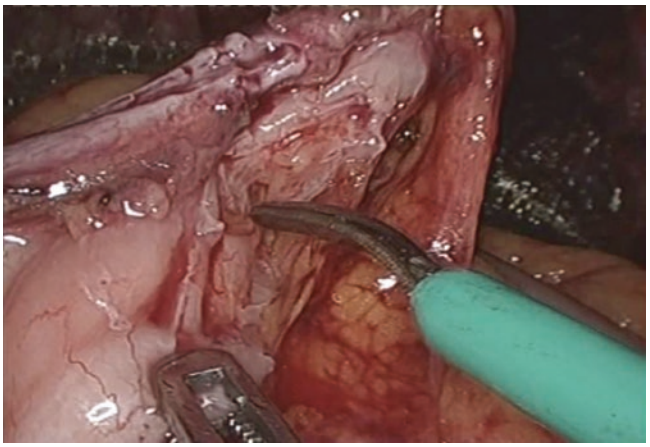


Fig. 45.22 A cut is being made on the sigmoid, anteriorly overlying the taenia coli

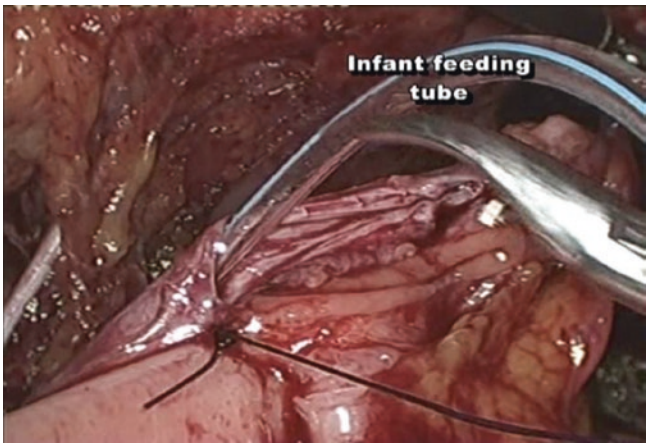


Fig. 45.23 Infant feeding tube no. 5 or 6 is inserted in the ureter to act as a stent across the anastomosis

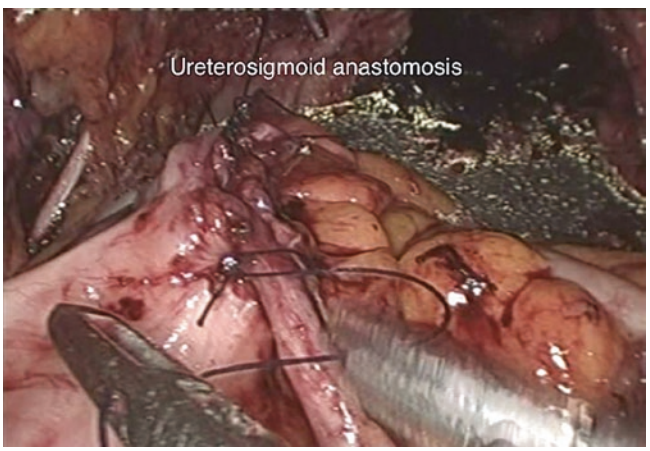


Fig. 45.24 Ureterosigmoid anastomosis

Step 8

The vagina is then sutured with 2:0 vicryl continuous intracorporeal suturing. Haemostasis achieved. An abdominal drain is placed in the pelvis. The ports are then removed under vision and closed.

Posterior Exenteration

Posterior exenteration is one of the treatments described for advanced cancers of the cervix, uterus, ovary, and rectum. Until recently, due to the complexity of the surgery, only the open method was used, however, minimally invasive surgery is now being used as a modality of surgery.

Preoperative Workup

1. Computed tomography of the abdomen and pelvis,
2. Chest radiography,
3. Liver function tests,
4. Cystoscopy
5. Proctoscopy.

All patients are examined under anesthesia before the procedure to confirm the extent of rectal involvement and to assess the feasibility of a stapled colorectal anastomosis.

The need for a temporary colostomy and the possibility of a permanent colostomy is also to be considered and discussed with the patients. The final decision is made at laparoscopy.

Inclusion Criteria

1. Ovarian cancer involving pouch of Douglas
2. Postradiation cervical cancer recurrence localized posteriorly
3. Cervical cancer with rectovaginal fistula
4. Vaginal cancer with rectal involvement

Exclusion Criteria

1. Extrapelvic spread
2. Distant metastasis including para-aortic nodes
3. Involvement of urinary bladder
4. Involvement of ureters
5. Limb edema or sciatic pain
6. Patient medically unfit

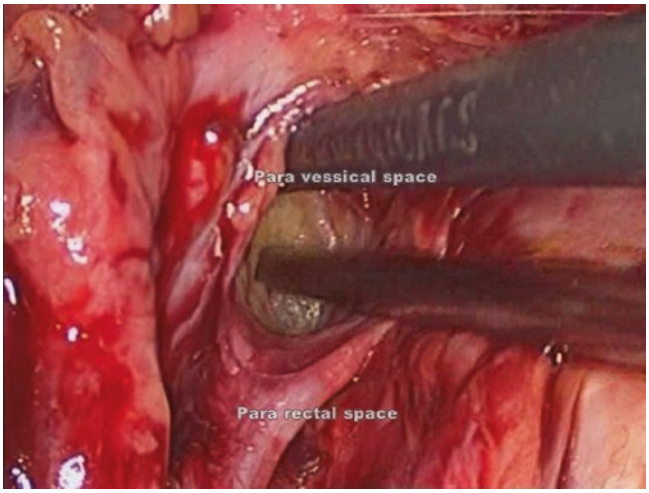


Fig. 45.25 Pararectal and paravesical spaces

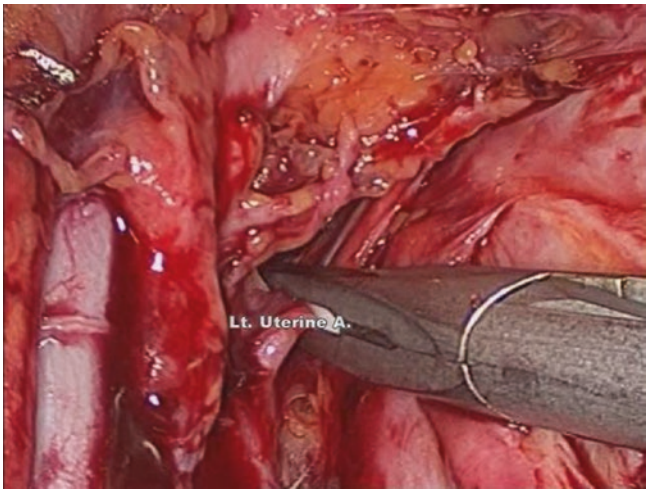


Fig. 45.26 Uterine artery being clipped

Preoperative Bowel Preparation

Routine bowel preparation was with 1 L of oral isosmotic solution (Peglec) taken the night before surgery.

Anaesthesia, patient position, port positions and surgeon position is same as laparoscopic radical hysterectomy.

Procedure [13]

The uterus can be manipulated with the help of a myoma screw or uterine hitch [14].

Step 1

The dissection is begun at the level of sacral promontory after identifying the external iliac vessels and ureters on the left side. A fold of peritoneum is opened and the ureters are lateralised. Infundibulopelvic ligament is skeletonised, clipped and cut.

Step 2

The pararectal spaces on both sides are dissected, remaining parallel and lateral to the ureter. Dissection proceedes anteriorly into the paravesical spaces upto the levator ani, which is used as the distal limit of dissection (Fig. 45.25). The uterine arteries and veins are clipped or ligated (Fig. 45.26). The ureter is further lateralised by dissecting the endopelvic fascia on the medial side. Similar steps are followed on the opposite side.

Step 3

Anterior U cut is made and the urinary bladder is dissected from the uterine cervix(Fig. 45.27).

Involvement of the urinary bladder at this stage would require a total pelvic exenteration.

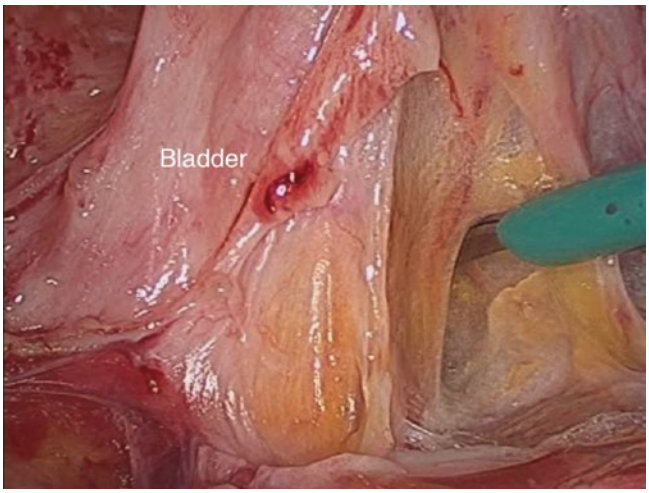


Fig. 45.27 Bladder being dissected using the principle of fat belongs to the bladder

Step 4

The presacral space is dissected between the rectum (Fig. 45.28) and the presacral fascia by following the dictam fat belongs to the rectum (Fig. 45.29). This is an avascular plane, and following this plane distally reveals the levator ani as its inferior limit. The virgin plane is entered between the vaginal wall and the rectum below the level of the Pouch of Douglas. The distal level of rectal involvement is the criterion to decide whether supralevator or infralevator posterior extenteration is to be used.

In supralevator cases rectal continuity be made using endostaping device. In patients with involvement of the sphincter complex, tumor involvement extending very low in the rectum and low malignant rectovaginal fistula require infralevator resection with a permanent colostomy.

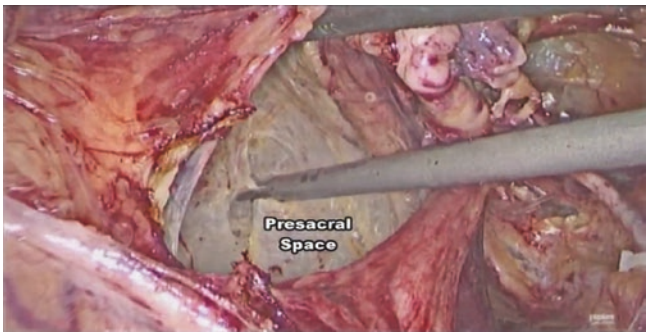


Fig. 45.28 Presacral space

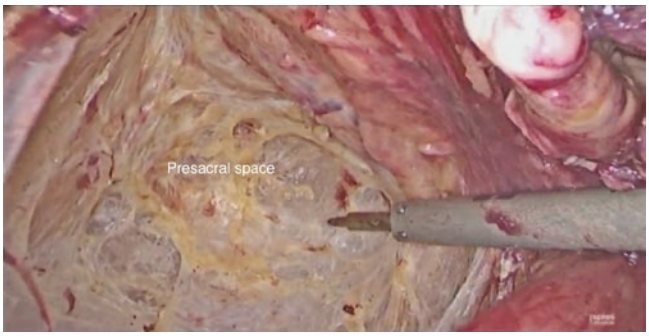


Fig. 45.29 Presacral space opened up using the principle of fat blongs to the rectum

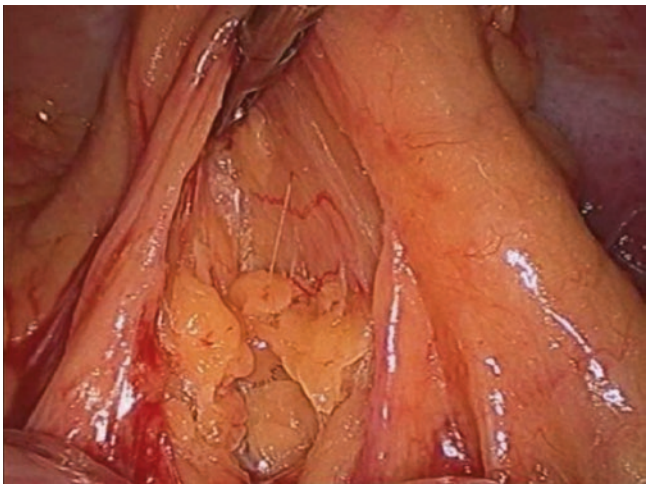


Fig. 45.30 Large bowel being mobilized

Step 5

A low colpotomy is performed.

Step 6

The proximal large bowel is mobilized (Fig. 45.30). The inferior mesenteric artery is clipped and cut at its origin (Fig. 45.31). The rectum distal to the tumor is visualized, which enables transection with the endostapling device (Fig. 45.32).

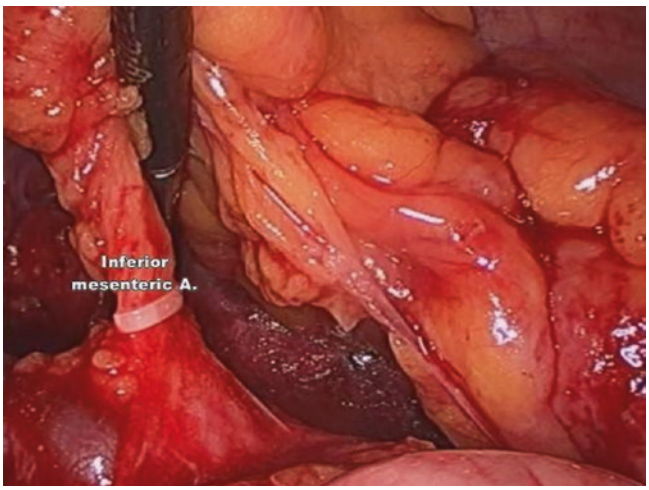


Fig. 45.31 Inferior mesenteric artery being clipped

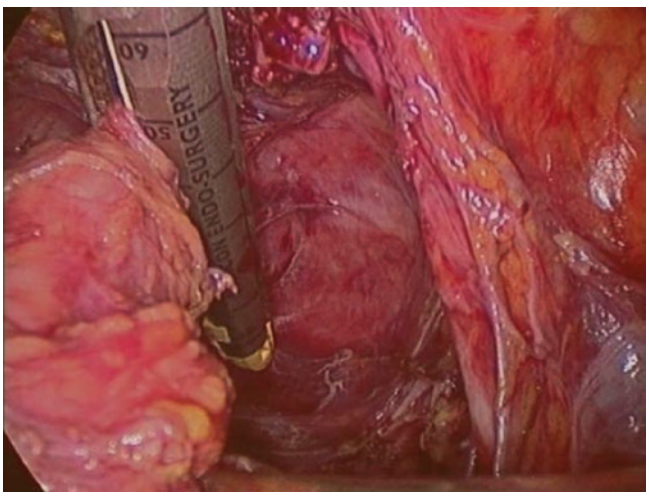


Fig. 45.32 Endostapler

Step 7

Although extraction of the specimen (Fig. 45.33)is possible vaginally, insertion of the anvil of the stapler in the colon is difficult via that route; thus, a suprapubic minilaparotomy of approximately 3 cm is used for specimen extraction. The remainder of the procedure was performed laparoscopically.

Thus, laparotomy is used for specimen extraction, proximal bowel transection and placement of the anvil of the end-to-end anastomotic stapler in the mobilized proximal colon. Circular stapled anastomosis was performed (Fig. 45.34) as well as temporary colostomy. Thus, posterior exenteration involves removal of the rectum, uterus, and vagina, and vulva if necessary.

Step 8

Fibrofatty lymphovascular tissue along the external iliac veins and the obturator nerves is removed (Fig. 45.35). The type of radical hysterectomy performed according to the new classification for radical surgery was type C2.

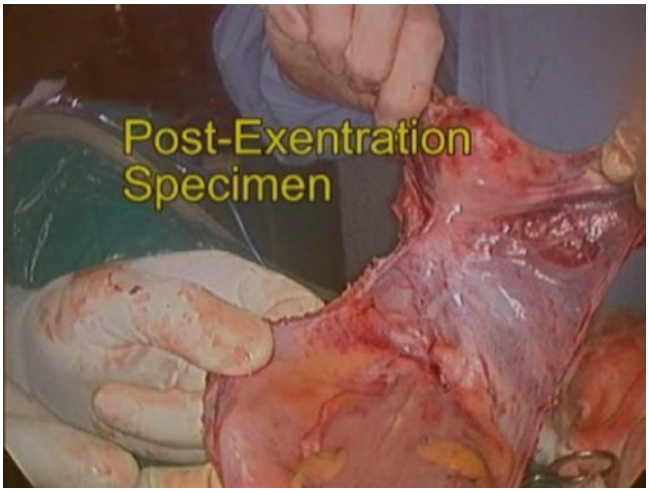


Fig. 45.33 Specimen of posterior exenteration

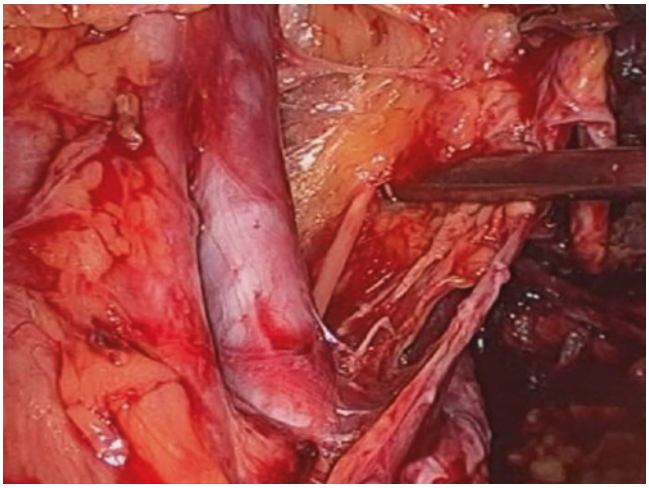


Fig. 45.35 Ilioobturator lymph node dissection

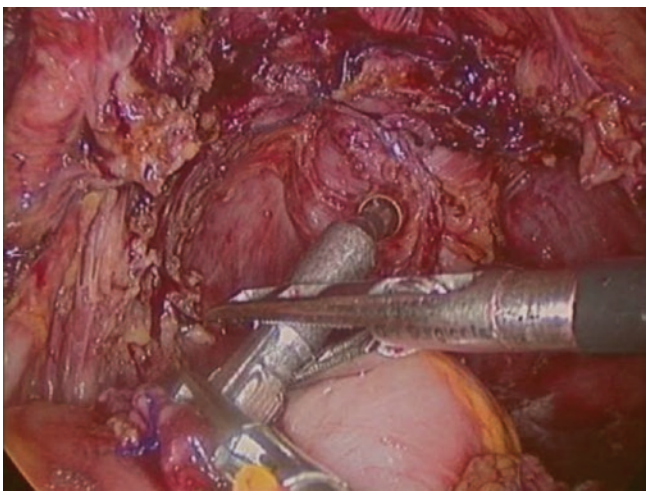


Fig. 45.34 Circular stapler

Complications

- Delayed bladder recovery
- Surgical site infection
- Anastamotic leak
- Prolonged ileus

Successful colostomy reversal is performed after 4–6 weeks in six patients with a temporary colostomy.

References

1. Shanta V, Krishnamurthi S, Gajalakshmi CK, et al. Epidemiology of cancer of cervix: global and national perspective. J Indian med Assoc. 2000;98(2):49–52.
2. Ware RA, van Nagell Jr JR. Radical hysterectomy with pelvic lymphadenectomy: indications, technique, and complications. Obstet Gynaecol Int. 2010;2010 :9. doi:10.1155/2010/587610. Article ID587610
3. Puntambekar S, Palep R, Puntambekar S, Wagh G, Patil A, Rayate N, Agarwal G. Laparoscopic total radical hysterectomy by the Pune technique: our experience of 248 cases. J Minim Invasive Gynecol. 2007;14:682–9.
4. Piver, Ghomi. The twenty-first century role of Piver-Rutledge type III radical hysterectomy and FIGO stage IA, IB1, and IB2 cervical cancer in the era of robotic surgery: a personal perspective. J Gynecol Oncol. 2010;21(4):219–22.
5. Querleu D, CP M. Classification of radical hysterectomy. Lancet Oncol. 2008 Mar;9(3):297–303.
6. Puntambekar SP, Lawande A, Puntambekar S, Joshi S, Kumar S, Kenawadekar R. Nerve-sparing radical hysterectomy made easy by laparoscopy. J Minim Invasive Gynecol. 2014;21(5):732.
7. Puntambekar SP, Patil A, Joshi SN, Rayate NV, Puntambekar SS, Agarwal GA. Preservation of autonomic nerves in laparoscopic total radical hysterectomy. J Laparoendosc Adv Surg Tech A. 2010;20(10):813–9.
8. Brunschwig A. Complete excision of pelvic viscera for advanced carninoma. Cancer. 1948;1:177–83.
9. Brunschwig A. What are the indications and results of pelvic exenteration. JAMA. 1965;194:274.
10. Puntambekar SP, Kudchadkar RJ, Gurjar AM, Sathe RM, Chaudhari YC, Agarwal GA, Rayate NV. Laparoscopic pelvic exenteration for advanced pelvic cancers: a review of 16 cases. Gynecol Oncol. 2006 Sep;102(3):513–6.
11. Jamkar AV, Puntambekar SP, Kumar S, Sharma V, Joshi S, Mitkare S. Laparoscopic anterior exenteration with intracorporeal ureterosigmoidostomy. J Minim Invasive Gynecol. 2015;22(4):538–9.
12. Martínez A, Filleron T, Vitse L, Querleu D, Mery E, Balague G, et al. Laparoscopic pelvic exenteration for gynaecological malignancy: is there any advantage? Gynecol Oncol. 2011 Mar;120(3):374–9.
13. Puntambekar S, Rajamanickam S, Agarwal G, Joshi S, Rayate N, Deshmukh A. Laparoscopic posterior exenteration in advanced gynecologic malignant disease. J Minim Invasive Gynecol. 2011;18(1):59–63.
14. Puntambekar SP, Patil AM, Rayate NV, Puntambekar SS, Sathe RM, Kulkarni MA. A novel technique of uterine manipulation in laparoscopic pelvic oncosurgical procedures: the uterine hitch technique. Minim Invasive Surg. 2010;2010:836027.

Laparoscopic Radical Hysterectomy (LRH) with Anterior and Posterior Exenteration: Urological Perspectives

46

Jens J. Rassweiler, Ali S. Gözen, Marcel Fiedler, and Jan T. Klein

Introduction

Laparoscopic and robot-assisted radical cystectomy has become an established procedure in the management of muscle-invasive bladder cancer and even accepted in the actual EAU-guidelines [1]. In a recent study coordinated by the EAU-section of uro-technology (ESUT) 18 % of patients were female [2], but the number is increasing due to the higher proportion of smoking women. Even, if there are forms of uterus-sparing of radical cystectomy, the vast majority of women undergo *anterior exenteration* with and without ovarectomy depending on the age of the patient. Based on this, the urologist is familiar with the anatomic details of such an operation regardless whether it is open, laparoscopic or robot-assisted [2, 3]. In gynaecology, the main indications include invasive carcinoma of cervix stage IVA and IVB, respectively advanced endometrial cancer with isolated invasion in the bladder (FIGO IVA) and stage T3 (FIGO III) of vulvar cancer [4–9].

In contrast, *posterior exenteration* is performed very rarely in patients suffering from advanced bladder cancer because the vagina represents an anatomical barrier for tumour infiltration. Such procedures are usually indicated as a salvage procedure (i.e. following radiotherapy of cervix carcinoma; advanced carcinoma of cervix or endometrium with invasion of bladder and rectum (FIGO IVA). Due to the complexity of this operation, it is mainly performed by open surgery in cooperation with a team of abdominal surgeons rather than by means of minimally invasive surgery [10, 11].

Therefore, we want to focus on technical aspects and outcome of *laparoscopic anterior exenteration*, which might be also indicated in advanced stages of cervical and endometrial cancers as well as in rare cases of carcinoma of the vulva respectively other tunours invading the vulva such as melanoma in combination with vulvectomy [6].

Beside the ablative part, the *form of urinary diversion* becomes an important factor with significant impact on the quality of life for the patient, but also regarding complexity and morbidity of the procedure particularly when performed laparoscopically [12–14]. There is an increasing experience with laparoscopic or robot-assisted ileal conduit and neobladders in the literature. Whereas advantages of the ablative part of operation have been demonstrated, it is still controversial about benefits of the complete intra-corporeal technique versus an extracorporeal approach extending the incision required for removal of the specimen [14, 15]. In women, however, the specimen can be extracted via the opening of the vagina [12]. Nevertheless, until now, there is no consensus, which approach offers the best option for the patients.

Indications for Laparoscopic Anterior Exenteration

Since recently, similar oncological outcome could be shown in a large European trial, there are no differ from those of open surgery, including T1–3 stages of bladder cancer. In gynaecology, anterior exenteration is only indicated for advanced stages (FIGO IV) of carcinoma of the cervix uteri, endometrial cancers, as well as vulva carcinoma (FIGO III) respectively as salvage therapy following irradiation and local progression, vesico-bladder fistula [4–9].

Type of Urinary Diversion

The choice of the type of urinary diversion depends on various factors, such as age, compliance, local extension of disease. Basically one has to distinguish between

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Table 46.1 Laparoscopic urinary diversion following anterior exenteration– technical steps and options

Operative step	Options	Comments
Transposition of ureter	Ileal-Conduit	Not for sigmoid-bladder
	Ileal-Neobladder (Studer)	Or ureterosigmoidectomy
		Not for Ileal-Neobladder (Hautmann)
Creation of reservoir	Intracorporeally	Technically difficult
		Stapler for GI-Anastomosis
		V-lock for neo-bladder
	Extracorporeally	Via mid-line incision
		Open technique
Conduit in females	Intracorporeally	Stapler for GI-Anastomosis
		Laparoscopic suture
	Extracorporeally (lap-assisted)	Via mid-line incision
		Open technique
Ureteral anastomosis	Intracorporeally	Sigmoid/Ileal-neobladder
		Sigmoid-pouch
		Ileal conduit
	Extracorporeally	Ileal neobladder (Studer)
		Ileal-pouch
Urethral anatomosis	Intracorporeally	All continent diversions (as first step)
		After re-insufflation (as last step)
	Extracorporeally	With laparoscopic pre-placed stitches

continent and incontinent diversion. The most popular form of incontinent diversion represents the ileal conduit. In selected case with one functioning kidney, ureterocutaneostomy might be an option. Continent urinary diversion includes a modified ureterosigmoidostomy with creation of a reservoir (Mainz-Pouch II), ileal neobladder, and various forms of catherizable pouches attached to the umbilicus (Table 46.1).

Whereas ileal conduit can be performed in almost every patient, ileal (sigmoid) neo-bladder requires some preliminaries: (i) the tumour has not infiltrated the bladder neck, (ii) the patient is able to manage the use of the neo-bladder including possibility to self-catheterize. A pouch can be also performed is almost all situation, however, represents a complex procedure and requires also the ability to self-catheterize [12, 16].

The patient has to be informed about all variation of urinary diversion. For this purpose, we administer an enema of 300 cm^3 of physiologic sodium chloride solution transanally and recod the time, the patient can hold this in the rectum. If the holding time is below 60 min, the patient should not undergo a continent diversion using a sigmoid pouch (ie Mainz-Pouch II). The use of ureterosigmodostomy without pouch has been abandoned. Additionally, we place a urostoma bag filled with 200 cm^3 of normal saline on the right side of the body to check the appropriate position of the stoma of an ileal conduit (Fig. 46.1). Since the rate of hypercontince of a neobladder in women may reach up to 30 %, women should be mentally and physically able to perform self-catheterization.

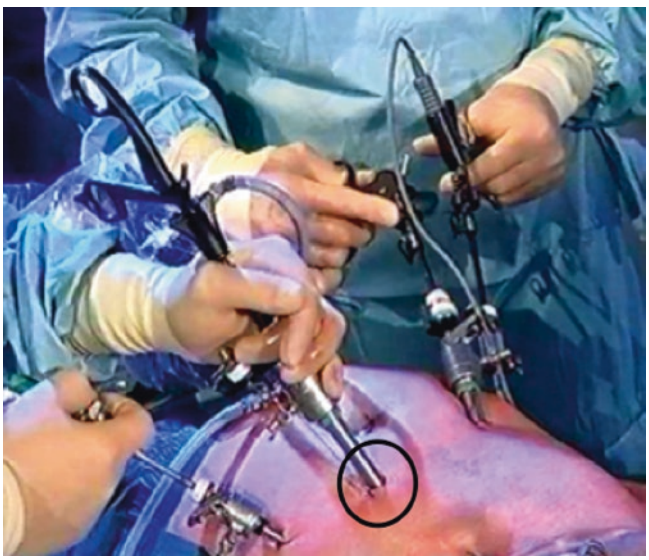


Fig. 46.1 Port placement for laparoscopic anterior exenteration – the right medial trocar entrance is used for the urostoma (*black circle*)

Patient Preparation

Initially, the bowel was prepared by oral self-administration of 2 l of electrolyte lavage solution during two days before the surgical procedure. However, we have changed this to a classical form of bowel preparation by administration of laxatives. It is important to hydrate the patient during the preoperative night (ie. 1500 ml electrolyte solution i.v) to

improve renal function during the procedure and minimize the risk of hyperhydration by the anaethesiologist, which has a negative impact on the healing of bowel anatomosis.

Antibiotic prophylaxis with a cephalosporin (2 × 2g) and metronidazole (3x500 mg) is performed from day 1–5 and low molecular weight heparin (4000 units) is administered preoperatively and until the postoperative day 15. Compression stockings are applied as the patient is placed in supine position with the legs apart to allow free access to the vagina. The table is set to a 30 ° Trendelenburg position. An 18F-Foley catheter is inserted to drain the bladder and a nasogastric tube is positioned. As the lower limbs are carefully strapped to the table without compressions, no shoulder pads are necessary.

Technique of Laparoscopic Anterior Exenteration

Equipment

The technique is challenging, requiring state-of-the-art laparoscopic infrastructure and expertise. Using a five- or six-port transperitoneal approach (Fig. 46.1) anterior exenteration in combination with extended pelvic lymph node dissection is performed. Standard laparoscopic surgical equipment with few special instruments is required (Table 46.2). This may include an endoscopic stapler (i.e. Endo-GIA) for control of the pedicles of the bladder and eventually for the intracorporeally performed intestinal anastomosis. The use of an ergonomic chair like ETHOS might be very useful during the procedure (Fig. 46.2).

Table 46.2 Laparoscopic pelvic anterior exenteration–equipment

Standard laparoscopic equipment	
High flow insufflator / Air Seal	1
300 W Xenon light fountain	1
HD-camera (Karl Storz)	1
10 mm 30° laparoscope	1
Trocars	
10–12 mm trocars	2–3
5 mm trocars	3
(reusable trocars preferred)	
Instruments	
Laparoscopic Metzenbaum scissors, 5 mm	1
Laparoscopic bipolar forceps, 5 mm	1
Laparoscopic endo-dissectors, 5 mm	2
Laparoscopic right-angle-dissector, 10 mm	1
Laparoscopic atraumatic prehension forceps	2
Laparoscopic suction irrigation canula	1
Laparoscopy bags (i.e. Storz-Extraction Bag, 800 cm^3)	1
Surgical endoscopy 5–10 mm clips appliers	1
Needle-holder (i.e. Duffner, Storz), for both hands	2
Endo-GIA30-stapler (i.e. Covedien)	
Optional	
Harmonic scalpel (i.e. Ultracision, Ethicon), 10 mm device	1
Ligasure® (ie. Covedien) 5–10 mm forceps	1
	1



Fig. 46.2 Use of ergonomic chair (ETHOS, United States) with arm rest an chest support during laparoscopic anterior exenteration. The surgeons sits over the head of the patient

Trocar Placement

The patient is in supine position, with the lower limbs slightly (15 °) abducted. A 30 ° flexion is given to the knees, to define accordingly the value of Trendelenburg position. Extension of the hips should be avoided to prevent any backache. In male patients, the technique can be also performed with the legs in a paralell, non-abducted position.

The first 10 or 13 mm trocar is placed 1 cm above the umbilicus, using an open Hasson-technique through a mini-laparotomy. This trocar is reserved for the 30 °-laparoscope. The remaining four ports are placed under endoscopic control after establishment of the pneumoperitoneum (12–15 mmHg, high flow; AirSeal-Insufflator, Dach Medical Group, Freilassing. Germany).

At the « left Mac Burney » point a 12 mm diameter port is used, which can also be used to ease the retrieval of pelvic lymph nodes after dissection. At the true right Mac Burney point, another 12 mm trocar is placed to accept larger instruments (i.e. 10 mm-clip-applicator, right-angle dissector, needle with reducer-sheath, Endoscopic stapler) if necessary. Two 5 mm trocars are placed at the horizontal level of the navel, lateral to the 10/12 mm trocars. Optionally, on the midline, a 5 mm trocar is placed,.

During diagnostic laparoscopy the abdomen and pelvis are inspected focussing on possible peritoneal metastases. If necessary, intestinal adhesions are released by blunt and sharp dissection.

Posterior Dissection

The posterior dissection starts at the level of the recto vaginal space. As described in laparoscopic surgery for prolapse, the posterior vaginal bottom is lifted by the second assistant with a curved metal retractor, exposing immediately the recto- vaginal space to blunt and sharp dissection (Fig. 46.3a). This dissection is extended laterally to the ischio-rectal fossae (Fig. 46.3b).

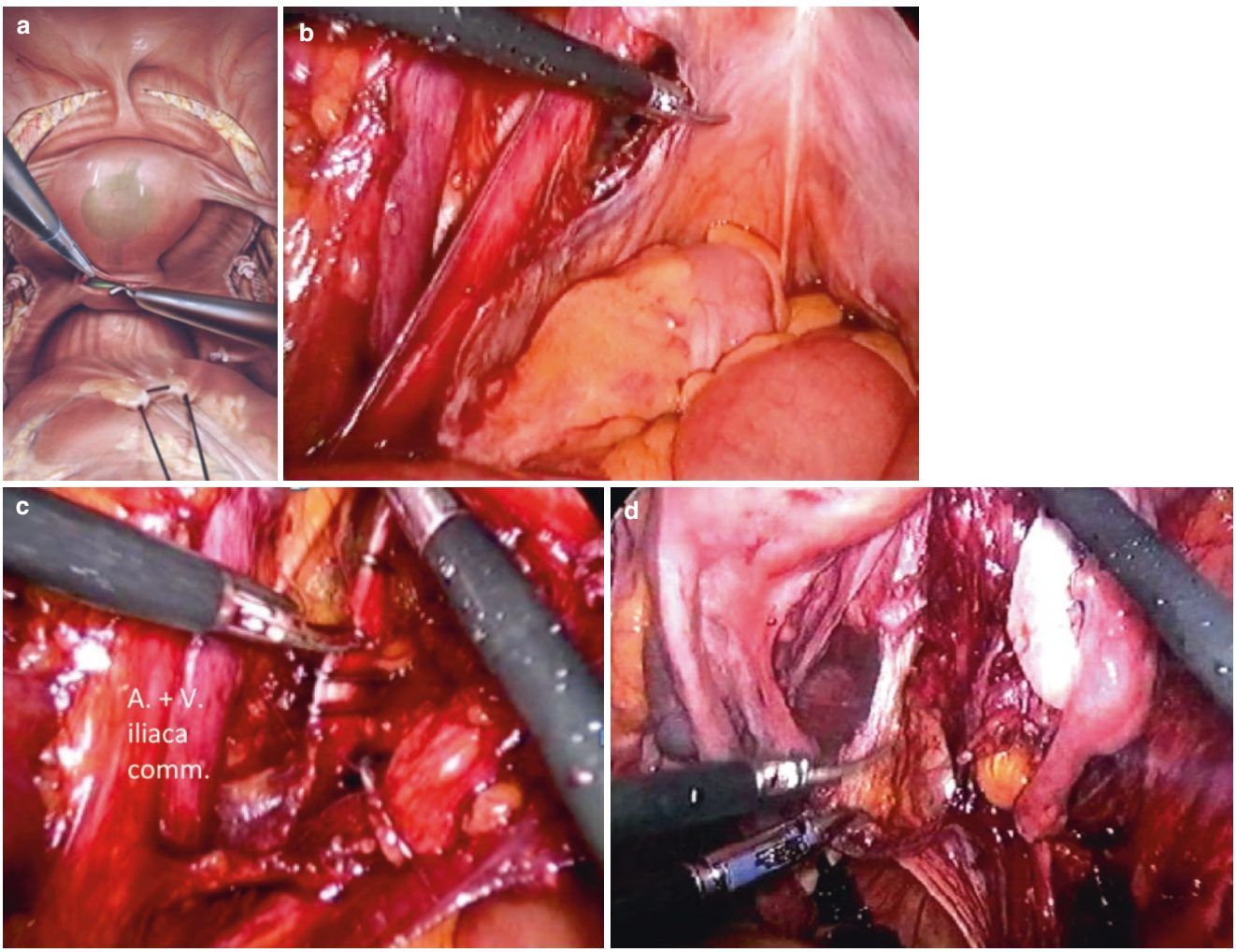


Fig. 46.3 Technical steps of laparoscopic anterior exenteration. (**a**) Posterior approach to the cul de sac, uterus and vagina. Note retraction stich of the sigmoid. (**b**) Incision of the peritoneum cranial to the sigmoid. (**c**) Division of the proximal pedicle (A. vesicalis sup.) on the right side between 10 mm Titanium-clips. (**d**) Transection of adherences between sigmoid and vagina. Both ovaries are included en-bloc in the specimen. Both uterine arteries have been clipped and divided

Table 46.3 Laparoscopic anterior exenteration–technical steps and options

Operative step	Options	Comments
Positioning of Patient	Deflected Supine Lithotomy	For all female patients
Trocar arrangement	Semilunar W-shaped	In case of ileal conduit one port = Urostoma
Transperitoneal access	None	Similar to open surgery
Incision of Douglas Pouch and retrovesical dissection	None	None
Pelvic lymph node dissection	Extended	According to indication
Division of ureters	None	None
Division of ovarian and uterine vessels	Endo-clips	For female patients
Division of umbilical ligaments and pedicles	Endo-GIA Hem-o-lock® Ligasure® Ultracision®	According to surgeon
Suturing of dorsal vein	None	None
Division of urethra	Closed by catheter Closed by clip	According to technique
Incision of anterior vagina	None	None
Entrapment of specimen	Organ-bag intra-abdominally Transrectally	None
Retrieval of specimen	Mini-laparotomy Transvaginal	Periumbilical, mid-line Pararectal Preferable in women

Exposure of Ureter and Iliac Vessels

If pelvic lymph node dissection is done primarily, the peritoneal incision starts at the level of the first peritoneal fold to find and dissect the ureters. The lateral incisions of the parietal peritoneum are extended to the internal inguinal ring. Then, both ligamenta teres are divided and retracted medially to expose the medial aspect of the external iliac vessels. Pelvic lymph node dissection is done on each side, as already described in view of frozen sections. The subsequent dissection and antegrade division of ureters and upper vesical pedicles are then carried out (Fig. 46.3c). In case of an anterior exenteration, removing the bladder and uterus together with the ovaries (Fig. 46.3d), this step includes the division of the ovarian vein (Table 46.3).

Anterior Dissection

Umbilical ligaments and urachus are divided and the prevesical space is opened and bluntly dissected to expose the anterior aspect of the bladder until the bladder neck, urethra and anterior wall of the vagina. Opening of the endopelvic fascia allows the dissection to be continued until the lateral aspects of the urethra, which is dissected completely, secured between clips and transected. A metal retractor might be moved to the anterior vaginal bottom to enable the dissection of the urethro-vaginal space, which is developed in a retrograde way after section of the urethra. Preoperative packing of the vagina can be used for the same purpose.

If an *orthotopic bladder replacement* is planned, a maximal urethral stump is then preserved in view of the anastomosis (Fig. 46.4a–e). According to patient's age and expectations, cystectomy may be carried out with vaginal and uterine preservation [16]. More often, according to the tumour burden and stage, the uterus and part of the vagina may need to be taken with the bladder.

The section of the vaginal anterior wall is carried out with the help of the retractor, giving a flat horizontal shape to vagina ; the gas leak during section of the vagina is prevented by packing the vagina or by the fingers of the assistant. The use of a high-flow insufflator (ie. AirSeal, Dach Medical Group, Freilassing. Germany) is very helpful. Then, the specimen can be extracted transvaginally preferably in an Endobag.

Removal of the Specimen

In advanced cases, even for this manoeuver entrapment of the specimen in an organ-bag is recommended to minimize the risk of tumour cell spillage. Finally, the vagina is repaired and closed with continuous sutures (Fig. 46.5 ; i.e. V-lock, 30 cm, SH-needle).

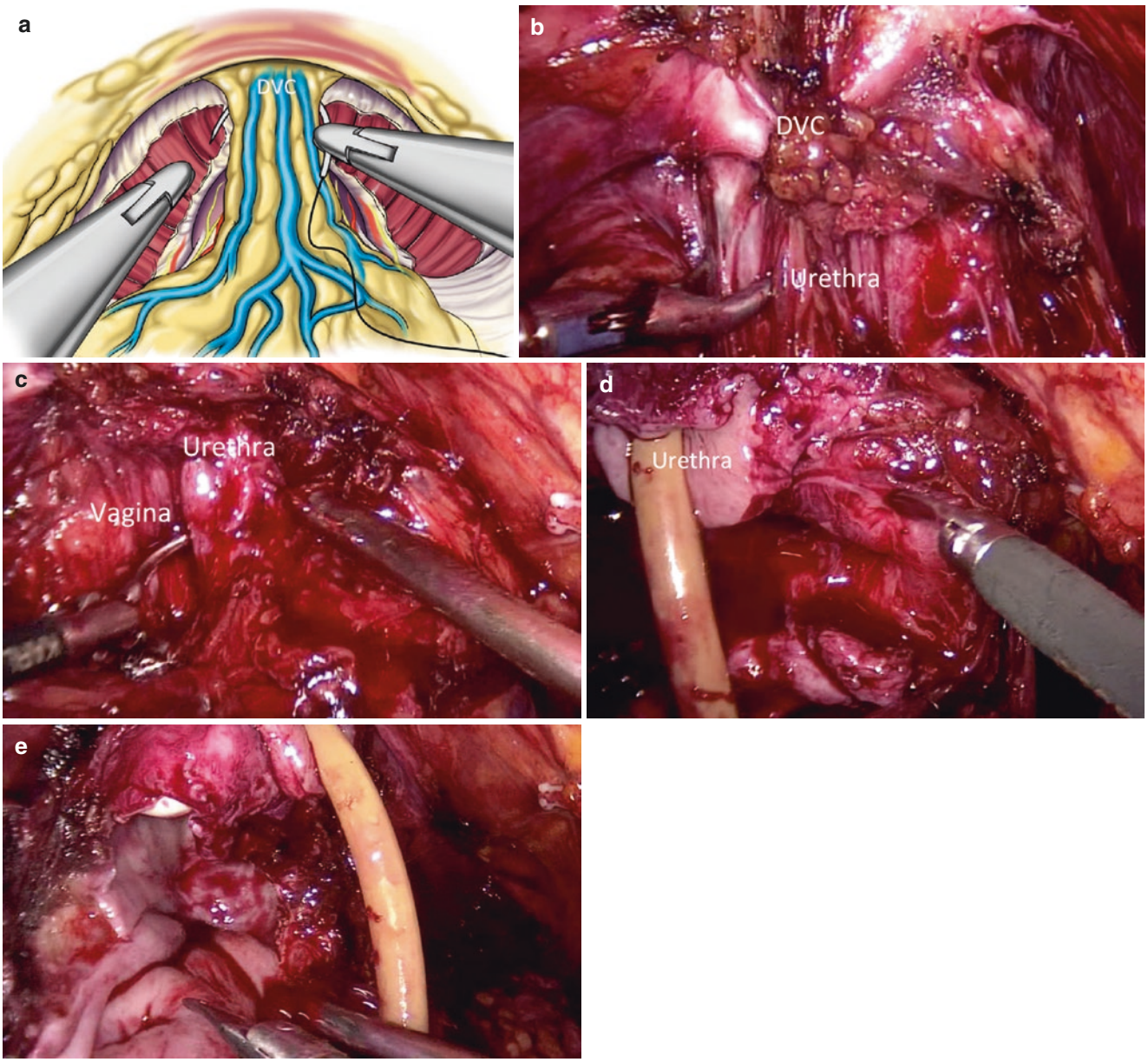


Fig. 46.4 Technical steps of dissection around the urethra during laparoscopic exenteration with formation of an ileal neo-bladder. (**a**) Suturing of the dorsal vein (Santorini's plexus) with an MH-needle (Vicryl, 15 cm or using a barbed suture (V-lock, 30 cm, SH-needle; Ethicon, Conneticut, United States). (**b**) Preservation of pubo-vesical collar and levator fascia lateral to the urethra to improve postoperative continence due to reduced injury to intrapelvic branches of pudendal nerve. (**c**) Posterior dissection of the urethra providing a long urethral stump. (**d**) Transection of the urethra at the level of the bladder neck with indwelling Foley catheter. (**e**) Opening of the vagina preserving a long anterior part. Note the finger of the assistant exposing the urethra and providing sealing of the vagina to minimize loss of carbondioxide

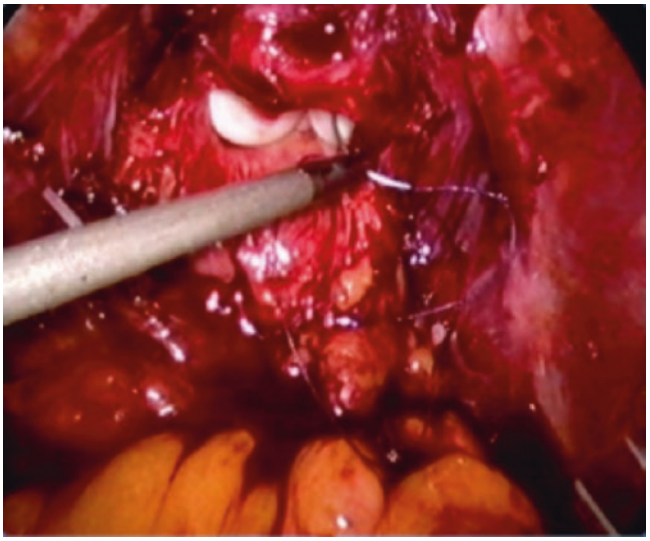


Fig. 46.5 Reconstruction of the vagina over the fingers of the assistant preferably using a barbed suture

Table 46.4 Distribution of urinary diversion in the ESUT-study on laparoscopic cystectomy

Urinary diversion	
Bricker	345 (69 %)
Ureterocutanostomy	10 (2 %)
Mainz II	8 (2 %)
Orthotopic neobladder	128 (25 %)
Continent pouch (Kock, Indiana)	12 (2 %)

Urinary Diversion

Depending on the gender, age of the patient as well as on the specific indication several types and techniques of urinary diversion can be performed (Table 46.4).

Laparoscopic Assisted Ileal Conduit

Completely Intra-Corporeally Construction of Ileal Conduit

In the female patient, following closure of the vagina (Fig. 46.5), the formation of an ileal conduit can be carried out completely laparoscopically. First step represents the transposition of the left ureter (Fig. 46.6a, b). Subsequently a 20-cm ileal segment is isolated by use of an endoscopic stapler (Fig. 46.6c). The ileo-ileal anastomosis is performed with antimesenteric side-to-side stapling and closure of the remaining opening by endoscopic suturing. Then, the distal end of the ileal segment is pulled out via an enlarged trocar incision in the right lower abdomen and sutured to the skin (Fig. 46.6d). Via the so created urostoma, single-J-stents can be introduced, and both ureters are stented and sutured to the ileal conduit in a modified Wallace-type (Fig. 46.6e) technique or individually using interrupted sutures, according to the Bricker's technique (Fig. 46.6d).

Extracorporeal Creation of Ileal Conduit

For most patients, the ileal conduit usually is performed laparoscopically assisted. The extended peri-umbilical mini-laparotomy for retrieval of the specimen is used for the isolation of the 20-cm segment of the distal ileum in an open technique (Fig. 46.7a, b). The ileo-ileal anastomosis is performed by interrupted seromuscular stitches, and the ileum is brought back into the abdominal cavity. Next step represent the uretero-ileal anastomosis using an open technique (Fig. 46.7c). Subsequently, the 10 mm trocar incision in the right lower abdomen is used as ileostoma (Fig. 46.7d): the trocar incision has to be enlarged allowing the pulling of the distal conduit end through the wound, and suture it to the rectus fascia and skin. After placement of two single-J-stents the ileal segment is manipulated back into the abdominal cavity, the periumbilical incision is closed, and the pneumoperitoneum re-established. The separate use of two trocar incisions offers the advantage of a better cosmetic result of the urostoma, and thus minimal problems with the adhesive plates.

Intracorporeal Uretero-Ileal Anastomosis

Alternatively the uretero-ileal anastomosis can be performed laparoscopically, the already transposed left ureter is sutured to the right one in a Wallace fashion (i.e. Vicryl 3/0, RB1-needle). Then both ureters are stented by insertion of the single-J-stents, and sutured to the ileal conduit using interrupted or continuous sutures.

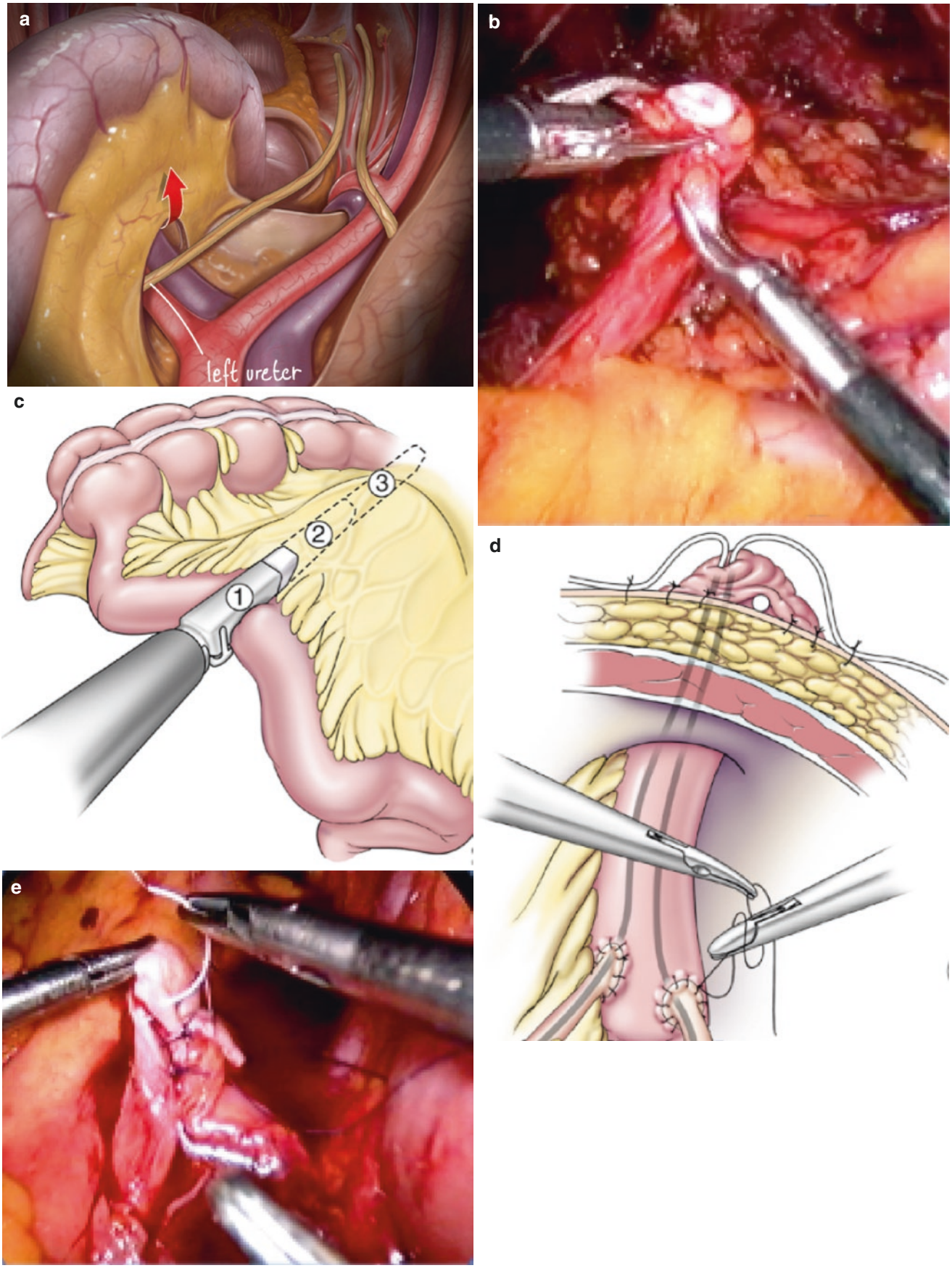


Fig. 46.6 Technical steps of laparoscopic intra-corporeal ileal-conduit. (**a**) Transposition of the left ureter under the meso-sigma, which is facilitated by the previous extended pelvic lymph node dissection (Level I and II). (**b**) Spatulation of the ureter. (**c**) Isolation 20 cm terminal ileum using endoscopic stapler. (**d**) Wallace end-to-side anastomosis of both ureters. (**e**) Fixation of the conduit at the skin; here use of to individual uretero-ileal implantation sites

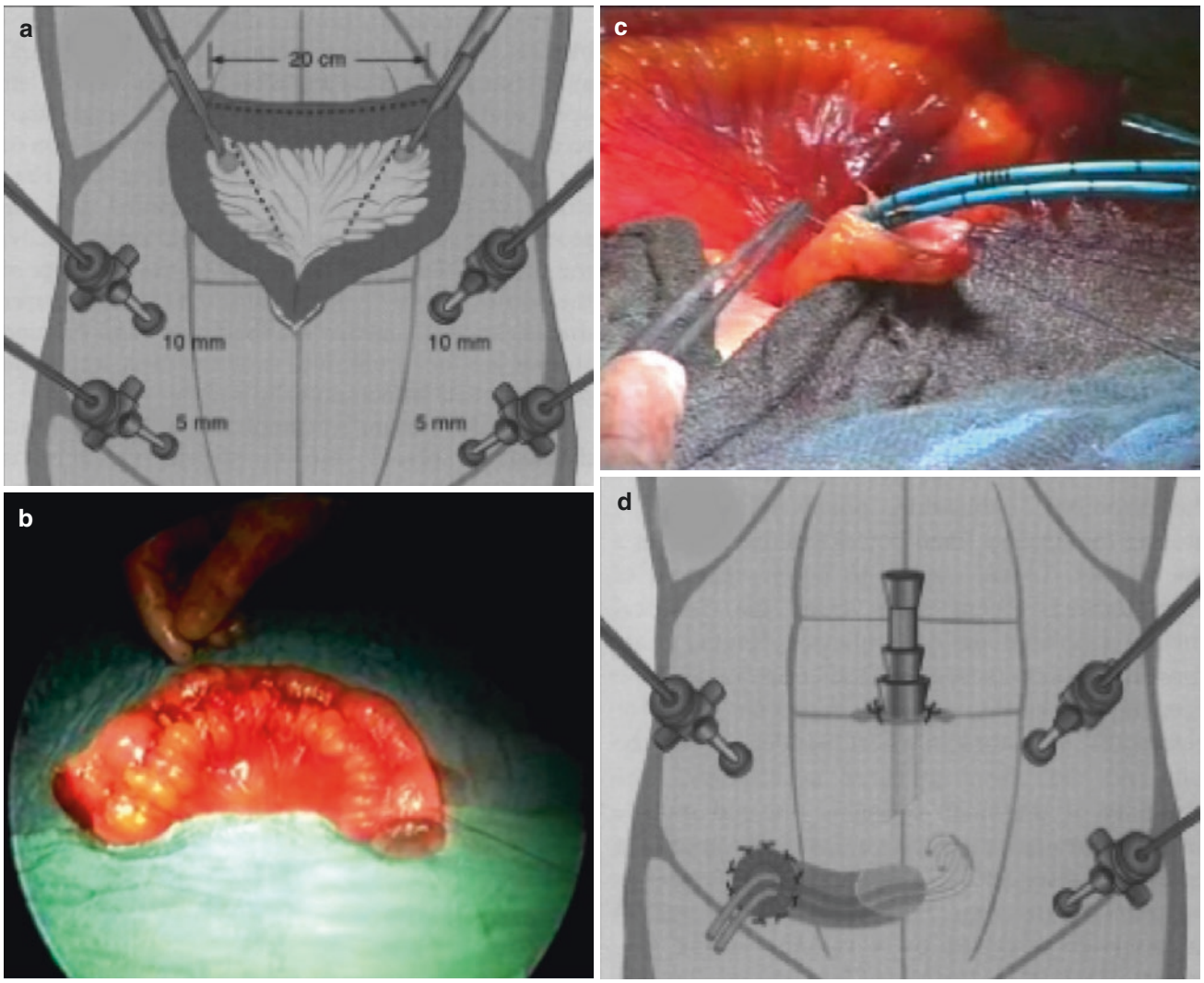


Fig. 46.7 Technical steps of laparoscopic-assisted extra-corporeal ileal-conduit. (**a**) Isolation of the ileal segment via a sub-umbilical incision using open technique. (**b**) Isolated ileal segment, the ileo-ileal end-to-end anastomosis has been performed and the restored ileum carefully replaced intraabdominally. (**c**) Uretero-ileal anastomosis performed in an open technique. (**d**) After accomplishing the urostoma, the abdomen is reinsufflated to check the correct position of conduit and anastomosis

Laparoscopic Assisted Orthotopic Neo-Bladder

This procedure represents the most frequently applied technique of urinary diversion following laparoscopic radical cystectomy, however in the advanced indications in gynaecology they cannot be applied in most cases due to involvement of the bladder neck and urethra.

Extra-abdominal Construction of the Ileal Neobladder

The orthotopic neobladder pouch is created by suturing opened small bowel together to form a new bladder. Like usually, a 55- to 60-cm segment of ileum located 15 cm away from the ileocecal junction is isolated and detubularized, leaving intact a proximal 10-cm isoperistaltic afferent Studer limb segment. As a function of surgeon's skills or preferences, an Hautmann's ileal bladder can be built as well and the bowel prepared accordingly. The continuity of the small bowel is restored outside the body through the incision made for specimen retrieval. Subsequently, a spherical neobladder is constructed extracorporeally. The anterior wall of the reservoir is closed by a running suture (i.e. PDS 3/0 with straight needle; Vicryl 3/0 ; SH-needle) ; the caudal part of this closure is left open in view of the neo-vesico-urethral anastomosis.

Uretero-Ileal-Anastomosis

A termino-terminal uretero-ileal anastomosis is then performed through the same incision, according to Wallace or to Bricker. Ureters are intubated with 8 Fr. smooth catheters

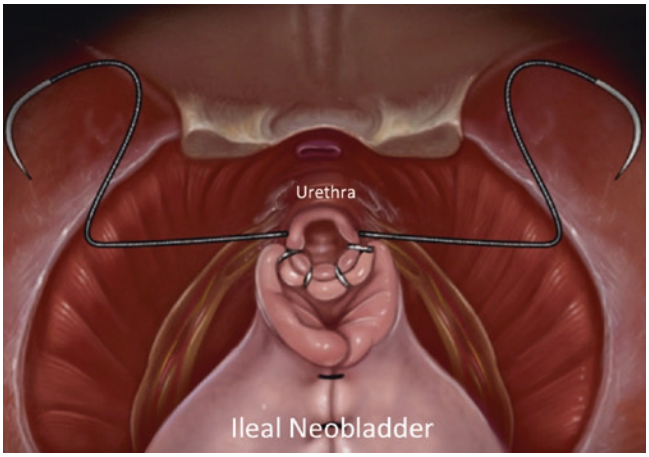


Fig. 46.8 Laparoscopic assisted extracorporeal neo-bladder: urethra-vesical anastomosis using van Veltoven-technique as last step of the procedure

temporarily attached to the posterior wall of the pouch with quickly absorbable sutures (Vicryl rapid ® *2/0)*. Both catheters are exteriorized through the anterior wall of the pouch, and subsequently, will be passed through the abdominal wall.

Urethral Anastomosis

When the pouch is ready, it is placed into the abdomen and the mini-laparotomy is closed classically. The 10 mm trocar is replaced for the telescope in an infraumbilical position and the pneumo-peritoneum re-insufflated.

After appropriate positioning of the ileal neo-bladder in its orthotopic position a « vesico » urethral anastomosis is started between the ileal orifice left open and the urethral stump using a single-knot technique (van Velthoven) minimizing the tension of the tissue (Fig. 46.8). The suture is started at six o'clock on the ileal edge of the suture ; two 6–7 in. of 2/0 PGA monolayer threads knotted together are used ; two hemi-running sutures are then built until twelve o'clock where the only knot tied intracorporeally is done.

When this suture is completed, a Jackson-Pratt drainage is placed into the pelvis ; the tube is exteriorized through a trocar hole in the right fossa. Fascial incisions of 10 mm are closed with interrupted sutures. The skin is closed with surgical staples.

Intra-corporeal Laparoscopic or Robot-Assisted Neo-Bladder

The entire neo-bladder can be also performed laparoscopically as a sigmoid-neobladder [12]. However, most experience exists with the ileal-neobladder replicating the Studer-neobladder. This includes mainly seven steps (Table 46.5). Evidently, this represents a very complicated procedure

Table 46.5 Surgical steps of robot-assisted intra-corporeal laparoscopic orthotopic neo-bladder

Choice of longest ileal segment and urethro-ileal anastomosis
Isolation of 60 cm ileal segment using endoscopic stapler
Ileao-ileal anastomosis using endoscopic stapler
Anti-mesenterial incision of ileal segment preserving the distal end for uretero-ileal anastomosis
Continuous suture of posterior wall of neo-bladder
Closure of anterior wall of neo-bladder
Stenting of both ureters
Uretero-ileal anastomosis

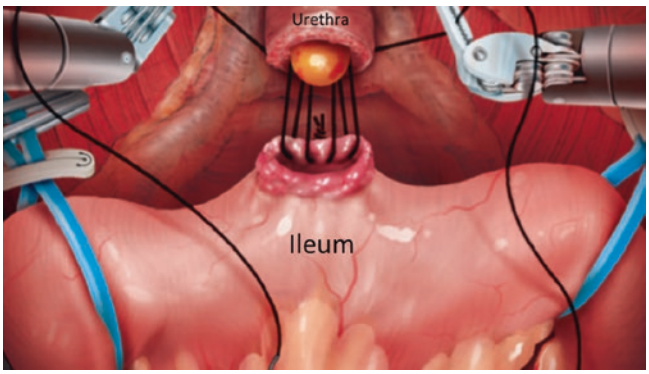


Fig. 46.9 Robot-assisted intracorporeal neo-bladder: anastomosis between urethra and ileal loop ad first step of urinary diversion

even with the assistance of the Da-Vinci-robot [17]. The main advantage represents the fact, that the first step includes urethro-ileal anastomosis (Fig. 46.9) thus minimizing the tension on anastomosis.

Laparoscopic Assisted Sigmoid-Pouch (Mainz-Pouch II)

The Mainz-Pouch II has been used frequently in women, due to the problems of "hypercontinence" with ileal neo-bladders ranging up to 30 % of the patients. However, this technique requires adequate control of the anal sphincter. The procedure can be performed completely laparoscopic or laparoscopic-assisted creating the sigmoid-pouch via a 10 cm- midline incision respectively using a Pfannenstiel incision.

Postoperative Management

In the first night, all patients were monitored on the intensive care unit for vital parameters monitoring and adequate pain management. Parenteral nutrition was continued until complete oral feeding (i.e. day 3–5). The drains are removed

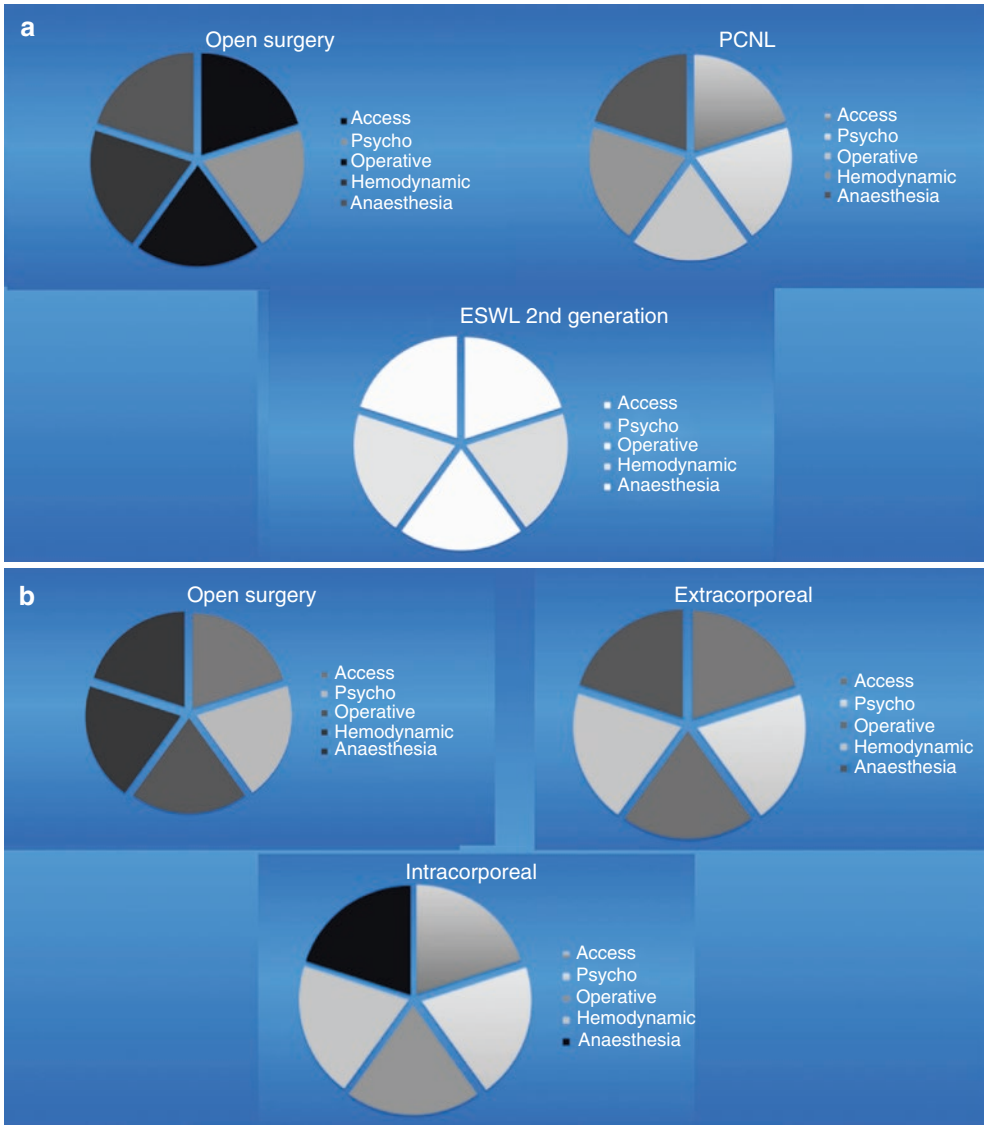


Fig. 46.10 The impact of minimally invasive techniques on the outcome of the procedure (according to Wickham 1991). (**a**) The introduction of percutaneous nephrolithtomy (PCNL) and extracorporeal shock wave lithotripsy (ESWL) significantly improved all five relevant aspects of a surgical procedure (*white* = no problems, *black* = significant problems). (**b**) The introduction of extracorporeal and intracorporeal radical cystectomy with urinary diversion has also reduced some of the five aspects, but on the other hand the associated morbidity might be increased (*white* = no problems, *black* = significant problems)

after reduction of secretion below 50–100 ml. On day 10 and 11, the ureteral stents are removed. Following a cystogram, the urethral catheter of neo-bladders is removed on postoperative day 14–18 (Fig. 46.10), after 48 h of intermittent clamping every 2 h.

Results

Of note, median LN retrieval in the *European Study* was 14 nodes (IQR 9–17). Positive surgical margins (PSM) were detected in 29 specimens (5.8 %): 26/29 PSM were found in patients harboring extravesical disease (11 had pT3, 15 pT4). This underlines, hat laparoscopic technique allows to perform adequate pelvic lymph node dissection.

Minor complications (Clavien I-II) occurred in 39 % (195/503) of patients, with post-operative infections requiring antibiotic therapy being the most frequent (Table 46.6). Major complications instead (Clavien IIIa-IVb) were found in 17 % (85/503) of patients in the early (<30 days) post-operative period. Specifically, 60 patients (12 %) underwent a second surgical operation of which 18 (4 %) due to bowel leak/peritonitis, 8 (2 %) for a urinary leak/fistula, 6 (1 %) for operative management of abdominal wall defects, 5 (1 %) for adhesiolysis due to occlusive syndrome, 3 (0.5 %) for surgical drainage of infected intraabdominal collection and 2 (0.5 %) for post-operative bleeding. Finally six patients (1 %) were re-operated for other causes (including endoarterectomy, ureteral reimplantation, fasciotomy, preputium necrosis), and in 12 patients the cause of re-operation was unknown. Clavien IV complications occurred in five patients (1 %), notably 2 acute respiratory failures (IVa), 1 acute renal failure (IVa), 1 septic multi-organ failure (IVb) and finally 1 patient experiencing both a Clavien IVa (respiratory distress)

Table 46.6 Postoperative complications of European Study on Laparoscopic Cystectomy

Post-op complications	
Clavien I	71 (14 %)
Clavien II	140 (28 %)
Clavien IIIa	29 (6 %)
Clavien IIIb	60 (12 %)
Clavien IVa	4 (1 %)
Hospital stay*(days)*	14 (10–20)
Median (IQR)	18 ± 15

and a Clavien IVb (septic multiorgan failure) complication. The rate of Clavien V complications was estimated at 2 %, with ten patients dying in the early postoperative period principally as a consequence of septic multi-organ failure. Conversion to an open procedure occurred in 12 cases (3.4 %), and depended on different factors ranging from extensive intra-abdominal adhesions to uncontrollable bleeding.

Oncologic Outcomes

There is no doubt, that the prognosis of anterior exenteration for advanced disease (FIGO IV; T4 TCC) is poor. Even in the European Study of laparoscopic cystectomy with D a median follow-up 52 months, 134 recurrences were detected and 118 (23 %) were due to metastatic disease, 14 (3 %) were local and 2 (0.5 %) urethral recurrences. 343 patients are alive and free from disease, 108 died as a consequence of bladder cancer (10 in the early post operative period, 98 due to disease progression), and 52 died of non-cancer specific causes. Actuarial RFS, CSS and OS rates were calculated at 74 %, 82 % and 79 % after 2 years; 66 %, 75 % and 62 % at 5 years; 62 %, 55 % and 38 % at 10 years. Patients with positive surgical margins experienced the worst survival outcomes, with 2- and 5 year OS rates of 31 % and 16 %, respectively. Tumor stage and node involvement were significant predictors of RFS, CSS and OS (all $p < 0.0001$). Notably, no port-site metastases were detected during the entire follow-up of this cohort.

Discussion

Anterior exenteration plays an important role in the management of muscle-invasive bladder cancer in women, representing 18–20 % of patient population [2]. In rare cases of advanced gynaecological tumours stage FIGO IV it may be also indicated [7, 8]. The procedure can be accomplished laparoscopically, but it represents a challenging operation. On the other site, laparoscopy in experienced hands has significantly reduced blood loss of this procedure. Most of the serious complications (Clavien III–IV) are not related to the ablative part, but to the urinary diversion ([7]; Table 46.6).

There is still the debate, whether the urinary diversion should be performed completely intracorporeally or extracorporeally extending the incision required for removal of the specimen. In women, the specimen can be extracted transvaginally. Thus, an additional incision becomes necessary. The main argument against the entire laparoscopic approach represents the technical difficulty of the procedure including bowel anastomosis, uretero-intestinal-anastomosis, stent placement which may be very time-consuming with the hazard of severe postoperative complications (Table 46.6). Even in the hand of the most experienced surgeons the OR-times are very long, which also adds to the associate trauma of the procedure [18].

In case of anterior exenteration for gynaecological indications, usually a neo-bladder is not indicated. This means, that an ileal conduit will be mostly performed. This might be easier, however, we still encountered some complications when doing the procedure intracorporeally, such as a fistula between conduit and ileum at site of intestinal anastomosis. Moreover, it is important to follow all surgical steps established in open surgery to minimize the risk of complications [18]. When using a sigmoid-pouch (Mainz-Pouch) for urinary diversion, we did not perform a sacropexy of the pouch, which resulted in formation of a sigmoidal-vaginal fistula. On the other side, to perform urinary diversion extracorporeally has the advantage of a significantly shorter operating time. Thus, the combination of laparoscopic anterior exenteration with extracorporeal ileal conduit may represent an ideal form of minimally invasive surgery for such extended cases. This can be nicely demonstrated when using the Wickham Wheel ([19]; Fig. 46.10).

In the future, further experience with robot-assisted radical cystectomy and urinary diversion may alleviate to perform the procedure [5, 17, 20]. This could include the use of easier-to construct neo-bladders (i.e. T-pouch, Y-pouch), the use of absorbable staplers and better suturing techniques. Actually, robot-assisted anterior exenteration with intracorporeally urinary diversion is still experimentally.

References

1. Gakis G, Efstathiou J, Lerner SP, et al. ICUD-EAU International Consultation on Bladder Cancer 2012: radical cystectomy and bladder preservation for muscle-invasive urothelial carcinoma of the bladder. Eur Urol. 2013;63:45–57.
2. Albisinni S, Rassweiler J, Abbou CC, Cathelineau X, Chlosta P, Fossion L, Gaboardi F, Rimington P, Salomon L, Sanchez-Salas R, Stolzenburg JU, Teber D, van Velthoven R. Long-term analysis of oncologic outcomes after laparoscopic radical cystectomy in Europe: results from a multi-centric study of EAU-section of Uro-Technology. BJU Int. 2015;115:937–45.

3. Pruthi RS, Wallen EM. Robotic assisted laparoscopic radical cystoprostatectomy: operative and pathological outcomes. J Urol. 2007;178:814–8.
4. FIGO committee on gynecologic oncology. FIGO staging for carcinoma of the vulva, cervix, and corpus uteri. Int J Gynaecol Obstet. 2014;125:97–8.
5. Iavazzo C, ID G. Robotic technology for pelvic exenteration in cases of cervical cancer. Int J Gynaecol Obstet. 2014;125:15–7.
6. Rajaram S, Maheswari A, Srivastava A. Staging for vaginal cancer. Best Pract Res Clin Obstet Gynaecol 2015; ahead of print
7. Martinez A, Fileron T, Vitse L, Querleu D, Mery E, Balague G, Delannes M, Soulie M, Pomel C, Ferron G. Laparoscopic pelvic exenteration for gynaecological malignancy: is there any advantage? Gynecol Oncol. 2011;120:374–9.
8. Mettler L, Meinhold-Heerlein I. The value of laparoscopic surgery to stage gynaecological cancers: present and future. Minerva Ginecol. 2009;61:319–37.
9. Jamkar AV, Puntambekar SP, Kumar S, Sharma V, Joshi S, Mitkare S. Laparoscopic anterior exenteration with intracorporeal urterosigmoidostomy. J Minim Invasive Gynecol. 2015;22:538–9.
10. Odetto D, Saadi J, Saraniti G, Noll F, Salvo G, Perrotta M. Laparoscopic posterior exenteration in cervical cancer: initial experience at Hospital Italiano de Buenos Aires: IGCS-0085 cervical cancer. Int J Gynecol Cancer. 2015;25(Suppl. 1):30–1.
11. Akiyoshi T, Nagasaki T, Ueno M. Laparoscopic total pelvic exenteration for locally recurrent rectal cancer. Ann Surg Oncol. 2015;22(12):3896. epub ahead of print
12. Rassweiler J, Frede T, Teber D, van Velthoven R. Laparoscopicradical cystectomy with and without orthotopic bladder replacement. Minim Invasive Ther Allied Technol. 2005; 14:78–95.
13. Rassweiler J, Godin K, Goezen AS, Kusche D, Chlosta P, Gaboardi F, Abbou CC, van Velthoven R. Radical cystectomy–pro laparoscopy. Urologe A. 2012;51:671–8.
14. Haber GP, Crouzet S, Gill IS. Laparoscopic and robotic assisted radical cystectomy for bladder cancer: a critical analysis. Eur Urol. 2008;54:54–62.
15. Hayn MH, Hellenthal NJ, Seixas-Mikelus SA, et al. Is patient outcome compromised during the initial experience with robot-assisted radical cystectomy? Results of 164 consecutive cases. BJU Int. 2011;108:882–7.
16. Gaboardi F, Simonato A, Galli S, et al. Minimally invasive laparoscopic neobladder. J Urol. 2002;168:1080–3.
17. Collins JW, Wiklund NP. Totally intracorporeal robot-assisted radical cystectomy: optimizing total outcomes. BJU Int. 2014; 114:326–33.
18. De Wilde RL. The danger of time-consuming operative laparoscopies: avoiding severe complications. Geburtshilfe Frauenheilkd. 2012;72:291–2.
19. JE W. Editorial: the concept of minimally invasive therapy. Minim Invasive Ther. 1991;1:1–5.
20. DeBernardo R, Starks D, Barker N, Armstrong A, Kunos C. Robotic surgery in gynecologic oncology. Obstet Gynecol Int. 2011;2011(2011):139867. Epub 2011 Nov 16.

LRH with Anterior and Posterior Exenteration: Surgical Perspectives

47

Gwenael Ferron, Juan J. Torrent, Christophe Pomel, Bernard Malavaud, D. Querleu, and Alejandra Martinez

Introduction

Pelvic exenteration (PE) is the most radical surgery performed in gynecologic oncology. Pelvic exenteration is the only therapeutic approach for the management of pelvic relapse within irradiated fields or in locally advanced tumors resistant to radiochemotherapy.

Over the last decade, the selection criteria have been refined. The surgical technique has substantially evolved, with the development of new haemostatic devices, description of laterally extended endopelvic resection and mainly to the systematization of complex reconstruction techniques of the vagina, perineum, urinary and digestive tract.

Indeed, many reconstructive surgical techniques are available to re-establish pelvic functions lost after an exenterative procedure. Surgical methods have been developed and validated to increase quality of life, enabling assessment of the relevance of reconstructive surgery for patient's well-being. In addition, reconstruction procedures contribute to avoid the empty pelvis syndrome and therefore result in an additional benefit in reducing the pelvic complication rate.

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This complex surgery requires highly qualified surgical, anaesthesiology, and paramedical teams. It is associated with a high complication rate and a consequently a long average hospital stay.

The denudated and irradiated pelvis represents the source of complications, such as bowel obstruction and bowel fistula formation. However, the use of non-irradiated colon for urinary diversion decreases fistula rate, and the pelvis filled by a musculocutaneous flap also greatly reduces complications like fistula or abcess. Association of complex reconstruction techniques (myocutaneous flap for vaginal reconstruction associated to a continent colic urinary diversion and digestive's restoration) improves quality of life and also postoperative courses.

Patient Selection for Pelvic Exenteration

An evaluation of the potential oncologic benefit is mandatory before proposing a patient pelvic exenteration, which is a mutilative procedure. Except in rare palliative indications for complex fistulas, only patients with relatively favorable long-term prognosis should be selected. The presence of extrapelvic visceral metastasis, of peritoneal disease, and/or macroscopic aortic lymph nodes metastasis are associated with a poor short-term prognosis and therefore are generally considered as a contraindication.

The objective of the surgery is to achieve free margins. The hypothesis of a residual tumor (R1 or R2) at the end of the surgery must be minimized. The contribution of new imaging techniques such as MRI and PET-CT has improved the preoperative assessment of tumor extent and the detection of distant metastases. Although preoperative imaging is helpful in detecting obvious contra-indications to exenteration, preoperative laparoscopic staging possibly associated with aortic lymph node dissection may be useful to further decrease the rate of abortive surgery.

The type of excision and organ removal must be adapted to the tumor location. The term 'exenteration" encompasses

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a variety of surgeries, depending on the involvement of the pelvic organs and the required level of pelvic floor resection. Anterior, posterior, or total exenteration, with or without removal of the pelvic floor and perineum (supralevator, infralevator or extended) are described in the Magrina's classification [1].

Preoperative Preparation of the Patients

The extent of planned surgery determines the information given to the patient. The patient must be informed about potential resections, functional consequences and expected complications, including both body image and sexual function alteration. The available reconstruction techniques, the associated complications and potential benefit must be addressed. Information regarding the day-to-day management of diversion must be provided. Support of a nursing team, stomatologist, dietician and psychologist is mandatory. Placement of stomas must be decided with the patient before the surgery according to her morphotype and clothing habits. In case of continent pouch, urostomy is often placed in the umbilicus.

Even though it is not generally recommended in elective colic surgery, bowel preparation may be useful, particularly in the case of the creation of a continent urinary pouch.

Thorough preoperative assessment of the medical condition of the patient, active anesthesiologic management, including invasive monitoring and peridural analgesia are mandatory. Routine respiratory physiotherapy and early enteral and oral feeding have been found to shorten the postoperative stay.

Patient Selection for Laparoscopic Pelvic Exenteration

Pelvic exenteration as well as reconstruction techniques are feasable by laparoscopy [2]. The contribution of perineal approach to the laparoscopy allows to reduce the mean surgical time as well as to adapt perineal approach to oncologic rules [3].

The use of both new haemostatic tools and automatic suture devices allows to manage in well selected cases this type of surgery with reasonable mean surgical time.

Although the use of this technique is currently undertaken by only a few surgeons**,** its reproductibility is assured for the ablative phase and also for reconstruction techniques such as Miami continent pouch or ileal loop derivation.

Techniques of vaginal reconstruction are limited in laparoscopic approach with the impossibility to use the current reference rectus abdominis myocutaneous flap.

Indications for lparoscopic approach for PE must be limited to:

- patients with a locally advanced tumor or a small size isolated centro-pelvic relapse.
- non sexually active patients, without the need of "optimal" vaginal reconstruction. For young and sexually active patients, we believe that open surgery with rectus abdomininis flap (or vertical DIEP flap) represents the best option [4].

Gynecologists must keep in mind that such a technically challenging procedure needs to be used with caution, as special laparoscopic and oncologic experience is required.

In this chapter, we report our stepwise surgical procedure of laparoscopic supralevatori anterior (and middle, with complete vaginectomy) pelvic exenteration. In addition, specific steps for rectal resection in case of total PE are described. Lymp nodes dissection are not described here. Indications of pelvic and aortic nodes dissection are depending to results of PET-CT and to the patient medical history. In case of pelvic recurrence, lymphadenectomies have been routenelly previously performed.

Laparoscopic Pelvic Exenteration: A Three Step Procedure

Description of laparoscopic PE can be divided into three different phases [2, 3]:

Step 1: Laparoscopic Ablative Phase

Like in open surgery, anterior (and middle) PE with total vaginectomy represents a multimesovisceral resection including a total mesometrial resection and removal of the ureterovesical compartment. The dissection plans of PE have to be adjusted to the borders of pelvic compartments [5].

The dissection is stopped as soon as laparoscopic dissection is deemed sufficiently complete to later allow en-bloc removal of the specimen via perineal or vaginal approach. Additional steps adapted to each individual case are then performed before the loss of pneumoperitoneum secondary to later removal of the specimen.

Step 2: Laparoscopic Reconstructive Phase with Urinary Diversion Construction (Continent or Not) and Omental J Flap Harvesting

After a complete laparoscopic mobilization of the right colon and both ureters, the urinary diversion is created extracorporeally

through a small 5 cm medial minilaparotomy adjacent to the umbilicus or a 5 cm minilaparotomy over the right 10 mm port site.

Step 3: Perineal or Vaginal Approach

The en-bloc specimen is removed through the vagina or after perineal excision adapted to the tumor location.

The vaginal reconstruction is done by using the omental J flap and if needed, additional local flaps.

New haemostatic devices such as vessel sealing combined with ultrasonic and advanced bipolar energy are used to reduce bleeding and instrument changing. Endo-GIA staplers are necessary for bowel section.

Standard laparoscopic instruments are used during this procedure: two non-traumatic graspers, one Leriche dissector, and one needle holder.

Specific instrumentation is required for the continent pouch construction similar to open surgery [6, 7].

Patient Position

The patient is placed in a lithotomy position, with the legs at the same level than the abdomen with complete access to the perineum.

Both arms are placed along the abdomen to facilitate the laparoscopic procedure.

The surgeon operates from the left side and the assistant is on the right. The surgeon can move between both legs to easily access the upper part of the abdomen during omental J flap harvesting and mobilization of the right colon.

Laparoscopic Ports Placement

The umbilicus is used as the port site for the laparoscope. Four operative trocars are placed:

- one 5 mm on each iliac fossa.
- one 10 mm in the placement of preoperative marked stoma site.

Altogether, five trocars are placed. (Fig. 47.1).

Ergonomic placement of trocars is mandatory to access the entire peritoneal cavity, and allows pelvic and supraabdominal procedure with the same ports.

The absence of undefined preoperative intra-abdominal metastatic disease should be confirmed at this time. Since R0 resection is the goal of surgery, and undiagnosed peritoneal or visceral metastases are often unresectable, definitive surgery should be avoided in these cases, except for palliative surgery.

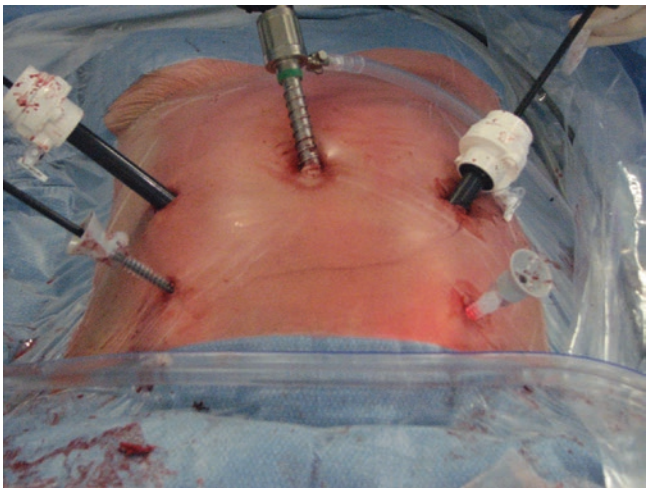


Fig. 47.1 Laparoscopic ports placement

Laparoscopic PE Phase

The abdominal phase is completely performed by laparoscopy.

The patient is placed in Trendelenburg position. Optimal pelvic exposure is required. The small intestine is packed in the upper quadrant after a right paracolic guttier incision.

If necessary, the sigmoid is attached to the left paracolic guttier to empty the posterior pelvis.

Dissection of Retzius and Pelvic Spaces

The anterior visceral peritoneum of the bladder is incised (Fig. 47.2), and the space of Retzius is opened. Both paravesical (Fig. 47.3) and pararectal (Fig. 47.4) spaces are developed.

During this dissection, the ureters still attached to the peritoneum are pouched medially or laterally to widely open the pararectal space.

The pelvic side peritoneum is incised laterally to the rectum.

Ureters Dissection

The infundibulopelvic ligaments are divided. The ureters are obstructed using hemoloks ® then transsected as low as possible in the pelvis (Fig. 47.5).

Of note, the ureters are often located medially in patients who have previously undergone surgery. Preoperative placement of ureteral stents is not required.

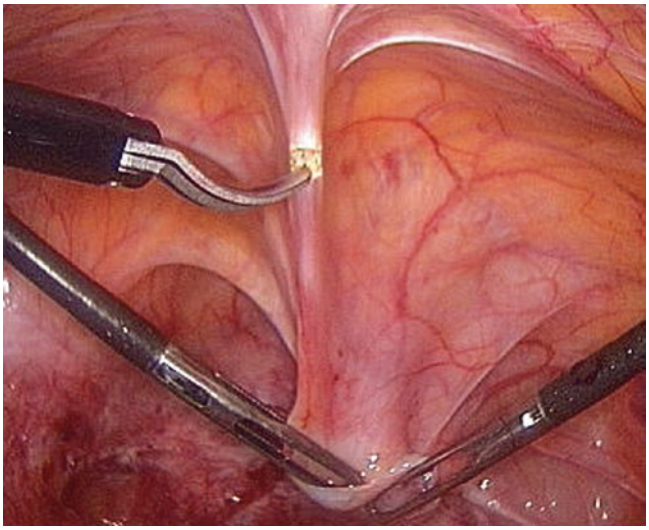


Fig. 47.2 Incision of the anterior visceral peritoneum of the bladder

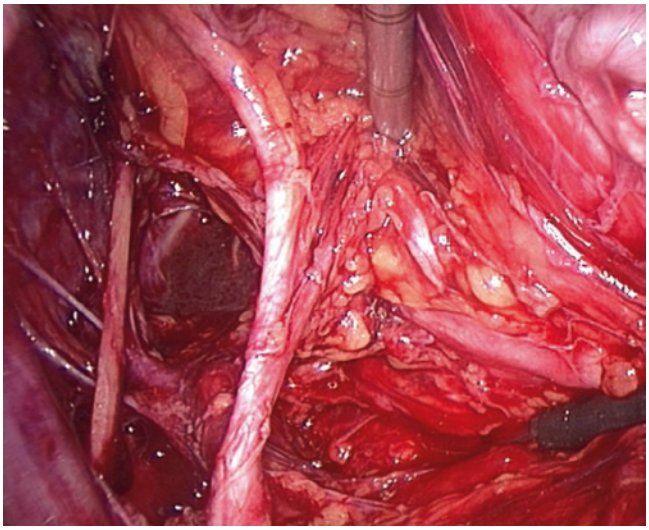


Fig. 47.4 Development of pararectal space

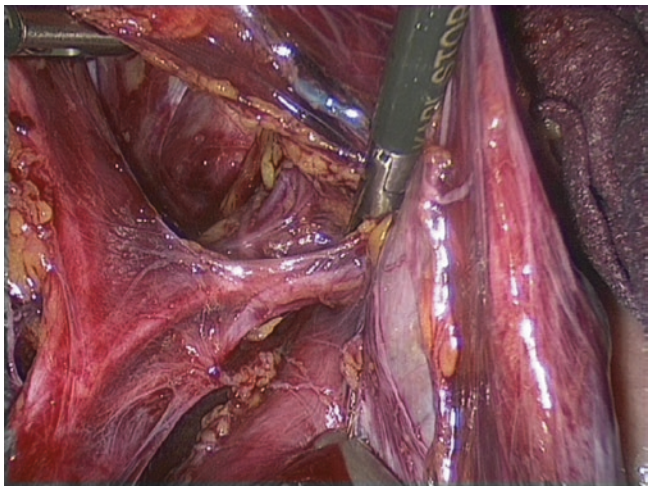


Fig. 47.3 Opening of the Retzius space

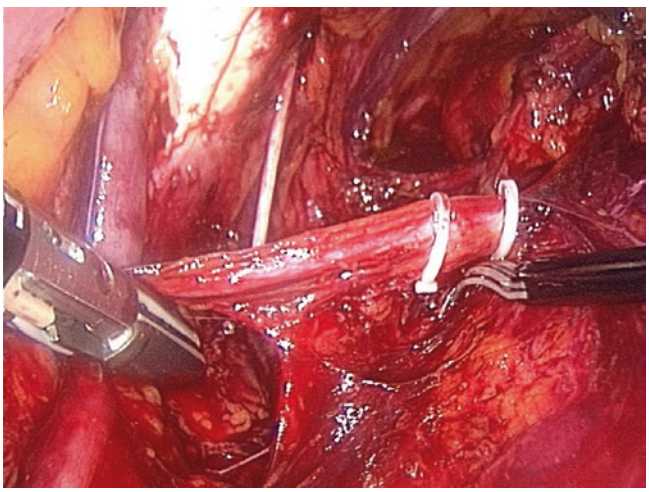


Fig. 47.5 Transsection of the left ureter

Dissection of the Rectovaginal Septa

The peritoneal incision is extended into the Douglas pouch (Fig. 47.6). The anterior aspect of the rectum is separated from the posterior vaginal wall with a blunt dissection (Fig. 47.7).

Coagulation and Section of the Parametrium

The entire specimen is pushed to one side by the assistant. The dissection is started in the pararectal space. The uterine artery and the superior vesical artery are coagulated or clipped (Fig. 47.8). The dissection is carried caudally and medial to the hypogastric pedicle.

The same step is then carried out on the other side.

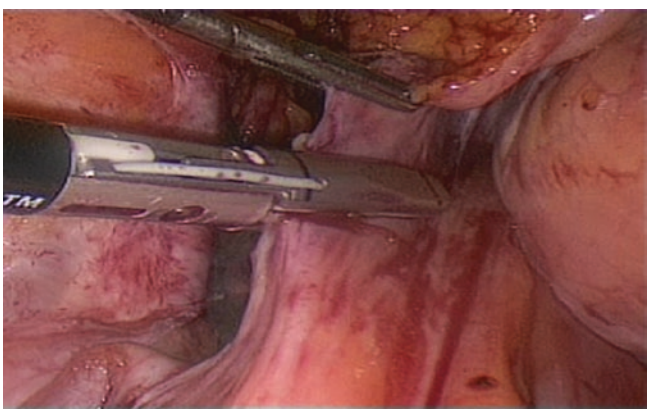


Fig. 47.6 Incision of the peritoneum into the Douglas pouch

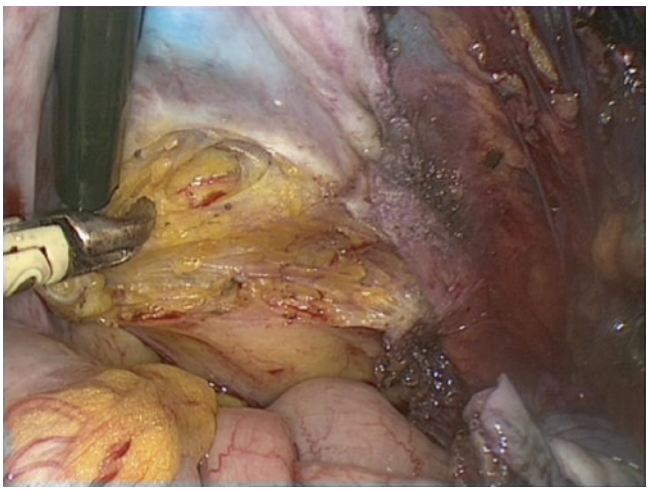


Fig. 47.7 Blunt dissection between the anterior aspect of the rectum and the posterior vaginal wall

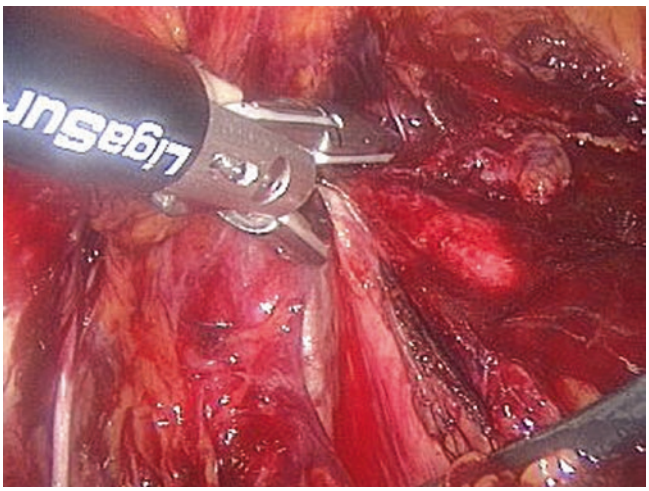


Fig. 47.9 Transsection of the uterosacral ligaments and paracolpos

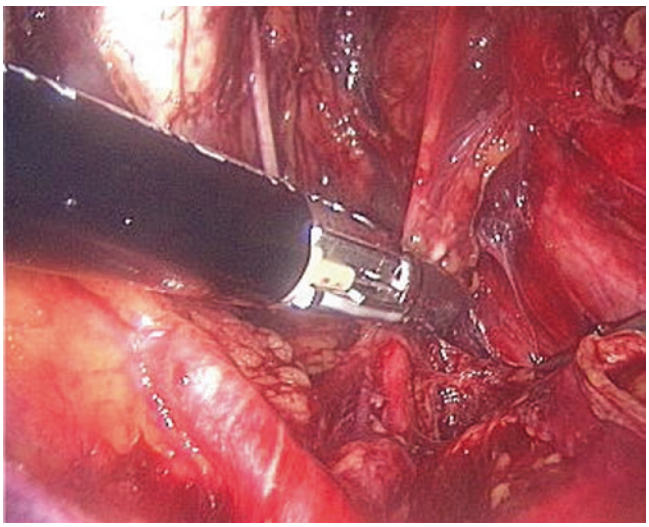


Fig. 47.8 Coagulation of the uterine artery and the superior vesical artery

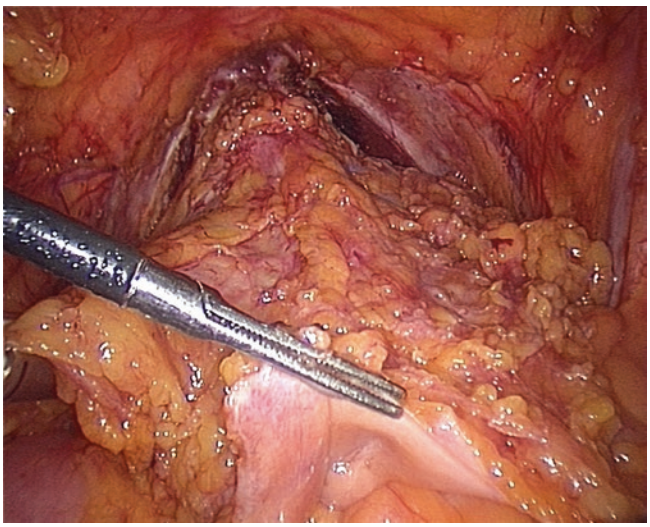


Fig. 47.10 Opening of the endopelvic fascia

Coagulation and Section of Paracervix and Paravaginal Tissue to the Pelvic Floor, and Identifying the Levator Ani

Uterosacral ligaments and paracolpos are transected as laterally as possible according to a complete mesometrial compartmentectomy and removal of the ureterovesical compartment (Fig. 47.9).

The endopelvic fascia is cleaned, and opened in case of infralevator or extended PE (Fig. 47.10).

In Case of Total PE

The rectum is dissected off the sacrum and coccyx by blunt dissection. This is performed by retracting the uterus and distal segment of the rectum anterior and cephalad, inserting an instrument behind the rectum in the presacral space, and freeing the rectum down to the coccyx.

In order to perform a colo-anal or colorectal anastomosis without tension, the left colon including the spleen flexure is widely mobilized.

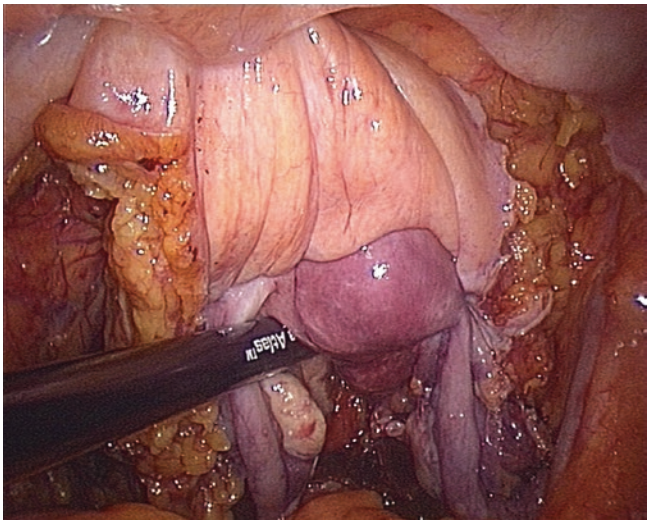


Fig. 47.11 Final laparoscopic view before en-bloc removal via perineal or vaginal approach

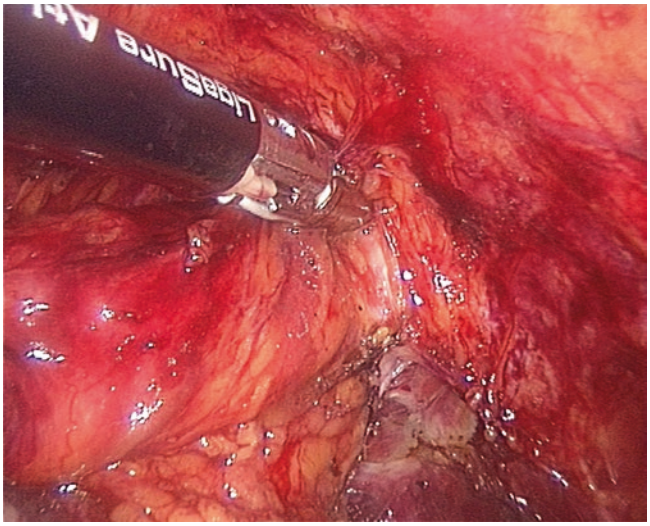


Fig. 47.12 Coagulation of paravesical plexus

The inferior mesenteric artery is transected at the origin and if necessary the inferior mesenteric vein close to the inferior aspect of the pancreas.

The rectum and the descending colon can be transected by laparoscpy using Endo-GIA staplers or outside after removal of the specimen (see next step).

Later Removal of the Specimen

The dissection is stopped as soon as laparoscopic dissection is deemed sufficiently complete to later allow en-bloc removal of the specimen via perineal or vaginal approach (Fig. 47.11).

By cephalad traction, the urethra can be exposed and transected at this time after coagulation of paravesical plexus (Fig. 47.12).

Additional steps adapted to each individual case are then performed before the loss of pneumoperitoneum, secondary to later removal of the specimen.

In the case of supralevatori PE, some authors have proposed to transect the vagina and remove the entire specimen through the vagina [2, 8]. The vagina is then packed to prevent pneumoperitoneum leakage.

Reconstructive Phase: Urinary Diversion (Bricker Diversion)

Mobilization of Both Ureters

The right ureter is mobilized up to the lower renal pole (Fig. 47.13), whereas for the left, it is dissected above the level of the inferior mesenteric artery and brought across the midline to the right without tension through a window created in the mesentery above the inferior mesenteric artery (Fig. 47.14). This step is facilitated in case of simultaneous aortic lymphadenectomy.

Creation of the Diversion

A 5 cm median incision starting from the umbilical trocar site is performed.

A segment of ileum is mobilized and exteriorized through the incision (Fig. 47.15). A 10 cm ileal segment 15 cm away from the ileocecal junction is isolated to construct the urinary diversion.

Bowel continuity is restored with stapled side-to-side ileo-ileal anastomosis.

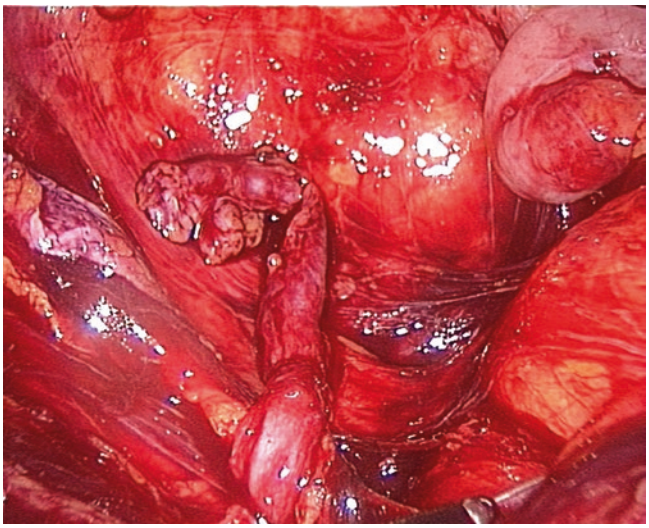


Fig. 47.13 Mobilization of the right ureter

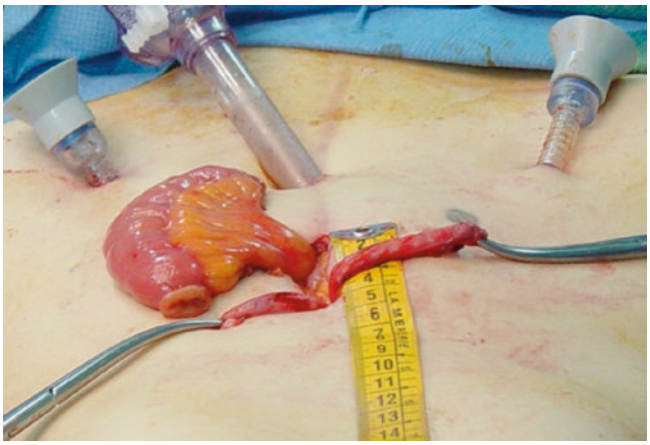


Fig. 47.15 Exteriorization of a segment of the ileum and the both ureters through the ombilical incision before creation of the Bricker diversion

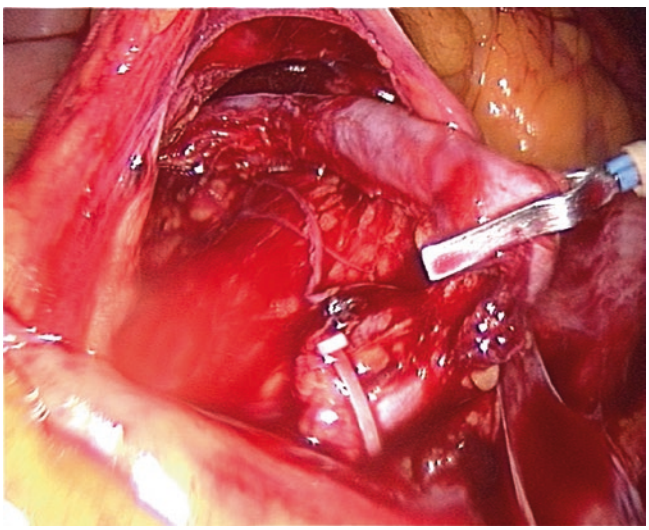


Fig. 47.14 Mobilization of the left ureter after creation of a peritoneal window above the level of the inferior mesenteric artery

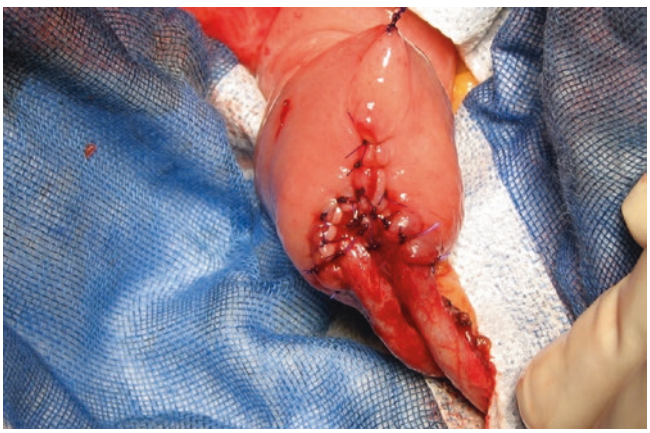


Fig. 47.16 Ileo-ureteral anastomoses in a wallace faction

Ileo-ureteral anastomoses in a Wallace faction are performed extracoporeally (Fig. 47.16). They are bilateral stented (8F Double JJ).

Finally the conduit stoma is fashioned: the end of the ileum is then brought out through a 10 mm port site previously placed in a preoperative marked stoma site.

Reconstructive Phase: Continent Miami Pouch

Right colon Mobilization Up to the Hepatic Flexure and Omental J Flap Harvesting

The patient is then positioned in a 15 ° reversed Trendelenburg with 15 ° left sided rotation to facilitate the mobilization of the ascending and the hepatic flexure of the colon.

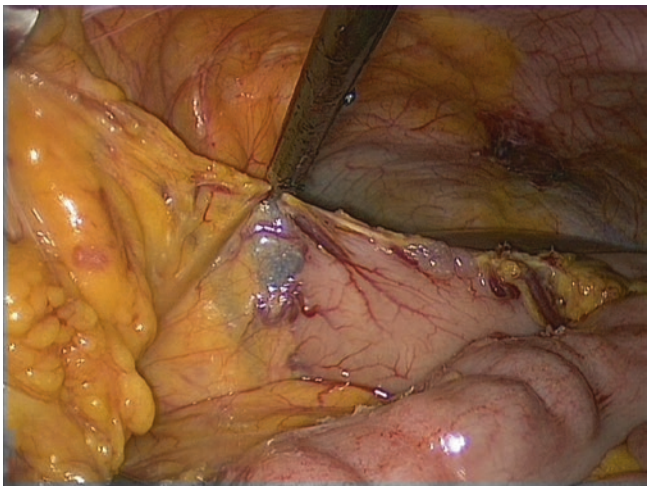


Fig. 47.17 Transection of the omentum off the greater curvature of the stomach

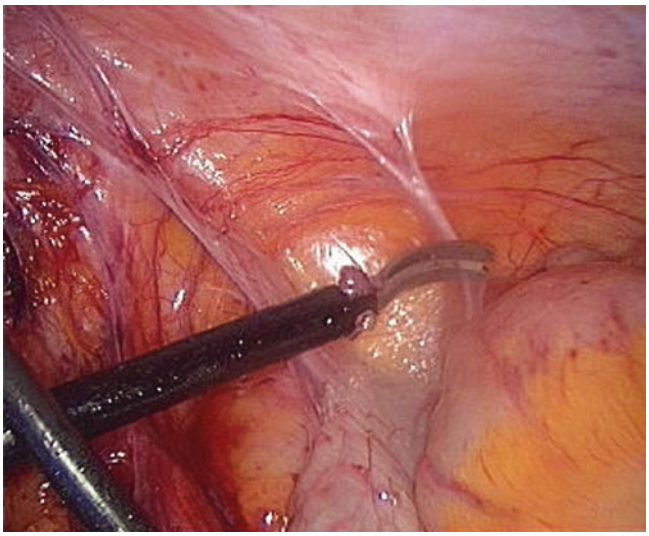


Fig. 47.19 Mobilization of the hepatic flexure

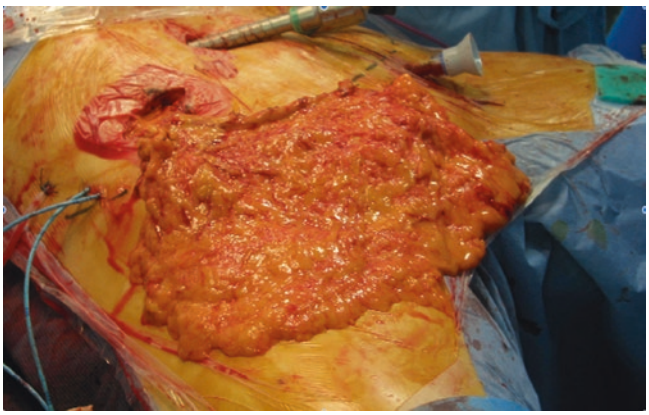


Fig. 47.18 Exteriorization of the omental J flap through the 5-cm iliac incision for neovaginal creation

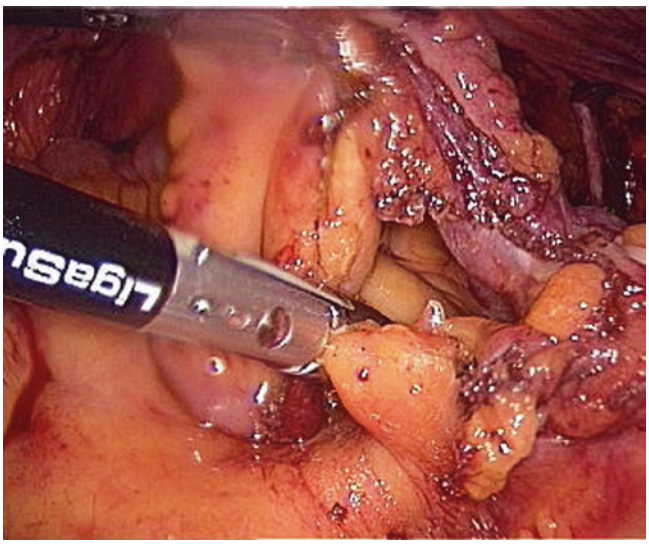


Fig. 47.20 Coagulation of the mesentery

The omentum is liberated from the transverse colon. Omental J flap is harvested at this time, after opening the omental bursa. The omentum is tipped over the anterior aspect of the stomach. The omental J flap is initiated by transecting the omentum off the greater curvature of the stomach (Fig. 47.17). The right gastroepiploic pedicle is skeletonized for the flap vascular supply. The omental J flap is stored at the upper part of the abdomen for the vaginal reconstruction. It will be transferred into the pelvis during the last phase after the removal of the specimen to fill the pelvis and optionally reconstruct the vagina (Fig. 47.18).

Then, the right part of the colon up to and including the hepatic flexure is mobilized (Fig. 47.19). This is to facilitate harvesting of an appropriate length of colon as well as entry into the retroperitoneal space to mobilize the ureters. The colon is transected proximaly to the middle colic artery, thus preserving an important blood supply. Transillumination through the right lower port with a 5 mm endoscope can be useful in identifying this important vessel in obese patients. It is also important to identify the position of the ileocolic artery before dividing the ileal mesentery, because this will be the main blood supply for the pouch. The colon and ileum are skeletonized (Fig. 47.20) and defatted before transection with EndoGIA staplers. 25 cm of colon and 15 cm of the terminal ileum are necessary to create a 250 cc volume pouch.

Mobilization of both ureters:

The right ureter is mobilized up to the lower renal pole, whereas for the left, it is dissected above the level of the

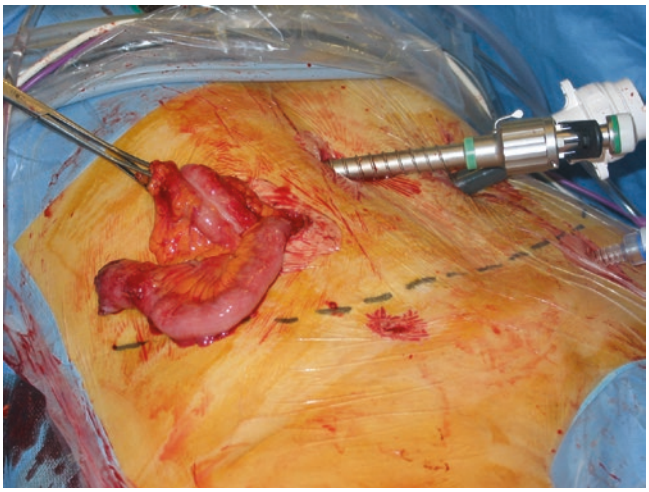


Fig. 47.21 Exteriorization of the ileum and the transverse colon before extracorporeally side-to-side anastomosis

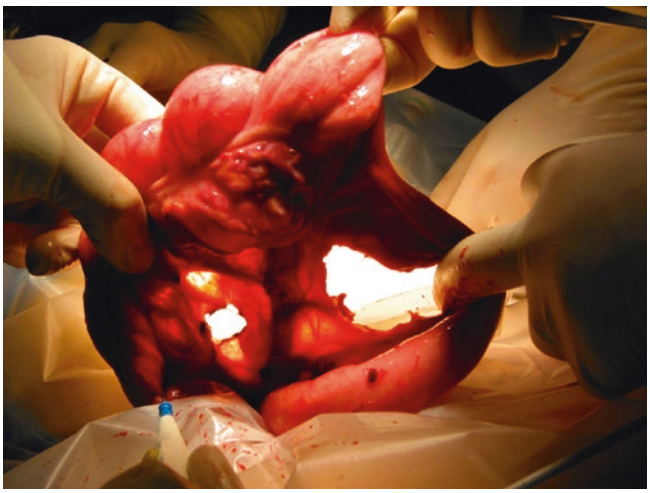


Fig. 47.22 Transillumination of the ileocolic conduit.

inferior mesenteric artery and brought across the midline to the right without tension through a window created in the mesentery above the inferior mesenteric artery. At this point, we prefer to fix the two ureteric ends with sutures near the site for the minilaparotomy to facilitate the exteriorization of the ureters during the next step.

Creation of a 5 cm Lateral Minilaparotomy

Through this, the transected intestinal ends are exteriorized, and a standard ileotransverse anastomosis is performed to restore bowel continuity (Fig. 47.21). We employ a side-to-side technique using two GIA 80 linear staplers.

Exteriorization of Ureters and Ileocolic Conduit (Fig. 47.22)

An appendicectomy is performed if it is present.

Creation of the Reservoir

The colon is folded on itself in a « U » configuration, and two sutures are used to maintain the alignment. Two 2 cm colostomies are made at the medial tip of both ends, and detubularization is done with resorbable staples (Poly-GIA) (Fig. 47.23).

The pouch is then unfolded and the detubularization is completed with a second resorbable stapler, thus creating a pouch (Fig. 47.24).

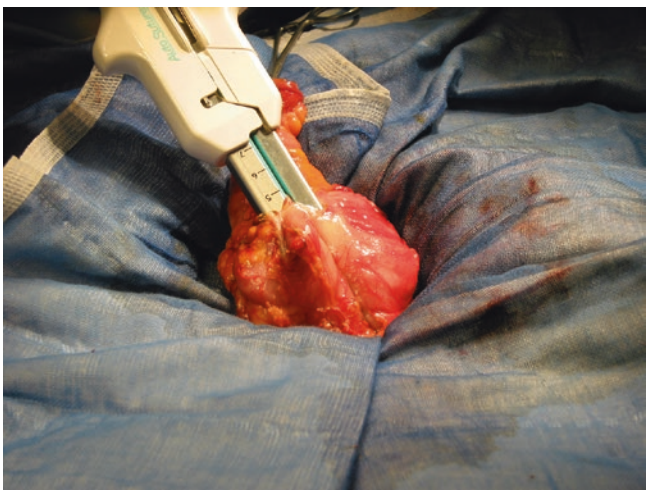


Fig. 47.23 Construction of the reservoir using resorbable staplers

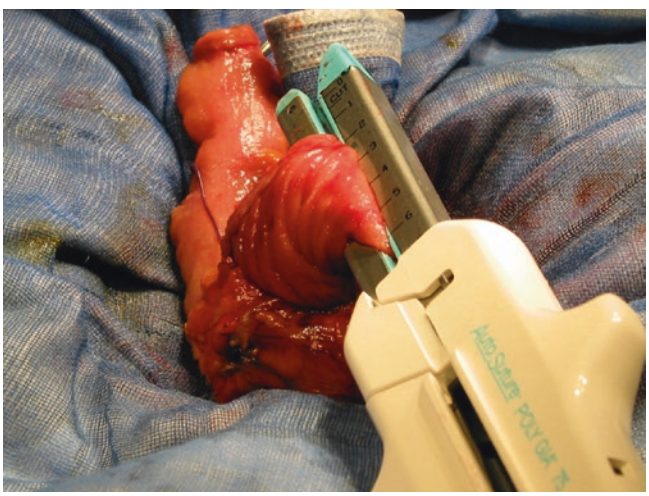


Fig. 47.24 Application of the second resorbable stapler to achieve the detubularization

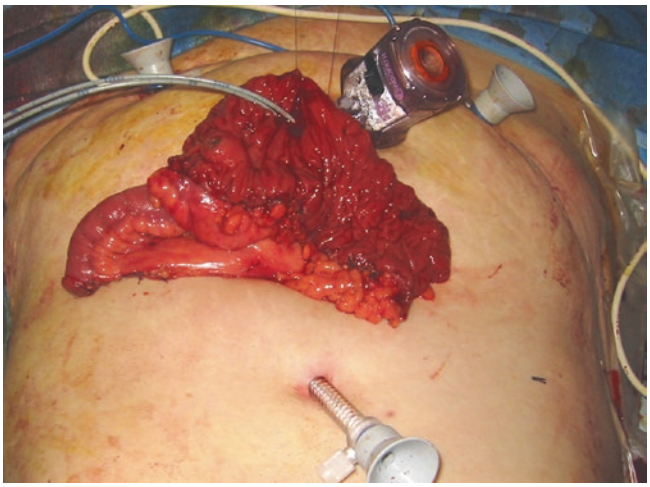


Fig. 47.25 Ureteric anastomosis to continent pouch

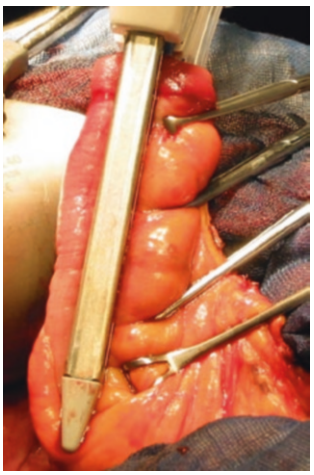


Fig. 47.26 Construction of continent mechanism by tapering of the distal ileal segment

Ureteric Anastomosis to Continent Pouch

Initialy, the ureteric ends were simply spatulated and anastomosed mucosa to mucosa at the base of the pouch with interrupted 4-O PDS sutures (Fig. 47.25).

Currently, in order to provide an efficient antireflux mechanism with a intraluminal valve, the 2 cm end of both ureters are left free into the reservoir and suturred serosa to mucosa at the pouch.

Single J stents (8F) are inserted, and their free ends are tunneled through the right lower abdominal wall to prevent obstruction by irrigation during early postoperative course.

Closure of the Pouch

After the placement of stents, the pouch is closed by a running suture.

Construction of Continent Mechanism: Tapering of the Distal Ileal Segment

A 14F catheter is placed through the ileum, and the ileum is narrowed with a GIA stapler. To obtain an optimal diameter, the 14F catheter is maintained with three or four Babcock forceps on the mesenteric side of the ileum (Fig. 47.26).

Checking the Continence and Integrity of the Pouch

200 mL of blue dye is infused to check for continence and the integrity of the pouch.

Continent Pouch Placement

The pouch is then replaced back into the cavity. The base is sutured to the posterior aspect of the abdominal wall to prevent displacement and torsion of the pouch. The minilaparotomy is then closed, and once the perineal and laparoscopic phases are completed, the ileal conduit is brought through and sutured at the umbilicus.

Specific Post Operative Care

Standard postoperative care includes the use of regular pouch irrigation to prevent mucus accumulation. Permeability of J stents have to be regulary controled and irrigation performed in case of obstruction.

A pouchogram is performed routinely on day 10 to confirm that there is no leakage before removing the J stents and the 14F Foley catheter.

All patients are taught how to self-catheterize with the 14F single-use urinary catheter.

En Bloc Removal of the Specimen Via Perineal or Vaginal Approach Phase

After completion of all required laparoscopic steps, a vaginal approach in type I–II or perineal approach in type III exenterations is used to complete the removal of the specimen.

Vaginal and perineal incision adapted to the extent of disease is followed by dissection with a haemostic device of the attachments of the urethra or vagina to the pelvic wall (Figs. 47.27 and 47.28).



Fig. 47.27 Vaginal and perineal incision adapted to the extent of disease

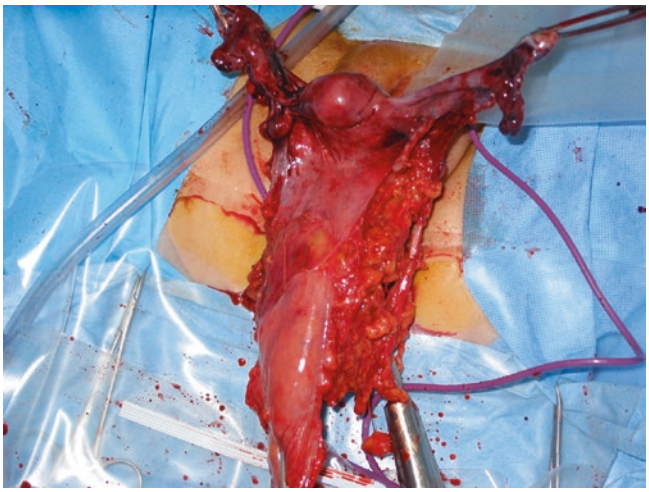


Fig. 47.28 Exteriorization of the anterior and middle PE specimen

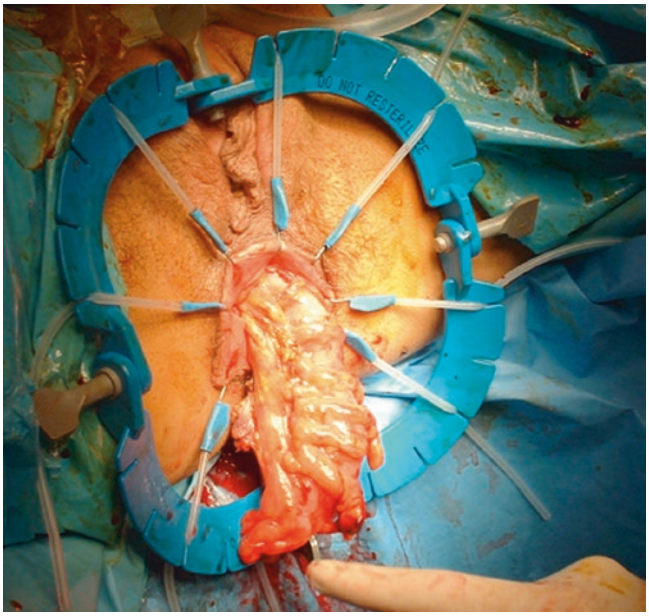


Fig. 47.29 Coloanal anastomosis

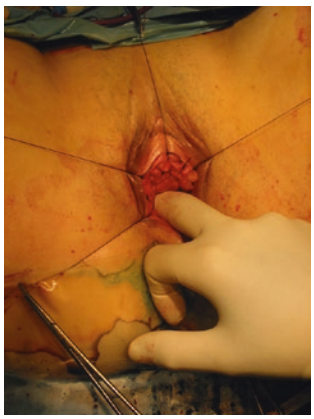


Fig. 47.30 Vaginal reconstruction using an omental J flap

Restoration of Bowel Continuity

The left colon is exteriorized through the anal sphincter to facilitate the colo-anal anastomosis (Fig. 47.29).

If the remain rectum is long, a colorectal anastomosis is performed by laparoscopy using EEA staplers.

A loop ileostomy is performed on left iliac fossa to protect both ileal and colo-anal anastomosis.

Vaginal Reconstruction

The omental J flap, harvested during the previous surgical phase is transferred into the pelvis. It is tubularized and sutured to the introitus or the remaining vagina (Fig. 47.30).

The use of vicryl or biological mesh combined with an omental flap have been described by some authors to reduce the rate of neovaginal prolapse [9].

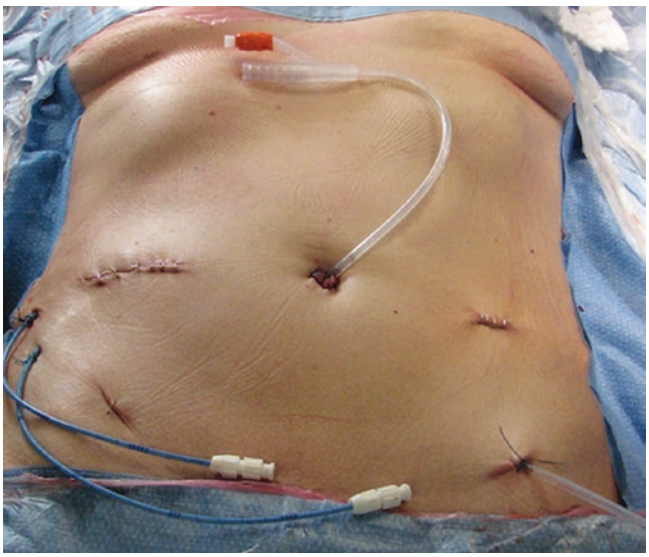


Fig. 47.31 Final view after anterior and middle PE with placement of the urostomy through the umbilicus. Drainage

A vaginal mold is placed and removed each day for irrigation. In our experience, split thickness skin graft is not needed, as spontaneous reepidermization will be completed after several weeks.

An additional local myocutaneous flap can be used if necessary.

Drainage

Abdominal drainage is achieved through the upper umbilical port site and a second one through the vaginal suture (Insert Fig. 47.31).

References

1. Magrina JF. Types of pelvic exenterations: a reappraisal. Gynecol Oncol. 1990;37(3):363–6.
2. Pomel C, Rouzier R, Pocard M, Thoury A, Sideris L, Morice P, Duvillard P, Bourgain JL, Castaigne D. Laparoscopic total pelvic exenteration for cervical cancer relapse. Gynecol Oncol. 2003;91(3):616–8.
3. Ferron G, Querleu D, Martel P, Letourneur B, Soulié M. Laparoscopy-assisted vaginal pelvic exenteration. Gynecol Oncol. 2006;100(3):551–5.
4. Martínez A, Filleron T, Vitse L, Querleu D, Mery E, Balague G, Delannes M, Soulie M, Pomel C, Ferron G. Laparoscopic pelvic exenteration for gynaecological malignancy: is there any advantage? Gynecol Oncol. 2011;120(3):374–9.
5. Höckel M, Dornhöfer N. Pelvic exenteration for gynaecological tumours: achievements and unanswered questions. Lancet Oncol. 2006;7(10):837–47.
6. Penalver MA, Bejany DE, Averette HE, Donato DM, Sevin BU, Suarez G. Continent urinary diversion in gynecologic oncology. Gynecol Oncol. 1989;34(3):274–88.
7. Ferron G, Lim TY, Pomel C, Soulie M, Querleu D. Creation of the miami pouch during laparoscopic-assisted pelvic exenteration: the initial experience. Int J Gynecol Cancer. 2009;19(3):466–70.
8. Puntambekar S, Kudchadkar RJ, Gurjar AM, Sathe RM, Chaudhari YC, Agarwal GA, Rayate NV. Laparoscopic pelvic exenteration for advanced pelvic cancers: a review of 16 cases. Gynecol Oncol. 2006;102(3):513–6.
9. Momoh AO, Kamat AM, Butler CE. Reconstruction of the pelvic floor with human acellular dermal matrix and omental flap following anterior pelvic exenteration. J Plast Reconstr Aesthet Surg. 2010;63(12):2185–7.

Hysterectomy in the Surgical Management of Endometriosis

48

Rouba Murtada, Gabriele Centini, Karolina Afors, and Arnaud Wattiez

Endometriosis is the ectopic presence of endometrial glandular and stromal tissue. It affects 10–20 % of women, and up to 60 % of women suffering from dysmenorrhea [1–4]. As a hormone dependent condition, menopause usually brings an end to its evolution. Infertility and pain are its two major symptoms. The pains most frequently linked to endometriosis are dysmenorrhea, non-menstrual chronic pelvic pain, dyschezia, dysuria and dyspareunia. In certain patients, the severity of symptoms is such that it can cause a significant impact on quality of life, sexual function and psychological physical well-being.

The treatment of endometriosis relies on 2 pillars: hormonal treatment and surgery. In the surgical management of endometriosis, hysterectomy is one of the options. It is generally considered a last resort solution which is to be reserved for severe symptoms, only after failure of other treatments or procedures and after the patient has accomplished her family project.

Few publications are dedicated to the place of hysterectomy in endometriosis. Nevertheless there is evidence to support both the rationale of performing a hysterectomy in endometriosis, and its efficiency in treating painful symptoms.

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The Rationale of Hysterectomy for Endometriosis

The Innervation of Eutopic Endometrium

It was demonstrated by Tokushige et al. that patients with endometriosis have a greater density of nervous fibers whithin the eutopic endometrium and myometrium when compared to patients without endometriosis [5].

The same team demonstrated that hormonal treatment significantly decreases the density of nervous fibers within the eutopic endometrium and myometrium, supplying an explanation for their efficacy in treating pelvic pain attributed to endometriosis [6].

Al Jefout et al. went as far as suggesting the immunohistochemical detection of nervous fibers on endometrial biopsy as a diagnostic technique for endometriosis [7]. In a population of 99 women presenting with pelvic pain and/or infertility, they found that this technique had a sensibility and specificity of 83 % and 98 %, and a positive and negative predictive strength of 91 % and 96 %, respectively. Women with endometriosis and pelvic pain had significantly higher density of nervous fibers than women with endometriosis but without pelvic pain (2.3 vs 0.8 /mm2, p = 0.005).

These elements are in favor of a participation of the uterus to nocicetive mechanisms implicated in endometriosis pain.

Nevertheless, Zhang et al. studied the density of nervous fibers in the endometrium of 30 patients with endometriosis, 40 women with adenomyosis, 41 women with uterine fibroids and 47 women with endometriosis and adenomyosis. They demonstrated a greater density in women presenting with pelvic pain as compared to those without painful symptoms, whichever the pathology [8].

Retrograde Menstruation Theory

It is one of the theories concerning the genesis of endometriosis. The persistence of menstrual reflux could contribute

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to the maintaining of endometriosis, and its suppression could decrease the genesis of new lesions. Women with endometriosis could have heavier menstrual flux than other women [9, 10]. Also, high levels of prostaglandins have been found in the menstrual flux of women with dysmenorrhea and their recurring outpour into the abdominal cavity could contribute to inflammation and a mechanism of peripheral sensitization [11].

Uterine Dyssynergia

Physiologically, uterine contractions spread from the fundus to the uterine cervix during the menstrual period, which allows the evacuation of uterine debris [12]. These contractions don't occur in women under oral contractives, suggesting a hormonal participation in this phenomenon [13].

These contractions could also occur differently in women with endometriosis, with a hyperkinesia or dyskinesia that could contribute to dysmenorrhea as well as reduce the efficacy of evacuation of the menstrual flux. The pressure of contractions and their frequency were significantly increased in 16 patients with endometriosis in comparison to 14 control patients in a study by Bulletti et al. This inefficacy of uterine contractions resulted in retrograde menstruation, with the previously cited consequences [14].

Adenomyosis Associated to Endometriosis

Adenomyosis, previously called internal endometriosis is the presence of endometriosis within the myometrium. It is a pathology of the fourth and fifth decade and is revealed by menorragia and/or pelvic pain. An association between adenomyosis and endometriosis has been found. It is particularly the case of external adenomyosis, whereby endometriotic lesions principally recto-vaginal nodules, are contiguous to adenomyosis within the myometrium, with a similar histological structure in both lesions [15].

In a radiological study, Kunz et al. found aprevalence in adenomyosis (based on the thickening of the junctional zone) of 79 % in a population of 160 women with endometriosis [16]. Larsen et al. after pathological study of hysterectomy specimens found a prevalence of adenomyosis of 34.6 % in a group of 153 patients with endometriosis, vs 19.4 % in a control group ($p < 0.05$) [17]. Moreover, there was a tendency towards an increase in the prevalence of adenomyosis with the severity of endometriosis: 42,8 % in the ASRM IV group vs 29.4 % in the ASRM I, II and III (NS, $p = 0.10$), as well as in the depth of infiltration of adenomyosis in the myometrium (NS, $p > 0.05$).

The participation of adenomyosis in the persistence of pain after excisional surgery for endometriosis has been studied. Parker et al. studied the thickness of the myometrial junctional zone on MRI, as an indicator for adenomyosis, in 53 patients suffering from pelvic pain [18]. After surgery 40 had histologically proven endometriosis. In these patients, dysmenorrhea and non-menstrual pelvic pain were significantly and three times more likely to persist after surgery when thickness was superior to 11 mm on pre-operative MRI.

Ferrero et al. performed a similar study in women with bowel endometriosis, with or without associated adenomyosis (diagnosis was based on MRI findings) [19]. Dysmenorrhea was significantly improved in patients without adenomyosis or those in whom an excision of focal adenomyosis had been performed, on an 18 months study period. No improvement of dysmenorrhea was obtained when adenomyosis was left untreated. Deep dyspareunia and non menstrual pelvic pain were improved in all groups, as well as specific bowel symptoms.

The presence of adenomyosis could be responsible for an incomplete resolution of painful symptoms in endometriosis after conservative surgery, in particular with the persistence of dysmenorrhea.

The Place of Hysterectomy in Endometriosis

Performing a hysterectomy for a benign condition, all conditions included, generally yields favourable results [20]. Nevertheless, the results of hysterectomy for chronic pelvic pain seem inferior to those obtained in other benign conditions. Indeed, pre-operative pain is a risk factor for post-operative pain in hysterectomy.

In a 2004 study by Hartmann et al. on 1200 patients having undergone a hysterectomy for a benign condition, all indications included, the group of patients presenting with pelvic pain and depression was identified as having a three to five times greater risk of suffering from altered quality of life, dyspareunia and pelvic pain [21]. Nonetheless an improvement was reported in 78–86 % of patients in this sub-group. This observation was again found in a Danish study in 2007 where a questionnaire was sent to 1299 1 year after they had undergone a hysterectomy. It was found that pre-operative pain, as well as pain as an indication for surgery, were risk factors for post-operative pain with respectively odd-ratios of 3.25 and 2.98 [22].

Hysterectomy Is Efficient for Pain Improvement Rather than Pain Resolution

In 1990, Stovall et al. reported the results of hysterectomy by laparotomy for chronic pelvic pain attributed to a uterine cause (leimyomatosis, adenomyosis) one year after surgery

[23]. Pelvic endometriosis cases were excluded. They were surprised to find lower results than expected. 22.2 % of patients had persisting pain, of which 5 % had increased pain. They concluded in the efficacy of hysterectomy for pain improvement, rather than pain resolution. In 1995, Hillis et al. in a serie of 388 patients having undergone a hysterectomy reported similar results with 74 % of pain resolution, 21 % of pain decrease and 5 % of pain increase [24]. A high-risk subgroup, with 40 % of persistent pain, was identified and included patients younger than 30 years, without medical insurance, without an identified pelvic pathology, or with a history of pelvic inflammatory disease.

Hysterectomy Is Efficient in the Treatment of Pain Related to Endometriosis

Endometriosis is one of the causes of chronic pelvic pain. It affects young women, and therefore the surgical management of endometriosis is often focused towards uterine conservation and fertility preservation. Few studies have been dedicated to hysterectomy in endometriosis. Its results are often merged with those of hysterectomy for other indications, and the outcome measures used are heterogeneous throughout literature.

In the study of Hillis et al., the subgroup of patients with histologically proven endometriosis without mention of severity or stage, 81.3 % of patients (n = 13) had no pelvic pain at one year after surgery, 18.7 % had decreased but persistent pelvic pain, and no patient reported increased pain [24]. In a study by Berner et al. on the results of subtotal laparoscopic hysterectomy, all indications included, 37 patients had undergone the procedure for pelvic pain attributed to endometriosis [25]. A significant decrease in pain scores measured on a visual analogic scale was reported at 3 years of surgery, with a mean of 4.01 points. Thirty one percent of patients had residual pain. Nevertheless, the residual pain score was significantly greater than in other pathologies (3.46 vs 0.94, $p < 0.001$).

Despite Imperfect Results, There Is Evidence That Hysterectomy Is Superior to Conservative Surgery in the Treatment of Endometriosis-Related Pain

Hysterectomy in general seems more efficient than conservative procedures. In an observational study of a cohort of 1503 patients reporting a pelvic problem (uterine bleeding, chronic pelvic pain, symptomatic fibroid tumor), Kuppermann et al. studied the impact of hysterectomy, uterine-preserving surgery and non-surgical treatments on health-related quality of life [20]. 13.8 % of patients had undergone a hysterectomy and 9 % a uterine-preserving surgery. An improvement was registered in all parameters of the quality of life questionnaire, in all three categories. Improvement was greater after hysterectomy.

In endometriosis specifically, there is also direct and indirect evidence that hysterectomy is more efficient than conservative surgery for the treatment of pain.

An indirect argument was provided by Weir et al. who studied on a 4 year period the rate of readmission in a population of 7993 patients having undergone surgery for endometriosis [26]. 27 % of patients were readmitted at some point after conservative surgery and 12 % after hysterectomy. Shakiba et al. studied the rate of reoperation in three groups: 107 patients who had uterine preserving surgery, 47 patients who had hysterectomy without oophorectomy and 50 patients who had hysterectomy with oophorectomy [27]. Hysterectomy was performed by laparotomy, laparoscopy or laparoscopically-assisted vaginal way. Patients who had a hysterectomy had a significantly lower rate of reoperation for pelvic pain as compared to the conservative treatment group. At, 2, 5 and 7 years, the percentage of reoperation-free patients was respectively of 79.4, 53.3 and 44.6 % for conservative surgery, 95.7, 86.6 and 77 % for hysterectomy without oophorectomy, 96, 91.7 and 91.7 % for hysterectomy with oophorectomy.

A study by Sinaii et al. compared 802 conservative laparoscopic surgeries for endometriosis to 230 oophorectomies, 209 hysterectomies with ovarian preservation, and 144 hysterectomies without ovarian preservation [28]. 94.6 % of patients had pelvic pain at time of surgery. In the isolated hysterectomy group, 45.9 % of patients considered their procedure to be a complete success for 30.4 % in the conservative surgery group ($p < 0.001$), 37.8 % in the oophorectomy group and 40.3 % in the hysterectomy with oophorectomy group.

Hysterectomy for Endometriosis-Related Pain Should be Part of a Radical Approach

For a long time, hysterectomy with bilateral salpingo-oophorectomy was considered the definitive treatment of endometriosis in that it associates a surgical effect with a hormonal effect due to the removal of the ovaries. Other endometriotic locations were sometimes overlooked, with the idea that the disease would regress after menopause was induced.

There is nevertheless data in favor of the radicality of excision when performing a hysterectomy as the definitive treatment of endometriosis. Fedele et al. compared the results of laparotomic extra-fascial hysterectomy (n = 26) with those of radical hysterectomy comprising a parametrectomy (n = 12) in treating patients presenting with endometriosis

and pelvic pain [29]. Pain recurrence occurred in 30 % of patients of the former group and none of the latter. Redwine reported 75 cases of endometriosis occurring after ovarian castration and requiring repeat surgery for excision due to pain recurrence. He concluded that no endometriosis should be left untreated at castration [30].

There Is Conflicting Data on the Importance of Concomittant Bilateral Salpingo-Oophorectomy When Performing a Hysterectomy for Endometriosis

Namnoum et al. compared the results of laparotomic hysterectomy for endometriosis in 29 patients with ovarian preservation and 109 without [31]. They reported a rate of pain recurrence of 62 % in patients of the first group and 10 % in the second, with a reoperation rate of respectively 31 % and 3.7 %. Patients with ovarian preservation had a 6.1 relative risk of painful recurrence and 8.1 of reoperation. In the study of Shakiba et al. the relative risk of reoperation in case of ovarian preservation was of 2,44, although not statistically significant [27]. On the other hand, in the sub-group of patients of ages 30–39 years, BSO did not significantly increase the interval between initial and repeat surgery.

It is also to be taken into consideration that ovarian preservation is preferable in the young patient because of the cardio-vascular risk that comes with early menopause.

For that purpose, bilateral salpingo-oophorectomy is not systematic in our institution when performing a hysterectomy for endometriosis. The adnexae is only considered to be another potential site of involvement, requiring excision only when affected.

Despite Imperfect Results, Hysterectomy for Endometriosis Yields a High Level of Satisfaction

In a personal series of 39 patients having undergone hysterectomy with or without BSO for pain attributed to endometriosis between 2006 and 2012, 30 % responded to being "satisfied" of having had the procedure, and 53 % were "very satisfied", as opposed to "quite satisfied" (7.7 %) and dissatisfied (5.1 %). This came in spite of high rates of significant residual pain, defined by pain described as "important" or "unbearable" in intensity, with nearly 40 % at one year post-operatively and 30 % at 2 years.

Predictors of a high level of satisfaction were patient age, as older patients were more likely to be "very satisfied" and patient request, as patient who had requested the surgery were 50 times more likely to be "very" satisfied.

Predictors of long-term significant residual pain were age and BMI, as a patient was more likely to have pain described as "important" or "unbearable" if she was younger or with a lower BMI.

Age as a predictor is consistent with previously published data whereby age is recurrently stated as being a pejorative factor, whether in conservative surgery for endometriosis, hysterectomy for endometriosis or hysterectomy for pelvic pain in relation to a pathology other than endometriosis. Mac Donald et al. compared the results of hysterectomy for endometriosis related pain in 16 patients of age less than 30 years and 27 patients of age above 40 years [32]. In the two groups, a similar proportion of women considered themselves to be completely treated (80 %). There was no difference with regards to residual dyschezia but dyspareunia persisted in 50 % of patients younger than 30 years versus 17.4 % of patients in the other group ($p = 0.035$). There was no significant difference in the proportion patients regretting having had the procedure. Younger patients had a greater sense of loss.

Far from concluding that hysterectomy for endometriosis should be restricted to women approaching menopause, it does call for a particularly extensive information on the benefits to be expected of the surgery and its imperfect but significant impact on pain. Before performing a surgery marking the end to fertility, the surgeon should be certain that the patient is fully convinced of its usefulness. Performing a hysterectomy at the patient's request was a strong predictor of satisfaction. Therefore, hysterectomy should be suggested with caution to the younger patient, and after a reflection period.

In conclusion, hysterectomy does deserve its attribute of "definitive surgery" in that it is more efficient on chronic pain than conservative surgery, with the lowest reoperation rates. This is true only if hysterectomy is part of a radical approach of the surgical management of endometriosis and is paired with the resection of all associated lesions. The role of concomitant BSO remains to be clarified and its usefulness balanced with its potential morbidity.

Hysterectomy yields a high level of satisfaction from patients, despite an imperfect resolution of pain. Its impact on pain is significant and covers all types of pains associated with endometriosis. Hysterectomy should be suggested to patients older than 40 years as an interim solution before menopause can bring an end to the active phase of the disease. It should be performed with caution in the young patient, even when she no longer wishes to retain fertility. A strong demand coming from the patient is a good indicator of an adherence to the treatment plan and a factor of high level of satisfaction.

Surgical Strategy in Hysterectomy for Endometriosis

Endometriosis is a complex disease which can cause considerable anatomical distortion. It is multicentric and can affect the anterior and posterior compartments of the pelvis as well as the adnexaes and the urinary tract laterally.

In a normal anatomical context, performing a hysterectomy entails the application of a specific surgical approach with reproducible key steps. In case of endometriosis the surgery is a variation on this approach made to include a general strategy. The purpose of this general strategy is three-fold: restore the anatomy, identify landmarks to preserve during dissection (most importantly the ureter) and separate diseased tissue from in sano tissue. Only once these conditions have been fulfilled can the hysterectomy be performed.

The first step is exploratory for a proper assessment of lesions. This starts with a vaginal examination to search for a palpable nodule, and will serve as a benchmark for sequential examination as the nodule is dissected.

A uterine manipulator is placed, and the patient is placed in Trendelenbourg position. Thorough examination of the intra-abdominal cavity is carried. Adhesiolysis is performed, ovaries are liberated from the ovarian fossa and endometriotic cysts are drained. If ovarian preservation is decided their treatment is delayed to the end of the surgery in order to prevent blood spillage from polluting the operative field.

At this point, before undertaking the regular steps of hysterectomy, the ureters should be identified. What is usually achieved through transperitoneal direct visualization isn't possible in the context of severe endometriosis. On the left side it is made possible by removing the physiological attachment of the sigmoid to the left parietal wall. There are four advantages to this step:

1. It allows to mobilize the colon and displace it cranially in order to enhance the working space.
2. It gives direct access to the left adnexae and allows to properly identify the infundibulo-pelvic ligament.
3. The course of the ureter is visualized. This is key in deep endometriosis where it is typically medialized as a result of fibrotic retraction. It is the first structure medial to the infundibulo-pelvic ligament. It can then be lateralized and its distance with the uterus increased during central dissection.
4. It gives access to the left pararectal fossa, an avascular plane which is developed in the case of rectovaginal nodule and/or bowel involvement, or in case of a simple ventral retraction of the rectum with an adhesion to the uterine torus (posterior aspect of the uterus). This space is developed starting at the level of the pelvic brim, or more caudally, laterally to the rectovaginal space, in the absence of anatomic distortion.

During this dissection, special care should be taken in individualizing and preserving the hypogastric nerve which is found immediately underlying the peritoneum.

Once this general strategic sequence has been completed, a specific strategy is adopted depending on the organs affected.

The twin goals of this strategy are: to isolate the uterus from the affected organs in order to perform the hysterectomy, then secondarily remove the residual disease as part of a radical approach. This is the exact opposite of en bloc resection used in oncological cases, and allows a radical but economical approach disregarding the notion of safe margins. Only when the involvement is contiguous to the uterus, such as in the case of a vaginal nodule, can the resection line be displaced in order to include the immediately adjacent disease.

Case 1

The first laparoscopic view (Fig. 48.1) is of a uterus without sign of adenomyosis, but with a retracted left adnexae bearing an endometriotic cyst as well as a hydrosalpynx, adherent to the mesosigmoid. The contralateral adnexae is normal. The first step consists in performing adhesiolysis in order to first liberate the left adnexae from the mesosigmoid through simple cutting action (Fig. 48.2). This reveals fully the endometrioma which is impacted in the ovarian fossa as it is usually the case. The aspiration device is used along with the bipolar to liberate it (Fig. 48.3) and in doing so a spontaneous rupture occurs and the typical chocolate fluid is immediately and progressively aspirated (Fig. 48.4) so as to prevent it from polluting the spaces. For this reason the ovariolysis is always performed with aspirating device in hand. Once the endometrioma has been emptied, a fibrotic retration of the left adnexae is better revealed. At this point, the ureter isn't



Fig. 48.1 Initial laparoscopic view: endometriosis affects the left lateral compartment

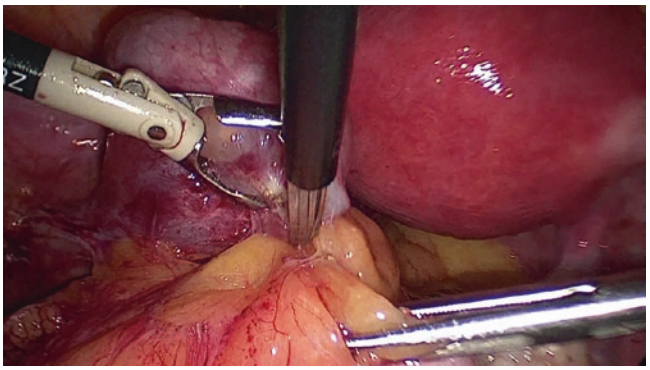


Fig. 48.2 The first step is adhesiolysis: the attachment of the mesosigmoid to the left adnexae is removed

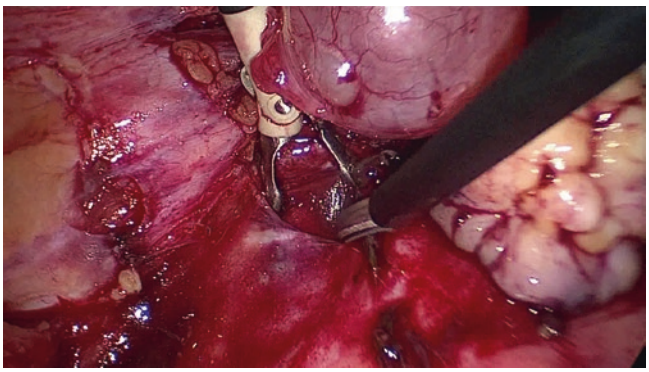


Fig. 48.5 Identify the ureter: the peritoneum is opened at the level of the IP ligament

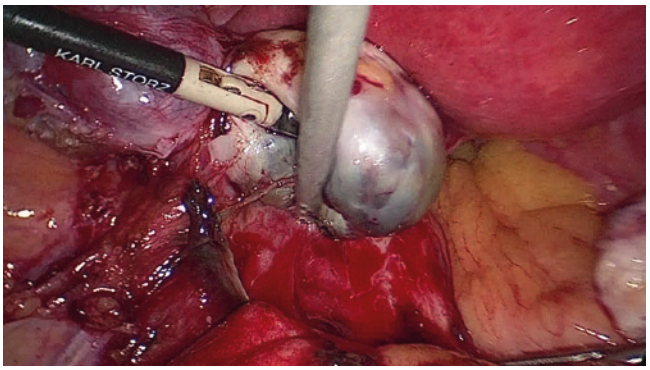


Fig. 48.3 Ovariolysis: the left endometrioma is liberated from the ovarian fossa

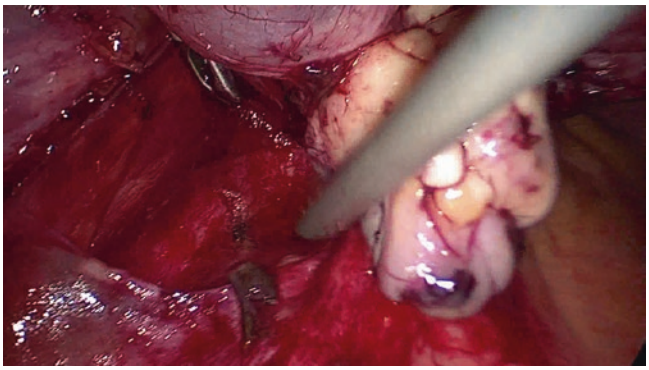


Fig. 48.6 Dividing tissues using divergent forces reveals the ureter, medial to the IP ligament

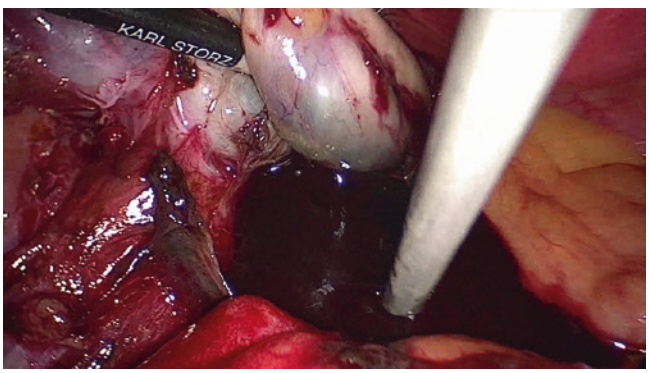


Fig. 48.4 Aspitation of typical chocolate liquid

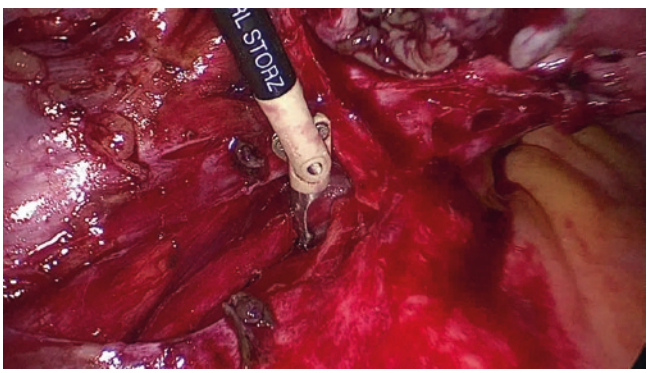


Fig. 48.7 Dissection progresses caudally and left pararectal fossa is entered

identified and it is crucial to individualize it in order to preserve it during further dissection. The peritoneum is opened at the level of infundibulo-pelvic (IP) ligament (Figs. 48.5 and 48.6). Tissues are divided until the ureter becomed apparent, medial to the IP ligament (Fig. 48.7). Dissection is carried caudally and the pararectal fossa is entered (Fig. 48.8). In doing so the ureter is reclined laterally and the bowel is separated from the adnexae. Further ureterolysis is performed to separate it from the IP ligament (Fig. 48.9). Once this preparatory step has been achieved, the hysterectomy can be started as usual with the section-coagulation of the round ligament (Fig. 48.10) and the division of the anterior peritoneum towards the isthmus (Fig. 48.11). Due to the retraction of the adnexae, the IP ligament is not as easily skeletonised as usual, and a further division of the anterior peritoneum is carried

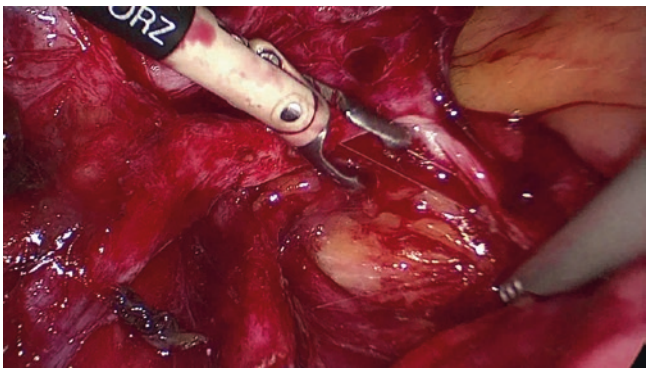


Fig. 48.8 Ureter is reclined laterally, separated from the bowel

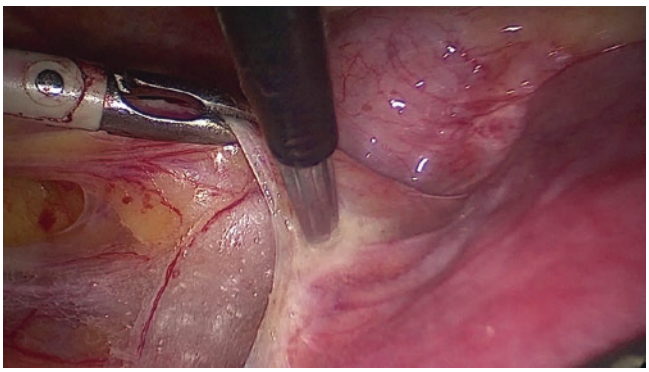


Fig. 48.11 Division of the anterior peritoneum of the broad ligament

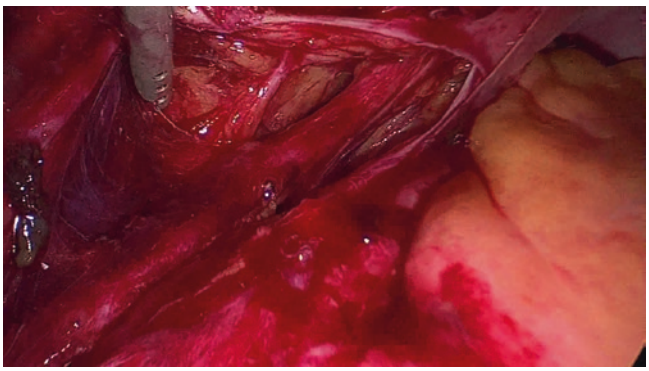


Fig. 48.9 Ureterolysis is pursued in order to separate it from the IP ligament

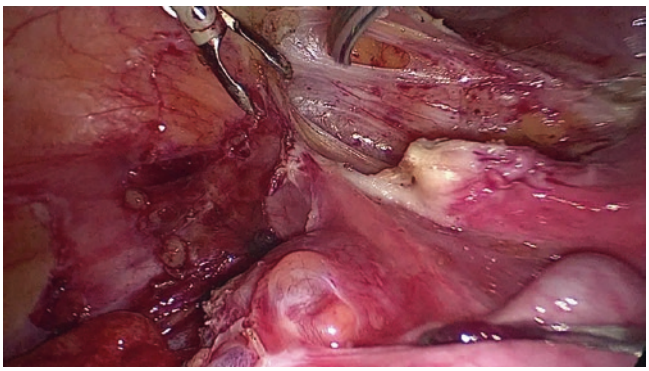


Fig. 48.12 Further division of the anterior fold, cranially, parallel to the IP ligament

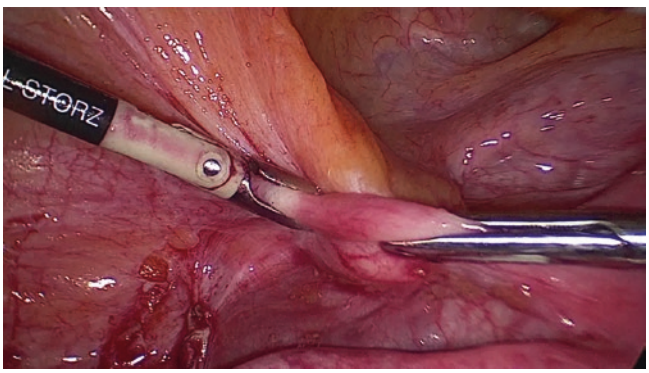


Fig. 48.10 Once the preparatory step has been achieved, the usual steps of hysterectomy can be performed: the round ligament is divided

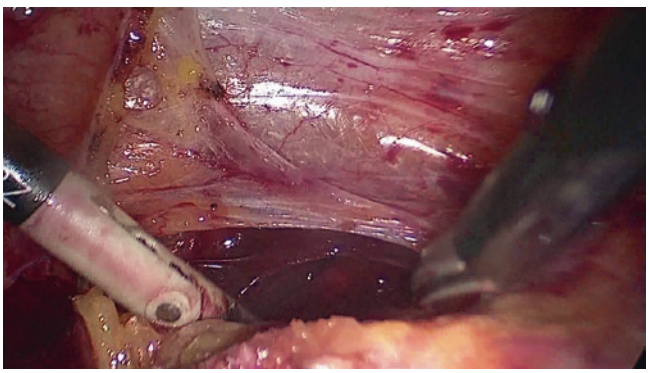


Fig. 48.13 Fenestration of the broad ligament allows to skeletonize the IP ligament

cranially, parallel to the IP ligament in order to better identify it (Fig. 48.12). The posterior peritoneum is fenestrated as usual (Figs. 48.13 and 48.14) and as a further verification measure the bipolar is passed through the opening and to the other side (Fig. 48.15). It then becomes apparent that the ureter is at a safe distance and the section-coagulation of the IP ligament can be performed safely. The rest of the hysterectomy is achieved through the classical steps.

Case 2

In this case, the endometriotic involvement is at the level of the anterior compartment with a retraction of the vesico-uterine peritoneum (Fig. 48.16). It is uncertain whether the endometriotic nodule affects the bladder or merely the anterior aspect of the uterus. Two thick lateral folds in the peritoneum are a consequence of the retraction. The dissection is initiated laterally at their level, at a safe distance

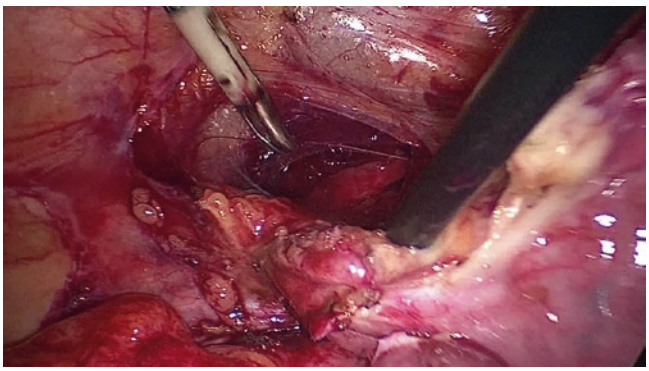


Fig. 48.14 Fenestration is achieved applying divergent forces

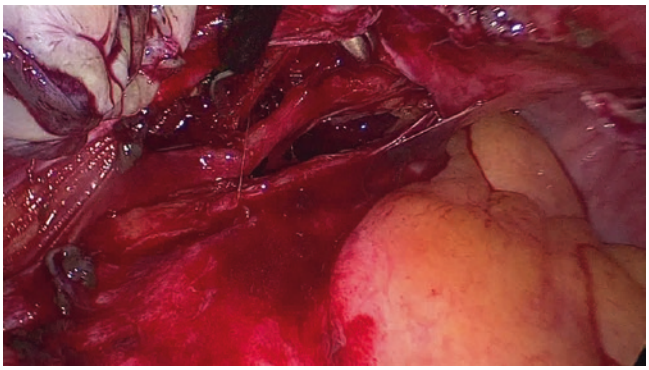


Fig. 48.15 Prior to sectioning the IP ligament, an instrument is passed through the window created in the broad ligament, and seen at a safe distance from the ureter

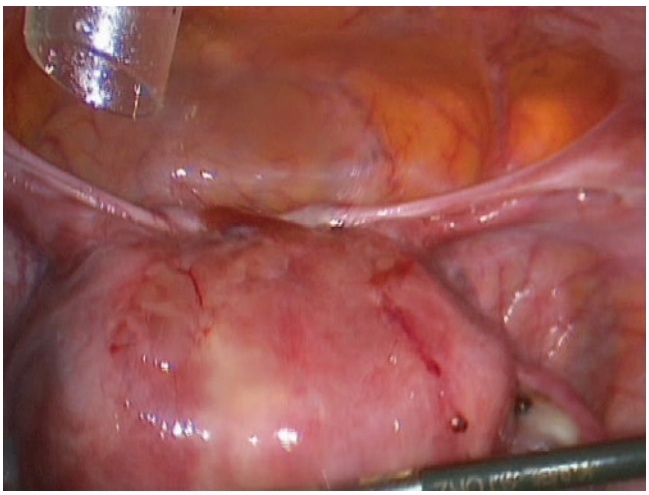


Fig. 48.16 Initial laparoscopic view: endometriotic retraction affecting the anterior compartment

from the bladder (Fig. 48.17). The peritoneum is incised and through pneumodissection, the bubble effect is seen at the level of the paravesical space (Fig. 48.18). The vesico-uterine peritoneum is divided medially (Fig. 48.19),

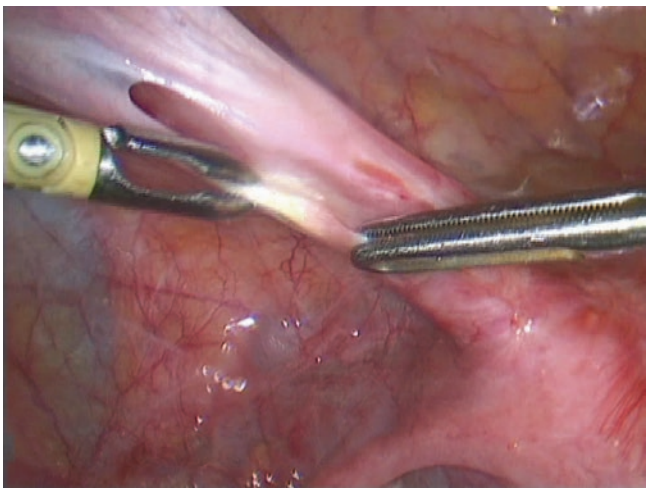


Fig. 48.17 Dissection is initiated laterally in the peritoneal retractile folds, at a safe distance from the bladder

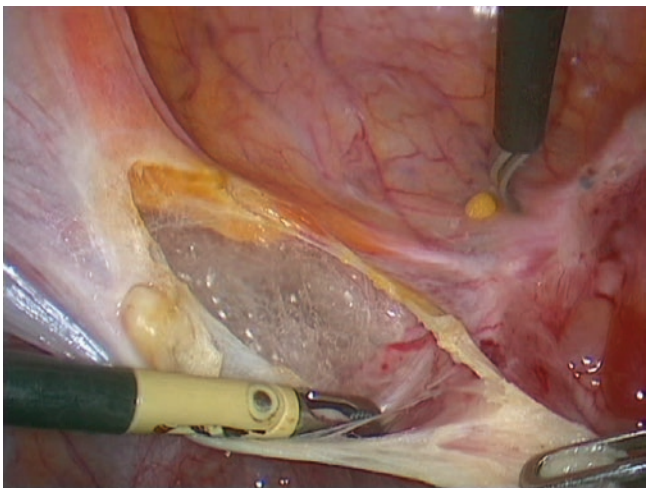


Fig. 48.18 Pneumodissection creating a bubble effect in the left paravesical fossa

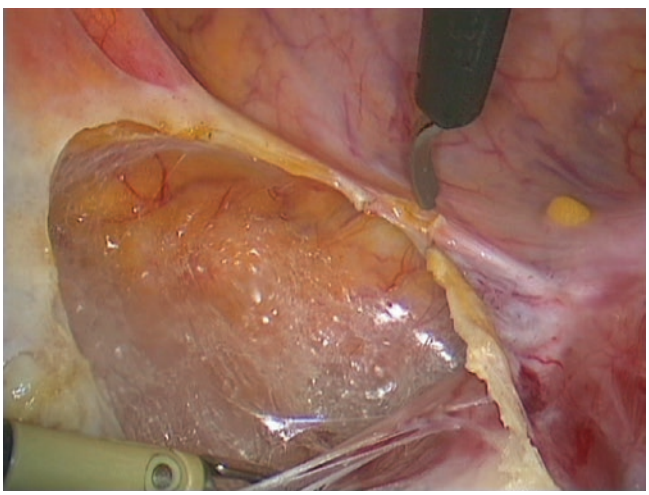


Fig. 48.19 Division of the vesico-uterine peritoneum

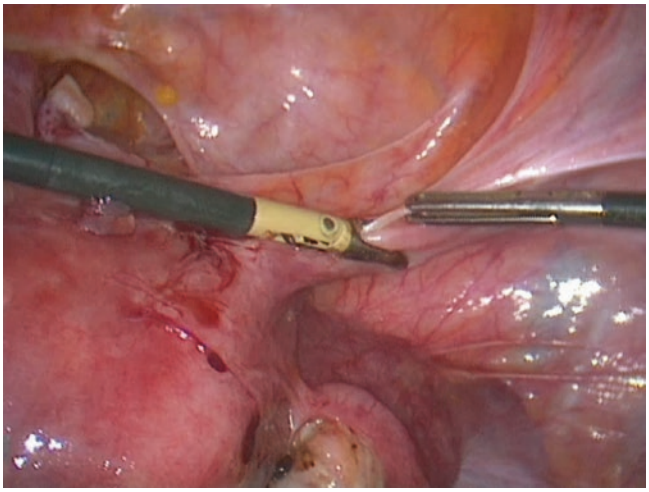


Fig. 48.20 Contralateral dissection

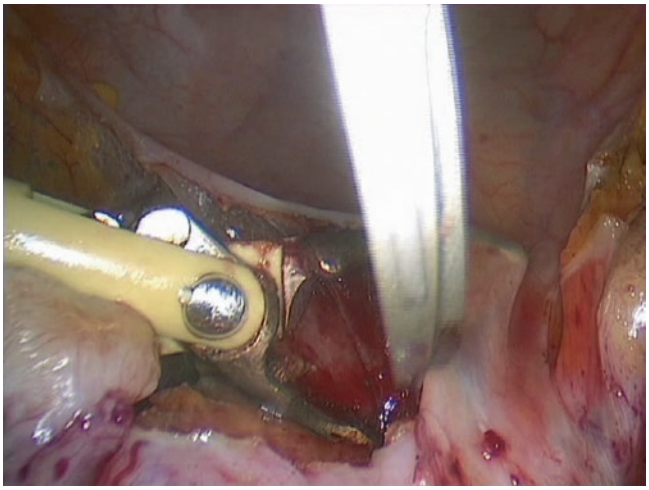


Fig. 48.22 Peritoneum dissected away from the bladder

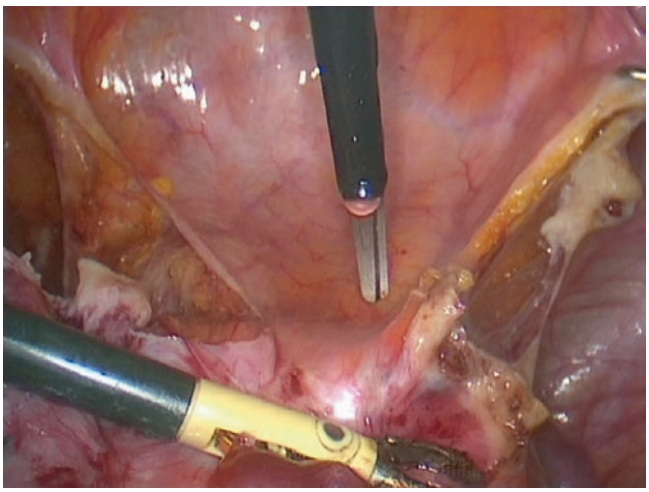


Fig. 48.21 A peritoneal bridge at the level of the bladder lays remnant after bilateral dissection

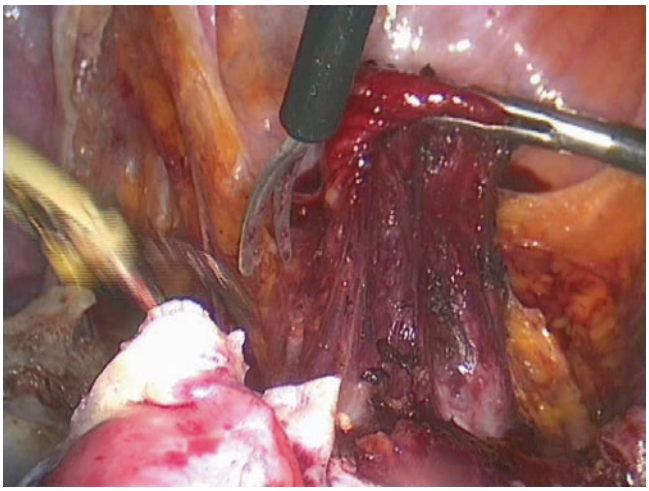


Fig. 48.23 Usual dissection of the vesico-uterine space, the endometriosis affecting the anterior aspect of the uterus, and sparing the bladder

without fully reaching the midline. The dissection is then initiated contra-laterally with the section-coagulation of the right round ligament and safely carried medially (Fig. 48.20). A peritoneal bridge then lays between the two lateral spaces of dissection (Fig. 48.21), close to the bladder. Through divergent movements of the bipolar jaws (Fig. 48.22), the peritoneum is progressively separated from the bladder then divided. It is at that point apparent that the bladder is unaffected. The bladder is seized and the vesico-uterine space is dissected in the usual manner (Fig. 48.23). At the end of the dissection, the endometriotic retraction has been fully separated from the bladder and is entirely on the anterior aspect of the uterus (Fig. 48.24). At that level, the colpotomy will be displaced caudally in order to include the disease. The rest of the hysterectomy can be carried through the usual steps.

In conclusion of these two cases, the usual steps of the hysterectomy apply, but depending on the location of the

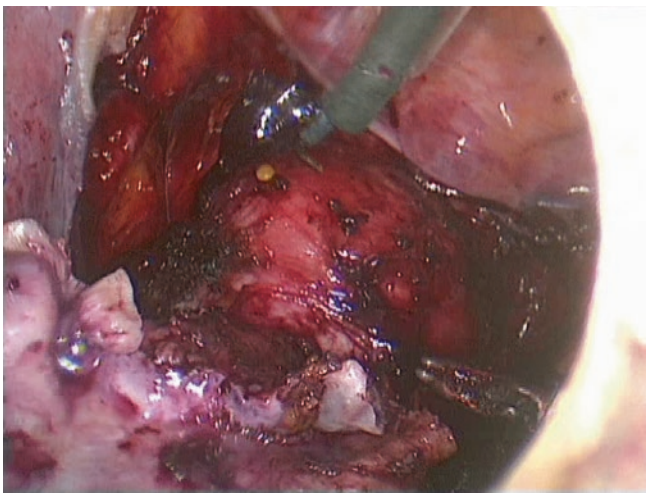


Fig. 48.24 Initiation of colpotomy. The line will be displaced caudally for the hysterectomy to entirely include the endometriotic tissue

endometriosis, a preparatory operative step is necessary. It aims to identify and keep the adjacent organs at a safe distance.

References

1. Eskenazi B, Warner ML. Epidemiology of endometriosis. Obstet Gynecol Clin North Am. 1997;24:235–58.
2. Moen MH, Muus KM. Endometriosis in pregnant and non-pregnant women at tubal sterilisation. Hum Reprod. 1991;6:699–702.
3. Gruppo italiano per lo studio dell'endometriosi. Prevalence and anatomical distribution of endometriosis in women with selected gynaecological conditions: results from a multicentric Italian study. Hum Reprod. 1994;9:1158–62.
4. Waller KG, Lindsay P, Curtis P, Shaw RW. The prevalence of endometriosis in women with infertile partners. Eur J Obstet Gynecol Reprod Biol. 1993;48:135–9.
5. Tokushige N, Markham R, Russell P, Fraser IS. High density of small nerve fibers in the functional layer of the endometrium in women with endometriosis. Hum Reprod. 2006;21:782–7.
6. Tokushige N, Markham R, Russell P, Fraser IS. Effects of hormonal treatment on nerve fibers in endometrium and myometrium in women with endometriosis. Fertil Steril. 2008;90:1589–98.
7. Al-Jefout M, Dezarnaulds G, Cooper M, Tokushige N, Luscombe GM, Markham R, et al. Diagnosis of endometriosis by detection of nerve fibres in an endometrial biopsy: a double blind study. Hum Reprod. 2009;24:3019–24.
8. Zhang X, Lu B, Huang X, Xu H, Zhou C, Lin J. Endometrial nerve fibers in women with endometriosis, adenomyosis, and uterine fibroids. Fertil Steril. 2009;92:1799–801.
9. Cramer DW, Missmer SA. The epidemiology of endometriosis. Ann N Y Acad Sci. 2002;955:11–22.
10. Treloar SA, Martin NG, Heath AC. Longitudinal genetic analysis of menstrual flow, pain, and limitation in a sample of Australian twins. Behav Genet. 1998;28:107–16.
11. Baird DT, Cameron ST, Critchley HO, Drudy TA, Howe A, Jones RL, et al. Prostaglandins and menstruation. Eur J Obstet Gynecol Reprod Biol. 1996;70:15–7.
12. Martinez-Gaudio M, Yoshida T, Bengtsson LP. Propagated and nonpropagated myometrial contractions in normal menstrual cycles. Am J Obstet Gynecol. 1973;115:107–11.
13. Maslow KD, Lyons EA. Effect of prostaglandin and antiprostaglandin on midcycle myometrial contractions. Fertil Steril. 2004;82:511–3.
14. Bulletti C, Rossi S, Albonetti A, Polli VV, De Ziegler D, Massoneau M, et al. Uterine contractility in patients with endometriosis. J Am Assoc Gynecol Laparosc. 1996;3(4 suppl):S5.
15. Koninckx PR, Martin DC. Deep endometriosis a consequense of infiltration or retraction or possible adenomyosis externa. Fertil Steril. 1992;58:924–8.
16. Kunz G, Beil D, Huppert P, Noe M, Kissler S, Leyendecker G. Adenomyosis in endometriosis-prevalence and impact on fertility. Evidence from magnetic resonance imaging. Hum Reprod. 2005;20(8):2309–16.
17. Larsen SB, Lundorf E, Forman A, Dueholm M. Adenomyosis and junctional zone changes in patients with endometriosis. Eur J Obstet Gynecol Reprod Biol. 2011;157(2):206–11.
18. Parker JD, Leondires M, Sinaii N, Premkumar A, Nieman LK, Stratton P. Persistence of dysmenorrhea and nonmenstrual pain after optimal endometriosis surgery may indicate adenomyosis. Fertil Steril. 2006;86:711–5.
19. Ferrero S, Camerini G, Menada MV, Biscaldi E, Ragni N, Remorgida V. Uterine adenomyosis in persistence of dysmenorrhea after surgical excision pelvic endometriosis and colorectal resection. J Reprod Med. 2009;54(6):366–72.
20. Kuppermann M, Learman LA, Schembri M, Gregorich SE, Jackson RA, Jacoby A, et al. Contributions of hysterectomy and uterus-preserving surgery to health-related quality of life. Obstet Gynecol. 2013;122(1):15–25.
21. Hartmann KE, Ma C, Lamvu GM, Langenberg PW, Steege JF, Kjerulff KH. Quality of life and sexual function after hysterectomy in women with preoperative pain and depression. Obstet Gynecol. 2004;104:701–9.
22. Brandsborg B, Nikolajsen L, Hansen CT, Kehlet H, Jensen TS. Risk factors for chronic pain after hysterectomy: a nationwide questionnaire and database study. Anesthesiology. 2007;106(5):1003–12.
23. Stovall TG, Ling FW, Crawford DA. Hysterectomy for chronic pelvic pain of presumed uterine etiology. Obstet Gynecol. 1990;75:676–9.
24. Hillis SD, Marchbanks PA, Peterson HB. The effectiveness of hysterectomy for chronic pelvic pain. Obstet Gynecol. 1995;86:941–5.
25. Berner E, Qvigstad E, Myrvold AK, Lieng M. Pelvic pain and patient satisfaction after laparoscopic supracervical hysterectomy: prospective trial. J Minim Invasive Gynecol. 2014;21(3):406–11.
26. Weir E, Mustard C, Cohen M, Kung R. Endometriosis: what is the risk of hospital admission, readmission, and major surgical intervention? J Minim Invasive Gynecol. 2005;12(6):486–93.
27. Shakiba K, Bena JF, McGill KM, Minger J, Falcone T. Surgical treatment of endometriosis: a 7-year follow-up on the requirement for further surgery (published erratum appears in: Obstet Gynecol. 2008; 112(3):710). Obstet Gynecol. 2008;111(6):1285–92.
28. Sinaii N, Cleary SD, Younes N, Ballweg ML, Stratton P. Treatment utilization for endometriosis symptoms: a cross-sectional survey study of lifetime experience. Fertil Steril. 2007;87(6):1277–86.
29. Fedele L, Bianchi S, Zanconato G, Berlanda N, Borruto F, Frontino G. Tailoring radicality in demolitive surgery for deeply infiltrating endometriosis. Am J Obstet Gynecol. 2005;193(1):114–7.
30. Redwine DB. Endometriosis persisting after castration: clinical characteristics and results of surgical management. Obstet Gynecol. 1994;83:405–13.
31. Namnoum AB, Hickman TN, Goodman SB, Gehlbach DL, Rock JA. Incidence of symptom recurrence after hysterectomy for endometriosis. Fertil Steril. 1995;64(5):898–902.
32. MacDonald SR, Klock SC, Milad MP. Long-term outcome of non-conservative surgery (hysterectomy) for endometriosis-associated pain in women < 30 years old. Am J Obstet Gynecol. 1999;180(6 Pt 1):1360–3.

Laparoscopic Hysterectomy (TLH) in Obese Patients

49

Raffaele Tinelli and Ettore Cicinelli

Introduction

Several studies showed that LPS treatment of obese women with endometrial pathologies offers many advantages compared to the open approach [1–4] primarily considering the less postoperative pain, better visibility of the operative field, and shorter hospital stay as the main benefit [5, 6]; postoperative complications after LPS treatment seems to be reduced or similar [1, 3], likely related to the laparoscopic expertise of the operating surgeons and the patient's co-morbidities.

However, this procedure does not seem to modify the incidence of intra-operative and post-operative complications [3, 7].

It appears from data of several studies that LPS hysterectomy may offer significant advantages over LPT in the comprehensive surgical management of extremely obese women, but it should be performed by advanced laparoscopic gynaecologic surgeons [7].

Surgical Technique of Laparoscopic Hysterectomy

After dilatation with a Hegar dilator (no. 7.5), an uterine manipulator (*Clermont-Ferrand,* Karl Storz, Tuttlingen, Germany) is inserted.

A 11 mm Endopath XCEL® trocar (Ethicon, Johnson & Johnson, USA) that incorporates the zero-degree laparoscope (Karl Storz, Tuttlingen, Germany) was inserted through an umbilical vertical incision, after pneumoperitoneum by Veress needle (Covidien Cares, Minneapolis, MN) has been induced at the level of umbilicus.

Difficulties of entry into the abdomen in obese patients are often associated with the expanded thick fatty layer of the abdominal wall, especially with translocation of the umbilicus which is more caudal to the normal umbilical site and just below the aortic bifurcation.

In our technique, an 11 mm skin incision is created at the superior crease of the umbilical fold, and the underlying subcutaneous adipose tissue is bluntly dissected using the tip of a fine clamp until the umbilical stalk is isolated at the inferior and central part of the incision.

There is a concern that rare but life-threatening complications can occur, including severe bleeding due to damages of major abdominal vessels, as well as other injuries related to bowel and bladder trauma, subcutaneous emphysema and postsurgical infections.

To prevent these complications and risks, the abdominal wall is elevated by upward traction. In obese patients the Veress needle is then inserted nearly perpendicular to the incision and turned toward the pelvis "immediately" after resistance to the needle has been lost.

Three suprapubic ancillary trocars were used: one 5 mm Endopath XCEL® trocar (Ethicon, Johnson & Johnson, USA) trocar was inserted in the midline 3 cm under the umbilicus, and one in each iliac fossa (11 mm on the left side and 5 mm on the right size) laterally to inferior epigastric vessels, respectively.

Before the operative procedure, all the pelvic structures are inspected and the abdomen explored through the laparoscope in a clockwise fashion.

Laparoscopic hysterectomy is performed with the patient in an approximately 30 ° Trendelenburg position to facilitate retroperitoneal exposure by retaining the small intestine in the mid and upper abdomen using gravity and gentle instrumentation. In patients with a prior midline incision, the initial entry into the abdominal cavity was made approximately 2 cm below the left costal margin at the level of the midclavicular line to avoid injury to bowel adherent to the anterior abdominal wall.

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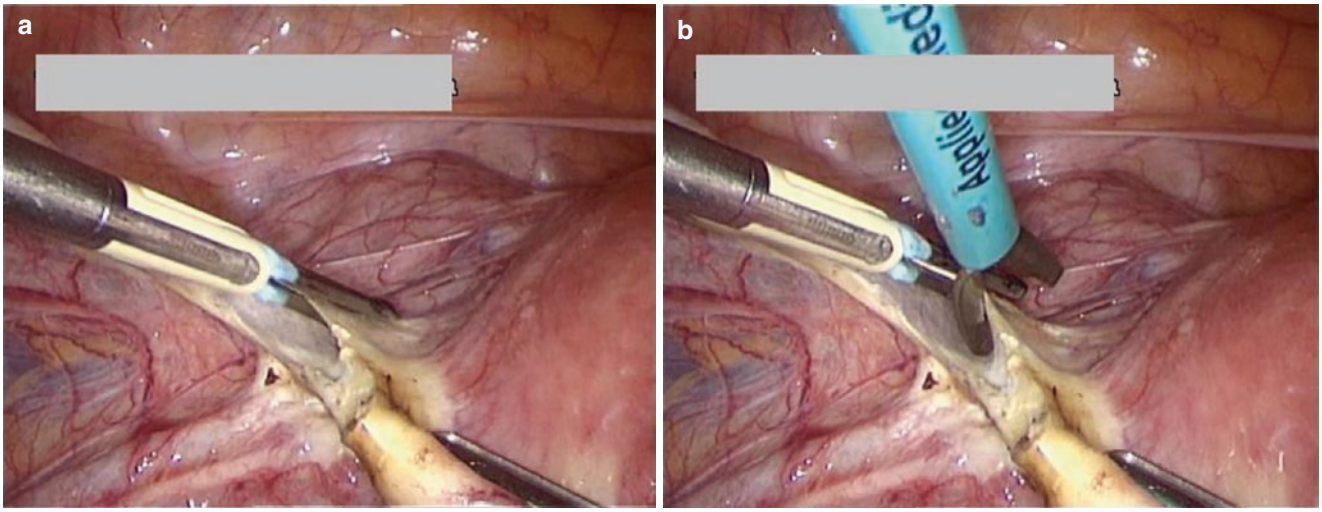


Fig. 49.1 (**a**, **b**) The round ligament is coagulated and transected with endoscopic shears

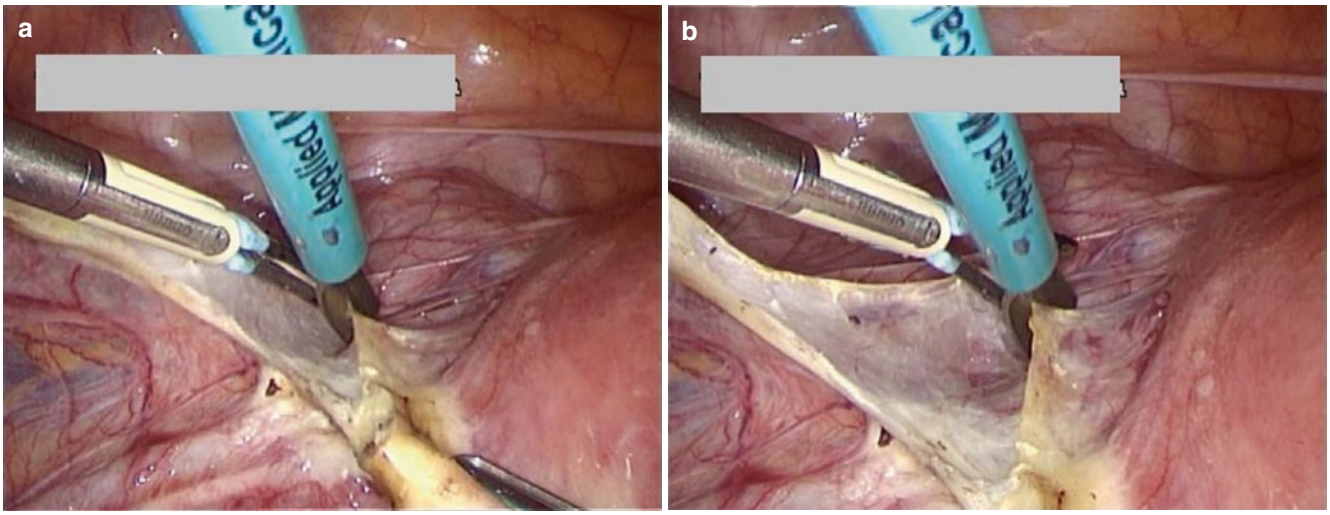


Fig. 49.2 (**a**, **b**) The vesico-uterine fold is grasped and incised

A MiniPort 2 mm single use introducer (MiniPort-Auto-Suture, USSC, Norwalk, CT) and a stopcock for insufflation and desufflation were used to establish the pneumoperitoneum.

The obturator had a spring-loaded, blunt stylet similar in function to a Veress needle. A circular adjustable stopper located on the sleeve of the miniport allowed for adjustment of depth in the cavity. The system was used to establish and maintain the pneumoperitoneum in the abdomen while providing access for a minilaparoscope with a diameter of 1.9 mm and a length of 10 or 12 cm (Karl Storz, Tuttlingen, Germany).

The round ligament is coagulated and transected with endoscopic shears (Fig. 49.1). The vesico-uterine fold is grasped and incised (Fig. 49.2) while the bladder is isolated: after dividing the vesico-uterine fold (Fig. 49.3, the suction-irrigator probe pushes the bladder completely from the upper vagina (Fig. 49.4).

The anterior and posterior peritoneal layers of the broad ligament are opened and the ureter is identified at the pelvic brim, traced into the pelvis and freed from the posterior leaf of the broad ligament. The ovarian ligament is coagulated (Fig. 49.5) with bipolar forceps and transacted with scissors. The uterine vessels are identified allowing an excellent skeletonization of the obliterated artery by preparing the anterior and posterior web. The uterine artery is coagulated and transected.

The vagina is visualized and the vaginal cuff around the cervix is transected with the monopolar needle (Fig. 49.6), incising the vagina circumferentially using the

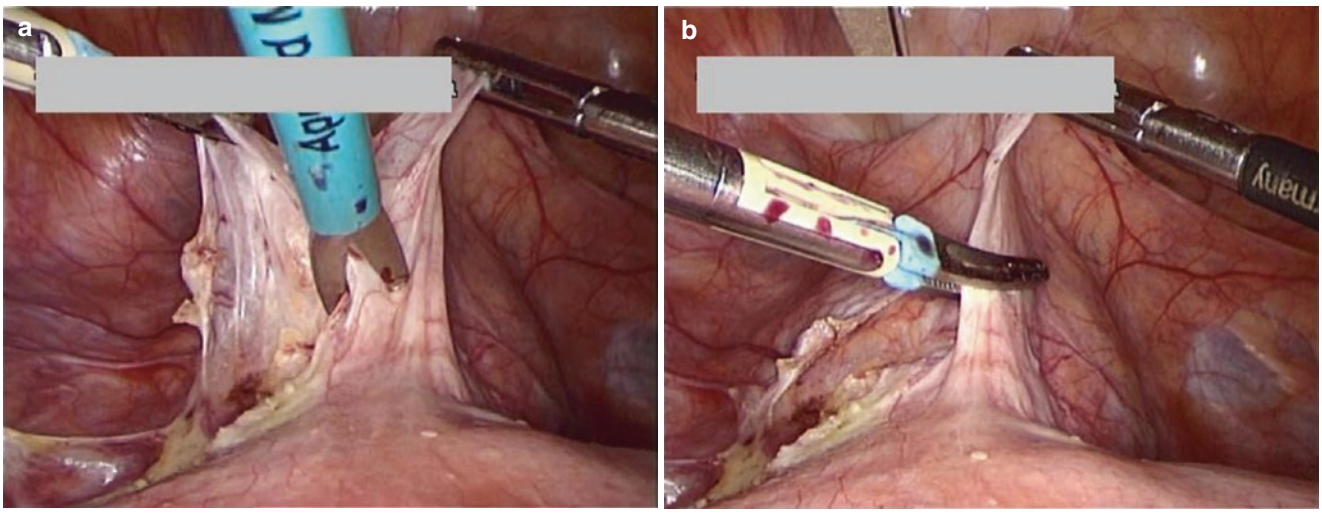


Fig. 49.3 (**a**, **b**) The bladder is isolated after dividing the vesico-uterine fold

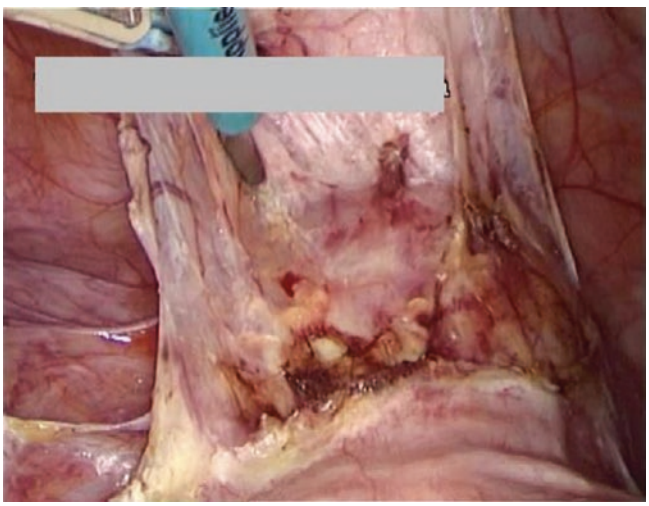


Fig. 49.4 The endoscopic sheras pushes the bladder completely from the upper vagina

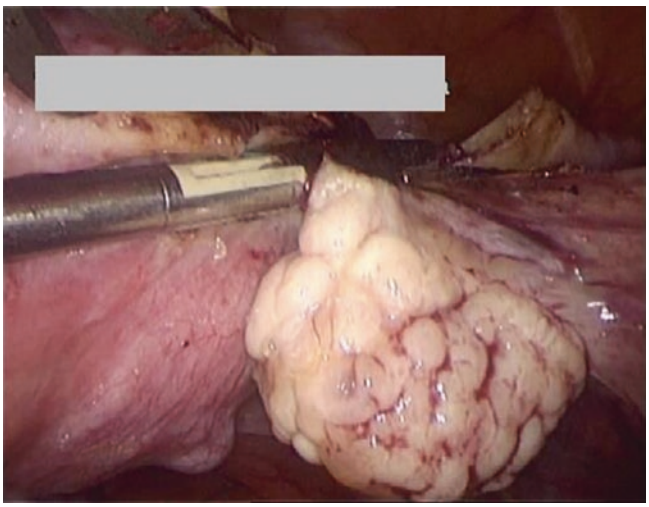


Fig. 49.5 The ovarian ligament is coagulated with bipolar forceps and transacted with scissors

porcelain-valve of the uterine manipulator as a guide; the uterus is removed vaginally. The vaginal vault is closed with continuous 0-polysorb sutures by laparoscopic access and after the laparoscopic control of the haemostasis is performed (Fig. 49.7). The 5- and 10-mm incisions are closed with mattress sutures of 2–0 Rapide Vycril. At the conclusion of the surgical procedure we deflated the abdomen before removing the trocars.

During laparoscopic surgery in obese patients, sufficient intraabdominal workspace is important for the surgeon. Therefore, most surgeons request that their patients be placed in an adequate Trendelenburg position to facilitate retroperitoneal exposure in the case of lymphadenectomy. This leads to retention of the small intestine in the mid and upper abdomen using gravity and gentle instrumentation and reduces bowel injury; however, the effect of an increased workspace is not always sufficient.

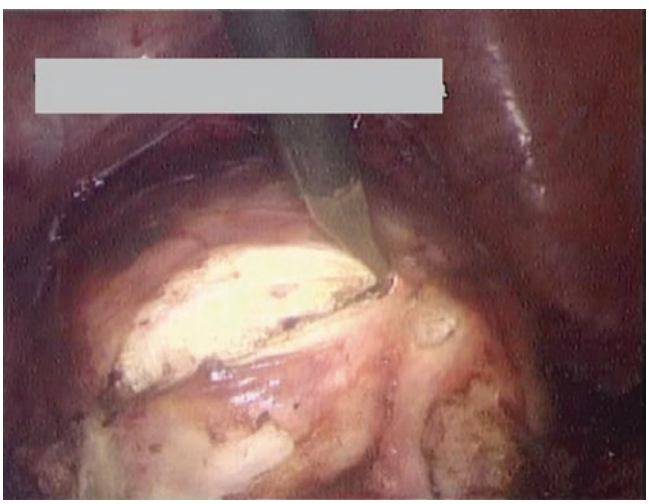


Fig. 49.6 The vagina is visualizated and vaginal cuff around the cervix is transected with monopolar needle

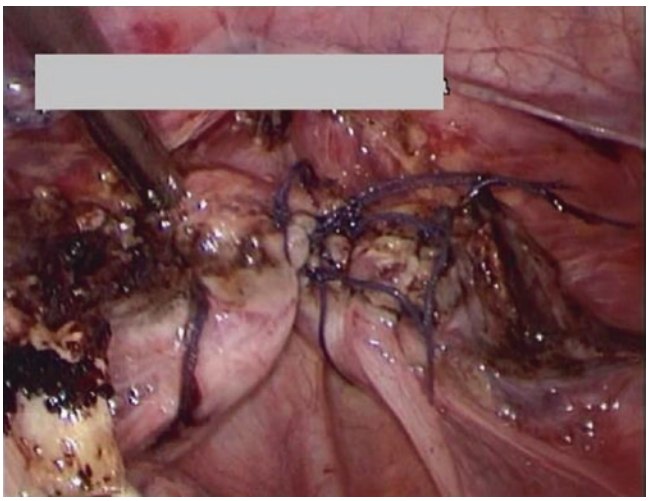


Fig. 49.7 The vaginal vault is closed with continuous 0-polysorb sutures by laparoscopic access and after the laparoscopic control of the hemostasis is performed

Discussion

Obese patients with endometrial cancer patients exhibit a large accumulation and abnormal distribution of abdominal fat; these characteristics seriously affect the exposure of the operative field. In addition, perivascular fat parcels and lipid deposition on vascular walls lead to increased vascular fragility; as a result, slight stretching of blood vessels can easily lead to vascular rupture and bleeding, which severely affect the surgical process and increase surgical difficulty and risk. Furthermore, obesity is frequently associated with many cardiopulmonary and other chronic diseases that decrease operational tolerance.

Many patients with gynaecologic pathologies present with co-morbidity such as obesity, hypertension, and diabetes [8]. Abdominal surgery is therefore exposing patients into increased risk of complications [9].

The role of minimally invasive surgical staging in the management of extremely obese patients with gynaecologic pathologies continues to evolve. Recently, several studies concluded, as others, that the post-operative complications after LPS treatment are reduced or similar [5, 9–12].

Brezina et al. compared the surgical outcomes of 293 obese women undergoing hysterectomy (LPT, vaginal, or LPS). No significant difference was found in obese women between LPS and LPT hysterectomy for operative time and anaesthesia. They concluded that in obese patients for whom vaginal hysterectomy is not possible, LPS hysterectomy should be considered before LPT hysterectomy because the LPS route reduced hospital time and blood loss [13].

Nawfal et al. estimated the impact of body mass index (BMI) on the surgical outcomes of 135 patients undergoing robotic-assisted total LPS hysterectomy for benign indications. They concluded that BMI is not associated with blood loss, duration of surgery, length of stay, or complication rates in patients undergoing robotic-assisted total LPS hysterectomy. Robotic assistance may help surgeons overcome adverse outcomes sometimes found in obese patients [14].

Bardens et al. investigated the influence of the body mass index (BMI) on 200 patients who underwent LPS hysterectomy for benign disease. The group of overweight women had the highest rate of complications and the group of obese women had the lowest. However, the rate of women who required readmission and reoperation was not elevated in the overweight group. They concluded that LPS hysterectomy is a safe and feasible method even in obese and morbidly obese patients. Overweight and obesity increase the time needed to perform LPS hysterectomy but do not seem to relevantly influence the rate of major intra and postoperative complications [15].

Harmanli et al. compared the effect of obesity on perioperative outcomes in women undergoing LPS supracervical hysterectomy (LSH) or LPS total hysterectomy (TLH) for benign conditions in obese (body mass index > or = 30 kg/m^2) and non-obese women. The rates of urinary tract injury, vaginal cuff dehiscence, postoperative fever, and ileus were similar between the groups. Of all seven cuff dehiscences, 5 (71 %) occurred in non-obese women undergoing TLH. They concluded that obesity increased the risk of bleeding requiring transfusion and conversion to laparotomy but did not influence the other perioperative complications. LSH in non-obese women seems to result in best outcomes [16].

In a recent study by Fanfani et al. they analysed perioperative outcomes of Laparo-Endoscopic Single-Site (LESS) hysterectomy in obese and non-obese women in a multicentric retrospective case-control study on 115 women who underwent LESS hysterectomy and were divided into two groups: obese (n = 43, BMI $\geq$ 30 kg/m^2) and non-obese (n = 72, BMI < 30 kg/m^2). No statistical differences regarding perioperative outcomes were observed between the two groups. Conversion to laparotomy occurred in 1 obese (2.3 %) and 3 (4.2 %) non-obese women. Intraoperative complication rate was 11.6 % and 9.6 % in obese and non-obese women, respectively. The early postoperative complication rate was 6.9 % in obese and 4.1 % in non-obese women. This study suggested that obesity (BMI $\geq$ 30) does not preclude successful completion of total LESS hysterectomy [17].

In a recent retrospective study Tinelli et al. compared the safety, complication and recurrence rate after total LPS hysterectomy with lymphadenectomy and LPT hysterectomy with lymphadenectomy for early stage endometrial carcinoma in a series of 75 extremely obese women (BMI > 35).

They performed a multicenter study of all the complications after treatment of 75 consecutive extremely obese patients with clinical stage I endometrial cancer who

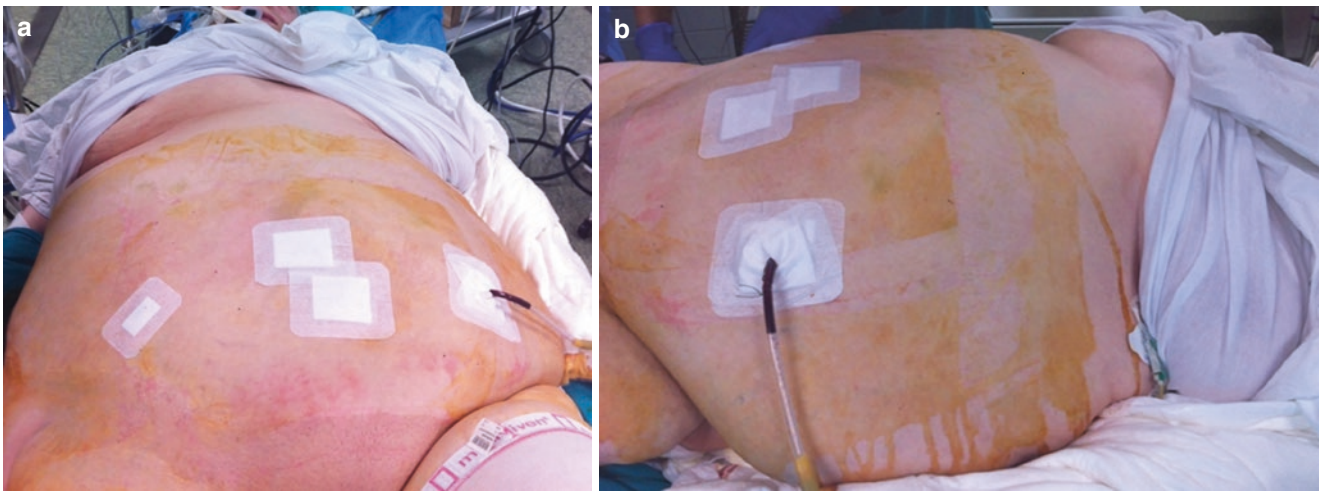


Fig. 49.8 (**a**, **b**) LPS procedures were successfully completed without conversion to LPT and no patient of the two groups required an intraoperative or postoperative blood transfusion

underwent LPS hysterectomy (45 cases) or LPT hysterectomy (30 cases) with pelvic and aortic lymph node dissection.

According to the FIGO staging system, all the patients underwent surgical staging consisting of total hysterectomy, bilateral salpingo-oophorectomy, and in all cases systematic bilateral pelvic lymphadenectomy was performed. In three patients of the LPT group they observed a dehiscence of the abdominal suture with surgical site infection in the first week after surgery that was resutured with interrupted sutured with no sequelae. Postoperative fever was reported in 6 (20 %) patients of the LPT group and in 2 patient of LPS (4.4 %) group.

No case of port-site metastasis, no vascular injury and no wound complications were detected.

In all cases the LPS procedures were successfully completed without conversion to LPT and no patient of the two groups required an intra-operative or postoperative blood transfusion (Fig. 49.8).

One case of bladder injury occurred in the LPS group at the time of utero-vesical fold incision that was laparoscopically sutured.

In this multicentre study, no significant difference in intra-operative complications was observed between groups, whereas postoperative were significantly less common in the LPS than in the LPT group.

We can speculate that LPS hysterectomy in extremely obese women is associated with safety and efficacy outcomes that are similar to those that have been reported for LPT hysterectomy for the treatment of endometrial pathologies [18, 19].

In fact, in almost cases the LPS procedures were successfully completed without conversion to LPT and no patient of the two groups required an intra-operative or postoperative blood transfusion.

Therefore, it appears from data of our studies that LPS hysterectomy may offer significant advantages over LPT in the comprehensive surgical management of extremely obese women, but it should be performed by advanced laparoscopic gynaecologic surgeons.

In fact, a totally LPS hysterectomy is more difficult in the morbidly obese and other patient factors such as associated co-morbidities, adhesive disease, large uteri, fatty mesentery, and inability to tolerate steep Trendelenburg have limited widespread use of this approach in the treatment of uterine pathologies [3–7, 20].

The obese patients with associated co-morbidities had the most to gain from a successfully completed minimally invasive procedure, but also offered the surgeon the greatest challenges to complete the case [21–24].

Moreover, the LPS permits a better exposure of the operative field in association with the advancement of the LPS techniques allowing better dissection of the pelvic spaces; however, it should be outlined that LPS procedures have to be always performed by the same surgical team [4, 7, 12].

Several studies confirm that LPS hysterectomy remains, in expert hands, the procedure better related to the best short-term outcomes in obese women [13–19, 25].

In fact, LPS hysterectomy was associated with a shorter time of post-operative ileus, shorter hospitalization, lower cases of dehiscence of the suture with surgical site infection, reduced cases of postoperative fever, and a reduced time of discharge when compared with LPT fever reducing the costs.

Conclusion

Our data confirm that LPS hysterectomy in extremely obese women improves quality of life in the postoperative period with reduced time of discharge.

The low intra-operative and post-operative complications rate observed in the LPS group highlights the feasibility, safety and efficacy of this surgical approach for the obese patients.

LPS hysterectomy can be considered a safe and effective therapeutic approach for management of e obese women with a better visibility of the operative field, lower postoperative pain, and a significantly lower blood loss, although multicentre randomized trials, long-term follow-up and cost-benefit analyses are required to determine if the use of LPS improves outcomes over standard LPT in obese women and if the advantages of this technique could be extended to a larger proportion of patients.

References

1. Ghezzi F, Cromi A, Bergamini V, Uccella S, Beretta P, Franchi M, Bolis P. Laparoscopic management of endometrial cancer in non-obese and obese women: a consecutive series. J Minim Invasive Gynecol. 2006;13:269–75.
2. Malur S, Possover M, Michels W, Schneider A. Laparoscopic-assisted vaginal versus abdominal surgery in patients with endometrial cancer: a prospective randomized trial. Gynecol Oncol. 2001;80:239–44.
3. Malzoni M, Tinelli R, Cosentino F, Perone C, Rasile M, Iuzzolino D, Malzoni C, Reich H. Total laparoscopic hysterectomy versus abdominal hysterectomy with lymphadenectomy for early-stage endometrial cancer: a prospective randomized study. Gynecol Oncol. 2009;112:126–33.
4. Palomba S, Falbo A, Mocciaro R, Russo T, Zullo F. Laparoscopic treatment for endometrial cancer: a meta-analysis of randomized controlled trials (RCTs). Gynecol Oncol. 2009;112:415–21.
5. Galaal K, Bryant A, Fisher AD, Al-Khaduri M, Kew F, Lopes AD. Laparoscopy versus laparotomy for the management of early stage endometrial cancer. Cochrane Database Syst Rev 2012;(9):CD 006655.
6. Perrone AM, Di Marcoberardino B, Rossi M, Pozzati F, Pellegrini A, Procaccini M, Santini D, De Iaco P. Laparoscopic versus laparotomic approach to endometrial cancer. Eur J Gynaecol Oncol. 2012;33:376–81.
7. Litta P, Merlin F, Saccardi C, Pozzan C, Sacco G, Fracas M, Capobianco G, Dessole S. Role of hysteroscopy with endometrial biopsy to rule out endometrial cancer in postmenopausal women with abnormal uterine bleeding. Maturitas. 2005;50:117–23.
8. Kalogiannidis I, Lambrechts S, Amant F, Neven P, Van Gorp T, Vergote I. Laparoscopy-assisted vaginal hysterectomy compared with abdominal hysterectomy in clinical stage I endometrial cancer: safety, recurrence, and long-term outcome. Am J Obstet Gynecol. 2007;196:248.
9. Litta P, Bartolucci C, Saccardi C, Codroma A, Fabris A, Borgato S, Conte L. Atypical endometrial lesions: hysteroscopic resection as an alternative to hysterectomy. Eur J Gynaecol Oncol. 2013;34:51–3.
10. Mariani A, Webb MJ, Galli L, Podratz KC. Potential therapeutic role of para-aortic lymphadenectomy in node-positive endometrial cancer. Gynecol Oncol. 2000;76:348–56.
11. Lu Q, Liu H, Liu C, Wang S, Li S, Guo S, Lu J, Zhang Z. Comparison of laparoscopy and laparotomy for management of endometrial carcinoma: a prospective randomized study with 11-year experience. J Cancer Res Clin Oncol. 2013;139:1853–9.
12. Walker JL, Piedmonte MR, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS, Spiegel G, Barakat R, Pearl ML, Sharma SK. Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: Gynecologic Oncology Group Study LAP2. J Clin Oncol. 2009;27:5331–6.
13. Brezina PR, Beste TM, Nelson KH. Does route of hysterectomy affect outcome in obese and nonobese women? JSLS. 2009;13:358–63.
14. Nawfal AK, Orady M, Eisenstein D, Wegienka G. Effect of body mass index on robotic-assisted total laparoscopic hysterectomy. J Minim Invasive Gynecol. 2011;18:328–32.
15. Bardens D, Solomayer E, Baum S, Radosa J, Gräber S, Rody A, Juhasz-Böss I. The impact of the body mass index (BMI) on laparoscopic hysterectomy for benign disease. Arch Gynecol Obstet. 2014;289:803–7.
16. Harmanli O, Esin S, Knee A, Jones K, Ayaz R, Tunitsky E. Effect of obesity on perioperative outcomes of laparoscopic hysterectomy. J Reprod Med. 2013;58:497–503.
17. Fanfani F, Boruta DM, Fader AN, Vizza E, Growdon WB, Kushnir CL, Corrado G, Scambia G, Turco LC, Fagotti A. Feasibility and surgical outcome in obese vs. non-obese patients undergoing Laparo-Endoscopic Single-Site (LESS) hysterectomy: a multicenter case-control study. J Minim Invasive Gynecol. 2014;12:401–10.
18. Barakat RR, Lev G, Hummer AJ, Sonoda Y, Chi DS, Alektiar KM, Abu-Rustum NR. Twelve-year experience in the management of endometrial cancer: a change in surgical and postoperative radiation approaches. Gynecol Oncol. 2007;105:150–6.
19. Seamon LG, Cohn DE, Henretta MS, Kim KH, Carlson MJ, Phillips GS, Fowler JM. Minimally invasive comprehensive surgical staging for endometrial cancer: robotics or laparoscopy? Gynecol Oncol. 2009;113:36–41.
20. Tinelli R, Malzoni M, Cicinelli E, Fiaccavento A, Zaccoletti R, Barbieri F, Tinelli A, Perone C, Cosentino F. Is early stage endometrial cancer safely treated by laparoscopy? Complications of a multicenter study and review of recent literature. Surg Oncol. 2011;20:80–7.
21. Malzoni M, Tinelli R, Cosentino F, Fusco A, Malzoni C. Total laparoscopic radical hysterectomy versus abdominal radical hysterectomy with lymphadenectomy in patients with early cervical cancer: our experience. Ann Surg Oncol. 2009;16:1316–23.
22. Malzoni M, Tinelli R, Cosentino F, Perone C, Vicario V. Feasibility, morbidity, and safety of total laparoscopic radical hysterectomy with lymphadenectomy: our experience. J Minim Invasive Gynecol. 2007;14:584–90.
23. Palomba S, Ghezzi F, Falbo A, Mandato VD, Annunziata G, Lucia E. Laparoscopic versus abdominal approach to endometrial cancer: a 10-year retrospective multicenter analysis. Int J Gynecol Cancer. 2012;22:425–33.
24. Tinelli R, Malzoni M, Cosentino F, Perone C, Fusco A, Cicinelli E, Nezhat F. Robotics versus laparoscopic radical hysterectomy with lymphadenectomy in patients with early cervical cancer: a multicenter study. Ann Surg Oncol. 2011;18:2622–8.
25. Tinelli R, Litta P, Meir Y, Surico D, Leo L, Fusco A, Angioni S, Cicinelli E. Advantages of laparoscopy versus laparotomy in extremely obese women (BMI > 35) with early-stage endometrial cancer: a multicenter study. Anticancer Res. 2014;34:2497–502.

Laparoendoscopic Single-Site (LESS) Hysterectomy

50

Anna Fagotti, Cristiano Rossitto, Francesco Fanfani, and Giovanni Scambia

Introduction

Since its introduction laparoscopic surgery has undergone several advancements. More minimally invasive approaches to further reduce surgical morbidity represent a recent progress in laparoscopy. They consist of a reduction either in port's dimension or in port's number. This last option is called single-site surgery. This approach is performed through a single trans-umbilical multiport device. A multidisciplinary consortium of surgeons, who met at the Cleveland Clinic in July 2008, coined the acronyms of laparoendoscopic single-site surgery (LESS) that included all the techniques performed with a single transumbilical skin incision [1]. Since its first reports [2–5], there has been a considerable surge of interest in LESS as a virtually scarless procedure for a variety of surgical indications in different fields. LESS has been utilized to successfully perform a large number of procedures also in general surgery [6–8]. It was first reported for gynecological procedures in the 1970s for laparoscopic tubal ligations [9]. However, this procedure did not initially gain popularity because of technical challenges. In the last decade, technological advances in flexible optical and coagulation devices allowed performing more advanced procedures, such as total LESS hysterectomy and pelvic/aortic lymphadenectomy. In this period several reports have come out to demonstrate the feasibility and reproducibility of this approach for benign and malignant uterine disease [1, 3, 4, 10, 11].

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The benefits of single-site surgery seem superior to those reported for standard laparoscopy, including faster recovery, and lower postoperative analgesic requirements and better cosmetic results [12–14].

Or Set-Up and Patient's Positioning

Since single port surgery is a technically complex approach even in case of simple operations, the operating room set up needs to be modified to make the surgeon drive in the most ergonomic position. To this purpose, every single detail should not be overlooked, to avoid difficulties during surgery.

We demonstrated that the OR staff must move around the patient, in an anti clockwise of about half an hour. Accordingly, the first surgeon is positioned at the head of the patient, the first assistant is sitting at her right side, and the second assistant is sitting and moving the uterine manipulator between the patient's legs [10]. The anaesthesiologist and his instrumentation are located between the surgeon and the assistant. The nurse is at the left side of the patients, to easily switch the surgeon's instruments. Finally, two monitors should be positioned at the head and legs of the patient, respectively (Fig. 50.1).

Following the induction of general anaesthesia, the patient is positioned in the dorsal lithotomic position with both legs supported in stirrups with a steep Trendelenburg tilt. In this way, the head of the patient is located at the level of the surgeon's legs. This position allows a number of benefits: (1) small bowel ansae are easily dislocated outside the pelvis; (2) the distance between the working instruments at the umbilicus and surgeon's hands is significantly reduced; (3) the surgeon achieves a very ergonomic position, thanks to the 90 ° angle between the surgeon's arm and forearms.

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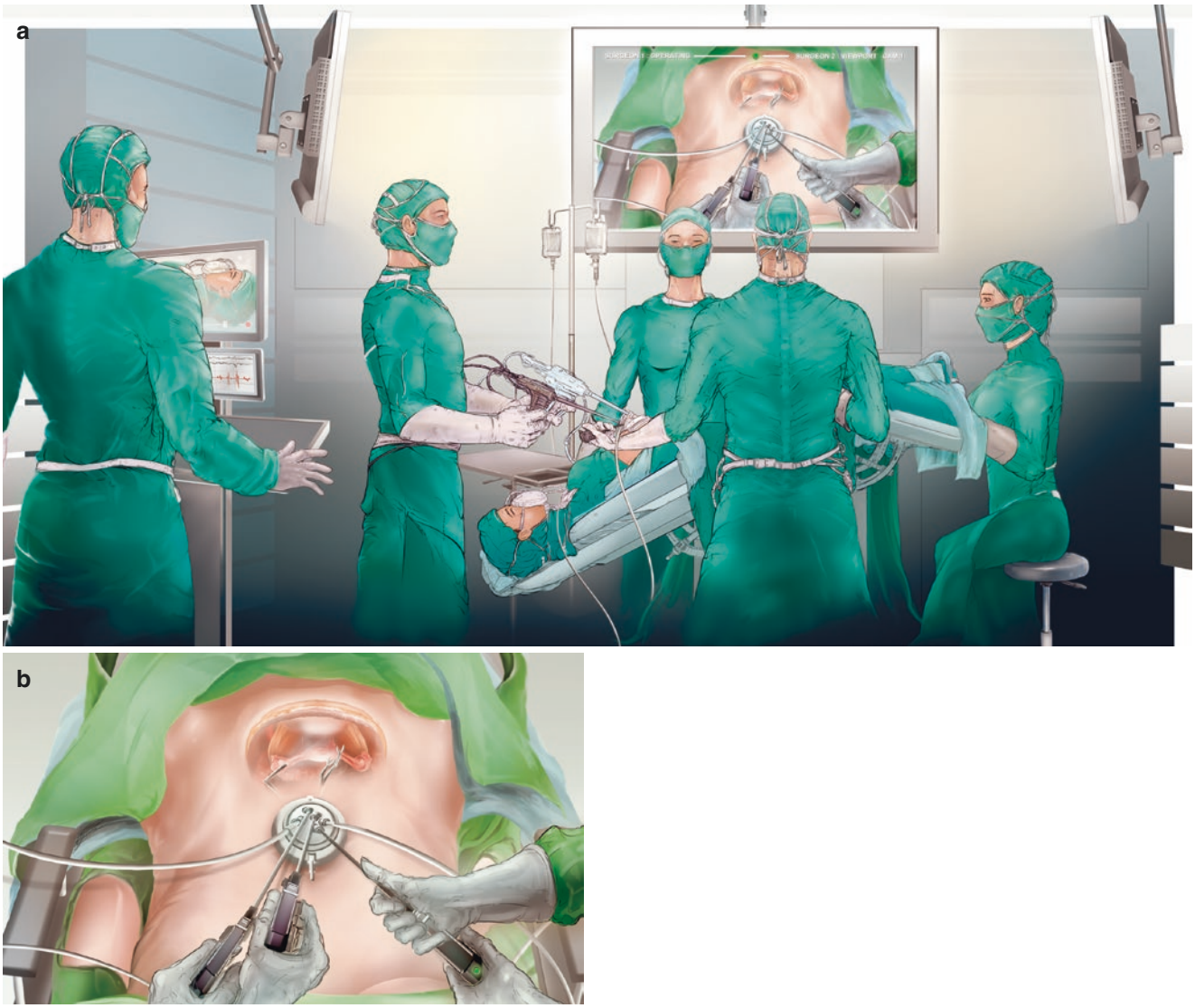


Fig. 50.1 (**a**) OR setting, (**b**) Surgeon's point of view on LESS approach

Instruments

The insertion of the single trocar is obtained by a skin incision within the umbilical scar of about 1.5–2 cm. We suggest performing a larger incision (2.5 cm) in the underlying abdominal fascia in order to avoid any clashing between the instruments and the optic [10]. Single port trocar may have different numbers and sizes of ports for the insertion of the instruments. However, a minimum of three 5 mm ports is required to perform SS hysterectomy.

Dedicated optics to single port surgery allow the best balance between an excellent intra abdominal visualization and no conflict between the camera and the instruments outside the patient. To this purpose, they are usually 5 mm HD telescopes, either with a long and flexible external arm and a 30 ° optic, or with a flexible internal tip and a 0 ° optic.

We strongly suggest using the uterine manipulator to perform single-site hysterectomy. It may partially replace the *third missing hand* with single port surgery, making the indispensable traction on the uterus, and thus resulting much more helpful than in traditional laparoscopy.

Working 5-mm instruments are inserted into the remaining ports, choosing among graspers, bipolar coagulator, cold scissors, suction/irrigation, and a multifunctional device, which grasps, coagulates and transects, simultaneously.

To prevent clashing between instruments and surgeon's hands and to facilitate surgical manoeuvres, the combination of one 33-cm-long instrument with a 43-cm-long straight instrument is suggested. Alternatively, one double bended and one straight instrument could be adopted.

In our opinion, the standard equipment to perform LESS hysterectomy should consist of a 5 mm HD 0 degree optic



Fig. 50.2 Standard equipment to perform LESS hysterectomy

with flexible tip, a 43 cm long bipolar grasper, a standard multifunctional device, a 43 cm long suction/irrigation, and a uterine manipulator. This set allows the best performances in terms of intra-operative visualization, safe and effective coagulation and cutting, which reflects in a shorter operating time, and lower complication rate (Fig. 50.2)**.**

Surgical Steps and Technique

Surgical steps during LESS hysterectomy should not differ from those described for any abdominal hysterectomy (either laparotomy and traditional laparoscopy). This avoids potential confusion, which may lead to serious intra- and post-operative complications.

Here we present the CUSH (Catholic University of the Sacred Heart) technique for total extrafascial hysterectomy (class A according to Querleu and Morrow) [15].

Coagulation and Section of the Round Ligament

The cutting landmark is the perpendicular projection of the obliterated umbilical artery on the ligament itself (Fig. 50.3). The identification of the correct point allows a safe access to the pelvic retro-peritoneum, through an avascular space, thus avoiding unnecessary bleeding from the small vessels of the broad ligament.

Access to the Pelvic Retro-Peritoneum

Once the round ligament has been sectioned, the wide ligament is opened in a dorso-caudal direction through the surgeon's forceps and CO2 (Fig. 50.4).

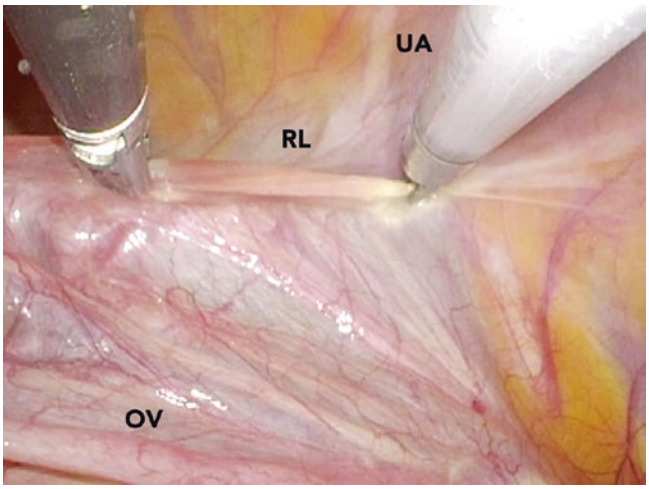


Fig. 50.3 Round ligament (*RL*), coagulated and resected along the vertical projection of the umbilical artery (*UA*). Ovarian vessels (*OV*)

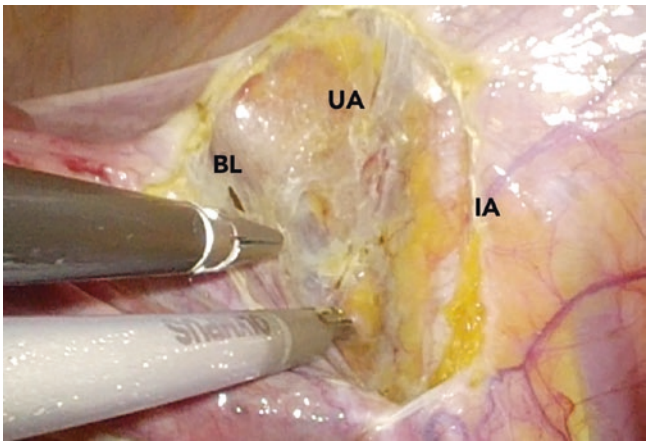


Fig. 50.4 Access to the pelvic retro-peritoneum on the right side. Umbilical artery (*UA*), iliac artery (*IA*), broad ligament (*BL*)

Identification of the Ureter

Through a gentle dissection of the loose connective tissue, the pelvic portion of the ureter is visualized at the posterior layer of the broad ligament. The peristaltic movement of the ureter may be helpful, for its correct identification (Fig. 50.5).

Identification and Closing of the Uterine Artery at Its Origin

In most cases, the uterine artery is the first branch of the obliterated umbilical artery, which is, in turn, a branch of the internal iliac artery. In a small percentage of anatomical variants (about 10 %), it can come directly from the internal iliac or hypogastric iliac artery.

Closing with metal clips the uterine artery at its origin, laterally to the ureter, may serve either as effective haemostats as well as an indirect landmark for the ureter throughout the operation (Fig. 50.6).

Coagulation and Section of the Ovarian Vessels/Utero-Ovarian Ligament

In case of hysterectomy with adnexa removal, we suggest to create a peritoneal window between the ovarian vessels (upper) and the ureter (below) (Fig. 50.7). This procedure moves the ureter further away from the coagulating energy, thus avoiding any ureteral potential injury. The ovarian vessels should be coagulated with extreme caution to avoid any bleeding, in subsequent steps, by alternating between coagulations and cut of small parts of the vessels.

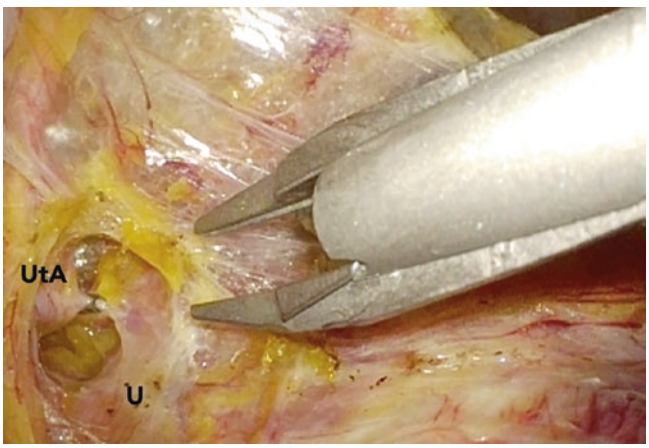


Fig. 50.5 Identification, dissection and closure of the uterine artery (*UtA*) at its origin. The ureter (*U*) passing below the arc drawn by the uterine artery.

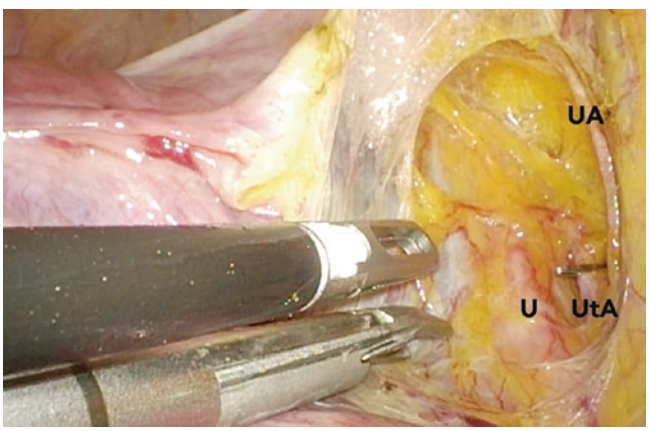


Fig. 50.6 Identification of the retro-peritoneal structures. Uterine artery (*UtA*) closed at the origin with haemostatic clip. Ureter (*U*). Umbilical artery (*UA*)

In case the adnexa will be conserved, the section of the ovarian vessels will be performed proximally to the uterus, at the level of the utero ovarian ligaments. They should be coagulated and cut, leaving 1–2 cm from the uterine body, in order to avoid any bleeding of the cervical branches of the uterine artery.

Section of the Utero-Sacral Ligaments

Detachment and section of the peritoneum covering the utero-sacral ligaments allows colpotomy to be performed more bloodlessly, moves the ureters further away from the energy application and avoids damage to the uterine vessels which remain in the lateral position (Fig. 50.8).

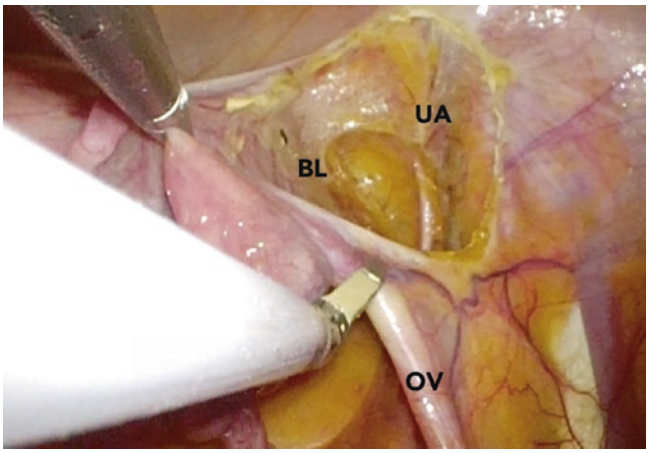


Fig. 50.7 Coagulation and section of the ovarian vessels (*OV*). Umbilical artery (*UA*). Broaf ligament (*BL*)

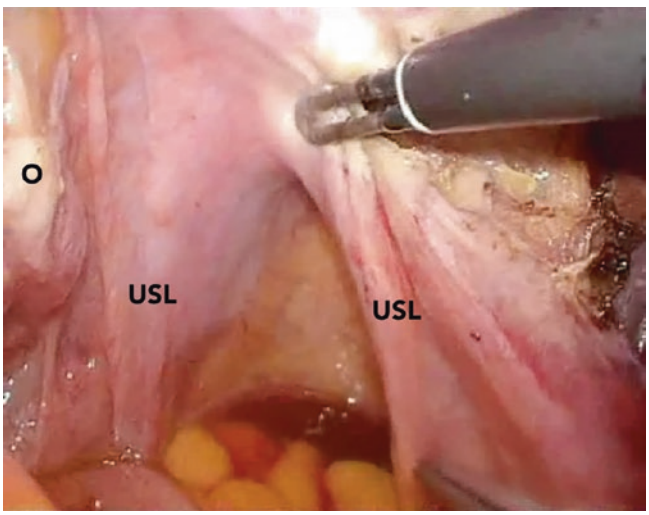


Fig. 50.8 Dissection along the posterior part of the broad ligament, to resect the uterosacral ligaments (*USL*). Ovary (*O*)

Development of the Vesico Uterine and Vesico Vaginal Spaces

Development of the anterior space requires the assistant to apply a strong tension to the uterus in a ventro-medial direction. This tension allows the surgeon to develop the anterior space, between the uterine vessels (dorsal – lateral), the cervix (caudal-medial) and the bladder (anterior). This step must be performed following a latero-medial direction, to avoid any potential risk of damaging the bladder, as in case of previous surgery at this level (i.e. caesarean section). The peritoneal reflection between cervix-vagina and bladder is often very clear. The dissection should be performed 1 cm caudally to this reflection, not to open the cervical fascia. After completing the lateral dissection, both on the right and the left side, the surgeon may grasp the bladder upwards to highlight the peritoneal passage during the central detachment (Fig. 50.9).

Identification, Coagulation and Section of the Uterine Vessels

The coagulation of the uterine vessels in the iuxta-uterine position entails their dissection, so that haemostasis is more precise and safe. After closing the uterine artery at its origin, the vessel coagulation shall be performed progressively since venous reflux bleeding can still occur from the cervical and vaginal branches (Fig. 50.10).

Colpotomy

Colpotomy is a circular incision of the vagina, which is performed closer to the cervix to reduce the vaginal border removal. Colpotomy can be performed with monopolar current (Hook or scissors) or with new multifunctional devices (advanced bipolar or ultrasonic). After closing of the uterine vessels and preparing the anterior and posterior peritoneal planes, this step will be virtually bloodless.

The uterine manipulator valve, introduced into the vagina, will help us to decide on the incision starting point and will guide the operator throughout the colpotomy (Fig. 50.11).

Removal of the Uterus and Closure of the Vaginal Cuff

In the case of histologically proven benign pathologies, the uterus can be removed vaginally, integrally or through cold morcellation. In the case of malignant disease, the uterus must be removed integrally, either through the vaginal approach or by mini-laparotomy (if vaginal removal is impossible). Vaginal suture can occur either laparoscopically or through the vaginal approach. Due to the waste of time, in the single port approach,

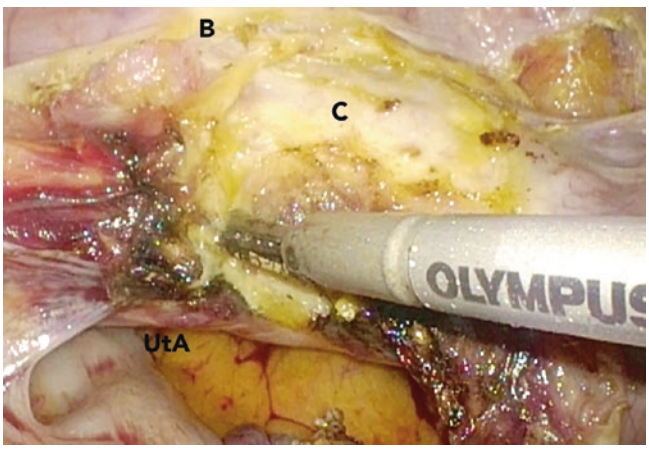


Fig. 50.10 Section and coagulation of the uterine artery (*UtA*), medially to the ureter, at the level of the cervix (*C*). Bladder (*B*)

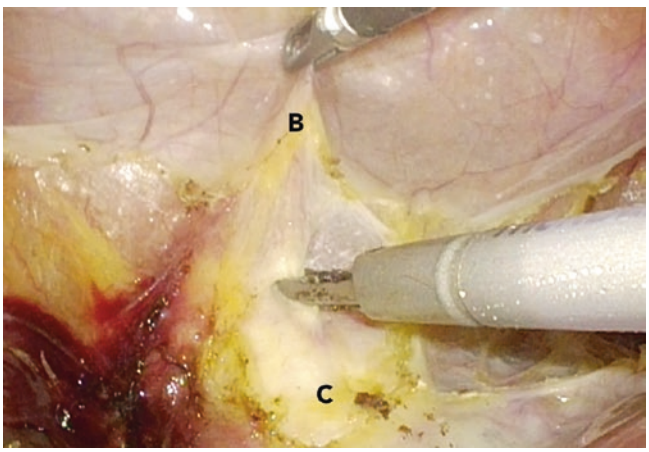


Fig. 50.9 Detachment of vesico-uterine peritoneal reflection. Bladder (*B*), cervix (*C*)

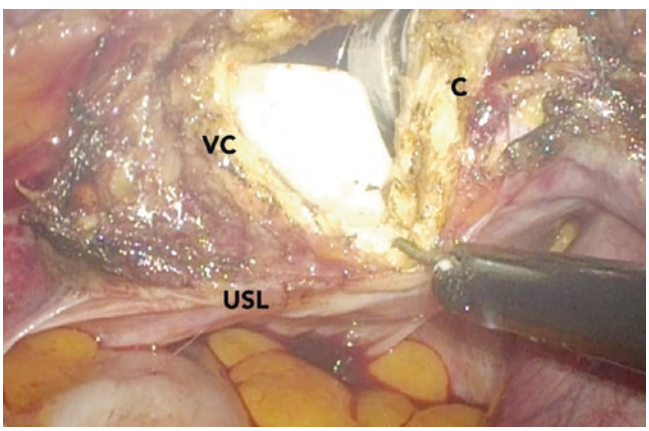


Fig. 50.11 Posterior colpotomy and section of the utero sacral ligament (*USL*). Vaginal cuff, cervix (*C*)

we prefer the vaginal suturing, using a stitch with 1 absorbable wire, first anchoring the vaginal angles and then suturing from right to left with a continuous suture.

Final Control

After suturing the vaginal vault, pneumoperitoneum is re-induced to check haemostats at the trigger points (ovarian pedicles, uterine arteries and utero-sacral ligaments), integrity of the ureter, and the bladder at the idropneumatic test. At the end of the procedure, complete CO2 essufflation should be obtained to avoid patient's pain complain after surgery. The umbilical fascia is closed with a figure-of-eight 0-Vicryl (Fig. 50.12).

Following these simple rules, each surgeon needs about twenty cases to complete his/her learning curve (Fig. 50.13)**.**

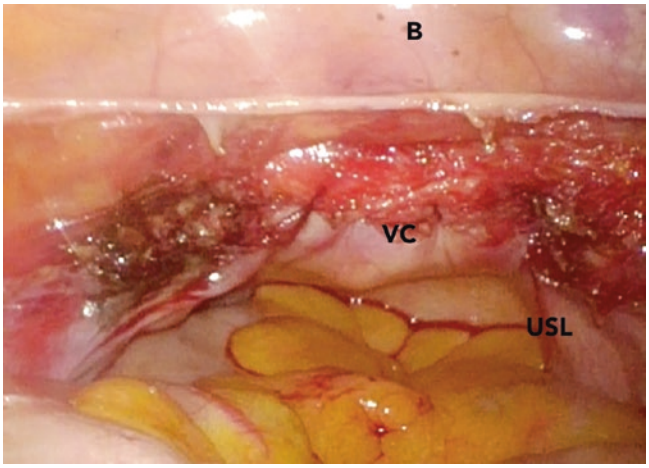


Fig. 50.12 Final imaging after removal of the uterus and vaginal colporrafy. Bladder (*B*), vaginal cuff (*VC*), utero sacral ligament (*USL*)

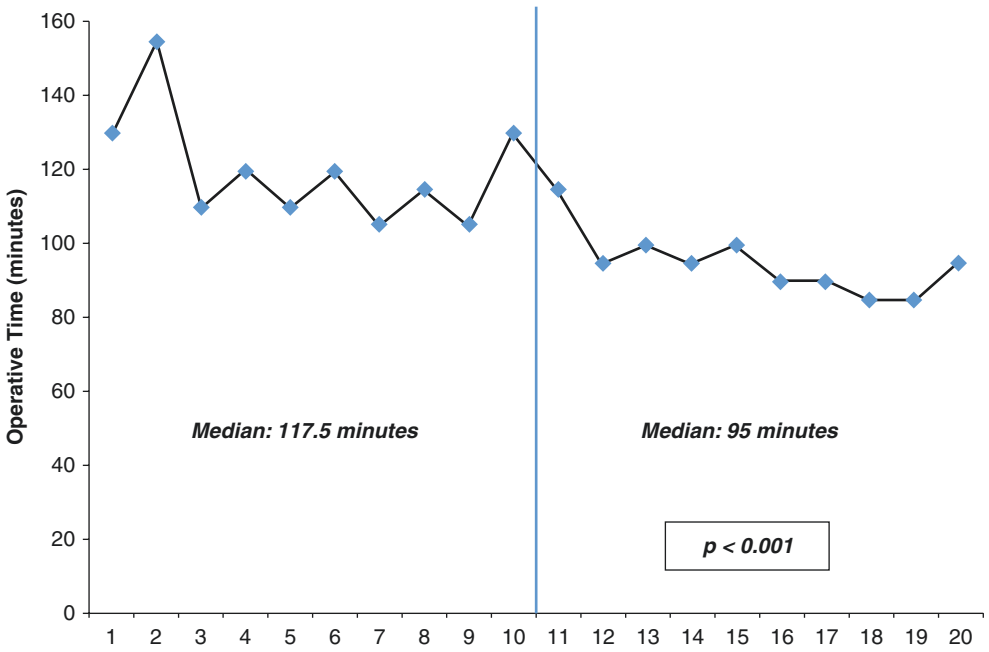


Fig. 50.13 Learning curve for LESS hysterectomy

References

1. Fagotti A, Boruta 2nd DM, Scambia G, et al. First 100 early endometrial cancer cases treated with laparoendoscopic single-site surgery: a multicentric retrospective study. Am J Obstet Gynecol. 2012;206:353.e1–6.
2. Fanfani F, Fagotti A, Gagliardi ML, et al. Minilaparoscopic versus single-port total hysterectomy: a randomized trial. J Minim Invasive Gynecol. 2013;20:192–7.
3. Fader AN, Escobar PF. Laparoendoscopic single-site surgery (LESS) in gynecologic oncology: technique and initial report. Gynecol Oncol. 2009;114:157–61.
4. Yim GW, Jung YW, Paek J, et al. Transumbilical single-port access versus conventional total laparoscopic hysterectomy: surgical outcomes. Am J Obstet Gynecol. 2010;203:26.e1–e6; e1–6.
5. Fanfani F, Fagotti A, Scambia G. Laparoendoscopic single-site surgery for total hysterectomy. Int J Gynaecol Obstet. 2010;109:76–7.
6. Sodergren MH, Aslanyan A, McGregor CG, et al. Pain, well being, body image and cosmesis: a comparison of single-port and four-port laparoscopic cholecystectomy. Minim Invasive Ther Allied Technol. 2014;23(4):223–9.
7. Pini G, Veneziano D, Altieri V, et al. Laparoendoscopic single-site radical nephrectomy for kidney tumor. Surgical technique, cosmetic and postoperative pain control outcomes. Urologia. 2013;80(Suppl 22):16–23.
8. Qiu J, Yuan H, Chen S, et al. Single-port laparoscopic appendectomy versus conventional laparoscopic appendectomy: evidence from randomized controlled trials and non randomized comparative studies. Surg Laparosc Endosc Percutan Tech. 2014;24:12–21.
9. Yoon BS, Park H, Seong SJ, et al. Single-port laparoscopic salpingectomy for the surgical treatment of ectopic pregnancy. J Minim Invasive Gynecol. 2010;17:26–9.
10. Fanfani F, Rossitto C, Gagliardi ML, et al. Total laparoendoscopic single-site surgery (LESS) hysterectomy in low-risk early endometrial cancer: a pilot study. Surg Endosc. 2012;26:41–6.
11. Fanfani F, Fagotti A, Rossitto C, et al. Laparoscopic, minilaparoscopic and single-port hysterectomy: perioperative outcomes. Surg Endosc. 2012;26:3592–6.
12. Li M, Han Y, Feng YC. Single-port laparoscopic hysterectomy versus conventional laparoscopic hysterectomy: a prospective randomized trial. J Int Med Res. 2012;40(2):701–8.
13. Yim GW, Jung YW, Paek J, Lee SH, Kwon HY, Nam EJ, Kim S, Kim JH, Kim YT, Kim SW. Transumbilical single-port access versus conventional total laparoscopic hysterectomy: surgical outcomes. Am J Obstet Gynecol. 2010;203(1):26.e1–6. doi:10.1016/j.ajog.2010.02.026. Epub 2010 Apr 24.
14. Fagotti A, Bottoni C, Vizzielli G, Alletti SG, Scambia G, Marana E, Fanfani F. Postoperative pain after conventional laparoscopy and laparoendoscopic single site surgery (LESS) for benign adnexal disease: a randomized trial. Fertil Steril. 2011;96(1):255–259.e2. doi:10.1016/j.fertnstert.2011.04.006. Epub 2011 May 11.
15. Querleu D, Morrow CP. Classification of radical hysterectomy. Lancet Oncol. 2008;9(3):297–303. doi:10.1016/S1470-2045(08)70074-3.

Laparoscopic Pelvic and Paraaortic Lymphonodectomy

51

Bernd Holthaus and Sven Becker

Current Significance of Lymphonodectomy in Gynecologic Oncology

Our current understanding of cancer has its roots in the nineteenth century. At that time the novel techniques of tissue staining – which incidentally have not changed much since – first allowed us to distinguish between normal cells and cancerous growth. The notion that cancer originates within a specific organ, invades locally but ultimately finds its way through the body to metastasize at distant sites remains one of the most fundamental tenements of current oncologic thought.

The question "How does the cancer get from A to B?" logically follows and only two pathways seem obvious: either the bloodstream or the lymphatic drainage system of the body.

It has been and remains exceptionally difficult to systematically detect cancer cells within the bloodstream and reliable technologies have only evolved over the past two decades, spurring a whole scientific industry involved with "Circulating Tumor Cells"and notions of "Liquid Biopsies". At this point, the presence of cancer cells in the bloodstream is documented, a relationship to the prognosis seems established, but the exact significance remains unclear.

The presence of supposedly "migrating" tumor cells within the lymphatic system and particularly within the lymphatic nodes has been documented for much longer. Virchow and his contemporaries were already able to discern these cells using standard hematoxylin-eosin staining.

Linking the presence of micrometastatic cancers cells in lymph nodes to a normally reduced prognosis was yet another milestone in our understanding of cancer.

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It is important to stress how much this model or cancer progression, which has been the rock upon which all our treatment concepts have been built, is rooted in the mechanical view of the world that dominated the nineteenth century.

Viewing the cancer as a "runaway" renegade inevitably led to therapeutic concepts of "radical excision" and "removing the bad cells" wherever possible.

If cancerous cells are present in lymphatic nodes and if their presence there leads to a poorer prognosis, surely we can reverse this process by removing the affected lymph nodes.

Because lymphonodectomy is technically challenging and longer operating times only became possible after the introduction of endotracheal intubation after the Second World War, these pathophysiological concepts were not put into action until the 1950s. At this time Joe Vincent Meigs introduced lymph node dissection to the standard oncologic surgery of the day: the radical hysterectomy, originally pioneered by Wertheim, without lymphonodectomy. Hence the now commonly used term for the surgery: "Wertheim-Meigs-Okabayashi".

Lymphonodectomy, by and large, became the standard of all surgical oncologic procedures. Proper "staging" of the tumor became one of the most important advances in standardizing oncologic care, as multimodal treatment approaches depended on stratification to assess the exact treatment.

As a result, no tumor was deemed adequately diagnosed and treated, if the "TNM"-status (tumor, nodal, metastasis) status was not available.

Lost in this great leap forward with regard to overall quality of care was the question at the core of the presence of cancers cells within the lymphatics: Was their presence merely a prognostic marker or would their removal – by removing the "advancing" maximal border of the systemically spreading cancer – improve cure rates?

To this day, there appears to be no definitive answer. In breast cancer, the therapeutic significance of axillary lymph node dissection was unquestioned 20 years ago. Today, as

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the molecular markers of the individual disease take the lead in treatment stratification, the removal even of affected lymph nodes has been called into question. Axillary lymph node dissection is now seen as a purely diagnostic procedure without any therapeutic effect.

In gynecologic cancers, the current evaluation of the significance of lymph node dissection is changing, but different approaches are emerging for the different disease entities: endometrial cancer, cervical cancer, ovarian cancer and vulvar cancer.

For the surgeon, deciding who to operate and how to operate, this basic knowledge is decisive as we balance the inherent surgical harm of what we do with the oncologic benefit, a balancing act that – while relying on guidelines and standards – must be made individually for each patient every day.

In endometrial cancer, the available literature – though far from uncontroversial – appears to support a clinical benefit of surgical staging in the form of pelvic and paraaortic lymphonodectomy for all high-risk endometrial cancers, i.e. FIGO IB and above, G3 and non-endometrial cancers irrespective of stage. Statistically, this approach makes sense, as a high proportion of "low-risk" cancers will have negative, non-cancerous lymph nodes.

There is little doubt that removing tumor-free lymph nodes will have no beneficial effect. This argument, however, ignores the fact that statistical probabilities mean little for the individual low-risk patient who is undertreated because she did not have a lymphonodectomy but just happens to be part of the unlucky few.

In fact, it is important to logically stratify the statement: Removing non-affected lymph nodes probably has no survival benefit. Does removal of affected lymph nodes provide a survival benefit, either because the patient will receive additional treatment or because the accessible cancer burden is actually decreased?

When lymph nodes are grossly positive, there is general agreement that they should be removed if possible. This will reduce the residual tumor burden but it might also improve long-term outcome after radiation therapy, as studies have shown that "bulky" lymph nodes larger than 3–4 cm often will not be sufficiently sterilized by radiation. Under these circumstances, laparoscopic – but not laparotomic – lymphonodectomy has the potential to improve the outcome of chemoradiation therapy.

Of course, overall, a reasonable balance between statistical surgical risk and statistical clinical benefit needs to be found. Contrary to chemotherapy or radiation therapy, which can be standardized, the risk of a surgical procedure depends mostly on the two variables "surgeon's skill" and "patient's disposition".

As already mentioned, particularly for cervical cancer, there exists data showing that the removal of grossly affected lymph nodes might confer a survival benefit. While the role of lymphonodectomy for adenocarcinomas such as breast cancer and endometrial cancer has been questioned, squamous lymphatic metastasis appears to be amenable to surgical treatment with curative intention. Furthermore, "oncologic tailoring", i.e. determining the radicality of parametrial resection inevitably depends on histopathologic lymph-node assessment. Because of this, contrary to endometrial cancer, lymphonodectomy remains an integral part of the treatment of all cervical cancers, with the exception of low-risk pT1a1-stages.

In fact, even for non-operable cervical cancer, evaluating lymph nodes, as a means to delineate the limits of the radiation field or to define additional need for systemic chemotherapy, continues to be evaluated.

The role of lymphonodectomy in ovarian cancer is under intense investigation. Laparoscopy does not play a generally accepted role in the staging of early ovarian cancer, where lymphonodectomy is called for under any circumstances. While the existing literature supports the oncologic equivalence of open vs. laparoscopic staging, fear of incompetent use of the difficult laparoscopic techniques has led to a great reluctance to accept the laparoscopic approach within the different national guidelines. Opinions differ along national society recommendations. Overall and globally speaking, laparoscopy is becoming more and more accepted as a staging tool in early ovarian cancer as well as a treatment-stratification tool in advanced ovarian cancer.

For vulva cancer, again a cancer of predominantly squamous histology, the therapeutic effect of adequate treatment of inguinal lymph nodes remains unquestioned – mostly because an inguinal recurrence is basically not treatable and will lead to inevitable death, often after extensive periods of suffering. Laparoscopic pelvic-lymphonodectomy is generally accepted to delineate the limits of subsequent radiation therapy.

Some Remarks About the Access

Laparoscopic pelvic and particularly laparoscopic paraaortic lymphonodectomy remain difficult "high-end" procedures within the spectrum of surgical laparoscopy. As safe laparoscopy relies heavily on patient setup as well as technical and anesthesiologic support, we will now review the key points of patient setup and laparoscopic access.

Adequate Positioning of the Patient

Proper, safe and stable positioning of the patient are key elements of successful laparoscopic surgery.

The patient should be in the regular supine position with adequate dorsal padding. The arms must be "tucked"

laterally, i.e. aligned to the body axis (Fig. 51.1a). In very obese patients, this sometimes is not possible, making particularly the pelvic LND much more challenging. Positioning with only one arm tucked to the body is unacceptable as a routine setup. The stability of the patient on the table is less crucial for lymphonodectomy than for hysterectomy, but as the two procedures are often combined and as the same routine positioning should apply to all laparoscopic procedures, the same rules should apply. As the patient needs to be placed in a Trendelenburg position for some time, it is essential to prevent cephalad slide (Fig. 51.1b, c). Consequently, we recommend the use of heavily padded, symmetrically placed shoulder pads (Fig. 51.1d, e). Legs should be in stirrups – the classic position for all gynecologic laparoscopy, allowing easy placement and management of the uterine manipulator. All exposed body parts, such as hands, fingers, elbows etc., need to be safely padded. Particular attention needs to be paid to possible changes of positioning during the surgery, when the patient is completely covered by sterile draping and can no longer been seen directly. Ideally, the patient setup is arranged by the trained scrub-nurse team and reviewed by the surgeon. Usually, the OR nurses are much



Fig. 51.1 (**a**) Positioning of the patient. Arms always tucked tightly – but well padded – parallel to the thorax. (**b**) Neutral positioning of the OR table. (**c**) "Head-down" >45° i.e. Trendelenburg position during surgery. (**d**) Shoulder padding to prevent positioning injuries. Side view. (**e**) Shoulder padding to prevent positioning injuries. View from *top*



Fig. 51.1 (Continued)

more competent with regard to positioning, but ultimate responsibility rests with the surgeon. Scrubbing the patient for laparoscopy should be no different than for any other patient, but the constant use of electrical energy makes "dry" scrubbing even more important: no amount of scrubbing liquid should run off the patient and moisten dorsal or gluteal parts that could serve as exit points for electrical currents. There are lots of different ways to drape a patient and only the general rules for draping should apply.

Proper Trocar Placement (Figs. 51.2 and 51.3)

As for all advanced laparoscopy, special rules apply to trocar placement. As laparoscopic surgeons are often used to suboptimal situations, they often do not realize the details that make their daily lives more difficult. The central trocar will be placed through the umbilicus after a small vertical incision at the bottom of the umbilical scar. Making this incision too big will lead to inward sliding of the optical trocar, making surgery miserable and more complicated. For all advanced laparoscopic surgery in the pelvis, the lateral trocars should be placed "high and lateral", almost at the level of the umbilicus (but never more than 1–2 cm below that transverse line), and far lateral, but never more medial than 3 cm medial of a sagittal line drawn through the anterior iliac spinal processus. There is less pain for the patient if the placement does not touch the rectal muscle. The working trocar should not be placed in the classic suprasymphysiary position as that inevitably means the surgeon will be working "towards" him

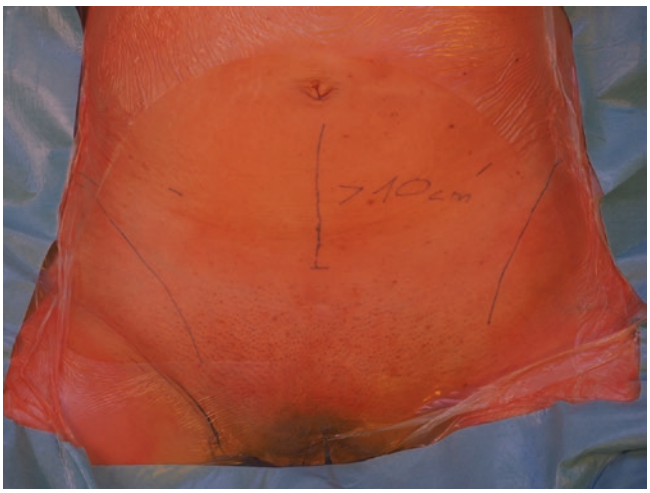


Fig. 51.2 Marking down the trocar positions. The middle, working trocar should be placed sufficiently away from the optical trocar to avoid interference, 10 cm is usually sufficient

or herself. It should be placed midway between the symphysis and the navel, taking care not to go too close to the optical trocar to avoid intraabdominal interference.

All available hands should be used. The first assistant or better the second surgeon should hold the camera and use the right lateral port to hold an atraumatic grasper and assist as the surgery demands. The surgeon should use both hands equally. The left lateral port for traumatic or atraumatic grasping and the medial trocar for cutting, dissection and thermocoagulation. For the surgeon to use the right and left lateral trocars creates unnecessary strain. This will work for

cysts, but even then it is awkward although many surgeons used to this approach do not notice this anymore. The use of electrical, harmonic and cutting force, i.e. the use of any potentially dangerous instrument, should be limited to the medial trocar placed between navel and symphysis. Of course, this recommendation needs to be applied reasonably as sometimes (but only rarely) the required angle for cutting will make lateral access better. Generally, however, the medial trocar is the safest access for all potentially dangerous instruments. Only here is the instrument observed in its entirety, irregularity in electrical currents can be immediately realized, and total control is guaranteed.

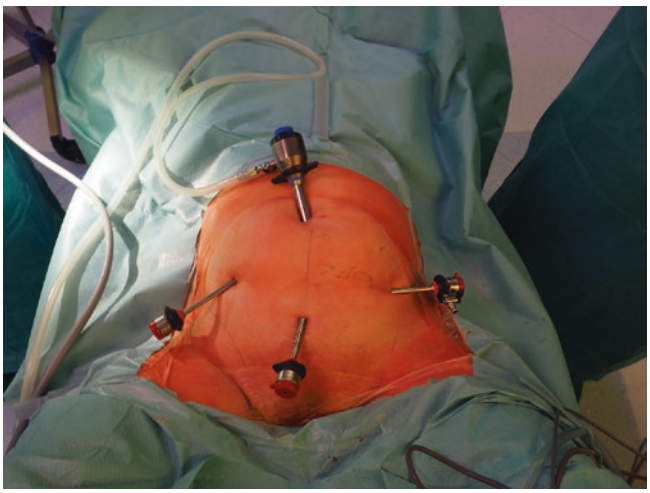


Fig. 51.3 Trocars placed

Very experienced surgeons will be able to use a coagulating grasper through the medial trocar and an electrified scissor through the lateral trocar, but the less experienced surgeon should be wary of such setups.

Having stated how the two authors place their trocars, it should be noted, that trocar placement is ultimately at the surgeon's discretion and will depend also on local traditions and simply on how the individual surgeon was taught. There is no and never will be any scientific evidence as to what is the best placement. An alternative would be the "Indian-Style" placement often seen in the United States, with the two main working trocars placed high and low on the left side of the patient's abdomen.

For removal of the (pelvic) lymph nodes, we recommend placement of a 10 mm trocar in the suprasymphysary position. This trocar will become necessary for placement of the camera during the retrograde approach for the paraaortic lymphonodectomy. An alternative in cases of hysterectomy is to take out the nodes through the opened vagina.

Optimal Positioning of the Surgical Team (Figs. 51.4 and 51.5)

"Optimal" is what works best, and that might very well vary for different surgeons and different teams. However, it is curious to observe how clearly inferior techniques remain long in use, simply because everyone has gotten used to them. Most laparoscopic surgeons were trained in the posi-

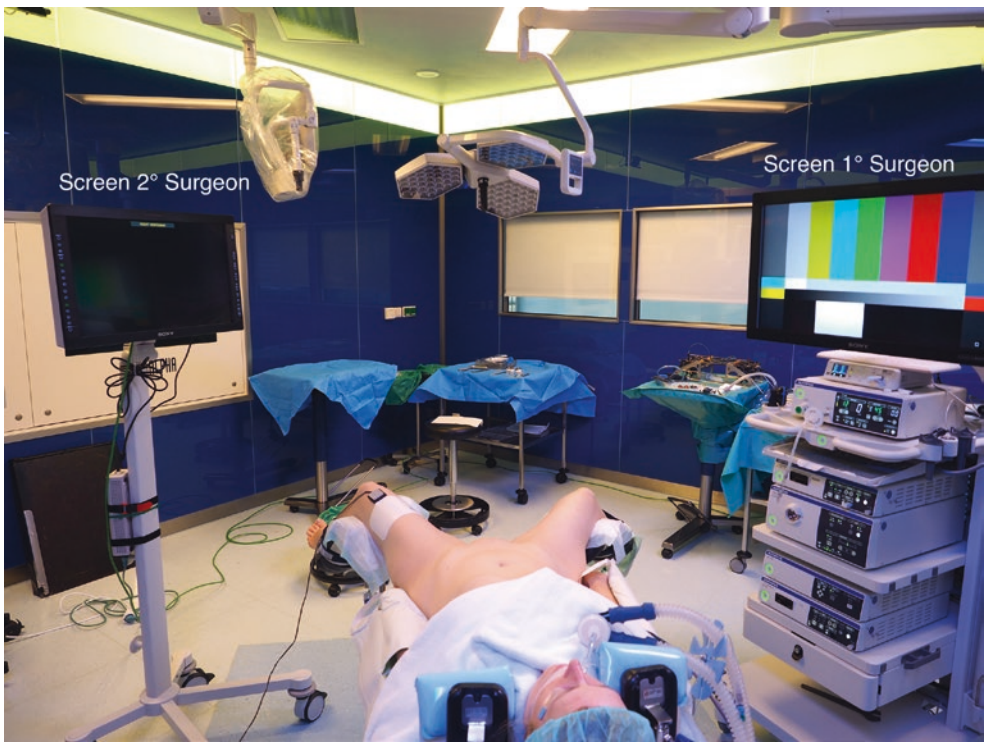


Fig. 51.4 Positioning of the monitors for the first and second surgeon



Fig. 51.5 Placement of the generator, insufflator

tion of the first assistant on the right side of the patient and as the responsible surgeon on the left side of the patient.

The second assistant if necessary should sit comfortably between the legs and follow the surgery on an extra monitor placed above the head of the surgeon. If there is a third assistant, ideally, anesthesia will allow for complete draping of the patient and the third assistant will be able to comfortably stand at the head of the patient and hold the camera with both hands. However, this way of draping sadly remains limited to a few centers with highly experienced anesthesia teams as superficially it limits access to the head of the patient although such access really remains immediate at all times by lifting up the drape.

Availability of Necessary Instruments and Video Equipment (Fig. 51.6)

The more complicated the surgery, the better the equipment needs to be. Both pelvic and paraaortic lymphonodectomy can be done using standard equipment: two atraumatic and two traumatic graspers, an Overholt-Clamp for dissection, a clamp for coagulation (curved clamp that can also be used for dissection such as the Kelly-clamp is to be preferred), regular scissors (keeping in mind that monopolar electricity should be used by experienced surgeons only) and suction-irrigation (to be used extremely judiciously and rarely. Particularly irrigation will inevitably make fine dissection more difficult). Any kind of advanced laparoscopy will be easier and speedier for the average laparoscopist if harmonic energy is available, such as Ethicon's Ultracision® or more recently Olympus' Thunderbeat®, the latter combining



Fig. 51.6 Used laparoscopic instruments for lymphadenectomy

harmonic and electric energy. With regard to optical instruments, we recommend the routine use of 30° optics, as they allow a better range of vision and a better evaluation, particularly of the field of vision in paraaortic lymphonodectomy, but both surgeries can also be done using zero degree optics. One monitor between the legs and one monitor above the head are the minimum setup required. Ideally, an integrated operating room is available. High resolution camera and video equipment should be available.

The availability of 3D vision systems will improve overall feasibility particularly of high-end laparoscopic procedures as an increasing body of literature continues to demonstrate.

Optimal Use of Surgical Instruments

Every surgeon will develop a highly individual approach to surgery. However, some principles should be considered: All laparoscopic surgery requires a much higher degree of

finesse than abdominal or vaginal surgery. Any kind of bleeding must be avoided during laparoscopy at any time and at all costs as bleeding will disturb the field of vision, obscure the anatomy, require dangerous coagulation, the more so the larger the bleeding. Also, bleeding will make the surgery less beautiful. What does "finesse" mean? The difference between good and bad laparoscopic surgery is the right balance between careful dissection, taking down the tissue sometimes millimeter by millimeter, never cutting were you cannot see, never cutting pedicles that are too thick. It means using the preformed anatomic spaces that can be opened without any sharp dissection at all. It means setting up the vascularized pedicles almost down to the actual artery and vein before sealing the vessels under direct view. It means using the peritoneum as a safe plane of preparation. But it also means doing these things swiftly and decisively to avoid stalling the surgery.

As in all surgery, it means finding the right balance between courage and caution, both based on skill and competence that only time and experience will teach.

Practical little tricks can be important: Try to avoid irrigation, as somehow the crispness of the un-irrigated surgical field will be irrevocably lost after one thorough rinsing. Use suction instead. Train your assistant to focus on proper camera management and sparing interference: "One person only moving" is a simple but important principle. Check the assistant at the uterine manipulator frequently. Uterine manipulation is in essence ureteral distancing and thus protects the single most vulnerable structure in your surgical field.

Technique of Laparoscopic Pelvic Lymphonodectomy

Ultimately, pelvic lymphonodectomy should lead to the representative removal of lymph nodes that reflect the lymphatic drainage of the uterus. This involves the lymphatic axis of the externa iliac vessels as well as the oburatoria fossa, the axis of the internal iliac vessels as well as the common iliac artery. Interestingly, literature looking at patterns of lymphatic spread along these different areas is practically non-existent.

While sentinel lymphonodectomy remains imperfect for endometrial cancer and not yet sufficiently standardized for cervical cancer, the extensive studies surrounding the identification of the pelvic sentinel node all point towards a node of fairly stable location at the bifurcation of common iliac artery to the external and internal iliac artery, towards the appearance of the obturator nerve when accessing the oburatoria fossa medially.

Equally unclear is the desired number of lymph nodes to be removed. Amazing differences exist between the written and unwritten standards of different countries.

We propose a standardized approach. What follows is first an outline of our approach, followed by a detailed explanation of the underlying rationale.

1. Normalization of anatomy – dissection of the ileocoecum cranially and resolution of the sigmoid adhesions in the pelvis
2. Opening of the pelvic sidewall by transecting the round ligament
3. Short extension of the peritoneal incision caudad and medial, towards the bladder
4. Long extension of the peritoneal incision in an arc transversing the external iliac vessels and opening the psoas space
5. Medialization of the infundibulopelvic ligament medially, exposing the ureter as it crosses the pelvic brim
6. Following and dissecting the ureter into the pelvis
7. Separation of the ureter and the internal iliac artery
8. Again moving to the anterior part of our dissection: Isolating the lateral umbilical ligament
9. Opening of the paravesical space
10. Opening of the Fossa obturatoria – Dissection of the obturator nerve
11. Complete lateralization of the axis internal iliac artery – Umbilical Artery/Lateral Umbilical ligament. Finding and dissecting this arterial axis is crucial because it will allow us to do the most important thing gynecologic surgeons do in the pelvic sidewall: Finding where the uterine artery branches off the internal iliac artery.
12. For beginners, managing the arterial axis often appears daunting; however, injuries to big arterial vessels are actually very rare. You really have to directly cut into or puncture these big muscular vessels. Blunt dissection on top of these arteries is easily possible. Of note: There are no significant structures leaving this arterial axis ventrally, laterally or even medially (until the branching of the uterine artery), so it can be used as a safe "preparation" street. In fact, the more vulnerable internal iliac vein lies "protected" behind the artery on both sides and will not be in danger until you have exposed more than half of the arterial circumference
13. Exposing the branching of the uterine artery off the internal iliac artery
14. Opening of the pararectal space
15. Start of the lymphonodectomy at the most distal part of the external iliac artery. Distal limit: Crossing of the circumflex vein. This vein does not need to be coagulated and it has no great significance. Because of the low intravenous pressure, it often appears as a flat, ligamentous structure crossing the artery. To us, it means: "far enough" with regard to the distal end of lymphonodectomy.
16. Avoid disturbing the lateral fatty tissue on the psoas muscle

17. Expose the external iliac artery and remove lymph nodes in a retrograde fashion, using a combination of blunt (80%) and sharp (20%) dissection
18. Try for en-bloc removal
19. At the distal end, expose the internal iliac vein
20. Find the pelvic bone directly "underneath", i.e. medial and dorsal of the internal iliac vein
21. Re-expose the obturator nerve
22. Start removal of the Fossa obturatory lymph nodes
23. Distance the external iliac vessels from the psoas muscle to expose the obturator fossa laterally
24. Use the obturator nerve as a guide to further remove the fossa obturatoria lymph nodes
25. Continue this dissection towards the internal iliac artery lymph nodes
26. Remove the bifurcation node (sentinel node)
27. Cut remaining attachments of the lymph nodes into the fossa obturatoria and to the lateral umbilical ligament
28. Expose branching of the internal iliac vein off the common iliac vein
29. Remove remaining and most proximal external iliac artery lymph nodes into the en-bloc resection tissue
30. Remove lymph nodes using an endobag if at all possible
31. Complete lymphonodectomy by removing the lymph node pads lateral to the common iliac artery (right side).

What follows is a more detailed explanation of the above mentioned step-by-step approach.

Normalization of anatomy – dissection of the ileocoecum cranially and resolution of the sigmoid adhesions in the pelvis (Fig. 51.7a–h)
Ultimately, dissection of the lymph nodes will require sufficient exposure laterally and cranially. If postoperative adhesions pulling the ileocaecum on the right side or the sigmoid colon on the left side towards the pelvis are not removed initially, it will have to be done later, when it tends to be more difficult as the planes are no longer as anatomically pristine.

Particularly the physiologic adhesions of the sigmoid colon towards the left pelvic sidewall are extremely varied. Taking them down requires a certain degree of practice. Opening of the retroperitoneum at this point needs to be avoided. The perfect dissection requires sharp scissors only. Excessive bleeding means the dissection plain is incorrect. Coagulation with electrocautery carries a high risk of thermal bowel injury.

Opening of the pelvic sidewall by transsecting the round ligament (Fig. 51.8a–f)
The classical step. The opening should be performed at the most lateral position. Normally, there are no vessels associated with the round ligament, even though in the English literature, a variable so-called "Sim's artery" is frequently mentioned. Using laparoscopy means the opening of the retroperitoneum allows immediate CO_2 access, leading to distention of this artificial space.

Short extension of the peritoneal incision caudad and medial, towards the bladder (Fig. 51.9a–d)
It is tempting to go further towards the bladder, particularly if a hysterectomy is part of the surgery; however, there is always a danger to run into bleeding or even to injure the bladder.

Long extension of the peritoneal incision in an arc transversing the external iliac vessels and opening the psoas space (Fig. 51.10a–c)
This is the key step at the start of the surgery. Limiting the incision to the peritoneal layer makes this move very safe. The psoas space is one of the "safe" areas. The only danger exists while crossing the external iliac vessels, which theoretically could be injured. Once the psoas space is reached, the incision now bends cranially, going up as far cephalad as possible. At this point, a previous meticulous dissection and removal of the ileocoecum on the right side and the sigmoid colon on the left side becomes crucial. Each further centimeter cephalad helps with the next step: mobilization of the infundibulopelvic ligament medially.

Medialization of the infundibulopelvic ligament medially, exposing the ureter as it crosses the pelvic brim (Fig. 51.11)
This step exposes the ureter. Dissecting the infundibulopelvic ligament always needs to be done with extreme caution. Aside from tearing the ovarian vein (which requires some force…) there are numerous smaller vessels that can tear and cause unnecessary bleeding. This step needs to be done more than once, bluntly, to carefully expose the ureter. This is easier on the right side (no sigmoid).

Following and dissecting the ureter into the pelvis (Fig. 51.12)
This can be either very easy (no previous surgery, no adhesions) or very difficult, when the tissue does not yield easily. Small peritoneal bleeders can be annoying and obscure. Ideally, the ureter is followed caudad easily, leading to the internal iliac artery as it stays close to the pelvic sidewall, while the ureter runs more medial towards the peritoneum of the Douglas space. There are slight differences with regard to the position of the ureter, but they are curiously difficult to describe. On the right side, the ureter sits more "on top" and medial of the internal iliac artery, while on the left side, it runs more laterally to the artery even at the pelvic brim.

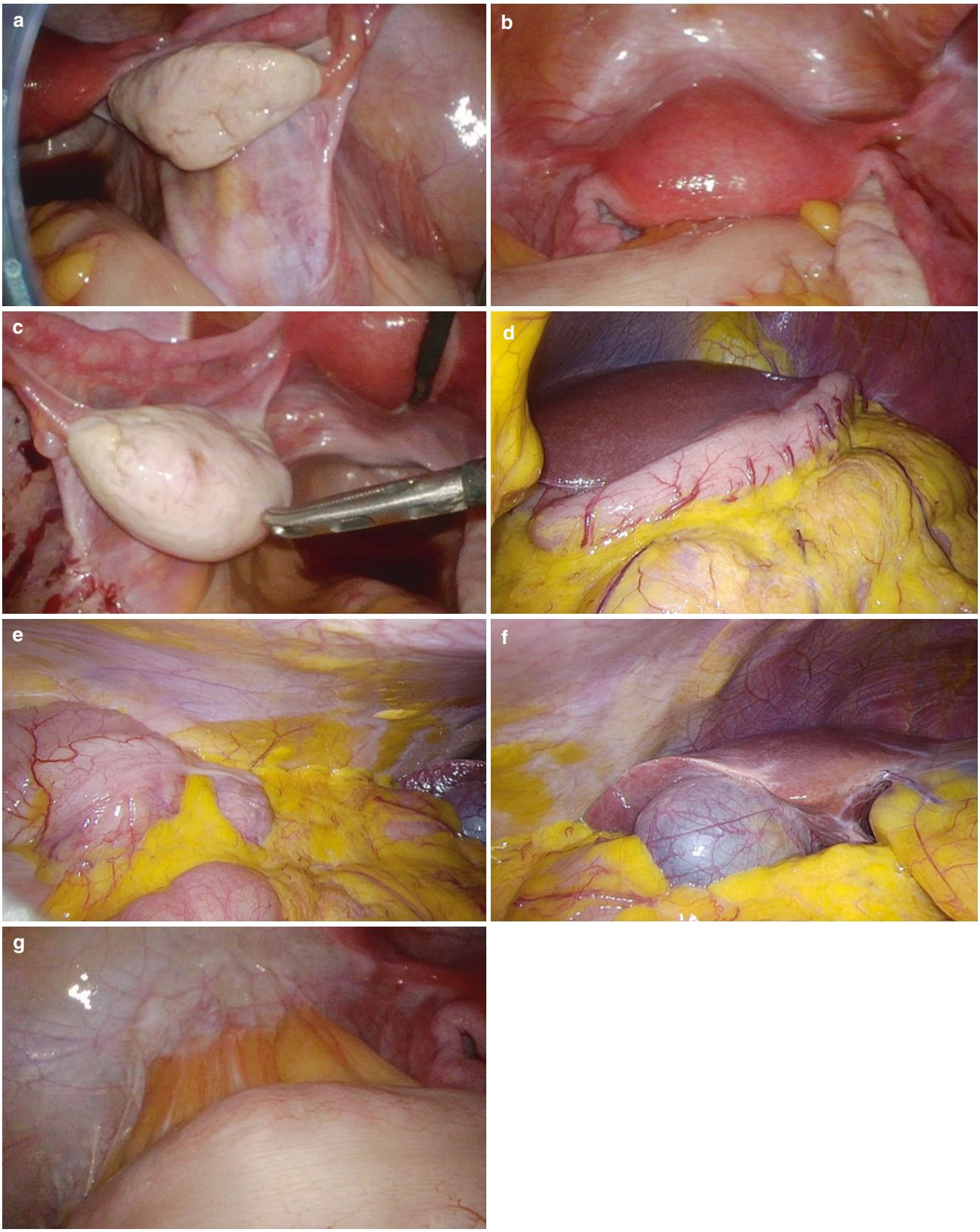


Fig. 51.7 (**a**) Inspection of the pelvis after Trendelenburg positioning. Right adnex. (**b**) Inspection of the pelvis after Trendelenburg positioning. Midline view. Uterus. (**c**) Inspection of the pelvis after Trendelenburg positioning. Left adnex. (**d**) Inspection of the abdominal cavity. Left upper abdomen with liver and stomach. (**e**) Inspection of the abdominal cavity. Right middle abdomen. Coecum. (**f**) Inspection of the abdominal cavity. Right upper abdomen. Liver and gall bladder. (**g**) Inspection of the abdominal cavity. Left middler abdomen. Sigma adhesions to the pelvic side wall

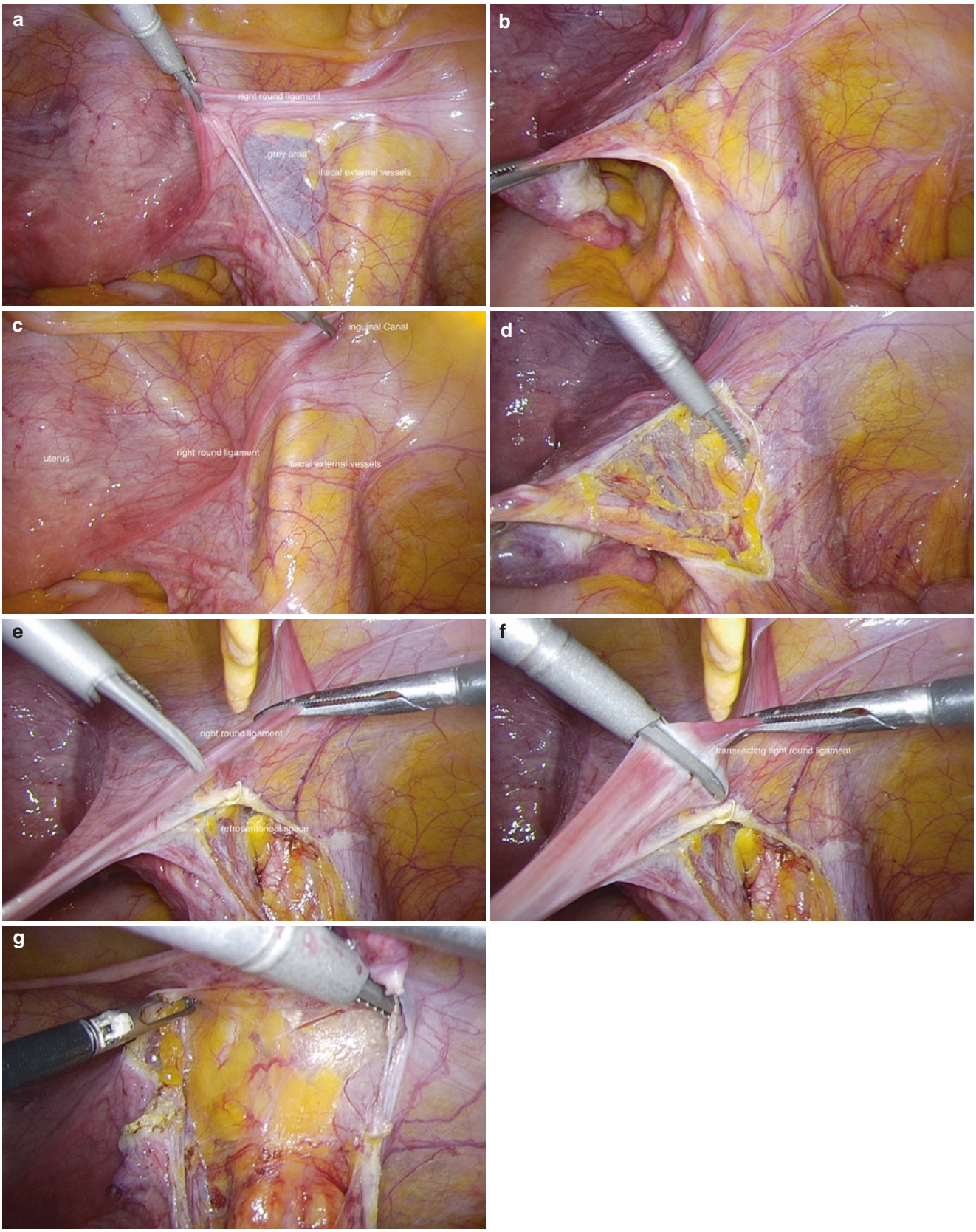


Fig. 51.8 (**a**) Start of the pelvic lymphonodectomy on the right side, exposing the round ligament. (**b**) Identification of the right illiac vessels and psoas muscle. Grasping the right infundibulopelvic ligament. (**c**) Idendification of the right illiac vessels and psoas muscle. (**d**) Incision of the peritoneum above the psoas muscle. (**e**) Tension to the round ligament. (**f**) Transsection of the round ligament. (**g**) Opening of the retroperitoneal space

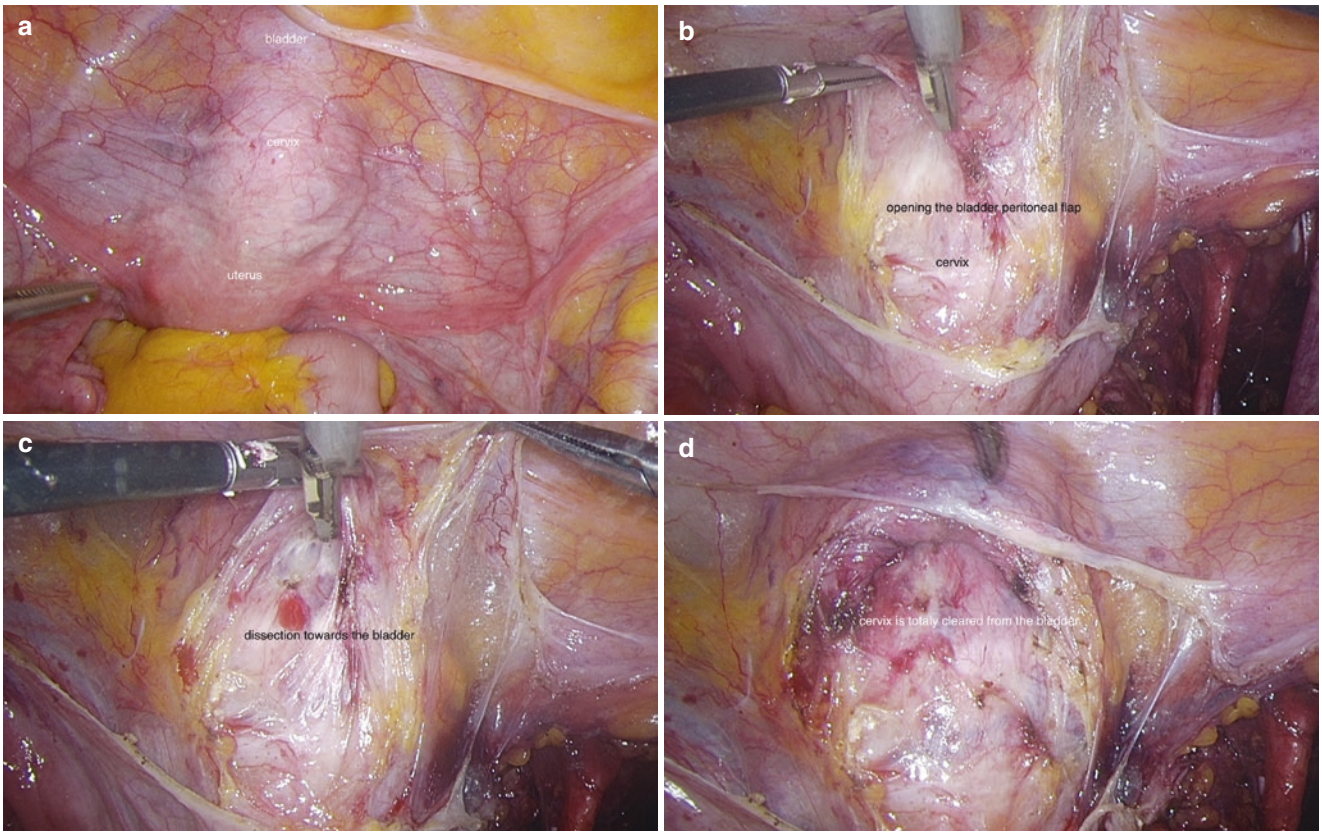


Fig. 51.9 (**a**) Identification of the bladder edge. (**b**) Opening of the bladder peritoneum. (**c**) Downward preparation of the drained bladder. (**d**) Exposing the vesicovaginal fascia

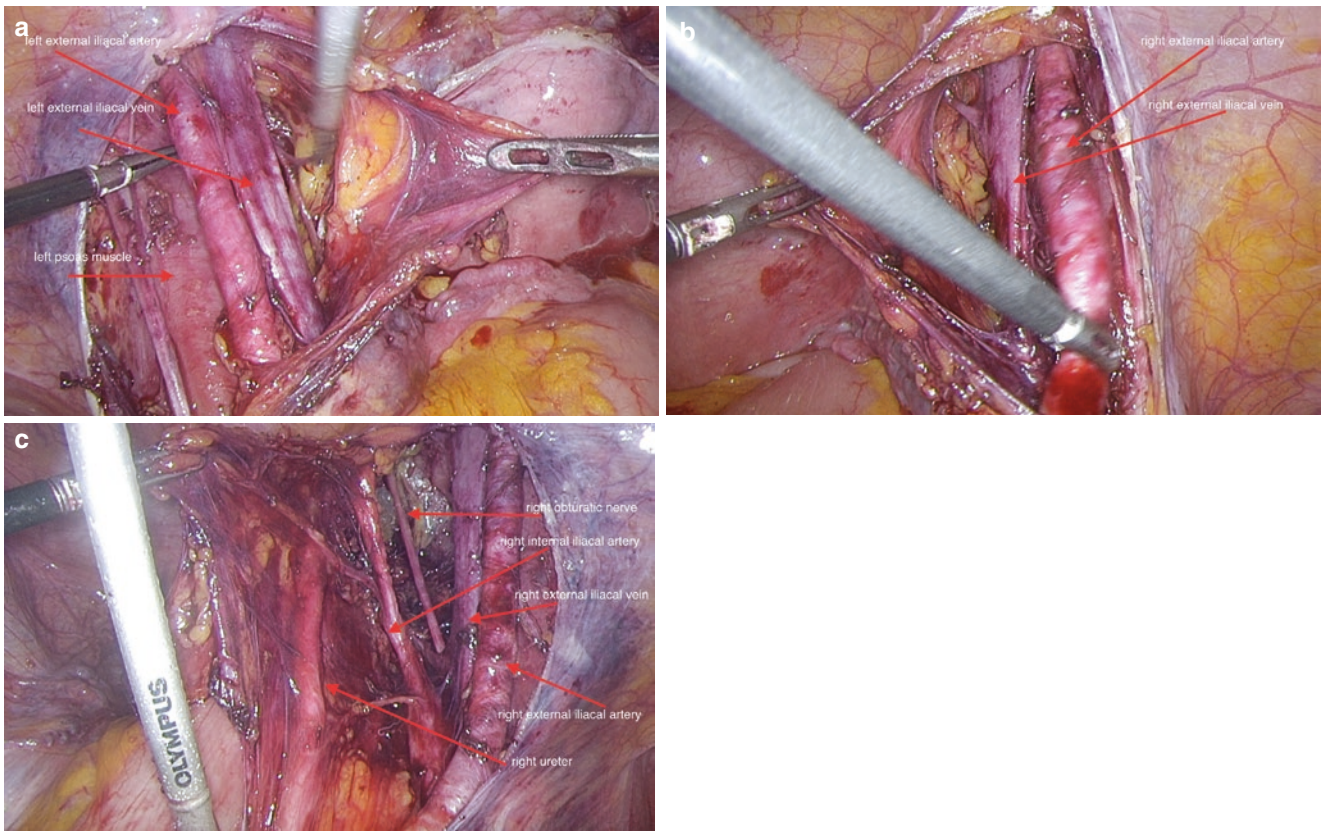


Fig. 51.10 (**a**) Pelvic lymphonodectomy on the left side. Exposition of the external illiac vessels and the psoas muscle. Opening of the obturator fossa. (**b**) Pelvic lymphonodectomy on the right side. Exposition of the external illiac vessels and the psoas muscle. (**c**) Opening of the obturator fossa

If this step is overly difficult, attention can be given to the anterior aspect of the dissection, first.

Separation of the ureter and the internal iliac artery
As already mentioned above, this leads the way to the branching of the uterine artery. At the same time, it prepares access to the pararectal space (opening necessary only when a radical hysterectomy is planned).

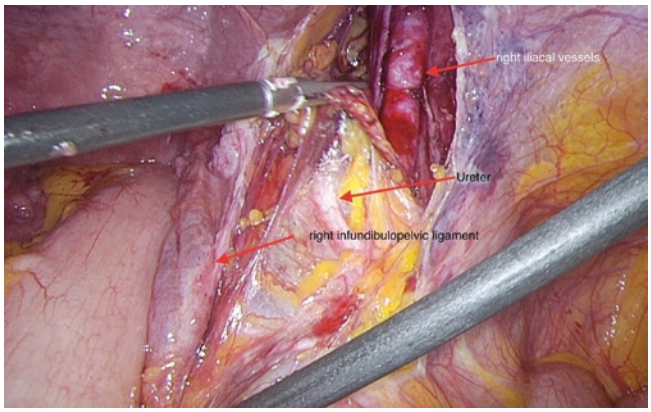


Fig. 51.11 Visualization of the ureter at the level of the right illiac artery bifurcation

Again moving to the anterior part of our dissection: Isolating the lateral umbilical ligament
This step can be performed at any time. Generally, the most important rule of "rules for dissection" is: every operative procedure is different. There is no point in persevering at a particularly difficult part, when other areas can be dealt with more easily. Often, magically, when returning to the difficult area, the anatomy has become kinder and the surgical procedure can move forward, where it was very difficult previously.

No matter how difficult the anatomy or how obese the patient, the lateral umbilical ligament can usually be found on the anterior abdominal wall and followed in a retrograde fashion cephalad, allowing for orientation in the most desperate pelvis.

Opening of the paravesical space (Fig. 51.13)
The paravesical space, immediately medial to the lateral umbilical ligament is the most accessible space of the pelvis. It should be dissected bluntly. The dissection can be carried down almost to the pelvic floor – where unnecessary bleeding awaits, so the last centimeter remains unnecessary and should be avoided. In thin patients, dissecting the paravesical space can sometimes lead to the obturator nerve laterally and the ureter posteriorly.

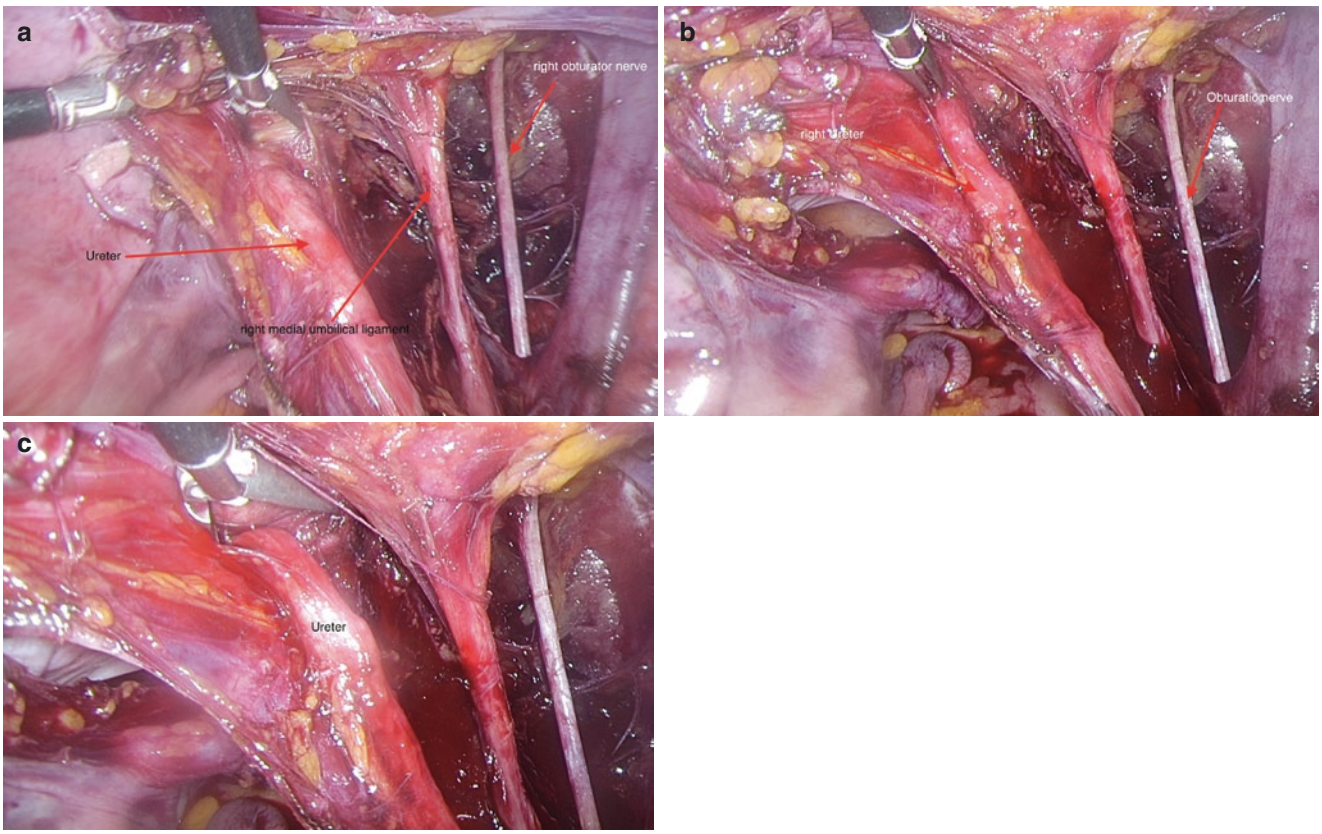


Fig. 51.12 (**a**) Dissection of the right ureter until it is crossed by the uterine artery. (**b**) Visualisation of the right obturator nerve. (**c**) Dissection of the crossing of ureter and uterine atrtery

Opening of the Fossa obturatoria – Dissection of the obturator nerve

Medial of the lateral umbilical ligament (containing the obliterated umbilical artery), the obturator fossa can be accessed. This sometimes requires some sharp dissection as the lateral umbilical ligament can be very lateral, almost attached to the adjacent structures, i.e. the external iliac vein. Because of this, the safe opening of this space should proceed directly lateral of the lateral umbilical ligament, as far away from the pelvic sidewall as possible. The "bottom" of the obturator fossa is the obturator nerve, which needs to be freed from surrounding fatty and lymphatic tissue over some distance to be truly visible during the rest of the surgery. The obturator nerve needs to be frequently checked for its location. It follows the old ureteral rule: "Now you see it, now you don't" and can be easily damaged with electrocautery, thermal energy or by sharp transection. The obturator nerve is the largest nerval structure normally dissected in the pelvis. It is accompanied by the obturator vessels, which rarely need to be coagulated, but can lead to unnecessary and annoying bleeding if not respected. The obturator vein often branches off the *external* iliac vein, in which case coagulation is advised to facilitate lymphonodectomy.

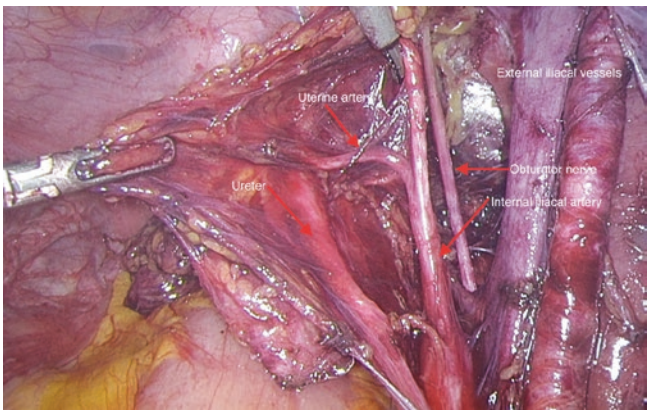


Fig. 51.13 Final view. Preparation and visualization of the crossing of the uterine artery and the ureter

Complete lateralization of the axis internal iliac artery – Umbilical Artery/Lateral Umbilical ligament (Fig. 51.14a)

After a successful approach from caudad and cephalad, this axis often remains attached to the pelvic sidewall. However, other than small peritoneal vessels, there remain no important vessels or other structures so that sharp dissection should carry the most dorsal part of the surgical field down to this vessel axis.

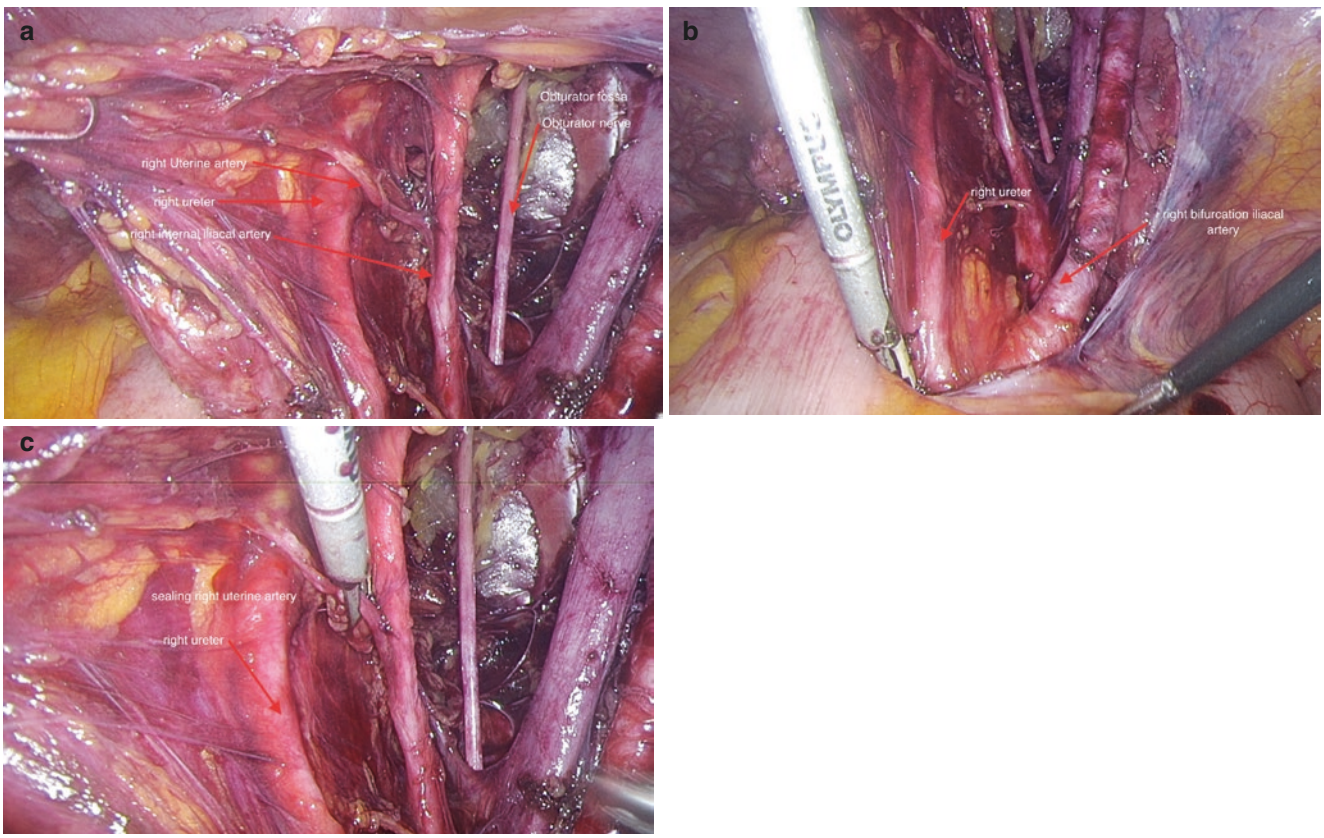


Fig. 51.14 (**a**) Preparation/dissection of the paravesical space. (**b**) Preparation/dissection of the pararectal space. (**c**) Coagulation of the uterine artery at its origin from the internal illiac artery (*right side*)

Exposing the branching of the uterine artery off the internal iliac artery (Fig. 51.14b)
Finding the uterine artery where it branches off (in an almost 90° angle) from the internal iliac artery remains the most critical skill to be mastered by the gynecologic surgeon. It is essential for radical hysterectomy, but extremely helpful in many challenging situations of benign gynecologic surgery. Essentially, it requires a sufficient dissection of the paravesical and the pararectal spaces which are separated by the uterine artery.

Opening the pararectal space (Fig. 51.14c)
Opening the pararectal space is not strictly necessary for pelvic lymphonodectomy, as is the isolation of the uterine artery. It would be necessary as part of the setup for a radical hysterectomy.

Start of the lymphonodectomy at the most distal part of the internal iliac artery (Fig. 51.15a)
Once all the relevant structures have ben delineated and all the spaces opened, lymphonodectomy can safely begin. Grasping of the lymph nodes is usually possible with atraumatic graspers. Lymph nodes tend to bleed, so caution is required. The guiding structure for this first part of the dissection is the external iliac artery.

Distal limit: Crossing of the circumflex vein (Fig. 51.15b)
Care should be take not to go too far into the inguinal canal. Exposing this vein, crossing the external iliac artery is sufficient for the distal limit of dissection.

Avoid disturbing the lateral fatty tissue on the psoas muscle (Fig. 51.16a–e)
Many surgeons believe that the all too easy removal of this lymph node-free fad-pad leads to an increased incidence of lymphoceles/lymph cysts. It certainly does not add to the lymph node count.

Expose the external iliac artery and remove lymph nodes in a retrograde fashion, using a combination of blunt (80 %) and sharp (20 %) dissection
The external iliac artery needs to be exposed and protected. However, it is a sturdy structure and lymph nodes can be "pulled" off the artery in a blunt fashion – as is done in open cases routinely.

Try for en-bloc removal
Particularly on the right side, en-bloc-removal is possible, making later removal from the abdominal cavity easier. However, it is not a goal in itself.

At the distal end, expose the internal iliac vein
After removing the lymph nodes overlying the external iliac artery, the move is medially, down on the very thin and often "empty" (because of the patient's Trendelenburg position) external iliac vein.

The key is to define the "lower" edge of the vein, to make sure that the paper-thin vessel is not accidently injured. The danger is that an injured but "empty" external iliac vein might not immediately bleed.

Find the pelvic bone directly "underneath", i.e. medial and dorsal of the internal iliac vein (Fig. 51.17)
This bony part of the pelvis is a key part of the dissection. It allows safe access to the lateral limits of the obturator space (obturator muscle) and further allows for the safe isolation of the obturator nerve.

Because the obturator lymphatic fat-pad can be easily dissected off the smooth bone, it is also a good starting point for the lymph node resection

Re-expose the obturator nerve
As mentioned above: Again and again, the obturator nerve needs to be visualized. However, this distal part is not the

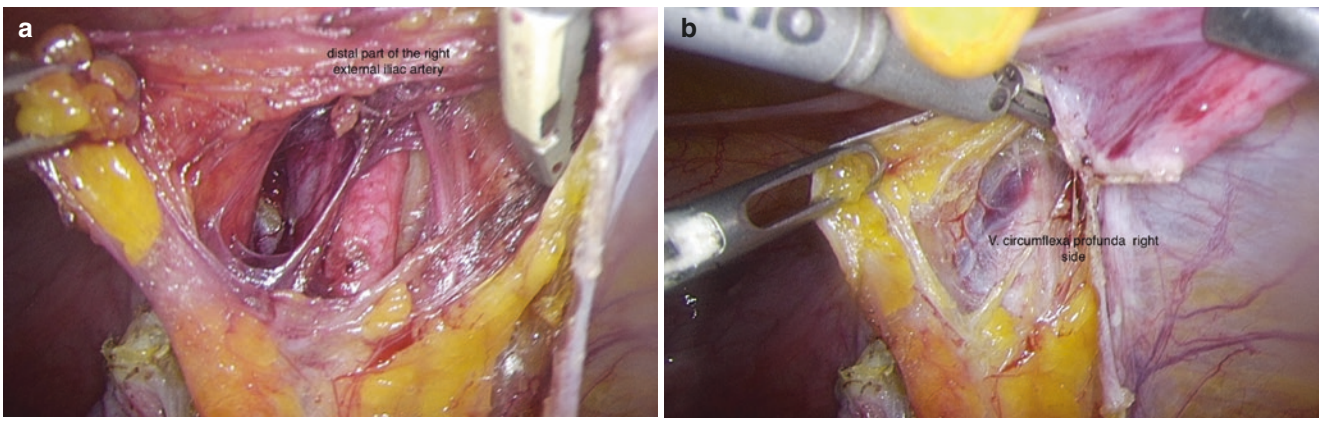


Fig. 51.15 (**a**) Distal limitation of the pelvic lymphonodectomy. Visualization of the distal part of the right external iliac artery. (**b**) Distal limitation of the pelvic lymphonodectomy. Visualization of the V. circumflexa profunda just cranial of the inguinal ligament

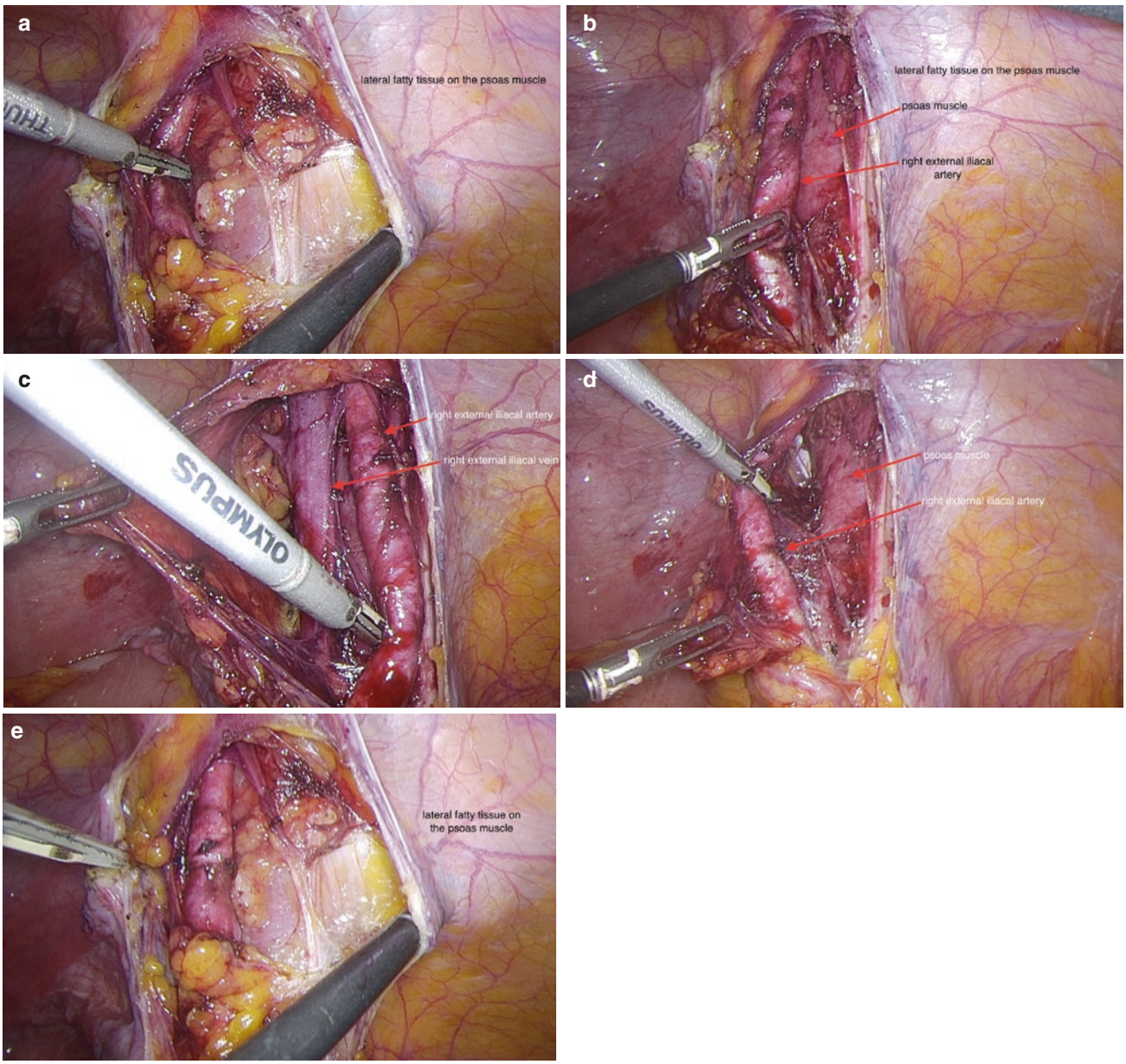


Fig. 51.16 (**a**) The lateral limits of the pelvic lymphonodectomy: psoas muscle and lateral adipose tissue which should not be removed. (**b**) The external illiac vessels are medialized bluntly away from the psoas muscle to allow optimal access to all lymphatic tissue. (**c**) Dissection of the right exteranl artery and vein. (**d**) "Lateral" access to the oburator fossa between psoas muscle and external vessels. (**e**) The lateral border of the lymphonodectomy: psoas muscle

part most likely to be injured. Injuries usually occur right where it appears underneath the external iliac vein into the obturator fossa.

Start removal of the fossa obturatory lymph nodes

(Fig. 51.18a–d)

With the external iliac vein safely away and the obturator nerve visualized, lymphonodectomy starts sharply, coagulating and cutting the incoming lymphatic vessels and then removing the lymph node tissue mostly bluntly. Aberrant obturator veins, branching of the external iliac vein need to be watched carefully and usually must be coagulated and transected.

Distance the external iliac vessels from the psoas muscle to expose the obturator fossa laterally

For the laparoscopist, this move does not add much and does not need to be performed at all costs. It allows for slightly better control if bleeding from the obturator muscle perforators occurs. A lot of traditional open surgeons, however, strongly believe that this is an essential part of the pelvic lymphonodectomy,

claiming that the lymph nodes just above the sacral nerves in the area are a common site of recurrence, particularly of cervical cancer, a claim never corroborated by solid evidence nor by the experience of the authors of this chapter.

Also, recent understanding about the lymphatic drainage of the uterus and cervix point to a common sentinel node at a completely different location.

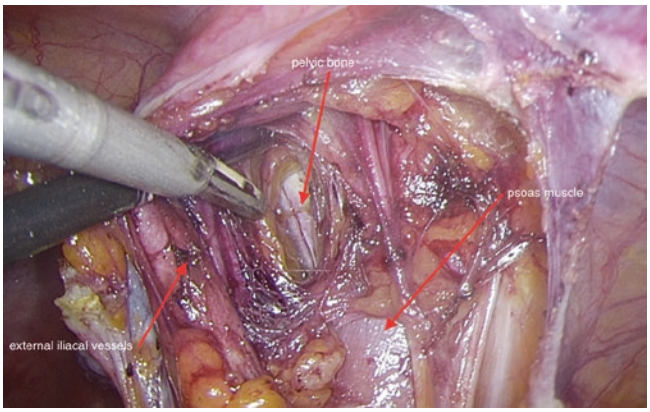


Fig. 51.17 The dorsal limit of the pelvic lymphonodectomy. Vizualisation of the pelvic bones

Still, it is a nice and fairly easy technique to master. Sometime, when all else fails, it might be the only way to find the obturator nerve.

Use the obturator nerve as a guide to further remove the fossa obturatoria lymph nodes

The nerve is a fairly strong structure as far as mechanical force is concerned. Overlying attachments, however, need to be carefully dissected, taking care not to injure the nerve thermally.

Continue this dissection towards the internal iliac artery lymph nodes (Fig. 51.19)

This lymph node, incidentally, is the sentinel node for both endometrial and cervical cancer, making sentinel lymphonodectomy in the area somewhat more tricky than in vulva and breast cancer.

Remove the bifurcation node (sentinel node) (Fig. 51.20a–c)

At this area, the obturator nerve is at its most vulnerable. It is the critical triangle, with strong lymphatic attachments, rich

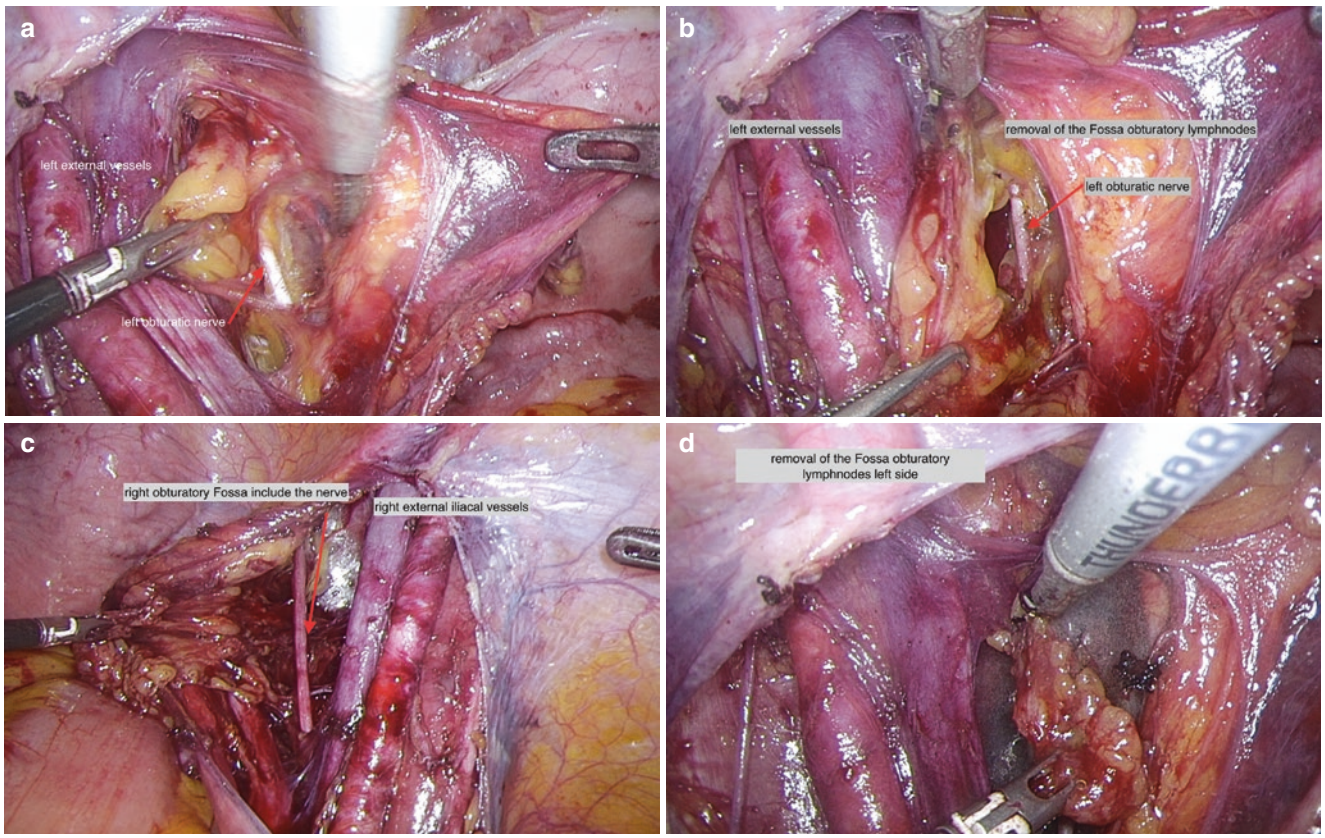


Fig. 51.18 (**a**) Opening of the obturator fossa and identification of the oburator nerve. (**b**) Dissection of the oburator nerve (*left side*). (c) Opening of the obturator fossa and identification of the oburator nerve. Dissection of the oburator nerve (*right side*). (**d**) The "lower" edge of the iliac vein needs to be well exposed before the lymph nodes are removed

microvasculature and numerous dangerous structures underneath or directly lateral (obturator nerve, internal iliac vein).

Cut remaining attachments of the lymph nodes into the fossa obturatoria and to the lateral umbilical ligament
With great caution and care. At this point, tendency is to pull the lymph node package medially, to make these attachments more visible. This, however, dangerously distorts the course of the obturator nerve which must be kept in mind.

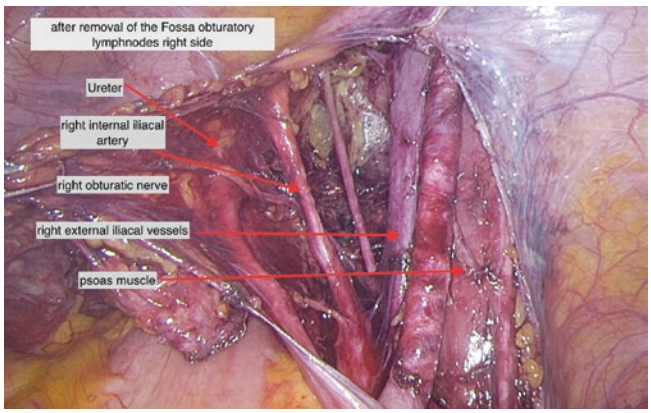


Fig. 51.19 Final view after completed right pelvic lymphonodectomy

Expose branching of the internal iliac vein off the common iliac vein
This is a quality step of the lymph node dissection. If you can actually see this branching, you have certainly done a thorough resection of the most relevant lymph nodes.

Remove remaining and most proximal external iliac artery lymph nodes into the en-bloc resection tissue
Here, the lymphatic chain continuing towards the common iliac artery must be cut at some point.

Remove lymph nodes using an endobag if at all possible (Fig. 51.21)
Other than being aesthetically more satisfying, it also keeps your suprasymphysary 10 mm trocar clean which will be important for the camera positioned there during the paraaortic lymph node dissection.

Complete lymphonodectomy by removing the lymph node pads lateral to the common iliac artery (right side)
Lymph node tissue in this area is usually somewhat flat and patchy. Some bleeding is common.

On the right side, at some point, the posterior limit becomes the inferior vena cava which is not to be injured inadvertently.

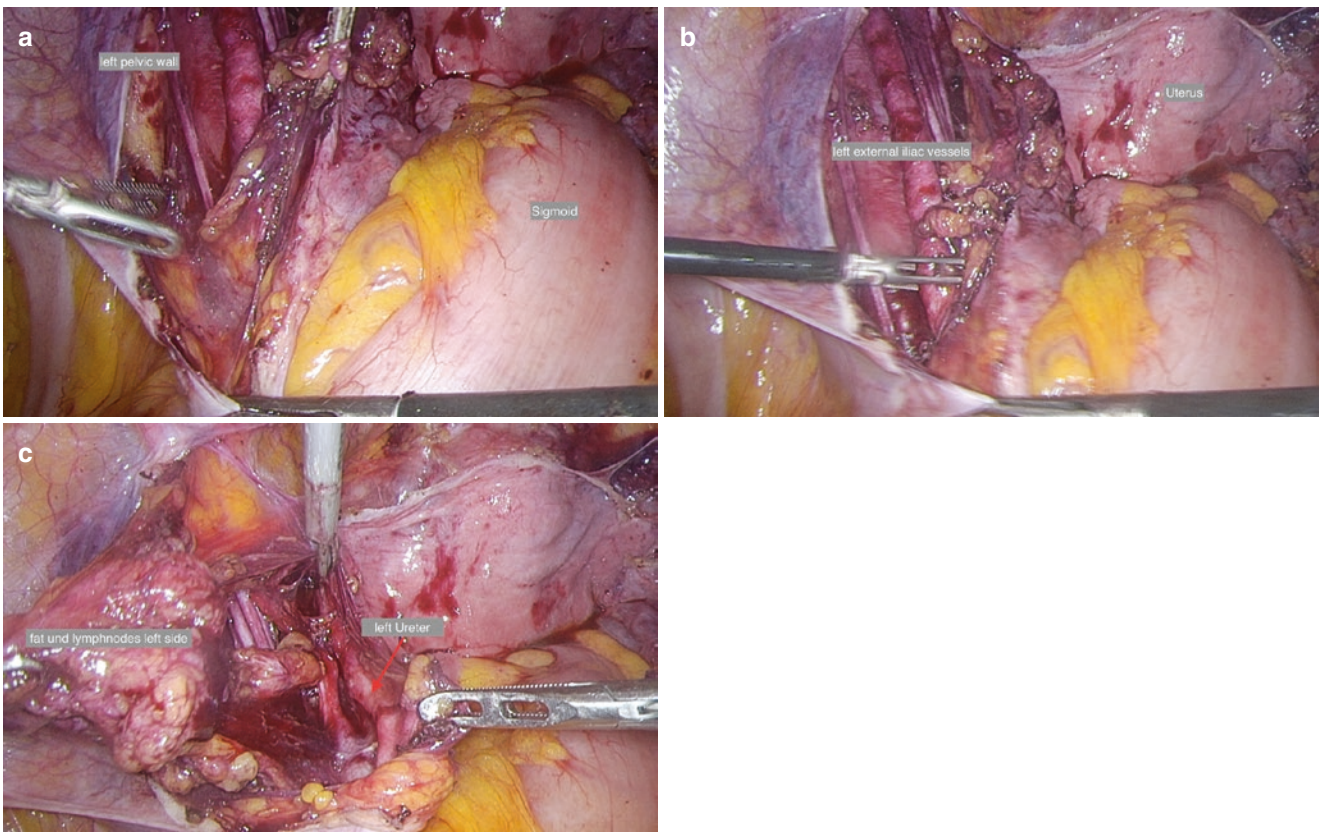


Fig. 51.20 (**a**–**c**) Identification of the left illiac vessels. (**b**) Identification of the ureter. (**c**) Removal of lymph nodes

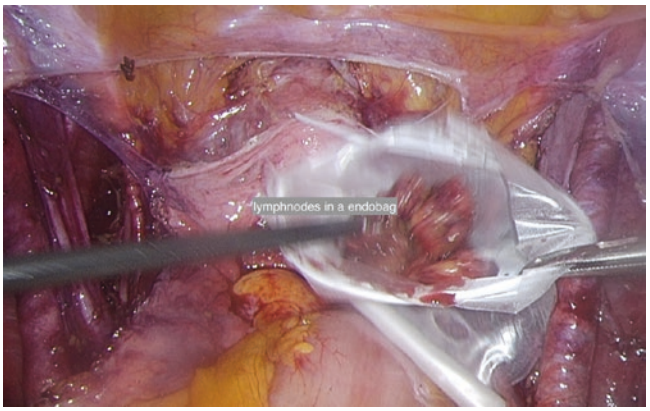


Fig. 51.21 The freed lymphatic tissue is removed separately using endobags

Technique of Laparoscopic Paraaortic Lymphonodectomy

1. Positioning. Retrograde laparoscopy. Camera in the additional suprasymphysary 10 mm port. Second assistant between the legs holding camera only. Surgeon on the patient's right side looking cephalad, First assistant on the patient's left side looking cephalad.
2. Exposing the pelvic brim – starting point is the common right iliac artery.
3. Moving the rectosigmoid to the left side of the abdominal wall and moving the small intestine towards the right side of the abdominal wall. Adjusting Trendelenburg position as needed.
4. Lifting up the peritoneal covering just above the right common iliac artery creates an opening into the retroperitoneal space.
5. Using the arterial trunk, the peritoneal incision is extended upward towards the ligament of Treitz, avoiding all vulnerable structures.
6. In essence, the preparation is about opening the peritoneal tent needed for the surgery.
7. The tent needs to be extended towards the patient's right side, where the ureter needs to be identified separately from the right ovarian vein
8. The right ureter needs to be distanced, exposing the psoas space directly to the right of the vena cava inferior.
9. Delineating the right edge of the vena cava, care must be taken to identify the branching of the ovarian vein – if necessary, the vein needs to be coagulated.
10. Similarly, the crossing of the small right ovarian artery needs to be identified, either to be respected or to be carefully coagulated and transected.
11. After securing the "right side" of the tent, the left side needs to be defined.
12. First, the branching of the interior mesenteric artery needs to be found. It is fairly constant midway between the aortic bifurcation and the crossing of the left renal vein and comes off slightly to the left side of the aorta.
13. Finding the crossing of the left renal vein is challenging. Dissection cannot be sharp: cutting into the lower edge of the left renal vein is a catastrophe that must not happen.
14. About 2 cm towards the left off the aorta, the left ovarian vein starts to descend from the left renal vein. This corner is the most difficult part of the paraaortic lymphonodectomy
15. The tent is now sufficiently defined.
16. Lymphonodectomy can be performed either from cranial to caudal or from caudal to cranial. The decision how to proceed is often situational and depends on the individual anatomy. Distal dissection tends to be more difficult and more dangerous and maybe therefore should be the first step.
17. Preparation on the aorta is unproblematic; dissecting off the vena cava needs to be slow and meticulous. Even pulling on the lymphatic tissue can lead to perforator veins tearing off the vena cave and possible cava bleeders.
18. Cava bleeders need to be closed with pressure immediately. About 90% of them can be stopped by applying sufficient pressure for at least 5 min. What still bleeds after prolonged pressure needs to be sutured with a 4-0 or 5-0 monofilament suture.
19. En-bloc lymphonodectomy down the paracaval and paraaortic spaces is challenging. We recommend a step-by-step approach that takes place in different spaces:
20. Paraaortic area cranial to inferior mesenteric artery (including the difficult angle between the left renal and left ovarian vein).
21. Paraaortic area inferior to the inferior mesenteric artery (careful, the ureter is very close towards the left lateral edge of the preparation and can be easily injured). Visualization of the left ureter remains one of the great challenges. Patient and mostly blunt dissection will eventually allow us to see this important structure. It is deeply imbedded in adipose tissue on the left and does not yield easily to blunt dissection, but sharp dissection is dangerous in this region.
22. Paracaval region, upper half – attention to crossing of the right ovarian artery, branching of the right ovarian vein.
23. Paracaval region, lower half – attention to the perforator veins which are increasing in frequency towards the caudad region.
24. Interaorto-caval region – careful not to injure the lumbar veins going off in a dorsal and downward manner.
25. Paracaval region towards the right side of cava – psoas space. Careful not to injure the right ureter.
26. The key to paraaortic lymphonodectomy is to avoid major bleeding, as it will often require laparotomy.

27. Lymph node tissue is often smaller and can be removed through the umbilical 10 mm trocar.

What follows is a more detailed explanation of the above mentioned step-by-step approach.

Positioning. Retrograde laparoscopy. Camera in the additional suprasymphysary 10 mm port. Second assistant between the legs holding camera only. Surgeon on the patient's right side looking cephalad, First assistant on the patients left side looking cephalad (Fig. 51.22).

These are recommendations only, of course. Each surgeon needs to find out his or her best approach. Some surgeons might want to stand between the legs. However, we strongly encourage our readers to try our approach.

Exposing the pelvic brim – starting point is the common right iliac artery (Fig. 51.23a, b)
This is a test also for the feasibility of this very challenging surgery. If the common right iliac artery cannot be dissected, the surgery might not be possible.



Fig. 51.22 Positioning of the surgeon. Surgeon on the patient's right side looking cephalad, First assistant on the patient's left side looking cephalad

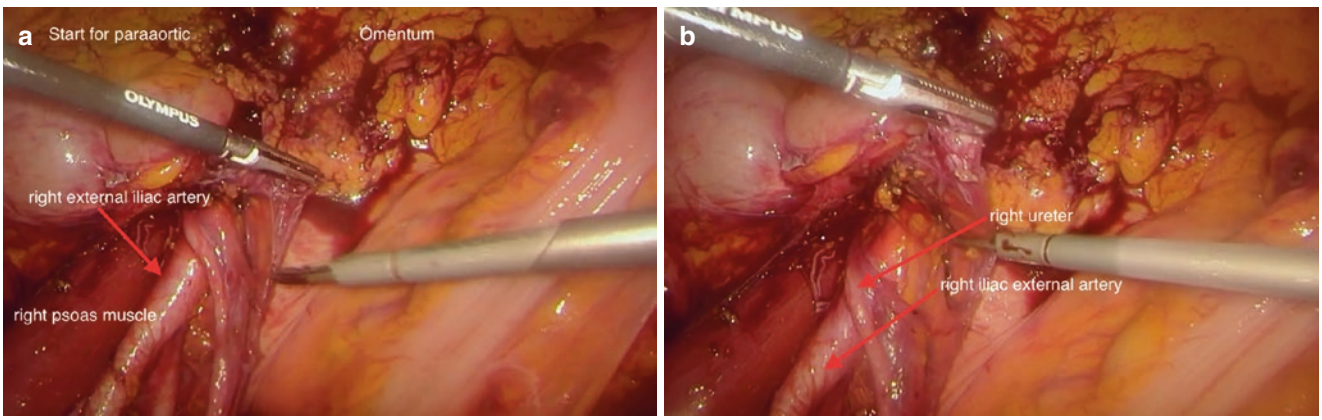


Fig. 51.23 (**a**) The bifurcation of the right common illiac artery is a good starting point for the paraaortic lymphonodectomy. (**b**) Always identify the ureter at this point

Moving the rectosigmoid to the left side of the abdominal wall and moving the small intestine towards the right side of the abdominal wall. Adjusting Trendelenburg position as needed (Fig. 51.24a, b)
At this point, we should discuss the order of the surgery. Oncologically speaking, it is nice to know, if the pelvic lymph nodes are affected. In cervical cancer this might be the reason for performing a paraaortic lymph node dissection. However, given the fact that the paraaortic dissection is the most challenging part of the surgery, with the highest conversion rate (though still very low in the hands of a skilled surgeon), one might consider starting out with this part of the surgery. The advantage is that if the surgeon starts with the paraaortic dissection, the attachments of the sigmoid colon to the left pelvic sidewall have not yet been taken down, helping in the lateralization.

Lifting up the peritoneal covering just above the right common iliac artery creates an opening into the retroperitoneal space
Most laparoscopic oncologic surgery can be done with almost any level of skill on the part of the first assistant. However, paraaortic dissection is different. The presence of at least a minimally skilled assistant is essential.

Using the arterial trunk, the peritoneal incision is extended upward towards the ligament of Treitz, avoiding all vulnerable structures
Again, these first steps are crucial. The oncologic context of the lymphonodectomy needs to be understood. If these first steps are not possible because of bowel obliteration of the field or because of extreme obesity, another, if necessary laparotomic approach must have been discussed with the patient. For this reason, too, the feasibility of the laparaoscopic approach must be established at the beginning of the procedure, just as it needs to be ascertained whether the uterus can be removed vaginally.

In essence, the preparation is about opening the peritoneal tent needed for the surgery (Fig. 51.25a–c)
The laparoscopic paraaortic dissection follows a two-tiered approach: first go upward to create the tent, then go upward to start the lymphonodectomy on the aorta.

The tent needs to be extended towards the patient's right side, where the ureter needs to be identified separately from the right ovarian vein
The difficulties on the right side are always the same: What is the ureter and what is the vein? They look surprisingly similar and waiting for the ureter can be time-consuming. Still, one has to be certain. Sometimes, just extending the dissection on the lateral edge of the vena cava more cranially will solve the problem.

The right ureter needs to be distanced, exposing the psoas space directly to the right of the vena cava inferior (Fig. 51.26a, b)
This space is easily opened and – one more time – the psoas space (this one much more cranial than the first one described during pelvic lymphonodectomy) offers safety.

Delineating the right edge of the vena cava, care must be taken to identify the branching of the ovarian vein – if necessary, the vein needs to be coagulated (Fig. 51.27)
Not coagulating the vein increases the risk of tearing it off, sometimes directly where it comes out of the vena cava, creating a hole that cannot be closed by pressure only.

Similarly, the crossing of the small right ovarian artery needs to be identified, either to be respected or to be carefully coagulated and transected
The ovarian arteries are quite small, but they bleed considerably. Sometimes their coagulation is not even noticed but the lack of coagulation is always apparent on transection. Their identification is not always possible, but they are always there.

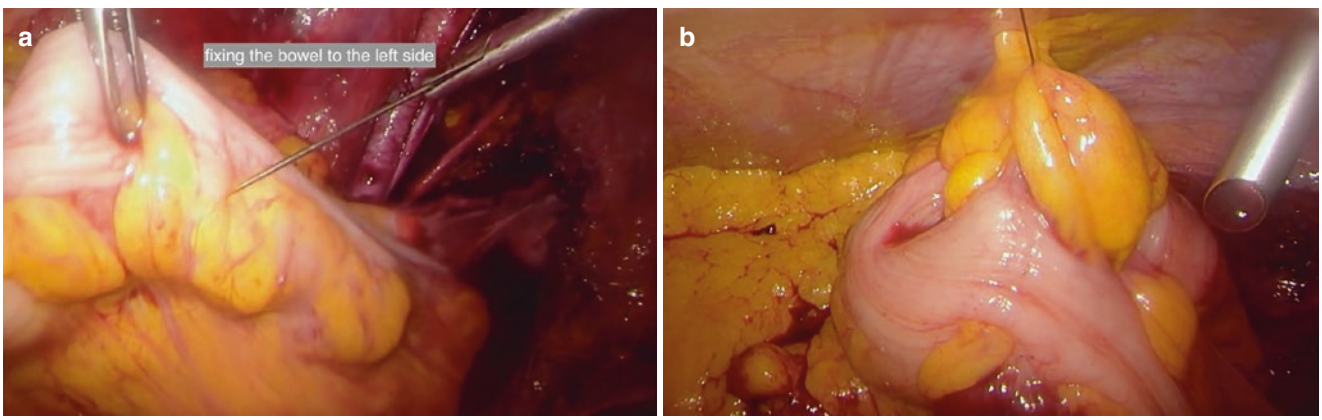


Fig. 51.24 (**a**) To allow optimal access to the aorta, the sigmoid colon is mobilised. (**b**) The sigmoid is fixed towards the left of the patient with a percutan suture

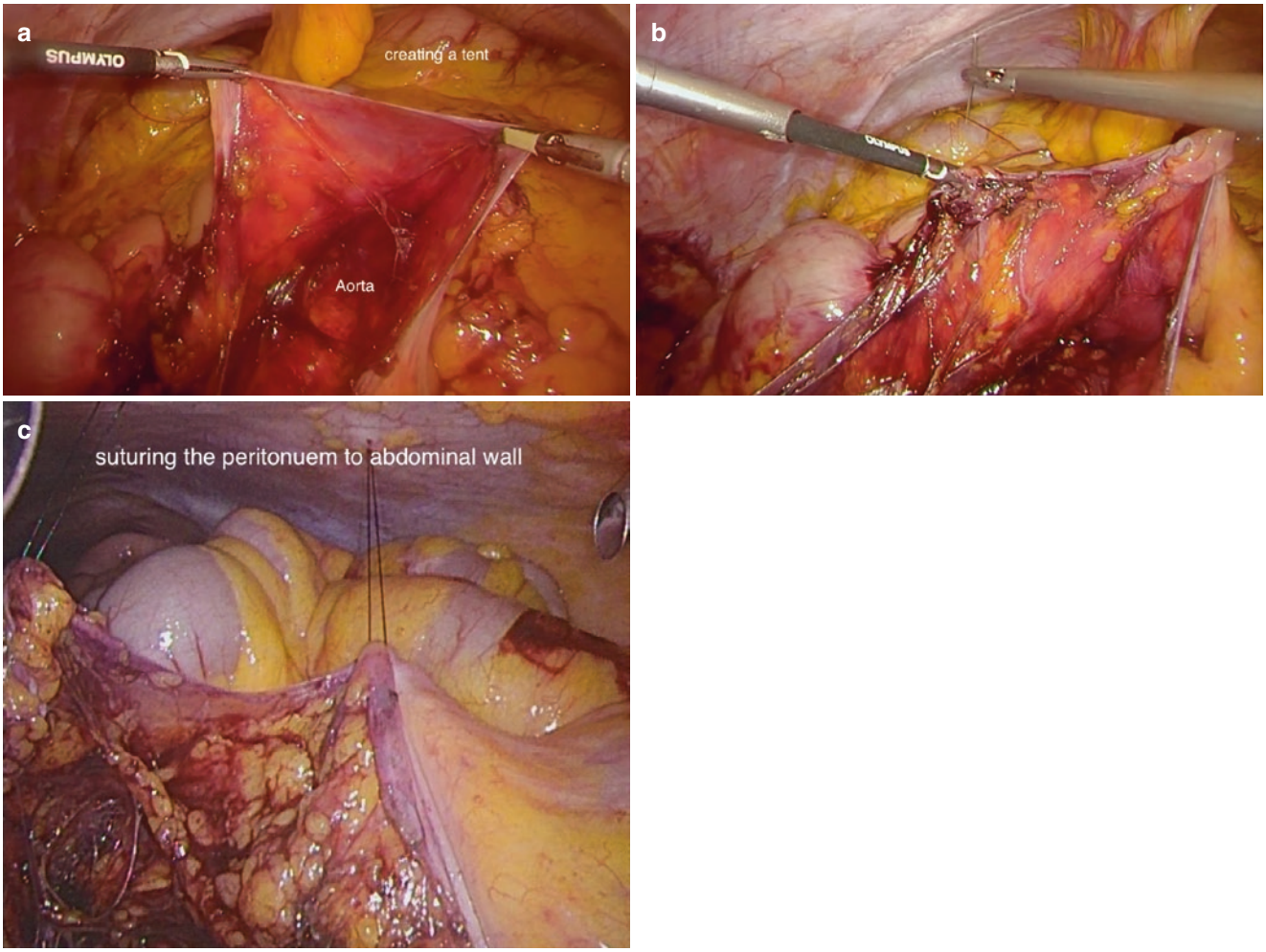


Fig. 51.25 (**a**–**c**) The peritoneum is opened up to the ligament of Treitz. (**b**) The peritoneum is then fixed towards the abdominal wall with percutaneus sutures. (**c**) The "tent" exposes the surgical field and keeps the small bowel in the upper abdomen

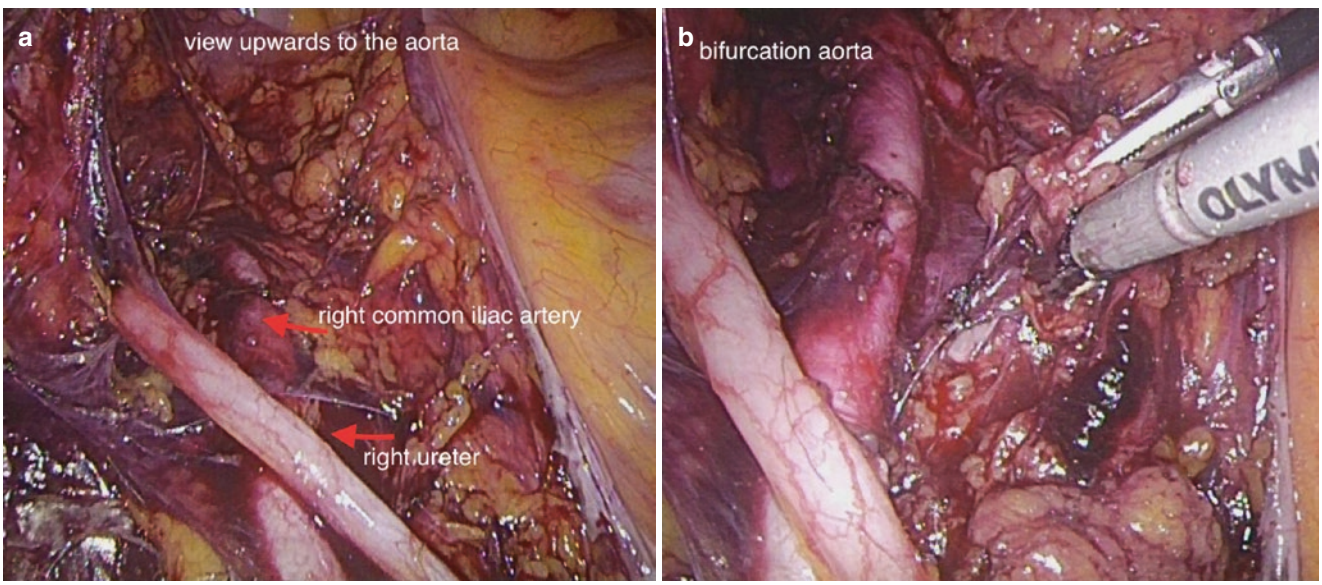


Fig. 51.26 (**a**) Dissection along the right common illiac artery, leading towards the aortic bifurcation. (**b**) The lymphatic tissue below the bifurcation should be removed carefully with the left common illiac vein just below

After securing the "right side" of the tent, the left side needs to be defined (Fig. 51.25c)
On the right side, particularly the right ureter is far more easily visualized than the left ureter.

First, the branching of the interior mesenteric artery needs to be found. It is fairly constant midway between the aortic bifurcation and the crossing of the left renal vein and comes off slightly to the left side of the aorta (Fig. 51.28)
Finding the branching of the inferior mesenteric artery, which serves as a sort of central reference point in the entire field of dissection is the key to all subsequent orientation. With more experience, one realizes that it is relatively constant. Sometimes it can be seen in its lateral trajectory, but ultimately, the branch directly off the aorta needs to be dissected by blunt preparation. We prefer to do this coming from the medial line of aortic preparation.

Finding the crossing of the left renal vein is challenging. Dissection cannot be sharp: cutting into the lower edge of the left renal vein is a catastrophe that must not happen (Fig. 51.29a, b)
The location of the left renal vein is about 4–5 cm cranial of the inferior mesenteric artery. Blunt dissection is essential, can, however, lead to small vessel bleeding which might require coagulation, obscuring the field and making further dissection more difficult. The learning curve of paraaortic laparoscopic lymphonodectomy takes several years, as shown by the group of Achim Schneider, and this is one of the reasons it take time to be comfortable in this region.

About 2 cm towards the left of the aorta, the left ovarian vein starts to descend from the left renal vein. This corner is the most difficult part of the paraaortic lymphonodectomy
Because of the lymphatic drainage of the corpus, these lymph nodes are of particular importance. If they are negative, the paraaortic lymphonodectomy has truly analyzed the complete lymphatic drainage of the uterus.

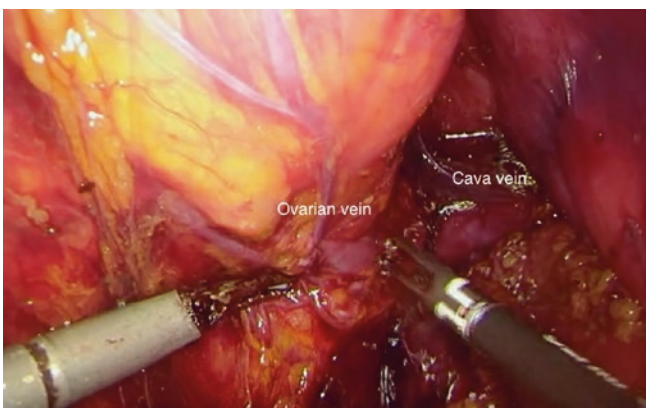


Fig. 51.27 Exposition and dissection of the right ovarian vein

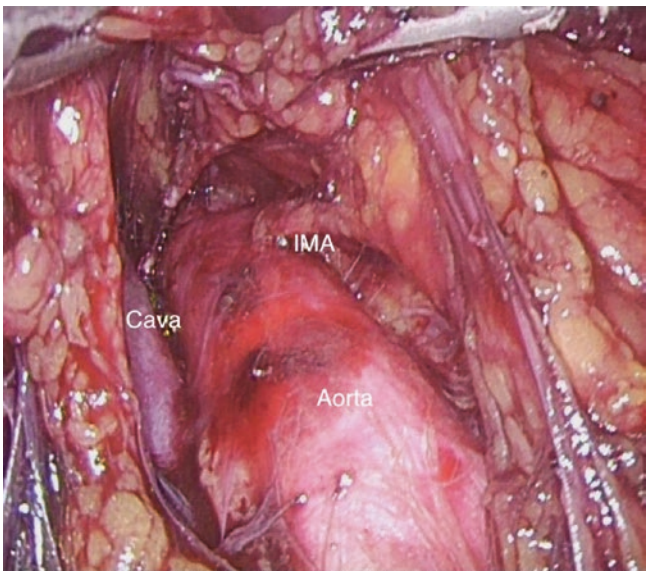


Fig. 51.28 Exposition of the aorta and delineation of the inferior mesenteric artery towards the left and the vena cava toward the right of the patient

The tent is now sufficiently defined
How to best hold the tent open is a matter of debate. We have had good experience with the first assistant opening the tent, as needed, with two blunt instruments. Some surgeons advocate suturing the peritoneal edge to the abdominal wall, others introduces a retractor through an additional trocar in the left upper quadrant.

Lymphonodectomy can be performed either from cranial to caudal or from caudal to cranial
In the end, the order depends on surgeon preference and the actual anatomical situation. Again: The steps of any surgery can be precisely described, but not necessarily their order.

Dissection on the aorta is unproblematic, dissecting off the vena cava needs to be slow and meticulous. Even pulling on the lymphatic tissue can lead to perforator veins tearing off the vena cave and possible cava bleeders (Fig. 51.30a–e)
The aorta is like a well-paved street easily traveled. Blunt dissection is possible. The vena cava tends to be more vulnerable, blunt dissection is to be avoided.

Cava bleeders need to be closed with pressure immediately. About 90 % of them can be stopped by applying sufficient pressure for at least 5 min. What still bleeds after prolonged pressure needs to be sutured with a 4-0 or 5-0 monofilament suture.
Pressure is the most effective hemostatic measure for small cava bleeders. Be careful using clips and sutures too early. Sometimes they make matters only worse.

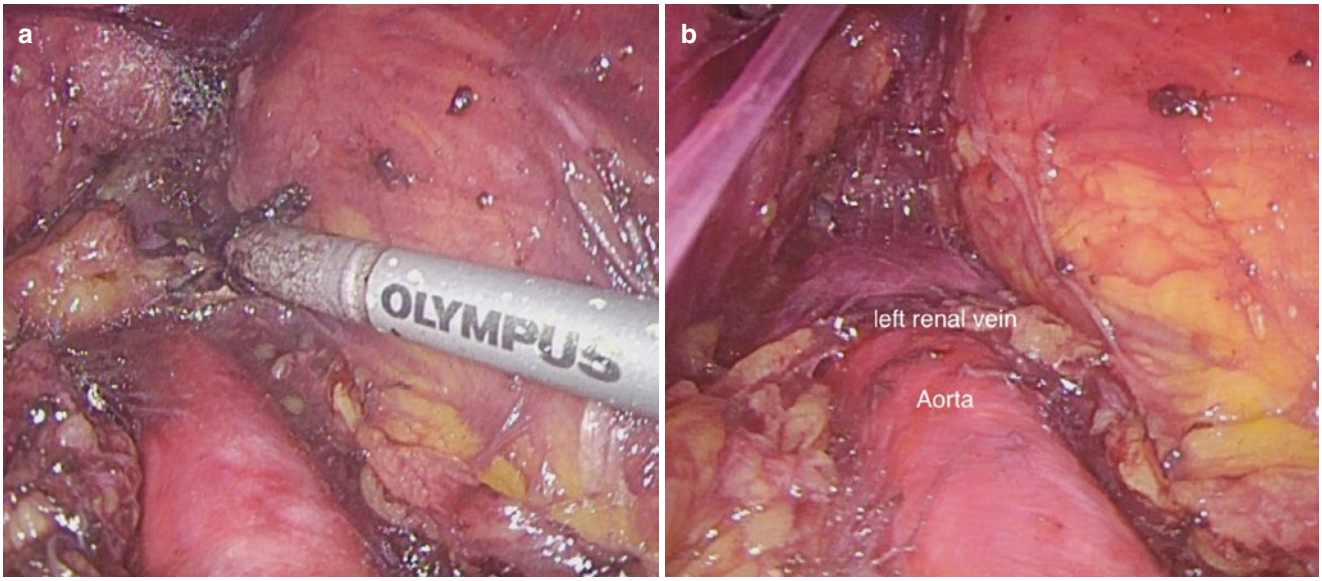


Fig. 51.29 (**a**) Further preparation "upward" i.e. cephalad until the left renal vein crossing the aorta is reached. (**b**) The left renal vein is the upper limit of the gynecologic paraaortic lymphonodectomy

En-bloc lymphonodectomy down the paracaval and paraaortic spaces is challenging. We recommend a step-by-step approach that takes place in different spaces
Lymph nodes should be removed as they become available through the 10 mm trocar at the umbilical position.

Paraaortic area cranial to inferior mesenteric artery (including the difficult angle between the left renal and left ovarian vein) Figs. 51.31 and 51.32a, b)
This is at the same time the most challenging and the most important area of dissection. Even very experienced surgeons continue to find this area very challenging.

Paraaortic area inferior to the inferior mesenteric artery (careful, the ureter is very close to the left lateral edge of the preparation and can be easily injured).
This area – rich in lymph nodes – should be assessed. It is crucial to identify the ureter towards the left lateral side.

Paracaval region, upper half - attention to crossing of the right ovarian artery, branching of the right ovarian vein
Careful dissection includes the identification, coagulation and transection of the above-mentioned structures. Vena cava perforators at this level are rare.

Paracaval region, lower half – attention to the perforator veins which are increasing in frequency towards the caudad region
In the Anglo-American medical community, these perforators are referred to as the "Fellow's veins", indicating that injury is mostly associated with lack of experience, However, here "experience" mostly teaches caution. Blunt dissection will inevitably lead to tearing of these small veins and to holes in the vena cava.

Interaorto-caval region – careful not to injure the lumbar veins going off in a dorsal and downward manner
This is a region rich in lymph nodes, but also rich in big and difficult-to-visualize vessels that are rarely encountered. Careful dissection and reassessment of the oncologic context are important.

Paracaval region towards the right side of cava – psoas space. Careful not to injure the right ureter
This remains one of the most challenging parts. Careful preparation is essential. Respect the trajectory of the inferior mesenteric artery which should remain lateral and cranial of the field. The ureter is difficult to visualize until you have dissected it. Still, it is an important area rich in lymphatic tissue.

The key to paraaortic lymphonodectomy is to avoid major bleeding as it will often require laparotomy
For this step, excellent visualization, using a 30° scope and optimal camera assistance are important. The big dangers are perforator bleeders from the inferior part of the vena cava, the left renal vein, if not exposed carefully, the ovarian veins and the lumbar veins if dissection is performed in a radical manner.

The most common serious source of bleeding will be small holes in the inferior part of the vena cava because of exaggerated pulling on lymphatic tissue, tearing off the small perforator veins. Ninety percent of these bleeders – which are easily diagnosed as venous bleeders because of the dark blue color of the blood – can be stopped by applying at least 5 min of direct pressure on the bleeding site. Patience is the key.

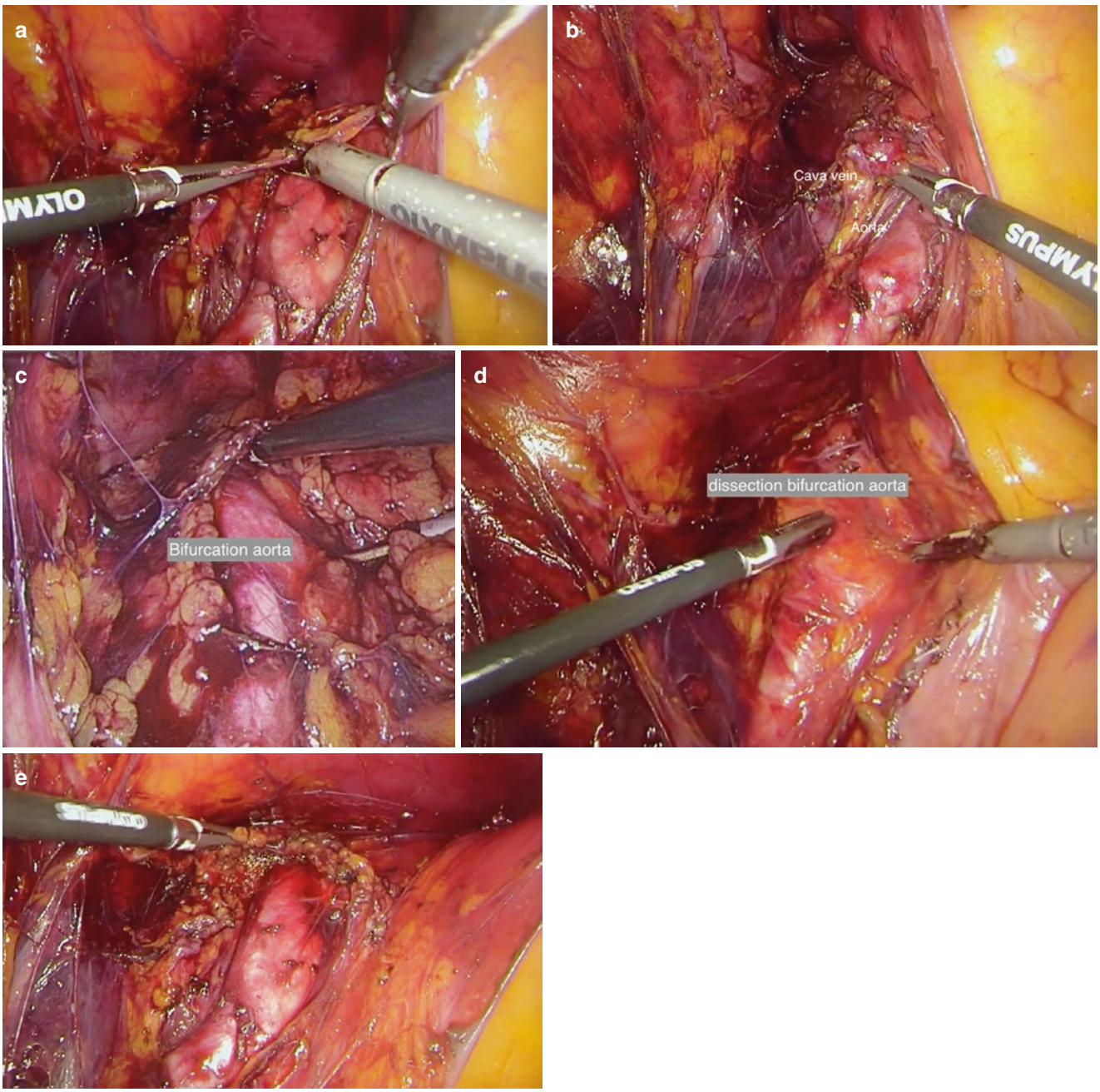


Fig. 51.30 (**a**) The dissection in the aorta is a sharp dissection. (**b**) Sharp dissection on the wall of the aorta. Attention to small perforating vessels. (**c**) First step is to clear the bifurcation of the aorta. (**d**) The use of vessle-sealing devices will facilitate the preparation. (**e**) The surgery follows exactly the course of the aorta

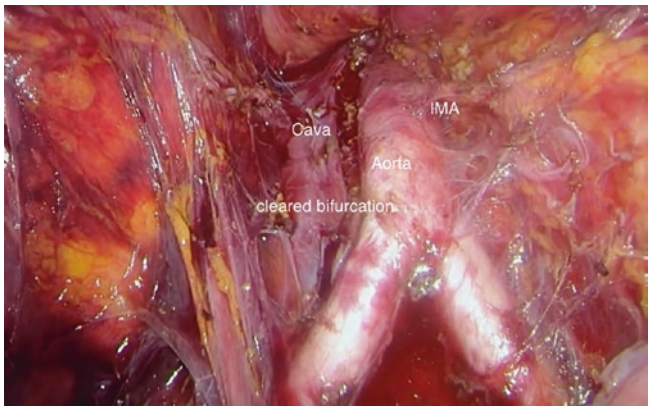


Fig. 51.31 Final view after exposing the aorta and the vena cava inferior

However, if the tear is too large, it needs to be closed with sutures. All venous defects – in fact all vascular defects – need to be closed with monofilament sutures, either 5-0 or 4-0 PDS or, as preferred by some surgeons, permanent sutures. Suturing the vena cava is not only difficult but also dangerous as tearing on the paper-thin venous wall has the potential to catastrophically enlarge the whole, necessitating immediate and urgent laparotomy. It is much better to avoid these bleeders than to control them.

Lymph node tissue is often smaller and can be removed through the 10 mm umbilical trocar

Do not leave small lymph nodes "waiting" in the abdominal cavity. Remove them immediately, lest they should be lost.

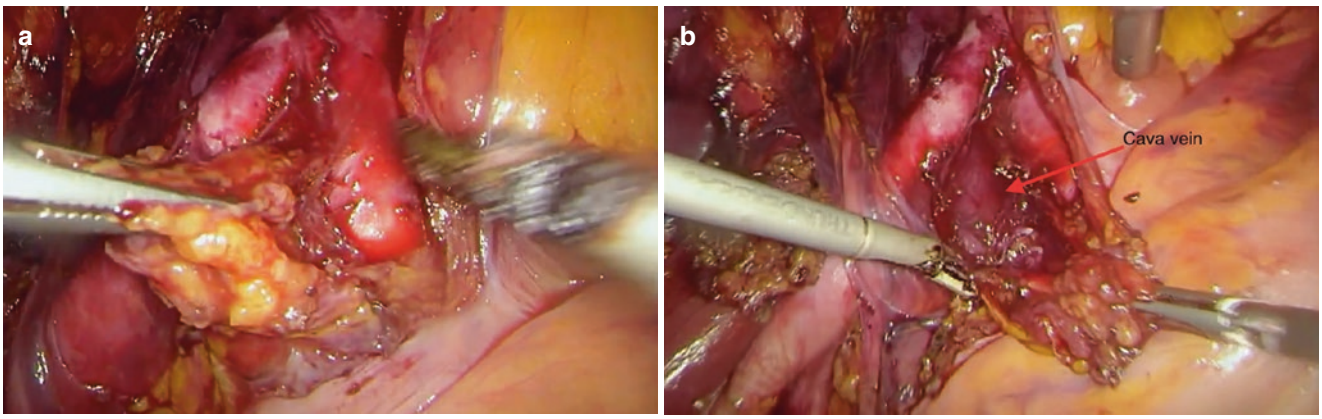


Fig. 51.32 (**a**) Dissesction of lymph nodes downwards the aortic bifurcation. (**b**) Attention! The cava vein is just below the aortic bifurcation

Surgical Techniques of Laparoscopic Omentectomy

52

Jun Ho Lee and Jieun Kim

Introduction

Omentectomy refers to the surgical removal of the omentum. It is usually performed in conditions of malignancies that are likely to transperitoneal metastasis. Omentectomy is a part of standard procedure during surgery for gastrointestinal and genitourinary malignancies like gastric cancer and ovarian cancer. It is a relatively safe procedure once you understand the anatomy and the avascular plane. It is important to be aware of the relationships with adjacent organs that are attached to the omentum to avoid injuries, such as colon, spleen, pancreas, stomach and duodenum. Finding avascular plane by proper traction is the key technique to perform safe omentectomy.

Anatomy and Functions

The greater omentum is a large double layered folds of peritoneum attached from the stomach hanging down to the transverse colon like an apron. It is made up of four layers. The anterior two layers descend from the greater curvature of the stomach and the proximal part of the duodenum, it passes down in front of the small intestines, sometimes as low down as the pelvis. Then they folded on itself and ascend again and attached to the transverse colon. The greater omentum is considered as composition of gastrocolic ligament and gastrosplenic ligament. It is continuous structure but named separately for descriptive purposes. The left border of the greater omentum continuous with the gastrosplenic ligament; and its right border extends as far as the proximal duodenum. Occasionally gastrocolic ligament itself is considered as synonym for "greater omentum" [1].

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The omentum has been known to play an immunologic role in defending the peritoneal cavity. It is a storage site for lipids, a regulator of peritoneal fluid transit, and a reservoir for immune cells in the peritoneal cavity. It serves as an antibacterial defense, provides hemostasis, reduces intestinal adhesion, and absorbs foreign material from peritoneal cavity. Yet, the omentum remains an understudied organ whose function and role in cancer is not completely understood. Role of omentum in immunology and cancer is still ongoing study [2].

Blood Supply and Lymphatic Drainage

The right and left gastroepiploic vessels provide the blood supply to the greater omentum (Fig. 52.1). The right gastroepiploic artery is a branch of the gastroduodenal artery, which is a branch of the common hepatic artery, which is a branch of the celiac trunk. It runs from right to left along the greater curvature of the stomach except at the pylorus. The left gastroepiploic artery is the largest branch of the splenic artery. It runs from left to right along the greater curvature of the stomach. These arteries lie about a fingerbreadth or more from the greater curvature and anastomose within the two layers of the anterior greater omentum [1, 3].

The right and left gastroepiploic vein run parallel to the same named artery. The right gastroepiploic vein is joined to the anterosuperior pancreaticoduodenal vein then drains into the superior mesenteric vein, and the left gastroepiploic vein drains into the splenic vein. And then, venous blood flow drains to the portal vein and entering the liver cycle.

Generally, the lymphatic drainage of the stomach parallels the vasculature. There are two lymph node groups: those along the left gastroepiploic vessels and those along the right gastroepiploic vessels [3]. Lymph nodes along the left gastroepiploic artey is defined as lymph node station 4sb by Japanese classification of gastric carcinoma [4]. Lymph nodes along the second branch and distal part of the right gastroepiploic artery is defined as lymph node station 4d.

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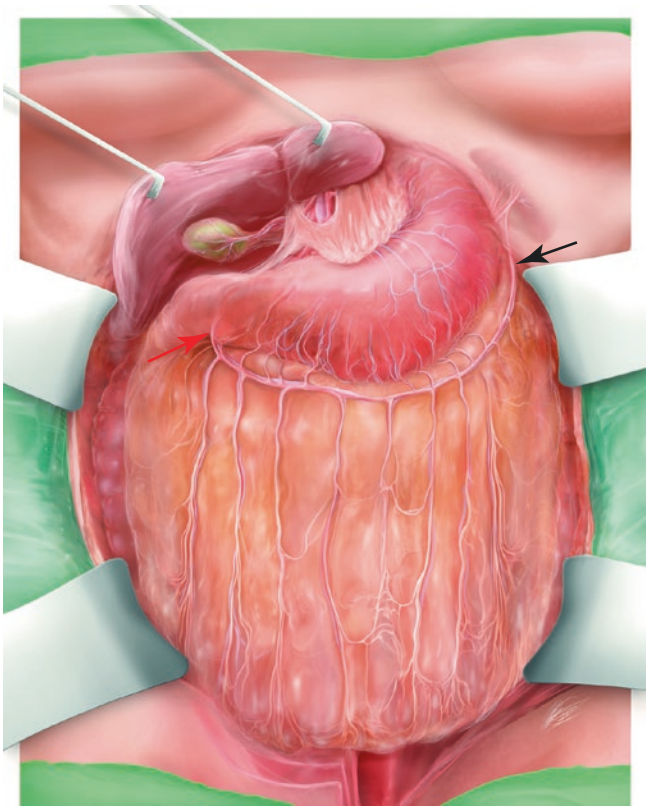


Fig. 52.1 Overview illustration of the omentum and the vessels

Lymph node stations of 4sb and 4d are regional gastric lymph nodes, which are essential for adequate lymph node dissection during curative resection for gastric cancer [4].

How to Perform Omentectomy

Dissection trough the avascular plane with proper counter traction of the transverse colon can lead to rapid and safe omentectomy during open surgery. In laparoscopic surgery, total omentectomy is time consuming procedure and has potential risk of injury to the adjacent organs. Surgeons not familiar with the upper abdominal anatomy in the laparoscopic view, limited working space, and loss of tactile sense might lead to inappropriate traction and it would make it difficult to find proper dissection plane through overlapped layers of omentum. We would like to introduce some tips to perform omentectomy without an assistant, which could be applied in single incision laparoscopic surgery as well [5].

Total Omentectomy

The patient can be placed in the supine position or lithotomy position, depending on the operator's preference. The operator should stand at either right side of the patient or between the legs of the patient if the patient is in the lithotomy position. After pneumoperitoneum is made and the laparoscopic trocars are in inserted (Fig. 52.2), greater omentum is easy to find in the center of abdominal cavity covering small bowel. Fifteen to twenty degree reverse Trendelenburg position would make a better view to start. Place patient in the left side up position while performing left side omentectomy, begin the procedure by removing all the omental adhesion to the parietal peritoneum. Grasp omentum attached to the parietal peritoneum, and gently pull to the medial side to find avascular white line by operator's left hand (Fig. 52.3). Adhesions can be easily divided with a scissors or electrocautery.

Identify splenocolic ligament by pulling down splenic flexure with operator's left hand (Fig. 52.4). Dividing dense splenocolic ligament could help find dissection plane. Sometimes dividing splenorenal ligament might be neces-

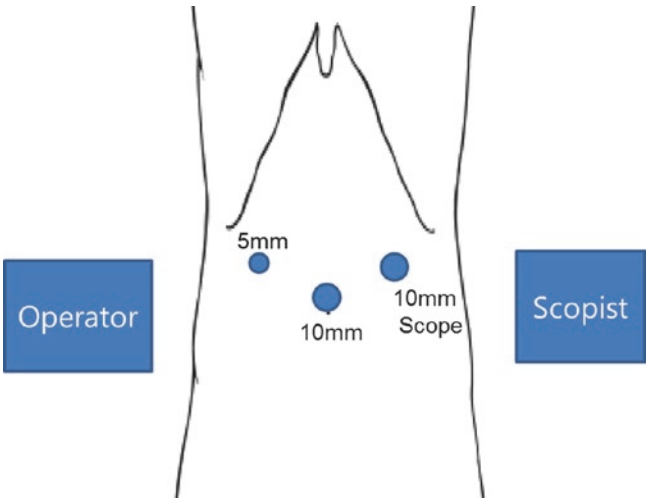


Fig. 52.2 Trocar placement. Five mm port is placed on the patient's right side of abdomen, 10 mm port is placed at the umbilicus, and another 10 mm port is placed at the left side. Five mm port is for the operator's left hand 10 mm port in umbilicus is used for operator's right hand

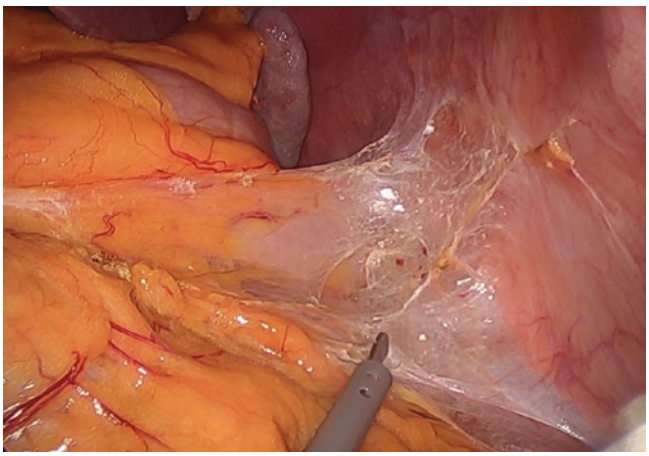


Fig. 52.3 Removing adhesions from the parietal peritoneum

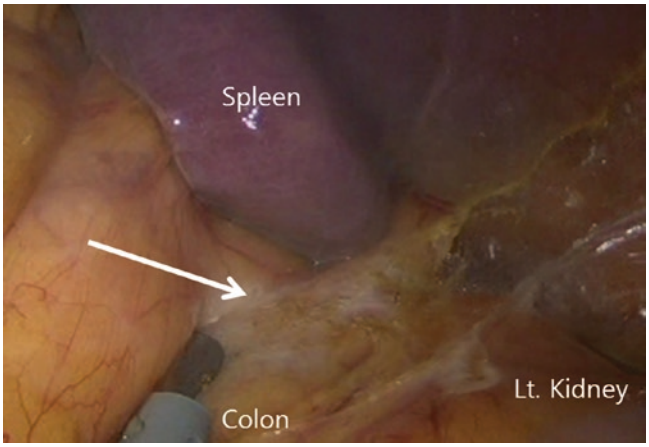


Fig. 52.4 Dividing splenocolic ligament. *Arrow*: splenocolic ligament

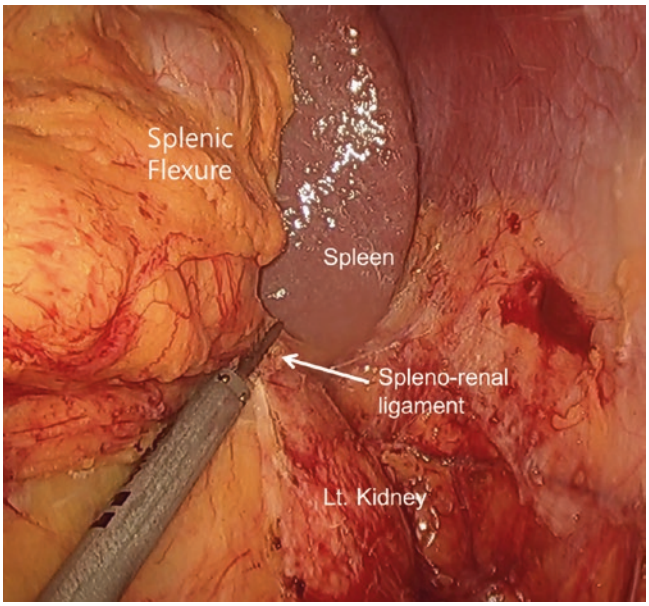


Fig. 52.5 Dividing splenorenal ligament. Left kidney is covered with Gerota's fascia

sary for a better view (Fig. 52.5). Grasp omental tissue 2–3 cm apart from the distal transverse colon with operator's left hand gently lift to the cranial, medial direction. Divide omentum with electrocautrery at the avascular plane just beside transverse colon (Fig. 52.6). Operater's left hand should stay upward direction while operator's right hand should press down transverse colon as if peeling the mesocolon off from the omentum. Continue until tail of the pancreas reveals then follow superior border of the pancreas to the lower pole of the spleen (Fig. 52.7). Occasionally, small vessel branching to inferior pole of the spleen needs to be divided. Careful dissection will identify the root of left gastroepiploic vessels coming up just behind the pancreas tail (Fig. 52.8). The left gastroepiploic vessels are ligated using the hemolock.

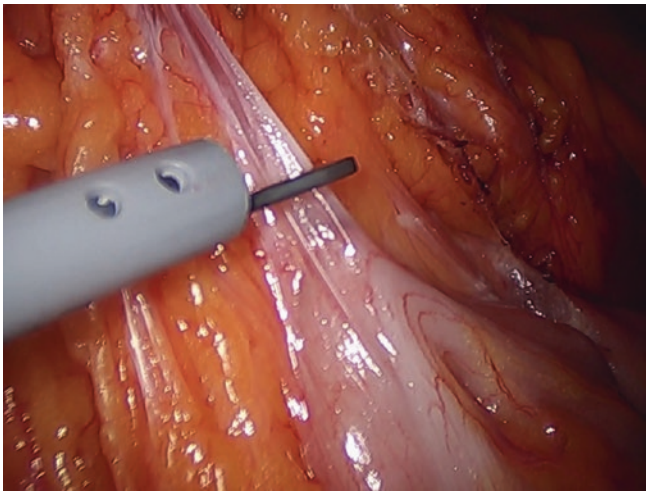


Fig. 52.6 Start dividing omentum with electrocautrery at the avascular plane just beside transverse colon

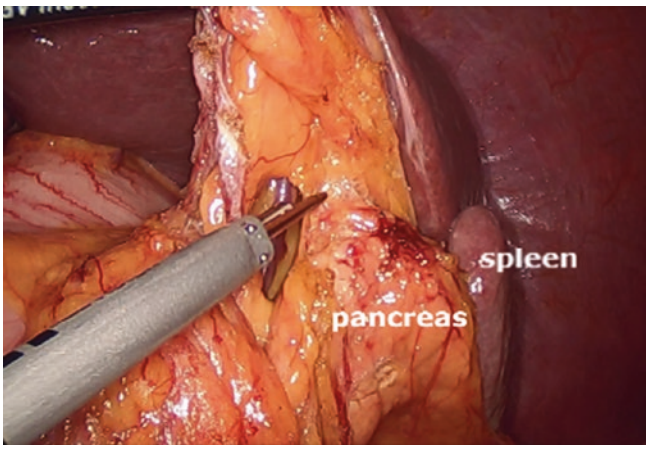


Fig. 52.7 Left side dissection following to the tail of the pancreas

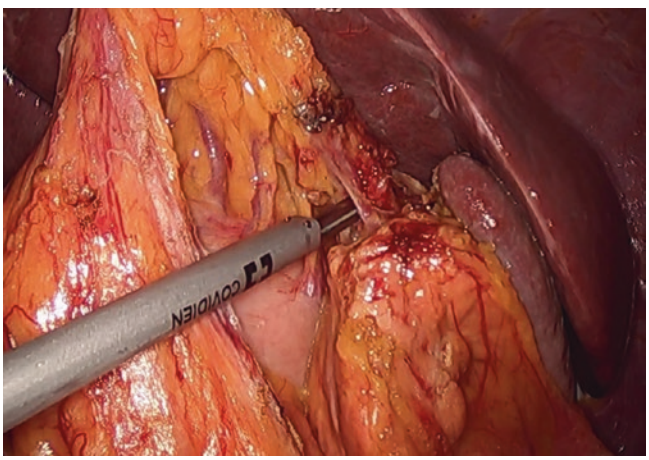


Fig. 52.8 Ligating left gastroepiploic vessels

Continue separating omentum from transverse colon from left to right direction. Keep on upward traction of the ometum with operator's left hand while pressing down

transverse colon as previously described (Fig. 52.9). This maneuver will help to minimize injury to the colon. Be careful of the thermal injury of the serosa of the colon by electrocautrery or active blade of ultrasonic shears (Fig. 52.10). If the thermal injury of the serosa is suspected, reinforce suture is needed. Once you divide white line attached to the tenia coli of the transverse colon with an electrocautery, strip off mesocolon from the omentum by gentle push and pull down maneuver with a blunt tip of the monopolar. If you encounter vessels in this layer, mostly it is vessels from mesocolon (Fig. 52.11). Trace the vessels and if it runs horizontal direction, it is vessel from the mesocolon, if the vessel trace up to the vertical direction it is a vessel to the omentum, which you should ligate with the energy device. Gentle press down layer just above the vessel will guide you to the next layer.

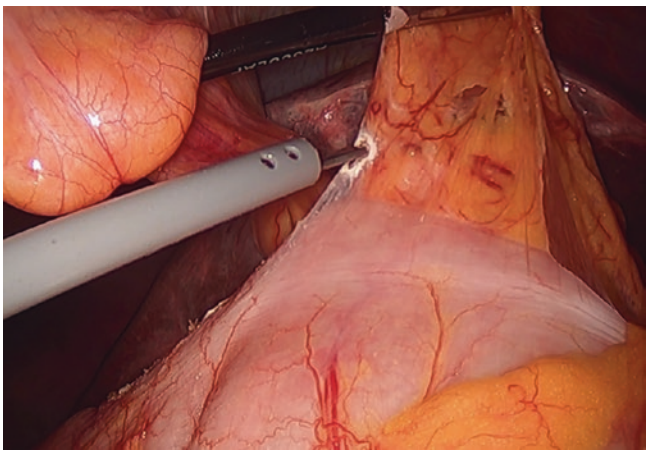


Fig. 52.9 Upward traction of the omentum with operator's left hand while pressing down transverse colon

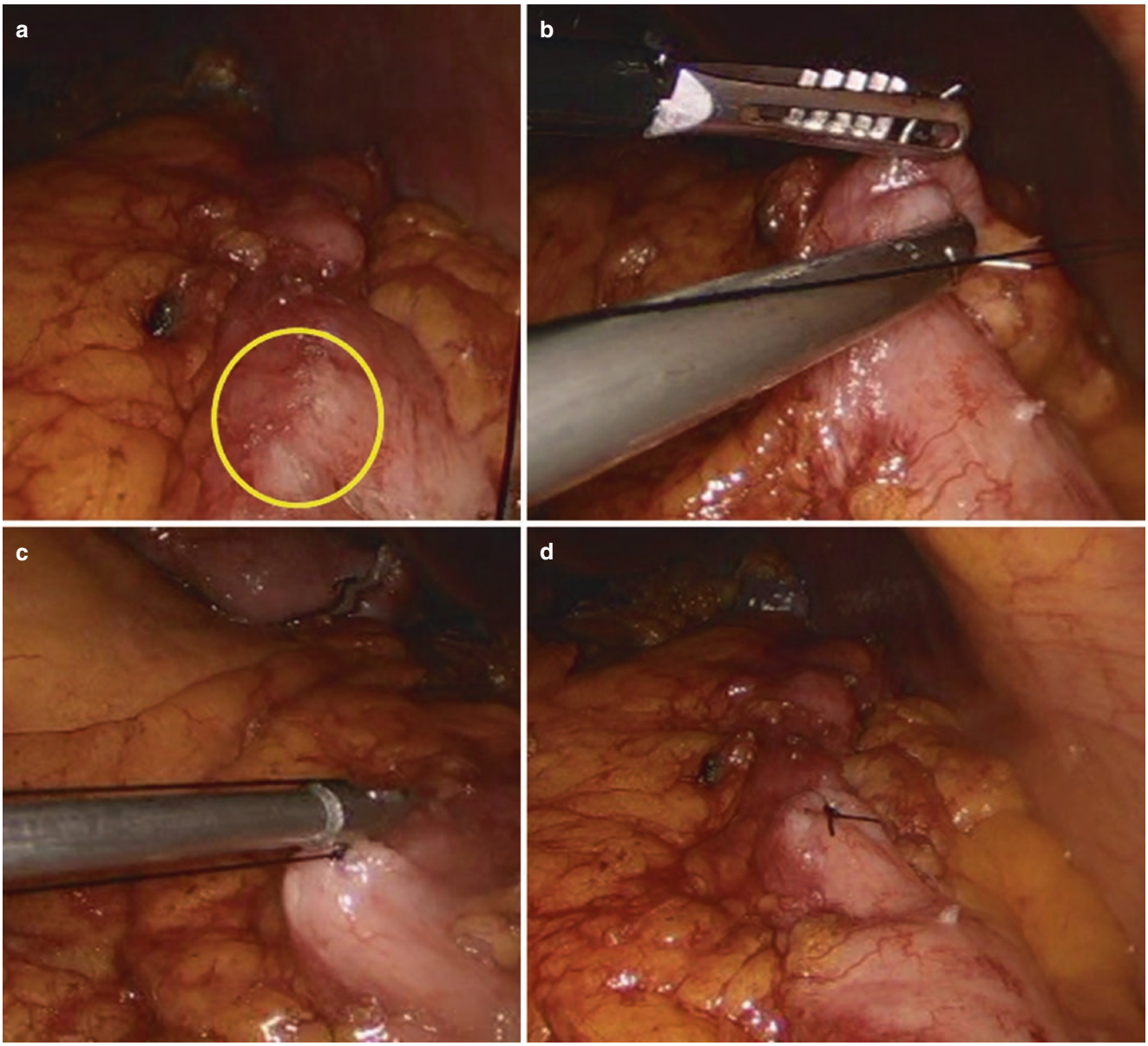


Fig. 52.10 (**a**) *Yellow circle*; Thermal injury to the colon wall. (**b**) Repairing serosa with interrupt suture. (**c**) Making knot with the knot-pusher. (**d**) Final view after serosa repair

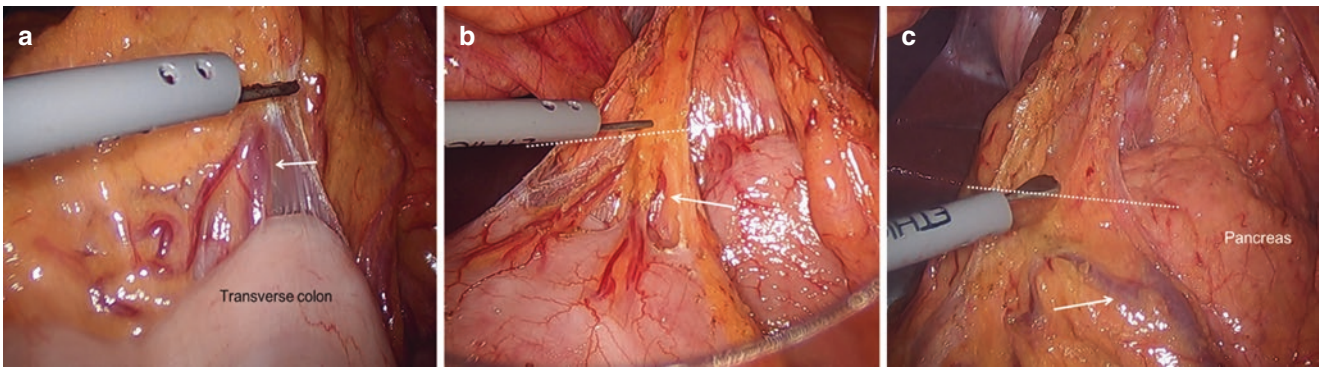


Fig. 52.11 Peeling off mesocolon from the omentum. Be aware of the mesocolic vessels (*arrow*). Dotted line: dissection plane

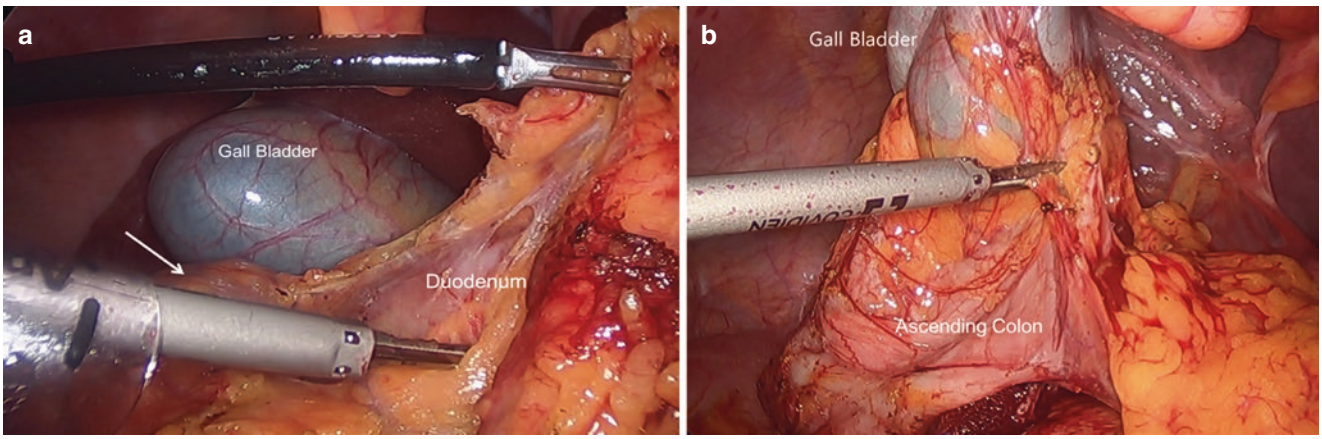


Fig. 52.12 (**a**) Right side omentectomy until the duodenum is seen. *Arrow*: ascending colon. (**b**) Adhesions between the ascending colon and the gall bladder

When you reach right side to the proximal transverse colon, unusual attachment of the omentum may be encounterd. Sometimes colon is folded in hide behind bulky fat tissue in this area. Track down colon until the second portion of the duodenum is seen (Fig. 52.12). Then trace duodenum and trim omentum to the pylorus level.

After separation of the omentum from the transverse colon, flip up the omentum and identify right gastroepiploic vessels arising vertically from the pancreas. Operator's left hand grasp pedicles of the gastroepiploic vessels and stretch to the cranial direction, careful dissection with right hand and ligation of the vessels with the hemolock just above the pancreas (Fig. 52.13). Too much tension before ligating vessels, might cause tearing or injuries to the vessels.

Follow ligated gastroepiploic vessels to the greater curvature of the stomach for trimming (Fig. 52.14). Be careful not to injure short gastric vessels inside the gastrosplenic ligament. Once you reach the greater curvature of the stomach, grasp omentum just 2–3 cm apart from the greater curvature with the operator's left hand and trim the greater curvature from left to the right direction with the operator's right hand with the energy device. Hold the omentum upward direction to maintain proper traction, gently pressing down the greater curvature as you divide omentum from the stomach from left to

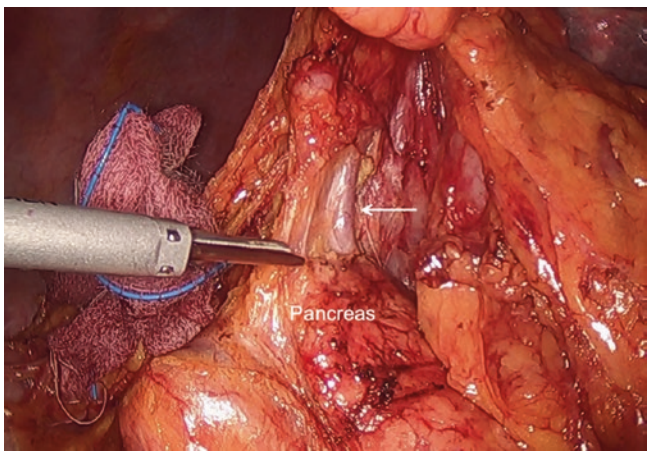


Fig. 52.13 Ligating the right gastroepiploic vessel. *Arrow*: right gastroepiploic artery

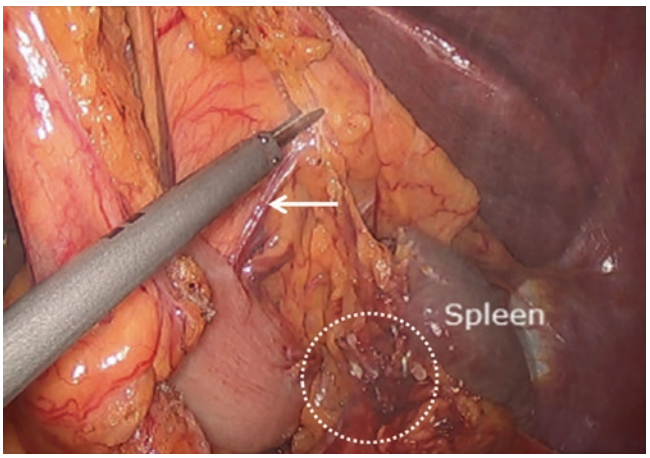


Fig. 52.14 Follow short gastric vessels toward stomach wall for trimming. Arrow: short gastric vessel, *Circle*: ligated left gastroepiploic vessels

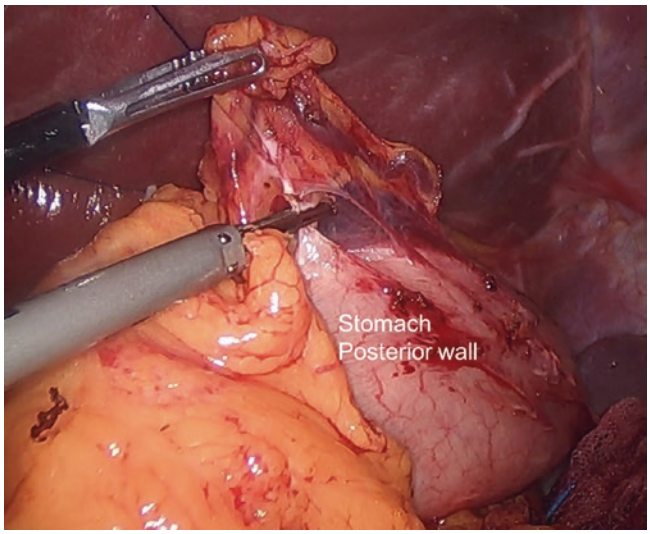


Fig. 52.15 Trimming of the omentum from the stomach

right (Fig. 52.15). This maneuver will show the layers of the dissection plane and minimize the injury of the stomach wall.

Partial Omentectomy

Partial omentectomy is the procedure literally removing only certain part of the omentum. For gastric surgery, partial omentectomy will be removal of the omentum attached to the greater curvature of the stomach including the arcades of the gastroepiploic vessels with the lymph node stations [6, 7]. For gynecologic surgery, terminology of infracolic omentectomy is used [8, 9]. For this case, arcades of the gastroepiploic vessels will be preserved, range of resection would be below gastroepiploic arcades and the rest of the gastrocolic ligament.

Either partial omentectomy or infracolic omentectomy, dissection line should be 4–5 cm apart from the greater curvature of the stomach. The omentum is divided 2–3 cm distance from the gastroepiploic vessels. First, start with making a window at 2–3 cm apart from the arc of the gastroepiploic vessels near lower to mid body of the stomach (Fig. 52.16). Operator's left hand grasp the greater curvature of the stomach and lift upward direction while operator's right hand divide omentum following the gastroepiploic vessels to the left side toward the lower pole of the spleen (Fig. 52.17). When approaching the lower pole of the spleen, it is important to identify the colon to prevent its injury. Make sure colon wall is not in the way of dissecting plane. The left gastroepiploic vessels are ligated as the same method as used for total omentectomy.

The right sided partial omentectomy is mostly same as previously described in the total omentectomy. Follow gastroepiploic vessels to the right side towards proximal duodenum, ligate the right gastroepiploic vessels

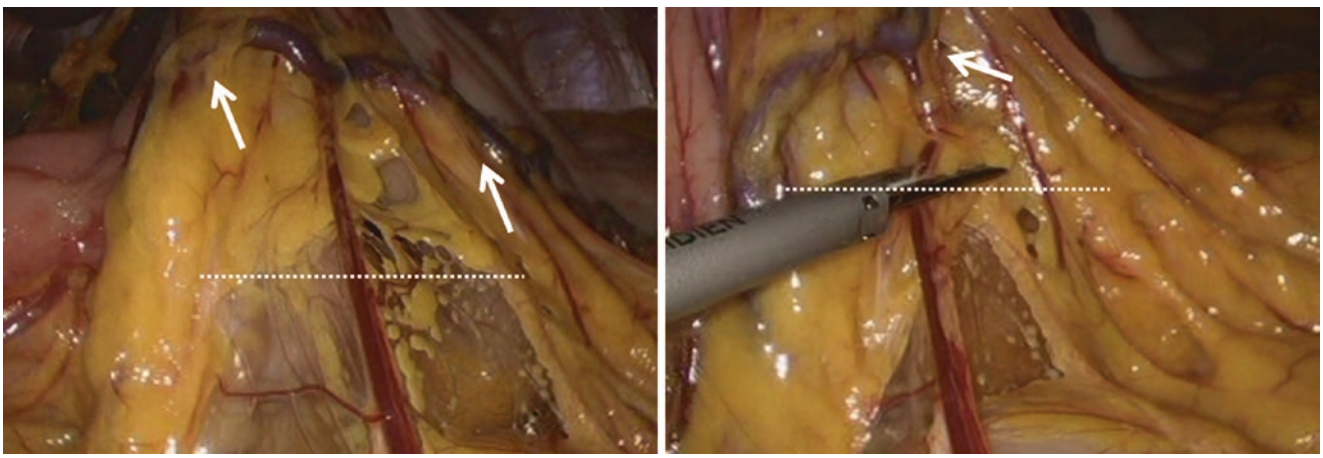


Fig. 52.16 Start partial omentectomy by making a window at 2–3 cm apart from the arc of the gastroepiploic vessels near lower to mid body of the stomach. *Arrow*: gastroepiploic arcade. *Dotted line*: dissection plane

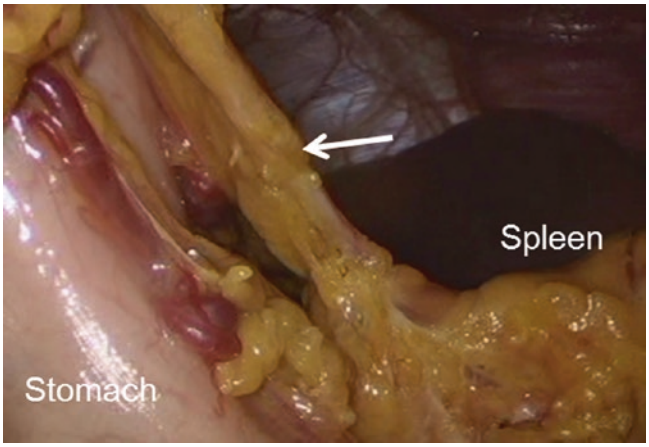


Fig. 52.17 Ligating the left gastroepiploic vessel during the partial omentectomy. *Arrow*: left gastroepiploic vessel

References

1. Moore KL, Agur AMR, Dalley AF. Clinically oriented anatomy. 7 ed. Philadelphia: Lippincott Williams & Wilkins; 2014.
2. Ben Arie A, McNally L, Kapp DS, Teng NN. The omentum and omentectomy in epithelial ovarian cancer: a reappraisal. Part I – omental function and history of omentectomy. Gynecol Oncol. 2013;131(3):780–3. doi:10.1016/j.ygyno.2013.09.014.
3. Lee JH, Kim CY, Kodera Y, Fujiwara M. Dissection of the greater omentum and left gastroepiploic vessels. In: Kitano S, Yang HK, editors. Laparoscopic gastrectomy for cancer. Japan: Springer; 2012. p. 65–74.
4. Japanese Gastric Cancer A. Japanese classification of gastric carcinoma: 3rd English edition. Gastric Cancer Off J Int Gastric Cancer Assoc Jpn Gastric Cancer Assoc. 2011;14(2):101–12. doi:10.1007/s10120-011-0041-5.
5. Kim SM, Lee SH, Ha MH, Seo JE, Kim JE, Choi MG, et al. Techniques of the single-port totally laparoscopic distal gastrectomy. Ann Surg Oncol. 2015;22 Suppl 3:S341. doi:10.1245/s10434-015-4839-y.
6. Kim DJ, Lee JH, Kim W. A comparison of total versus partial omentectomy for advanced gastric cancer in laparoscopic gastrectomy. World J Surg Oncol. 2014;12:64. doi:10.1186/1477-7819-12-64.
7. Kim SM, Lee JH, Lee SH, Ha MH, Seo JE, Kim JE, et al. Techniques of reduced PRT Laparoscopy-Assisted Distal Gastrectomy (Duet LADG). Ann Surg Oncol. 2014;22(3):793. doi:10.1245/s10434-014-4087-6.
8. Nezhat FR, Pejovic T, Finger TN, Khalil SS. Role of minimally invasive surgery in ovarian cancer. J Minim Invasive Gynecol. 2013;20(6):754–65. doi:10.1016/j.jmig.2013.04.027.
9. Arie AB, McNally L, Kapp DS, Teng NN. The omentum and omentectomy in epithelial ovarian cancer: a reappraisal: part II – the role of omentectomy in the staging and treatment of apparent early stage epithelial ovarian cancer. Gynecol Oncol. 2013;131(3):784–90. doi:10.1016/j.ygyno.2013.09.013.

Final Steps and Postoperative Considerations

53

Monika Martina Wölfler

Final Steps After Hysterectomy Via Laparoscopy

Upon finalizing the hysterectomy by removing the uterus transvaginally and closure of the culdotomy or removing the uterine corpus via morcellation in case of a subtotal hysterectomy, extensive lavage of the peritoneal cavity to remove debris and clots and inspection of the entire operating field are essential. Meticulous inspection of the culdotomy, the adnexal region or site of salpingoophrectomy, all peritoneal edges, blood vessels and vascular pedicles for bleeders and good hemostasis after irrigation and suction of fluids reduce the risk of postoperative hemorrhage.To identify small bleeders it might be helpful to temporarily reduce the intraperitoneal pressure. Bipolar electrocauterisation under direct vision is standard for steady hemostasis. Additionally, hemostatic agents, tissue sealants and compression suture clips can be used, however, good evidence is scarce [1].

Irrespective of the dimension of the operative procedure, be it a standard laparoscopic hysterectomy in an outpatient setting or major surgery for deep infiltrating endometriosis or a radical hysterectomy including lymphonodectomy, at the end of the procedure it is important to visualize normal ureteral peristalsis and document whether the urine is clear in the urinary catheter. Normal ureteral peristalsis is certainly not a proof for the absence of for instance thermic ureteral lesion, however, forensically it is substantial to at least address the macroscopic integrity of the ureter intraoperatively.

After major surgery the application of an intraperitoneal drain might be requested although there is no scientific evidence to favor the use of drains at all. Furthermore, data from randomized trials underline that routine use of drains does increase the risk of wound infection. In case drains are inserted they should be removed as soon as possible [2].

When finishing the laparoscopy, the removal of the accessory trocars should be carried out carefully and under direct vision. Small bleeders can mostly be controlled with pressure or electrocauterisation,otherwise a full thickness suture should be placed. For 12 mm accessory trocars and the laparoscope trocar fascial closure is required to prevent herniation. After removing the laparoscope, extensive deflation of carbon dioxide prior to removing the trocar avoids postoperative discomfort caused by residual gas [3].

For the closure of all cutaneous incisions intracutaneous absorbable monofilament sutures will guarantee for optimal aesthetic outcome. All wounds need to be covered with sterile dressings. Alternatively, for the small incisions tape strips and dressings or a skin adhesive dressing can be used.

Postoperative Considerations

The perioperative management was subject to major changes in recent decades, hence checklists for the prevention of complications and for the improvement of patients´ safety are nowadays standard in most clinics and are explicitly recommended by several gynecologic and surgical societies (see also Fig. 53.1 displaying the checklist used at our clinic as an example).Data from abdomino surgical studies underline the superiority of the “fast-track surgery” concept and enhanced postoperative recovery programs compared to traditional concepts in perioperative management [2, 4]. Data from these studies refer to major abdominal surgery and patients with mostly advanced morbidity. Since the majority of gynecologic patients scheduled for hysterectomy are American Society of Anesthesiologists category 1 or 2 (ASA1 healthy or ASA2 mild systemic disease) they might benefit even more from the “fast-track surgery” concept. For the postoperative management in particular several issues need to be addressed.

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Preoperative Checklist

Department of Gynecology and Obstetrics

Medical University of Graz

1 Nursing	✔
Patient ID tag confirmed	
Informed consent for surgery	
Informed consent for anesthesia	
Allergies checked	
Premedication administered	
Fasting	
Umbilicus cleaned	
Dental prostheses, jewelry, piercings, nail polish, hearing aid device, contact lenses, glasses, make-up etc. removed	
Compression stockings	

Date, signature:

2 Gyn. Surgeon	✔
Surgical listing confirmed	
Site of surgery checked	
Previous abdominal surgery and relevant diagnoses checked	
Informed consent for surgery	
Anesthesic protocol checked	
Allergies checked	
Surgical consultants informed	
Diagnostic imaging reviewed	
Biobank consent	

Date, signature:

3 Anesthesiologist	✔
Cleared for anesthesia	
Informed consent for anesthesia	
Labs reviewed	
Allergies checked	
Blood products	
Anesthesia modality	
Postoperative requirements	

Date, signature:

Patient ID

Intraoperative Checklist

Modified according to the WHO recommendations

Department of Gynecology and Obstetrics

Medical University of Graz

1 Sign in	✔
Nursing	
Patient ID confirmed	
Preoperative checklist reviewed	
Allergies checked	
Special hygiene issues checked	
Patient positioning	
Equipment for operation checked	
Metal implants	
Anesthesiologist	
Patient ID confirmed	
Difficult airway/aspiration risk	
Anesthesia equipement checked	
Anesthesia modality checked	
Blood products available	

2 Team Time Out prior to operation	✔
Patient ID confirmed	
All team members introduced themselves by name and role	
Surgical procedure confirmed	
Imaging studies available	
Site of operation identified	
Positioning of patient checked	
Allergies known	
Antibiotic prophylaxis within the last 60 minutes	
Questions	

OP-date	
OP-room	
Signature surgeon	

3 Sign Out at the end of operation	✔
Deviations from protocol	
Instrument, sponge and needle counts complete	
Specimens labelled	
Postoperative care	
Medication	
Drains	
Dressings	
Urinary catheter	
Transfer organized	
Questions	

Patient ID

Fig. 53.1 Preoperative checklist(Courtesy of the Department of Gynecology and Obstetrics, Medical University of Graz. Adapted English version 2015)

Discharge Checklist

Department of Gynecology and Obstetrics

Medical University of Graz

1 Gynecologist	✔
Information/instruction regarding	
- wound management	
- DVT prophylaxis	
- medications	
- post-op risks	
- convalescence	
Follow-up appointments	
Report and prescription completed	
Referring physician checked	

Date, signature:

2 Nursing	✔
Discharge documents handed out (medical report, convalescence recommendations, ..)	
Follow-up appointments arranged	
Instructions completed and understood (e.g. subcutaneos injections)	
Patient paperwork completed	
Medications/medical aids handed out	

Date, signature:

Patient ID

Fig. 53.1 (continued)

Analgesia

Effective analgesia that allows early mobilization is a fundamental prerequisite for improved postoperative recovery. Especially in case of extensive surgery epidural analgesia followed by multimodal non-opioid analgesia is the most effective evidence-based method [2]. Epidural analgesia, however, is not indicated in the vast majority of laparoscopic hysterectomies and can be replaced by opioid-sparing multimodal analgesia, including oral paracetamol, non-steroidal anti-inflammatory drugs, gabapentanoids and local anesthetics [5]. For vaginal hysterectomy recent data have shown that preemptive local analgesia prior to hysterectomy is associated with significantly lower pain scores and a reduction in narcotic use postoperatively [6, 7]. Patients undergoing laparoscopic hysterectomy might benefit from paracervical analgesia as well. Additionally, there is substantial evidence that transversus abdominis plane (TAP) blocks (see also Fig. 53.2) and local anesthetic infiltration of trocar insertion sites in several laparoscopic procedures result in reduced pain scores and analgesic requirement [8–10]. TAP block in laparoscopic hysterectomy in particular was associated with lower use of opioids in the postoperative phase [11]. A recent study on extended assisted ventilation with an open umbilical trocar valve after laparoscopic hysterectomy showed that this is an effective and safe method to reduce postoperative pain levels, in particular abdominal and shoulder pain [3].

For efficient postoperative pain treatment it is crucial that clinical standards of care provide anticipatory pain management and that the use of opioids is evited.

Postoperative Nausea and Vomiting (PONV)

Besides postoperative use of opioids, non-smoking status and history of PONV or motion sickness, female gender per se is a risk factor for PONV according to the Apfel risk score [12]. This risk score and an individual risk based multimodal PONV prophylaxis is advocated by evidence-based guidelines as standards of care. Tailored anesthesia and pain management in particular avoiding too liberal dosing of anesthetics and opioid analgesics is essential in order to reduce the risk for PONV [13].

Thus multi-modal opioid sparing analgesia and a risk-based prophylaxis should be provided to every patient

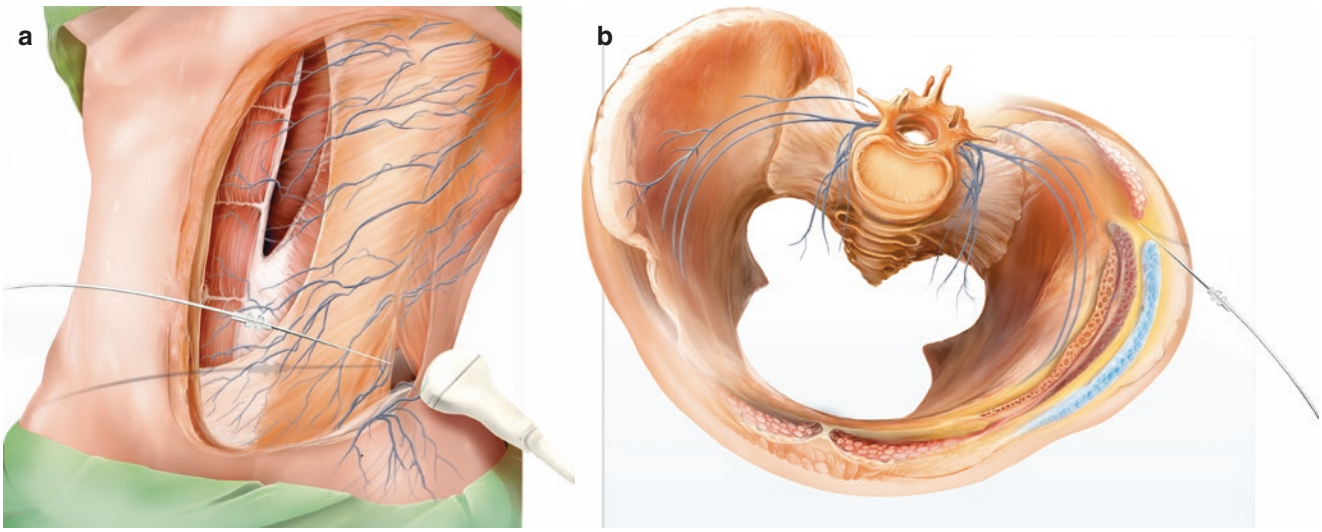


Fig. 53.2 The anatomical background for performing the transversus abdominis plane (TAP) block. The original technique described by Rafi et al. in 2001 [14] was a "blind" TAP block injecting a local anesthetic through the triangle of Petit on the lateral abdominal wall, whereas currently the ultrasound guided insertion of the needle is performed in an anterior to posterior manner to the plane of the rectus abdominis muscle [15]. Therefore, the ultrasound probe is placed diagonally over the lateral abdominal wall at the level of the mid axillary line (**a**). The extent of analgesia which can be achieved by TAP block is from the umbilical to the suprapubic region (block of the innervation of the anterior abdominal wall by the tenth thoracic intercostal nerve to first lumbar nerve) (**b**)

undergoing laparoscopic hysterectomy in order to minimize the occurrence of PONV.

Urinary Catheter, Drains and Tamponades

A recent meta-analysis of randomized controlled trials on immediate and delayed removal of urinary catheters following uncomplicated hysterectomy suggests that delayed catheter removal increases the incidence of postoperative bacteriuria and symptomatic urinary tract infection but reduces the risk of re-catheterization [16]. For laparoscopic radical hysterectomy and extensive resection of deep infiltrating endometriosis of the pelvis no such evidence is available albeit the removal of the urinary catheter upon mobilization is advisable. Functional bladder dysfunctions are common following nerve-sparing radical hysterectomy. Systematic bladder training, however, does not influence the rate of urinary retention or readmissions for bladder catheterization and is therefore not indicated [17].

There is no scientific evidence to favor the use of drains and tamponades. Several randomized trials addressing intraperitoneal drainage have shown that routine use of drains does increase the risk of wound infection, causes discomfort and postoperative pain and should therefore never be used routinely. In case drains are inserted they should be removed as soon as possible [2].

According to data from a recent Cochrane Database systematic review, patients with gynecological malignancies undergoing pelvic lymphadenectomy do not benefit form the placement of retroperitoneal tube drains to preventlymphocyst formation. When the pelvic peritoneum is left open, tube drain placement is associated with an even higher risk of short and long-term symptomatic lymphocyst formation [18].

Antibiotic Prophylaxis

There is no evidence for antibiotic prophylaxis in the postoperative phase. Antibiotic medication should only be initiated upon specific indication.

Venous Thromboembolic Event Prophylaxis

The rate of venous thromboembolic events (VTEs) including deep venous thrombosis and pulmonary embolism among women undergoing gynecologic surgery is high, particularly for women with a gynecologic malignancy. Current guidelines recommend VTE prophylaxis in the immediate postoperative period for patients undergoing open surgery. However, the VTE prophylaxis recommendations for women undergoing minimally invasive gynecologic surgery are not as well established. The risk of VTEs in patients undergoing minimally invasive surgery of intermediate complexity such as laparoscopic hysterectomy appears to be low based on retrospective analyses [19]. To date, there are no established guidelines that specifically provide a standard of care for patients undergoing minimally invasive gynecologic surgery for benign or malignant disease [20].

Pelvic surgery in general increases the risk of VTEs. The expositional risk after laparoscopic hysterectomy is considered to be intermediate and the dispositional risk of any patient is individual and needs to be addressed separately. Besides mechanical compression by graduated compression stockings the use of low molecular weight heparins (LMWH) is the standard postoperative pharmacologic prophylactic strategy based on multiple high-quality randomized trials [21–24].There is insufficient evidence to recommend graduated compression stockings alone in intermediate and high-risk surgical patients. According to a very recent evidence-based review the duration of prophylaxis should be extended to 28–35 days for patients undergoing abdominal/pelvic cancer surgery and higher doses of LMWH should be considered in obese patients [24]. In all studies the importance of early mobilization is emphasized.

Mobilization

Mobilization of patients at an early stage after surgery reduces postoperative complications and improves recovery and is one of the vital issues in the "fast-track surgery" concept [2]. For standard laparoscopic hysterectomy this can be within a few hours after surgery and even after extensive operative procedures mobilization on the day of surgery should be aspired.

Nutrition

In the past few years the dominating dogma of fasting periods after vaginal or laparoscopic hysterectomies was abandoned in favor of early food intake [25]. Even after major abdominal gynecologic surgery for either benign or malignant conditions early postoperative intake of fluids and food appeared to be safe without increased gastrointestinal morbidities or other postoperative complications according to a systematic Cochrane Database review. The benefits of this early postoperative feeding approach include faster recovery of bowel function, lower rates of infectious complications, shorter hospital stay, and higher satisfaction scores [26].

Daily Care, Monitoring and Diagnostics

The provision of a detailed nursing-care programme for each postoperative day is mandatory, and details about the care programme and the expected duration of hospital stay should be provided to patients (and relatives) upon indication for surgery and detailed planning of the surgical procedure for as well in-patients and out-patients [2, 4]. Intensive care observation is rarely necessary after laparoscopic hysterectomy and may be due to the patient's individual risk factors. Most clinics have standards for postoperative monitoring including recordings of pain, digestion, urination, vaginal bleeding and discomfort, daily ward rounds and if indicated physical examination. Any further diagnostic evaluation or examination should be symptom-driven and not be performed routinely. For instance, there is substantive evidence that routine hemoglobin level testing has little clinical benefit following elective laparoscopic hysterectomy and should be reserved for patients who develop signs or symptoms suggestive of acute anemia [27].

Very recent data suggest that e-health interventions providing personalized pre- and postoperative instructions on the resumption of daily activities, and tools to improve self-empowerment and to identify recovery problems result in a faster return to work, a higher quality of life and less pain during postoperative recovery after inter alia hysterectomy for benign conditions [28]. Thus, besides efficient nursing-care it is effective to inform patients in detail about the process of convalescence, instruct them and empower their responsibility.

Discharge and Recommendations to the Patient

After an uneventful postoperative recovery a general physical examination and conversation with the patient about the laparoscopic procedure, subsequent medical checkups, and instructions for the phase of convalescence are recommended and should be documented. There is no evidence to conduct a gynecologic examination or sonography prior to discharge without specific indication. It is important to make sure that the patient is mobile, urinating freely, has regular digestion and adequate pain control, and does not have excessive vaginal bleeding. Most clinics have checklists for the management of discharge and provide brochures with convalescence recommendations on daily activities (avoid heavy lifting, no sexual intercourse, no bath tub and swimming for up to 6 weeks, etc.). There is no scientific evidence to sustain these concrete recommendations, however. A Dutch interdisciplinary team defined convalescence recommendations rooted in expert-based knowledge for gynecological surgery. For laparoscopic hysterectomy his expert panel recommends the resumption of light, moderate and heavy activities after 1, 2 and 4 weeks respectively. These recommendations reflect an average functional recovery time for a healthy woman, but certainly the specialist in charge will take the presence of co-morbidities or potential complications into account for individual recommendations to a patient [29] (see also Table 53.1).

Table 53.1 Multidisciplinary convalescence recommendations

	Examples	Considered medically possible from (days/weeks after day of surgery)				
		Lapsc– Adn	LSH	TLH	VH	AH
Light activities	Lifting or carrying 5 kg	2 dy	1 wk	1 wk	2 wk	2 wk
	2 h sustained sitting					
	30 min sustained standing and walking					
Moderate activities	Lifting or carrying 10 kg	1 wk	2 wk	2 wk	3 wk	3–4 wk
	Pushing or pulling 15 kg					
	Riding a bicycle					
	Vacuum cleaning					
Heavy activities	Lifting or carrying 15 kg	2 wk	3 wk	3 wk	4 wk	6 wk
	Standing and walking during entire working day					
Resumption of (average) job	+/– 8 h a day	2 wk	3 wk	3–4 wk	4 wk	6 wk
	+/– 40 h a week					

Source: VonkNoordegraaf et al. [29]
Abbreviations: *Lapsc Adn* laparoscopic adnexal surgery, *LSH* laparoscopic supracervical Hysterectomy, *TLH/LAVH* total laparoscopic hysterectomy/laparoscopic assisted vaginal Hysterectomy, *VH* vaginal hysterectomy, *AH* abdominal hysterectomy
Time schedule**:** *dy* day (s), *wk* week (s)

Ambulatory Care Setting

Recent data suggest that ambulant care appears to be safe and does not have higher rates of complications or readmissions even in advanced laparoscopic surgery such as laparoscopic hysterectomy [30–32].

In an ambulatory care setting, the patient is monitored for discomfort in the recovery room for a few hours postoperatively. The evaluation of vital signs every 30 min should provide sufficient safety. Preemptive analgesia, early mobilization and fluid and food intake at an early stage are recommended. The minimal duration of surveillance after general anesthesia is 2 and 4 h after application of opioids, respectively. After a final checkup by the anesthesiologist and gynecologic surgeon the patient can be discharged. Information about convalescence and practical instructions for daily activities should be provided to the patient prior to surgery and handing out brochures providing this information upon discharge are beneficial.

References

1. KlinglerCH, RemziM, MarbergerM, JanetschekGHaemostasis in laparoscopy. EurUrol.2006;50:948–56; discussion 956–47.
2. Kehlet H, Dahl JB. Anaesthesia, surgery, and challenges in postoperative recovery. Lancet. 2003;362:1921–8.
3. Radosa JC, Radosa MP, Mavrova R, Rody A, Juhasz-Boss I, Bardens D, Brun K, Solomayer EF, Baum S. Five minutes of extended assisted ventilation with an open umbilical trocar valve significantly reduces postoperative abdominal and shoulder pain in patients undergoing laparoscopic hysterectomy. EurJObstetGynecolReprod Biol. 2013;171:122–7.
4. Kehlet H. Fast-track colorectal surgery. Lancet. 2008;371:791–3.
5. White PF, Kehlet H, Neal JM, Schricker T, Carr DB, Carli F. The role of the anesthesiologist in fast-track surgery: from multimodal analgesia to perioperative medical care. AnesthAnalg. 2007;104:1380–96. table of contents
6. Long JB, Eiland RJ, Hentz JG, Mergens PA, Magtibay PM, Kho RM, Magrina JF, Cornella JL. Randomized trial of preemptive local analgesia in vaginal surgery. IntUrogynecolJ Pelvic Floor Dysfunc. 2009;20:5–10.
7. O'Neal MG, Beste T, Shackelford DP. Utility of preemptive local analgesia in vaginal hysterectomy. AmJ Obstet Gynecol. 2003;189:1539–41; discussion 1541–32.
8. Keir A, Rhodes L, Kayal A, Khan OA. Does a transversus abdominis plane (tap) local anaesthetic block improve pain control in patients undergoing laparoscopic cholecystectomy? A best evidence topic. Int J Surg. 2013;11:792–4.
9. Siddiqui MR, Sajid MS, Uncles DR, Cheek L, Baig MK. A meta-analysis on the clinical effectiveness of transversus abdominis plane block. JClinAnesth. 2011;23:7–14.
10. CharltonS, CynaAM, MiddletonP, GriffithsJDPerioperative transversus abdominis plane (tap) blocks for analgesia after abdominal surgery. Cochrane Database SystRev.2010;(12):CD007705.
11. Pather S, Loadsman JA, Gopalan PD, Rao A, Philp S, Carter J. The role of transversus abdominis plane blocks in women undergoing total laparoscopic hysterectomy: a retrospective review. AustN ZJ ObstetGynaecol. 2011;51:544–7.
12. Apfel CC, Laara E, Koivuranta M, Greim CA, Roewer N. A simplified risk score for predicting postoperative nausea and vomiting: conclusions from cross-validations between two centers. Anesthesiol. 1999;91:693–700.

13. Obrink E, Jildenstal P, Oddby E, Jakobsson JG. Post-operative nausea and vomiting: update on predicting the probability and ways to minimize its occurrence, with focus on ambulatory surgery. Int J Surg. 2015;15C:100–6.
14. Rafi AN.Abdominal field block: A new approach via the lumber triangle. Aneasthesia. 2001;56:1024–1026.
15. Hebbard P, Fujiwara y, Shibata y, Royse C: Ultrasound-guided transversus abdominis plane (TAP) block.Aneasthesia and intensive care. 2007;35:616–617.
16. Zhang P, Hu WL, Cheng B, Cheng L, Xiong XK, Zeng YJ. A systematic review and meta-analysis comparing immediate and delayed catheter removal following uncomplicated hysterectomy. IntUrogynecol J. 2015;26(5):665–74.
17. Fanfani F, Costantini B, Mascilini F, Vizzielli G, Gallotta V, Vigliotta M, Piccione E, Scambia G, Fagotti A. Early postoperative bladder training in patients submitted to radical hysterectomy: is it still necessary? A randomized trial. ArchGynecolObstet. 2015;291(4):883–8.
18. CharoenkwanK, KietpeerakoolC: Retroperitoneal drainage versus no drainage after pelvic lymphadenectomy for the prevention of lymphocyst formation in patients with gynaecological malignancies. Cochrane Database SystRev.2014;(6):CD007387.
19. Nick AM, Schmeler KM, Frumovitz MM, Soliman PT, Spannuth WA, Burzawa JK, Coleman RL, Wei C, dos Reis R, Ramirez PT. Risk of thromboembolic disease in patients undergoing laparoscopic gynecologic surgery. ObstetGynecol. 2010;116:956–61.
20. Ramirez PT, Nick AM, Frumovitz M, Schmeler KM. Venous thromboembolic events in minimally invasive gynecologic surgery. JMiniInvasive Gynecol. 2013;20:766–9.
21. Eppsteiner RW, Shin JJ, Johnson J, van Dam RM. Mechanical compression versus subcutaneous heparin therapy in postoperative and posttrauma patients: a systematic review and meta-analysis. World J Surg. 2010;34:10–9.
22. Falck-Ytter Y, Francis CW, Johanson NA, Curley C, Dahl OE, Schulman S, Ortel TL, Pauker SG, Colwell Jr CW. Prevention of vte in orthopedic surgery patients: antithrombotic therapy and prevention of thrombosis, 9th ed: American college of chest physicians evidence-based clinical practice guidelines. Chest. 2012;141: e278S–325S.
23. SachdevaA, DaltonM, AmaragiriSV, LeesT.Elastic compression stockings for prevention of deep vein thrombosis. Cochrane Database SystRev.2010;(7):CD001484.
24. Bell BR, Bastien PE, Douketis JD. Prevention of venous thromboembolism in the enhanced recovery after surgery (eras) setting: an evidence-based review. CanJAnaesth J Canadien d'anesthesie. 2015;62:194–202.
25. Reif P, Drobnitsch T, Aigmuller T, Laky R, Ulrich D, Haas J, Bader A, Tamussino K. The decreasing length of hospital stay following vaginal hysterectomy: 2011–2012 vs. 1996–1997 vs. 1995–1996. Geburtshilfe und Frauenheilkunde. 2014;74:449–53.
26. CharoenkwanK, MatovinovicE: Early versus delayed oral fluids and food for reducing complications after major abdominal gynaecologic surgery. Cochrane Database SystRev.2014;(12):CD004508.
27. Chamsy DJ, Louie MY, Lum DA, Phelps AL, Mansuria SM. Clinical utility of postoperative hemoglobin level testing following total laparoscopic hysterectomy. AmJ ObstetGynecol. 2014;211:224 e221–7.
28. Vonk Noordegraaf A, Anema JR, van Mechelen W, Knol DL, van Baal WM, van Kesteren PJ, Brolmann HA, Huirne JA. A personalised ehealth programme reduces the duration until return to work after gynaecological surgery: results of a multicentre randomised trial. BJOG: IntJ ObstetGynaecol. 2014;121:1127–35. discussion 1136
29. Vonk Noordegraaf A, Huirne JA, Brolmann HA, van Mechelen W, Anema JR. Multidisciplinary convalescence recommendations after gynaecological surgery: a modified delphi method among experts. BJOG Int J ObstetGynaecol. 2011;118:1557–67.
30. Nezhat C, Main J, Paka C, Soliemannjad R, Parsa MA. Advanced gynecologic laparoscopy in a fast-track ambulatory surgery center. JSLS J SocLaparoendosc SurgSocLaparoendosc Surg. 2014;18: e2014.00291.
31. de Lapasse C, Rabischong B, Bolandard F, Canis M, Botchorischvili R, Jardon K, Mage G. Total laparoscopic hysterectomy and early discharge: satisfaction and feasibility study. JMiniInvasive Gynecol. 2008;15:20–5.
32. Lassen PD, Moeller-Larsen H. P DEN: same-day discharge after laparoscopic hysterectomy. Acta Obstet Gynecol Scand. 2012; 91:1339–41.

54 Extraperitoneal Hysterectomy-Total Pelvic Peritonectomy Combined with the Segmental Resection of the Rectosigmoid

Massaki Andou

The Extraperitoneal Hysterectomy

Theoretically, total removal of the pelvic peritoneum is the most beneficial tactic for disease restricted to the pelvis. With the total removal of the pelvic peritoneum in mind, we developed our laparoscopic extraperitoneal hysterectomy. The goals for this surgery are the complete eradication of tumor cells for stage II ovarian cancer and this surgery is also implemented as optimal cytoreductive surgery for selected stage III patients who have massive residual pelvic disease after previous surgery or neoadjuvant chemotherapy, where upper abdominal tumors have been completely controlled.

Ovarian cancer has the possibility to be extensive disease, with a traditionally invasive approach to treatment. Because ovarian cancer requires the most invasive surgery in gynecology, making this surgery patient friendly is a necessary theme. The feasibility and efficacy of laparoscopic staging and cytoreductive surgery in ovarian cancer is demonstrated in our series. Laparoscopic surgery for ovarian cancer is traditionally regarded as a contraindication. However, the standard laparotomy is a very invasive procedure which is sometimes difficult to perform with very poor performance status patients, and also potentially causes the delay of the main therapy; chemotherapy. In contrast, laparoscopic optimal cytoreduction allows quick recovery from surgery meaning a quick return to primary treatment. It also has the advantage of decreasing bowel morbidity, which also frequently causes delays in administration of chemotherapy.

Procedure

Four ports are used in this surgery- a 12 mm port in the umbilicus, another 12 mm port is placed in 4 cm median and 4 cms above the right iliac crest. One 5 mm port is placed at the same position on the opposite side. Another 5 mm port is placed directly between these two ports. The patient is placed in the lithotomy position with a slight Trendelenberg tilt. Standard laparoscopic instruments are used for most of the procedure. We also used a linear stapler and circular stapler for bowel reconstruction.

The extraperitoneal hysterectomy begins with a peritoneal incision starting from the pelvic sidewall triangle at the level of the pelvic brim (Fig. 54.1). The incision is extended anteriorly, curving along the upper edge of the public bone and finally arriving at the same point on the left side of the pelvis. The next step is the dissection of the bladder peritoneum from the bladder wall. The bladder peritoneum is dissected until the uterine cervix appears. The bladder is then dissected off from the cervix. After mobilization of the peritoneum of the bladder and pelvic

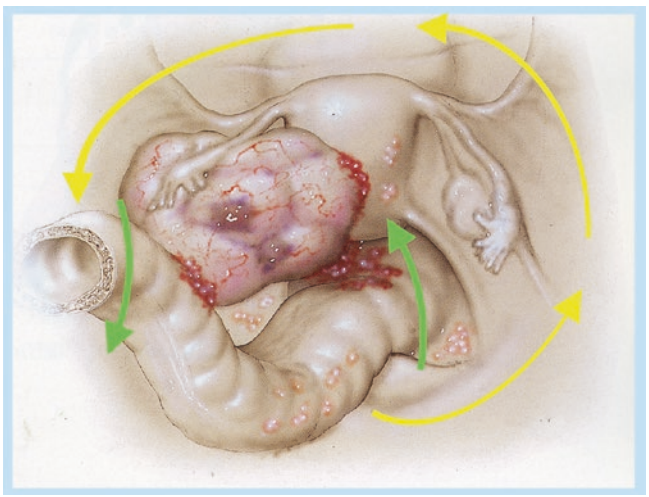


Fig. 54.1 Incision line of the pelvic peritoneum

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sidewall, the extraperitoneal transection of the parametria is started (Fig. 54.2).

After the ureter is detached from the posterior layer of the broad ligament, the ureter is dissected down until the entrance of the ureteral tunnel is reached. Then, the cardinal ligament is bipolar desiccated and transected (Fig. 54.3). The vagina is exposed and transected.

The second stage of this procedure is the removal of the rectosigmoid. As the peritoneum of this portion cannot be detached from the organ, the procedure requires the segmental resection of this segment. The rectosigmoid is mobilized starting from the dissection of the presacral space. This dissection continues until the pelvic diaphragm is reached. The mesosigmoid is divided using a harmonic scalpel. After full mobilization of the mesosigmoid, the upper portion of the segment is transected using a linear stapler (Fig. 54.4) and the caudal portion of this segment is also transected. After all of these procedures have been completed, the uterine body along with the rectosigmoid are put into a protection bag to stop the spilling of tumor cells in the abdominal cavity, and removed through the vagina (Fig. 54.5). Finally, the rectum is anastomosed to the sigma using a circular stapler (Fig. 54.6).

All cases underwent a hysterectomy, bilateral salpingo-oophorectomy, retroperitoneal lymph node dissection, sampling of ascitic fluid, multiple peritoneal biopsy, appendectomy and omentectomy. Some selected cases underwent cytoreductive procedures including elimination of peritoneal dissemination using an argon beam coagulator, removal of the pancreas tail and spleen because of metastatic tumors to the splenic hilus, resection of the total pelvic peritoneum including extraperitoneal hysterectomy, segmental resection of the rectosigmoid due to dissemination to the pelvic peritoneum and/or bowel wall

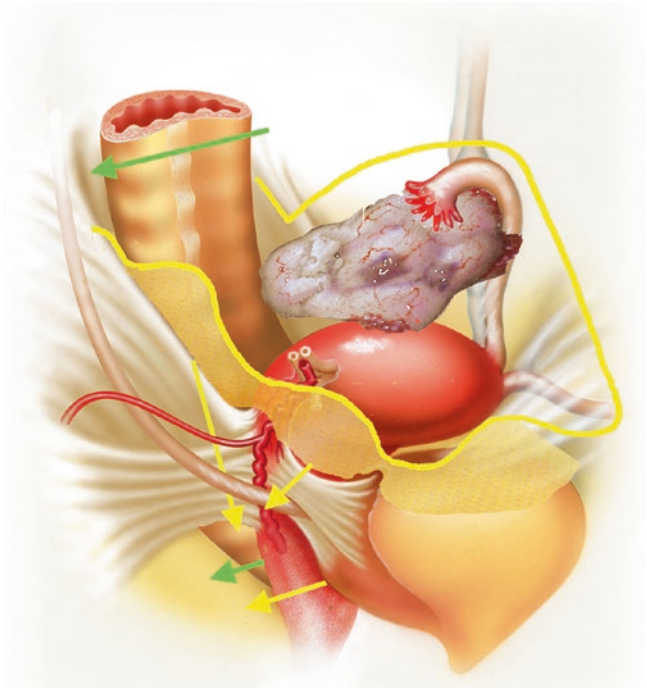


Fig. 54.2 Extraperitoneal resection of the parametria

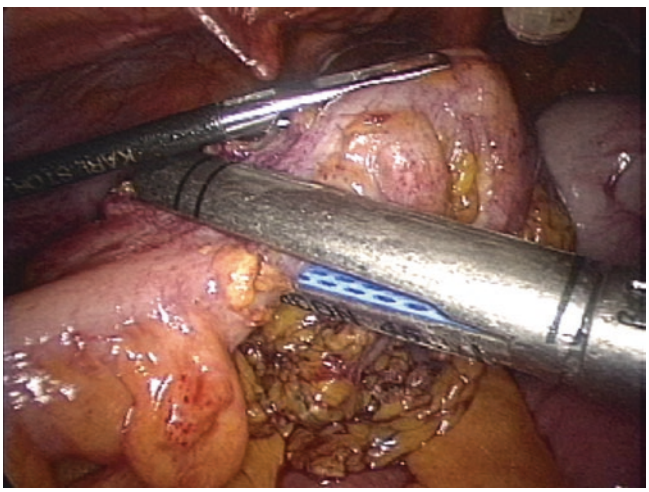


Fig. 54.4 Transection of the rectosigmoid

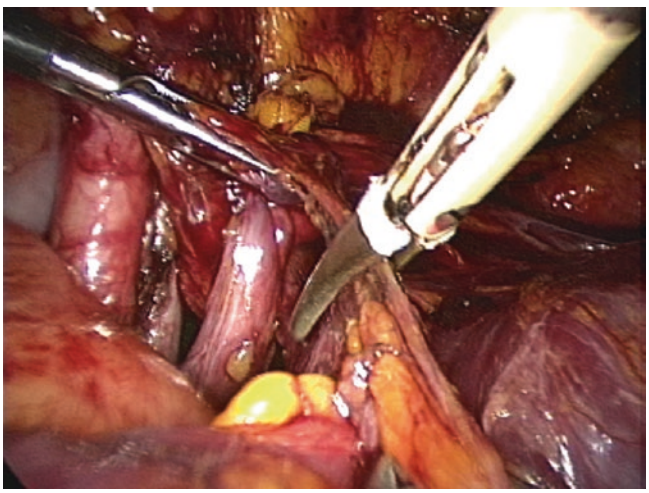


Fig. 54.3 Transection of the left cardinal lig

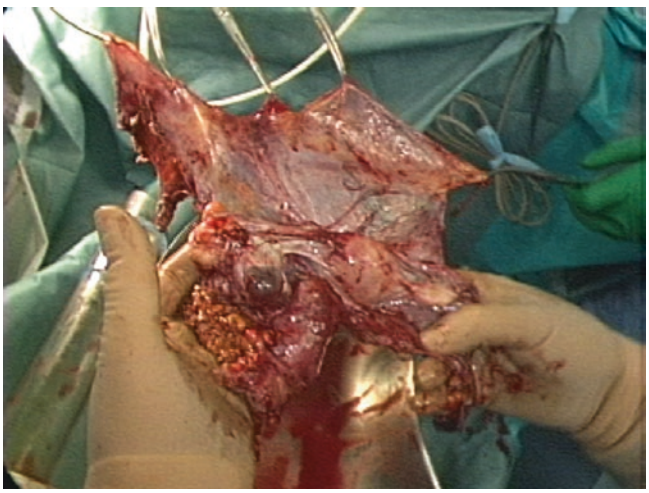


Fig. 54.5 Retrieved specimen

invasion (Fig. 54.7). Although the indications for this surgery are not broad, it is efficacious and safe for patients who require extensive pelvic resection or cytoreduction. Through this procedure, it has become possible to achieve complete tumor eradication if the tumor is located in the pelvis.

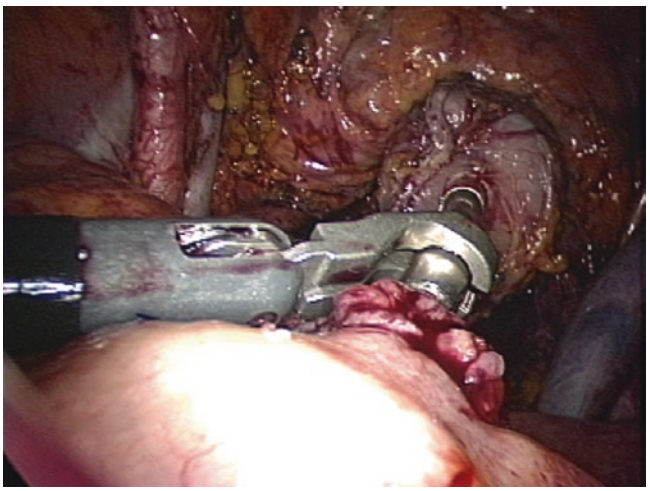


Fig. 54.6 Anastomosis of the rectosigmoid

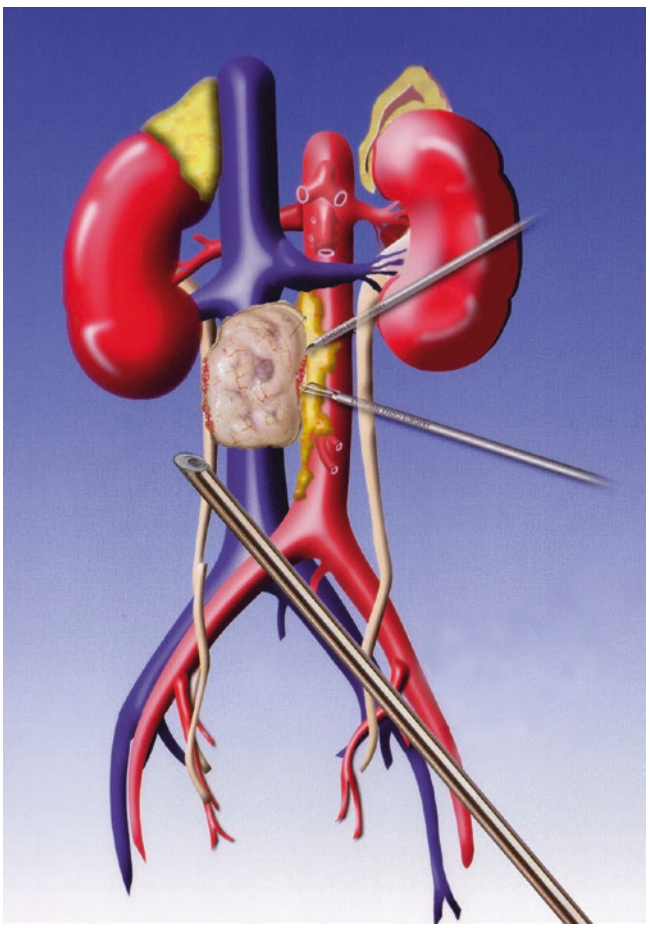


Fig. 54.7 Illustration showing the metastatic lymph node fixed to the inferior vena cava in debulking lymphadenectomy

Additional Cytoreductive Procedures

Because of the aggressive nature of ovarian cancer, many cases suffer from extensive tumor distribution or dissemination. For these cases it is necessary to find ways to manage the broad extension of the disease while considering the quality of life of the patient. We have introduced some additional procedures for laparoscopic cytoreductive surgery for advanced ovarian cancer such as a debulking lymphadenectomy, diaphragma stripping, omentectomy, and segmental resection of the small bowel or the rectosigmoid.

In the case of the debulking lymphadenectomy we use the paraortic dissection followed by the transperitoneal approach in the pelvis (Fig. 54.8). We use very fine bipolar forceps to grasp the base of the adhered metastatic lymph node and then simultaneously coagulate the connected area and slice off the lymph node in a sweeping motion (Fig. 54.9). The resected lymph nodes are retrieved from the port site after being placed in a retrieval bag to prevent the spillage of tumor cells.

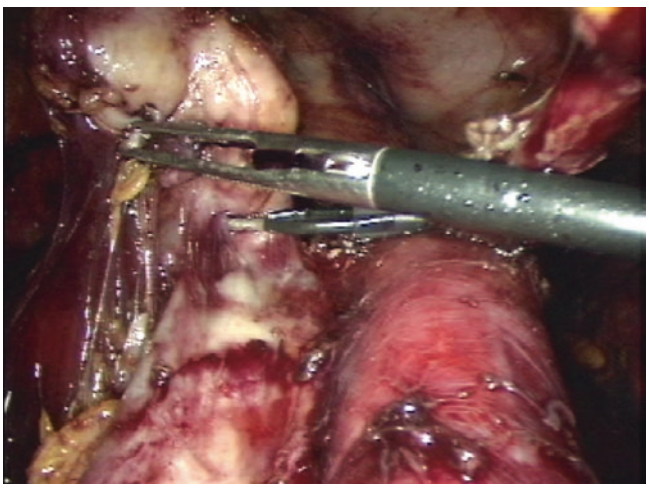


Fig. 54.8 Dissection of metastatic lymphnodes using bipolar forceps

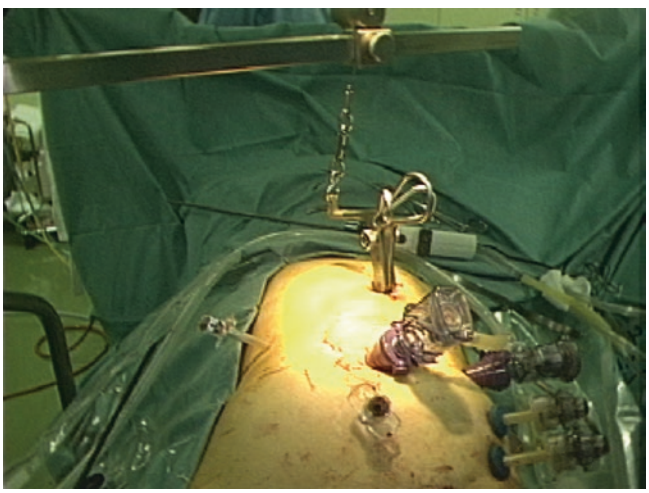


Fig. 54.9 Gasless technique for diaphragma-stripping

As for diaphragma stripping we use gasless laparoscopy at the very end of the entire procedure (Fig. 54.10). The reason for this is to prevent barotraumas like pneumothorax. We infiltrate diluted pitressin between the diaphragma fascia and the diaphragma muscle to create space (Fig. 54.11). Then we use a harmonic scalpel to remove the fascia layer. We do not use electrocautery to avoid the contraction of the diaphragma (Fig. 54.12a–d).



Fig. 54.10 Infiltration of diluted pitressin as aquadissection (diaphragma -stripping)

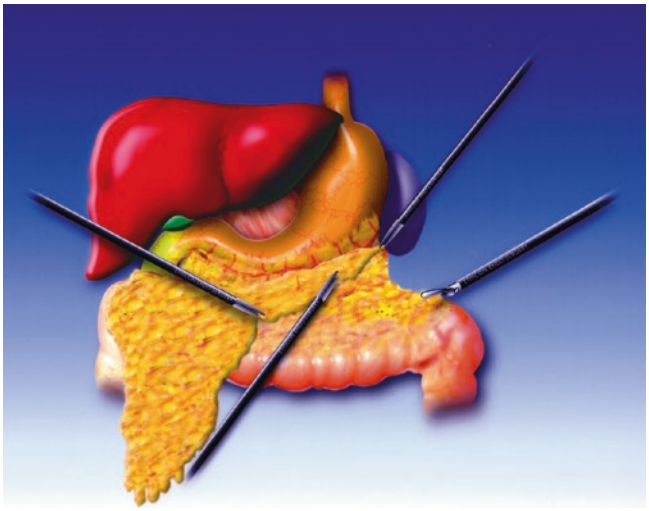


Fig. 54.12 Infragastric omentectomy- the omentum is removed below the gastroepiploic artery

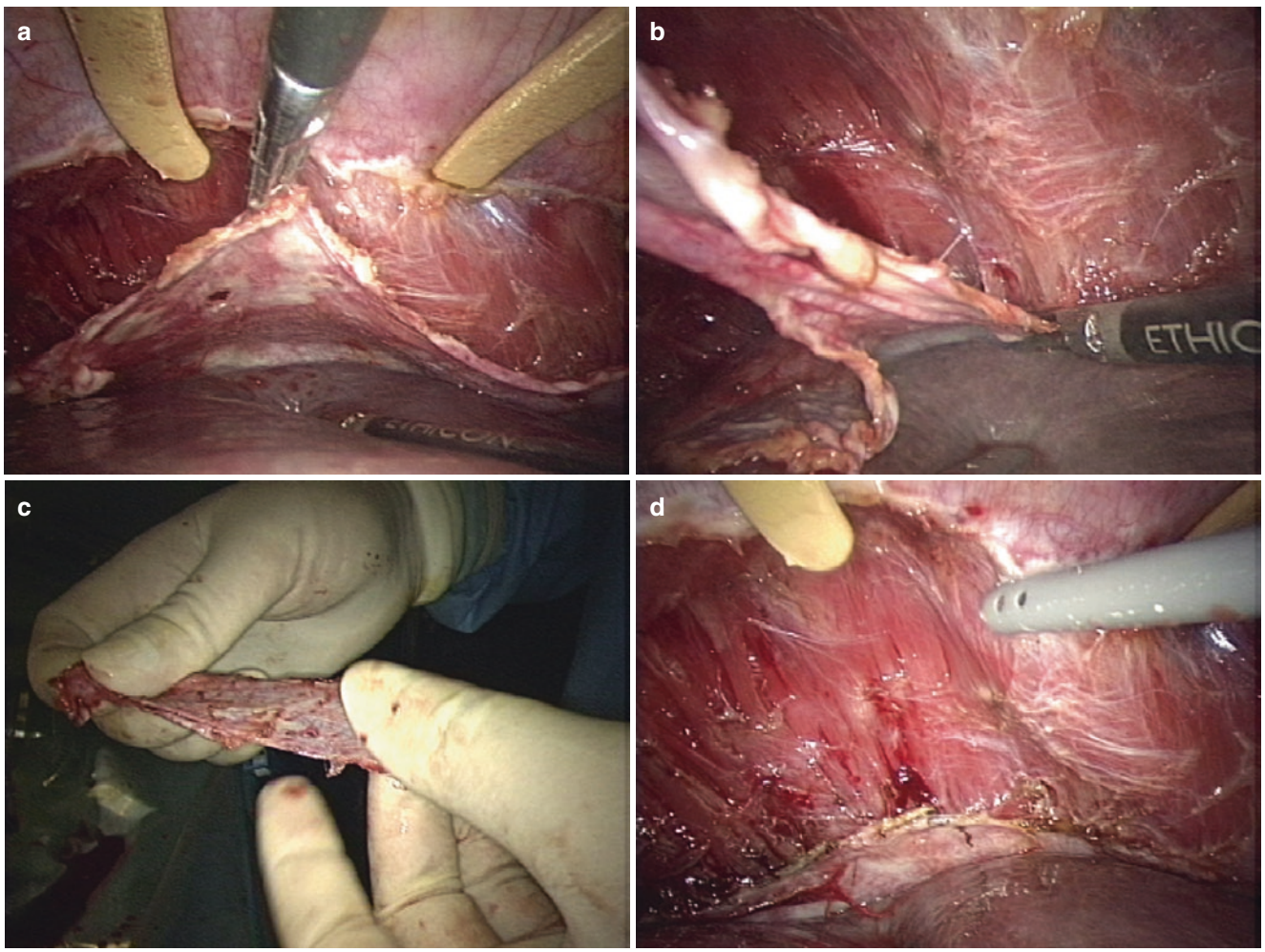


Fig. 54.11 (**a**) Dissection using harmonic scalpel (diaphragma-stripping). (**b**) Removal of dissected diaphragma (diaphragma-stripping). (**c**) Retrieved specimen after diaphragma-stripping. (**d**) Status after diaphragma-stripping



Fig. 54.13 Specimen after omentectomy

The omentectomy we perform is an infragastric omentectomy. The goal of this procedure is to remove as much of the tumor as possible. Initially, we cut the omentum from the transverse colon (Fig. 54.13) and dissect until the upper boundary, just under the gastroepiploic artery, with a harmonic scalpel (Fig. 54.14).

For resection of the bowel, we employ reconstructive techniques. Segmental resection of the bowel requires stapling, using both a linear and circular stapler. For the small bowel, functional end-to-end anastomosis using four linear staples produces the best result (Figs. 54.15 1–14, 54.16, 54.17, and 54.18). After transection of the segment of the small bowel using two 45 mm linear staples, anastomosis of the residual bowel stumps can proceed. The antimesenteric sidewall of both bowel stumps is approximated using a 3-0 stay suture. Each fork of a linear stapler is inserted into each of the orifices of the oral and anal stumps of the small bowel. Firing of the linear stapler results in side-to-side anastomosis. The open cut end of connected bowel stumps is stapled and closed using a 60 mm linear stapler.

For cases with extensive peritoneal implants, we eliminate peritoneal dissemination using an argon beam coagulator (Fig. 54.19). Some cases underwent resection of the pancreas tail and spleen because of metastatic tumors to the splenic hilus. We used a linear stapler to transect the pancreas tail. As a result of performing these additional procedures, we can offer optimal cytoreduction tailored to individual patients.

Results

From June 2000 to date, 21 patients have undergone pelvic peritonectomy with or with out rectal resection combined standard procedure. For some patients, the procedure had to be divided into two operative sessions due to the extensive nature of their disease. All patients underwent a hysterectomy and bilateral adnexectomy and retroperitoneal lymphadenectomy and omentectomy. Some patients also required an appendectomy. Six patients with one stage IIc, (clear cell carcinoma), five IIIc (serous papillary adenocarcinoma) and one IV (papillary adenocarcinoma) underwent he standard procedure plus a pelvic peritonectomy with LAR. Fourteen cases underwent the standard procedure plus a pelvic peritonectomy without LAR. These cases ranged from stage Ia to stage IV, diagnosed with granulose cell carcinoma, clear cell carcinoma, serous papillary adenocarcinoma, papillary adenocarcinoma and mucinous adenocarcinoma.

The average observation period is 87 months (range 16 months to 168 months). Of the patients who underwent rectal resection, two patients are alive with disease, five patients are alive with no evidence of disease. Of the 14 patients who did not undergo rectal resection seven patients are alive with no evidence of disease. Six of these patients have died from disease and we have no data on one patient. No major complications requiring reoperation occurred during the surgical procedures and the post-operative courses of all patients was uneventful and recovery was very quick.

Discussion

Although we cannot draw any definite conclusions for survival advantage in this retrospective analysis as we only have a limited number of cases over a relatively short period, the quality of life of patients who underwent this minimally invasive surgery is obviously better. There are some problems with this minimally invasive approach such as, the occurrence of port site metastasis and the difficulty in mastering the necessary surgical skills. Evaluating the treatment methods for patients with malignancy is difficult when considering the small number of patients with advanced ovarian cancer. We believe that the limit of traditional therapy may have already been reached. In order to achieve a new stage in management and to increase the quality of life of patients, it is necessary to break traditional patterns and attempt a new approach. This was our motivation in applying this technique to ovarian cancer cases.

Laparoscopic surgery, with its minimally invasive advantages, is vital for achieving a more patent friendly approach, even when dealing with diseases like advanced ovarian cancer. Through the kind of extensive debulking techniques described here, optimal cytoreduction can be achieved completely laparoscopically. Laparoscopy allows the possibility of expanding the radicality of surgery to match the needs of patients with advanced and recurrent gynecologic malignancy, without increasing the invasiveness of the surgery itself. Additionally, by also applying reconstructive techniques, it is possible to ensure full resection of all questionable tissue, a necessity for cases with malignant disease. Minimally invasive surgery benefits those who must undergo the most radical procedures and laparoscopy provides the necessary platform for reaching a new stage in malignancy management.

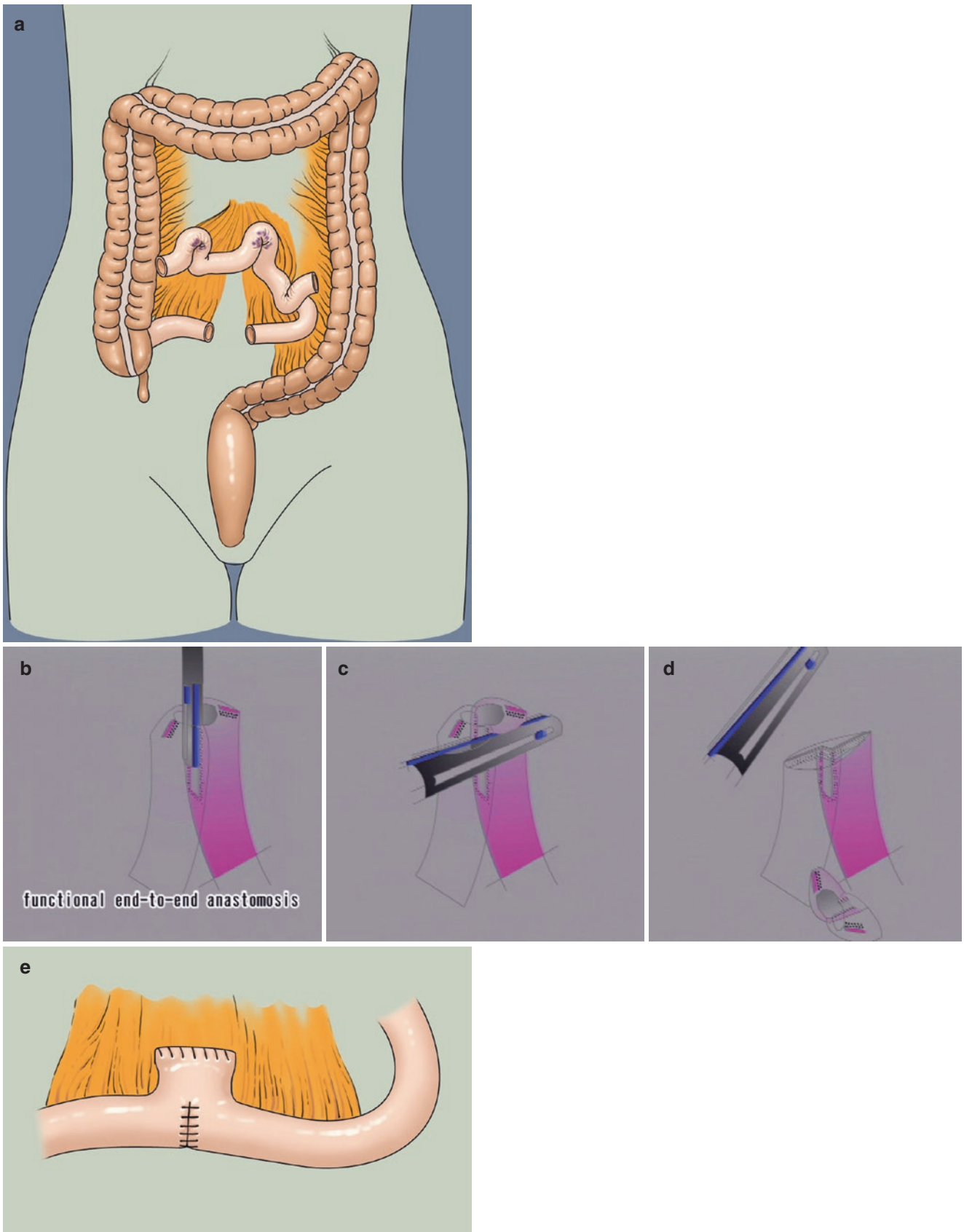


Fig. 54.14 (**a**) Dissemination to the small bowel- the resected segment of the small bowel is infiltrated by ovarian cancer metastasis. (**b**) Functional end-to-end anastomosis. This technique is required when large tracts of the small bowel need to be resected due to extensive invasion or numerous smaller invasion sites that cannot be resected individually. (**c**) Connection of the two bowel loops. (**d**) Creation of a new flow. (**e**) Status after functional end-to-end anastomosis

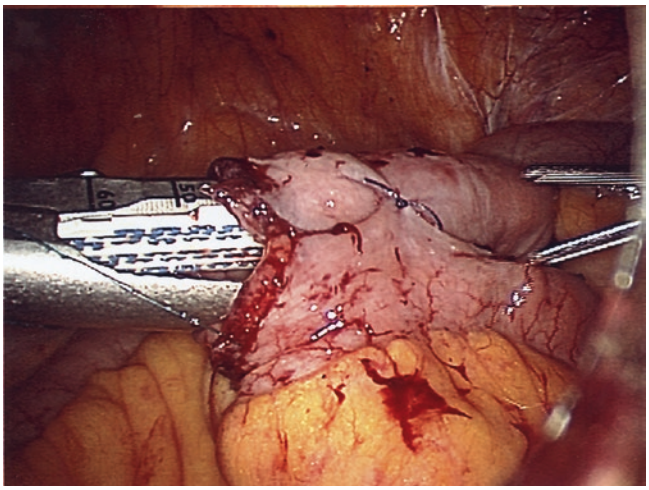


Fig. 54.15 The antimesenteric sidewall of both bowel stumps are approximated and stapled (side to side fixation)

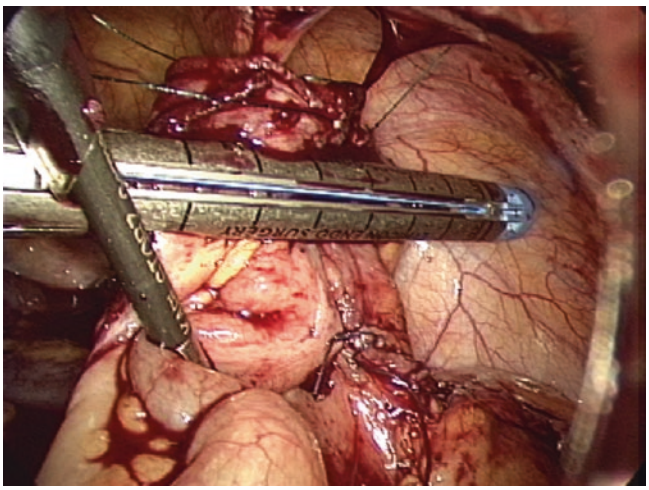


Fig. 54.16 Closure of the open cut end of the connected bowel stumps using a 60 mm linear stapler



Fig. 54.17 Specimen after small bowel resection



Fig. 54.18 Elimination of peritoneal dissemination using an argon beam coagulator

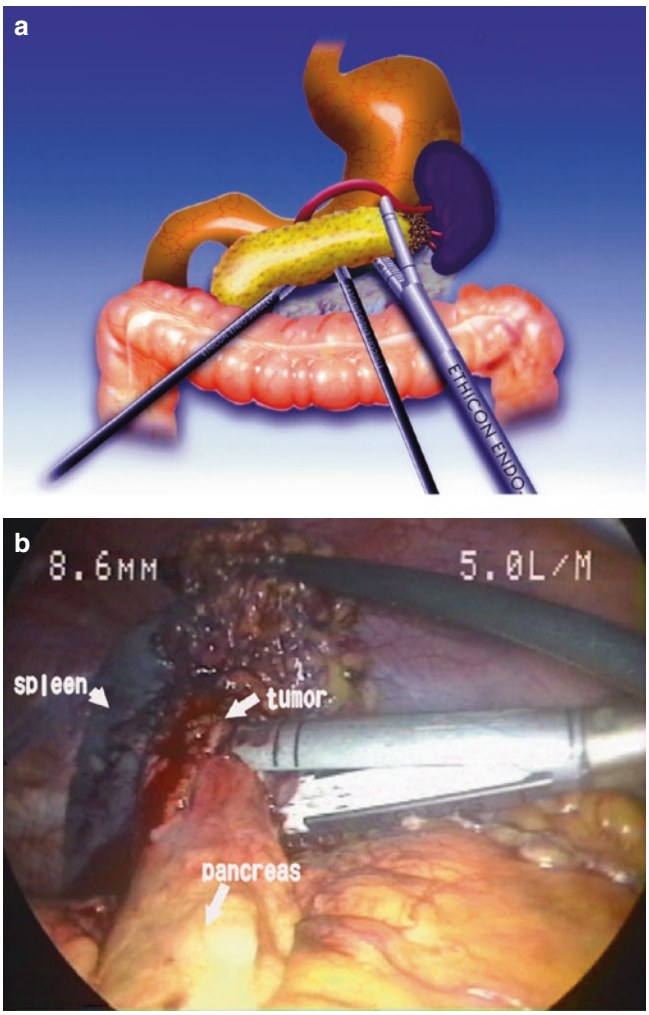


Fig. 54.19 (**a**) Removal of the pancreas tail and spleen because of metastatic tumors to the splenic hilus. (**b**) removal of the pancreas tail and spleen because of metastatic tumors to the splenic hilus

Part IX

Robotic-Assisted Laparoscopic Hysterectomy and Extended Procedures for Benign and Malignant Indications



Indications and Contraindications to Robotic-Assisted Hysterectomy

55

Melissa H. Lippitt, Edward J. Tanner III, and Amanda Nickles Fader

Introduction

Hysterectomy is one of the most common surgical procedures performed during a woman's lifetime. In 1998, there were approximately 540,000 hysterectomies performed in the U.S. This decreased to 430,000 by 2010 [1], due to introduction of more conservative approaches to management of uterine fibroids and abnormal uterine bleeding, the most common indications to hysterectomy. While the overall number of hysterectomies performed in the U.S. and Europe has declined substantially over the past decade, the use of minimally invasive techniques (MIS), including laparoscopic and robot-assisted approaches, has increased. Level I studies have shown the benefit of minimally invasive surgery compared with laparotomy, including improved perioperative outcomes, shorter hospital stays, improved quality of life and faster return to daily functions [2]. With regards to minimally invasive hysterectomy techniques, the first elective hysterectomy utilizing a vaginal approach was performed in Germany in 1801. Almost 200 years later, the first total laparoscopic hysterectomy was performed in 1988 [3], which was followed in 1999 with the first published case of robot-assisted gynecologic surgery [4]. After several iterations were developed by different U.S. companies, in 2005, the da Vinci Surgical System® (Intuitive Surgical, Sunnyvale, CA), was approved by the Food and Drug Administration for use in gynecologic surgery (Figs. 55.1 and 55.2).

Currently, robotic-assisted surgery is performed for both benign and oncologic gynecologic indications (Table 55.1) [5]. Gynecologists may perform a wide variety of robotic-assisted procedures, including hysterectomy, myomectomy, excision of endometriosis, tubal re-anastomosis to restore fertility, sacrocolpopexy, adnexal cyst removal, repair of vesicovaginal fistulas and staging of cervical and endometrial cancers [6–12]. The potential benefits of robotic surgery over conventional laparoscopy include improved depth perception with three dimensional stereoscopic vision, wristed instruments for improved dexterity, tremor canceling software to improve surgical precision, improved range of motion, optimization of ergonomics and autonomy, decreased learning curves and potentially decreased incisional pain [2, 13] (Table 55.2). The limitations of robotic surgery include the lack of haptic feedback, bulky platform, and increased cost compared with laparoscopic platforms and instrumentation.

Indications

Benign Indications

Robotic surgery for benign gynecologic disease is on the rise since the approval of the da Vinci Surgical System® in 2005. A recent study by Wright et al. examined the rate of hysterectomy for benign gynecologic disorders at 441 U.S. hospitals. During 2007 to 2010, robotically assisted hysterectomy rates increased from 0.5 % in 2007 to 9.5 % of all hysterectomies, while laparoscopic hysterectomy rates increased from 24.3 to 30.5 % [14]. Additionally, the authors found that the abdominal hysterectomy rates decreased among hospitals where robotic-assisted hysterectomy was both performed *and* not performed. A contemporary Cochrane review in 2014 concluded, "We are uncertain as to whether robotic assisted surgery (RAS) or conventional laparoscopic surgery (CLS) has lower intraoperative and postoperative complication rates because of the imprecision of the effect and inconsistency among studies when they are used for hys-

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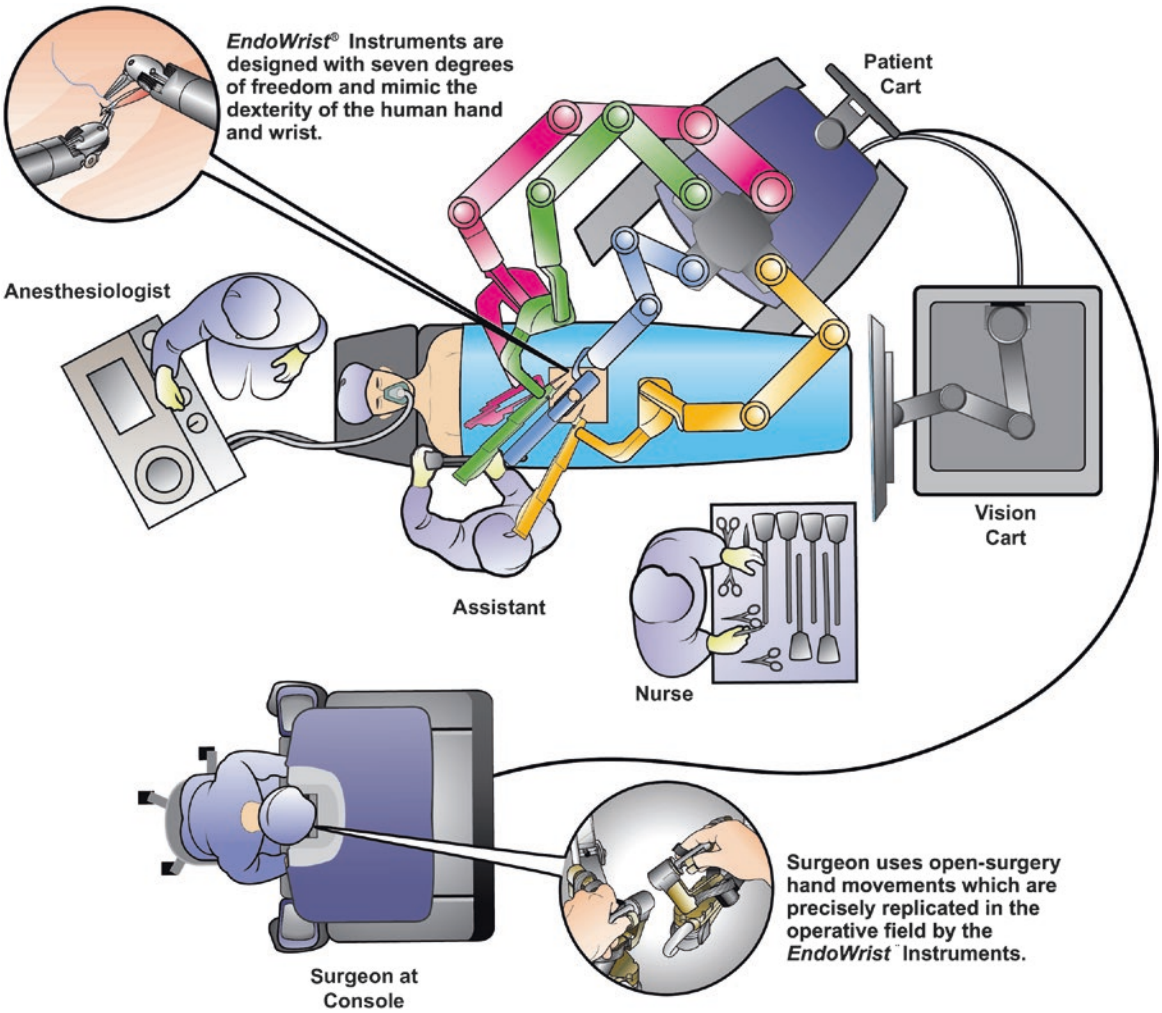


Fig. 55.1 da Vinci Si operating room schematic (©2016 Intuitive Surgical, Inc Used with permission)



Fig. 55.2 da Vinci Si operating room (©2016 Intuitive Surgical, Inc Used with permission)

Table 55.1 Indications for robotic-assisted hysterectomy

Benign indications	Large uteri
	Leiomyomas
	Endometriosis
	Severe adhesive disease
	Cervical dysplasia
	Benign adnexal mass or cysts
	Sacrocolpopexy
	Morbid obesity
Malignant indications	Endometrial cancer
	Cervical cancer
	Early ovarian cancer
	Risk reducing surgery for women with familial cancer syndromes

Table 55.2 Benefits and limitations of robotic surgery compared to conventional laparoscopy

Benefits	Limitations
Improved depth perception with three dimensional stereoscopic vision	Lack of haptic feedback
Wristed instruments for improved dexterity	Possible increased operative time
Tremor canceling software to improve surgical precision	Lack of direct access to the patient
Improved range of motion	Cost
Optimization of ergonomics and autonomy	
Decreased learning curves	
Decreased incision pain	

terectomy and sacrocolpopexy. Moderate-quality evidence suggests that these procedures take longer with RAS but may be associated with a shorter hospital stay following hysterectomy. Ongoing trials are likely to have an important impact on evidence related to the use of RAS in gynecology [15]." Currently, robotic surgery is used to treat a variety of benign gynecological diseases including large uteri, uterine leiomyomas, endometriosis, severe adhesive disease, cervical dysplasia, benign adnexal masses or cysts, management of pelvic organ prolapse and sacrocolpopexy.

Large Uteri and Leiomyomas

Payne et al. reported the feasibility of robotically assisted hysterectomy in women with large uteri in five community practices. The largest uteri removed in this study weighed 3020 g. The study showed that women with large uteri (uterine weights greater than 250 g) may successfully undergo robotically- assisted hysterectomy with low morbidity, low blood loss, and minimal risk of conversion to laparotomy [16]. A subsequent retrospective review compared outcomes of mini-laparotomy versus robot-assisted laparoscopy for uteri weighing at least 500 g. Unadjusted mean blood loss, rate of hemorrhage, and rate of blood transfusion were all higher with mini-laparotomy than with robot-assisted surgery, while the median postoperative stay was significantly shorter with robotic surgery [17]. Additionally, given the wristed instrumentation of the robotic platform, suturing and knot tying in the repair of myomectomy defects may be technically less challenging to perform with robotic-assistance than with conventional laparoscopy.

Endometriosis and/or Severe Adhesive Disease

In the hands of experienced surgeons, robot-assisted laparoscopic hysterectomy may facilitate hysterectomy for patients with endometriosis and/or severe adhesive disease who may otherwise not have been offered a minimally invasive approach. Advincula et al. published a feasibility study in 2005 and reported on the success of robot-assisted laparoscopic hysterectomy in patients with a scarred or obliterated anterior cul-de-sac [18]. More recently, a retrospective cohort study compared robotic versus laparoscopic approach of hysterectomy in patients with severe pelvic adhesions [19]. Robotic surgery was associated with a shortened operation time and reduced blood loss in patients with severe adhesions compared with laparoscopy. They also reported a lower postoperative pain score in the robotic group as compared to the laparoscopic group.

Pelvic Organ Prolapse – Sacrocolpopexy

The gold standard procedure for the surgical treatment of severe pelvic organ prolapse is open abdominal sacrocolpopexy. An alternative approach to laparotomy includes laparoscopic sacrocolpopexy and more recently robot-assisted laparoscopic sacrocolpopexy. A recent systematic review of conventional laparoscopic sacrocolpopexy versus robot-assisted laparoscopic sacrocolpopexy reported the clinic outcomes (estimated blood loss, intraoperative and postoperative complications) of prolapse surgery are similar, but robotic surgery is less efficient in terms of cost and time [20]. Laparoscopic sacrocolpopexy is technically more challenging because it requires the surgical skills to perform suturing with knot tying and the ability to accurately determine the correct planes for safe dissection of the vesicovaginal and rectovaginal spaces [21]. Robotic technology overcomes some of these limitations, allowing a surgeon who may be uncomfortable with laparoscopy to still be able to offer a minimally invasive approach.

Obese Patients

Obesity represents one of the most common causes of death in the Western hemisphere [22]. The robotic technique can optimize the surgical approach and recovery of obese patients with equally, if not better outcomes, compared to open and/or

laparoscopic techniques. Advantages of the robotic approach include minimal blood loss, low conversion to open rates, no need for drain use and quicker recovery period [23]. Robotic assisted hysterectomy is feasible in patients with all classes of obesity, including super obesity. A patient with a BMI of 98 successfully underwent a robotic-assisted hysterectomy [24].

Malignant Indications

In 2012, the Society for Gynecologic Oncology released their consensus statement on the use of robotic-assisted surgery in gynecologic oncology, stating "Robotic-assisted surgery has had a significant impact on the minimally invasive surgical approach to patients with gynecologic malignancies in the United States [25]." Currently, the robotics platform is used in the treatment of endometrial cancer, cervical cancer, and less commonly for ovarian cancer and resection of recurrent, oligometastatic disease.

Endometrial Cancer

Endometrial cancer is the most common gynecologic cancer in the United States and it has the most common use of the robotic platform [25]. Minimally invasive surgery approach is the accepted standard of care for endometrial cancer surgical staging. Eight randomized controlled trials, including the U.S. Gynecologic Oncology Group LAP2 study in 2009 demonstrated an improvement in surgical outcomes for patients undergoing laparoscopy for endometrial cancer staging when compared with those operated on by laparotomy [26–28]. While more data is needed to compare robotic surgery directly to laparoscopy, the adoption of the robotic platform has led to an increase in the total number of patients who were offered minimally invasive surgery [27, 29, 30].

In 2011 Paley et al. published a large, prospective, non-randomized study of 377 consecutive robotic surgical staging procedures for endometrial cancer compared with 121 staging procedures performed by laparotomy for the same indication. Overall, serious complications, such as wound dehiscence, bleeding, and urologic injury were found to be three times more likely in the laparotomy group. However, this study did not include a laparoscopy arm for direct comparison. Gaia et al. [28] published a systematic review of 1591 patients, from eight studies, undergoing robotic-assisted surgeries compared with traditional laparoscopic or laparotomy techniques for the treatment of endometrial cancer. The study found that the estimated blood loss was reduced in robotic hysterectomy compared with laparotomy ($P < 0.005$) and laparoscopy ($P=0.001$), length of stay was shorter for both robotic and laparoscopic cases compared with laparotomy ($P < 0.01$) and operative time for robotic hysterectomy was similar to laparoscopic cases but was greater than laparotomy ($P <0.005$). Conversion to laparotomy was more than double in the laparoscopy group (4.6 % vs. 9.9 %), but this was not statistically significant ($P = 0.06$). The mean number of lymph nodes and perioperative complication rates, which included gastrointestinal injury, urologic injury, and vaginal cuff dehiscence, were the same in the three study arms.

Sentinel lymph node mapping for endometrial cancer at that time of hysterectomy and staging results in reliable mapping of relevant lymph nodes that drain the uterus (Fig. 55.3). Advantages of SLN mapping including reduction of lymphedema and intraoperative complications and improved detection of positive lymph nodes with ultrastaging techniques. Sinno et al. published a study in 2014 comparing colorimetric versus flurometric sentinel lymph node mapping during robotic surgery for endometrial cancer, suggesting that fluorescence imaging with indocyanine green may be superior to colorimetric imaging with isosulfan blue in women undergoing sentinel node mapping for endometrial cancer. Currently, the robotic platform remains the most feasible method for performing accurate sentinel lymph node mapping [31–33].

Cervical Cancer

The standard of care for a patient with early cervical cancer (FIGO stage IA2 – IIA) is a radical hysterectomy, with 5-year overall survival rates of 62–90 % [34]. The intricacies of radical hysterectomy, which include a sophisticated

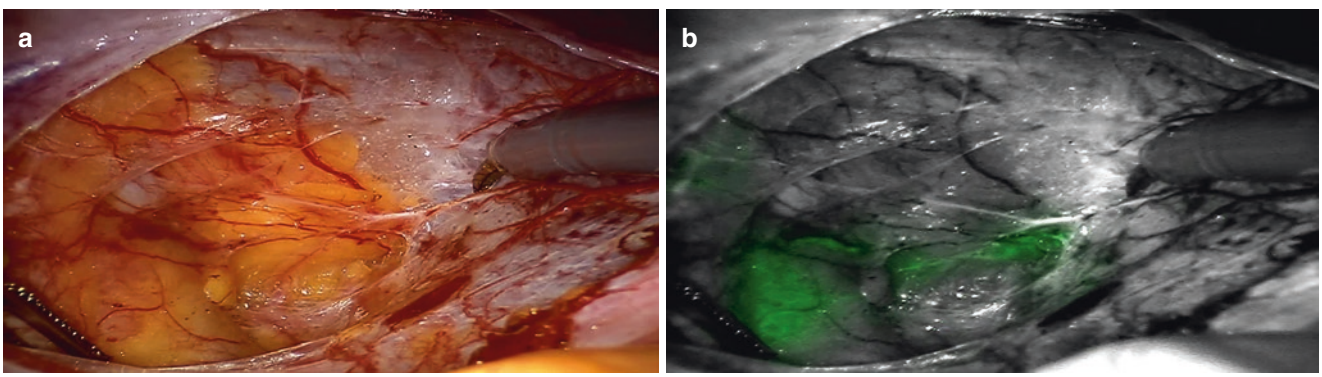


Fig. 55.3 Sentinel node mapping with indocyanine green: (**a**) without fluorescence, (**b**) addition of firefly fluorescence

dissection of the parametria, unroofing of the ureter from the ureteric canal within the cardinal ligament, and an en block resection of the uterus, cervix, parametria, and uterosacral ligaments, make it an ideal procedure to perform on the robotic platform, especially as only a small number of surgeons adopted the laparoscopic technique for this complex procedure [2]. Multiple studies have assessed the feasibility and safety of robotic-assisted radical hysterectomy (RRH) [35–38]. Boggess et al. [35] showed RRRH versus radical abdominal hysterectomy (RAH) to be associated with reduced operating room time, estimated blood loss, and length of surgery as compared to radical abdominal hysterectomy; Magrina et al. [38] showed improved outcomes for RRH vs total laparoscopic radical hysterectomy and RAH; Cantrell et al. [36] showed similar progression free survival and overall survival compared to RAH. One study, Soliman et al. [13] showed overall decreased intravenous opioid administration compared with the total laparoscopic radical hysterctomy (TLRH).

The robotic platform is also quite useful for radical trachelectomy in select patients with early-stage cervical cancer desiring fertility preservation [39]. Radical trachelectomy is a complex procedure, and the superior optics and wristed hand motions offered by the robotic platform compared with conventional laparoscopy are particularly attractive in this setting [2].

Ovarian Cancer

Comprehensive surgical staging in ovarian cancer requires exploration of the entire peritoneal cavity, from the diaphragm to the pelvic floor. The new fourth generation system allows multi-quadrant surgery without needing to undock and rotate patients. More research is needed to determine whether initial ovarian cancer debulking surgery will become a common use of robotic-assisted surgery in the future. Data suggests that robotic surgery is feasible for early stage ovarian cancer staging and select patients with recurrent ovarian cancer, in the absence of carcinomatosis, may be candidates for secondary surgical cytoreduction via a robotic approach [40, 41].

Contraindications

The only absolute contraindication to robotic hysterectomy is an anesthetic contraindication to pneumoperitoneum. Relative contraindications would include need for laparotomy to control bleeding, advanced malignancy and poor visualization or exposure, which may occur in a patient who has undergone multiple abdominal surgeries and has extensive adhesive disease. Additionally, in order to ensure a safe working environment, it is essential for the surgeon, bedside assistant and scrub technicians to be well versed and comfortable using the robotic surgical platform.

Additional Considerations

Single Site Robotic Assisted Hysterectomy

Laparoendoscopic single-site surgery may offer advantages versus conventional laparoscopy, including fewer operative complications related to trocar insertion, a cosmetically more pleasing incision, and a larger surface area for specimen retrieval in the post-power morcellator era [42, 43]. One of the first robotic assisted laparoendoscopic single-site surgeries was described by Escboar et al. in 2009, in which a hysterectomy was performed for a BRCA mutation carrier [44]. In this initial case report, a GelPort along with standard robotic trocars and standard robotic instruments were used. Today, Intuitive Surgical has developed a single-site apparatus that can be used with the Si da Vinci Surgical System. It utilizes novel robotic instruments with curved instrument cannulae and semi-rigid instruments, thereby optimizing the single site robotic-assisted hysterectomy (Fig. 55.4). Scheib et al. [45] presented one of the first series of robotic laparoendoscopic single-site surgery in 40 patients for the treatment of various gynecological conditions. A case report in 2015 reported the feasibility of sentinel lymph node biopsy and hysterectomy utilizing the single incision robotic surgery platform [46]. Further studies are needed to better define the ideal benign and malignant gynecological conditions for this new technology.

Cost Considerations

A controversy with robotic surgery remains the high cost associated with performance of the procedure. Proponents of robotic surgery have suggested that the technology can be made more cost-effective, especially as the learning curve improves and shorter operating times are optimized [2]. A large portion of the cost includes the initial purchase cost of

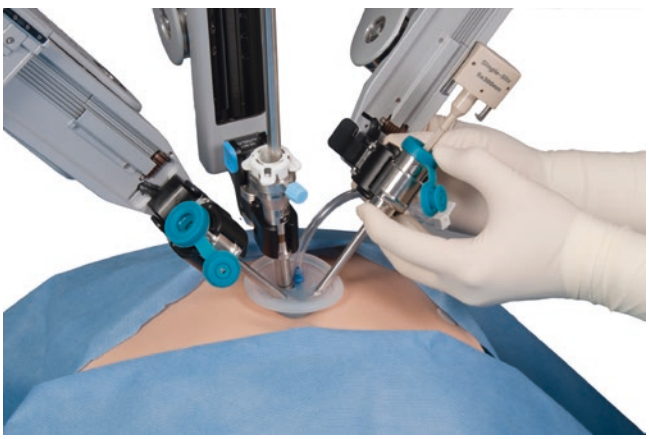


Fig. 55.4 da Vinci single-siteTM instrumentation for the da Vinci Si system (©2016 Intuitive Surgical, Inc Used with permission)

the robot as well as routine maintenance. In 2014, Wright et al. [47] performed an economic analysis to examine the influence of procedure volume, variation in hospital accounting methodology and use of various analytic methodologies on cost of robotically assisted hysterectomy for benign gynecologic disease and endometrial cancer. The authors concluded that the cost of robotic gynecologic surgery decreases with increasing procedure volume. However, in all of their scenarios, robotically assisted hysterectomy remained substantially higher in cost than laparoscopic hysterectomy. For surgeons who performed more than 50 procedures, robotic hysterectomy for benign indications cost $924 more than laparoscopic hysterectomy, and was $688 more for endometrial cancer. Compared to laparotomy, minimally invasive surgery has additional economic benefits including decreased complication rates leading to societal and indirect economic benefits of an earlier return to work [48]. While robotic surgery may remain more costly than laparoscopic surgery, the introduction of robotic surgery has led to an overall decline in the rate of open abdominal hysterectomy [14], and thereby decreasing the overall societal cost of hysterectomies. We expect to see the costs of robotic surgery continue to decrease as other technologies are introduced to the marketplace.

Conclusion

Minimally invasive surgery, including vaginal, laparoscopic and robotic approaches, should be the standard of care for hysterectomy when feasible. Many studies support the feasibility of robotic surgery for benign and malignant gynecologic indications. As robotic surgery continues to gain more popularity, we expect to see more studies exploring the benefits of the robot for benign and malignant gynecologic indications. Ideally, we will see a future with continued increases in the rates of minimally invasive surgery and therefore improved patient outcome.

References

1. Wright JD, Herzog TJ, Tsui J, Ananth CV, Lewin SN, Lu Y-S, et al. Nationwide trends in the performance of inpatient hysterectomy in the United States. Obstet Gynecol. 2013;122(2 Pt 1):233–41.
2. Sinno AK, Fader AN. Robotic-assisted surgery in gynecologic oncology. Fertil Steril Elsevier. 2014;102(4):922–32.
3. Sutton C. Past, present, and future of hysterectomy. J Minim Invasive Gynecol Elsevier Ltd. 2010;17(4):421–35.
4. Falcone T, Goldberg J, Garcia-Ruiz A, Margossian H, Stevens L. Full robotic assistance for laparoscopic tubal anastomosis: a case report. J Laparoendosc Adv Surg Tech A [Internet]. 1999;9(1):107–13. Available from: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=10194702
5. Escobar P, Falcone T. Atlas of single-port, laparoscopic, and robotic surgery. New York: Springer; 2014.
6. Lenihan JP, Kovanda C, Seshadri-Kreaden U. What is the learning curve for robotic assisted gynecologic surgery? J Minim Invasive Gynecol. 2008;15:589–94.
7. Nezhat C, Saberi NS, Shahmohamady B, Nezhat F. Robotic-assisted laparoscopy in gynecological surgery. JSLS. 2006;10(3):317–20.
8. Cela V, Freschi L, Simi G, Tana R, Russo N, Artini PG, et al. Fertility and endocrine outcome after robot-assisted laparoscopic myomectomy (RALM). Gynecol Endocrinol. 2012;3590(January):1–4.
9. Göçmen A, Şanlıkan F, Uçar MG. Comparison of robotic-assisted laparoscopic myomectomy outcomes with laparoscopic myomectomy. Arch Gynecol Obstet. 2013;287(1):91–6.
10. Caillet M, Vandromme J, Rozenberg S, Paesmans M, Germay O, Degueldre M. Robotically assisted laparoscopic microsurgical tubal reanastomosis: a retrospective study. Fertil Steril. 2010;94(5):1844–7.
11. Hemal AK, Kolla SB, Wadhwa P. Robotic reconstruction for recurrent supratrigonal vesicovaginal fistulas. J Urol. 2008;180(3):981–5.
12. Melamud O, Eichel L, Turbow B, Shanberg A. Laparoscopic vesicovaginal fistula repair with robotic reconstruction. Urology. 2005;65(1):163–6.
13. Soliman PT, Langley G, Munsell MF, Vaniya HA, Frumovitz M, Ramirez PT. Analgesic and antiemetic requirements after minimally invasive surgery for early cervical cancer: a comparison between laparoscopy and robotic surgery. Ann Surg Oncol. 2013;20(4):1355–9.
14. Wright JD, Ananth CV, Lewin SN, Burke WM, Lu Y-S, Neugut AI, et al. Robotically assisted vs laparoscopic hysterectomy among women with benign gynecologic disease. JAMA. 2013;309(7):689–98.
15. Liu H, Lawrie TA, Lu D, Song H, Wang L, Shi G Robot-assisted surgery in gynaecology. Cochrane Database Syst Rev. 2014;(12):CD011422.
16. Payne TN, Dauterive FR, Pitter MC, Giep HN, Giep BN, Grogg TW, et al. Robotically assisted hysterectomy in patients with large uteri: outcomes in five community practices. Obstet Gynecol. 2010;115(3):535–42.
17. Smorgick N, Dalton VK, Patzkowsky KE, Hoffman MR, Advincula AP, As-Sanie S. Comparison of 2 minimally invasive routes for hysterectomy of large uteri. Int J Gynecol Obstet. 2013;122(2):128–31.
18. Advincula AP, Reynolds RK. The use of robot-assisted laparoscopic hysterectomy in the patient with a scarred or obliterated anterior cul-de-sac. JSLS. 2005;9(3):287–91.
19. Chiu L-H, Chen C-H, Tu P-C, Chang C-W, Yen Y-K. Comparison of robotic surgery and laparoscopy to perform total hysterectomy with pelvic adhesions or large uterus. J Minim Access Surg [Internet]. 2015;11(1):87. Available from: http://www.journalofmas.com/text.asp?2015/11/1/87/147718
20. Pan K, Zhang Y, Wang Y, Wang Y, Xu H. A systematic review and meta-analysis of conventional laparoscopic sacrocolpopexy versus robot-assisted laparoscopic sacrocolpopexy. Int J Gynecol Obstet. 2016;132:284–91.
21. Clifton MM, Pizarro-Berdichevsky J, HB G. Robotic female pelvic floor reconstruction: a review. Urology. 2016;91:33–40.
22. Fontaine K, Redden D, Wang C, Westfall A, Allison D. Years of life lost due to obesity. JAMA. 2003;289(2):187–93.
23. Iavazzo C, Gkegkes ID. Robotic assisted hysterectomy in obese patients: a systematic review. Arch Gynecol Obstet [Internet]. 2016;293(6):1169–83. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26861466
24. Stone P, Burnett A, Burton B, Roman J. Overcoming extreme obesity with robotic surgery. Int J Med Robot Comput Assist Surg. 2010;6(4):382–5.
25. Ramirez PT, Adams S, Boggess JF, Burke WM, Frumovitz MM, Gardner GJ, et al. Robotic-assisted surgery in gynecologic oncology: a society of gynecologic oncology consensus statement developed by the society of gynecologic oncology's clinical practice robotics rask force. Gynecol Oncol. 2012;124:180–4.
26. Walker JL, Piedmonte MR, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS, et al. Laparoscopy compared with laparotomy for

comprehensive surgical staging of uterine cancer: gynecologic oncology group study LAP2. J Clin Oncol. 2009;27(32):5331–6.
27. Paley PJ, Veljovich DS, Shah CA, Everett EN, Bondurant AE, Drescher CW, et al. Surgical outcomes in gynecologic oncology in the era of robotics: analysis of first 1000 cases. Am J Obstet Gynecol Elsevier Inc. 2011;204(6):551.e1–9.
28. Gaia G, Holloway RW, Santoro L, Ahmad S, Di Silverio E, Spinillo A. Robotic-assisted hysterectomy for endometrial cancer compared with traditional laparoscopic and laparotomy approaches: a systematic review. Obstet Gynecol. 2010;116(6):1422–31.
29. Holloway RW, Ahmad S, DeNardis SA, Peterson LB, Sultana N, Bigsby GE, et al. Robotic-assisted laparoscopic hysterectomy and lymphadenectomy for endometrial cancer: analysis of surgical performance. Gynecol Oncol. Elsevier Inc. 2009;115(3):447–52.
30. Hoekstra A V., Morgan JM, Lurain JR, Buttin BM, Singh DK, Schink JC, et al. Robotic surgery in gynecologic oncology: impact on fellowship training. Gynecol Oncol. Elsevier Inc. 2009;114(2):168–72.
31. Abu-Rustum NR, Khoury-Collado F, Pandit-Taskar N, Soslow RA, Dao F, Sonoda Y, et al. Sentinel lymph node mapping for grade 1 endometrial cancer: is it the answer to the surgical staging dilemma? Gynecol Oncol. Elsevier Inc. 2009;113(2):163–9.
32. Tanner EJ, Sinno AK, Stone RL, Levinson KL, Long KC, Fader AN Factors associated with successful bilateral sentinel lymph node mapping in endometrial cancer. Gynecol Oncol. Elsevier Inc. 2015;138(3):542–7.
33. Cormier B, Rozenholc AT, Gotlieb W, Plante M, Giede C Sentinel lymph node procedure in endometrial cancer: a systematic review and proposal for standardization of future research. Gynecol Oncol. Elsevier Inc. 2015;138(2):478–85.
34. Landoni F, Maneo A, Colombo A, Placa F, Milani R, Perego P, et al. Randomised study of radical surgery versus radiotherapy for stage Ib-IIa cervical cancer. Lancet. 1997;350(9077):535–40.
35. Boggess JF, Gehrig PA, Cantrell L, Shafer A, Ridgway M, EN S, et al. A case-control study of robot-assisted type III radical hysterectomy with pelvic lymph node dissection compared with open radical hysterectomy. Am J Obstet Gynecol. 2008;199(4):357.e1–7.
36. Cantrell LA, Mendivil A, Gehrig PA, Boggess JF. Survival outcomes for women undergoing type III robotic radical hysterectomy for cervical cancer: a 3-year experience. Gynecol Oncol. Elsevier Inc. 2010;117(2):260–5.
37. Estape R, Lambrou N, Diaz R, Estape E, Dunkin N, Rivera A. A case matched analysis of robotic radical hysterectomy with lymphadenectomy compared with laparoscopy and laparotomy. Gynecol Oncol. 2009;113:357–61.
38. Magrina JF, Kho RM, Weaver AL, Montero RP, Magtibay PM. Robotic radical hysterectomy: comparison with laparoscopy and laparotomy. Gynecol Oncol. 2008;109(1):86–91.
39. Ramirez PT, Schmeler KM, Malpica A, Soliman PT. Safety and feasibility of robotic radical trachelectomy in patients with early-stage cervical cancer. Gynecol Oncol [Internet]. Elsevier Inc. 2010;116(3):512–5. Available from: http://dx.doi.org/10.1016/j.ygyno.2009.10.063
40. Minig L, Padilla Iserte P, Zorrero C, Zanagnolo V. Robotic surgery in women with ovarian cancer: surgical technique and evidence of clinical outcomes. J Minim Invasive Gynecol [Internet]. Elsevier Inc. 2016; 23(3):309–16. Available from: http://dx.doi.org/10.1016/j.jmig.2015.10.014
41. Escobar PF, Levinson KL, Magrina J, Martino MA, Barakat RR, Fader AN, et al. Feasibility and perioperative outcomes of robotic-assisted surgery in the management of recurrent ovarian cancer: a multi-institutional study. Gynecol Oncol [Internet]. Elsevier Inc. 2014;134(2):253–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24844594.
42. Fagotti A, Bottoni C, Vizzielli G, Alletti SG, Scambia G, Marana E, et al. Postoperative pain after conventional laparoscopy and laparo-endoscopic single site surgery (LESS) for benign adnexal disease: a randomized trial. Fertil Steril [Internet]. Elsevier Ltd. 2011;96(1):255–9.e2. Available from: http://dx.doi.org/10.1016/j.fertnstert.2011.04.006.
43. Song T, Park J-Y, Kim T-J, Lee Y-Y, Choi CH, Lee J-W, et al. A prospective comparative study of cosmetic satisfaction for three different surgical approaches. Eur J Obstet Gynecol Reprod Biol [Internet]. Elsevier Ireland Ltd. 2015;190(January 2011):48–51. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25978858.
44. Escobar PF, Fader AN, Paraiso MF, Kaouk JH, Falcone T Robotic-assisted laparoendoscopic single-site surgery in gynecology: initial report and technique. J Minim Invasive Gynecol Elsevier Ltd. 2009;16(5):589–91.
45. Scheib SA, Fader AN. Gynecologic robotic laparoendoscopic single-site surgery: prospective analysis of feasibility, safety, and technique. Am J Obstet Gynecol [Internet]. Elsevier Inc; 2015;212(2):179.e1–179.e8. Available from: http://dx.doi.org/10.1016/j.ajog.2014.07.057.
46. Sinno AK, Fader AN, Tanner EJ. Single site robotic sentinel lymph node biopsy and hysterectomy in endometrial cancer. Gynecol Oncol [Internet]. Elsevier Inc. 2015;137(1):190. Available from: http://dx.doi.org/10.1016/j.ygyno.2014.12.033.
47. Wright JD, Ananth CV, Tergas AI, Herzog TJ, Burke WM, Lewin SN, et al. An economic analysis of robotically assisted hysterectomy. Obstet Gynecol. 2014;123(5):1038–48.
48. Advancing Minimally Invasive Gynecology Worldwide A. AAGL position statement: robotic-assisted laparoscopic surgery in benign gynecology AAGL advancing minimally invasive gynecology worldwide. J Minim Invasive Gynecol. 2013;20:2–9.

Preparation of Robotic-Assisted Laparoscopic Hysterectomy

56

Martin Heubner

Planning robotic hysterectomy, special conditions and requirements have to be taken into account. The positioning of the patient is a crucial aspect regarding safety as steep Trendelenburg position, which is associated with special risks, is mandatory. The set-up of the robotic device, including draping and positioning of the patient cart again are issues concerning the technical functionality of the robotic system. Even more than other operative techniques, robotic surgery has to be regarded a team task in which communication and interaction between surgeons, nurses and anesthesiologists is mandatory to achieve good results.

History of the Patient

Noteworthy aspects of history taking involve precedent surgical procedures and preexisting comorbidities. It is important to recognize that patient positioning in robotic surgery is substantial for good results and is –in contrast to classic laparoscopy- not alterable during the operation.

Previous operations, especially abdominal operations should be recognized in order to estimate the extent and the location of adhesions, which is especially important considering the placement of the camera trocar. Open laparoscopy might be an option if extensive adhesions are suspected in the mid-abdomen. Heart, lung and cerebral diseases might be important considering the ability of steep Trendelenburg positioning of the patient.

Especially patients with obesity can benefit from the use of robotic surgery as it might avoid laparotomy with subsequent complications and intraoperative problems. There is no upper limit with respect to the patients' BMI. However, the prospects of anaesthesiological ventilation can be impaired to high ventilation pressure, especially in Trendelenburg position of the patient [1]. A useful indicator is whether the patient is able to sleep in a flat position without heightening of the upper part of the body. Special instrument, especially extra-long trocars should be held available for obese patients.

Important preexisting illnesses comprise heart diseases, especially higher grade heart valve failures or pulmonary hypertension, pulmonary illnesses such as chronic obstructive lung disease and vessel problems such as cerebral aneurysms. Orthopedic musculoskeletal problems are also important to recognize. All these and further yet unmentioned aspects may result in impaired options of patient positioning and require conference with the anaesthesiological team. Allergies are of importance as perioperative antibiotics are usually applied during surgery.

Informed Consent of the Patient

The preoperative information of the patient should cover all common complications and risks of other techniques of hysterectomy. Still, some special aspects should be considered. Steep Trendelenburg position requires special handling and can result in special complications such as ventilation problems, extremely rare ophthalmologic problems (corneal abrasion, ischemic optic neuropathy, visual loss) and postoperative orthopedic problems (e.g. shoulder problems or distension of the brachial plexus if shoulder pads are used). It is noteworthy that some authors report a higher rate of vaginal cuff dehiscence after robotic surgery; hence, this should be mentioned. As the size of the trocars regularly exceeds 7 mm, port-site hernias are also of importance.

Operative Set-Up

Patient positioning has to be carried out with great caution. Trendelenburg position of at least 30° is mandatory to assure adequate access to the pelvis. To prevent the patient from

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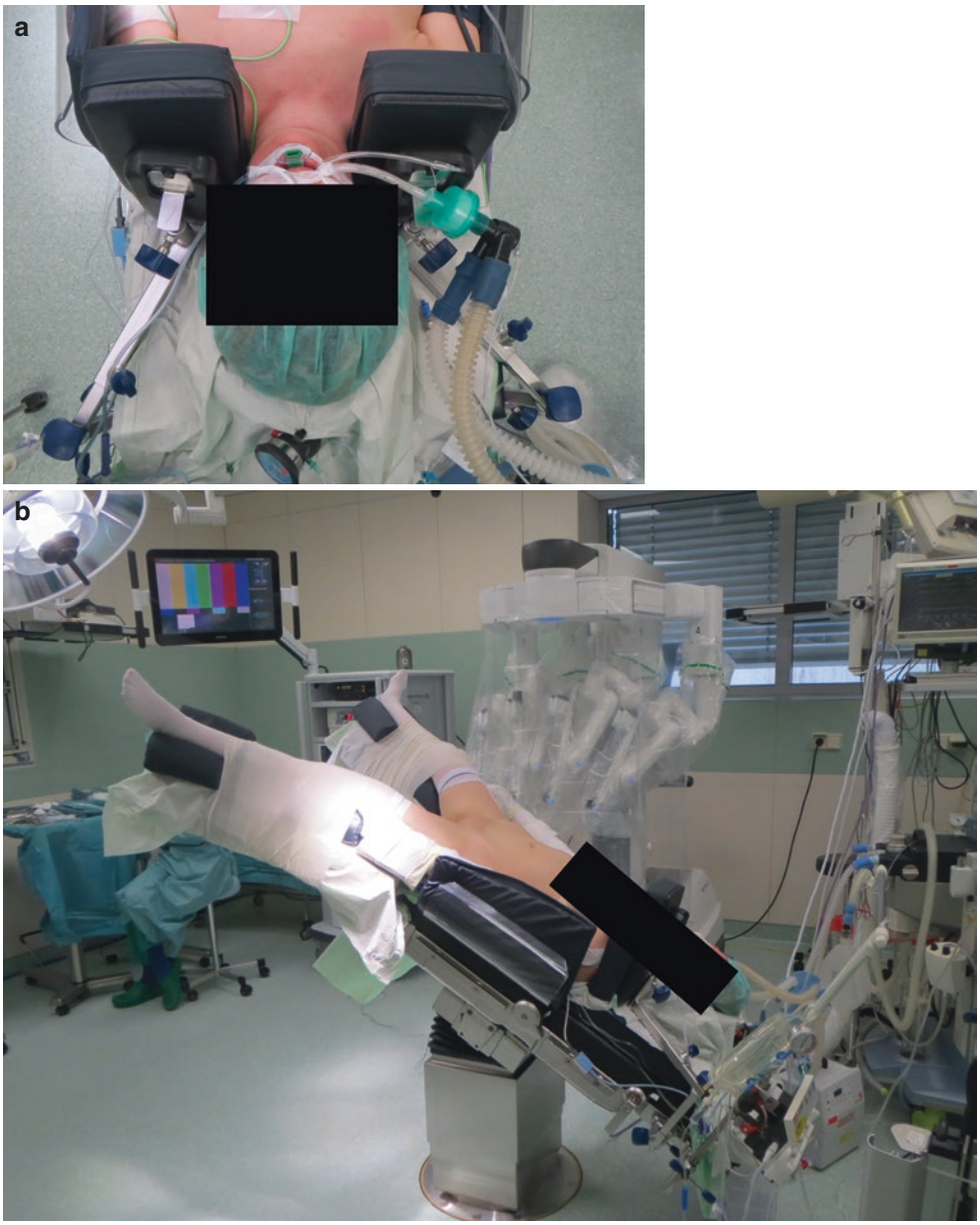


Fig. 56.1 Shoulder pads can be used to provide the patient from sliding (**a**), allowing steep Trendelenburg position (**b**)

sliding off the operating table, different technical options are available. Fixated shoulder pads, vacuum mattresses or boot-type leg holders are devices which might be useful, the preference is certainly individual (Fig. 56.1). The resulting forces acting upon the respective body parts in Trendelenburg position must not be underestimated. Positioning should be controlled before disinfection and during the operation and is a team task demanding involvement of surgeons, anesthesiologists and nurses. A skilled and experienced team is the major key to avoid complications and docking problems.

Docking should be carried out according to the manufacturers' instructions. The technique differs between different types of robotic systems. However, it is important to recognize that a professional docking is one of the most important aspects for a successful operation. Mistakes in the docking procedure occur frequently in the introduction phase of a robotic system and can grossly impair handling of the instruments during surgery. The position of the arms has to be considered not only in the start position but also extrapolated to future potential movements which again depend on the planned operating field. In this regard, it has to be ensured that moving robotic arms will not impair the patient, members of the OR-team or OR-equipment. This aspect appears self-evident. However, a surgeon beginning with robotic surgery technique faces a completely new situation: not being physically present at the operating table with no haptic or optical feedback apart from the direct operating field inside the abdomen. Thus, the permanent critical surveillance by assistants and immediate feedback to the console surgeon is crucial.

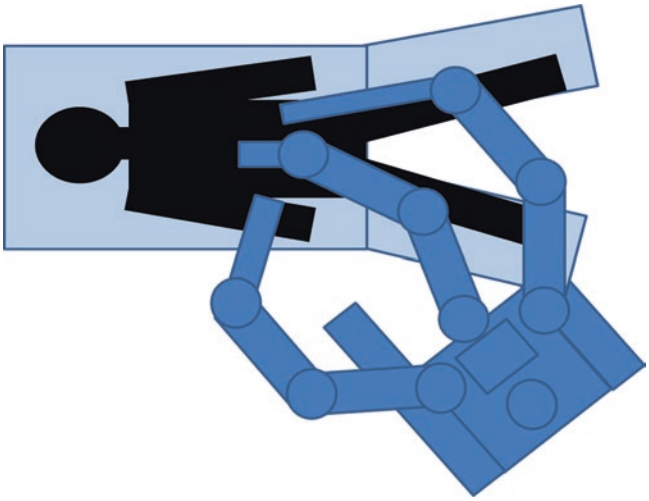


Fig. 56.2 Schematic sketch of side docking approaching over the right hip of the patient

There are different ways of approaching the patient with the patient cart. Placing the patient cart between the patients' legs usually makes the docking procedure easy as the resulting symmetrical geometry gives maximum space between the robotic arms. However, the prospects of vaginal manipulation are impaired by this method. **Side docking** in a 30° angle, usually approaching from caudally over the right hip of the patient, is a feasible method allowing access for vaginal manipulation and docking of the robotic arms without interference (this applies to the da Vinci® Si system or lower; see Fig. 56.2).

The type of docking also depends on the model of robotic device that is used. It is recommended that representatives of the accordant company and/or skilled physicians with experience on the respective device attend the first operations to give advice.

General Aspects: Introduction of Robotic Surgery as a Team Task

Introducing robotic surgery, it is certainly beneficial if the whole OR team including surgeons and anesthesiologists attend the first attempts of patient positioning, disinfection, draping and docking, as perspectives may differ within the team. E.g., potential movement dysfunctions of the robotic arms caused by wrong draping may be better foreseen by the surgeon while potential impairments of sterility aspects are often better estimated by the OR nurses. Patient positioning again has to offer good access to the surgical field for the surgeon and access to the patient for the anesthesiologist and has to ensure the patients' safety. In general, experience shows that it is helpful if the whole team is familiar with all aspects of the setup. This allows quick development of know-how and efficacy and helps to avoid demotivation throughout the whole staff.

Disinfection and draping should be carried out according to the standards of the surgical unit. It should be kept in mind that a switch to open surgery might become necessary and this should therefore be considered. Draping of the robot-arms and their handling under aspects of sterility is a complicated procedure requiring training and experience. It is important to consider the necessary free moving space of the robotic arm, tension should strictly be avoided. Wrong draping can result in functional errors of the robotic arms. The OR team should undergo several training sessions before conducting the first operation on a patient.

Although emergency transition to open surgery is very rare, draping should be conducted in a manner also allowing open access to the abdomen without necessity of additional draping/undraping or disinfection.

The perioperative application of a single-shot antibiotic prophylaxis should be carried out 30 min before surgery. A combination of ampicillin/sulbactam is feasible. Alternatively, e.g. in case of allergy to penicillin and its derivates, clindamycin can be administered. A prolonged treatment with antibiotics beyond the time of surgery cannot be recommended.

Reference

1. Wysham WZ, Kim KH, Roberts JM, Sullivan SA, Campbell SB, Roque DR, Moore DT, Gehrig PA, Boggess JF, Soper JT, Huh WK. Obesity and perioperative pulmonary complications in robotic gynecologic surgery. Am J Obstet Gynecol. 2015;213(1): 33.e1–7. doi:10.1016/j.ajog.2015.01.033. Epub 2015 Jan 28.

Instruments, Apparatuses and Uterine Manipulators for Hysterectomy with Special Focus on Robotic-Assisted Laparoscopic Hysterectomy

57

Mona E. Orady

Introduction

Hysterectomy is the surgical removal of the uterus. It may also involve removal of the cervix, ovaries, fallopian tubes and other surrounding structures [1]. Hysterectomy is the most common procedure performed for gynecological disorders. Overall hysterectomy rates vary from 1.2 to 4.8 per 1000 [2]. Removal of the uterus renders the patient unable to bear children (as does removal of the ovaries and fallopian tubes) and has surgical risks as well as long-term effects, hence surgery is only recommended when other treatment options are not available or have failed. It is expected that the frequency of hysterectomies for non-malignant indications will decrease as there are good alternatives in many cases [3]. However, hysterectomy will remain as the definitive treatment of uterine pathology. Uterine myomas are the most frequent indication for abdominal hysterectomy, accounting for 40 % of all hysterectomies, with other indications including endometriosis (12.8 %), malignancy (12.6 %), abnormal uterine bleeding (9.5 %), pelvic inflammatory disease (3.7 %) and uterine prolapse (3.0 %). Utero-vaginal prolapse is the indication for 44 % of all vaginal hysterectomies. In recent years, non – descent vaginal hysterectomy (NDVH) is being tried for most benign conditions and uteri of up to 12 weeks gestational size or more can be safely removed intact vaginally [2]. However, large leiomyomas, severe pelvic inflammatory disease, malignancy (invasive cervical cancer, endometrial carcinoma, ovarian and fallopian tube cancer, and gestational trophoblastic tumors) and most suspicious adnexal masses are still often approached via laparotomy [2].

The introduction and rapid advancement of laparoscopy has allowed for the development of alternative minimally invasive approaches to hysterectomy thus avoiding the morbidity associated with an abdominal hysterectomy when the vaginal approach is not feasible [4, 5]. Initially utilized in laparoscopic assisted vaginal hysterectomy, the laparoscope allowed the treatment of adnexal pathology or endometriosis and assistance in the release of the uterine structures and bladder flap from above, facilitating the vaginal approach in more complex cases. As tools and techniques advanced, a greater proportion of the hysterectomy procedure was undertaken using the laparoscopic approach leading to the first total laparoscopic hysterectomy successfully completed via laparoscopy in 1989 [4].

Following this, the development of tools that facilitated dissection, vessel sealing and suturing were developed in order to simplify and improve the procedure. The advantages of the minimally invasive approach for the patient included reduced pain, hospital stay, blood loss, and a much shorter recovery as compared to abdominal hysterectomy [5, 6]. This led to the desire to utilize this approach even in complex hysterectomy procedures, obese patients, and cancer surgeries. This motivated surgeons and the industry as whole to push the limits of the surgery, and to develop and explore other laparoscopic approaches such as single port surgery, mini-laparoscopy, natural orifice surgical procedures (NOTES) and combinations of the above, to see if the procedure could be accomplished with even less scarring, pain, and time required for recovery [7].

The most advanced and expensive tool used to date for the performance of minimally invasive hysterectomy procedure is the daVinci™ surgical robot (Fig. 57.1). After receiving FDA approval for use in gynecology in 2005, the frequency of daVinci robotic assisted total laparoscopic hysterectomy has exponentially increased [8, 9]. It offers all the benefits of the laparoscopic approach, but affords the surgeon improved vision utilizing a three dimensional magnified high definition camera and scope as well as superior control over articulating instruments with 7° of freedom. These features enable the surgeon to accomplish more difficult procedures by making it easier to work in areas deep within the pelvis or work around large fibroids which would otherwise restrict the

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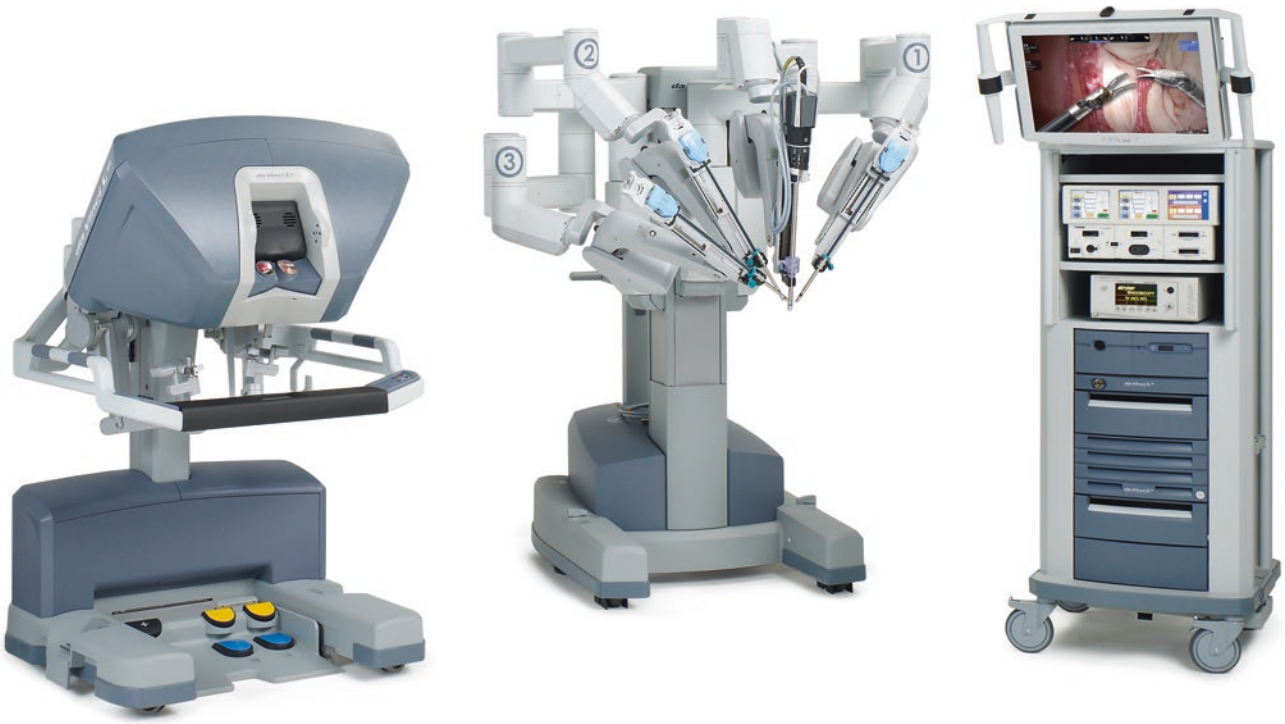


Fig. 57.1 The DaVinci surgical system TM is comprised of three components. The Vision Tower, Robotic Patient-side cart and the Surgeon Control Console. The tower contains light and energy sources as well as the vision monitor. The robot consists of the arms which attach to the robotic trochar cannulas, the robotic instruments, and the robotic camera, which pass through the robotic trocars, providing surgeon with direct intuitive control of the instruments, camera, and energy from the surgeon console. Some systems come with two consoles (Dual Console) which allow the surgeon to train a resident, fellow, or colleague giving the instructing surgeon the ability to take over control at any time, telestrate, or direct the learning real time during a case

Table 57.1 Comparison between traditional laparoscopy and robotic assisted laproscopy

	Traditional laparoscopy	Robotic assisted laparoscopy
Number of ports	3–5 ports	Tends to average one more than laparoscopy
Size of ports	Three 5 mm and one 10 mm on average	Three to Four 8 mm and one 5–12 mm on Average
Vision	2-D vision although some 3-D Scopes are becoming available	3-D HD 10 X vision Autofocus and Auto white balance available on newer models
Control of instruments	Camera and opposing instruments controlled by assistant but instruments easily interchangeable between ports	Camera and Opposing instruments controlled by surgeon but assistance must do all instrument exchanges and troubleshooting
Precision of movement	Straight instruments with fulcrum effect	Wristed instruments with 7° of movement
Ability to scale movements	Direct control	Console allows surgeon to allow scaling to 1:1, 3:1, or 5:1 ratio of hand movement to instrument movement to allow for fine motor control
Energy devices available	All ultrasonic and Advanced energy devices compatible with instrument ports	Only traditional monopolar and bipolar devices, as well as a single vessel sealing device and a PK dissector utilizing PK energy are available. Harmonic device lacks wristing
Tremor	Amplified by fulcrum effect	Filtered by console programming

movement and reach of conventional laparoscopic instruments [10, 11]. Table 57.1 provides a comparison of robotic assisted versus conventional laparoscopy for hysterectomy. This chapter will review the different tools that are utilized in hysterectomy procedures and the optimal tool selection methods appropriate for each individual procedure method.

Instruments for Access and Exposure

The most important aspects of surgery are access and exposure. Without access to and exposure of the relevant anatomy, the procedure cannot be performed. The three main approaches to hysterectomy require different vantage points

of access in order to achieve the appropriate exposure. More often than not, the perceived inability to achieve the required access and exposure of the anatomy in question via one approach is what leads a surgeon to selecting one modality over another.

Abdominal Hysterectomy

For abdominal hysterectomy, access is achieved directly through the abdominal wall, either through a transverse or vertical incision. The transverse Pfanennstiel incision is the most common in benign procedures while the midline vertical incision is more favored in oncologic procedures (Fig. 57.2). Vertical Incisions can be extended to accommodate larger or more complex pathology or allow access to para-aortic lymph nodes by extending it above the umbilicus. In turn, using a Maylard or Churney incision allows for increased exposure through a transverse incision, which is often preferred due to decreased pain, risk of hernia, and improved cosmesis [12].

Once the incision is made, the choice of retractor will aid in attaining the appropriate exposure. The most commonly used retractor in benign abdominal hysterectomy is the Balfour retractor which comes with wrenched side blades, an attachable bladder blade and an optional upper blade. For more complicated or larger pathology, the Bookwalter retractor allows attachment of multiple retractor blades of multiple sizes and configurations to a metal ring which is placed floating above the incision attached to a metal arm fastened to the operating table. More recently, disposable plastic double ring wound retractors such as the Alexis wound retractor can be useful in thicker abdominal walls providing retraction of skin, subcutaneous fat, muscle, fascia and peritoneum within a plastic sheath, thus providing maximal retraction and exposure with an even distribution of pressure. This can be useful for performance of a hysterectomy in obese patients, in whom obtaining exposure is often challenging [12] (Fig. 57.3).

Vaginal Hysterectomy

Vaginal exposure for vaginal hysterectomy yields its own challenges. Generally, the best candidates for vaginal hysterectomy are multiparous patients with some degree of uterine descensus and adequate room in the vagina to obtain exposure of the cervix. Most gynecologists will use vaginal sidewall retractors as well as a long posterior retractor in order to obtain exposure and protect the rectum such as a weighted Steiner retractor with a long lip that will reach the posterior vaginal cuff to retract it inferiorly. Anteriorly, either a long bladed Deaver or Right angle retractor can be used to protect and retract the bladder superiorly. Briesky or Jackson vaginal retractors can also be used to retract laterally as needed. The labia may be retracted using a suture or a Lonestar retractor

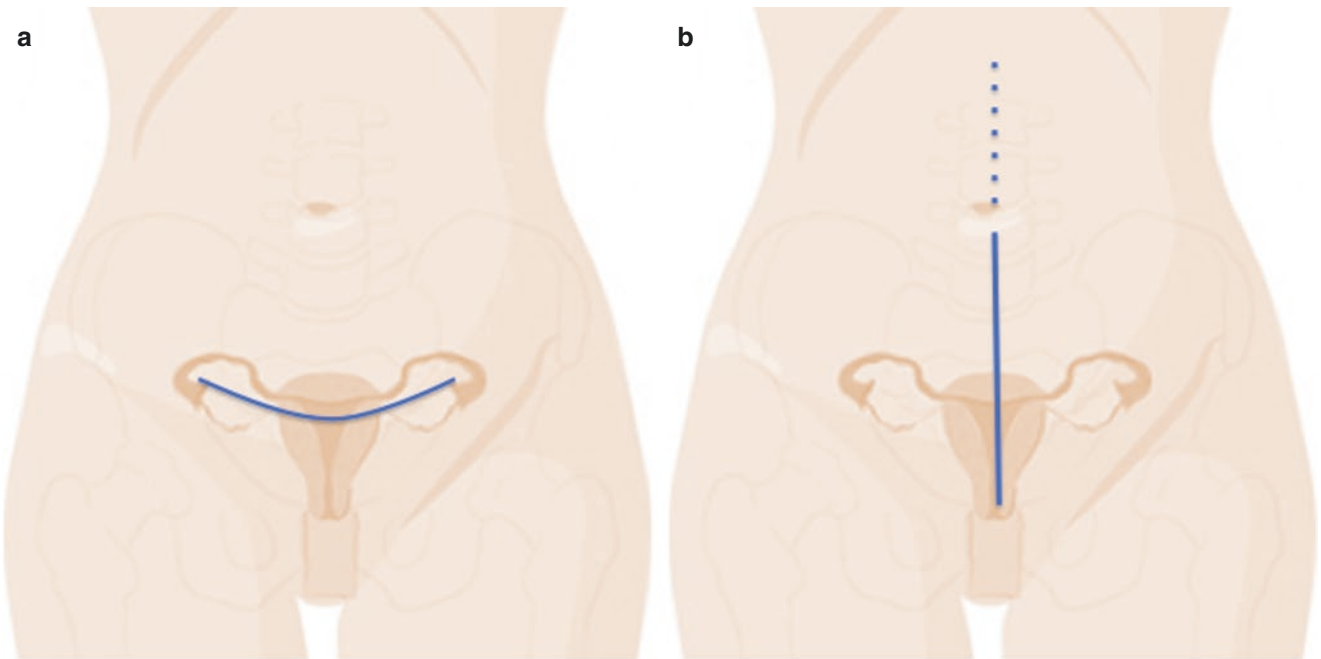


Fig. 57.2 Abdominal hysterectomy incisions: (**a**) Transverse Incision includes the options of a Pfanennstiel incision, Maylard Incision, or Cherney Incisions, depending on whether rectus muscles are separated, cut, or detached from insertion on the pubis. (**b**) Vertical incisions can remain below umbilicus or be extended above as needed and thus provide the opportunity to extend the incision in order to increase visualization, and are thus the most versatile. However, they cause more pain, worse cosmesis, and a greater risk for hernia than transverse incisions

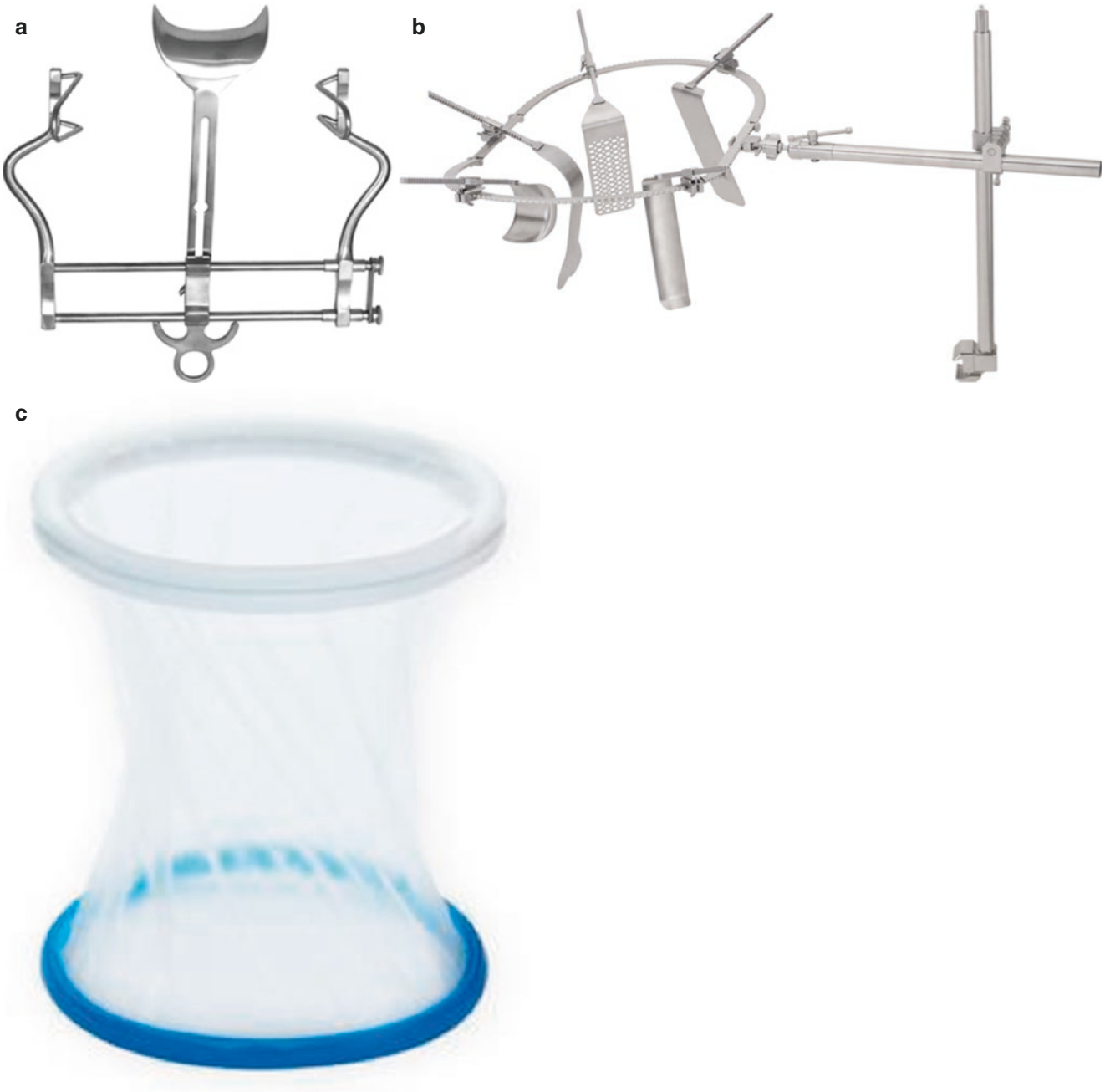


Fig. 57.3 Retractors for abdominal hysterectomy. (**a**) Balfour Retractor provides side wall retraction as well as a bladder blade for retraction of the bladder. (**b**) Bookwalter Retractor is the most versatile and can retract in all directions with many options for blades. It can thus be adjusted to the anatomy more easily. (**c**) Alexis Wound Retractor is useful for thick abdominal walls when limited visualization is needed or if an incision is meant to be kept small as in a mini-laparotomy. It provides 360° of retraction in all directions but is disposable and thus is just for single use

which consists of a plastic ring with hooks that grasp the labial folds or vaginal muciosa in order to obtain retraction at the introitus. A Bookwalter type of retractor (Bookwalter® Magrina II Retractor System) has also been developed for use in vaginal hysterectomy and is very useful to obtain stable, controlled retraction for efficient performance of a vaginal hysterectomy [13] (Fig. 57.4).

Laparoscopic Hysterectomy

For all the laparoscopic approaches to hysterectomy, including single port, mini-laparoscopy and robotic assisted laparoscopy, retraction is provided by insufflation of the peritoneal cavity, which creates space to work within the abdominal cavity without directly opening the abdominal wall. The Trendelenburg position then provides gravity

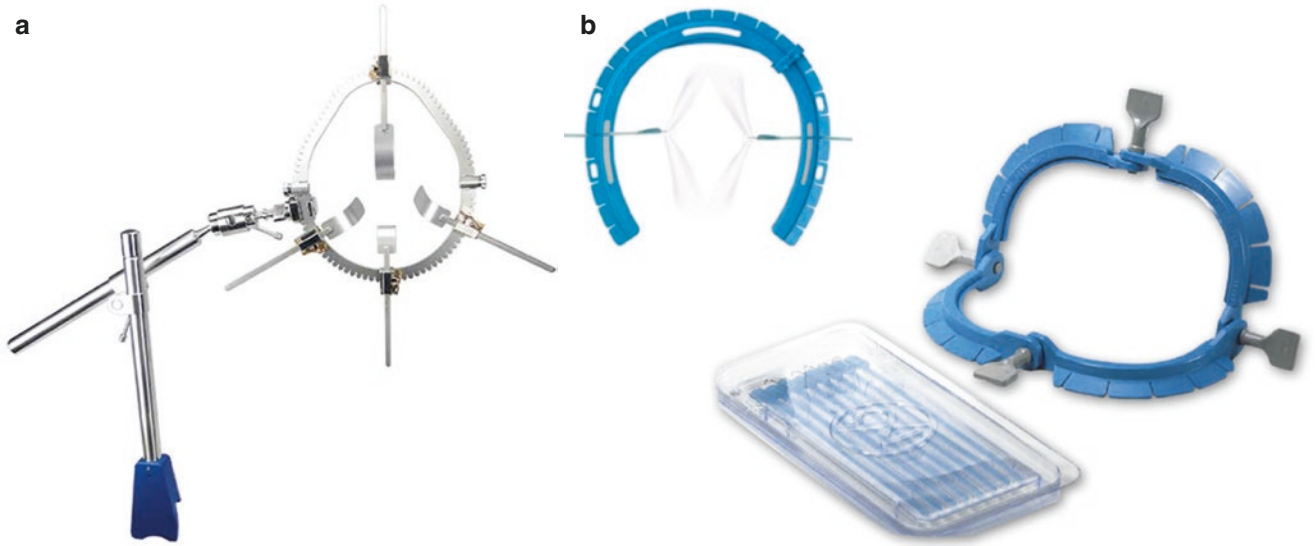


Fig. 57.4 Retractors for vaginal hysterectomy. (**a**) Bookwalter Magrina II Retractor System is similar to the abdominal bookwalter retractor but was developed specifically for vaginal hysterectomy providing adjustable blades in order to maximize visualization into the vagina. (**b**) Lonestar Vulvar Retractor is useful to enhance visualization during vaginal hysterectomy by using adjustable minimally traumatic hooks to retract away labia allowing easier access to the vagina

assisted retraction of the bowel while the uterine manipulator elevates the uterus allowing visualization and access to the uterus and surrounding structures for the performance of the hysterectomy. Passages through the abdominal wall then allow a camera to obtain visualization and instruments to be placed through the abdominal wall in order to perform the surgical procedure. Thus, the key is obtaining access to the intraperitoneal space, then placement of trochars through the abdominal wall, followed by utilizing an appropriate camera to provide visualization and an appropriate vaginal manipulator to provide manipulation and exposure of the vascular pedicles for the performance of the hysterectomy procedure [14].

None of the laparoscopic methods of hysterectomy differ on these two points but only differ on the size, number and location of the passages through the abdominal wall and the specific instruments used through these passages in order to perform the procedure. Thus, the advantages of each relate to the instruments used for the procedure since ultimately the end result of a hysterectomy is accomplished in a similar manner of isolating and sealing ovarian and uterine pedicles, transecting the uterus, removal of the specimen, and then closing the vaginal cuff if needed. All methods share the benefit of minimally access surgery for the patient including small scars and a fast recovery. The advantage of the robotic instrument relates to its precision, enhanced vision, and greater control, which allows more complex or difficult hysterectomies to be accomplished in a safe and efficient manner. Thus, patients who are morbidly obese, have extensive adhesions resulting from multiple prior surgeries or endometriosis, or have very large or obstructing fibroids may benefit from the surgeon choosing this instrument. For relatively straightforward hysterectomies in which the best cosmetic result is desired, either the vaginal, or mini-laparoscopic approach should be considered. If patients desire only a single incision then either single port laparoscopy or single port robotic assisted laparoscopic approach may be considered. Standard laparoscopy however remains the most utilized approach as all the other approaches are modifications of this approach and are highly dependent on the availability of specific instruments that facilitate the other approaches.

Initial Entry Techniques

Three forms of access or initial entry exist in Laparoscopy. Open (Hassan) technique, Veress Needle technique, and Direct entry. In the Open technique a disposable or re-usable trochar is placed directly into the peritoneal cavity after a small incision is made using retractors and a scalpel. The incision is then carried through the fascia and peritoneum. The Hassan cannula is then secured using sutures placed at the angles of the fascia and tied to the Hassan cannula. This technique can be useful if there is suspicion for severe adhesions or risk of adherence of bowel to the anterior abdominal wall. This method of entry is the method utilized in single port laparoscopy only a larger 1.5–3 cm incision is often needed. After this various single port access devices such as the Covidien SILSTM Port or the GELPORT by Applied Medical, and the Triport or Quadraport by Advanced Surgical Concepts are placed into the umbilical incision providing channels through which the instruments and the camera can then be introduced into the peritoneal cavity. Another option is to group small low profile laparoscopic trochars in a single incision made at the umbilicus [7] (Fig. 57.5).



Fig. 57.5 Port options for single port or single incision Hysterectomy. (**a**) Covidien SILS Port has instrument ports built in with an insufflation access point laterally and an additional vent available for smoke evacuation. (**b**) Storz Single port system also has three active port as well as an insufflation port. Its advantage is that it is re-usable and similar to the Covidian port does not require additional trochar because instruments can be passed directly through the ports (©2015 Photo Courtesy of KARL STORZ Endoscopy-America, Inc.) (**c**) ASC Triport and quadraport by advanced surgical concepts is another disposable multi-instrument access port for single incision laparoscopic surgery requiring a 2.5 cm incision that allows up to four instruments to be used simultaneously. (**d**) The GelPOINT Advanced Access Platform by Applied Medical allows low profile ports to be placed through a gel port seal which thus gives greater versatility for port placement but may thus sometimes requires a slightly larger incision for access. However, he integral Alexis wound protector/retractor offers atraumatic retraction and protection for specimen removal



Fig. 57.5 (continued)

For robotic single port surgery access is obtained in the same manner as for laparoscopic single port surgery, but currently a special port and cannulas are used that then attach to the robotic instrument (Fig. 57.6). Prior to these cannulas and ports being developed specifically for this platform surgeons would use the straight robotic cannulas placed through a GELPORT access port placed at the umbilicus. The 8 mm robotic camera and 8 mm robotic instruments would then be introduced through the approximately 2.5–3 cm umbilical entry point, occasionally with a hybrid 5 mm assistant port. This allowed the surgeon to have some wristed movements but there were still some issues with instrument clashing and difficulty in triangulation around relevant anatomy. The subsequently released single port robotic platform reduced the size of the umbilical incision down to 1.5–2 cm with a port similar to the SILS port and reduced the diameter of the cannulas down to 5 mm and added a curved shape in order to improve triangulation. However, reducing the diameter of the instruments and allowing them to bend to follow the curve of the cannula removed the wristing feature from the instruments and thus greatly decreased the range of motion of the instruments as compared to the straight 8 mm robotic instruments. Recently a needle driver with 4° of movement has been developed in order to allow some increased range of motion to facilitate suturing.

In the Veress technique a disposable or re-usable Veress needle (Fig. 57.7) is introduced into the peritoneal cavity via the umbilicus or left upper quadrant at Palmer's point in order to obtain insufflation of the peritoneal cavity with CO_2 gas prior to the introduction of initial cannula and trochar. The purpose of insufflation is to tense the abdominal wall and create a distance between it and the bowel and blood vessels with the intention of making an introduction of the blind trochar easier and safer. However, there is no concrete evidence that this technique reduces initial entry tochar injury. Initial trochar may then consist of a re-usable trochar with a sharp tip versus various configurations of re-usable trochars with bladed, blunt, or spreading tips. The advantage of spreading tips which are designed to spread rather than cut the muscle and fascia fibers is to reduce trauma to these fibers and reduce the size of the remaining defect once the cannula is removed. This may reduce pain at the trochar site and risk of hernia

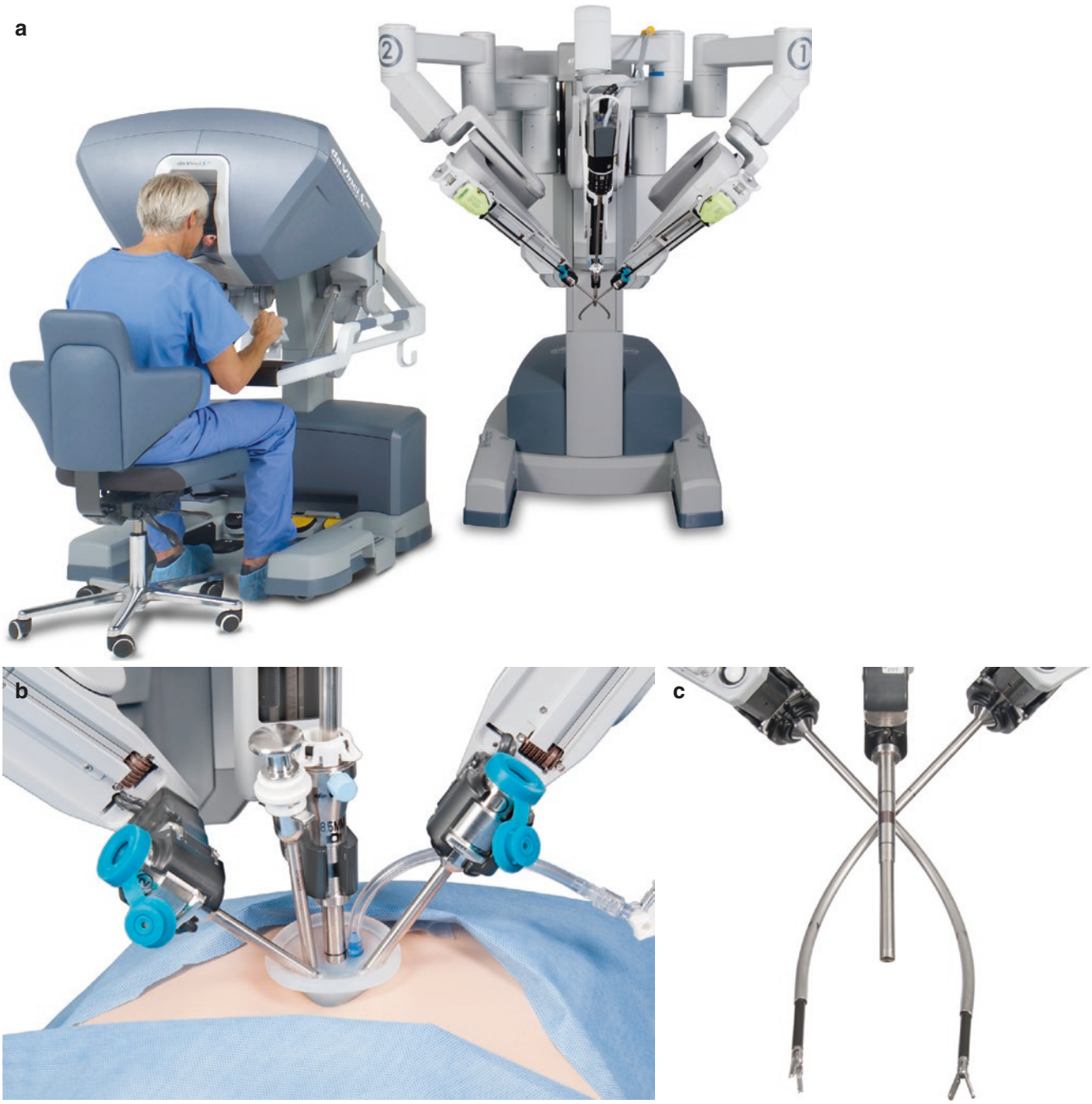


Fig. 57.6 Single port platform for DaVinci Robot. (**a**) The Si and Xi daVinci Systems have the possibility of use with a single port platform, which consists of a five-lumen SILS access port through which instruments and camera pass and cross. Remote center technology minimizes cannula collisions, arm interferences and port-site movement while the daVinci System software corrects for the crossing in order to intuitively coordinate the surgeon's hands with the instruments movements. (**b**) The five lumen port is placed through a 1.5–2 cm incision and provides access for two 5 mm curved instrument cannula, through which two semi-rigid 5 mm instruments pass, as well as the regular 8.5 mm 3D endoscope as well as a 5/10 mm accessory assistant port and the insufflation adaptor. (**c**) The curved architecture of the instrument cannulas allow the semi-rigid instruments to curve in order to optimize triangulation while minimizing external collision and crowding of instruments

formation. Some of the disposable trochars available include the possibility of visual entry via a camera channel within the trochar which allows the surgeon to visualize the layers of the abdominal wall as they are penetrated. The Versastep system includes a Veress needle with a sheath surrounding it, which may then be dilated using a blunt trochar allowing a completely blunt entry into the peritoneal cavity after access is secured with the needle at the site of needle placement. The only re-usable spreading visual entry trochar is the Ternamian trochar with a screw like blunt entry through the abdominal

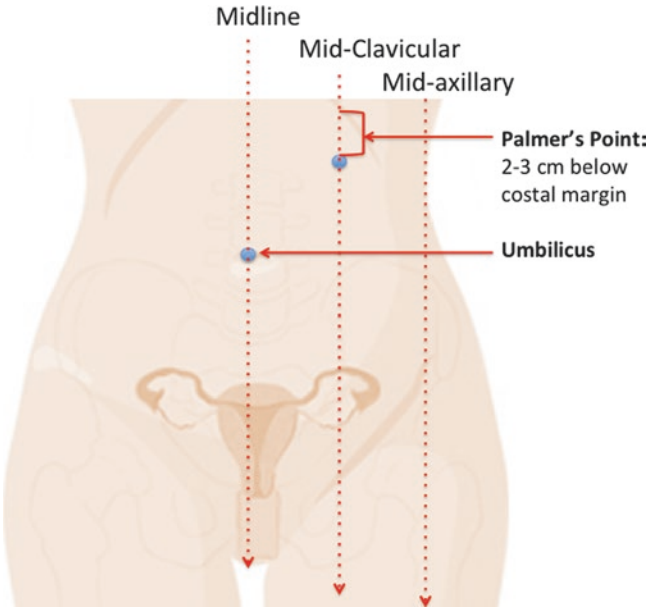


Fig. 57.7 Veress needle and points of entry. Palmer's point is 2–3 cm below left costal margin in Mid-clavicular line may be utilized if adhesions are suspected at umbilicus from prior surgeries. Contraindications to utilizing Palmer's point include right upper quadrant surgery such as prior gastrectomy or splenectomy

wall which allows the layers to be visualized as the trochar is screwed through them thus spreading the fibers [15].

The final method of entry into the peritoneal cavity is direct entry through the umbilicus without prior insufflation. In this method the abdominal wall is elevated via superior traction with the surgeons non-dominant hand or towel clip and the initial trochar is introduced directly into the peritoneal cavity either using a visual entry blunt-tipped or non-visual entry sharp disposable or re-usable trochar. Access is then confirmed via introduction of the camera, followed by insufflation through the port. In all methods, once access with initial trochar is obtained remaining trochars may then be introduced under direct visualization.

In robotic surgery, since the camera port can often be above the umbilicus, especially in the case of the large fibroid uterus extending above the level of the umbilicus, this needs to be taken into account when deciding on entry technique. Thus, open entry or the Hassan technique may not be optimal as it is more difficult to use the open technique above the umbilicus. Few surgeons are comfortable with direct entry above the umbilicus, and thus when a supra-umbilical camera port is desired most surgeon's will insufflate using a Veress needle, then either place the camera port first and then introduce remaining ports under direct vision. The author's preferred method is to place a 5 mm left upper quadrant visual entry port after insufflation and then use this port to survey the pelvis and decide on locations of both the robotic camera port and robotic re-usable ports dependent on the pathology. This is preferred as by optimizing camera and robotic ports according to pathology in difficult cases, one can obtain maximal vision and range of motion and prevent clashing of instrument arms or restriction of movement. As in other single-port procedures, single port robotic assisted procedures utilize open entry at the umbilicus and this location cannot be varied for the pathology, which is one of the limitations of single port surgery in general.

In mini-laparoscopy, small mini-laparoscopy ports measuring less than 3 mm in diameter are introduced laterally or in the suprapubic location after the initial camera port is placed at the umbilicus. Some mini-laparoscopy instruments measuring 2.5 mm in diameter do not require cannulas and are introduced directly through the skin into the peritoneal cavity. Generally, the initial port will consist of a 5 or 10 mm camera port placed at the umbilicus and mini-instruments are used laterally unless the small 3 mm mini-scope is available in which case this mini-scope is placed at the initial entry point.

As outlined above, the choice of type of entry and trochar type and tip is extremely surgeon specific. However, all surgeons should understand the different types of trochars that exist including advantages and disadvantages of each when selecting their preferred method of entry, torchar type and placement location [15]. After a preferred method is chosen, the surgeon should utilize this method as much as possible and only vary as needed for the case, as repetition prevents injury and several studies have shown that the highest rates of entry related complications occur immediately after changing a trochar type or entry method used by the surgeon. Figures 57.8 and 57.9 highlight the differences in access ports as well as port locations for the various approaches.

Visualization

Camera and scope technology are continuously evolving leading to the development of smaller, more maneuverable visualization tools that provide significantly improved vision while performing surgical procedures. Currently, laparoscopic scopes are available in the 10, 5, and 3 mm sizes (Fig. 57.9) and the 10 and 5 mm laparoscopes are available in either the 0 or 30° fields of view. The 30° increases the field of view in order to look around, above, or underneath structures and is most useful when operating deep in the pelvis with deep endometriosis or when performing hysterectomy for a very large uterus. The 3 mm camera by Storz is most useful in the performance of mini-laparoscopic hysterectomy, or for initial survey from the left upper quadrant in complex cases in which entry at palmer's point is preferred. Camera's with a flexible tip are (Fig. 57.9) available through Olympus are most useful for single port hysterectomy as they allow the camera tip to bend in order to obtain a better view for triangulation so that a surgeon's hand do not clash with the camera. It is also useful for NOTES procedures in which a Natural Orifice is used for introduction of the scope. Since one of the main advantages of robotic surgery includes the 3D HD

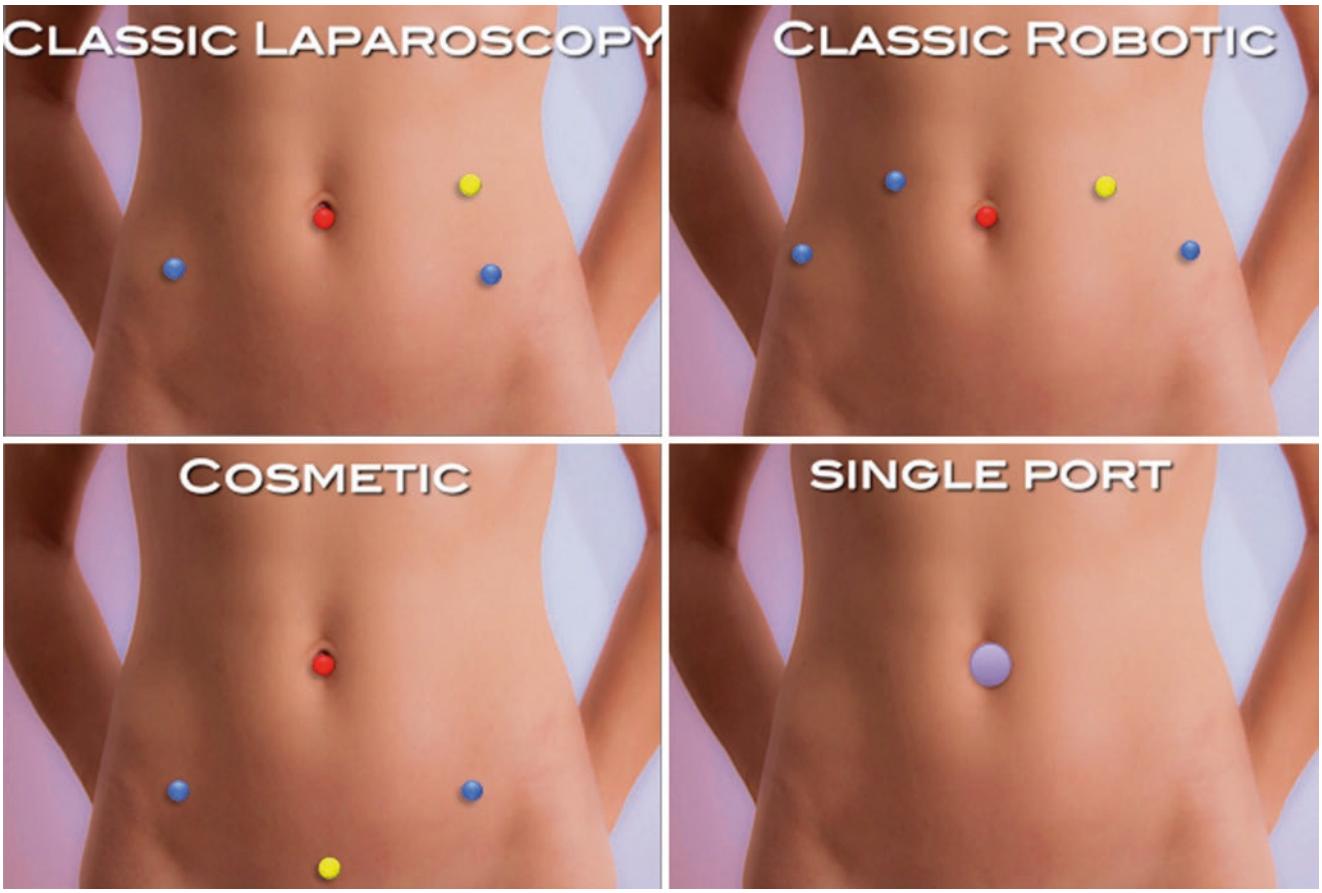


Fig. 57.8 Port placement in laparoscopic, robotic, single port, and mini-laparoscopy procedures. In Classic Laparoscopic hysterectomy four 5–10 mm ports are place as shown, although the accessory port (*yellow*) may vary in placement to opposite side or to the suprapubic area depending on surgeon preference. In classic robotic surgery port placement is usually in an M configuration or slight arc varied according to the pathology. Laparoscopic or robotic procedures can be made more cosmetic by lowering lateral ports or placing them more ultra laterally. However, the wristed instruments of the robotic platform make these more cosmetic port locations much easier to use with the wristed instruments of the robotic platform. Single port or single incision procedures always utilize the umbilicus. The incision incision is usually larger than laparoscopic ports measuring 2–3 cm and thus has a higher rate of herniation and wound complications. The advantage of mini-laparoscopy is that ports are only 2–3 mm and thus do not need closure and produce very minimal scars and have little to no risk of hernia formation

magnified vision for the surgeon, some companies such as Olympus have released a 3D laparoscopic scope and camera in order to provide a similar view for the laparoscopic surgeon. However, it does not duplicate the magnification and the complete immersion in the three dimensional environment provided by the surgeon console in robotic procedures.

Exposure and Uterine Manipulation

Uterine manipulators with a colpotomizer are a very important part of any of the laparoscopic approaches to hysterectomy, whether traditional laparoscopy, mini-laparoscopy, or robotic assisted laparoscopy. The uterine manipulator fulfills many functions (Table 57.2). However, the main purpose of the uterine manipulator is exposure. It assists in the elevation and movement of the uterus upwards and out of the pelvis to help provide exposure to the uterine vasculature and bladder flap while increasing the distance away from the ureters in order to avoid direct or indirect injury. This increases the safety of a laparoscopic hysterectomy. In addition, the colpotomy ring, cup, or blade can be used to push the ureters more laterally, and the uterine artery superiorly, while delineating the junction between the cervix and the vaginal fornices tenting them upwards. Tenting the vaginal fornices upwards will provide the necessary exposure aiding in the dissection of the bladder flap and cervicovaginal fasica as well as delineating the site for colpotomy incision at the apex of the vagina such that the incision will not shorten the vagina significants. This also provides the tissue tension required to swiftly make the colpotomy incision with minimal energy in order to avoid tissue necrosis and complications such as cuff cellulitis or dehiscence [16].

Many different uterine manipulators exist including some that are disposable, reusable, or have both re-usable and disposable components (Figs. 57.10 and 57.11). Some have straight handles and others are arched or curved. Arched manipulators allow the user to follow the arc of the sacrum



Fig. 57.9 Various cameras and scopes utilized in laparoscopic, robotic, single port, and mini-laparoscopy procedures. (**a**) Traditional laparoscopic Ports come in either 5 or 10 mm scopes providing a 0 or 30° scope angle. Bariatric 30° scopes assist with larger pathology or in single port procedures in order to move the camera away from other instruments to prevent clashing. ©2015 Photo Courtesy of KARL STORZ Endoscopy-America, Inc. (**b**) Mini-laparoscopy scopes are also now available measuring a mere 3.5 mm diameter, which is very useful in simpler or diagnostic procedures in which minimization of the port site may be desired. (**c**) Olympus has developed an articulating 5 mm scope as well as an articulating 5 mm 3-D scope designed for optimal visualization for singe port or notes procedures. (**d**) The scope providing the best visualization for precise intricate surgery is the scope and camera designed for the DaVinci Robotic instrument. This scope provides extremely detailed High definition vision utilizing both a right eye and a left eye in order to give the surgeon a 10X magnified 3D view inside the patient at the surgeon console. The camera is controlled by the surgeon from the surgeon console providing optimal control. With the newest Xi system the camera also has newer features of auto focus, auto white balance, and instant switch from 30° up to 30° down view. The camera can also now be placed at any position and be controlled by any of the robotic arms which greatly facilitates multi-quadrant surgery

and thus manipulate in a more anatomical fashion allowing for maximal elevation of the uterus out of the pelvis and away from the ureters. Straight manipulators, may be assisted by (articulation) in order to antevert or retrovert the uterus for exposure. Metal manipulators are sturdier and thus are less likely to bend or break with a larger uterus or severely deformed or deviated pathology such as in patients with large lower segment fibroids or severe endometriosis. [17].

In the United States the two most commonly used uterine manipulators for laparoscopic hysterectomy are V-care, which is entirely disposable, and Cooper Surgical's uterine manipulators including the Rumi, Rumi arch, Rumi II, and Advincula arch manipulators which work with a Koh ring and disposable tips. Recently the Koh ring has been incorporated into a backloading disposable piece which also incorporated the vaginal occluder balloon. One of the advantages of the Rumi and Arch

Table 57.2 Functions of the uterine manipulator

Functions of the uterine manipulator [11, 13]
Mobilizes the uterus including anteversion, retroversion, lateral and elevation movements
Clearly identifies and distends the vaginal fornices to enable a circular incision of the vaginal apex
Elevates and defines the cervico-vaginal junction to enable a safer dissection of the vesico-uterine fold and fascia
Enables the elevation of the uterus upwards in the abdomen, in order to obtain a good visualization of the uterine artery and its elevation above the ureter
Maintains pneumoperitoneum during colpotomy
Raises the uterus and brings it closer to the laparoscopic surgical instruments, facilitating the procedure
Manipulates the uterus, thus stretching and presenting the side being operated upon
Increases the distance between the uterus and the bladder, the ureters, and the rectum, thus reducing the chance of injury
Can be used pull the uterus out vaginally after its complete detachment
Facilitates the identification of the uterovesical peritoneum, the cul-de-sac, and the vaginal cuff just below the cervical attachment



Fig. 57.10 Examples of re-usable uterine manipulators. Many different re-usable uterine manipulators that consist of a manipulator portion and a colpotomizer system exist. Some examples include the Donnez, Clermont-Ferrand, Hohl and Mangeshikar uterine manipulators sold by Storz. Some of the features of these manipulators are reviewed in Table 57.4 (©2015 Photo Courtesy of KARL STORZ Endoscopy-America, Inc)

manipulators is that they are attachable to Copper Surgical's Uterine Positioning System (UPS) (Fig. 57.12). This device attaches to the operating room bed and holds the manipulator firmly in position using a hydraulic system which allows the manipulator to be moved in any direction and then holds the position without drifting. This precludes the need for a vaginal assistant to constantly hold and push up on the manipulator and affords the surgeon several advantages, especially in more complicated, difficult, or long cases. First, the surgeon can personally position the uterus as desired at any time, knowing that the position will not change. Second, it provides stability such that there is no drifting downwards as occurs when the assistant fatigues which often places the ureter at risk. Third by stabilizing and securing the anatomy, the surgeon can focus on dissection of the important anatomical structures without the position changing as the surgeon is working near or around the uterus [18].

Many other disposable manipulators exist including ones with a lighted ring in order to aid colpotomy. However, in Europe and other areas of the world re-usable manipulators predominate in an attempt to limit disposable instruments utilized in surgical procedures. Many re-usable manipulators

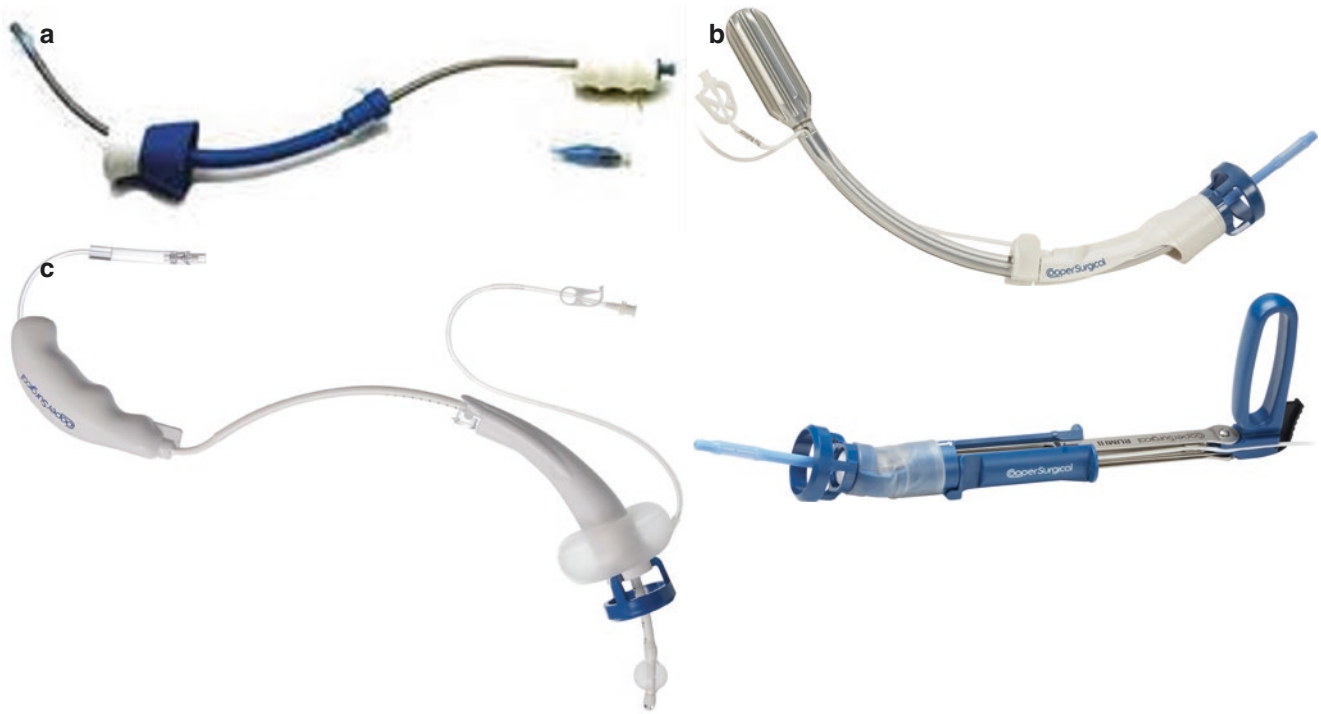


Fig. 57.11 Examples of disposable or partially disposable uterine manipulators. (**a**) V-Care uterine manipulator is fully disposable and has three cup sizes. It is shaped as an S shape for easier manipulation. (**b**) Copper surgical utilizes the Koh colpotomizer ring which is fenestrated and more cup shaped and thus provides clearer delineation of the colptomy site and lateralizes the ureter away from the uterine artery. The colpotomizer and occluder balloon section is disposable and comes in various sizes, as do the balloon tips which secure the uterus to the manipulator. Two manipulator bodies exist. One is a curved metal arc (Advincula Arch) which takes the curve of the vagina and is most useful for larger pathology. The other is the Rumi II system which allows anteversion and retroversion of the uterus via the handle. (**c**) Recently Cooper surgical has released a completely disposable version of the Advincula Arch which has the same advantaged of the KOH colpotomy ring and vaginal occluder balloon built in but has more of the S-shaped curve giving it easier handling for the user and less need for assembly. However, for larger pathology it may not be as sturdy as the metal arch



Fig. 57.12 Uterine positioning system. The uterine positioning system produced by Cooper surgical is compatible with either the Advincula arch or Rumi uterine manipulators. It is a device which attaches to the operating room table and holds the uterine manipulator with a hydraulic arm which remains fixed in place until the surgeon changes the position using a foot-pedal to release the hold. This allows the surgeon to position the uterine manipulator and uterus into any position and fixes it in place so that it does not drift or move. This thus takes the place of a vaginal assistant and allows the surgeon precise control of the uterus which greatly assists in difficult laparoscopic or robotic hysterectomy procedures

Table 57.3 Factors to consider in choosing a uterine manipulator

Factor for consideration	Ideal quality
Cost	Re-usable preferred
Ease of assembly	Minimal number of parts
Material	Metal or indestructible material
Range of motion	Pivoting head or arched shape
Placement into uterus	Easy placement with minimal cervical dilation required
Fixation into uterus	Method of fixation into uterus
Adjustability	Variable tip lengths and cup sizes to adjust for size of the uterus and cervix
Delineation of vaginal fornices	Circular cup or ring preferred over rotating valve
Vaginal occlusion	Method of occlusion to prevent loss of pneumoperitoneum

are present on the market. All share similar components of a method of fixation to the uterus, a cervical cup for delineation of fornices, and a method of vaginal occlusion. Most are straight rather than curved and several have the capability of anteversion and retroversion of the uterus. Table 57.3 lists some factors that should be taken into consideration when evaluating a uterine manipulator while Table 57.4 provides a comparison of some of the uterine manipulators available.

Table 57.4 Comparison of uterine manipulators

Manipulator	Re-usable	Number of parts	Pivoting head	Shape	Variable tip lengths	Method of fixation in uterus	Number fornix delineator sizes	Method of delineation of fornix
V-care	No	1	No	S-Shape	Yes	Balloon	4	Ridged cone
Rumi II	Partial	3	Yes	Straight	Yes	Balloon	4	Fenestrated cup
Advincula Arch	Partial	3	No	Arched	Yes	Balloon	4	Fenestrated cup
Donnez	Yes	3	No	Slight Curve	No	None	3	Cap
Clermont-Ferrand	Yes	6	Yes	Straight		Screw	3	Rod
Konninckx	Yes	4	Yes	Straight	No	Intrauterine clamp	1	Rotating cap
Hohl	Yes	4	No	Straight	Yes	Screw	3	Curved cap
Mangeshikar	Yes	6	No	Straight	Yes	Forceps	5	Cap
Minneli	Yes	4	No	Straight		Screw	3	Rotating valve

Ultimately cost and a surgeon's preferences determine which manipulator is used during a case [17].

Instruments for Dissection and Hemostasis

In general terms, a Hysterectomy has three components:

1. Isolation, sealing, and ligation of either the utero-ovarian or infundibulopelvic ligament depending on desire for ovarian preservation
2. Isolation, sealing, and ligation of uterine vasculature
3. Colpotomy or uterine amputation dependent on desire to preserve the cervix, followed by assurance of hemostasis and closure of openings including the vaginal cuff if needed.

All three components require dissection of the two vascular bundles, the bladder flap, and cervical vaginal fascia and transection with hemostasis of the two vascular bundles at the uterine isthmus and the adnexa [19].

Abdominal Hysterectomy

The standard instruments for surgeons are a clamp, scissors, and suture for ligation, and forceps and a needle driver for suturing. Thus, in abdominal hysterectomy, the clamp traditionally used is the Heaney clamp. However, the Seppelin clamp is more frequently used in oncologic procedures as the Z-configuration of clamp minimizes tissue slippage and need for a pedicle so that the cut can be made directly on the clamp with scissors or a scalpel. The neeldle driver tends to be a long handled but heavy needle driver in order to drive bites of suture through thicker ligaments such as the cardinal or uterosacral ligaments, and then used later for closure of the vaginal cuff which also consists of thick tissue and fascia. A monopolor current via bovie, is often used for dissection, cutting, and hemostasis while vasclular bundles are ligated generally using suture unless hand-held advanced bipolar instruments are used as an alternative. Vaginal hysterectomy is similarly performed but in the reverse order with dissection performed again with a scalpel, scissors, and bovie, while division of vascular pedicles is performed using a curved Heaney clamp to clamp, curved mayo scissors to cut, and a Heaney needle driver to suture the pedicles and for vaginal cuff closure.

Vaginal Hysterectomy

Since the advent of Laparoscopic surgery, many devices for dissection, hemostasis, and advanced vessel sealing have been developed and are even now slowly being incorporated into abdominal and vaginal procedures secondary to ease of use and speed of control of vascular pedicles. The main goal of energy devices is to seal vessels and attain hemostasis with or without cutting of the pedicle. Since exposure is usually adequate in abdominal surgery, there is little need to avoid the traditional clamp, cut, and tie rhythm. Thus, in abdominal hysterectomy, using these devices may add expense and save an insignificant amount of time. However, for difficult vaginal hysterectomies and in the vagina in general, where exposure is limited, a vessel sealing device can ease the procedure as it is often difficult to suture and tie pedicles in the tight vaginal space. Therefore, utilization of either a re-usable or disposable energy vessel sealing and cutting device may be advantageous. All are shaped similar to the curved Heaney clamp and thus may be applied in a similar manner to seal and divide the uterosacral or cardinal ligaments, followed by the uterine artery and broad ligaments, then either the infundibulopelvic or utero-ovarian ligaments in order to remove or preserve the ovaries. Re-usable devices include

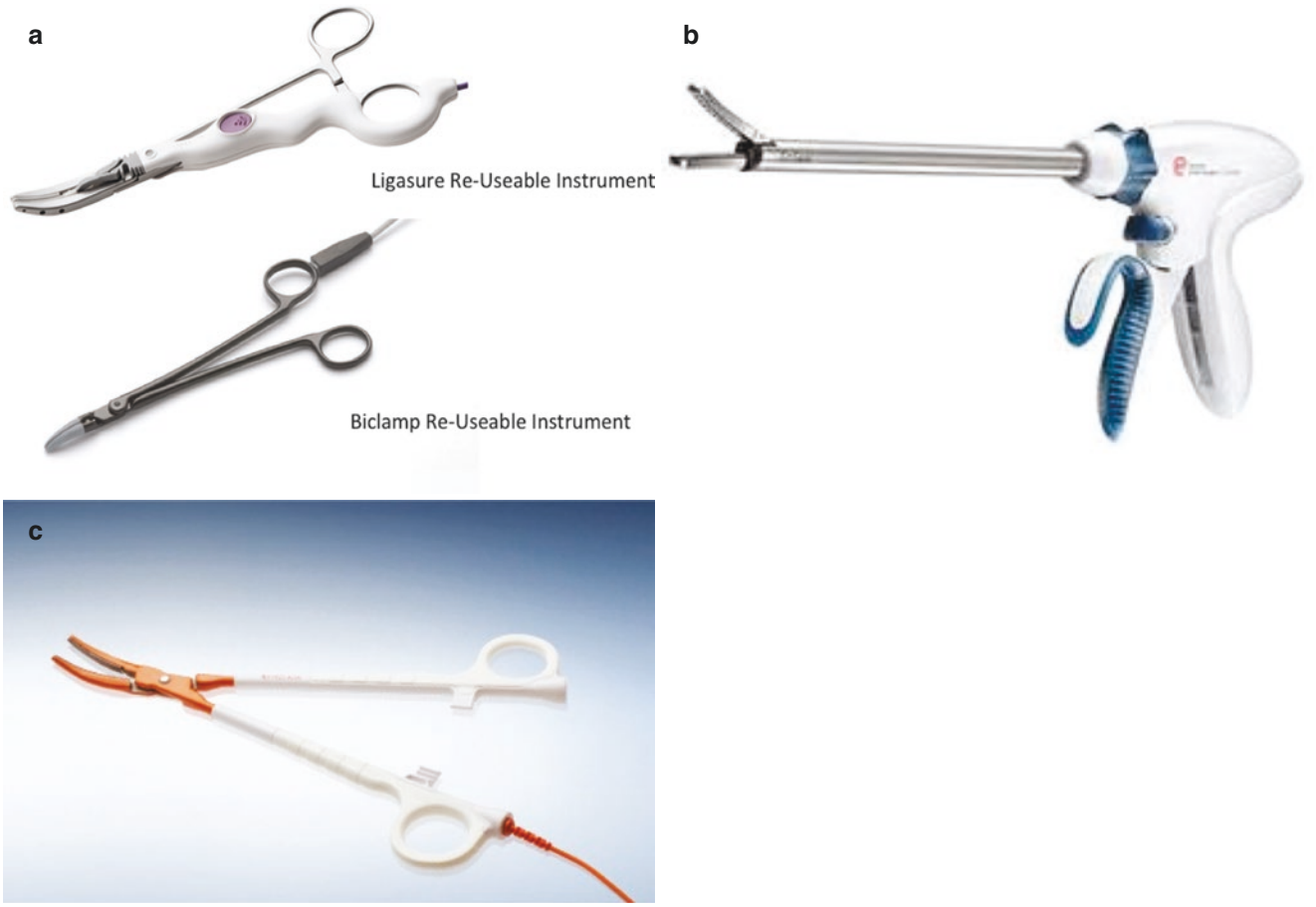


Fig. 57.13 Energy devices for vaginal hysterectomy. Bipolar instruments can be useful for expediting vaginal hysterectomy, used to seal vessels instead of suturing. (**a**) Re-usable instruments like the Ligasure or Biclamp are the most economic but only seal without seal and cut features. (**b**) Disposable instruments exist with the Enseal allowing sealing and cutting to occur simultaneously. (**c**) One of the first disposable instruments which was also used for vessel sealing in vaginal hysterectomy was the PKS Seal open forceps

the Biclamp or re-usable Ligasure devices, both of which have advance bipolar energy with Ligasure also utilizing additional pressure for vessel sealing. Disposable devices include the Gyrus SEAL, ENSEAL, and the Disposable Ligasure (Fig. 57.13). The Gyrus was the original advanced bipolar device using PK energy, followed by Ligasure and then the ENSEAL. Both Ligasure and Enseal utilize pressure, heat, and advanced bipolar energy to seal and cut the vessels. As the blade in Enseal applies pressure as it cuts, the pressure is more evenly distributed rather than decreasing near the tip as in Ligasure. However, Ligasure, like the Gyrus SEAL allows the surgeon to seal without cutting, thus providing the surgeon with more control [20]. Hysterectomy by using them to seal vascular pedicles instead of suture ligation. Re-usable instruments like the Ligasure or the Biclamp are overall the most economical but only seal without seal and cut features. The disposable Enseal allows sealing and cutting to occur simultaneously but this can be a disadvantage if the seal is not complete and does cost more per case. The PK seal open forceps was one of the first disposable instruments used for vessel sealing in vaginal hysterectomy but did not have the same cut feature as the PK used in laparoscopy. Thus, when choosing a device the advantages and disadvantages of each must be considered.

Laparoscopic Hysterectomy

Advanced Laparoscopic Surgeries such as total laparoscopic or supracervical hysterectomy have really been revolutionized by the advanced energy vessel sealing devices that have been developed for laparoscopy. The original energy utilized in Laparoscopy was monopolar energy, which is most useful for cutting (rather than sealing) such as in the use of monopolar scissors. Bipolar energy allowed passage of energy between the two blades of a grasper or forceps such as a Maryland and thus became utilized for coagulation of vessels in hysterectomy procedures. However, inadequate sealing of vessels secondary to charring and desiccation of tissue

surrounding the vessel which did not allow adequate passage of energy into the center of the vessel. This often resulted in inadequate sealing of the vessel and either immediate or delayed bleeding. In addition, other problems included lateral thermal spread to surrounding tissue, and sticking of the vessels and tissue to the clamp used to apply the energy with surface charring of the tissue. Thus, their use was limited especially when desiring to seal larger vessels. For this reason, early developers of the total laparoscopic hysterectomy procedure such as Harry Reich, would often suture uterine vessels rather than trying to seal them with energy [21]. Modern laparoscopic vessel sealing devices were later developed and have greatly facilitated the performance of laparoscopic hysterectomies. These devices may be categorized into advanced bipolar or ultrasonic energy devices or a combination of the two. All devices effectively seal vessels up to 7 mm in diameter and some have built in tissue transection capabilities. A comparison of these devices is provided in Table 57.5.

The first advanced bipolar energy system was the plasmakinetic pulsed bipolar system named the PK Gyrus (Olympus). It had an impedance dependent feedback-controlled method of delivery pulsed bipolar energy to the tissue causing vapor pulse coagulation induced sealing of vessels upto 7 mm in diameter. The intermittent and automatically adjusted pulses of bipolar energy produced by the plasma kinetic generator cause minimal lateral thermal spread and prevented sticking of tissue to the plasma kinetic forceps blades after coagulation. The Gyrus then offered a sharp blade for cutting the sealed pedicle with a hand control. The PK energy type could also be used with a dissecting forcep, spatula, needle-point, and hook in order to avoid the need for mono-polar energy during a case.

Other advanced bipolar devices include Ligasure, Bicision, and EnSeal. Advanced bipolar devices possess active feedback control over the power output, adjusting the energy according to the measured impedance of the tissue between the blades. Heat production is kept below 100 °C and the energy is pulsed to allow cooling [22]. However, there is no simultaneous tissue division and a cutting blade or mechanism is required for division or transection of the sealed vessel or tissue. Ultrasonic devices such as the ACE harmonic scalpel combine both the sealing and cutting steps into a single process and thus may increase dissection speed. However, the literature had reported that ultrasonic devices can create temperatures of up to 200 °C which can potentially put adjacent tissue at risk to lateral damage [21]. This concern has been partially addressed by adding a Teflon coating in newer ACE Harmonic devices which may decrease the peak temperature of the device.

Although many comparative studies have been performed, neither type of device has been proven superior. In general terms however, advanced bipolar devices ultimately produce less heat than ultrasonic devices. Both advanced bipolar and ultrasonic devices efficiently seal vessels ($\leq$7 and $\leq$5-mm diameter, respectively), and most also have built-in tissue transection capabilities. Bipolar devices are said to seal slightly larger vessels but do not seal and cut simultaneously or as efficiently as ultrasonic energy. Ultrasonic energy is best known for efficient dissection reflected by its ability to use the device in a cutting mode, and low lateral thermal spread to adjacent tissue. However, the device itself reaches higher temperatures and remains at this high temperature for an extended period resulting in initial concern of a higher rate of thermal injury to the ureter or bowel during hysterectomy procedures [23]. All Ultrasonic energy devices are disposable, as are most advanced bipolar energy devices, and thus add to the cost of the procedure. A reusable Biclamp using and Erbe generator is available and is frequently used in Europe for laparoscopic as well as vaginal hysterectomy as it is available in both a Maryland dissector and standard bipolar Forceps tips for use in laparoscopic hysterectomy. For vaginal hysterectomy it had a heavy ridged curved clamp similar to the Haney Clamp.

Only one device combines both bipolar and ultrasonic energy in order to try to combine the advantages of both types of energy [24]. The Thunderbeat (Olympus, Japan) is the first device to integrate both ultrasonically generated frictional heat energy and advanced bipolar energy in one instrument. This multifunctional device can interchangeably deliver the energies via two separate control buttons allowing the surgeon to favor advanced bipolar energy for sealing larger vessels and surface coagulation, while ultrasonic energy is preferred for quick cutting and sealing. The jaw is designed in a thin dissector design facilitating tissue dissection and increasing the multifunctional uses of the instrument.

Two publications involving animal models using this newer device compared the Thunderbeat with other commercially available energy devices in the market, namely, Harmonic Ace (Ethicon Endo-Surgery, USA), LigaSure (Covidien, USA), and EnSeal (Ethicon Endo-Surgery, USA) in the porcine model [24]. Compared with the other three devices, the Thunderbeat showed faster dissection speed, similar bursting pressure, and similarly acceptable thermal spread. The device was proven to be safe in cutting, coagulating, and tissue dissection. In another experiment led by Seehofer et al. [25] the Thunderbeat was compared to the Harmonic Ace and LigaSure in a pig model. Temperature profile, seal failures, maximum burst pressure, and cutting speed were measured. In this study, the Thunderbeat was faster than Harmonic Ace in terms of dissection while equaled the sealing efficacy of the LigaSure with a similar heat production.

Table 57.5 Comparison of advanced bipolar devices used in laparoscopy

Device	Energy type	Description	Positive features	Negative features
PK Gyrus (Olympus)	Plasma kinetic technology (Advanced bipolar)	Delivers a high current and very low voltage to the tissue. A series of rapid pulses allows a cooling phase decreasing lateral thermal spread	Holds onto the tissue being desiccated without slipping or sticking	Disposable
			A blade can be manually deployed through the forceps to transect tissue	Jaws can be traumatic
			Facilitates Dissection	Unreliable on vessels >7 mm
		The vessel is sealed by denaturing the protein within the vessel walls, forming a coagulum which occludes the lumen	Both a 5 and 10-mm version is available	Consistency somewhat dependent on user
			A Gyrus spatula is also available and can be used as both a cutting and coagulating instrument	
Ligasure (Covidien)	Advanced bipolar energy with pressure	Delivers high current, low voltage along with pressure from the jaws to tissue	Fast seal using combination of advanced bipolar energy and pressure	Disposable
			Compresses surrounding tissues to seal with the vessel	Hinders dissection secondary to bulky jaws and sealing of surrounding tissue
		The system monitors the energy expended while denaturing the collagen and elastin within the vessels walls. During the cooling phase of the cycle, cross-linking re-occurs creating a new seal	Both a 5 and 10 mm version is available	Unreliable on vessels >7 mm
				Pressure decreases near tip of the jaw
				Consistency less dependent on user
Enseal (Ethicon)	Advanced bipolar energy with pressure	Uses a bipolar electrode to concentrate energy on tissue within the plastic jaws of the instrument	Sealing using combination of advanced bipolar energy and pressure	Disposable
		Temperature sensitive matrix (nanopolar thermostats) within the jaws controls the energy delivered to the electrode-tissue interface	Easier to dissect with than Ligasure secondary to slim Jaws	Cutting may occur prior to adequate sealing as sealing is still occurring during cutting phase
			Has an articulating version which facilitates single port procedures and improves angles for vessel sealing	Unreliable on vessels >7 mm
		Pulsing of energy according to temperature allows cooling		Proper use requires a certain level of surgical skill thus is surgeon dependent
				Less efficient than some other devices
BiClamp (Erbe)	Advanced bipolar	A bipolar electrosurgical current produced by the ERBE VIO system ,with an optimally adjusted waveform, voltage and current density is applied and the tissue is coagulated and sealed	Tissue structures can be coagulated over larger areas and surgeon has greater control over width of area coagulated that seal and cut devices	Is a seal only device, therefore requires a separate instrument (usually laparoscopic scissors) for cutting once the vessel is sealed.
		The particular features of the ERBE BiClamp create a parchment-like coagulation seam during bipolar coagulation, thus sealing the vessel	Highly economical as the ERBE BiClamp is reusable	This may decrease efficiency of the procedure
			Auto stop and plug and play feature is user-friendly and adjusts automatically for different procedures	

(continued)

Table 57.5 (continued)

Device	Energy type	Description	Positive features	Negative features
Harmonic ACE (Ethicon)		High frequency ultrasonic transducer with active titanium blade vibrates at 55,000 cycles per second	Fast seal and cut	High external temperature
		Mechanical energy causes a breakdown of protein creating a coagulum. Vessel and tissue sealing is dependent on the power setting as well as the pressure exerted and the tissue tension	Low lateral thermal spread	Vessel sealing ideal <5 mm
			5 mm instrument	Poor reliability on vessels ≤7 mm
			Good for efficient dissection	
		A straight and curved blade is available	Lower working temperature causes less charring and sticking	Consistency is highly dependent on the user
			Variability of energy delivered can be adjusted by the surgeon ,depending on the need and tissue being transected	
			The active bade can also be used as a cutting knife useful for colpotomy	
Thunderbeat (Olympus)	Ultrasonic and advanced bipolar energy	Integrates both ultrasonically generated frictional heat energy and advanced bipolar energy in one instrument as a multifunctional device	Multifunctional device can interchangeably deliver the different energies	Disposable
			Allows the surgeon to simultaneously seal and cut vessels up to 7 mm in size with minimal thermal spread	Unreliable for vessels above 7 mm
			The jaw is designed to provide precise, controlled dissection and continuous bipolar support with grasping allowing for efficient dissection and hemostasis	Ease of use required practice and training of the surgeon

Specialized Laparoscopic Hysterectomy

For single port laparoscopic procedures, if an advanced energy device is desired for vessel ligation the surgeon must either try to present the vessels and tissue to the vessel sealer that they normally use for laparascopic hysterectomy or choose an articulating vessel sealing device. To date the only vessel sealer that is available with the ability to bend or articulate is the Enseal system by Covidien. The articulation of the instrument facilitates triangulation in single-port procedures.

In mini-laparoscopy, one of the main limitations to the performance of hysterectomy was the lack of bipolar energy devices. Thus, a 5 mm port was often utilized in a hybrid laparoscopic technique in either a "single port" or traditional laparoscopic orientation in order to seal the vascular pedicles. Storz has now released 3.5 mm ROBI Bipolar Graspers and Scissors providing energy application through a mini-laparoscopic port (Fig. 57.14). Other 2 or 2.5 mm instruments do not provide energy and thus mainly function as graspers, scissors, or dissectors but not as vessel sealers. As the energy devices advance in mini-laparoscopy instruments, it is likely that the performance of hysterectomies using "mini" ports will increase.



Fig. 57.14 ROBI bipolar graspers and scissors for mini-laparoscopy procedures. 3.5 mm instruments that allow bipolar energy application have been developed by KARL STORZ. These include graspers, dissectors and scissors. The ROBI bipolar grasper can be used to seal infundibulopelvic ligaments as well as uterine vasculature in laparoscopic hysterectomy procedures (©2015 Photo Courtesy of KARL STORZ Endoscopy-America, Inc)



Fig. 57.15 DaVinci surgical system. Robotic cart attaches to the trocars placed into the peritoneal cavity. Instruments are then placed into the peritoneal cavity through the trocars and attach to the robotic arms and intuitive full range of motion is given to the surgeon via the controls at the Surgeon Console. Assistants stand at the bedside and help with instrument exchanges, camera management and retraction. The surgeon controls the robotic instruments, energy, and camera from the surgeon console

The daVinci robotic surgical system (Fig. 57.15) is one of the most expensive and advanced tools available for the performance of hysterectomy, greatly extending the ability of a surgeon to push the limits of laparoscopy. However, one of the criticisms of the system is its extensive reliance on traditional bipolar and monopolar energy thus requiring the surgeon to understand the proper use of this type of energy and its effect on tissues in order to reduce risk of injury resulting from thermal spread. The disadvantages of traditional bipolar energy can be overcome using the concepts of adequate tissue dissection down to the vessel wall, made easier by the superior vision and articulating precisely



Fig. 57.16 Typical instruments used in DaVinci Hysterectomy. (**a**) Grasping instruments include the prograsp, long-tipped forceps, and robotic tenaculum. (**b**) Cutting devices include the mono-polar scissors, mono-polar hook, and mono-polar spatula. (**c**) Other useful instruments include the clip applier and suction irrigation device. The only other instruments required are some kind of bipolar vessel sealing or coagulation instruments reviewed in Fig. 57.17

controlled instruments. Bipolar energy can then be applied, applied directly to the vessel with intermittent manually pulsed application allowing heat and charring to dissipate so that the energy transmits further into the vessel. This thus mimics the pulsed bipolar energy of advanced devices but without the ability to adjust power for tissue impedance. Similarly, using appropriate tension and counter-tension techniques and principles of utilizing a larger surface area for coagulation and smaller surface area with a swift movement with tissue on tension for cutting using the mono-polar scissors reduces tissue damage and thermal spread (Fig. 57.16). These swift movements and precision in energy application is greatly facilitated by the wristed instruments that mimic the surgeons' hands exactly to a set scale (1:1, 1:3, 1:5 depending on the setting). Therefore, in experienced hands the energy can be used safely and effectively since the surgeon has much greater control over the movements and the precision of the dissection and energy application as compared to traditional laparoscopy. Thus, if the energy is utilized precisely and selectively only when needed, a safe and efficient dissection and hemostatic control of pedicles can be acheived with the added possibility of decreasing blood loss over laparoscopy.

As far as advanced bipolar energy use with the daVinci robotic surgical system, the S and Si Systems are compatible with a PK gyrus generator utilizing the PK dissector instrument for vessel sealing (Fig. 57.17). This instrument has the advantages of advanced bipolar energy and is optimally shaped for both dissection and vessel sealing, although it does not function well as a grasper and thus does not have the multi-purpose advantages of the fenestrated bipolar or bipolar Maryland instrument which utilize traditional bipolar energy. Thus, when choosing the instrument the surgeon must compromise one of two functions and compare that to the preference for type of energy. The PK dissector is slim and long and is optimal for careful dissection around vessels or in retroperitoneal space but does not grasp peritoneum or tissue well. However, its vessel sealing ability is superior secondary to the pulsed PK advanced energy. Thus, surgeons who utilize this instrument have a style of surgery focused on dissection and selective vessel sealing and use the blades of the PK dissector much like a Kelley instrument in abdominal

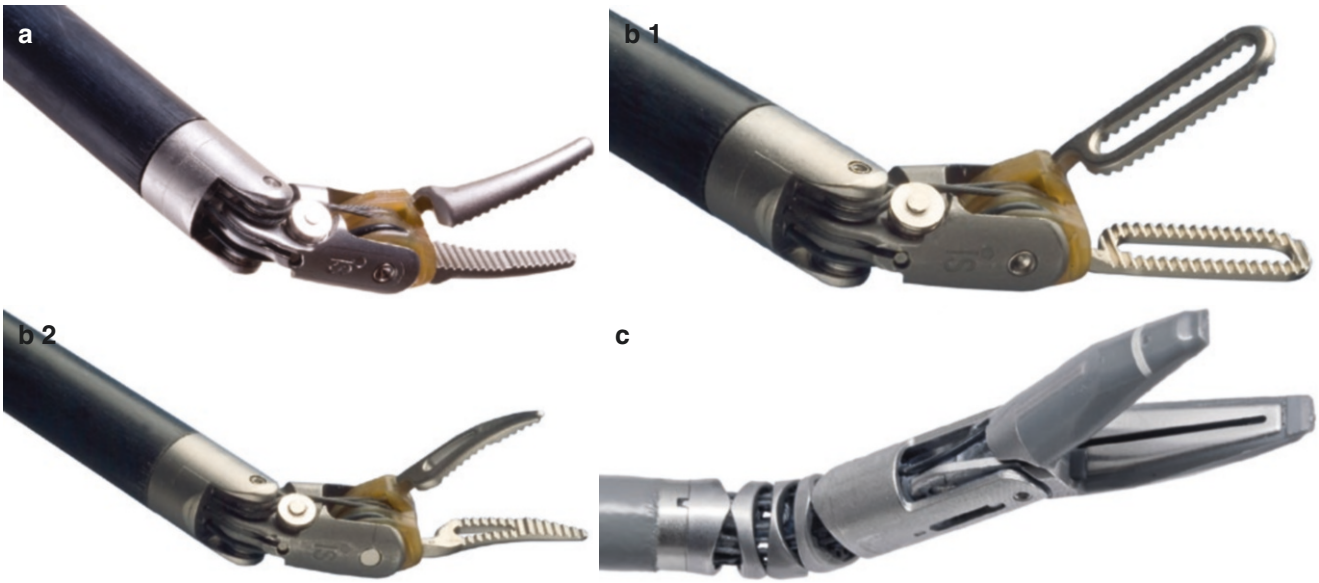


Fig. 57.17 Bipolar Instruments for use with DaVinci surgical System. (**a**) The PK dissector allows application of advanced bipolar energy for optimal vessel sealing. Its thin jawline also allows dissection of anatomy down to the vessel wall. (**b**) The fenestrated bipolar and bipolar Maryland apply traditional bipolar energy and thus require manual pulsing of the jaws in order to allow tissue to cool between pulses thus reducing sticking and charring and increasing efficiency during vessel sealing. (**c**) The newest instrument is a vessel sealer employing Ligasure-like technology to seal and cut vessels efficiently and rapidly. However the instrument is not multifunctional and thus functions poorly as a grasper or a dissector

surgery, utilizing the monopolar energy to cut tissue that is elevated between the blades. (Figure) Surgeons, who utilize the fenestrated bipolar or bipolar Maryland, tend to use more blunt dissection and traction of tissue and peritoneum to open spaces and will need to apply more energy in order to accomplish similar vessel sealing. Thus, the style of the surgeon also determines the instrument chosen for the task.

A newer vessel sealing and cutting instrument (Fig. 57.17) has also been released for the Si and Xi systems which has a similar seal and cut technology as the Ligasure device but its thickness and bulk make it function poorly as a dissector or a grasper. As such, it may not provide much advantage over the PK dissector for hysterectomies [26, 27]. Surgeons, that utilize this instrument prefer the combined sealing and cutting as compared to the seal and then cut seal and then cut with scissors or monopolar hook stating that this may save time by the combined sealing and cutting of pedicles. This is especially useful for colectomy, or other general surgery procedures. In hysterectomy, if a surgeon wishes to mimic the laparoscopic approach of sealing and cutting utero-ovarian or infundibulopelvic ligaments then sealing and cutting the broad ligament along the uterus until the uterine artery is reached then this instrument may accomplish this effectively. However, authors caution that if the broad ligament is not opened, allowing the ureter to fall ever further inferiorly or laterally, that this may decrease the distance between the ureter and vascular pedicles. This is especially important in cases of distorted anatomy such as in patients with a large fibroid uterus or severe endometriosis. In addition, as this instrument functions poorly as a dissector, the vascular pedicles may not be skeletonized as effectively potentially compromising vessel sealing especially if the vessel size is large such as in patients with large fibroids. It is thus extremely important that surgeons understand the instruments and energy that they are utilizing and watch different surgery styles using these instruments before selecting the method that will achieve both safety and efficiency in their hands.

Instruments for Tissue Extraction

Once a hysterectomy is performed the tissue needs to be removed from the abdominal cavity. In abdominal or vaginal hysterectomies, the pathology is removed via the incision used to obtain access, either abdominally or vaginally. When the laparoscopic approach is undertaken, removal of the specimen is dependent on the type of hysterectomy performed. If a total laparoscopic hysterectomy is performed, then extraction may occur vaginally through the colpotomy incision. Even if the uterus is enlarged, by placing vaginal retractors similar to those utilized in vaginal hysterectomy and using either long single, double, or triple toothed graspers on the uterus, the uterus can be extracted using wedge or strip cutting of the specimen until it is completely removed. If containment of the tissue is a concern, the specimen may be placed into a laparoscopic bag first then by pulling the opening of the bag out through the vagina and placing the

retractors within the bag, morcellation can be performed via the vaginal route in a contained fashion (Fig. 57.18).

If the specimen is too large to pull into the vagina, a small 2–4 cm suprapubic or umbilical incision can be made, placing a small Alexis wound retractor into the wound, grasping the tissue with towel clips or triple toothed graspers and similarly cutting the specimen in a systematic fashion in order to remove it. Again, if containment is desired, the specimen may be placed within a bag first then by pulling the bag up through the incision and placing the alexis retractor within, then morecellation can be performed in a contained environment. Newer bags with the retraction ring already built in have also been released and may be utilized for the same purpose (Fig. 57.19).

For supra-cervical hysterectomy, the cervix is spared and there is no colpotomy incsion. Therefore, the only options for extraction of the uterus with or without the adnexa are mini-lap morcellation or mechanical morcellation. Again consideration should be made for containment of the specimen if required. Mechanical morcellators are devices introduced into the peritoneum through a trochar site which is extended to 15–20 mm with a revolving blade that cuts the specimen into strips for extraction as a grasper pulls the tissue towards to blade pulling the strip out through the morcellator channel. Most mechanical morcellators are disposable and utilize a sharp blade for cutting. Although an energy based morcellator was available from Gyrus, lack of efficiency and excessive smoke production were limiting factors. The rotacut morcellator from Stortz is a re-usable mechanical morcellator in which only the blade is disposable. It is relatively strong and efficient but does require some assembly and does not have a retractable safety guard similar to disposable morcellators. There are several completely disposable morcellators available on the market that vary in their features but are limited by cost and durability. Table 57.6 compares the available morcellators. The Gynecare Morcellex was one of the

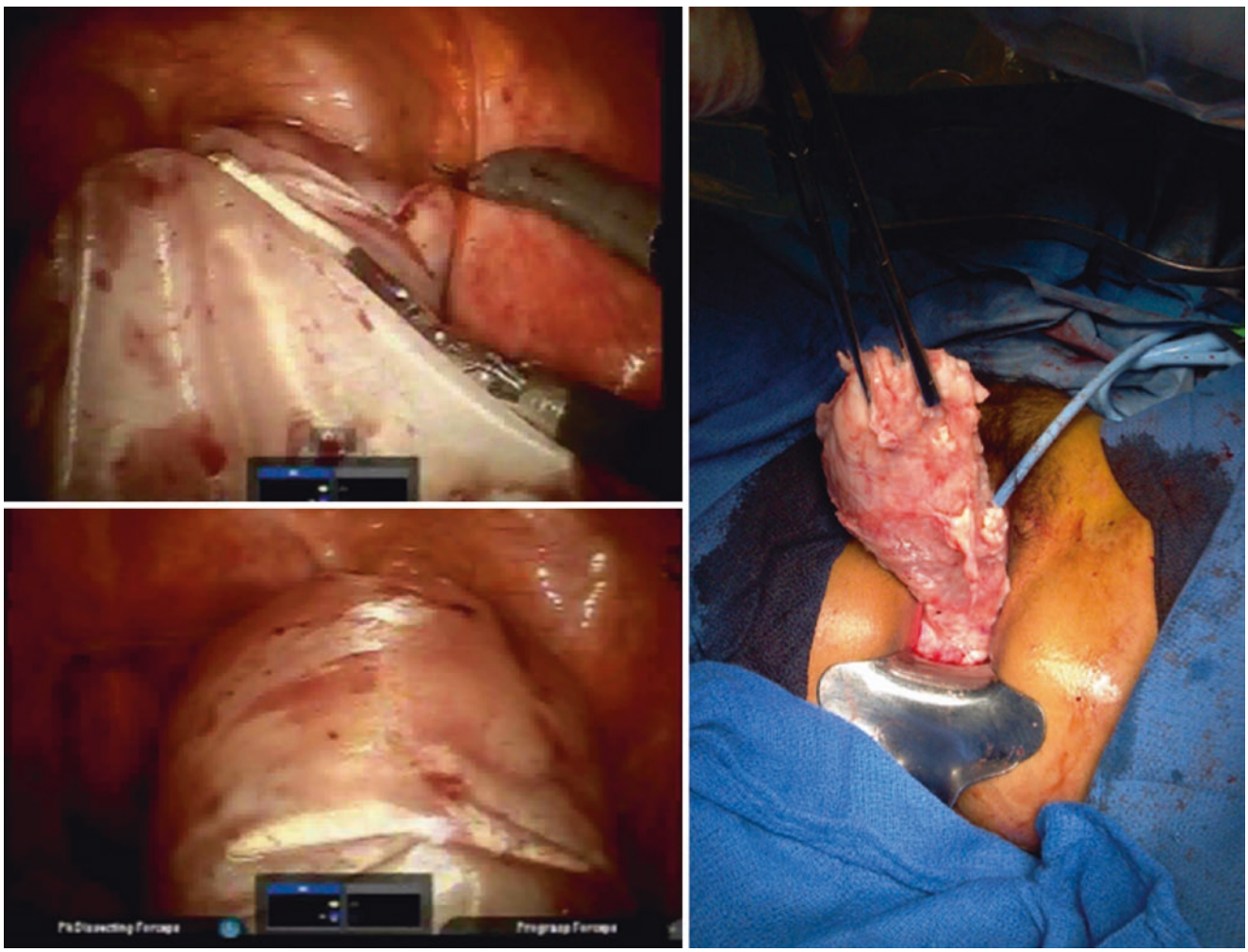


Fig. 57.18 Uterine specimen removed vaginally after placement within a specimen bag and hand scalpel morcellation within the bag. The bag is introduced through the vagina after the colpotomy is completed. The uterus can then be placed within the bag and the bag pulled out through the vagina. Vaginal retractors can then be placed and the uterus can be wedge resected or morcellated with the assistance of a scalpel until it is completely removed

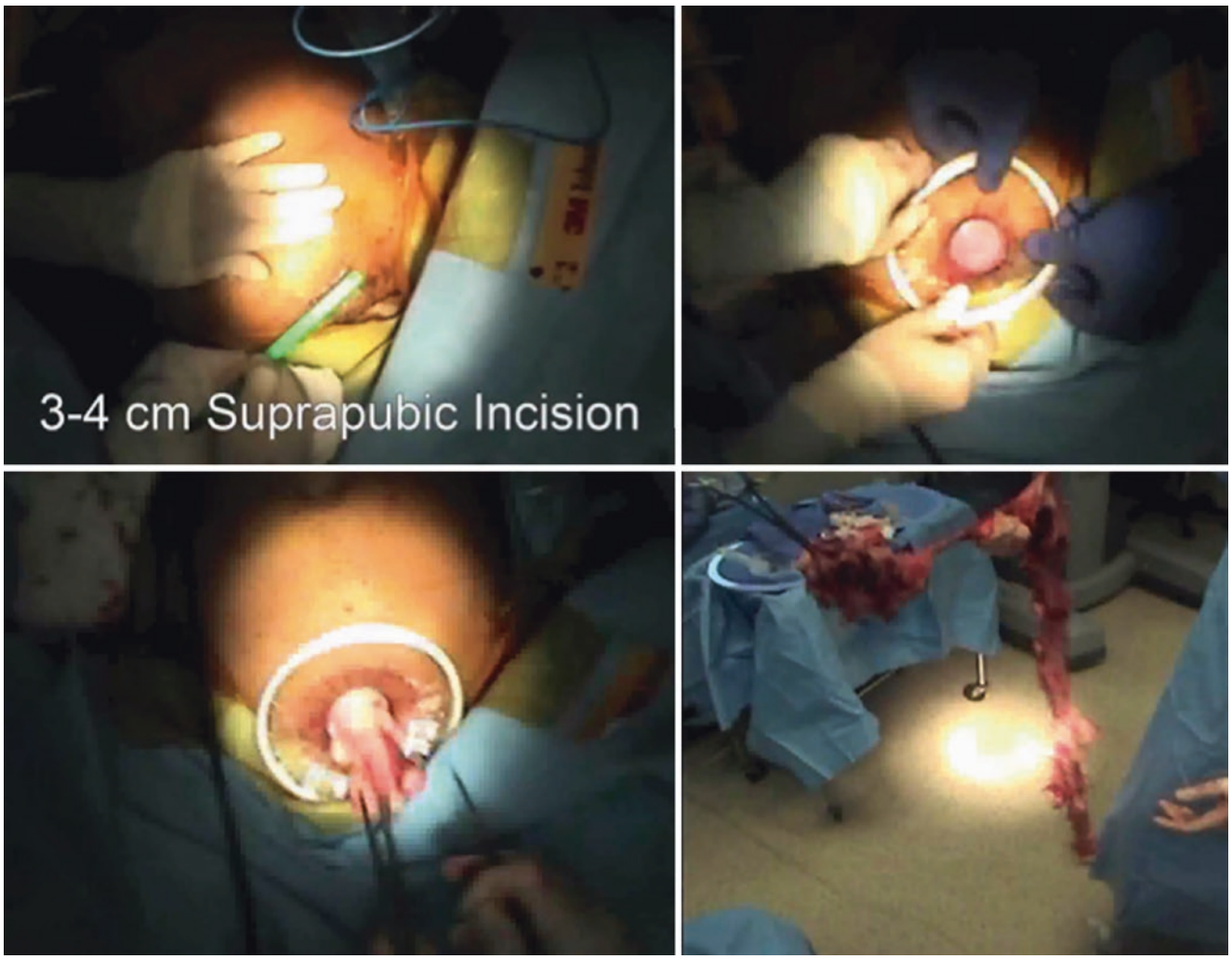


Fig. 57.19 Minilap Morcellation. Specimen is placed within a bag and pulled out through a suprapubic or umbilical incision measuring 2–3 cm. Wound protector/retractor is placed within the bag and scalpel is used to extract specimen using hand morcellation techniques

Table 57.6 Comparison of mechanical morcellators

Morcellator	Disposable	Cordless	Safety guard	Detachable from port	Sizes available	Criticisms
STORZ Rotocut Morcellator	No	No	Yes	No	15 mm	Bulky and heavy in size
	Disposable Blade		Cannula without safety also available for coring			Assembly required
LiNA Xcise	Yes	Yes	Yes	No	15 mm	Battery life is a limitation
		Battery operated				Hand control is only option
Blue Endo MOREsolution Tissue Morcellator	Yes	No	Yes	Yes	15 mm	As does disassemble some practice needed to keep morcellator from detaching from port
				Allows for extraction of tissue that may get stuck in the port	20 mm	
					Allows choice to increase size for larger specimen	
Gynecare Morcellex Tissue Morcellator	Yes	No	Yes	No	15	Inefficient blade
			First to be developed			Tissue fragmentation appears to be excessive
The PKS Plasma Sword Bipolar Morcellator	Yes	No	No	No	15 mm	Extremely inefficient compared to bladed systems
						Excessive smoke production
						Thermal injury is a concern

first disposable morcellators on the market and included the safety guard to protect the blade when not in use. It initially did lack some durability and when the blade dulled it tended to shred tissue leading the surgeon to have to use a second morcellator to complete the case. The Lina morcellator is completely cordless and functions off a battery pack. The Blue endo morcellator comes in both 15 and 20 mm sizes, allowing surgeons to extract larger pathology more easily. In addition, it detaches from its port so that if tissue gets caught within the channel it can be pulled out. Both of these also have a safety guard in their design. The use of morcellators in hysterectomy has been declining since the FDA warning was released in 2013 and many registries and studies are taking place to evaluate possible use of morcellation within containment systems to prevent spread of tissue within the peritoneal cavity during morcellation [28].

Instruments for Vaginal Cuff Closure

Closure of the vaginal cuff in both the Abdominal and Vaginal hysterectomy approaches is relatively simple as compared to Laparoscopic approaches. Although there were a few now abandoned attempts at staple devices used initially in an attempt to expedite abdominal hysterectomy, most surgeons close the vagina using either continuous or interrupted sutures incorporating the cardinal and uterosacral ligaments into the angles in order to provide support. Only a toothed forceps and long handled heavy needle driver are required. Similarly, in Vaginal hysterectomy a heavy Haney needle driver can make suturing the cuff at the apex of the vagina simpler. Again uterosacral ligaments are usually incorporated into the cuff closure in order to provide support and help prevent prolapse of the apex at a later time.

Although, with practice and persistence, laparoscopic suturing can be performed relatively efficiently utilizing either intracorporeal or extracorporeal knot tying utilizing a knot pusher, it is this area in which some devices have been developed in order to assist in vaginal cuff closure or laparoscopic suturing in general. These can be especially useful in single port hysterectomy procedures in which the lack of triangulation makes vaginal cuff suturing extremely challenging. Therefore, some surgeons may choose to either close the vaginal cuff using a vaginal approach or utilize a device to assist with suturing or knot placement. Two categories of such devices exist. The first are devices that assists in passing the needle through tissue and may also expedite knot tying, and another are devices that assists with knot tying by utilizing pre-loaded Roeder knots that are placed after the needle is passed through the tissue using standard laparoscopic suturing techniques. Although some of these devices are re-usable, all require purchasing of suture with needles specifically designed for each particular device and thus the cost of this suture should be accounted for in addition to the cost of the device.

Two examples of devices that assist with knot tying are the Pare Surgical Inc. Quik-Stitch re-usable knot tying device and the Ethicon Endo-Surgery Suture assistant. Quik-Stitch is re-usable, while Endo-surgery Suture assistant can only be reloaded 5 times. Both are 5 mm in diameter and function in a similar manner allowing the surgeon to pass the suture into the peritoneal cavity with a grasper at the end of the device, then after passing the needle through the tissue utilizing standard laparoscopic needle drivers the device is used to place and synch the knot in place.

There are several devices that assist with passing the suture through the cuff, as well as knot tying, by toggling a needle back and forth between tips of the grasping end of the device. Endo evolution Endo360° Reusable Stainless Steel Suturing Device is a 10 mm re-usable device with a curved tip and needle that may be used for vaginal cuff closure purposes as well as other applications. The suture with needle is specifically made for this device and thus must be purchased separately. Covidien has also developed a 10 mm single use device. Covidien Endo Stitch™ single use suturing device uses a straight needle that passes from one jaw to the next after grasping the tissue through which the needle needs to be passed. A similar articulating device, the SILS™ Stitch articulating suturing device performs a similar function but is designed specifically for single port surgery. Again, suture with needles need to be purchased separately. In addition to the expense, the disadvantages of these devices is that it is difficult to compensate for different tissue thickness or to adjust the size of the bites taken as well as with traditional suturing and thus there may be concern for inadeqate closure if not used properly.

Development of a needle driver with a small diameter for mini-laparoscopy that is strong enough to drive a needle through thick vaginal tissue did take some time and surgeon's performing hysterectomy by mini-laparoscopy often resorted to suturing vaginally, as did the surgeons' performing single port hysterectomy. Storz did develop an adequate needle driver which is re-enforced by a low-friction cannula that prevents the needle driver from bending when passing needles through tougher tissue. This now can allow surgeons to utilize a 3.0 mm port site in order to close the vaginal cuff. Both the trochar/cannula set and the needle driver are re-usable stainless steel instruments and thus are cost efficient.

For Hysterectomy, the robotic instrument has simplified vaginal cuff closure by greatly simplifying suturing and knot tying because of the ergonomic intuitive movements of robotic instrument arms completely mimicking open surgical technique allowing suturing in any angle. Although the single port platform still includes instruments that are not wristed, this will also soon change and will simplify single

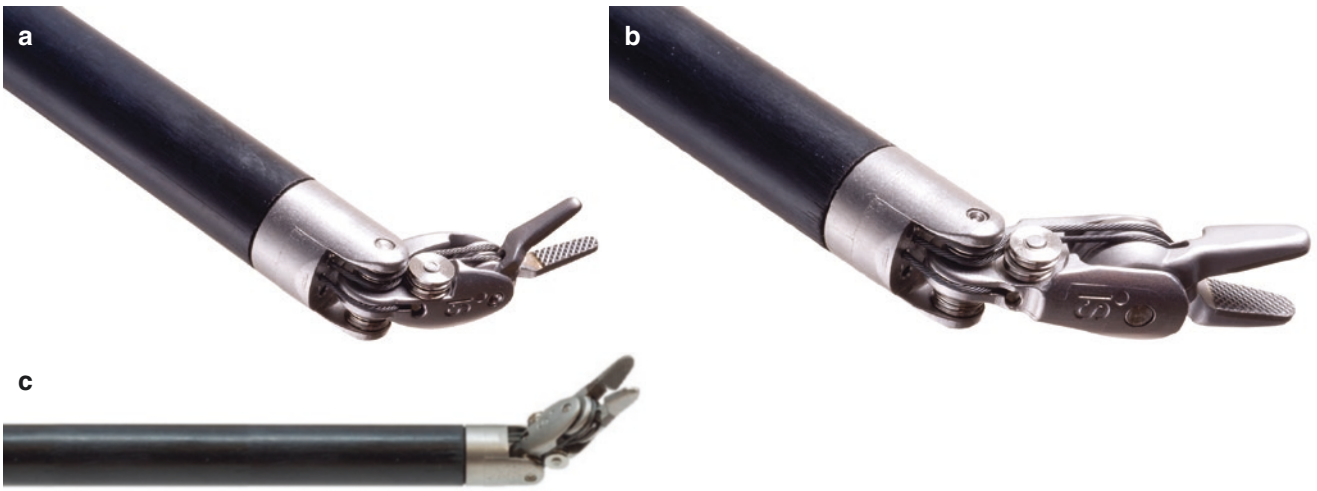


Fig. 57.20 DaVinci Suturing Instruments. For robotic hysterectomy there are two sizes of needle drivers that are available for use in vaginal cuff closure. The large needle driver (**a**) however is not as heavy or as sturdy as the mega needle driver (**b**) which is easier to use on thick vaginal tissue. Both also come as a suture-cut needle driver (**c**) which has a suture scissor in the shank thus allowing the surgeon to save time cutting suture. Initially 5 mm single port robotic needle drivers were not wristed and thus gave the surgeon more difficulty in suturing the cuff, but recently a wristed 5 mm single port needle driver was released greatly simplifying vaginal cuff suturing with the single-port platform

port robotic hysterectomy as well. Options for instrumentation for grasping the vaginal cuff include the Pro-grasp (often used for retraction with fourth arm during the case), the toothed cobra grasper, the long-tipped forcep, or the bipolar instrument utilized during the case such as the bipolar Marylyn or fenestrated bipolar instrument. As each robotic instrument utilized during the case costs money, most surgeons will try to use one of the instruments used earlier during the case for elevation and manipulation of the vaginal cuff rather than choosing a specific instrument solely for this purpose. For optimal suturing however, a needle driver should be used for driving the needle and trying to drive the needle with one of these other instruments may be cumbersome and cost time. In general, the heaviest option for needle driver should be chosen as the vaginal cuff tends to be relatively tuff tissue as compared to bowel or bladder for which a smaller (Large) needle drive is often used. One may choose either the option which incorporates scissors into the needle driver (Mega-Suture cut) or the needle driver on its own (Mega) needle driver and utilize their assistant for cutting the suture [26] (Fig. 57.20).

Conclusion

A well-informed surgeon should study and know the uses and limitation of the instruments available before selecting the appropriate instrument for the procedure and task at hand. Hysterectomies are one of the most commonly gynecologic procedures performed in women. The ultimate goal of a surgeon is to perform the procedure efficiently and safely while causing the least amount of trauma to the tissue and patient. Technology and devices is now allowing these procedures to be performed in most women utilizing minimally invasive surgical techniques, minimizing the need for laparotomy. Whether the vaginal, laparoscopic, mini-laparoscopic, single port, or robotic approach is undertaken, both patient selection and the choice of the appropriate instruments will determine the overall success of the procedure.

References

1. Duhan N, Al-Hendy A. Techniques of hysterectomy, hysterectomy (Ed.). 2012. ISBN: 978–953–51-0434-6.
2. Wu JM, Wechter ME, Geller EJ, Nguyen TV, Visco AG. Hysterectomy rates in the United States. Obstet Gynecol. 2003;110:1091–54.
3. Bahamondes L, Bahamondes MV, Monteiro I. Levonorgestrel-releasing intrauterine system: uses and controversies. Expert Rev Med Devices. 2008;5:437–45.
4. Reich H, Roberts L. Laparoscopic hysterectomy in current gynaecological practice. Rev Gynaecol Pract. 2003;3:32–40.
5. Einarsson JI, Suzuki Y. Total laparoscopic hysterectomy: 10 steps toward a successful procedure. Rev Obstet Gynecol. 2009;2:57–64.
6. Johnson N, Barlow D, Lethaby A, Tavender E, Curr L, Garry R. Methods of hysterectomy: systematic review and meta-analysis of randomised controlled trials. BMJ. 2005;330:1478–86.
7. Uppal S, Frumovitz M, Escobar P, Ramirez PT. Laparo-endoscopic single-site surgery in gynecology—a review of the literature and available technology. J Minim Invasive Gynecol. 2011;18:12–23.
8. Reynolds RK, Advincula AP. Robot-assisted laparoscopic hysterectomy: technique and initial experience. Am J Surg. 2006;191:555–60.
9. Beste TM, Nelson KH, Daucher JA. Total laparoscopic hysterectomy utilizing a robotic surgical system. J Soc Laparoendosc Surg. 2005;9:13–5.
10. Orady M, Hrynewych A, Nawfal AK, Wegienka G. Comparison of robotic-assisted laparoscopic hysterectomy to other minimally invasive approaches. J Soc Laparoendosc Surg. 2012;16:542–8.

11. Orady ME, Aslanova R, Paraiso MFR. Hysterectomy for benign indications. Minerva Ginecol. 2014;66(1):13–21.
12. Stone HH, Hoefling SJ, Strom PR, et al. Abdominal incisions: transverse vs vertical placement and continuous vs interrupted closure. South Med J. 1983;76:1106–8.
13. Wong WSF, Lee TCE. Hybrid approach for difficult vaginal hysterectomy. Vaginal Hysterectomy. 2nd edn., Jaypee Brothers Medical Publishers Pvt Ltd. 2014:180–186.
14. Vilos GA, Ternamian A, Dempster J, Laberge PY. Laparoscopic entry: A review of techniques, technologies, and complications. SOGC. 2007;193:433–47.
15. Vilos GA, Ternamian A, Dempster J, Laberge PY. Laparoscopic entry: a review of techniques, technologies, and complications. J Obstet Gynaecol Can. 2007;29(5):433–65.
16. Van den Haak L, Alleblas C, Nieboer TE, Rhemrev JP, Jansen FW. Efficacy and safety of uterine manipulators in laparoscopic surgery. A review. Arch Gynecol Obstet. 2015;292(5):1003–11. doi:10.1007/s00404-015-3727-9.
17. Ornella Sizzi. Overcoming technical limits to laparoscopic hysterectomy. Ob Gyn. 2006. http://www.obgyn.net/.
18. Swan K, Kim J, Advincula AP. Advanced uterine manipulation technologies. Surg Technol Int. 2010;20:215–20.
19. Brill AI, Stamos MJ. Perpendicular blood vessel sealing in surgical practice. 2012;1:13.
20. Campbell PA, Cresswell AB, Frank TG, Cuschieri A. Real-time thermography during energized vessel sealing and dissection. Surg Endosc Other Interventio Tech. 2003;17:1640–5.
21. Emam TA, Cuschieri A. How safe is high-power ultrasonic dissection? Ann Surg. 2003;237:186–91.
22. H. Z. Lin, Y. W. Ng, A. Agarwal, Y. F. Fong. Application of a new integrated bipolar and ultrasonic energy device in laparoscopic hysterectomies. ISRN Minimally Invasive Surg. 2013;2013:Article ID 453581.
23. Seehofer D, Mogl M, Boas-Knoop S, et al. Safety and efficacy of new integrated bipolar and ultrasonic scissors compared to conventional laparoscopic 5-mm sealing and cutting instruments. Surg Endosc. 2012;26:2541–9.
24. Milsom J, Trencheva K, Monette S, et al. Evaluation of the safety, efficacy, and versatility of a new surgical energy device (THUNDERBEAT) in comparison with Harmonic ACE, LigaSure V, and EnSeal devices in a porcine model. J Laparoendosc Adv Surg Tech A. 2012;22:378–86.
25. Seehofer D, Mogel M, Boas-Knoop S, Under J, Schirmeir A, Chopra S, Eurich D. Safety and efficacy of new integrated bipolar and ultrasonic scissors compared to conventional laparoscopic 5-mm sealing instruments. Surg Endosc. 2012;26(9):2541–9. doi:10.1007/s00464-012-2229-0. Epub 2012 Mar 24
26. Payne TN. Advancements in robotic hysterectomy, ACS Surgery News, 2013.
27. Hoste G, Van Trappen P. Robotic hysterectomy using the vessel sealer for myomatous uteri: technique and clinical outcome. Eur J Obstet Gynecol Reprod Biol. 2015;194:241–4. doi:10.1016/j.ejogrb.2015.09.030.
28. Barron K, Richard T, Robinson PS, Lamvu G. Association of the U.S Food and Drug Administration Morcellation warning with rates of minimally invasive hysterectomy and myomectomy. Obstet Gynecol. 2015;126(6):1174–80.

Diagnostic Laparoscopy via the Da Vinci Robot in General and Site Recognition

58

Agnieszka Oleszczuk-Cosse

Introduction

The robot assisted surgery is an innovative technique to perform laparoscopic procedures that is still evolving and is open for new operative possibilities. Robotic precision in tumor excision, easier intracorporal suturing and favorable ergonomics for the surgeon make the da Vinci robot particularly suitable for performing complex laparoscopic microinvasive surgical operations [1]. However, diagnostic laparoscopic procedure needs to be performed before every operation with the Da Vinci robot. Ongoing efforts to improve the morbidity and cosmesis have led to minimization of size and number of ports required for laparoscopic surgery. Single port laparoscopy or Laparo-Endoscopic Single Site surgery (LESS) represent the latest innovation in minimally invasive surgery. The advantages of the LESS via Da Vinci robot, with the use of only one port for a 3D camera and intuitive instruments together with the option to perform a tissue biopsy and a variety of therapeutic interventions through only one incision could be used also specifically for a diagnostic laparoscopy in a future.

The robotic surgery provides also the possibility of: performing an intraoperative ultrasound as well as through a Firefly™ Imaging System blood or lymph vessel or bile duct flow, now used in gynecologic oncology for real-time lymphangiography.

Thanks to better ergonomics of minimal invasive procedure, 3D stable visualization of enlarged operations field, and improvement of dexterity, as well as a use of a second console for assisted learning and also the intraoperative possibility of drawing lines on the screen showing the actual surgical site, the robot assisted surgery is the most effective way to teach and to learn pelvic anatomy and new surgical techniques due to a better site recognition. Through the extensive knowledge of the anatomy, the identification and the appropriate exposure of the surgical region with a safeguard of relevant structures like: ureter and depending on the operation also uterine artery and/ or pelvic nerves, almost every operation via the Da Vinci robot has a potential to be performed near to bloodless.

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Diagnostic Laparoscopy via the Da Vinci Robot in General

Diagnostic laparoscopy via the Da Vinci robot is a minimally invasive method for identification of all relevant abdominal and pelvic structures and for the diagnosis of intra-abdominal diseases by direct inspection of intra-abdominal and intrapelvic organs with a possibility for a tissue biopsy, a culture acquisition, and a variety of therapeutic interventions.

Indication

The diagnostic laparoscopy is performed before every minimal-invasive operative procedure via the Da Vinci robot (Table 58.1). However, some surgeons preceding the previously planned robotic operation still prefer to perform the diagnostic laparoscopy by a gold standard method through a conventional laparoscopy [2].

The diagnostic laparoscopy via Da Vinci robot as a staging procedure of early cervical and endometrial cancer is useful for making a definitive clinical diagnosis whenever there is a diagnostic dilemma even after routine diagnostic workup. By enabling accurate staging, diagnostic laparoscopy permits patient selection for curative resection or a neoadjuvant chemotherapy while avoiding nontherapeutic laparotomy, which is associated with a delay in initiation of chemotherapy.

However, for other indications like: identifying the cause of infertility, acute or nonspecific abdominal pain, suspected intra-abdominal injuries or anatomical pathologies is the

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Table 58.1 Indications for a diagnostic laparoscopy via the Da Vinci robot and via the conventional standard method with advantages and disadvantages of the Da Vinci robot in comparison to the conventional laparoscopy

Indications for a diagnostic laparoscopy	Via the Da Vinci robot	Via the conventional laparoscopy	Advantages of the da Vinci over the conventional laparoscopy	Limitations of the da Vinci in the shadow of the conventional laparoscopy
Laparoscopic operative probedure	Before every robotic operative probedure	Before every (robotic or conventional) laparoscopic operative probedure	Ergonomics Intuitive instruments 3D	Higher costs of the system An absence of a tactile feedback Additional time for docking Additional learning curve
Cervical or endometrial cancer	Before planned lymphadenectomy by an early cervical or endometrial cancer	Just to examine the abdomen and pelvis with or without planned lymphadenectomy		
Infertility	Only before a specific operative procedure	Just to examine the abdomen and pelvis with or without planned operative proceure		
Abdominal pain	Only characteristic pain before a specific operation for example on an endometiose	Acute and non-specific with or without planned operative proceure		
Suspected abdominal injuries	Only before a specific operation	With or without planned operative proceure		
Anatomical pathologies	Only before a specific operation	With or without planned operative proceure		

standard conventional laparoscopy the procedure of choice and the use of Da Vinci robot is until now still suboptimal. Although the robotic surgery is very advantageous through better ergonomics and intuitive instruments, for a short basic procedure as a diagnostic laparoscopy those advantages are not able to overwhelm still existing limitations of the robotics like much higher costs of the system maintenance and disposables per case as well as the absence of tactile feedback.

Procedure

Before the start of every robotic case, a patient is placed in low dorsal lithotomy position with arms padded and tucked at the sides of the patient after general anesthesia is administered. The bladder is drained with an indwelling urinary catheter, and if needed: a uterine manipulator, and alternatively an intrauterine catheter for chromopertubation is placed to assess tubal patency intraoperatively. Typically four trocars are used after pneumoperitoneum is obtained. A long 12-mm trocar is placed usually at the umbilicus or above it (depending on the size of the pelvic pathology or art of the planned operative surgery). This trocar serves the 3-dimensional robotic camera. Previously, it is possible to place an entry with a 3-mm micro-laparoscope in a left upper quadrant to help guide all other operative trocarplacements in patients with enlarged pelvic pathology or who may are at risk for intra-abdominal adhesions. Further, two 8-mm trocars are placed in the left and right lower quadrants, respectively. A fourth trocar as an accessory port can be placed between the camera port and the right lower quadrant port or also in the left upper quadrant. This trocar is typically 12 to

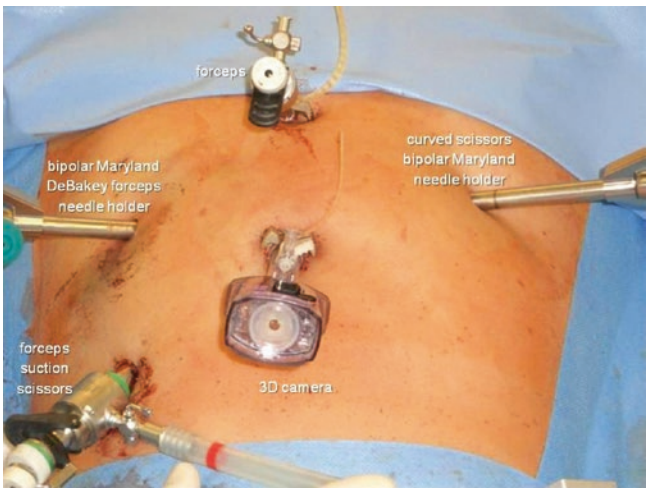


Fig. 58.1 Possible placement of trocars for a diagnostic and an operative laparoscopy via Da Vinci robot with an example of the instruments used in those trocars. A long 12-mm trocar at the umbilicus: is for 3-dimensional robotic camera; two 8-mm trocars are placed in the left and right lower quadrants are for: bipolar Maryland, DeBakey forceps, needle holder; and curved scissors, bipolar Maryland, needle holder, respectively; a left upper quadrant accessory entrance for: forceps, suction, scissors, or a special trocar a 3-mm microlaparoscope

15 mm to enable an introduction of other laparoscopic instruments for suction-irrigation, traction and countertraction or a possibility for introduction of a suture or probe for microbiologic examination. Additionally one 5-mm trocar above the symphysis can be placed for traction/ countertraction as needed.

Once all trocars are in place (Fig. 58.1), the patient can be placed in steep Trendelenburg position and the surgical cart with three robotic arms can be brought between the patient's legs and docked. Then, each trocar can be attached to the

assigned robotic arm with the exception of the accessory port(s) that are manipulated by the bedside surgical assistant(s). The robotic arms are docked to the assigned trocars: right and left operating robotic arms directly to the right and left lower quadrant trocars, respectively, whereas the robotic camera arm to either umbilical or supraumbilical trocar. Then the diagnostic laparoscopy can be performed while adhering to the basic principles of conventional diagnostic laparoscopic technique. A systematic examination of the abdominal and pelvic sites as well entire abdominal and pelvic viscera, including the peritoneum, omentum, liver, uterus, fallopian tubes, ovaries and bladder is performed to identify any pathology and its extension.

After the diagnostic procedure and depending on the diagnosed, abdominal and pelvic status, the planned operative procedure via Da Vinci robot can begin. If there is, however, an evidence of widespread or peritoneal-based disease, or for example bladder, rectum or depending on the operation lymph node metastasis diagnosed, or when there is a direct extension of the pathology to surrounding structures that preclude its respectability, the diagnostic laparoscopy procedure via Da Vinci robot may need to be terminated after taking confirmatory biopsy specimens.

To end the procedure, an adequate hemostasis and correct instrument and gauze and sponge counts is ensured. Ports are removed under direct visualization to prove that there is no visceral herniation or bleeding. A decompression of the abdominal cavity by expelling the pneumoperitoneum to reduce postoperative shoulder pain is performed. All port sites greater than 5–10 mm should be closed with an absorbable suture and skin is closed with either continuous or interrupted subcuticular sutures.

Possible complications typical for laparoscopy are the same for conventional as well as via Da Vinci robot and include fatal gas embolism, problems due to hypercarbia, postoperative crepitus, and pneumothorax, as well as procedure-specific complications for the diagnostic laparoscopy such as uterus, bladder, bowel, nerves and/or vessels injury.

Further Possibilities through Innovations

Ongoing advancements in surgical instruments, optics, and ports have allowed the development of new options for intraoperative procedures with the Da Vinci robot.

Single Port Surgery

LESS is surgical term used to describe various techniques that aim at performing laparoscopic surgery through a single, small skin incision concealed within the umbilicus. Single port techniques may help to reduce postoperative pain, promote earlier return to daily activities, and improve cosmesis and patient satisfaction. There is also a potential reduction in other complications associated with multiple incisions, such as port-site hernias and hemorrhage [3]. Recently published outcome data demonstrate feasibility, safety and reproducibility for LESS in gynecology in general but comparative data and prospective trials are required to determine the clinical impact of LESS in treatment under gynecologic conditions [4]. The Da Vinci robotic system with articulating instruments can also be integrated with LESS for many gynecologic surgical procedures. However, we are still far from the ideal robotic platform. Significant improvements are needed before this technique might reach widespread adoption beyond selected centers [5].

Advantages of the single-port robotic surgery over conventional multi-port laparoscopy include better cosmesis from a hidden umbilical scar, a possible decrease in morbidity that can result from visceral and vascular injury during trocar placement, a decrease in post-operative wound infections, hernia formation, an elimination of multiple trocar site closures, 3D visualization, and improvement of dexterity. Escobar et al. found, using robotic-assisted LESS for bilateral salpingo-oophorectomy and total hysterectomy, that the Da Vinci robotic LESS attempts to further enhance cosmetic benefits and reduce morbidity of minimally invasive surgery in gynecology, and the use of LESS improved patient recovery time and cosmesis [6].

Significant advances have been achieved in the field of robotic LESS since the first reported clinical series in 2009. The ideal robotic platform should have a low external profile, the possibility of being deployed through a single access site, and the possibility of restoring intra-abdominal triangulation while maintaining the maximum degree of freedom for precise maneuvers and strength for reliable traction [5]. A very promising new robotic development in form of instruments created for a combined use with one single port is da Vinci Sp Single Port Robotic Surgical System (Intuitive Surgical ®) that consists of three articulating endoscopic instruments and an articulating endoscopic camera inserted through a single robotic port (Fig. 58.2). The patient side cart uses the same basic cart as the da Vinci Surgical System, but the configuration of the surgical arms and manipulators are changed to manipulate the unique EndoWrist Sp instruments and a 3D high definition camera through a single port: a 25 mm cannula. This device is already available and approved by FDA up until now for special urologic procedures only. The robotic intuitive instruments available to be used by the system include flexible endoscopes, blunt and sharp endoscopic dissectors, scissors, forceps, needle holders, endoscopic retractors, electrocautery and accessories for manipulation of tissue, including grasping, cutting, blunt and sharp dissection, approximation, ligation, electrocautery and suturing. The instruments have also two more degrees of freedom than the da Vinci Single-Site instruments previously



Fig. 58.2 Da Vinci Sp Single Port Robotic Surgical System (Intuitive Surgical ®) that consists of three articulating endoscopic instruments and an articulating endoscopic camera inserted through a single robotic port

available allowing substantially more control for the surgeon. This da Vinci Sp Single Port Robotic System could further overwhelm the limitations of robotics and be very advantageous for cosmesis especially by performing as basic as a diagnostic procedure.

Laparoscopic Ultrasound

For a diagnostic purpose, to evaluate organs that are not amenable to inspection during an operative laparoscopic procedure via Da Vinci robot, also a laparoscopic ultrasound is possible to be performed by using a unique specialized ultrasound transducer for robotic-assisted surgery (BK Medical ProART™ 8826 Robotic "Drop-in" Transducer, Intuitive Surgical®) that fits through a standard robotic trocar.

Ultrasound during diagnostic laparoscopy via the Da Vinci robot, already used during urologic procedures, could be very useful especially proceeding oncologic procedures for example to see intraoperative high resolution real-time borders of a tumor on the same screen as an robotic operative field.

Fluorescent Robotic Lymphangiography

The ability to view intraoperative blood or lymph vessel, or bile duct flow provides a Firefly™ Fluorescence Imaging System, now used in gynecologic oncology for robotic real-time lymphangiography. The Firefly™ Imaging System is build inside the Da Vinci 3D camera and forms the Da Vinci Fluorescence Imaging Vision System for the Da Vinci Surgical System. During a sentinel lymphadenectomy operation for cervical or endometrial cancer, when indicated, this specifically built camera enables the performance of diagnostic real-time fluorescent lymphangiography, called also near-infrared (NIR) fluorescent robotic lymphangiography [7, 8].

Before the diagnostic lymphangiographic procedure an indocyanine green (ICG) fluorescent glowing dye is injected into the cervix. The ICG naturally binds to albumin that flows in lymph vessels. The da Vinci® Fluorescence Imaging Vision System is a special Da Vinci camera with excitatory light source for laser (Firefly™) built inside the scope. The Firefly Imaging System is intended to be used along with the usual white light as usual during an operation and, when indicated, the light source for laser (Firefly) can be activated and intraoperative real-time lymphangiography can be performed. For that, while operating, a surgeon turns on the Firefly through the console, then from the Firefly source in the scope the 803 nm wave length laser illuminates the surgical scene, the ICG dye is excited and glows green signal, showing the path of vessels to the Da Vinci camera and this into the vision cart. That enables surgeons to see the in real-time the green lymph vessels as the tissue without lymph flow appears gray. This provides the ability to view a real-time imaging of lymphatic tissue during lymphadenectomy.

Near-infrared (NIR) fluorescence imaging with intracervical ICG injection using the robotic platform has a high bilateral sentinel lymph node detection rate and appears more favorable than using blue dye alone and/or other modalities [8].

Site Recognition via the Da Vinci Robot

By operating via the Da Vinci robot it is important to recognize not only the surgical site where the 3-D camera is directed but also the structures that are in that region before and during a performed dissection.

Transperitoneal Site: Before any Dissection

During the diagnostic laparoscopy via the robot Da Vinci many additional key vascular structures can be identified transperitoneally before any dissection:

- The internal iliac artery runs parallel and just posterior to the ureter.
- The external iliac artery is several centimeters anterior to it on the psoas muscle.
- The external and internal iliac arteries can be followed superiorly to find the bifurcation of the common iliac arteries at the pelvic brim overlying the sacroiliac joint. This is an ideal place to identify the ureter transversing the point of bifurcation as it enters the pelvis.
- The right common iliac artery can be followed superiorly to the bifurcation of the aorta, above the presacral space at approximately the fourth lumbar vertebra.
- The left common iliac artery is difficult to identify because of the overlying mesentery of the sigmoid colon.

– The left common iliac vein is located just medial and inferior to the left common iliac artery in the presacral space. It may also cover the entire space between the both common iliac arteries [11].

Retroperitoneal Site: During Abdominal Dissection

The recognition of structures in an abdominal site and a presacral region are important for procedures like paraaortic lymphadenectomy or ovarian transposition. The structures, important to recognize for paraaortic lymphadenectomies are from right to left: the psoas muscle; ovarian vessels; the right ureter that runs medial at this point to the psoas muscle and lateral to the inferior vena cava (Fig. 58.3); vena cava that runs to the right lateral of the aorta; aorta and both common iliac arteries. Below the bifurcation of the aorta superficially in a presacral region is the superior hypogastric nerve plexus and the presacral nodes, and beneath them, the left common iliac vein crossing from the left to the right. On the left side of the aorta are further: the inferior mesenteric artery, the sigmoid colon, and its mesentery. Deeper medially, there are the lumbar veins and artery; laterally is the left ureter (Fig. 58.4) and on the far left is the psoas muscle.

Retroperitoneal Site: During Pelvic Dissection

The pelvic site is the main operating field in the gynecology. Therefore, through the knowledge of the anatomy and the identification of the three vascular pelvic regions: the pelvic brim, the pelvic sidewall and the base of the broad ligament, position of the ureter, as well as of the eight avascular spaces and through exposure and safeguard of the relevant anatomy, the operation via the Da Vinci robot can be performed near to bloodless. Therefore it is crucial to identify the structures and where is the ureter running within those regions.

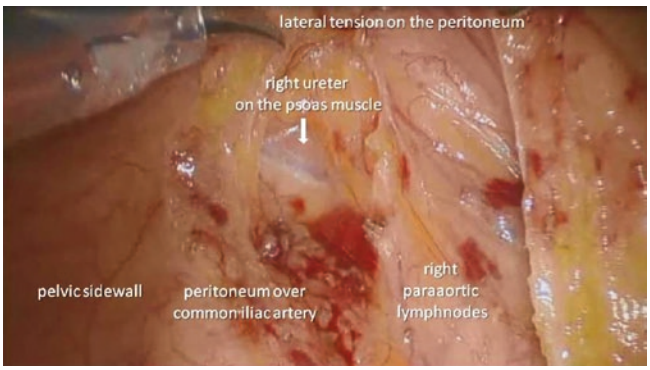


Fig. 58.3 Before the right paraaortic lymphadenectomy: identification of the right ureter. The right ureter runs medial to the psoas muscle

Vascular Regions

At the **pelvic brim** region we find vertically peritoneum, underneath that ovarian vessels in the infundibulopelvic ligament and medially is the ureter crossing over the bifurcation of the common iliac to internal and external artery (Fig. 58.5), underneath that is common iliac vein, further underneath is obturator nerve: exiting the psoas muscle medially to pass over the pelvic brim to the pelvic sidewall; and underneath that is the sacroiliac joint. The pudental nerve and the ureter comes into the pelvic brim in a vertical fashion, and then rotates in 90° to enter the pelvic sidewall.

In the **pelvic sidewall** region there are three surgical layers. The first pelvic sidewall layer is the ureter layer, where the ureter is enveloped in its own visceral sheet of visceral connective tissue [10]. There, an ureterolysis is performed posteriorly to the base of the broad ligament (Fig. 58.6). It leads inferiorly further to the pararectal space. The second pelvic sidewall layer is a vascular layer, which is also a safe zone for coagualtion and cutting that consists of the internal iliac vessels and their branches (Figs. 58.6 and 58.7). And last but not least, the third pelvic sidewall layer is a parietal

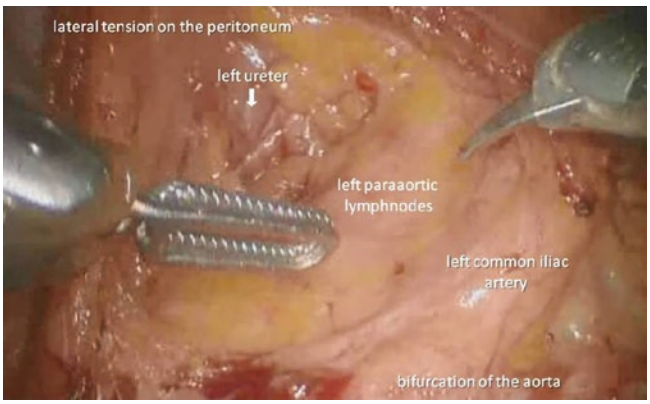


Fig. 58.4 Before the left paraaortic lymphadenectomy: identification of the left ureter. On the left side of the aorta laterally is the left ureter

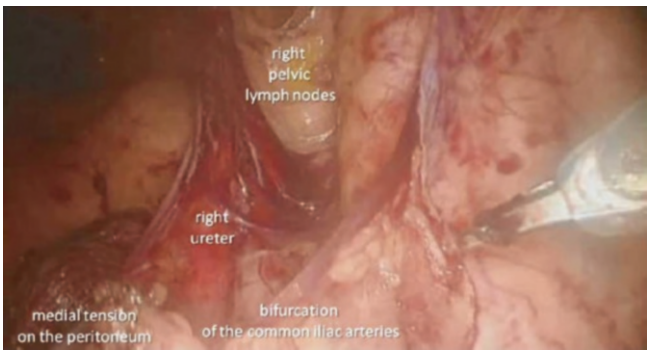


Fig. 58.5 Before the right pelvic lymphadenectomy identification of the right ureter in a peritoneal flap. At the pelvic brim region medially is the ureter crossing over the bifurcation of the common iliac to internal and external artery

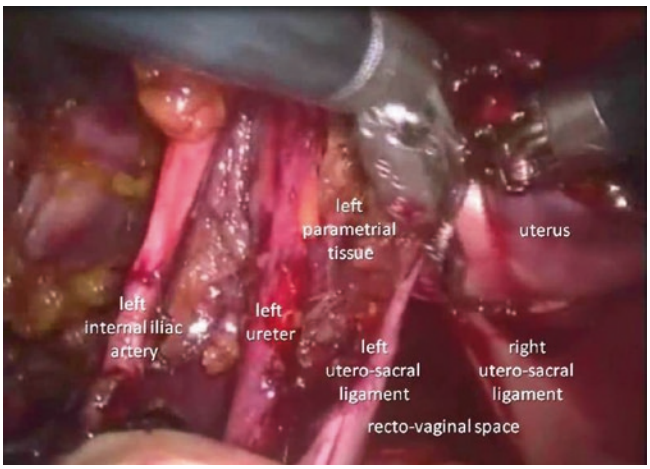


Fig. 58.6 After the ureterolysis and the dissection of uterine artery just before the arametrectomy on the left side by performing robotic radical hysterectomy. The rectovaginal space was previously entered vaginally. In the first pelvic sidewall layer is the ureter layer, where the ureter is enveloped in its own visceral sheet of visceral connective tissue. There is performed ureterolysis posteriorly to the base of the broad ligament

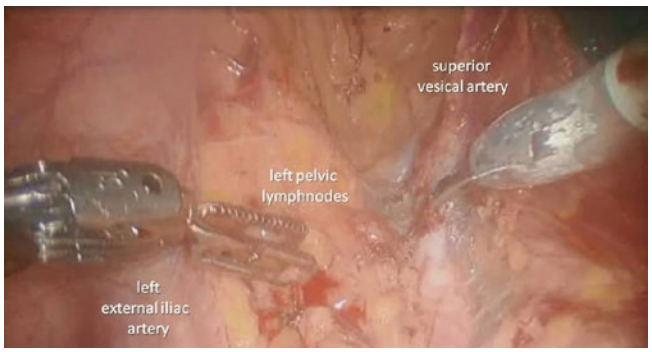


Fig. 58.7 Before the left pelvic lymphadenectomy: identification of the left superior vesical artery. The second pelvic sidewall layer is a vascular layer, which a safe zone that consists of the internal iliac vessels and their branches (here superior vesical artery)

layer that consists of the external iliac vessels on the medial board of the psoas muscle and obturator vessels and nerve on the anterior portion of the obturator internal muscle (Fig. 58.8). The base of the pelvic sidewall is a base of the broad ligament.

By every laparoscopic hysterectomy technique also performed by the robot Da Vinci the broad ligament is dissected. Anteriorly to the dissected ligament the bladder flap is developed in a vesico-vaginal space, posteriorly to the dissected ligament the posterior peritoneum of the uterus is dissected toward the base of the uterosacral ligaments where the uterosacral ligaments meet the cervix (Fig. 58.9). With the push-press dissection technique the uterine artery is identified and skeletonized laterally from there. Then the uterine artery is followed to find the ureter in the base of the broad ligament.

The **base of the broad ligament** region is a place to find where the ureter passes underneath the internal iliac artery (Fig. 58.10), 1–2 cm medial to the cervix but 2–3 cm medial

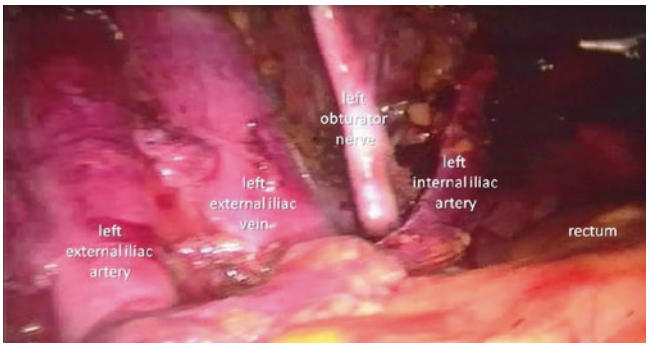


Fig. 58.8 Situs after the left pelvic lymphadenectomy. The third pelvic sidewall layer is a parietal layer that consists of the external iliac vessels and obturator nerve

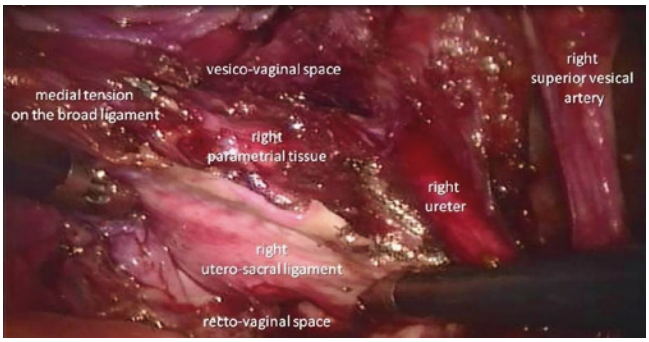


Fig. 58.9 After the ureterolysis, during the right parametrectomy by performing the robotic radical hysterectomy on the right side. The avascular vesico-vaginal and recto-vaginal spaces were previously entered vaginally. The dissection of the base of the broad ligament: anteriorly to the parametrial tissue is a vesico-vaginal space, posteriorly is the utero-sacral ligament. Here the rectovaginal space was previously entered vaginally

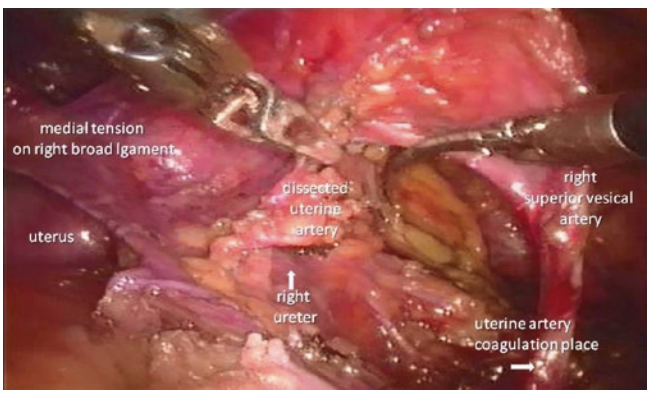


Fig. 58.10 After a dissection of the right uterine artery running over the right ureter, during robotic radical hysterectomy procedure. The ureter passes underneath the internal iliac artery at the base of the broad ligament region

and superior to the ischial spine. It is also the base of the cardinal ligament. The dissection allowed at the base of the broad ligament region is without cutting, only tenting, traction and counter-traction, push-press technique.

The further dissection anteriorly and inferiorly from the base of the broad ligament leads to the paravesical space which is simply also a paravaginal space and then more anterior and medial dissection leads into retropubic space of Retzius. The dissection posteriorly and inferiorly from the base of the broad ligament leads to the pararectal space.

Avascular Spaces

Three pairs of ligaments: uterosacral ligament (rectal pillars), cardinal ligament and vesicouterine ligament (bladder pillars) divide the pelvis into six potential avascular spaces with some vascular boarders: presacral, pararectal space, rectovaginal space, vesicovaginal space, paravesical/ paravaginal/ obturator space, prevesical (retropubic) space of Retzius [12].

The **presacral (retro-rectal or perlumbal) space**: is boarded laterally on the right side with the right ureter, on the left side with the left common iliac artery. It begins at the bifurcation of the aorta into the common iliac which boarder this space and lead into the pelvic brim. At the base of the mesosigma just inferior to the aortic bifurcation, the superior hypogastric plexus can be identified.

The **pararectal space**: is triangular, with the base of the cardinal ligament representing the anterior boarder. The medial boarder is the ureter and the rectal pillars (uterosacral ligament) with the rectum and the hypogastric nerve adhering medially to the mesorectum (Fig. 58.11) and the lateral border is the internal iliac artery and the iliococcygeus fascia and muscles. The hypogastric nerve is a continuation of the superior hypogastric plexus on either side. Inferiorly the hypogastric nerve, where the pelvic splanchnic nerves and the sacral splanchnic nerves join, form the inferior hypogastric plexus on the lateral surface of the uterosacral ligament (Fig. 58.12). On the floor is levator ani muscle and it leads to ischial spine and sacrospinous ligaments. The pararectal space is crossed by the vesical and rectal nerve plexuses. This space can be easily developed by bluntly dissecting

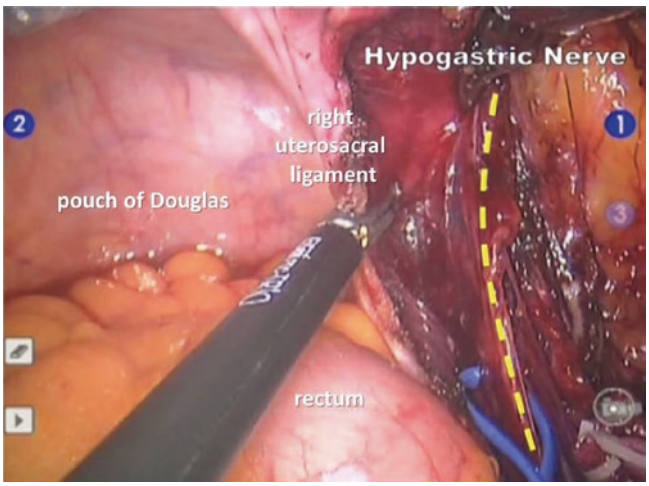


Fig. 58.11 Right pararectal space is triangular, the medial boarder is the right ureter and the right rectal pillars (uterosacral ligament) with the rectum and the right hypogastric nerve (right pelvic nerve) adhering medially to the mesorectum, to the lateral side of the right uterosacral ligament (rectal pillars). The right hypogastric nerve will be isolated till the cut end of the uterine vein and will be preserved by the devision of the right uterosacral ligament during nerve-sparing hysterectomy (Photo from educational video by Maggioni [9])

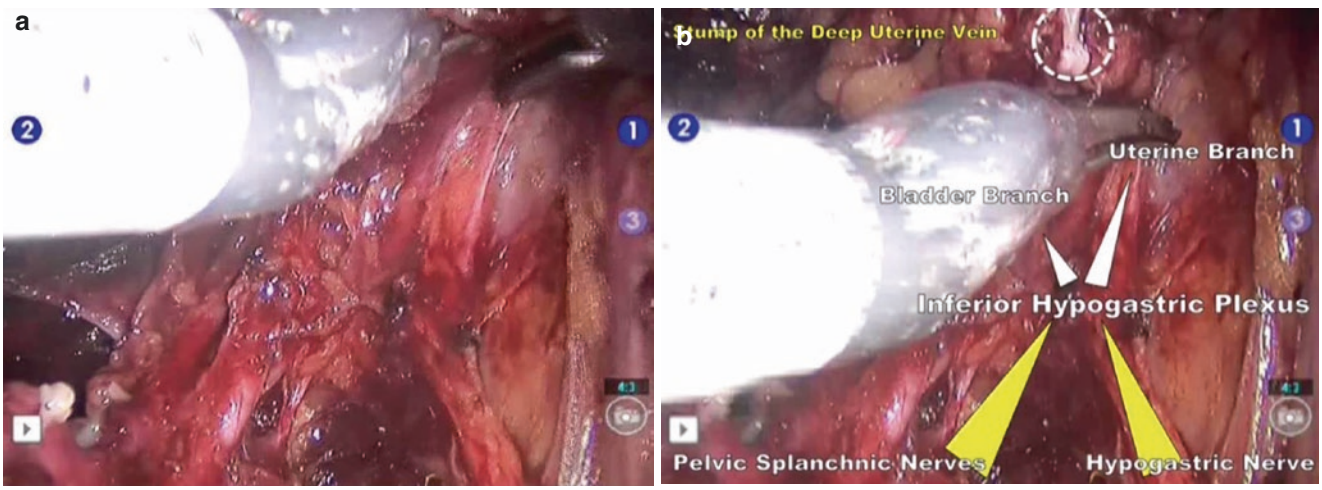


Fig. 58.12 Inferior hypogastric plexus (pelvic plexus) on the lateral surface of the uterosacral ligament. It is formed as a junction of splanchnic nerves and hypogastric nerve and has the bladder and the uterine branch. Only the uterine branch of the inferior hypogastric plexus is resected by the nerve-sparing radical hysterectomy. Left pararectal space after isolation and transsection of: the uterine artery, the superficial uterine vein and the deep uterine vein. The stump of the deep uterine vein is elevated up the level of hypogastric nerve (Photos from educational video by Maggioni [9])

posteriorly to the origin of the uterine artery and lateral to the ureter.

The **rectovaginal space**: is a safe avascular space, what is used for repair of the posterior vaginal wall defects or rectocel. It is framed by: superiorly with cul-de-sac peritoneum and utero-sacral ligaments; laterally: with iliococcygeus muscles; posteriorly: with rectum and its visceral fascial capsule with rectal fat; anteriorly: with vagina and its visceral fascial capsule; inferiorly: with perineum. It builds rectovaginal fascia/ septum. It is necessary to perform initially the ureterolysis on the both sides and then the dissection of the uterosacral ligaments to get to and dissect safely this rectovaginal space. To enter the space of the rectovaginal septum a transverse incision is made over the posterior cervix superiorly between the two uterosacral ligaments, also known as the medial-rectal-pillars. Then, the rectum is dissected inferiorly until the uterosacral ligaments are identified and transsected, thereafter, the rectovaginal space may be entered.

The **vesicovaginal space**: is a potential space between the bladder and the vagina (Fig. 58.13). Therefore, it has to be developed to mobilize the bladder of the lower uterine segment and the upper third of the vagina. Its lateral boarder is: the bladder pillars with ureters on the both sides. It is covered by the anterior peritoneal reflection and must be dissected for the completion of the hysterectomy to develop the bladder flap as a crucial part of that operation (Fig. 58.14). The dissection in this space is important to be performed medially and centrally, away from the bladder pillars in which are vascular vessels as well as the ureter. Once the dissection is done from both sides the bladder can be dissected of the cervix with cold scissors using push-(from below to the bladder)-cut-spread technique.

The **paravesical and paravaginal, and obturator space**: is anterior and inferior to the base of the broad ligament. Its boarders are: medial: the bladder and anterior vagina; lateral: obturator internus fascia with obturator nerve and vessels; floor: fascia endopelvina and the "white line": the arcus tendineus of the pelvis; posterior: internal iliac vessels and ischial spine; anterior: back of pubic bone. During dissection in the obturator space: in a straight line underneath the place where the obturator nerve enters the obturator foramen is the ischial spine with the pudental nerve behind the sacrospinal ligament. The obturator space and paravesical space are particularly important in pelvic lymphadenectomy, paravaginal space in nerve-sparing radical hysterectomy (Figs. 58.7 and 58.15).

The **prevesical (retropubic) space of Retzius** is the retropubic continuation of the paravesical space. It is located between the posterior part of the pubic bone and Cooper's ligament, which is its anterior boundary. Posteriorly is the anterior part of the bladder, lateral: the internal obturator

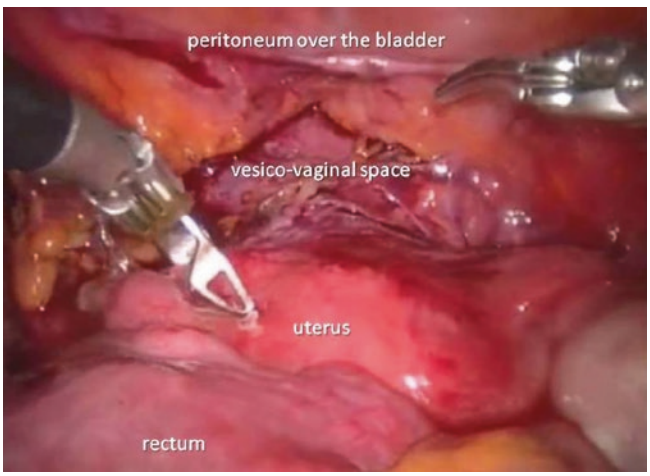


Fig. 58.13 After opening of the vesico-vaginal space before the robotic radical hysterectomy. The vesicovaginal space is a potential space between the bladder and the vagina

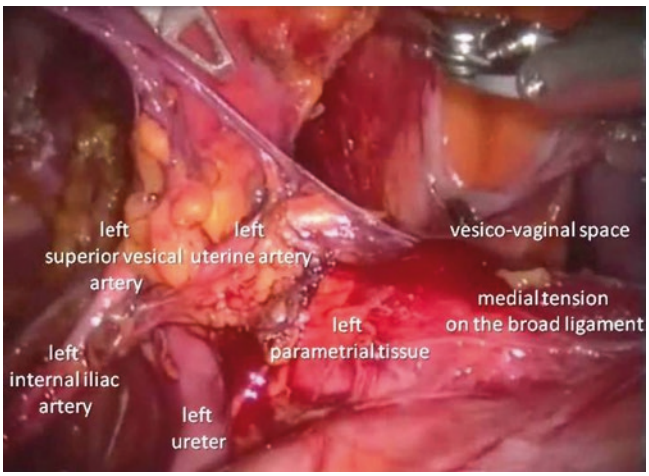


Fig. 58.14 After the ureterolysis, before the robotic radical hysterectomy on the left side. In the vesicovaginal space: the bladder flap was developed

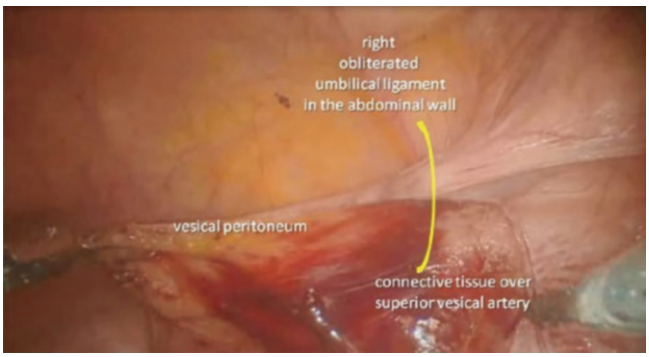


Fig. 58.15 An opening of the right paravesical space. By pulling up and down on the obliterated umbilical ligament the superior vesical artery can be easily identified and medial to that the paravesical space opened. After identification of the superior vesical artery and following it cranially the first medial branch of it is the begin of the uterine artery

muscle and it is continued posteriorly with the vesicovaginal space. The floor is the pubocervical (paravaginal) fascia, inserted into the tendinous arch in the internal obturator fascia. During the Retzius space development with blunt and sharp dissection of fibrofatty tissue a special care needs to be taken to avoid periurethral neurovascular injury.

Laparoscopic Identification of the Ureter, the Uterine Artery

For every gynecologic laparoscopic procedure via the Da Vinci robot, the previous anatomic surgical knowledge and the key gynecologic structures, especially where of the **ureter** is running in the abdominal and pelvic regions is essential for its intraoperative identification and to guarantee a safe gynecologic procedure. The lumbar ureter lies on the psoas muscle medial to the ovarian vessels (Fig. 58.3). It enters the pelvic cavity just superficial to the bifurcation of the common iliac artery and just deep to the ovarian vessels, which lie in the infundibulopelvic ligament at the pelvic brim. It lies in the anterior medial leaf of the broad ligament as it winds toward the bladder and can be recognized by its characteristic peristaltic motion. The ureter then passes just lateral to the uterosacral ligament, approximately 2 cm medial to the ischial spine through the upper part of the cardinal ligament at the base of the broad ligament. Here it lies just beneath the uterine artery, approximately 1.5–2 cm lateral to the side of the cervix. The ureter forms a "knee" turn under the uterine vessels and at from this point travels medially and anteriorly to pass on the anterolateral fornix of the vagina to enter the bladder at the junction of the upper and middle third of the vagina [11]. Therefore, special attention must be given after the hysterectomy by closing the vaginal cuff, where at the lateral angle of the vagina, as well as anterior and anterio-lateral in the upper third of the vagina is the ureter.

Before every operative procedure with the Da Vinci robot, in which the **uterine artery** needs to be ligated, in order to guarantee a hemostasis and a safe procedure, even before identification of the uterine artery, previously performed ureterolysis via the Da Vinci robot is of great importance. For the ureterolysis, the ureter can be found on the pelvic sidewall medial to the infundibulopelvic ligament as it crosses the external iliac. The peritoneum superior to the ureter is gently grasped and entered. The ureter is in the medial tenting sheet to the infundibulopelvic ligament. The peritoneal incision is extended: by tenting of the further peritoneum and cutting with millimeter by millimeter progression only of what can be seen or determined. The medial traction is placed on the medial edge of the peritoneal incision of the first pelvic sidewall layer to open retroperitoneal space, and the dissection is continued in a fat-nonfat interface (fat belongs to the rectum, the dissection is performed superior to the fat) until the ureter is identified medially in the opened space that further inferiorly leads to the pararectal space. There are two main structures after opening the peritoneum of the pelvic sidewall, that go down in the pelvis: first medial, that peristalses, that is the ureter; and the second lateral, that pulsates, that is the internal artery (Fig. 58.16) that branches medially to the uterine artery (Fig. 58.17). With further medial traction of the peritoneum, the ureterolysis is performed with push-spread-push-spread, traction-countertraction as well as millimeter snaps and millimeter wipes dissection technique continued to the level of the cardinal ligament.

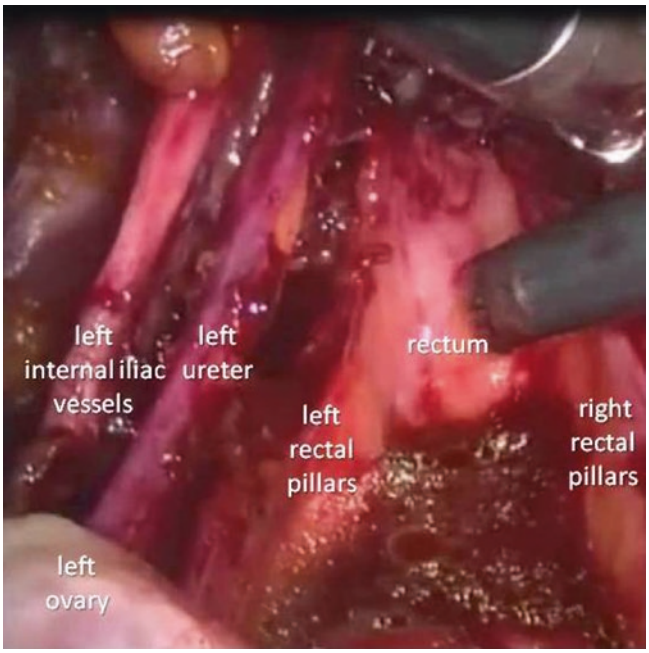


Fig. 58.16 Situs after a robotic radical hysterectomy without salpingectomy. There are two main structures that go from the pelvic sidewall down into the pelvis: first medial, that peristalses, that is the ureter; and the second lateral, that pulsates, that is the internal artery

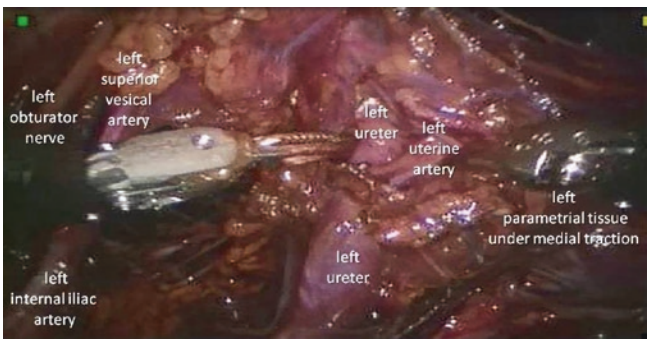


Fig. 58.17 After a pelvic lymphadenectomy and ureterolysis but before radical hysterectomy on the left side. The internal artery branches medially into the uterine artery that crosses from above the ureter in order to run into the uterus

In order to find the uterine artery, first, identification of the obliterated umbilical ligament can be helpful as a continuation of the superior vesical artery on the anterior abdominal wall (Fig. 58.15). Moving this ligament provokes a movement of the superior vesical artery, that lead straight further to the internal iliac artery (named also the hypogastric artery) coming from the bifurcation of the common iliac artery. The medial branch of the internal iliac artery is always the uterine artery (Fig. 58.14). Medial to the branching of the uterine artery from the internal iliac artery is the ureter, as the uterine artery crosses the ureter on its top aiming to the uterus. The ligation of the uterine artery is performed as lateral from the ureter as possible (at the uterus by total hysterectomy or at the internal iliac artery by radical hysterectomy procedure).

Laparoscopic Identification of the Hypogastric (Pelvic) Nerve, Splanchnic Nerves and Inferior Hypogastric (Pelvic) Plexus

Especially the Da Vinci robot with 3D stable and enlarged site view enable the surgeons to recognize the parts of the autonomic nerve system in the pelvis in order to preserve them during oncologic procedures and perform nerve-sparing operations. Those autonomic nerves that could be damaged during oncologic operations are: lumbar splanchnic nerves during periaortic lymph node dissection; superior hypogastric plexus during presacral lymph node dissection; hypogastric nerve during resection of the uterosacral ligaments (rectal pillars); proximal inferior hypogastric plexus during a division of the uterosacral ligaments and cardinal (transverse cervical) ligaments; and distal inferior hypogastric plexus during transection of the vesicouterine (pubocervical) ligaments.

The **hypogastric nerve (pelvic nerve)** can be identified in the pararectal space through an opening of the pararectal space between the internal iliac artery and the ureter, posteriorly to the uterine artery. There the hypogastric nerve runs parallel and approximately 2 cm inferior to the ureter (Fig. 58.18). The hypogastric nerve can be also found in the para\rectal space as adhering fibers to the lateral side of the uterosacral ligament (rectal pillars) (Fig. 58.11). The hypogastric nerve will be isolated until the cut end of the uterine vein to be preserved during the division of the uterosacral ligament by the nerve-sparing radical hysterectomy [9].

The hypogastric nerve inferiorly in a site where the pelvic splanchnic nerves and the sacral splanchnic nerves join, form **the inferior hypogastric (pelvic) plexus** with two branches (bladder and uterine branches) on the lateral surface of the uterosacral ligament (Fig. 58.12). In order to identify the hypogastric (pelvic) plexus: the ureter is separated from the posterior leaf of the VUL (vesico-uterine ligament) up to the loose tissue of the entrance of paravaginal space. The ureter is than shifted laterally. Then one can see: the posterior leaf of the left vesicouterine ligament that consists of left vesical veins that are draining into the deep uterine vein in the posterior layer of the vesicouterine ligament (VUL) (Fig. 58.19). The transsection of the vessical veins expose the bladder branch of the inferior hypogastric plexus (pelvic plexus) that runs posteriorly to the posterior part of the VUL. The exposure of the bladder branch (Fig. 58.12) is needed for its preservation during the nerve-sparing hysterectomy as only the anterior layer of the VUL is resected, where the uterine branch of the pelvic plexus runs.

In order to identify the **pelvic splanchnic nerves** the following structures need to be recognized: the uterine artery that is running just superior and parallel to the superficial uterine vein. Just inferior and parallel to the superficial uterine vein is the deep uterine vein (all those vessels are isolated and transected by the nerve-sparing radical hysterectomy) (Fig. 58.18). Just inferior and parallel to the deep uterine vein there are the pelvic splanchnic nerves localized. The pelvic splanchnic nerves are laterally to the hypogastric nerve that is running inferiorly to the ureter. If we follow the fibers of the hypogastric nerve further anteriorly, we can observe that they run just below the deep uterine vein (Fig. 58.18c).

Through a better site recognition, 3D stable view as well as magnification of the surgery area with better ergonomics, with the Da Vinci robot it is possible not only to learn and to teach the laparoscopic surgical anatomy but also to perform advanced laparoscopic operations that have been performed almost only by an abdominal approach before.

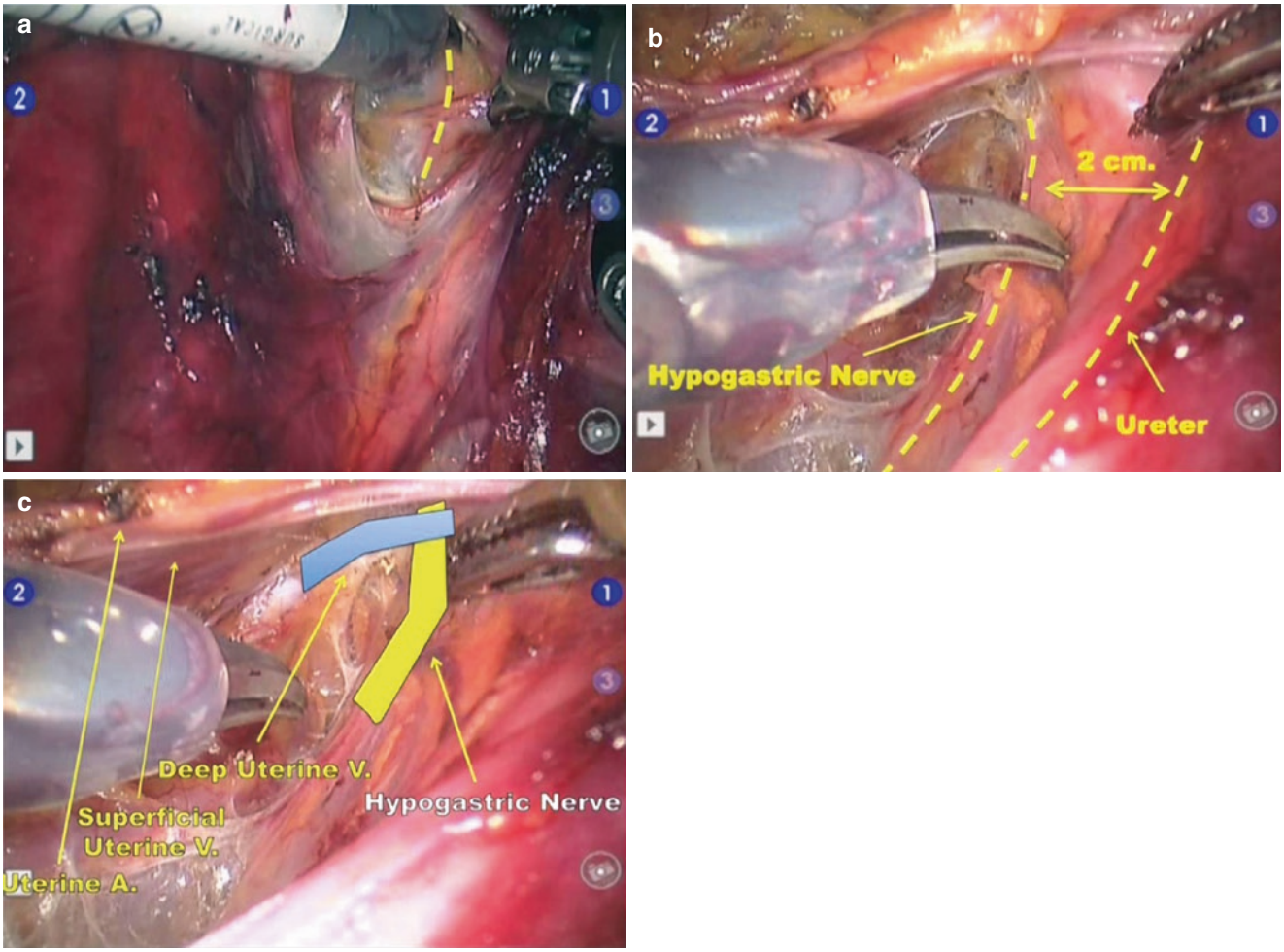


Fig. 58.18 Left pararectal space. The hypogastric nerve (pelvic nerve) can be identified in the pararectal space through an opening of the pararectal space between the internal iliac artery and the ureter, posteriorly to the uterine artery. There the hypogastric nerve runs parallel and approximately 2 cm inferior to the ureter. (**a**). An opening of the left pararectal space (between the left internal iliac artery and the left ureter, posteriorly to the left uterine artery) looking for the left hypogastric nerve (marked *yellow* here). (**b**). In the opened left pararectal space: the left hypogastric nerve is approximately 2 cm inferior to the left ureter. (**c**). The uterine artery is running just superior and parallel to the superficial uterine vein. Just inferior and parallel to the superficial uterine vein is the deep uterine vein (all will be isolated and transsected by the nerve-sparing radical hysterectomy) and just inferior and parallel to the deep uterine vein there are the pelvic splanchnic nerves localized. The pelvic splanchnic nerves are lateral to the hypogastric nerve, that is running inferior the ureter. If we follow the fibers of the left hypogastric nerve further anteriorly, we can observe that they run just below the left deep uterine vein (Photos from educational video by Maggioni [9])

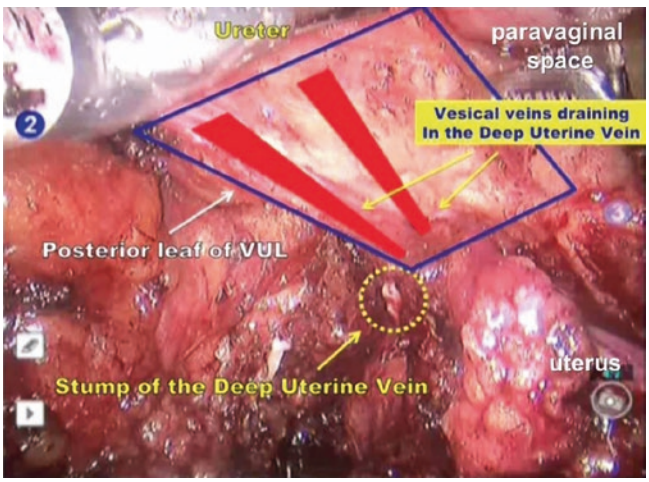


Fig. 58.19 Left vesicouterine ligament. The posterior leaf of the left vesicouterine ligament that consists of left vesical veins that are draining into the deep uterine vein in the posterior layer of the vesicouterine ligament (VUL) (Photo from educational video by Maggioni [9])

References

1. Mettler L, Schollmeyer T, Boggess J, Magrina JF, Oleszczuk A. Robotic assistance in gynecological oncology. Curr Opin Oncol. 2008;20(5):581–9.
2. Oleszczuk A, Kohler C, Paulick J, Schneider A, Lanowska M. Vaginal robot-assisted radical hysterectomy (VRARH) after laparoscopic staging: feasibility and operative results. Int J Med Robot. 2009;5(1):38–44.
3. Bedaiwy MA, Franjoine SE, Ali MK. Laparoendoscopic single-site (LESS) surgery in gynecology: Current status and future directions. Middle East Fertil Soc J. 2013;18(1):1–8.
4. Fader AN, Cohen S, Escobar PF, Gunderson C. Laparoendoscopic single-site surgery in gynecology. Curr Opin Obstet Gynecol. 2010;22(4):331–8.
5. Autorino R, Kaouk JH, Stolzenburg JU, Gill IS, Mottrie A, Tewari A, et al. Current status and future directions of robotic single-site surgery: a systematic review. Eur Urol. 2013;63(2):266–80.
6. Escobar PF, Fader AN, Paraiso MF, Kaouk JH, Falcone T. Robotic-assisted laparoendoscopic single-site surgery in gynecology: initial report and technique. J Minim Invasive Gynecol. 2009;16(5):589–91.
7. Rossi EC, Jackson A, Ivanova A, Boggess JF. Detection of sentinel nodes for endometrial cancer with robotic assisted fluorescence imaging: cervical versus hysteroscopic injection. Int J Gynecol Cancer. 2013;23(9):1704–11.
8. Jewell EL, Huang JJ, Abu-Rustum NR, Gardner GJ, Brown CL, Sonoda Y, et al. Detection of sentinel lymph nodes in minimally invasive surgery using indocyanine green and near-infrared fluorescence imaging for uterine and cervical malignancies. Gynecol Oncol. 2014;133(2):274–7.
9. Maggioni, A. Robot-assisted laparoscopic nerve sparing Okabayashi's radical hysterectomy according to Shingo Fujii's Technique [educational video]. European Institute of Oncology Milan, Italy; 2010.
10. Rogers RM. Pelvic anatomy seen through the laparoscope. In: Pasic RP, Levine RL, editors. A practical manual of laparoscopy: a clinical cookbook. Lancashire: Parthenon Publishing Group; 2002. p. 7–17.
11. Yadav J, Datta MS, Nezhat C, Nezhat C, Nezhat F. Intraperitoneal and retroperitoneal anatomy. In: Nezhat C, Nezhat F, Nezhat C, editors. Netzhat's operative gynecologic laparoscopy and hysteroscopy. 3rd ed. Cambridge: Cambridge University Press; 2008. p. 70–82.
12. Barbosa C, Wattiez A, Mencaglia L. Gynecologic laparoscopic surgical anatomy. In: Mencaglia L, Minelli L, Wattiez A, editors. Manual of gnecological laparoscopic surgery. 2nd ed. Tuttlingen: Endo-Press; 2007. p. 57–71.

General Aspects and Their Handling: Adhesions

59

Alexander Di Liberto and Kubilay Ertan

Introduction

Peritoneal adhesions, this means mainly non congenital, abnormous fibrous connections between tissues, that are normally anatomically not conjoined, are an ubiquitous problem in abdominal surgery that could appear after every surgical intervention of each kind, including robot-assisted interventions and in this context robot-assisted hysterectomies, but with different likelihood.

Prior surgical interventions respectively post-inflammatory alterations in the upper abdomen (state after cholecystectomy, after pancreatitis and also after extensive surgical interventions via laparotomy) are mostly not relevant for the predominant proportion of laparoscopic interventions in the lesser pelvis respectively concerning the laparoscopic access points, but can cause problems and challenges just as the trocar positions would be shift to a more cranial localization, this means above the umbilicus (for example for the access to the paraaortic lymph node regions or to perform hysterectomy procedures in big uteri), especially in robot-assisted interventions, where generously a cranial shifting of the trocars have to be performed.

Basical problem is the preoperative estimation of the extent of adhesions, just after surgical interventions in the lower abdomen and lesser pelvis at the colon and small intestine or localised adhesions in the lesser abdomen and pelvis (e.g. after pelveoperitonitis due to adnexitis or severe endometriosis, but also after cesarean sections were unexpected large-area and firm adhesions between the anterior uterine wall and the abdominal wall can be found). In the state after peritonitis in particular generalised peritonitis respectively four-quadrant peritonitis extensive peritoneal adhesions have to be anticipated, so that the laparoscopic respectively robot-assisted methods of entrance to the peritoneal cavity have to be adapted correspondingly. The most commonly consequences of intraperitoneal adhesions are chronic pain syndroms in the lower abdomen, small intestine obstruction up to ileus, for the gynaecological patient cohort primary or secondary sterility and dyspareunia as well as the formation of pseudocysts in the lesser pelvis (with the partially difficult differential diagnosis to genuine cystic lesions and, for this reason, hindered decision-making for or against surgical clarification), and relating to subsequent operative interventions in the peritoneal cavity a higher risk of organ injury, especially bowel lesion (serosal defects, enterotomy, primary detected or unnoticed during surgery), major blood loss, and a increased rate of conversions to laparotomy (Table 59.1).

Adhesion-related complaints themselves frequently result in re-operations (the SCAR3 trial demonstrated an incidence of 10 % concerning adhesion-related hospital stays within 5 years postoperatively [1]) and are, in a great extent, both very questionable regarding the primary surgical outcome (i.e. elimination of the complaints), and concerning the long-term course, because the likelihood of recurrence of adhesion formation in identical or other localizations is very high, in spite of application of substances and materials for adhesion prophylaxis.

This leads to a significant long-term impairment of the quality of life on the one hand and a considerable charging of costs in the healthcare systems on the other hand.

Robot-assisted laparoscopic interventions are affected at least in an equal measure related to the complex of problems concerning peritoneal adhesions, both regarding preexisting adhesion (of any origin), and the induction of de novo adhesions, the last one perhaps in a higher degree, because just complex operative interventions are performed robot-assisted (notably complex hysterectomies, oncological therapy, surgical interventions in higher-degree endometriosis, complex myomectomies, etc.).

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Table 59.1 Medical and surgical consequences of peritoneal adhesions

General medical and surgical aspects	Gynaecological aspects
Chronic pain syndroms (localised or generalised in the abdomen)	Primary/secondary sterility; increased rate of ectopic pregnancies
Small intestine obstruction up to ileus	Dyspareunia
Subsequent operative interventions (with higher risk of organ lesions, major blood loss and laparotomy)	Formation of pseudocysts in the lesser pelvis (diagnostic dilemma)
Socio-economic consequences	Increased complexity of gynaecological operations

Particularly in oncological interventions in cervical and endometrial cancer, which are exceedingly eligible for the robot-assisted technique, large-area accesses to the retroperitoneum have to be established, by what substantial peritoneal traumata occur.

In comparison to traditional laparoscopy the robot-assisted interventions are characterized by the utilization of a higher number of trocars and a larger trocar diameter leading primary to a greater surgical trauma in the area of the peritoneal entrances, but no data or reports are available on this topic, especially in comparison to traditional laparoscopy.

Surgical Principles of Prevention of Adhesions and of Adhesiolysis

In general, for robot-assisted laparoscopic interventions in gynecology the same surgical principles are valid for prevention of adhesions and of adhesiolysis.

For prevention of adhesiolysis, finally representing the most effective potential to avoid respectively to reduce adhesion-associated morbidity, the principles of "good surgical technique" are valid; this are beside the general awareness which pathophysiological mechanisms constitute for formation of adhesions the minimisation of direct and indirect surgical trauma at the parietal peritoneum and other serosal surfaces, provided that these are not related to the therapeutical target area. Therefore, this means gentle handling of tissues and organs, the reduction of HF surgical-caused heat effect at the peritoneum and other surfaces (i.e. sparing coagulation), the avoidance of ischemic change, this means especially the diminuation of bleeding not only by coagulation but by accurate and anatomical dissection and by conservation of smaller vessels, the avoidance of desiccation, which is particularly relevant in laparoscopic interventions concerning the capnoperitoneum, the reduction of application of external material and foreign bodies, the shortening of operation time, and, if necessary, the application of materials of adhesions prevention (see Chap. 6).

The basic principles of correct adhesiolysis are the careful and accurate dissection of adhesions, as possible without additional injury and trauma of the peritoneum and serosal surfaces, the economic use of electrocoagulation with concurrent avoidance of bleedings. Finally, the extent of adhesiolysis also depends on the mode of intervention and the dimensions of the required surgical field, and, eventually apparent complaints concerning adhesions.

Adhesions which do not impair the access to the surgical area or the surgical target area, and which do not cause anamnestic and/or clinical complaints, and are not a potential future menace, for example provoking intestinal/small bowel obstruction, should better be left and not to be touched.

However, even if they seem not to present a direct obstacle to the surgical activity, adhesions can constitute a risk factor for sticking with laparoscopic instruments and therefore causing delayed noticed bleedings or unnoticed blunt tissue trauma up to higher grade organ injury and complications.

For the traditional laparoscopy, which is characterized in comparison to open abdominal surgery by reduced formation of postoperative adhesions, there exist additional problems concerning the complex of problems of the capnoperitoneum, generally the gas pressure leading to microtrauma at the hole peritoneum, and the consecutive desiccation of the peritoneal surface – all of these constitue risk factors for the formation of adhesions, at least contribute to adhesions. However, these risk factors can be influenced by various methods and techniques: Adding of O_2 to the carbonic dioxide, limitation of gas pressure to a minimum limit (with the disadvantage of a potential diminished visualisation or an increase of bleeding in the surgical area), and a continuous humidification of the peritoneal cavity via the insufflation system or by an intermittend irrigation.

Robot-assisted laparoscopic operations allow a decreased gas pressure or a minimum of pressure of some mmHg because the abdominal wall is stretched tent-like by the anchorage of the trocars at the patient side cart, thus imitating a "gasless" laparoscopic intervention. In addition, the robotic technique provides the potential to perform adhesiolysis more precisely (better visualisation [higher image resolution and particularly spatial view], and the higher flexibility and dexteritiy of the robotic instruments and for this reason a pinpoint adhesiolysis, selective and punctual coagulation of small vessels in adhesion threads, respectively the avoidance of bleeding by increased visualisation. Robot-assisted adhesiolysis is carried out in close analogy to traditional laparoscopy by grasping the adhesion with a smooth grasping forces (e.g. of eligible EndoWrist™

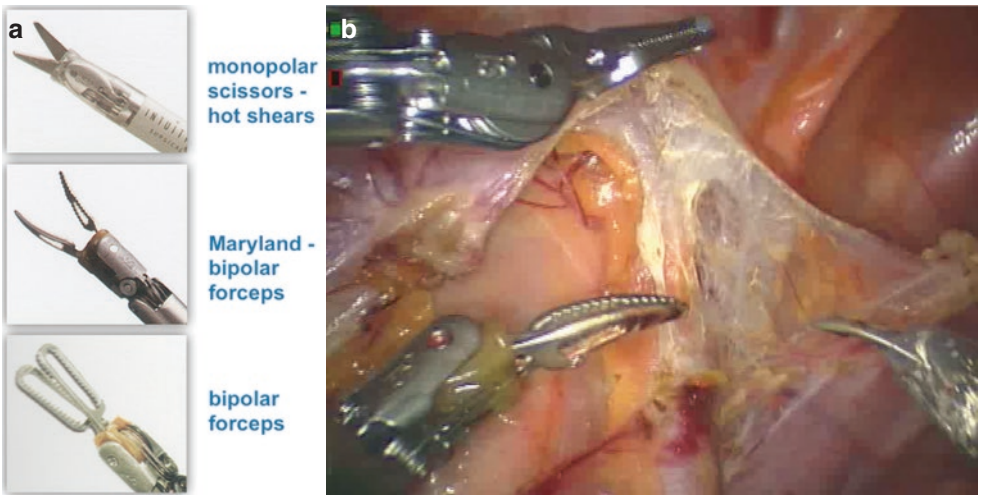


Fig. 59.1 (**a**) Eligible EndoWrist instruments for robot-assisted adhesiolysis (Source: Intuitive Surgical, Sunnyvale, California, with permission). (**b**) Arrangement of instruments in robot-assisted adhesiolysis (above: Grasping Forceps, bottom left: Maryland Bipolar Forceps; bottom right: Monopolar Curved Scissors, "Hot Shears")

instruments: Maryland Forceps or Bipolar Forceps, Fig. 59.1a), slight to moderate tension of the adhesion for delineation of the borders to normal peritoneum or other neighbouring organs (uterus, adnexa, bowel), as required selective and punctial coagulation of vessels in the adhesion and cutting the adhesion with monopolar scissors (e.g. of eligible EndoWrist™ instrument: Monopolar Curved scissors, Hot Shears, Fig. 59.1a), as necessary careful shifting and pushing of adjacent tissue structures respectively neighbouring organs under minimisation of bleedings, tissue trauma and especially serosal defects. Figure 59.1b shows a typical arrangement of instruments in robot-assisted adhesiolysis.

However, possible disadvantages of robot-assisted interventions are the generally higher number of inserted trocars leading to a larger peritoneal wound area (reduction of the peritoneal trauma by availability and application of a robot-assisted single port technique, which is already in use, but to date it is limited concerning complex minimal invasive procedures; for the future a flexible robotic single port technique is under way, which might overcome the current limitations of single port techniques), the absence of haptic and tactile feedback endangering a gentle handling of peritoneal and serosal surfaces, the increased view can compensate the latter only partially. There are no comparative and descriptive studies on this topic up to now.

Risk Factors for Adhesions/Planning of Operations in Expected Adhesions

Essentially, risk factors for existing peritoneal adhesions result from the patient's history, i.e. the indicated and presumed previous operations; the presumed previous operations are commonly only apparent by existing scarring at the abdominal wall because the patients oftenly do not remember operations which have been long ago, especially elderly patients.

Besides the medical history of an operation respectively the existence of an operation scar the antecedent of inflammatory disease (concerning the gynaecological sector these are adnexitis, resp. Pelveoperitonitis or simply chronic lower abdominal pain), and the history of endometriosis are relevant. Particularly in chronic inflammatory diseases of the bowel (Crohn's disease, ulcerative colitis) the presence of peritoneal adhesions with different extent must be anticipated.

This applies similarly both for robot-assisted and traditional laparoscopic interventions, and especially for hysterectomies.

Within the scope of the planning and preparation of operations the patient has to be informed about possible accesses to the peritoneal cavity (trocar placement), their situative variability (modification of the number of the trocars and their position), the higher risk of a conversion to laparotomy (including the information of and discussion about the particular incision line: Pfannenstiel incision versus longitudinal incision) and of an intraoperative neighbouring organ injury, particularly an enterotomy respectively an increased postoperative complication rate.

In addition, the constitution of the surgical team, if necessary the stand-by of a visceral surgeon has to be considered; furthermore, a longer operation time has to be taken into account (both concerning the medical resilience of the patient and the allocation of a sufficient logistic prearrangement [positioning, the patient warming, anaesthesiologic monitoring]). Finally, the essential items about this have to be documented in the informed consent.

In this connection there are no fundamental differences between robot-assisted laparascopic interventions and traditional laparoscopic operations, whereupon, in most cases, the primary more complex intervention would be accommodated.

Laparoscopic and Robot-Assisted Accesses in Presence of Adhesions

For robot-assisted intervention there are only a few differences concerning the accesses to the abdominal cavity compared to traditional laparoscopic procedures. Due to the major importance of the distance of the camera to the top of the uterus in robot-assisted operations (reduced flexibility of the daVinci™ camera, respectively the restrictation of fast camera movements), i.e. always a sufficient distance has to be given, this corresponds to a hand, in these interventions the trocar positions are in most cases more cranial as compared to traditional laparoscopic trocar positions (Fig. 59.2a–c). Just in operations of big uteri the camera trocar has frequently be placed above the umbilicus, so that especially in existing adhesions in the lower abdomen and in the pelvis the trocar positioning is primary outside of the hazardous zone. Insofar the Palmer's point can be utilized as access way as well as in traditional laparoscopy and later for replacement of the Veres needle with a daVinci™ working trocar. Here, plenty of surgeons apply previously of placing the daVinci™ camera a traditional endoscope to get a picture of the situation inside of the abdominal cavity. Likewise, an open sky technique can be applied in robot-assisted interventions; in this technique the abdominal cavity is opened under visual control both in the area of the lower umbilicus and supraumbilical, similarly to traditional laparoscopic open accesses, the so-called open sky access, whereas special open sky trocars for robotic-assisted surgery are not available.

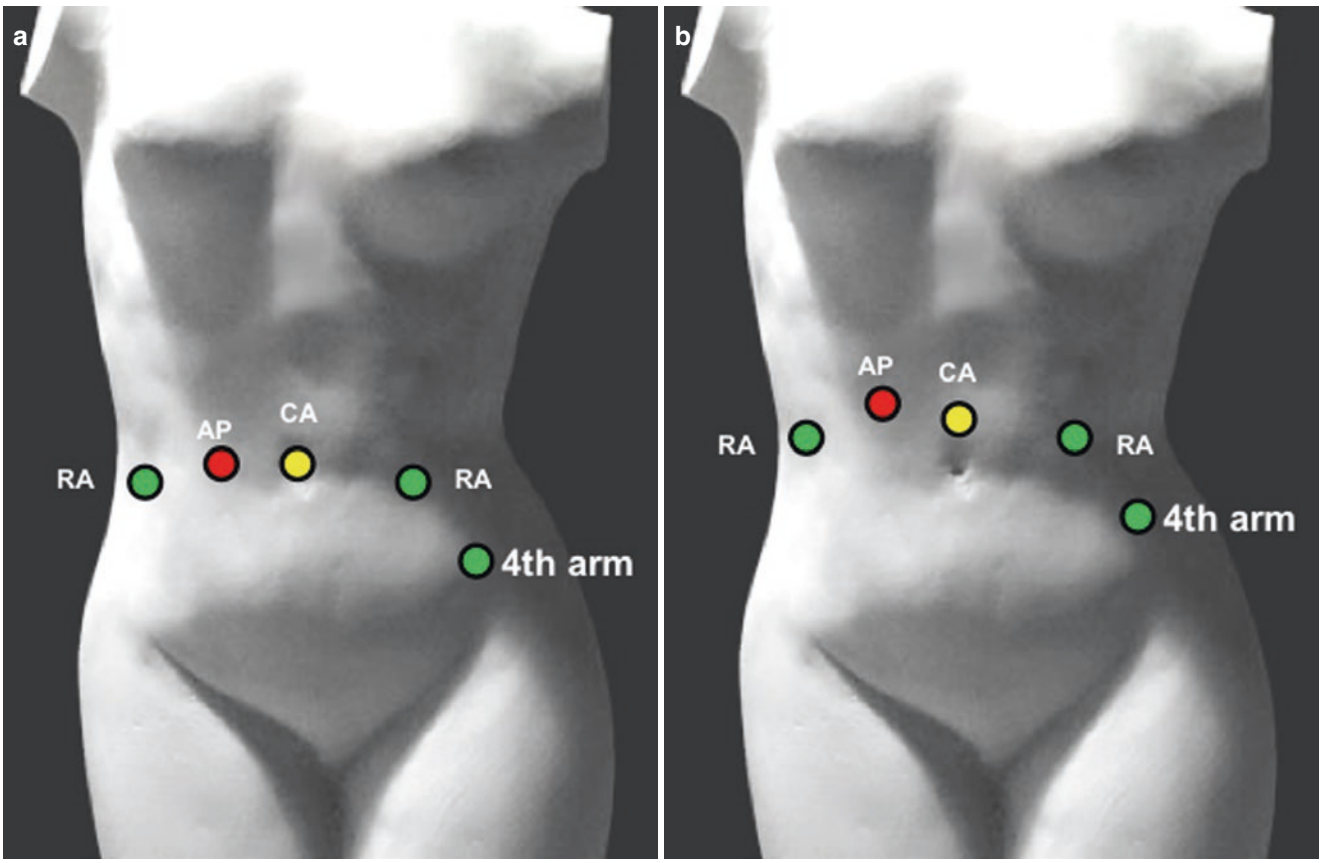


Fig. 59.2 (**a**) Suggestion for umbilical placement and arrangement of the camera and robotic trocars in case of adhesions in the lesser pelvis. (**b**) Suggestion for supraumbilical placement and arrangement of the camera and robotic trocars in case of adhesions in the lower abdomen and lesser pelvis and/or enlarged uterus. (**c**) Suggestion for subcostal placement and arrangement of camera and robotic trocars in case of upper abdominal adhesions and/or huge uterus

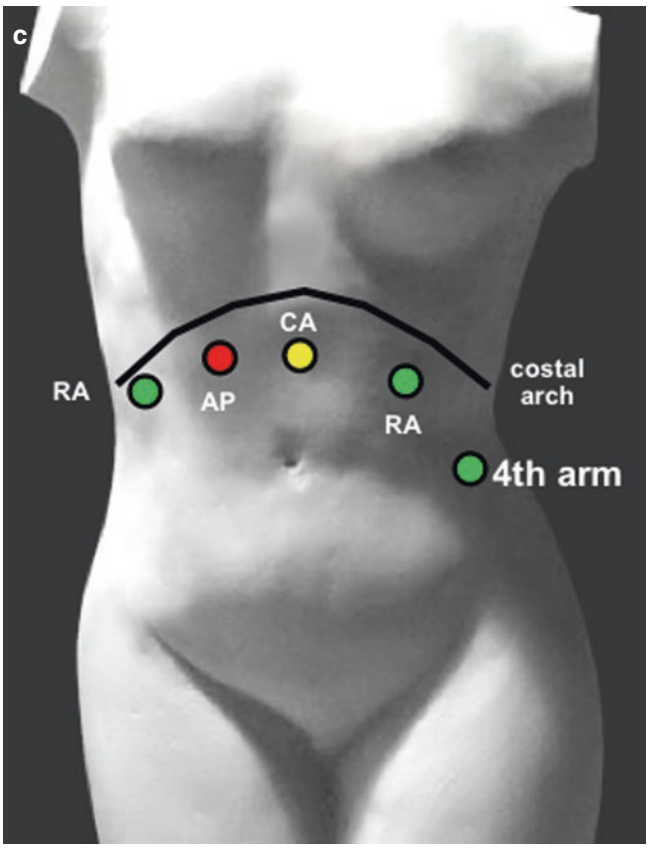


Fig. 59.2 (Continued)

Traditional Laparoscopic/Robot-Assisted Management of Adhesions (Before and After Docking of the Patient Side Cart)

In the case of existence of adhesions in the area of the trocar accesses the required flexibility of the robotic arms is limited in robot-assisted surgery. In this connection a traditional laparoscopic adhesiolysis is required until enough space, i.e. a sufficient surgical field for a sufficient mobility of the robotic arms is achieved in the proper surgical field in order to place all the needed daVinci™ trocars in the middle and lower abdomen.

Not till then, the patient side cart can be placed, the robotic arms can be docked and the operation can be continued from the surgeon's console.

In the event of adhesions in the lower abdomen and in the lesser pelvis adhesiolysis can be continued with the daVinci™ system after establishment of a sufficient surgical visual field, docking maneuver and taking over of the operation at the console.

Here, adhesiolysis can be performed much easier than in traditional laparoscopy due to the three-dimensional view, the superiority of instrument flexibility, and the higher number of freedom degrees of the EndoWrist™ instruments; for example, combined with the fixed camera position and the magnification of the daVinci™ optical system vessels can better be visualized in adhesional threads and can accurately be coagulated, and, thus, bleedings can be reduced at the best and thermal effects can be limited to a minimum.

In case of a required mobilisation of the intestinum for a better accessibility to the lesser pelvis (i.e. pelvic and paraaortic lymh node dissection) an adequate adhesiolysis has to be performed via traditional laparoscopy in the middle abdomen prior to the docking of the patient side cart so that the small intestine and the colon can be shifted to the middle and upper abdomen sufficiently by Trendelenburg positioning.

After docking of the patient side cart and installation of the camera the visual field is limited to the upper regions of the abdomen; this constitutes a relevant confinement of the robotic technique (the daVinci™ camera cannot pivoting more than 90° cranially; this limitation is largely eliminated in the daVinci™ 4th generation device, the daVinci™ Xi).

Application of Techniques for Prophylaxis of Adhesions.

All techniques of adhesion prevention and prophylaxis (e.g. oxidised regenerated cellulose [Interceed™], expanded polytetrafluoroethylene [Gore-Tex™], sodium hyaluronate and carboxymethylcellulose [Seprafilm™], icodextrin 4 % [Adept™], dextrane 32 %, carboxymethylcellulose and polyethylene oxide [Oxiplex™], polyethylene gylcol gels [Spraygel™], hyaluronic acid based gel [Hyalobarrier™], ferric hyaluronate gel 0.5 % [Intergel™], and others) are applicable in robot-assisted interventions as well as in traditional laparoscopic operations, at which the application of the particular medium and technique will be done after termination of the console phase and after undocking of the patient side cart at the end of the operation.

Available Data About Postoperative Adhesions After Robot-Assisted Operations

Regarding the influence of robot-assisted laparoscopic operations on the postoperative formation of adhesions there are no clinical or experimental trials from the gynecological sector available demonstrating a reduction or increase of adhesions on the one hand, and analyzing the performance of adhesiolysis in terms of effectivity and complication rate on the other hand, both in comparison to traditional laparoscopy and to open abdominal surgery.

There is only one experimental trial existing, from the urological sector [2], in which advantages of robot-assisted operations compared to open abdominal operations have been demonstrated in robot-assisted laparoscopic ileocystoplasty (RALI) on the basis of a porcine model.

The fact, that there is a higher amount of inserted trocars in robot-assisted surgery (at least 1 more trocar compared to

traditional laparoscopy), the larger incisions as well as the presumably stronger traction and shear forces at the abdominal wall by a quasi suspension of the abdominal wall at the patient side cart, and consequently a more intense trauma to the peritoneum, and the bias of a so-called negative selection, i.e. a case selection, which is primarily more complex due to the robotic case selection profile (both concerning anatomical alterations and surgical pretreatments) let at least suppose that the advantages of the more precise adhesiolysis and the operation technique of robotic surgery are revoked hereby.

Conclusions

Existing adhesions in the context of robot-assisted operations and especially robot-assisted laparoscopic hysterectomies are treated according to the basic principles as well as traditional laparoscopic operations. The establishment of an adequate field of action is carried out for the robot-assisted technique with the daVinci™ system with means of traditional laparoscopy. Adhesiolysis in the lesser pelvis can be performed effective and precise with the daVinci™ technique related to their advantages (3D view, flexibility and dexterity of the EndoWrist™ instruments, tremor free surgery, amount of magnification of the daVinci™ endoscope) (Fig. 59.3a–h).

To which extent de novo adhesions are fewer respectively the effectiveness of adhesiolysis in robot-assisted surgery is superior to traditional laparoscopic operations has to be investigated in further research.

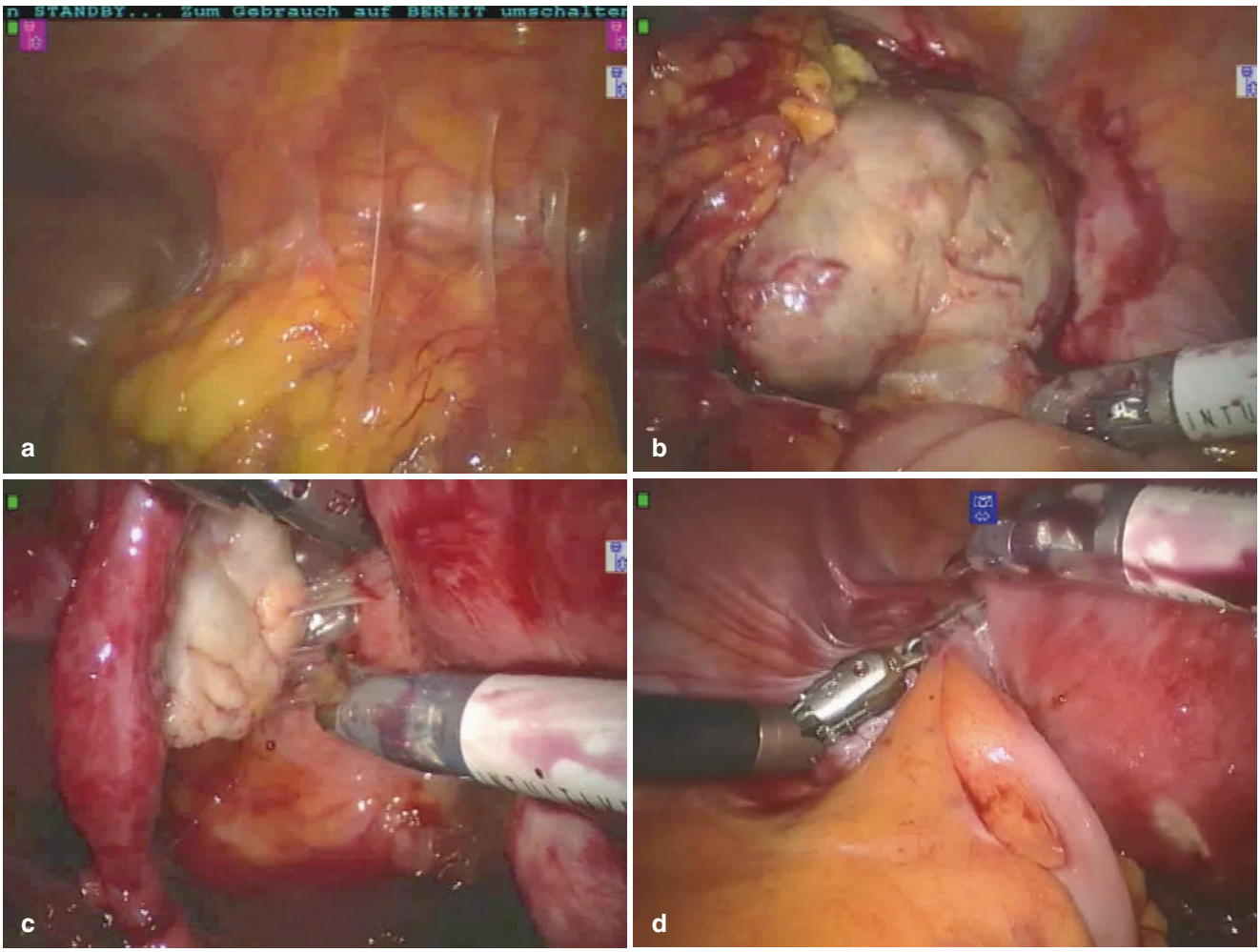


Fig. 59.3 (**a**) Robot-assisted hysterectomy due to uterus myomatosus and myoma necrosis with consecutive pelveoperitonitis; initial view into the lesser pelvis; recent adhesions. (**b**) Robot-assisted hysterectomy due to uterus myomatosus and myoma necrosis with consecutive pelveoperitonitis; after exposing of a necrotic myoma; recent adhesions. (**c**) Robot-assisted hysterectomy due to uterus myomatosus and myoma necrosis with consecutive pelveoperitonitis; adhesiolysis of the adnexa in concomitant adnexal inflammation, recent adhesions. (**d**) Robot-assisted hysterectomy with concomitant endometriosis; endometriotic adhesion between colon sigmoideum, left adnexa and left round ligament. (**e**) Robot-assisted hysterectomy with concomitant endometriosis, adhesiolysis of the right adnexa. (**f**) Robot-assisted hysterectomy with concomitant endometriosis with obliteration of the rectovaginal excavation (pouch of Douglas); sharp and blunt adhesiolysis. (**g**) Robot-assisted hysterectomy with accidental finding of concomitant endometriosis; initial aspect. (**h**) Robot-assisted hysterectomy with accidental finding of concomitant endometriosis; adhesiolysis of the right adnexa with involved colon and small intestine

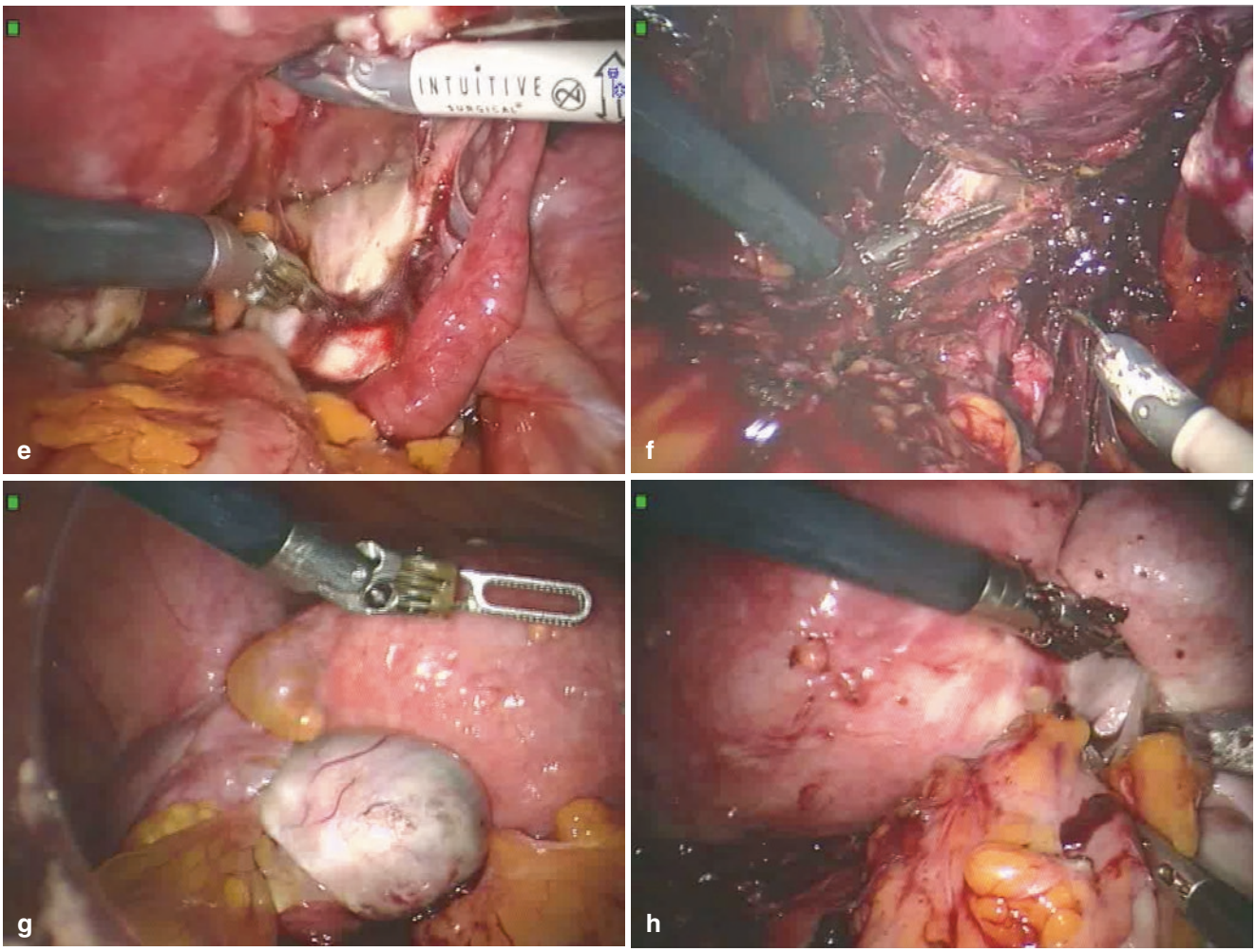


Fig. 59.3 (Continued)

References

1. Parker MC, Wilson MS, Menzies D, Sunderland G, Clark DN, Knight AD, Crowe AM. The Scar-3 study: 5-year adhesion-related readmission risk following lower abdominal surgical procedures. Colorectal Dis. 2005;7(6):551–8.
2. Razmaria AA, Marchetti PE, Prasad SM, Shalhav AL, Gundeti MS. Does robot-assisted laparoscopic ileocystoplasty (RALI) reduce peritoneal adhesions compared with open surgery? BJU Int. 2014;113:468–75.

Suggested Reading

Ahmad G, Mackie FL, Iles DA, O'Flynn H, Dias S, Metwally M, Watson A. Fluid and pharmacological agents for adhesion prevention after gynaecological surgery. Cochrane Database Syst Rev 2014; 9(7). Art No.: CD001298. doi: 10.1002/ 14651858.CD001298.pub4.

Al-Jabri S, Tulandi T. Management and prevention of pelvic adhesions. Semin Reprod Med. 2011;29:130–7.

Anderson SA, Beierle EA, Chen MK. Role of laparoscopy in the prevention and in the treatment of adhesions. Semin Pediatr Surg. 2014;23:353–6.

Arung W, Meurisse M, Detry O. Pathophysiology and prevention of postoperative peritoneal adhesions. World J Gastroenterol. 2011;17(41):4545–53.

Audebert A, Darai E, Bénifla JL, Yzbeck C, Déchaud H, Wattiez A, Crowe A, Pouly JL. Postoperative abdominal adhesions and their prevention in gynaecological surgery: What should you know? Gynecol Obstet Fertil. 2012;40:365–70.

Awonuga AO, Saed GM, Diamond MP. Laparoscopy in Gynecologic Surgery: Adhesion development, prevention, and use of adjunctive therapies. Clin Obstet Gynecol. 2009;52:412–22.

Blackburn SC, Stanton MP. Anatomy and physiology of the peritoneum. Semin Pediatr Surg. 2014;23:326–30.

Brokelman WJA, Lensvelt M, Borel Rinkes IHM, Klinkenbijl JHG, Reijnen M. Peritoneal changes due to laparoscopic surgery. Surg Endosc. 2011;25:1–9.

Chiu LH, Chen CH, Tu PC, Chang CW, Yen YK, Liu WM. Comparison of robotic surgery and laparoscopy to perform total hysterectomy with pelvic adhesions or large uterus. J Minim Access Surg. 2015;11(1):87–93.

Diamond MP, Wexner SD, Di Zereg GS, Korell M, Zmora O, Van Goor H, Kamar M. Adhesions prevention and reduction: current status

and futur recommendations of a multinational interdisciplinary consensus conference. Surg Innov. 2010;17(3):183–8.

Hackethal A, Sick C, Szalay G, Puntambekar S, Joseph K, Langde S, Oehmke F, Tinneberg HR, Muenstedt K. Intra-abdominal adhesion formation: does surgical approach matter? Questionnaire survey of South Asian surgeons and literature review. J Obstet Gynaecol Res. 2011;37(10):1382–90.

Hindocha A, Beere L, Dias S, Watson A, Ahmad G. Adhesion prevention agents for gynaecological surgery: an overview of Cochrane reviews. Cochrane Database of Syst Rev 2015; (1). Art No:CD011254.doi:10.1002/14651858.CD011254.pub2.

Molinas CR, Binda MM, Manavella GD, Koninckx PR. Adhesion formation after laparoscopic surgery: what do we know about the role of the peritoneal environment? Obstet Gynecol. 2010;2(3):149–60.

Ott DE. Laparoscopy and adhesion formation, adhesions and laparoscopy. Semin Reprod Med. 2008;26(4):322–30.

Ten Broek R, Kok-Krant N, Bakkum EA, Bleicrodt RP, Van Goor H. Different surgical techniques to reduce post-operative adhesion formation: a systematic review and meta-analysis. Hum Reprod Update. 2013;19(1):12–25.

Vettoretto N, Carrara A, Corradi A (Associazione die Chirurghi Ospedalieri Italiani – ACOI) et al Laparoscopic adhesiolysis: consensus conference guidelines. Colorectal Dis 2012; 14: e208–e215

Wallwiener M, Koninckx PR, Hackethal A, Brölman H, Lundorff P, Mara M, Wattiez A, De Wilde RL. A Eurpean survey on awarness of post-surgical adhesions among gynaecological surgeons. Gynecol Surg. 2014;11:105–12.

General Aspects and Their Handling: Comorbidities

60

Celine Lönnerfors and Jan Persson

Medical and Surgical Comorbidities

In medicine, the term "comorbid" entails medical condition(s) existing simultaneously, but independently, with another condition.

Medical conditions known to increase the risk of surgery include bleeding disorders, diabetes mellitus, heart disease, obesity, liver disease, infectious disease, chronic respiratory disease, obstructive sleep apnoea, substance abuse and immunological disorders [1, 2], (Table 60.1).

In addition, the presence of extensive intraabdominal adhesions, advanced endometriosis and obesity are conditions associated with an increased surgical risk.

An understanding of the potential morbidity associated with surgery and different surgical approaches, as well as the impact of comorbidity, is important to offer the patient optimal treatment. For women with malignant disease, a higher surgical risk is acceptable than for women with benign disease and for women with significant comorbidities a thorough preoperative evaluation including patient information, optimizing patient status, and a comprehensive consideration of alternative, less invasive treatment options are key.

Minimally invasive hysterectomy is associated with less postoperative pain and a lower rate of morbidity, shorter hospital stay and convalescence [3–6]. An effort put into preserving the clinical benefits of laparoscopic surgery and facilitating the performance of more advanced surgery has led to the development of robotic surgery. The uptake of robot-assisted surgery was rapid. In 2008, only 3 years after the introduction, one in five hysterectomies for benign disease in the United States were performed robotically [7]. Three randomized, controlled trials comparing laparoscopic to robotic hysterectomy for benign disease have been published where the studies by Paraiso et al. and Sarlos et al. found a similar clinical outcome but an increased cost for robotics [8, 9]. In contrast, the randomized trial from our clinic showed that robotic hysterectomy for benign disease could be economically feasible if performed as excess capacity at a high volume center [10]. A recent Cochrane review on surgical approach to hysterectomy for benign disease concluded that when a vaginal hysterectomy is unfeasible, a laparoscopic hysterectomy is preferable to an abdominal approach. In addition, although the present evidence does not suggest that robotic hysterectomy is of benefit in this population, further evaluation is needed. The study further concluded that the benefits and hazards associated with different approaches is dependent on surgical expertise and that the approach to hysterectomy should be decided by the woman in discussion with her surgeon [11].

Patients with both substantial medical and surgical comorbidities are patients in whom surgery is particularly hazardous and where a minimally invasive approach might be particularly beneficial. Leonard et al. demonstrated that BMI, uterine size, leiomyoma size, and previous abdominopelvic surgery are all independent risk factors for intraoperative conversions from laparoscopy to laparotomy and Bonilla et al. showed that a large uterus increased the risk of a longer hospital stay, morbidity, and blood loss [12, 13]. These characteristics thereby provide a measure of the complexity and potential difficulty of a surgery and as such these high-risk surgeries have traditionally been performed by laparotomy [14]. Robotic surgery was introduced to overcome some of the limitations of traditional laparoscopy and to expand the patient population being offered minimal invasive surgery.

Robotic surgery is laparoscopic surgery utilizing an advanced tool. However, contrary to laparoscopic surgery, the requirement of a steep Trendelenburg position, large machinery impeding direct access to the patient, and an increased number of advanced, time consuming procedures all present additional management challenges for the surgical team [15], (Table 60.2).

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Table 60.1 Medical conditions that increase the risk of surgery [1, 2]

Condition	Type and reason for increased risk
Bleeding or clotting disorder	Increased risk of bleeding or developing blood clots during and after surgery
Cardiovascular disease	Increased demands on the myocardium to maintain cardiac output due to surgical stress Increased susceptibility to surgical factors such as blood loss and volume shifts Enhanced myocardial oxygen demand caused by increased heart rate and blood pressure as a result of surgical stress
Chronic respiratory disease	Reduced ability to compensate for any alteration in the acid-base balance Increased risk of hypoventilation due to depressed respiratory function during anesthesia Changes in ventilation impair the diaphragm resulting in reduced volumes and lung capacities Increased risk of postoperative pulmonary complications due to risk of exacerbation of bronchial inflammation and increased risk of bronchospasm and postoperative pneumonia
Diabetes mellitus	Increased risk of infection and impaired wound healing due to altered glucose metabolism and associated impaired tissue perfusion Increased risk of lower limb ischemia and pressure sores Disruption and worsening of diabetes control Increased risk of postoperative acute myocardial infarction
Immunological disorders	Increased risk of impaired wound healing and infection
Chronic kidney disease	Impaired tubular excretory function of the kidney cause elevation in levels of creatinine and blood urea nitrogen Impaired synthetic function leads to a decrease in the production of erythropoietin (resulting in anemia) and active vitamin D-3 (causing hypocalcemia, secondary hyperparathyroidism, and hyperphosphatemia), accumulation of acid, potassium, sodium and water excretion (causing acidosis, hyperkalemia, hypertension, and edema), and platelet dysfunction (promotes bleeding) Drugs usually eliminated by the kidney including anesthetic drugs can accumulate to toxic levels Renal insufficiency is a risk factor for cardical complications in surgical patients
Liver disease	Decreased synthesis of plasma-binding proteins Impaired drug metabolism and elimination Impaired hormonal response to surgical stress Increases the risk of morbidity (bleeding, impaired wound healing, renal dysfunction, hepatic failure, infection) and mortality in the postoperative period
Nutritional status	Malnutrition further exacerbates the catabolic state induced by surgical stress Increased risk of postoperative infection and impaired wound healing for both obese and underweight women Obesity increases risk of having other comorbidities

Table 60.2 Anesthesiological challenges specific to robotic surgery [11]

Patient positioning	Steep Trendelenburg	Compromised hemodynamics and oxygenation. Restricted intraoperative airway access Increased risk of postoperative respiratory stress, nerve injury, occult blood loss, corneal abrasion
Pneumoperitoneum		Increased peak inspiratory and plateau airway pressures and end-tidal CO_2 tension while decrease in lung compliance and vital capacity leading to ventilation-perfusion mismatch, atelectasis, subcutaneous emphysema and gas embolism
Restricted access		Might impact patient care in emergency situations

Communication and teamwork are vital to create a safe, effective and efficient environment to minimize complications and optimize the perioperative period for the patient. Proper training and experience with the procedure in low-risk patients is important prior to undertaking surgery in high-risk patients.

To perform robotic gynecologic surgery optimal exposure of the pelvis is necessary and this is possible through a steep Trendelenburg position [16]. Without proper exposure, the procedure is prolonged and there is an increased risk of intraoperative complications [17]. The dorsal lithotomy position can have significant physiological consequences. Most susceptible to the head-down extreme position are the cardiac, respiratory, and central nervous systems and patients with underlying disease might be especially vulnerable [18]. The cranial movement of the diaphragm by pneumoperitoneum and abdominal contents, can decrease pulmonary compliance and functional residual capacity, cause pulmonary edema, and exacerbate ventilation/perfusion mismatch, which can be particularly perilous in the morbidly obese or in patients with underlying chronic lung disease [19–21] The establishment of pneumoperitoneum can result in increased postoperative

complications in patients with underlying lung disease. Patients with chronic obstructive pulmonary disease are less efficient in eliminating excessive CO_2, which can lead to postoperative respiratory hypercarbia and acidosis [22, 23]. In addition, the development of subcutaneous emphysema contributes significantly to the total amount of CO_2 absorbed [15]. Obese women have less efficient ventilation during pneumoperitoneum and are at higher risk of coronary artery disease, pulmonary dysfunction, and diabetes [24, 25]. The combination of the steep Trendelenburg position with pneumoperitoneum influences cardiopulmonary physiology; increased left ventricular filling pressure and systemic vascular resistance and decreased cardiac output [26–28]. Prolonged surgery places the patient's cardiorespiratory capacity under pressure for longer [29].

The president of the American Congress of Obstetricians and Gynecologists released the following statement in 2013: *Patients should be advised that robotic hysterectomy for benign disease is best used for unusual and complex clinical conditions in which improved outcomes over standard minimally invasive approaches have been demonstrated* [30]. No randomized studies on the optimal hysterectomy approach for women with significant medical or surgical comorbidities or for complex cases such as severe adhesions, extensive endometriosis or difficult anatomical conditions are available, i.e. cases where robotic surgery has been suggested to be most beneficial.

Retrospective and prospective studies on the impact of surgical comorbidities are available and several studies have indicated robotic surgery to be feasible and safe in women with complex benign disease. Boggess et al. found robotic hysterectomy in 152 consecutive cases with complex benign disease (obese patients, patients with one or more prior pelvic or abdominal surgeries, patients with moderate to severe endometriosis or leiomyomas, and patients with large uteri) to be associated with short hospital stay, minimal blood loss and no conversion to laparotomy. They concluded that robotics allows for a safe and efficient surgery in patients with complex pathology [14]. Several study groups have reported on the feasibility of complex endometriosis surgery using robotics and several studies have indicated that robotic surgery is feasible and safe in women with other complex benign disorders such as large uteri, pelvic fistula or in case of previous intraabdominal surgery [18, 24, 31–42]. In addition, several publications indicate that robotic surgery is utilized to an increased extent in women with comorbidities [24, 33, 34, 43, 44]. Patzkowsky et al. compared the perioperative outcome of 288 robotic and 257 laparoscopic hysterectomies for benign disease and found that even though more complex cases were being performed robotically the surgical outcome was similar in both groups [45]. This selection case bias where more difficult cases are chosen for a robotic approach, is increasingly evident at our clinic where the referrals specifically indicating a wish for robotic surgery has increased substantially.

The impact of obesity has been most extensively studied, particularly in women undergoing hysterectomy for endometrial cancer. Obese patients are more likely to have additional comorbidities that may increase the risk of surgical and anesthetic morbidity and mortality when compared with women of normal weight [46–48].

Due to the increasing prevalence of obesity, it is important to develop surgical techniques to manage these patients appropriately. Three large randomized controlled trials found laparoscopic surgery to be a valid alternative to laparotomy for surgical treatment of endometrial cancer [5, 49–51]. The complexity of advanced traditional laparoscopic procedures in obese women has hindered a general adoption of laparoscopic surgery for this group of patients.

For morbidly obese patients (BMI $\geq$40 kg/m^2) laparoscopic surgery is particularly challenging but also more advantageous compared to open surgery [52–54]. A recent study evaluating the impact of obesity on the outcomes of surgical treatment of endometrial cancer by either laparoscopy or laparotomy found laparoscopy to be associated with a better clinical outcome [55]. However, the conversion rate increased and the lymph node yield decreased in women with BMI exceeding 40, the latter was true even for women operated by laparotomy. In the Lap2 study, the overall conversion rate was 25.8 %, although for women with BMI $\geq$40, the rate was 56 % [5]. Wound related complications are the most common complications for obese women undergoing laparotomy. Decreasing the rate of laparotomy while retaining an acceptable oncological outcome is highly important in obese women.

Extreme obesity has traditionally been considered a relative contraindication to laparoscopic surgery; thicker panniculus reducing the range of instrument motion, the effect of steep Trendelenburg position on the respiratory system and the redundancy of bowel interfering with optimal exposure of the pelvis [56].

Robotic surgery for gynecological disease has been found to be feasible in obese women [44, 57–62]. Concerns about whether or not robotic surgery is safe in obese patients has been raised, particularly due to the need for a very steep Trendelenburg position during the procedure. Several recent publications have concluded that robotic surgery is safe in this group of patients. Wysham et al. found a low incidence of pulmonary complications and overall complications in 1032 obese women following robotic surgery for gynecological disease and Corrado et al. reported a perioperative complication rate of 10 % and no conversions to laparotomy in their study on 70 morbidly obese patients [60, 63]. A large cohort study by Zakhari et al. showed that although women undergoing robotic surgery were more likely to have a much higher burden of comorbidities as well as significantly more

often being obese or morbidly obese, a greater rate of lymph node dissection, a decreased length of hospital stay as well as comparable postoperative morbidity and mortality was seen when compared to laparoscopy [44]. This trend towards a higher utilization of robotics in higher BMI categories has also been demonstrated in urology [64].

The intraoperative management of extensive intraabdominal adhesions is a surgical challenge. Adhesiolysis is associated with a prolonged operative time and an increased risk of intraoperative and postoperative complications, especially inadvertent bowel injury [65–67]. Unlike other postoperative complications, the consequences of adhesion formation comprise a lifelong risk of various clinical entities [65, 68–72]. The presence of adhesions increases the risk of small bowel obstruction, the need for emergency surgery with adhesiolysis as well as decreased pregnancy rates, increased need for fertility treatments, and chronic abdominal pain [65, 66, 72–77].

Data about the incidence of adhesions differ considerably, although most studies report an incidence of between 20 and 93 % [78–82]. These significant variations may be explained by diverse procedures and entry techniques as well as by varying underlying disease [83]. Pediatric and lower gastrointestinal surgery is associated with a majority of adhesion-related problems whereas the rate is lower following urological and gynecological procedures [77]. The presence of adhesions is more probable in patients with a history of laparotomy or extended surgery. Laparoscopy reduces, but does not prevent, the occurrence of adhesion-related complications [79, 84].

For laparoscopic and robotic surgery, the presence of adhesions in the umbilical area must be considered as the insertion of a trocar can lead to bowel injury. In their study on 814 patients, Audebert and Gomel found the rate of umbilical adhesions to be 0.68 % of patients with no previous abdominal surgery, 1.6 % following laparoscopic surgery, 19.8 % following a previous horizontal suprapubic incision, and 51.7 % after a midline incision [85]. In addition, the study demonstrated that the presence of severe adhesions involving the bowel was low in women with no previous surgery, after laparoscopic surgery or after a horizontal incision (0.42–6.87 %), but 31.46 % in women with a previous midline incision [85]. Sepilian et al. found the incidence of umbilical adhesions and bowel adhesions to be 21.2 and 2.6 % in patients with a history of laparoscopy through an umbilical incision [86]. Consequently, in patients with a history of laparoscopy or laparotomy, an alternative access to the abdominal cavity such as the Palmer's point should be considered to minimize the risk of inadvertent organ perforation during trocar entry. The occurrence of adhesions at the Palmer's point after previous operations is unlikely because most abdominopelvic operations are conducted farther from this anatomical region [83]. Since 2012, direct access at Palmers point using the 12 mm semi blunt assistant trocar has been the preferred method for gaining access to the abdominal cavity for robotic procedures at our clinic. During the last 3 years performing approximately 900 procedures, one complication (bleeding from mesenteric vessels in a women with low BMI) has occurred following direct entry at Palmers point. The overall complication rate during port placement at our institution is low (0.3 %) and known or suspected adhesions are considered an indication rather than a contraindication for robotic surgery [87].

Lysis of adhesions is associated with a prolonged operative time and an increased risk of intraoperative and postoperative complications [65, 66, 77]. Adhesions precluding acceptable exposure are, in addition to unanticipated carcinomatosis, the most commonly stated reasons for conversion to laparotomy in robotic surgery.

The conversion rate during robotic hysterectomy for benign disease is low. Most studies report rates of less than 1 % [8–10] and even in women with complex benign disease the rates are in the range of 0–1.7 %. [14, 45]. For robotic hysterectomy for malignant disease most report rates <4 %, although in a recent publication by Jones et al. the rate was 8.7 % [62, 87–91]. The latter publication evaluated the risk factors for conversions from robotic surgery to laparotomy in 459 patients and found bowel injury, increasing BMI and non-White race but not prior surgery, medical comorbidities or malignant disease to be associated with conversion to open surgery [91]. The Lap2 study, a randomized study comparing staging for endometrial cancer by laparoscopy and laparotomy found increasing BMI, age and metastatic disease to be associated with an increased risk of conversion [5].

The conversion rate in the first 1000 robotic procedures performed at our institution for malignant or benign disease was 3.7 %; 41 % of the conversions were due to intraabdominal adhesions and 3 % due to an intraoperative complication [87]. Overall, 36 % of the women had at least one previous laparotomy and 24 % had intraabdominal adhesions necessitating adhesiolysis. An intraoperative complication occurred in 3.3 %. A urinary injury (ureter or bladder) occurred in 1.7 %, a bowel injury in 0.8 %, a vessel injury in 0.6 % and a neural injury in 0.2 % of the patients. Sixty-five per cent of patients with an intraoperative complication had major intraabdominal adhesions. The conversion rate and the rate of intraoperative complications in patients with adhesions was 5.8 % and 5.4 % respectively [86].

In a later study on our first 949 hysterectomies for malignant and benign disease, the overall conversion rate was 2.4 %; 46 % was due to intraabdominal adhesions. In 70 % of the conversions, the decision was made prior to docking the robot and the conversion rate among women in whom the robot was docked was 0.8 %. The conversion rate in the 240 women undergoing hysterectomy for benign disease was 0.4 % [87]. In 2013/2014, one (1.2 %) conversion and no

intraoperative complications occurred during a hysterectomy for benign disease even though 66 % had at least one complicating factor (ASA ≥3, severe endometriosis, > one previous midline incision, BMI >40 kg/m^{2,} uterine size >200 g). The conversion was due to extensive intraabdominal adhesions in a woman with several previous midline incisions.

The presence of adhesions is associated with a somewhat higher risk of conversion and intraoperative complications. The latter can, in a majority of cases, be managed robotically and adhesions should not dissuade from performing a robotic procedure if other factors favor this approach.

Dry-lab studies have shown that the robot is more advantageous compared to traditional laparoscopy when the procedure becomes technically more challenging regardless of the level of the surgeons experience [92]. Even though no randomized controlled trials comparing laparoscopy and robotics for patients with significant comorbidities within this patient group are available, several studies indicate that even with an experienced and skilled surgeon, obese patients, patients with prior abdominal surgeries, or patients requiring lengthy and high-risk surgeries are likely to benefit from robotic surgery. In addition to a thorough preoperative evaluation, intraoperative monitoring, teamwork, good communication and a heightened awareness of the possible problems that might arise are important to achieve a successful surgery and an uncomplicated postoperative period. Training, experience and refinement of practice has, at our institution lead to a decrease in the overall rate of intraoperative-, postoperative-, and ≥ grade 3 complications according to the Clavien-Dindo scale by 46 %, 44 % and 76 % respectively. This decrease has occurred over a seven-year period and illustrates that the effort and time needed to implement a successful robotic program should not be underestimated.

Robotic surgery for benign disease has been suggested to be beneficial primarily in complex cases or in high-risk patients. The development a standardized, reproducible method of hysterectomy for all benign cases called **safe, simple hysterectomy** is in our opinion key to minimize the risk of complications for all patients. This method mimics surgery for malignant disease where the pelvic sidewalls are opened and the ureters identified, dissected and visualized during the entire surgery and the vascular pedicels are skeletonized and secured. Proper training and experience with this method in non-complex cases is important prior to undertaking the more challenging procedures. In high-risk surgeries aberrant anatomy due to endometriosis or adhesions, decreased visibility due to obesity, enlarged uteri or suboptimal pneumoperiotoneum or Trendeleburg's positioning due to anaesthesiological issues are challenges that must be overcome to successfully complete the case. The predictability of this method for the console surgeon, the bedside assistant and the operating room nurse optimizes the chances of the surgery being uneventful. This allows for swift damage control when necessary, and thereby decreases the risk of intraoperative complications, intraoperative bleeding, and conversion to laparotomy as well as the risk of reoperation, which is particularly important for this high-risk population.

Safe, Simple Hhysterectomy: Surgical Technique

All models of the da Vinci robots can be used. Ports should be placed as for standard pelvic surgery. Central docking or side docking at surgeon's discretion for the Si robot whereas the Xi robot is usually docked 90 ° from the side. Suitable robot instruments are: monopolar scissors, a bipolar forceps, and a prograsp. The latter can, in most cases, be used for closing the vaginal cuff. For the assistant, a 10–12 mm trocar is used for suction/irrigation, insertion of sponges, clips, and needles.

For identification of the vaginal fornices, a vaginal tube is placed at onset of surgery.

Initial entry into the abdomen is usually achieved through direct entry at Palmers point in the upper left quadrant with the assistant trocar or with Verress needle or open entry at the midline. A midline entry is avoided in case of previous extensive intraabdominal surgery.

Triangulation and tensioning of the tissue is created using the fourth arm with the infindibulopelvic (IP) ligament, the round ligament and the pelvic sidewall as the parameters (Fig. 60.1) and the peritoneum is opened approximately 1 cm lateral to the IP ligament (Figs. 60.2 and 60.3). The areolar, avascular space is identified and, when possible, dissection is performed in this space to minimize bleeding. The ureter is identified (Fig. 60.4), the pararectal space is developed (Figs. 60.5 and 60.6) and the uterine artery is identified (Fig. 60.7), skeletonized (Fig. 60.8) and sealed with a hemostatic clip

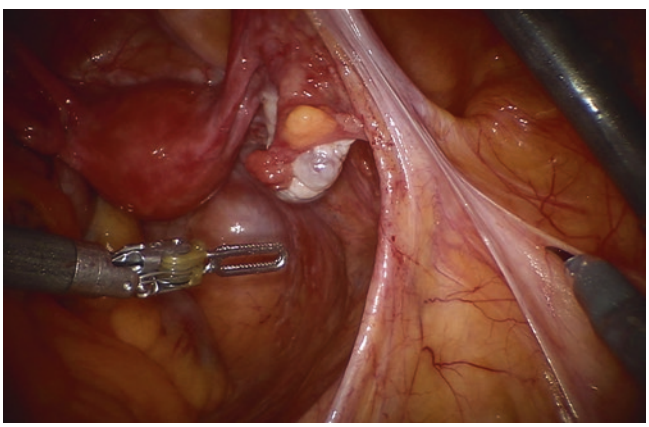


Fig. 60.1 Triangulation of the peritoneum to gain access to the pelvic sidewall

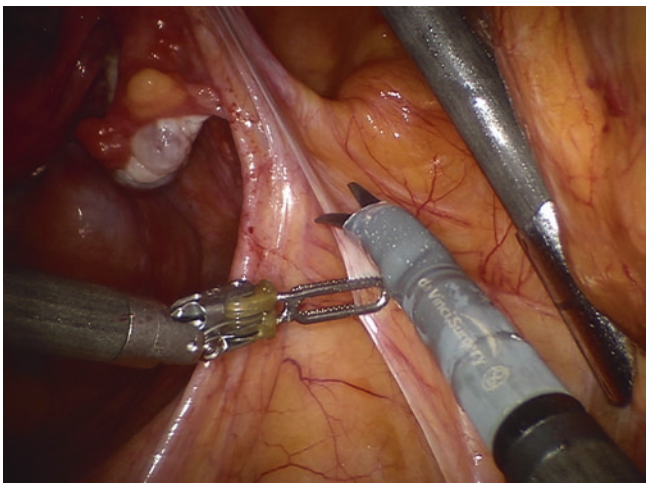


Fig. 60.2 Opening of the peritoneum approximately 1 cm lateral to the IP ligament

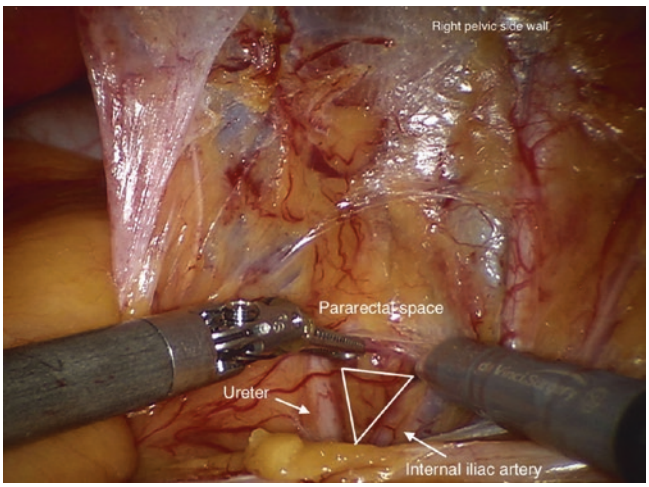


Fig. 60.5 Identifying and developing the pararectal space

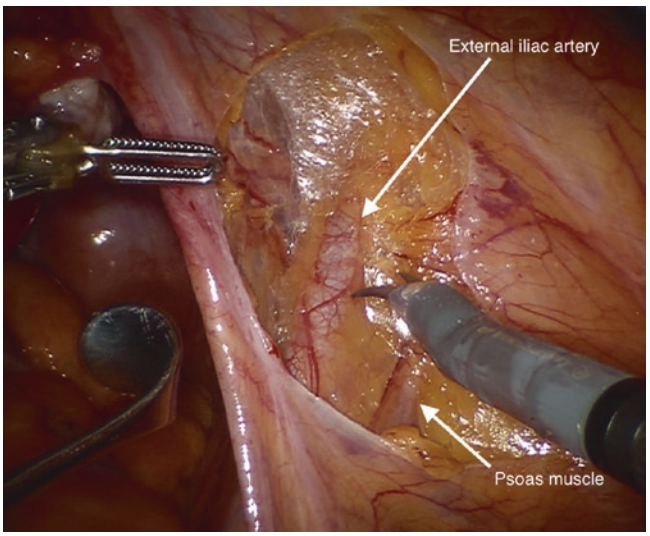


Fig. 60.3 Visualizing the anatomy of the pelvic sidewall including the psoas muscle and the external iliac artery

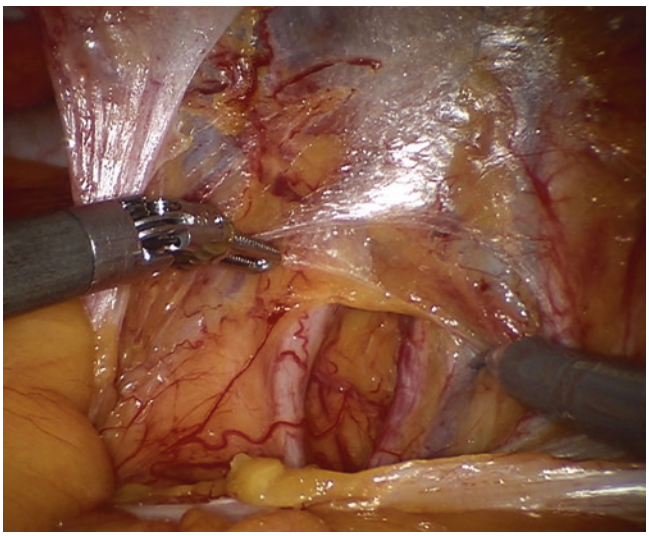


Fig. 60.6 Further atraumatic development of the pararectal space

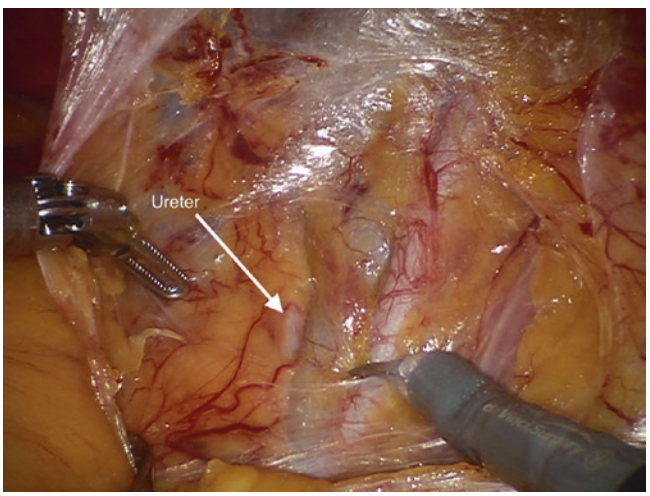


Fig. 60.4 Identifying the ureter

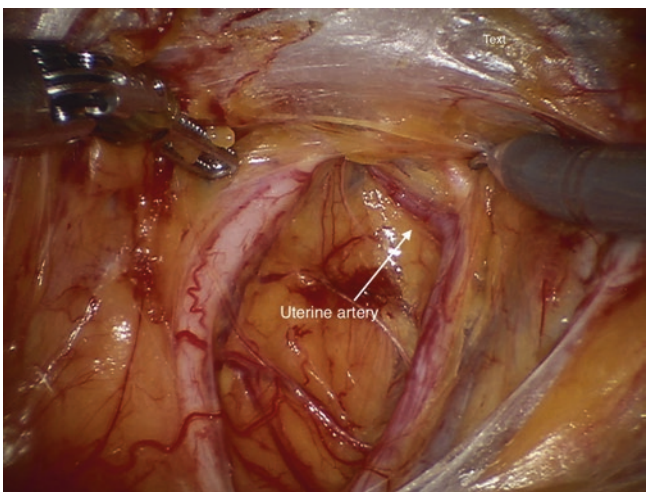


Fig. 60.7 Identifying the uterine artery

(Figs. 60.9 and 60.10). The ureters are dissected off the posterior peritoneum, carefully lateralized to maintain blood supply (Fig. 60.11). The previous steps are performed on the contralateral side. In case of ovarian preservation, the fallopian tubes are removed (Fig. 60.12). The medial broad ligament is opened (Figs. 60.13 and 60.14), the IP ligament is skeletonized, and in case of a bilateral salpingoophorectomy, a hemostatic clip is placed (Figs. 60.15 and 60.16). When preserving the ovaries careful coagulation of the ovarian ligament including the parametrial veins is performed (Fig. 60.17). The Okabayashis space is developed (Figs. 60.18 and 60.19) and the rectovaginal space is opened (Figs. 60.20, 60.21 and 60.22). The round ligaments are divided, (Figs. 60.23 and 60.24) the anterior peritoneum opened (Figs. 60.25 and 60.26), the vesicouterine peritoneal fold is identified and, using the vaginal tube as a guide, the bladder is mobilized off the lower uterine segment (Figs. 60.27 and 60.28). The vaginal tube facilitates identification of the vaginal fornices as well as moving the ureters laterally. Desiccate and divide the uterine vessels at the level of the lower isthmus

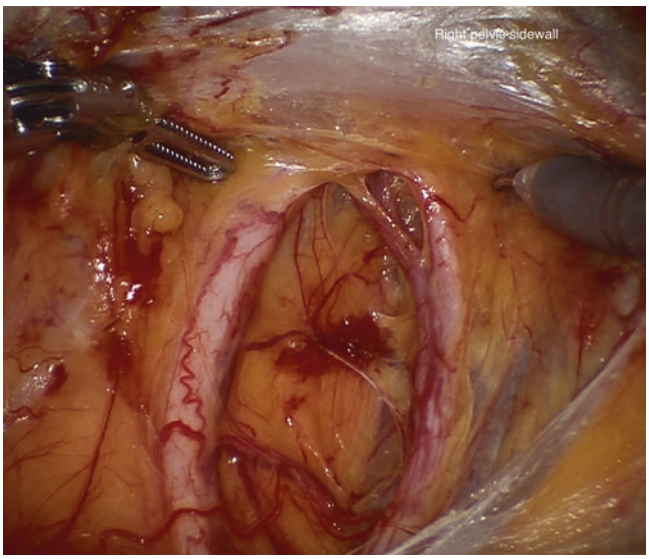


Fig. 60.8 Skeletonizing the uterine artery

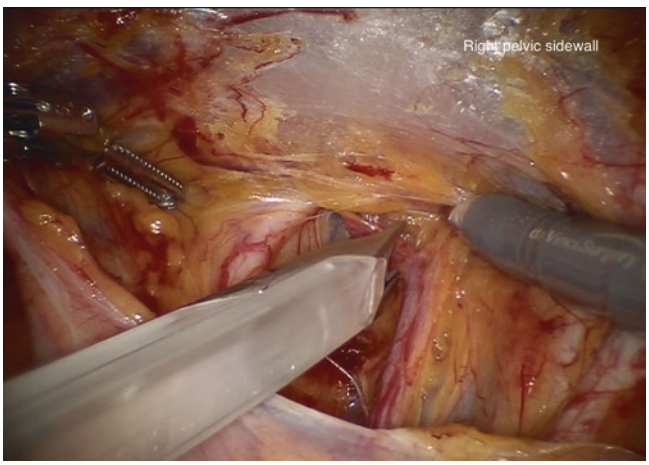


Fig. 60.9 Placing a hemostatic clip on the uterine artery at its origin

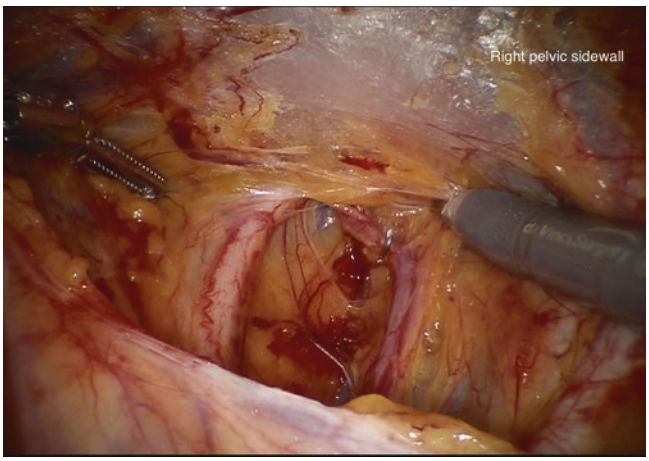


Fig. 60.10 Clips on the uterine artery at the pelvic sidewall

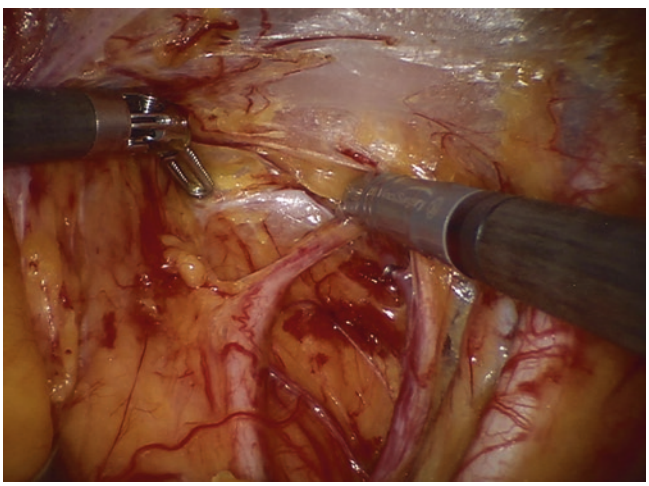


Fig. 60.11 Lateralizing the ureter

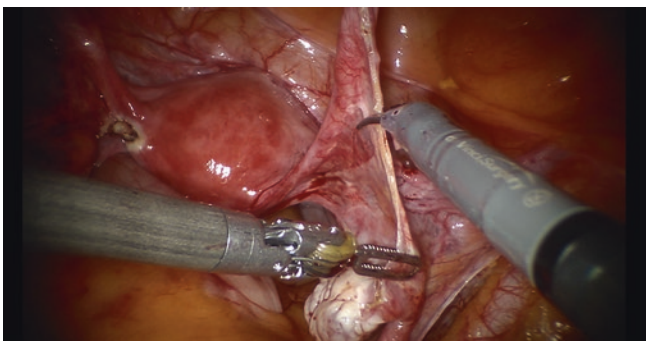


Fig. 60.12 Dissection of the fallopian tube in case of ovarian preservation

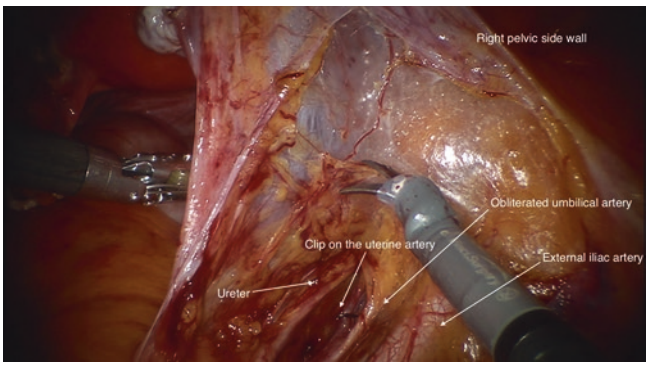


Fig. 60.13 Opening of the broad ligament

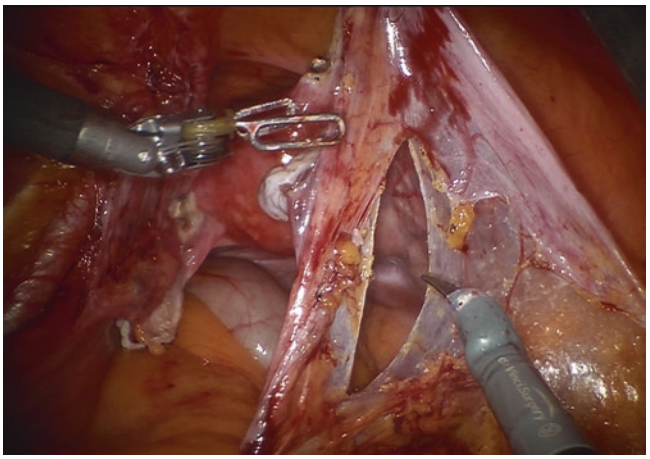


Fig. 60.14 Skeletonizing the ovarian ligament

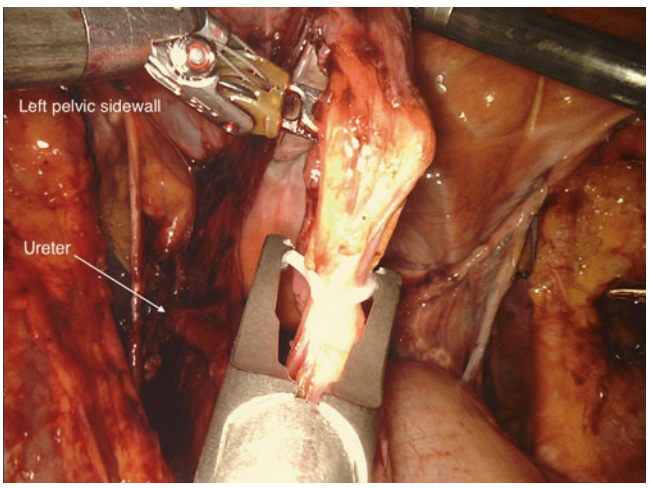


Fig. 60.15 Placing a hemostatic clip on the ovarian ligament when performing a salpingoophorectomy

(Figs. 60.29 and 60.30) and thereafter dissect medially to the uterine vessels down to the vaginal tube to minimize the risk of ureteral injury to provide a vascular pedicle that can be

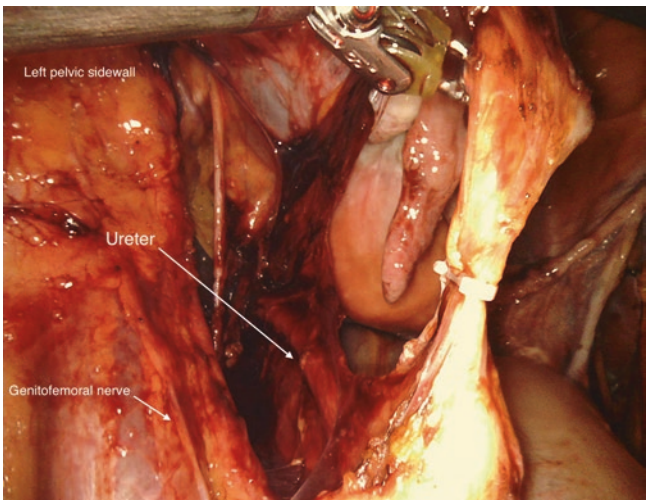


Fig. 60.16 Hemostatic clip on the ovarian ligament

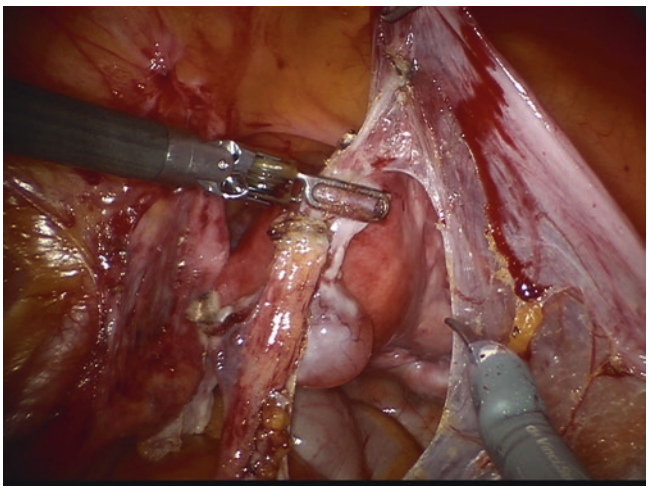


Fig. 60.17 Coagulation of the ovarian ligament

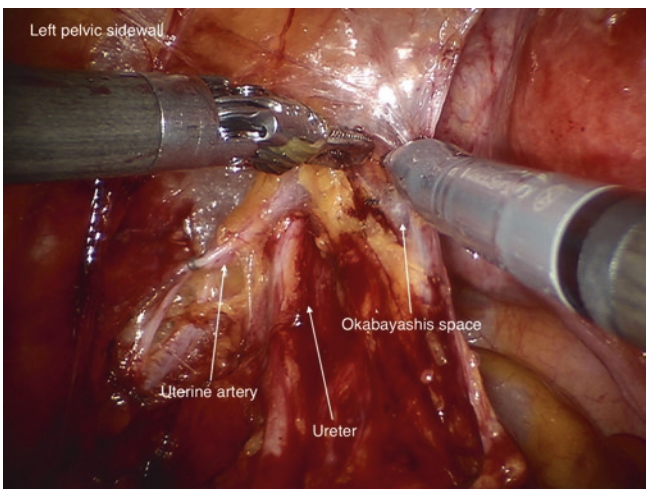


Fig. 60.18 Development of Okabayashis space

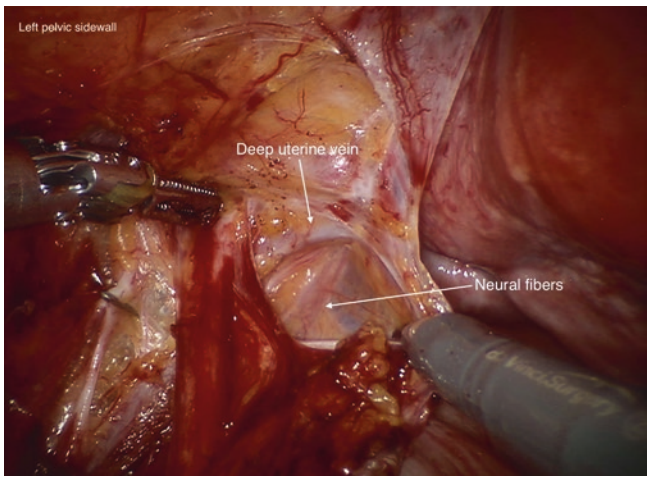


Fig. 60.19 Further development of Okabayashis space

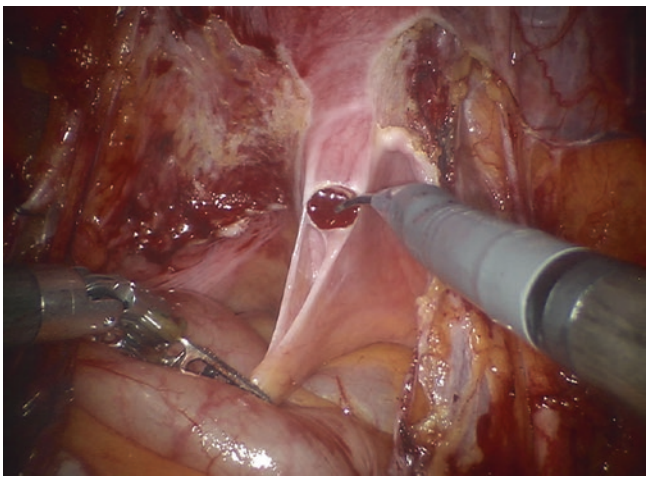


Fig. 60.22 Opening of the peritoneum in the rectovaginal space

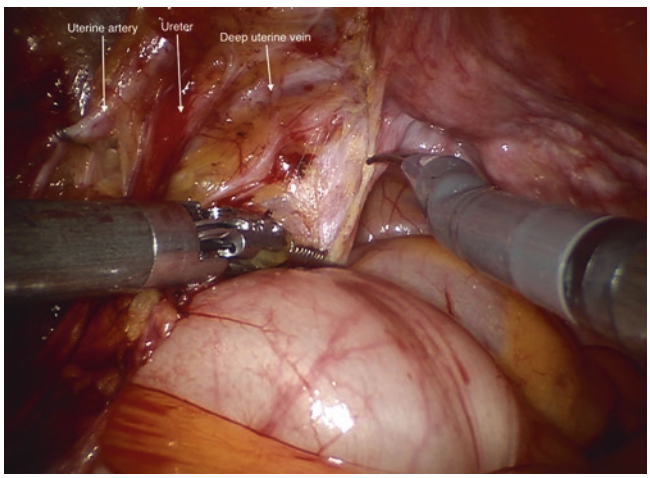


Fig. 60.20 Opening the rectovaginal space

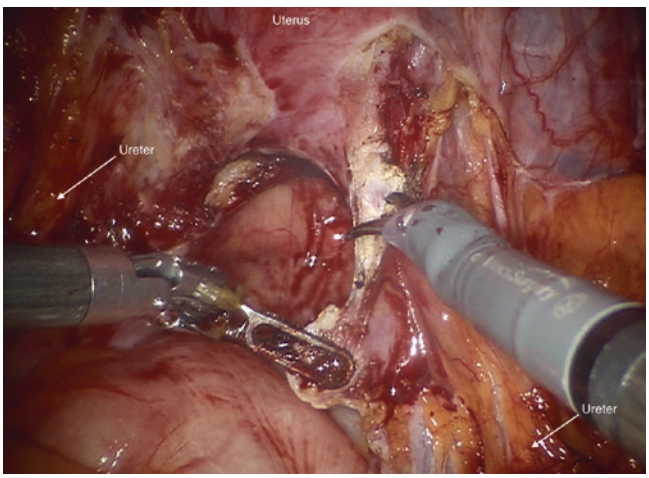


Fig. 60.23 Tissue tension during dissection helps to identify the correct plane

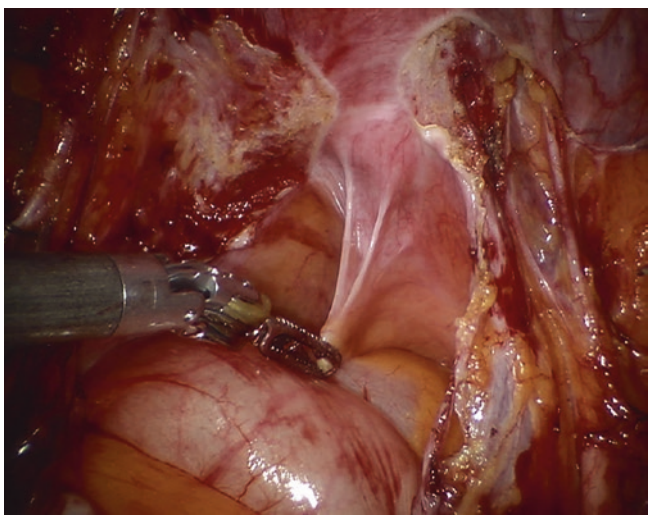


Fig. 60.21 Identifying the correct plane to dissect in the rectovaginal space

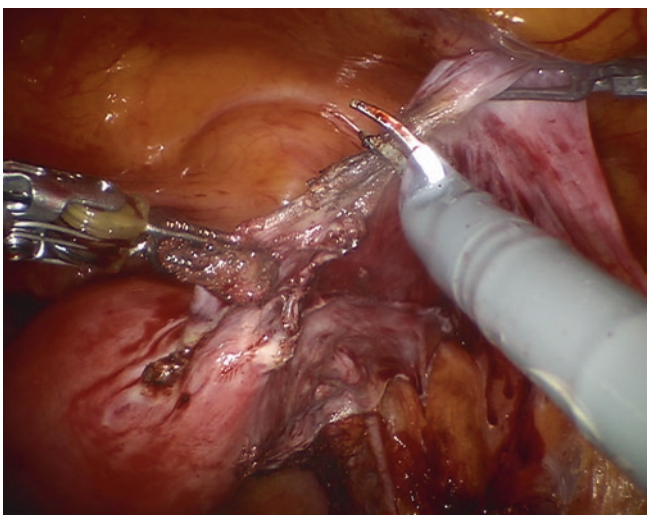


Fig. 60.24 Coagulation and division of the round ligament

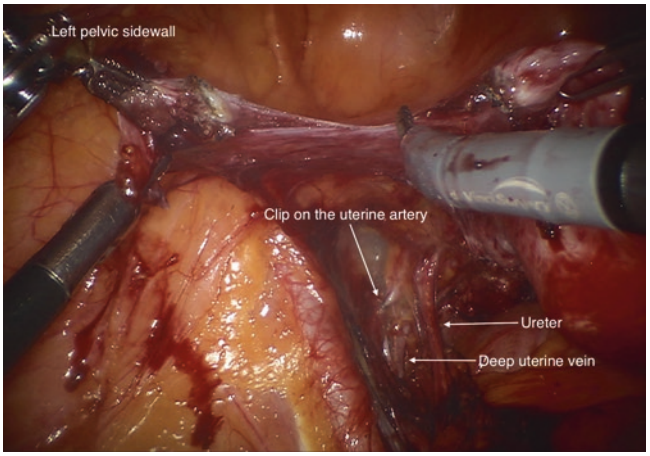


Fig. 60.25 Division of the anterior peritoneum utilizing tissue tension with visualization of the ureter and uterine artery

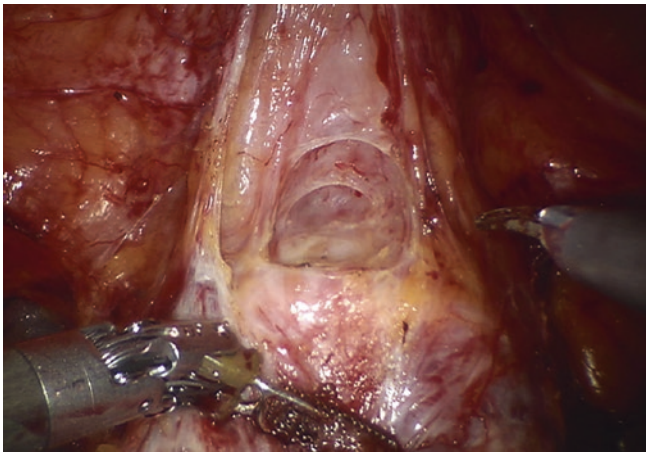


Fig. 60.28 Further mobilization of the bladder

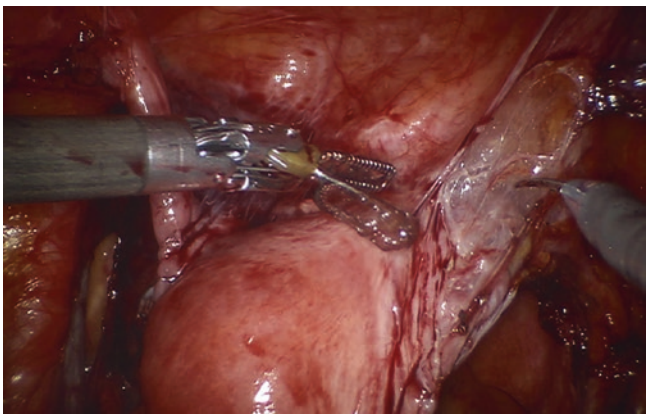


Fig. 60.26 Further division of the anterior peritoneum

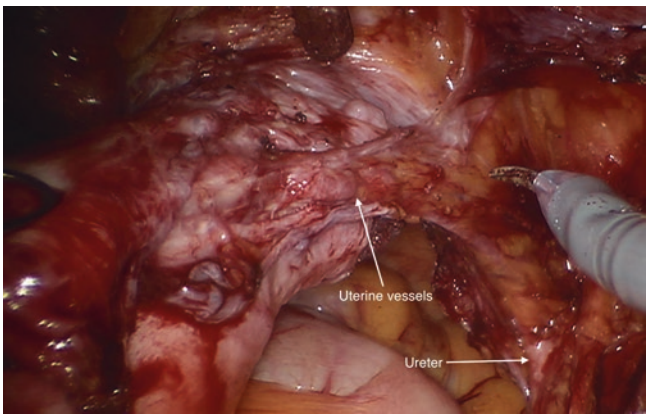


Fig. 60.29 Skeletonized uterine vessels

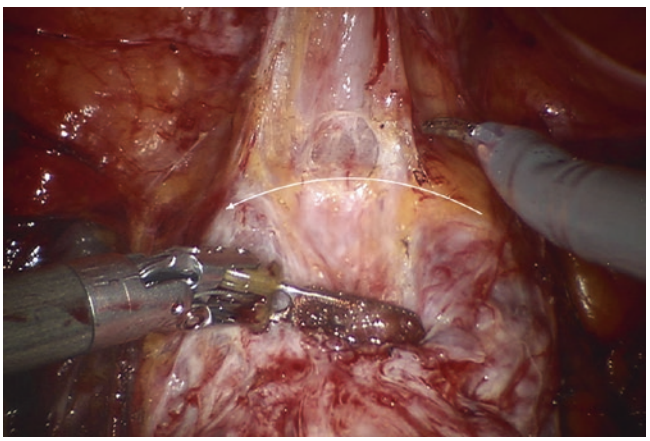


Fig. 60.27 Mobilizing the bladder using the edge of the vaginal tube as a guide to identify the correct plane

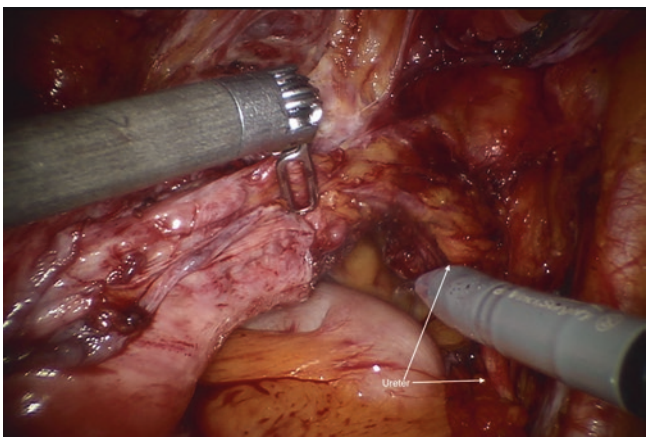


Fig. 60.30 Coagulation of uterine vessels

safely desiccated further in the event of bleeding (Fig. 60.31). To optimize cuff closure and healing, dissecting and mobilization of 7–10 mm of the vagina is desirable (Fig. 60.32). The colpotomy is performed using the tip of the monopolar scissors in cutting mode (Figs. 60.33, 60.34 and 60.35). Vaginal cuff closure is performed (Figs. 60.36 and 60.37).

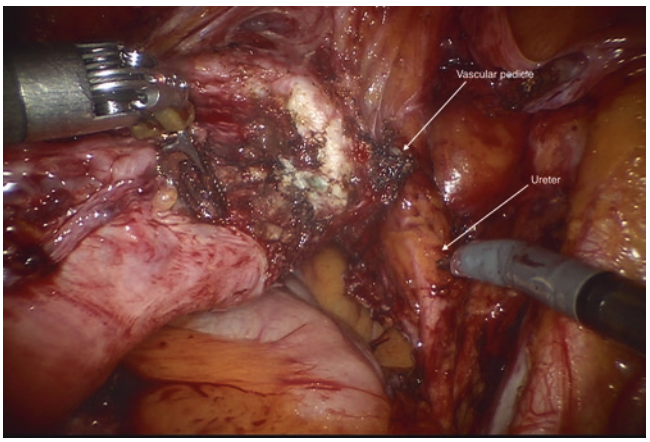


Fig. 60.31 The uterine vessels have been divided and further dissection is performed medially to the vascular pedicle

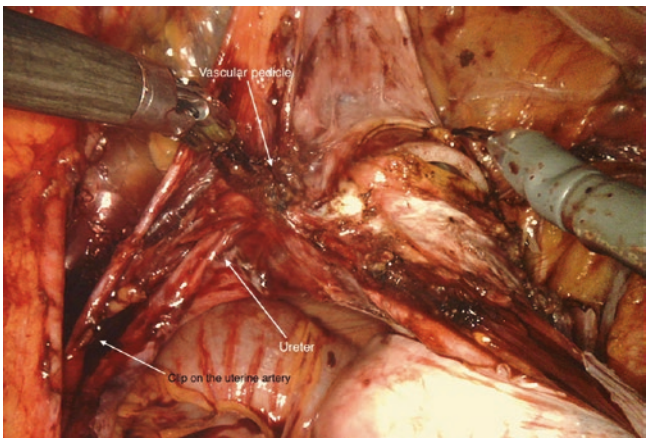


Fig. 60.34 The colpotomy is performed at a safe distance from the ureters

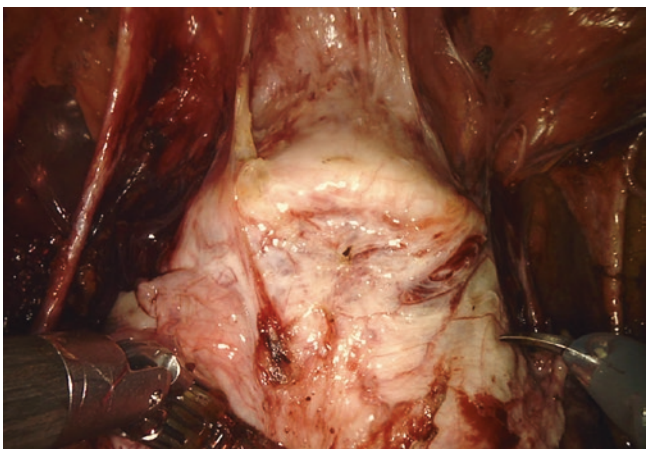


Fig. 60.32 Preparation of the vaginal cuff

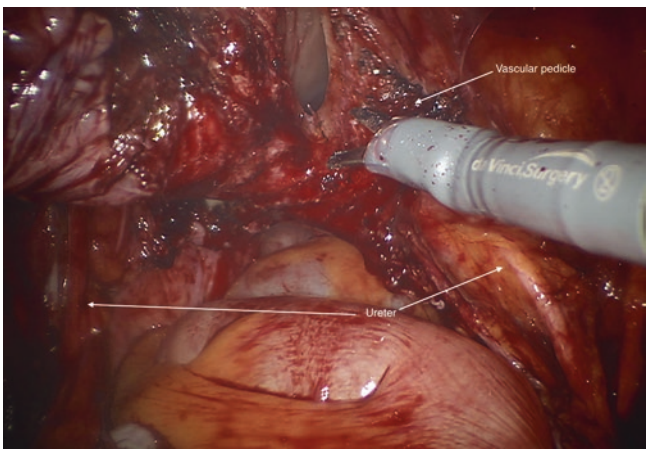


Fig. 60.35 Colpotomy on the lateral/posterior part of the vagina

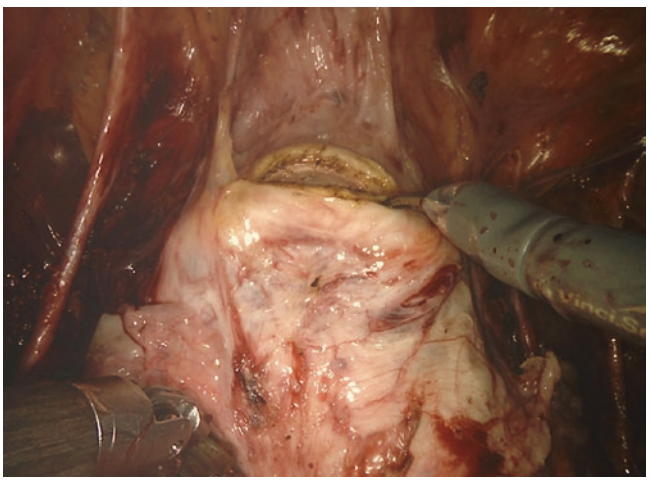


Fig. 60.33 Colpotomy using monopolar cutting current

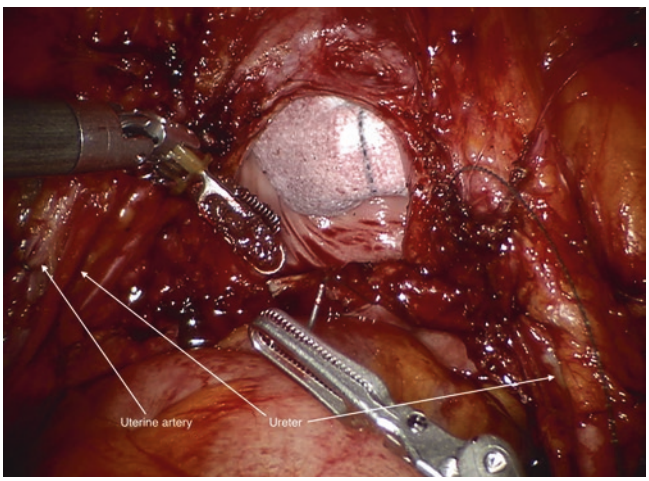


Fig. 60.36 Suturing the vaginal vault

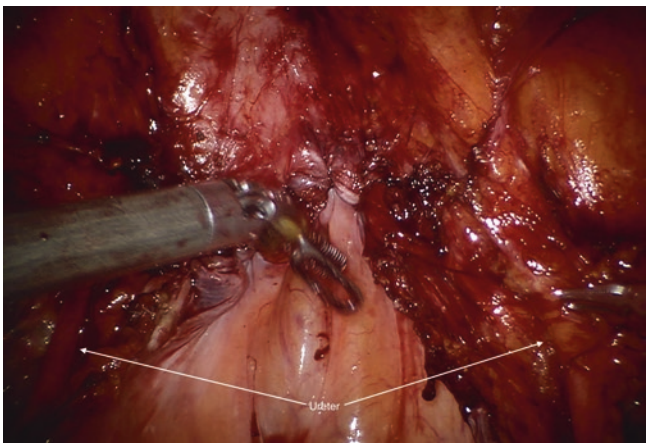


Fig. 60.37 Completed cuff closure

Key Points

- Identify patients with significant comorbidities
- Proper indications for surgery
- Adequate patient information, informed consent
- Optimize the patient prior to surgery
- Be aware of the increased risks of performing surgery in patients with comorbidities
- Training and experience in non complex cases before undertaking complex cases
- Use a standardized, reproducible, safe surgical approach
- Be prepared for all possible medical or surgical complications during surgery
- Teamwork and communication

References

1. Potter PA, Perry AG, Ross-Kerr JC, et al. Canadian fundamentals of nursing. 5th ed. Toronto: Elselvier; 2014.
2. Hoffman B, McGowan T. Chapter 18: Surgery in the patient with kidney disease. In: Merli GJ, Weitz HH, editors. Medical management of the surgical patient. 3rd ed. Philadelphia: Saunders Elsevier; 2008. p. 605–33.
3. Nieboer TE, Johnson N, Lethaby A, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2009;8(3):CD003677.
4. Jacoby VL, Autry A, Jacobson G, et al. Nationwide use of laparoscopic hysterectomy compared with abdominal and vaginal approaches. Obstet Gynecol. 2009;114(5):1041–8.
5. Walker JL, Piedmonte MR, Spirtos NM, et al. Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: Gynecologic Oncology Group Study LAP2. J Clin Oncol. 2009;27(32):5331–6. Epub 2009 Oct 5.
6. Galaal K, Bryant A, Fisher AD, et al. Laparoscopy versus laparotomy for the management of early stage endometrial cancer (Review). Cochrane Database Syst Rev. 2012;(9):CD006655. doi: 10.1002/14651858.CD006655.pub2.
7. Wright JD, Ananth CV, Lewin SN, et al. Robotically assisted vs laparoscopic hysterectomy among women with benign gynecologic disease. JAMA. 2013;309(7):689–98. Epub 2010 May 14.
8. Paraiso MF, Ridgeway B, Park AJ, et al. A randomized trial comparing conventional and robotically assisted total laparoscopic hysterectomy. Am J Obstet Gynecol. 2013;208: 368.e1–7.
9. Sarlos D, Kots L, Stevanovic N, Schaer G. Robotic compared with conventional laparoscopic hysterectomy: a randomized controlled trial. Obstet Gynecol. 2012;120:604–11.
10. Lönnerfors C, Reynisson P, Persson J. A randomized trial comparing vaginal and laparoscopic hysterectomy vs robot-assisted hysterectomy. J Minim Invasive Gynecol. 2015;22(1):78–86. Epub 2014 Jul 19.
11. Aarts JW, Nieboer TE, Johnson N, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2015;8:CD003677. doi:10.1002/14651858.CD003677.pub5.
12. Leonard F, Chopin N, Borghese B, et al. Total laparoscopic hysterectomy: preoperative risk factors for conversion to laparotomy. J Minim Invasive Gynecol. 2005;12:312–7.
13. Bonilla DJ, Mains L, Whitaker R, et al. Uterine weight as a predictor of morbidity after a benign abdominal and total laparoscopic hysterectomy. J Reprod Med. 2007;52:490–8.
14. Boggess JF, Gehrig PA, Cantrell L, et al. Perioperative outcomes of robotically assisted hysterectomy for benign cases with complex pathology. Obstet Gynecol. 2009;14(3):585–93.
15. Kaye AD, Vadivelu N, Ahuja N, et al. Anestetic considerations in robotic-assisted gynecologic surgery. Ochsner J. 2013;13(4):517–24. Review.
16. Klauschie J, Wechter ME, Jacob K, et al. Use of anti-skid material and patient-positioning to prevent patient shifting during robotic assisted gynecologic procedures. J Minim Invasive Gynecol. 2010;17(4):504–7.
17. Ramanathan R, Carey RI, Lopez-Pujals A, Leveillee RJ. Patient positioning and trocar placement for robotic urologic procedures. In: Patel VR, editor. Robotic urologic surgery. 2nd ed. London: Springer; 2012. p. 107–20.
18. Sener A, Chew BH, Duvdevani M, et al. Combined transurethral and laparoscopic partial cystectomy and robot-assisted bladder repair for the treatment of bladder endometrioma. J Minim Invasive Gynecol. 2006;13(3):245–8.
19. Kalmar AF, Foubert L, Hendrickx JF, et al. Influence of steep Trendelenburg position and CO(2) pneumoperitoneum on cardiovascular, cerebrovascular, and respiratory homeostasis during robotic prostatectomy. Br J Anaesth. 2010;104(4):433–9. Epub 2010 Feb 18.
20. Hirvonen EA, Nuutinen LS, Kauko M. Hemodynamic changes due to Trendelenburg positioning and pneumoperitoneum during laparoscopic hysterectomy. Acta Anaesthesiol Scand. 1995;39(7): 949–55.
21. Choi SJ, Gwak MS, Ko JS, et al. The effects of the exaggerated lithotomy position for radical perineal prostatectomy on respiratory mechanics. Anaesthesia. 2006;61(5):439–43.
22. Carry PY, Gallet D, Francois Y, et al. Respiratory mechanics during laparoscopic cholecystectomy: the effects of the abdominal wall lift. Anesth Analg. 1998;87(6):1393–7.
23. Koivusalo AM, Lindgren L. Respiratory mechanics during laparoscopic cholecystectomy. Anesth Analg. 1999;89(3):800.
24. Lowery WJ, Leath 3rd CA, Robinson RD. Robotic surgery applications in the management of gynecologic malignancies. J Surg Oncol. 2012;105(5):481–7.
25. Sprung J, Whalley DG, Falcone T, et al. The impact of morbid obesity, pneumoperitoneum,and posture on respiratory system mechanics and oxygenation during laparoscopy. Anesth Analg. 2002;94(5):1345–50.

26. Barnett JC, Hurd WW, Rogers Jr RM, et al. Laparoscopic positioning and nerve injuries. J Minim Invasive Gynecol. 2007;14(5):664–72.
27. Lestar M, Gunnarsson L, Lagerstrand L, et al. Hemodynamic perturbations during robot-assisted laparoscopic radical prostatectomy in 458 Trendelenburg position. Anesth Analg. 2011;113(5):1069–75. Epub 2011 Jan 13.
28. Joris JL, Noirot DP, Legrand MJ, et al. Hemodynamic changes during laparoscopic cholecystectomy. Anesth Analg. 1993;76(5):1067–71.
29. Bird VG, Winfield HN. Laparoscopy in urology: physiologic considerations. In: Fallon B, editor. Hospital physician urology board review. Wayne: Turner White Communications, Inc.; 2002.
30. Choosing the route of hysterectomy for benign disease. ACOG Committee Opinion 444. Obstet Gynecol. 2009;114:1156–8.
31. Cadiére GB, Himpens J, Germay O, et al. Feasibility of robotic laparoscopic surgery: 146 cases. World J Surg. 2001;25(11):1467–77.
32. Nezhat C, Saberi NS, Shahmohamady B, Nezhat F. Robotic assisted laparoscopy in gynecologic surgery. JSLS. 2006;10(3):317–20.
33. Liu H, Lawrie TA, Lu D, et al. Robot-assisted surgery in gynaecology. Cochrane Database Syst Rev. 2014;10:12.
34. Weinberg L, Rao S, Escobar PF. Robotic surgery in gynecology: an updated systematic review. Obstet Gynecol Int. 2011;2011:852061. Epub 2011 Nov 28.
35. Swan K, Advincula AP. Advances in urogynaecological robotic surgery. BJU Int. 2011;108(6 Pt 2):1024–7.
36. Advincula AP, Xu X, Goudeau S, Ransom SB. Robotic-assisted, laparoscopic, and abdominal myomectomy: a comparison of surgical outcomes. Obstetrics & Gynecology. 2011;117(2, part 1):265–56.
37. Giep BN, Giep HN, Hubert HB. Comparison of minimally invasive surgical approaches for hysterectomy at a community hospital: robotic-assisted laparoscopic hysterectomy, laparoscopic-assisted vaginal hysterectomy and laparoscopic supracervical hysterectomy. J Robot Surg. 2010;4(3):167–75.
38. Silasi DA, Gallo T, Silasi M, et al. Robotic versus abdominal hysterectomy for very large uteri. JSLS. 2013;17(3):400–6.
39. Payne TN, Dauterive FR, Pitter MC, et al. Robotically assisted hysterectomy in patients with large uteri: outcomes in five community practices. Obstet Gynecol. 2010;115(3):535–42.
40. Liu C, Peresic D, Samadi D, Nezhat F. Robotic-assisted laparoscopic partial bladder resection for the treatment of infiltrating endometriosis. J Minim Invasive Gynecol. 2008;15(6):745–8.
41. Chammas Jr MF, Kim FJ, Barbarino A, et al. Asymptomatic rectal and bladder endometriosis: a case for robotic-assisted surgery. Can J Urol. 2008;15(3):4097–100.
42. Barakat EE, Bedaiwy MA, Zimberg S, et al. Robotic-assisted, laparoscopic, and abdominal myomectomy: a comparison of surgical outcomes. Obstet Gynecol. 2011;117:256–65.
43. Magrina JF, Espada M, Munoz R, et al. Robotic adnexectomy compared with laparoscopy for adnexal mass. Obstet Gynecol. 2009;114(3):581–4.
44. Zakhari A, Czuzoj-Schulman N, Spence AR, et al. Laparoscopic and robot-assisted hysterectomy for uterine cancer: a comparison of costs and complications. Am J Obstet Gynecol. 2015;213(5):665.e1–7. Epub 2015 Jul 15.
45. Patzkowsky KE, As-Sanie S, Smorgick N, et al. Perioperative outcomes of robotic versus laparoscopic hysterectomy for benign disease. JSLS. 2013;17:100–6.
46. Bamgbade OA, Rutter TW, Nafiu OO, Dorje P. Postoperative complications in obese and nonobese patients. World J Surg. 2007;31(3):556–60.
47. National Institute for Health and Care Excellence. Obesity: identification, assessment and management of overweight and obesity in children, young people and adults. London: NICE; 2014. p. 64.
48. Adams JP, Murphy PG. Obesity in anaesthesia and intensive care. Br J Anaesth. 2000;85(1):91–108.
49. Mourits MJ, Bijen CB, Arts HJ, et al. Safety of laparoscopy versus laparotomy in early-stage endometrial cancer: a randomised trial. Lancet Oncol. 2010;11(8):763–71.
50. Janda M, Gebski V, Brand A, et al. Quality of life after total laparoscopic hysterectomy versus total abdominal hysterectomy for stage I endometrial cancer (LACE): a randomised trial. Lancet Oncol. 2010;11(8):772–80. Epub 2010 Jul 16.
51. Zullo F, Falbo A. Palomba. Safety of laparoscopy vs laparotomy in the surgical staging of endometrial cancer: a systematic review and metaanalysis of randomized controlled trials. Am J Obstet Gynecol. 2012;207(2):94–100. Epub 2012 Jan 13. Review.
52. Pitkin RM. Abdominal hysterectomy in obese women. Surg Gynecol Obstet. 1976;142(4):532–6.
53. O´Gorman T, MacDonald N, Mould T, et al. Total laparoscopic hysterectomy in morbidly obese women with endometrial cancer. Anaesthetic and surgical complications. Eur J Gynaecol Oncol. 2009;30:171–3.
54. Eltabbakh GH, Shamonki MI, Moody JM, Garafano LL. Hysterectomy for obese women with endometrial cancer: laparoscopy or laparotomy? Gynecol Oncol. 2000;78(3 Pt 1):329–35.
55. Uccella S, Bonzini M, Palomba S, et al. Impact of obesity on surgical treatment for endometrial cancer: a multicenter study comparing laparoscopy vs open surgery with propensity-matched analysis. J Minim Invasive Gynecol. 2016;23(1):53–61. E pub 2015 Aug 14.
56. Palomba S, Nelaj E, Zullo F. Visceral fat amount as predictive factor for early laparotomic conversion in obese patients with endometrial cancer. Gynecol Oncol. 2006 Jul;102(1):128–9.
57. Seamon LG, Cohn DE, Henretta MS, et al. Minimally invasive comprehensive surgical staging for endometrial cancer: robotics or laparoscopy? Gynecol Oncol. 2009;113(1):36–41.
58. Tang KY, Gardiner SK, Gould C, et al. Robotic surgical staging for obese patients with endometrial cancer. Am J Obstet Gynecol. 2012;206(6):513.e1–6. Epub 2012 Jan 12.
59. Backes FJ, Brudie LA, Farrell MR, et al. Short- and long-term morbidity and outcomes after robotic surgery for comprehensive endometrial cancer staging. Gynecol Oncol. 2012;125(3):546–51.
60. Wysham WZ, Kim KH, Roberts JM, et al. Obesity and perioperative pulmonary complications in robotic gynecologic surgery. Am J Obstet Gynecol. 2015;213(1):33.e1–7. Epub 2015 Jan 28.
61. Gallo T, Kashani S, Patel DA, et al. Robotic-assisted laparoscopic hysterectomy: outcomes in obese and morbidly obese patients. JSLS. 2012;16(3):421–7.
62. Geppert B, Lönnerfors C, Persson J. Robot assisted laparoscopic hysterectomy in obese and morbidly obese women: surgical technique and comparison with open surgery. Acta Obstet et Gynecol Scand. 2011;90:1211–7.
63. Corrado G, Chiantera V, Fanfani F, et al. Robotic hysterectomy in severely obese patients with endometrial cancer: a multicenter study. J Minim Invasive Gynecol. 2015;23(1):94–100. pii: S1553-4650(15)01510-1. doi: 10.1016/j.jmig.2015.08.887. [Epub ahead of print].
64. Sundi D, Reese AC, Mettee LZ, et al. Laparoscopic and robotic radical prostatectomy outcomes in obese and extremely obese men. Urology. 2013;82(3):600–5.
65. Ten Broek RP, Strik C, Issa Y, et al. Adhesiolysis-related morbidity in abdominal surgery. Ann Surg. 2013;258:98–106.
66. Van Der Krabben AA, Dijkstra FR, Nieuwenhuijzen M, et al. Morbidity and mortality of inadvertent enterotomy during adhesiotomy. Br J Surg. 2000;87:467–71.
67. LeBlanc KA, Melvin JE, Corder JM. Enterotomy and mortality rates of laparoscopic incisional and ventral hernia repair: a review of the literature. JSLS. 2007;11:408–14.
68. Van Goor H. Consequences and complications of peritoneal adhesions. Colorectal Dis. 2007;9(suppl 2):25–34.

69. Taylor GW, Jayne DG, Brown SR, et al. Adhesions and incisional hernias following laparoscopic versus open surgery for colorectal cancer in the CLASICC trial. Br J Surg. 2010;97:70–8.
70. Nieuwenhuijzen M, Reijnen MMPJ, Kuijpers JHC, van Goor H. Small bowel obstruction after total or subtotal colectomy: a 10-year retrospective review. Br J Surg. 1998;85:1242–5.
71. Ellis H, Moran BJ, Thompson JN, et al. Adhesion-related hospital readmissions after abdominal and pelvic surgery: a retrospective cohort study. Lancet. 1999;353:1476–80.
72. Ording Olsen K, Juul S, Berndtsson I, et al. Ulcerative colitis: female fecundity before diagnosis, during disease, and after surgery compared with a population sample. Gastroenterology. 2002; 122:15–9.
73. Parikh JA, Ko CY, Maggard MA, Zingmond DS. What is the rate of small bowel obstruction after colectomy? Am Surg. 2008;74: 1001–5.
74. Ng SS, Leung KL, Lee JF, et al. Long-term morbidity and oncologic outcomes of laparoscopic-assisted anterior resection for upper rectal cancer: ten-year results of a prospective, randomized trial. Dis Colon Rectum. 2009;52:558–66.
75. Leung TT, Dixon E, Gill M, et al. Bowel obstruction following appendectomy: what is the true incidence? Ann Surg. 2009;250:51–3.
76. Ahmad G, Duffy JM, Farquhar C, et al. Barrieragents for adhesion prevention after gynaecological surgery. Cochrane Database Syst Rev. 2008;2:CD000475.
77. Ten Broeck RPG, Issa Y, van Santbrink EJP, et al. Burden of adhesions in abdominal and pelvic surgery: systematic review and meta-analysis. BMJ. 2013;347:f5588.
78. Dubuisson J, Botchorishvili R, Perrette S, et al. Incidence of intraabdominal adhesions in a continuous series of 1000 laparoscopic procedures. Am J Obstet Gynecol. 2010;203:111e1e3.
79. Tinelli A, Malvasi A, Guido M, et al. Adhesion formation after intracapsular myomectomy with or without adhesion barrier. Fertil Steril. 2011;95:1780e5.
80. Trew G, Pistofidis G, Pados G, et al. Gynaecological endoscopic evaluation of 4 % icodextrin solution: a European, multicentre, double-blind, randomized study of the efficacy and safety in the reduction of de novo adhesions after laparoscopic gynaecological surgery. Hum Reprod Update. 2011;26:2015e27.
81. Brill AI, Nezaht F, Nezhat CH, et al. The incidence of adhesions after prior laparotomy: a laparoscopic appraisal. Obstet Gynecol. 1995;85:269e72.
82. Menzies D, Ellis H. Intestinal obstruction from adhesions-how big is the problem? Ann R Coll Surg Engl. 1990;72:60e3.
83. Herrmann A, De Wilde RL. Adhesions are the major cause of complications in operative gynecology. Best Pract Res Clin Obst Gynaecolo. 2015;35:71–83. pii: S1521-6934(15)00193-5. doi: 10.1016/j.bpobgyn.2015.10.010. Epub ahead of print.
84. Ten Broek RP, Kok-Krant N, Bakkum EA, et al. Different surgical techniques to reduce post-operative adhesion formation: a systematic review and meta-analysis. Hum Reprod Update. 2013;19:12–25.
85. Audebert AJ, Gomel V. Role of microlaparoscopy in the diagnosis of peritoneal and visceral adhesions and in the prevention of bowel injury associated with blind trocar insertion. Fertil Steril. 2000;73(3):631–5.
86. Sepilian V, Ku L, Wong H, et al. Prevalence of infraumbilical adhesions in women with previous laparoscopy. JSLS. 2007;11:41–4.
87. Lönnerfors C, Persson J. Implementation and applications of robotic surgery within gynecologic oncology and gynecology; analysis of the first thousand cases. Ceska Gynekol. 2013;78(1):12–9.
88. Lönnerfors C, Reynisson P, Geppert B, Persson J. The effect of increased experience on complications in robotic hysterectomy for malignant and benign gynecological disease. J Robot Surg. 2015;9(4):321–30.
89. Paley PJ, Veljovich DS, Shah CA, et al. Surgical outcomes in gynecologic oncology in the era of robotics: analysis of first 1000 cases. Am J Obstet Gynecol. 2011;204:551.e1–9.
90. Reynisson P, Persson J. Hospital costs for robot-assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy. Gynecol Oncol. 2013;130:95–9.
91. Jones N, Fleming ND, Nick AM, et al. Conversion from robotic surgery to laparotomy: a case-control study evaluating risk factors for conversion. Gynecol Oncol. 2014;134(2):238–42.
92. Kaul S, Shah NL, Menon M. Learning curve using robotic surgery. Curr Urol Rep. 2006;7(2):125–9.

General Aspects and Their Handling: General Surgery Conditions and Techniques for Robotic Hysterectomy

61

Jan-Hendrik Egberts

During the last 30 years, minimal invasive surgery has revolutionized many general and especially oncological surgical techniques. After a controversial debate about the safety and efficacy of this new surgical approach, it is now widely accepted. For colorectal cancer, several prospective and multicenter studies have demonstrated the potential advantages of minimal invasive techniques [1, 2]. However, even today the rate of minimal invasive resections for colorectal cancer is still limited due to technical limitations, the long learning curve and other reasons.

The application of robotic assistance in minimal invasive surgery has been a logical development over the last years. Today, robotic assisted surgery is gaining acceptance in all surgical fields, such as thoracic surgery, upper GI surgery, HPB surgery and transplantation surgery, with encouraging results [3].

Especially in anatomical regions like the pelvic or the thorax with limited access, the advantages are obvious. The first use in colorectal surgery was for a segmental colonic resection for a benign disease in 2002 [4] and for a low anterior rectal resection in 2006 [5]. In 2012 a prospective multicenter study was initiated, investigating the safety and efficacy of robotic-assisted vs. laparoscopic low anterior rectum resection (ROLARR-study) [6]. The recruitment was recently completed.

Besides the technical improvements in surgery, another milestone in rectal cancer surgery was the description of the "holy plane" by Heald [7]. Based on the embryology of the rectum with the development of the complex anatomy of the pelvic floor, the distribution of lymphatic nodes and vessels and nerval structures becomes more systematic. The surgeon should follow the embryological fasciae (i.e. perirectal fascia and the pelvic fascia which is called the "holy plane") in order to achieve the best optimal oncological specimen by preserving the autonomic pelvic nerves that comprise the superior hypogastric plexus, the right and left hypogastric nerves and the right and left inferior hypogastric plexuses. The precise preparation in this plane, developing the whole rectum with perirectal tissue, is called "total mesorectal excision (TME)" [8].

Knowledge of embryology might be of special interest for the oncological resection of other compartments in the pelvic region, such as urological and gynecological cancers. Especially in tumors infiltrating the rectum, for example ovarian cancers or in cases of deep endometriosis, the gynecological surgeon might be in a position to dissect this tissue.

In the following section, the set-up and technique for a low anterior resection, as an example of a pelvic surgical procedure, is described.

Setup

Patient Positioning

Due to the current limitation in the movement of the patient table, the patient positioning gains even more importance before the docking maneuver since the procedure sometimes requires an extreme positioning of the patient. Also, several surgical procedures require a dual docking, in which the robot arms are disconnected and re-docked after the repositioning of the patient. Future developments will synchronize the robot arms with the table in order to move the patient during the robot procedure similar to the conventional laparoscopic technique.

For procedures in the pelvic region, such as low anterior resections, the patient is placed supine in a modified lithotomy position. The legs are abducted with flexed knees and the arms alongside the body. It is important to standardize the set-up for different procedures in order to maximize the safety and efficacy.

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OR Set-Up

A 12 mmHg pneumoperitoneum is achieved by a mini-laparotomy and the ports are introduced as follows:

- Two 12 mm conventional laparoscopic trocars (camera and assistant trocar)
- Three 8 mm robotic trocars

Once the camera trocar is inserted, an assessment of the entire abdomen is performed and the trocars are placed at their optimal sites.

Elements of the Procedure

The major elements of a low anterior resection (LAR) for rectal cancer are:

- central ligation of the inferior mesenteric artery (IMA) and inferior mesenteric vein (IMV)
- mobilization of the left colon/ splenic flexure
- rectal resection with total mesenteric excision (TME)
- specimen removal and anastomosis

The operation for LAR starts with a visual inspection of the abdomen (especially the liver for metastases) and a central ligation of the IMA and IMV. A so-called "medial to lateral approach" begins with the incision of the peritoneum after lifting the sigmoid colon and upper rectum. The incision starts at the level of sacral promontory. The superior rectal artery will be seen and followed to its origin of the IMA after identification of the left colonic artery and sigmoidal artery. These structures should be free of other tissue in order to avoid an injury of the ureter. The ligation of the artery can be taken by the surgeon's preferred method as shown in Fig. 61.1.

The dissection in this plane will be continued in the layer of the anteriorly localized IMV and colonic mesentery and the posteriorly localized retroperitoneum (Fig. 61.2). In this layer the retroperitoneal structures, such as the pancreas, ureter and vessels, can be detected and saved by blunt dissection. The surgeon dissects the tissue laterally to the left colonic flexure and cranially the pancreas tail (Fig. 61.3). During this dissection the IMV is ligated near the ligament of Treitz. The final mobilization of the left colon and splenic flexure is then performed from a lateral approach.

The removal of the rectum and mesorectum (total mesorectal excision –TME) is carried out according to Heald's principles [7]. By staying in the avascular plane between the endopelvic visceral fascia and the endopelvic parietal fascia, an avascular space is developed. In this plane the hypogastric nerve plexus becomes visible and can be preserved. Also, the sacral venous plexus, located deep in the parietal layer, will be untouched. During this preparation it is essential to use the robot arms to provide upward traction and counter traction by cautious and frequent repositioning in order to avoid damage to the TME specimen. The dissection in this plane is completed posteriorly to the level of the pelvic floor. The lateral stalks are then dis-

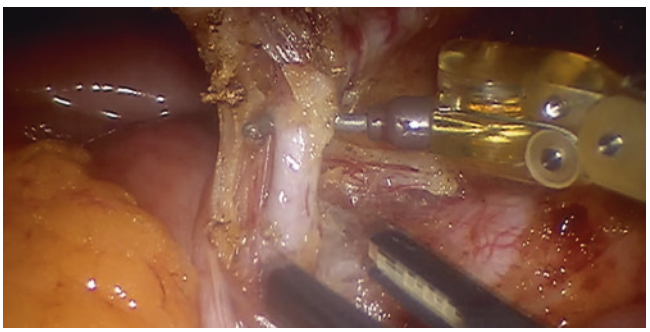


Fig. 61.1 Inferior mesenteric artery prior to central ligation

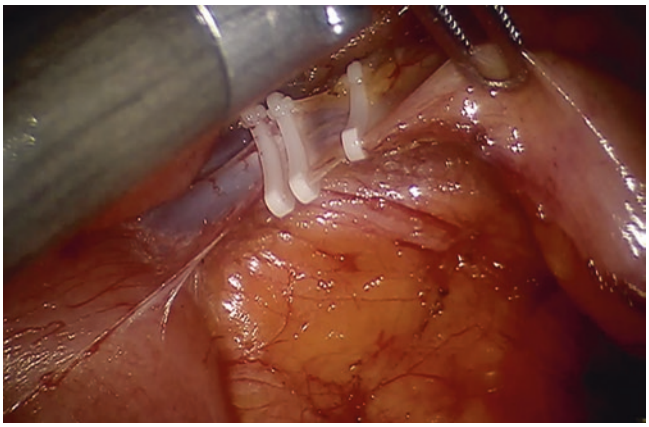


Fig. 61.2 Inferior mesenteric vein after central ligation close to the duodenum (left lower corner)

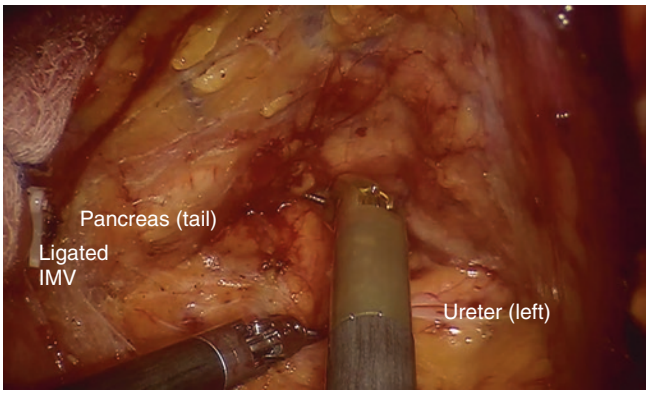


Fig. 61.3 Medial to lateral view after left flexure mobilization

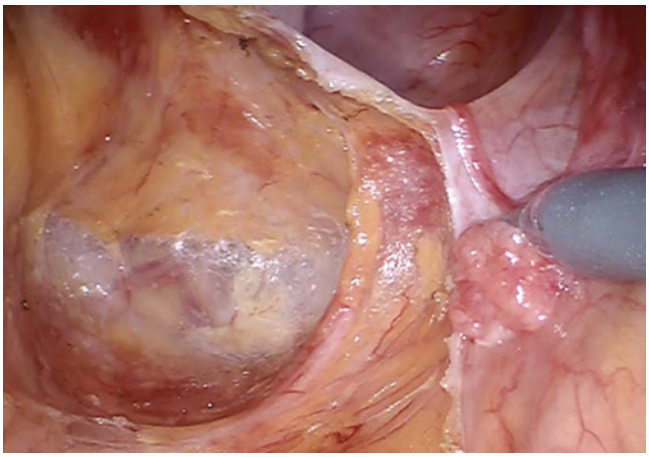


Fig. 61.4 View in the pelvic after dorsal mobilization of the rectum

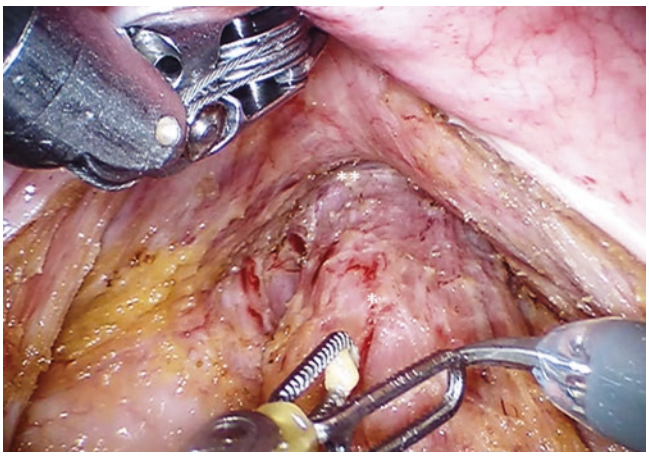


Fig. 61.6 View in the pelvic after complete ventral mobilization of the rectum

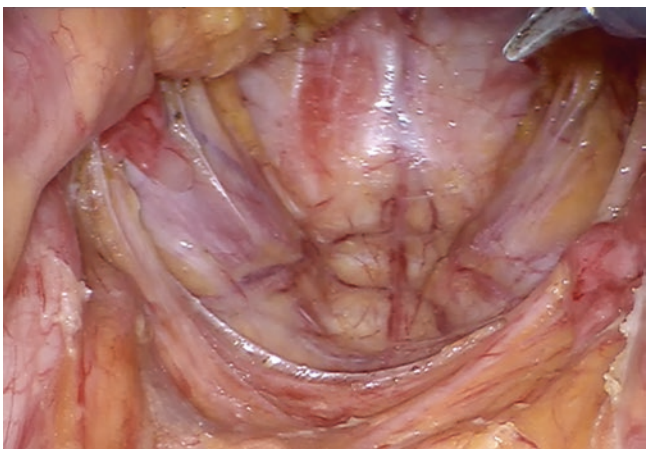


Fig. 61.5 View in the pelvic after complete dorsal mobilization of the rectum

sected. Here the vagina or the seminal vesicals and prostate are dissected free and protected (Figs. 61.4, 61.5 and 61.6). The autonomic nerves are localized laterally on the pelvic wall and should be protected during these dissecting steps.

The dissection is continued until the pelvic floor is reached (bare rectum area) and finally divided with a stapler device. The removal of the specimen is now possible and performed by an incision.

The anastomosis and reconstruction is usually performed by a circular stapler device with a side-to-end anastomosis. If adequate colonic length is present, a colonic J pouch is performed.

Up until now, the anastomosis and reconstruction is performed in a standard laparoscopic approach since no robotic instruments are available so far.

Conclusions

The robotic approach for surgery for rectal cancers appears promising. It creates new opportunities and allows a perfect view and mobility in the limited area of the pelvic region.

In general and thoracic surgery, the number of robotic-assisted procedures is increasing. There is a wide range of indications for procedures that can be performed with robotic assistance, extending the limitations of the minimal invasive approach.

References

1. Dalibon N, Moutafis M, Fischler M. Laparoscopically assisted versus open colectomy for colon cancer. N Engl J Med. 2004; 351(9):933–4. author reply -4
2. Jayne DG, Thorpe HC, Copeland J, Quirke P, Brown JM, Guillou PJ. Five-year follow-up of the Medical Research Council CLASICC trial of laparoscopically assisted versus open surgery for colorectal cancer. Br J Surg. 2010;97(11):1638–45.
3. Spinoglio G, editor. Robotic surgery: current applications and new trends (updates in surgery). Milan: Springer; 2014. p. 238.
4. Weber PA, Merola S, Wasielewski A, Ballantyne GH. Telerobotic-assisted laparoscopic right and sigmoid colectomies for benign disease. Dis Colon Rectum. 2002;45(12):1689–94. discussion 95–6.
5. Diana M, Marescaux J. Robotic surgery. Br J Surg. 2015;102(2):e15–28.
6. Collinson FJ, Jayne DG, Pigazzi A, Tsang C, Barrie JM, Edlin R, Garbett C, Guillou P, Holloway I, Howard H, Marshall H, McCabe C, Pavitt S, Quirke P, Rivers CS, Brown JM. An international, multicentre, prospective, randomised, controlled, unblinded, parallel-group trial of robotic-assisted versus standard laparoscopic surgery for the curative treatment of rectal cancer. Int J Colorectal Dis. 2012;27(2):233–41.
7. Heald RJ. The 'Holy Plane' of rectal surgery. J R Soc Med. 1988;81(9):503–8.
8. Weaver KL, Grimm Jr LM, Fleshman JW. Changing the way we manage rectal cancer-standardizing TME from open to robotic (including laparoscopic). Clin Colon Rectal Surg. 2015;28(1):28–37.

Robotic Assisted Supracervical Hysterectomy

62

Noam Smorgick

Introduction

Supracervical (subtotal) hysterectomy refers to the removal of the uterine corpus with preservation of the uterine cervix. This subtype of hysterectomy is technically simpler compared with total hysterectomy because it does not require an extensive dissection of the cardinal ligaments and the vesico-uterine fold, nor suturing of the vaginal cuff. Thus, with the advent of laparoscopic and robotic hysterectomy, the rates of supracervical hysterectomy from all hysterectomies increased considerably. More recently, robotic assisted supracervical hysterectomy combined with sacral colpopexy has been found to be an excellent treatment for apical (level I) prolapse, further increasing the use of this procedure. Nevertheless, because supracervical hysterectomy requires some type of morcellation for specimen extraction, recent concerns regarding dissemination of leiomyosarcoma during power morcellation may limit the use of this procedure. Similar to total hysterectomy, the debate regarding the benefits and challenges of the robotic platform for supracervical hysterectomy continues. This debates centers on the relative advantage of converting an open hysterectomy to a minimally invasive hysterectomy by using the robotic platform when taking into account its higher cost.

Indications for Robotic Supracervical Hysterectomy

The main indications for this procedure are:

1. Hysterectomy for benign indication in women without cervical pathology. Robotic supracervical hysterectomy is an acceptable alternative to total hysterectomy in women requiring removal of the uterus for benign indications such as uterine fibroids, abnormal uterine bleeding and pelvic pain. As for total hysterectomy, the robotic platform may enable performing a minimally invasive hysterectomy in women with high surgical complexity (such as large fibroids or extensive pelvic adhesive disease from prior abdominal surgeries or pelvic inflammatory disease) who may not have been candidates for laparoscopic hysterectomy. Of note, supracervical hysterectomy is contraindicated in cases of cervical dysplasia for obvious reasons. Supracervical hysterectomy is less recommended for women with advanced endometriosis and pelvic pain because of higher rates of persistent postoperative pelvic pain [1].
2. Removal of the uterine corpus combined with sacral colpopexy in cases of pelvic organ prolapse. Sacral colpopexy for repair of level I pelvic floor defect (i.e., apical prolapse) is considered an excellent treatment for this pathology, and has been found to be superior to vaginal repair in a recent Cochrane review [2]. This procedure is often combined with total or supracervical hysterectomy. Sacral-colpopexy requires extensive suturing for placement of the mesh on the cervix and the anterior and posterior vaginal walls, which may be simplified with the use of the robotic platform. Moreover, supracervical rather than total hysterectomy has the advantage of lower risk of mesh erosion [3].
3. Patient desire and request. Some women may elect to preserve the cervix when it is unrelated to the uterine pathology (i.e., in case of uterine corpus leiomyoma) because of personal preference. The surgeon should provide appropriate counseling regarding advantages and disadvantages of supracervical hysterectomy (see below) in order to allow for patient's informed decision and consent.

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Advantages of Robotic Assisted Supracervical Hysterectomy

To date, no studies have directly compared robotic assisted total and supracervical hysterectomy. However, related trials have been performed comparing abdominal total and supracervical hysterectomy. Most of these studies have not found a significant difference between the two surgeries in long term outcomes. A highly quoted 2002 randomized controlled trial by Thakar et al. found similar outcomes regarding bladder, bowel, and sexual function at 12 months [4]. In addition, the rate of pelvic organ prolapse was similar between the two groups. Nevertheless, short term outcomes such as postoperative hospital length of stay and rates of postoperative fever and wound hematoma were lower in the supracervical hysterectomy group [4]. On longer follow up of 14 years using a mailed questionnaire, no differences were found in rates of urinary incontinence, pelvic organ prolapse, pelvic pain, sexual function and quality of life [5].

Despite similar long term outcomes when compared to total hysterectomy, supracervical hysterectomy remains popular because it is considered technically "simpler" compared with total hysterectomy. Supracervical hysterectomy requires less dissection of the cardinal ligaments and the vesicouterine fold (i.e., bladder flap), and more importantly does not require suturing for closure of the vaginal cuff. This advantage is very important for the laparoscopic approach, since laparoscopic suturing is a relatively advanced surgical skill. Furthermore, the main surgical complication associated with vaginal cuff closure, vaginal cuff dehiscence, which is more common in laparoscopic and robotic assisted hysterectomy compared with abdominal and vaginal hysterectomy, is practically non-existent in supracervical robotic and laparoscopic hysterectomy [6]. Accordingly, supracervical hysterectomy constitutes up to 80 % of laparoscopic hysterectomies in Germany [7], as well as a large share of robotic assisted hysterectomies.

Disadvantages of Subtotal Hysterectomy

The risk of cervical cancer in the remaining cervix has been considered a disadvantage of subtotal hysterectomy. However, recent high quality studies have concluded this risk to be less than 0.1 % when appropriate pre-operative patient selection is performed [8]. Cyclic vaginal bleeding caused by remnants of endometrial tissue in the cervical stump occurs in up to 15 % of women [9].

Tissue extraction remains the main disadvantage of subtotal hysterectomy. In the absence of vaginal vault opening, the only means of extraction of the uterine corpus are power morcellation (using commercially available morcellators) or "cold knife" hand morcellation through incisions in the abdominal wall or the pouch of Douglas. As discussed below, recent concerns regarding the dissemination of malignant fibroids by use of power morcellation are currently a major limitation of this technique.

Morcellation

Until recently, the usual method for specimen extraction in supracervical hysterectomy was the use of laparoscopic power morcellators through a 12–15 mm port. The unquestionable disadvantage of this method is intraperitoneal spread of uterine and fibroid fragments. It was assumed that those fragments may cause dissemination of malignant fibroids (leiomyosarcoma) or stromal sarcoma, but these events were considered extremely rare, in the range of 1/1000 [10]. However, following claims that dissemination of leiomyosarcoma may be more common than previously thought, the US Food and Drug Administration (FDA) issued a statement in 2014 warning against the use of power morcellators in the majority of women undergoing hysterectomy [11].

Setting aside the FDA warning and its impact on medical practice, the actual rate of inadvertent leiomyosarcoma morcellation in a patient undergoing supracervical hysterectomy for fibroids presumed benign is debatable. The FDA concluded that the risk of unsuspected uterine sarcomas and leiomyosarcomas in patients undergoing hysterectomy for presumed benign fibroids is 1 in 352 and 1 in 458, respectively. However, this report was based on retrospective studies originating from referral centers with high risk patients with possible selection bias [11]. Furthermore, due to the lack of high quality studies, the impact of unsuspected sarcoma dissemination by power morcellation on the patient's ultimate survival is also unknown. More recent studies have attempted to investigate the risk of a sarcoma being inadvertently morcellated. A large Norwegian study which included 4791 women undergoing various gynecologic procedures concluded that the incidence of leiomyosarcoma among women suspected of having benign fibroids was 0.5 % (1 in 183 women), while the risk of unintended morcellation of a leiomyosarcoma was much lower, 0.02 % (1 in 4791 women) [12].

In view of the medical and medico-legal issues that are currently associated with the use of power morcellators [13], other methods for specimen removal which may be used for supracervical hysterectomy have been suggested. These include cold knife hand morcellation through the abdominal wall (after the specimen is placed in a retrieval bag) and contained power morcellation, i.e. power morcellation of the specimen within a closed bag. The former technique is straightforward to perform, but may require an extension of the port incision (especially when the specimen removed is large) and longer operative time. The latter technique is more cumbersome, and has mostly been described in vitro [14]. However, future development of contained power morcellating devices may once again make this technique both safe and easy to use.

Prophylactic Removal of the Adnexa or Fallopian Tubes

Removal of the adnexa or the fallopian tubes may be performed in conjunction with supracervical hysterectomy for benign conditions. Removal of the fallopian tubes with ovarian preservation carries minimal surgical risks and presumably low risk of premature ovarian failure, but may provide some protection from ovarian carcinoma in the future [15]. Furthermore, prophylactic bilateral salpingectomy prevents the benign post-hysterectomy complication of hydrosalpings (which may appear on ultrasound as ovarian cysts and may lead to unnecessary future surgery) [16]. Thus, we favor prophylactic salpingectomy in all patients undergoing hysterectomy.

The decision to perform prophylactic oophorectomy is more complex and depends on the patient's age, menopausal status, and their personal or familial history of breast and ovarian cancer. Prophylactic oophorectomy in pre-menopausal women would cause early surgical menopause, associated with increased risks for coronary artery disease, osteoporosis, and possibly dementia [17–19]. These risks may be partially overset by replacement estrogen therapy. On the other hand, the overall risk of ovarian cancer in those women without family history of breast/ovarian cancer whose ovaries were preserved during benign hysterectomy is low, ranging from 0.03 to 1.96 % [17]. Thus, the risks and benefits of this procedure should be considered and appropriate patient's consultation should be provided. The current recommendations of the American College of Obstetrics and Gynecology [20] and the Society of Gynecologic Oncologists [21] are to favor ovarian preservation in pre-menopausal women with average risk for ovarian cancer. The recommendations for ovarian preservation versus removal in menopausal women with average risk for ovarian cancer are inconclusive due to lack of sufficient studies. In women with higher risk for ovarian cancer due to family history or BRCA1/BRCA2 mutation, the risk-reducing bilateral oophorectomy is recommended in pre-menopausal women when childbearing is complete, factoring in the age at onset of cancer in affected family members.

The Step-by-Step Use of the Robotic Platform for Subtotal Hysterectomy

Patient's Positioning and Preparation

As for laparoscopic and robotic total hysterectomy, patient's positioning and operating room organization is of the utmost importance for the successful completion of this surgery. Following general anesthesia and endotracheal intubation, the patient is placed in a dorsal lithotomy position, with the buttocks slightly protruding outside the operating table. The arms are padded and tucked to the patient's sides. The legs are placed in stirrups, preferably padded "boot" stirrups which allow placing most of the patients' weight on their heels as well as easy upward and downward movement of the legs during surgery, if required (Fig. 62.1). Use of pneumatic compression device is recommended. Robotic hysterectomy, especially when combined with sacral-colpopexy, requires positioning in steep Trendelenburg position, often for several hours. As a result, patients' positioning on the operating table must be secure in order to avoid cephalad slippage during the surgery. This may be accomplished by using shoulder braces, vacuum positioning systems, or specially designed mattresses such as the "egg-crate" mattress. A grounding electrode is placed on the patient's thigh.

Following patient's positioning, the vagina and the abdomen are prepped and draped. A Foley catheter is routinely placed. A uterine manipulator, although not always deemed necessary for removal of a small uterus, is often very helpful for performing subtotal hysterectomy. Uterine manipulators containing a cervical ring, which helps delineate the vaginal margins when performing the colpotomy incision during total hysterectomy, are also useful for subtotal hysterectomy by elevating the uterine vessels further away from the ureters and possibly decreasing the risk of thermal injury during the coagulation of these vessels. These manipulators are manufactured in reusable and non-reusable forms. The choice of specific uterine manipulator is usually guided by surgeon's preference. Our own preference is to use easy to handle manipulators containing colpotomy rings such as the VCare (Conmed, Utica, New York, USA) or the RUMI (Cooper Surgical, Trumbull, Connecticut, USA) (Fig. 62.2).



Fig. 62.1 "Boot" stirrups allowing for comfortable positioning of patients in a lithotomy position during long surgeries, as well as easy movement of the legs from low to high lithotomy position



Fig. 62.2 Operative vaginal table prepared for robotic supracervical hysterectomy and sacral colpopexy. A plastic uterine manipulator containing a cervical ring (in this figure, the VCare) and an end-to-end anastomosis sizer are shown

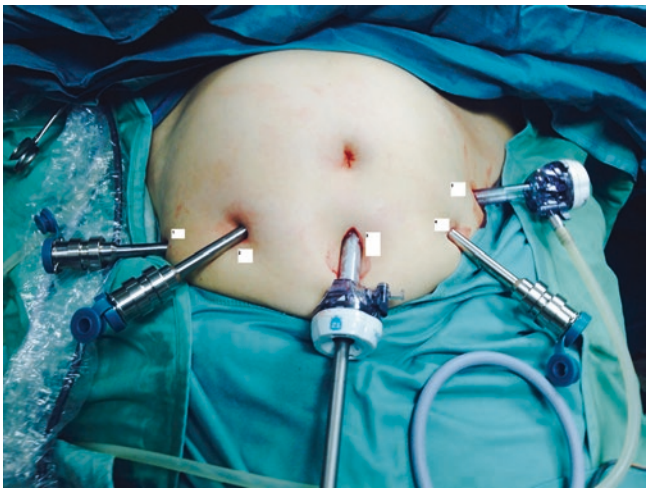


Fig. 62.3 Port configuration for robotic supracervical hysterectomy and sacral colpopexy. The camera port is located about 3 cm above the umbilicus. One robotic port is placed on the right side and two other robotic ports are placed on the left side. The bed-side assistant port is placed on the right side

Setup of the Robotic Platform

The basic setup includes the surgeon operating from the robotic console and controlling the robotic camera and 2 or 3 robotic arms, a bedside assistant using a laparoscopic port and standing on the right or left side of the patient (according to the port configuration – see below), and a second assistant sitting between the patient's legs and handling the uterine manipulator. The scrubbed surgical technician is often positioned in front of the first surgical assistant, on the other side of the patient. This positioning allows for easy reach to each of the robotic arms, required for instrument replacement and troubleshooting. A "vaginal" table is placed within arm's reach of the second surgical assistant. On this table are placed surgical instruments required for the insertion of the uterine manipulator (i.e., speculum, uterine sound and cervical dilators) and other vaginal instruments which may be required for sacral-colpopexy (i.e., sizers and spatula retractors). It is extremely important to place monitors in the room to allow for comfortable viewing of the surgery by the two surgical assistants and the surgical technicians. The robot may be docked in a direct line over the lower part of the patient's body, or on the left side or right side of the patient (i.e., side docking). The side docking technique allows for more comfortable seating for the second surgical assistant, which often translates into easier manipulation of the uterine manipulator.

Initiation of Pneumoperitoneum

According to surgeon's preference, pneumoperitoneum may be initiated with the closed technique (using a Veress needle), the open technique (i.e., the Hasson method) or the direct entry technique. The latter was recently modified with the introduction of optical trocars, which allow "under vision" direct entry.

Port Configuration for Robotic Subtotal Hysterectomy

Similar to other types of robotic hysterectomy, the usual port configuration for robotic subtotal hysterectomy will include -

1. *The robotic camera port (either 8 or 12 mm)*: this port should be placed at least a handbreadth (i.e., 10 cm) above the uterine fundus. For normal size uteri to mildly enlarged uteri (up to ~12 gestational weeks size), the typical placement is the umbilicus. For enlarged uteri, this port is moved cephalad. In cases of combined subtotal hysterectomy and sacral-colpopexy, although most often a normal sized uterus is removed, it is helpful to place the camera port a few centimeters above the umbilicus to allow for optimal visualization of the sacral promontory area (Fig. 62.3).
2. *Two lateral ports for robotic instruments*: the typical placement is a right sided 8 mm port for the monopolar shears and a left sided 8 mm port for the bipolar forceps (or similar electrosurgical instruments such as the Plasma Kinetic forceps). These two ports may be used later on to introduce needle drivers, in case a suture is placed on the cervical stump or on the vaginal walls for sacral-colpopexy.
3. *A third robotic arm*: this arm may be placed when an additional grasping instrument is required, most often in

cases of large uteri, peritoneal adhesive disease, or when a concomitant sacral-colpopexy is performed. The robotic instruments often used for these purposes are the pro-grasp or the tenaculum. The third robotic arm is usually placed between the camera port and the lateral robotic port, either on the right side or on the left side. When a concomitant sacral-colpopexy is performed, it is convenient to place the third robotic arm of the left side to allow for retraction of the sigmoid colon and easier exposure of the sacral promontory area. When the procedure includes only the subtotal hysterectomy without sacral-colpopexy, it is more convenient to place the third robotic arm on the right side of the patient in order to allow the surgeon a control of robotic grasping instruments on both side of the pelvis.

4. *Laparoscopic port for bedside surgical assistant*: this port is usually placed on the opposite side of the third robotic arm. In cases only two robotic arms are used, this port is usually placed on the left side of the patient. This port is used for introduction of laparoscopic graspers, suction irrigator and sutures as required. The size of the port can range from 5 mm (in case only graspers and suction/irrigation are used) to 12 mm (in case multiple sutures are used, i.e. in a sacral-colpopexy procedure).

Surgical Steps for Robotic Assisted Supracervical Hysterectomy

The surgical steps are similar to laparoscopic and open supracervical hysterectomy. The pelvis and the abdomen are surveyed, and any adhesions which may hinder the hysterectomy steps are taken down with sharp or blunt dissection. The course of the ureters from the pelvic brim downward is identified. When a concomitant sacro-colpopexy is planned, the sacral promontorium is identified. In cases of a large fibroid uterus, the uterus is moved with the manipulator and the robotic/laparoscopic instruments in order to evaluate the access of the vascular pedicles and the visibility of the colpotomy ring.

1. *Separation of the adnexa from the uterus*: The hysterectomy itself may begin with coagulation and division of the utero-ovarian ligaments and the fallopian tubes, even in those cases when removal of the adnexa is planned (Fig. 62.4). This step allows a good visualization of the posterior leaf of the broad ligament and the posterior side of the uterus. The adnexa may be removed later on separately when indicated.
2. *Division of the round ligament and anterior leaf of the broad ligament*: The round ligaments are coagulated and divided, and the incision is carried anteriorly to the vesico-uterine pouch (Fig. 62.5). The upper margin of the colpotomy ring may serve as a guide to the location of this incision, with the manipulator pushed cephalad.
3. *Dissection of the vesico-uterine pouch (i.e., the bladder flap)*: The vesico-uterine pouch is developed by using blunt and sharp dissection of the areolar tissue separating the urinary bladder from the cervix and the upper part of the vagina (Fig. 62.6). In most cases, this is easily accomplished with a downward pressure using the blunt side of the monopolar shears while the bladder is held with a grasping instrument to provide counter-traction, combined with the cephalad traction by the manipulator. In women with prior cesarean section or endometriosis, this step of the surgery is often more complicated because of dense adhesions. In those cases, the surgical plane may be identified laterally rather than medially. In addition, retrograde filling of the bladder with 200–300 cc may help identify its margins. Of note, the

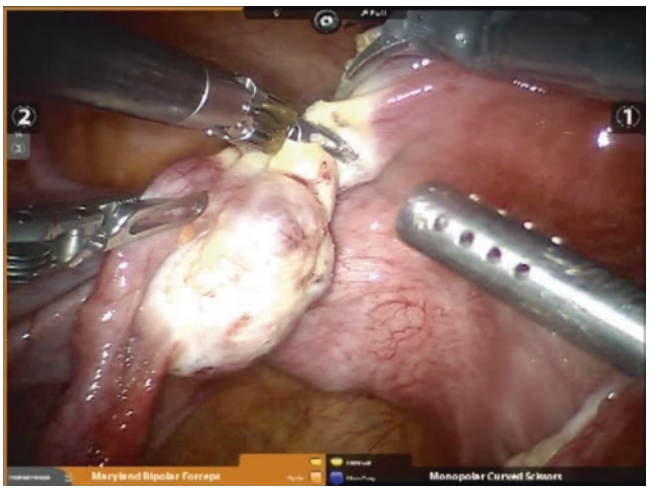


Fig. 62.4 Coagulation of the utero-ovarian ligaments



Fig. 62.5 Division of the round ligament



Fig. 62.6 Development of the bladder flap. The bladder flap is developed by holding the bladder upwards with a grasping instrument and applying sharp and blunt traction with the blunt end of the monopolar shears on the vesico-uterine fold



Fig. 62.7 Coagulation of the uterine arteries. After skeletonization of the uterine arteries, the vessel is grasped and coagulated with a bipolar instrument (in this figure, with robotic bipolar forceps)



Fig. 62.8 Amputation of the uterine corpus. Once the uterine vessels are secured, the corpus is amputated at its isthmus with monopolar shears. The movement of the uterine manipulator as well as the use of grasping robotic and laparoscopic instruments for upwards traction of the uterus is helpful in maintaining the uterus in a safe distance from the bowel and the bladder, minimizing the risk of thermal injury through the extensive use of electro-surgery during this step of the surgery

dissection of the vesico-uterine pouch required for supracervical hysterectomy (unless combined with sacral colpopexy) is less extensive than for total hysterectomy. In the former, this dissection should allow for safe margins when coagulating the uterine vessels and resecting the uterine corpus.

4. *Division of the posterior leaf of the broad ligament*: The incision of the round ligament is then carried posteriorly to the level of the colpotomy ring, just above the insertion of the sacro-uterine ligaments to the uterus. During this step, the serosa is separated from the underlying uterine vessels. This step may be performed using the bipolar Maryland forceps or PK forceps as a dissecting instrument.
5. *Skeletonization of the uterine vessels*: The areolar tissue surrounding the uterine vessels is taken down with sharp and blunt dissection in order to create a distinct vascular pedicle. This will allow to coagulate those vessels with less electro-surgery, resulting with decreased thermal spread (Fig. 62.7).
6. *Division of the uterine vessels*: During this step, the cephalad traction of manipulator increases the distance from the ureters. The uterine vessels are coagulated with bipolar or PK forceps, while ensuring that the coagulating instrument is placed at a 90° angle to the vessel. Before the vessels are divided, it is important to ensure that the distal portion of the pedicle is well coagulated. In addition, the proximal portion of the pedicle is also coagulated in order to decrease the "backflow" bleeding from the uterus.
7. *Division of the cardinal ligaments*: This step is minimal for supracervical hysterectomy. The cardinal ligaments are coagulated by placing the bipolar instrument at a 90 degree angle to the colpotomy ring. It is important to avoid excessive electro-surgery during this step due to the risk of thermal spread and thermal injury to the ureters. As before, cephalad traction on the manipulator will decrease this risk.
8. *Amputation of the uterine corpus*: The uterus is separated from the cervix by cutting it at its isthmus, above the insertion of the utero-ovarian ligaments to the uterus, using the monopolar shears (Fig. 62.8). The usual direction of the incision is from one side to the other. Due to extensive use of electro-surgery during this step, the

adjacent organs (i.e., bowel, bladder, etc.) must be clearly visualized at all times. Movement of the manipulator in the appropriate direction may facilitate this step, which may be difficult when removing a large and bulky uterus. Monopolar loops are usually unnecessary for robotic supracervical hysterectomy. If the uterine manipulator is left in place during this step, its stem is encountered along the process, marking the midline of the isthmic incision. Most manipulators stems are manufactured from plastic or other non-conductive materials so that thermal injury through the monopolar shears is minimized. However, judicious use of monopolar energy and complete visualization of pelvic structure during this step is essential since inadvertent thermal injury to adjacent pelvic structure (i.e., bowel, bladder) may occur.

9. *Coagulation of the internal cervical os*: once the uterus is removed, the cervical canal may be coagulated with the bipolar forceps. This step may decrease the long term sequel of cyclic cervical bleeding originating from residual endometrial tissue within the cervical canal. Another option is to perform a "reverse cervical conization", where a cone-shaped cervical tissue is removed with monopolar shears. This technique may also decrease the rates of cyclic bleeding. The uterine manipulator may be removed vaginally once the uterine corpus has been amputated, and replaced by vaginal retractors such as a malleable retractor or rectal sizers (Fig. 62.2). Alternatively, some manipulators (such as the VCare) allow to retract the uterine stem, leaving in place the cervical ring which allows for some cervical manipulation vaginally.
10. *Adnexectomy or salpingectomy*: As explained above, prophylactic removal of the adnexa or the fallopian tubes should be discussed with the patient before surgery. Prior to coagulation of the ovarian vessels, the course of the ureters is again visualized. The ovarian vessels are coagulated with bipolar forceps, taking care to ensure adequate coagulated margins before the vessel are divided. The adnexa or the fallopian tubes may be removed through a 12 mm assistant laparoscopic port or with the use of a bag.
11. *Hemostasis*: the surgical pedicles are irrigated in a stepwise fashion and any bleeding is identified and coagulated. Further hemostasis control may be performed with a "low pressure check", whereby the intra-abdominal pressure is lowered to 4–5 mmHg.
12. *Specimen removal*: National guidelines should guide whether or not power morcellation is performed for specimen removal. Other options for specimen removal include cold knife morcellation through the largest abdominal port. For this technique, the uterus is placed in a specimen retrieval bag and brought with a grasper to the abdominal wall. For normal size uteri, a 12 mm incision may be sufficient. However, larger uteri containing fibroid may necessitate an enlargement of the abdominal incision to 2–3 cm.
13. *Routine cystoscopy*: Although routine cystoscopy has not been found to be cost-effective in all hysterectomy cases [22, 23], it may be performed with low surgical risks associated with the procedure and relatively quickly. Due to the higher rates of urethral injury in prolapse or incontinence surgery, routine cystoscopy may be justified in those cases.
14. *Port closure*: Fascial closure is often performed for laparoscopic ports larger than 10–12 mm. This may be performed with a laparoscopic needle. Smaller ports do not require fascial closure, and the skin may be closed with a continuous intradermal suture or with interrupted mattress sutures.

Surgical Steps for Concomitant Sacral Colpopexy

This procedure includes dissection of the anterior and posterior vaginal walls, followed by exposure of the longitudinal ligaments at the sacral promontory area, and placement of Y shaped mesh. Finally, the mesh may be covered by a peritoneal layer. The procedure begins with assessment of the pelvic anatomy, ease of visualizing the anterior and posterior vaginal walls, and the sacral promontory area.

1. Dissection of the anterior vaginal wall: similar to the technique described above for dissection of the bladder flap for hysterectomy, the bladder is taken down further using traction on the bladder with a grasping instrument (i.e., the robotic prograsp, or a laparoscopic grasper held by the bedside assistant) and combined sharp and blunt dissection with the monopolar shears (Fig. 62.9). In the correct surgical dissection plane, minimal bleeding is encountered. This dissection is aided by use of a wide curved vaginal obturator such as the end-to-end rectal anastomosis sizer (Fig. 62.2). The extent of the dissection is guided by the degree of prolapse of the anterior vaginal wall on pre-operative exam.
2. Dissection of the rectovaginal space: after the vaginal manipulator is placed in the posterior fornix, the loose peritoneal covering of the pouch of Douglas, in between the sacro-uterine ligaments, is grasped and a shallow incision is made in order to enter the rectovaginal space. This space usually contains loose areolar tissue which may be easily separated downward to the level of the rectum medially and the levator ani muscles laterally, while exposing the rectovaginal septum (also called Denonvilliers' fascia) (Fig. 62.10). As before, in the cor-



Fig. 62.9 Further exposure of the arterial vaginal wall. In this figure, the end-to-end anastomosis sizer is placed in the anterior fornix of the vagina, providing excellent demarcation of surgical plane between the vagina and the bladder



Fig. 62.10 Dissection of the rectovaginal space and exposure of the rectovaginal septum

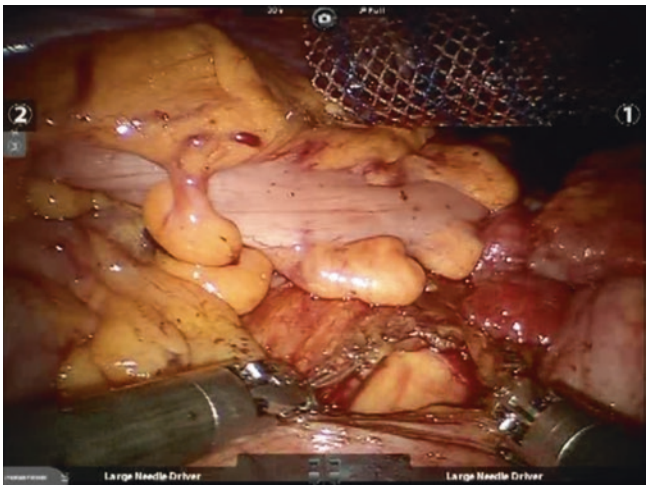


Fig. 62.11 Exposure of the anterior longitudinal ligament at the presacral area

rect surgical plane the bleeding is minimal during most of the dissection. However, in cases of extensive dissection (which may be required for advanced prolapse) some blood vessels are often encountered close to the rectum. We have found that use of the 30° optics pointed upwards aids in the visualization of the rectovaginal space. Likewise, a rectal probe may aid in recognizing the borders of the rectum. As for the dissection of the anterior vaginal wall, the extent of dissection of the rectovaginal space is guided by the degree of prolapse.

3. Dissection of the presacral area: this area is best visualized with a 30° optics pointed downwards, and after the sigmoid colon is retracted to the left with a grasping instrument (usually the prograsp) placed in the left robotic arm. In cases of a relatively mobile sigmoid colon the retraction of the sigmoid colon with grasping instruments may be insufficient for optimal visualization. In those cases, the sigmoid colon may be fixed to the left middle anterior abdominal wall by passing a suture on a straight long needle through the abdominal wall, to the sigmoid epiploica in 2–3 spots and back through the abdominal wall, close to the entry point. The suture is then tied and left in place for the duration of the surgery. Next, the bifurcation of the aorta, the course of the right common iliac artery and the course of the right ureter crossing over the pelvic brim are noted. The peritoneum above the dissection area in the sacral promontory is grasped and incised. The loose areolar tissue bellow is gently separated until the white anterior longitudinal ligament is seen. A dissection area of several centimeters is sufficient (Fig. 62.11). The major intraoperative complication during this step of the procedure is bleeding, which may originate from the middle sacral artery and vein or from smaller vessels. Thus, meticulous coagulation with bipolar forceps or the PK forceps combined with careful dissection is key. In addition, vascular clips or hemostatic agents should be available in the operating room in case they are required for hemostasis.
4. Dissection of the lateral peritoneum: the peritoneal incision on the presacral area is continued towards the Douglas pouch, medial to the right ureter and lateral to the rectum. This incision will be used to cover the mesh at the conclusion of the procedure. Alternatively, blunt dissection of this space while undermining the peritoneum with monopolar shears but without the peritoneal incision would allow to pass the mesh from the pelvic to the presacral area below the lateral peritoneum. This technique

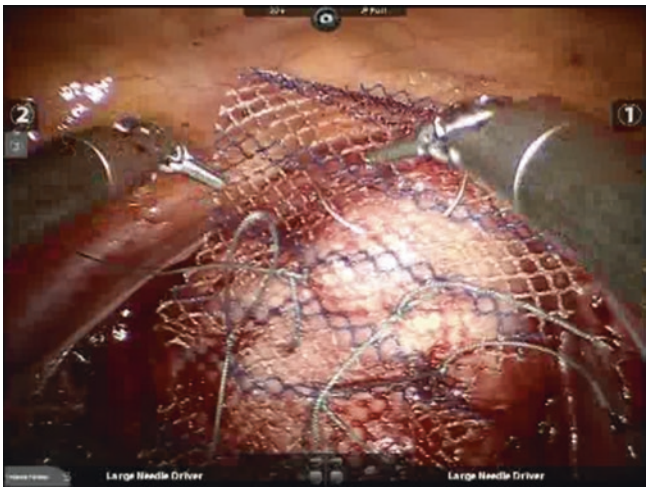


Fig. 62.12 Interrupted sutures anchoring the mesh to the cervical stump using a 2-0 non-absorbable suture and intracorporeal knots

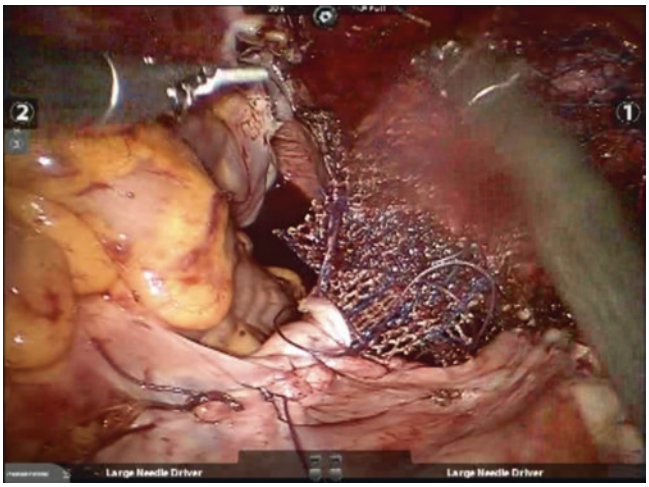


Fig. 62.13 The peritoneum is closed over the mesh using a running 2-0 or 1-0 absorbable suture

may shorten surgical time because peritoneal closure over the mesh with a continuous suture is unnecessary.

5. Tailoring of the mesh: the macroporous, polypropylene mesh, required for sacral colpopexy has a Y shape and include two rectangular pelvic arms (for the anterior and posterior vaginal walls) and one rectangular sacral arm. This mesh may be fashioned individually from a large 15*15 cm mesh square or purchased as a "ready to use" Y mesh. The commercially available Y meshes may also need some tailoring prior to their introduction into the abdominal cavity because their arms are too long for most patients.
6. Suturing of the Y mesh: the robotic monopolar shears and bipolar forceps are switched to needle drivers. The triangle of the Y mesh is placed on the cervical stump and 1–2 sutures are used to anchor it in place (Fig. 62.12). Subsequently, the mesh is anchored to the anterior vaginal wall, followed by the posterior vaginal wall, by a series of interrupted sutures using a small diameter suture (such as 2-0) and intracorporeal knotting. Use of the vaginal obturator to move the cervical stump according to the suturing area is very helpful. The choice of suture material is debatable: a non-absorbable polyester braided suture such as Ethibond (Ethicon, Somerville, New Jersey, USA) or a comparable absorbable suture (such a polyglactin suture). The former is easy to handle and knot, but should it protrude to the vaginal side of the vaginal wall, postoperative removal may be required. For the sake of efficiency, a relatively long suture (~35–40 cm) may be introduced into the abdominal cavity and used for several interrupted sutures.
7. Anchoring the mesh to the anterior longitudinal ligament: The sacral arm of the mesh is pulled cephalad, carrying the cervical stump upwards and correcting the prolapse. The position of the cervical stump is adjusted to ensure it is "tension free". At the chosen location, the sacral mesh arm is anchored to the anterior longitudinal ligament at the S1 region with a tacking instrument or with a couple of non-absorbable sutures. The tacking instrument is easy and quick to use, however, concerns have been raised regarding its possible role in the development of lumbosacral osteomyelitis and spondylodiscitis, a rare but severe complication of sacral colpopexy. Those concerns stem from the presumed deeper penetration of the bone tack compared to sutures. Nevertheless, since lumbosacral osteomyelitis has been reported with use of both tacking instruments and sutures, it is unclear whether one technique is safer than the other, and many surgeon continue to use tacking instruments until further evidence is available [24, 25]. If use of the tacking instrument is preferred, the best approach to operate it in terms of proximity to the presacral area and angle is offered by the right robotic port. This would require temporary undocking of the right robotic arm.
8. Peritoneal closure: any excess mesh is excised, and after hemostasis of the presacral area and the pelvic has been checked, the peritoneum is reapproximated over the entire length of the mesh with a running 2-0 absorbable suture (Fig. 62.13).

Surgical Outcomes and Complications of Robotic Sacral Colpopexy

Abdominal sacro colpopexy, whether by open, laparoscopic or robotic approach is considered superior in treatment of apical prolapse compared to the vaginal approach in terms of prolapse recurrence, residual prolapse [2]. However, the

robotic approach is not necessarily superior to the conventional laparoscopic sacral colpopexy. In a randomized controlled trial by Paraiso et al. [26], 78 patients were randomized to the laparoscopic or robotic sacral colpopexy. There were no differences in vaginal support and functional outcomes at 1 year follow up, but the robotic surgery was significantly longer and more expensive than the laparoscopic one. Nevertheless, since laparoscopic sacral colpopexy is a technically demanding procedure requiring advanced suturing skills and a long learning curve, the robotic platform may allow additional surgeons to perform it.

A recent systematic review on the outcomes and complications of robotic sacral colpopexy included 1488 cases from 27 studies, published from 2006 to 2013 [27]. Intraoperative complication occurred in 3 % (including mostly vaginotomies, urinary tract injuries, and bowel injuries). Postoperative complications occurred in 11 % of cases overall, but only 2 % were graded as severe (such as bowel obstructions, port site hernia, port site nerve entrapment, and peritonitis due to bowel injury). Mesh erosion at the vaginal area was reported in 2 % of patients, and appeared to be related to the execution of total hysterectomy as opposed to supracervical hysterectomy, and to the use of a standard weight polypropylene mesh as opposed to a lightweight polypropylene mesh (the latter being a protective factor).

Finally, spondylodiscitis of the L5-S1 disc or vertebral osteomyelitis is rare complication of the procedure, with less than 30 cases reported in the literature for all sacral colpopexy surgical approaches [24]. This severe complication (which may or may not involve mesh erosion at the presacral area) is often preceded by a urinary tract or vaginal cuff infection. Patients present with back pain several weeks after the procedure and often require additional surgeries for drainage, debridement and mesh removal in addition to broad spectrum intravenous antibiotic treatment.

References

1. Lieng M, Qvigstad E, Istre O, Langebrekke A, Ballard K. Long-term outcomes following laparoscopic supracervical hysterectomy. BJOG. 2008;115:1605–10.
2. Maher C, Feiner B, Baessler K, Schmid C. Surgical management of pelvic organ prolapse in women. Cochrane Database Syst Rev. 2013;4:CD004014.
3. Osmundsen BC, Clark A, Goldsmith C, Adams K, Denman MA, Edwards R, Gregory WT. Mesh erosion in robotic sacrocolpopexy. Female Pelvic Med Reconstr Surg. 2012;18:86–8.
4. Thakar R, Ayers S, Clarkson P, Stanton S, Manyonda I. Outcomes after total versus subtotal abdominal hysterectomy. N Engl J Med. 2002;347:1318–25.
5. Andersen LL, Ottesen B, Alling Møller LM, Gluud C, Tabor A, Zobbe V, Hoffmann E, Gimbel HM, Danish Hysterectomy Trial Group. Subtotal versus total abdominal hysterectomy: randomized clinical trial with 14-year questionnaire follow-up. Am J Obstet Gynecol. 2015;212(6):758.e1–54.
6. Uccella S, Ghezzi F, Mariani A, Cromi A, Bogani G, Serati M, Bolis P. Vaginal cuff closure after minimally invasive hysterectomy: our experience and systematic review of the literature. Am J Obstet Gynecol. 2011;205:119.
7. Wallwiener M, Taran FA, Rothmund R, Kasperkowiak A, Auwärter G, Ganz A, Kraemer B, Abele H, Schönfisch B, Isaacson KB, Brucker SY. Laparoscopic supracervical hysterectomy (LSH) versus total laparoscopic hysterectomy (TLH): an implementation study in 1,952 patients with an analysis of risk factors for conversion to laparotomy and complications, and of procedure specific re-operations. Arch Gynecol Obstet. 2013;288:1329–39.
8. Gimbel H, Zobbe V, Andersen BM, Filtenborg T, Gluud C, Tabor A. Randomised controlled trial of total compared with subtotal hysterectomy with one-year follow up results. BJOG. 2003;110:1088–98.
9. Donnez J, Nisolle M. Laparoscopic supracervical (subtotal) hysterectomy (LASH). J Gynecol Surg. 1993;9:91–4.
10. Liu FW, Galvan-Turner VB, Pfaendler KS, Longoria TC, Bristow RE. A critical assessment of morcellation and its impact on gynecologic surgery and the limitations of the existing literature. Am J Obstet Gynecol. 2015;212(6):717–24.
11. Food and Drug Administration. Quantitative assessment of the prevalence of unsuspected uterine sarcoma in women undergoing treatment of uterine fibroids. Available at: http://www.fda.gov/downloads/MedicalDevices/Safety/AlertsandNotices/UCM393589.pdf.
12. Lieng M, Berner E, Busund B. Risk of morcellation of uterine leiomyosacomas in laparoscopic supracervical hysterectomy and laparoscopic myomectomy, a retrospective trial including 4791 women. J Minim Invasive Gynecol. 2015;22:410–4.
13. Ton R, Kilic GS, Phelps JY. A medical-legal review of power morcellation in the face of the recent FDA warning and litigation. J Minim Invasive Gynecol. 2015;22(4):564–72.
14. Cohen SL, Greenberg JA, Wang KC, et al. Risk of leakage and tissue dissemination with various contained tissue extraction (CTE) techniques:an in vitro pilot study. J Minim Invasive Gynecol. 2014;21:935–9.
15. Morelli M, Venturella R, Mocciaro R, Di Cello A, Rania E, Lico D, D'Alessandro P, Zullo F. Prophylactic salpingectomy in premenopausal low-risk women for ovarian cancer: primum non nocere. Gynecol Oncol. 2013;129:448–51.
16. Vorwergk J, Radosa MP, Nicolaus K, Baus N, Jimenez Cruz J, Rengsberger M, Gajda M, Diebolder H, Runnebaum IB. Prophylactic bilateral salpingectomy (PBS) to reduce ovarian cancer risk incorporated in standard premenopausal hysterectomy: complications and re-operation rate. J Cancer Res Clin Oncol. 2014;140:859–65.
17. Parker WH, Broder MS, Chang E, Feskanich D, Farquhar C, Liu Z, Shoupe D, Berek JS, Hankinson S, Manson JE. Ovarian conservation at the time of hysterectomy and long-term health outcomes in the nurses' health study. Obstet Gynecol. 2009;113:1027–37.
18. Rocca WA, Grossardt BR, de Andrade M, Malkasian GD, Melton 3rd LJ. Survival patterns after oophorectomy in premenopausal women: a population-based cohort study. Lancet Oncol. 2006;7:821–8.
19. Shuster LT, Gostout BS, Grossardt BR, Rocca WA. Prophylactic oophorectomy in premenopausal women and long-term health. Menopause Int. 2008;14:111–6.
20. Elective and risk-reducing salpingo-oophorectomy. ACOG Practice Bulletin No. 89. American College of Obstetricians and Gynecologists. Obstet Gynecol. 2008;111:231–41.
21. Berek JS, Chalas E, Edelson M, Moore DH, Burke WM, Cliby WA, Berchuck A, Society of Gynecologic Oncologists Clinical Practice Committee. Prophylactic and risk-reducing bilateral salpingo-oophorectomy: recommendations based on risk of ovarian cancer. Obstet Gynecol. 2010;116:733–43.

22. Visco AG, Taber KH, Weidner AC, Barber MD, Myers ER. Cost-effectiveness of universal cystoscopy to identify ureteral injury at hysterectomy. Obstet Gynecol. 2001;97:685–92.
23. Vakili B, Chesson RR, Kyle BL, Shobeiri SA, Echols KT, Gist R, Zheng YT, Nolan TE. The incidence of urinary tract injury during hysterectomy: a prospective analysis based on universal cystoscopy. Am J Obstet Gynecol. 2005;192:1599–604.
24. Propst K, Tunitsky-Bitton E, Schimpf MO, Ridgeway B. Pyogenic spondylodiscitis associated with sacral colpopexy and rectopexy: report of two cases and evaluation of the literature. Int Urogynecol J. 2014;25:21–31.
25. Nosseir SB, Kim YH, Lind LR, Winkler HA. Sacral osteomyelitis after robotically assisted laparoscopic sacral colpopexy. Obstet Gynecol. 2010;116:513–5.
26. Paraiso MF, Jelovsek JE, Frick A, Chen CC, Barber MD. Laparoscopic compared with robotic sacral colpopexy for vaginal prolapse. Obstet Gynecol. 2011;118:1005–13.
27. Serati M, Bogani G, Sorice P, Braga A, Torella M, Salvatore S, Uccella S, Cromi A, Ghezzi F. Robot-assisted sacrocolpopexy for pelvic organ prolapse: a systematic review and meta-analysis of comparative studies. Eur Urol. 2014;66:303–18.

Cervical Stump Extirpation with Regard to Robotic-Assisted Laparoscopic Hysterectomy

63

Hung-Cheng Lai and Yu-Chi Wang

Introduction

Over the past decades, minimally invasive surgery MIS) has become a trend in the field of surgery. The laparoscopic surgery boomed in the late 1980s and continued to gain popularity into the 1990s and this MIS have been successfully applied to the gynecological benign and malignant tumors. For many years, MIS appeared to represent an alternative approach in the gynecological surgery compared to the traditional exploratory laparotomy. Another novel MIS technology called "robotic surgery" which composed of patient-side cart, computer stand-interface and surgeon console is introduced in the 2000s and provide advantages for the surgeons. It is particular useful in obese patients, long-time surgeries and the operation required extensive suturing. This newly technology is similar to or better than previous laparoscopic surgery in shortened hospital stay, less blood loss, less surgical pain, a faster recovery and less scarring.

Since the approval by the US Food and Drug Administration (FDA) in 2005, robotic surgeries have been widely used in gynecologic field including benign and malignant disorders [1]. The first case of hysterectomy by robotic surgery was reported in 2002 [2]. By 2011, 37 % of hysterectomies in United State were performed by laparoscopy and 27 % were by robot. (Intuitive surgical Inc., Sunnyvale, CA, USA).

Although minimally invasive surgery provide many advantages, the extirpation of uterine cervix remains a challenge since the vicinity of cervix contains structures such as bladder, ureter and rectum which may subject to injuries (Fig. 63.1). The key of success include the identification of uterine artery, ureter and the plans of uterine-vesicle fold and recto-vaginal space. Here, we described the details of these procedures in this chapter.

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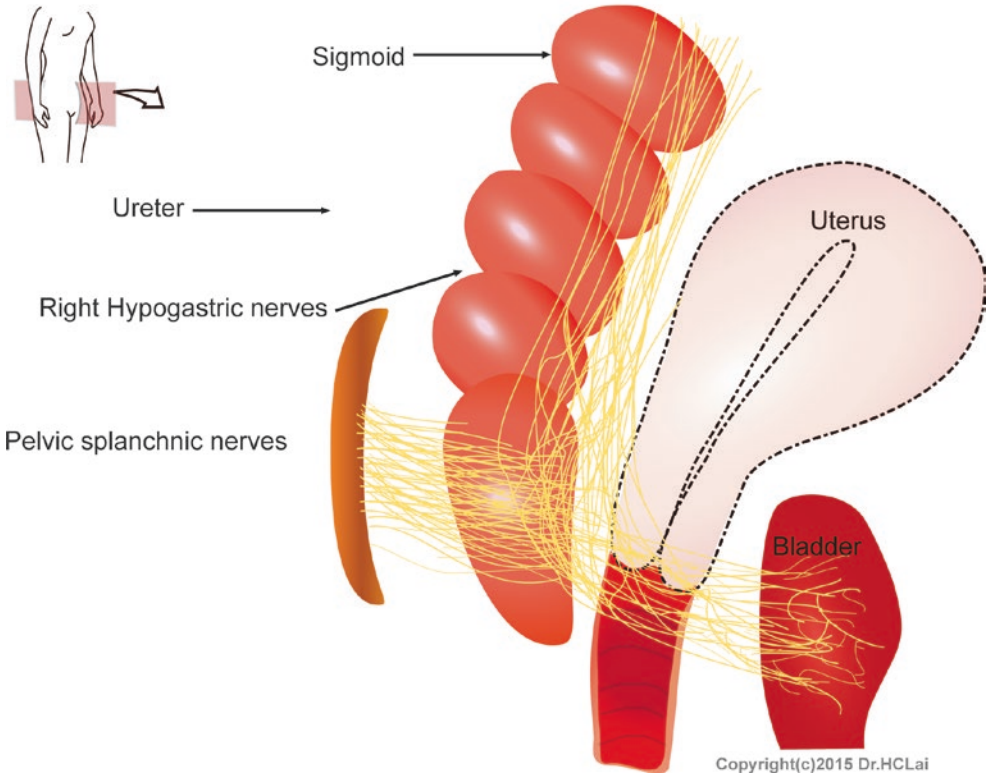


Fig. 63.1 The anatomy of the pelvic structures including bladder, uterus, cervix, bowel, ureter and pelvic nerve. The ureter comes across uterine cervix at about 2–3 cm lateral to the isthmus. Nerve innervation spread along and below ureter to the bladder

Hysterectomy

The uterus is elevated using manipulator (Fig. 63.2). Carefully checking the whole pelvis and avoid to trauma and tear the bowel, bladder and vessels. First, the round ligament and fallopian tubes are grasped and coagulated by a bipolar forceps and then cut using monopolar spatula or scissors at right side (Fig. 63.3). Then, the anterior leaf of broad ligament is subsequently separated down to the bladder peritoneum to the uterus. After opening the retroperitoneum, the ureter can be identified on the posterior leaf of the broad ligament The grasper can hold the peritoneum and the ureter can be dissected carefully using a blunt dissector or spatula. The uterine artery is then identified and clamped (Figs. 63.4 and 63.5). The ureter, then, can be bluntly pushed a little bit laterally to have more space when doing colpotomy. The bladder is pushed downward to expose the vaginal colpus. Then the anterior colpotomy can be made using the unipolar spetula or forceps, and, circumscribe the cervix (Fig. 63.6). The uterine manipulator can be pushed forward to get a little tension of tissues for better cutting. Then the cervix is clamped by a tenaculum forceps and retrieved it through vagina. If the specimen is large, the uterus can be removed piece by piece

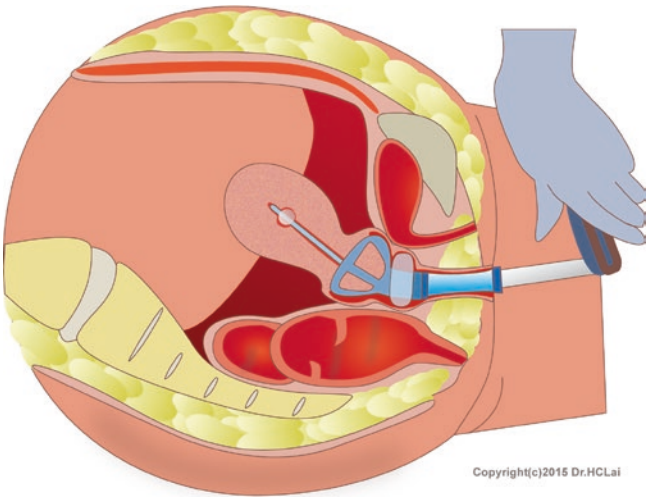


Fig. 63.2 The uterine manipulator is used to displace the uterus away from the bladder, ureter and rectum

by vaginal or transumbilical morcellation. The sponge in a glove or a baby nose suction bulb is placed into the vagina to prevent the loss of pneumoperitoneum (Figs. 63.7 and 63.8). Finally, the edge of the vaginal cuff is sutured (Fig. 63.9).

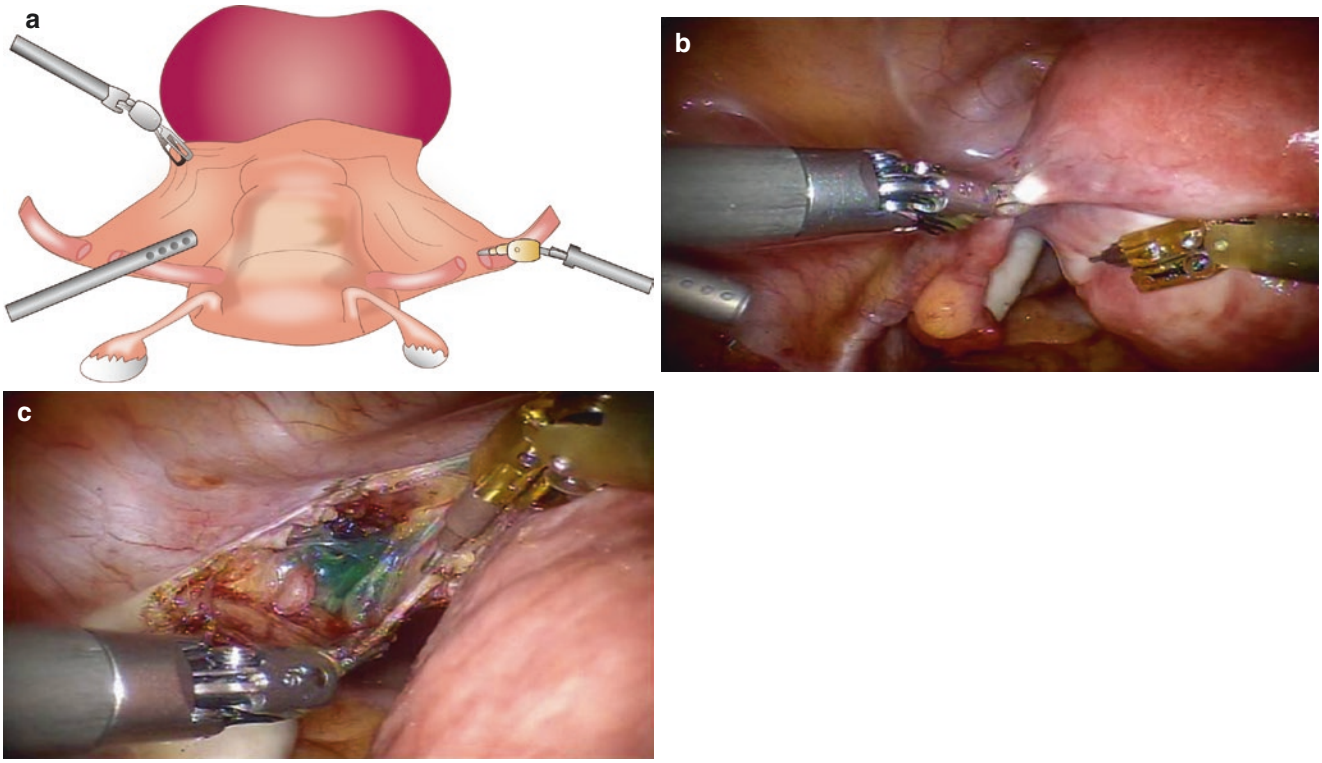


Fig. 63.3 (**a**) Illustration of round ligaments and the leaves of the broad ligament. (**b**) The round ligament and fallopian tubes are coagulated and then cut. (**c**) The anterior leaf of broad ligament is subsequently separated down to the bladder peritoneum to the uterus

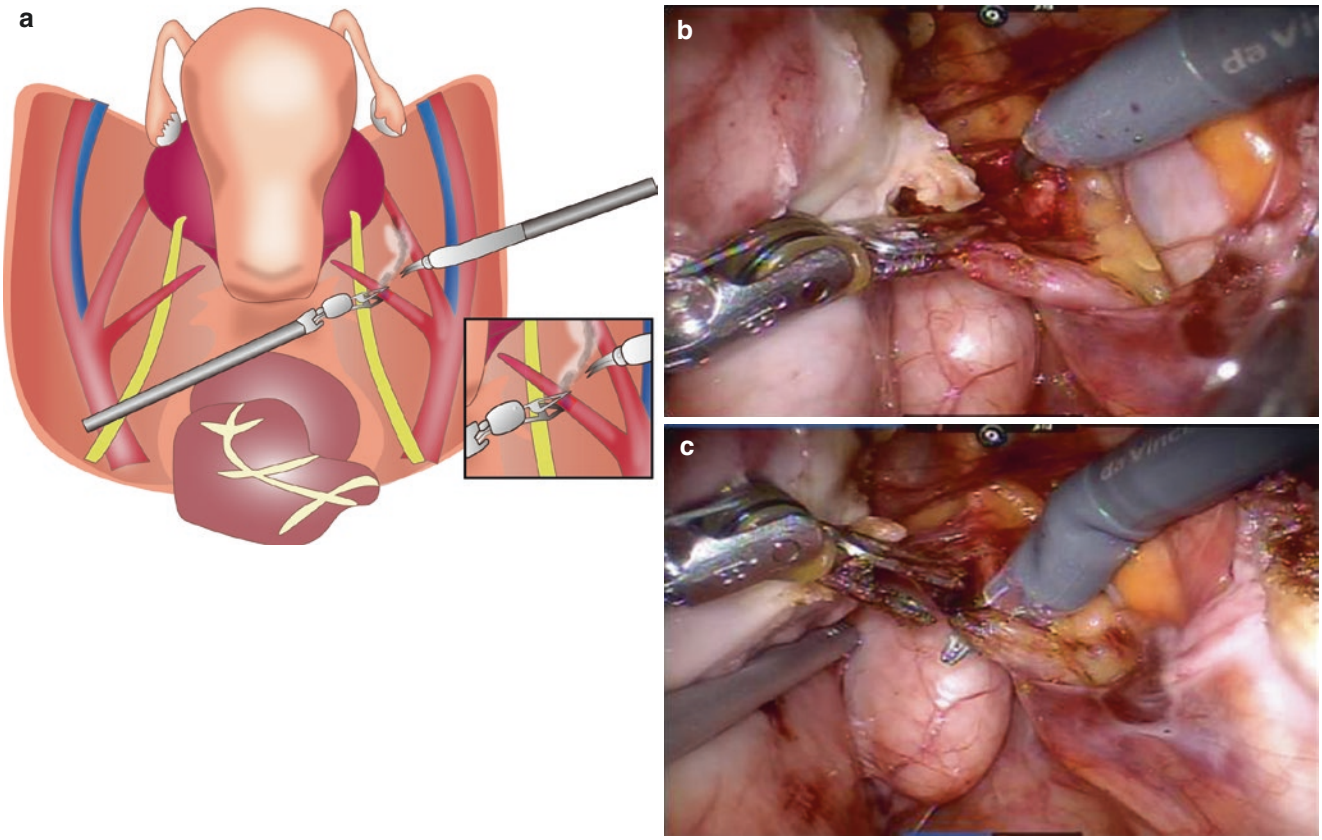


Fig. 63.4 (**a**) Illustration of uterine artery and ureter at the level of "bridge over trouble water". (**b**)The ureter can be identified at the level of pelvic brim and be bluntly dissected by scissor from its peritoneal attachment down to the parametrial level. (**c**) The uterine artery is then skeletonized as "the bridge over trouble water" and then coagulated using bipolar forceps

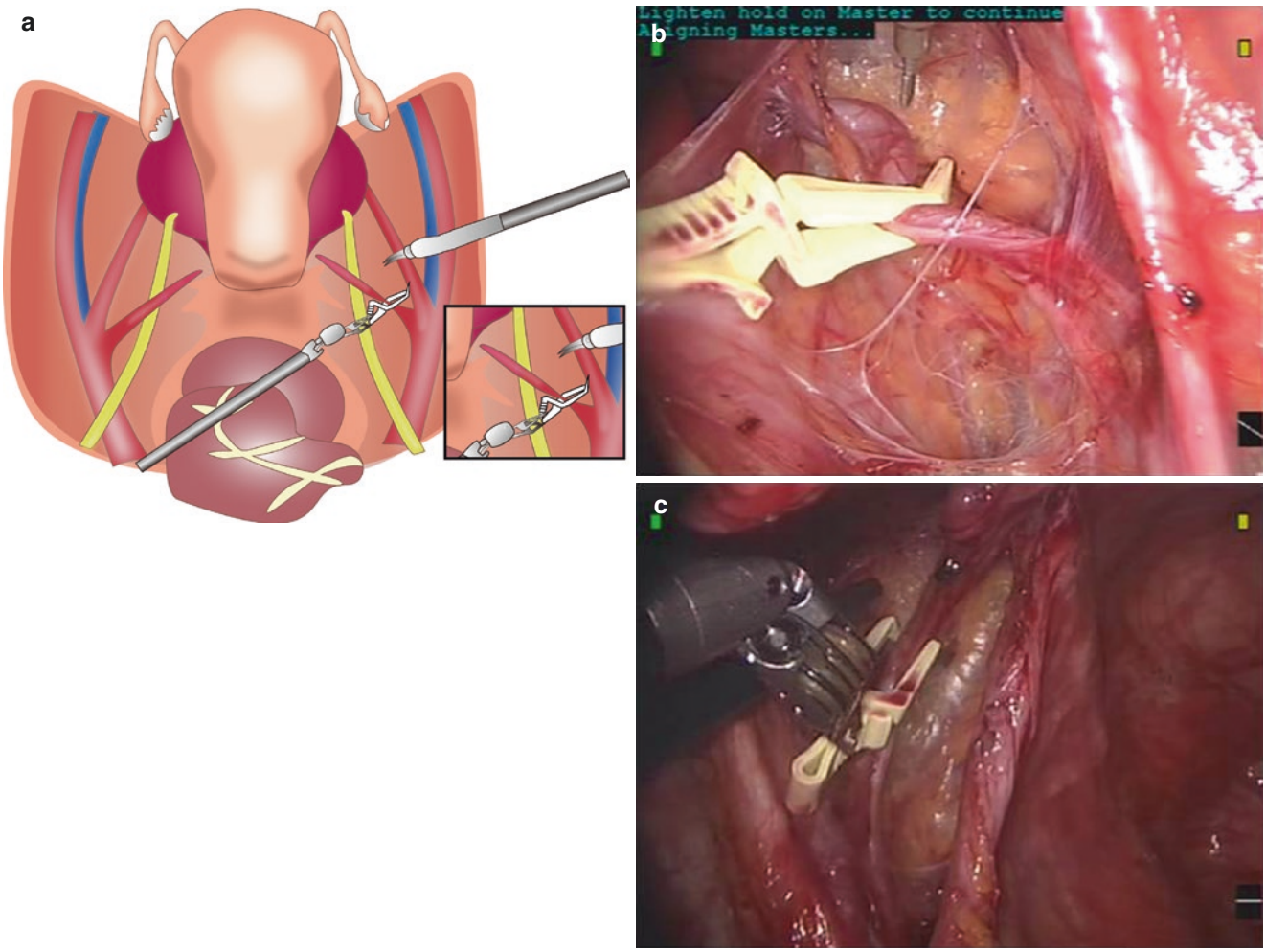


Fig. 63.5 (**a**) Illustration of clamping uterine artery at its origin from internal iliac artery. (**b**) The right ureter was bluntly dissected using a scissor dissector or spatula. The origin of uterine artery from internal iliac artery can be identified parallel to the ureter at this level. A bulldog clamp can be introduced using fenestrated forceps and temporarily clip the uterine artery until the uterine incision was sutured. The bulldog is removed after a complete homeostasis of the uterine body. (**c**) The clipped uterine artery and ureter, left

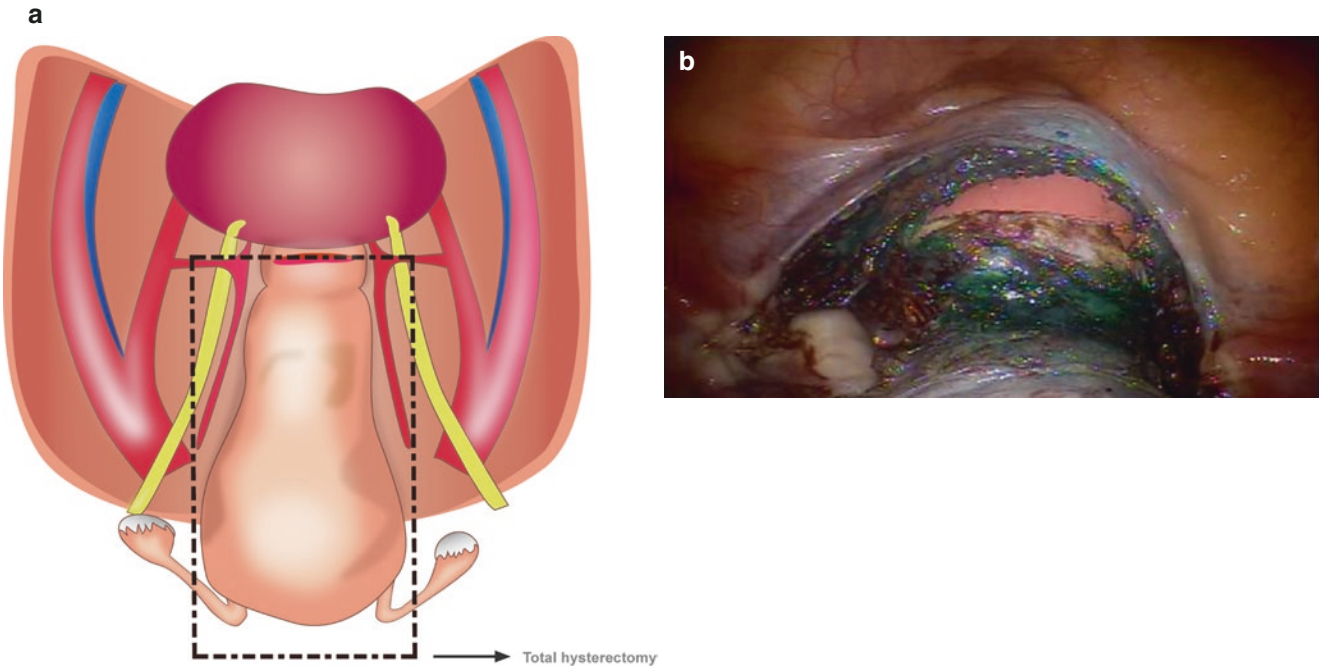


Fig. 63.6 (**a**) Illustration of the robotic view of total hysterectomy. (**b**) The placement of a baby nose sucker in vagina provides a good support for colpotomy. After the placement of a suction ball to the apex of the fornix, the bladder is released from the cervix by using scissors. Then the vagina is incised and opened by monopolar scissors

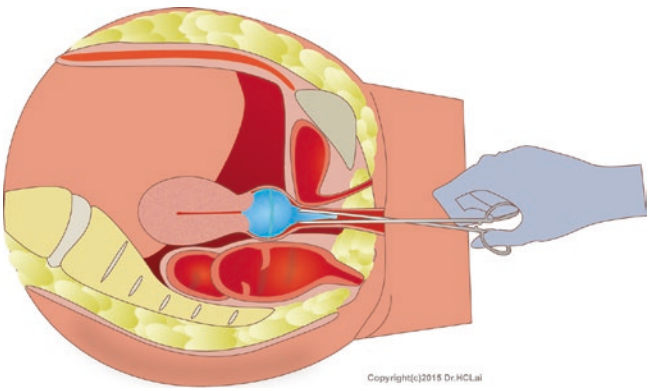


Fig. 63.7 The application of nose sucker as a pneumo-occluder

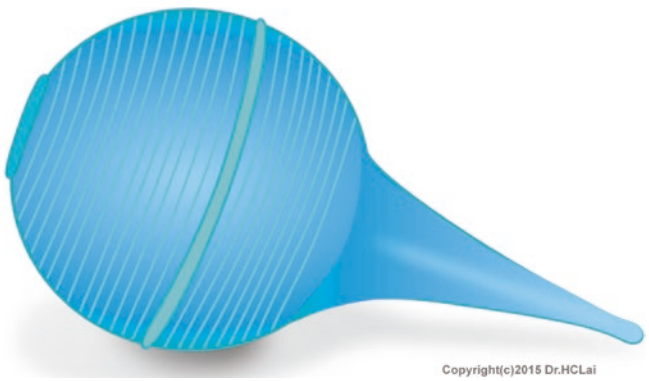


Fig. 63.8 The view of the suction bulb

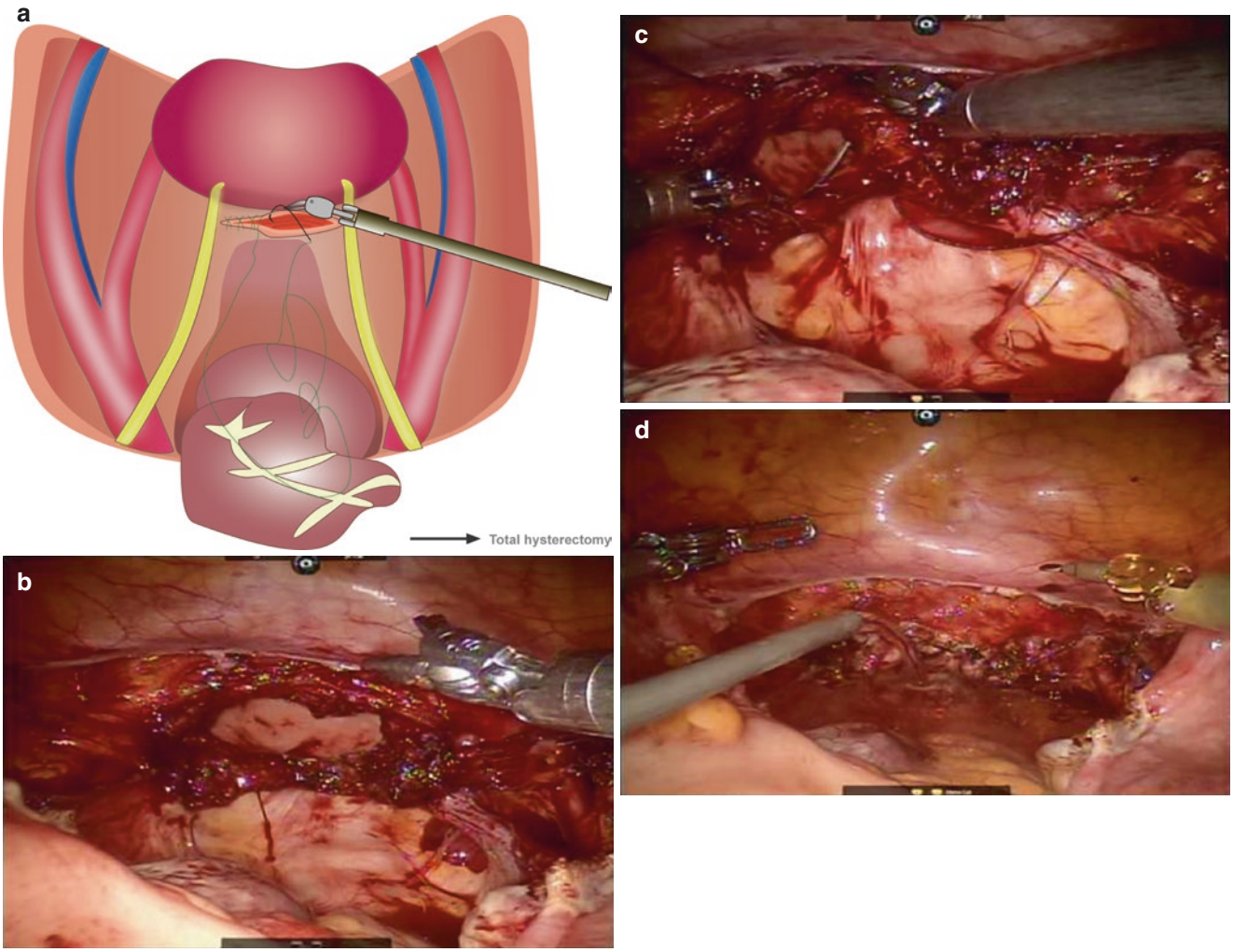


Fig. 63.9 (**a**) Illustration of the vaginal cuff closure. (**b**) The vaginal cuff after colpotomy and removal of uterus. (**c**) Closure of the first layer of vaginal cuff using V-lock suture. (**d**) Completion of double layered suture of vaginal cuff

Subtotal Hysterectomy

After the dissection of round ligament and ovarian ligament, the ureter can be identified at the posterior leaf of peritoneum. The peritoneum can be graped by bipolar grasper. Then, a gentle scratching using spatula or scissor on the medical aspect of peritoneum from the level around internal iliac artery may lead to the white peristalsing ureter covered by whirling vessels. Parallel to the ureter along the pelvic wall, the uterine artery can be identified by pulsation. The uterine artery can be skeletonized and dissected down to the cross above ureter (Figs. 63.4 and 63.5). Care should be taken to avoid tearing veins below. The uterine artery can be cauterized by bipolar forceps at any level of the course. For a large uterine mass, the origin of uterine artery can only be identified below the level around pelvic brim. Usually, using robot, the "bridge over trouble water" can be reached posteriorly. After uterine artery is cauterized, the ureter can be gently pushed laterally to release more space between cervix and ureter (Figs. 63.10 and 63.11). Then, the fundus is elevated by manipulator or tracted by tenaculum forceps or grasp. An incision is made anteriorly or posteriorly at the isthmus level above uterine artery. Ascending branches of uterine arteries and veins can be cauterized by bipolar forceps. After hemi-transection of the cervix, the manipulator can be removed.

The dragging of uterus due to deep Trendelenburg position exposes the cervical cannel. The cervix can be cut using unipolar spatula or scissor. The uterus can be removed by morcellator. Alternatively, a tenaculum forceps can be used to grasp the uterus to avoid wandering uterus in the abdominal cavity. Then, the robot can be detached. The uterus can be removed through a 2.5 cm umbilical incision with wound retractor.

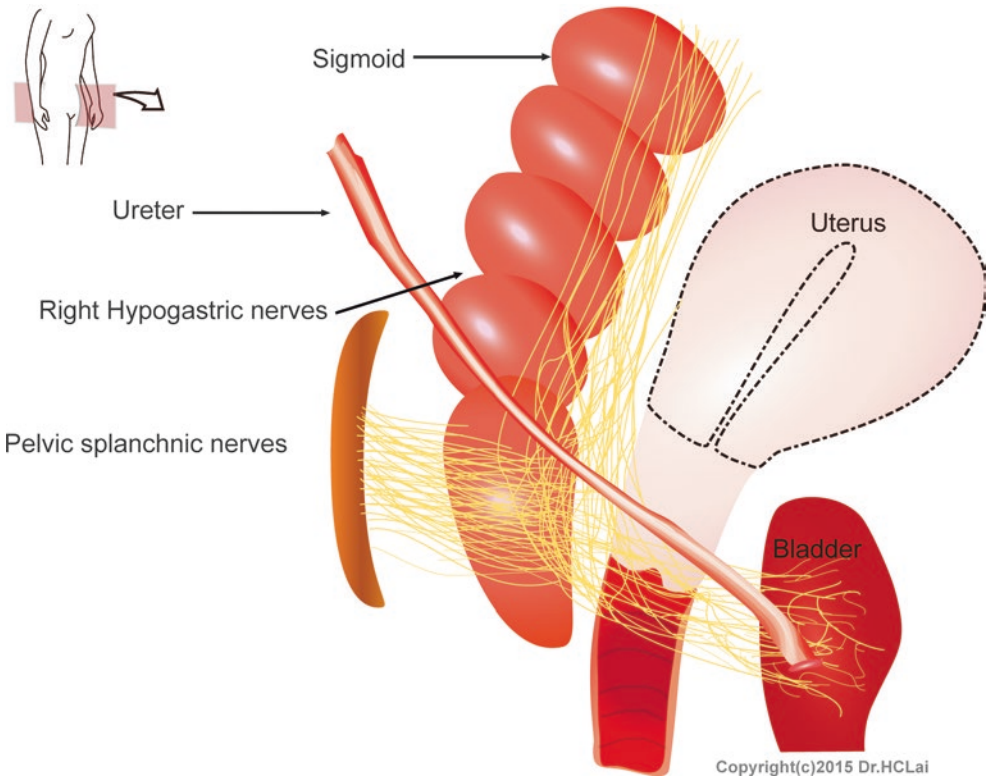


Fig. 63.10 Subtotal hysterectomy: After the uterine artery is clamped or ligated, the uterus is retracted by a grasper or a manipulator. The uterus and cervix is separated by the monopolar scissors at the isthmus where uterine artery enters uterus

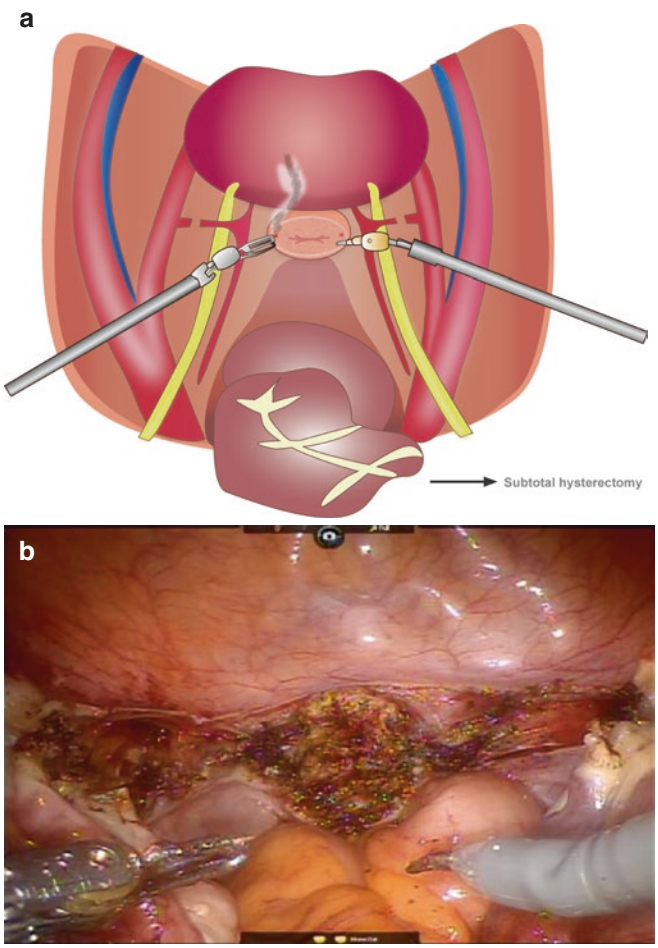


Fig. 63.11 (**a**) Illustration of cervical stump after supracervical hysterectomy. (**b**) Cervical stump after supracervical hysterectomy. Hemostasis is easier if the uterine arteries are ligated before the transection of uterine cervix

Radical Hysterectomy

The paravesical spaces are bounded by the external vessels laterally and the bladder medially (Fig. 63.12). The pararectal spaces are bounded by the rectum medially and the hypogastric artery laterally (Fig. 63.13). Then they are opened with gentle dissection using the monopolar spatula or scissors down to the pelvic wall. Furthermore, the uterine artery can be identified at the origin of hypogastric artery (Fig. 63.14). It is coagulated using bipolar forceps and cut. Then the uterine artery is elevated using grasper and the ureter can be identified below along the medial leaf of peritoneum. The ureter is pushed laterally along the tunnels and anterior leaf is exposed. The hypogastric nerve can be identified along the lateral aspect of rectal peritoneum (Fig. 63.15). The nerve fibers heading to the uterus is cut using monopolar scissor or spatula along the posterior leaf of tunnel. Then the recto-vaginal space is dissected and exposed at the middle, extended laterally to bilateral uterosacral ligament (Fig. 63.16). The uterosacral ligament are transected using the bipolar forceps ad scissors later. Finally, the bladder is pushed downward to expose the vaginal colpus. A circle colpotomy is made (Fig. 63.17). The uterus is dissected, extirpated through vagina (Fig. 63.18). The vaginal cuff is sutured (Fig. 63.19).

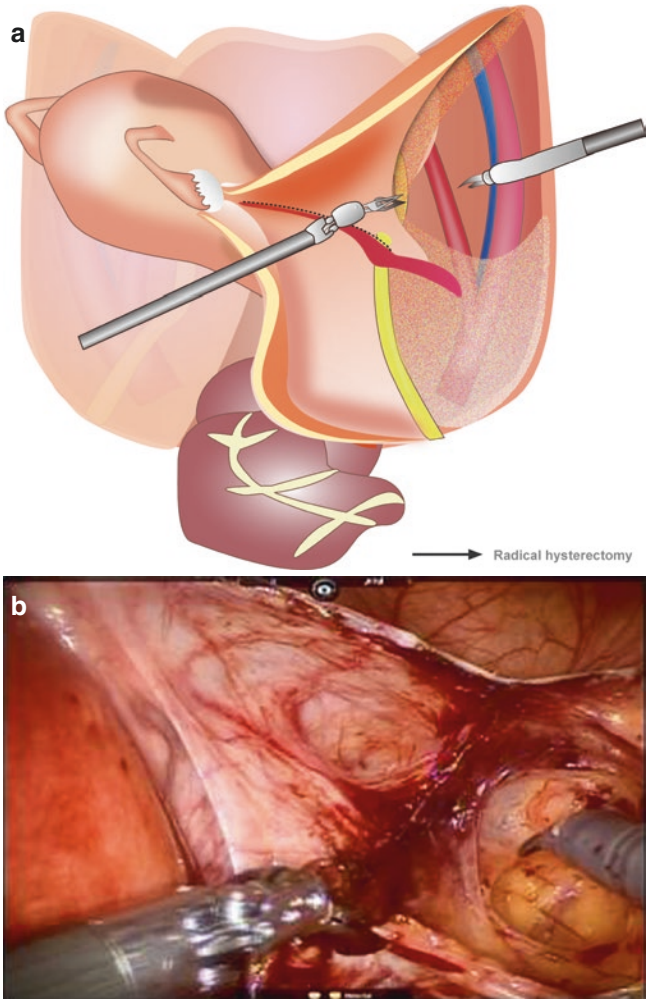


Fig. 63.12 (**a**) Illustration of paravesicle space. (**b**) The paravesical space is developed by a gentle dissection of bladder away from pelvic wall laterally. The umbilical artery can be identified and pushed laterally

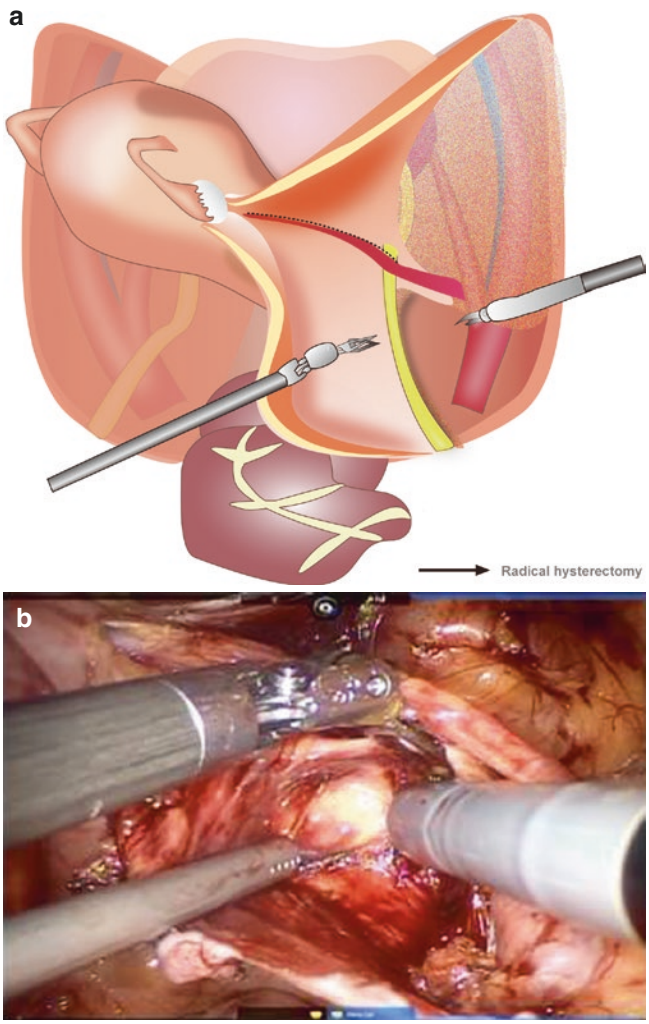


Fig. 63.13 (**a**) Illustration of pararectal space. (**b**) The pararectal space is developed by dissection down along the medial aspect of peritoneum. The ureter can be identified at the peritoneum medially and the internal iliac artery is the boundary laterally. The space can be developed down to the pelvic floor

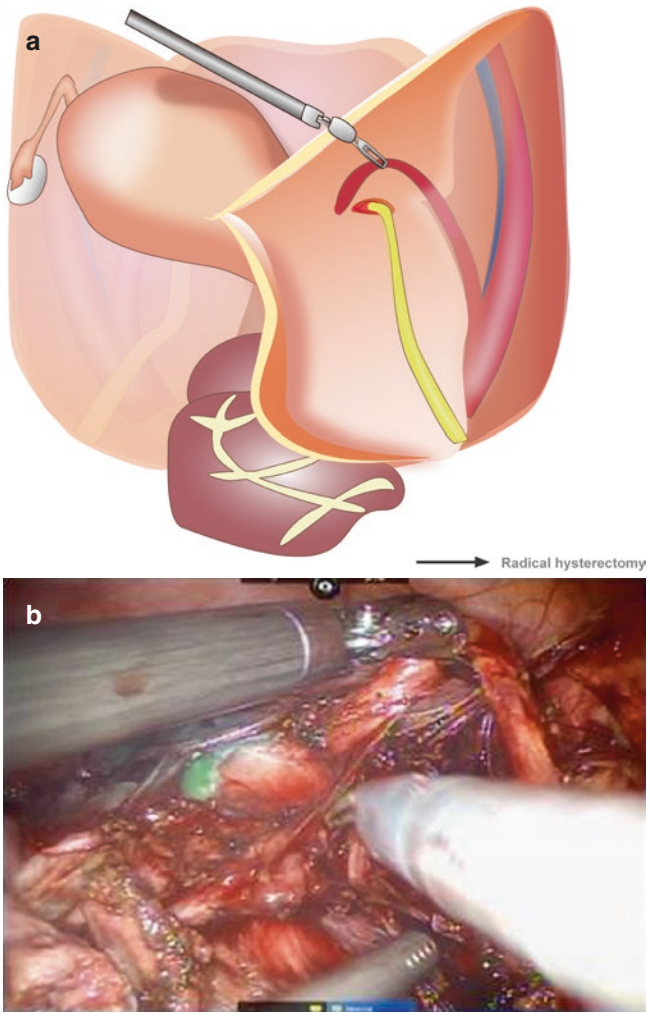


Fig. 63.14 (**a**) Development of anterior leaf of tunnel. (**b**) The ureter tunnel is identified by lifting the uterine artery and pushing downward the ureter until the complete separation of ureter and uterine artery. The anterior leaf is identified by the tissues covering ureter between bladder and uterus

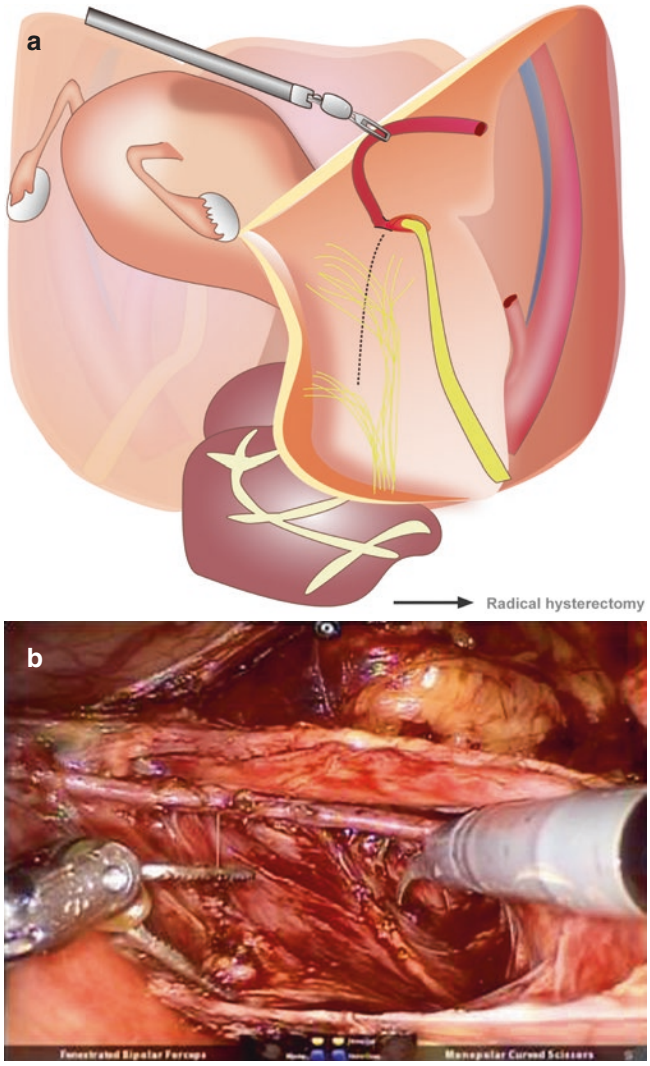


Fig. 63.15 (**a**) Illustration of posterior leaf of tunnel and hyogastric nerve. (**b**) The ureter run from pelvic wall to the uterus along (along with a preserved uterine vein). The posterior leaf of tunnel can be identified at below the ureter. Nerve fibers spreading around the peritoneum, the hypogastric nerve, are identified along the medial aspect of peritoneum down to the posterior leaf. An incision perpendicular to ureter can be made from the pararectal peritoneum along the posterior leaf. Nerve fibers toward uterus are dissected whilst fibers toward bladder can be preserved

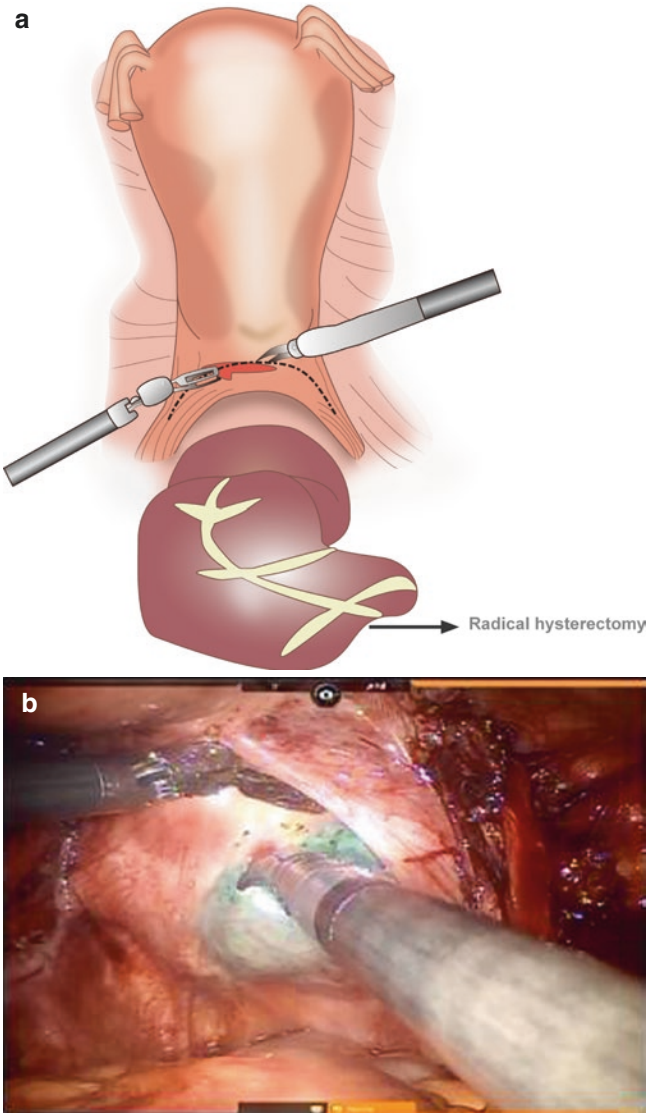


Fig. 63.16 (**a**) Illustration of posterior colpotomy. (**b**) The bulging of posterior fornex by pushing the nose sucker in vagina can be identified. An incision is made at the level of uterosacral ligaments and the recto-vaginal space can be developed downward. The space can be expanded laterally toward uterosacral ligaments. Then, uterosacral ligaments are transected, followed by the paracolpos below

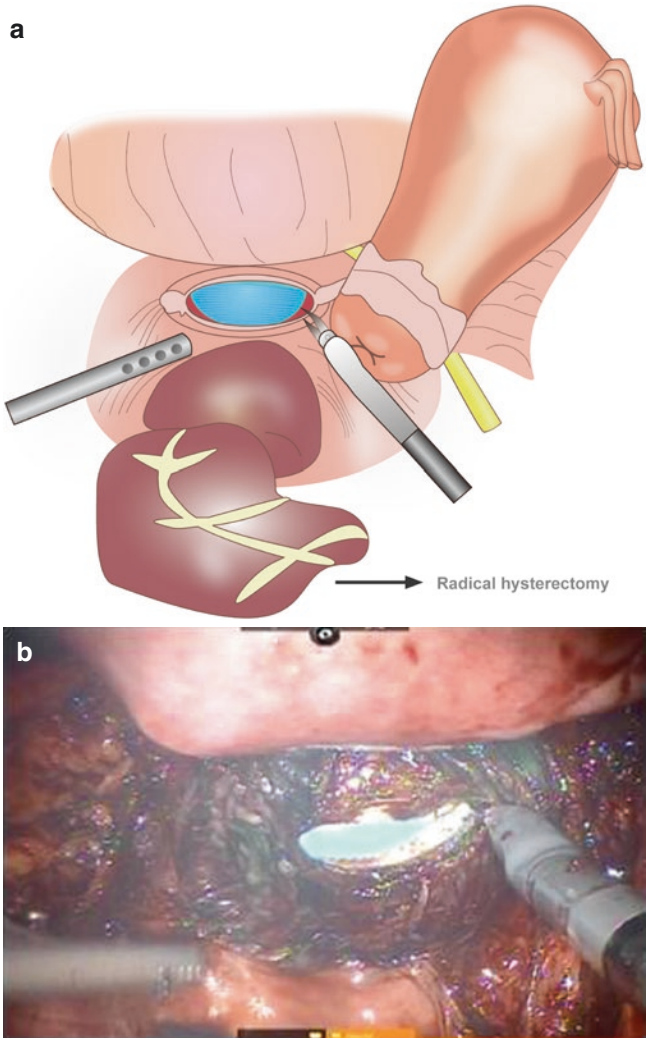


Fig. 63.17 (**a**) Illustration of colpotomy. (**b**) The colpotomy is made using monopolar scissors at posteriorly and anteriorly. The dissection is completed by circumscribing the vagina on the sucker bulb

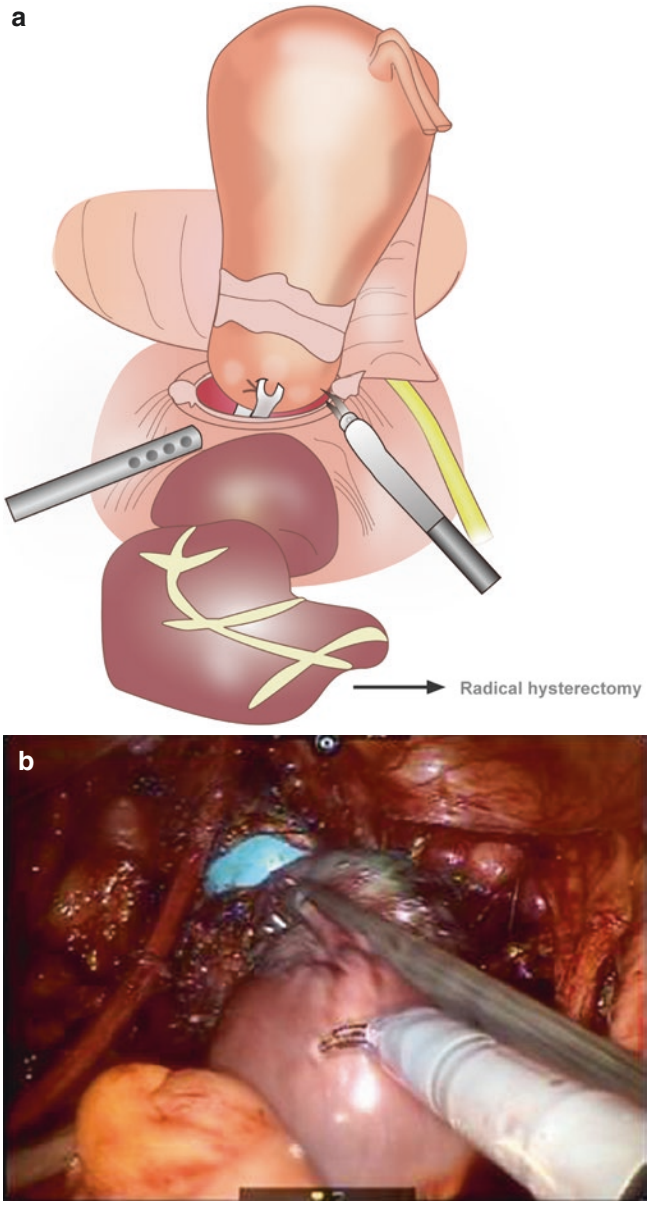


Fig. 63.18 (**a**) Illustration of removal of uterus. (**b**) The uterus is extirpated from the vagina using the Allis clamp or tenaculum forceps

Acknowledgement The authors acknowledge Ms. Hui-Yin Su for the preparation of illustrations.

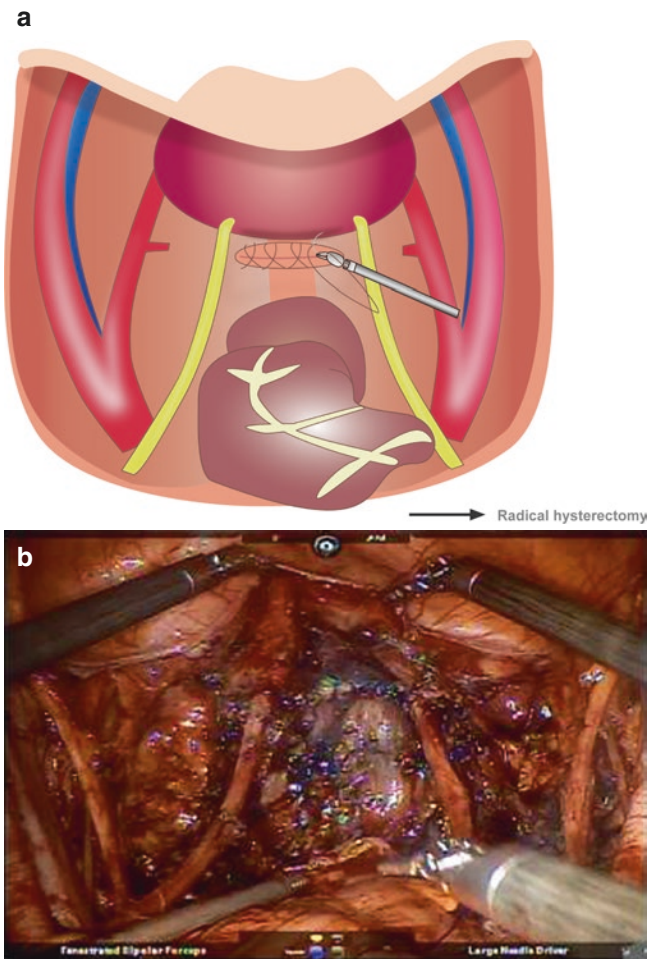


Fig. 63.19 (**a**) Illustration of vaginal cuff closure. (**b**) The panoramic view after vaginal cuff closure

References

1. Tan SJ, Lin CK, Fu PT, Liu YL, Sun CC, Chang CC, Yu MH, Lai HC. Robotic surgery in complicated gynecologic diseases: experience of Tri-Service General Hospital in Taiwan. Taiwan J Obstet Gynecol. 2012;51:18–25.
2. Diaz-Arrastia C, Jurnalov C, Gomez G, Townsend Jr C. Laparoscopic hysterectomy using a computer-enhanced surgical robot. Surg Endosc. 2002;16:1271–3.

Robotic-Assisted Total Hysterectomy: Hysterectomy Techniques in the Normal-Sized and Small Uterus

64

Megan N. Wasson and Javier F. Magrina

Introduction

The introduction of robotic technology has dramatically altered the surgical approach to hysterectomy. Following introduction of the robotic surgical system, there has been a dramatic decrease in the proportion of hysterectomies being performed via laparotomy. Furthermore, a continually growing number of hysterectomies are being performed via laparoscopy both with and without the assistance of robotic technology [1].

Patient Positioning

The combination of Trendelenburg and dorsal lithotomy positioning and can result in neurologic injury if not performed correctly. Correct preparation of the operating room table prior to the patient entering the operating room is essential (Figs. 64.1, 64.2, 64.3 and 64.4). Following administration of anesthetic, methodical positioning of the patient in the dorsal lithotomy position is performed (Figs. 64.5, 64.6, 64.7, 64.8, 64.9, 64.10, 64.11 and 64.12).If the patient is obese, the arms may be supported on arm boards placed alongside the operating table.



Fig. 64.1 The operating table is prepared for the patient by placing a draw sheet across the table. This will later be used to assist in securing the patient's arms at her side



Fig. 64.2 A piece of egg crate foam is placed on top of the draw sheet and operating table padding

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Fig. 64.3 The egg crate foam is then secured to the hand rails with tape



Fig. 64.6 It is ensured that the thighs and legs are gently flexed, the ankles and feet are evenly supported and hips are minimally abducted

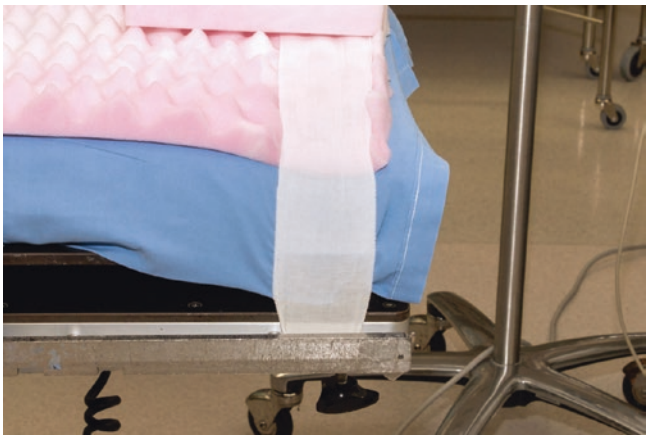


Fig. 64.4 Securing the egg crate foam to the hand rails will decrease the amount of sliding the patient will experience when placed in Trendelenburg



Fig. 64.7 Care is made to ensure the buttocks are firmly seated on the operating table. They must be at the edge of the table, but not overhanging



Fig. 64.5 After general anesthesia is achieved, the patient is placed in low dorsal lithotomy position using Allen stirrups

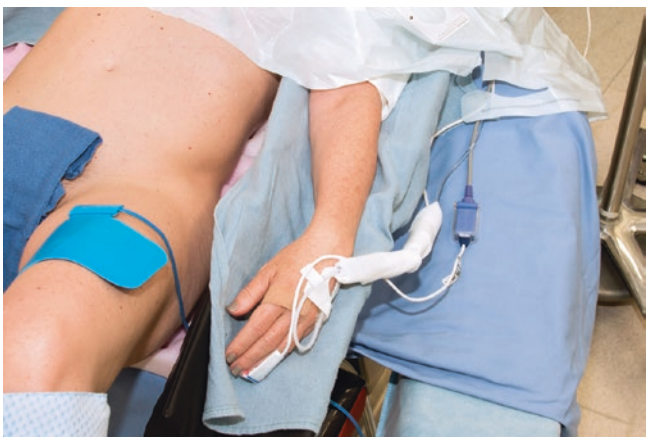


Fig. 64.8 The patient's arms are then padded with foam from the upper arm to her forearm



Fig. 64.9 The arm is the rested alongside the body, palm facing the thigh and fingers unclenched. Padding is provided to areas along the intravenous tubing which could result in pressure injury utilizing gauze wrapping



Fig. 64.10 The draw sheet is then wrapped over the arms and tucked underneath the patient's back. This securely fastens the arms to the side



Fig. 64.11 Care is taken to ensure there are no areas of pressure or potential nerve compression



Fig. 64.12 Correct positioning ensures that there are no areas or pressure or potential nerve compression

Trocar Placement

When completing a hysterectomy for a normal-sized or small uterus, four trocars are typically required (Fig. 64.13). One serves as the optical trocar, one serves as the assistant port, and two are used for the robotic arms. Use of the third robotic arm is not routinely necessary in these cases.

Correct placement of the trocars is essential to prevent robotic arm collision during the procedure. A common configuration consists first of the optical trocar placed through the deepest aspect of the umbilicus. Two robotic trocars are placed at the level of the umbilicus, 12 cm to the right and left, respectively. A 5 or 10 mm assistant trocar is positioned equidistant and 3 cm cranial between the umbilicus and the left robotic trocar.

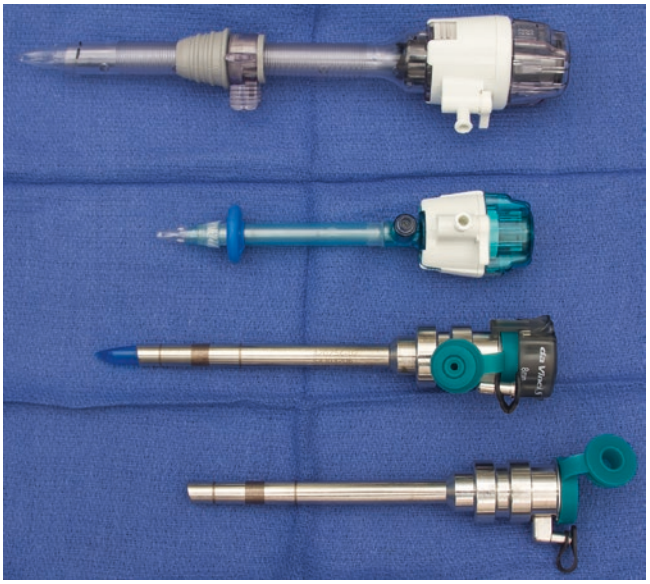


Fig. 64.13 Four trocars are typically required for completing a robotic hysterectomy



Fig. 64.14 The robotic column is maintained away from the operating table until the surgeon is ready for docking

Robotic Column Location

At the initiation of the hysterectomy, the robotic column is stored away from the surgical field (Fig. 64.14). When docking is performed, the robotic column can be placed in the midline or to the right or left of the patient. Midline placement is not ideal, as this impedes access to the vagina and thereby limits the ability for specimen removal or uterine manipulation (Fig. 64.15). Utilization of a template can assist in obtaining an optimal docking location (Figs. 64.16 and 64.17).

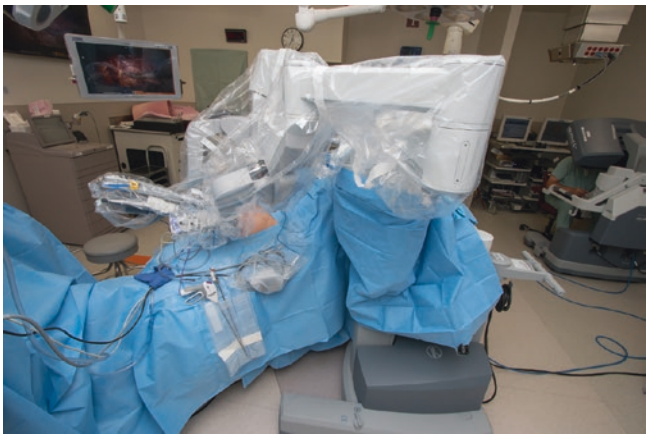


Fig. 64.15 Placing the robotic column to the left or right of the patient's legs eliminates the restriction faced with midline placement



Fig. 64.16 The Mayo Clinic robotic template is placed in the area of desired robotic column location



Fig. 64.17 Utilization of the Mayo Clinic robotic template facilitates accurate, efficient, and reproducible placement of the robotic column for all pelvic surgeries



Fig. 64.18 The robotic laparoscope is 12 mm in diameter and is introduced through the optical trocar at the umbilicus

Robotic Instrumentation

Following docking of the robotic system, the robotic instruments are introduced through the robotic trocars. The first instrument introduced is the laparoscope as this allows for direct visualization of all subsequent manipulation of the robotic instruments (Fig. 64.18).

Utilization of a bipolar instrument, monopolar instrument, and needle driver are essential to completing a robotic hysterectomy (Fig. 64.19).Use of the monopolar scissors or spatula is dependent on the surgeon's preference.

Typical placement of the robotic instruments for a right-handed surgeon consists of the monopolar instrument in the right hand and the bipolar instrument in the left hand (Fig. 64.20).

Monopolar energy is ideal for opening thin tissue layers overlying larger structures, such as the vesicouterine peritoneum. Monopolar energy can also be utilized to achieve and maintain hemostasis when addressing small or superficial blood vessels.

Bipolar energy is ideal when larger vessels are encountered and able to be isolated from surrounding structures. Coagulation of the infundibulopelvic ligament or uterine arteries can be achieved with either bipolar energy or a vessel sealing device. If bipolar energy is utilized to coagulate large blood vessels, monopolar energy must be employed for vessel transection.

When the time comes for suturing, the monopolar instrument is exchanged for the meganeedle holder.

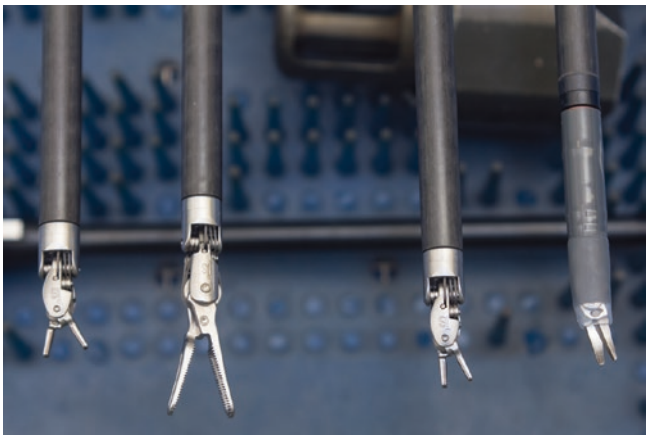


Fig. 64.19 For completion of a hysterectomy for a normal-sized or small uterus, the most commonly used instruments are the bipolar PK dissecting forceps, monopolar scissors or spatula, and meganeedle holder. When permitted, it is preferred that the meganeedle holder have the incorporated suture-cutting scissors

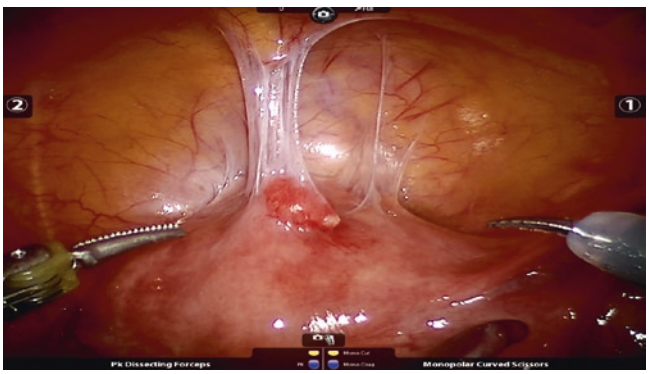


Fig. 64.20 The monopolar instrument is used with the right arm and a bipolar PK dissecting forceps is used with the left arm for right-handed surgeons



Fig. 64.21 Various laparoscopic instruments are utilized by the assistant

Use of Assistants

The efficiency and economy of the hysterectomy is improved by the use of a trained, knowledgeable assistant. The assistant provides assistance with vessel-sealing, suction and irrigation, tissue retraction, specimen retrieval, introduction and removal of suture and needles, and correcting malfunctions of the robotic instruments or arms (Fig. 64.21).

Hysterectomy Procedure for a Normal or Small-Sized Uterus

To begin a robotic hysterectomy, first expose the pelvic side wall by placing traction on the round ligament. Enter the retroperitoneal space by incising the peritoneum adjacent to the infundibulopelvic ligament (Fig. 64.22). Further open the retroperitoneal space to identify the ureter (Fig. 64.23). Following identification of the ureter, the infundibulopelvic ligament can be easily isolated and divided if a salpingo-oophorectomy is desired (Figs. 64.24 and 64.25). The peritoneum is then opened further separating the uterus from the pelvic side wall (Fig. 64.26). The round ligament is then divided (Fig. 64.27). The vesicouterine peritoneum is then opened to develop the bladder flap (Fig. 64.28). Continue to open the broad ligament and skeletonize the uterine vessels (Fig. 64.29).Follow the ureter starting at the pelvic brim where it is most easily identified. The distance between the cervix, uterine vessels, and the ureter should be noted to estimate the risk of ureteral injury when dividing the cardinal ligament.

If the ureter appears coursing towards the cervix, divide the uterine artery over the ureter and displace the ureter laterally. Utilize the vessel sealing device to seal and divide the lower cardinal ligaments adjacent to the cervix bilaterally (Fig. 64.30).

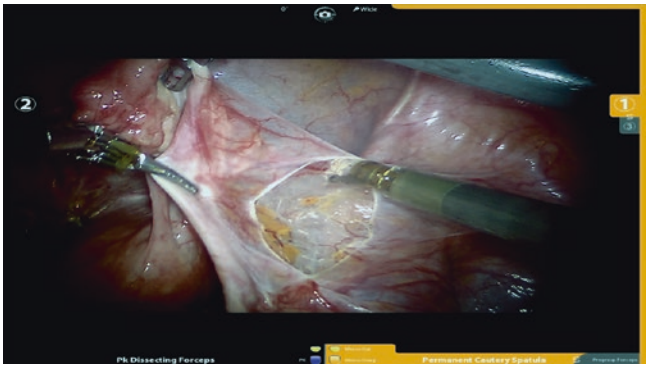


Fig. 64.22 Grasp the uterus by one of the round ligaments and pull it towards the patient's contralateral side. Make a peritoneal incision lateral and parallel to the infundibulopelvic ligament using monopolar energy

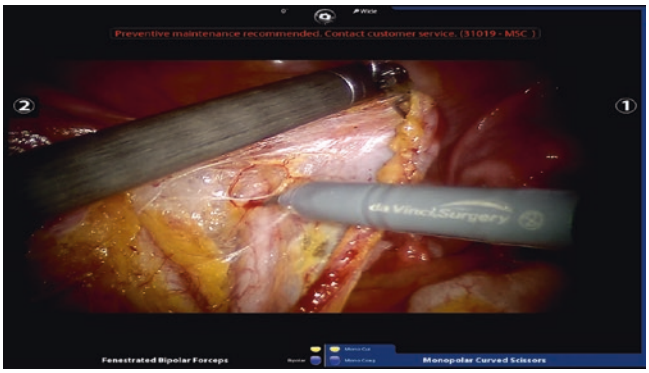


Fig. 64.23 Open the retroperitoneal space lateral to the infundibulopelvic ligament using monopolar energy and identify the ureter. Short bursts of monopolar energy followed by blunt dissection allows hemostasis to be maintained, while decreasing risk of injury to surrounding structures

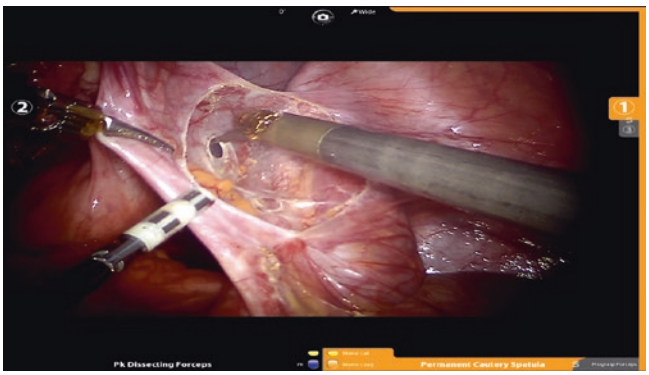


Fig. 64.24 Create a window in the medial leaf of the broad ligament above the ureter and below the infundibulopelvic ligament using monopolar energy

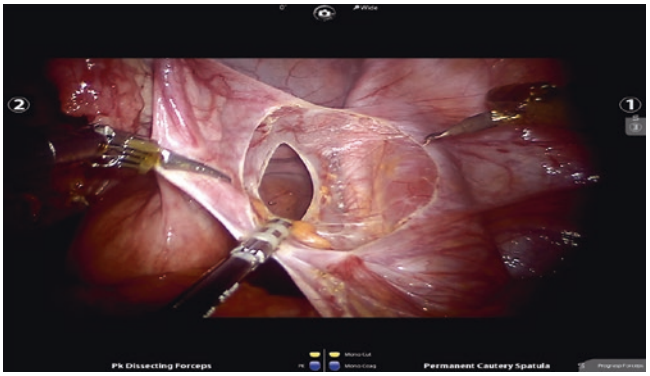


Fig. 64.25 Grasp and divide the infundibulopelvic ligament using a vessel sealing device

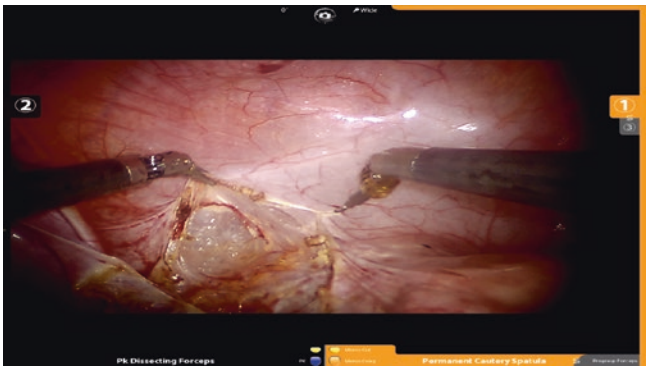


Fig. 64.28 Using monopolar energy from the scissors or the spatula incise the anterior leaf of the broad ligament towards the vesicouterine peritoneal reflection

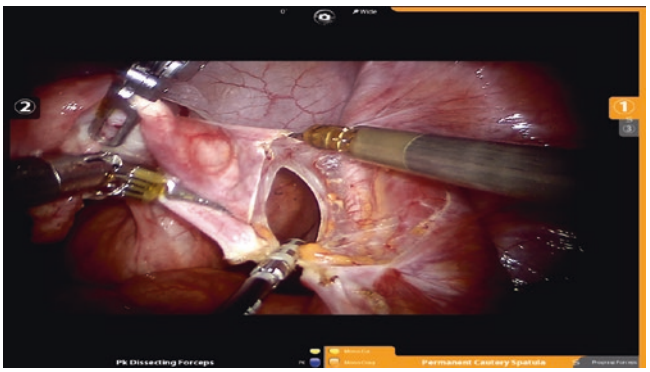


Fig. 64.26 Using monopolar energy, incise the peritoneum overlying the external iliac vessels towards the lateral aspect of the round ligament

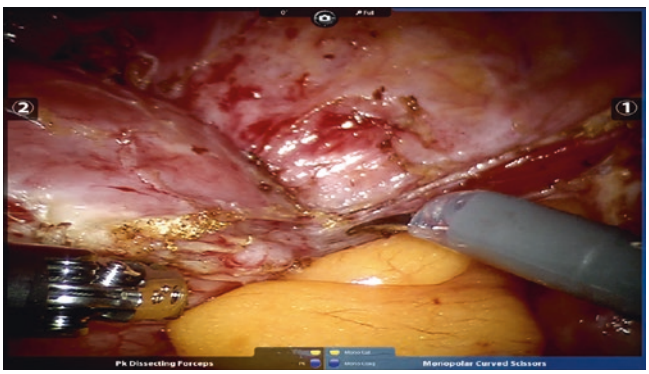


Fig. 64.29 Dissect the retroperitoneal areolar tissue in the broad ligament using monopolar energy until the uterine vessels are clearly visible along the lateral wall of the uterus

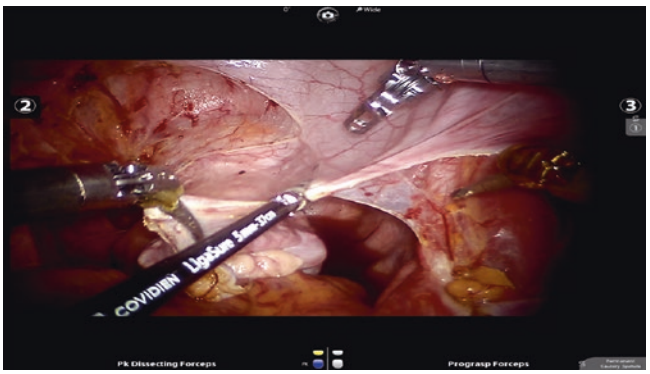


Fig. 64.27 Transect the round ligament at its lateral aspect using the bipolar PK dissecting forceps and monopolar energy or a vessel sealing device

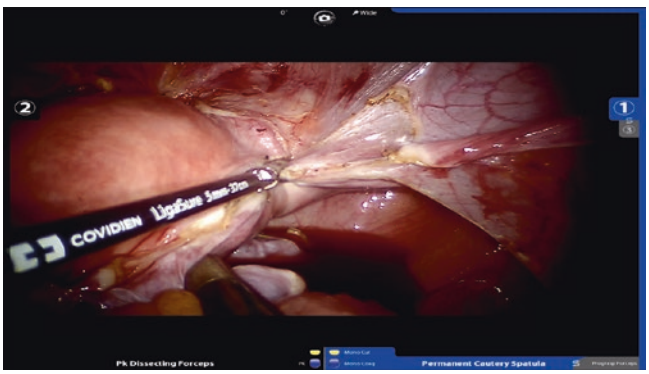


Fig. 64.30 Utilize a vessel sealing device to divide the upper cardinal ligament adjacent to the lateral cervical wall

All steps are then repeated on the opposite side.

Utilize a vaginal probe to assist with further development of the bladder flap (Figs. 64.31 and 64.32).

When performing a hysterectomy on a patient with history of cesarean delivery, adhesions between the bladder and uterus are likely to be encountered. Care must be employed to safely separate the bladder from the uterus (Figs. 64.33 and 64.34).

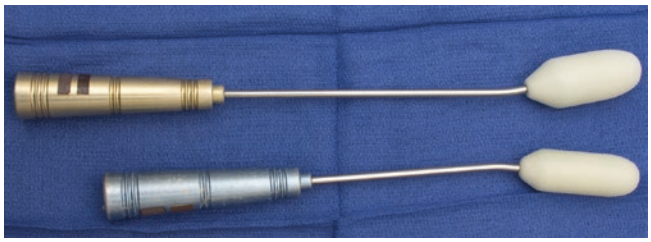


Fig. 64.31 To assist with bladder dissection, the surgical technician introduces a reusable vaginal probe or cervical cup. This helps to facilitate bladder dissection and identification of the cervicovaginal junction. A uterine manipulator is not required with this technique



Fig. 64.32 The bladder is dissected from the anterior cervix and upper vagina at a distance of 1–2 cm from the cervicovaginal junction by separating the areolar tissue between the cervix and bladder using monopolar energy. The dissection is carried out first in the midline and then to the right and left



Fig. 64.33 Patients with a history of cesarean delivery can develop scar tissue between the bladder and uterus

The vaginal probe is also essential for identifying the cervicovaginal junction (Fig. 64.35). Monopolar energy is then utilized for perform a circumferential colpotomy (Figs. 64.36, 64.37, 64.38 and 64.39). When making the colpotomy, maintenance of pneumoperitoneum is achieved by

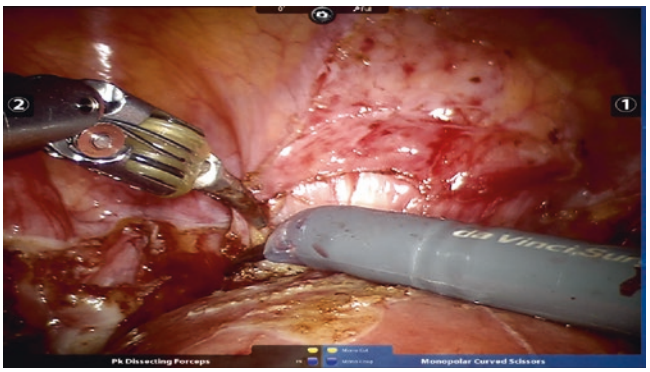


Fig. 64.34 In patients with a history of cesarean section, the dissection is carried out first on the right or left of the uterine scar and then in the midline



Fig. 64.35 The cervicovaginal junction is identified and marked with monopolar energy

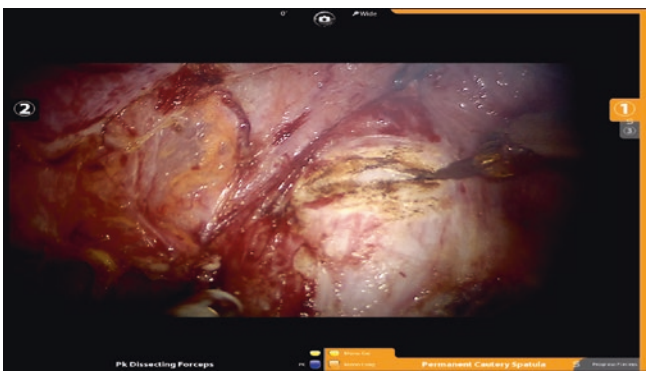


Fig. 64.36 Perform a colpotomy utilizing monopolar energy starting at the 12 o'clock position at the previously identified site on the cervicovaginal junction. It is preferred that this is completed on the "cut" monopolar energy setting

approximating the labia majora in the midline over a laparotomy sponge.

Following completion of the colpotomy, the uterus is delivered through the vagina (Fig. 64.40). Pneumoperitoneum is then maintained utilizing a vaginal occluder (Fig. 64.41).

The vaginal cuff is then closed with barbed suture in a continuous fashion, with a continuous suture using 2-0 PDS, or with interrupted figure-of-eight sutures (Figs. 64.41, 64.42, 64.43, 64.44, 64.45, 64.46, 64.47, 64.48, 64.49, 64.50, 64.51, 64.52, 64.53, 64.54, 64.55, 64.56, 64.57 and 64.58).

Assess for hemostasis including lowering the intraabdominal CO_2 pressure, allowing visualization of any venous bleeding. Any areas of bleeding should be identified. Small,

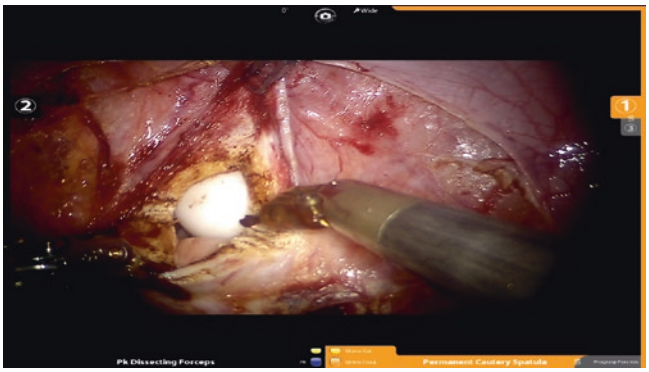


Fig. 64.37 Extend the colpotomy towards the right vaginal fornix

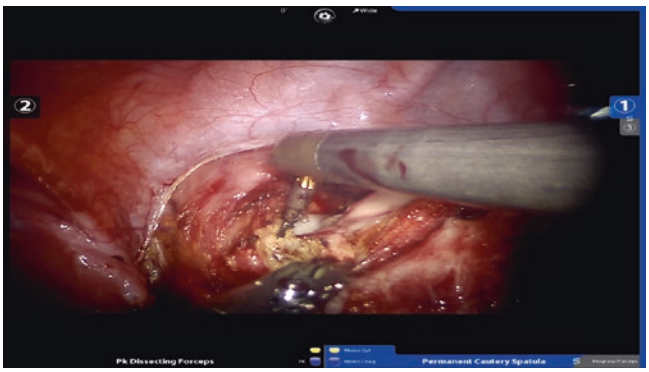


Fig. 64.38 Continue the colpotomy circumferentially along the cervico-vaginal junction

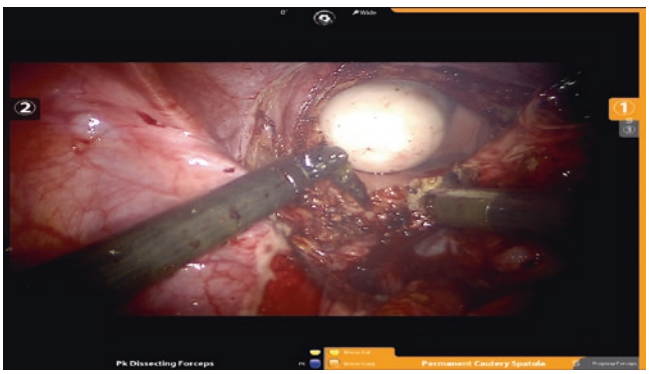


Fig. 64.39 Continue the colpotomy posteriorly until the previous site of transection is met on the opposite side

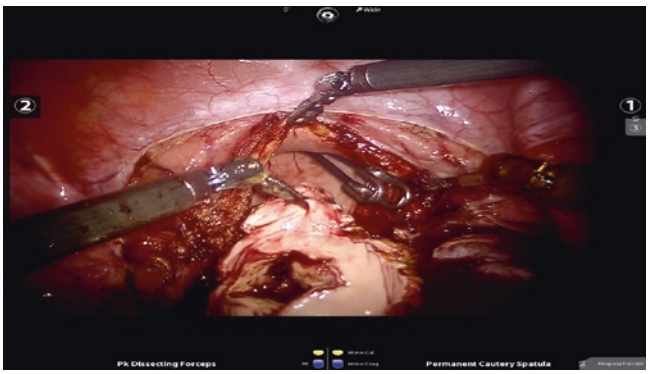


Fig. 64.40 Once the colpotomy is complete, a double-toothed tenaculum is introduced through the vagina, while maintaining approximation of the labia majora. The cervix is then grasped and the uterus is removed through the vagina

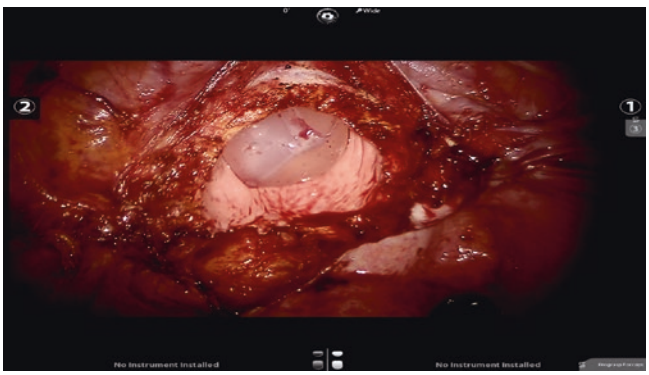


Fig. 64.41 Following specimen removal, a plastic balloon is placed in the vagina and filled with 60 mL of water. This allows pneumoperitoneum to be maintained throughout colpotomy closure

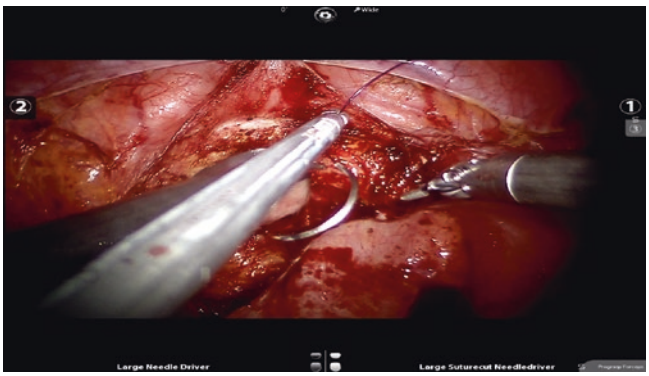


Fig. 64.42 The assistant then exchanges the monopolar device for the meganeedle holder and introduces the needle and suture for the vaginal cuff closure

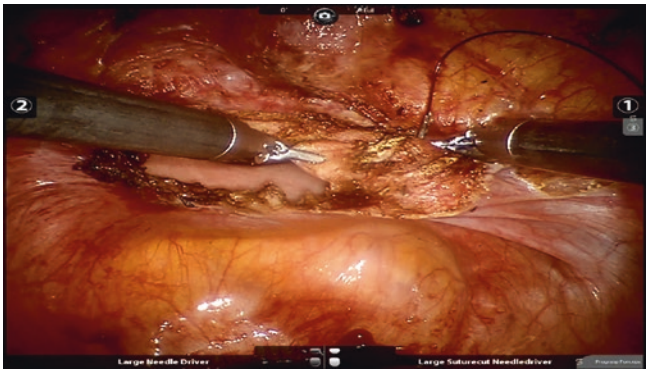


Fig. 64.43 To close the cuff with figure-of-eight sutures, the vaginal angle is first everted and the vaginal mucosa is exposed using the non-dominant hand. The needle is then placed laterally to the vaginal angle. Care is taken to avoid entrapment of the ureter

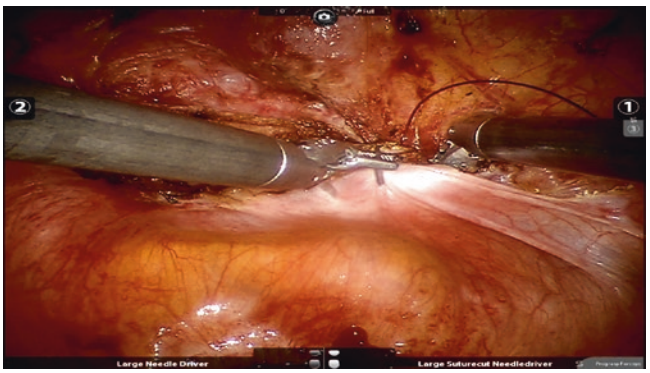


Fig. 64.44 The non-dominant hand then grasps the needle as it exits the uterosacral ligament and overlying peritoneum

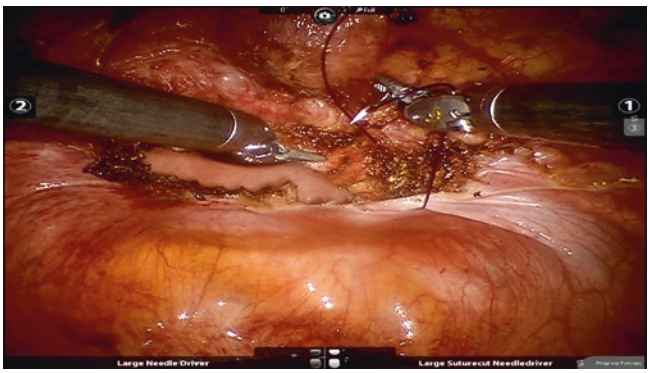


Fig. 64.45 The needle is transferred back to the dominant hand. The anterior portion of the vaginal cuff is then grasped and everted with the non-dominant hand. The needle is placed through the vaginal cuff using the dominant hand

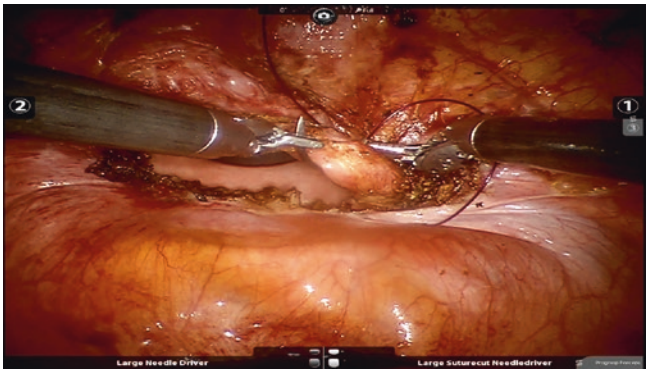


Fig. 64.46 The non-dominant hand then grasps the needle as it exits the vaginal mucosa

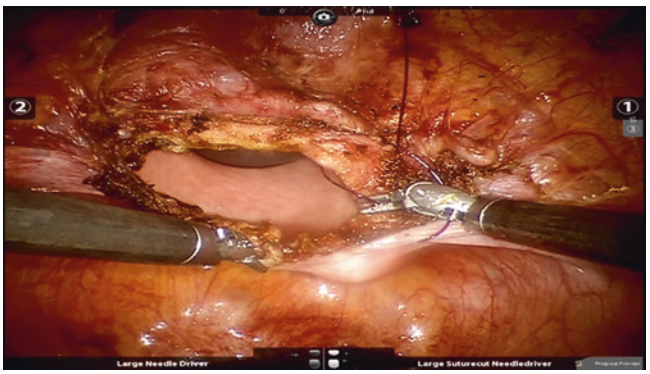


Fig. 64.47 The needle is transferred back to the dominant hand. The posterior portion of the vaginal cuff is then grasped and everted with the non-dominant hand. The needle is placed through the vaginal cuff using the dominant hand

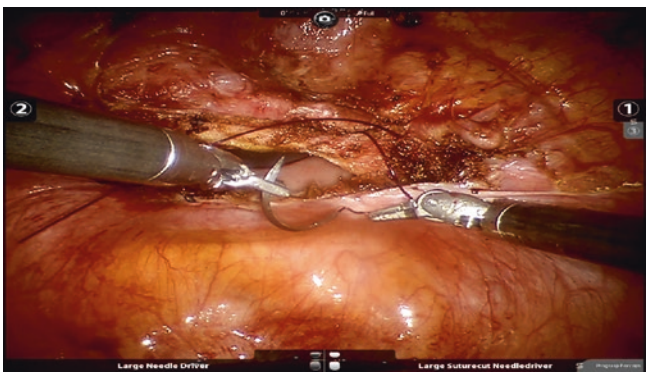


Fig. 64.48 This technique creates a figure-of-eight stitch

superficial vessels can be coagulated using monopolar energy. Larger vessels, such as the uterine artery, can be coagulated using bipolar energy or a vessel sealing device.

When assured of excellent hemostasis, undock the robotic arms from the trocars. The robotic column is then moved away from the patient to its initial parking location. The surgeon returns to the operating table to assist with closure.

During vaginal cuff closure, 5 mL of indigo carmine is injected intravascularly. Depending on the trained personnel available, cystoscopy is performed before, during, or after trocar closure to ensure bladder integrity and bilateral ureteral outflow.

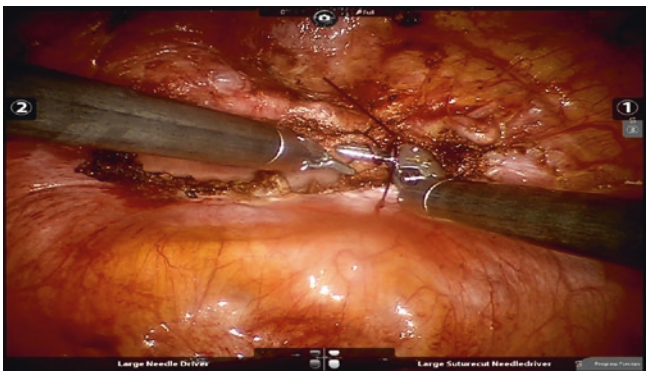


Fig. 64.49 The dominant hand is then placed along the suture line. The non-dominant hand is used to wrap the suture counter-clockwise around the dominant hand for two complete circles. This creates a surgeon's knot

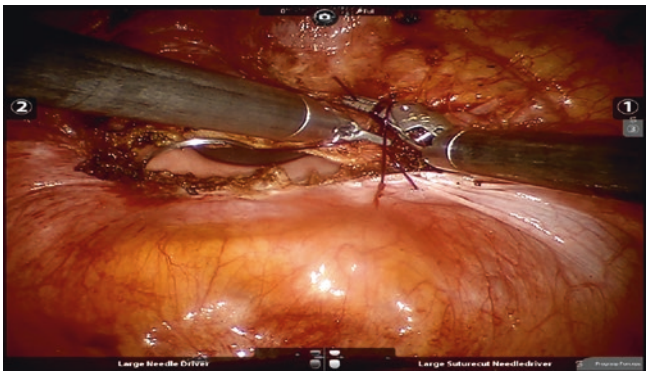


Fig. 64.50 The dominant hand then grasps the free end of the suture

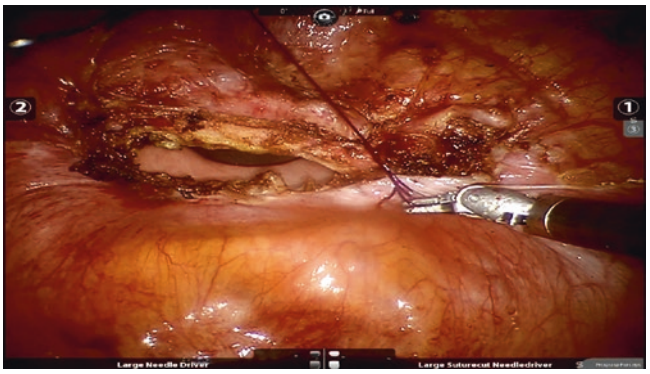


Fig. 64.51 The dominant and non-dominant hands are then pulled apart. The knot is laid flat

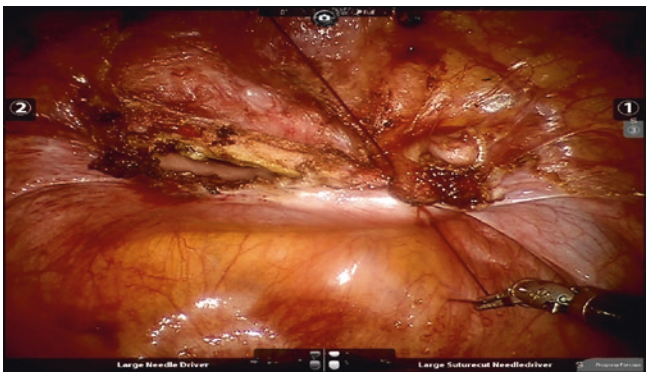


Fig. 64.52 Tension is applied to ensure tight approximation of the cuff edges

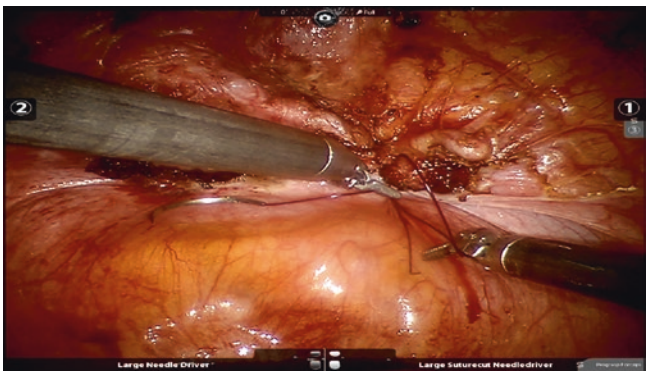


Fig. 64.53 The non-dominant hand is used to wrap the suture clockwise around the dominant hand. The dominant hand then grasps the free end of the suture

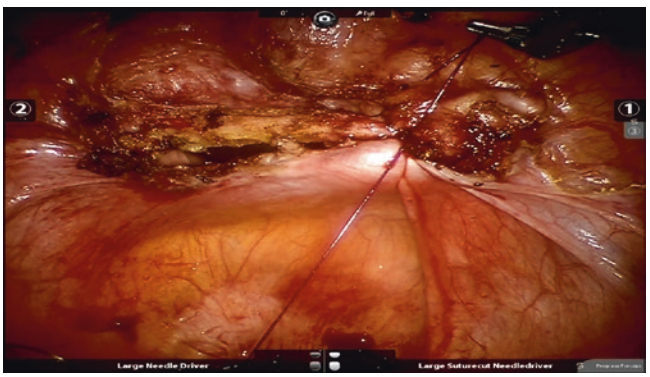


Fig. 64.54 The dominant and non-dominant hands are then pulled apart, creating a square knot. This is repeated for an additional two throws. The suture is then cut and the steps repeated along the entire length of the vaginal cuff

While performing cystoscopy, pneumoperitoneum is evacuated to decrease the intraabdominal pressure. Following cystoscopy reestablish pneumoperitoneum and evaluate for hemostasis.

Close the fascia on all laparoscopic ports greater than or equal to 10 mm using a delayed absorbable suture, such as 0-0 vicryl. A fascial closure device can be used to provide assistance.

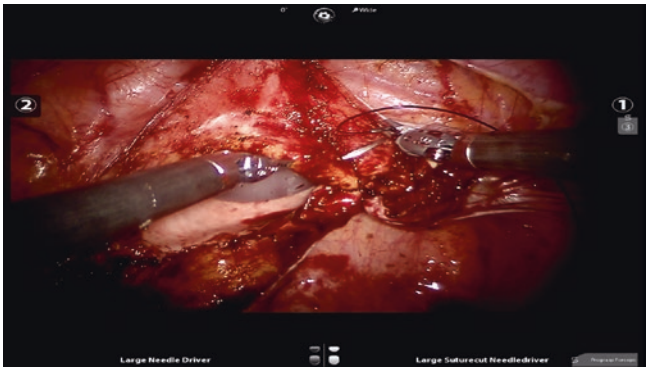


Fig. 64.55 Regardless of the technique, the needle is placed 5 mm from the outer (not mucosal) vaginal margin, which is easily identifiable by the cautery marking. The needle bites are placed at 5 mm intervals

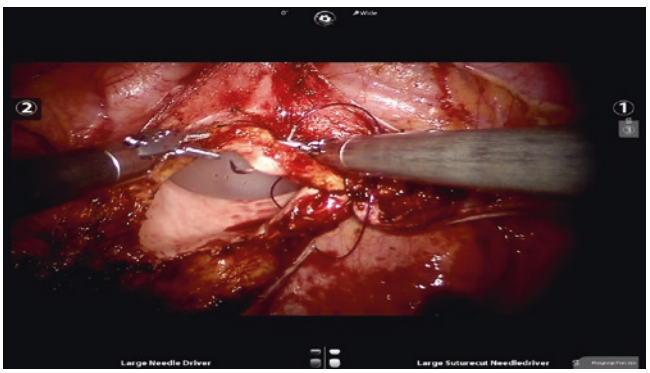


Fig. 64.56 Eversion of the vaginal mucosa confirms adequate distance from the vaginal margin

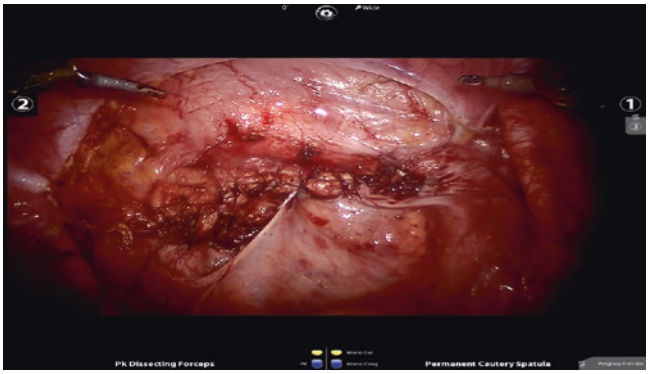


Fig. 64.57 Care is taken to incorporate the uterosacral ligaments at each vaginal angle

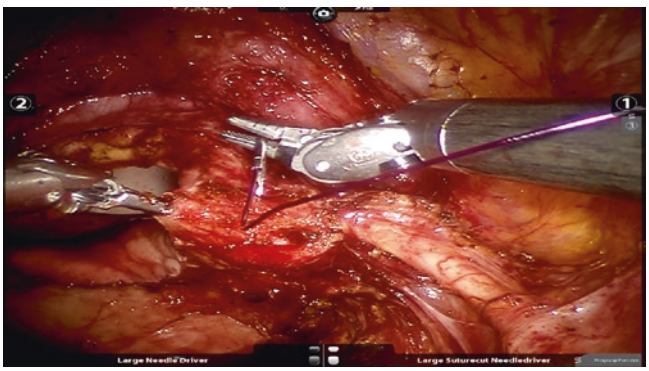


Fig. 64.58 Ensure adequate distance between the cuff closure and the ureters

Reference

1. Wright JD, Herzog TJ, Tsui J, Ananth CV, Lewin SN, YS L, Neugut AI, Hershman DL. Nationwide trends in the performance of inpatient hysterectomy in the United States. Obstet Gynecol. 2013;122:233–41.

Suggested Reading

Kho RM, Hilger WS, Hentz JG, Magtibay PM, Magrina JF. Robotic hysterectomy: technique and initial outcomes. Am J Obstet Gynecol. 2007;197(1):113.e1–4.

Magrina JF, Kho R, Magtibay PM. Robotic radical hysterectomy: technical aspects. Gynecol Oncologia. 2009;113(1):28–31. Epub 2009 Jan 26.

Robotic-Assisted Total Hysterectomy: Hysterectomy Techniques for the Large Uterus

65

Dan-Arin Silasi

Introduction

Uterine leiomyomata are common benign tumors in women of reproductive age. They can reach significant sizes and cause debilitating symptoms such as abnormal uterine bleeding, dysmenorrhea, pelvic pain, dyspareunia, or urinary and intestinal symptoms.

Hysterectomy is the definitive treatment for leiomyomata, and in the United States leiomyoma represents the leading indication for this operation [1, 2]. Published studies recognize laparoscopy as a surgical approach with better outcomes when compared with laparotomy [3].

However, the ability to perform a laparoscopic hysterectomy decreases as the uterine size increases [4–7]. Other deterrents for a laparoscopic approach are a history of abdominal or pelvic surgeries and morbid obesity [8].

In our practice, we believe that the robotic surgical system has significantly impacted patients who present with a surgical indication for very large uteri [9].

In our experience, a large uterine size does not constitute a contraindication for robotic surgery and none of our surgeries for uteri larger than 1000 grams have required laparotomy [10–13]. This chapter addresses the challenges in robotic surgery when treating patients with a very large myomatous uterus.

Preoperative Evaluation

Our routine preoperative evaluation includes taking a complete history and performing a physical examination. Aspects to consider are the size and mobility of the uterus and the vaginal caliber.

Uterine Mobility

Very large uteri are commonly wedged into the pelvis but in most cases, on examination, the uterus can be mobilized cephalad, sometimes by just a few millimeters. When uterine mobility is present, even when it is severely limited, access can be gained to the uterine vessels and to the ureters. A frozen pelvis should be addressed with caution. The most common cause of lack of mobility is the expansion of the leiomyomata deep into the retroperitoneum. In these cases, extensive retroperitoneal dissection will be necessary to free the uterus and gain access to the vascular pedicles and ureters (Fig. 65.1).

Vaginal Caliber

With the exception of a few patients who present with a very wide vaginal caliber or extensive uterine adenomyosis rendering the uterus soft and pliable, the uterus will be too large to be delivered transvaginally intact. In most cases, the uterus will be morcellated in the vagina. Morcellation via minilaparotomy should be reserved for patients with unfavorable vaginal anatomy.

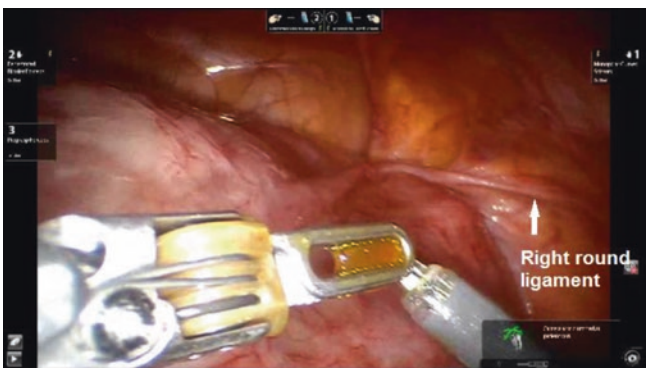


Fig. 65.1 The uterus is too large to fit into the operator's view. It is wedged into the pelvis. Extensive retroperitoneal dissection is necessary to free the uterus and gain access to the ureters and vessels

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Uterine Size

Imaging studies for evaluation of the pelvic anatomy and uterine size are not routinely ordered in our practice unless very large pelvic masses are identified preoperatively [14]. Large masses are not a contraindication to robotic surgery if they have a cystic component. This will allow the mass to be contained in a laparoscopic bag; the mouth of the bag will then be everted at the vaginal introitus and the mass will be partially drained without any spillage or contamination of the peritoneal cavity. The limiting factor is the diameter of the laparoscopic bags available to the surgeon from the supply room. The largest laparoscopic bag available at our institution is the 20 cm wide LapSac® Surgical Tissue Pouch by Cook Medical (Bloomington, IN) (Fig. 65.2).

GnRH Analogues

We do not routinely administer gonadotropin release hormone (GnRH) analogues. In most cases, they will decrease the uterine size and may improve the preoperative anemia. However, the uterine sizes addressed in this chapter are too large for GnRH analogues to make a meaningful impact at the time of surgery.

Preoperative Diagnosis of Cancer

Patients who present with abnormal uterine bleeding require endometrial sampling prior to hysterectomy. The tests available to diagnose uterine sarcomata preoperatively are unreliable.

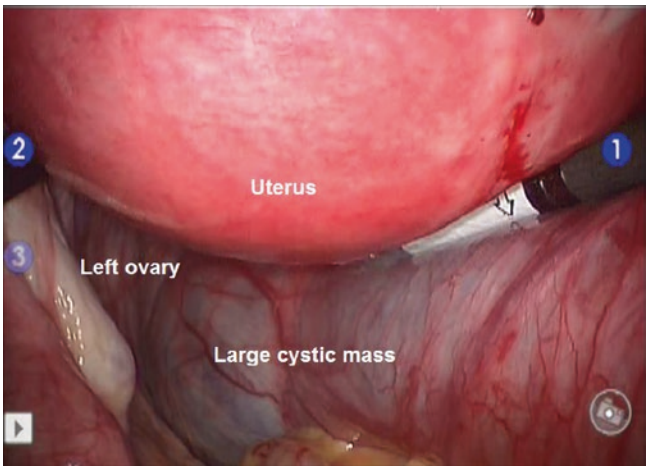


Fig. 65.2 Large myomatous uterus and large cystic mass. The cyst was densely adherent to the cul-de-sac peritoneum and rectum serosa

Bowel Preparation

Preoperative mechanical bowel preparation is common in the clinical practice of laparoscopic pelvic surgeons. Current clinical data, mostly obtained from colorectal surgery practice, offers no evidence to support the claim that preoperative colon cleansing reduces the risk of anastomotic leaks or infectious complications. On the contrary, doing so may increase the rate of anastomotic complications. For laparoscopic gynecologic procedures, randomized controlled trials have shown no improved exposure during the procedure [15]. Preoperatively, our patients are given instructions for a clear liquid diet the day before the procedure.

However, certain aspects related to the lack of exposure in these patients need to be mentioned. In obese patients, the mesentery and epiploica are heavily laden with fat and so the volume that the intestines occupy in the peritoneal cavity is much larger. This impairs the manipulation of the bowel and its storage in the upper abdomen during pelvic surgery. Also, the hypertrophic omentum also takes up more space in the upper abdomen, thus displacing the bowel towards the pelvis. In addition, the severely hypertrophic uterus takes up the entire pelvis and a good portion of the abdomen. For these reasons, in some cases, preoperative bowel preparation may be of value by decreasing the amount of intraluminal chime, hopefully allowing better exposure and visualization. In these cases, where the operator struggles to obtain visualization, considerations other than the preoperative patients' discomfort should be prioritized, such as intraoperative safety and reduced operative time.

Patient Positioning

We use two positioning methods:

- The patients are positioned on a gel pad over a bean bag (Vac-Pac® Olympic Medical, Seattle, WA) and then placed in a dorsal low lithotomy position using Yellofin® stirrups (Allen Medical Systems, Acton, MA). The disadvantage of using the bean bag is that a laparotomy retractor such as the Bookwalter retractor cannot be attached to the operating table's siderails in case of conversion to laparotomy (Fig. 65.3)
- Alternatively, a foam pad and padded shoulder braces can achieve the same stabilization of the patient (Figs. 65.4, 65.5 and 65.6)



Fig. 65.3 The patient is stabilized on a bean bag with the help of a sling made from hospital sheets



Fig. 65.4 The patient is placed on Devon™ Trendelenburg Positioning Kit (Medtronic, Minneapolis, MN)



Fig. 65.5 The hands are protected and the arms are tucked

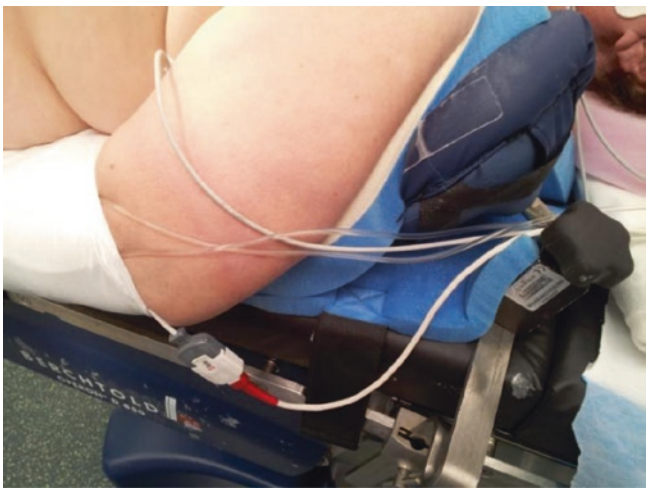


Fig. 65.6 Shoulder supports prevent the patient from sliding on the table. The pressure is on the infraspinous fossa, not on the acromion

Port Placement

Commonly we place the ports symmetrically, in an arch centered by the camera port ("sunrise or half-moon distribution"). The camera port is inserted at a level that is higher than the uterine fundus. If the uterine fundus extends to the xyphoid, the initial port can be placed in the left upper quadrant or left flank to achieve pneumoperitoneum and visualization.

These port configurations work well for all 3 robotic systems: S, Si, and Xi (Figs. 65.7, 65.8 and 65.9).

Sunrise placement of ports: Variations of the sunrise configuration can be used, depending on the particular anatomy of the patient (Figs. 65.10, 65.11, 65.12, 65.13, 65.14, 65.15 and 65.16).

The surgeon can oversee the entire operative field when performing hysterectomies for moderately sized uteri. This is not possible in most cases described in this chapter. The lack of access and visualization and particularities of each case dictate the strategy in each operation. The same operative routine will not be applicable in different patients. Instead, the surgeon must visualize in his/her mind the



Fig. 65.7 The most common port placement (sunrise): the camera port located above the umbilicus, one robotic port and the assistant port on each side of the umbilicus and two robotic ports below the umbilicus. This is the Xi system; from right to left: arm 1 (Prograsp), arm 2 (fenestrated bipolar), arm 3 (camera port), 12 mm assistant port, arm 4 (monopolar scissors)

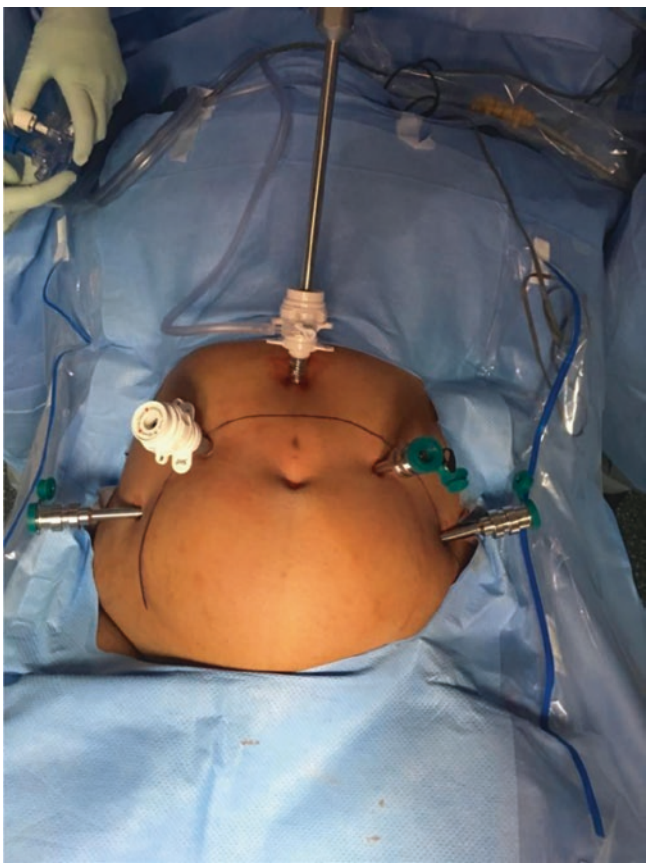


Fig. 65.8 The sunrise placement for the S and Si systems. From right to left: arm 3 (Prograsp), arm 2 (fenestrated bipolar), camera arm and port, 12 mm assistant port, arm 1 (monopolar scissors). The contour of the uterus is outlined on the abdominal wall for illustration purposes

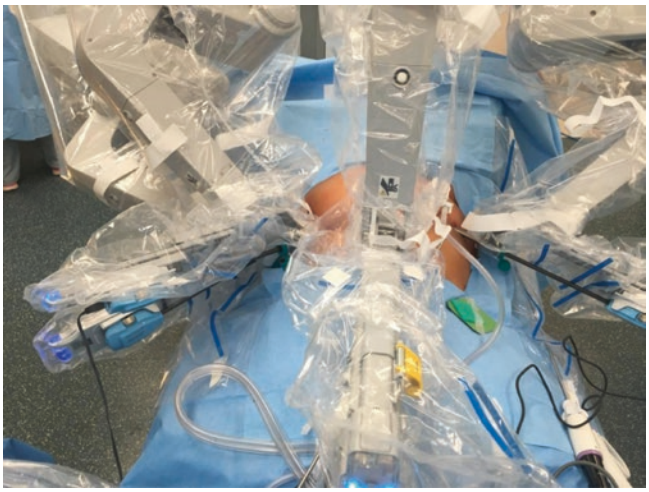


Fig. 65.9 The Si system after docking.

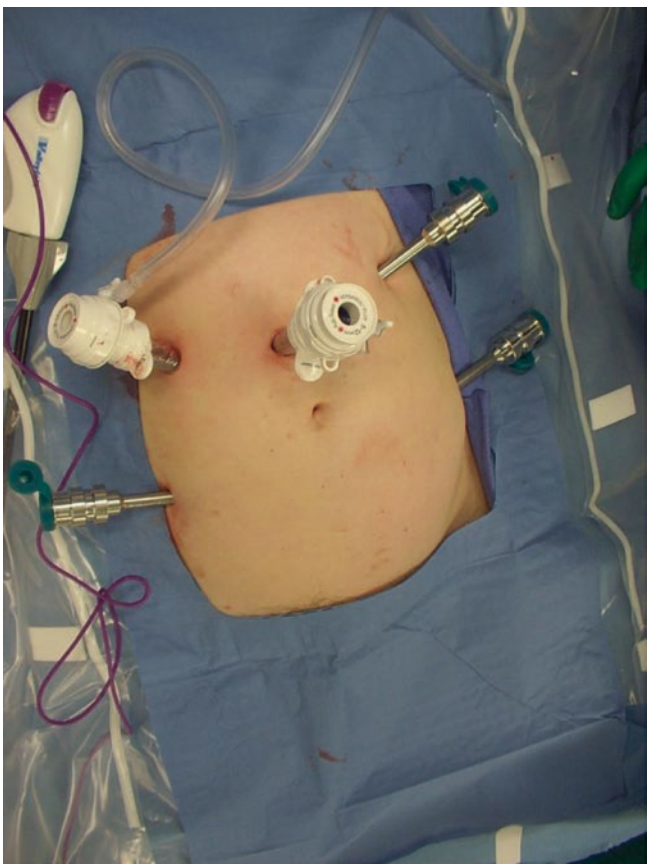


Fig. 65.10 The camera port is midline and above the umbilicus. The abdomen of this patient is long and narrow. For this patient, this port configuration is more favorable than the usual sunrise placement since the ports are closer to each other. This configuration prevents the arms clashing during the procedure



Fig. 65.11 Tips and tricks: Telescoping. Freehand laparoscopy and camera placement through several ports (for lysis of adhesions, etc.) may be needed prior to docking. The camera of the Xi system is 8 mm in diameter and fits through all ports. However, this is not the case for the S and Si systems. The figure shows the repurposing of a regular port into a robotic port. A port-in-a-port placement works well, without undue tension on the fascia

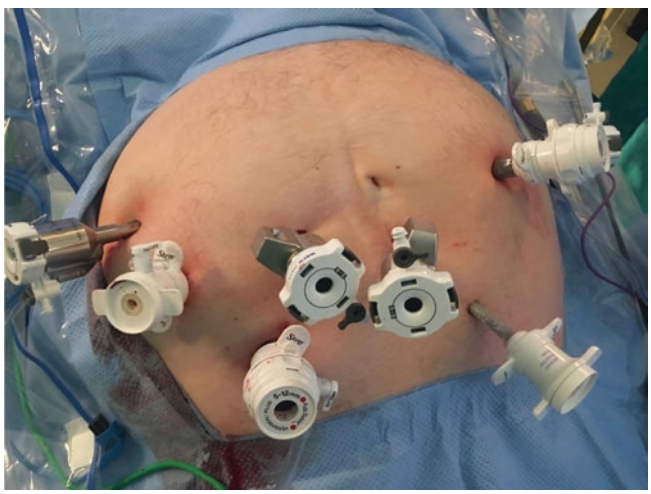


Fig. 65.12 Severe adhesions in the entire abdomen required placement of more ports. Additional laparoscopic incisions will have no detrimental impact on the patient's recovery

necessary to complete the procedure and the remaining surgical steps and bring everything together in the end.

Sometimes simple adjustments like switching a 0º degree to a 30º camera provide significant payback. The figures show how the visual field changes dramatically when switching cameras. One has to remember that the angle of the camera to the patient's body changes for different angles of the lens. The 30º camera is much closer to the patient's face and padding of the face and endotracheal tube is prudent (Fig. 65.17).

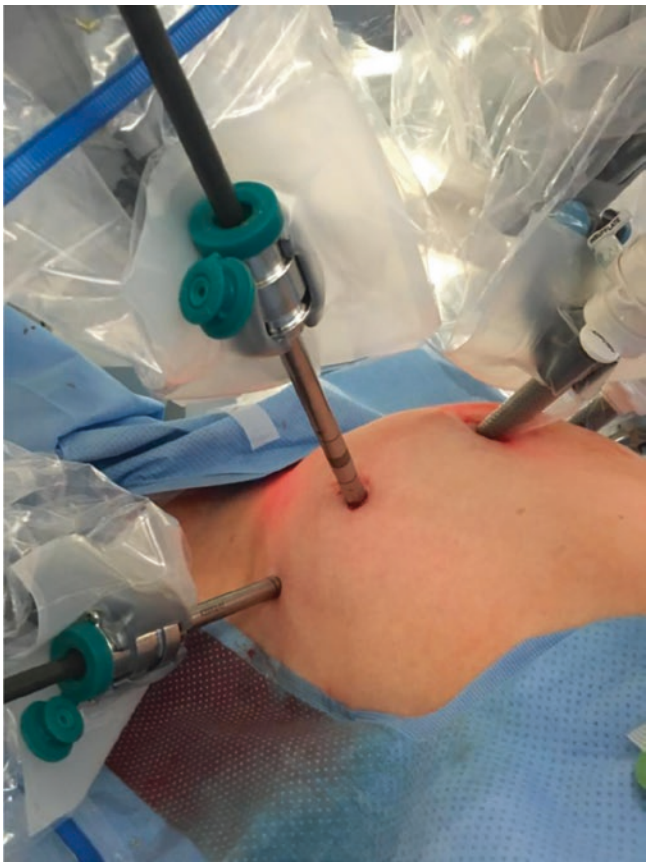


Fig. 65.13 Tips and tricks. S and Si systems: The best use of the obesity trocar is in very thin patients. In a patient with a narrow abdomen the ports will be very close to each other. The figure shows the camera port (right), the obesity trocar for arm 2 (middle) and a regular robotic port for arm 3 (left). This "stacking" will prevent clashing of the robotic arms during the procedure

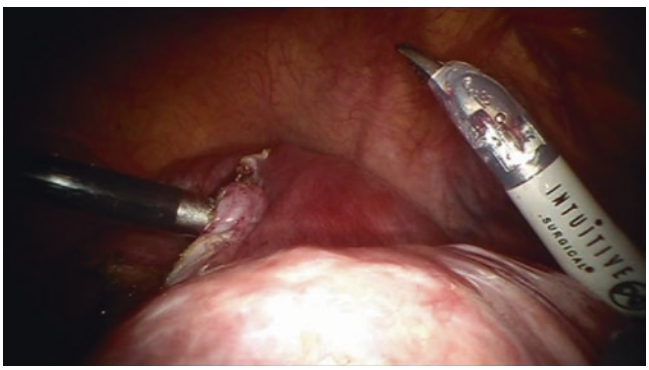


Fig.65.14 A large myoma causes ballooning of the lower uterine segment. In cases like this, changing the 0 ° to a 30 ° camera helps visualization when developing the bladder flap

Sometimes, additional ports may need to be inserted during difficult cases, mostly to assist with bowel retraction and exposure or when instruments cannot reach from one side of

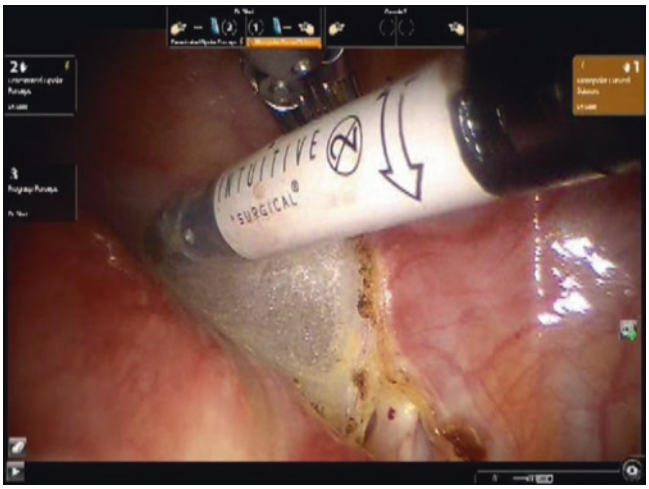


Fig. 65.15 This is an example of how visualization improves when changing the 0º degree to a 30 ° camera. Figure 65.15 shows the maximum achievable visualization with the 0 ° camera

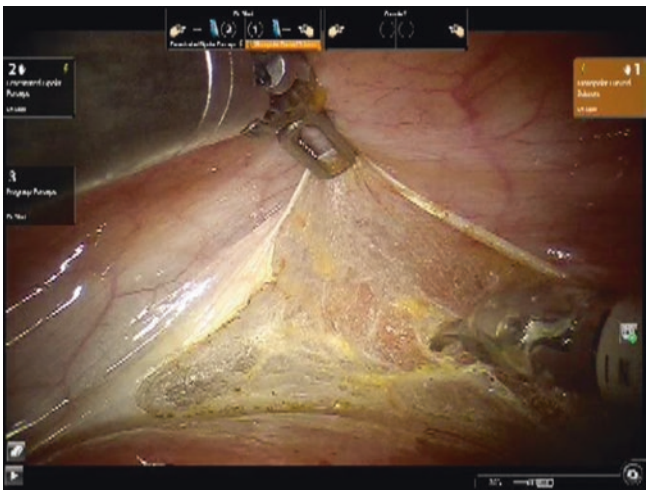


Fig. 65.16 It is easier to complete the bladder serosa incision by switching to the 30 ° down camera

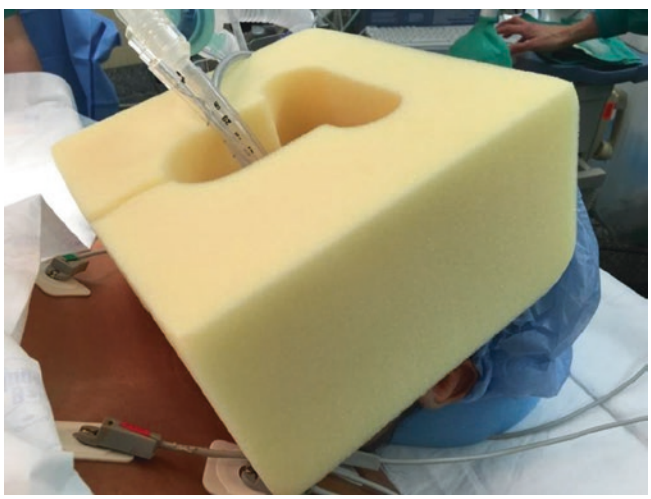


Fig. 65.17 Protection for the patient's face

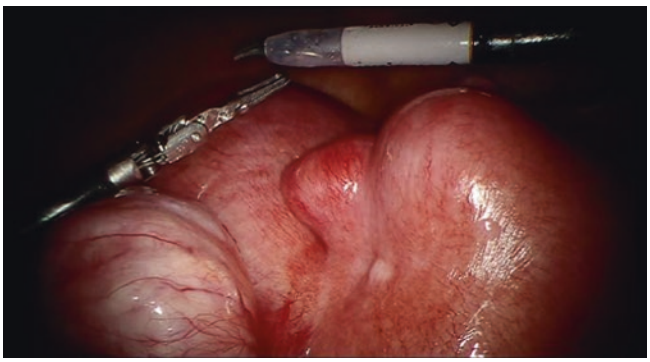


Fig. 65.18 The instruments' reach to the opposite side of the pelvis is severely impaired by the large uterine corpus

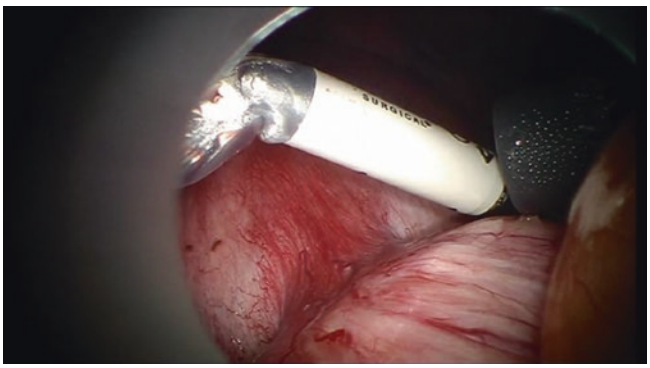


Fig. 65.19 Visualization and maneuvering can be severely impaired. The fat in the right lower corner is from high placement of the port into the falciform ligament

the abdomen over the massive uterus to the other side. In some cases, the uterine size precludes the access of the dissecting instrument used by the dominant hand all the way to the contralateral side across the uterine bulk. Switching the instruments and operating with the nondominant hand while grasping with the dominant hand can overcome this situation (Figs. 65.18 and 65.19).

In patients with previous scars from abdominoplasty, cholecystectomy, or other surgeries, we have inserted the ports through the existing scars, if feasible.

However, these are only guidelines and, depending on the torso length or overall width of the patient, as well as the goals to be achieved during the surgical procedure, the ports should be logically placed so as to maximize maneuverability and visualization.

The assistant port should measure 11 or 12 mm in diameter. This will facilitate insertion of sponges in the peritoneal cavity when needed. The 8 mm robotic ports or a 5 mm assistant port will make this task unfeasible.

The assistant trocar is used for insufflation, and one of the robotic ports is used to attach a smoke evacuator.

For patients with very large uteri, we recommend performing the operations using all four arms of the robotic surgical system. Also, we recommend positioning the robot between the patients' legs (S and Si models) since side-docking severely

limits the reach of arm 3 into the upper abdomen. For this setting, the robotic system will be undocked for transvaginal delivery of the uterus. The boom of the Xi model allows side-docking with no impact on the arms' maneuverability.

Robotic Instruments

The main robotic instruments (Intuitive Surgical, Sunnyvale, CA, USA) used are Hot Shears (monopolar curved scissors) with a tip cover accessory and power setting of 50 W for arm 1, fenestrated bipolar forceps with a power setting of 50 W for arm 2, and Cadiere or ProGrasp (Intuitive Surgical, Sunnyvale, CA, USA) forceps for arm 3. The arm numbers are different for the Xi model. Vascular pedicles were coagulated and transected by the scrubbed assistant with a LigaSure sealer/divider (Valleylab, Boulder, CO, USA).

Grasping and traction and counter-traction should be generally avoided. The specimen is too heavy and the tissue will tear and bleed. Instead, manipulation by pushing the uterine corpus is effective in achieving exposure (Figs. 65.20, 65.21, 65.22 and 65.23).

Uterine Manipulator

The uterine manipulator is less useful for manipulation since the uterus is so large. However, when coupled with a cervical cup, it is an excellent tool for delineating the vaginal fornices prior to colpotomy. This is especially useful when the uterocervical junction is extremely bulky or when abundant adiposity completely obscures the anatomical landmarks. I prefer the Koh Colpotomizer™ System (CooperSurgical, Trumbull, CT) in conjunction with a RUMI® Uterine Manipulator (CooperSurgical, Trumbull, CT) and a Colpopneumo Occluder™ balloon. These are inserted prior to port placement. When the manipulator is pushed by the assistant, the distance between the uterine vessels and ureters will increase by up to 1 cm. This additional maneuver helps to protect the ureters from thermal injury. Generally, in heavy patients, the distance between the cervix and ureters is slightly less than in thin patients, but this difference is clinically insignificant. Also, in many cases, as an added difficulty to the lack of visualization and exposure, the distances between the ureters and cervix are not the same on the right and left [18, 19].

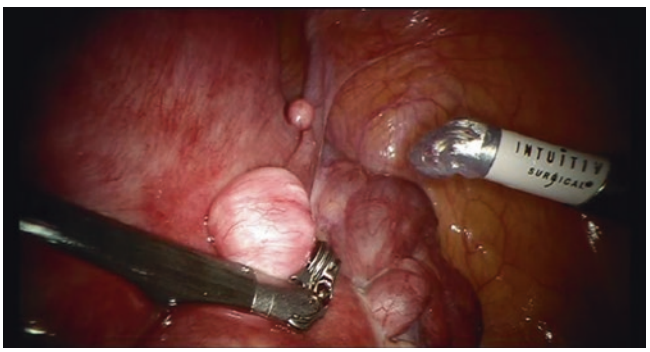


Fig. 65.20 Irregularities in the uterine contour are very helpful for providing grasp and manipulation

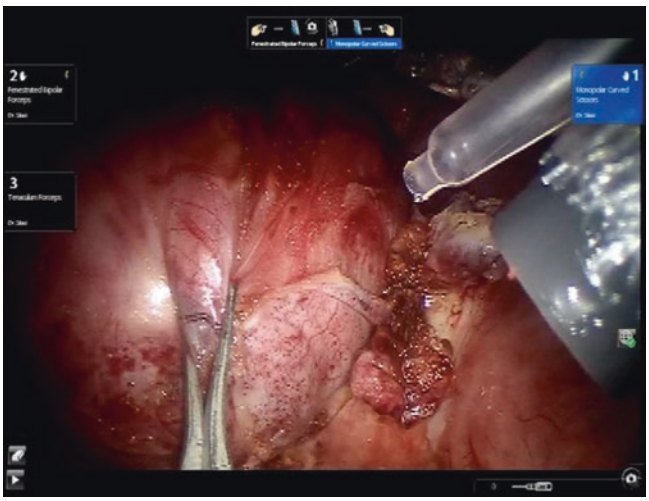


Fig. 65.21 The robotic tenaculum can be used when no other means of manipulation are available. This is frequently the case when lower uterine segments are ballooned out. The insertion site should be carefully chosen. A trial and error approach will result in profuse bleeding from every puncture site

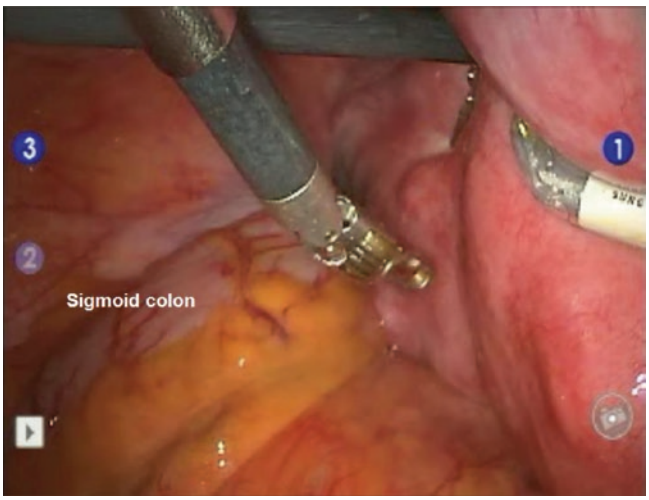


Fig. 65.22 The left ovary is engulfed by expanding leiomyomata. Pushing is a more effective strategy than grasping

Energy Instruments

The cost of the operating instruments is an important consideration for any surgical procedure. The use of the robotic bipolar cautery is effective and inexpensive. However, for the resection of very large uteri I recommend the use of an

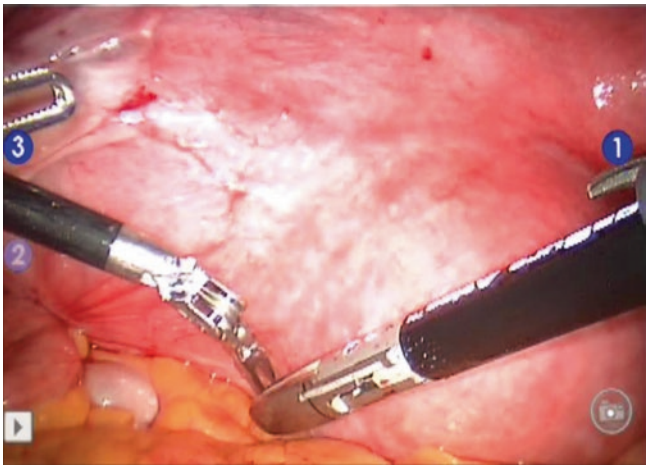


Fig. 65.23 The assistant can help with lifting and manipulation when the uterus is too heavy for the robotic instruments

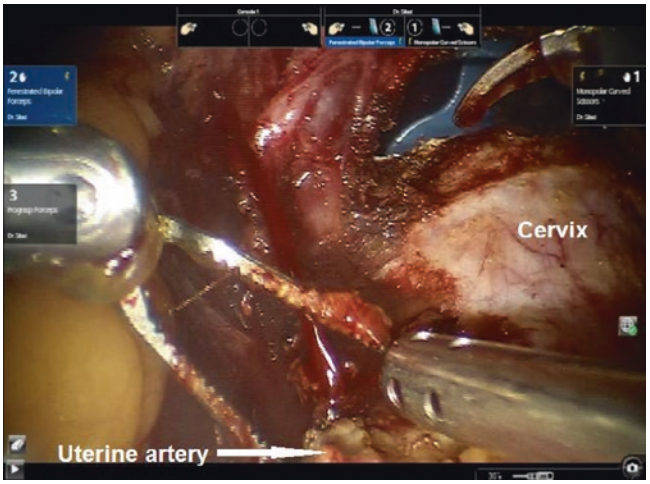


Fig. 65.24 The distal segment of the transected left uterine artery is actively bleeding after sealing was unsuccessful. The fenestrated bipolar cautery will grasp the bleeding vessel

advanced energy device in addition to the traditional bipolar cautery. A wristed vessel sealer is also available for the robotic system. The maneuverability of this device is outstanding but the tradeoff is poor grasping and dissection capabilities.

I prefer a free-hand 5 mm advanced vessel sealer, which will allow freehand laparoscopy when needed. Sometimes these complex procedures require a combination of freehand and robotic laparoscopy. The sealing capacity of the 5 mm instrument is close to that of the wider device with the advantage that this vessel sealer can be inserted through the 8 mm robotic port.

Frequently, one or several of the vessels' diameters will exceed the manufacturer's recommendations for the safe use of any sealing device. In addition, when pelvic edema is present, the vessel walls have a higher than normal water content as well. The efficacy of the sealing devices can be impaired in these circumstances. The vessel wall edema can be anticipated when the dissected retroperitoneal tissues are edematous and fluid is leaking from the open retroperitoneal spaces. Excessive amounts of steam will be released when sealing the vessels: because of the crowded space, the camera is very close to the operative site and the lens will fog. The edema and tissue weeping will resolve once the hysterectomy is completed, sometimes even before the vaginal apex is sutured.

For prevention of catastrophic hemorrhage of very large vessels, I grasp the pedicle with the bipolar cautery while the assistant applies the sealing device on the pedicle. Both ultrasonic and bipolar electrosurgical instruments employ tissue sensing technology and can seal blood vessels with supra-physiologic burst pressure equal to or higher than that of surgical clips or ligatures. The thermal impact to surrounding tissue is minimal [16, 17].

If the sealing is not complete and the vessel is still open after transection, the bipolar cautery will keep the vessels from retracting and can accomplish the following maneuvers:

- Coagulate the vessels held within the jaws of the instrument and achieve hemostasis. Desiccation of the tissues in bipolar diathermy is accomplished when the bubbling stops. The disadvantage of this approach is that when it fails the surgeon is left with the charred end of a (still) bleeding vessel (Fig. 65.24)
- Hold the vessels and apply Weck® Hem-o-lok® polymer clips on the pedicle. The titanium clips available for the robotic system are too small for this task. Alternatively, if the surgeon estimates that successful sealing of the vessels is improbable, the pedicle or individual vessels can be skeletonized and then transected after polymer clips have been applied, without any use of thermal energy (Fig. 65.25)
- One of the advantages of the wristed robotic instruments is the ease of suturing and knot-tying. However, for patients with very large uteri, this advantage is almost always lost because of the very limited space available to perform these maneuvers

Vessels

The most important aspect of hysterectomy for very large uteri is securing the vascular pedicles. Failure to achieve hemostasis in operations where the uterus is massive and extends into the abdominal cavity often leads to abandoning the laparoscopic approach and performing a laparotomy to control the bleeding. It is imperative that meticulous hemostasis is maintained throughout the entire case.

An important reminder is that the anatomy of the pelvic structures can be severely altered. The bladder location and

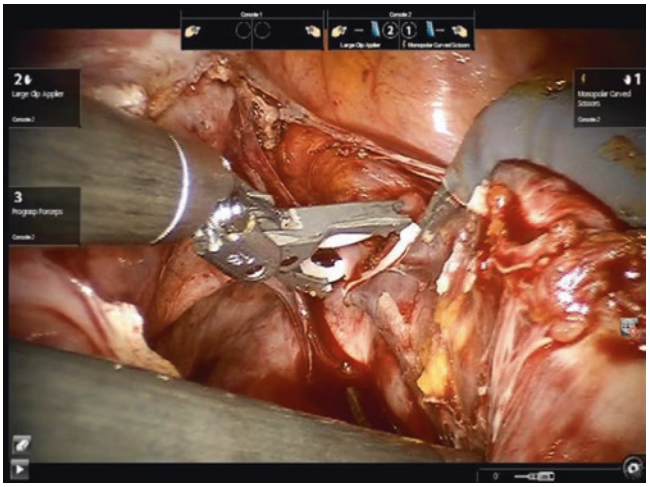


Fig. 65.25 Application of the Weck® Hem-o-lok® polymer clips using the specialized robotic instrument

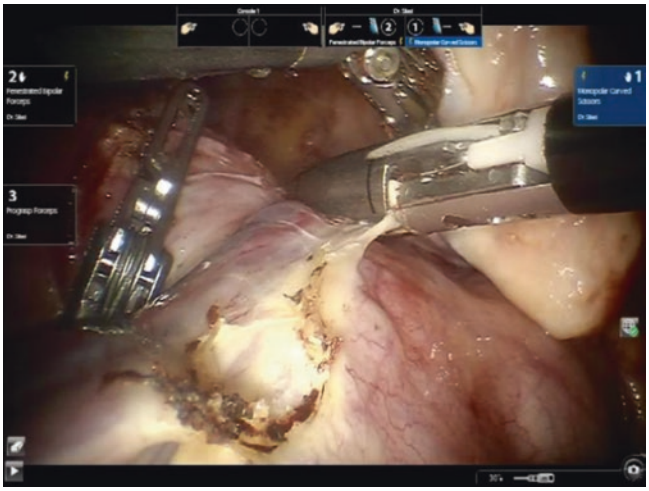


Fig. 65.26 The sealing instrument is applied on the hypertrophic utero-ovarian vascular arcade. The ProGrasp™ instrument is wrapped around the utero-cervical junction: it is very effective in moving the uterus out of the pelvis. I call it the 'choking maneuver'

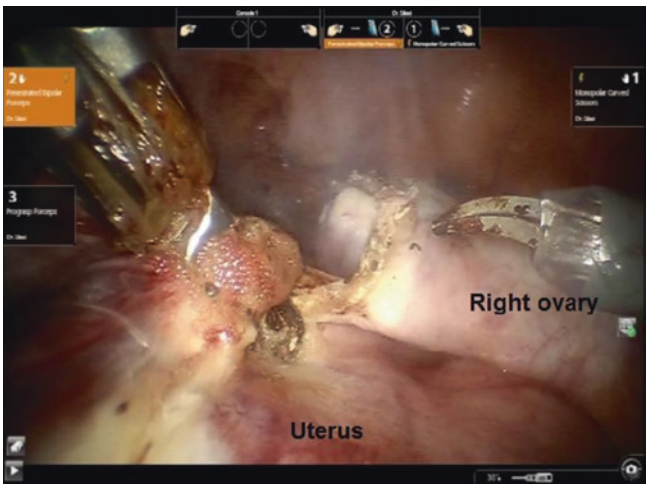


Fig. 65.27 Sealing was incomplete. The severed vessel retracts into the body of the uterus. A lengthy application of bipolar diathermy is necessary to control the bleeding. Ongoing bubbling means that complete desiccation has not occurred yet

contour, the trajectory of the ureters and sometimes even the course of the external iliac or hypogastric vessels can be different than expected. Meticulous dissection is the key to identify these structures and restore the normal anatomy. When the retroperitoneal tissues achieve the foamy appearance caused by pneumodissection, the vessels, ureters, and bladder are easier to identify. However, even a small hemorrhage will saturate the retroperitoneum with blood and obscure the surgical landmarks. Irrigation will also saturate the avascular planes, albeit with a clear and transparent fluid, and it should be avoided if possible. The best approach to improve visualization once the actively bleeding vessels have been secured and the blood is suctioned, is to insert a sponge through the assistant port and dab the bloody site.

Despite limited visualization from above because of the uterine bulk, the location of the four uterine pedicles is quite predictable.

Ovarian Vessels

Even if they are not visible initially, the ovarian vessels are easy to find by pushing the uterus forward.

The anatomy of these pedicles is the most consistent and the infundibulo-pelvic ligaments retain their usual location. They are the easiest to secure, whether the hysterectomy includes adnexectomy or it is performed with the intent of ovarian preservation. The diameter of these vessels is larger than normal. For ovarian preservation, the utero-ovarian arcade can be more difficult to secure if the ovaries are engulfed by the expanding uterus. In this case, care must be taken to seal the vessels thoroughly before transection. When transected without achieving complete hemostasis, the vessels will retract inside the uterine mass and will be out of reach for repeat thermal applications. This will cause profuse bleeding that is very difficult to contain. If there is enough room for maneuvering, it may be prudent to apply the energy device at adjacent spots on any pedicle and increase the probability of sealing. Redundant thermal sealing will increase the operative time but achieving complete hemostasis is very important since these complex procedures leave very little room for error (Figs. 65.26 and 65.27).

It is easier in these procedures, when compared to hysterectomy for normal-size uteri, to avoid thermal injury to the ureters at the pelvic brim while securing the infundibulo-pelvic ligaments. The ovarian vessels are elongated and stretched away from the ureters by the large uterus (Fig. 65.28).

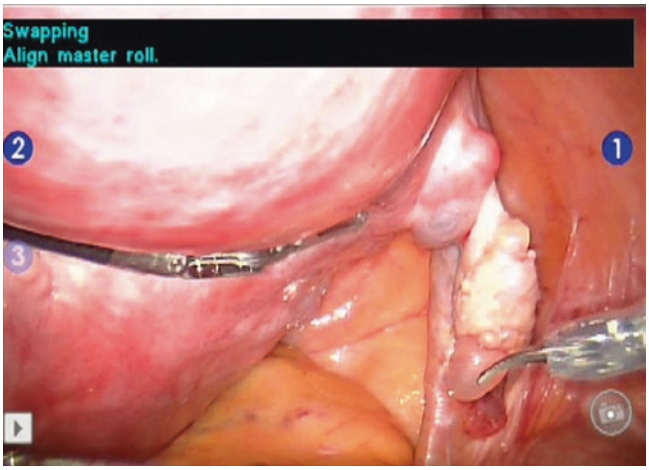


Fig. 65.28 The infundibulo-pelvic ligaments are exposed by lifting the uterus. Routinely they are elongated and stretched away from the ureters

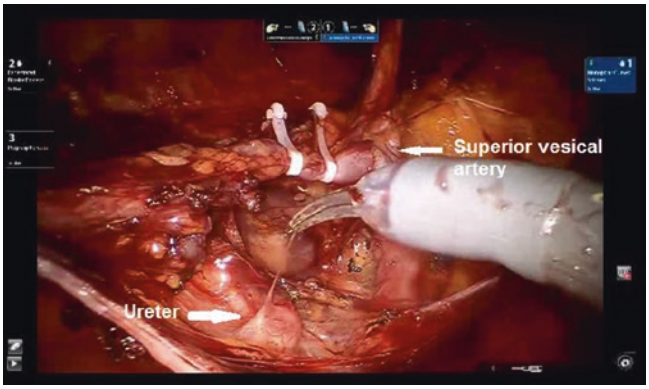


Fig. 65.29 The vessels can be secured at or close to their emergence

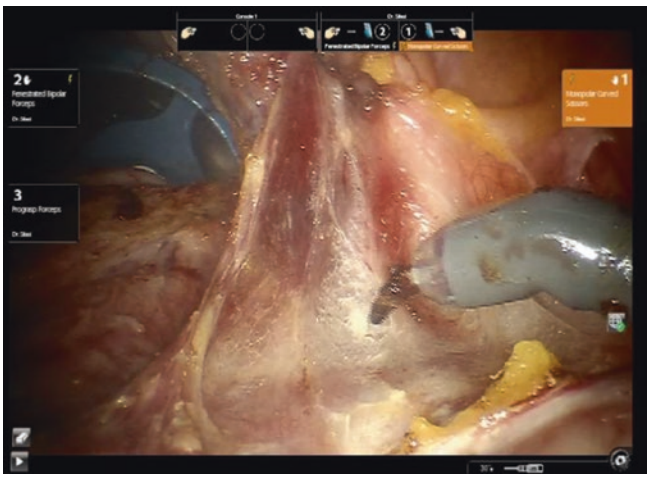


Fig. 65.30 The edema of the retroperitoneal tissues is pronounced as evidenced by the glistening and weeping areolar spaces

Uterine Vascular Supply Below the Pelvic Brim

Unless the anatomical presentation dictates otherwise, I recommend securing the left-sided uterine vessels first, followed by the right-sided ones. The reason is that once three out of four uterine pedicles have been sealed, the fourth will swell up, sometimes markedly so. The absence of the sigmoid colon on the right side of the pelvis allows for better exposure and increased room for maneuvering, which may be necessary to achieve hemostasis.

Arteries

The arteries are hypertrophic because of the increased blood supply and the surgeon will frequently encounter unusual branching. Even the ascending cervical artery, an insignificant vessel in normal circumstances, can flood the pelvis when transected without effective sealing.

Frequently, the uterine bulk completely obscures the utero-cervical junction. A simple strategy to find the uterine vessels is to follow the lateral uterine contour down into the pelvis after dissection of the avascular space of Graves. For better visualization of the vessels, the 0 ° camera may need to be changed to a 30 ° down camera. The camera will sneak in between the massively enlarged uterus and pelvic sidewall and may need to be rotated clockwise on the right and counterclockwise on the left to achieve visualization.

If the uterine vessels cannot be secured at the utero-cervical junction, the alternative is to coagulate them at the emergence from the superior vesical artery. At this proximal level, the arterial wall is less edematous and the success of thermal sealing with one application is higher. The ureter should be identified and mobilized if necessary. The para-vesical and para-rectal spaces should be developed in the same manner as in a radical hysterectomy and the skeletonized vessels can be sealed safely (Fig. 65.29).

Excessive blood loss can occur when the sealing device cannot achieve complete hemostasis of the uterine vessels, especially when the vessel diameter exceeds the recommended 7 mm size. In addition, the retroperitoneal tissues and the vessel walls can be quite edematous from impaired venous return, and although collagen denaturation will occur, tissue desiccation can be suboptimal after firing the sealing device (Fig. 65.30).

When the diameter of the vessels, especially of the veins, is too large, we recommend skeletonizing the components of the pedicle and sealing the vessels individually (Fig. 65.31).

For smaller vessels, if hemostasis is not complete, titanium clips can correct the problem when applied by the assistant or by the robotic arm while the operator holds and exposes the bleeding vessel. Despite the fact that placement of suture ligatures are facilitated by the articulated wrist, this is usually not possible because of the limited space.

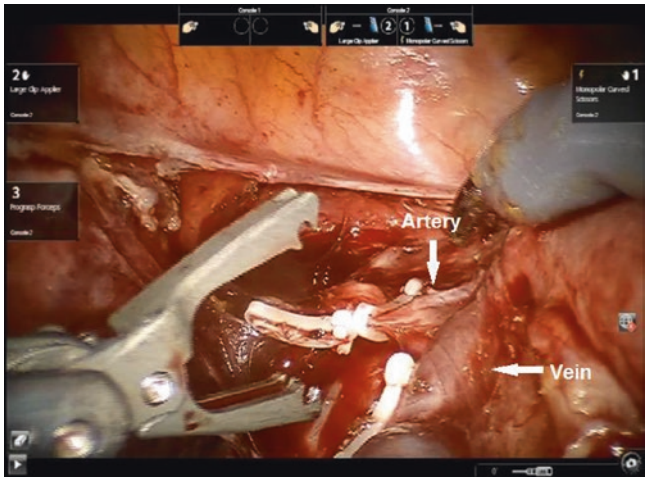


Fig. 65.31 The dilated uterine vein is secured first, followed by the artery

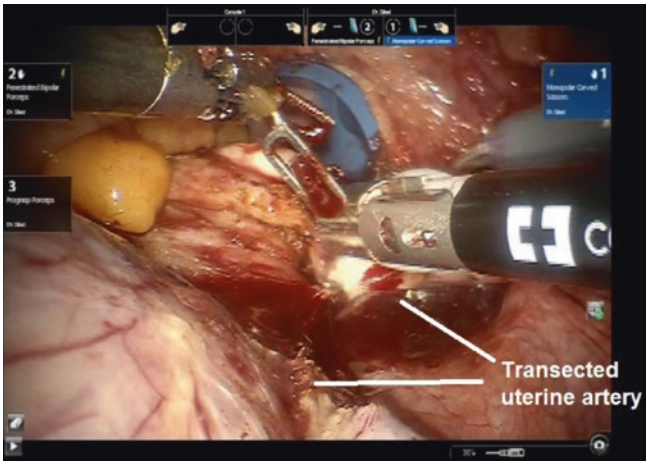


Fig. 65.33 The sealing was unsuccessful

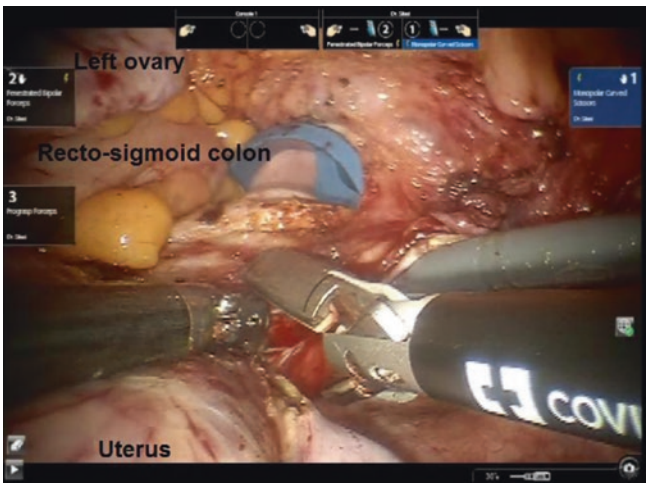


Fig. 65.32 The sealer divider is applied on the right uterine pedicle

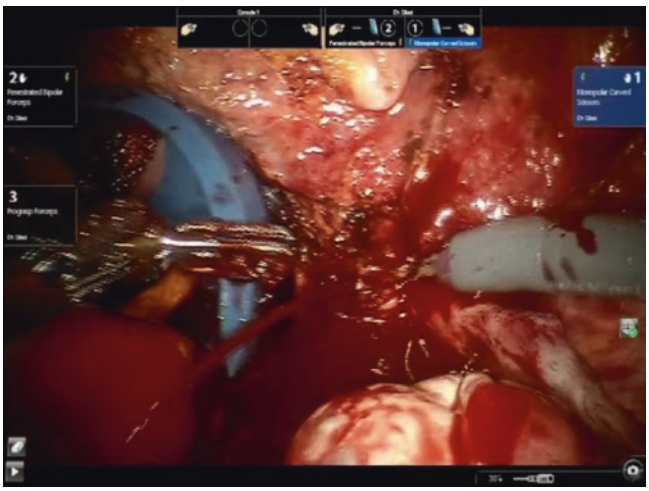


Fig. 65.34 Active bleeding from the uterine artery

In very difficult cases, when the surgeon is confronted with a lower uterine segment too large to allow access to both uterine arteries with the sealing device from the assistant port, the placement of a sixth port in a convenient location can provide the required access (Figs. 65.32, 65.33, 65.34 and 65.35). In morbidly obese patients this additional port can be used for a bowel retractor to improve exposure. Alternatively, the wristed vessel sealer of the robotic system can be used with any arm, for a multitude of angles.

Veins

The enlarged vein diameter is caused by the increased blood supply, but it is also compounded by the impaired venous return produced by the mechanical compression of the hypertrophic uterus resting on the great vessels in the pelvis. Special consideration needs to be given to the venous plexus

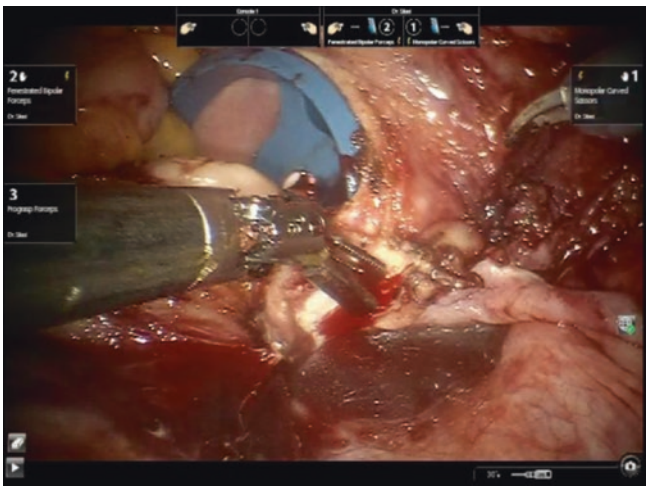


Fig. 65.35 The artery retracts, floods the pelvis and can be difficult to secure. Prior lateral mobilization of the ureter is essential to avoiding thermal injury when exposure is severely limited

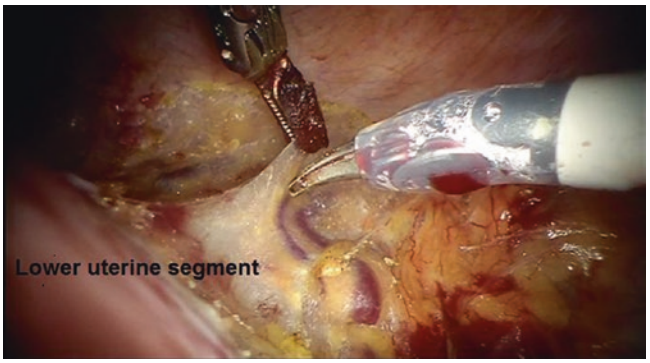


Fig. 65.36 The anatomy of the venous plexus of the bladder is unpredictable and meticulous dissection is required

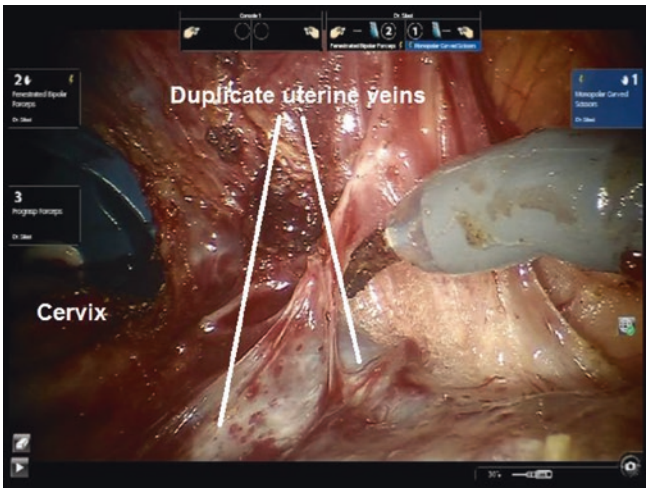


Fig. 65.37 The diameter of the very wide double veins can be estimated intraoperatively by comparing it to the known size of one of the instruments

of the bladder when leiomyomata are ballooning out the lower uterine segment. These vessels have highly irregular locations, are very tortuous, and tend to be severely engorged and prone to easy bleeding. Once injured, they will flood the pelvis and will be very difficult to secure (Fig. 65.36).

Indiscriminate suction to evacuate the blood will collapse the pneumoperitoneum and the intestines will slide from the upper abdomen over the sacral promontory and pile up on top of the pelvic organs. The trocars are fixed to the robotic arms and the collapse of the anterior abdominal wall may cause the loss of one or more ports at a time when complete access and visualization are critical (Fig. 65.37).

Special emphasis has to be placed on neovascularization when the uterine leiomyomata extend into the retroperitoneum, as is frequently the case. Vessels of various origins and calibers will feed and drain the leiomyomata that grow into the virtual spaces of the retroperitoneum. Most commonly, the location of these uterine extensions are deep within the broad ligaments and in the pararectal spaces. Involvement of the paravesical spaces or Waldeyer's space is less common. A thorough knowledge of the retroperitoneum is required if the uterine bulk extends into the retroperitoneal virtual spaces and distorts the normal anatomy.

Bleeding

Blood loss is inherent to surgery and while all surgeons strive for bloodless procedures and dry operative fields, heavy bleeding will happen occasionally, irrespective of the level of skill or experience. However, the level of skill and experience will determine how fast the hemorrhage will be stopped.

Prevention is key and one of the steps that should always be be accomplished is mobilization of the bladder and ureters laterally at enough distance to prevent thermal injury to these structures in case repeat application of heat is required. The classic teaching is to seal (or clamp) the uterine vessels intimately close to the cervix, and the residents are thought to bounce the instrument off the cervix while closing the jaws. This technique leaves no room for error if the vessels bleed after transection. They will inevitably retract and make re-grasping and sealing very difficult. Instead, the sealer/divider should be applied slightly more lateral to the cervix and this will compensate for vessel retraction in the event of non-sealing. However, this approach requires intraoperative knowledge of the ureter trajectory.

Other prevention methods that can be used:

- The surgeon develops the para vesical and para-rectal spaces similar to a radical hysterectomy and the uterine vessels are secured at this level. The linear segment of uterine artery as it crosses over the ureter is one of the most stable characteristics of this otherwise tortuous vessel (Figs. 65.38 and 65.39)
- An X-ray detectable sponge inserted into the peritoneal cavity prior to attempting to seal the vessels can be an useful adjunct in case the bleeding vessel is not easily discernible. It has a much greater surface than the robotic/laparoscopic instruments and can be used to tamponade the bleeding area. The robotic system provides the surgeon with the advantage of locking in place the arm with the sponge without getting tired. This time can be gainfully used to suction the pool of blood, dissect around the area with the other two arms, and have the circulator nurse bring needed supplies into the room (Fig. 65.40)

Arterial blood can squirt on the camera lens and completely obscure the view. This is unusual for venous hemorrhage.

If only one lens of the binocular camera is affected, there is no need to waste valuable time to clean the camera and the surgeon can continue to operate using only one eye until the hemorrhage is contained. If the loss of visualization is

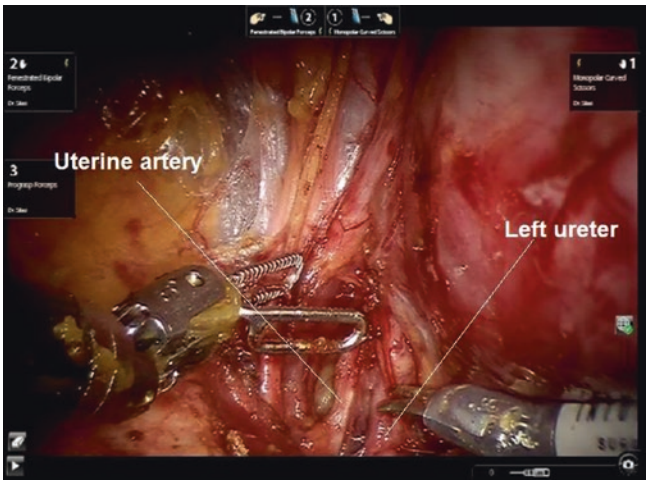


Fig. 65.38 Dissection of the retroperitoneum with emphasis on the ureter and uterine artery

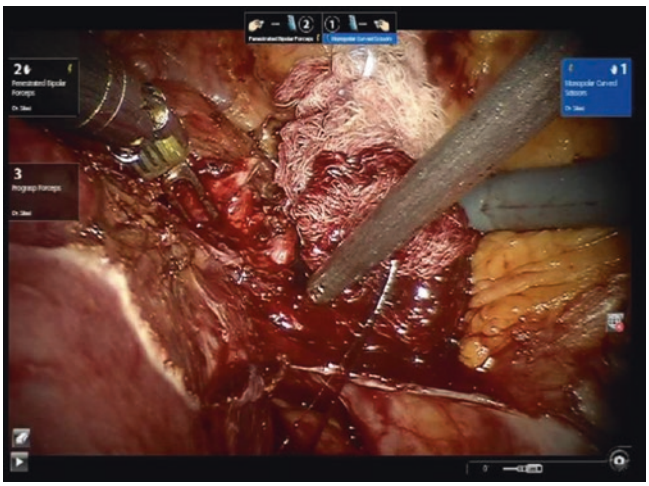


Fig. 65.40 The sponge is held in place with arm 1. Arm 2 with the bipolar cautery is holding one end of the bleeding vessel while the assistant uses the suction to clean the operative field

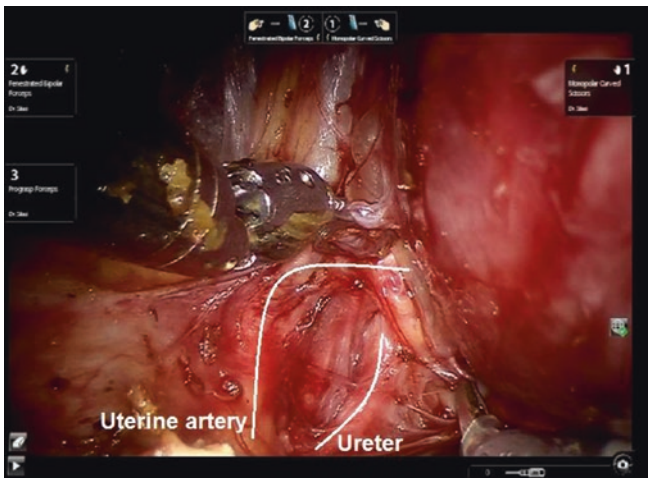


Fig. 65.39 Once dissection is completed, the uterine artery is easily elevated away from the ureter. The uterus is too large for the sealing device to reach from across the abdomen but the bipolar cautery in arm 2 will be used to desiccate the vessel

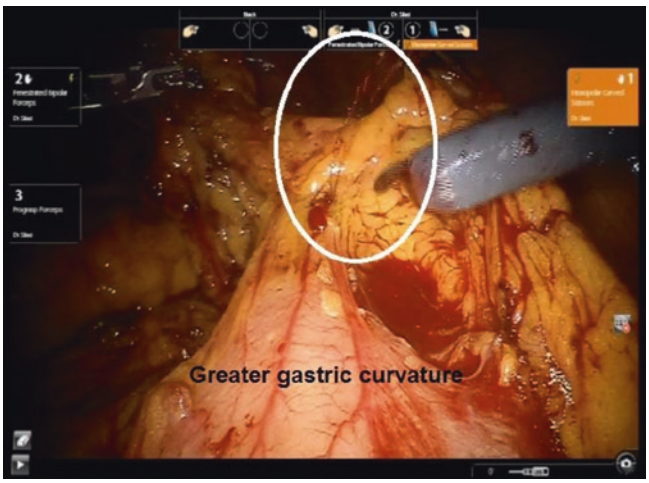


Fig. 65.41 No hysterectomy images were available for blood squirting onto the lens. However, the problem is the same regardless of the procedure. Blood from one of the short gastric vessels shoots towards the lens during omentectomy

complete, the surgeon will move the camera back and point it straight down. This simple move that changes the angle of the camera to the patient's axis will greatly facilitate the ability of the assistant to remove the camera and clean it at a time when seconds matter (Figs. 65.41 and 65.42).

In the rare event when the previously described intra-abdominal sponge was not damp or soaked, I have used it to clean the lens with the robotic arm, with inconsistent results.

If bleeding is uncontrollable, do not hesitate to undock the robot and perform a laparotomy. In most but the life-threatening cases, a Pfannenstiel or Maylard incision will be adequate to access the uterine vessels proper. The risk of bladder injury is minimal since the bladder was already mobilized caudad. There is no need to access the mid- and upper abdomen to reach the ovarian pedicles; they were already secured. Once the bleeding vessels are secured and the colpotomy completed, the specimen can be easily delivered through the new incision.

Lymphatics

Occasionally, the surgeon encounters massively distended lymphatic vessels with serpiginous channels of 1–2 cm diameter accompanying, wrapping around, and obscuring the blood vessels. Lymphatic drainage, even more so than venous drainage, can be severely impaired by the mechanical obstruction caused by the large and irregular uterus. There is

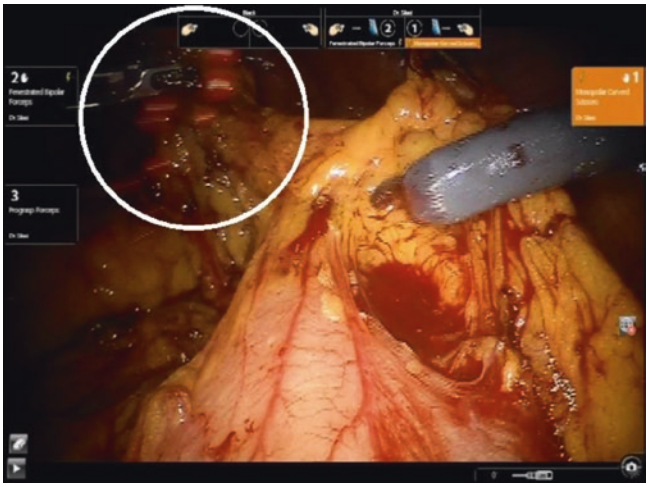


Fig. 65.42 The recording shows the blood drops immediately before they splash into the camera

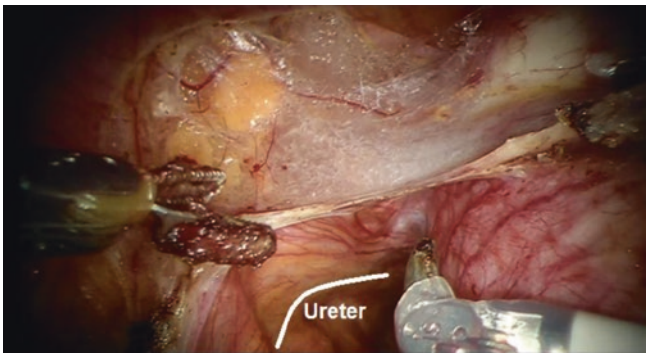


Fig. 65.43 Favorable situations like this one are rare: there is no edema or neovascularization, and the ureter can be easily identified

no corresponding lymphedema of the lower extremities, but cystic spaces of up to several centimeters in size surround the uterine vessels and are filled with clear straw-colored fluid. Their presence can surprise the operating physician. A sudden gush of this clear fluid can be misinterpreted as injury to urinary structures but is of no consequence.

Complications

The following retroperitoneal structures need to be identified and dissected with caution: the external iliac and hypogastric vessels and the ureters.

Injuries to the Ureter

The identification of the ureter trajectory is imperative before applying an energy source to seal any uterine vessels (Figs. 65.43 and 65.44).

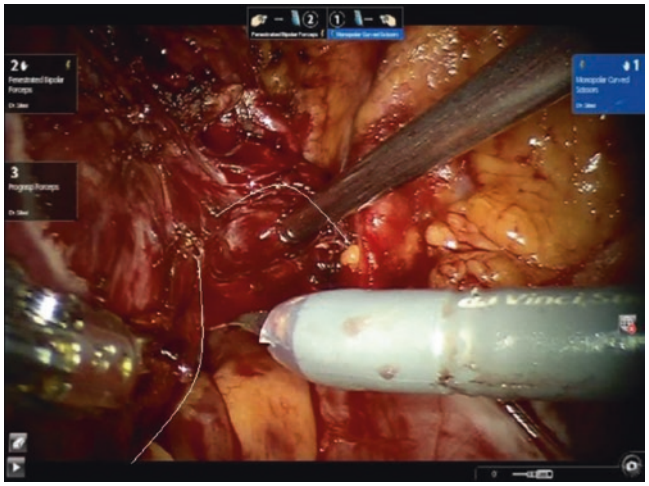


Fig. 65.44 This is an example of an unfavorable situation. There is bleeding, fibrosis, and poorly defined surgical planes. The trajectories of the ureter and uterine artery are more a guess than a certainty. In such cases, patience and meticulous dissection are required

The uterine vessels are pushed laterally by the expanding lower uterine segment and are in closer proximity than usual to the ureters. In addition, the anatomy can be significantly distorted and the ureters pushed cephalad by the uterus as it grows out of the pelvis. It is not unusual for the ureters to be at the same or higher level than the superior vesical artery. For this reason, sometimes it is easier to seal the uterine vessels at their origin from the anterior division of the hypogastric artery. The ureters are easiest to identify at the bifurcation of the common iliac arteries, as they dive into the pelvis. From there, their trajectory can be followed to the level of the uterine vessels and into the ureter tunnel. Another good landmark for ureter identification is where it crosses under the uterine artery.

Precise identification of the ureter course into the retroperitoneum has important practical implications. Incomplete sealing of the vessels requires re-application of thermal energy in a crowded pelvis, while the visualization is impaired from the accumulating blood. Knowledge of the ureters' trajectories will afford the opportunity to use energy more liberally.

Transperitoneal observation of ureteral peristalsis at the pelvic brim provides no assurance that thermal injury or transection below the pelvic brim has been avoided. While complete ureterolysis is not necessary in all cases, the surgeon should be proficient in this procedure and perform it when necessary (Figs. 65.45 and 65.46).

When extensive ureterolysis has been performed and the ureter is readily visible, injuries can easily be averted. However, comprehensive visualization of the ureter is not always possible. Ureter injury prevention relies heavily on mobilizing the ureter laterally, away from the vessels where thermal energy will be applied. Adequate mobilization of the

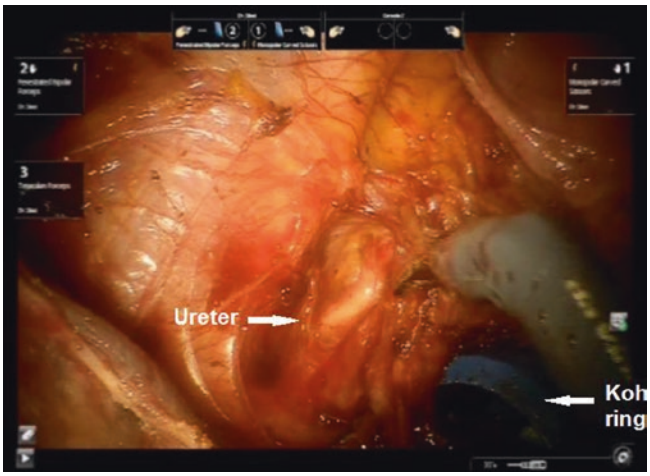


Fig. 65.45 The left ureter is very close to the colpotomy incision despite pushing the colpotomy ring from below

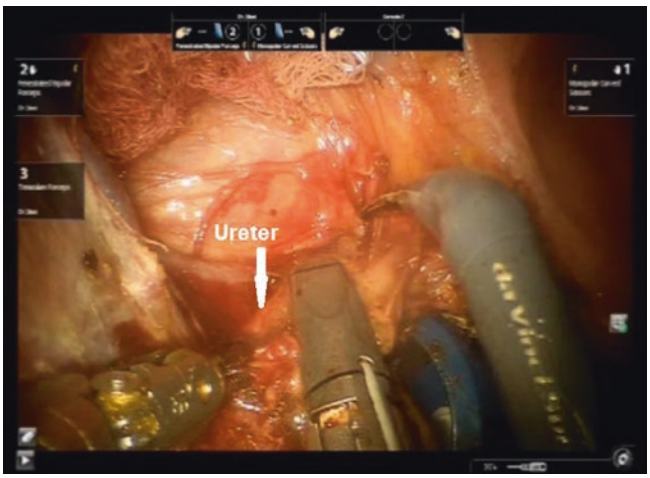


Fig. 65.46 The ureter is immediately adjacent to the vessels. An overzealous assistant attempts to apply the sealer divider on the vessels and ureter. Previous dissection of the left ureter allowed timely identification and prevention of thermal injury

bladder flap will move the ureters laterllay. Also, pushing the uterine manipulator cephalad will add up to 1 cm to the distance between the point of sealing the uterine vessels and the trajectory of the ureters, thus adding an additional maneuver of protecting the ureters from thermal injury [18].

A study performed at Ben-Gurion University in Israel evaluated this extremely important aspect in hysterectomy: the anatomical proximity between the cervix and the ureters. The distance between the ureters and the cervix was measured in 499 computerized tomography (CT) studies at the most dorsal reflection of the ureters. At least one ureter was within 0.5 cm of the cervix in 3.6 % of patients with normal CT scans and in 10.3 % of patients with cervical pathology. Overall, the right ureter was significantly closer to the cervix than the left (2.0 ± −0.8 cm vs. 2.2 ± 1.0 cm, $p < 0.05$). In cases were the pathology was limited to the cervix, the right ureter was more distant than the left (2.0 ± 0.6 cm vs. 1.7 ± 0.6 cm, $p < 0.05$). The distance between the ureters and the cervix was inversely correlated with the lateral diameter of the cervix ($r = 0.18$, $p < 0.001$) and its anterior-posterior diameter ($r = 0.11$, $p < 0.001$) [19].

A study from the University of Indianapolis in the United States was aimed at determining the distance of the ureter from the cervix and the influence of age and weight on this distance. In 52 patients, at the most dorsal reflection of the ureter, the average distance from ureter to cervical margin was 2.3 ± 0.8 cm (range, 0.1–5.3 cm). There was no relationship to age, but there was a linear relationship between this distance and body mass index (R2 = 0.075; P = .049); thus the ureter was slightly more proximal to the cervical margin in heavier women. They concluded that in women with apparently normal pelvic anatomy, the average distance between the ureter and cervix is >2 cm but this distance is <0.5 cm in 12 % of the patients studied [20].

We have not used the preoperative placement of regular or lighted ureteral stents to facilitate intraoperative ureter identification and we recommend against the practice of universal cystoscopy during major gynecologic cases.

Injuries to the Vessels

The prevention of injuries to the aorta or vena cava at the beginning of the procedure require full attention of the surgeon. Trivial aspects and sounds common to the start of any procedure such as the scrub technician setting up the instrumens, with the accompanying noise, the beeping of the monitors, and everybody talking at once, can distract the operator. However, no other surgical inadvertent situation can change the fate of the entire procedure within seconds and put the patient's life at risk.

My preference for insufflation is the Verres needle with the gas on high flow and as it penetrates the abdominal wall into the peritoneal cavity, the gas pressure readings provide the surgeon with useful information and decrease the 'blindness' of the blind insertion. Insertion injuries of the solid organs like liver, kidney, pancreas, are exceedingly rare and a clean needle stick does not need to be addressed. The only life-threatening injury that demands immediate attention is to the greater vessels. For obese patients, the point of entry into the abdomen in relationship to the retroperitoneal greater vessels is higher than for thin patients and for patients with very high BMI the needle is not long enough to reach the vessels. However, the surgeon should keep in mind the possibility of vessel injury and retroperitoneal hemorrhage. A retroperitoneal hematoma needs to be observed for expansion with the intra-abdominal pressure decreased to a minimum. If it appears stable, the surgeon can continue with

the procedure. Re-insufflation of the peritoneal cavity for the duration of the procedure will add to the hemostatic effect. Retroperitoneal exploration is usually counterproductive in small injuries of the great vessels and should be reserved for large iatrogenic defects.

Other penetrating injuries of the great vessels are immediately evident. The uterine bulk severely limits exposure and maneuvering space and these injuries can be life-threatening. If feasible, one of the robotic graspers can hold and approximate the vessel defect tight while titanium clips are applied by the assistant or the robotic specialized instrument. Vessel suturing can be accomplished much easier with the robotic system than with conventional laparoscopic instruments.

In patients with very large uteri, the trajectory of the external iliac vessels is less affected than that of the ureters. The hypogastric vessels have the most stable presentation, with the exception of the anterior division.

When the uterus expands into the retroperitoneum, neovascularization is present and unpredictable. Meticulous and gentle dissection will avoid tears, especially of the veins. A previously inserted sponge is much more effective in applying pressure and containing the bleeding than the instrument alone.

The surgeon should notify the anesthesiology team immediately if a major injury occurs. Do not hesitate to perform an emergent laparotomy if the hemorrhage cannot be contained laparoscopically.

In patients with uteri up to 16–18 weeks' size, the organ can be visualized in its entirety at all times throughout the procedure. For very large uteri, 24–30 weeks' size and above, the organ is too large and extends beyond the visual field of the surgeon. For this reason, I strongly recommend periodic surveillance of the already sealed pedicles. While the operator is focused on the lower uterine segment, the pressure and traction applied on the corpus for manipulation and visualization purposes can force the previously sealed utero-ovarian vessels to re-open. The surgeon will not notice this extensive hemorrhage since the blood will be pooling into the upper abdomen because of the Trendelenburg position. This complication is unique to these procedures.

Injuries to the Bladder

The use of the 30° down laparoscope is helpful when developing the bladder flap.

If injured, the bladder can be easily repaired once the uterus is removed. The defect should be closed in several layers. The wristed instruments facilitate suturing greatly. Imbricating the tissues is aided by the redundancy of a bladder that was extensively stretched by the enlarged uterus (Figs. 65.47 and 65.48).

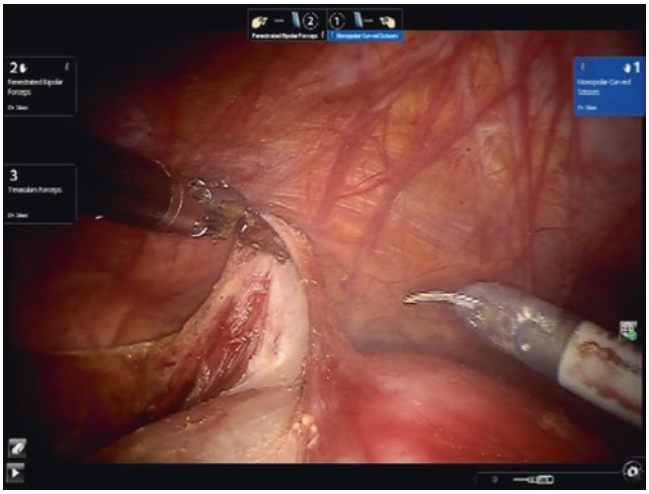


Fig. 65.47 A large anterior myoma has stretched the bladder and the bladder serosa reflection is almost at the level of the umbilicus

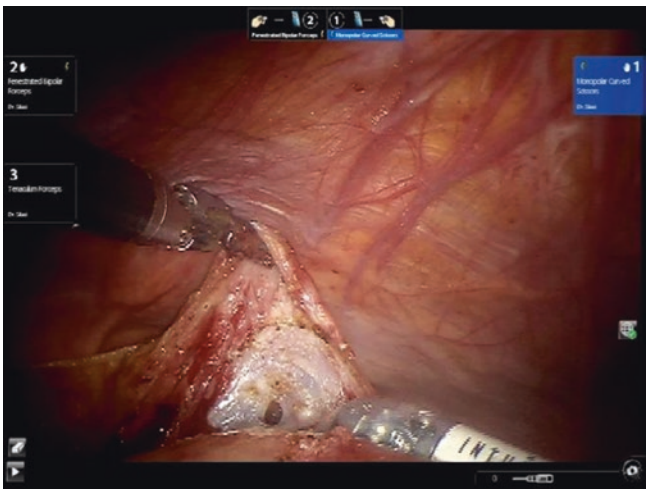


Fig. 65.48 The bladder wall is very thin at this level and a more careful dissection would have avoided the cystotomy

Delivery of the Specimen

The tests available to diagnose uterine sarcomas preoperatively are unreliable. The incidence of uterine sarcomas in patients with leiomyomata is the subject of significant controversy and the use of power morcellators has been the focus of the Federal Drug Administration [20].

The surgical presentations addressed in this chapter are not cases where the uterus can be delivered intact transvaginally. If cancer is diagnosed or suspected preoperatively, the hysterectomy should be accomplished by laparotomy. Techniques where the uterus with endometrial cancer is cored or spirally sliced to fit in the vagina and is delivered without intraperitoneal spillage have been described [21, 22].

However, these techniques are not applicable to uteri of this size when cancer is suspected or diagnosed.

The technique of power morcellation in a bag has been described but no commercially available bags exist for specimens this large.

After complete devascularization and separation of the uterus, the large specimens are removed by two methods: (1) piecemeal delivery of the uterus through the vagina or (2) piecemeal delivery of the uterus through mini-laparotomy.

Specimen removal, especially the transvaginal approach, accounts for a considerable part of the operative time. Delivery is facilitated when extensive adenomyosis is present, making the uterus soft. Also, multiple small leiomyomata can be individually shelled from their pseudocapsule and this will also aid delivery. The least desirable situation for delivery is the presence of a single very large and very firm leiomyoma.

Transvaginal Delivery

If the robotic system is docked between the patient's legs, undocking provides a much greater range of motion for the operator and assistant and allows the return of the patient to a horizontal or minimal Trendelenburg position for the duration of the specimen removal. The uterus is grasped and gradually brought into the vagina and cut piecemeal with scissors and/or a scalpel while Breisky-Navratil vaginal retractors provide exposure and protection of the vaginal walls. All cutting occurs in the vagina without contamination of the peritoneal cavity. Inevitably, blood and other fluids will run off from the uterus while it is being cut into pieces. Removing the patient from the Trendelenburg position will prevent contamination of the peritoneal cavity with these fluids. Any type of morcellation can be used: bisection, coring, "paper-roll" technique, or wedge morcellation [23–25].

Special consideration should be given to old and infarcted leiomyomata that are completely calcified and larger than the vaginal caliber. When sharp instruments are unable to cut through this tissue, monopolar cautery on high power can penetrate the tissue. Delivery of these specimens is very tedious.

Transabdominal Delivery

Some patients will present with a narrow and/or long vagina. In these cases, enlarging one of the port sites or performing a suprapubic mini-laparotomy allows piecemeal delivery of the uterus. However, this approach will contaminate the peritoneal cavity and abdominal wall with uterine debris.

Conclusion

Resection of very large uteri using the robotic system is a feasible alternative to laparotomy, regardless of the patients' body habitus. However, it requires sophisticated surgical skills and is a more time-consuming approach. Without doubt, the benefits of this approach to the patients surpass the longer operative times and the higher costs associated with the amortization of the robotic system.

References

1. Cohen SL, Vitonis AF, Einarsson JI. Updated hysterectomy surveillance and factors associated with minimally invasive hysterectomy. JSLS. 2014;18(3)
2. Vilos GA, Allaire C, Laberge PY, Leyland N; Special Contributors, Vilos AG, Murji A, Chen I. The management of uterine leiomyomas. J Obstet Gynaecol Can 2015; 37(2):157–181.
3. Smorgick N, Dalton VK, Patzkowsky KE, Hoffman MR, Advincula AP, As-Sanie S. Comparison of 2 minimally invasive routes for hysterectomy of large uteri. Int J Gynaecol Obstet. 2013;122(2):128–31.
4. Marana R, Busacca M, Zupi E, Garcea N, Paparella P, Catalano GF. Laparoscopically assisted vaginal hysterectomy versus total abdominal hysterectomy: a prospective, randomized multicenter study. Am J Obstet Gynecol. 1999;180:270–5.
5. Ferrari MM, Berlanda N, Mezzopane R, Ragusa G, Cavallo M, Pardi G. Identifying the indications for laparoscopically assisted vaginal hysterectomy: a prospective, randomized comparison with abdominal hysterectomy in patients with symptomatic uterine fibroids. BJOG. 2000;107:620–5.
6. Uccella S, Cromi A, Casarin J, Bogani G, Serati M, Gisone B, Pinelli C, Fasola M, Ghezzi F. Minilaparoscopic versus standard laparoscopic hysterectomy for uteri ≥ 16 weeks of gestation: surgical outcomes, postoperative quality of life, and cosmesis. J Laparoendosc Adv Surg Tech A. 2015;25(5):386–91.
7. Kovac SR. Route of hysterectomy: an evidence-based approach. Clin Obstet Gynecol. 2014;57(1):58–71.
8. Sinha R, Sundaram M, Lakhotia S, Hedge A, Kadam P. Total laparoscopic hysterectomy in women with previous cesarean sections. J Minim Invasive Gynecol. 2010;17(4):513–7.
9. Loring M, Morris SN, Isaacson KB. Minimally invasive specialists and rates of laparoscopic hysterectomy. JSLS. 2015;19(1):e2014.00221.
10. Silasi DA, Gallo T, Silasi M, Menderes G, Azodi M. Robotic versus abdominal hysterectomy for very large uteri. JSLS. 2013;17(3):400–6.
11. Uccella S, Cromi A, Serati M, Casarin J, Sturla D, Ghezzi F. Laparoscopic hysterectomy in case of uteri weighing ≥1 kilogram: a series of 71 cases and review of the literature. J Minim Invasive Gynecol. 2014;24(3):460–5.
12. Alperin M, Kivnick S, Poon KY. Outpatient laparoscopic hysterectomy for large uteri. J Minim Invasive Gynecol. 2012;19(6):689–94.
13. Uccella S, Cromi A, Bogani G, Casarin J, Formenti G, Ghezzi F. Systematic implementation of laparoscopic hysterectomy independent of uterus size: clinical effect. J Minim Invasive Gynecol. 2013;20(4):505–16.
14. Stoelinga B, Huirne J, Heymans MW, Reekers JA, Ankum WM, Hehenkamp WJ. The estimated volume of the fibroid uterus: a comparison of ultrasound and bimanual examination versus volume at MRI or hysterectomy. Eur J Obstet Gynecol Reprod Biol. 2015;184:89–96.
15. Ryan NA, Ng VS, Sangi-Haghpeykar H, Guan X. Evaluating mechanical bowel preparation prior to total laparoscopic hysterectomy. JSLS. 2015;19(3)

16. Paul PG, Prathap T, Kaur H, Shabnam K, Kandhari D, Chopade G. Secondary hemorrhage after total laparoscopic hysterectomy. JSLS 2014 Jul-Sep;18(3).
17. Camran Nezhat, MD, Michael Lewis, MD, Louise P. King, MD, JD. Laparoscopic vessel sealing devices. Prevention and management of laparoendoscopic surgical complications, 3rd edition.
18. DA Silasi. Robotic surgery in the morbidly obese patient: a surgeon's planning guide. Contemporary OB/GYN. http://contemporaryobgyn.modernmedicine.com/contemporary-obgyn/news/robotic-surgery-morbidly-obese-patient-surgeon-s-planning-guide
19. Hurd WW, Chee SS, Gallagher KL, Ohl DA, Hurteau JA. Location of the ureters in relation to the uterine cervix by computed tomography. Am J Obstet Gynecol. 2001;184(3):336–9.
20. Gemer O, Simonovsky A, Huerta M, Kapustian V, Anteby E, Linov L. A radiological study on the anatomical proximity of the ureters and the cervix. Int Urogynecol J Pelvic Floor Dysfunct. 2007;18(9):991–5.
21. Harris JA, Swenson CW, Uppal S, Kamdar N, Mahnert N, As-Sanie S, Morgan DM. Practice patterns and postoperative complications before and after food and drug administration safety communication on power morcellation. Am J Obstet Gynecol. 2015;214(1):98.e1–98.e13.
22. Favero G, Miglino G, Köhler C, Pfiffer T, Silva E, Silva A, Ribeiro A, Le X, Anton C, Baracat EC, Carvalho JP. Vaginal morcellation inside protective pouch: a safe strategy for uterine extration in cases of bulky endometrial cancers: operative and oncological safety of the method. J Minim Invasive Gynecol. 2015;22(6):938–43.
23. Montella F, Riboni F, Cosma S, Dealberti D, Prigione S, Pisani C, Rovetta E. A safe method of vaginal longitudinal morcellation of bulky uterus with endometrial cancer in a bag at laparoscopy. Surg Endosc. 2014;28(6):1949–53.
24. Montella F, Cosma S, Riboni F, Dealberti D, Benedetto C, Abate S. A safe and simple laparoscopic cold knife section technique for bulky uterus removal. J Laparoendosc Adv Surg Tech A. 2015;25(9):755–9.
25. Clark Donat L, Clark M, Tower AM, Menderes G, Parkash V, Silasi DA, Azodi M. Transvaginal morcellation. JSLS. 2015;19(2)

Robotic-Assisted Total Hysterectomy: Hysterectomy Techniques in Prolapse Situations

66

Emad Matanes, Roy Lauterbach, and Lior Lowenstein

Introduction

Pelvic organ prolapse (POP) is a protrusion of pelvic organs and their associating vaginal segments descend from their normal positions into the vagina [1]. This condition is common, being symptomatic in approximately 30 % of women 50–89 years of age and requiring a corrective procedure in 11 % of women by 80 years of age. In the next 30 years, the demand for treatment of POP will increase 45 % on the background of the increase of old women population [2]. Other associated risk factors for development of POP include: vaginal delivery, history of hysterectomy, obesity, race and history of previous operations [3].

Definitions

Cystocele: Herniation of the anterior vaginal wall. (Fig. 66.1)
Rectocele: Herniation of the posterior vaginal wall. (Fig. 66.1)
Enterocele: Protrusion of the small intestines and peritoneum into the vaginal canal. (Fig. 66.2)
Uterine prolapse: Downward protrusion of the cervix and uterus toward the introitus. (Fig. 66.3)

Pathophysiology

POP results from weakening of the supportive structures which is caused either by stretching and tearing of the supportive system or by neuromuscular dysfunction. The structures that support the vagina and the uterus are divided into three levels which correspond to differing areas of support [4]:

Level I: The upper part of the vagina and the cervix are suspended from above. The suspension referred to the **cardinal and uterosacral ligaments**.

Level II: The midline position of the vagina is maintained by the paravaginal attachments of the lateral vagina and the **endopelvic fascia** to **arcus tendineus**.

Level III: The distal vagina is supported by muscles and connective tissue which surround it. It is fused laterally to the levator muscle and posteriorly to the perineal body while anteriorly it blends with the urethra.

Anatomy

The pelvic organs are arranged in three compartments:

Anterior compartment: Contains the urinary bladder, the Urethra and the anterior wall of the vagina.
Posterior compartment: Includes the rectum and the vaginal posterior wall. It is supported by the pelvic floor musculature and connective tissue posteriorly and the pararectal fascia and its attachments to the lateral pelvic floor musculature and its fascia.
Apical compartment: Contains the uterus, cervix and the apical part of the vagina.

Treatment

The treatment for POP is based on both, surgical and nonsurgical approaches.

Nonsurgical Treatment

It is recommended in cases of:

- Mild to moderate POP.
- Patients who are still interested in having future pregnancies.
- Patients who are not interested in surgical approach.

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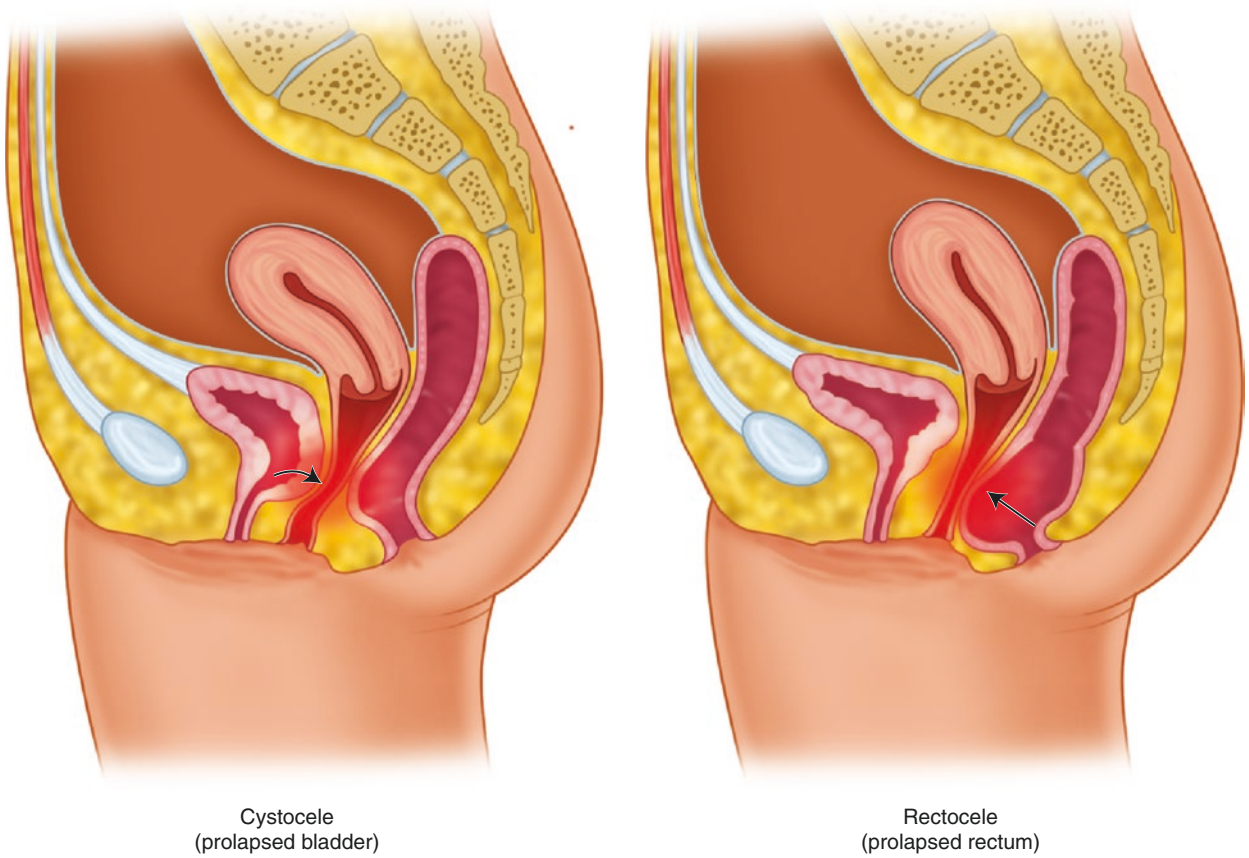


Fig. 66.1 Weak Vesico-vaginal and Recto-vaginal connective tissues result in a vaginal hernia that precedes the bladder (*left*) and rectum (*right*) herniation's that follow

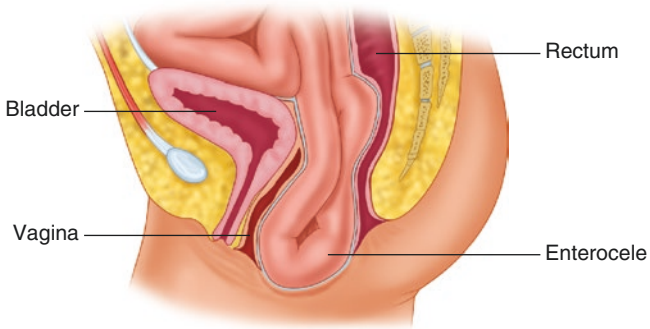


Fig. 66.2 Protrusion of the small intestines into the vagina

Options for treatment are:

1. Life style intervention:
   - Pelvic floor muscle training PFMT
   - Weight loss
2. Mechanical devices (Pessary)

Surgical management

The main purpose of surgical treatment is symptomatic relief by restoration of the vaginal anatomy. Three main surgical approaches for treatment of POP: vaginal, abdominal and laparoscopic (both conventional and robotic). The use of vaginal meshes was very common until October 2008, when the FDA published its` first warning regarding possible complications following the use of mesh in vaginal surgeries. Since then, many surgeons around the world converted their surgical approach from vaginal to abdominal and returned to use the traditional gold standard approach for POP repair thus sacrocolpopexy [5].

Sacrocolpopexy can be performed by abdominal approach, conventional laparoscopy or robotic laparoscopy.

The principle of the procedure is to lay a Y shaped mesh over the prolapsed organ, whether it is the vaginal wall, the cervix (in cases in which Supra cervical hysterectomy is performed) or the uterus (in cases in which the uterus is not excised). The upper arms of the Y shaped mesh embrace the prolapsed organ and the remaining part of the mesh is fixated to the anterior longitudinal ligament of the sacrum.

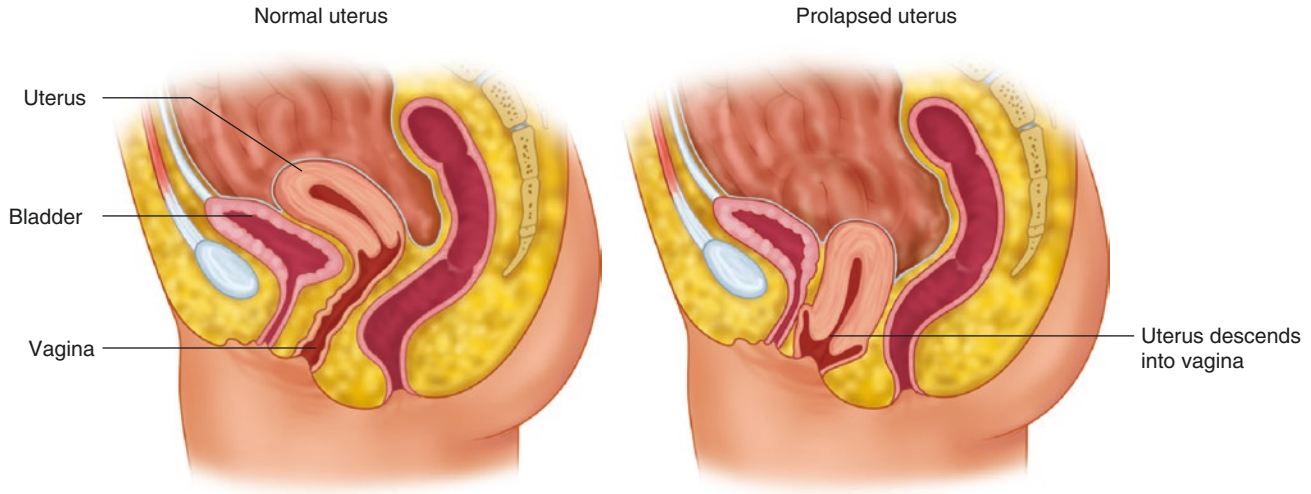


Fig. 66.3 Weakened cardinal and utero-sacral ligaments may lead to uterine prolapse

In the past two decades, the open approach has been replaced by the laparoscopic one due to its` proven advantages, and recently, there has been another shift from conventional laparoscopy to robotic laparoscopy [6] .

The Robot Evolution

- 1985: The first robotic surgical operation was presented, Kwoh and his associates reported performing a brain biopsy with a robotic arm PUMA560 successfully [1]
- 1993: Robodec was the first robot to be granted FDA approval for a hip replacement surgery.
- 2001: The first Telerobotic cholecystectomy was performed successfully with the ZEUS robot.
- 2005: The FDA approved robotic technology for gynecologic surgery.
- 12/2011: The FDA accepted the specific Single-Site equipment for use with the Da Vinci Surgical System (Fig. 66.4).



Fig. 66.4 The Da Vinci Robot is the most utilized robot today in the surgical world. The arms marked "1", "2", "3" are the operating arms, and the 4th arm is the camera holder. During single port surgery the arm marked "3" is not in use during surgery. ©2016 Intuitive Surgical, Inc.

Robotic Sacrocolpopexy and Supracervical Hysterectomy–Multiport

Insertion of the veress needle and creation of pneumoperitoneum. Before inserting the veress needle in, it is necessary to identify the possible insertion points based on the patient's medical and surgical history. The common approach is by making a small medial incision approximately 2 centimeters above the umbilicus. In patients with a history of previous abdominal surgery, it may be wise to consider approaching the abdomen with an incision at palmer's point, located at the left mid-clavicular line, approximately 2–3 centimeters under the rib cage.

During the insertion of trocars at the site of the first incision, RUQ, RLQ and LLQ (Fig. 66.5), it is imperative to

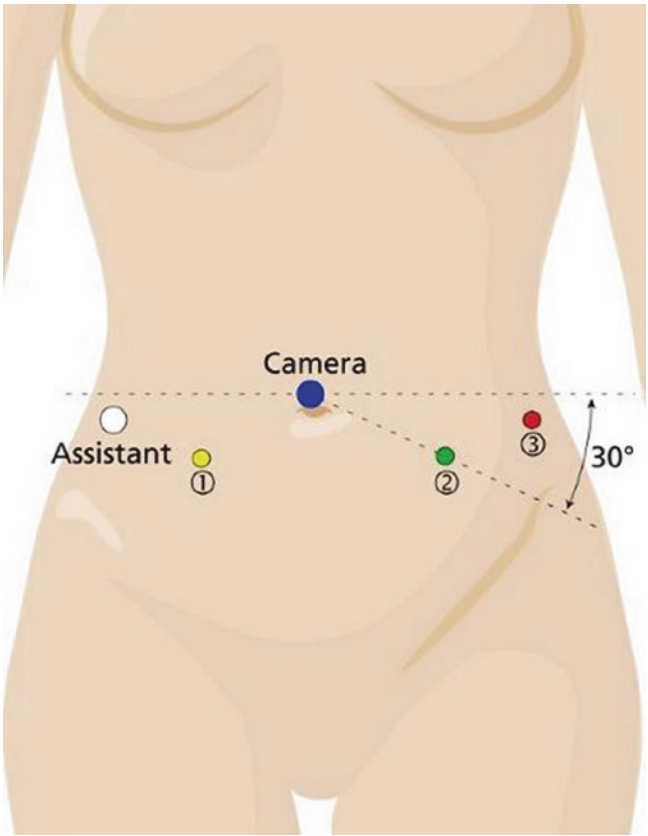


Fig. 66.5 During multi-port surgery 5 incisions are made in the abdomen, in the shape of a "W", 4 incisions are designated for the insertion of the robot arms, and the 5th incision is designated as the assistant port, allowing the insertion and extraction of surgical tools (needles/mesh/instruments) that otherwise assist the surgeon during surgery. Single port surgery utilizes a single supra-umbilical incision, thus making the other incisions redundant. ©2016 Intuitive Surgical, Inc.

avoid perforating 2 significant arteries that pass through the abdominal wall:

(a) Inferior Epigastric vessels that originate from the External Iliac arteries run superiorly and enter the rectus sheath deep to the rectus abdominis, while supplying the rectus abdominis muscle, and the deep abdominal wall of the pubic and inferior umbilical regions.
(b) Superficial Epigastric arteries that originate from the Femoral artery run in the subcutaneous tissue toward the umbilicus, while supplying the superficial abdominal wall of the pubic and inferior umbilical regions (Fig. 66.6).

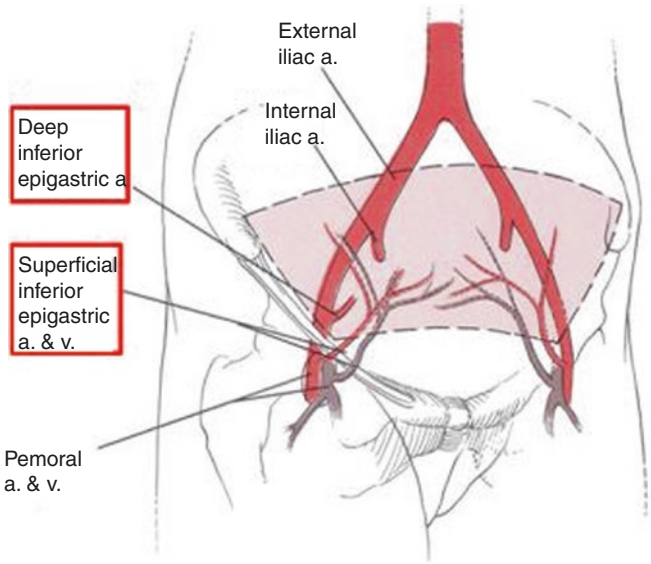


Fig. 66.6 Make an effort to avoid making incisions on the course of the DEEP INFERIOR EPIGASTRIC ARTERY AND SUPERFICIAL INFERIOR EPIGASTRIC VESSELS- that run down the abdominal wall



Fig. 66.7 Two robot instruments are inserted through the single port on top of a camera, an assistant trocar and the gas tube attached to the port, thus making the extra 4 incisions made in multi-port surgery redundant. ©2016 Intuitive Surgical, Inc.

Single-Port Surgery

The next generation of robotic assisted laparoscopy is the single port access, in which the surgeon operates almost exclusively through a single entry point, typically the patient's navel, leaving only a single small scar (Figs. 66.7, 66.8 and 66.9). Benefits of single-port robotic assisted sacrocolpopexy surgery may include:

- Faster recovery.
- Shorter hospitalization.
- Minimal post op pain.

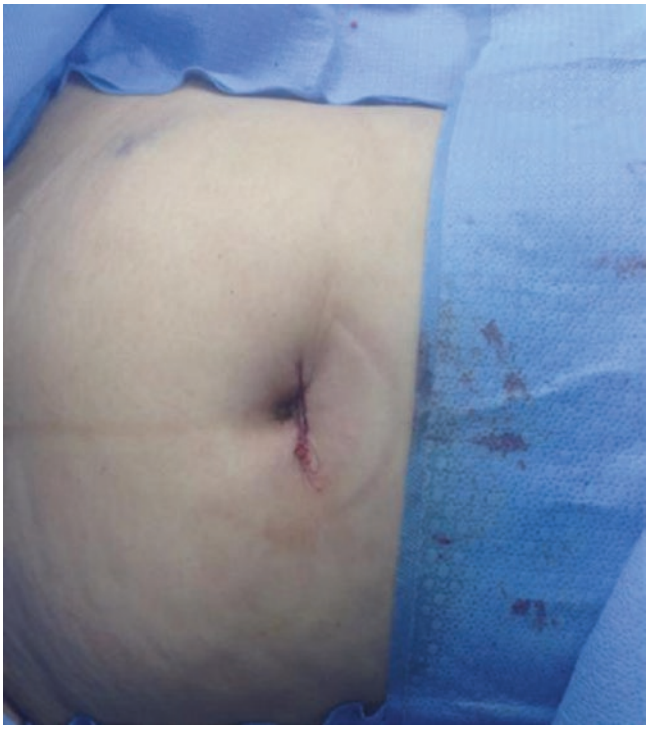


Fig. 66.8 The post-surgical minimal scar after single port surgery

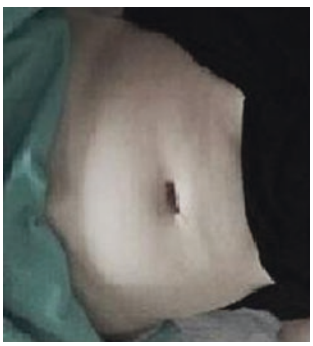


Fig. 66.9 Three weeks post-surgery, the scar is embedded into the umbilicus and is barely recognizable

- Virtually Scar free results.
- Minimal blood loss.

Four instruments are inserted via the single port in addition to the CO2 tube creating the pneumoperitoneum.

During Surgery

On visualization of the pelvic cavity it is crucial to keep in mind the course of the ureters. The ureters descend subperitoneally into the pelvis, passing inferior of the uterine artery. They then penetrate the bladder wall obliquely from its` posterio-inferior angle. The pelvic portion of each ureter is served by the vaginal artery and the internal iliac veins.

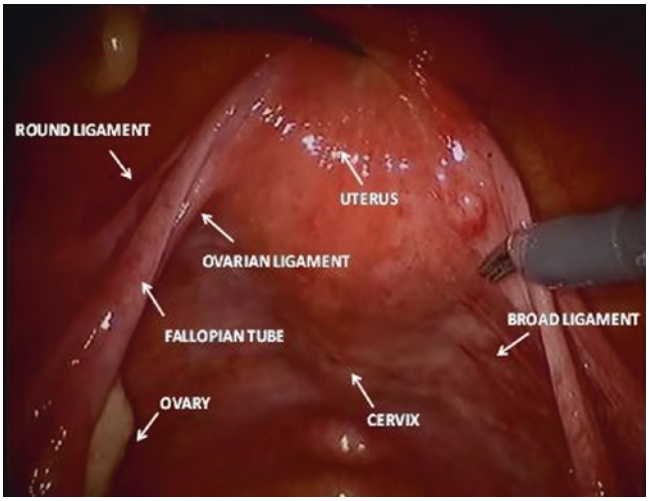


Fig. 66.10 Anatomical orientation: The posterior plane of the uterus, attached on both sides to the ovarian ligaments (connecting the uterus and the ovaries); the round ligament lies anterior to the fallopian tubes that are connect at the superior-lateral aspects of the uterus on their medial part and run laterally to the ovaries, which can be recognized on the left side as an oval, white structure. The broad ligament is the peritoneal sheet that covers the uterus anteriorly and posteriorly and contains several important structures including uterine blood vessels, ovarian blood vessels, ligaments and fallopian tubes

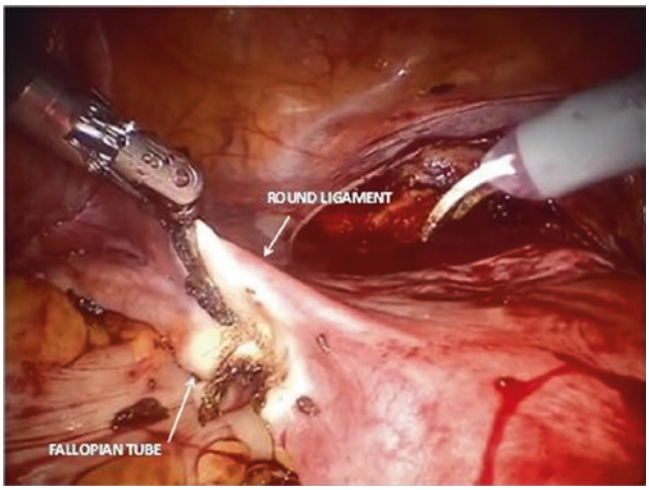


Fig. 66.11 Bipolar (searing) in the right arm, and scissors (cutting) in the left arm utilized to detach the round ligament, a preliminary step during Hysterectomy

Upon entering the peritoneal cavity, it is very important to orientate anatomically (Fig. 66.10):

Surgery Steps

1. Sealing and cutting of the round ligament and the fallopian tube (Fig. 66.11).

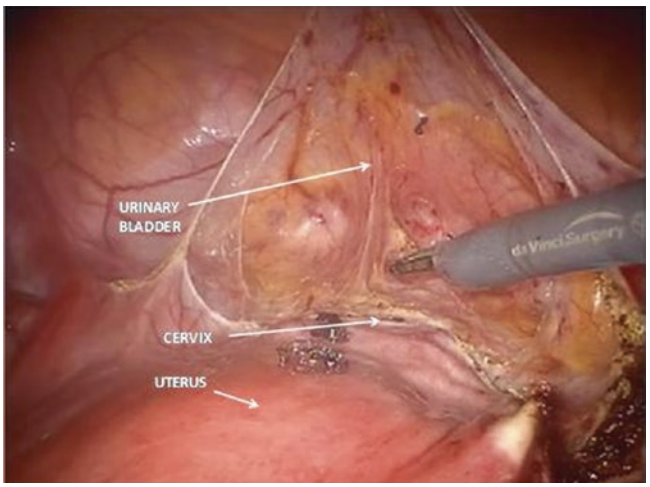


Fig. 66.12 Peeling of the bladder off the cervix

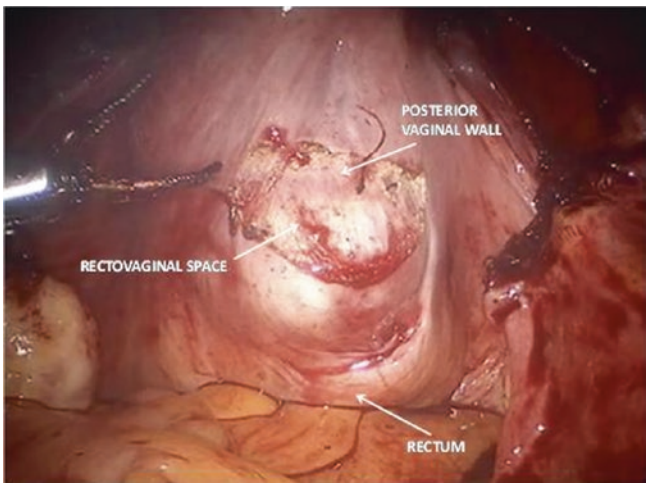


Fig. 66.14 Preparation of the posterior vaginal wall for the fixation of the posterior portion of the mesh

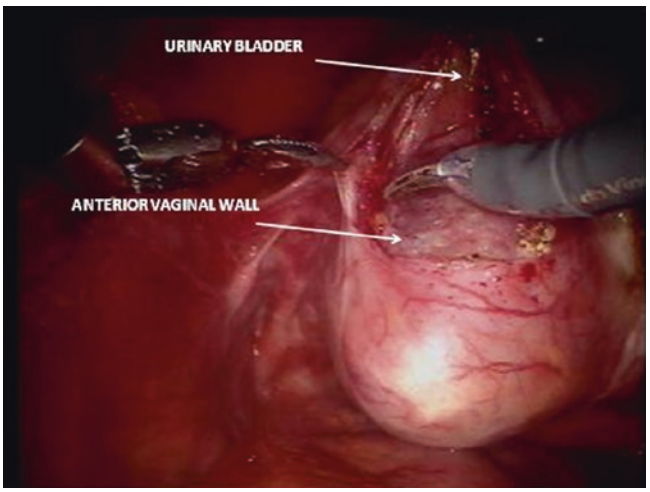


Fig. 66.13 Preparation for the fixation of the anterior portion of the mesh, an important step during surgery that serves a double purpose: avoiding damage to the bladder, and optimal fixation of the mesh, thus allowing better prolapse fixation results

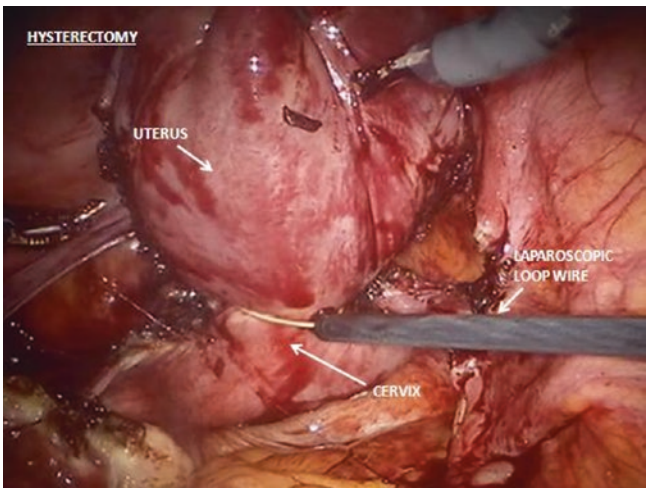


Fig. 66.15 Hysterectomy: usually performed supra-cervically. After detaching the uterus from its` supplying blood vessels, a loop wire is manipulated around the uterus, until reaching the upper part of the cervix, where uterine detachment is facilitated

2. Opening of the broad ligament and the posterior sheet.
3. The same actions need to be repeated on the other side of the uterus.
4. Opening of the bladder fold and pushing it over the anterior vaginal wall and the bladder's neck (Figs. 66.12 and 66.13).
5. Sealing and cutting the uterine arteries.
6. Developing the posterior rectovaginal space- opening the peritoneum on the posterior vaginal wall. (Fig. 66.14)
7. Total removal of the uterus using a loop wire while leaving the cervix intact (Figs. 66.15 and 66.16).
8. The anterior longitudinal ligament is exposed. The middle sacral vessels should be visualized to avoid inadvertent injury (Figs. 66.17 and 66.18).
9. Open the peritoneum from the sacral promontory downward toward the cul-de-sac and the posterior vaginal wall in order to cover the mesh with peritoneum.
10. Sewing the surgical mash to the posterior vaginal wall, the cervical stump and the anterior vaginal wall.

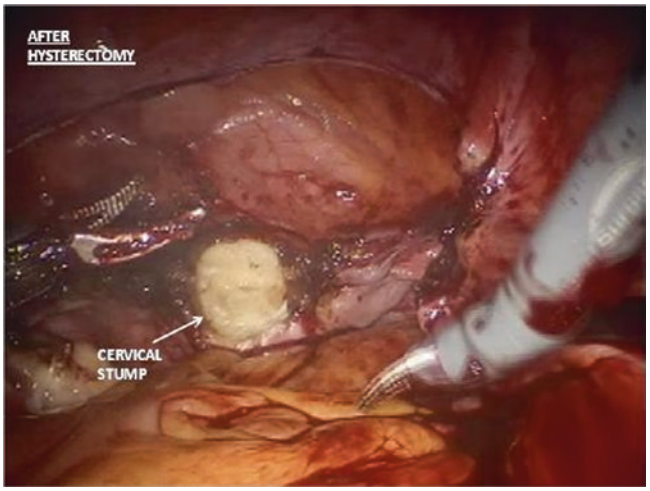


Fig. 66.16 The cervical stump is utilized later in surgery as an anchor for mesh fixation

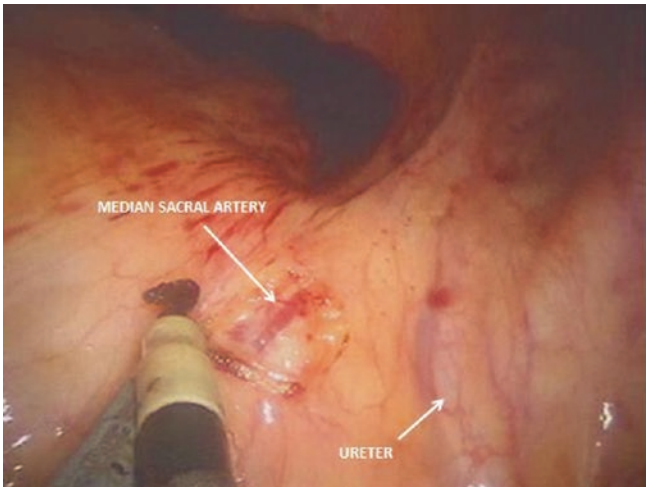


Fig. 66.18 Avoid damage to the median sacral vessels

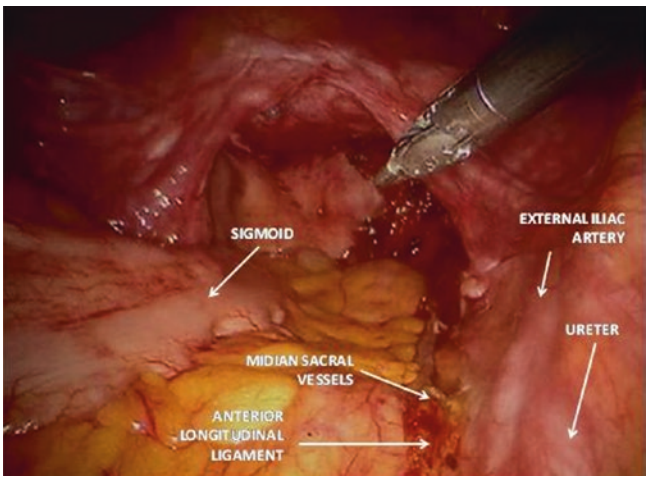


Fig. 66.17 Preparation of the promontorium for mesh fixation-anatomical landmarks that the surgeon must identify in order to avoid complications-ureter on the right side of the picture (usually identified by it's peristalsis; the common iliac artery in its` bifurcation to internal and external iliac arteries. Peeling the peritoneum off the promontorium to identify the longitudinal ligament

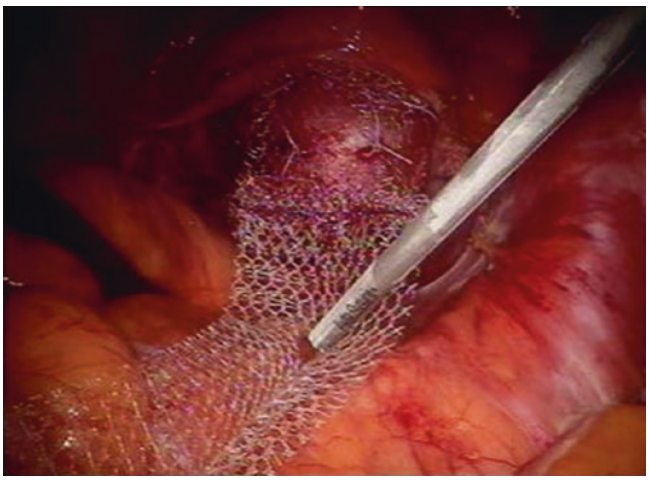


Fig. 66.19 Fixation of the inferior portion of the "Y" shaped mesh to the longitudinal ligament with tacks

11. Fixation of the surgical mesh to the promontory of the sacrum with tacks (Fig. 66.19).
12. Peritoneal closure: Fixation of the mesh to the sacral promontory, followed by re approximation of the peritoneal edges, and concealment of the mesh retroperitoneally.

Covering the mesh with peritoneum is in debate, while some consider this as a preventive measure for bowel adhesions to the mesh, this was not proven to be evidence based.

Opening the peritoneum along the promentriom toward posterior vaginal wall can result in bleeding and rarely to damage the sigmoid colon or the ureter. Closure the peritoneum over the mesh needs to be learned. Injury to adjacent vessels or the ureter can also occur during the procedure (Figs. 66.20 and 66.21).

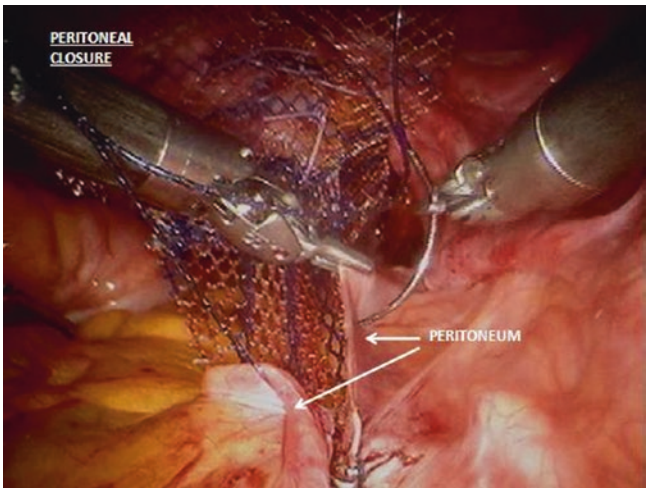


Fig. 66.20 After peeling the peritoneum and fixating the mesh to the promontorium, the mesh is "buried" under the peritoneum by suturing both ends of the peritoneum with a v-lock suture

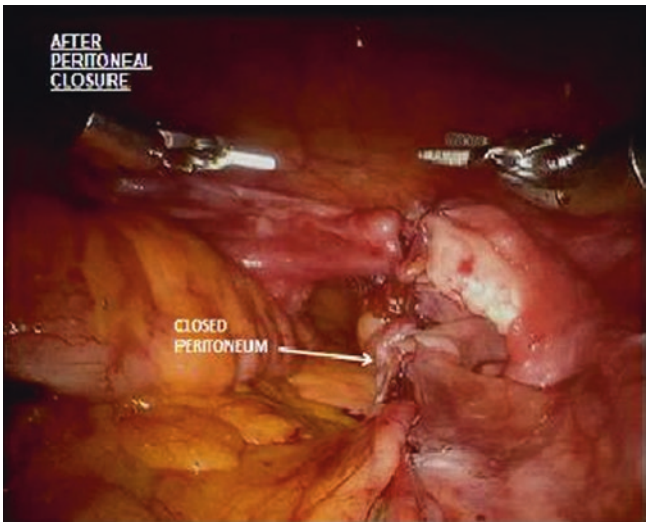


Fig. 66.21 The sutured peritoneum after peritonization (the mesh is buried under the peritoneum)

References

1. Jelovsek JE, Maher C, Barber MD. Pelvic organ prolapse. Lancet. 2007;369(9566):1027–38.
2. Luber KM, Boero S, Choe JY. The demographics of pelvic floor disorders: current observations and future projections. Am J Obstet Gynecol. 2001;184(7):1496–501. discussion 1501–3
3. Swift SE, Pound T, Dias JK. Case–control study of etiologic factors in the development of severe pelvic organ prolapse. Int Urogynecol J Pelvic Floor Dysfunct. 2001;12:187–92.
4. Young SB, Daman JJ, Bony LG. Vaginal paravaginal reapair: one-year outcomes. Am J Obstet Gynecol. 2001;185:1360–6.
5. Wang LC, Awamlh BA, et al. Trends in Mesh Use for Pelvic Organ Prolapse Repair from the Medicare Database. Urology. 2015;86(5):885–91. doi:10.1016/j.urology.2015.08.022. pii: S0090-4295(15)00834-1. [Epub ahead of print]
6. Nezhat CH, Nezhat F, Nezhat C. Laparoscopic sacral colpopexy for vaginal vault prolapse. Obstet Gynecol. 1994;84:885–8.

Robotic-Assisted Radical Hysterectomy

67

Emma L. Barber and John F. Boggess

Indications for Robotic Radical Hysterectomy

Piver, Rutledge and Smith originally described five types of hysterectomy for treatment of cervical cancer in 1974 [1]. A type I hysterectomy is an extrafascial or simple hysterectomy and is appropriate for the treatment of stage IA1 carcinoma of the cervix without lymph-vascular space invasion. In a type II hysterectomy, the uterine artery is ligated at its junction with the ureter and the para-cervical tissue medial to this is removed. This allows for preservation of the blood supply to the ureter and a decreased risk for ureteral vaginal fistula formation. A type II radical hysterectomy along with pelvic lymphadenectomy is appropriate treatment for IA2 carcinoma of the cervix, with or without lymph-vascular space invasion. A type III radical hysterectomy mandates removal of the parametria medial to the origin of the uterine artery as it branches off the internal iliac artery, removal of the uterosacral ligaments at their origin and an upper vaginectomy. A type III radical hysterectomy along with pelvic lymphadenectomy is the standard treatment for IB1 cervical cancer and may also be used for select IB2 as well as IIA lesions. Radical hysterectomy, either type II or type III can also be used to treat cases of uterine cancer with gross cervical involvement (Table 67.1).

Soon after the introduction of the robotic platform in 2005, Sert and Abeler published the first case report of robotic assisted type III radical hysterectomy [2]. The technique was later described in a series of 51 patients where robotic hysterectomy was found to decrease complications, specifically blood loss, and to shorten hospital stay when compared to open radical hysterectomy [3]. In addition, retrospective studies have shown that robotic assisted radical hysterectomy has equivalent survival to open radical hysterectomy [4–6]. The oncologic indications for robotic type III radical hysterectomy are the same as those for the open procedure. Laparoscopy and the robotic platform also require appropriate patient selection. Insufflation and steep Trendelenberg positioning promote physiologic cardiopulmonary changes that can result in increased hypercarbia, decreased cardiac output, and decreased pulmonary compliance. Thus, patients with significant pulmonary or cardiac conditions may not be able to tolerate the required positioning for the duration of the operation. This patient positioning also increases both the intraocular pressure and intracranial pressure. Thus, any intracranial pathology associated with intracranial hypertension or disruption of the blood-brain barrier are contraindications (Table 67.2). Additionally, among patients with glaucoma, preoperative tonometry should ensure that intraocular pressure is not increased, as robotic surgery in addition to an already elevated intraocular pressure can result in permanent ocular damage (Fig. 67.1).

Uterine size is another contraindication to a minimally invasive approach. A large bulky uterus can limit visualization and given that morcellation should be avoided in the case of cervical carcinoma, the uterine specimen must be able to be delivered through the vagina at the conclusion of the surgery. Previously described contraindications include increased patient BMI and extensive prior surgical history. While it is true that patients with a high BMI can provide a challenge in terms of increased weight on the diaphragm and the resulting decreased pulmonary compliance, we have found that many morbidly obese patients without significant cardiopulmonary co-morbidities are able to tolerate required positioning and do not experience an increased risk of perioperative pulmonary complications based on the degree of obesity [7]. Additionally, the surgical benefits of wristed instruments within the abdomen and pelvis as well as a camera that is able to descend into the pelvis actually offers increased visualization and dexterity in the obese patient over open surgery. Extensive prior surgical history has also been noted as a contraindication to minimally invasive surgery, however, we do not consider this a contraindication.

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Table 67.1 Types of radical hysterectomy

	Indications	Location of uterine artery ligation	Uterosacral ligaments	Vaginal margin
Type I (extrafascial)	IA1 cervical carcinoma without LVSI	Insertion into the cervix	Insertion into cervix	At cervico-vaginal junction
Type II (modified radical)	IA2 cervical carcinoma, uterine cancer with cervical involvement	Junction with the ureter	Midpoint between cervix and sacral attachments	1–2 cm of vaginal margin
Type III (radical)	IB1 cervical carcinoma and select IB2 and IIA lesions, uterine cancer with cervical involvement	Origin at the internal iliac artery	At sacral attachment	2–3 cm of vaginal margin

Table 67.2 Contraindications to a robotic approach

	Degree of contraindication	Rationale
Uterine size	Absolute	Morcellation should not be performed. Therefore, the specimen must be able to be delivered vaginally at the conclusion of the procedure
Conditions with increased ICP	Absolute	Required positioning will exacerbate intracranial hypertension ad can result in disruption of blood-brain barrier
Glaucoma with increased IOP	Absolute	Required positioning increases the intraocular pressure and can result in permanent vision loss and even blindness
Morbid obesity without cardiopulmonary compromise	None	These patients are generally able to be ventilated and the benefits of minimally invasive surgery and the wristed instruments of the robotic platform are even more pronounced in the morbidly obese
Cardiopulmonary compromise	Relative	Depending on the degree of compromise, patients may not be able to tolerate the required positioning, however, this is difficult to predict preoperatively and thus patients should have a trial of positioning before deeming this a contraindication
Extensive surgical history	None	Robotic platform allows for increased dexterity and visualization allowing the surgeon to perform lysis of adhesions



Fig. 67.1 Securing patient for steep Trendelenberg positioning. The patient's chest is padded and she is secured to the bed using thick cloth tape. The tape is passed around the patient and the bed 3–5 times depending on the patient's weight

Robotic Versus Laparoscopic Versus Abdominal Radical Hysterectomy

Minimally invasive radical hysterectomy, including both robotic and laparoscopic radical hysterectomy, offers advantages over abdominal radical hysterectomy. Minimally invasive radical hysterectomy has been associated with decreased blood loss, lower rates of transfusion, decreased length of hospital stay, equal or lower rates of postoperative complication, and an equal or increased number of lymph nodes sampled when compared with an open procedure [8–11].

Studies examining robotics versus traditional laparoscopy have found that traditional laparoscopy is associated with similar postoperative outcomes, but longer operative times. In addition, most laparoscopic radical hysterectomy series are limited to patients with a BMI under 30 whereas robotic papers include obese and morbid obese patients in their cohorts. Traditional laparoscopy is also associated with a longer learning curve and does not offer the same ergonomic benefits as robotic surgery. In contrast with other surgical procedures such as benign hysterectomy, robotic radical hysterectomy is not associated with increased cost compared with traditional laparoscopy [11]. In the only study to examine the cost of robotic, abdominal and laparoscopic radical hysterectomy for the treatment of cervical cancer using a large national database, the authors found that laparoscopic radical hysterectomy was associated with median costs of $11,774 whereas robotic radical hysterectomy actually had a statistically significant lower median cost of $10,176 [11].

Data on oncologic outcomes are similarly reassuring. One study showed no difference in 3-year overall and recurrence free survival for patients undergoing robotic versus abdominal radical hysterectomy [4]. A multicenter retrospective study examined 517 patients and demonstrated no difference in recurrence or survival between patients undergoing open or robotic radical hysterectomy with a median follow up of 34 months [12]. The same is true for laparoscopic versus open radical hysterectomy with both having similar risk of recurrence and mortality [6].

Surgical Procedure

Clinic Evaluation and Patient Counseling

History and physical examination are essential to identify patients who are good candidates for robotic radical hysterectomy. Evidence of parametrial spread on examination or imaging that reveals metastatic disease necessitates primary treatment with pelvic chemoradiation or systemic chemotherapy. Preoperative assessment should also screen for the previously mentioned contraindications to robotic surgery. Standard preoperative assessment with indicated laboratory work including a type and screen should be performed. Bowel preparation is not necessary.

As with any surgical procedure, patients should have an informed consent discussion regarding the risks and benefits of robotic radical hysterectomy. Standard risks such as bleeding, infection and injury to blood vessels, nerves, bladder, ureter, and bowels should be discussed. Additionally, for robotic radical hysterectomy, the risk of conversion to a laparotomy, risk of fistula formation and risk of both short-term and long-term bladder dysfunction should all be discussed. Patients should also be informed of the possibility of postoperative radiation depending on the final surgical pathology.

Preoperative Positioning

The patient is brought to the operating room and placed under general anesthesia. Prior to induction, sequential compression devices are placed on the lower extremities. She is then positioned in the low dorsolithotomy position using Allen stirrups to allow for adequate space to bring the robot to the bedside. Examination under anesthesia is performed prior to beginning the surgery to reorient the surgeon to the patient's anatomy and to confirm the absence of parametrial or pelvic sidewall disease, which would preclude a surgical approach. After the patient is positioned in the dorsolithotomy position, she is secured to the table to allow for steep Trendelenberg positioning. This can be done using shoulder blocks, chest padding with taping or a beanbag device which molds to the patient. Given the risk of brachial plexus injuries relying only on shoulder blocks and the cost of bean bag devices, we prefer to use chest padding and taping to secure the patient to the bed. Although uterine manipulation is standard in robotic hysterectomy, for a robotic radical hysterectomy, we prefer to avoid disruption of the tumor and instead place a large rectal dilator (EEA sizer) in the vagina prior to draping for use at the time of colpotomy. A pneumo-occluder balloon is also placed in the vagina to prevent loss of pneumoperitoneum during the colopotomy. A foley catheter is also placed to decompress with bladder and decrease the risk of bladder injury. Prophylactic antibiotics are administered prior to skin incision (Fig. 67.2).

Abdominal Entry

We routinely enter the abdomen in the left upper quadrant at Palmer's point (left upper quadrant 2 cm below the costal margin in the mid-clavicular line) after an orogastric tube has been placed to suction. This allows us to avoid adhesions from prior surgery and will be the site for our assistant port [13]. We inject the skin with local anesthetic prior to incision and enter the abdomen with a 2 mm miniport. Once the abdomen is insufflated, a 2 mm camera is inserted into the abdomen and an abdominal survey is performed focusing on the anterior abdominal wall and presence of any adhesive disease. An alternative technique is to insufflate at this site with a veress needle and place a 5 mm visiport under direct visualization.

Port Placement

Five total trocars are used. Two traditional laparoscopic trocars are used for the camera and assistant port and three robotic trocars are used for the robotic arms. A 12 mm trocar is placed in the umbilicus and functions as the camera port. The robotic camera is introduced through this port and a complete abdominopelvic survey is completed to identify any evidence of metastatic disease or adhesive disease that



Fig. 67.2 EEA sizer and vaginal balloon. A rectal end-to-end anastomosis (EEA) sizer is placed into the vagina to allow for uterine manipulation and to assist in identification of the cervico-vaginal junction. A pneumo-occluder balloon is placed around the handle and inflated to prevent the loss of pneumoperitoneum during colpotomy

will prevent port placement. Any abnormalities encountered in the abdomen or pelvis that are suspicious for metastatic disease should be biopsied and sent for frozen section. Confirmation of metastatic disease should prompt the surgeon to consider aborting the surgery in favor of radiation therapy depending on the clinical scenario. Any encountered adhesive disease, which prevents port placement or will not be accessible with the robot is taken down laparoscopically. Additional robotic trocars are placed as follows: arm 1 is placed 8–10 cm lateral to the camera port in the right upper abdomen, arm 2 is placed in the left upper abdomen again, 8-10 cm lateral to the camera port, mirroring arm 1, and arm 3 is placed in the left lower quadrant just superior to the anterior iliac spine and at least 8 cm in distance from arm 2. A 10/12 mm assistant port is placed in the left upper quadrant at the site of laparoscopic entry. All trocars are placed under direct visualization and all ports are advanced to the thick black line on the trocar cannula to allow for optimal range of motion for the robotic arms. The patient is then placed in steep Trendelenberg. If tolerated, we use 30 ° of Trendelenberg. The robot is moved into position either between the patient's legs or over the left leg in a side docking position. The camera arm is docked first. The robotic arm clutch button is pressed and the angle of the camera arm is aligned with the angle of the trocar. The trocar is stabilized with one hand and the other hand is used to press the robotic arm clutch button and deliver the arm to the trocar, clipping both wings to secure the robotic arm to the trocar. The remaining three robot arms are docked to their respective trocars in the same fashion (Fig. 67.3).

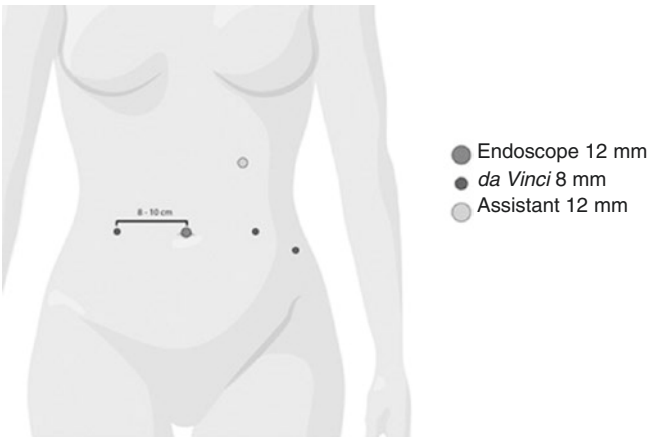


Fig. 67.3 Port placement. A 12 mm trocar is placed in the umbilicus and functions as the camera port. Arm 1 is placed 8–10 cm lateral to the camera port in the right upper abdomen and arm 2 is placed in the left upper abdomen mirroring arm 1. Arm 3 is placed in the left lower quadrant just superior to the anterior iliac spine and at least 8 cm in distance from arm 2. A 10/12 mm assistant port is placed in the left upper quadrant at the site of laparoscopic entry (With kind permission from John F. Boggess, MD 2007)

Robotic Instruments

Once the robot arms have been docked, the robotic camera is introduced through the camera port. We use a 0-degree camera throughout the surgery. The robotic instruments are then introduced. The monopolar scissors are used in the right hand and the fenestrated bipolar in the left hand. A blunt grasper, such as a prograsp or a cadiere, is used in arm 3. All instruments are introduced into the abdomen under direct visualization.

Opening the Retroperitoneum and Avascular Spaces of the Pelvis

The uterus is manipulated with the fourth robotic arm. The right uterine cornua is grasped and moved to the patient's left. The right round ligament is transected using monopolar cautery as far laterally as possible and this peritoneal incision is extended cephalad parallel to the infundibulopelvic ligament. The medial umbilical ligament is placed on tension medially and caudad to allow for identification of the superior vesical artery. The peritoneum just lateral to the artery is incised cephalad to its origin. The monopolar scissors and fenestrated bipolar graspers are then used to spread perpendicular to the pelvic sidewall to bluntly open the paravesicle space down to the level of the levator muscles. The pararectal space is opened in a similar fashion by spreading in a perpendicular manner in between the ureter and internal iliac artery and vein. After the paravesical and pararectal spaces have been opened, the parametria to be resected can be easily identified as the remaining tissue between the two spaces. At this time, any extension of tumor into the parametrial tissues is evaluated and as evidence of extension indicates the need for postoperative radiation and the surgeon evaluates whether or not to proceed depending on the clinical scenario (Fig. 67.4).

Pelvic Lymphadenectomy

A bilateral pelvic lymphadenectomy is then performed. The fourth robotic arm is used to reflect the superior vesical artery medially and open the paravesical space. The operative assistant using a laparoscopic grasper retracts the proximal peritoneum at the pelvic brim to expose the entire area of nodal dissection. The nodal tissue just inferior to the bifurcation of the common iliac artery is grasped and elevated with the fenestrated bipolar forceps. The monopolar scissors are used to make an incision overlying the psoas muscle just lateral to the artery and the genitofemoral nerve is mobilized laterally. Once the sur-

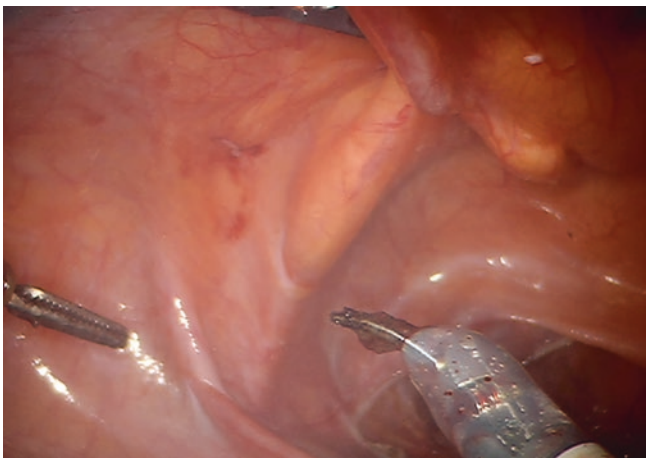


Fig. 67.4 Identification of the superior vesical artery. The median umbilical ligament is identified on the anterior abdominal wall. It is placed on tension medially and caudad which in turn pulls the superior vesical artery medially and away from the pelvic sidewall to allow for easy identification

face of the external iliac artery is identified, the nodal tissue is dissected free from the artery caudally using a combination of blunt dissection and cautery, as appropriate, until the deep circumflex iliac vein is encountered. The nodal bundle is reflected medially and gentle dissection is used to identify the surface of the external iliac vein and the nodal tissue is freed from its attachments to the vein cephalad to the bifurcation. The nodal bundle is grasped at the midpoint between the bifurcation of the common iliac artery and the crossing of the deep circumflex iliac vein. The vein is pushed laterally in order to enter the space between the nodal bundle and the pelvic sidewall. The obturator nerve is identified and the caudad portion of the nodal bundle in the obturator space is grasped with the fenestrated bipolar forceps and reflected medially and cephalad. The surface of the vein is pushed laterally and the obturator nerve is pushed inferiorly to free the nodal bundle from the obturator space. This process is continued cephalad until the bifurcation is reached and the specimen is freed. It is placed in a specimen bag in the upper abdomen for subsequent removal. The same is done on the left side (Figs. 67.5 and 67.6).

Ureteral Dissection

The ureter is identified along the medial leaf of the broad ligament. It is dissected free from its medial attachments and mobilized laterally to the level of the uterine artery and cardinal ligament in order to allow adequate visualization for the origin of the uterine artery. Care is taken to preserve the blood supply, adventitia and muscularis of the ureter to decrease the risk of fistula (Fig. 67.7).

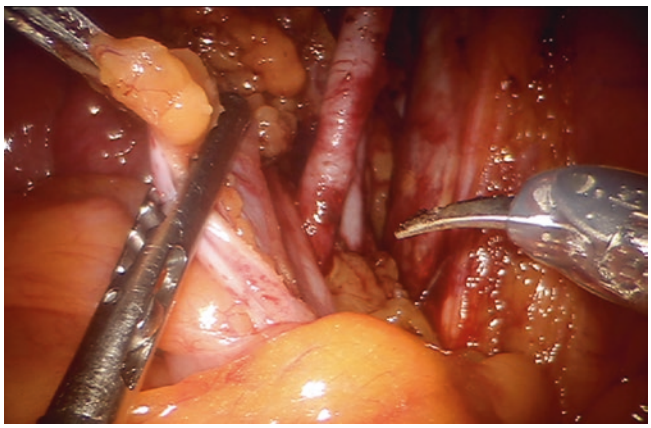


Fig. 67.5 Peritoneal retraction. The assistant retracts the peritoneum at the pelvic brim medially to allow for exposure to perform the nodal dissection

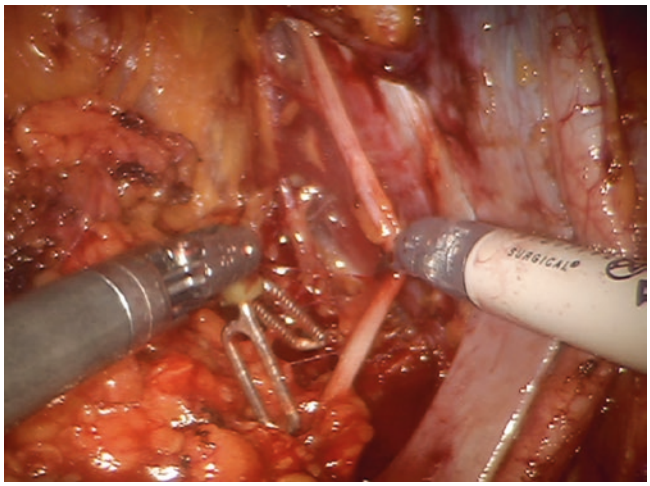


Fig. 67.6 Obturator nerve. The obturator nerve is identified and the nodal bundle is dissected free by grasping the nodal bundle, moving it cephalad and medially, and pushing the nerve laterally and inferiorly

Bladder Flap, Uterine Artery Transection and Parametrial Dissection

The vesico-uterine fold is incised with monopolar cautery and extended laterally to create the bladder flap. The vesico-uterine peritoneum is elevated and the vesico-uterine space is entered using a combination of blunt and sharp dissection with use of cautery as appropriate. This space is further dissected caudally until the bladder has been taken down sufficiently off the anterior vaginal wall to achieve an adequate margin. The uterine artery is identified at its origin from the internal iliac artery. The origin is isolated by dissecting away the surrounding tissue with blunt dissection with the fenestrated bipolar forceps. The artery and vein are then cauterized with bipolar cautery and transected. The artery is then freed from its attachments to the ureter and the ureter is

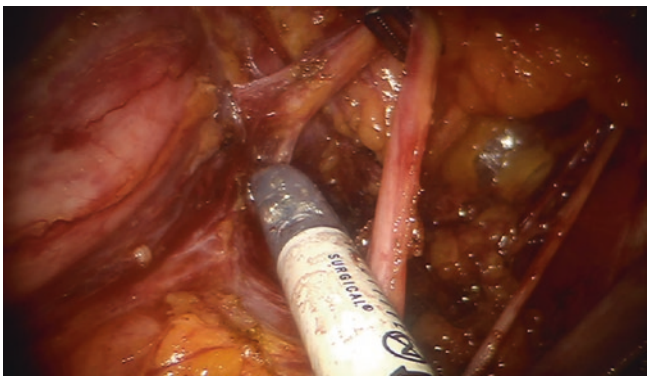


Fig. 67.7 Ureteral dissection. The ureter is reflected laterally and dissected free from its medial attachments

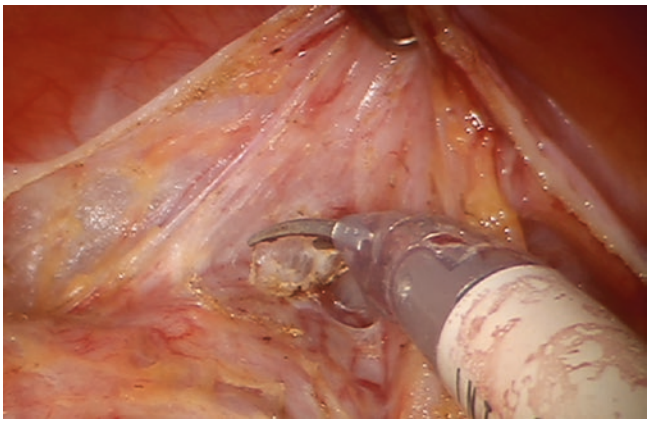


Fig. 67.8 Bladder flap. The vesico-uterine peritoneum is elevated and the bladder is dissected off the cervix and vagina

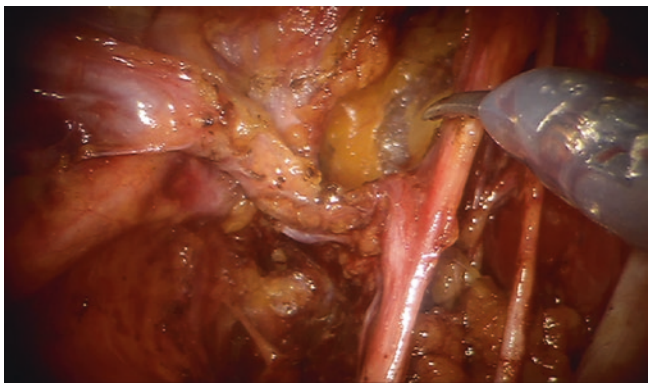


Fig. 67.9 Uterine artery isolation. The uterine artery is isolated at its origin

further mobilized laterally. The parametrial tissue is dissected off the ureter and mobilized medially. This allows for exposure of the ureteral tunnel of Wertheim and the ureter is unroofed to its insertion into the bladder by bipolar coagulating the anterior vesico-uterine ligament (Figs. 67.8, 67.9 and 67.10).

Transect the Utero-Ovarian Ligament or Infundibulopelvic Ligament

At this time, either the infudibulopelvic ligament or the utero-ovarian ligament is transected depending on the patient's age and the clinical circumstance. If the ovary is preserved, salpingectomy should be considered in order to reduce the future risk of ovarian cancer [14]. The paravesical space has been previously opened and the ureter is again identified. A window is made in the broad ligament below the infundibulopelvic ligament and above the ureter using the monopolar scissors. Blunt traction is used to extend this incision along the length of the infundibulopelvic ligament. Bipolar cautery followed by transection with the monopolar scissors is used to transect either the infundibulopelvic ligament at its origin or the utero-ovarian ligament (Fig. 67.11).

Transect Uterosacral Ligaments While Preserving the Sacral Nerve Plexus

The uterus is retracted anteriorly using the third robotic arm. The incision along the posterior broad ligament is continued medially towards the uterosacral ligament. As this is performed, the endopelvic fascia containing the hypogastric nerve plexus is dissected laterally. The peritoneum overlying the rectovaginal space between the two uterosacral ligaments is incised and the rectovaginal space is developed with blunt dissection. The uterosacral ligaments are cauterized with bipolar cautery at their insertion into the posterior vaginal wall and the remainder of the cardinal ligament is resected to the pelvic sidewall (Figs. 67.12, 67.13 and 67.14).

Colpotomy with Upper Vaginectomy

The EEA sizer which was previously placed in the vagina is advanced to identify the cervicovaginal margin. An incision is made along the anterior vaginal wall 2–3 cm inferior to the cervicovaginal junction to allow for an adequate margin. This incision is made with the monopolar cautery and continued around circumferentially, freeing the specimen. The specimen is removed through the vagina as are the specimen bags with the previously dissected pelvic lymph node specimens (Fig. 67.15).

Vaginal Cuff Closure

A mega suture cut needle driver is introduced into the right hand and a 0-vicryl suture on a CT-1 needle cut to 25 cm is passed through the assistant port. The vaginal cuff is closed in a running unlocked fashion from right to left. It is important

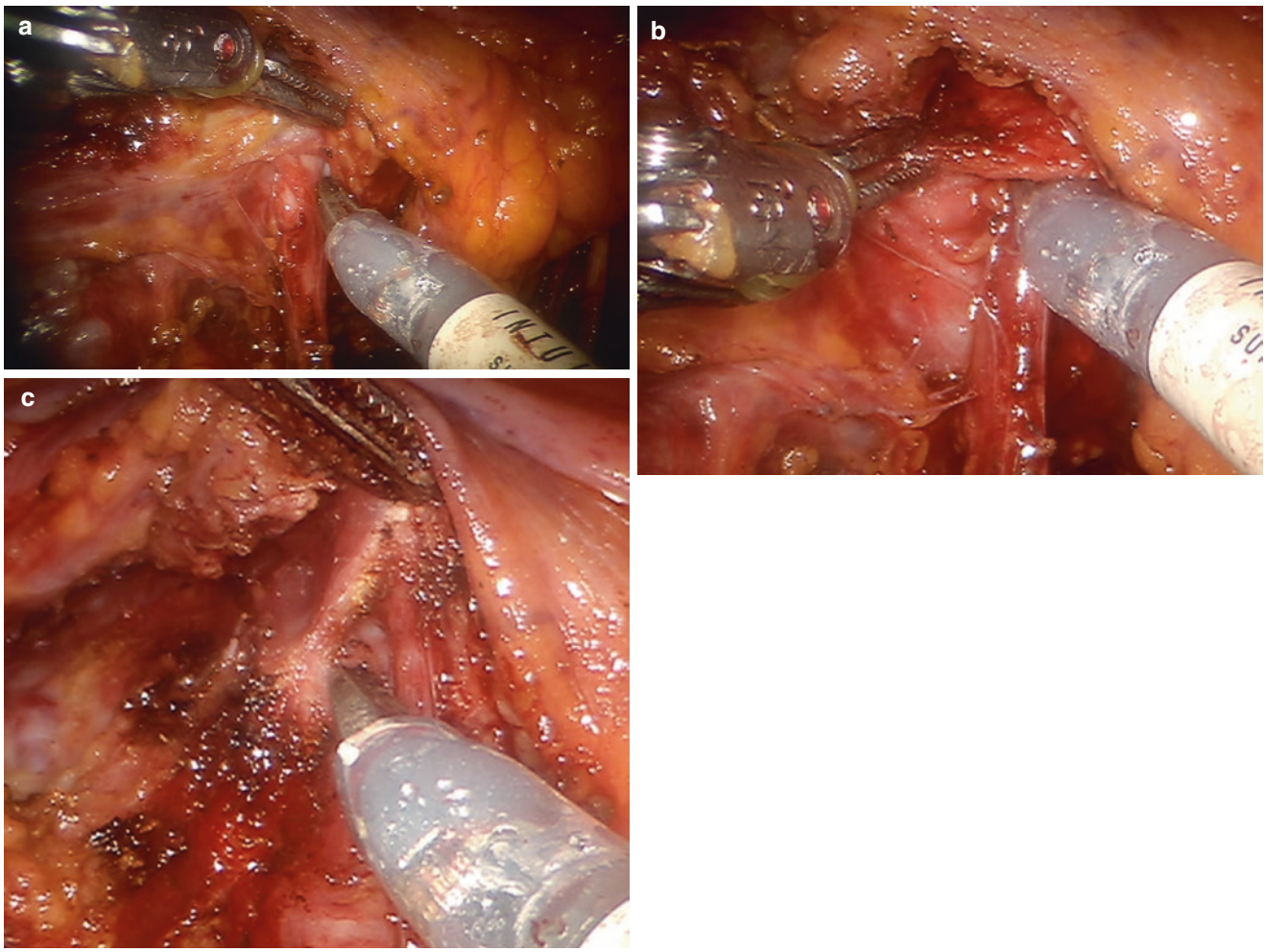


Fig. 67.10 Anterior vesicouterine ligament and tunnel of Wertheim. The ureter is unroofed through the tunnel of Wertheim (**a**). The anterior vesicouterine ligament is coagulated (**b**) and transected (**c**) exposing the insertion of the ureter into the bladder

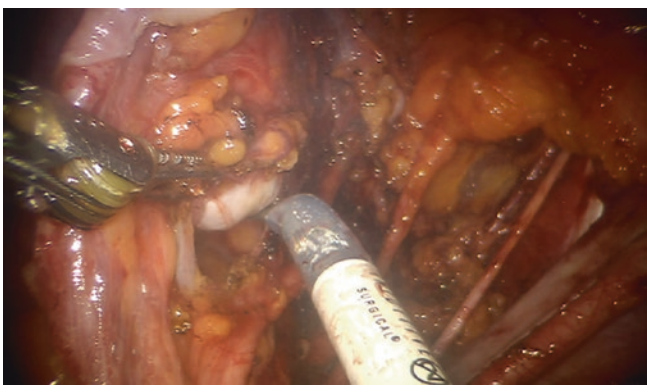


Fig. 67.11 Infundibulopelvic ligament. A window is made in the broad ligament and the infundibulopelvic ligament is cauterized and transected

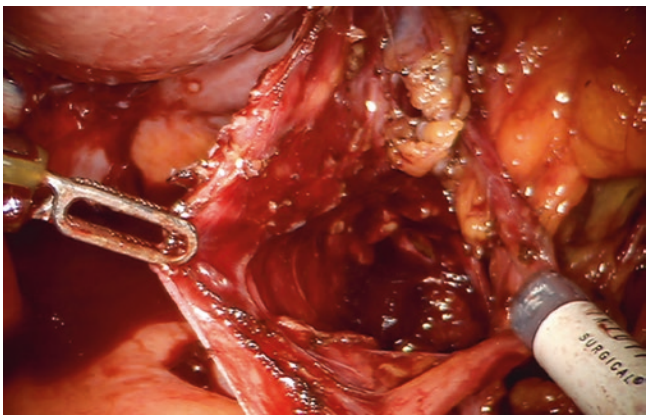


Fig. 67.12 Preserve the hypogastric plexus. The peritoneum is grasped and the endopelvic fascia containing the hypogastric nerve plexus is dissected off the peritoneum by sweeping laterally

to incorporate approximately 1 cm of vagina in each suture bite, to include the fascia and to keep the running closure on tension throughout by having the surgical assist "follow" with a laparoscopic needle driver holding the suture. The suture cut needle driver is used to cut the suture and the needle is

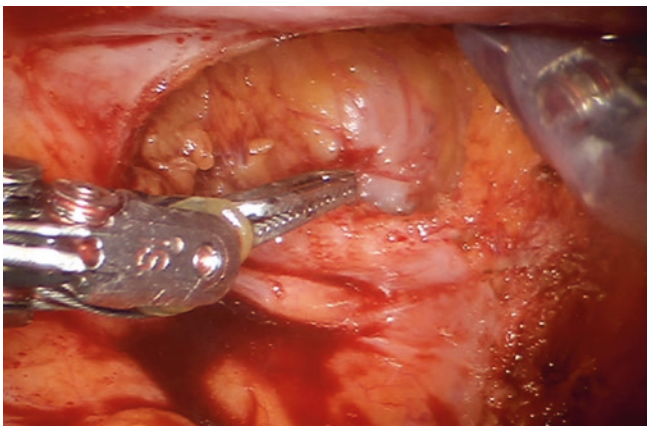


Fig. 67.13 Open rectovaginal space. The rectovaginal space is developed using blunt dissection

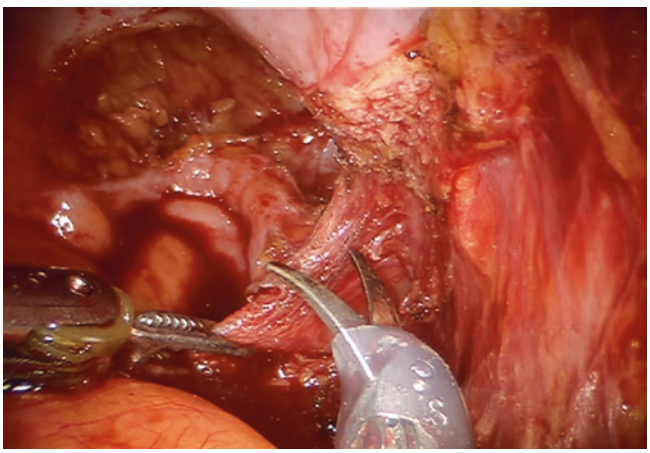


Fig. 67.14 Uterosacral transection. The uterosacral ligaments are transected at their sacral insertion after the hypogastric nerve plexus has been dissected laterally

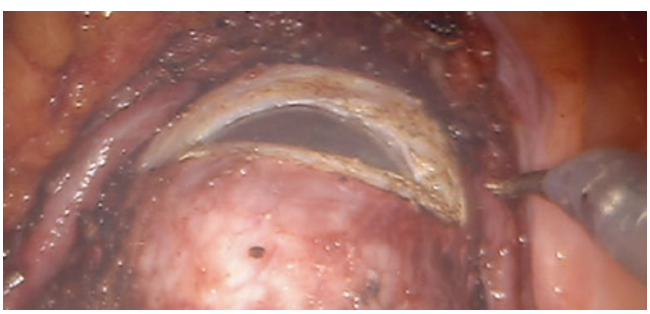


Fig. 67.15 Colpotomy. An incision is made along the vaginal wall 2-3 cm inferior to the cervico-vaginal junction. The EEA sizer is used to provide anatomic orientation

passed out of the assistant port. The abdomen and pelvis are irrigated and all operative sites are assessed for hemostasis (Fig. 67.16).

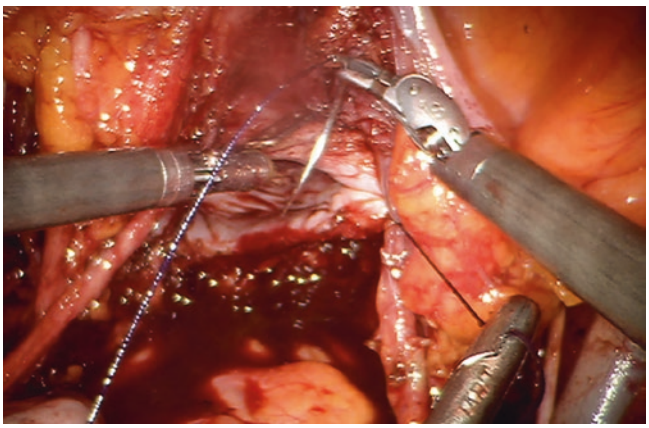


Fig. 67.16 Vaginal cuff closure. The assistant follows the surgeon using a laparoscopic needle driver to ensure continuous tension is maintained

Oophoropexy

If the ovaries are left in situ, oophoropexy may be performed to protect ovarian function in the event that adjuvant radiation is required. The peritoneum surrounding the infundibulopelvic ligament is further skeletonized using the monopolar scissors to allow increased mobility. The adnexa is mobilized above the pelvic brim. A 0-vicryl suture is passed through the assistant port and the ovary is sutured and tied to the pelvic peritoneum above the pelvic brim using a figure of eight stich. If desired, the ovaries can be marked with surgical clips for identification in radiation planning. The needle is removed via the assistant port.

Closing

After the abdomen and pelvis are irrigated and hemostasis is achieved, all robotic instruments are removed from the patient's abdomen. The robotic arms are undocked from the trocars and the robot is moved from the bedside. The abdomen is desufflated and manual breaths are given by the anesthesiologist to decrease residual intra-abdominal gas. The fascia at the 12 mm ports is closed with 0-vicryl to prevent hernia formation. The skin is closed in a subcuticular fashion with 4–0 vicryl or using dermabond (Fig. 67.17).

Postoperative Care

The postoperative management and recovery after a robotic radical hysterectomy mirrors that of other minimally invasive surgery. Patients are given a general diet on postoperative day zero and in our experience, all patients are able to tolerate oral pain medications and do not require any intravenous narcotics.

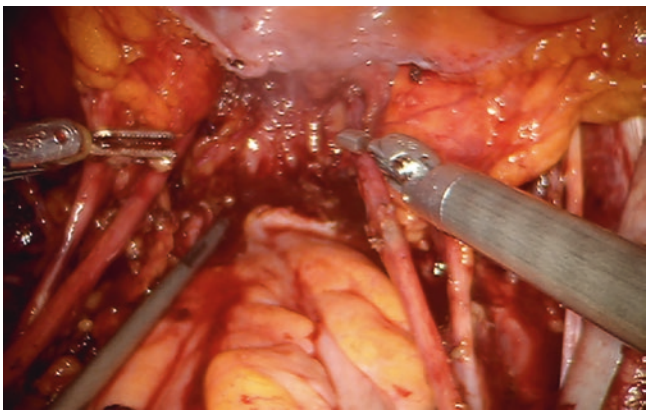


Fig. 67.17 Irrigation and hemostasis. At the conclusion of the procedure, irrigation is performed and hemostasis is assured

Patients do not require intravenous fluids by early postoperative day one. The vast majority of patients are able to go home on postoperative day one. Given the extensive bladder dissection and resulting parasympathetic and sympathetic denervation required for type III radical hysterectomy, all patients are sent home with a foley catheter and present to clinic four to seven days postoperatively for a voiding trial to ensure adequate bladder function prior to catheter removal.

References

1. Piver MS, Rutledge F, Smith JP. Five classes of extended hysterectomy for women with cervical cancer. Obstet Gynecol 1974;44:265–72.
2. Sert BM, Abeler VM. Robotic-assisted laparoscopic radical hysterectomy (Piver type III) with pelvic node dissection–case report. Eur J Gynaecol Oncol. 2006;27:531–3.
3. Boggess JF, Gehrig PA, Cantrell L, et al. A case-control study of robot-assisted type III radical hysterectomy with pelvic lymph node dissection compared with open radical hysterectomy. Am J Obstet Gynecol. 2008;199:357 e1–7.
4. Cantrell LA, Mendivil A, Gehrig PA, Boggess JF. Survival outcomes for women undergoing type III robotic radical hysterectomy for cervical cancer: a 3-year experience. Gynecol Oncol. 2010;117:260–5.
5. Hoogendam JP, Verheijen RH, Wegner I, Zweemer RP. Oncological outcome and long-term complications in robot-assisted radical surgery for early stage cervical cancer: an observational cohort study. BJOG. 2014;121:1538–45.
6. Li G, Yan X, Shang H, Wang G, Chen L, Han Y. A comparison of laparoscopic radical hysterectomy and pelvic lymphadenectomy and laparotomy in the treatment of Ib-IIa cervical cancer. Gynecol Oncol. 2007;105:176–80.
7. Wysham WZ, Kim KH, Roberts JM, et al. Obesity and perioperative pulmonary complications in robotic gynecologic surgery. Am J Obstet Gynecol. 2015;213(1):33.e1–7.
8. Estape R, Lambrou N, Diaz R, Estape E, Dunkin N, Rivera A. A case matched analysis of robotic radical hysterectomy with lymphadenectomy compared with laparoscopy and laparotomy. Gynecol Oncol. 2009;113:357–61.
9. Ko EM, Muto MG, Berkowitz RS, Feltmate CM. Robotic versus open radical hysterectomy: a comparative study at a single institution. Gynecol Oncol. 2008;111:425–30.
10. Lowe MP, Chamberlain DH, Kamelle SA, Johnson PR, Tillmanns TD. A multi-institutional experience with robotic-assisted radical hysterectomy for early stage cervical cancer. Gynecol Oncol. 2009;113:191–4.
11. Wright JD, Herzog TJ, Neugut AI, et al. Comparative effectiveness of minimally invasive and abdominal radical hysterectomy for cervical cancer. Gynecol Oncol. 2012;127:11–7.
12. Sert BM, Boggess JF, Ahmad S, Jackson AL, Stavitzski NM, Dahl AA, Holloway RW. Robotic versus open yype III radical hysterectomy: a multi-institutional experience for early stage cervical cancer. Soc Gyencol Oncol. Chicago, IL2015
13. Vilos GA, Ternamian A, Dempster J, Laberge PY, The Society of O, Gynaecologists of C. Laparoscopic entry: a review of techniques, technologies, and complications. J Obstet Gynaecol Can(JOGC = Journal d'obstetrique et gynecologie du Canada : JOGC). 2007;29:433–65.
14. Committee on Gynecologic Practice. Committee opinion no. 620: Salpingectomy for ovarian cancer prevention. Obstet Gynecol. 2015;125:279–81.

Robotic-Assisted Radical Hysterectomy (RRH) as Nerve-Sparing Procedure

68

Gun Oh Chong and Yoon S. Lee

Radical hysterectomy is a well-accepted treatment modality of early-stage cervical cancer. Radical hysterectomy is defined as the en bloc removal of the uterus and cervix with the surrounding parametrial tissue, upper vagina. The term radical hysterectomy has been used to refer to a wide range of procedures that act with different degrees of radicality. In 1974, Piver and Rutledge describe five different types of extended abdominal radical hysterectomy [1].

A new classification has recently been proposed by Querleu and Morrow in 2008 (Table 68.1) [2].

Because conventional radical hysterectomy (CRH) involves dividing and disrupting the cardinal and utersacral ligament, which contain the autonomic nerves, urinary, anorectal, and sexaul dysfunction can be developed. One thrid of patients report bladder dysfunction after radical hysterectomy such as difficulty emptying the bladder, incomplete emptying and urgency [3]. Furthermore, anorectal dysfuction, including constipation, have been reported in 5–10 % of patients after CRH [4]. Considerable sexual dysfunction, including decrease in sexual interest and organism, and vaginal dryness, are also noticed after CRH, which compromise sexual activity and result in subtantial distress [5].

Japanese surgeons first introduced the nerve-sparing radical hysterectomy (NSRH) procedure to preserve pelvic autonomic nerves, with desire to prevent disabling long-term adverse effect [6]. Subsequently, most international investigators who described their experiences using NSRH reported favorable outcomes, including earlier return of bladder function [7, 8], better vaginal blood flow [9], and fewer symptoms related to anorectal function [10]. A recent meta-analysis also showed that NSRH may decrease intraoperative complications, and urinary and anorectal dysfunction [11, 12]. Howerver, NSRH has been suggested to decrease the resection scope of radical hysterectomy, so that the narrowed resection scope may compromise therapeutic effect [13]. Possover et al. and Höckel et al. provided type III NSRH including meticulous cleansing of the neural part of the cardinal ligament from all fatty and lymphoid tissue [7, 14]. Whether leaving neural part of the cardinal ligament poses an increased risk for recurrence or lowers chances of survival remains a matter debate in the literature [15–17]. A recent meta-analysis demonstrated that NSRH may have similar clinical safety and extent of resection compared with CRH and not affect prognosis [11, 12]. However, Basaran et al. provided that the evidence adressing the oncological safety of NSRH over that of CRH is neither adequate nor statistically relevant in their systemic review [18]. A properly disigned, prospective randomized noninferiority trial is needed to assess the oncological outcomes of NSRH.

Since the introduction of the conventional laparoscopy, improvements in gynecologic surgery have been notable. However, laparoscopic radical hysterectomy is not a popular choice among gynecologic oncologist because of the increased operative time and the steep learning curve required for competency [18]. Moreover, laparoscopic NSRH has a higher urological complication rate, longer operating times, and much blood loss than does CRH, especilly during the initial learning perioid [8]. Robotic technology has recently come into wide-spread use to overcome the limitations of laparoscopic surgery. Robotic surgery gives more surgical options, such as nerve-sparing technique, due to its superior visualization (3-dimensional imaging of the operative field), mechanical improvement (seven degree of instrument mobility inside the body) and stabilization/tremor filtration of the instrument within the surgical field which lead to easier identification and preservation of anatomical structures. Marchal et al. [19] performed the robotic radical hysterectomy (RRH) in 2005, and more recently Magrina et al. [20] described techniques of robotic NSRH. It has been reported that RRH is a feasible and safe surgical modality compared with the existing radical abdominal hysterectomy and laparoscopic radical hysterectomy for the treatment of early-stage cer-

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Table 68.1 Classification of radical hysterectomy by Querleu and Morrow

Q-M classification	Ureter mobilization	Transection of paracervix	Transection of uterosacral and vesicouterine ligament	Vaginal resection	Piver-Smith classification
A	Not done	Medial to ureter and lateral to cervix	At the level of cervix	<10 mm	Extrafascial hysterectomy
B	Unroofed and rolled laterally	At the level of the ureteral tunnel	Partial resection	At least 10 mm	Modified radical hysterectomy
C	Mobilised completely	Transected completely	At the level of rectum and bladder	15–20 mm	Classical radical hysretecomy
C1	With autonomic nerve preservation				
C2	Without autonomic nerve preservation				

Table 68.2 Comparison of surgical outcomes between nerve-sparing robotic radial hysterectomy and total laparoscopic radical hysterectomy

	RRH (n=50)	TLRH (n=50)	*P* value
Operating time (min)	230.1±35.8	211.2±46.7	0.025[a]
Blood loss (ml)	54.9±31.5	201.9±148.4	<0.001[a]
Pelvic node (n)	25.0±9.9	23.1 ±10.4	0.361[a]
Length of hospital stay (days)	9.6±5.6	8.7±3.1	0.325[a]
Time to normal residual urine (days)	9.6±6.4	11.0±6.2	0.291[a]
Transfusion (n, %)	1 (2 %)	4 (8 %)	0.169[b]

Data are presented as the mean ± SD or as a percentage of the total number
RRH robotic radical hysterectomy, *TLRH* total laparoscopic radical hysterectomy
[a]Student t-test
[b]Chi-square test

Table 68.3 Comparison of intraoperative and postoperative complications between nerve-sparing robotic radial hysterectomy and total laparoscopic radical hysterectomy

	RRH (n=50)	TLRH (n=50)	*P* value
Intraoperative complications (n)	0	4	0.041[a]
Bladder injury	0	3	
Major vessels injury	0	1	
Postoperative complications (n)	7	9	0.585[a]
Febrile morbidity	1	2	
Ileus	2	1	
Ureterovaginal fistula	1	2	
Hydronephrosis	2	0	
Lymphedema	0	2	
Vaginal cuff dehiscence	0	1	
Postoperative bleeding	1	0	
Trocar site herniation	0	1	
Total complications (n)	7	13	0.134[a]

Data are presented as a percentage of the total number
RRH robotic radical hysterectomy, *TLRH* total laparoscopic radical hysterectomy
[a]Chi-square test

vical cancer. [21–24]. Chong et al. reported that mean blood loss and intraoperative complication rate in the robotic group were significantly lower than those of laparoscopic group during initial phase of NSRH (Tables 68.2 and 68.3) [25]. Furthermore, no differences in cervical cancer recurrences occured in patients who undergone robotic, conventional laparoscopic, or abdominal radical hysterectomy in long-term follow-up data [22, 26].

If we focus on the advantages of robotic NSRH, esay differentiation between the fine sacral afferent fibers and the deep uterine veins due to articulating movement of the robotic arms ; stable traction and conter-traction of robotic arms, which enable us to expose the surgical plane consistently and precisely ; and an excellent 3-dimensional viwe of the robotic system within the narrow space. Furthermore, these technical advantages have given us improved dissection of the posterior vesicouterine ligament. The vesical branch of the inferiror hypogastric plexus can be preserved after dissecting several fragile veins step-by-step.

Anatomy of Pelvic Autonomic Nerves

1. Superior hypogatric plexus

Superior hypogatric plexus (SHP) is an unpaired structure situated anterior to the fifth lumbar vertebra and the sacral promontory, between the two common iliac arteries, and is formed by the union of numerous filaments, which descend on either side from the aortic plexus, and from the lumbar ganglia [27]. The SHP divides into right and left branch at or below the sacral promontory.

2. Pelvic splanchnic nerves

Pelvic splanchnic nerves (PSN) are parasympathetic nerve fibers arising near the sacral foramina from the ventral rami of the sacral nerve S2-S4. They are variable number and not always found arising from S2-S4 [28]. The S3 and S4 branches are the main contributors to the inferior hypogastric plexus (IHP) [29], the S3 branch being the largest one [28].

3. Sacral splanchnic nerves

The sacral splanchnic nerves are orginated from S2 sympathetic ganglion and contributes to the IHP [29]. Their primary function is to provide sympathetic component to the sacral plexus nerves for vasomotor, pilomotor, and sudomotor innervation of the lower extremity.

4. Inferior hypogastric plexus

IHP is composed of three different component : SHP via the hypogastric nerve, the sympathetic trunk via sacral splanchnic nerves, and the parasympathetic nerves via pelvic splanchnic nerves. IHP contains sympathetic and parasympathetic innervation. Symphathetic innervation from the SHP projects to the two IHPs via the bilateral fiber bundles of the hypogastric nerves. The sacral splanchinc nerve is originated from S2 symphathetic ganglion and contributes to the IHP. The hypogastric nerve fuses with parasympathetic splanchnic nerves originating from S2-S4 to the inferior hypogastric plexus (IHP). In the horizontal plane the IHP is located at about the level of S4 and S5. In the sagittal plane, the IHP is observed more commonly in the uterosacral ligament (57 %) and less commonly at the level of the parametrium (30 %), or between the lateral vaginal wall and the bladder (11 %) or at the rectal wall (2 %) [29]. The IHP continues inferior the vagina and bladder along with posterior vesicouterine ligament and the lateral wall of the vagina [30, 31].

Functions of Pelvic Autonomic Nerves

The pelvic autonomic nerves are essential for a normal physiologic function of the pelvic organs. For urinary function, parasymphathetic nerve disruption causes a hypocontractile of acontractile bladder with decreased sensation. Symphathetic nerve disruption results in a bladder with decreased compliance and high storage pressures. Moreover, sympathetic denervation may cause bladder neck incompetence and incontinenec. Disruption of the autonomic nerve supply to the rectum results in colorectal motility disorder [32, 33]. Autonomic nerve disruption results in altered vascular function during sexual arousal, and possibly disordered orgasm [34]. The exact role of SHP still remains unclear. However, Virtanen et al. reported an increase in the frequency of constipation and defecation problems after sacrocoloplexy [35]. Moreover, damage to the SHP could lead to urinary incontinence, especially due to incompetence and leakage at the internal urethral sphincter [36]. Hence, we should make an effort to preserve SHP during para-aortic lymphadenectomy.

Procedures of Robtoic NSRH: Step-by-Step

Patient Preparation, Docking and Instrumentation

The patients were placed in the a 20–30° Trendelenburg position. Proper initial positioning is essential because the robot must be disengaged before any change in position of the oprating table can be made. A 5-puncture technique was used with 4 robotic arms. A 12-mm primary trocar for 30 degree telescope was directly placed though the umbilicus. For lower para-aortic lymphadenectomy, a 12-mm primary trocar was placed 1–3 cm above the umbilicus. Two 8-mm lateral trocars were placed 7–8 cm lateral to the primary trocar for the 2 robotic arms. A fourth robotic tracar was placed 7–8 cm lateral and caudal to the right robotic trocar. An accessory 12-mm trocar was placed in the left upper quardrant for assistance, such as suctioning, irrigation, retraction, or grasping (Fig. 68.1). An EndoWrist monopolar scissors (Intuituve Inc., Sunnyvale, CA) was used in the right hand, and EndoWrist fenestrated bipolar forceps (Intuituve Inc., Sunnyvale, CA) in the left hand. An EndoWrist Prograsper (Intuituve Inc., Sunnyvale, CA) was placed in the fourth robotic arm. For vaginal cuff closure, the monopolar scissor was replaced by an EndoWrist needle holder (Intuituve Inc., Sunnyvale, CA).

The assistant, sitting to the left of the patient, at shoulder level, performed important tasks using an accessory torcar, such as sealing and division vascular structure using a Ligasure system (Covidien, Valleylab, Boulder, CO) or an Enseal device (SurgRx Inc., Redwood City, CA), suction and irrigation, removal of biopsy specimens, tissue retraction and grasping, and introduction and retrieval of sutures for vagianl cuff closure. The second assistant was situated between the patients' legs and moved the uterine manipulator. The robotic column was positioned between the legs of the patient, behind the second assistant.

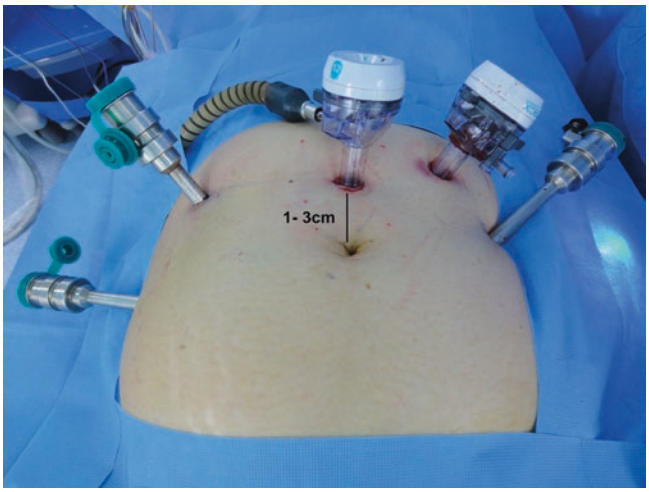


Fig. 68.1 Positioning of trocars for robotic nerve-sparing radical hysterectomy.

Identification of Superior Hypogsatric Plexus (SHP)

After left upward traction of rectosigmoid mesentery using EndoWrist Prograsper, a peritoneal incision is made at below inferior mesenteric artery. The SHP is found overlying the aorta and sacral promontory, medial to both ureters (Fig. 68.2). Rectosigmoid is mobilized, and then the avascular space of the lateral rectal portion is found by using the upward traction of rectosigmoid mesentery. The SHP is isolated by vessel loop. The SHP divides into right and left branches at or below the sacral promontory. A continuous downward dissection is then made uint the hypogastric nerve is identified. Using this approach, communication between the SHP and hypogatric nerve could be found.

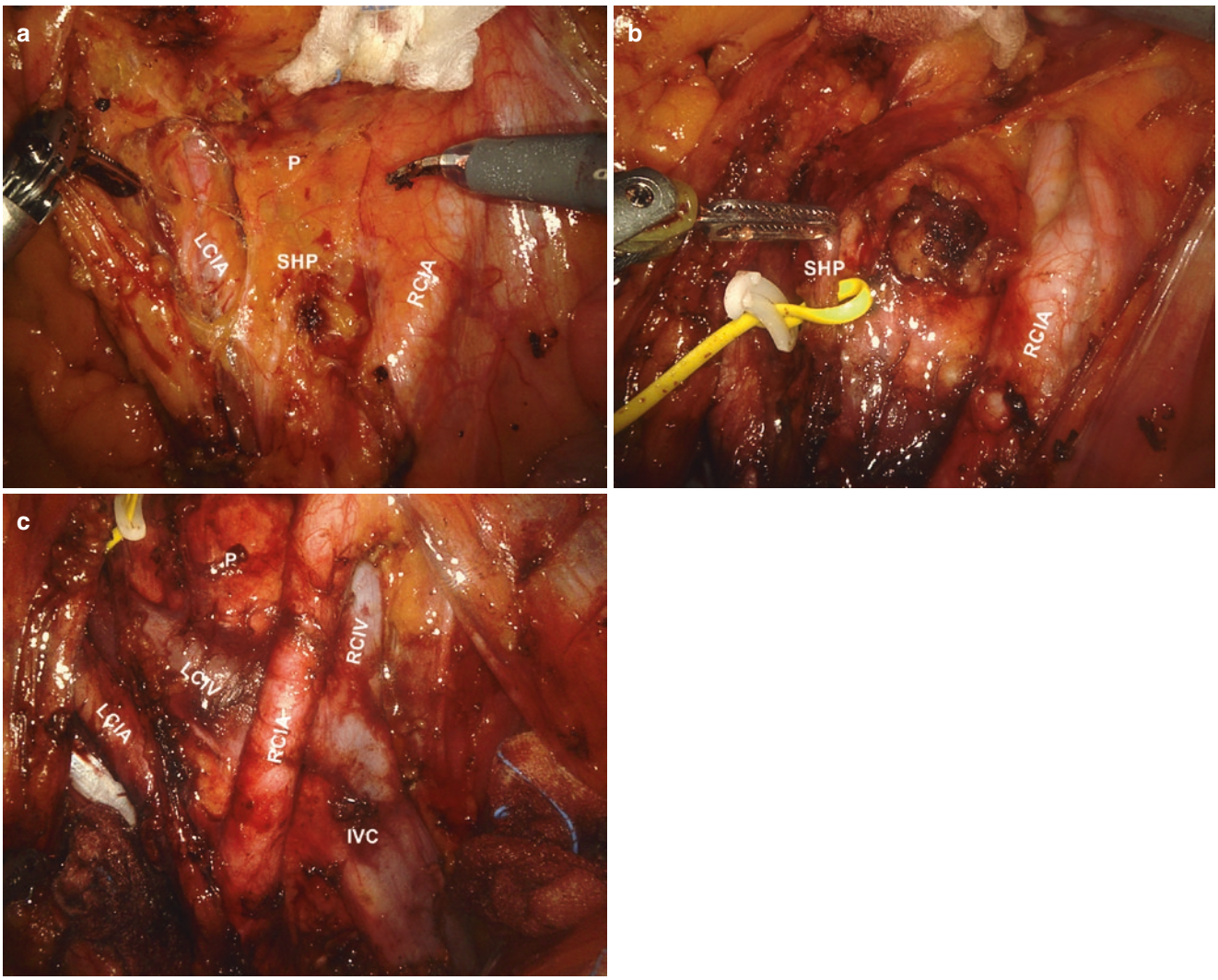


Fig. 68.2 Identification of Superior hypogastric plexus. (**a**) After traction of rectosigmoid, peritoneal incision is made and we can identify the common iliac artery, superior hypogastric plexus, and promontory. (**b**) Superior hypogastric plexus is isolated by vessel loop. (**c**) Final view of lower para-aortic lymphadenectomy and the superior hypogastric plexus (isolated by vessel loop). *IVC* inferior vena cava, *LCIA* left common iliac artery, *LCIV* left common iliac vein, *P* promontory, *RCIA* right common iliac artery, *RCIV* right common iliac vein, *SHP* superior hypogastric plexus

Identification of Pelvic Splanchnic Nerve (PSN), Inferior Hypogastric Plexus (IHP) and Hypogastric Nerve

Between the paravesical and pararectal spaces, the cardinal ligament was sperated by a scissor dissector. The uterine artery is dissected at the level of the hypogatric artery and several deep uterine veins are coagulated with bipolar graspers and transected. After careful seperation of deep uterine vessels to the base of the cardinal ligament, PSNs that communicated with the IHP and hypogastric nerve are observed. PSNs are variable in number 3–4. Sometimes PSN are indistinguishable to fibrotic connective structure. Then, the hypogastic nerve appears as a thickened band and is identified approximately 2–5 cm below the ureter (Fig. 68.3).

Identification of the Hypogastric Nerve and IHP During the Dissection of the Uterosacal and Rectovaginal Ligaments

After well dissection of the rectovaginal space, both uterosacral ligaments clearly identified. The hypogastric nerve is located in the lateral portion of the uterosacral ligament. The hypogastric nerve is mobilized laterally from the the lateral aspect of the uterosacral ligament. A space between medial part of uterosacral ligament and hypogastric nerve is developed. Only the medial fibrous component of the uterosacral ligament is divided, and the lateral nervous compartment is perserved (Fig. 68.4).

Identification of Vesical Branch of the IHP from Posterior Vesicouterine Ligament

This step is the most critical step in the nerve-sparing procedure. After unroofing the ureter with dissection of the anterior vesicouterine ligament, the ureter is mobilized laterally to identify and isolate the posterior vesicouterine ligament. Posterior vesicouterine ligament is exposed by anterior and lateral retraction of the ureter. And then, several vesical veins (lateral, middle, medial, inferior) in the posterior vesicouterine ligament are identified and these veins are carefully separated and skeletonized step-by-step. The vesical branches of the IHP may be easily damaged during extensive removal of paravaginal tissue. To spare the vesical branches of the IHP completely, only the uterovaginal branches of the IHP should be resected. After the cut edge of the inferior vesical vein is pulled medially with upward traction, the vesical branches of the IHP are exposed, which divided into medial and lateral branches [37]. In advanced cases, the medial branches of the IHP could be sacrificed to obtain an adequate cancer-free margin [37]. After these procedures, the vesical branches of the IHP are preserved (Fig. 68.5). After nerve-sparing RRH, the entire course of pelvic autonomic nerves could be examined cleary incluing SHP, hypogatric nerve communicating with parasympathetic nerves, and vesical branch of the IHP (Fig. 68.5e).

Extended Lymphadenectomy

The areas of extended lymphadenectomy are the superior and inferior gluteal, presacral (subaortic), common iliac, and lower paraaortic nodes. Extended lymphadenectomy is started without injury to the SHP and hypogastric nerve. Right paraaortic lymph nodes are dissected at the level of the inferior mesenteric artery. The inferior mesenteric artery and SHP are then identified, and a space is created between the inferior mesenteric artery and SHP that enable the ureter to be displaced laterally and the left paraaortic node to be displaced medially. Inframesenteric nodes are removed without injury to the ureter and the left common iliac nodes are easily removed due to the upward traction of the rectosigmoid. Through the left upward traction of the SHP, the right side of presacral nodes on the promontory is removed without injury to the presacral vein. By using the right upward traction of the SHP, the left side of the presacral nodes and left common iliac nodes are removed. After further dissection of the hypogastric vessels, we can identify the posterior branches of the hypogastric artery, the superior gluteal artery which locates between lumboscaral plexus and S1, and inferior gluteal artery which locates between S2 and S3. After extended lymphadenectomy, the pelvic anatomy could be examined more clearly including the SHP, promontory, lower part of aorta, common iliac vessels, hypogastric vessels, hypogastric nerve communicating with parasympathetic nerves, and vesical branches of the IHP (Fig. 68.6).

Extended lymphadenectomy may contribute to the prevention of locoregional relapse [38]. Recent study showed the the prevalence of internal iliac vein anomalies was 26.7 % in the presacral area [39]. To prevent life-threatening the internal iliac vein injury, the anatomical variations of the internal iliac vein should be known exactly during lymphadenectomy at presacral area.

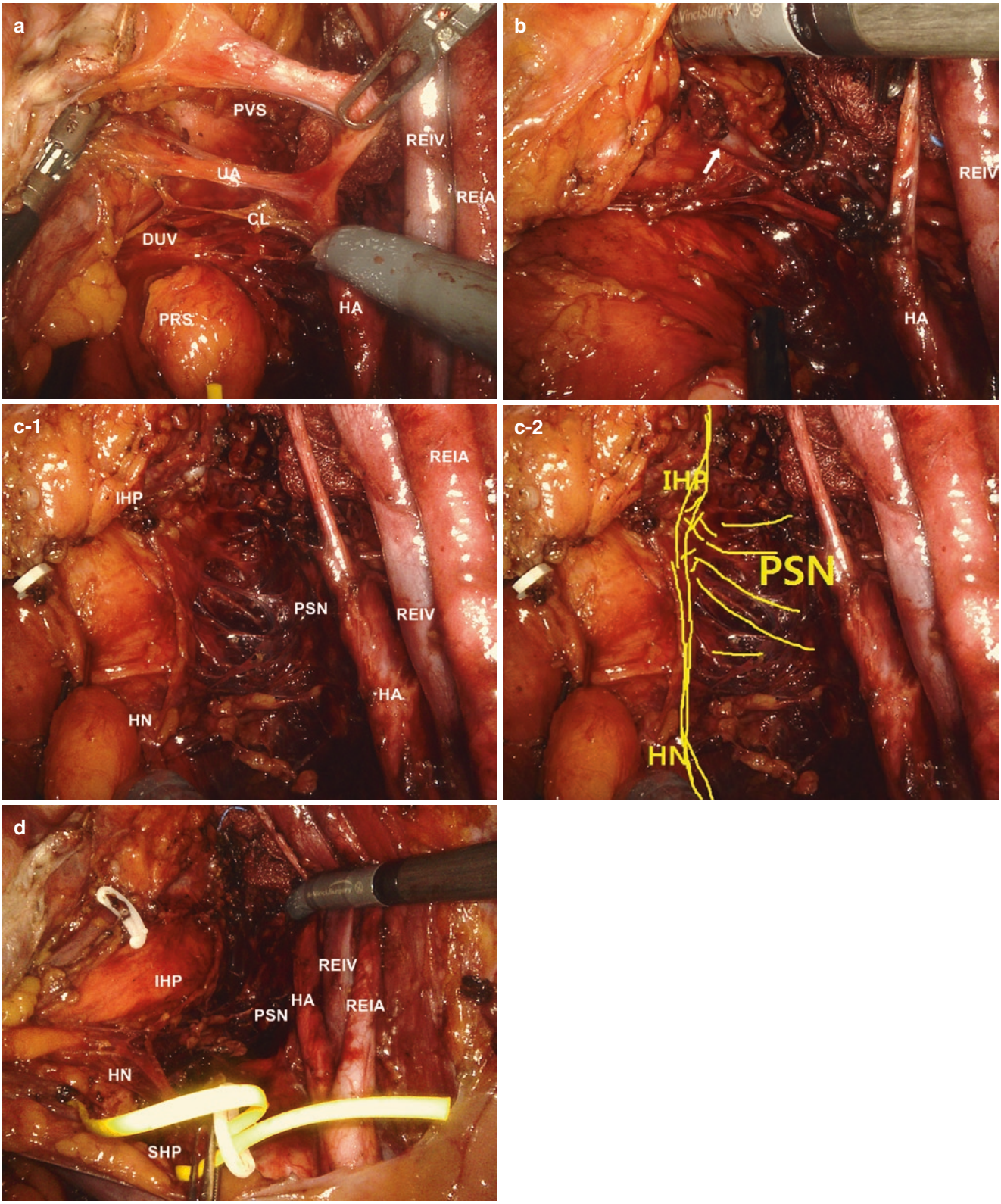


Fig. 68.3 Identification of pelvic splanchnic nerve, hypogastric nerve and inferior hypogastric plexus. (**a**) Between paravesical and pararectal space, the uterine artery and deep uterine veins which are located in the cardinal ligament are divided by step by step. (**b**) Uterine veins (white arrow) are isolated by robotic scissor, then divided by bipolar or Ligasure system. (**c1**) Pelvic splanchnic nerves are communicated with the inferior hypogastric plexus and hypogastric nerve. (**c2**) Schematic view of **c1**. (**d**) Hypogastric nerve is communicated with superior hypogastric plexus (isolated by vessel loop). *CL* cardinal ligament, *DUV* deep uterine vein, *HA* hypogastric artery, *IHP* inferior hypogastric plexus, *PSN* pelvic splanchnic nerve, *PRS* pararectal space, *PVS* paravesical space, *SHP* superior hypogastric plexus, *UA* uterine artery

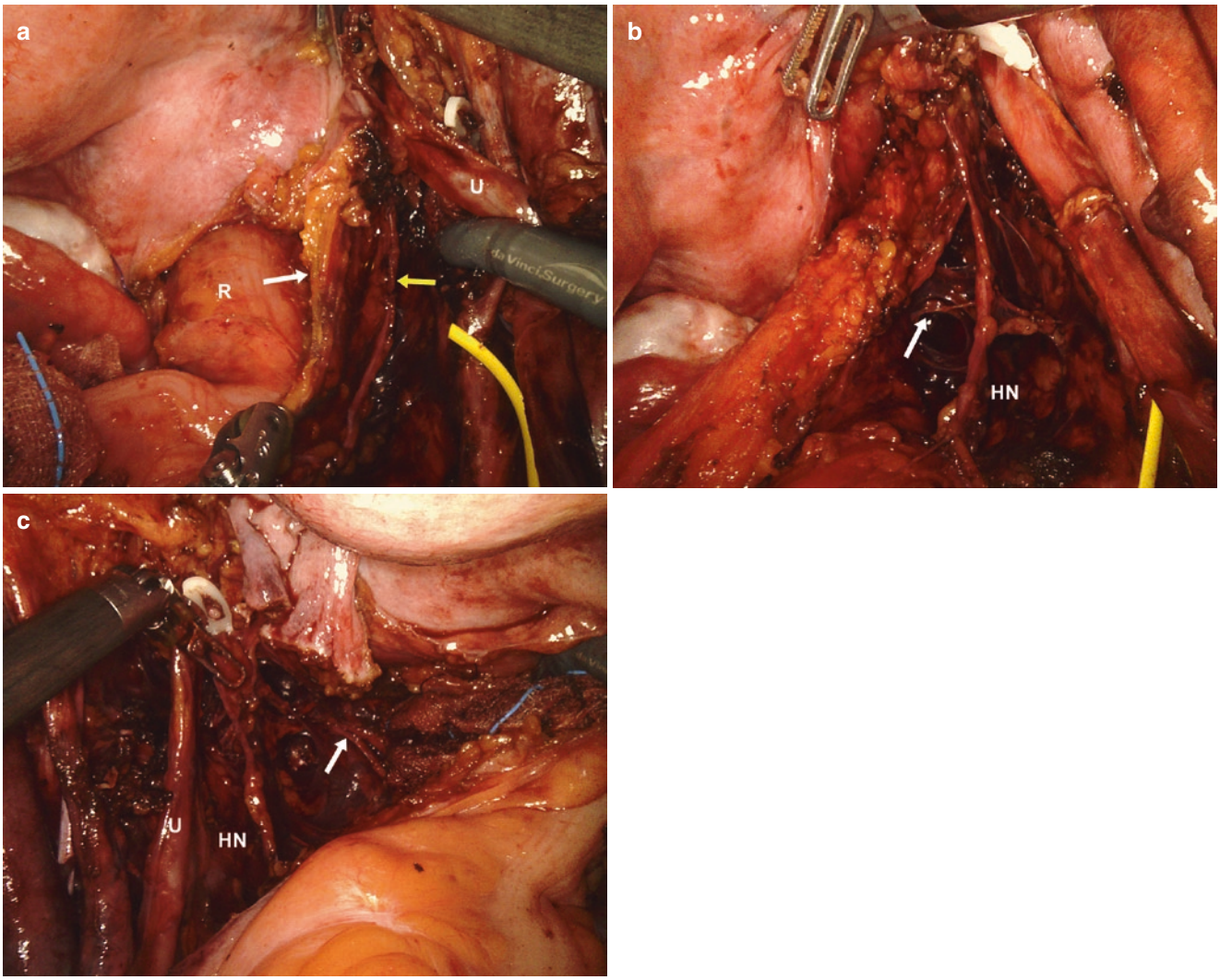


Fig. 68.4 Identification of hypogastric nerve during dissection of uterosacral and rectovaginal ligament. (**a**) After dissection of rectovaginal space, rectovaginal and uterosacral ligaments (*white arrow*) and hypogastric nerve (*yellow arrow*) are identified (*right side*). (**b**) After dissection of rectovaginal and uterosacral ligaments, rectal branches of hypogastric nerve (*white arrow*) are clearly preserved (*right side*). (**c**) Rectal branches of hypogastric nerve (*white arrow, left side*). *HN* hypogastric nerve, *R* rectum, *U* ureter

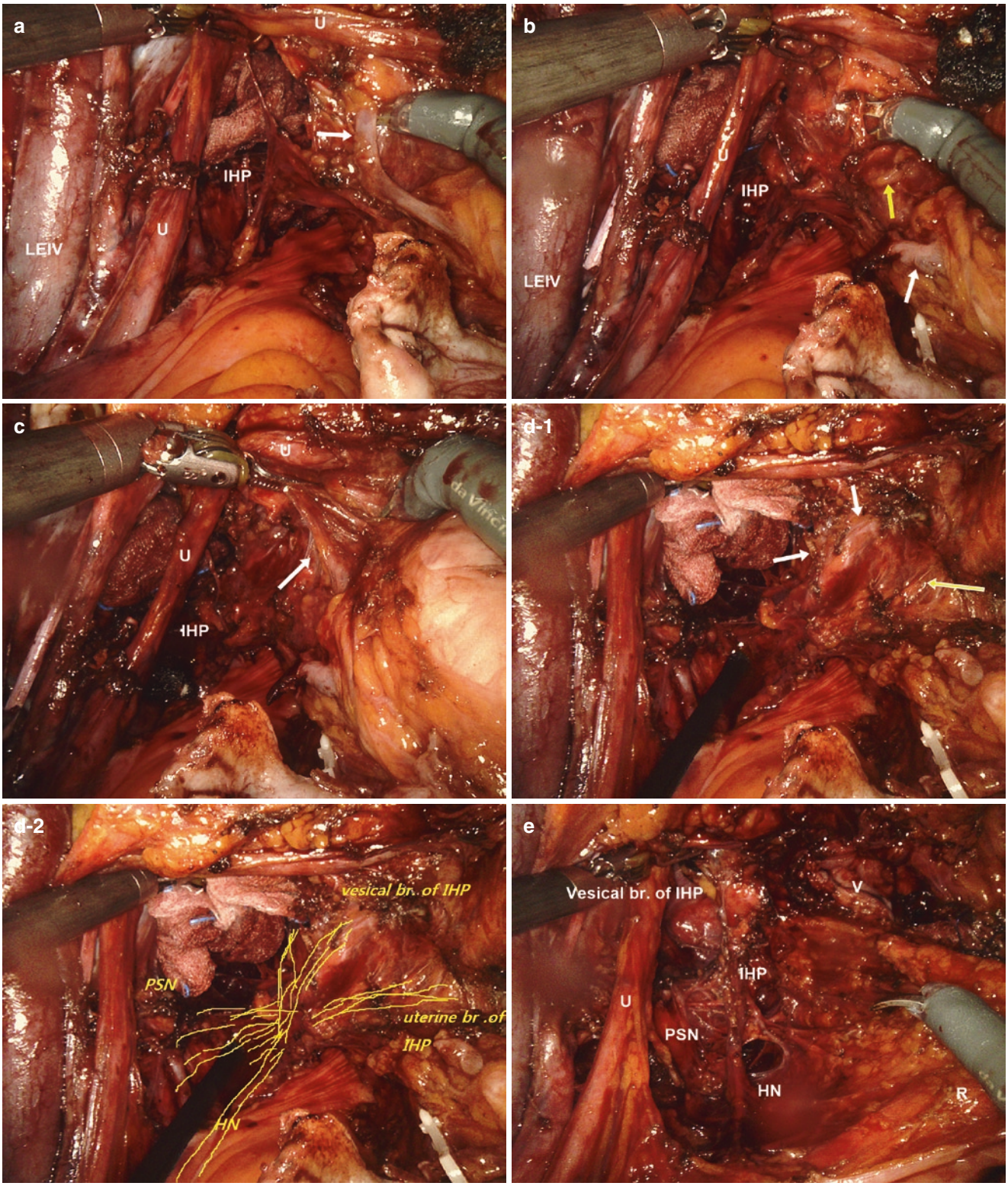


Fig. 68.5 Identification of vesical branches of inferior hypogastric plexus from posterior vesicouterine ligament. (**a**) Several veins in posterior vesicouterine ligament are identified by fine movement of robotic scissor and skeletonized by step by step. First, lateral vein (*white arrow*) is isolated (*left side*). (**b**) Lateral (*white arrow*) and middle (*yellow arrow*) veins are isolated (*left side*). (**c**) Medial vein (*white arrow*) is isolated (*left side*). (**d1**) After all veins are divided and isolated, veins are retracted upward. Vesical (*white arrow*) and uterine branches (*yellow arrow*) of inferior hypogastric plexus are identified (*left side*). (**d2**) Schematic view of **d1**. (**e**) After removal of the uterus, preserved pelvic autonomic nervous parts are clearly identified (*left side*). *HN* hypogastric nerve, *IHP* inferior hypogastric plexus, *LEIV* left external iliac vein, *PSN* pelvic splanchnic nerve, *R* rectum, *U* ureter.

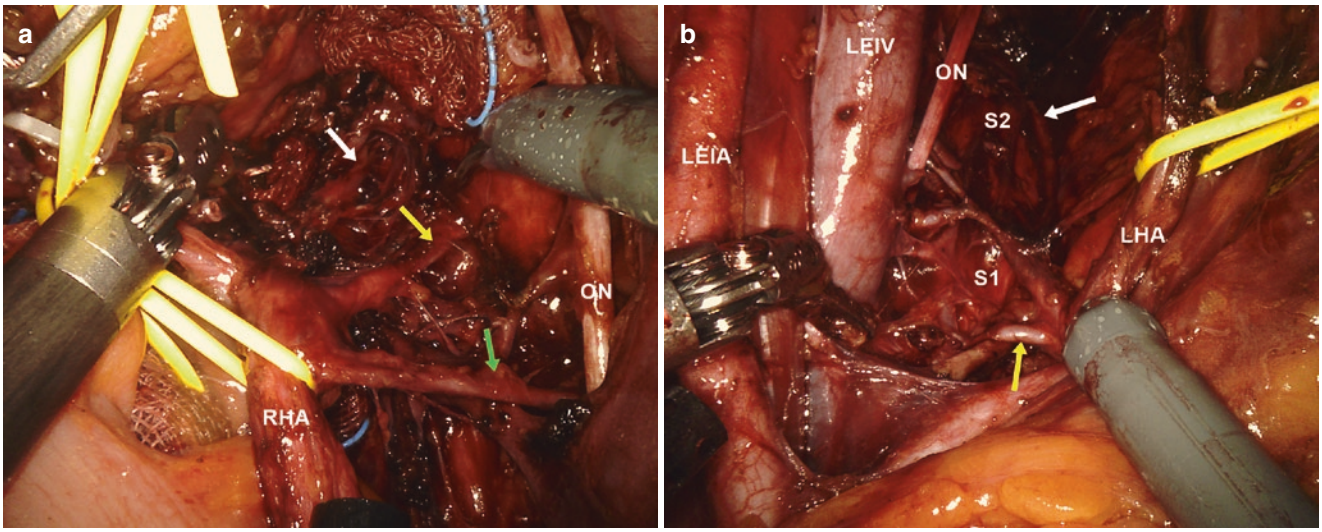


Fig. 68.6 After traction of hypogastric artery, branches of hypogastric artery are clearly identified. (**a**) Common trunk of inferior gluteal artery and internal pudendal artery (*white arrow*), superior gluteal artery (*yellow arrow*), and iliolumbar artery with veins (*green arrow, right side*). (**b**) Common trunk of inferior gluteal and internal pudendal artery (*white arrow*), and superior gluteal artery with veins (*yellow arrow, left side*). *LEIA* left external iliac artery, *LEIV* left external iliac vein, *LHA* left hypogastric artery, *ON* obturator nerve, *RHA* right hypogastric artery

Table 68.4 Systemic review of robotic radical hysterectomy versus abdominal radical hysterectomy and robotic radical hysterectomy versus laparoscopic radical hysterectomy

Variables	RRH vs. ARH	RRH vs. LRH
Estimated blood loss	RRH – Pro ARH – Con	RRH – Pro LRH - Con
Operative time	Equivalent	Equivalent
Lymph nodes count	Equivalent	Equivalent
Intraoperative complications	Equivalent	Equivalent
Hospital stay	RRH – Pro ARH – Con	Equivalent

RRH robotic radical hysterectomy, *ARH* abdominal radical hysterectomy, *LRH* laparoscopic radical hysterectomy

Robotic NSRH

Recent systemic review and meta-analysis shows that RRH may be superior to abdominal radical hysterectomy (ARH) with lower estimatated blood loss, shorter hospital stay, less febrile morbidity and wound-related complications [38]. Although RRH was associated with less estimated blood loss than laparosocpic radical hysterectomy (LRH), mean differnenc was of borderline significance. There was no significant differece in operative time or intraoperative complications. RRH and LRH appear equivalent in intraoperative and short-term postoperative outcomes (Table 68.4) [40].

Robotic NSRH is a feasible and safe modality for the treatment of early cervical cancer without compromising radicality. Excellent 3-dimensional image amplification facilitates visualization and the teaching of the pelvic autonomic nerves. Moreover, articulating movement of the robotic arms, lack of tremor, stable traction and counter-traction of robotic arms provide us to expose the surgical plane consistently and precisely.

References

1. Piver MS, Rutledge F, Smith JP. Five classes of extended hysterectomy for women with cervical cancer. Obstet Gynecol. 1974;44:265–72.
2. Querleu D, Morrow CP. Classification of radical hysterectomy. Lancet Oncol. 2008;9:297–303.
3. Pieterse QD, Maas CP, ter Kuile MM, Lowik M, van Eijkeren MA, Trimbos JB, Kenter GG. An observational longitudinal study to evaluate miction, defecation, and sexual function after radical hysterectomy with pelvic lymphadenectomy for early-stage cervical cancer. Int J Gynecol Cancer. 2006;16:1119–29.
4. Barnes W, Waggoner S, Delgado G, Maher K, Potkul R, Barter J, Benjamin S. Manometric characterization of rectal dysfunction following radical hysterectomy. Gynecol Oncol. 1991;42:116–9.
5. Bergmark K, Avall-Lundqvist E, Dickman PW, Henningsohn L, Steineck G. Vaginal changes and sexuality in women with a history of cervical cancer. N Engl J Med. 1999;340:1383–9.

6. Fujii S, Takakura K, Matsumura N, Higuchi T, Yura S, Mandai M, Baba T, Yoshioka S. Anatomic identification and functional outcomes of the nerve sparing Okabayashi radical hysterectomy. Gynecol Oncol. 2007;107:4–13.
7. Possover M, Stöber S, Plaul K, Schneider A. Identification and preservation of the motoric innervation of the bladder in radical hysterectomy type III. Gynecol Oncol. 2000;79:154–7.
8. Chong GO, Park NY, Hong DG, Cho YL, Park IS, Lee YS. Learning curve of laparoscopic radical hysterectomy with pelvic and/or paraaortic lymphadenectomy in the early and locally advanced cervical cancer: comparison of the first 50 and second 50 cases. Int J Gynecol Cancer. 2009;19:1459–64.
9. Pieterse QD, Ter Kuile MM, Deruiter MC, Trimbos JB, Kenter GG, Maas CP. Vaginal blood flow after radical hysterectomy with and without nerve sparing. A preliminary report. Int J Gynecol Cancer. 2008;18:576–83.
10. Cibula D, Velechovska P, Sláma J, Fischerova D, Pinkavova I, Pavlista D, Dundr P, Hill M, Freitag P, Zikan M. Late morbidity following nerve-sparing radical hysterectomy. Gynecol Oncol. 2010;116:506–11.
11. Long Y, Yao DS, Pan XW, Ou TY. Clinical efficacy and safety of nerve-sparing radical hysterectomy for cervical cancer: a systematic review and meta-analysis. PLoS One. 2014;9:–e94116.
12. Kim HS, Kim K, Ryoo SB, Seo JH, Kim SY, Park JW, Kim MA, Hong KS, Jeong CW, Song YS, Study Group FUSION. Conventional versus nerve-sparing radical surgery for cervical cancer: a meta-analysis. J Gynecol Oncol. 2015;26:100–10.
13. Landoni F, Maneo A, Cormio G, Perego P, Milani R, Caruso O, Mangioni C, Class II. versus class III radical hysterectomy in stage IB-IIA cervical cancer: a prospective randomized study. Gynecol Oncol. 2001;80:3–12.
14. Höckel M, Konerding MA, Heussel CP. Liposuction-assisted nerve-sparing extended radical hysterectomy: oncologic rationale, surgical anatomy, and feasibility study. Am J Obstet Gynecol. 1998;178:971–6.
15. Girardi F, Lichtenegger W, Tamussino K, Haas J. The importance of parametrial lymph nodes in the treatment of cervical cancer. Gynecol Oncol. 1989;34:206–11.
16. Landoni F, Bocciolone L, Perego P, Maneo A, Bratina G, Mangioni C. Cancer of the cervix, FIGO stages IB and IIA: patterns of local growth and paracervical extension. Int J Gynecol Cancer. 1995;5:329–34.
17. Hagen B, Shepherd JH, Jacobs IJ. Parametrial resection for invasive cervical cancer. Int J Gynecol Cancer. 2000;10:1–6.
18. Frumovitz M, Ramirez PT, Greer M, Gregurich MA, Wolf J, Bodurka DC, Levenback C. Laparoscopic training and practice in gynecologic oncology among Society of Gynecologic Oncologists members and fellows-in-training. Gynecol Oncol. 2004;94:746–53.
19. Marchal F, Rauch P, Vandromme J, Laurent I, Lobontiu A, Ahcel B, Verhaeghe JL, Meistelman C, Degueldre M, Villemot JP, Guillemin F. Telerobotic-assisted laparoscopic hysterectomy for benign and oncologic pathologies: initial clinical experience with 30 patients. Surg Endosc. 2005;19:826–31.
20. Magrina JF, Pawlina W, Kho RM, Magtibay PM. Robotic nerve-sparing radical hysterectomy: feasibility and technique. Gynecol Oncol. 2011;121:605–9.
21. Boggess JF, Gehrig PA, Cantrell L, Shafer A, Ridgway M, Skinner EN, Fowler WCA. case-control study of robot-assisted type III radical hysterectomy with pelvic lymph node dissection compared with open radical hysterectomy. Am J Obstet Gynecol. 2008;199:357.e1–7.
22. Magrina JF, Kho RM, Weaver AL, Montero RP, Magtibay PM. Robotic radical hysterectomy: comparison with laparoscopy and laparotomy. Gynecol Oncologia. 2008;109:86–91.
23. Ko EM, Muto MG, Berkowitz RS, Feltmate CM. Robotic versus open radical hysterectomy: a comparative study at a single institution. Gynecol Oncol. 2008;111:425–30.
24. Estape R, Lambrou N, Diaz R, Estape E, Dunkin N, Rivera A. A case matched analysis of robotic radical hysterectomy with lymphadenectomy compared with laparoscopy and laparotomy. Gynecol Oncol. 2009;113:357–61.
25. Chong GO, Lee YH, Hong DG, Cho YL, Park IS, Lee YS. Robot versus laparoscopic nerve-sparing radical hysterectomy for cervical cancer: a comparison of the intraoperative and perioperative results of a single surgeon's initial experience. Int J Gynecol Cancer. 2013;23:1145–9.
26. van den Tillaart SA, Kenter GG, Peters AA, Dekker FW, Gaarenstroom KN, Fleuren GJ, Trimbos JB. Nerve-sparing radical hysterectomy: local recurrence rate, feasibility, and safety in cervical cancer patients stage IA to IIA. Int J Gynecol Cancer. 2009;19:39–45.
27. Correia JA, De-Ary-Pires B, Pires-Neto MA, De Ary-Pires R. The developmental anatomy of the human superior hypogastric plexus: a morphometrical investigation with clinical and surgical correlations. Clin Anat. 2010;23:962–70.
28. Havenga K, DeRuiter MC, Enker WE, Welvaart K. Anatomical basis of autonomic nerve-preserving total mesorectal excision for rectal cancer. Br J Surg. 1996;83:384–8.
29. Baader B, Herrmann M. Topography of the pelvic autonomic nervous system and its potential impact on surgical intervention in the pelvis. Clin Anat. 2003;16:119–30.
30. Maas CP, Trimbos JB, DeRuiter MC, van de Velde CJ, Kenter GG. Nerve sparing radical hysterectomy: latest developments and historical perspective. Crit Rev Oncol Hematol. 2003;48:271–9.
31. Fujii S. Anatomic identification of nerve-sparing radical hysterectomy: a step-by-step procedure. Gynecol Oncologia. 2008;111:S33–41.
32. Yalla SV, Andriole GL. Vesicourethral dysfunction following pelvic visceral ablative surgery. J Urol. 1984;132:503–9.
33. Smith AN, Varma JS, Binnie NR, Papachrysostomou M. Disordered colorectal motility in intractable constipation following hysterectomy. Br J Surg. 1990;77:1361–5.
34. Levin RJ. The physiology of sexual function in women. Clin Obstet Gynaecol. 1980;7:213–52.
35. Virtanen H, Hirvonen T, Mäkinen J, Kiilholma P. Outcome of thirty patients who underwent repair of posthysterectomy prolapse of the vaginal vault with abdominal sacral colpopexy. J Am Coll Surg. 1994;178:283–7.
36. Johnson RM, McGuire EJ. Urogenital complications of anterior approaches to the lumbar spine. Clin Orthop Relat Res. 1981;154:114–8.
37. Park NY, Cho YL, Park IS, Lee YS. Laparoscopic pelvic anatomy of nerve-sparing radical hysterectomy. Clin Anat. 2010;23:186–91.
38. Lee YS, Chong GO, Lee YH, Hong DG, Cho YL, Park IS. Robot-assisted total preservation of the pelvic autonomic nerve with extended systematic lymphadenectomy as part of nerve-sparing radical hysterectomy for cervical cancer. Int J Gynecol Cancer. 2013;23:1133–8.
39. Chong GO, Lee YH, Hong DG, Cho YL, Lee YS. Anatomical variations of the internal iliac veins in the presacral area: clinical implications during sacral colpopepxy or extended pelvic lymphadenectomy. Clin Anat. 2015;28:661–4.
40. Shazly SA, Murad MH, Dowdy SC, Gostout BS, Famuyide AO. Robotic radical hysterectomy in early stage cervical cancer: a systematic review and meta-analysis. Gynecol Oncol. 2015;138:457–71.

Robotic-Assisted Radical Hysterectomy as Compartmental Resection According to rTMMR and rPMMR

69

Rainer Kimmig

Introduction

On the basis of ontogenetic compartmental development the findings about compartmental border control in malignant tumour progression led to the concept of "compartmental resection" in solid malignant tumors [1–4]. Since loco-regional recurrence usually occurs in compartment remnants or in the associated lymph compartments total "compartments of risk" have to be removed completely, whereas neighbouring compartments may left entirely untouched. The first tumour resected following this concept was rectal cancer by total mesorectal excision (TME) resulting in dramatically reduced loco-regional recurrence [5]. At present this procedure has become standard in rectal cancer surgery [6]. For cervical cancer M. Höckel has convincingly shown by his monocentric data that the corresponding method named total mesometrial resection (TMMR) also reduces efficiently locoregional recurrences compared to standard treatment – without any additional radiation therapy even in risk situations [7, 8]. The Method is described for open surgery in a separate chapter. Together with M. Höckel total mesometrial resection (rTMMR) has been translated to robotic surgery [9]. On parallel, the modification of compartmental resection for endometrial cancer as peritoneal mesometrial resection (PMMR) according to the different lymph drainage has also been adopted to robotic surgery as rPMMR [10]. Although, the two methods have to be applied together with therapeutic pelvic or pelvic and paraaortic lymphadenectomy to control not only for local but also for regional disease, in this chapter the technique of radical hysterectomy only is described; however technique of therapeutic lymphonodectomy has already been published elsewhere, and will be described step by step in the following chapter 70.

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Anatomical Basis of Müllerian Compartment and Local Lymph Drainage

For uterine cancer removal of the Müllerian compartment and its draining lymphatic compartments has to be performed completely. Embryological development, compartment borders and type of resection in uterine cancer is perfectly described by M. Höckel [4, 7]. As shown in Fig. 69.1, the uterus has to be removed together with the vascular mesometrium (corresponding to the uterine vessel system including vesicouterine anastomoses) and the ligamentous mesometrium (corresponding to the rectovaginal and sacrouterine ligament). However, there is no longer any modification with respect to the tumor size, as the concept requires always complete resection. There is only one part of the Müllerian compartment left in situ for functional reasons – the vagina. The vaginal resection margin is the only intracompartmental resection has directly to be controlled for clear margins (>10 mm recommended) in compartment confined tumors [4]. According to the different lymph drainage of the upper and lower Müllerian compartment in cervical cancer vascular and ligamentous mesometria have to be resected. In endometrial cancer without cervical involvement there is no drainage along the ligamentous mesometria; on the other hand there is drainage along the mesonephric pathway on parallel to the ovarian vessel system. Thus, ligamentous mesometria may be preserved, but infundibulopelvic ligaments have to be resected completely in corporal uterine disease as can be seen from Fig. 69.1 a–d.

Due to the lymphatic network which develops embryologically by sprouting from embryonal veins [11], compartment visualization can be achieved by fluorescent agents. Isocyanine-green (ICG) may be injected into the uterine cervix or corpus according to the tumour site and fluorescence will be detectable in the lymphatic system from minutes to many hours from application during surgery [12]. In short, 0.3 ml of a solution of 1.25 mg/ml ICG had injected ´0.5–1 cm deep either into cervical stroma at 3, 6, 9 and 12 o'clock in cervical cancer or at 3 and 9 o'clock twice at the fundal and midcorporal part in endometrial cancer. Lymphatic drainage is

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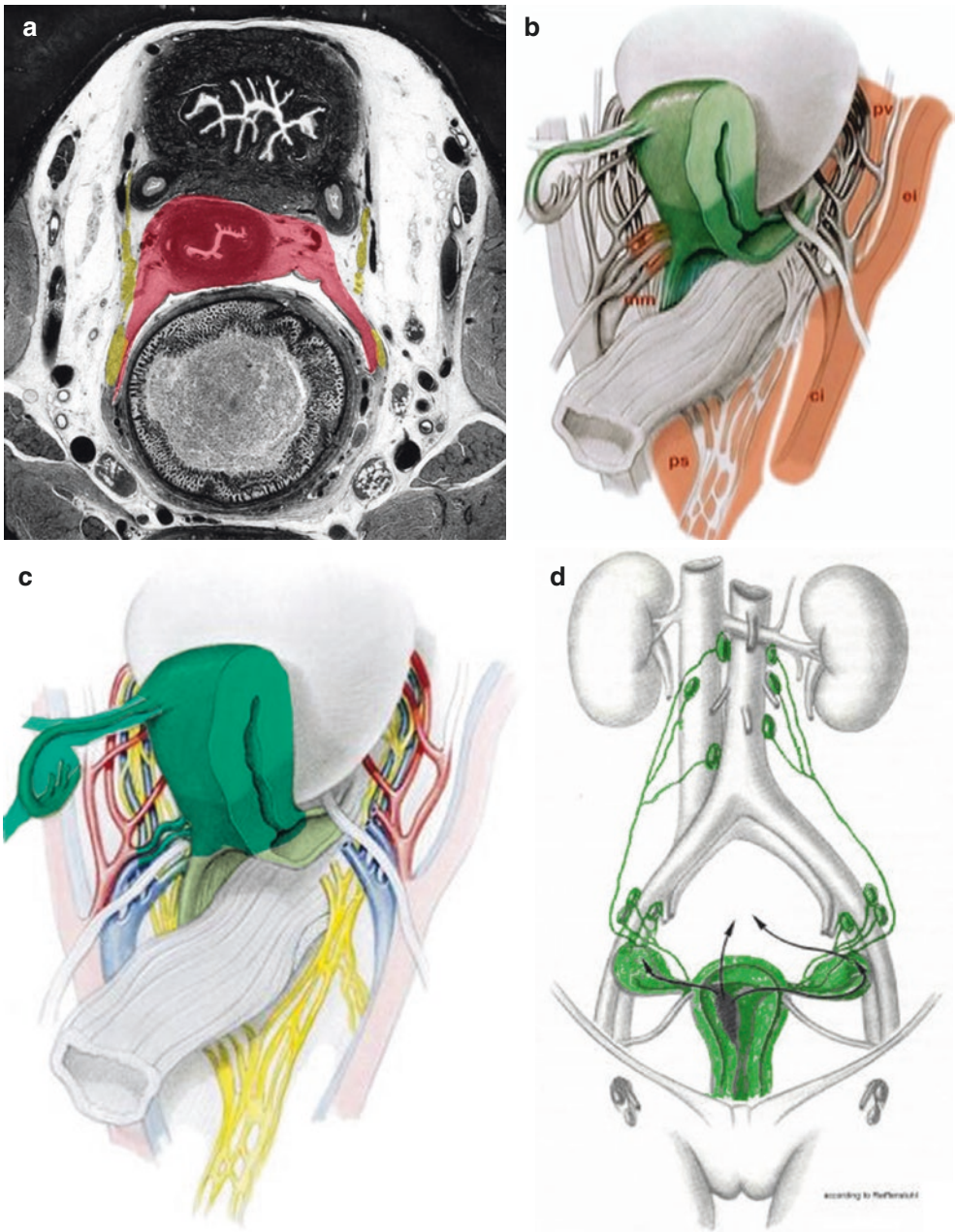


Fig. 69.1 (**a**) Embryologic development of Müllerian compartment (*red*). (**b**) Müllerian compartment in the adult (*green*). Draining pelvic lymphatic compartments: mesometrial (*mm*), paravisceral (*pv*), external iliac (*ei*), common iliac (*ci*) and presacral (*ps*). (**c**) Involvement of Müllerian compartment in endometrial cancer (*green*). (**d**) Lymphatic drainage in endometrial cancer (*green*). (**a**) Reprinted from The Lancet, 6(10), Höckel M, Horn LC, Fritsch H, Association between the mesenchymal compartment of uterovaginal organogenesis and local tumour spread in stage IB-IIB cervical carcinoma: a prospective study, 751–6, Copyright 2005, with permission from Elsevier; (**b**) Reprinted from Lancet Oncol, 10, Michael Höckel, Lars-Christian Horn, Norma Manthey, Ulf-Dietrich Braumann, Ulrich Wolf, Gero Teichmann, Katrin Frauenschläger, Nadja Dornhöfer, Jens Einenkel, Resection of the embryologically defined uterovaginal (Müllerian) compartment and pelvic control in patients with cervical cancer: a prospective analysis, 683–92, Copyright 2009, with permission from Elsevier. (**c**) Reprinted from Gynecologic Oncology, vol. 107, supplement 1, Höckel M, Do we need a new classification for radical hysterectomy? Insights in surgical anatomy and local tumor spread from human embryology, S106–S112, Copyright 2007, with permission from Elsevier. (**d**) (Modified from Hepp et al. [14], with permission)

directed from midline to lateral and drains primarily either to the iliac nodes along the vascular and ligamentous mesometria or to the paraaortic nodes along the mesonephric ovarian vessel system, or both. Up to now we never observed a drainage into the vesical or rectal compartment, neither via the vesicouterine nor the rectovaginal ligament. For better understanding of compartmental resection visualization by fluorescence will be added to the anatomical illustrations of the technique.

Technique of Total Mesometrial Resection and Peritoneal Mesometrial Resection [9, 10]

Principles of TMMR are described already in detail by Michael Höckel. The compartmental resection of the Müllerian compartment with respect to cervical and endometrial cancer does not differ in principle but only with respect to sub-compartments and their route of lymph drainage. Therefore, the technique of TMMR and PMMR adapted to robotic surgery will be described "Step by Step" for both procedures together. Steps only valid for cervical cancer or endometrial cancer will be indicated, common steps will be highlighted. As already mentioned, intention of compartmental surgery in uterine cancer is invariably to remove the local and regional compartment of risk entirely. Thus, the therapeutic lymphadenectomy is intrinsically tied to the radical hysterectomy, although not described in this chapter. The radical hysterectomy will usually be preceded by the therapeutic pelvic and – if indicated – paraaortic lymphadenectomy (technique [13]). Dependent on the sub-compartmental origin of the tumor either TMMR or PMMR or a combination of the two is performed. Differences and common steps are summarized in Table 69.1.

Surgical steps for TMMR are described in Steps 6 and 8–20, for PMMR in Steps 1–7 and 12–20, whereas all common steps are high-lighted in the text.

General Remarks and Trocar Placement

Robotic surgery usually starts cranially and proceeds caudally for technical reasons due to the steep Trendelenburg positioning to guarantee a clear visual field throughout the surgery. Four robotic arms (camera and three instruments) are used and one 10 mm trocar for assistance. The incision for the camera has to be made about 8–10 cm cranially to the upper limit of surgery, if possible. A typical setting of Incisions is shown in Fig. 69.2 for TMMR and pelvic lymphadenectomy for the da Vinci SI system. In the da Vinci Xi System this is no longer necessary since surgery can be performed in the entire abdomen without any change in docking.

Steps one to seven are dedicated to the therapeutic resection of the mesonephric sub-compartment of infundibulopelvic ligaments, therapeutic pelvic and paraaortic lymphadenectomy and peritoneal incision strategy. Except for lymphadenectomy these steps refer exclusively on PMMR for endometrial cancer.

Lymphatic drainage of uterine corpus may be visualized by intracorporal injection of Indocyanine green (ICG) solution made visible by near infrared excitation during surgery. As demonstrated in Fig. 69.3 lymphatic drainage from uterine corpus via infundibulopelvic ligaments runs along the mesosalpinx and mesovarian lymphatic network (A/B) and consists of two main lymphatic truncs accompanying the ovarian artery and vein (C/D) with variable intercalated nodes. They drain to the preaortic nodes inferior to the right ovarian artery and the precaval nodes medially of the ovarian vein on the right and to the left "renal angle" on the left (not shown).

Step 1

Incision of the peritoneum lateral to the right infundibulopelvic ligament superior to the crossing of right common iliac artery and division of peritoneum along the border to the right mesocolic fat tissue (Fig. 69.4) to expose the anterior aspect of the caval vein, the right ureter, the right infundibulopelvic ligament and the right colon mesentery (Fig. 69.5).

Step 2

The border between the mesonephric compartment of the ovarian vessel system and the compartment of right colon is identified; anastomosing vessels of the ovarian and right colonic vessels – which always are present - have to be identified and dissected (Fig. 69.6).

Step 3

The infundibulopelvic ligament is elevated and mobilized from laterally to medially keeping the connections to the paraaortic lymphatic system intact and separating it dorsolaterally from the right ureter and mesureter. Ureteral supplying vessels should kept intact (Fig. 69.7).

Table 69.1 Common and different steps in TMMR and PMMR

	Uterus	Vascular mesometrium	Ligamentous mesometrium	Fallopian tubes	Ovaries	IP ligaments
TMMR and therapeutic LNE	Yes	Yes	Yes	Yes	No[a]	No
PMMR and therapeutic LNE	Yes	Yes	No[a]	Yes	Yes	Yes

[a]This is usually not part of the procedure, but may be indicated based on the individual situation

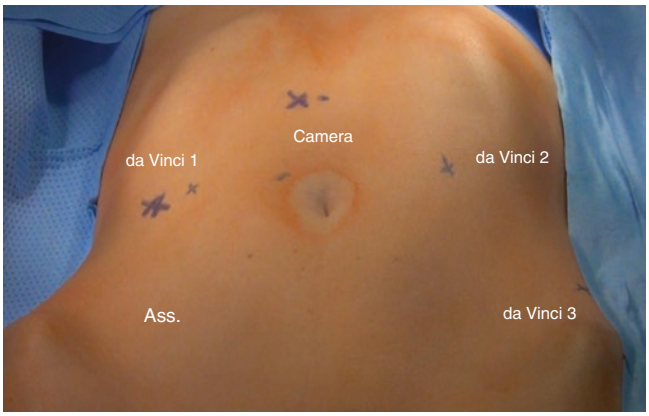


Fig. 69.2 Trocar postitioning for robotic TMMR

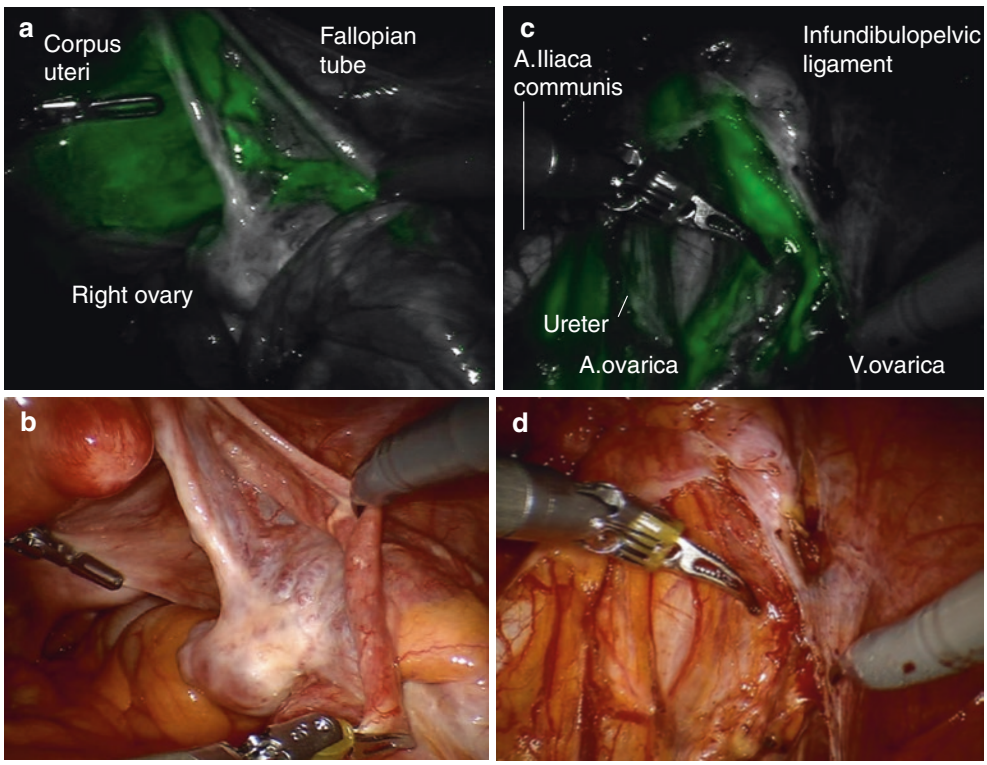


Fig. 69.3 Lymph drainage right infundibulopelvic ligament: mesovary and mesosalpinx (**a**, **b**) and infundibulopelvic ligament (**c**, **d**) each in normal light and infrared induced ICG fluorescence

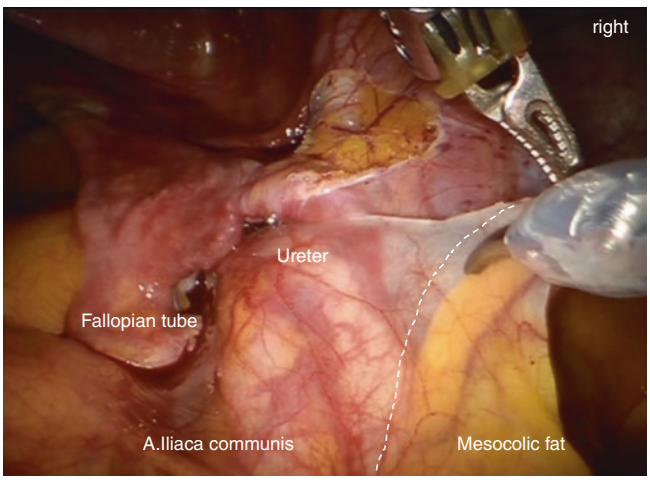


Fig. 69.4 Peritoneal incision between right infundibulopelvic ligament and mesocolon

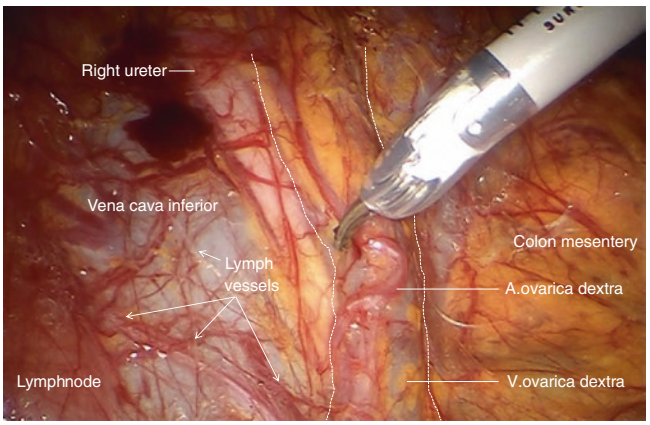


Fig. 69.5 Identification of right infundibulopelvic ligament, ureter and right colon mesentery

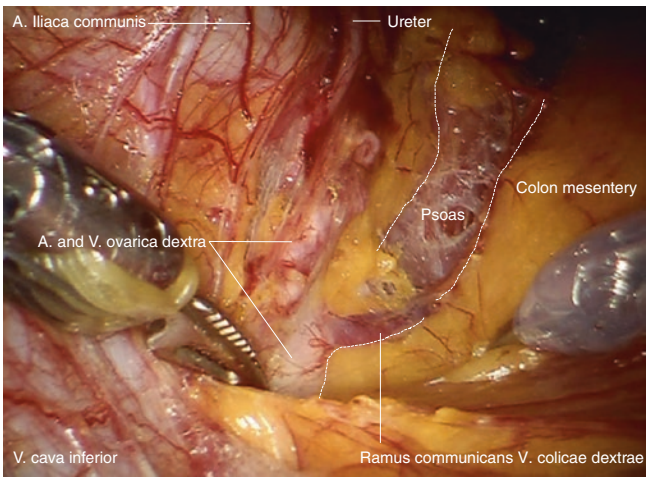


Fig. 69.6 Separation of right infundibulopelvic ligament from right colon mesentery

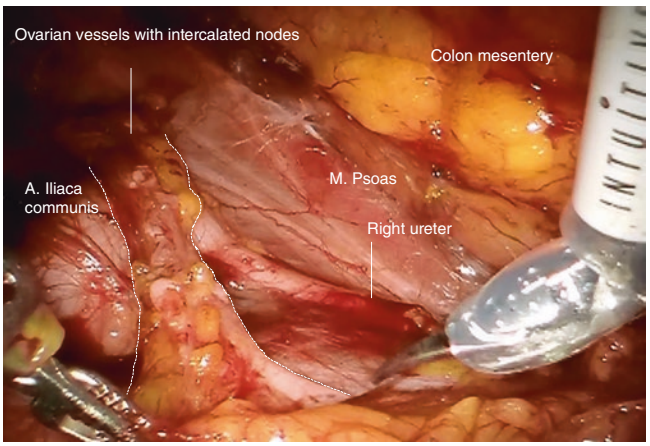


Fig. 69.7 Separation of ovarian vessel system from mesocolon, psoas muscle, ureter and caval vein

Step 4

Resection of the right infundibulopelvic ligament following the dissection of ovarian vessels at their origin together (Fig. 69.8) with periaortic lymphadenectomy which has to be performed completely up to the renal vessels. The right infundibulopelvic mesonephric compartment is completely mobilized together with adherent compartment of right periaortic nodes (Fig. 69.9).

Step 5

On the left side preparation of the infudibulopelvic ligament will start cranially. Following mobilization and dissection of the left paraaortic lymph compartment the left ovarian vein and artery (Fig. 69.8 c, d) are resected at their origin and mobilized from laterally to medially; again vessel anastomoses to the left colon mesentery have to be resected and the left ureter has to be prepared identically to the right (Fig. 69.10). The ligament is developed to the left pelvis dorsally of the mesosigma and pulled though the so-called "sigmoid tunnel". Since there are no lymphatic connections to the infundibulopelvic ligament below the left common iliac vessels the further moblization to the uterus now may be done as usual.

Step 6

Completion of therapeutic pelvic and paraaortic lymphadenectomy as previously described for endometrial cancer and/or cervical cancer [13].

Step 7

Incision of the peritoneum covering the round ligament, the ovarian vessels, the utero-ovarian junctions and the vascular mesometrium. This maneuver assures a complete resection of Müllerian compartment together with the connecting structures to the mesonephric compartment containing the lymphatic network together with the ovaries and the infundibulopelvic ligaments (Fig. 69.11).

Step 8

Radical hysterectomy with complete resection of the vascular mesometrium will now be performed as described

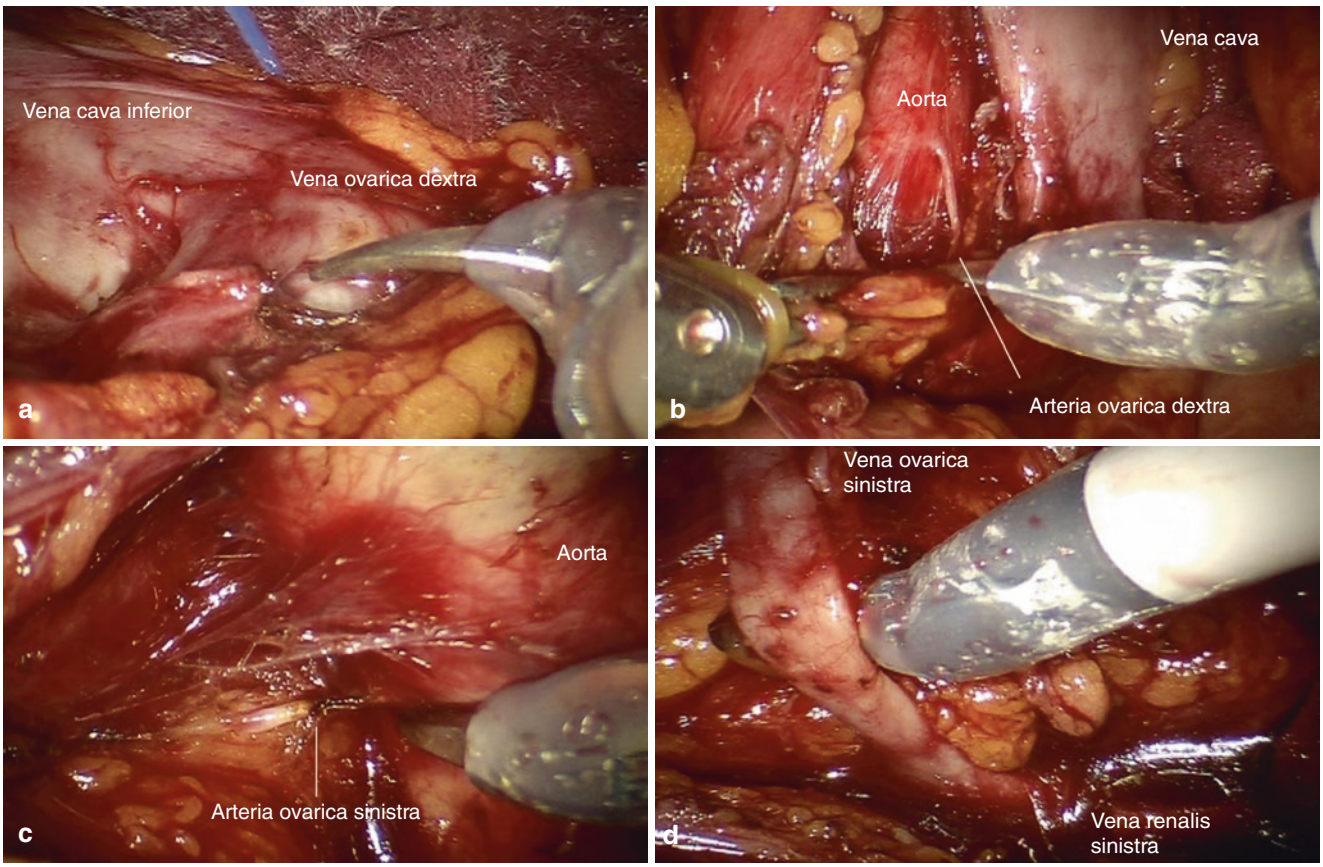


Fig. 69.8 (**a**–**d**) Dissection of ovarian veins and arteries from caval and renal veins and aorta

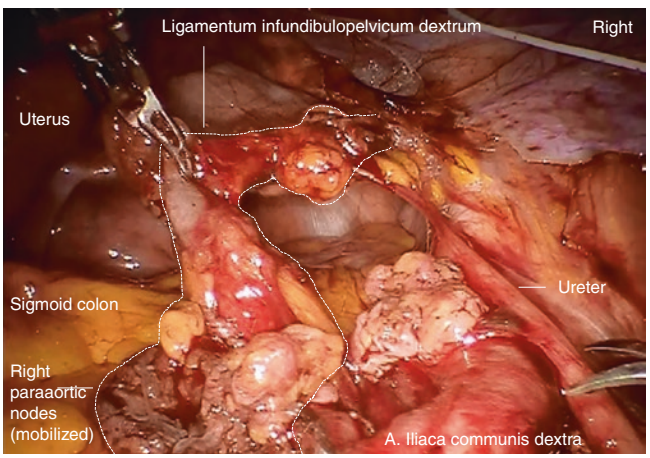


Fig. 69.9 Completely mobilized right ovarian vessel system with right paraaortic nodes

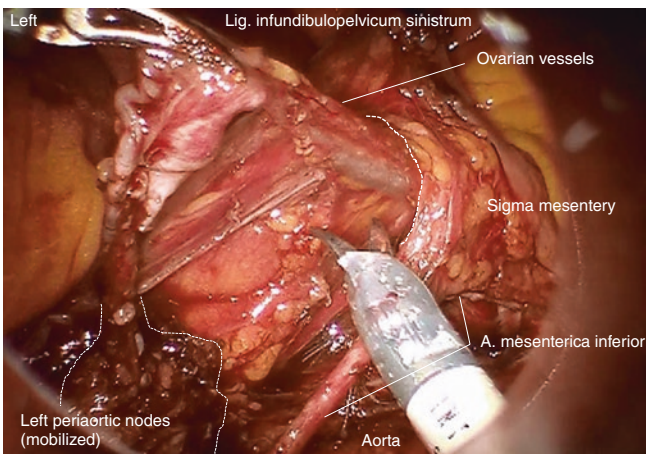


Fig. 69.10 Mobilized left ovarian vessel system entering the "sigmoid tunnel"

in detail for rTMMR [9]. If ovaries should be preserved in cervical cancer, fallopian tubes will be dissected along the mesosalpinx and ligg. Ovarii propria will be dissected.

Step 9

Preferably preparation starts posteriorly. Peritoneum will be incised in the pouch of Douglas and the rectum is mobilized medially from the vaginal wall. Preparation should free the

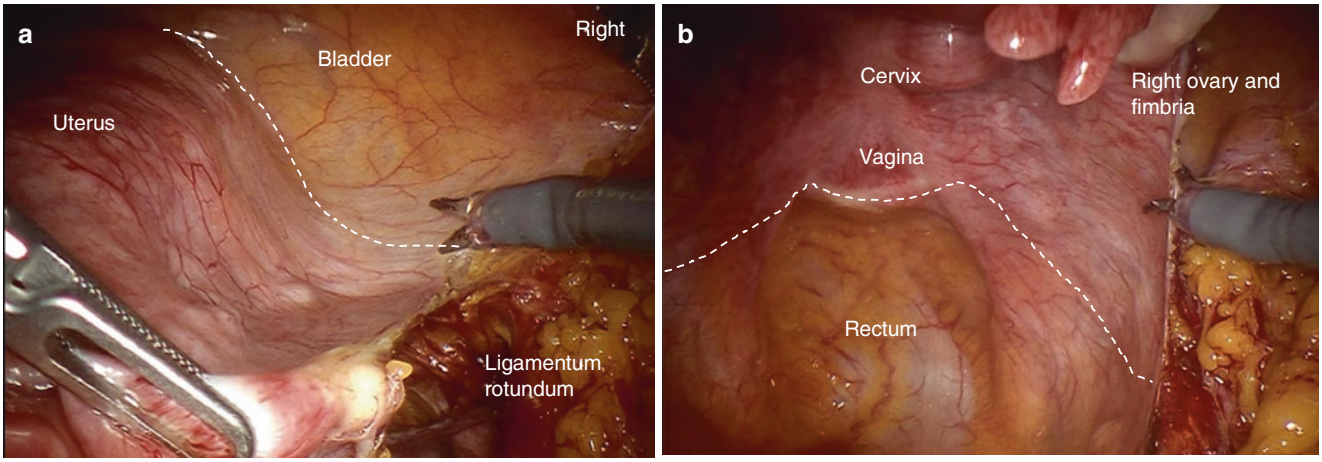


Fig. 69.11 Ventral (**a**) and dorsal (**b**) peritoneal incision in PMMR covering the utero-ovarian vessels

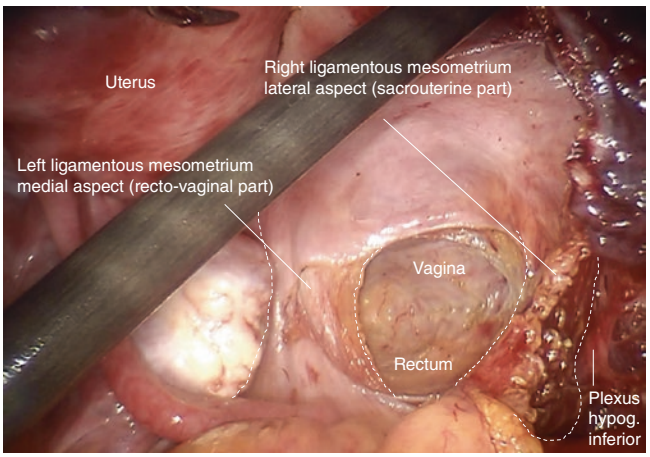


Fig. 69.12 Incision of peritoneum of Douglas pouch and separation of vagina and rectum and preparation of ligamentous mesometria

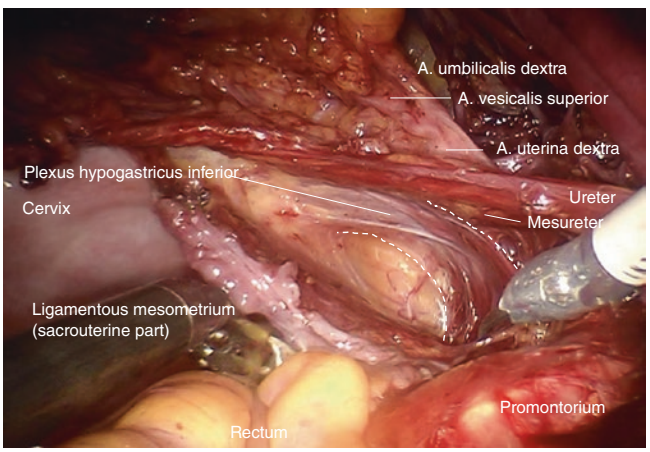


Fig. 69.13 Detaching of right ureter, mesureter and plexus hypogastricus inferior from right ligamentous mesometrium

vaginal wall at least 1 cm more caudally as intended resection line. The ligamentous mesometria (Fig. 69.12) which correspond medially to rectovaginal and rectouterine ligament are lateralized until their insertion to the perirectal tissue is reached usually ventrally to the descendent branch of the rectal artery.

Step 10

Starting on the right side the ureter is identified at its attachment to the pararectal peritoneum and detached together with the mesureter and the adherent inferior hypogastric plexus and nerve without separating these structures from each other. Thus, the avascular plain between the lateral part of the ligamentous mesometrium (anatomically corresponding to the sacrouterine ligament) may easily be opened and the nerve plain can be dissociated laterally from the ligamentous mesometrium (Fig. 69.13). The lymphatic drainage from uterine cervix is demonstrated by ICG fluorescence and is limited to the ligamentous mesometrium and postponed lymph compartment not draining to the rectal compartment, the ureteral or nerve plains (Fig. 69.14).

Step 11

The medial and lateral part of the ligamentous mesometrium may now be completely exposed (left, Fig. 69.15) and resected first laterally, pararectally along the pelvic side wall (sacrouterine part, along the mm. coccygeus and iliococcygeus and the endopelvic fascia); second, prerectally along the descending branch of the rectal artery (rectouterine/vaginal part).

Step 12

To detach the vesico-uterine attachment, the anterior surface of the uterus has to be exposed and put under tension to facilitate incision of the peritoneum at the vesico-uterine fold. The

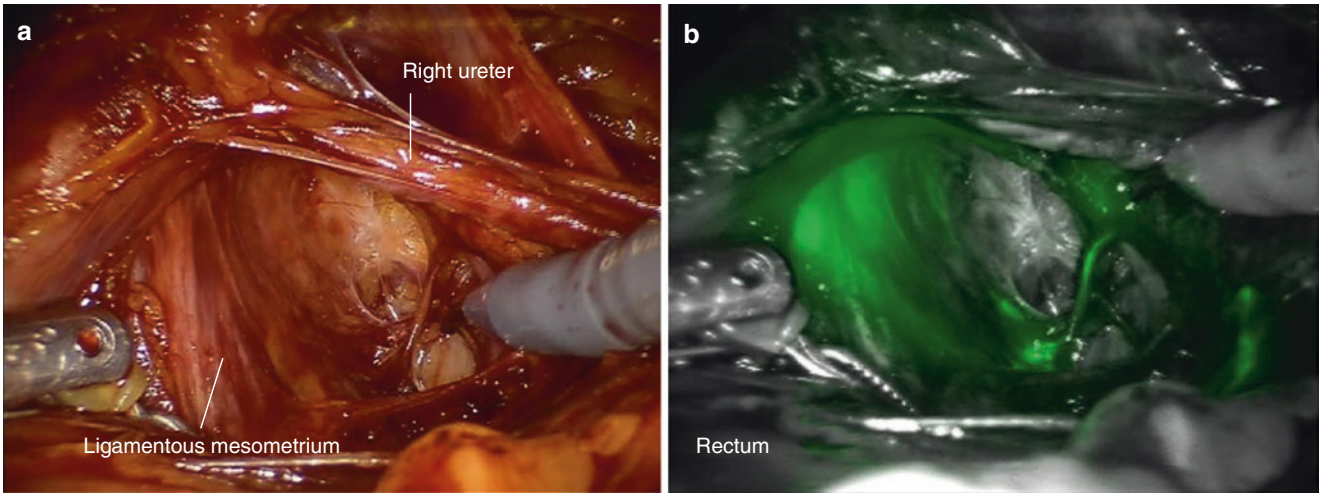


Fig. 69.14 Lateral (sacrouterine) part of right ligamentous mesometrium in cervical cancer and its connections to deep paravisceral lymph node compartments ((**a**) normal light, (**b**) ICG Fluorescence in near infrared light)

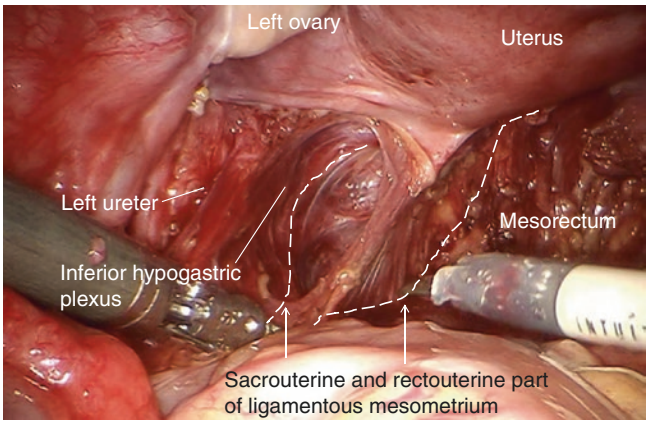


Fig. 69.15 Ligamentous mesometrium on the left side. Overview and resection lines of ligamentous mesometrium in cervical cancer

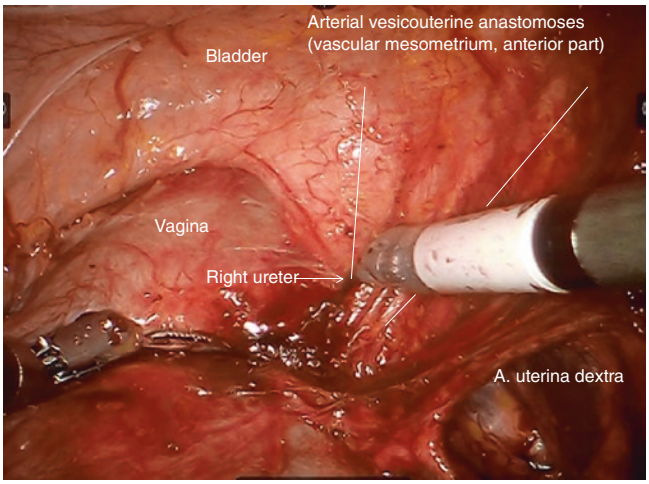


Fig. 69.16 Dissection of the vesicouterine and vesicovaginal tissue plain and preparation of vesicoureteral junctions

peritoneum has to be incised in direction to the lateral part of the round ligaments to divide these at the entrance to the inguinal channel. The loose connective tissue of the vesicouterine and vesicovaginal tissue plain is dissected caudally until the ureters are identified entering the vesical wall (Fig. 69.16). The preparation is extended then laterally and the border of the vesical and Müllerian compartments is identified.

Step 13

The right umbilical artery is identified and completely exposed to its origin from the internal iliac artery. Thus, branching of uterine artery and one or more superior vesical arteries can easily be identified (Fig. 69.17). Now, the ventral border of the vascular mesometrium may be prepared between the uterine and superior vesical vessels, the dorsal border between the uterine artery and the hypogastric plexus, laterally to the ureter.

As it has been shown already for the ligamentous mesometrium in Fig. 69.17, the vascular mesometrium will also be identified by ICG transporting lymph vessels from uterine cervix (Fig. 69.18). There is sharp delineation and no lymphatic drainage to the bladder compartment or along the superior vesical artery.

Step 14

The vascular mesometrium can now be exposed, first by developing the avascular space between its anterior surface and the bladder mesentery containing the superior vesical artery (Fig. 69.17); secondly, by developing the avascular space between the posterior surface and the plain of the ureter, mesureter and inferior hypogastric plexus (Fig. 69.19). The caudal border of the vascular mesometrium is marked by

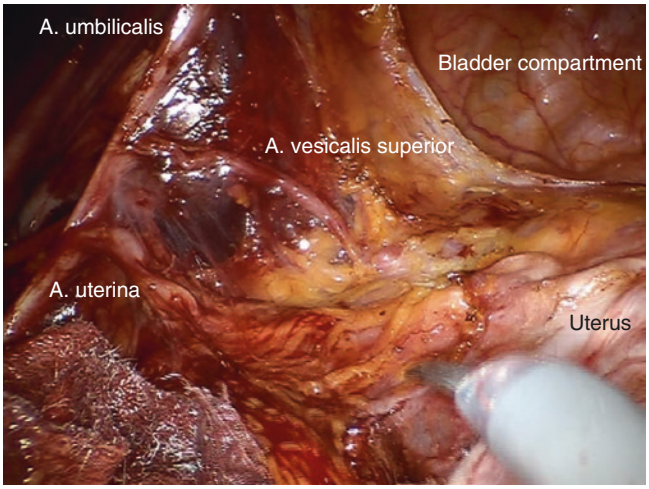


Fig. 69.17 Ventral aspect of vascular mesometrium separated from the bladder compartment

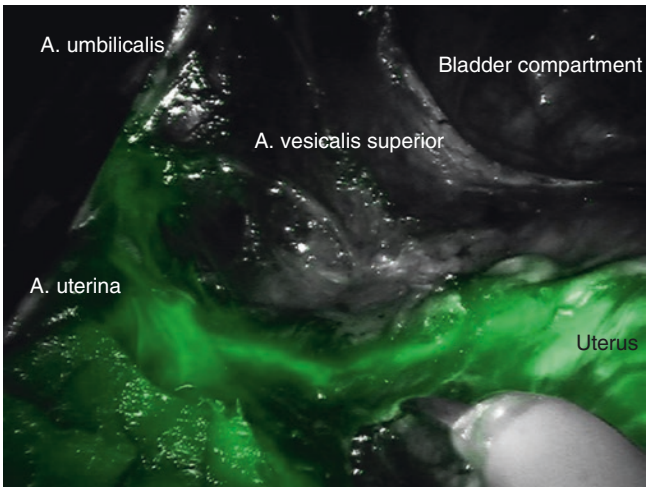


Fig. 69.18 Corresponding ICG lymphography of left vascular mesometrium (Fig. 69.17)

the deep uterine vein, which should also be resected in cervical cancer, but may be left in endometrial cancer (Fig. 69.20). The deep uterine vein often is branching from a common trunc with superior vesical vein. It should be prepared and coagulated before dissection to avoid bleeding. Splanchnic nerves always cross below the vein, thus never will be damaged, if the level of deep uterine vein is taken as the caudal border of resection – with or without resection of the vein.

Step 15

The complete resection of the vascular mesometrium including all paracervical/mesometrial intercalated nodes starts with the coagulation and division of the uterine artery and superficial uterine veins at their origin from the iliacal vessels. This step should be carried out without separating

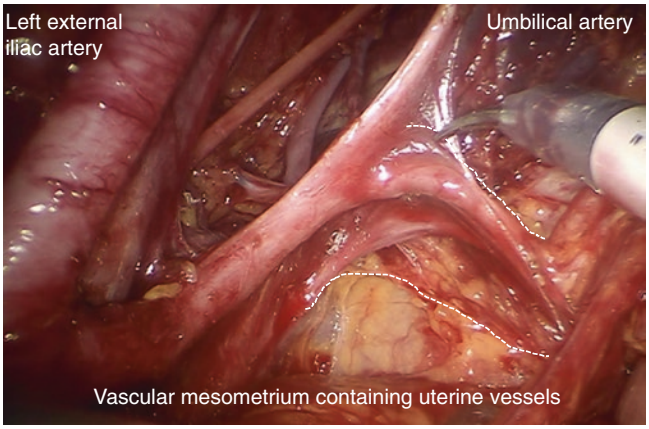


Fig. 69.19 Left vascular mesometrium (lateral part, dorsal aspect)

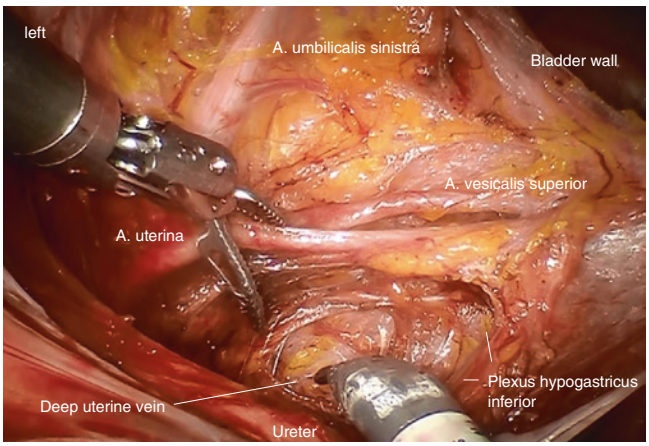


Fig. 69.20 Resection of left vascular mesometrium

the vessels in order to remove all perivascular lymphatic tissue "en bloc" (Fig. 69.20). The deep uterine vein is identified and coagulated separately.

Step 16

Dissection of the ureteral branch of the uterine artery (and vein) following elevation of the uterine bundle is necessary to mobilize the ureter in its "tunnel" (Fig. 69.21). Coagulation and dissection of vesicouterine/vaginal arterial anastomoses in the anterior part of vesicouterine ligament will separate the Müllerian from the vesical compartment ventrally, carefully preserving the ureteral branches of the bladder mesentery (Fig. 69.22).

Step 17

Dissection of the uterine nerve fibers of the hypogastric nerve at the lateral posterior aspect of the cervix will enable to preserve the bladder branches of the hypogastric nerve.

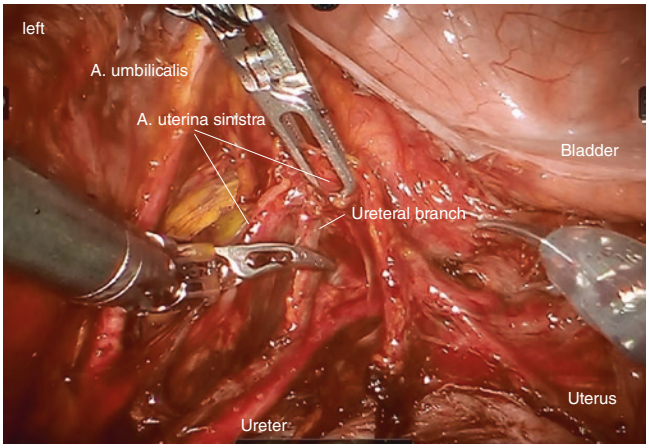


Fig. 69.21 Disection of ureteral branch of uterine artery, left vascular mesometrium

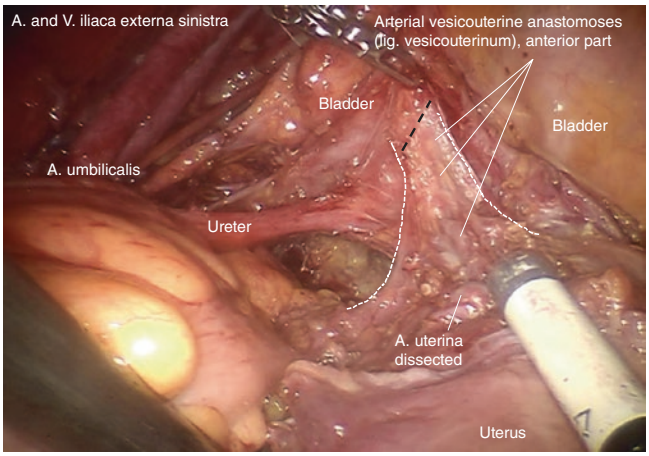


Fig. 69.22 Preparation of anterior part of left vascular mesometrium corresponding to vesico-uterine ligament

They will be lateralized and pushed caudally together with the ureter (Fig. 69.23).

Step 18

Dissection of the "ladder-like" arranged vesicovaginal venous anastomoses (Fig. 69.24), if not already done during separation of the ventral aspect of vascular mesometrium from the bladder mesentery (so called "posterior leaf of vesicouterine ligament").

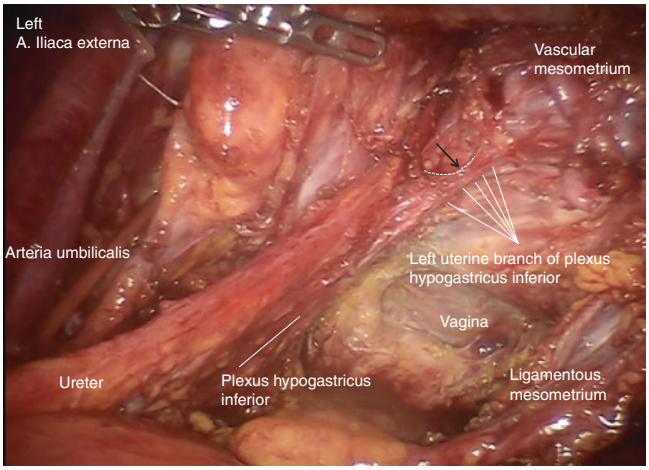


Fig. 69.23 Dissection of left uterine branching nerves to lateralize inferior hypogastric nerve

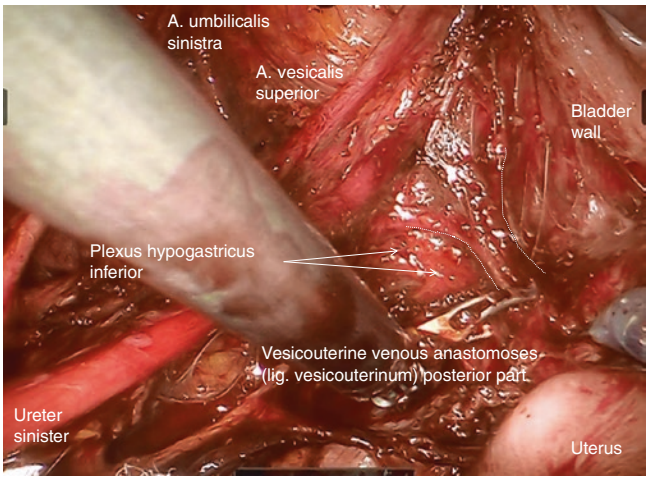


Fig. 69.24 Dissection of venous vesico-uterine anastomoses of vascular mesometrium on the left

Step 19

Definition of the vaginal resection plane and dissection of the mesocolpium if necessary. Opening the vagina from dorsally and resection of vaginal cuff with sufficiently clear margins confirmed by frozen section (Fig. 69.25).

Step 20

Removal of resected tissue, bags and sponges vaginally, and confirmation of clear margins. The vagina is closed by running suture.

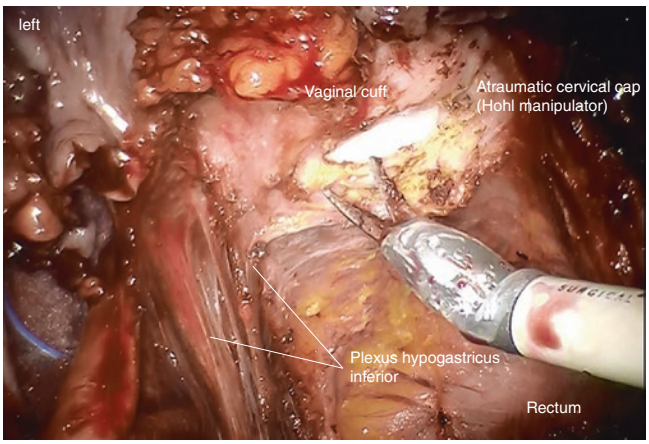


Fig. 69.25 Definition of length of vaginal cuff and colpotomy

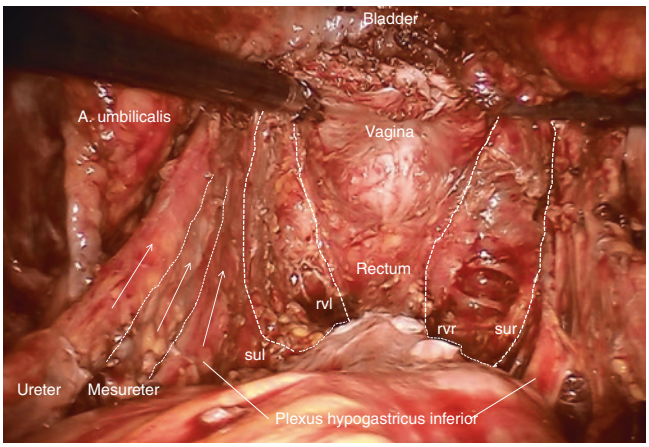


Fig. 69.26 Final situation following TMMR: resection lines ligamentous mesometria su (sacrouterine), rv (recto-vaginal), l/r

Finally, all tissue of Müllerian compartment has been removed completely - except for the vaginal part for functional reasons - but adjacent structures of neighbouring compartments such as ureter, mesureter, hypogastric plexus, rectal and vesical mesentery are entirely preserved whereas the vascular and ligamentous mesometria are entirely removed (Fig. 69.26). Thus, this procedure may be performed identically for all compartment defined cervical and endometrial cancers ensuring maximum radicalness with respect to tumor resection without increasing morbidity by extending surgery to neighboring structures. Adaption of surgery to compartments instead of tumor size and extent may enhance loco-regional tumor control, whereas unnecessary morbidity is prevented.

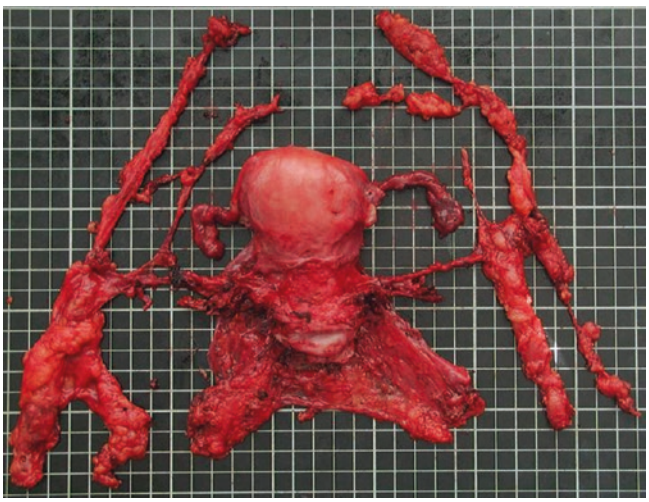


Fig. 69.27 Typical specimen following TMMR in cervical cancer with vascular and ligamentous mesometria and pelvic lymph node compartments

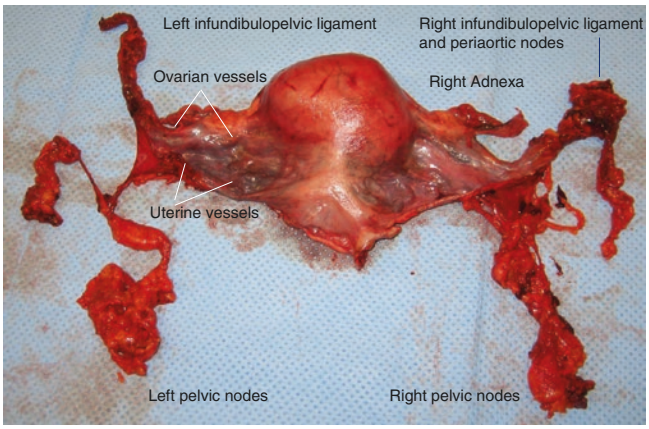


Fig. 69.28 Typical specimen following PMMR in endometrial cancer with vascular mesometria, uteroovarian vessel network and mesonephric compartment of infundibulopelvic ligaments

Finally, typical specimens following TMMR (Fig. 69.27) and PMMR (Fig. 69.28) are shown. Figure 69.29 demonstrates that ICG labeling of the Müllerian compartment reliably persists over hours during cancer surgery for intraoperative orientation and postoperative control.

To compare clinical results of surgical techniques in practice and even more in studies the procedure has to be named and exactly standardized. Thus, in this chapter the technique of TMMR and PMMR performed by robotically assisted laparoscopic surgery has been defined and described step by step.



Fig. 69.29 Green ICG fluorescence of Müllerian compartment after corporal injection in endometrial cancer, PMMR specimen

References

1. Wolpert L. Positional information and spatial pattern of cellular differentiation. J Theor Biol. 1969;25:1–47.
2. Garcia-Bellido A, Ripoll P, Morata G. Developmental compartmentalization of the wing disk of Drosophila. Nature. 1973;245:251–3.
3. Dahmann C, Oates AC, Brand M. Boundary formation and maintenance in tissue development. Nat Rev Genet. 2011;12:43–55.
4. Höckel M. Morphogenetic fields of embryonic development in locoregional cancer spread. Lancet Oncol. 2015;16(3):e148–51. doi:10.1016/S1470-2045(14)71028-9.
5. Heald RJ, Rayan DRH. Recurrence and survival after total mesorectal excision for rectal cancer. Lancet. 1986;327:1479–82.
6. Weaver KL, Grimm Jr LM, Fleshman JW. Changing the way we manage rectal cancer-standardizing TME from open to robotic (including laparoscopic). Clin Colon Rectal Surg. 2015;28(1):28–37. doi:10.1055/s-0035-1545067.
7. Höckel M, Horn L-C, Manthey N, Braumann U-D, Wolf U, Teichmann G, Frauenschläger K, Dornhöfer N, Einenkel J. Resection of the embryologically defined uterovaginal (Müllerian) compartment and pelvic control in patients with cervical cancer: a prospective analysis. Lancet Oncol. 2009;10:683–92.
8. Höckel M, Horn LC, Tetsch E, Einenkel J. Pattern anlaysis of regional spread and therapeutic lymph node dissection in cervical cancer based on ontogenetic anatomy. Gynecol Oncol. 2012;125:168–74.
9. Kimmig R, Wimberger P, Buderath P, Aktas B, Iannaccone A, Heubner M. Definition of compartment-based radical surgery in uterine cancer: radical hysterectomy in cervical cancer as 'total mesometrial resection (TMMR)' by Michael Höckel translated to robotic surgery (rTMMR). World J Surg Oncol. 2013;11(1):211.
10. Kimmig R, Aktas B, Buderath P, Wimberger P, Iannaccone A, Heubner M. Definition of compartment-based radical surgery in uterine cancer: modified radical hysterectomy in intermediate/high-risk endometrial cancer using peritoneal mesometrial resection (PMMR) by M Höckel translated to robotic surgery. World J Surg Oncol. 2013;11(1):198.
11. Kimmig R, Aktas B, Buderath P, Rusch P, Heubner M. Lymphatic network visualized by Indocyanine-green (ICG) as in vivo marker for embryologically derived organ compartments and their drainage in uterine cancer surgery. J Surg Oncol. 2016;113(5):554–9. doi: 10.1002/jso.24174.
12. Yang Y, Oliver G. Development of the mammalian lymphatic vasculature. J Clin Invest. 2015;124:888–97.
13. Kimmig R, Iannaccone A, Buderath P, Aktas B, Wimberger P, Heubner M. Definition of compartment based radical surgery in uterine cancer-part I: therapeutic Pelvic and periaortic lymphadenectomy by Michael Höckel translated to robotic surgery. ISRN Obstet Gynecol. 2013;2013:297921. doi:10.1155/2013/297921.
14. B. U. Sevin. Kap 2. H. Hepp, P. Scheidel, J. M. Monaghan, editors. Lymphonodektomie in der gynäkologischen Onkologie. Indikation, Technik und Konsequenzen für die Therapieplanung. Urban&Schwarzenberg; 1988. p. 24, ISBN 3-541-12351-6.

Robotically Assisted Therapeutic Pelvic and Paraaortic Lymphadenectomy in Uterine Cancer

70

Rainer Kimmig

Introduction

There are several strategies in lymphadenectomy and even more techniques all named "pelvic lymphadenectomy" or "paraaortic lymphadenectomy."

Thus, first it has to be defined what will be the intention of lymphadenectomy – diagnostic or therapeutic? In case of diagnostic intent sentinel node biopsy may be an adequate approach for reduction of morbidity, other forms of staging lymphadenectomy may be too but are more or less undefined. To confirm a "sufficient" lymphadenectomy indication of numbers of nodes retrieved has been proposed. However, on the contrary, in case of therapeutic intention it makes no sense to define any number of nodes to be taken out, but to define not to leave any node in with respect to the compartment of risk.

In conjunction with compartmental resection of "organ compartments at risk" which have to be resected entirely, only resection of the entire "node compartments at risk" may considered adequate for maximum potential therapeutic effect.

Just to remember the basis of compartmental resection from Chapter 69: On the basis of ontogenetic compartmental development the findings about compartmental border control in malignant tumour progression led to the concept of "compartmental resection" in solid malignant tumors [1–4]. Since loco-regional recurrence usually occurs in compartment remnants or in the associated lymph compartments total "compartments of risk" have to be removed completely, whereas neighbouring compartments may left entirely untouched. The first tumour resected following this concept was rectal cancer by total mesorectal excision (TME) resulting in dramatically reduced loco-regional recurrence [5]. At present this procedure has become standard in rectal cancer surgery [6]. For cervical cancer M. Höckel has convincingly shown by his monocentric data that the corresponding method named total mesometrial resection (TMMR) also reduces efficiently locoregional recurrences compared to standard treatment – without any additional radiation therapy even in risk situations [7, 8]. The Method is described for open surgery in a separate chapter. Together with M. Höckel total mesometrial resection (rTMMR) has been translated to robotic surgery [9]. On parallel, the modification of compartmental resection for endometrial cancer as peritoneal mesometrial resection (PMMR) according to the different lymph drainage has also been adopted to robotic surgery as rPMMR [10]. Although, the two methods have to be applied together with therapeutic pelvic or pelvic and paraaortic lymphadenectomy to control not only for local but also for regional disease, in this chapter the technique of therapeutic lymphonodectomy (tLNE) only is described; however technique of TMMR and PMMR has already been described step by step in Chapter 69.

Anatomical Basis of Müllerian Compartment and Local Lymph Drainage

For uterine cancer removal of the Müllerian compartment and its draining lymphatic compartments has to be performed completely. Embryological development, compartment borders and type of resection in uterine cancer is perfectly described by M. Höckel [4, 7]. As shown in Fig. 70.1 the uterus has to be removed together with the vascular mesometrium (corresponding to the uterine vessel system including vesicouterine anastomoses) and the ligamentous mesometrium (c+orresponding to the rectovaginal and sacrouterine ligament). However, there is not any longer any modification with respect to the tumor size, as the concept requires always complete resection. There is only one part of the Müllerian

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compartment left in situ for functional reasons – the vagina. The vaginal resection margin is the only intracompartmental resection has directly to be controlled for clear margins (>10 mm recommended) in compartment confined tumors [4]. According to the different lymph drainage of the upper and lower Müllerian compartment in cervical cancer vascular and ligamentous mesometria have to be resected. In endometrial cancer without cervical involvement there is no drainage along the ligamentous mesometria; on the other hand there is drainage along the mesonephric pathway on parallel to the ovarian vessel system. Thus, ligamentous mesometria may be preserved, but infundibulopelvic ligaments have to be resected completely in corporal uterine disease as can be seen from Fig. 70.1 a–d.

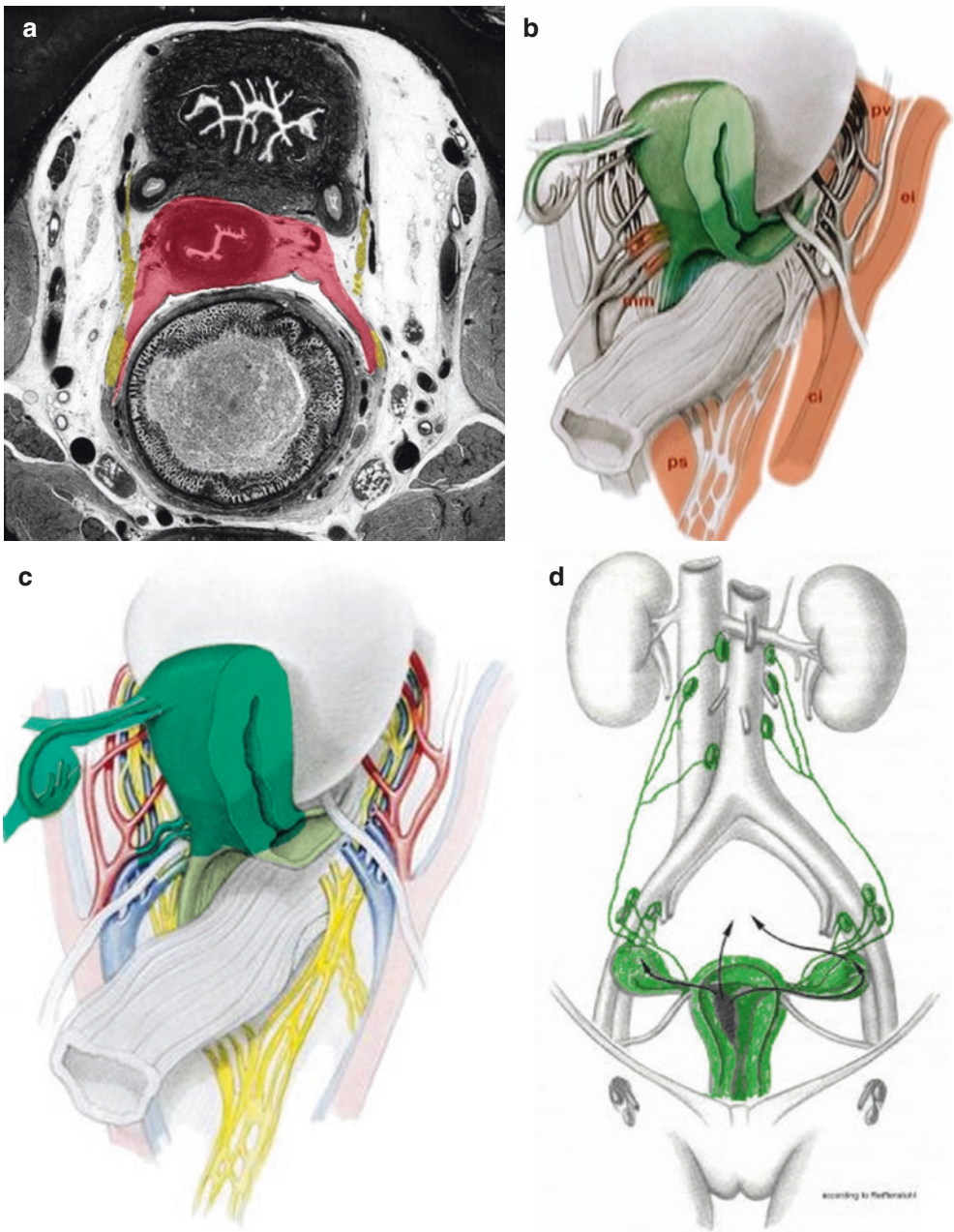


Fig. 70.1 (**a**) Embryologic development of Müllerian compartment (*red*); (**b**) Müllerian compartment in the adult (*green*); (**c**) Involvement of Müllerian compartment in endometrial cancer (*green*); (**d**) Additional lymphatic drainage in endometrial cancer (*green*)

Therapeutic Lymphadenectomy

In this chapter this type of "therapeutic lymphadenectomy" as described by M. Höckel will be demonstrated using robotically-assisted laparoscopy exclusively for the different pelvic and paraaortic lymph compartments. This has already been published in [9–17].

As outlined in Chapter 69 the lymphatic network of the Müllerian system derives from embryonal veins [18] and thus covers the whole compartment and may visualized by fluorescence lymphography intraoperatively. In mammals, embryologic development is suggested as a stepwise process starting from the embryonic veins, where lymphatic endothelial cells (LEC) are initially specified [19]. The lymphatic system develops by budding from "cardinal veins" and thus, necessarily parallels the venous system, although no open connection remains between the two systems except for the iugular lymph sacs to the subclavian veins which enable lymph drainage back to the blood circulation. There is some evidence that the origin of the very first draining lymphatic capillaries may arise not only by sprouting but also by scattered local mesenchymal cells expressing lymphoendothelial markers [19]. Very important is the fact, that collecting lymph vessels and also main transporting lymph vessels develop lymphatic valves which guarantee a directed "downstream" lymph flow [19]. This is also true for the connecting lymph vessels from the organ compartment to the lymph compartments (basins of first or subsequent order). Thus, visualization of the lymphatic vessel network of a distinct organ should be able to mark the organ compartment and the compartments of specific lymphatic drainage "downstream" from a defined localization resembling functional aspects. This should have dramatic clinical impact on surgical oncology with respect on individual radical compartmental surgery in cancer due to the compartmental order of tumor progression [20] and the tremendous impact of the lymphatic system on local, regional and distant tumor progression.

Uterine Cervix and upper vagina is drained via two different pathways: first, along the uterine and vaginal arteries and veins to the pelvic side wall, using mainly the lymph vessels running along of the uterine artery. They drain primarily into the paravisceral and external iliac lymph basin which are the lymph compartments of first order for these organ (sub) compartments and contain the respective site information. The second pathway runs along the posterior ligamentous mesometrium and mesocolpium (corresponding to the sacrouterine and rectovaginal ligaments) and drains primarily to the deep paravisceral nodes ventrally to the ischiadic spine and the nerve roots of the ischiadic nerve. There are collecting lymph channels transporting the lymph fluid to the common iliac lymph basin, ventrally and dorsally of the common iliac vessels and again connecting this compartment of second order to the inferior paracaval and paraaortic lymph node compartment (third order) connected again to the infrarenal lymph paraaortic and paracaval nodes (forth order) which may also serve as first order lymph compartment for the mesonephric and colonic system, for example.

We have to keep in mind, that the draining lymph channels of the lower Müllerian compartment (Cervix, Vagina) run caudally and dorsally, thus involving rather the posterior nodes along the vessels; Anatomically the paraaortic and paracaval nodes are separated in two subcompartments on each side: the anterior (mesenteric) and the posterior (lumbar) part. Although, lymphatic spread is found in cervical and vaginal cancer predominantly in the lumbar subcompartment there are a lot of anastomoses between the lymphatic systems, which can be shown anatomically and by ICG fluorescence, that ther may be also metastatic spread to the mesenteric subcompartment.

In endometrial cancer lymphatic spread is different. From the upper part of Müllerian compartment lymphatic drainage runs cranially of the uterine artery and predominantly ventrally to the main vessels. In addition, there is a mesonephric pathway along the ovarian vessels directly to the paraaortic lymph compartment. Consequently, tumor spread is predominantly found in the ventral, mesenteric subcompartments; same is true for ovarian cancer where more or less the same lymphatic pathways are used.

If we respect that in a functional intact lymphatic system the lymphatic flow is unidirectional due to valves consequent and complete removal of the lymph compartments at risk should be able to control for locoregional disease. This may no longer be true in macroscopically bulky disease since in that situation due to tumor barriers in the downstream system may lead to upstream dissemination by valve insufficiency.

For systematic reasons it makes sense to define pelvic and paraaortic lymphadenectomy as different entities. However, with respect to the compartmental order of lymph basins in ontogenetic development it seems to be more appropriate to define pelvic and paraaortic lymph compartments draining the respective organ (sub) compartments of the tumor origin.

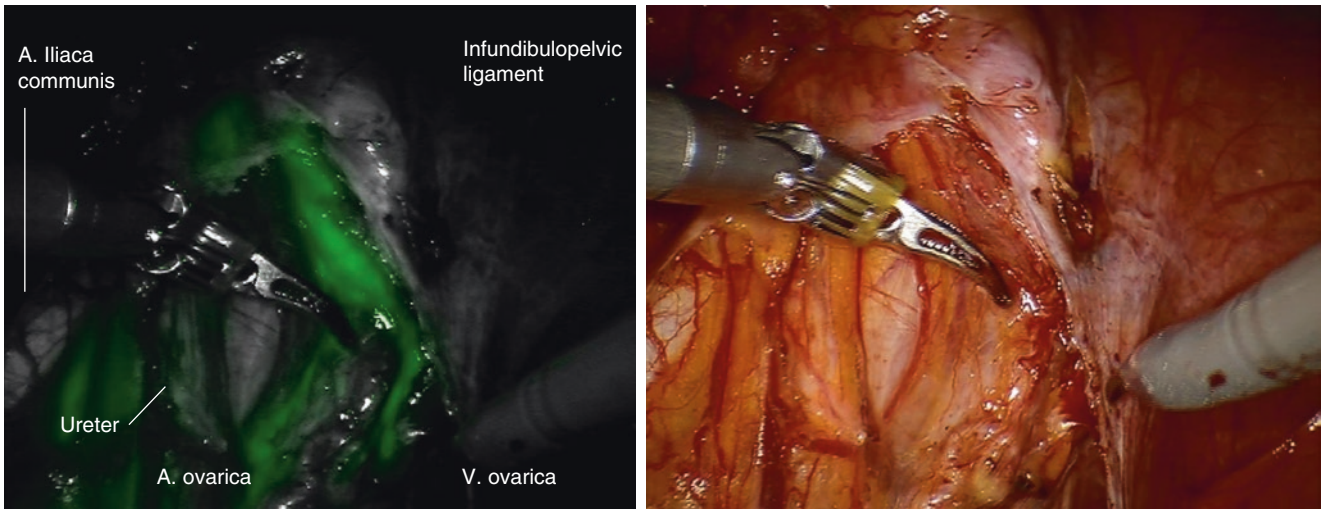


Fig. 70.2 Lymph drainage right infundibulopelvic ligament (ICG and real light comparison)

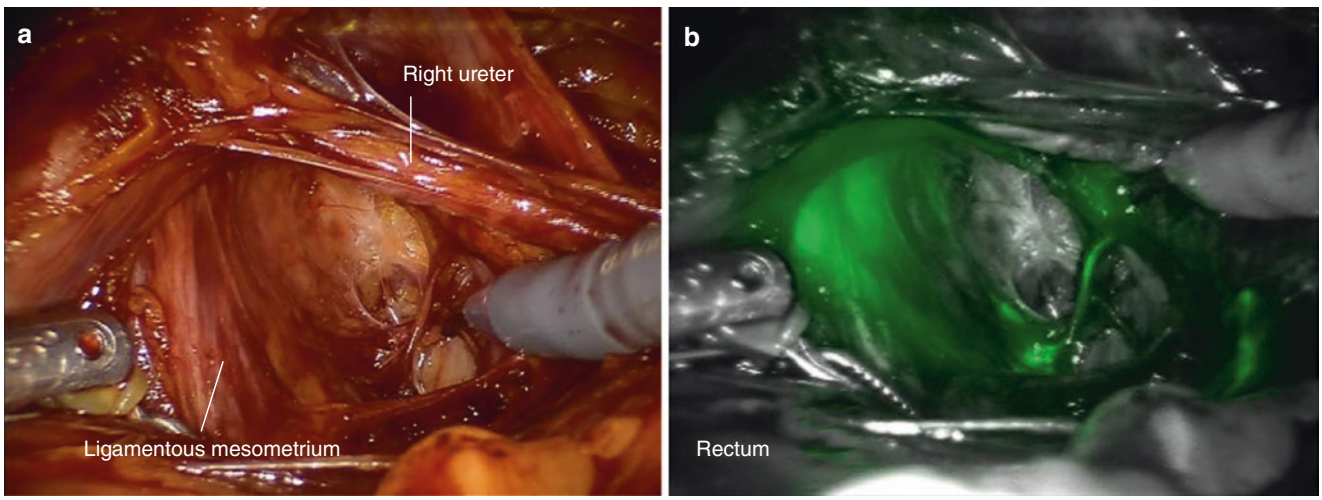


Fig. 70.3 Lateral (sacrouterine) part of right ligamentous mesometrium in cervical cancer and its connections to deep paravisceral lymph node compartments (*A* normal light, *B* ICG Fluorescence in near infrared light)

Lymph Compartments at Risk for Endometrial and Cervical Cancer

Due to the embryological development of lymphatic drainage of the Müllerian compartment there are three main pathways to reach the pelvic and paraaortic basins. First, Müllerian pathway along the vascular mesometrium to the paravisceral and external iliac basin, second along the ligamentous mesometrium to the paravisceral basin, predominantly along obturator and gluteal vessels to posterior part of internal iliac vessels. Third, the mesonephric pathway along the infudibulopelvic ligaments. Wheras cervical subcompartment drains to the lower vascular and ligamentous mesometrium, the corporal subcompartment drains to the upper vascular mesometrium and the infundibulopelvic ligament. Typical situations of intraoperative visualization using ICG in cervical and endometrial cancer are shown in Figs. 70.2, 70.3, 70.4, and 70.5.

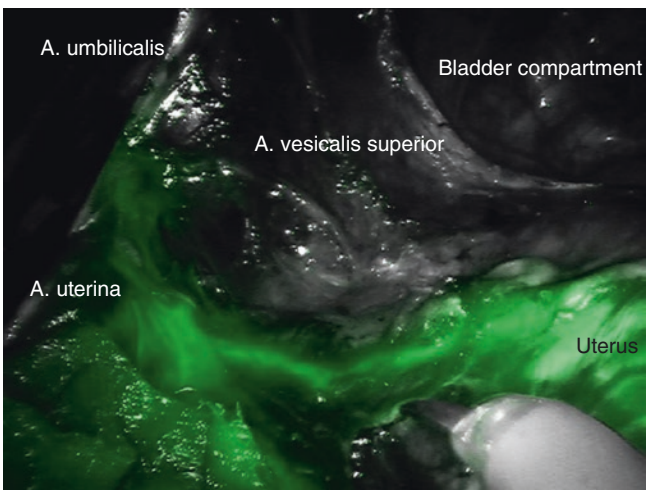


Fig. 70.4 Ventral aspect of vascular mesometrium separated from the bladder compartment

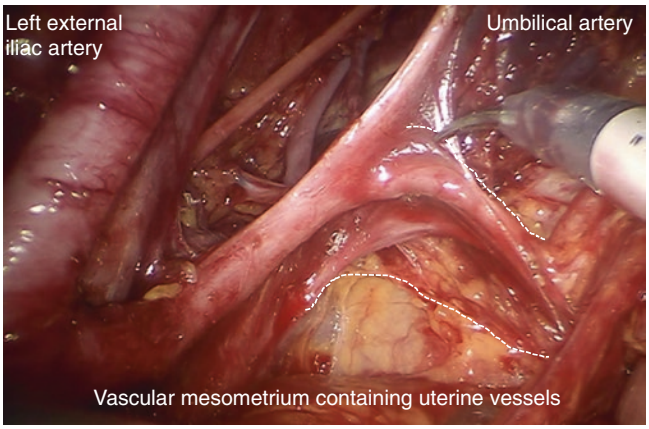


Fig. 70.5 Corresponding ICG lymphography of left vascular mesometrium (Fig. 70.4)

Therapeutic Pelvic Lymphadenectomy: Step by Step

The pelvic lymph basins draining the uterine compartment are: External iliac basin, paravisceral basin including preischiadic and prespinal region, common iliac basin including subaortic nodes (Fig. 70.1).

Thus, the lymph compartment of first order is represented by the paravisceral and external iliac lymph basin and of highest risk, postponed (second order) are the common iliac basins including subaortic nodes getting at risk following involvement of first order lymph basins.

Surgical Strategy and Technique

Step 1

Usually, pelvic lymphadenectomy starts at the level of the right common iliac artery. Following opening of the peritoneum laterally to the artery but medial to the ureter the complete retroperitoneal lymph basins are exposed from the aortic bifurcation to the bifurcation of the common iliac vessels down to S2 (Fig. 70.6, before dissection). Following peritoneal incision the superior hypogastric plexus will be elevated ventrally together with the mesosigma, forming the so-called sigmoid tunnel and the intact retroperitoneal lymphatic compartments are exposed (Fig. 70.7).

Step 2

Lateral borders of the dissection dorsally are defined by the psoas muscle, the ureter, the genitofemoral nerve and if preserved, ventrally the infundibulopelvic ligament (Fig. 70.8). All structures have to be separated from the lymphatic compartment.

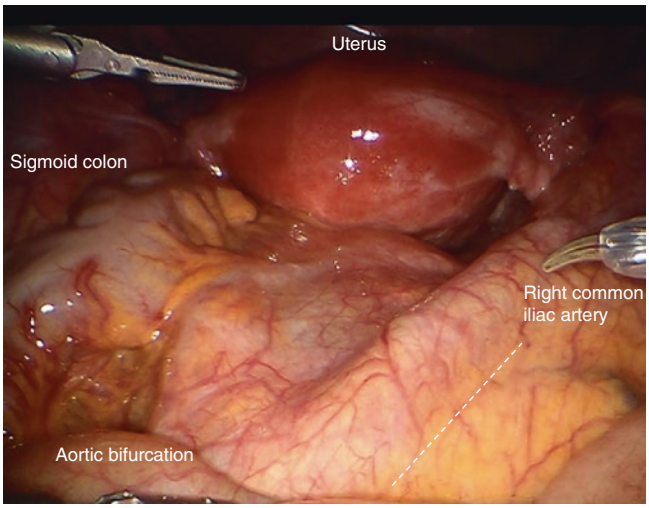


Fig. 70.6 Exposition prior to peritoneal incision at the level of right common ilac artery

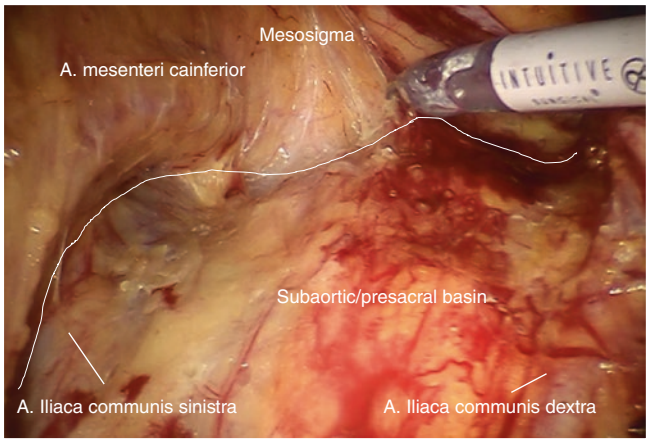


Fig. 70.7 Subaortic and caudal mesenteric paraaortic lymph compartment exposed

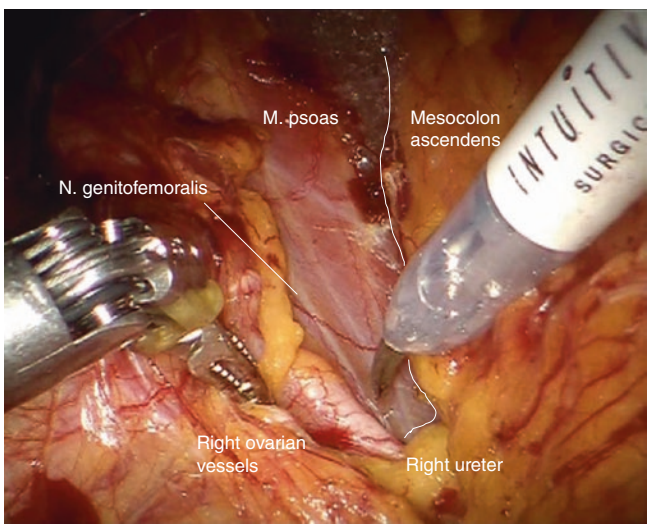


Fig. 70.8 Right lateral border of common iliac lymph basin

Step 3

Common iliac lymph basins will be resected "en bloc" from right to left, starting at the level of aortic bifurcation. Following structures should be exposed and detached from right to left: ureter, left sympathetic chain, n. genitofemoralis, n. obturatorius, truncus lumbosacralis, a. and v. iliaca communis, promontorium, A. sacralis media and same to the left (Figs. 70.8, 70.9, 70.10, 70.11, and 70.12). The connection to the inferior lumbar and mesenteric aortic basins can be taken as upper border for the dissection (Fig. 70.13). The lower border of dissection will be the ureter crossing at the common iliac bifurcation; medially, however, internal iliac nodes should be resected already down to the level of S2 (Fig. 70.14); lower crossing splanchnic nerves will thus be preserved.

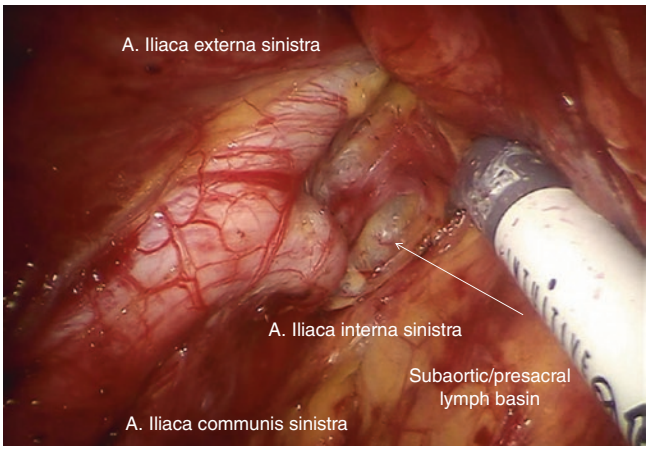


Fig. 70.11 Subaortic (left medial common iliac) and upper paravisceral lymph compartment to S2

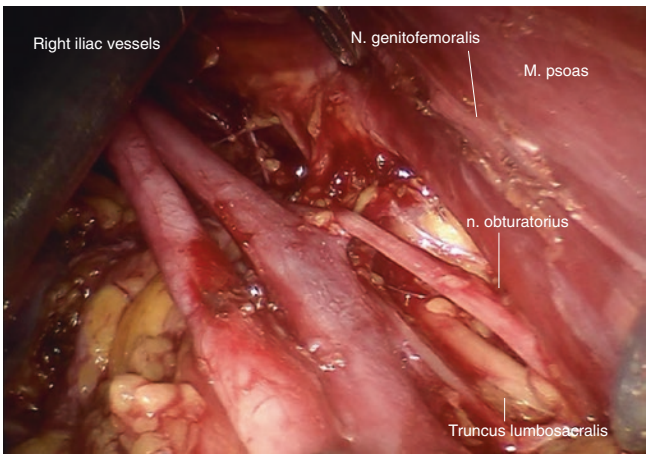


Fig. 70.9 Lateral common iliac lymph basin partially dissected on the right

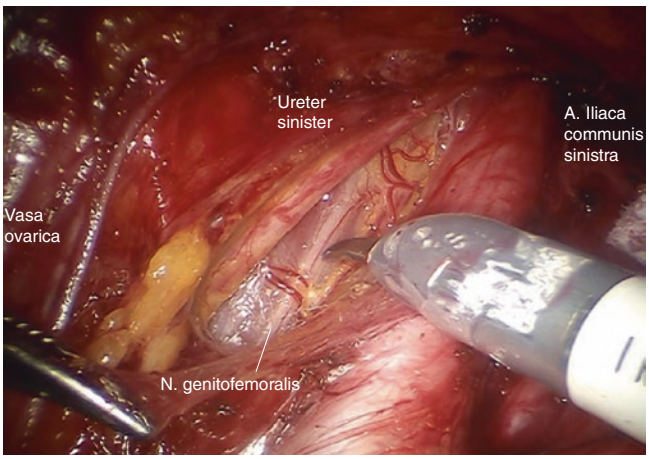


Fig. 70.12 Left lateral border of common iliac lymph basin

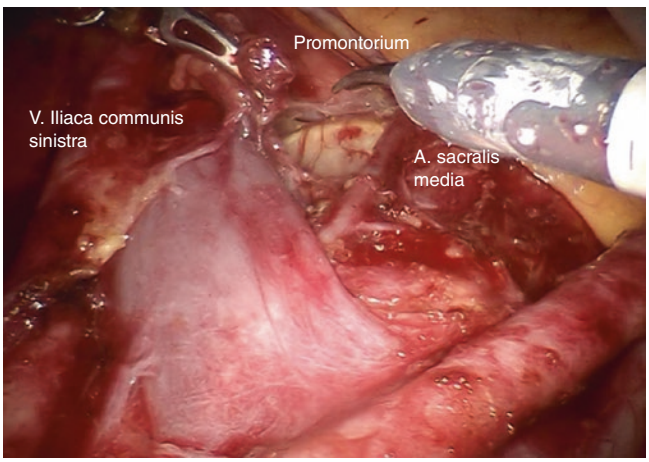


Fig. 70.10 Subaortic (medial common iliac) lymph basin partially dissected

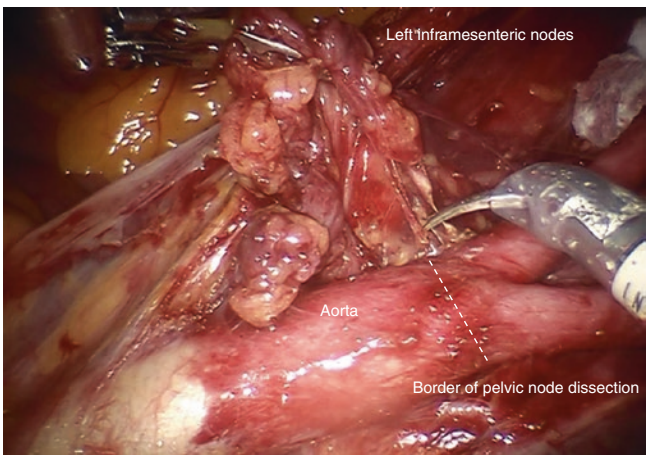


Fig. 70.13 Cranial border of common iliac lymph basin

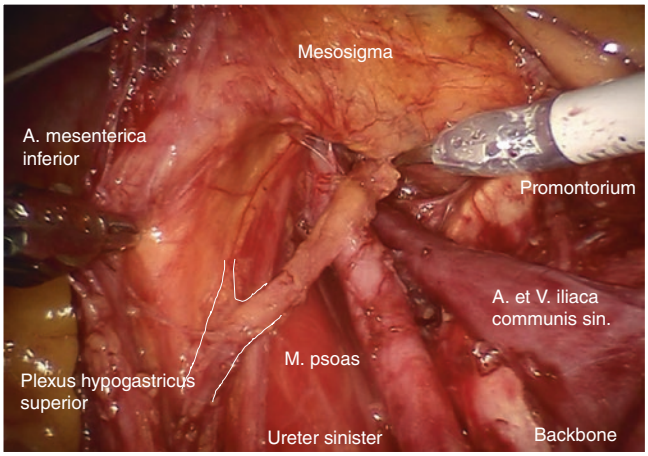


Fig. 70.14 Left caudal border of common iliac lymph basin

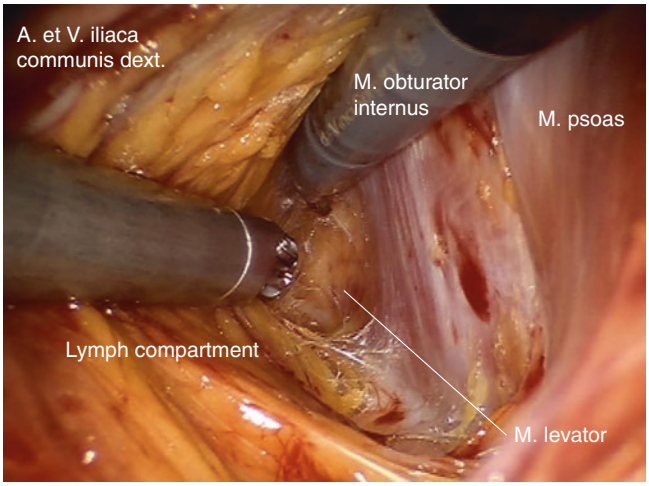


Fig. 70.15 Lateral border of right pelvic paravisceral lymph compartment

Step 4

Lateral exposition of external and paravisceral lymph basin on the right. Lateral border again is represented by the genitofemoral nerve and the psoas fascia. These structures will be separated from the lymph compartment. Next, the lymph compartment will be detached from the pelvic side wall by following the psoas muscle to the internal obturator muscle, passing the arcus tendineus to the levator muscle and the endopelvic fascia. This can easily be achieved lateral to the external iliac vessels, inferior to the gluteal vessels and the ischiadic nerve since this region is more or less avascular (Fig. 70.15).

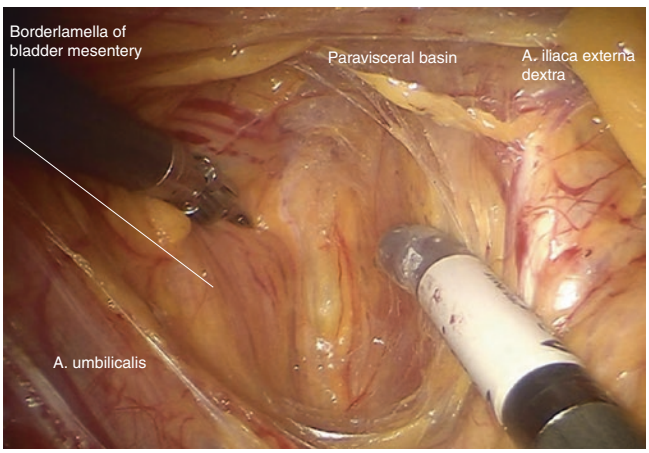


Fig. 70.16 Medial border of right pelvic paravisceral lymph compartment

Step 5

Medial exposition of external and paravisceral lymph basin on the right. Medial border is represented by the bladder mesentery containing the umbilical artery. The avascular space beween the border lamella and the lymphatic compartment will be opened again down to the endopelvic fascia (Fig. 70.16). Now the caudal resection of external iliac nodes is defined and the compartment border is detached in the avascular space separating it from the parainguinal fat tissue ventrally to the iliac vessels. At this level the inferior epigastric and the circumflex iliac vessels can be visualized (Fig. 70.17). The connecting lymph vessels of the medial femoral channel will be dissected and the connecting vein from external iliac to obturator vein can easily be followed to the obturator nerve and vessels.

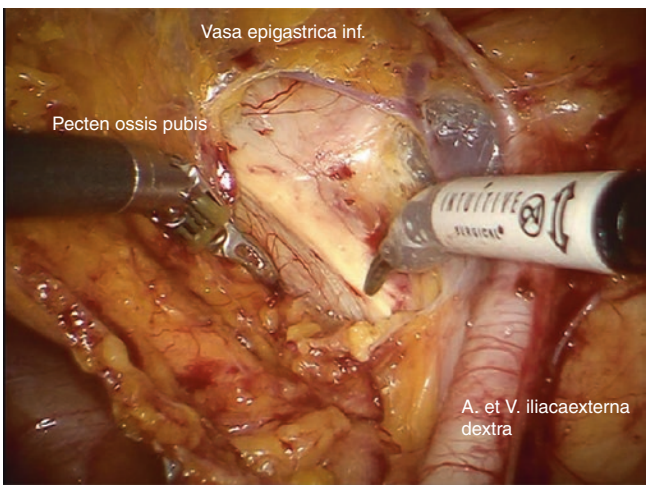


Fig. 70.17 Caudal border of right pelvic external iliac lymph compartment

Step 6

Resection of external and paravisceral lymph basin "en bloc".

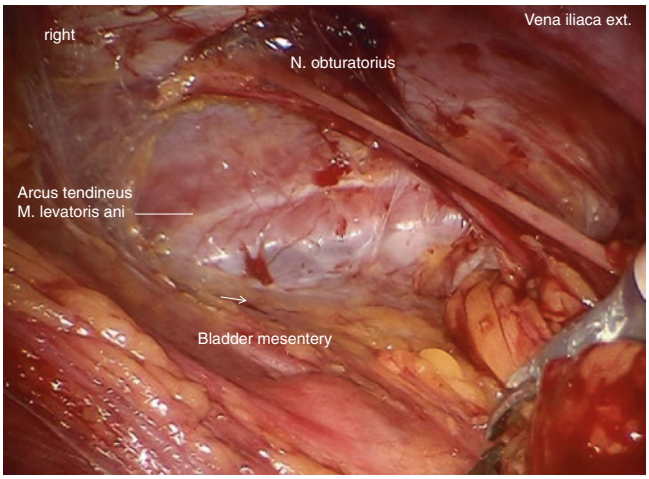


Fig. 70.18 Caudal part of right paravisceral lymph compartment removed

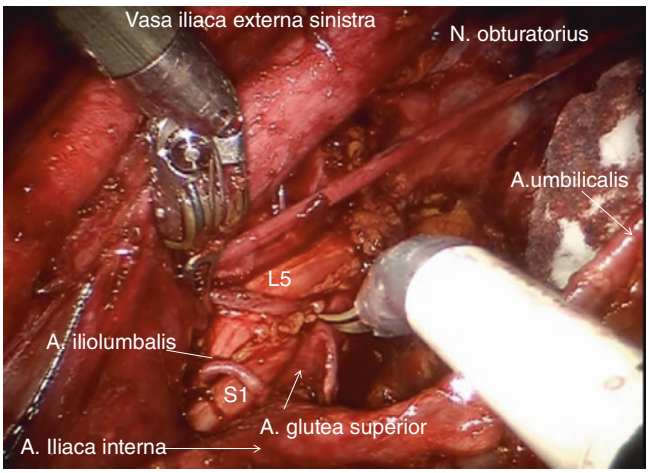


Fig. 70.19 Cranial part of left paravisceral lymph compartment removed (**a**)

To unwrap the external iliac vessels lymphatic tissue of the medial and lateral part is divided best along external iliac artery. Pulling the nodal tissue medially it may be detached from the iliac vein and the obturator bundle is exposed. Due to the prior lateral detachment, the whole tissue can now be detached completely from the obturator bundle and the obturator fossa from caudally to cranially reaching the posterior internal iliac region laterally and the anterior branches ventrally. At this level, all the lymphatic tissue up to the dissection border of common iliac nodes can now be retrieved from medially (Fig. 70.18).

Step 7

Resection of upper posterior paravisceral lymph basin preischiadically.

Whereas the prespinal nodes are already resected with the obturator nodes it is more challenging to remove all the preischiadic nodes between the gluteal and pudendal vessels. If necessary veins can be dissected but arteries normally can be preserved. The tissue has to be removed and the sacral roots and main stem of ischiadic nerve are cleaned (Figs. 70.19 and 70.20, shown on the left).

Steps 8–11 on the Left Side Are as Described for Step 4–7 on the Right

The surgical steps on the left side will be identically performed as desrcibed for the right.

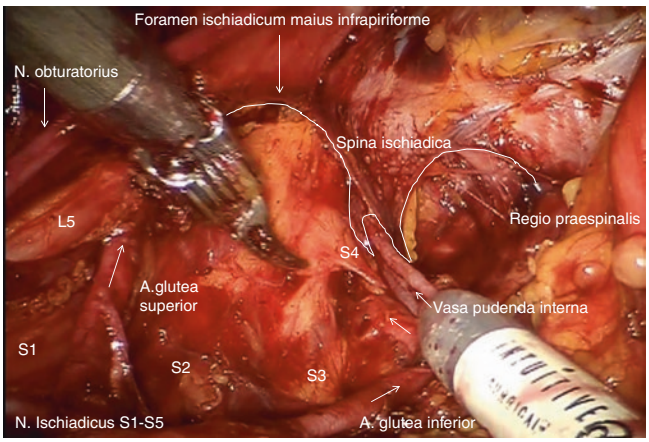


Fig. 70.20 Cranial part of left paravisceral lymph compartment removed (**b**)

Therapeutic Paraaortic Lymphadenectomy: Step by Step

There are two different types of paraaortic lymphadenectomy; with or without mesonephric lymph system along the ovarian vessels; this has to be removed additionally in endometrial and ovarian cancer, whereas in cervical cancer it will be not necessary.

Trocar Placement

With respect to trocar placement it is important to define preoperatively to define at which level nodes have to be removed, predominantly using a “da Vinci Si″ system. The

camera trocar has to be placed about 8–10 cm more cranially as the most cranial point of planned dissection and the instrument trocars have to be placed more cranially but in the same configuration as in demonstrated in Fig. 70.21. If this is not possible, trocars have to be placed around the umbilicus (mostly a little bit lower) and the patient cart has to be re-docked to reach the higher abdominal regions. Using the "da Vinci Xi" system this is no longer mandatory; placing the trocars at the level of the umbilicus in one straight line the whole abdomen is accessible without re-docking, facilitating the procedure in the cranial part and allowing easily to extent the surgery to the upper abdomen, if necessary.

Differences of Paraaortic Lymphatic Drainage in Cervical and Endometrial Cancer

Again to keep in mind: In endometrial cancer lymph drainage primary lymph basins are pelvic and paraaortic and have to be removed entirely since lymphatic drainage follows the vascular mesometrium and the infundibulopelvic ligament. Thus, whereas in cervical cancer, paraaortic lymph basins are of third or higher order postponed to pelvic basins and may be spared in case of negative pelvic nodes, in endometrial cancer paraaortic nodes are of first order. That means the compartment at high risk for nodal metastases comparable to the pelvic lymph compartments.

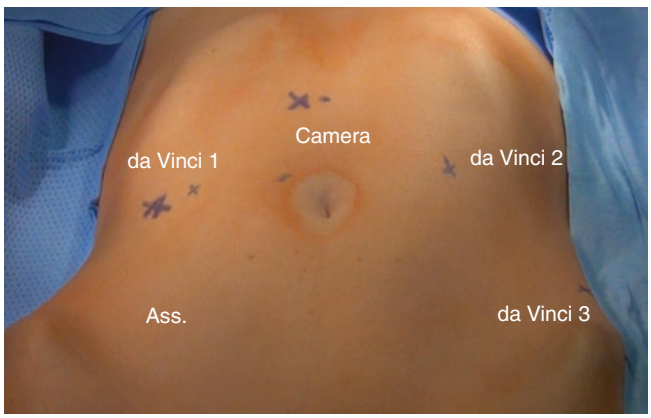


Fig. 70.21 Trocar postitioning for robotic TMMR and therapeutic pelvic LNE

Consequently, in the therapeutic approach – analogous to cervical cancer – in endometrial cancer together with the vascular mesometrium also the network for vascular and lymphatic anastomoses between uterus and adnexa has to be removed, at best covered by the peritoneal leaves of the broad ligament (PMMR). The vascular and lymphatic drainage system along the ovarian vessels has also to be removed in analogy to the vascular mesometrium up to its connection to the periaortic and pericaval lymph basins. Whereas the vascular anastomoses to the mesenteric vessel system (right and left colon) are dissected the connections to the periaortic lymph basins are preserved and removed together "en bloc." Since there is no drainage from uterine corpus to the ligamentous mesometrium the deep gluteal, pudendal, and rectal nodes may be preserved. As already outlined lymphatic tumor spread in endometrial cancer will take place predominantly in the ventral part of lymph compartment such as the mesenteric paraaortic and paracaval nodes, due to embryologically derived anatomy.

Table 70.1 illustrates lymph compartments to be removed in cervical and endometrial cancer.

Step 12

In case of cervical cancer inframesenteric periaortic lymphadenectomy may be performed following elevation of the superior hypogastric plexus (Fig. 70.22), the inferior mesenteric artery, and the sigmoid colon ventrally, thus continuing lymphadenectomy from common iliac vessels (Figs. 70.13 and 70.23). It has to be ascertained to remove the interaortocaval nodes (Fig. 70.24) and the lumbar chains dorsolaterally of vena cava (Fig. 70.25) and aorta; the connecting branches from right sympathetic chain to the superior hypogastric plexus may be maintained (Fig. 70.26).

Step 13

For infrarenal lymphadenectomy dissection has to be extended cranially to the renal vessels. In principle, retroperitoneal compartments will be exposed by defining right lateral border (ureter and psoas muscle), cranial border (renal veins, detaching duodenum). The ventral border by elevating

Table 70.1 Common and different steps in therapeutic lymphadenectomy in cervical and endometrial cancer

	External iliac and paravisceral nodes	preischiadic and prespinal nodes	Common iliac nodes	Subaortic/ presacral nodes	Inframesenteric paraaortic nodes	infrarenal paraaortic nodes
TMMR and therapeutic LNE	Yes	Yes	Yes	Yes	No, only if common iliac nodes are positive	No, only if im paraarotic nodes are positive
PMMR and therapeutic LNE	Yes	No	Yes	Yes	Yes	Yes

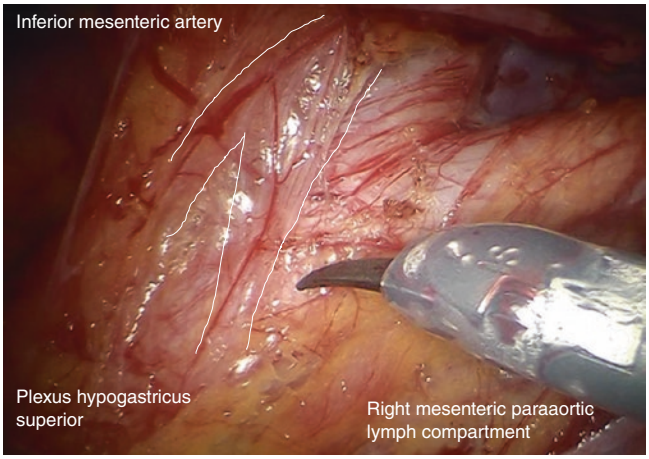


Fig. 70.22 Plexus hypogastricus superior crossing Aorta inframesenterically

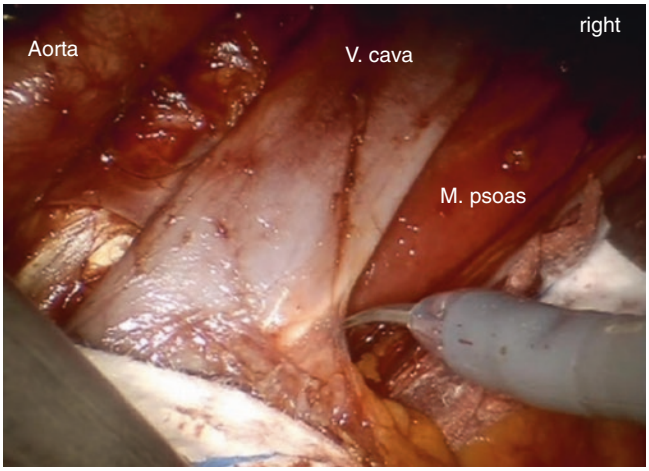


Fig. 70.25 Removal of infrarenal paracaval lumbar lymph compartment on the right

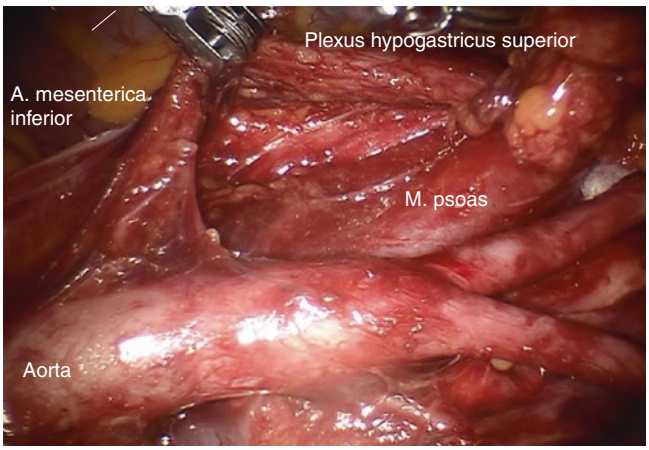


Fig. 70.23 Inframesenteric paraaortic lymph mesenteric and lumbar lymph compartment removed

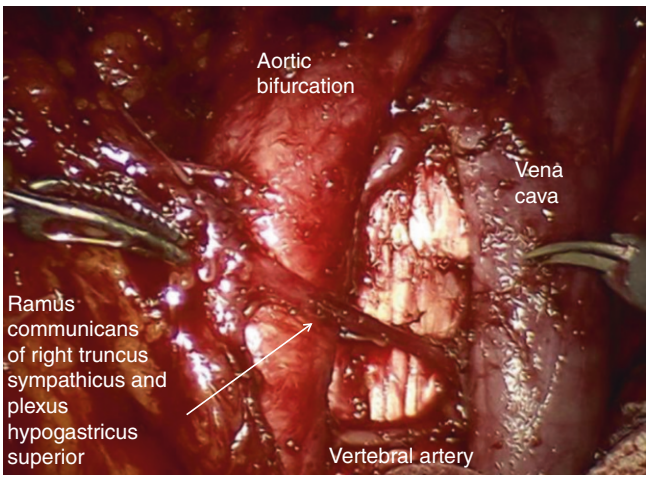


Fig. 70.26 Removal of mesenteric interaortocaval lumbar lymph compartment

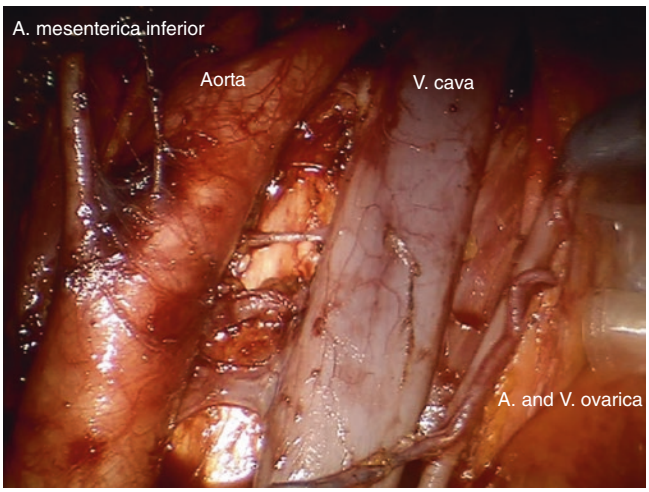


Fig. 70.24 Infrarenal interaortocaval mesenteric and lumbar lymph compartment removed

the plexus mesentericus inferior and hypogastricus superior together with inferior mesenteric artery and vein. Usually, connecting nerve branches to the right sympathetic chain (Fig. 70.26) have now to be dissected to allow ventral elevation of the plexus. Finally, left lateral border will be defined by the ovarian vein, ureter and psoas muscle; now interaortocaval infrarenal nodes and left infrarenal nodes can be removed; connecting nerve fibres to the left sympathetic chain may be preserved (Fig. 70.27).

Step 14

Complete resection of paraaortic infrarenal lumbar and mesenteric lymph compartments from right to left is now completed (Fig. 70.28) in cervical cancer without the need of resecting the mesonephric ovarian vessel system.

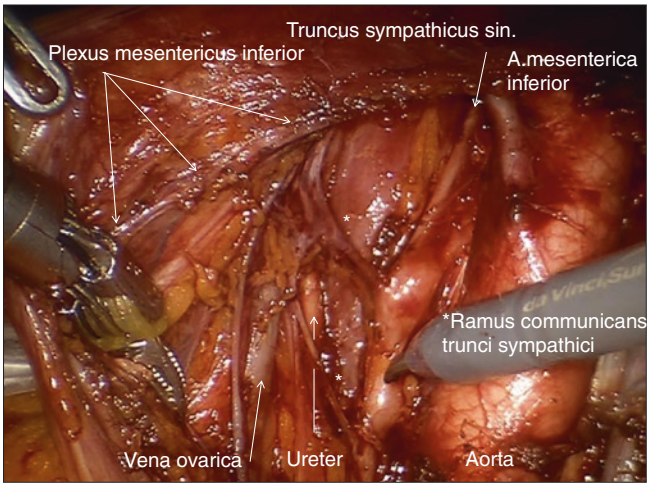


Fig. 70.27 Removal of left infrarenal paraaortic lumbar lymph compartment

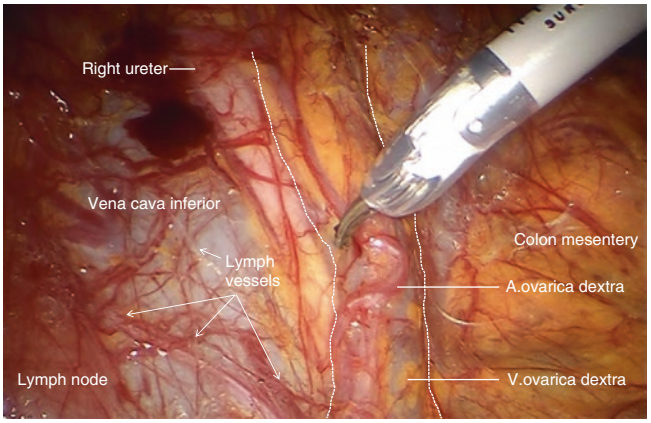


Fig. 70.29 Identification of right infundibulopelvic ligament, ureter and right colon mesentery

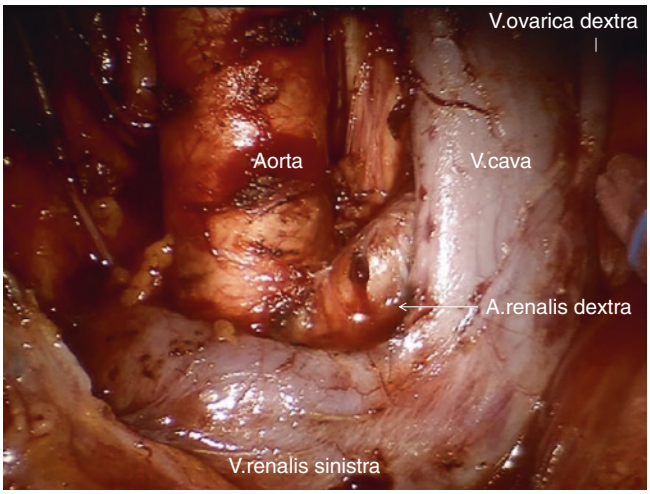


Fig. 70.28 Removal of left infrarenal mesenteric and lumbar lymph compartment (renal angle)

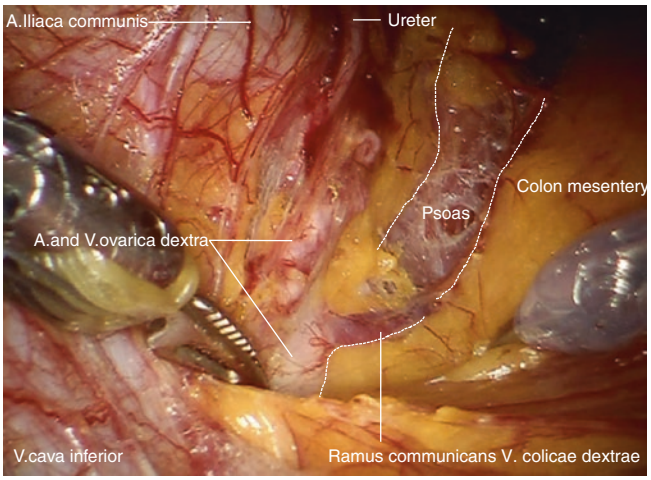


Fig. 70.30 Separation of right infundibulopelvic ligament from right colon mesentery

Step 15 in Endometrial and Ovarian Cancer (Instead of Steps 12–14)

In case of endometrial or ovarian cancer the infundibulopelvic ligaments have to be resected first; aorta, vena cava, the right ureter, and the right infundibulopelvic ligament are identified (Fig. 70.29). Mobilization of the right colic mesentery allows to identify vessel anastomoses to the ovarian vessel system and can be divided (Fig. 70.30). Following the ovarian vein the lateral border of the ovarian lymphovascular drainage bundle can be mobilized until the caval vein is reached (Fig. 70.31). Thus all anastomoses to the periaortic lymph basin will be kept intact. The duodenum usually is loosely attached to the preaortic region and has to be mobilized.

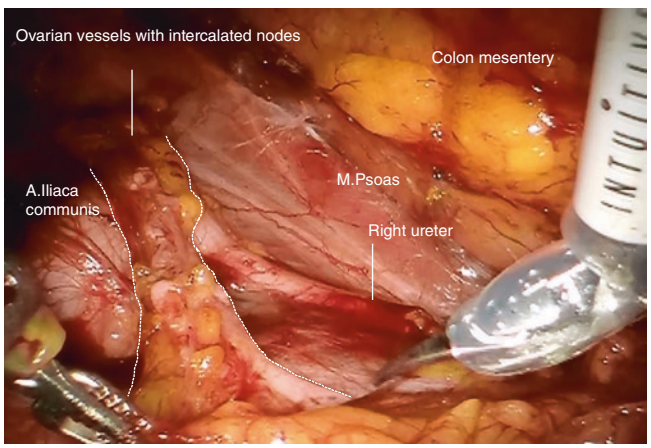


Fig. 70.31 Separation of ovarian vessel system from mesocolon, psoas muscle, ureter and caval vein

Step 16

The right ovarian vein is dissected at the level of caval vein and dissected (Fig. 70.32a). The lymphatic downstream channels may be dissected cranially along the right renal vein and dorsally to the right paracaval region to expose the back bone. The mobilized right lymphatic paraaortic compartment may now be pulled to the left, and the interaortocaval region will be exposed. The vertebral vessels will identified and and detached from lymphatic tissue as it is the case with the caval vein. Care has to be taken to remove the lumbar lymph node chain running dorsolaterally draining from deep right pelvis, which is not directly connected to the ventral chain of the mesenteric compartment. The right ovarian artery will be exposed, coagulated and divided (Fig. 70.32b). The left renal vein will be followed from its caval angle to lateral, and again the lymph channels will be dissected along the left renal vein until the left ovarian vein can be identified. The nerve fibres of the inferior mesenteric plexus are crossing ventrally, should be elevated and preserved (Fig. 70.33). The left ovarian vein is coagulated, and cut ((Fig. 70.32c). Now moving downward using the ovarian vein as lateral border and the aorta as medial border for mobilization and resection of left periaortic lymphatic basin left ovarian artery will be identified approximately at the level of right ovarian artery, coagulated, and cut (Fig. 70.32d). As described in the Chapter PMMR, the mesonephric vessel system will be removed together with the adjacent paraaortic lymph nodes.

Most important, in therapeutic lymphadenectomy, is to keep the surgical field dry to be able to safely remove the entire compartment. Although, there are plenty of vessels, which may be injured, normally it is no problem to perform surgery in a way that the vessels are kept intact or coagulated before dissected. To prevent problems prophylactically, sponges should be used instead of suction/irrigation since those are not at risk to cause additional injury and keep the field try; in addition, in venous bleeding compression with a sponge for some minutes may be very effective in controlling bleeding from smaller vessels; in larger venous lesions the application of a hemostatic patch such as Tachosil® instead of a suture is most efficient in our hands. In arterial lesions, however, a suture using 4-0 to 5-0 monofilamental unresorbable material is usually the best way to control the bleeding following clamping the proximal and distal part of the vessel transiently for endoscopic suture. Most bleedings may be managed endoscopically; prevention of any bleeding, however, is the safest way, to avoid further complications. Specifically for robotic surgery: don't risk bleeding

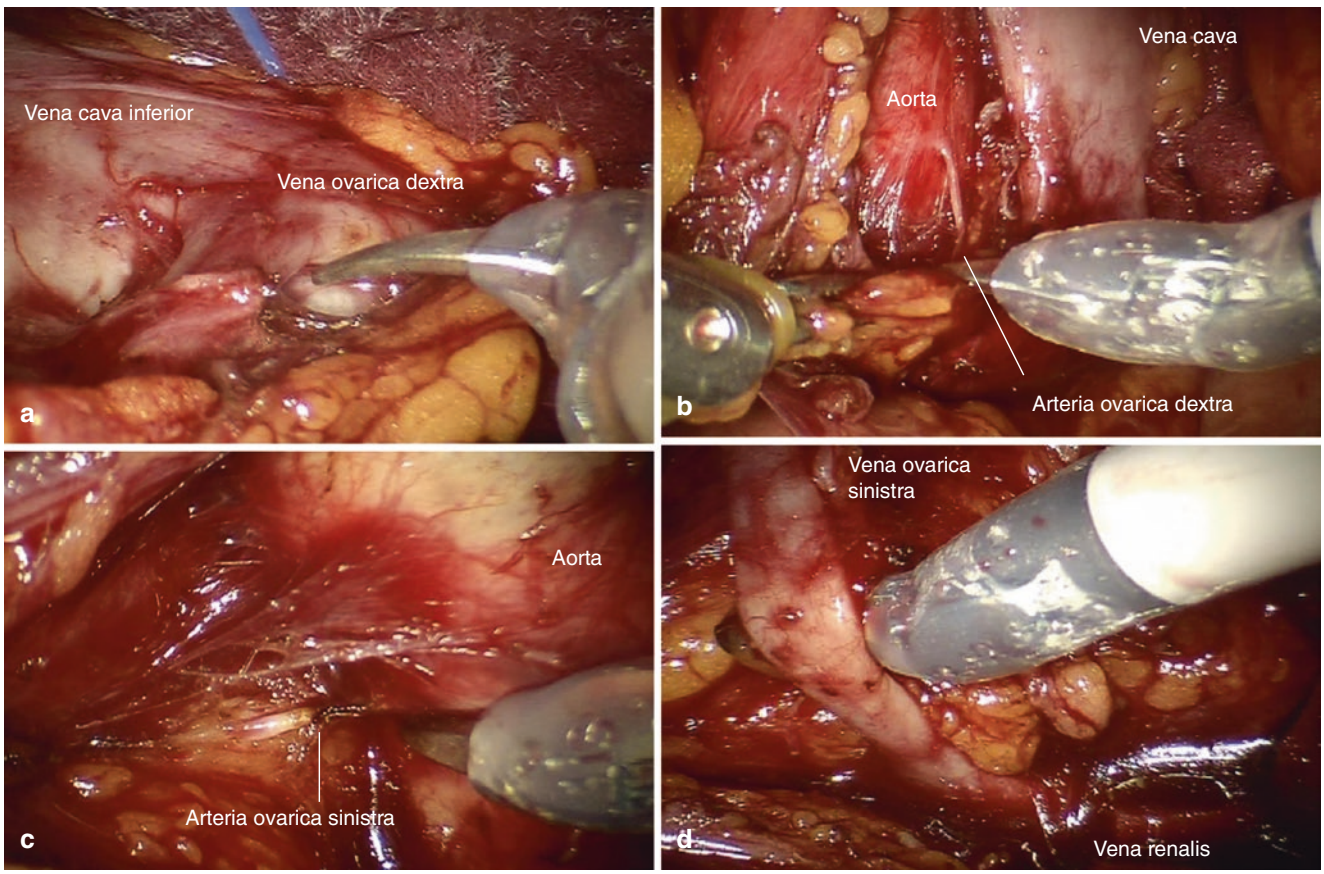


Fig. 70.32 Dissection of ovarian veins and arteries from caval and renal veins and aorta

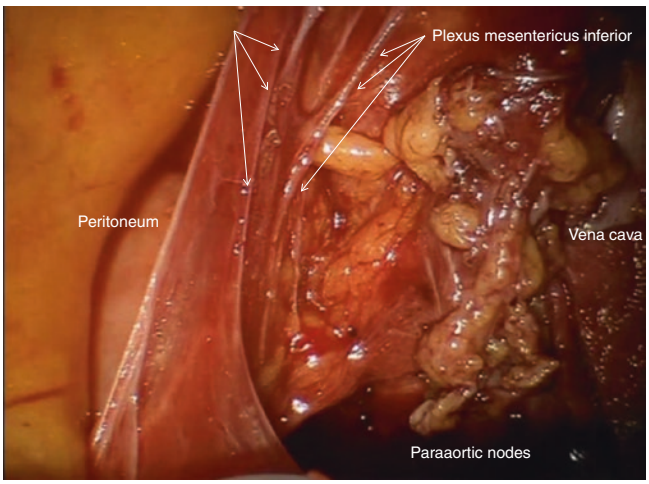


Fig. 70.33 Inferior mesenteric plexus in preparation at the infrarenal level

when you are close to the border of range of motion with your instruments! This will primarily be true using the "da Vinci SI" instead of the "da Vinci Xi".

In summary, therapeutic lymphadenectomy in cervical cancer consists of: external iliac, paravisceral, common iliac and subaortic lymph compartments. In case of positive nodes additionally the inframesenteric lumbar and mesenteric lymph compartments and if also involved the infrarenal lumbar and mesenteric lymph compartments. In endometrial and ovarian cancer all the compartments correspond to primary sites but the preischiadic and prespinal nodes of the paravisceral compartment may be spared since they will not be involved in the drainage of these subcompartments as long as lymphatic valves are intact. However, additionally, the mesonephric ovarian vascular and lymph vessel system has to be removed.

References

1. Wolpert L. Positional information and spatial pattern of cellular differentiation. J Theor Biol. 1969;25:1–47.
2. Garcia-Bellido A, Ripoll P, Morata G. Developmental compartmentalization of the wing disk of Drosophila. Nature. 1973;245:251–3.
3. Dahmann C, Oates AC, Brand M. Boundary formation and maintenance in tissue development. Nat Rev Genet. 2011;12:43–55.
4. Höckel M. Morphogenetic fields of embryonic development in locoregional cancer spread. Lancet Oncol. 2015;16(3):e148–51. doi:10.1016/S1470-2045(14)71028-9.
5. Heald RJ, Rayan DRH. Recurrence and survival after total mesorectal excision for rectal cancer. Lancet. 1986;327:1479–82.
6. Weaver KL, Grimm Jr LM, Fleshman JW. Changing the way we manage rectal cancer-standardizing TME from open to robotic (including laparoscopic). Clin Colon Rectal Surg. 2015;28(1):28–37. doi:10.1055/s-0035-1545067.
7. Höckel M, Horn L-C, Manthey N, Braumann U-D, Wolf U, Teichmann G, Frauenschläger K, Dornhöfer N, Einenkel J. Resection of the embryologically defined uterovaginal (Müllerian) compartment and pelvic control in patients with cervical cancer: a prospective analysis. Lancet Oncol. 2009;10:683–92.
8. Höckel M, Horn LC, Tetsch E, Einenkel J. Pattern anlaysis of regional spread and therapeutic lymph node dissection in cervical cancer based on ontogenetic anatomy. Gynecol Oncol. 2012;125:168–74.
9. Kimmig R, Wimberger P, Buderath P, Aktas B, Iannaccone A, Heubner M. Definition of compartment-based radical surgery in uterine cancer: radical hysterectomy in cervical cancer as 'total mesometrial resection (TMMR)' by Michael Höckel translated to robotic surgery (rTMMR). World J Surg Oncol. 2013;11(1):211.
10. Kimmig R, Aktas B, Buderath P, Wimberger P, Iannaccone A, Heubner M. Definition of compartment-based radical surgery in uterine cancer: modified radical hysterectomy in intermediate/high-risk endometrial cancer using peritoneal mesometrial resection (PMMR) by M Höckel translated to robotic surgery. World J Surg Oncol. 2013;11(1):–198.
11. Kimmig R, Iannaccone A, Buderath P, Aktas B, Wimberger P, Heubner M. Definition of compartment based radical surgery in uterine cancer-part I: therapeutic pelvic and periaortic lymphadenectomy by Michael Höckel translated to robotic surgery. ISRN Obstet Gynecol. 2013;2013:297921. doi:10.1155/2013/297921.
12. Kimmig R, Aktas B, Buderath P, Rusch P, Heubner M. Lymphatic network visualized by Indocyanine-green (ICG) as *in vivo* marker for embryologically derived organ compartments and their drainage in uterine cancer surgery. J Surg Oncol. 2016;113(5):554-9. doi: 10.1002/jso.24174.
13. Kimmig R. Diagnostische und therapeutische Lymphonodektomie, Kap. 8, S. 97–108; Totale mesometriale Resektion nach Höckel, Kap. 12, S. 119–128 und Fertilitätserhaltende mesometriale Resektion", Kap. 13, S. 129–136. In: Wagner U, Hofmann R, Bartsch DK, Boekhoff J, Hrsg. Operationsatlas Gynäkologische Onkologie. Springer verlag; 2013, Berlin, Heidelberg. ISBN 978–3–642-35127-3.
14. Kimmig R. Compartment based surgery: the TMMR, FMMR and PMMR family in uterine cancer. In: Kilic SG, Ertan K, Kose FM, editors. Robotic surgery: practical examples in gynecology, Chapter 23. Berlin/Boston: de Gruyter Verlag; 2013. p. 287–318. ISBN 3110306557.
15. Kimmig R. Innovationen in der operativen Therapie von Genitalkarzinomen. Gynakologe. 2014;12:932–41.
16. Kimmig R, Aktas B, Heubner M. Endometriumkarzinom – operative Strategie und Adjuvanz. Gynakologe. 2013;46:339–44.
17. Kimmig R.. Robotic surgery for cervical cancer. Endoscopic total mesometrial resection and therapeutic lymphonodectomy [Robotic Surgery beim Zervixkarzinom. Endoskopische totale mesometriale Resektion und therapeutische Lymphonodektomie]. Gynakologe. 2012;45:707–711, (German).
18. Ribatti D, Crivellato E. The embryonic origins of lymphatic vessels: an historical review. Br J Haematol. 2010;149:669–74.
19. Yang Y, Oliver G. Development of the mammalian lymphatic vasculature. J Clin Invest. 2015;124:888–97.
20. Höckel M. Cancer permeates locally within ontogenetic compartments: clinical evidence and implications for cancer surgery. Future Oncol. 2012;8(1):29–36. doi:10.2217/fon.11.128.

Robot Assisted Laparoscopic Fertility Sparing Radical Trachelectomy

71

Jan Persson

Introduction

In 1994 Daniel Dargent described vaginal radical trachelectomy in conjunction with laparoscopic pelvic lymphadenectomy to preserve fertility in women with early stage cervical cancer [1]. A trachelectomy can also be performed abdominally either as an open procedure or by laparoscopy. The latter approach has not gained any popularity, probably due to its complexity [2–5]. Robot assisted laparoscopic trachelectomy was first described in 2008 and may help overcome some of the surgical difficulties associated with traditional laparoscopy [6]. More than 900 cases of fertility sparing trachelectomy have been published, of those 760 with the laparoscopic/vaginal approach [7]. The procedure is considered as safe as a radical hysterectomy, with a recurrence rate of less than 5 % and a mortality of less than 3 % given strict selection criteria [7–13].

As a rule, only well informed women with a wish for preserved fertility and no previous history of infertility are candidates for fertility sparing trachelectomy. Selection criteria include cervical squamous or adenosquamous epithelial cancers from stage IAI (with lymphovascular space invasion) to stage 1B1 ≤2 cm. A more restrictive policy is advocated in case of adenocarcinomas and in particular in case of rare high risk histologies such as clear cell or neuroendocrine cancers. The tumor should be possible to resect with sufficient margins still leaving an adequate length of the remaining cervix which may disqualify women with previous large cone biopsies from being candidates for trachelectomy. If applying the aforementioned criteria, around 45 % of women younger than 40 years and with operable cervical cancer are estimated as potential candidates for fertility sparing surgery [8]. As age at first childbirth is increasing in many countries the proportion of women being candidates for trachelectomy will most likely increase further over time.

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Surprisingly, and despite the use of recommended fecundity criteria as above, Ramirez et al. report that only 43 % of women attempt to get pregnant following a trachelectomy. A 70 % pregnancy rate is reported among those with an active wish to conceive [7, 8, 14–17].

There are no studies evaluating the risk of premature birth related to the remaining cervical length but it is generally believed that the remaining cervix should be at least 10 mm to avoid a too high prematurity rate. The use of a permanent cervical cerclage may compensate for a short cervical length but may cause problems in case of a late spontaneous abortion. A cerclage placed to distally may erode to the vaginal and cause a foreign body reaction usually necessitating removal in particular if multifilament materials are used for the cerclage. The association between cervical stenosis and cervical cerclage is however unclear.

Due to the importance of radical resection and still an adequate remaining cervix, it is cruzial that the surgical approach is reproducible, allows an exact resection level and an optimal placement of the cervical cerclage.

So far, the da manufacturer of the da Vinci robot (da Vinci ® Surgical System, Intuitive Surgical Inc, CA, USA) has so far launched four different robot systems (DaVinci standard, S, Si and Xi systems) all four providing instruments with a wrist function at the tip, movement downgrading, tremor elimination, a stable 3-dimension view of the operative field and an ergonomic working position. These features may help the surgeon overcome some of the limitations associated with traditional laparoscopic surgery. As most women candidates for radical trachelectomy are nulliparous vaginal access may be restricted. Therefore a radical vaginal trachelectomy may be difficult to perform in a standardized manner and times between procedures may be long making surgical training for this particular approach insufficient. In a setting where robot assisted surgery is frequently used for other advanced gyneoncological procedures a robot assisted laparoscopic abdominal approach for the trachelectomy seems reproducible and accurate and experience from other advanced procedures helpful [18–21].

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Patient Selection and Preoperative Assessment

A careful selection is mandatory to achieve the desired oncological and fertility outcome and includes women with a desire to preserve fertility and with beneficial tumor characteristics. It is important that the woman and her partner are well informed about preoperative examinations, situations in which a planned trachelectomy concept may have to be abandoned (i.e. metastatic lymph nodes or inadequate surgical margins) as well as alternative treatment in such situations. It is also important to discuss the risk of premature delivery. The cervical cancer should have diameter less than two cm (FIGO stage IAI with LVSI, IA2, IBI), preferably squamous cell cancers. IBI cancers requires a beneficial localization in the distal part of the cervix and with tumor invasion less than half the cervical stroma. A more restrictive attitude should be advocated in case of adenocarcinomas. Patients with clear cell and neuroendocrine cancers should not primarily be candidates for fertility sparing surgery. Therefore a review by an expert gynecological pathologist with focus on the histological subtype, lymphovascular space invasion, depth of invasion and in case of a cone biopsy the proximal and distal tumor margins is important. To evaluate the tumor diameter, the degree of stromal invasion against outer cervical margins and to evaluate the possibility to achieve adequate negative surgical margins a MRI is recommended. A CT scan of the thorax and abdomen should be performed to rule out disseminated disease. It is also strongly recommended that the surgeon him/herself estimates the length of the whole cervix with the use of high resolution vaginal ultrasonography to ensure both the possibility of adequate surgical margins and ideally 10 mm remaining cervix after a completed trachelectomy. A preoperative evaluation of the cervix is particularly important after a previous cone biopsy. A colposcopy is recommended to rule out cancer spread or severe dysplasia in the vagina.

Intraoperative Assessment

A radical trachelectomy may be performed in two separate sessions, an initial lymphadenectomy, and if lymph nodes are free from metastases at final histology, the trachelectomy in a second session. From a logistic and patients' perspective this approach is not ideal. Given appropriate selection, women planned for fertility sparing trachelectomy have a low risk for lymph node metastases. The sentinel lymph node concept allows an intraoperative detection of the nodes with the highest risk for metastases and a reversal of the fertility sparing approach if nodes are found metastatic at frozen section. It is still under debate whether it is safe to remove the sentinel nodes only but if used in tumors less than two cm the sentinel node technique has shown a high sensitivity and low false negative detection rate [22].

The transsection level of the cervix is cruzial. On one hand, the remaining cervix should be at least 10 mm to minimize premature childbirth and on the other hand, the tumor should be removed with adequate proximal (and distal) surgical margins to ensure safe oncological outcome without need for adjuvant treatment. The importance of the preoperative workout and surgeons' experience cannot be overestimated. It is recommended that the trachelectomy specimen and in some cases also a separate proximal disc of the remaining cervix are evaluated as frozen section as well as a being subject for an elaborate final histological workout. Finally, during surgery it is important also to investigate for and describe the presence and extent of possible factors that may impair fertility, i.e endometriosis, tubal pathology and pelvic adhesions, for proper postoperative fertility guidance and to avoid a delayed instigation of necessary assisted reproduction measures.

Surgical Technique

All models of the da Vinci robots can be used but we recommend a da Vinci Si or Xi system adapted for the near infrared fluorescent technique with the use of Indocyanine green as detecting dye. Ports should be placed for standard pelvic surgery as recommended for the respective systems. The Si robot may be docked centrally or side docked at surgeons' discretion whereas the Xi robot usually is docked 90° from the side. Suitable robot instruments are; a monopolar scissors, a bipolar forceps, a grasper and a needle holder. For the assistant one 10–12 mm trocar is needed for suction/ irrigation, insertion of sponges and loops and for retrieval of lymph nodes. We recommend to always use a nodal retrieval bag. For identification of the vaginal fornices a vaginal tube or another type of fornix presenter without an intracervical part is placed at onset of surgery.

The operation may be divided into three steps; the pelvic lymphadenectomy with detection of sentinel lymph nodes, the radical trachelectomy including dissection and lateralization of the ureters pelvic hypogastric nerve fibres and the reconstructive part including readaptation of the vagina to the remaining cervix and placement of a permanent cerclage. To avoid time loss during waiting for frozen section, it is important to perform the different steps in a correct order depending on local logistics for frozen section.

For detection of sentinel lymph nodes we inject a total of one mL Indocyanine green (diluted to 2.5 mg/mL in sterile water) slowly submucosally at 2-4-8-10 o'clock in the cervix immediately before docking the robot.

The identification of nodes starts with a careful development of the pararectal and paravesical spaces during which

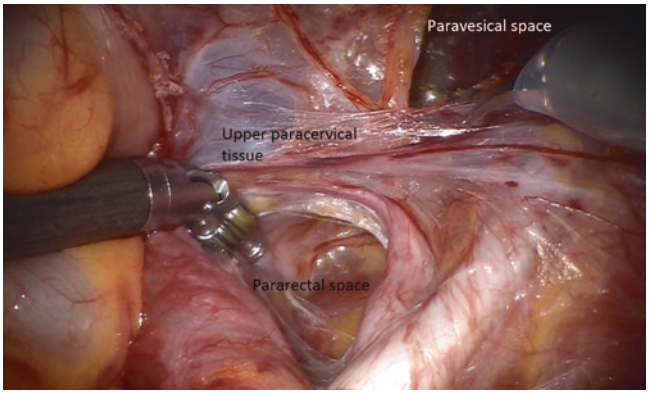


Fig. 71.1 The upper paracervical tissue is kept intact by opening the avascular paravesical and pararectal spaces

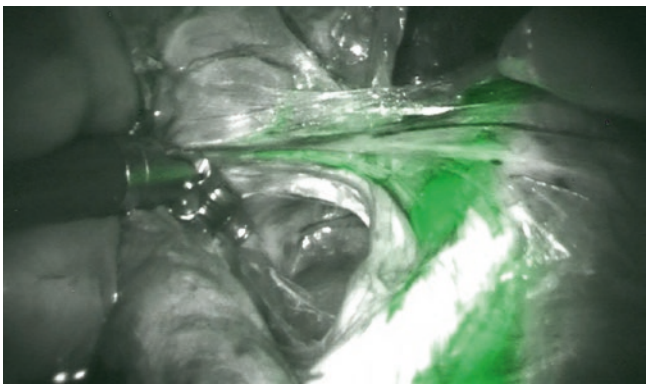


Fig. 71.2 Lymphatic vessels and a sentinel lymph node appears green with the use of the near infrared fluorescent technique and indocyanine green injected into the cervix

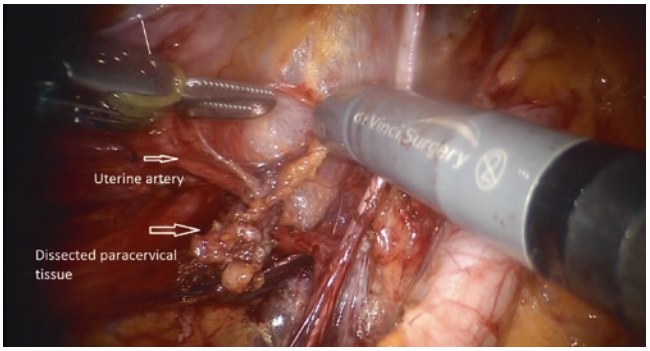


Fig. 71.3 The upper paracervical tissue is removed separately sparing the uterine artery

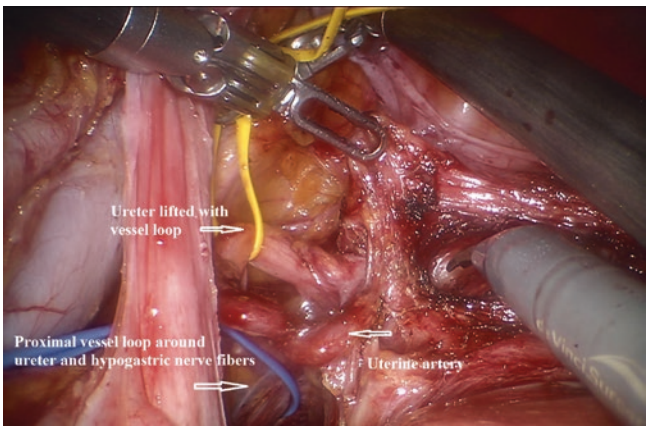


Fig. 71.4 Vessel loop placed around the ureter distal of the uterine artery

it is important to leave the upper paracervical tissue and lymph vessels intact to avoid spillage of dye and to enable a detection of individual lymph vessels (Fig. 71.1). The sentinel nodes are removed separately and sent for frozen section along with any clinically suspect nodes (Fig. 71.2). In case of a no uptake of Indocyanine green a full pelvic lymphadenectoomy has to be performed at the respective pelvic side wall and in this situation it is particularly important to look for macroscopically suspicious nodes for analyse during surgery. Awaiting frozen section results, the common iliac nodes are removed bilaterally. This is most easily done by opening the peritoneum along the medial part of the right common iliac artery to the level of the aortic bifurcation and on the left side by lifting the sigmoid colon together with the ureter and infundibulopelvic ligament with the fourth robot arm to get full access to the nodes. Local treatment protocol and the histology and size of the cervical cancer decide whether removal of the sentinel nodes only should be considered safe or if the frozen section results should be used only for tailoring of the further lymphadenecomy and abortion of the trachelectomy concept if sentinel lymph nodes are metastatic. After the remaining pelvic lymphadenectomy (if so required) the uterine arteries are identified together with the upper paracervical tissue. The ureters are then dissected and visualized also at the ventral and distal side of the uterine arteries to enable a careful removal of the upper paracervical tissue sparing the uterine arteries and visualizing the descending uterine artery (Fig. 71.3). Vessel loops are placed around the ureter distal of the uterine artery to facilitate later dissection of the lower paracervical tissue and bladder pillar (Fig. 71.4).

The posterior dissection starts with a further dissection of the pararectal space to identify the hypogastric nerves. The medial broad ligament is then opened and by developing the Okabayashi space the lateral nervous part of the sacrouterine ligament is separated from the medial fibrous part (Fig. 71.5). Vessel loops are then placed around the ureter and the nervous part of the ligament for retraction and to help identification of the hypogastric nerve fibers during further dissection (Fig. 71.6). The rectovaginal space is then opened to facilitate division of the fibrous parts of the sacrouterine ligaments at the desired level. Then the anterior peritoneum is opened (leaving the round ligaments intact) and a strict

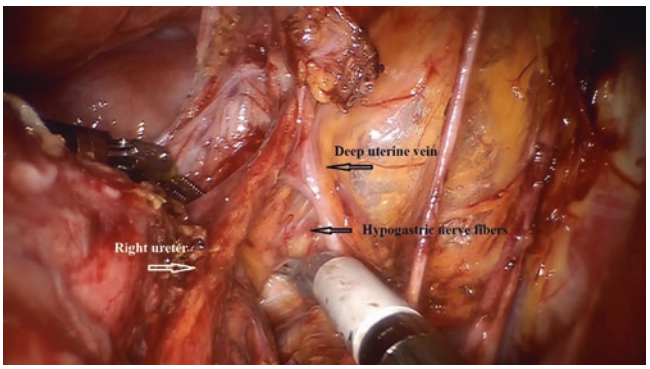


Fig. 71.5 The Okabayashi space is opened to separate the medial fibrous and lateral nervous parts of the sacrouterine ligament followed by lateralization of the ureter and nerves with a vessel loop (Jan Persson 2012)

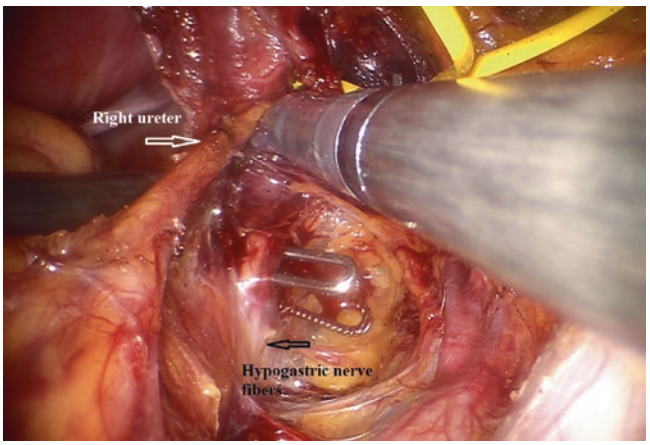


Fig. 71.6 Identification and dissection of the lower paracervical tissue and bladder pillar (left side)

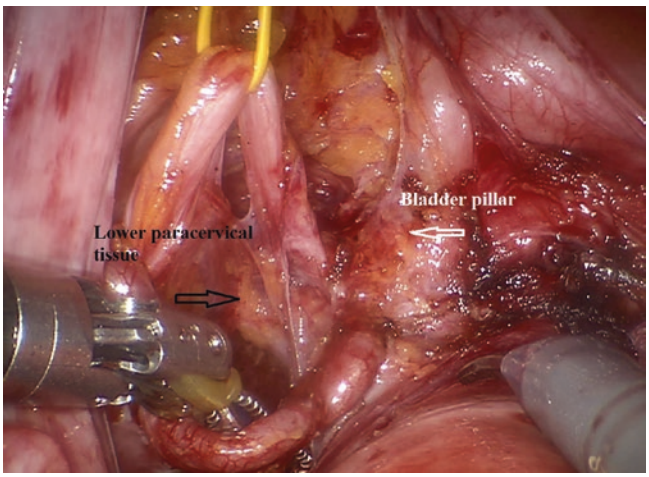


Fig. 71.7 The vaginal tube helps identification of the vaginal fornices and estimation of an appropriate length of the vagina

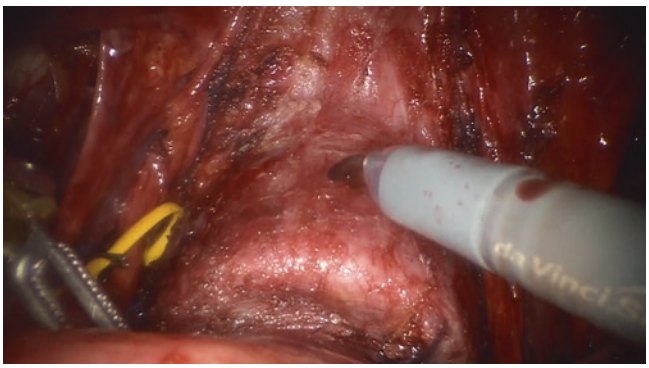


Fig. 71.8 The level of cervical transsection is dediced with help of the uterine contour after the vagina is opened

midline dissection of the bladder is performed to separate the bladder pillars for later division. Before the final lateral dissection the descending uterine arteries are identified and ligated twice on each side allowing to allow cutting in between them without blood loss. The further lateral dissection (lower paracervical tissue) and dissection of the bladder pillar is facilitated by the aid of the previously placed second vessel loop around the ureter distal of the intact uterine artery (Fig. 71.7). By the use of separate vessel loops around the hypogastric nerves and the distal ureters the bladder branches of the nerves may be identified and saved along their course in the lower paracervical tissue. Finally, the vagina is dissected distally approximately 1.5 cm further than the desired vaginal cuff specimen length to mobilize enough vaginal tissue for a sufficient reaattachment to the cervix (Fig. 71.8). With the preoperative vaginal ultrasonography and tumor localization in mind a careful planning of the cervical transsection level is important. The outer contour of the uterus as well as the level of the approaching main uterine branches is a good help for defining the level of the proximal uterine isthmus (Fig. 71.9). The vagina is opened at the desired level to facilitate the transsection of the cervix by visualization from the vaginal and abdominal side. The whole trachelectomy specimen is sent for frozen section to ensure negative margins. It is recommended to dye the proximal and distal edges of the specimen to simplify its orientation for the pathologist. Awaiting the final frozen section results the vagina is reattached to the remaining cervix with resorbable mattress sutures in order to cover most of the cut cervix but still leaving the new external orifice free. The suturing should start at the lateral corners of the vagina to ensure an even distribution of the opened larger vaginal circumference around the smaller cervix (Fig. 71.10). Finally, a permanent monofilament non resorbable cerclage (i.e 0 Prolene) is placed at the level of the inner os. The cerclage is placed medial of the uterine arteries. The tension of the cerclage suture is decided visually with the aid of a posterior sliding locking knot gradually tightened to achieve a slight induration of the tissue (Fig. 71.11). No intracervical device is

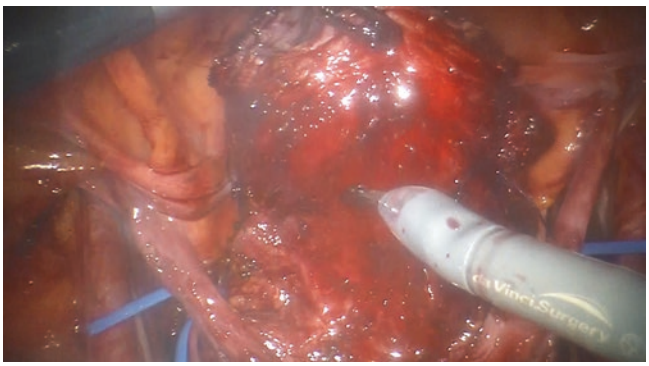


Fig. 71.9 The vagina is sutured to the remaning cervix starting at the lateral corners to ensure an even distribution of vagina anteriorly and posteriorly

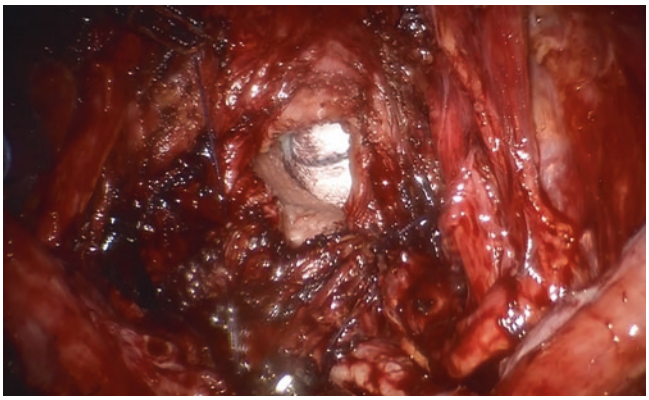


Fig. 71.10 A permanent monofilament suture is placed medial of the vessels at the level of the upper uterine isthmus

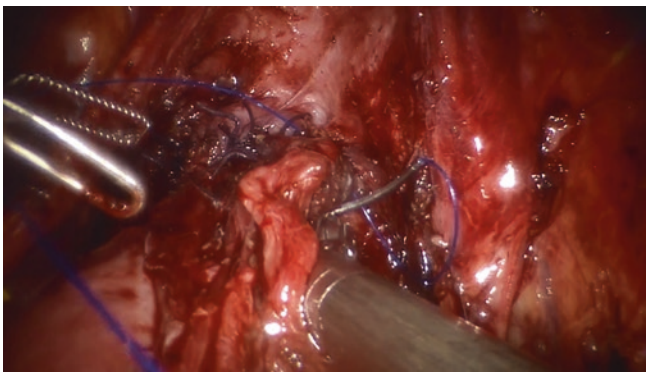


Fig. 71.11 Laparoscopic view three weeks after a robotic radical trachelectomy

necessary to secure patency of the cervical canal. A final check of the readapted uterus should be done.

If proximal margins are insufficient it may in selected cases be place for removal of an extra part of the cervix. If the margins are tumor involved a conversion to a radical hysterectomy is recommended, simply by releasing the vaginal/cervical sutures and cutting the round ligaments and by releasing the ovaries. The ovaries can then be tunnelled retroperitoneally and transpositioned in the paracolic gutters at desired level. Figure 71.11 shows a laparoscopic view of the pelvis three weeks after a robotic trachelectomy.

Postoperative Care and Follow Up

Postoperative surgical morbidity is low frequent after a vaginal or laparoscopic trachelectomy. Most side effects are due to the lymphadenectomy. An early onset moderate abdominal swelling or a proximal lymphedema of the vulvar area, labiae and inner thighs may be scaring for the patient but are usually self limiting. Postoperative urinary retention is rarely a problem but should be controlled. Bleeding from the cut cervix may occur similar to after a large cone biopsy. Fertility sparing trachelectomy is associated with cervical stenosis and rejection/exteriorization of the cervical cerclage. A cervical stenosis is associated with subsequent infertility and may hinder retrieval of intracervical cells for Pap-smear during follow up. Rejection of parts of the suture used for cervical cerclage is likely associated with a too distal placement of the suture. One study indicates that robotic trachelectomy, compared with vaginal trachelectomy, results in a cerclage placement closer to the inner cervical os, theoretically beneficial for reducing both the rate of cerclage erosion and the rate of preterm delivery [19].

No commonly used criteria for timing of pregnancy after surgery exist. It may be advisable to await a negative Pap-smear at first follow up 3 months after surgery. It is unclear whether antibiotic prophylaxis and general advise during pregnancy reduces the risk for prematurity. Some centers advocate the use of oral Metronidazol from gestational week 16 to 22, no sexual intercourse and in case of a strenuous work sick leave from week 22 + 0 and throughout the pregnancy.

All patients should be planned for a Cesarean delivery and informed to seek immediate help in case of premature uterine contractions. A particular problem with the permanent cervical cerclage is late first trimester or second trimester miscarriages necessitating a removal/ division of the cerclage to enable a complete transvaginal evacuation of the fetus and placenta without the need for a Sectio Parva. Cutting of the cerclage can be performed via a posterior culdotomy or laparoscopy and the cerclage may later be replaced laparoscopically. In general we discourage from the use of IUD as contraceptive due to a potentially increased risk for ascending infections.

Protocols for follow up usually advocate controls every 3–4 months the first 2 years, then every 6 months until 5 years after which the patient may be subject to routine controls or on an individual basis. It is important to harvest intracervical cells for Pap-smear. It should be indicated that the patient has

been subject to a trachelectomy as the cytological evaluation may be more difficult to interpret. A HPV test may add further information. A colposcopy and guided biopsies or cervical curettage should be performed in case of aberrant bleeding and a pathological Pap-smear. It is however common with aberrant vaginal bleedings in particular the first 6–12 months due to exteriorization of intracervical mucosa. As quality control, a vaginal ultrasonography can be performed to evaluate the length of the remaining cervix, the placement of the cerclage and to rule out retention of menstrual blood in the uterus as a sign of a cervical stenosis. MRI or PET-CT investigations should be performed if clinically indicated.

Some patients ask for a post trachelectomy hysterectomy after finalizing childbirth. This may be performed after proper counselling as a second operation will further shorten the vagina. As a post-trachelectomy hysterectomy, preferably by a second robot assisted laparoscopic approach, may be complex the operation should be performed by an experienced gynecological oncologist and include a thorough inspection of the whole pelvis.

References

1. Dargent D, Burn JL, Roy M, Remi I. Pregnancies following radical trachelectomy for invasive cervical cancer. Gynecol Oncol. 1994;52:105. (Abstract)
2. Abu-Rustum NR, Sonoda Y, Black D, Levine DA, Chi DS, Barakat RR. Fertility-sparing radical abdominal trachelectomy for cervical carcinoma: technique and review of the literature. Gynecol Oncol. 2006;103:807–13.
3. Ungár L, Smith JR, Pálfalvi L, Del Priore G. Abdominal radical trachelectomy during pregnancy to preserve pregnancy and fertility. Obstet Gynecol. 2006;108:811–4.
4. Martin A, Torrent A. Laparoscopic nerve-sparing radical trachelectomy: surgical technique and outcome. J Minim Invasive Gynecol. 2010;17:37–41.
5. Kim JH, Park JY, Kim DY, Kim YM, Kim YT, Nam JH. Fertility-sparing laparoscopic radical trachelectomy for young women with early stage cervical cancer. BJOG. 2010;117:340–7.
6. Persson J, Kannisto P, Bossmar T. Robot-assisted abdominal laparoscopic radical trachelectomy. Gynecol Oncol. 2008;111:564–7.
7. Shepherd JH, Milliken DA. Conservative surgery for carcinoma of the cervix. Clin Oncol (R Coll Radiol). 2008;20:395–400.
8. Ramirez PT, Schmeler KM, Soliman PT, Frumovitz M. Fertility preservation in patients with early cervical cancer: radical trachelectomy. Gynecol Oncol. 2008;110:25–8.
9. Rob L, Skapa P, Robova H. Fertility-sparing surgery in patients with cervical cancer. Lancet Oncol. 2011;12:192–200.
10. Martinez A, Poilblanc M, Ferron G, De Cuypere M, Jouve E, Querleu D. Fertility-preserving surgical procedures, techniques. Best Pract Res Clin Obstet Gynecol. 2012;26:407–24.
11. Dursun P, LeBlanc E, Nogueira MC. Radical vaginal trachelectomy (Dargent's operation): a critical review of the literature. Eur J Surg Oncol. 2007;33:933–41.
12. Diaz JP, Sonoda Y, Leitao MM, Zivanovic O, Brown CL, Chi DS, Barakat RR, Abu-Rustum NR. Oncologic outcome of fertility-sparing radical trachelectomy versus radical hysterectomy for stage IB1 cervical carcinoma. Gynecol Oncol. 2008;111:255–60.
13. Plante M, Gregoire J, Renaud MC, Roy M. The vaginal radical trachelectomy: an update of a series of 125 cases and 106 pregnancies. Gynecol Oncol. 2011;121:290–7.
14. Dargent D, Martin X, Sacchetoni A, Mathevet P. Laparoscopic vaginal radical trachelectomy: a treatment to preserve the fertility of cervical carcinoma patients. Cancer. 2000;88:1877–82.
15. Jolley JA, Battista L, Wing DA. Management of pregnancy after radical trachelectomy: case reports and systematic review of the literature. Am J Perinatol. 2007;24:531–9.
16. Kim CH, Abu-Rustum NR, Chi DS, Gardner GJ, Leitao MM Jr, Carter J, Barakat RR, Sonoda Y. Reproductive outcomes of patients undergoing radical trachelectomy for early-stage cervical cancer. Gynecol Oncol 2012;125(3):585-588
17. Boss EA, van Golde RJ, Beerendonk CC, Massuger LF. Pregnancy after radical trachelectomy: a real option? Gynecol Oncol. 2005;99:152–6.
18. Persson J, Imboden S, Reynisson P, Andersson B, Borgfeldt C, Bossmar T. Reproducibility and accuracy of robot-assisted laparoscopic fertility sparing radical trachelectomy. Gynecol Oncol. 2012;127(3):484–8. Epub 2012 Aug 28
19. Nick AM, Frumovitz MM, Soliman PT, Schmeler KM, Ramirez PT. Fertility sparing surgery for treatment of early-stage cervical cancer: open vs. robotic radical trachelectomy. Gynecol Oncol. 2012;124:276–80.
20. Al-Niaimi AN, Einstein MH, Perry L, Hartenbach EM, Kushner DM. Uterine artery sparing robotic radical trachelectomy (AS-RRT) for early cancer of the cervix. Int J Gynaecol Obstet. 2011;112:76–80.
21. Ramirez PT, Schmeler KM, Malpica A, Soliman PT. Safety and feasibility of robotic radical trachelectomy in patients with early-stage cervical cancer. Gynecol Oncol. 2010;116:512–5.
22. Darlin L, Persson J, Bossmar T, Lindahl B, Kannisto P, Måsbäck A, Borgfeldt C. The sentinel node concept in early cervical cancer performs well in tumors smaller than 2 cm. Gynecol Oncol. 2010;117:266–9.

Robotic-Assisted Radical Hysterectomy with Anterior and Posterior Exenteration-Urological Perspectives

72

Saad Hatahet, Ahmad Shabsigh, Dimitrios Moschonas, and Petros Sountoulides

Introduction

Pelvic exenteration (PE) describes a radical surgery involving the en bloc resection of the pelvic organs, including the internal reproductive organs, the urinary bladder and the rectosigmoid. Indications include advanced primary or recurrent pelvic malignancies, most commonly local or locally advanced cervical and bladder carcinomas.

From an urological point of view, PE has been utilized for the treatment of localized or locally advanced bladder cancer. Bladder cancer is one of the most common urologic malignancies in the world. In the USA, about 74,000 new cases are expected to be diagnosed in 2015, with an estimated 16,000 deaths related to them [1]. At initial diagnosis, more than 70 % of patients have Non-Muscle-Invasive Bladder Cancer (NMIBC). These less aggressive neoplasms are generally treated with transurethral resection of bladder (TURB) with or without intravesical immuno or chemotherapy [2]. Radical cystectomy (RC) with bilateral pelvic lymphadenectomy is still the gold standard treatment for the local control of non-metastatic muscle invasive bladder cancer (pT2-T4aN0M0) [3]. Radical cystectomy is one of the most morbid surgeries in urologic oncology. It is associated with high post-operative complication rates (27–64 %) [4], high risk of readmission, and re-operation. Over the last few decades, numerous modifications of the surgery were developed to reduce the post-operative morbidity and the long-term impact of this major operation. Minimally invasive techniques, continent urinary diversions, and better perioperative management all aim to achieve these goals. In the following few pages we review the history, surgical steps and outcomes of robotic assisted radical cystectomy in the setting of total pelvic exenteration.

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History of Laparoscopy and Robotic Surgery in Bladder Cancer Management

The first laparoscopic simple cystectomy was reported by Para in 1992 [5]. A year later, de Badajoz performed the first laparoscopic radical cystectomy for bladder cancer with an ileal conduit urinary diversion [6]. By the year 2000, experienced minimally invasive surgeons took advantage of better laparoscopic instruments, and performed the first two cases of laparoscopic radical cystoprostatectomy with intracorporeal ileal conduit [7].

Shortly after the Da Vinci surgical system was approved by the Food and Drug Administration (FDA) in 2000, the Vattikuti Urology Institute in Henry Ford Hospital reported the nerve-sparing robot-assisted radical cystectomy (RRC) for in 17 bladder cancer patients (14 men and 3 women) [8]. In 2003, Beecken and his colleagues performed the first robotic radical cystectomy and completely intra-abdominal formation of an orthotopic neobladder [9].

Over the last decade, the use of the Da Vinci system became more prevalent. By 2012, more than 400,000 robotic surgeries were done in the USA, triple the number just four years earlier. In 2013 almost 1,400 U.S. hospitals (nearly 1 out of 4) had at least one Da Vinci system. By June 30, 2015, there were 3,398 units worldwide, 2,295 of them in the United States (Intuitive LLC).

The early reports of RRC were promising. Not surprisingly, the operation took more time than open radical cystectomy. More importantly, RRC was associated with lower post-operative morbidity. As expected, there was a rapid adaptation of technology. Data from 279 hospitals across the United States revealed an increase in RRC rates from 0.6 % in 2004 to 12.8 % in 2010 [10]. Currently, most, if not all, large oncology centers in the USA utilize robotic assisted radical cystectomy.

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Laparoscopic Radical Cystectomy (LAR): Benefits and Difficulties

Since its inception, laparoscopic radical cystectomy remained a technically challenging procedure. The inherent constraints of laparoscopic instruments and the challenging nature of minimally invasive pelvic surgery prevented the wide adaptation of this technique. Even with these difficulties, most published studies have shown LAR to be feasible with less morbidity and mortality, and comparable oncologic outcomes compared to open surgery.

Recently, a meta-analysis of sixteen eligible case series reports comparing LRC vs ORC was performed. The study confirmed the safety and feasibility of LRC. It was clear that while the average operative time for LRC was longer, laparoscopic radical cystectomy was associated with significantly fewer overall complications, less blood loss, shorter length of hospital stay, less need of blood transfusion, shorter time to ambulation, shorter time to regular diet, and less narcotic requirement [20]. Surprisingly, there were fewer positive surgical margins, positive lymph node, lower distant metastasis rate, and lower mortality with LRC. These findings are more likely to be related to patients' selection than true better oncologic outcome with laparoscopic surgery [11].

Robotic Radical Cystectomy Benefits

The robotic systems provided reliable solutions for most of the difficulties encountered during laparoscopic surgery. Surgeons can benefit from the magnified 3D high-definition vision system and special wristed instruments that bend and rotate far greater than the human wrist, allowing the surgeon to perform difficult dissections and suturing. A surgeon's hands tremors or sudden strong moves are not transmitted to the robotic arms, protecting patients from accidental errors and enhancing their safety. Despite the surgeon's loss of real tactile sensation of the tissue with the Da Vinci system, surgeons were able to use the visual clues to perform safe and efficient surgeries. More importantly, there was a significantly shorter learning curve compared to laparoscopy, increasing the benefit of minimally invasive surgery for patients with bladder cancer.

Pelvic Lymph Node Dissection (PLND) in Radical Cystectomy

General Aspects

Bilateral pelvic lymph node dissection is an essential part of surgical therapy for bladder, prostate and gynecologic malignancies [3, 12, 13]. To develop the needed skills to perform adequate lymph node dissection, surgeons need to commit significant time and effort to learn the subtleties of systematic and efficient dissection. In most cases, skilled surgeons spend more time performing pelvic lymph node dissection than the time required to complete the exenteration. Unless cystectomy alone is considered, it is recommended that PLND is done first. This sets the surgical fossa for a fast and easy radical cystectomy, helps define the vascular pedicels of the bladder and the prostate, and gets the pelvis ready for urinary diversion.

Technically, there is no reason that the same lymph node dissection done in open surgery is not duplicated robotically. With appropriate port placement and exposure, robotic pelvic lymph node dissection achieves comparable results to open surgery [14].

How Many Lymph Nodes Should Be Dissected?

The number of lymph nodes identified after surgery depends on multiple factors, including the limits of the dissection and its thoroughness, the pathologic processing, and how meticulous the pathological examination is. In practice, wider and more systematic resection leads to an increase in the likelihood of identifying positive LNs. Furthermore, extended LNs dissection not only provides the most accurate staging but may also offer the patient the best chance of survival [15–17].

With increased experience, the number of lymph nodes dissected during RC increased substantially between 1988 and 2010 (≥10 nodes removed as an adequate number). However, a minority of patients still do not receive LND, and removing >14 lymph nodes has been shown to improve progression-free survival [18].

Limited (Standard) Pelvic Lymph Node Dissection

Standard PLND was described by "Stewart's Operative Urology" and includes the pelvic sidewall between the genitofemoral and obturator nerves, and bifurcation of the iliac vessels to the circumflex iliac vein [19], including all lymphatic tissues around the common iliac, intercommon iliac, and internal iliac groups, and the obturator group bilaterally [20, 21] (Fig. 72.1).

Up to one-third of all positive lymph nodes are located around the common iliac artery. About 80 % of all positive nodes could be cleared completely by standard PLND, including all lymphatic tissues along the common, external, and internal iliac regions [14, 16, 22]. Some experts recommend doing frozen section on the true pelvis LNs; if the frozen section examination revealed no positive LNs, LN dissection does not need to be carried out further. If, however, the frozen section examination is not performed, or if it identifies positive nodes, an extended PLND is done [21].

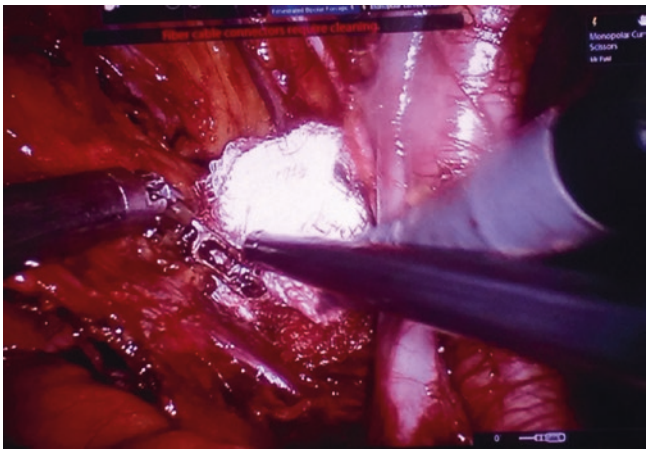


Fig. 72.1 Taking care of minor bleeding during robot-assisted lymph node dissection at the time of radical cystectomy

Extended PLND Limits and Benefits

Extending the dissection up to the aortic bifurcation or the inferior mesenteric artery increased the detection of positive nodes by 13–16 % [16, 20].

A recent lymphatic bladder mapping study suggests that the template for an appropriate PLND at cystectomy should include the external iliac (including the fossa of Marcille), obturator and internal iliac region (lateral and medial to the internal iliac vessels), as well as the common iliac vessels up to at least the uretero-iliac junction bilaterally [17].

Standard PLND is associated with suboptimal staging, and a higher rate of local progression. In contrast, extended PLND provides better 5-year recurrence-free survival for patients with lymph node positive disease. Even patients with pT2N0 or pT3N0 bladder cancer have better prognosis after RC and extended pelvic lymph node dissection [16, 17, 23].

The possible benefits of higher resection must be weighed against the potential increased demands in both time and extent of surgical field, the increased risk of complications, and injury to the autonomic sympathetic nerves, threatening both sexual function and continence in patients who are candidates for orthotopic bladder substitution [17].

Robotic Radical Cystectomy: Surgical Technique

Patient Preparation

Bowel preparation before radical cystectomy and urinary diversion does not provide any advantage. It does not seem to impact the rates of perioperative infectious, wound, and bowel complications [24, 25]. Omitting bowel preparation before ileal urinary diversion is safe, and not associated with bacterial overgrowth or added complications [24]. To the contrary, avoidance of preoperative bowel preparation led to early restoration of intestinal function and shorter hospital stay [25, 26].

Improving performance status prior to surgery is essential. Proper nutrition, ambulation, and relieving ureteral obstruction with ureteral stent or nephrostomy tube are all good measures that should be considered if possible. Post radical cystectomy venous thrombus events are common [4, 27]. Thus, wearing compression socks, using sequential compression devices, and perioperative anticoagulation are indicated for these patients [28].

Positioning

Lithotomy position with legs in Allen Yellowfins stirrups (Allen Medical Systems, Acton, Massachusetts) is the standard position during RRC. This allows the Robot cart to be moved between the patient's legs. All pressure points should be padded for safety and the patient should be secured to the table. The patient should then be put in a steep Trendelenburg position, which helps in mobilization of the small bowel for better access to the pelvis. The assistant can stand on either side of the patient. After prepping and draping the patient, a 20–22 Fr Foley catheter should be inserted in the bladder. In female patients a sponge on stick can be placed in the vagina to help in identification of vaginal cuff. We personally like to use EEA reusable stainless steel sizer and vaginal pneumo-occluder.

Port Placement in Four-Arm Robotic Approach

To facilitate proximal lymph node and ureteral dissection, the port placement is considerably more cephalad in comparison with robotic assisted radical prostatectomy. The camera 12-mm port is placed 3–8 cm above the umbilicus while the three working 8 mm robotic ports are placed 2–5 cm above the level of the umbilicus in an arch line. If the patient had prior surgeries, the first port is usually placed under direct vision away from the scars. The abdomen is then inspected, and any adhesions are taken down.

A 12 or 15-mm assistant port is placed slightly more caudal and lateral; this positioning allows for improved angulation during stapling of the bowel reconstruction. The 15-mm port is used to pass the 15-mm Endocatch bag as well. In females, if possible, the specimen is extracted via the vagina. Additional 12 mm assistant port could be used and placed laterally in the level of robotic ports on the side of the assistant [29].

Bladder Removal and Extended PLND

Right Ureter Dissection

The posterior peritoneum is incised around the cecum. The incision is extended laterally at the white line of Told and medially anterior to the right common iliac artery. The right ureter is identified over the common iliac artery. The ureter is dissected off the common iliac artery. A vessel loop is used to to mobilize the ureter by the assistant. The ureter is dissected distally all the way to the superior vesical artery. It is very important to preserve as much of the peri-ureteral tissue as possible to avoid ureteral ischemic injury. The ureter can be clipped distally with two clips and cut between them at this time, or just prior to taking the bladder pedicels. Distal ureteral margin can be sent for frozen section. It is recommended to use Hem-o-lock to clip the ureter and take a suture at the corner of the distal ureter end; this will help in handling the ureter and reduce traumatic injury to the ureter [30].

Extended PLND

The first important role of a thorough and efficient pelvic lymph node dissection is exposure and setting up the field. After isolation of the right ureter, the hypogastric artery is dissected to the obliterated medial umbilical ligament. This is usually retracted medially, to expose the medial side of the external iliac and obturator lymph nodes. The dissection is carried on both sides of hypogastric vessels to the perirectal fat. This will isolate the obturator fossa from the hypogastric lymph node packet. Attention is then paid to the lateral limits of the dissection. The femoro-genital nerve is identified and isolated. The external iliac lymph nodes are pushed medially. We recommend that the lateral limit of the dissection is developed at this point by dissecting the right external iliac and obturator lymph nodes medially of the pelvic side wall. Small vessels and lymphatics should be cauterized. Splitting the lymphatic tissue over the entire extent of the right common iliac artery and right external iliac artery is recommended. The tissue is dissected on both sides of the right external iliac artery and vein. The distal side of the external iliac packets should be clipped to reduce the formation of symptomatic lymphocele. Next the right obturator nerve and vessels are identified. The obturator lymph node packet is then dissected off the posterior edge of the external iliac vein all the way from the bifurcation of the iliac arteries to the lymph node of cloquet. The lymph nodes are then dissected off the anterior side of the obturator nerve. It is strongly recommended that the proximal end of the packet is dissected first. This will prevent the obturator lymph nodes from dropping and making the dissection of the proximal end more difficult. The distal side of the packet is then clipped. The lateral hypogastric lymph nodes are then dissected. The right common iliac lymph nodes are dissected all the way to the lateral edge of the right common iliac vein and IVC. Followed by the dissection of the right fossa of Marcille, this is done by retracting the right common iliac vein medially. Attention to the proximal end of the obturator nerve is important. The tissue is then dissected in a medial direction exposing the left common iliac vein and anterior surface of the sacrum. The lymph nodes of the left common iliac vein are then removed. Use of bipolar is recommended to control the small vessels at the inferior side of the left common iliac vein toward the sacrum. The lymph nodes anterior to the sacrum and at the medial side of the hypogastric lymph nodes are removed. The right and left common iliac node packets are clipped and divided at the anterior side of the bifurcation of the aorta and also starts the left pelvic lymph node dissection by exposing the medial aspect of the left common iliac artery which will serve as a landmark after the leftcolon is reflected. This will help in developing the mesenteric window that is used to pass the left ureter to the right side of the pelvis. After completion of the medial dissection, the lymphatic packet is mobilized laterally.

Additionally, this approach allows improved exposure of the internal iliac vein. The lymph nodes should be placed in a 10 mm specimen retrieval bag and can be removed in appropriate packets through the 12 or 15 mm port. In order to limit cost, a reusable 10 mm bag can be used for all lymph node packets [30].

Left Ureter Dissection

The sigmoid colon is mobilized at the white line of Told, then it is mobilized medially with the forth arm (Prograsp forceps). This usually exposes the left ureter anterior to the left common iliac artery. The ureter is dissected all the way to the superior vesical artery. At this point we usually develop the mesenteric window caudal to the inferior mesenteric artery. Caution should be taken to avoid injury to the colon blood supply. The left pelvic lymph node dissection is then performed.

The Posterior Dissection in Women

Unless fertility preservation is a consideration, the surgeon should remove the uterus, ovaries, and Fallopian tubes with or without anterior vaginectomy. This depends on the location of the bladder cancer and the stage of the disease. Examination under anesthesia and pre-operative imaging are essential in this decision. If the female genital organs are spared, the peritoneum is incised at the posterior bladder wall between the bladder and the uterus. The plane is developed inferiorly and laterally to reach the lower ureters which should be dissected. The rest of the surgery is similar to the full pelvic exenteration.

Since cystectomy is much more common in elderly patients, sparing the female genitalia is rare and full pelvic exenteration is usually done. In this case the gonadal vessels

are clipped at the time of ureteral dissection. Attention should be to the infindibulopelvic (IP) ligaments, which should be clipped and cut. By continuing dissection inferiorly, the uterine artery should be identified and clipped. The sponge stick or the vaginal sizer is pushed anteriorly in the posterior fornix. If the anterior vaginal wall is removed with hysterectomy, the vaginal sizer is pushed and the vaginal cuff is incised posterior to the cervix. The vascular pedicles of the bladder are defined, dissected, clipped and cut bilaterally. Then the vesico-vaginal space is dissected inferiorly, all the way to the urethra, and if vagina is persevered then performing a supra-cervical hysterectomy. After the anterior dissection (discussed in a following section), the vagina is closed with figure of eight absorbable sutures.

Bladder Pedicles and Neurovascular Bundles Dissection Nerve-Sparing Technique

The anterior peritoneum is incised lateral to the medial umblilical ligaments and the urachus. The bladder should not be dropped at this point, as it would increase the difficulty of bladder pedicle dissection and control.

The right and left ureters are double clipped with Hem-o-loc clips and incised as close as possible to the bladder. The endopelvic fascia is incised and opened to the prostato-urethral junction. At this point the vascular pedicles of the bladder are defined, clipped or stapled with an Endo-GIA or bipolar device like the Ligasure.

Unless nerve sparing is contraindicated, the neurovascular bundles should be identified close to the tips of the seminal vesicles. The dissection starts immediately next to the walls of the seminal vesicle, between the vesicle and the posterior layer of Denonvillier's fascia; high anterior dissection is preferred. A combination of antegrade and retrograde dissection of the neurovascular bundle is done similar to robotic radical prostatectomy. Use of electrocautery during dissection of the pedicles is controversial. Some surgeons recommend avoiding any thermal injury, while others advocate the safety of bipolar devices [8, 31–33]. Finally, nerve sparing should be carried down to the genitourinary diaphragm to prevent injury during the apical and urethral dissection.

Anterior Bladder Wall Dissection

The urachus is incised; attention to the small vessels at the proximal end is important. The bladder is dropped from the anterior abdominal wall all the way to the space of Retzius towards the bladder neck.

If neobladder urinary diversion is planned, the puboure-thral suspensory ligaments should be spared to avoid extensive dissection of the urethra for better preservation of the urethral sphincter complex and its nerve supply.

Urethral Dissection and Removal of the Bladder Specimen

When reaching the anterior wall of the bladder neck, the Dorsal Vein complex should be identified and ligated with 0 polysorb suture or stapled with EndoGIA. In females, flexible cystoscopy helps to identify the proximal limit of the urethra and the relationship to the tumor. This facilitates excellent preservation of the urethra and improves the recovery of continence after neobladder diversion. Preservation of the neurovascular bundles lateral to the urethral is achieved by blunt and gentle dissection. Similarly, for male patients, the apex of the prostate is dissected superiorly to obtain adequate urethral stump. Avoidance of spillage is achieved by leaving a catheter balloon inflated, grabbing the catheter with Prograsp forceps and cutting distally. The catheter can then be used to lift the specimen until it is placed in an Endobag. Alternatively, the catheter can be removed and the bladder neck can be closed with a figure of eight suture. If neobladder urinary diversion is planned, urethral margin sample should be sent for frozen section. This can be taken from the bladder neck.

Urinary Diversion

One of the main questions when performing a urinary diversion after a robot-assisted cystectomy, is whether to create the urinary diversion intra- or extracorporeally? The standard types of urinary diversion that are used in a classical open radical cystectomy could be performed in RRC. The first extracorporeal ileal conduit was described by Menon et al. [8]. In this approach, a periumbilical extraction incision is usually sufficient. We would recommend that the ureters are tagged with full length 2-0 suture robotically prior to opening the abdomen. This will help in bringing the ureters to the extraction incision for anastomosis. An Alexis retractor can be used to facilitate the extracorporeal construction of the ileal conduit. It is recommended that a continent cutaneous urinary diversion should be done in an extracorporeal fashion as well.

Intracorporeal Ileal Conduit Formation

Isolate the Bowel Segment

To isolate the bowel segment, the ileocecal valve is identified first. Using a marked umbilical tape, the distal end of the bowel segment is defined approximately 15–20 cm from the ileocecal valve. Some surgeons prefer Intraoperative fluorescence imaging to evaluate the segment's blood supply [34]. Double 3-0 silk sutures are placed on both the proximal and distal end of the ileal conduit for retraction. The bowel segment is then isolated and stapled using a 60 mm Endo-GIA stapler with bowel staples.

The bowel continuity is restored by a standard side-to-side anastomosis using a 60 mm Endo-GIA stapler through the assistant 12 mm assistant port. Three 3–0 silk sutures are placed spaced 2 cm apart on the anti-mesenteric sides to re-approximate the segments of bowel and to aid in completing the side-to-side anastomosis. The stapler should be applied at the anti-mesenteric ileum border. Finally the mesenteric window is closed with interrupted 3-0 silk sutures.

Uretero-Intestinal Anastomosis

The anastomosis between the ureters and the bowel segment could be performed by either Wallace technique or Bricker techniques [7, 30].

Wallace Technique

A stay suture is placed to hold the two ureters ends together. The ureters are spatulated 2 cm long. The posterior walls of the ureters are sutured side-to-side using a 4-0 polyglactin suture. Two single-J, 90-cm ureteric stents or 8 Fr pediatric feeding tubes are introduced over a guide wire. Double J stents can also be used. Using the Prograsp forceps, the stents are pulled through the afferent limb and pushed up into the ureters on each side. The uretero-ileal anastomosis between the Wallace plate and the pouch is performed according to a modified van Velthoven et al. technique. A suture is placed close to the distal end of the conduit to help with maturation of the stoma. Finally, the stoma is performed in the standard method after de-inflating the abdomen [30]

Bricker Anastomosis

Two small incisions are made in the ileal conduit near its proximal edge. The ureters are spatulated as mentioned before. We prefer to place a 5-0 silk suture as a sty suture between the peri-ureteral tissue and the ileal conduit. This can facilitate the anastomosis. The uretero-enteric anastomosis is done by placing one 4–0 polyglactin sutures at each sides of the anastomosis, and then continue the anastomosis with some interrupted sutures. Stents are placed and the anastomosis is completed (Fig. 72.2).

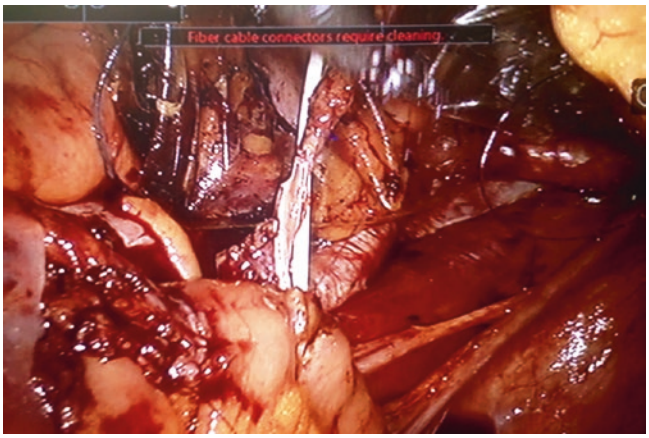


Fig. 72.2 Uretero-iliac anastomosis during a Bricker urinary diversion. The stented ureter is ready to be anastomosed to the isolated ileal segment

Intracorporeal Neobladder Formation

Robotic intracorporeal neobladder reconstruction is more challenging. Initial perioperative results seem to be comparable to open series [35]. Some researcher reported that it can be performed in a safeand reproducible fashion, even during the early learning curve [36].

There are general concepts that are used in all types of intracorporeal neobladders. The first general step is returning the patient's position from the Trendelenburg position to the supine position. This allows the bowels to move back to the lower abdomen cavity, reducing the tension off the urethro-enteric anastomosis. Second, isolating the bowel segment is done in the same fashion as described earlier. The length of the bowel segment depends on the type of the neobladder that is planned. Third, we recommend that a 3-0 silk suture is placed at the most depended part of the segment to advance the pouch into the pelvis for the anastomosis. Finally, the uretero-enteric anastomoses are performed in a similar fashion as the anastomoses performed during a robot-assisted ileal conduit.

U-shaped Pouch

A 60 cm segment is isolated. The distal 45 cm of the bowel segment is detubularized in the standard fashion for a Studer neobladder [34]. The proximal limb of 15 cm of ileum is left intact for the chimney and the eventual site for the ureteral anastomoses. The posterior plate of the bowel is then sutured together with a barbed suture in a running fashion to achieve a watertight closure [37]. The inferior side of the anterior plate should also be closed prior to the urethro-enteric anastomosis. A 2 cm incision at the most depended part of the pouch is made. Using the midpoint silk suture, the pouch is advanced into the pelvis using the Prograsp forceps.

A figure of eight 2-0 polysorb or barbed suture is then tied down from the posterior side of the most dependent portion of the pouch to posterior plate to Denonvillier's fascia just adjacent to the rectrourethralis muscle. This releases the tension from the urethro-eneteric anastomosis [38]. The urethro-enteric anastomosis is performed by placing a double armed 3-0 barbed sutures (or double armed 3-0 Monocryl) on a small tapered needle. The closure is usually started at a 4–5 o'clock position of the right side of the pouch's neck. In a running counterclockwise fashion, the posterior closure is completed. The assistant should facilitate the closure with the tip of a Foley catheter. The right arm of the suture is then used to close the anterior part of the anastomosis.

Modified Ileum Studer Neobladder

In a modified Studer neobladder the anastomosis between the urethra and bowel is performed at the beginning, before detubularisation of the bowel segment. This will stabilize the bowel loop and enhance forming the neobladder. First, the most dependent part of the bowel segment is identified, this is usually more than 35 cm proximal to the ileocecal valve. This part is brought down to the urethra and a small incision at the contra-mesenteric side is made to perform the urethral anastomosis according to the Van Velthoven technique with a two-times 2-0 suture. First, the suture is placed at the 5:30-o'clock position by passing the needle from the outside to the inside of the bowel's opening, and from inside to outside in urethral lumen. Then, the other suture is put at the 6:30- o'clock position by the other needle. The rest of the anastomosis is done in standard fashion. A 22 Fr Foley catheter is passed through the anastomosis and the balloon is inflated to 5 ml. Then an ileal segment of 20–25 cm from the ileocecal valve and 15 cm from the urethral–enteric anastomosis is selected and isolated as before. For the afferent reservoir loop, a distance of about 40 cm from the urethral–enteric anastomosis is selected and cut with a stapler in the same way. The rest of the procedure is similar to the standard Studer pouch [35, 36, 39].

Robotic Radical Cystectomy Versus Open Radical Cystectomy Outcomes

Retrospective Cohort Studies

Over the last few years, multiple reports of case cohorts were published, as is common for a new surgical technique. These focused on defining the perioperative benefits, morbidity, and mortality of RRC compared to gold standard ORC. Most of these studies were small in numbers and represented single center experiences. Recently, a good systematic literature review was conducted. The study focused on reports published within the last 5 years [40]. In summary, the review showed that robotic radical cystectomy consistently had less estimated blood loss, faster time to bowel activity, and reduced hospital stay; however, these improvements come with increased operative time and cost [40].

Retrospective comparative studies showed statistically significant reduction in operative **Estimated Blood Loss** (EBL) in RRC (<300 ml) [41, 42]. As a consequence, the rate of perioperative blood transfusion was lower [42–45]. Most studies indicated a longer **Operation Time** in RRC [40, 46, 47]. The average operation time was between 349–393 min in ORC compared to 415–455 min in RRC [47, 48].

Regarding post-operative morbidity and mortality, results were mixed. Some researchers reported favorable rates of low grade complications after RRC. However, these favorable trends did not translate to a decrease in major complications [46, 49, 50]. Others reported lower risk of mortality and minor and major complications after RRC [43, 44].

Patients who underwent RRC have quicker **bowel function recovery**, and shorter time to passing flatus [46, 51]. They used less **analgesics** [40, 52]. Finally, most studies reported a shorter **hospital stay** after RRC [43, 49].

Short term oncological outcomes of RRC were similar to ORC [41, 50]. Due to the short follow up in these studies, their focus was on pathologic stage, number of nodes harvested, and positive surgical margin rates [22, 52, 53]. Short term survival rates were also similar in both approaches. The Kaplan-Meier estimate for 2-year recurrence-free, disease-specific, and overall survival were 67 %, 75 %, and 68 % for robotic radical cystectomy, and 58 %, 63 % , and 63 % for open radical cystectomy [49]. In one small study, the long-term oncologic outcome of 14 RRC patients who were followed for more than 5 years was comparable to these for ORC (overall survival of 64 %, disease-specific survival of 75 %, and disease-free survival of 50 %) [48].

Health-related quality-of-life measures were not significantly different between ORC and RRC. Aboumohamed et al. used validated instruments (cancer body image scale (BIS) and the bladder cancer index (BCI)) to evaluate urinary, bowel, sexual function, and body image after RRC and ORC. Prospectively collected data from 182 patients from multiple institutions showed no difference between the two groups [51].

Prospective Randomized Control Trials

Up till now, only three randomized trials were performed to compare RRC and ORC. All of these trials agree on the benefits of RRC in lowering the EBL and in cost of longer operating time. None of the randomized trials showed statically significant benefits for RRC over ORC in reducing complications rate or improving the oncological outcomes.

The first trial was published in **2009 by Nix J** in University of North Carolina [45]. 41 patients were randomly assigned to one of the two techniques. The study showed that RRC was associated with lower EBL (258cc vc 575cc), significantly longer operation time (4.20 h vs 3.51 h), and less need for inpatient narcotic requirements. Other variables including complication rates were almost similar between the two procedural groups [45].

The second randomized surgical trial was published in 2012 by Parekh DJ et al, at The University of Texas Health Sciences Center at San Antonio. Again, this was a small trial of 40 patients. There was decreased estimated blood loss with RRC (400cc vs. 800) and decreased hospital stay with no significant differences in surrogates of oncologic efficacy [54].

The last and largest randomized trial was published in 2014 by Bochner et al. from Memorial Sloan Kettering

Cancer Center, New York. The study was a superiority trial of 118 patients. Although there was a trend for lower low grade complications after RRC, the authors concluded that the RRC is associated with lower mean intraoperative blood loss and significantly longer operative time. But it is similar in 90-d complication rates, hospital stay, pathologic outcomes, and 3- and 6-mo health-related quality-of-life outcomes between the two surgical techniques. Of note, the trial was designed to prove a 20 % improvement of post-operative morbidity after RRC. Thus the trial failed to identify a large advantage for RRC over ORC [54].

Finally a multi-institutional, randomized, non-inferiority NCI sponsored Trial (RAZOR) finished accrual of 350 patients in 2014. Fifteen institutions used standardized measures to evaluate cancer outcomes, surgical complications and HRQL of ORC vs. RRC with a primary endpoint of 2-year progression free survival. Full data from the RAZOR trial is not expected until 2016–2017 [55].

Costs

Few studies evaluated the financial burden of robotic surgeries. A recent systematic study compared the cost effectiveness of robotic surgeries (not only RRC) to open surgeries. The authors found that robotic surgeries' costs were consistently higher than open and laparoscopic surgery [56].

Smith and his colleagues looked specifically at the economics of RRC as part of the first randomized surgical trial in 2010. RRC was associated with an overall higher financial cost (+$1,640) than the ORC in the perioperative setting. (Robotic $16,248 vs open $14,608) [57]. A larger study that compared the cost of 1444 ORCs to 224 RRCs have also shown that the robotic approach is significantly more costly [58]. This increase of expenses in the robotic surgery itself were related to the high purchase and maintenance cost of the robotic platform[58], longer operating time, and the higher costs of robotic supplies [49, 59]. In a well done analysis, Martin et al. found that RRC was 16 % more expensive than ORC when only comparing direct operative costs[60].

The two main drivers of higher cost after radical cystectomy cited in the published data were hospital length of stay and operative durations [59, 60]. Although RRC was consistently associated with shorter length of stay, the cost deference was insufficient to offset the increased cost of robotic surgery [59]. Interestingly, there was a 38 % cost advantage found favoring RRC in the actual total patient costs in the Martin AD study [60].

It is possible that cost of robotic surgery will drop with the increased competition between manufacturers and wider dissemination of the technology [61]. When that happens, it is expected that the impact of indirect costs of post-operative complications and the longer hospital stay of ORC may deem RRC to be a more cost efficient treatment for invasive bladder cancer [43, 58].

The Future of RRC

The use of the robot in urologic surgery continues to increase. With the facilities that this technology provide for surgeons and the comparable outcomes between RRC and ORC that have shown by the available studies, RRC continues to be more popular and favorable. The improvement of surgeons' experience was quick and obvious with the decrease in operative time [61] and the performance of more complicated procedures, such as intra corporeal urinary diversion, robotically and successfully. The short learning curve of RRC compared with laparoscopic radical cystectomy as minimally invasive approaches helps new physicians and residents to perform radical cystectomy more efficiently [62]. All these factors and many others make the RRC a promising surgery either in regards to the quality of health care, or in surgeon's preference. And who knows – if RRC shows more significant clinical and statistical outcomes, it could become the gold standard approach in management of muscle invasive bladder cancer!

Comments

Because it includes many different surgical steps and techniques, radical cystectomy is a comparatively unique surgery in urology. The high morbidity and mortality rates make this procedure more challenging. Now, 12 years after the initial RRC was performed, urologists have formed a more inclusive understanding of the advantages and disadvantages of RRC. It is clear that the technical advantages, lower EBL, and faster recovery after RRC comes at the price of increased operative time and financial burden. However, it is promising that the perioperative and oncological outcomes of RRC were similar or better but not worse when compared with the gold standard ORC.

The results of a valuable multi-institutional, non-inferiority, randomized surgical trial (**RAZOR**) designed to compare RRC with ORC is expected in the near future. This trial is promising because of its statistical design and large cohort. It remains to be seen if it will support the RRC as an acceptable minimally invasive alternative to the classical ORC.

Urological Complications of Radical Hysterectomy and P.E

Injuries to the Bladder and Ureters

Ureteral injuries as well as bladder injuries may happen during any type of hysterectomy, particularly during the

learning curve, and are estimated to occur with a frequency of 1.2% (range 0–6%) for ureteral injuries and 2 % (range 0.6–4%) for bladder injuries [63, 64]. Ureter injuries are in 70% of cases detected after surgery, often resulting in an unintended emergency laparotomy or second laparoscopy [65].

The ureters are always at risk during any type of radical pelvic surgery as they lie close to the rectum and the female reproductive organs. During laparoscopic hysterectomy, in particular, the distal ureters may be injured during ligation of the uterine arteries, or at the time of dissection and division of the cardinal ligaments below the uterine vessels [66]. However it is the cases with abnormal anatomy that pose the highest risk for ureteral injury. Special caution should be exercised in patients with severe prolapse where the pelvic anatomy is distorted and the ureter may lie just 0.5 cm lateral to the cervix. Cystoscopic evaluation with administration of i.v Indigo carmine dye may be helpful in these cases in order to confirm bilateral ureteral integrity.

Steps to be taken in order to avoid ureteral injury include (a) staying in the midline when incorporating the perivesical fascia as sutures placed too lateral may cause ureteral injury, (b) placing the clamps close to the uterus, (c) removing the uterus intact with surgical margins in close proximity to the uterus, thereby avoiding ureteral injury.

Ureteral injuries are much less likely to be recognized intraoperatively, and in some cases can be missed despite the use of intraoperative cystoscopy. The surgical treatment for ureteral injuries follows established operative principles, which include resecting devitalized injured ureteral tissue, establishing tensionless mucosal apposition over a stented ureter, isolating the anastomotic repair with omentum or fat, and placing of a drain in close proximity to the repair. The operative technique is dependent upon the location of the ureteral injury. Distal ureteral injuries, which are usually the case in R.E, can be managed with direct uretero-utereral anastomosis, ureteroneocystostomy with psoas hitch or Boari flap.

Lately, minimally invasive surgery using the robot is leading to a paradigm shift in the management of urinary tract injuries, which has been traditionally approached with open surgery. There are reported cases of robotic total hysterectomy and concomitant repair of incidental ureteral injury via ureteroureterostomy using standard end-to-end anastomosis technique and intracorporeal retrograde double J stent placement [67–69].

Bladder injuries may occur during attempt to enter the vesicouterine peritoneal space and are more frequent in women with history of cesarean section and scarring in this area. In transvaginal procedures, injuries to the bladder most commonly occur when perforating into the retropubic space. In general the risk of cystotomy can be reduced when one makes sure that the bladder is empty prior to perforation. Usually these cystotomies are at the base of the bladder and generally above the trigone. When repairing bladder injuries, care must be taken to close the cystotomy in two layers using absorbable sutures and test for watertightness using methylene blue dye instilled through the catheter. A bladder catheter is such cases should be kept for 7–10 days postoperatively [70].

In patients with a history of pelvic irradiation, an omental flap of labial fat pad interposition should be considered in order to prevent fistula formation [71]. If a bladder injury however is not detected intraoperatively, a trial of conservative management with an indwelling Foley catheter can be attempted. It is important to remember that early identification of bladder, or ureteral injury is crucial, considering that the best time for repair is at the time of injury when the tissues are in their best condition and all options for repair are still available.

Delayed Complications-Ureteral Stricture

Ureteral strictures are the usual long-term complications of iatrogenic injuries to the ureters. Upper urinary tract obstruction from a stricture may encounter months to years after hysterectomy. The treatment options include either an immediate percutaneous nephrostomy in case of a severely obstructed urinary tract or efforts to dilate the ureter and pass a retrograde stent over a guidewire in cases of mild dilatation and short stricture length [72, 73].

According to some, delayed recognition of a ureteral injury should be best managed by percutaneous drainage and definitive surgical repair should be postponed until after several months, depending again on the location and length of the strictured area. Percutaneous ureteral dilatation followed by antegrade stent placement has been reported with good success rates especially in strictures that are short in length [74].

Finally in challenging cases when other options are not available, a short segment of the ileum can be used for the creation of an ileal ureter. Ileal-ureter substitution is a valuable option in selected patient with complex ureteral defects that are not amenable to or have failed endourological approaches. Avoiding the complexity of tailored and tunnelled anastomoses may reduce the potential morbidity and re-intervention rate in patients with challenging surgical fields [75, 76].

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2015. CA Cancer J Clin. 2015;65(1):5–29.
2. Babjuk M, Oosterlinck W, Sylvester R, Kaasinen E, Böhle A, Palou-Redorta J, et al. EAU guidelines on non-muscle-invasive urothelial carcinoma of the bladder, the 2011 update. Eur Urol. 2011;59(6):997–1008.
3. Witjes JA, Compérat E, Cowan NC, Santis M, Gakisi G, Lebret T, et al. EAU guidelines on muscle-invasive and metastatic bladder cancer: summary of the 2013 guidelines. Eur Urol. 2014;65(4):778–92.

4. Shabsigh A, Korets R, Vora KC, Brooks CM, Cronin AM, Savage C, et al. Defining early morbidity of radical cystectomy for patients with bladder cancer using a standardized reporting methodology. Eur Urol. 2009;55(1):164–74.
5. Parra RO, Andrus CH, Jones JP, Boullier JA. Laparoscopic cystectomy: initial report on a new treatment for the retained bladder. J Urol. 1992;148(4):1140–4.
6. Sánchez de Badajoz E, Reche Rosado A, Gutiérrez de la Cruz JM, Jiménez Garrido A. Radical cystectomy and laparoscopic ileal conduit. Arch Esp Urol. 1993;4(7):4.
7. Gill IS, Fergany A, Klein EA, Kaouk JH, Sung GT, Meraney AM, et al. Laparoscopic radical cystoprostatectomy with ileal conduit performed completely intracorporeally: the initial 2 cases. Urology. 2000;56(1):26–9.
8. Menon M, Hemal AK, Tewari A, Shrivastava A, Shoma AM, El-Tabey NA, et al. Nerve-sparing robot-assisted radical cystoprostatectomy and urinary diversion. BJU Int. 2003;92(3):232–6.
9. Beecken WD, Wolfram M, Engl T, Bentas W, Probst M, Blaheta R, et al. Robotic-assisted laparoscopic radical cystectomy and intraabdominal formation of an orthotopic ileal neobladder. Eur Urol. 2003;44(3):337–9.
10. Leow JJ, Reese SW, Jiang W, Lipsitz SR, Bellmunt J, Trinh QD, et al. Propensity-matched comparison of morbidity and costs of open and robot-assisted radical cystectomies: a contemporary population-based analysis in the United States. Eur Urol. 2014;66(3):569–76.
11. Tang K, Li H, Xia D, Hu Z, Zhuang Q, Liu J, et al. Laparoscopic versus open radical cystectomy in bladder cancer: a systematic review and meta-analysis of comparative studies. PLoS One. 2014;9(5):e95667.
12. Kim HS, Suh DH, Kim MK, Chung HH, Park NH, Song YS. Systematic lymphadenectomy for survival in patients with endometrial cancer: a meta-analysis. Jpn J Clin Oncol. 2012;42(5):405–12.
13. Briganti A, Blute ML, Eastham JH, et al. Pelvic lymph node dissection in prostate cancer. Eur Urol. 2009;55(6):1251–65.
14. Abaza R, Dangle PP, Gong MC, Bahnson RR, Pohar KS. Quality of lymphadenectomy is equivalent with robotic and open cystectomy using an extended template. J Urol. 2012;187(4):1200–4.
15. Herr HW, Bochner BH, Dalbagni G, Donat SM, Reuter VE, Bajorin DF. Impact of the number of lymph nodes retrieved on outcome in patients with muscle invasive bladder cancer. J Urol. 2002;167(3):1295–8.
16. Leissner J, Ghoneim MA, Abol-Enein H, Thüroff JW, Franzaring L, Fisch M, et al. Extended radical lymphadenectomy in patients with urothelial bladder cancer: results of a prospective multicenter study. J Urol. 2004;171(1):139–44.
17. Stein JP. The role of lymphadenectomy in patients undergoing radical cystectomy for bladder cancer. Curr Oncol Rep. 2007;9(3):213–21.
18. Cole AP, Dalela D, Hanske J, Mullane SA, Choueiri TK, Meyer CP, et al. Temporal trends in receipt of adequate lymphadenectomy in bladder cancer 1988 to 2010. Urol Oncol. 2015;33(12):504 e9–504 e17.
19. Pontes JE. Lymphadenectomy technique. In: Novick AC, Streem SB, Pontes JE, editors. Operative urology, vol. 2. Baltimore: Williams & Wilkins; 1989. p. 451.
20. Abol-Enein H, El-Baz M, Abd El-Hameed MA, Abdel-Latif M, Ghoneim MA. Lymph node involvement in patients with bladder cancer treated with radical cystectomy: a patho-anatomical study-a single center experience. J Urol. 2004;172(5 Pt 1):1818–21.
21. Axel Heidenreich DP. Anatomic extent of pelvic lymphadenectomy in bladder cancer. Eur Urol Suppl. 2010;9(3):419–23.
22. Wang L, Mudaliar K, Mehta V, Barkan GA, Quek ML, Flanigan RC, et al. Seeking a standard for adequate pathologic lymph node staging in primary bladder carcinoma. Virchows Arch. 2014;464(5):595–602.
23. Dhar NB, Klein EA, Reuther AM, Thalmann GN, Madersbacher S, Studer UE. Outcome after radical cystectomy with limited or extended pelvic lymph node dissection. J Urol. 2008;179(3):873–8.
24. Hashad MM, Atta M, Elabbady A, Elfiky S, Khattab A, Kotb A. Safety of no bowel preparation before ileal urinary diversion. BJU Int. 2012;110(11 Pt C):E1109–13.
25. Shafii M, Murphy DM, Donovan MG, Hickey DPI. Mechanical bowel preparation necessary in patients undergoing cystectomy and urinary diversion? BJU Int. 2002;89(9):879–81.
26. Maffezzini M, Campodonico F, Canepa G, Gerbi G, Parodi D. Current perioperative management of radical cystectomy with intestinal urinary reconstruction for muscle-invasive bladder cancer and reduction of the incidence of postoperative ileus. Surg Oncol. 2008;17(1):41–8.
27. Alberts BD, Woldu SL, Weinberg AC, Danzig MR, Korets R, Badani KK. Venous thromboembolism after major urologic oncology surgery: a focus on the incidence and timing of thromboembolic events after 27,455 operations. Urology. 2014;84(4):799–806.
28. Pridgeon S, Allchorne P, Turner B, Peters J, Green J. Venous thromboembolism (VTE) prophylaxis and urological pelvic cancer surgery: a UK national audit. BJU Int. 2015;115(2):223–9.
29. Chopra S, Metcalfe C, Castro Abreu AL, Azhar RA, Satkunasivam R, Desai M, et al. Port placement and docking for robotic surgery: the University of Southern California approach. J Endourol. 2015;29(8):868–72.
30. Collins JW, Hosseini A, Sooriakumaran P, Nyberg T, Sanchez-Salas R, Adding C, et al. Tips and tricks for intracorporeal robot-assisted urinary diversion. Curr Urol Rep. 2014;15(11):457.
31. Savera AT, Kaul S, Badani K, Stark AT, Shah NL, Menon M. Robotic radical prostatectomy with the "Veil of Aphrodite" technique: histologic evidence of enhanced nerve sparing. Eur Urol. 2006;49(6):1065–73. discussion 1073–4
32. Tewari A, Peabody JO, Fischer M, Sarle R, Vallancien G, Delmas V, et al. An operative and anatomic study to help in nerve sparing during laparoscopic and robotic radical prostatectomy. Eur Urol. 2003;43(5):444–54.
33. Ahlering TE, Eichel L, Skarecky D. Evaluation of long-term thermal injury using cautery during nerve sparing robotic prostatectomy. Urology. 2008;72(6):1371–4.
34. Goh AC, Gill IS, Lee DJ, Castro Abreu AL, Fairey AS, Leslie S, et al. Robotic intracorporeal orthotopic ileal neobladder: replicating open surgical principles. Eur Urol. 2012;62(5):891–901.
35. Fahmy O, Asri K, Schwentner C, Stenzl A, Gakis G. Current status of robotic assisted radical cystectomy with intracorporeal ileal neobladder for bladder cancer. J Surg Oncol. 2015;112(4):427–9.
36. Desai MM, Abreu AL, Goh AC, Fairey A, Berger A, Leslie S, et al. Robotic intracorporeal urinary diversion: technical details to improve time efficiency. J Endourol. 2014;28(11):1320–7.
37. Shah HN, Nayyar R, Rajamahanty S, Hemal AK. Prospective evaluation of unidirectional barbed suture for various indications in surgeon-controlled robotic reconstructive urologic surgery: Wake Forest University experience. Int Urol Nephrol. 2012;44(3):775–85.
38. Pham KN, Sack BS, O'Connor RC, Guralnick ML, Langenstroer P, See WA, Jacobsohn K. V-Loc urethro-intestinal anastomosis during robotic cystectomy with orthotopic urinary diversion. Can Urol Assoc J. 2013;7(11-12):E663–6.
39. Abreu AL, Chopra S, Azhar RA, Berger AK, Miranda G, Cai J, et al. Robotic radical cystectomy and intracorporeal urinary diversion: The USC technique. Indian J Urol. 2014;30(3):300–6.
40. Luchey AM, Agarwal G, Poch MA. Robotic-assisted radical cystectomy. Cancer Control. 2015;22(3):301–6.
41. Smith AB, Raynor M, Amling CL, Busby JE, Castle E, Davis R, et al. Multi-institutional analysis of robotic radical cystectomy for

bladder cancer: perioperative outcomes and complications in 227 patients. J Laparoendosc Adv Surg Tech A. 2012;22(1):17–21.
42. Pruthi RS, Nielsen ME, Nix J, Smith A, Schultz H, Wallen EM. Robotic radical cystectomy for bladder cancer: surgical and pathological outcomes in 100 consecutive cases. J Urol. 2010;183(2):510–4.
43. Ng CK, Kauffman EC, Lee MM, Otto BJ, Portnoff A, Ehrlich JR, et al. A comparison of postoperative complications in open versus robotic cystectomy. Eur Urol. 2010;57(2):274–81.
44. Yu HY, Hevelone ND, Lipsitz SR, Kowalczyk KJ, Nguyen PL, Choueiri TK, et al. Comparative analysis of outcomes and costs following open radical cystectomy versus robot-assisted laparoscopic radical cystectomy: results from the US Nationwide Inpatient Sample. Eur Urol. 2012;61(6):1239–44.
45. Nix J, Smith A, Kurpad R, Nielsen ME, Wallen EM, Pruthi RS. Prospective randomized controlled trial of robotic versus open radical cystectomy for bladder cancer: perioperative and pathologic results. Eur Urol. 2010;57(2):196–201.
46. Guru KA, Wilding GE, Piacente P, Thompson J, Deng W, Kim HL, et al. Robot-assisted radical cystectomy versus open radical cystectomy: assessment of postoperative pain. Can J Urol. 2007;14(6):3753–6.
47. Styn NR, Montgomery JS, Wood DP, Hafez KS, Lee CT, Tallman C, et al. Matched comparison of robotic-assisted and open radical cystectomy. Urology. 2012;79(6):1303–8.
48. Khan MS, Elhage O, Challacombe B, Murphy D, Coker B, Rimington P, et al. Long-term outcomes of robot-assisted radical cystectomy for bladder cancer. Eur Urol. 2013;64(2):219–24.
49. Wang GJ, Barocas DA, Raman JD, Scherr DS. Robotic vs open radical cystectomy: prospective comparison of perioperative outcomes and pathological measures of early oncological efficacy. BJU Int. 2008;101(1):89–93.
50. Niegisch G, Albers P, Rabenalt R. Perioperative complications and oncological safety of robot-assisted (RARC) vs. open radical cystectomy (ORC). Urol Oncol. 2014;32(7):966–74.
51. Aboumohamed AA, Raza SJ, Al-Daghmin A, Tallman C, Creighton T, Crossley H, et al. Health-related quality of life outcomes after robot-assisted and open radical cystectomy using a validated bladder-specific instrument: a multi-institutional study. Urology. 2014;83(6):1300–8.
52. Xia L, Wang X, Xu T, Zhang X, Zhu Z, Qin L, et al. Robotic versus open radical cystectomy: an updated systematic review and meta-analysis. PLoS One. 2015;10(3):e0121032.
53. Kader AK, Richards KA, Krane LS, Pettus JA, Smith JJ, Hemal AK. Robot-assisted laparoscopic vs open radical cystectomy: comparison of complications and perioperative oncological outcomes in 200 patients. BJU Int. 2013;112(4):E290–4.
54. Messer JC, Punnen S, Fitzgerald J, Svatek R, Parekh DJ. Health-related quality of life from a prospective randomised clinical trial of robot-assisted laparoscopic vs open radical cystectomy. BJU Int. 2014;114(6):896–902.
55. Smith ND, Castle EP, Gonzalgo ML, Svatek RS, Weizer AZ, Montgomery JS, et al. The RAZOR (randomized open vs robotic cystectomy) trial: study design and trial update. BJU Int. 2015;115(2):198–205.
56. Tandogdu Z, Vale L, Fraser C, Ramsay CA. Systematic review of economic evaluations of the use of robotic assisted laparoscopy in surgery compared with open or laparoscopic surgery. Appl Health Econ Health Policy. 2015;13(5):457–67.
57. Smith A, Kurpad R, Lal A, Nielsen M, Wallen EM, Pruthi RS. Cost analysis of robotic versus open radical cystectomy for bladder cancer. J Urol. 2010;183(2):505–9.
58. Mmeje CO, Martin AD, Nunez-Nateras R, Parker AS, Thiel DD, Castle EP. Cost analysis of open radical cystectomy versus robot-assisted radical cystectomy. Curr Urol Rep. 2013;14(1):26–31.
59. Lee R, Ng CK, Shariat SF, Borkina A, Guimento R, Brumit KF, et al. The economics of robotic cystectomy: cost comparison of open versus robotic cystectomy. BJU Int. 2011;108(11):1886–92.
60. Martin AD, Nunez RN, Castle EP. Robot-assisted radical cystectomy versus open radical cystectomy: a complete cost analysis. Urology. 2011;77(3):621–5.
61. Hayn MH, Hellenthal NJ, Seixas-Mikelus SA, Mansour AM, Stegemann A, Hussain A, et al. Is patient outcome compromised during the initial experience with robot-assisted radical cystectomy? Results of 164 consecutive cases. BJU Int. 2011;108(6):882–7.
62. Ahmed K, Ibrahim A, Wang TT, Khan N, Challacombe B, Khan MS, et al. Assessing the cost effectiveness of robotics in urological surgery – a systematic review. BJU Int. 2012;110(10):1544–56.
63. Johnson N, Barlow D, Lethaby A, Tavender E, Curr L, Garry R. Methods of hysterectomy: systematic review and meta-analysis of randomised controlled trials. BMJ. 2005;330(7506):1478.
64. Harkki-Siren P, Sjoberg J, Kurki T. Major complications of laparoscopy: a follow-up Finnish study. Obstet Gynecol. 1999;94:94–8.
65. Janssen PF, Brölmann HA, Huirne JA. Recommendations to prevent urinary tract injuries during laparoscopic hysterectomy: a systematic Delphi procedure among experts. J Minim Invasive Gynecol. 2011;18(3):314–21.
66. Tamussino K, Lang P, Breinl E. Ureteral complications with operative gynecologic laparoscopy. Am J Obstet Gynecol. 1998;178:967–71.
67. Menderes G, Clark LE, Azodi M. Incidental ureteral injury and repair during robotic-assisted total laparoscopic hysterectomy. J Minim Invasive Gynecol. 2015;22(3):320.
68. Magrina JF, Kho R, Magtibay PM. Robotic radical hysterectomy: technical aspects. Gynecol Oncol. 2009;113(1):28–31.
69. Lim PCW. Robotic assisted total pelvic exenteration: a case report. Gynecol Oncol. 2009;115(2):310–1.
70. Gomez RG, Ceballos L, Coburn M, et al. Consensus statement on bladder injuries. BJU Int. 2004;94:27–32.
71. Kniery KR, Johnson EK, Steele SR. Operative considerations for rectovaginal fistulas. World J Gastrointest Surg. 2015;7(8):133–7.
72. Koukouras D, Petsas T, Liatsikos E, Kallidonis P, Sdralis EK, Adonakis G, et al. Percutaneous minimally invasive management of iatrogenic ureteral injuries. J Endourol. 2010;24(12):1921–7.
73. Zhang Z, Zhang C, Wu C, Yang B, Wang H, Hou J, et al. Progressive ureteral dilations and retrograde placement of single-j stent guided by flexible cystoscope for management of ureteroenteral anastomotic stricture in patients after radical cystectomy and bricker urinary diversion. J Endourol. 2015;29(1):90–4.
74. Uflacker A, Sheeran D, Khaja M, Patrie J, Elias G, Saad W. Outcomes of percutaneous management of anastomotic ureteral strictures in renal transplantation: chronic nephroureteral stent placement with and without Balloon dilatation. Cardiovasc Intervent Radiol. 2015;38(3):693–701.
75. Xu YM, Feng C, Kato H, Xie H, Zhang XR. Long-term outcome of ileal ureteric replacement with an iliopsoas muscle tunnel antirefluxing technique for the treatment of long-segment ureteric strictures. Urology. 2016;88:201–6. pii: S0090-4295(15)01052-3
76. Gomez-Gomez E, Malde S, Spilotros M, Shah PJ, J Greenwell T, Ockrim JL. A tertiary experience of ileal-ureter substitution: contemporary indications and outcomes. Scand J Urol. 2016;50(3):192–9.

Robotic-Assisted Radical Hysterectomy with Anterior and Posterior Exenteration: Surgical Perspective

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Introduction

Cervical cancer is the fourth most common cancer in women, with an estimated 528,000 new cases/yr. worldwide. In 2012, it was also the fourth most common cause of cancer deaths in women worldwide. More than 70 % of all cervical cancers occur in underdeveloped areas [1]. Human papillomavirus (HPV) infection is regarded as the major cause of cervical intraepithelial neoplasia (CIN) and cervical cancer. Genital HPV infection is common in sexually active young women and persistent infection with carcinogenic HPV causes almost all cervical cancers. A minority of women with precancerous lesions develop invasive cancer [2–4]. The establishment of causal links between HPV and cervical cancer has helped to guide age-appropriate interventions for preventing cervical cancer [5].

The rates of incidence and death of cervical cancer have decreased gradually over the last decade due to early detection and treatment in most developed countries [6]. In the past, open radical hysterectomy (RH) through a midline incision, was the standard operative management for early stage cervical cancer. However, minimally invasive surgery for RH has recently become widespread as the result of advances in laparoscopic instrumentation and surgical techniques [7–10]. Many studies have demonstrated the safety, feasibility, and benefits of laparoscopic RH. The advantages of laparoscopic surgery include decreased blood loss, shorter recovery time, shorter hospital stay, earlier return of bowel and bladder function, and higher quality of life [9, 11, 12]. An increasing number of studies comparing the feasibility and advantages of robot-assisted surgery for early stage cervical cancer with conventional laparoscopy or laparotomy have appeared during recent years [13–16].

Here, we reviewed published articles to assess the current role of robotic surgery including RH and pelvic exenteration in women with cervical cancer.

Robotic Radical Hysterectomy

RH is one of the most complex surgeries in gynecologic oncology and is the standard surgical treatment for early stage cervical cancer. More than a century ago, the first abdominal RH was reported by Wertheim. The technique was then modified by Meigs in the 1950s [44]. Later, vaginal RH was described by Schauta in 1901. Laparoscopic RH with pelvic and paraaortic lymphadenectomy was introduced by Canis et al. in 1989. In the early 1990s, and over the last two decades, numerous studies have indicated that total laparoscopic RH is feasible.

Traditionally, RH has been associated with higher complication rates due to the numerous dissections required for the bladder, ureter, parametrium, and rectum. In the past two decades, gynecologic oncologic surgeons have utilized minimally invasive techniques to decrease morbidity while maintaining surgical and oncological outcomes. Many studies have demonstrated the safety and feasibility of laparoscopic RH as the treatment for early-stage cervical cancer. Although the laparoscopic approach provides long-term outcomes comparable to those of open radical hysterectomy, this approach was not widely adopted in surgical practice, due to disadvantages such as: long learning curve, two dimensional view, poor ergonomic position for surgeons, and limited movements of instruments. These conditions negatively influenced the surgical performance, resulting in tremor, fatigue, and less accuracy [37]. Laparoscopic RH also poses difficulties in ureteral and parametrial dissection similar to conventional laparoscopy [17]. Dissection is technically easier with robotic approaches [18]. The concept of robotic assisted surgery started in 1994 [45]. Initially developed for

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battlefield medicine, robot-assisted surgery was approved by the U.S. Food and Drug Administration in 1999 for urologic and cardiac procedures [43]. Robotic surgery has several advantages over laparoscopy: three dimensional vision, wristed instrumentation, less tremor, and ergonomic positioning for the surgeon while performing the surgical procedures [19]. Such benefits enhance dexterity and decrease skill-based error. Since 2005, the role of robots in gynecological surgery has increased, with robot assistance being used in many traditional procedures, including hysterectomy, prolapse surgery, myomectomy, tubal surgery, endometriotic and adnexal surgery, pelvic and paraaortic lymph node dissection, and sacrocolpopexy [26]. In procedures such as RH, that are technically challenging by laparoscopy [37, 38], the enhanced visualization provided by the robotic technique gives surgeons improved ability to identify tissue planes, blood vessels, and nerves during surgery [20]. Therefore, robotic surgery is reported to be associated with decreased blood loss in comparative studies.

The female pelvis is a confined space for surgeons to perform procedures. Standard laparoscopic instruments have more limited degrees of freedom than human hands, and they may hamper surgeons' procedures. Standard laparoscopic instruments have limited degree of positioning for the surgeon during intracorporeal knot tying. On the other hand, wristed robotic instrumentation, like human hands, provides greater dexterity with seven degrees of movement. Three degrees are provided by the robotic arms attached to the abdominal wall trocars (insertion, pitch, yaw) and 4 ° result from the "wristed" instruments (pitch, yaw, roll and grip). The degrees provided by the robotic arms attached to the abdominal wall trocars around the robotic instruments coordinate system origin and the center of mass. Pitch is the rotation around the lateral or transverse axis; yaw is the rotation around the vertical axis; and roll is the rotation around the longitudinal axis. The resultant improved dexterity allows finer, more delicate and tremor-free manipulation, dissection, removal, or resection of tissue. In addition, fatigue and physical discomfort can limit any surgical procedure. During laparoscopy, surgeons have to pose uncomfortably to successfully complete the surgical procedure because they need to reach over the patient. With robotic surgery, surgeons may sit comfortably at the surgical console from the vantage point of standing at the patient's head, and manipulate the hand controls and foot pedals in an ergonomic position. This may reduce fatigue and discomfort during complex surgical procedures.

The major disadvantages of robotic surgery include the cost, large volume of robots and consoles, limited availability within some health systems, and the need to train the residents, attending surgeons, and operating room personnel in the use of such technology. Another limitation of robotic surgery is the lack of haptic or tactile feedback. This has been noted to be a limitation for novice robotic surgeons, but they most quickly adapt and obtain heightened visual feedback from the magnified, three-dimensional vision system. If there are particular structures that surgeons desire to palpate, such as the cervicovaginal colpotomy ring during hysterectomy or sacral promontory during sacrocolpopexy, they can do so by laparoscopy before docking robots, or by asking the bedside assistant to palpate and confirm the location.

The first robotic assisted RH for cervical cancer was reported by Sert and Abeler in 2006 [21]. Since then, there have been several case series focusing on cervical cancer management. Kim et al. examined 10 patients with cervical cancer, and Fanning et al. included 20 patients in their analysis. These patients underwent robotic laparoscopic RH with only a few intraoperative complications; one patient had a cystectomy, which was repaired. They also had only a few postoperative issues; one patient had an uterovaginal fistula and one patient developed pneumonia, with operating time 355–390 min, and mean blood loss 207 and 300 ml, respectively. Recent systematic reviews and meta-analyses suggest that robotic RH may be superior to abdominal RH with less estimated blood loss, shorter hospital stays, less febrile morbidities, and wound-related complications. The percentage of robotic-assisted hysterectomies is increasing; while 0.5 % of total hysterectomies were performed robotically in 2007, 9.5 % utilized robotic techniques in 2010 [42].

Robotic RH and laparoscopic RH appear to have equivalent intraoperative and short-term postoperative outcomes [22]. Longer operative time and learning curve are among the reasons why the robotic technique has not yet been adopted worldwide in gynecologic oncology practice. In robotic surgery, total operation time consists of docking and console time. Docking time is the time needed to assemble instruments, attach patient to the robot, advance column to the operating table, fasten the robotic arms to the inserted trocars, and introduce the laparoscope. Console time is defined as the surgical time needed to perform the entire operation at the console. Operative time is defined by the anesthesiologists as the time between the insertion of the Foley catheter and the closing of the last trocar site. Sert and Eraker described 25 patients with early stage cervical cancer who had undergone robot-assisted RH and pelvic lymph node dissection, showing a total mean time of 219 min, with a mean console time of 170 min. Estape et al. compared 32 RH by robotic approach with 17 by laparoscopy and 14 by open surgery; the mean console time in the robotic, laparoscopic, and laparotomy groups was 2.4 h, 2.2 h, and 1.9 h, respectively [16]. Magrina et al. compared 27 patients who underwent robotic or modified RH with patients who underwent RH via laparoscopic and laparotomic approach. They found similar operative time from skin incision to skin closure between robotic (189.6 min) and laparotomic RH, but it was significantly shorter than the time required for the laparoscopic approach [20]. From a multi-institutional experience, Lowe and Chamberlain et al. found the median

operative time of robotic-assisted RH to be 215 min. From a prospective study of seven patients who underwent robot-assisted RH, Lowe and Hoekstra et al. found no statistically significant difference in operative times; 260 min in robot-assisted RH and 264 min in traditional RH [45]. Overall, surgical experience and personal learning curve may influence the operative time. Several studies demonstrated that the robotic docking time decreases significantly as surgeons and assistants gain experience, with the reported mean docking time being 10 min at the beginning and 2–3 min at the end of the learning curve [20, 38].

There is a general agreement on the significant decrease in intraoperative bleeding in minimally invasive surgery. An article reported similar levels of blood loss between robotic with laparoscopic RH; which were, importantly, different from those of open surgery. In patients who underwent robotic or laparoscopic RH, the overall rate of blood transfusion was very low. Sert and Abeler compared 35 patients who underwent hysterectomy via robotic radical (RRH), laparoscopic (TLRH) and laparotomic (ORH) approaches. The mean estimated blood loss was significantly reduced in the group of patients who received robot-assisted surgeries compared with those who received laparoscopic and laparotomy surgeries [41]. Blood transfusion rates for symptomatic postoperative anemia after robotic RH vary from 5 to 35 % [16, 39]. Magrina et al. reported that in the robotic group, one patient with an operative blood loss of 180 ml had an unexplained drop of Hb to 6.6 g on her first postoperative day. The patient was transfused and discharged the following day. In the laparotomy group, all three patients were transfused postoperatively, while one of them had preoperative anemia (Hgb 9.0 g/ml) secondary to postmenopausal bleeding [20]. Gortchev et al. compared 294 T1b1 cervical cancer patients; robot assisted RH was performed in 73 patients, laparoscopic-assisted vaginal RH in 46 patients, and abdominal RH in 175 patients. No significant differences between the three operative methods were found in the values of the postoperative hematocrit ($p = 0.153$), and between the pre- and postoperative hematocrit ($p = 0.253$). In a systematic literature review and meta-analysis by Geetha et al., 21 studies (1339 patients) of laparoscopic RH, 14 open RH (1552 patients) and 12 robotic RH (327 patients) were compared. Mean blood loss was significantly higher in open RH than in both laparoscopic and robotic RH (ANOVA $F(2.44) = 21.6$; $P<0.001$). The difference in blood loss between laparoscopic and robotic RH was not statically significant. Both laparoscopic and robotic RH had a significantly lower proportion of patients with blood transfusion compared with the open method (ANOVA $F(2.24) = 20.5$; $P<0.001$). Although the robotic RH appears to require less blood transfusion, the difference in transfusion percentage between laparoscopic and robotic RH was not statistically significant [46]. Moreover, Estape at al. compared 32 cases of RH by robotic approach with 17 by laparoscopy and 14 by open surgery. The results showed that the incidence of blood transfusion was highest (35.7 %) in the cases of laparotomy, with one patient given a blood transfusion pre-operatively due to anemia [16].

Lower rates of intraoperative complications occur in minimally invasive surgery compared with the open approach, due to more accurate tissue manipulation and better anatomic visualization [37]. The complication rates in radical robotic surgery vary in a wide range-from 7.8 to 59 %. Different criteria for defining minor complications and different periods of follow-up are the main reasons for the variations observed. Definitions of early and late postoperative complications also vary. Magrina et al. define early complications as those that occur in the first 6 weeks after the operation, while Maggioni et al. define them as those that occur in the first month after the operation [38]. Urinary injury, which may happen during ureterolysis and bladder isolation steps, is frequently reported in RH. Sert and Eraker described three cases of bladder perforation among 25 cases of robotic RH, which were successfully repaired robotically. A recent review comparing robotic versus total laparoscopic RH for early stage cervical cancer found similar overall rates (~6 %) of major intraoperative complications, with lower rates of vascular and bladder injury during robotic RH [37]. Estape et al. reported one cystotomy in the robotic group in a patient with three cesarean sections, and two cystotomies in the laparoscopic group. Another recent review article described a significant difference in the number of major postoperative complications between RRH (9.6 %) and TLRH (5.5 %). The RRH group included 11 cases of vaginal dehiscence, 10 cases of vaginal cuff abscess, and 5 cases of port site hernia [39]. On the contrary, no significant differences in the frequency of the complications were established in publications that compared the robotic with the open and/or laparoscopic surgery [16, 41].

An increased relative risk of vaginal cuff complication has been observed for minimally invasive hysterectomy techniques when compared with vaginal or abdominal ones. The study that observed this risk is controversial, due to the lack of a standardized method of classification and registration of postoperative injuries. A recent review showed a higher rate of vaginal dehiscence in the RRH group than in the laparoscopic group, which may be associated with the extensive use of monopolar and bipolar electrosurgery, which may increase thermal damage and devascularization of the cuff site. Other studies disagree with the above review and describe a similar incidence of vaginal cuff separation in laparoscopic and robotic hysterectomies [39]. Other organs are also under the risk of thermal injury. Thermal injury to bowel may be more difficult to diagnose intraoperatively [47]. Person et al. reported the leaking of lymphatic fluid through the vagina and/or vaginal cuff dehiscence in 10 out of 80 women (12 %) who underwent robotic RH with pelvic lymphadenectomy. The frequency of this complication was significantly different between three surgeons who performed robotic RH [37].

Magrina et al. reported that intraoperative injuries were noted in the laparoscopy group and laparotomy group only. One patient from the laparoscopy group had rectotomy during the resection of an invasive endometriotic lesion of the anterior rectal wall, and was included as complication, but was the only readmission. Another patient had an umbilical trocar site infection. In the laparotomy group, one patient developed pneumonia, one had sterile wound seroma, and one had ileus. Minor early complications (<6 weeks) in the robotic group consisted of one case of urinary retention and two of urinary tract infection. In the laparoscopic group, one patient had a corneal abrasion, one experienced urinary retention and one had passage of lymphatic fluid through the vagina on the fifth postoperative day through an intact vaginal cuff. In the laparotomy group, one patient had urinary retention, and two had vomiting [20]. Sert and Abeler et al. reported that three robot-assisted RH patients and one laparoscopic patient had accidental cystotomy, which was repaired peri-operatively. No readmission was required, and no bowel or ureter injuries happened [41].

Geetha et al. reported the mean percentage of patients with infectious morbidity for the three types of RH studies. Post-operative infectious morbidity was significantly higher among patients who underwent open RH compared with those who underwent RH via other methods (ANOVA F (2.36) = 6.24; P = 0.005). The difference in infectious morbidity between laparoscopy and robotic RH was well within the range for chance fluctuations. The mean percentage of patients with non-infectious morbidity for the three types of RH was similar (ANOVA F (2.37) = 1.80; P = 0.179). No cases of bowel injury were reported among patients who underwent robotic RH. The mean number of patients with ureteric injury after all three types of RH was similar (ANOFA F (2.39) = 1.21; P = 0.309). Ureteric injury was reported in 7/13 (53.9 %), 6/19 (31.6 %) and 2/10 (20 %) of ARH, LRH, and RRH studies, respectively [46].

Shorter hospital stay is one of the most important advantages of minimally invasive surgery. The length of hospital stay reflects the difference in the postoperative outcomes of the patients with different operative procedures. Factors that determine the hospital stay are: the ability of the patient to ambulate independently, recovery of the functions of the gastrointestinal tract and the ability to use oral drugs. Recovery of urinary bladder function (residual urine <50 ml) is not a determinant. All comparative studies of robotic RH reported a mean length of hospital stay of 1–2 days, which was similar in the laparoscopic RH group, but significantly shorter than in the open RH group [16, 37–40, 42]. Table 73.1 summarizes reports on robot assisted laparoscopic radical hysterectomy for early stage cervical cancer.

Increased maneuverability of the instruments with a robotic platform is most likely the reason for increased lymph node yield in the robotic group when compared with both laparoscopic and laparotomy groups [41]. Oncological outcomes after RH for early stage cervical cancer are determined by the number of lymph nodes retrieved and the recurrence rate. Results concerning the number of lymph nodes retrieved by the different surgical approaches are controversial. Several comparative studies found no significant differences in the number of lymph nodes retrieved between robotic, laparoscopic, and open techniques. A case control study which compared robotic to open type III RH found a better node retrieval outcome in the robotic approach. On the contrary, Maggioni et al. showed a reduced number of lymph nodes in the RRH group compared with the ORH group [37]. More recently, Estape et al. reported a case-matched comparative analysis between laparoscopic, robotic, and abdominal RH with lymphadenectomy, and reported a significantly higher number of nodes retrieved in the robotic approach and equivalent rates of positive surgical margins [37]. The increased lymph node yield may be explained by the agility of the robotic instruments that allows more comprehensive and accurate node dissection. The number of lymph nodes obtained may increase further following a learning curve [42].

Data about the follow-up period and recurrence rates in patients with cervical cancer who underwent robotic RH have been reported in a few articles [48, 51, 47, 49] Estape et al. reported that mean patient follow up was shortest for the robotic group (242.2 days) followed by the laparoscopic (941.6 days) and laparotomy groups (1382 days) [16]. Gortchev et al. reported that the mean follow-up period was significantly shorter in the robotic group (316 days), followed by the laparotomy (808 days) and laparoscopy groups (1531 days) [38]. All patients were followed according to the routine study protocol, including clinical examination, vaginal ultrasound, smear from the vaginal cuff, routine blood tests, and chest x-ray. The follow up examination was performed every 3 months during the first 3 years, every 6 months until 5 years and once a year thereafter. In some cases, MR scans of the pelvis, additional PET-CTs or CT scans were required [41].

Although robotic assisted-technology is theoretically an enhancement of conventional laparoscopy, several studies have reported the conversion of the robotic approach to laparotomy, not laparoscopy. There were six cases of conversion from robot-assisted laparoscopy to laparotomy in two studies due to: dense adhesions (n = 1), tumor erosion into the rectosigmoid colon (n = 2), non-life threatening bleeding from the vena cava (n = 2), and uterine myomas and obliterated cul-de-sac to avoid morcellation (n = 1). Some physicians are comfortable using the robot, while those who are not, continue the procedure using the traditional laparoscopic technique. This is of concern because the advantages of laparoscopy and robotic technology are comparable, whereas laparotomy leads to greater complications, such as more blood loss and longer hospital stay. Robotic assisted laparoscopy and traditional laparoscopy have differences.

Table 73.1 Summary of reports on RALPH for early stage cervical cancer

Study	Parameters	Patients (n)	OP time (min)	EBL (ml)	Transfusion rate (%)	LOS (days)	Complications (%)
Sert and Abeler [21]	Robot	7	241	71	0	4	57.1
	Lap	7	300	160	0	8	85.7
Magrina et al. [20]	Robot	27	190	131	3.7	1.7	7.4
	Lap	31	220	208	0	2.4	9.7
	Open	35	267	444	8.6	3.6	14.3
Ricardo et al. [16]	Robot	32	200	130	1	2.6	6
	Lap	17	180	209	0	2.3	4
	Open	14	120	621	5	4	4
Grigor et al. [38]	Robot	73	152	NM	NM	4	3
	Lap	46	232	NM	NM	4	1
	Open	175	168	NM	NM	9	9
Lambaudie et al. [52]	Robot	20	190	100	0	3	4
	Lap	12	210	400	0	7	2
Sert and Abeler [41]	Robot	35	263	82	2.8	3.8	20
	Lap	7	364	160	0	8.4	85.7
	Open	26	163	595	7	9.2	46.1
Estape et al. [39]	Robot	32	144	130	3.1	2.6	18.8
	Lap	17	132	209	0	2.3	23.5
	Open	14	114	621	35.7	4.0	28.6

Abbreviations: *RALRH* robot-assisted laparoscopic radical hysterectomy, *Lap* laparoscopy, *Op time* operation time, *EBL* estimated blood loss, *LOS* length of hospital stay, *NM* not mentioned

Because of the bulkiness and limitations unique to the robot, certain procedures, such as achieving hemostasis of uncontrolled bleeding and performing dissection and resection of bulky tissue (e.g., bowel resection and large tumors), are easier with traditional laparoscopy than with the robot. The robotic surgical approach may have negative effects on the training of surgical fellows, because some institutions rarely choose the traditional laparoscopic approach and, instead, choose the robotic approach when considering minimally invasive surgery. Future surgeons should be trained in both laparoscopy and robotic technology to take advantage of both techniques [42].

Surgical Procedure for Radical Hysterectomy

The round ligaments are clamped and divided, and a bladder flap is developed on either side. The top of the broad ligament is incised in a cranial direction. The infundibulopelvic ligament is clamped, transected, and doubly suture-ligated. At this point, the peritoneum on the lateral aspect of the broad ligament is dissected further laterally to expose the psoas major muscle. During the course of the dissection, the ureter is identified and dissected free at the point where it crosses the common iliac artery, which is then identified and cleared of fat, as is the external iliac vein. During the course of the dissection, the ureter is located posterior to the ovarian vascular complex. As the external iliac node dissection proceeds towards the iliac bifurcation, the internal iliac artery is identified and cleared of fat. Elevation of the external iliac vein exposes the obturator fossa, which is filled with fat and lymph nodes. The fat is dissected out of the fossa, and the obturator nerve and artery are cleaned of fat and lymph tissue. The dissection is carried laterally until the fascia of the obturator internus muscle is reached. Great care must be taken not to tear or otherwise injure the tributaries of the internal iliac veins because they bleed profusely and are very difficult to secure. When the obturator dissection is completed, the operator turns their attention to the common iliac node dissection. Again, great care must be taken not to injure the left common iliac vein. Next, the ureter is dissected inferiorly, removing the encompassing fibrofatty tissue, and reflecting it medially to be removed with the uterus. The uterine arteries and veins are clamped far laterally, just distal to their origin from the anterior division of the hypogastric artery. If the hypogastric artery is to be clamped, this should be performed distal to the origin of the superior and inferior gluteal arteries. At this point, the ureter is entering its tunnel through the cardinal ligament just cephalad to where it enters the wall of the bladder. The ureter is now free of the parametria. Next, the bladder pillars are identified, cut, and secured. The vesicouterine space is dissected downward well below the uterine cervix. The peritoneum between the uterosacral ligaments is divided, and the rectouterine space is developed and dissected downward below the cervix. The uterosacral ligaments are cut and suture-ligated. The lower cardinal ligament, deep parametrial fat, and fascia are clamped and cut medial to the



Fig. 73.1 Robotic radical hysterectomy. (**a**) Opening of the paravesical and pararectal spaces and dissection of the ureter (yellow rubber band ligation) and vessels. Resection of pelvic lymph nodes and the right lateral parametrium. (**b**) Dissection of the urinary bladder and vaginal wall. Removal of the specimen and closure of the vaginal cuff

ureter. The vagina is clamped approximately 4 cm below the cervix, and the specimen is removed. The peritoneum is drained with catheter and the abdominal incision closed [48] (Fig. 73.1).

Robotic Pelvic Exenteration

Pelvic exenteration (PE) has been used for 60 years to treat cancers of the lower and middle female genital tract in

radiated pelvis [27]. PE is a radical surgery involving the en bloc resection of the pelvic organs, including the internal reproductive organs, bladder, and rectosigmoid. The indications for PE include advanced primary or recurrent pelvic malignancies, among which centrally recurrent cervical carcinomas are most common; while other gynecologic, urologic, and rectal cancers are also included [28]. The following are contra-indications for PE: patients with major medical, psychiatric, or emotional co-morbidity, and incapacity; lower extremity lymphedema indicating unresectable disease; extrapelvic disease associated with poor prognosis; immobile tumors fixed to the pelvic sidewall (relative if bone can be resected); invasion of the proximal (S1 or higher) lumbosacral spine or lumbosacral plexus/sciatic nerves; and encasement of the external or common iliac vessels by the tumor [31]. Distant metastasis has also traditionally been a contraindication for PE with curative intent [28].

In 1948, Brunshwing introduced PE as the treatment for persistent or recurrent gynecological cancer [27]. The first study of this technique reported that among 22 patients studied, 5 died from the operation itself [30]. In the following 50 years, the criteria for selecting patients that would benefit the most from this extensive surgery were defined. Improvements in surgical techniques and peri-operative care, and implementation of reconstructive procedures reduced the operative mortality to 0–5.3 % [29]. PE is now considered a safe and feasible procedure that can help selected patients with no other options for cure, although the reported morbidity rates remain high (38–65 %) [32]. PE is associated with a significant complication rate, with ~40–50 % major complications and ~80 % minor complications [28]. The most common morbidity is infection (19–86 %), which includes wound infection, urinary tract infection, sepsis, and abscess. The most common late morbidities are intestinal obstruction and fistula (5–10 %) [30]. Mortality rate is 1–16 %, with disparate causes including sepsis, thromboembolic disease, and cardiopulmonary failure. Death in the perioperative period occurs in less than 5 % of patients, while women over the age of 65 have the highest risk [28]. Relative contra-indications are: ureteral obstruction, poor candidate for surgery because of medical comorbidities, or poor candidate for surgery because of inability to care for stomas or senility. Advanced age has previously been considered a relative contraindication to exenterative surgery, probably because older patients are more likely to have pre-existing medical conditions, such as heart disease, obstructive pulmonary disease, decreased renal function, and altered immunologic response [49].

The 5 year survival rate of patients who underwent PE for recurrent or persistent cervical cancer following surgery and radiotherapy or radiation therapy alone was 52 % [28, 29]. This result confirms that cervical cancer patients are appropriate candidates for PE. Even though vaginal, vulvar, and endometrial cancer patients can benefit from the operation, it is still debatable whether they are good candidates for such an aggressive surgery, given that their usual bad prognosis maybe due to the different biology and pathways of diffusion of their cancers.

The recent development of laparoscopic pelvic surgery and robotically assisted laparoscopic pelvic surgery, particularly in uro-oncology and colorectal cancer, has created new possibilities. Minimally invasive therapy can offer operative and early postoperative advantages, although the long-term oncological and palliative outcomes still have to be evaluated. Blood loss and transfusion rate are significantly reduced, and the time needed to recover oral intake and bowel function are reduced. The patients generally return to normal activity more quickly, although complication rates are more or less equivalent [31]. Careful selection of patients is vital for robotic-assisted PE to be successful. The tumor should be removed according to strict oncologic criteria (en-bloc removal of cancer, obtaining free margins, avoiding dissemination of tumor by manipulation of cancer mass) and correct surgical technique should be used in order to achieve urinary and fecal diversion [32]. Table 73.2 summarizes reports on robot assisted pelvic exenteration for cervical cancer.

Surgical Procedures for Pelvic Exenteration

PE is classified as anterior (APE), posterior (PPE), and total (PE). APE is the removal of the reproductive tract and bladder; PPE is the removal of the reproductive tract along with the rectosigmoid colon; and TPE is the removal of the reproductive tract, bladder, and rectosigmoid colon [29]. Here, we describe the surgical techniques for all three procedures.

Pelvic exenteration consists of three important and distinct components: determination of resectability, resection, and reconstruction. The procedure begins with the patient in a low lithotomy position to allow for abdominal and perineal portions of the surgery. Combined epidural and general anesthesia may be considered for additional postoperative pain control. PE is traditionally performed as an open abdominal procedure, but recent developments in laparoscopy and robotics have allowed for the minimally-invasive adaptation of the technique. First, the abdomen and pelvis are thoroughly examined for evidence of metastatic disease. Washings may be sent for cytology. Any suspicious lesion is biopsied and sent for frozen section to exclude the possibility of distant metastatic disease that would preclude complete resection or alter the surgical plan. For recurrent cervical cancer, low para-aortic and pelvic lymph node dissection may be performed again to preclude metastatic spread beyond the pelvis. Lateral involvement of disease to the pelvic sidewall should be assessed at this time [27, 28, 50]. The round ligaments are divided, and the paravesicular and pararectal spaces are

Table 73.2 Summary of reports on robotic pelvic exenteration for cervical cancer

Study	Publication type	Histologic type	Type of operation	Procedure duration, (min)	Blood loss, (ml)	Complications	Postoperative stay (days)
Lambaudie et al. [25]	Case report	Squamous cell carcinoma	Anterior pelvic exenteration	480	200	Perineal abscess, Miami pouch fistula, ureteral stenosis	53
Akhil et al. [30]	Case report	Squamous cell carcinoma	Total pelvic exenteration	240	300	NM	11
Davis et al. [36]	Case report	Squamous cell carcinoma	Anterior pelvic exenteration	540	550	NM	8
Lim et al. [24]	Case report	Squamous cel carcinoma	Total pelvic exenteration	375	375	None	10
Lavazzo et al. [33]	Cases	Squamous cervical cancer	Anterior pelvic exenteration	375–600	200–550	Postoperative complications-perineal abscess, ureteral stenosis	3–53

NM not mentioned

developed. At this time, the pelvic sidewalls may again be examined. At this point, the extent of PE must be determined. Total PE includes removal of the bladder and distal uterus, portions of rectum and sigmoid colon, internal reproductive organs, and vagina.

En bloc resection Removal of the specimen begins with the ligation and division of the fibrovascular pedicle containing the uterine vessels, cardinal ligament, and ureter bilaterally. The uterine artery is ligated at its origin from the hypogastric artery, lateral to the ureter. The infundibulopelvic ligaments are ligated above the level of the common iliac vessels. The sigmoid is then mobilized and transected with a gastrointestinal anastomotic stapler, and the sigmoid vessels are identified and ligated. Care must be taken to preserve blood flow to the remaining colon-usually the sigmoid and the sacrum are developed to the level of the levator ani muscles. The avascular plane between the sigmoid and the sacrum is developed to the level of the levator ani muscles. The prevesicular space is extended bluntly. At this point, the specimen should be freely mobile in the pelvis. The perineal portion of the procedure is then performed. An incision is marked to include the urethra, vaginal opening, anus, and possibly the vulva. The muscles of the pelvic floor are transected circumferentially. The pubococcygeal and anococcygeal ligaments are identified and divided. Upon completion of the dissection, the entire specimen is free to be removed.

Anterior pelvic exenteration Anterior PE involves the removal of the bladder and internal reproductive organs but spares the gastrointestinal tract. The rectosigmoid, anus, and lower portion of the posterior vagina are left intact. Bimanual palpation, in which the pelvic hand inserts one finger into the vagina and another into the rectum, while the abdominal hand palpates the posterior cul-de-sac and retracts the rectum posteriorly, will confirm the initial impression that an anterior resection is advisable. If the space posterior to the cervix feels free, then an incision can be made in the cul-de-sac to allow the rectum to drop away from the upper vagina, leaving at least 4 cm margin on the vagina. The potential space between the rectum and posterior vagina is developed abdominally, and adequacy of the margin is confirmed by direct vision vaginally. The posterior vaginal incision is made from below, with the cancer in view, to ensure adequate margin. Biopsies of the vagina, which will be left intact over the rectum, are sent for frozen section. The perineal incision is made, removing the urethra and surrounding soft tissue, but preserving the clitoris and labia (Fig. 73.2).

Posterior pelvic exenteration Posterior exenterations are rarely performed, except for primary stage IVA cancers of the cervix invading the rectum. Posterior PE removes the internal reproductive organs and rectosigmoid, but spares the anterior vagina, urinary bladder, and uterus. After dividing the round ligaments and developing the perivesicular and perirectal spaces, the peritoneum between the bladder and uterus is incised, and the bladder is reflected as inferiorly as possible with sharp dissection. The uterus is then mobilized and dissected free of soft tissue attachments, similar to the technique for RH. The uterine arteries are divided at their origin and reflected medially, trying to preserve other branches of the internal iliac arteries. The cardinal ligaments are then divided laterally, the ureteral dissection is completed to the bladder, and the anterior vagina is entered. The rectosigmoid is freed posteriorly, the parametrium is mobilized medially, and the dissection is carried down to the levator muscles, identical to the posterior dissection in a total exenteration. The perineal incision will involve only the posterior aspect of the vulva and anus. An omental flap and small pack

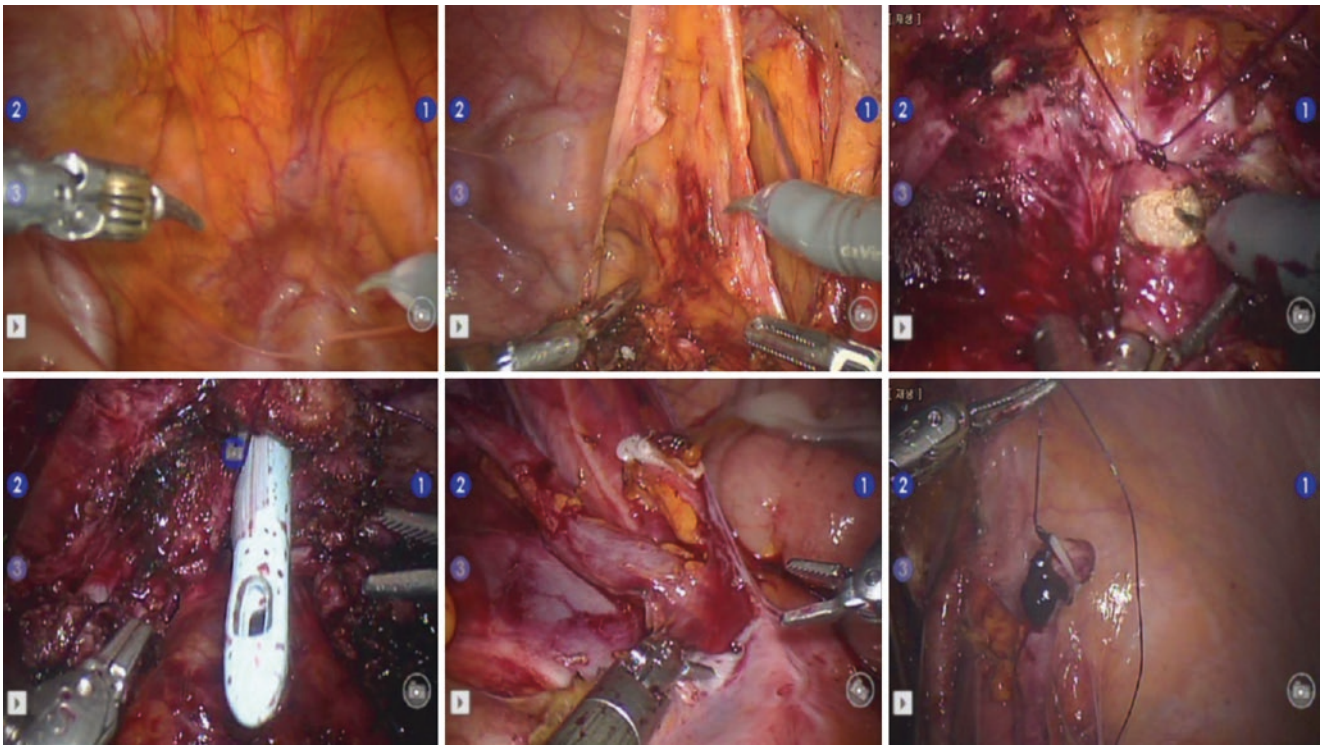


Fig. 73.2 Robot-assisted pelvic exenteration-Anterior PE. Dissection of the lateral pelvic wall and urinary bladder. Resection of the urinary bladder and mobilization of the ureter. Preparing of the urinary diversion to the lower abdominal wall

can be used to complete the management of the defect, and colostomy is performed (Fig. 73.3).

Supralevator pelvic exenteration Women with disease extending posteriorly from the cervix onto the vaginal epithelium or into the rectal wall are candidates for this procedure, provided the cancer does not extend to the lower third of the vagina posteriorly. After the bladder, urethra, and anterior vagina are mobilized, as previously described, the posterior vaginal wall incision is made 4 cm below the tumor. The vaginal epithelium is mobilized for 1–2 cm away from the rectal muscularis. The hand then encircles the mobilized rectum and pulls it cephalad. The specimen side is clamped to reduce spillage of feces and divided, leaving an anal and rectal stump. The length of the anal rectal stump from the anal sphincter is ideally 6 cm or greater. If less than 6 cm in length, the risk of fistula and incontinence is greater. After mobilization of this lower specimen, the sigmoid colon is divided along with the sigmoidal arteries and the superior rectal artery. Ample mobilization for reanastomosis is accomplished by incising the lateral attachments of the sigmoid and descending colon, mobilizing it and, if necessary, sacrificing some of the sigmoidal vessels. The major blood supply is from the inferior mesenteric artery, which has significant anastomoses between it and the middle colic artery. After the sigmoid and left colon are mobilized, the colon should be observed for adequacy of blood supply and viability while the urinary diversion is done, and the flaps for neovaginal construction are harvested. The anastomosis is accomplished using 28–31 mm-diameter circular staplers. Following anastomosis, the omentum is mobilized and brought into the pelvis as an omental graft. It is used to wrap the low rectal anastomosis and to fill the presacral space.

Reconstruction

Urinary Diversion The standard urinary diversion for several decades was the urinary conduit using a segment of the ileum to which the ureters would be anastomosed, and a stoma created in the right lower abdomen. Currently, the preferred method of urinary diversion is a continent pouch, created from the distal ileum, ascending colon, and a portion of the transverse colon. The ileum is divided 10–12 cm proximal to the ileocecal valve, and the transverse colon is divided just distal to the middle colic artery (Miami pouch). An ileotransverse colon enterostomy is performed to restore continuity to the gastrointestinal tract. The isolated segment of bowel is opened with cautery along the tenia. The bowel is then folded on itself in a U-shape conduit and the edges closed with a stapling device. This formation of the colon creates a reservoir and interrupts the ability of the bowel to peristalsis and increase the pouch pressure.

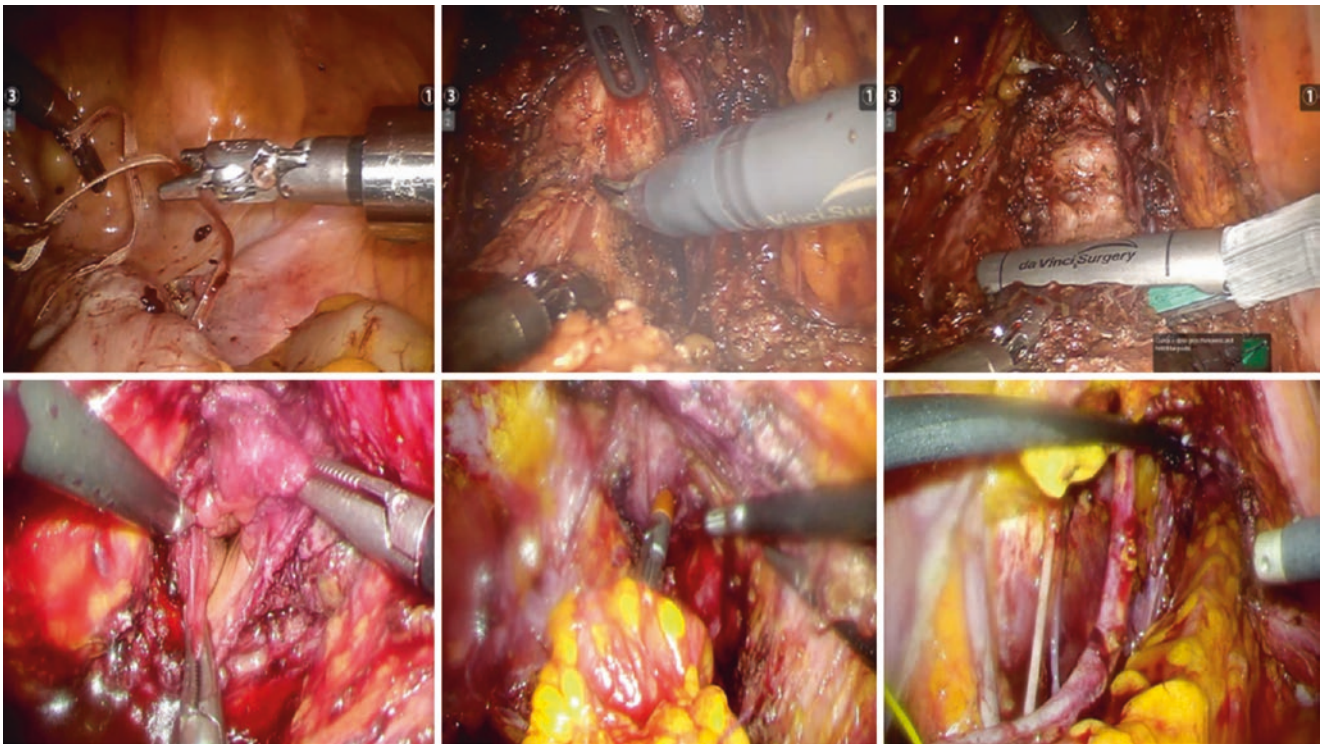


Fig. 73.3 Robot-assisted pelvic exenteration-Posterior PE. Developing of the perirectal spaces and dissection of the rectosigmoid colon. Resection of the rectosigmoid colon above the levator muscles. Reconstruction of the proximal sigmoid colon to the rectal stump

The ureters brought through stab wounds into the bowel reservoir, and the spatulated ends are anastomosed mucosa to mucosa. The left ureter is brought through the sigmoid mesentery to reach the reservoir. A 14 French catheter is placed into the ileum and passed through into the reservoir. Excess ileum is excised from the antimesenteric edge with a stapling device, and three purse string sutures are placed at the ileocecal valve to tighten the ileum. The tapered end of the ilium is brought out as a stoma. The ureters are stented and, with a Malecot catheter, are brought out through the anterior wall of the reservoir and through a separate opening in the abdominal wall. Stents and catheter are removed 2 weeks postoperatively.

Fecal diversion For patients whose disease requires infralevator dissection posteriorly, permanent end colostomy will be required because the anal sphincter is compromised or excised. If the sphincter and enough rectum may be spared without compromising the chance at complete disease resection, low rectal anastomosis with circular staplers is a reasonable option, if enough healthy tissue remains. To improve the frequency of stooling by improving the reservoir of the rectum, a colonic J-pouch may be used, particularly in patients with very little rectum remaining (less than 5 cm) [27, 28, 50, 51].

Robotic systems maintain the advantages of conventional laparoscopy while enabling the surgeon to dissect down and into the narrow pelvic floor. 3D stereoscopic vision (facilitated by the use of binocular optical systems), tremor filtration, and reduced operators' fatigue are the obvious advantages of robotic technology. The articulated instruments permit a wide range of motions while increasing the ability of the operator to work efficiently within the confines of the pelvic floor. All of these advantages can help procedures to preserve anatomic structures of the pelvis and make both destruction and reconstruction phases of PE easier [31, 32]. Moreover, the harmonic scalpel enables control of the pelvic sidewall vessels and transaction of the ligamentous attachments around the extirpated pelvic structures. Intestinal anastomosis after colorectal cancer resection can be performed by an experienced surgeon, in accordance with current oncologic guidelines. In addition, the 360° motion of a robotic wrist permits fine suturing that is necessary for performing ureteral iliostomy and ideal loop urinary diversion [34]. Robotic assisted laparoscopic surgery is associated with significantly less blood loss, less pain, shorter recovery time, shorter hospital stay, and better aesthetic results. Furthermore, shorter hospital stays and quicker return to normal activity may mean that postoperative chemotherapy or radiation can begin earlier, and complications related to bowel adhesions caused by radiation can be reduced [28, 32].

The cases of robotic-assisted laparoscopic PE with urinary diversion performed extracorporeally (ileal conduit diversion + orthotopic neobladder) were first described by Pruthi et al. [23] in 12 women with localized bladder cancer. Lim [24] reported the first case of robotic assisted total PE with ileal loop urinary diversion and end colostomy for the treatment of recurrent cervical cancer. Lavazzo et al. reported eight patients between 43 and 67 years of age treated with robotic-assisted PE for IB2 to IVA squamous cell carcinoma of the cervix. In 7 out of the 8 patients, anterior PE was performed; the other woman underwent total PE, with the duration ranging from 375 to 600 min, and blood loss from 200 to 550 ml. Postoperative complications occurred in two patients and included perineal abscess, Miami pouch fistula, and ureteral stenosis. Postoperative hospital stay ranged from 3 to 53 days, while postoperative follow-up ranged from 2 to 31 months [32].

Lawande et al. reported a 35 year old female with advanced cervical cancer who presented with vesicovaginal and rectovaginal fistula. They performed total robotic PE with colo-anal anastomosis and uretero-sigmoidostomy. The total operation time was 240 min and the console time was 120 min. The estimated blood loss was 300 ml and the intensive care unit stay was 2 days. Post-operatively, the patient had good fecal and urinary continence and high quality of life [26].

Davis et al. reported two women, 50 and 58 years old respectively, who required anterior PE for recurrent cervical cancer (squamous cervical cancer-IVB). Mean operation time was 9 h, mean blood loss was 550 ml, and postoperative hospital stay was 8 days. Postoperative complications were not mentioned. The authors reported that the robotic system is promising in patients needing surgery for recurrent cervical cancer. It provides improved visualization of the deep pelvis, enhanced manipulation of radiated fibrotic tissue, and reduced blood loss [36]. Subsequently, Lambaudie et al. reported a case series of three patients who underwent robot-assisted total PE [25]. Interestingly, the urinary diversion was made extracorporeal by transrectal laparotomy. The authors reported that with regard to hospital stay, there was no benefit compared with laparotomy, essentially due to urinary diversion management (catheterization) and self-catheterization to preserve the nerve.

Given the radical and prolonged nature of this procedure, patients and providers must be prepared for a long and potentially complicated hospital course. Many patients, after operation, need to stay in the intensive care unit immediately for close monitoring, particularly for dramatic fluid shifts. Blood loss may be high with transfusion required in most patients. Special attention to prophylaxis for thromboembolism, respiratory care, and nutrition is required. Some patients will require total parenteral nutrition due to prolonged inability to eat postoperatively to prevent relatively common ileus [43].

All series show that about 25–40 % of well selected patients with no metastatic disease survive for a minimum of 5 years. Patients who had palliative exenteration may still benefit from surgery in terms of quality of life and life expectancy of 18–24 months. The organ and histological subtypes often have significant influence on long-term prognosis. As a rule, exenteration for colonic and rectal adenocarcinomas results in better survival. This may be partly due to better responsiveness to chemotherapy and new small molecule-targeting agents. Cervical cancer also shows reasonably good survival due to its response to radiation therapy [31].

Considering the novelty of this minimally invasive procedure, several principles and standards must be rigorously evaluated and maintained. First, it remains paramount to observe and maintain the oncologic principles of such procedure without surgical modifications. That is, pathologic endpoints and consequent oncologic outcomes must never be compromised with such new techniques. Second, such procedures should have appropriate perioperative outcomes including operation time, blood loss, and length of hospital stay. Such measures may reflect and influence morbidity, recovery, and operative difficulty (i.e., the learning curve) of surgeons. For example, in robotic prostatectomy procedures, operation time has been used as an indirect measure of surgical difficulty and progress in overcoming the learning curve [35].

Conclusions

In summary, laparoscopy and robotics are preferable to laparotomy for patients requiring RH, with some advantages noted for robotics over laparoscopy. Current evidence demonstrates the safety and feasibility of robotic-assisted RH for early stage cervical cancer. Robotic approach provides clear benefits of minimally invasive surgery, such as lower morbidity, reduced blood loss, and faster recovery than open surgery. Further studies are necessary to evaluate long term survival and to analyze morbidity after surgery and adjuvant therapies.

Despite the apparent encouraging early results suggesting the advantage of minimally invasive surgery for PE, questions remain about the surgical effectiveness of this approach. Further studies on minimally invasive techniques for PE are needed prior to widespread clinical application of these techniques. Furthermore, research should also focus on the postoperative quality of life and other benefits for the patient.

References

1. GLOBOCAN Cancer Fact Sheet- globocan 2012. Available at: http://www.iarc.fr/en/media-centre/pr/2013/pdfs/pr223_E.pdf.
2. Schiffman M, Castle PE, Jeronimo J, Rodriguez AC, Wacholder S. Human papillomavirus and cervical cancer. Lancet. 2007;370:890–970.

3. Winer RL, Hughes JP, Feng Q, et al. Condom use and the risk of genital human papillomavirus infection in young women. N Engl J Med. 2006;354:2645–54.
4. Min KJ, Lee JK, Lee S, Kim MK. Alcohol consumption and viral load are synergistically associated with CIN1. J Open Access. 2013; doi:10.1371/journal. pone.0072142.
5. Lee S, Kim JW, Hong JH, et al. Clinical significance of HPV DNA contesting in Korean women with ASCUS or ASC-H. Diagn Cytopathol. 2014;23:1058–62.
6. Vizcaino AP, Moreno V, Bosch FX, et al. International trends in incidence of cervical cancer: II. Squamous-cell carcinoma. Int J Cancer. 2000;86:429–35.
7. Canis M, Mage G, Pouly JL, et al. Laparoscopic radical hysterectomy for cervical cancer. Baillieres Clin Obstet Gynaecol. 1995;9:675–89.
8. Nezhat CR, Burrell MO, Nezhat FR, et al. Laparoscopic radical hysterectomy with paraaortic and pelvic node dissection. Am J Obstet Gynecol. 1992;166:864–5.
9. Frumovitz M, dos Reis R, CC S, et al. Comparison of total laparoscopic and abdominal radical hysterectomy for patients with early-stage cervical cancer. Obstet Gynecol. 2007;110:96–102.
10. Nezhat F, Mahdavi A, Nagarsheth NP. Total laparoscopic radical hysterectomy and pelvic lymphadenectomy using harmonic shears. J Minim Invasive Gynecol. 2006;13:20–5.
11. Obermair A, Ginbey P, McCartney AJ. Feasibility and safety of total laparoscopic radical hysterectomy. J Am Assoc Gynecol Laparosc. 2003;10:345–9.
12. Ramirez PT, Slomovitz BM, Soliman PT, et al. Total laparoscopic radical hysterectomy and lymphadenectomy: the M. D. Anderson Cancer Center experience. Gynecol Oncol. 2006;102:252–5.
13. Sert MB. Comparison between robot-assisted laparoscopic radical hysterectomy (RRH) and abdominal radical hysterectomy (ARH): a case control study from EIO/Milan. Gynecol Oncol. 2010;117:389–90.
14. Geisler JP, Orr CJ, Khurshid N, et al. Robotically assisted laparoscopic radical hysterectomy compared with open radical hysterectomy. Int J Gynecol Cancer. 2010;20:438–42.
15. Maggioni A, Minig L, Zanagnolo V, et al. Robotic approach for cervical cancer: comparison with laparotomy: a case control study. Gynecol Oncol. 2009;115:60–4.
16. Estape R, Lambrou N, Diaz R, et al. A case matched analysis of robotic radical hysterectomy with lymphadenectomy compared with laparoscopy and laparotomy. Gynecol Oncol. 2009;113:357–61.
17. Swan K, Advincula AP. Role of robotic surgery in urogynecologic surgery and radical hysterectomy: how far can we go? Curr Opin Urol. 2011;21:78–83.
18. Sert BM, Abeler VM. Robotic-assisted laparoscopic radical hysterectomy (Piver type III) with pelvic node dissection: case report. Eur J Gynaecol Oncol. 2006;27:531–3.
19. Corcione F, Esposito C, Cuccurullo D, et al. Advantages and limits of robot-assisted laparoscopic surgery: preliminary experience. Surg Endosc. 2005;19:117–9.
20. Magrina JF, Kho RM, Weaver AL, Montero RP, Magtibay PM. Robotic radical hysterectomy: comparison with laparoscopy and laparotomy. Gynecol Oncol. 2008;109:86–91.
21. Sert B, Abeler V. Robotic radical hysterectomy in early-stage cervical carcinoma patients, comparing results with total laparoscopic radical hysterectomy cases. The future is now? Int J Med Robot. 2007;3:224–8.
22. Shzly SA, Murad MH, Dowdy SC, Gostout BS, Famuyide AO. Robotic radical hysterectomy in early stage cervical cancer: a systemic review and meta-analysis. Gynecol Oncol. 2015;138:457–71.
23. Pruthi RS, Stefaniak H, Hubbard JS, Wallen EM. Robot-assisted laparoscopic anterior pelvic exenteration for bladder cancer in the female patient. J Endourol. 2008;22:2397–402.
24. Lim PC. Robotic assisted total pelvic exenteration: a case report. Gynecol Oncol. 2009;115:310–1.
25. Lambaude E, Narducci F, Leblanc E, Bannier M, Houvenaeghel G. Robotically-assisted laparoscopic anterior pelvic exenteration for recurrent cervical cancer: report of three first cases. Gynecol Oncol. 2010;116:582–3.
26. Lawande A, Kenawadekar R, Desai R, et al. Case report. Robotic total pelvic exentration. J Robot Surg. 2014;8:93–6. doi:10.1007/s11701-013-0404-5.
27. Hockel M, Dornhofer N. Pelvic exentration for gynecological tumors; achievements and unanswered guestions. Lancet Oncol. 2006;7:837–47.
28. Diver EJ, . Alejanro Rauh-Hain J, Del Carmen MG. Total pelvic exentration for gynecologic malignancies. Int J Surg Oncol. 2012; doi:10.1155/2012/693535.
29. Maggioni A, Roviglione G, Landoni F, et al. Pelvic exenteration; ten-year experience at the Europan Institute of Oncology in Milan. Gynecol Oncol. 2009;114:64–8.
30. Jonathan S. Berek, Candace Howe, Leo D. Lagasse, Neville F. Hacker Gyncol Oncol. 2005;99:153–9.
31. Boustead GB, Feneley MR. Pelvic exentrative surgery for palliation of malignant disease in Robotic Era. Clin Ongol. 2010;22:740–6.
32. Lavazzo C, Gkegks ID. Review article Robotic technology for pelvic exentration in cases of cervical cancer. Int J Obstet Gynecol. 2014;125:15–7.
33. Kaufmann OG, Young JL, Sountoulides P, Kaplan AG, Dash A, Ornstein DK. Roboic radical anterior pelvic exentration: the UCI experience. Mini Invasive Therapy. 2011;20:240–6.
34. Guru KA, Nogueira M, Piacente P, Nyquist J, Mohler JL, Kim HL. Rapid communication: Robot-assisted anterior exentration: technique and initial series. J Endourol. 2007;21:633–9.
35. Herrell SD, Smith Jr JA. Robotic assisted laparoscopic prostatectomy: what is the learning curve? Urology. 2005;66:105–7.
36. Davis MA, Adams S, Eun D, Lee D, Randall TC. Robotic-assisted laparoscopic exenteration in recurrent cervical cancer Robotics improved the surgical experience for 2 women with recurrent cervical cancer. Am J Obstet Gynecol. 2010;202:582–3.
37. Renato S, Mohamed M, Serena S, et al. Robot assisted radical hysterectomy for cervical cancer: review of surgical and ongological outcomes. ISRN Obstet Gynecol. 2011; doi:10.5402/2011/872434.
38. Gortchev G, Tomov S, Tantchev L, Velkova A, Radionova Z. Robot-assisted radical hysterectomy-perioperative and survival outcomes in patients with cervical cancer compared to laparoscopic and open radical surgery. Gynecol Surg. 2012;9:81–8. doi:10.1007/s10397-011-0683-7.
39. Estape R, Lambrou N, Diaz R, et al. A case matched analysis of robotic radical hysterectomy and pelvic lymphadenectomy compared with laparoscopy and laparotomy. Gynecol Oncol. 2009;113:357–61.
40. Pasic RP, Rizzo JA, Fang H, Ross S, Moore M, Gunnarsson C. Comparing robot-assisted with convntional laparoscopic hyserectomy: impact on cost and clinical outcomes. J Minim Invasive Gynecol. 2010; doi:10.1016/j.jmig.2010.06.009.
41. Bilal Sert M, Abeler V. Robot-assisted laparoscopic radical hysterectomy: comprison with total laparoscopic hysterectomy and abdominal radical hysterectomy; one surgeone's experience at the Norwegian Radium Hospital. Gynecol Oncol. 2011;121:600–4.
42. Cho JE, Nezhat FR. Robotic and gynecologic oncology: review of the literature. J Minim Invasive Gynecol. 2009; doi:10.1016/j.jmig.2009.06.024.
43. Committee opinion. The American College of Obstetricians and Gynecologists, Committee Opinion, Number 628, March 2015.
44. E. Ancuta, Codrina Ancuta, L. Gutu. Robotic surgery versus abdominal and laparoscopic radical hysterectomy in cervical cancer. 2012. http://www.intechopen.com/books/.

45. Lowe MP, Chamberlain DH, Kamelle SA, Johnson PR, Tillmans TD. A multiinstitutional experience with robotic-assisted radical hysterectomy for early stage cervical cancer. Gynecol Oncol. 2009;113:191–4.
46. Geetha P, M. KN. Laparoscopic, robotic and open method of radical hysterectomy for cervical cancer: a systematic review. J Mini Access Surg. 2012;8:67–73.
47. Busmar B. Comparison between Robotic radical Hysterectomy with laparoscopic and open abdominal radical hysterectomy in the treatment of early stage cervical cancer. World J Lap Surg. 2015;8:26–31.
48. Michael S. Baggish, Mickey M. Karram. Atlas of pelvic anatomy and gynecologic surgery. 2nd edn. Saunders. 2006. p. 184–98.
49. Gressel GM, Partride EE, Makhiji S. Pelvic exenteration. Glob Lib Women's Med. 2015; doi:10.103843/GLOWM.10233.
50. Rock J, Jones H. Te Line's operative gynecology. 10th ed. Philadelphia: Lippincott, Williams, and Milkins; 2011.
51. Exentreation for gynecologic cancer: guidance for healthcare workers.c2014 [updated 2014 Jul 21]. Available from: http://www.uptodate.com/.
52. Lambaudie E, Houvenaeghel G, Walz J, et al. Robot-assisted laparoscopy in gynecologic ongology. Surg Endosc. 2008;22:2743–7.

Robotic-Assisted Laparoscopic Hysterectomy and Endometriosis

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Camran Nezhat, Erika Balassiano, Ceana H. Nezhat, and Azadeh Nezhat

Introduction of Robotic Surgery in the Field of Gynecology

Leonardo da Vinci sketched the first prototype of a robot in 1464 when he was 12 years old (Fig. 74.1). His life-sized armored robot knight was not realized until 1495 when it was built for the entertainment of his patron, the Duke of Sforza, at a celebration in the Court of Milan [1]. Five hundred years later, the field of robotics is not limited to entertainment, but has improved many aspects of everyday life. In medicine, for example, robotics has brought advancements to minimally invasive surgery.

The da Vinci robot was developed by the Medical Technology Laboratory (MTL) team, at the Stanford Research Institute (SRI), under the direction of Dr. Ajit Shah in early 1990s [2]. In collaboration with the Department of Defense and the National Aeronautics and Space Administration, the initial objective was to allow military surgeons to perform surgery from a remote location on wounded soldiers in mobile medical facilities close to the battlefield [3]. As the technology further developed with improved visual systems, articulating instrument manipulators, and better ergonomics, new uses for the robotic telepresence technology evolved and the robotic system was adapted to civilian surgical use as a new minimally invasive surgical technology.

The da Vinci® Robotic Surgical System (Intuitive Surgical® Inc., Sunnyvale, CA) pioneered as the first integrated three-dimensional viewing systems for minimally invasive surgery. The first successful telesurgery with the da Vinci® was a cholecystectomy performed in 1997 by Jacques Himpens and Guy Cardier in Brussels, Belgium [4]. A few years later in 2000, the U.S. Food and Drug Administration approved the da Vinci® Surgical Robotic device for laparoscopy, and in 2005, it was specifically approved for laparoscopic hysterectomy. Its current breadth of medical applications includes minimally invasive cardiothoracic surgery, urology, colorectal, general surgery, otolaryngology, and gynecology.

In the field of gynecology, the da Vinci® surgical system assists with a number of procedures including hysterectomy, myomectomy, complex resections of endometriotic lesions, tubal reversal, sacral colpopexy, and oncology surgery [5]. Since its introduction in 2000 to the U.S. market, the number



Fig. 74.1 A recreation of da Vinci's robot, fashioned in German-Italian medieval armor, was able to make several human-like movements. This model is on display in Berlin

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of surgeon users has exponentially increased. Its widespread acceptance and application to gynecologic surgery can be attributed to its ease of use over conventional laparoscopy which subjects surgeons to counterintuitive hand movements, 2-dimensional video images, limited degrees of instrument motion, in addition to ergonomic challenges and tremor amplification [5]. Currently, there are over 3000 da Vinci® Systems installed worldwide and more than 2000 in the U.S. alone. The number of da Vinci® procedures performed in 2009 was 180,000 and within 1 year the number of procedures increased by 35 % to 278,000 in 2010 [6].

Advantages

The most obvious advantages of minimally invasive surgery are smaller incisions, less pain, shorter hospital stays, faster postoperative recovery, and improved patient satisfaction. Specific features of the da Vinci® Robotic System that enhance laparoscopic surgery are the immersive, high definition, 3-dimensional visual imaging which allows the surgeon to have better depth of perception and ability to magnify (x2 to x10). The computer can translate the surgeon's hand movements into the same movements of the robotic instruments. The robotic wrist can roll (twisting motion), pitch (up/down), yaw (side-to-side), and grip, allowing the surgeon 7° of freedom for each hand. Dexterity is further enhanced through computer motion scaling which allows the surgeon to make large macroscopic movements that the computer translates into microscopic movements of the instrument tips in the surgical field. In addition, the computer filters out high frequency hand motion and decreases operator tremor. The surgeon console decreases operator fatigue by allowing the surgeon to sit and comfortably perform the procedure.

Disadvantages

Certainly, there are some drawbacks to robotic surgery. The initial cost for the hospital system is high. A da Vinci® Robotic Surgical System costs slightly under $two million with an annual maintenance average cost of $140,000 per year. The cost-per-case for drapes and instruments is approximately $1000 [6]. The three component robotic system is bulky and requires large operating room space to comfortably accommodate and maneuver the system components. The unwieldy robotic arms have large excursion arcs that lead to frequent collisions and limitations on the placement of ports on the patient's torso. Furthermore, the bedside surgical assistant has to maneuver around the large robot and manage the uterine manipulation. Technical disadvantages are lack of tactile feedback to the surgeon operating from the console, and the inability to regulate the force applied to the tissue. Another drawback is that neither the patient nor the surgical table can be moved or repositioned once the robot is docked.

Preoperative Preparation, Patient Selection, and Anesthesia Considerations

Preoperative preparation can help assess the patient's ability to successfully undergo a robotic-assisted laparoscopic surgical procedure. Cardiovascular and pulmonary comorbidities should be thoroughly evaluated with appropriate preoperative testing. Although there is no data to support the use of preoperative mechanical bowel preparation, we believe that it helps to decompress the bowel for better visualization, decreases the risk of contamination due an unintended bowel injury, and allows for primary repair of the bowel, if needed. Specifically in cases of severe and deep infiltrating endometriosis involving the posterior cul-de-sac and the recto-sigmoid colon, adhesion formation and anatomy distortion can be very prominent, making bowel preparation extremely helpful.

In order to provide safe patient care, surgeons and anesthesiologists must understand the physiologic derangements that robotic-assisted laparoscopic surgery can have on anesthetic management. Several important issues specifically related to robotic surgeries include patient medical comorbidities, especially cardiovascular and pulmonary diseases, patient positioning, duration of the procedure, development of hypothermia, hemodynamic and respiratory effects of the pneumoperitoneum, and blood loss.

Intraoperative anesthesia considerations during robotic surgery are similar to traditional laparoscopy. Gynecologic procedures such as hysterectomy are performed in lithotomy with steep Trendelenburg position to take advantage of gravity that allows the bowel to drop down and out of the surgical field. It also helps to run the bowel in order to search for endometriotic lesions. Several hemodynamic changes occur with insufflation of the abdomen and the steep Trendelenburg position. The compressive effects of CO_2 insufflation on arterial vasculature result in a dramatic increase in systemic vascular resistance (SVR), particularly during the initial phase of insufflation. Using impedance cardiography, Westerband et al. reported a 30 % reduction in cardiac index (CI) and a 79 % increase in SVR immediately after peritoneal insufflation to 15 mm Hg [7]. In addition, patient position can markedly affect the cardiovascular system; a 10–30 % reduction in cardiac output occurs when a patient is placed in Trendelenburg [8].

The respiratory system is also impacted by CO_2 insufflation and pulmonary compliance is reduced by 30–50 % in both healthy and obese patients [8]. Peak airway pressure, plateau pressure, and intrathoracic pressure are increased [9]. Maintenance of normocarbia and acid-base status may be challenging in patients with poor pre-operative respiratory

statuses. The main factors contributing to an increase in $PaCO_2$ and respiratory acidosis are the peritoneal absorption of CO_2, increased dead space in patients with coexisting lung disease, increased metabolism during surgery, inadequate ventilation, subcutaneous emphysema, and CO_2 embolism.

Obese patients undoubtedly benefit from minimally invasive surgery; however, there are challenges to anesthesia in this population. Arterial oxygenation is significantly impaired in overweight patients under general anesthesia in Trendelenburg position. Fluid replacement is also challenging, as crystalloids cause edema to form quickly around the face, eyes, and upper airway. Post extubation respiratory distress has been described, requiring emergent reintubation. Thus, fluid replacement should be restricted to 1–2 l over the course of the surgery using sufficient colloids. At the end of the surgery, it is crucial to ensure that significant laryngeal edema has not occurred while in steep Trendelenburg, and that the patient can breathe around the endotracheal tube with a deflated cuff prior to extubation [10].

Basic Set up for the Da Vinci® Robotic System

The da Vinci® Robotic System is composed of three components: the surgeon console, the patient-side robotic cart, and the InSite vision console (Fig. 74.2). The surgeon sits at the console away from the patient and uses a stereoscopic 3-dimensional viewer with hand manipulators and foot pedals, which control the robotic-assisted instruments within the patient. Ergonomic hand controls translate the 3-dimensional motion of the surgeon's hands into signals that directly control the robotic arms. The ratio of the surgeon hand motions to robotic arm motion can be modified through motion scaling. For example, a 5:1 ratio translates 5 inches of movement by surgeon into 1 inch of movement by the robotic arm. These ratios are preset. Foot pedals within the console are used for activation of electrosurgery, "clutching" or readjusting the hand controls, and switching between functioning robotic arms [11].

The patient-side robotic cart has telerobotic arms to which the EndoWrist® instruments attach. The robotic cart has four arms; one of the arms holds the laparoscope while the other two to three arms hold various laparoscopic surgical instruments. The InSite® vision console processes the images from the endoscope containing the stereoscopic cameras and dual optical lenses to the surgeon console where the operator has a 3-dimensional image of the surgical field.

Three people are directly involved in the robotic surgery: the surgeon, the bedside surgical assistant, and the scrub nurse. However, an anesthesiologist and circulating nurse familiar with the robotic laparoscopy can assist in making the procedure run efficiently (Fig. 74.3).



Fig. 74.2 The da Vinci Surgical System by Intuitive Surgical® Inc. (Sunnyvale, CA). The three main components are: surgeon console (*left*), the patient-side robotic cart (*middle*), and the InSite® vision console (*right*)

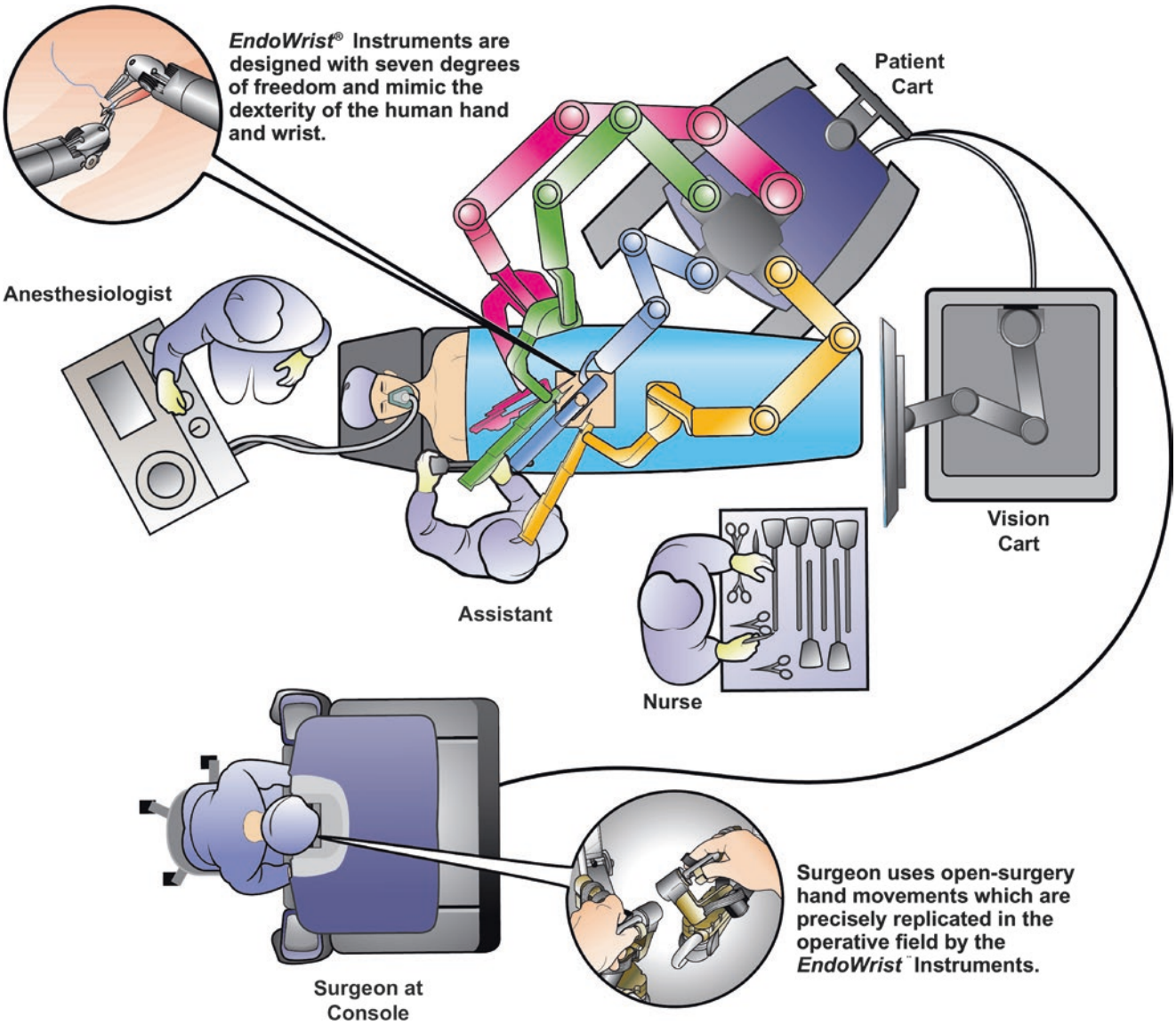


Fig. 74.3 General operating room set-up for the da Vinci® surgical system

The Robotic-Assisted Laparoscopic Hysterectomy (RALH)

Hysterectomy continues to be the most common gynecologic surgery in the United States. An estimated 600,000 women each year undergo hysterectomies for benign indications, most commonly uterine myomas, endometriosis, and uterine prolapse [12]. The goal of laparoscopic hysterectomy and laparoscopic-assisted vaginal hysterectomy is to convert abdominal hysterectomies to endoscopic ones [13]. A cross-sectional analysis of national discharge data in 2005 found that the most common route of hysterectomy was total abdominal hysterectomy (64 %), followed by vaginal hysterectomy (22 %), and laparoscopic hysterectomy (14 %) [14].

Though vaginal hysterectomy is the optimal and most minimally invasive approach, the inability to visualize the abdominal-pelvic anatomy is a disadvantage. The benefit of laparoscopic hysterectomy is the ability to visualize *in situ* the abdominal and pelvic pathology prior to removing the uterus and adnexa, if needed.

Different studies have compared laparoscopic hysterectomy with and without robotic assistance [15, 16]. It has been shown that the use of the robot is more time consuming and it could also be more expensive, however surgical outcomes are the same, except for a higher rate of vaginal cuff dehiscence associated with robotic assistance. In our experience, the robotic platform can be regarded as an "another instrument for laparoscopic surgery". It potentially allows to master suturing in lesser time and is less tiring when

operating on obese patients instead of adhering to the old fashioned exploratory laparotomy. It is simply another tool available to the gynecologic surgeon.

Patient Positioning

Similar to laparoscopic-assisted hysterectomy, preparing for a robotic-assisted hysterectomy begins with safe and appropriate patient positioning. The operating room table should be configured for gynecological procedures, with the ability to lower the bottom of the bed. A gel pad or another non-slip device should be placed between the operating room table and the patient in order to prevent the patient from sliding down after steep Trendelenburg has been established. Obese patients are especially prone to shift down the operating room table during surgery. This movement is problematic for both uterine manipulation and surgical field displacement. Shoulder braces should be avoided because of the risk of brachial plexus nerve injuries.

For the RALH, the patient is placed in low dorsal lithotomy position with arms padded and tucked to the side of the table (Fig. 74.4). Proper padding of pressure points prior to draping is extremely important to prevent tissue and nerve injury especially during longer procedures. A Foley catheter is placed to drain the bladder. A nasogastric tube (NGT) or orogastric tube (OGT) is placed to decompress the stomach and reduce the risk of visceral injury upon entry. Antibiotic prophylaxis should be given prior to the start of the case, cefazolin 1–2 g IV or clindamycin 600 mg IV plus gentamycin 1.5 mg/kg IV for patients with penicillin allergies [17]. Though it is a laparoscopic procedure, the RALH is still considered a surgical wound Class 2, a clean-contaminated wound.

Uterine Manipulation

An exam under anesthesia is performed to reassess the size and position of the uterus, to sound the uterus, and to measure the size of the cervix. The cervix size is assessed visually or with a hand held cervical sizer. There are several commonly used uterine manipulators which have a colpotomy ring that is essential for a successful colpotomy at the end of the laparoscopic hysterectomy procedure. The VCare® Uterine Manipulator (ConMed Corporation, Utica, NY) and the RUMI (Cooper Surgical, Trumbull, CT) are two examples. The VCare® is a disposable unit with its own colpotomy ring attached to a handle and vaginal occludes (Fig. 74.5). The KOH colpotomizer system® incorporates the RUMI handle, a choice of different sized colpotomy rings, and a selection of different sized tips. A vaginal balloon pneumo-occluder should also be assembled on the RUMI® uterine manipulator and inflated in the vagina to maintain pneumoperitoneum as the colpotomy is made (Fig. 74.6).

Laparoscopic Entry and Port Placement

After the uterine manipulator is placed and the colpotomy ring sits securely in the cervicovaginal junction, the surgeon can return to the patient's abdomen and establish pneumoperitoneum by various methods. A 12 mm port (Fig. 74.7. location A) is usually placed at the umbilicus, or higher depending on the size of the uterus, after pneumoperitoneum is obtained to 15 mmHg. A survey of the abdomen and pelvis is performed, noting the liver edge, gallbladder, fundus of the stomach, and appendix, in order to thoroughly search for extragenital endometriosis. Two 8 mm robotic trocars are placed bilaterally 10 cm lateral to the umbilicus and 2 cm

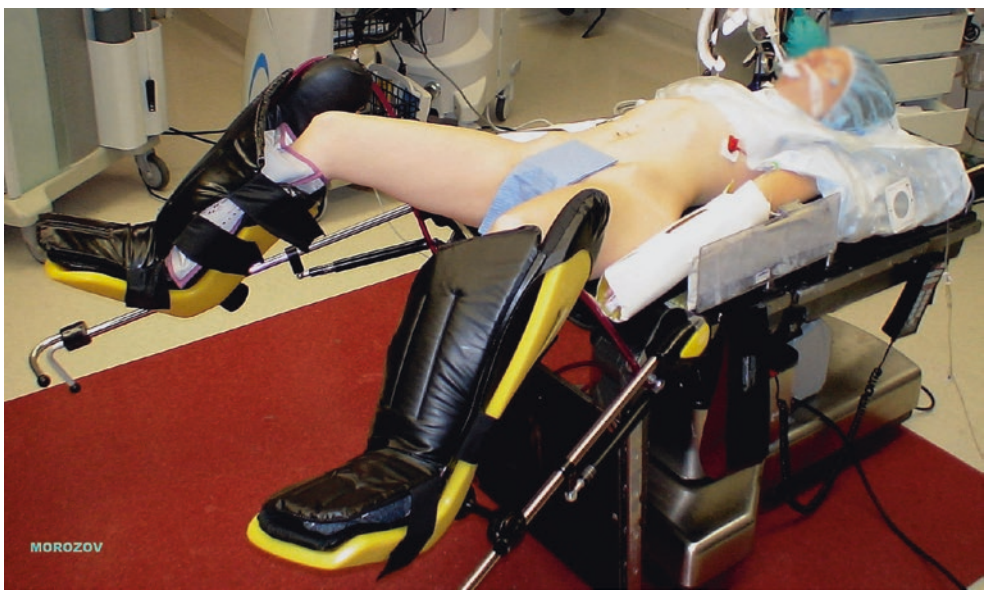


Fig. 74.4 Patient positioning for gynecologic robotic procedures. The patient is positioned in dorsal lithotomy using Allen stirrups with arms tucked to the side. Later on, steep Trendelenburg will be used

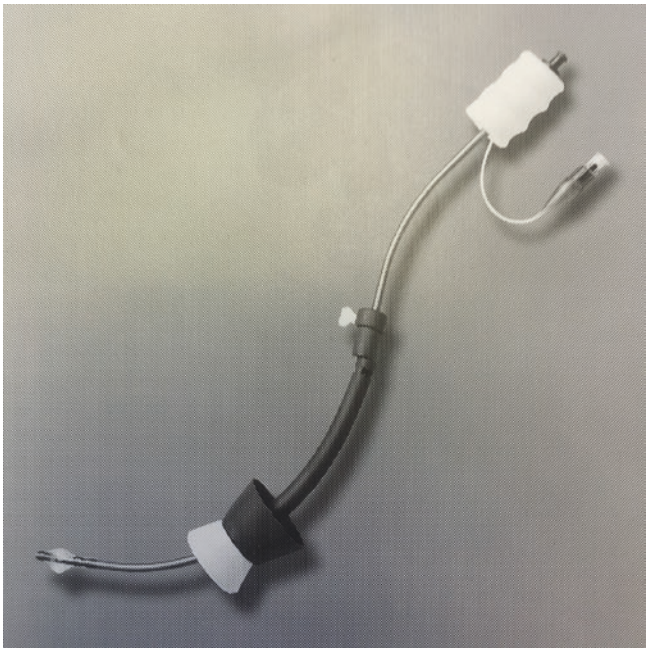


Fig. 74.5 VCare®, a commonly used uterine manipulator with a colpotomy ring

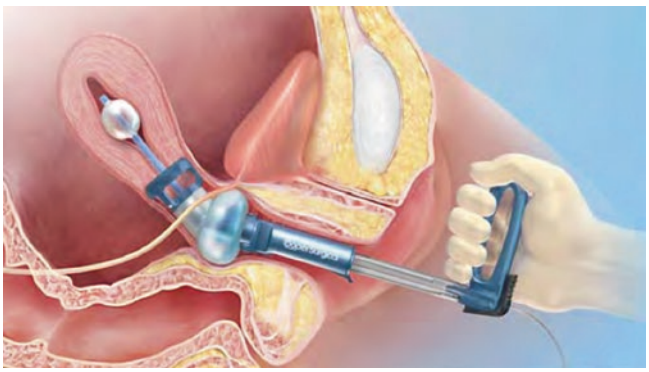


Fig. 74.6 RUMI®, a commonly used uterine manipulator with a colpotomy ring

above the level of the uterine fundus (Fig. 74.7. location B) under direct laparoscopic visualization. An accessory 5 mm trocar is placed between the umbilical port and the lateral port 3 cm caudal to the umbilicus (Fig. 74.7. location C). When the fourth robotic arm is used, that trocar is placed at least 8 cm lateral to the umbilicus and 8 cm cephalad to the right robotic trocar.

The operating room table is lowered, and the patient is placed in the maximum amount of Trendelenburg to allow optimal visualization with the bowel falling away from the pelvis into the upper abdomen. After the final degree of Trendelenburg is established and the patient-side robotic cart has been docked, no further table movements can be made.

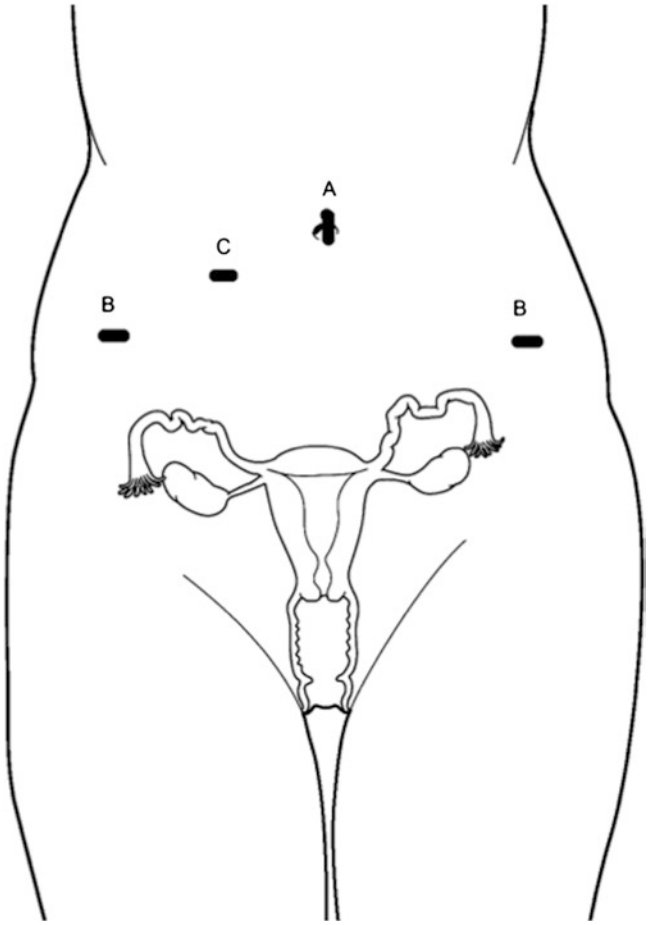


Fig. 74.7 Robotic port site placement for gynecologic surgery

The average set up time, defined as the time between switching from laparoscopy to the robot, is 16–18 min for an experienced OR team. This process includes docking the sterile draped robot, switching trocars, changing the camera, and attaching the surgical instruments. Disassembly time is 2.5–3 min on average [18, 19].

Docking the Bedside Robot

The traditional docking of the robotic cart for gynecological procedures is between the patient's legs. The advantage of this docking position is that the camera and working arms are placed in the same axis as the patient's torso. However, this position poses challenges for gynecologic procedures, as the bedside assistant is unable to access to the vagina and provide good uterine manipulation and exposure.

An alternative for gynecologic surgery is side docking at a 45° angle from the midline, with the central column of the robotic cart and the camera arm in line with the patient's contra lateral shoulder. This configuration allows the bedside

assistant easier access to the uterine manipulator and the vagina, should the uterine manipulator need to be adjusted during the surgery or if there is difficulty removing the uterus after the hysterectomy is completed. It also provides room for an intraoperative rectovaginal exam if needed to localize and palpate endometriotic nodules, in an attempt to overcome one of the drawbacks of the current robotic platform: the lack of haptics. This is an important disadvantage when considering treatment and resection of endometriotic nodules in the rectovaginal space using robotic assistance. The fibrotic tissue, consequence of severe disease, cannot be felt in the rectovaginal septum.

Once the patient-side robotic cart is docked, the robotic arms can be attached to the 8 mm trocars and the robotic endoscope and instruments can be inserted. Careful attention should be given to the robotic arms to prevent them from contacting the patient directly. Crush injuries to the patient may occur unintentionally if the robot is improperly positioned.

Switching the Laparoscopic Camera to the Robotic Scope

The endoscope typically used for gynecologic procedures, including hysterectomy, is the 12 mm 0-degree laparoscope that is introduced through the 12 mm umbilical port. There is a 30° laparoscope that is helpful for urogynecology cases in the lower pelvis. As in traditional laparoscopy, the camera and light source should be carefully monitored and never left directly on drapes in order to avoid fires and thermal injury to the patient. If the tip of the robotic endoscope becomes dirty or fogged during surgery, it should be removed from its robotic arm and cleaned with a proper solution and lens cloth in order to prevent scratching of the optics. Wiping the tip of the robotic endoscope on internal organs should not be done because the robotic endoscope is significantly hotter than standard endoscopes and will cause thermal damage to the viscera.

EndoWrist Instruments

The da Vinci® Robotic System has a selection of 8 mm EndoWrist® instruments for gynecologic surgery. Most of the robotic instruments (Fig. 74.8) have been adapted from traditional laparoscopic equipment. Among the most common and useful for RALH procedures are the monopolar curved scissors, fenestrated bipolar forceps, tenaculum forceps, mega needle driver, Gyrus PK® grasper (Olympus Company, Southborough, MA) (not pictured), and Harmonic scalpel® (Ethicon Endo-Surgery, Cincinnati, OH) (not pictured). These instruments can be snapped into the robotic 8 mm ports.

Robotic-Assisted Laparoscopic Hysterectomy Technique

The RALH technique is similar to the open hysterectomy. Initially, the round ligament is identified, desiccated with bipolar forceps at 25-35 W current and cut with the monopolar scissors (Fig. 74.9). The anterior leaf of the broad ligament is then incised towards the bladder and the vesicouterine reflection (bladder flap) is created. If the ovaries are to be removed, the infundibulopelvic (IP) ligament is identified along with the ipsilateral ureter, isolated and desiccated with bipolar electrosurgery or ultrasonic energy and cut with shears. The laparoscopic surgeon should skeletonize the ureter and uterine vessels, so their courses are properly identified and injures avoided (Fig. 74.10a, b). Ureterolysis is performed after proper identification of the ureter as it enters the pelvis at the pelvic brim. The retroperitoneum is then opened in the ovarian fossa superiorly to the ureter with aid of the CO2 laser. Hydrodissection is then accomplished with the Nezhat-Dorsey probe which is also used for blunt dissection if needed in case of dense scar tissue in this area. The ureter is then pushed inferiorly from the dissection area to a safe location after hydrodissection is completed. Small bleeders are cauterized at the same time dissection is performed with the CO_2 laser.

If the ovaries are to be conserved, then the utero-ovarian ligament is desiccated and cut. The anterior leaf of the broad ligament is then fully incised, completing the vesicouterine reflection anteriorly. The vesicouterine reflection is tented up using fenestrated bipolar and the bladder is gently dissected off the lower uterine segment and cervix using sharp dissection with the Endoshears or bluntly. The tendinous attachments between the bladder, cervix, and upper vagina may be dissected or desiccated (Fig. 74.11).

The uterine arteries are identified and skeletonized, allowing the ureters to fall further laterally for safe vessel sealing and division of the vessels. The cardinal ligaments are subsequently desiccated and divided. The uterine manipulator is helpful in retracting the uterus in the opposite direction, facilitating exposure of the uterine vessels. After the uterine arteries are divided, the bedside assistant performing the uterine manipulation should push the uterine manipulator cephalad to accentuate the edges of the colpotomy cup (Fig. 74.12). Deep infiltrating endometriosis can be dissected off the retrocervical areas with the CO2 laser and the Nezhat-Dorsey probe. Very careful dissection is performed specially if bowel adhesions are encountered.



Fig. 74.8 Selection of EndoWrist® instruments

At this point, the experience of the surgeon plays a major role in order to avoid bowel injuries.

The colpotomy is performed with the monopolar hot shears at 30 W cutting current. The uterus (and ovaries) can then be pulled through the vaginal cuff or if too large, it may be removed through extracorporeal morcellation in the vagina. Vaginal morcellation is performed with a long knife handle and a #10 blade, making circumferential incisions into the uterus while pulling outwards on the cervix. It is important to always keep the blade inside the myometrium and away from the surrounding vagina. A self retained retractor (Alexis® retractor, Applied Medical, CA) can

also be used to protect the vaginal walls during morcellation.

If supracervical hysterectomy is requested or vaginal access is limited, morcellation can be done through the anterior abdominal wall in a similar fashion.

A mini-laparotomy is performed (no more than 3–4 cm long) and a self retained retractor also used for exposure plus or minus a specimen bag for contained morcellation. Lahey clamps are used to exteriorize the uterus and extracorporeal morcellation is then performed in the same manner previously described. In light of the current controversy regarding uterine morcellation and the possibility of diagnosing a leiomyosarcoma, we recommend against the use of electromechanical devices for intracorporeal morcellation [20, 21].

If the uterus is small enough to be left in the vagina just below the vaginal cuff, then it can serve as a pneumo-occluder

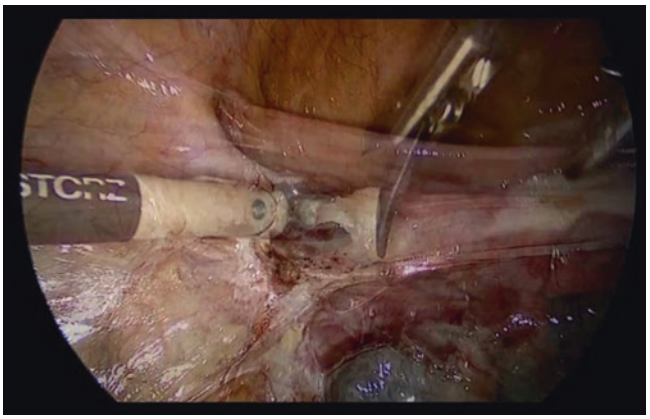


Fig. 74.9 The round ligament is identified, desiccated and cut with the monopolar scissors

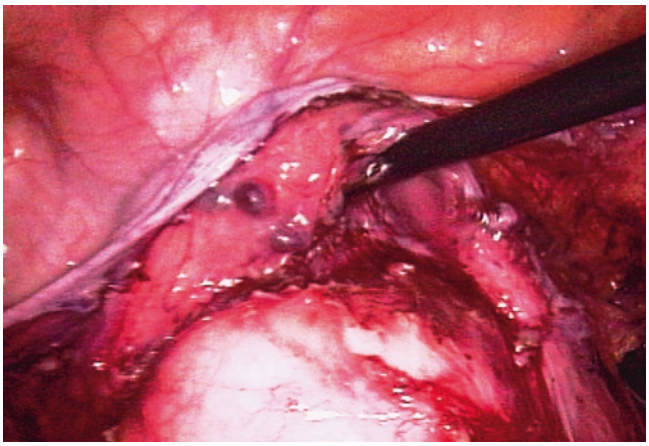


Fig. 74.11 Vesicouterine space after complete dissection

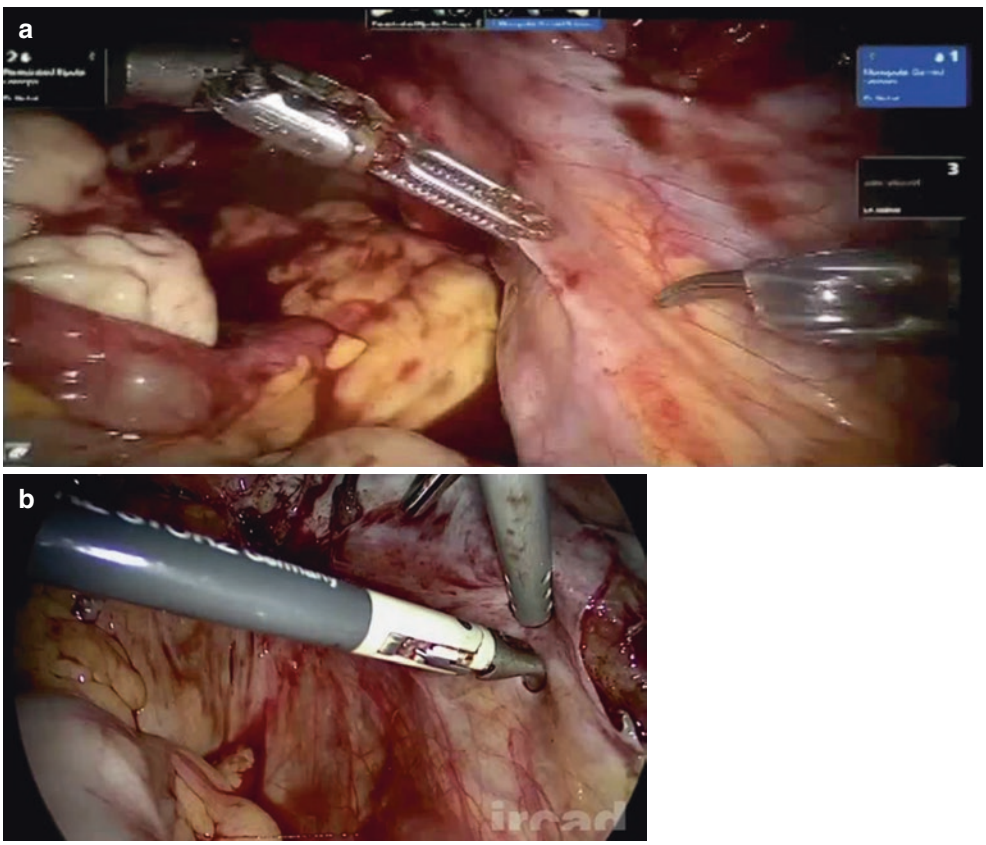


Fig. 74.10 (**a**, **b**) Ureterolysis. It is important to skeletonize the ureter in order to properly identify its course



Fig. 74.12 The colpotomy cup edges were accentuated with the correct placement and use of the uterine manipulator, allowing good exposure for colpotomy

or the balloon occluder can be replaced into the vagina after removing the specimen. Irrigation of the abdomen and pelvis and control of bleeding are performed prior to closing the vaginal cuff. Minor bleeding at the cuff can be controlled with cuff closure.

Excessive desiccation at the cuff should be avoided in order to prevent thermal damage to tissue and poor tissue healing which may lead to cuff breakdown and vaginal cuff dehiscence. The vaginal cuff can be securely closed with 2–0 Vicryl on at CT-1 needle via interrupted figure of eight stitches or with a running stitch and use of Lapra-ty® suture clips (Ethicon Endo-surgery, Cincinnati, OH).

Once the vaginal cuff is closed, the pelvis is irrigated a final time and examined for hemostasis. Desufflation of the abdomen and reinsufflation is another method of examining hemostasis under a physiologic lower intraabdominal pressure. For vaginal cuff support and prolapse prevention, the Moskowitz procedure is performed. The uterosacral ligaments are identified and a string suture is placed. Firstly, it transverses the right uterosacral ligament, then goes to the cardinal ligament under the uterine artery, followed by a very small bite posteriorly into the rectovaginal fascia, then over the left cardinal fascia and finally concludes its course at the left uterosacral ligament. An extracorporeal tie brings the cardinal ligaments, uterosacral ligaments and posterior vaginal fascia together in the midline. It provides excellent support for the vaginal cuff apex.

Cystoscopy at the conclusion of the hysterectomy is routinely performed to confirm the patency of the ureters and integrity of the bladder. Rates of bladder and ureteral injury during laparoscopic hysterectomy have been reported to be as high as 2.9 and 1.75 %, respectively [22]. One ampule of indigo carmine (1 ampule, 40 mg in 5 ml) is injected by IV approximately 5–10 min prior to the cystoscopy to aid in visualizing the patency of the ureters. If indigo carmine is not available, 200 mg of over the counter phenazopyridine (Pyridium®) given 30 min prior to procedure exerts the same effect. The dye should be visualized through both ureteral orifices. The bladder should also be inspected for sutures and thermal injuries.

Port sites larger than 10 mm should be closed to prevent trocar site herniation. These sites can be laparoscopically closed with a fascial closure device such as a Carter-Thomason CloseSure® System (Cooper Surgical, Trumbull, CT). A 0-Vicryl suture in a UR-6 needle can also be used for closure of the umbilicus fascia if the subcutaneous fat layer is not too thick, allowing proper identification of the fascia layer. The skin can be closed with Dermabond® (Ethicon Inc., Menlo Park, CA) or a subcutaneous stitch using 4–0 Monocryl suture.

Postoperative Care

The average length of stay for a robotic hysterectomy is less than 24 h. After the surgery and patient's recovery in PACU are completed, the patient can be restarted on a clear or regular diet if she is not experiencing nausea. Patients may ambulate on postoperative day 0. The Foley catheter can be removed immediately postoperatively, but more often it is left in the bladder overnight and removed the next morning. The patient can be discharged to home on postoperative day 1 with precautions for vaginal bleeding, vaginal discharge, abdominal pain, and fever. Six to eight weeks is recommended before the patient can resume vaginal intercourse to allow the vaginal apex to heal properly.

Complications of Robotic Surgery

According to Jonsdottir et al., the rates of intraoperative and minor postoperative complications have significantly decreased with the RALH procedure versus abdominal hysterectomy, while there was no difference in overall mean costs [23]. Comparing RALH to laparoscopic hysterectomy in a meta-analysis, the estimated blood loss, length of postoperative

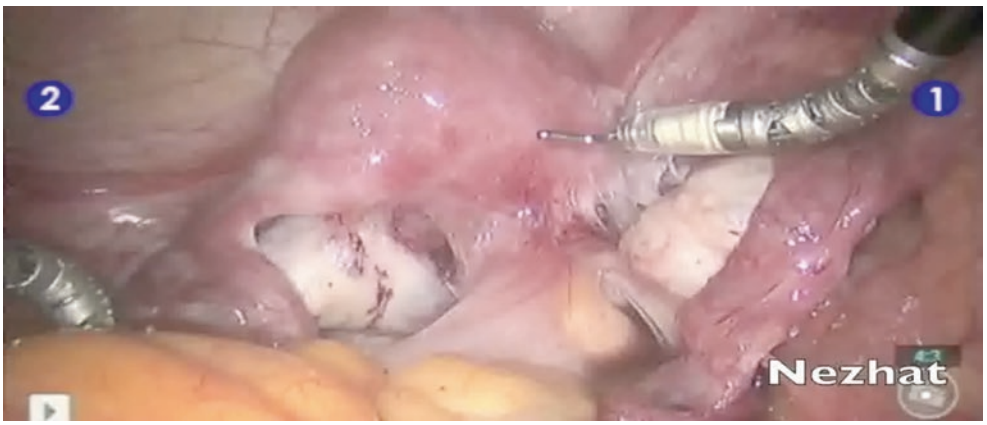


Fig. 74.13 Example of pelvic adhesions distorting the normal pelvic anatomy and increasing the risk of complications

hospital stay, and complications were comparable [24]. One perioperative complication found more frequently with both RALH and laparoscopic hysterectomy is vaginal cuff dehiscence with small bowel evisceration.

Though vaginal cuff dehiscence is rare, it is a serious and potentially life-threatening condition. Incidences of vaginal cuff dehiscence after robotic hysterectomy have been reported as high as 4.1 % (95 % CI 2.3–5.8 %) [25]. However, more recent literature suggests a lower incidence in laparoscopic hysterectomies 0.75 % (95 % CI 0.09–1.4), but the incidence is higher than that of abdominal 0.38 % (95 % CI 0.16–0.61) and vaginal 0.11 % (95 % CI 0.0–0.32) hysterectomies [26]. This difference suggests that vaginal cuff dehiscence may be occurring due to the use of electro-surgery to perform the colpotomy. The electro-surgery creates thermal cuff tissue damage and the devascularized tissue delays or even halts wound healing.

Ureter complications are another potential problem with laparoscopic and robotic-assisted hysterectomy. The ureters are commonly injured at the level of the IP ligament when this is transected prior to performing an oophorectomy. Another potential location for injury is where the ureters travel under the uterine arteries during uterine artery ligation, at the level of the uterosacral ligaments and during ureter insertion at the bladder dome when creating the vesicouterine space. If the anatomy is distorted due to the presence of leiomyomas or endometriosis, or adhesions from previous surgeries or history of pelvic inflammatory disease (Fig. 74.13), the risk for ureteral injury is even higher.

Most ureteral injuries are not identified or even suspected without cystoscopy [27–29]. Prompt recognition and management is essential in order to prevent further sequelae and patient morbitity, including multiple surgeries and organ loss. From our experience, we strongly recommended routine cystoscopy after every laparoscopic or robotic-assisted laparoscopic hysterectomy.

When dealing with endometriosis, prevention and recognition are the most important steps in order to avoid serious postoperative complications. Due to the severe adhesion formation that can be encountered, knowing the pelvic anatomy is crucial. Identification of the pelvic organs needs to be accomplished prior to attempting lysis of adhesions, ligation of vessels or treatment of the disease. Then, after the procedure is completed, we inspect the pelvic once again and perform cystoscopy and proctoscopy as indicated.

Conclusion

There is a clear trend in surgery, driven by patient demand, to perform less invasive approaches to common gynecologic procedures such as hysterectomy. The da Vinci® Robotic Surgical System enables gynecologic surgeons to convert complex cases such as hysterectomy, myomectomy, incontinence, microsurgical tubal anastomosis, and endometriosis cases, to endoscopic ones. Performing endoscopic surgery on the da Vinci® Robotic Surgical System has several advantages over traditional laparoscopy, such as high definition 3-dimensional visual imaging, greater dexterity with more degrees of freedom, and intuitive hand movements, which provide less-experienced laparoscopists with the confidence and technological support to master difficult endoscopic suturing and knot tying.

The advent of robotic surgery has enabled conversion of even more complex gynecologic procedures, including radical hysterectomy and fistula repair, especially in obese patients, to minimally invasive techniques [30–34]. This new technology may allow lower volume gynecologic surgeons to offer their patients procedures with clear health advantages – less pain, shorter hospital stay, fewer complications, and earlier return to activity and work [34].

References

1. Rosheim ME. Leonardo's lost robots. Berlin: Springer; 2006.
2. Shah A and Schipper E. A History of Telepresence Surgery. In: Nezhat's video-assisted and robotic-assisted laparoscopy and hysteroscopy, Chapter 23.1, 4th ed. 2013. p. 629–31.
3. Satava RM. Robotic surgery: from past to future – a personal journey. Surg Clin North Am. 2003;83:1491–500. xii
4. Cadiere GB, Himpens J, Germay O, et al. Feasibility of robotic laparoscopic surgery: 146 cases. World J Surg. 2001;25:1467–77.
5. Nezhat C, Hajhosseini B, King LP. Robotic-assisted laparoscopic treatment of bowel, bladder, and ureteral endometriosis. JSLS J Soc Laparoendosc Surg/Soc Laparoendosc Surg. 2011;15:387–92.
6. Intuitive Surgical Inc. Frequently asked questions. 2015. Accessed 20 Jan 2015, at http://www.intuitivesurgical.com/company/faqs.html.
7. Westerband A, Van De Water J, Amzallag M, et al. Cardiovascular changes during laparoscopic cholecystectomy. Surg Gynecol Obstet. 1992;175:535–8.
8. Hirvonen EA, Nuutinen LS, Kauko M. Hemodynamic changes due to Trendelenburg positioning and pneumoperitoneum during laparoscopic hysterectomy. Acta anaesthesiol Scandinavica. 1995;39:949–55.
9. Irgau I, Koyfman Y, Tikellis JI. Elective intraoperative intracranial pressure monitoring during laparoscopic cholecystectomy. Arch Surg. 1995;130:1011–3.
10. Sullivan MJ, Frost EA, Lew MW. Anesthetic care of the patient for robotic surgery. Middle East J Anesthesiol. 2008;19:967–82.
11. Sroga J, Patel SD, Falcone T. Robotics in reproductive medicine. Front Biosci J Virtual Library. 2008;13:1308–17.
12. Whiteman MK, SD H, Jamieson DJ, et al. Inpatient hysterectomy surveillance in the United States, 2000-2004. Am J Obstet Gynecol. 2008;198:34 e1–7.
13. Reich H and Katz A. Total Laparoscopic Hysterectomy–indications, techniques, and outcomes. In: Nezhat's video-assisted and robotic-assisted laparoscopy and hysteroscopy, Chapter 14, 4th ed. 2013. p. 370–85.
14. Jacoby VL, Autry A, Jacobson G, Domush R, Nakagawa S, Jacoby A. Nationwide use of laparoscopic hysterectomy compared with abdominal and vaginal approaches. Obstet Gynecol. 2009;114:1041–8.
15. Reynolds RK, Advincula AP. Robot-assisted laparoscopic hysterectomy: technique and initial experience. Am J Surg. 2006;191:555–60.
16. Pasic RP, Rizzo JA, Fang H, Ross S, Moore M, Gunnarsson C. Comparing robot-assisted with conventional laparoscopic hysterectomy: impact on cost and clinical outcomes. J Minim Invasive Gynecol. 2010;17(6):730–8.
17. ACOG Committee on Practice Bulletins--Gynecology. ACOG practice bulletin No. 104: antibiotic prophylaxis for gynecologic procedures. Obstet Gynecol. 2009;113:1180–9.
18. Nezhat C, Saberi NS, Shahmohamady B, Nezhat F. Robotic-assisted laparoscopy in gynecological surgery. JSLS J Soc Laparoendosc Surg/Soc Laparoendosc Surg. 2006;10:317–20.
19. Nezhat C, Lavie O, Hsu S, Watson J, Barnett O, Lemyre M. Robotic-assisted laparoscopic myomectomy compared with standard laparoscopic myomectomy – a retrospective matched control study. Fertil Steril. 2009;91:556–9.
20. Kho KA, Nezhat CH. Evaluating the risks of electric uterine morcellation. JAMA. 2014;311(9):905–6.
21. Kho KA, Shin JH, Nezhat C. Vaginal extraction of large uteri with the Alexis retractor. J Minim Invasive Gynecol. 2009;16(5):616–7.
22. Gilmour DT, Das S, Flowerdew G. Rates of urinary tract injury from gynecologic surgery and the role of intraoperative cystoscopy. Obstet Gynecol. 2006;107:1366–72.
23. Jonsdottir GM, Jorgensen S, Cohen SL, et al. Increasing minimally invasive hysterectomy: effect on cost and complications. Obstet Gynecol. 2011;117:1142–9.
24. Sarlos D, Kots LA. Robotic versus laparoscopic hysterectomy: a review of recent comparative studies. Curr Opin Obstet Gynecol. 2011;23:283–8.
25. Kho RM, Akl MN, Cornella JL, Magtibay PM, Wechter ME, Magrina JF. Incidence and characteristics of patients with vaginal cuff dehiscence after robotic procedures. Obstet Gynecol. 2009;114:231–5.
26. Hur HC, Donnellan N, Mansuria S, Barber RE, Guido R, Lee T. Vaginal cuff dehiscence after different modes of hysterectomy. Obstet Gynecol. 2011;118:794–801.
27. McMaster-Fay RA, Jones RA. Laparoscopic hysterectomy and ureteric injury: a comparison of the initial 275 cases and the last 1000 cases using staples. Gynecol Surg. 2006;3:118–21.
28. Sharon A, Auslander R, Brandes-Klein O, et al. Cystoscopy after total and subtotal laparoscopic hysterectomy: the value of a routine cystoscopy. Gynecol Surg. 2006;3:122–7.
29. Wu HH, Yang PY, Yeh GP, et al. The detection of ureteral injuries after hysterectomy. J Minim Invasive Gynecol. 2006;13:403–8.
30. Falcone T, Goldberg JM. Robotics in gynecology. Surg Clin North Am. 2003;83:1483–9. xii
31. Chang-Jackson SC, Acholonu Jr UC, Nezhat FR. Robotic-assisted laparoscopic repair of a vesicouterine fistula. JSLS J Soc Laparoendosc Surg/Soc Laparoendosc Surg. 2011;15:339–42.
32. Nezhat C, Xie J, Aldape D, Balassiano E, Soliemannjad R, Nezhat F. Use of Laparoscopic modified nerve-sparing radical hysterectomy for the treatment of extensive endometriosis. Cureus. 6(1):e159. doi:10.7759/cureus.159.
33. Nezhat FR, Sirota I. Perioperative outcomes of robotic assisted laparoscopic surgery versus conventional laparoscopy surgery for advanced-stage endometriosis. JSLS. 2014;18(4):e2014.00094.
34. Nezhat C, Lavie O, Lemyre M, et al. Laparoscopic hysterectomy with and without a robot: stanford experience. JSJS. 2009; 13:125–8.

Hysterectomy Techniques for Obese Patients

75

Amanda M. Hill, Lindsay Clark Donat, and Masoud Azodi

Introduction

Obesity poses certain challenges and risks to patients and surgeons in the perioperative period. Patients with obesity often have other comorbidities, which increase the risks of surgery and anesthesia. The increased adipose tissue makes positioning and surgical exposure more difficult. Patients are also at higher risk of cardiopulmonary events in the postoperative period.

The use of a robotic system such as the Da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) affords possible advantages when used for hysterectomy in obese patients [1–4]. While traditional laparoscopy can be ergonomically challenging, the robotic system allows the surgeon to sit comfortably at the console, providing improved ergonomics [5]. Robotic surgery also conveys the advantage of a third arm, controlled by the primary surgeon, which aids in visualization despite the increased adipose tissue obscuring the surgical field. Patients experience faster recovery when compared to open surgery, which is especially important in the obese population [6]. Women are able to ambulate and tolerate a regular diet more rapidly, decreasing the risk of venous thromboembolism (VTE) and ileus.

This chapter will outline the challenges, advantages, and additional considerations in the preoperative, intraoperative, and postoperative periods in patients with obesity undergoing robotically-assisted hysterectomy.

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Preoperative Considerations

Like all surgical procedures, proper patient selection is an important consideration when planning to perform a robotic-assisted laparoscopic hysterectomy. Patients with obesity often have other comorbidities that must be considered when deciding on treatment options and optimally managed before proceeding with surgery. Typical indications for benign hysterectomy such as abnormal uterine bleeding, pelvic pain from adenomyosis or endometriosis, and even endometrial hyperplasia may be more appropriately managed medically (Table 75.1). It is important to weigh the risks and benefits of surgery in these patients to avoid potential complications of anesthesia and recovery. That being said, studies have shown no increased risk of surgical complications in obese patients compared with those of normal BMI [4, 7].

Obesity is associated with cardiovascular, pulmonary, and metabolic conditions. Patients with obesity are more likely to suffer from hypertension, coronary and peripheral vascular disease, ventricular hypertrophy, obstructive sleep apnea (OSA), hypoventilation due to restrictive or obstructive respiratory syndromes, dyslipidemias, diabetes mellitus, and decreased exercise tolerance [7–9]. It is essential that patients are evaluated by their medical doctor for a medical risk assessment prior to proceeding with elective surgery. They should also see a cardiologist and/or pulmonologist if they suffer from more severe cardiopulmonary disease or if specific conditions are uncovered during the preoperative evaluations. These specialists can offer recommendations to optimize the patient's clinical condition and thus reduce the risk of adverse perioperative cardiopulmonary outcomes.

Patients may also be unaware of existing medical problems due to lack of screening or if they have not seen a primary care physician. All patients with obesity planning elective surgery should be seen by a primary care physician to have appropriate screening tests prior to surgery. It is also beneficial for the patient to have a preoperative assessment with the anesthesiologist that will be caring for

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Table 75.1 Alternatives to hysterectomy

Diagnosis	Alternative to hysterectomy
Abnormal uterine bleeding	
Endometrial polyps	Hysteroscopic polypectomy
	Global endometrial ablation
Submucosal leiomyoma	Hysteroscopic myomectomy
	Global endometrial ablation
Ovulatory dysfunction	Oral contraceptive pills
	Depo medroxyprogesteroneacetate
	Levonorgestrel intrauterine system
	Leuprolide
Endometrial dysfunction (heavy, regular bleeding with no structural pathology)	Oral contraceptive pills
	Depo medroxyprogesteroneacetate
	Levonorgestrel intrauterine system
	Leuprolide
	Tranexamic acid
	Global endometrial ablation
Dysmenorrhea / Adenomyosis	NSAIDs
	Oral contraceptive pills
	Depo medroxyprogesteroneacetate
	Levonorgestrel intrauterine system
	Leuprolide
Endometriosis	NSAIDs
	Oral contraceptive pills
	Depo medroxyprogesterone acetate
	Levonorgestrel intrauterine system
	Leuprolide
Leiomyoma	Myomectomy
	Radiofrequency ablation
	Uterine artery embolization
	Magnetic resonance guided focused ultrasound
Endometrial hyperplasia	Progestin therapy
	Medroxyprogesterone acetate
	Megestrol acetate
	Levonorgestrel intrauterine system
	Aromatase inhibitors
	Hysteroscopy resection

them. The anesthesiologist may request additional tests or evaluation by specialists in order to prepare a safe plan to manage the patient's cardiopulmonary needs in the perioperative period.

Routine preoperative assessment should include a clinical evaluation, indicated routine blood work (complete blood count, blood type and antibody screen, basic metabolic panel), electrocardiogram, and chest x-ray [7–10]. Some authors suggest that routine chest x-ray is not necessary as it does not alter perioperative management [7, 8]. However, most recommendations call for chest x-ray in those over the age of 50, those with known heart or lung disease, or those with abnormal physical exam findings. Electrocardiogram is recommended for all patients with obesity given that obesity is a risk factor for heart disease [7, 8].

Patients with known cardiac disease or those with abnormal findings on routine preoperative assessment should be referred to a cardiologist for further testing such as echocardiography or a stress test. Routine echocardiogram and stress test are not recommended due to the low rate of abnormalities and lack of consequence on perioperative management [8].

Impaired pulmonary mechanisms due to obesity increase the risk of complications such as pneumonia, respiratory failure, pulmonary hypertension, and pulmonary embolism after surgery [9]. It also makes mechanical ventilation more difficult due to decreased compliance and increased intra-abdominal pressure leading to reduced lung volumes [9]. Patients with known pulmonary disease should be evaluated by their pulmonologist preoperatively. Polysomnography

(or sleep study) should be strongly considered due to the high prevalence (up to 40 %) of OSA in patients with obesity [8]. CPAP should ideally be initiated 6 weeks prior to surgery [8]. Routine spirometry is not recommended, unless COPD is suspected [8, 9]. Abnormal pulmonary function tests, when severe, can prompt planned intensive care unit admission [7].

As with any patient, patients with obesity undergoing robotic-assisted laparoscopic hysterectomy should have complete preoperative counseling including the indication for surgery, alternatives, and risks. The risk of complications related to the patient's underlying medical conditions should be clearly addressed, and special attention should be paid to risks of VTE and infectious complications, since obesity increases these risks [4, 9]. There is also an increased risk of conversion to an open procedure in obese patients [4]. Bowel preparation may be advisable to decompress the bowel, improving visualization of the surgical field [3]. Patients should have a good understanding and realistic expectations of the preparation for and recovery from surgery.

When operating on morbidly obese patients, the surgeon should be aware of the resources and limitations of the facility in which they operate. With the increasing prevalence of obesity, many hospitals and surgery centers are equipped with bariatric wheelchairs, lifts, and beds. The surgeon should be aware of the weight limits of the operating room tables and other special equipment required. Specially designed OR tables do exist in the case that a patient's weight exceeds the standard limit. However, some of these models have mobility limitations which could interfere with the degree of trendelenburg required for robotic-assisted laparoscopic hysterectomy. OR table accessories such as table extenders are often required for the obese patient. Most robotic-assisted laparoscopic hysterectomies will be done in lithotomy position using stirrups. The weight limit of the Basic Stirrups and Yellofins® Stirrups (Allen Medical Systems, Acton, MA) is 350 pounds (159 kilograms), while the Yellofins® Elite Stirrups (Allen Medical Systems, Acton, MA) can accommodate a patient up to 500 pounds (227 kilograms). Specially designed for larger patients, Ultrafins® (Allen Medical Systems, Acton, MA) can be used for patients up to 800 pounds (363 kilograms). The OR staff should be alerted to the special needs of the obese or morbidly obese patient to adequately prepare for transporting, positioning, and transferring the patient to prevent delays or embarrassment for the patient.

Intraoperative Considerations

Obesity adds complexity to all aspects of robotic-assisted laparoscopic hysterectomy, including patient positioning, anesthesia, and exposure and visualization. Robotic-assisted laparoscopic hysterectomy has many measurable benefits over laparotomy, including shorter hospital stay, less pain, faster return to normal activity, decreased incidence of post-operative ileus, fever, and wound infection, and improved quality of life [1–3]. This is particularly true for the obese patient. In this section we will address how obesity affects various aspects of robotic-assisted laparoscopic hysterectomy and strategies for combating obesity in the operating room.

Anesthetic Considerations

Obesity significantly increases the risk of preexisting medical conditions in women undergoing robotic-assisted laparoscopic hysterectomy. Adults with a BMI > 40 are at increased risk of diabetes mellitus, hypercholesterolemia, hypertension, and asthma [7]. Women with obesity have an increased oxygen demand, increased cardiac output, larger stroke volumes, increased vascular resistance, increased cardiovascular work and ultimately increased risk of heart disease [11]. These women are also at increased risk for congestive heart failure, pulmonary edema, and arrhythmias. The pulmonary system is also affected by obesity. The respiratory function in obese patients is characterized by reduced functional vital capacity, functional residual capacity, total lung volume, total lung capacity, and expiratory reserve volume [4]. Compromises to lung function are compounded in women with OSA or obesity hyperventilation syndrome [4]. Additionally, obese patients are at higher risk for aspiration, due to increase gastric volumes and delayed emptying [12].

Due to these physiologic changes, induction of general anesthesia is a critical step in the care of the obese patient undergoing robotic-assisted laparoscopic hysterectomy. Women with obesity experience a more rapid desaturation during the apneic episodes that take place during induction of anesthesia [13]. This can be counteracted by optimal pre-oxygenation of obese patients [4]. With induction of anesthesia, ventilation with a facemask is considerably more difficult as a result of the decreased lung compliance and increased airway resistance associated with obesity. It is notable that most patients who tolerate induction of anesthesia and supine positioning are able to tolerate pneumoperitoneum and trendelenburg positioning [4].

During the procedure, the anesthesiologist may employ specific ventilation techniques. Pressure control ventilation may be used to improve the lung ventilation-perfusion ratio, generate higher flow peaks, and improve alveolar recruitment [14]. Additionally, higher inspiratory pressures may need to be used if ventilatory compliance is reduced secondary to the weight of abdominal viscera when the patient is in steep trendelenburg position [15]. Breaks from trendelenburg positioning may be necessary to prevent

unsafe elevations of arterial carbon dioxide levels [4]. If the partial pressure of arterial carbon dioxide level increases, the robot should be undocked, the patient should be taken out of Trendelenburg position, and the abdomen should be desufflated. Once the partial pressure of arterial carbon dioxide level returns to normal, the patient can be placed back into Trendelenburg position, the abdomen can be insufflated, and the robot re-docked, allowing surgery to continue [4]. Obese women are also at increased risk of laryngeal edema, which may require prolonged intubation postoperatively [4].

In addition to considerations regarding airway management, intravenous access must also be considered. Multiple IV lines may be placed once the patient is in the operating room. Many anesthesiologists prefer to use invasive patient monitoring [4]. This may be particularly true for robotic-assisted laparoscopy, where the patient is more difficulty to access during surgery.

Positioning

Positioning obese and morbidly obese women for robotic-assisted laparoscopic hysterectomy can be challenging and may take additional time [3, 16]. In preparation for robotic-assisted laparoscopic hysterectomy, women are traditionally positioned in the dorsal lithotomy position with arms tucked at military position at the patient's sides. When positioning the patient, the use of a bariatric bed should be considered. Bariatric beds are wider, allowing for easier tucking of the arms, and have a lower profile to the floor. Bed extenders or sleds should be utilized if needed in order to ensure that the arms are secured [4]. Furthermore, moving the asleep obese patient into the dorsal lithotomy position can be challenging. It may take a team approach to safely position the patient. If airway management is not an issue, patient "self-positioning" into stirrups prior to anesthesia induction may be considered [3].

The patient should be securely positioned in order to prevent movement while in steep trendelenburg position. Downward movement may make the surgery more difficult and lead to nerve stretch injuries to the brachial plexus [17]. Anti-skid materials such as egg crate foam, gel pad, or surgical beanbag should be used to prevent slippage. Some surgeons prefer the use of shoulder braces. These should only be used when the patient's arms are tucked at the side [17, 18]. They should be placed over the acromioclavicular joint, as inappropriate placement can lead to brachial plexus injury [17, 18].

It is important to ensure correct positioning with ample padding, as obese patients are at greater risk for pressure sores and nerve injuries as compared to non-obese patients [4]. To reduce the risk of ulnar nerve injury, the arm should be pronated and liberally padded [18]. Care should be taken to pad the lateral aspect of the knee to avoid peroneal nerve injuries. Excess flexion (> 90°) of the hip and external rotation of the thigh should be avoided, as this can lead to sciatic, femoral, and lateral femoral cutaneous nerve injuries. Due to the complexities associated with positioning, surgeons should be aware of the increased time this may add to the surgical case [16, 19]. Figure 75.1 demonstrates some aspects of patient positioning.

Surgical Prophylaxis

Most surgical procedures for benign gynecologic indications are considered intermediate risk for VTE [20, 21]. Sequential compression devices are the standard prophylactic treatment for moderate risk procedures, defined as major abdominal

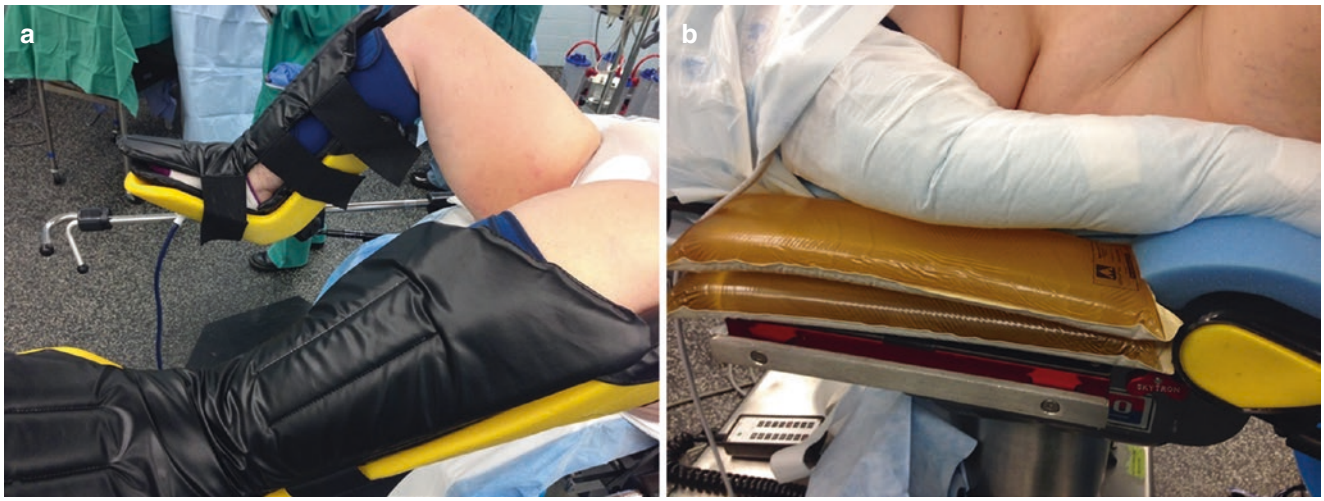


Fig. 75.1 Patient positioning utilizing Yellofins® Stirrups (**a**) and additional padding and a bed extender (**b**)

procedures lasting longer than 30 minutes [21]. It is important to ensure that there are appropriately sized devices available to adequately protect against VTE. If appropriately fitting devices are not available, pharmacologic prophylaxis with 5000 units of subcutaneous unfractionated heparin or 30–40 mg subcutaneous enoxaparin should be given prior to incision.

All women undergoing hysterectomy should receive appropriate preoperative antibiotics, adjusted for weight, for the prevention of postoperative infection. Antibiotics should be re-dosed after 3 hours or with an estimated blood loss over 1500 mL [22]. While there is no data in the gynecology literature, 2 g cefazolin has been shown to provide adequate coverage for clean-contaminated procedures in morbidly obese patients [23].

Abdominal Access and Trocar Placement

Abdominal access may be more challenging in obese patients. This is secondary to an increased distance from the skin to fascia and from the fascia to the peritoneum. Understanding the changes in anatomy is an important for ensuring a safe entry. The shortest distance between the skin and the peritoneal cavity is always through the umbilicus. As BMI increases it has been demonstrated that the umbilicus drifts caudad in relation to the aortic bifurcation [24, 25]. If choosing to enter at the umbilicus, a 90-degree entry should be utilized in order to maximize triangulation [4, 25]. In women with a large pannus, a supra-umbilical or left upper quadrant entry may be preferable, in order to maximize triangulation and access to the anatomy. Obesity is a risk factor for failed entry and pre-peritoneal insufflation [26]. Utilization of the open Hassan technique or left upper quadrant entry may minimize this risk [26]. If a left upper quadrant entry technique is chosen, the entry point should be in the mid-clavicular line, 2–3 cm below the subcostal margin [27]. An orogastric or nasogastric tube should be placed, and the stomach should be drained prior to entry.

When placing accessory trocars for robotic-assisted hysterectomy, it is important to consider the mechanics of the robotic movements as well as the anterior abdominal wall anatomy in the obese patient. When operating on the Da Vinci Surgical System, it is recommended that trocars be placed approximately 8–10 cm apart when moving laterally across the abdomen. The increased diameter of the abdomen may aid in appropriate trocar placement, and decrease the risk of arm collision. Additionally, as morbidly obese patients may have increased subcutaneous fat in the lower part of the abdomen or a pannus, trocar placement will be higher on the abdomen, closer to the level of the umbilicus [4] (Fig. 75.2). The use of long or bariatric trocars should be considered to overcome the increased thickness of the anterior abdominal wall [4]. Additionally, while placement of accessory trocars under direct visualization minimizes risk of injury, visualization of the inferior epigastric vessels and bladder may be limited [28] (Fig. 75.3).

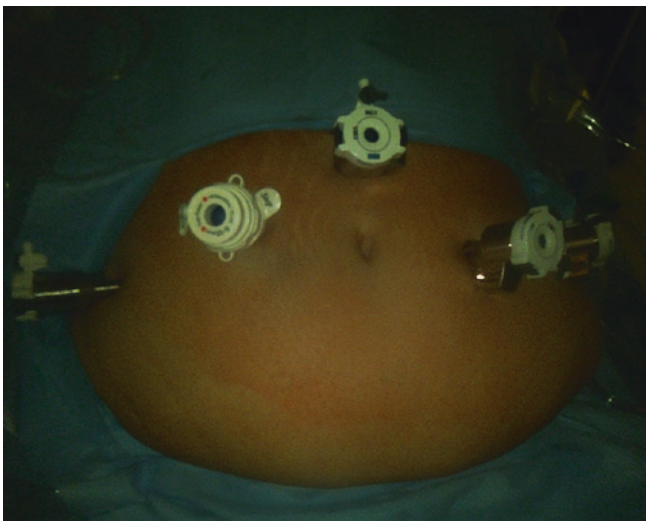


Fig. 75.2 Example of proper trocar placement for robotic assisted laparoscopic hysterectomy

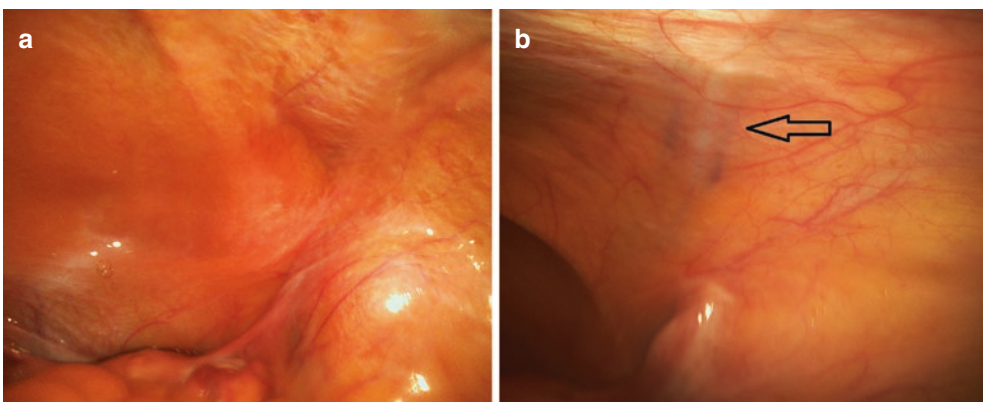


Fig. 75.3 The inferior epigastric vessels are unable to be visualized in an obese patient (**a**) compared to a patient with normal BMI (**b**)

Exposure and Visualization

Excess adiposity effects visualization and exposure of the surgical field (Fig. 75.4). During placement of the accessory trocars, the inferior epigastric vessels are not reliably visualized due to larger amounts of preperitoneal adipose tissue [28]. A comprehensive understanding of anterior abdominal wall anatomy is necessary to minimize risks of injury to these vessels.

Robotic-assisted laparoscopic hysterectomy traditionally requires the patient to be placed in steep trendelenburg position in order to displace the bowel cephalad and gain access to the pelvis [29]. Prior to beginning the surgery, a 2–5 minute trial of steep trendelenburg may be useful to assure the patient can tolerate the trendelenburg position. This should also be done after insufflation, but prior to beginning the operation. Generally if a patient is able to tolerate this trial, the patient is able to tolerate robotic-assisted laparoscopic surgery [30]. Often, despite steep trendelenburg positioning, exposure may be inadequate due to extra fat on the sigmoid colon (Fig. 75.5). This may be managed by utilizing additional assistant ports to introduce a laparoscopic fan to hold the bowel, or a stitch placed through the epiploic appendices and attached to the anterior abdominal wall drawing the bowel away from the surgical field [4, 19] (Fig. 75.6). Additionally, robotic-assisted surgery allows the surgeon to use the third arm as a retractor, which may be useful in the setting of a redundant colon or extra epipolic appendices.

Increased adiposity may also affect the urinary system. Studies have shown that identification of the bladder margins may be more difficult in obese patients [28]. This may lead to injury at the time of trocar placement or bladder dissection. Understanding anatomic landmarks, careful dissection of the bladder away from the uterine vessels, and skeletonization of the vessels may reduce the likelihood of injury. Backfilling the bladder may also allow the surgeon to better delineate bladder margins. While no studies have shown an increase in ureteral injury, transperitoneal visualization of the ureters is reduced in obese patients. Retroperitoneal identification may be required to appropriately identify the ureter (Fig. 75.7).

In general, increasing obesity is associated with prolonged operative time, prolonged time under anesthesia, and increased blood loss for patients undergoing laparoscopic and robotic-assisted laparoscopic hysterectomy [16, 29]. Interestingly one study by Siedhoff et al. demonstrated an increasing severity of complications in women undergoing laparoscopic hysterectomy with increasing BMI [16]. This may also be true in robotic surgery. In studies comparing robotic and laparoscopic surgery for the treatment of endometrial cancer, robotic-assisted surgery has been shown to have advantages, including decreased operative time and decreased estimated blood loss [29]. This may be related to improved visualization, improved dexterity to maneuver around fatty tissue, less surgeon fatigue, and improved exposure through retracting excess tissue with the 3rd robotic arm [19].

In summary, the surgeon should perform the same steps when performing a robotic-assisted laparoscopic hysterectomy on an obese patient, as compared to a non-obese patient. What differs is that anatomy may be obscured by increased adiposity. A complete understanding of pelvic anatomy and meticulous surgical technique can improve the surgeon's ability to identify the essential structure and safely complete a robotic-assisted laparoscopic hysterectomy in the obese patient.

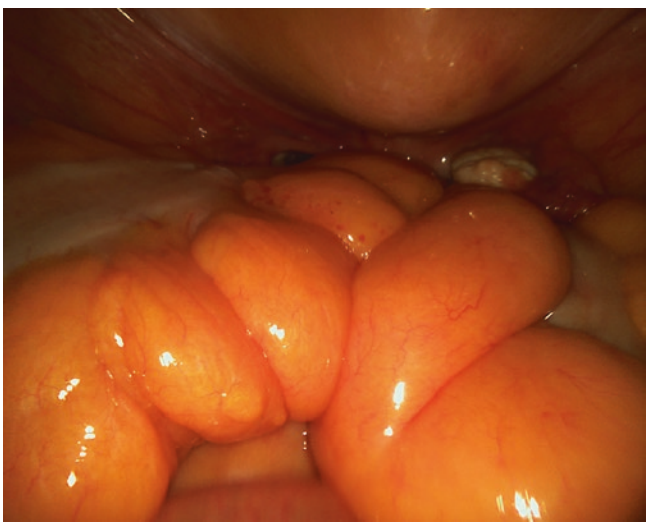


Fig. 75.4 Excess adipose tissue obscuring surgical field

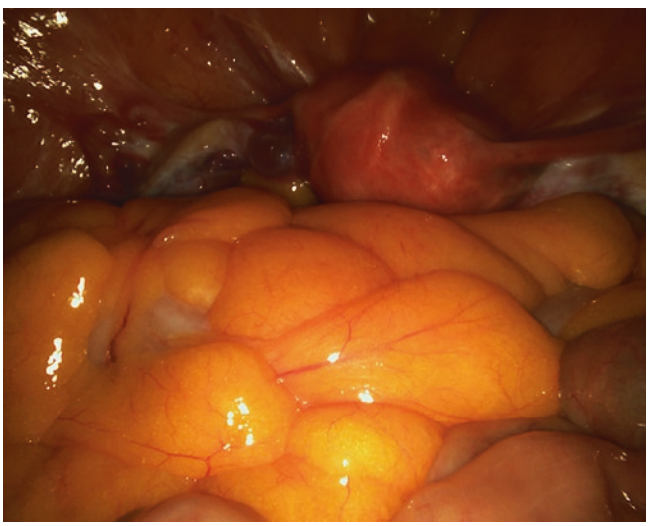


Fig. 75.5 Excess adipose tissue on the colon

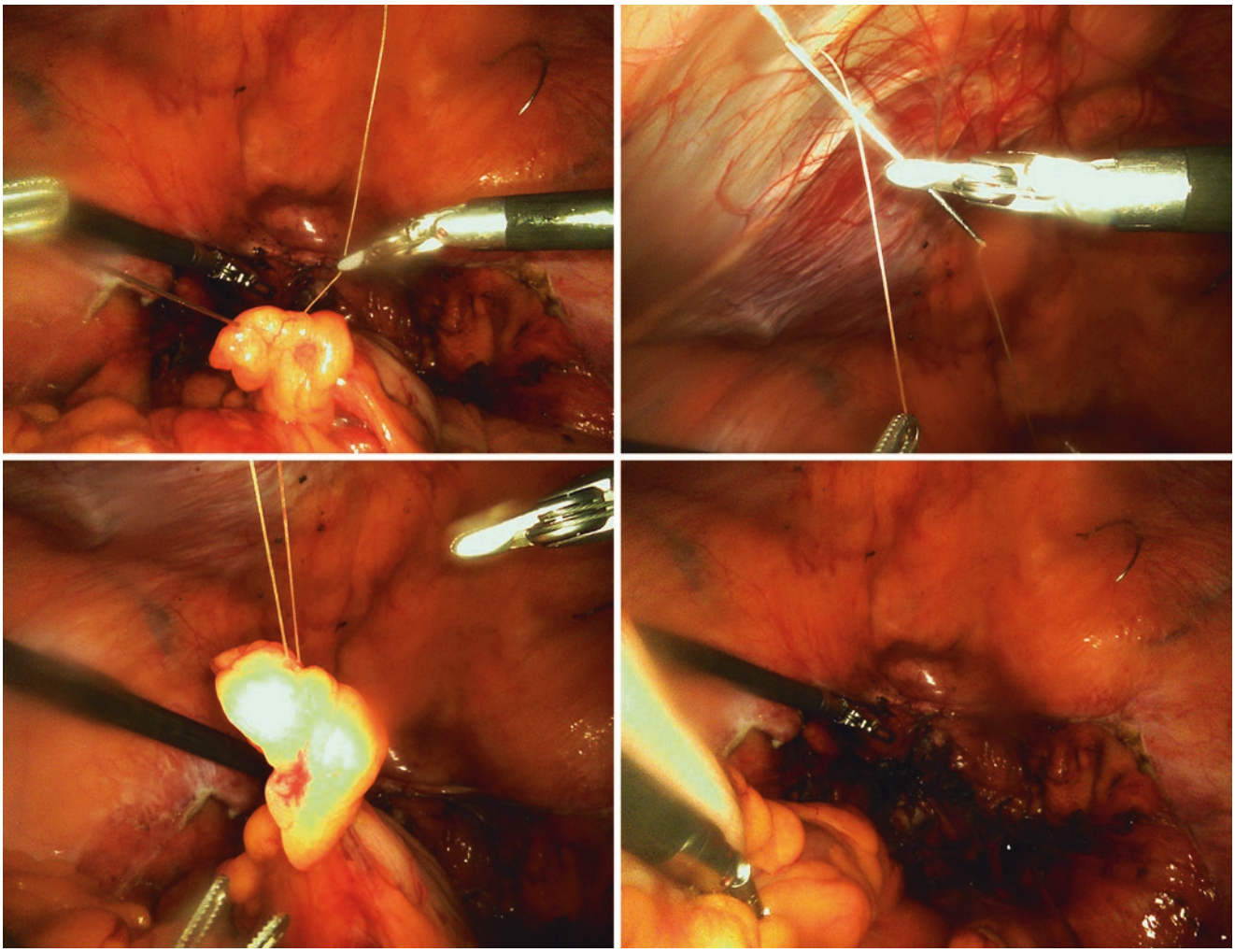


Fig. 75.6 Temporary suture through sigmoid colon epiploica to tack it to the anterior abdominal wall to aid in visualization of the pelvis

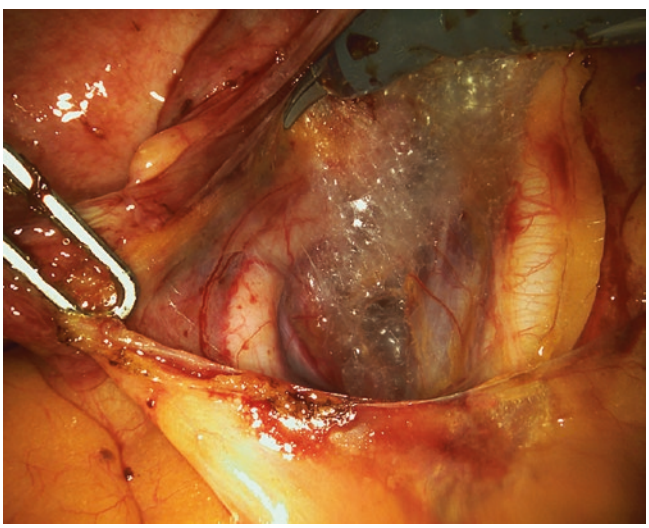


Fig. 75.7 Identification of the ureter by retroperitoneal dissection. Technical skill and knowledge of anatomy is required to complete this procedure

Postoperative Considerations

Patients with obesity are at higher risk for postoperative complications. They have a higher rate of venous thromboembolism and resumption of ambulation may be more difficult particularly for the morbidly obese patient [9, 31]. They are also at higher risk of cardiopulmonary and metabolic problems related to underlying comorbidities. Routine postoperative recommendations should be encouraged in this population, in addition to some special considerations outlined below.

Postoperatively, patients are at risk of pneumonia and postoperative fever attributed to atelectasis [8, 9]. Incentive spirometer use is important to prevent atelectasis. Pain control is also essential to prevent splinting, which leads to poor lung expansion and atelectasis. One of the advantages of robotic surgery is the lower pain level that patients experience compared to open surgery [1–3]. This decreases the amount of narcotic use, and minimizes the risk of decreased

respiratory drive [9]. Many patients with obesity also suffer from OSA, and use of CPAP should be continued or initiated in the postoperative period [8, 9]. Even for patients without a diagnosis of OSA, positive pressure noninvasive ventilation may be required in the immediate postoperative period. Additionally, OSA increases the risk of coronary heart disease and heart failure, and these patients should be closely monitored for at least 23 hours after surgery [4, 8].

Obesity increased the risk of VTE, especially in women [31, 32]. Proposed mechanisms include enhanced platelet activity, increased clotting factors, and impaired fibrinolysis [32]. Early ambulation will decrease the rate of VTE by removing stasis of blood flow from Virchow's triad. Additionally, VTE prophylaxis is recommended in all patients hospitalized after surgery [4]. According to the 2012 CHEST Evidence-Based Clinical Practice Guideline, patients undergoing gynecologic surgery who are at moderate risk for VTE (Caprini score 3–4) should receive low-molecular-weight heparin (LMWH) or mechanical prophylaxis; those at high risk (Caprini score ≥5) should receive both; those undergoing surgery for cancer require 4 weeks of LMWH [33]. The Caprini score includes points for BMI greater than 25 and additional point for BMI over 40. Of note, the CHEST guidelines are not specific for laparoscopic surgery, and use of LMWH is controversial after laparoscopic or robotic surgery for benign disease [4, 34].

Starting a regular diet as soon as tolerated after surgery will decrease the rate of postoperative ileus, as well as expedite the resumption of the patient's home medications for diabetes, hypertension, and dyslipidemia. Most patients undergoing a robotic-assisted laparoscopic hysterectomy will be able to resume their usual diet the same day. Patients with diabetes mellitus should have a carbohydrate-consistent diet and tight blood glucose control, as elevated blood glucose levels can impair healing and increase the risk of infection [35].

In conclusion, robotic-assisted laparoscopic hysterectomy is an attractive option for the obese population, with many advantages such as decreased pain, shorter hospital stay, and faster return to daily activities. While these factors decrease the rate of complications, proper patient selection and attention to the unique challenges and comorbidities of this patient population are essential.

References

1. Nawfal K, Orady M, Eisenstei D, Wegienka G. Effect of body mass index on robotic assisted total laparoscopic hysterectomy. J Minim Invasive Gynecol. 2011;18:328–32.
2. Gallo T, Kashani S, Patel D, Elsahwi K, Silasi D, Azodi M. Robotic-assisted laparoscopic hysterectomy: outcomes in obese and morbidly obese patients. JSLS. 2012;16:421–7.
3. Almeida O. Robotic hysterectomy strategies in the morbidly obese patient. JSLS. 2013;17:418–22.
4. Scheib S, Tanner E, Green I, Fader A. Laparoscopy in the morbidly obese: physiologic considerations and surgical techniques to optimize success. J Minim Invasive Gynecol. 2014;21:182–95.
5. Lee GI, Lee MR, Clanton T, Sutton E, Park AE, Marohn MR. Comparative assessment of physical and cognitive ergonomics associated with robotic and traditional laparoscopic surgeries. Surg Endosc. 2014;28(2):456–65.
6. Wright KN, Jonsdottier GM, Jorgensen S, Shah N, Einarsson JI. Costs and outcomes of abdominal, vaginal, laparoscopic and robotic hysterectomies. JSLS. 2012;16:519–24.
7. Ramaswamy A, Gonzalez R, Smith D. Extensive preoperative testing is not necessary in morbidly obese patients undergoing gastric bypass. J Gastrointest Surg. 2004;8:159–65.
8. Catheline J, Bihan H, Quang T, Sadoun D, Charniot J, Onnen I, Fournier J, Bénichou J, Cohen R. Preoperative cardiac and pulmonary assessment in bariatric surgery. Obes Surg. 2008;18:271–7.
9. Kaw R, Aboussouan L, Auckley D, Bae C, Gugliotti D, Grant P, Jaber W, Schauer P, Sessler D. Challenges in pulmonary risk assessment and perioperative management in bariatric surgery patients. Obes Surg. 2008;18:134–8.
10. Maddox T. Preoperative cardiovascular evaluation for noncardiac surgery. Mt Sinai J Med. 2005;72(3):185–92.
11. Kral JG. Morbidity of severe obesity. Surg Clin North Am. 2001;81(5):1039–61.
12. Sugerman HJ. Effects of increased intra-abdominal pressure in severe obesity. Surg Clin North Am. 2001;81:1063–75.
13. Juvin P, Lavaut E, Dupont H, Lefevre P, Demetriou M, Dumoulin JL, et al. Difficult tracheal intubation is more common in obese than in lean patients. Anesth Analg. 2003;97(2):595–600.
14. Cadi P, Guenoun T, Journois D, Chevallier JM, Diehl JL, Safran D. Pressure-controlled ventilation improves oxygenation during laparoscopic obesity surgery compared with volume-controlled ventilation. Br J Anaesth. 2008;100:709–16.
15. Talib HF, Zabani IA, Abdelrahman HS, et al. Intraoperative ventilatory strategies for prevention of pulmonary atelectasis in obese patients undergoing laparoscopic bariatric surgery. Anesth Analg. 2009;109:1511–6.
16. Siedhoff MT, Carey ET, Findley AD, Riggins LE, Garrett JM, Steege JF. Effect of extreme obesity on outcomes in laparoscopic hysterectomy. J Minim Invasive Gynecol. 2012;19(6):701–7.
17. Coppieters MW. Shoulder restraints as a potential cause for stretch neuropathies: biomechanical support for the impact of shoulder girdle depression and arm abduction on nerve strain. Anesthesiology. 2006;104:1351–2.
18. Bradshaw AD, Advincula AP. Postoperative neuropathy in gynecologic surgery. Obstet Gynecol Clin N Am. 2010;27:451–9.
19. Stone P, Burnett A, Burton B, Roman J. Overcoming extreme obesity with robotic surgery. Int J Med Robot. 2010;6(4):382–5.
20. Rahn DD, Mamik MM, Sanses TV et al. Society of Gynecologic Surgeons Systematic Review Group. Venous thromboembolism prophylaxis in gynecologic surgery: a systemic review. Obstet Gynecol 2011: 118:1111–25
21. Geerts WH, Bergqvist D, Pineo GF, et al. American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th edition). Chest. 2008;133(6 Suppl):381S–453S.
22. ACOG Committee on Practice Bulletins: Gynecology. ACOG practice bulletin No. 104. Antibiotic prophylaxis for gynecologic procedures. Obstet Gynecol. 2009;113:1180–9.
23. Forse RA, Karam B, MacLean LD, Christou NV. Antibiotic prophylaxis for surgery in morbidly obese patients. Surgery. 1989;106:750–6.
24. Hurd W, Burde R, DeLancey J, Gauvin J, Aisen A. Abdominal wall characterization with magnetic resonance imaging and computer

tomography: the effect of obesity on the laparoscopic approach. J Reprod Med. 1991;36:473–6.
25. Hurd W, Bude R, DeLancey J, Pearl M. The relationship of the umbilicus to the aortic bifurcation: implications for laparoscopic technique. Obstet Gynecol. 1992;80:48–51.
26. Ahmad G.O'Flynn H, Duffy JM, Phillips K, Watson A. Laparoscopic entry techniques. Cochrane Database Syst Rev. 2012: 2:CD006583.
27. Tulikangas PK, Nicklas A, Falcone T, Price LL. Anatomy of the left upper quadrant for cannula insertion. J Am Assoc Gynecol Laparosc. 2000;7:211–4.
28. Hurd WW, Amesse LS, Gruber JS, Horowitz GM, Cha GM, Hurteau JA. Visualization of the epigastric vessels and bladder before laparoscopic trocar placement. Fertil Steril. 2003;80(1):209–12.
29. Boggess JF, Gehrig PA, Cantrell L, Shafer A, Ridgway M, Skinner EN, Fowler WC. A comparative study of 3 surgical methods for hysterectomy with staging for endometrial cancer: robotic assistance, laparoscopy, laparotomy. Am J Obstet Gynecol. 2008;199(4):360.
30. Lamvu G, Zolnoun D, Boggess J, JF S. Obesity: physiologic changes and challenges during laparoscopy. Am J Obstet Gynecol. 2004;191:669–74.
31. Stein P, Beemath A, Olson R. Obesity as a risk factor in venous thromboembolism. Am J Med. 2005;118:978–80.
32. Freeman A, Pendleton R, Rondina M. Prevention of venous thromboembolism in obesity. Expert Rev Cardiovasc Ther. 2010;8(12):1711–21.
33. Guyatt G, Akl E, Crowther M, Gutterman D, Schuunemann H, American College of Chest Physicians. Antithrombotic therapy and prevention of thrombosis, 9th ed: American College of check physicians evidence-based clinical practice guidelines. Chest. 2012;141:7s.
34. Ramirez P, Nick A, Frumovitz M, Schmeler K. Venous thromboembolic events in minimally invasive gynecologic surgery. J Minim Invasive Gynecol. 2013;20:766–9.
35. Pomposelli JJ, Baxter JK, Babineau TJ, Pomfret EA, Driscoll DF, Forse RA, et al. Early postoperative glucose control predicts nosocomial infection rate in diabetic patients. JPEN. 1998;22(2):77–81.

Robotic-Assisted Single-Port Laparoscopic Hysterectomy

76

Vito Cela, Nicola Pluchino, and Letizia Freschi

Introduction

The recent phenomenon of laparo-endoscopic single-site surgery (LESS) opened a new way to perform minimally invasive gynaecological surgery presenting a number of advantages over traditional laparoscopic surgery. However, LESS is challenging due to the lack of port triangulation, two dimensional view, poor ergonomic position for the surgeon and a steep learning curve overall for suturing. To potentially overcome these challenges, single-site robotic surgical platforms have been developed recently. Robotic surgical platforms may shorten the minimally invasive learning curve for select surgeons compared with traditional laparoscopy. A single-site robotic platform may also help to overcome some of the technical limitations of LESS (learning curve, instrument crowding, lack of triangulation, and loss of depth of perception/instability with current 2-dimensional flexible optics). Furthermore, the introduction of the da Vinci robotic system to single-site surgery, will further diminish the impediments that limit this minimally invasive technique.

Robotic-Assisted Single-Port Laparoscopic Hysterectomy

During the past years, the field of laparoscopy has undergone several changes and continuous efforts have been made to improve the morbidity and cosmesis of laparoscopic surgery with a special focus on miniaturization of equipment, evolution of robotic surgical units, and reduction of port size and number. Laparoendoscopic single-site surgery (LESS) is a term that covers a spectrum of surgical techniques that perform laparoscopic surgery by consolidating all ports into only one surgical incision. Although early results are encouraging, this should not disguise the technical difficulties associated with performing LESS procedure. LESS is challenging due to the lack of port triangulation (which lead to the clashing of laparoscopic instruments), two dimensional view, poor ergonomic position for the surgeon and a steep learning curve overall for suturing. New technologies such as flexible scopes, angle instruments and novel robotic platforms have improved the success and consistency of the single-port approach, leading to the inevitable hybridization of robotic technology with LESS surgery. As result, employment of the da Vinci surgical system (Intuitive Surgical, Inc., Sunnyvale, CA) allows greater surgical maneuverability and improves ergonomics during LESS. Preliminary advances in R-LESS (robotic laparoendoscopic single-site surgery) have been already documented in urologic and general, but just in last years have been analyzed the possible application of the robotic laparoendoscopic single-site technology to the gynecological surgery.

In 2011 Nam et al. described a series of seven women with a diagnosis of benign or malignant gynaecological disease concluding that RSSH is feasible and offers some potential advantages over standard robotic or laparoscopic surgery, i.e. minimally invasive access with a smaller scar, less pain and results comparable to those obtained using classical procedures [1]. In the same year, Escobar et al. published a pilot study aiming to evaluate the possible application of robotic laparoendoscopic single-site technology to gynecological surgery, analyzing feasibility and reproducibility of a dedicated da Vinci single-port robotic platform in cadavers for the performance of various gynecologic oncology procedures [2]. All surgical procedures were performed through a single 3–4 cm umbilical incision with a multichannel system that consisted of a wound retractor, surgical gloves, and two 10/12 mm and two 8-mm trocars. A 3–4 cm vertical umbilical skin incision via an open Hasson approach was made and then, the Alexis Wound Retractor (Applied

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Medical, Rancho Santa Margarita, CA, USA) was inserted into the peritoneal cavity. The wrist portion of a size 7.5 surgical glove was fixed to the outer ring of the wound retractor. After making a small hole in the fingertips of the glove, two 10/12-mm and two 8-mm trocars were inserted, and the abdomen was insufflated with CO2 gas. After placing the robotic single-port access system, the overall procedure was similar to that of single-port transumbilical laparoscopic surgery.

However, in October 2011, has been performed the first worldwide case of robot-assisted laparoscopic single-site hysterectomy (RSSH) with the newly designed multichannel port (Intuitive Surgical) for the da Vinci surgical system [3].

Single-site instruments and accessories are designed for the Si version of the da Vinci Surgical System. The single-site port is a multichannel disposable access port with a target anatomy arrow indicator and room for four cannulae and an insufflation valve. Two curved cannulae are for robotically controlled instruments whereas the other two cannulae are straight: one is 8.5 mm and accommodates the high-definition three-dimensional endoscope, and the other is a 5-mm bedside-assistant surgeon port (Fig. 76.1). The docking clamps of the robot automatically recognize the shape of the single-site curved cannulas and reassign each master control to the slave instrument on the opposite side, compensating for the crossing of the curved cannulas. The system includes a range of 5-mm nonwristed, semirigid, and reposable instruments, including a monopolar hook, two bipolar instrument options (a fenestrated bipolar and a Maryland dissector), different types of graspers, curved scissors, a medium-large Hem-o-lok clip applier (Teleflex Medical), needle drivers, and a suction irrigator. Patients are placed in a modified dorsal lithotomy position, and extremities are separated and flexed using adjustable boot stirrups. Anti-skid methods (e.g., vacuum bean bag and gel pad) can be used, and maximum Trendelenburg position (>30°) has to be attained before the Da Vinci Si robot is docked between the legs. After the placament of bladder catheter, an uterine manipulator device ha sto be placed, when possible, in order to improve uterine mobilization. Port placement is performed by using Hasson's technique modified with a 2.0-cm omega-shaped intraumbilical incision (Fig. 76.2) down to the level of the fascia; this is entered and a finger sweep to check for adhesions is performed. Prelubrication of the single-site port with a sterile saline solution prior to introduction is recommended, then, port insertion can be reached utilizing two techniques, the "unfolded" and the "folded" port-clamping technique using an atraumatic clamp and grasping just above the lower rim before proceeding with insertion (Fig. 76.3); at last the arrow marking on the port is aligned with the target anatomy (uterus/pelvis). After an initial pneumoperitoneum at 20 mmHg, it can be reduced to 8 mmHg taking advantage of the strength of the its mobility before curved cannulae's insertion (Fig. 76.4). This step is important to ensure that there is adequate working space for the curved cannulae during the entire surgical procedure and that the instruments are fully supported. Adhesions have to be removed as necessary and loops of small bowel have to be folded, not pushed, back into the upper abdomen to expose the root of the mesentery.

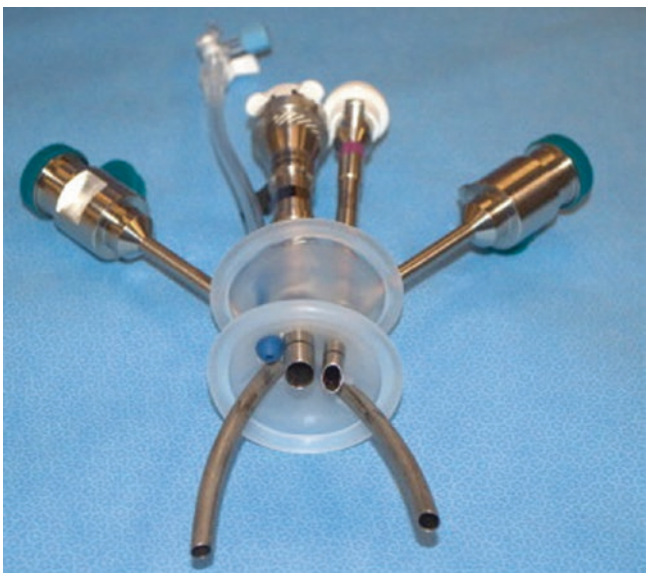


Fig. 76.1 A Single-port cluster



Fig. 76.2 Omega-shape umbelical incision

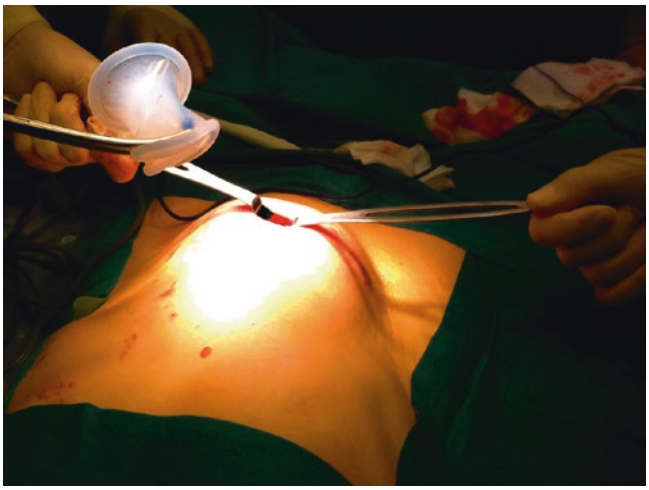


Fig. 76.3 Single-site port introduction with the "folded" port-clamping technique using an atraumatic clamp

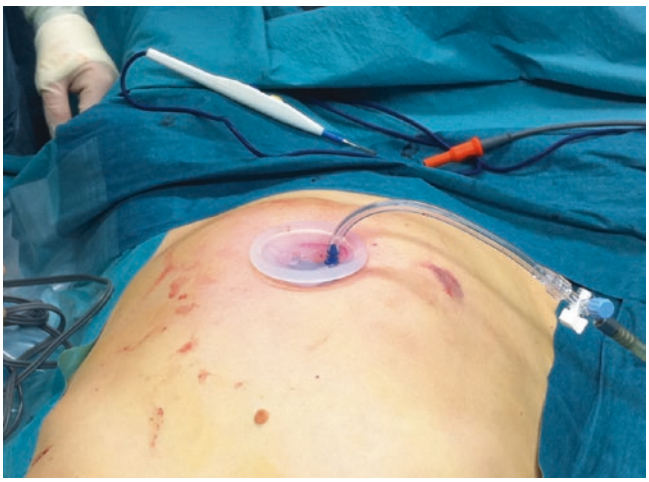


Fig. 76.4 Pneumoperitoneum induction after the umbelical placement of the single-site port

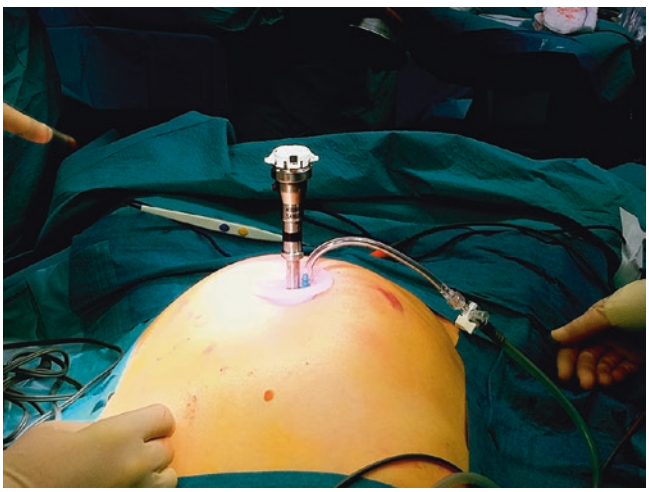


Fig. 76.5 Positioning of the 12-mm lubricated trocar for the robotic 30-degree scope

Once sufficient initial exposure is achieved, the cart can be docked and the 12-mm lubricated trocar for the robotic 30-degree scope and two 8-mm trocars for the robotic instruments are placed in a triangular way under direct visualization (Figs. 76.5 and 76.6). Through the 5-mm bedside-assistant port endoscopic suction, coagulation and cutting with electrothermal bipolar vessel sealer can performed. Placing the robotic single-port access system, As far as the surgical technique, the procedure is similar to that of multiport robot-assisted surgery: The ovaries are examined. The right round ligament is coagulated and transected (Fig. 76.7) and the retroperitoneal space is opened to identify the ureter (Fig. 76.8). Then, the infundibulopelvic ligament is securely skeletonized, coagulated and transected. The uterine arteries are skeletonized, coagulated and transected. The bladder and the attached peritoneal flap are developed using a monopolar hook and dissected below the colpotomy cup (Fig. 76.9). Both uterosacral ligaments are excised with the monopolar hook and the peritoneum on the posterior cervix is excised and divided from the cervix. Similar steps are performed

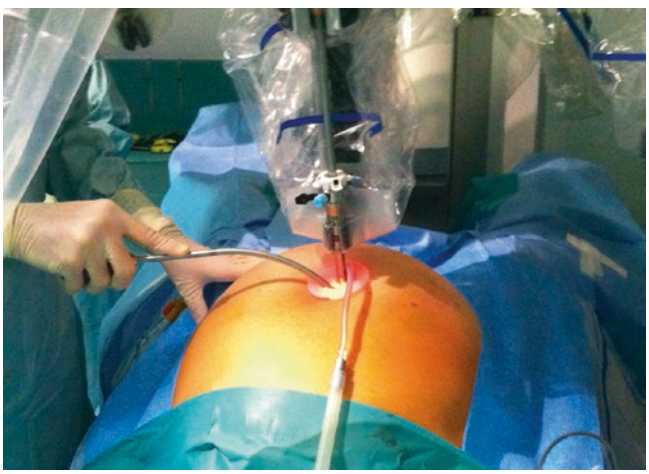


Fig. 76.6 One of the two 8-mm trocars for the robotic instruments placed under direct visualization

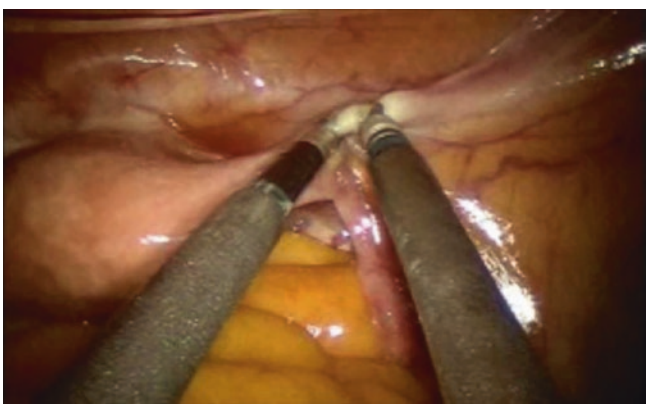


Fig. 76.7 Coagulation and section right broad ligament

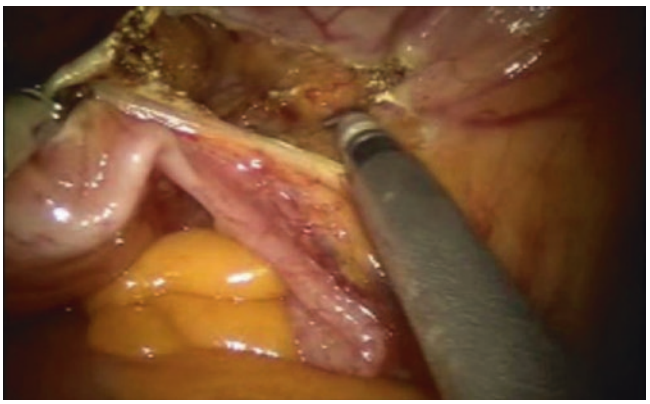


Fig. 76.8 Retroperitoneal space opening and identification of the ureter

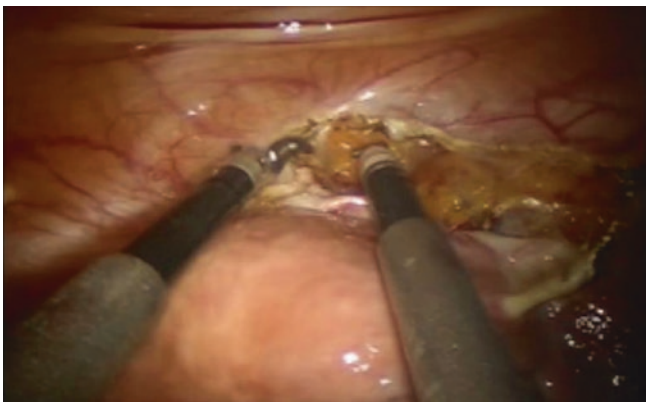


Fig. 76.9 Opening of the vescico-uterine space

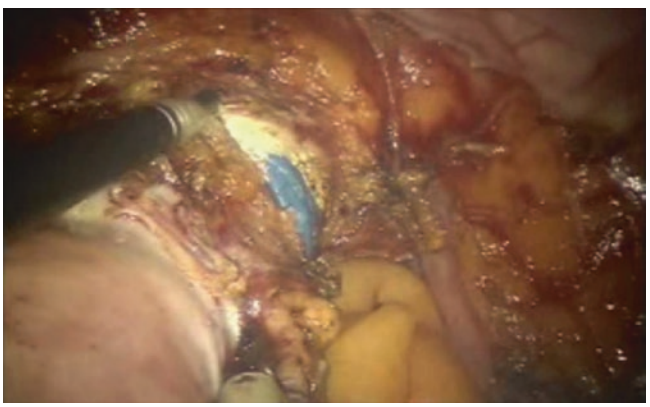


Fig. 76.10 Anterior colpotomy

contralaterally. The anterior colpotomy (Fig. 76.10) and posterior colpotomy are performed with the monopolar hook and the vagina delineated with colpotomizer. The uterus and adnexae are then removed through the vagina. In cases of younger patients the ovaries could be preserved to avoid menopausal symptoms. (Fig. 76.11). As far as the vaginal cuff closure, it can be obtained in different ways according to

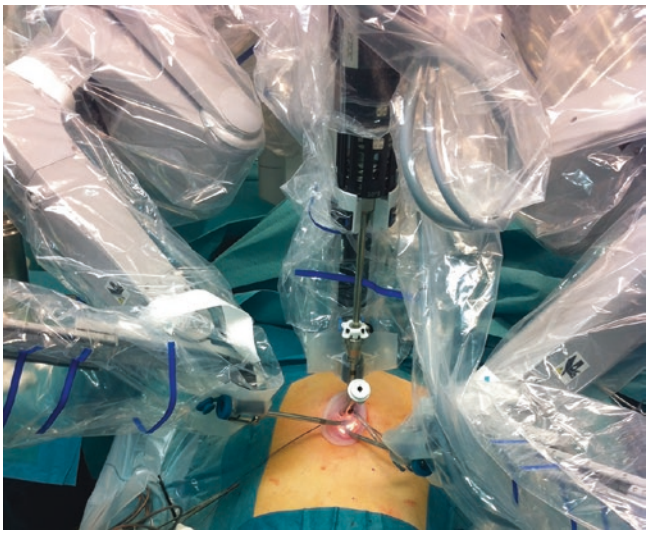


Fig. 76.11 Final single-site robotic port dock

the anatomical features of the vagina itself: with an intracorporeal barbed suture or intracorporeal interrupted figure-of-eight sutures (0 Vicryl™, Ethicon) or transvaginally with interrupted delayed absorbable suture of Vicryl 2/0 (Ethicon Inc., Somerville, NJ).

Discussion

Bogliolo et al. proposed also in some circumstances, such as a narrow vagina or the need of vaginal vault suspension, requiring a robotic approach to colporraphy, an intracorporeal suture with extracorporeal knots a particolar way to close the vaginal vuff. The procedure was performed introducing the 0 caliber polyglycolic acid suture (Vicryl ™; Ethicon) by the 10 mms trocar through the single site port. The number of suture in vaginal cuff closure was four and was performed with interrupted figure-of-eight sutures. The knots were pushed in to the pelvis by the use of Knot Pusher Storz device [4]. Undoubtedly, one of the greatest limitations of the single-site platform is that the semiflexible robotic instruments are not currently capable of articulation (as in multiport robotic surgery), ad the cannulas are rather long. This means that there are fewer degrees of freedom than with multiport robotic surgery and a very small distance between the instrument and the uterus. This makes the suture really demanding, not only in the tying of the incorporeal knots but also in the pulling of the vaginal tissue in the right direction (i.e., parallel to the needle) during the needle's passage.

Another important aspect, is that, according to current evidence, transvaginal suturing of the vaginal stump is associated with a lower incidence of vaginal dehiscence or general cuff complications compared with both laparoscopic and robotic suturing. Anyhow, the method of vaginal

cuff closure during robotic total hysterectomy should be simple and time efficient, with the risks of infection and vaginal cuff dehiscence minimized.

After hemostasis, the fascia was repaired with a 2/0 Vicryl interrupted stitches (Ethicon Inc.) and skin closed with 3/0 Ethilon interrupted stitches.

Cela et al. analyzed, in vivo, using a CUSUM method, the learning curve of robot-assisted single-site hysterectomy identifing two different phases of the learning curve of the procedure: phase 1, found to require six cases, can represent the initial learning curve phase, and phase 2 can represent the mastery phase, with a reduction in OT (operative time). When comparing the six initial cases with the last six cases any statistical difference in terms of morbidity was revealed, but a trend has been reported in terms of OT and CT (console time). These data suggest that after a learning curve phase, the surgeon may achieve a higher level of competence and consider offering this approach to patients presenting with more complicated cases. Furthermore, data demonstrated that large BMI or high uterine weight would have a negative impact on the surgical performance of RSSH by increasing the operative times, console times, or docking times. Based on these results, an increased BMI as well as high uterine weight is not associated with prolonged operative times.

These data are confirmed also by Bogliolo et al. in a recent retrospective analysis in which large BMI and short stature seemed not to have a negative impact on the surgical performance, suggesting that this innovative surgical technique should also be used for obese patients to achieve the goal of very minimally invasive surgery. Indeed, regarding overweight and obese patients, although they reported BMI $\geq$ 25 in 20 cases and BMI $\geq$ 30 in seven patients, laparoscopic conversion was required in only one case.

High uterine weight was significantly correlated with longer operative time, but it seemed not to prejudice good surgical outcome. Sixteen weeks were chosen as the size limitation because, according to our standard laparoscopic experience, large uteri could require supra-umbilical access, which is technically not recommended in single-site surgery.

Regarding hospital stays in their series, Bogliolo et al. reported a long hospitalization time on average because the two patients who experienced a complication were discharged on days 8 and 14 [5].

Two recent studies analyzed the role of robotic single-site approach to endometrial cancer.

Abdulrahman et al. [6] proposed the sentinel lymph node (SLN) biopsy as a safe and less morbid approach to full lymphadenectomy in endometrial cancer (EC) and demonstrated SLN biopsy and extrafascial hysterectomy utilizing the single-site robotic system, to be feasible and able to offer some benefits over traditional robotic surgery.

Mereu et al., instead, treated four patients with histological diagnosis of endometrial adenocarcinoma G1 and instrumental FIGO stage IA or IB with total single access robotic laparoscopic extra-fascial hysterectomy and bilateral salpingo-oophorectomy. The procedure was performed through a single trans-umbilical incision of 35 mm using a Da Vinci Robotic S System and a Gelport device with one 12 mm trocar for robotic 3D optic, two 8-mm trocars and one 5-mm trocar. Data confirmed the procedure to be technically feasible and reproducible in patients with low-stage endometrial cancer with optimal surgical outcome and postoperative course [7].

In 2014 Bogliolo et al. published an interesting retrospective series of perioperative data from ten consecutive patients who underwent robotic-assisted single-site laparoscopic hysterectomy (RSSH) for female-to-male transsexualim (FMT). Single-site robotic surgery was confirmed to be a valid choice in FMT reassignment surgery, with a low rate of complications, good pain control, and excellent aesthetic results with only a minor perioperative complication occurred and not directly related to single-site technique [8].

Recently, has been published a case of combined cholecystectomy and hysterectomy using the da Vinci surgical system with the single site platform providing a critical analysis of the technique, including limitations of current single-site technology. Data demonstrated the feasibility of performing general surgery and gynecologic procedures concomitantly using a robotic single site (RSS) surgical approach. Cholecystectomy and total hysterec-tomy were conducted uneventfully and they were performed in a relatively short time by surgeons with previous experience of RSS, working in a multidisciplinary robotic center [9].

In conclusion, over the past 10 years, many efforts have been made to reduce the surgical invasiveness of minimally invasive surgery. The evolution of the single-port technique in laparoscopy achieved the goal of reducing the number of ports, improving the cosmetic benefits, avoiding the potential morbidity associated with multiple incisions and minimizing postoperative pain and recovery time. However, LESS surgery is characterized by a longer operative time that is partially justified by the lack of the third operative instrument. Single-site robotic surgery has the same advantages as LESS, but the automatic reversion of the crossed instruments allows for far greater manoeuvrability and ergonomics compared with other single-site methods. However, actually we are still far from having a perfect system and are rather in the infancy of robotic single site. The robotic single-site platform has several limitations, including reduced extracorporeal triangulation and a limited repertoire of non-articulating instruments and electrosurgical options compared with conventional multiport robotic surgery [10, 11] (Table 76.1). Taken together, these limitations may require significant modifications in technique for the traditional robotic surgeon. Each aspect of the set-up, including the exact umbilical incision length and positioning of the port

Table 76.1 Pros and Cons of robot-assisted single site hysterectomy

PROS	CONS
Minimally invasive approach	Limited repertoire of non-articulating instruments and electrosurgical options
3D visualization	Costs
Improved surgeon dexterity	Reduced extracorporeal triangulation
Enhanced ergonomics	
Short learning curve	

and platform, had to be precise for the RSS instrumentation to operate efficiently.

The possible future use of flexible endoscopes will improve the practicality of robotic LESS and will may increase the range of its applications.

Advances in the field of robotics will hopefully overcome these limitations and provide improved triangulation, degrees of freedom, dexterity, visualization, and new instruments with different kind of energies. However, the introduction of the da Vinci robotic system to single-site surgery, will further diminish the impediments that limit this minimally invasive technique. Prospective comparison studies are needed, but preliminary results are encouraging and the development of robotic systems specific to RSS may define the new horizon of single-site surgery.

References

1. Nam EJ, Kim SW, Lee M, et al. Robotic single-port transumbilical total hysterectomy: a pilot study. J Gynecol Oncol. 2011;22:120–6.
2. Escobar PF, Kebria M, Falcone T. Evaluation of a novel single port robotic platform in the cadaver model for the performance of various procedures in gynecologic oncology. Gynecol Oncol. 2011;120:380–4.
3. Cela V, Freschi L, Simi G, et al. Robotic single-site hysterectomy: feasibility, learning curve and surgical outcome. Surg Endosc. 2013;27:2638–43.
4. Bogliolo S, Cassani C, Babilonti L, Spinillo A. Vaginal cuff closure during robotic single-port hysterectomy: is the vaginal route always the best one? Surg Endosc. 2013;27(12):4754–5. doi:10.1007/s00464-013-3106-1. Epub 2013 Aug 13.
5. Bogliolo S, Mereu L, Cassani C, Gardella B, Zanellini F, Dominoni M, Babilonti L, Delpezzo C, Tateo S, Spinillo A. Robotic single-site hysterectomy: two institutions' preliminary experience. Int J Med Robot. 2015;11(2):159–65.
6. Sinno AK et al. Single site robotic sentinel lymph node biopsy and hysterectomy in endometrial cancer. Gynecol Oncol. 2015;137(1):190.
7. Mereu L, Carri G, Khalifa H. Robotic single port total laparoscopic hysterectomy for endometrial cancer patients. Gynecol Oncol. 2012;127(3):644. doi:10.1016/j.ygyno.2012.07.129. Epub 2012 Aug 4.
8. Bogliolo S, Cassani C, Babilonti L, Gardella B, Zanellini F, Dominoni M, Santamaria V, Nappi RE, Spinillo A. Robotic single-site surgery for female-to-male transsexuals: preliminary experience. ScientificWorldJournal. 2014;2014:674579. doi:10.1155/2014/674579. Epub 2014 Apr.
9. Pluchino N, Buchs NC, Drakopoulos P, Wenger JM, Morel P, Dällenbach P. Robotic single-site combined cholecystectomy and hysterectomy: advantages and limits. Int J Surg Case Rep. 2014;5(12):1025–7. doi:10.1016/j.ijscr.2014.10.001. Epub 2014 Oct 29.
10. Verit A, Rizkala E, Autorino R, Stein RJ. Robotic laparoendoscopic single-site surgery: from present to future. Indian J Urol. 2012;28:76–81.
11. White MA, Haber GP, Autorino R, Khanna R, Altunrende F, Yang B, Stein RJ, Kaouk JH. Robotic laparoendoscopic single-site surgery. BJU Int. 2010;106(6 Pt B):923–7.

Robot-assisted Laparoscopic Pelvic and Paraaortic Lymphadenectomy

77

Jan Persson

Introduction

Pelvic and paraaortic lymphadenectomy is mainly used for staging of genital and other pelvic cancers. Both pelvic and paraaortic lymphadenectomy are well suited for laparoscopy with a low complication rate reported in large series from centers of excellence [1, 2]. Still, despite being described more than 20 years ago, traditional laparoscopic lymphadenectomy, in particular, the paraaortic type, has not been performed at most centers. This is probably due to the complexity of traditional laparoscopy and/or a lack of large enough volumes to introduce and maintain a new surgical approach. The da Vinci surgical robot (da Vinci ® Surgical System, Intuitive Surgical Inc., CA, USA) was approved for gynecological procedures in 2005. So far, four robot systems have been launched (da Vinci standard, S, Si and Xi systems) of which the first (standard) model is no longer kept active by the manufacturer. All models provide instruments with a wrist function at the tip, movement downgrading, tremor elimination, a stable 3-dimensional view of the operative field and an ergonomic working position. These features may help the surgeon overcome some of the limitations associated with traditional laparoscopic surgery.

As no prospective randomized studies compare robotic and laparoscopic pelvic and paraaortic lymphadenectomy alone, available data is restricted to case series with or without retrospective control groups, not seldom data from early robot adopters even using the first robot model with its limitations. Still, the overall conclusion is that robot assistance results in the same or better nodal yield, less bleeding and less conversions to open surgery, in particular in obese patients. [3–8].

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Robot Assisted Laparoscopic Pelvic Lymhadenectomy

All models of the da Vinci robots can be used, although preferably a da Vinci Si or Xi system adapted for the near infrared fluorescent technique (Firefly) which allows for the use of Indocynaine green for detection of sentinel lymph nodes [9]. Ports should be placed for standard pelvic surgery as recommended for the respective systems. The S-Si robot may be docked centrally or side docked at surgeons' discretion whereas the Xi robot can be docked at various positions, usually from the side of the patient. In case of a simultaneous paraaortic lymphadenectomy port placement is adjusted accordingly as described below. Suitable robot instruments are; a monopolar scissors, a bipolar forceps and a grasper. For the assistant one or two trocars are needed for suction/irrigation, grasping, insertion of sponges and for retrieval of lymph nodes, the latter usually requiring a 12–15 mm trocar diameter. The procedure starts with inspection of the whole abdomen and pelvis to rule out disseminated disease. This is best performed before the robot arms and instruments are docked as this allows a complete abdominal overview including the liver and diaphragm and avoids unnecessary cost for robot instruments in case an immediate conversion to open surgery should be indicated.

The pelvic lymphadenectomy starts with developing the avascular planes and identifying landmarks from the aortic bifurcation and distally before any lymphadenectomy is performed. Sentinel lymph nodes (if such technique is applied) or otherwise cancer suspect nodes should be looked for and removed separately for frozen section. Lymph nodes should always be retrieved in a protective bag. It is important to avoid grasping directly on the lymph nodes with robot instruments as this otherwise may crush a potentially metastatic node with risk of tumor spread. In general, the dissection is most easily performed if tension of the tissue is applied and with dissection close to the adjacent vessels.

The presacral and common iliac node dissection starts with opening the peritoneum medial of the right common iliac artery to the level of the aortic bifurcation (Fig. 77.1).

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This way, the right ureter and infundibulopelvic ligament are visualized and lateralized. The third robot instrument (usually the grasper) can be used to lift the sigmoid colon, the infundibulopelvic ligament and the ureter to expose the left common lymph node chain (Fig. 77.2). It is usually helpful to retract the sigmoid colon towards the left abdominal side wall with a sponge reinforced stitch. The hypogastric nerve should be identified at the level of the aortic bifurcation and saved (Fig. 77.3). With the whole presacral and common iliac nodal areas exposed the lymphadenectomy is performed starting with the area medial of the common iliac arteries and the presacral area (Fig. 77.4) followed by the lateral common iliac lymph node chains saving the genitofemoral nerves visualized as they run along the psoas muscles (Fig. 77.2).

The paravesical and pararectal spaces are then opened. This is most easily performed by lifting the round ligament cranially and medially creating a fold of the lateral broad ligament as a starting point (Fig. 77.5). The broad ligament is then incized laterally along the infundibulopelvic ligament and if needed the incision is prolonged lateral of the caecum/sigmoid colon for slight mobilization of the colon. The paravesical space, limited by the pubic bone, the obliterated umbilical artery, the upper paracervical tissue and the exter-

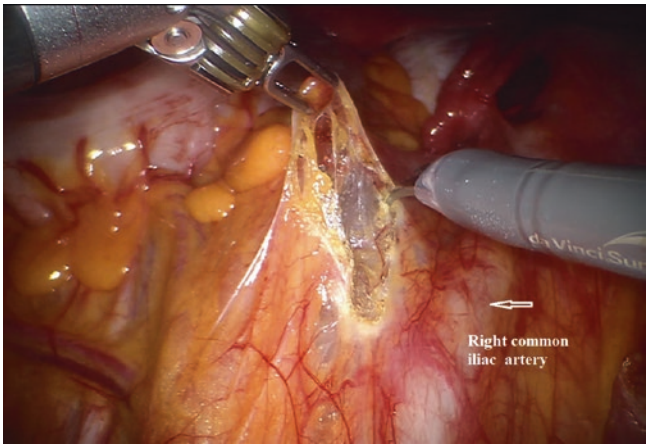


Fig. 77.1 The presacral and common iliac node dissection starts with opening of the peritoneum medial of the right common iliac artery

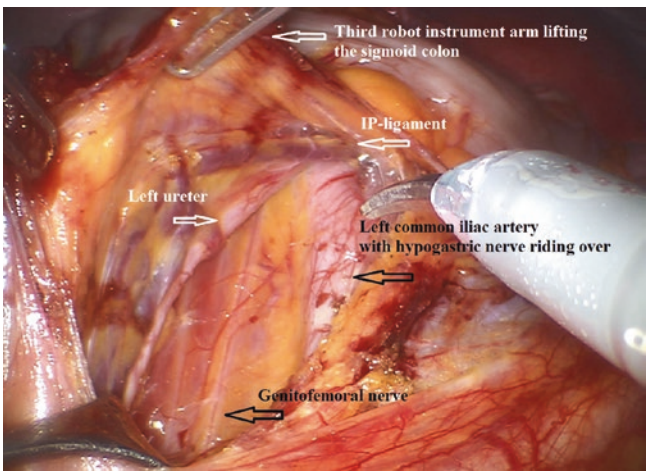


Fig. 77.2 The third robot arm is used for lifting the sigmoid colon to expose the left side common iliac area

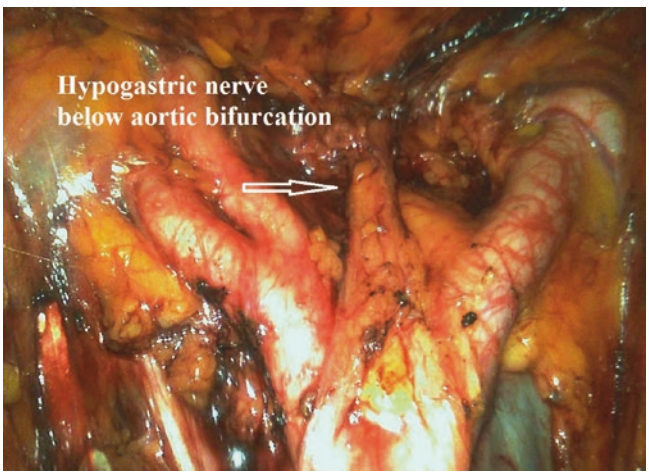


Fig. 77.3 The hypogastric nerve shall be isolated and saved

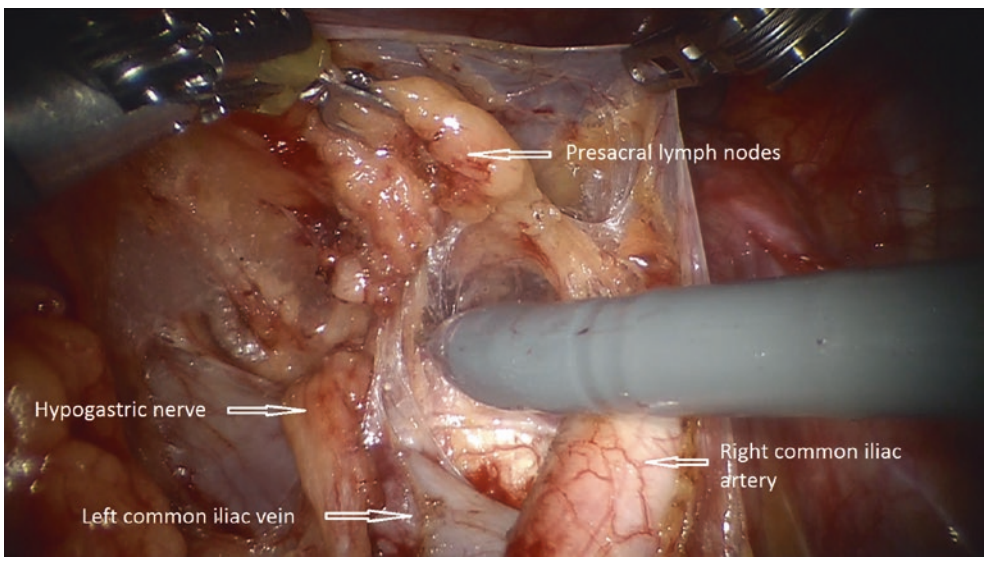


Fig. 77.4 Presacral nodal dissection

nal iliac vessels, is developed bluntly visualizing the course of the obturator nerve and associated deep blood vessels and lymph nodes (Fig. 77.6). Then the pararectal space is opened starting by identifying the ureter running along the medial broad ligament (ideally kept intact until later) and the hypogastric artery as medial and lateral borders (Fig. 77.7). Opened deeper, the pararectal space will display the deep uterine vein, the hypogastric nerve fibers and the origin of the obliterated umbilical artery where the uterine artery is usually found (Fig. 77.8). It is important to keep the upper parametrium (paracervical tissue) intact between the paravesical and pararectal spaces for a later radical hysterectomy or a separate upper paracervical parametrectomy and for not disrupting the lymphatics in case a sentinel node technique is applied (Figs. 77.7 and 77.9). The external iliac node dissection starts with the identification of genitofemoral nerve, usually serving as a lateral border. The superficial lateral lymph chain is then released from lateral to medial and folded over the external iliac artery and completed with the medial nodes and ideally removed en bloc (Fig. 77.10). The deep external nodes and the proximal obturator nodes are removed after the iliac vessels are mobilized medially to expose the obturator fossa and the proximal course of the obturator nerve (Fig. 77.11). Vessels from the ileopsoas muscle to the obturator nodal tissues can be coagulated at this stage as they are a common cause of bleeding during later lymphadenectomy in the obturator fossa (Fig. 77.11). Then, the remaining obturator nodes are removed en bloc following the obturator nerve sparing the obturator vein and exposing the pelvic floor (Fig. 77.12). A check of the whole pelvic retrieval area should be performed at the end.

Finally, it is worth mentioning some risks: It is important to avoid grasping the obturator nerve with the robot instruments as the constant grip force will risk damaging

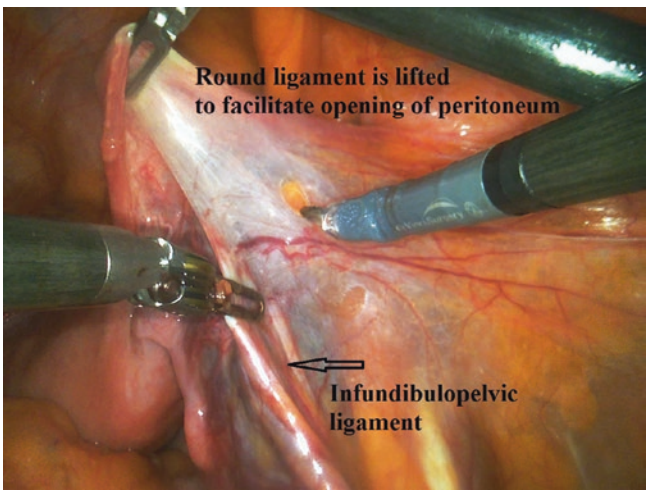


Fig. 77.6 The paravesical space

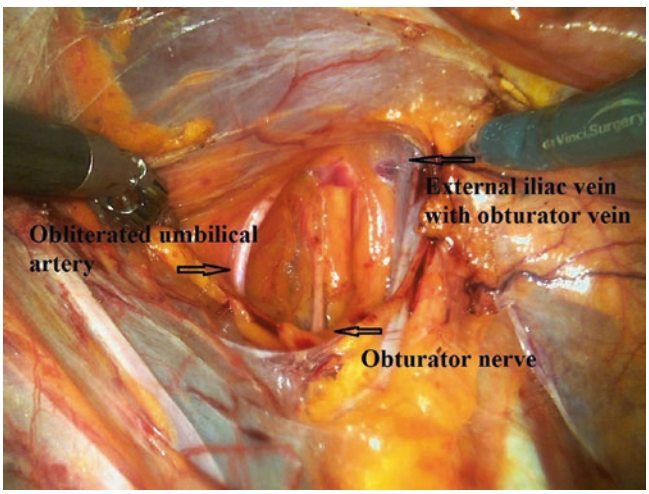


Fig. 77.7 The pararectal space

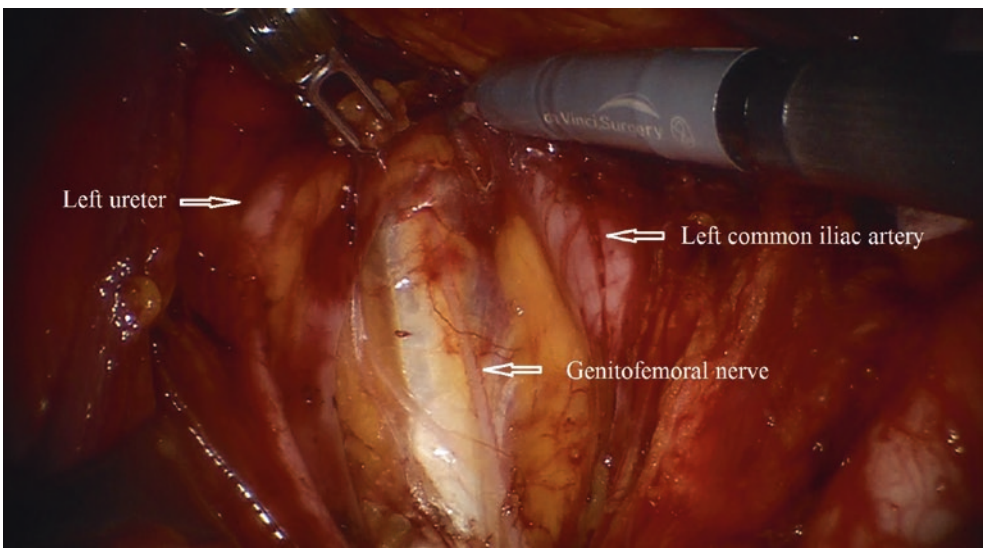


Fig. 77.5 Opening of the pelvic side wall avascular planes is facilitated by lifting the round ligament to create a fold of the lateral broad ligament

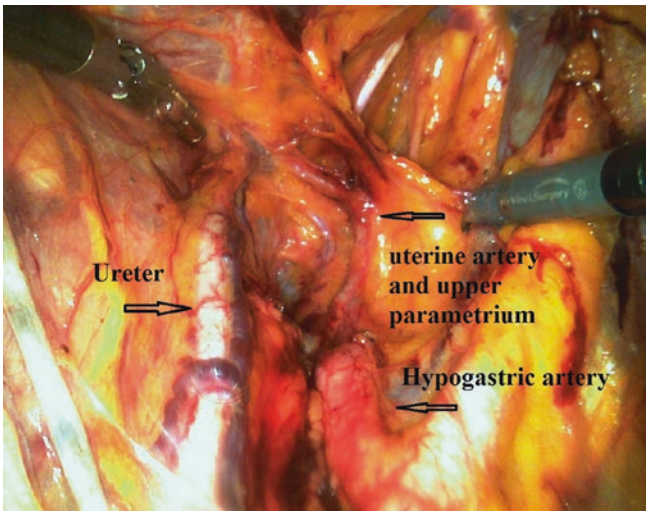


Fig. 77.8 Deeper dissection of the pararectal space

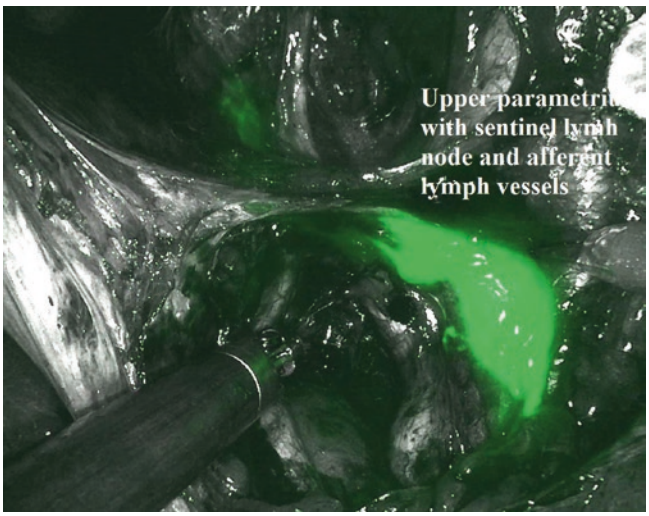


Fig. 77.10 Right side superficial external iliac nodes

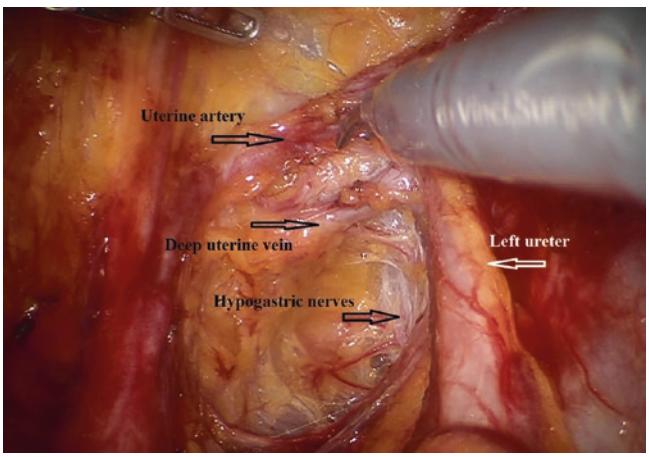


Fig. 77.9 Upper parametrial lymphatics and a sentinel lymph node displayed with the firefly technique

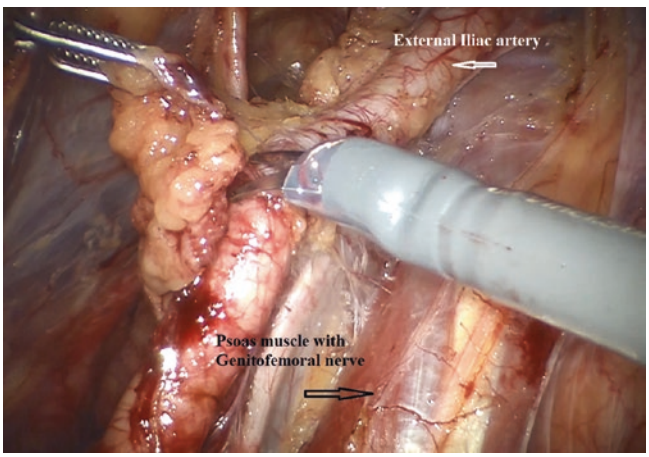


Fig. 77.11 Right side deep external and proximal obturator lymph nodes. *Black arrow* shows blood vessels from the ileopsoas muscle often causing bleeding during obturator node dissection

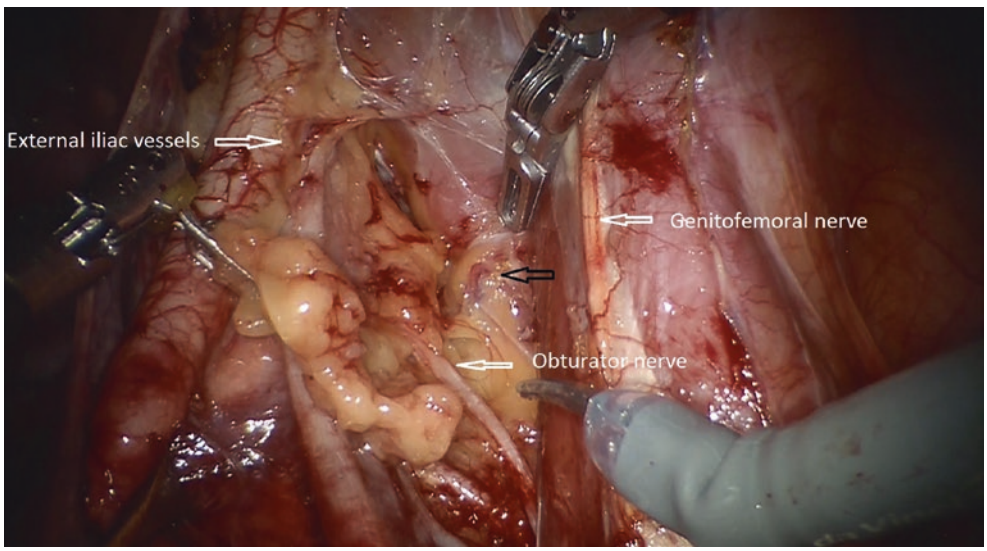


Fig. 77.12 Right side obturator lymph nodes

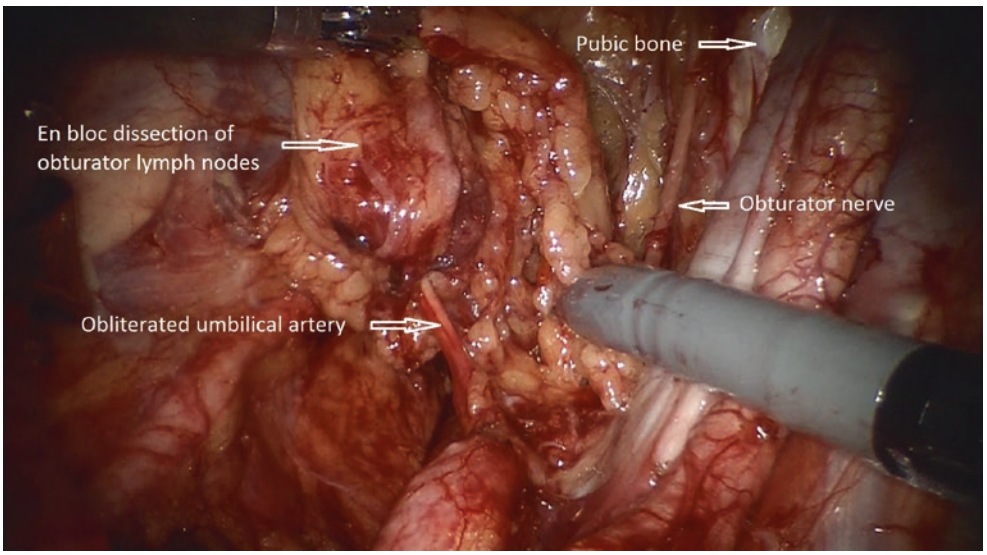


Fig. 77.13 Close proximity between obturator nerve and proximal obturator lymph nodes (left side)

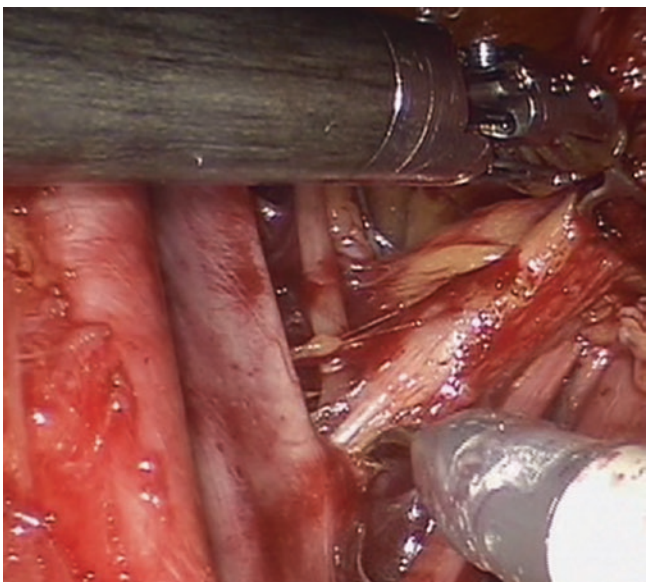


Fig. 77.14 Genitofemoral nerve and Lateralcutaneous femoral nerve (left side).

the nerve. During the final proximal part of the obturator node dissection, if performed from the medial side, extra attention should be given to the nerve to avoid damage of the obturator nerve and hypogastric vein due to their close proximity (Fig. 77.13). A too deep and lateral dissection during the external node removal risks harming the lateral cutaneous femoral nerve (Fig. 77.14).

Robot Assisted Laparoscopic Paraaortic Lymphadenectomy

Paraaortic lymphadenectomy can be performed as a single procedure or in conjunction with pelvic lymphadenectomy and removal of pelvic organs. A retroperitoneal approach may be clinically beneficial in case the paraaortic lymphadenectomy is a single procedure, in particular in case of intraabdominal adhesions and in obese patients. However, with the retroperitoneal approach the space for robot arms is limited and there are no obvious overall advantages with the use of robots compared with traditional laparoscopy [9]. It is likely that the more slender robot arms of the new da Vinci Xi model will be advantageous but this remains to be seen. Therefore, and due to the fact that other procedures are often planned in the same session, a transperitoneal approach will most often be the choice for the robotic paraaortic lymphadenecomy. Principally, this can be performed in two ways: as a proximal prolongation of the pelvic lymphadenectomy along the aorta with the robot docked centrally between the patients legs or side docked for pelvic surgery. This requires ports placed higher than for pelvic surgery only and a steep Trendelenburg position of the patient (Fig. 77.15 and 77.16). This approach may be technically difficult, mainly due to obscuring bowel, and restricted access to the inframesenteric area particularly in obese and short patients [10, 11].

The alternative transperitoneal approach is to place the S or Si robot at the patients head or shoulder and dissect from caudal to cranial through a smaller opening of the

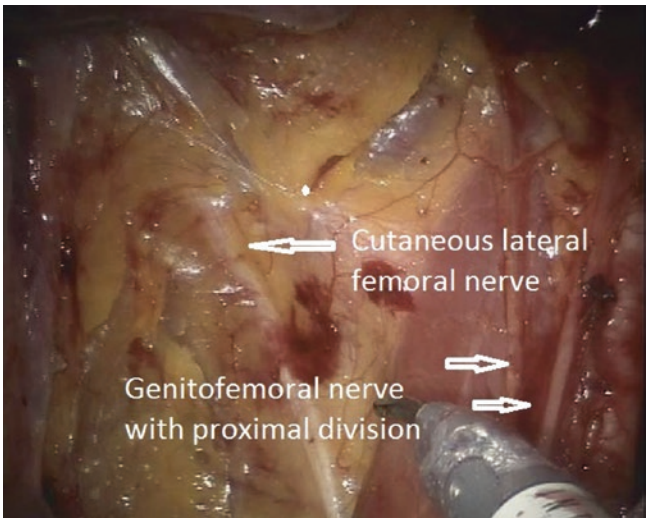


Fig. 77.15 Port placement for paraaortic and pelvic lymph node dissection with pelvic docking of a S-Si robot

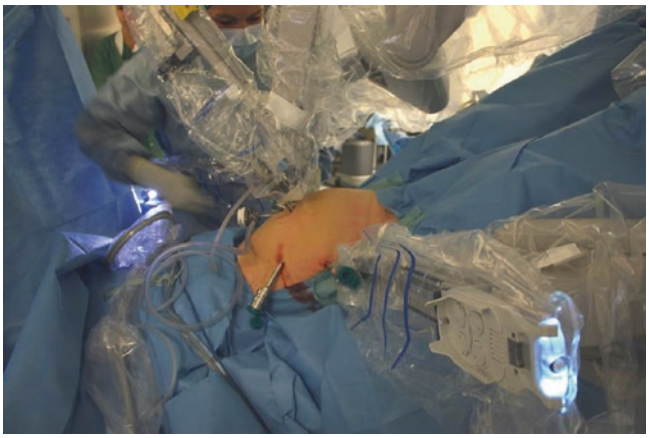


Fig. 77.17 A paraaortic lymphadenectomy with the Xi robot or S-Si robots with double docking starts with creating a tunnel under the bowel along the aorta starting opening the peritoneum below the aortic bifurcation.

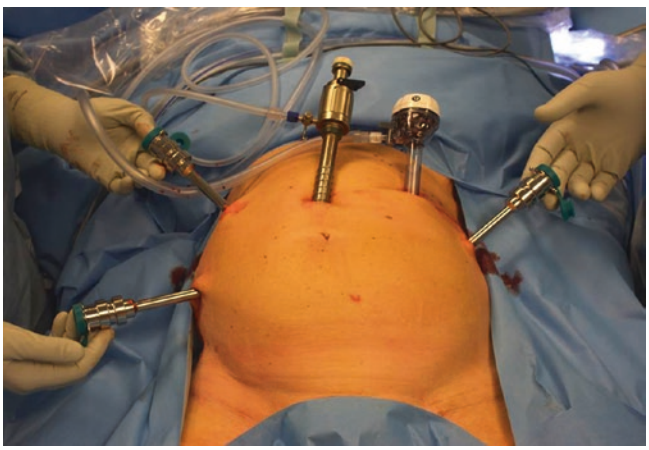


Fig. 77.16 The robot arms should be adjusted to reach the upper abdomen during paraaortic and pelvic lymph node dissection with pelvic docking of the S-Si robot

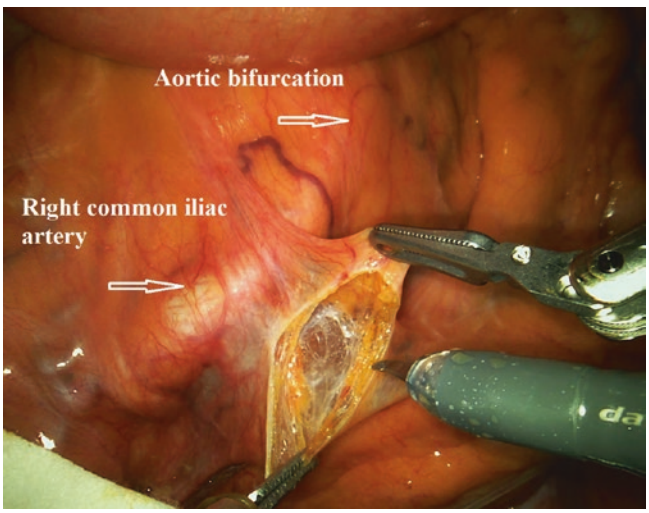


Fig. 77.18 The paraaortic lymph node dissection with the Xi robot starts with a small opening of the peritoneum just below the aortic bifurcation

peritoneum at the level of the bifurcation (Fig. 77.17). This may be beneficial to prevent the bowel from interfering with the surgical field but sometimes requires an additional higher port for optics and a separate upper abdominal assistant's port in case pelvic surgery will be performed during the same session. With the S-Si robots a de-redocking for later pelvic position after the patient has been rotated 180 degrees will be necessary ("double docking"). Alternatively, with the robot initially placed at patients shoulder it can be redocked in a pelvic side position with a smaller adjustment of patients position sideways ("double side docking") and a full 180 degree rotation, often time consuming and cumbersome for the anesthetist, can be avoided.

Using the da Vinci Xi model both these double docking alternatives can be omitted due to the " roof hanged" robot arm boom and the increased range of motion of the robot arms. Instead of a cumbersome rotation of the patient or double docking the robot arm boom can be rotated 180 degrees, either via a swift de-redocking and rotating the whole robot arm boom or by using the increased range of motion of the arms, with the robot fundament unchanged. A rotation of the whole robot arm set provides more space for the assistant using at least one suprapubic port which is necessary for assisting parallel to the robot instruments and for lifting the roof of the peritoneal tunnel created over the aorta (Figs. 77.18, 77.19 and 77.20).

The basic surgical principle for all approaches is similar. All surgery requires a good anatomical knowledge and awareness that approximately one third of patients have some vascular anomaly in the paraaortic area [12–14]. A preoperative



Fig. 77.19 Paraaortic lymphadenectomy with the Xi robot. Note position of the robot arm boom

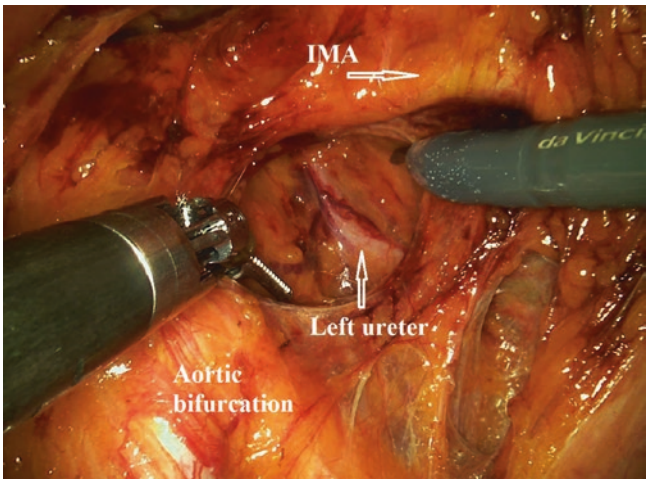


Fig. 77.21 Visualization of the left ureter and the IMA

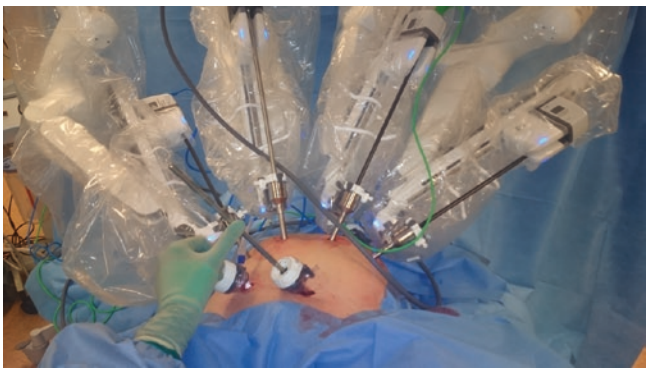


Fig. 77.20 Position of assistant and assistants trocars for a paraaortic lymph nodes dissection with the Xi robot

CT scan of the abdomen should include information on any major blood vessel anomalies and in case of enlarged lymph nodes an exact position of those related to easily identified vascular landmarks. It is particularly important that the whole staff is familiar with all used assistants instruments, hemostatic agents and that an emergency de-docking plan is implemented. Although conversion to open surgery due to bleeding rarely occurs, a laparotomy set including vessel repairing instruments should be readily available. The anesthetist should be asked to keep fluid balance on the negative side to avoid too distended veins. In all, everyone should be prepared and experienced with their respective tasks.

Usually, it is beneficial to use the Palmers' point entry and a similar position of the 12 mm assistants' trocar as this allows an intraabdominal overview of the position of the optics trocar and a partial removal of the lower falciform ligament that sometimes hinders an optimal position of the optics trocar. This entry point also allows for the release of midline oriented adhesions as well as diagnosing a previously unknown umbilical hernia. The incision for the optics trocar should be kept minimal to avoid leaking of gas and minimize the risk for the optics trocar to slide out if some retraction is necessary. For the same reason, it is often beneficial to use an optics trocar with outer ridges or a balloon trocar. The remaining trocars are then placed (Fig. 77.15). An overview of the abdomen to rule out disseminated disease should be performed before docking the robot instruments. The necessary degree of Trendelenburg is controlled from inside with the optics. After docking the robot the range of motion of the robot arms should be optimized to reach the paraaortic area (Fig. 77.16).

With the Xi robot or in case of double docking/patient rotation it is recommended to initiate the procedure as described above but also place at least one suprapubic assistant's port for the paraaortic dissection (Figs. 77.19 and 77.20). The paraaortic dissection starts with making a 5–6 centimeter peritoneal incision just below the aortic bifurcation as a tunnel opening (Fig. 77.18). With the aid of the fourth arm and instruments inserted via the supraumbilical assistant's port the roof of the tunnel is elevated simply by using the shafts of closed instruments inserted to the apex of the created tunnel. Then, before any attempts of lymphadenectomy, a gradual further cranial dissection to fully visualize the anatomical landmarks and potential vessel anomalies to the level of the left renal vein is performed (Figs. 77.21, 77.22 and 77.23). For finding the left supramesenteric part of the ureter, which is often runs deep, it is usually helpful to dissect the left ureter as far cranially as possible when exploring the left side inframesenteric part. The main left and right side hypogastric nerve branches is usually possible to preserve without compromising the lymphadenectomy (Fig. 77.24). The lymphadenectomy is performed from cranial to distal. The upper limit of the dissection can be marked with a titanium clip.

With this approach, the access is usually good, and with less obscuring bowel compared with the technique described

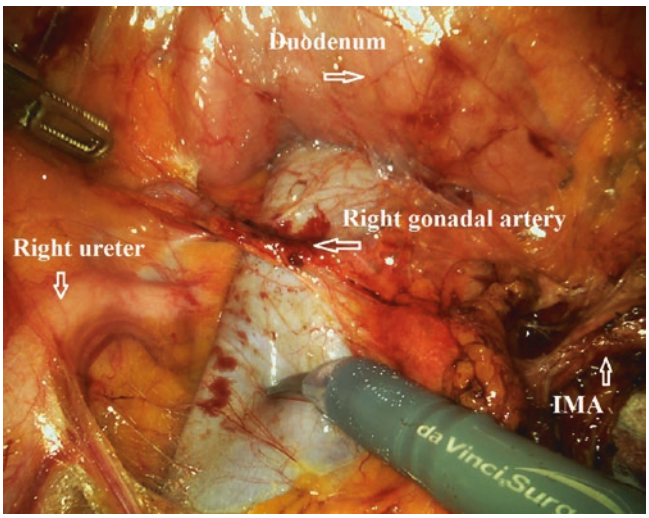


Fig. 77.22 Dissection of the paracaval right side visualizing the right ureter and gonadal vessels

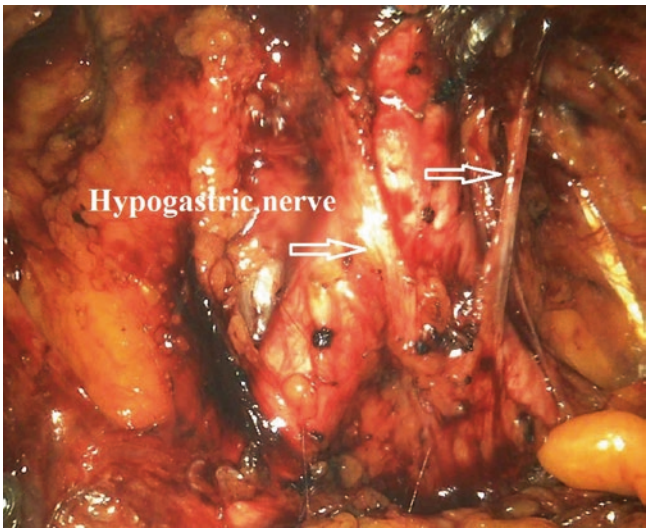


Fig. 77.24 The right and left branches of the hypogastric nerves can usually be preserved

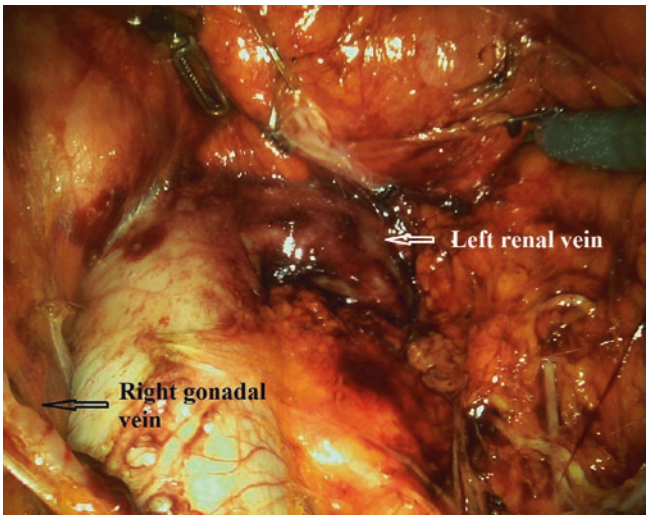


Fig. 77.23 Reaching the left renal vein with requires a gentle lift of the duodenum

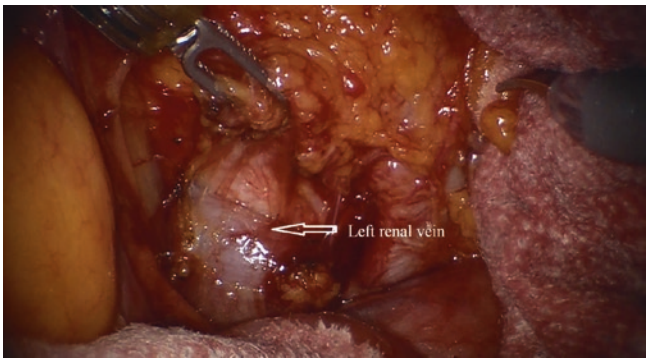


Fig. 77.25 Reaching the left renal vein with pelvic position of the S-Si robots usually requires help of two assistants retractors and sponges

below. The disadvantages are the need for one or two suprapubic assistant's ports, the need for rotation of the patient, and the lower robot port placement needed for an adequate angle related to the aorta. This results in a more perpendicular instrument angle for the lower paraaortic and upper pelvic lymphadenectomy and a shorter distance from the pelvic operative area to the optics with a decreased overview and more need for cleaning of the lens.

With the pelvic position of the robot, the operation starts with retracting the sigmoid colon against the left abdominal wall with one or two sponge reinforced sutures through appendices epiploicae. Then the caecum and ascending colon are mobilized by incizing the lateral peritoneum as far up as possible. The small bowel mesentery is often adherent to the IP-ligament and has to be released to allow the small bowel to retract cranially. The peritoneum is then opened medial of the right common iliac artery to the level of the aortic bifurcation and further to the inferior mesenteric artery (IMA) and the ureters, the IP-ligaments and the hypogastric nerve are visualized similar to the onset of a pelvic lymphadenectomy (Figs. 77.1, 77.2 and 77.3). The third robot arm grasper is useful for further lifting the sigmoid or retracting the right ureter and IP-ligament. The lower paraaortic and paracaval lateral areas are then opened carefully to clearly explore the vessel anatomy. Then the IMA is skeletonized and the dissection continued to reach the level of the left renal vein (Fig. 77.25). The role of the assistant at this stage is to lift the proximal peritoneal fold to prevent the small bowel from interfering with the surgical field, sometimes

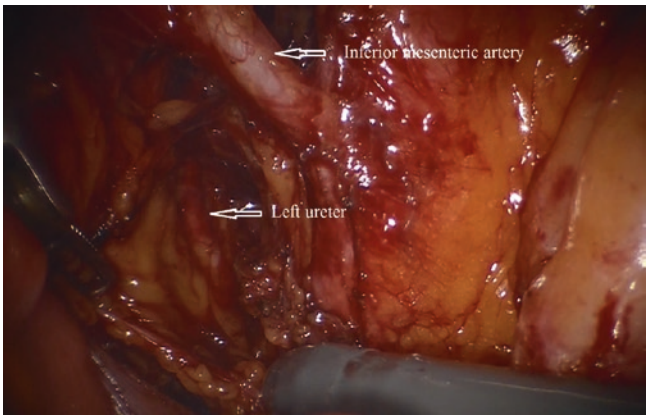


Fig. 77.26 The left supramesenteric part of the ureter must be visualized and lateralized before removing lymph nodes

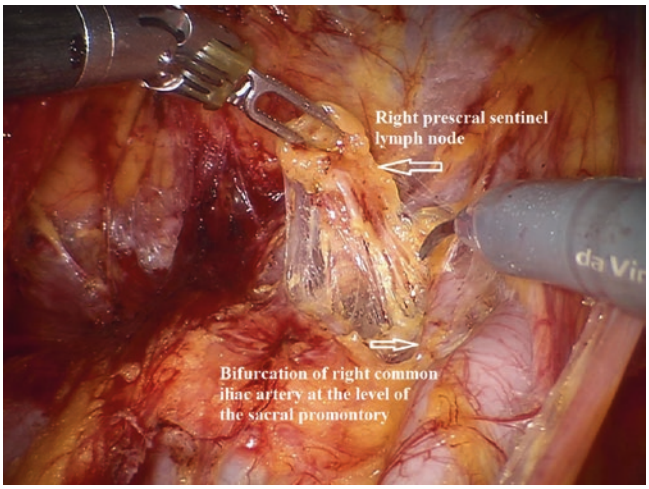


Fig. 77.27 Right side presacral dissection

requiring a second assistants' port and a several sponges. The third arm is used for retracting the left side of the peritoneal opening at desired level. The origin of the IP-ligaments and the gonadal arteries are identified as well as the ureters in the supramesenteric area, in particular on the left side where the course of the ureter is deeper (Fig. 77.26). The ureter must be lateralized before removal of the lymph nodes.

After exploring the whole operative field a final view of the vessel anatomy is obtained before the lymphadenectomy begins. The order of dissection is optional but it usually a good idea to start cranially and with the left supramesenteric paraaortic area as this tends to be the most difficult part, followed by the intraaortacaval and finally the precaval parts. Any bleeding from previous distal dissection may also be cumbersome when the supramesenteric dissection is performed. In case leaking of large amount of lymphatic fluid occurs, in particular if opaque/chylous, it is important to find the leak and close it with clips as it may be associated with later development of chylous ascites. A metal clip marking the proximal limit for the dissection is often appreciated by the radiooncologists. Finally the inframesenteric nodal dissection is performed compartmentwize. Attention should be given to free nodal tissue under the IMA which is easily overseen. It is usually possible to free and save the main branches of the hypogastric nerve running from right to left over the inframesenteric aorta via the aortic bifurcation and then further on presacrally (Fig. 77.24).

Effort should be made to achieve good hemostasis throughout the procedure, not only to reduce the risk for a major bleeding and conversion but to avoid time consuming hemostatic actions. Before nodal dissection it is recommended to have a laparoscopic sponge in the abdomen practical for simultaneous suction and compression of smaller bleeds i.e. from Fellows veins that usually stops with compression with or without help of surgical hemostatic agents. Smaller arterial bleeds are best controlled with clips or bipolar diathermia whereas vessel damage considered inappropriate for compression or diathermia may be sutured. Any attempt to repair a larger bleed should include a temporary control, i.e. by grasping with the robot instruments and only after optimizing the surgical and anesthesiological situation the actual repair should be attempted. It is for safety reasons important to strongly discourage from repeated unsuccessful attempts to control a bleed.

The near infrared fluorescent technique for detection of sentinel lymph nodes is available with the Xi and Si systems. By the use of an adapted light source, optics and software the used tracer (Indocyanine green) will appear green against a grey background. So far, no standardized technique of injection sites, dosing and timing for the use within gynecology are agreed on but several centers perform studies. A standardization must include knowledge of the lymphatic anatomy, a clear definition of sentinel lymph nodes and a defined stepwise surgical algorithm. The tracer has a rapid spread leading to many coloured lymph nodes which cannot all be defined as sentinel lymph nodes. Therefore, the afferent lymph vessel in each major lymphatic chain must be identified to define the node closest to the tumour (the sentinel lymph node). Hence the retroperitoneal dissection must be performed meticulously to avoid cutting lymph vessels. To avoid disturbance from tracer leakage during sentinel node remove, dissection of nodes preferably starts cranially, i.e. with the presacral nodes (Figs. 77.27 and 77.28) followed by the pelvic side walls (Figs. 77.29 and 77.30). In case of no uptake of tracer a full lymphadenectomy shall be performed. In this situation it is particularly important to look for macroscopically cancer suspect nodes.

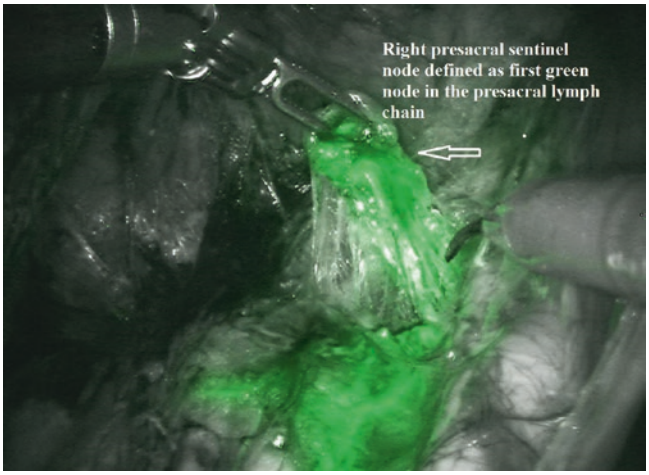


Fig. 77.28 Right side presacral dissection with the firefly technique

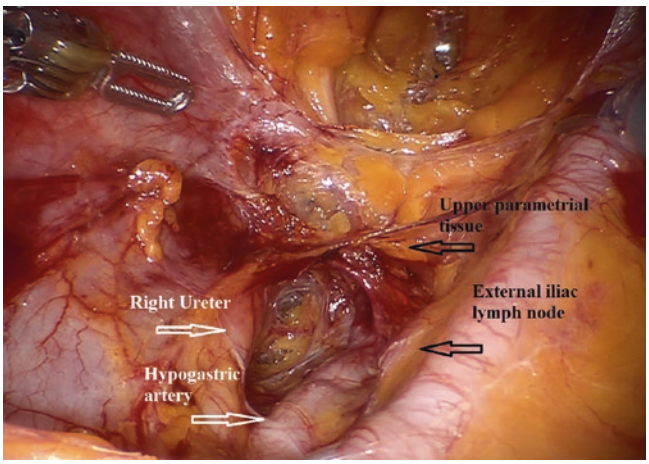


Fig. 77.29 Right upper paracervical/parametrial tissue

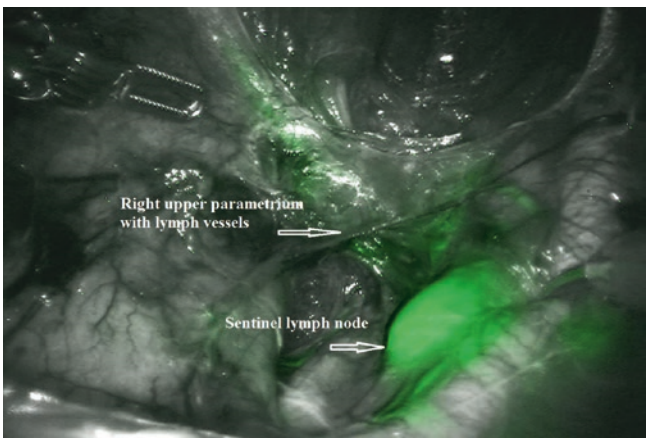


Fig. 77.30 Right upper parametrium seen with the firefly technique

References

1. Köhler C, Klemm P, Schau A, Possover M, Krause N, Tozzi R, Schneider A. Introduction of transperitoneal lymphadenectomy in a gynecologic oncology center: analysis of 650 laparoscopic pelvic and/or paraaortic transperitoneal lymphadenectomies. Gynecol Oncol. 2004;95(1):52–61.
2. Querleu D, Leblanc E, Cartron G, Narducci F, Ferron G, Martel P. Audit of preoperative and early complications of laparoscopic lymph node dissection in 1000 gynecologic cancer patients. Am J Obstet Gynecol. 2006;195(5):1287–92. Epub 2006 May 3
3. Boggess JF, Gehrig PA, Cantrell L, Shafer A, Ridgway M, Skinner EN, Fowler WC. A comparative study of 3 surgical methods for hysterectomy with staging for endometrial cancer: robotic assistance, laparoscopy, laparotomy. Am J Obstet Gynecol. 2008;199(4):360.e1–9. doi:10.1016/j.ajog.2008.08.012.
4. Somashekhar SP, Jaka RC, Zaveri SS. Prospective randomized study comparing robotic-assisted hysterectomy and regional lymphadenectomy with traditional laparotomy for staging of endometrial carcinoma -initial Indian experience. Indian J Surg Oncol. 2014;5(3):217–23. doi:10.1007/s13193-014-0321-8. Epub 2014 Jun 21
5. Chiou H, Chiu L, Chen C, Yen Y, Chang C, Liu W. Comparing robotic surgery with laparoscopy and laparotomy for endometrial cancer management: a cohort study. Int J Surg. 2014;13C:17–22. doi:10.1016/j.ijsu.2014.11.015. [Epub ahead of print].
6. Abaza R, Dangle PP, Gong MC, Bahnson RR, Pohar KS. Quality of lymphadenectomy is equivalent with robotic and open cystectomy using an extended template. Urol. 2012;187(4):1200–4. doi:10.1016/j.juro.2011.11.092. Epub 2012 Feb 15.
7. Lim PC, Kang E, Park DH. A comparative detail analysis of the learning curve and surgical outcome for robotic hysterectomy with-lymphadenectomy versus laparoscopic hysterectomy with lymphadenectomy in treatment of endometrial cancer: a case-matched controlled study of the first one hundred twenty two patients. Gynecol Oncol. 2011;120(3):413–8. doi:10.1016/j.ygyno.2010.11.034. Epub 2010 Dec 30.
8. Seamon LG, Bryant SA, Rheaume PS, Kimball KJ, Huh WK, Fowler JM, Phillips GS, Cohn DE. Comprehensive surgical staging for endometrial cancer in obese patients: comparing robotics and laparotomy. Obstet Gynecol. 2009;114(1):16–21. doi:10.1097/AOG.0b013e3181aa96c7.
9. Gehrig PA, Cantrell LA, Shafer A, Abaid LN, Mendivil A, Boggess JF. What is the optimal minimally invasive surgical procedure for endometrial cancer staging in the obese and morbidly obese woman? Gynecol Oncol. 2008;111(1):41–5. doi:10.1016/j.ygyno.2008.06.030. Epub 2008 Aug 9.
10. Rossi EC, Ivanova A, Boggess JF. Robotically assisted fluorescence-guided lymph node mapping with ICG for gynecologic malignancies: a feasibility study. Gynecol Oncol. 2012;124(1):78–82. doi:10.1016/j.ygyno.2011.09.025. Epub 2011 Oct 11.
11. Bats AS, Mimouni M, Bensaïd C, Seror J, Douay-Hauser N, Nos C, Lécuru F. Robotic extraperitoneal paraaortic lymphadenectomy in gynecological cancers: feasibility, safety, and short-term outcomes of isolated and combined procedures. Int J Gynecol Cancer. 2014;24(8):1486–92. doi:10.1097/IGC.0000000000000240.
12. Franké O, Narducci F, Chereau-Ewald E, Orsoni M, Jauffret C, Leblanc E, Houvenaeghel G, Lambaudie E. Role of a double docking to improve lymph node dissection: when robotically assisted laparoscopy for para-aortic lymphadenectomy is associated to a

pelvic procedure. Int J Gynecol Cancer. 2014. [Epub ahead of print].
13. James JA, Rakowski JA, Jeppson CN, Stavitzski NM, Ahmad S, Holloway RW. Robotic transperitoneal infra-renal aortic lymphadenectomy in early-stage endometrial cancer. Gynecol Oncol. 2014; pii: S0090–8258(14)01625–4. doi: 10.1016/j.ygyno.2014.12.028. [Epub ahead of print].
14. Klemm P, Fröber R, Köhler C, Schneider A. Vascular anomalies in the paraaortic region diagnosed by laparoscopy in patients with gynaecologic malignancies. Gynecol Oncol. 2005;96(2):278–82.

Techniques for Gastrocolic and Infracolic Robotic Omentectomy

78

Gerald Feuer and Nisha Lakhi

Anatomy

The greater omentum is composed of a double layer of peritoneum and mainly fatty tissue. It extends from the greater curvature of the stomach, passes in front of the small intestines, and reflects on itself to ascend to the transverse colon (Fig. 78.1). The gastrocolic omentum extends from the greater curvature of the stomach to the superior aspect of the transverse colon [1]. When performing an omentectomy, the right border of the omentum can normally be identified at the ceacum and the left border at the splenic flexure. Identifying these landmarks may be useful for acquiring orientation during dissection.

Blood Supply

The right and left gastroepiploic vessels traverse the greater curvature of the stomach and provide the sole blood supply to the greater omentum. Three dominant omental vessels, along with smaller branches, arise from the gastroepiploic system and provide vascular supply to the omentum (Fig. 78.2) [1].

Function of the Omentum

The omentum has three main functions:

1. Fat deposition.
2. Functions as a secondary lymphoid organ.

The omentum contains secondary lymphoid tissue called "milky spots". It has been demonstrated that this tissue is a rich source of lymphocytes, macrophages and monocytes, which may aid in the removal of foreign material and bacteria. In addition, this tissue possesses antimicrobial and angiogenic properties through release of fibroblast growth factors and hence has a role in healing inflamed or ischemic tissue [2, 3].

3. Infection and Wound Isolation

The omentum is a mobile organ in the peritoneum. It serves to fix the viscera and isolate abnormal tissue or infection to limit its spread [2, 3].

Indications for Omentectomy

An omentectomy is indicated as part of the standard surgical staging for malignant ovarian neoplasms, borderline tumors, and primary peritoneal cancers (Table 78.1). It should be performed in cases even if there is not macroscopically visible disease [4]. The safety and feasibility of an omentectomy as part of a robotic staging operation for ovarian cancer has been documented in the literature [5]. Omentectomy should also be performed as part of the staging operation for serous papillary endometrial cancer, as this histological subtype of uterine cancer tends to spread transperitoneally and behaves in a manner similar to epithelial ovarian cancer [6].

In cases where there is no macroscopically visible disease on the omentum, the extent of omentectomy has not been elucidated, as there has been no study comparing total omentectomy, subtotal omentectomy, or omental biopsies alone for the purposes of staging and treatment of epithelial ovarian cancer [4]. In our practice, we perform an infracolic omentectomy as part of the general staging procedure, and include resection of the gastrocolic omentum in cases where

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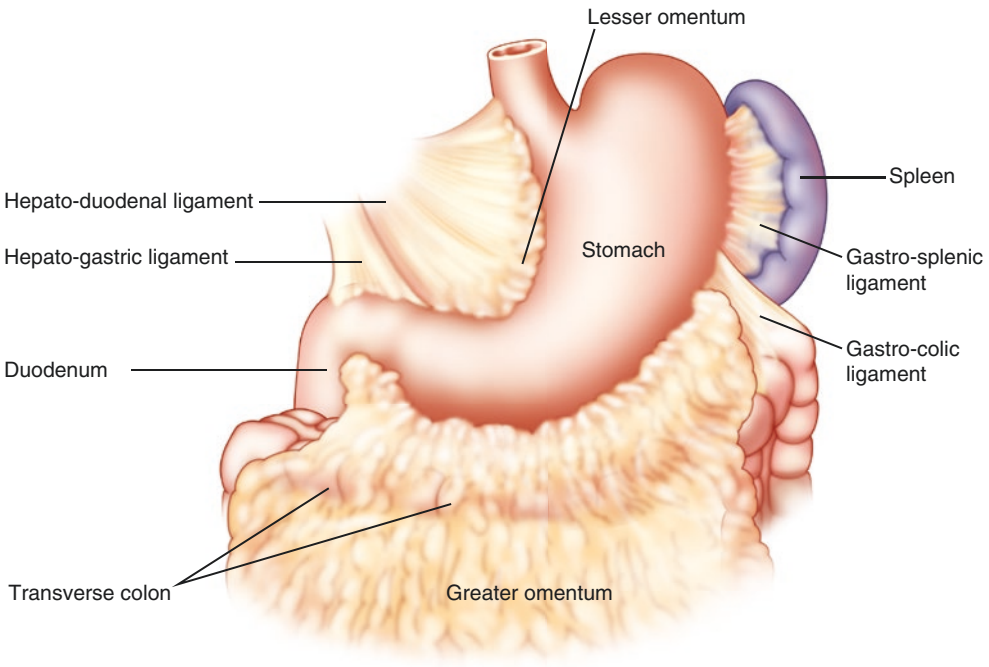


Fig. 78.1 Relationship of omentum to surrounding structures

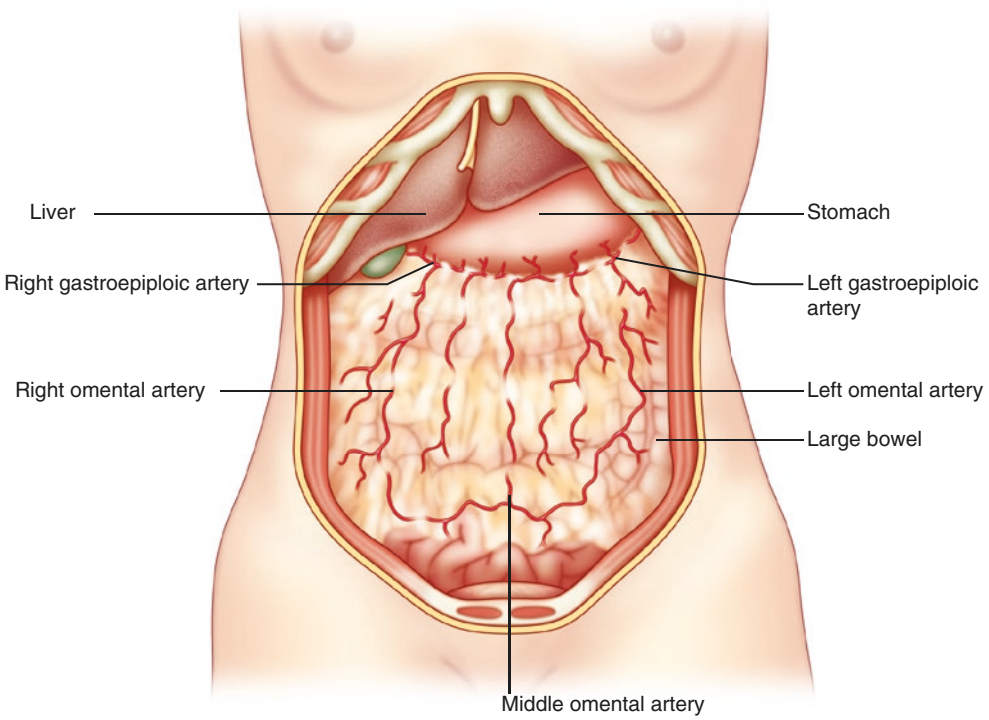


Fig. 78.2 Blood supply to the omentum

Table 78.1 Indications for omentectomy

Indications for Omentectomy
Epithelial ovarian cancer
Borderline ovarian tumors
Sex cord stromal ovarian tumors
Germ cell ovarian tumors
Primary peritoneal cancer
Uterine serous papillary/clear cell tumors
Uterine sarcoma

there is extensive upper abdominal disease or macroscopically visible disease on the gastrocolic omentum.

Note: The technique described is for performing an omentectomy utilizing the da Vinci® Si System (Si). Modifications of technique and port placement that are necessary when utilizing the da Vinci® Xi System (Xi) are mentioned where appropriate.

Robotic Infracolic Omentectomy

Port Placement and Docking

The optical port is positioned midline, approximately 22–24 cm (9 inches) above the symphysis pubis. Two lateral 8 mm robotic ports are introduced. The right 8 mm robotic port is positioned 10 cm lateral and 2 cm inferior to the optical port. The left 8 mm robotic port is placed 11–12 cm lateral and 2 cm inferior to the optical port. The left port is further lateralized in order to optimize dissection at the splenic flexure. If an assistant utilizes two ports, one 12 mm port is placed at the right lateral side of the patient 10 cm from the robotic port, and one 5 mm port in the right upper quadrant below the costal margin and midway between the left lateral port and the midline port. (Fig. 78.3).

The robot is centrally docked between the patient's legs, as this placement provides more range on the right side as compared to side docking (Fig. 78.4).

If utilizing the *da Vinci® Xi System* (Xi), the two lateral 8 mm robot ports are placed at the same plane as the optical port, each 9–10 cm lateralized from the midline (Fig. 78.5). It is not necessary to further lateralize the left robotic port to adequately reach the splenic flexure as in the Si model. For the Xi model, the robot can be docked centrally, but preferably from the patient's left side (Fig. 78.6).



Fig. 78.3 Port position of infracolic omentectomy using the *da Vinci® SI System*



Fig. 78.4 *da Vinci® SI System* docked between the patient's legs in preparation for infracolic omentectomy.

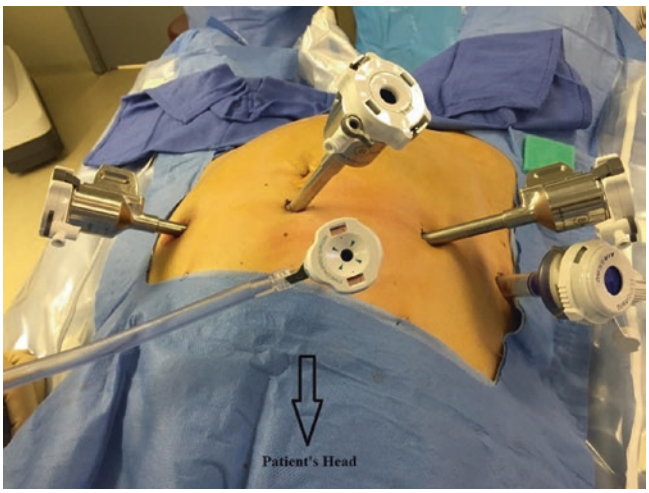


Fig. 78.5 Port position of infracolic omentectomy using the *da Vinci® XI System*

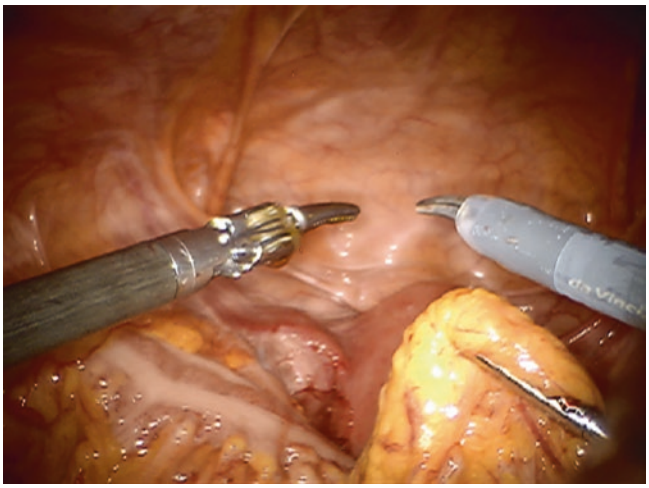


Fig. 78.7 Assistant laparoscopically grasping the omentum

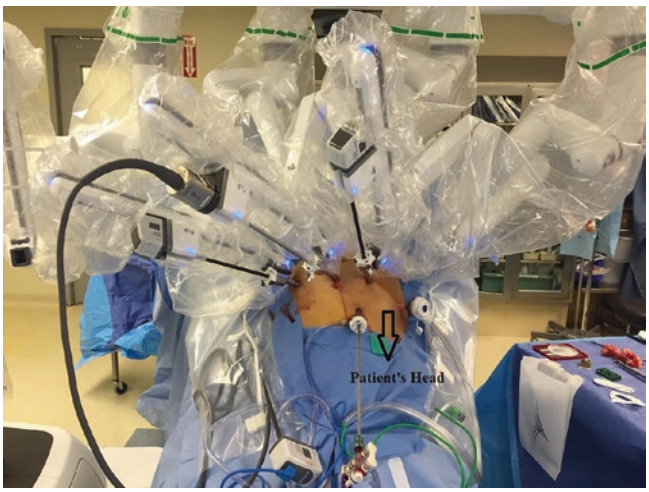


Fig. 78.6 *da Vinci® XI System* docked between the patient's legs in preparation for infracolic omentectomy.

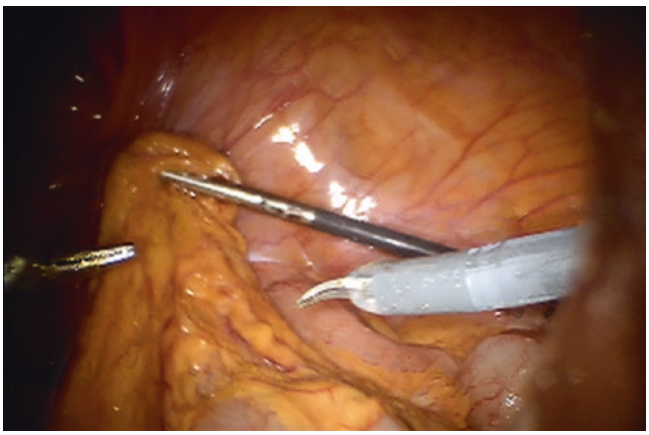


Fig. 78.8 Assistant pulling the omentum towards the pelvis

Role of the Assistant in Robotic Omentectomy

We describe a three arm technique for a robotic infracolic omentectomy. In this technique, the assistant has a critical role: The assistant laparoscopically maintains the omentum midline, pulls it deep into the pelvis, and provides countertraction. This allows for easier dissection and visualization throughout the procedure. It is important that the surgeon and the assistant work in tandem, maintaining equal traction and countertraction. If a skilled assistant is not available, a fourth arm can be employed to provide countertraction in the direction of the pelvis. The port would be placed in the same plane as the other robotic port on the left side, approximately 9–10 cm lateral for the Xi system and 10–12 cm lateral for the Si system. However the use of a fourth arm is less effective, as the fine, real-time adjustments a skilled assistant can make are difficult to duplicate with an additional robotic arm.

Procedure

At the start of the procedure, the assistant grasps the omentum at an area to the right of the mid-transverse colon and places it within the pelvis (Fig. 78.7).

The assistant or fourth arm maintains the position of the omentum toward the pelvis (Fig. 78.8), while the surgeon utilizes the left robotic arm to provide gentle traction immediately adjacent to area to be incised (Fig. 78.9). This aids in exposure of the anterior and posterior peritoneal reflections of the omentum, where the point of entry is made (Fig. 78.10).

The surgeon commences dissection at the mid-transverse colon (Fig. 78.11). Monopolar scissors are used to cut

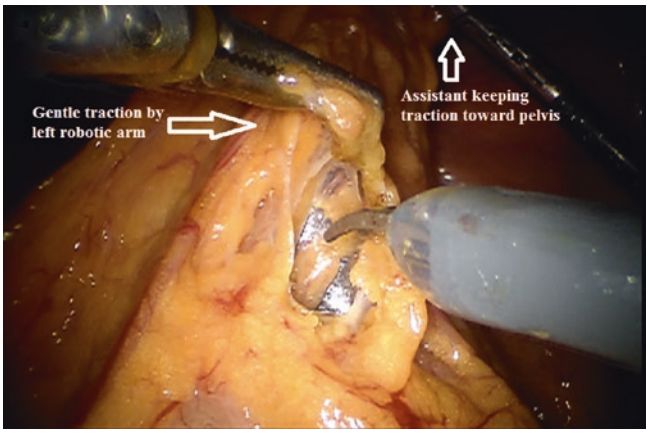


Fig. 78.9 Assistant maintaining the position of omentum in pelvis as the surgeon exerts gentle traction with the left robotic arm to reveal the peritoneal folds.

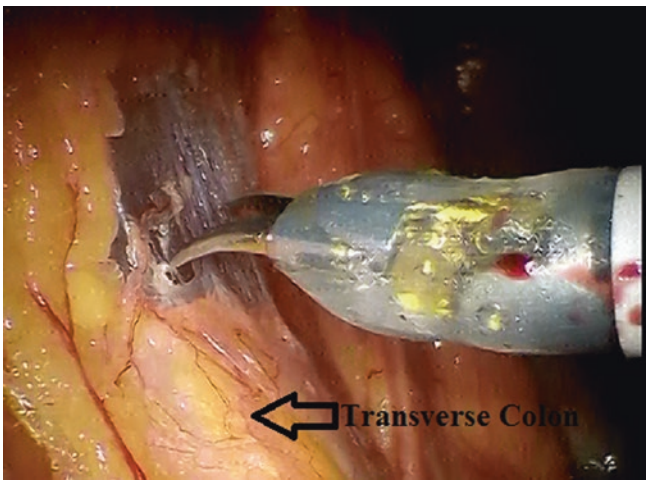


Fig. 78.10 The point of entry is made at the mid-transverse colon where the thin anterior posterior peritoneal fold can be visualized

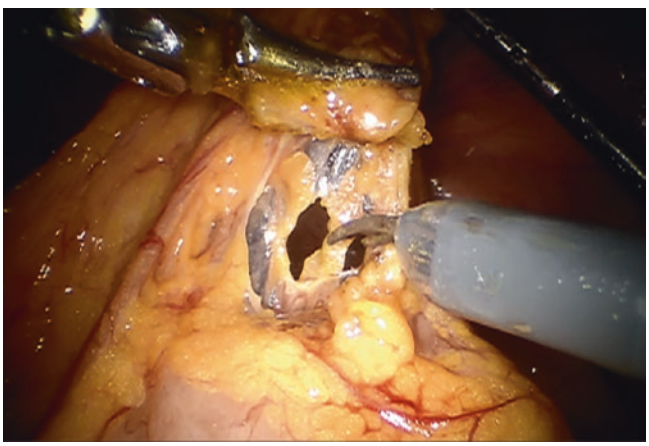


Fig. 78.11 Surgeon begins dissection by incising the peritoneal folds with the robotic scissors

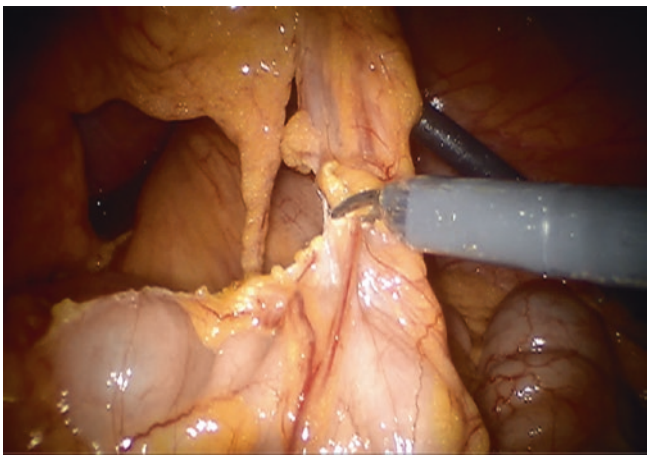


Fig. 78.12 Cutting current is used along the mid-transverse colon to incise the peritoneal folds. The assistant maintains traction of the omentum towards the pelvis.

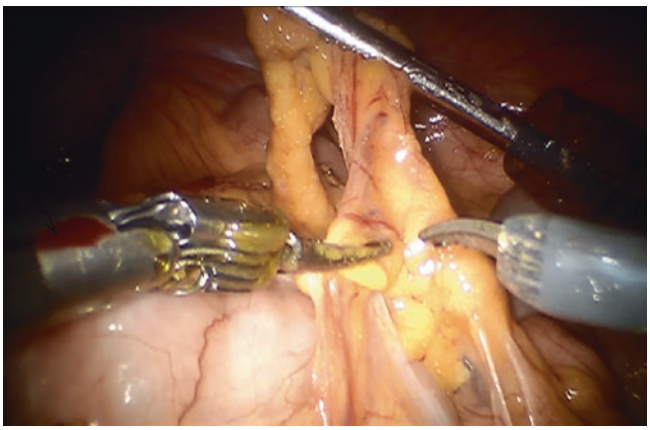


Fig. 78.13 Bipolar current being used to coagulate larger pedicles

the thin anterior and posterior peritoneal reflections (Fig. 78.12). Thicker vascular pedicles are first desiccated with bipolar cautery (Fig. 78.13). It is important to keep the bowel in direct visualization to avoid thermal injury (Fig. 78.14). In order to avoid thermal injury to the bowel, a distance of 3–5 mm from the bowel should be kept when using cutting current. A distance of 1 cm should be maintained when using coagulation current due to its increased thermal spread.

The surgeon continues dissection from the mid-transverse colon towards the ceacum (Fig. 78.15). This step can be more difficult in cases where the bowel is inadequately prepared or in obese patients that have abundant abdominal fat. In the obese patient, a useful trick to identify the peritoneal reflection along the transverse colon is to flip to omentum so that its posterior surface is visualized. The posterior surface can be followed to identify the transverse colon and find the peritoneal reflections.

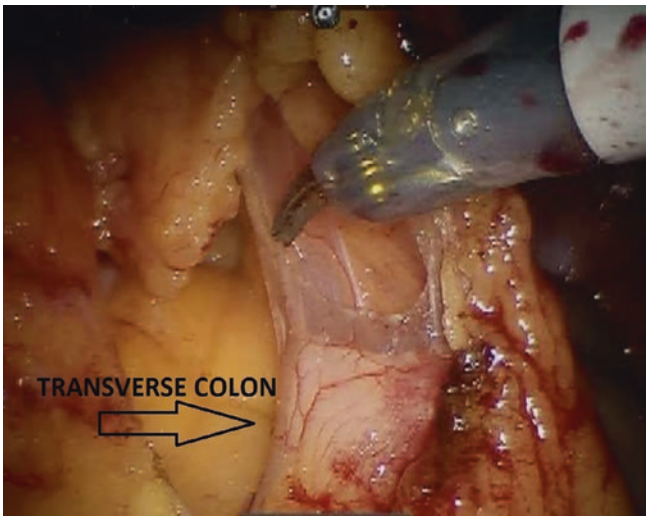


Fig. 78.14 A distance of 3–5 mm from the bowel should be maintained when using cutting current.

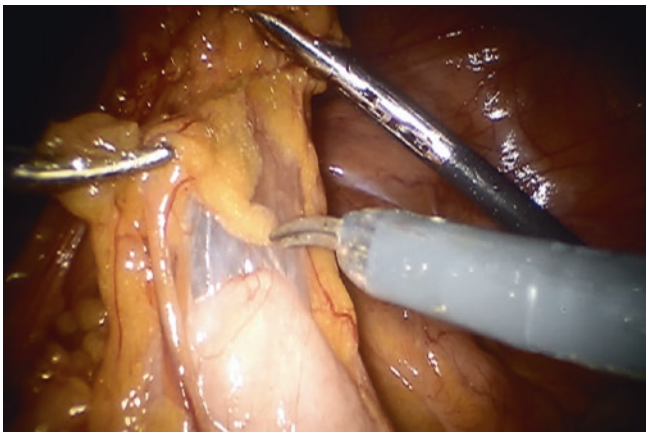


Fig. 78.16 Near the splenic flexure, the assistant is pulling the omentum towards the right lower quadrant as the surgeon uses the left robotic arm to pull up on the omentum, thereby revealing the peritoneal reflection.

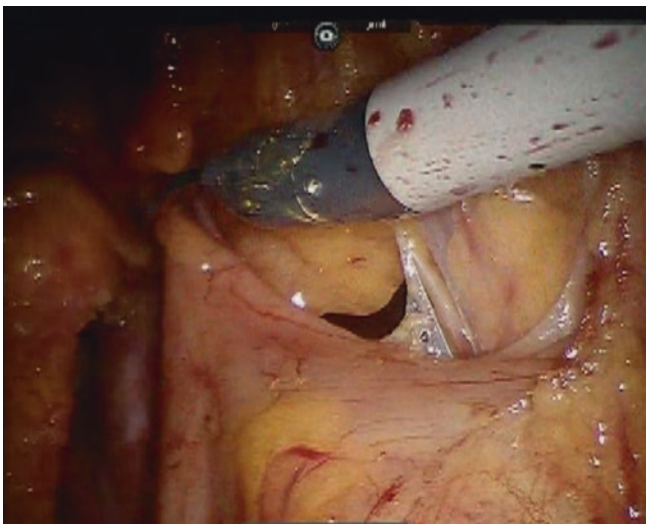


Fig. 78.15 Dissection along the mid-transverse colon towards the ceacum

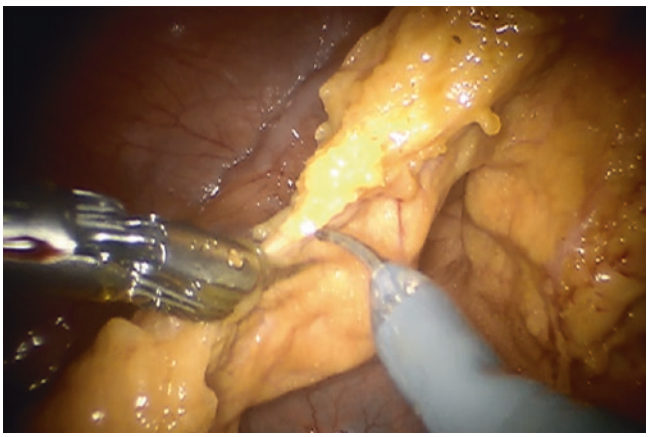


Fig. 78.17 Transection of the omentum after completion of infracolic omentectomy

In order for the procedure to be successful, the surgeon and the assistant have to make periodic adjustments in the amount and direction of traction and countertraction, so that the peritoneal reflections and transverse colon can be easily visualized.

After completion of dissection at the ceacum, the surgeon returns to the mid-transverse colon and dissects towards the splenic flexure. The ability to reach the splenic flexure is dependent on optimal placement of the left robotic arm. The first consideration is during the initial port placement, where the arm is placed 11–12 cm lateral left from the midline for the Si system. Placement of this port 9–10 cm from the midline is sufficient for Xi system. Second, at this point in the procedure, if the Si system is being utilized, the left robotic arm is redirected with the elbow manually pushed so that it is pointing toward the robot.

As dissection continues toward the splenic flexure, the assistant or fourth arm provides countertraction towards the right lower quadrant as the surgeon maintains upward traction (Fig. 78.16). The anterior and posterior peritoneal reflections are identified and cut with monopolar cautery. Vascular pedicles are identified and initially desiccated with bipolar cautery and cut with the robotic scissors with or without the utilization of cautery. Once one satisfactorily accomplishes the extent of dissection towards the splenic flexure similar to an open procedure, the specimen is transected using bipolar current or monopolar in combination with the robotic scissors (Fig. 78.17).

At the completion of the infracolic omentectomy, the omentum is tacked to the left pelvic sidewall using a surgi-

cal clip or a stitch. It is extracted vaginally at the completion of the hysterectomy and staging procedure. The omentum is grasped with a sponge stick and rotated clockwise during extraction. The key steps for infracolic omentectomy are summarized below (Table 78.2).

Robotic omentectomy, once mastered, can be performed with operative times similar to open and faster than laparoscipic omentectomies. However, some differences between robotic and other approaches should be noted. Compared to the laparoscopic approach, port positioning for robotic omentectomy is usually higher, as described. This is important, especially for the placement of the optical port, since its position is not easily interchangeable as it is in conventional laparoscopy. The higher position of the optical port in robotic surgery allows for visualization of both the upper abdomen as well as the pelvis. Laparoscopiclly, the camera can be moved to a suprapubic port and the surgeon can dissect in the upper abdomen via accessory ports. With the robotic approach, the optical port is fixed; therefore, the surgeon is more dependent on the assistant maintaining the position of the omentum in the pelvis. Additionally, access to the left upper quadrant toward the splenic flexure can be more difficult with the robotic approach. If there is no macroscopically visible disease, we generally terminate the infracolic omentectomy 10–15 cm (4–6 inches) from the splenic flexure, which is similar to an open procedure. Access to the left upper quadrant when using the Si model is optimized by further lateralizing the left robotic port and when approaching the splenic flexure, manually re-directing the left robotic arm, so that its elbow points towards the robot. Coordination between the surgeon and assistant, the robotic omentectomy can accomplished with efficiency similar to open and faster than laparoscopic approaches.

Robotic Gastrocolic Omentectomy

A gastrocolic omentectomy is performed when there is upper abdominal disease or macroscopic disease on the gastrocolic omentum. We initially make a laparoscopic assessment prior to docking the robot and decide if this procedure needs to be undertaken. If necessary, it is performed prior to the infracolic omentectomy that is described above. For the Si system, a double docking technique is necessary: first docking the robot over the patient's right shoulder for the gastrocolic dissection (Fig. 78.18), and then centrally docking the robot



Fig. 78.18 Docking of the *da Vinci® SI System* over the patient's right shoulder in preparation for a gastrocolic omentectomy

Table 78.2 Key steps for infracolic omentectomy procedure

Beginning of procedure 1. The omentum is laparoscopically placed in the pelvis. The assistant maintains traction throughout the procedure to keep the omentum in the pelvis rather than the upper abdomen. 2. Dissection begins at the mid-transverse colon, where the anterior and posterior peritoneal folds are identified and entered. 3. In order to identify the peritoneal folds, the left robotic arm pulls up on the omentum, exerting upward traction to assist in revealing the peritoneal reflections.
Middle of procedure 1. Dissection begins from the point of entry along mid-transverse colon and continues toward the caecum. 2. Cutting current with the monopolar scissors is used to dissect along the anterior and posterior peritoneal folds. 3. Once dissection to the caecum is complete, we return to the point of entry along the mid-transverse colon in order to dissect in the opposite direction, towards the splenic flexure. 4. At this point, if the Si system is being used, manually re-directing the left robotic arm, so that its elbow points towards the robot, can optimize dissection towards the splenic flexure. 5. Dissection continues along the anterior and posterior peritoneal folds as previously.
End of procedure 1. The extent of dissection is variable; however, if there is no grossly visible disease, we normally terminate dissection 10–15 cm (4–6 inches) from the splenic flexure. 2. In order to terminate the procedure, a point of transection is determined. Bipolar current is used to desiccate the thick fatty area of the omentum being transected, and robotic scissors are used to cut and free the specimen.

between the patient's legs to accomplish the infracolic portion. This is not necessary with the Xi system as the boom of the robot can be turned to approach multiple quadrants.

Procedure

To begin the gastrocolic omentectomy, the stomach is tented up (Fig. 78.19) and the peritoneal folds of the omentum are incised to the right of the midline with cutting current in order to enter the lesser sac (Fig. 78.20). It is useful to identify a thin area of peritoneum along the greater curvature of the stomach and enter the lesser sac from this point.

A robotic vessel sealer is helpful for dissection and maintaining hemostasis. The sealer is used in the left robotic arm and an atraumatic fenestrated grasper is placed in the right incised to the right of the midline robotic arm. The role of the assistant is to exert upwards traction on the stomach with an atraumatic grasper while the right robotic arm places downward traction on the omentum. This dynamic should be maintained throughout the dissection (Fig. 78.21).

The omentectomy is commenced from the point where the lesser sac was entered. The sealer is placed approximately 1–1.5 cm away from the short gastric arteries (Fig. 78.22). A double seal technique is used, in which the sealer is fired twice before cutting; this allows for a more hemostatic dissection. Dissection is continued along the greater curvature of the stomach toward the splenic flexure (Fig. 78.23).

Upon reaching the splenic flexure, the dissection is directed towards the transverse colon (Fig. 78.24). This facilitates the infra-colic omentectomy that can be continued from the pelvis. In order to define the limit of the omentetomy, it is important to make a detailed visual inspection of any residual disease so that it can be included with the specimen.

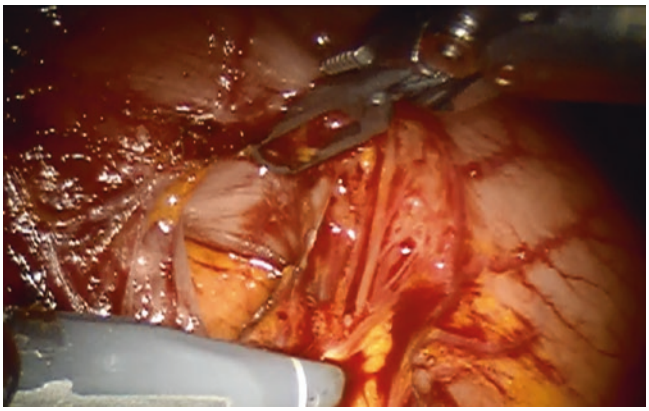


Fig. 78.20 Cutting current used to enter lesser sac

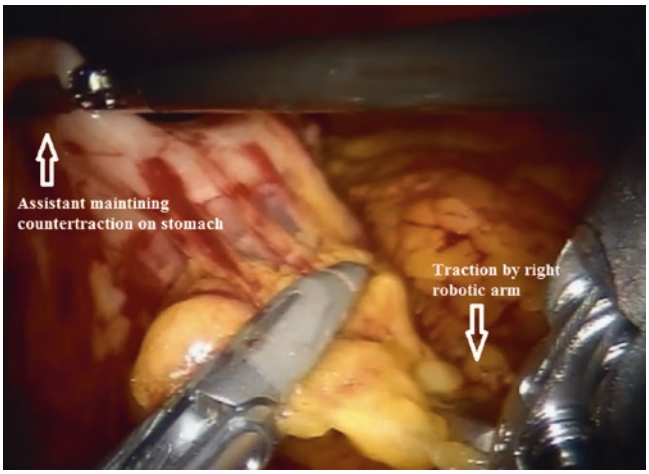


Fig. 78.21 The sealer is used in the left robotic arm. The assistant maintains upward traction on the stomach as the surgeon uses an atraumatic grasper in the right robotic arm to pull the omentum downwards

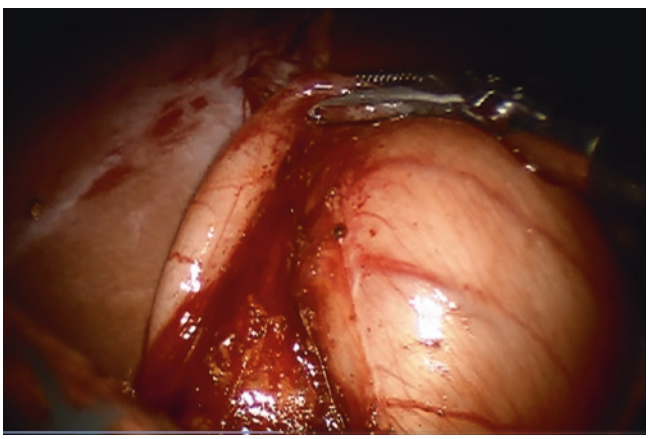


Fig. 78.19 The surgeon uses the robotic arm to grasp and tent up the stomach in order to identify point of entry to lesser sac

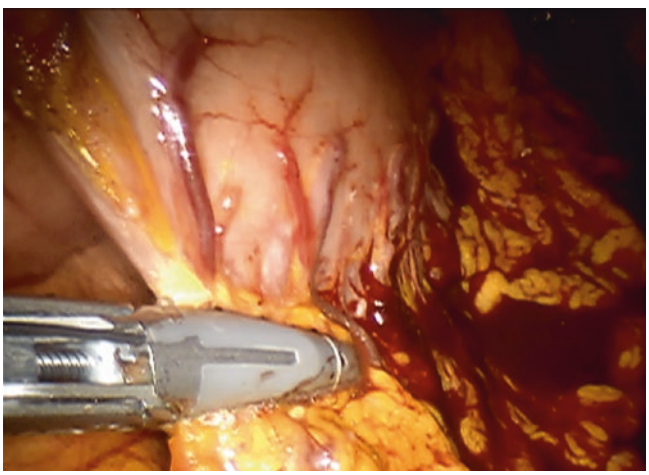


Fig. 78.22 The sealer is placed approximately 1–1.5 cm away from the short gastric arteries



Fig. 78.23 Dissection with the sealer along the greater curvature of the stomach towards the splenic flexure

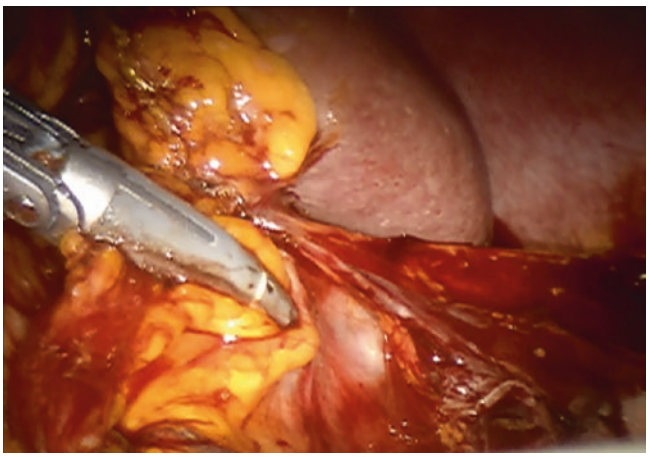


Fig. 78.24 Direction of dissection directed towards the transverse colon after reaching the splenic flexure

At this point the sealer is placed in the right arm and the atraumatic grasper in the left arm and dissection is continued for a short while to the right and then towards the transverse colon. This sets up dissection for the infracolic omentectomy as described above, and allows the entire omentum to be removed en bloc. If using the Si system, the robot is undocked from over the patient's right shoulder and re-docked centrally. This can be accomplished by either turning the patient's bed (with cooperation from the anesthesiologist) or mobilizing of the robot. For the Xi system one undocks, simply rotates the boom, re-docks, and then redirects the orientation for the new anatomy targeted.

References

1. Liebermann-Meffert D. The greater omentum. anatomy, embryology, and surgical applications. Surg Clin North Am. 2000;80(1):275–93 xii.
2. Shah S, Lowery E, Braun RK, Martin A, Huang N, Medina M, Sethupathi P, Seki Y, Takami M, Byrne K, Wigfield C, Love RB, Iwashima M. Cellular basis of tissue regeneration by omentum. PLoS One. 2012;7(6):e38368.
3. Arie AB, McNally L, Kapp DS, Teng NN. The omentum and omentectomy in epithelial ovarian cancer: a reappraisal. Part I--Omental function and history of omentectomy. Gynecol Oncol. 2013; 131(3):780–3.
4. Arie AB, McNally L, Kapp DS, Teng NN. The omentum and omentectomy in epithelial ovarian cancer: a reappraisal: part II--the role of omentectomy in the staging and treatment of apparent early stage epithelial ovarian cancer. Gynecol Oncol. 2013;131(3):784–90.
5. Feuer GA, Lakhi N, Barker J, Salmieri S, Burrell M. Perioperative and clinical outcomes in the management of epithelial ovarian cancer using a robotic or abdominal approach. Gynecol Oncol. 2013; 131(3):520–4.
6. Feuer GA, Lakhi N, Woo A, Salmieri SS, Beryl MO, Serur E. Robotic surgery for staging of serous papillary and clear cell carcinoma of the endometrium. Int J Med Robot. 2014;10(3):306–13.

Robotic-Assisted Laparoscopic Hysterectomy: Final Steps and Postoperative Considerations

79

Bahriye Aktas

Robotic surgery provides all the benefits of the laparoscopic technique with greater precision and effectiveness with no major difference regarding postoperative considerations and complications.

When the surgery is completed, an exploration of the upper abdomen and pelvis is required to control that there is no damage. Immediate intraoperative management of any damage is recommended for the best postoperative outcome.

Performing cystoscopy should not be done routinely, but in select cases cystoscopy is helpful after vaginal closure to check ureteral patency and for any signs of bladder injury. Please note that a normal cystoscopy does not exclude a delayed thermal injury to either the ureters or the bladder [1].

Vaginal cuff dehiscence after hysterectomy is a rare but severe postoperative complication. The rate of vaginal cuff dehiscence seems to have been shown to increase after both robotic and laparoscopic surgeries compared with that after the open approach [2]. However the incidence is significantly higher in total laparoscopic hysterectomy than laparoscopy assisted vaginal hysterectomy. Thus the vaginal closure technique is essential to avoid any cuff dehiscence. The intra – corporeal cuff suture seems to be superior to the vaginal suture to prevent the vaginal cuff complications [3]. Additionally abstaining from vaginal intercourse should be recommended to decrease the rate for postcoital vaginal cuff dehiscence.

Whereas adhesions are common after hysterectomies and could be the reason for delayed abdominal pain. To avoid accumulation of seroma a soft plastic drain sometimes is placed through one of the incisions, which usually will be removed before the patient goes home. There are a lot of ambiguous data with on the efficacy of agents against adhesions, but only a few of the various available pharmacological and non – pharmacological agents have been studied in randomized controlled trials [4].

Once the robotic assisted procedure is finished, all instruments and endoscopes and cannulas are removed. The cannulas will be removed after disconnecting the roboter arms. Subcutaneous emphysema could result from placement of the Veress needle into the extraperitoneal space or during prolonged procedures after using robotic assisted or laparoscopic techniques when cannulas are dislocated. Patient's companions should be told that during laparoscopic hysterectomy may secondarily occur subcutaneous emphysema as gas gains access through enlargement of the trocar incision in the parietal peritoneum and usually dissolves in 12–24 hours [5–8].

The port site skin incisions are closed with dissolving sutures or skin glue. Any 12 mm incisions and extended incisions for delivering specimen retrieval bag require fascial closure using 0 vicryl sutures to prevent incisional hernias. The skin is closed with 4–0 monocryl sutures in a continuous subcutaneous or intracutaneous fashion. The 5 mm incisions generally do not require fascial closure and are closed with single sutures with 4–0 monocryl or glue for better cosmetic results.

For reducing immediate postoperative pain, injection of local analgesia at all post incision sites is possible [9] but not necessary.

Subsequently, the sterile accessories and drapes can be removed and the patient will be transferred to the recovery room. The nurses and doctors will monitor patients' recovery as she wakes up and will continue monitoring until she is discharged from the hospital.

A post – operative assessment should be done at the same day of the surgery, including palpation of the abdomen, checking the drainage, if any was placed and looking for any vaginal bleeding. Checking the blood values is not necessary; accept there are clinical signs for postoperative hemorrhage.

In cases of postoperative vaginal cuff hematoma usage of antibiotics could be necessary to prevent any infections.

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Single prophylactic doses and additional intraoperative doses in prolonged surgeries are useful and recommended.

The main indications to extend the application of antibiotics postoperatively are intraoperative interventions on the intestines or urinary tract.

In patients who underwent general anesthesia, the Foley catheter should be removed postoperatively when the patient is awake and no longer immobile. Mobilization of the patients should also be performed as soon as possible to prevent thrombosis, if indicated heparin should be given in patients at risk, especially patients with cancer diagnosis. During hospitalization patients should receive thrombosis prophylaxis, because thromboembolism is relatively common in gyneco – oncological surgery.

Against the past there are no special steps for rebuilding the diet after hysterectomy but flatulent foods should be avoided.

A discharge assessment will be performed including abdominal sonography to check the kidneys and a vaginal sonography to exclude any hematoma.

In most cases patients return to their routine activities 2 weeks after the operation. Final pelvic examination is usually indicated after 6–12 weeks, mainly are indicated for pain or pyrexia. Sexual activity may be allowed after a recovery time to avoid postcoital vaginal cuff dehiscence and infections as previously described. In general, patients can resume sexual relations after 8 weeks, may be later for patients at risk for impaired healing like obese patients and patients with diabetes.

A review of the literature published 2011 described a significant difference in number of major postoperative complications between robotic radical hysterectomy (9.6 %) and total laparoscopic radical hysterectomy (5.5 %). In the robotic procedure group were included 11 cases of vaginal cuff dehiscence, 10 cases of vaginal cuff abscess, and 5 cases of port site hernia [10]. Despite to these data, Estape et al. demonstrated that the incidence of postoperative complications was less in the robotic group (18.8 %) than either the laparoscopic group (23.5 %) or the laparotomy group (28.6 %). In the first group, one patient developed a pelvic abscess and another one a vaginal evisceration [11]. Two other studies did not observe any significant differences in postoperative outcomes [12, 13]. Similar early, less than 6 weeks, major postoperative complications in robotic radical hysterectomy (7 %), laparoscopic radical hysterectomy (6 %), and open radical hysterectomy (9 %) groups was described by Magrina et al. [13]. Overall postoperative complications rate of 12 %, including deep venous thrombosis (2.4 %), pyelonephritis (2.4 %), prolonged bladder catheterization of 21 days (2.4 %), and infection (4.8 %) was demonstrated by Lowe et al. [14]. Early mobilization and administering heparin in patients at risk for developing deep venous thrombosis, removing of the Foley catheter and treating prophylactically with an antibiotic intraoperatively could help to prevent these complications.

Robotic approach provides clear benefits of minimally invasive surgery, such as a reduced blood loss, a lower morbidity, and a faster recovery than open surgery. Although surgical outcomes are similar or slightly improved when compared to laparoscopy [15]. Complication rates and hospital stay are also similar for robotic and conventional laparoscopic surgery [16], indeed, current studies shows faster recovery time for patients underwent robotic surgery [17].

Overall there is no major difference between robotic – assisted hysterectomy and the laparoscopic hysterectomy regarding postoperative considerations and complications [18, 19].

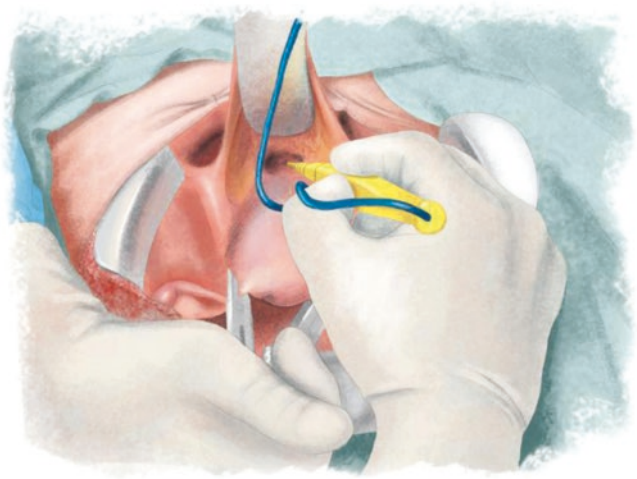
References

1. Einarsson JI, Suzuki Y. Total laparoscopic hysterectomy: 10 steps toward a successful procedure. Rev Obstet Gynecol. 2009;2(1):57–64.
2. Zapardiel I, Zanagnolo V, Peiretti M, Maggioni A, Bocciolone L. Avoiding vaginal cuff dehiscence after robotic oncological surgery: reliable suturing technique. Int J Gynecol Cancer. 2010;20:1264–7.
3. Kim MJ, Kim S, Bae HS, Lee JK, Lee NW, Song JY. Evaluation of risk factors of vaginal cuff dehiscence after hysterectomy. Obstet Gynecol Sci. 2014;57(2):136–43.
4. Hirschelmann A, Tchartchian G, Wallwiener M, Hackethal A, De Wilde RL. A review of the problematic adhesion prophylaxis in gynaecological surgery. Arch Gynecol Obstet. 2012;285(4):1089–97.
5. Jhingran A, Levenback C. Malignant disease of the cervix. Microinvasive and invasive cancers. In: Katz VL, Lentz GM, Lobo RA, Gershenson DM, editors. 5th comprehensive gynecology. Philadelphia: Mosby/Elsevier ; 2007. p. 759–81.ISBN: 978-0-323-02951-3
6. Kim,Y.T. (2007).Robotic radical hysterectomy with pelvic lymphadenectomy for cervical carcinoma: a pilot study, Gynecol Oncol, Vol. 105, pp. 176-180, ISSN: 0090-8258.
7. Li G, Yan X, Shang H. A comparison of laparoscopic radical hysterectomy and pelvic lymphadenectomy and laparotomy in the treatment of Ib-IIa cervical cancer. Gynecol Oncol. 2007;105:176–80. ISSN: 0090-8258.
8. Tang A, Obermair A. Technique of laparoscopic radical hysterectomy and comparison of three techniques: laparotomy, laparoscopy and robotics. In: Textbook of Gynaecological Oncology; 2009.
9. Einarsson JI, Sun J, Orav J, Young AE. Local analgesia in laparoscopy: a randomized trial. Obstet Gynecol. 2004;104:1335–9.
10. Kruijdenberg CBM, Van Den Einden LCG, Hendriks JCM, Zusterzeel PL, Bekkers RL. Robot-assisted versus total laparoscopic radical hysterectomy in early cervical cancer, a review. Gynecol Oncol. 2011;120(3):334–9.
11. Estape R, Lambrou N, Diaz R, Estape E, Dunkin N, Rivera A. A case matched analysis of robotic radical hysterectomy with lymphadenectomy compared with laparoscopy and laparotomy. Gynecol Oncol. 2009;113(3):357–61.

12. Nezhat FR, Datta MS, Liu C, Chuang L, Zakashansky K. Robotic radical hysterectomy versus total laparoscopic radical hysterectomy with pelvic lymphadenectomy for treatment of early cervical cancer. JSLS. 2008;12(3):227–37.
13. Magrina JF, Kho RM, Weaver AL, Montero RP, Magtibay PM. Robotic radical hysterectomy: comparison with laparoscopy and laparotomy. Gynecol Oncol. 2008;109(1):86–91.
14. Lowe MP, Chamberlain DH, Kamelle SA, Johnson PR, Tillmanns TD. A multi-institutional experience with robotic-assisted radical hysterectomy for early stage cervical cancer. Gynecol Oncol. 2009;113(2):191–4.
15. Renato S, Mohamed M, Serena S, et al. Robot-assisted radical hysterectomy for cervical cancer: review of surgical and oncological outcomes. ISRN Obstet Gynecol. 2011;2011:872434.
16. Sarlos D, Kots LV, Stevanovic N, Schaer G. Robotic hysterectomy versus conventional laparoscopic hysterectomy: outcome and cost analyses of a matched case–control study. Eur J Obstet Gynecol Reprod Biol. 2010;150:92–6.
17. Buderath P, Aktas B, Heubner M, Kimmig R. Robot-assisted hysterectomy: a critical evaluation. Robot Surg:Res Rev. 2015;2:59–63. Dove Press
18. Basil J, Pavelka J. Robotic gynecologic surgery. In: Baggish MS, Karram MM, editors. Atlas of pelvic anatomy and gynecologic surgery. 3 ed. Saunders: Elsevier; 2011. p. 1327–34 .ISBN: 978-1-4160-5909-7.
19. Orady M, Hrynewych A, Nawfal AK, Wegienka G. Comparison of robotic-assisted hysterectomy to other minimally invasive approaches. JSLS. 2012;16(4):542–8.

Part X

Abdominal Hysterectomy and Extended Procedures for Benign and Malignant Indications



Abdominal Hysterectomy: Indications and Contraindications

80

Russalina Mavrova, Julia C. Radosa,
Ingolf Juhasz-Böss, and Erich-Franz Solomayer

Hysterectomy is the most common non-obstetric gynecologic procedure with an incidence of 3.6 per 1000 person-years in Germany in 2006; 4.8 per 1000 woman-years in Australia in 2003 and 5.1 per 1000 person-years in the US in 2004 [1, 2, 3]. Although the number of hysterectomies has decreased over the last decade [2, 4], it remains the gold standard for the treatment of benign uterine pathologies and part of the surgical treatment of gynecologic malignancies. Hysterectomy may be performed via abdominal, vaginal, laparoscopic or robotic approach. The choice of the surgical approach depends upon clinical circumstances, surgeon's technical experience and patients` preference. Furthermore a combination of techniques can be used and should be considered. When choosing the route and method of hysterectomy the patient's safety should be the most important factor. The cost effectiveness should not influence the choice of surgical approach. Many guidelines have been published regarding the best technique to perform hysterectomy. Although overall recommendations endorse a vaginal or minimal invasive approach as an alternative whenever feasible [5, 6] most hysterectomies (39.5 % in Germany in 2006; 40 % in Australia in 2003 and 54.2 % in the US in 2010) worldwide are performed via laparotomy [1, 2, 4]. Vaginal and laparoscopic hysterectomy are superior to open surgery in terms of less intraoperative blood loss, fewer postoperative infections, less postoperative pain, a shorter duration of hospitalization and a faster reconvalescence and resumption of normal daily activities [5, 7–10]. Improvement in postoperative quality of life and sexual function following laparoscopic or vaginal hysterectomy for benign uterine pathologies due to postoperative symptom relief have also been reported in the literature [11, 12]. However, analysis of hysterectomy rates worldwide shows that abdominal hysterectomy is performed most frequently [13–19] and still plays an important role in gynecologic surgery.

The most common indications for hysterectomy are uterine leiomyomas, pelvic organ prolapse, pelvic pain or infection (e.g. endometriosis, pelvic inflammatory disease), abnormal uterine bleeding and malignant/premalignant disease as shown in Table 80.1. Although hysterectomy is the treatment for most gynecologic malignancies, the vast majority of hysterectomies are performed for benign gynecologic diseases [4]. Open surgery offers the possibility of abdomino-pelvic exploration which is limited when using the vaginal approach. The following contraindications for the vaginal route are described in the literature: enlarged and bulky uterus (estimated uterine size exceeding the umbilicus), narrow vagina and pubic arch, undescended immobile uterus, supracervical hysterectomy, an extrauterine disease as adnexal pathology/severe endometriosis/adhesions and malignancies. Relative contraindications for the vaginal route are: nullipara [20, 21], prior cesarean delivery [22, 23] and elective salpingoophorectomy, as the success of removing the ovaries vaginally varies from 65 to 97.5 % [24–26]. The combination of a vaginal approach with laparoscopic surgery to facilitate vaginal hysterectomy, analogous to a laparoscopic assisted vaginal hysterectomy (LAVH), is not recommend in cases in which laparoscopic surgery alone is feasible as it offers no benefits. Consecutively, if a vaginal hysterectomy cannot be performed, surgeons should choose between the laparoscopic and the abdominal approach, as experience with robot-assisted hysterectomy is limited to date. Morbidity and mortality rates are higher for abdominal hysterectomy compared to minimal invasive surgery. Patients undergoing abdominal hysterectomy have a three times higher morbidity and mortality rate than those who undergo laparoscopic hysterectomy [27, 28]. They suffer more postoperative infections, a higher rate of incisional hernias, a higher rate of thromboembolic complications and tend to have a higher intraoperative blood loss. However the laparoscopic approach has its limitations too. A considerable disadvantage of laparoscopic

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Table 80.1 Overview of the most common indications for hysterectomy

Benign disease	Malign disease
Uterine leiomyoma	Cervical intraepithelial neoplasm
Adenomyosis uteri	Invasive cervical cancer
Abnormal bleeding	Atypical endometrial hyperplasia
Pelvic organ prolaps	Invasive endometrial cancer
Endometriosis	Ovarian cancer
Pelvic inflammatory disease	Fallopian tube cancer
Chronic pelvic pain	Gestational throphoblast tumors
Pregnancy-related pathologies	–

hysterectomy is the lengthen duration of surgery as it takes longer to perform than abdominal hysterectomy [29]. A meta-analysis performed by Walsh et al. in 2009 [30] compares total abdominal hysterectomy to total laparoscopic hysterectomy for benign indications. They found out that the only trade-off for a better outcome appears to be a longer operating time in the TLH group (WMD 22 min; 95 % CI 5–39 min; $p = 0.01$) compared to the TAH group. Another meta-analysis by Gendy et al. [31] published in 2011 compares vaginal hysterectomy to total laparoscopic hysterectomy for benign disease. They found out that TLH took longer to perform (WMD 29.3 min; $P = 0.003$) compared to VH. This is comparable to lots of other papers [32, 33] dealing with the same topic.

Abdominal hysterectomy is easier to perform and to learn compared to laparoscopic hysterectomy as the published learn curves in the literature show [34–36].

The equipment for an abdominal hysterectomy is broadly available in most institutions. The experience of the surgeon and his dexterity are important factors when choosing surgical approach. Another important parameter which should be taken into consideration is the duration of surgery. Surgeons should choose the surgical approach which helps reducing the duration of surgery, as prolonged exposure to anesthesia can lead to an unfavorable postoperative outcome, especially for patients with comorbidities.

In summary an enlarged and immobile uterus might be an indication for an abdominal approach. But there are no specific recommendations up to which uterus weight or size a laparoscopic approach should be preferred over an abdominal approach, as every author has its own definition of an enlarged uterus. Few studies report successful laparoscopic hysterectomy in cases of enlarged uteri [37–40]. Even a case report of a successful total laparoscopic hysterectomy of a 3030 g enlarged uterus exists in the literature [41]. It might be helpful to coagulate the uterine artery before starting with laparoscopic hysterectomy in cases of enlarged uteri to reduce intraoperative blood loss [42]. We recommend laparoscopic surgery of enlarged uteri only in specialized laparoscopic centers with experienced and advanced laparoscopic surgeons.

In uro-gynecology, the abdominal hysterectomy still plays an important role. As urogenital prolapse becomes more and more common because of increasing life expectancy, pelvic organ prolapse repair surgery is being performed more frequently. Vaginal vault prolapse is reported frequently after hysterectomy. Abdominal sacro-colpopexy is the gold standard for surgical repair of vaginal vault prolapse [43–45]. It is superior in patients´ outcome when compared to a variety of vaginal procedures including sacrospinous colpopexy, uterosacral colpopexy and transvaginal mesh [45, 46]. As a consequence abdominal sacrocolpopexy can be performed after hysterectomy in cases of upper vaginal prolapse. The Cochraine database report from 2013 [46] shows that abdominal sacro-colpopexy for upper vaginal prolapse was associated with a lower rate of recurrent vault prolapse on examination and less painful intercourse than vaginal sacrospinous colpopexy. Furthermore in single studies the sacro-colpopexy had a higher success rate on examination and lower re-operation rate than high vaginal uterosacral suspension and trans-vaginal polyprolene mesh. But these benefits must be balanced against a longer operation time, longer time to return to activities of daily life and increased costs of the abdominal approach. There are hints that laparoscopic sacro-colpopexy upholds the outcome of the gold standard abdominal sacro-colpopexy with minimal morbidity [45]. But prospective and randomized trials are needed to confirm these results. When counseling patients about alternatives for pelvic organ prolapse repair surgery numerous aspects have to be considered. Hysterectomy has been traditionally performed in cases of pelvic organ prolapse surgery. Nowadays, conflict data exist regarding the effectiveness of pelvic organ prolapse surgery with and without uterine preservation [47, 48]. Marschalek et al. [48] claim that uterus preservation at time of pelvic organ prolapse surgery is a safe and effective alternative for women who wish to preserve their uterus but is associated with more recurrent symptomatic prolapses. Nevertheless, the question regarding the superiority of either sacral hysteropexy or sacro-colpopexy has not yet been answered.

Morcellation can be needed while performing laparoscopic or vaginal hysterectomy, if the trocar opening or the

vaginal outlet is insufficient to pass the resected tissue. The power morcellator is an instrument with a fast rotating cylindrical knife which aims to divide the tissue into smaller pieces or fragments. Morcellation has been used in gynecologic surgery since 1993 and has become the subject of recent discussions because of the U.S. Food and Drug administration (FDA) safety warning about the use of power morcellation published in November 2014 [49] and the possible risk of spreading an undiagnosed uterine sarcoma or leiomyosarcoma, which may worsen patient's outcome [50]. Uterine sarcomas are difficult to diagnose preoperatively [51] and the risk of an unexpected uterine sarcoma following surgery for presumed benign uterine leiomyoma is low as the annual incidence of uterine sarcomas in the international literature ranges from 0.35 to 7.02 for every 100,000 women, depending on the investigated cohort [52].

Lin et al. [53] showed in their study published in 2015 that tumor morcellation irrespective of the access (abdominal, vaginal or laparoscopic) did not increase the abdominal-pelvic recurrence rate, but may be associated with lower DFS and OS in Stage 1 uterine leiomyosarcomas. There have been a number of attempts to increase the safety of morcellation, for example by morcellating within an insufflated bag, which might minimize the risk of spreading malignant cells while preserving the benefits of minimal invasive surgery [54]. Even if this risk is difficult to assess because of the rarity of uterine sarcomas, these risks should be discussed with the patient preoperatively.

A relative contraindication for abdominal hysterectomy is obesity, as it is known to be a risk factor for increased peri- and postoperative morbidity following abdominal hysterectomy [55]. Obese patients were shown to profit from vaginal or laparoscopic approaches, including robotic surgery, since these procedures show lower rates of postoperative wound healing complications and a faster mobilization compared to open surgery. An abdominal hysterectomy should be avoided in cases of obesity.

Abdominal hysterectomy plays an important role in gynecological oncology, as the majority of gynecologic malignancies are still operated on via laparotomy. This practice is likely to be maintained for women with ovarian cancer and advanced stages of cervical and endometrial cancer.

Women with ovarian cancer frequently have extensive pelvic and upper abdominal metastases. The role of laparoscopy in ovarian cancer is still controversially discussed, but there are attempts to assess the impact of laparoscopy in early-stage ovarian cancer [56, 57]. The standard treatment of advanced-stage ovarian cancer includes upfront surgery with intent to accurately diagnose and stage the disease and to perform maximal cyto-reduction and tumor debulking as this is the most important factor for patients´ survival [58–60].

Since minimal invasive surgery is gaining more and more importance and surgeons achieve more and more advanced laparoscopic skills, laparoscopic techniques are being used more frequently in the treatment of early-stage cervical and endometrial carcinoma [56]. Studies show that the use of laparoscopy in early-stage cervical and endometrial carcinoma in terms of oncologic effectiveness is equivalent to that of laparotomy [61–69]. Advanced-stage cervical and endometrial carcinomas occasionally require extensive surgery e.g. a pelvic exenteration and are indications for open surgery.

Certainly financial factors and the cost effectiveness should not influence the choice of the access or method of hysterectomy. But we want to discuss this aspect in this chapter as well. Many authors compare minimally invasive procedures such as laparoscopic and vaginal hysterectomy with the traditional abdominal hysterectomy method by evaluating clinical and economic outcomes. As soon as robotic-assisted hysterectomy became available, it also was compared to the laparoscopic, vaginal and abdominal approach. Cosson et al. [70] divided the costs of a procedure into direct and indirect costs. Direct costs are represented by hospital costs. These expenses vary from one country to another. Direct costs are on the one hand fixed expenses linked to the use of the hospital's infrastructure and equipment, and on the other hand variable expenses related to the amount of personnel, medical prescriptions or use of disposable equipment. Indirect costs are related to the loss of economic productivity of the patient during hospital stay and recovery resulting from the procedure. They depend directly on the country's welfare system and on the patient's incentive to resume work. The operative time, the length of hospitalization and the type of equipment used are the most important factors for the calculation. A longer operative time and length of hospitalization increase the costs; the use of basic equipment can reduce costs. All studies to date show longer operative times for laparoscopic hysterectomy compared to vaginal or abdominal hysterectomy as shown above. A simple vaginal hysterectomy is faster to perform than an abdominal hysterectomy when both options are possible [71]. Although laparoscopic hysterectomy implicate the longest operating times, it show the lowest morbidity rate, the best quality of life in patients and a shorter time of hospitalization compared to the abdominal route. All studies confirm that hospitalization is definitely longer after abdominal hysterectomy compared to laparoscopic and vaginal hysterectomy; for LAH 1.2–4.2 days; for VH 3–4.1 days and for AH 3.3–6.6 days [33, 72, 73]. According to the costs for the equipment, the costs for an abdominal hysterectomy are lower compared to the laparoscopic approach, but the costs for laparoscopy can be reduced with the use of bipolar coagulation, reusable trocars and the abandonment of automatic staplers and prosthetic devices such as endoclips [33, 70]. The shorter hospital stay

Table 80.2 Overview of the (relative) indications and contraindications of abdominal hysterectomy

Indications for abdominal hysterectomy	Contraindications for abdominal hysterectomy
Abdominal surgery in the past	Availability of vaginal or laparoscopic approach*
Enlarged, bulky uterus	Obese and overweight patients
Narrow vagina and pubic arch	–
Undescended immobile uterus	–
Supracervical hysterectomy	–
Extrauterine diseases	–
Adnexal pathologies	–
Severe endometriosis	–
Severe adhesions	–
Suspicion of sarcoma	–
Gynecological malignancies	–
Lack of surgeons experienced in laparoscopy or vaginal hysterectomy	–

in patients undergoing laparoscopic hysterectomy compensates for the increased procedure costs. Combining shorter hospitalization, convalescence and operative times, vaginal hysterectomy is undoubtedly the least costly intervention. It should therefore, whenever possible, be preferred to the other surgical routes. Sculpher et al. [74] found out that laparoscopic hysterectomy was comparable in terms of cost effectiveness to abdominal hysterectomy when taking all the points mentioned above into account. Rosero et al. [75] found out that the median cost of hospital care was $9788 (interquartile range $7105–12,780) for robotic hysterectomy and $7299 (interquartile range $5650–9583) for laparoscopic hysterectomy ($P<.001$). Hospital costs were on average $2489 (95 % CI $2313–2664) higher for patients undergoing robotic hysterectomy. Whrite et al. [76] presented comparable results. All the authors conclude that perioperative outcomes are similar between laparoscopic and robotic hysterectomy, but robotic assisted hysterectomy costs substantially more and is therefore not recommended.

Table 80.2 gives an overview of the indications and contraindications for choosing an abdominal approach. We describe them as "relative" indications and contraindications since most conditions are also applicable for laparoscopic surgery nowadays.

In conclusion, abdominal hysterectomy is a widespread technique and indicated whenever vaginal hysterectomy is not feasible. As laparoscopic surgery has gained more and more importance over the last decades it mainly replaces the abdominal route, but has its own limitations.

Furthermore it is important to avoid the lack of surgical skills for the upcoming generation that primarily learns endoscopic procedures instead of the conventional surgery and will have a lack of technical knowledge in "conventional" abdominal surgery. This knowledge is nevertheless fundamental for the oncogynecological surgery in cases of ovarian cancer, advanced cervical and endometrial cancer, all cases of benign gynecological diseases which need open surgery and in cases where a conversion to a laparotomy is needed.

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References

1. Stang A, Merrill RM, Kuss O. Hysterectomy in Germany: a DRG-based nationwide analysis, 2005-2006. Dtsch Arztebl Int. 2011;108:508–14.
2. Spilsbury K, Semmens JB, Hammond I, Bolck A. Persistent high rates of hysterectomy in Western Australia: a population-based study of 83 000 procedures over 23 years. BJOG An Int J Obstet Gynaecol. 2006;113:804–9.
3. Whiteman MK, Hillis SD, Jamieson DJ, Morrow B, Podgornik MN, Brett KM, et al. Inpatient hysterectomy surveillance in the United States, 2000-2004. Am J Obstet Gynecol. 2008;198:34.e1–7.
4. Wright JD, Herzog TJ, Tsui J, Ananth C V, Lewin SN, Lu Y-S, et al. Nationwide trends in the performance of inpatient hysterectomy in the United States. Obstet Gynecol [Internet]. 2013;122:233–41. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3913114&tool=pmcentrez&rendertype=abstract.
5. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database of Syst Rev. 2009.(2):CD003677
6. Position Statement AAGL. Route of hysterectomy to treat benign uterine disease. J Minim Invasive Gynecol. 2011;18:1–3.
7. Nezhat F, Nezhat C, Gordon S, Wilkins E. Laparoscopic versus abdominal hysterectomy. J Reprod Med [Internet] 1992 ;373:247–50. Available from: http://www.ncbi.nlm.nih.gov/pubmed/1532990. Mar [cited 2014 Dec 29].
8. Garry R, Fountain J, Brown J, Manca A, Mason S, Sculpher M, et al. Evaluate hysterectomy trial: a multicentre randomised trial comparing abdominal, vaginal and laparoscopic methods of hysterectomy. Health Technol Assess. 2004;8(26):1–154.
9. Johnson N, Barlow D, Lethaby A, Tavender E, Curr L, Garry R. Methods of hysterectomy: systematic review and meta-analysis of

randomised controlled trials. BMJ [Internet] 2005 ;3307506:1478. Available from: http://books.google.com/books?hl=en&lr=&id=8QeOAgAAQBAJ&oi=fnd&pg=PA85&dq=randomised+controlled+trials&ots=b4ET_STn-Y&sig=bDDxHaEO1v8fQoy6YBqWhWji-f8. Jun 25 [cited 2014 Dec 29].
10. Shepherd JA, Hudgens JL, Yussman MA, Biscette SM, Pasic R. Stepwise approach to laparoscopic hysterectomy: evaluation of technique and cost benefit. Surg Technol Int [Internet] 2013 ;23:166–75. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24081842. Sep [cited 2014 Dec 29].
11. Carlson KJ, Miller BA, Fowler FJ. The maine women's health study: i. outcomes of hysterectomy. Obstet Gynecol. 1994;83:556–65.
12. Radosa JC, Meyberg-Solomayer G, Kastl C, Radosa CG, Mavrova R, Gräber S, Baum S, Radosa M. Influences of different hysterectomy techniques on patients' postoperative sexual function and quality of life. J Sex Med. 2014;11:2342–50.
13. Wu JM, Wechter ME, Geller EJ, Nguyen TV, Visco AG. Hysterectomy rates in the United States, 2003. Obstet Gynecol. 2007;110:1091–5.
14. Mäkinen J, Johansson J, Tomás C. Morbidity of 10 110 hysterectomies by type of approach. Hum Reprod [Internet]. 2001 ;16(7):1473–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11425832. Jul [cited 2014 Dec 29].
15. Chapron C, Laforest L, Ansquer Y, Fauconnier A. Hysterectomy techniques used for benign pathologies:results of a French multicentre study. Hum Reprod. 1999;14(10):2464–70.
16. Farquhar CM, Steiner CA. Hysterectomy rates in the United States 1990-1997. Obstet Gynecol. 2002;99:229–34.
17. Maresh MJA, Metcalfe MA, McPherson K, Overton C, Hall V, Hargreaves J, et al. The VALUE national hysterectomy study: description of the patients and their surgery. BJOG An Int J Obstet Gynaecol. 2002;109:302–12.
18. Møller C, Kehlet H, Utzon J, Ottesen B. Hysterectomy in Denmark. An analysis of postoperative hospitalisation, morbidity and readmission. Dan Med Bull [Internet] 2002 ;49(4):353–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12553170. [cited 2014 Dec 29].
19. Cohen SL, Vitonis AF, Einarsson JI. Updated hysterectomy surveillance and factors associated with minimally invasive hysterectomy. JSLS J Soc Laparoendosc Surg [Internet]. 2014;18:e2014.00096. Available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4208898/.
20. Tohic AL, Dhainaut C, Yazbeck C, Hallais C, Levin I, Madelenat P. Hysterectomy for benign uterine pathology among women without previous vaginal delivery. Obstet Gynecol. 2008;111:829–37.
21. Agostini A, Bretelle F, Cravello L, Maisonneuve AS, Roger V, Blanc B. Vaginal hysterectomy in nulliparous women without prolapse: a prospective comparative study. BJOG An Int J Obstet Gynaecol. 2003;110:515–8.
22. Sheth SS, Malpani AN. Vaginal hysterectomy following previous cesarean section. Int J Gynaecol Obstet. 1995;50:165–9.
23. Unger JB, Meeks GR. Vaginal hysterectomy in women with history of previous cesarean delivery. Am J Obstet Gynecol. 1998;179:1473–8.
24. Ballard LA, Walters MD. Transvaginal mobilization and removal of ovaries and fallopian tubes after vaginal hysterectomy. Obstet Gynecol. 1996;87:35–9.
25. Davies A, O'Connor H, Magos AL. A prospective study to evaluate oophorectomy at the time of vaginal hysterectomy. Br J Obstet Gynaecol. 1996;103:915–20.
26. Sheth SS. The place of oophorectomy at vaginal hysterectomy. Br J Obstet Gynaecol. 1991;98:662–6.
27. Clarke-Pearson DL, Geller EJ. Complications of hysterectomy. Obstet Gynecol [Internet]. 2013;121:654–73. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00006250-201303000-00023.
28. Wiser A, Holcroft CA, Tulandi T, Abenhaim HA. Abdominal versus laparoscopic hysterectomies for benign diseases: evaluation of morbidity and mortality among 465,798 cases. Gynecol Surg. 2013;10:117–22.
29. Garry R, Fountain J, Mason S, Hawe J, Napp V, Abbott J, et al. The eVALuate study: two parallel randomised trials, one comparing laparoscopic with abdominal hysterectomy, the other comparing laparoscopic with vaginal hysterectomy. BMJ (Clinical research ed). 2004;328(7432):129.
30. Walsh CA, Walsh SR, Tang TY, Slack M. Total abdominal hysterectomy versus total laparoscopic hysterectomy for benign disease: a meta-analysis. Eur J Obstet Gynecol Reprod Biol. 2009;144(1):3–7.
31. Gendy R, Walsh CA, Walsh SR, Karantanis E. Vaginal hysterectomy versus total laparoscopic hysterectomy for benign disease: a metaanalysis of randomized controlled trials. Am J Obstet Gynecol. 2011;204(5)
32. Howard FM, Sanches R. A comparison of laparoscopically assisted vaginal hysterectomy and abdominal hysterectomy. J Gynecol Surg. 1993;9(2):83–90.
33. Nezhat C, Bess O, Admon D, Nezhat CH, Nezhat F. Hospital cost comparison between abdominal, vaginal, and laparoscopy-assisted vaginal hysterectomies. Obstet Gynecol. 1994;83(5 Pt 1):713–6.
34. Perino A, Cucinella G, Venezia R, Castelli A, Cittadini E. Total laparoscopic hysterectomy versus total abdominal hysterectomy: an assessment of the learning curve in a prospective randomized study. Hum Reprod [Internet] 1999 ;14(12):2996–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10601085. Dec [cited 2014 Nov 28].
35. Leminen A. Comparison between personal learning curves for abdominal and laparoscopic hysterectomy. Acta Obstet Gynecol Scand [Internet]. 2000 ;79(12):1100–4. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11130095. Dec [cited 2014 Dec 30].
36. Vaisbuch E, Goldchmit C, Ofer D, Agmon A, Hagay Z. Laparoscopic hysterectomy versus total abdominal hysterectomy: a comparative study. Eur J Obstet Gynecol Reprod Biol [Internet] 2006;126(2):234–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16616408. un 1 [cited 2014 Dec 30].
37. Yavuzcan A, Çağlar M, Üstün Y, Dilbaz S, Kumru S. Evaluation of the outcomes of laparoscopic hysterectomy for normal and enlarged uterus (>280 g). Arch Gynecol Obstet [Internet] 2013;289:831–7. Available from: http://link.springer.com/10.1007/s00404-013-3065-8.
38. Kondo W, Bourdel N, Marengo F, Azuar A-S, Tran-ba-Vang X, Roman H, et al. Surgical outcomes of laparoscopic hysterectomy for enlarged uteri. J Minim Invasive Gynecol. 18:310–3.
39. Wattiez A, Soriano D, Fiaccavento A, Canis M, Botchorishvili R, Pouly J, et al. Total laparoscopic hysterectomy for very enlarged uteri. J Am Assoc Gynecol Laparosc. 2002;9:125–30.
40. Bojahr B, Tchartchian G, Ohlinger R. Laparoscopic supracervical hysterectomy: a retrospective analysis of 1000 cases. JSLS [Internet] 2009 ;13(2):129–34. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3015940&tool=pmcentrez&rendertype=abstract. [cited 2014 Nov 28].
41. Ceccaroni M, Roviglione G, Pesci A, Quintana S, Bruni F, Clarizia R. Total laparoscopic hysterectomy of very enlarged uterus (3030 g): and review of the literature. Videosurgery Other Miniinvasive Tech [Internet]. 2014;2:302–7. Available from: http://www.termedia.pl/doi/10.5114/wiitm.2014.43026.
42. Roman H, Zanati J, Friederich L, Resch B, Lena E, Marpeau L. Laparoscopic hysterectomy of large uteri with uterine artery coagulation at its origin. JSLS. 12:25–9.
43. Woodruff AJ, Roth CC, Winters JC. Abdominal sacral colpopexy: surgical pearls and outcomes. Curr Urol Rep. 2007:399–404.

44. Winters JC, Cespedes RD, Vanlangendonck R. Abdominal sacral colpopexy and abdominal enterocele repair in the management of vaginal vault prolapse. Urology. 2000;56:55–63.
45. Ganatra AM, Rozet F, Sanchez-Salas R, Barret E, Galiano M, Cathelineau X, et al. The current status of laparoscopic sacrocolpopexy: a review. Eur Urol. 2009:1089–105.
46. Maher C, Feiner B, Baessler K, Schmid C. Surgical management of pelvic organ prolapse in women. [Internet]. Cochrane Database Syst Rev 2013. p. CD004014. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24368487.
47. Farthmann J, Watermann D, Erbes T, Roth K, Nanovska P, Gitsch G, et al. Functional outcome after pelvic floor reconstructive surgery with or without concomitant hysterectomy. Arch Gynecol Obstet [Internet]. 2014;291:573–7. Available from: http://link.springer.com/10.1007/s00404-014-3435-x.
48. Marschalek J, Trofaier M-L, Yerlikaya G, Hanzal E, Koelbl H, Ott J, et al. Anatomic outcomes after pelvic-organ-prolapse surgery—comparing uterine preservation with hysterectomy. Eur J Obstet Gynecol Reprod Biol [Internet]. 2014;183:33–6. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0301211514005351.
49. Hampton T. Use of morcellation to remove fibroids scrutinized at FDA hearings. JAMA. 2014;13(3126):588.
50. ACOG. ACOG Releases Special Report; Power Morcellation and Occult Malignancy in Gynecologic Surgery. 2014.
51. Ebner F, Friedl TW, Scholz C, Schochter F, Janni W, Vorwerk E, deGregorio N. Is open surgery the solution to avoid morcellation of uterine sarcomas? A systematic literature review on the effect of tumor morcellation and surgical techniques. Arch Gynecol Obstet. 2015;292:499. Epub ahead.
52. Beckmann MW, Juhasz-Böss I, Denschlag D, Gaß P, Dimpfl T, Harter P, et al. Surgical methods for the treatment of uterine fibroids – risk of uterine sarcoma and problems of morcellation: position paper of the DGGG. Geburtshilfe Frauenheilkd [Internet]. 2015;75(2):148–64. Available from: https://www.thieme-connect.com/DOI/DOI?10.1055/s-0035-1545684.
53. Lin K-H, Torng P-L, Tsai K-H, Shih H-J, Chen C-L. Clinical outcome affected by tumor morcellation in unexpected early uterine leiomyosarcoma. Taiwan J Obstet Gynecol [Internet] 2015;54(2):172–7. Available from: http://linkinghub.elsevier.com/retrieve/pii/S1028455915000467.
54. Cohen SL, Einarsson JI, Wang KC, Brown D, Boruta D, Scheib S A. et al. Contained power morcellation within an insufflated isolation bag. Obstet Gynecol [Internet]. 2014;124:491–7. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00006250-201409000-00003.
55. Khavanin N, Lovecchio FC, Hanwright PJ, Brill E, Milad M, Bilimoria KY, et al. The influence of BMI on perioperative morbidity following abdominal hysterectomy. Am J Obstet Gynecol. 2013;208:499.e1–6.
56. Rimbach S, Neis K, Solomayer E, Ulrich U, Wallwiener D. Current and future status of laparoscopy in gynecologic oncology. Geburtshilfe Frauenheilkd [Internet] 2014;74:852–9. Available from: http://www.thieme-connect.de/DOI/DOI?10.1055/s-0034-1383075.
57. Nezhat FR, Pejovic T, Finger TN, Khalil SS. Role of minimally invasive surgery in ovarian cancer. J Minim Invasive Gynecol. 2013:754–65.
58. Griffiths C. Surgical resection of tumor bulk in the primary treatment of ovarian carcinoma: seminar on ovarian cancer. J Natl Cancer Inst Monogr. 1975;42:101.
59. Griffiths CT, Parker LM, Fuller FA. Role of cytoreductive surgical treatment in the management of advanced ovarian cancer. Cancer Treat Rep. 1979;63(2):235.
60. Hacker NF, Berek JS, Lagasse LD, et al. Primary cytoreductive surgery for epithelial ovarian cancer. Obs Gynecol. 1983;61:413.
61. Abu-Rustum NR, Gemignani ML, Moore K, Sonoda Y, Venkatraman E, Brown C, et al. Total laparoscopic radical hysterectomy with pelvic lymphadenectomy using the argon-beam coagulator: pilot data and comparison to laparotomy. Gynecol Oncol. 2003;91:402–9.
62. Frumovitz M, Dos Reis R, Sun CC, Milam MR, Bevers MW, Brown J, et al. Comparison of total laparoscopic and abdominal radical hysterectomy for patients with early-stage cervical cancer. Obstet Gynecol. 2007;110:96–102.
63. Wright JD, Herzog TJ, Neugut AI, Burke WM, Lu YS, Lewin SN, et al. Comparative effectiveness of minimally invasive and abdominal radical hysterectomy for cervical cancer. Gynecol Oncol. 2012;127:11–7.
64. Van de Lande J, von Mensdorff-Pouilly S, Lettinga RG, Piek JM, Verheijen RH. Open versus laparoscopic pelvic lymph node dissection in early stage cervical cancer: no difference in surgical or disease outcome. Int J Gynecol Cancer [Internet]. 2012;22:107–14. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21857347
65. Geetha P, Nair MK. Laparoscopic, robotic and open method of radical hysterectomy for cervical cancer: a systematic review. J Minim Access Surg [Internet] 2012;8:67–73. Available from: https://www.ncbi.nlm.nih.gov/pubmed/22837592/, http://www.journalofmas.com/article.asp?issn=0972-9941;year=2012;volume=8;issue=3;spage=67;epage=73;aulast=Geetha/, http://media.proquest.com/media/pq/classic/doc/2715987321/fmt/pi/rep/NONE?hl=&cit:auth=Geetha
66. Zullo F, Falbo A, Palomba S. Safety of laparoscopy vs laparotomy in the surgical staging of endometrial cancer: a systematic review and metaanalysis of randomized controlled trials. Am J Obst Gynecol. 2012;207(2):94–100.
67. Galaal K, Fisher A, Kew F, Lopes A. Laparoscopy versus laparotomy for the management of endometrial cancer. Cochrane Database of Syst Rev 2007.(9):CD006655
68. Walker JL, Piedmonte MR, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS, et al. Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: gynecologic oncology group study LAP2. J Clin Oncol. 2009;27:5331–6.
69. Walker JL, Piedmonte MR, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS, et al. Recurrence and survival after random assignment to laparoscopy versus laparotomy for comprehensive surgical staging of uterine cancer: Gynecologic Oncology Group LAP2 study. J Clin Oncol. 2012;30:695–700.
70. Cosson M, Rajabally R, Querleu D, Crepin G. Hysterectomy: Indications, surgical routes, cases for adnexal or cervical conservation Eur J Obstet Gynecol Reprod Biol. 1998.;80(1); 5–15.
71. Dargent D, Rudigoz RC. Vaginal hysterectomy. Our experience between the years 1970 to 1979 (556 operations) (author's transl). J Gynecol Obstet Biol Reprod (Paris). 1980;9(8):895–908.
72. Bronitsky C, Payne RJ, Stuckey S, Wilkins D. A comparison of laparoscopically assisted vaginal hysterectomy vs traditional total abdominal and vaginal hysterectomies. J Gynecol Surg. 1993;9(4):219–25.
73. Cosson M, Querleu D, Subtil D, Switala I, Buchet B, Crepin G. The feasibility of vaginal hysterectomy. Eur J Obstet Gynecol Reprod Biol. 1996;64(1):95–9.
74. Sculpher M, Manca A, Abbott J, Fountain J, Mason S, Garry R. Cost effectiveness analysis of laparoscopic hysterectomy compared with standard hysterectomy: results from a randomised trial. BMJ (Clinical research ed.). 2004;328(7432):134.
75. Rosero EB, Kho KA, Joshi GP, Giesecke M, Schaffer JI. Comparison of robotic and laparoscopic hysterectomy for benign gynecologic disease. Obstet Gynecol [Internet] 2013;122(4):778–86. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24084534.
76. Wright JD, Ananth C V, Lewin SN, Burke WM, Lu YS, Neugut AI, et al. Robotically assisted vs laparoscopic hysterectomy among women with benign gynecologic disease. JAMA [Internet] 2013;309(7):689–98. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23423414\nhttp://jama.jamanetwork.com/data/Journals/JAMA/926413/joc130005_689_698.pdf.

Abdominal Hysterectomy: Preparation

81

Siew Fei Ngu and Karen K.L. Chan

Introduction

Abdominal hysterectomy is a major operation and can significantly impact on a woman's physical as well as mental wellbeing. Therefore, it is paramount that health care professionals should take all necessary precautions to ensure a successful surgical outcome with minimal morbidity and mortality. Additionally, it is important to allow adequate time for preparation prior to surgery. Each patient should be carefully assessed by both the surgeons and the anaesthesiologists before the operation. Close collaboration with other medical specialists may also be necessary in order to optimize the patient's pre-existing medical conditions.

The objectives of preoperative preparation include:

1. To ensure that the indication for the procedure is valid
2. To ensure patient is medically fit to undergo the procedure
3. To ensure precautions are taken to minimize risks of complications
4. To ensure the availability of extra resources that may be needed in the preoperative, intraoperative and postoperative period
5. To ensure that the patient understands the nature of the procedure and its benefits and risks

These objectives may be accomplished with the following preparation:

1. Assess the condition
   (a) What is the condition? What is the extent of the condition? Is surgery indicated for the condition?
   (b) Review medical history (e.g. patient's symptoms) and investigation results (e.g. imaging, histology)
2. Assess the patient
   (a) General condition (e.g. age, effect of the current disease)
   (b) Pre-existing medical condition, medications, allergies
   (c) Possibility of pregnancy (e.g. last menstrual period, contraception, pregnancy test)
3. Assess the need for resources
   (a) Need for involvement from other specialties
   (b) Need for special equipment or instrument
   (c) Need of extra postoperative care (e.g. intensive care bed)
4. Communication with the patient and her family
   (a) Counseling and written information sheet
   (b) Informed consent for the procedure

Medical History

A comprehensive medical history must be obtained, and should include current and past medical disease with specific questions to assess the performance status. Systematic physical examination is necessary to detect any signs of coexisting illnesses. The indications for preoperative investigations would depend on patient's age, diagnosis and risk of the procedure based on detailed history and physical examination. The baseline pre-operative investigations for abdominal hysterectomy should include complete blood count, and blood group and antibody screen. For some patients (e.g. oncologic patient), coagulation profiles, liver and renal function test, blood glucose level and chest X-ray may be necessary. Pregnancy test should be preformed shortly before surgery on all fertile women who could be pregnant. Electrocardiogram may be required in selected patients. Specific precautions and evaluation should be individualized, taking associated conditions and comorbidities into consideration. The guideline for some of the preoperative tests and its indications that is used in our unit is shown in Table 81.1. The general physical status is commonly classified according to the American

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Table 81.1 Indications of preoperative investigations for elective surgery

1. Complete blood count
(a) Age > 60 years
(b) History or physical examination suggesting anaemia
(c) Known cardiac, pulmonary or renal disease, malignancy
(d) As baseline when heavy blood loss is anticipated
(e) Bleeding tendency as evidenced by history or physical examination
(f) Suspicious of infection
2. Coagulation profile (INR and APTT)
(a) Patient on warfarin or heparin
(b) Hepatic disease
(c) Bleeding tendency as evidenced by history or physical examination
3. Blood groups and antibody screen
(a) When heavy blood loss or transfusion is anticipated
4. Liver function test
(a) Hepatic disease, hepatitis carrier, chronic alcoholic
(b) Bleeding tendency as evidenced by history or physical examination
(c) Anticoagulant therapy
(d) Malnourished patient, patient on total parenteral nutrition (TPN)
5. Renal function test
(a) Cardiac disease
(b) Renal disease
(c) Diabetes mellitus
(d) Patient on drugs that can cause electrolyte disturbances, (e.g. diuretics, ACE inhibitor, corticosteroids) or drugs whose level may be affected by renal function (e.g. digoxin)
(e) As baseline for major surgery (e.g. bowel resection, hepatectomy)
(f) Age > 60 years
(g) Positive urine albumin
(h) Patient on TPN
(i) Patient having bowel preparation for surgery
(j) Recent vomiting or diarrhoea
6. Blood glucose level
(a) Diabetes mellitus, adrenal disease
(b) On corticosteroid or TPN
(c) Positive urine glucose
7. Arterial blood gas
(a) Moderate or severe respiratory disease
(b) Morbid obesity
(c) Cyanotic congenital heart disease
8. Chest X-ray
(a) Known or suspected malignancy
(b) Patient with cardiac or irreversible pulmonary disease (not asthma) as evidenced by history or physical examination who have not had a chest X-ray in the past 6 months
(c) Close exposure (e.g. family member) to tuberculosis in the past year
9. Electrocardiogram (ECG)
(a) Age > 50 years
(b) Cardiac disease as evidenced by history or physical examination
(c) Patient with cardiac risk factors (e.g. hypertension, vulvular heart disease, diabetes mellitus)
Note: Not required if ECG performed within past 3 months and condition stable
10. Pulmonary function test
(a) Moderate or severe respiratory disease
(b) Previous pneumonectomy
(c) Spinal scoliosis
(d) Neuromuscular disease (e.g. muscular dystrophy)

Table 81.1 (continued)

11. Cervical spine X-ray
(a) Down's syndrome
(b) Rheumatoid arthritis – require flexion and extension view
12. Pregnancy testing
(a) Routine for all women of childbearing age with possibility of pregnancy

Table 81.2 American Society of Anesthesiologists Physical Status Classification System

Classification	Definition
ASA I	Normal healthy patient
ASA II	Patient with mild systemic disease
ASA III	Patient with severe systemic disease
ASA IV	Patient with severe systemic disease that is a constant threat to life
ASA V	Moribund patient who is not expected to survive without the operation
ASA VI	Declared brain-dead patient whose organs are being removed for donor purposes

The addition of "E" denotes Emergency surgery

Table 81.3 Risk factors for perioperative major adverse cardiac events

Coronary artery disease
Unstable angina
<60 days after myocardial infarction (in the absence of coronary intervention)
History of cerebrovascular disease
Clinical heart failure or history of heart failure
Cardiomyopathy
Vulvular heart disease
Arrhythmias and conductive disorders
Pulmonary vascular disease (pulmonary hypertension)
Adult congenital heart disease

Society of Anesthesiologists (ASA) Physical Status Classification System (Table 81.2) [1].

Cardiovascular Risk

The American College of Cardiologist (ACC) and American Heart Association (AHA) Task Force has published a guideline on Perioperative Cardiovascular evaluation and management of patients undergoing noncardiac surgery [2]. The risk of perioperative major adverse cardiac events (myocardial infarction or death) can be predicted by assessing the clinical (Table 81.3) and surgical risks. The risk of perioperative major adverse cardiac events in patients undergoing noncardiac surgery can be predicted using a validated risk-prediction tool. For patients with a low risk of perioperative major adverse cardiac events, further investigations are not recommended before the scheduled surgery. However, patients with increased risk of perioperative cardiac complications should have cardiologist consultation and further investigations, which may include 12-lead electrocardiogram, echocardiography, assessment of left ventricular function (most commonly left ventricular ejection fraction), exercise testing with cardiac imaging and coronary angiography. It is important that the patients' condition is optimized preoperatively and this may require initiation or adjustment of medications or even cardiac interventions. In the past, patients at risk of infective endocarditis were given antibiotic prophylaxis before dental and certain nondental interventional procedures. However, the British Society for Antimicrobial Chemotherapy Guidelines for the prevention of endocarditis [3] and the American Heart Association Guideline on Prevention of infective endocarditis [4] recommended changes in clinical practice. Currently, antibiotic prophylaxis against infective endocarditis is not recommended for patients undergoing gynaecological procedures.

Hypertension

Hypertension is defined by World Health Organisation (WHO) as persistent elevation of blood pressure greater than 140/90 mmHg. Most patients with stable controlled diastolic blood pressure of less than 110 mmHg will tolerate surgery

without cardiac complication. Antihypertensive drugs should be taken up to the time of surgery and resumed early in the postoperative period.

Respiratory Risks

The risk of postoperative complications will be increased in patients with poor pulmonary function. It is therefore best to optimize the lung function preoperatively. Risk factors that predispose patients to pulmonary complications postoperatively include advanced age, smoking, obesity and known pulmonary disease. Smoking should be stopped for at least 4 weeks prior to surgery. Preoperative smoking cessation may also decrease wound complications. In patients with mild chronic obstructive airway disease and asthma, pulmonary status can be assessed using a simple peak flow meter. Patients with more severe impairment should have arterial blood gas analysis and pulmonary function tests. Adjustment of the bronchodilators and corticosteroids may be necessary to improve the control.

Diabetes Mellitus

The stress of surgery and anaesthesia could interfere with the glycaemic control in diabetic patients by increasing the production of catabolic hormones. This would induce glycogenolysis and gluconeogenesis, leading to hyperglycaemia. Hyperglycaemia impairs neutrophil functions and increases the risk of infection and wound complications. Consequently, the diabetic control should be maintained to as near to normoglycaemic range as possible. Table 81.4 describes the perioperative management for diabetic women on oral hypoglycaemics used in our unit. For those who are on insulin or have poorly controlled diabetes, review by the endocrinologists before surgery should be considered.

Anaemia

Anaemia is a common finding in patients undergoing hysterectomy for abnormal uterine bleeding (e.g. uterine fibroid with heavy menstrual flow). During preoperative preparation these patients should be identified and managed accordingly. Strategies to correct anaemia preoperatively include iron supplementation, medical treatment for heavy menstrual flow (e.g. suppression of menses with progestins or gonadotrophin-releasing hormone analogues), blood transfusion and erythropoiesis-stimulating agents.

Prophylactic Antibiotics

Abdominal hysterectomy carries a significant risk of infection, including surgical site infection (wound infection, pelvic infection, vaginal cuff cellulitis), urinary tract infection and septicaemia. Prophylactic antibiotics have been shown to reduce the risk of infection in women undergoing hysterectomy by half [5]. The choice of antibiotics depends on the likely infective organisms as well as local microbiological recommendations and cost. The agent must be given in a way that enables adequate serum and tissue levels before incision is made. Moreover, the therapeutic levels of the agent in serum and tissue should be maintained during surgery and for a few hours after the incision is closed. Cephalosporins are the most commonly used and studied antimicrobials for prophylaxis in abdominal hysterectomy. The recommended regimen for women undergoing abdominal hysterectomy is a single intravenous dose of cefazolin 1 g administered 15–60 min prior to the procedure or at induction of anaesthesia [6]. Other options of antibiotics are listed in Table 81.5. If bowel resection is expected or there is increased risk of bowel injury, e.g. from dense adhesions in endometriosis or ovarian debulking surgery, then additional antibiotics to cover anaerobes

Table 81.4 Perioperative management of women on oral hypoglycaemics

1. Place patient as first case in the morning.	
2. Omit oral hypoglycaemic agents on the day of operation.	
3. Check glucose level (Hemastix) just before the operation.	
4. For procedure lasting more than 1 h, start dextrose-insulin-potassium (DKI) infusion: 500 ml of 5 % dextrose with 6–8 units of actrapid and 10 mmol potassium chloride over 8 h. Potassium requirement should be adjusted according to the patient's pre-operative potassium level.	
5. Check glucose level every 4 h with the use of sliding scale (see below) in the postoperative period.	
6. Resume oral hypoglycaemiscs when the patient is feeding well postoperation	
Sliding scale:	
Glucose level (every 4 h)	*Actrapid (units) subcutaneously (every 4 h)*
<5	Consider reducing insulin dose in the DKI infusion
5–10	0
10.1–15	4
15.1–20	8
>20	12 and adjust insulin dose in DKI infusion

Table 81.5 Antibiotic prophylaxis for abdominal hysterectomy

Antibiotic agents (*given as single dose intravenously)*
Cefazolin 1–2 g
Cefotetan 1–2 g
Cefoxitin 1–2 g
Cefuroxime 1.5 g
Ampicillin/sulbactam 1.5–3 g
Alternative agents for patients with penicillin allergy
Clindamycin 600 mg plus gentamicin 1.5 mg/kg
Metronidazole 500 mg plus gentamicin 1.5 mg/kg
Ciprofloxacin 400 mg
Levofloxacin 500 mg
Moxifloxacin 400 mg

such as metronidazole may be administered. If patients have history of penicillin allergy, then clindamycin or metronidazole plus gentamicin or fluoroquinolone (levofloxacin, ciprofloxacin or moxifloxacin) may be used. Additional dose of prophylactic antibiotic may be given 3–4 h after the initial dose for prolonged surgery (>3 h) or when there is large blood loss (>1500 ml). In patients who are morbidly obese (BMI > 35), the antibiotic dosage may be doubled (e.g. cefazolin 2 g IV). Patient known to have bacterial vaginosis should be treated with metronidazole prior to undergoing hysterectomy.

Bowel Preparation

For surgery with high risks of bowel injury or that may require bowel resection, there is no significant evidence that patients benefit from mechanical bowel preparation or use of rectal enemas. Omission of mechanical bowel preparation has not been found to increase the risks of anastomotic leakage or wound infection in patients undergoing elective colorectal surgery [7], but it should be interpreted with cautious in the context of complex gynaecological surgery. Therefore, in selected patients, rectal enema may be given the night before surgery to prevent a loaded colon limiting access to pelvic surgery and to facilitate retraction of bowel away from the pelvis. Furthermore, bowel preparation may be considered in patients undergoing abdominal hysterectomy for gynaecologic cancers (especially ovarian cancer) and severe endometriosis, especially when pre-operative imaging suggests bowel involvement.

Thromboprophylaxis

Patients undergoing major gynaecological surgery are at increased risk of developing postoperative venous thromboembolism (VTE), with a 16 % risk of developing deep venous thrombosis and a 1 % risk of developing symptomatic pulmonary embolism in patients not receiving thromboprophylaxis [8]. Risk factors that may increase the risk of developing VTE are listed in Table 81.6. Thromboprophylaxis is recommended for patients undergoing gynaecological surgery who are considered to be at increased risk of VTE. Low dose unfractionated heparin or low molecular weight heparin (LMWH) has been shown to be effective at reducing the risk of VTE (Table 81.7). However, the administration of thromboprophylaxis to reduce the risk of VTE must be balanced against potential risk of major perioperative bleeding. The thromboprophylaxis may be continued for up to one week or until the patient is fully mobile. For selected patients undergoing major abdominal or pelvic surgery who are at high risk of developing postoperative VTE (e.g. patients undergoing major cancer surgery), prolonged administration of thromboprophylaxis for 4 weeks with LMWH should be considered [9]. Additional use of graduated compression stockings or other mechanical devices, such as intermittent pneumatic compression should be considered following major gynaecological surgery, especially if pharmacological thromboprophylaxis is contraindicated (e.g. patients with high risk of major bleeding) [10]. It is also important to encourage mobilization as soon as possible and to avoid dehydration (unless clinically indicated). The risk of postoperative VTE may also vary in different racial groups, thus the need of thromboprophylaxis should be assessed balancing the risk of VTE in the local population. Patients taking oestrogen-containing contraception or hormone replacement therapy should be advised to stop 4 weeks before scheduled surgery. In these patients, advise on alternative contraceptive methods should be provided to avoid possibility of unplanned pregnancy. For patients who are on long-term antiplatelet therapy (e.g. aspirin), the risks and benefits of stopping the drugs 1 week prior to surgery should be considered and if necessary advise from relevant specialist should be sought.

Table 81.6 Risk factors for venous thromboembolism

Age over 60 years
Previous VTE or first degree relative with VTE
Known thrombophilias
Obesity (BMI > 30)
Active malignancy or undergoing surgery for malignancy
Acute surgical admission with inflammatory or intra-abdominal disease
Prolonged surgery: Total anaesthetic and operation time > 90 min, or > 60 min if operation involves pelvis or lower limb
Reduced mobility
Intensive care admission
Dehydration
Use of oestrogen-containing contraception or hormone replacement therapy
Significant medical comorbidities (e.g. heart disease, metabolic, endocrine or respiratory disease, acute infection or inflammatory condition)
Varicose veins with phlebitis
Pregnancy and up to 6 weeks postpartum

Table 81.7 Thromboprophylaxis for abdominal hysterectomy

Low-dose unfractionated heparin 5000 U every 8 to 12 hourly (may start 2 h before surgery; for patients with renal failure)
Low molecular weight heparin Enoxaparin 40 mg daily Dalteparin 2500 U daily
Graduated compression stockings
Intermittent pneumatic compression devices

Obtaining Informed Consent

An inform consent involves a process of shared understanding and decision making between patient and clinician [11]. Prior to obtaining a woman's consent for operation, the clinician should ensure that she is fully informed, understands the nature of the disease for which it is being proposed, its prognosis, likely consequences and the risks of not receiving treatment, as well as any possible alternative treatments. In addition, the patient should be informed of possible complications, and that additional treatment for complications or unexpected findings may be required. Any uncertainties that the woman may have about the treatment of the condition should be explored. In preparing women for hysterectomy, the clinician should remember that this process might be stressful for them. Therefore, it is important for the clinician to provide information and obtain consent in an appropriate manner, taking individual needs of the women under consideration. For example, some women would prefer to involve their family members in the discussion and the process of seeking consent for the operation, while others choose to keep the information to themselves. A written information sheet on the intended operation is usually provided for the patient. The information should be in a language that the patient can understand. A written consent form is then signed by the patient and the doctor who provided the explanation of the procedure, ideally in the presence of a witness who is often a nursing staff and this is filed in the patient's medical records.

Geriatric Patient

Although age alone should not be a limiting factor in the decision for surgery, older patients may have multiple comorbid conditions that limit their functional capacity and recovery and increase the risk of morbidity and mortality. In addition to coronary artery disease, hypertension, congestive heart failure, pulmonary disease, renal impairment and diabetes mellitus, older patients have increased risk of nutritional deficiencies, impaired cognition and may have limited support at home. Older patients undergoing abdominal hysterectomy have increased operative risks especially cardiovascular, respiratory, thromboembolic and infectious complications. A thorough preoperative assessment including detailed medical and drug history is important for these patients in order to identify risk factors and optimise their status. Furthermore, to ensure adequate informed consent in elderly person, especially in those who have impaired mental status, the family member or the legal guardian should be informed about the procedure and any potential complications.

Obesity

Obesity (BMI ≥ 30) is associated with coronary artery disease, hypertension, dyslipidaemia, diabetes mellitus, obstructive sleep apnoea, obesity hypoventilation syndrome, reflux oesophagitis and osteoarthritis. Therefore, obese patients undergoing abdominal hysterectomy have increased surgical risks especially cardiovascular, respiratory and thromboembolic risks, as well as infectious complications. Additionally, they present significant challenges to the anaesthesiologists, which make early detailed preoperative anaesthetic assessment mandatory. The perioperative management of these patients also poses significant organisational and practical challenges. Patients who are obese may also require special operating tables and transfer trolleys that can accommodate their weight, and special surgical instruments (e.g. longer clamps, retractors). These patients may require intensive care beds in the early postoperative period and should ideally be arranged before the surgery. Obese patients should receive thromboprophylaxis and be encouraged to mobilise early to reduce the risk of venous thromboembolism.

Universal Protocol

The Universal Protocol was designed to prevent wrong patient, wrong procedure and wrong site surgery. It consists of a preoperative verification of the patient's identifying information, surgical site marking to prevent wrong site procedures, and a presurgical "time out" immediately prior to starting the planned procedure. Furthermore, the time out was recently extended to include the need for preoperative antibiotics and other essential medications (e.g. corticosteroid), the verification of correct patient positioning and availability of relevant documents, diagnostic images, instruments and implants. This protocol is applicable in the operating room as well as in clinical setting outside the operating room where invasive procedure requiring a patient's consent is performed.

Summary

Good preoperative care will minimise the complications from the operation as well as psychological distress caused.

References

1. American Society of Anesthesiologists. ASA physical status classification system. 2014 [cited 8 November 2015]; Available from: https://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system.
2. Fleisher LA, Fleischmann KE, Auerbach AD, Barnason SA, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. Developed in collaboration with the American College of Surgeons, American Society of Anesthesiologists, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and Society of Vascular Medicine Endorsed by the Society of Hospital Medicine. J Nucl Cardiol. 2015;22:162–215.
3. Gould FK, Elliott TS, Foweraker J, Fulford M, et al. Guidelines for the prevention of endocarditis: report of the Working Party of the British Society for Antimicrobial Chemotherapy. J Antimicrob Chemother. 2006;57:1035–42.
4. Wilson W, Taubert KA, Gewitz M, Lockhart PB, et al. Prevention of infective endocarditis: guidelines from the American Heart Association: a guideline from the American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. Circulation. 2007;116:1736–54.
5. Marjoribanks J, Calis KA, Jordan V. Antibiotic prophylaxis for elective hysterectomy. Cochrane Database Syst Rev 2004:CD004637.
6. Van Eyk N, van Schalkwyk J, Infectious Diseases C. Antibiotic prophylaxis in gynaecologic procedures. J Obstet Gynaecol Can. 2012;34:382–91.
7. Guenaga KF, Matos D, Wille-Jorgensen P. Mechanical bowel preparation for elective colorectal surgery. Cochrane Database Syst Rev. 2011:;(9):CD001544.
8. National Clinical Guideline Centre – Acute and Chronic Conditions (formerly the National Collaborating Centre for Acute Care). Venous thromboembolism: reducing the risk of venous thromboembolism (deep vein thrombosis and pulmonary embolism) in patients admitted to hospital. 2010 [cited 8 November 2015]; Available from: http://www.nice.org.uk/guidance/cg92.
9. Rasmussen MS, Jorgensen LN, Wille-Jorgensen P. Prolonged thromboprophylaxis with low molecular weight heparin for abdominal or pelvic surgery. Cochrane Database Syst Rev. 2009;(1):CD004318.
10. Clarke-Pearson DL, Abaid LN. Prevention of venous thromboembolic events after gynecologic surgery. Obstet Gynecol. 2012;119:155–67.
11. Royal College of Obstetricians & Gynaecologists. Obtaining valid consent. Clinical Governance Advice No. 6. 2015 [cited 8 November 2015]; Available from: https://www.rcog.org.uk/globalassets/documents/guidelines/clinical-governance-advice/cga6.pdf.

Abdominal Hysterectomy: Instrumentation and Apparatuses

82

Siew Fei Ngu and Karen K.L. Chan

Introduction

Various surgical instruments are required to perform abdominal hysterectomy and surgeons must know the applications and limitations of the instruments. The aim of this chapter is to review the basic surgical instruments that are required for most abdominal hysterectomy and it is not intended to be a comprehensive list of all instruments available. The instruments included in this chapter are commonly used in our hospital for abdominal hysterectomy.

Scalpel

The first instrument used in abdominal hysterectomy is scalpel, which consists of a handle (Fig. 82.1) and disposable blade (Fig. 82.2). Scalpel blades are available in different shapes and sizes, commonly referred to blade number. The larger blades are used to rapidly perform an incision, while the smaller blades are used for making small incision and are safer when used in tight operative field (Table 82.1).

Scissors

The scissors are used to divide tissue. Apart from cutting, it can be used for blunt dissection by inserting the tips into a tissue plane and then opening the scissors. The scissors used in abdominal hysterectomy includes Mayo, Metzenbaum, Mayo-Harrington and Monaghan (Fig. 82.3). The scissors come with either straight or curved blades, and may have rounded or sharp tips. Mayo scissors have rounded tips, which can reduce accidental injury of tissue and are used to divide thick tissue (e.g. rectus sheath, vaginal cuff). Metzenbaum scissors are more delicate and have relatively shorter blades in proportion to the shafts compared to Mayo scissors. Metzenbaum scissors can be used to cut thinner tissue (e.g. peritoneum, adhesions) and to develop tissue planes in adherent or distorted tissue. Suture scissors are used to cut suture.

Needle Holders

A needle holder is used to hold curved needles as it passed through tissue. It is available in different sizes, depending on the size of needle used, and different lengths, depending on type of surgery performed. For most abdominal hysterectomy, the eight inch needle holder is suitable. Needle holders come in straight or curved version. Common types of needle holders used in abdominal hysterectomy are Ryder (straight) and Heaney (curved) (Fig. 82.4). Curved needle holders are useful in vaginal surgery where the angled head permits easier needle placement.

Tissue Forceps

Tissue forceps are used to grasp and hold tissue during cutting, dissection and suturing. It is available in various shapes and configuration, depending on its purpose (Fig. 82.5). The tissue forceps can be smooth or toothed. Smooth forceps are used to hold delicate and friable tissue, while toothed forceps are used to bite into tissue allowing a firm grasp with



Fig. 82.1 Bard-Parker handle

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Fig. 82.2 Surgical scalpel blades (from *left* to *right*): No. 10, 11, 15, 22

Table 82.1 Role of scalpel blades in abdominal hysterectomy

Scalpel blades	Site of incisions
10	Hysterectomy pedicles Vaginal vault
11	Stab skin incisions (e.g. for drains) Incision and drainage procedure
15	Small skin incision (e.g. for drains)
20 or 22	Abdominal incision

minimal pressure. Ramsey tissue forceps are used for handling fascia (e.g. during sewing of rectus sheath). Adson forceps are usually used to approximate skin during placement of suture or staple. DeBakey forceps have fine long smooth tips that allow accurate control of delicate tissue deep in the pelvis. Other types of forceps commonly used during hysterectomy are Bonney, Russian, Martin and Potts-Smith forceps.

Clamps

Clamps can be used for grasping and applying traction to tissues (Figs. 82.6, 82.7, and 82.8). Babcock clamps are atraumatic and can be used to hold and grasp delicate tissues (e.g. fallopian tube, bowel) without causing injury. Allis forceps have serrated grasping surface and short teeth that will hold tissue firmly. During hysterectomy, it can be used to



Fig. 82.3 Scissors (from *left* to *right*): Straight Mayo, Curved Mayo, Metzenbaum, Mayo-Harrington



Fig. 82.4 Needle holders (from *left* to *right*): Ryder Fine, Ryder, Heaney CVD

grasp the anterior vaginal wall during entry into vagina. Littlewood and Lanes forceps have interlocking teeth at the tip that prevents slipping of tissues within the clamp and are usually used to grasp tough tissues (e.g. rectus sheath). Sponge holding forceps are used to hold folded sponges, which can function to retract tissue, soak fluid or blood, or apply antiseptic solution to the skin in preparation for operation. Ring forceps are used when a secure hold is required on tissues that would be traumatised by toothed forceps, or can also be used as sponge holding forceps.

Artery forceps (e.g. Birkett, Robert) are primarily used as haemostatic forceps to clamp vessels and allow ligation of those vessels. They can also be used to hold suture materials and grasp tissues. Robert artery forceps can be used to clamp the infundibulopelvic ligament during hysterectomy. Lahey forceps are right angle clamps and can be used to grasp vessels or for passing a ligature around a clamped pedicle. Kocker forceps are strong toothed tissue forceps used for grasping tough fascia (e.g. rectus sheath). They are available in straight and curved form, and have varying lengths. During hysterectomy, Kocker forceps can be placed immediately lateral to the uterus at each cornua to allow elevation, traction and rotation of the uterus.

Hysterectomy clamps are designed to control the rich vascular supply of the uterus during hysterectomy. There are numerous hysterectomy clamps available such as Moynihan, Ballentine and Heaney hysterectomy forceps (Table 82.2).



Fig. 82.5 Tissue forceps (from *left* to *right*): Ramsey-Toothed, Ramsey-Smooth, Adson-Toothed, Adson-Smooth, DeBakey



Fig. 82.6 Clamps (from *left* to *right*): Babcock, Littlewood, Lanes, Sponge holding forceps, Ring forceps



Fig. 82.7 Clamps (from *left* to *right*): Birkett artery forceps, Allis forceps, Lahey forceps



Fig. 82.8 Clamps (from *left* to *right*): Kocher forceps, Robert artery forceps, Moynihan hysterectomy forceps, Ballentine hysterectomy forceps

Table 82.2 List of clamps that may be used for abdominal hysterectomy

Hysterectomy pedicles	Clamps
Round ligament	Kocher
Uteroovarian ligament	Kocher, Heaney, Kelly
Infundibulopelvic ligament	Robert, Heaney, Kelly
Uterine vessels	Moynihan, Heaney (curved), Zeppelin
Cardinal ligament	Ballentine, Heaney (straight), Zeppelin
Vaginal fornix	Heaney (curved)



Fig. 82.9 Tenaculum (*left*), Vulsellum (*right*)

They are heavy crushing forceps with ridged shafts and are used to clamp the parametrial and paracervical tissues. Ideally, a hysterectomy clamp must be able to grasp and hold these tissues firmly until the pedicles are cut and ligated. Ballentine forceps have longitudinal serrations, which may be better for clamping the cardinal ligaments as this design reduce the risk of lateral slippage of tissue from the clamp.

Tenaculum and Vulsellum Forceps

During abdominal hysterectomy, tenaculum and vulsellum (Fig. 82.9) may be used to grasp the cervix to provide traction when cutting circumferentially around the vagina.

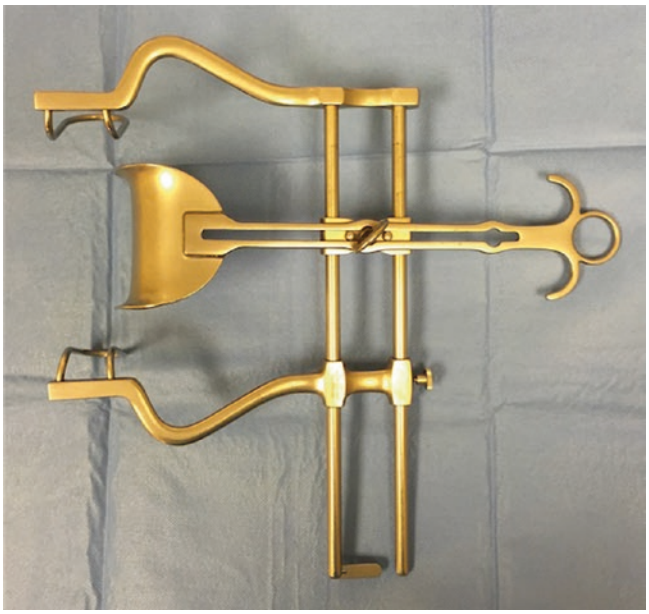


Fig. 82.10 Balfour self-retaining retractor

Tenaculum can also be used to grasp fibroid during myomectomy.

Retractors

Retractors are used to hold tissue out of the surgical field to improve exposure during operative procedures. Retractors can be manual (held by an assistant) or self-retaining (hold themselves in place). Balfour self-retaining retractor has two lateral blades and one additional retractor blade that can be used as bladder retractor or upper blade (Fig. 82.10). Bookwalter retractor is a self-retaining retractor that attaches to the operating table and consists of a circular ring to which a wide variety of retractors can be placed at any point. It is most useful for radical pelvic surgery or when operating on extremely obese patiens. Commonly used manual retractors during abdominal hysterectomy includes Deaver, Morris, Czerny and Malleable (Fig. 82.11).

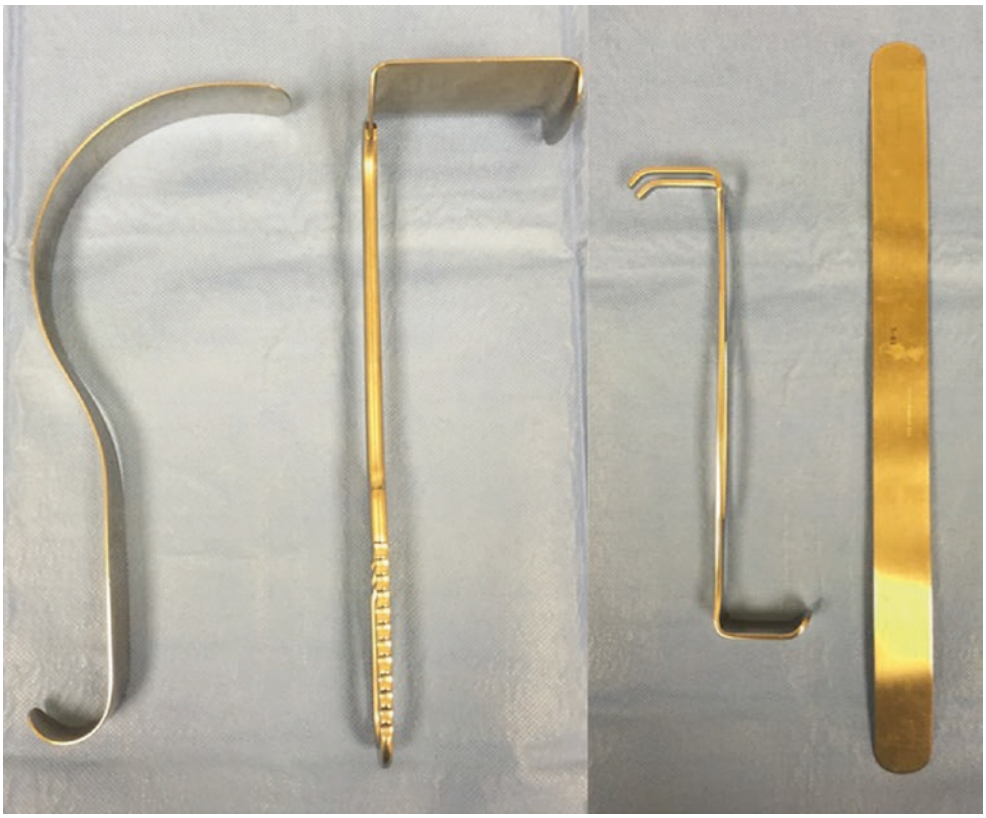


Fig. 82.11 Manual retractors (from *left* to *right*): Deaver, Morris, Czerny, Malleable

Needles and Sutures

Suture needles consist of the swage, the body and the point. Nowadays, most of the needles are swaged (eyeless) needles in which the suture is attached to the end of the needle, thereby forming a continuous unit. The body may be straight, half-curved or curved. Straight needles are designed for easily accessible tissues and can be used for skin closure during abdominal hysterectomy. Similarly, half-curved needles may also be used for skin closure. Curved needles facilitate passage of needle in confined space such as deep narrow pelvis. The curvature can range from 1/4, 3/8, 1/2 or 5/8 circle. The 1/2 circle is commonly used for hysterectomy pedicles, while 3/8 circle is frequently used for skin closure. The point of the needle comes in cutting, taper and blunt version. The cutting needle is usually used for cutting through though tissues (e.g. rectus sheath, skin). Taper point needles pierce and spread the tissue rather than cutting it, thus are used in easily penetrated tissues (e.g. peritoneum, bowel, bladder). Blunt point needles dissect through tissue and are usually used to prevent needle-stick injuries.

Suture material is designed to support the apposed tissue temporarily while allowing time for the tissues to recover enough tensile strength and maintain the apposition. The characteristics of an ideal suture include good tensile strength, flexible, easy to handle, provide adequate knot security, absorbable, inert, non-allergenic, atraumatic passage through tissue and resistance to infection. Sutures are available in natural or synthetic, absorbable or non-absorbable, and monofilament or multifilament types. Nowadays, natural materials (e.g. catgut, silk) have been mostly replaced with synthetic material. Compared to multifilament sutures (e.g. Vicryl), monofilament sutures (e.g. Monocryl, PDS, Ethilon, Prolene) have smooth surface, therefore produce less tissue trauma and reduce the risk of harboring microorganisms. Nonetheless, multifilament sutures are stronger and more flexible, allowing easier handling and knotting. Absorbable sutures (e.g. Vicryl, Monocryl, PDS) are used for temporary wound support, while non-absorbable suture (e.g. Ethilon, Prolene) provide permanent support in tissues that heal slowly (e.g. rectus sheath). Furthermore, sutures are divided into size based on their diameter, in which progressively larger size are numbered in increasing numerical order (e.g. 0, 1, 2), while progressively smaller size are indicated by increasing number of zeros (e.g. 0, 00 or 2/0, 000 or 3/0). Recently, some of the sutures are also available in antibacterial forms, which are aimed to reduce the risk of infection. Tables 82.2 and 82.3 shows the sutures or instruments that are commonly used for abdominal hysterectomy in our hospital.

Table 82.3 List of sutures/instruments that may be used for abdominal hysterectomy

Site	Sutures/instruments
Abdominal skin	MCP3213 – Ethicon Monocryl Plus Antibacterial Poliglecaprone 25, 3/0 gauge, PS 26 mm 3/8 circle cutting needle, 70 cm long. For subcuticular suture. MCP523 – Ethicon Monocryl Plus Antibacterial Poliglecaprone 25, 3/0 gauge, KS 60 mm cutting needle, 70 cm long. For subcuticular suture. W630 – Ethicon Prolene Polyprophylene, 3/0 gauge, KS 60 mm straight cutting needle, 75 cm long with beads and collars. For subcuticular suture. W795 – Ethicon Ethilon Polyamide 6, 2/0 gauge, KP-3 Conv 90 mm 3/8 circle cutting needle, 100 cm long. For interrrupted suture. Skin stapler
Rectus sheath	VCP371 – Ethicon Coated Vicryl Plus Antibacterial Polyglactin 910, CTX 48 mm 1/2 circle taper needle, 90 cm long. PDP9262 – Ethicon PDS Plus Antibacterial Polydioxanone, CTX 48 mm 1/2 circle taper needle, loop 150 cm)
Hysterectomy pedicles and vaginal vault	VCP9213 – Ethicon Coated Vicryl Plus Antibacterial Polyglactin 910, 1 gauge, MH-1 plus 31 mm 1/2 circle needle, 70 cm long. VCP247 – Ethicon Coated Vicryl Plus Antibacterial Polyglactin 910, 0 gauge, MH-1 plus 31 mm 1/2 circle needle, 70 cm long.

Electrosurgical Units

Nowadays, instruments that use electrosurgery or other energy source are commonly used for cutting and coagulation of tissues. Surgeons using this technique should understand the mechanism of action, how to prevent and mange potential complications and how to troubleshoot equipment. Electrosurgery employs high frequency electrical current to create heat within tissue cell to cut or coagulate tissue. The electrosurgical units available in operating theatre are used to produce high frequency electrical current, that does not stimulate muscle or nerve. The application of electrical current to tissue can result in vapourisation (cut), desiccation (coagulate deeply) or fulguration (coagulate superficially), depending on the setting of the electrosurgical units and the degree of contact between the tissue and surgical instrument. Dessication are created by direct contact of the instrument and the tissue, while fulguration and vapourisation are produced by holding the tip of the electrode at the tissue surface without direct contact.

The main output settings for the electrosurgical units are 'cutting' and 'coagulation'. With cutting mode, the electrosurgical units generates a continuous, low voltage current, concentrating the energy at a small area (high current density), resulting in rapid tissue heating, intense vibration within the cells and explosion of the cells (vapourisation). With coagulation mode, the electrosurgical units generates interrupted, high voltage current, dispersed over a large surface area (low current density), resulting in slower tissue heating compared to cutting mode, and dehydration effect (dessiccation). In addition, several "blend" modes are also available, utilising different proportion of cutting and coagulation currents. Blend modes improve the ability of cutting currents to coagulate small vessels during dissection, and coagulation currents to dissect tissue during haemostasis. Electrosurgery can be done with either a monopolar or a bipolar instrument (Table 82.4). During abdominal hysterectomy, electrosurgery can be used for abdominal incision, dissection of peritoneum or bladder, and vaginal vault incision.

Recently, a variety of more advanced electrosurgical devices are available such as Ligasure device, PlasmaKinetic tissue management system and Enseal. Furthermore, alternative energy sources have also been used, namely ultrasonic and laser energy. Examples of ultrasonic cutting and coagulating devices include Harmonic scalpel, Sonocision and Thunderbeat.

Table 82.4 Comparison of monopolar and bipolar electrosurgery

Monopolar electrosurgery	Bipolar elctrosurgery
Electrical current passes through a single electrode (e.g. cautery pencil) to the tissue	Electrical current passes between two electrodes (active and return) of a surgical instrument (e.g. forceps)
Electrical current passes through the patient and needs to exit the patient (through the least resistance path) to complete the current cycle	Electrical current is limited to the tissue between the two electrodes of a surgical instrument
A return elctrode pad (usually attached to the thigh of the patient during abdominal hysterectomy) is required for the current to exit the patient to complete the current cycle	A return electrode pad is not required
Possibility of alternate pathway for current flow which can be prevented by: Use of isolated generator system with return electrode pad Ensure return pad is applied properly to prevent skin burns Use of electrosurgical unit with sensors to detect poor contact Use lowest voltage necessary	Eliminate the possibility of alternate pathways for current flow
Avoid use in patients with implantable pacemakers/cardioverter defibrillators, cochlear implant or metal implant	Preferred in patients with implantable pacemakers/cardioverter defibrillators, cochlear implant or metal implant
May utilise either low voltage (cutting mode) or high voltage (coagulation mode) to achieve the desired tissue effect	Utilise low voltage (cutting mode) due to relatively low tissue impedence caused by vicinity of the two electrodes
Cutting mode: preferred when thermal spread is undesirable (e.g. adjacent to bowel or ureter) *Coagulation mode*: allows better penetration through high-resistance areas (e.g. adipose or scar tissue), preferred when fulgurating a large surface area with superficial bleeders	Less effective for cutting tissue as difficult to obtain adequate vaporization (may cause tissue to char and stick to surgical instrument)
Less effective for hemostasis: electrical current disperses within the blood causing inadequate tissue damage at the vessel lumen	Effective for hemostasis of vascular areas or small blood vessels of 3–7 mm (e.g. uterine artery)

Summary

Surgeons should know the applications and limitations of surgical instruments commonly used in abdominal hysterecomy.

Midline Laparotomy

83

Carol E.H. Scott-Conner

Vertical Versus Transverse Incisions

The ideal incision for laparotomy should provide adequate, if not excellent, access and exposure to the surgical field. It should be extensible, so that if unexpected findings were encountered at surgery, greater access could easily be achieved. Healing should be secure and relatively pain-free. Postoperative adhesion formation should be minimal, if not eliminated. The scar should be cosmetically acceptable. The healed incision should not hinder subsequent access to other parts of the abdomen for other purposes, or use of abdominal flaps for reconstructive surgery (for example, after mastectomy). It should permit stoma creation if necessary.

It should be obvious that no one single incision satisfies all of these criteria. This chapter (on midline laparotomy), and the chapter which follows (on transverse incisions), detail commonly used incisions for open gynecologic surgery and discuss the anatomy of the abdominal wall as it pertains to these procedures.

Advantages of Midline Incisions The vertical midline incision divides no major blood vessels or nerves; it can be made quickly and easily. It is easily extended from the lower midline up into the upper midline. Stomas can easily be sited on either side as needed. It is thus traditionally used for cancer surgery, where thorough and complete exploration and eradication of tumor deposits in the upper as well as the lower abdomen may be required.

Disadvantages of Midline Incisions Low transverse skin incisions such as the Pfannenstiehl and Maylard, low and hidden in a natural skin crease, provide excellent cosmetic outcomes. It has been proposed that these incisions may heal more securely than vertical incisions, and hence result in a decreased risk of hernia formation. In this respect, it is important to note that the Pfannenstiehl combines a transverse skin incision with a vertical midline fascial incision (see Chap. 75). It is thus a kind of hybrid incision.

The tantalizing proposition that transverse incisions might heal more securely is based largely upon observations that the overall pull of the abdominal wall muscles tends to distract vertical incisions, but runs parallel to transverse or oblique incisions. It has been difficult to demonstrate an advantage in individual trials using standard endpoints of "burst abdomen" or evisceration as a rare but catastrophic acute complication, and incisional hernia as a much more common and probably underreported event [1–4].

The aggregate evidence was considered strong enough, however, for the European Hernia Society [5] to issue a recommendation the "To decrease the incidence of incisional hernias it is strongly recommended to utilize a non-midline approach to a laparotomy whenever possible." Lack of systematic standardized follow up, including use of ultrasound to check for subclinical incisional hernias, has hampered progress in this area [5]. The pros and cons of the vertical midline incision, as compared with low transverse incisions, are summarized in Table 83.1.

Adhesions tend to form to the underside of any incision, and a long vertical midline incision may thus create a long line of adhesions which complicates subsequent abdominal access and may even result in postoperative small bowel obstruction. See Chap. 76 for further information on adhesions.

Implications for Subsequent Reconstructive Surgery (If Needed) While this is not a major consideration, it is worthy of discussion. Lower abdominal wall tissue is increasingly used in reconstructive surgery. Probably the most common application, and that familiar to most clinicians, is

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Table 83.1 Advantages and disadvantages of vertical midline incision, compared with low transverse incisions typically used for gynecologic surgery

Advantages of vertical midline incision	Disadvantages
Versatile – provides exposure of any intra-abdominal structure	May not heal as securely (may be more prone to hernia formation)
Extensile – an incision made in the lower midline is easily extended into the upper if pathology dictates	Scar is unsightly
Compatible with stoma creation	May be more painful in immediate postoperative period
Repeat laparotomy through same incision through same or other purpose is feasible	Adhesions forming to upper part of incision may be more problematic for repeat operation
	Divides tissues of lower abdomen used for TRAM flap reconstruction (if needed later)

autologous reconstruction after mastectomy. Because the breast cancer population comprises a significant subset of women, it is important that surgeons operating upon women understand how abdominal tissue is used for reconstruction.

Use of autologous tissue provides all the advantages of using the patient's own tissues (rather than an implant) and provides a bonus in the form of a "tummy tuck." It is important to understand how incision choice might influence later reconstructive options, should the woman require them [6].

A variety of autologous flaps have been described, but for purposes of this discussion it is important to focus on only two of these. These are the TRAM (transverse rectus abdominis muscle) and DIEP (deep inferior epigastric) flaps.

TRAM flaps take tissue from the lower abdomen, including one of the rectus abdominis muscles. Pedicled TRAM flaps derive their blood supply from the (preserved) superior epigastric artery. Free TRAM flaps require microvascular anastomosis of one of the arteries supplying the flap to an artery in the region. For many years, before microvascular free flap techniques were widely available, the pedicled TRAM flap was the workhorse flap for autologous reconstruction. Many general surgeons learned, to their dismay, that an open cholecystectomy incision (an oblique right upper quadrant incision paralleling the costal margin which completely divided the superior epigastric vessels and rectus muscle on that side), common in the pre-laparoscopic cholecystectomy era, rendered subsequent ipsilateral pedicled TRAM flap reconstruction impossible.

The TRAM is still commonly used, either as a pedicled or a free flap. However, concerns about abdominal wall function after loss of a rectus muscle have fueled interest in the DIEP flap as an alternative.

DIEP flaps are free flaps that transfer only skin and subcutaneous fat, leaving intact the rectus abdominis muscle. They require microvascular anastomosis to a suitable artery in the field.

Many considerations influence the choice of flap. The bulk of missing breast tissue relative to the tissue available in the donor site, unilateral versus bilateral, vascular health of the woman (diabetes, smoking, atherosclerotic disease), and presence or absence of scars on the abdomen all must be considered. It is noteworthy that previous panniculectomy also may be a factor [7].

A lower midline incision divides the skin and fatty tissue down the middle. Typically, the reconstructive surgeon will then split the tissue down the middle. This is not a problem in obese women, but may be problematic in slender individuals where abdominal fat is limited.

If the deep inferior epigastric vessels have been ligated during a previous low transverse incision, then a TRAM flap is still possible (indeed, division of these vessels is sometimes performed several weeks prior to flap creation, in order to stimulate the superior epigastric vessels to grow) but a DIEP flap will not be possible.

How does this affect choice of incision for a gynecologic surgeon? Obviously, the necessities of the operation at hand must dominate clinical decision-making. But simply keep this in mind: all other things being equal, design of these flaps is more difficult and choice of options more limited if a woman has had a lower midline incision or a transverse incision which divides rectus muscle and regional arteries than if she has had a classic Pfannenstiehl. From the reconstructive surgeon's perspective, a Pfannenstiehl incision causes the least disruption. Fortunately, this corresponds to the incision of choice for many gynecologic procedures. See Chap. 75 for additional considerations with low transverse incisions which divide the rectus muscles and/or inferior epigastric vessels.

Anatomy of the Abdominal Midline

Superficial fascia The superficial fascia of the anterior abdominal wall is primarily adipose tissue above the umbilicus. Below the umbilicus, superficial fatty and deeper membranous layers may be appreciated. The membranous layer may form a barrier to extravasation of fluid, and is often included in suture closure of a midline incision.

The superficial fatty layer is typically thicker below the umbilicus, and in morbidly obese individuals may form a huge, edematous, dependent pannus that hangs down below the pubic region. In such cases, the normally relatively avas-

cular fat may contain very large subcutaneous veins. There is a fusion plane in the midline and access to the midline fascia may be obtained, once the subcutaneous veins are controlled, by traction and counter-traction. This midline fusion plane is often seen on CT scans as a vertical septum. This fusion plane can be exploited by the surgeon and used as an aid to identification of the midline during laparotomy.

Linea alba In slender individuals, the midline linea alba may be visible as a linear indentation running from xiphoid to pubis. It is formed from decussating fibers of the aponeuroses of the external oblique, internal oblique, and transversus abdominis (Fig. 83.1).

The linea alba is more robust above the umbilicus than it is below, because these fibers form the bilateral anterior and posterior rectus sheaths which completely enclose these muscles. The posterior rectus sheath terminates about 1/3 of the way from umbilicus to pubis in the arcuate line. Below the arcuate line, the posterior sheath is composed only of transversalis fascia. Incising the linea alba in the lower midline thus frequently exposes both rectus muscles directly,

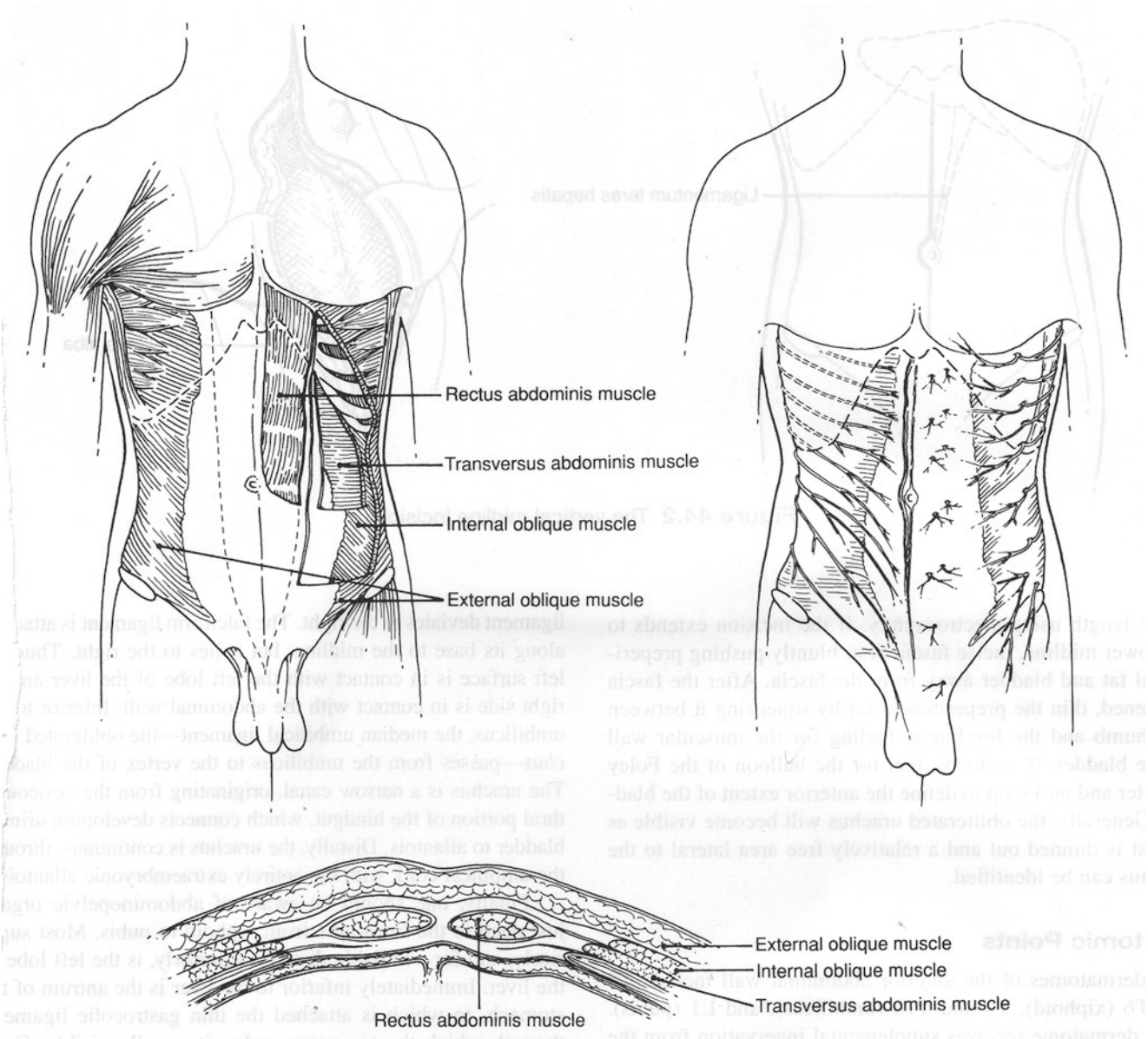


Fig. 83.1 The muscles and aponeurotic layers of the anterior abdominal wall. Laterally, the external oblique, internal oblique, and transversus abdominis muscle provide three strong muscle layers with fibers running in criss-crossing directions. Medially, these three muscles contribute aponeurotic fibers to the anterior and posterior rectus sheathes and form the decussating fibers of the linea alba (Reproduced from Fig. 44.1 Scott-Conner and Dawson [15], with permission)

sometimes creating the impression that the incision has deviated from the midline.

A very few small vessels and nerves pierce the linea alba to reach the skin, but no major vessels or nerves need be divided when an incision is made directly through this structure. Thus a major advantage of the midline incision is rapid, bloodless entry into the abdomen with no damage to motor or sensory nerves.

Muscles The paired, segmental rectus abdominis muscles originate from the pubis and run nearly vertically to insert upon the costal margin and xiphoid process. As they ascend, they become broader and the distance between them increases. They are encased within the strong fibrous rectus sheathes, which coalesce to form the midline linea alba as noted above. Segments of the rectus muscles are demarcated by fibrous inscriptions that create the appearance of a "six pack" on the abdominal wall of lean, muscular individuals. The inscriptions may be adherent to the rectus sheathes.

Each rectus muscle is innervated by multiple thoracoabdominal nerves, which approach obliquely from lateral to medial and run deep to the muscle in the rectus sheath [8]. This segmental innervation allows the rectus to be transected at any point without creating denervation and atrophy. The transected rectus simply forms another fibrous inscription as it heals. This property is exploited by general surgeons who create transverse or oblique incisions in the upper abdomen.

The blood supply comes from above and below. From above, the superior epigastric arteries pass on the deep aspect of the rectus. From below, the usually larger inferior epigastric arteries ascend deep to the rectus and enter the rectus sheath at the arcuate line. Typically the epigastric artery and vein anastomose, a feature exploited by reconstructive surgeons when they "delay" a flap by ligating the inferior epigastric artery. Small twigs of the lower six intercostal arteries also enter the rectus sheath from the lateral aspect.

All of this can be summarized to say that the rectus muscles, although they may be encountered in the midline, are easily retracted laterally without division of any significant vessels or nerves.

The paired pyramidalis muscles may be encountered in the space between the anterior rectus sheath and the rectus muscles. They are absent in about 20 % of individuals. These muscles originate from the pubic ligament and anterior surface of the pubis. Their fibers then run obliquely toward the midline to insert into the linea alba about halfway between the pubis and the umbilicus. Theoretically these muscles could tense the linea alba, but in reality they are of no known clinical significance. When encountered, they form an additional confirmation that the incision is truly midline. A low vertical midline incision is simply taken between the muscles, usually with electrocautery to minimize bleeding.

Other muscles of the abdominal wall are discussed in more detail in Chap. 75. These are, from superficial to deep; the paired external oblique, internal oblique, and transversus abdominus muscle. The external oblique muscle runs obliquely (as the name implies) from its origin on the lower ribs and become aponeurotic medially to form the anterior rectus sheath and decussate in the linea alba. It's aponeurosis also forms the inguinal ligament. Medical students use the image of "putting one's hands in one's pockets" to remember the way in which this muscle runs.

The internal oblique muscle lies deep to the external oblique. It similarly passes obliquely, but its fibers run nearly at right angles to the external oblique, arising from the inguinal ligament and adjacent structures to terminate in an aponeurosis which contributes to the anterior rectus sheath in the lower abdomen, and to both the anterior and posterior rectus sheath in the upper abdomen.

The deepest muscular layer laterally is the transversus abdominis muscle. Fibers arise from the inguinal ligament, iliac crest, and lower ribs. They run transversely, as the name implies, to become aponeurotic and contribute to the posterior rectus sheath in the upper midline. Deep to the transversus abdominis muscle lies the transversalis fascia (see below).

All of these broad, flat, muscles of the lateral anterior abdominal wall, take their innervation from segmental nerves, and derive their blood supply from multiple relatively small vessels in the area. Denervation or devascularization is not an issue during construction of incisions.

Finally, the manner in which fibers from these muscle layers cross over each other provides the basis for the gridiron or muscle-splitting incision used for appendectomy.

Innervation The anterior abdominal wall is innervated by thoracoabdominal nerves derived from T7-L1. These nerves approach the midline from each side, and are not at risk during creation of a midline incision. They are discussed in greater detail in the chapter which follows (Transverse Incisions).

Blood supply The largest vessels encountered in this region are the paired inferior and superior epigastric arteries and veins. As previously noted, these run deep to the rectus muscles, within the rectus sheath, and are not encountered in the midline. They are discussed further in the subsequent chapter (Chap. 75. Transverse Incisions).

Umbilicus The umbilicus is the cicatrix or scar where the fetal umbilical vessels and associated structures passed

through the linea alba. Skin and all fascial layers are fused together at this site. It is a potential weak spot through which hernias form. Traditionally, a midline incision passing through the mid-abdomen is carried to one side of the umbilicus, rather than through it. This allows more secure closure with a decent amount of subcutaneous tissue between fascia and skin.

Because the ligamentum teres hepatis runs from the underside of the umbilical plate to the liver (with the falciform ligament spanning the space between the ligamentum teres hepatis and the anterior abdominal wall), it is generally simplest to pull the umbilicus to the right when creating a midline incision through the mid-abdomen. This allows entry without division of the ligamentum teres hepatis and falciform ligament (unless needed for access to the liver).

Extraperitoneal (Preperitoneal) space Deep to the linea alba, extraperitoneal fat, endoabdominal fascia, and peritoneum are encountered. The transversalis fascia, a fibrous layer deep to the transversus abdominis muscles and superficial to the extraperitoneal fat, becomes more robust laterally (see Chap. 75). A well-defined plane exists between the transversus abdominis muscle and this fascia laterally, and that plane can be exploited to enter the retroperitoneum. Medially, it is less robust, and in the midline it is rarely surgically apparent, although a variable amount of fat will be encountered superficial to the peritoneum. This extraperitoneal fat may be brushed aside from the midline to expose the transparent peritoneum, and brushed inferiorly to push the urinary bladder out of the surgical field.

Urinary bladder and median umbilical ligament The median umbilical ligament (urachus) travels from the underside of the umbilicus to the apex of the urinary bladder. The urachus is usually just a fibrous remnant. Occasionally cysts or residual patency of the urachus may be encountered in the midline.

As a vertical incision is extended down toward the pubis, the fat becomes thicker and the bladder may be encountered. In the absence of previous surgery or other local pathology, the urinary bladder lies reasonably free within the extraperitoneal fat. Thus, in the usual situation, pushing the extraperitoneal fat downward and away from the pubis will suffice to protect the bladder from harm during the creation of a midline incision. Sharp dissection may be required if adhesions are present.

Parietal peritoneum The glistening parietal peritoneum lines the abdominal wall and is continuous with the visceral peritoneum which covers the internal abdominal organs. It has little or no strength, and its single layer of epithelial cells rapidly reconstitute themselves, thus it is simply divided during entry into the abdomen and not sutured closed at closure (see section which follows).

Creating the Vertical Midline Incision

Incision Drape the entire abdomen so that the incision can be extended as needed. In the obese patient, make sure that the pannus is hanging straight down rather than over to one side or the other. Mark the landmarks and the incision, especially in the morbidly obese, as it is easy to lose the midline in the fatty pannus. Reliable bony landmarks include the xiphoid and the pubis. Many surgeons start with a relatively short incision and then extend it if justified by surgical findings.

The skin incision is generally made with scalpel and deepened with electrocautery. The so-called "skin knife" is generally not used for subsequent dissection, more because it will have become dull than for concerns about infection. As you progress, take care not to "buttonhole" a large and pendulous pannus inferiorly. Remember that the umbilicus is generally displaced caudally in morbidly obese individuals. If necessary, again palpate the pubic bones under the pannus and the costal margin and xiphoid process to get dependable landmarks [9].

Take care around the umbilicus If the incision is taken into the upper midline, curve your incision around the left side of the umbilicus (Fig. 83.2). If you are standing on the patient's left side, this is most easily done by having your first assistant, who is standing to the right, pull the umbilicus to the right. Be aware that small occult umbilical hernias are quite common.

Pull the fat apart to expose the midline Take advantage of the fusion plane in the abdominal midline by traction and counter-traction, which may actually pull the fat apart for you. Use scalpel or cautery sparingly to help the separation process until the midline fascia is fully exposed. Recognize the midline by the characteristic decussation of fibers as previous noted.

Clean the fascia Lightly clean the subcutaneous fat (and umbilicus) from the underlying fascia just enough to allow easy subsequent closure. Avoid doing this for more than 1 cm, as this is likely to increase bleeding and create more dead space for subsequent fluid collection.

Incise the fascia Open the fascia at a convenient point in the midportion of the incision. Yellowish fat and transparent

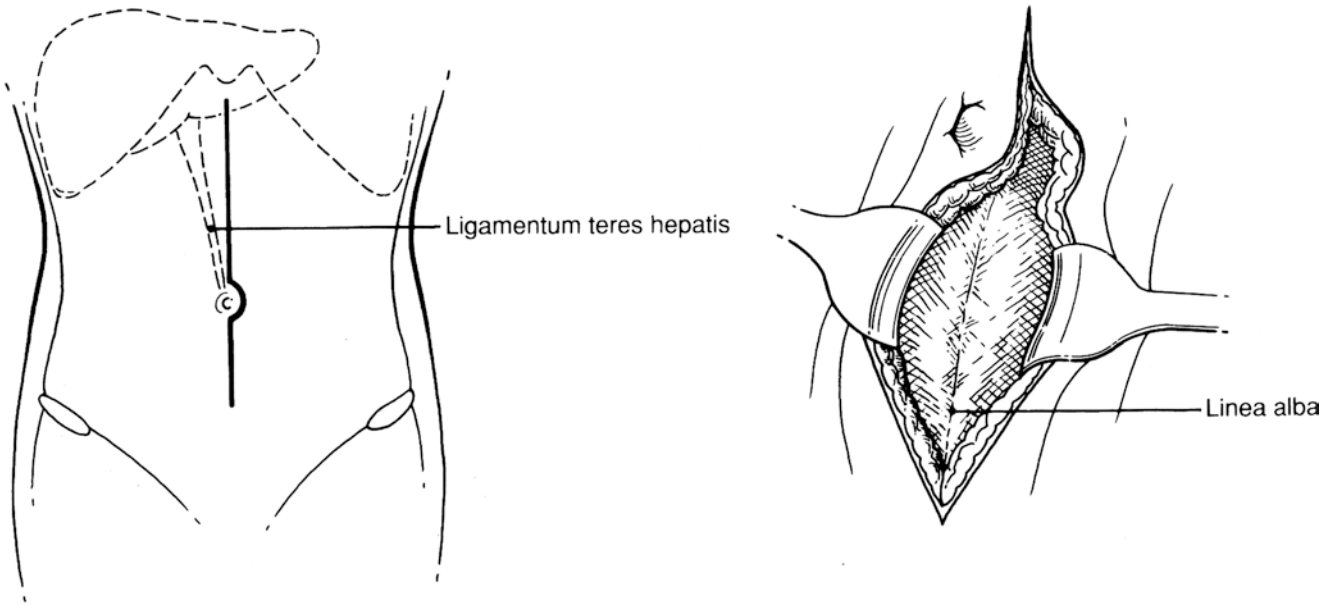


Fig. 83.2 In the upper abdomen, take the incision to the left of the umbilicus in order to leave undisturbed the underlying ligamentum teres hepatis which connects the underside of the umbilical plate to the liver (Reproduced from Fig. 44.2 Scott-Conner and Dawson [15], with permission)

peritoneum should be revealed. Gently push the extraperitoneal fat and peritoneum downward and incise just the fascia for the entire length of the incision. In the lower abdomen, the paired rectus muscles may appear confluent (due to lack of posterior sheath). Gently tease these apart from cephalad – where the separation will be more evident – to caudad, working parallel to their fibers.

Divide the pyramidalis muscles in the midline, if necessary – In the 80 % of so of individuals who have these muscles, you will encounter them in the rectus sheath. Divide them along the midline with electrocautery.

Enter the peritoneum Look for a transparent region and, if necessary, sweep the extraperitoneal fat to left and right to find such a place. Entry through a transparent portion will allow you to easily avoid underlying bowel and to minimize bleeding. Elevate the peritoneum with forceps and open it sharply, with due care to avoid injury to underlying small or large intestine. Keep in mind that pulling up on the edges of the peritoneum will increase your safety margin, pushing down will decrease it.

Push the bladder inferiorly As you extend the peritoneal incision inferiorly, push the extraperitoneal fat and peritoneum downward to protect the urinary bladder. It is often possible to leave the inferior couple of centimeters of peritoneum intact and simply displace it out of the way. A fibrous urachus can be simply divided with electrocautery. In the rare event that you encounter a more substantial tubular urachus that may be partially patent, simply clamp and secure it close to the dome of the bladder with absorbable ties or suture-ligatures.

Explore the abdomen and place fixed retractors Confirm the pathology, document any additional findings, and adjust your surgical plan if needed. The initial exploration is best done with hand-held retractors. Perform this exploration in a systematic fashion, working clockwise or counterclockwise as you prefer. Pay particular attention to the liver, undersurface of the diaphragm, and omentum, but do not ignore the rest of the viscera.

Repeat laparotomy While the general topic of adhesions is considered in greater depth in Chap. 76, a few words on repeat laparotomy are in order. Adhesions and small occult hernias are possible after any kind of previous surgery, even laparoscopic. Adhesions tend to form wherever injury has taken place, and may be especially tenacious at sutures. Hence there is a tendency for dense adhesions to line a previous midline incision. Take special care when opening the abdomen in this situation. It is not at all unusual to need to perform a midline laparotomy in a patient who has had a previous midline incision. In this case, if at all possible, enter the abdomen just above the previous incision. Work circumferentially around areas of dense adhesions and repair any partial or complete enterotomies as needed.

Be especially vigilant in the lower abdomen as previous dissection may have displaced the urinary bladder cephalad to its usual location, and it may be bound up in scar tissue.

Careful sharp dissection is the safest technique to use. See Chap. 75 for further details.

Closing the Vertical Midline Incision

Final check before closure Make sure all counts are correct and that you have obtained meticulous hemostasis. Place any displaced viscera back in their normal position. If omentum is available, bring it down and allow it to lie under the incision and over the surgical field, where it can provide a natural barrier against adhesions. Agents used for prevention of adhesions are discussed in Chap. 76 – if desired, place these at this point. Make sure that you have good neuromuscular blockade. Do not try to close a "tight" abdomen – visceral injury may result, or your fascial sutures may tear through. If necessary, place a flexible visceral retractor (such as the FISH® Glassman Visceral Retractor, Adept-Med International, USA) under the incision. Metallic ribbon retractors may be used to serve a similar purpose and are preferred by some surgeons.

Peritoneal closure not needed Separately closing the peritoneum is not necessary and may cause additional adhesions [5, 10, 11]. It adds another step to the operation, prolongs operative time, and may increase postoperative pain (because of sensory innervation). The European Hernia Association recommends against it. The peritoneum will reconstitute itself within about 24 h. This is a good general rule, regardless of the kind of incision (vertical or transverse) that one is closing.

Close the fascia He European Hernia Association recommends single layer aponeurotic closure; using a continuous, small-bite suturing technique, using a suture:incision length ratio of at least 4:1, with a slowly-absorbable synthetic suture [5].

Most surgeons close with a running suture of a heavy synthetic monofilament absorbable suture, such as an 0 PDS™II (Ethicon Corporation, USA) [12, 13]. The suture is available in a looped form in which both ends of the suture are swaged into the needle hub, and in the usual form. The looped form eliminates the need for the initial knot and effectively increases the strength of the suture (by doubling the amount of suture material used).

The European Hernia Society notes that no recommendation on size of sutures can be made due to lack of data [5].

To use a looped running suture, place your initial bite at one end of the incision, preferably the end at which exposure is most difficult. The reason to start at the most difficult place is that it will only get more difficult to place bites of suture as the incision closes. You will then secure this bite by passing the suture needle through the loop. The only knot that you will need will be at the opposite end of the incision and will either be buried in fat or will need to be buried (see below). In time, the entire suture, including the knot, will dissolve but this can be painfully slow and aggravating to deal with in thin patients.

To bury the knot, leave the needle attached as you knot the suture and then run the needle carefully under the last couple of bites, superficial to the fascia, and apply strong traction to pull the knot down under at least one of these bites. This will cause the knot to lie horizontally, with the tails buried, rather than vertically, with the tails sticking up.

To use a non-looped suture, be aware that the mid-portion of the incision will be the easiest to close as you progress, and that the two ends may be the most difficult. For this reason, many experienced surgeons prefer to use two sutures, and to start one at each end, meeting at the middle. This is not always necessary, but may be helpful in the obese patient.

In high-risk closures, some have advocated placing a piece of reinforcing mesh over the incision as a further safeguard against incisional hernia [5]. The precise role for this in routine surgery remains to be delineated, and it may complicate repeat operation.

Closure of subcutaneous tissue It may be useful to close the membranous part of the subcutaneous fascia with a few interrupted absorbable sutures. This does not contribute to the strength of the closure, but may, by minimizing dead space, discourage fluid accumulation. Drains are not routinely used in this space, even in corpulent individuals.

Skin closure An excellent cosmetic result may be obtained with carefully applied skin clips or with sutures. Many patients fear suture removal and most do not like clips. They appreciate a subcuticular suture, usually done with a running absorbable monofilament suture and optionally reinforced with strips or skin "glue" [14].

Other vertical (non-midline) incisions Other vertical incisions that are made to the right or left of the midline have little to recommend them and several significant disadvantages. A brief review of the terminology may be helpful, along with a discussion of their associated problems.

The classical paramedian incision **The classical paramedian incision** is made parallel to the midline and only a few centimeters away from it. The anterior rectus sheath is incised vertically and the rectus muscles are retracted laterally without damaging or dividing any neurovascular structures. The posterior sheath is then incised vertically. Theoretically, such

an incision could be made directly over a structure of interest and might provide a more secure closure because the anterior and posterior rectus sheaths are closed separately. In actual practice, these incisions work better in the upper abdomen than in the lower abdomen (where the posterior sheath is flimsy to nonexistent) and they significantly limit subsequent options for repeat laparotomy. There is nothing to commend this incision for exposure in the pelvic region.

Rectus-splitting and pararectus incisions are even worse, because part of the rectus muscle is denervated. These are obsolete incisions, mentioned only to be condemned. Always keep in mind that the rectus is a segmental muscle, and that it should be retracted laterally.

Vertical incision in the patient with an old paramedian incision Most surgeons try to avoid parallel incisions because of concerns about devascularizing the strip of tissue between the two scars. In the rare event that repeat laparotomy is required in a patient with an old paramedian incision, and that a vertical incision is needed for exposure, most surgeons will incorporate the old paramedian incision into their new incision, curving the new longer incision back to the midline above (or below) the paramedian. No data are available on outcomes. This is simply an area where the surgeon must be prepared to individualize, and here some familiarity with the anatomy of a paramedian incision may be helpful. The crucial thing is to remember to retract the rectus muscle laterally rather than splitting it or retracting it medially, to avoid neurovascular structures.

References

1. Grantcharov TP, Rosenberg J. Vertical compared with transverse incisions in abdominal surgery. Eur J Surg. 2001;167:260–7.
2. Seiler CM, Deckert A, Diener MK, Knaebel HP, Weigand MA, Victor N, Buchler MW. Midline versus transverse incision in major abdominal surgery: a randomized, double-blind equivalence trial (POVATI:ISRCTN60734227). Ann Surg. 2009;249:913–20.
3. Brown SR, Tiernan J. Transverse verses midline incisions for abdominal surgery (review). Cochrane Database Syst Rev 2005; 19 Issue (4). Art. No.: CD005199. DOI: 10.1002/14651858.CD005119.pub2, reviewed 2011.
4. Bickenbach KA, Karanicolas PJ, Ammori JB, Jayaraman S, Winter JM, Fields RC, Govindarajan A, Nir I, Rocha FG, Brennan MF. Up and down or side to side? A systematic review and meta-analysis examining the impact of incision on outcomes after abdominal surgery. Am J Surg. 2013;206:400–9.
5. Muysoms FE, Antoniou SA, Bury K, Campanelli G, Conze J, Cuccurullo D, de Beaux AC, et al. European Hernia Society guidelines on the closure of abdominal wall incisions. Hernia. 2015;19:1–24.
6. Dragu A, Unglaub F, Wolf MB, Beier JP, Schnabl SMK, Kneser U, Leffler M, Horch RE. Scars and perforator-based flaps in the abdominal region: a contraindication? Can J Surg. 2010;53:137–55.
7. Hopkins MP, Shriner AM, Parker MG, Scott L. Panniculectomy at the time of gynecologic surgery in morbidly obese patients. Am J Obstet Gynecol. 2000;182:1502–5.
8. Milloy FJ, Anson BJ, McFee DK. The rectus abdominus muscle and the epigastric arteries. Surg Gynecol Obstet. 1960;110:293–6.
9. Alexander CI, Liston WA. Operating on the obese woman – a review. BJOG. 2006;113:1167–72.
10. Bamigboye AA, Hofmeyr GJ. Closure versus non-closure of the peritoneum at caesarean section: short- and long-term outcomes. Cochrane Database Syst Rev. 2014;8:CD000163. doi:10.1002/14651858. CD000163.pub2.
11. Gurusamy KS, Cassar Delia E, Davidson BR. Peritoneal closure versus no peritoneal closure for patients undergoing non-obstetric abdominal operations. Cochrane Database Syst Rev. 2013;7:CD010424. doi:10.1002/14651858.CD010424.pub2.
12. Seiler CM, Bruckner T, Diener M, Papyan A, Folcher H, Seidlmayer C, et al. Interrupted or continuous slowly absorbable sutures for closure of primary elective midline abdominal incisions: a multicenter randomized trial (INSECT: ISRCTN24023541). Ann Surg. 2009;249:576–82.
13. Deerenberg EB, Harlaar JJ, Steyerberg EW, Lont HE, van Doorn HC, Heisterkamp J, et al. Small bites versus large bites for closure of abdominal midline incisions (STITCH): a double-blind, multicenter, randomized controlled trial. Lancet 2015;. 86(10000):1254-1260 . pii: S0140-6736(15)60459-7. doi: 10.1016/S0140-6736(15)60459-7. [Epub ahead of print].
14. Mackeen AD, Schuster M, Berghella V. Suture versus staples for skin closure after cesarean: a metaanalysis. Am J Obstet Gynecol. 2015;212:e1–10. doi:10.1016/j.ajog.2014.12.020. [Epub 2014 Dec 19].
15. Scott-Conner, Dawson. Essential operative technique and anatomy. 4th ed. Philadelphia: Lippincott Williams & Wilkins/A Wolters Kluwer publication; 2014. p. 225.

Transverse Incisions

84

Carol E.H. Scott-Conner

Transverse Incisions Versus the Vertical Midline Incision

In 2015, the European Hernia Society published their guidelines on closure of abdominal incisions, and included the recommendation that transverse incisions be used whenever possible [1]. Fortunately for the gynecologic surgeon, the low transverse incisions commonly used for gynecologic surgery provide many desirable characteristics and are used whenever possible. The primary alternative to these transverse incisions is the vertical midline incision, which is unparalleled for extensibility and access to all aspects of the abdomen (see Chap. 74). These advantages and disadvantages are summarized in Table 84.1 (for low transverse incisions) and Table 84.2 (for high transverse incisions).

Advantages of Transverse Incisions

Because of the direction of pull of the abdominal muscles, transverse incisions may heal more securely than vertical incisions [1–5]. Low transverse incisions are easily concealed under clothing and may fade to invisibility if hidden in the natural skin crease above the pubis or just above the pubic hair line. They provide direct exposure of the pelvic organs without dissection above the pelvis and thus might result in less adhesive small bowel obstruction (although this is unproven). A low transverse incision might be combined with a panniculectomy in obese women, either to facilitate exposure or as part of a planned procedure to spare a patient a second operation. The Pfannenstiel incision does not compromise subsequent use of lower abdominal tissue for TRAM or DIEP flap.

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Disadvantages of Transverse Incisions

Even when extended as far as possible, transverse incisions do not provide equal access to the upper and lower abdomen. Compared with vertical incisions, transverse incisions may be more painful (especially the upper abdominal ones) and the lower abdominal ones compromise stoma placement. They may involve slightly greater operative time and more potential blood loss compared with the vertical midline incision. Elevation of flaps (as with the Pfannenstiel incision) or combination with panniculectomy may increase the chances of a wound complication such as hematoma or infection. Division of the deep inferior epigastric arteries during construction of a Maylard or Cherney incision may compromise subsequent use of a free flap of lower abdominal tissue for reconstructive purposes [6, 7]. Upper transverse incisions such as the subcostal, extended subcostal, or chevron incision may denervate part of the abdominal wall causing eventration. These upper abdominal incisions also compromise subsequent TRAM flap creation.

Implications for Subsequent Reconstructive Surgery

Autologous tissue is valued for reconstruction of soft tissue defects after mastectomy or radical surgery. The skin, adipose tissue, and (sometimes) muscles of the lower abdominal wall form a convenient source. Because the breast cancer population comprises a significant subset of women, it is important that surgeons operating upon women understand how abdominal tissue is used for reconstruction. For convenience of the reader accessing this book electronically, some information given in Chap. 74 is repeated here.

Use of autologous tissue provides all the advantages of using the patient's own tissues (rather than an implant) and provides a bonus in the form of a "tummy tuck." It is important to understand how incision choice might influence later reconstructive options, should the woman require them.

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Table 84.1 Advantages and disadvantages of low transverse incisions typically used for gynecologic surgery, compared with the vertical midline incision

Advantages of low transverse incisions	Disadvantages
May heal better with lower incidence of hernia or dehiscence	Not as versatile or extensile
Cosmetically excellent scar	Less compatible with stoma creation
Pfannenstiel does not compromise subsequent use of lower abdominal tissue for TRAM or DIEP flaps	Ligation of deep inferior epigastric arteries during Maylard or Cherney may limit reconstructive options
Less formation of adhesions to small bowel	
May be combined with panniculectomy to enhance exposure or if desired by patient	Divides tissues of lower abdomen used for TRAM flap reconstruction (if needed later)
Does not compromise reoperation through vertical midline incision	Takes slightly longer and may be associated with greater blood loss

Table 84.2 Advantages and disadvantages of upper abdominal transverse or oblique incisions (such as subcostal, extended subcostal, or chevron), compared with vertical midline incision

Advantages of upper abdominal transverse incisions	Disadvantages
Excellent exposure of upper abdominal structures, particularly liver and diaphragm	Poor exposure of rest of abdomen
Reoperation after long vertical midline incision may allow surgeon to avoid adhesions	Scar is unsightly
May heal more securely than vertical midline incision	Dividing nerves may cause denervation (ballooning) of a large part of abdominal wall
Provides particularly good exposure in individuals with a wide costal arch	Not such good exposure in slender individuals with narrow costal arch
	Divides superior epigastric artery and thus pedicled TRAM flap reconstruction (if needed later) is impossible
	May be more painful in immediate postoperative period

A variety of autologous flaps have been described, but for purposes of this discussion it is important to focus on only two of these. These are the TRAM (transverse rectus abdominis muscle) and DIEP (deep inferior epigastric) flaps.

TRAM flaps take tissue from the lower abdomen, including one of the rectus abdominis muscles. Pedicled TRAM flaps derive their blood supply from the (preserved) superior epigastric artery. Sometimes the inferior epigastric artery is ligated as a first step, in order to cause the superior epigastric artery to enlarge. Thus, incisions in the lower abdomen which entail ligation of the inferior epigastric artery do not jeopardize subsequent creation of a pedicled TRAM flap.

Free TRAM flaps require microvascular anastomosis of one of the arteries supplying the flap to an artery in the region. For any free flap, it is crucial that the reconstructive surgeon assess local blood supply of the donor tissue. For many years, before microvascular free flap techniques were widely available, the pedicled TRAM flap was the workhorse flap for autologous reconstruction. Both the free and pedicled TRAM flap are rendered impossible after an upper abdominal Chevron (or subcostal) incision) because this incision divides the superior epigastric artery.

The TRAM is still commonly used, either as a pedicled or a free flap. However, concerns about abdominal wall function after loss of a rectus muscle have fueled interest in the DIEP flap as an alternative.

DIEP flaps are free flaps that transfer only skin and subcutaneous fat, leaving intact the rectus abdominis muscle. They require microvascular anastomosis of the deep inferior epigastric artery to a suitable artery in the recipient field. Previous ligation of the deep inferior epigastric artery renders this option impossible. It is thus important that gynecologic surgeons document ligation of these arteries during performance of Maylard or Cherney incisions. Reconstructive surgeons have been cautioned to check these vessels with Doppler ultrasound or other modalities when planning a DIEP flap on a patient with a long low transverse incision [7].

Many considerations influence the choice of flap. The bulk of missing breast tissue relative to the tissue available in the donor site, unilateral versus bilateral, vascular health of the woman (diabetes, smoking, atherosclerotic disease), and presence or absence of scars on the abdomen all must be considered. It is noteworthy that previous panniculectomy also may be a factor [6].

A lower midline incision divides the skin and fatty tissue down the middle. Typically, the reconstructive surgeon will then split the tissue down the middle. This is not a problem in obese women, but may be problematic in slender individuals where abdominal fat is limited.

If the deep inferior epigastric vessels have been ligated during a previous low transverse incision, then a TRAM flap

is still possible (indeed, division of these vessels is sometimes performed several weeks prior to flap creation, in order to stimulate the superior epigastric vessels to grow) but a DIEP flap will not be possible because the vascular trunk will be gone.

How does this affect choice of incision for a gynecologic surgeon? Obviously, the necessities of the operation at hand must dominate clinical decision-making. But simply keep this in mind: all other things being equal, design of these flaps is more difficult and choice of options more limited if a woman has had a lower midline incision or a transverse incision which divides rectus muscle and regional arteries than if she has had a classic Pfannenstiehl. From the reconstructive surgeon's perspective, a Pfannenstiehl incision causes the least disruption. Fortunately, this corresponds to the incision of choice for many gynecologic procedures. If it is necessary to ligate one or both deep inferior epigastric arteries, document this in the operative note.

Combination with Panniculectomy

Panniculectomy consists of surgical removal of the pannus, the hanging apron of excess skin and fatty tissue overlying the pubic region in morbidly obese patients (or those who have lost large amounts of weight). Typically, the umbilicus is displaced inferiorly from its normal location. The fold under the pannus is difficult for patients to clean and often colonized by Candida and various bacteria. With a surgical panniculectomy, the umbilicus may be retained and moved to a more normal location, or may simply be excised. Excision of the umbilicus, while clearly the simplest option surgically, may not be acceptable to some patients.

Abdominoplasty, also termed a "tummy tuck", combines panniculectomy with a procedure to tighten sagging abdominal muscles. It is commonly performed in women who have lax abdominal muscles and excess fatty tissue after completion of their childbearing years.

Panniculectomy or abdominoplasty are most often performed as a separate procedure rather than combined with intra-abdominal surgery. Panniculectomy was first combined with ventral hernia repair to enable stronger hernia repair and was demonstrated to be safe and effective. In some instances, it has been combined with gynecologic surgery. It was initially described as a way to facilitate access to the pelvis for radical pelvic surgery. This has been described as "medically necessary" panniculectomy [8–10].

It has subsequently been employed electively in selected patients who are undergoing gynecologic surgery through a low transverse incision and who desire panniculectomy [10–12]. Concerns have been raised about combining a clean procedure (panniculectomy) with a contaminated one (hysterectomy) but a recent review using the American College of Surgeons National Surgical Quality Improvement Project data base (NSQIP) indicated that a combined abdominoplasty-hysterectomy procedure actually carried a lower morbidity than the morbidity of the two individual procedures [13]. This review supported the addition of abdominoplasty to those patients undergoing abdominal hysterectomy who would otherwise undergo a second, separate procedure, to attain a better contour.

When considering combining panniculectomy with gynecologic surgery, there are several potential disadvantages to consider. First, it is important to note that body contouring can be a complex operation, involving resection of tissue around the entire torso (to attain a normal body habitus). The procedure is best performed after planned weight loss has been achieved, rather than incidentally during performance of another procedure. "Dog ears" of redundant tissue at the lateral aspects of a simple elliptical panniculectomy (as described in this chapter) are common and may be bothersome to the patient. It is thus crucial that both patient and surgeon have realistic expectations when panniculectomy is performed during gynecologic surgery. Consent is obtained for both procedures and the panniculectomy is performed first.

Second, panniculectomy, even the limited form described below, may be accompanied by sufficient blood loss to require transfusion. It requires significant undermining of the upper flap. Seromas are common. It significantly prolongs operative time. Infection of the operative site will be more difficult to manage than the usual sort of deep wound infection, simply by virtue of the size of the dissected field in the subcutaneous tissues.

Panniculectomy (as noted above) also eliminates some tissue commonly used for reconstructive surgery. Flaps of lower abdominal skin, fatty tissue, and (sometimes) muscle are employed for reconstruction after breast cancer surgery and sometimes used in other locations.

Anatomy of the Abdominal Wall

Superficial fascia The superficial fascia of the anterior abdominal wall is primarily adipose tissue above the umbilicus. Below the umbilicus, superficial fatty and deeper membranous layers may be appreciated. The membranous layer may form a barrier to extravasation of fluid, and is sometimes sutured to decrease dead space during wound closure.

The superficial fatty layer is typically thicker below the umbilicus, and in morbidly obese individuals may form a huge, edematous, dependent pannus that hangs down below the pubic region. In such cases, the normally relatively avascular fat may contain very large subcutaneous veins.

Linea alba and umbilicus The linea alba is visible in slender individuals as an shallow indented line running from xiphoid to pubis. It marks the midline of the anterior abdominal wall. It is formed from decussating fibers of the external oblique, internal oblique, and transversus abdominis aponeuroses. This relatively avascular structure is incised during performance of vertical midline incisions.

Muscles of the lateral abdominal wall Laterally, three broad flat muscles (the external oblique, internal oblique, and transversus abdominis muscles) comprise the abdominal wall. Medially, all three become aponeurotic and contribute to the rectus sheathes and linea alba. The most superficial of these muscles is the external oblique. Muscular fibers of the external oblique arise from the 5–12 ribs, laterally seeming to interdigitate with muscular slips from the serratus anterior muscle. These fibers course medially and inferiorly ("as if putting one's hands in one's pockets"). The portion of the muscle arising from the lowest ribs inserts upon the iliac crest, and the remainder of the muscle becomes aponeurotic and forms part of the anterior rectus sheath, to terminate in the decussating fibers of the linea alba.

The internal oblique muscle lies deep to the external oblique. The fibers of these two muscles run nearly at right angles to each other, creating a gridiron effect. Fibers of this muscle arise from the inguinal ligament, iliac crest, and lumbodorsal fascia. Medially this muscle similarly becomes aponeurotic. It contributes to the anterior and posterior rectus sheath and linea alba in the upper abdomen, and to the anterior rectus sheath and linea alba only in the lower abdomen.

The transversus abdominis muscle forms the deepest muscle layer of the lateral abdominal wall. Lying just deep to the internal oblique, its fibers run almost directly medially from their origin on the inguinal ligament, the iliac crest, and the lower ribs. In the medial half, this muscle also becomes aponeurotic and contributes to the posterior rectus sheath in the upper abdomen, and the anterior rectus sheath in the lower abdomen, as well as the linea alba.

Rectus abdominis muscle The paired, segmental rectus abdominis muscles originate from the pubis and run nearly vertically to insert upon the costal margin and xiphoid process. As they ascend, they become broader and the distance between them increases. They are encased within the strong fibrous rectus sheathes, which coalesce to form the midline linea alba as noted above. Segments of the rectus muscles are demarcated by fibrous inscriptions that create the appearance of a "six pack" on the abdominal wall of lean, muscular individuals. The inscriptions may be adherent to the rectus sheathes.

Each rectus muscle is innervated by multiple thoracoabdominal nerves, which approach obliquely from lateral to medial and run deep to the muscle in the rectus sheath [14]. This segmental innervation allows the rectus to be transected at any point without creating denervation and atrophy. The transected rectus simply forms another fibrous inscription as it heals. This property is exploited by gynecologic surgeons during creation of the Maylard incision, and by general surgeons who create transverse or oblique incisions in the upper or lower abdomen.

The blood supply of the rectus muscles comes from above and below. From above, the superior epigastric arteries pass on the deep aspect of the rectus. From below, the usually larger deep inferior epigastric arteries ascend deep to the rectus and enter the rectus sheath at the arcuate line – above which, there is a well-defined posterior rectus sheath. Typically the epigastric artery and vein anastomose, a feature exploited by reconstructive surgeons when they "delay" a flap by ligating the inferior epigastric artery. Small twigs of the lower six intercostal arteries also enter the rectus sheath from the lateral aspect.

All of this can be summarized to say that the rectus muscles, because of their segmental innervation and dual blood supply, can be transected to construct a transverse incision at any level of the abdominal wall with minimal long-term morbidity.

Innervation In general, the muscles of the anterior abdominal wall derive their innervation from branches of the lower thoracic nerves, as well as the iliohypogastric and ilioinguinal nerves. Innervation is segmental, and comes from lateral to medial with the individual nerves following an oblique path slanting slightly inferiorly as they enter the muscles. Nerves are found deep to the muscles that they innervate.

The ilioinguinal or iliohypogastric nerves may be encountered during the creation of low transverse incisions, and should be spared to avoid the formation of painful neuromas. If that rule is followed, the transverse incisions used in gynecologic surgery do not denervate muscles. High transverse incisions used in general surgery, such as a subcostal incision, cross the course of several of these nerves and thus may result in denervation and subsequent ballooning (termed "eventration") of a large portion of the abdominal wall.

Blood supply The two major (paired) named arteries of the anterior abdominal are the superior epigastric artery and the inferior epigastric artery. The superior epigastric artery, generally the smaller of the two, arises from the internal thoracic artery and passes inferiorly deep to the rectus muscle in the rectus sheath. The larger inferior epigastric artery (sometimes termed the deep inferior epigastric artery, to differentiate it from the smaller superficial inferior epigastric artery) arises from the external iliac artery. The inferior epigastric and superior epigastric arteries commonly anastomose in the

mid-abdomen and hence ligation of the inferior epigastric artery is generally well-tolerated, except in patients with severe vascular pathology (who may be dependent upon collaterals for circulation). Laterally, three large arteries – the 10th and 11th intercostal arteries and the subcostal artery may be encountered, primarily in the upper abdomen. These may similarly generally be ligated with impunity. In the medial aspect of the lower abdomen, the superficial inferior epigastric artery may be encountered in the subcutaneous tissues running from the femoral artery toward the umbilicus. More laterally in the lower abdomen, the deep circumflex iliac artery runs in the subcutaneous tissues parallel to the inguinal ligament. In brief, all of these regional arteries may be ligated. Most are accompanied by paired veins.

Extraperitoneal (preperitoneal) space Deep to the linea alba, extraperitoneal fat, endoabdominal fascia, and peritoneum are encountered. The transversalis fascia, a fibrous layer deep to the transversus abdominis muscles and superficial to the extraperitoneal fat, is the major component of the endoabdominal fascia. It becomes more robust laterally. Dissection superficial to this fascia allows access to the retroperitoneal space without entering the peritoneum. This extraperitoneal dissection is easier laterally, where the transversalis fascia is well-defined. Medially, it is less robust, and in the midline it is rarely surgically apparent, although a variable amount of fat will be encountered superficial to the peritoneum. This extraperitoneal fat may be brushed aside from the midline to expose the transparent peritoneum, and brushed inferiorly to push the urinary bladder out of the surgical field.

Umbilicus The umbilicus is the cicatrix or scar where the fetal umbilical vessels and associated structures passed through the linea alba. Skin and all fascial layers are fused together at this site. It is a potential weak spot through which hernias form. When a panniculectomy is performed, decision must be made whether to preserve the umbilicus or sacrifice it. Preserving the umbilicus will generally require repositioning it cephalad (as the panniculectomy will, of necessity, pull it even farther down from its usual position).

Urinary bladder and median umbilical ligament the median umbilical ligament (urachus) travels from the underside of the umbilicus to the apex of the urinary bladder. The urachus is usually just a fibrous remnant. Occasionally cysts or residual patency of the urachus may be encountered in the midline. Division of the median umbilical ligament allows the bladder to be gently displaced inferiorly as the peritoneal cavity is entered. The urinary bladder lies in fatty tissue of the retropubic space (anteriorly) and in loose visceral connective posteriorly where it lies on the cervix of the uterus and anterior vaginal wall.

Transversalis fascia This thin aponeurotic membrane is well developed laterally and becomes more tenuous medially. It is found between the transversus abdominis muscle and the parietal peritoneum. It is a major component of the endoabdominal fascia, which forms a kind of sac within which the peritoneum and intraperitoneal organs are found. The transversalis fascia is the first major structure which an incipient hernia must breach.

Parietal peritoneum the glistening parietal peritoneum lines the abdominal wall and is continuous with the visceral peritoneum which covers the internal abdominal organs. It has little or no strength, and its single layer of epithelial cells rapidly reconstitute themselves. While studies have shown that there is no strength benefit to closure of the parietal peritoneum [15, 16], some surgeons will close a deep layer of transversalis and peritoneum together after creating a transverse incision which divides muscles. This effectively "compartmentalizes" the wound, so that any bleeding from the transected muscles will be contained in the wound, rather than spilling into the peritoneal cavity.

Transverse Incisions Used in Gynecologic Surgery

Pfannenstiel

The Pfannenstiel incision is used when limited exposure to pelvic organs is desired, such as is needed for surgery for benign gynecologic pathology. It is also used for specimen extraction after laparoscopic surgery of all sorts (including, for example, laparoscopic splenectomy. It provides a seemingly-ideal combination of strength, adequate access, and excellent cosmetic result. The limitations of this incision include the need to create a flap to expose the peritoneum, and the limited exposure.

The classic Pfannenstiel incision (Fig. 84.1a, red line) begins with a relatively short skin incision in or just above the suprapubic skin crease. Typically this incision is 10–13 cm long, curves gently upwards like a smile, and is centered on the midline. It has been said that an incision "the length of an Allis clamp" will prove adequate for Caesarian section. Once encountered, the anterior rectus sheathes are divided sharply along the same line as the skin incision, and flaps are then raised cranially in such a manner as to elevate the anterior sheath and expose the underlying rectus abdominis muscles Fig. 84.1b). The peritoneum and transversalis fascia are then divided in a vertical fashion to enter the abdomen (Fig. 84.1c).

Closure involves suturing the linea alba together with running or continuous slowly absorbable sutures [17–19]. As previously noted, there is no virtue in attempting to separately close the peritoneum.

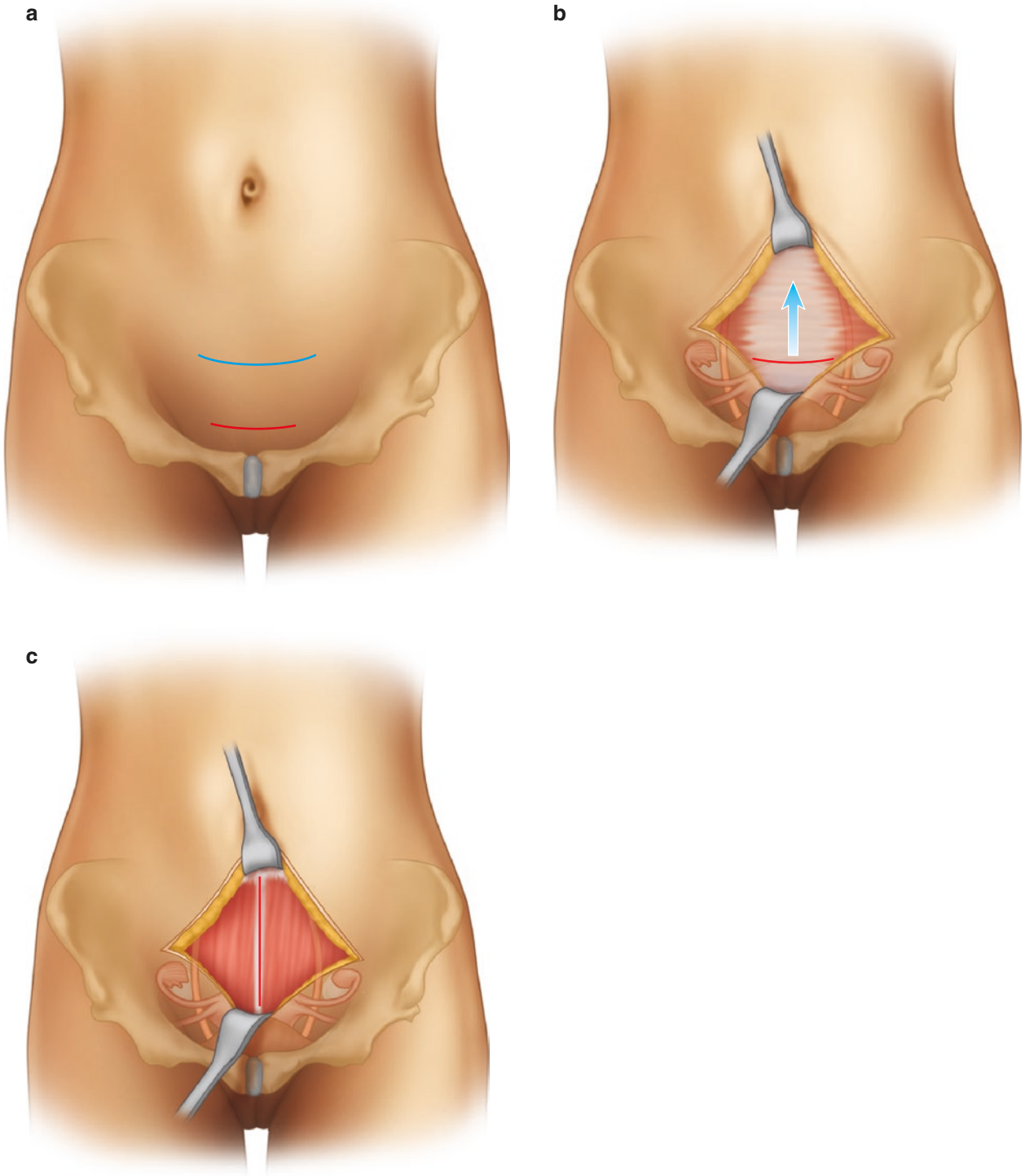


Fig. 84.1 (**a**)The Pfannenstiel incision begins with a relatively short incision in or just above the pubic skin crease. (**b**) The Pfannenstiel incision dissection is continued by incising the anterior rectus sheath and linea alba along the red line. This fascial flap is then elevated cephalad (*blue arrow*) to expose the underlying rectus muscles. Note that the extent of the skin incision and retracted subcutaneous tissues are exaggerated in this figure for clarity. (**c**) The Pfannenstiel is completed by incising the vertical midline between the rectus muscles. Note that the extent of the skin incision and retracted subcutaneous tissues are exaggerated in this figure for clarity (Reproduced with modifications from Scott-Conner [23])

Several variations of the incision have been described. These attempt to combine the advantages of the incision, as originally described, with greater exposure.

Joel Cohen (Sometimes Written Joel-Cohen)

This is a modification of the Pfannenstiel in which the skin incision is made significantly higher than the natural skin line (Fig. 84.1a, blue line), about 1 cm inferior to the line between the anterior superior iliac spines [20]. It was originally described for use in Caesarian sections and still may be used for this purpose in slender women. The remainder of the incision is the same as the Pfannenstiel. Less dissection under the fascial flaps is required, the incision may extend a bit longer, and it appears to be able to be made much more rapidly.

Misgav Ladach

The Misgav Ladach incision is another transverse incision that can be made rapidly and with minimal blood loss, yet heals securely [21]. It, too, is primarily used for Caesarian sections. This incision begins with a transverse incision identical to the Joel Cohen, but deep dissection is completely different. Dissection progresses transversely through the subcutaneous fat and superficial fascia to the anterior rectus sheathes and linea alba. This is opened transversely for about 2 cm and then surgeon and first assistant insert two to three fingers of each hand and manually stretch the fascia open cranially and caudally. The rectus muscles are then pulled apart. The parietal peritoneum is similarly opened with a small incision and the incision extended by pulling it apart. In addition to rapid entry and good healing, this approach minimizes the use of sharp instruments deep in the incision and thus may be preferred when exposure to blood-borne pathogens is a particular concern.

The only closure that is required is closure of the anterior rectus sheathes and linea alba. Classically, only a few interrupted sutures are placed in the skin to allow loose closure and reduce the risk of wound infection.

The general surgeon will find the method of stretching open the layers rather than cutting them very reminiscent of techniques used to open "muscle-splitting" gridiron incisions such as those used for open appendectomy.

Küstner

This incision starts with a skin incision similar to the Pfannenstiel, but somewhat longer. The incision is deepened through the subcutaneous fat and flaps are raised superficial to the anterior rectus sheathes. A vertical midline incision is then made through fascia and peritoneum.

This incision has little to recommend it. Elevating the subcutaneous tissues is frequently bloody and time--consuming, the fascial incision although vertical is not extensible as the true vertical midline incision is. It is sometimes, mistakenly, referred to as a Pfannenstiel variant.

Maylard

This incision begins like the Pfannenstiel, but after transecting the anterior rectus sheath transversely, the surgeon divides both rectus abdominis muscles (Fig. 84.2a–c). The muscles may or may not be re-approximated during closure. This incision provides better access for difficult pelvic operations. Although some surgeons try to preserve the deep inferior epigastric arteries, most ligate and divide them before transecting the rectus muscles.

Cherney

In this variation, after transversely dividing the anterior rectus sheath, the rectus abdominis muscles are detached from the pelvic bones and rolled upward out of the way (Fig. 84.3a, b). This is thought to better preserve the strength of the anterior abdominal wall, compared with dividing the rectus muscles, but evidence is lacking. It may also be easier to re-attach the rectus muscles than to attempt to re-approximate them after division. It may be easier to preserve the deep inferior epigastric arteries when the muscles are detached rather than transected, as these arteries approach the rectus muscles from laterally are may not be encountered so close to the pubis. The muscles are re-attached to the anterior rectus sheath inferiorly, rather than the pubis, to avoid causing osteitis. Closure is facilitated by flexing the operating table.

Other Transverse Incisions: Subcostal and Chevron Upper Abdominal Incision

In a difficult reoperative case, access to the upper abdomen may be gained by a transverse (oblique) subcostal or bilateral subcostal (chevron) incision (Fig. 84.4). The subcostal incision is made parallel to and several fingerbreadths (3–4 cm) below the costal margin. All layers of the abdominal wall are transected along this line. It is particularly important to maintain an upper flap of muscular and aponeurotic tissue on the upper aspect, rather than allowing the incision to wander cephalad up towards the ribs. This upper flap will be utilized during closure.

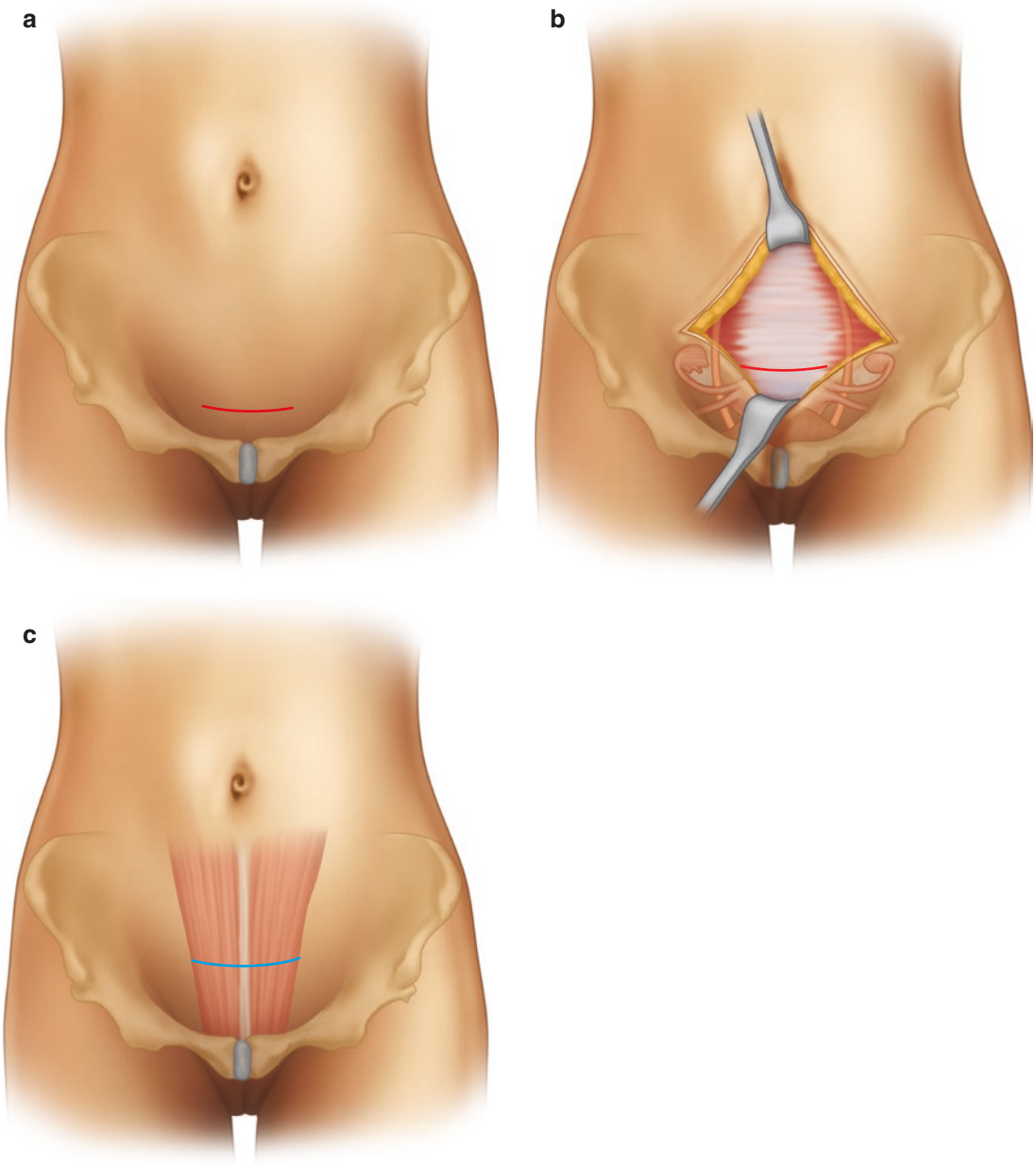


Fig. 84.2 (**a**) The Maylard incision is made with a skin incision similar to the Pfannenstiel. Typically, the incision is made a bit longer than the classic Pfannenstiel. (**b**) The fascia is incised transversely (again, like the Pfannenstiel), but flaps are not developed under the fascia. . Note that the extent of the skin incision and retracted subcutaneous tissues are greatly exaggerated in this figure for clarity. (**c**) The underlying rectus muscles are divided along the incision line. Typically both deep inferior epigastric vessels are ligated and divided during creation of this incision. Again, please note that the extent of the skin incision and retracted subcutaneous tissues are exaggerated in this figure for clarity (Reproduced with modifications from Scott-Conner [23])

A subcostal incision may be made on one side (for example, the right side to access the biliary tree) and extended across the midline partially or completely as needed. A complete bilateral subcostal incision provides superb access to the upper abdomen and heals well, but may be quite painful. These incisions are usually closed in two layers, concentrating upon fascial/aponeurotic closure rather than on any attempt to actually re-approximate the muscles. Generally the first layer of the closure is the posterior rectus sheath and, laterally, transversus abdominis muscle.

Less often, straight transverse incisions (usually unilateral) may be made for open right colon resection or for pediatric surgical procedures.

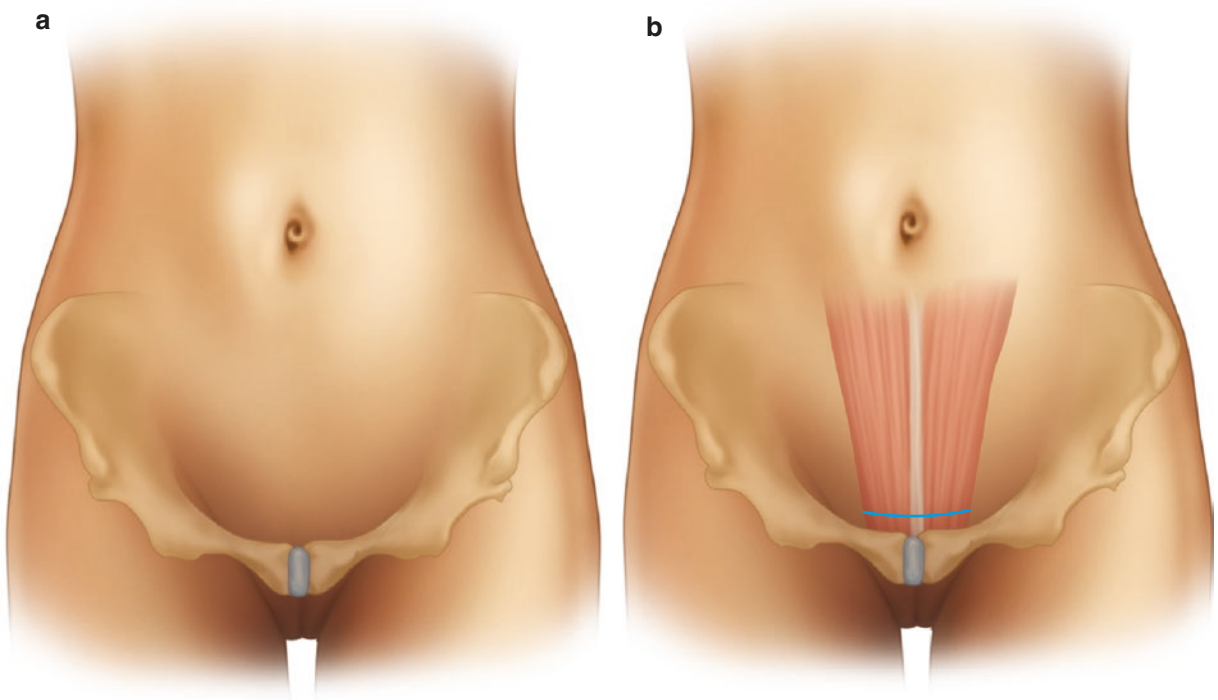


Fig. 84.3 (**a**) The Cherney incision is made with a skin incision similar to the Pfannenstiehl. The incision may be made a bit longer if necessary. (**b**) The fascia and underlying rectus muscles are incised low, close to their attachment on the pubic bone. Note that the extent of the skin incision and retracted subcutaneous tissues are exaggerated in this figure for clarity (Reproduced with modifications from Scott-Conner [23])

Options When Additional Exposure Is Needed

The low transverse incisions used for gynecologic surgery are chosen when the need for exposure of the upper abdomen is not anticipated. Sometimes, despite the best preoperative evaluation and workup, a surgeon may encounter unexpected pathology that requires exploration and access greater than that afforded by the initial incision.

There are basically two options in this situation. The first option, if only a bit more exposure in the pelvis is required, is to extend the incision. When exposure of the upper abdomen is required, it is often best to simply close the transverse incision and create a second, upper midline incision. As with all things, it is prudent to warn the patient of this possibility before the procedure. Options are summarized in Table 84.3.

Extending the Pfannenstiel Incision

Some small amount of additional exposure can be obtained by detaching the rectus muscles at the inferior aspect of the incision, as is done for the Cherney incision. This is preferred over the alternative of dividing the rectus muscles because it will prove easier to close (and potentially less bloody) than the Maylard.

Extending the Cherney or Maylard Incision

Both incisions can be extended laterally by ligating and dividing the deep inferior epigastric arteries (if not already done) and then dividing all layers of the abdominal wall in a transverse oblique fashion along the line of the incision. Excellent retroperitoneal exposure can be obtained by extending the incision obliquely or even farther to create a hockey-stick (Fig. 84.5a, b). Experience from renal transplant literature suggests that the oblique incision heals better than the hockey-stick, but there is only limited data [22].

Although these maneuvers will significantly enhance exposure of the pelvis, pelvic retroperitoneum, and lower abdominal organs, these do not generally provide sufficient access to the upper abdomen.

Creating and Closing the Pfannenstiel Incision

Mark an incision in a natural skin crease approximately 3 cm above the pubic symphysis and extending in a gently curvilinear fashion for a total length of 10–14 cm. Incise skin and subcutaneous tissue along this line until the fascia of the anterior abdominal wall is encountered. This fascia will constitute the anterior rectus sheath and linea alba medially.

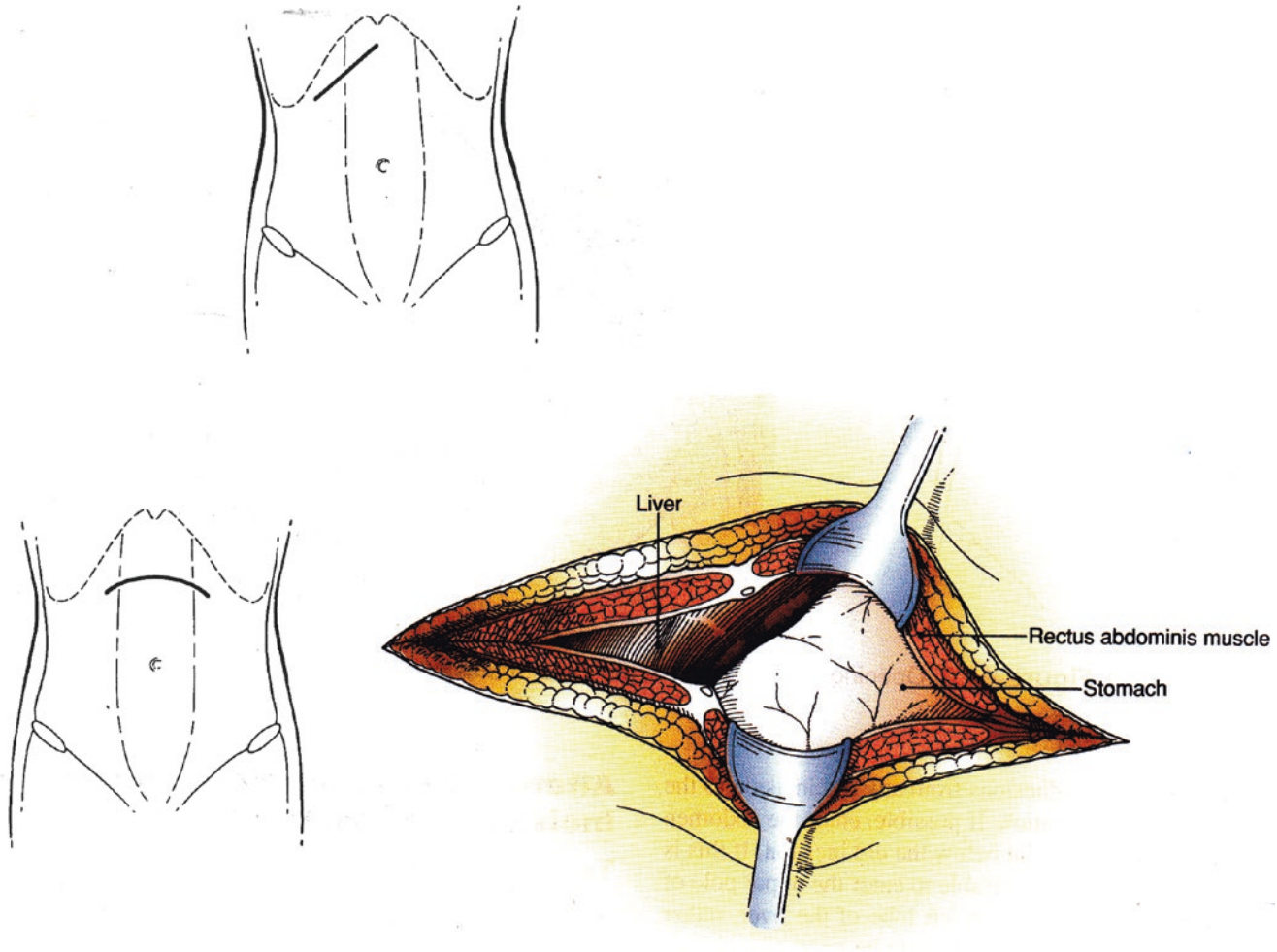


Fig. 84.4 The subcostal incision may be made on either the right or the left side, depending upon the area to be accessed. The right subcostal incision is the most common, because it provides superb access to the gallbladder and extrahepatic biliary tree. The bilateral subcostal, here shown as a relatively short incision, may be extended as needed on either side. With all subcostal incisions, musculoaponeurotic layers are divided along the line of incision (Reproduced from Scott-Conner [23])

Table 84.3 Options for additional exposure when the initial incision is a low transverse one and unexpected pathology is encountered

Initial incision	Options for additional exposure
Pfannenstiel	Convert to Cherney Incision Close Pfannenstiel and create vertical midline
Cherney	For greater exposure (especially retroperitoneal) on one side, extend that side laterally and upward as a "hockey-stick" incision Close and create vertical midline
Maylard	"Hockey-stick" incision as noted above Close and create vertical midline

Elevate it from the underlying rectus abdominis muscles and divide it transversely without damaging the muscles. Then dissect cephalad in the plane between the divided fascia and the underlying muscle for 8–10 cm. Leave the subcutaneous fat of the upper flap adherent to the anterior rectus fascia. Coagulate any small perforating vessels as encountered. Gently separate the rectus abdominis muscles in the midline, elevate the transversalis fascia and parietal peritoneum and divide it vertically between the two rectus muscles.

Closure begins with meticulous hemostasis. Do not close the peritoneum. Allow the rectus muscles to return to the midline. Suture the anterior rectus sheathes and midline fascia with a running suture of heavy slow-absorbing material, such as 0 PDS.

Creating and Closing the Cherney Incision

Mark an incision similar to that used for a Pfannenstiel but extending farther on each side to about 3–4 cm below and medial to the anterior superior iliac spine. Frequently, the incision is made slightly higher than a Pfannenstiel (3–8 cm above the pubis), and less curved. Deepen this through subcutaneous tissues until the fascia of the anterior abdominal

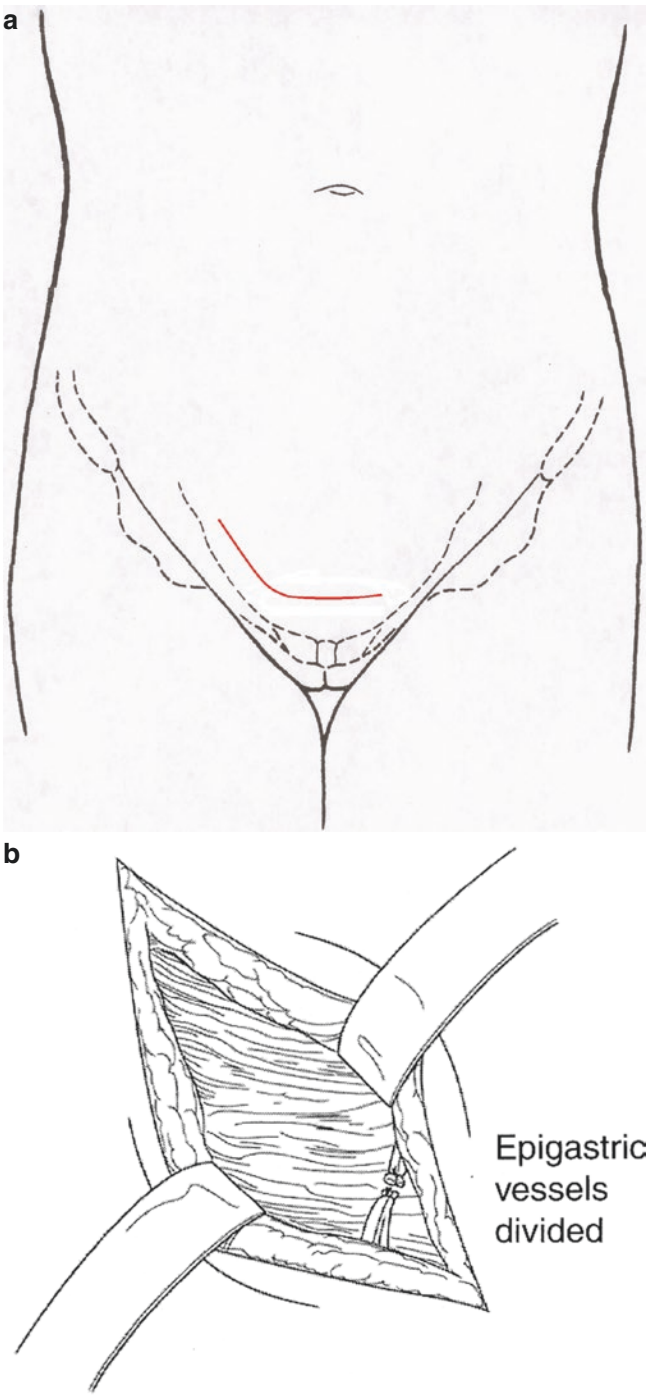


Fig. 84.5 (**a**) The Maylard (or Cherney) incision may be extended laterally on either side as a hockey stick (*red line*). If unilateral exposure is needed (for example, for a retroperitoneal node dissection), an oblique incision (*blue line*) may be preferable. (**b**) The hockey stick or oblique incision (shown here) requires division of all fascial and aponeurotic layers along the incision line. The deep inferior epigastric artery must be divided (if not already done (Reproduced from Scott--Conner [23])

wall is encountered. Elevate the anterior rectus sheath from the underlying rectus muscles and divide the anterior rectus sheathes along the same line as the skin incision. Take care to retain sufficient fascial tissue inferiorly to allow secure closure. Detach the rectus abdominis muscles from their insertion upon the pubic symphysis and roll them cephalad to expose the transversalis fascia and peritoneum. Incise the peritoneum transversely, taking care not to injure the inferior epigastric vessels which will usually be lateral to the operative field. Be aware that nerve injury has resulted from placement of the deep blades of fixed retractors in the lateral inferior aspect of this incision (and the Maylard). Make sure that any self-retaining retractor blades are placed on the incision, not on the psoas muscle.

To facilitate closure, flex the operating table and ensure that muscle relaxation is adequate. Many surgeons close the peritoneum with a simple running suture. Re-attach the rectus abdominis muscles to the underside of inferior flap of the anterior rectus sheath, rather than to the pubis. Use interrupted horizontal mattress sutures of 0 PDS or some similar slowly-dissolving synthetic material. Then close the rectus sheath and midline fascia with a running suture of 0 PDS or a similar material.

Creating and Closing the Maylard Incision

Mark an incision similar to that described above for the Cherney incision. Deepen this through the anterior rectus sheath as described for the Cherney incision. Elevate the rectus muscle on each side from underlying transversalis fascia and divide it slowly and gradually with electrocautery. Be vigilant about identifying and carefully cauterizing small muscular arterioles, which may go into spasm and retract into the muscle. These can cause postoperative hematomas. Try not to injure the inferior epigastric vessels. If injured, secure these with ties and divide them. Incise the transversalis fascia and parietal peritoneum transversely. Take care with fixed retractors as noted for the Cherney incision.

During closure, it is important to recheck hemostasis from the divided rectus muscles. It is not unusual for small muscular arterioles to go into spasm and cause bleeding in the early postoperative period. Closure of the parietal peritoneum is prudent, as it will confine any bleeding to the wound, essentially excluding it from the peritoneal cavity. It is not necessary to re-approximate the rectus muscles for abdominal wall strength. Some surgeons do this to reinforce hemostasis. If attempted, flex the operating table and ensure relaxation. Use interrupted horizontal mattress sutures to bring the cut edges of the muscles together. As with any situation where sutures are placed under some tension through tissue that does not hold suture well, place all of your sutures first, then have an assistant pull them all up so that you can tie them. This allows the tension to be borne along the entire length of the suture line, rather than concentrated upon one suture. Next, close the anterior rectus sheath with a running suture of 0 PDS.

Combination with Panniculectomy (Fig. 84.6)

Assess the amount of pannus to be removed by elevating the redundant tissue. Be conservative. The most straightforward (but not necessarily the cosmetically optimal) approach is to outline a skin incision that extends from the lumbar regions laterally to curve above and below the umbilicus. If it is necessary to preserve the umbilicus, make a separate skin incision around it. Deepen the incisions through subcutaneous fat to fascia, and take care to ligate the large subcutaneous veins as encountered. The Harmonic Scalpel ™ has been described for this purpose. Obtain meticulous hemostasis. Cover the exposed fat with damp laparotomy pads or towels to avoid dessication.

Proceed with the gynecological incision, procedure, and fascial closure in the usual fashion.

Undermine the superior flap of skin and subcutaneous fat sufficiently to allow it to slide down and approximate without tension to the inferior flap. If the umbilicus is to be preserved, select an appropriate location, taking care that it lies on the midline, and create a skin hole and subcutaneous tunnel. Obtain meticulous hemostasis. Pull the umbilicus through the new incision and secure it with fine interrupted synthetic absorbable sutures. This is not much different than placing a stoma. Many surgeons place closed suction drains under the upper flap before suturing it to the inferior flap. Consider a compressive dressing.

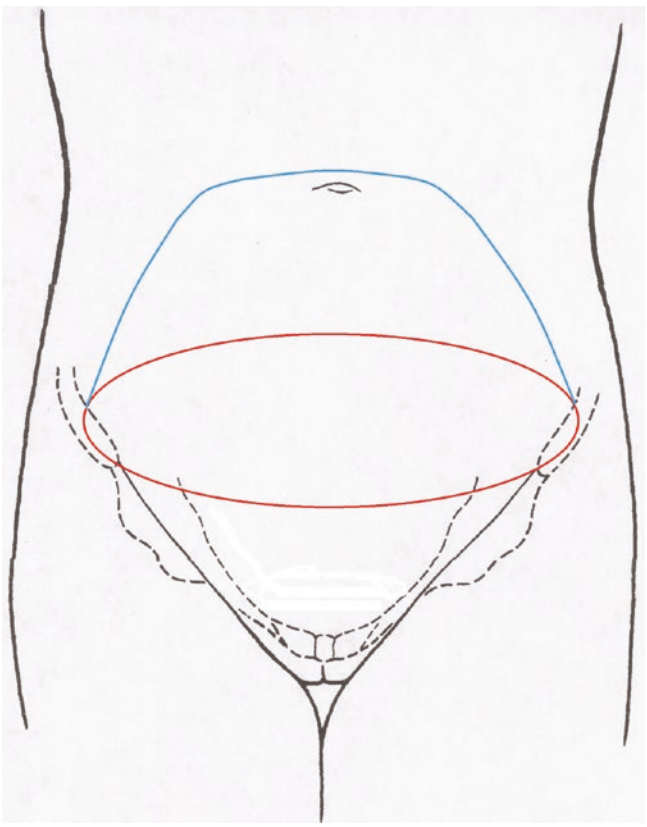


Fig. 84.6 A modest panniculectomy may be performed to enhance exposure or as an adjunctive procedure. The skin incision, shown in red, may be taken below the umbilicus (as shown here) or above the incision. The two ends of the incision generally must be tailored to avoid flaps of redundant tissue or dog ears. Skin, superficial fascia, and fat are removed within the outline of the ellipse so that the underlying musculoaponeurotic layers of the abdominal wall are cleanly seen. Generous undermining (*shown in blue*) is required to allow flap closure. If the umbilicus has not been excised, it will need to be repositioned cephalad (Reproduced with modifications from Scott-Conner [23])

Oblique and Hockey Stick Extensions

To obtain greater exposure at the lateral aspect of a Cherney or Maylard incision, mark a skin incision extending laterally and obliquely slightly cephalad. In the extreme case, the lateral aspect of this incision may be extended upwards in a so-called Hockey-stick configuration. Ligate and divide the deep inferior epigastric vessels (if not already done). Divide subcutaneous tissues and all muscular and aponeurotic layers of the abdominal wall as encountered. Preserve, if possible, any nerves (ilioinguinal or iliohypogastric) that are encountered. Close the medial aspect of the incision in the normal fashion, and the lateral extension in two layers as described below.

Subcostal and Chevron Incision

To make a classic subcostal (Kocher) incision, outline an oblique skin incision approximately 4 cm inferior and parallel to the costal margin on the side of interest. Do not hesitate to extend the incision across the midline if necessary to achieve adequate exposure. Divide the subcutaneous tissue along the same line until fascia is encountered. At the lateral aspect, the 8th thoracic nerve may be encountered and may need to be divided. The larger 9th thoracic nerve should be protected. These nerves are less likely to be injured if the incision is extended medially rather than laterally. Open the anterior rectus sheath and divide the rectus muscle with electrocautery. Take time to secure any small arteriolar bleeders in the muscle belly, as these may go into spasm and rebleed during the postoperative period. Ligate and divide the superior epigastric vessels in the rectus sheath.

The easiest place to enter the abdomen is through the posterior rectus sheath, which is well-developed above the umbilicus. Divide the peritoneum and confirm atraumatic entry. Extend the fascial and peritoneal incision medially and laterally for the full extent of the incision.

These incisions are usually closed in two layers using running synthetic slowly-absorbable suture such as 0 PDS. The first layer incorporates peritoneum, posterior rectus sheath (medially) and transversus abdominis and internal oblique (laterally). The second layer consists of anterior rectus sheath medially and external oblique laterally.

References

1. Muysoms FE, Antoniou SA, Bury K, Campanelli G, Conze J, Cuccurullo D, de Beaux AC, et al. European Hernia Society guidelines on the closure of abdominal wall incisions. Hernia. 2015;19:1–24.
2. Grantcharov TP, Rosenberg J. Vertical compared with transverse incisions in abdominal surgery. Eur J Surg. 2001;167:260–7.
3. Seiler CM, Deckert A, Diener MK, Knaebel HP, Weigand MA, Victor N, Buchler MW. Midline versus transverse incision in major abdominal surgery: a randomized, double-blind equivalence trial (POVATI:ISRCTN60734227). Ann Surg. 2009;249:913–20.
4. Brown SR, Tiernan J. Transverse versus midline incisions for abdominal surgery (Review). Cochrane Database Syst Rev. 2005;19(4):CD005199. doi:10.1002/14651858.CD005119.pub2. reviewed 2011.
5. Bickenbach KA, Karanicolas PJ, Ammori JB, Jayaraman S, Winter JM, Fields RC, Govindarajan A, Nir I, Rocha FG, Brennan MF. Up and down or side to side? A systematic review and meta-analysis examining the impact of incision on outcomes after abdominal surgery. Am J Surg. 2013;206:400–9.
6. Dragu A, Unglaub F, Wolf MB, Beier JP, Schnabl SMK, Kneser U, Leffler M, Horch RE. Scars and perforator-based flaps in the abdominal region: a contraindication? Can J Surg. 2010;53:137–55.
7. Bar-Meir ED, Reish RG, Yueh JH, McArdle C, Tobias AM, Lee BT. The Maylard incision: a low transverse incision variant seen in DIEP flap breast reconstruction. J Plast Reconstr Aesthet Surg. 2009;62:e447–52.
8. Alexander CI, Liston WA. Operating on the obese woman – a review. BJOG. 2006;113:1167–72.
9. Micha MD, Rettenmaier MA, Francis L, Willenberg R, Brown JV. "Medically necessary" panniculectomy to facilitate gynecologic cancer surgery in morbidly obese patients. Gynecol Oncol. 1998;69:237–42.
10. Bloomfield PI, Le T, Allen DG, Planner RS. Panniculectomy: a useful technique for the obese patient undergoing gynecological surgery. Gynecol Oncol. 1998;70:80–6.
11. Hopkins MP, Shriner AM, Parker MG, Scott L. Panniculectomy at the time of gynecologic surgery in morbidly obese patients. Am J Obstet Gynecol. 2000;182:1502–5.
12. Tillmanns TD, Kamelle SA, Abudayyeh I, McMeekin SD, Gold MA, Korkos TG, Johnson PR. Panniculectomy with simultaneous gynecologic oncology surgery. Gynecol Oncol. 2001;83:518–22.
13. Massenburg BB, Sanati-Mehrizy P, Ingargiola MJ, Jonatan Hernandez R, Taub P. Abstract 44: Outcomes and safety of combined abdominoplasty-hysterectomy versus the individual procedures. Plast Reconstr Surg. 2015;135:38–9.
14. Milloy FJ, Anson BJ, McFee DK. The rectus abdominus muscle and the epigastric arteries. Surg Gynecol Obstet. 1960;110:293–6.
15. Bamigboye AA, Hofmeyr GJ. Closure versus non-closure of the peritoneum at caesarean section: short- and long-term outcomes. Cochrane Database Syst Rev. 2014;8:CD000163. doi:10.1002/14651858. CD000163.pub2.
16. Gurusamy KS, Cassar Delia E, Davidson BR. Peritoneal closure versus no peritoneal closure for patients undergoing non-obstetric abdominal operations. Cochrane Database Syst Rev. 7:CD010424. doi:10.1002/14651858.CD010424.pub2.
17. Seiler CM, Bruckner T, Diener M, Papyan A, Folcher H, Seidlmayer C, et al. Interrupted or continuous slowly absorbable sutures for closure of primary elective midline abdominal incisions: a multicenter randomized trial (INSECT: ISRCTN24023541). Ann Surg. 2009;249:576–82.
18. Deerenberg EB, Harlaar JJ, Steyerberg EW, Lont HE, van Doorn HC, Heisterkamp J, et al. Small bites versus large bites for closure of abdominal midline incisions (STITCH): a double-blind, multicenter, randomized controlled trial. Lancet 2015; 386(10000):1254--1260 . pii: S0140-6736(15)60459-7. doi: 10.1016/S0140-6736(15)60459-7. [Epub ahead of print]..
19. Mackeen AD, Schuster M, Berghella V. Suture versus staples for skin closure after cesarean: a metaanalysis. Am J Obstet Gynecol. 2015;212:e1–10. doi:10.1016/j.ajog.2014.12.020. [Epub 2014 Dec 19].
20. Olofsson P. Opening of the abdomen ad modum Joel Cohen, Joel--Cohen, Joel-Joel-Cohen, or just Cohen? Acta Obstet Gynecol Scand. 2015;94:224–5.
21. Federici D, Lacelli B, Muggiasca L, Agarossi A, Cipolla L, Conti M. Cesarean section using the Misgav Ladach method. Int J Gynecol Obstet. 1997;57:273–9.
22. Nanni G, Tondolo V, Citterio F, Romagnoli J, Borgetti M, Boldrini G, Castagneto M. Comparison of oblique versus hockey-stick surgical incision for kidney transplantation. Transplant Proc. 2005;37:2479–81.
23. Scott-Conner CEH, editor. Scott-Conner & Dawson essential operative techniques and anatomy. 4 ed. Philadelphia: Lippincott Williams & Wilkins; 2013.

Adhesions

85

Carol E.H. Scott-Conner

As surgeons, we want the abdominal incision to heal securely. If a bowel resection has done, we want the anastomosis to heal without leakage or stricture. These are all good and necessary outcomes from wound healing. We want to avoid hypertrophic skin scar formation and the formation of intra-abdominal adhesions. Unfortunately, the goal of secure wound healing without scar formation, including adhesion formation, remains elusive. Intra-abdominal adhesions form when the raw surfaces created during surgery heal together in an undesired manner. This is the topic of this chapter.

The first part of this chapter gives a brief overview of current knowledge of the pathogenesis of adhesion formation, and then segues into prevention strategies. While this information may seem to be of less value if fertility preservation is not a consideration, adhesions cause substantial morbidity in other ways, so this information is important for all surgeons.

The second part of the chapter deals with strategies for opening the abdomen and lysing adhesions. It includes information on identifying and fixing inadvertent enterotomies and the special surgical considerations involved when radiation enteritis is suspected or possible.

The Magnitude of the Problem

In the developed world, adhesions after previous surgery are the leading cause of small bowel obstruction [1, 2]. The Surgical and Clinical Adhesions Research Study (SCAR) used the Scottish NHS Medical Record Linkage Database to determine that the ten-year risk of readmission for adhesions after open gynecologic surgery was 4.5 % [1]. In a subsequent report, the same group looked at adhesion-related readmissions after gynecological laparoscopy or laparotomy [2]. Caesarian sections were excluded. They analyzed records from 24,046 patients and determined that laparoscopic gynecologic surgery (with the exception of laparoscopic sterilization) did not diminish the risk of subsequent adhesions when compared with open gynecologic surgery [2]. The risk of subsequent readmission was lowest after laparoscopic tubal sterilization procedures, and highest after laparoscopic adhesiolysis or cyst drainage [2]. Thus any intervention in the peritoneal cavity may set the stage for subsequent adhesion formation that may be sufficiently severe as to require later intervention.

Adhesions cause four general types of problems: pain, impaired fertility, small bowel obstruction, and difficult re-entry if second laparotomy required. The extent to which adhesions cause pain is somewhat controversial and beyond the scope of this chapter. Similarly, fertility preservation is not a consideration when hysterectomy is performed (although much of what we know about adhesion prevention comes from the gynecological fertility literature) and will not be discussed here. Thus the two areas of concern that are emphasized in this chapter are prevention of small bowel obstruction (as a complication of adhesions), and difficulty in performing a laparotomy if adhesions are present.

Pathogenesis of Adhesion Formation

As noted above, adhesions form between areas of injury. To a certain extent, they represent the natural healing response. Thus, it is predictable that adhesions will form to the underside of any incision, whether that is a formal laparotomy incision or the stab wounds associated with laparoscopic trocar placement.

Patients who have had remote peritonitis (for example, from a ruptured appendix or perforated duodenal ulcer) will often have adhesions related to that inflammatory process in addition to any adhesions they might exhibit from undergoing surgery. Such adhesions may even form in the complete absence of surgical intervention. A classic example of this would be perihepatic adhesions seen in Fitz-Hugh-Curtis

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syndrome as a sequela of previous previous gonococcal or chlamydial infection.

Endometriosis or pelvic inflammatory disease may similarly elicit a fierce inflammatory reaction, including formation of localized adhesions. Such adhesions may cause pain and infertility, and create difficulties in identifying tissue planes in the pelvis. While the general principles outline here are applicable to this situation, the majority of this chapter will deal with adhesions created by previous surgery.

Suspect adhesions any time a patient has undergone previous surgery, including laparoscopic surgery. While laparoscopic surgery eliminates the large raw surface associated with a major laparotomy incision, it may still be associated with local tissue trauma, creation of raw surfaces in the region of dissection, and the implantation of biomaterials.

Be particularly wary of performing laparotomy in patients who have had previous mesh repair of ventral incisional hernias.

Tissue injury and hypoxia cause oxidative stress which increases a variety of inflammatory mediators (Table 85.1) all of which have been implicated in adhesion formation [3, 4]. Unfortunately these mediators are also crucial for normal wound healing; for this reason, systemic or intraperitoneal agents targeting adhesion formation have largely failed. Barrier agents have proven some efficacy and are discussed in the subsequent section.

As fibrinous adhesions form, the fibrinolytic system is activated. A balance is thus created between adhesion formation and resolution (Fig. 85.1).

In addition to tissue injury, biomaterials elicit a "foreign body response" when implanted deliberately (such as when sutures are placed, or mesh used to close a ventral hernia defect) or accidentally (such as lint shed from laparotomy pads or powder from surgical gloves – both of these have been minimized by modern manufacturing processes). The first part of this response consists of a nonspecific protein adsorption phase that is not seen in the normal process of wound healing [5]. Thus, from the earliest phase, reaction elicited to sutures and other biomaterials starts down a pathway toward fibrosis.

Just as scars remodel over time, so do adhesions. General Surgeons traditionally prefer to re-enter the abdomen either very early (within the first week or so) or very late (after 6–12 months) in the postoperative period, in order to mini-

Table 85.1 Physiological mediators implicated in adhesion formation [1]

Tissue plasminogen activator
Transforming growth factor beta-1
Tumor necrosis factor-alpha α
Interleukin-6
Matrix metalloproteases
Vascular endothelial growth factor
Cyclo-oxygenase-2

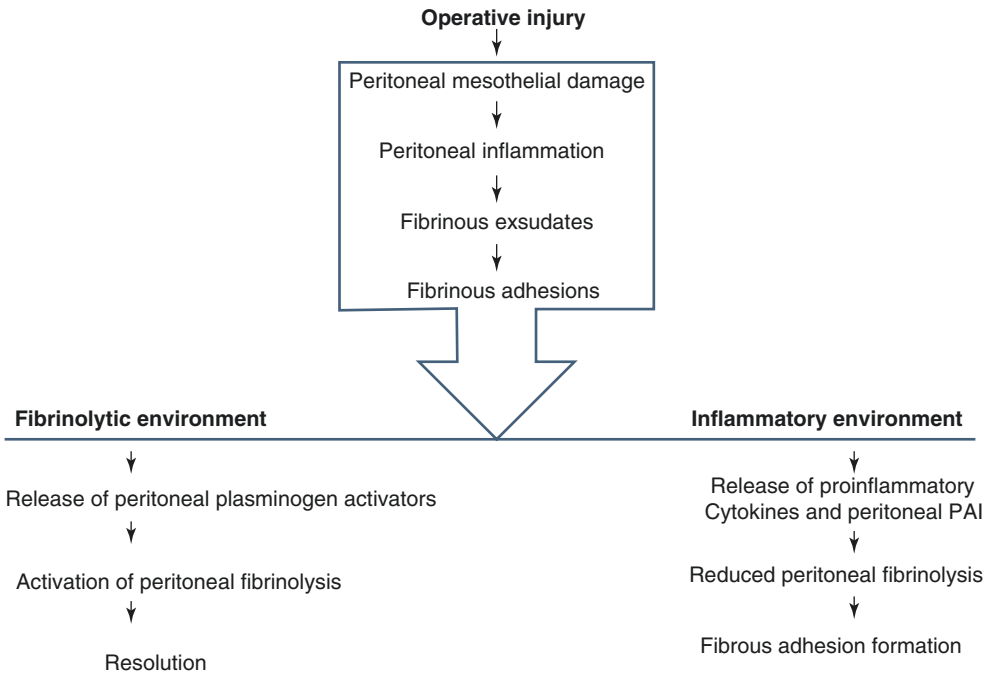


Fig. 85.1 Consequences of Operative Surgery (From: Mettler et al. [4]. With permission from Taylor & Francis Ltd., www.tandfonline.com)

mize problems with adhesions. If surgery has been limited to the pelvis (as, for example, hysterectomy) and the subsequent pathology report reveals an unexpected neoplasm that requires reoperation, gynecologic surgeons should be aware that delay beyond a week or two will make reoperation a bit more difficult. The primary difficulty lies in adherence of loops of small bowel to the incision and to each other. If surgery has been performed through a Pfannenstiel incision and limited to the pelvis, this is less likely to be an issue.

Early in the postoperative period, adhesions are largely fibrinous and loops of bowel may be easily separated without damage to adherent bowel. That early postoperative period rapidly gives way to a phase in which adhesions may be dense, vascular, and difficult to differentiate from bowel.

With time, the adhesions become "mature." During the maturation phase, many fibrinous adhesions probably dissolve, many adhesions become filmy and easy to deal with and others become dense and problematic. It is difficult to predict how adhesions will progress in an individual patient, or which adhesions will progress to dense fibrosis. It appears likely that anything that potentiates and perpetuates the inflammatory part of the cycle (as opposed to fibrinolysis) will lead to locally dense adhesions.

Prevention of Adhesions

A list of tactics for adhesion prevention are given in Table 85.2. First, it is crucial to emphasize general principles of gentle tissue handling. These include sharp dissection with complete hemostasis, avoiding mass ligatures, exposing only the area needed for surgery, and keeping exposed tissues moist. Meticulous hemostasis is important. Accumulation of serum and/or blood triggers fibrin clot formation and subsequent inflammation and fibrosis [6–12].

Second, if possible, place omentum under any upper abdominal incision and interpose it between anastomoses and the incision. Obviously, if omentectomy is part of a cancer operation, this is simply not feasible. But in most other situations omentum is available and should be used. Omentum can also be used to fill dead space and help prevention of fibrin clot formation.

If the omentum does not reach to a surgical site deep in the pelvis, create a vascularized omental pedicle by studying the vascular arcades, ligating the vascular arcade on one side and then developing a long tongue of omentum based upon the preserved arcade. In this manner, omental pedicles long enough to reach the brain have been created, so it can surely be made to reach into the pelvis!

Such an omental pedicle is a useful barrier to interpose between vaginal cuff and rectum, or to place over any bladder repair. Note that the barrier agents described later in this section may actually increase the risk of anastomotic leak and cannot be used for this purpose. Omentum, on the other hand, may help improve the local blood supply.

Omentum does not prevent adhesion formation but helps decrease the chance that a loop of bowel will become densely adherent to the incision or that a fistula between an anastomotic site and the incision will form.

No systemic therapy has proven safe and effective as everything that might potentially inhibit adhesion formation also interferes with wound healing [9]. A variety of agents have been investigated and local intraperitoneal or topical agents that can be applied directly to the surgical field have emerged as the most promising [11].

Instillation of various solutions such as Dextran or heparin into the peritoneal cavity has similarly not been particularly effective [9]. Gels are used for delivery of topical ("barrier") agents during laparoscopic surgery, primarily for fertility preservation. Most studies on these agents use fertility preservation as an end-point and hence may be of less value to the surgeon performing hysterectomy.

Barrier agents are interposed between the raw surfaces (such as the underside of the incision, or the pelvic floor after radical pelvic surgery) and the viscera. Three such agents have emerged as effective. These are: expanded polytetrafluroethylene (PTFE), hyaloruonic acid, and hyaluronate-carboxymethylcellulose membrane (Seprafilm). Studies have also shown that oxidized regenerated cellulose is effective in decreasing adhesion formation but data for prevention of small bowel obstruction is lacking [10].

These are generally available as sheets. They must be cut to size and handled with dry instruments. Careful hemostasis must be attained before placement of the barrier agent. The

Table 85.2 Tactics to decrease adhesion formation[a, b]

Gentle tissue handling
Avoid injury to serosa of bowel
Minimize use of foreign materials
Meticulous hemostasis
Use of omentum[a]
Barrier agents (Septrafilm, Interceed)

[a]Facilitates reoperation if needed, role in prevention of adhesions unproven

[b]Separate closure of the peritoneum has not been shown to decrease adhesion formation. If peritoneum is closed separately, use fine absorbable suture

agent is then carefully and gently introduced over the desired area, such as the underside of the incision or a raw area following pelvic dissection.

Barrier agents are not without problems. PTFE does not dissolve and must eventually be removed; thus its use is primarily limited to ventral hernia repair (where the lack of adhesion formation is a distinct benefit). In one systematic review and meta-analysis, Seprafilm decreased the rate of adhesion formation but increased the risk of intra-abdominal abscess and anastomotic leak [6]. The manufacturer's literature on Seprafilm states that it should not be wrapped directly around a fresh anastomosis, due to data from a post-approval study. A variety of previous studies designed to tackle the separate problem of anastomotic leakage have shown that isolating the anastomosis from the peritoneal cavity by wrapping it with anything other omentum increases leakage. Thus it does not appear prudent to place any of these agents directly against a bowel anastomosis or suture line. It should be noted that more recent meta-analysis did not confirm adverse events directly related to barrier agents, but studies vary in end-points and are often industry-sponsored [12].

Choice of Incision When Adhesions Are Likely

If at all possible, avoid an initial entry through the middle of an old incision. The easiest way to do this is by using an incision that goes in a different direction. Thus, when faced with a scar from an old vertical midline incision, a transverse incision may be an ideal choice. Table 85.3 lists some suggested options for various situations. The most difficult situation is midline re-entry in the setting of a previous long vertical midline incision ("from xiphoid to pubis"). In this situation, re-enter the abdomen through the upper part of the incision. Here you will encounter the left lobe of the liver and the stomach, which are more tolerant of injury and easier to repair than loops of small bowel (which will be encountered as the incision progresses inferiorly).

Of course, cosmetic considerations may dictate reoperation through the same incision. In such a case, it is important to be aware that the procedure may be complicated by local adhesions in the region of the incision.

Consider using ultrasound to map out adhesions to the underside of the incision. The "visceral slide" maneuver has been used to identify adhesion-free areas for laparoscopic trocar placement [12] and can easily be adapted to map out areas relatively free of adhesions under a laparotomy incisions. In this situation, the "adhesion-free" area would be the site chosen for initial entry into the peritoneum.

The visceral slide maneuver is based upon the observation that, in the absence of adhesions to the parietal peritoneal, loops of bowel and any other underlying viscera move a significant distance up and down (cranial and caudad) with respiration. Thus, the ultrasound transducer is placed with the long axis of the transduced parallel to the incision and underlying structures are visualized. With the transducer held steady, the awake patient is instructed to breathe deeply (or the anesthesiologist is asked to manually ventilate the patient in such a manner as to cause exaggerated respiratory excursions. Visceral slide is defined as "craniocaudal movement of the viscera greater than 50 % of the width of the screen, suggesting that the visualized viscera moved in an unrestricted manner" [13]. Several videos are available on YouTube under the topc "Visceral Slide", of which the one referenced by Minaker et al. [13] was accessed here (https://www.youtube.com/watch?v=dIyZ8Rd1T1E&feature=youtu.be) on September 19, 2015.

Table 85.3 Choice of incision in previously-operated abdomen

Old incision	Region desired to access	Options
Vertical midline or paramedian	Pelvis	Cherney, Maylard, or Pfannenstiel
Low vertical midline	Entire abdomen	Long vertical midline with initial entry through upper half of incision
Long vertical midline	Entire abdomen	Long vertical midline with initial entry through upper half of incision (over liver) Long vertical midline with ultrasound adhesion mapping to define best entry site
Upper abdominal vertical midline or paramedian	Pelvis	Low vertical midline Pfannenstiel, Cherney, or Maylard
Upper abdominal vertical midline	Entire abdomen	Long vertical midline with initial entry through lower half of incision
Long vertical midline or upper abdominal midline	Upper abdomen	Upper abdominal transverse incision such as a Kocher or chevron incision Re-enter old incision, consider ultrasound mapping
Upper or lower abdomen paramedian incision	Entire abdomen	Incorporate old paramedian in part of a long vertical midline incision to avoid "parallel incisions"

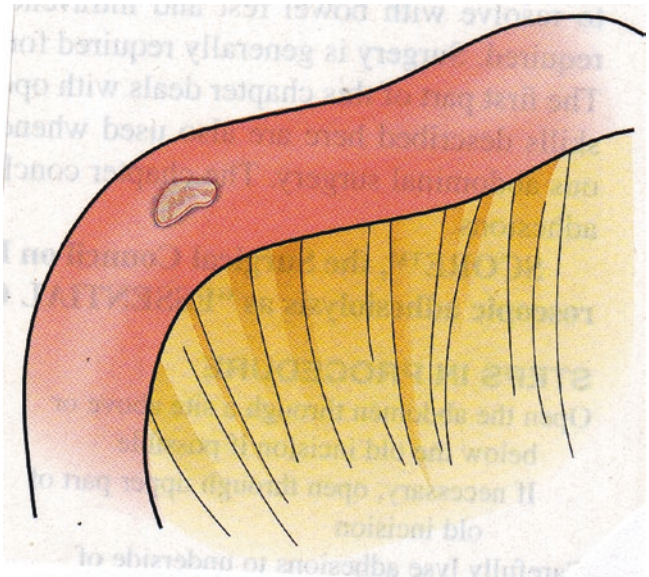


Fig. 85.2 A small button of peritoneum or fascia may be left adherent to small bowel if necessary (From: Scott-Conner [19], Fig. 88.1b with permission)

Lysis of Adhesions

As noted above, make the initial entry into the abdomen through an area likely to be free of underlying adherent small intestine. Tactics for this are described above. Generally, adhesions will be most dense along the line of the previous incision. Thus, once entry into the peritoneum is accomplished, gentle exploration of the underside of the incision both visually and by digital palpation helps establish the extent of the problem.

Do not attempt to open the entire extent of the fascial incision at once. Rather, having entered through a safe area, gradually extend the fascial incision as adhesions are lysed. Sometimes this is easily done, but at other times great patience is required. Do not hesitate to leave a small amount of peritoneum, scar tissue, or even a bit of old suture material adherent to a loop of densely adherent small intestine (Fig. 85.2). This is far preferable to chancing an intestinal injury by meticulously trying to separate bowel from incision.

Have an assistant elevate the abdominal wall by placing Kocher or Allis clamps on the edge of the fascia. You can then work under the fascia to take down adherent loops of bowel (Fig. 85.3).

Avoid use of electrocautery and use sharp dissection with Metzenbaum scissors or scalpel. When adhesions are very dense, sharp dissection by shaving a layer of abdominal wall off and allowing it to remain adherent to the bowel is the best approach. A scalpel is the best tool for this type of dissection.

If possible, pass a finger or two behind the loop of bowel and gently pull downwards as you work (Fig. 85.4). Be aware that the adhesion may have a greater tensile strength than the adherent small bowel. Do not tear the small bowel by pulling too hard on it.

Once the entire length of the incision is open and all adhesions to abdominal wall have been lysed, proceed with exploration as planned. It may not be necessary to lyse all remaining adhesions. Remember, adhesions form to areas of injury, so adhesiolysis is apt to result in formation of more adhesions.

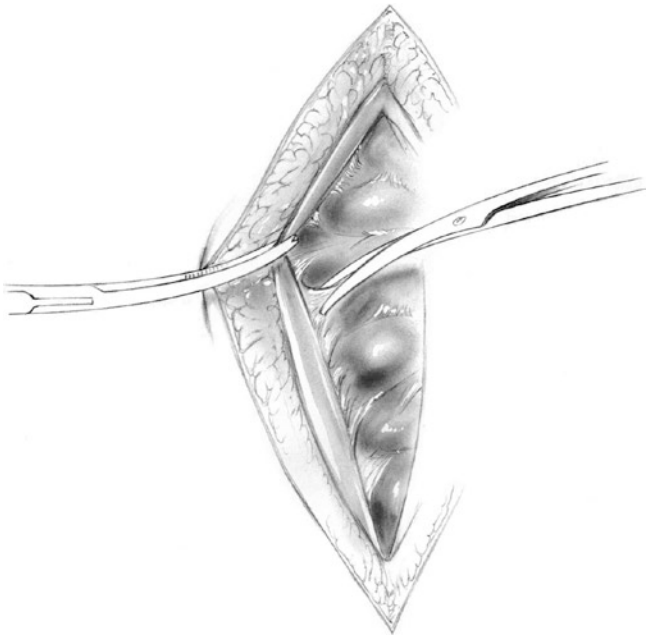


Fig. 85.3 With an assistant elevating the abdominal wall, sharply lyse underlying adherent loops of bowel (From: Scott-Conner [20]. Fig. 44.1 with permission)

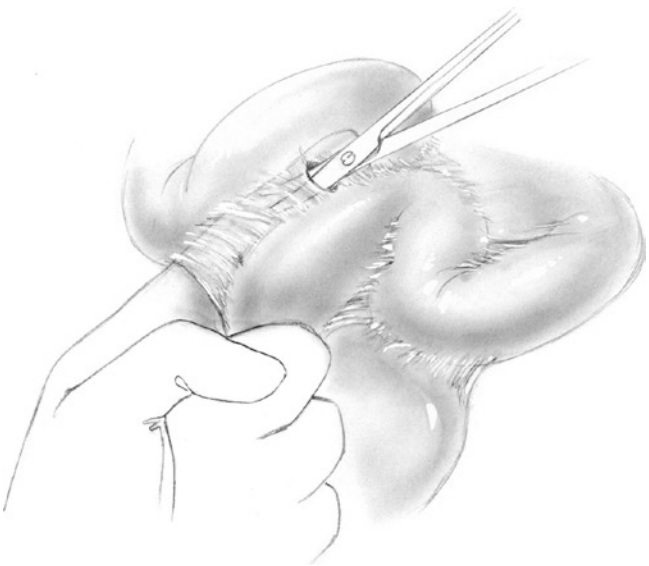


Fig. 85.4 Pass a finger behind adhesions, if possible, to define them better. Then sharply lyse the adhesio. (Scott-Conner [20]. Fig. 44.3 with permission)

Keep in mind the basic purpose of your operation, and only lyse those adhesions relevant to that purpose. In other words, if you enter the abdomen planning to do a radical hysterectomy for endometrial carcinoma and encounter a cocoon-like encasement of most of the small intestine by adhesions from previous surgery, consider carefully whether lysing these adhesions is important to your cancer surgery. Do not lyse adhesions simply because they are there.

An exception might be band-like adhesions from abdominal wall to underlying viscera or between loops of viscera; these can be sites for future small bowel obstruction due to internal hernia formation. Such bands are easily divided.

Dealing with Inadvertent Enterotomies

Unfortunately, even with the best surgical technique, the bowel is sometimes injured. This is most likely to happen during entry into the abdominal cavity. Injuries may be partial thickness or full thickness.

A difficult situation arises when bowel is injured early in the initial phases of laparotomy, when the loop of intestine is only partially exposed and often still adherent to the underside of the abdominal wall. Liquid small intestinal contents (succus entericus, or succus) pour out freely. Anticipate this possibility and have suction and laparotomy pads readily at hand so that succus can be contained. The hole is likely to get larger as the loop of bowel is freed. Try to limit the extent of injury by continuing your careful dissection. If necessary, put a stitch in to control the flow of succus but do not attempt repair until the loop is completely freed. A limited injury to the antimesenteric surface of the bowel (the commonest site) may be repaired transversely with the gastrointestinal suturing technique of your choice. There is much to be said for the security of an old-fashioned hand-sutured two-layer repair in this situation.

While it is beyond the scope of this chapter to describe techniques for bowel anastomosis, these are well-described in standard textbooks of general surgery. The surgeon who is not confident in the use of these techniques is urged to consult a more experienced colleague if bowel repair is required.

If a segment of bowel has multiple injuries or is otherwise battered, a limited segmental resection with primary anastomosis is a good choice. Here surgical staplers may speed resection and closure.

Partial thickness injuries may or may not require repair. If the injury extends into or through the submucosa, repair is prudent. Assess this by gently squeezing the loop of bowel to cause the segment with the injury to balloon out (Fig. 85.5).

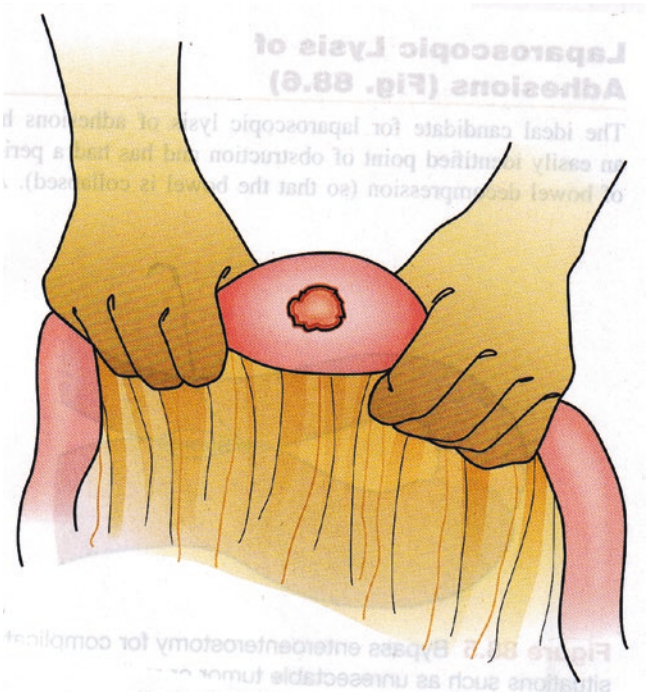


Fig. 85.5 A partial thickness injury requires repair if it "balloons" out when the segment of bowel is squeezed (From: Scott-Conner [19], Fig. 88.3a with permission)

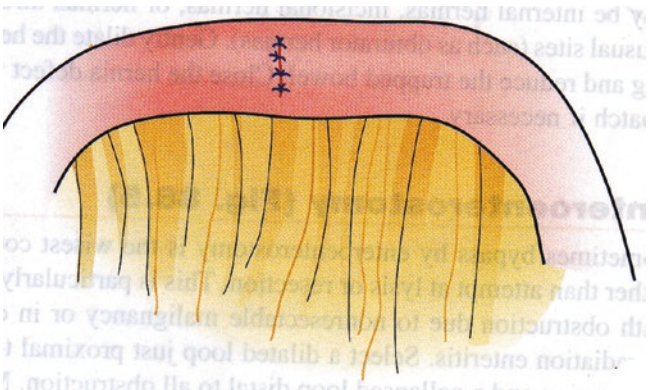


Fig. 85.6 Repair a partial-thickness bowel injury with several interrupted sutures that reapproximate the outer layers of bowel (From: Scott-Conner [19], Fig. 88.3b with permission)

If the injured area protrudes beyond the contour of the bowel, then the injury is deep and should be repaired. Do this with a couple of simple interrupted sutures placed in such a manner as to reapproximate the outer layers of the bowel (Fig. 85.6).

If a partial thickness injury does not balloon out, it may not require repair. However, in any doubtful situation, it is better to repair than to risk delayed perforation.

Radiation Enteritis

Radiation damages healthy tissues, including bowel. Acute radiation effects, and tactics for prevention of radiation injury are beyond the scope of this chapter. The important thing to recognize is that radiation damage to the small intestine and adjacent tissues is a chronic, progressive condition. Be wary when operating upon any patient who has a history of pelvic radiation.

The "magic window" for operating within a radiated field is very narrow; only about 6–8 weeks after radiation therapy has been completed. This is the time interval classically employed for planned resection after radiation has been administered, for example when low anterior resection of the rectum is done after radiation with or without chemotherapy. After this time, surgery becomes slowly but inexorably more difficult and more dangerous as the late effects of radiation dominate the clinical picture.

The late effects of radiation include tissue fibrosis and obliteration of small blood vessels causing a progressive obliterative endarteritis. A vicious cycle is established in which the resulting ischemia potentiates the formation of additional fibrosis, thus worsening the ischemia; and any new vessels and lymphatics that form are telangiectatic and dysfunctional [14, 15].

For the surgeon, normal tissue planes may be lost, and radiated tissue does not heal well. For the gynecologist, the tissues of concern are primarily small intestine and ureter. An additional consideration is that dead space created during dissection may not fill in normally, and a vascularized flap (such as rectus muscle) may be necessary.

All of this implies that entry into the abdomen and adhesiolysis must be undertaken with special care. An inadvertant enterotomy in radiated bowel creates the potential for devastating complications. Simple repair of an enterotomy made in radiated bowel is unlikely to heal well, and segmental resection with primary anastomosis in unaffected bowel is the best approach. Sometimes it is easy to determine the most severely affected bowel by its thickness and fibrotic appearance, but not always [16–18].

Often, when the previous radiation was pelvic, the area affected is the terminal ileum, and it is fairly well demarcated. In other cases, the delineation between normal and radiated bowel can be difficult to ascertain. The surgeon must strike a balance between preservation of small bowel length and desire to create an anastomosis in "normal" bowel.

The largest experience with radiation enteritis comes from specialized teams doing planned bowel resection when other treatment has failed [16–18]. Surgery of this kind is appropriately viewed as a last resort. Their experience suggests that anastomotic leakage can occur in up to 30 % of patients undergoing resection, with 40–60 % of patients requiring repeat surgery. Careful preoperative preparation, including correction of nutritional deficits, smoking cessation, physical therapy, and use of a critical path detailing the preoperative and postoperative management have improved results somewhat. Hyperbaric oxygen treatment has been used to assist healing, although benefit is difficult to prove [16–18].

References

1. Lower AM, Hawthorn RJS, Ellis H, O'Brien F, Buchan S, Crowe AM. The impact of adhesions on hospital readmissions over ten years after 8849 open gynaecological operations: an assessment from the Surgical and Clinical Adhesions Research Study. Br J Obstet Gynaecol. 2000;107:855–62.
2. Lower AM, Hawthorn RJS, Clark D, Boyd JH, Finlayson AR, Knight AD, Crowe AM, on behalf of the Surgical and Clinical Research (SCAR) Group. Adhesion-related readmissions following gynaecological laparoscopy or laparotomy in Scotland: an epidemiological study of 24,046 patients. Hum Reprod. 2004;19:1877–85.
3. Braun KM, Diamond MP. The biology of adhesion formation in the peritoneal cavity. Semin Pediatr Surg. 2014;23:336–43.
4. Mettler L, Sammur W, Scholmeyer T, Alkatout I. Cross-linked sodium hyaluronate, an anti-adhesion barrier gel in gynaecological endoscopic surgery. Minim Invasive Ther. 2012;16:1–6.
5. Ratner BD, Bryant SJ. Biomaterials: where we have been and where we are going. Annu Rev Biomed Eng. 2004;6:41–75.
6. Zheng Q, Yu Z, You J, Zhang Q. Efficacy and safety of Seprafilm for preventing postoperative abdominal adhesion: systematic review and meta-analysis. World J Surg. 2007;31:2125–31.
7. De Wilde RL, Brölmann H, Koninckx PR, Lundorff P, Lower AM, Wattiez A, Mara M, Wallwiener M, The Anti-Adhesions in Gynecology Expert Panel (ANGEL). Prevention of adhesions in gynaecological surgery: the 2012 European field guideline. Gynaecol Surg. 2012;9:365–8.
8. Practice Committee of the American Society for Reproductive Medicine in collaboration with the Society of Reproductive Surgeons. Pathogenesis, consequences, and control of peritoneal adhesions in gynecologic surgery: a committee opinion. Fertil Steril. 2013;99:1550–5.
9. Ahmad G, Mackie FL, Iles DA, O'Flynn H, Dias S, Metwally M, Watson A. Fluid and pharmacological agents for adhesion prevention after gynaecological surgery. Cochrane Database Syst Rev. 2014;9:CD001298.
10. ten Broek, Stommel MWJ, Strik C, van Laarhoven CJHM, Keus F, van Goor H. Benefits and harms of adhesion barriers for abdominal surgery: a systematic review and meta-analysis. Lancet. 2014;383:48–59.
11. Hindocha A, Beere L, Dias S, Watson A, Ahmad G. Adhesion prevention agents for gynaecological surgery: an overview of Cochrane reviews. Cochrane Database Syst Rev. 2015;1:CD011254. pub 2
12. Ahmad G, O'Flynn H, Hindocha A, Watson A. Barrier agents for adhesion prevention after gynaecological surgery (review). Cochrane Database Syst Rev. 2015;4:CD00475. pub3

13. Minaker S, MacPherson C, Hayashi A. Can general surgeons evaluate visceral slide with transabdominal ultrasound to predict safe sites for primary laparoscopic port placement? A prospective study of sonographically naïve operators at a tertiary center. Am J Surg. 2015;209:804–9.
14. Theis VS, Sripadam R, Ramani V, Lal S. Chronic radiation enteritis. Clin Oncol. 2010;22:70–83.
15. Harb AH, Fadel CA, Sharara AI. Radiation Enteritis. Curr Gastroenterol Rep. 2014;16:383–92.
16. Li N, Zhu W, Gong J, Li Y, Yu W, Chen Q, Ni L, Zhang L, Gu L, Li J. Ileal or ileocecal resection for chronic radiation enteritis with small bowel obstruction: outcome and risk factors. Am J Surg. 2013;206:739–47.
17. Kalaiselvan R, Theis VS, Dibb M, Teubner A, Anderson ID, Shaffer JL, Carlson GL, Lal S. Radiation enteritis leading to intestinal failure: 1994 patient-years of experience in a national referral centre. European J. Clin Nutr. 2014;68:166–70.
18. Zhang L, Gong J-F, Dong J-N, Zhu W-M, Li N, Li J-S. Effectiveness of a clinical pathway for inpatients undergoing ileal/ileocecal resection for chronic radiation enteritis with intestinal obstruction. Am Surg. 2015;81:252–8.
19. Scott-Conner CEH, editor. Scott-Conner & Dawson essential operative techniques and anatomy. 4th ed. Philadelphia: Lippincott Wolters Kluwer; 2014.
20. Scott-Conner CEH, editor. Chassin's operative strategy in general surgery. 4th ed. New York: Springer Verlag; 2014.

Comorbidities and Abdominal Hysterectomy

86

Katherine Nixon and Christina Fotopoulou

Pre-admission Review

Before any planned hysterectomy it is advisable for patients to be seen in a pre-admission clinic. In this setting their medical history can be established and any pre-operative investigations carried out. For the majority of patients, planned for abdominal hysterectomy due to a malignancy, it is recommended to check a full blood count, renal profile, liver profile and clotting, plus have a valid group and save or cross match available for the day of surgery. In the case of ovarian malignancy where neo-adjuvant chemotherapy has been used, it is vital to know when the last cycle of chemotherapy has been given and have an up to date white cell- and neutrophil level as these may be reduced. Albumin level may also be low as a reflection of nutritional status and fluid balance; this may affect intra and post-operative fluid management. An ECG is usually performed to pick up possible pre-existing cardiac conditions and if there is suspected respiratory disease, lung function tests may also be recommended along with a chest xray. Any concerns should be raised with the surgical and anaesthetic teams involved.

Key Points

1. Be pro-active with investigating and optimizing patients' condition pre-operatively
2. Involve multi-disciplinary team with the planning of procedures

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Obesity

Patients who are overweight or obese have a significantly higher risk of complications peri- and post operatively. High BMI can affect both the practicalities of the procedure and the medical outcomes for the patients involved. A multidisciplinary approach is needed to help these patients on their surgical pathway. Patients should be weighed either in clinic or on admission to the ward and theatre staff need to be informed in advance if a patient is significantly overweight, to ensure the correct theatre bed and transport trolleys are used. Different equipment may be needed by the surgical team e.g. longer instruments for the deeper pelvis or larger retractors. From an anaesthetic point of view, obesity provides obstacles with IV access, medication dosing and response, ventilation and monitoring. Increasing weight has been shown to trend with higher risk of surgical complications such as bleeding and injury to surrounding structures.

Post operatively there is a larger incidence of Deep venous thrombosis and pulmonary embolus amongst the overweight population undergoing abdominal hysterectomy. During surgery it is therefore recommended to provide prophylaxis with either TED stockings or ideally devices such as Flowtron boots. Post-operatively therapeutic prophylaxis with low molecular weight heparin should commence as soon as deemed clinically safe. Early mobilization is important and physiotherapists can help with this on the ward.

Obesity also has an associated increased risk of wound breakdown and infection post abdominal hysterectomy [3]. This may affect the type and position of abdominal entry and closure method. It is important to avoid abdominal folds in the presence of a pannus where possible as this will be the area most likely to be colonized with bacteria and yeasts. Fast absorbable sutures with antibacterial coating agents such as Tricosan decrease wound infection rates and do not appear to increase the hernia rate, after midline abdominal incision, compared with slowly absorbable sutures [1]. The development of incisional hernia is significantly increased in patients with a BMI > 30 kg/m^2.

Specialised wound care post-operatively is essential to decrease the risk of infection. Tissue viability is a concern

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with all surgical patients but especially the obese and specialist teams can be used to help prevent skin breakdown and pressure sores.

Key Points
1. High BMI increases surgical complications
2. MDT involvement essential e.g. tissue viability, physiotherapists
3. VTE prophylaxis with low molecular weight heparin, early mobilisation

Diabetes

Linked to rising obesity levels are increasing rates of type 2 diabetes [2]. These patients may require more input pre, peri and postoperatively. Cardiac events are more likely to occur in this group of patients therefore they should always have had an ECG prior to surgery. Blood sugar control may be affected by being nil by mouth for surgery therefore, where possible, these patients should be operated on first thing. Intra-operatively blood sugars should be monitored and it may be necessary to start an insulin sliding scale which should be continued until eating and drinking can be resumed post-operatively and normal medication regimes recommenced.

Incidence of diabetes is increased in postmenopausal women, due to the lack of ovarian affect on glucose uptake and insulin sensitivity [2]. The additional performance of bilateral salpingoophorectomy (BSO) at the time of the hysterectomy in premenopausal women may negatively impact the overall hormonal axis, therefore women with diabetic predisposition may be at higher risk of developing insulin resistance and, subsequently, diabetes. Review of diabetic status may be advised in follow up.

Cardiovascular studies have also shown that, after surgery, young premenopausal women who had undergone BSO had higher levels of atherogenic and stress-induced lipids. They also tended to have higher circulating levels of epinephrine and stress-induced systolic and diastolic blood pressure compared to women who had undergone hysterectomy only. This is consistent with the hypothesis that presence of ovarian hormones plays a key role in determining a woman's risk factor status [4].

Key Points
1. Be conscious of at risk populations for pre-operative assessment and post operative follow up

Anaemia and Blood Transfusion

Transfusions are more common amongst patients having open procedures generally but especially in the presence of malignancy. Patients are often anaemic beforehand and with the presence of masses, large debulking procedures and potential clotting derangement the need for a transfusion is likely to increase. All patients undergoing hysterectomy should be consented for transfusion prior to surgery. In cases of patients refusing transfusion like in the case of Jehovas witnesses, the case should be discussed with all members of staff involved to ensure an appropriate and safe management plan is agreed upon. The patient's wishes regarding all blood products should be obtained and documented clearly, patients may have a written advanced directive confirming which if any blood products they will accept.

In cases where transfusion is refused, haemoglobin levels should be optimized as much as possible pre-operatively, testing for deficiencies with bloods for haematinics can be useful in guiding prescription of folic acid, ferrous preparations or B12. In the absence of malignancy and if auto--transfusion is accepted by the patient, Cell Saver® equipment should be organized and on standby in theatre if available.

Intra-operatively, the use of diathermy equipment for dissection and coagulation is advised in order to reduce blood loss; this can also be aided through administration of antifibrinolytic medications such as Tranexamic Acid. Use of haemostatic agents like Floseal® or Tachosyl® may also help.

Key Points
1. Discuss transfusion with all patients and discern their wishes
2. Optimise pre-operative haemoglobin
3. Use of intra-operative techniques for haemostasis

Respiratory Diseases

Identifying pre-existing comorbidities is vitally important both for the surgeon but also for the anaesthetic team. Abdominal hysterectomy is a major procedure and can take from less than one to several hours depending on the extent of surgery required. Respiratory conditions (such as COPD, asthma or fibrotic lung disease) can affect ventilation during the surgery, increase the risk of hospital acquired pneumonia and prolong recovery and hospital stay. Pre and post procedure it may be recommended for patients to have nebulisers, any regular inhalers should be prescribed and their use encouraged. Specialist chest physiotherapists and use of

incentive spirometry on the ward may help to reduce the risk of post-operative atelectasis and infection.

Preoperative ergometry exercises can additionally quantify and predict the level of stress that a patient might tolerate postoperatively.

Key Points

1. Pre-operative involvement of Anaesthetists and recommended investigations
2. Post-operative use of physiotherapists and spirometry equipment to improve respiratory function

Radical Surgery

A radical hysterectomy may be recommended for patients with early stage cervical cancer. This procedure involves removal of the uterus, cervix, top of the vagina, and as much parametrial tissue as possible ± pelvic and para-aortic lymph node dissection ± bilateral salpingoophorectomy.

All abdominal hysterectomies can be complicated by previous surgery, the presence of endometriosis or previous infection which may have caused adhesions. These will increase the risk of surgical complications and this is more apparent in radical surgery where navigation of the abdominal planes is vital for operative safety and outcome.

Because of the location and extensive nature of the surgery, ureteric injury is more common than with a routine extra fascial hysterectomy. Ideally, these injuries will be recognized at the time of surgery and repair/stenting can take place straight away, alternatively, if not noticed they may present post-operatively. One should be suspicious of a ureteric injury in the presence of deranged renal function, haematuria or reduced urine output post op.

Bladder dysfunction is also significantly increased in this population of patients compared to routine hysterectomy due to denervation of the bladder. Either an indwelling or suprapubic catheter should be left in the bladder for the immediate post-operative period. Patients unable to void or with high residual urine volumes following removal of their catheter may need to have the indwelling catheter replaced for a longer time period or carry out intermittent self catheterisation. Most voiding difficulties will resolve within 2–3 weeks.

With radical surgery, especially when used in conjunction with radiotherapy, although a rare complication, there is an increased frequency of uretero-vaginal/vesical fistulas which can cause significant morbidity to patients' bladder and sexual function. Studies investigating sexual dysfunction following radical hysterectomy, looking at different factors both physical and mental, have found that although sometimes present in the post-operative period it is short lasting and less severe than experienced by patients undergoing radiotherapy [5].

Key Points

1. Radical surgery may be indicated for certain conditions
2. The extent of the surgery should be discussed with patient and balanced against potential complications/comorbidites and resultant quality of life
3. Bladder dysfunction is the most common complaint following radical surgery

Advanced Age

Decreased physiologic reserve and increased number of underlying medical disorders affecting the older patient cohort results in a basic elevated risk for intra- and postoperative complications. This is evident in cases of large uterus, with high intra-operative blood loss and in the presence of additional risk factors like malignancy. Various preoperative assessment scores, for the elderly, have been developed, however, none has so far been validated for the gynaecological population or for the hysterectomy procedure. A preoperative geriatric assessment tool, commonly used for elderly women with endometrial cancer planned for abdominal hysterectomy, is PACE (Pre-operative assessment of cancer in the elderly) [6]. This should be routinely incorporated into the pre-operative evaluation and operability assessment of elderly patients, prior to indication for surgery, in order to balance the risks and benefits of the procedure in this more fragile population.

Final Points

All surgical procedures require a multidisciplinary approach to ensure the right patient is receiving the right care. Pre-existing conditions may influence the management before admission and the type of procedure planned. It is important to know both the patient's medical history and social situation pre-operatively to help predict how they might behave clinically and psychologically post-operatively.

Patients must be counselled thoroughly about the benefits and risks of the procedure. Patients with little support at home may require longer hospital care, or transfer for

respite care during their recovery. Patients who are more frail from medical conditions or age may not be suitable, from a performance status point of view, for more radical procedures and this must be discussed with them and possible alternatives offered, as surgery in these cases could reduce quality of life whilst not prolonging it. Patient centred care should be the focus of management and surgical planning.

References

1. Justinger C, Slotta JE, Schilling MK. Incisional hernia after abdominal closure with slowly absorbable versus fast absorbable, antibacterial-coated sutures. Surgery 2012 Mar;151(3):398-403. doi: 10.1016/j.surg.2011.08.004. Epub 2011 Nov 16.
2. Appiah D, Winters SJ, Hornung CA. Bilateral Oophorectomy and the Risk of Incident Diabetes in Postmenopausal Women. Diabetes Care. 2014;37(3):725–33.
3. Khavanin N, Lovecchio FC, Hanwright PJ, Brill E, Milad M, Bilimoria KY, Kim JYS. The influence of BMI on perioperative morbidity following abdominal hysterectomy. Am J Obstet Gynecol. 2013;208(6):449.e1–6.
4. Stoney CM, Owens JF, Guzick DS, Matthews KA. A natural experiment on the effects of ovarian hormones on cardiovascular risk factors and stress reactivity: bilateral salpingo oophorectomy versus hysterectomy only. Health Psychol. 1997;16(4):349–58.
5. Frumovitz M, Sun CC, Schover LR, Munsell MF, Jhingran A, Wharton JT, Eifel P, Bevers TB, Levenback CF, Gershenson DM, Bodurka DC. Quality of Life and Sexual Functioning in Cervical Cancer Survivors. J Clin Oncol. 2005;23(30):7428–743.
6. Pope D, Ramesh H, Gennari R, et al. Pre-operative assessment of cancer in the elderly (PACE): a comprehensive assessment of underlying characteristics of elderly cancer patients prior to elective surgery. Surg Oncol. 2006;15(4):189–97.

Subtotal Abdominal Hysterectomy

87

Zouhair Amarin

Introduction

Anatomically, the uterus consists of two parts, the uterine body and the cervix. A total hysterectomy involves the removal of both the uterine body and the cervix; a subtotal hysterectomy involves the removal of only the uterine body, leaving the cervix insitu (Fig. 87.1). Subtotal hysterectomy is also referred to as supracervical hysterectomy.

The first abdominal hysterectomy, a subtotal operation, was performed by Charles Clay in Manchester, England in 1863, unfortunately the patient died [1, 2]. Subtotal hysterectomy remained the standard type until the late 1920s, when total abdominal hysterectomy was introduced in 1929 by the American surgeon E. H. Richardson, to avoid serosanguinous discharge from the cervical stump and development of carcinoma of the cervix [3]. Subsequently this method became the predominant way of removing the uterus for both malignant and benign disease of the uterus [4–7].

In the last three decades, there has been some evidence of a shift from performing total abdominal hysterectomy to subtotal abdominal hysterectomy as a less invasive procedure for treating benign gynaecological disorders [8–13].

Abdominal hysterectomy, total or subtotal, is the most commonly performed major gynecologic operation [14], and is the second most frequently performed surgical procedure (after cesarean section) for women who are of reproductive age [15]. There is considerable variation in rates between countries, ranging between 1.2 per 1000 and 5.4 per 1000 women [16, 17]. Almost 20 % of women will have a hysterectomy by the age of 55 years [10, 18]. The rates of hysterectomy for benign indications are decreasing. Uterine leiomyoma remains the most common benign indication for hysterectomy [19].

Hysterectomy is usually highly effective in curing serious conditions. A substantial number of women have marked improvement in their symptoms following hysterectomy, as well as significant improvement in their overall physical and mental health [20], but like any other surgery, hysterectomy has certain risks and side effects [21]. In the treatment of menorrhagia, hysterectomy is associated with a decrease in lower abdominal pain, but has no beneficial effects on back pain [22].

It has been suggested that hysterectomy may disrupt the blood supply to the ovaries. Research demonstrated that the postmenopausal ovary remains a critical source of androgen throughout the lifespan of older women. The clinical consequences of lower testosterone levels years after oophorectomy are unknown [23].

Estrogen levels fall sharply when the ovaries are removed at hysterectomy. This is often referred to as "surgical menopause". It has been shown that risk of subsequent cardiovascular disease is substantially increased for women who had hysterectomy before the age of 50 [24, 25]. Other studies have found that osteoporosis and increased risk of bone fractures are associated with hysterectomies [26, 27]. "Surgical menopause" before the age of 45 is associated with a fivefold mortality from neurologic and mental disorders [28]. Reconsideration of prophylactic oophorectomy at hysterectomy has been suggested [23].

The risk of vaginal prolapse is approximately doubled after hysterectomy, total or subtotal [29]. There are some reports of an increased risk of the relatively rare renal cell carcinoma after hysterectomy [30]. The increased risk is more prevalent in young women, and may be related to an undiagnosed hereditary leiomyomatosis and renal cell cancer syndrome. On extremely rare occasions, sexual intercourse after total hysterectomy may cause a transvaginal evisceration of the small bowel [31].

Despite the prevalence of hysterectomy for treatment of benign gynecologic conditions, providers worldwide have been adopting minimally invasive surgical techniques. Surgical practice is being transformed from primarily open hysterectomy to traditional laparoscopic and minimally invasive hysterectomy, for all types; total, subtotal and vaginal hysterectomy; with a dramatic increase in the percentage of

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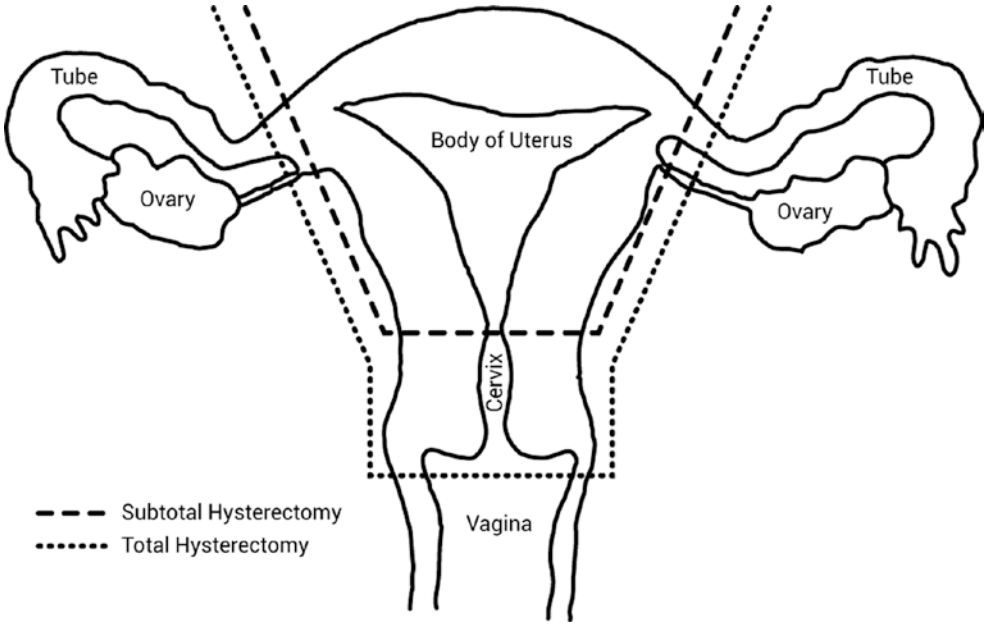


Fig. 87.1 Diagram showing difference between subtotal and total hysterectomy

robotically assisted hysterectomies. This paradigm shift is fueled by patient demand. Laparoscopic surgery is now the primary modality for performing hysterectomy amongst minimally invasive subspecialists. In some centres, the majority of hysterectomies are performed as outpatient procedures [32, 33].

Subtotal hysterectomy may be preferable to total hysterectomy because it may be technically easier to perform. Excising the uterine cervix at total abdominal hysterectomy is anatomically the most disruptive part of the operation since it disrupts the local nerve supply and anatomical relationships. Subtotal abdominal hysterectomy requires less mobilization of the bladder and less risk of injury to the ureters. It is also associated with less anatomical disruption, and perhaps, is associated with less adverse effects than total hysterectomy.

A meta-analysis of 34 studies comparing total and subtotal abdominal hysterectomy found that the operation time, peroperative bleeding, and postoperative complications were significantly lower in subtotal hysterectomy [34].

A randomised controlled trial of total compared to subtotal hysterectomy with 1 year of follow up, subtotal abdominal hysterectomy had a shorter operation time and less perioperative bleeding than total abdominal hysterectomy. Median operation time was 70 min (range: 34–165 min) for the subtotal abdominal hysterectomy group, and 85 min (range: 35–255 min) for the total abdominal hysterectomy group. The median per-operative bleeding was 250 mL (range: 10–2500 mL) for the subtotal abdominal hysterectomy group and 400 mL (range: 25–4500 mL) for total abdominal hysterectomy group [35].

After subtotal abdominal hysterectomy, residual amounts of endometrial tissue would be associated with cyclical vaginal bleeding in premenopausal women where the ovaries have been conserved. To prevent this, most gynaecologists advocate routinely "reverse conization" of the cervix, followed by endocervical cautery to ablate the cervical epithelium down to the transformation zone. In the author's series, utilizing this approach in subtotal abdominal hysterectomy, there have been no cases of cyclical vaginal bleeding in women whose ovaries were conserved, or in those who were prescribed combined hormone replacement therapy [36].

The concern that cancer might develop in the cervical stump should not be considered a justification for routine use of total abdominal hysterectomy as continued screening would cover this concern, considering that the risk of cervical cancer after subtotal abdominal hysterectomy is less than 0.1 % [37]. Nevertheless, after subtotal abdominal hysterectomy, women need to have regular Papanicolau smears testing and a minority of women may experience slight cyclical bleeding [35].

Abdominal hysterectomy is often combined with bilateral oophorectomy. Evidence is lacking to guide hormone replacement prescription following subtotal abdominal hysterectomy and bilateral oophorectomy [38]. Until such evidence become available, it is felt that hormone replacement therapy should include progesterone.

Although hysterectomy has been performed for over 150 years, an area of persistent controversy is whether the subtotal procedure, when the cervix is conserved, confers any benefits over total hysterectomy. Debate rages among gynaecologists themselves as to whether there are any benefits of one procedure over the other, hence the wide global variation in the comparative rates of subtotal and total hysterectomy.

In a survey regarding the attitude and practice of gynecologists to subtotal versus total abdominal hysterectomy, almost half of respondents always removed the cervix. The

Table 87.1 Comparative complications of subtotal versus total abdominal hysterectomy for benign uterine diseases

Intra-operative parameters
Blood loss (amount in ml)
Requirement for blood transfusion
Technical problem
Surgical injury
Conversion
Operating time
Post-operative parameters
Short term
Pyrexia
Haemoglobin level
Blood transfusion
Urinary tract infection
Any other infection
Urinary retention
Pelvic haematoma
Wound haematoma
Ileus
Vaginal bleeding
Length of hospital stay
Return to normal activities
Long term
Readmission to hospital related to surgery
Alleviation of pre-surgery symptoms
Bowel obstruction
Vault granulation
Cyclical vaginal bleeding
Dyspareunia
Sexual satisfaction
Ureter lesion
Urinary stress incontinence
Urinary urgency
Voiding dysfunction (incomplete emptying)
Vaginal or cervical stump prolapse
Small bowel obstruction
Persistent pain
Constipation
Incontinence (stool)
Quality of life (measured by validated scales)
Overall
Mortality

indication being the future risk of cervical cancer. The most common reason for subtotal hysterectomy was the intraoperative surgical difficulty. Few counseled women regarding the advantages and disadvantages of either total or subtotal hysterectomy [20, 39].

To compare the short-term and long-term outcomes of subtotal hysterectomy with total hysterectomy for benign gynaecological conditions, the main objectively measurable parameters of morbidity and mortality are listed in Table 87.1.

In general, the majority of studies demonstrate that the quality of life does improve from baseline (before surgery), regardless of the type of surgery. Many women feel that without the symptoms and trouble for which they have had the operation in the first instance, their life is improved thereafter [20, 22].

Urinary Function

Injury to the urinary tract is a frequent cause of litigation after total abdominal hysterectomy [40]. It occurs in 0.5–3.0 % of cases [41]. There is a lack of evidence from randomized controlled trials regarding ureteric or bladder injuries following subtotal abdominal hysterectomy compared to total abdominal hysterectomy. As probably would be expected, if such a difference does exist, it would be in favour of subtotal abdominal hysterectomy.

There is no evidence of a significant difference in the post-operative prevalence of stress incontinence, urinary urgency, urinary frequency, nocturia, urgency incontinence, poor stream, interrupted stream, and incomplete emptying between subtotal hysterectomy and total hysterectomy [42–44].

Urinary incontinence and vaginal prolapse may develop 10–20 years after hysterectomy, total or subtotal [45]. The risk for urinary incontinence is approximately doubled within 20 years after hysterectomy, with 2.4 fold increased risk for surgery for urinary stress incontinence following hysterectomy in general [46, 47].

Bowel Function

There is no evidence of a difference in the rates of constipation or incontinence of stools between the abdominal subtotal and total hysterectomy [43].

Sexual Function

The majority of women report improvement in sexual life after hysterectomy for benign indications, total or subtotal. A smaller proportion of women report worsening of sexual life [48]. Some patients who undergo a hysterectomy for chronic pelvic pain may continue to have the same problem after hysterectomy, total or subtotal, and may develop dyspareunia [49].

The frequency of intercourse, desire for intercourse, orgasm frequency, initiation of intercourse, dyspareunia and overall sexual outcome did not differ significantly between subtotal abdominal hysterectomy versus total abdominal hysterectomy [50–54].

Women contemplating a vaginal, laparoscopic, or abdominal hysterectomy for the management of benign uterine disease should be reassured that hysterectomy is usually associated with improved quality of life, including improved sexual function, whether or not the cervix is removed [42, 53, 55].

Quality of Life and Psychological Outcome

In general, women show improvement following both total and subtotal hysterectomy, with no significant differences between them in the amount of anxiety, depression, somatic symptoms and social function, between baseline (before surgery) and post-operative measurements [42].

Operation Time

The length of time required for surgery is significantly shorter for subtotal abdominal hysterectomy when compared with total abdominal hysterectomy [43, 44, 56]. The blood loss is significantly less in subtotal abdominal hysterectomy compared with total abdominal hysterectomy. In a randomised controlled trial of total compared with subtotal hysterectomy with one-year follow up results of 11 departments of obstetrics and gynaecology in Denmark, the median operation time was 70 min (range: 34–165 min) for the subtotal abdominal hysterectomy group and 85 min (range: 35–255 min) for the total abdominal hysterectomy group, $P < 0.0001$]. The median per-operative bleeding was 250 mL (range: 10–2500 mL) for the subtotal abdominal hysterectomy group and 400 mL (range: 25–4500 mL) for the total abdominal hysterectomy group ($P < 0.0001$) [27].

A meta-analysis of 34 studies comparing total and subtotal abdominal hysterectomy found that the operation time, peroperative bleeding, and postoperative complications were significantly lower in subtotal hysterectomy [35].

Perioperative and Postoperative Morbidity

In a study by the author to assess the morbidity of hysterectomy, 134 patients undergoing hysterectomy for benign gynaecological conditions were retrospectively analyzed, of which 90 (67 %) had total abdominal hysterectomies, and 44 (33 %) subtotal abdominal hysterectomies.

Menorrhagia constituted the commonest indication for both types of procedure (89.5 %). The majority of patients undergoing total abdominal hysterectomy (79 %) were given prophylactic antibiotics, in contrast to only 32 % of those undergoing subtotal abdominal hysterectomy [57].

The incidence of short term complications that included post-operative pyrexia, urinary retention, blood loss, hematoma formation, need for post-operative analgesia, low post-operative haemoglobin levels, blood transfusion, wound infection, wound re-suturing, urinary tract infection, and presence of vaginal vault granulation tissue for subtotal abdominal hysterectomy were lower than those for total abdominal hysterectomy. On the other hand, there was a higher incidence of abscesses, wound infection, pyrexia, use of antibiotics and longer hospital stay in the total-hysterectomy group [57].

With regard to intermediate and long term outcomes, there is no evidence of significant differences in the rates of persistent pain after discharge, pelvic prolapse or gynaecological cancer between the two types of hysterectomy. Less than 10 % of the subtotal abdominal hysterectomy patients experience cyclical vaginal bleeding [41].

Hysterectomy is a common, routine operation with comparatively rare serious complications. However, younger women, women with more vascular pelvis, who undergo hysterectomy, are at most risk of experiencing severe complications both intraoperatively and postoperatively, with a crude mortality rate of 3.8/1000 (2.5–6.4) [58]. The mortality rates for hysterectomy associated with pregnancy or cancer, standardized for age and race, are higher than for procedures not associated with those conditions. Hysterectomies associated with pregnancy or cancer constitutes around 10 % of all hysterectomies, but the majority of deaths occur among this category of patients [59]. As mortality at abdominal hysterectomy is such an infrequent event, there are no meaningful statistical comparisons comparing mortality of subtotal abdominal hysterectomy versus total abdominal hysterectomy.

Hysterectomy is occasionally performed as a peripartum procedure. Although uncommon in modern obstetrics, peripartum hysterectomy is mostly performed as an emergency procedure to control torrential life-threatening haemorrhage as a life-saving procedure [60–62].

Peripartum hysterectomy can be defined as the removal of the corpus uteri alone or with the cervix at the time of a caesarean section, or within the puerperium. The operation may be performed as an emergency or as a planned procedure [61, 62].

Despite advances in medicine and surgery, peripartum hysterectomy is associated with high rates of morbidity and mortality, with considerable differences in its incidence in different parts of the world, with higher figures in low-resource countries, while developed countries generally report lower rates [62, 63].

Emergency peripartum hysterectomy is more common following caesarean section than vaginal deliveries, with a significant association between emergency peripartum hysterectomy and previous caesarean section and placenta pre-

via. There is an increased incidence of previous caesarean section in patients with placenta previa and in patients with adherent placenta [64–74].

Worldwide, the incidence of emergency peripartum hysterectomy is rising. This is due to the rising caesarean section rate, and the concomitant rise in malplacentation and multiple births [75, 76].

Elective peripartum hysterectomy may be performed in women with an antepartum diagnosis of placenta accreta or stage IA2, IB1 and IIA1 cervical carcinoma [77]. Severe postpartum infection unresponsive to antibiotic therapy and placental site vessel subinvolution are potential indications for the procedure [78, 79].

Adequate resuscitation and prompt decision making for hysterectomy would contribute to decreasing maternal morbidity and mortality. Time is critical in decreasing the likelihood of coagulopathy, severe hypovolemia, hypothermia, and acidosis [80].

For peripartum hysterectomy, an experienced senior obstetrician with an experience in obstetric hysterectomy should be present at surgery. Of concern however, is the limited experience of performing emergency hysterectomy among some obstetricians. Emergency peripartum hysterectomy being performed by an experienced senior obstetrician would significantly reduce operating time, blood loss, number of units of transfused blood and maternal morbidity [81–83].

Patients at risk of caesarean hysterectomy should be scheduled for delivery at a time when appropriate ancillary staff with high-risk anesthetists, interventional radiologists and urologists are readily available [84]. Women should be counseled about the procedure, issues related to ovarian conservation and possible need for recovery in an intensive care unit. Some women that receive an emergency peripartum hysterectomy are primigravid. The fertility-ending nature of emergency obstetric hysterectomy can be devastating [85].

Peripartum hysterectomy may be either subtotal or total. Subtotal hysterectomy may be may be technically easier with shorter operating time, less blood loss, less risk of urological injury and lower morbidity. The cervix may be difficult to identify in a patient whose cervix is fully effaced and dilated, especially in cases of consumption coagulopathy that results in heavy hemorrhage that interferes with proper exposure [8, 86].

In cases of peripartum hysterectomy for placenta previa accreta, increta and percreta and if the cervix is involved in the haemorrhage, total hysterectomy will be necessary. The fetus is delivered through a classical uterine incision, and the intact placenta is left in situ while the hysterectomy is completed [87].

The technique of peripartum hysterectomy, total or subtotal, is similar in principle to that of abdominal hysterectomy for nonobstetric indications (in gynecology), except for the remarkable anatomical and physiological changes in pregnancy that result in gross enlargement and distention of all pelvic blood vessels. In addition, the parametrial tissues tend to be greatly oedematous and friable, rendering the procedure more surgically challenging.

The acute loss of blood and the unplanned nature of surgery render the conditions less than ideal to perform the procedure of peripartum hysterectomy. Compared with nonobstetric hysterectomy, peripartum hysterectomy is associated with higher rates of morbidity and mortality [88, 89].

In a population-based analysis to compare the morbidity and mortality of peripartum hysterectomy with nonobstetric hysterectomy. Bladder and ureteral injuries were more common for peripartum hysterectomy. Rates of reoperation, postoperative haemorrhage, wound complications, venous thromboembolism were all higher in women who underwent peripartum hysterectomy. In multivariable analysis, the odds ratio for death from peripartum compared to nonobstetric hysterectomy was 14.4 (95 % confidence interval 9.84–20.98) [88].

During peripartum hysterectomy, the application of tourniquet (catheter) around the uterine cervix can reduce blood loss. This is facilitated by the use of transillumination, where the avascular spaces in the broad ligament, at level of a transverse lower caesarean incision, can be identified. This would compress the uterine arteries and reduce blood loss. Subtotal hysterectomy is usually performed at this level. It is recommended that all pedicles should be doubly ligated.

There appears to be resurgence in subtotal hysterectomy. This review confirms that subtotal hysterectomy is faster with less blood loss and urinary tract injuries. With reverse conization of the endocervix in addition to endocervical cautery would significantly decrease, if not eliminate, the cyclical vaginal bleeding. In the case of peripartum hysterectomy for postpartum haemorrhage that is due to uterine atony, specially where there is an element of consumption coagulopathy, subtotal hysterectomy may save time and decrease blood loss, that are important in the setting of this emergent procedure.

It is important that women are adequately counseled prior to and after subtotal hysterectomy regarding the need for routine cervical screening. Furthermore, hormone replacement therapy ought to be of the combined type if prescribed to women who have undergone the operation of subtotal hysterectomy.

References

1. Sutton C. Hysterectomy: a historical perspective. Baillieres Clin Obstet Gynaecol. 1997;11(1):1–22.
2. Sutton C. Past, present, and future of hysterectomy. J Minim Invasive Gynecol. 2010;17:421–35.
3. Richardson EH. A simple technique for abdominal panhysterectomy. Surg Gynaecol Obstet. 1929;48:248–51.

4. Kimbrough RA. General considerations in the treatment of myoma uteri. Clin Obstet Gynecol. 1958;1:437–43.
5. Bergman P, Ferbas E. Total extirpation eller supravaginalamputation av uterus? [Total extirpation or supravaginal amputation of the uterus?]. La¨kertidningen. 1961;58:3624–32.
6. Lauridsen L, VC J. Total contra subtotal hysterektomi. [Total versus subtotal hysterectomy]. Ugeskr Laeger. 1961;123:298–307.
7. Ekelo¨f-Stangus S. Total versus supravaginal hysterectomy. Ann Chir Gynaecol Fenn Suppl. 1963;52:1–64.
8. Yoong W, Massish N, Oluwu A. Obstetric hysterectomy: changing trends over 20 years in a multiethnic high risk population. Arch Gynecol Obstet. 2006;274:37–40.
9. Gimbel H, Settnes A, Tabor A. Hysterectomy on benign indication in Denmark 1988– 1998. A register based trend analysis. Acta Obstet Gynecol Scand. 2001;80:267–72.
10. Farquhar CM, Steiner CA. Hysterectomy rates in the United States 1990–1997. Obstet Gynecol. 2002;99:229–34.
11. Merrill RM. Hysterectomy surveillance in the United States, 1997 through 2005. Med Sci Monit. 2008;14:CR24-31.
12. Jacobson GF, Shaber RE, Armstrong MA, Hung YY. Hysterectomy rates for benign indications. Obstet Gynecol. 2006;107:1278–83.
13. Esdaile BA, Chalian RA, Del Priore G, Smith JR. The role of supracervical hysterectomy in benign disease of the uterus. J Obstet Gynaecol. 2006;26:52–8.
14. CJ DF, CA L, VC B, Golosinskiy A. 2006 National Hospital Discharge Survey. Natl Health Stat Report. 2008;5:1–20.
15. Centers for Disease Control and Prevention Website. Key Statistics from the National Survey of Family Growth. Atlanta, GA: Centers for Disease Control and Prevention; 2015 .http://www.cdc.gov/nchs/nsfg/key_statistics/h.htm#hysterectomy
16. Materia E, Rossi L, Spadea T, Cacciani L, Baglio G, Cesaroni G, et al. Hysterectomy and socioeconomic position in Rome, Italy. J Epidemiol Community Health. 2002;56:461–5.
17. Farquhar C, Steiner CA. Hysterectomy rates in the United States. Obstet Gynecol. 2002;99:229–34.
18. Keshavarz H. Hysterectomy surveillance – United States, 1994–1999. MMWR Surveill Summ. 2002;51:1–8.
19. Jacobson GF, Shaber RE, Armstrong MA, Hung YY. Hysterectomy rates for benign indications. Obstet Gynecol. 2002;107:1278–83.
20. Parker WH. “Hysterectomy—A Gynecologist's Second Opinion”. Retrieved 2007–06-07.
21. Barmparas G, Branco BC, Schnüriger B, Lam L, Inaba K, Demetriades D. The incidence and risk factors of post-laparotomy adhesive small bowel obstruction. J Gastrointest Surg. 2010;14:1619–28.
22. Heliövaara-Peippo S, Halmesmäki K, Hurskainen R, Teperi J, Grenman S, Kivelä A, et al. The effect of hysterectomy or levonorgestrel-releasing intrauterine system on lower abdominal pain and back pain among women treated for menorrhagia: a five-year randomized controlled trial. Acta Obstet Gynecol Scand. 2009;88:1389–96.
23. Laughlin GA, Barrett-Connor E, Kritz-Silverstein D, von Mühlen D. Hysterectomy, oophorectomy, and endogenous sex hormone levels in older women: the Rancho Bernardo Study. J Clin Endocrinol Metab. 2000;85:645–51.
24. Atsma F, Bartelink ML, Grobbee DE. Postmenopausal status and early menopause as independent risk factors for cardiovascular disease: a meta-analysis. Menopause. 2006;13:265–79.
25. Ingelsson E, Lundholm C, Johansson AL, Altman D. Hysterectomy and risk of cardiovascular disease: a population-based cohort study. Eur Heart J. 2011;32:745–50.
26. Kelsey JL, Prill MM, Keegan TH, Quesenberry CP, Sidney S. Risk factors for pelvis fracture in older persons. Am J Epidemiol. 2005;162:879–86.
27. Durães Simões R, Chada Baracat E, Szjenfeld VL, de Lima GR, José Gonçalves W, de Carvalho R, et al. Effects of simple hysterectomy on bone loss. Rev Paul Med. 1995;113:1012–5.
28. Rivera CM, Grossardt BR, Rhodes DJ, Rocca WA. Increased mortality for neurological and mental diseases following early bilateral oophorectomy. Neuroepidemiology. 2009;33:32–40.
29. Altman D, Falconer C, Cnattingius S, Granath F. Pelvic organ prolapse surgery following hysterectomy on benign indications. Am J Obstet Gynecol. 2008;198:572.
30. Altman D, Yin L, Johansson A, Lundholm C, Grönberg H. Risk of renal cell carcinoma after hysterectomy. Arch Intern Med. 2010;170:2011–6.
31. Quiróz-Guadarrama CD, Martínez-Ordaz JL, Rojano-Rodríguez ME, Beristain-Hernández JL, Moreno-Portillo M. Vaginal evisceration. Report of a case and a literature review. Ginecol Obstet Mex. 2013;81:349–52.
32. Loring M, Morris SN, Isaacson KB. Minimally invasive specialists and rates of laparoscopic hysterectomy. JSLS. 2015;19(1)
33. Wasson MN, Hoffman MK. Impact of a robotic surgical system on hysterectomy trends. Del Med J. 2015;87:45–50.
34. Gimbel H. Total or subtotal hysterectomy for benign uterine diseases? A meta-analysis. Acta Obstet Gynecol Scand. 2007;86:133–44.
35. Gimbel H, Zobbe V, Andersen BM, Filtenborg T, Gluud C, Tabor A. Randomised controlled trial of total compared with subtotal hysterectomy with one-year follow up results. BJOG. 2003;110:1088–98.
36. Amarin Z. Subtotal versus total abdominal hysterectomy for benign gynecological conditions. Hysterectomy. InTech Publishers. 2012. DOI:10.5772/34770.ISBN 978–953–51-0434-6, ch2.
37. Herbert A. Cervical screening in England and Wales: its effect has been underestimated. Cytopathology. 2000;11:471–9.
38. Maina WC, Morris EP. Management of women requesting subtotal hysterectomy. Menopause Int. 2010;16:152–5.
39. Zekam N, Oyelese Y, Goodwin K, Colin C, Sinai I, Queenan JT. Total versus subtotal hysterectomy: a survey of gynecologists. Obstet Gynecol. 2003;102:301–5.
40. Whitelaw JM. Hysterectomy: a medical-legal perspective, 1975 to 1985. Am J Obstet Gynecol. 1990;162:1451–8.
41. Hendry WF. Urinary tract injuries during gynaecological surgery. In: Studd J, editor. Progress in obstetrics and gynaecology, vol. 5. Edinburgh, Scotland: Churchill Livingstone; 1985. p. 362–77.
42. Thakar R, Ayers S, Georgakapolou A, Clarkson P, Stanton S, Manyonda I. Hysterectomy improves quality of life and decreases psychiatric symptoms: a prospective and randomised comparison of total versus subtotal hysterectomy. BJOG. 2004;111:1115–20.
43. Thakar R, Ayers S, Clarkson P, Stanton S, Manyonda I. Outcomes after total versus subtotal abdominal hysterectomy. N Engl J Med. 2002;347:1318–25.
44. Learman LA, Summitt Jr RL, Varner RE, McNeeley SG, Goodman-Gruen D, Richter HE, Total or Supracervical Hysterectomy (TOSH) Research Group, et al. A randomized comparison of total or supracervical hysterectomy: surgical complications and clinical outcomes. Obstet Gynecol. 2003;102:453–62.
45. Brown JS, Sawaya G, Thom DH, Grady D. Hysterectomy and urinary incontinence: a systematic review. The Lancet. 2000;356:535–9.
46. Altman D, Falconer C, Cnattingius S, Granath F. Pelvic organ prolapse surgery following hysterectomy on benign indications. Am J Obstet Gynecol. 2008;198:572.e1–6.
47. McPherson K, Herbert A, Judge A, Clarke A, Bridgman S, Maresh M, Overton C. Self-reported bladder function five years post-hysterectomy. J Obstet gynaecol (The Journal of the Institute of Obstetrics and Gynaecology). 2005;25:469–75.
48. Maas CP, Weijenborg PT, ter Kuile MM. The effect of hysterectomy on sexual functioning. Annu Rev Sex Res. 2003;14:83–113.
49. Komisaruk BR, Frangos E, Whipple B. Hysterectomy improves sexual response? Addressing a crucial omission in the literature. J Minim Invasive Gynecol. 2011;18:288–95.

50. Virtanen HS, Makinen JI, Tenho T, Kiiholma P, Pitkanen Y, Hirvonen T. Effects of abdominal hysterectomy on urinary and sexual symptoms. Br J Urol. 1993;72:868–72.
51. Gorlero F, Lijoi D, Biamonti M, Lorenzi P, Pullè A, Dellacasa I, et al. Hysterectomy and women satisfaction: total versus subtotal technique. Arch Gynecol Obstet. 2008;278:405–10.
52. Flory N, Bissonnette F, Amsel RT, Binik YM. The psychosocial outcomes of total and subtotal hysterectomy: a randomized controlled trial. J Sex Med. 2006;3:483–91.
53. Kuppermann M, Summitt Jr RL, Varner RE, McNeeley SG, Goodman-Gruen D, Learman LA, et al. Sexual functioning after total compared with supracervical hysterectomy: a randomized trial. Obstet Gynecol. 2005;105:1309–18.
54. Zobbe V, Gimbel H, Andersen BM, Filtenborg T, Jakobsen K, Sørensen HC, et al. Sexuality after total vs. subtotal hysterectomy. Acta Obstet Gynecol Scand. 2004;83:191–6.
55. Ellström Engh MA, Jerhamre K, Junskog K. A randomized trial comparing changes in sexual health and psychological well-being after subtotal and total hysterectomies. Acta Obstet Gynecol Scand. 2010;89:65–70.
56. Persson P, Brynhildsen J, Kjølhede P. Hysterectomy Multicentre Study Group in South-East Sweden. Short-term recovery after subtotal and total abdominal hysterectomy--a randomised clinical trial. BJOG. 2010;117:469–78.
57. Jamal H, Amarin Z. Subtotal versus total abdominal hysterectomy. Bahrain Med Bull. 2001;23:119–23.
58. McPherson K, Metcalfe MA, Herbert A, Maresh M, Casbard A, Hargreaves J, et al. Severe complications of hysterectomy: the VALUE study. BJOG (An International Journal of Obstetrics and Gynaecology). 2004;111:688–94.
59. Wingo PA, Huezo CM, Rubin GL, Ory HW, Peterson HB. The mortality risk associated with hysterectomy. Am J Obstet Gynecol. 1985;152:803–8.
60. Smith J, Mousa HA. Peripartum hysterectomy for primary postpartum haemorrhage: incidence and maternal morbidity. J Obstet Gynecol. 2007;27:44–7.
61. Ribeiro F, Correia L, Paula T, Santana I, Vieira Pinto L, Borrego J, et al. Cervical cancer in pregnancy: 3 cases, 3 different approaches. J Low Genit Tract Dis. 2013;17:66–70.
62. Lim WH, Pavlov T, Dennis AE. Analysis of emergency peripartum hysterectomy in Northern Tasmania. Aust J Rural Health. 2014;22:235–40.
63. Umezurike CC, Feyi-Waboso PA, Adisa CA. Peripartum hysterectomy in Aba Southeastern Nigeria. Aust N Z J Obstet Gynecol. 2008;48:580–2.
64. Whiteman MK, Kuklina E, Hillis SD, Jamieson DJ, Meikle SF, Posner SF, et al. Incidence and determinants of peripartum hysterectomy. Obstet Gynecol. 2006;108:1486–92.
65. Selo-Ojeme DO, Bhattacharjee P, Izuwa-Njoku NF, Kadir RA. Emergency peripartum hysterectomy in a tertiary London hospital. Arch Gynecol Obstet. 2005;271:154–9.
66. Turner MJ. Peripartum hysterectomy: An evolving picture. Int J Gynecol Obstet. 2010;109:9–11.
67. Allam IS, Gomaa IA, Fathi HM, Sukkar GF. Incidence of emergency peripartum hysterectomy in Ain-shams University Maternity Hospital, Egypt: a retrospective study. Arch Gynecol Obstet. 2014;290:891–6.
68. Tikkanen M, Paavonen J, Loukovaara M, Stefanovic V. Antenatal diagnosis of placenta accreta leads to reduced blood loss. Acta Obstet Gynecol Scand. 2011;90:1140–6.
69. Hall T, Wax JR, Lucas FL, Cartin A, Jones M, Pinette MG. Prenatal sonographic diagnosis of placenta accreta–impact on maternal and neonatal outcomes. J Clin Ultrasound. 2014;42:449–55.
70. Baskett TF. Emergency obstetric hysterectomy. J Obstet Gynaecol. 2003;23:353–5.
71. Glaze S, Ekwalanga P, Roberts G, Lange I, Birch C, Rosengarten A, et al. Peripartum hysterectomy: 1999 to 2006. Obstet Gynecol. 2008;111:732–8.
72. Habek D, Becareviç R. Emergency peripartum hysterectomy in a tertiary obstetric center: 8-year evaluation. Fetal Diagn Ther. 2007;22:139–42.
73. Danisman N, Kahyaoglu S, Celen S, Akselim B, Tuncer EG, Timur H, et al. The outcomes of surgical treatment modalities to decrease "near miss" maternal morbidity caused by peripartum haemorrhage. Eur Rev Med Pharmacol Sci. 2014;18:1092–7.
74. Bateman BT, Mhyre JM, Callaghan WM, Kuklina EV. Peripartum hysterectomy in the United States: nationwide 14 year experience. Am J Obstet Gynecol. 2012;206:63.e1–8.
75. Silver RM, Landon MB, Rouse DJ, Leveno KJ, Spong CY, Thom EA, et al. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstet Gynecol. 2006;107:1226–32.
76. Francois K, Ortiz J, Harris C, Foley MR, Elliott JP. Is peripartum hysterectomy more common in multiple gestations? Obstet Gynecol. 2005;105:1369–72.
77. Zhou J, Ran J, He ZY, Quan S, Chen QH, SG W, et al. Tailoring Pelvic Lymphadenectomy for Patients with Stage IA2, IB1, and IIA1 Uterine Cervical Cancer. J Cancer. 2015;6:377–81.
78. Anderson BL. Puerperal group A streptococcal infection: beyond Semmelweis. Obstet Gynecol. 2014;123:874–82.
79. Al-Mehaisen L, Al-Kuran O, Amarin ZO, Matalka I, Beitawi S, Muhtaseb A. Secondary postpartum haemorrhage following placental site vessel subinvolution: a case report. Arch Gynecol Obstet. 2008;278:585–7.
80. Chestnut DH, Eden RD, Gall SA, Parker RT. Peripartum hysterectomy: a review of cesarean and postpartum hysterectomy. Obstet Gynecol. 1985;65:365–70.
81. Machado LS. Emergency peripartum hysterectomy: incidence, indications, risk factors and outcome. N Am J Med Sci. 2011;3(8):358–61.
82. Chalya PL, Massinde AN, Kihunrwa A, Simbila S. Iatrogenic ureteric injuries following abdomino-pelvic operations: a 10-year tertiary care hospital experience in Tanzania. World J Emerg Surg. 2015;10:17.
83. Ibrahim M, Ziegler C, Klam SL, Wieczorek P, Abenhaim HA. Incidence, indications, and predictors of adverse outcomes of postpartum hysterectomies: 20-year experience in a tertiary care centre. J Obstet Gynaecol Can. 2014;36:14–20.
84. Silver RM, Fox KA, Barton JR, Abuhamad AZ, Simhan H, Huls CK, et al. Center of excellence for placenta accreta. Am J Obstet Gynecol. 2015;212:561–8.
85. de la Cruz CZ, Coulter ML, O'Rourke K, Amina Alio P, Daley EM, Mahan CS. Women's experiences, emotional responses, and perceptions of care after emergency peripartum hysterectomy: a qualitative survey of women from 6 months to 3 years postpartum. Birth. 2013;40:256–63.
86. Amarin Z. Subtotal versus total abdominal hysterectomy for benign gynecological conditions. In: Al-Hendy A, Sabry M, editors. Hysterectomy: InTech Publishers; 2012. p. 23–9 .ch2.
87. Fitzpatrick KE, Sellers S, Spark P, Kurinczuk JJ, Brocklehurst P, Knight M. The management and outcomes of placenta accreta, increta, and percreta in the UK: a population-based descriptive study. BJOG. 2014;121:62–70.
88. Wright JD, Devine P, Shah M, Gaddipati S, Lewin SN, Simpson LL, et al. Morbidity and mortality of peripartum hysterectomy. Obstet Gynecol. 2010;115:1187–93.
89. Balayla J, Bondarenko HD. Placenta accreta and the risk of adverse maternal and neonatal outcomes. J Perinat Med. 2013;41:141–9.

Cervical Stump Extirpation

88

Marcella L. Roenneburg

The subtotal or supracervical hysterectomy was described as "one of the safest major operations performed within the abdominal cavity by Bland in 1924 [1]. In this era without blood transfusions or antibiotics, the supracervical hysterectomy decreased blood loss, did not require entry into the bacteria filled vagina, and rarely caused ureteral injuries. Wharton in 1943 described the total hysterectomy as a much more serious and difficult operation with more accidents, complications and mortality. At this time, mortality for a subtotal hysterectomy when performed for fibroids was 1–2.5 % while total abdominal hysterectomies for benign pathology such as endometriosis and tubo-ovarian abscesses carried a mortality risk of 3–6.5 %. Death was most commonly due to peritonitis, shock, hemorrhage and pulmonary embolism. Wharton noted that injury to the ureter and bladder was ten times more frequent with total hysterectomies and vesico-vaginal fistulas were more likely to occur associated with bladder injury in a total hysterectomy. Given a 0.45 % subsequent risk of cancer arising in the cervical stump at that time, the subtotal or supracervical hysterectomy was the preferred route [2].

Over the next 30 years there was a slow, steady transition to total abdominal hysterectomies with subtotal/supracervical hysterectomies coming to represent only 1 % of all hysterectomies [3]. There were several contributing factors. E. H. Richardson developed the intrafascial technique for total abdominal hysterectomies significantly contributing to the safety of the procedure [4]. Antibiotics became more widely available. In addition, the Red Cross' experience in blood donation and transfusion services for the US military during WWII was expanded to begin a nationwide program for civilians in 1948 [5]. At this time, more gynecologists were being trained and hysterectomies were less commonly being performed by general practitioners and general surgeons. The remaining subtotal/supracervical hysterectomies were more likely to be performed when the surgeon encountered distorted pelvic anatomy, operative difficulties such as with pelvic inflammatory disease or advanced endometriosis, or when the patient's co-morbidities required a shorter, less risky procedure. In other words, when less bladder dissection, less bleeding and shorter operating time was desirable, the supracervical hysterectomy could be performed. Subsequent excision of the cervix was expected to be a difficult procedure and was generally performed via an abdominal laparotomy.

Supracervical hysterectomies noted a resurgence in popularity in the late 1990's with the onset of minimally invasive or laparoscopic hysterectomies. Laparoscopic subtotal or supracervical hysterectomies were performed to decrease operating time, blood loss, and postoperative vaginal dehiscence. In addition, they could be performed without laparoscopic suturing skills. Therefore gynecologic surgeons today are more likely to encounter patients who require excision of the cervical stump, also known as a trachelectomy.

Common indications for extirpation of the cervical stump include cyclic bleeding, prolapse, pelvic mass, pain, and severe cervical dysplasia/carcinoma in situ or cervical cancer. The risk of cervical cancer in the remaining stump is 0.7 % and unchanged by the prior subtotal hysterectomy [6]. The American College of Obstetrics and Gynecology reports 1.5 % of patients required a second surgery to remove the cervix less than 3 months from the time of their original subtotal hysterectomy, and 23 % of women required return to the operating room for excision of the cervical stump at a mean of 14 months from their first surgery. Vaginal bleeding is experienced by 11–17 % of women having undergone a subtotal hysterectomy [7]. The most common complications of excising the cervical stump include infection and bleeding in 9 % and bowel injury in 2 % [8]. Fewer complications are noted with a vaginal approach when compared to an abdominal excision. The approach however, is often dictated by the indication for the return for extirpation with a vaginal approach being more commonly performed for prolapse and

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the abdominal approach more commonly used for pelvic masses [8]. The bladder and/or rectum could have been used to re-peritonealize the pelvis after the supracervical hysterectomy and therefore care must be taken not to injury these organs during the cervical stump resection. After a sacrocolpopexy in which mesh grafting was placed over the cervical stump to repair the anterior and posterior vaginal walls as well as provide apical support, subsequent extirpation of the cervical stump will be more difficult. Dense adhesions should be expected with increased risks of bladder and bowel injury during dissection. Additionally, previous surgery may have altered the path of the ureters and therefore the ureters may be adhered to the cervical stump. It is important that the ureters be identified and if necessary be dissected free from the cervix.

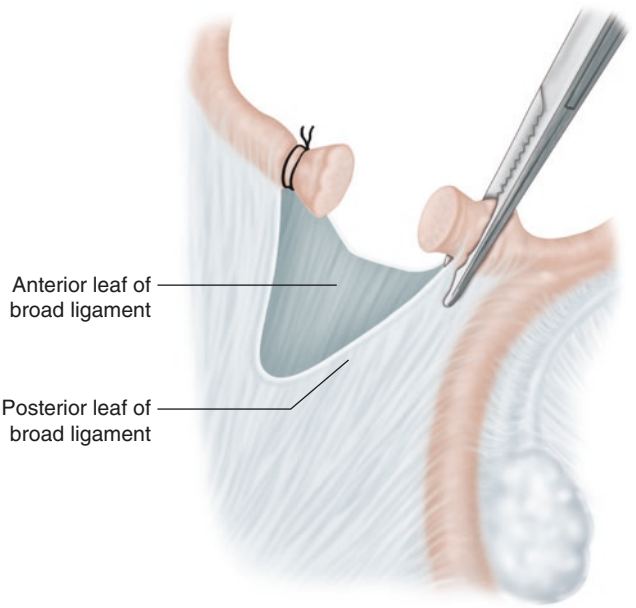


Fig. 88.1 Transection of round ligament and opening of the leaves of the broad ligament (From Wheeless and Roenneburg [9])

Procedure

The patient is placed in a supine position and a transverse or vertical incision is made in the usual fashion to open the abdomen. Once a self-retaining retractor is placed, bowel is packed away and the patient is placed in a moderate Trendelenburg position. The Fallopian tubes and ovaries, as well as the round ligaments, may be adherent to the cervix. In addition the bladder and peritoneum may be closed over the cervical stump. The best way to begin the procedure is to identify the previously transected round ligaments as they enter the pelvic side wall. The stumps of these fibromuscular bands of tissue should be easy to locate in their position anterior and laterally in the pelvis before they exit through the inguinal canals. The round ligaments are clamped with a curved clamp such as a Kelly or curved Heaney clamp. An interrupted 0 synthetic absorbable suture is placed distally underneath the ligament and tied down. A second suture is placed proximal to the clamp and again tied down. This proximal stump remains connected to the medial portion of the peritoneum or may be connected to the cervical stump (see Fig. 88.1). The round ligaments can then be transected with a Mayo scissors or with cautery which opens access to the retroperitoneal space. Accessing the retroperitoneal space allows identification and if necessary dissection of the ureter. Previous surgery and disease can significantly alter the expected course of the ureters. Once the transected round ligaments are elevated, a plane of dissection will be easier to identify, and the surgeon will be able to incise the anterior leaf of the broad ligament in order to begin dissecting the bladder from the cervix (see Fig. 88.2). Counter traction for easier dissection is provided by elevating the cervical stump cephalad with a tenaculum. The posterior leaf of the broad ligament can also be incised. If it is advisable to remove the Fallopian tubes and ovaries,

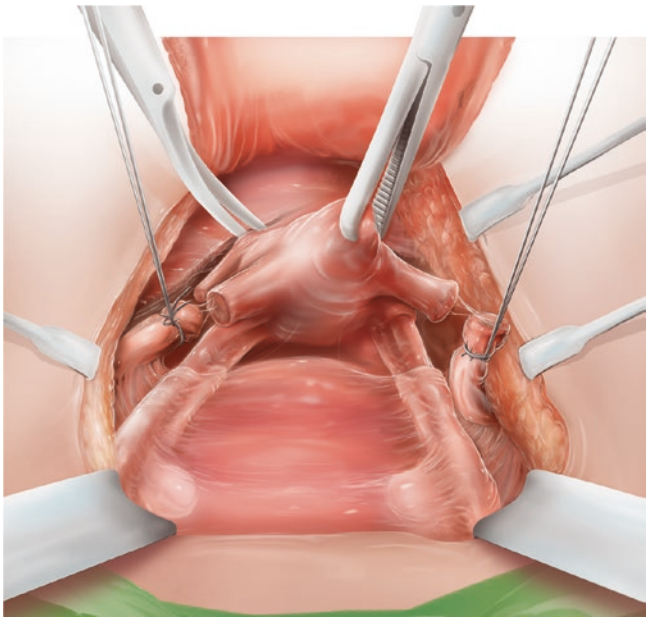


Fig. 88.2 Elevation of round ligament to incise the anterior leaf of broad ligament assists in beginning dissection of bladder from the cervix

the infundibulopelvic ligament with the ovarian artery and vein can be doubly clamped with a Kelly or curved Heaney clamp at this juncture (see Fig. 88.3). A ligature of 0 or 2–0 synthetic absorbable suture is tied down around the pedicle while carefully opening or "flashing" the clamp and then re-clamping the pedicle. A transfixion suture is then placed through the pedicle and tied down on both sides while

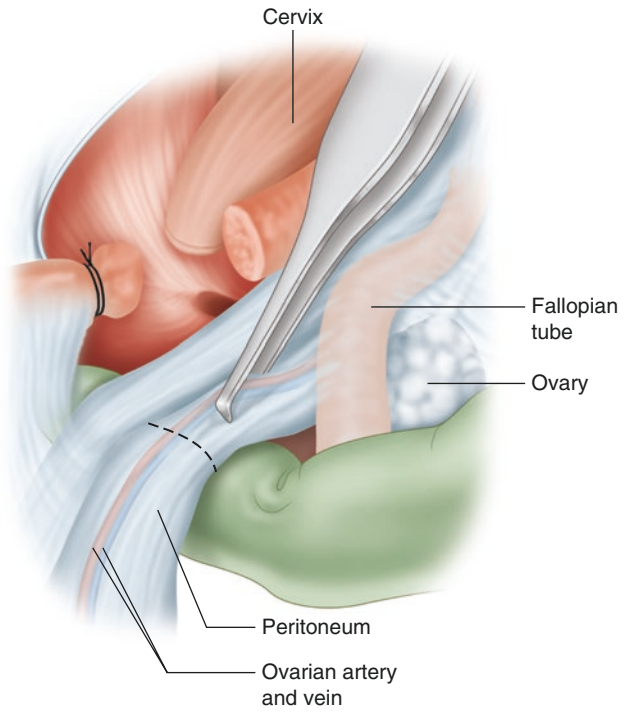


Fig. 88.3 Identifying the infundibulopelvic ligament with the ovarian artery and vein (From Wheeless and Roenneburg [9])

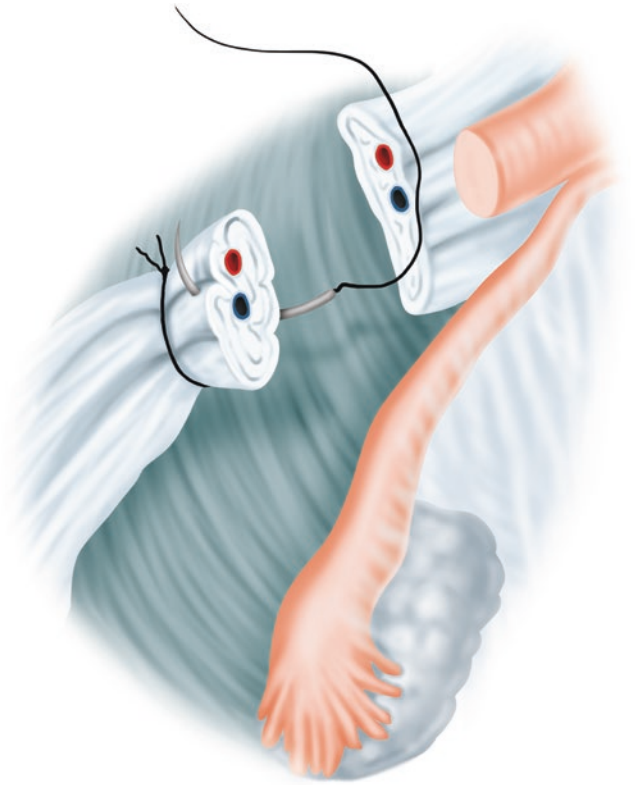


Fig. 88.4 Transfixion suture of should be placed distal to the first ligature to prevent hematoma formation (From Wheeless and Roenneburg [9])

releasing the clamp. This transfixion suture should be placed distal to the first ligature to prevent hematoma formation (see Fig. 88.4). Once again, the ureter should be identified prior to placing clamps and ligatures to prevent any damage. The vesicoperitoneal fold is then elevated with a bladder blade or curved Deaver retractor while counter traction is placed on the cervical stump. The filmy attachments of the bladder to the cervix can be identified and taken down with blunt or sharp dissection (see Fig. 88.5). If previous surgery or disease has caused extensive adhesions, sharp dissection rather than blunt dissection should be performed. Blunt dissection with a sponge stick or the operator's finger in the case of dense adhesions can cause shearing and tearing with increased risk for incidental cystotomy and subsequent vesicovaginal fistula formation.

A straight Heaney or Masterson clamp is used to clamp the cardinal ligament for a distance of approximately 2 cm by sliding off the cervical stump and clamping immediately lateral to the cervix. The cardinal ligament is then transected with knife or scissors taking care to leave a barrel shaped portion protruding from the clamp. Transecting the ligament too close to the clamp can cause the ligament to slip out of the Heaney or Masterson clamp (see Fig. 88.6). This pedicle is suture ligated with a 0 synthetic absorbable suture and the process is repeated on the contralateral side.

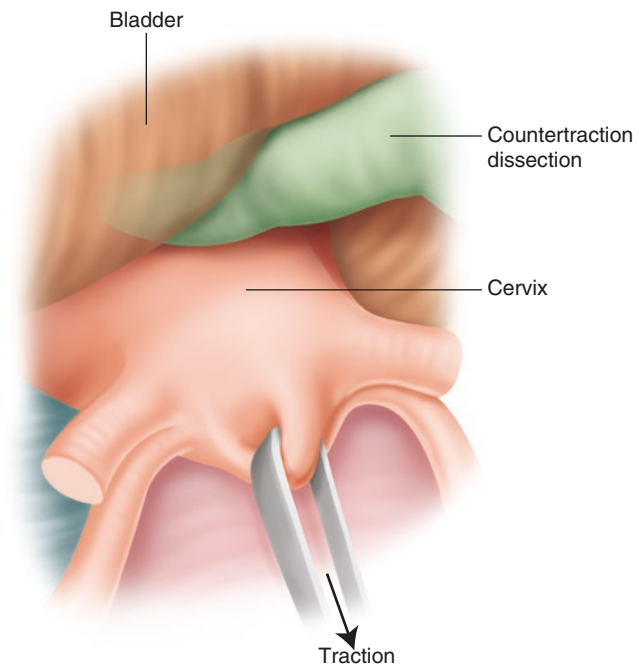


Fig. 88.5 Traction on the cervix and counter traction on the bladder assist the blunt or sharp dissection of the filmy attachments between the cervix and bladder required to develop the bladder flap (From Wheeless and Roenneburg [9])

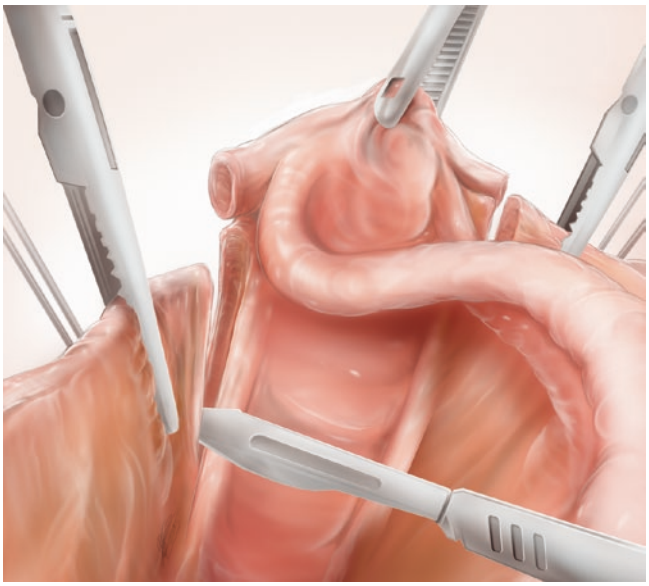


Fig. 88.6 The cardinal ligament is clamped and then transected taking care to leave a barrel shaped portion protruding medially to the clamp.

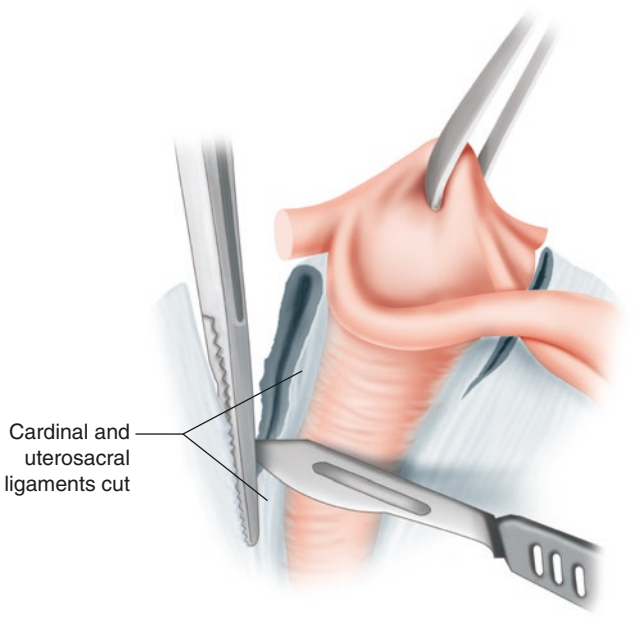


Fig. 88.7 Second and possibly third pedicles are taken in a similar fashion. The final pedicle should include the uterosacral ligaments to begin resuspension of the vagina (From Wheeless and Roenneburg [9])

Second and third pedicles as needed are performed in a similar fashion. The operator's thumb and index finger are used to palpate the distal edge of the cervix. The final pedicle should include the uterosacral ligament (see Fig. 88.7). Including the uterosacral ligament in the final cardinal ligament pedicle will begin re-suspension of the vaginal cuff which will be completed when the uterosacral ligament is included in the vaginal angle suture.

With continued cephalad traction on the cervical stump the vagina is entered anteriorly via a stab incision using a scalpel or by incision with a Mayo scissors (see Fig. 88.8). A curved Mayo scissors or the curved Jorgenson's scissors is used to circumferentially excise the cervical stump from the vagina. The curved scissors allows the inner blade to be snugged up against the cervix to help maintain as much vaginal length as possible. The vaginal edges are picked up with Ochsner or Kocher clamps at 12, 3, 6 and 9 o'clock. Figure of eight 0 synthetic absorbable sutures are placed at the angles of the vagina and must include the uterosacral ligaments for re-suspension of the vagina as the uterosacral ligaments have no anatomic attachment to the vagina (see Fig. 88.9). Care should be taken not to place sutures beyond the previous ligament sutures to prevent hematomas.

The vaginal cuff can then be reefed 360 ° for hemostasis with a running locking 2–0 or 0 synthetic absorbable suture to allow the cuff to remain open and allow drainage. If the vaginal cuff gapes open widely, it can be partially closed

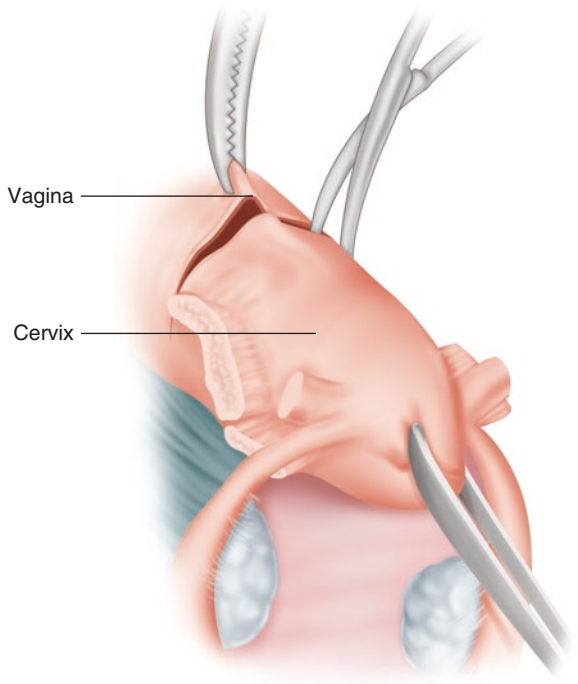


Fig. 88.8 The anterior wall of the vagina is entered sharply aided by cephalad traction on the cervical stump. Scissors are used to circumferentially excise the cervical stump from the vagina (From Wheeless and Roenneburg [9])

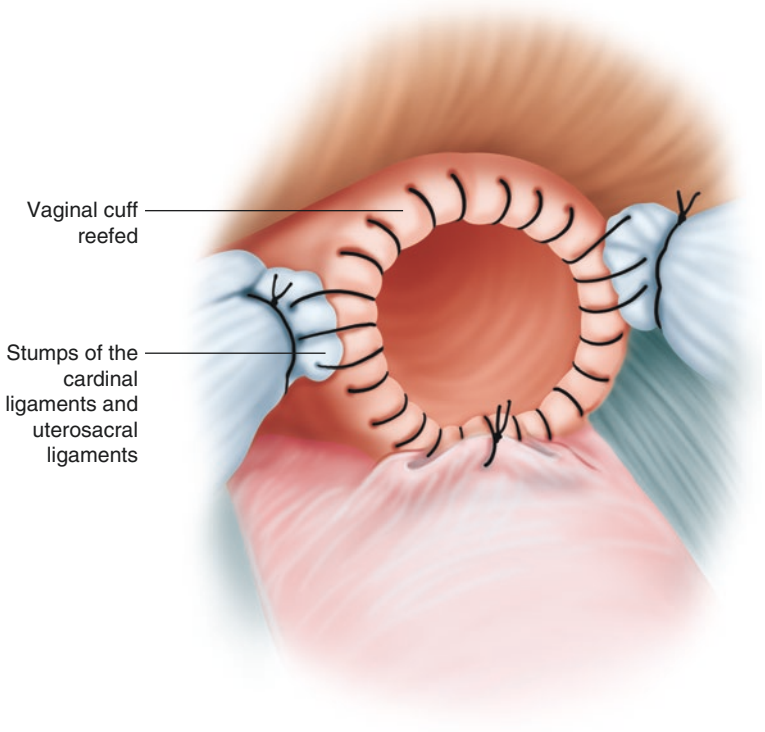


Fig. 88.9 Angle sutures are placed in the vaginal cuff and should include the uterosacral ligaments to re-suspend the vagina. The vaginal cuff is reefed for hemostatsis

with interrupted figure of eight sutures. Complete closure of the vaginal cuff increases risks for postoperative febrile morbidity and abscess formation.

The pelvis should then be thoroughly irrigated or washed and care taken to ensure hemostasis. It is not necessary to reperitonealize the pelvis. The abdominal incision can then be closed in the usual fashion. Post-operative care is similar to an abdominal hysterectomy with early ambulation and early resumption of a regular diet.

Cervical stump extirpation is not a common procedure, but when indicated it can be performed with a low risk of complications.

References

1. Bland P. Gynecology – medical and surgical. Philadelphia: F. A. Davis Company; 1924. p. 975.
2. Wharton L. Gynecology with a section on female urology. Philadelphia/London: W. B. Saunders Company; 1943. p. 561.
3. Mattingly R. TeLinde's operative gynecology. Philadelphia/Toronto: J. B. Lippincott Company; 1977. p. 195.
4. Mattingly R. TeLinde's operative gynecology. Philadelphia/Toronto: J. B. Lippincott Company; 1977. p. 11.
5. American Red Cross [Internet]. Washington, D.C.: American Red Cross; c. 2015. History of Blood Transfusion. Available from: http://www.redcrossblood.org/learn-about-blood/history-blood-transfusion.html.
6. Surveillance, Epidemiology, and End Results Program [Internet]. Washington, D.C.; National Cancer Institute; c. 2015. SEER Stat Fact Sheets: Cervix Uteri Cancer. Available from: http://seer.cancer.gov/statfacts/html/cervix.html.
7. "Supracervical Hysterectomy." American College of Obstetrics and Gynecology Committee Opinion #388, November 2017, Reaffirmed 2013.
8. Hilger WS, Pizarro AR, Magrina JF. Removal of the retained cervical stump. Am J Obstet Gynecol. 2005;193(6):2117–21.
9. Wheeless CR, Roenneburg ML. Atlas of pelvic surgery. On-line Edition, 2015, www.atlasofpelvicsurgery.com.

Total Abdominal Hysterectomy in Benign Conditions: Hysterectomy Techniques for the Normal-Sized and Small Uterus

89

Engelbert Hanzal

Not too many years ago this would have been one of the prime chapters in a book about hysterectomy, which highlights how much progress has been made in terms of technique, concept and attitude to surgery of the uterus and today this piece reads already like something slightly anachronistic and almost historic. Are there still indications for open abdominal hysterectomy in a normal-sized or small uterus for benign conditions at all? At first sight there are none. A few absolute indications remain and there are special chapters in this book dealing with those, with the exception of the still more experimental uterine explantation for transplantation, possibly the most complex type of hysterectomy ever performed up to now [1]. Often, when thinking of open hysterectomy the uterus will be enlarged or a malignant or otherwise difficult condition, like endometriosis or dense adhesions present; but even in these clinical situations one will always want to carefully consider vaginal or laparoscopic approaches first and seek contraindications to these – which are becoming increasingly rare – before resorting to laparotomy. As far as indications are concerned, there are no differences to those for laparoscopic hysterectomy in benign, premalignant or – like in a few cases of early invasive cancer of the cervix or endometrium – malignant conditions. This is to say that given adequate mobility and vaginal compliance in these indications, the vaginal approach should always be favoured and tested for feasibility – if necessary under anesthesia – also in nulliparous patients. Some rare opportunities to come across a normal-sized or small uterus in a patient with an indication for hysterectomy may include an operation by another surgical specialty with a need for laparotomy. In some low resource settings, however, open abdominal hysterectomy may still be an acceptable alternative, when laparoscopic equipment is unavailable and a vaginal approach not feasible.

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The following assumes an already laparotomized patient (including checklists, antibiotic prophylaxis etc.), where exploration, and adhesiolysis has already been performed. Please refer to the respective chapters on laparotomy techniques and adhesiolysis for detailed descriptions on procedures and steps before the actual hysterectomy. Here we will describe just one technique of simple extrafascial hysterectomy used widely with a few modifications, but there is no way to cover all the different and possibly equally effective techniques used worldwide. This chapter leans heavily on an surgical atlas now out of print which has served the author well for over 20 years in the circumstance of open operations in gynecologic oncology [2]. The paucity of clinical data, randomly comparing different types of techniques in terms of suture material, instruments used, use of cautery, exact sequence of steps, etc. suggests that there may only be marginal and clinically unimportant differences. But this is only an assumption and there may well be unsafe techniques out there, so it is far from advisable to use an "anything goes" type of approach for any hysterectomy. Techniques need to be adequately standardized, trained and examined in the surgical skills lab and afterwards in the operating theater, before it is safe to assume that someone masters the surgery enough to perform it safely on a patient [3].

For this atlas, the author describes the technique he is most familiar with – albeit less so in recent years, where the laparoscopic approach has continually replaced indications for primary laparotomy (Table 89.1). He uses monopolar cautery (with a straight, narrow blade and extension wherever necessary), for incisions (including skin) and dissection, a pair of Péan clamps for manipulating the uterus, two slightly curved clamps and another two sharply curved clamps with a longitudinal jaw-profile for transection of parametrial tissue and ligaments. Occasionally, a number 10 (or similar curved-blade) scalpel, Metzenbaum scissors and strong parametrial scissors, straight needle-holders (long and medium sized), surgical and anatomical (or DeBakey) forceps all in an adequate length to facilitate use deep down in the pelvis, complete a basic set of instruments, readily

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Table 89.1 Checklist for open abdominal hysterectomy suitable for training (objective structured assessment of technical skills [2])

Place 2 Péan clamps across broad ligament medial to the adnexa to manipulate uterus and to put tissues under tension
Palpate uterine cervix
Doubly ligate and transect right round ligament after applying tension and incise peritoneum medially across the bladder to the left side and laterocranially to expose extraperitoneal space
Always apply upward traction on peritoneal surfaces to facilitate cutting and to allow air to enter extraperitoneal space to facilitate vision of extraperitoneal anatomy
Identify right ureter and ovarian vessels on medial leaf of peritoneum
Incise medial leaf of peritoneum between ovarian vessels and ureter ("avascular space of Graves"), carry the incision medially to lateral margin of uterus and laterally to pelvic brim
If adnexa is to be removed, ovarian vessels are clamped, transected and clamps replaced by figure-of-eight stitches; when preserving ovaries, tube is transected and ovarian ligament clamped and ligated
Treat left adnexa in analogous fashion
Pull bladder peritoneum caudad and anteriorly to expose tissue between bladder and cervix, then carefully dissect bladder downwards staying in the middle and away from vessels of bladder pillar on both sides
Palpate cervix and finish creation of bladder flap when encountering anterior vaginal wall approximately 1 cm below the cervix
Skeletonize, clamp (at a 90° angle with sharply curved clamps) and transect uterine vessels at the level of the uterine isthmus and replace clamps with figure-of-eight stitches
Clamp (with slightly curved clamps), cut and suture cardinal ligaments with figure-of-eight stitches downward in portions of no more than 3 cm, as many as needed to reach the level of the vaginal fornices
Always place clamps medially to those placed before to avoid ureteral damage
Place two sharply curved clamps across vagina just below cervix and transect vagina to deliver uterus
Replace clamps by figure-of-eight stitches thereby closing the vaginal cuff
Check for and control bleeding if necessary

available in most operating theaters worldwide to permit open abdominal hysterectomy. For simplicity, all stitches are performed with atraumatic 0-polyglactin sutures.

Accessing the Extraperitoneal Space

With two Péan clamps placed across the broad ligament medially to the adnexa, the uterus can be manipulated and put under tension. The cervix is palpated between thumb anteriorly and the other fingers resting in the pouch of Douglas. The right round ligament is stretched out firmly, then suture ligated and transected. With the peritoneum still under tension, allowing air to enter into the areolar tissue of the endopelvic fascia, the peritoneal incision is carried medially towards the bladder and over the midline to the other side, then latero-cranially across the iliac vessels and parallel to the ovarian vessels. The ligature securing the stump of the round ligament can be left long and tagged to facilitate upward traction of the lateral peritoneal edge. Small bleeding vessels are controlled by monopolar cautery to have a clear operating field. This will ease visualisation of the psoas muscle with the overlying genitofemoral nerve, iliac and ovarian vessels, and the ureter, which crosses over the common iliac artery and runs down the medial leaf of the peritoneum to the posterior aspect of the broad ligament to pass under the uterine vessels. By placing the hand in the pouch of Douglas and the thumb laterally into the bottom of the peritoneal opening, the ureter can almost invariably be palpated. A clicking sound can be heard, when sliding the ureter between the fingers. The part of the medial peritoneal leaf between ovarian vessels, ureter and lateral edge of the uterus is sometimes called avascular space of Graves. This is now incised or bluntly perforated and the incision carried medially towards the uterus and laterocranially towards the pelvic brim to skeletonize the ovarian vessels. The same procedure is performed on the other side if necessary in an analogous fashion.

Treatment of the Adnexa

In case of complete adnexal removal, the ovarian vessels on the right side are now clamped, cut, suture ligated and thereby tube and ovary mobilized. The paradigm shift that now sees the tubes as origins of at least some types of epithelial ovarian cancer has led to the suggestion to remove the oviducts whenever possible [4]. Therefore, if the ovaries are to be preserved, the fallopian tube is transected off the mesosalpinx, which can elegantly be performed by monopolar cautery alone (as long as the mesosalpinx is cut by cautery slowly and immediately adjacent to the tube), a clamp placed over the ovarian ligament and the clamp replaced by a figure-of-eight stitch, leaving the ovary intact and separating it from the uterus. Treatment of the adnexa is repeated on the other side if necessary in analogous fashion.

Creating a Bladder Flap

With the bladder gently pulled caudad and anteriorly the endopelvic fascia of the vesicouterine space is exposed and with Metzenbaum scissors or monopolar cautery the collagen fibers are separated to dissect the bladder off the cervix. Initially it is important to stay in the middle of the cervix, that can be palpated by hand or with the instrument to avoid bleeding from the bladder pillars. Eventually, connective tissue from the cranial parts of the bladder pillars will be taken down to create a satisfactory bladder flap that extends downward at least 1 cm beyond the anterior cervical lip. Although in simple (i.e. non-radical) abdominal hysterectomy the ureter is never dissected out of the broad ligament, one can and should still imagine and palpate its course because it always passes in close proximity of the structures developed, cut and sutured during hysterectomy.

Ligating the Uterine Vessels

The uterine vessels are now skeletonized by incising the posterior leaf of the peritoneum towards the uterosacral ligaments and by carefully cutting or pushing away the connective tissue of the broad ligament to expose the vascular bundle. A sharply bent clamp is placed perpendicularly across the uterine vessels by letting it slide off the cervix to also encompass vessels near the uterus at the level of the isthmus. The deeper this clamp is placed, the nearer it will be to the ureter so placing it high is an important safety step. The clamp is replaced by a figure-of-eight stitch.

Division of the Cardinal and Uterosacral Ligaments

Resorting to slightly curved clamps, the tissue of the broad ligament is now grasped parallel to the cervix by letting the jaws of the clamp slide off of the cervix from medially to laterally. Care is taken to always have the stump of the previous portion lateral to the clamp to avoid ureteral damage. Also, the portion taken with the clamp should never exceed 3 cm in length, because too much shrinking of the tissue after suture ligation could lead to ureteral kinking. This may especially be the case in women with a small uterus and an elongated cervix. Often in this situation more than 3 clamps are necessary on each side to achieve satisfactory transection of the parametrial tissue without the risk of kinking the ureter. The clamps can be placed with the convexity facing the cervix or away from it, whichever is easier to handle. In both cases the critical issue is having the jaws of the clamp as near the uterus as possible and medially to the previous bite of the clamp. Every clamp is replaced by figure-of-eight stitches after having transected the tissue with cautery, scissors or scalpel taking care to stop cutting approximately 2 mm before reaching the tip of the clamp. Otherwise retrograde bleeding from the uterovaginal vascular plexus can ensue, leading to unnecessary blood loss and blurring or the operating field. Palpation of the cervix will determine, when the level of the vaginal fornices is reached. In the case an elongated cervix often 2 – 4 clamps are necessary to achieve this goal.

Completing the Hysterectomy

With sharply curved clamps, the vagina is grasped at the level of the fornices perpendicular to the vaginal axis by letting the jaws of the clamps slide off of the cervix downward to the apical vagial wall, the tips facing each other. By cutting the tissue between clamps and cervix, the apical vagina is transected along with the uterosacral ligaments and the uterus with tubes or adnexa falls away to be sent off for pathology. The clamps are then replaced by figure-of-eight stitches, whereby the uterosacral ligaments automatically become sutured to the vaginal apex. The gap between the two ligatures at the top of the vagina medially can be left open for drainage, however, the author always closes it with a z-stitch to avoid postoperative discharge. In the absence of studies showing a benefit for vaginal drainage after hysterectomy this seems reasonable. In the case of postoperative hematoma or abscess formation, which occurs in about 1.3 – 2.8 % of patients [5, 6] usually around the 4th postoperative day, the vaginal sutures can be removed from vaginally and the cuff opened to allow infectious material to drain vaginally. Alternatively, the vagina can be opened by cautery, scalpel or scissors at the level of the anterior fornix and transected openly, allowing visualization of the upper vagina, which is sometimes beneficial when vaginal pathology like endometrial implants are suspected. In these cases, two angle sutures are placed through the lateral fornices and uterosacral ligaments, which are tagged to facilitate vaginal cuff closure with running sutures.

Today, open hysterectomy for the normal-sized and small uterus in benign indications is mainly a theme from the past. Whenever such a case crops up in a surgical schedule it should be viewed with utmost scrutiny for possible alternatives, like vaginal or laparoscopic hysterectomy, or minimally invasive procedures sparing the uterus altogether. It is to be expected that even in low-resource settings this operation will soon be obsolete.

References

1. Brännström M, Johannesson L, et al. Livebirth after uterus transplantation. Lancet. 2015;385(9968):607–16.
2. Morrow CP, Curtin JP. Gynecologic cancer surgery. Philadelphia: Churchill Livingstone; 1996.
3. Reznick RK, McRae H. Teaching surgical skills – changes in the wind. N Engl J Med. 2006;355:2664–9.
4. Reade CJ, McVey RM, et al. The fallopian tube as the origin of high grade serous ovarian cancer: review of a paradigm shift. J Obstet Gynaecol Can. 2014;36(2):133–40.
5. Gandaglia G, Ghani KR, et al. Effect of minimally invasive surgery on the risk for surgical site infections: results from the National SurgicalQuality Improvement Program (NSQIP) Database. JAMA Surg. 2014;149(10):1039–44.
6. Lake AG, McPencow AM, et al. Surgical site infection after hysterectomy. Am J Obstet Gynecol. 2013;209(5):490.

Total Abdominal Hysterectomy in Benign Indications: Hysterectomy Techniques for the Large Uterus

90

Atul P. Munshi and Sujal A. Munshi

Hysterectomy is an operation frequently done in routine Gynec practice worldwide. It is difficult to get exact incidence as many surgeries are not reported. The National Surveillance data from USA showed that 6,00,000 hysterectomies were performed yearly of which approximately 90 % were done for benign condition [1]. In India and other Asian countries with less availability of conservative modalities to mass population and reluctance for these methods, the number is even higher.

Abdominal hysterectomy was more common than vaginal route (65 v/s 35 %) for many decades. But for past one and a half decade worldwide vaginal and Laparoscopically assisted hysterectomies are becoming increasingly popular and now secure an larger proportion than ever before amongst all procedures performed.

History

In November 1843 Charles Clay performed the 1st hysterectomy in Manchester England; earlier hysterectomies were supra cervical or subtotal. In 1929, Richardson M.D. performed the first Total Abdominal Hysterectomy.

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Indications

- Benign Diseases
  - Abnormal Uterine Bleeding
  - Leiomyoma
  - Adenomyosis
  - Endometriosis
  - Pelvic Organ Prolapse with other pathology
  - Pelvic Inflammatory Diseases
  - Chronic Pelvic Pain
  - Pregnancy Related Conditions
  - Miscellaneous
- Traumatic
  - Uterine Perforation
  - High Cervical Tear
  - Rupture Uterus
- Obstetrical
  - Intractable Atonic PPH
  - Morbidly Adherent Placenta
- Prophylactic Hysterectomy
  - BRCA1/BRCA2 positive
  - HNPCC gene positive

Current trend is to remove the uterus from the natural orifice (vaginal). Traditionally accepted, contraindications to the vaginal route, including: uterine enlargement (uterine weight estimated >500 g or uterine size more than 20 weeks); vagina deemed "too narrow" (e.g., vagina narrower than 2 fingerbreadths, especially at the apex); lack of uterine descent and mobility; presence of adnexal disease; prior pelvic surgery; malignancy; contracted pelvis; and need to explore the upper abdomen [2]. However, these traditional indications for laparotomy have been challenged [3, 4]. When vaginal hysterectomy is not possible, it is suggested that a laparoscopic approach might avoid the need for abdominal hysterectomy; however, the length of the surgery increases as the scope of the surgery performed laparoscopically increases and these procedures require greater surgical expertise [5, 6].

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Preoperative Counseling

The reasons for the hysterectomy, risk and benefits of the procedure, alternatives and outcome should be discussed in detail. Informed consent with thorough exploration of patient preferences and expectations is particularly important. In the decision to proceed with hysterectomy is made by woman and her physician based upon functional impairment, childbearing plans, response to medical therapy and discussion of alternatives.

Other Treatment Modalities

1. Uterine Artery Embolization and Myomectomy may be used to treat Symptomatic Leiomyoma.
2. Pain control services may be able to return patients with intractable pelvic pain to a functional status without surgery.
3. Endometrial ablation may be an effective therapy for excessive uterine bleeding.
4. Medical Therapy with GnRH analogs can help reduce discomfort associated with endometriosis.
5. Endometrial Hyperplasia can sometimes be treated medically with progestin.
6. Conization (Cold Knife, Loop Electro cautery) may be adequate therapy for some women with high grade CIN/CIS.

Once the decision for the hysterectomy has been made, physician and the patient must decide together on the route of surgery and the type of surgery to be performed. The route chosen depends upon the woman's clinical findings and surgeon's preference. Risk and benefits of Oophorectomy and proposed plan for keeping or removing ovaries should be discussed with patient before surgery.

Preoperative Preparations

- Through counseling with written and informed consent.
- Complete History and Physical Examination.
- Routine Blood Ix.
- Special Tests according to Patient's Medical Condition.
- Chest X-Ray in women with Cardio Respiratory disease.
- Intravenous Pyelogram or CT Scan of abdomen and pelvis in women with uterine or extra uterine pelvic mass
- Pap smear to rule out cervical neoplasia.
- Recent Pregnancy test in Reproductive aged women prior to Hysterectomy.
- Bowel preparation prior to pelvic surgery to facilitate exposure and reduce trauma to bowel caused by retraction and packing. (Usually laparoscopy or laparotomy – abdominal hysterectomy, bowel preparation is necessary to evacuate fecal material. Rectal suppository or enema previous night or early morning before surgery is advocated by many surgeons. Empty bowels reduces chances of injury during surgery and allows proper packing to keep them away from operative field.)
- Clear liquid diet on the day prior to surgery.
- One or two fleet enemas, the evening prior to surgery.
- A laxative suppository immediately on arising on the morning of surgery, will evacuate residual faeces in sigmoid and prevent contamination of field during surgery.
- Routine use of intravenous antibiotics given immediately prior to induction of anesthesia – second generation cephalo-sporine are commonly used.
- If necessary, the pubic and/or vulvar hair should be clipped with an electric clipper or even scissors rather than shaved.
- Shaving prior to surgery has been shown to increase the risk of wound infection and cellulites.

Types of Hysterectomy

Depending upon the extent of removal of the uterus and adjacent structures, following types are described.

- Total Hysterectomy – Removal of the entire uterus with cervix.
- Subtotal – Removal of the body or corpus leaving behind the cervix.
- Panhysterectomy – Removal of uterus along with removal of tubes and ovaries of both the sides. The term "Hysterectomy with Bilateral Salpingo-Oophrectomy" is preferred.
- Extended Hysterectomy – Panhysterectomy + Removal of cuff of vagina.
- Radical Hysterectomy – Removal of uterus, tubes and ovaries of both sides, upper one third of vagina, adjacent parametrium and draining lymph glands of the cervix. **(Not for benign conditions.)**

Operative Technique

After obtaining adequate anesthesia, examination under anesthesia is performed. Foley's catheter is recommended in most cases. Vagina cleaned with antiseptic solution. Skin preparations followed by placement of surgical drapes is carried out.

Skin incision may be transverse or vertical and is determined by variety of factors, such as need for exploration, of upper abdomen, size of uterus, presence of prior incision and desired cosmetic results. If prior incision exists, parallel scars are undesirable.

In a uterus where the fundus is at level of umbilicus or above it and patient having previous vertical scar (previous CS or laparotomy) longitudinal incision is preferable.

In other cases of patients having Pfannenstiel scar, transverse incision is preferable. Even in larger uteri transverse incision may be used in case of difficulty in delivery of the uterus, muscle cutting may be resorted to.

The peritoneal cavity is entered and the upper abdomen and pelvis explored for unexpected pathology and to confirm suspected pathological findings. Cytological sampling of peritoneal fluid or peritoneal washings, may be collected if indicated because of possible malignancy.

The wound edge should be protected with moist laparotomy packs or towels before placing retractor blades.

To begin, the pelvic organs are mobilized by dividing omental, intestinal or abdominal wall adhesions, as indicated.

A large Kelly clamp is placed across each uterine cornu, running down the side of the uterus across the round ligaments. This allows uterine elevation and prevents back bleeding when the round ligaments are divided. The uterus is manually deviated to the patient's left, stretching the right round ligament. The round ligament is suture ligated, clamped & divided.

Anterior broad ligament is incised along the vesicouterine fold, separating bladder peritoneum from lower uterine segment.

If ovaries are to be retained, the uteroovarian ligament on each side is clamped with Heaney clamp, cut and ligated with both free tie and suture ligature. The medial clamp at uterine cornue will control back bleeding.

If ovaries are to be removed, infundibulopelvic ligament is cut, ligated with free tie followed by suture ligature. Tying pedicle before suturing it prevents formation of an expanding hematoma through inadvertent puncture of ovarian vessels.

Bladder is then sharply dissected off the lower uterine segment and cervix. Uterus is then retracted to one side of pelvis, placing the lower uterine ligaments on stretch. Any loose connective tissue overlying the uterine vessels is sharply removed to skeletonize the vessels and a curved Heaney clamp is placed perpendicular to the uterine artery at the junction of the cervix and body of uterus. The opposite side is managed in a similar fashion, the uterine arteries cut and suture ligated.

If Rectum required mobilization from posterior cervix, posterior peritomeum between uterosacral ligaments just beneath the cervix and rectum is incised. The cardinal ligament and any remaining broad ligament are divided by placing a straight Heaney clamp medial to uterine vascular pedicle for a distance of 2–3 cm parallel to the uterus. Pedicle is cut and ligated with a suture ligature. Procedure is completed on contralateral side. A series of pedicles may be required depending upon the size of the uterus.

The pubovesicocervical fascia is then dissected off the lower uterine segment and cervix. A curved Heaney clamp is placed inside the fascia on each side of uterus to incorporate the uterosacral ligaments and upper vagina just below cervix. Care should be taken to avoid foreshortening the vagina. Uterus is resected using scissors.

Numerous techniques have been described for vaginal cuff closure one effective method is to place a figure of eight suture of 0 or 2–0 gauge synthetic absorbable suture between the tips of the two clamps. This suture is used for both traction and hemostasis.

Sutures are placed at the tip of each clamp and pedicle is transfixed with suture ligature. This suture incorporates the uterosacral and cardinal ligament at the angle of the vagina.

Vaginal cuff can also be left open to heal secondarily. If this method is used, a running suture is used for hemostasis along the cuff edge. The pelvis is thoroughly irrigated with warm saline or Ringer's lactate solution. Meticulous hemostasis is assured. Urethral and Bladder integrity are confirmed. Abdomen closed in layers.

Technique of Removal of Large Uterus

Many a times large uterus has specific problems. Pelvic anatomy is distorted and in cases having multiple fibroids (myoma) or a big adenomyoma, delivery in the incision before clamping is often difficult, to overcome this

- Take adequate incision (vertical or muscle cutting transverse)
- Carefully separate adhesion of previous surgery or endometriosis
- At times removal of big fibroid (myomectomy) may be needed to reduce the size.
- First few clamps can be applied keeping the uterus in abdomen itself.
- Big uterus has increased blood supply so proper ligation and complete hemostasis is essential (Fig. 90.1).

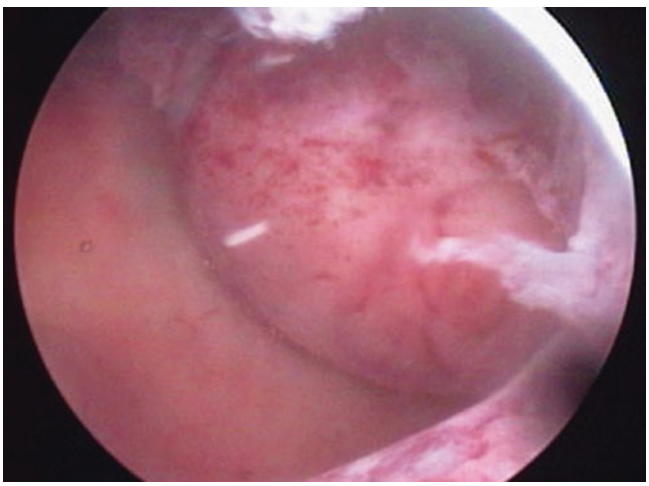


Fig. 90.1 Picture of large uterus

Postoperative Care

If a catheter is used, it can be removed any time around morning following surgery or even before that.

Intravenous fluids are generally administered for the first 24 h to ensure that patient remains well hydrated especially if she experience any nausea or vomiting.

Postoperative colonic stasis lasts for approximately 3 days but does not require nasogastric decompression or preclude early feeding.

Ambulation and deep breathing encouraged.

For adequate pain control, patient controlled analgesia can be utilized.

Instructions on Discharge

- Resume normal daily activity as quickly as possible.
- Walking and stair climbing are encouraged.
- Tube baths or showers are permissible.
- Avoid heavy lifting for 4–6 weeks to minimize stress on healing fascia.
- Vaginal intercourse is also discouraged to allow the vaginal cuff to heal completely which is usually at around 6 weeks.
- Driving should be avoided till full mobility returns & analgesics no longer required.
- The patient should inform her surgeon if she experience:-
  a. Increase in pain.
  b. Persistent nausea or vomiting.
  c. Bleeding heavier than menses.
  d. Any signs/symptoms of infection.

Complications [7]

Immediate

1) During Operation→
   - Hemorrhage.
   - Injury to adjacent structures like bladder, intestine, ureter.
   - Anesthetic hazards.
2) Postoperative→
   - Shock – hypovolaemic
   - Urinary – Retention, Cystitis, Anuria
   - Incontinence – Overflow, Stress, True
   - Pyrexia (vault cellulitis, UTI, Thrombophlebitis, Cystitis, etc.)
   - Hemorrhage (Primary, secondary or Vault)
   - Hematoma
   - Wound Dehiscence
   - Paralytic ileus and intestinal obstruction
   - Phlebitis
   - DVT
   - Pulmonary Embolism

Remote Complications

- Vault Granulation
- Vault Prolapse
- Prolapse of fallopian tube
- Incisional Hernia
- Post-operative adhesion formation
- Early Menopause
- Mortality

Some Special Considerations (For Benign Lesions)

- Age and Parity:
  An ideal condition is that the patient preferably be in the perimenopausal age group with family completed. However, operation may have to be done under forced circumstances even in comparatively young age group or unmarried or nulliparous women. Ex- contemplating myomectomy.
- Total or Subtotal:
  The preferred surgery is always a total hysterectomy unless there is a sufficient reason to leave behind cervix. Pap smear must be normal.
- Indications of subtotal/supracervical hysterectomy are—
  (i) Difficult tubo ovarian mass.
  (ii) Pelvic endometriosis involving rectovaginal septum.
  (iii) Obstetric causes.
  (iv) Sudden deterioration of general condition either due to blood loss or anesthetic complications while contemplating to perform total hysterectomy.
- Advantages (subtotal):
  (i) Reduced operative & postoperative morbility.
  (ii) Reduced vaginal shortening and vault prolapse.
  (iii) Increased sexual satisfaction.
- Risks (subtotal):
  (i) Cervicitis with abnormal vaginal discharge.
  (ii) Stump carcinoma (1 %)

Difficult Hysterectomies

When extensive pathology exists, the surgeon must alter the approach with full awareness of normal anatomy and the deviation from normal that has been produced by this pathologic process. Fundamental principles in removing an

organ include isolation and ligation of its blood supply and dissection and removal from the surrounding tissue without injury to adjacent vital organs, nerves, or vessels. The ability to identify the ureter outside the area of pathologic changes and to follow its course through the field of dissection is essential. **A retroperitoneal approach** is extremely helpful in the isolation and removal of adherent adnexa. The ureter should be left attached to the peritoneum as much as possible but can be isolated from it if the adjacent pathology is densely adherent. If extensive bowel adhesions are suspected, the bowel should be appropriately prepared. An enterotomy can then be primarily closed with drainage established and a temporary colostomy avoided. Thorough knowledge and recognition of the anatomy will allow the surgeon to alter the standard hysterectomy as required by existing pathology with the minimum potential for injury or morbidity in these difficult cases.

Approach to Retoperitoneum in Difficult Hysterectomies

The retroperitoneum is entered by extending the incision on posterior leaf of broad ligament cephalad, remaining lateral to both the infundibulopelvic ligament and iliac vessels. Blunt or sharp dissection clears the loose connective tissue overlying the external iliac artery. The ureter is identified crossing the common iliac artery by following the external iliac artery cephalad to bifurcation. Ureter is left attached to the medial or posterior leaf of the broad ligament so as not to disrupt its blood supply.

The same procedure is completed on the opposite side. The left ureter is usally more medial than the right. If patient has extensive pelvic disease, the ureter must be dissected down towards bladder as far as necessary. The position of the ureter should never be assumed and must always be kept under direct visualization. The perivesical and perirectal spaces may be created to facilitate safe hysterectomy particularly if there is distortion of anatomy by pelvic pathology. Any problems encountered intraoperatively can safely and quickly be addressed when the spaces have been developed.

- Preservation of Ovaries:
  Amidst controversy, it seems rational to preserve the ovaries in premenopausal women, if they are found healthy. Routine removal after age of 45 is no more practiced.
- Advantages:
  (i) Menopausal symptoms appear less.
  (ii) Ovarian function continue till the expected time of spontaneous menopause, so less incidence of osteoporosis and atherosclerosis.
- Drawbacks:
  (i) Malignancy or Benign neoplasm.
  (ii) Residual ovarian syndrome.
  (iii) Chronic pelvic pain and dyspareunia.
  (iv) Chance of Re-laparotomy.
- Early Removal is required:
  (i) If the ovaries are diseased in inflammatory process or involved in neoplastic condition with patient around the age of 40 or earlier.
  (ii) H/o ovarian cancer in first degree relative of patient.

Hormone Replacement Therapy is to be considered when ovaries are removed.

Removal of Fallopian Tube

Recently, the distal Fallopian tube has attracted considerable attention not only as site of origin for serous cancer in women with *BRCA* mutations, but also as the anatomical location where the majority of serous ovarian cancers apparently develop.

Terminology for Tube Removal

(i) When the ovaries are removed. (Salpingo-oophrectomy)
(ii) When the tubes are diseased but ovaries are conserved due to young age. (Salpingectomy).

References

1. Keshavarz H, Hillis SD, Kieke BA, Marchbanks PA. Hysterectomy surveillance – United States, 1994–1999. MMWR Surveill Summ. 2002;51(SS05):1–8.
2. Kovac SR. Hysterectomy outcomes in patients with similar indications. Obstet Gynecol. 2000;95:787.
3. Sizzi O, Paparella P, Bonito C, et al. Laparoscopic assistance after vaginal hysterectomy and unsuccessful access to the ovaries or failed uterine mobilization: changing trends. JSLS. 2004;8:339.
4. Doucette RC, Sharp HT, Alder SC. Challenging generally accepted contraindications to vaginal hysterectomy. Am J Obstet Gynecol. 2001;184:1386.
5. Johnson N, Barlow D, Lethaby A, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2006;8(3):CD003677.
6. Garry R, Fountain J, Mason S, Napp V, et al. The Evaluate study: two parallel randomised trials, one comparing laparoscopic with abdominal hysterectomy, the other comparing laparoscopic with vaginal hysterectomy. BMJ. 2004;328:129.
7. McPherson K, Metcalfe MA, Herbert A, et al. Severe complications of hysterectomy: the VALUE study. BJOG. 2004;111:688.

Treatment for Prolapse of the Uterus: Cervico-Sacropexy (CESA) and Cervico-Recto-Sacropexy (CERESA)

91

Wolfram Jaeger

Introduction

Prolapse

The term "prolapse" is used when the internal genitalia have lost their original position within the body and protrude along the vertical axis. It is not a disorder which appears from one moment to the other but a continuous development which may take several years. Prolapse usually starts in the second part of life – it is a problem associated with aging.

The pelvic organ prolapse quantification (POP-Q) system differentiates 4 stages "on that way out" (POP-Q I – IV) and is valuable for describing, quantifying and staging uterine and vaginal vault prolapse [1].

However, the distribution of stages is unequal. While the positions of the leading part from 1 cm above the hymenal ring to totally outside is subdivided into 3 stages (II, III and IV), the equally long distance within the body from the top of the vagina (e.g. −10 cm) to −1 cm is termed stage I.

A further characterization of the anterior vaginal wall can be achieved by the points A and B. These points in combination with D and the total vaginal length are defined simply on distances to the hymenal ring. They are helpful to describe anatomical prolapse quite precisely.

Prolapse has a close relationship to urinary incontinence [2].

The absolute frequency of urinary incontinence in patients with prolapse is difficult to determine. Most of these patients have reached an advanced age and they either do not appear at a clinic with a minor prolapse or they do not complain about urinary incontinence (UI). Up to 50 % of patients who were hysterectomized because of uterine prolapse had urinary incontinence (UUI) [3].

The number of patients increases with age so that an absolute percentage cannot be determined.

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For physiological purposes some other aspects should be taken into consideration as they may be important in the mechanisms of continence. Especially the anterior vaginal wall deserves further characterization [4].

These may be the parts of the vagina below the urethra, below the urethral-vesical junction, the area where the bladder adheres to the anterior vaginal wall and the fixation site of the bladder and the anterior cervix.

The role of these different areas is not clear. However, the area above the urethral-vesical junction was described by PETROS as the "zone of critical elasticity" – an area where the brain receives its information about the filling state of the bladder and thereby starts or inhibits voiding [4].

In that area a movement with the anterior blade can easily induce the feeling of urgent need to void or not during vaginal examination.

Etiology

The exact aetiology and the pathophysiology of genital prolapse are unknown.

The observation that prolapse is a continuous development argues strongly against the rupture of a "holding structure". The function of the "holding apparatus" diminishes over time; therefore, it is tempting to speculate that a continuous influence is important for the reduced elasticity of the respective tissues [5].

Because prolapse is an absolutely rare phenomenon in animals, the upright body position could be essential. It has been hypothesized that the pressure on the pelvic structures which hold the pelvic organs (uterus, vagina, ovaries, bladder and rectum) is increased by the upright body position. As premise, it is taken that a special critical "pressure" must exceed the "holding forces".

One aspect of increased pressure on this pelvic holding apparatus is pregnancy (baby, uterus and amniotic fluid) and the mechanisms of birth.

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Increasing body weight as a continuous development seems plausible; however, prolapse is irrespective of body weight.

During pregnancy the pressure on the pelvic floor increases; however, the physiological development of the baby, uterus and amniotic fluid during pregnancy do not directly exert their whole pressure on the pelvic floor since the anterior part of the abdomen does not remain in its normal position but bulges.

The power vectors under these conditions are probably not directed at the critical parts of the "holding apparatus".

Pelvic Anatomy

The delivery of the baby leads to dramatic changes in the outlet part of the uterus, cervix (as special closing structure), vagina and the muscular outlet ring (including the connective tissue in that area) of the vaginal introitus.

In contrast to the anatomy of a woman outside of pregnancy, the respective diameters of the "birth tunnel" for the baby (predominately head) need to dilate massively.

The most dramatic changes take place in the cervical channel which has to increase its diameter from some millimetres to about 10 cm, which means a hundredfold increase in diameter. Compared to these changes the increase in the diameters of the vagina and the introitus are marginal (two to threefold); however, a diameter which may reach to 10 cm means a massive extension of these structures.

In a few hours the muscular uterine contractions lead to an increase of the anatomical outlet and shortening of the cervix. Despite the fact that the pre- and perinatal changes are most dramatic in the cervix, a cervical rupture during delivery is a rare event. Prolapse after delivery is an even more seldom event.

The stretching and the later reduction to normal size must be influenced by the increasing hCG, estrogen and progesterone levels during pregnancy.

After the delivery of the baby the correct anatomical reconstruction of the internal genitalia is also influenced by the reduction of these hormones and by prolactin which induces oxytocin release after suckling and thereby contractions of the uterus muscle.

Uterine Prolapse and Urinary Incontinence

A considerable number of women become urinary incontinent after childbirth [6].

However, this incontinence is reversible as it usually disappears after some weeks.

It has been hypothesized that this incontinence is based on the "stretched" pelvic-holding structures at the end of pregnancy. This assumption is based on the difference in the incidence of incontinence between women who delivered spontaneously and those who were delivered by cesarean section (CS). In women with CS the incidence of UI is significantly lower than in women who delivered spontaneously [7].

Forty percent of women suffering from genital prolapse also report UI [2].

It was assumed that UI and genital prolapse were two different disorders which only coincide by chance.

During a retrospective analysis based on personal interviews we could demonstrate that more than 50 % of women who had a vaginal hysterectomy because of prolapse stage II–IV of the uterus also presented with mixed urinary incontinence. The same numbers were reported by others who stated that up to 50 % of all women with vaginal hysterectomy developed stress and urge urinary incontinence thereafter [3].

On the other hand the remaining women with prolapse did not develop UI.

Therefore, prolapse alone cannot be the only reason for UI but UI is often associated with prolapse!

Pathophysiology of Prolapse and Incontinence

According to the above mentioned observations prolapse is probably based on a defect of the "holding apparatus" perhaps combined with some hormonal influences and genetic disposition. The ensuing laxity of the anterior vaginal wall leads to urinary incontinence. The uterus is probably not the etiological responsible factor for prolapse; therefore, a causal treatment must focus on the repair of the holding structures [4].

Prolapse is a disorder which usually appears after menopause. However, when it appears hormonal treatments can no longer repair the damage.

From observations that incontinence disappears some months after delivery, it was concluded that estrogens may be effective in strengthening the respective tissues in the pelvic floor [8].

Therefore, estrogens are often used as first treatment in women with urinary incontinence. The connective tissues can be strengthened by estrogens; however, it is difficult to achieve any effects if the women are already postmenopausal. Most likely the respective receptors can no longer induce the effects on the target tissues.

This may be caused by the diminished number of functioning E2 receptors in the target tissue or by damage to the tissue itself.

As target tissue, the connective tissue of the small pelvis with its body-position-specific "holding function" cannot be repaired. Estrogen replacement therapies cannot repair the prolapse or the incontinence.

In experiments with the corpses of rhesus monkeys, the change to an upright position led to an increased tension of the

left and right USL which could be seen most effectively when the bladder of the monkey was filled with 80 ml saline solution.

When the bladder fills, the position of the bladder in the pelvis increases the pressure on the different surrounding tissues and structures, probably dependent on the different body positions. In the standing and sitting position one could assume that the pressure of the full bladder will exert its power mainly on the upper vaginal wall.

To characterize this position, one has to consider that the length of the urethra differs somewhere between 2.5 and 4.5 cm. That means that the entrance of the urethra into the bladder is somewhere between 3.5 and 5.5 cm from the entrance of the vagina (assuming that the additional 1 cm is the part between the entrance of the vagina and the introitus urethrae).

This correlates with the "zone of critical elasticity" of PETROS. This may be different in the prone position when the pressure is more directed to the lateral parts of the bladder or lying on the back where the pressure is more horizontal [4].

However, the pressure on the vaginal wall is transmitted to the holding structures. This is the anatomical fixation at the vaginal entrance and the cervix. The cervix, however, transfers this pressure to its holding structure – the USL.

(Interestingly enough the fixation points of the USL at the backside of the cervix are nearly exactly opposite the highest fixation points of the bladder at the front side of the cervix.)

In analogy the position of the vagina can be compared with a bridge with two pylons in the front and in the back: the pubo-urethral ligament (PUL) and the USL [4].

Because, according to developmental research, the USL are derived from the uterus and not from the presacral area, it must be important that women have two USL at the cervix and not only one. These two USL do not arise from the same point at the cervix but have two different origins at a distance from each other, depending on the size of the cervix. It can be speculated that this distance improves the three dimensional stability of the pelvic floor and especially of the position of the bladder. By increasing the distance between the origins of the USL the stability of the bladder position is increased.

Therefore, prolapse treatment needs to focus on the holding apparatus and especially on the USL. Since in patients with prolapse the structures of the USL diminish by two thirds in their muscle and elastic tissue composition, the USL cannot only be repaired but must be replaced.

Pelvic Floor and Standardization of the Operations

The premise of the CESA and CERESA operations is a standardised surgical replacement of the USL (Fig. 91.1).

Standardised operation means that the operation will be performed in every patient in exactly the same way: identical length of tapes which is guaranteed by stitch marks on the

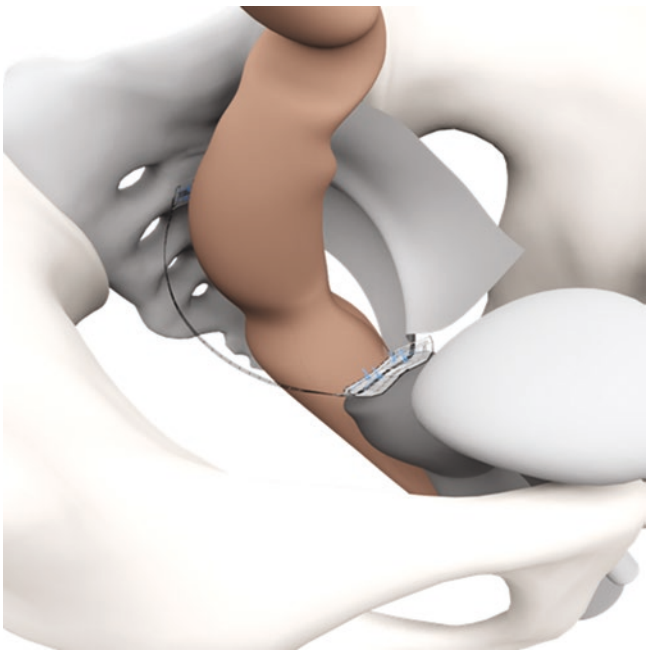


Fig. 91.1 The CESA structure was sutured to the cervical stump and the os sacrum. The USL tapes of the structure run retroperitoneally

structure, defined fixation sites at the cervix and in front of S1/S2. The structures are pulled through the peritoneal fold of the USL and thereby placed retroperitoneal at a defined channel.

Considering the great variety of women's shapes one would expect that the lengths of the USL are different in every woman; however, this is not the case.

In obstetrical textbooks the diameters between the bony structures in the small pelvis are identical in all women irrespective of weight, parity or racial derivation. This has been confirmed by extensive MRT measurements by several institutions [9].

For this reason we hypothesized that the ligaments in the small pelvis, especially the USL and the PUL, are also of identical length or differ only slightly in all women after puberty.

Therefore, we decided to implant USL structures of the same length in every woman. According to the literature and our own measurements we arrived at the conclusion that the length of the USL is between 8.5 and 9.0 cm. According to the literature we decided to implant 8.8 cm long USL structures with a distance between each other of 4 cm at the "bridge" in CESA (Dynamesh CESA, FEG, Aachen, Germany) [10].

CESA and CERESA as Prolapse Surgery

Prolapse is a disorder of the "holding apparatus" of the uterus.

If this apparatus loses its strength, the held structures will give way according to the laws of gravity.

According to the "bridge allegory" of PETROS, the "tows" which hold the lane continuously lose their tension. These "tows" of the bridge are the pelvic connective tissues and probably most importantly, the uterosacral ligaments (USL) [4].

Because prolapse does not occur from one day to the next, it is not an accidental happening which leads to prolapse.

Prolapse is mainly a disorder of the postmenopausal woman. Therefore, it seems reasonable to speculate that the drop in hormones after menopause plays an essential role in this development.

Estrogens can be effective in preventing softening of the connective tissues. Estrogen replacement therapy (ERT) is preventive in this respect; however, estrogens cannot repair an already existing defect.

For this reason, treatment of prolapse must consist of repairing the existing defects.

The defects can be repaired by reparation of the most important "tow" which is the USL [4].

The observation that women who were hysterectomized because of uterine prolapse tend to develop a vaginal vault prolapse thereafter clearly indicates two aspects:

The uterus cannot be the leading cause for prolapse and the underlying disorder has not been effectively treated. We do not know how to treat the chronic disorder but we propose to repair the "tows" of the bridge.

CESA and CERESA as Incontinence Surgery

The bilateral replacement of the USL by the CESA or CERESA structures demonstrated that even patients suffering from urge urinary incontinence were cured of this complaint [11].

So far there is no explanation for this finding.

However; the success rates decrease with increasing age which indicates an underlying problem which is age dependent.

The PVDF Tapes

Polyvinylidene fluoride (PVDF) monofilaments were used as the material of choice for the construction of four new implants to augment the USL.

The augmentation of the uterosacral ligaments was performed using a narrow but open-pore sling structure of 4 mm width, made of high strength PVDF filaments (Dynamesh CESA and Dynamesh CERESA, Dynamesh VASA and Dynamesh VARESA, FEG Textiltechnik mbH, Aachen, Germany). The large-pored structure avoids the formation of a scar strand and the encapsulation with a fibrotic granuloma of the tape. It also enables the ingrowth of fatty tissue [12].

This allows the long-term and constant mobility of the newly formed ligaments.

Stitch marks on the right and left sides ensure that the identical ligament length is restored. For CESA we took an 8.8 cm long USL.

The anterior fixation site is 3 cm x 4 cm.

Additional Rectopexy (CERESA)

If a rectopexy has to be performed (CERESA), a non-resorbable suture 3–0 is placed in front of the marked posterior fixation sites. Special tapes have been developed for this procedure (Dynamesh CERESA). The sutures grab the mesorectum on both sides and are tied on the anterior net structure of the tape in that area.

Repair of the Anterior ("Cystocele") and Posterior ("Rectocele") Vaginal Wall

The decision to perform an additional repair of the anterior or posterior vaginal wall i.e. a vaginal colporrhaphy has to be taken at the end of surgery and should only be performed when points Aa, Ba or C are >-2 cm (-1, 0, +1, $\geq$+2).

Before the Operations

Explanation of the Operation

During the explanation of the Cervico-Sacropexy (CESA) or Cervico-Recto-Sacropexy (CERESA) the surgeon must know what should be done if a cervix-conserving operation cannot be performed. A current PAP smear must have been obtained. The possibility that the operation could end as a hysterectomy without any USL replacement must be discussed with the patient. Furthermore, the patient has to decide whether she wishes to keep the tubes and ovaries or have them removed.

Clinical and Ultrasound Examination

The examination has to rule out malignancies and must detect possible myoma. It has to be decided how to treat the respective findings. Myoma are usually resected by supracervical hysterectomy.

Bowel Cleansing

One day before surgery the patient must have a bowel cleansing as for a colonoscopy. If the bowel is not absolutely empty, the operation can become very difficult because the diameter

of the "working place", especially in front of S1/S2, may be only a few centimeters.

Note: Every additional centimeter makes it easier.

Body Weight

If the patient has a body weight exceeding 100 kg, we abstain from the operation due to the feasibility of the surgical techniques.

Bladder

A catheter is placed at the beginning of surgery.

At the end of surgery it is advisable to fill the bladder with blue saline solution to detect any possible injuries.

Antibiotic Coverage

Cephalosporines are administered according to the body weight as a single dose injection immediately at the start of surgery.

Anti-coagulation

Coagulation must be controlled. If the patient is under anti-coagulant treatment, adaptations must be started before surgery.

Note: Even chronic aspirin treatment can cause heavy bleeding which is difficult to control.

In some cases it is prudent to consider the help of a hematologist.

A bleeding of the venous plexus in front of the os sacrum is one of the leading causes for severe bleedings during these operations. If electrocautery cannot control the bleeding, compression with a swab has to be performed for several minutes.

The control of this bleeding can become very difficult if the patient is under anti-coagulation treatment.

Pre-operative Interactive Talk ("Time-Team-Out")

We calculate the operation time for a CESA, from opening the peritoneum until closing the peritoneum, to be 70–150 min (for CERESA 10 min longer).

The remaining time is used for "cut and final closing of the skin". This is dependent on the experience of the surgeon.

The overall operation time is usually calculated as 120–150 min.

Blood loss is calculated at 100–200 ml.

Pre-operative Measurements

Prolapse Measurement

The vagina is examined and a clamp is placed at the cervix (Fig. 91.2). A newton meter is placed at the clamp and a force of 10 N (1 kg) is exerted at the clamp (Fig. 91.3). The distance between the cervix and the hymenal ring is measured (Fig. 91.4).

The index finger is then placed at the clamp at the side of the hymenal ring. The clamp is opened and the distance between the cervix and the hymenal ring is measured.

Opening the Abdominal Cavity (According to the Internal Institutional Standards)

The dermal incision should be horizontal ("cesarean section"). It is between 8 and 12 cm according to the pre-rectoral fatty tissue.

After opening the peritoneum, we prefer placement of a rectangular frame.

The first step is to decide whether the operation can be carried out as planned.

If ovarian cysts complicate the situation, these should be removed and examined. The aim of this part of the operation is to "empty" the pouch of Douglas as much as possible.

Therefore, the bowel and the small intestines have to be out of the small pelvis.

We use two surgical towels. With the first towel we place the small intestine into the upper abdominal cavity. With the

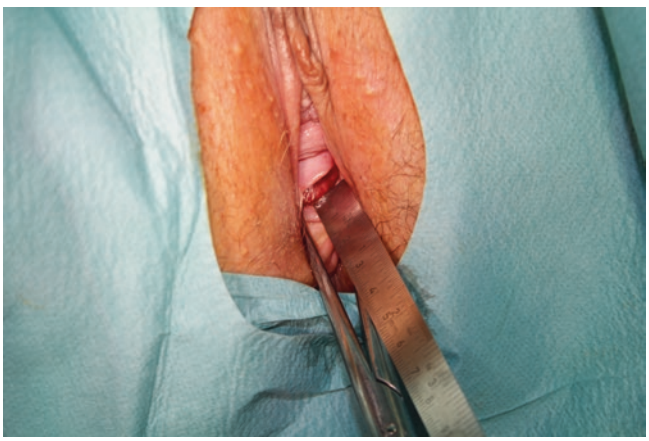


Fig. 91.2 Before surgery the distance between the cervix and the hymenal ring is measured. A clamp is placed at the lateral cervix



Fig. 91.3 With a newton meter a defined tension of 10 N (1 kg) is placed at the clamp

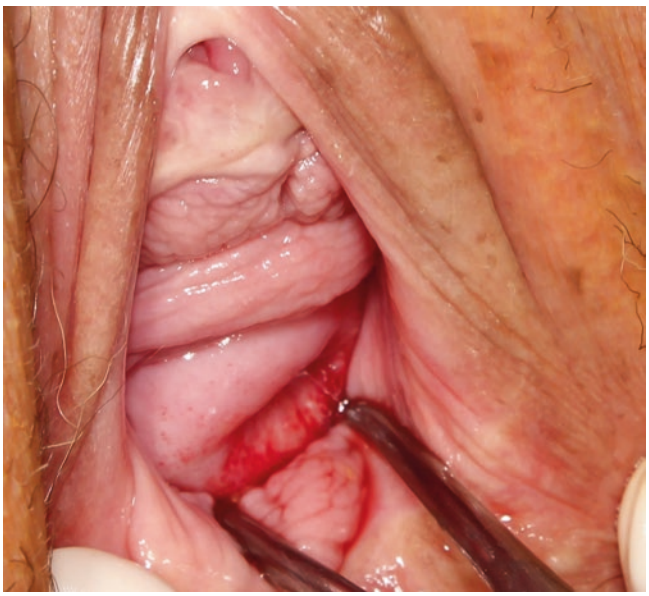


Fig. 91.4 In this case, under these measuring conditions the cervix comes to the hymenal ring. Therefore, according to this measurement the distance of Point C is 0. (This standardized measurement is not the POP-Q system, but uses its definitions of the points and distances.)

second towel (which is folded into a rectangular shape) we move the descending and ascending large intestine upwards. At the end of this step the pouch of Douglas should be free of intestine apart from the sigmoid colon. Especially the pelvic rims (the transition into the small pelvis) must be clearly visible in order to make incisions there without any problem.

Dissection of the Tubes and the Ovaries from the Uterus

The adnexa are identified at the uterine corpus. They are dissected by coagulation and cut (Figs. 91.5 and 91.6).

The uterine vessels are coagulated and cut (Figs. 91.7, 91.8, 91.9 and 91.10).

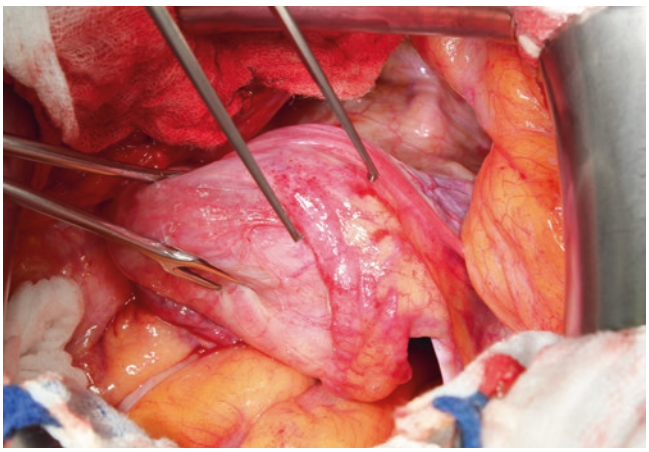


Fig. 91.5 After opening of the abdomen the uterus is grabbed with a hooked clamp. The forceps demonstrate the right adnexa on top of a myoma of the uterine corpus. The round ligament and the tube are clearly visible

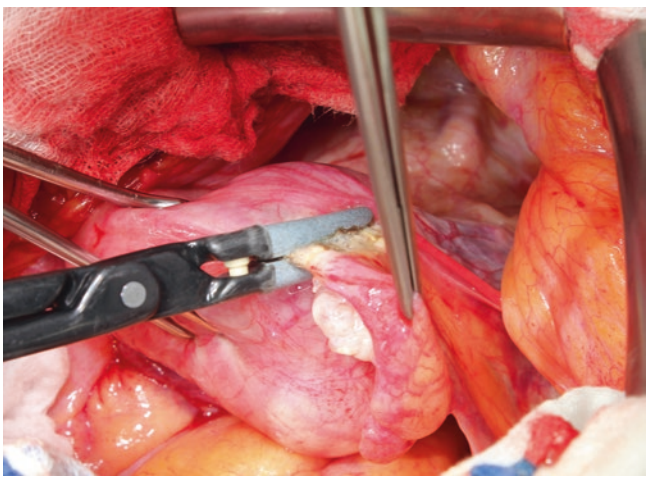


Fig. 91.6 The right adnexa are cut and cauterized

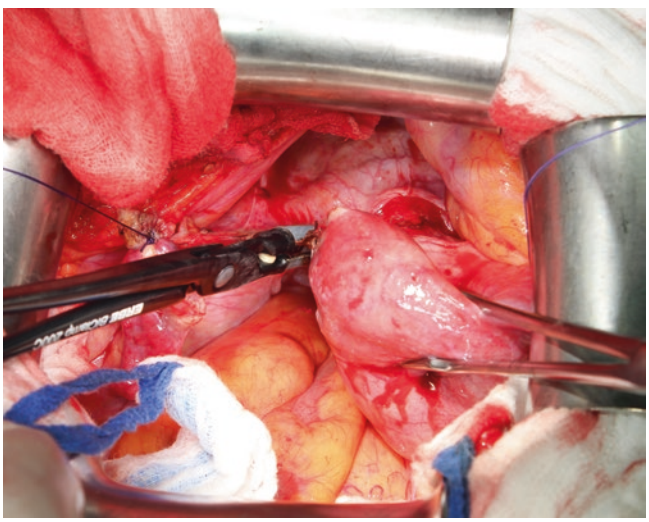


Fig. 91.7 The same is done on the left side and the parametrium is cut until the cervix region is reached

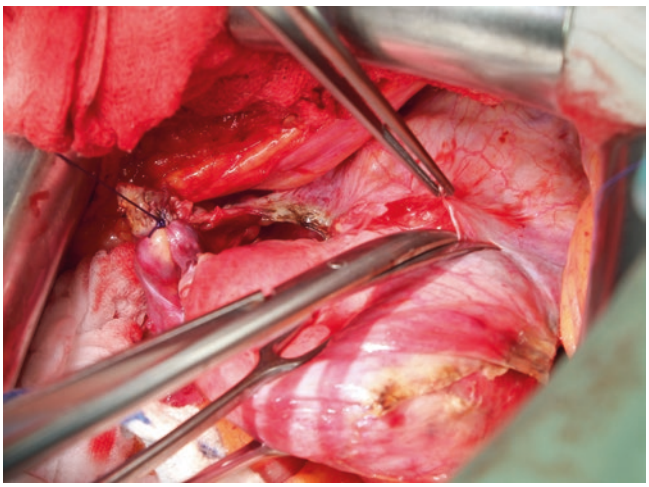


Fig. 91.8 The bladder peritoneum is incised. The bladder remains at the cervix

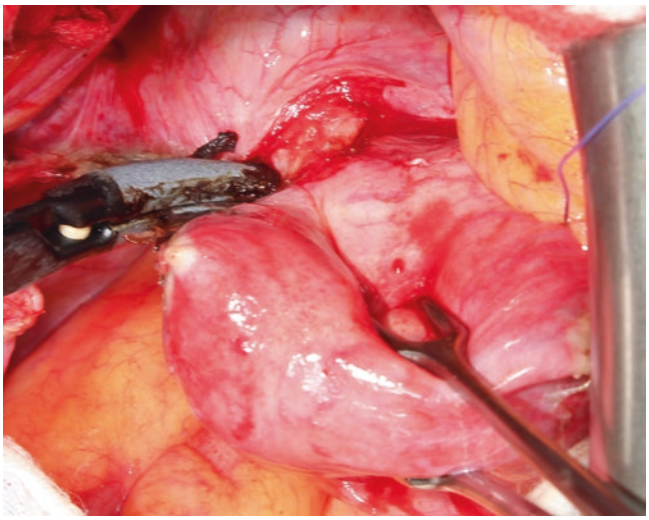


Fig. 91.9 The left parametrium is coagulated. Take care to coagulate the left uterine vessels – vein and artery.

Identifying the Peritoneal Folds of the Uterosacral Ligaments (USL)

The next step of surgery is the demonstration of the USL.

(In patients with a previous supracervical hysterectomy the cervical stump is identified. We then place a strong suture (Vicryl 1–0) into the cervical stump as a holding suture.)

The uterus is pulled vertically towards the outside of the abdominal cavity. With increasing tension the peritoneal folds of the USL will become visible at the backside of the cervix.

The origins of the USL at the uterus can always be identified. The origins of the USL are at the posterior part of the cervix. The USL arise nearly opposite the insertion side of the bladder at the anterior side of the cervix.

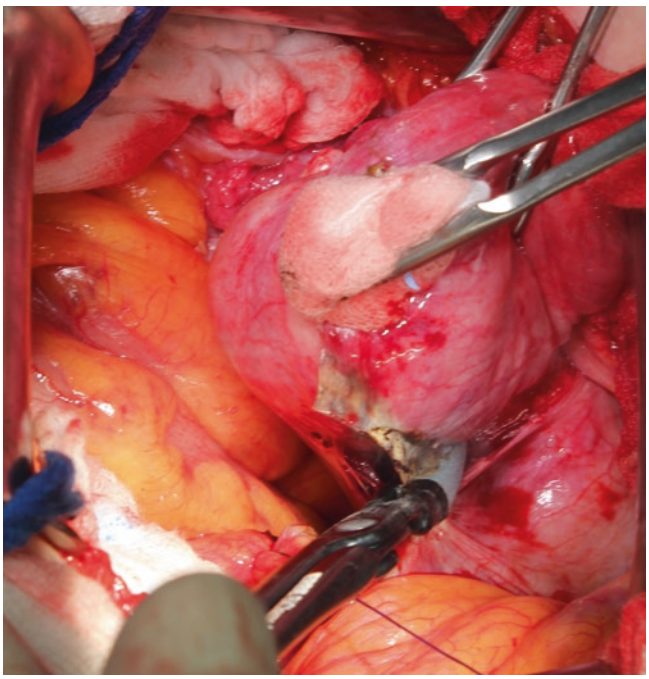


Fig. 91.10 The right parametrium is coagulated and incised. Take care that the uterine vein and artery are cauterized

The two origins diminish within 1 or 2 cm from the cervix and continue their way to the sacrum as folds of the peritoneum. These folds contain the remnants of the USL.

If the peritoneal fold of the USL cannot clearly be identified, then a swab is placed in front of S2 and the pre-sacral peritoneum is pushed medially until the USL (peritoneal fold) becomes visible.

The USL extend beyond the peritoneum into the small pelvis. The urether is located higher at the pelvic wall. Be sure to identify the ureter from its path into the small pelvis until the region of the cervix.

The middle parts of the USL (especially in women suffering from prolapse) cannot be identified with the surgeon's eye; however, this is not important as only the peritoneal coverage (fold) is important for the correct placement of the structures.

The peritoneal folds of the USL end at the level of S2. The USL structures reach up to the sacral spine in the area between S1 and S2.

Note: At this stage the surgeon should get an impression of the length of the cervix in order not to cut the entire cervix.

The length of the cervix below level 0 varies in most women. The remaining cervical stump should be about 2 cm. In patients with an elongated cervix one has to assess if the cervix has to be shortened.

In postmenopausal patients the uterus and the cervix may be so small that a VASA structure could be more suitable.

Definition of Level 0

The points at the cervix where the USL originate are delineated. An imaginary horizontal line between these points of origin is called "level 0" (zero).

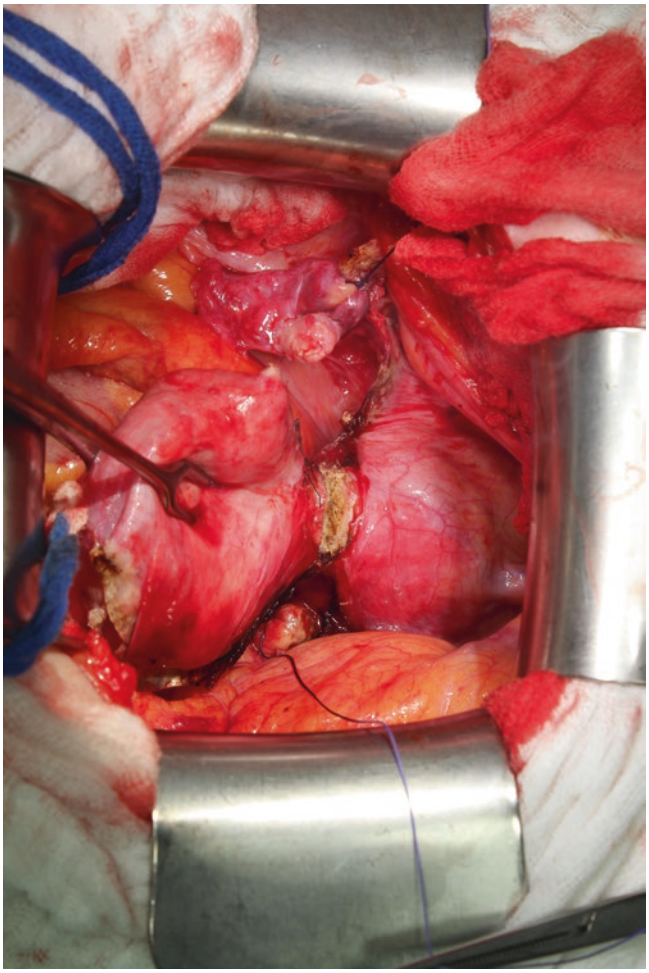


Fig. 91.11 The cervix is incised where the bladder reaches the cervix. This is the place where the USL reach the cervix at the backside

A small horizontal incision ("mark") is made at the backside of the cervix at the level 0 (Fig. 91.11).

Take care that the incision is only used as a "mark" at which the corpus of the uterus is dissected. Too big marks could cause bleedings of the uterine artery or vein which are absolutely unnecessary at this point of time.

The supracervical hysterectomy is performed at the height of the "level 0".

One has to consider the length of the remaining cervix. Usually it is between 1 and 2 cm. If the remaining cervix is longer than 2 cm (given that the level 0 was correctly defined), one has to decide if the cervix has to be amputated from the vagina. We deliberately decided to leave these "extra-long" cervices.

Note: In sexually active patients the above aspect must be considered. In some circumstances a cervical resection could be necessary.

Supracervical Hysterectomy (SH)

To be able to see the USL, the uterus has to be elevated. The cutting level of the SH will be in the range of level 0, i.e. very close to the beginning of the bladder on the anterior cervix.

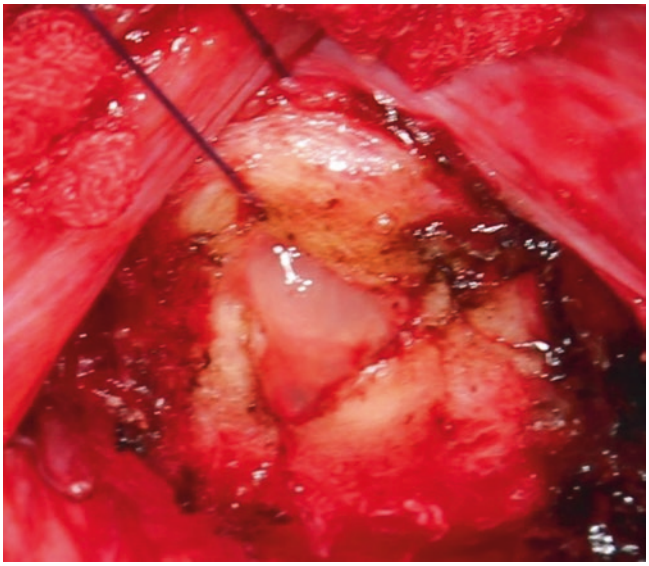


Fig. 91.12 After the cervix has been cut, a "holding suture" is placed and armed with a clamp. This will help to "navigate" the cervix during further operation

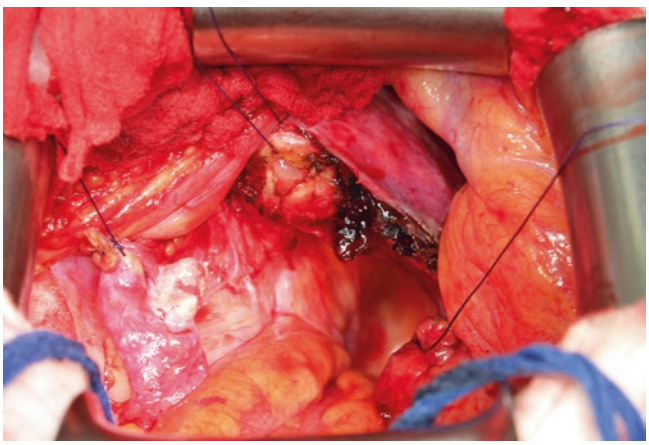


Fig. 91.13 The uterus is then removed

Therefore, grasp the bladder with a forceps and identify this place ("bladder insertion") at the cervix.

The corpus will later be resected at the level 0.

The supracervical hysterectomy can be performed according to the clinical standards.

Note: Abstain from dissecting the bladder from the cervix. This fixation of the bladder is essential and should not be destroyed!

Usually level 0 lies at or slightly below the insertion of the uterine artery and vein. Keep in mind that these vessels therefore come from the lateral part of the pelvis and not along the uterine body.

After supracervical hysterectomy, it is easier for the next steps to fix a holding suture at the anterior ("bladder") side of the cervical stump. This facilitates placement of the next sutures and peritonealization at the end of surgery (Figs. 91.12 and 91.13). The holding suture in not knotted so that it can be removed easily.

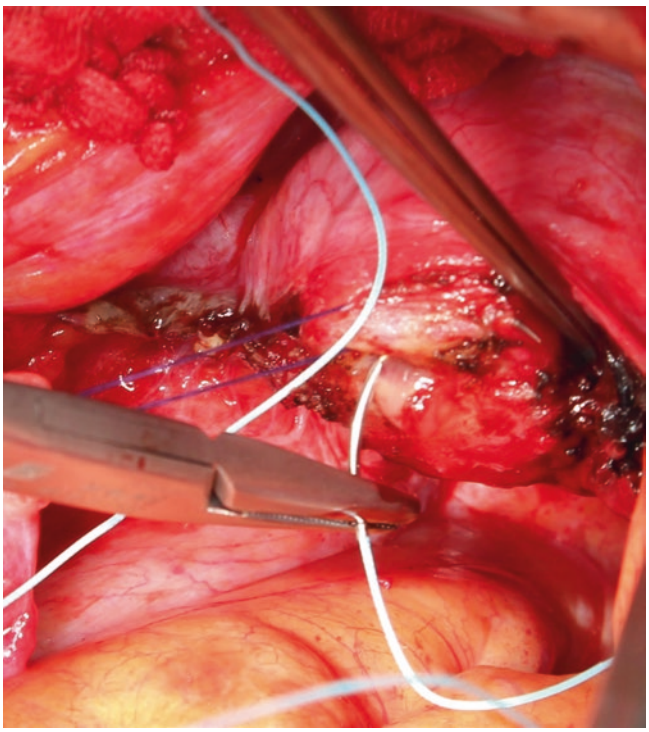


Fig. 91.14 The non-resorbable sutures are placed at the cervical stump. The first stitch grabs the right anterior quadrant

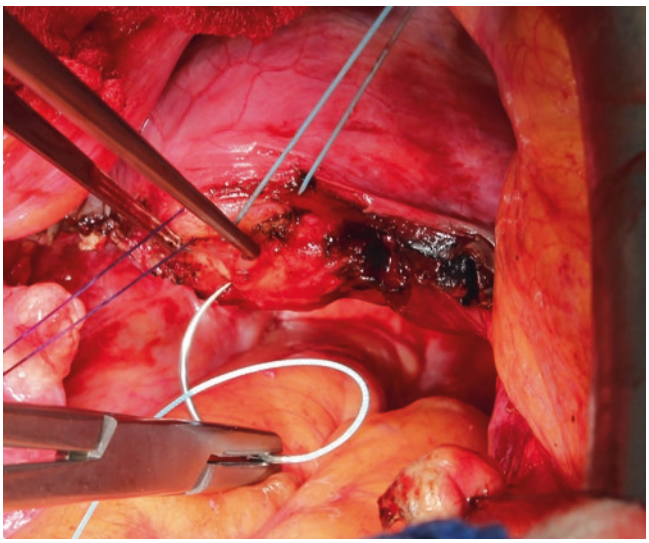


Fig. 91.15 The second stitch grabs the right posterior quadrant

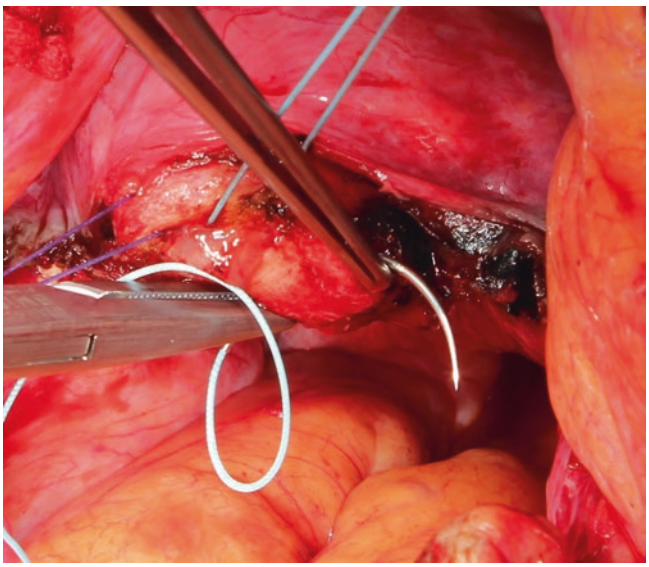


Fig. 91.16 Note: Avoid injuring the uterine vessels

Note: If the vagina was opened during any steps of the CESA or CERESA, there is a high risk of the development of pelvic infections.

In premenopausal patients the infection rate is definitively higher than in postmenopausal patients.

Fixation of the Tapes at the Cervical Stump

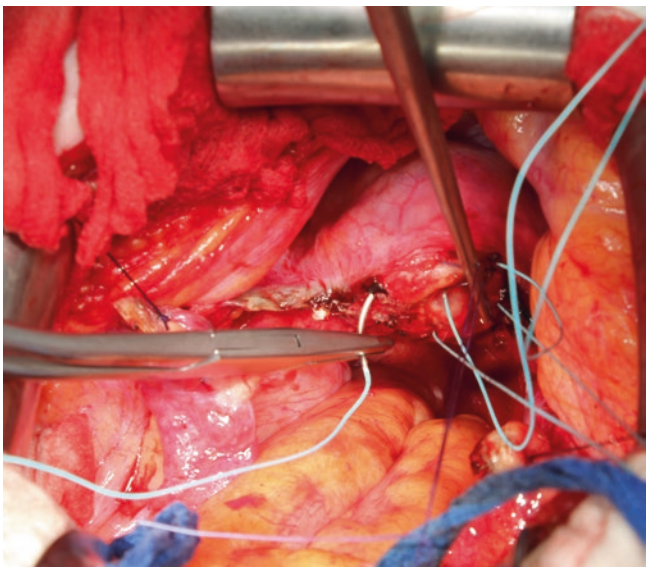
Four non-resorbable sutures 2–0 are placed at all 4 quadrants of the cervical stump (Figs. 91.14, 91.15, 91.16, 91.17 and 91.18). Special care should be taken that the stump of the cervix is totally covered by the mesh structure ("bridge") and secured by the sutures, "like linen on a table".

Care should be taken that the distance between the USL after suturing the bridge is 3 cm to ensure a stable horizontal fixation of the vagina and bladder. Furthermore, the holding vectors must be on the anterior vaginal wall, i.e. in the part of the cervical stump close to the bladder.

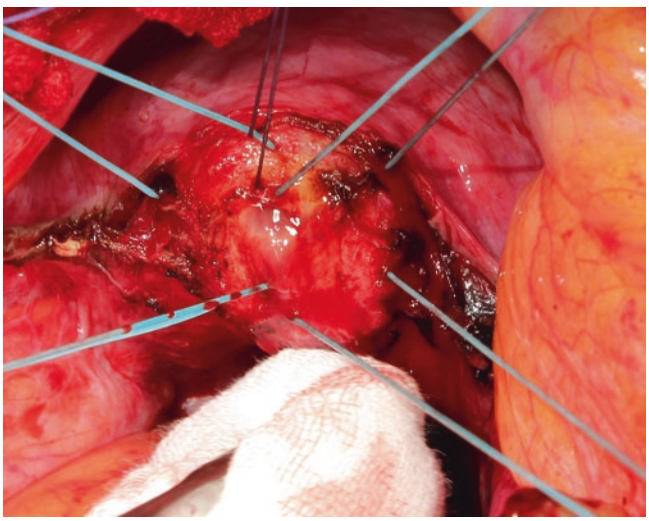
The four stitches should not pass through the cervical channel.

Thereafter, the CESA or CERESA structure has to be chosen (Figs. 91.19, 91.20 and 91.21). In patients with a very small uterus it may be necessary to use a VASA or VARESA mesh!

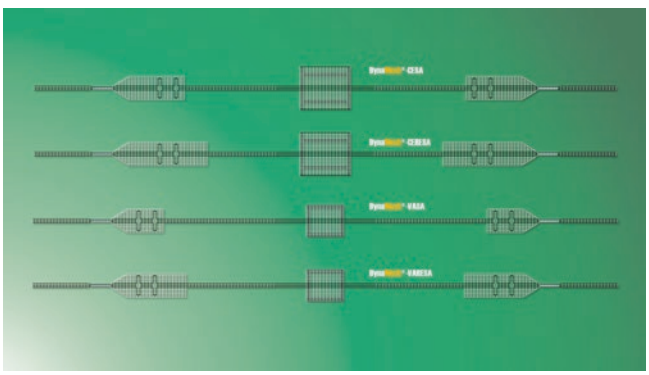
After placing the CESA mesh on the cervical stump, the sutures are pulled through the net structure between the USL ("bridge") and carefully tied (Figs. 91.22, 91.23 and 91.24). The sutures must not cut the cervical tissue. The sutures are not used to hold the "bridge" tightly to the uterus but just to keep the "bridge" in position.



Flg. 91.17 The third stitch is placed in the left anterior quadrant



Flg. 91.18 The four sutures were placed



Flg. 91.19 Several structures can be compared. The CESA and CERESA USL tapes are 0.5 cm shorter than the VASA/VARESA USL-tapes. The "bridge" (anterior fixation side") is 3 cm x 4 cm. The augmentation of the uterosacral ligaments is performed using a narrow but open-pore sling structure of 4 mm width, made of high strength PVDF-filaments (Dynamesh CESA, Dynamesh CERESA, FEG Textiltechnik mbH, Aachen, Germany)

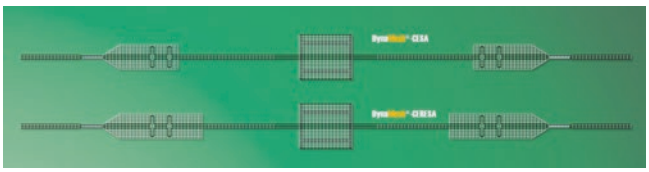


Fig. 91.20 CESA (top) and CERESA (bottom) tape

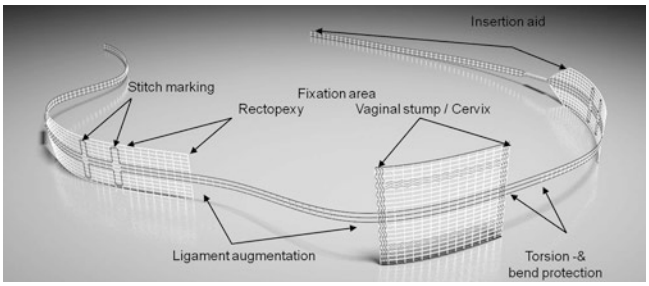
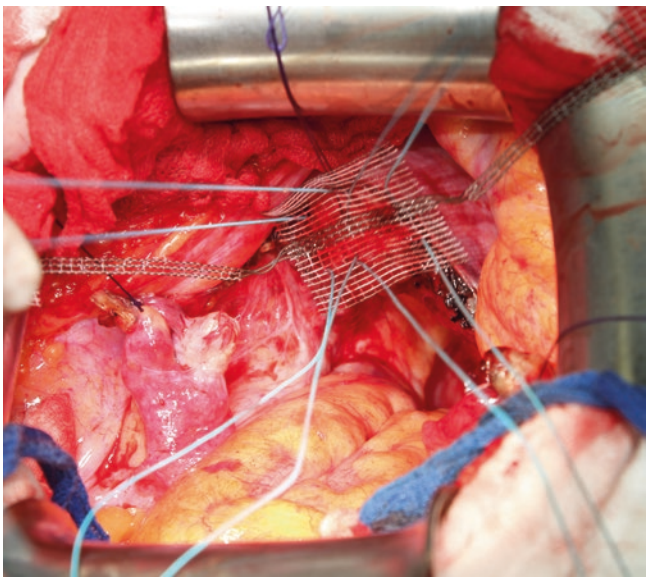
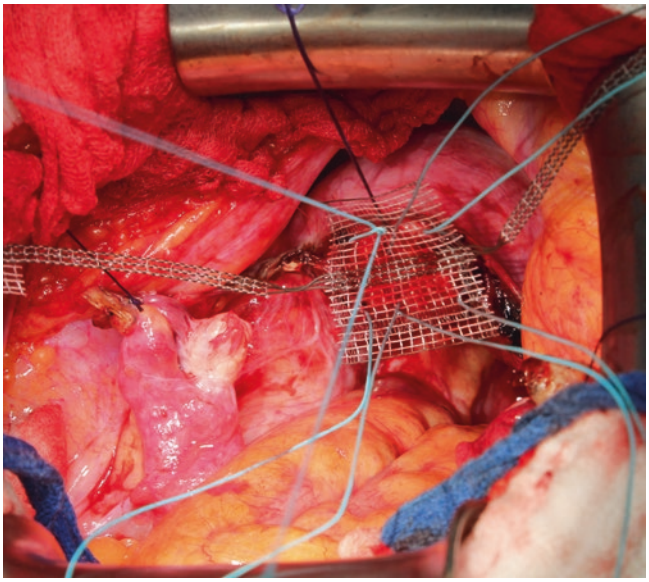


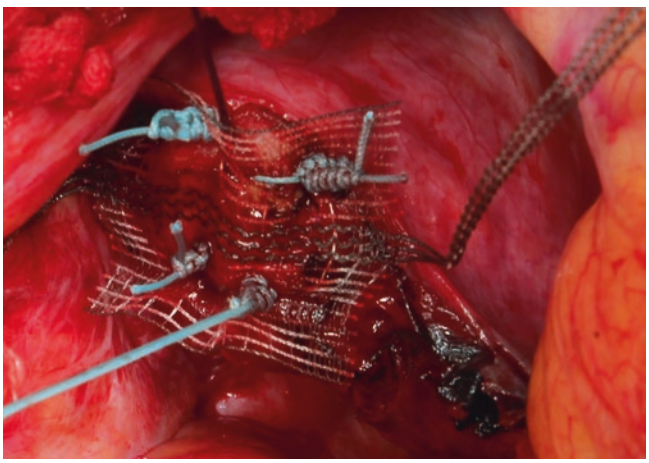
Fig. 91.21 The details of a CERESA tape. The ligament augmentation is from the end of the "bridge" to the first stitch marking. This distance is 8.8 cm. In the CERESA structure – as shown here – before the stitch markings a mesh is added for rectopexy. After placement of the structure in the USL peritoneal fold, the insertion aid is cut



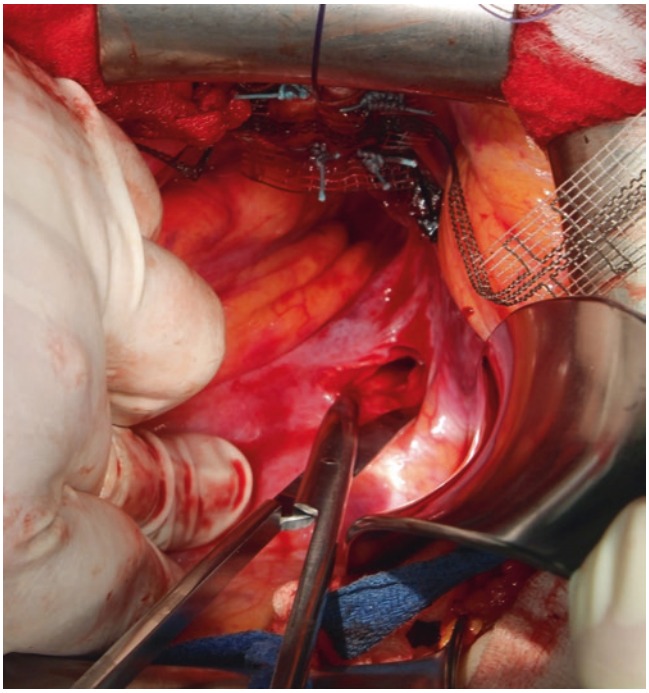
Flg. 91.22 The sutures are placed through the "bridge" of the structure and the structure is placed on the cervical stump



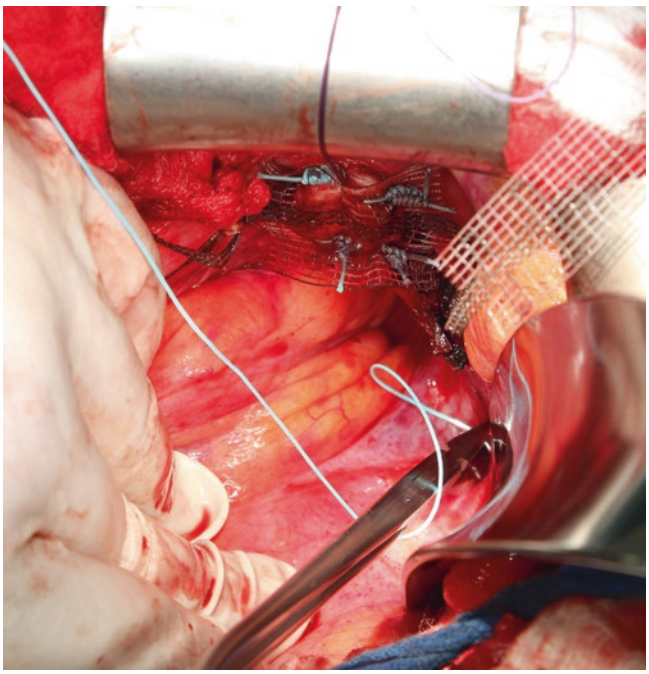
Flg. 91.23 The sutures must not be tied so tightly that the vaginal wall builds folds. The aim of these sutures is just to fix the "bridge" at the cervix



Flg. 91.24 The sutures were cut



Flg. 91.25 The peritoneum on the right side is incised. The incision is on top of the USL in front of S1/S2



Flg. 91.26 After preparation of the prevertebral fascia, the first suture is placed horizontally. The suture is armed with a clamp which is put on the head part of the frame

Preparation of the Posterior Fixation Site

After the USL have been identified, the incisions at the sacrum are placed horizontally, 0.5 cm above the insertion side in front of S1/S2 (Fig. 91.25).

An incision along the USL (from cervix to sacrum) should be avoided since the "original" peritoneal folds protect the tape structure from adhesion formation. Furthermore, the folds form the intended anatomical "semi-circle" formation when the structures are under tension. The PVDF structures do not form fibrotic adhesions to this peritoneal fold; therefore, it remains movable.

The incision is usually above the first vertebra (S1). From these incisions the pre-vertebral fascia is prepared. Be aware of the hypogastric nerve and take the nerve laterally from the stitches later on. Identify the presacral artery and vein and coagulate them at 2 cm lengths so that the needle cannot injure these vessels. Two non-resorbable sutures 2–0 are placed horizontally in this fascia, one below and one higher at a distance of about 1 cm from each other. They are armed with a clamp and placed at the top of the wound (Figs. 91.26 and 91.27).

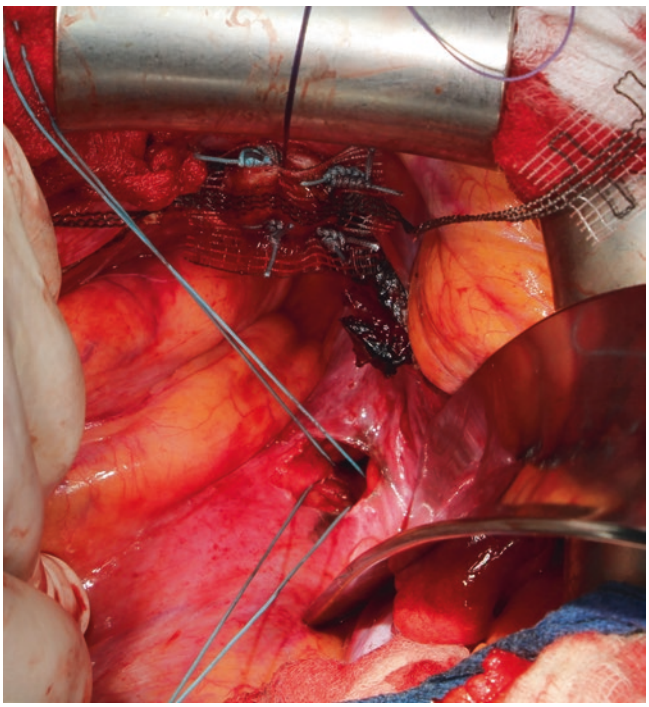
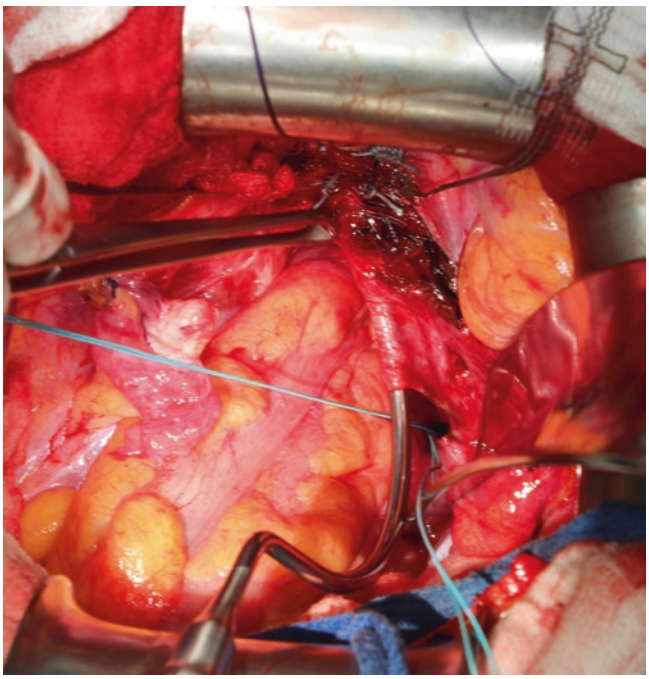


Fig. 91.27 The second suture is placed below and armed with a clamp. The clamp is put at the foot of the frame



Flg. 91.28 The trocar is brought into the peritoneal fold of the USL.

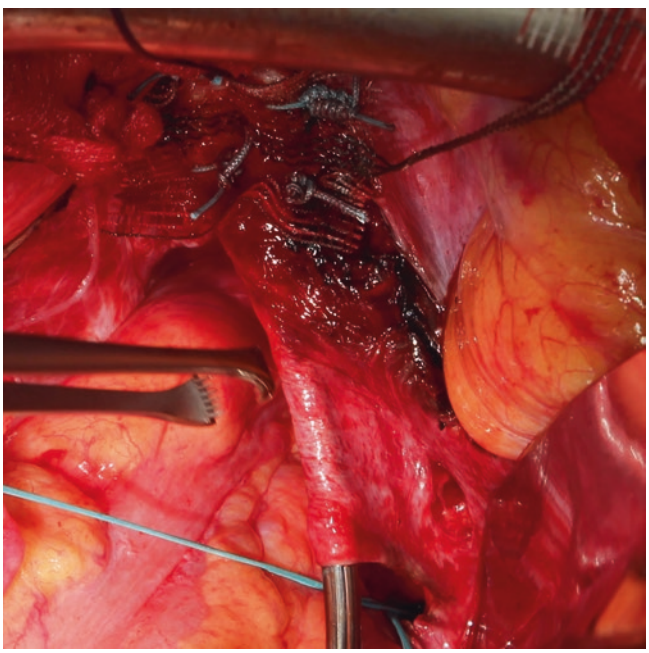
Placement of the New USL

For the next step, care must be taken to avoid injury to the peritoneal fold of the USL.

A small trocar, as usually used for a TVT placement, is pulled through the peritoneal fold of the USL from the back to the base at the vaginal end (Figs. 91.28, 91.29 and 91.30). Care must be taken not to injure the stumps of the uterine vein or artery which were cut during the previous hysterectomy. Bleeding can be difficult to identify since the blood tends to flow through the peritoneal channel to the opening incision in front of S1/S2.

Advice: If the origin of the bleeding cannot easily be identified, this may cause considerable problems for the surgeon. In this case a 3–0 vicryl suture can be placed in the paracervical tissue close to the cervical stump. It should be placed in a double stitch manner in the region of the vessels until the bleeding stops.

Note: Leave the suture untied until you want to close the peritoneum. You can then draw the suture. Usually, thereafter, no more bleeding will occur.



Flg. 91.29 The trocar is pushed forward to the cervix

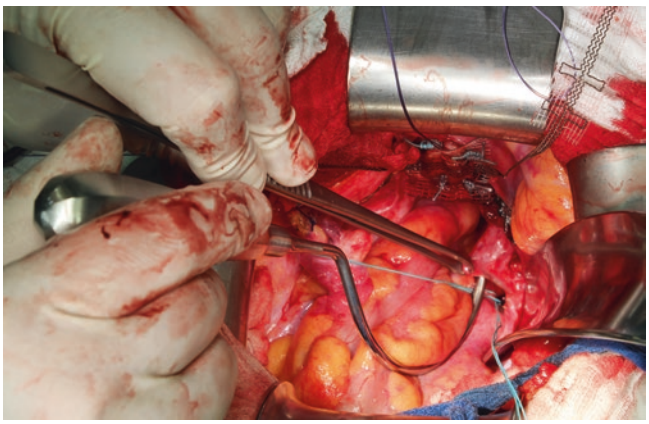


Fig. 91.30 At the cervix the tip of the trocar is placed forward towards the origin of the USL

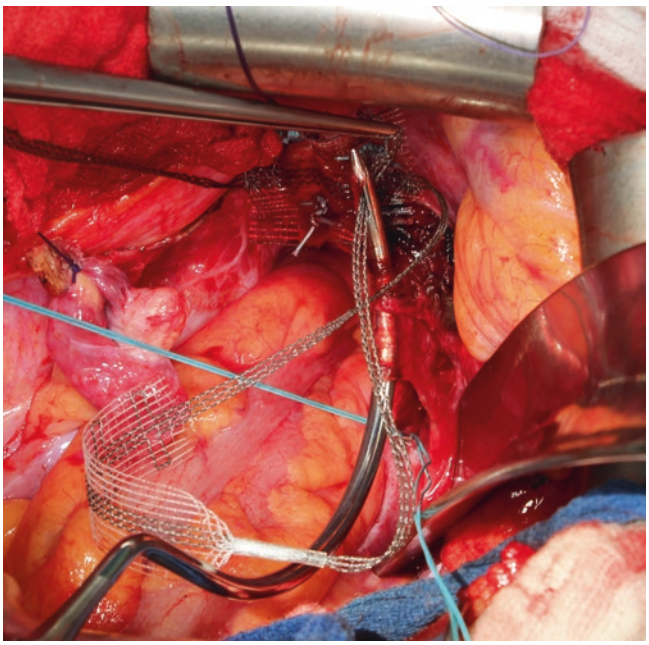


Fig. 91.31 After perforation with the trocar the insertion aid is put into the hole at the tip of the trocar

The insertion aid of the tape is pulled through the hole at the top of the trocar and the trocar is then pulled backwards to the sacrum (Figs. 91.31 and 91.32).

When the fixation mesh appears out of the "channel", it is placed where it should be fixed.

The previously-placed sutures are pulled through the marked fixation sites on the tape; the insertion aid is cut (Figs. 91.33, 91.34 and 91.35). At the end of this step the incisions at the sacrum is closed (Fig. 91.36).

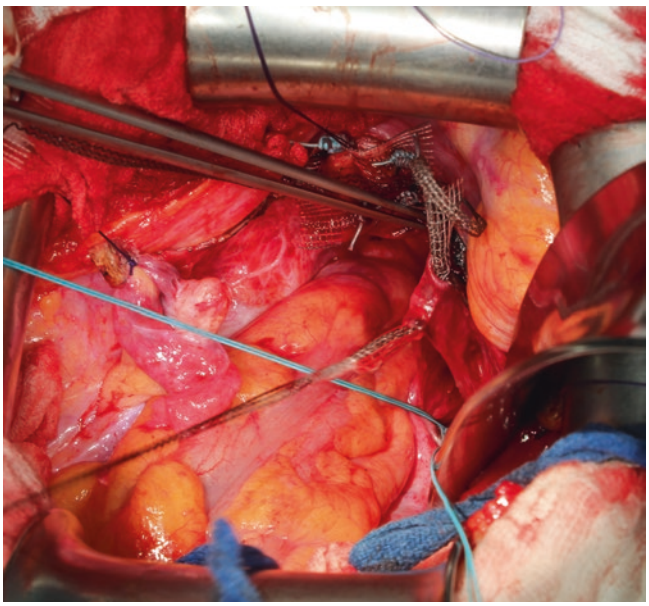


Fig. 91.32 Care must be taken when the posterior part of the mesh with the suturing marks are pulled through the channel. An injury of the uterine vessels could lead to bleeding which will appear at the posterior fixation side!

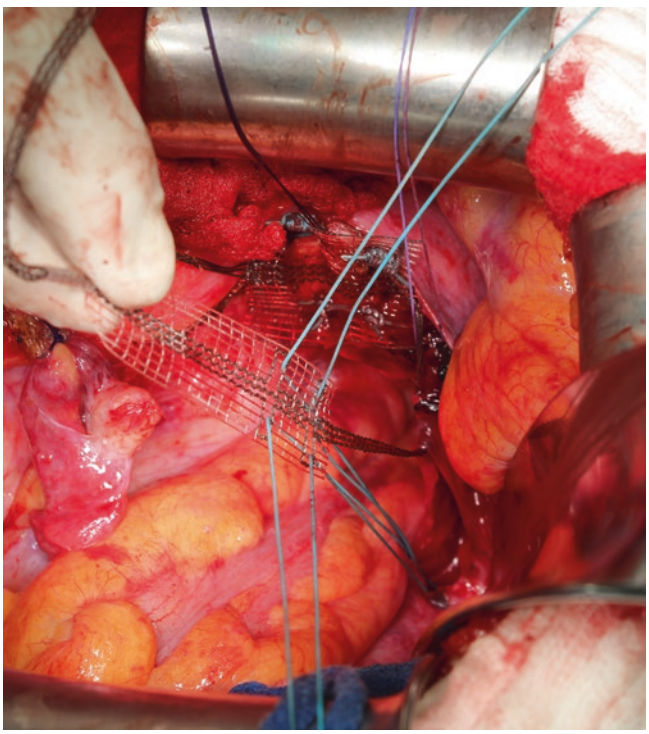


Fig. 91.33 The sutures are placed through the suturing marks

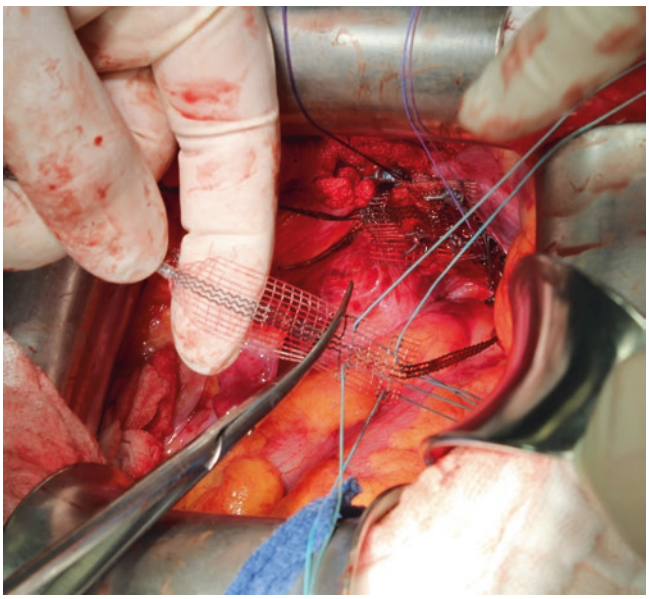


Fig. 91.34 Thereafter the insertion aid is cut

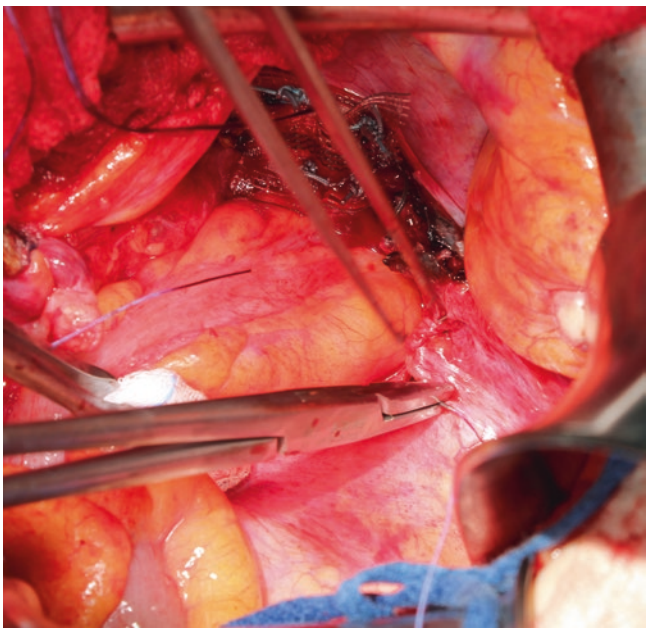


Fig. 91.36 The peritoneum is closed with a running suture

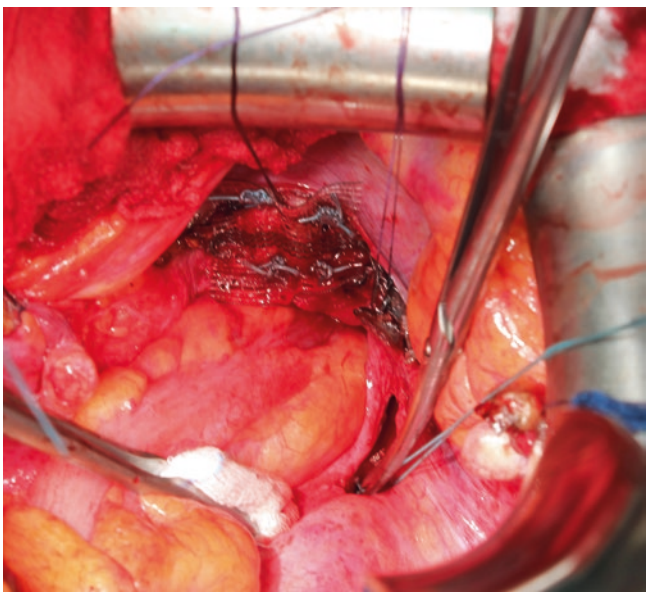


FIg. 91.35 After both sutures have been tied the ends are cut

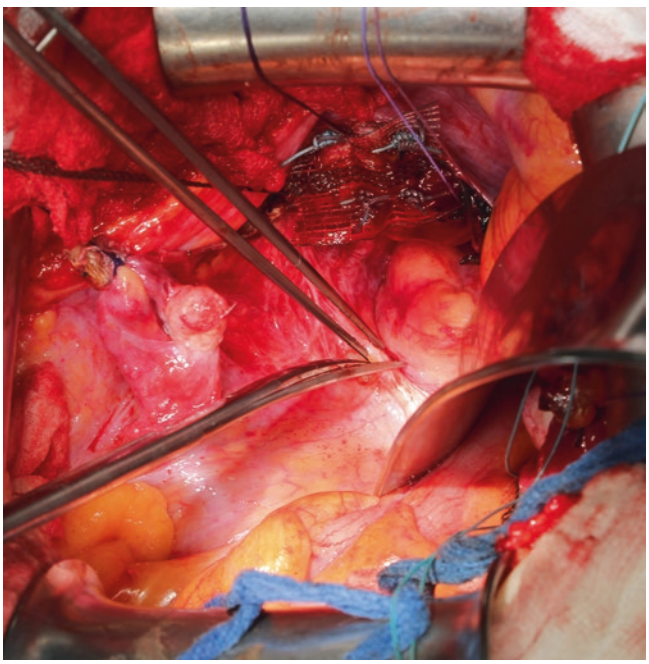


Fig. 91.37 The peritoneum on the left side is incised at the end of the left peritoneal fold of the USL in front of S1

The same procedure is then performed on the left side.

The left side is a little more difficult because the meso-sigma crosses the fixation side.

The sigma/rectum needs to be pushed to the right side. This can be done either with a retractor held by an assistant, or the surgeon takes the sigma in one hand and pulls it in the respective direction.

The surgeon then palpates the retroperitoneal sutures on the other (right) side. This palpatation will help to find the respective identical fixation site on the left side. With the other hand, the incision is placed as on the other side (Figs. 91.37 and 91.38).

When the posterior fixation sites are prepared – two sutures on the left and two sutures on the right side of the sigma colon – the sutures are armed with clamps and pulled aside (Figs. 91.39 and 91.40).

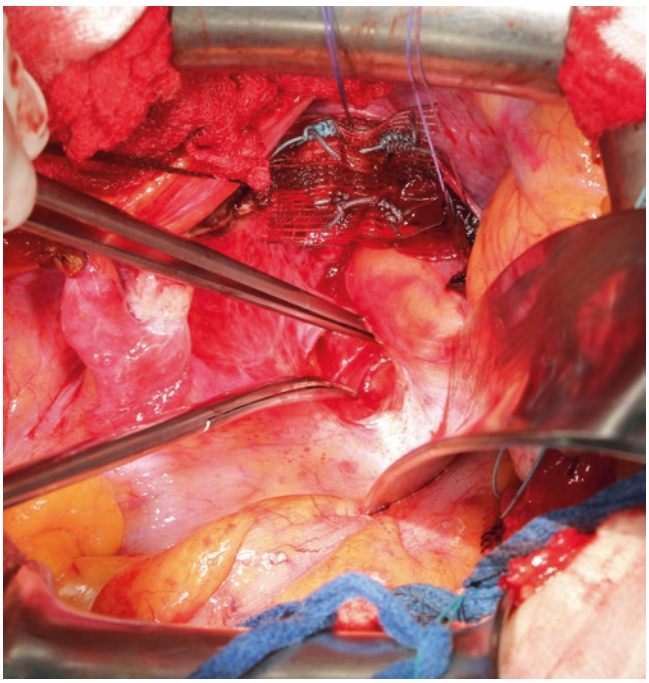


Fig. 91.38 The prevertebral fascia in front of S1 is prepared

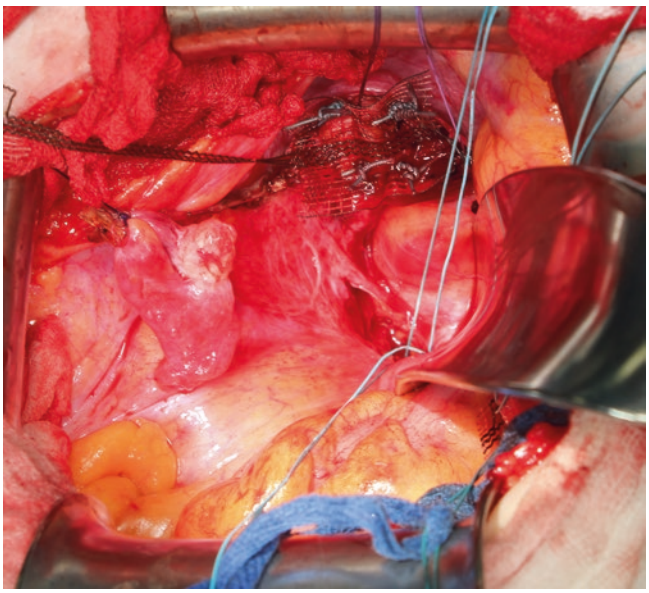


Fig. 91.40 A second suture is placed below the first and armed with clamps as on the left side

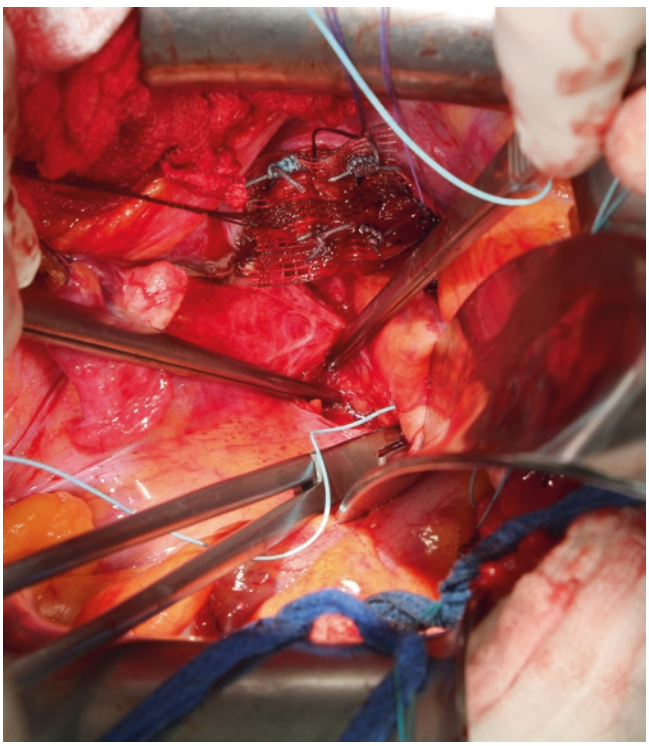


Fig. 91.39 The sutures are placed as on the left side

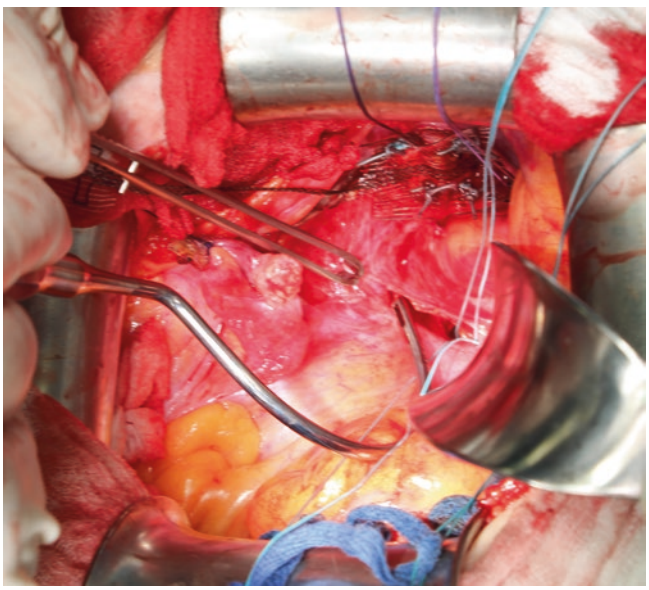


Fig. 91.41 The trocar is brought into the peritoneal fold and pushed forward to the cervix

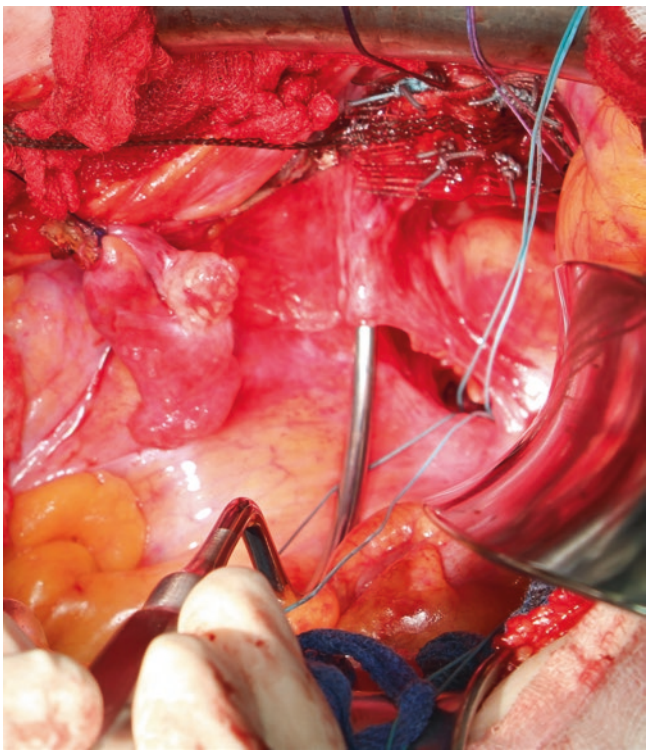
The trocar is placed at the opening and the peritoneal "channel" of the USL is used as the entrance for the trocar (Figs. 91.41 and 91.42).

The insertion aid is pulled through the hole in the trocar and the trocar is pulled backwards with the structure (Figs. 91.43 and 91.44).

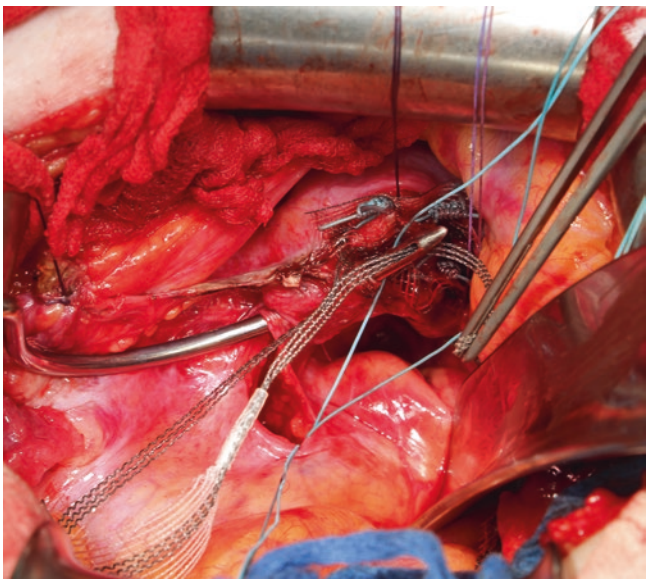
The sutures are pulled through the markings at the structure – each on one side – and the insertion aid is cut (Figs. 91.45 and 91.46).

(In case a CERESA is indicated, the anterior mesh in front of the marking at the structure is taken and a non-resorbable suture takes a part of the mesorectum and sutures that to the CERESA structure (Figs. 91.47 and 91.48).

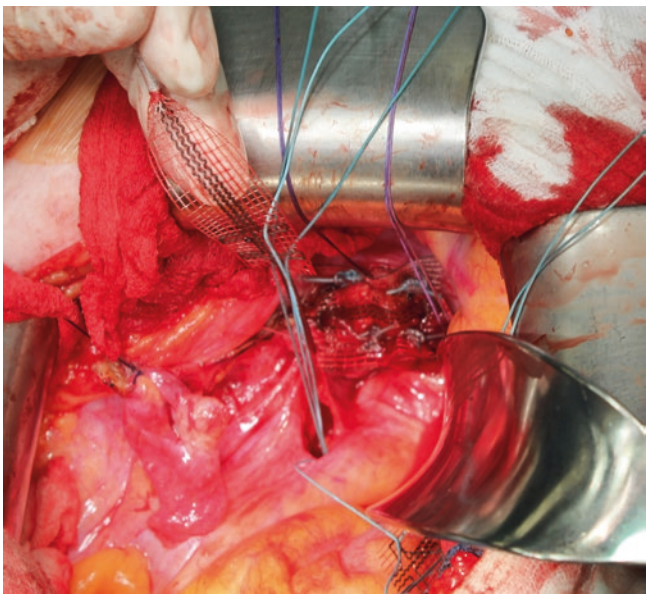
Thereafter the peritoneum is closed (Figs. 91.49).



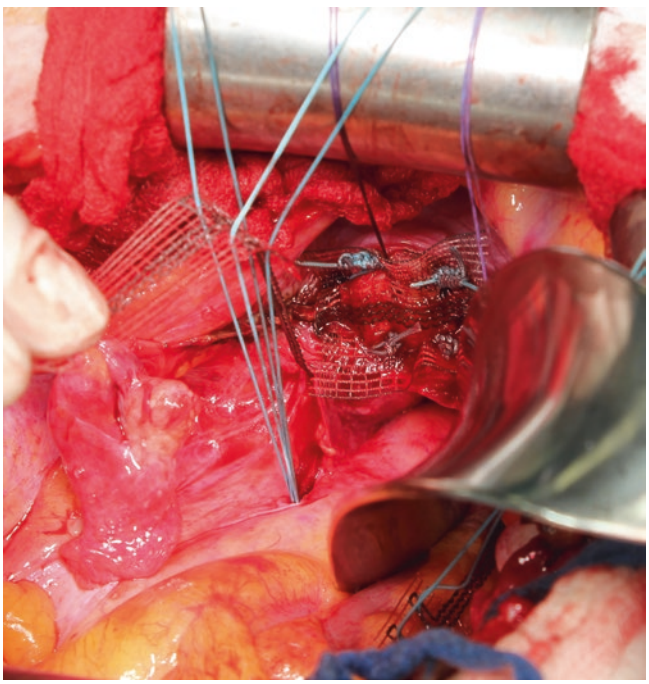
Flg. 91.42 At the cervix the trocar perforates the USL, as on the left side



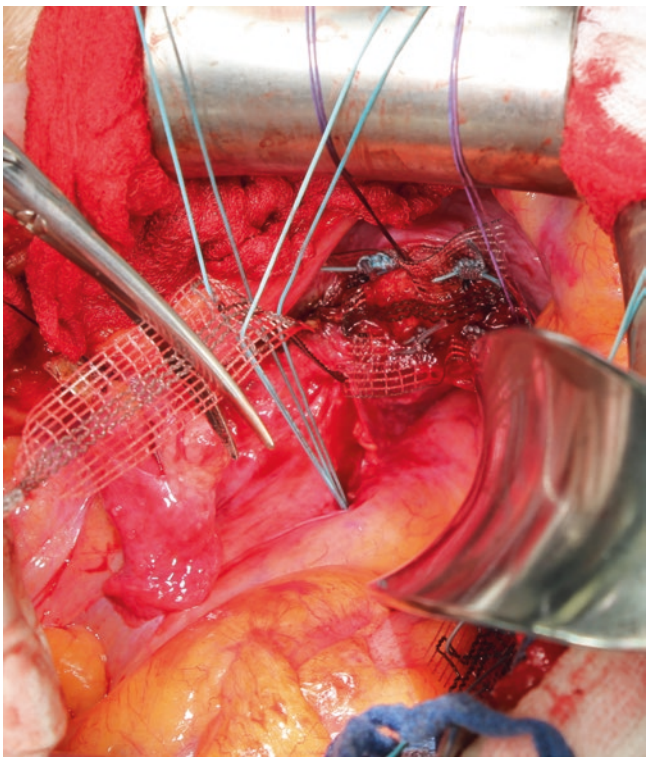
Flg. 91.43 The insertion aid is placed into the hole of the trocar



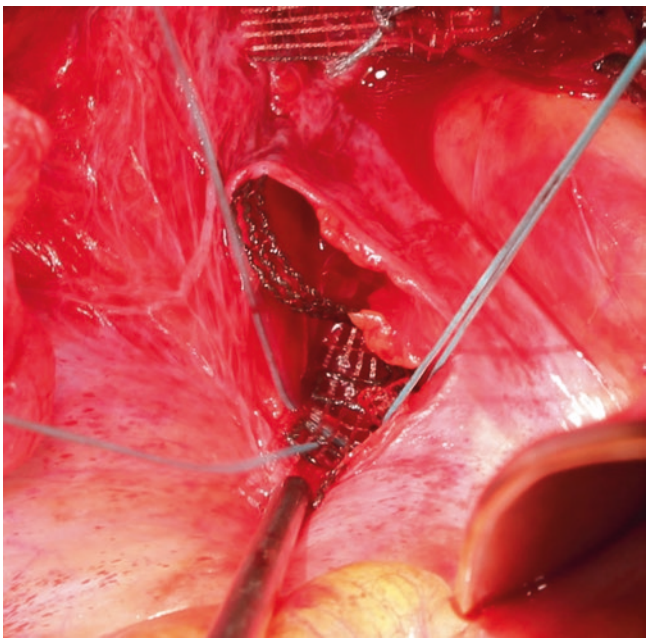
Flg. 91.44 After the structure has been pulled though the channel of the USL, the sutures are placed at the respective marks. Note: The sutures are always placed on one side of the mesh, either above or below the black strip



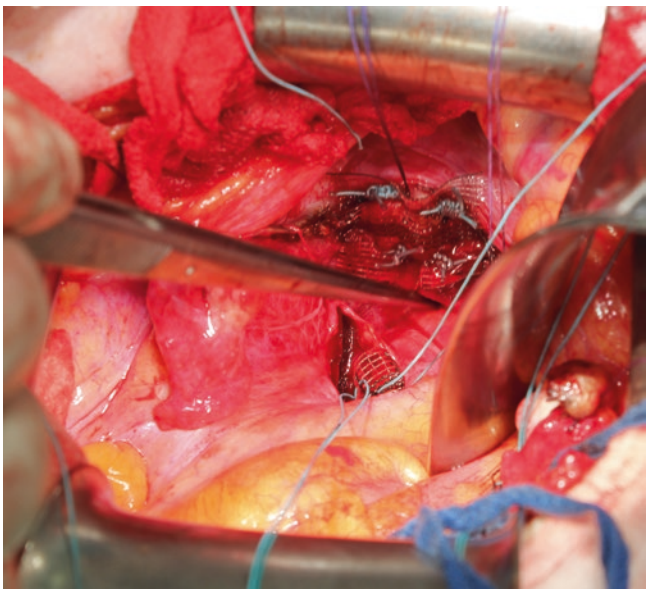
Flg. 91.45 Both sutures are placed



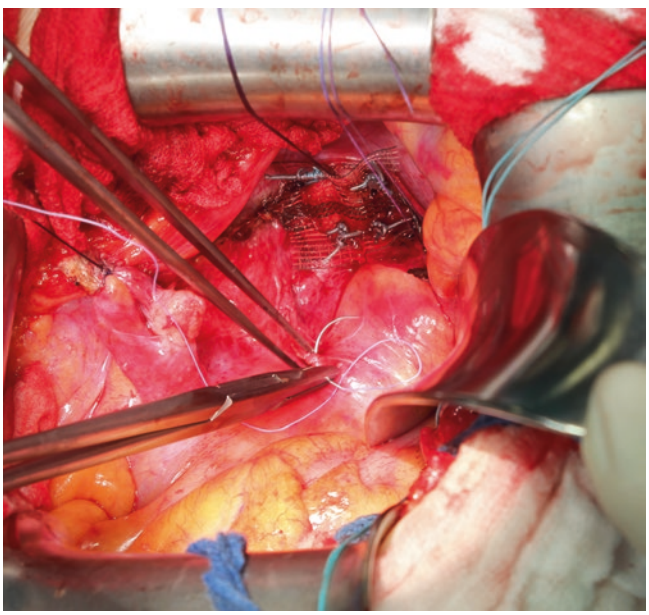
Flg. 91.46 The insertion aid is cut



Flg. 91.48 In CERESA a additional suture is placed in the mesorectum



Flg. 91.47 The sutures are tied



Flg. 91.49 The peritoneum is closed with a running suture

Closing the Peritoneum on the Cervical Stump

The cervical stump is peritonealized with the bladder and Douglas peritoneum. All sutures and the whole net structure ("bridge") must be covered by peritoneum (Figs. 91.50, 91.51, 91.52 and 91.53U).

Thereafter the towels are removed.

After removal of the towels 150 ml saline solution is added to prevent the drying out of the sigma epithelium leading to adhesion formation.

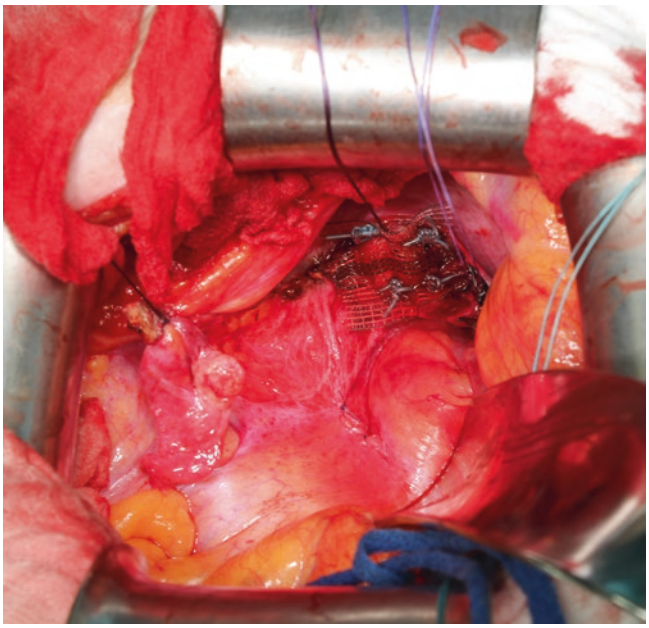


Fig. 91.50 The suture at the cervix is pulled and the cervix is elevated

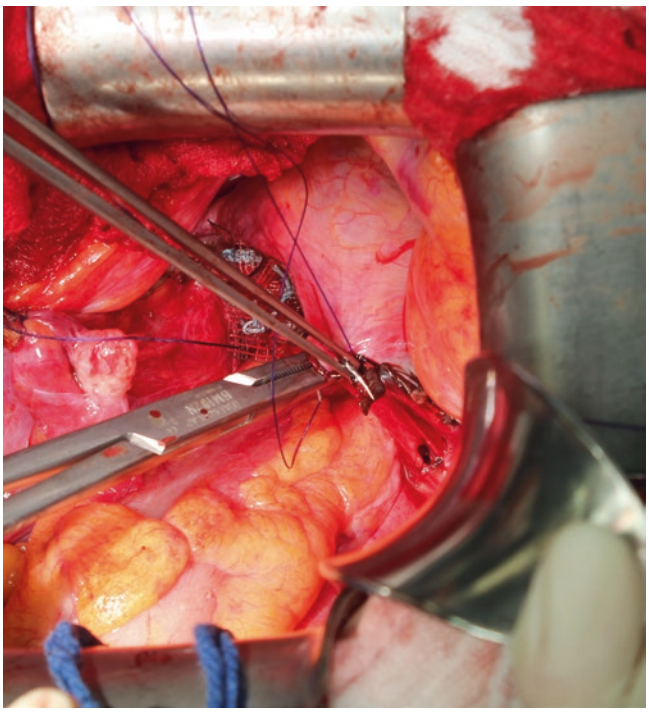


Fig. 91.51 The peritoneum is closed above the cervical stump so that everything is covered by the peritoneum

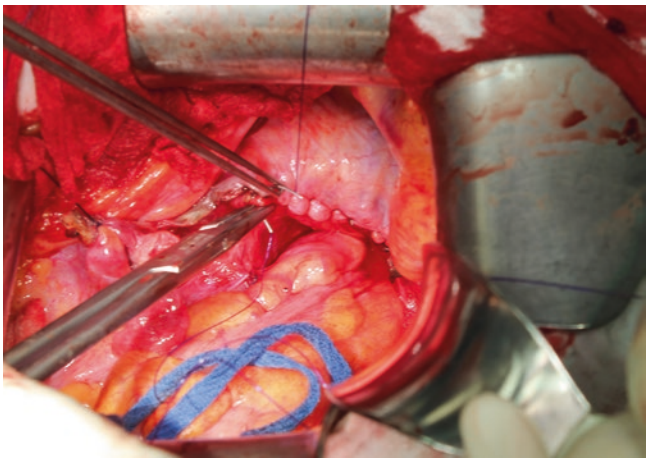


Fig. 91.52 The peritoneum above the cervix is closed

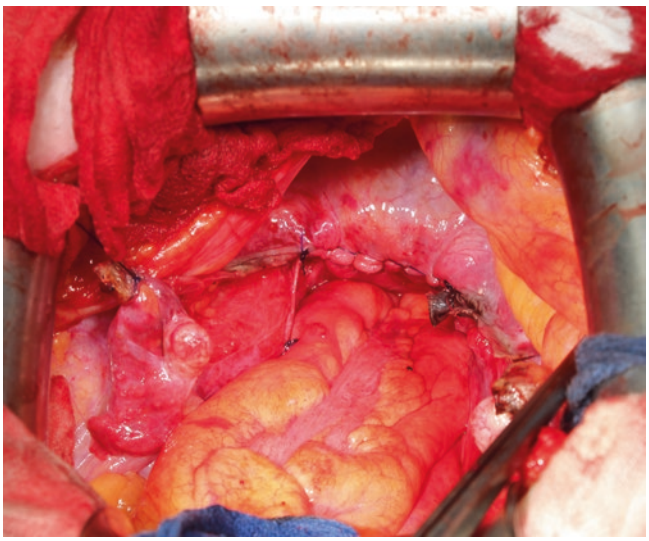


Fig. 91.53 View into the small pelvis after CESA

Additional Rectopexy (CERESA)

If a rectopexy has to be performed (CERESA), a non-resorbable suture 3–0 is placed in front of the marked posterior fixation sites. Special tapes have been developed for this procedure (Dynamesh CERESA). The sutures grab the mesorectum on both sides and are tied on the anterior net structure of the tape in that area.

Repair of the Anterior ("Cystocele") and Posterior ("Rectocele") Vaginal Wall

The decision to perform an additional repair of the anterior or posterior vaginal wall i.e. a vaginal colporrhaphy has to be taken at the end of surgery and should only be performed when points Aa, Ba or C are >2 cm (−1, 0, +1, +2…..).

At the end of the surgery the position of the cervix is controlled (Figs. 91.54, 91.55, 91.56 and 91.57).



Fig. 91.54 At the end of the operation the clamp is placed at the cervix as in the beginning

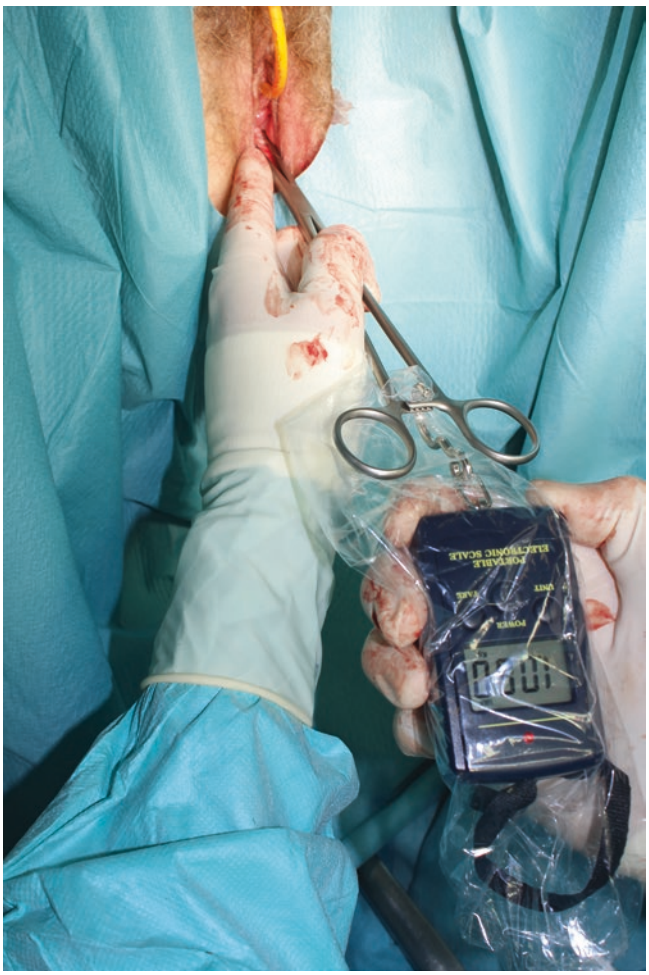


Fig. 91.55 The tension with 10 N is applied to the clamp. The index finger is placed on the clamp where the clamp reaches the hymenal ring

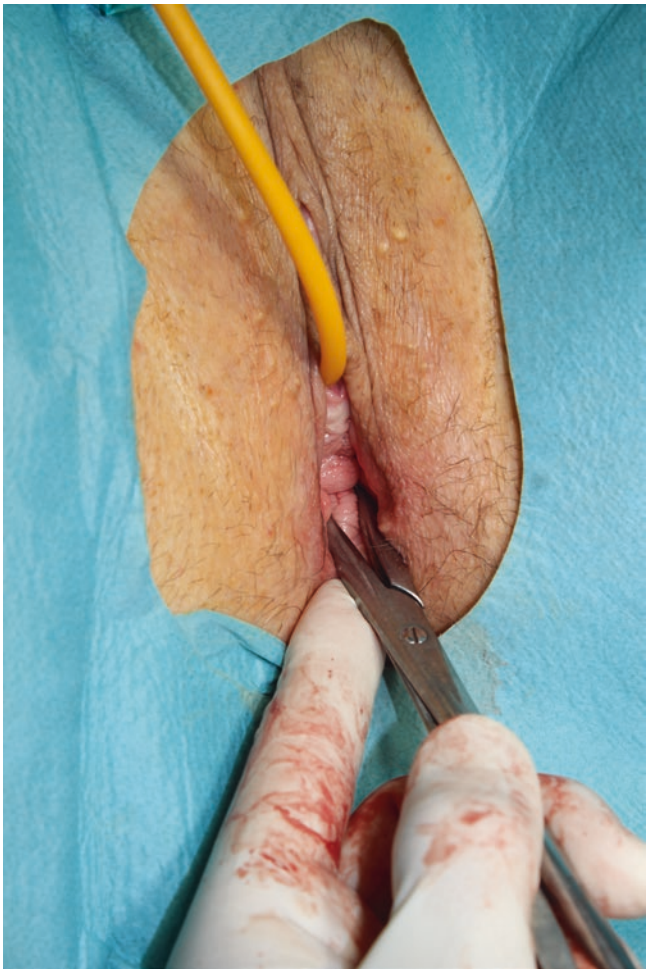


Fig. 91.56 The length is measured and reflects the position of the cervix (under tension under total muscle relaxation)



Fig. 91.57 The length is then measured and noted

References

1. Bump RC. The POP-Q system: two decades of progress and debate. Int Urogynecol J. 2014;25:441–3.
2. Buchsbaum GM. Urinary incontinence and pelvic organ prolapse. Minerva Urol Nefrol. 2006;58:311–9.
3. van Brummen HJ, van de Pol G, Aalders CI, Heintz AP, van der Vaart CH. Sacrospinous hysteropexy compared to vaginal hysterectomy as primary surgical treatment for a descensus uteri: effects on urinary symptoms. Int Urogynecol J Pelvic Floor Dysfunct. 2003;14:350–5.
4. Petros PE, Ulmsten UI. An integral theory and its method for the diagnosis and management of female urinary incontinence. Scand J Urol Nephrol Suppl. 1993;153:1–93.
5. DeLancey JO. Anatomy and biomechanics of genital prolapse. Clin Obstet Gynecol. 1993;36:897–909.
6. Brubaker L. Postpartum urinary incontinence. BMJ. 2002;324:1227–8.
7. Rortveit G, Daltveit AK, Hannestad YS, Hunskaar S, Norwegian ES. Urinary incontinence after vaginal delivery or cesarean section. N Engl J Med. 2003;348:900–7.
8. Kim DK, Chancellor MB. Is estrogen for urinary incontinence good or bad? Rev Urol. 2006;8:91–2.
9. Rizk DE, Czechowski J, Ekelund L. Dynamic assessment of pelvic floor and bony pelvis morphologic condition with the use of magnetic resonance imaging in a multiethnic, nulliparous, and healthy female population. Am J Obstet Gynecol. 2004;191:83–9.
10. Siddique SA, Gutman RE, Schon Ybarra MA, Rojas F, Handa VL. Relationship of the uterosacral ligament to the sacral plexus and to the pudendal nerve. Int Urogynecol J Pelvic Floor Dysfunct. 2006;17:642–5.
11. Jager W, Mirenska O, Brugge S. Surgical treatment of mixed and urge urinary incontinence in women. Gynecol Obstet Invest. 2012;74:157–64.
12. Klinge U, Klosterhalfen B, Ottinger AP, Junge K, Schumpelick V. PVDF as a new polymer for the construction of surgical meshes. Biomaterials. 2002;23:3487–93.

Vaginal Vault Prolapse: Replacement of the Uterosacral Ligaments by Vaginosacropexy (VASA) or Vaginorectosacropexy (VARESA)

92

Wolfram Jaeger

Introduction

Prolapse

Vaginal prolapse describes the descending apex of the vagina. After hysterectomy the vagina is closed. Some surgeons leave the vaginal stump as it is, others suture the stump to the surrounding tissues [1].

The pelvic organ prolapse quantification (POP-Q) system differentiates four stages "on that way out" (POP-Q I – IV). So far there are no recommendations for different treatments according to POP-Q stages. Therefore, the POP-Q system is just a description of the actual anatomical status at the time of examination.

A further characterization of the vaginal wall can be achieved by the points A and B.

Per definition, point A is 3 cm upwards from the hymenal ring along the vagina [2].

At the anterior vaginal wall Aa is considered to be the area at the end of the urethra. Therefore, a shortening of point Aa indicates a descent of the urethra. This can be caused by an insufficient support of the urethra; however, one has to take into account that the length of the urethra differs considerably. Usually the length of the urethra varies between 2 cm and more than 4 cm in different women [3].

A point Aa at 3 cm, therefore, describes either a point at the urethral bladder junction or a point close to the middle of the urethra.

For this reason, the actual length of the urethra should be measured and then decided if the urethra is still in its original position or not.

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The role of these different areas is not clear. However, the area above the urethral-vesical junction was described by PETROS as the "zone of critical elasticity" – an area where the brain receives its information about the filling state of the bladder and thereby starts or inhibits voiding. In that area a movement with the anterior blade can easily induce the feeling of urgent need to void or not during vaginal examination [4].

Etiology

The exact etiology and the pathophysiology of vaginal prolapse are unknown.

One could assume that the vagina is kept in its position by the holding forces of the uterus. When these "forces" diminish, the uterus descends and the vagina accompanies that prolapse. If the uterus is resected, the "holding forces" must be cut to remove the uterus. This then leads to a diminished suspension of the vagina. The vagina is then kept in position mainly by the paravaginal tissues.

Vaginal Prolapse and Urinary Incontinence

A considerable number of women become urinary incontinent after hysterectomy.

Forty percent of women suffering from vaginal vault prolapse also report UI [5].

During a retrospective analysis based on personal interviews we could demonstrate that more than 50 % of women who had a vaginal hysterectomy for prolapse stage II to IV of the uterus also presented with mixed urinary incontinence. The same numbers were reported by others who stated that up to 50 % of all women with vaginal hysterectomy developed stress and urge urinary incontinence thereafter [6].

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Repair of Prolapse Leading to Incontinence

One of the most convincing observations that the vagina in associated with urinary incontinence came from long-time follow-up studies of prolapse surgery.

Women suffering from vaginal vault prolapse were operated by sacrocolpopexy (SCP) or sacrospinous fixation (SSF).

All patients were continent at that time.

Of these patients, 35 % developed urinary incontinence within 2 years of surgery, irrespective of which treatment modality – SCP or SSF – was chosen [7]. In another study it was found that 7 years after SCP 81 % of the patients were incontinent [8].

An additional BURCH operation reduced the percentage by only 10 %.

These results demonstrated that SCP and SSF can induce urinary incontinence. The question remains how and why not immediately after surgery rather than some years later.

SCP and SSF are considered to be two clearly defined operations [9].

However, several steps of the operations are not defined.

How tight must be the fixation of the vagina to the presacral fascia in SCP or at the sacrospinous ligament in SSF?

This could be an important facet of the operation but it is not defined but subject to the opinion of the surgeon.

Therefore, SCP and SSF are only the "family names" and not the definition of the members of the family.

However, the high long-term failure rate of 80 % in 7 years indicates that some other aspects could also be important which have not yet been evaluated.

Both procedures – SCP and SSF – have in common that the vagina is pulled to one side, either at the sacrum (in SCP) or on the sacrospinous ligament (SSF).

Compared to the suspension of the bilateral USL the SCP and SSF are unbalanced.

The bilateral replacement of the USL by VASA or VARESA does not induce urinary incontinence but, in contrast, can cure incontinence [10].

One could assume that the bilateral suspension of the anterior vaginal wall is important in respect to urinary continence.

Pelvic Floor and Standardization of the Operations

The premise of the CESA and VASA operations is a standardised surgical replacement of the USL (Fig. 92.1).

Standardised operation means that the operation will be performed in every patient in exactly the same way: identical length of tapes which is guaranteed by stitch marks on the structure, defined fixation sides at the cervix (or vaginal stump) and in front of S1/S2. The structures are pulled through the peritoneal fold of the USL and thereby placed retroperitoneal at a defined channel.

Considering the great variety of women's shapes one would expect that the lengths of the USL are different in every woman. However, this is not the case.

In obstetrics several diameters are well defined and the length of these diameters is the same all over the world. In the respective obstetrical textbooks these diameters between the bony structures in the small pelvis are identical in all women irrespective of weight or parity or racial derivation.

This has been confirmed by extensive MRT measurements by several institutions [11].

We therefore hypothesized that also the ligaments in the small pelvis especially the USL and the PUL are of identical length or differ only in small ranges in all women after puberty.

We therefore decided to implant USL structures with the same length in every woman. According to the literature and our own measurements, we arrived at the conclusion that the length of the USL is between 8.5 and 9.0 cm [12].

In hysterectomized patients we deliberately decided that probably 0.5 cm of the vagina had been resected. Therefore, we decided that the VASA and VARESA structures must be 0.5 cm longer than the CESA and CERESA structures.

The USL part of the VASA structure is 9.3 cm long and the fixation site at the vaginal stump is smaller (2 × 3 cm) (Dynamesh VASA and Dynamesh VARESA, FEG, Aachen, Germany).

The standardization of VASA covers several uncertainties. Especially the length of the vagina after hysterectomy is different in every patient. This is not the case in patients who have undergone a supracervical hysterectomy.

For all other patients who had a previous hysterectomy the length of the remaining vagina does not substantially influence prolapse surgery.

However, in patients who underwent an operation for uterine prolapse an anterior colporrhaphy was usually additionally performed. By this procedure a substantial part of the subvesical vaginal skin is resected. The extent of skin resection is defined by the individual surgeon and therefore differs between patients. The effects of these surgical resections of skin and the closure of the endopelvic fascia on incontinence are not predictable.

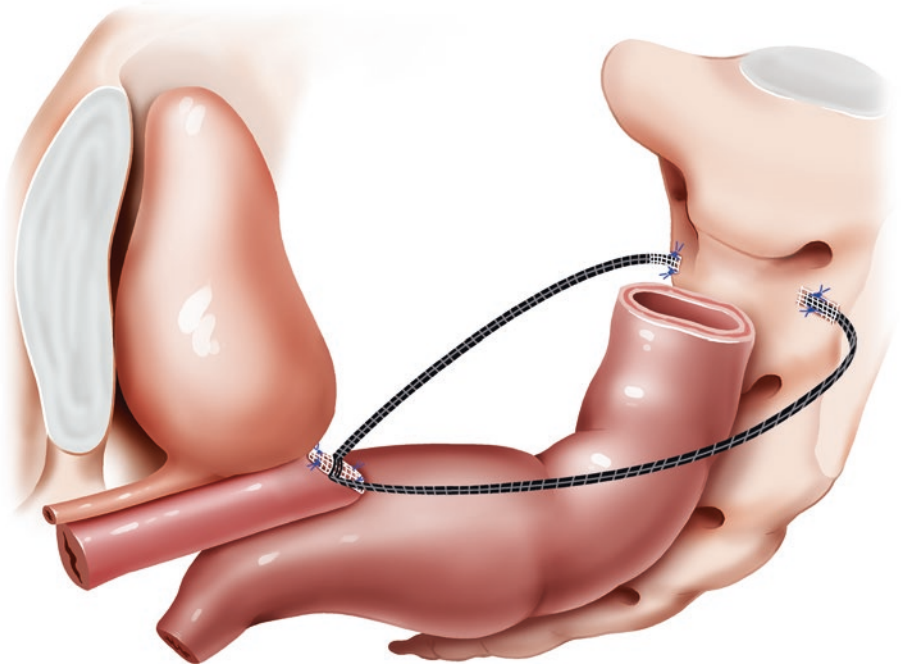


Fig. 92.1 VASA: The VASA structure was sutured to the vaginal stump and the os sacrum. The *black-marked middle* of the fixation site at the vaginal stump should be exactly on the scar. The USL tapes of the structures run retroperitoneally

Before the Operations

Explanation of the Operation

The surgeon has to explain to the patient that the sutures which fix the net structure ("bridge") at the vaginal stump could perforate the vaginal skin. The suture will then be visible in the vagina. In such a case the sutures can be cut from the vagina after 6 weeks. By that time the bridge will remain in position without the suture.

Note: the surgeon has to consult with the patient whether she wishes to keep the tubes and ovaries or have them removed.

Body Weight

If the patient has a body weight exceeding 100 kg, we abstain from the operation, due to the feasibility of the surgical techniques.

Bowel Cleansing

One day before surgery the patient must have a bowel cleansing as for a colonoscopy. If the bowel is not absolutely empty, the operation can become very difficult because the diameter of the "working place", especially in front of S1/S2, may be only a few centimeters.



Fig. 92.2 VASA: Equipment used for VASA, VARESA, CESA, CERESA, Uterosacropexy and Uterorectosacropexy. For VASA and VARESA a rectal probe is placed in the vagina

Note: Every additional centimeter makes it easier.

In the Operation Theater

Equipment

The standard equipment for abdominal gynecological surgery is used.

(Fig. 92.2).

The instruments should be as long as the surgeon requires.

For pre-operative examination and measurements an extra table is prepared (Fig. 92.3).



Fig. 92.3 VASA: Equipment for vaginal examination before surgery. A clamp is used to secure the vaginal vault during surgery



Fig. 92.4 VASA: A posterior blade is placed into the vagina after catheterization of the patient. A prolapse of the anterior vaginal wall is visible

Bladder

A catheter is placed at the beginning of surgery.

At the end of surgery it is advisable to fill the bladder with blue saline solution to detect any possible injuries.

Prolapse Measurement

The anterior vaginal wall is examined to decide if a colporrhaphy should be performed (Fig. 92.4). A special clamp takes a part of the vaginal scar and a newton meter is placed at the clamp (Fig. 92.5).

A power of 10 N is exerted at the clamp – the index finger is then placed at the clamp at the side of the hymenal ring. The clamp is opened and the distance between the the vaginal scar and the hymenal ring is measured (Fig. 92.6).

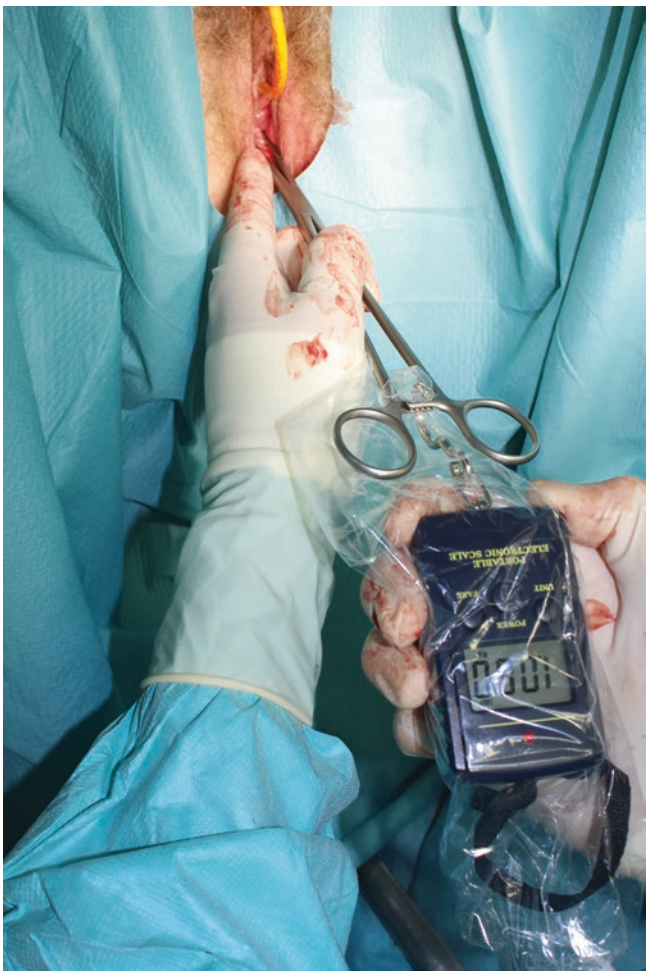


Fig. 92.5 VASA: At the end of the clamp a newton meter is placed with a hook. A standardized tension of 10 N is exerted at the clamp



Fig. 92.6 VASA: The index finger is placed at the clamp in the region of the hymenal ring. The clamp is opened and the distance between the *top* of the finger and the *top* of the clamp is measured (in this case 3.3 cm)



Fig. 92.7 VASA: The probe is wettened and placed into the vagina to move the vagina during further surgery

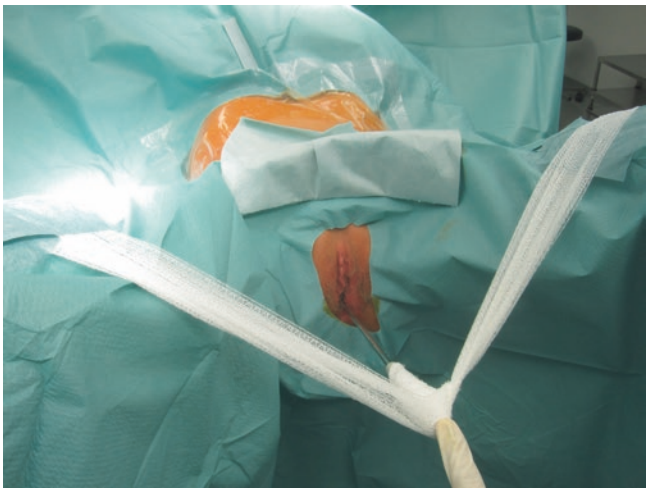


Fig. 92.8 VASA: The probe is then fixed in its position

Vaginal Phantom

A plastic phantom has to be placed in the vagina before the start of the operation (Fig. 92.7). It is important that different sizes of these phantoms are available according to the width and length of the vagina.

The phantom should be fixed to remain in the vagina during surgery; however, one must be able to move it during surgery (Fig. 92.8).

Antibiotic Coverage

Cephalosporines are administered according to the body weight as a single dose injection immediately at the start of surgery.

Anti-coagulation

The coagulation must be controlled. If the patient is under anti-coagulant treatment adaptations must be started before surgery.

Note: Even chronic aspirin treatment can cause heavy bleeding which is difficult to control.

In some cases it is prudent to consider the help of a hematologist.

A bleeding of the venous plexus in front of the os sacrum is one of the leading causes for severe bleedings during these operations. If electrocautery cannot control the bleeding, compression with a swab has to be performed for several minute. The control of this bleeding can become very difficult if the patient is under anti-coagulation treatment.

Pre-operative Interactive Talk ("Team-Time-Out")

We calculate the operation time for a VASA, from opening the peritoneum until closing the peritoneum, to be 60–90 min (for VARESA 10 min longer).

The remaining time is used for "cut and final closing of the skin". This is dependent on the experience of the surgeon.

The overall operation time is usually calculated as 90–130 min.

Blood loss is calculated at 50–100 ml.

The Tapes

The main requirements for the USL structure and tapes were that the USL should not shrink and also not lead to massive fibrosis which would make the USL structures unmovable.

The above pre-requisites were achieved by using polyvinylidene fluoride (PVDF).

PVDF monofilaments were used as the material of choice for the construction of four new implants to augment the USL.

The size of the fixation site at the vaginal stump is 2 × 3 cm.

The augmentation of the USL was performed using a narrow but open-pore sling structure of 4 mm width, made of high strength PVDF filaments. The length of the USL tapes is 9.3 cm.

Dynamesh VASA and Dynamesh VARESA structures are used for the respective operations (FEG Textiltechnik mbH, Aachen, Germany).

Opening the Abdominal Cavity (According to the Internal Institutional Standards)

The dermal incision should be horizontal ("cesarean section"). It is between 8 and 12 cm according to the pre-rectoral fatty tissue.

After opening the peritoneum we prefer placement of a rectangular frame with a 25 cm diameter.

The first step is to decide whether the operation can be carried out as planned.

If ovarian cysts complicate the situation, these should be removed and examined. The aim of this part of the operation is to "empty" the pouch of Douglas as much as possible. Therefore, the bowel and the small intestines have to be out of the area (Fig. 92.9).

We use two surgical towels. With the first towel we place the small intestine into the upper abdominal cavity. With a second towel, which is folded into a rectangular shape, we move the descending and ascending large intestine upwards. At the end of this step the pouch of Douglas should be free of intestine apart from the sigmoid colon. Especially the pelvic rims (the transition into the small pelvis) must be clearly visible to make incisions there without any problem.

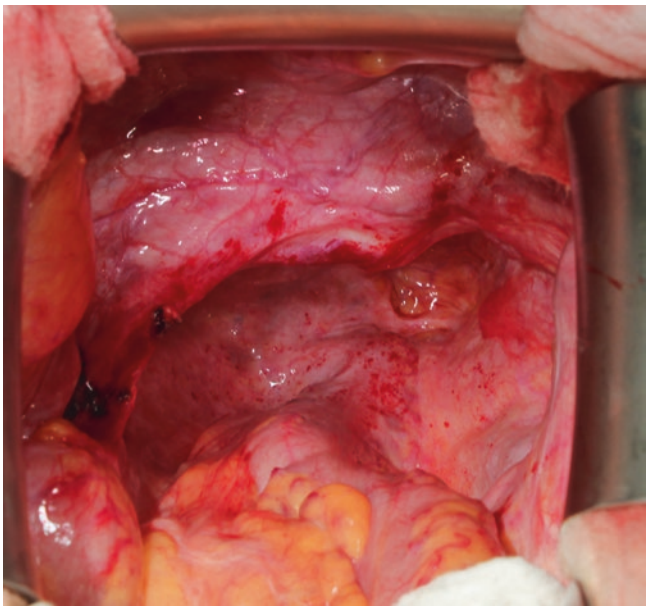


Fig. 92.9 VASA: View into the pelvic cavity ("pouch of Douglas"). The bowel has been pushed back into the upper abdomen and is held there by two towels. The *left tube* and some adhesions have been removed, the stumps have been cauterized. The USL cannot be seen in this situation

Identifying and "Clearing" of the Vaginal Scar After Previous Hysterectomy

The VASA or VARESA structures must be placed on the vaginal skin.

However, after previous hysterectomy several different anatomical situations can be found. (If a supracervical hysterectomy was performed previously and a cervical stump can be identified the operation is continued as CESA.)

If the uterus has been totally removed, the end of the vagina must be identified.

This can be done by pushing the intravaginal phantom straight forward. Take care not to place the phantom in a pre-existing rectocele. Usually the scar of the vaginal vault is very close to the bladder (Fig. 92.9).

According to the hysterectomy technique of the previous surgeon the scar at the end of the vagina can be covered by some remaining structures from the adnexa. Some surgeons suture the tubes together and fix them at the top of the vaginal scar, while others tie the round ligaments together and place them on top of the vaginal scar.

These structures must be resected so that an area of about 2 × 3 cm is prepared at the scar of the vaginal vault. Care must be taken that the VASA or VARESA structures are placed exactly at the top of the scar and not on the posterior vaginal wall, i.e. on a rectocele.

Identifying the Peritoneal Folds of the Uterosacral Ligament (USL)

To find the USL, one has to grab the vaginal vault.

The origins of the USL at the uterus are cut during hysterectomy. The remaining USL are attached to the vaginal scar during closure of the vaginal wound after hysterectomy.

Often the peritoneal fold of the USL cannot clearly be identified (Fig. 92.9).

Therefore, a swab is placed in front of S2 and the presacral peritoneum is pushed medially until the USL (peritoneal fold) becomes visible (Figs. 92.10 and 92.11).

The origin of the USL at the cervix has usually already been resected so that only the peritoneal fold can be found at the scar. A USL cannot be seen with the surgeon's eye. However, this is not important as only the peritoneal coverage (fold) is important for the correct placement of the structures.

The peritoneal folds of the USL end at the level of S2. The USL structures reach up to the sacral spine in the area between S1 and S2.

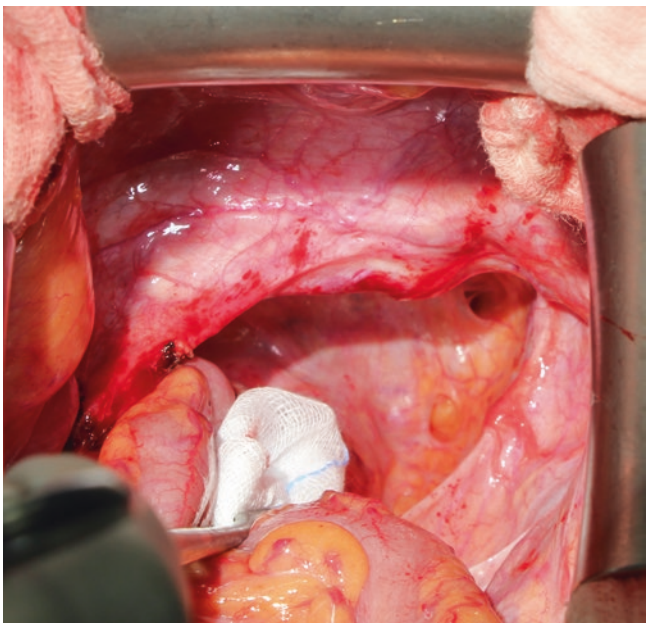


Fig. 92.10 VASA: A swab is placed in front of the second sacral vertebra. The peritoneum is pushed slightly to the *left* and the *right* USL can be identified

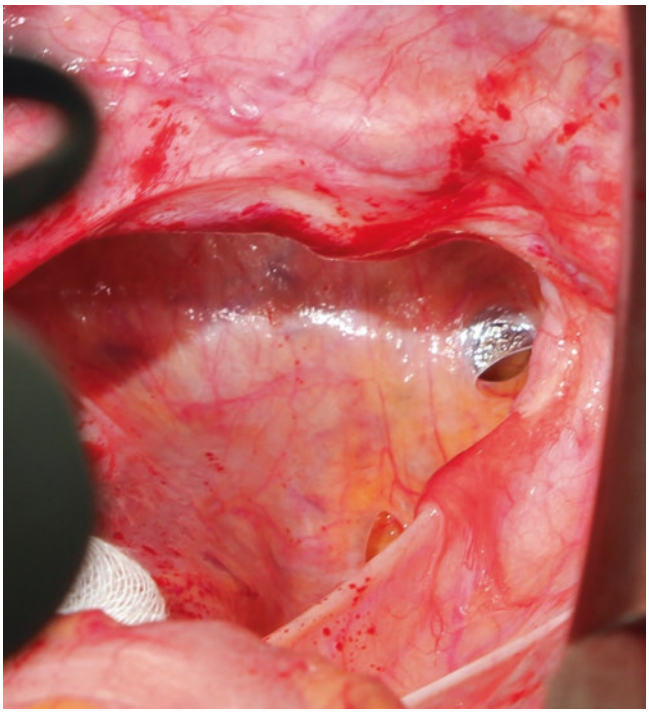


Fig. 92.11 VASA: The *right* USL. The end of the USL at the vagina is the scar which needs to be identified. Any further tissue above the scar of the vaginal vault must be dissected

Fixation of the Structures at the Anterior Fixation Side: The Vaginal Stump

After the vaginal stump (scar) has been cleared of other tissues and the scar has been identified, the phantom in the vagina must be pulled upwards. The Foley catheter in the bladder is identified, grabbed and pulled at the highest part of the bladder to find the end of the bladder.

According to the technique of the surgeon who performed the hysterectomy, the vaginal stump might be covered by the round ligaments which have been tied together. Another alternative is that the end of the tubes which were resected from the uterus might be tied together and fixed at the vaginal stump.

All these structures must be removed and put aside or resected (Figs. 92.12, 92.13, 92.14, 92.15, 92.16 and 92.17).

Identify the scar and place two stitches parallel to the scar, two in front and two behind the scar (Figs. 92.18, 92.19, 92.20, 92.21, 92.22 and 92.23).

The decision must now be taken which structure is to be used (Figs. 92.24, 92.25 and 92.26).

The VASA or VARESA structure is brought into the abdominal cavitiy and placed at the vaginal stump. All sutures are pulled through the net structure of the "bridge" and should be equally distributed in all four quadrants of the vaginal stump (Figs. 92.27, 92.28, 92.29 and 92.30).

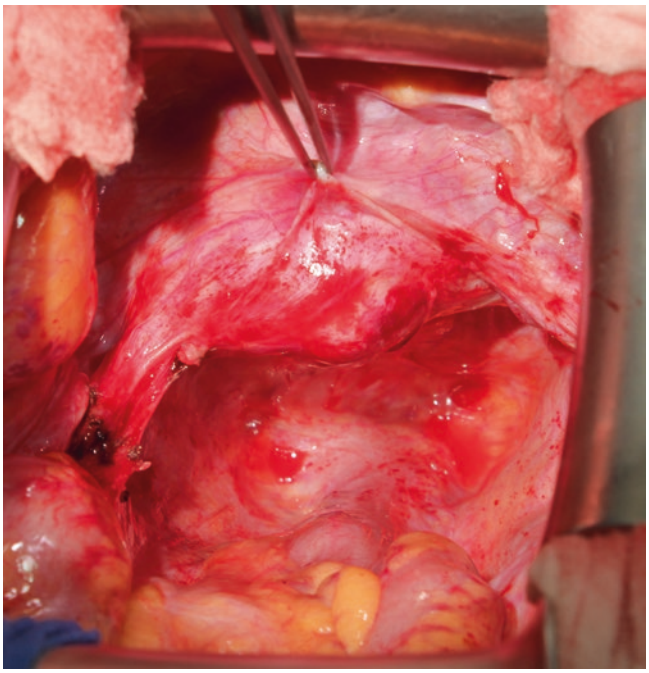


Fig. 92.12 VASA: The phantom in the vagina is pulled forward and the peritoneum of the bladder edge is elevated with forceps. In the case of a rectocele the phantom in the vagina will probably elevate the rectocele which will cause problems in identifying the scar and the anterior vaginal wall of the vagina

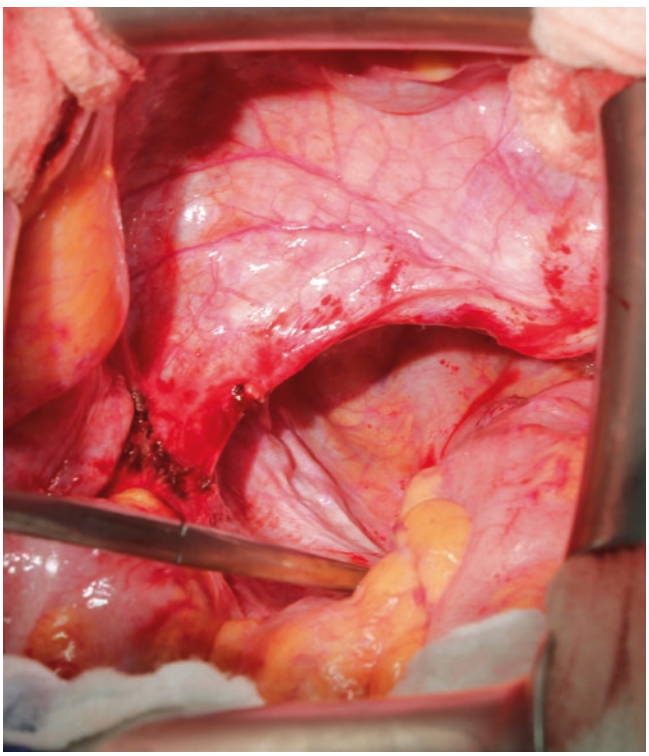


Fig. 92.13 VASA: The *left* USL is demonstrated in the same way as the *right*

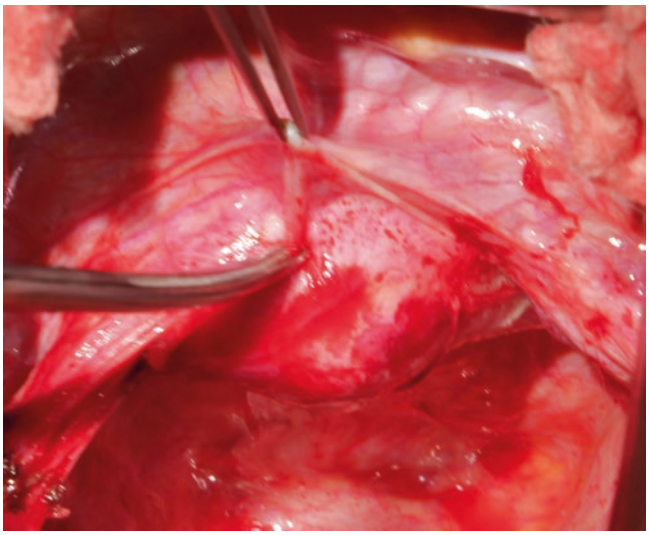


Fig. 92.14 VASA: The bladder peritoneum is elevated and incised. The phantom elevates the vaginal vault

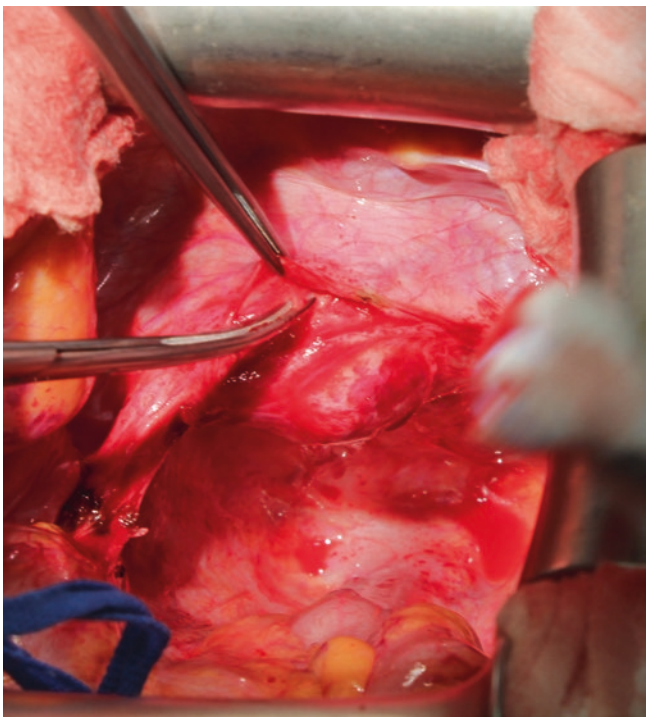


Fig. 92.15 VASA: The anterior wall is freed of the physiological adhesions to the bladder on an area of about 1 cm above the vaginal scar

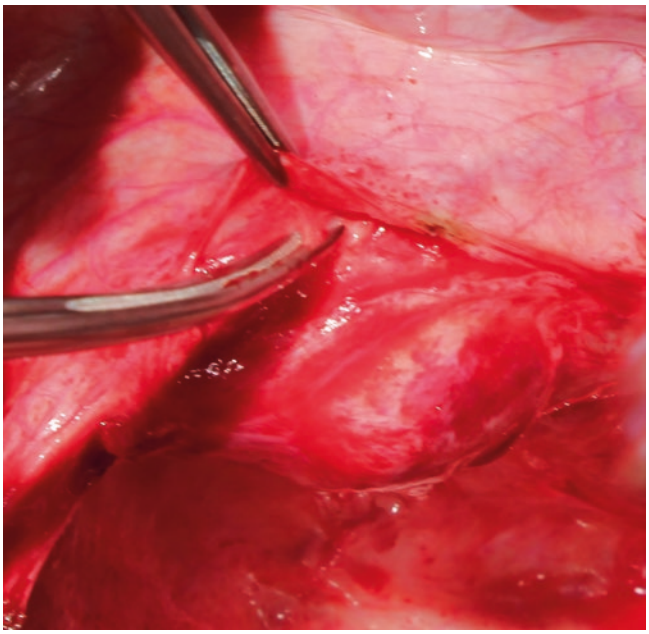


Fig. 92.16 VASA: The scar of the vaginal vault. The anterior and posterior vaginal vault are dissected from the above lying tissues on an area of about 2 × 3 cm

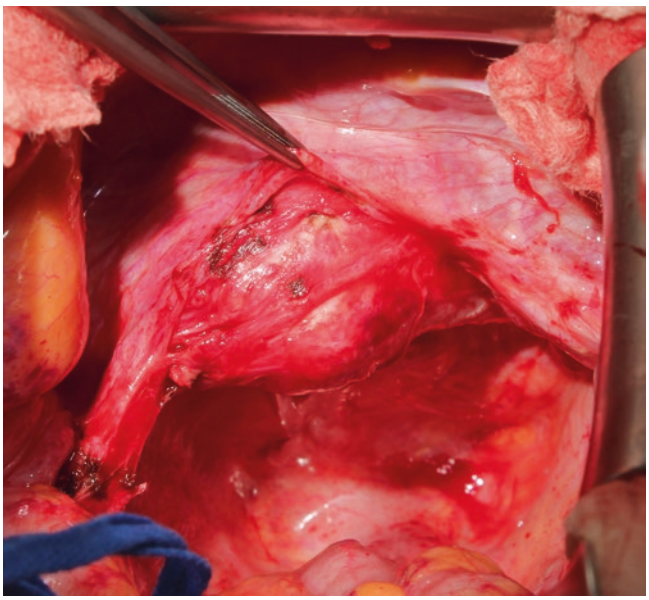


Fig. 92.17 VASA: Minor bleedings are coagulated

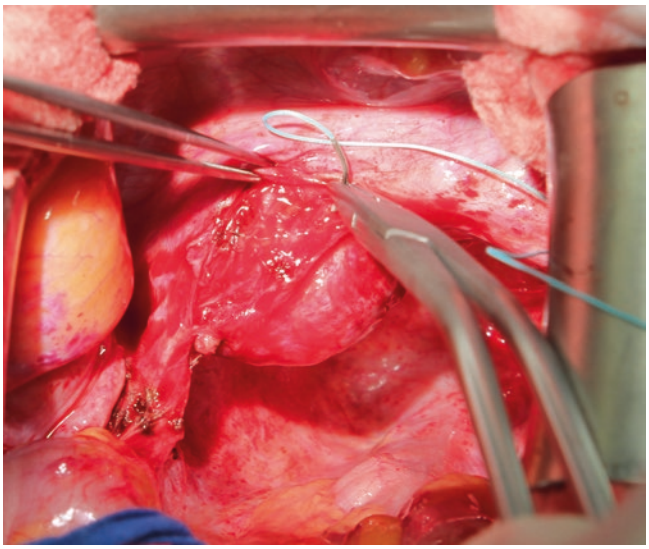


Fig. 92.18 VASA: Four sutures are placed at the vaginal vault. The first suture is from the *right* corner on the anterior vaginal wall to the *middle* of the anterior vaginal wall

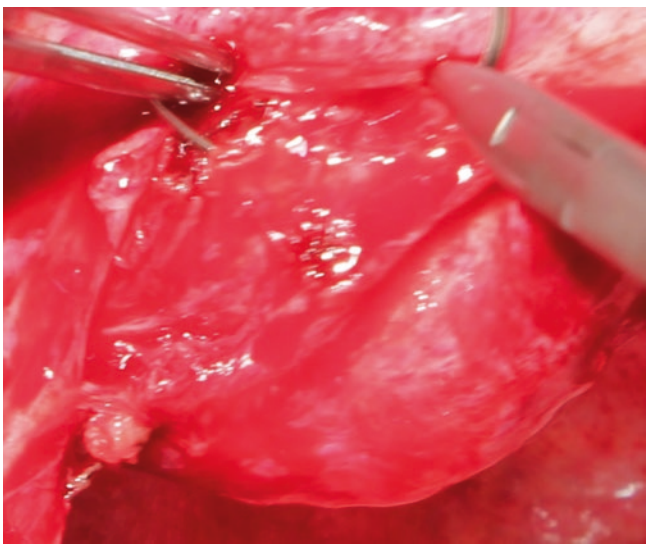


Fig. 92.19 VASA: The stitch and the suture are in the vaginal skin. If the suture can be seen at the end of the vagina at the end of surgery, it can remain there for three 3 months. Thereafter the "bridge" will be fixed at the vaginal vault and the suture can be cut from the vagina and pulled out

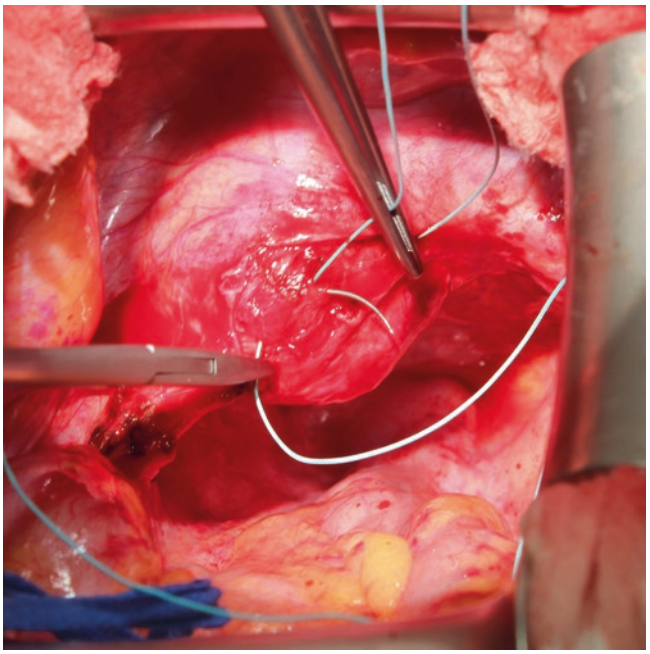


Fig. 92.20 VASA: The second suture is from the *left* outer side of the anterior vaginal wall to the *middle* of the anterior vaginal wall

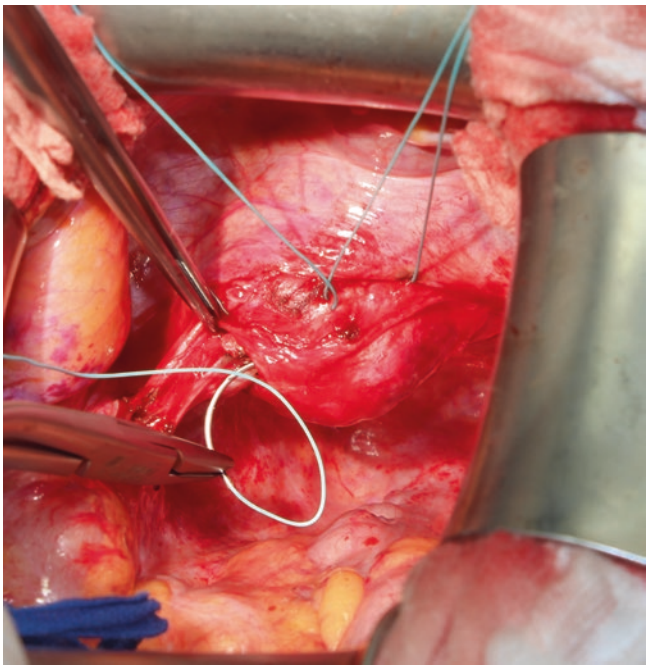


Fig. 92.22 VASA: The next two sutures are placed beyond the scar of the vaginal vault

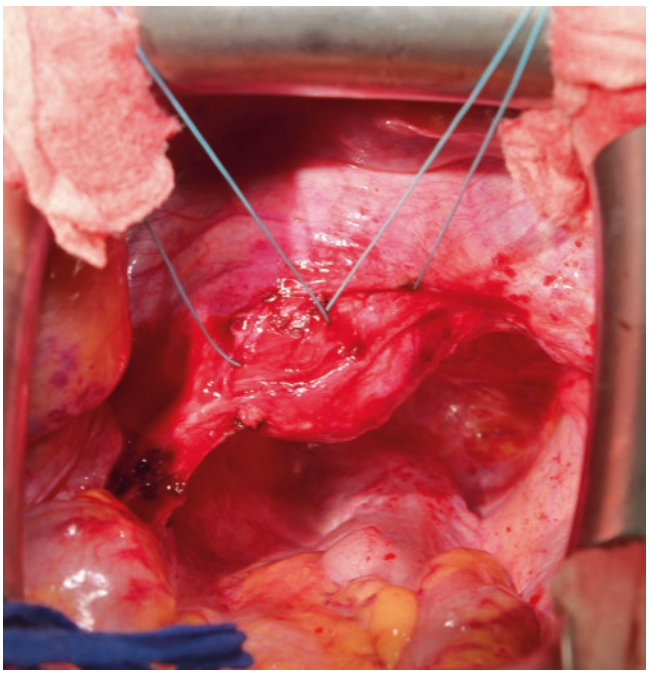


Fig. 92.21 VASA: The anterior sutures are placed and armed with two clamps

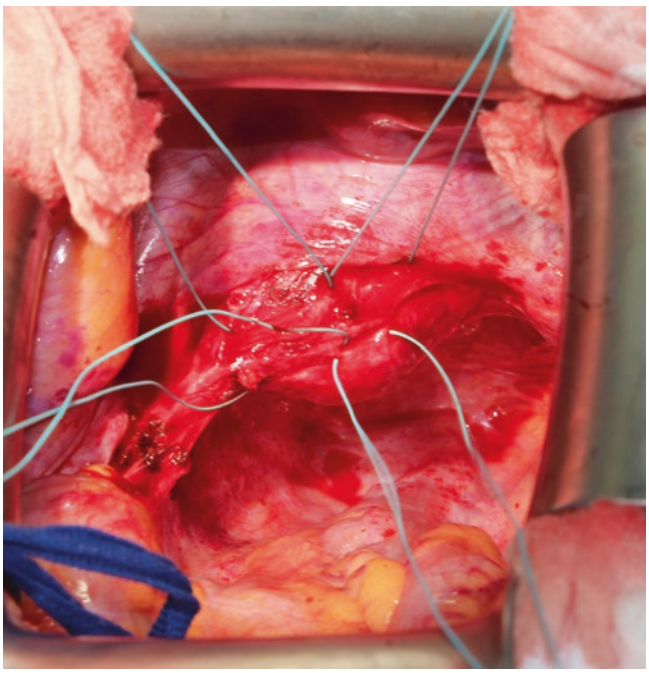


Fig. 92.23 VASA: All four sutures are placed

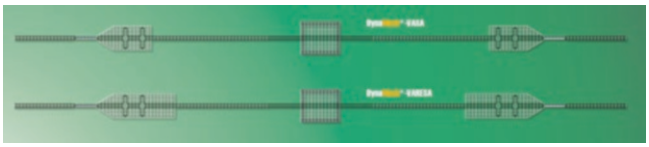


Fig. 92.24 VASA: The VASA and VARESA structures. The size of the "bridge" is 2 × 3 cm and the length of the USL is 9.3 cm. In the VARESA structures the posterior fixation side is prolonged by a 1 cm mesh on both sides for rectopexy sutures. Note the stitch marks at both anterior fixation sites. The parts on the outside of the suture marks are cut when the tape is placed. The augmentation of the uterosacral ligaments is performed using a narrow but open-pore sling structure of 4 mm width, made of high strength PVDF filaments (Dynamesh CESA, Dynamesh CERESA, Dynamesh VASA and Dynamesh VARESA, FEG Textiltechnik mbH, Aachen, Germany)

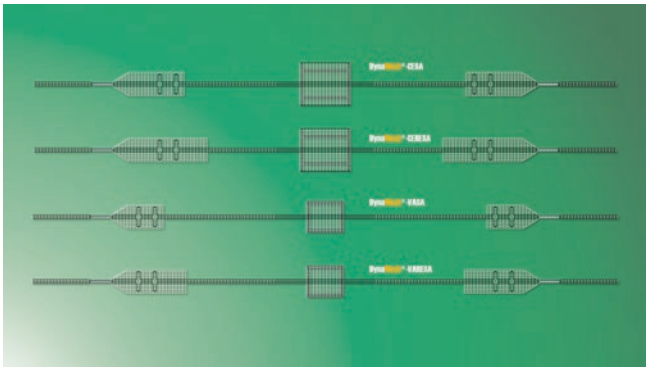


Fig. 92.25 VASA: Comparison of the CESA and CERESA tapes. The USL in these structures is 8.8 cm since the vagina has its normal length. The "bridge" is 3 × 4 cm, adapted for larger cervical stumps

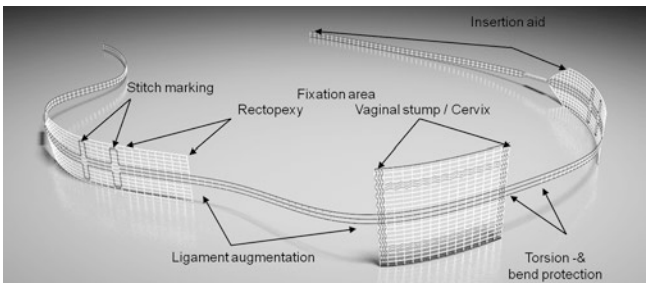


Fig. 92.26 VASA: Demonstration of the details of the structures (as an example of a CERESA structure). The 3 × 4 cm mesh in the middle is the part which is sutured to the vaginal vault (or cervical stump). In the *middle* of both sides of the "bridge" the USL augmentation is inserted. At the end of both ligament augmentations stitch marks are placed to define the correct fixation sites of the structures. The insertion aid on both sides are cut when the sutures are placed in the structure

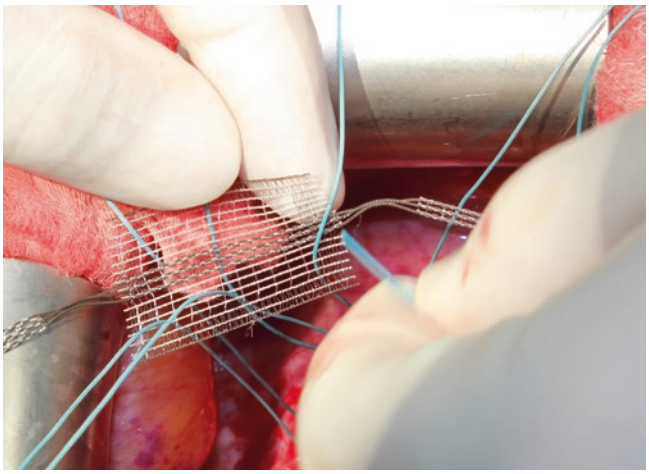


Fig. 92.27 VASA: The sutures are pulled through the "bridge" so that they fit easily onto the vaginal vault

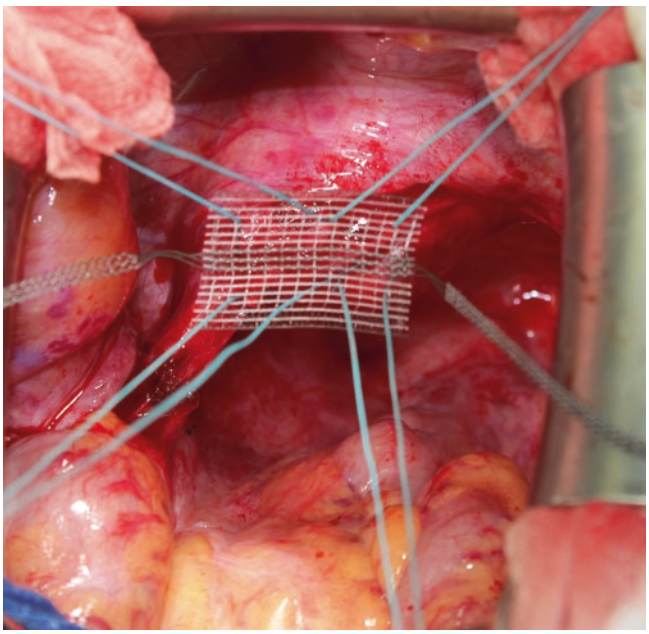


Fig. 92.28 VASA: All sutures are placed

They are tied and cut (Fig. 92.31).

*Advice: I*f the sutures can be seen in the vagina at the end of surgery, leave them in place.

They can be cut 3 months after surgery. By this time the net structure of the tape has formed a secure attachment with the vaginal vault.

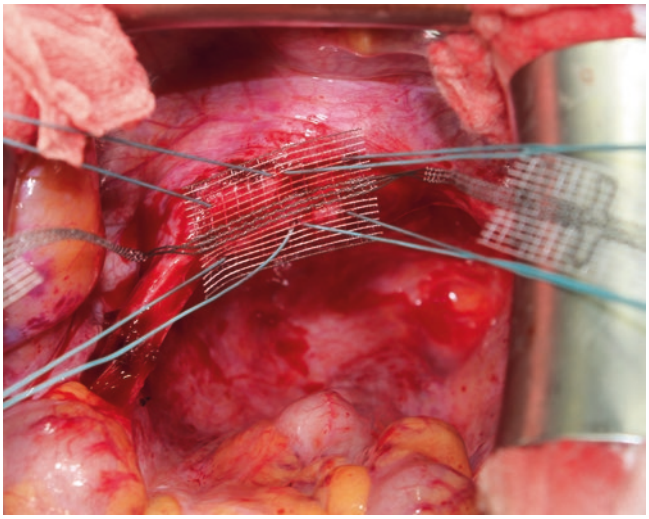


Fig. 92.29 VASA: The "bridge" is placed at the vaginal vault

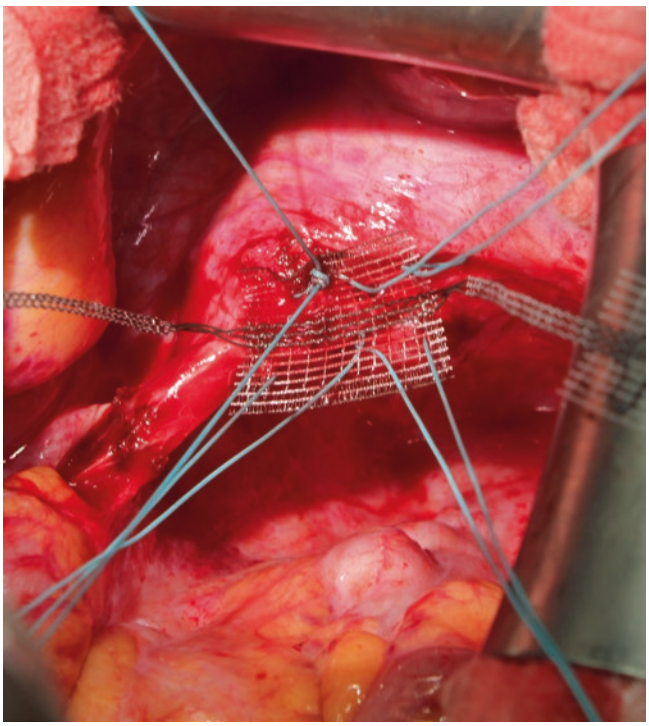


Fig. 92.30 VASA: The sutures must be tied carefully so that the vagina is not put in folds. The aim is to place the mesh of the "bridge" like a "cloth on a table"

Preparing the Posterior Fixation Site

After the USL have been identified, the incisions at the sacrum are placed horizontally, 0.5 cm above the insertion side in front of S1/S2 (Figs. 92.32 and 92.33).

An incision along the USL (from cervix to sacrum) should be avoided since the "original" peritoneal folds protect the tape structure from adhesion formation. Furthermore, the folds form the intended anatomical "semi-circle" formation when the structures are under tension. The PVDF structures do not form fibrotic adhesions to this peritoneal fold, therefore, it remains movable.

The incision is usually above the first sacral vertebra (S1) (Fig. 92.33). From this incision the pre-vertebral fascia is prepared. Be aware of the hypogastric nerve and take the nerve laterally from the stitches later on (Fig. 92.34). Identify the presacral artery and vein and coagulate them at 2 cm lengths so that the needle cannot injure these vessels. Two non-resorbable sutures 2-0 are placed horizontally in this fascia, one below and one higher at a distance of about 1 cm from each other (Figs. 92.35 and 92.36).

Advice: The four sutures in front of S1 have a lateral and a medial part. The **lateral** part of the sutures should be left **longer** before put in a clamp. When they are pulled through the posterior fixation sites, these **lateral parts of the sutures** always go through the **lower** part of the structure (the 3-L rule:"lateral, long, low").

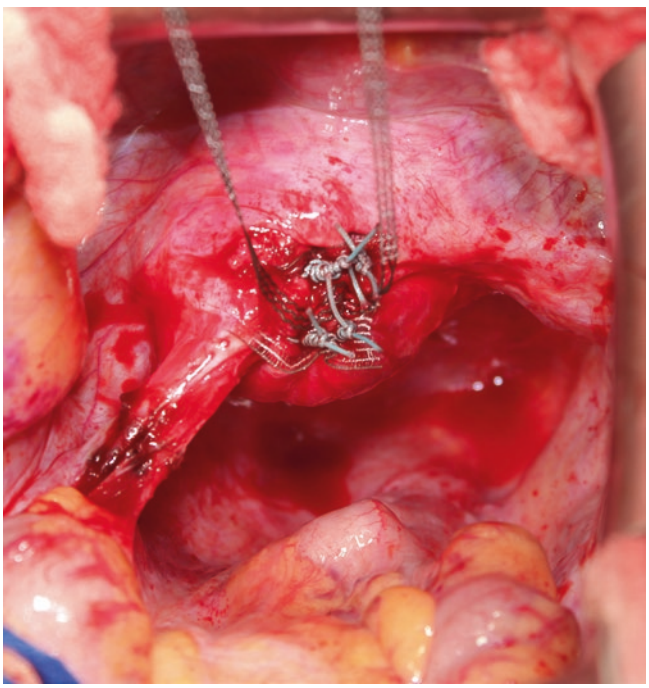


Fig. 92.31 VASA: The insertion aids of the USL are armed with clamps and the clamps are placed at the operation frame

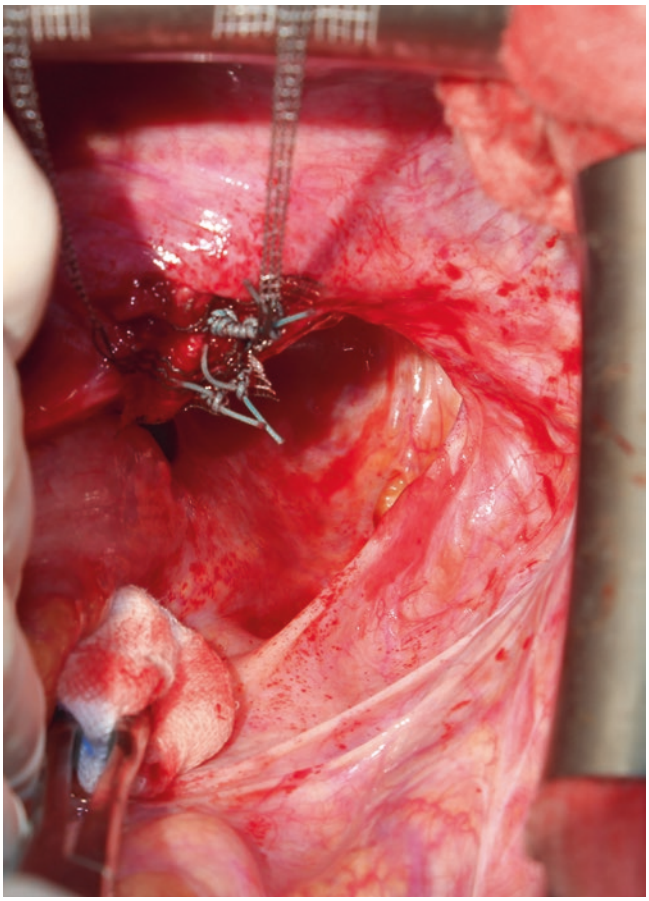


Fig. 92.32 VASA: With the help of the swab and a little pull at the *right* clamp with the "new USL", the *right* peritoneal fold of the USL can be identified

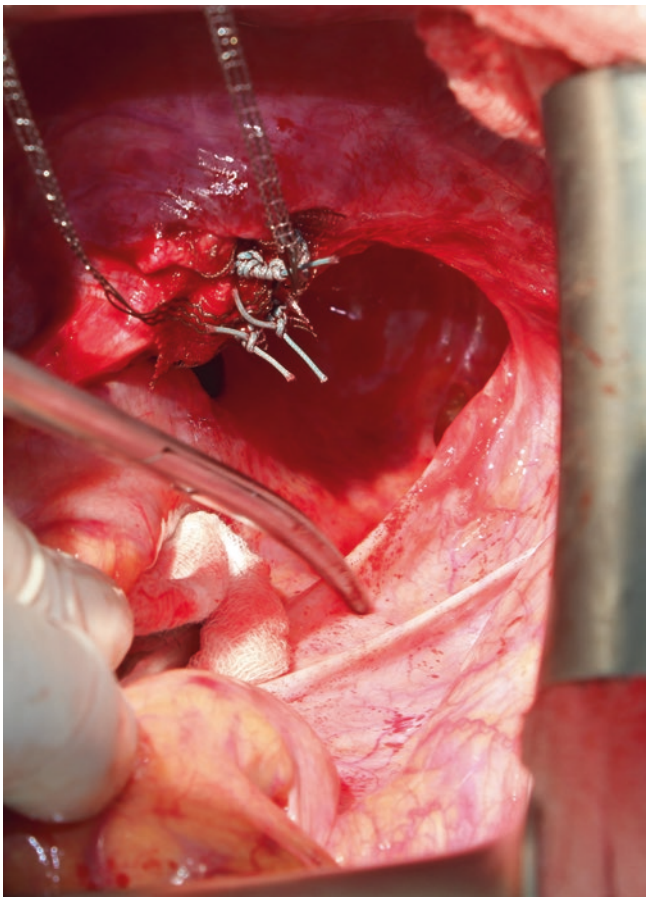


Fig. 92.33 VASA: The incision of the peritoneum is horizontal (in order not to destroy the peritoneal fold) at the height of S1

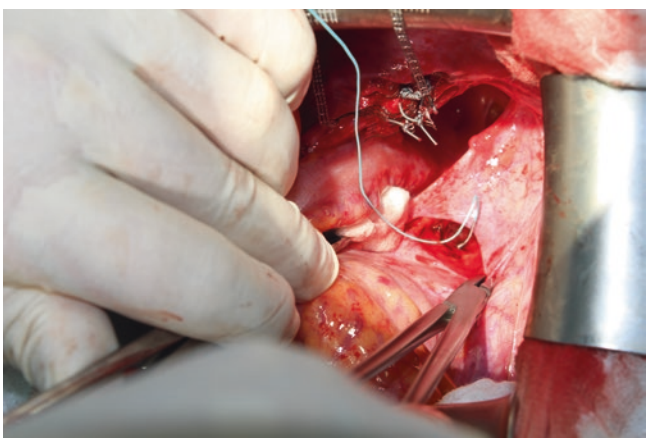


Fig. 92.34 VASA: Two sutures are placed in front of the S1/S2 prevertebral fascia. (The index finger of the left hand is at the promontorium)

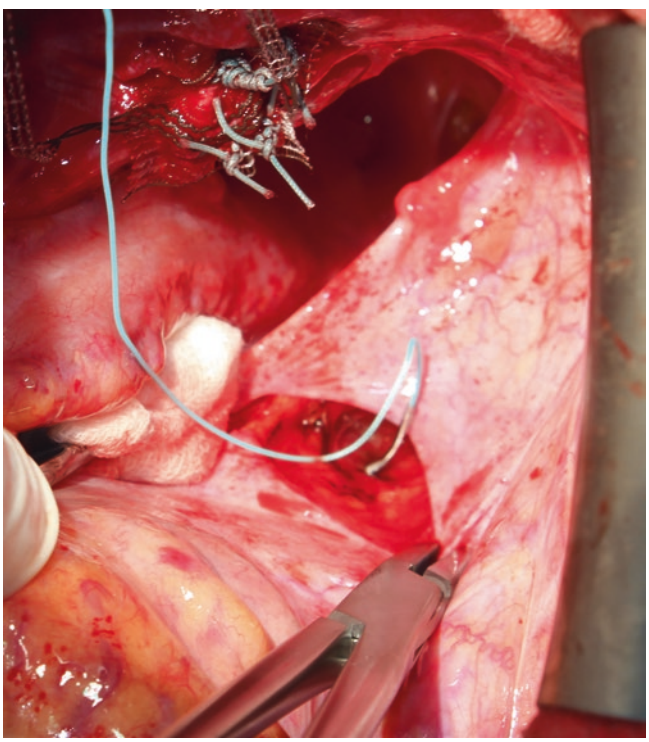


Fig. 92.35 VASA: The stitches are placed from far lateral to medial (Note: The lateral part of the suture should be *left* long, the medial part of the suture short! Makes it easier later on!)

Placement of the New USL

For the next step, care must be taken to avoid injuries of the peritoneal fold of the USL.

A small trocar, as usually used for a TVT placement, is pulled through the peritoneal fold of the USL from the back to the base at the vaginal end (Figs. 92.37, 92.38 and 92.39).

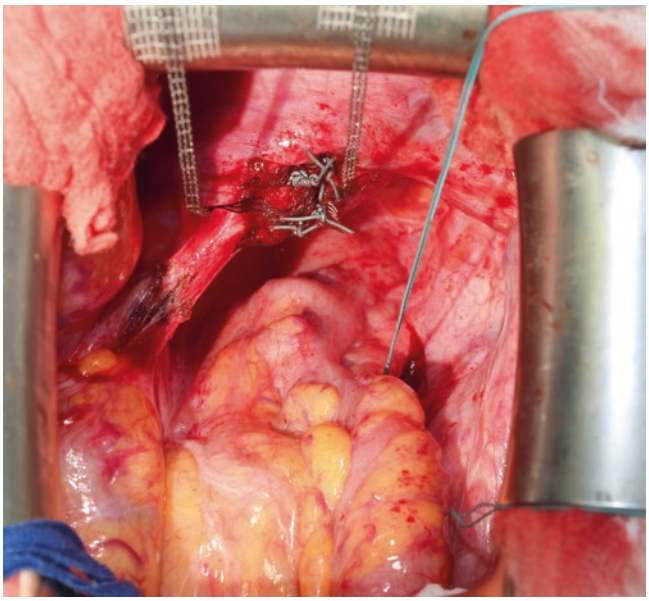


Fig. 92.36 VASA: The lower suture is armed with a clamp and placed on the *foot* side of the frame. The upper suture is armed with a clamp and placed on the *bottom* side of the frame

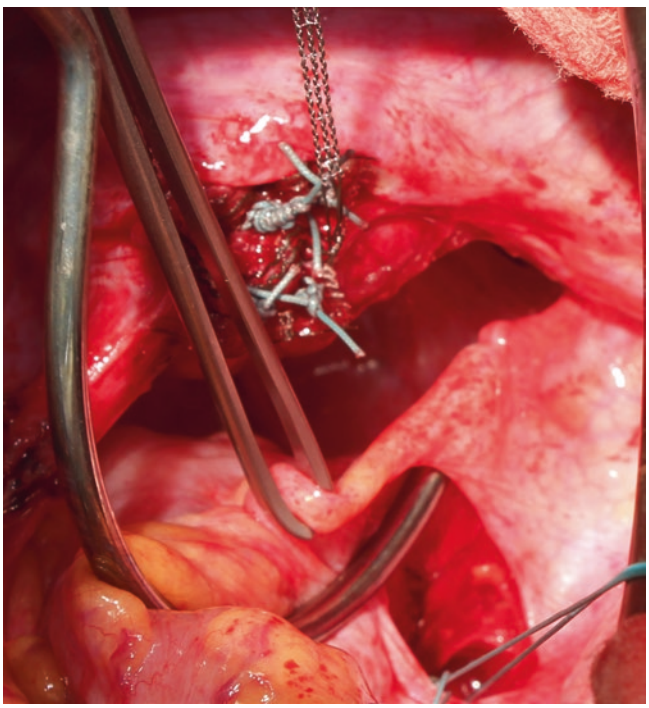


Fig. 92.37 VASA: The peritoneal incision in front of the sacrum is grasped and a TVT trocar is pushed into the peritoneal fold of the USL

Care must be taken not to injure the stumps of the uterine vein or artery which were cut during the previous hysterectomy. Bleeding can be difficult to identify since the blood tends to flow through the peritoneal channel to the opening incision in front of S1/S2. If the origin of the bleeding cannot be identified, this may cause considerable problems for the surgeon. In that case a 3-0 vicryl suture can be placed close to the vaginal end at the region of the vessels in a double stitch manner until the bleeding stops.

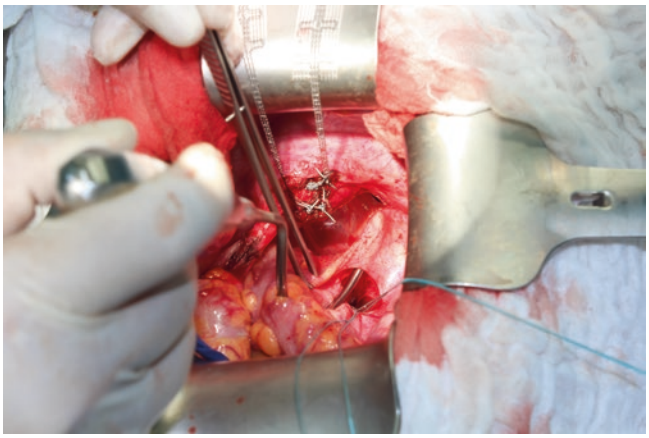


Fig. 92.38 VASA: For the first few centimeters the direction of the trocar is lateral

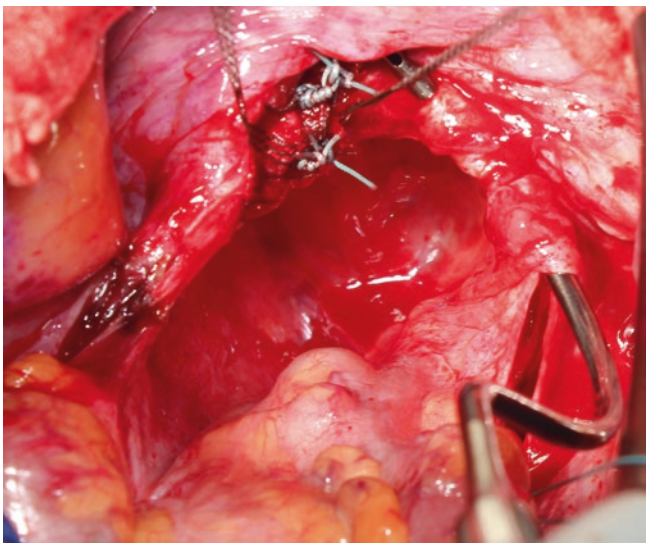


Fig. 92.39 VASA: Afterwards the direction of the trocar is toward the vaginal stump

Note: Leave the suture untied until you want to close the peritoneum. You can then draw the suture. Usually, thereafter, no more bleeding will occur.

The insertion aid of the tape is pulled through the hole at the top and pulled backwards to the sacrum (Fig. 92.40).

During this pulling action the net structure of the tape can injure the uterine artery or vein leading to bleedings; therefore, the pull should be done carefully. Bleedings cannot definitively be prevented; however, it is important that the surgeon immediately detects the origin of the bleeding.

The USL structure and the mesh are then pulled through the USL fold. This is performed easily, as in an empty channel. When the fixation mesh appears out of the "channel", it is placed where it should be fixed.



Fig. 92.40 VASA: The trocar is pushed through the *right* edge of the vaginal stump and the edge of the insertion aid is placed through the hole of the trocar

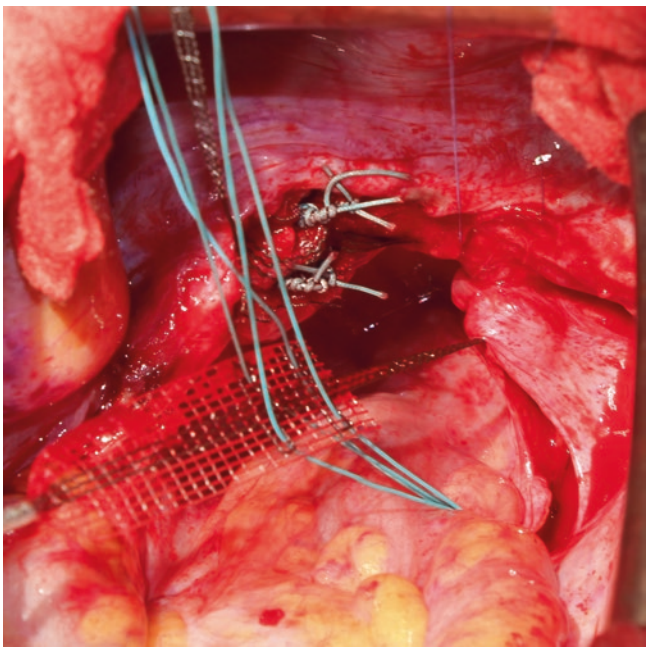


Fig. 92.41 VASA: The previously placed sutures are pulled through the suture marks at the end of the *right* USL structure

The previously-placed sutures are pulled through the marked fixation sites on the tape, the insertion aid is cut (Figs. 92.41, 92.42 and 92.43).

The new PVDF structure holds the vagina "with open arms" and not with "stretched out arms". Thereafter, the sutures are tied.

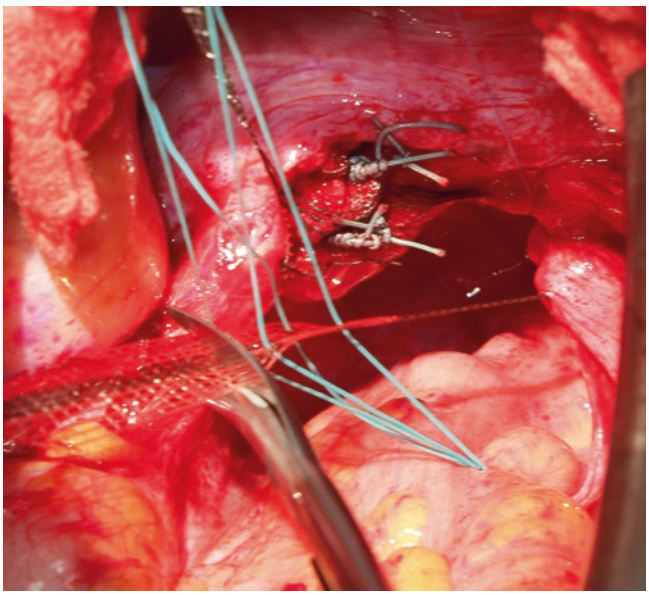


Fig. 92.42 VASA: After the two sutures have been placed, the insertion aid is cut

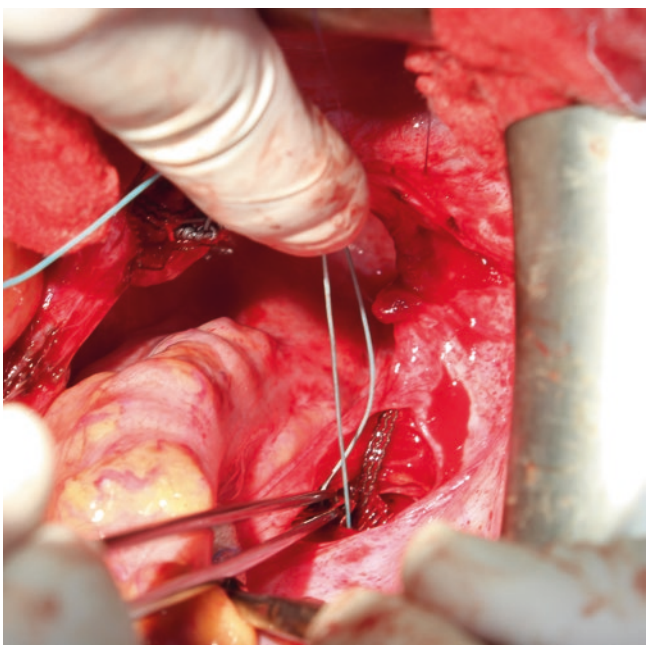


Fig. 92.43 VASA: The sutures are then tied

To prevent adhesion formation the incision side is closed with 4-0 Vicryl sutures (Fig. 92.44).

The same procedure also needs to be done on the left side.

The left side is a little more difficult since the meso-sigma crosses the fixation side.

The sigma/rectum needs to be pushed to the right side, this can be done either with a retractor held by an assistant, or the surgeon takes the sigma in one hand and pulls it in the respective direction (Fig. 92.45).

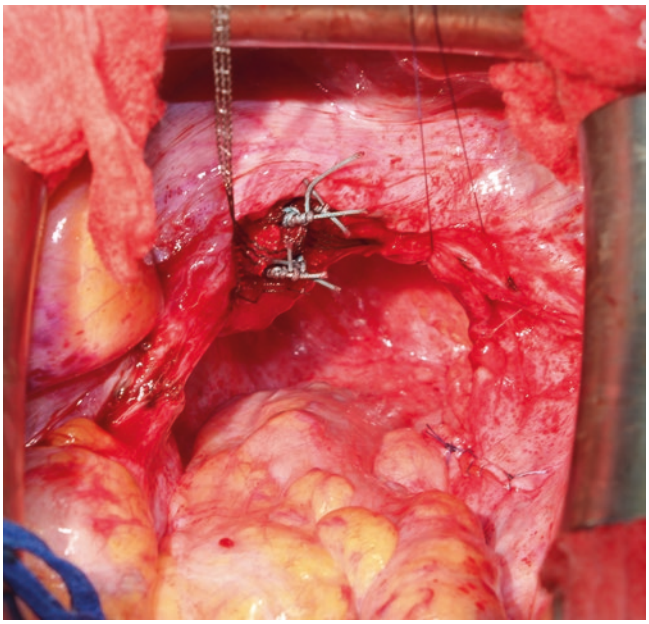


Fig. 92.44 VASA: Thereafter the peritoneum is closed with a running suture

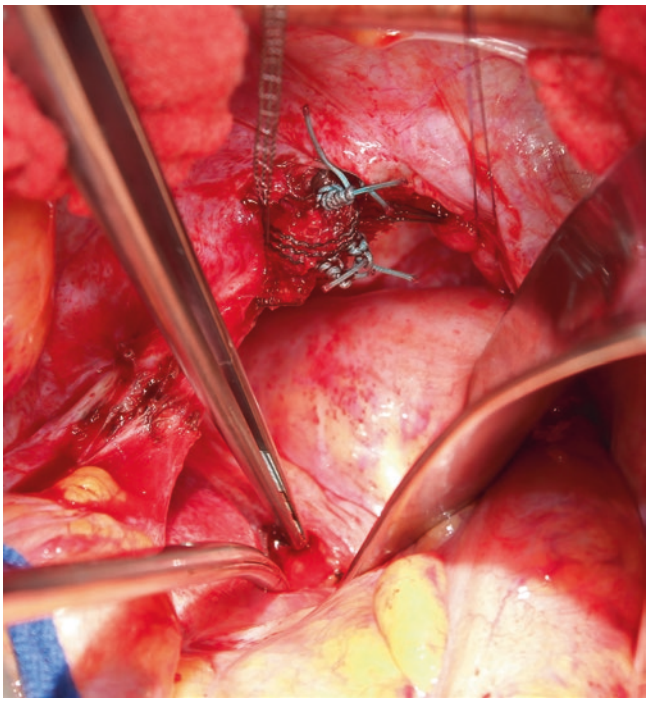


Fig. 92.45 VASA: The operation continues on the *left* side with the incision of the peritoneum in front of S1/S2

The surgeon then palpates the retroperitoneal sutures on the other (right) side. This palpatation will help to find the respective identical fixation site on the left side (Fig. 92.46).

With the other hand the incision is placed as on the other side.

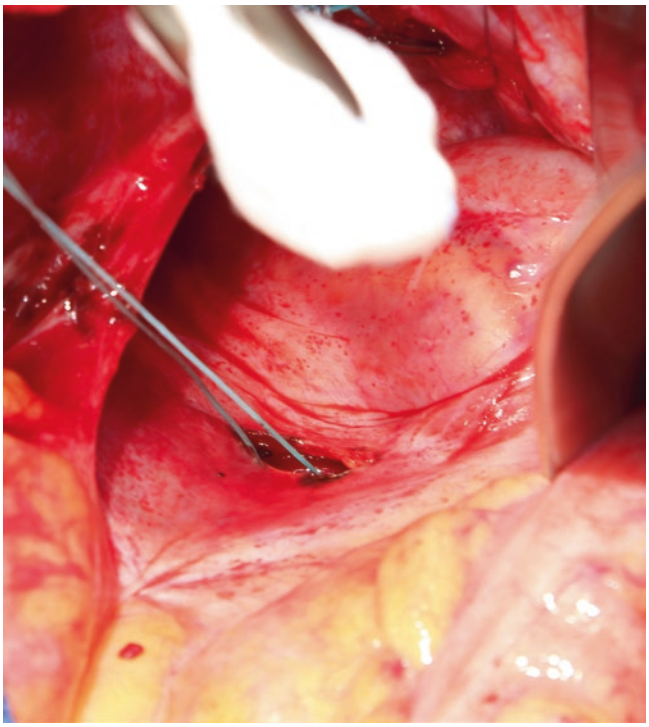


Fig. 92.46 VASA: The first suture is placed horizontally

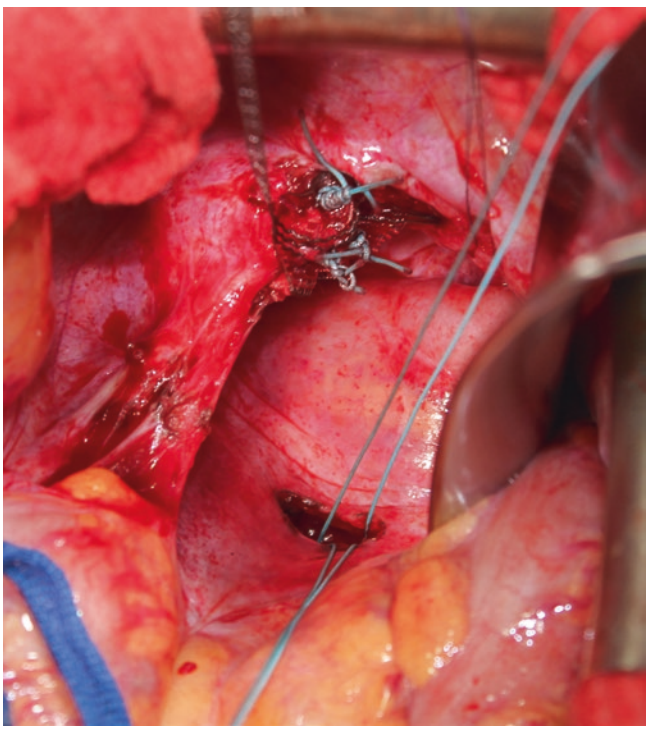


Fig. 92.47 VASA: Both sutures are placed

The same procedure as on the right side is then performed (Figs. 92.47, 92.48, 92.49, 92.50, 92.51 and 92.52).

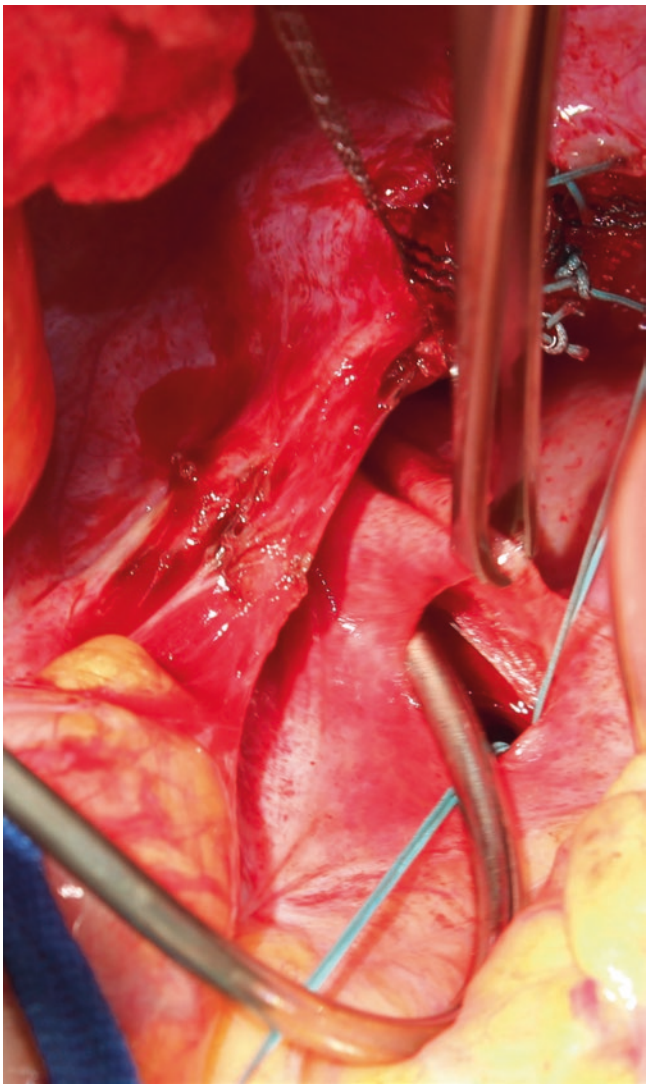


Fig. 92.48 VASA: The trocar is then inserted as on the *right* side

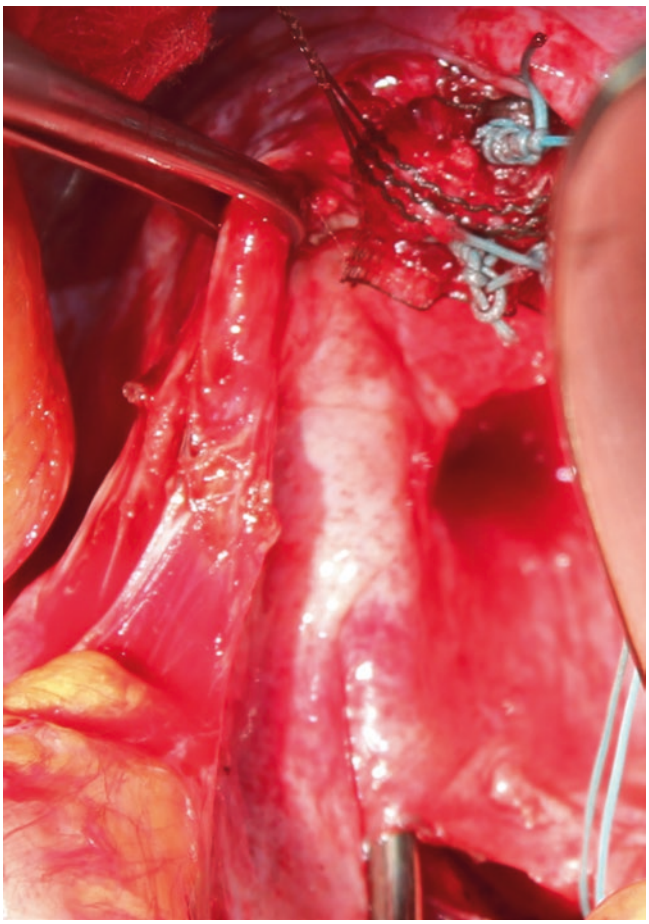


Fig. 92.49 VASA: The *top* of the trocar is brought forward to the corner of the *left* vaginal vault

After removal of the towels, we add 150 ml saline solution to prevent the drying out of the sigma epithelium and possible adhesion formation (Fig. 92.56).

Closing the Peritoneum on the Vaginal Stump

After the posterior fixation sites have been closed, the vaginal stump is peritonealized with the bladder and Douglas peritoneum (Fig. 92.53).

In order to get enough peritoneum to cover the net, take peritoneum from the posterior vaginal wall in the pouch of Douglas up to 2 cm from the scar and suture it to the bladder peritoneum (Fig. 92.54).

Take care that no suture or net is left uncovered by peritoneum otherwise adhesions will follow which can make the system "stiff and unmovable" (Fig. 92.55).

Additional Rectopexy (VARESA)

If a rectopexy has to be performed (VARESA), a non-resorbable suture 3-0 is placed in front of the marked posterior fixation sides. Special tapes have been developed for this procedure (Dynamesh VARESA). The sutures grab the mesorectum on both sides and are tied on the anterior net structure of the tape in that area.

Postoperative Vaginal Examination

This examination must reveal whether the sutures can be seen at the vaginal stump; they do not need to be removed immediately. After 3 months the sutures can be resected. By

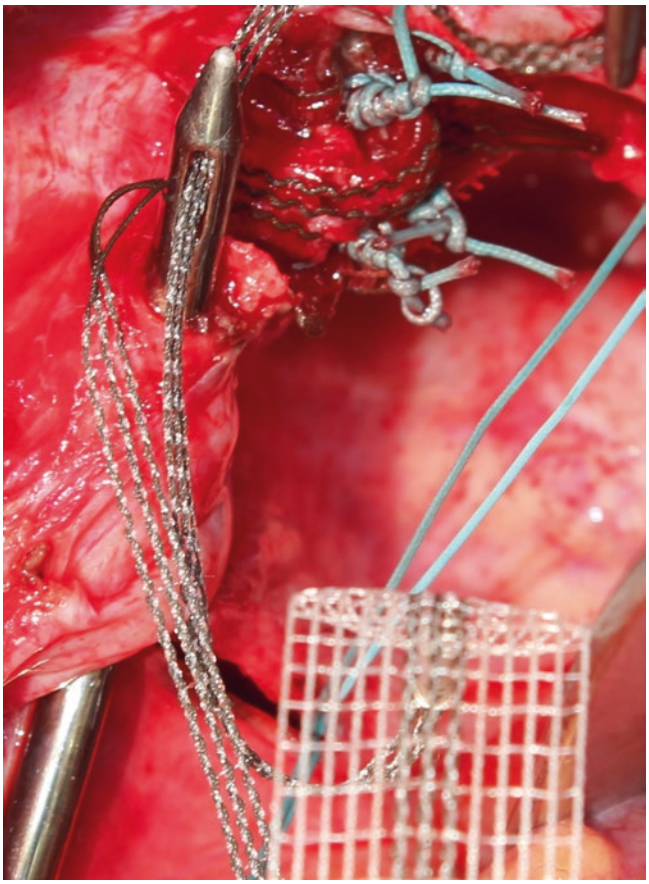


Fig. 92.50 VASA: The insertion aid is placed through the hole of the trocar and the *left* structure is pulled through the channel of the USL

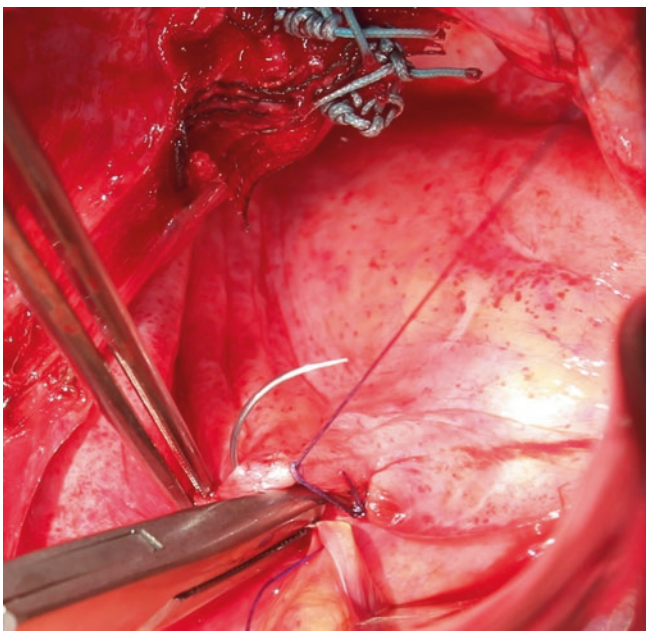


Fig. 92.52 VASA: The peritoneum is closed with a running suture

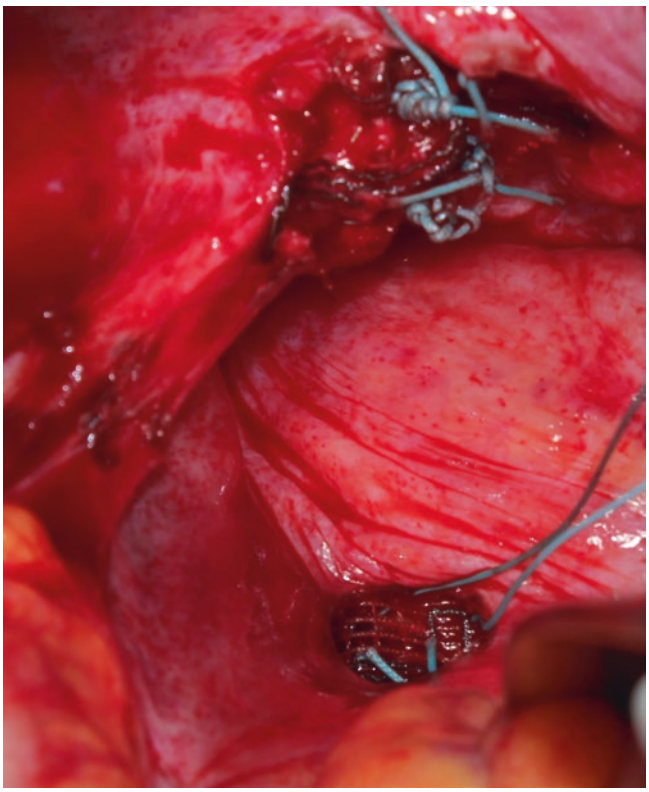


Fig. 92.51 VASA: The sutures are placed through the markings of the structure, tied and cut

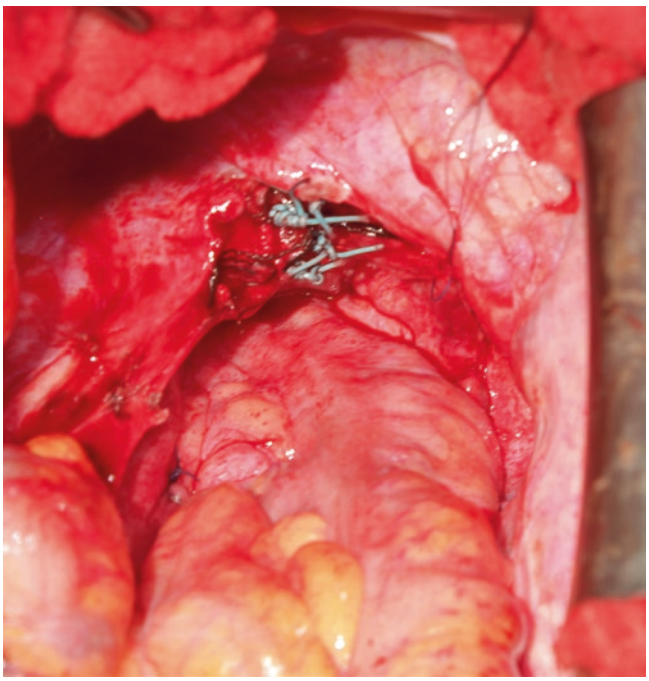


Fig. 92.53 VASA: View into the pelvic cavity after placement of the structure and closure of the posterior peritoneal incisions

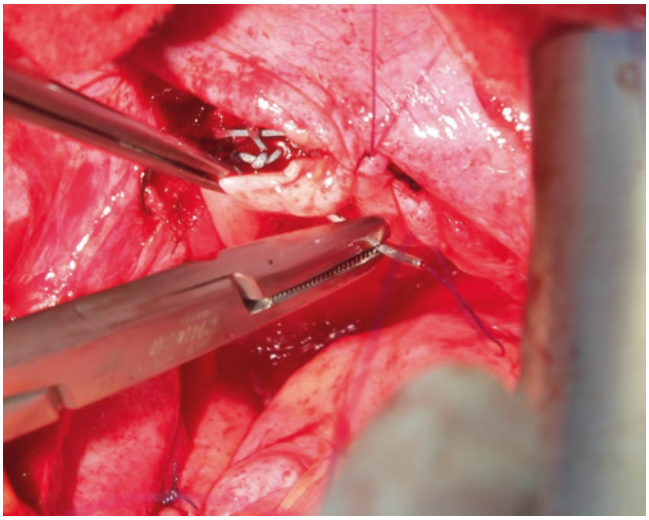


Fig. 92.54 VASA: The peritoneum at the end of the vagina is closed to cover the structure and the knots to prevent adhesions

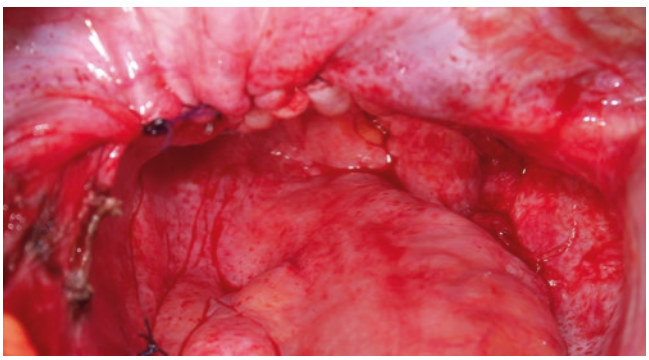


Fig. 92.55 VASA: The anterior wound is closed

that time the "bridge" is enclosed in the fibrotic tissue at the stump which holds the "bridge" in position.

The decision to perform an additional repair of the anterior or posterior vaginal wall i.e. a vaginal colporrhaphy has to be taken at the end of surgery and should only be performed when points Aa, Ba or C are >2 cm (−1, 0, +1, +2…..). Therefore, the same measurements as at the beginning of the operation are repeated (Figs. 92.57, 92.58, 92.59 and 92.60).

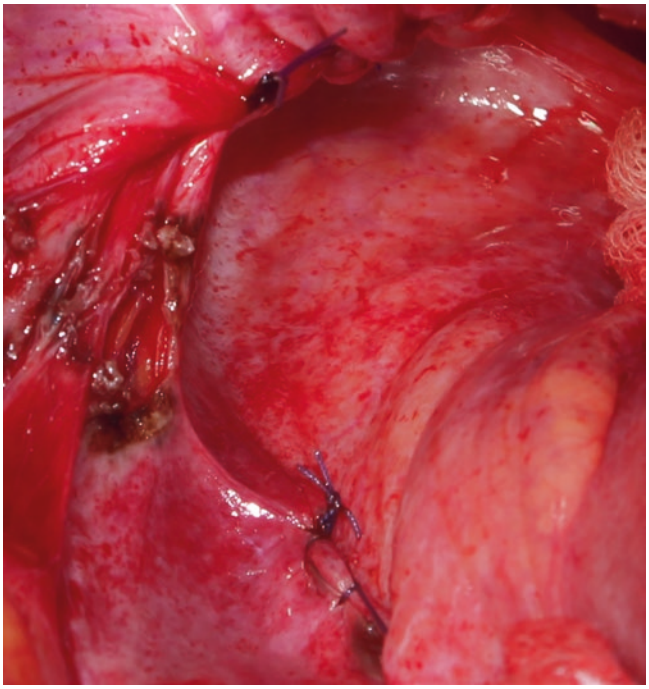


Fig. 92.56 VASA: At the end of these steps the new USL structures are placed and covered with peritoneum. The operation towels are removed. Before closure we add 150 ml saline solution to the pouch of Douglas so that the bowel is wettened to prevent adhesions



Fig. 92.57 VASA: View into the vagina after VASA



Fig. 92.58 VASA: A catheter is placed and remains for 2 days until the patient can reach the toilet without help during the night. The clamp is placed at the vaginal stump as at the beginning of the surgery



Fig. 92.59 VASA: The clamp is pushed with ten newton horizontally. The index finger marks the region of the clamp where the hymenal ring was



Fig. 92.60 VASA: At the end of the VASA the vaginal stump can be pulled down under traction to −5 cm from the hymenal ring

References

1. Uzoma A, Farag KA. Vaginal vault prolapse. Obstet Gynecol Int. 2009;2009:275621.
2. Bump RC. The POP-Q system: two decades of progress and debate. Int Urogynecol J. 2014;25:441–3.
3. DeLancey JO. Correlative study of paraurethral anatomy. Obstet Gynecol. 1986;68:91–7.
4. Petros PE, Ulmsten UI. An integral theory and its method for the diagnosis and management of female urinary incontinence. Scand J Urol Nephrol Suppl. 1993;153:1–93.
5. Buchsbaum GM. Urinary incontinence and pelvic organ prolapse. Minerva Urol Nefrol. 2006;58:311–9.
6. van Brummen HJ, van de Pol G, Aalders CI, Heintz AP, van der Vaart CH. Sacrospinous hysteropexy compared to vaginal hysterectomy as primary surgical treatment for a descensus uteri: effects on urinary symptoms. Int Urogynecol J Pelvic Floor Dysfunct. 2003;14:350–5. ; discussion 355

7. Brubaker L, Nygaard I, Richter HE, Visco A, Weber AM, et al. Two-year outcomes after sacrocolpopexy with and without burch to prevent stress urinary incontinence. Obstet Gynecol. 2008;112:49–55.
8. Nygaard I, Brubaker L, Zyczynski HM, Cundiff G, Richter H, et al. Long-term outcomes following abdominal sacrocolpopexy for pelvic organ prolapse. JAMA. 2013;309:2016–24.
9. Rock JA Jr, Jones HW III: Te Linde´s operative gynecology. Lippincott Williams and Wilkins ISBN 978-1-4511-7736-7 (2015).
10. Jager W, Mirenska O, Brugge S. Surgical treatment of mixed and urge urinary incontinence in women. Gynecol Obstet Invest. 2012;74:157–64.
11. Rizk DE, Czechowski J, Ekelund L. Dynamic assessment of pelvic floor and bony pelvis morphologic condition with the use of magnetic resonance imaging in a multiethnic, nulliparous, and healthy female population. Am J Obstet Gynecol. 2004;191:83–9.
12. Siddique SA, Gutman RE, Schon Ybarra MA, Rojas F, Handa VL. Relationship of the uterosacral ligament to the sacral plexus and to the pudendal nerve. Int Urogynecol J Pelvic Floor Dysfunct. 2006;17:642–5.

Uterine Prolapse Repair without Removing the Uterus: Uterosacropexy and Uterorectosacropexy

93

Wolfram Jaeger

Introduction

Prolapse

The term "prolapse" is used when the internal genitalia have lost their original position within the body and protrude along the vertical axis. It is not a disorder which appears from one moment to the other but a continuous development which may take several years. Prolapse usually starts in the second part of life – it is a problem associated with aging.

The pelvic organ prolapse quantification (POP-Q) system differentiates four stages "on that way out" (POP-Q I–IV) and is valuable for describing, quantifying and staging uterine and vaginal vault prolapse [1].

So far there are no recommendations for different treatments according to POP-Q stages. Therefore, the POP-Q system is just a description of the actual anatomical status at the time of examination.

A further characterization of the vaginal wall can be achieved by the points A and B.

Per definition, point A is 3 cm upwards from the hymenal ring along the vagina [1].

At the anterior vaginal wall Aa is considered to be the area at the end of the urethra; therefore, a shortening of point Aa indicates a descent of the urethra. This can be caused by an insufficient support of the urethra; however, one has to take into account that the length of the urethra differs considerably. Usually the length of the urethra varies between 2 cm and more than 4 cm in different women [2].

A point Aa at 3 cm, therefore, describes either a point at the urethral bladder junction or a point close to the middle of the urethra.

For this reason the actual length of the urethra should be measured and then decided whether the urethra is still in its original position or not.

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The role of these different areas is not clear. However, the area above the urethral-vesical junction was described by PETROS as the "zone of critical elasticity" – an area where the brain receives its information about the filling state of the bladder and thereby starts or inhibits voiding. In that area a movement with the anterior blade can easily induce the feeling of urgent need to void or not during vaginal examination [3].

Etiology

The exact aetiology and the pathophysiology of genital prolapse are unknown.

The observation that prolapse is a continuous development argues strongly against a rupture of a "holding structure". The function of the "holding apparatus" diminishes over time. Therefore, it is tempting to speculate that a continuous influence is important for the reduced elasticity of the respective tissues [4].

Because prolapse is an absolutely rare phenomenon in animals the upright body position could be essential. It has been hypothesized that the pressure on the pelvic structures which hold the pelvic organs (uterus, vagina, ovaries, bladder and rectum) is increased by the upright body position. As premise it is taken that a special critical "pressure" must exceed the "holding forces".

One aspect of increased pressure on this pelvic holding apparatus is pregnancy (baby, uterus and amniotic fluid) and the mechanisms of birth.

Increasing body weight as a continuous development seems plausible; however, prolapse is irrespective of body weight.

During pregnancy the pressure on the pelvic floor increases; however, the physiological development of the baby, uterus and amniotic fluid during pregnancy do not directly exert their whole pressure on the pelvic floor since the anterior part of the abdomen does not remain in its normal position but bulges.

The power vectors under these conditions are probably not directed at the critical parts of the "holding apparatus".

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Uterine Prolapse and Urinary Incontinence

A considerable number of women become urinary incontinent after childbirth [5].

However, this incontinence is reversible as it usually disappears after some weeks.

It has been hypothesized that this incontinence is based on the "stretched" pelvic-holding structures at the end of pregnancy. This assumption is based on the difference in the incidence of incontinence between women who delivered spontaneously and those who were delivered by caesarean section (CS). In women with CS the incidence of UI is significantly lower than in women who delivered spontaneously [6].

Forty percent of women suffering from genital prolapse also report UI [7].

It was assumed that UI and genital prolapse were two different disorders which only coincide by chance.

During a retrospective analysis based on personal interviews we could demonstrate that more than 50 % of women who had a vaginal hysterectomy because of prolapse stage II–IV of the uterus also presented with mixed urinary incontinence. The same numbers were reported by others who stated that up to 50 % of all women with vaginal hysterectomy developed stress and urge urinary incontinence thereafter [8].

On the other side the remaining women with prolapse did not develop UI.

Therefore, prolapse alone cannot be the only reason for UI but UI is usually associated with prolapse!

Pathophysiology of Prolapse and Incontinence

According to the above mentioned observations prolapse is probably based on a defect of the "holding apparatus" perhaps combined with some hormonal influences and genetic disposition. The ensuing laxity of the anterior vaginal wall leads to urinary incontinence. The uterus is probably not the etiological responsible factor for prolapse; therefore, a causal treatment must focus on the repair of the holding structures [3].

Prolapse is a disorder which usually appears after menopause. However, when it appears hormonal treatments can no longer repair the damage.

From observations that incontinence disappears some months after delivery, it was concluded that estrogens may be effective in strengthening the respective tissues in the pelvic floor [9].

Therefore, estrogens are often used as first treatment in women with urinary incontinence. The connective tissues can be strengthened by estrogens; however, it is difficult to achieve any effects if the women are already postmenopausal. Most likely the respective receptors can no longer induce the effects on the target tissues.

This may be caused by the diminished number of functioning E2 receptors in the target tissue or by damage to the tissue itself.

As target tissue, the connective tissue of the small pelvis with its body-position-specific "holding function" cannot be repaired. Estrogen replacement therapies cannot repair the prolapse or the incontinence.

In experiments with the corpses of rhesus monkeys, the change to an upright position led to an increased tension of the left and right USL which could be seen most effectively when the bladder of the monkey was filled with 80 ml saline solution.

When the bladder fills, the position of the bladder in the pelvis increases the pressure on the different surrounding tissues and structures, probably dependent on the different body positions. In the standing and sitting position one could assume that the pressure of the full bladder will exert its power mainly on the upper vaginal wall.

To characterize this position, one has to consider that the length of the urethra differs somewhere between 2.5 and 4.5 cm. That means that the entrance of the urethra into the bladder is somewhere between 3.5 and 5.5 cm from the entrance of the vagina (assuming that the additional 1 cm is the part between the entrance of the vagina and the introitus urethrae).

This correlates with the "zone of critical elasticity" of PETROS. This may be different in the prone position when the pressure is more directed to the lateral parts of the bladder or lying on the back where the pressure is more horizontal [4].

However, the pressure on the vaginal wall is transmitted to the holding structures. This is the anatomical fixation at the vaginal entrance and the cervix. The cervix, however, transfers this pressure to its holding structure – the USL.

(Interestingly enough the fixation points of the USL at the backside of the cervix are nearly exactly opposite the highest fixation points of the bladder at the front side of the cervix.)

In analogy the position of the vagina can be compared with a bridge with two pylons in the front and in the back: the pubo-urethral ligament (PUL) and the USL [4].

Since, according to developmental research, the USL are derived from the uterus and not from the presacral area, it must be important that women have two USL at the cervix and not only one. These two USL do not arise from the same point at the cervix but have two different origins at a distance from each other, depending on the size of the cervix. It can be speculated that this distance improves the three dimensional stability of the pelvic floor and especially of the position of the bladder. By increasing the distance between the origins of the USL the stability of the bladder position is increased.

Therefore, prolapse treatment needs to focus on the holding apparatus and especially on the USL. Since in patients with prolapse the structures of the USL diminish by two

thirds in their muscle and elastic tissue composition, the USL cannot only be repaired but must be replaced.

Pelvic Floor and Standardization of the Operations

The premise of the CESA, VASA and Uterosacropexy operations is a standardised surgical replacement of the USL (Figs. 93.1, 93.2, 93.3, 93.4 and 93.5).

Standardised operation means that the operation will be performed in every patient in exactly the same way: identical length of tapes which is guaranteed by stitch marks on the structure, defined fixation sites at the cervix and in front of S1/S2. The structures are pulled through the peritoneal fold of the USL and thereby placed retroperitoneal at a defined channel.

Considering the great variety of women's shapes one would expect that the lengths of the USL are different in every woman; however, this is not the case.

In obstetrical textbooks the diameters between the bony structures in the small pelvis are identical in all women irrespective of weight, parity or racial derivation. This has been confirmed by extensive MRT measurements by several institutions [9].

For this reason we hypothesized that the ligaments in the small pelvis, especially the USL and the PUL, are also of identical length or differ only slightly in all women after puberty.

Therefore, we decided to implant USL structures of the same length in every woman. According to the literature and our own measurements we arrived at the conclusion that the length of the USL is between 8.5 and 9.0 cm [10].

In patients who want to keep the uterus we decided to use the VASA/VARESA structures (Dynamesh VASA and Dynamesh VARESA, FEG, Aachen, Germany) (See figs. 92.24, 92.25 and 92.36 in Chapter 92).

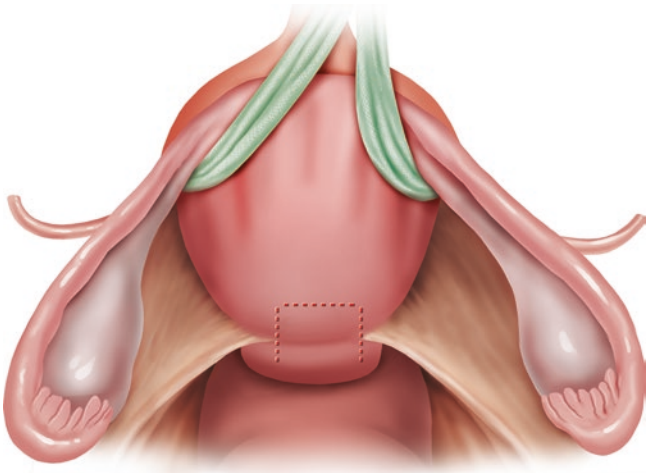


Fig. 93.1 Uterosacropexy: The uterus is held by a small tape pulled through the parametrium. The incision side at the cervix/corpus is marked with a *red line*

Additional Rectopexy (CERESA)

If a rectopexy has to be performed (CERESA), a non-resorbable suture 3-0 is placed in front of the marked posterior fixation sites. Special tapes have been developed for this procedure (Dynamesh CERESA). The sutures grab the mesorectum on both sides and are tied on the anterior net structure of the tape in that area.

Repair of the Anterior ("Cystocele") and Posterior ("Rectocele") Vaginal Wall

The decision to perform an additional repair of the anterior or posterior vaginal wall i.e. a vaginal colporrhaphy has to be taken at the end of surgery and should only be performed when points Aa, Ba or C are −2 cm (−1, 0, +1, ≥+2).

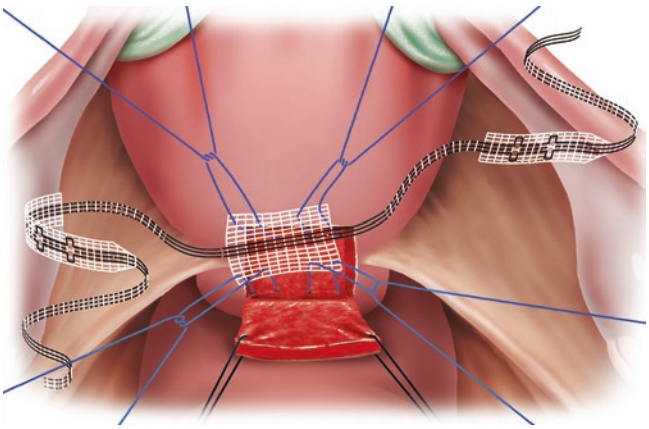


Fig. 93.2 Uterosacropexy: A muscle flap is incised at the back of the uterus. The site of the incision was chosen so that the new USL of the structure could easily be pulled into the peritoneal fold of the original USL. Four stitches were placed in each quadrant of the implantation site and the holding part of the structure ("bridge"). The muscle flap is armed with two lateral stitches

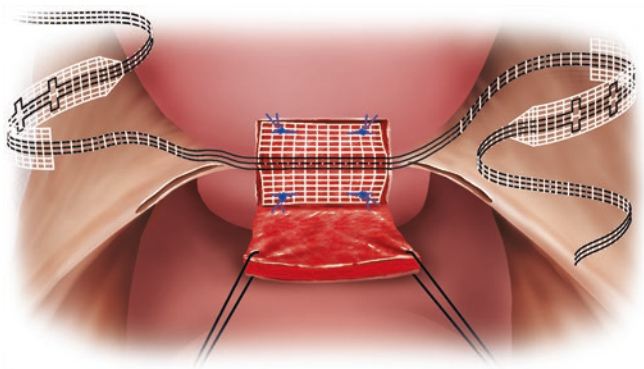


Fig. 93.3 Uterosacropexy: The four sutures were tied and the peritoneal folds of the USL were incised. (Take care not to injure the uterine artery and/or vein!)

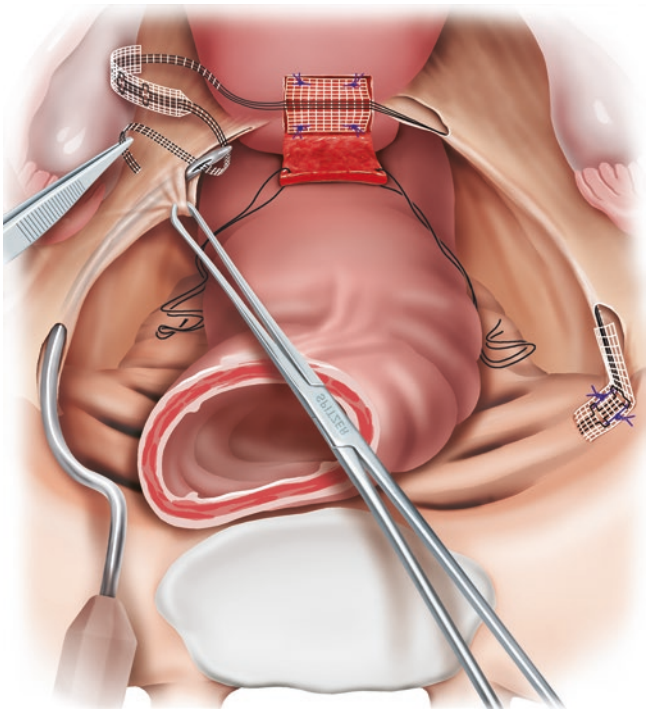


Fig. 93.4 Uterosacropexy: The right USL of the structure has been placed under the peritoneal fold. It was sutured to the os sacrum with two horizontal sutures. On the left side the trocar is pushed through the USL channel and the *top* of the insertion aid of the trocar. The trocar is pulled backwards and the left USL of the structure is brought into place

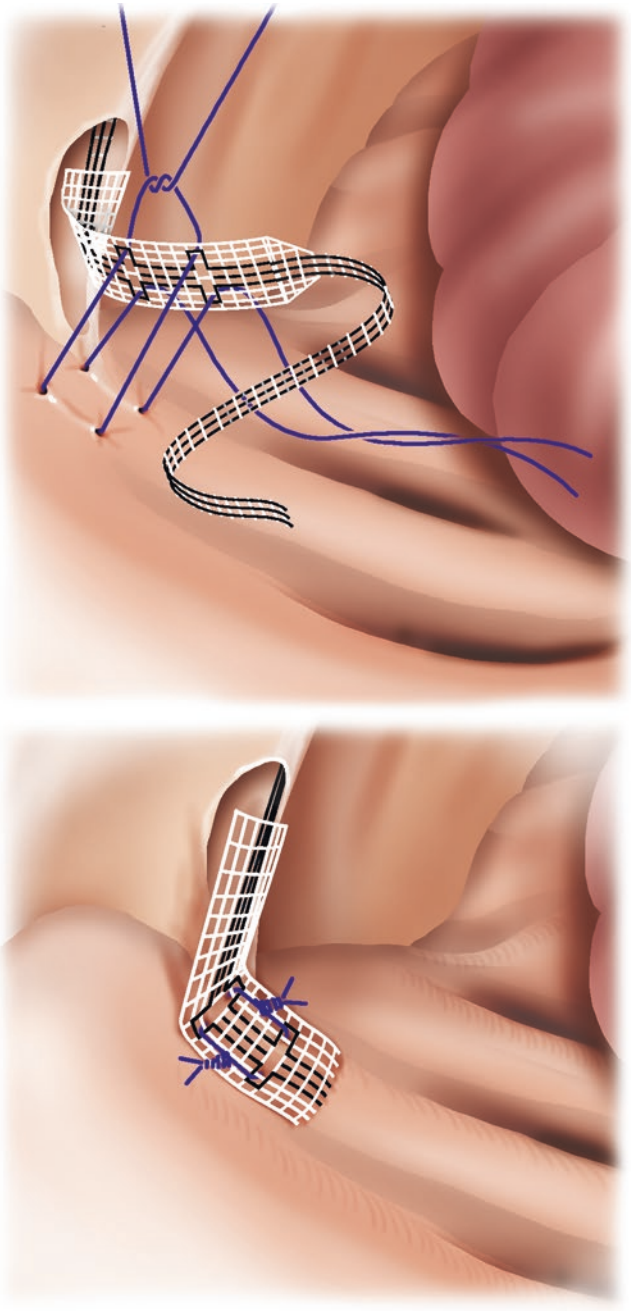


Fig. 93.5 Uterosacropexy: The fixation in front of S2 is shown. The stitches go through the marked areas of the fixation site. The stitches are horizontally. They are pulled tight and thereafter the peritoneal incision closed

Uterus-Sacropexy and Uterus-Recto-Sacropexy

Before the operation the uterine prolapse is measured. This can be done by taking the cervix with a clamp and pulling it horizontally with a force of 10 N (1 kg) (Fig. 93.6) (also see figures 92.4 and 92.5 of Chapter 92).

During this examination the anterior vaginal wall is examined to decide whether an additional repair of the anterior wall is necessary. The rugae indicate that this is not necessary in this case.

Opening of the Abdominal Cavity (According to the Internal Institutional Standards)

The dermal incision should be horizontal ("cesarean section") between 8 and 12 cm according to the pre-rectoral fatty tissue. After opening the peritoneum we prefer placement of a rectangular frame with a 25 cm diameter.

The first step is to decide whether the operation can be carried out as planned. The reasons being, firstly the size of the uterus could be a problem. If the diameter of the corpus is enlarged by myomas, it is recommended to resect to reduce the diameter of the uterus. Secondly, if ovarian cysts complicate the situation, these should be removed and examined. The aim of this part of the operation is to "empty" the pouch of Douglas as much as possible.

Therefore, the bowel and the small intestines have to be out of the area.

We use two surgical towels. With the first towel we place the small intestine into the upper abdominal cavity. With a second towel, which is folded into a rectangular shape, we move the descending and ascending large intestine upwards. At the end of this step the pouch of Douglas should be free of intestine apart from the sigmoid colon. Especially, the pelvic rims (the transition into the small pelvis) must be clearly visible in order to make incisions there and to avoid any complications.



Fig. 93.6 Uterosacropexy: Before the operation the cervix is fixed with a clamp and pulled horizontally downwards with a force of 10 N (1 kg). In this case a prolapse of the uterus POP-Q stage 3 was found



Fig. 93.7 Uterosacropexy: The right peritoneal fold of the USL can be identified

The Sequence of the Different Steps of the Operation Is Different to Those of CESA or CERESA and VASA or VARESA

The reason for the above is that as soon as the new structures are tied at S1/S2, the uterus can no longer be moved; therefore, the closure of the uterus flap must be carried out beforehand.

Identifying the Peritoneal Folds of the Uterosacral Ligaments (USL)

The first step of surgery is the demonstration of the USL.

To find the USL, the uterus must be grabbed with one hand (usually the left hand for right-handers) (Fig. 93.7).

The uterus should be pulled in the opposite direction to the USL being sought (Figs. 93.8 and 93.9).

The origins of the USL at the uterus can always be identified. The origins of the USL are at the posterior part of the cervix. They arise nearly opposite the insertion side of the bladder at the anterior side of the cervix.

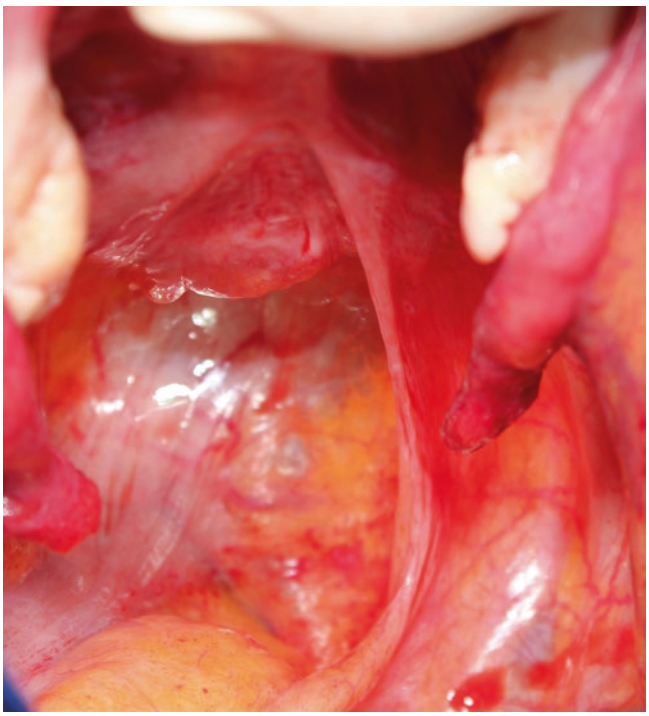


Fig. 93.8 Uterosacropexy: The right USL

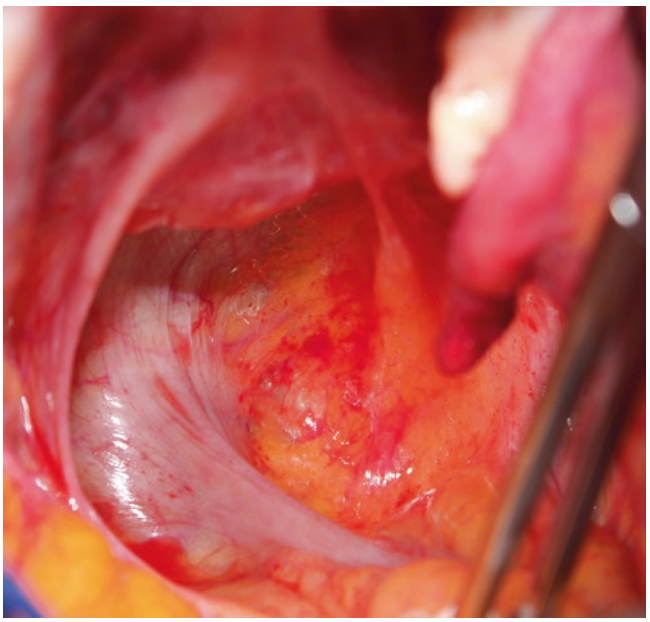


Fig. 93.9 Uterosacropexy: The left USL



Fig. 93.10 Uterosacropexy: The musle flap is prepared. The incision starts 0.5 cm below the origin of the USL at the cervix on both sides

Preparing the Anterior Fixation Side: the Uterus

Definition of Level 0

The upper points at the cervix where the USL originate are delineated. An imaginary horizontal line between these points of origin is called level 0 (zero).

The incision made at the backside of the uterus and cervix is an inverted U: upside down!

The aim is to prepare a muscular flap at the backside of the uterus with its basis at the cervix.

The incision begins just below level 0 on the backside of the cervix. The incision starts a little below level 0, medial of the origin of the USL at the cervix (Figs. 93.10 and 93.11).

The "length" of the flap should be between 2 and 3 cm depending on the size of the cervix.

The distance between the upside incision and the down-side incision ("the width") should be as large as possible depending on the size of the uterus. It is usually between 1 and 3 cm (Fig. 93.12).

Take care not to incise the uterine artery and vein on each side!

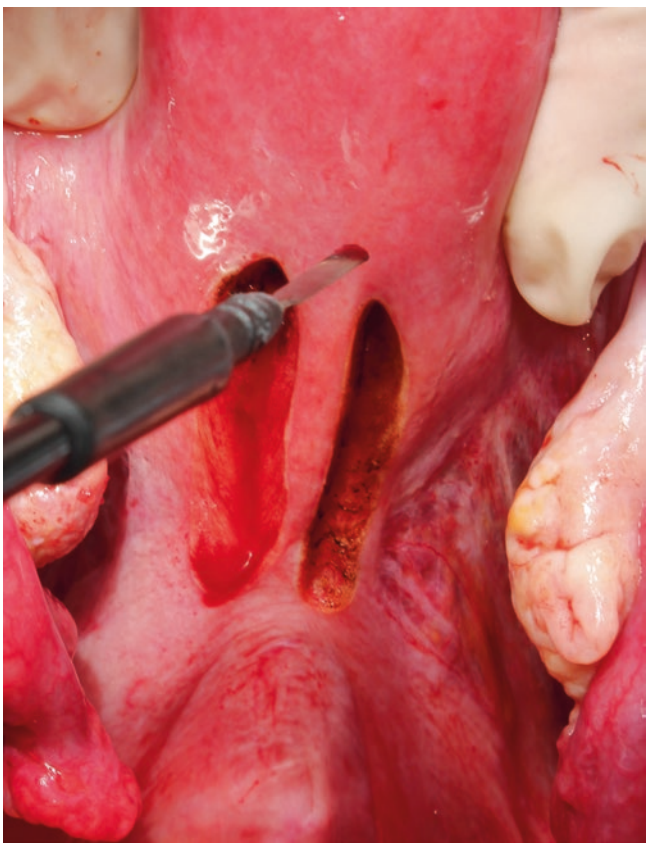


Fig. 93.11 Uterosacropexy: The anterior part is cut



Fig. 93.12 Uterosacropexy: The size of the flap is cut

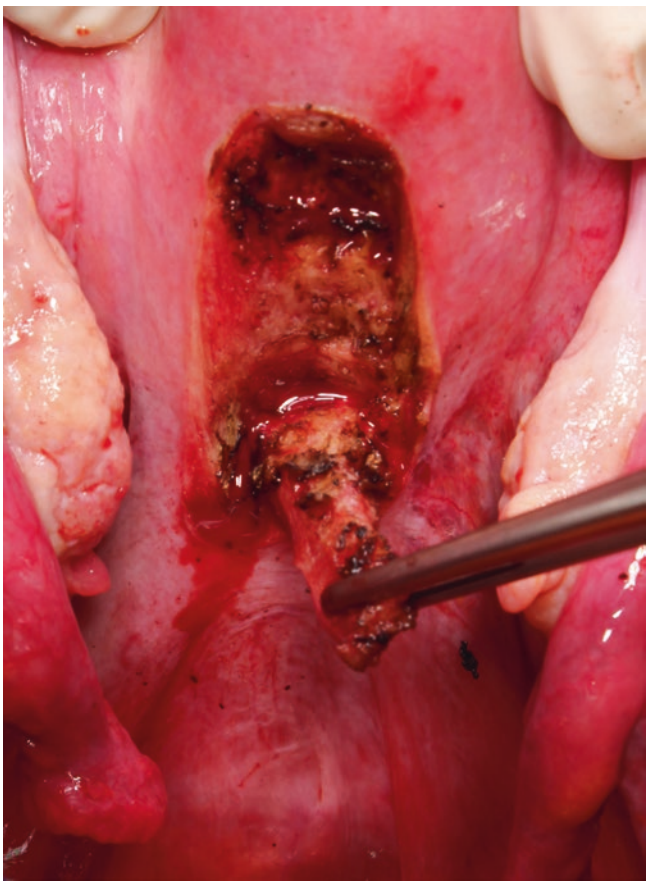


Fig. 93.13 Uterosacropexy: The flap is pulled downwards

The incision should be 3 mm wide and performed with an electrical knife.

In this way an inverted U-shaped flap is formed (Fig. 93.13).

A small incision is made in the parametrium close to the round ligaments. A loop is pulled through one of these holes, placed around the uterus and pulled out at the other hole. The ends of the loop are armed with a clamp (Figs. 93.14 and 93.15). The clamp is then placed at the frame, exerting some tension on the uterus.

The peritoneal folds of the USL end at the level of S2. The USL structures reach up to the sacral spine in the area between S1 and S2.

Preparation of the Posterior Fixation Site

After the USL have been identified, the incisions at the sacrum are placed horizontally, 0.5 cm above the insertion side in front of S1/S2 (Fig. 93.16).

An incision along the USL (from cervix to sacrum) should be avoided since the "original" peritoneal folds protect the tape structure from adhesion formation. Furthermore, they

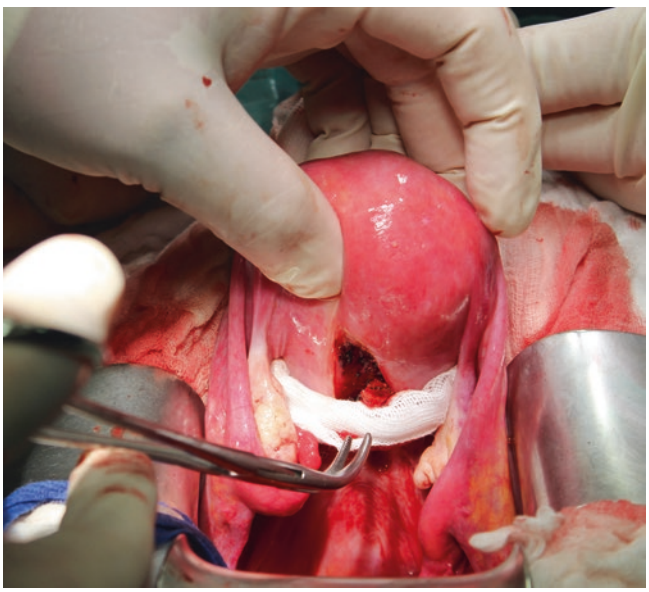


Fig. 93.14 Uterosacropexy: The parametrium is incised on both sides of the uterus and a small towel is put through these holes and armed with a clamp

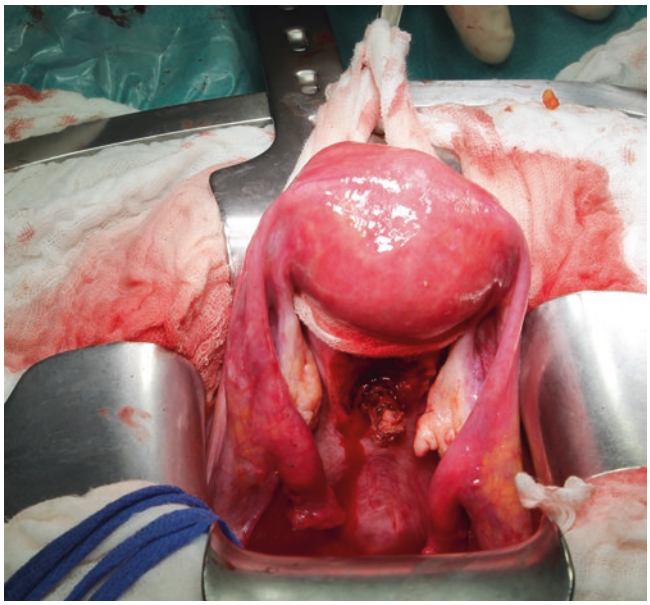


Fig. 93.15 Uterosacropexy: The uterus is fixed by this towel at the frame to make the operation easier

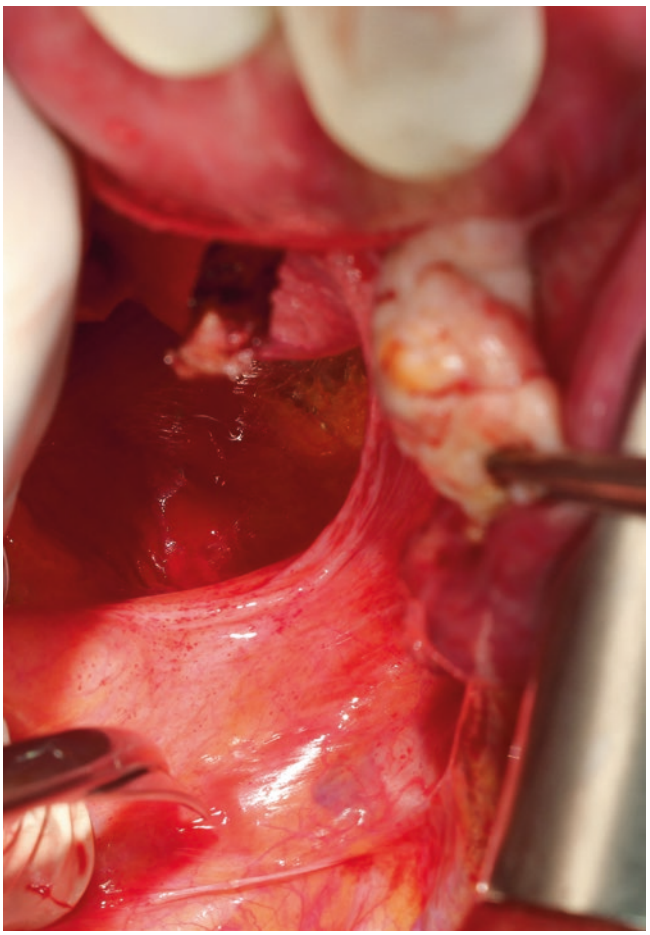


Fig. 93.16 Uterosacropexy: The right peritoneum is tied and the incision site is identified, lateral to the USL in front of S1/S2

form the intended anatomical "semi-circle" formation when the structures are under tension. The PVDF structures do not form fibrotic adhesions to this peritoneal fold, therefore it remains movable.

The incision is usually above the first vertebra (S1). From these incisions the pre-vertebral fascia is prepared (Fig. 93.17). Be aware of the hypogastric nerve and take the nerve laterally from the stitches later on. Identify the presacral artery and vein, and coagulate them at 2 cm lengths so that the needle cannot injure these vessels (Fig. 93.18).

Two non-resorbable sutures 2-0 are placed horizontally in this fascia, one below and one higher at a distance of about 1 cm from each other (Figs. 93.19, 93.20 and 93.21). They are armed with a clamp and placed at the top of the wound.

The same procedure also needs to be carried out on the left side (Fig. 93.22).

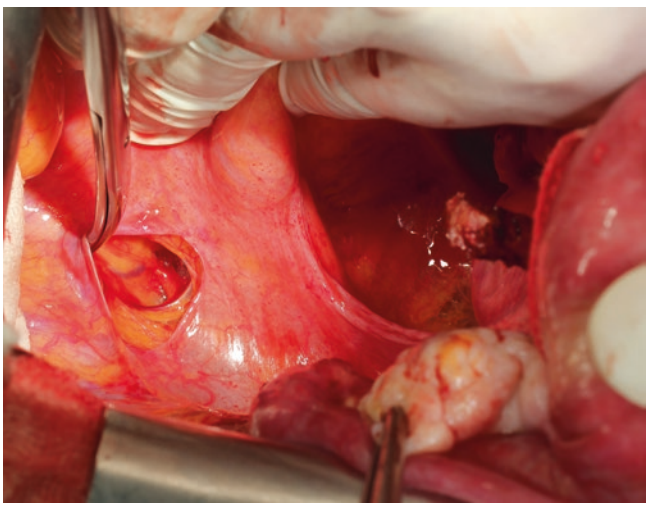


Fig. 93.17 Uterosacropexy: The peritoneum is incised and the fixation sides in front of S1/S2 are freed of fatty tissue

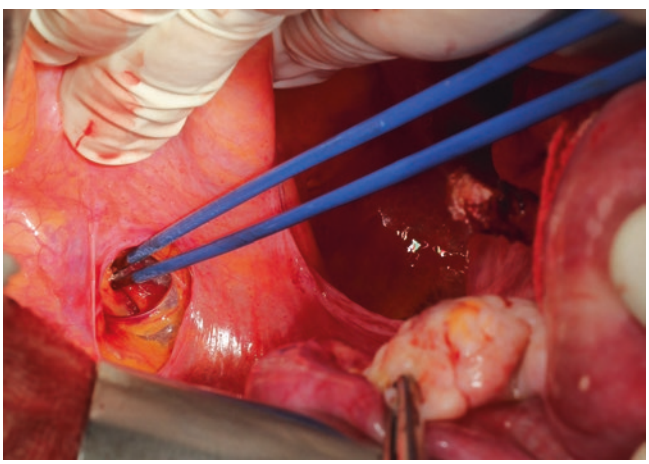


Fig. 93.18 Uterosacropexy: The sacral artery and vein are cauterized

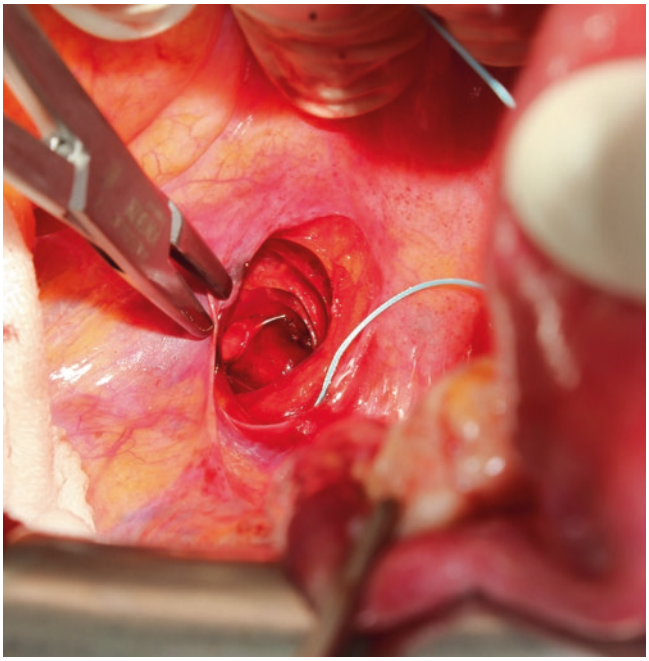


Fig. 93.19 Uterosacropexy: The first stitch is placed

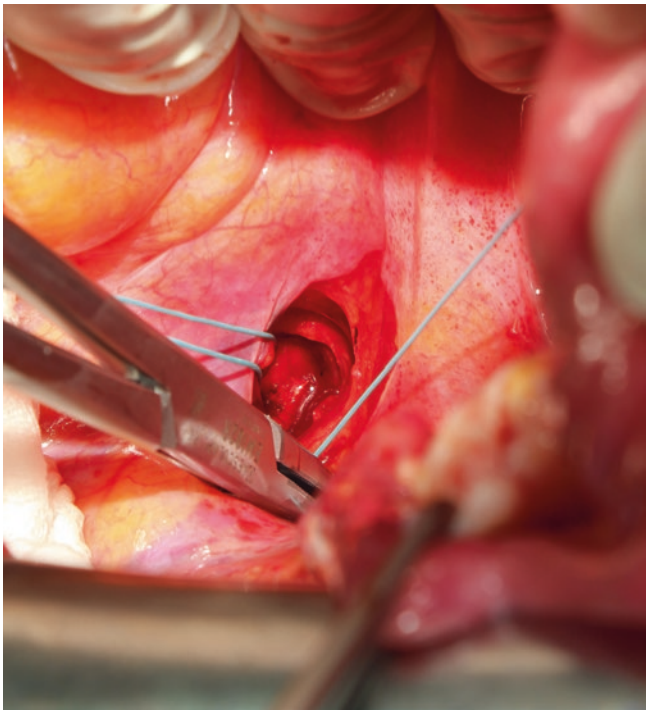


Fig. 93.21 Uterosacropexy: A second stitch is placed horizontally below the first. The sutures are armed with clamps and placed on side of the frame (Note: The sutures are not tied at this phase of the operation!)

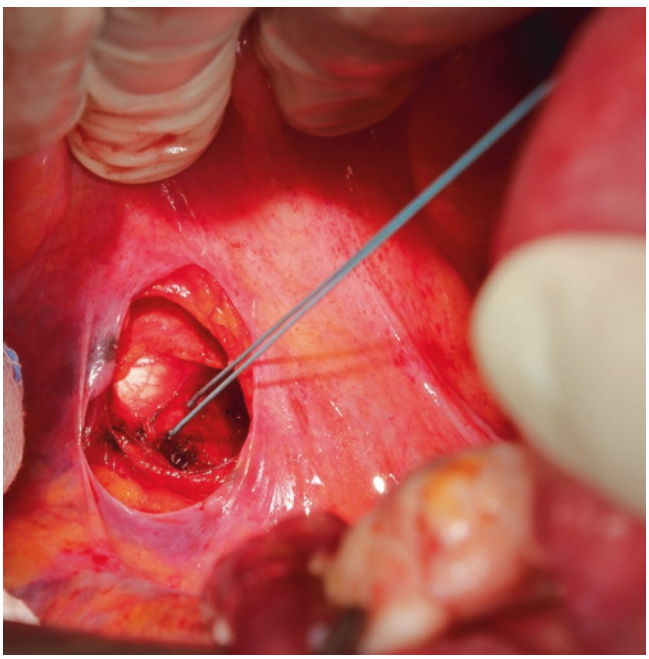


Fig. 93.20 Uterosacropexy: The suture is armed with a clamp

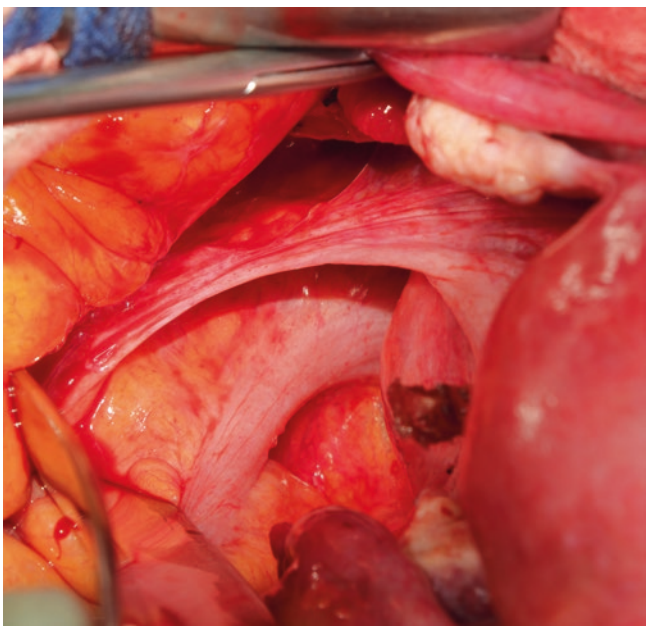


Fig. 93.22 Uterosacropexy: The USL of the left side is demonstrated

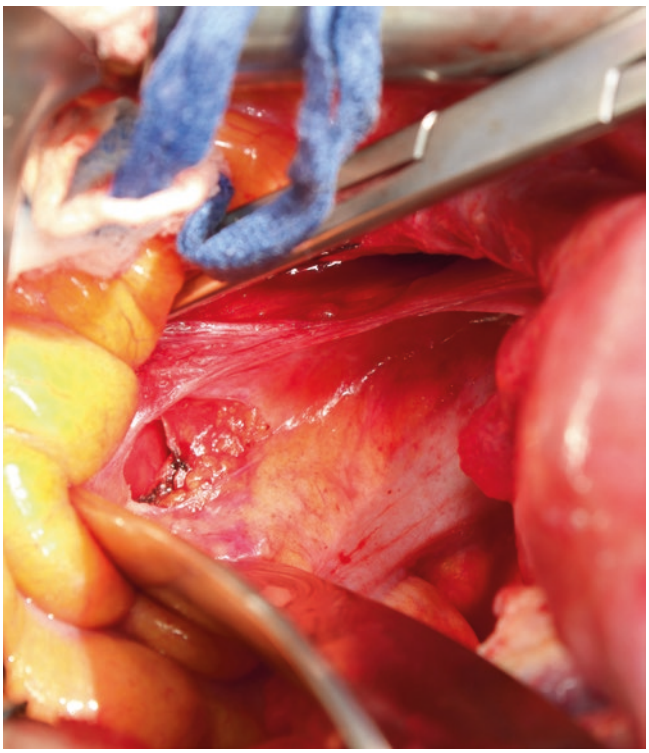


Fig. 93.23 Uterosacropexy: The presacral area is prepared

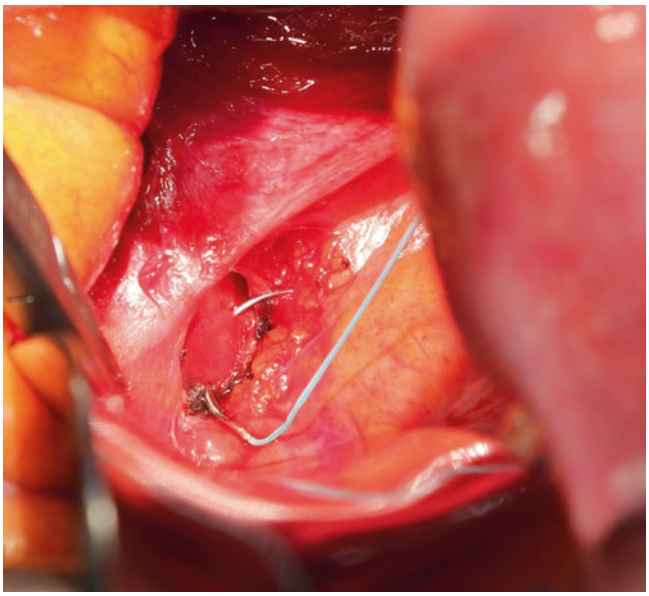


Fig. 93.24 Uterosacropexy: The first stitch is placed

The left side is a little more difficult, since the meso-sigma crosses the fixation side. Therefore, the sigma/rectum needs to be pushed to the right side. This can either be done with a retractor held by an assistant or the surgeon takes the sigma in one hand and pulls it in the respective direction.

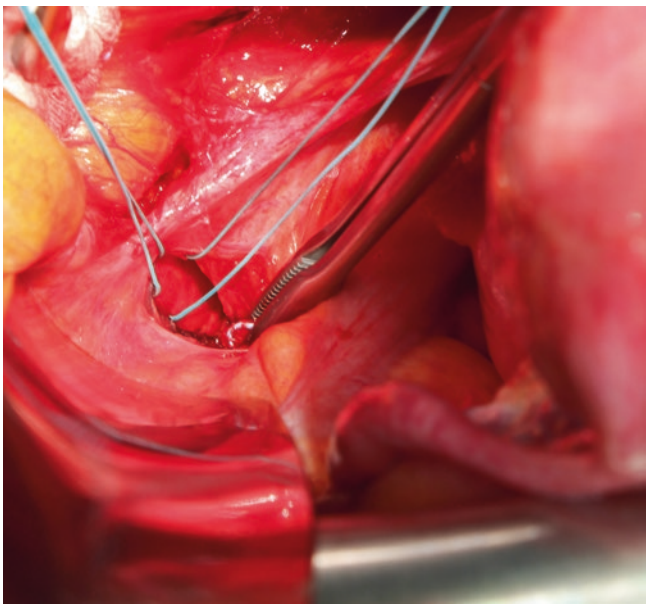


Fig. 93.25 Uterosacropexy: The second suture is placed below (Note: The sutures are not tied at this phase of the operation)

The surgeon then palpates the retroperitoneal sutures on the other (right) side. The palpatation will help to find the respective identical fixation site on the left side. With the other hand the incision is placed as on the other side.

After the posterior fixation sites have been prepared – two sutures on the left and two sutures on the right side of the sigma colon – the sutures are armed with clamps and pulled aside (Figs. 93.23, 93.24 and 93.25).

Advice At the end of surgery you must define the higher and the lower suture and the medial and the lateral part of the suture. Therefore, put the upper sutures with a clamp in the direction of the patient's head. Put the clamp with the lower sutures on the outside, on the left or the right of the patient. The stitches for the sutures run from lateral to medial on the right side and from medial to lateral on the left side. Leave the suture end of the lateral stitch long and on the medial side short ("lateral is long").

Placement of the New USL

For the next step, care must be taken to avoid injury to the peritoneal fold of the USL.

The structure can be either a CESA or a VASA tape according to the size of the uterus (Fig. 93.26).

Four sutures are placed in the prepared fixation site at the back of the cervix/corpus area (Figs. 93.27, 93.28, 93.29, 93.30, 93.31, 93.32 and 93.33).

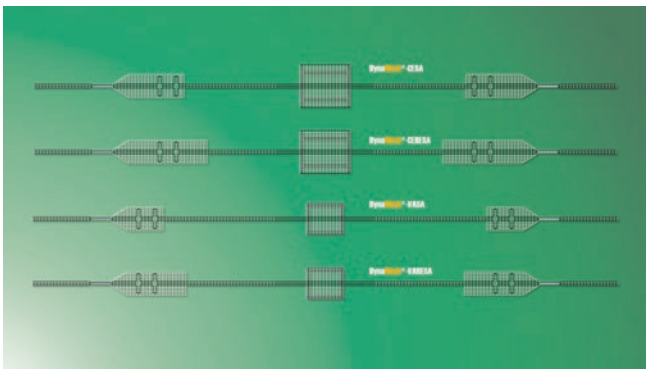


Fig. 93.26 Uterosacropexy: The augmentation of the uterosacral ligaments is performed using a narrow but open-pore sling structure of 4 mm width, made of high strength PVDF-filaments (Dynamesh CESA, Dynamesh CERESA, Dynamesh VASA and Dynamesh VARESA, FEG Textiltechnik mbH, Aachen, Germany). Theoretically each of the four structures could be used. For smaller cervices we use the VASA or VARESA structures. For younger women a larger structure of the CESA or CERESA type can be indicated

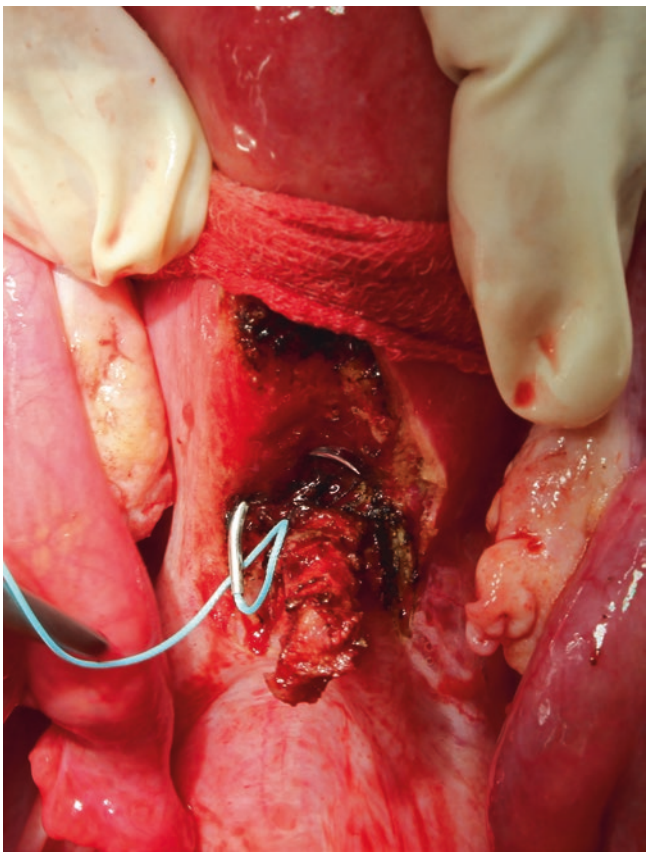


Fig. 93.27 Uterosacropexy: The first suture is placed in the lower left quadrant of the uterus/cervix region

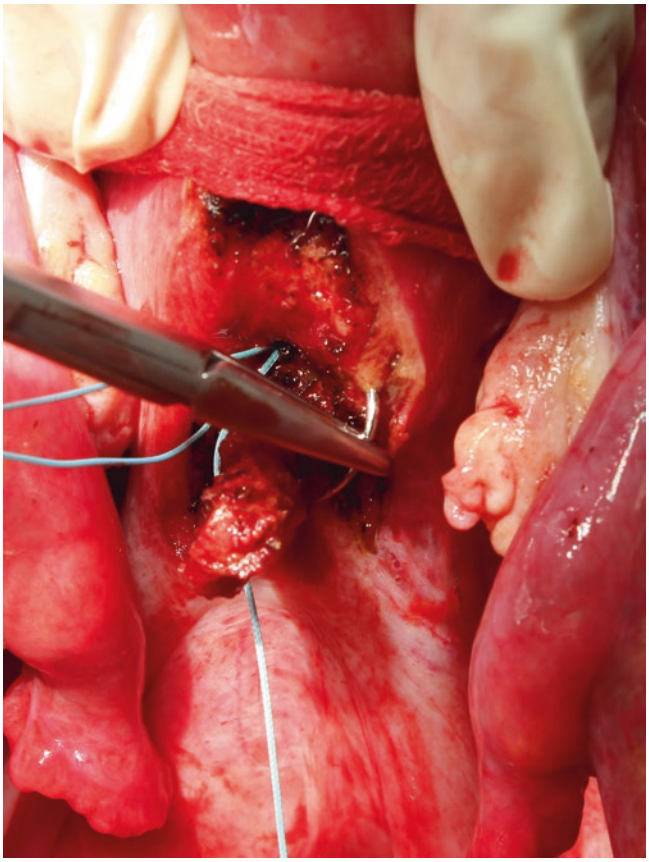


Fig. 93.28 Uterosacropexy: The second suture is placed on the *lower* right quadrant

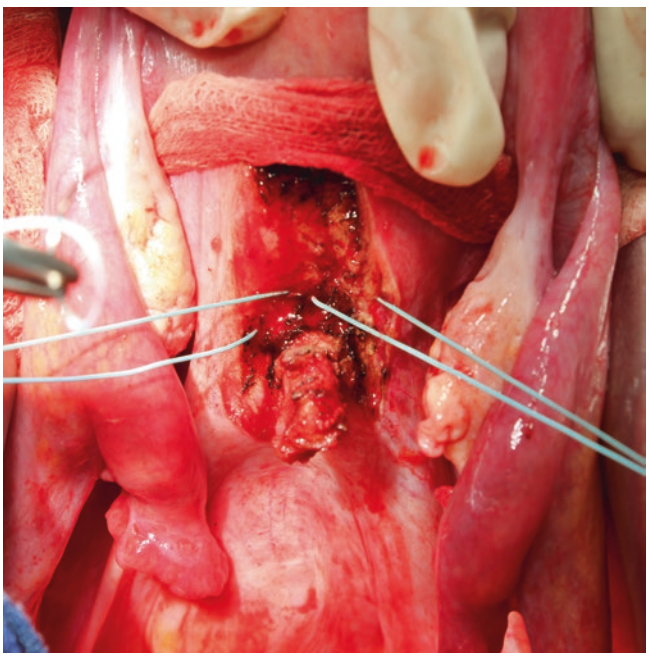


Fig. 93.29 Uterosacropexy: The two sutures of the lower quadrants are placed

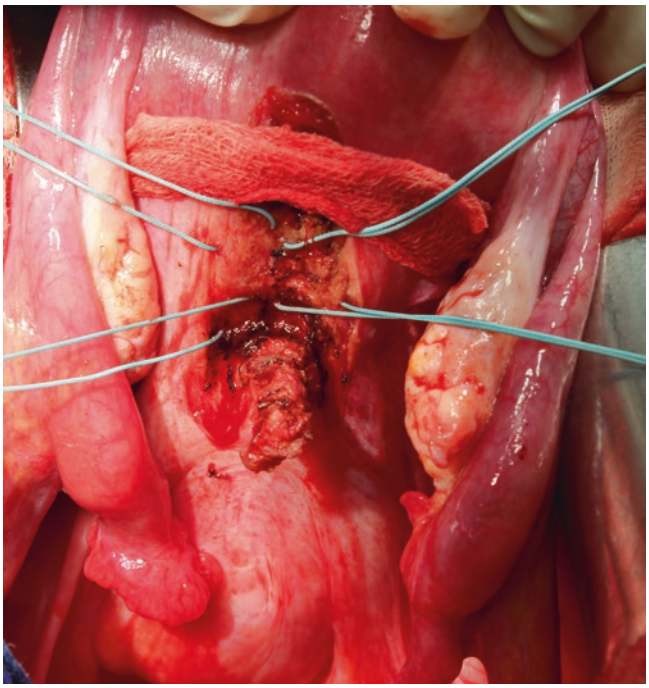


Fig. 93.30 Uterosacropexy: All four sutures are placed

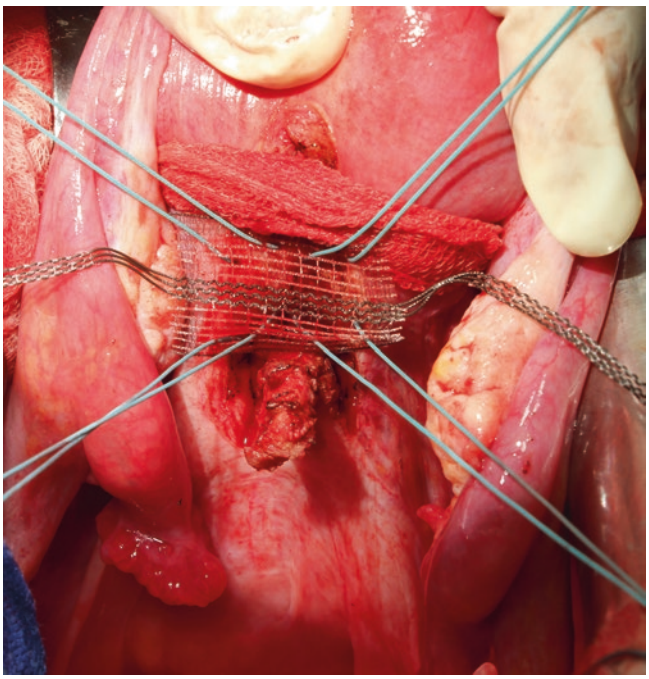


Fig. 93.32 Uterosacropexy: The USL of the structure are demonstrated

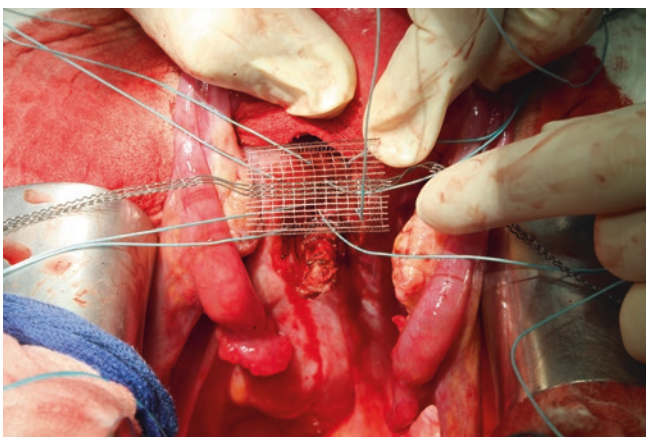


Fig. 93.31 Uterosacropexy: The sutures are pulled through the structure (Dynamesh VASA)

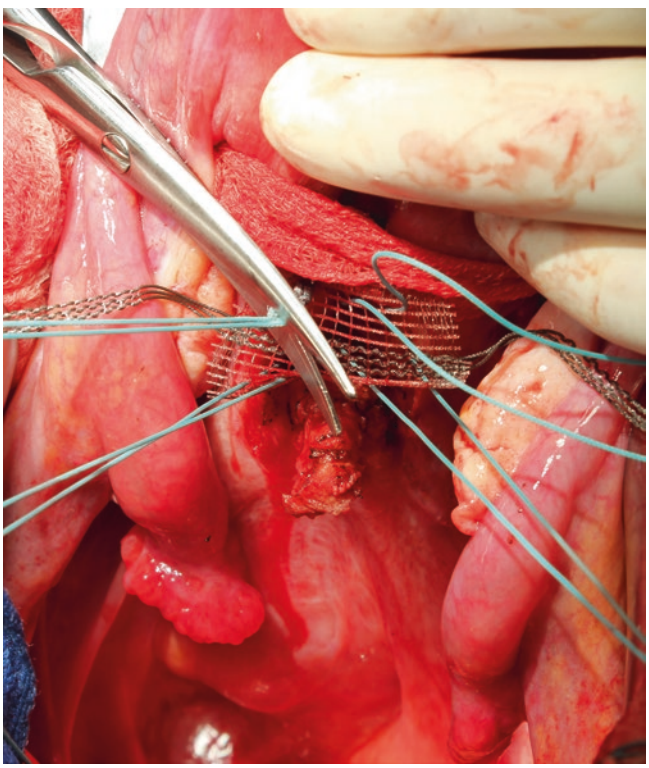


Fig. 93.33 Uterosacropexy: The sutures are cut

The bridge is sutured at the backside of the cervix (Fig. 93.34).

A small trocar, as usually used for a TVT placement, is pulled through the peritoneal fold of the USL from the back to the base at the cervix (Figs. 93.35 and 93.36).

Care must be taken not to injure the uterine vein or artery which was cut during the previous supracervical hysterectomy. If bleeding occurs at this moment, the respective vessels should be identified and coagulated precisely. They can easily follow the original paths of the USL on both sides.

The insertion aid of the tape is pulled through the hole at the top of the trocar (Fig. 93.37). The trocar is then pulled backwards towards the sacrum. This pulling action should be performed very carefully (Fig. 93.38).

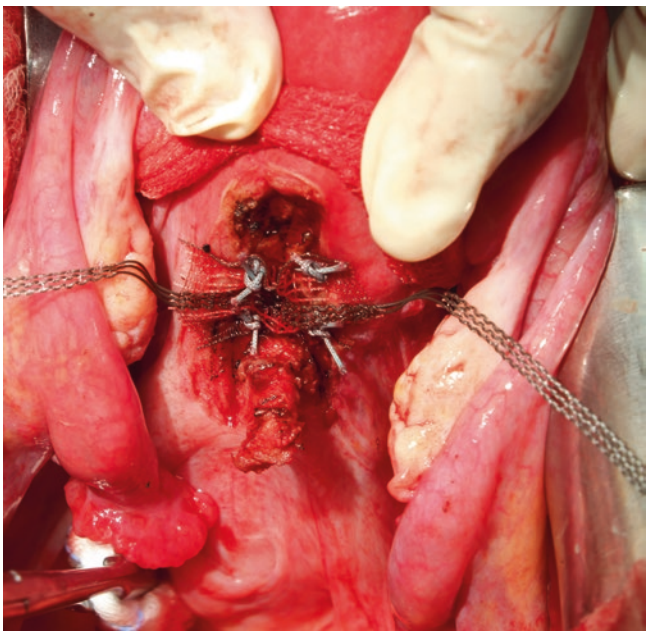


Fig. 93.34 Uterosacropexy: The "bridge" is fixed at the cervix/corpus of the uterus

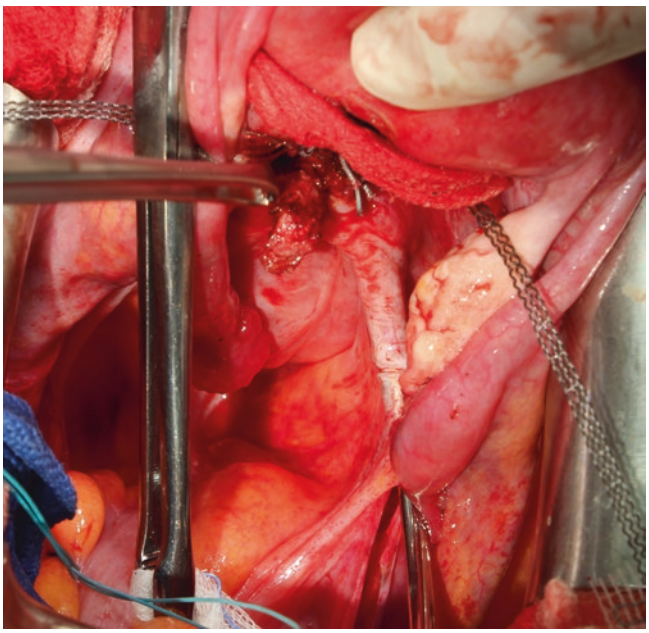


Fig. 93.36 Uterosacropexy: The trocar is pulled forward towards the origin of the USL

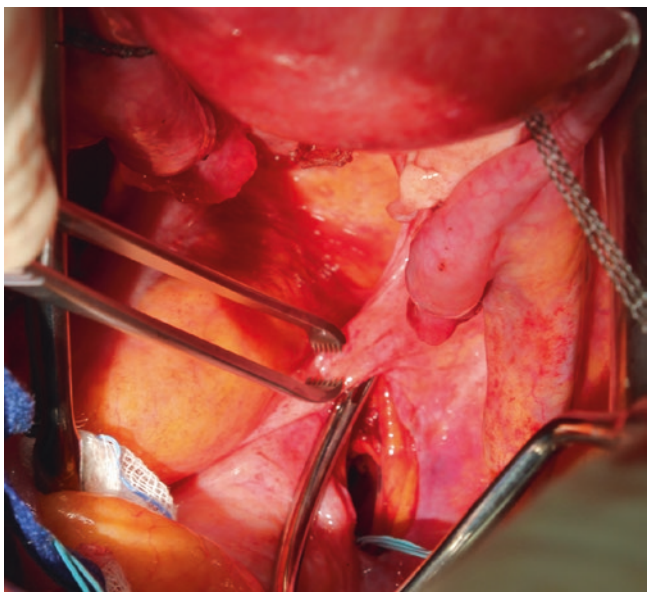


Fig. 93.35 Uterosacropexy: The trocar is inserted in the right peritoneal fold of the USL

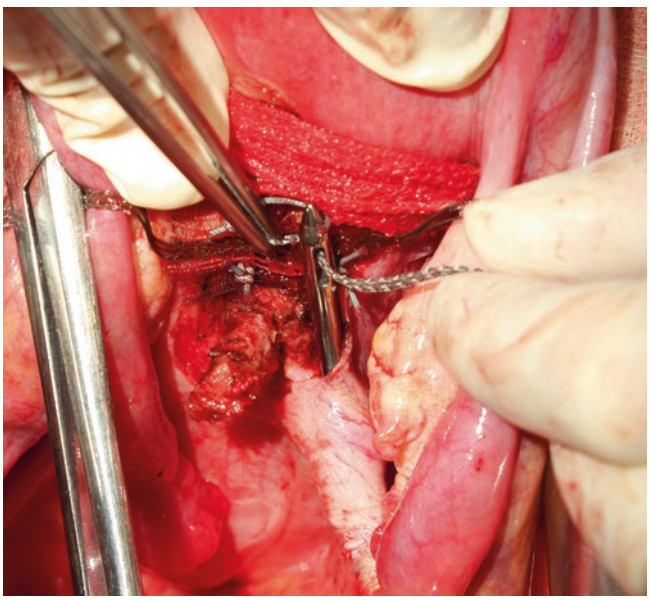


Fig. 93.37 Uterosacropexy: The top of the trocar is pushed through the origin of the USL. The insertion aid is placed through the hole of the trocar

Bleeding cannot definitively be avoided; however, it is important that the surgeon immediately detects the origin of the bleeding.

The USL structure and the fixation mesh are then pulled through the USL fold. This is performed easily – as through an empty channel. When the fixation mesh appears out of the "channel", it is placed where it is to be fixed (Fig. 93.39).

The previously-placed sutures are pulled through the marked fixation sites on the tape (Figs. 93.40, 93.41 and 93.42). The upper suture is placed on the lateral part of the fixation mesh, the lower suture on the medial part of the mesh. Once this has been done, the longer arms of the sutures are placed laterally and the shorter ones medially. The insertion aid is cut.

The new PVDF structure holds the cervix "with open arms" (not with "stretched out arms"). Both sutures are armed and placed again laterally or upwards until they are tied at the end of the operation (Figs. 93.43, 93.44, 93.45 and 93.46). The same steps are then repeated on the left side (Figs. 93.47 and 93.48).

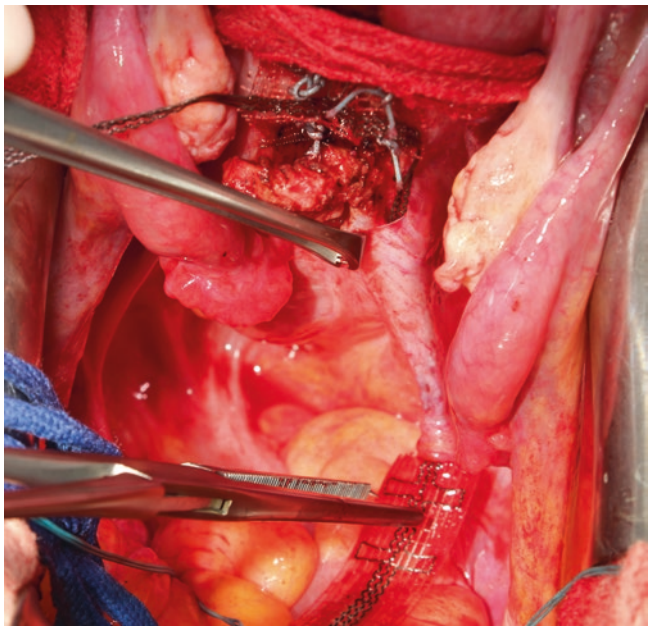


Fig. 93.38 Uterosacropexy: The structure is pulled through the channel of the USL

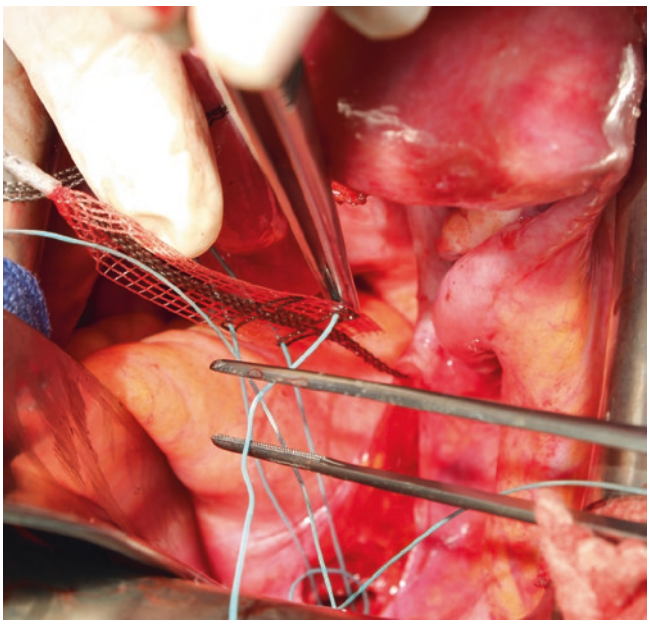


Fig. 93.40 Uterosacropexy: The preplaced sutures are pulled through the suture marks

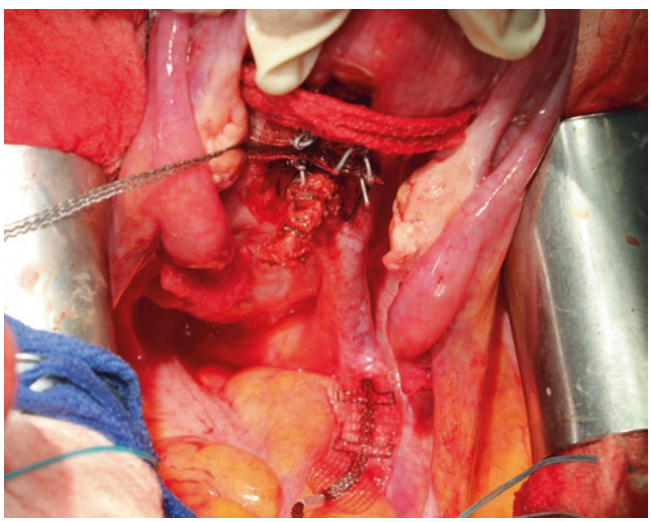


Fig. 93.39 Uterosacropexy: The structure is placed as it should be

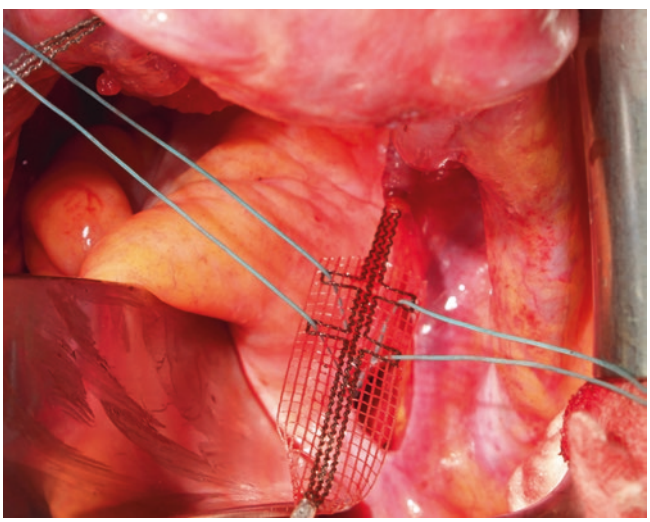


Fig. 93.41 Uterosacropexy: All two sutures are pulled through the mesh structure

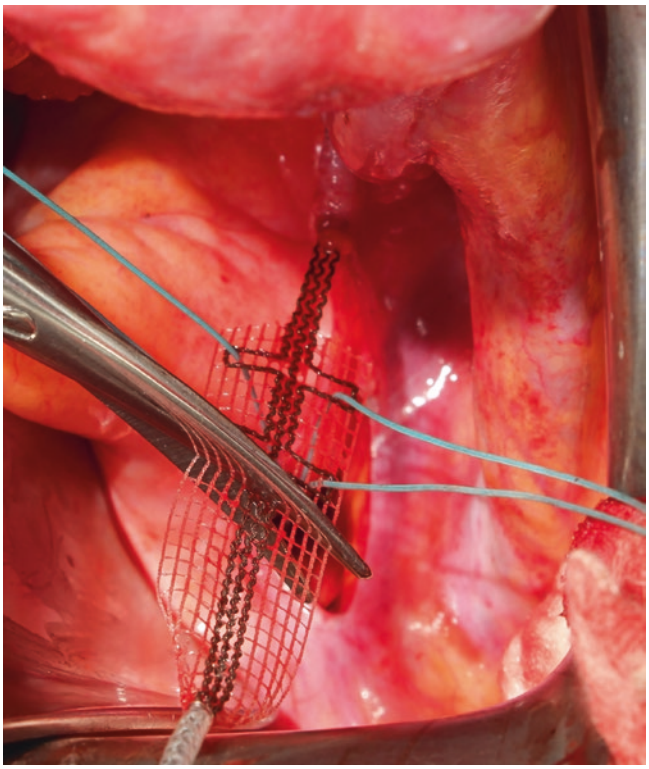


Fig. 93.42 Uterosacropexy: The insertion aid is cut (Note: The sutures can be tied at this part of the surgery or at the end of the surgery)

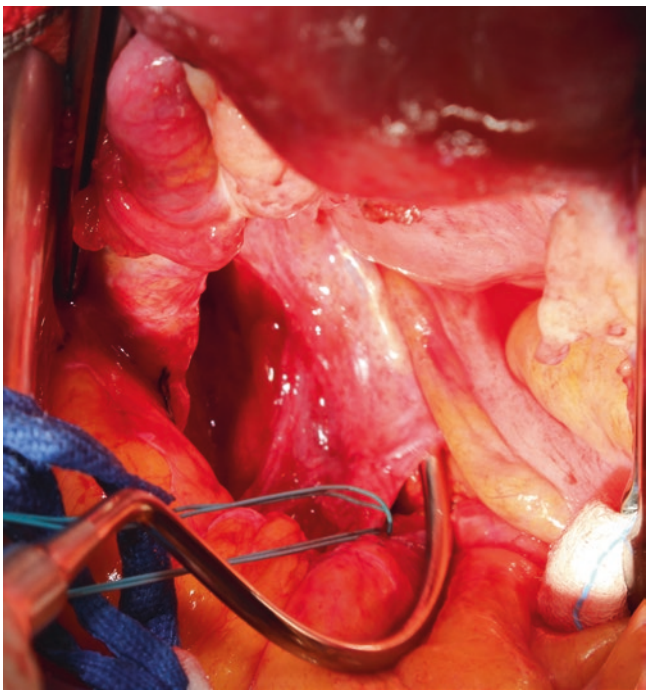


Fig. 93.43 Uterosacropexy: The same procedure is performed on the left side. Insertion of the trocar

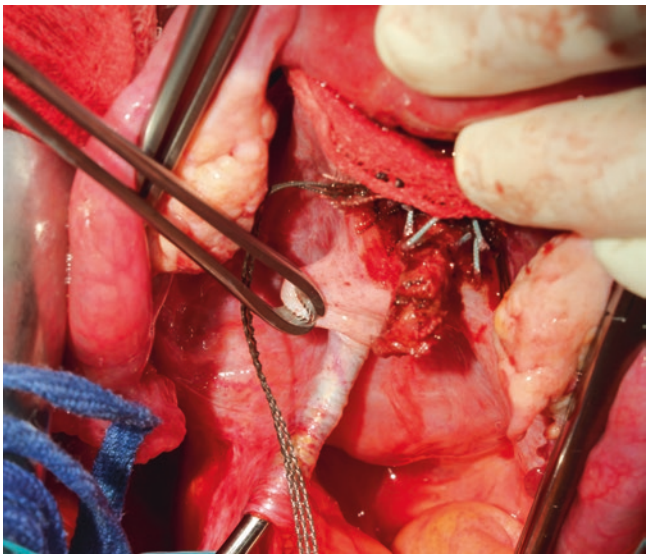


Fig. 93.44 Uterosacropexy: The trocar is pushed forward towards the origin of the left USL

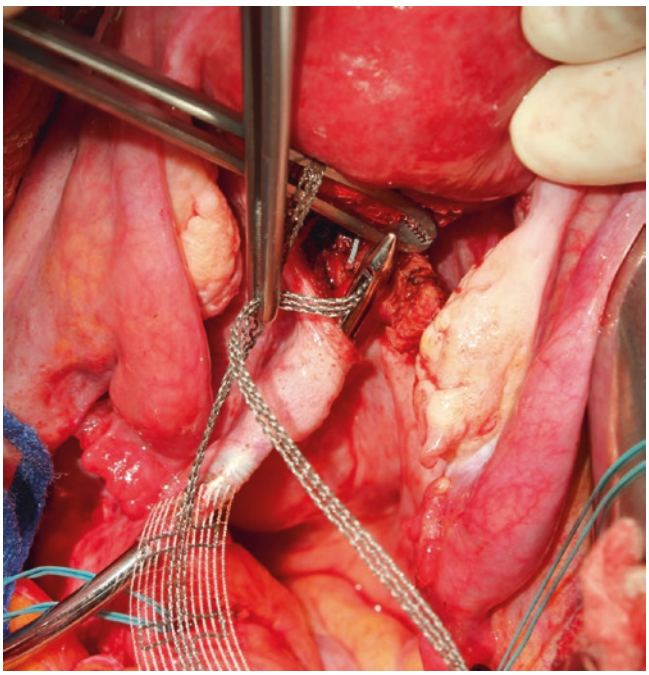


Fig. 93.45 Uterosacropexy: The insertion aid is pulled through the hole of the trocar

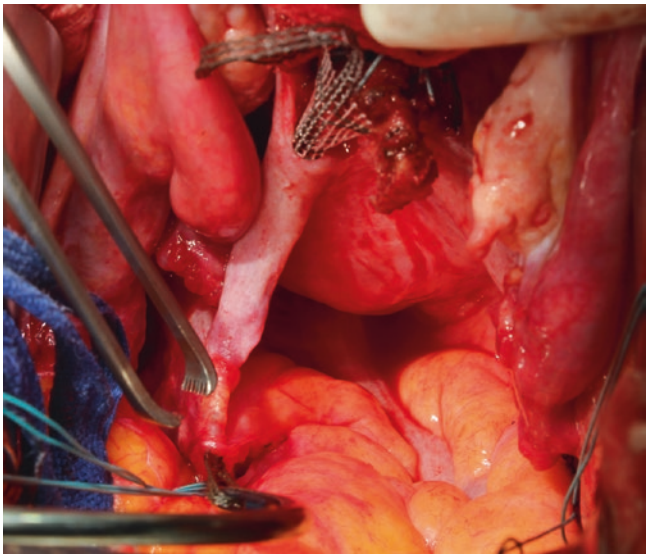


Fig. 93.46 Uterosacropexy: The trocar with the insertion aid is pulled through the channel of the USL

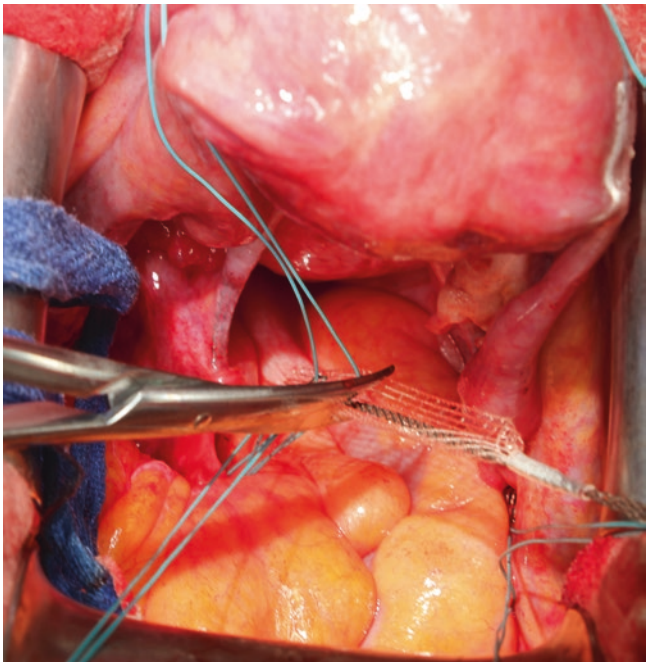


Fig. 93.48 Uterosacropexy: The insertion help is cut

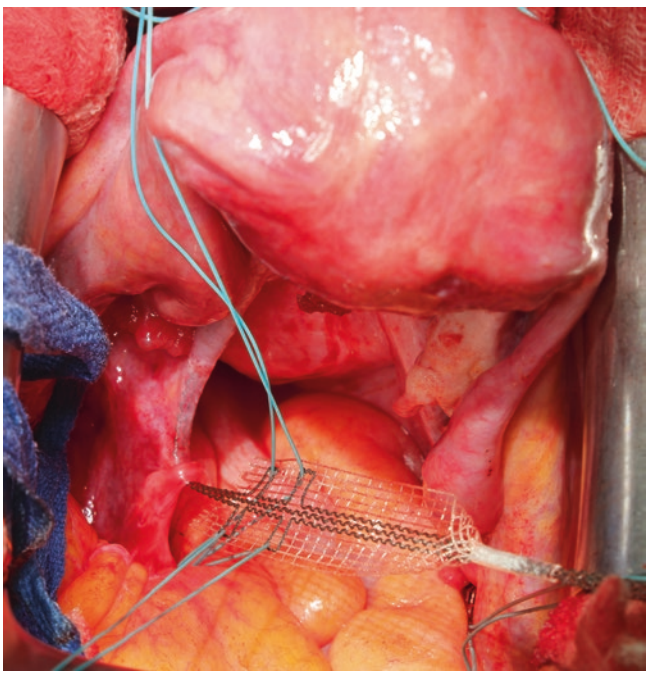


Fig. 93.47 Uterosacropexy: The sutures are placed through the marked sites on the tape

The sutures should not be tied at this moment! (This would lead to a smaller space for closing the uterine flap at the end of surgery.)

Closing the Backside of the Uterus

The next step is the closure of the uterus flap!

The flap usually shrinks considerably within a few seconds.

The closure or replacement of the flap should be started with a single suture in the middle of the flap to define the center and the top of the flap (Fig. 93.49).

Thereafter, a continuous suture (PDS 4-0) with a small needle adapts the flap again to the uterus. If any part of the mesh tape is still visible, it should be resected to avoid adhesion formation in that area afterwards (Figs. 93.50, 93.51, 93.52, 93.53 and 93.54).

After finishing that step, the uterus can be placed back into the peritoneal cavity. Therefore, remove the loops which hold the uterus. The holes in the parametrium do not need to be sutured.

The sutures of the posterior fixation site in front of the os sacrum are then tied (Fig. 93.55).

As the last step, the peritoneum on the posterior fixation side is closed to prevent adhesions (Fig. 93.56).

After removal of the towels, a 150 ml saline solution is added to prevent the drying out of the sigma epithelium and possible adhesion formation (Figs. 93.57, 93.58 and 93.59).

After closure of the abdomen, the vaginal examination demonstrates that a repair of the anterior vaginal wall is unnecessary (Fig. 93.60).

The final prolapse is documented (Fig. 93.61).

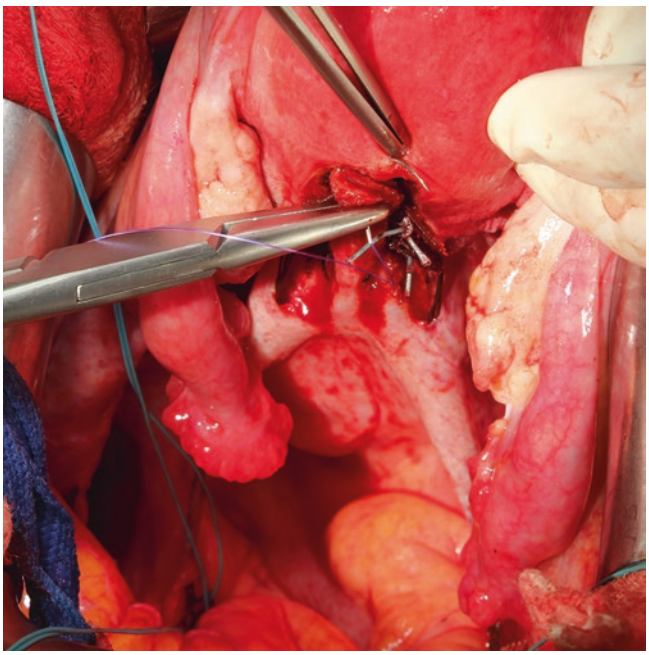


Fig. 93.49 Uterosacropexy: The flap at the end of the uterus is sutured to the uterus/cervix (Note: The flap will shrink considerably within a few seconds)

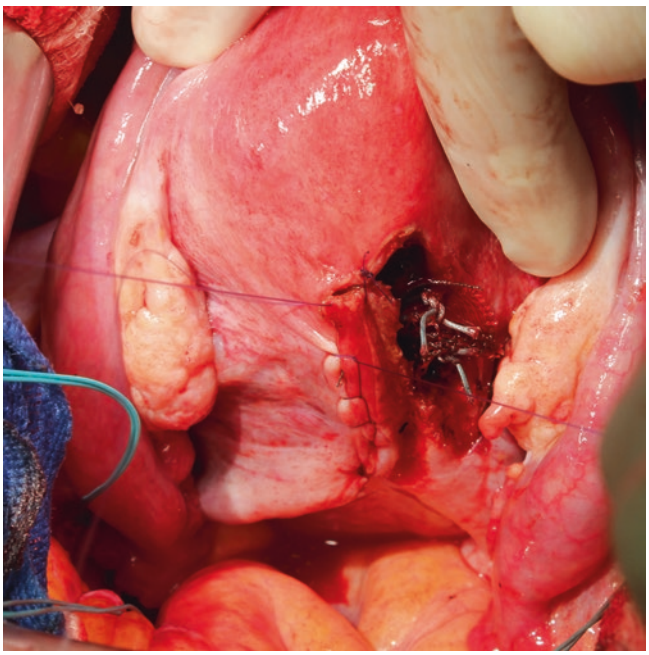


Fig. 93.51 Uterosacropexy: The left side of the flap is closed with a trapped running suture (Note: The "bridge" is not resected!)

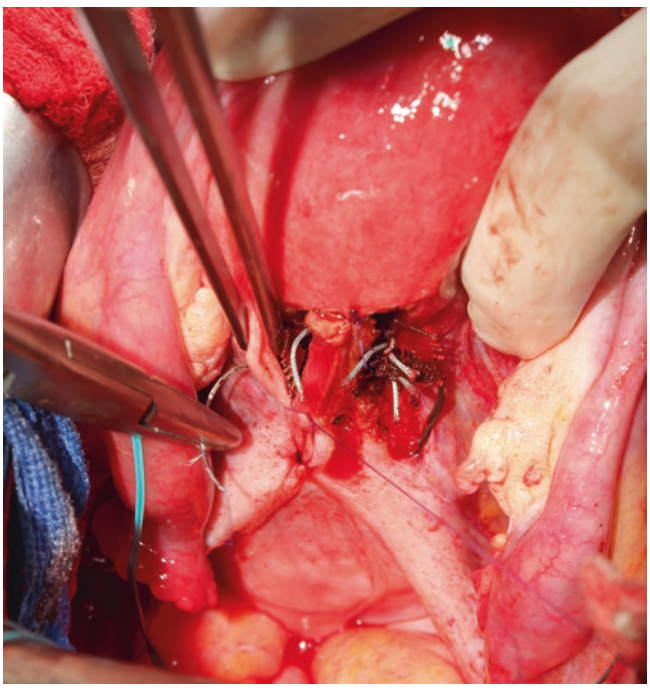


Fig. 93.50 Uterosacropexy: The closure of the implantation site starts on the left side using a 4-0 PDS suture

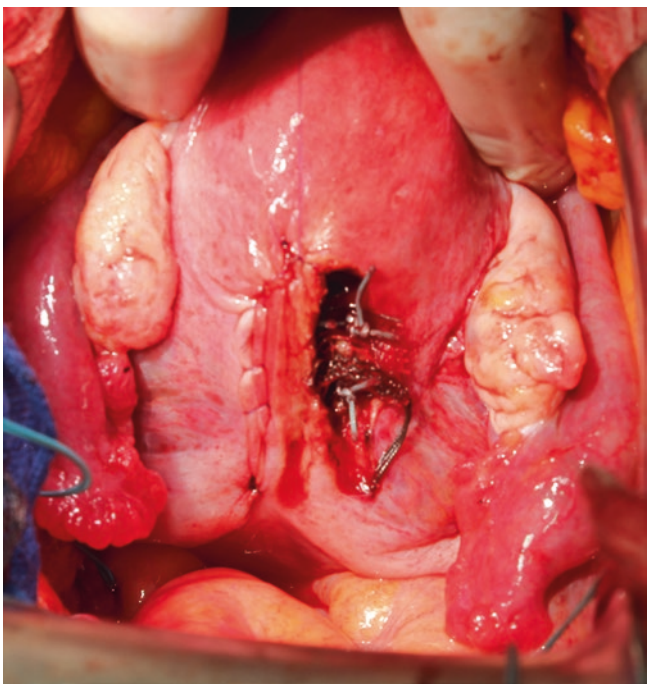


Fig. 93.52 Uterosacropexy: The left side of the flap is closed. The right side is still open

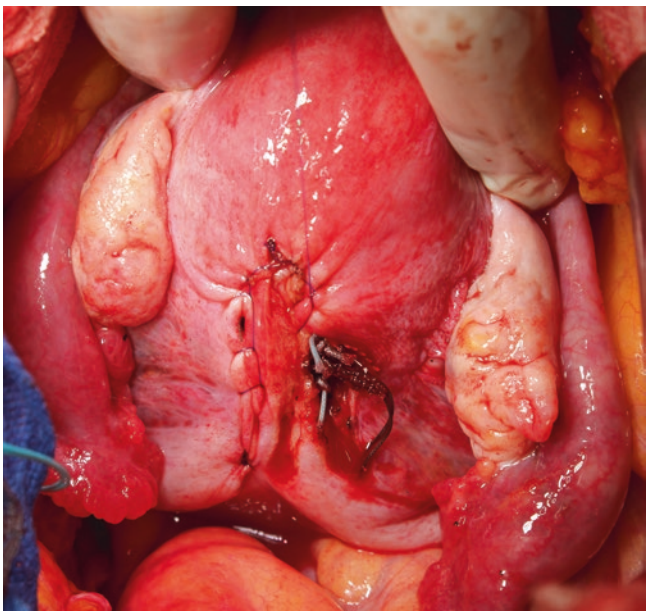


Fig. 93.53 Uterosacropexy: The right side continues to be closed

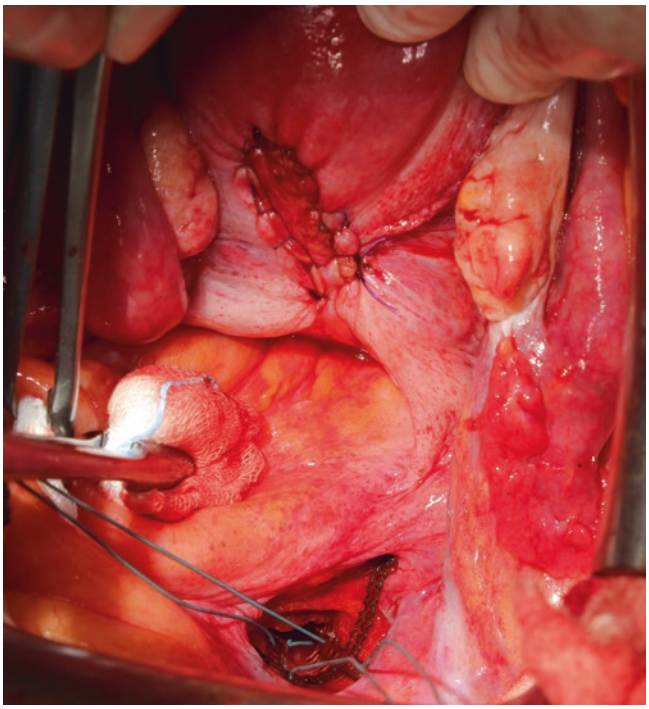


Fig. 93.55 Uterosacropexy: The posterior sutures at S1 are tied



Fig. 93.54 Uterosacropexy: The flap is closed

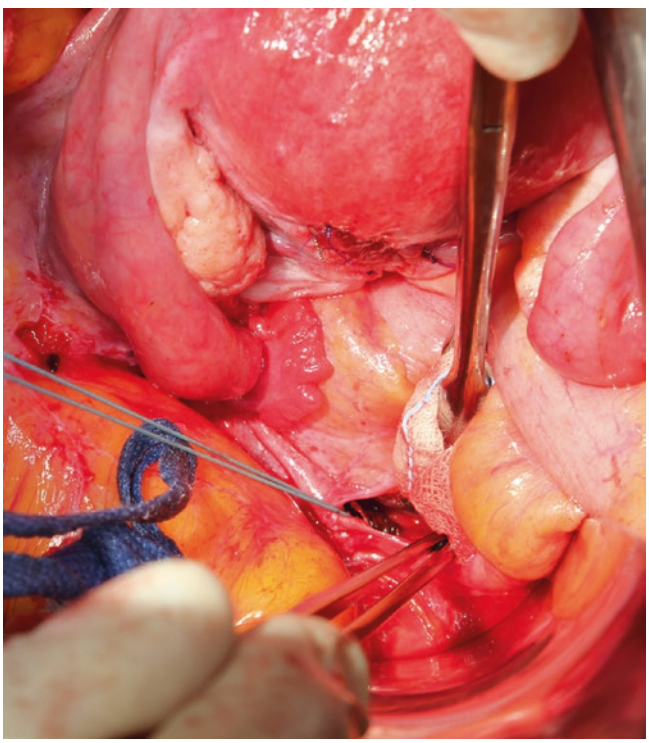


Fig. 93.56 Uterosacropexy: The sutures are cut and the peritoneum is closed

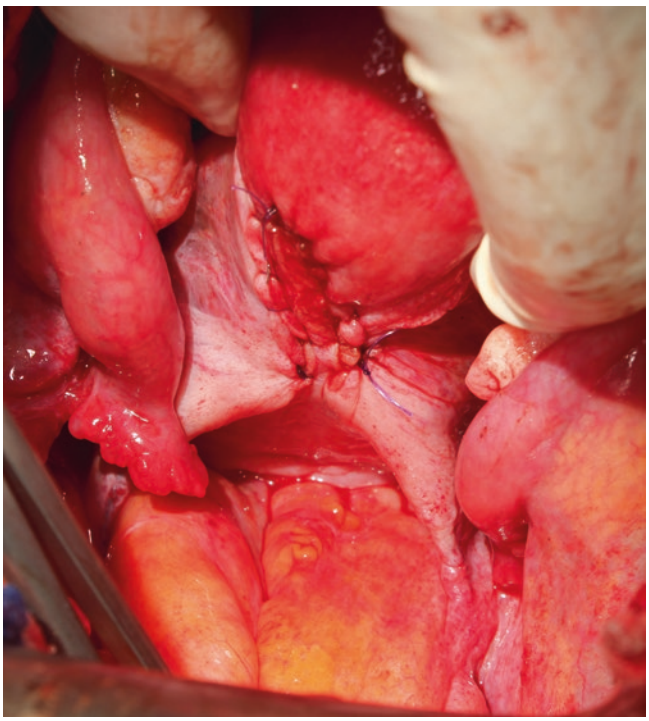


Fig. 93.57 Uterosacropexy: The final view with the bowel still held aside with towels

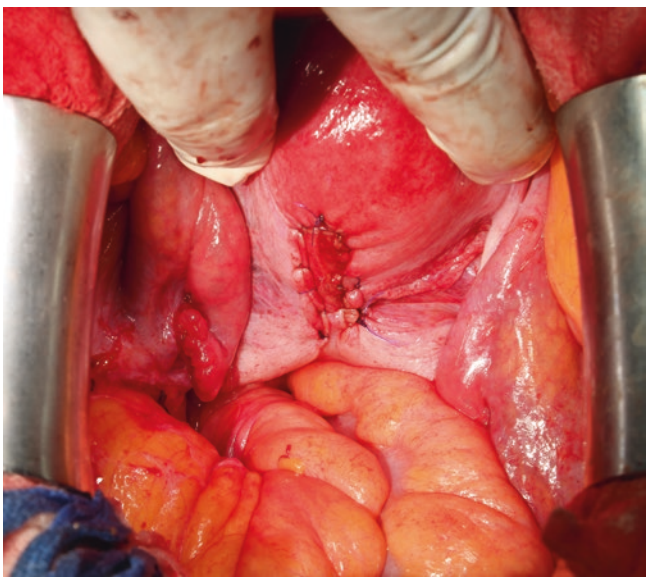


Fig. 93.58 Uterosacropexy: The towels are removed and the bowel falls into the pouch of Douglas

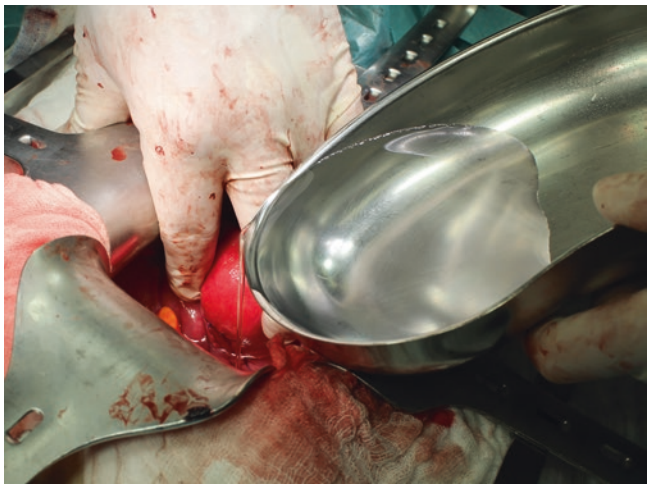


Fig. 93.59 Uterosacropexy: The surface of the bowel has dried, therefore, saline solution is added to prevent adhesion formation

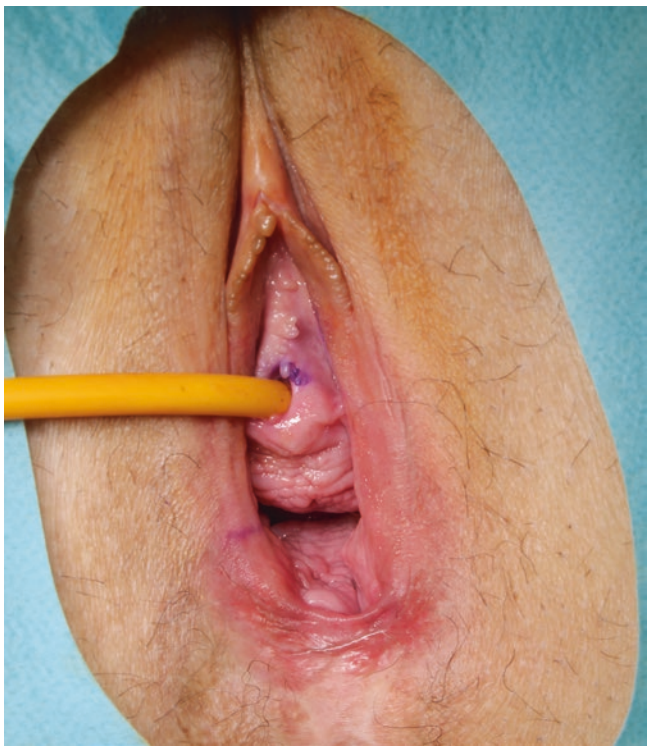


Fig. 93.60 Uterosacropexy: The final view

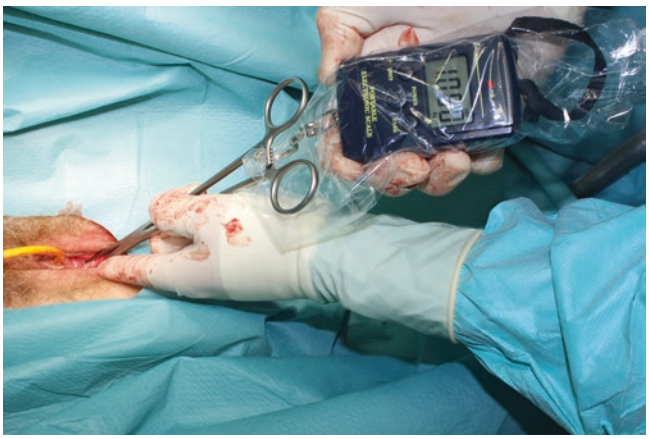


Fig. 93.61 Uterosacropexy: The clamp is fixed at the cervix and a tension of 10 N is exerted. The distance to the hymenal ring is documented

References

1. Bump RC. The POP-Q system: two decades of progress and debate. Int Urogynecol J. 2014;25:441–3.
2. DeLancey JO. Correlative study of paraurethral anatomy. Obstet Gynecol. 1986;68:91–7.
3. Petros PE, Ulmsten UI. An integral theory and its method for the diagnosis and management of female urinary incontinence. Scand J Urol Nephrol Suppl. 1993;153:1–93.
4. DeLancey JO. Anatomy and biomechanics of genital prolapse. Clin Obstet Gynecol. 1993;36:897–909.
5. Brubaker L. Postpartum urinary incontinence. BMJ. 2002;324:1227–8.
6. Rortveit G, Daltveit AK, Hannestad YS, Hunskaar S, Norwegian ES. Urinary incontinence after vaginal delivery or cesarean section. N Engl J Med. 2003;348:900–7.
7. Buchsbaum GM. Urinary incontinence and pelvic organ prolapse. Minerva Urol Nefrol. 2006;58:311–9.
8. van Brummen HJ, van de Pol G, Aalders CI, Heintz AP, van der Vaart CH. Sacrospinous hysteropexy compared to vaginal hysterectomy as primary surgical treatment for a descensus uteri: effects on urinary symptoms. Int Urogynecol J Pelvic Floor Dysfunct. 2003;14:350–5. ; discussion 355
9. Kim DK, Chancellor MB. Is estrogen for urinary incontinence good or bad? Rev Urol. 2006;8:91–2.
10. Siddique SA, Gutman RE, Schon Ybarra MA, Rojas F, Handa VL. Relationship of the uterosacral ligament to the sacral plexus and to the pudendal nerve. Int Urogynecol J Pelvic Floor Dysfunct. 2006;17:642–5.

Total Abdominal Hysterectomy with Electrosurgical Bipolar Vessel Sealing

94

Ilgın Türkçüoğlu and Rauf Melekoğlu

Introduction

Hysterectomy is the most commonly performed major gynecological surgery in gynecology practice [1]. It is the most common non–pregnancy-related gynecologic surgical procedure carried out in the United States [2]. It has been estimated that one in three women will have a hysterectomy by the age of 60 [3, 4]. A large proportion of hysterectomies are performed abdominally or laparoscopically, and fewer than 30 % are performed vaginally in most series [1]. Laparoscopic hysterectomy has several advantages to abdominal hysterectomy, with less intraoperative blood loss; less wound infection, slighter postoperative pain, an economically shorter hospital stay and rapid return to normal activities (Table 94.1). Further, there are very few contraindications to laparoscopy like cases with a cardiopulmonary disease that may not tolerate pneumoperitoneum and/or Trendelenburg positioning. Therefore laparoscopic hysterectomy may replace abdominal hysterectomy in cases where vaginal hysterectomy is not accessible [5–8]. Nevertheless, laparoscopic hysterectomy needs surgical skills, and everyone may not be able to perform a laparoscopy. Also, it is associated with longer operating time and a greater risk of trauma to the bladder or ureters compared to abdominal hysterectomy [9]. Although recent data have shown an increase in rates of minimally invasive hysterectomy, the majority of hysterectomies continue to be performed through abdominal routes [10, 11]. Another important issue is the extensive use of laparoscopy by some clinics. Therefore the new generation obstetrics and gynecology residents may graduate without learning how to perform a hysterectomy through abdominal route well. The current chapter focuses on the surgical procedure of hysterectomy through abdominal route, as well as the use of electrosurgical bipolar vessel sealing systems. The route of the hysterectomy can be chosen by the surgeon according to the need of patient and/or the skills of the surgeon. The indication of the abdominal hysterectomy is mentioned in Table 94.2.

Hemorrhage is the most frequent complication during abdominal gynecologic surgery. To reduce hemorrhage-related morbidity, adequate hemostatic techniques are essential during surgical procedures. In open procedures, conventional mechanical hemostatic techniques that use sutures or clips are the most frequently used methods to control bleeding. After the introduction of laparoscopy, lasers and different electro-thermal and ultrasonic coagulation modalities gained importance [12]. Each modality has its strengths and weaknesses. All of the mechanical methods introduce foreign bodies into the patient and, perhaps with the exception of sutures, carry an increased cost. Clips are easily placed but require accurate vessel dissection and have a considerable risk of dislodgement during tissue manipulation. In laparoscopic surgery, mechanical hemostatic techniques are almost completely replaced by coagulation techniques that use mono- or bipolar coagulation (electrical energy converted to thermal energy) and ultrasonic devices (mechanical energy converted to thermal energy). Lasers carry such a high associated capital investment that they are rarely used in general gynecologic surgery [13]. Different coagulation techniques have some advantages over others (Table 94.3).

Ultrasonic technology controls bleeding through the use of ultrasonic vibration. The vibrating blade induces a rapid rise in temperature resulting in the denaturation of proteins to form a coagulum that seals the vessel [14]. This technique produces minimal amounts of smoke, and the depth of penetration of the energy lateral to the intended focus is also minimal [15]. Although the ultrasonic technology has the ability to achieve hemostasis with limited

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Table 94.1 Comparisons among different approaches to hysterectomy

Advantages of vaginal hysterectomy over abdominal hysterectomy
Shorter duration of hospital stay
Faster return to normal activity
Decreased postoperative febrile morbidity
Advantages of vaginal hysterectomy over laparoscopic hysterectomy
Shorter operating time
Advantages of laparoscopic hysterectomy over abdominal hysterectomy
Faster postoperative recovery
Shorter duration of hospital stay
Lower intraoperative blood loss and smaller drop in hemoglobin level
Decreased postoperative febrile morbidity
Fewer wound and abdominal wall infections
Faster return to normal activity
Advantages of abdominal hysterectomy over laparoscopic hysterectomy
Shorter operating time

Data from Johnson et al. [32]

Table 94.2 Abdominal hysterectomy indications

Abnormal uterine bleeding
Uterine leiomyoma
Pelvic pain or Infection (e.g., endometriosis, adenomyosis, pelvic inflammatory diseases)
Pelvic organ prolapse
Premalignant and malignant diseases

Table 94.3 Different hemostatic techniques in gynecological surgery

Techniques	Mechanism	Advantages	Disadvantages	Expected thermal spread
Monopolar electrocoagulation	Electrical current created in the electrosurgical unit passes through a single electrode to the tissue, causing the desired tissue effect	Due to higher voltage the coagulation mode achieves better penetration through high resistance areas, such as fatty tissue or scar tissue More applicable when fulgurating a large surface area with superficial bleeders, such as might be encountered following ovarian cystectomy	The greatest degree of thermal spread in tissues	2.3 mm – >20 mm (it's dependent upon application time and setting)
Bipolar electrocoagulation	Electrical current created in the electrosurgical unit is confined to the tissue between the two electrodes of the surgical instruments	A separate return electrode (i.e., dispersion pad) to return current is not needed. Ideal when dealing with vascular areas or 3–7 mm blood vessels such as the uterine artery	Less effective for cutting tissue since adequate vaporization is difficult to achieve	2–22 mm

Table 94.3 (continued)

Techniques	Mechanism	Advantages	Disadvantages	Expected thermal spread
Ultrasonic cutting and coagulation device	Convert ultrasonic energy into mechanical energy at the functional end of the instrument. A piezoelectric crystal in the hand piece generates vibration at the tip of active blade at 55,500 times per second over a variable excursion of 50–100 μm. This results in rupture of hydrogen bonds and produces heat, which leads to denaturation of proteins and eventually, separation of tissue	Minimal thermal spread Decreased tissue charring and smoke formation No risk of electrical injury due to absence of electrical current within the patient Versatile instrument allowing the surgeon to dissect, cut and coagulate using one instrument	Potential for extensive thermal spread at high energy levels for more than 5 s The limited ability to coagulate vessels larger than 3–5 mm Increased cost of disposable instruments User dependent nature of the instrument	0–3 mm. (It's dependent upon application time and setting)
LASER (Light Amplification and Stimulated Emission of Radiation)	Laser energy is generated when electrons jump from higher to lower energy levels during their circuits around the nucleus. The energy created induces molecular vibration and thermal energy upon contact with the target tissue	Can be used to cut, coagulate, ablate or image tissue	The safe and appropriate use of lasers requires a trained clinician with a working knowledge of laser delivery systems. Long periods of continuous exposure of the laser beam or insufficient cooling time can lead to excessive tissue heating	Changes upon the type of medium, modes of operation and application time
EBVS devices	Applies a precise amount of bipolar energy and pressure to fuse collagen and elastin within the vessel walls. This results in a permanent seal that can withstand three times the normal systolic pressure	Seals vessels up to 7 mm Minimal thermal spread The generator for this device uses a feedback controlled response system to ensure adequate tissue sealing	More cost since these devices are disposable	1.1 mm for the EnSeal® tissue sealing and hemostasis system 1.8 mm with the 10 mm LigaSure® device 4.4 mm with the 5 mm LigaSure® device 6.3 mm with the Gyrus Plasma Trissector®

collateral thermal damage, it is only labeled for vessels up to 3–5 mm in diameter, thereby restricting its application in many procedures [13].

Monopolar high-frequency electrical energy is the oldest method used to coagulate vessels; however, it induces local heating and tissue damage. Due to potential capacitive coupling and spark generation, its use is associated with the risk of electrical injury to the bowel and other organs [16]. Conventional bipolar electrosurgical technology is safer than monopolar energy as the current flows between the two electrodes of the instrument and so reduces collateral damage. Bipolar coagulation enables the surgeon to operate at lower currents thereby decreasing the effect on other organs [15].

Vessel sealing systems use bipolar electrocoagulation as the technology. (Insert Fig. 94.1) Most vessel- sealing devices use a tissue-based feedback program to regulate the dosage of applied energy. Due to this feedback system, less energy is required, and, based on in vitro studies, it is reported that these devices have reduced local tissue damage in comparison to conventional bipolar devices. Potentially, they, therefore, represent a decreased risk of injury to adjacent structures. Further, vessel-sealing devices are indeed more effective than other electrothermal or ultrasonic devices regarding reduced coagulation time, fewer complications, and lower total costs during laparoscopic and open surgical procedures.



Fig. 94.1 Handset of various electrosurgical bipolar vessel sealing systems

Electrosurgical Bipolar Vessel Sealing Systems

Vessel-sealing technology is a variant of bipolar electrosurgical technology. It is a combination of a precise amount of bipolar electrocoagulation (high current, low voltage) and pressure on the tissue that leads to the denaturation of the collagen and elastin in the vessel walls and a fusion of these into a hemostatic seal [17]. The electrothermal bipolar vessel sealing (EBVS) system was shown in several animal studies to achieve hemostasis in small, medium, and large arteries. EBVS system is increasingly being used in a variety of surgical procedures [18]. High-frequency electrosurgery has traditionally been the workhorse in the operating room, and the recent development of electrosurgical bipolar vessel sealing systems offers the abdominal surgeon a safe and effective alternative hemostatic method.

EBVS system provides some advantages, including ease of handling and fast hemostasis that does not require the use of foreign bodies that should remain in the surgical site. These advantages are not only useful in laparoscopy but also in open procedures, leading to an increase in the implementation of these techniques in open procedures as well.

The EBVS system consists of a specialized electrosurgical generator and handset and can effectively seal vessels and vascular bundles up to 7 mm in diameter. This new energy-based technology uses an alternate form of electrosurgery to denature collagen and elastin in vessel walls and subsequently reform these proteins into a hemostatic seal. The performance of this technology, reflected in the seal burst strength, depends on the application of mechanical energy or pressure in conjunction with the delivery of electrical energy. The simultaneous delivery of mechanical and electrical energy remodels the vessel tissue to form a desiccated absorbable collagen seal out of native vessel protein.

During activation, the specific electrosurgical generator measures both voltage and current to monitor tissue response. As tissue impedance changes because of resistive heating, voltage and current will vary accordingly. When tissue response indicates a successful seal, a cool cycle is entered, during which time the device position is maintained and no power is delivered. After the cooling period, the generator emits an audible tone to indicate cycle completion. On average, the entire sealing and cooling cycle take approximately 5 s (Fig. 94.2) [13].

In March 2006 the NHS—Purchasing and Supply Agency—Center for Evidence- based Purchasing published the "Report 06008: Electrosurgical vessel sealing systems" [19] describe five electrosurgical devices. More recently two other EBVS have been introduced to the market [20]. All the instruments clamp the vessel, or tissue bundle, and deliver a high-frequency electrical current to achieve heating within the tissue. The prongs should remain relatively cool, so the instrument does not tear the tissue when the clamp is released. The combination of temperature and pressure shrinks and denatures collagen and other cellular proteins in an irreversible process. The structure of collagen changes as its bonds become broken and it forms a gel-like substance that acts as a glue between vessel walls. To achieve this effect the tissue needs to be heated to between 70 and 95 °C, sufficient for collagen and elastin in the tissue to convert into gelatin. As the gelatin cools under compression, it becomes an effective seal, which can withstand considerable pressures. Tissue and vessels can appear flexible, transparent and plastic-like when fusion is complete [21].

Several industry supported animal studies have compared different EBVS systems (Table 94.4). The sealing time, burst pressure of the seal, seal width, and radial thermal damage has been found different with different EBVS systems, [22] however all of the EBVS systems have been used safely in different surgical procedures, providing adequate hemostasis with similar seal quality [20].

In the clinics, EBVS systems have safely been used in various surgical procedures providing adequate hemostasis. Besides, several other advantages of EBVS systems have also been shown. Systematic review and meta-analysis of the randomized controlled trials comparing EBVS systems with mechanical hemostatic method (clamping- suture ligation, clips) or other hemostatic devices (mono-polar, bipolar cautery) in various surgical procedures consisting most commonly of hemorrhoidectomy, hysterectomy and thyroidectomy found the operation time, blood loss, postoperative pain and complication rates less with EBVS systems [12, 18, 23]. For the gynecological operations, the use of EBVS systems

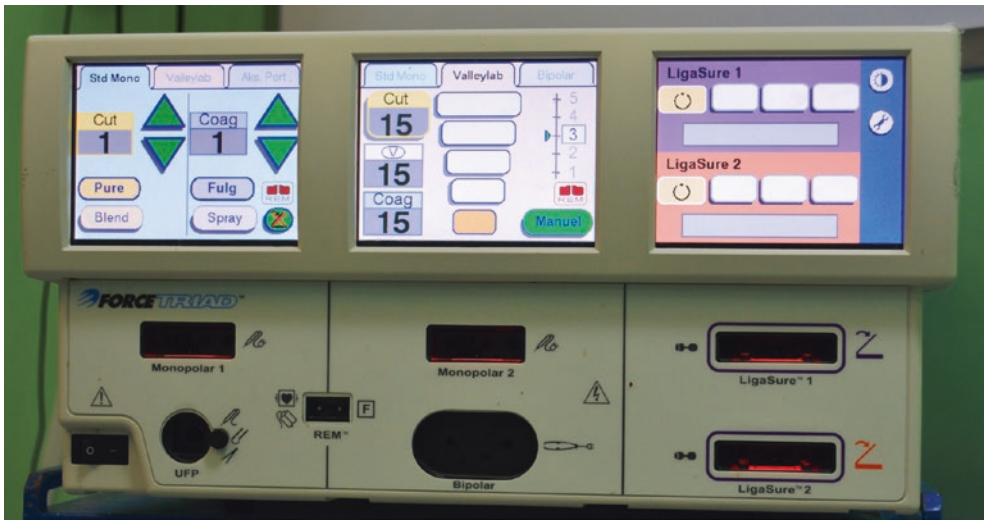


Fig. 94.2 Specialized electrosurgical generator measures both voltage and current to monitor tissue response

Table 94.4 Comparison of electrosurgical bipolar vessel sealing systems

Techniques	Mechanism	Advantages	Disadvantages	Expected thermal spread	Maximum lateral tissue temperature (measured by needle thermistor placed 2 mm from edge)
LigaSure® DEVICE	This system applies a precise amount of bipolar energy and pressure to fuse collagen and elastin within the vessel walls	Minimal sticking and charring A feedback-controlled response system to ensure adequate tissue sealing. Consistent seals with burst pressure above 150 mmHg for a majority (80 %) of repeated applications. Shortest vessel sealing and cutting time compared with other devices	Cost	1.8 mm with the 10 mm LigaSure® device 4.4 mm with the 5 mm LigaSure® device	55.5 °C
EnSeal® DEVICE	Provides vessel sealing by combining a compression mechanism with thermal energy. Controlled energy delivery utilizing NanoPolar thermostats to reach collagen denaturation temperatures in seconds, which are maintained at approximately 100 °C throughout the power delivery cycle	Seal strengths up to seven times the normal systolic pressures on vessels up to 7 mm A cutting mechanism to allow one-step sealing and transection of vessels and soft tissues Uniform pressure along the full length of the instrument jaw. Narrowest seal width and less denaturation of adventitial collagen in vessel	Cost Vessel sealing and cutting time is longer than other devices. Slightly greater amounts of particulates/smoke. Greater wall injury to proximal inner wall layers	1.1 mm	58.9 °C

(continued)

Table 94.4 (continued)

Techniques	Mechanism	Advantages	Disadvantages	Expected thermal spread	Maximum lateral tissue temperature (measured by needle thermistor placed 2 mm from edge)
Gyrus Plasma Trissector® DEVICE	Vapor-pulse mode delivers high energy to grasped tissue, creating vapor zones, ultimately resulting in uniform coagulation of tissue. PlasmaKinetic tissue-cutting mode allows simultaneous cutting and coagulation of tissue with bipolar energy	Pulsed bipolar energy, allows intermittent tissue cooling, which limits lateral thermal spread and tissue sticking. Instrument identification feature automatically detects the optimal settings for the specific instrument	Lower burst pressures when compared to other systems. Produce significantly higher amounts of particulates/smoke compared to other devices	6.3 mm	64.5 °C
BOWA Arc 350 DEVICE	Electrosurgical unit can be configured for use with a range of modular instruments: LIGATOR for laparoscopic sealing and TissueSeal for open surgery sealing	Has a good range of operating modes and a useful range of pre-programmed power settings, covering most of the commonly performed surgical procedures	All the instruments are reusable but the open instruments require single-use electrodes It is not intuitive to use, requiring frequent reference to the operator's manual	Not supplied	Not supplied
Martin Maxium DEVICE	Electrosurgical unit generator can use Seal- Safe technology and specialist instruments for vessel sealing: marLap for laparoscopic surgery and marClamp for open surgery	The generator is easy to operate with responsive operating buttons in a logical LCD screen design All are reusable	It offers 37 different pre-programmed output settings, which may be confusing for some users	Not supplied	Not supplied

decreased the operation duration, blood loss and postoperative pain with similar complication rates, in vaginal hysterectomy [11, 24, 25]. This beneficial effect was found more pronounced in difficult cases [26]. Also in cases undergoing a radical hysterectomy, the use of EBVS systems resulted in less blood loss during surgery and similar postoperative complication rates. However, the surgery time was similar to the conventional surgical technique [27]. Albeit the beneficial effect of EBVS systems in vaginal hysterectomy and radical hysterectomy, such an advantage in the operation time and blood loss could not be shown in the abdominal hysterectomy [28–30]. Only a randomized controlled trial showed the postoperative pain lower and recovery time shorter with EBVS system use [28]. Nevertheless, EBVS system use in the abdominal hysterectomy was as safe as the conventional surgical method with similar complication rates. Also, the tissue damage was similar in the EBVS system use the conventional surgical method [30].

Procedure

Before starting the abdominal hysterectomy procedure, all patients must be subjected to detailed history taking and physical examination including general examination, abdominal examination and pelvic examination. The pelvic examination must include assessment of the uterine size, mobility and descent, as well as the presence of adnexal mass. Performing a preoperative transvaginal ultrasonography to assess the volume, size of the uterus, gross uterine pathology and any adnexal pathology is necessary. The preoperative laboratory investigation must include hemoglobin

value and hematocrit percent, biochemical analysis of the liver and kidney functions, as well as the electrolyte levels, the thyroid function tests and the serologic tests for blood-borne viral infections.

Surgery is started with the performance of an incision on the anterior abdominal wall. A transverse supra-pubic incision (pfannenstiel type) or midline infra-umbilical incision is preferred according to the uterine size and mobility and the presence of a malignant and/or huge adnexal mass. Abdominal hysterectomy using electrosurgical vessel sealing systems starts by securing the round ligament. (Fig. 94.3) To use the EBVS device the electrodes on the hand-piece are placed across the hysterectomy pedicles (round, infundibulopelvic ligaments, uterine artery and utero- sacral-cardinal ligaments), so that the tissue is interposed between the jaws of the hand- piece in the center of the electrode. The handle is then closed until it latched into place in the tightest ratchet position. The coagulation hand pedal is pressed until a characteristic 2-tone sound from the machine confirmed complete coagulation of tissue. After the feedback-controlled response system is delivered the appropriate amount of energy required to seal the tissue, the flow of current is automatically halted to minimize heat transmission to the surrounding tissues. The hand pedal is then released, the coagulated tissue is cut, and the electrode is released by squeezing the handle of the handset until it unlocked [20]. In the other type of EBVS device, coagulation and cutting processes occur simultaneously. The coagulation hand pedal is pressed, and simultaneously we squeeze the handle to apply compression to the grasped tissue, but during that compression, the blade advances perpendicular to the electrodes and cut the tissue. In that system, 3-tone sound direct the surgeon in a way that the cutting process should be half way the electrode when the second sound tone is heard. The coagulation and cutting process is completed by the third sound [31].

After electrocoagulating the round ligament, the space between the anterior and posterior leafs of the broad ligament is entered. Then, a window is created on the posterior leaf of the broad ligament to seal the infundibulopelvic ligament or the utero-ovarian ligament and fallopian tube proximally in abdominal hysterectomies with or without salphingo-oophorectomy, respectively (Fig. 94.4).

Same steps should be applied to the other side of the uterus as well. Next, the anterior leaf of the broad ligament bilaterally and the peritoneum over the vesico-uterine pouch are dissected horizontally at the level of the uterine isthmus, to reduce the urinary bladder from the lower segment of the uterus, till the upper segment of the anterior vaginal wall (Fig. 94.5). Dissection of the peritoneum can be accomplished with an EBVS device or with an ultrasonic device.

Next, the uterine artery is visualized and sealed at the level of uterine isthmus by EBVS bilaterally. For avoiding ureteral injury during the uterine artery sealing we prefer to open retro-peritoneum and visualize the ureter. Identification and dissection of ureters before the sealing process will secure them from the lateral thermal damage of EBVS devices (Fig. 94.6).

The utero-sacral ligaments and the cardinal ligaments are electrocoagulated bilaterally with the EBVS device (Fig. 94.7).

Then an incision is made on the anterior vaginal wall just beneath the cervix and the vagina is entered with the aid of

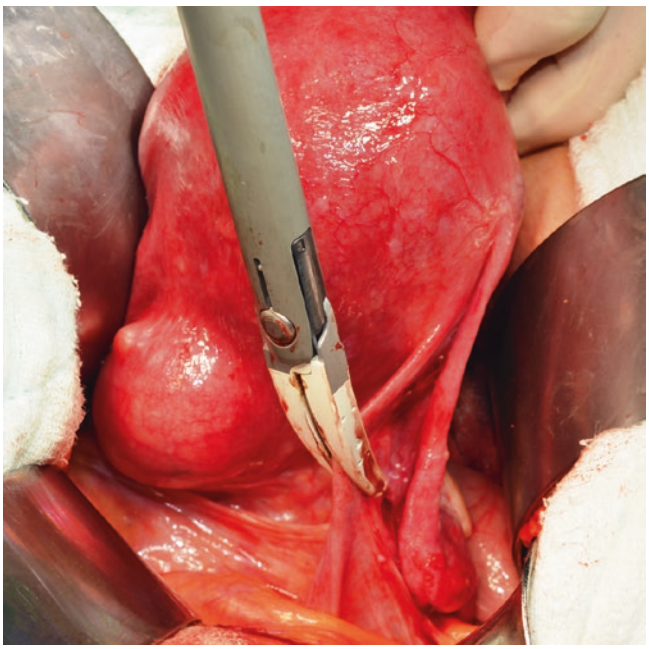


Fig. 94.3 Electrocoagulation of the round ligament with EBVS device

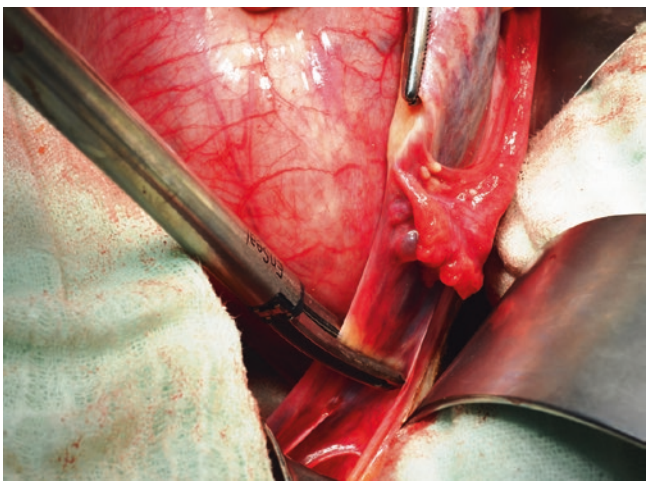


Fig. 94.4 Sealing the infundibulopelvik ligament with EBVS device

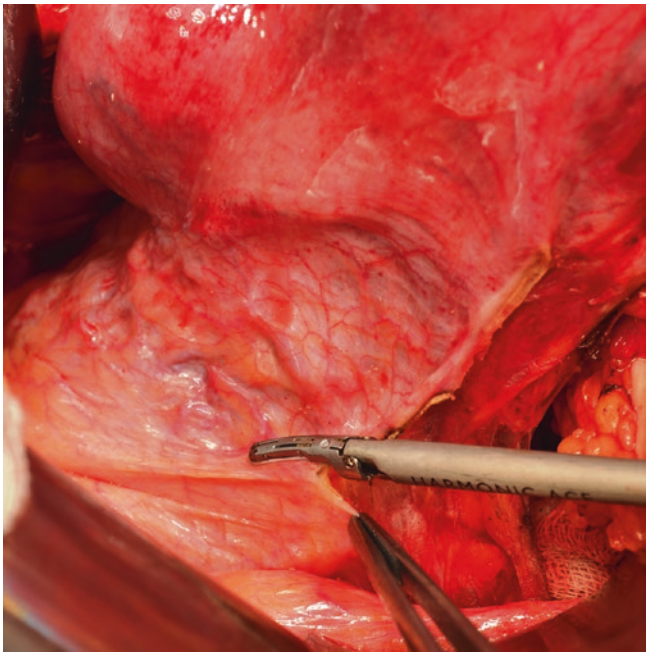


Fig. 94.5 Urinary bladder dissection with ultrasonic device

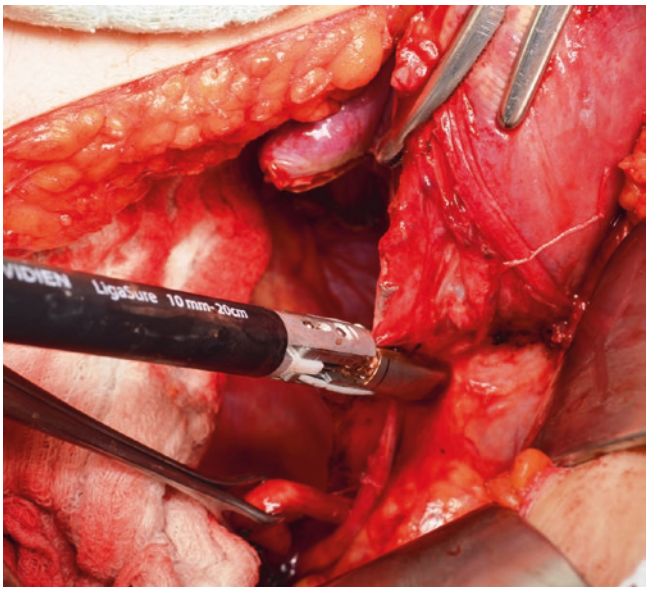


Fig. 94.6 Sealing the Uterine artery with EBVS device. Identification and dissection of the ureter for avoiding ureteral injury during the sealing. For demonstrating, ureter is hold by Babcock clamp

monopolar cautery or ultrasonic technology. The vaginal vault is dissected circumferentially with EBVS device. The other option is to grasp the vagina horizontally from lateral to medial bilaterally with the clamps just under the level of the cervix and to dissect the vaginal vault with EBVS above the clamps (Fig. 94.8).

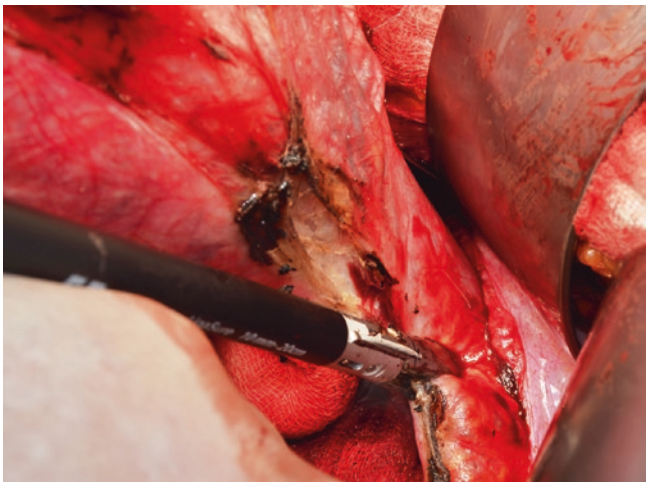


Fig. 94.7 Electrocoagulation of the cardinal ligament with EBVS device

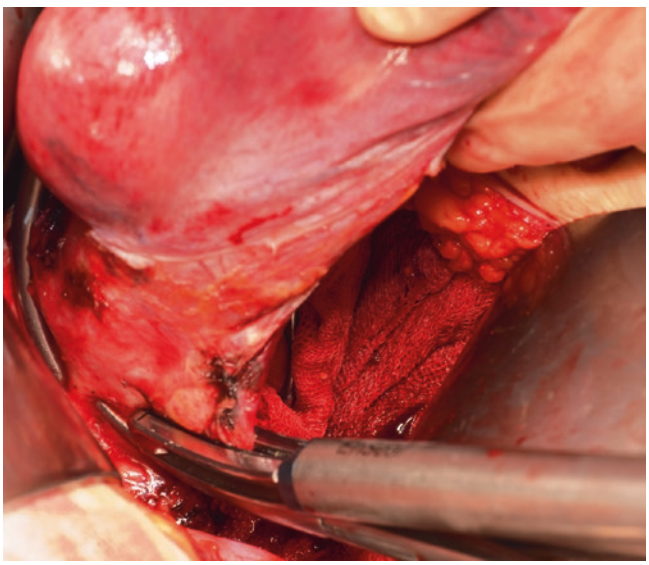


Fig. 94.8 The vagina grasped horizontally from lateral to medial bilaterally with the clamps just under the level of cervix and dissection of the vaginal vault with EBVS above the clamps

After extraction of the uterus, vaginal vault is closed continuously by using a size 0 absorbable suture.

After vaginal vault closure, the pelvis is thoroughly irrigated with warm saline or Ringer's lactate solution. Meticulous hemostasis at all pedicles is confirmed. The bladder and ureters are inspected than the operation is finished (Fig. 94.9).

Conclusion

An alternative to suture ligation of vascular pedicles is the use of electrosurgical bipolar vessel sealing

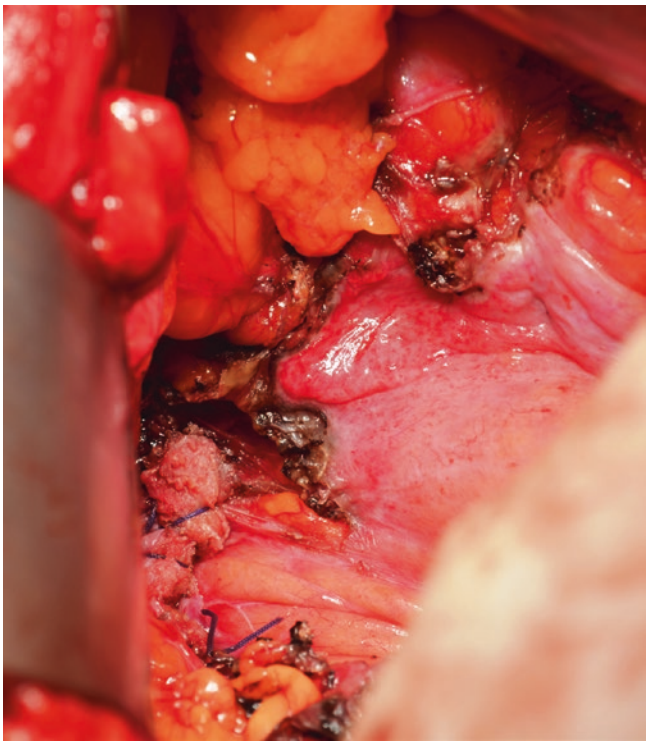


Fig. 94.9 After vaginal vault closure, the view of the operation field and the pedicles

systems. Growing evidence supports the safety of EBVS systems in various surgical procedures, as well as the gynecological surgeries. The current literature does not support the decrease in the duration of surgery and the amount of blood loss in abdominal hysterectomies, as in the vaginal hysterectomy or radical hysterectomy. However, the current evidence is too small to make a conclusion. Nevertheless, in our practice we think that the EBVS devices facilitate access, minimize procedural time and decrease blood loss relative to sutures when the competent surgeon is equipped with such devices. In respect to postoperative pain and recovery time, EBVS systems seem advantageous over classical surgical techniques. EBVS systems at least provide a more comfortable postoperative period and faster recovery, after abdominal hysterectomies performed for benign pathologies. Currently, there is no study analyzing the costs of EBVS system use for the gynecological operations. Nevertheless, despite the higher costs of these disposable devices, shorter operation time, less postoperative pain, faster recovery may decrease the hospital stay and total hospital costs. This may even reflect time to return to the work as for the laparoscopy. As related costs and use of materials differ considerably between the countries and even hospitals, the cost analysis should be interpreted with caution, and these calculations will probably be beneficial for centers performing large numbers of surgical procedures per year.

References

1. Wilcox LS, Koonin LM, Pokras R, Strauss LT, Xia Z, Peterson HB. Hysterectomy in the United States, 1988–1990. Obstet Gynecol. 1994;83:549–55.
2. Lepine LA, Hillis SD, Marchbanks PA, Koonin LM, Mor- row B, Kieke BA, Wilcox LS. Hysterectomy surveillance – United States, 1980 –1993. MMWR CDC Surveill Summ. 1997;46:1–15.
3. Farquhar CM, Steiner CA. Hysterectomy rates in the United States, 1990–1997. Obstet Gynecol. 2002;99:229–34.
4. Chapron C, Fauconnier A, Goffinet F, Breart G, Dubuisson JB. Laparoscopic surgery is not inherently dangerous for patients presenting with benign gynaecologic pathology. Results of a meta-analysis. Hum Reprod. 2002;17:1334–42.
5. Elkington NM, Chou D. A review of total laparoscopic hysterectomy: role, techniques and complications. Curr Opin Obstet Gynecol. 2006;18:380–4.
6. Lamvu G, Zolnoun D, Boggess J, Steege JF. Obesity: physiologic changes and challenges during laparoscopy. Am J Obstet Gynecol. 2004;191:669–74.
7. Siedhoff MT, Carey ET, Findley AD, et al. Effect of extreme obesity on outcomes in laparoscopic hysterectomy. J Minim Invasive Gynecol. 2012;19:701–7.
8. Morgan-Ortiz F, Soto-Pineda JM, López-Zepeda MA, Peraza-Garay Fde J. Effect of body mass index on clinical outcomes of patients undergoing total laparoscopic hysterectomy. Int J Gynaecol Obstet. 2013;120:61–4.
9. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2009;8:CD003677.
10. Wu JM, Wechter ME, Geller EJ, et al. Hysterectomy rates in the United States, 2003. Obstet Gynecol. 2007;110:1091–5.
11. Wright JD, Ananth CV, Lewin SN, et al. Robotically assisted vs laparoscopic hysterectomy among women with benign gynecologic disease. JAMA. 2013;309:689–98.
12. Janssen PF, Brölmann HA, Huirne JA. Effectiveness of electrothermal bipolar vessel-sealing devices versus other electrothermal and ultrasonic devices for abdominal surgical hemostasis: a systematic review. Surg Endosc. 2012;26:2892–901.
13. Levy B, Emery L. Randomized trial of suture versus electrosurgical bipolar vessel sealing in vaginal hysterectomy. Obstet Gynecol. 2003;102:147–51.
14. Noble EJ, Smart NJ, Challand C, Sleigh K, Oriolowo A, Hosie KB. Experimental comparison of mesenteric vessel sealing and thermal damage between one bipolar and two ultrasonic shears devices. Br J Surg. 2011;98:797–800.
15. Lantis JCII, Durville FM, Connolly R, Schwaitzberg SD. Comparison of coagulation modalities in surgery. J Laparoendosc Adv Surg Tech A. 1998;8:381–94.
16. Harrell AG, Kercher KW, Heniford BT. Energy sources in laparoscopy. Semin Laparosc Surg. 2004;11:201–9.
17. Kennedy JS, Stranahan PL, Taylor KD, Chandler JG. High-burst-strength, feedback-controlled bipolar vessel sealing. Surg Endosc. 1998;12:876–8.

18. Macario A, Dexter F, Sypal J, Cosgriff N, Heniford BT. Operative time and other outcomes of the electrothermal bipolar vessel sealing system (LigaSure) versus other methods for surgical hemostasis: a meta-analysis. Surg Innov. 2008;15:284–91.
19. Edwards SD, Peirce SC, Crawford DC. Electrosurgical vessel sealing systems. UK market survey. NHS–Purchasing and Supply Agency–Centre for Evidence-based Purchasing Report 06008. March 2006.
20. Rothmund R, Kraemer B, Neis F, Brucker S, Wallwiener M, Reda A, Hausch A, Scharpf M, Szyrach MN. Efficacy and safety of the novel electrosurgical vessel sealing and cutting instrument BiCision®. Surg Endosc. 2012;26:3334–43.
21. Mistrangelo E, Febo G, Ferrero B, Ferrero S, Deltetto F, Camanni M. Safety and efficacy of vaginal hysterectomy in the large uterus with the LigaSure bipolar diathermy system. Am J Obstet Gynecol. 2008;199:475.e1–5.
22. Person B, Vivas DA, Ruiz D, Talcott M, Coad JE, Wexner SD. Comparison of four energy-based vascular sealing and cutting instruments: a porcine model. Surg Endosc. 2008;22:534–8.
23. Nienhuijs S, de Hingh I. Conventional versus LigaSure hemorrhoidectomy for patients with symptomatic hemorrhoids. Cochrane Database Syst Rev. 2009;1:CD006761.
24. Cronjé HS, de Coning EC. Electrosurgical bipolar vessel sealing during vaginal hysterectomy. Int J Gynaecol Obstet. 2005;91:243–5.
25. Lakeman MM, Roovers JP. Electrosurgical bipolar vessel sealing versus conventional clamping and suturing for vaginal hysterectomy: a randomised controlled trial. BJOG. 2013;120:777.
26. Elhao M, Abdallah K, Serag I, El-Laithy M, Agur W. Efficacy of using electrosurgical bipolar vessel sealing during vaginal hysterectomy in patients with different degrees of operative difficulty: a randomised controlled trial. Eur J Obstet Gynecol Reprod Biol. 2009;147:86–90.
27. Tamussino K, Afschar P, Reuss J, Perschler M, Ralph G, Winter R. Electrosurgical bipolar vessel sealing for radical abdominal hysterectomy. Gynecol Oncol. 2005;96:320–2.
28. Lakeman M, Kruitwagen RF, Vos MC, Roovers JP. Electrosurgical bipolar vessel sealing versus conventional clamping and suturing for total abdominal hysterectomy: a randomized trial. J Minim Invasive Gynecol. 2008;15:547.
29. Hagen B, Eriksson N, Sundset M. Randomised controlled trial of LigaSure versus conventional suture ligature for abdominal hysterectomy. BJOG. 2005;112:968.
30. Türkçüoğlu I, Kafkaslı A, Doğan Ç, Tanrıkut E. Tissue damage in abdominal hysterectomy performed with a vessel sealing system. Turk J Med Sci. 2012;42:471–6.
31. ENSEAL® G2 Articulating Tissue Sealer. //www.ethicon.com/sites/default/files/products/energy/pdf/12-1219-ethicon-ENSEAL-Articulating-Steps-to-Use.pdf.
32. Johnson N, Barlow D, Lethaby A, Tavender E, Curr E, Garry R. Surgical approach to hysterectomy for benign gynecological disease. Cochrane Database Syst Rev. 2006, (2). Art. No. : CD003677.

Peripartum Hysterectomy

95

Alexander Strauss

Introduction

Maternal mortality rates worldwide decrease, − 34 % while the incidences in industrialized countries rise, + 16 % (1990–2008, WHO). Peripartum hemorrhage (PPH) remains a main cause of maternal mortality. Among 600.000 maternal deaths worldwide hemorrhage accounts for 140.000 every year (25 %). The incidence of an obstetrical blood loss >1000 ml complicates 0.5–1 % of all deliveries in Germany. Life-threatening maternal bleeding is defined as a blood loss of >1500–2000 ml or >150 ml/min within 20 min or >50 % of the individual total blood volume (= 9 % of body weight) in less than 3 h. Peripartum hysterectomy (PH), the most dramatic operation in modern obstetrics, is defined as a hysterectomy performed at the time, or within 24 h of delivery. As the operation is uncommon only limited individual experience may be gained by the obstetrical surgeon. Emergency peripartum hysterectomy (EPH) is an unequivocal marker of severe maternal morbidity and, in many respects, the treatment of last resort for severe PPH [1]. Hysterectomy following cesarean section (CS) was first described by Porro and at that time was used to prevent maternal mortality due to PPH [2]. The unplanned nature of EPH and the need for performing it expeditiously already delineate concerns associated with this potential life-saving approach. Moreover the acute loss of blood renders the patient in a less than ideal condition to undergo an emergency surgical intervention. The incidence of EPH ranges from 0.24 to 8.7 ‰, with the higher figures usually found in low-resource countries. More common EPH is following CS (0.17–8.7 ‰) than vaginal deliveries (0.1–0.3 ‰) [3]. This increase in incidence in some countries can be attributed to rising CS rates and concomitant abnormal placentation in subsequent pregnancies (Canada, 1991–2000, EPH-rate almost doubled from 0.26 to 0.46 ‰, RR 1.7, 95 % CI 1.48–2.08) [1, 4–8]. There are reasons to believe that PH-rates may continue to rise as other factors than CS-rates contribute to the namely trend: among others assisted reproductive treatment and multiple pregnancy (twins 6× and higher order multiples 24× compared to singleton-pregnancies) [9]. Initially in peripartum emergency situations an algorithm of conservative measures to control uterine hemorrhage (responsible for 25 % of direct maternal deaths) is attempted to avoid morbidity and sterilization as a result of hysterectomy [10]. For those patients, who inevitably require hysterectomy, clear decision making and immediate performance of the procedure (without using multiple conservative measures) leads to a lower blood loss/transfusion requirement and a better outcome [11]. Nevertheless maternal morbidity from PH ranges from 26.5 to 31.5 % and mortality varies from 2.8 to 23.8 % with a mean of 4.8 % [12].

Indications for EPH

The predominant indication for EPH is severe uterine hemorrhage due to abnormal placentation (45–73.3 %), uterine atony (20.6–43 %) that cannot be controlled by conservative measures or uterine rupture (11.4–45.5 %) [13–16]. Traditionally, uterine atony was the most common indication for EPH. The use of modern oxytocic drugs has greatly improved the conservative as well as the surgical treatment of uterine atony. Recent studies however indicate trend of changing indications towards abnormal placentation [3, 8]. Further potential causes for ERH are severe intra- or postpartum uterine hemorrhage following leiomyoma or laceration of uterine vessels and severe postpartum infection unresponsive to medical therapy. Concerning the patients history first of all previous CS (21–59 %), with a risk rising parallel to the increasing number of previous cesarean deliveries (Table 95.1), maternal age, multiple gestation, multiparity and cesarean delivery in the index pregnancy (64–82 %) induce

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Table 95.1 Estimated risk for PH in different categories of women [17]

Category	Risk of requiring PH (range)
Woman undergoing their first delivery vaginally	1 in 30,000 (1: 17,000–152,000)
Woman undergoing their first delivery by CS	1 in 1700 (1: 1300–2300)
Subsequent delivery in woman who had had one previous CS	1 in 1300 (1: 1000–1600)
Subsequent delivery in woman who had had two or more previous CS	1 in 220 (1: 180–270)

Table 95.2 Risk factors/indications for EPH (multiple reference possible) [1, 3–8, 17, 23]

Maternal factors	Placental factors	Fetal factors
Uterine atony (21–53 %)	Placenta previa (34 %)	Fetal macrosomia
Coagulopathy	Placenta ac−/in−/percreta (39–45 %)	Polyhydramnios
Uterine rupture (8–46 %)	Abruptio placentae (6 %)	Multiple gestation (twins OR 6.30, 95 % CI 1.73–23.0)
Precipitate or prolonged labor (protracted oxytocin use)	Retained placenta (1: 300)	
Pelvoperitonitis/sepis (8 %)	Previous abnormal placentation	
Uterine anomaly/myoma (1–2 %)		
Cervical cancer (<1 %)		
Multiparity, ≥3 (OR 2.30, 95 % CI 1.26–4.18)		
Advanced maternal age, >35 years (OR 2.42, 95 % CI 1.66–3.58)		
Maternal obesity		
Augmentation of labor (OR 2.0)		
CS in actual pregnancy (OR 7.13, 95 % CI 3.71–13.7)		
Extension of uterine incision at CS (6 %)		
Previous CS, 1 CS (OR 2.14, 95 % CI 1.37–3.33), ≥2 CS (OR 18.6, 95 % CI 7.67–45.4)		
Previous primary postpartum hemorrhage		
Previous uterine surgery: manual placental removal (OR 12.5, 95 % CI 1.17–133.0), curettage (OR 1.48, 95 % CI 0.95–2.29), myomectomy (OR 14.0, 95 % CI 1.31–149.3)		

PH-risks. Nevertheless from recent data one can conclude that there is a considerable variability in the incidence of EPH worldwide (Netherlands 0.33 ‰, 95 % CI 0.20–0.46, Israel 0.48 ‰, 95 % CI 0.35–0.60, Canada 0.55 ‰, 95 % CI 0.44–0.67, Germany 0.68 ‰, 95 % CI 0.59–0.77 and United States 0.77 ‰, 95 % CI 0.73–0.81) [17], and it varies with obstetric practice in each center [18]. Preplanned PH may be performed in patients diagnosed with placenta previa ± placenta ac−/in−/percreta or cervical/ovarian cancer. Risk-factor-listing for EPH is registered in Table 95.2.

Abnormal Placentation

Pathology in placentation (localization, invasion) is the most common indication for PH (Fig. 95.1). The combination of factors including high parity, advanced maternal age, number of previous CS, previous uterine surgery (e.g. curettage) strongly increase the likelihood of placenta previa and increase the risk of abnormal adherent placenta (Fig. 95.2) [11]. The association between abnormal placentation and prior cesarean delivery suggests that an increase of EPH is directly related to general rise of the number of CS performed [11, 13–16]. The risk of placenta previa after one previous CS (0.2 %) is increased by 47 fold in patients with four previous CS (9 %) [14]. The incidence of previous CS between 60 % in patients with adherent placenta and 75 % in patients with placenta previa [15]. Patients with placenta previa and scarred uterus had a risk of 16 % undergoing EPH compared to 3.6 % in patients with unscarred uterus [11, 13, 14]. Furthermore, the probability for EPH is higher in patients with placenta previa and accreta (in−/percreta) than in patients with placenta previa alone (Fig. 95.3).

Prediction: The predisposing risk factors can be determined to a certain extent by performing antenatal ultrasound with color Doppler and magnetic resonance imaging (MRI). However, high MRI-cost and the need for experienced operators in obstetrical ultrasound impede early diagnosis (Fig. 95.4) [19].



Fig. 95.1 Placenta previa – ultrasound: placenta overlaps internal os of the cervical canal

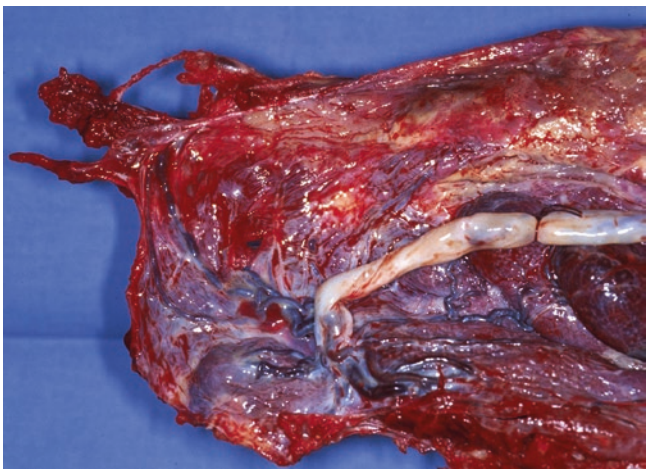


Fig. 95.3 Placenta increta – postoperative specimen: placenta with infiltrated/inextricable myometrial tissue (in left upper angle of the figure)

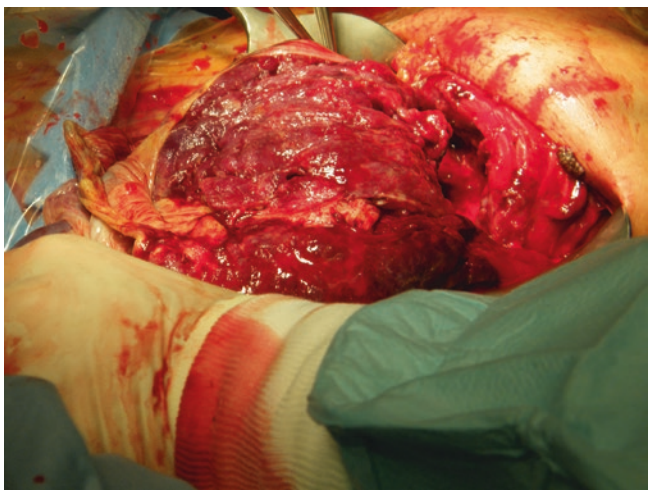


Fig. 95.2 Placenta previa accreta – intraoperative finding: due to an abnormal adherence of the placenta to the uterus an anatomic accurate separation of placenta tissue from the uterine wall fails during CS

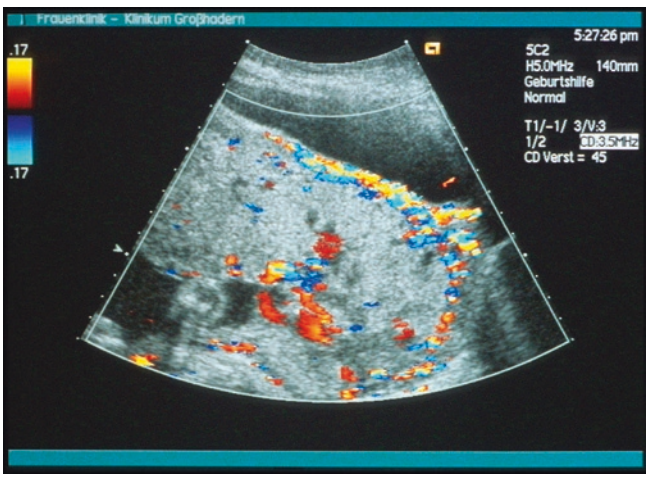


Fig. 95.4 Placenta increta – Doppler-ultrasound: longitudinal scan of the color coded depiction of highly vascularized invasion of the anterior uterine wall allows prenatal anticipation of placenta previa increta

Uterine Atony

Uterine atony is a frequent indication for EPH. Excessive uterine distension (e.g. fetal macrosomia, twins, and polyhydramnios), preeclampsia, nulliparity, induction, prolonged, augmented and/or obstructed labor with the consequence of uterine anergy to all uterotonics are risk factors for uterine atony possibly requiring surgery [11, 13–15]. While atony was traditionally the leading cause for EPH, its relevance for surgery today is reduced due to the development of effective pharmacologic treatment strategies (e.g. prostaglandins) as well as non-pharmacologic therapy options (e.g. balloon compression devices, organ preserving compressing sutures) (Fig. 95.5) [20].

Uterine Rupture

External trauma, such as motor vehicle accident, fall or assault is relatively rare cause of uterine perforation or rupture with potentially detrimental consequences for mother and fetus (Fig. 95.6). Obstetrical risk factors for uterine rupture are multiple previous uterine operations (e.g. CS, myomectomy, precedent uterine rupture) resulting in a scarred hollow organ (Figs. 95.7 and 95.8). If the rupture is extensive and hemorrhage cannot be contained by suture of the lacerated area, hysterectomy may be necessary. In addition, rupture of the intact uterus can occur in multiparous women in response to inappropriate use of oxytocic agents in the first and second stages of labor [1].

Uterine Trauma

Traumatic laceration of the uterus can occur with delivery especially when a variety of obstetric maneuvers (e.g. ventouse or forceps delivery, manual removal of the placenta or its fragments) or instrumental manipulation (curettage) is necessary. Second stage of labor or CS in in with the fetal head deeply impacted in the lower uterine segment may be associated with lateral cervical laceration potentially engaging major paravaginal/paracervical vessels. On rare occasions, the extent of this tear may necessitate hysterectomy, especially if one or both uterine arteries are lacerated and a hematoma obscures the surgical repair [21].

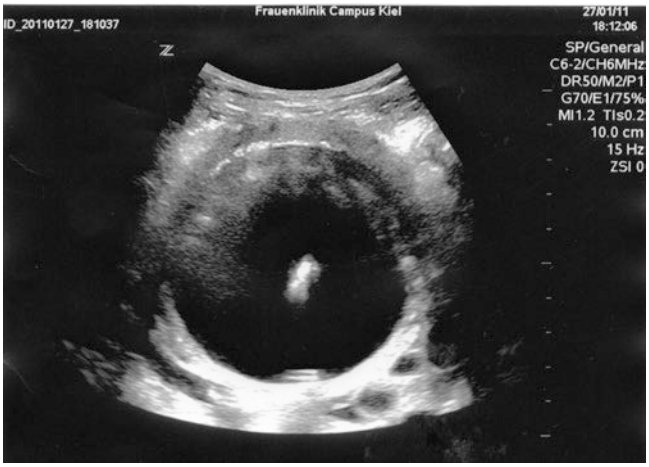


Fig. 95.5 Uterine atony – ultrasound: conservative therapy using a transvaginal inserted intrauterine balloon device

Abruption of Placenta

As a rare indication abruption of placenta may cause heavy bleeding leading to DIC (Figs. 95.9, 95.10, 95.11 and 95.12). Under peculiar circumstances placenta abruption can be associated with extravasation of blood into the myometrium to such an extent as to make the organ unresponsive to uterotonic agents (= Couvelaire uterus). It has to be adopted, however, that in the majority of cases of abruptio placentae with Couvelaire uterus, the response to oxytocic drugs is appropriate and the hemorrhage is due to DIC rather than failure of the uterus to contract [1, 22].

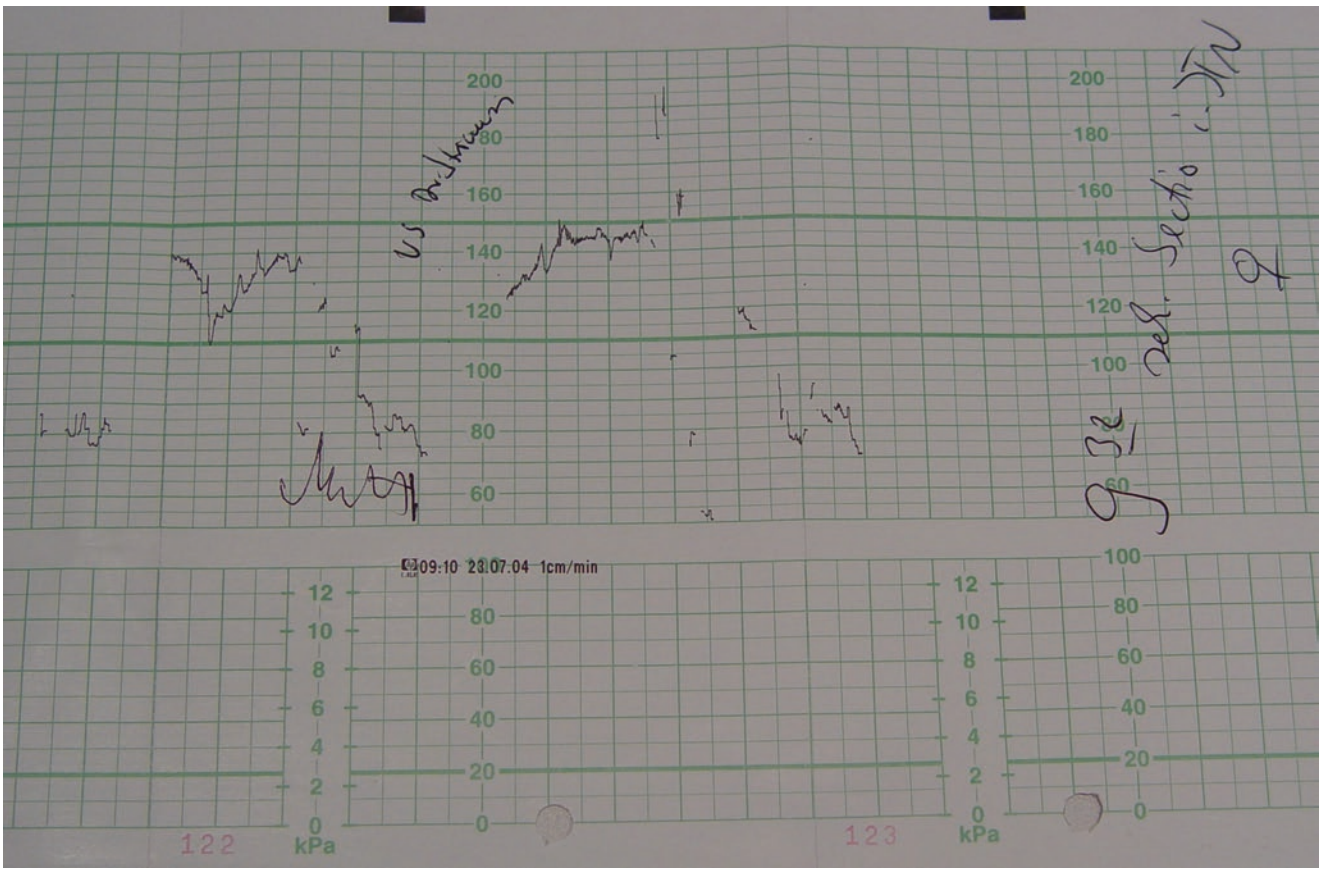


Fig. 95.6 Uterine rupture – peripartal cardiotocography with signs for severe fetal hypoxia due to maternal bleeding and acute placental insufficiency following uterine rupture (neonatal parameters at birth: pH 6.86, BE −-23.6 mmol/l, pCO2 71.9 kPa, PO2 26.9 kPa, Hb 13.9 g/dl)



Fig. 95.7 Uterine rupture – intraoperative finding: lower midline incision immediately displays a large amount of free blood in the abdominal cavity

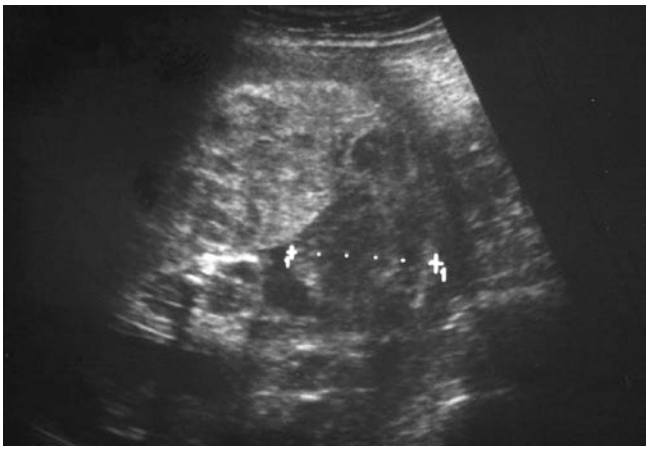


Fig. 95.9 Abruption of placenta – ultrasound: hypoechogenic retroperitoneal hematoma between placenta and uterine wall (marked by *cursors*)

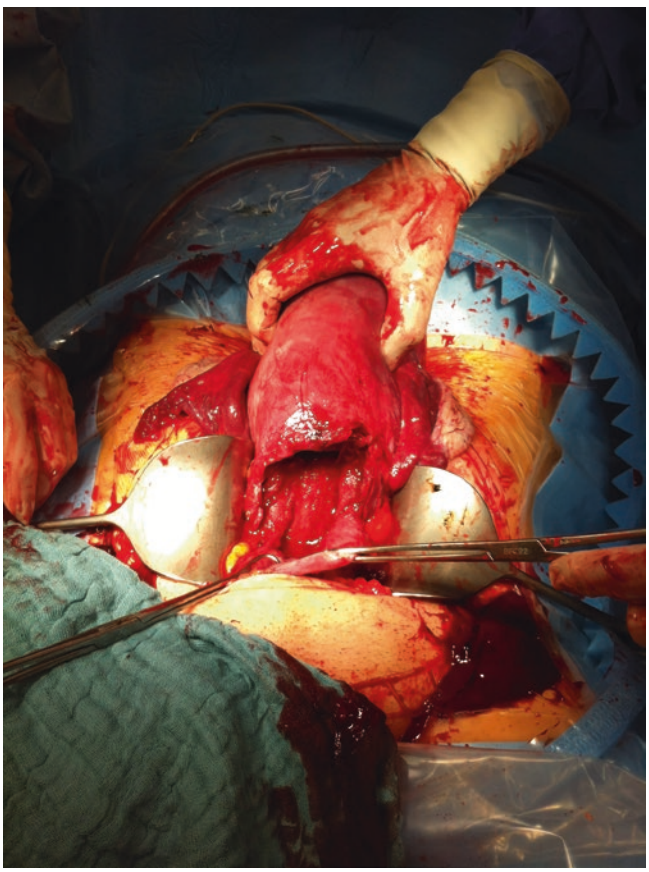


Fig. 95.8 Uterine rupture – intraoperative finding: atonic uterus iatrogenic dislocated in front of the abdominal wall with a complete rupture of the former CS-scar

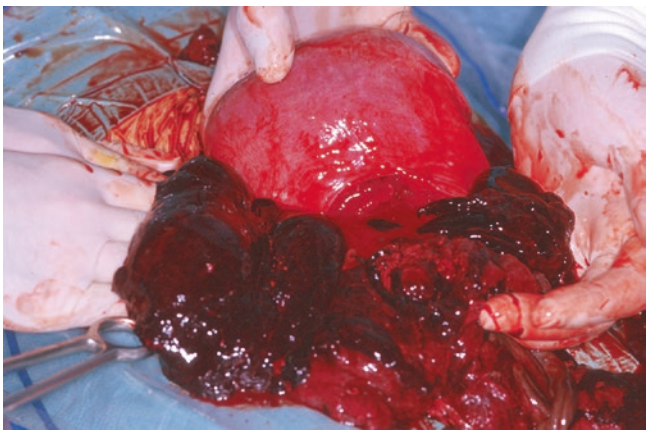


Fig. 95.10 Abruption of placenta – intraoperative finding: delivery of placenta with simultaneous bilateral protrusion of a large retroperitoneal hematoma caused by placental abruption

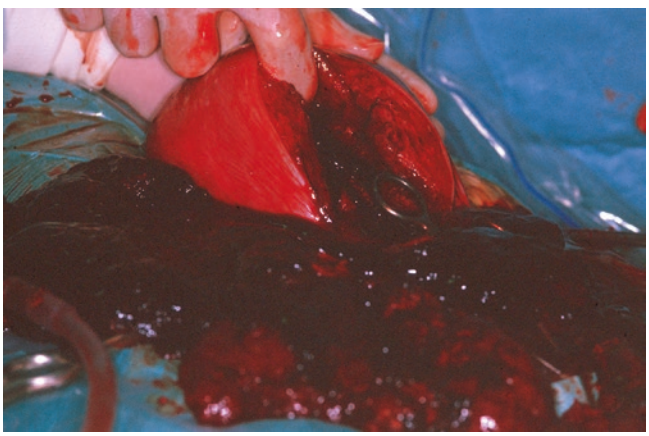


Fig. 95.11 Abruption of placenta – intraoperative finding: vertical hysterotomy with a mass of coagulated blood (retroperitoneal hematoma)



Fig. 95.12 Abruption of placenta – placental macroscopy: abruption of a third of placenta identifiable by adherent hematoma

Sepsis

In the era of modern antibiotics, sepsis is an uncommon reason for PH. However, it still may be necessary in cases of extensive uterine infection (endo−/myometritis) or endo−/myometrial abscess, in which antibiotic treatment fails to control the infection. Other septic causes of secondary PPH include cesarean scar infection and necrosis, arteriovenous fistula formation secondary to uterine trauma or infection/endomyometritis associated with retained placental fragments. All may rarely require PH [1].

Therapeutic Management

The antenatal presence of an increased likelihood for severe PPH (e.g. sonographic signs of pathology in placentation) can facilitate risk adapted consultation, referral or in the end prenatal transfer of patients at risk to a tertiary care facility. However, in case of necessity 24 % of patients requiring EPH are transported to another facility immediately after their index episode [23]. In trying circumstances this conflict of aims regarding uterus-preserving-management versus EPH needs an individualized balance between ineffectively spending excessive time on non-surgical techniques leading to a delay of moving to hysterectomy. Due to the complexity of the surgery and decision making, the involvement of an experienced obstetrician at an early stage is mandatory. Proper (sequential) conservative and surgical measures such as uterotonics (oxytocin, prostaglandin), fluid replacement (crystalloid), uterine massage/cooling, vaginal/cervical tear-repair, manual/instrumental removal of placenta, uterine packing (balloon), recombinant-activated factor VIIa (success rate 76 %) or tranexamic acid are options in attempting uterine conservation particularly in (young) patients to whom future fertility is important [24]. As surgery is inevitable, before hysterectomy is performed, hemostatic (compression) sutures, pelvic vessel ligation, uterine or hypogastric artery embolization or pelvic packing for (diffuse) bleeding are last options (Fig. 95.13). In case organ preservation is likely to fail or has already failed, further delay in performing EPH is unacceptable, as postponement leads to increase in blood loss, transfusion requirement, operative time, disseminated intravascular coagulation (DIC), more frequent/prolonged admission to ICU (41 %, range 17.6–77) and maternal mortality (4.8 %, range 2.8–23.8) [11–16].

Surgery

The technique of PH is similar in principle to that of total abdominal hysterectomy (TAH) in gynecology. A number of anatomical and physiological changes during pregnancy are responsible for potential intraoperative impediments requiring adaptation of surgery in the peripartum setting [1]:

Emergency Peripartum Hysterectomy (EPH)

EPH is a most demanding obstetric surgery performed in trying circumstances of life-threatening hemorrhage/disease.

1. In case of massive hemorrhage most important EPH should be performed early enough to avoid irrepressible DIC:

   command variable of peri−/intraoperative coagulation management are:

   prothrombin time (PT) >50 %; partial thromboplastin time (PTT) <50 s; thrombocytes >50/nl; fibrinogen >150 mg/dl; Ca++ > 0,9 mmol/l; pH > 7,2; hemoglobin >8 g/dl; patients body temperature >35 °C.
2. The surgical team consists of the most experienced obstetric surgeon available, operatively sustained by two to three skilled assistants, one or two midwifes, a team of neonatologists and an appropriate staff from the department of anesthesiology and intensive care (Fig. 95.14).
3. Abdominal access can be accomplished by Pfannenstiel incision (especially if a previous transverse scar is present) or lower midline incision (provides better exposure) depending on indication and urgency required (Fig. 95.15).
4. If CS is required, the common steps of a cesarean delivery are to be performed first.
5. The type of hysterotomy used is guided by obstetric indications; however, a low vertical incision is less likely to extend and lacerate the uterine vasculature. In case a disruption of the placenta localized in the lower uterine segment (previa, in−/percreta) is to be avoided by modi-

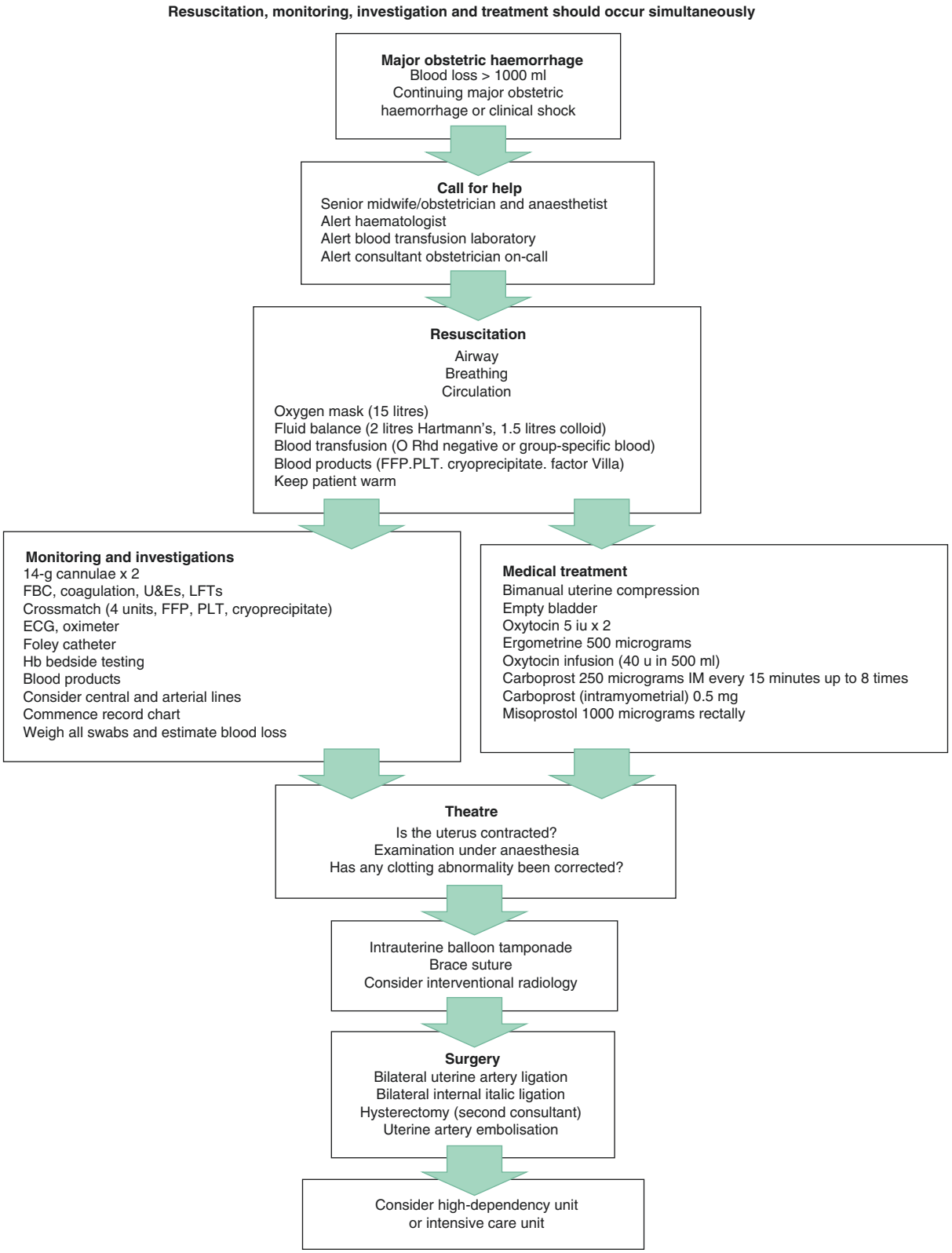


Fig. 95.13 Management of major PPH [26]

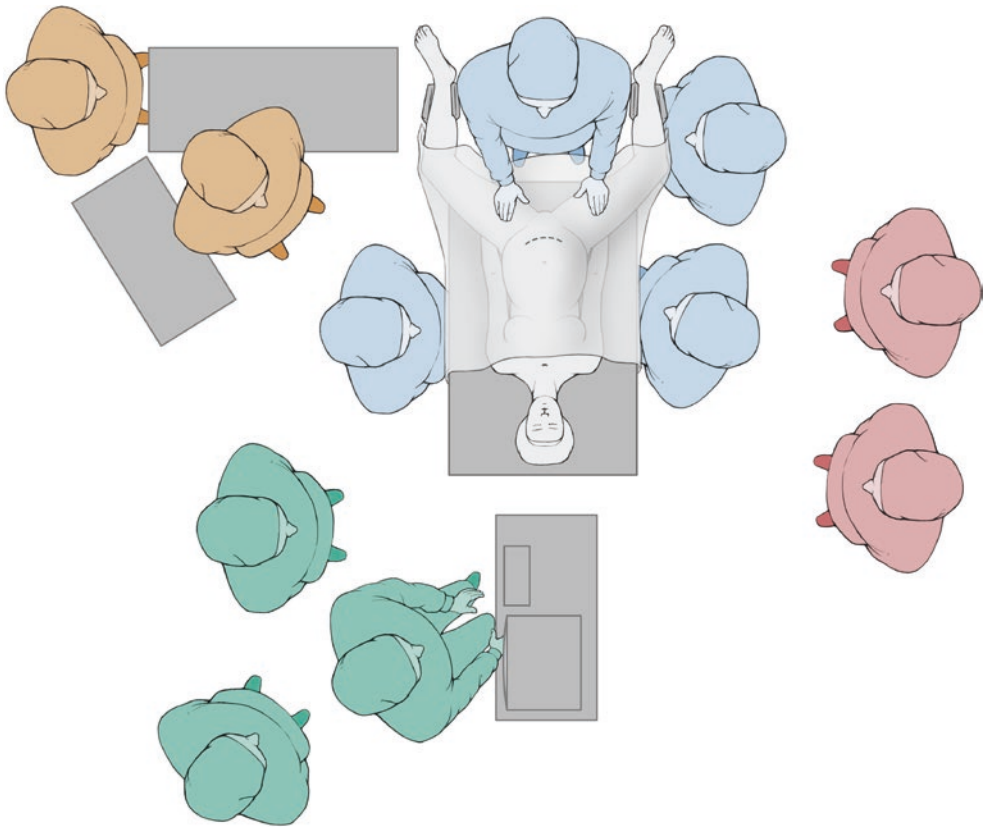


Fig. 95.14 Surgical setting – surgical setting and team needed when performing peripartum hysterectomy. Surgical team: (1) Most experienced obstetrical surgeon available (*grey*) – tasks: decision making, specific information to team, performing surgery. (3) Experienced obstetricians (*grey*) – tasks: organize patients transport, information transfer to team, patients disinfection, assistance during surgery. (1) Theater nurse (*orange*) – tasks: preparation of instruments, assist changing dressings of surgical team, patients desinfection and sterile covering, selecting and passing instruments to the surgeon. (1) Circulating nurse (*orange*) – tasks: assist preparation of instruments, assist changing dressings of surgical team, patrolling the operating room to make sure that everyone stays sterile, counting instruments, drapes and other equipment. (2) Midwifes (*red*) – tasks: perform patients transport to theater, assist patients positioning on the operating table, place urinary catheter, provide specific obstetrical medication care, take care of placenta and neonate (if necessary). Anesthesia team: (2) Anesthesiologists (*green*) – tasks: patient contact, anamnesis, patient monitoring, provide anesthesia, intraoperative patient monitoring and handling, postoperative patient care, patients transport to intermediate care unit/ICU. (1) Anesthetic nursing staff (*green*) – tasks: patient contact, administration of sodium citrate, i.v. access, assisting patient monitoring, assisting intra- and postoperative patient care, assisting patients transport to intermediate care unit/ICU

fications of the uterine incision: longitudinal corporal incision or even incisions through the uterine fundus or posterior wall are applicable.

6. After delivery of the fetus and the decision to proceed with PH, the placenta is expressed unless there is no known pathologic placentation.
7. To minimize blood loss hysterotomy is closed running suture. Reapproximation of the myometrium optimizes uterine contractility and decreases the likelihood of uterine atony.
8. Round ligament, fallopian tube, utero-ovarian ligament and the avascular upper segment of broad ligament are grasped with atraumatic (straight) clamps (Kocher) on each side, and the uterus is kept under upward traction to constrict the uterine vasculature and control blood loss from the uterine arteries and collaterally the ovarian arteries.
9. As the uterine and ovarian vessels are enlarged and distended and the adjacent pelvic tissues are edematous and extremely friable, care should be taken to place clamps and ligations between (especially at the tips) (Fig. 95.16).
10. The broad ligament is then incised anteriorly to the point where the vesicouterine peritoneum was dissected off the lower uterine segment to create and step by step displace the bladder flap below the operative field. In patients having had previous surgery (most) tissue scaring/adhesion is frequent. As a result, sharp dissection of vesicouterine pouch is necessary and implicates attention to avoid lateral dissection into the highly vascular bladder pillars (Fig. 95.17).
11. Scarring from previous surgery, particularly previous CS, is a common complicating feature of PH and

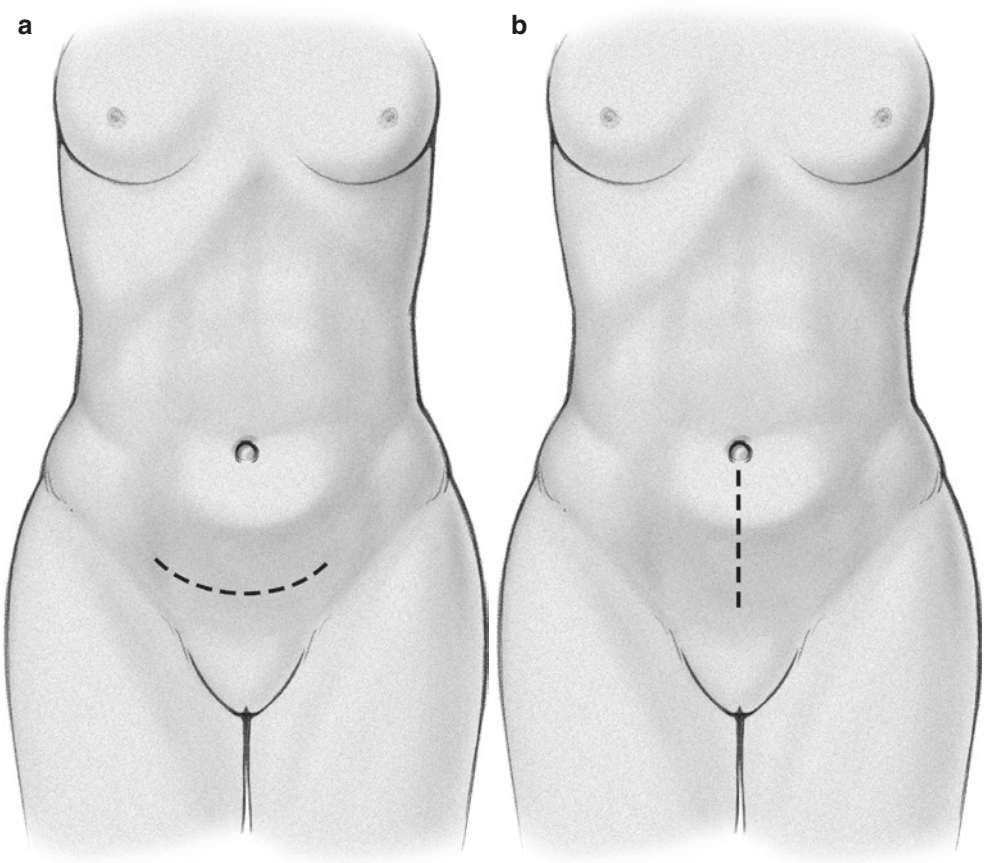


Fig. 95.15 Transabdominal access in peripartum hysterectomy – Pfannenstiel incision (**a**) vs. lower midline incision (**b**)

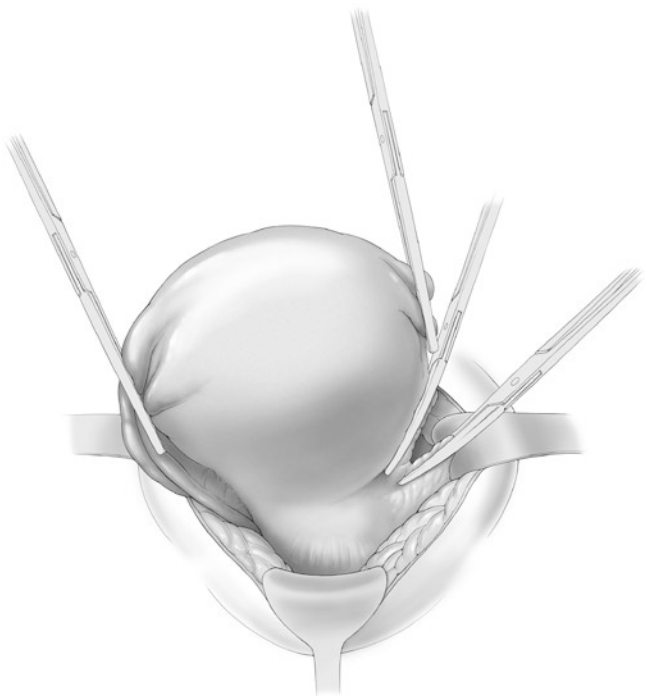


Fig. 95.16 Parametrial Dissection – surgical procedures are to be performed according to the vulnerable tissue characteristics

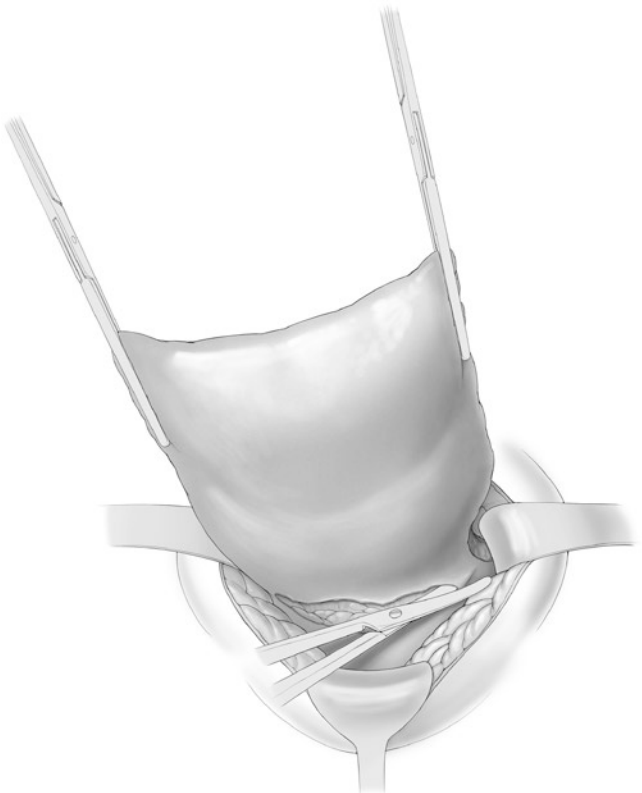


Fig. 95.17 Bladder flap dissection – incision of vesicouterine peritoneum and atraumatic displacement of the urinary bladder from the adjacent lower uterine segment

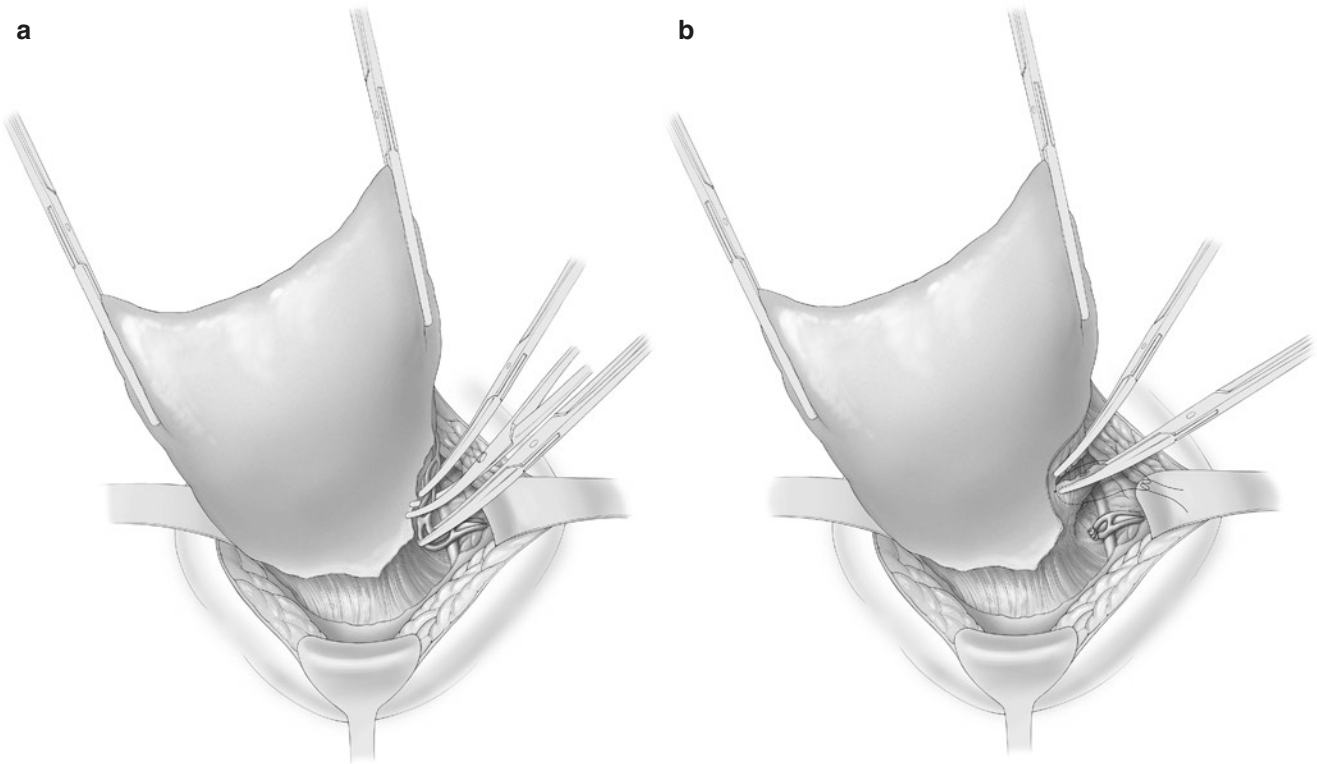


Fig. 95.18 Vicinity of ureter – safety precautions (close to uterine wall surgery) are recommended when dissecting (**a**) and ligating (**b**) uterine vessels

increase complication rates of surgical activities in the vesicouterine pouch and parametric space.

12. Posteriorly, the broad ligament is incized laterally and parallel to the infundibulopelvic ligament to expose the retroperitoneum. Careful dissection parallel to the course of the ureter allows visualization of the retroperitoneal space and the ureter throughout its course.
13. Uterine vessels, significantly enlarged in pregnancy are double clamped atraumatic exactly against the lateral wall of the uterus and cervix and ligated by sutures carefully incorporating the tissue tip. Once the procedure is performed bilaterally blood loss should rapidly diminish. The use of a second clamp on the specimen side reduces back-bleeding from the uterus, which can obstruct the operative field.
14. Ureters should be avoided by placing all clamps tight to the lateral uterine boundary (medial to those used to secure the uterine arteries) (Fig. 95.18).
15. Large hematomas especially in the broad ligament and/or retroperitoneal space distort anatomic relations and defy attempts at direct clamping and suturing (difficult orientation). A solution may be free dissection near the lateral pelvic wall and ligation of uterine vessels near to their origin from the internal iliac artery or, failing this, the internal iliac (hypogastric) artery itself can be isolated and ligated. In drastic emergencies, the aorta may be compressed/clamped for a time to stop bleeding while regaining a clear view on the bleeding sites (Fig. 95.19).

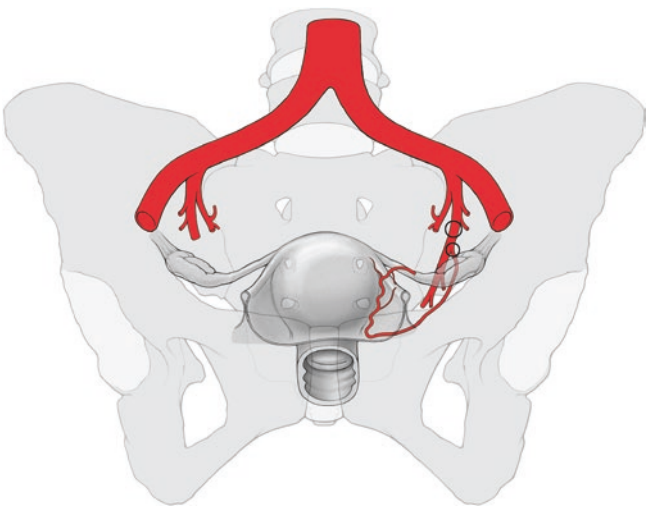


Fig. 95.19 Vessel ligation – in order to stop uterine bleeding, feeding vessels (uterine artery, internal iliac artery) are ligated distant to the uterine wall

16. Once the cardinal ligament dissection reaches the lower limit of the cervix, the vagina is entered, usually at the last pedicle. Identification of the lowest extent of the

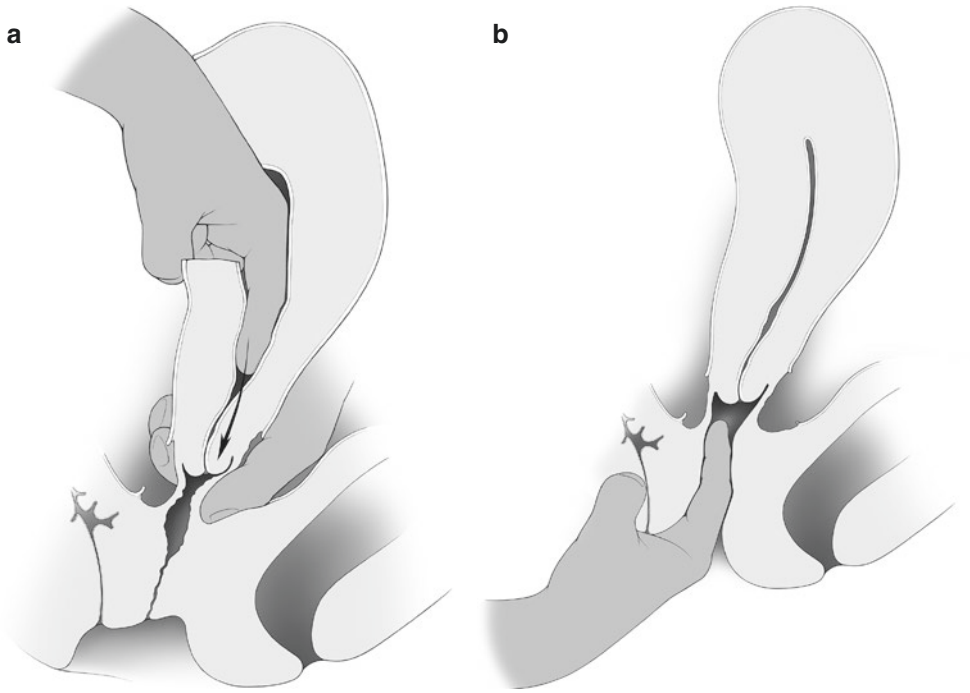


Fig. 95.20 Identification of cervical-vaginal boundary – due to pregnancy-related tissue alteration the vaginal fornix is difficult/impossible to be differentiated from the caudal edge of cervix uteri by traditional means of hysterectomy in gynecological patients. Solving this problem transcervical (**a**) or transvaginal (**b**) palpation may be helpful

dissection is the junction of the cervix and vagina usually to be felt between the thumb and forefinger by palpating. When the cervix is dilated, it can be difficult to discern its lower end. If a uterine incision has been made, digital inner identification of the cervical rim is possible. It is safest to incise the vagina posteriorly, identify the rim of cervix and then proceed anteriorly. If transcervical identification fails, transvaginal examination allows selective clipping of the boundaries of the cervix (Fig. 95.20).

17. Curved clamps and scissors are used to dissect the vaginal fornix and circumscribe the upper vagina to complete the dissection (Fig. 95.21).
18. The vaginal epithelium is very friable and must be handled gently. Surgical management of the vaginal cuff consists of supporting angle sutures followed by either interrupted sutures to close the vaginal cuff or to leave the cuff open and to secure hemostasis of the anterior and posterior cuff edges with a continuous nonlocking suture in order to allow drainage until spontaneous re-peritonealization occurs (Fig. 95.22).
19. If the surgeon is suspicious that the integrity of the bladder wall has been breached at any time during the operation, the bladder may be filled retrograde with an opaque solution and the operating field inspected for extravasation of the solution. If there has been an inadvertent cystotomy, the area is dissected so that two layers of 3/0 polyglactin or equivalent suture, with the second layer imbricating the first, can be placed without tension. Accordingly, a bladder dye-filling is to be implemented again after repair of any bladder injury. When bladder repair is necessary, postoperative antibiotic coverage and Foley catheter drainage of the bladder should be continued for 7–10 days.



Fig. 95.21 Clamping and dissection of vaginal fornix allows complete organ removal

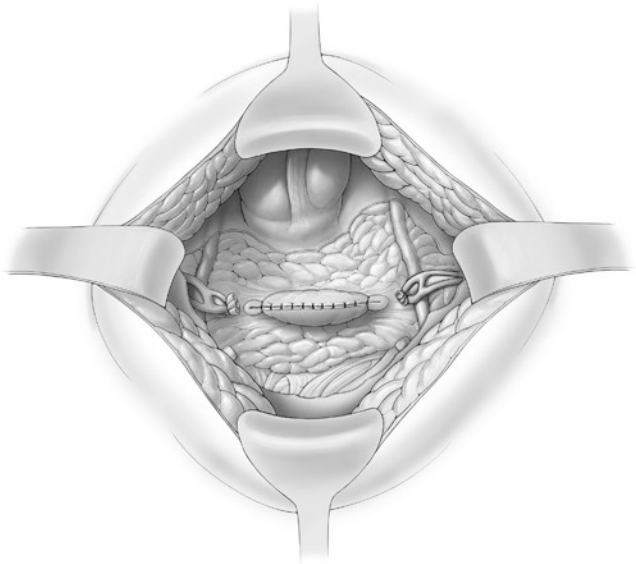


Fig. 95.22 Surgical management of the vaginal cuff – interrupted sutures of the vagina close the abdominal cavity. Reperitonealization is attempted in a self-healing process

Table 95.3 Adverse maternal/fetal sequelae in % among patients undergoing EPH [10, 17, 18, 23]

Blood transfusion	81–100
Acute posthemorrhagic anemia	81
Vaginal cuff hematoma/infection	14
DIC	< 1
Bladder/urinary tract injury	6–21
Cystotomy	3
Repair procedures on the urinary system	9
Fistula (vesicovaginal 0.9 %, ureterovaginal 0.2 %)	1
Ileus	3
Embolism	2
Fever	1–27
Wound infection/wound dehiscence	5–8
Urinary tract infection	18
Puerperal sepsis	2
ICU admission (duration median 2 days, range 1–26)	56–84
Readmission to hospital (within 30 days of surgery)	17
Reoperation	8–25
NICU admission (newborn)	19
Stillbirth	5
Neonatal mortality	1–4

20. If the integrity of the ureters is in doubt, and after any extensive repair of bladder injury, postoperative cystoscopy can confirm urine coming from each ureteric orifice. This test may be facilitated by giving intravenous indigo carmine and waiting 10–15 min. Alternative, radiological diagnosis is achieved by excretion urogram. If lower urinary tract injuries are not diagnosed until the postoperative period, clinical morbidity is increased, diagnostic and surgical management is much more complex [25].
21. During/following PH traumatized tissues at the base of the pelvis may continue to bleed despite ligation of obvious bleeding pedicles. Diffuse superficial blood loss is associated with the fragile tissue situation in pregnancy, a general hyperemia and/or DIC. In these cases the application of systemic (tranexamic acid intravenous bolus 1–2 g, if bleeding persists infusion of 6–10 mg/kg/h, recombinant-activated factor VIIa) and local hemostatic agents (superficial bleeding areas) or a pelvic pressure pack (abdominal compresses) can provide hemostasis and offer time, either permanent or temporary, until hematological stability and/or vascular embolization is achieved. Packs are removed, usually within 72 h. Alternatively compressing the aorta for a short time allows blood component replacement to catch up with a possible coagulopathy.
22. Intraoperative blood salvage (cell saver) recovering blood lost during surgery and re-infusing it into the patient (autologous autotransfusion) is an option to be implemented in every EPH and a fortiori in preplanned PH.
23. In addition/complementary interventional radiology may be an invaluable tool. Hypogastric artery embolization can play a role during PPH-management pre- or postoperatively. Selective embolization can stop bleeding without the need for a (second) surgical procedure.
24. Postoperative complications after EPH (vaginal cuff hematoma and febrile infection or abscess formation, sepsis, abdominal wound seroma/hematoma/infection) are similar to those after any abdominal hysterectomy performed for gynecologic indications but augmented by the unplanned type of surgery (Table 95.3).
25. To optimize a holistic patient care, postoperative requirements and logistics are to be anticipated and organized early during PH. Maternal intensive care facilities and in case neonatal resuscitation and intensive medical treatment for a potentially depressed newborn are to be prepared. In case EPH had to be performed outside from a center, postoperative transport of mother and/or newborn is to be already considered/logistically planned early during surgery.
26. Postoperative care: thromboprophylaxis with heparin should be instituted as soon as hemostasis is secure and perioperative antibiotic prophylaxis is to be continued for several days.
27. Following surgery most women are physically and emotionally traumatized by the rapid sequence of major complications, culminating in the loss of her uterus (fertility-ending nature procedure). After the initial postoperative recovery, the patient/family should receive a

comprehensive outline of events and supportive follow-up from the obstetrician responsible for the surgery (head of department).

28. Detailed and timed documentation including the preoperative events, indications and therapeutic/surgical details is to be put into writing not only by the responsible surgeon but by all team members involved in the whole perinatal process.

Preplanned Peripartum Hysterectomy (PH)

Preplanned PH is primary considered for prenatally diagnosed placenta in- or percreta ± placenta previa concomitant with completed family planning (see Fig. 95.4). When PH is planned in advance, the surgeon has the advantage of a complete preoperative evaluation of the patient including her hematologic and coagulation status. General preoperative triage decisions derived from requirements concerning hospital infrastructure (perinatal center) and the facilities/experience levels of all medical disciplines involved, direct patients management prior to hospital admission. Furthermore local surgical logistics can be optimized if CS combined with PH (e.g. antizipate procedures/problems, choose an experienced team, prepare necessary instruments and sutures before the operation) is preplanned. Timing of surgery depends on risk assessment balancing the hazard of hemorrhage versus fetal maturation with increasing gestational age. During planned surgery simultaneous CS is performed prior to hysterectomy. After delivery of the fetus the hysterotomy, performed at the far side of the placenta (previa), is relocked with the objective of avoiding additional blood loss and a restoration of a surgically familiar anatomical site. After cord clamping the placenta is left untouched in utero. From this point on surgical management follows the recommendations of EPH (Fig. 95.23). Premise for supracervical surgery would be a placenta-free, not-lacerated lower uterine segment and an indication for PH that does not compel the cervix to be excised (e.g. sepsis).

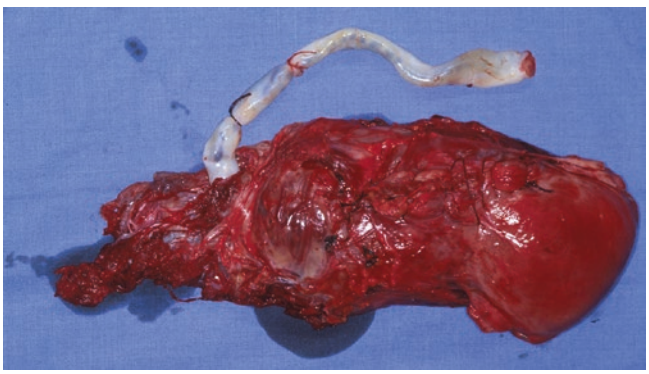


Fig. 95.23 TAH – postoperative PH-specimen: preplanned CS followed by simultaneous PH for placenta previa percreta leaving the placenta in situ during hysterectomy

Surgical Technique

There are several ways to accomplish the special problems posed by PH successfully. TAH is the traditional surgical method of EPH. It is essential in all cases of active bleeding from lower uterine segment as subtotal abdominal hysterectomy is not effective in management of placenta ac−/in−/percreta located in the lower uterine segment with the cervical branch of uterine artery being intact [8]. Furthermore, the potential risk of malignancy developing in the cervical stump, the need for regular cytology or bleeding/discharge associated with the residual cervical stump PH is to be taken into account when it comes to decision making concerning surgical techniques (see Fig. 95.14). If the cervix and paracolpos are not involved as the source of hemorrhage, abdominal supracervical hysterectomy (ASH) is adequate to achieve hemostasis. Supracervical surgery requires a lesser complex surgical technique, reduces operating time, leads to lesser blood loss, diminishes the need for blood transfusion and intra- and postoperative complications (e.g. persistence/diffuse bleeding, injury of urine bladder or ureter). The reduction of surgical radicalness by the decision of performing ASH is significantly influenced by patient's condition, indication for EPH, surgeon's experience and the probability of complications (Table 95.4). If ASH is performed, the uterine corps is amputated with a scalpel/electrical bistoury by cutting superiorly to the ligated uterine arteries. The cervical stump is approximated in an anterior-to-posterior fashion using interrupted sutures. Special care should be taken to avoid the bladder (Fig. 95.24). Currently the proportion of ASH performed for EPH ranges regional highly different from 17 [23] to 97 % [4].

Surgeon's Experience

In the recent years decreasing rates of abdominal hysterectomy for gynecological conditions impede a transfer of valu-

Table 95.4 Surgical complications in EPH compared with ASH [1, 8, 11–16, 23, 27]

	EPH	ASH
Blood transfusion	++	+
Blood febrile episodes	+	+
Bladder/ureter injuries	+	−
Bleeding for hyperemia and peripartum pelvic tissue injury	++	+
Cervical bleeding	−	+
Vaginal cuff bleeding	+	−
DIC	++	+
Abdominal wound infection	+	+
Vaginal wound infection/abscess	+	−
Ileus	+	−
Surgical required adnexectomy, uni- or bilateral (8 %)	+	+

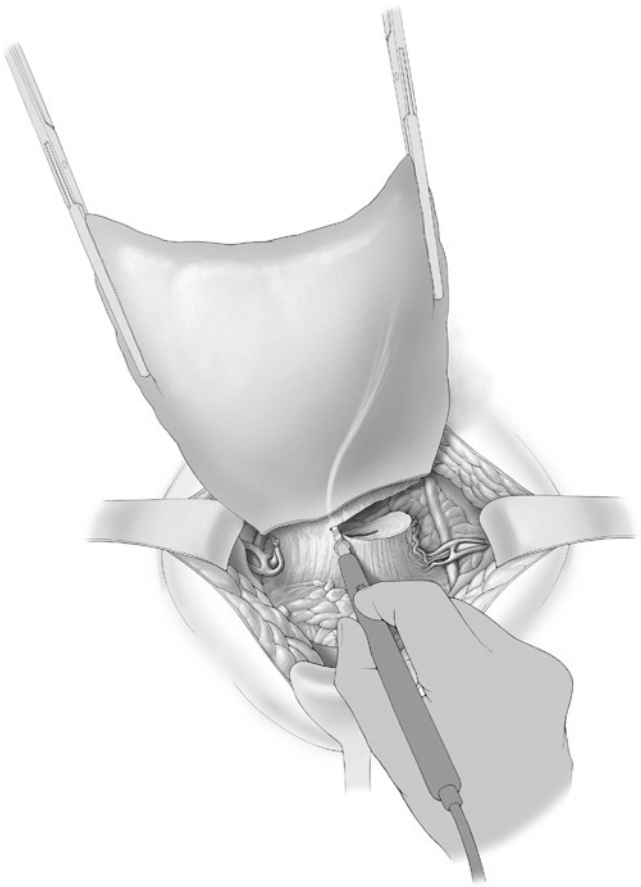


Fig. 95.24 Supracervical hysterectomy – isthmocervical dissection of the cervix helps to avoid complications at the level of the female pelvic floor

able experience with the procedure from gynecology to the more complex circumstances the obstetrician faces when performing PH. For the general obstetrician the average chance of performing EPH is once in 11 years [14]. Despite experienced surgery, reoperation rates (e.g. unplanned revision, planned removal of abdominal compresses) are to be expected to be as high as 23.6 % (range 7.8–38) [1]. EPH being performed by an experienced surgeon significantly reduces the operating time, number of units of blood transfusion, reoperation rates and hospital stay. As a consequence a risk-factor-stratified centralization of selected patients is to be advocated.

References

1. Baskett TF. Peripartum hysterectomy. In: Lynch CB, editor. A textbook of postpartum hemorrhage: a comprehensive guide to evaluation, management and surgical intervention: Jaypee Brothers Publishers; 2006.
2. Porro E. Dell amputazione utero-ovarica come complement di taglio cescareo. Ann Leniv Med Chir. 1876:237–89.
3. Kwee A, Boto ML, Visser GH, Bruinse HW. Emergency peripartum hysterectomy: a prospective study in The Netherlands. Eur J Obstet Gynecol Reprod Biol. 2006;124(2):187–92.
4. Christopoulos P, Hassiakos D, Tsitoura A, Panoulis K, Papadias K, Vitoratos N. Obstetric hysterectomy. A review of cases over 16 years. J Obstet Gynecol. 2011;31(2):139–41.
5. Karayalcin K, Ozcan S, Ozyer S, Mollamahmutoglu L, Danisman N. Emergency peripartum hysterectomy. Arch Gynecol Obstet. 2010;283(4):723–7.
6. El Jallad MF, Zayed F, Al-Rimawi HS. Emergency peripartum hysterectomy in Northern Jordon: indications and obstetric outcome (an 8 year review). Arch Gynecol Obstet. 2004;270(4):271–3.
7. Yamani Zamzami TY. Indications of emergency peripartum hysterectomy: review of 17 cases. Arch Gynecol Obstet. 2003;268(3):131–5.
8. Yucel O, Ozdemir I, Yucel N, Somunkiran A. Emergency peripartum hysterectomy: a 9 year review. Arch Gynecol Obstet. 2006;274(2):84–7.
9. Francois K, Ortiz J, Harris C, Foley MR, Elliott JP. Is peripartum hysterectomy more common in multiple gestations? Obstet Gynecol. 2005;105:1369–72.
10. Yalinkaya A, Güzel AI, Kangal K. Emergency peripartum hysterectomy: 16 year experience of a medical hospital. J Chin Med Assoc. 2010;73(7):360–3.
11. Knight M, UKOSS. Peripartum hysterectomy in the UK: management and outcomes of the associated haemorrhage. BJOG. 2007;114:1380.
12. Lovina SM. Machado Emergency peripartum hysterectomy: incidence, indications, risk factors and outcome. N Am J Med Sci. 2011;3(8):358–61.
13. Glaze S, Ekwalanga P, Roberts G, et al. Peripartum hysterectomy: 1999 to 2006. Obstet Gynecol. 2008;111:732.
14. Bodelon C, Bernabe-Ortiz A, Schiff MA, Reed SD. Factors associated with peripartum hysterectomy. Obstet Gynecol. 2009;114:115.
15. Rossi AC, Lee RH, Chmait RH. Emergency postpartum hysterectomy for uncontrolled postpartum bleeding: a systematic review. Obstet Gynecol. 2010;115:637.
16. Flood KM, Said S, Geary M, et al. Changing trends in peripartum hysterectomy over the last 4 decades. Am J Obstet Gynecol. 2009;200:632. .e1.
17. Lanneau GS, Muffley P, Magann EF. Cesarean Hysterectomy in Gynecology and Obstetrics. In: Hiscock T, editor. Looseleaf CD-ROM. Philadelphia: Lippincott Williams & Wilkins; 2004.
18. Carvalho JF, Cubal A, Torres S, Costa F, do Carmo O. Emergency peripartum hysterectomy: a 10-year review. International Scholarly Research Network. Emerg Med. 2012:1–7.
19. Strauss A, unter Mitarbeit von Heer IM, Müller-Egloff S, Burges A. Ultraschallpraxis Geburtshilfe und Gynäkologie. 2 ed. Springer, Heidelberg; 2008.
20. Strauss A, unter Mitarbeit von Heer IM, Schulze A, Bauerfeind I. Geburtshilfe Basics. Springer, Heidelberg, 2006.
21. Allen VM, O'Connell CM, Baskett TF. Maternal and perinatal morbidity of caesarean delivery at full cervical dilatation compared with caesarean delivery in the first stage of labour. Br J Obstet Gynaecol. 2005;112:986–90.
22. Strauss A, Jonat W, Diedrich K. Behandlungspfade in der Gynäkologie und Geburtshilfe. Heidelberg: Springer; 2013.
23. Wills R. Morbidity and mortality associated with peripartum hysterectomy in Queensland. 2012; Health Statistics Unit, Queensland Health, StatBite 54: 1–2
24. Bouma LS, Bolte AC, van Geijn HP. Use of recombinant activated factor VII in massive postpartum haemorrhage. Eur J Obstet Gynecol Reprod Biol. 2008;137(2):172–7.
25. Gilmour DT, Baskett TF. Disability and litigation from urinary tract injuries at benign gynaecological surgery in Canada. Obstet Gynecol. 2005;105:109–14.
26. Prevention and management of postpartum haemorrhage. Royal College of Obstetricians and Gynaecologists – RCOG, Green-top Guideline No. 52 2009.
27. Stanco LM, Schrimmer DB, Paul RH, Mishell DR. Emergency peripartum hysterectomy and associated risk factors. Am J Obstet Gynecol. 1993;168(3):879–83.

Abdominal Hysterectomy for Obese Patients

96

Emad Mikhail

Introduction

Since 1980, obesity has become a frequently encountered health problem in both children and adults and in all racial, ethnic, and socioeconomic groups [1]. The National Institutes of Health defines a normal BMI as 18.5–24.9 kg/m^2. Overweight is defined as a BMI between 25.0 and 29.9 kg/m^2. Class I obesity is a BMI between 30 and 34.9 kg/m^2, class II obesity is a BMI between 35.0 and 39.9 kg/m^2, and class III obesity is a BMI of >40 kg/m^2 [2]. Obesity is becoming a challenging health problem worldwide and in the United States, where national estimates indicate that 35.5 % of the adult population is obese (defined as a body mass index (BMI) ≥30) [3]. It has been shown that obesity is directly related to increased morbidity and mortality, where in adults ages 30–74, mortality from all causes increases in proportion to the degree of obesity [4]. Obesity is associated with an increased risk of morbid conditions (including hypertension, diabetes mellitus (DM), obstructive sleep apnea, and hypercholesterolemia) as well as malignancies such as endometrial and postmenopausal breast cancer [5]. Not only that but also, wound complications, surgical site infections, and venous thromboembolism remain a major source of morbidity for obese patients undergoing abdominal surgery [5].

Hysterectomy is one of the most frequently performed surgical procedures in the United States [6]. Minimally invasive approach for hysterectomy is more favorable due to its well-known benefits including; less blood loss, fewer perioperative complications, less postoperative pain, shorter hospital stay, quicker recovery time and better cosmesis. Despite these benefits, more than half of the hysterectomy procedures in the United States are performed through laparotomy incisions [7]. Recent studies have shown that increasing BMI was associated with increased rate of open hysterectomy in the United States [8]. Due to increased costs associated with minimally invasive approaches for hysterectomy [9], it is estimated that the percentage of abdominal hysterectomy is even higher in developing countries.

Research has shown that the metabolic comorbidities of obesity are directly related to the increased risk of perioperative complications. Surprisingly the overall mortality and composite morbidity in the obese patient without metabolic complications undergoing general surgery actually has been shown to be lower than that of normal-weight patients in a phenomenon referred to as the "obesity paradox" [10].

For patients presenting for hysterectomy, the impact of obesity on a particular patient's risk of surgery must be weighed prior to deciding upon the route of hysterectomy [11]. Obese patients experience some of the greatest differential benefit from performance of a hysterectomy in a minimally invasive route compared to an open procedure [12].

If increasing weight is associated with a higher risk of the operation, then the benefits of surgery must also increase proportionately. So, in morbidly obese women, risks-benefits should be evaluated and discussed and other non-surgical treatment options should be pursued before exploring surgical options [12]. Since the risks associated with increased BMI were dependent on the route of surgery and were mainly seen in patients undergoing abdominal hysterectomy [13], special attention should be employed during the perioperative care of obese women undergoing abdominal hysterectomy, which will be discussed in this chapter.

Pre-op Assessment/Testing

The perioperative care start with the surgical decision-making during the office visit. It is recommended that obese surgical patients undergo a thorough history and physical examination before undergoing a surgical intervention. The importance of this step is magnified in obese women due to

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the possible co-morbidities associated with obesity including hypertension, diabetes, and asthma. In obese patients with DM, blood glucose evaluation and counseling the woman on the importance of euglycemia to improve postoperative wound healing is important. On the other hand, routine screening of the obese patient for diabetes before surgery is not recommended [5]. Surgical clearance is usually obtained from the patient primary care physician in order to optimize the operative outcome. Obesity is associated with increased risk of skin infections. An evaluation for fungal or bacterial skin infections should also be performed prior to surgery, and appropriately treated, in order to prevent post-operative infections [14].

Pulmonary function testing on all patients is not currently recommended but screening for obstructive sleep apnea (OSA) should be considered, as the prevalence of undiagnosed OSA is 24 % [15].

Cardiology consultation may be beneficial in obese patients who have abnormal EKG changes or other comorbidities including hypertension and diabetes [16].

Anesthesia Considerations

Obesity can be challenging for administering anesthesia and controlling the airway, not only at the time of intubation, but throughout the entire procedure. Clear communication and collaboration with the entire surgical team is paramount to successful and safe surgery. The anesthesia team should perform pre-operative airway evaluation as excessive fat around the neck, a short neck, and limited jaw and neck movement can lead to difficult intubation [17].

Functional residual capacity, expiratory reserve volume, and total lung capacity are decreased with increasing weight [18]. This decrease in the functional residual capacity can lead to quicker oxygen desaturation and apneic episodes in the obese patient [19]. Anesthesiologists may use pressure control ventilation to improve the lung ventilation-perfusion ratio [20].

Positioning and Pre-op Preparation

Proper positioning of the obese patient is very important to maximize exposure and reduce the risk of injury. Some operating room (OR) tables may not be wide enough to support the patient, but extenders are available for most operating beds. Larger beds for morbidly obese patients are recommended if available. Operating tables typically accommodate 205 kg, although some tables can accommodate 455 kg [5]. The patient should be allowed to transfer themselves to the OR table. After the patient is transferred to the OR table, proper positioning and appropriate padding is necessary [11]. The skin preparation before incision can be challenging in obese patients with multiple skin folds. Additionally, multiple kits may be necessary for abdominal skin preparation [5].

Surgical Techniques

Commonly used abdominal incisions in gynecologic surgery include the Pfannenstiel, Cherney, and Maylard transverse incisions and median and paramedian vertical incisions. In obese patients, the abdominal wall anatomy is distorted by a large panniculus.

The vertical incision has the advantage of being easy to perform; it can be accomplished quickly, because the midline is the least vascular area of the abdominal wall, and provides excellent exposure to the pelvis. The principal blood supply to the anterior abdominal wall is from the inferior epigastric vessels, which are located laterally in the rectus sheath posterior to the rectus abdominis muscles, and these vessels are avoided by the mid-line incision [21]. The paramedian incision is performed over the medial or lateral position of the rectus muscle, and provides the same exposure as the median incision. Additional benefit for the paramedian incision over the midline incision in the obese patients is doubtful. The principal problem associated with the midline incision is that it has the highest rate of wound dehiscence when compared with all other incisions. Dehiscence rates as high as 2–3 % have been reported in obese patients [22].

When compared to patients with low BMI, the umbilicus is located caudad to its normal position in the obese patients [23]. If a midline incision is made, it is essential to take care not to 'buttonhole' the pannus [24]. The midline incision is made by first retracting the panniculus caudad, below the inferior margins of the symphysis, to avoid an incision in the anaerobic subpannicular fold. The fascial incision is always extended up to the symphysis [25]. Although midline or vertical incisions are associated with more postoperative pain, dehiscence and hernia formation, but with correct closure, the latter two can be minimized [26].

A Pfannenstiel incision is the most common transverse incision for pelvic surgery, and is made one to three fingerbreadths above the pubic symphysis. It is associated with greater wound strength and better cosmesis compared with vertical incisions. However, a Pfannenstiel incision provides limited exposure for the entire abdomen and requires more time to attain a sufficient surgical field [27]. The Pfannenstiel incision is used extensively in gynecologic surgery because of its excellent cosmetic result, low incidence of hernia and dehiscence, and earlier return to ambulation. This incision is associated with an increased hematoma rate and should be used with caution in patients with an abnormal coagulation profile [28]. If a transverse incision is made, care should be

taken to avoid the area under the panniculus as wound complications will be higher [24].

In the Maylard incision, the rectus muscles are cut and the inferior epigastric vessels are ligated. On the other hand the Cherney incision is a modified transverse incision in which the tendinous insertion of the rectus muscles are cut. In our experience with the obese patients, the benefits of all types of transverse incisions are over weighted by the limited access provided, so we routinely use mid line incision in the morbidly obese patients.

Regardless of the type of incision, we recommend using scalpel for the incision, as multiple animal studies have shown that the use of electrosurgery leads to increased tissue damage and decreased tensile strength. Despite the inconsistent results in human subjects concerning the impact of electrosurgery use on wound complications, in a study by Kolb et al., electrosurgery use was found to be an independent risk factor for the development of wound complications [29]. Wounds with large areas of "dead space" remain hypoxic. A surgical incision into thick subcutaneous tissue with increased tissue damage due to electrosurgical effects may lead to such an environment [30].

Pulmonary function should also be considered when planning an incision. In a study where patients with chronic obstructive pulmonary disease were randomly assigned to midline or transverse incisions, after a transverse incision, these patients had better postoperative lung function and fewer pulmonary complications. However, no difference was seen in patients without preoperative pulmonary disease [31].

Abdominal wall retraction is of utmost importance to provide good visualization in obese patients. Due to the increased thickness of the anterior abdominal wall, retraction can be challenging. There are many available techniques for abdominal wall retraction. We routinely use self-retaining retractors, to free the hands of the assistant surgeon. Some handheld models, like the Deaver and Richardson, remain in use today. Self-retaining retractors that have been widely used in gynecology include: Bookwalter retractor, Balfour-Doyen retractor, Alexis O retractor. We prefer using the bookwalter retractor, as different blade length is available to allow for different depths of the abdominal wall. Also the angle of retraction can be changes easily due to the ratchet system [32]. The iliohypogastric and ilioinguinal nerves are branches of the lumbar plexus that course along the abdominal oblique muscles and innervate the overlying skin in an oblique distribution inferomedially from near the level of the anterior spine of the iliac crest. Postoperative pain due to injury of these sensory nerves occurs, in particular with Pfannenstiel incisions [33]. Particular attention – during performing or closing Pfannenstiel incisions or during prolonged abdominal wall retraction- should be paid to decrease the risk of injury to those nerves. Also the femoral nerve is at risk of injury due to abdominal wall retraction, care must be taken with the placement of the pelvic blades to minimize that risk [34].

We utilize the same basic steps for performing open hysterectomy described elsewhere, with special consideration to the following:

Packing of the bowels is of special importance particularly in obese patients. The cecum and sigmoid are packed first with separate packs, and a third rolled or folded pack is placed in the center behind the superior retractor blade to hold back the small bowel [25]. Moist laparotomy sponges are preferred, and also it is recommended to decrease the duration of packing to the needed minimum.

Ureteric identification is important during hysterectomy and can help in preventing injuries. The ureter can be identified easily transperitoneally in thin patients as there is minimally amount of retroperitoneal fat, but in obese patients with increased retroperitoneal adiposity, it may be difficult to visualize the ureter in this manner [35]. On the contrary in obese patients, retroperitoneal dissection and ureterolysis is usually needed to visualize and identify the ureter.

For women undergoing abdominal hysterectomy, increased BMI was shown to be associated with increased odds of heavy bleeding during surgery (defined as >1000 mL of estimated blood loss) [odds ratio (OR) = 3.64; 95 % confidence interval (CI), 2.90–4.56] [13]. Achieving hemostasis can be challenging in obese patients, but it can be obtained with meticulous dissection. Type and screen should be ordered, in case blood transfusion will be needed.

The Use of Drains

Meta-analyses have shown that the effect of using a subcutaneous drain in obese women undergoing laparotomy remains controversial, Kozol et al. conducted a randomized trial of 98 morbidly obese patients and found no difference in wound infection, skin separation, or hematoma in patients who had closed suction drainage of the subcutaneous space or patients who had stay suture closure of this space [36]. Since no significant benefit was established with the routine use of drains, we do not recommend routine prophylactic drainage.

Fascial Closure

We routinely use PDS (Ethicon, Somerville, NJ) or Maxon (Medtronic, Minneapolis, Minnesota) to close midline laparotomy incision in obese patients. In a prospective randomized multicenter trial by Wissing et al., that included 1491 patients randomized into four different fascial closure techniques; interrupted closure with polyglactin; continuous closure with polyglactin; continuous closure with polydioxanones,

and continuous closure with nylon, concluded that polydiaxanone (PDS), or a similar suture, was the best choice as it had a hernia rate almost as low as nylon, but with less pain and with fewer sinus tracts [37].

Subcutaneous Closure

The management of subcutaneous tissue in the obese population remains controversial, in a study that included 222 patients, no significant difference was found in wound complications between the study arms, 1-suture approximation of Camper's fascia, 2- closed suction drainage of the subcutaneous space, or 3- no intervention as a control group [38].

In a RCT by Naumann et al., where 245 women with at least 2 cm of subcutaneous fat were randomized to closure of Camper's fascia (with 3/0 Vicryl) or no closure with cesarean delivery, a significant difference was found in the rate of wound disruption [39]. Despite the fact that we could not find a similar study for open hysterectomy, we adopted subcutaneous closure for all patients with more than 2 cm thickness of subcutaneous tissues.

We prefer Skin closure using subcuticular absorbable monofilament sutures. Two other advantages of absorbable monofilament are its high tensile strength and better anti-inflammatory properties [27].

Surgical Site Infection (SSI)

In a recent large retrospective study, certain risk factors have been shown to be associated with surgical site infections in patients undergoing abdominal hysterectomy including; overweight (OR, 1.7; 95 % CI, 1.2–2.5; p = .004), obesity (OR, 3.2; 95 % CI, 2.3–4.5; p = .001), operative time >180 min (OR, 1.8; 95 % CI, 1.2–2.6; p = .002) [40]. The relationship between SSI and obesity and operative time is interchanging. It has been shown that duration of operation greater than the 75th percentile was associated with increased odds of SSI in the multivariable analysis [41]. On the other hand, obesity is associated with increased operative time [8]. But also it is worth mentioning that obesity has also been shown to be independently associated with SSI specifically after abdominal hysterectomy.

When choosing an incision type, special attention must be paid to the excess soft tissue of the obese patient in relation to the body core [1]. In addition, increased dead space may lead to an increase in wound fluid acting as a suitable culture medium for contaminating microorganisms [30].

The pooled rate of surgical site infection (SSI) after abdominal hysterectomy as reported by the National Healthcare Safety Network for 2006–2007 was 1.7 % [42]. Before routine use of prophylactic antibiotic regimens, SSI rates reported for abdominal hysterectomy were 9 % or higher [30, 43, 44].

Risk factors for SSI identified with multivariable analysis include obesity, depth of subcutaneous tissue, use of abdominal approach, and inadequate antimicrobial prophylaxis [41]. Morbid obesity was associated with the greatest odds of incisional SSI, with a dose-response relationship between risk and increased BMI [41]. When prophylactic antibiotics are warranted, some have advocated a 2-g prophylactic cefazolin dose in those patients who weigh more than 80 kg, with an increase to 3 g for those who weigh more than 120 kg [45].

Postoperative Venous Thromboembolism

The incidence of venous thromboembolism after gynecologic surgery varies significantly and depends on the diagnostic modality. When diagnosed by I-125 fibrinogen leg scanning, approximately 14 % of patients undergoing gynecologic surgery for benign indications develop thromboembolism [46]. When diagnosed clinically only 3 % were diagnosed with DVT [47]. Obesity is associated with increased risk for developing venous thromboembolism (VTE) [48]. The incidence of VTE for open hysterectomy was higher (0.6 %, 81/12,733) than minimally invasive hysterectomy (0.2 % 73/31,434, P < .001) [49]. In a large retrospective study that included 9917 patients, overweight patients were found to be at a higher risk for thrombotic events than both obese and ideal BMI patients [50]. Authors assumed that this finding is attributed to the increased use of prophylactic anticoagulant therapies in the obese, which may explain this apparently paradoxical observation [50].

Early ambulation is highly recommended as immobilization is a major risk factor for development of VTE, with a ninefold increase seen in patients on bed rest [47]. Intermittent pneumatic compression has been shown to reduce the incidence of venous thromboembolism in a gynecologic oncology patient population [51]. We recommend using a perioperative validated scoring system to stratify the patient's risk for developing VTE and use compression devices and/or pharmacologic anticoagulation as indicated. One of the commonly used scoring systems is the Caprini Score [52], which is one of two scoring systems used by American College of Chest Physicians (ACCP) for risk stratification [53].

These risk stratification systems will advice practitioners according to the individualized patient score on which method or combination of methods better suits the patient's risk.

Conclusion

Obesity is not only a challenging health problem but also it affects surgical decision-making [11]. Significant increased in perioperative morbidity is seen in obese

patients undergoing open hysterectomy, which can be decreased through an appropriate risk stratifying perioperative care.

References

1. Matthews KJ, Brock E, Cohen SA, Chelmow D. Hysterectomy in obese patients: special considerations. Clin Obstet Gynecol. 2014;57(1):106–14.
2. Executive summary of the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. Archives of internal medicine. 1998. 158(17):1855–67.
3. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999–2010. JAMA. 2012;307(5):491–7.
4. Stevens J, Cai J, Pamuk ER, Williamson DF, Thun MJ, Wood JL. The effect of age on the association between body-mass index and mortality. N Engl J Med. 1998;338(1):1–7.
5. Committee on Gynecologic P. Committee opinion no. 619: gynecologic surgery in the obese woman. Obstet Gynecol. 2015;125(1):274–8.
6. ACOG. Committee opinion no. 444: choosing the route of hysterectomy for benign disease. Obstet Gynecol. 2009;114(5):1156–8.
7. Jacoby VL, Autry A, Jacobson G, Domush R, Nakagawa S, Jacoby A. Nationwide use of laparoscopic hysterectomy compared with abdominal and vaginal approaches. Obstet Gynecol. 2009;114(5):1041–8.
8. Mikhail E, Miladinovic B, Velanovich V, Finan MA, Hart S, Imudia AN. Association between obesity and the trends of routes of hysterectomy performed for benign indications. Obstet Gynecol. 2015;125(4):912–8.
9. Dayaratna S, Goldberg J, Harrington C, Leiby BE, McNeil JM. Hospital costs of total vaginal hysterectomy compared with other minimally invasive hysterectomy. Am J Obstet Gynecol. 2014;210(2):120 e1–6.
10. Mullen JT, Moorman DW, Davenport DL. The obesity paradox: body mass index and outcomes in patients undergoing nonbariatric general surgery. Ann Surg. 2009;250(1):166–72.
11. Mikhail E, Scott L, Imudia AN, Hart S. Total laparoscopic hysterectomy in the obese patient. Surg Technol Int. 2014;25:167–74.
12. Siedhoff MT, Carey ET, Findley AD, Riggins LE, Garrett JM, Steege JF. Effect of extreme obesity on outcomes in laparoscopic hysterectomy. J Minim Invasive Gynecol. 2012;19(6):701–7.
13. Osler M, Daugbjerg S, Frederiksen BL, Ottesen B. Body mass and risk of complications after hysterectomy on benign indications. Hum Reprod. 2011;26(6):1512–8.
14. Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. JAMA. 2003;289(1):76–9.
15. Isono S. Obstructive sleep apnea of obese adults: pathophysiology and perioperative airway management. Anesthesiology. 2009;110(4):908–21.
16. Poirier P, Alpert MA, Fleisher LA, Thompson PD, Sugerman HJ, Burke LE, et al. Cardiovascular evaluation and management of severely obese patients undergoing surgery: a science advisory from the American Heart Association. Circulation. 2009;120(1):86–95.
17. Shenkman Z, Shir Y, Brodsky JB. Perioperative management of the obese patient. Br J Anaesth. 1993;70(3):349–59.
18. Brodsky JB. Positioning the morbidly obese patient for anesthesia. Obes Surg. 2002;12(6):751–8.
19. Scheib SA, Tanner 3rd E, Green IC, Fader AN. Laparoscopy in the morbidly obese: physiologic considerations and surgical techniques to optimize success. J Minim Invasive Gynecol. 2014;21(2):182–95.
20. Cadi P, Guenoun T, Journois D, Chevallier JM, Diehl JL, Safran D. Pressure-controlled ventilation improves oxygenation during laparoscopic obesity surgery compared with volume-controlled ventilation. Br J Anaesth. 2008;100(5):709–16.
21. Berek and Hacker's gynecologic oncology. 4th ed. Lippincott Williams & Wilkins. Philadelphia, PA. 2010.
22. Brolin RE. Prospective, randomized evaluation of midline fascial closure in gastric bariatric operations. Am J Surg. 1996;172(4):328–31.
23. Hurd WW, Bude RO, DeLancey JO, Pearl ML. The relationship of the umbilicus to the aortic bifurcation: implications for laparoscopic technique. Obstet Gynecol. 1992;80(1):48–51.
24. Alexander CI, Liston WA. Operating on the obese woman – a review. BJOG Int J Obstet Gynaecol. 2006;113(10):1167–72.
25. Te Linde's operative gynecology. 10th ed. Lippincott Williams & Wilkins. Philadelphia, PA. 2008.
26. Cliby WA. Abdominal incision wound breakdown. Clin Obstet Gynecol. 2002;45(2):507–17.
27. Inotsume-Kojima Y, Uchida T, Abe M, Doi T, Kanayama N. A combination of subcuticular sutures and a drain for skin closure reduces wound complications in obese women undergoing surgery using vertical incisions. J Hosp Infect. 2011;77(2):162–5.
28. Nygaard IE, Squatrito RC. Abdominal incisions from creation to closure. Obstet Gynecol Surv. 1996;51(7):429–36.
29. Kolb BA, Buller RE, Connor JP, DiSaia PJ, Berman ML. Effects of early postoperative chemotherapy on wound healing. Obstet Gynecol. 1992;79(6):988–92.
30. Soper DE, Bump RC, Hurt WG. Wound infection after abdominal hysterectomy: effect of the depth of subcutaneous tissue. Am J Obstet Gynecol 1995;173(2):465–9; discussion 9–71.
31. Becquemin JP, Piquet J, Becquemin MH, Melliere D, Harf A. Pulmonary function after transverse or midline incision in patients with obstructive pulmonary disease. Intensive Care Med. 1985;11(5):247–51.
32. Barr J, Brayman KL. Development and evolution of self-retaining retractors in surgery: the example of the Bookwalter retractor. J Am Coll Surg. 2015;221(2):628–34.
33. Shin JH, Howard FM. Abdominal wall nerve injury during laparoscopic gynecologic surgery: incidence, risk factors, and treatment outcomes. J Minim Invasive Gynecol. 2012;19(4):448–53.
34. Maneschi F, Nale R, Tozzi R, Biccire D, Perrone S, Sarno M. Femoral nerve injury complicating surgery for gynecologic cancer. Int J Gynecol cancer Off J Int Gynecol Cancer Soc. 2014;24(6):1112–7.
35. Dassel MW, Adelman MR, Sharp HT. Recognition and management of urologic injuries with laparoscopic hysterectomy. Clin Obstet Gynecol. 2016;4:323–8.
36. Kozol RA, Fromm D, Ackerman NB, Chung R. Wound closure in obese patients. Surg Gynecol Obstet. 1986;162(5):442–4.
37. Wissing J, van Vroonhoven TJ, Schattenkerk ME, Veen HF, Ponsen RJ, Jeekel J. Fascia closure after midline laparotomy: results of a randomized trial. Br J Surg. 1987;74(8):738–41.
38. Cardosi RJ, Drake J, Holmes S, Tebes SJ, Hoffman MS, Fiorica JV, et al. Subcutaneous management of vertical incisions with 3 or more centimeters of subcutaneous fat. Am J Obstet Gynecol 2006;195(2):607–14; discussion 14–6.
39. Naumann RW, Hauth JC, Owen J, Hodgkins PM, Lincoln T. Subcutaneous tissue approximation in relation to wound disruption after cesarean delivery in obese women. Obstet Gynecol. 1995;85(3):412–6.
40. Mahdi H, Goodrich S, Lockhart D, DeBernardo R, Moslemi-Kebria M. Predictors of surgical site infection in women undergoing hysterectomy for benign gynecologic disease: a multicenter analysis

using the national surgical quality improvement program data. J Minim Invasive Gynecol. 2014;21(5):901–9.
41. Olsen MA, Higham-Kessler J, Yokoe DS, Butler AM, Vostok J, Stevenson KB, et al. Developing a risk stratification model for surgical site infection after abdominal hysterectomy. Infect Control Hosp Epidemiol. 2009;30(11):1077–83.
42. Edwards JR, Peterson KD, Andrus ML, Dudeck MA, Pollock DA, Horan TC, et al. National Healthcare Safety Network (NHSN) report, data summary for 2006 through 2007, issued November 2008. Am J Infect Control. 2008;36(9):609–26.
43. Shapiro M, Munoz A, Tager IB, Schoenbaum SC, Polk BF. Risk factors for infection at the operative site after abdominal or vaginal hysterectomy. N Engl J Med. 1982;307(27):1661–6.
44. Kandula PV, Wenzel RP. Postoperative wound infection after total abdominal hysterectomy: a controlled study of the increased duration of hospital stay and trends in postoperative wound infection. Am J Infect Control. 1993;21(4):201–4.
45. Bratzler DW, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, Bolon MK, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm AJHP Off J Am Soc Health Syst Pharm. 2013;70(3):195–283.
46. Walsh JJ, Bonnar J, Wright FW. A study of pulmonary embolism and deep leg vein thrombosis after major gynaecological surgery using labelled fibrinogen-phlebography and lung scanning. J Obstet Gynaecol Br Commonwealth. 1974;81(4):311–6.
47. Clarke-Pearson DL, Abaid LN. Prevention of venous thromboembolic events after gynecologic surgery. Obstet Gynecol. 2012;119(1):155–67.
48. Horvei LD, Braekkan SK, Mathiesen EB, Njolstad I, Wilsgaard T, Hansen JB. Obesity measures and risk of venous thromboembolism and myocardial infarction. Eur J Epidemiol. 2014;29:821–30.
49. Barber EL, Neubauer NL, Gossett DR. Risk of venous thromboembolism in abdominal versus minimally invasive hysterectomy for benign conditions. Am J Obstet Gynecol. 2015;212(5):609 e1–7.
50. Khavanin N, Lovecchio FC, Hanwright PJ, Brill E, Milad M, Bilimoria KY, et al. The influence of BMI on perioperative morbidity following abdominal hysterectomy. Am J Obstet Gynecol. 2013;208(6):449 e1–6.
51. Clarke-Pearson DL, Synan IS, Hinshaw WM, Coleman RE, Creasman WT. Prevention of postoperative venous thromboembolism by external pneumatic calf compression in patients with gynecologic malignancy. Obstet Gynecol. 1984;63(1):92–8.
52. Bahl V, Hu HM, Henke PK, Wakefield TW, Campbell Jr DA, Caprini JA. A validation study of a retrospective venous thromboembolism risk scoring method. Ann Surg. 2010;251(2):344–50.
53. Guyatt GH, Akl EA, Crowther M, Gutterman DD, Schuunemann HJ, American College of Chest Physicians Antithrombotic T, et al. Executive summary: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest. 2012;141(2 Suppl):7S–47S.

Wertheim-Meigs Abdominal Radical Hysterectomy and Lymphadenectomy

97

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The Wertheim-Meigs surgical procedure is an operation performed for the management of selected case of uterine or vaginal carcinomas (including uterine carcinoma involving the uterine cervix and/or the upper vagina). In the late years of the 1800, Ernst Wertheim developed this procedure characterized by the extirpation of the uterus within its surrounding structures (i.e., parametria). However, the high morbidity and mortality rates reported by the Viennese physician in comparison to the standard treatment (i.e., radiotherapy) used for the management of cervical carcinoma, discouraged the widespread diffusion of this operation. Notwithstanding, in 1944, Joe Vincent Meigs, re-popularized this operation developing the modified Wertheim hysterectomy, characterized by the removal of all pelvic nodes within the uterus and the parametria.

In the present era, radical hysterectomy represents the mainstay of treatment of many gynecologic malignancies [1–3]. In fact, technical and technological improvements allow the execution of an abdominal radical hysterectomy (ARH) in a safe and effective way, thus allowing the extirpation of the tumor and reducing damage on surrounding tissue (i.e., bladder, bowel and vagina) that are injured by radiotherapy.

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Indications for the execution of ARH include: early stage cervical cancer, locally advanced stage cervical cancer after the execution of neoadjuvant chemotherapy, FIGO stage II endometrial cancer and gynecologic sarcomas extending beyond the uterine corpus [1–3]. Although several studies underlined how minimally invasive surgery (i.e., laparoscopic and robotic-assisted surgery) improve short and medium-term outcomes of patients undergoing radical hysterectomy, in comparison to open abdominal operation, the majority of radical hysterectomies are still performed via abdominal incisions [4]. In this chapter we describe the technique of the standard Wertheim-Meigs surgical procedure and pelvic lymphadenectomy.

Wertheim-Meigs Radical Hysterectomy

To perform this procedure, the patient is placed in a dorsal (supine) lithotomic and Trendelenburg position to facilitate intraoperative pelvic organs exposure of the operative field. Pelvic examination is performed. A Foley catheter is placed in the bladder. Examination under anesthesia is paramount to assess status of the cervix, vagina, parametria as well as uterosacral ligaments. Examination is performed in the same session of surgical treatment; but when the status of vagina and parametria is not clear, it should be performed in a separate previous session. A careful selection of the incision site is needed and depends on the basis of patient's characteristics (e.g., body habitus, previous scars). After the execution of an abdominal incision (midline or transverse), the pelvis and the upper abdomen are carefully explored. Generally, a midline incision is preferred, since it allows an accurate exposure to the upper abdomen and aortic lymph nodes. A retractor is used to keep an adequate operating field. The intestine is packed in the upper abdomen, thus allowing to expose the pelvis. The uterus is pulled on using clamps placed on the cornua bilaterally. First, the uterus is located to

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the patient's right. The left round ligament is placed on stretch and incised close to the pelvic sidewall. The anterior leaf of the left broad ligament is opened along with the uterine-bladder peritoneal fold. These steps are carried out on the oppose site. The peritoneum above the bladder is grasped and elevated. Scissors are used to dissect the uterovescical fold. The bladder is sharply dissected caudally, from the anterior upper vagina (at least 3–4-cm). The posterior leaf of the broad ligament is opened, exposing the infundibulopelvic ligament. The ureter is identified at the level of the common iliac vessels and it is separated from the infundibulopelvic ligament. If the ovaries have to be removed, the infundibulopelvic ligament is clamped, cut and doubly suture-ligated. The tubes and the ovaries are tied to the clamps holding the uterus. If the ovaries have to be preserved, the posterior leaf of the broad ligament is further incised parallel and inferior to the infundibulopelvic and utero-ovarian ligaments. The utero-ovarian ligament is then clamped, cut, and ligated, and the ovary is tucked in the upper abdomen (at the end of the procedure they will be suspended to the lateral pelvic wall, outside of the radiation field, and clips will be placed to allow their identification at postoperative imaging studies).

Next, the iliac vessels are identified: common iliac, external iliac, and internal iliac vessels and the ureter are exposed on both pelvic sides (Fig. 97.1). A pelvic lymphadenectomy (PL LND) can be performed before or after completing the radical hysterectomy (in this chapter the technique of PL LND is reported below). In some instances, surgeons prefer to excise nodes before the execution of radical hysterectomy. The nodes are sent for frozen section analysis and in case of documented lymph node metastases the procedure is aborted in favor of a chemoradiotherapic management, thus reducing morbidity of a combined treatment (surgery plus postoperative adjuvant pelvic chemoradiotherapy for positive nodes) [5].

Paravesical and pararectal spaces are developed with blunt dissection to gain access to the lateral parametria (Fig. 97.2). The round ligament is ligated and divided close to the pelvic sidewall. The pelvic peritoneum is then opened parallel to the infundibolopelvic ligament cranially up to the level of the common iliac vessels. The retroperitoneum is then developed bluntly. The paravesical space is opened by dissecting medial to the junction of the external iliac and circumflex veins and lateral to the bladder and obliterated umbilical artery, down to the pelvic floor. The landmarks of the paravescical space are the obliterated umbilical artery and the bladder wall medially, the levator ani muscle caudally, the external iliac vessels and the obturator fossa laterally and the cardinal ligament dorsally. First, the obliterated umbilical artery is identified and pulled medially with the bladder wall, then the areolar space is developed bluntly between external iliac vessels laterally and obliterated umbilical artery and bladder medially down to the levator ani muscle. Similarly, the pararectal space is developed bluntly between the rectum and the ureter medially, the sacrum ventrally, the pelvic sidewall and the internal iliac vessels laterally. The landmarks of the pararectal space are the ureter and the rectum medially, the sacrum caudally, the internal iliac vessels and the pelvic sidewall laterally and the cardinal ligament ventrally. After having opened the pelvic sidewall peritoneum, the adnexa il pulled medially. The ureter is identified via blunt dissection and pulled medially, separating it from the structures of the pelvic pelvic sidewall. First, the areolar tissue between external iliac vessels laterally and ureter medially is developed bluntly; then the areolar tissue between internal iliac vessels laterally and rectum medially

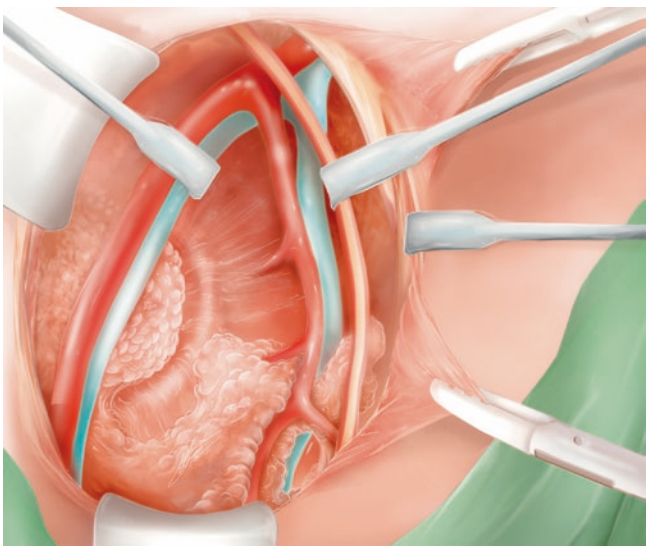


Fig. 97.1 Retroperitoneal pelvic space

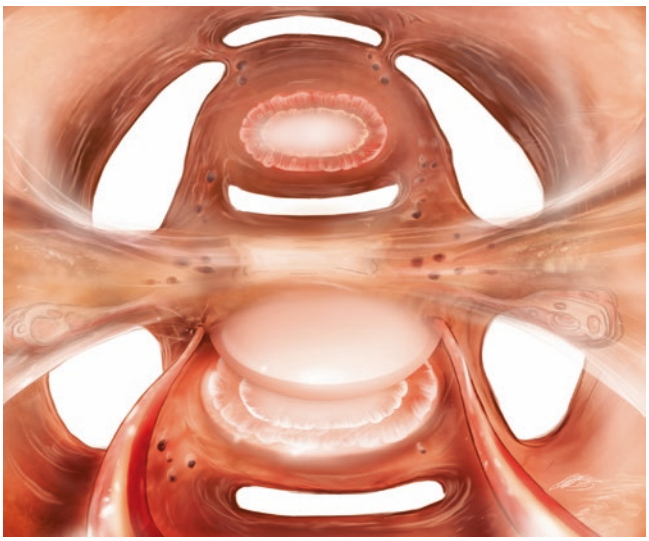


Fig. 97.2 Pelvic spaces

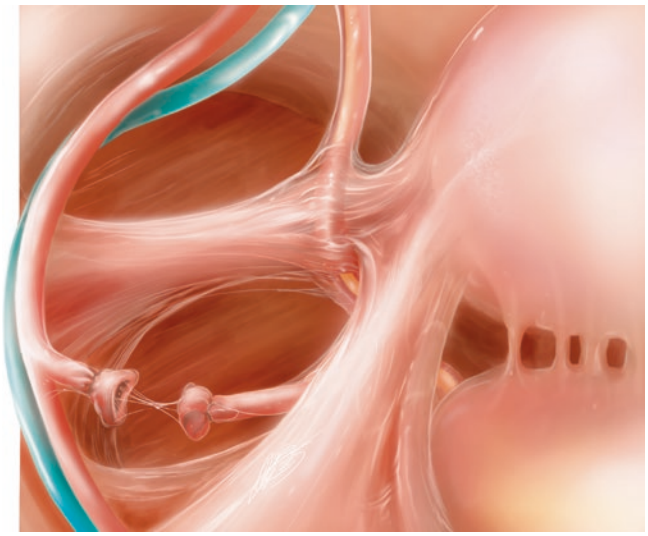


Fig. 97.3 Section of uterine artery

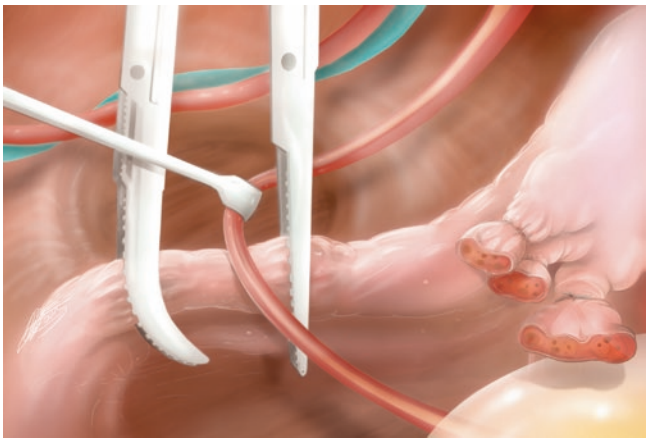


Fig. 97.4 Dissection of Wertheim's tunnel

is developed in the same manner. An accurate palpation of the parametria is necessary to assess the extension of the tumor beyond the uterine cervix. The ureters have to be gently dissected for their entire course in the pelvis to the point where the ureter enters in the parametrial tunnel of Wertheim. Both the ureters should be placed within a vessel-loop for their traction. A backward traction on the ureter is essential to allow its safe dissection from the paracervical tissue.

Then the uterine vessels are identified; tracing proximally the upper vesical artery may facilitate the identification of the uterine artery. On each side, after its skeletonization, the uterine artery is double ligated at its origin from the hypogastric artery (Fig. 97.3). Similarly, the uterine veins (superficial and deep) are ligated and mobilized medially. The deep uterine vein represents the caudal limit of the dissection. The lower part of the lateral parametria, containing the splancnic nerves has to be preserved during this step. In order to do so, the deep uterine vein is identified, ligated and cut. The distal stump of the vein is lifted ventrally and medially and the tissue just underneath it dissected medially until the cross with the ureter is reached. This allows for a preservation of the splancinc nerves. Then the caudal part of the ureter is dissected from the parametria and mobilized medially too (Fig. 97.3). The dissection of Wertheim's tunnel, within the uterovescical ligament, is usually performed using a right angle clamp along the superior border of the ureter. In this step a gentle traction on the ureter is paramount to avoid damages of the ureter (Fig. 97.4). The uterovescical ligaments are divided, thus releasing the ureters free. At this point, the uterus is pulled on ventrally. The posterior leaf of the broad ligament is incised. The posterior peritoneum is opened from the broad ligament to the pouch of Douglas. The rectum is dissected from the upper part of the posterior vaginal wall, in order to develop the recto-vaginal space (for approximately 4 cm). During this step, the rectum must be pulled dorsally, to facilitate the dissection of the correct plane, thus reducing rectal injuries.

Then, the uterosacral ligaments are identified, isolated, clamped and tied. The lower part of the uterosacral ligaments, containing the parasympathetic nerves have to be preserved during this step. The paravaginal tissue at the inferior margin of the dissection is clamped, cut, and tied. The vagina is clamped using two right-angle Heaney or Zeppelin clamps and transected approximately 3 cm below the cervix. The specimen including the uterus, upper vagina, parametria and uterosacral ligaments is removed from the surgical field. The vaginal cuff is closed using two continuous interlocking running sutures. The abdominal and pelvic cavity have to be irrigated in order to check hemostasis. Routine use of suction drains has to be avoided. Then, if indicated other procedures are performed on the basis of clinical indication. Incision is closed in layers.

Lymphadenectomy

Systematic PL LND was defined as the removal of all lymphatic tissue in the external iliac and internal iliac regions and in the obturator fossa. The borders of the dissection are: the psoas muscle laterally, the hypogastric artery medially, the obturator fossa posteriorly, the origin of the epigastric artery caudally, at the level of the circumflex vein, and the bifurcation of the common iliac artery cranially. When PL LND is performed with radical hysterectomy the pelvic retroperitoneal structures (i.e., ureters, iliac vessels and pelvic nerves) are already identified and the retroperitoneal pelvic spaces are already developed. PL LND is started with the removal of all lymphatic tissue from the common iliac artery and vein (Fig. 97.1).

Therefore, the iliac vessels are retracted medially. The lymphatic tissue is detached from the psoas muscle, retracted laterally. Usually, the obturator nerve is identified during this step, at the level of iliac bifurcation. In order to access to the lymphatic tissue located in the obturator fossa, the external iliac vessels are retracted laterally. The obturator nerve is freed from the lymphatic tissue. This latter is isolated from vessels, nerve and the vascular part of the cardinal ligament. The femoral ring represents the caudal border of the specimen. Lymphatic pedicles are identified and closed using clips or sutures. At the end of the procedure, the external iliac artery and vein, the internal iliac vessels, the iliac artery bifurcation, and the obturator nerve are fully exposed.

Although the standard treatment of cervical cancer does not require the execution of para-aortic lymphadenectomy (PA LND), this procedure can be performed if indicated. Generally, the upper margin of the dissection for cervical cancer patients is the origin of the inferior mesentery artery; while in endometrial and ovarian cancer the upper limit is represented by the renal vessels. The medial surgical margin is the prevertebral fascia; while the psoas muscles is the lateral margin. During PA LND all lymph nodes close to the aorta, the cava and between these two vessels are dissected.

The spaces are developed by blunt and sharp dissection and only bipolar coagulation is used for blood and lymphatic vessels sealing. Before starting with PA LND, the ureter is identified, separated from the ovarian vessels and displaced laterally. Lymphatic tissue is removed en-bloc and separately from each side. Caution must be exercised in order to avoid damages of the inferior mesentery artery, accessory vessels to the lower renal pole as well as lumbar vessels. No closure of the peritoneal layer is performed.

Conclusion

In the present chapter, we described the classical "Wertheim-Meigs radical hysterectomy". However, we have to stress that the term "radical hysterectomy" encompasses various degrees of radicality. In particular, several authors proposed a modification of the technique, but anatomical nomenclature was unclear and classification between different procedures is not based always on anatomical landmarks. For this reason, in 2008, Querleu and Morrow proposed a new classification based on strict anatomical criteria. In this classification, type C radical hysterectomy corresponds to the classical "Wertheim-Meigs radical hysterectomy" [1, 6]. Interestingly, in this classification, the Authors defined two subcategories of type C radical hysterectomy: type C1 and C2 characterized by preservation and no preservation of the autonomic nerves, respectively [1, 6]. Accumulating evidence supports the embrace of type C1 instead of type C2 procedures. In fact, type C1 radical hysterectomy upholds oncologic results of conventional type C2 operation, minimizing postoperative pelvic dysfunctions and enhancing postoperative course [7–10]. Oncologic control and tailored radicality are key points in order to improve patients' quality of life. Further studies on radical hysterectomy are warranted in order to improve patients' care.

References

1. Cibula D, Abu-Rustum NR, Benedetti-Panici P, Köhler C, Raspagliesi F, Querleu D, Morrow CP. New classification system of radical hysterectomy: emphasis on a three-dimensional anatomic template for parametrial resection. Gynecol Oncol. 2011;122:264–8.
2. Cibula D, Abu-Rustum NR. Pelvic lymphadenectomy in cervical cancer – surgical anatomy and proposal for a new classification system. Gynecol Oncol. 2010;116:33–7.
3. Mariani A, Webb MJ, Keeney GL, Calori G, Podratz KC. Role of wide/radical hysterectomy and pelvic lymph node dissection in endometrial cancer with cervical involvement. Gynecol Oncol. 2001;83:72–80.
4. Juhasz-Böss I, Mallmann P, Möller CP, Solomayer EF. Use of laparoscopy in the treatment of endometrial and cervical cancer – results of a 2012 Germany-wide survey. Geburtshilfe Frauenheilkd. 2013;73:911–7.
5. Bogani G, Cromi A, Serati M, et al. Predictors of postoperative morbidity after laparoscopic versus open radical hysterectomy plus external beam radiotherapy: a propensity-matched comparison. J Surg Oncol. 2014;110:893–8.
6. Querleu D, Morrow CP. Classification of radical hysterectomy. Lancet Oncol. 2008;9:297–303.
7. Ditto A, Martinelli F, Mattana F, et al. Class III nerve-sparing radical hysterectomy versus standard class III radical hysterectomy: an observational study. Ann Surg Oncol. 2011;18:3469–78.
8. Raspagliesi F, Ditto A, Hanozet F, et al. Nerve-sparing radical hysterectomy in cervical cancer: evolution of concepts. Gynecol Oncol. 2007;107:S119–21.
9. Bogani G, Serati M, Nappi R, Cromi A, di Naro E, Ghezzi F. Nerve-sparing approach reduces sexual dysfunction in patients undergoing laparoscopic radical hysterectomy. J Sex Med. 2014;11:3012–20.
10. Ditto A, Martinelli F, Borreani C, et al. Quality of life and sexual, bladder, and intestinal dysfunctions after class III nerve-sparing and class II radical hysterectomies: a questionnaire-based study. Int J Gynecol Cancer. 2009;19:953–7.

Okabayashi Radical Hysterectomy

98

Tsutomu Tabata

Introduction

In 1912 Wertheim [1] reported on the results of his first 500 patients using his technique for radical cervical cancer surgery, subsequently his name was assigned to the procedure and all of the modifications to his original procedure are to this date collectively referred to as *Wertheim*. Wertheim was ingenious with two things: Firstly he set goals of prognostic improvement rather than just developing the procedure, that is, he investigated prognosis by statistically analyzing outcomes of surgeries performed. Secondly, with resected specimens, the extent of lesions and presence or absence of metastasis was histopathologically examined. However there were initially some problems with this approach, for example removing only the swollen lymph nodes.

In 1919 Latzko and Schiffman [2] built on the Wertheim method by proposing that a lymph node dissection be performed first, followed by separating the three parts of the uterine supporting ligaments: uterosacral ligaments, cardinal ligaments and vesicouterine ligaments.

The Okabayashi procedure was introduced in 1921 [3, 4]. Features of this surgery formula, similar to Latzko's, advocated separating the uterus support tissue in three parts: the uterosacral ligament, cardinal ligament and vesicouterine ligament. The characteristic feature of the Okabayashi surgical formula was that the anterior and posterior layers of the vesicouterine ligaments were dissected allowing extensive resection of parametrial and paravaginal tissue. This part of the procedure was the most significant change to Latzko's technique. In addition, with concern to the regional lymph nodes, it emphasized the systematic dissection of all lymph nodes rather than only removing the swollen lymph nodes. Both Latzko and Okabayashi have been reported on separately.

The Okabayashi type radical hysterectomy has been passed down in Japan with some improvements having been made. Especially, by Dr. Fuji [5] of Kyoto University who reported on the nerve sparing Okabayashi radical hysterectomy procedure. However, most of the surgical technique is almost the same today as the original. In this chapter, I would like to explain the Okabayashi surgical technique as it is performed today in Japan.

With regard to the order of surgery, there are some differences between the original Okabayashi procedure and the one now [6, 7]. First the original Okabayasi procedure had a radical hysterectomy followed by lymphadenectomy. However for now we are performing lymphadenectomy before radical hysterectomy, because after lymphadenectomy we can see more clearly in pelvic anatomy. Next in the original method a pararectal and paravesical space are developed after the treatment of cardinal ligament, but now we expand these spaces first. This is because expanding the side spaces exposes the ligaments more clearly, thus making the operation more convenient.

The patient is placed in the lithotomy position, with the pelvis high and the surgeon on the left side of the patient. The abdominal cavity is reached through a lower abdominal midline incision. Immediately after laparotomy the degree of cancer progression is observed to determine whether surgery is to be performed. In the cases shown here, in preoperative pelvic examinations, infiltration into both sides of the paracolpium was observed in MRI images with cases that had been diagnosed as Stage IIb (see Figs. 98.1 and 98.2).

Ligation of Round Ligament and Exposure of the Retroperitoneal Space

First the uterus is held by two long Kocher forceps. The round ligament is transected and the peritoneum between the bladder and the uterus is incised (see Fig. 98.3). The opera-

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Fig. 98.1 Sagittal view of MRI. Images in a 62 year-old woman with FIGO stage IIB adenocarcinoma of the uterine cervix. Sagittal T2-weighted image shows the 6 cm tumor in the cervix



Fig. 98.2 Transverse view of MRI. Transverse T2-weighted image shows a slightly hyperintense cervical mass with an irregular margin and disruption of the cervical stromal rim on the left side

bility is checked to see if it is possible to divide between the uterus and the bladder. If it is judged to be possible, the peritoneum on the lateral aspect of the broad ligament is incised further in a lateral direction along with the infundibulopelvic ligament in the cranial direction (see Fig. 98.4). When the retractor is pulled to the cranial side across the surface of the common iliac artery, the ureter can be found. Then pulling the rectum in the opposite direction from the external iliac artery can give the tension to the broad ligament, and it is possible to make a cavity between the ureter

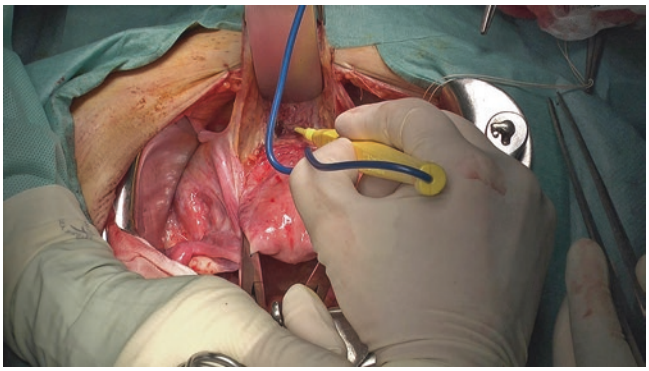


Fig. 98.3 Dissection of the peritoneum uterovesical fold and separation of the bladder. The right round ligament has been clamped, cut, and ligated. The peritoneum of the uterovesical fold has been opened. The vagina is then separated with an electric scalpel from the bladder which is pressed by a retractor and then it is determined whether or not cancer has metastasized to the bladder

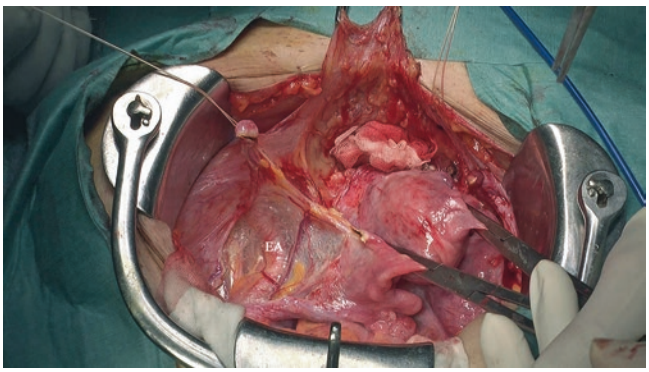


Fig. 98.4 Expansion of the retroperitoneal space. The left round ligament has been cut and the peritoneum has been opened. The external iliac artery (*EA*) is clearly seen

and the umbilical ligament. Thus a pararectal space is easily exposed, because there is little fatty tissue in this space. Furthermore, when the round ligament is pulled outward and the umbilical ligament is pulled to opposite site from this ligament; the surface of paravesical space is then exposed. The dissection is carried laterally until levator ani muscle located at the bottom of paravesical space (see Fig. 98.5). In the original Okabayashi method, the pararectal and paravesical space are developed after the treatment of cardinal ligament, but developing these side cavities first allows for an easier look at the operative area. These spaces did not exist naturally and must be created artificially.

Lymphadenectomy

For regional lymph node dissection please refer to other sections. Briefly, peripheral lymph nodes are gathering to the cervix and such lymph nodes are totally extracted as en bloc lymphadenectomy. Extracted lymph nodes are as follows: Common iliac lymph node, external iliac lymph node, lateral

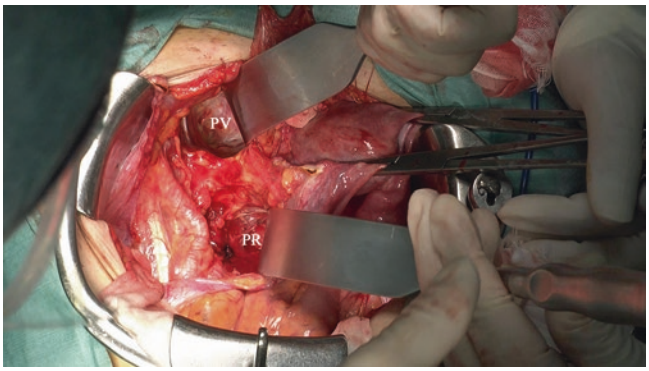


Fig. 98.5 Expansion of the paravesical and pararectal spaces. After developing the paravesical (*PV*) and pararectal (*PR*) spaces, two retractors are placed into both spaces. The tissue between the paravesical and pararectal spaces contains the cardinal ligament and the uterine artery

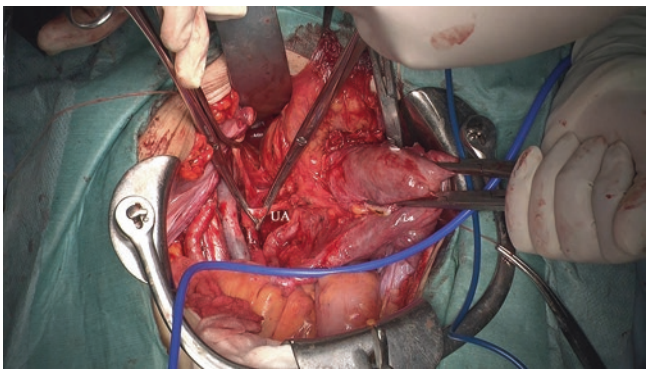


Fig. 98.7 Left uterine artery dissection and ligation. The uterine artery (*UA*) is clamped outside and laterally to the ureter, slightly distal the branch of the internal iliac artery

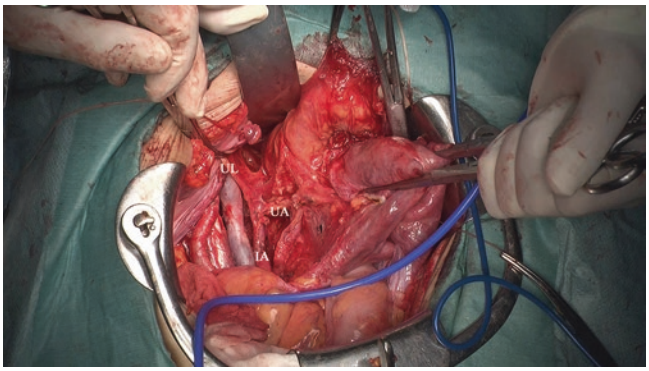


Fig. 98.6 Exposing the uterine artery. When the uterus is held well over to the right side and the umbilical ligament (*UL*) is pulled outward, the uterine artery (*UA*) which branches from the internal iliac artery (*IA*) is exposed in the pararectal space

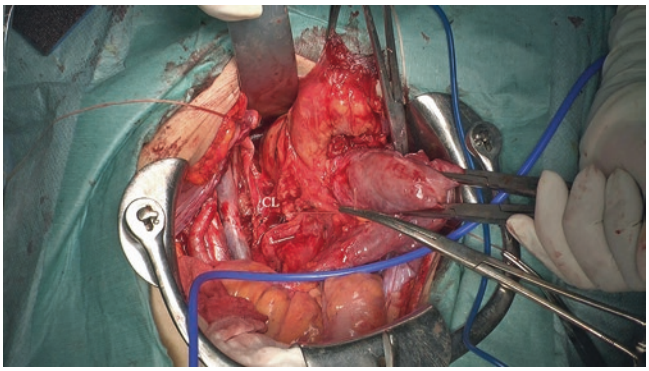


Fig. 98.8 Exposing the cardinal ligament (*CL*). After dividing the uterine artery, the cardinal ligament is exposed beneath the uterine artery

suprainguinal lymph node, medial suprainguinal lymph node, obturator lymph node, internal iliac lymph node, lateral sacral lymph node, and cardinal ligamentous lymph node. If it is needed, para-aortic lymph node is removed.

Ligation of the Uterine Artery

When the umbilical ligament is pulled outward, the uterine artery is exposed in the pararectal space. When the uterine artery is identified, it should be cleared of fat with a vacuum device. The uterine artery is clamped laterally at the distal from the internal iliac artery (see Figs. 98.6, 98.7, and 98.8).

Separation of the Ureter

The ureter is separated from the posterior layer of the broad ligament using an electric scalpel, separating the ureter to near the point where it intersects with the uterine artery (see Figs. 98.9 and 98.10). In this case it is simple to separate and lift up the uterine side stump of the uterine artery that was disconnected earlier. In the case of oophorectomy, after separating the ureter the ligation of the infundibulo-pelvic ligament is performed (see Figs. 98.11 and 98.12). The opposite side is also performed in the same manner.

In the Wertheim procedure the ureter passes through the tunnel of the cardinal ligament, but in the Okabayashi procedure the cardinal tunnel does not exist.

Douglas Fossa

The uterus is pulled in the posterior direction of the pubic symphysis, pulling the rectum to the cranial side. Thereupon, tension is created in the uterosacral ligaments and the Douglas fossa is clear. First, incise the Douglas fossa with an electric scalpel, and then also dissect the surface of the uterosacral ligaments with an electric scalpel (see Figs. 98.13 and 98.14).

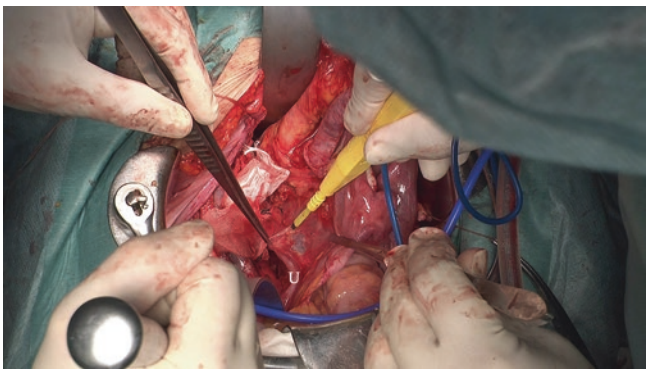


Fig. 98.9 Separation of the ureter. The ureter (*U*) is detached from the broad ligament with electronic scalpel to the point where the uterine artery crosses over the ureter

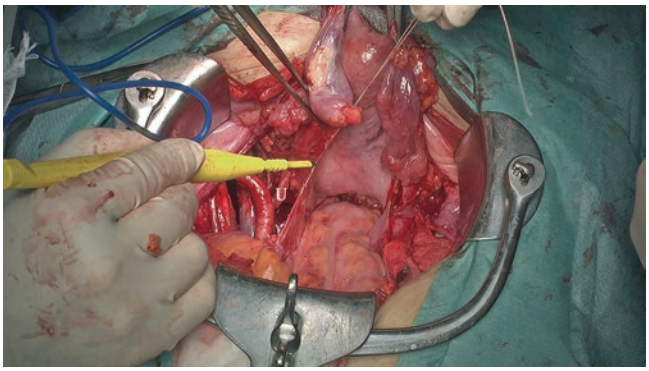


Fig. 98.12 Dissection of the broad ligament. After lifting the cut edge of the infundibulopelvic ligament, the broad ligament is incised toward the uterosacral ligament

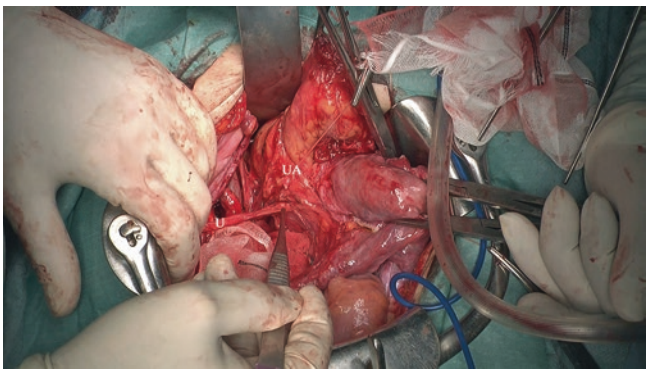


Fig. 98.10 Dissection of the ureter. These ureteral branches of the uterine artery (*UA*) are cut with a Harmonic Focus

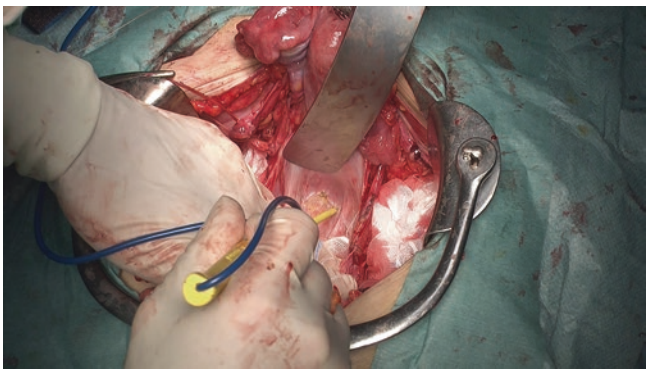


Fig. 98.13 Incision of the Douglas' fossa. When the rectum is pulled in the cranial side and the uterus is pulled to the opposite side, the Douglas' pouch is visible between the two uterosacral ligaments. The peritoneum of Douglas' pouch is cut, and the rectum is separated from the vagina

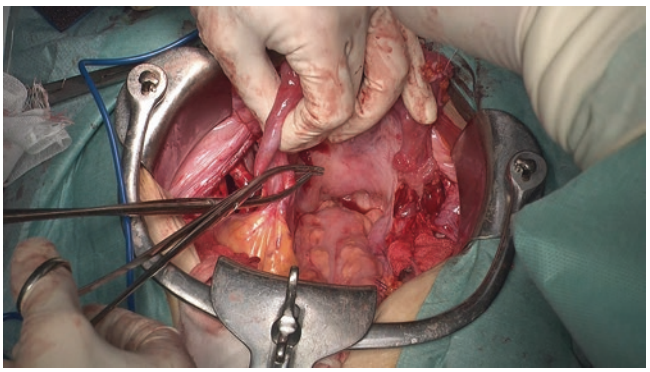


Fig. 98.11 The dissection and ligation of the Infundibulopelvic Ligament. The infundibulopelvic ligament is clamped, cut, and doubly suture-ligated

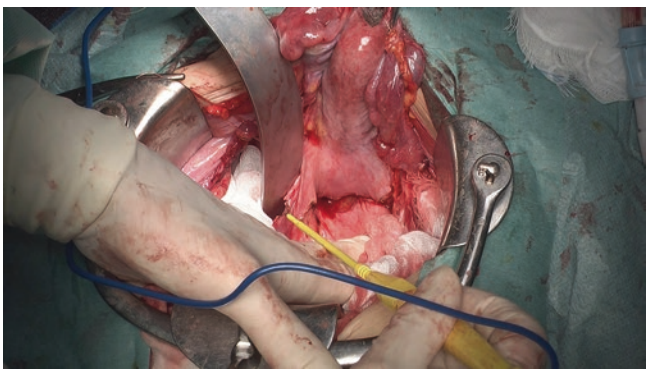


Fig. 98.14 Dissection of the uterosacral ligament. The uterosacral ligament is cut, and the incision connects to the cut membrane of the peritoneum of Douglas' pouch

Uterosacral Ligaments and the Rectovaginal Ligaments

In the rectum marginal line, incise and ligate the left and right uterosacral ligaments. When separating the uterosacral ligaments, the uterus is lifted up and this tends to put tension on the ligaments. Although the uterosacral ligaments lead to the rectovaginal ligaments (see Fig. 98.15), the boundary between the two can be difficult to discern. However, care must be taken not to cut into the rectovaginal ligaments.

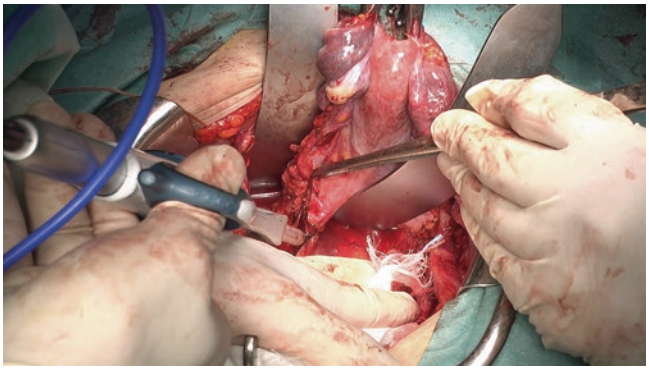


Fig. 98.15 Separation of the left rectovaginal ligament. The rectovaginal ligament behind the uterosacral ligament is dissected with a sealing device

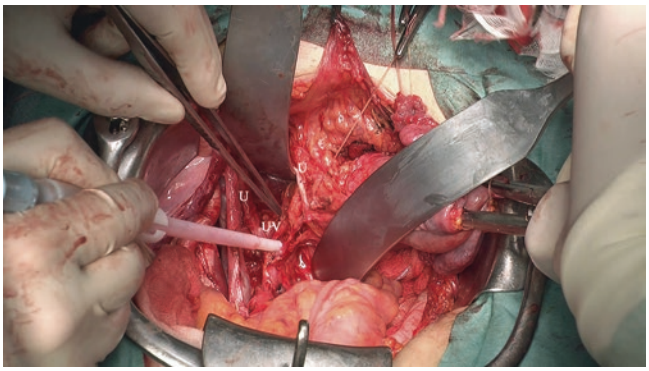


Fig. 98.17 Exposure of the deep uterine vein. The fatty tissue is dissected out of the cardinal ligament by a vacuum device and then the deep uterine vein (*UV*) is exposed. Ureter (*U*)

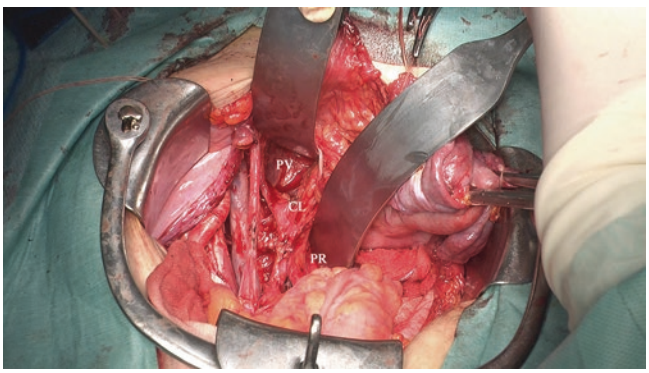


Fig. 98.16 Exposure of the cardinal ligament. After pulling the uterus, two retractors are placed in the paravesical (*PV*) and pararectal (*PR*) spaces and then the cardinal ligament (*CL*) is exposed between the two retractors

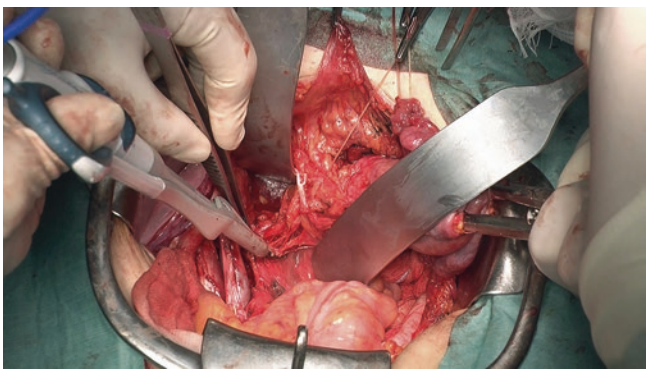


Fig. 98.18 Treatment of the cardinal ligament. The small vessels in the cardinal ligament are cut with a sealing device, and then the deep uterine vein is exposed. Ureter (*U*)

Dissection of the Cardinal Ligaments

Pulling the uterus upward, if two retractors are inserted in the pararectal and paravesical spaces, the cardinal ligaments will become apparent between the two spaces (see Fig. 98.16). The deep uterine vein and pelvic splanchnic nerve are included in the cardinal ligament. Beneath the deep uterine vein is the splanchnic nerve, when the entire cardinal ligament is cut this connects the pararectal space and paravesical space (see Figs. 98.17, 98.18, 98.19, 98.20, 98.21, and 98.22). Under the pararectal space is the sacral region. One must avoid scrapping this region with the retractor as it may cause major hemorrhaging and hemostasis is difficult. In the original Okabayashi method, the cardinal ligaments were cut, thus the deep uterine vein and pelvic splanchnic nerve were ligated together. Therefore it is possible to cut the pelvic splanchnic nerve in the Okabayashi procedure. In recent years, we have tried to avoid severing the nerve plexus when possible.

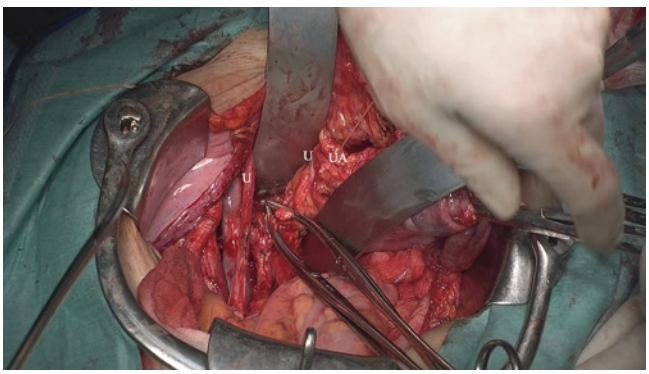


Fig. 98.19 Dissection of the deep uterine vein. The deep uterine vein is clamped with Kelly forceps, then cut and ligated with 2-0 Vyclile. Ureter (*U*), Uterine artery (*UA*)

In Fig. 98.22, with the original Okabayashi method, the cardinal ligament collectively with the nerves and blood vessels were cut, but in this case the cardinal ligament is not cut. This is because we wish to spare the nerves as much as possible. However, in Figs. 98.36 and 98.37, ultimately it has been found

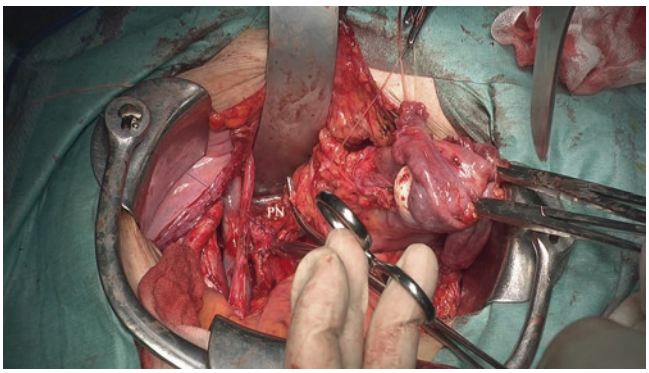


Fig. 98.20 Exposure of the cardinal ligaments nerve section. By lifting the cut end of the deep uterine vein, the pelvic splanchnic nerve (*PN*) becomes visible beneath the deep uterine vein

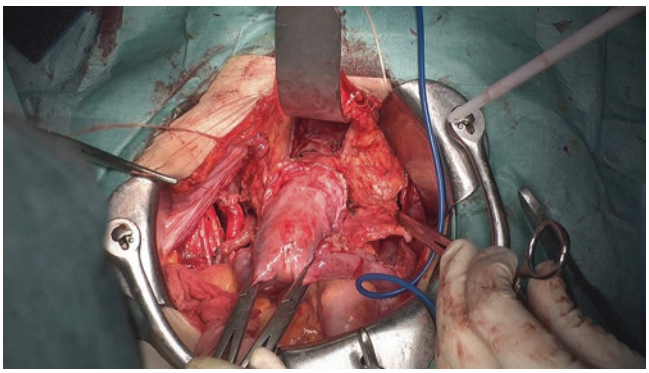


Fig. 98.23 Separation of the bladder. The bladder is separated from the vaginal wall until it is 2 cm beneath the cutting line

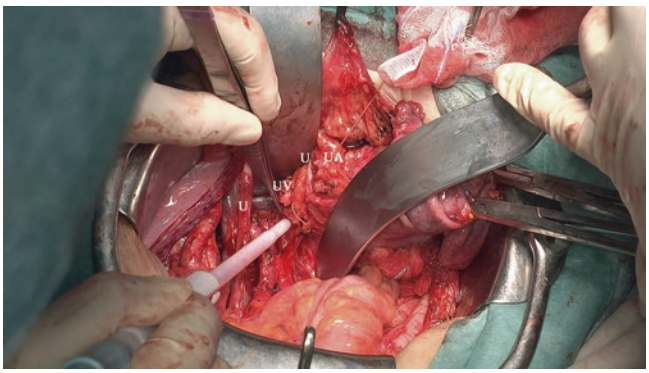


Fig. 98.21 Treatment of the cardinal ligament. Fat and connective tissue is removed from the cardinal ligament with a vacuum device. Deep uterine vein (*UV*), Uterine artery (*UA*), Ureter (*U*)

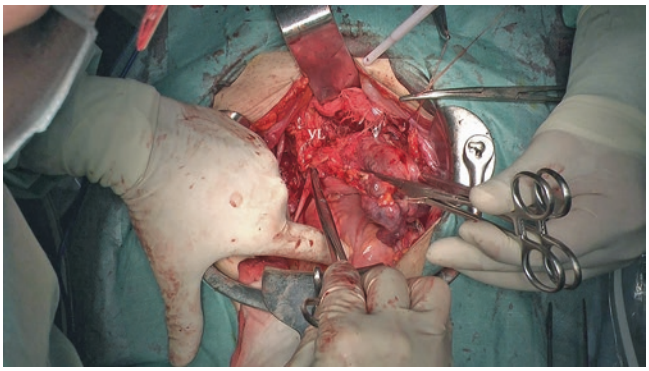


Fig. 98.24 The ureter tunnel. The ureter is located over the cardinal ligament and passes through its' tunnel through the vesicouterine ligament (*VL*). The roof of the ureter tunnel is the anterior leaf of vesicouterine ligament, and the floor of the ureter tunnel is the posterior leaf of vesicouterine ligament. After lifting up the uterine artery, curved Kelly forceps are inserted along the ureter from the entrance of the ureter tunnel. The ureter tunnel is then expanded with these forceps. Great care must be taken not to damage or scratch the vessels within the vesicouterine ligament because they hemorrhage easily and so require great care and skill

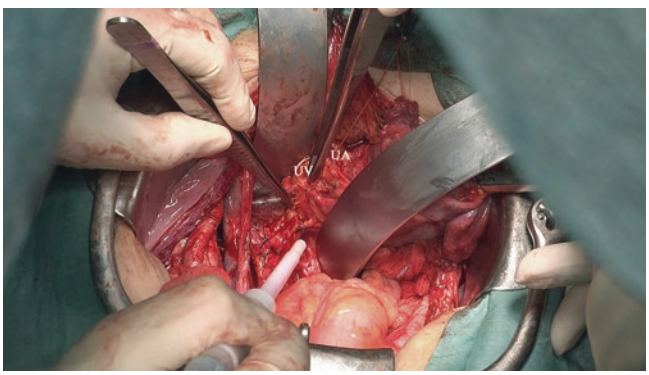


Fig. 98.22 Cardinal ligament nerve section. Fat and lymph nodes have been dissected from the cardinal ligament, and the pelvic splanchnic nerve can then be clearly seen. In the original Okabayashi procedure, the pelvic splanchnic nerve of this cardinal ligament is cut at this point. However, in this case, the cardinal ligament is not cut now, because there exists the possibility that the nerve can be preserved. Deep uterine vein (*UV*), Uterine artery (*UA*)

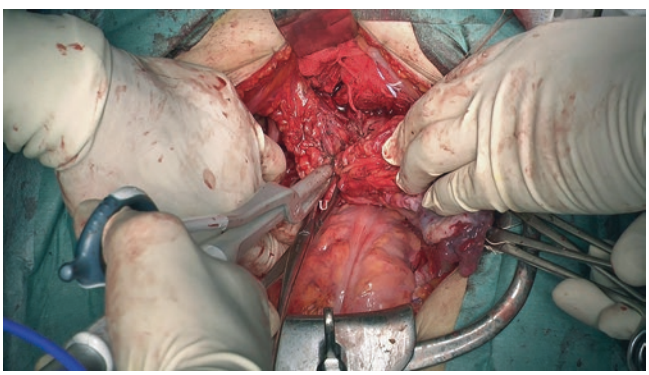


Fig. 98.25 Dissection of the anterior leaf of the vesicouterine ligament. When the ureter is clearly free from the roof of the ureter tunnel, the anterior leaf of the vesicouterine ligament is separated with a sealing device. Ureter (*U*)

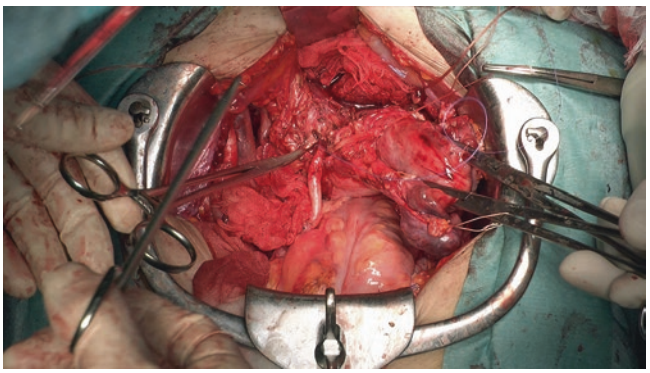


Fig. 98.26 Dissection of the anterior leaf of the vesicouterine ligament. If the ureter is near from the cutting margins, Kelly forceps may be used to clamp the anterior leaf of the vesicouterine ligament as shown in the photo

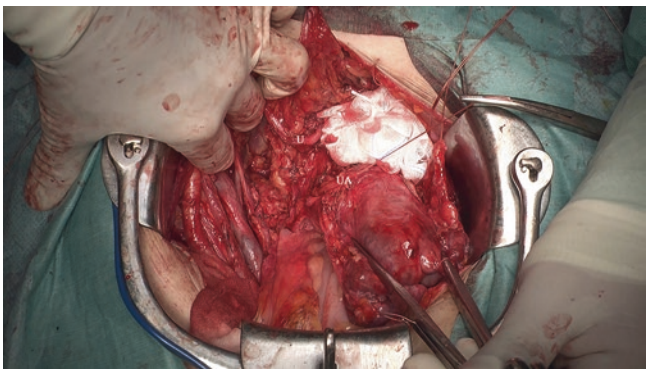


Fig. 98.29 Completion of the treatment of the anterior leaf of the vesicouterine ligament. The division of the anterior leaf of vesicouterine ligament has been completed. The entire course of the left ureter is shown above the posterior leaf of vesicouterine ligament. Uterine artery (*UA*), Ureter (*U*)

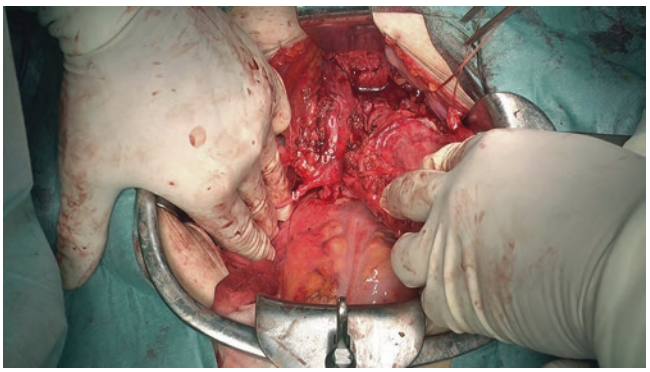


Fig. 98.27 Dissection of the anterior leaf of the vesicouterine ligament. Once the roof of ureter tunnel has been separated, the entire ureter (*U*) within the vesicouterine ligament is exposed

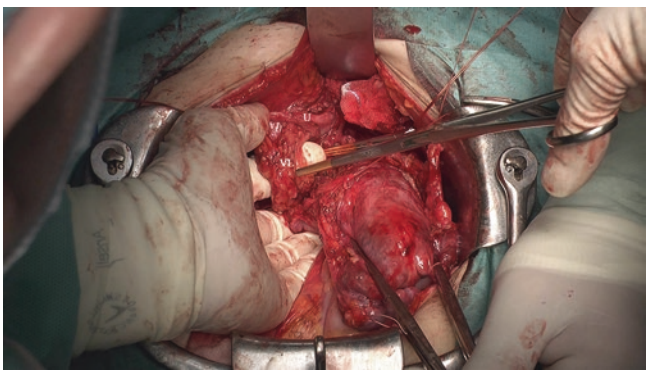


Fig. 98.30 Treatment of the posterior leaf of the vesicouterine ligament. The area located between the posterior leaf of the vesicouterine ligament and the paracolpium is non vascular adipose tissue. Professor Okabayashi referred to this space as the paravaginal space. In this photograph, the index finger of the operator has been inserted in the paravaginal space and is holding the posterior leaf of vesicouterine ligament (*VL*). Ureter (*U*)

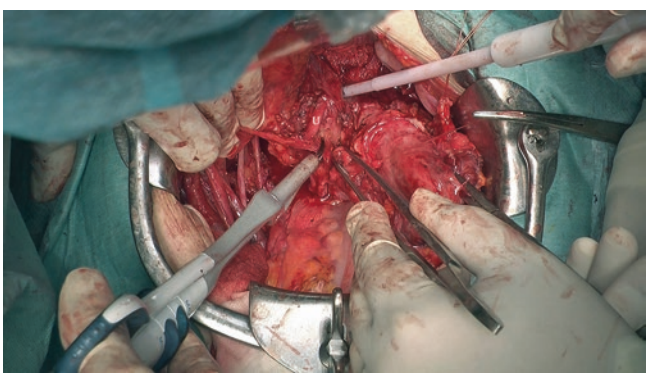


Fig. 98.28 Treatment of loose connective tissue around the ureter. The layer of loose connective tissue which is located on the cranial side from the ureter is divided with the sealing device, and then the ureter is pushed in the caudal direction

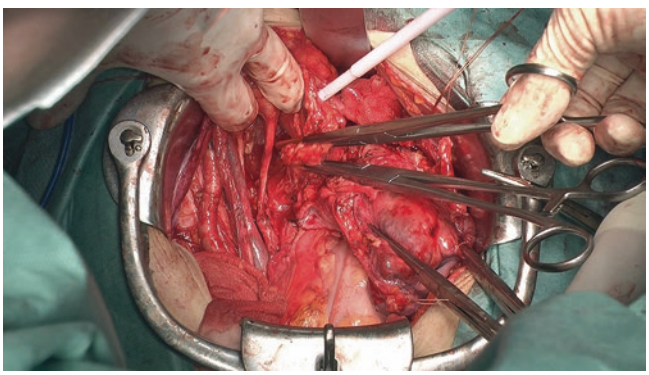


Fig. 98.31 Clamping of the posterior leaf of the vesicouterine ligament. The posterior leaf of vesicouterine ligament is clamped with Sanritu fine serration forceps

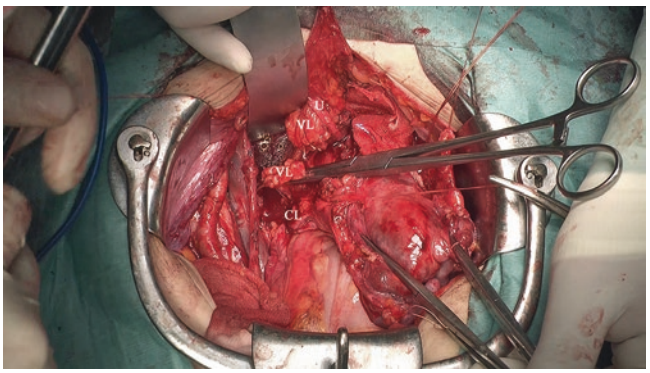


Fig. 98.32 Dissection of the posterior leaf of the vesicouterine ligament. The posterior leaf of vesicouterine ligament (*VL*) has been cut. The cardinal ligament (*CL*) is located behind the cut edge of the vesicouterine ligament on the uterine side. Ureter (*U*)

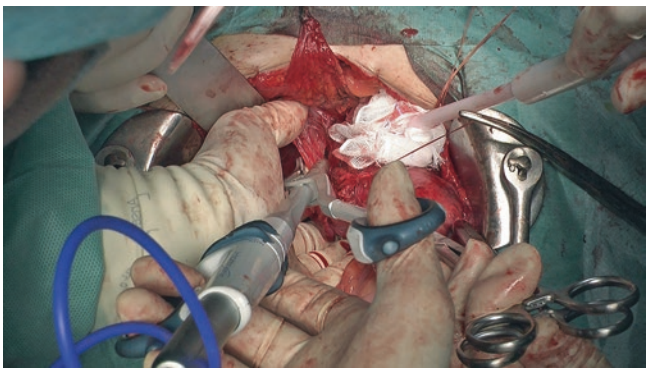


Fig. 98.33 Dissection of the vesicovaginal ligament. The posterior leaf of vesicouterine ligament is connected to the vesicovaginal ligament. If the vesicovaginal ligament remains, it is separated with a sealing device

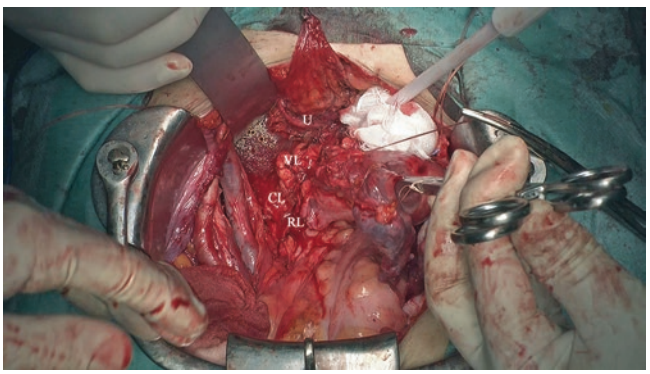


Fig. 98.34 Completion of the dissection of the anterior and posterior vesicouterine ligaments. The posterior leaf of vesicouterine ligament is dissected, and then the vesicouterine ligament (*VL*) is completely divided from the bladder. Ureter (*U*), Cardinal ligament (*CL*), Rectovaginal ligament (*RL*)

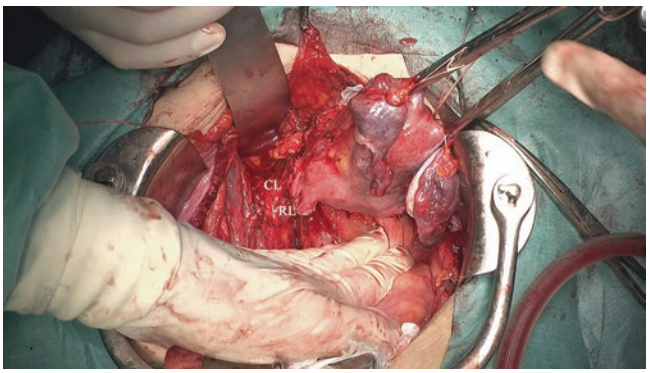


Fig. 98.35 Treatment of the rectovaginal ligament. When the rectum is pulled in the cranial direction and the uterus is pulled in the caudal direction, both the cardinal (*CL*) and rectovaginal ligament (*RL*) are stretched

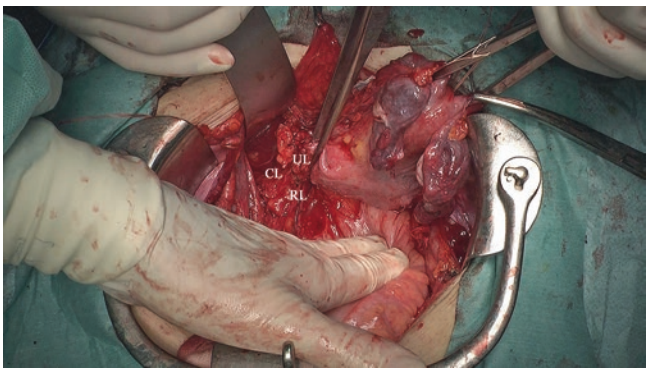


Fig. 98.36 Treatment of the rectovaginal ligament. By lifting the cut edge of uterosacral ligament with (*UL*) the forceps, the rectovaginal ligament (RL) connected to the cardinal ligament (*CL*) is identified. If the cardinal ligament had been dissected like the original Okabayashi's method, the rectovaginal ligament is more visible

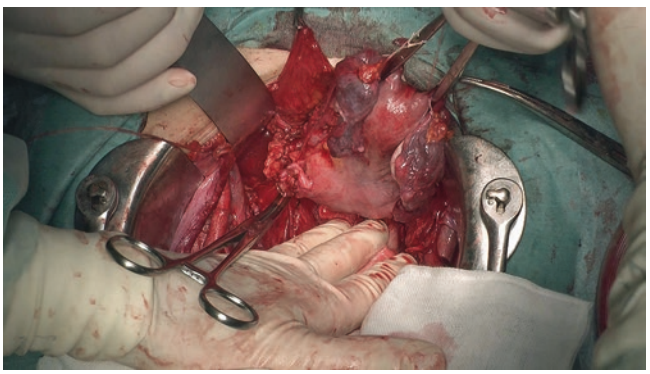


Fig. 98.37 Treatment of the rectovaginal ligament. The rectovaginal ligament is clamped, cut and ligated

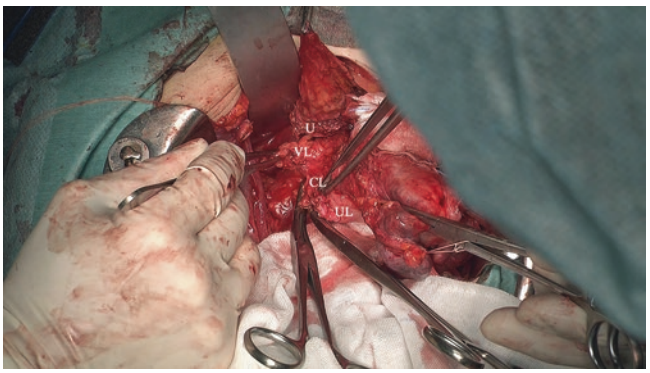


Fig. 98.38 Clamping of the cardinal ligament. In this case, due to tumor invasion of the cardinal ligament (*CL*), it is difficult to perform a nerve sparing procedure, thus the cardinal ligament is clamped. Vesicouterine ligament (*VL*), Uterosacral ligament (*UL*), Ureter (*U*)

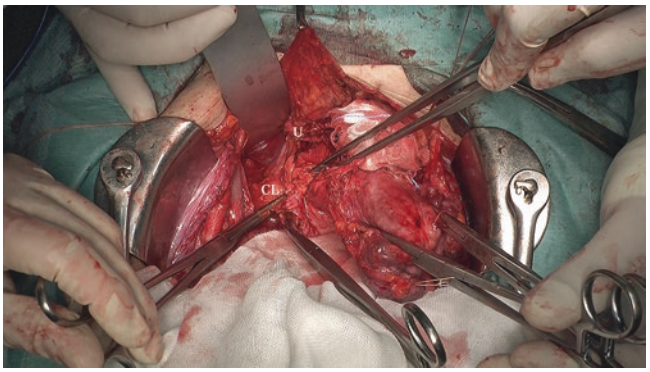


Fig. 98.39 Clamping of the cardinal ligament on the uterine side. The cardinal ligament (*CL*) of the uterine side is clamped

that nerve sparing is difficult when the rectovaginal ligament is cut and tumors are observed in the parametrium. Therefore, in Fig. 98.38, the cardinal ligament is clamped and cut.

Separation of the Bladder from the Vagina

The uterus is pulled to the cranial side while the bladder is pulled with a retractor to the caudal side, then the uterus is separated between the bladder and vagina with an electric scalpel (see Fig. 98.23). The separation is then performed from the central area.

Treatment of the Anterior Leaf of the Vesicouterine Ligaments

The vesicouterine ligaments are thinned as much as possible. However, as in this case, it is often difficult to thin the vesicouterine ligaments.

The uterus is pulled to the cranial side, the bladder retracted with a retractor to the caudal side and the uterine

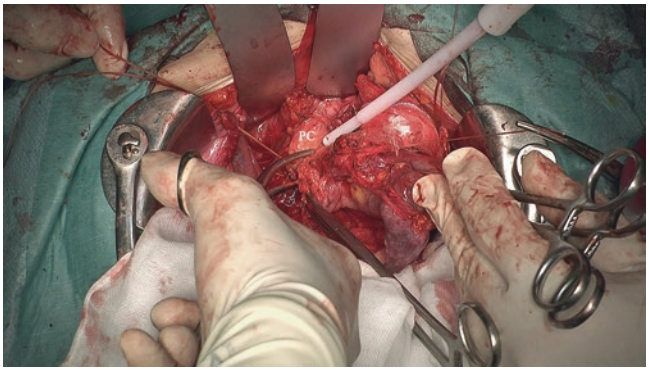


Fig. 98.40 Clamping of the paracolpium. The paracolpium (*PC*) is clamped

artery is also kept raised. Insert Cayley forceps along the urinary tract and create a ureteral tunnel (see Fig. 98.24). The first layer of the vesicouterine ligaments are separated with sealing device such as a Harmonic Focus® (see Fig. 98.25), or dissection ligation (see Fig. 98.26). After separating the superficial layer of the vesicouterine ligaments, for a urinary tract that is covered with loose connective tissue, push the ureter to the caudal side exposing the posterior leaf of the vesicouterine ligament (see Figs. 98.27, 98.28, and 98.29).

Treatment of the Posterior Leaf of the Vesicouterine Ligament

Thin between the posterior leaf of the vesicouterine ligament and paracolpium and clamp the posterior leaf of the vesicouterine ligament with forceps (see Figs. 98.30, 98.31, and 98.32). After it is confirmed with forceps to be far enough away from the ureter, sever the posterior leaf of the vesicouterine ligament and ligate. If any part of the posterior leaf remains cut it with a Harmonic Focus (see Figs. 98.33 and 98.34).

Cardinal Ligament and Rectovaginal Ligament Dissection.

The cardinal ligament and rectovaginal ligament are createded by the surgeon. In this case I do not cut the cardinal ligament till after cutting the rectovaginal ligament. Generally if a strong infiltration of cancer is observed the nerve plexus does not remain uncut. Figure 98.38 summarizes the clamping, disconnection and ligation of the rectovaginal and cardinal ligaments together (see Figs. 98.35, 98.36, 98.37, 98.38, and 98.39).

Paracolpium Disection

The paracolpium is clamped, cut and ligated (see Figs. 98.40, 98.41, 98.42, and 98.43).

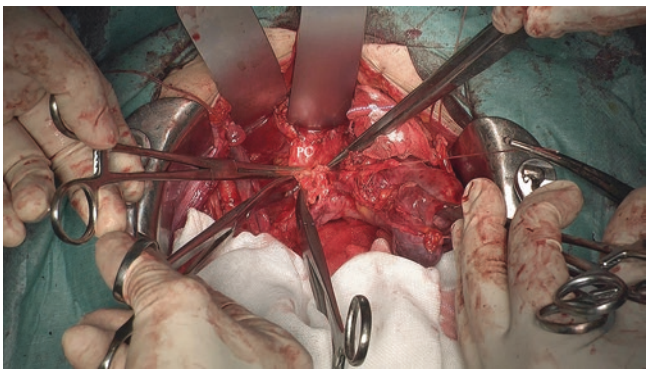


Fig. 98.41 Clamping of the paracolpium. After cutting the cardinal ligament, the paravaginal tissue remains on the lateral wall of the vagina. This is paracolpium (*PC*) and it is grasped with Sanritu fine serration forceps

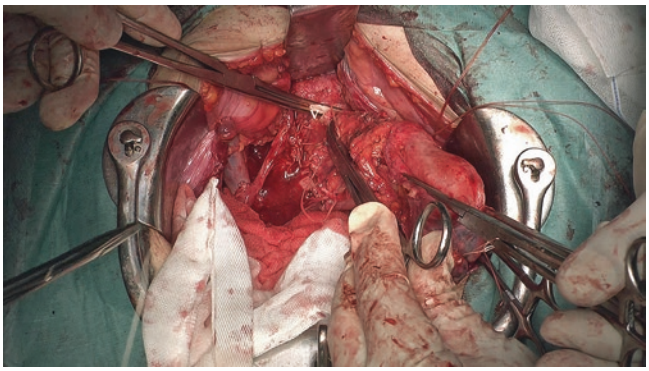


Fig. 98.44 Dissection of vaginal wall. The vagina (*V*) is clamped, and is cut. The edge of the vagina is closed with 1-0 Vicryl

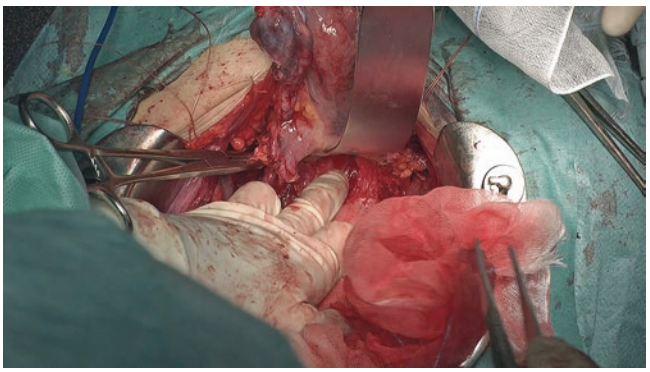


Fig. 98.42 Checking the rectum. After clamping the paracolpium, check to confirm that the rectum has not been clamped

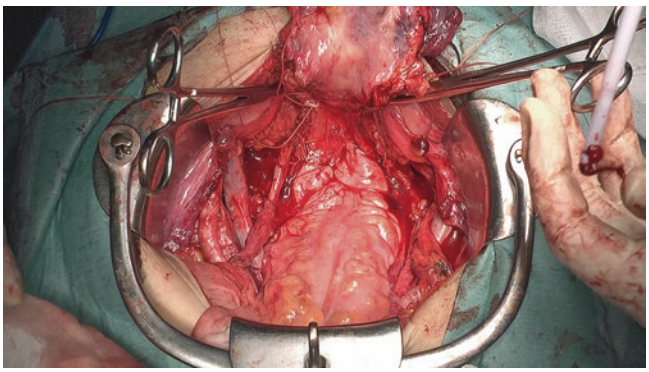


Fig. 98.45 Confirmation of the vaginal wall margin. From the posterior view, confirm that the rectum has not been damaged

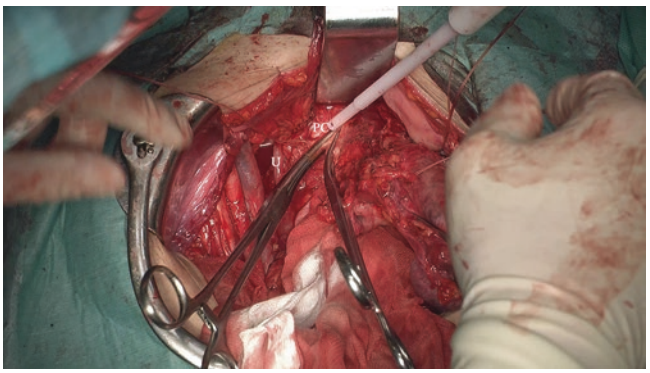


Fig. 98.43 Clamping of the paracolpium. The paracolpium is cut and ligated with 1-0 Vicryl. Ureter (*U*)

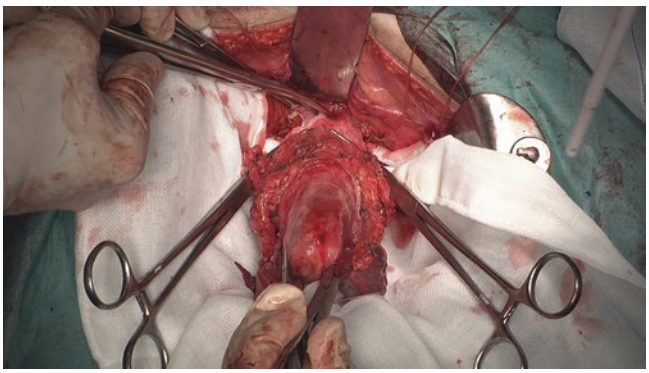


Fig. 98.46 Vaginal wall dissection. The vaginal wall is cut with Mayo scissors and the uterus is amputated from the vagina

Vaginal Tract Dissection

The vaginal tract is clamped laterally and dissection, as well as ligation, is then performed within the vaginal tract (see Figs. 98.44, 98.45, 98.46, 98.47, 98.48, and 98.49).

While most of the original Okabayashi procedure remains the same today, new adaptations to the original such as the development of the retroperitoneal space and performing a lymphadenectomy have made the procedure more convenient. After creating the retroperitoneal space and performing the

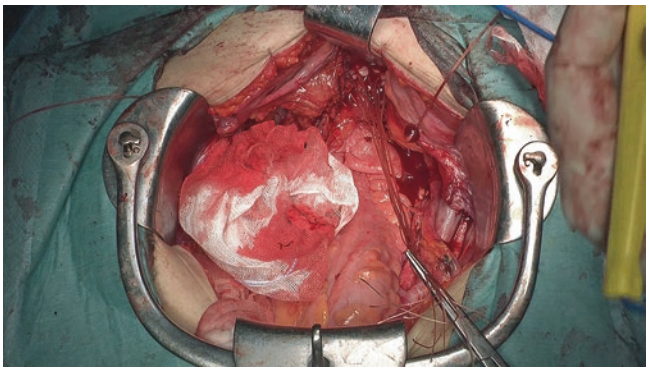


Fig. 98.47 Vaginal wall suture. The vaginal wall is closed with 1-0 Vicryl



Fig. 98.48 Extracted formalin fixed uterus. In the anterior view of the formalin fixed uterus, the 8 cm tumor is located in the cervix. Adequate vaginal tissue is removed

lymphadenectomy the surgeon can clearly see the structure of the ligaments. In addition, to the benefit of the patient, we now perform nerve sparing radical hysterectomy whenever possible, something that was not done in the original procedure.



Fig. 98.49 Posterior view of the formalin fixed uterus. In the posterior view of the formalin fixed uterus, the parametrial tissues are widely excised. The excised specimen includes the cardinal ligament, uterosacral ligament, vesicouterine ligaments, and adequate parametrial and paravaginal tissue

References

1. Weltheim E, Hermann G, translated. The extended abdominal operation for carcinoma of the cervix. Am J Obstet Gynecol. 1912. 66:169–232.
2. Latzko W, Schiffmann J. Klinisches and anatomisches zur radikaloperation des Gebarmutterkrebses. Zbl Gynak. 1919;43:715.
3. Okabayashi H. Radical abdominal hysterectomy for cancer of the cervix uteri, modification of the Takayama operation. Surg Gynecol Obstet. 1921;33:335–21.
4. Okabayashi H. Radical operation of cervical cancer (in Japanease). Kanehara Pubulishing Co: Tokyo; 1952.
5. Fujii S, Takakura K, Matsumura N, Higuchi T, Yura S, Mandai M, Baba T, Yoshioka S. Anatomic identification and functional outcomes of the nerve sparing Okabayashi radical hysterectomy. Gynecol Oncol. 2007;107:4–13.
6. Kobayashi T. Abdominal radical hysterectomy with pelvic lympyhadenectomy for cancer of the cervix (in Japanese). Tokyo: Nanzando; 1961.
7. Yabuki Y, Asamoto A, Hoshiba T, Nishimoto H, Kitamura S. Dissection of the cardinal ligament in radical hysterectomy for cervical cancer with emphasis on the lateral ligament. Am J Obstet Gynecol. 1991;164:7–14.

Radical Abdominal Hysterectomy with Electrosurgical Bipolar Vessel Sealing

99

Satoru Kyo

During each radical hysterectomy, a number of large vessels must be dissected, and firm hemostasis is absolutely required throughout the operative procedure. Therefore, reliable suture ligation is generally used to secure vascular pedicles in this operation; however, suturing involves clamping, cutting, and ligation, which together require considerable time and result in prolonged operative time and substantial blood loss. To resolve these operative issues, a variety of vessel sealing systems have been developed and used for this operation; these systems include LigaSure™ (Covident, Inc.), ENSEALR G2 Tissue Sealers Ethicon Endo-Surgery, Inc., Gyrus PlasmaKinetic Superpulse System (Gyrus, Inc.), and ERBE BiClamp™ Open (ERBE USA, Inc.). Several studies have compared the efficacy of these devices in a variety of fields [1].

We have used the LigaSure™ vessel sealing system, which is a hemostatic system involving a combination of pressure and bipolar electrical energy that can seal vessels up to 7 mm in diameter [2]. The device delivers a controlled high-power current at low voltage to melt and fuse the collagen and elastin within vessel walls. The seals created with LigaSure™ can withstand a minimum of three-times normal systolic pressure, resulting in a distinctive permanent translucent seal zone. In a study that compared the LigaSure™ system to three other approaches (ultrasonic coagulation, bipolar coagulation, or surgical clips and sutures), the LigaSure™ system created seals stronger than those created by the other energy-based ligation methods and comparable in strength with those created by mechanical ligation techniques [2]. Notably, this vessel sealing mechanism produces significantly less thermal spread than bipolar instruments because the energy automatically switches off when tissue impedance reaches a critical level [2]. Furthermore, the current delivered to achieve hemostasis takes between 2 and 4 s, which is faster than suture ligation. These technical merits prompted us to apply this vessel sealing system to radical hysterectomy. In our previous study [3], 85 consecutive cases involving radical abdominal hysterectomy (RAH) with pelvic lymphadenectomy for cervical cancer or endometrial cancer were analyzed; in 18 cases the LigaSure™ system was used to secure the vascular pedicles; in the remaining 67 cases, clamps were used, and the pedicles suture were ligated. Compared to the conventional suture group, the LigaSure group had a significantly and substantially shorter mean operation time (mean, LigaSure 242.8 ± 36.1 vs. conventional 349.1 ± 82.6 min, $P < 0.001$) (Fig. 99.1) and significantly less blood loss (mean, 583.1 ± 287.6 vs. 999.0 ± 524.2 ml, $P < 0.005$) (Fig. 99.2). Only one (0.06 %) of the 18 patients in the LigaSure group was transfused; in contrast, 27 (40.2 %) of the 67 patients in the conventional suture group were transfused. These findings indicated that the LigaSure vessel sealing system is useful for reducing blood loss in and shortening operating times of RAHs. In this chapter, I introduce our operative procedures and how to use vessel sealing system for RAH with a focus on sparing nerves.

The first step toward sparing the autonomic nerve is to isolate the hypogastric nerve and laterally translocate it before the dissection of the sacrouterine and rectouterine ligaments. To isolate the hypogastric nerve, we usually develop Okabayashi's pararectal space [4] by sharp dissection of broad ligament just above the ureter, making a shallow dimple that can be developed bluntly (Fig. 99.3). Using forceps, we isolate in a lateral direction a thin and loose lateral part of the broad ligament that sits directly underneath the ureter; this segment of the ligament is called the mesoureter or ureteral leaf and it contains the hypogastric nerve. This procedure exposes a firm medial part of the ligament that consists of the uterosacral fibers. Eventually, the hypogastric nerve is translocated laterally by this maneuver. Then, the medial part of the broad ligament that consists of the sacrouterine fibers is resected, while the hypogastric nerve is far from the line of resection and is safely preserved. The

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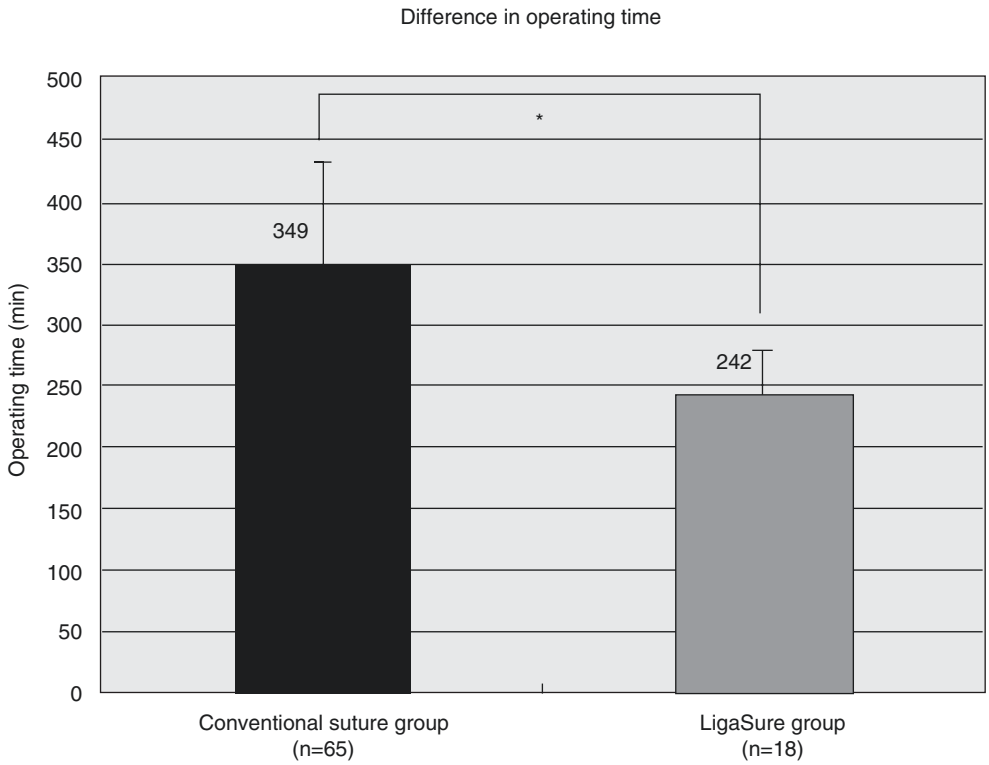


Fig. 99.1 Comparison the LigaSure and conventional suture groups with regard to operating time. *$P < 0.001$ (With permission from Kyo et al. [3])

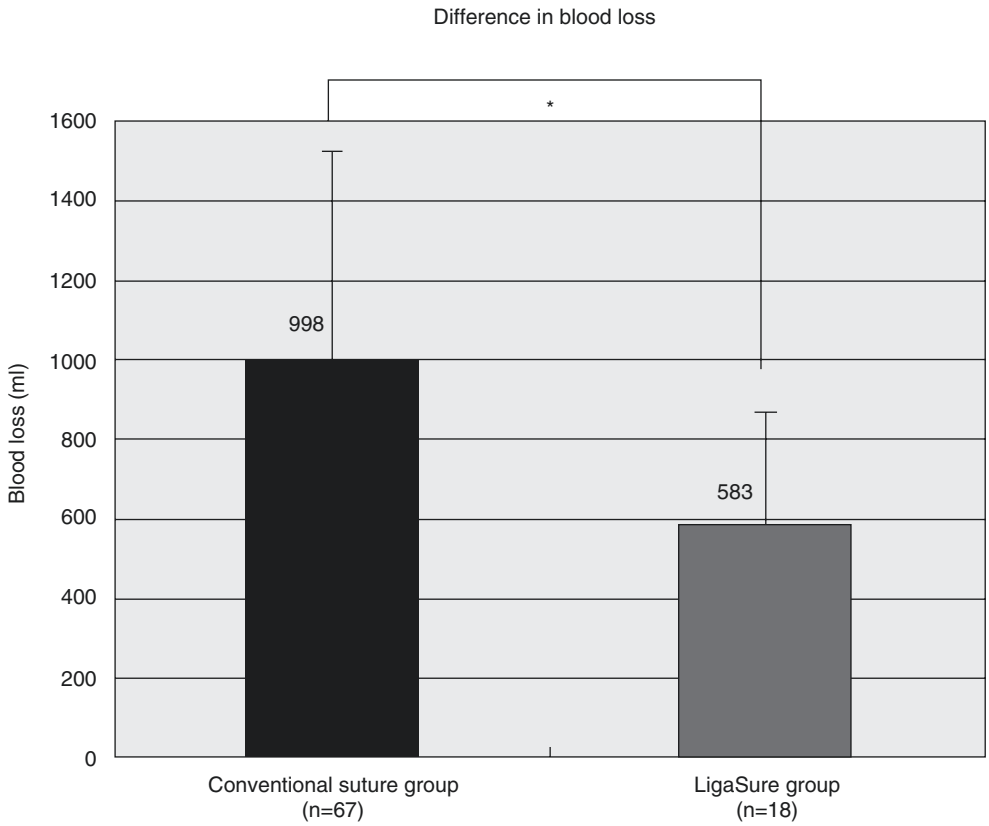


Fig. 99.2 Comparison between patients in the LigaSure and conventional suture groups with regard to blood loss. *$P < 0.005$ (With permission from Kyo et al. [3])

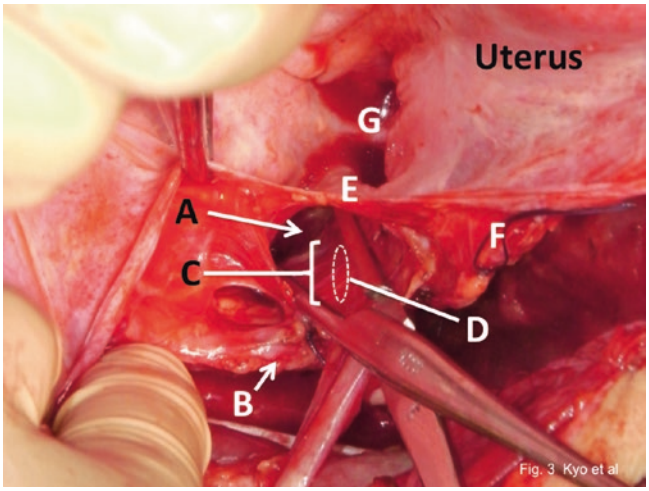


Fig. 99.3 Right-side view of the uterus and Douglas cavity. Okabayashi's pararectal space (*A*) is developed by sharp dissection of the broad ligament just above the ureter (*B*). With the use of forceps, the mesoureter (*C*) that contains the hypogastric nerve (*D*) is laterally isolated, leaving a firm medial tissue consisting of the sacrouterine ligament. Eventually, the hypogastric nerve was translocated laterally by this maneuver. Then, the medial part consisting of the sacrouterine fibers (*E*) is resected, while the hypogastric nerve remains far from the line of resection and safely preserved. (*G*) Douglas cavity. (*F*) Uterine-side edge of dissected uterine artery

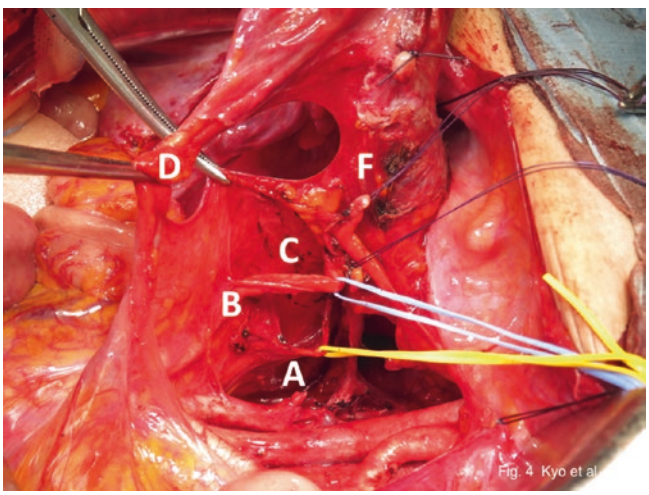


Fig. 99.4 Right-side view of the uterus and pelvic cavity. The hypogastric nerve (*A*) can be fully isolated from the mesoureter and be marked by taping. (*B*) Ureter. (*C*) Okabayashi's pararectal space. (*D*) Infundiburopelvic ligament. (*F*) Uterine-side edge of dissected uterine artery

hypogastric nerve can be fully isolated from the mesoureter and be marked by taping (Fig. 99.4).

Among the most suitable targets for this vessel sealing system in RAH are the cardinal ligaments, which include the deep uterine veins and middle vesical veins; these vessels are particularly suitable targets because they are situated most deeply in the pelvic cavity and are often hard to handle. We preferentially use LigaSure Impact™ (Fig. 99.5a) on this site because this system has an ideal blade size and a ligation strength that is suited to the broad ligaments and large vessels. Furthermore, we prefer the shape of the blade because of the gentle curve, which is preferable for ligaments located in the deep layer of the pelvic cavity. Figure 99.6 shows the three major vessels of the left cardinal ligament (the deep uterine vein, middle and inferior vesical veins); all three veins converge into the internal iliac vein. These vessels are most clearly exposed by complete dissection of the cardinal lymph nodes with ultrasonic surgical aspirators. Of these three vessels, only the deep uterine vein should be dissected; the other two usually remain untreated. The distal-most cut line depends upon the judgment of the surgeons, and this judgment is informed by clinicopathological findings of cancer. In some cases, the deep uterine vein swells to greater than 5 mm in a diameter; notably, we have successfully treated deep uterine veins that were 7–8 mm in a diameter. To guarantee secure and complete seals, we prefer to repeatedly seal one site when completing the first sealing. Because the area of the pelvic splanchnic nerves and plexus is anatomically separated from these vessels at the cardinal ligament [5], this dissection does not affect the function of the splanchnic nerves. Thereafter, the uterine-side edge of the deep uterine vein is ventrally elevated by detaching the surrounding membranes over the upper border of the hypogastric nerve tract; this maneuver results in complete separation of the deep uterine vein from the pelvic nerve plexus (Fig. 99.7) [6]. The bladder branch of the pelvic nerves arises from the pelvic plexus at the same level with the hypogastric nerve tract; consequently, the subsequent resection of the rectovaginal ligament above this level guarantees the preservation of the bladder branches of the pelvic nerves, while the deep uterine vein can be fully resected.

Other prime sites for the use of vessel sealing are the anterior and posterior layers of the vesicouterine ligaments that encircle the ureter. Making a "ureter tunnel" in the space just inside the ureter is the initial step in stratifying the anterior and posterior layers of this ligament. After making the tunnel, the ureter is laterally translocated with forceps; the space between the ureter and the cervix in the anterior layer of vesicouterine ligament is then carefully sealed up to the vesicoureteral junction; a secure seal in this layer usually requires three to four consecutive sealing processes. This layer contains two or three vesicocervical veins. Although these vessels are small, establishing hemostasis at these vessels is sometimes difficult because the ureter is very close and surgical carelessness can result in ureter injury. We preferentially use the LigaSure Small Jaw™ (Fig. 99.5b) at this site; this tool is probably best choice for the sealing of this site because of the size and the shape of the blade (Fig. 99.8). To reduce costs by avoiding using two

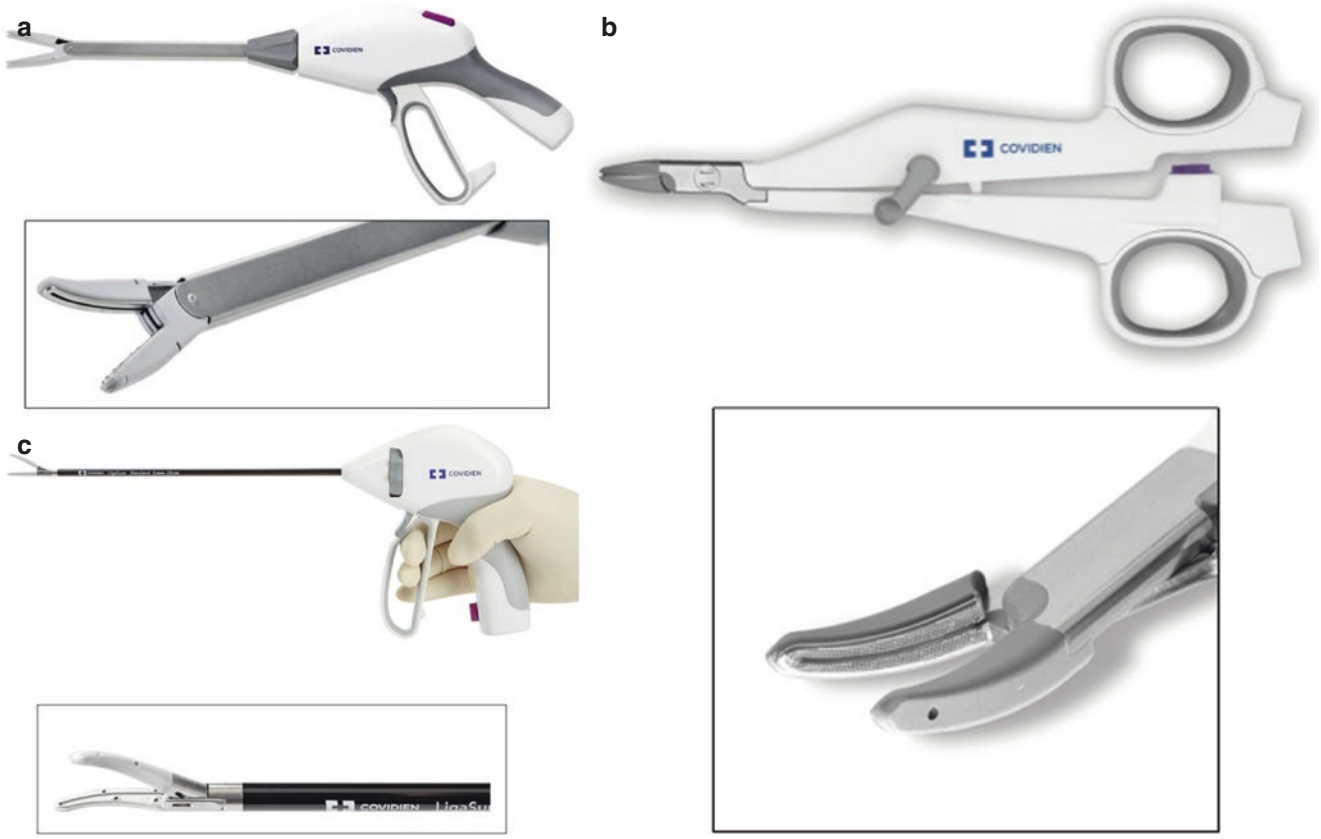


Fig. 99.5 Images of the sealing devices. (**a**) LigaSure Impact™ (**b**) LigaSure Small Jaw™(**c**) LigaSure Meryland 23™ (http://www.covidien.com/surgical/products/vessel-sealing)

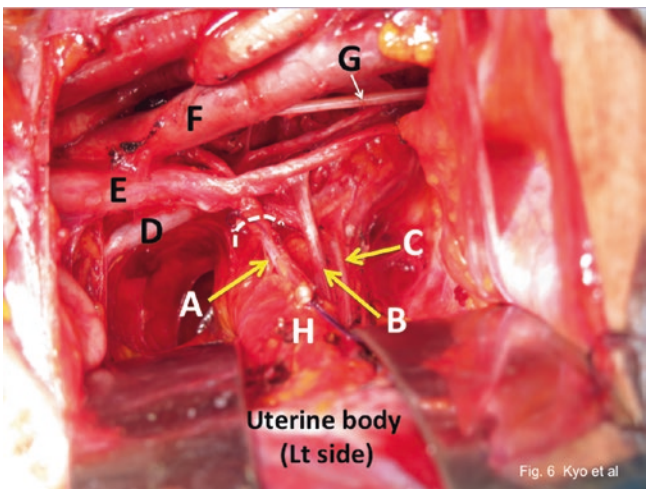


Fig. 99.6 Left-side view of the uterus and pelvic cavity. The three major vessels associated with the left cardinal ligament are shown; (*A*) Deep uterine vein. (*B*) Middle vesical vein. (*C*) Middle rectal vein. These vessels were fully exposed after complete dissection of cardinal lymph nodes with ultrasonic surgical aspirators. (*D*) Internal iliac vein. (*E*) Internal iliac artery. (*F*) External iliac vein. (*G*) Obturator nerve. (*H*) Uterine-side edge of dissected uterine artery. *Dotted lines* indicate possible vessel sealing system cut line for the deep uterine vein

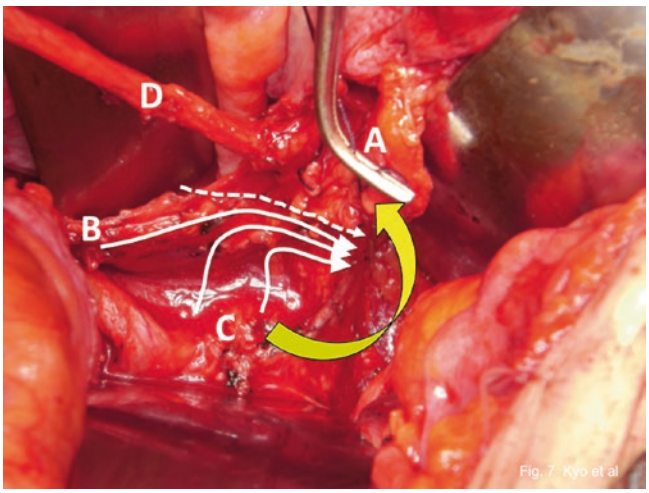


Fig. 99.7 Separation of deep uterine veins from the pelvic nerve plexus. The uterine-side edge of the deep uterine vein (*A*) is ventrally elevated by detaching the surrounding membranes over the upper border of the hypogastric nerve tract, resulting in complete separation of the deep uterine vein from the pelvic nerve plexus. *Solid lines* and arrowheads show the hypogastric nerve (*B*) and splanchnic nerve tracts (*C*), which together comprise the pelvic nerve plexus. Since the bladder branch of the pelvic nerves arises from the pelvic nerve plexus at the same level with the hypogastric nerve tract, the subsequent resection of the rectovaginal ligament above this level (shown as *dotted line*) guarantees the preservation of the bladder branches of the pelvic nerves, while the deep uterine vein can be fully resected. (*D*) Ureter

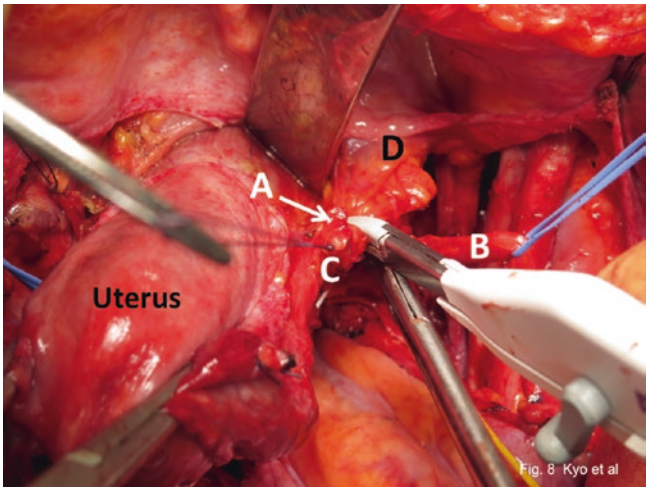


Fig. 99.8 Dissection of the anterior layer of the vesicouterine ligament (*A*) with a LigaSure™ Small Jaw. The ureter (*B*) is laterally translocated via a forceps to prevent mechanical and heat injury. (*C*) Uterine-side edge of dissected uterine artery. (*D*) Bladder

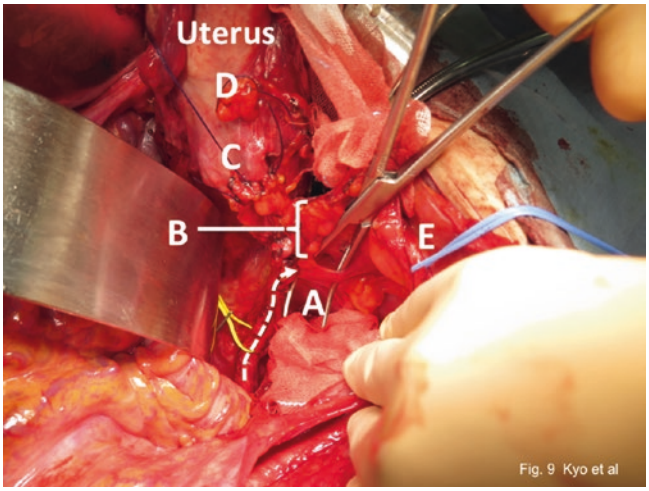


Fig. 99.9 Isolation or prediction of vesical nerve tracts in the posterior layers of vesicouterine ligaments. Lateral view of the right pelvic cavity. The tracts of vesical branches of pelvic nerves (*A*) are exposed by the forceps, which are continuous with the hypogastric nerves (shown in a *dotted line*). (*B*) Posterior layers of vesicouterine ligament. (*C*) Uterine-side edge of dissected deep uterine vein. (*D*) Uterine-side edge of dissected uterine artery. (*E*) Ureter

different sealing devices, the LigaSure Impact™ might be used for both the vesicouterine and cardinalvesicouterine ligaments; however, the blade seems slightly large for manipulating the vesicouterine ligament. Conversely, the LigaSure Small Jaw™ might be used for both ligaments; however, this tool appears to be insufficient in size to seal the larger vessels. Either way, the important point when using these devices in pelvic cavity, especially for the vesicouterine ligament, is to avoid heat injury of the ureter. Sufficient lateral translocation of the ureter with forceps is essential for avoiding such injury (Fig. 99.8).

The use of these devices for the posterior layers as well as subsequently for the paracolpium raises another concern. These tissues include autonomic nerves, called "vesical branches", and these nerves arise from the pelvic nerve plexus. Heat injury or directly cutting of these nerves causes post-operative urinary dysfunction. Although it is not always successful, we often attempt to visualize the bladder branches that run along these sites and to isolate these branches with tape (Fig. 99.9). Even when these branches cannot be visualized, it is optimal to predict the course of these nerve tracts in these tissues. Anatomically, the tracts of the vesical branches of pelvic nerves are continuous with the hypogastric nerves; however, the latter joins the pelvic splanchnic nerves from the sacral nerves (S2, 3, and 4) from which the vesical branches arise. Therefore, we mark the hypogastric nerve, which is easily identified between the rectouterine ligament and the mesoureter (Fig. 99.4). The posterior layer of the vesicouterine ligament can be dissected with either LigaSure Impact™ or LigaSure Small Jaw™ when special care is taken to keep sufficient distance between the sealing lines and the nerve

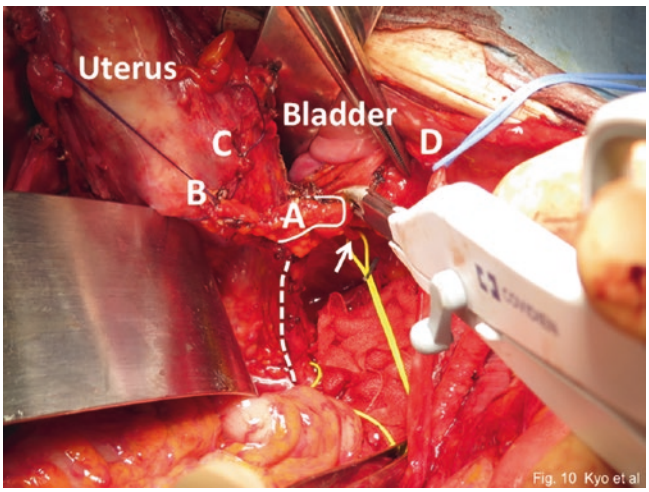


Fig. 99.10 Dissection of the posterior layer of the vesicouterine ligament with the LigaSure™ Small Jaw. The posterior layer of the vesicouterine ligament (*A*) should be dissected without cutting these nerves. When these nerves are hard to visualize, the surgeon should carefully predict the tract of the nerves by recognizing that they are continuous and in line with the hypogastric nerves (shown as *dotted line*). The arrow indicates the bladder branches of the pelvic nerves, which are isolated and marked with tape. The *solid line* indicates the line to be dissected; the lateral edge of this line should be completely out of the line of the vesical branches of pelvic nerves. (*B*) Uterine-side edge of dissected deep uterine vein. (*C*) Uterine-side edge of dissected uterine artery. (*D*) Ureter

tract in these sites; such distance is essential to preventing intra- and postoperative complications in urinary function (Fig. 99.10).

The selection of devices for each site may be challenging for surgeons. Very recently, a new device (LigaSure Maryland 23™) that can resolve this issue has become available (Fig. 99.5c). This device has an intermediate blade size that is suitable for both the cardinal ligament and the vesicouterine ligaments. Furthermore, this new device has a longer shaft than the LigaSure Small Jaw™; this additional length facilitates sealing the ligaments in deeper positions, such as the rectovaginal ligaments. I believe that LigaSure Maryland 23 ™ can be used at every site for nerve-sparing RAH and that this multi-functionality should reduce surgical costs.

Finally, I will briefly address the use of these devices at other sites, such as the upper ligaments of the uterus or infundibulopelvic ligaments. These other sites are very amenable to mechanical suturing, and I think that use of LigaSure devices is not necessary for these other sites and that it is more important to avoid exhausting the devices and optimizing LigaSure-mediated sealing at the less tractable sites.

References

1. Lamberton GR, Hsi RS, Jin DH, Lindler TU, Jellison FC. Baldwin DD Prospective comparison of four laparoscopic vessel ligation devices. J Endourol. 2008;22:2307–12. doi:10.1089/end.2008.9715.
2. Landman J, Kerbl K, Rehman J, Andreoni C, Humphrey PA, Collyer W, et al. Evaluation of a vessel sealing system, bipolar electrosurgery, harmonic scalpel, titanium clips, endoscopic gastrointestinal anastomosis vascular staples and sutures for arterial and venous ligation in a porcine model. J Urol. 2003;169:697–700.
3. Kyo S, Mizumoto Y, Takakura M, Hashimoto M, Mori N, Ikoma T, Nakamura M, Inoue M. Experience and efficacy of a bipolar vessel sealing system for radical abdominal hysterectomy. Int J Gynecol Cancer. 2009;19:1658–61.
4. Yabuki Y, Asamoto A, Hoshiba T, Nishimoto H, Nishikawa Y, Nakajima T. Radical hysterectomy: an anatomic evaluation of parametrial dissection. Gynecol Oncol. 2000;77:155–63.
5. Kato T, Murakami G, Yabuki Y. Does the cardinal ligament of the uterus contain a nerve that should be preserved in radical hysterectomy? Anat Sci Int. 2002;77:161–8.
6. Fujii S, Takakura K, Matsumura N, Higuchi T, Yura S, Mandai M, Baba T, Yoshioka S. Anatomic identification and functional outcomes of the nerve sparing Okabayashi radical hysterectomy. Gynecol Oncol. 2007;107:4–13.

ARH as a Nerve-Sparing Procedure

100

Tomoyasu Kato

Pelvic organ function is organized by both central and peripheral nerve system. For instance, the lower urinary tract is innervated by 3 sets of peripheral nerves involving the parasympathetic, sympathetic, and somatic nervous systems. Pelvic parasympathetic nerves arise at the sacral level of the spinal cord, excite the bladder, and relax the urethra. Lumbar sympathetic nerves inhibit the bladder body and excite the bladder base and urethra. Pudendal nerves excite the external urethral sphincter. These nerves contain afferent sensory as well as efferent motor axons. These autonomic nerves are running and distributed as shown in Fig. 100.1.

Autonomic nerve damage during surgery is thought to play a crucial role in the etiology of bladder dysfunction, sexual dysfunction and colorectal motility disorders that are seen in patients after radical hysterectomy [1]. Bladder dysfunction is present in 70–85 % of patients for up to 12 months postoperatively, including urinary or anal incontinence or retention [1]. In order to prevent these complications, Japanese gynecologists introduced a surgical technique with preservation of the pelvic autonomic nerves in 1961 [2]. Thereafter Japanese doctors had learned and modified this procedure. In the twentieth century there were few articles reported in English [3, 4]. It is only recently that nerve-sparing radical hysterectomy has been introduced to Western [5] as well as to Asian countries [6]. As the postoperative QOL was noted, studies on precise neuroanatomical studies [1, 7] as well as the technique of nerve-sparing radical hysterectomy were reported [8]. Nowadays the concept of preservation of autonomic nerves during radical hysterectomy has become standard in many gynecological cancer centers in the world [9].

These autonomic nerves related to bladder function can be dissected during the different phases of radical hysterectomy. A level of nerve preservation is classified into 4 levels: non-touch, exposure, partial preservation and dissection. From a point of view on nerve preservation, non-touch preservation provides high quality of life. Simple and modified radical hysterectomy can archive non-touch preservation of autonomic nerves, however, they compromise radicality for invasive cervical cancer. To achieve a good balance between radicality and retaining pelvic function, we conducted to perform exposure or partial preservation of these autonomic nerves. Our procedures based on the previous anatomical study are noted as follows [7]:

1. Opening of retroperitoneal spaces (Figs. 100.2, 100.3, 100.4, and 100.5)
2. Identification of the hypogastric nerves during developing the pararectal space (Figs. 100.6, 100.7, 100.8, and 100.9):

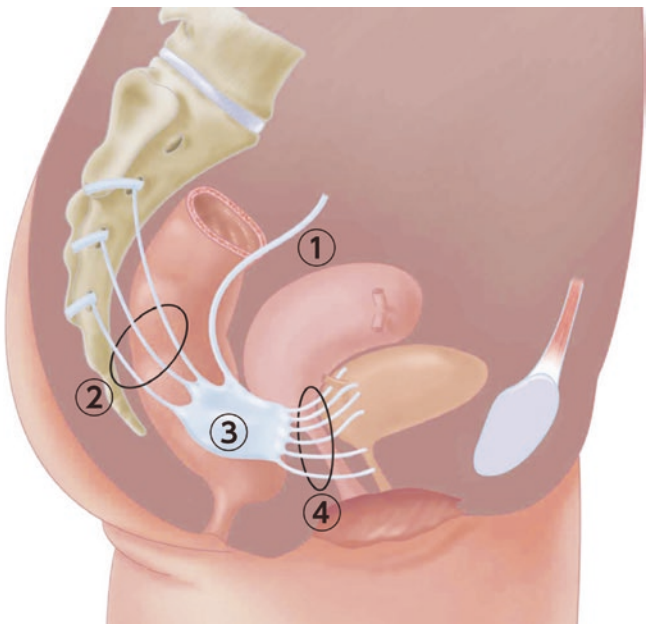


Fig. 100.1 Illustration of running of autonomic nerves in the pelvis (right lateral view) *1*: Hypogastric nerves, *2*: Pelvic splanchnic nerves (S2 – 4), *3*: Pelvic plexus, *4*: Vesical branches

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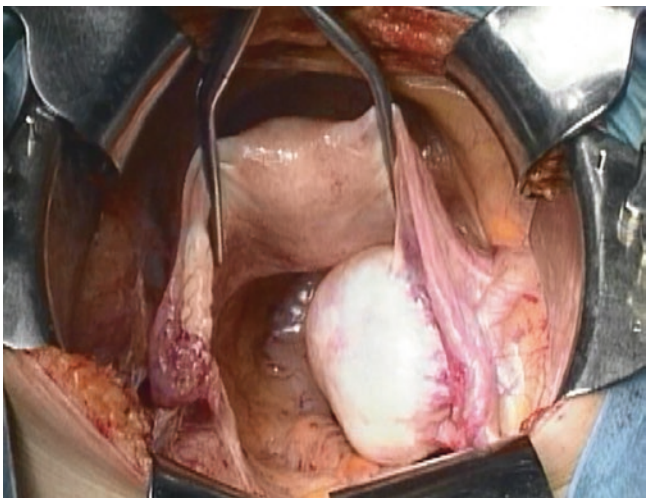


Fig. 100.2 View of opening of the lower abdominal cavity. The uterus is pulled upward with two clamps

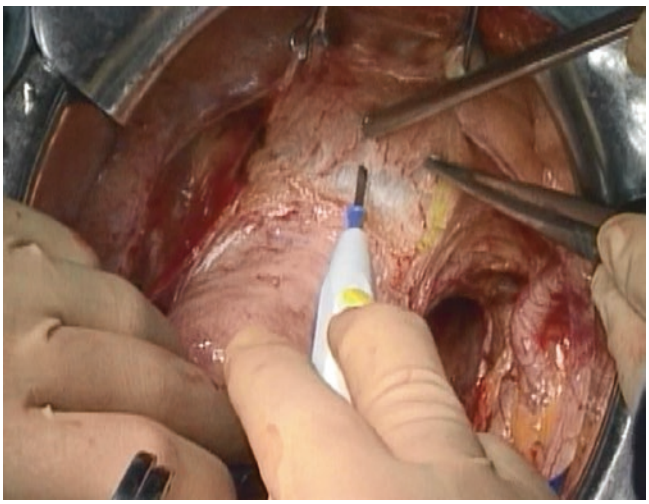


Fig. 100.5 Separation of the bladder from the anterior cervix

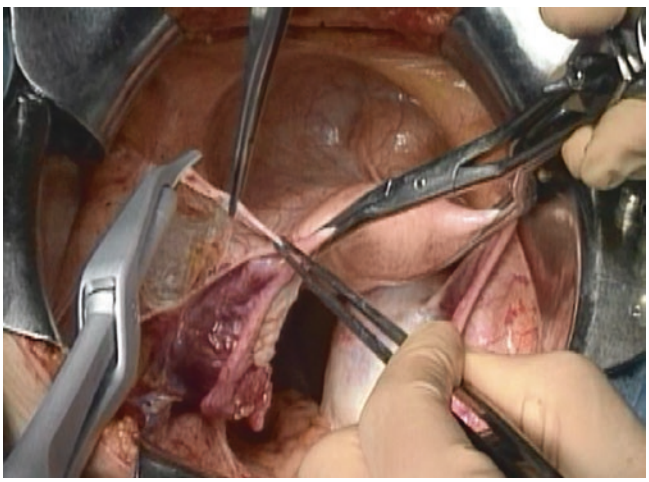


Fig. 100.3 Division of the round ligament

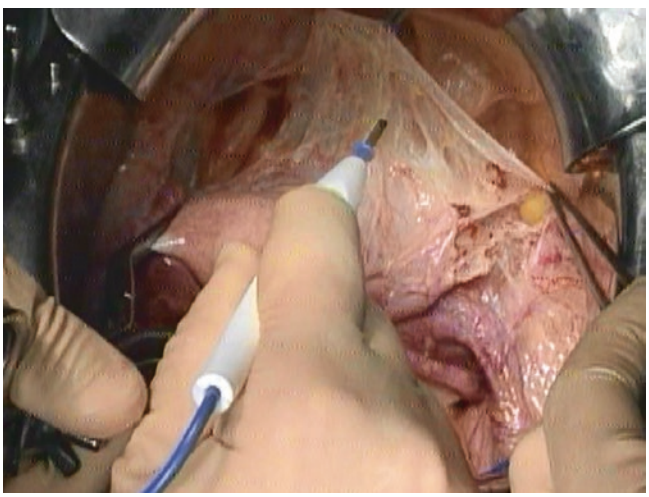


Fig. 100.4 Incision of bladder peritoneum

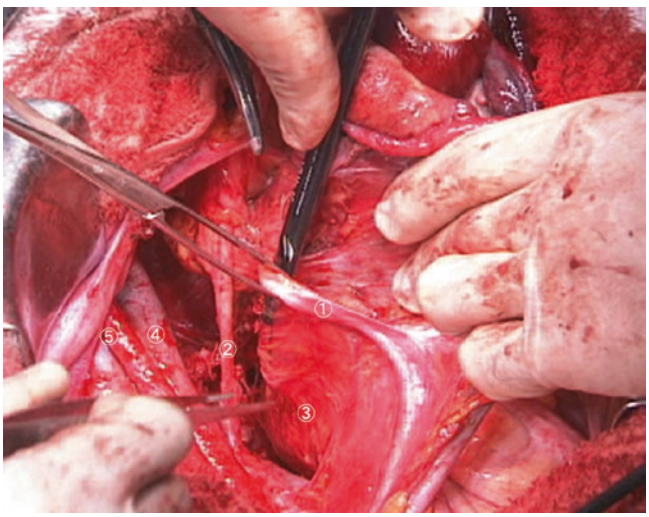


Fig. 100.6 Separation of the ureterohypogastric fascia from the posterior leaf of the broad ligament. The ureterohypogastric fascia including ureter is separated from the posterior leaf of the broad ligament. This isolation progresses in a downward direction. *1*: Ureter; *2*: Internal iliac artery, *3*: Hypogastric nerves, *4*: External iliac vein, *5*: External iliac artery

Developing the pararectal space between the ureter and the internal iliac vessels, the hypogastric nerves (HGN) running along the rectum is to be identified. The ureter is separated from the retroperitoneum and this tissue plane is kept facing downwards. The ureter should not be free from the posterior layer of the broad ligament. HGN are found to be running in parall under 3–4 cm of the ureter. This tissue plane is corresponded to the ureterohypogastric fascia (UHF), which includes the HGN and the pelvic plexus.

3. Pelvic lymphadenectomy (Figs.100.10, 100.11, 100.12, and 100.13)

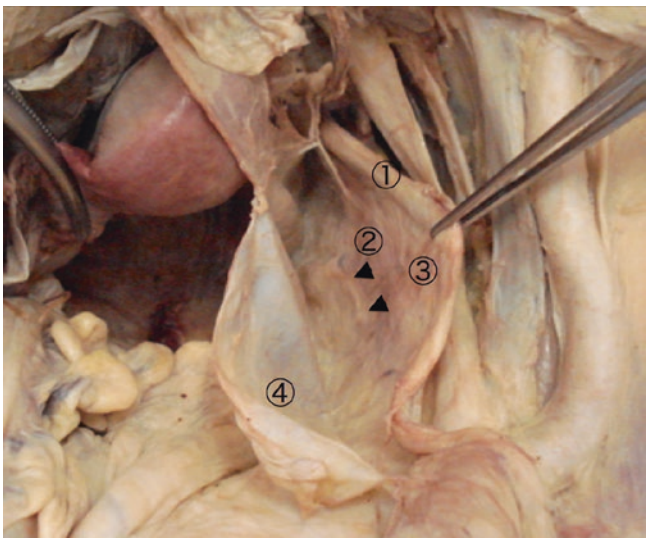


Fig. 100.7 Separation of the ureterohypogastric fascia from the posterior leaf of the broad ligament (formalin embalmed cadaver dissection, as a reference). The ureterohypogastric fascia including ureter is separated from the posterior leaf of the broad ligament. *1*: Ureter; *2*: Hypogastric nerves, *3*: the ureterohypogastric fascia, *4*: Posterior leaf of the broad ligament

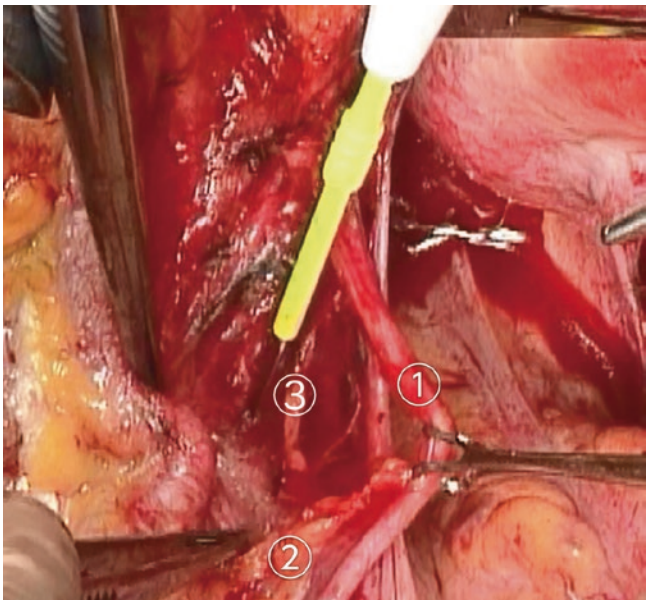


Fig. 100.8 Developing of paravesical space. The paravesical space is developed between the ureter and the external iliac vein. *1*: Ureter; *2*: Ureterohypogastric fascia, *3*: Hypogastric nerves

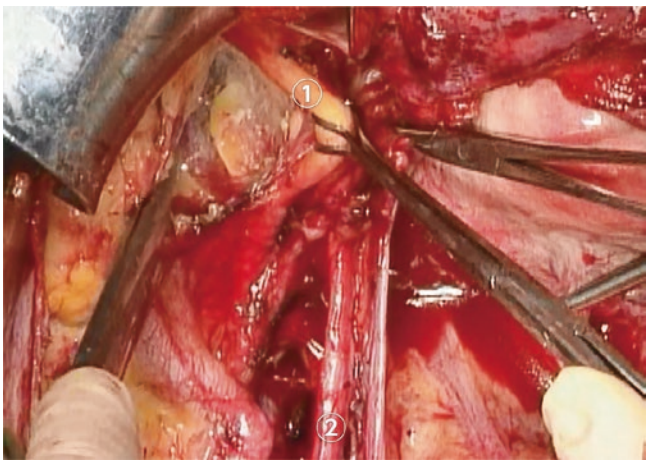


Fig. 100.9 Developing of paravesical space. The paravesical space is developed between the ureter and the external iliac vein. *1*: Lateral umbilical ligament, *2*: Ureter

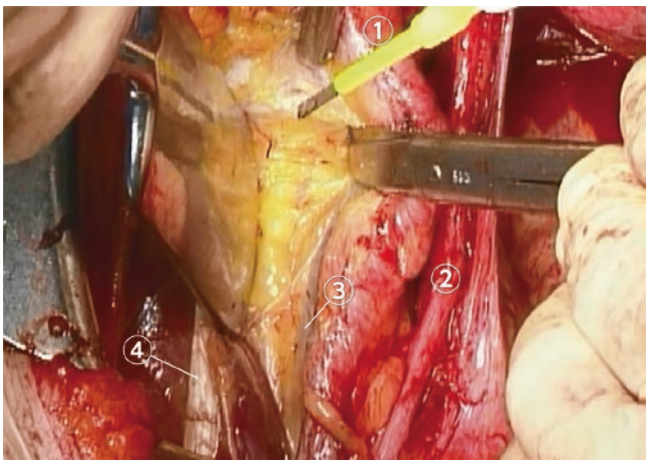


Fig. 100.10 Pelvic lymphadenectomy. *1*: External iliac artery, *2*: Ureter, *3*: External iliac vein, *4*: Psoas major muscle

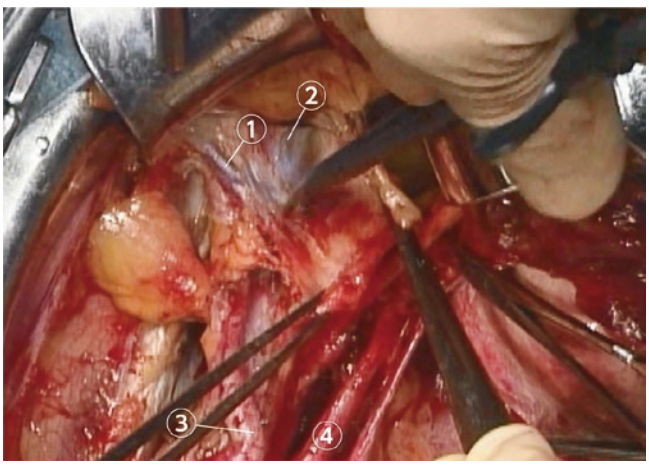


Fig. 100.11 Pelvic lymphadenectomy. The dissection of the external iliac vessels continues caudally by power star until the circumflex iliac vessels are encountered. *1*: Deep circumflex iliac vein, *2*: External iliac vein, *3*: External iliac artery, *4*: Ureter

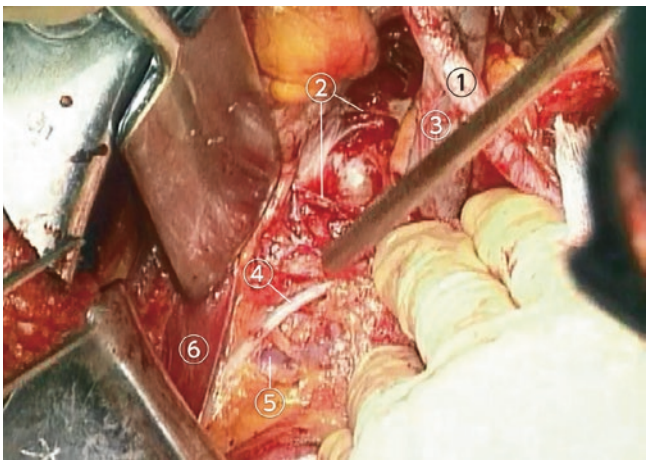


Fig. 100.12 Exposure of the obturator fossa. *1*: External iliac artery, *2*: perforating branch, *3*: External iliac vein, *4*: Obturator nerves, *5*: Superior gluteal vein, *6*: psoas muscle

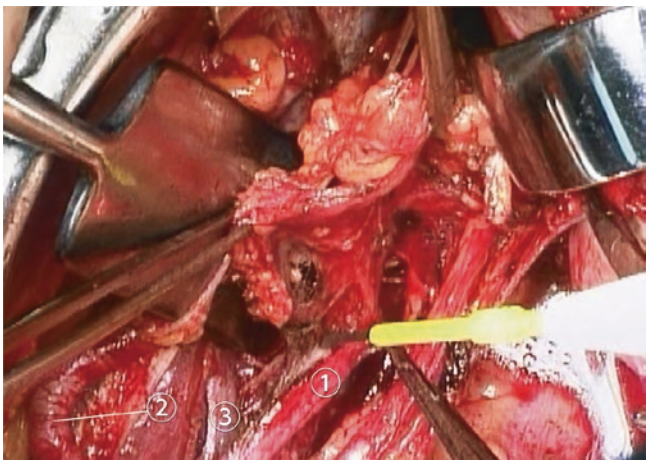
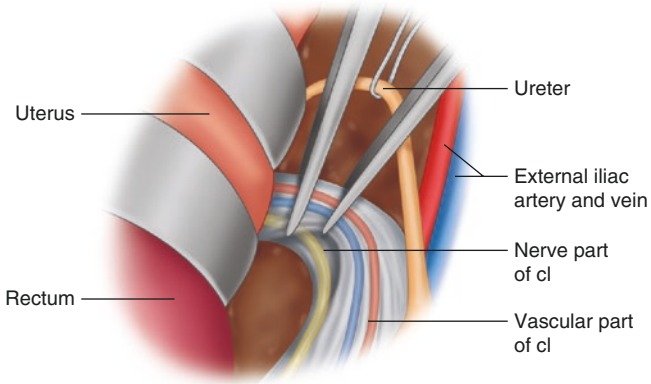


Fig. 100.13 Completion of pelvic lymphadenectomy. En bloc pelvic lymph node dissection has completed. *1*: Internal iliac artery, *2*: External iliac artery, *3*: External iliac vein



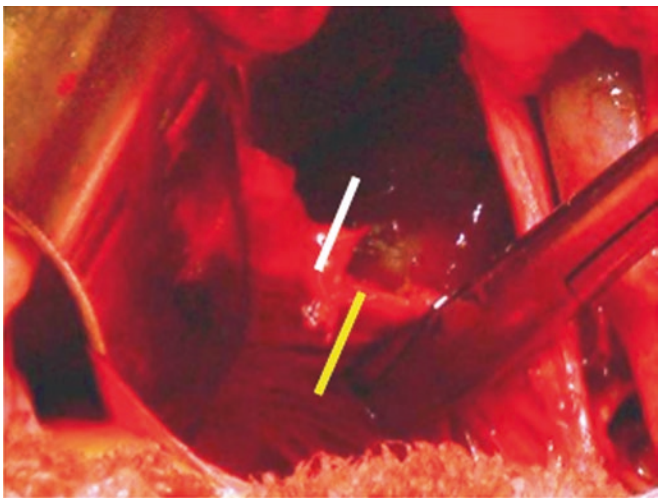


Fig. 100.14 Division of the cardinal ligaments according to the original procedure. According to the original procedure [2], the cardinal ligament is divided into two parts. The superficial vascular part (*white line*) is dissected, while the deep neural part (*yellow line*) that contains the pelvic splanchnic nerves is preserved

4. Preserving the pelvic splanchnic nerves during dividing of the cardinal ligament (Figs. 100.14, 100.15, 100.16, and 100.17):

According to the original procedure [2, 3], the cardinal ligament (CL) is divided into two parts. The superficial vascular part is dissected, while the deep neural part that contains the PSN is preserved. Because the surgical margin of the CL might compromise radicality, the indication of this method is limited to cervical cancer with early stage. In order to raise radicality of nerve-sparing radical hysterectomy we demonstrated that the pelvic splanchnic nerves (PSN) arise from the dorsomedial portion of the neural part of the CL, based on operative findings as well as fresh cadaver studies [7].

The CL is dissected immediately above the middle rectal artery as close as possible to the pelvic sidewall. The PSN originating from S3 run to the pelvic plexus dorsal to the middle rectal artery. The landmark of middle rectal artery is vessels that run under 1–2 cm of the deep uterine vein and pierce the pelvic plexus.

5. Developing the rectovaginal space (Figs. 100.18, 100.19, 100.20, 100.21, and 100.22)

To connect both ends of posterior layer of the broad ligament, the peritoneum of cul-de-sac is dissected. As the rectum being pulled cranially with gauze, the rectovaginal space is developed.

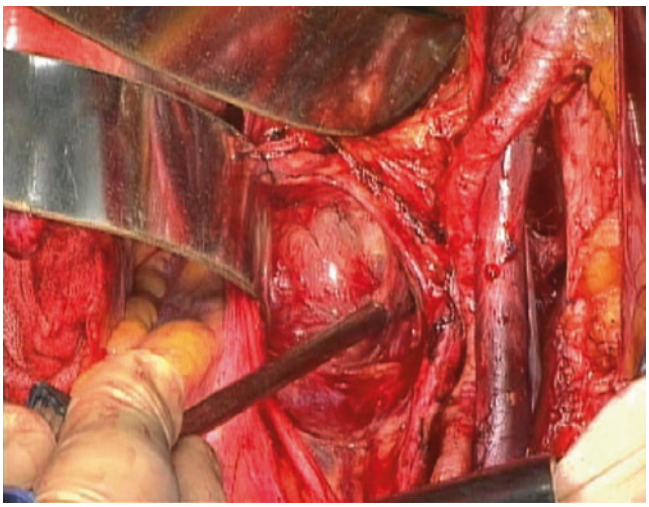


Fig. 100.15 Developing of the paravesical and the pararectal spaces. The cardinal ligaments are exposed

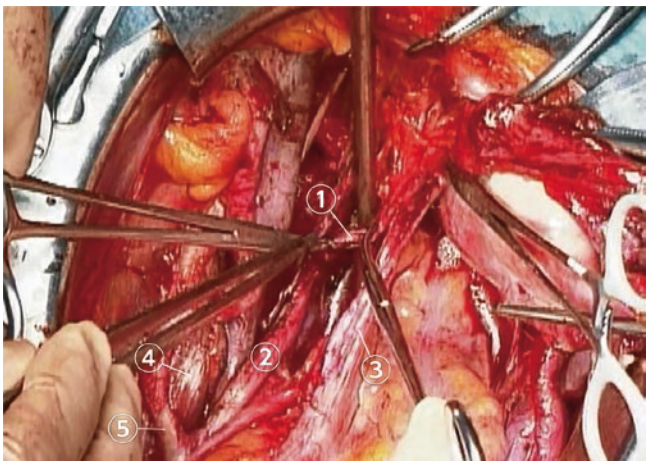


Fig. 100.18 Division of uterine artery. The uterine artery is divided closed to the origin. *1*: Uterine artery, *2*: Internal iliac artery, *3*: Ureter; *4*: External iliac vein, *5*: External iliac artery

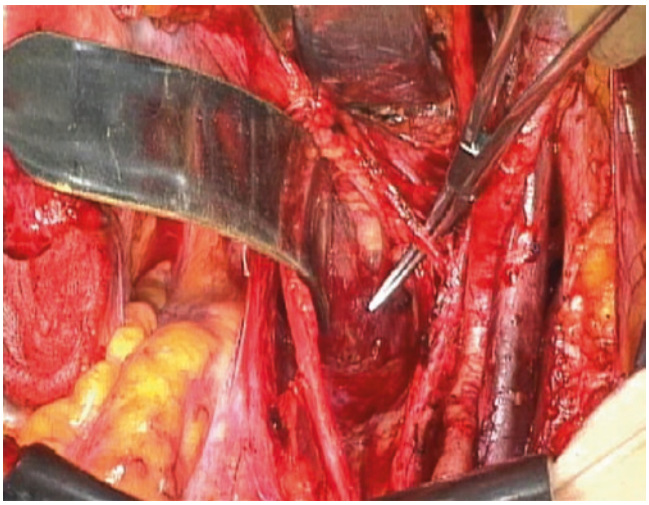


Fig. 100.16 Division of the cardinal ligaments. The cardinal ligaments immediately above the middle rectal artery are divided as close as possible to the pelvic wall by ligation of individual vessels

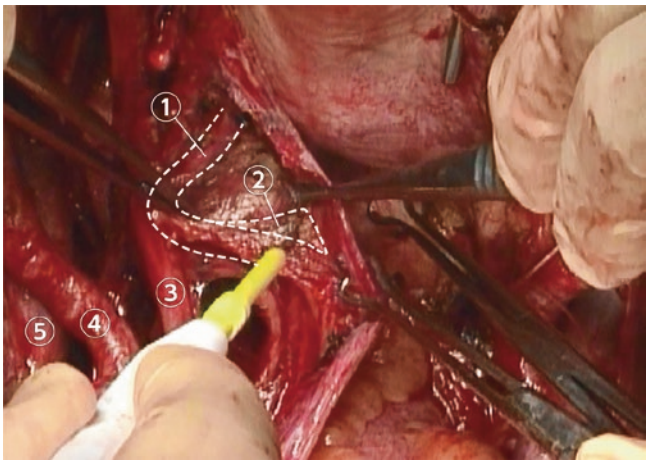


Fig. 100.19 Separation of the ureter and ureterohypogastric fascia from the broad ligament. The ureter and ureterohypogastric fascia is further separated from the peritoneum until the entrance of the ureteric tunnel. *1*: Ureter; *2*: Ureterohypogastric fascia, *3*: Internal iliac artery, *4*: External iliac artery, *5*: External iliac vein

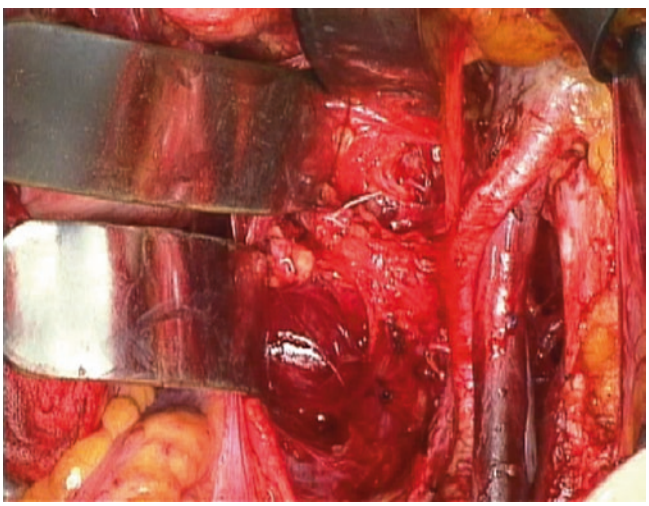


Fig. 100.17 Final view of division of the cardinal ligament. The PSN from S3 is running beneath the middle rectal artery

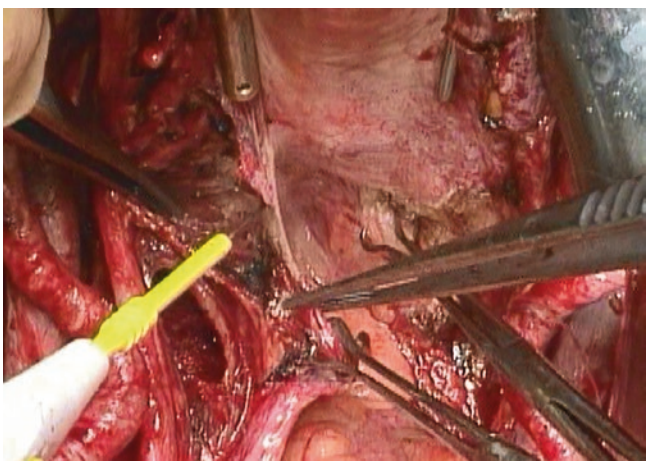


Fig. 100.20 Incision of the posterior leaf of the broad ligament. The posterior leaf of the broad ligament is incised to mobilize ureter laterally

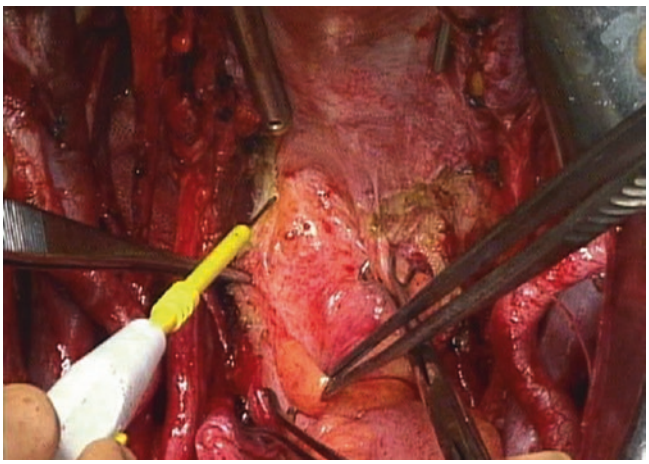


Fig. 100.21 Incision of peritoneum of the cul-de-sac. To connect both ends of posterior layer of the broad ligament, the peritoneum of the cul-de-sac is incised

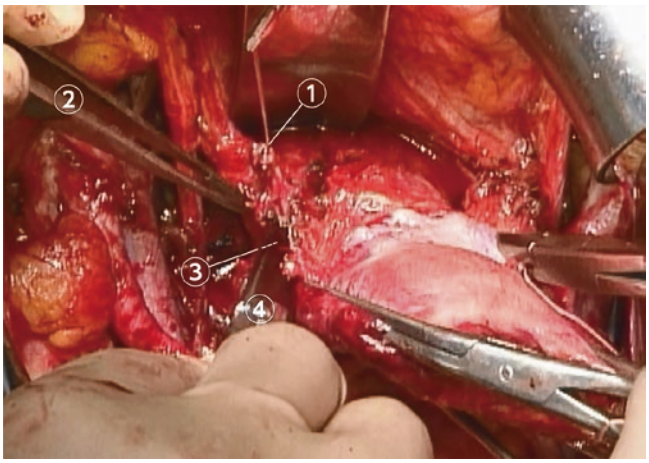


Fig. 100.23 Division of the anterior layer of the vesicouterine ligament. The ureteral tunnel is deroofed, allowing exposure of the ureters. *1*: Stump of uterine artery *2*: Superior vesical vein, *3*: Ureter, *4*: Ureteric tunnel (behind the sccissors)

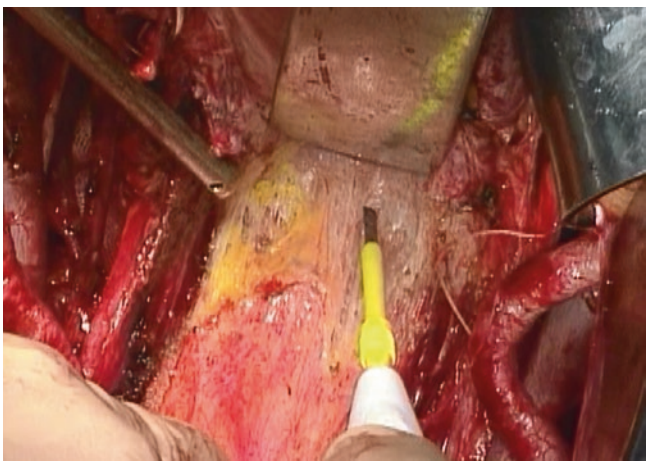


Fig. 100.22 Developing the rectovaginal space. The rectum is dissected sharply down 3 to 4 cm from its attachment to the vagina

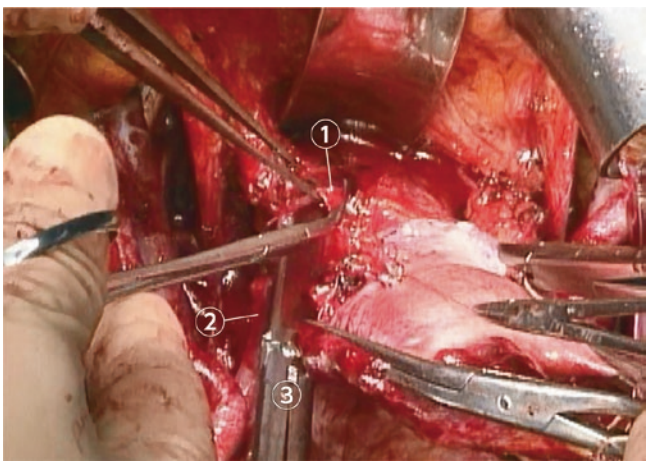


Fig. 100.24 Division of cervicovesical vessels. Division of cervicovesical vessels leads to roll ureter downward and laterally. The bladder is further dissected laterally to expose the paracolpium. *1*: Cervicovesical vessels, *2*: Ureter, *3*: Ureteric tunnel

6. Dissection of the anterior layer of vesicouterine ligaments with keeping the ureterohypogastric fascia (Figs. 100.23 and 100.24)
7. Preserving the pelvic plexus during dissection of the uterosacral ligaments (Figs. 100.25, 100.26, 100.27, and 100.28):

The UHF is incised at midline between the HGN and the ureter. The HGN entered the pelvic plexus at the anterosuperior corner. Deep uterine vein is located below the HGN. The HGN and the pelvic plexus were frequently damaged during dissection of the uterosacral ligaments (USL). To diminish these nerve injuries, the medial stump of the CL should be fully mobilized above the HGN before dissecting the USL. In the case of the tumor with deep myometrial or parametrial invasion, we dissect the USL just below the medial stump of the CL. Then the pelvic plexus is preserved partially.

8. Preserving the bladder branches during the dissection of the rectovaginal ligaments (Figs. 100.29 and 100.30):

The ventral half of bladder branches to the ureter are more likely to be injured in dissection of the posterior leaf of the vesicouterine ligament for wide resection of the paracolpium and the vagina. In order to maximize preservation of the dorsal half of bladder branches, the rectovaginal ligaments should be clamped using right angle forceps not to involve them.

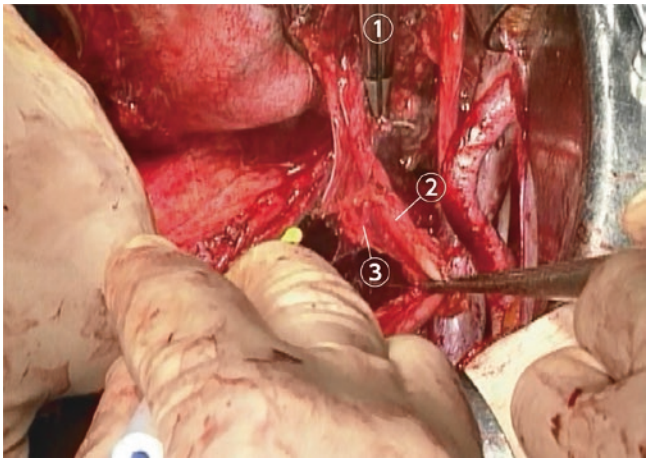


Fig. 100.25 Incision of the ureterohypogastric fascia. Right ureterohypogastric fascia is incised at midline between the ureter and hypogastric nerves. *1*: Medial stump of the cardinal ligaments *2*: Ureter, *3*: Ureterohypogastric fascia

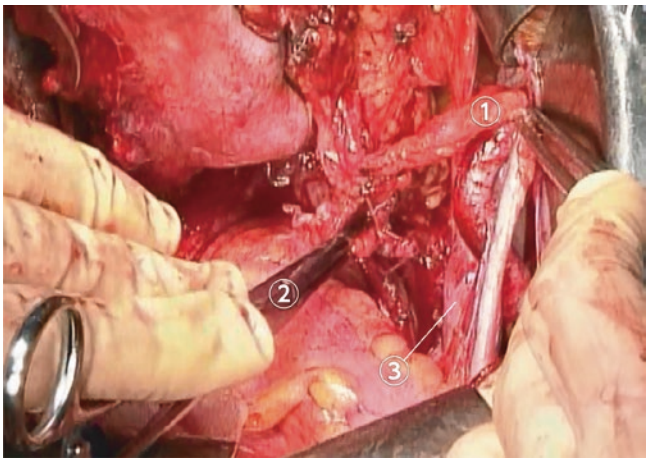


Fig. 100.26 Re-clamping of the medial stump of the cardinal ligaments. The medial stump of the cardinal ligament is re-clamped from the inside of the ureterohypogastric fascia. *1*: Ureter *2*: Medial stump of the cardinal ligaments, *3*: Ureterohypogastric fascia

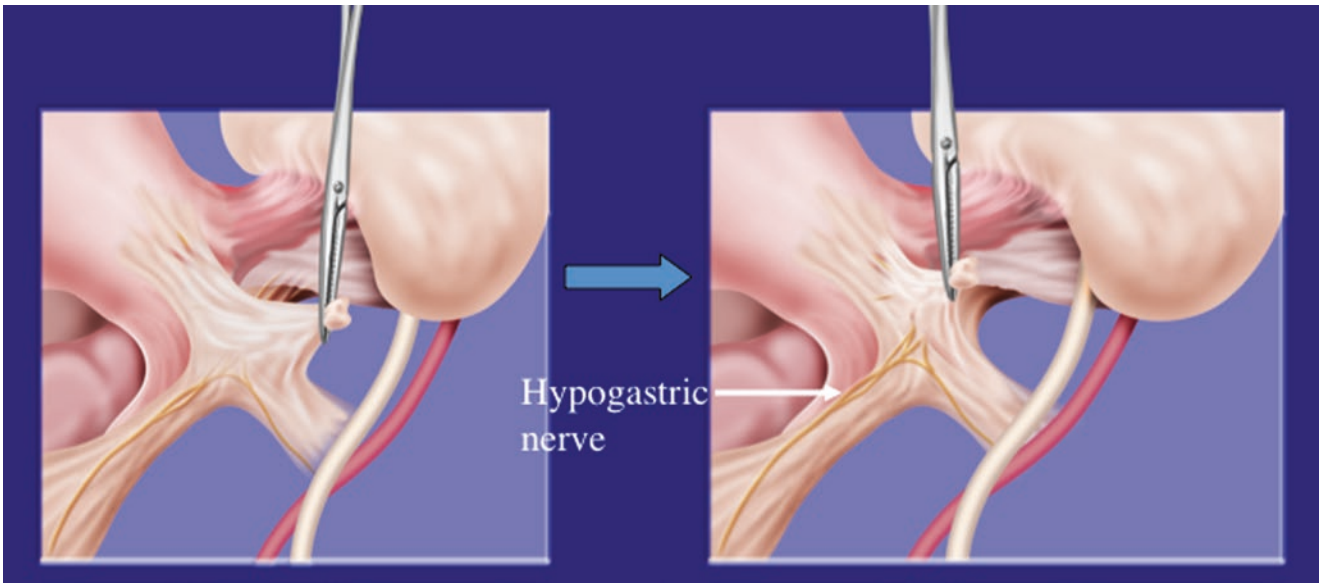


Fig. 100.27 Mobilization of medial stump of cardinal ligaments. The bottom of medial stump of the cardinal ligaments usually located beneth the hypogastric nerves. To diminish these nerve injuries during dissecting the uterosacral ligaments, the medial stump of the cardinal ligament should be mobilized above the hypogastric nerves in advance

9. Dissection of the posterior layer of vesicouterine ligaments (Figs. 100.31, 100.32, 100.33, and 100.34):

Further rolling the ureter allows the clearance of the boundary between the posterior layer of the vesicouterine ligaments and the paracolpium. Forceps are inserted into this boundary.

10. Dividing the paracolpium and the vagina (Figs. 100.35, 100.36, 100.37, and 100.38)

Separating the paracolpium from the posterior layer of the vesicouterine ligament to extend the resection field of the paracolpium is an original point of Okabayashi hysterectomy [10, 11]. This procedure allows us wider and longer resection of paracolpium and vagina.

11. The level of preservation of autonomic nerves after nerve-sparing radical hysterectomy (Figs. 100.39, 100.40, 100.41, 100.42, 100.43, and 100.44):

Dissection line of autonomic nerves by our procedures is indicated by red line in Fig. 100.43. According to our method, the HGN are found to preserved in exposure, the PSN in non-touch or exposure, pelvic plexus in exposure or partial, and

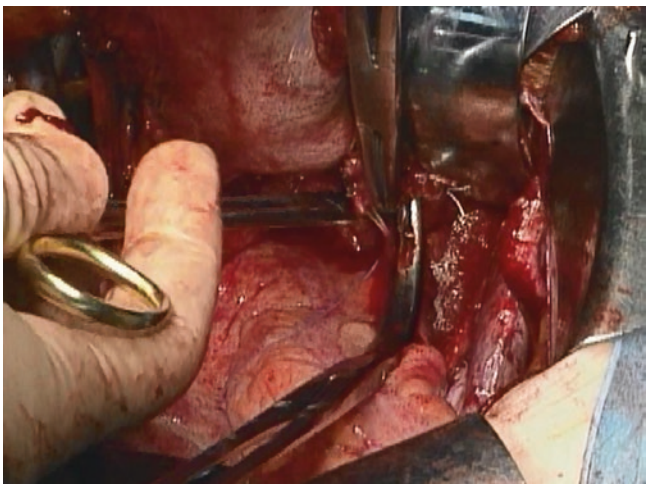


Fig. 100.28 Division of the sacrouterine ligaments. The uterosacral ligaments are divided immediately the hypogastric nerves

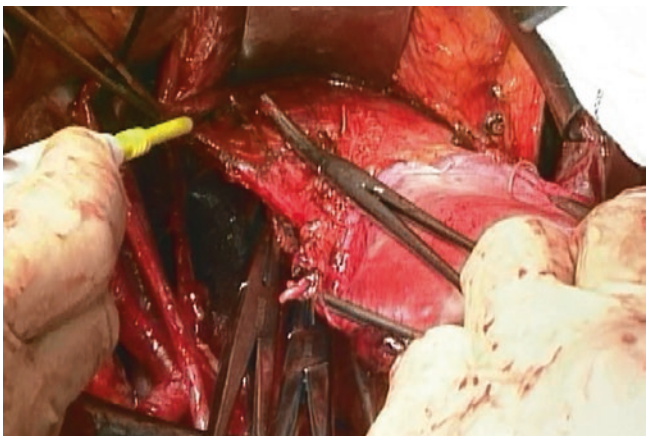


Fig. 100.31 Rolling the ureter. The top of electric cautery indicates the boundary between the paracolpium and the posterior layer of the vesicouterine ligaments

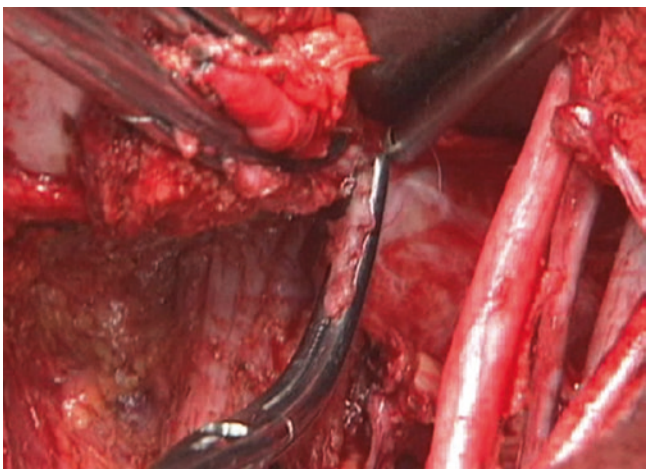


Fig. 100.29 Division of the rectovaginal ligaments. The rectovaginal ligaments are clamped with right angle forceps to avoid vesical branches

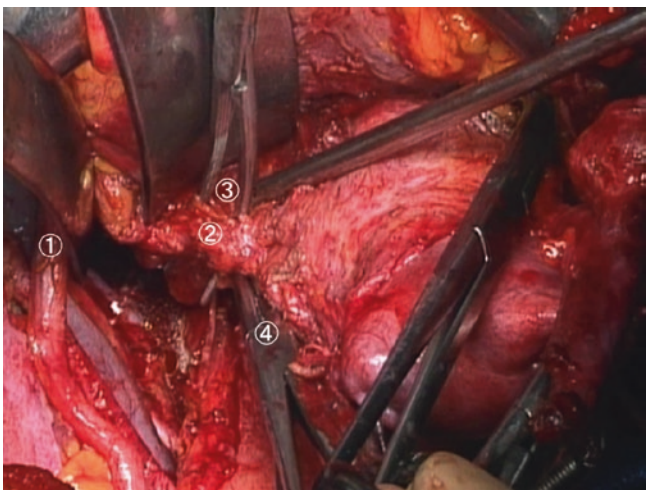


Fig. 100.32 Division of the posterior layer of the vesicouterine ligaments(another case). The forceps are inserted into this boundary and the posterior layer of the vesicouterine ligaments is divided. *1*: Ureter, *2*: Posterior layer of the vesicouterine ligaments, *3*: Paracolpium, *4*: Medial stump of the cardinal ligaments

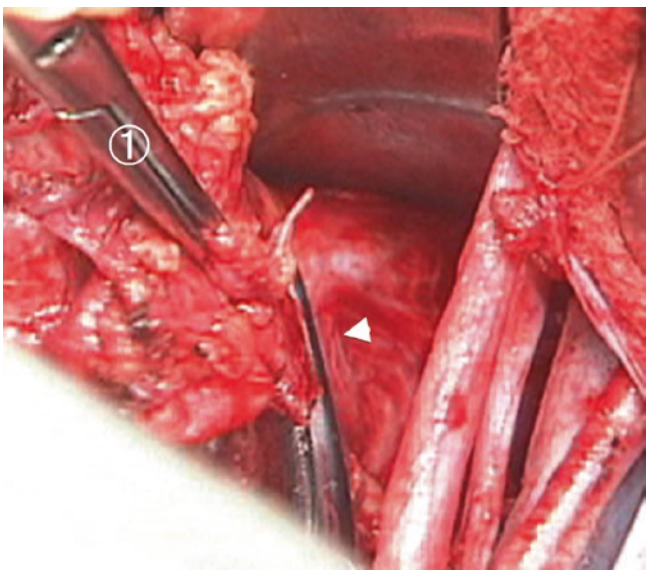


Fig. 100.30 Division of the rectovaginal ligaments. Some vesical branches (*arrow head*) are found to be preserved. *1*: Medial stump of the cardinal ligaments

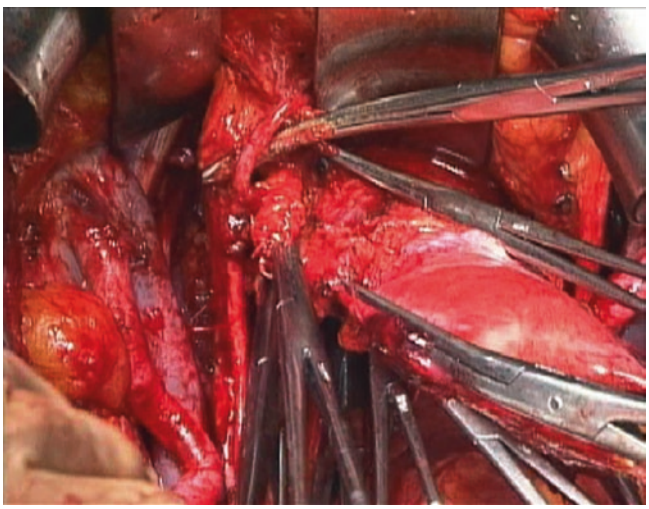


Fig. 100.33 Division of the posterior layer of the vesicouterine ligaments. The posterior layer of the vesicouterine ligaments is divided

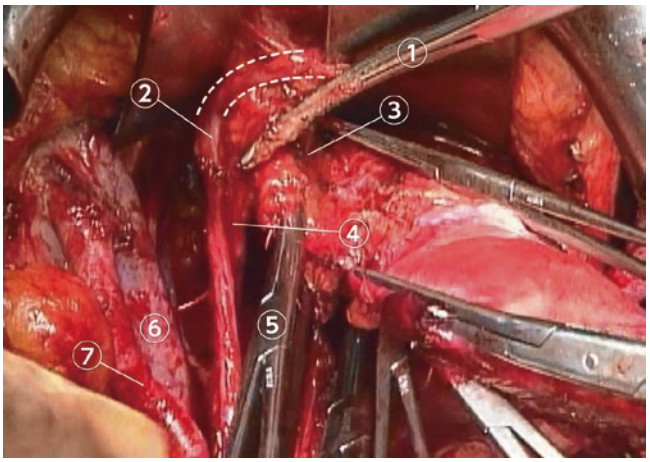


Fig. 100.34 Division of the posterior layer of the vesicouterine ligaments. The caudal side of the posterior layer of the vesicouterine ligaments is shown. *1*: Posterior layer of the vesicouterine ligaments, *2*: Ureter, *3*: Paracolpium, *4*: Internal iliac artery, *5*: Medial stump of the cardinal ligaments, *6*: External iliac vein, *7*: External iliac artery

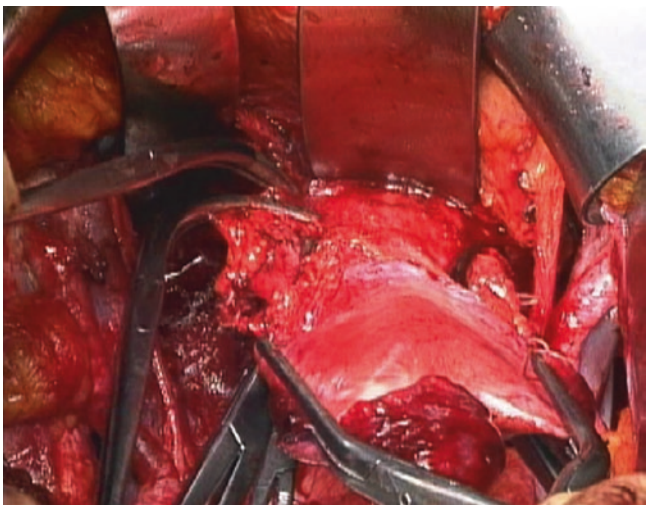


Fig. 100.36 Division of the paracolpium. The paracolpium are divided by two steps

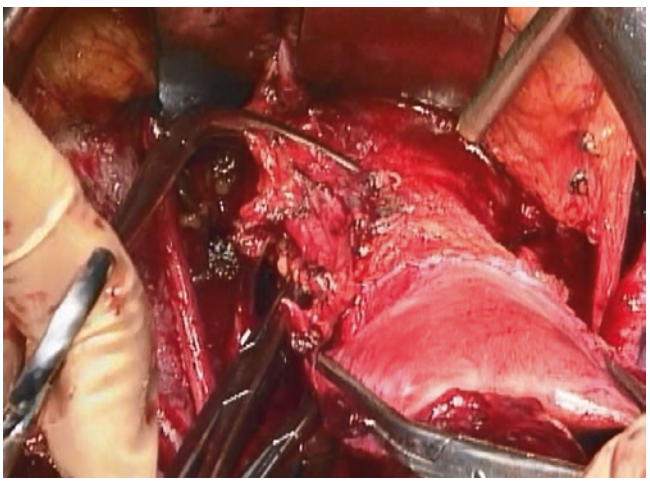


Fig. 100.35 Division of the paracolpium. The paracolpium are clamped with right angle forceps

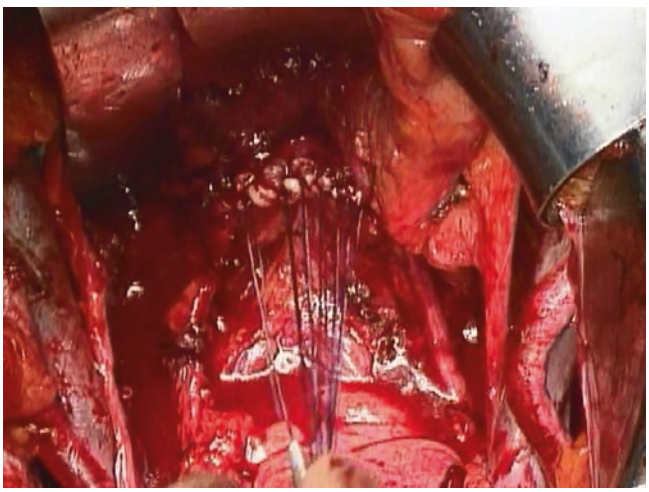


Fig. 100.37 Division of the vagina. The specimen is removed by dividing the vagina. The vaginal vault is closed with a Z-figure suture



Fig. 100.38 Resected specimens

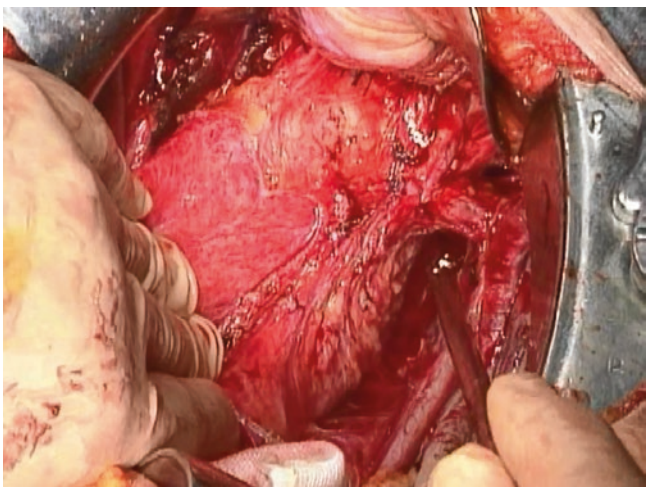


Fig. 100.39 Preservation of autonomic nerves (right side). The ureterohypogastric fascia including hyppogastric nerves, PP, some bladder branches are identified to be preserved

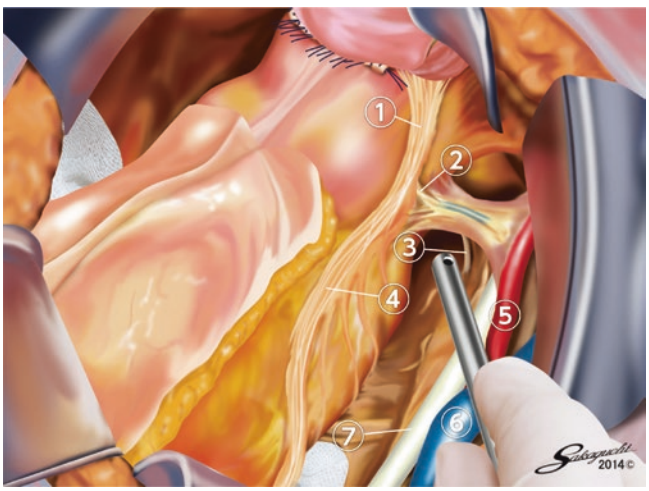


Fig. 100.40 Scheme of Fig. 100.39. *1*: Vesical branches, *2*: Pelvic plexus, *3*: Pelvic splanchnic nerves (S3), *4*: Hypogastric nerves, *5*: External iliac artery, *6*: External iliac vein, *7*: Ureter

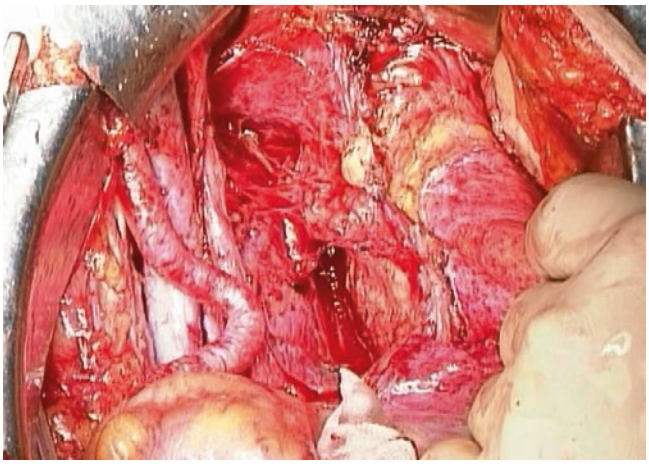


Fig. 100.41 Preservation of autonomic nerves (left side)

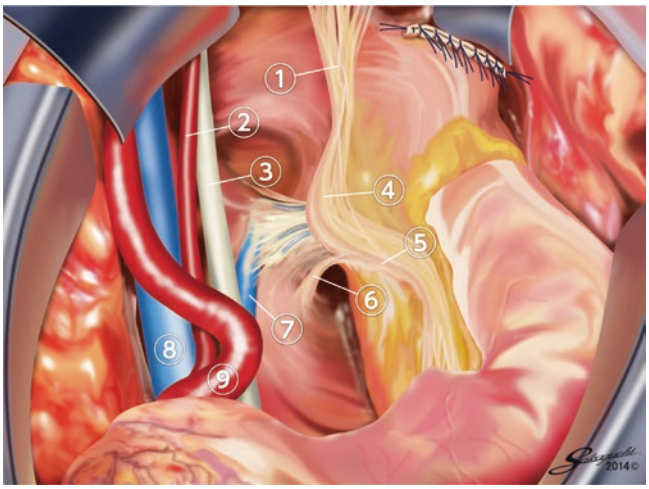


Fig. 100.42 Scheme of Fig. 100.41. *1*: Vesical branches, *2*: Internal iliac artery, *3*: Ureter, *4*:Pelvic plexus, *5*: Hypogastric nerves, *6*: Pelvic splanchnic nerves (S3), *7*: Internal iliac vein, *8*: External iliac vein, *9*: External iliac artery

bladder branches in partial preservation. The difference of dissection line between radical hysterectomy and nerve-sparing radical hysterectomy is also shown in Fig. 100.44.

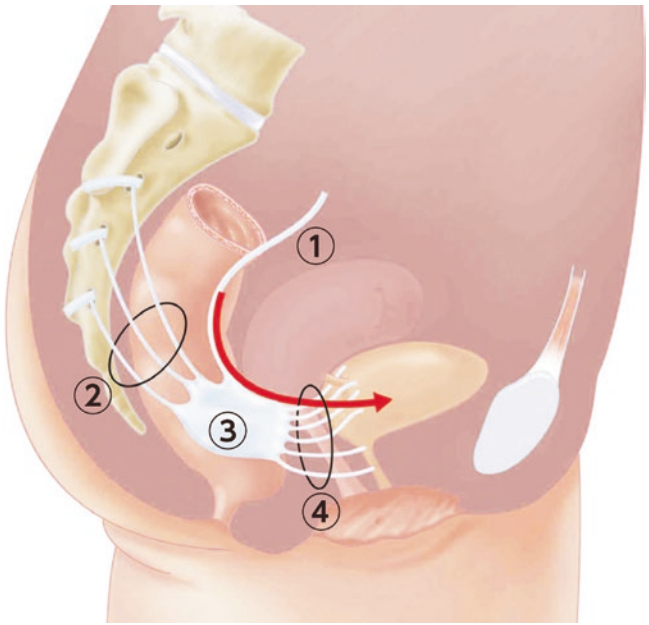


Fig. 100.43 Illustration of cutting line of nerve-sparing radical hysterectomy. Red line is indicating the cutting line of total preservation of pelvic plexus and hypogastric nerves and dorsal half preservation of vesical branches. *1*: Hypogastric nerves, *2*: Pelvic splanchnic nerves (S2–4), *3*: Pelvic plexus, *4*: Vesical branches

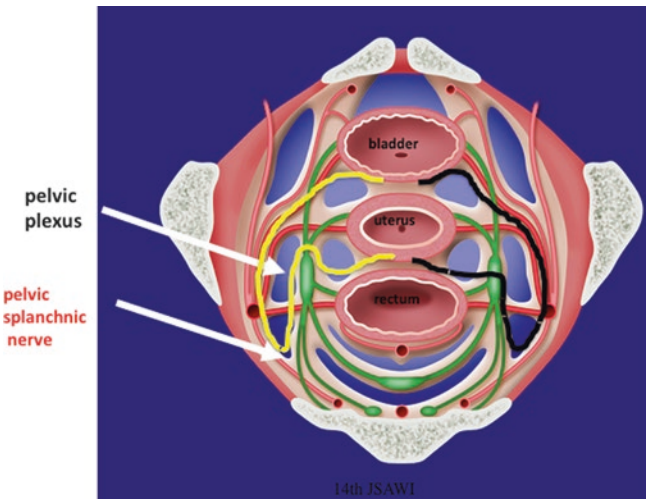


Fig. 100.44 Illustration of differential cutting line of autonomic nerves between radical hysterectomy and nerve-sparing radical hysterectomy. *Black line* is indicating the cutting line of autonomic nerves by radical hysterectomy and *yellow* one by nerve-sparing radical hysterectomy

References

1. Zullo MA, Manci N, Angioli R, et al. Vesical dysfunctions after radical hysterectomy for cervical cancer: a critical review. Crit Rev Oncol Hematol. 2003;48:287–93.
2. Kobayashi T. Radical hysterectomy. Tokyo: Nanzando; 1961.
3. Sakamoto S, Takizawa K. An improved radical hysterectomy with fewer urological complications and with no loss of therapeutic results for invasive cervical cancer. Baillieres Clin Obstet Gynaecol. 1988;2:953–62.
4. Yabuki Y, Asamoto A, Hoshiba T, et al. Radical hysterectomy: an anatomic evaluation of parametrial dissection. Gynecol Oncol. 2000;77:155–63.
5. Trimbos JB, Maas CP, et al. A nerve-sparing radical hysterectomy: guidelines and feasibility in Western patients. Int J Gynecol Cancer. 2001;11:180–6.
6. Lee YN, Wang KL, Lin MH, et al. Radical hysterectomy with pelvic lymph node dissection for treatment of cervical cancer: a clinical review of 954 cases. Gynecol Oncol. 1989;32:135–42.

7. Kato T, Murakami G, Yabuki Y. A new perspective on nerve-sparing radical hysterectomy: nerve topography and over-preservation of the cardinal ligament. Jpn J Clin Oncol. 2003;33:589–91.
8. Sakuragi N, Todo Y, Kudo M, et al. A systematic nerve-sparing radical hysterectomy technique in invasive cervical cancer for preserving postsurgical bladder function. Int J Gynecol Cancer. 2005;15:389–97.
9. Querleu D, Morrow CP. Classification of radical hysterectomy. Lancet Oncol. 2008;9:297–303.
10. Okabayashi H. Radical hysterectomy for cancer of the cervix uteri. Surg Gynecol Obstet. 1921;33:335–43.
11. Fujii S. Anatomic identification and functional outcomes of the nerve sparing Okabayashi radical hysterectomy. Gynecol Oncol. 2007;107:4–13.

Total and Peritoneal Mesometrial Resection

101

Benjamin E. Wolf and Nadja Dornhöfer

Principles of Conventional Radical Hysterectomy and Their Shortcomings

Since the introduction of radical hysterectomy as the main surgical approach to the treatment of cervical cancer about 100 years ago, only minor modifications of the procedure as proposed by Wertheim have been made (Wertheim 1912). Endoscopy and robotically assisted surgery as well as nerve sparing surgical techniques have reduced postoperative morbidity and sequelae significantly [6, 24]. In essence, traditional radical hysterectomy is based on the principle of wide excision, which is considered to be the basis of curative cancer resection. This principle has not changed over more than 100 years.

The concept of wide excision rests on two assumptions which are regarded hallmarks of malignant tumors: that cancer growth is isotropic, dissipating peritumoral tissues potentially in all directions following paths of least mechanical resistance, and that the macroscopic and microscopic tumor fronts can be preceded by the spread of occult tumor cells. Thus, all tumors should be resected with a metrically defined radial margin of microscopically healthy tissue (Fig. 101.1a–d).

The width of resection margins is considered the most important quality parameter of wide excision which may necessitate the resection of functionally important healthy adjacent tissue increasing procedure related morbidity. However, the association between margin width and probability of local tumor recurrence is not robust and results of different studies examining the benefit of wider excision margins have reported conflicting results [16].

Nevertheless, if such empirically defined tumor-free margins cannot be achieved surgically as determined by histological examination, adjuvant chemo-radiotherapy is considered standard of care [23, 26, 28]. Less frequently, targeted additional tissue resection can be considered in some situations.

Although adjuvant radiotherapy leads to a significant reduction in local tumor recurrence in cervical and endometrial cancer, it is associated with additional morbidity without improving overall survival [25]. According to data from Landoni and colleagues, adjuvant radiotherapy is required in up to 54 % of patients treated for cervical cancer [20]. Finally, local tumor control fails in up to 50 % of cervical cancer patients treated with surgery alone and in 10–20 % of patients receiving adjuvant radiotherapy [8].

Depending on tumor characteristics and stage, regional lymph node dissection is an integral part of operative tumor staging and in the case of metastasis part of tumor debulking surgery in cervical cancer. If histological analysis reveals lymph node metastasis, patients are usually referred for adjuvant radiation, frequently combined with chemotherapy as well [26, 28].

In endometrial cancer, the benefit of adjuvant radiation is unclear, as is the role of lymph node dissection with both treatments adding significantly to treatment related morbidity [10]. Traditional radical hysterectomy including bilateral salpingo-ovarectomy combined with adjuvant radiation (if indicated) leads to a good overall survival of about 90 % for patients with stage I endometrial cancer and a favorable histological risk factor profile. However, 5-year overall survival for stage I endometrial cancer patients can fall below 50 % depending on histologic risk factors. In patients who do not receive adjuvant radiation, 45–65 % of recurrences occur primarily in the pelvis while most patients die of distant metastasis [1]. Pelvic recurrence indicates that tumor foci are left in place during initial surgical treatment. Adjuvant radiotherapy fails to eliminate these residual tumor foci since adjacent pelvic structures frequently limit maximal radiation dose and volume and thus cannot reach all potential areas of residual tumor [7]. Not surprisingly, the PORTEC-1 study of

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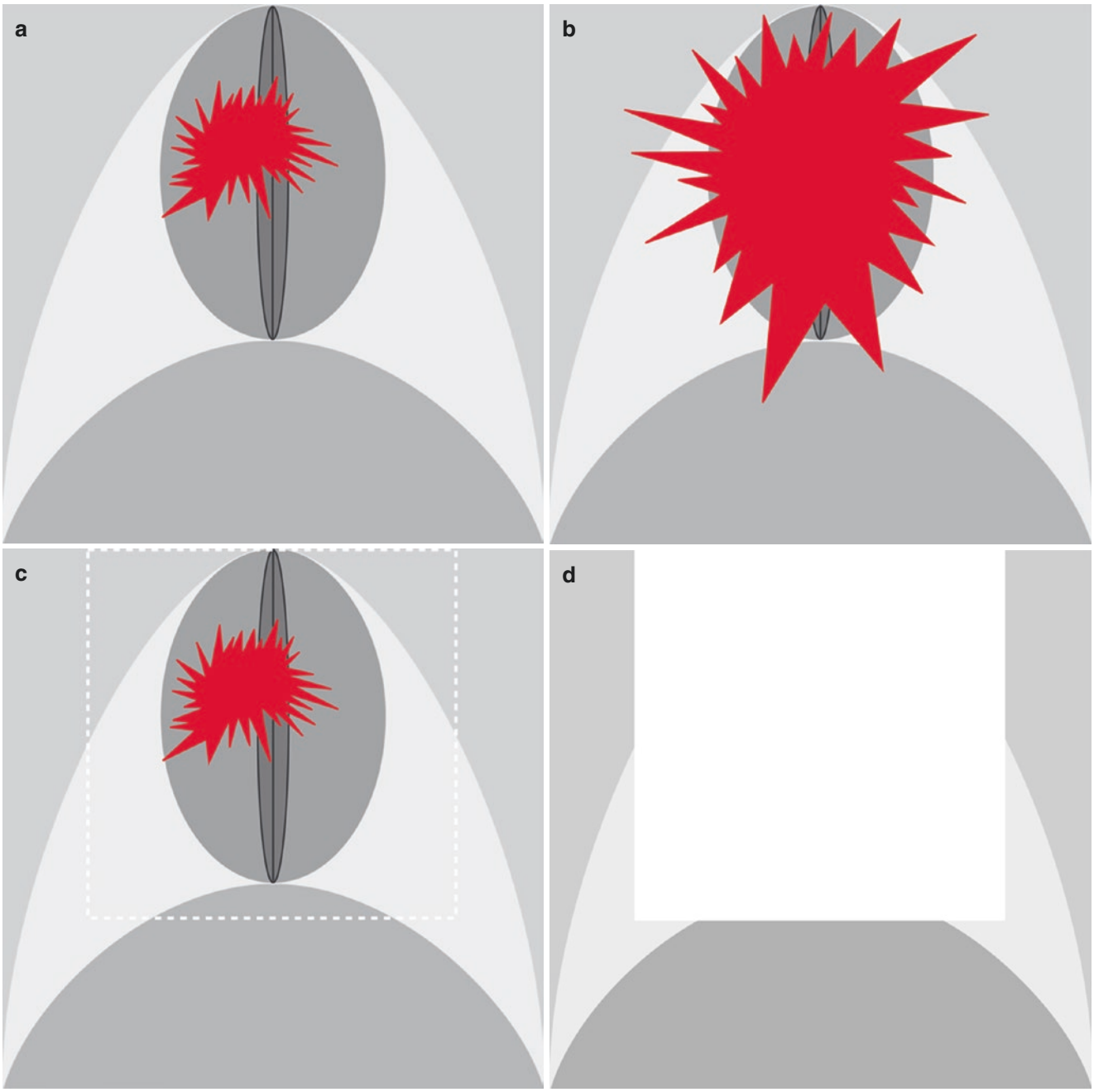


Fig. 101.1 Traditional theory of tumor spread. Traditional theories of tumor spread assume isotropic tumor permeation of all surrounding tissues (**a**, **b**). Surgical tumor resection aims to achieve metrically defined clear margins at all sides (**c**, **d**) (Courtesy of Prof. Michael Höckel. Modified from Höckel [14] (Reproduced with permission by Future Medicine Ltd))

stage I endometrial cancer found a significantly improved reduction in loco-regional recurrence but no improvement in overall survival [4, 27]. The 10-year locoregional recurrence rates were 5 % in patients receiving adjuvant radiation and 14 % (p<0,0001) in the observation group while 10-year overall survival was 66 % and 73 % respectively (*P*=0.09). The most common site of relapse was isolated vaginal recurrence (73 %).

Local recurrence of endometrial cancer in patients who did not receive adjuvant radiotherapy initially can frequently be treated successively by salvage surgery while most recurrences after adjuvant or primary radiotherapy are not amenable to surgical treatment. This was also shown in the PORTEC- trial for vaginal recurrence: 70 % of patients who did not receive adjuvant radiation were treated successfully by salvage surgery while this was only the case in 38 % of patients with adjuvant radiation [27].

15-year follow-up data of this trial published in 2011 confirmed that survival after vaginal relapse was 51 % in patients who did not receive adjuvant radiation while it was 25 % in irradiated patients. Survival-rates for pelvic relapse were 18 % and 0 % respectively. There was a trend towards an increased incidence of second cancer in irradiated patients [5]. Also, in the ASTEC/EN5 combined trial analysis [3], no overall survival benefit of adjuvant external beam radiation following surgery for medium and high risk stage I endometrial cancer was found.

This probably explains the fact, that a reduction in pelvic recurrence in patients who receive adjuvant radiotherapy does not translate into an overall survival benefit [10].

Especially for patients with a high risk for recurrence as determined by histological factors, there is urgent need for an improved surgical strategy without the need for adjuvant radiation. Studies examining the therapeutic role of lymph node dissection have revealed conflicting results (ASTEC and [2]; Panici et al. 2008; [29]). This can be explained by the inconsistency with regard to extend and quality of lymph node dissection across different studies with many not taking into account the possible routes of lymphatic spread and performing only pelvic lymph node dissection. As such, only pelvic lymphonodectomy was performed consistently in the ASTEC and the Italian trial reported by Panici et al. even though it has been clearly shown that the risk for isolated paraaortic lymph node metastasis in patients with tumor free pelvic lymph nodes can be as high as 16 % [22]. This could explain why there was a therapeutic benefit for patients treated with systematic pelvic and paraaortic lymph node dissection in the retrospective SEPAL study [29].

In summary, the established gynecological cancer operations are based on functional anatomy and on a model of radial progressive tumor permeation. They aim to resect tumors with a metrically defined radial margin of tumor-free, healthy tissue accepting a hereby caused higher morbidity. Nevertheless, this treatment strategy often needs additional adjuvant (chemo)radiation which further increases treatment-related morbidity and relapses still occur. Therefore, new strategies with a better therapeutic index were needed to improve oncologic outcome and lower morbidity.

The Ontogenetic Theory of Cancer Fields: New Strategies for Gynecologic Oncology

During the last two decades, a new paradigm of radical oncological surgery based on considerations derived from ontogenetic anatomy has been pioneered by Michael Höckel.

During embryonic morphogenesis, tissue domains with increasing specificity and differentiation develop. In this process, definite compartments and finally subcompartments evolve from early and late developmental metacompartments. This process is thought to be driven by the sequential activation of genetically encoded developmental programs which are silenced successively until a state of morphostasis is reached in adult organisms [18]. According to the ontogenetic theory of cancer fields, malignant progression of cancer is caused by a retrograde activation of these developmental programs. Reactivation of these programs occurs in a fixed sequence and thus cancerous morpholysis follows a predictable way. During malignant progression, a tumor arising in an ontogenetic subcompartment sequentially infiltrates the surrounding compartment and then successively the late and early metacompartments. Transgression from one developmental domain to the next is the phenotypic correlation of malignant progression. Thus, at a certain tumor stage, malignant cells are confined to a clearly demarcated, ontogenetically defined field of potential tumor growth (cancer field), the borders of which have intrinsically tumor suppressive properties. It should be noted that tumors grow isotropically *within* a given ontogenetic domain (Fig. 101.2a, b).

Based on these observations, a novel ontogenetic tumor staging system has been proposed and developed for cervical cancer which is shown in Table 101.1 [17]. The extent of the respective ontogenetic domains is highlighted in (Fig. 101.3a–f).

Taking this into account, locoregional tumor control can be achieved surgically by complete resection of the developmental domain of potential cancer spread according to ontogenetic tumor stage (Fig. 101.2c,d). When the entire ontogenetic domain of potential tumor spread is removed, there is an exceedingly small risk of local recurrence, even if the cancer reaches the resection margins (without transgressing it).

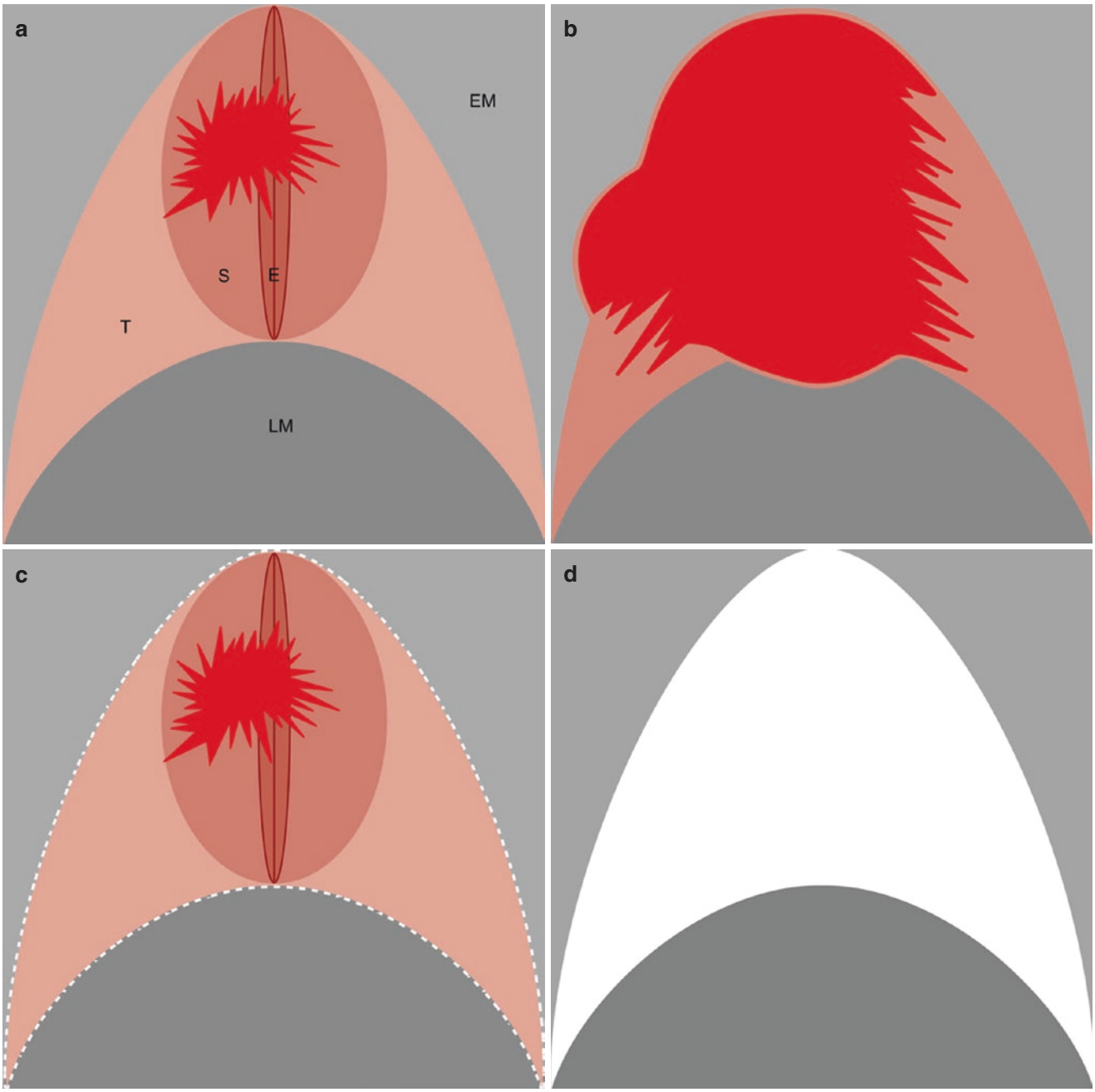


Fig. 101.2 Ontogenetic theory of cancer fields. The ontogenetic compartment (*shades of red*) contains an epithelial subcompartment (E), functional stroma (S) and tissue without apparent function (T) which are all derived from one embryonic precursor (anlage). The ontogenetic theory of cancer fields assumes that malignant tumors grow isotropically only within this compartment (**a**). The borders of a given cancer field have intrinsically tumor suppressive function and thus inhibit infiltration of the adjacent tissue (**b**) until malignant progression permits infiltration of the early and then the late metacompartment. The tumors in (**a**) and (**b**) can both be treated by complete resection of the compartment (**c** and **d**). All tumors which are contained inside the compartment (e.g. Müllerian compartment) are by definition staged as oT2-Tumors. *E* Epithelium, *SC* Subcompartment, *C* Compartment, *EM* Early Metacompartment, *LM* Late Metacompartment (Courtesy of Prof. Michael Höckel. Modified from Höckel [14] (Reproduced with permission by Future Medicine Ltd))

Table 101.1 Ontogenetic domains, tumor stages and tailored surgeries for respective domain resection

Ontogenetic Domain	Anatomical Structures	Ontogenetic Tumor Stage	Surgical Procedure
Subcompartment	Cervical stroma	oT1	LLETZ+first-line LND/ TMMR
Compartment (Müllerian)	Cervical stroma + uterine corpus, Fallopian tubes, mesosalpinx, proximal 2/3 of vagina and paracolpos	oT2	TMMR
Late (genital) Metacompartment	Müllerian + ovaries, infundibulopelvic, ovarian and round ligaments, dorsal bladder wall, medial bladder mesentary, distal vagina and dorsal urethra	oT3	EMMR/LEER
Early (urogenital ridge) Metacompartment	Late Metacompartment + peritoneum, retroperitoneum, urogenital mesentery, ureters and kidneys, bladder and urethra, rectovaginal septum, rectum and mesorectum	oT4	LEER in selected cases

LLETZ large loop excision of the transformational zone, *TMMR* total mesometrial resection, *EMMR* extended mesometrial resection, *LEER* laterally extended endopelvic resection, *LND* lymph node dissection

Surgical Procedures

As stated before, local tumor control according to the concept of the ontogenetic cancer field theory can be achieved by complete resection of the respective cancer field. Different surgical procedures have been designed at our institution for different gynecological cancers. In line with the book title, this text is concerned with different types of hysterectomy according to ontogenetic principles. The TMMR as a novel treatment approach to cervical cancer has been evaluated most extensively and will be described in detail. For endometrial cancer, a variant of this procedure termed peritoneal mesometrial resection (PMMR) has been developed and will be described briefly. A prospective proof of principal study for PMMR is currently underway.

Other surgical procedures based on the ontogenetic theory of cancer fields are extended mesometrial resection (EMMR) and laterally extended endopelvic resection (LEER) for treatment of oT3 cervical cancer, and LEER for oT4 disease (in form of primary or recurrent cancers). Vulva field resection (VFR) has been developed for surgical treatment of vulvar cancer. These procedures will not be discussed here, the interested reader should refer to the respective publications [12, 15].

Evidence and Benefits

The benefits of this surgical strategy have been clearly demonstrated in a series of 367 cervical cancer patients who were treated with operations tailored to ontogenetic tumor stage, i.e. TMMR/EMMR and LEER [17]: 217 patients had oT1- , 101 oT2-, 38 oT3- and 11 oT4-disease. Traditional tumor stages for the same collective ranged from pT1 to pT4. 88 % of the patients received TMMR, 6 % EMMR and 6 % LEER.

Microscopically free margin resection could be achieved in 99 % of patients irrespective of pathologic tumor stage.

Sustained locoregional tumor control over 5 years was achieved 94 % of patients who received surgery alone. Local tumor control during the same period was maintained in 96 % of patients. Close free margin resection (<5 mm) was not an independent risk factor for tumor recurrence, lending proof to our concept of compartment resection.

5-year overall survival for patients with oT1 tumors was 97 %, for oT2 tumors it was 94 %. In contrast, it was 64 % for patients with compartment transgressing oT4 disease.

Of note, none of the patients was treated with adjuvant radiotherapy. This represents an obvious advantage for patients since radiotherapy adds significantly to overall morbidity. Accordingly, moderate to severe procedure-related perioperative morbidity in patients treated with TMMR (grade 2–4 according to the Franco-Italian glossary) was 15 % [11] which is much lower than the morbidity reported with radical hysterectomy combined with adjuvant radiation [19].

Taken together, TMMR presents a surgical option for the treatment of cervical cancer which achieves better locoregional tumor control than traditional radical hysterectomy without the need of adjuvant radiation, thus decreasing treatment related morbidity significantly.

PMMR is currently being evaluated in an ongoing prospective observational study at our institution.

Relevant Ontogenetic Anatomy: The Müllerian Compartment

The anatomical structures of the adult female belonging to the Müllerian compartment have been defined [9, 13] and are outlined in Fig. 101.4. Its borders can be visualized using

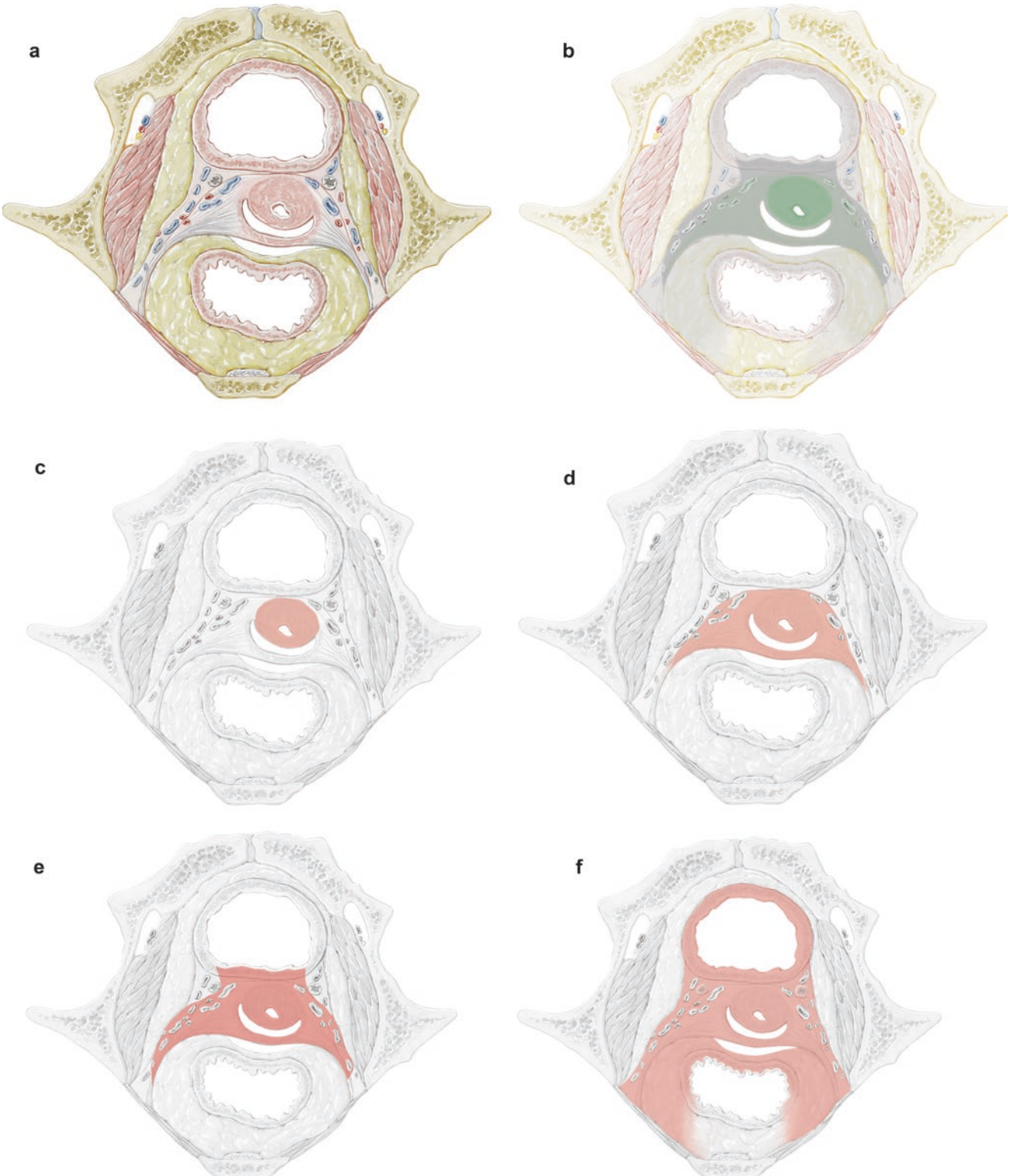


Fig. 101.3 Adult anatomic structures of possible tumor spread at different ontogenetic tumor stages. Transsectional anatomy of the pelvis (**a**). The Müllerian compartment (*green*) and the late genital metacompartment (*darker green*) (**b**). The tumor first grows in the uterine cervix (oT1, C), infiltrates during its malignant progression the structures belonging to the Müllerian compartment (oT2, D), the genital metacompartment (oT3, E) and the urogenital ridge metacompartment (oT4, F) (From Höckel et al. [17], Copyright 2014 with permission from Elsevier)

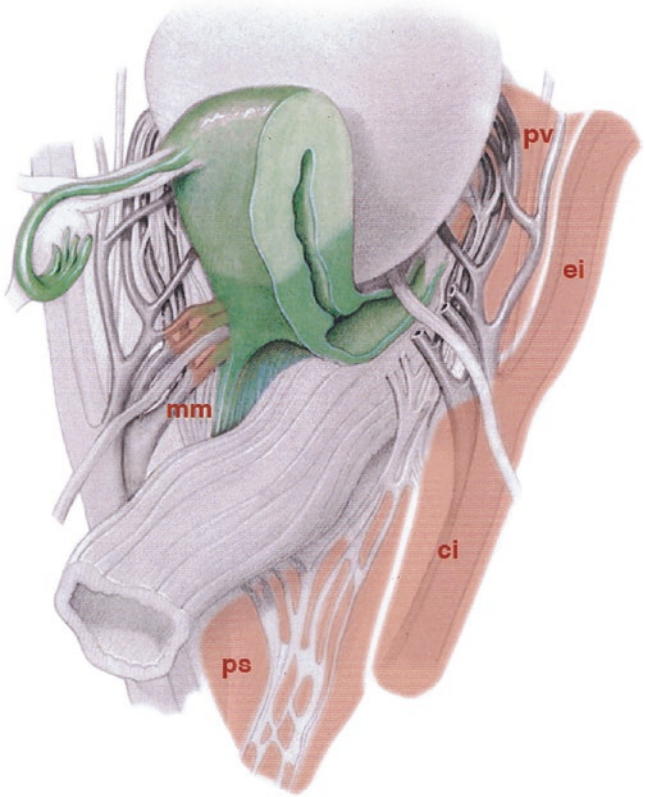


Fig. 101.4 Anatomy of the Müllerian compartment and its lymphatic drainage basins. The anatomic structures belonging to the Müllerian compartment are marked green, first-line lymph node stations dark red and second-line lymph node basins bright red. *mm* mesometrial, *pv* paravisceral, *ei* external iliac, *ci* common iliac, *ps* presacral (Reprinted from Höckel et al. [11], Copyright 2009, with permission from Elsevier

high resolution 3.5 Tesla MR-Imaging. Cranially, the compartment is located intraperitoneally and includes the fimbriae, fallopian tubes, mesosalpinx, uterine corpus and broad ligaments. The caudal part extends retro- and subperitoneally and is comprised of the uterine cervix, the proximal two thirds of the vagina and the enveloping tissue termed parakolpos and paracervix. The subperitoneal part of the Müllerian compartment is a closed vessel system covered by a continuous tissue lamella, multiple venous connections to the neighboring bladder compartment exist however.

The mesometrium can be divided into two ontogenetically and functionally distinct parts, the vascular and the ligamentous mesometrium. The vascular mesometrium extends dorsolaterally and contains the uterine and vaginal vessels as well as the lymphatic drainage system including important intercalated lymph nodes. The vascular mesometrium is adherent to the bladder mesentery and is traversed by the ureters. The ligamentous mesometrium is directed dorsally, is attached to the mesorectum and may also harbor intercalated lymph nodes draining the Müllerian compartment. By conventional terminology it is composed of parts of the broad ligament, the rectouterine and rectovaginal ligaments as well as the rectovaginal septum. The inferior hypogastric plexus marks the lateral border of the ligamentous mesometrium, dorsally and inferiorly it is continuous with the endopelvic fascia of the pelvic wall and floor. It should be noted, that the mesometrium is not part of the Müllerian compartment but of the genital (late) metacompartment.

TMMR and TLND

The objective of TMMR is the resection of the Müllerian compartment, the mesometria and the pelvic and paraaortic lymphnodes (where indicated) to achieve optimal local and regional tumor control without compromising adjacent structures (e.g. bladder meso, inferior hypogastric plexus) and without the need for adjuvant radiation. With the exception of the vagina, the compartment should be resected completely along the borders described before. For the purpose of maintaining a functional vaginal stump, the vaginal resection is performed intracompartimental in form of a wide excision with a resection margin of 2 cm. We believe this compromise in radicalness to be justified considering the rarity of vaginal recurrence (2 % according to our data) and the large benefit of maintaining vaginal integrity.

It should be stressed that therapeutic lymph node dissection as outlined in the step by step surgical description below is an integral part of TMMR. Without therapeutic lymph node dissection regional tumor control cannot be achieved.

Current treatment strategies incorporate lymph node dissection for staging purposes to determine the need for adjuvant radiation. As outlined before, in addition to patients with lymph node metastasis, patients which are considered at high risk for tumor recurrence on the basis of histological findings are subjected to adjuvant radiation of the pelvis. Meticulous pelvic (and paraaortic) lymph node dissection using the adventitia stripping technique can achieve excellent locoregional tumor control without the need for adjuvant radiation as was shown in the TMMR trials [11, 17]. Taking this into account lymph node dissection in the context of TMMR is therapeutic rather than diagnostic.

There is a fixed anatomic relation between lymph nodes and their tributary tissues through the afferent lymphatic vessels. With increasing ontogenetic tumor stage an increasing number of first-line lymph node drainage basins become potential stations for metastasis [17]. According to data from our institution, lymph node metastasis in cervical cancer occurs most frequently in the external iliac and paravisceral lymph node basins (Fig. 101.4). Together with

intercalated lymph nodes in the vascular mesometrium, these lymph nodes are considered first-line lymph nodes and should always be dissected and subjected to intraoperative frozen section examination. In clinical stage IB1 tumors of less than 2 cm in size, it is sufficient to remove the first-line lymph nodes. Second-line lymph nodes consisting of the common iliac and presacral lymph nodes must be removed in all other tumors or if first-line lymph nodes carry metastasis. If the latter is the case, ascending lymph node dissection up to the origin of the lower mesenteric artery should also be performed since preliminary data suggests, that direct metastasis from first-line pelvic lymph node stations to the aortic bifurcation can occur. Importantly, in the case of tumor infiltration of the uterine corpus, complete infrarenal paraaortic lymph node dissection is essential since metastasis can occur via the lymphatic drainage system of the uterine corpus along the infundibulopelvic ligaments. In this situation, infrarenal paraaortic lymph nodes become first-line lymph nodes. The algorithm for therapeutic lymph node dissection which we use is outlined in Fig. 101.5.

Ovariectomy should be performed in all oT3-Tumors since the ovaries are part of the genital (late) metacompartment. This is the case when there is evidence for mesometrial tumor infiltration as determined by intraoperative frozen section examination. Also, according to empirical data from our institution, the likelihood for subclinical oT3 disease increases significantly when more than two first-line lymph nodes carry metastasis. In these circumstances, the ovaries should be resected. Adjuvant radiotherapy is not indicated.

PMMR and TLND

PMMR includes surgical removal of the Müllerian compartment (except the distal vagina) including the genital peritoneum and the gonadal compartment. It is indicated for oT1 endometrial cancer which corresponds to FIGO stage I. The surgical technique is the same as for TMMR with the exception that the ovaries including the meso are always resected as well as the infundibulopelvic ligament which contains intercalated lymph nodes along the lymphatic drainage vessels from the corporal subcompartment analogous to the intercalated lymph nodes of the cervical subcompartment in the mesometria. In contrast to TMMR, the distal ligamentous mesometrium is left in place. This means that when performing a PMMR, preparation of the mesometrium stops just below the uterine artery while in TMMR the paracervical ligamentous mesometrium is dissected all the way down to the vaginal fold to include all paracervical drainage tissue. Since the inferior hypogastric plexus is separated from the distal ligamentous mesometrium in TMMR, the incidence of bladder function disturbances is much lower with PMMR than with TMMR.

If there is pre-operative suspicion for Stage II disease (cervical involvement), TMMR is indicated.

At our institution, we use the Mayo Clinic criteria to determine risk of lymphatic spread with G3-grading, extrauterine disease, non-endometrioid cancer and myometrial invasion depth of more than 50 % indicating high risk of lymph node metastasis [21]. If there is risk for lymphatic tumor spread, TLND needs to include all lymphatic drainage

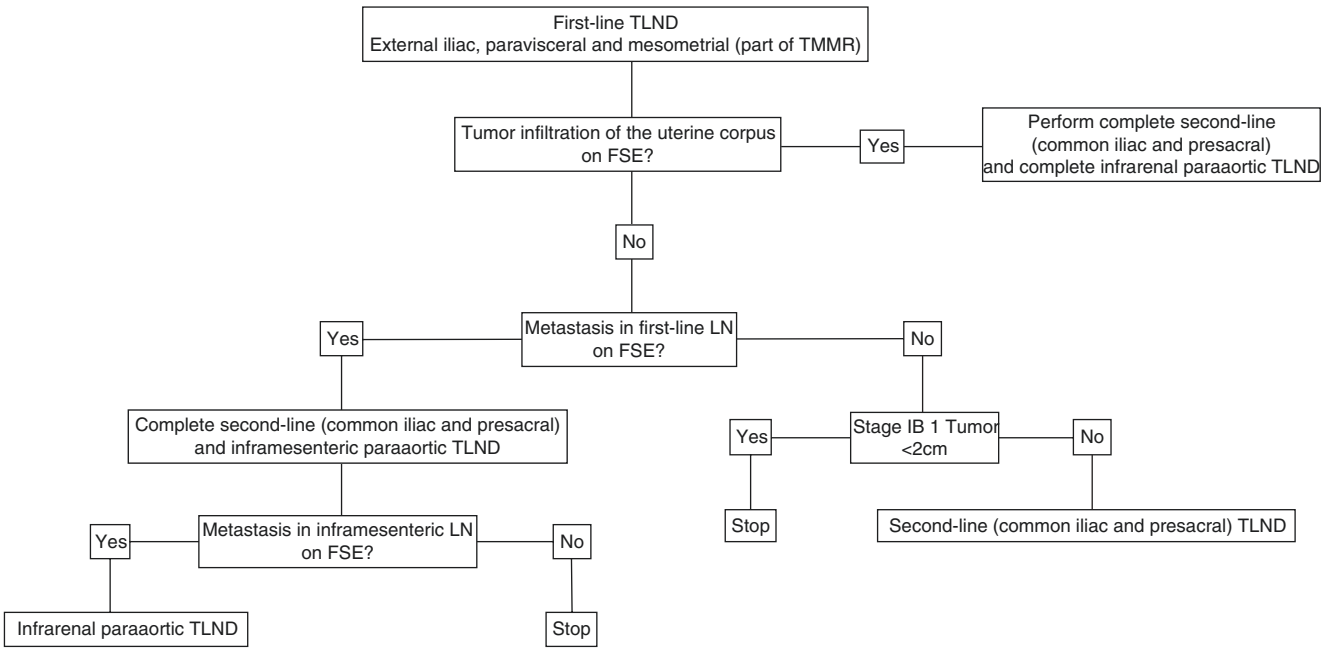


Fig. 101.5 Flowchart showing the successive steps of comprehensive therapeutic lymph node dissection in cervical cancer. *TLND* therapeutic lymph node dissection, *LN* lymph nodes, *FSE* frozen section examination

regions of the uterine corpus. Lymphatic drainage occurs directly to the internal iliac lymph nodes and along the ovarian vessels via the infundibulopelvic ligament into the infrarenal paraaortic region. TLND in this region is carried out as in cervical cancer cases with tumor infiltration into the uterine corpus. Adjuvant radiation is not indicated.

We acknowledge that there is a collective of patients with low to intermediate risk for lymphatic tumor spread (e.g. G2-grading). In these cases we recommend performing only first-line TLND including external iliac, paravisceral and infrarenal paraaortic lymph node basins. If intraoperative frozen-section examination reveals lymph node metastasis in first-line regions, TLND of all pelvic and paraaortic regions is indicated. If there should be *preoperative* evidence of significant cervical tumor infiltration (i.e. stage II tumors), TMMR is indicated.

TMMR: Surgical Management

Indication

Management protocol for the treatment of cervical cancer stage FIGO IB1-IIA and some cases of IIB (oT1 and oT2 tumors).

Surgical Treatment Oals

1. Local tumor control through complete resection of the Müllerian compartment with a wide tumor-free vaginal margin (intracompartimental resection margin)
2. Regional tumor control through resection of the mesometria and therapeutic lymph node dissection as outlined in Fig. 101.5.
3. Ovarectomy in oT3 tumors (i.e. mesometrial tumor infiltration, more than 2 lymph node metastases on frozen section examination)

Presurgical Diagnostics and Management

- History and general clinical investigation
- High resolution pelvic MRI (at least sagittal and transverse T2-weighted scans) presented during the examination under anesthesia
- Clinical evaluation under anesthesia by an experienced gynecologic oncologist
- Tumor biopsy and biopsies of clinically suspicious tissues within the Müllerian compartment
- Staging applying the FIGO criteria
- cT cN cM summarizing all diagnostic information, including maximum tumor size
- oT-Staging if clinically possible
- PET/CT when distant metastasis is suspected
- Symptom-guided additional investigations to estimate the risks associated with surgical treatment
- Preoperative bowel preparation
- Perioperative single shot antibiotic prophylaxis

Surgical Strategy

1. Exposition of the relevant tissue structures based on ontogenetic anatomy as depicted in Figs. 101.6, 101.7, 101.8 and 101.9. After the usual mobilization of the intestinal mesentary, the key step is the mobilization of the ureters and their meso from the ligamentous mesometrium and perirectal peritoneum medially. Expose their crossing of the vascular mesometrium caudally and separate them from the iliac vessel system laterally. At this point, the ureter and its meso should be completely separated from the surrounding structures as it demarcates the lateral border of the genital metacompartment (see Fig. 101.10a, b of the step-by-step description below). All tissue lateral of the ureter will be left in place.
2. First-line pelvic TLND (Figs. 101.11, 101.12, and 101.13, send to frozen section examination immediately)
3. TMMR (Figs. 101.14, 101.15, 101.16, 101.17, 101.18, 101.19 and 101.20, surgical specimen is sent to frozen section examination for evaluation of resection margins, mesometrial infiltration and tumor spread into the uterine corpus.
4. Second-line pelvic TLND (common iliac vessels and presacral space, see Figs. 101.21 and 101.22), this step can be omitted in stage IB1 tumors of less than 2 cm size and negative first-line pelvic lymph nodes on intraoperative frozen section examination.

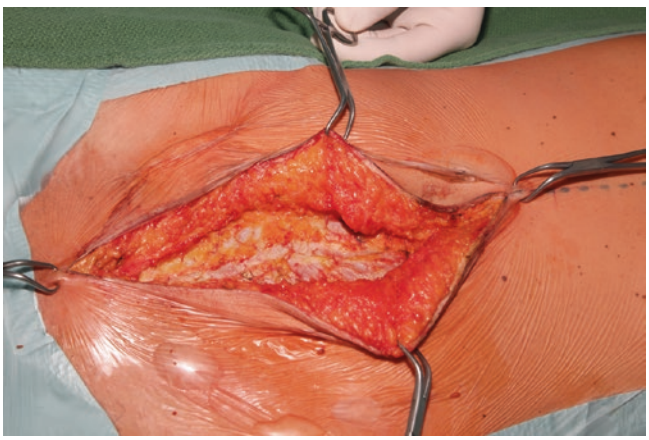


Fig. 101.6 Hypogastric midline laparotomy with left circumcision of the umbilicus. If periaortic lymph node dissection is required or in very obese patients, epigastric advancement of the laparotomy may be necessary

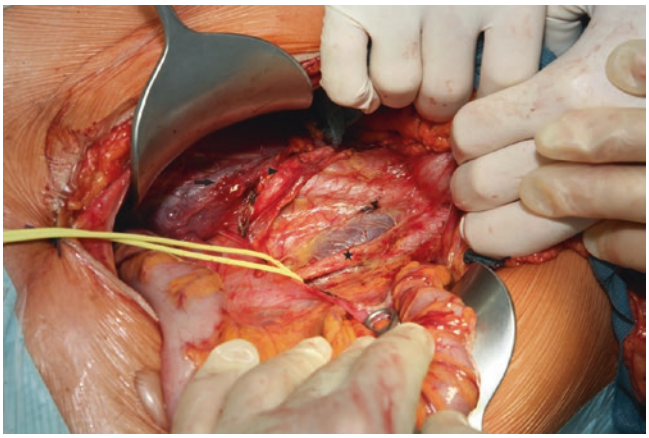


Fig. 101.7 Get retroperitoneal access through bilateral paracolic incisions and incision at the radix mesenterii. Expose ligamenta infundibulopelvica (*arrow*), ureters (*arrow head*) and plexus hypogastricus superior (*star*)

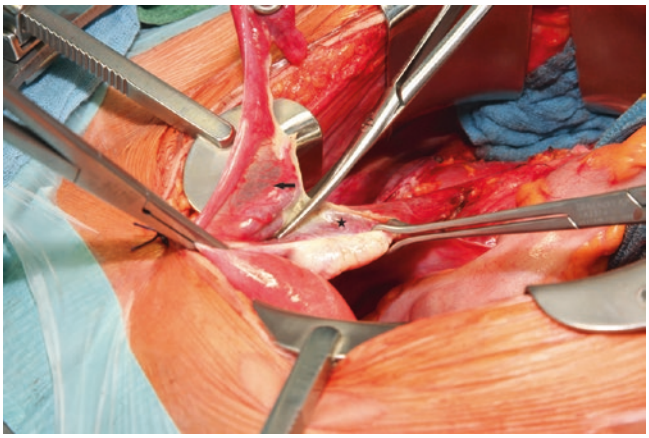


Fig. 101.9 Separate mesosalpinx (*arrow*) from mesovary (*star*), sever ligamentum rotundum, ligamentum latum, ligamentum ovarii proprium. Mobilize ovary attached to ligamentum infundibulopelvicum cranialward

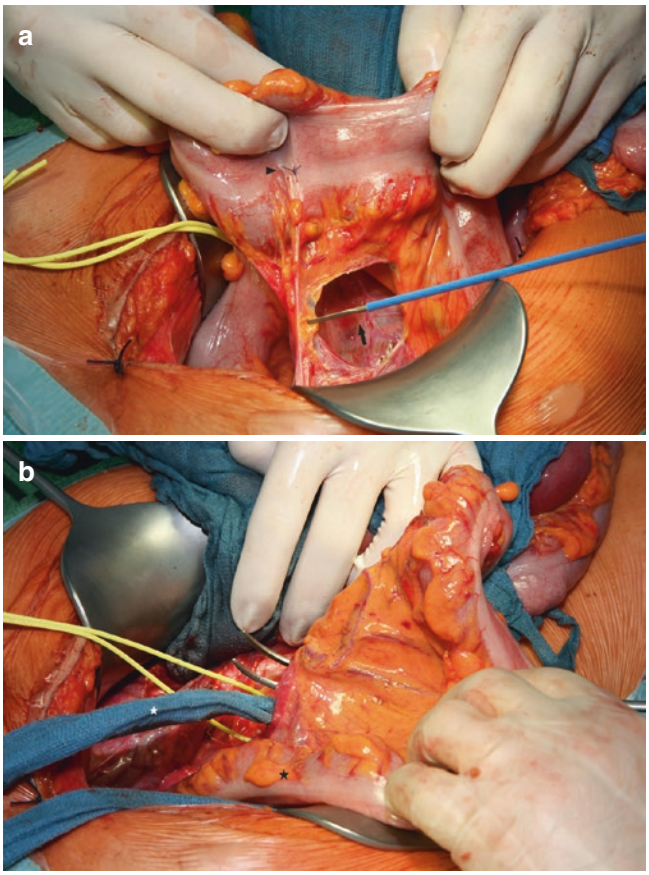


Fig. 101.8 (**a**) Lyse connatal peritoneal adhesions of the sigmoid colon (*black star*) to the left abdominal wall. Mark the site of colon sigmoid fixation (*arrow head*), mobilize caecum, duodenum and sigmoid colon cranialward. (**b**) Undermine the mesosigma (*arrow*) with two tissue stripes (*white star*) for optimal dynamic retraction of the mobilized colon rectosigmoideum

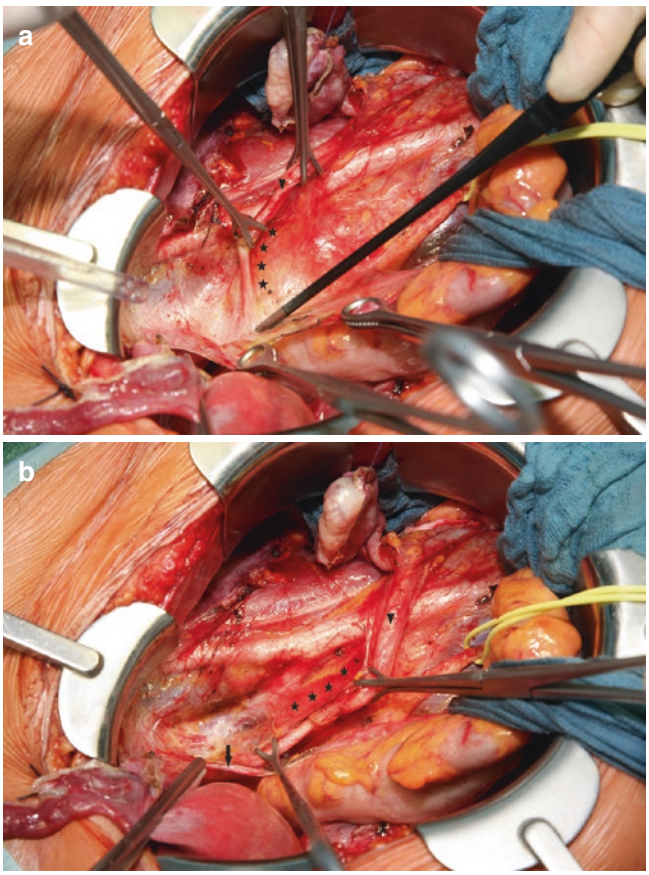


Fig. 101.10 (**a**) Mobilize pelvic ureter (*arrowhead*) with complete meso-ureter (*stars*) medially from perirectal peritoneum, ligamentous mesometrium (*arrow*) and plexus hypogastricus inferior (*yellow loop*). (**b**) Mobilize the ureter laterally from iliac vessels and lymphatic fatty tissue. Caudally expose the ureter up to the crossing vascular mesometrium. Be aware of keeping the meso-ureter intact

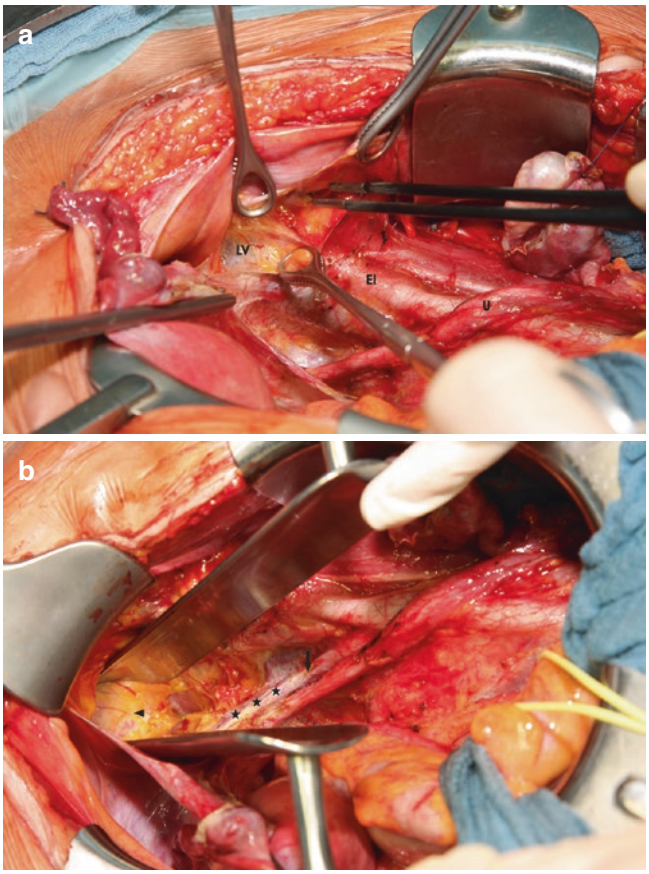


Fig. 101.11 (**a**) Dissect fatty tissue to expose the retroinguinal lacuna vasorum (LV) and the obliterated umbilical artery (*stars*) which should be visible from its origin at the internal iliac artery (*arrow*) up to the formation of the medial umbilical peritoneal fold. (**b**) Develop the complete paravisceral space by separation of the urogenital mesentery from the parietal paravisceral fat pad down to the levator ani muscle (*arrowhead*). *U* ureter, *EI* external iliac artery

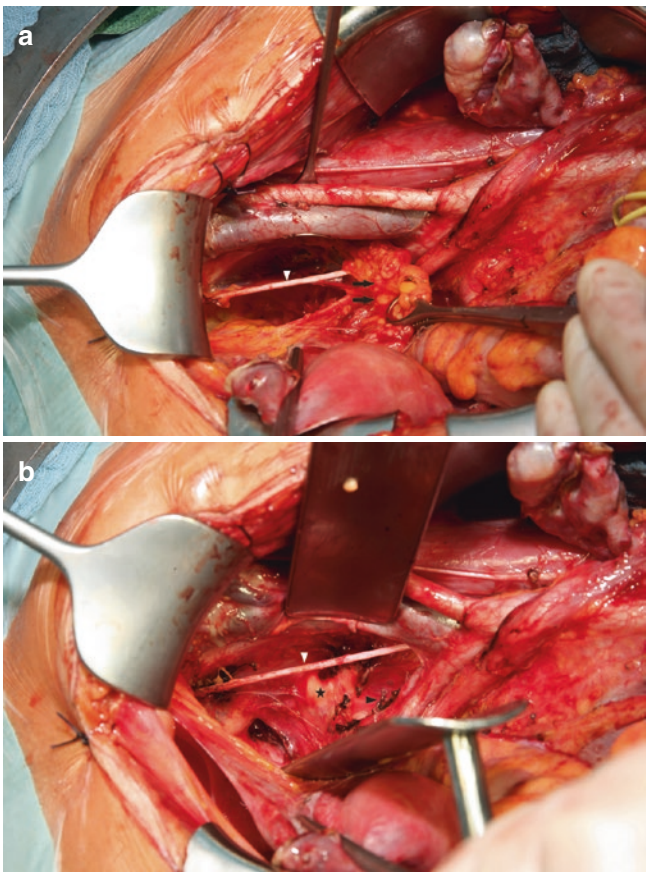


Fig. 101.13 (**a**) Remove the complete paravisceral fat pad (*black arrows*) and expose the obturator nerve (*white arrowhead*) and the proximal sciatic nerve (*black star*) along with its lumbar and first sacral trunci. Seal and dissect parietal branches of the internal iliac venous system (*black arrowhead*). (**b**) Expose the obturator muscle, levator ani muscle and its arci tendinei and the endopelvic aspect of the sciatic spine

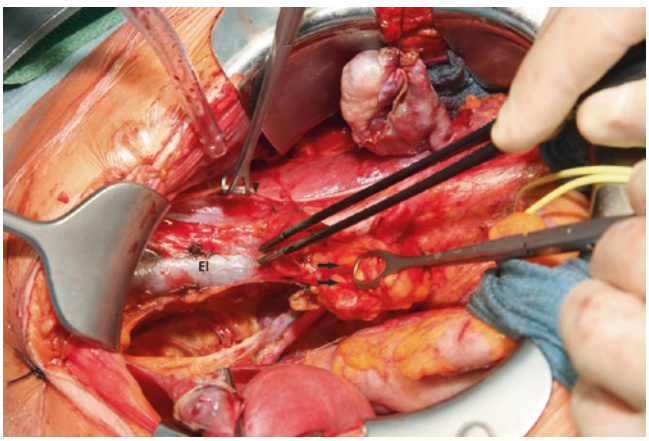


Fig. 101.12 Harvest the external iliac lymphoid tissue (*arrows*) by adventitia stripping taking care to preserve the genitofemoral nerve (*arrowhead*). *EI* external iliac vein

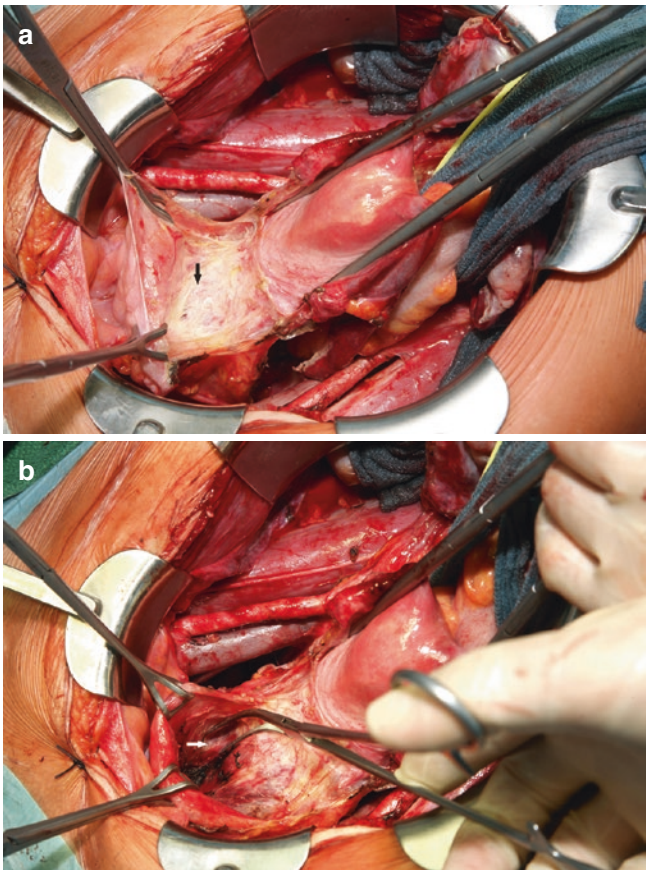


Fig. 101.14 (**a**) Incise the vesicouterine peritoneal fold (*black arrow*) and separate the bladder from the anterior cervix and proximal vagina. (**b**) Expose the medial uterovesical junctions (*white arrow*)

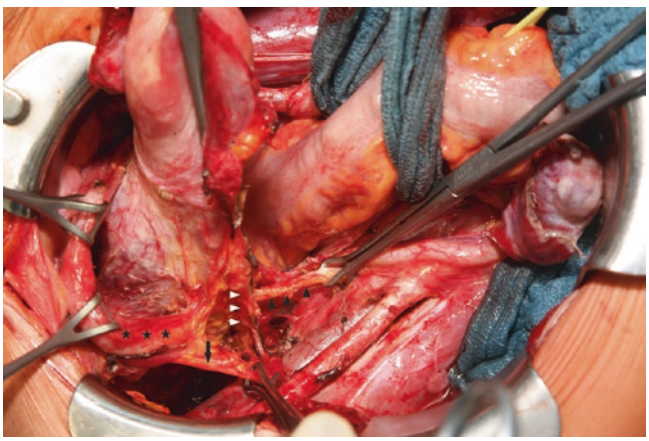


Fig. 101.15 Separate the vascular mesometrium (*white arrowheads*) from the superior bladder mesentery (*black stars*) anteriorly and the mesureter (*black arrow-heads*) posteriorly. The obliterared umbilical artery is marked by the *black arrow*

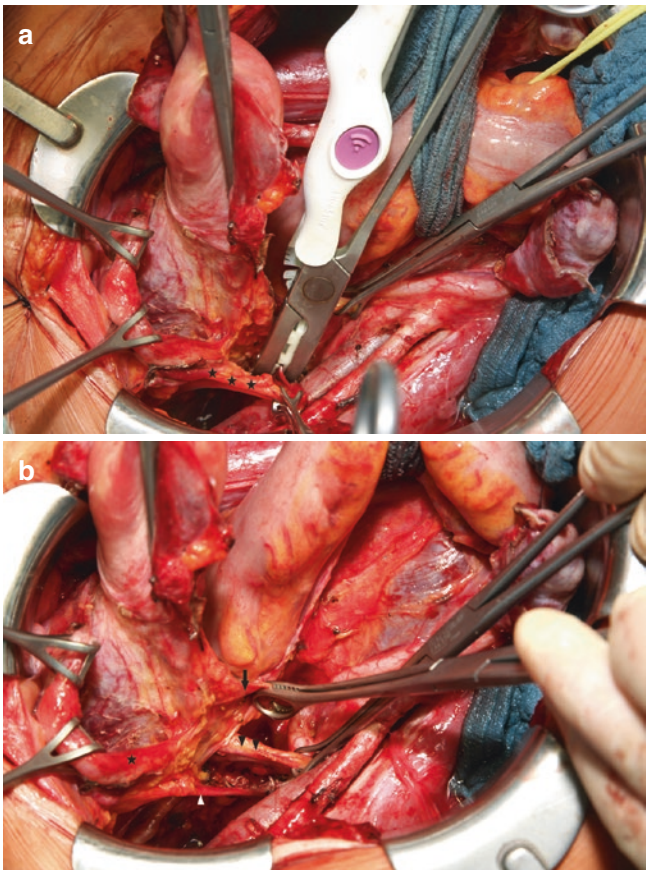


Fig. 101.16 (**a**) Seal and sever the vascular mesometrium (*black arrow*) containing the uterine artery at its origin from the hypogastric vessels. (**b**) Flip the vascular mesometrium medially over the ureter (*black arrowheads*). The bladder mesentary containing the obliterated umbilical artery (*white arrowhead*) is marked by black stars

5. When lymph node metastasis on first-line lymph nodes is present, ascending paraaortic lymph node dissection up to the inferior mesenteric artery is performed and lymph nodes are sent for frozen section examination (Fig. 101.23a, b). If there is metastasis, infrarenal lymph node dissection is performed.
6. When tumor involvement of the uterine corpus is present, infrarenal paraaortic TLND is indicated.
7. Ovariopexy when ovaries are preserved and closing procedures (Figs. 101.24 and 101.25).

Surgical Procedures (Step-By-Step)

The photographic pictures illustrating each step of the procedure are taken exclusively from the view of the surgeon

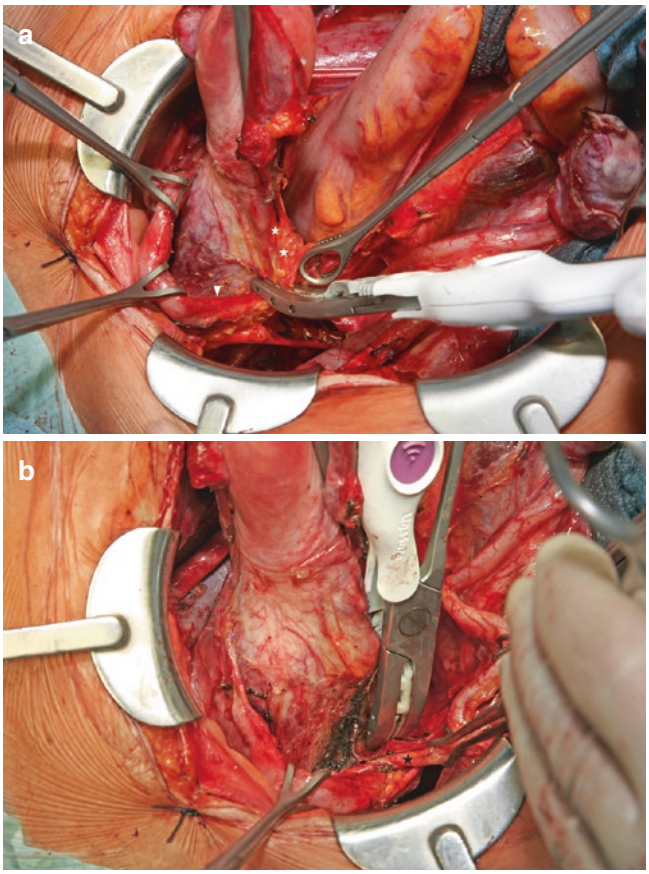


Fig. 101.17 (**a**) Seal and sever the vesicouterine vessel connections (*white arrowheads*) above the ureter and the vesicovaginal vessel connections below the ureter (**b**) taking care not to violate the ureter (*black star*) and mesureter containing the feeding vessels from the superior and inferior vesical artery. The bladder mesentary is marked by the *white arrowhead*

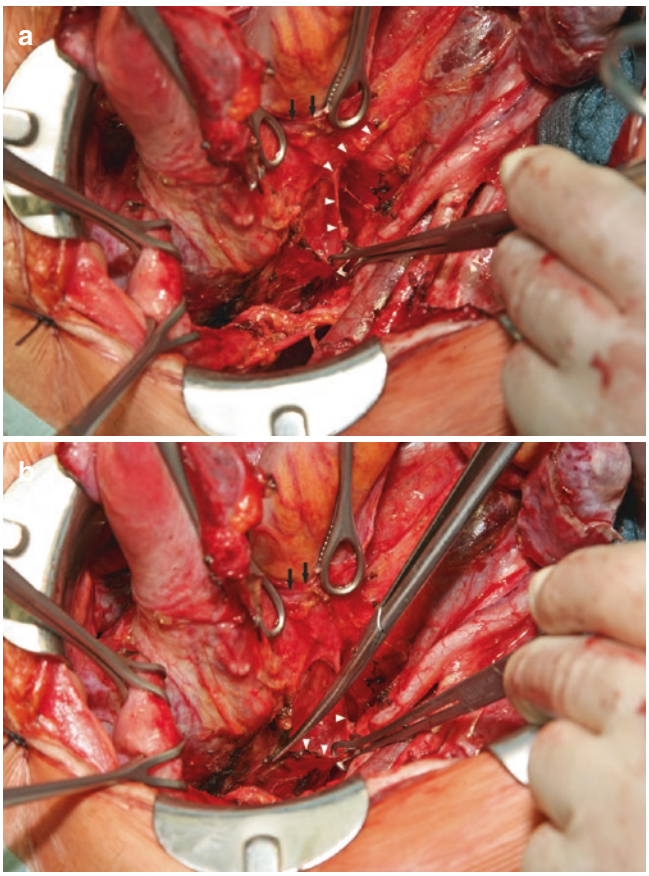


Fig. 101.18 (**a**) Separate the inferior hypogastric plexus (*white arrowheads*) from the ligamentous mesometrium (*black arrows*). (**b**) dissect its uterine braches

positioned at the patient's left side. Where applicable, all procedures are carried out on the contralateral side as well. A picture of the final surgical TMMR specimen is provided in Fig. 101.26.

PMMR: Surgical Management

Indication

Management protocol for the treatment of endometrial cancer FIGO IA and IB.

Surgical Treatment Goals

1. Local tumor control through resection of the Müllerian compartment (except the middle vagina) and the gonadal compartment.
2. Regional tumor control through therapeutic pelvic and paraaortic lymph node dissection including the infundibulopelvic ligaments (intercalated lymph nodes).

Presurgical Diagnostics and Management

- History and general clinical investigation
- Gynecologic ultrasound imaging
- Dilatation and curettage for pathologic diagnosis and tumor grading
- In advanced disease PET/CT to exclude distant metastasis
- Staging applying the FIGO criteria
- cT cN cM summarizing all diagnostic information, including maximum tumor size
- oT-Staging if clinically possible
- Determination of risk of lymphatic spread according to the Mayo Clinic criteria if possible (e.g. grading)

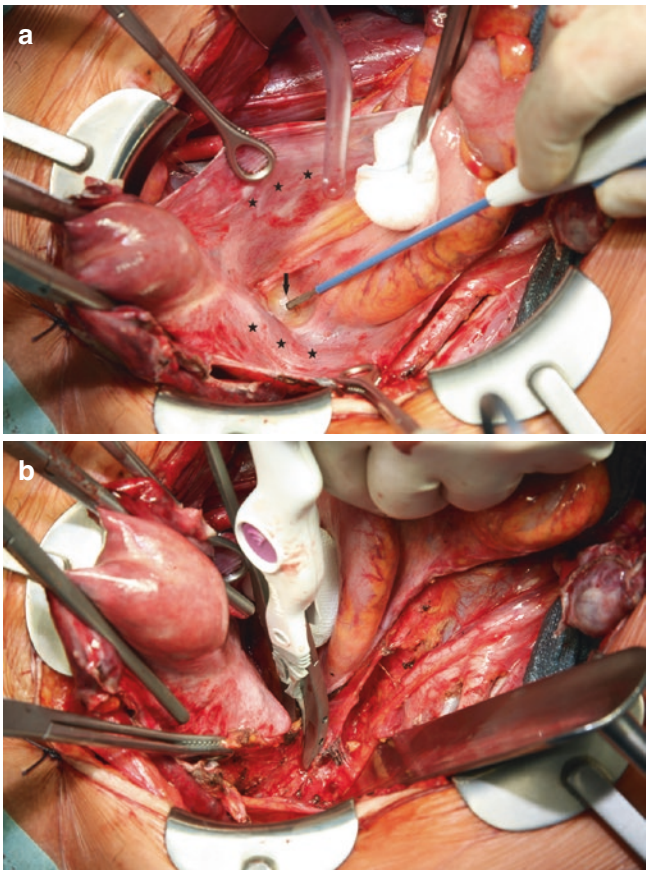


Fig. 101.19 (**a**) Exert tension on the pouch of Douglas and incise the peritoneum at its lowest level (*black arrow*). (**b**) Seal and sever the bilateral ligamentous mesometria (*black stars*) and the rectovaginal fibrofatty tissue at the anterior mesorectal surface keeping the inferior hypogastric plexus lateral

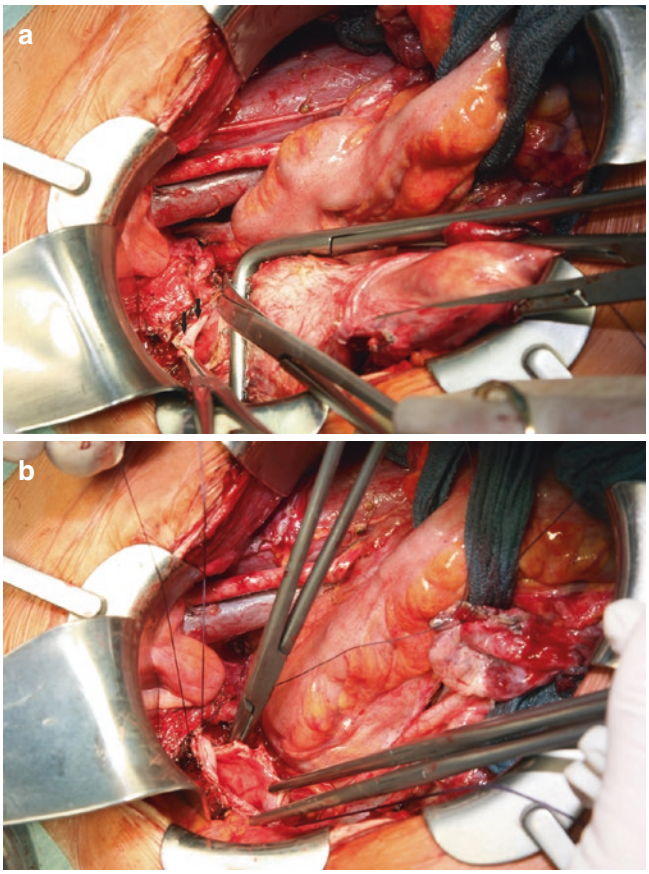


Fig. 101.20 (**a**) After clamping the proximal vagina perform a stab incision in its anterior wall followed by a circumferential colpotomy (*black arrows*). (**b**) Close the vaginal stump by a running everting suture

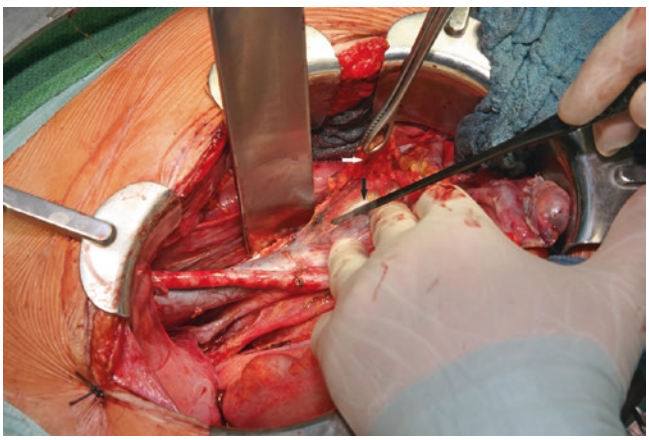


Fig. 101.21 Continue the therapeutic pelvic lymph node dissection by harvesting the common iliac lymphoid tissue (*white arrow*) bilaterally. The *black arrow* marks the common iliac vein

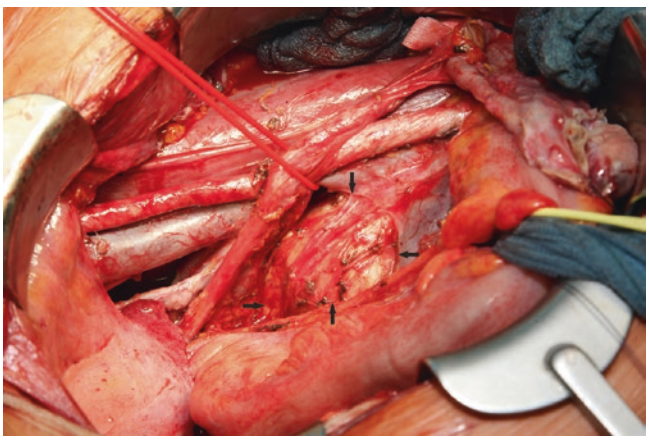


Fig. 101.22 Dissect the presacral fatpad containing the lymphatic tissue down to S2. The picture shows the presacral space (*black arrows*) after lymph node dis-section

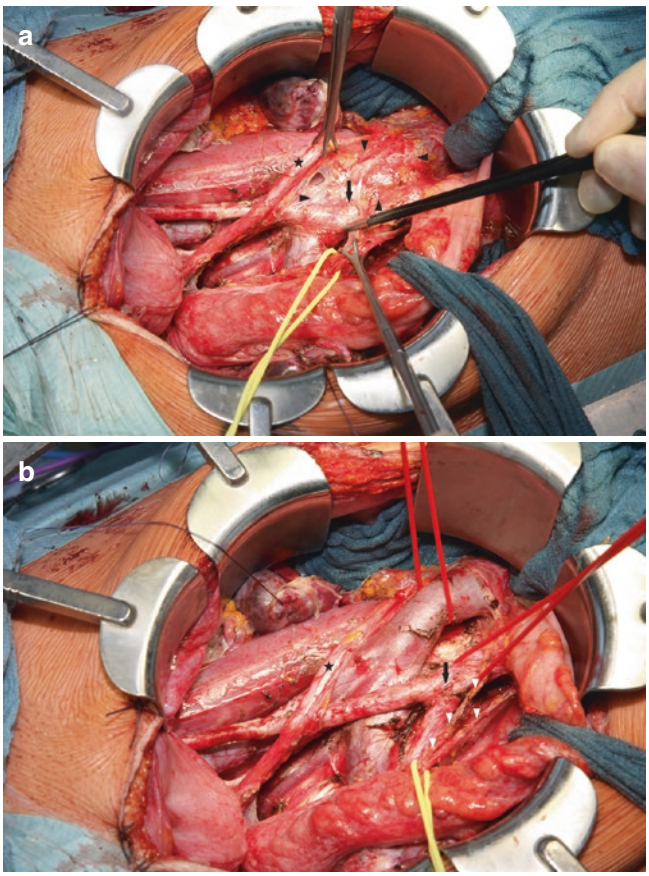


Fig. 101.23 (**a**) Mobilize the bifurcations of the aorta (*black arrow*) and inferior vena cava from each other and from the spine (**b**) Harvest the ambient lymphoid tissue (*black arrowheads*). The *black star* marks the ureter, the *white arrow-heads* the hypogastric nerves

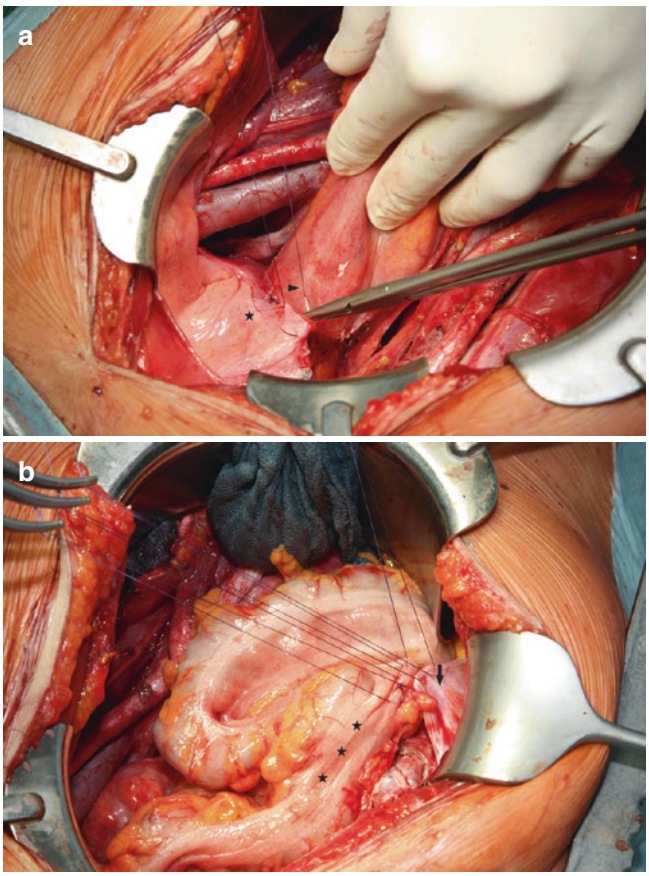


Fig. 101.24 (**a**) Unite the visceral peritoneum of bladder (*black star*) and rectum (*black arrowhead*) midsagittally. (**b**) Reconstitute the connatal colon sigmoid (*black stars*) fixation to the parietal peritoneum (*black arrow*) at the marked site

- Symptom-guided additional investigations to estimate the risks associated with surgical treatment
- Preoperative bowel preparation
- Perioperative single shot antibiotic prophylaxis

Surgical Strategy

1. Exposition of the relevant tissue structures based on ontogenetic anatomy (see Figs. 101.27, 101.28, 101.29, 101.30 and 101.31).
2. PMMR including ovaries, mesovary and infundibulopelvic ligaments (Figs. 101.32, 101.33, 101.34, 101.35, 101.36 and 101.37 send to frozen section examination to determine risk of lymphatic spread (i.e. myometrial tumor infiltration depth, grading etc.) and evaluation of resection margins.
3. When frozen section examination reveals an intermediate risk for lymphatic tumor spread (e.g. G2-grading), perform first-line TLND including infrarenal paraaortic, external iliac and internal iliac lymph node basins (see Figs. 101.11, 101.12 and 101.13, send to frozen section examination). The infundibulopelvic ligament is resected as well.
4. When there is lymph node metastasis in the first-line stations, complete therapeutic pelvic lymph node dissection including common iliac, presacral and inframesenteric lymph node basins is indicated. In high risk situations comprehensive TLND including all lymph node stations is performed irrespective of the presence of first-line lymph-node metastasis.
5. In case of serous-papillary or clear cell carcinoma perform peritoneal sampling biopsies.
6. Closing procedures (Figs. 101.38, 101.39 and 101.40).

PMMR Surgical Procedures (Step by Step)

The photographic pictures illustrating each step of the procedure are taken exclusively from the view of the surgeon positioned at the patient's left side.

For a description of the technique for lymph node dissection please refer to the TMMR step by step protocol.

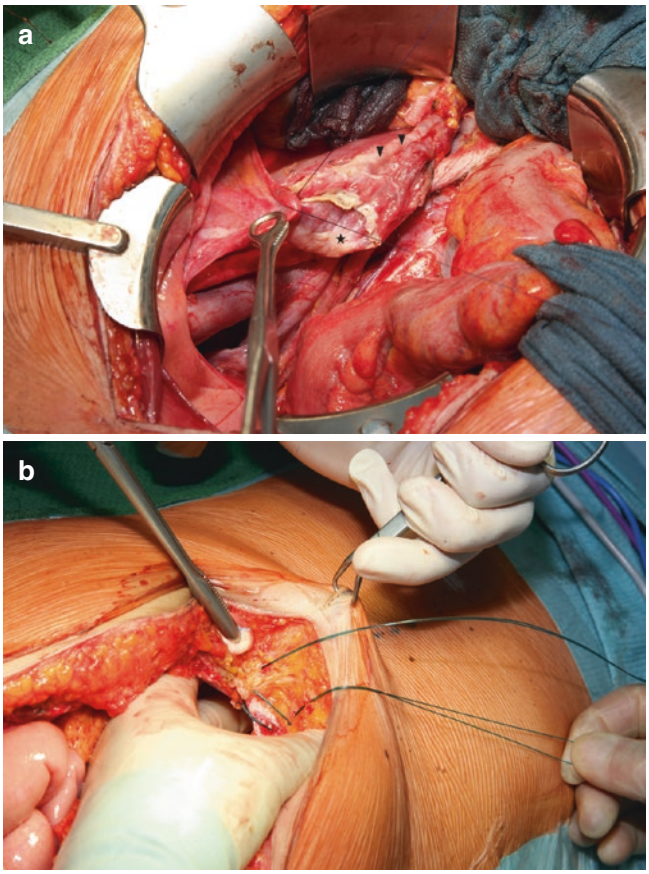


Fig. 101.25 (**a**) Fix the ovaries (*star*) to the incision margin of the parietal peritoneum. (**b**) Close the laparotomy. The *black arrowheads* mark the infundibulopelvic ligament. Depending on patient's choice suprapubic cystostomy and placement of a suprapubic catheter for future bladder training. Alternatively, a transuretheral catheter is inserted

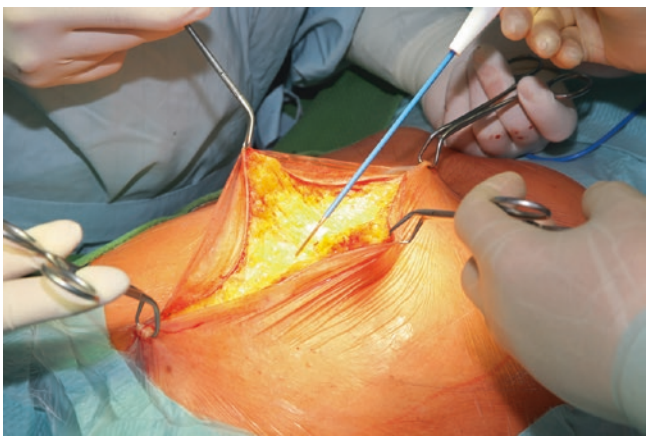


Fig. 101.27 Hypogastric midline laparotomy. If a high risk situation for lymphatic tumor spread is established pre-operatively, the laparotomy is extended cranially for infrarenal lymph node dissection

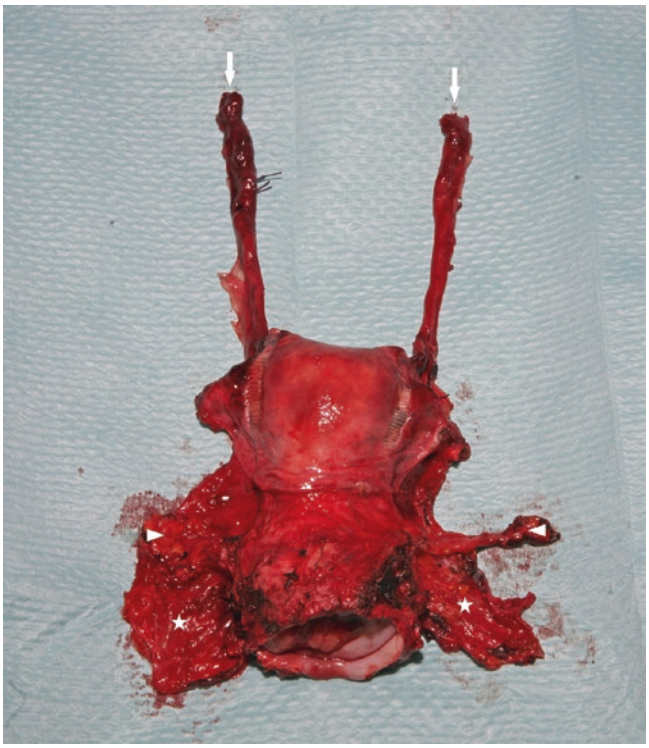


Fig. 101.26 Picture of the surgical TMMR specimen: Note the four-winged specimen including the vascular and the ligamentous mesometrium on both sides

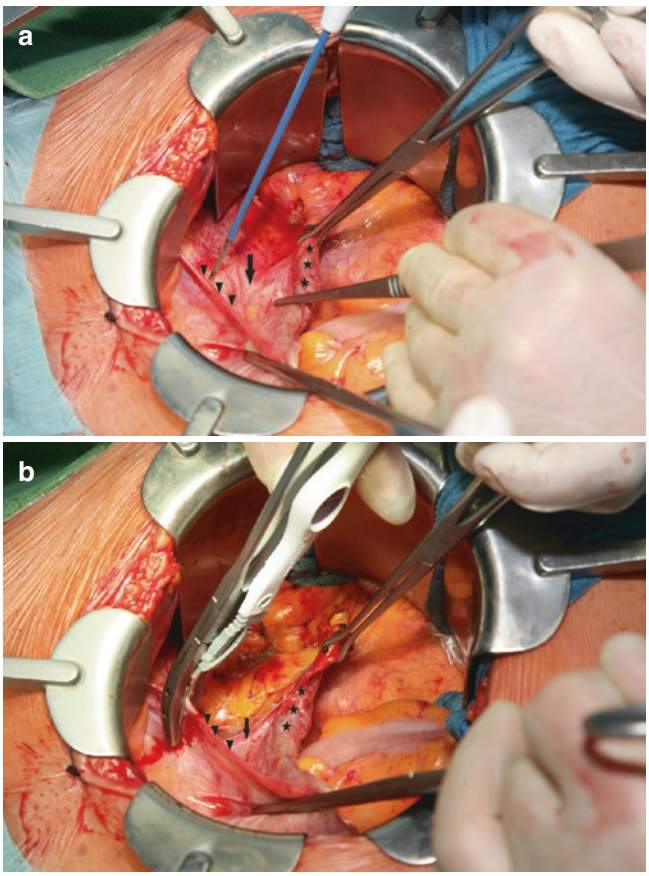


Fig. 101.28 (**a**) Incision of the parietal pelvic peritoneum just lateral to the origin of the peritoneal leaf of the broad ligament (*arrow*). (**b**) Seal and cut the round ligament (*black arrow heads*). The *black stars* mark the infundibulopelvic ligament

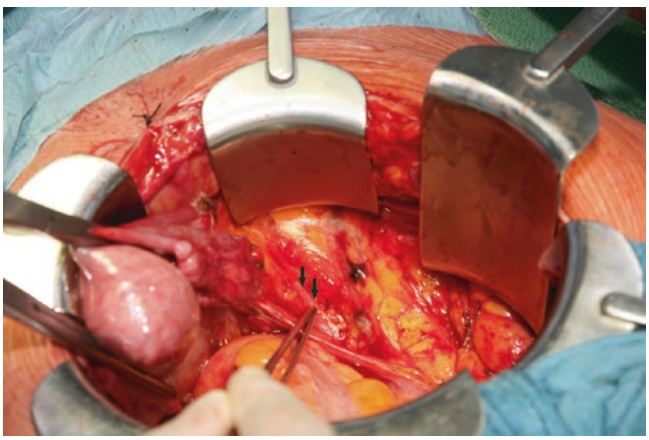


Fig. 101.30 Exposition of the subperitoneal umbilical artery (*black arrows*) and development of the ventral paravisceral space

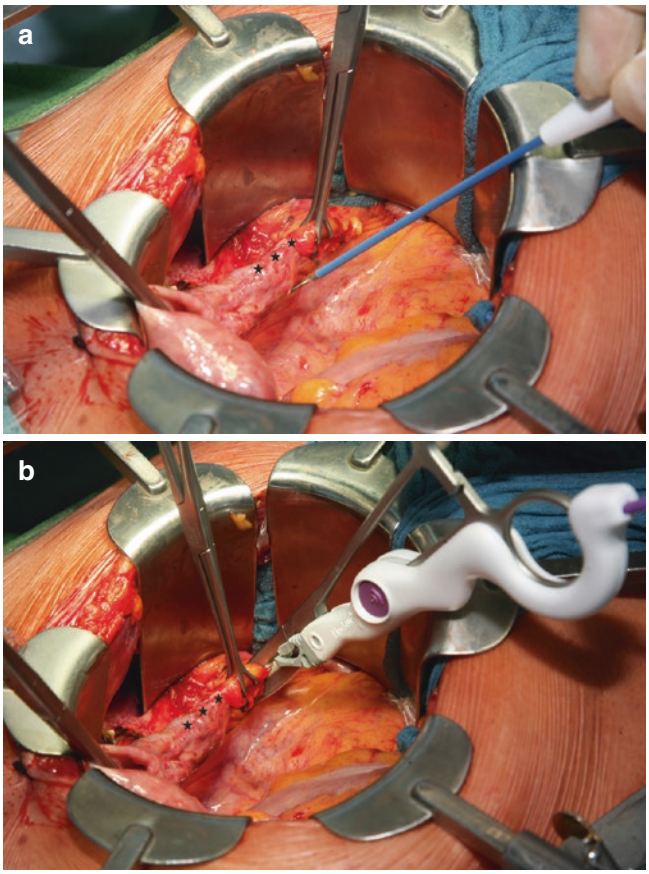


Fig. 101.29 (**a**) Incision of the visceral pelvic peritoneum just above the ureter (*black arrow heads*). (**b**) Exposition, sealing and severing of the distal infundibulopelvic ligament (*black asterix*). Mobilisation of the visceral leaf of the broad ligament up to the vascular mesometrium. Sealing and cutting of the peritoneal vascular mesometrium distally at the junction with the parietal lymph node containing fat pad (not shown)

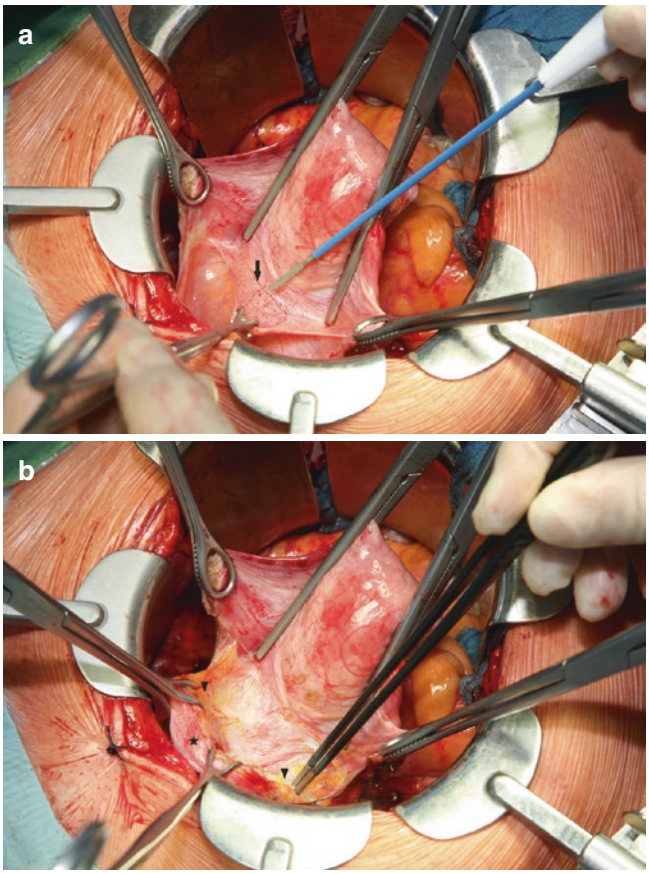


Fig. 101.31 (**a**) Incision at the lowest point of the uterovesical peritoneal fold (*arrow*) and separation of the bladder (*asterix*) from the Müllerian compartment up to the uretero-vesical junction ((**b**), *arrow heads*)

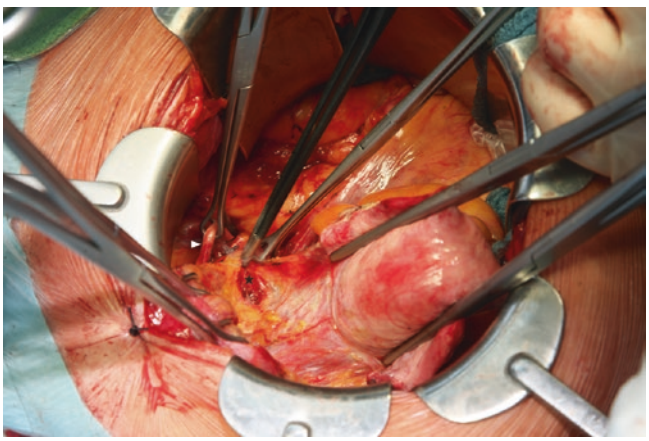


Fig. 101.32 Separation of the subperitoneal vascular mesometrium (*asterix*) from the bladder mesentary (containing the superior vesical artery). The white *arrowhead* marks the ureter

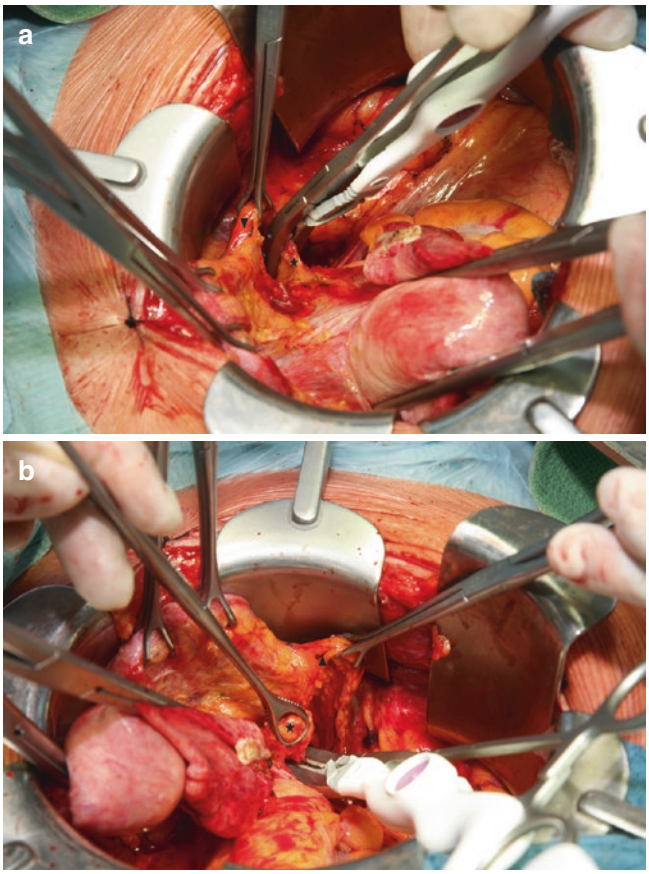


Fig. 101.33 (**a**) Sealing and severing of the subperitoneal vascular mesometrium (*asterix*) containing the uterine artery dissected at the junction with the hypogastric artery. (**b**) Dorsomedial rotation of the vascular mesometrium over the ureter. The *black arrowhead* marks the bladder mesentary. In contrast to TMMR, the more distal part of the vascular mesometrium is not resected

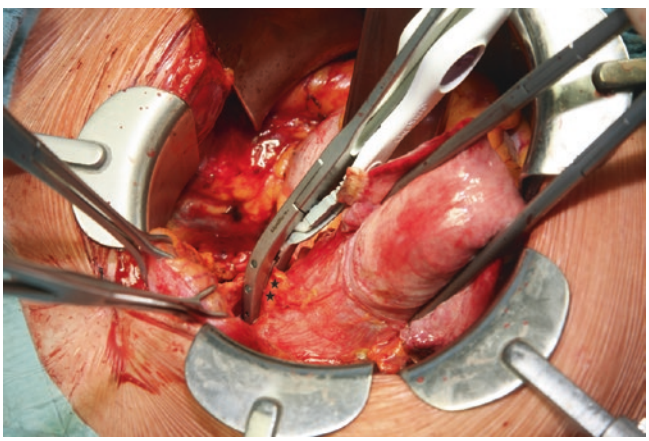


Fig. 101.34 Sealing and severing of the anterior ligamentous mesometrium (*asterix*) proximally

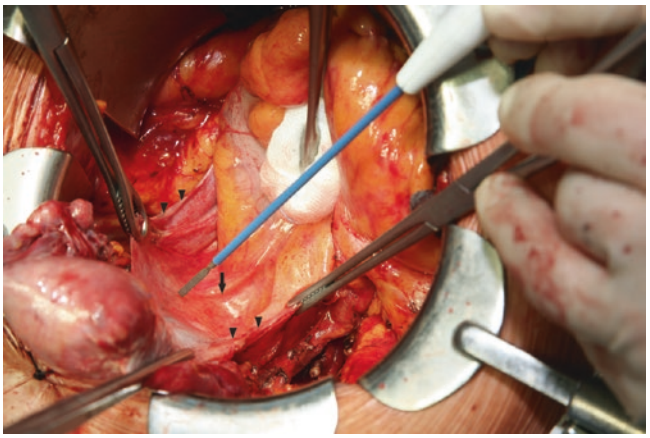


Fig. 101.35 Incision of the Douglas peritoneum (*arrow*). The *arrowheads* mark the posterior ligamentous mesometrium

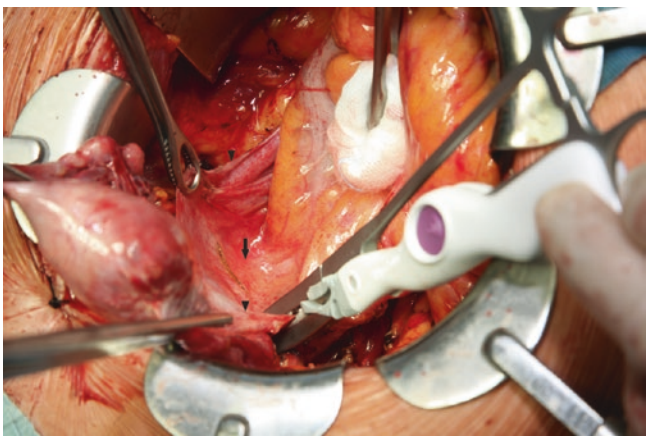


Fig. 101.36 Sealing and severing of the posterior ligamentous mesometrium (*arrowheads*) proximally. The *arrow* marks the Douglas peritoneum

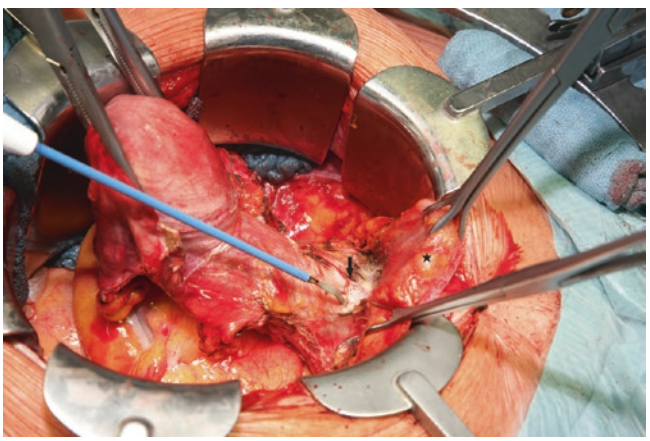


Fig. 101.37 Perform a colpotomy in the proximal third of the vagina (*black arrow*). The PMMR-Specimen is then sent for rapid frozen section examination. The *asterix* marks the bladder. Note that this picture is taken from the right side

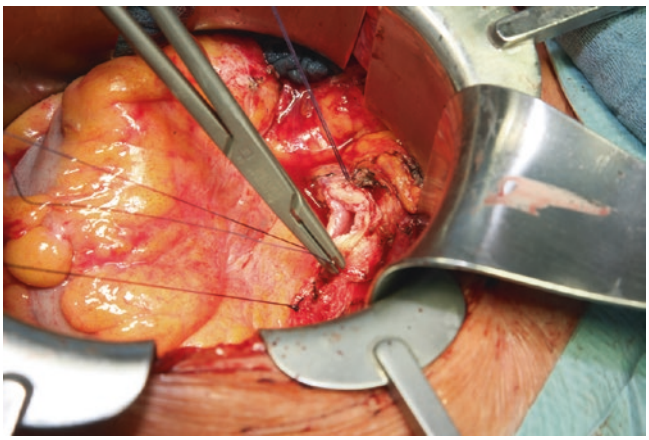


Fig. 101.38 Closure of the colpotomy. Note that this picture is also taken from the right side

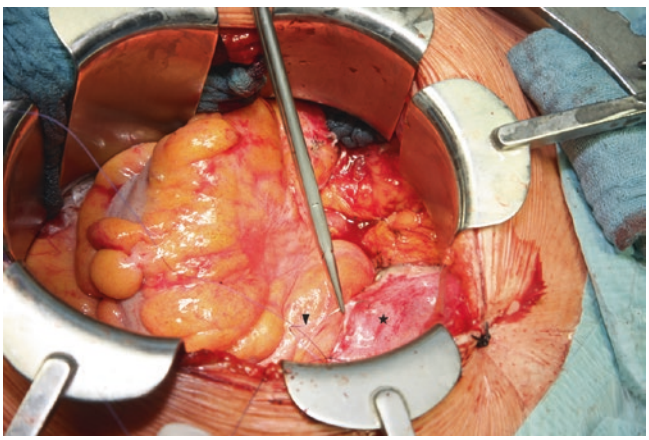


Fig. 101.39 Peritoneal reconstruction. The peritoneum of the bladder ist marked by the *asterix*, the rectal peritoneum by the *arrowhead*. Picture taken from the right side

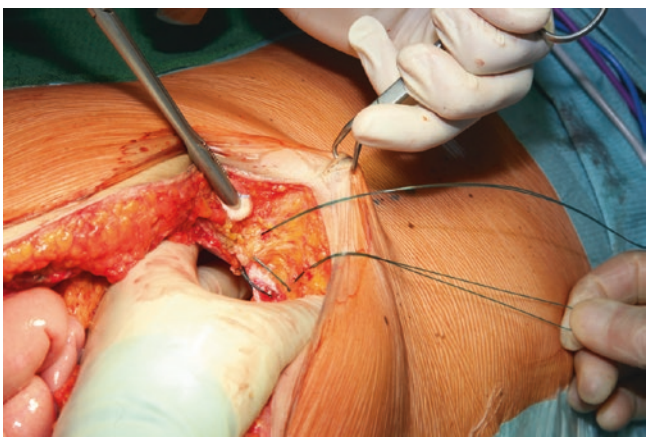


Fig. 101.40 Closing the laparotomy

Postoperative Management

Mobilization is possible immediately after surgery.

Purgatives are given on the third postoperative day if no stool has been passed spontaneously (we generally use sorbitol 30–40 ml).

Until the 5th postoperative day a suprapubic or transurethral catheter is continuously left open to avoid overextension of the bladder (does not apply for PMMR).

On day 5 training of bladder function with intermittent self-catheterization via transurethral or suprapubic catheter is commenced and continued until post-voiding residual urine is less than 50 ml on two successive measurements (does not apply for PMMR).

Skin staples are removed on days 10 and 14.

References

1. Amant F, Moerman P, Neven P, Timmerman D, van Limbergen E, Vergote I. Endometrial cancer. Lancet. 2005;366:491–505.
2. ASTEC study group writing committee. Efficacy of systematic pelvic lymphadenectomy in endometrial cancer (ASTEC): a randomised trial. Lancet. 2008;373:125–36.
3. ASTEC/EN5 writing committee. Adjuvant external beam radiotherapy in the treatment of endometrial cancer (MRC ASTEC and NCIC CTG EN.5 randomised trials): pooled trial results, systematic review, and meta-analysis. Lancet. 2008;373:137–46.
4. Creutzberg CL, van Putten WL, Koper PC, Lybeert ML, Jobsen JJ, Wárlám-Rodenhuis CC, De Winter KA, Lutgens LC, van den Bergh AC, van de Steen-Banasik E, Beerman H, van Lent M. Surgery and postoperative radiotherapy versus surgery alone for patients with stage-1 endometrial carcinoma: multicentre randomised trial. PORTEC Study Group. Lancet. 2000;355(9213):1404–11.
5. Creutzberg CL, Nout RA, Lybeert ML, Wárlám-Rodenhuis CC, Jobsen JJ, Mens JW, Lutgens LC, Pras E, van de Poll-Franse LV, van Putten WL, PORTEC Study Group. Fifteen-year radiotherapy outcomes of the randomized PORTEC-1 trial for endometrial carcinoma. Int J Radiat Oncol Biol Phys. 2011;81(4):e631–8.
6. Dursun P, Ayhan A, Kuscu E. New surgical approaches for the management of cervical carcinoma. Eur J Surg Oncol. 2008;34:487–96.
7. Hogberg T. Radiotherapy in endometrial cancer. In: Ayhan A, Reed N, Gultekin M, Dursun P, editors. Textbook of gynaecological oncology. Günes: Ankara; 2012.
8. Höckel M, Dornhöfer N. The hydra phenomenon of cancer: why tumors recur locally after microscopically complete resection. Cancer Res. 2005;65:2997–3002.
9. Höckel M, Horn L, Fritsch H. Association between the mesenchymal compartment of uterovaginal organogenesis and local tumour spread in stage IB-IIB cervical carcinoma: a prospective study. Lancet Oncol. 2005;6:751–6.
10. Höckel M, Dornhöfer N. Treatment of early endometrial carcinoma: is less more? Lancet. 2009;373:97–9.
11. Höckel M, Horn L, Manthey N, Braumann U, Wolf U, Teichmann G, Frauenschläger K, Dornhöfer N, Einenkel J. Resection of the embryologically defined uterovaginal (Müllerian) compartment and pelvic control in patients with cervical cancer: a prospective analysis. Lancet Oncol. 2009;10:683–92.
12. Höckel M, Schmidt K, Bornmann K, Horn L, Dornhöfer N. Vulvar field resection: novel approach to the surgical treatment of vulvar cancer based on ontogenetic anatomy. Gynecol Oncol. 2010;119:106–13.
13. Höckel M. Total mesometrial resection. In: Smith JR, editor. An atlas of gynecologic oncology: investigation and surgery. London: Dunitz; 2011.
14. Höckel M. Cancer permeates locally within ontogenetic compartments: clinical evidence and implications for cancer surgery. Future Oncol. 2012;8(1):29–36.
15. Höckel M, Horn L, Einenkel J. (Laterally) extended endopelvic resection: surgical treatment of locally advanced and recurrent cancer of the uterine cervix and vagina based on ontogenetic anatomy. Gynecol Oncol. 2012;127:297–302.
16. Höckel M, Horn L. The puzzle of close surgical margins is not puzzling. Gynecol Oncol. 2013;130:224–5.
17. Höckel M, Hentschel B, Horn L. Association between developmental steps in the organogenesis of the uterine cervix and locoregional progression of cervical cancer: a prospective clinicopathological analysis. Lancet Oncol. 2014;15:445–56.
18. Höckel M. Morphogenetic fields of embryonic development in locoregional cancer spread. Lancet Oncol. 2015;16:e148–51.
19. Landoni F, Maneo A, Colombo A, Placa F, Milani R, Perego P, Favini G, Ferri L, Mangioni C. Randomised study of radical surgery versus radiotherapy for stage Ib-IIa cervical cancer. Lancet. 1997;350:535–40.
20. Landoni F, Maneo A, Cormio G, Perego P, Milani R, Caruso O, Mangioni C. Class II versus class III radical hysterectomy in stage IB-IIA cervical cancer: a prospective randomized study. Gynecol Oncol. 2001;80:3–12.
21. Mariani A, El-Nashar SA, Dowdy SC. Lymphadenectomy in endometrial cancer: which is the right question? Int J Gynecol Cancer. 2010;20:S52–4.
22. Mariani A, Dowdy SC, Cliby WA, et al. Prospective assessment of lymphatic dissemination in endometrial cancer: a paradigm shift in surgical staging. Gynecol Oncol. 2008;109:11–8.
23. Peters 3rd WA, Liu PY, Barrett 2nd RJ, Stock RJ, Monk BZ, Berek JS, Souhami L, Grigsby P, Gordon Jr W, Alberts DS. Concurrent chemotherapy and pelvic radiation therapy compared with pelvic radiation therapy alone as adjuvant therapy after radical surgery in high-risk early-stage cancer of the cervix. J Clin Oncol. 2000;18:1606–13.
24. Rob L, Halaska M, Robova H. Nerve-sparing and individually tailored surgery for cervical cancer. Lancet Oncol. 2010;11:292–301.
25. Rogers L, Siu SS, Luesley D, Bryant A, Dickinson HO (2012) Radiotherapy and chemoradiation after surgery for early cervical cancer. Cochrane Database Syst Rev 5: CD007583
26. Rotman M, Sedlis A, Piedmonte MR, Bundy B, Lentz SS, Muderspach LI, Zaino RJ. A phase III randomized trial of postoperative pelvic irradiation in Stage IB cervical carcinoma with poor prognostic features: follow-up of a gynecologic oncology group study. Int J Radiat Oncol Biol Phys. 2006;65:169–76.
27. Scholten AN, van Putten WL, Beerman H, Smit VT, Koper PC, Lybeert ML, Jobsen JJ, Wárlám-Rodenhuis CC, De Winter KA, Lutgens LC, van Lent M, Creutzberg CL, PORTEC Study Group. Postoperative radiotherapy for Stage 1 endometrial carcinoma: long-term outcome of the randomized PORTEC trial with central pathology review. Int J Radiat Oncol Biol Phys. 2005;63(3):834–8.
28. Sedlis A, Bundy BN, Rotman MZ, Lentz SS, Muderspach LI, Zaino RJ. A randomized trial of pelvic radiation therapy versus no further therapy in selected patients with stage IB carcinoma of the cervix after radical hysterectomy and pelvic lymphadenectomy: a Gynecologic Oncology Group Study. Gynecol Oncol. 1999;73:177–83.
29. Todo Y, Kato H, Kaneuchi M, Watar H, Takeda M, Sakuragi N. Survival effect of para-aortic lymphadenectomy in endometrial cancer (SEPAL study): a retrospective cohort analysis. Lancet. 2010;375:1165–72.

Radical Abdominal Trachelectomy

102

Rene Pareja and Pedro Ramirez

Introduction

The standard recommendation for the treatment of patients with early-stage cervical cancer (stages IA2–IB1) interested in fertility preservation is radical trachelectomy [1]. In 1994, Dargent et al. [2] reported on the safety and feasibility of vaginal radical trachelectomy (VRT) with laparoscopic lymph node dissection for the treatment of early-stage cervical cancer. However, one of the major concerns with regard to the vaginal approach when considering radical trachelectomy is the fact that it requires surgeon expertise in radical vaginal surgery and also in advanced laparoscopic procedures. In 1997, Smith et al. published the first report of abdominal radical trachelectomy (ART) [3]. The advantages of ART include the reproducibility of the technique, the fact that the procedure can be performed without training in radical vaginal surgery, that it requires no laparoscopic equipment, and a wider parametrial resection can be achieved with this approach.

Radical trachelectomy has also been reported through a minimally invasive approach. The laparoscopic approach offers the benefits of minimally invasive surgery; however, it is also associated with the fact that it is a challenging technique requiring the expertise of a well-trained surgeon in radical laparoscopic pelvic surgery [4, 5]. Others have published on the robotic-assisted approach [6, 7]. However, the number of published data on these minimally invasive approaches is limited and the follow-up times are short thus limiting the information on long-term oncologic outcomes.

This chapter will describe the surgical technique, and the oncological and obstetric outcomes after radical trachelectomy. We will also provide details on the most common complications associated with this procedure.

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Surgical Technique

The initial entry into the abdominal and pelvic cavity is performed through either a low transverse (Pfannenstiel, Cherney, Maylard) or median incision. The main advantage of the median incision is the broader space that it provides. Careful inspection of the pelvic and peritoneal surfaces is performed in order to rule out any metastatic disease. To gain access into the retroperitoneum one may begin by transecting the round ligament and making an incision along the lateral aspect of the infundibulo-pelvic ligament. The round ligaments may also be preserved depending on the surgeon preference. However, as an alternative, one may also begin by opening the pouch of Douglas by making an incision between both uterosacral ligaments (Fig. 102.1). The paravesical (limited laterally by the iliac vessels, medially by the obliterated umbilical artery, caudally by the deep uterine vein, posteriorly by internal iliac artery and anteriorly by the pubic bone) and pararectal spaces (limited laterally by internal iliac artery, medially by the hypogastric nerve, anteriorly by the uterine artery and posteriorly by the sacral fascia) are developed (Figs. 102.2 and 102.3). Upon inspection of the retroperitoneum, if there is any evidence of obvious nodal disease, surgeons should consider sending the lymph node for frozen section evaluation to determine the status of the lymph node. If there is evidence of disease in the lymph node, the ART should be aborted and definitive chemotherapy and radiation recommended.

A complete pelvic lymphadenectomy is performed from the level of the bifurcation of the common iliac vessels proximally to the circumflex iliac vein distally. This dissection includes the external iliac nodes, internal iliac nodes, and obturator nodes (Fig. 102.4). There is no utility of sending normal appearing nodes to frozen section. As an alternative, sentinel node mapping can be performed, with

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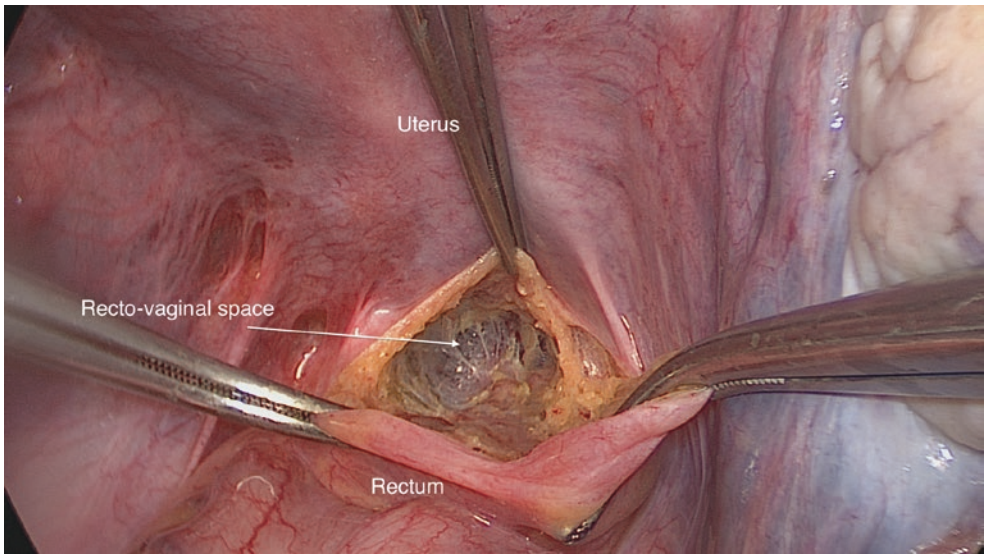


Fig. 102.1 Opening the pouch of Douglas

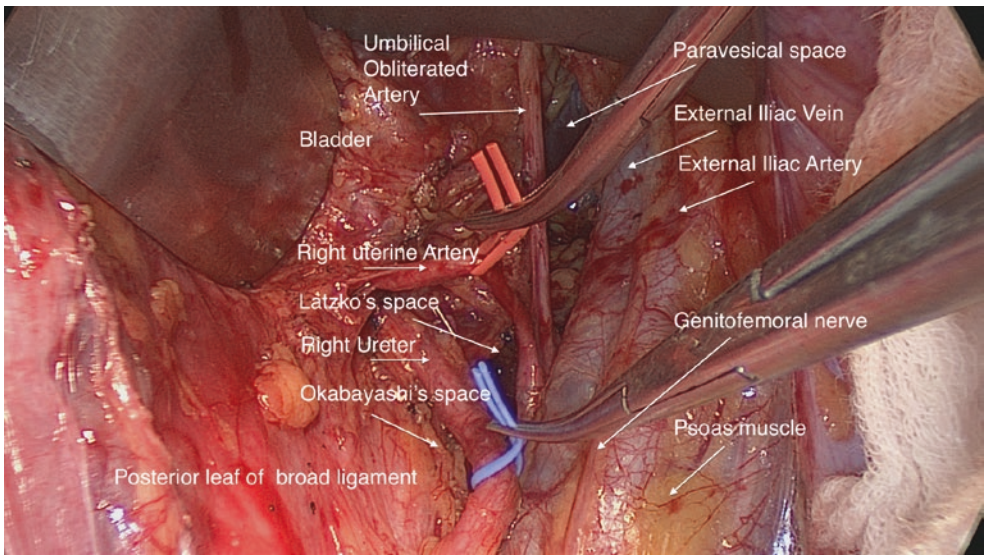


Fig. 102.2 Right pelvic lateral spaces

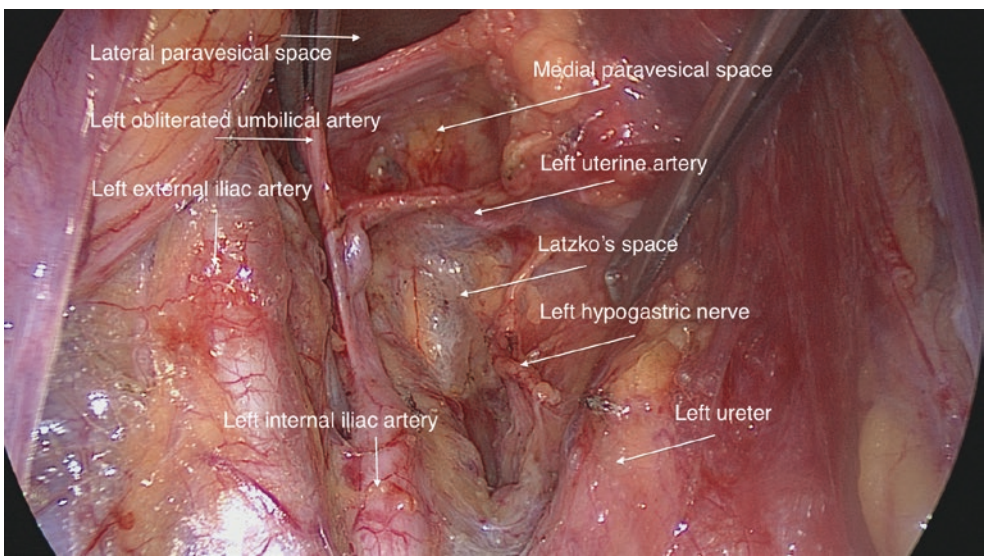


Fig. 102.3 Left pelvic lateral spaces

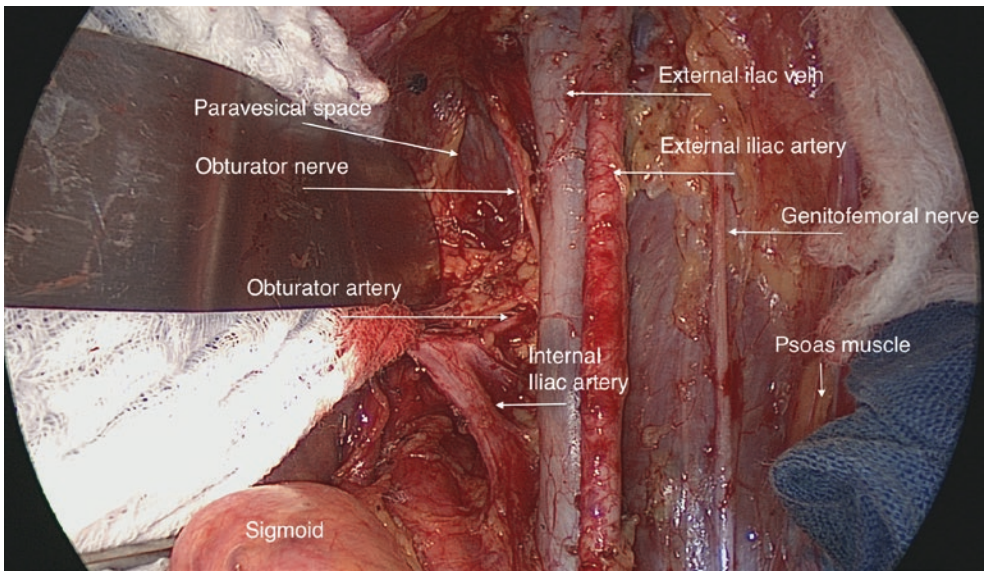


Fig. 102.4 Right lymph node dissection

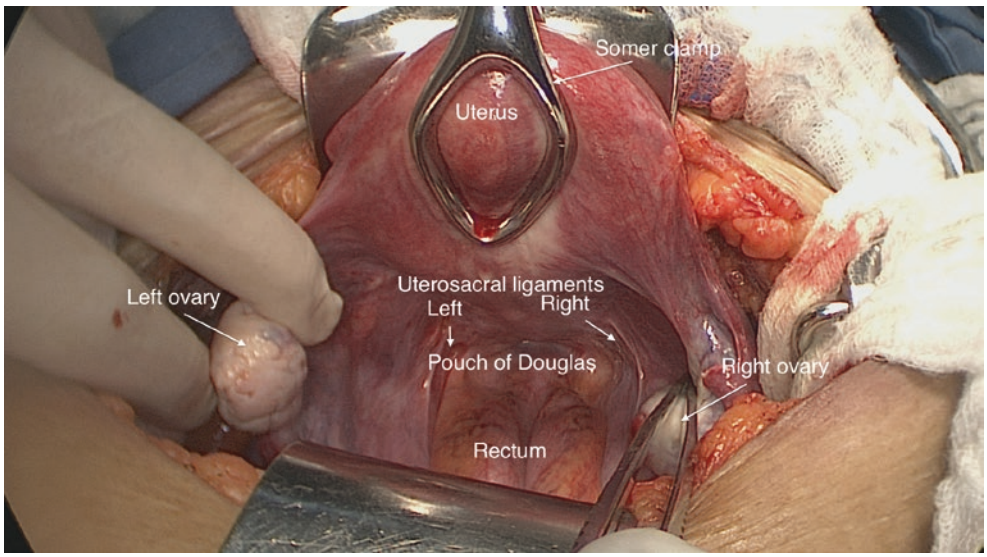


Fig. 102.5 Posterior view, uterine clamp

good performance regarding, detection rate , sensitivity and specificity [8].

The uterus is gently grasped with a Somer uterine elevating forceps (Aesculap Surgical Instruments, Tuttlingen, Germany) (Fig. 102.5). After exposing the paravesical and pararectal spaces bilaterally, the ureters must be identified bilaterally before proceeding with any pelvic dissection. Care must be taken to assure that the infundibulopelvic ligaments with the ovarian vessels are intact. In addition, special attention must be paid to assure that there is no injury to the fallopian tubes or the utero-ovarian ligament. Therefore, surgeons must place special emphasis to assure that fallopian tubes are not grasped during the surgery. The dissection continues by placing upward traction on the uterus and developing of peritoneal bladder fold. The bladder must be mobilized inferiorly to assure that at least a 1–2 cm margin of upper vagina is secured. The ureters are separated from the peritoneum medially starting the pelvic brim and continuing distally until the point where they course under the uterine vessels. .(Figs. 102.6, 102.7 and 102.8) Often one can also visualize the ureters entering the bladder in the Yabuki's space. (Figs. 102.9 and 102.10) The uterine arteries are then ligated at their origin.

There is some debate regarding preservation of the uterine vessels. According to Tang et al. [9] among 16 patients who had preserved uterine arteries, only two (12.5 %) showed identifiable bilateral uterine arteries, seven (43.6 %) showed unilateral uterine artery occlusion and seven (43.6 %) exhibited bilateral occlusion. The authors concluded that the uterine arteries, when dissected and pre-

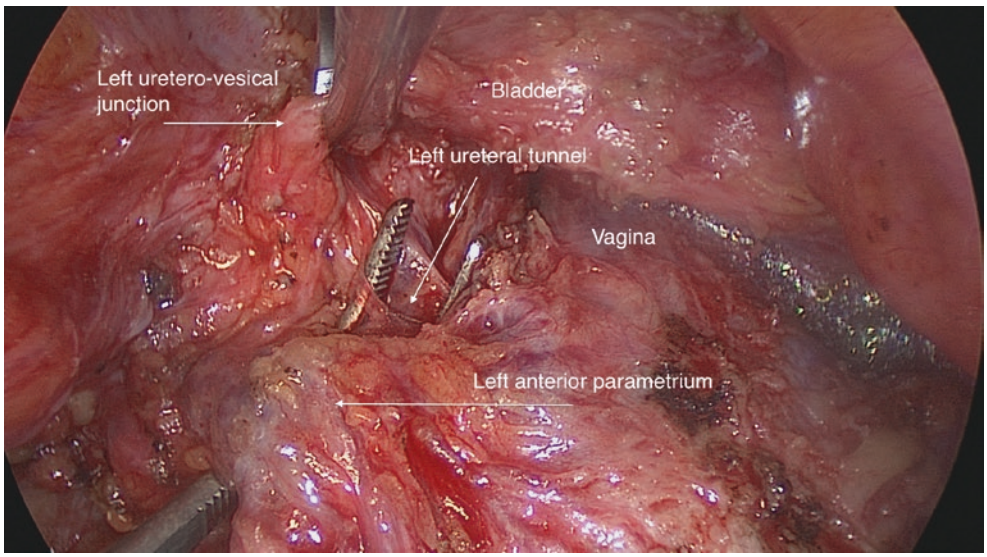


Fig. 102.6 Left ureteral tunnel

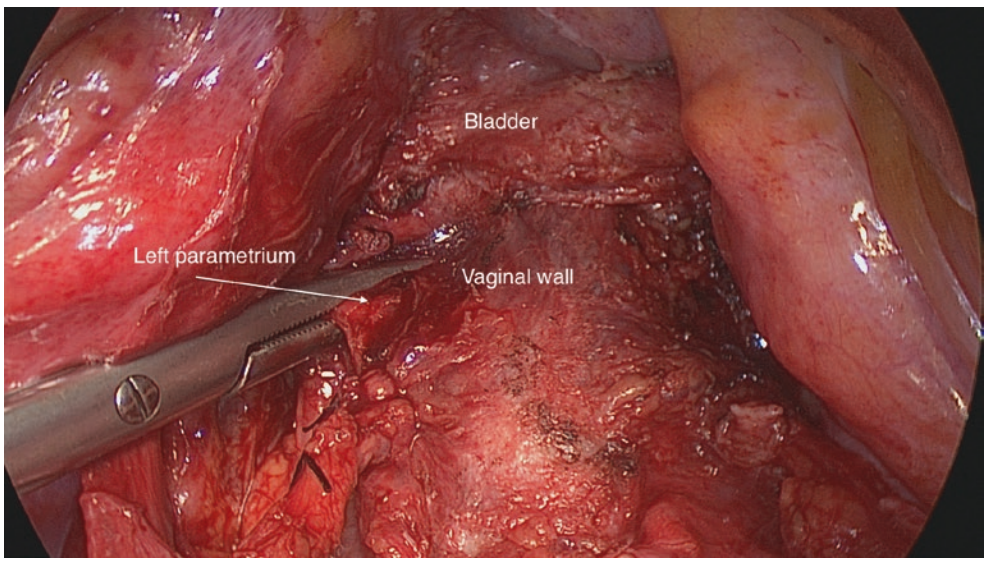


Fig. 102.7 Anterior parametrium

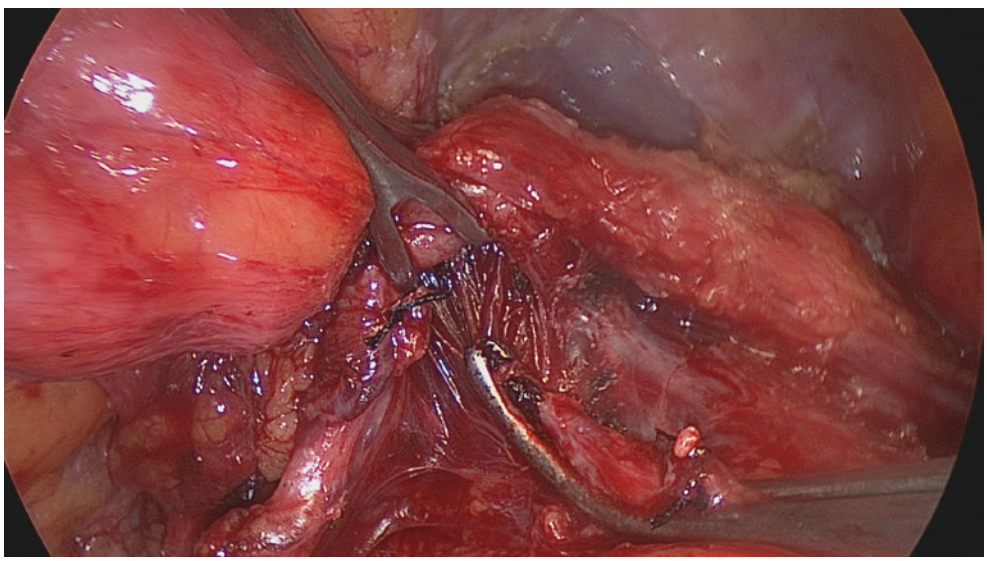


Fig. 102.8 Left uretero-vesical junction

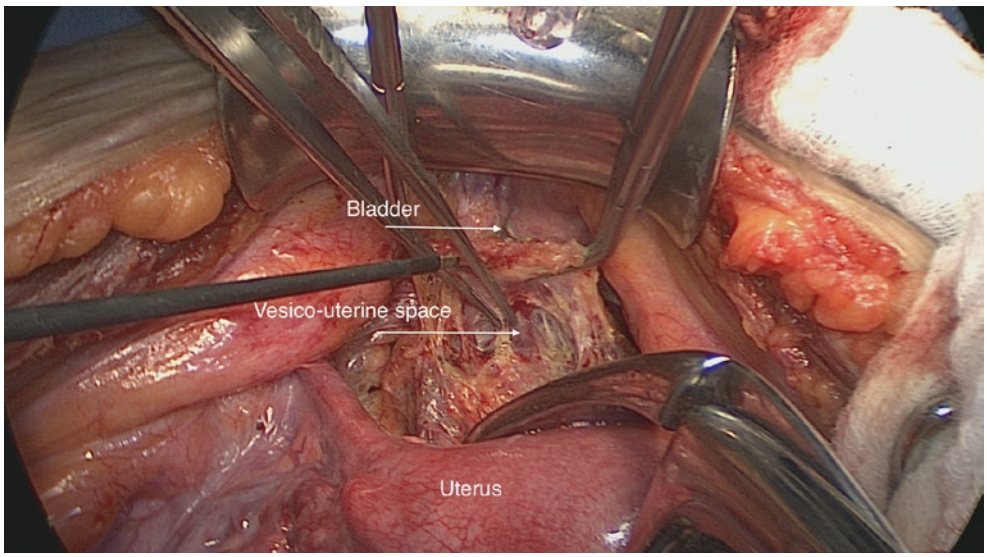


Fig. 102.9 Bladder fold dissection

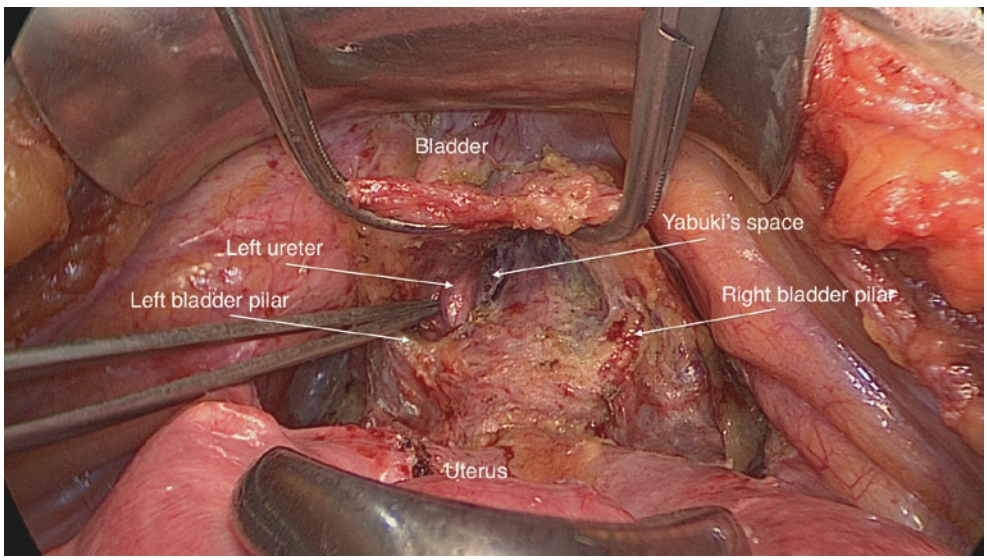


Fig. 102.10 Bladder pilars dissection

served, have an 87.4 % chance of obstruction in the postoperative period, thus the authors do not recommend uterine artery preservation when performing an abdominal radical trachelectomy.

Once the ureters have been properly mobilized bilaterally to the level of insertion into the bladder, surgeons must proceed with medial mobilization of the parametrial tissue bilaterally. This is done by assuring to mobilize the ureters inferiorly and laterally. In addition, surgeons must be certain to transect the vesico uterine ligament to further mobilize the bladder inferiorly. The uterosacral ligaments are then identified and transected bilaterally in medial-most third (Fig. 102.11). The parametrial tissue should be dissected so that there is a lateral margin of resection of approximately 3–5 cm (Fig. 102.12). A colpotomy is then performed circumferentially (Figs. 102.13 and 102.14). At this time, the cervix, parametrial tissue, and upper vagina are amputated from the uterus (Fig. 102.15). The landmark used to help guide with the amputation of the cervix is located approximately 0.5 or 1 cm below the internal uterine os, and the cut is preferably done with cold knife, in order to assure that there is no cauterized tissue that would potentially hinder the pathologic interpretation. The specimen is then sent for frozen section evaluation to assure that at least a 5-mm margin free of tumor (Figs. 102.16 and 102.17).

At this point, surgeons must determine whether they will place a cerclage at the same time of the procedure or do so when the patient becomes pregnant at a later time. In our institution, we prefer to place a cerclage at the time of the radical trachelectomy. The documented advantages of a cerclage are that it is important to reduce undesired obstetric complications such cervical incompetence, second trimester losses, premature rupture of membranes or preterm labor. The potential disadvantages are that it may cause cervical steno-

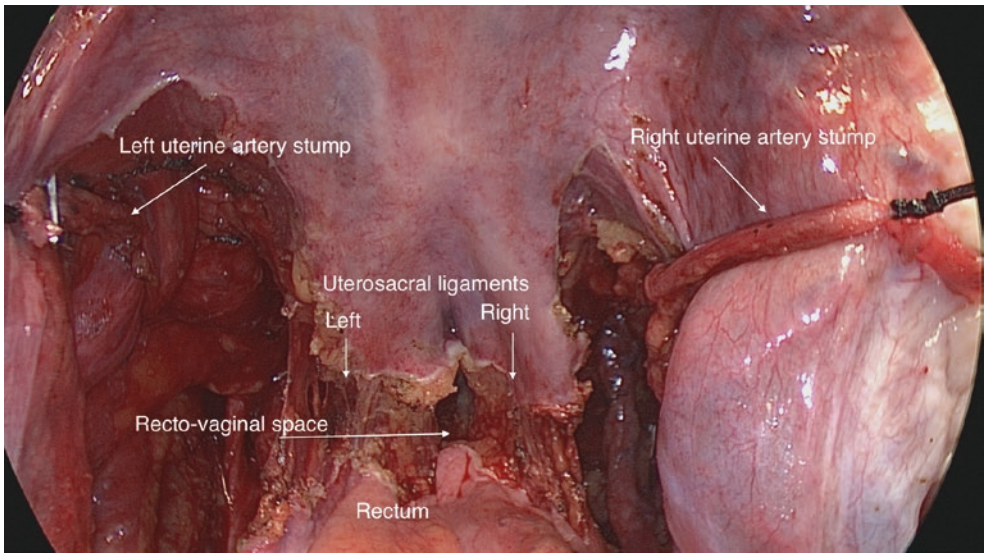


Fig. 102.11 Posterior view

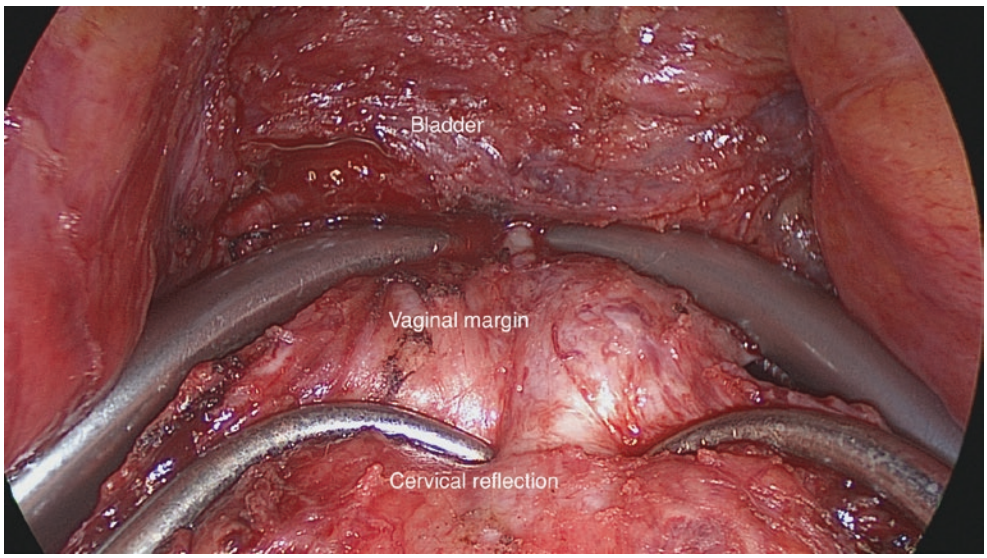


Fig. 102.12 Anterior margins

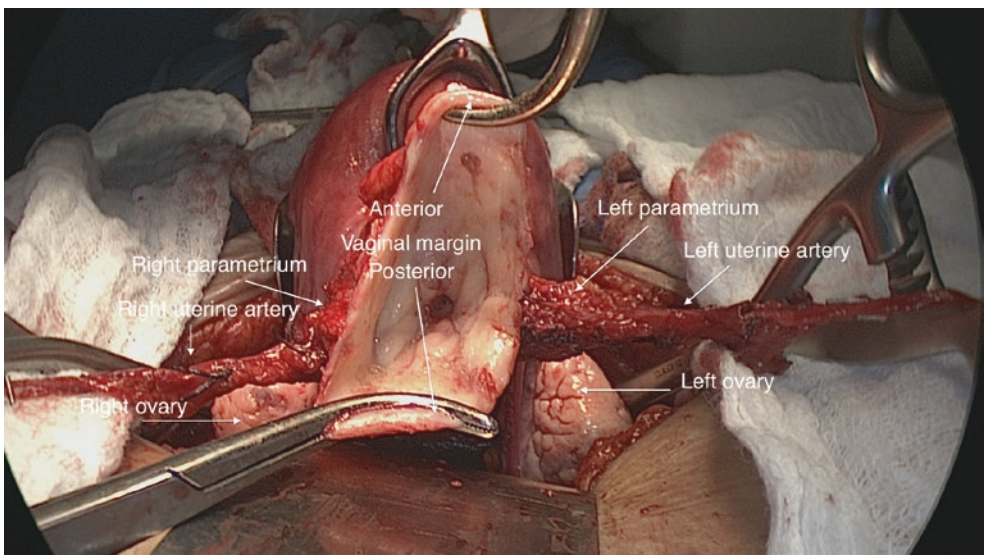


Fig. 102.13 Trachelectomy specimen pre-resection 1

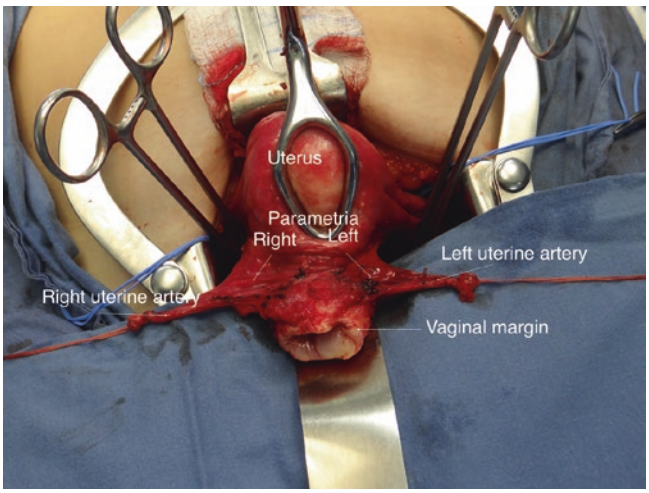


Fig. 102.14 Trachelectomy specimen pre-resection 2

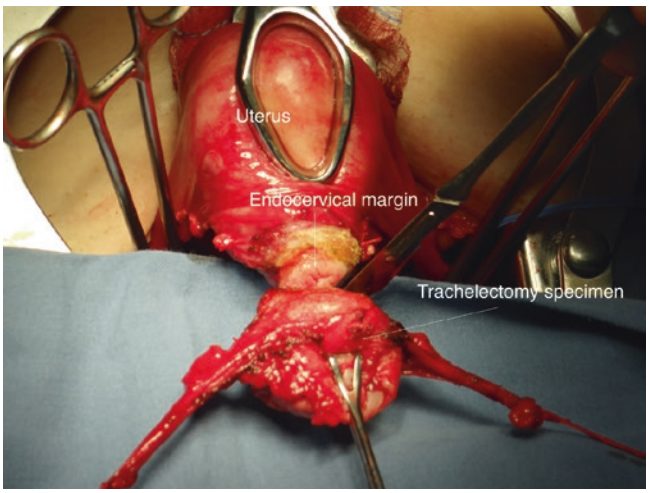
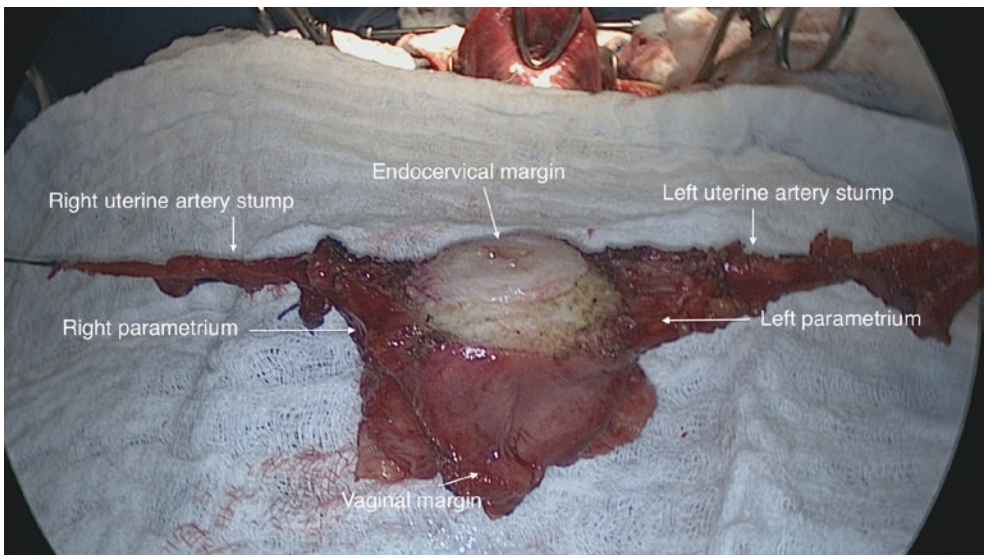


Fig. 102.15 Resection of the specimen

Fig. 102.16 Trachelectomy specimen 1



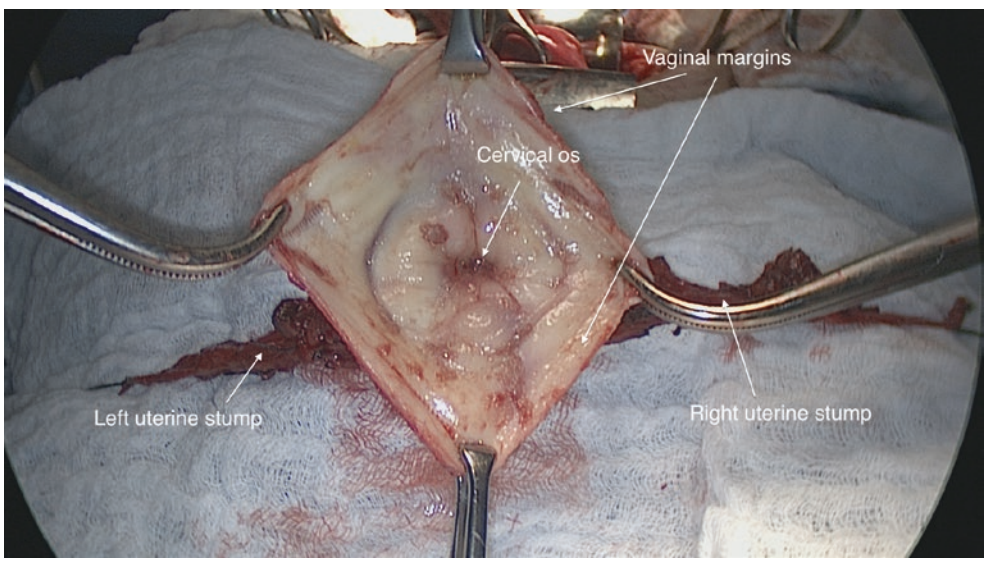


Fig. 102.17 Trachelectomy specimen 2

sis, chronic vaginal discharge, or it may potentially erode through the vagina. In a recent literature review, the investigators showed that the average rate of stenosis rate after radical trachelectomy was 10.5 % (0–73.3 %). The rates of cervical stenosis was 8.6 % when a cerclage was placed and 3.0 % when none was placed. In our institution, we do routinely place a cerclage at the time of radical trachelectomy.

When placing a cerclage, several suture may be used. We prefer to use 0-Ethibond suture(Johnsons & Johnsons, New Jersey, USA). The cerclage is placed approximately 2 cm superior to the lower edge of the uterus in order to decrease the likelihood of cerclage erosion into the vagina as a consequence of placing the cerclage too close to the uterine vaginal anastomosis. The suture of the cerclage should also be placed posteriorly to avoid erosion of the cerclage into the bladder. The abdominal wall is then closed in a routine fashion.

Another area of controversy is whether to place a uterine cannula to prevent the occurrence of future amenorrea after radical trachelectomy. A number of tools have been used such as pediatric Foley catheter or a Smitt sleeve (Elekta AB, Stockholm, Sweden) When placing the Smitt sleeve, it is important to suture the Smitt sleeve to the uterus using 4–0 Chromic suture. Among those in whom a cannula was placed the rate of stenosis was 4.6 % compared to 12.7 % when none was used ($P < 0.001$) [12]. In a recent study by Vieira el at. [10], the investigators used a pediatric Foley in 57 (62 %) of 92 patients versus a Smitt sleeve (Elekta AB, Stockholm, Sweden) in 23 (25 %) of 92 patients or none in 12 patients (13 %). In the Foley catheter group, six (10.5 %) developed cervical stenosis, compared with one (4.3 %) patient who developed stenosis in the Smitt sleeve group and one (8.3 %) patient with no catheter placement. Additionally, Nick et al. showed that the rate of cervical stenosis after radical trachelectomy prior to use of the Smitt sleeve was 14 % and 0 % after implementating its use in every case [11]. When a Smitt sleeve is secured to the uterus, it is then removed 3–4 weeks after the radical trachelectomy.

At this point, the uterus draws its blood supply from the utero-ovarian ligaments that in turn derive their blood supply from the ovarian vessels bilaterally (Fig. 102.18). The uterus is then anastomosed to the vagina using interrupted 2–0 Vicryl sutures. Sutures may be placed continuously or interrupted (Fig. 102.19). Alternatively, one may use a barbed suture, such as a V-loc suture (Covidien, London, UK).

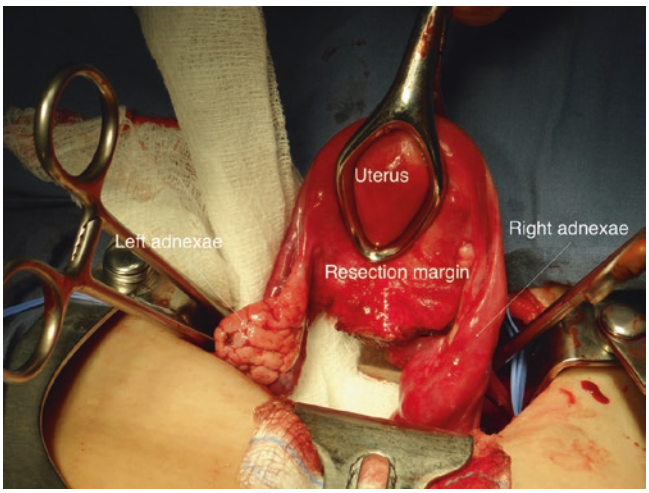


Fig. 102.18 Uterine corpus and adnexae pos-resection

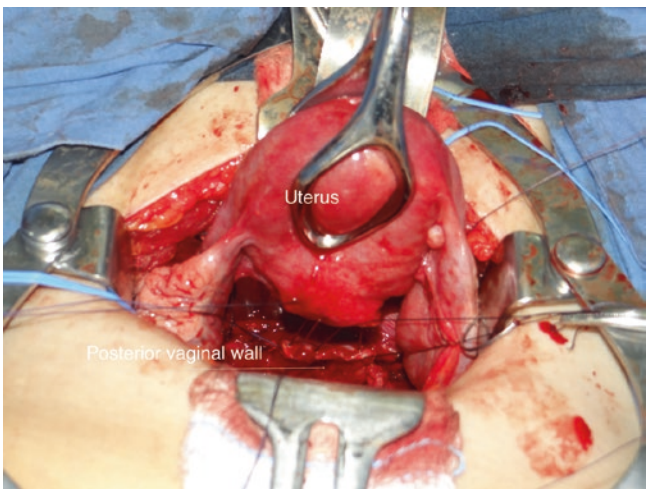


Fig. 102.19 Utero-vaginal anastomosis

Results

As of August 2015, there were a total of 663 intended ART's published in the literature [13–29]. The procedure was performed as planned in 608 patients, whereas in the remaining 55 patients a conversion to a radical hysterectomy was required. Conversions to radical hysterectomies were done for close margins or nodal involvement. The most common histology was squamous cell carcinoma (76 %), and the most frequent stage was IB1 (75 %). Lymphovascular space involvement was present in 21.5 % of cases (Table 102.1). The surgical time ranged from 100 to 611 minutes and the blood loss ranged from 50 to 4300 ml. The transfusion rate among those who reported this information was 42 % (102/238) (Table 102.2).

Intraoperative complications other than bleeding necessiting transfusion are rare, or not reported in most studies. The most common postoperative complication described is cervical stenosis occurring in 9.5 % of patients, followed by infection or abscess in 38 8.6 %, and lymphocyst in 5.9 % of patients [9] (Table 102.3). The global pregnancy rate after ART was 17.9 % which is very similar to 16.2 % described in a recent literature review [9]. Pregnancy rate was calculated as follows: total pregnancies/patients with

Table 102.1 Demographic and tumor information for patients who underwent abdominal radical trachelectomy

Author (year)	N	Median age (range), y	Histology			Stage				Tumor size	LVSI + preop N° (%)
			SCC	AC	Other	IA1 + LVSI	IA2	IB1	Other		
Ungar (2005) [8]	33[a]	+30.5 (23–37)	26	1	3 (1 adsq, 2 glassy)	0	10	15	5 (IB2)	NR	8 (26.6)
Pareja (2008) [8]	15	30 (25–38)	11	4	0	0	3	12	0	<2 cm	5 (33)
Jeremic (2009) [10]	12	+30.5 (22–40)	12	0	0	2	7	3	0	<2 cm	NR
Yao (2010) [11]	10	+29 (28–30)	8	2	0	0	5	5	0	<2 cm	NR
Du (2011) [12]	68	+28 (18–41)	68	0	0	3	28	37	0	56 <2 cm, 12 >2 cm	NR
Li (2011) [13]	64[b]	29.5 (11–41)	50	8	4 (3 bot, 1 adsq)	16	7	36	0	45 <2 cm, 14 >2 cm	NR
Nick (2011) [14]	25	28.8 (21.4–37.2)	7	15	3 (adsq)	2	7	16	0	NR	2 (8)
Saso (2012) [15]	30	+32.5 (23–41)	15	10	5 (4 adsq, 1 glassy)	0	2	25	3 (2 IB2 1 IIA)	25 <2 cm, 5 >2 cm	NR
Muraji (2012) [16]	23	33 (25–42)	16	6	1 (adsq)	2	2	19	0	NR	5 (21.7)
Karateke (2012) [17]	8	27 (18–35)	4	3	1 (clear)	0	0	7	1 (IIA)	3 <2 cm, 5 >2 cm	3 (37.5)
Wethington (2012) [18]	101	+31 (19–43)	40	54	7 (6 adsq, 1 clear)	3	8	88	2 (IB2, IIA)	NR	47 (47)
Testa (2013) [19]	30	31 (22–40)	20	59	0	0	6	19	0	1.2 (0.4–3.5)	5 (20)
Nishio (2013) [20]	114	33 (25–40)	99	14	1 (adsq)	9	12	93	0	NR	55 (48.2)
Cao (2013) [21]	73	31 (22–39)	64	9	0	5	10	58	0	0:20,<2:29,>2:24	NR
Kucukmentin (2014) [22]	16	26 (24–36)	13	3	0	0	0	16	0	NR	8 (57)
Capilna (2014) [23]	29	32 (24–40)	15	3	8 (adsq)	0	11	14	1 (IB2)	1.8 (0.3–4.2)	NR
Tokunaga (2014) [24]	42	32 (22–39)	42	0	0	1	4	37	0	NR	5 (11.9)

AC adenocarcinoma, *adsq* adenosquamous carcinoma, *bot* sarcoma botryoides, *clear* clear cell carcinoma, *glassy* glassy cell carcinoma, *LVSI* lymph-vascular space invasion, *NR* not reported, *preop* preoperative, *SCC* squamous cell carcinoma

[a]Histology and stage not reported for 3 patients

[b]Histology not reported for 2 patients; stage and tumor size not reported for 5 patients

[c]Histology and stage not reported for 10 patients

[d]Stage not reported for 3 patients

[e]Tumor size not reported in

+ Mean

fertility preservation. It is important to highlight that not all authors report the number of patients seeking to get pregnant, but among those reporting this information, the percentages fluctuate between 16.9 % [11] and 60 % [25]. Obtetrical outcomes show that there were 109 pregnancies out of a total 658 patients who maintained their fertility, with 25 miscarriages (14 first trimester and 9 s trimester). A total of 14 patients had an ongoing pregnancy at the time of report. There were 71 deliveries, 24 of them at term, 28 preterm, and 19 without information on delivery time. Table 102.4 summarizes the obstetrical results.

Given the current data on abdominal radical trachelectomy, it seems that this procedure is safe and feasible and offers patients with early-stage cervical cancer a very reasonable option for fertility preservation with excellent oncologic outcomes. In the future, perhaps less radical approaches, such as simple conization or simple hysterectomy, will be feasible for select patients with low-risk criteria.

Table 102.2 Intraoperative and postoperative outcomes for patients who underwent abdominal radical trachelectomy

				Outcomes of trachelectomy								
Author (year)	No. of planned trachelectomies	Trachelectomy done, n (%)	Immediate hysterectomy, n (%)	Median surgical time (range), min	Median blood loss (range), mL	Transfusions, n (%)	Median no. of pelvic nodes removed (range)	No. of patients with positive pelvic nodes	No residual disease, n (%)	Follow up, months (range)	Relapses	Deaths
Ungar (2005) [8]	33	30 (90.9)	3 (9)	+226 (170–300)	NR	20 (66.6)	+32.2 (17–44)	2	NR	32 (14–75)	0	0
Pareja (2008) [8]	15	15 (100)	0	265 (210–330)	400 (200–1000)	4 (27)	26 (11–48)	0	7 (47)	32 (5–32)	0	0
Jeremic (2009) [10]	12	11 (91.6)	1 (8.3)	NR	NR	NR	NR	1	NR	NR	0	0
Yao (2010) [11]	10	10 (100)	0	+261 (204–345)	+370 (150–500)	NR	NR	0	NR	(4–68)	0	0
Du (2011) [12]	68	60 (88.2)	8 (11.8)	NR	NR	NR	NR	8	NR	38 (3–84)	2	0
Li (2011) [13]	64	62 (96.8)	2 (3.12)	148 (110–230)	362 (100–700)	4 (6.45)	25 (12–53)	5	NR	22.8 (1–78)	0	0
Nick (2011) [14]	25	24 (96)	1 (4)	328 (203–392)	300 (50–1100)	2 (8)	18 (7–33)	3	16 (64)	26.4 (0.30–64.9)	0	0
Saso (2012) [15]	30	30 (100)	0	+170 (110–300)	+813 (50–4300)	6 (20)	24 (7–52)	3	NR	24 (7–113)	3	2
Muraji (2012) [16]	23	21 (91.3)	2 (8.7)	NR (175–352)	NR (200–988)	NR	NR	1	17 (68)	(2–45)	0	0
Karateke (2012) [17]	8	8 (100)	0	163 (120–210)	NR	1 (12.5)	32 (19–48)	0	2 (25)	33 (5–92)	0	0
Wethington (2012) [18]	101	81 (80)	20 (20)	NR	NR	NR	24 (2–60)	19	29 (44)	32 (1–124)	4	0
Testa (2013) [19]	30	27 (90)	3 (10)	240 (210–270)	350 (200–650)	0	21 (11–33)			29(4–68)	0	0
Nishio (2013) [20]	114	61 (85.9)	0	NR	NR	60(52 %)	NR	15	33 (54)	NR	6	NR

Cao (2013) [21]	73	73 (100)	0	177 (100–370)	322 (100–2700)	NR	26 (12–43)			20(6–42)	0	0
Kucukmentin (2014) [22]	16	16 (100)	0	NR	NR	NR	12 (8–19)			43 (8–110)	1	0
Capilna (2014) [23]	29	26 (89.6)	3 (11)	254 (182–302)	NR	NR	38 (16–60)			20(4–43)	1	0
Tokunaga (2014) [24]	42	42	0	304 (233–611)	848 (250–3984)	5(11.9 %)	35 (7–68)			29 (1–122)	3	2

NR not reported
[a]Twenty-one patients received adjuvant chemotherapy
[b]No available data to calculate outcomes
+ Mean

Table 102.3 Intraoperative and postoperative complications for patients who underwent abdominal radical trachelectomy

Reference	No. of patients undergoing trachelectomy	Intraoperative complications	Postoperative complications
Li	64	Transfusions (n = 4)	Cervical stenosis (n = 5), infected lymphocyst (n = 2), vesical dysfunction (n = 1)
Ungar	33	Transfusions (n = 20), ureteral injury (n = 1)	Antibiotic use (n = 14), endometrial cavity obliteration (n = 2)
Cibula	24	None	None
Abu Rustum	22	None	Cervical stenosis (n = 4), cerclage erosion (n = 1), infected lymphocyst (n = 2), amenorrhea (n = 1), leg lymphedema (n = 1)
Pareja	15	Transfusions (n = 4), injury to external iliac artery (n = 1)	Tuboovarian abscess (n = 1), cerclage expulsion (n = 2), voiding disfunction (n = 1), pelviperitonitis (n = 1)
Olawaiye	10	Pulmonary embolism (n = 1)	Cervical stenosis (n = 2), cerclage expulsion (n = 2)
Yao	10	None	Lymphocyst (n = 1)
Jeremic	12	Not reported	Not reported
Du	68	None	Cervical stenosis (n = 17), leg lymphedema (n = 7), infected lymphocyst (n = 5), amenorrhea (n = 3)
Saso	30	Not reported	Hematocolpos (n = 1), uterovaginal suture detachment (n = 1), omental prolapse through vaginal sutures (n = 1)
Nick	32	None	Urinary tract infection or urinary retention (n = 7), fever (n = 5) abnormal uterine bleeding or amenorrhea (n = 8) cerclage erosion (n = 4), cervical stenosis (n = 3)
Muraji	23	None	Amenorrhea (n = 2), lymphocyst (n = 4), cervical stenosis (n = 2)
Testa	30	None	Cervical stenosis (n = 3), tuboovarian abscess (n = 1), lymphocyst (n = 2)
Nishio	114	Transfusions (n = 60), secondary hemorrhage necessitating laparotomy (n = 1)	Cervical stenosis (n = 1), amenorrhea (n = 5), postsurgical infection (n = 15), lymphocyst requiring drainage (n = 9)
Cao	73	Pelvic vein tear (n = 1)	None
Kucukmentin	16	None	Urinary tract infection or urinary retention (n = 12), cerclage erosion (n = 1), ureterovaginal fistula (n = 1), cervical stenosis (n = 1)
Caplina	29	None	Cervical stenosis (n = 1)
Tokunaga	42	Ureteral injury (n = 1)	Lymphocyst (n = 4), ileus (n = 1)

Table 102.4 Pregnancy rates and obstetrical outcomes for patients who underwent abdominal radical trachelectomy

Author	No. of planned trachelectomies	Trachelectomy done, n (%)	Attempting to conceive, n (%)	Pregnancies	Miscarriages		Deliveries		Patients pregnant at time of report
					1st term	2nd term	At term	Preterm	
Ungar (2005) [8]	33	30 (90.9)	NR	3	1	0	2	0	0
Pareja (2008) [8]	15	15 (100)	6/14 (42.8)	3	0	0	2	1	0
Jeremic (2009) [10]	71	61 (85.9)	29/57 (50.8)	4	0	0	2	2	0
Yao (2010) [11]	12	11 (91.6)	NR	NR	NR	NR	NR	NR	NR
Du (2011) [12]	10	10 (100)	NR	2	0	0	1	1	0
Li (2011) [13]	68	60 (88.2)	15/60 (25)	8	1[a]		3	2	2
Nick (2011) [14]	64	62 (96.8)	10/59 (16.9)	2	0	0	1	0	1
Saso (2012) [15]	25	24 (96)	11/21 (52.3)	3	1	1	0	1	0
Muraji (2012) [16]	30	30 (100)	NR	3	0	1	2	0	0
Karateke (2012) [17]	23	21 (91.3)	NR	1	0	0	0	1	0
Wethington (2012) [18]	8	8 (100)	NR	3	0	1	1	1	0
Ungar (2005) [8]	101	81 (80)	38/70 (54.2)	31	3	6	16[b]		6
Testa (2013) [19]	30	27 (90)	6(20 %)	3	0		1	2	0
Nishio (2013) [20]	114	61 (85.9)	69(60 %)	31	5		4	17	5
Cao (2013) [21]	73	73 (100)	34(46 %)	3	0		3	0	0
Kucukmentin (2014) [22]	16	16 (100)	NR	1	0		1	0	0
Capilna (2014) [23]	29	26 (89.6)	7(27 %)	3	2		1	0	0
Tokunaga (2014) [24]	42	42	18(42 %)	5	2		3 ϕ		0

NR not reported
[a]Trimester in which miscarriage occurred not indicated
[b]Delivery time not indicated

References

1. NCC Network. Cervical cancer. NCCN clinical practice guidelines in oncology; 2015.
2. Dargent D, Brun JL, Roy M, Remy I. Pregnancies following radical trachelectomyfor invasive cervical cancer. Gynecol Oncol. 1994;52:105.
3. Smith JR, Boyle DC, Corless DJ, Ungar L, Lawson AD, Del Priore G, et al. Abdominal radical trachelectomy: a new surgical technique for the conservative manage- ment of cervical carcinoma. Br J Obstet Gynaecol. 1997;104:1196–200.
4. Kim JH, Park JY, Kim DY, Kim YM, Kim YT, Nam JH. Fertility-sparing laparoscopic radical trachelectomy for young women with early stage cervical cancer. BJOG. 2010;117:340–7.
5. Park JY, Joo WD, Chang SJ, Kim DY, Kim JH, Kim YM, et al. Long-term outcomes after fertility-sparing laparoscopic radical trachelectomy in young women with early-stage cervical cancer: an Asan Gynecologic Cancer Group (AGCG) study. J Surg Oncol. 2014;110:252–7.
6. Nick AM, Frumovitz MM, Soliman PT, Schmeler KM, Ramirez PT. Fertility sparing surgery for treatment of early-stage cervical cancer: open vs. robotic radical trachelectomy. Gynecol Oncol. 2012;124(2):276–80. doi:10.1016/j.ygyno.2011.09.035. Epub 2011 Oct 27
7. Persson J, Imboden S, Reynisson P, Andersson B, Borgfeldt C, Bossmar T. Reproducibility and accuracy of robot-assisted laparoscopic fertility sparing radical trachelectomy. Gynecol Oncol. 2012;127(3):484–8. doi:10.1016/j.ygyno.2012.08.022. Epub 2012 Aug 28
8. Du XL, Sheng XG, Jiang T, Li QS, Yu H, Pan CX, et al. Sentinel lymph node biopsy as guidance for radical trachelectomy in young patients with early stage cervical cancer. BMC Cancer. 2011;11:157.
9. Tang J, Li J, Wang S, Zhang D, Wu X. On what scale does it benefit the patients if uterine arteries were preserved during ART? Gynecol Oncol. 2014;134:154–9.
10. Vieira MA et al. Radical trachelectomy in early-stage cervical cancer: A comparison of laparotomy and minimally invasive surgery. Gynecol Oncol. 2015;138:585–9.
11. Nick AM, Frumovitz MM, Soliman PT, Schmeler KM, Ramirez PT. Fertility sparing surgery for treatment of early-stage cervical cancer: open vs. robotic radical trachelectomy. Gynecol Oncol. 2012;124:276–80.
12. Li X, Li J, Wu X. Incidence, risk factors and treatment of cervical stenosis after radical trachelectomy: a systematic review. Eur J Cancer. 2015;51(13):1751–9. doi:10.1016/j.ejca.2015.05.012. Epub 2015 Jun 3.
13. Ungar L, Palfalvi L, Hogg R, Siklos P, Boyle DC, Del Priore G, et al. Abdominal radical trachelectomy: a fertility-preserving option for women with early cervical cancer. BJOG. 2005;112:366–9.

14. Pareja FR, Ramirez PT, Borrero FM, Angel CG. Abdominal radical trachelectomy for invasive cervical cancer: a case series and literature review. Gynecol Oncol. 2008;111:555–60.
15. Jeremic K, Petkovic S, Stefanovic A, Stojnic J, Maksimovic M, Likic I, et al. Radical abdominal trachelectomy in managing early cervical invasion. Eur J Gynaecol Oncol. 2009;30:309–12.
16. Yao T, Mo S, Lin Z. The functional reconstruction of fertility-sparing radical ab- dominal trachelectomy for early stage cervical carcinoma. Eur J Obstet Gynecol Reprod Biol. 2010;151:77–81.
17. Du XL, Sheng XG, Jiang T, Li QS, Yu H, Pan CX, et al. Sentinel lymph node biopsy as guidance for radical trachelectomy in young patients with early stage cervical cancer. BMC Cancer. 2011;11:157.
18. Li J, Li Z, Wang H, Zang R, Zhou Y, Ju X, et al. Radical abdominal trachelectomy for cervical malignancies: surgical, oncological and fertility outcomes in 62 patients. Gynecol Oncol. 2011;121: 565–70.
19. Nick AM, Frumovitz MM, Soliman PT, Schmeler KM, Ramirez PT. Fertility sparing surgery for treatment of early-stage cervical cancer: open vs. robotic radical trachelectomy. Gynecol Oncol. 2012;124:276–80.
20. Saso S, Ghaem-Maghami S, Chatterjee J, Naji O, Farthing A, Mason P, et al. Abdom- inal radical trachelectomy in West London. BJOG. 2012;119:187–93.
21. Muraji M, Sudo T, Nakagawa E, Ueno S, Wakahashi S, Kanayama S, et al. Type II versus type III fertility-sparing abdominal radical trachelectomy for early-stage cervical cancer: a comparison of feasibility of surgical outcomes. Int J Gynecol Cancer. 2012;22: 479–83.
22. Karateke A, Cam C, Celik C, Baykal B, Tug N, Ozbasli E, et al. Radical trachelectomy in late pregnancy: is it an option? Eur J Obstet Gynecol Reprod Biol. 2010;152:112–3.
23. Wethington SL, Cibula D, Duska LR, Garrett L, Kim CH, Chi DS, et al. An interna- tional series on abdominal radical trachelectomy: 101 patients and 28 pregnan- cies. Int J Gynecol Cancer. 2012;22: 1251–7.
24. Testa R, Ramirez PT, et al. Abdominal radical trachelectomy: a safe and feasible option for fertility preservation in developing countries. J Low Genit Tract Dis. 2013;17(4):378–84.
25. Nishio H, Fujii T, et al. Reproductive and obstetric outcomes after radical abdominal trachelectomy for early-stage cervical cancer in a series of 31 pregnancies. Hum Reprod. 2013;28(7): 1793–8.
26. Cao DY, Yang JX, et al. Comparisons of vaginal and abdominal radical trachelectomy for early-stage cervical cancer: preliminary results of a multi-center research in China.China Gynecologic Oncology Group. Br J Cancer. 2013;109(11):2778–82.
27. Kucukmetin A, Biliatis I, et al. Laparoscopic radical trachelectomy is an alternative to laparotomy with improved perioperative outcomes in patients with early-stage cervical cancer. Int J Gynecol Cancer. 2014;24(1):135–40.
28. Căpîlna ME, Ioanid N, et al. Abdominal radical trachelectomy: a Romanian series. Int J Gynecol Cancer. 2014;24(3):615–9.
29. Tokunaga H, Watanabe Y, et al. Outcomes of abdominal radical trachelectomy: results of a multicenter prospective cohort study in a Tohoku Gynecologic Cancer Unit. Int J Clin Oncol. 2015; 20(4):776–80.

Radical Abdominal Hysterectomy with Anterior and Posterior Exenteration: Gynecological Perspectives

103

Ana-Maria Schmidt and Daniel Fink

Introduction

Alexander Brunschwig was the first surgeon to publish his preliminary experience with pelvic exenterations in 1948. The procedure included the en bloc resection of the internal and external reproductive organs, the bladder with the urethra, the pelvic ureter, anus, rectum and colon sigmoideum, including the perineum. There was no reconstruction, and the ureters were implanted in the colon [1]. The morbidity and mortality rates were very high because of the empty pelvis and the combined stoma. The new method involving an ileal conduit presented by Bricker in 1956 helped lower the number of renal complications, although at the price of an additional stoma [2, 3].

Today, new surgical techniques for resection and reconstruction and greatly enhanced postoperative care have improved patient outcomes significantly. Primary and palliative exenterations have also gained acceptance.

Classification and Indications

Pelvic exenterations are mostly performed with a curative aim; nevertheless, indications for palliative exenterations are possible in special cases. The exenteration is considered curative when no distant metastases are found on the preoperative imaging or intraabdominal survey during the operation and the pathological findings show clear margins. Tumor perforations into the pouch of Douglas, positive margins or peritoneal lavage or distant metastasis change the aim from curative to palliative.

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An anterior exenteration is defined as the removal of the reproductive tract and the bladder with the pelvic ureters and the urethra. A posterior exenteration includes the removal of the reproductive tract with the rectosigmoid colon. A total exenteration is the combination of both procedures.

Whenever possible a complete reconstruction is carried out, which includes the building of a continent bladder (often out of the ileocecal segment) and the formation of an omental flap, a neovagina and a colorectal anastomosis. These steps fill the empty pelvis, reducing complications such as ileus, and have a positive impact on the postoperative quality of life of the patients.

Indications for primary exenteration are uterine tumors infiltrating the bladder and/or rectum and tumor-induced fistulae between the bladder and/or rectum and vagina. Indications for secondary exenteration are tumor recurrences after surgery or irradiation with infiltration of the bladder and/or rectum. Large fistulae after radiotherapy or cloacae can also be an indication for exenteration, even in the absence of tumor.

Occasionally, additional interventions such as nephrectomy, vulvectomy or resection of the anus should be considered.

The most common genital tumor treated through exenteration is carcinoma of the cervix, followed by carcinomas of the uterine corpus, vagina and vulva.

Before undergoing an exenteration, all patients should have examinations under general or spinal anesthesia, including cystoscopy and rectoscopy, to evaluate their operability and to histologically verify the tumor. Positron emission tomography (PET) scans of the thorax and the abdomen and other examinations needed to evaluate the patient's operability should also be part of the preoperative evaluation (Fig. 103.1 and Table 103.1).

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Surgical Technique

The exenteration procedure comprises first a destructive and afterwards a reconstructive part.

The abdomen is opened through a longitudinal incision from the symphysis to the upper abdomen. The height of the incision depends on the weight of the patient and/or the necessity of performing a paraaortic lymphonodectomy.

After the insertion of the retractor system, a systematic inspection of the abdominal cavity is undertaken to exclude tumor spread. A lavage of the cavity for cytological examination is indicated.

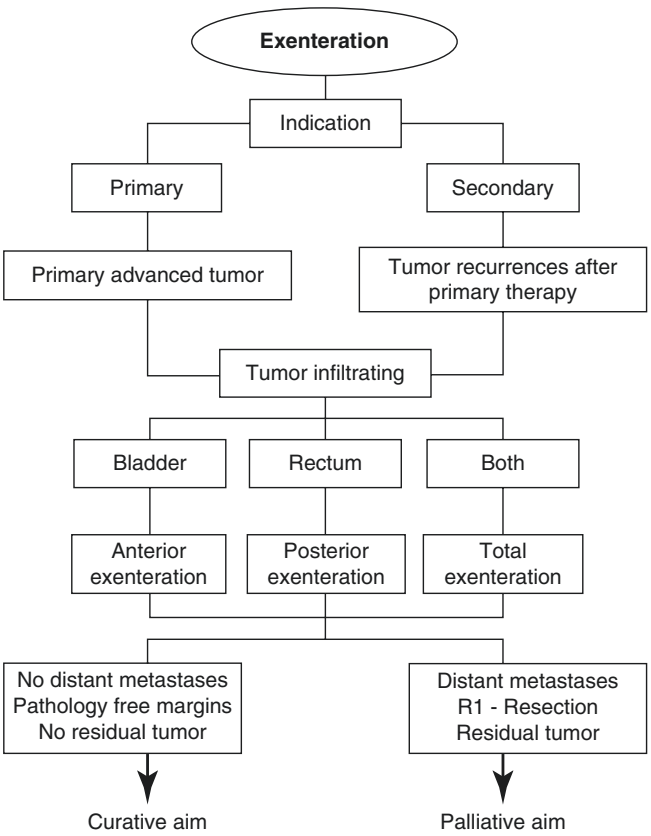


Fig. 103.1 Exenteration flow chart: indications and aims

If a lymphonodectomy has to be undertaken, the corresponding incisions are made in the peritoneum to expose both the descending aorta and the vena cava for a paraaortic lymphonodectomy or the bifurcations of the great vessels for a pelvic lymphonodectomy.

In cases with no indication for lymphonodectomy but with expected high blood loss, preemptive exposure of the internal iliac vessels should be considered. This step may save time later if ligation becomes necessary (Fig. 103.2).

The destructive part of a primary exenteration begins with dissection of the round ligament on the right side after straight grips have been applied to the uterus and tightened. The gap in the peritoneum is then enlarged with scissors, first in a cranial and then slightly medial direction (Fig. 103.3). Traction is applied to the medial part of the peritoneum so that the ureter can be exposed and lateralized. In the direction towards the tumor, the lateralization should end at a safe distance, which is at least 2 cm above the tumor. The lumbosacral plexus and the infundibulopelvic ligament should now be visible (Fig. 103.4).The ureters can now be dissected out followed by catheter insertion. The catheters are directed into reservoirs at the sides of the patient so that the urine does not flow into the abdomen (Fig. 103.5). If needed, the infundibulopelvic ligament can now be dissected.

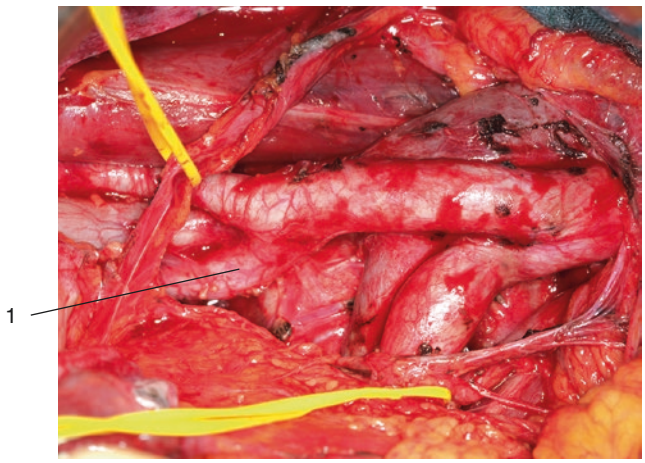


Fig. 103.2 Pelvis after lymphonoectomy (ureters with *yellow reins*). *1* Internal iliac artery

Table 103.1 Exenteration: type and reconstruction

	Reconstruction		
Exenteration	Continent	Incontinent	Additional
Anterior	Pouch	Conduit	180° colonic neovagina and Omental flap
Posterior	Colorectal anastomosis	Terminal colostomy	
Total	Pouch	Conduit	
	Colorectal anastomosis	Terminal colostomy	

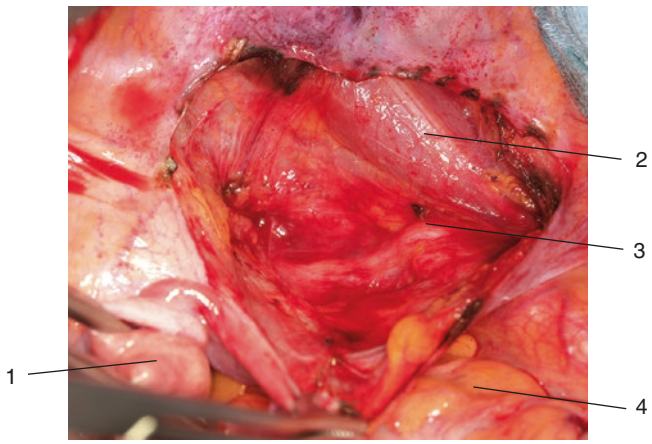


Fig. 103.3 Pelvic wall after peritoneal incision. *1* Uterus, *2* Psoas muscle, *3* Ureter, *4* Sigmoid colon

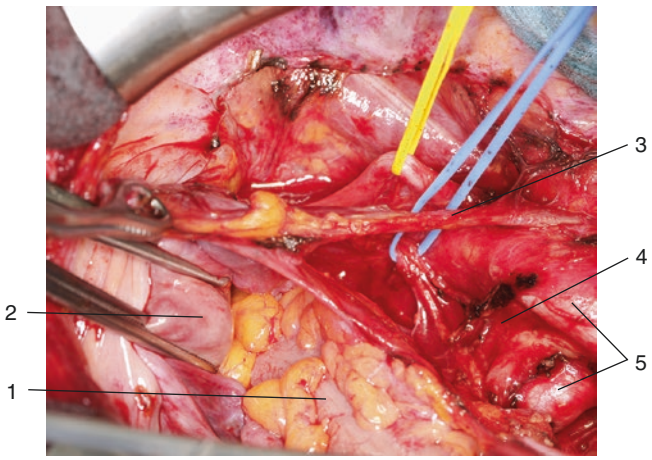


Fig. 103.4 Right retroperitoneal space. *Yellow rain*: Ureter. *Blue rain*: Lumbosacral plexus. *1* Sigmoid colon, *2* Uterus, *3* Infundibulopelvic ligament, *4* Sacral os, *5* Aortic bifurcation

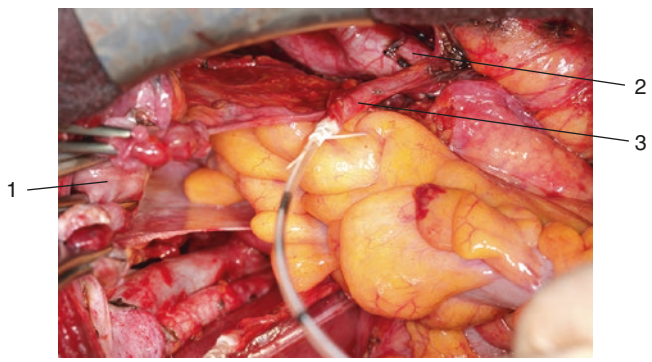


Fig. 103.5 Pelvis after ureter dissection. *1* Uterus, *2* Ureter, *3* Commone iliac artery

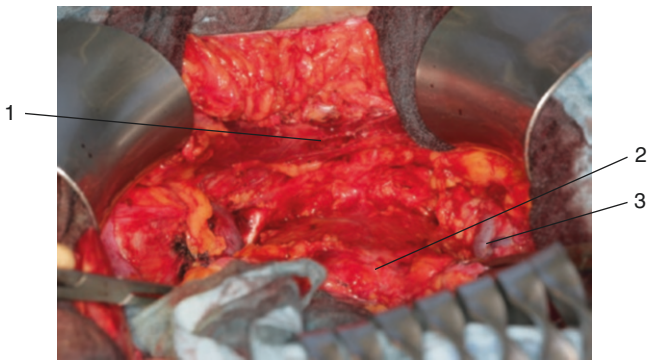


Fig. 103.6 Anterior pelvic space. *1* Posterior wall of the symphysis, *2* Anterior bladder wall, *3* External iliac vessels

If an anterior or a total exenteration is planned, the peritoneum is also dissected in a caudal and medial direction, following the curve of the dorsal face of the symphysis to expose the ventral surface of the bladder.

These steps are repeated on the other side of the pelvis. Now, the ventral surface of the bladder can easily be separated from the dorsal face of the symphysis (Fig. 103.6). Blunt separation may be used, and if small vessels are exposed, they can be coagulated and then dissected. For a posterior exenteration, the dissection of the peritoneum should occur immediately above the vesico-uterine fold. Then, the posterior wall of the bladder can be separated from the anterior uterine and cervical faces.

For a posterior or a total exenteration, the sigmoid colon is detached from the left pelvic wall, and the retroperitoneal space is opened. The round ligament and the infundibulopelvic ligament are then dissected after lateralization of the ureter. The ureter is then also dissected, if needed. Particularly, if a sub-total exenteration is the aim, the lumbosacral plexus should be preserved. The plexus is visible bilaterally to the medial peritoneum. After the peritoneum has been retracted, the plexuses can be easily moved aside. The plexus will then cover the sacral os like a fine net (Figs. 103.7 and 103.8). Now, the sigmoid colon is mobile, so the resection plane can be determined. The plane should be chosen at least 5 cm above the tumor level. It should not be so low that it would compromise the margins and not so high that more colon than needed is removed. The mesosigmoid is now bluntly mobilized from the anterior wall of the sacral os. The small vessels that occasionally appear can be dissected after coagulation (Fig. 103.8). In cases with very aggressive tumors, positive paracolic lymph nodes are found so that a complete resection of the mesosigmoid is recommended. The colon-tube is separated with a fine clamp from its mesentery, and then the mesentery is divided (Fig. 103.9). Afterwards, the intestine is divided as well, and a stapler is used to close both ends. For an anterior exenteration, the peritoneum in the

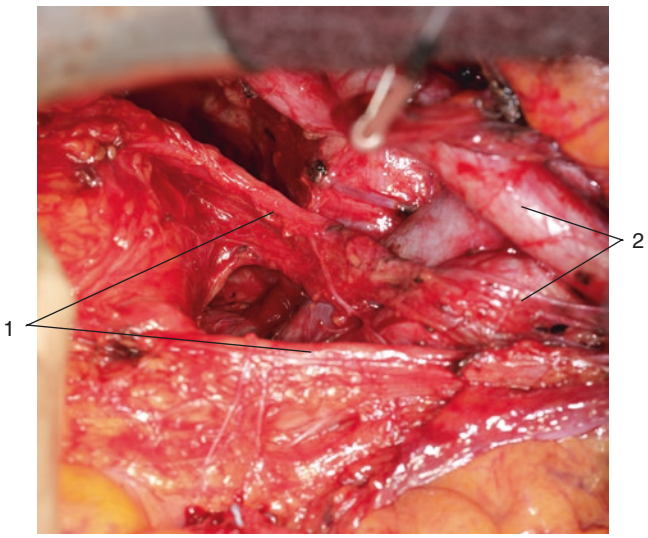


Fig. 103.7 Isolated lumbosacral plexus. *1* Lumbosacral plexus, *2* Aortal bifurcation

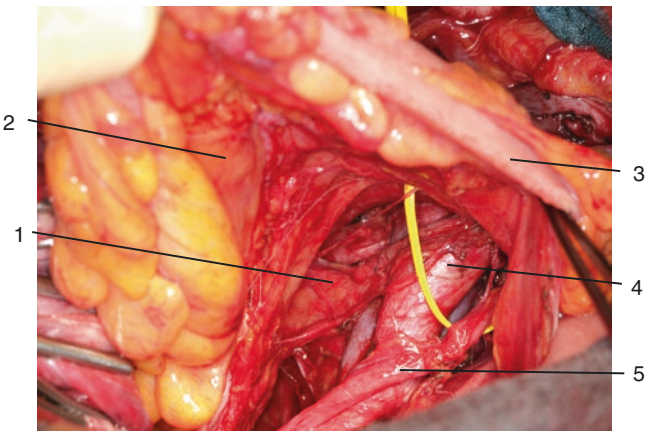


Fig. 103.8 Posterior pelvic space after. *1* Lumobosacral plexus, *2* Mobilized mesosigmoid, *3* Colonic tube, *4* Left commone iliac artery, *5* Ureter

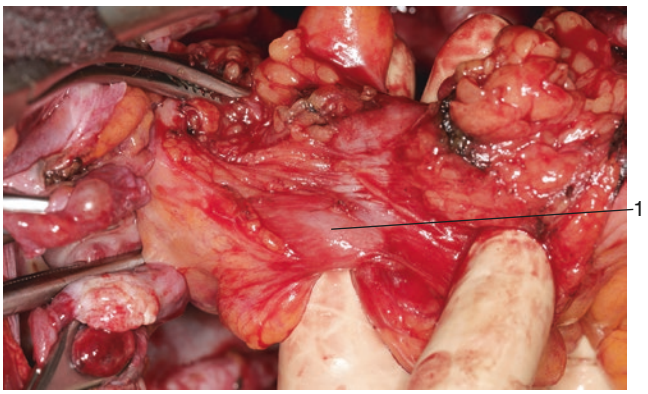


Fig. 103.9 Isolated colonic tube. *1* Isolated colonic viscus

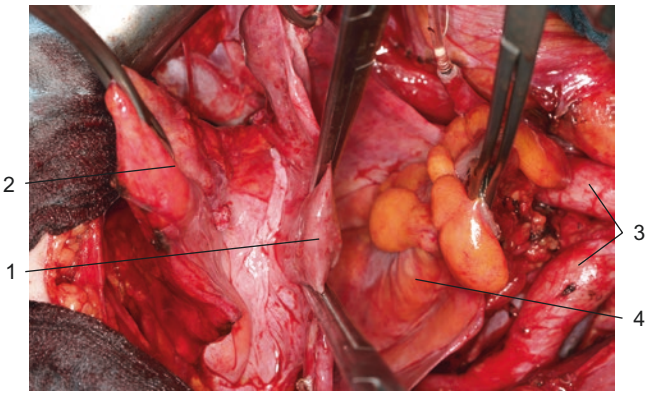


Fig. 103.10 Opened specimen. *1* Uterus, *2* Bladder, *3* Aortal bifurcation, *4* Intestine

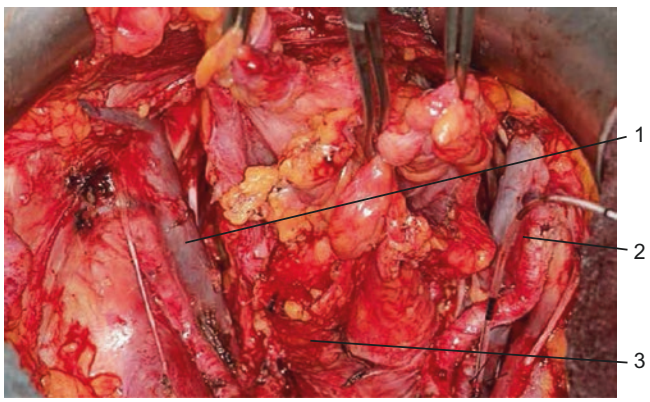


Fig. 103.11 Closed specimen. *1* Left external iliac vessels, *2* Right external iliac vessels, *3* Posterior colonic face

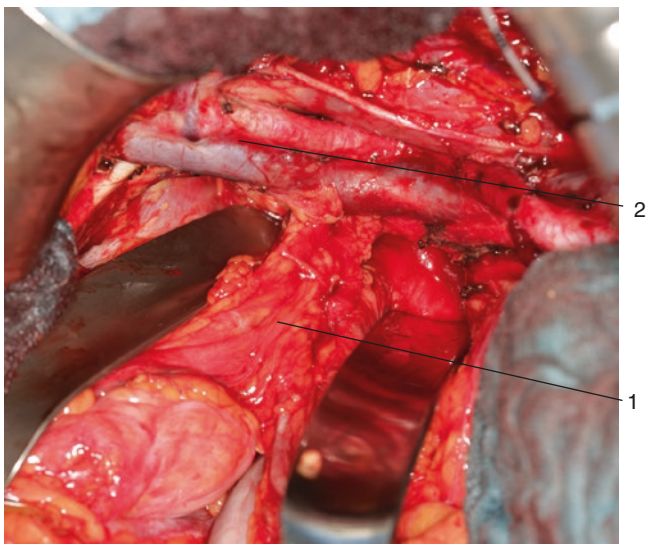


Fig. 103.12 Isolated right broad ligament. *1* External artery and vein, *2* Broad ligament

pouch of Douglas is opened, and the posterior vaginal wall is separated from the rectum.

Next, the specimen, consisting of the uterus, bladder and/or rectum (Figs. 103.10 and 103.11) is grasped with blunt clamps that have been tightened and retracted to the left side so that the right pelvic wall and the broad ligament with the uterine vessels are clearly shown (Figs. 103.12 and 103.13). If a pelvic lymphonodectomy has been performed, the iliac vessels (common, internal and external) and the obturator nerve come into view (Figs. 103.14 and 103.15). The lateral

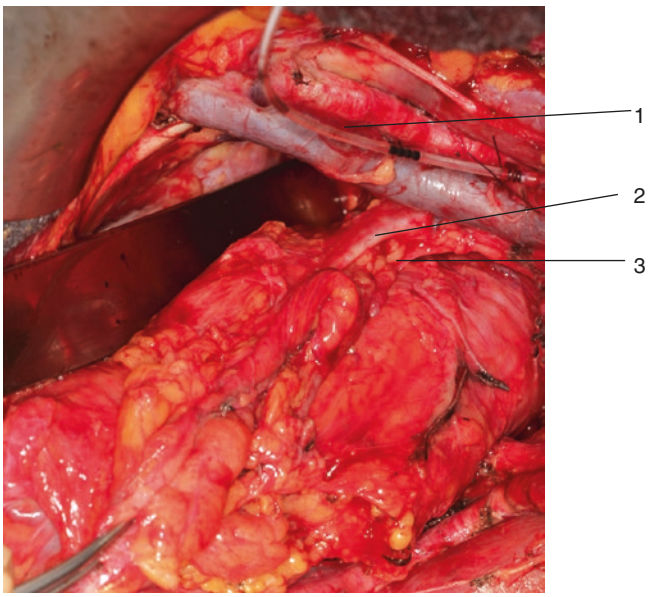


Fig. 103.13 Isolated right broad ligament. *1* External iliac artery and vein, *2* Uterine artery, *3* Broad ligament

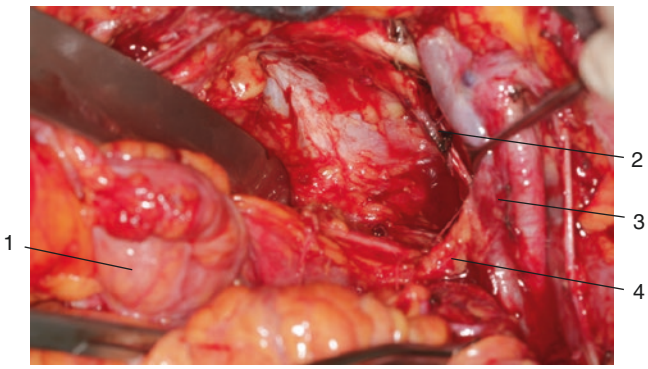


Fig. 103.14 Caudal end of the obturatoric fossa. *1* Uterus, *2* Obturator vessels, *3* External iliac vessels, *4* Right broad ligament

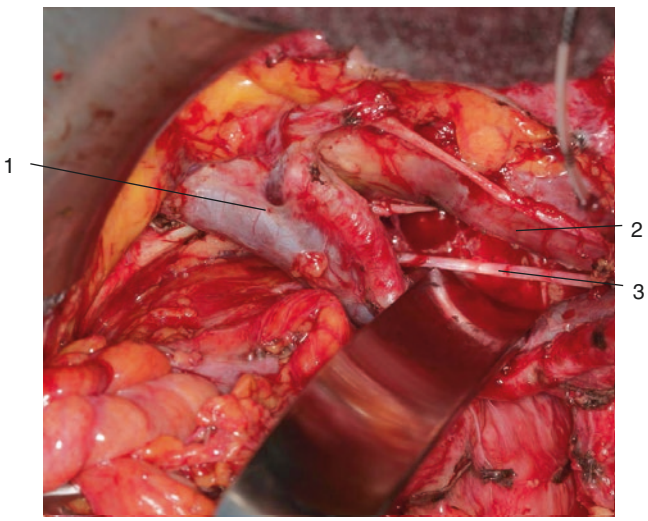


Fig. 103.15 Cranial part of the obturatoric fossa. *1* External iliac vessels, *2* Psoas muscle, *3* Right obturator nerv

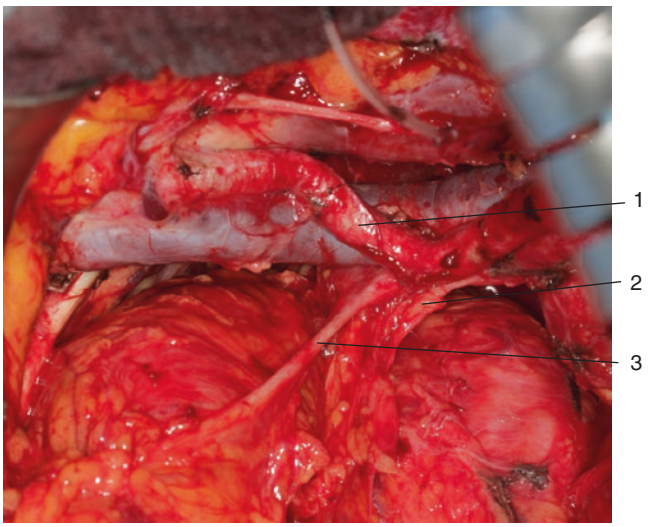


Fig. 103.16 Isolated broad ligament. *1* External iliac artery, *2* Uterine artery, *3* Lateral umbilical ligament

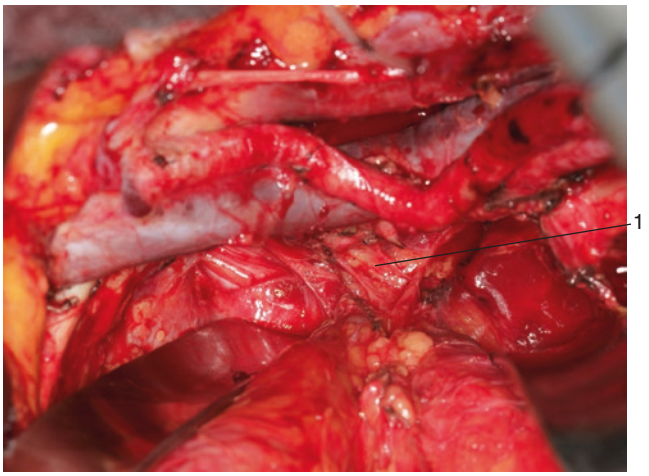


Fig. 103.17 Broad ligament after dissection of the upper part. *1* Broad ligament, lower part

bladder wall can now, mostly bluntly, be separated from the pelvic wall. There are sometimes some small vessels to be coagulated. Now, the specimen can be better retracted. The lateral umbilical ligament and the uterine artery thus come into view better (Fig. 103.16) so that the dissection of the upper part of the broad ligament can take place under direct visualization. Afterwards, the lower part will be visible (Fig. 103.17) and can also be dissected. Further retraction of the increasingly mobile specimen displays the paracolpic tissue (Figs. 103.18 and 103.19). Repeating this procedure on the left side displays the tissue connecting the urethra to the symphysis (Fig. 103.20), which can be now be divided. Using only the hand, one can now raise the specimen by lifting the dorsal part of the specimen out of the lower pelvis to display the anterior wall of the sacral os (Fig. 103.21). Afterwards, the posterior wall of the symphysis can also be totally displayed (Fig. 103.22). By the end of this procedure,

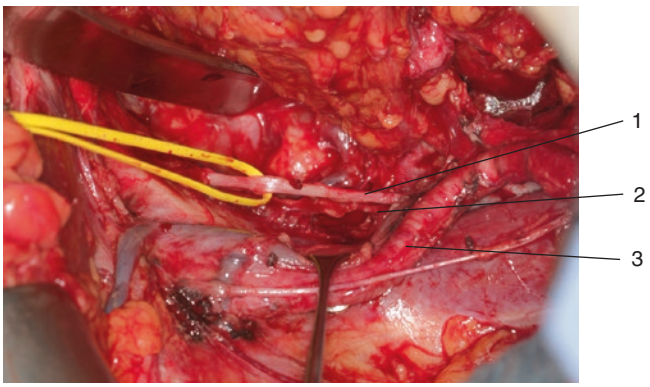


Fig. 103.18 Left pelvic wall. *1* Obturator nerv, *2* Paracolpic tissue, *3* External iliac vessels

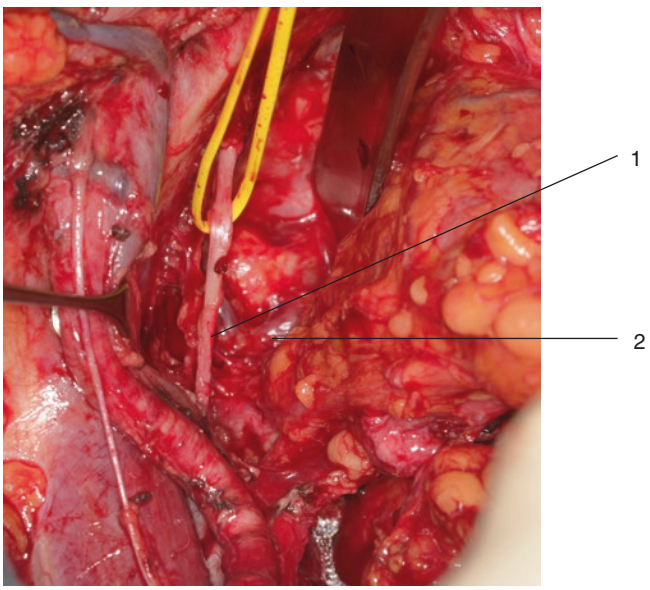


Fig. 103.19 Left pelvic wall. *1* Obturator nerv, *2* Paracolpic tissue

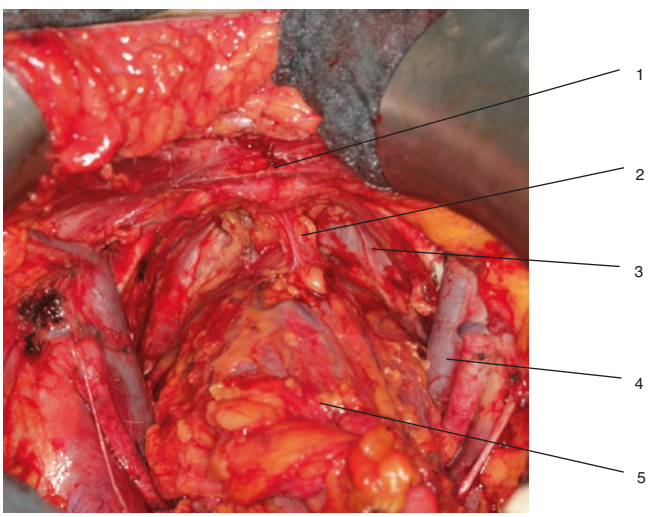


Fig. 103.20 Connections between urethra and symphysis. *1* Symphysis, *2* Urethral connections, *3* Tendineous arch, *4* External iliac vessels, *5* Anterior bladder wall

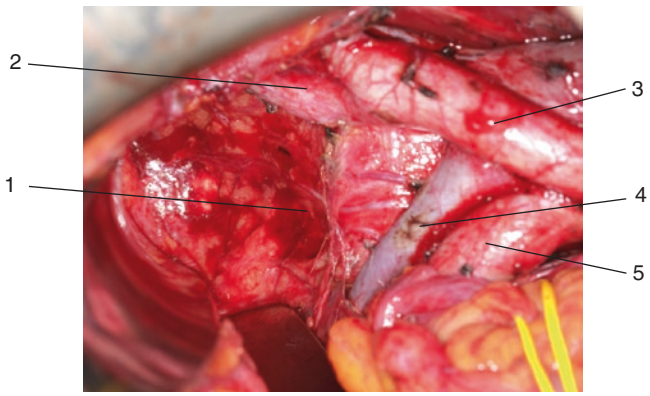


Fig. 103.21 Sacral os, anterior wall. *1* Sacral os, *2* Right internal iliac artery, *3* Right commone iliac artery, *4* Left commone iliac vein, *5* Left commone iliac artery

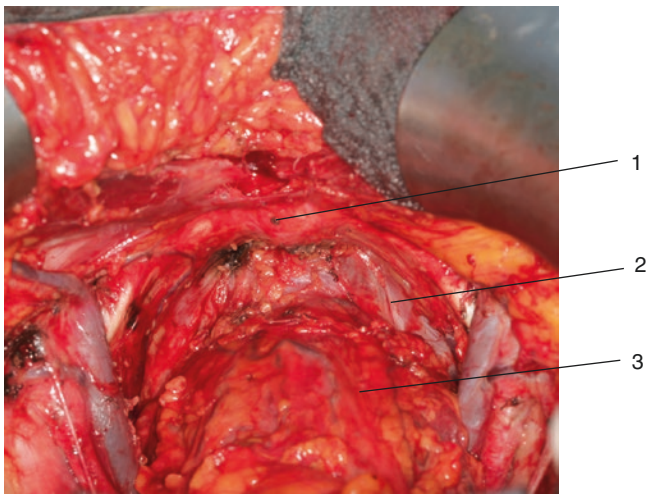


Fig. 103.22 Posterior wall of the symphysis with tendinous arch. *1* Symphysis, *2* Tendinous arch, *3* Anterior bladder wall

the tendinous arch of the pelvic will come into view laterally (Fig. 103.23). The abdominal procedure can now be completed by liberating the specimen from all remaining connections to the pelvis as much as possible, and the exenteration is then continued toward the vagina after positioning the patient in the lithotomy position.

It is recommended that the lower back of the patient be positioned a few centimeters over the lower edge of the operating table. This position provides better access to the rectum, especially when a rectum amputation is planned. In other cases, rectal digital control during the separation of the dorsal wall of the vagina from the rectum is mandatory.

If there is tumor debris protruding out of the vagina or rectum, it is recommended to place several alcohol-soaked cotton swabs inside to prevent tumor cells from being carried over to the remaining tissue.

Depending on the aim of the exenteration, the resection field is determined to include the urethral meatus and/or the anus and eventually the vulva, as well (Figs. 103.24 and

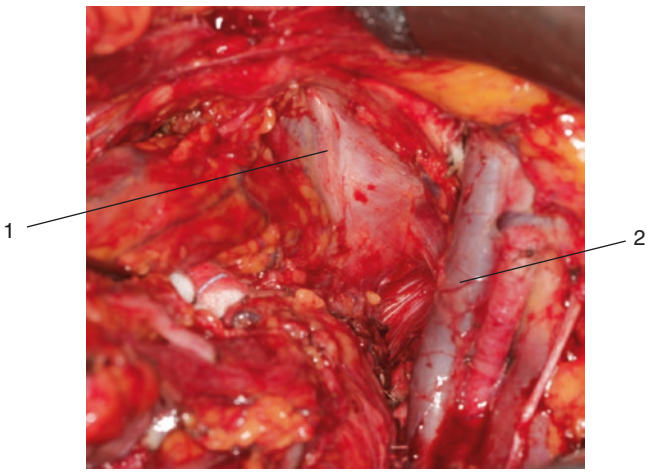


Fig. 103.23 Anterior/lateral/distal pelvic space. *1* Tendinous arch, *2* External iliac vessels

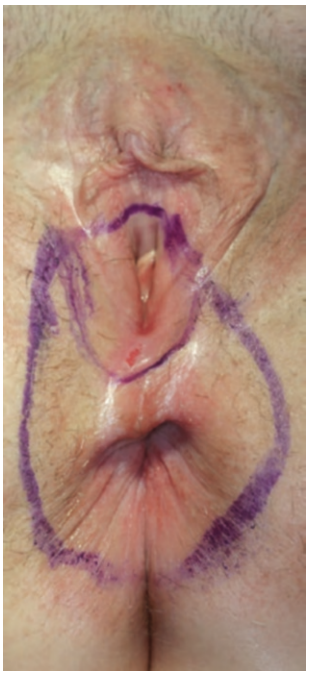


Fig. 103.24 Perineal excision

103.25). The vaginal incision is made just below the hymen, paying great attention to preserving the urethra or rectum if needed (Figs. 103.26 and 103.27). For an anterior or total exenteration, the dissection is continued alongside the posterior wall of the symphysis, both bluntly and sharply. Eventually, the connection to the abdominal operating field is completed after only a few steps. Then, the dorsal connection alongside the anterior rectal wall can be completed if an anterior exenteration is planned. This step will facilitate the lateral preparation. For a posterior or total exenteration, the level of preparation should be defined depending on the tumor position. Clear margins are most important, but a rectal stump of at least 6 cm is preferred. Now, the paracolpic tissue can be

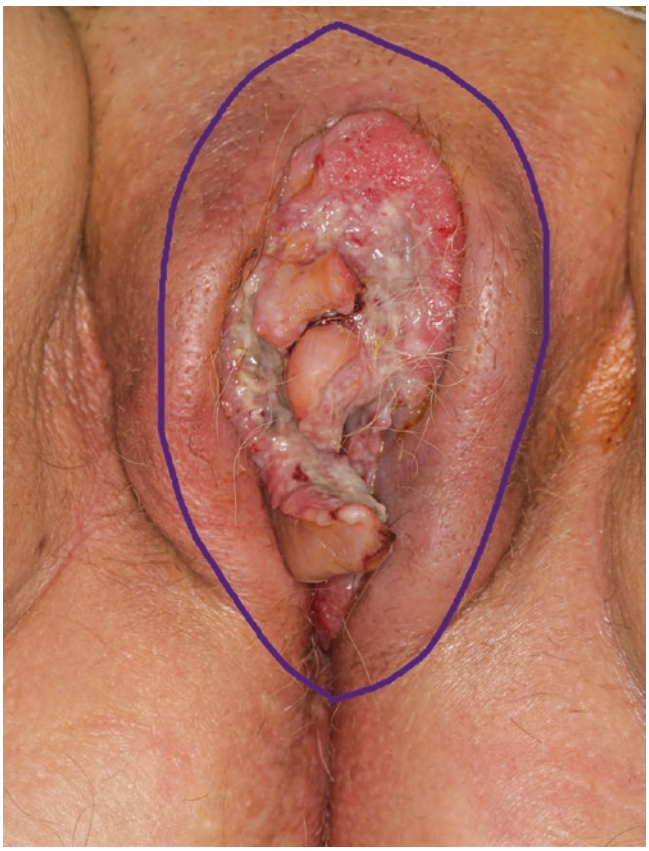


Fig. 103.25 Perineal excision with vulvectomy

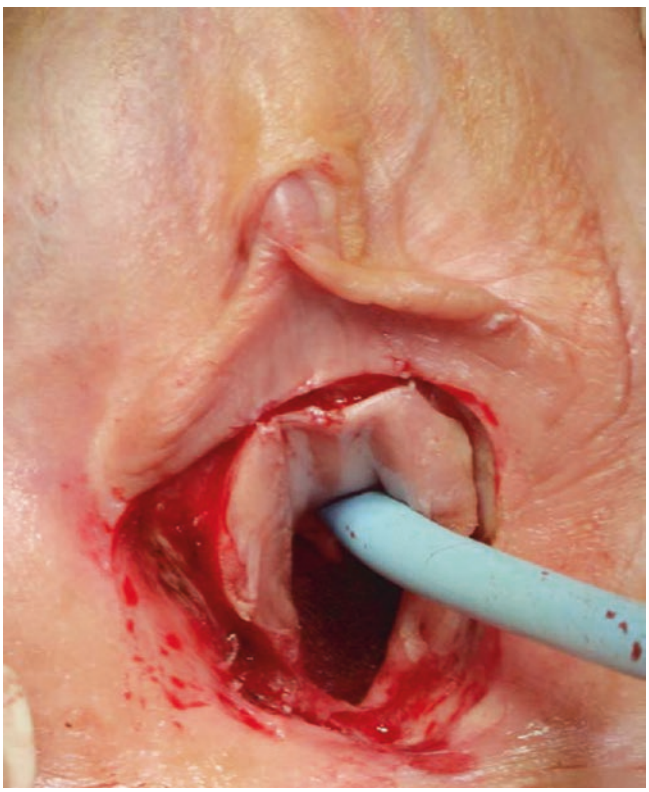


Fig. 103.26 Vaginal incision

displayed with Preisky blades and dissected so that the connection to the abdominal resection field is also completed. The specimen will now only be connected to the part of the rectum that is to be removed. The operational field is now again changed to an abdominal procedure.

Gently, the ventral part of the specimen is now upturned, paying attention not to spill tumor debris and not to avulse the caudal part of the tumor. The caudal rectal tube is now freed from the connecting tissue containing its blood supply and then divided using a stapler. Therewith, the resection of the specimen is completed (Fig. 103.28). After a total exenteration, the pelvis is now empty (Fig. 103.29).

It is recommended that the specimen should be pinned with the correct anatomical positioning on a cork disk (Figs. 103.30 and 103.31).

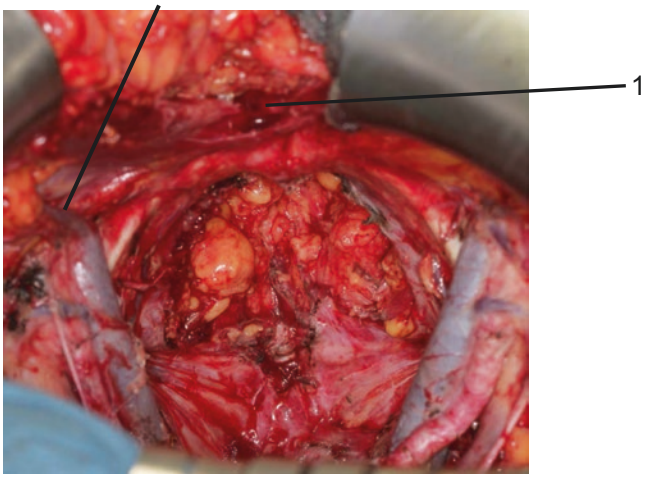


Fig. 103.29 Empty pelvis. *1* Symphysis

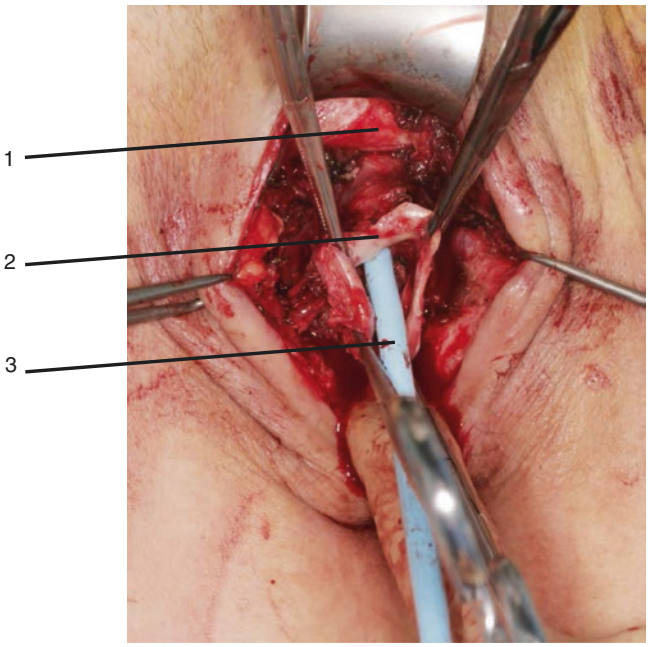


Fig. 103.27 Lateral preparation. *1* Symphysis, *2* Vagina, *3* Urethral catheter

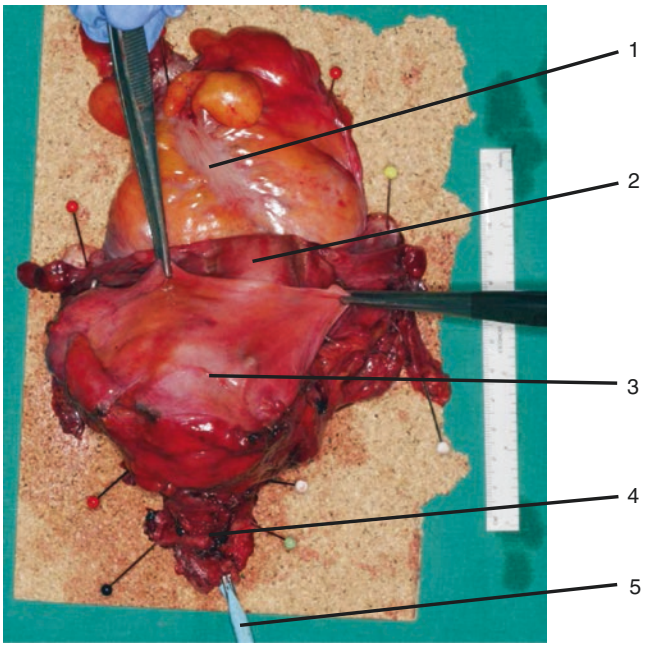


Fig. 103.30 Pined specimen. *1* Intestine, *2* Uterus, *3* Bladder, *4* Vagina, *5* Urethral catheter

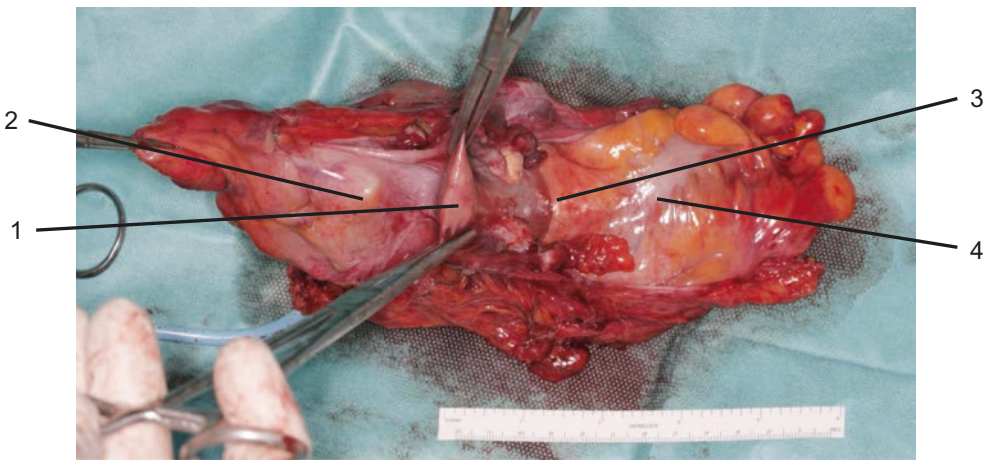


Fig. 103.28 Specimen total exenteration. *1* Uterus, *2* Bladder, *3* Pouch of Douglas, *4* Rectum

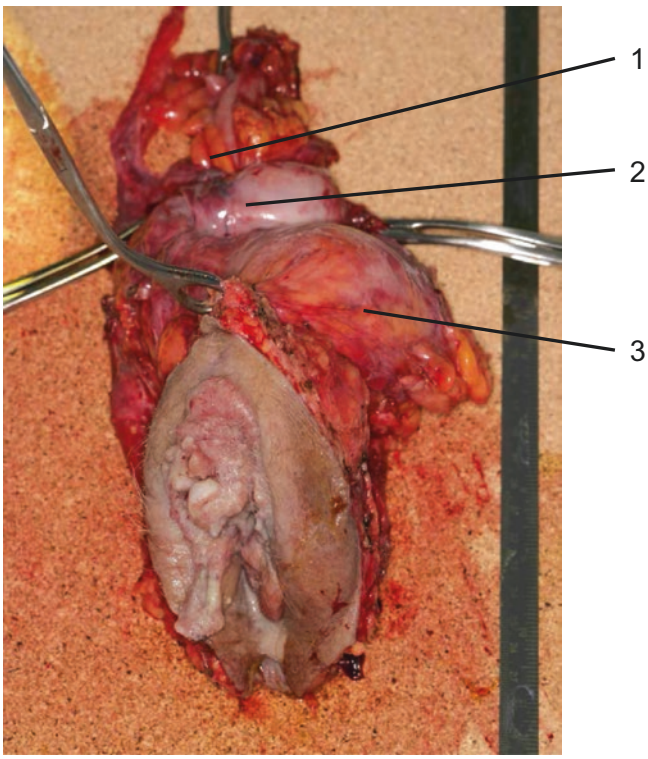


Fig. 103.31 Pined specimen with vulvectomy. *1* Intestine, *2* Uterus, *3* Bladder

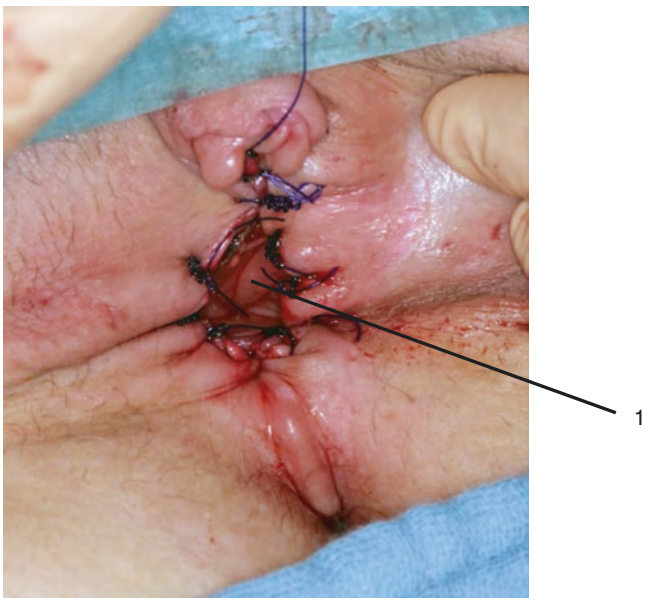


Fig. 103.32 1180° colonic neo – vagina

After rinsing all the operating fields with warm isotonic fluid and coagulating any bleeding vessels, the pelvis is packed with laparotomy sponges, and then the perineal wound is closed in 2–3 layers (Fig. 103.32), leaving a 3 cm gap for a neovagina, if needed. In cases involving an additional vulvectomy, skin grafts are eventually needed. In most cases, grafts are harvested from the inner thighs and rotated to cover the defect.

A secondary exenteration is a more challenging procedure due to the preceding treatment. These patients have undergone prior operations, irradiation or both. Depending on the prior treatment, adhesions and/or diffuse tissue induration can occur.

Reconstruction

A reconstruction that is as complete as possible is very important to the quality of life of the patients and also reduces the number of postoperative complications such as bowel obstruction.

To reconstruct the bladder, the two most frequently used options are an ileal conduit or a continent pouch. The first option is easier and faster to accomplish and needs only a small bowel anastomosis. However, it does involve a wet stoma and the necessity of wearing a collection bag. The building of the continent pouch, mostly out of the ileocecal segment of the bowel, takes 1–2 h longer and requires a colon anastomosis. If the appendix has not already been removed, it can serve as a neourethra. Once implanted at the bottom of the umbilicus, it is barely visible. The patient empties the pouch using a non-sterile catheter. If the prolongation of the operating time can be tolerated well by the patient and the patient can manage to regularly take care of the pouch, this should be the preferred option, especially in young patients.

The building of a neovagina can be a great psychological help, not only for younger patients. A neovagina also has the important function of filling the empty pelvis. When a posterior or total exenteration is undertaken, the caudal 10 cm of the remaining colon are separated, keeping the same blood supply, and then rotated 180°. The former cranial end is fixed at the introitus (Fig. 103.31). To prevent prolapse, the neovagina can be attached via a polypropylene mesh to the sacral os (180° colonic neovagina) [4].

The building of an omental flap is also highly recommended. The flap should retain its blood supply on the left side and should be placed ventrally to cover the colon anastomosis. It can prevent the formation of fistulae, and it also fills the empty pelvis. If the omentum is too small or has previously been resected, a polypropylene mesh can be attached to the pelvic side wall to prevent the small bowel from falling into the empty pelvis.

The colon anastomosis completes the reconstruction and should be carried out just before fixing the neovagina to the introitus. If the patient has previously undergone

irradiation or if the caudal rectum stump is shorter than 6 cm, a protective ileostoma should be performed for 6 weeks.

Even after an additional vulvectomy and/or anal extirpation, primary closure of the wound should be possible (Figs. 103.32, 103.33 and 103.34). If it is not, skin grafts from one or both thighs can be removed and rotated to cover the defect.

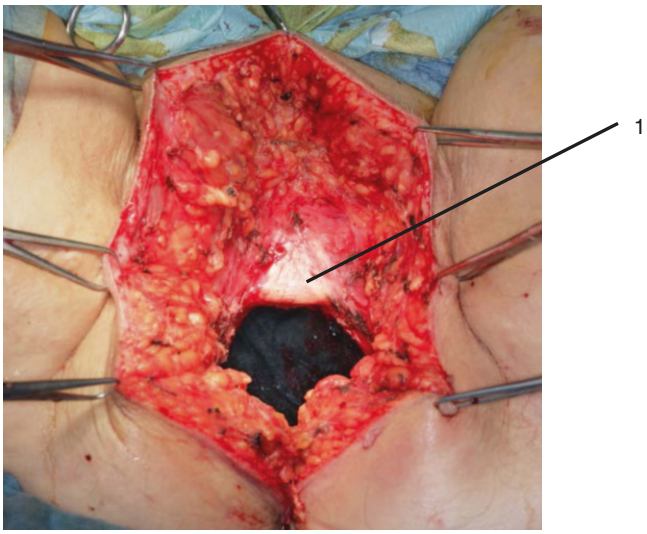


Fig. 103.33 Perineal sight after exenteration with vulvectomy and resection of the anus. *1* Symphysis



Fig. 103.34 Primary closure

Postoperative Care

Intensified care is usually needed for the first 1–2 postoperative days; afterwards the postoperative care should remain in the usual frame for patients undergoing large operations. Daily blood tests and clinical evaluation are needed. Prophylactic antimicrobial treatment is recommended for 5 days. Drains should be inspected twice daily for the color and appearance of their output. The critical period for an insufficiency of the colo-anal anastomosis is 3–5 days postoperatively. Physical training with the help of specialized personnel is recommended.

Complications

The most feared complications are septicemia, pulmonary embolism and those related to insufficiencies of the sutures in the bowel or neobladder. Eventually, relaparotomy is needed. The perioperative mortality is approximately 5 % [4-9].

Although the perioperative morbidity and mortality are not negligible, long-term survival in a considerable proportion of women with advanced or recurred gynecological cancer is possible. Due to modern reconstruction techniques, these patients can have a good quality of life.

References

1. Brunschwig A. Complete excision of pelvic viscera for advanced carcinoma. Cancer. 1948;1:177–83.
2. Bricker EM. Pelvic exenteration. Adv Surg. 1970;4:13–72.
3. Butcher Jr HR, Sugg WL, McAfee CA, Bricker EM. Ileal conduit method of ureteral urinary diversion. Ann Surg. 1962;156:682–91.
4. Schmidt AM, Imesch P, Fink D, Egger H. Indications and long-term clinical outcomes in 282 patients with pelvic exenteration for advanced or recurrent cervical cancer. Gynecol Onkol. 2012;125(3):604–9. doi:10.1016/j.ygyno.2012.03.001.
5. Matthews CM, Morris M, Burke TW, Gershenson DM, Wharton JT, Rutledge FN. Pelvic exenteration in the elderly patient. Obstet Gynecol. 1992;79(5 (Pt 1)):773–7.
6. Crowe PJ, Temple WJ, Lopez MJ, Ketcham AS. Pelvic exenteration for advanced pelvic malignancy. Semin Surg Oncol. 1999;17(3):152–60. Review
7. Berek JS, Howe C, Lagasse LD, Hacker NF. Pelvic exenteration for recurrent gynecologic malignancy: survival and morbidity analysis of the 45-year experience at UCLA. Gynecol Oncol. 2005;99(1):153–9.
8. Fotopoulou C, Neumann U, Kraetschell R, Schefold JC, Weidemann H, Lichtenegger W, Sehouli J. Long-term clinical outcome of pelvic exenteration in patients with advanced gynecological malignancies. J Surg Oncol. 2010;101(6):507–12. doi:10.1002/jso.21518.
9. Baiocchi G, Guimaraes GC, Rosa Oliveira RA, Kumagai LY, Faloppa CC, Aguiar S, Begnami MD, Soares FA, Lopes A. Prognostic factors in pelvic exenteration for gynecological malignancies. Eur J Surg Oncol. 2012;38(10):948–54.

Radical Abdominal Hysterectomy with Anterior Exenteration: Urological Perspectives

104

Siamak Daneshmand

Introduction

Radical abdominal hysterectomy with anterior exenteration (radical cystectomy) is most commonly performed by the urologist in the context of bladder cancer. In the United States, urothelial carcinoma of the bladder is the second most common malignancy of the genitourinary tract, and the second most common cause of death among all genitourinary tumors. An estimated 74,690 new cases of bladder cancer and 15,210 deaths from bladder cancer were expected in 2014 in the United States [1]. In women bladder cancer ranks as the 17th most common malignancy worldwide however it ranks 9th in developed countries [2]. Men are 2.7-times more likely to develop urothelial carcinoma in their lifetime [3]. The gender disparity may be due to differences in smoking and occupational risk factors although hormonal influences may also play a role [4]. Data is conflicting whether gender specific hormonal differences may influence UC development and prognosis [5, 6]. In general women tend to present with more advanced stage at diagnosis and have worse survival when compared to men, although recent data suggests the prognosis is similar to men in a large matched cohort [4, 7–9]. The difference in prognosis does not appear to be explained by differential under treatment or choice of therapy between sexes [10, 11].

Although about 70 % of patients with primary urothelial carcinoma of the bladder present with non-muscle-invasive tumors, up to 30 % will either present with or progress to high-grade, muscle-invasive disease. These cancers are highly lethal and are the cause of death in the vast majority of patients within 2 years of diagnosis without aggressive treatment. Approximately 70 % of patients present with localized disease, while 33 % have regional spread and 5 % have distant metastasis at the time of diagnosis [1]. Radical cystectomy with or without neoadjuvant chemotherapy is still considered the gold standard therapy for high-grade, muscle-invasive bladder cancer and high-grade non-muscle-invasive cancers deemed to be at high risk for progression or non responsive to intravesical therapy. In addition, radical cystectomy with a thorough, meticulous lymph node dissection provides accurate pathologic staging, and provides optimal outcomes in terms of survival and preventing local pelvic recurrence. Pelvic recurrence rates in patients undergoing an extended pelvic lymph node dissection range from 15 to 32 % in large institutional series [12–14].

Over the past several decades, improvements in anesthesia, surgical technique, and perioperative management have led to a decrease in perioperative morbidity and mortality. Nevertheless, radical cystectomy with pelvic lymphadenectomy remains a formidable surgery with significant early and late complications. Mortality rates, however, have decreased significantly to 2–3 % in contemporary series from centers of excellence [15]. In addition, radical cystectomy with a meticulous and thorough pelvic lymphadenectomy provides optimal local control of the tumor. Bladder substitution with an orthotopic ileal neobladder in general has excellent functional outcomes in experienced centers and may allow some patients and surgeons to consider radical cystectomy earlier in the disease process when it has the best chance of cure. Currently, most women with preserved pelvic floor function can safely undergo orthotopic lower urinary tract reconstruction to the native urethra following cystectomy [16, 17].

There have been significant refinements in the surgical technique of radical cystectomy over the past decade, particularly with respect to blood loss and preservation of the urethral rhabdosphincter and the neurovascular bundles without any compromise in oncologic principles. The surgical technique is critical in minimizing local recurrence and positive surgical margins and to maximize cancer-specific survival. Positive surgical margins and/or tumor spill during surgery put the patients at exceedingly high risk for local

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recurrence and should be avoided at all costs. Local pelvic recurrence is a lethal event in the vast majority of patients, and salvage therapies are currently ineffective [12].

There has been significant debate regarding the ideal limits of pelvic lymphadenectomy for bladder cancer over the last few decades. There is universal agreement that all patients should undergo at least a bilateral pelvic lymphadenectomy to include at least the external, internal, and obturator lymph nodes. There are abundant retrospective data suggesting that an extended pelvic and iliac lymphadenectomy including bilateral pelvic, common iliac, pre-sciatic (Fossa of Marcilles), and pre-sacral nodes increases the number of nodes identified by the pathologist and identifies more metastatic nodes in node-positive patients. At some centers the proximal limit of the dissection is further extended to include the para-caval and para-aortic nodes up to the inferior mesenteric artery.

In women, radical cystectomy is often called anterior pelvic exenteration which includes en bloc removal of the uterus, cervix, fallopian tubes, ovaries and the anterior vaginal wall [18]. A distal ureteral margin is usually sent for frozen section to ensure the absence of dysplasia or frank carcinoma although its relation to outcome is controversial [19]. The reproductive organs are removed in order to achieve negative margins and maximize oncologic control, although risk of involvement in female patients who undergo anterior pelvic exenteration for urothelial carcinoma of the bladder is less than 10 % with the vagina the most commonly involved site [20]. Patients with lower stage disease and no evidence of disease involving the anterior vaginal wall on bimanual examination preoperatively can be considered for vaginal sparing techniques, which can potentially offer better preservation of sexual function [21]. This may be in part due to preservation of the neurovascular tissue along the anterolateral vaginal wall. In addition, some studies have shown improved voiding patterns with an orthotopic urinary diversion when the vagina and uterus are spared during cystectomy, although randomized studies are lacking [22, 23]. However, most women undergoing radical cystectomy are elderly and not sexually active and performing organ preserving surgery must be weighed against the risk of compromising oncologic control. In unselected patients undergoing anterior pelvic exenteration for bladder cancer, the incidence of local invasion of the gynecological organs at the time of RC ranges from 2.6 to 7.5 % [24]. In our experience, the vagina is the most commonly involved with an incidence of 5 %, and is commonly associated with urothelial carcinoma present at the bladder base [20]. Concomitant gynecological malignancy is, however, much less common. In a large series of 609 patients undergoing anterior exenteration, none of the patients had a synchronous primary gynecological malignancy [25]. The long-term risk of cervical, uterine and ovarian cancer remains in this population and requires appropriate follow up. It should also be noted that in some women, preservation and transposition of the ovaries leads to cystic changes that may require eventual re-operation for oophorectomy [26]. Reproductive organ preserving cystectomy is best suited for younger women desiring preservation of sexual function and/or fertility and should be considered only after meticulous pre-operative staging and proper counseling.

Anatomy

The vascular anatomy of the urinary bladder is generally consistent and uniform. The primary blood supply is derived from the anterior division of the internal iliac (hypogastric) artery which in turn gives rise to the superior and inferior vesical arteries. When dissecting the ureters, preservation of the longitudinal blood supply within the peri-ureteral tissue is imperative in order to prevent uretero-intestinal anastomotic strictures. Colleselli et al., described the innervation of the urethral sphincteric mechanism in the female [27] Fibers from the pelvic nerve course along the lateral vaginal wall just posterior to the bladder to innervate the bladder neck, and fibers from the internal pudendal nerve travel underneath the endopelvic fascia to innervate the distal two-thirds of the urethra, and the rhabdoid sphincteric mechanism. If orthotopic urinary diversion (neobladder) is to be considered, it is imperative that these structures including the endopelvic fascia are preserved in order to maintain continence.

Lymph Node Drainage

The primary lymphatic drainage of the bladder is to the nodes in the true pelvis, which include the obturator, internal, and external iliac nodes. The secondary and tertiary lymphatic drainage is to the common iliac, para-caval and para-aortic nodes, respectively. The pre-sacral nodes also receive direct drainage from the trigone and posterior bladder wall and, although rare, nodal metastasis in this region may occur in the absence of disease distal to the common iliac bifurcation.

Lymph node metastases from bladder cancer tend to track to the ipsilateral nodes associated with the invasive cancer. However, node metastases contralateral to the primary site of the tumor are common and thus mandate a bilateral node dissection [28]. Up to 12 % of nodes found along the external iliac and distal common iliac vessels are located in the Fossa of Marcilles (also referred to as the pre-sciatic fossa). Complete skeletonization of the common iliac vessels and dissection in this area is important in order to remove all of the potential nodal tissue. Metastasis to common iliac and more proximal nodes in the absence of

pelvic nodal metastasis is uncommon but can occur via the posterior lymphatic collecting ducts which may drain directly to the common iliac nodes [29, 30].

Small perivesical lymph nodes lie within the perivesical fascia and intercalate within the lymphatic ductal network, organized around the trigone, anterior and posterior bladder walls. These nodes may be the only site of node metastasis, have been associated with aggressive tumor biology, and have an independent association with worse overall and disease-specific survival [31, 32].

Pre-operative Evaluation

Pre-operative evaluation includes the standard detailed history including gynecological health focusing on menopausal status, abnormal spotting, last pap smear and past gynecological procedures. We do not advocate routine cervical pap smear and transvaginal ultrasound prior to surgery given the low rates of concomitant gynecological malignancies in this population [33]. Sexual function and desire for future fertility should be documented although the vast majority of women undergoing cystectomy are beyond child-bearing ages. Staging should performed by transurethral resection of the tumor with adequate sampling of muscularis propria with specific focus on the bladder base, trigone and bladder neck. During this procedure, a bimanual examination under anesthesia must be performed, ideally before and after transurethral resection to aid in the clinical staging and identify concomitant gynecological pathology such as pelvic organ prolapse. A palpable tumor would designate clinical T3 disease and strong consideration should be made for neoadjuvant therapy in this setting. Imaging should include a CT scan of the chest, abdomen and pelvis with IV contrast whenever possible to rule out metastatic disease. It should be noted that clinical understaging remains a significant issue in bladder cancer management. Various clinico-histopathologic features such as lymphovascular invasion, presence of hydronephrosis, variant histology, and deep muscularis propria invasion substantially increase the risk of upstaging. Laboratory evaluation should include routine blood counts and comprehensive metabolic panels to include liver function tests and serum alkaline phosphatase. There are no specific tumor markers for bladder cancer although carbonic anhydrase 19–9 has been shown to have independent prognostic value when elevated [34]. Bone scintigraphy is not routinely used to screen for bone metastases unless there is an elevation of alkaline phosphatase or presence of bone pain [35]. Positron emission tomography combined with CT is not routine used although it may identify patients with locally advanced bladder cancer and identify occult metastases [36–38]. False positives and the excretion of the FDG tracer into the urinary tract limit its utility however.

Perioperative Management

Many patients undergoing cystectomy have significant comorbidities often related to long-term tobacco use. Preoperative evaluation and optimization of cardiac and pulmonary function are crucial in risk assessment and reducing post-operative complications. Cardiac clearance is obtained for most patients with a cardiac history with appropriate stress testing. Pulmonary function testing is not routinely performed unless a decision has to be made regarding the suitability of the patient for the surgery. Mechanical and antibiotic bowel preparations have been traditionally recommended in order to cleanse the bowel for urinary diversion, however this practice may lead to dehydration, alteration of normal bowel flora, and electrolyte disturbances. Retrospective studies have shown that the elimination of bowel preparation prior to radical cystectomy shows no difference in perioperative outcomes, including gastrointestinal complications [39, 40]. In addition, a meta-analysis performed to investigate the effect of bowel preparation in reducing the incidence of post-operative complications in patients undergoing elective colorectal procedures showed no differences in the rates of mortality, reoperation, peritonitis, and wound infection [41].

Nasogastric (NG) decompression is also commonly used post-operatively following cystectomy in an attempt to decompress the stomach, prevent emesis and aspiration, and to minimize the risk of bowel anastomotic leak or dehiscence. However, data suggest that NG tube decompression is unnecessary and may, in fact, *increase* complication rates [42]. Donat et al. described an overnight-only NG tube (NGT) with use of metoclopramide, demonstrating the benefits of an early return of bowel function and reduced pulmonary complications [43]. In a study including 430 patients, Inman et al. demonstrated prolonged NGT decompression was associated with prolonged time to GI recovery. Omission of NGT in these patients was associated with a shorter time to return of flatus and a reduced length of stay [44]. Numerous other studies including general surgery cases in addition to radical cystectomy have shown that bowel resection can be safely performed without the use of post-operative NGT decompression [45, 46]. A meta-analysis involving 26 trials including nearly 4000 patients established the non-necessity of routine NGT decompression by demonstrating a higher incidence of pulmonary complications with no clinical benefits such as reduction in gastrointestinal complications or length of stay [47].

Fasting and adherence to a clear liquid diet prior to surgery has long been the dogmatic approach to a patient undergoing surgery requiring bowel resection. In response to fasting, however, insulin resistance can develop and, in fact, increase post-operative complications. Pre-operative carbohydrate loading has been shown to play an important

role in decreasing hospital stay and in recovery after elective bowel surgery. Pre-operative administration of oral carbohydrate energy-containing fluids can help reduce insulin resistance and has been associated with a reduced length of stay following elective surgery [48].

Use of perioperative opioids for pain control is a significant contributor to post-operative ileus. Opioid receptors are distributed throughout the gastrointestinal tract, and most opiates have mu receptor activity that inhibits gastric motility and delays emptying [49]. Alvimopan is a mu-opioid receptor antagonist that has been shown in multiple randomized trials to accelerate the return of bowel function following bowel resection. Results from five multi-center, double-blind randomized placebo-controlled trials including 1877 patients, as well as a meta-analysis of three of the trials including a pooled modified intention-to-treat population of 1388 patients have documented the benefits of Alvimopan in reducing time to bowel recovery and hospital discharge in patients undergoing abdominal surgery [50]. A recent phase IV double-blind, placebo-controlled study involving the use of Alvimopan in patients undergoing radical cystectomy for bladder cancer confirmed the benefits by demonstrating quicker bowel recovery and shorter hospital stays compared with those who received placebo. There were significantly fewer episodes of post-operative ileus in the Alvimopan group (8.4 vs 29.1 %; $p<0.001$) with no increase in adverse effects [51].

We have adopted an evidence-based multimodal care pathway (commonly referred to as ERAS-enhanced recovery after surgery) aimed at providing optimal perioperative care for all patients undergoing radical cystectomy (Fig. 104.1). The goal of this protocol is to minimize perioperative gastrointestinal complications and reduce hospital stay while improving the perioperative experience. We have demonstrated a significant decrease in length of hospital stay with this protocol from a median of 8 days down to 4 days [52]. Given the evidence against the use of bowel preparation, and the potential for increasing complications, we have omitted all bowel preparation prior to surgery unless there is a preoperative plan for using the colon for continent cutaneous diversion. A high-protein, high-carbohydrate liquid drink is recommended for a few days prior to surgery, without any recommendation for withholding intake the day prior to surgery, i.e. a regular diet is maintained up to the night prior to

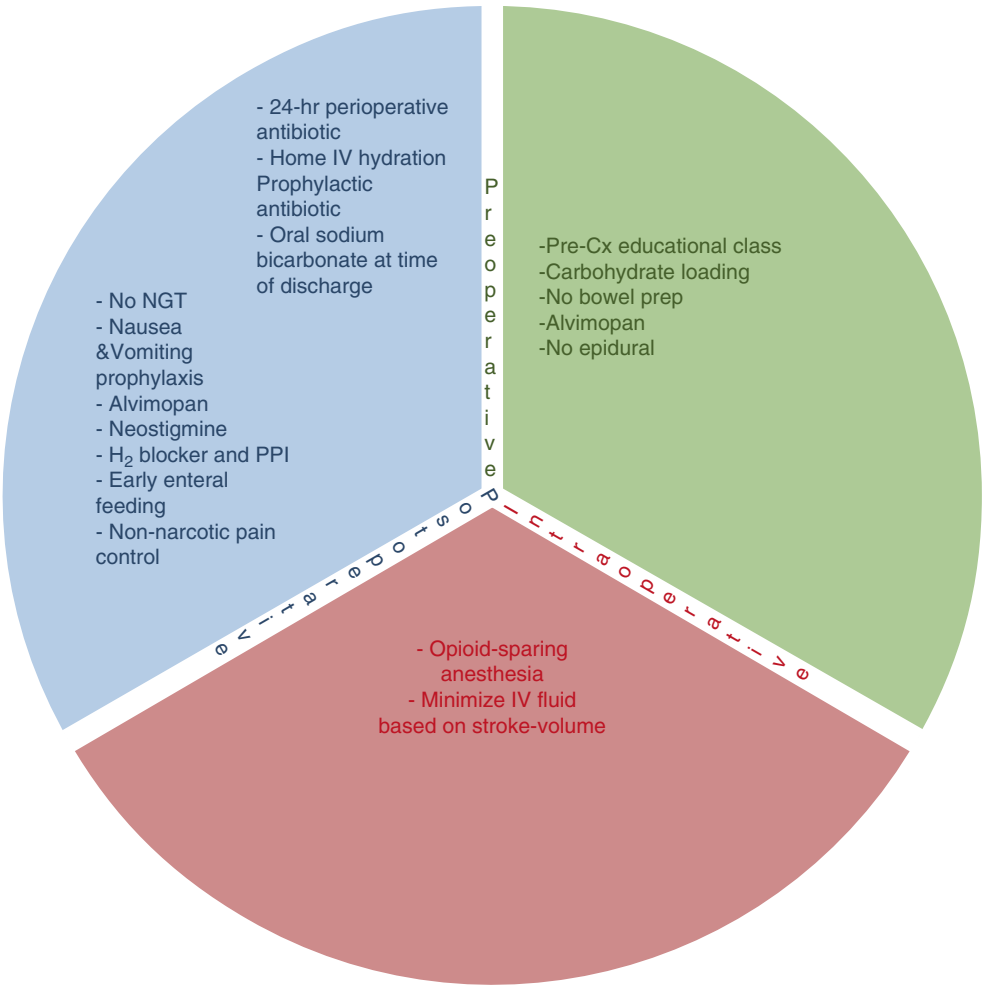


Fig. 104.1 Peri-operative management protocol for patients who undergo radical cystectomy and urinary diversion reconstruction for bladder cancer

surgery. A pre-operative counseling session as well as educational classes aimed at detecting psychosocial barriers that may impede early recovery can help improve outcomes with this surgery. Standardized pre-operative educational classes may also provide a platform for improvement of patient compliance and understanding of the post-operative milestones required prior to discharge. Alvimopan is given in the pre-operative holding area 30–60 min prior to the operation. Subcutaneous heparin is given in the pre-operative holding area for thromboprophylaxis. Our enterostomal therapy nurse marks all patients for a stoma in cases of cutaneous incontinent diversion.

Intraoperatively, blood loss and bowel manipulation are kept to a minimum. Fluid intake is minimized while the ureters are clipped. Intravenous acetaminophen acetate and ketorolac are started intraoperatively if there are no contraindications, and opioid use is kept to a minimum. An orogastric tube (if used) is removed at the conclusion of surgery and the patient is then transferred to the ward on telemetry unless there is any indication for admission to ICU.

Patient Positioning

Patients are placed in a frog leg position to allow access to the vagina intraoperatively. The patient is hyperextended to allow better exposure to the pelvis, with care being taken to protect the arms and adequately pad all sensitive areas. The patient is placed in a reverse Trendelenburg position to level the abdominal wall parallel to the floor, which helps keep some of the small bowel contents within the abdominal cavity. Arterial and central lines are placed as necessary and an orogastric tube is placed which is removed at the conclusion of the case. The patient is prepped per routine guidelines and the vagina is fully prepped. After draping, a Foley catheter is placed in the bladder and left to gravity drainage. A right-handed surgeon usually stands on the patient's left-hand side of the operating table.

Incision and Intra-abdominal Exposure

The pelvic organs are generally accessed through an infraumbilical midline incision. The anterior rectus fascia is incised and the rectus muscles are retracted laterally. The posterior rectus fascia is incised, the peritoneal cavity is entered and self-retaining retractors are placed. Manual palpation of the pelvis and retroperitoneum is performed to look for palpable lymphadenopathy and to make sure the bladder is not fixed to the pelvic sidewalls. Next, the posterior peritoneum is incised, taking down the peritoneal attachments to the small bowel mesentery. The right colon is not mobilized, unless a continent cutaneous reservoir using the colon is planned. It may be necessary to mobilize the mesentery of the terminal ilium in order to allow maximal mobility for neobladder reconstruction. The rectosigmoid is mobilized along the avascular line of Toldt and its mesentery is elevated off the sacral promontory up to the level of the inferior mesenteric artery (IMA) in order to allow the left ureter to pass easily to the right side and to expose the lower retroperitoneum for the extended lymphadenectomy. The ureters are dissected into the deep pelvis where they are clipped and divided with the distal circumferential tip sent for frozen sections analysis. Next, the small bowel is packed into the abdomen using lap pads and retractors.

Pelvic Lymphadenectomy

As previously mentioned, a meticulous pelvic lymph node dissection is a critical part of the procedure. It should be noted that this is not a lymph node 'sampling' procedure but rather an extensive removal of all lymphatic bearing tissues around the vessels which should be skeletonized whenever possible. The extended pelvic lymph node dissection is initiated approximately 3 cm above the aortic bifurcation at the level of the inferior mesenteric artery (superior limit of dissection). The dissection extends laterally over the aorta and vena cava to the genitofemoral nerve on either side, which represents the lateral limits of dissection. The para-aortic and para-caval nodal tissue is removed and the proximal tissue is clipped, with care being taken not to dissect too deeply in the interaortocaval area. Frequently, small anterior tributary veins originate from the vena cava just above the bifurcation, which should be clipped and divided. Hemoclips are generally used at the superior, inferior and lateral limits of the dissection while the rest of the vessels are circumferentially skeletonized. The infundibulopelvic ligament containing the ovarian vessels are ligated and divided in order to include the ovaries with the specimen.

Next, all fibroareolar and lymphatic tissue is peeled off the common iliac arteries with the dissection extending out laterally to the genitofemoral nerve and then sweeping medially down over the sacral promontory into the hollow of the sacrum. The genitofemoral nerve is preserved although small branches that course more medially that are intimately associated with the iliac arteries are excised. Care must be taken to avoid injury to the left common iliac vein, which courses directly posterior to the right common iliac artery. The sacral promontory is skeletonized and the presacral nodes are removed. The left median sacral vein drains into the left common iliac vein and must be recognized and often clipped to avoid avulsion during removal of the pre-sacral nodes.

Once the proximal portion of the lymph node dissection is completed, a finger is passed under the peritoneum proximally over the external iliac artery and vein distally to

the femoral canal. The opposite hand is used to connect with the proximal dissection from above and the peritoneum is divided lateral to the infundibulo-pelvic ligament and the round ligament is clipped and divided. The external iliac artery and vein are then circumferentially mobilized, freeing up all of the lymph node bearing tissue to join up with the proximal limits of dissection over the common iliac vessels. Care must be taken to recognize and ligate an accessory obturator vein, which originates from the inferomedial aspect of the external iliac vein in approximately 40 % of patients. There is often a psoas branch arising from the lateral aspect of the proximal external iliac artery, which must be clipped and divided. The distal limits of the dissection are the circumflex iliac vein crossing anterior to the external iliac artery distally, the genitofemoral nerve laterally, and the lymph node of Cloquet situated on Cooper's ligament medially. The lymph node of Cloquet (also known as node of Rosenmüller) is removed and the iliac vessels are carefully retracted medially in order to clear the obturator fossa. This can be facilitated by passing a small gauze sponge lateral to the vessels along the pelvic sidewall taking care to stay anterior to the internal iliac vein. The external iliac vessels can then be retracted laterally and the sponge is brought medially and removed. Care however must be taken not to avulse deep venous branches, which can be the source of significant bleeding. Small tributary vessels and lymphatics from the sidewall are clipped and the hypogastric artery is skeletonized while the obturator/internal iliac nodes are removed. The obturator vessels are generally not divided and are dissected proximally to the internal iliac vessels. Finally the fossa of Marcille (lateral to the common iliac vessels) is dissected and the lumbosacral branch of the sciatic nerve is identified. The lymphatic tissue is sent as separate packets and includes the para-aortic, para-caval, the common iliacs, presacral nodes, external iliacs, the pre-sciatic nodes (fossa of Marcilles) and the obturator/internal iliac nodes (Fig. 104.2a, b).

The Lateral and Posterior Bladder Pedicles

After skeletonizing the proximal internal iliac artery and vein, the lateral vascular pedicle of the bladder and uterus is stretched, clipped and divided down to the area of the

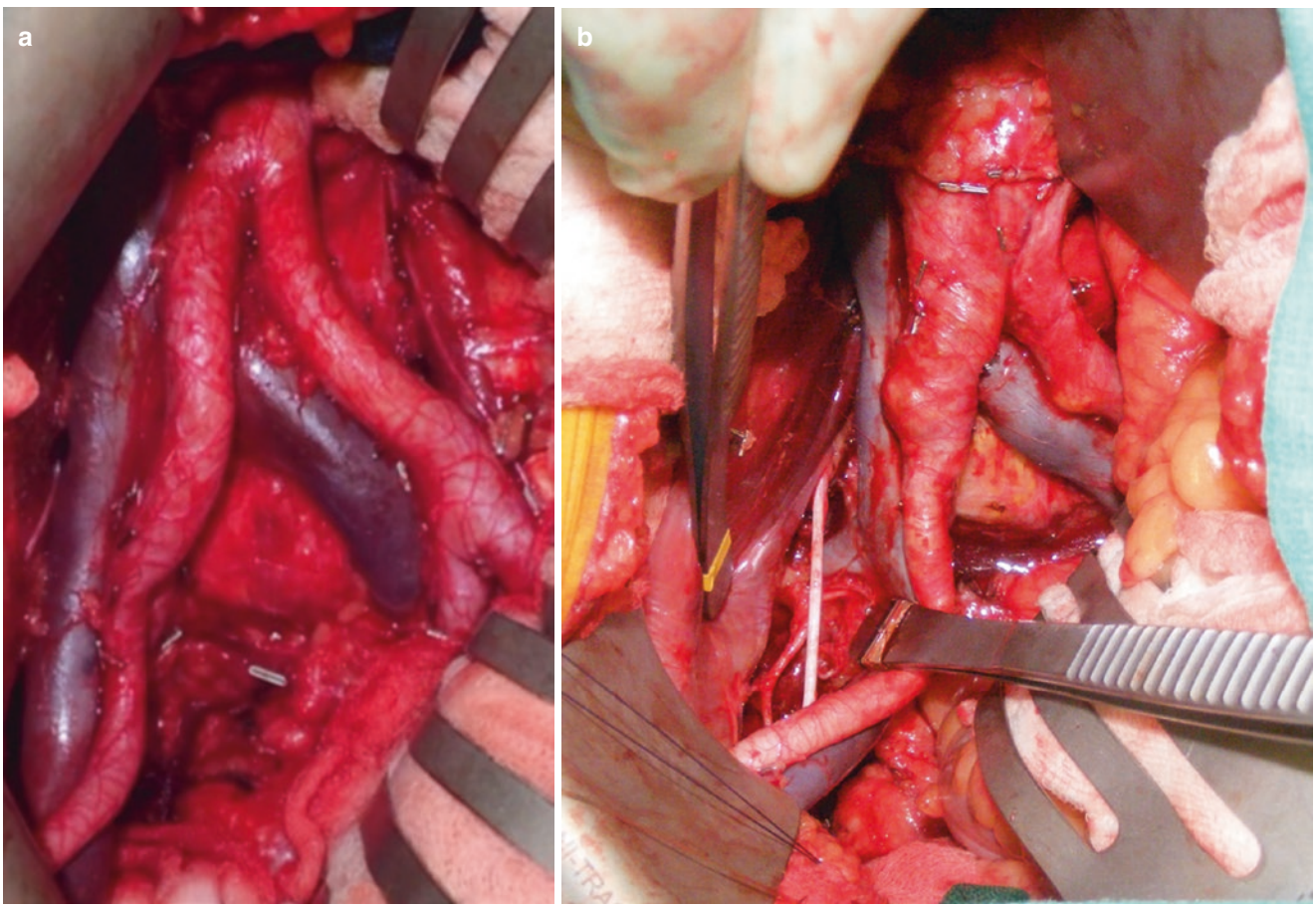


Fig. 104.2 Completion of an extended pelvic lymph node dissection for bladder cancer (**a**) Nodal packet includes the para-aortic, para-caval, common iliac, external iliac, internal iliac/obturator fossa, presacral as well as pre-sciatic nodes (within the Fossa of Marcille, **b**)

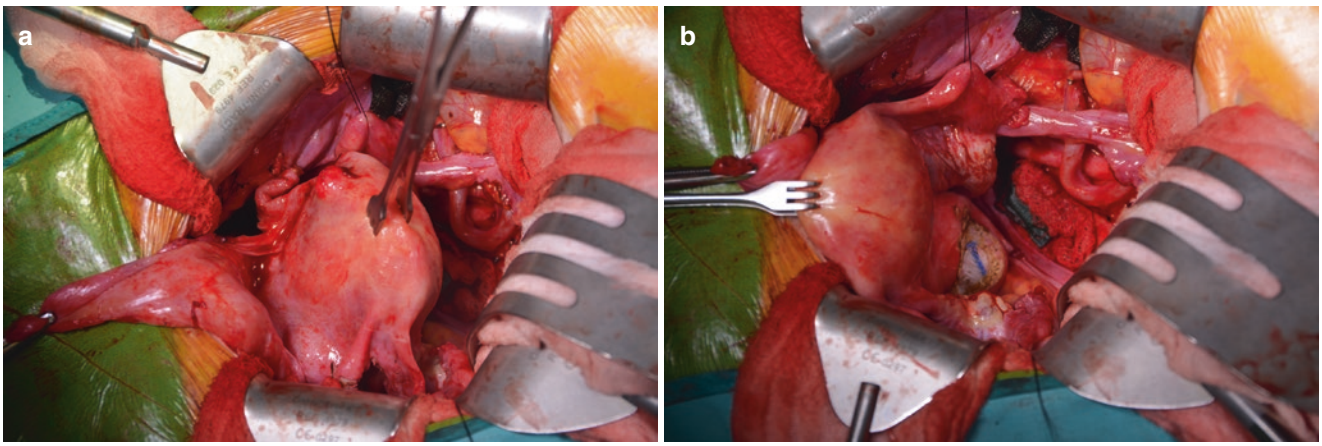


Fig. 104.3 (**a**) The uterus is grasped with forceps and lifted anteriorly. (**b**) A lubricated sponge stick is placed in the vagina and directed cephalad to allow precise identification of the apex of the vagina which can now be incised

endopelvic fascia. The uterus is grasped with a tenaculum and lifted anteriorly along with the bladder in order to align the lateral pedicle with identification of individual branches off the anterior branch of the internal iliac artery (Fig. 104.3a). The first branch to the bladder (the superior vesical artery) is clipped and divided which the rest of the branches of the lateral pedicle including the uterine artery and vaginal artery can be ligated using a tissue sealant device.

Posterior Dissection

A lubricated sponge stick is placed in the vagina and directed cephalad to allow precise identification of the apex of the vagina. The incision is made at the apex of the vagina just distal to the cervix (Fig. 104.3b) The cardinal ligaments are taken down and the vaginal wall is then circumferentially incised and the cervix, along with the uterus, fallopian tubes and ovaries are included in the specimen (Fig. 104.4). The tissue sealant device is then used to divide the anterior vaginal wall which is included in the specimen unless a vaginal-sparing technique is being performed (Fig. 104.5). If the bladder tumor is not located posteriorly or at the trigone, a vaginal sparing approach may be performed by developing the plane between the anterior vaginal wall and the posterior bladder. It is critical to avoid entry into the bladder or end up with a positive margin during this maneuver since there is no natural fascial plane between the bladder and the vagina. If there is copious fat lateral to the vagina, this can first be ligated with the tissue sealant device. This aids with the precise identification of the lateral wall of the vagina and also significantly reduces blood loss. However, if a nerve sparing technique is to be performed, then care must be taken to preserve that neurovascular bundle that course on the lateral aspect of the vaginal wall. A meticulous dissection along the lateral vaginal walls, bladder neck and proximal urethra is necessary to preserve these nerves and the use of electrocautery should be minimized. Nerve-sparing techniques typically go hand in hand with a vaginal sparing cystectomy. The dissection is carried just distal to the vesicourethral junction. Palpation of the Foley catheter balloon assists in identifying the bladder neck/urethral junction (Fig. 104.6) In the case of orthotopic diversion the plane between the anterior vaginal wall and the urethra is bluntly developed. The distal urethra is left intact along with the endopelvic fascia and the urethral support mechanism (Fig. 104.7a) The catheter can at this point be removed and the bladder neck clamped and divided. A total of 8–10 urethral sutures are placed circumferentially around the urethra for later neobladder anastomosis. The vaginal cuff is closed in 2 layers using 2-0 Vicryl and then pexed to the sacral promontory (sacrocolpopexy) using a soft prolene mesh using permanent suture to prevent an enterocele (Fig. 104.7b). In case of a posterior tumor, the anterior vagina is divided using the tissue sealant device and included en bloc with the specimen (Fig. 104.8). The urethra can still be preserved in these cases and orthotopic diversion is possible as long as the rhabdosphincter complex is kept intact. In these cases, the vagina is usually reconstructed by a clam shell or side to sided technique with absorbable sutures. A well-vascularized omental pedicle graft is mobilized off the colon based on the left gastroepiploic artery and secured anterior to the reconstructed vagina to prevent fistulization (Fig. 104.9). If a continent cutaneous diversion or ileal conduit is planned, the urethra can be removed en bloc by dividing the pubourethral ligaments and taking down the endopelvic fascia. The anterior vaginal wall is dissected further distally and incised around the urethral meatus. The vaginal cuff is closed as previously described. Alternatively the urethra can be dissected transvaginally to meet up with the dissection from the pelvis. In rare cases of concomitant bilateral upper tract involvement or previous renal transplant, the entire genitourinary tract can be removed en bloc (Fig. 104.10).

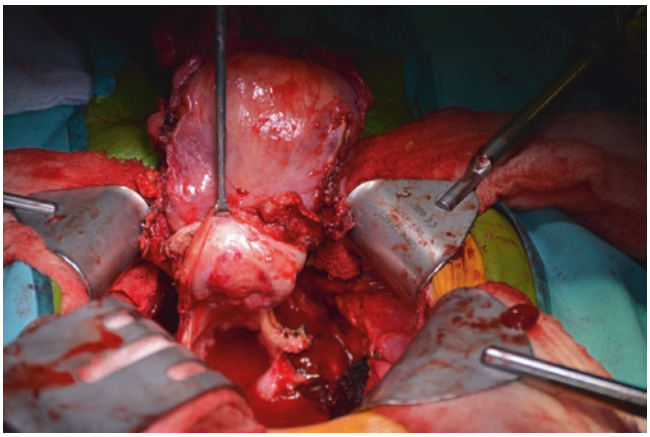


Fig. 104.4 The incision is made at the apex of the vagina just distal to the cervix. A tissue sealant device can now be used laterally to include the anterior vaginal wall with the specimen

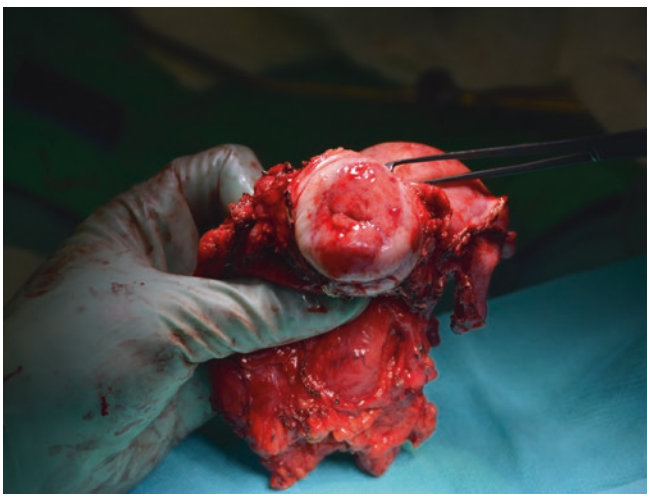


Fig. 104.5 Vaginal Sparing Specimen including bladder, uterus, fallopian tubes, ovaries and cervix

Urethra

A concomitant urethrectomy is typically performed with the anterior pelvic exenteration unless an orthotopic diversion is planned. In the past it was believed that the retained female urethra was insufficient to maintain continence and there were concerns about possible urethral recurrence. However ongoing anatomic and clinical evidence proved that excellent functional results can in fact be achieved with preservation of the urethra and the surrounding support structures [53].

Two important pathologic studies were critical to understanding of urethral preservation in female patients undergoing anterior exenteration for urothelial carcinoma. In a

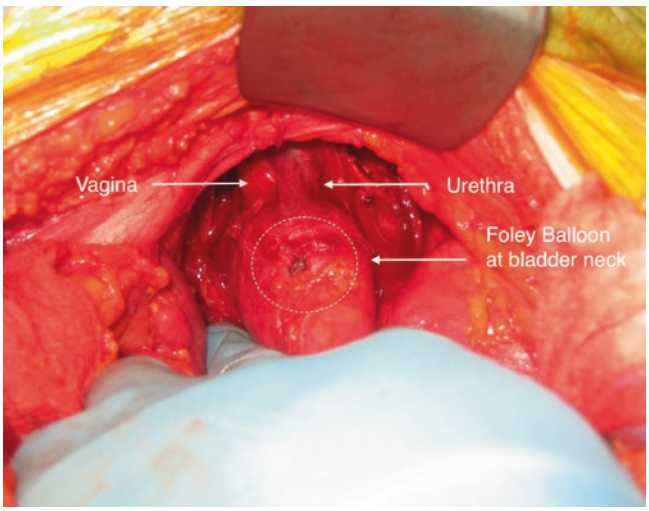


Fig. 104.6 Figure showing the anatomic relationship at the bladder neck. Precise identification of the bladder neck/urethral margin is critical in preservation of the sphincter mechanism in case of orthotopic urinary diversion

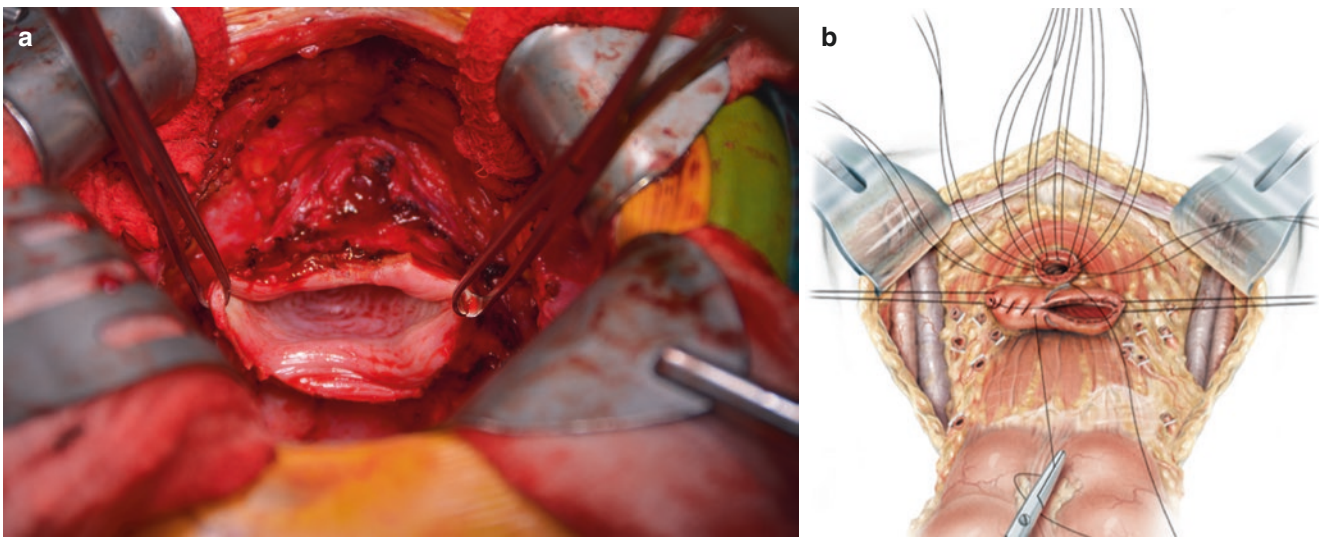


Fig. 104.7 (**a**) Urethral and vaginal sparing anterior pelvic exenteration in preparation for orthotopic ileal neobladder reconstruction. (**b**) Once the specimen is removed, the vaginal cuff is closed in two layers using 2-0 Vicryl and 8–10 urethral anastomotic sutures are placed. The vaginal cuff is then anchored to the sacral promontory (sacrocolpopexy) using a piece of soft Prolene mesh to prevent prolapse (From Stein and Skinner [67], with permission)

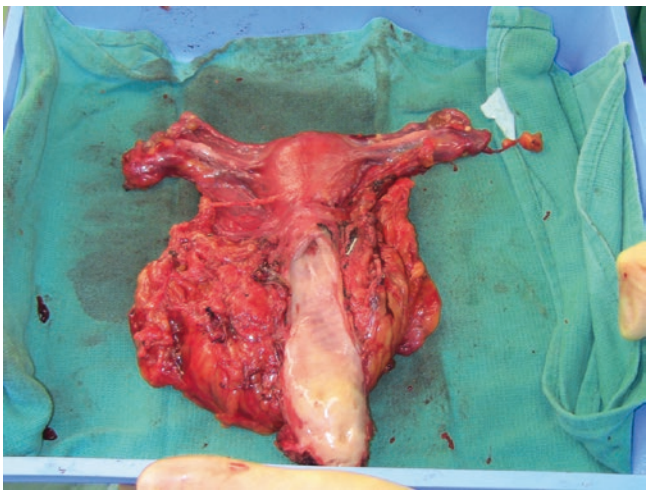


Fig. 104.8 En bloc anterior pelvic exenteration with anterior vaginectomy in a patient with tumor at the posterior bladder wall

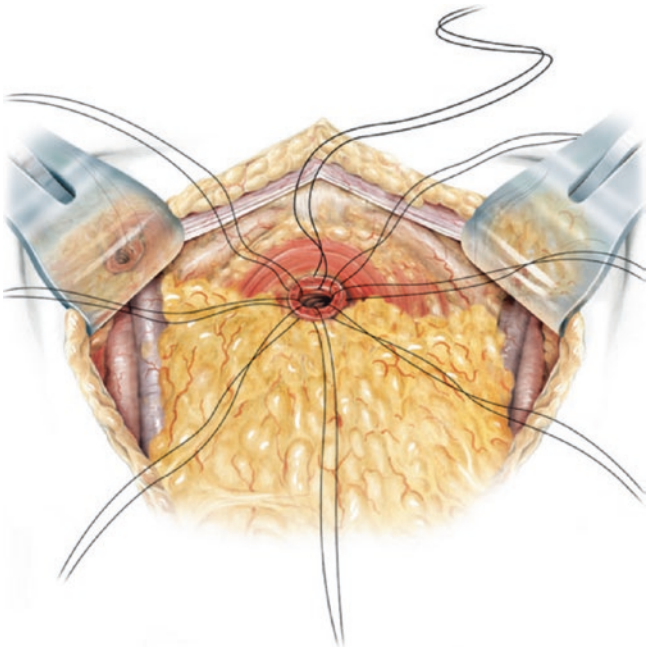


Fig. 104.9 In case of orthotopic urinary diversion the omentum is mobilized based on the left gastroepiploic pedicle and placed over the reconstructed vagina and secured to surrounding tissue in order to prevent a neobladder-vaginal fistula (From Stein and Skinner [67]. With permission)

series of 67 female patients undergoing cystectomy with urethrectomy for bladder cancer, Stein et al. re-evaluated the primary pathologic specimens and found 17 (25 %) had involvement of the bladder neck while 9 (13 %) of them had urethral involvement. All patients who did not have bladder neck involvement also had no urethral involvement whereas approximately 50 % of patients with a bladder neck tumor had concomitant urethral tumor involvement. The major risk favor for the presence of urethral tumor was found to be



Fig. 104.10 En bloc resection of the genitourinary tract in patient with urothelial carcinoma of bilateral upper tracts and the bladder. Specimen includes both kidneys, ureters, uterus, fallopian tubes, ovaries, bladder, anterior vagina and urethra

vaginal wall involvement, albeit rare (1 %) [53]. The presence of vaginal wall invasion is best evaluated on bimanual examination under anesthesia, either at transurethral resection or at cystectomy. Stenzl and colleagues also studied the risk of synchronous or secondary urethral tumors with long-term follow-up in 356 women with bladder cancer of all stages. Urethral involvement was only found in 2 % of the patients, and it was always associated with bladder neck involvement. Of the patients with cT2–T4 localized disease only 1 % had urethral involvement. The conclusion from these studies was that the urethra can be safely preserved in patients who have no involvement of the bladder neck [54].

In a prospective study aimed to identify appropriate female candidates for orthotopic urinary diversion, Stein et al. examined the final pathologic analysis of the bladder neck and proximal urethra and compared it with the intraoperative frozen-section analysis of the proximal urethral margin. Tumor involvement at the bladder neck and proximal urethra was found in 14 (19 %) and 5 (7 %) cystectomy specimens, respectively. All patients with urethral tumor also had concomitant bladder neck tumor as previously seen.

Bladder neck tumor involvement was again found to be the most significant risk factor for tumor involving the urethra. However, approximately half of patients with bladder neck tumors had a normal proximal urethra and none of the patients with normal bladder neck pathology had urethral involvement. In all cases, intraoperative frozen-section analysis of the proximal urethra correlated with and was correctly confirmed by final permanent section [55]. These results confirmed that intraoperative frozen section analysis of the proximal urethra can rule out urethral involvement and determine the eligibility for orthotopic diversion.

In the study examining the clinical follow-up data of the first 88 women undergoing orthotopic diversion at University of Southern California, there were no urethral recurrences observed with a median follow-up of 30 months [56]. In a similar study Ali el Dein et al. prospectively evaluated 145 women undergoing cystectomy and orthotopic diversion. Two patients developed urethral recurrence. One had a primary squamous cell cancer of the bladder, and the other had urothelial carcinoma with carcinoma in situ of the trigone [25, 57]. In a recently published multi-institutional study of 297 women undergoing radical cystectomy with ileal neobladder for bladder cancer at four centers, solitary urethral recurrence was seen in only 2 patients (0.6 %). Urethral recurrence was associated with a positive final urethral margin whereas no significant associations were found for carcinoma in situ, pathologic tumor and nodal stage, and bladder trigone involvement [58].

Detailed understanding of the urethral and pelvic anatomy is critical to preservation of sphincteric function if orthotopic diversion is planned. Knowledge of the rhabdosphincter complex was derived from elegant neuroanatomic studies of the female urethra. Colleselli and colleagues performed extensive microneuroanatomic dissections, histologic examination, and three-dimensional reconstructive imaging to better define the urethral sphincteric and rhabdosphincteric anatomy in women. The female urethral sphincter system consists of smooth muscle innervated by the autonomic nervous system and striated muscle supplied by somatic nerves. The autonomic nerves that emerge from the pelvic plexus course along the lateral aspect of the rectum and vagina to innervate the bladder neck and proximal urethra, however these nerves do not appear to play a significant role in the innervation of the actual rhabdosphincter that is responsible for the continence mechanism [27]. Most investigators agree that the rhabdosphincter is supplied primarily by the branches of the pudendal nerve [27, 59].

Complications

Many of the complications following anterior pelvic exenteration with urinary diversion are related to bowel complications. Each form of diversion carries a unique set of complications but all share similar changes in bowel habits such as chronic constipation and chance of bowel obstruction. Sexual dysfunction is common following anterior exenteration and includes diminished ability or inability to achieve orgasm, decreased lubrication, decreased sexual desire, and dyspareunia. Only half of the patients report being able to have successful vaginal intercourse with 52 % reporting decreased satisfaction with overall sexual function [60]. This is most likely a result of damage to the neurovascular bundles that course along the lateral vaginal wall [61]. Nerve sparing and reproductive organ sparing techniques however aim to preserve sexual function and satisfaction [21]. Sexual dysfunction however can be multi-factorial and choice of urinary diversion following anterior exenteration can have a significant impact on health related quality of life. Some studies demonstrate improved sexual function following orthotopic urinary diversion while others have shown no difference [62, 63].

Other complications include bowel vaginal fistulas particularly with neobladders where there could be overlapping suture lines. Rates of neobladder vaginal fistulas range from 3 to 5 % and may be diminished by placement of a pedicalized omental flap between the neobladder and vagina [64]. Preservation of the anterior vaginal wall and pubo-urethral ligaments also likely decreases the likelihood of anterior vaginal wall descent [65]. Concomitant fixation of the posterior vaginal wall to the sacrum (sacrocolpopexy) using mesh may further decrease the chance of prolapse and enterocele [66]. Other more rare complications include ureterovaginal fistulas and vaginal mesh erosion.

Conclusion

Anterior pelvic exenteration with a thorough pelvic lymph node dissection and subsequent urinary diversion remains a challenging operation with considerable morbidity. Surgical technique along with surgeon and hospital experience is critical in optimizing clinical outcomes. The surgery still provides the best survival rate with the lowest chance of local recurrence for high-grade invasive bladder cancer. Further refinement in identification of candidates for female organ preserving surgery may reduce complication rates and improve health related quality of life.

References

1. Siegel R, Ma J, Zou Z, Jemal A. Cancer statistics, 2014. CA Cancer J Clin. 2014;64(1):9–29.
2. Ferlay J, Shin HR, Bray F, Forman D, Mathers C, Parkin DM GLOBOCAN 2008. Cancer incidence and mortality worldwide: IARC CancerBase No.10 [Internet]. 2010. 16 Sept 2014. Available from: http://globocan.iarc.fr.
3. Hartge P, Harvey EB, Linehan WM, Silverman DT, Sullivan JW, Hoover RN, et al. Unexplained excess risk of bladder cancer in men. J Natl Cancer Inst. 1990;82(20):1636–40.

4. Mungan NA, Aben KK, Schoenberg MP, Visser O, Coebergh JW, Witjes JA, et al. Gender differences in stage-adjusted bladder cancer survival. Urology. 2000;55(6):876–80.
5. Cantwell MM, Lacey Jr JV, Schairer C, Schatzkin A, Michaud DS. Reproductive factors, exogenous hormone use and bladder cancer risk in a prospective study. Inter J Cancer J Inter du Cancer. 2006;119(10):2398–401.
6. Davis-Dao CA, Henderson KD, Sullivan-Halley J, Ma H, West D, Xiang YB, et al. Lower risk in parous women suggests that hormonal factors are important in bladder cancer etiology. Cancer Epidemiol Biomark Prev. 2011;20(6):1156–70.
7. Mitra AP, Skinner EC, Schuckman AK, Quinn DI, Dorff TB, Daneshmand S. Effect of gender on outcomes following radical cystectomy for urothelial carcinoma of the bladder: a critical analysis of 1,994 patients. Urol Oncol. 2014;32(1):52e1–9.
8. Cardenas-Turanzas M, Cooksley C, Pettaway CA, Sabichi A, Grossman HB, Elting L. Comparative outcomes of bladder cancer. Obstet Gynecol. 2006;108(1):169–75.
9. Tilki D, Svatek RS, Karakiewicz PI, Isbarn H, Reich O, Kassouf W, et al. Characteristics and outcomes of patients with pT4 urothelial carcinoma at radical cystectomy: a retrospective international study of 583 patients. J Urol. 2010;183(1):87–93.
10. Schrag D, Mitra N, Xu F, Rabbani F, Bach PB, Herr H, et al. Cystectomy for muscle-invasive bladder cancer: patterns and outcomes of care in the Medicare population. Urology. 2005;65(6):1118–25.
11. Konety BR, Joslyn SA. Factors influencing aggressive therapy for bladder cancer: an analysis of data from the SEER program. J Urol. 2003;170(5):1765–71.
12. Mitra AP, Quinn DI, Dorff TB, Skinner EC, Schuckman AK, Miranda G, et al. Factors influencing post-recurrence survival in bladder cancer following radical cystectomy. BJU Int. 2012;109(6):846–54.
13. Yafi FA, Aprikian AG, Fradet Y, Chin JL, Izawa J, Rendon R, et al. Surveillance guidelines based on recurrence patterns after radical cystectomy for bladder cancer: the Canadian Bladder Cancer Network experience. BJU Int. 2012;110(9):1317–23.
14. Baumann BC, Guzzo TJ, He J, Vaughn DJ, Keefe SM, Vapiwala N, et al. Bladder cancer patterns of pelvic failure: implications for adjuvant radiation therapy. Int J Radiat Oncol Biol Phys. 2013;85(2):363–9.
15. Quek ML, Stein JP, Daneshmand S, Miranda G, Thangathurai D, Roffey P, et al. A critical analysis of perioperative mortality from radical cystectomy. J Urol. 2006;175(3 Pt 1):886–9; discussion 9–90.
16. Lee RK, Abol-Enein H, Artibani W, Bochner B, Dalbagni G, Daneshmand S, et al. Urinary diversion after radical cystectomy for bladder cancer: options, patient selection, and outcomes. BJU Int. 2014;113(1):11–23.
17. Daneshmand S, Bartsch G. Improving selection of appropriate urinary diversion following radical cystectomy for bladder cancer. Expert Rev Anticancer Ther. 2011;11(6):941–8.
18. Marshall FF, Treiger BF. Radical cystectomy (anterior exenteration) in the female patient. Urol Clin North Am. 1991;18(4):765–75.
19. Satkunasivam R, Hu B, Daneshmand S. Is frozen section analysis of ureteral margins at time of radical cystectomy useful? Curr Urol Rep. 2015;16(6):38.
20. Djaladat H, Bruins HM, Miranda G, Cai J, Skinner EC, Daneshmand S. Reproductive organ involvement in female patients undergoing radical cystectomy for urothelial bladder cancer. J Urol. 2012;188(6):2134–8.
21. Bhatt A, Nandipati K, Dhar N, Ulchaker J, Jones S, Rackley R, et al. Neurovascular preservation in orthotopic cystectomy: impact on female sexual function. Urology. 2006;67(4):742–5.
22. Hautmann RE, Paiss T, de Petriconi R. The ileal neobladder in women: 9 years of experience with 18 patients. J Urol. 1996;155(1):76–81.
23. Blute ML, Gburek BM. Continent orthotopic urinary diversion in female patients: early Mayo Clinic experience. Mayo Clin Proc. 1998;73(6):501–7.
24. Chang SS, Cole E, Smith Jr JA, Cookson MS. Pathological findings of gynecologic organs obtained at female radical cystectomy. J Urol. 2002;168(1):147–9.
25. Ali-El-Dein B, Abdel-Latif M, Mosbah A, Eraky I, Shaaban AA, Taha NM, et al. Secondary malignant involvement of gynecologic organs in radical cystectomy specimens in women: is it mandatory to remove these organs routinely? J Urol. 2004;172(3):885–7.
26. Sella T, Mironov S, Hricak H. Imaging of transposed ovaries in patients with cervical carcinoma. AJR Am J Roentgenol. 2005;184(5):1602–10.
27. Colleselli K, Stenzl A, Eder R, Strasser H, Poisel S, Bartsch G. The female urethral sphincter: a morphological and topographical study. J Urol. 1998;160(1):49–54.
28. Roth B, Wissmeyer MP, Zehnder P, Birkhauser FD, Thalmann GN, Krause TM, et al. A new multimodality technique accurately maps the primary lymphatic landing sites of the bladder. Eur Urol. 2010;57(2):205–11.
29. Leissner J, Ghoneim MA, Abol-Enein H, Thuroff JW, Franzaring L, Fisch M, et al. Extended radical lymphadenectomy in patients with urothelial bladder cancer: results of a prospective multicenter study. J Urol. 2004;171(1):139–44.
30. Vazina A, Dugi D, Shariat SF, Evans J, Link R, Lerner SP. Stage specific lymph node metastasis mapping in radical cystectomy specimens. J Urol. 2004;171(5):1830–4.
31. Hu B, Satkunasivam R, Schuckman A, Sherrod A, Cai J, Miranda G, et al. Significance of perivesical lymph nodes in radical cystectomy for bladder cancer. Urol Oncol. 2014;32(8):1158–65.
32. Bella AJ, Stitt LW, Chin JL, Izawa JI. The prognostic significance of metastatic perivesical lymph nodes identified in radical cystectomy specimens for transitional cell carcinoma of the bladder. J Urol. 2003;170(6 Pt 1):2253–7.
33. Horenblas S, Meinhardt W, Ijzerman W, Moonen LF. Sexuality preserving cystectomy and neobladder: initial results. J Urol. 2001;166(3):837–40.
34. Ahmadi H, Djaladat H, Cai J, Miranda G, Daneshmand S. Precystectomy serum levels of carbohydrate antigen 19-9, carbohydrate antigen 125, and carcinoembryonic antigen: prognostic value in invasive urothelial carcinoma of the bladder. Urol Oncol. 2014;32(5):648–56.
35. Braendengen M, Winderen M, Fossa SD. Clinical significance of routine pre-cystectomy bone scans in patients with muscle-invasive bladder cancer. Br J Urol. 1996;77(1):36–40.
36. Kibel AS, Dehdashti F, Katz MD, Klim AP, Grubb RL, Humphrey PA, et al. Prospective study of [18F]fluorodeoxyglucose positron emission tomography/computed tomography for staging of muscle-invasive bladder carcinoma. J Clin Oncol. 2009;27(26):4314–20.
37. Mertens LS, Mir MC, Scott AM, Lee ST, Fioole-Bruining A, Vegt E, et al. 18F-fluorodeoxyglucose – positron emission tomography/computed tomography aids staging and predicts mortality in patients with muscle-invasive bladder cancer. Urology. 2014;83(2):393–8.
38. Lawrentschuk N, Lee ST, Scott AM. Current role of PET, CT, MR for invasive bladder cancer. Curr Urol Rep. 2013;14(2):84–9.
39. Shafii M, Murphy DM, Donovan MG, Hickey DP. Is mechanical bowel preparation necessary in patients undergoing cystectomy and urinary diversion? BJU Int. 2002;89(9):879–81.
40. Raynor MC, Lavien G, Nielsen M, Wallen EM, Pruthi RS. Elimination of preoperative mechanical bowel preparation in patients undergoing cystectomy and urinary diversion. Urol Oncol. 2013;31(1):32–5.
41. Guenaga KF, Matos D, Wille-Jorgensen P. Mechanical bowel preparation for elective colorectal surgery. Cochrane Database Syst Rev. 2011;(9):CD001544.
42. Maffezzini M, Campodonico F, Canepa G, Gerbi G, Parodi D. Current perioperative management of radical cystectomy with

intestinal urinary reconstruction for muscle-invasive bladder cancer and reduction of the incidence of postoperative ileus. Surg Oncol. 2008;17(1):41–8.
43. Donat SM, Slaton JW, Pisters LL, Swanson DA. Early nasogastric tube removal combined with metoclopramide after radical cystectomy and urinary diversion. J Urol. 1999;162(5):1599–602.
44. Inman BA, Harel F, Tiguert R, Lacombe L, Fradet Y. Routine nasogastric tubes are not required following cystectomy with urinary diversion: a comparative analysis of 430 patients. J Urol. 2003;170(5):1888–91.
45. Park HK, Kwak C, Byun SS, Lee E, Lee SE. Early removal of nasogastric tube after cystectomy with urinary diversion: does postoperative ileus risk increase? Urology. 2005;65(5):905–8.
46. Vermeulen H, Storm-Versloot MN, Busch OR, Ubbink DT. Nasogastric intubation after abdominal surgery: a meta-analysis of recent literature. Arch Surg. 2006;141(3):307–14.
47. Cheatham ML, Chapman WC, Key SP, Sawyers JL. A meta-analysis of selective versus routine nasogastric decompression after elective laparotomy. Ann Surg. 1995;221(5):469–76; discussion 76–8.
48. Ljungqvist O, Nygren J, Thorell A. Insulin resistance and elective surgery. Surgery. 2000;128(5):757–60.
49. Bueno L, Fioramonti J. Action of opiates on gastrointestinal function. Baillieres Clin Gastroenterol. 1988;2(1):123–39.
50. Vaughan-Shaw PG, Fecher IC, Harris S, Knight JS. A meta-analysis of the effectiveness of the opioid receptor antagonist alvimopan in reducing hospital length of stay and time to GI recovery in patients enrolled in a standardized accelerated recovery program after abdominal surgery. Dis Colon rectum. 2012;55(5):611–20.
51. Lee CT, Chang SS, Kamat AM, Amiel G, Beard TL, Fergany A, et al. Alvimopan accelerates gastrointestinal recovery after radical cystectomy: a multicenter randomized placebo-controlled trial. Eur Urol. 2014;66(2):265–72.
52. Daneshmand S, Ahmadi H, Schuckman AK, Mitra AP, Cai J, Miranda G, et al. Enhanced recovery protocol after radical cystectomy for bladder cancer. J Urol. 2014;192(1):50–5.
53. Stein JP, Cote RJ, Freeman JA, Esrig D, Elmajian DA, Groshen S, et al. Indications for lower urinary tract reconstruction in women after cystectomy for bladder cancer: a pathological review of female cystectomy specimens. J Urol. 1995;154(4):1329–33.
54. Stenzl A, Draxl H, Posch B, Colleselli K, Falk M, Bartsch G. The risk of urethral tumors in female bladder cancer: can the urethra be used for orthotopic reconstruction of the lower urinary tract? J Urol. 1995;153(3 Pt 2):950–5.
55. Stein JP, Esrig D, Freeman JA, Grossfeld GD, Ginsberg DA, Cote RJ, et al. Prospective pathologic analysis of female cystectomy specimens: risk factors for orthotopic diversion in women. Urology. 1998;51(6):951–5.
56. Stein JP, Ginsberg DA, Skinner DG. Indications and technique of the orthotopic neobladder in women. Urol Clin North Am. 2002;29(3):725–34, xi.
57. Ali-el-Dein B, Abdel-Latif M, Ashamallah A, Abdel-Rahim M, Ghoneim M. Local urethral recurrence after radical cystectomy and orthotopic bladder substitution in women: a prospective study. J Urol. 2004;171(1):275–8.
58. Gakis G, Ali-El-Dein B, Babjuk M, Hrbacek J, Macek P, Burkhard FC, et al. Urethral recurrence in women with orthotopic bladder substitutes: a multi-institutional study. Urol Oncol. 2015;33(5):204 e17–23.
59. Stenzl A, Colleselli K, Bartsch G. Update of urethra-sparing approaches in cystectomy in women. World J Urol. 1997; 15(2):134–8.
60. Zippe CD, Raina R, Shah AD, Massanyi EZ, Agarwal A, Ulchaker J, et al. Female sexual dysfunction after radical cystectomy: a new outcome measure. Urology. 2004;63(6):1153–7.
61. Stenzl A, Colleselli K, Poisel S, Feichtinger H, Pontasch H, Bartsch G. Rationale and technique of nerve sparing radical cystectomy before an orthotopic neobladder procedure in women. J Urol. 1995;154(6):2044–9.
62. Bjerre BD, Johansen C, Steven K. A questionnaire study of sexological problems following urinary diversion in the female patient. Scand J Urol Nephrol. 1997;31(2):155–60.
63. Porter MP, Penson DF. Health related quality of life after radical cystectomy and urinary diversion for bladder cancer: a systematic review and critical analysis of the literature. J Urol. 2005; 173(4):1318–22.
64. Ali-el-Dein B, el-Sobky E, Hohenfellner M, MA G. Orthotopic bladder substitution in women: functional evaluation. J Urol. 1999;161(6):1875–80.
65. Chang SS, Cole E, Cookson MS, Peterson M, Smith Jr JA. Preservation of the anterior vaginal wall during female radical cystectomy with orthotopic urinary diversion: technique and results. J Urol. 2002;168(4 Pt 1):1442–5.
66. Puppo P, Introini C, Calvi P, Naselli A. Pelvic floor reconstruction before orthotopic bladder replacement after radical cystectomy for bladder cancer. Urology. 2005;65(1):174.
67. Stein JP, Skinner DG. Surgical atlas: radical cystectomy. BJU Inter. 2004;94:197–221.

Radical Abdominal Hysterectomy (RAH) with Anterior and Posterior Exenteration: Surgical Perspectives

105

Manol B. Sokolov

Introduction

The pelvic exenteration is defined as a surgical intervention, including: removal of rectum, distal colon, urinary bladder, distal segments of ureters, internal genital organs, lymph nodes, which drain these organs, and pelvic peritoneum.

In terms of history we have to mention Brunschwig, who first published in 1948 a series of 22 patients, who underwent pelvic exenteration by marking perioperative mortality of 23 %. Bricker introduced in 1950 the use of ileal segment and forming of skin ureteroileostomy. Pomel et al. published in 2003 a report about the first laparoscopic total pelvic exenteration.

Factors that accentuate the expansive growth of tumor are:

- sites at which different and more numerous systems are in very close contact
- limited space at which tumors may expand
- hystological pathology and differentiation

Definition of Locally Advanced Pelvic Carcinoma

Making of a definition of locally advanced stage of the disease is required with the purpose of theoretical and practical clarity, concerning relatively big percentage of patients with colorectal carcinoma or malignant tumor of internal female genital organs, i.e. carcinoma with pelvic localization, including also carcinoma of urinary bladder and ureter. Some patients with pelvic carcinoma present with different form and grade of locally advanced primary or relapsed tumor process, but in stage of non-metastatic disease, which, despite the absence of generalization, cannot be resected. The criteria for non-resectability are variable and are not clearly defined. For example, the definitions for locally advanced colorectal cancer vary with different authors. Several authors determine it as one, visualized by means of endorectal ultrasound diagnostics as T3/4 and N1 tumor, or one that is also clinically diagnosed by a tumor mass found upon palpation during physical examination, but with no presence of distant metastases [1, 2].

American Joint Committee on Cancer Staging Scheme classifies them as T4 lesion [3].

The term "advanced cancer" was suggested in clinical and pathological sense for the first time by William Stewart Halsted (1852–1922), who established the foundations of modern surgical treatment of carcinoma of mammary gland. This notable surgeon added to that category the tumors with significant size, involving the underlying structures of thoracic wall or with presence of metastases in the regional lymph nodes, considered as direct tumor growth. Halsted noted some rules for extended resection of mammary gland as a prerequisite for radical treatment of early and advanced stages, and he accepted the advanced local growth of the tumor outside of organ borders as a main hindering factor for operative removal of the tumor or predetermining factor of poor prognosis after non-radical surgical operation. He did not assume that the distant metastases are related and originate from the primary tumor, and assessed them as other neoplastic diseases [4]. Stephen Paget circumstantially studied in 1921 the metastatic process of carcinomas of breast and lung, and made a well-grounded suggestion that the cancer cells disseminate by means of blood circulation, but may settle and grow only in certain organs, developing the "seed and soil" theory. Later, based on the studies of Virchow from 1885–1892, and his own observations and studies of synchronous metastatic process, Paget underlined the role of the lymph system as a main road for occurrence of secondary (metastatic) foci and generalization of neoplastic disease. He determined as advanced carcinoma the one which had presence of secondary lesions originating from the primary tumor [4].

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According to our opinion, a suitable working definition of locally advanced colorectal tumor, and generally of malignant tumor of lesser pelvis, is such that the final assessment by a multidisciplinary medical team for management of patient, represented by surgeons, pathologists, radiologists and medical oncologists, gastroenterologists and specialists in medical imaging is namely that standard single-organ resection could not be performed (without the major probability for remaining in the tissues surrounding the specimen and spaces of microscopically or macroscopically found residual disease due to the adhesion or the fixation of the tumor to the surrounding anatomical structures). Locally advanced lesion may vary from having apparently intimate adhesion to the surrounding tissues, i.e. marginally, "borderline" resectable tumor to one, which directly, macroscopically, involves the adjacent critical structures (for example main blood vessels, pelvic bones, lateral or anterior abdominal wall, other portions of large and small intestine or their mesenteria, internal genital organs or organs of urinary bladder, nerve plexuses, etc.). The sigmoid colon cancer may invade inside the urinary bladder, ovaries, and uterus. The preoperative medical imaging methods in many cases cannot ensure precise information about the malignant invasion. In this particular situation the intraoperative making of decision about performing of multivisceral resection is difficult. The tumor mass is usually very voluminous for adequate determination of the tumor borders. The data from the literature indicate that the surrounding anatomical structures and organs are involved in the context of primary localization of the tumor in the sigmoid colon and rectum – 66–89 % of the cases. The reasons for that are the big frequency of localization of carcinoma in these portions, mobility of sigmoid colon, and narrow spatial distances of structures in the lesser pelvis [5–7]. The determination of locally advanced stage of the disease depends on whether clinical assessment of the resectability is done preoperatively or intraoperatively. In some cases the inoperable tumor, assessed as such upon clinical or imaging radiographic examination, may consequently, upon intraoperative exploration, turn to one susceptible to radical resection [1].

From 5 to 22 % of all colorectal carcinomas present as "locally advanced" tumors [8, 9]. The absence of local tumor control, especially in locally advanced colorectal cancer, has disastrous consequences as intestinal or urinary obstruction, bleeding from the lower intestinal tract, and morphological and functional disorders of the remaining surrounding organs, fistulizations, and considerable pain. The successful eradication of locally advanced tumor would ensure better survival and better quality of life. Many investigators have reported the possibility of en bloc-resection in series of cases [10–15] and some have demonstrated significantly better long-term prognosis and actual survival. Nakafusa Y. et al. reported in 2004 53 patients with multivisceral resection, among 323 with elective surgery for pT3/pT4 without any distant metastases. They took into consideration that the en bloc-resections were significantly related to the tumor size, depth of invasion, surgical blood loss and hemotransfusions, as well as surgery time ($p < 0.0001$). The morbidity after en bloc-resections was higher compared to the standard – 49.1 % vs. 17.8 % ($p < 0.0001$) – without any intraoperative and early postoperative mortality in the two groups, while the perioperative and early postoperative mortality were 0 % in both groups. The level of survival had no significant difference (5-year 76.6 % vs. 79.5 %, $p = 0.9347$). The lymph node metastases (hazard ratio, 2.519; 95 % confidence interval, 1.460–4.315; $P = 0.0009$) and hemotransfusions (hazard ratio, 2.353; 95 % confidence interval, 1.185–4.651; $P = 0.0145$) were taken into consideration as independently associated with the survival [16]. Park S, Lee Y.S. [17], who studied in 2011 the short-term and long-term results of 54 patients with macroscopically found locally advanced tumor among a total of 266 patients with curative resection (2000–2007) for T3 and T4 colorectal carcinoma, found histological infiltration in 44.4 % of the en bloc-resections, and at the same time their results demonstrated increased postoperative morbidity in multivisceral resections (35.2 % compared to 17.5 % in standard resections), but long-term survival without any statistical difference to the one in standard single-organ resections (5-year survival: 61 % vs. 58 %; $p = 0.36$). Cho S. et al. demonstrated in 2009 similar results in 36 patients with en bloc-resections from a total of 476 patients with locally advanced colon cancer [18]. Hoffmann M. et al. published in 2012 the analyses of 78 patients with multivisceral resections from a total of 123 patients with T4-locally advanced colorectal carcinoma (2002–2008), who had as a main significant prognostic factor in multivariation analysis ($p < 0.0001$) the consideration of the possibility of achievement of R0-resection with 5-year survival in 55 % without any significant difference in the non-multivisceral resections ($p = 0.608$), without any significant difference for the tumor origin–colon or rectum ($p = 0.839$), in laparoscopic or open procedures ($p = 0.610$) and in emergency compared to elective procedures ($p = 0.674$). They found that the presence of lymph node metastases in their study was not a predictive factor for survival, not taking into consideration the difference in patient with or without N+ ($p = 0.658$) [19]. Gezen C. et al. published in 2012 an analysis of 90 patients with clinical T4 colorectal carcinoma from a total of 354 patients (2001–2010), and multivisceral resection in 91.1 % (82 of them), and at the same time in 34.4 % of the clinical T4 they found actual histological invasion in the surrounding anatomical structures–pT4, more rarely in men ($p < 0.05$). pT4 cancer was more frequent when the clinical T4 (cT4) was localized in colon (48.8 % vs. 21.3 %; $p < 0.01$), the laparoscopic method was used rarely and the risk of conversion was higher in the T4 tumors ($p < 0.05$), the number of

sphincter-saving procedures did not demonstrate any difference compared to the non-en bloc-resections, but the surgery time, intraoperative blood loss, and amount of blood transfused had considerable increase, when en bloc-resection was required ($p < 0.05$). There was no significant difference in the hospital stay, complications, and 30-day mortality. Identical level of 5-year survival was noted ($p > 0.05$) [20].

Types of Pelvic Exenteration

The types of pelvic exenteration are:

- Anterior pelvic exenteration (Fig. 105.1)
- Posterior pelvic exenteration(Fig. 105.2)
- Total pelvic exenteration
  - Supralevator
  - Infralevator (Fig. 105.3)

As a part of the pelvic exenteration, in the context of tumor involvemennt of the lower rectal portion and/or anal canal, the modern conception for performing of abdomino-perineal extirpation (APE) comprises three types of extent of resection–inter-sphincter APE; extra-levators APE (ELAPE); ischio-anal APE (Figs. 105.4 and 105.5).

- Extended exenteration, which includes abdomino-sacral resection (Figs. 105.6, 105.7, 105.8, 105.9, 105.10 and 105.11)

Approximately about 85–95 % of patients with advanced malignant disease of pelvis, subjected to pelvic exenteration, are expected to survive the surgical intervention. Initially designed as a palliative procedure in advanced malignant diseases of pelvis, today the 5-year survival of patients after pelvic exenteration due to relapsed pelvic tumor has improved and varied between 20 and 60 %.

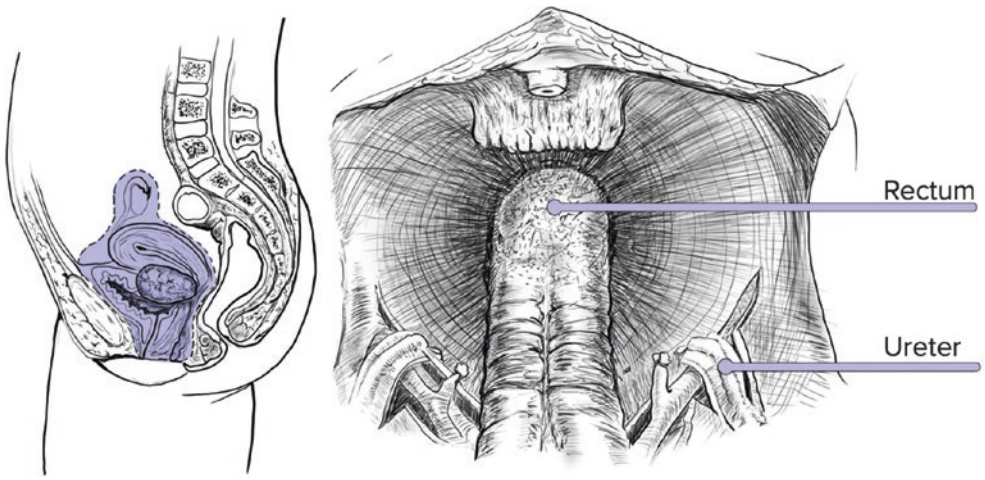


Fig. 105.1 Anterior pelvic exenteration

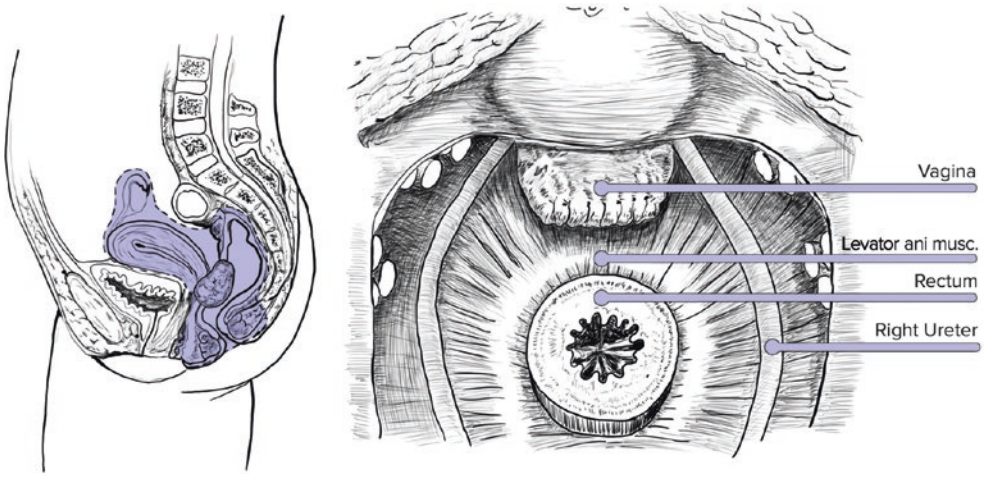


Fig. 105.2 Posterior pelvic exenteration

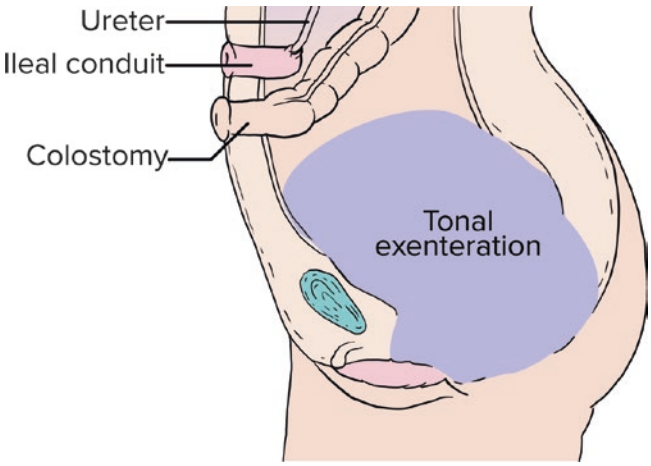


Fig. 105.3 Total pelvic exenteration

For many patients with massive, locally advanced primary or relapsed malignant pelvic disease, the aggressive pelvic exenteration is the best option for their treatment.

With the improvement of the surgical equipment and devices, and of perioperative care, the mortality and morbidity, related to the pelvic exenterations, significantly decreased.

Nevertheless, in the different modern series the frequency of serious complications varies between 36 and 46 %. When it is indicated, the pelvic exenteration for the treatment of locally advanced pelvic malignant diseases must by considered as a standard surgical intervention in the major surgical centers.

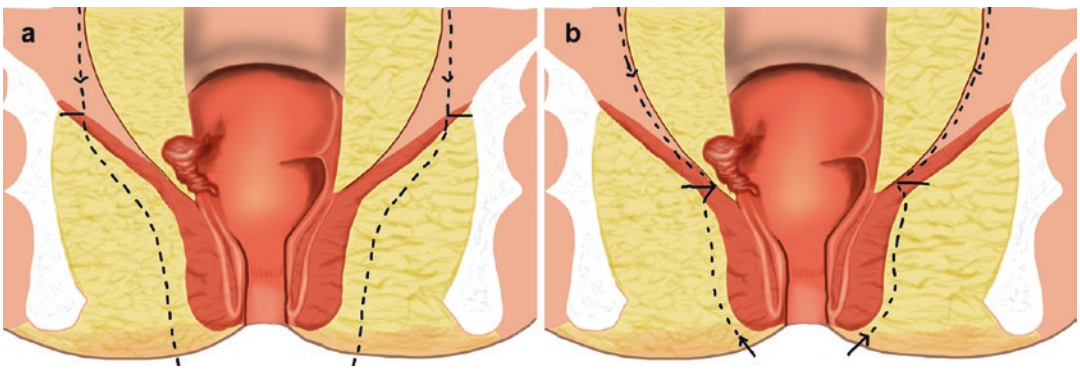
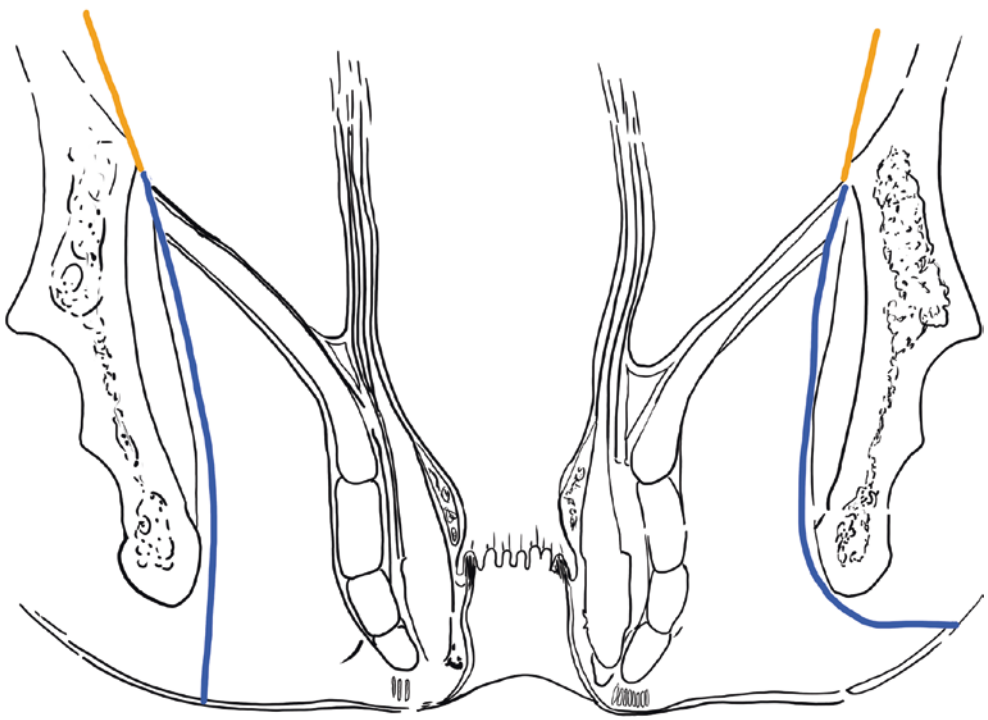


Fig. 105.4 Extent of resection in: (**a**) Extra-levators abdomino-perineal extirpation (ELAPE); (**b**) conventional APE–Miles

Fig. 105.5 Extent of resection in ischio-anal APE



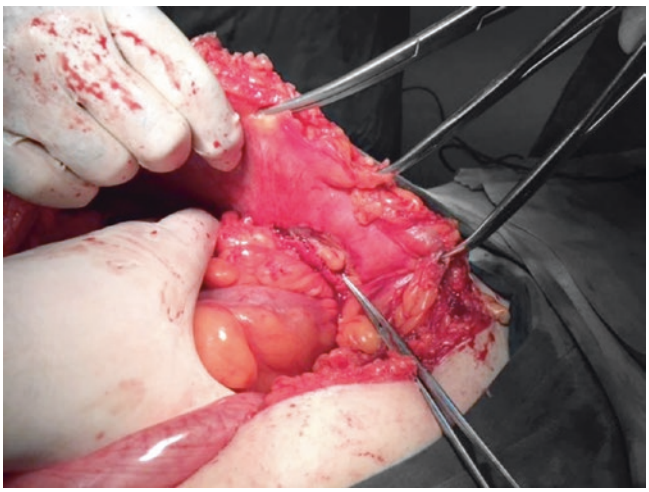


Fig. 105.6 Cancer of the sigma with infiltration of the urine bladder, and anterior abdominal wall (previous laparohysterectomy and adnexectomy on the occasion of myoma in advanced age)

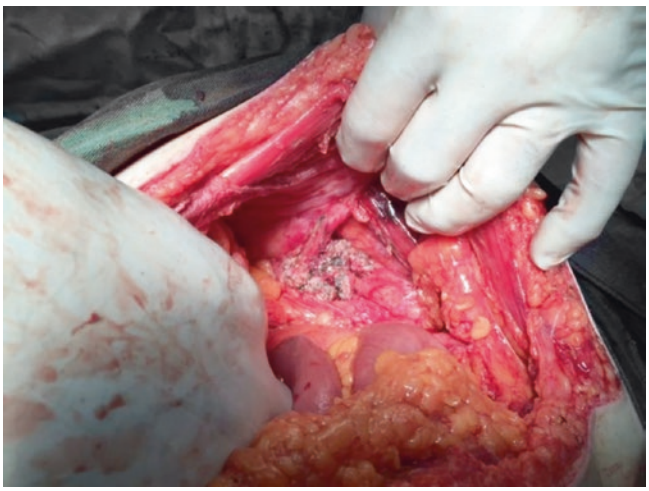


Fig. 105.7 Intraabdominal view after en bloc removal of rectum, (previous laparohysterectomy and adnexectomy on the occasion of myoma in advanced age) and partial resection and plastic of the bladder. Peritonisation of the pelvic floor

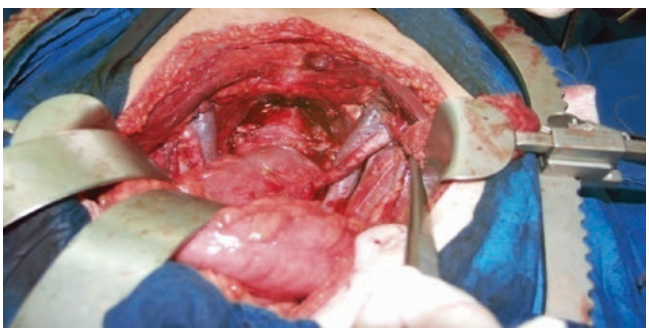


Fig. 105.9 Anterior exenteration–transabdominal view to the pelvis including the iliac blood vessels

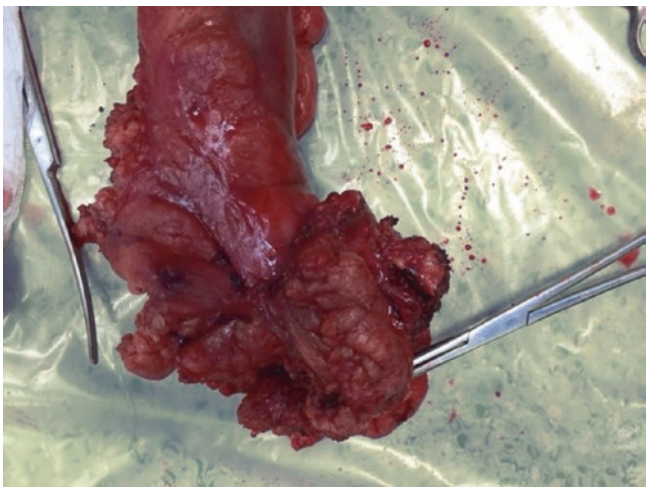


Fig. 105.8 Operative specimen after block-resection sigma/rectum and fundus of the bladder (postoperatively proven R0 resection)

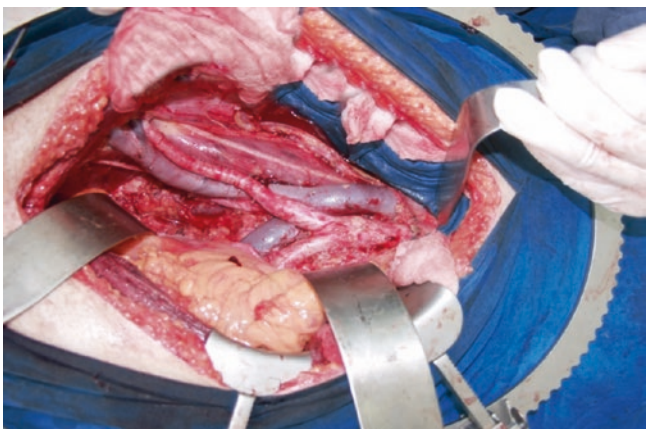


Fig. 105.10 Anterior pelvic exenteration with pelvic blood vessels dissection

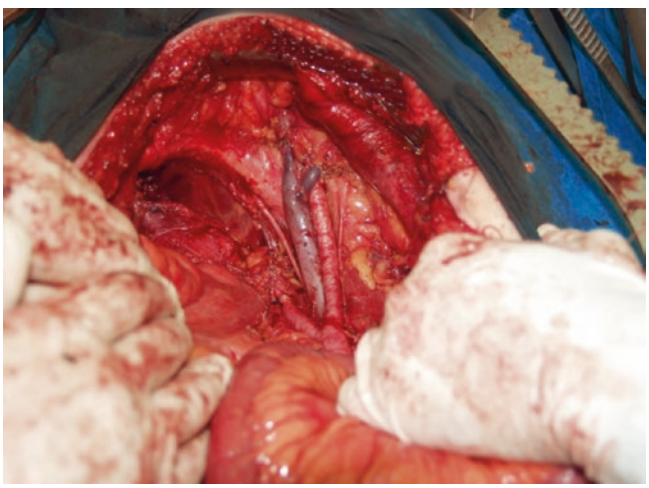


Fig. 105.11 A stage of total pelvic exenteration–intraoperative view of right iliac blood vessels

Indications for Pelvic Exenteration

- Carcinoma of urinary bladder–primary or relapsed
- Carcinoma of prostate–palliative treatment
- Carcinoma of rectum or sigmoid colon–primary or relapsed
- Squamous cell carcinoma of anus–relapsed
- Carcinoma of uterine cervix–primary or relapsed
- Carcinoma of uterine cervix–relapsed after radiotherapy
- Endometrial carcinoma–primary or relapsed
- Cervical carcinoma–palliative treatment
- Vaginal carcinoma–primary or relapsed
- Squamous cell carcinoma of vulva–relapsed
- Post-radiation lesser pelvis fibrosis, necrosis, or fistula

The main indications are cancer of uterine cervix, rectal carcinoma, and relapsed carcinoma of rectum.

Cancer of Uterine Cervix

The most frequent disease, treated by total pelvic exenteration is the central pelvic relapsed carcinoma of uterine cervix. Landoni et al. noted that among patients treated for IB and IIA stage of cancer of uterine cervix, not less than 25 % developed a relapse after the treatment [27]. Most of patients with non-treated cervical carcinoma died from locally advanced carcinoma, which might cause obstructive uropathy or peritonitis. Only 25 % of patients with non-treated cervical carcinoma have distant metastases.

The radiotherapy is considered in locally advanced disease, but the possibility of healing by radiotherapy in case of advanced carcinomas of uterine cervix is much lesser than in less advanced stages of the disease. The higher is the total dose of radiation, the higher is the morbidity related to it.

Rectal Carcinoma

Newer studies (Mercury study) [21] demonstrate that about 50–64 % of the primary rectal carcinomas are locally advanced (T4a,b at the time of admission), without any metastases found during the exploration or suitable for local radical surgery. The preoperative examinations, especially the endorectal intracavitary ultrasonography and magnetic resonance imaging currently visualize with high precision the infiltration in an adjacent organ (T4b), which excludes the performing of only the conventional resection strategy. The problems related to the locally advanced tumors localized in the pelvis are such, that the real tumor infiltration is hard to be intraoperatively distinguished from the peritumor inflammatory adhesions.

In earlier historical periods of the treatment of locally advanced colorectal carcinomas, the rule for performing of miltiorgan resection was adopted only, when there presented macroscopic infiltration, while upon possible separation of the adhered organ through “blunt dissection”, standard resection was performed. This, on its part, results in more than 35 % local relapses for the first postoperative year and 5-year survival–less than 30 % [22].

The dissection and disturbance of the integrity of tumor upon standard resections, even assessed as R0, is related to approximately 69 % locally advanced relapses and 5-year survival of 17 %, while in multiorgan resections, the frequency of relapses is 18 %, and the 5-year survival – 49 % [23, 24].

Although many tumors form adhesions to the adjacent anatomical structures, it would not be true to say that all of them present malignant infiltration. The frequency of these malignant adhesions varies between 40 and 85 %. Nevertheless, in these patients withholding from performance of radical en bloc-resection increases the number of local relapses and compromises the postoperative survival. In a clinical study (J. Hunter), the 5-year survival after en bloc-resection was 61 %, but it decreases to 23 %, when the tumor is only anatomized up to the organ, at which it had adhered [13]. In a similar clinical study (H. Jensen) 36 % had local relapse after en bloc-resection, compared to 77 %, when there was performed only anatomization of the tumors [25, 29].

Relapsed Carcinoma of Rectum

Despite the aggressive resection of primary rectal carcinoma, including also total mesorectal excision, the local relapses of rectal carcinoma vary from 5 to 15 % and require an approach as with primary T4 rectal carcinomas. In a study by Cass, the frequency of local relapses is related to the stage of the primary tumor, while for tumor of B1 stage according to Dukes staging system, it is 15 %, and for tumor of C2 stage – 52 % [30]. In patients, who have a relapse after low anterior resection, it is more probable to occur non-fixed, surgically resectable relapsed tumor than in patients, who had a relapse after abdomino-perineal resection. About 50 % of the local relapses are limited in the lesser pelvis and are associated with potentially operable oligometastatic disease, while thus they are candidates for curative radical repeated operation [36–38]. The surgical principal bases of these aggressive therapeutic measures require the surgical approach to be strictly individualized for the different patients and determined by the localization of the relapsed tumor and the involved anatomical structures. According to the anatomical region, the relapsed tumor is classified as:

- Central–the tumor is limited to the pelvic organs without any invasion of bone structures or pelvic walls
- Sacral–the tumor takes the presacral space and involves the sacrum
- To the lateral pelvic walls–laterally parietal lesser pelvis relapse (sidewall)–the tumor involves one of the lateral pelvic walls with or without extension through the greater sciatic foramen and/or piriformis muscle and gluteal region
- Combined–combined sacral and lateral pelvic walls relapse

In compliance with the latter, Mirnezami A. and Sagar P. divided the surgical procedures to radical and extensively radical resections [41, 42]. In radical resections removal of the relapsed tumor formation is achieved with no need for resection of the adjacent parts or whole pelvic organs. The extensively radical surgical procedures are characterized with resection of at least one involved pelvic organ (partially or totally), bone structure (e.g. sacrum), or main blood vessels (e.g. iliac artery or vein). Mirnezami A. and Sagar P. also accentuated on the multidisciplinary detailed consideration of patient in the preoperative period through the co-ordinated efforts of a medical team, consisting of a colorectal surgeon, urologist, vascular surgeon, plastic surgeon, neurosurgeon, orthopedic surgeon, and, frequently, gynecologist. The medical specialists in the latter team are sellected and co-ordinated by a coloproctological surgeon according to their experience in the resection and/or reconstruction of abdominopelvic anatomical structures.

Selection of Patients Suitable for Pelvic Exenteration

The locally advanced pelvic tumors may infiltrate adjacent organs as: urinary bladder, prostate galnd, seminal vesicles, urethra, ureter, uterus, adnexa, posterior vaginal wall, sacrum. Direct invasion of these structures may be susceptible to radical exenterative surgery and lead to healing in well-selected patients. Every case of locally advanced pelvic tumor must be assessed individually and by a multi-profile medical team (MDT – multidisciplinary team).

The main task of that assessment is performing of examination of the clinical, pathologo-anatomical, and radiological findings in order to be accomplished evaluation of the suitability of patient for potentially curative pelvic resection. The suitability of patient for major exenterative surgery is of first-rate significance for achievement of optimal postoperative results. Cardiopulmonary test loadings, Karnofsky Performance Scale Index, ASA classification, etc. were recently and most frequently used for that evaluation.

Preoperative Examination

Upon making a decision of the suitability of patient to be subjected to multivisceral resection, multimodal approach is necessary, including: physical examination (digital rectal examination, and examination of rectum and vagina under anesthesia), endoscopic examination, radiologic examination (magnetic resonance imaging with high resolution, endorectal sonography of local lesions, computed tomography of thoracic cage, abdomen, and pelvis), positron emission tomography-computed tomography (PET-CT) for searching of distant metastases and pathologo-anatomical examination (Figs. 105.12 and 105.13).

Only the experienced hand of a specialist in surgery may assess the tumor as mobile, withdrawn or fixed, or to determine its distance from the anorectal and anocutaneous lines, and the possibility for restorative or non-restorative procedure.

The endoscopic examination is helpful in assessment of tumors, which cannot be examined digitally, and it provides information about the size and degree of obstruction of an opening (this is important when undertaking of neoadjuvant therapy). The histological result confirms the diagnosis, and it also allows rejection of squamous cell carcinoma of anus. The local status of tumor is best assessed by magnetic resonance imaging of high resolution, using a protocol of examination for rectal carcinoma. The magnetic resonance imaging demonstrates with high sensibility and specificity the degree of tumor invasion in the surrounding anatomical structures. Additionally, it provides a precise



Fig. 105.12 X-ray of female patients with locally advanced rectal carcinoma with infiltration into the uterus and vagina. There are metachronous metastases–right chest wall–basal on average

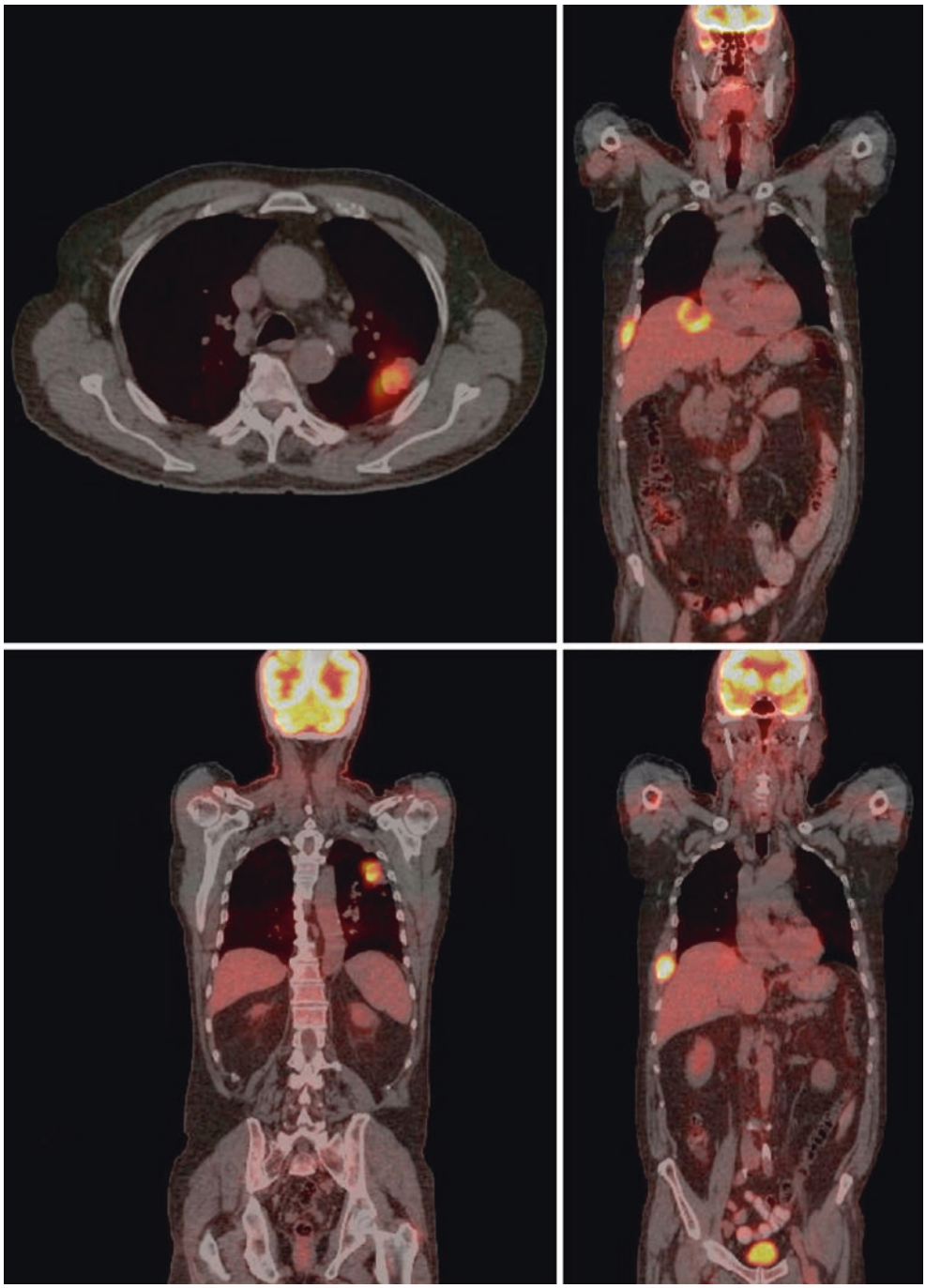


Fig. 105.13 PET CT scans + reconstruction after posterior pelvic exenteration with local recurrence. Enhanced signal intensity (bright yellow zones) of accumulation of the radiopharmaceutical substance indicating metachronous metastatic lesions in the right liver lobe, left lung and right chest wall. MDT assessed inability to achieve oncological radicalism–contraindicated for reoperation

assessment of the lymph node status of the tumor; it also provides with high grade of probability an assessment of the operability or inoperability; and it best aids the surgical team in the planning of the surgical intervention. The preciseness of magnetic resonance imaging decreases in tumors of the lower third of rectum, where endorectal sonography is preferred whenever an experienced sonographist is available. The presence of localized metastases in the liver and lung, which are assessed as resectable, according to the current guidelines, does not exclude performing of pelvic exenteration.

The clinical assessment allows the experienced clinician to correlate the results from the device examinations with their clinical signs and symptoms, and this provides an option for better evaluation of the ratio tumor/surrounnding tissues.

Contraindications for Potentially Curative Pelvic Exenteration

Absolute Contraindications

- Distant metastases
- Metastases in the paraaortic lymph nodes
- Massive infiltration in the pelvic wall (infiltration in the common or external iliac artery; venous or lymph obstruction)
- Infiltration in sacrum, proximally from S2/S3
- Transient R2-resection

Relative Contraindications

- Obstruction of ureter
- Presence of pronounced edema of lower extremity subsequent to lymph or venous obstruction
- Propagation of the tumor through greater sciatic foramen
- Tumor encircling of more than 180° of the external iliac blood vessels
- Relative contraindication due to concomitant disease (ASA physical status IV/V)
- Relative contraindication due to inability to care for a stoma or advanced age

All potentially operable candidates are considered when they pass through pedantic preoperative assessment process. The aim of the performed preoperative examinations is precise staging of the disease, identification of all contraindications for surgery, assessment of the comorbidity and finding of eventual, non-resectable metastases, covered by Mirnezami A. and Sagar P. The typical staging examinations include: computed tomography (CT) of thoracic cage, abdomen, and pelvis: magnetic resonance imaging (MRI) of pelvis and/or liver; and 18F–fluorodeoxyglucose positron emission tomography (FDG-PET), recently combined with computed tomography–PET/CT scan. The cystoscopy comes into consideration upon suspected involvement of urinary bladder, while the transcystoscopic stenting of ureters is related both to excluding of their eventual involvement by the tumor, and as a preventive measure against intraoperative iatrogenic lesions.

Lack of presentation of patients suspected for advanced disease to specialized oncology committee (MDT–multidisciplinary team) before surgery represents a gross "blunder of the medical art". This often leads to inadequate preoperative planning of the type and volume of intervention (potentially curative, i.e. radical surgery or palliative surgery) when it is discussed only in clinical board consisting mostly of general or coloproctology surgeons but often without participation of imaging diagnostics, pathologists, urologists, gynecologists and plastic surgeons as well as a specialist in anesthesiology and intensive care. As a result, the decision on the type and volume of operation is taken essentially by the operating surgeon during the intraoperative assessment of the tumor situs without supporting data from imaging studies and the poin of views of other particular specialists. We, therefore, allow ourselves to offer the following diagnostic algorithm in order to emphasize on preoperative suspicion of locally advanced tumor of the colon and rectum with a presumption of possible infiltration into neighboring pelvic structures. That would be which is necessary to carry out a particular type of pelvic exenteration (Fig. 105.14):

Following this algorithm, all suspected cases of locally advanced tumor with probability of infiltration of pelvic organs and structures should be submitted in advance for a comprehensive discussion to preoperative MDT.

In patients, who did not undergo prior radiotherapy, a long-term course of chemoradiotherapy is performed and after 6–8 weeks waiting for repeated complete staging before eventual repeated operation. Although by this method the disease can significantly transform in lower T-size (downsizing), all authors recommend the following surgical treatment to be complied with the involvement of the anatomical structures before the neoadjuvant–regarding the repeated operation–chemoradiotherapy [42]. Increasingly more newly found patients with locoregional relapses already receive neoadjuvant therapy before their first operation. Although most of them will not undergo a following radiotherapy, there are publications that in certain patients performing of additional hyperfractioned chemoradiotherapy with no significant toxicity is acceptable and with a proven result [43].

When there is a probability of the repeated resection to include in its dimensions portions of the large intestine that are non-excluded from function or previously formed neorectum of colon or ileal conduit, performing of complete preoperative mechanical or osmotic large intestinal preparation is necessary. Upon planning of resection only of non-functioning anorectum or neorectum, single cleansing enema is completely sufficient. As preoperative manipulations, assisting the dissection and resection, preoperative stenting of one or both ureters, or tattooing are performed–as a way of marking the level of forthcoming sacral resection. The early postoperative monitoring, and complete surgical and medical care of patient, is foreseen in a Specialized Clinic of Intensive Follow-up Observation and Care, especially after high risk procedures as resection of sacrum or lateral pelvic vascular dissection. Most of the procedures are performed by abdominal approach, but certain cases require only posterior or perineal access. In transabdominal or perineal accesses,

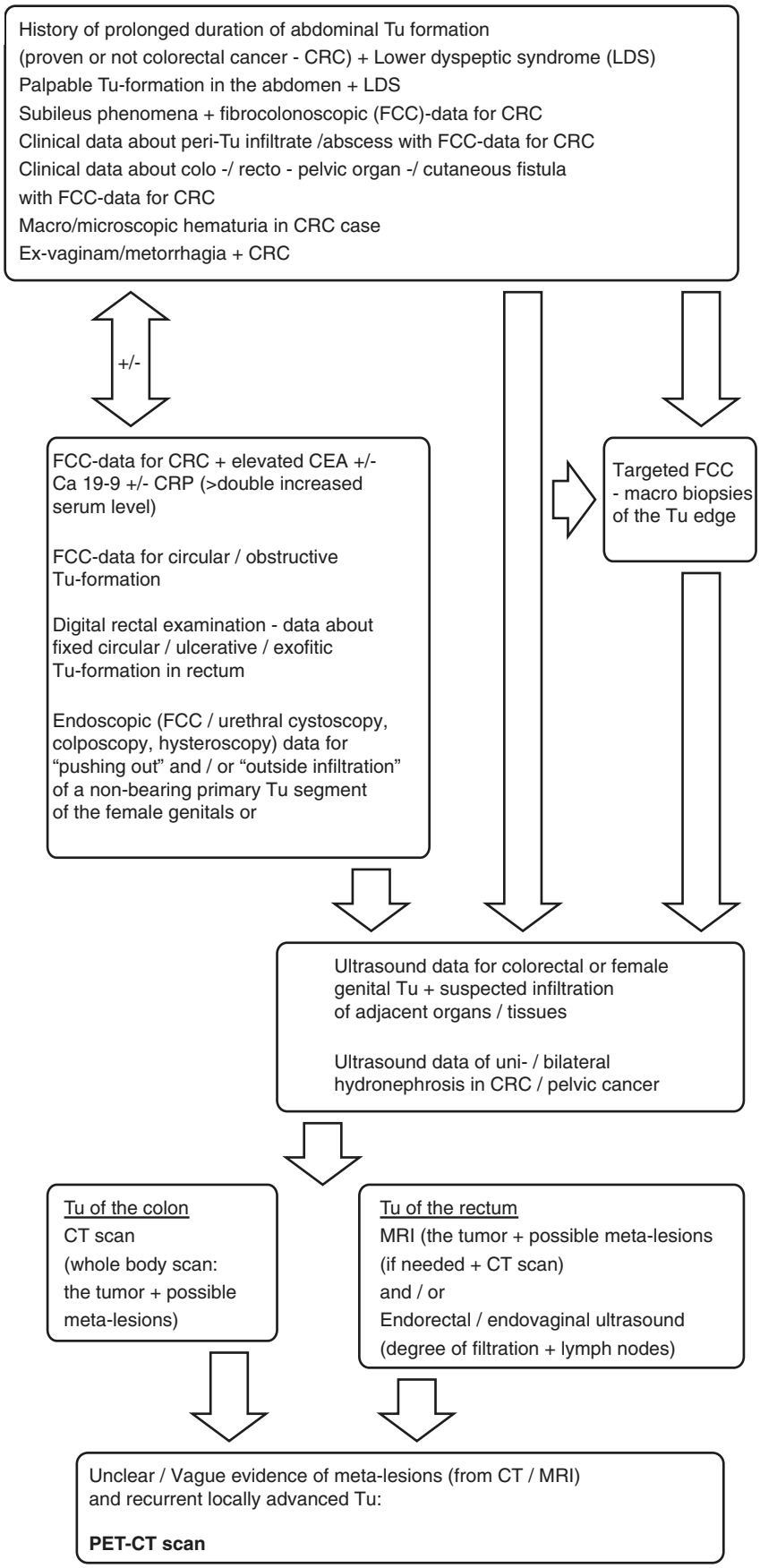


Fig. 105.14 Algorithm in diagnosis of locally advanced colorectal cancer

patients are placed on the operating table in Lloyd-Davies position, while in posterior access supine position is suitable, with bending of the table at the level of waist–"prone jack-knife position" [42].

Surgical Technique

- The aim of surgeon is R0-resection, including negative circumferent border, highly qualitative, verified total mesorectal excision (TME), negative proximal and distal resection line.
- This approach ensures 5-year survival to patients after pelvic exenteration for advanced primary rectal carcinoma from 32 to 66 %, and for the relapsed one–from 22 to 42 % [26].
- R0-resection is acquired after development of three main surgical planes, corresponding to different stages of the intervention:
  - ventral plane, with borders urinary bladder and internal genital organs;
  - ventrolateral plane, consisting of obturatory neurovascular structures, ureter, internal iliac blood vessels and their branches, passing through the suspensory net of rectum and intrapelvic part of internal obturatory muscle;
  - dorsal and dorsolateral plane, consisting of levator ani muscle, intrapelvic attachment of piriform muscle, sacral nerves and vascular plexuses, and sacrum.

In abdominal access, median laparotomy is applied with subsequent total adhesiolysis–"débridement generale" with the aim of overview of the peritoneal cavity for excluding of occult intraabdomial metastases. The discovery of non-diagnosed, preoperative, peritoneal or visceral metastases is a poor prognostic indicator and, with the exception of the cases when the metastases are single and/or resectable, it is a contraindication for definitive selective surgery. The aim of the surgical treatment is achievement of R0-resection, which requires resection of the tumor and of the involved by the tumor adjacent anatomical structures and organs to be performed "en bloc". Not rarely, however, it is possible to exist an uncertainty as regards the exactness of achievement of "clean" resection lines, especially upon presence of radio-induced fibrosis. In this case it is obligatory to be considered the introduction of the rapid intraoperative histological examination–frozen section procedure, for analysis and verification of the sections suspect for infiltration.

Ventral Plane

- Ventral plane is formed when preserving of the urinary bladder is planned.

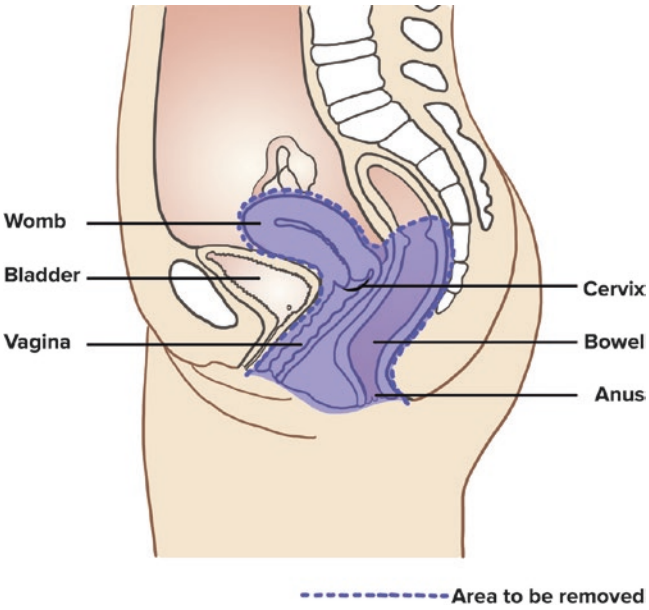


Fig. 105.15 Ventral plane in posterior pelvic exenteration

- The female genital organs are an easy for resection buffer, while in men the tumor infiltration in the genital organs often means, that the ventral plane cannot be elaborated.
- Upon tumor infiltration of dorsolateral position, it is possible a ventral plane to be formed in front of peritoneo-perineal fascia (Denonvilliers' fascia).
- The infiltration of the anterior fornix of vagina does not exclude the formation of ventral plane.
- In tumors with ventrolateral infiltration the transection of the ureters facilitated the achievment of clean lateral circumferent border.
- The repeated implantation of ureters, if they are not infiltrated, can be performed after mobilization of urinary bladder and its adjustment to the adjacent greater psoas muscle (Figs. 105.15 and 105.16).

In terms of the dimensions of resection in posterior exenteration, the following organs and structures need to be removed: recto-sigmoid colon; lymph nodes; uterus with ovaries; vagina; adjacent pelvic fat, and connective tissue; perineal structures (Figs. 105.17, 105.18 and 105.19).

Bilateral ligation of internal iliac artery is a significant critical turning point to continue the operation–to proceed with pelvic exenteration [28]. It may be used as palliation. This procedure results in decrease of operative blood loss and respectively decreases surgery time. It also facilitates finding and ligating of uterine and bladder arteries. It is important to certain extent for the iliac lymph node dissection. It is also possible to ligate internal iliac vein. It is possible even to resect internal iliac artery and vein–in cases when it is necessary to extract an obturatory fossa mass, penetrating the internal iliac blood vessels (Figs. 105.20, 105.21, and 105.22).

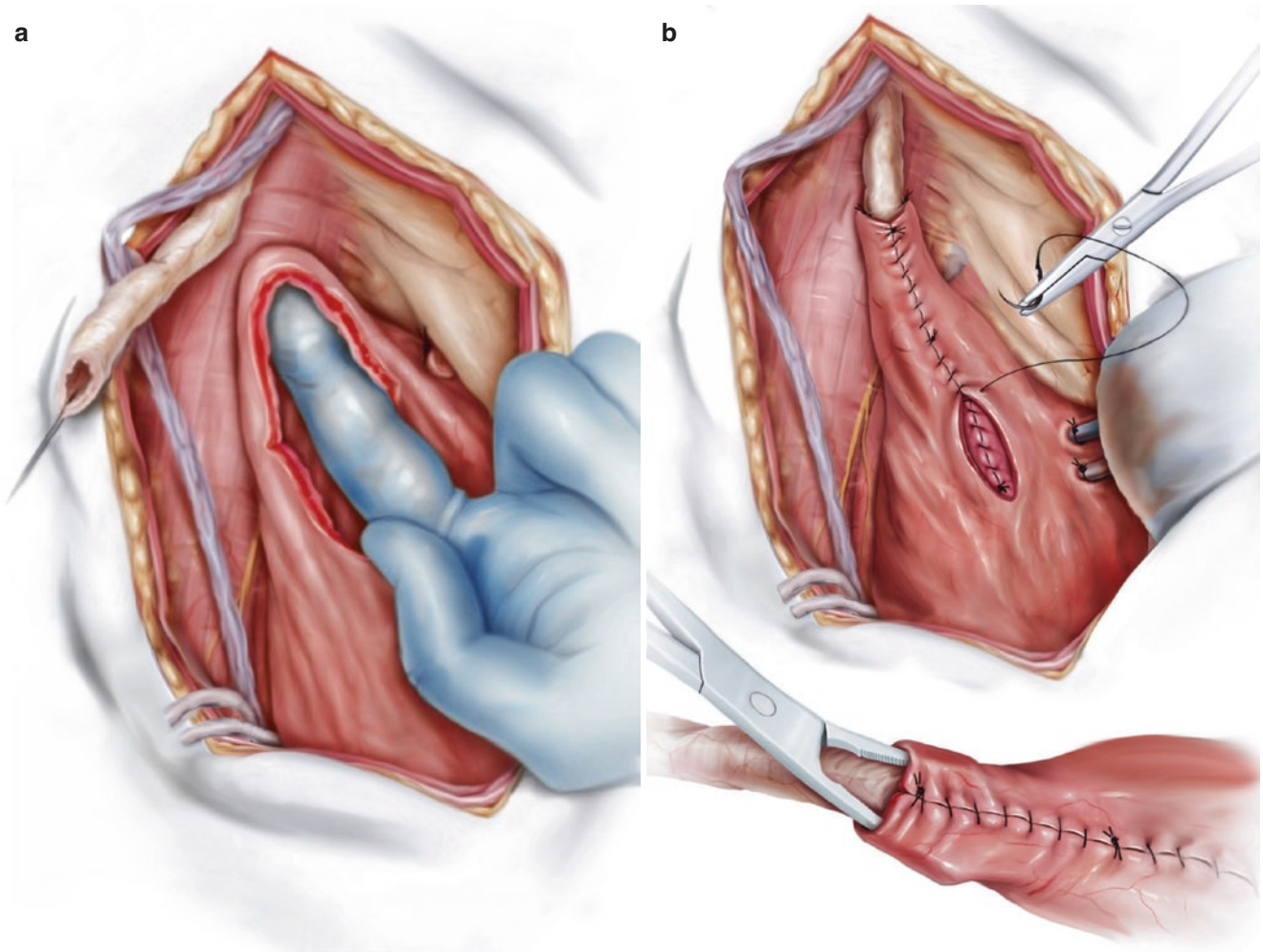


Fig. 105.16 (**a**, **b**) Repeated implantation of ureters in the wall of urinary bladder

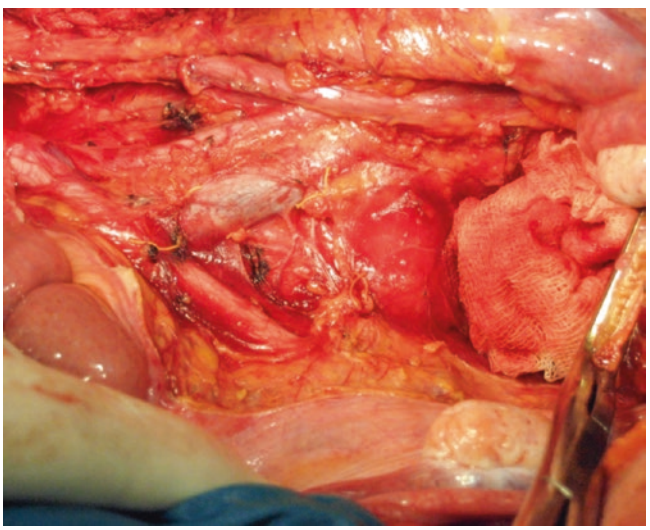


Fig. 105.17 Intraoperative view of the pelvis after en bloc resection of rectum and uterus

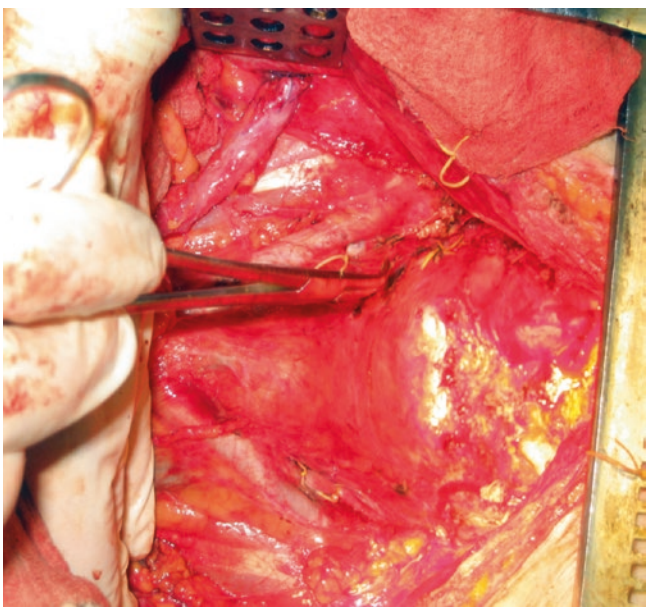


Fig. 105.18 Intraoperative ligation of the internal iliac arteries of both sides

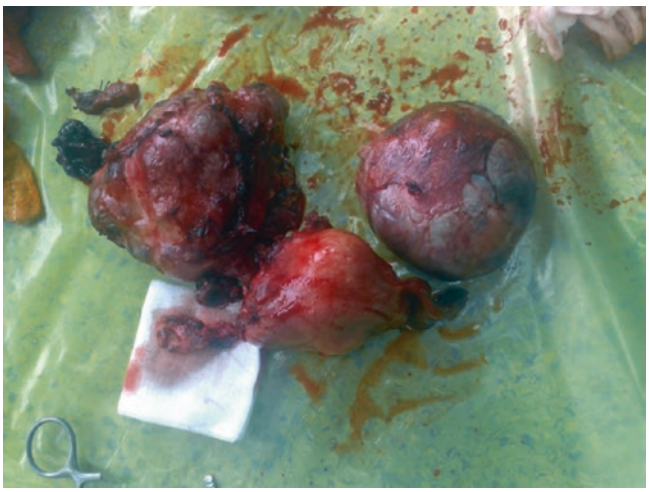


Fig. 105.19 Operative specimen of block anterior resection of the rectum and uterus + adnexes because of suspected malignant infiltration (pathologically proved postoperatively + metastasis in the left ovary of the same cancer)

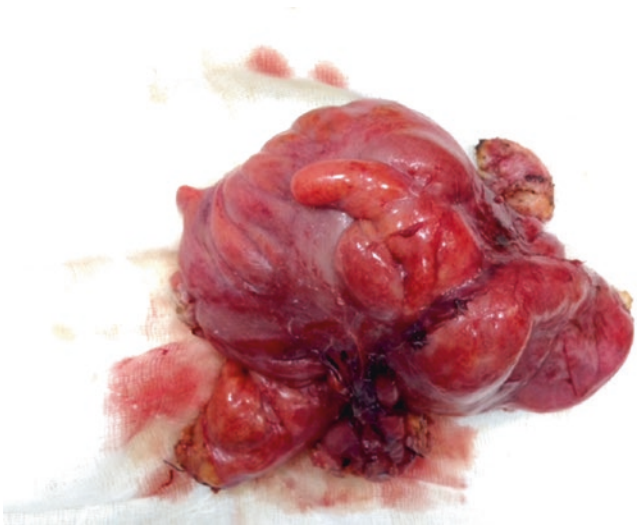


Fig. 105.21 Surgical specimen of en block-resection of sygma/rectum + mesorectum (partial mesorectal Excision – PME) + uterus

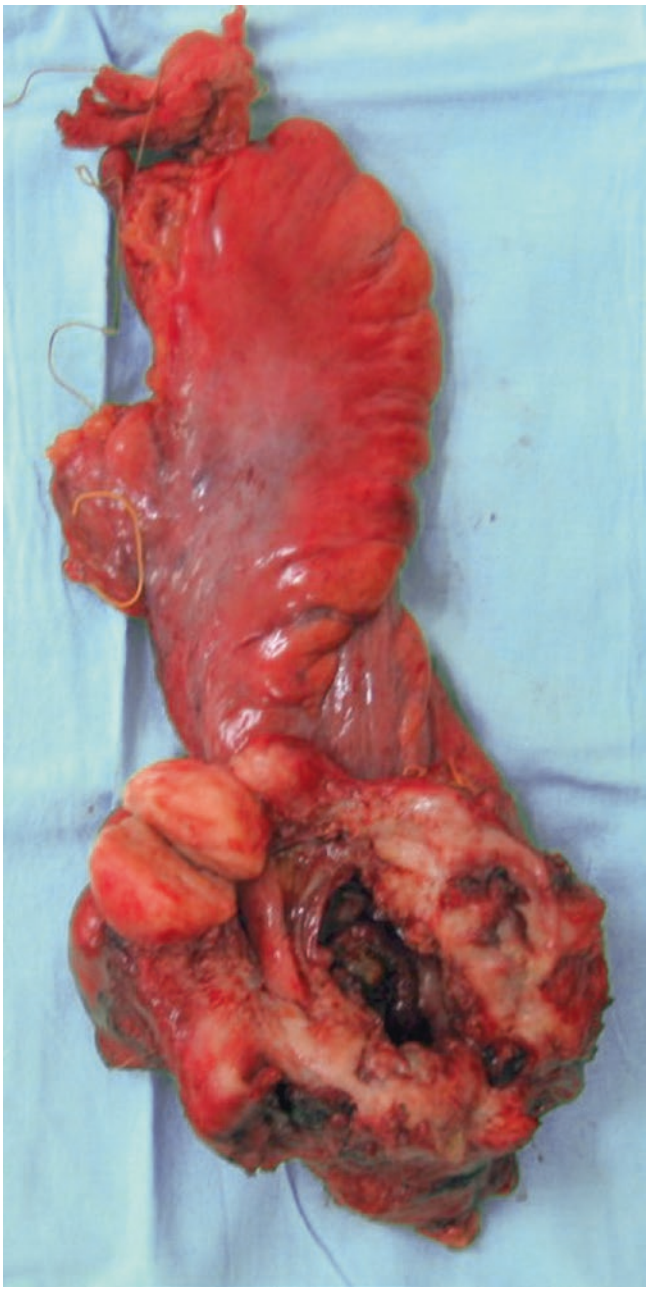


Fig. 105.20 Surgical specimen of en block-resection of rectum + mesorectum (Total Mesorectal Excision – TME) + uterus

An especially important milestone in the mobilization of rectum and performing of total mesorectal excision by the method of Heald in single-organ resection and posterior exenteration with no sacral resection is avoiding "blind" dissection performing in dorsal plane, which with a great probability would lead to damage of the sympathetic innervation–superior hypogastric plexus and forming in distal direction of left and right hypogastric nerve. This, of course, is of no importance in total exenteration, because innervated organs are removed (Fig. 105.23).

In a case of massive tumor infiltration of urinary bladder, negative ventral circumferent border cannot be achieved. These patients are suitable only for total pelvic exenteration.

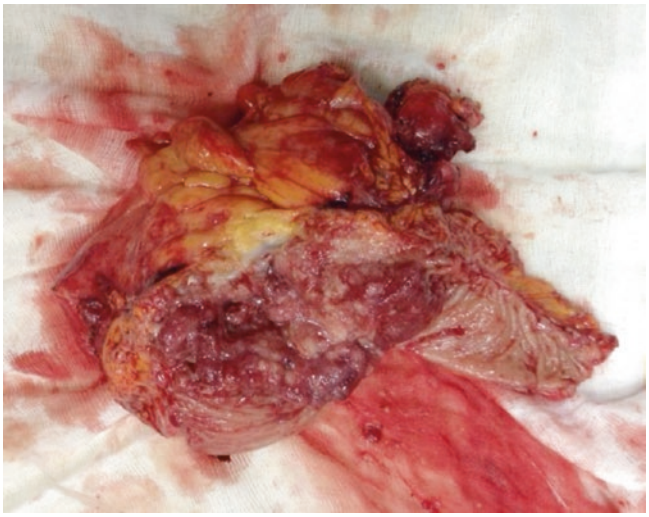


Fig. 105.22 Surgical specimen of en block-resection of coecum – right colectomy (with Complete Mesocolic Excision – CME) + uterus

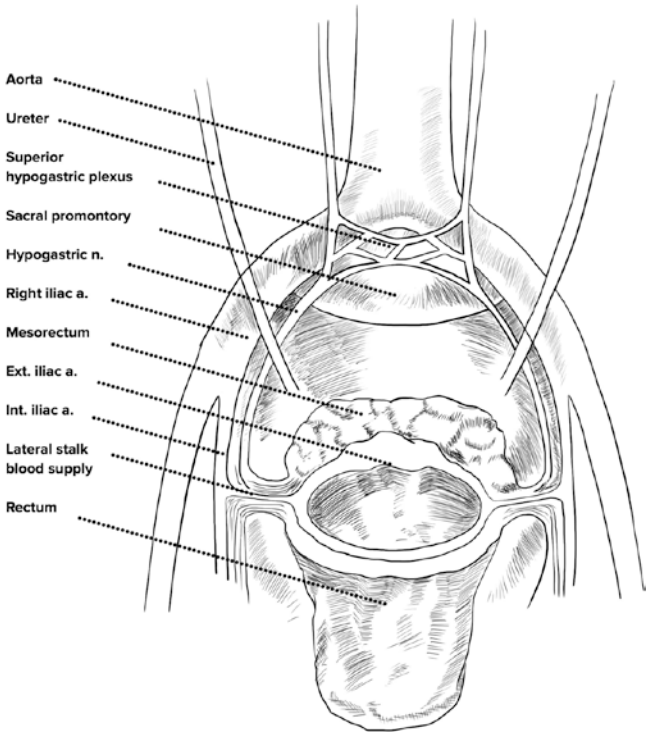


Fig. 105.23 Autonomic pelvic nerves and their positions amongst other pelvic structures

Total Pelvic Exenteration

The following organs and structures are to be removed: recto-sigmoid colon; lymph nodes; urinary bladder; urethra; uterus with ovaries; vagina; vulva; adjacent pelvic fat and connective tissue.

Locally Advanced Pelvic Carcinoma or Central Relapse

Several scenarios are possible in median, axial relapse depending on the gender and eventual involvement of urogenital structures, everyone of which requires different surgical approach. In all cases generally acquired oncological principle is that the resection of a relapse must be extended to a degree of preventing of positive resection lines, analogically with the resections in sarcomas.

In isolated perineal relapses, usually after abdominoperineal excision/extirpation of rectum (amputation) (APER), the transperineal access is sufficiently adequate, although sometimes it must be combined with posterior access, including the distal sacrum.

As it has been already explained, the involvement of visceral structures requires en bloc-resection. For example, the infiltration of the body/cupula of urinary bladder requires partial cystectomy, while the involvement of trigone of bladder is an indication for total pelvic exenteration. In women the involvement of vagina or uterus requires performing of hysterectomy with partial or total vaginectomy. The preoperative stenting of ureters supports their visualization in order iatrogenic lesions to be avoided.

In cases of central relapses, not involving urogenital structures, the operative strategy depends on whether the prior surgical operation had the dimensions of anterior resection or of abdominoperineal extirpation. In both cases the resection must be performed in a plane wider than the prior dissection with the purpose of preventing residual tumor sections. In the presence of "high" anastomosis at the prior operation, it is possible to be performed repeated anastomosis between the transverse or descending colon, and rectal section after ablastic tumor removal. Frequently, however, the technical difficulties in the context of adhesions from the first operation and radio-induced fibrosis require performing of ultra-low Hartmann procedure or abdominoperineal procedure–Miles-extirpation. The present prior anastomosis turns to be a critically "weak" place in cases with relapses and extensive traction of neorectum, and the anastomosis is a dangerous activity as regards the intestinal or tumor rupture, which must be avoided by suitable mobilizing practices. If Denonvilliers' fascia is well-presented and not involved by the tumor process and radiotherapy, a ventral plane from that structure is a choice in anterior dissection. In prior abdominoperineal extirpation with poor peritonization frequently in lesser pelvis, in a repeated surgical operation, multiple adhered small intestinal loops were found, not rarely infiltrated by a relapsed tumor, which requires their combined en bloc-resection with the main tumor mass [40].

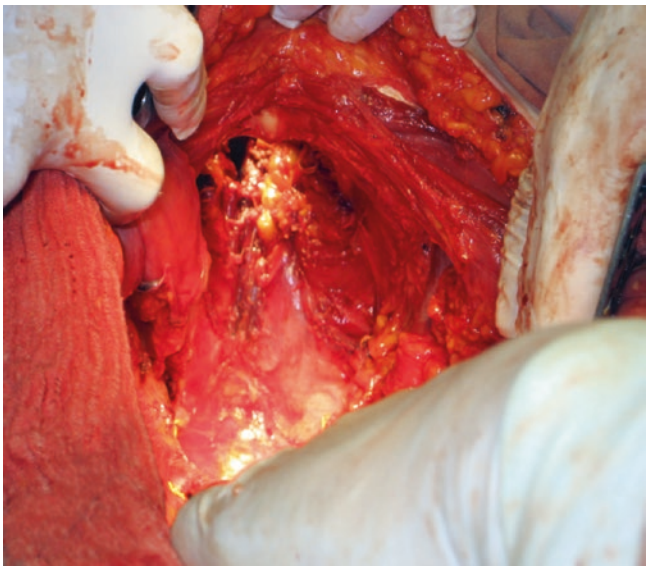


Fig. 105.24 Intraoperative view of the pelvis

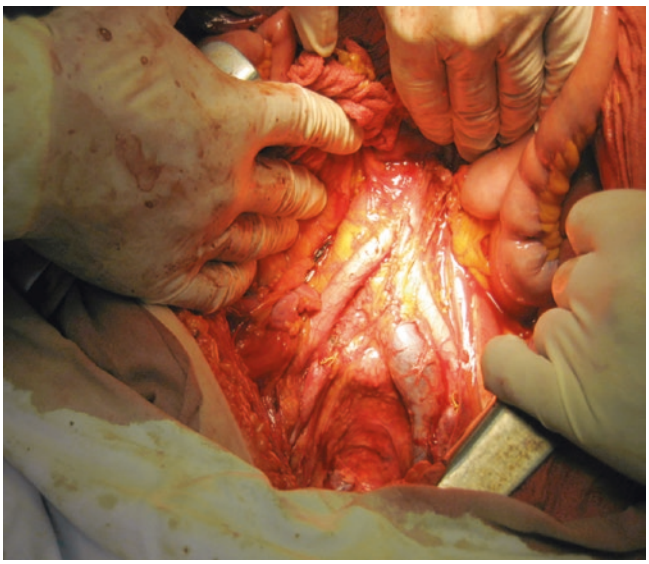


Fig. 105.25 Ligation of both internal iliac arteries is shown

The question about the dimensions of lymph node dissection in multivisceral resection of relapsed rectal carcinoma is important and not explicitly solved. Theoretically the invasion in other organs opens new lymph draining systems for the disease, because of which they have to be included in the dimensions of repeated resection in order to be prevented a new relapse or carcinomatous generalization in distant locations. There is still no consensus on this matter with a few present literature data. In the modern practice most surgeons, and we as well, keep close to the therapeutic measures of Mirnezami A. and Sagar P. for not performing of radical

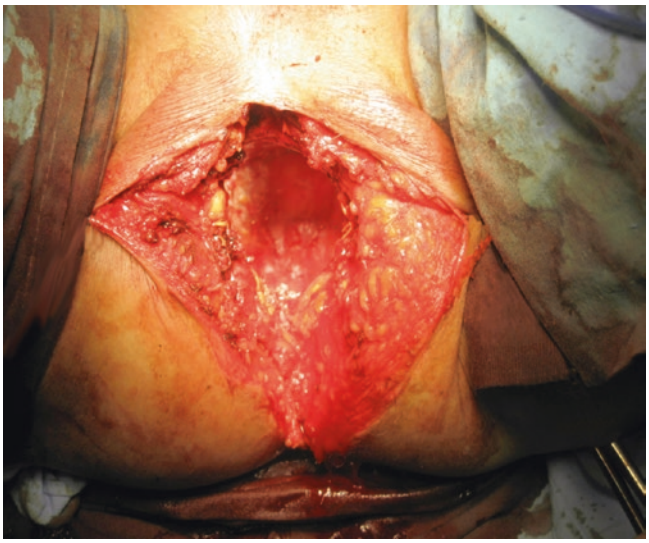


Fig. 105.26 Perineal view after total pelvic exenteration

pelvic lymphadenectomy due to the accompanying high morbidity, caused by that procedure, as well as the absence of specific proofs for the benefits–as regards the survival–of that method [44] (Figs. 105.24, 105.25 and 105.26).

Abdominosacral Resection

If the tumor invasion disseminates dorsally to the sacrum, lateral pelvic wall, or muscles of pelvic fundus, and wide dorsal access is necessary with a view to improvement of the operative field and easing the resection of the tumor within healthy tissues, performing of abdominosacral resection is required (Fig. 105.27).

Transsacral Resection

- patient is turned from supine position in prone jack-knife position (Fig. 105.28)

This position has the following *advantages*:

- improved visibility
- easier retraction by assistant
- reduced perforation
- reduced circumferential resection margin (CRM) positivity

and the following *disadvantages*:

- long surgery time as patient position needs to be changed

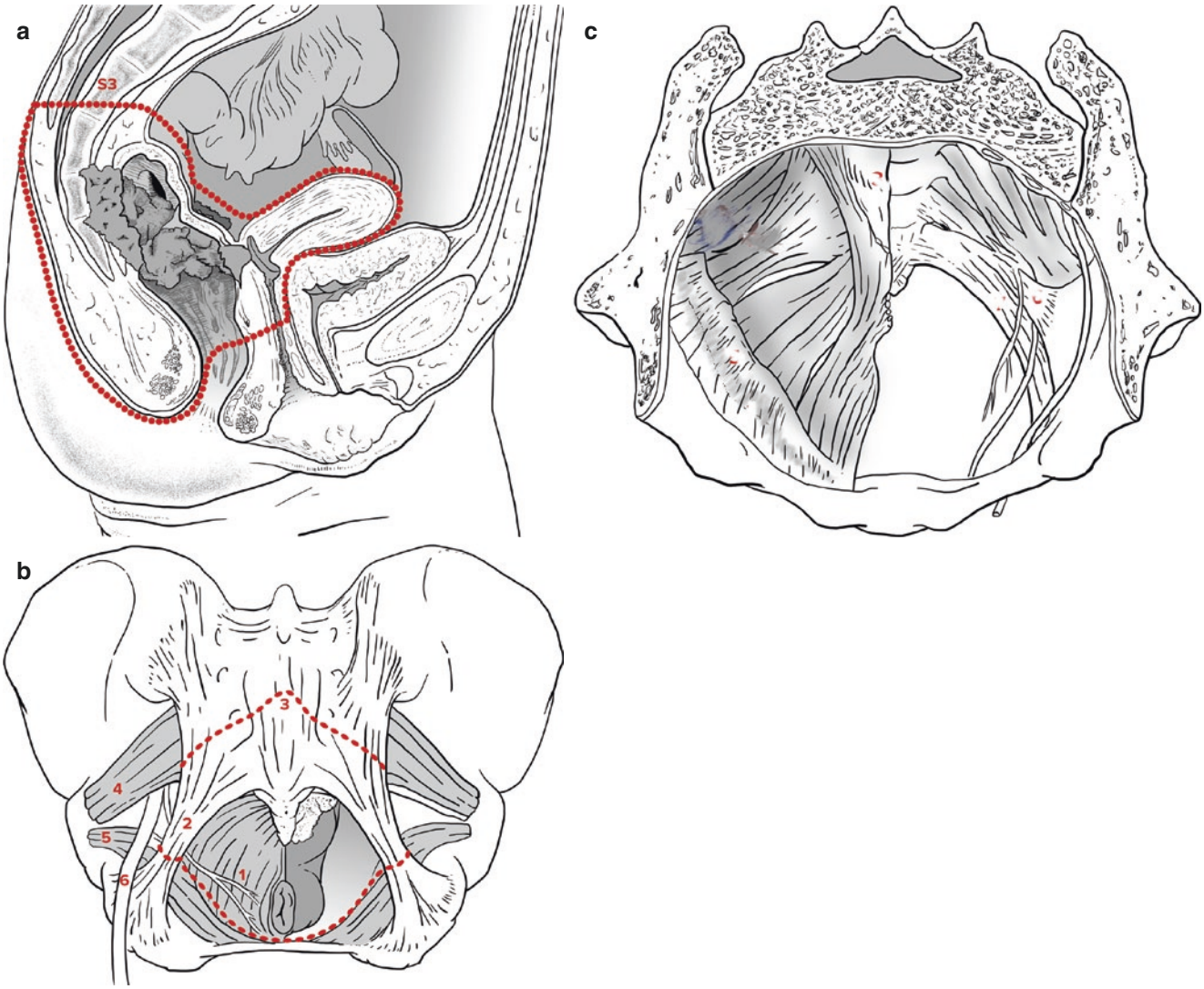


Fig. 105.27 (**a**–**c**) Abdomino-sacral resection in pelvic exenteration

- inability to perform rectus or gracilis transformation

The functional result after transsacral resection depends on the degree of resection. Transection of sacrum at level S3 for tumors with low position essentially is connected with normal function of urinary bladder, if the latter is preserved. The proximal transectional incision at level S1 is a more traumatic procedure frequently for more considerable or voluminous, and highly localized lesions. The stability of the pelvic ring may be maintained with no requirement of plastic reconstruction, if the lumbosacral facet surfaces are preserved at bilateral base and there is no pronounced neuromuscular locomotor deficit. The transection of levels S1, S2, and S3 compromises the functions of urinary bladder due to bladder denervation. Although the emptying can be managed by the method of Crede, the use of alpha agonists or the current catheterization requires permanent attention and care by the attending physician and–as a whole–aggravates the quality of life.

It seems that there is a consensus that the infiltration tissues involved in the tumor must be removed by resection within macroscopic borders of 2 cm. Although it is advisable, with no solid evidence for that 2 cm border, the rule is not always applied. If that rule is strictly observed, that means the resection of sacrum and/or piriform muscles with a part of the nerve sacral plexus must be performed in most of patients. The operation is difficult due to the absence of plan for dissection around the relapsed tumor mass. That is so especially after prior total mesorectal excision. “Guidance document”, published by National Health System / Department of Health in England, outlines a frame, based on the evidence, and recommends that such an operation must be performed only by a specialist with experience in that kind of surgery [24].

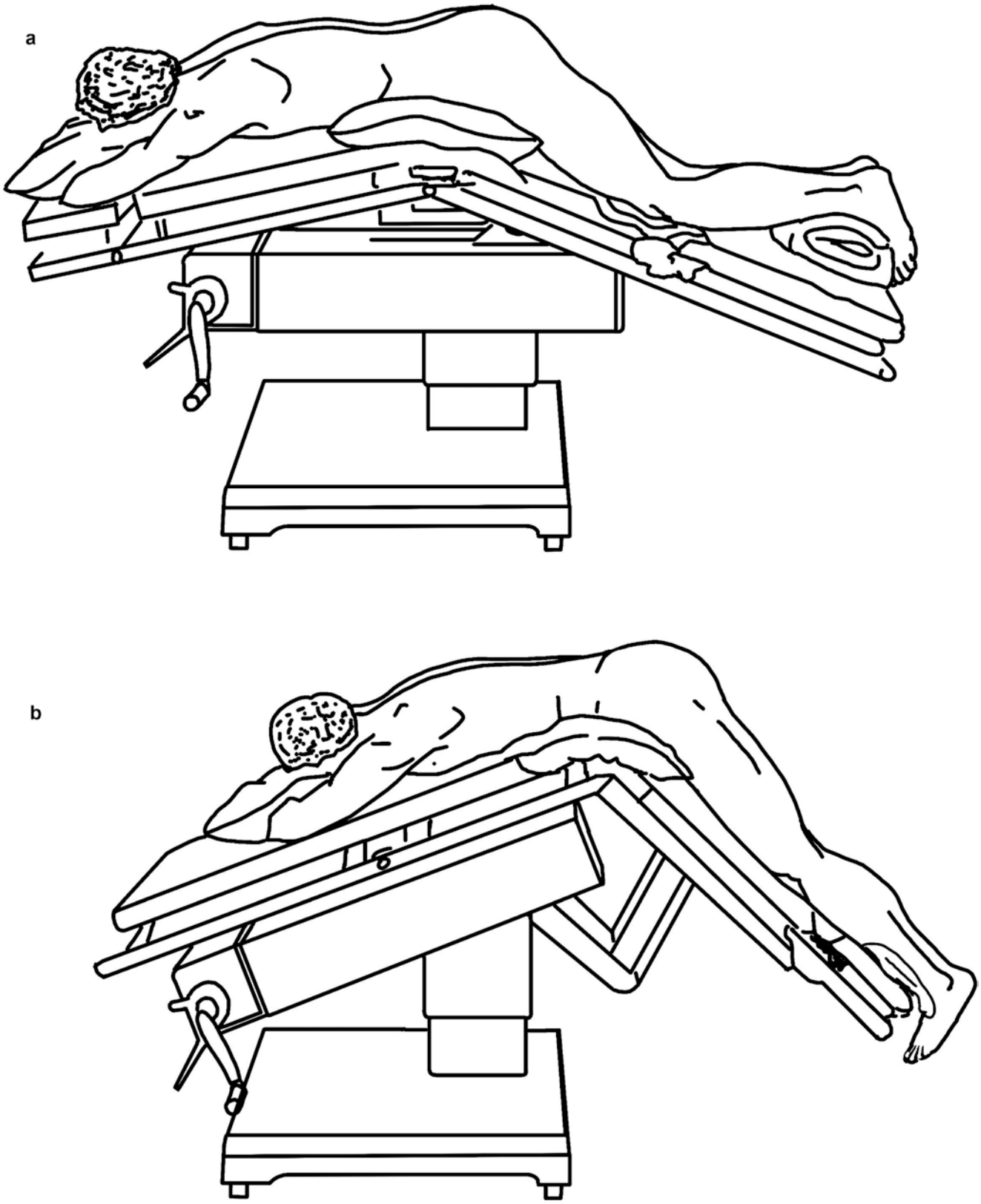


Fig. 105.28 (**a**, **b**) Prone jack-knife position

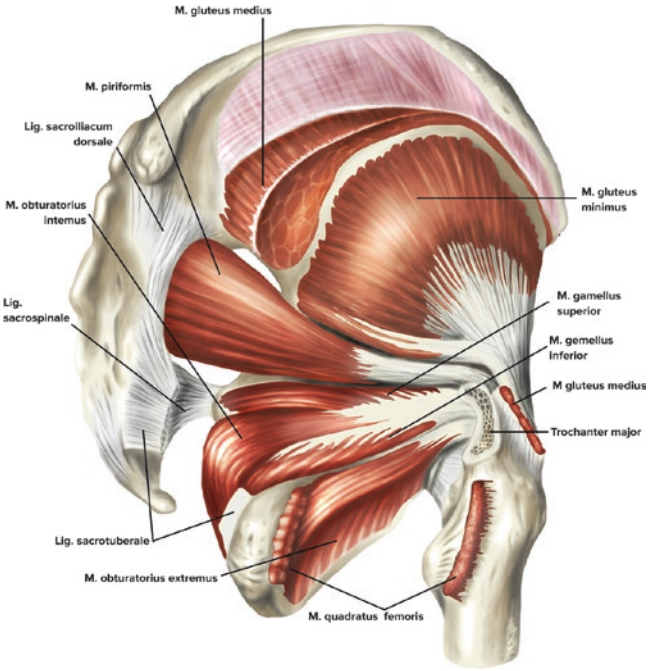


Fig. 105.29 Musculo-aponeurotic view in a stage of transsacral resection (Adopted by http://wellinhealth.com/sports-tissue-trauma/)



Fig. 105.30 Digital maneuver in mobilizing and grip of the sacrum

Dorsal longitudinal median sacral incision–from L5 to the perineum, and around anus or anal surgical scar–is performed. Myocutaneous flaps are formed bilaterally, including gluteus maximus muscle and gluteus minimus muscle, which are cut from their origins and elevated bilaterally (Fig. 105.29).

All visceral sections infiltrated by the tumor are removed en bloc, e.g. small intestinal loops, ovaries, etc. After the tumor mass remains fixed only in posterior direction, a stoma is brought out and ideal conduit is elaborated, draining tubes are implanted and lesser pelvis is "filled with an inlay" of omentum–omentoplastic surgery of lesser pelvis before closing of abdominal wall. A change in the position of patient follows–prone jack-knife position for the posterior stage of operation. This position allows sufficient exposition for the wide en bloc-resection, however, the control on the main blood vessels is insufficient and the danger of massive hemorrhage must be recorded by the medical team.

Dorsal longitudinal incision over the sacrum is performed at the level of fifth lumbar vertebra up to the perineal scar or anus–depending on the type of prior surgical operation. The incision is deepened up to the sacral bone, and the gluteal muscles are retracted laterally. The sacrotuberous and sacrospinous ligaments are cut laterally from the sacrum, which allows intervention inside the cavity of lesser pelvis, followed by digital revision of the presacral space in order to be verified the level of forthcoming sacral resection. In this case intraoperative radiographic scopy may also be used for precise determination of the level of resection. The osteotomy of sacrum is performed by the means of spinal elevator of Cobb and osteotomic forceps. The epidural adipose tissue, contained in the sacral canal is explored for presence of components from the dural canal, and if these are found, they have to be thoroughly ligated with non-resorbable sutures. All residual fascial and ligamentary infiltrative areas are dissected by electrocauter before completing of the sacrectomy and removal of the specimen en bloc. Different combinations of omentum, absorbing a prosthetic leaflets or pedicularized flaps could be used for reconstruction of the remaining defect and for prevention of prolapse of small intestinal loops in the lesser pelvis. The abdominal stage of surgical operation could be performed also laparoscopically, as described by some authors (Fig. 105.30).

Lateral Parietal Pelvis Relapse: Sidewall

The parietal relapse is related to poorer prognosis and involves lesser probability for achievement of R0 resection. The tumor frequently infiltrates critical structures as ureters, iliac blood vessels, sciatic nerve or the mass of side pelvic bones, and most of authors share the opinion that the wide parietal infiltration from a relapsed tumor is a relative contraindication for surgery. If a decision is made for performing of operation, the preoperative stenting of ureters is obligatory in order to the excluded their infiltration and for better identification upon the dissection. During the operation permanent control on the key structures is necessary

and obligatory, proximally and distally from the tumor area. After en bloc-resection of the tumor and structures infiltrated by it, reconstruction of the essential blood vessels and repeated implantation of ureters is performed, if necessary.

The dissection begins from the pelvic ring with identification and isolation of holder portions of ureters and common iliac blood vessels. The ureters are followed up to their running into urinary bladder, and dissection continues along the internal and external iliac arteries and veins. The ligation and cutting of internal iliac artery provides access to the underlying internal iliac vein, which can also be ligated and resected upon its involvement by the tumor process. These blood vessels may be ligated and cut bilaterally, if it is required for achievement of R0-resection. Whenever it is possible, the internal iliac artery is ligated distally from its first branch, as was already mentioned. Iliolumbar, superior gluteal, and lateral sacral branches successively separate from the first branch of the artery, and avoiding of the mentioned blood vessels from damage reduces and prevents from perineal and posterior wound complications in the postoperative period. The blood vessels, and their branches and tributaries are clasped individually, and are ligated with successive free and quilting ligatures, or are coagulated and cut with bipolar current from modern devices–Harmonic Scalpel ACE (Ethicon Endo-Surgery Inc., Cincinnati, OH; Johnson & Johnson, Arlington, TX). After control over the internal iliac blood vessels is achieved and they are cut, the removal of the relapsed tumor mass is made significantly easier, and subsequently multivisceral resections, excision of parts of pelvic fundus, and distal sacrectomy are performed with no technical difficulties. Some authors report also of a more aggressive approach with dissection in a plane between the bones of pelvis and parietal pelvic muscles, with reported 69 % survival achieved upon average period of follow-up of 19 months [41].

Paraaortic Lymphadenectomy

This procedure–although currently with controversial result in primary and relapsed colorectal carcinomas as regards the distant prognosis–has practical curative significance by removing present or future sites of metastases by ovarian, rectal, and cervical cancer. It is performed proximally to the left renal vein (Fig. 105.31).

Reconstructive Phase: Urine Derivation

The surgeon must be acquainted with the different technical aspects of the pelvic exenterations, but also with the different modifications of the procedure. Lateral pelvic lymph dissection, including the obturatory lymph nodes, is performed in combination with cystoprostatectomy.

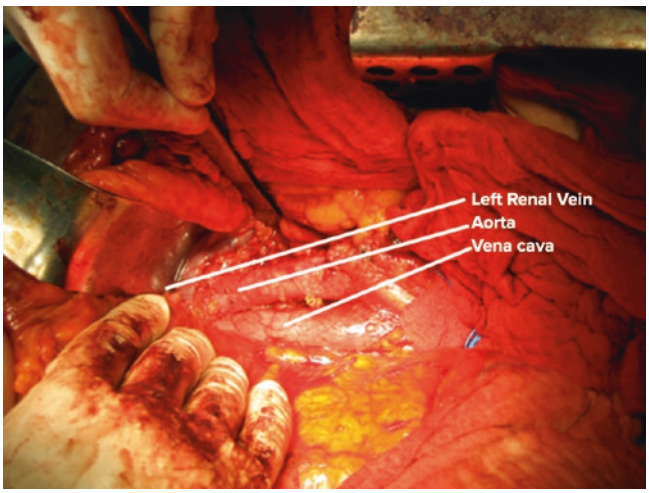


Fig. 105.31 The aorta, inferior vena cava, and left renal vein are shown

The knowledge and management of the different possibilities for urine derivation, and also for reconstruction of the pelvic fundus are especially significant. The reconstruction of the urinary tract, following performed multivisceral resection, most frequently is performed by forming of ileal or colon conduit. There are very little data from the literature, which differentiate the two methods, and the comparative studia do not demonstrate any existing advantages of one or the other method as regards urinary infection, reduction of glomerular filtration, stenosis, or other complications of uretero-intestinal anastomosis. Practically convenient is the model with creating of ileal conduit, and in the cases, when the trigone of urinary bladder is not involved, and partial cystectomy is possible, the plastic surgery of urinary bladder is performed with isolated and detubularized intestinal segment (in a good condition, with no signs of post-radiation ileitis along it) (Table 105.1) (Fig. 105.32).

Reconstructive Phase: Forming of Colostoma or Ileostoma

- Brooke technique
  - 3-point technique
  - full thickness of bowel – 2–3 mm (must include serous membrane)
  - serous muscular bite of the wall approximately 4 cm from the opening of bowel
  - deep dermal
  - absorbable suture–usually 3–0 or 4–0 Vicryl/Polysorb (Fig. 105.33)

- Pseudo-loop technique

Table 105.1 Algorithm in reconstruction of urine derivation after pelvic exenteration

Partial cystectomy ↓	Radical cystectomy ↓
Residual urinary bladder with sufficient capacity → Primary closure	Continuous urinary derivation → Ileal neovesica (orthotopic) → Ileocecal reservoir
Insufficient capacity → Augmentation with small intestinal segment	Non-continuous urinary derivation → Ileal conduit → Colon conduit

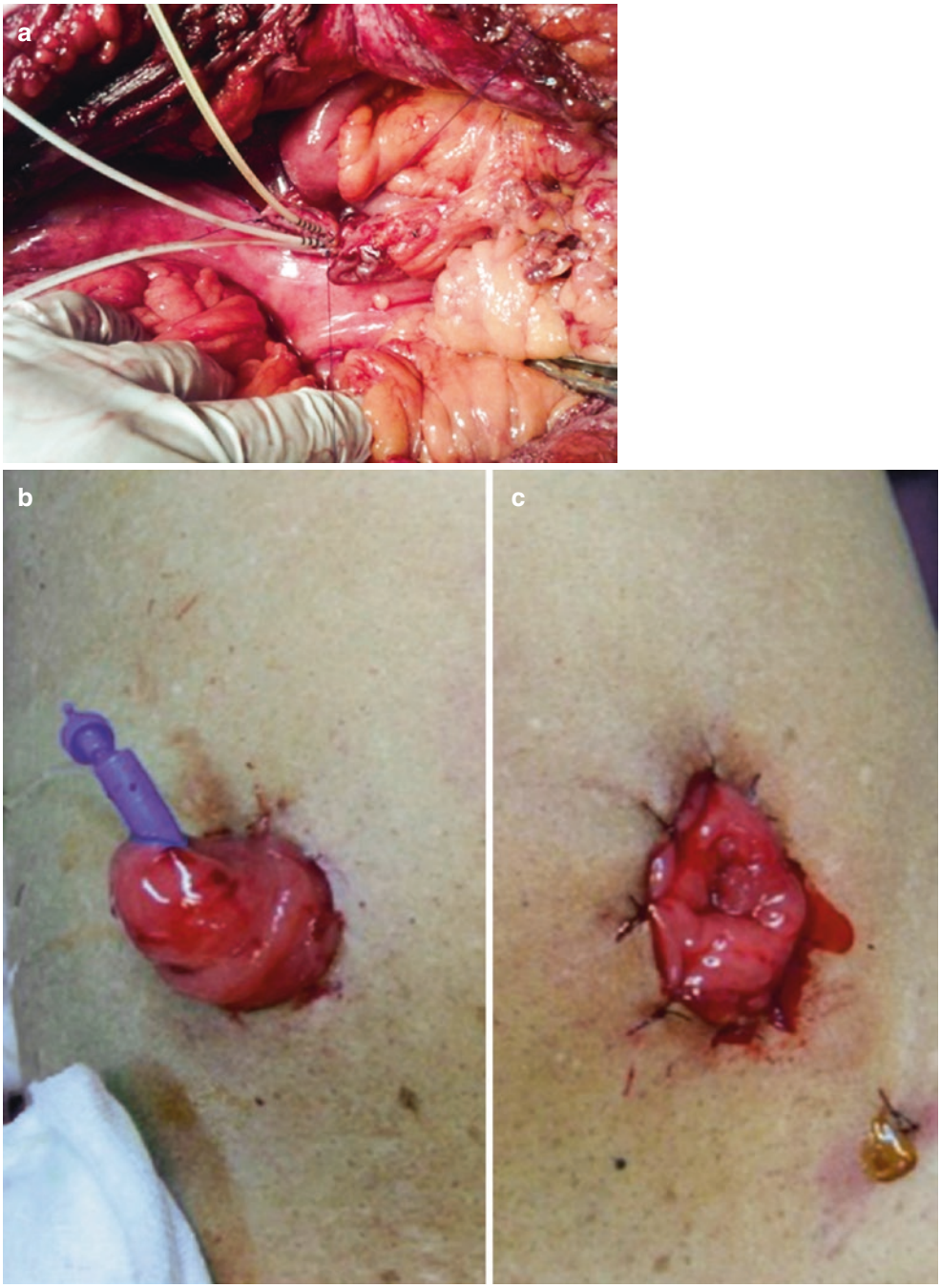


Fig. 105.32 Urine derivation with ileal conduit (**a**, **b**), and colostoma (**c**)

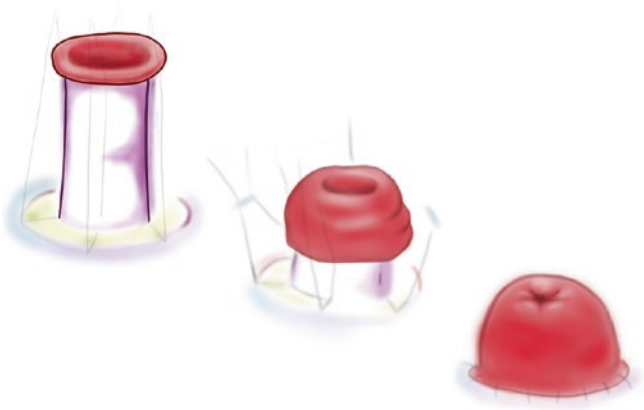


Fig. 105.33 Brooke technique of formation of stoma

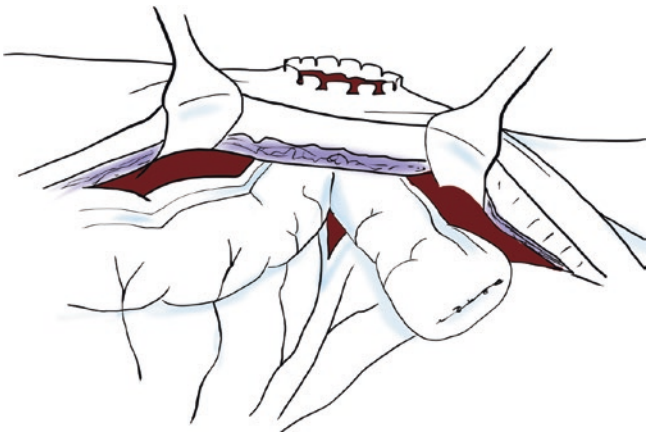


Fig. 105.34 Pseudo-loop technique

  - maturation of antimesenteric border of colon
  - no use of Brooke technique–often ends up at skin level, or retracted
  - emergencies only–only when no other stoma will reach (Fig. 105.34)

Appropriate Lengths for Stoma

- Ileostomy
  - Total bowel length above skin – 6–8 cm
  - Loop – 3 cm at mesenteric apex
  - Height of spout after Brooke ileostomy creation of more than 20 mm decreases skin/wound issues
- Colostomy
  - Total bowel length above skin – 2–4 cm
  - Height of stoma after colostomy maturation should be more than 5 mm

Stoma Complications

- Technical
  - Surgeon factors: judgement; technique; stoma type
  - Patient factors: indication for stoma creation; baseline functional status; postoperative care

- Physiological
  - electrolyte abnormalities
  - fluid balance
  - nutritional deficiencies
  - cholelithiasis
  - psychosocial issues.

The most frequent complications are:

Vascular Compromise of the Stoma due to

- technical error
- venous congestion
- disruption of segmental arterial supply
- too tight abdominal wall
- if inferior mesenteric artery is ligated, the ascending branch of left colic arter must be retained

Stenosis/Stricture (About 2–14 %)

- late sequela of vascular compromise
- it may present with bowel obstruction at level of fascia
- it is often successfully treated with finger tip dilation
- if there is unacceptable result, revision may be required
- if early on, it may be due to a small aperture through fascia

Dusky Stoma

- 2–17 % of stomas
- superficial
- full thickness

(If superficial–it can be watched and treated conservatively; if intraperitoneal–it needs laparotomy and revision) (Figs. 105.35 and 105.36).

Stomal Prolapse It is usually a late occurrence, and includes approximately 7 % of all stomas and up to 30 % of transverse

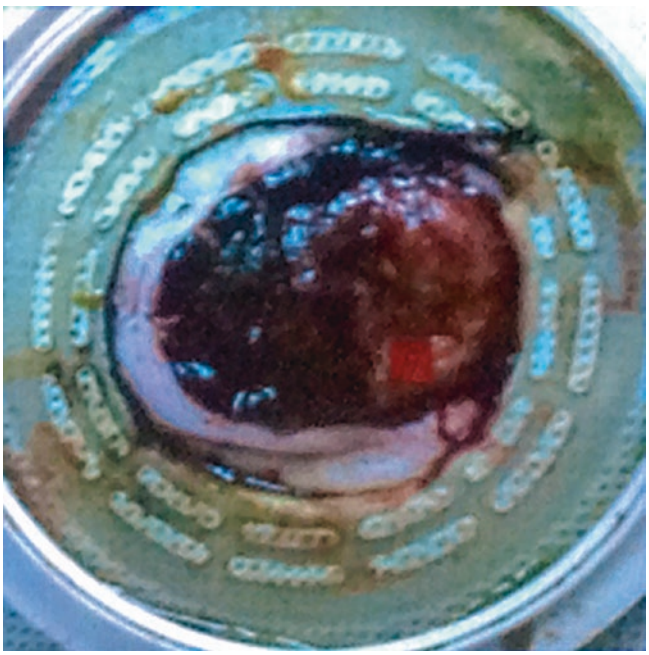


Fig. 105.35 Dusky stoma

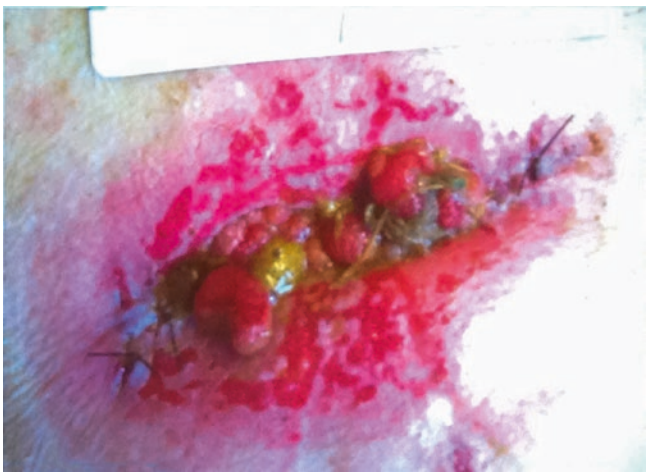


Fig. 105.36 Retraction of the stoma after vascular compromise

loop colostomies; it is controversial whether suturing bowel to fascia will prevent this (Figs. 105.37 and 105.38).

In case of chronic prolapse, the surgical options include:

- modified Altmeier or Delorme procedures (dissection of mucocutaneous junction; resection of either only mucose (Delorme procedure), or full thickness (Altmeier procedure)), and repeated Brooke stoma for creation of a new mucocutaneous border
- relocation of stoma with resection of extra length
- Burton modification of Thirsch Wire technique



Fig. 105.37 Stromal prolapse

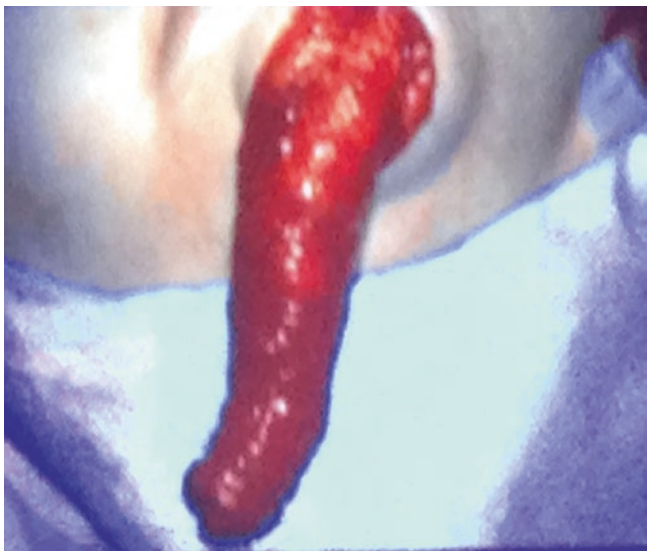


Fig. 105.38 Acute prolapse with necrosis of the bowel segment

Parastomal Hernia

- incidence is unknown due to underreporting and difficult detection
- estimated to be 20–80 %
- more frequent with colostomy than ileostomy
- early (presents with acute pain, mass, obstruction; less than 30 days from stoma creation).

It is due to technical failure; too large of an aperture in fascia.

- late ("inevitable"–according to many authors; it presents with slow growing mass, abnormal contour of tissues around stoma; consequence of increasing intraabdominal tension)

Difficult Stomas to Create

- inflamed, thickened, foreshortened mesentery (prior operation or inflammatory changes)
- obesity (thick abdominal wall and/or poor tissue quality)
- distended colon
- epiploic appendages (Fig. 105.39)

The strategy for success in those cases includes excision of the total inflamed sigmoid colon–the segment used for stoma must be free of inflammation.

Obesity stoma creation features with increased depth of skin creases, which causes pouching difficulties, even when properly constructed, and well-located ostomies; it is difficult to identify the rectus mucles preoperatively; obese patients cannot see their lower abdomen; thickened abdominal wall adipose tissue requires increased amount of length for mobilisation (Fig. 105.40).

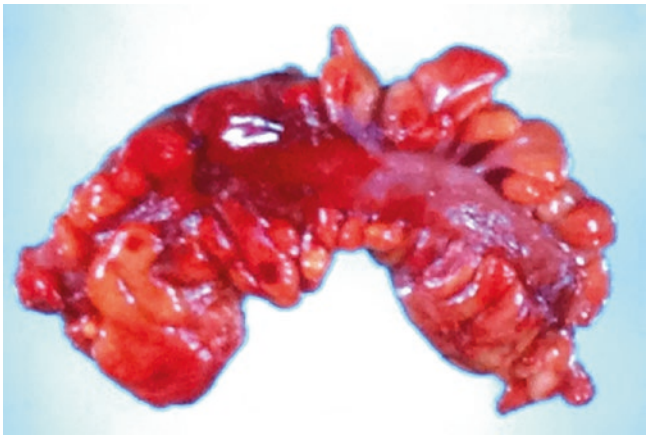


Fig. 105.39 Inflamed and full of epiploic appendages sigmoid colon–inappropriately for stoma creation segment–it must be resected

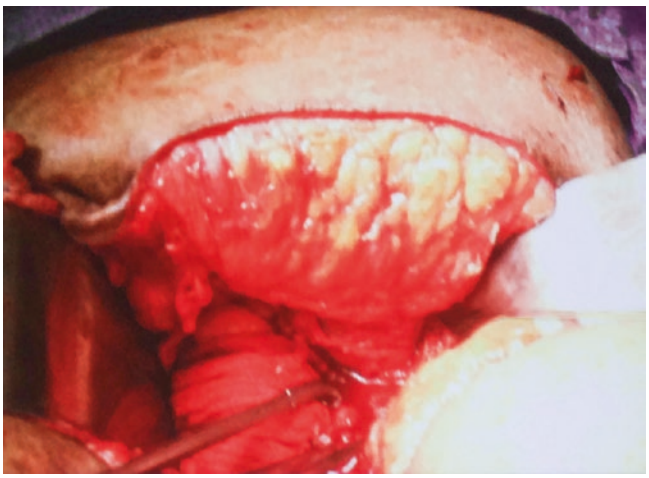


Fig. 105.40 Creation of colostoma in obese patient – BMI = 48.7

Tactics in Management and Reconstructions of Perineal Wound. Filling of the Pelvic "Dead Space" (Empty Space): Vaginal Reconstruction

The surgical removal of relapsed rectal tumor, especially in local advance of process and performed multivisceral and/or bone resections, results in formation of wide soft tissue defect and frequently requires also reconstruction of the urogenital tract. Additionally to the latter, the wound healing can be seriously affected by prior chemoradiotherapy, which involves significant risk of complications as infection, dehiscence, and delayed wound repair. The optimal healing and outcome can be achieved with the use of pedicularized cutaneous and muscular flaps.

In women with anterior pelvic exenteration, the vaginal reconstruction is performed with pedicularized flap–most frequently myocutaneous flap from rectus muscle of abdomen. This flap has the advantage of being constructed with a long pedicle, and it may fill the lesser pelvis, as well as be used for plastic surgery of vagina and perineum. The flap passes transpelvically and is rotated in order to cover the perineum. The nutrition of the flap is realized by the deep inferior epigastric blood vessels, with the use of the right muscle and skin area, because definitive colostoma is created most frequently on the left side of anterior abdominal wall. The authors, who use the method, do not report of any complications on the part of the donor portion of anterior abdominal wall. Only one out of five women have some complications subsequent to vaginal plastic surgery of that method and although most do not have any post-surgery sexual intercourses, almost all women prefer such plastic recovery [33].

The perineal and sacral defect after multivisceral surgical operation for rectal relapse may be wide with different options described for their plastic recovery. The closure of the defect may be achieved by means of biologic cloths (e.g. Pharmacol) or absorbable prosthetic cloths, or pedicularized flaps. Except for the transpelvic vertical myocutaneous flaps from the anterior right rectus muscle of abdomen, gluteal and femoral muscles are also used, as well as free myocutaneous flaps. In patients who had underwent preoperative radiotherapy, a myocutaneous flap with the use of rectus muscle of abdomen is preferred against the gluteal donor area. It is also used in patients with distal sacrectomy, when the first branch of the internal iliac blood

vessels is not preserved. Myocutenous flaps, according to many authors, are preferred to the omentoplastic surgery or primary provisionary closure with excellent results in several series [34]. A myocutaneous flap with the use of gracilis muscle is related to more complications and covers smaller portion, and therefore the authors do not recommend it [35].

The adding of surgical procedure of omentoplasty to the referred plasty methods allows reduction of the dead space in the lesser pelvis, decrease of the period of draining, as well as improvement of the healing of perineal wound. The omentoplasty takes little time and is performed by downward pulling in the lesser pelvis (antecolically or retrocolically) of the omentum priorly mobilized from the side of the greater curvature of stomach during the abdominal surgery time. During the perineal or sacral phase of operation, the omentum is finally drawn out and fixed at place (Figs. 105.41, 105.42, 105.43, 105.44, 105.45, 105.46, 105.47, 105.48 and 105.49).



Fig. 105.41 Perineal view after amputation of rectum + resection of urinary bladder with plastic surgery of urinary bladder and repeated implantation of ureters (wide extralevator excision in perineal stage)

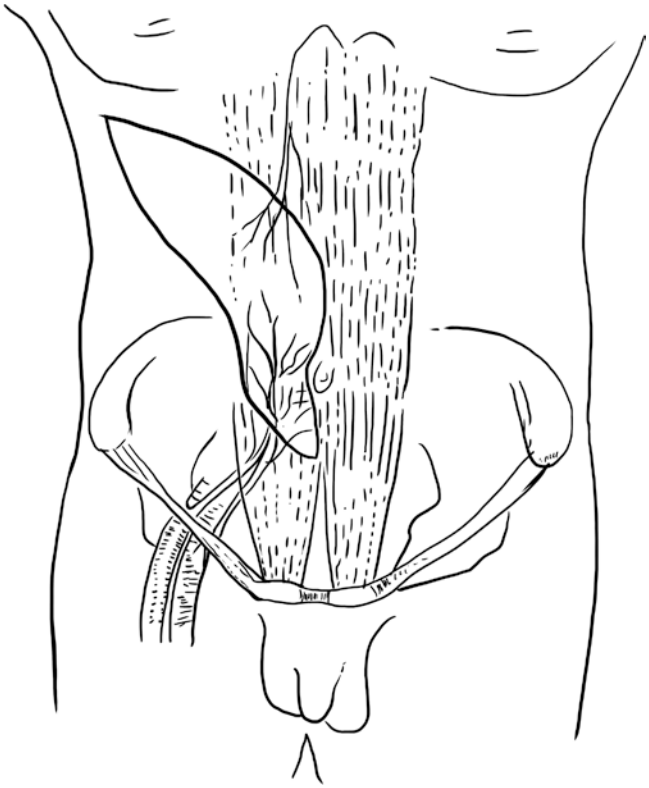


Fig. 105.42 Scheme of vertical rectus abdominis myocutaneous (VRAM) flap



Fig. 105.43 Reconstruction of perineal defect with a pedicularized flap–myocutaneous flap from rectus muscle of abdomen–anatomization and subsequently transpelvically rotated



Fig. 105.44 Preparation of a flap for replacement to the pelvic defect



Fig. 105.45 Covering of the pelvic defect with myocutaneous flap



Fig. 105.46 Gracilis-plastic creation in reconstructive phase

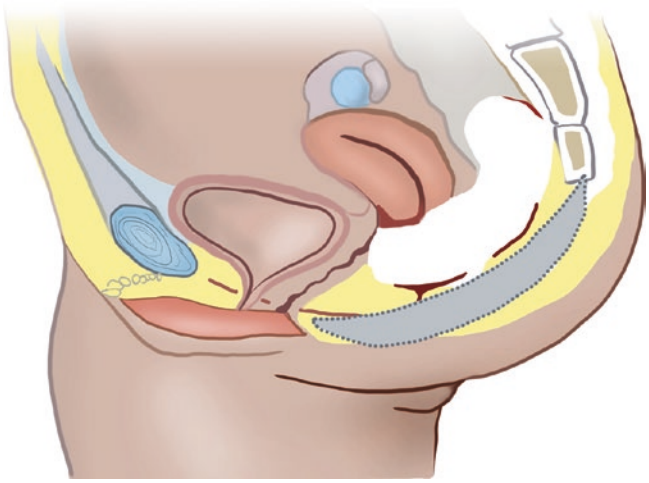


Fig. 105.47 Sheme of perineal reconstruction after sacro-coccygeal resection

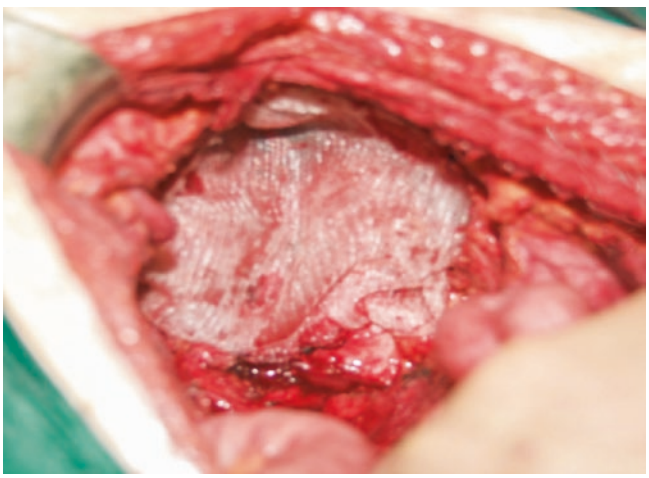


Fig. 105.48 Implantation of prosthetic polypropylene mesh after total pelvic exenteration



Fig. 105.49 Prosthetic mesh repair in pelvic reconstruction after transsacral extirpation

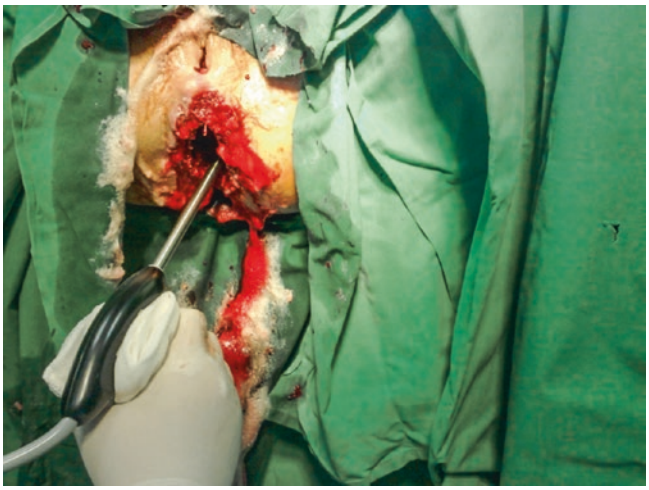


Fig. 105.50 Cryodestruction (using circulating in the cryo-probe gas N_2O – in −89 °C repeated freeze-thaw 1 min cycles for a period of 20 min) of unresectable rectal carcinoma with massive infiltration into the uterus, vagina, bladder, lateral and posterior pelvic walls + shaped a pathological fistula between the remnant pelvic cavity with the relapsed tumor and posterior wall of the vagina

Palliative Treatment

Although the pelvic exenteration was initially designed as a palliative procedure, its use for palliative treatment remains controversial. Due to the high morbidity and perioperative mortality, related to the procedure, some authors do not recommend it as palliative. Other authors consider that with pelvic exenteration the quality of life of patients with advanced stage of the disease can improve and that is why it is indicated for palliative treatment.

The pelvic exenteration is used as palliative treatment in cases of uncontrallable pains in the pelvis, tumor abscess, relapsing hemorrhages, intestinal obstruction, enterourinary and genitourinary fistulas, etc.

A wide variety of palliative locally destructive and other palliative techniques come into consideration in cases of locally advanced unresectable primary pelvic tumor or unresectable locoregional recurrence in pelvis . Those are: bypass anastomoses; disruption of the intestinal passage (anus preter without definitive resection of the tumor-bearing section); intermittent providing the mechanical intestinal conductivity–tunnelization (like Cryodestruction or stenting), cytoreductive surgery (includind Cryodestruction)–reduce cancer intoxication, palliative ligation of large blood vessels in order to prevent life-threatening bleeding; other methods – termoablation of metastasis, locoregional chemotherapy for liver metastasis by implantation a catheter through a. gastroduodenalis into *a. hepatica* propria–Port-A-Cath, hyperthermic intraperitoneal chemotherapy (HIPEC)–in cases of diffuse metastatic peritoneal spread (Figs. 105.50 and 105.51).

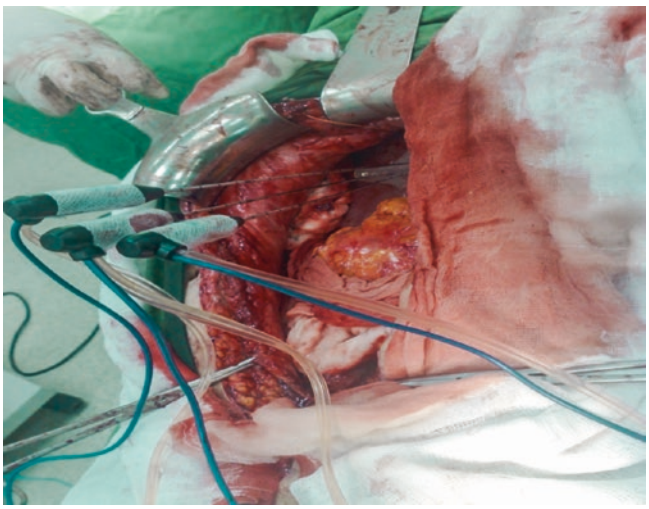


Fig. 105.51 Termoablation of unresectable liver metastasis

Potential Complications of Pelvic Exenteration

1. *Gastrointestinal complications*
   Intestinal obstruction
   Enteroperineal fistula
   Perineal hernia
   Peristomal hernia
   Bleeding

2. *Urine conduit*
   Insufficiency
   Stricture of the anastomosis
   Calculi
   Urinary sepsis or pyelonephritis
   Enterourethral fistula

3. *Pelvic*
   Abscess
   Fistula
   Wound infection

4. *General*
   Myocutaneous necrosis of the flap
   Pneumonia
   Deep venous thrombosis
   Depression
   Difficult social adaptation

Management of the Complications

Bleeding

The intraoperative hemorrhagia during surgery for advanced pelvic primary or relapsed tumor can be serious and life-threatening, and it requires methodical approach for its stopping. Most frequently the bleeding has as a source the presacral venous plexus or the internal iliac veins, and it could quickly result in the need for massive replacement hemotransfusion with subsequent fatal coagulopathy. In this case it is especially important to keep calm, and compression to be provided–a hot wet compress on the bleeding section, additional and sufficient light, and width of the field to be ensured by widening of the incision, if possible. The anesthesiologist must be informed of the quantity and intensity of blood loss, as well as about the planned units of blood and plasma. Frequently the "packing" is achieved by massive compression for 10 min. There is a dramatical effect, which results in hemostasis. The removal of compress requires careful manipulation with it in order not to be extracted the created vascular obturators and to prevent renewal of bleeding. If these occur, the following algorithm comes into consideration:

Persistent bleeding from the presacral veins → Mechanical hemostasis (1. Vascular ligation with non-resorbable sutures; 2. Clasps) → High-energy devices (1. Powerful diathermia (spray regimen); 2. Argon plasma coagulator; 3. Harmonic scalpel) → Hemostatic agents (1. Surgical; 2. FloSeal; 3. Fibrin-glue) → Packing (tamponade) for 36 h → Dissection along the sacrum and resection of the Waldeyer's fascia → Ligation of the dorsal veins → Clamping / ligation of the internal blood vessels → Looking for co-operation by a vascular surgeon.

Wound Complications

The wound complications are among the most frequent ones, accompanying the pelvic exenteration, and at the same time they frequently delay and prolong significantly the period of postoperative morbidity. Risk factors are the neoplastic disease itself with its reflection on the organism, preoperative radiotherapy, poor antiseptics and aseptics, coarse manipulation with the tissues and poor choice of surgical tactics for recovery of soft tissue defects. Approximately 43 % of patients, who underwent abdominoperineal resection, develop wound complications (Fig. 105.52).

In the presence of infection at the operative site, the adequate draining and necrectomy are the first important conditions for its overcoming. As a result a big open defect is created, in some cases this would be through performing of a laparotomy which is difficult for everyday care (Fig. 105.53). A good therapeutic variant in these cases is the Negative Pressure Wound Therapy (NPWT) with its necessary devices and consumables, which facilitate and accelerate the therapeutic process by preventing of multiple daily change of dressings, malodorous secretions from the wound, stimulation of repair of tissues and shortening of hospital stay, which represents financial benefit as well. System Info VAC® (KCI®) is excellent for such cases. After each surgery the wound defect is left under V.A.S. operational bandage to reduce contamination, drainage of wound secretions and stimulation of granulation. The most frequently used pressure is high level vacuum (−125 mmHg)

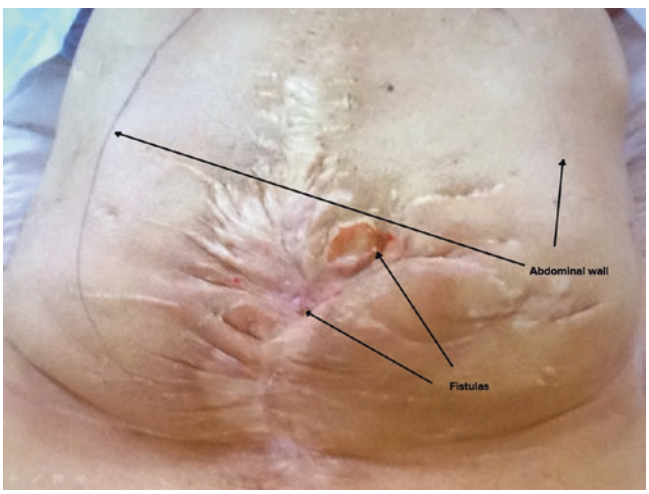


Fig. 105.52 Enterocutaneous fistulas after surgical side infection

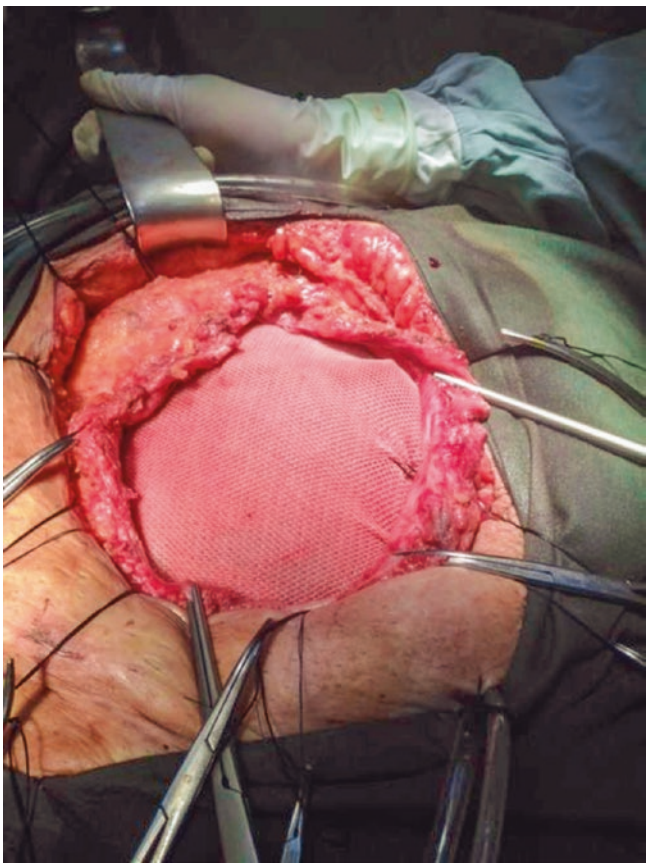


Fig. 105.53 Laparostoma covered with prosthetic mesh

and dressing type VAC Granu Foam® (KCI®) (Fig. 105.54). The frequency of replacement is 48 h. During the replacement of the dressing there should be carried out debridement with jet irrigation or lavage with saline according to the condition of the wound. It is often used also a modified vacuum assisted laparostoma consisting of three layers: an inner–silicone (nylon) canvas, intermediate–mesh (ampoksen shed, prolene, Miculitz compress) and outside–coverslip foil. The mesh is sutured to the fascia with absorbable suture – 2/0. Between the mesh and the cover sheet are placed gauze compresses and aspiration drain, providing negative pressure. Surgical wound and the whole abdomen are covered with surgical foil (e.g. Joban-2, 3 M). Drainages should be placed of permanent soft aspiration (50–125 mmHg) forming a vacuum that constantly cleans the wound. That negative pressure evacuates surgical wound secretions and also stimulates granulation on the wound surface.

Separation of the abdominal wall – Component separation technique by Oscar Ramirez, is a method of choice in impossible conventional secondary closing of the laparostoma defect after overcoming of the abdominal sepsis (Fig. 105.55a, b). The plan of dissection is comprised between the separate layers of the anterior abdominal wall as well as it is mandatory being especially careful to preserve the perforant branches of the lower and upper epigastric vessels to the rectus abdominis muscles and also prevent the development of abdominal compartment syndrome.



Fig. 105.54 A vacuum system for maintaining a negative pressure in the wound

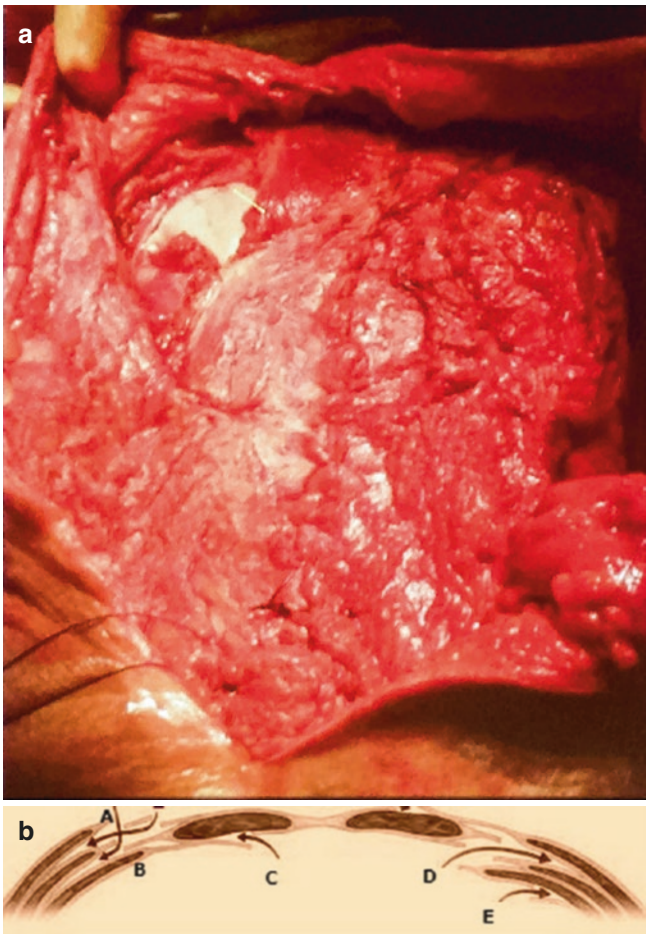


Fig. 105.55 (**a**) Abdominal wall separation as reconstructive method of abdominal wall closure after laparostoma. (**b**) – Scheme of Ramirez technique – component separation: *A* incision 2 cm laterally of m. rectis abdominis and plan of dissection between *m. obliquus* abd. externus and *m. obliquus* abd. internus; *B* plan of dissection between *m. obliquus* abd. internus and *m. transversus* abdominis; *C* incision of the posterior fascial sheath of *m. rectus* abdominis; *D* incision through peritoneum, fascia transversalis, fascia *m. obliquus* abd. internus and plan of dissection between *m. obliquus* abd. externus and *m. obliquus* abd. internus: *E* preperitoneal plan of dissection

Neoadjuvant Chemoradiotherapy and Adjuvant Chemotherapy in Cases of Rectal Cancer

- It has been proved that the preoperative radiotherapy improves the resectability of not less than 50–75 % of patients with non-resectable rectal tumors and it is more effective than the postoperative radiotherapy (L. Pahlman) [31].
- The use of chemotherapy in combination with radiotherapy may increase the effectiveness of radiotherapy as regards the transformation into lower stage of initially non-resectable tumors.
- Minsky et al. reported that the intake of 5-Fluorouracil + Leukovorin with additional 50.4 Gy preoperative radiation on the pelvis result in higher grade of response and less regional lymph nodes with metastases upon the resection, than the radiotherapy itself [32].
- Neoadjuvant chemoradiotherapy in case of rectal cancer:
  - It is applied in locally advanced cancer and is combined with radiotherapy 50–54 Gy + 5-Fluorouracil + Leukovorin.
- Adjuvant chemotherapy
  - It is applied after surgical treatment of locally advanced cancer. Preliminary histological examination of the tumor for the marker K-ras is recommended.
    (i) Leukovorin + 5-Fluorouracil
    (ii) Oxaliplatin + Leukovorin
    (iii) Capecitabine

In terms of evidence-based approach in pelvic exenteration, it would be useful to demonstrate a comparison as regards the survival of groups of patients with potentially curative pelvic exenteration, palliative pelvic exenteration, and palliative non-resectable procedure [39]. According to Zarkov et al. the 5-year survival for radical pelvic exenteration is about 22 %, whereas survival for the palliative pelvic exenteration does not exceed 18–30 months and explorative laparotomies and palliative procedures have reached only 2–9 months survival [28]. Those data eloquently emphasize significantly more prolonged period of overall survival in the group of potentially curative pelvic exenterations.

Conclusion

The pelvic exenterations have their place in the treatment of advanced pelvic tumors. Irrespective of the severe surgical trauma and the comparatively high frequency of postoperative complications, in well-selected patients, carefully precized surgical tactics, and adequate perioperative cares, the procedure provides an opportunity for improvement of the survival and it has explicit indications.

Nevertheless, the pelvic exenteration continues to be a very traumatic intervention with potential of severe complications in the early and late postoperative period.

There is a lot of evidence that the pelvic exenteration in patients with primary rectal cancer and cancer of uterine cervix may result in significant increase of their

5-year survival; however, the prognosis after pelvic exenteration in patients with relapsed rectal carcinoma still is not so good.

The pelvic exenteration keeps on having an important role in the multimodal approach in the treatment of patients with advanced pelvic tumors. Conditions for improvement of the surgical technique and lowering of the frequency of complications are established with the acquiring of bigger experience in the field of that pathology.

References

1. Willett C, Rodriguez-Bigas M, Ryan D. Treatment of locally recurrent rectal adenocarcinoma [Internet]. Uptodate.com. 2016 [cited 14 November 2016]. Available from: http://www.uptodate.com/contents/treatment-of-locally-recurrent-rectal-adenocarcinoma#H29
2. Guillem JG, Chessin DB, Cohen AM, et al. Long-term oncologic outcome following preoperative combined modality therapy and total mesorectal excision of locally advanced rectal cancer. Ann Surg. 2005;241:829.
3. Greene F, Page D, Fleming I, Fritz A, Balch C, Haller D, Morrow M. Colon and rectum. In: American Joint Committee on Cancer.: AJCC Cancer Staging Manual. 6th ed. New York: Springer. 2002:113–24.
4. Vanev Y. Advanced and complicated colorectal cancer. XIII National and International Surgical Congress, Oct 2010, Sofia, Report, p. 481–500.
5. Oh SY, Kim YB, Paek OJ, Suh KW. Contiguous invasion per se does not affect prognosis in colon cancer. J Surg Oncol. 2009;99(1):71–4.
6. Pittam MR, Thornton H, Ellis H. Survival after extended resection for locally advanced carcinomas of the colon and rectum. Ann R Coll Surg Engl. 1984;66:81–4.
7. Polk Jr HC. Extended resection for selected adenocarcinomas of the large bowel. Ann Surg. 1972;175:892–9.
8. Bonfanti G, Bozzetti F, Doci R, et al. Results of extended surgery for cancer of the rectum and sigmoid. Br J Surg. 1982;69:305–7.
9. Eisenberg SB, Kraybill WG, Lopez MJ. Long-term results of surgical resection of locally advanced colorectal carcinoma. Surgery. 1990;108:779–86.
10. de Wilt JHW, Vermaas M, Ferenschild F, Verhoef C. Management of locally advanced primary and recurrent rectal cancer. Clin Colon Rectal Surg. 2007;20(3):255–63.
11. Gall FP, Tonak J, Altendorf A. Multivisceral resections in colorectal cancer. Dis Colon Rectum. 1987;30:337–41. [PubMed]
12. Heslov SF, Frost DB. Extended resection for primary colorectal carcinoma involving adjacent organs or structures. Cancer. 1988;62:1637–40.
13. Hunter JA, Ryan Jr JA, Schultz P. En bloc resection of colon cancer adherent to other organs. Am J Surg. 1987;154:67–71. [PubMed]
14. Izbicki JR, Hosch SB, Knoefel WT, et al. Extended resections are beneficial for patients with locally advanced colorectal cancer. Dis Colon Rectum. 1995;38:1251–6.
15. McGlone TP, Bernie WA, Elliott DW. Survival following extended operations for extracolonic invasion by colon cancer. Arch Surg. 1982;117:595–9.
16. Nakafusa Y, Tanaka T, Tanaka M, et al. Comparison of multivisceral resection and standard operation for locally advanced colorectal cancer: Analysis of prognostic factors for short-term and long-term outcome. Dis Colon Rectum. 2004;47:2055–63.
17. Park S, Lee YS. Analysis of the prognostic effectiveness of a multivisceral resection for locally advanced colorectal cancer. J Korean Soc Coloproctology. 2011;27(1):21–6.
18. Cho S, Lee R-A, Chung S, Kim K. Concomitant adjacent organ resection in locally advanced colon cancer. J Korean Soc Coloproctol. 2009;25(2):94–9.
19. Hoffmann M, Phillips C, Oevermann E, Killaitis C, et al. Multiviszerale und Standardresektionen bei kolorektalen Karzinomen. Coloproctology. 2012; 34(3): 177–85. http://rd.springer.com/article/10.1007/s00053-012-0288-2.
20. Gezen C, Kement M, Altuntas Y, Okkabaz N, Seker M, Vural S, Gumus M, Oncel M. Results after multivisceral resections of locally advanced colorectal cancers: an analysis on clinical and pathological T4 tumors. World J Surg Oncol. 2012;10:39.
21. MERCURY Study Group. Diagnostic accuracy of preoperative magnetic resonance imaging in predicting curative resection of rectal cancer: prospective observational study. BMJ. 2006;333(7572):779. Epub 2006 Sep 19.
22. Moffat FL, Falk RE. Radical surgery for extensive rectal cancer: is it worthwhile? Recent Results Cancer Res. 1998;146:71–83. [PubMed].
23. Kukreja SS, Esteban-Agusti E, Velasco JM, Hieken TJ. Increased lymph node evaluation with colorectal cancer resection: does it improve detection of stage III disease? Arch Sur. 2009;144:612–7. -46.
24. Wiig J., Søreide O., Locoregional recurrence of rectal cancer, © 2001, W. Zuckschwerdt Verlag GmbH.,ncbi.nlm.nih.gov/books/NBK6972/Bookshelf ID: NBK6972–47.
25. Jensen, LH, Altaf, R, Harling, H, Jensen, M, Laurberg, S, Muhic, A, Vestermark, L, Jakobsen, A, Bülow, S & Jess, Danish Colorectal Cancer Group, P. 'Clinical outcome in 520 consecutive Danish rectal cancer patients treated with short course preoperative radiotherapy'. Euro J Surg Oncol. 2010; 36(3) : 237–43. doi: 10.1016/j.ejso.2009.10.008.
26. Williamson JS, Jones HG, Davies M, Evans MD, Hatcher O, Beynon J, Harris DA, Swansea Colorectal Cancer Group. Outcomes in locally advanced rectal cancer with highly selective preoperative chemoradiotherapy. Br J Surg. 2014;101(10):1290–8. doi:10.1002/bjs.9570. Epub 2014 Jun 12.
27. Landoni F, Maneo A, Colombo A, Placa F, Milani R, Perego P, Favini G, Ferri L, Mangioni C. Randomised study of radical surgery versus radiotherapy for stage Ib-IIa cervical cancer. Lancet. 1997;350(9077):535–40.
28. Zarkov K, Petkov C, Assenov A, Mochurova M, Velinov P, Yusef H, Shopov G, Vlahova A. Exended colo-rectal surgery for exended colonic, rectal and pelvic primary or relapse malignancies. Scripta Scientifica Medica. 2015;47(Suppl 1):pp65–6.
29. Lozev I, Smilov N, Halachev N, Lozev P, Pidakiev I. Pelvic exenteration for locally advanced pelvic tumors. Scripta Scientifica Medica. 2015;47(Suppl 1):86.
30. Cass AW, Million RR, Pfaff WW. Patterns of recurrence following surgery alone for adenocarcinoma of the colon and rectum. Cancer. 1976;37(6):2861–5.
31. Graf W, Påhlman L, Bergström R, Glimelius B. The relationship between an objective response to chemotherapy and survival in advanced colorectal cancer. Br J Cancer. 1994;70(3):559–63.
32. Minsky BD. Future of therapy for rectal cancer. Chin Clin Oncol. 2013;2(2):19. doi:10.3978/J.ISSN.2304-3865.2013.03.01.
33. Bell SW, Dehni N, Chaouat M, Lifante JC, Parc R, Tiret E. Primary rectus abdominis myocutaneous flap for repair of perineal and vaginal defect after extended abdominoperineal resection. Br J Surg. 2005;92:482–6.
34. Butler CE, Gůndeslioglu AO, Rodriguez-Bigas MA. Outcomes of immediate vertical rectus abdominis myocutaneous flap reconstruction for irradiated abdominoperineal resection defects. J Am Coll Surg. 2008;206:694–703.
35. Miles WK, Chank DW, Kroll SS, et al. Reconstruction of large sacral defects following total sacrectomy. Plast Reconstr Surg. 2000;105:2387–94.

36. Pilipshen SJ, Heilweil M, Quan SH, et al. Patterns of pelvic recurrence following definitive resections of rectal cancer. Cancer. 1984;53:1354–62.
37. McDermott FT, Hughes ESR, Pihl E, et al. Local recurrence after potentially curative resection for rectal cancer in a series of 10,008 patients. Br J Surg. 1985;72:34–7.
38. Rao AR, Kagan AR, Chan PM, et al. Patterns of recurrence following curative resection alone for adenocarcinoma of the rectum and sigmoid colon. Cancer. 1981;48:1492–5.
39. Hahnloser D, Nelson H, Gunderson LL, et al. Curative potential of multimodality therapy for locally recurrent rectal cancer. Ann Surg. 2003;237:502–8.
40. Suzuki M, Dozois RR, Devine RM, et al. Curative reoperations for locally recurrent rectal cancer. Dis Colon Rectum. 1996;39:730–6.
41. Boyle KM, Sagar PM, Chalmers AG, Sebag-Montefiore D, Cairns A, Eardley I. Surgery for locally recurrent rectal cancer. Dis Colon Rectum. 2005;48:929–37.
42. Mirnezami A, Sagar P. Surgery for recurrent rectal cancer: technical notes and management of complications. Tech Coloproctol. 2010;14(09):209–16.
43. Valentini V, Morganti AG, Gambacorta MA. Preoperative hyperfractionated chemoradiation for locally recurrent rectal cancer in patients previously irradiated to the pevis. A multicentric phase II study. Int J Radiat Oncol Biol Phys. 2006;64:1129–39.
44. Austin KK, Solomon MJ. Pelvic exenteration with en bloc iliac vessel reection for lateral pelvic wall involvement. Dis Colon Rectum. 2009;52:1223–33.

Pelvic and Para-aortic Lymph Node Dissection

106

Florian Heitz, Andreas du Bois, and Philipp Harter

General Surgical Approach of Systematic Abdominal LNE

Open surgery is the standard in ovarian malignancies and still indicated in some patients with uterine malignancies despite the advances of endoscopic surgery. If pelvic and paraaortic lymphadenectomy is indicated for surgical staging in women with malignant uterine disease and the laparoscopic approach is contraindicated or rejected by the patient, abdominal LNE should be performed. Minor bleedings are coagulated with the bipolar forceps immediately by the first assistant. The lymph vessels and the surrounding tissue at the cranial border at the renal vein and at the caudal border at the annulus inguinal internus should be cut horizontally with a vessel sealing device, to minimize the risk of lymphatic drainage postoperatively and the development of lymphoceles. In addition, a conventional ligature or clip should be placed to further reduce the risk. If the application of sponges to the resection site immersed with thrombin and coagulation factor 1 is of further benefit is currently under investigation.

Technical Requirements

To conduct abdominal systematic pelvic lymphadenectomy bipolar scissors, bipolar forceps and a monopolar needle should be available as well as vessel sealing instruments, clips and ligatures to minimize lymphatic spillage after excision of the lymph nodes. To obtain an optimal exposure of the surgical area a sufficient retractor must be available (in here, shown our most frequently used Muenster retractor, Fig. 106.1).

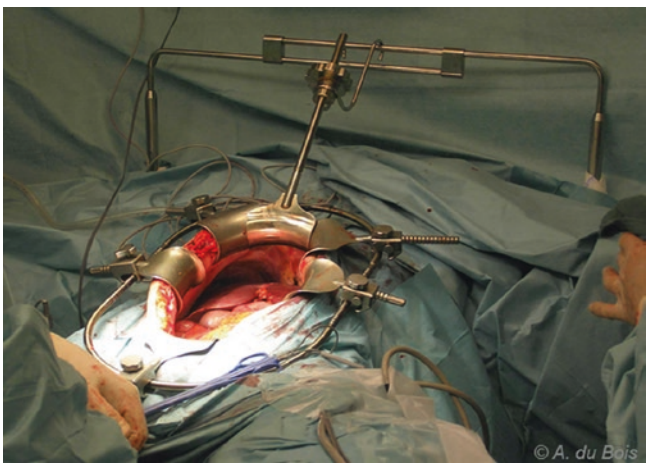


Fig. 106.1 A number of different retractors are commercially available. The retractor system shown here is a combination of the body-placed Münster retractor to obtain lateral and to a lesser degree vertical retraction combined with the Gnauert bracket for further vertical but also ventral retraction. If there is no tumor suspected in the upper abdomen, the midline incision must not be conducted as far as shown here, but probably 5 cm less

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Preparations

The patient is settled down on a vacuum mattress in lithotomy position and the lower legs and feet are placed into cushioned surgical shoes. The patient wears antithrombotic stockings. The hip and the knees are slightly (20–30°) inflected to prevent compartment syndromes and other lesion due to wrong positioning. The patient receives cefuroxim and metronidazol as antibiotic prophylaxis. The first surgeon needs assistance by at least one surgical assistant (superiorly by two, one on the other side and one between the legs) and an assisting nurse.

Median laparotomy is conducted with an incision from the pubic bone to the xiphoid with a scalpel and the layers of the abdominal wall are incised separately with bipolar scissors. After getting into the abdominal cavity, the fascia of the upper right incision is crabbed by two Mikulicz retractors. The abdominal wall is lifted by the second assistant to present the falciforme ligament. It is consecutively removed with bipolar scissors or vessel sealing instruments from the abdominal wall and from the liver surface via bipolar scissors. The teres ligament, which is the caudal end of the falciform ligament is removed over an Overholt forceps and this is replaced by ligature. The Münster retractor with the Gnauert bracket is getting installed (Fig. 106.1). The peritoneum of the paracolic gutter is incised longitudinally of the ascending and descending colon at the white line of Toldt and the peritoneum is separated laterally (Fig. 106.2). To mobilize the colon properly the phrenicocolic ligaments and the spenocolic ligament on the left side have to be incised. As the kidneys might be attached in the connecting tissue of the colon with the anterior lamella of the renal fascia, those should be separated by cutting down the connecting tissue with bipolar scissors, without opening the fascia. Thereafter, the mesocolon sigmoideum is separated from the dorsal connecting tissue up to the suspensory muscle of duodenum (ligament of Treitz) (Figs. 106.3, 106.4, 106.5, 106.6, and 106.7) and the bowl is placed on and covered with wet rags on the chest.

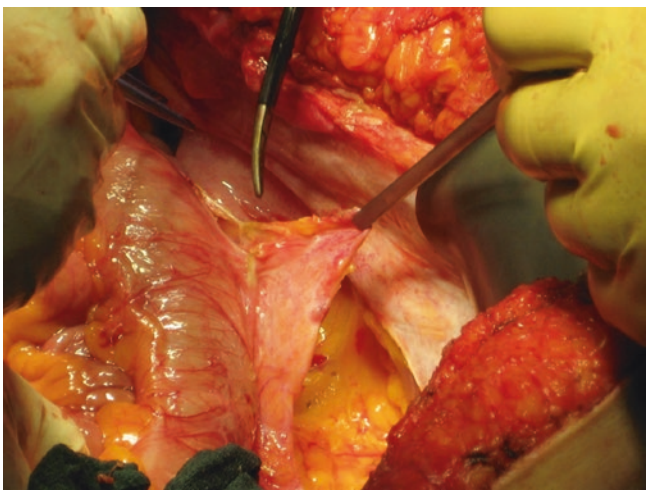
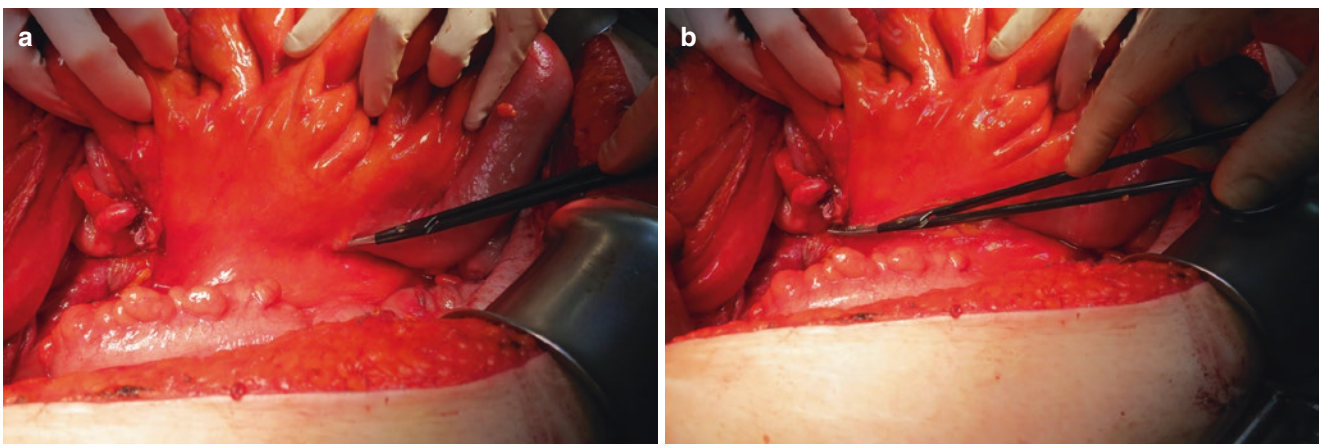
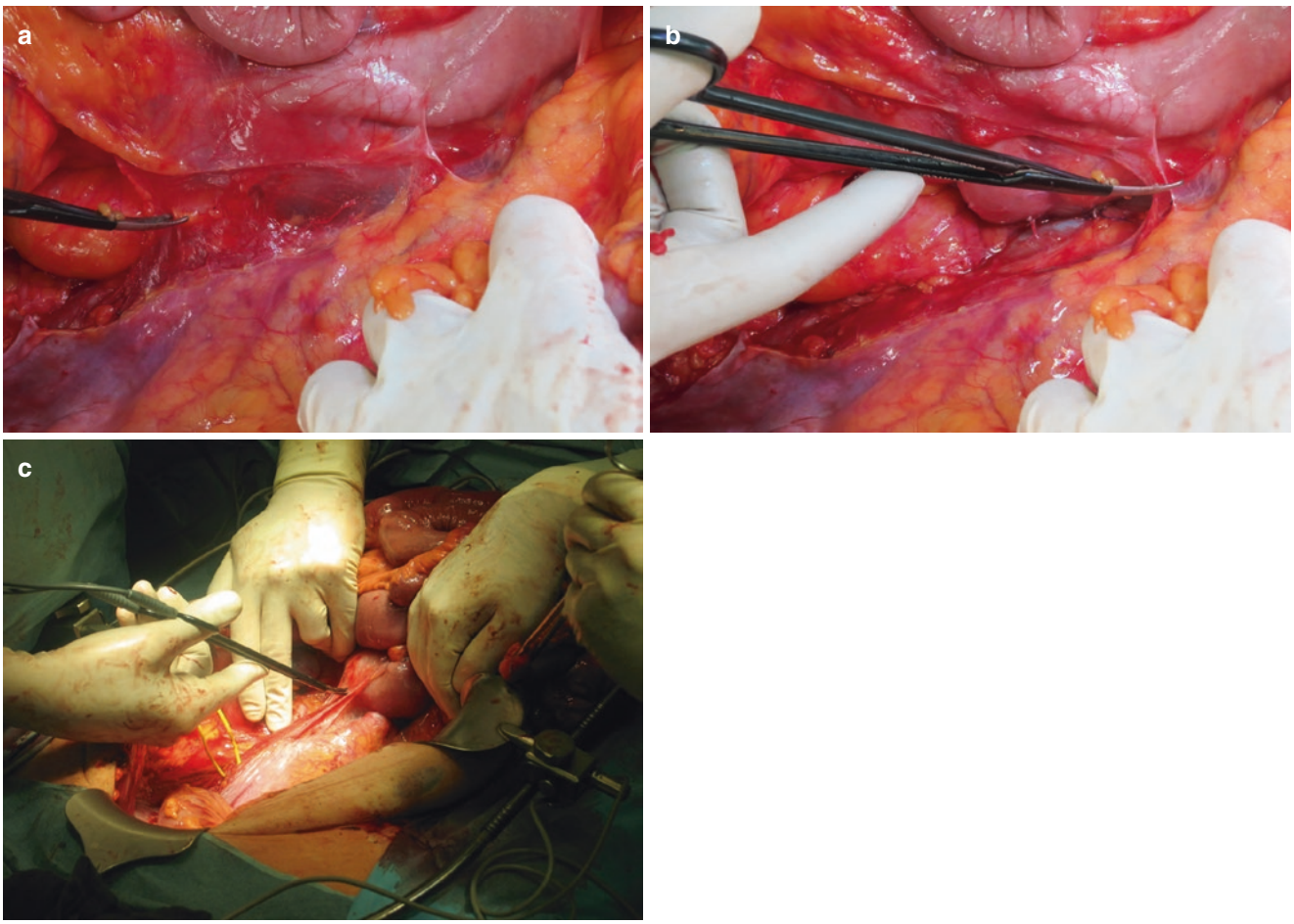


Fig. 106.2 The peritoneum of the paracolic gutter is incised longitudinally of the ascending and descending colon at the white line of Toldt and the peritoneum is separated laterally

In the next step the ureters are located. In case of adnexectomy, the infundibulopelvic ligaments should be identified ventrally and be branched off by Overholt forceps. After incision, the cranial portion is separated out of the connecting tissue being aware that the ureter is just a little dorsolateral. The kidney is pushed laterally with a swab. The infundibulopelvic ligaments will be cut over Overholt forceps at the inferior vena cava on the right side (Fig. 106.8a) and at the left renal vein (Fig. 106.8b). Before, or thereafter, the ureters are elevated and vessel loops might be attached, to minimize direct and traumatic traction (Fig. 106.9). The dorsal attachment to the connecting tissue is cut with bipolar scissors to move the ureters laterally. In case of the



Figs. 106.3 and 106.4 Thereafter, the mesocolon sigmoideum is separated from the dorsal connecting tissue up to the suspensory muscle of duodenum (ligament of Treitz). Therefore, the meso of the small intestine is mounted ventrally and it is incised horizontally



Figs. 106.5, 106.6 and 106.7 The connecting tissue is then cut in a stepwise fashion while mounting the small and large intestine cranially/ventrally

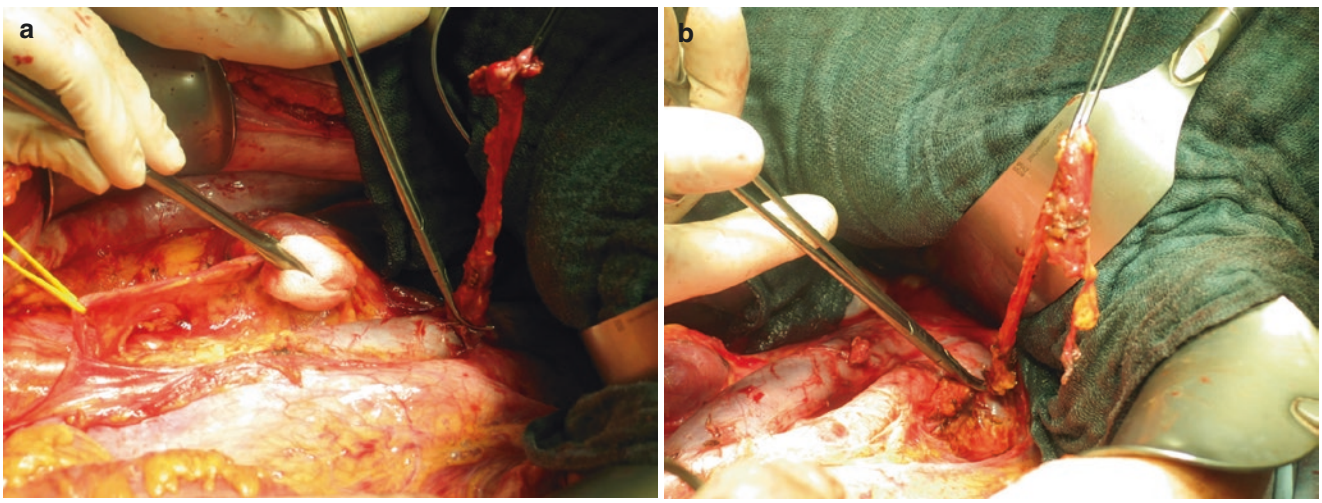


Fig. 106.8 The infundibulopelvic ligaments will be cut over Overholt forceps at the inferior vena cava on the right side (**a**) and at the left renal vein (**b**)

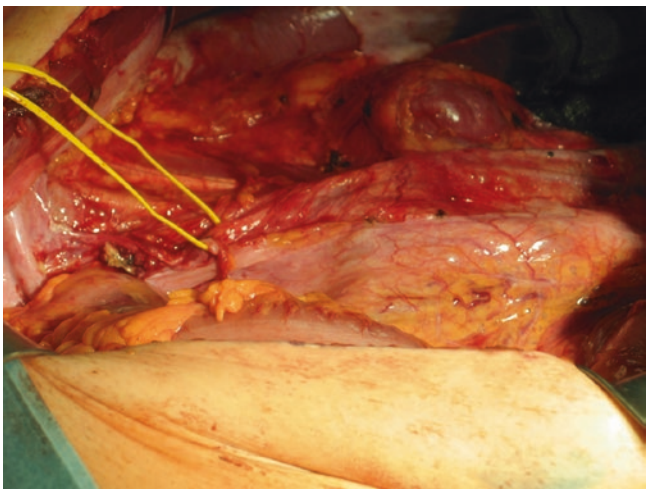


Fig. 106.9 Before, or thereafter, the ureters are elevated and vessel loops might be attached, to minimize direct and traumatic traction

preservation of the adnexa the infundibulopelvic ligaments have to be carefully separated from ureters on the entire lengths between the crossing of the ureters with the common iliac vessels and the insertion of the ureters in the pararenal fat tissue with bipolar scissors.

Surgical Approach of Systematic Abdominal Paraaortic LNE

Surgical Workflow

Basically, we dissect four compartments during systematic paraaortic lymphadenectomy, however, other approaches and subdivisions are possible. (1) paracaval: lateral and dorsal of the inferior vena cava, (2) inter-aortocaval: medial and dorsal of the inferior vena cava and medial and dorsal the aorta abdominalis, (3) low paraaortic: lateral and dorsal the aorta between the common iliac artery and the IMA and (4) high paraaortic: lateral and dorsal of the abdominal aorta and between the IMA and the renal vessels.

The paraaortic lymphadenectomy is started caudally at the bifurcatio aortae and the parietal peritoneum is vertically cut approximately 1 cm cranially of the aortic bifurcation, to avoid injuries of the common iliac arteries, mainly if the diameter of the vessel is small. Figure 106.10 displays all areas in which lymphadenectomy is conducted. The first area for lymphadenectomy is the paracaval space. Therefor the second assistant between the legs takes a large swab in the left hand to push the kidney and the ureter laterally and a wet small swab to push the inferior vena cava medially. . Alternatively, the inferior vena cava is pulled with two small hooks. The assistant should place the swab

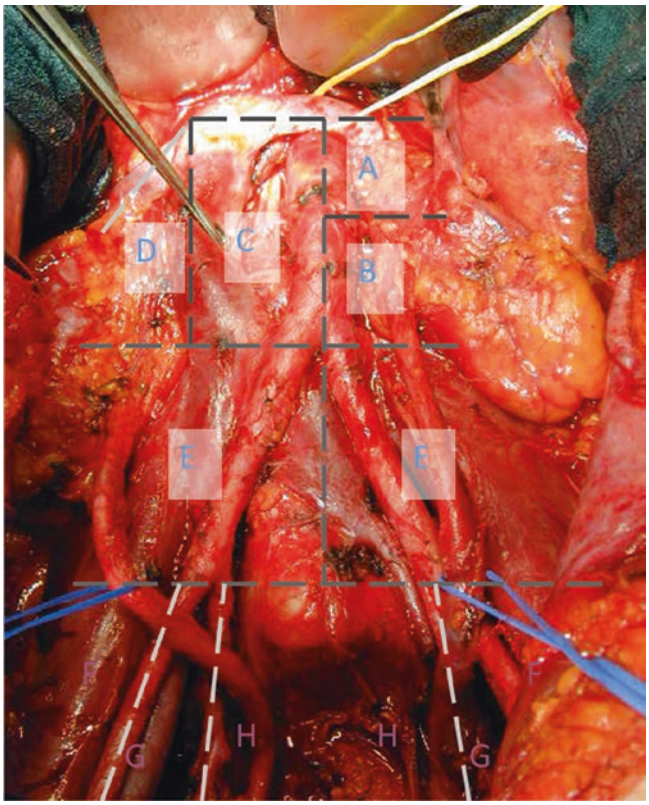


Fig. 106.10 Definitions of regions how we conduct para aortic lymphadenectomy: *A* high para-aortic: medial aorta abdominalis, left V. renalis, caudally A. mesenterica inferior, dorsally spine and right laterally fat for the kidney; *B* low para-aortic: medial Aorta abdominalis, cranially A. mesenterica inferior, caudally bifucatio aortae, dorsally spine, laterally M. psoas; *C* interaorto-caval: medial V. cava inferior, medial Aorta abdominalis, cranially left V. renalis, dorsally spine, caudally bifurcatio aortae; *D* para-caval: medial V. cava inferior, cranially right V. renalis, caudally bifurcatio aortae, laterally fat of the kidney/ M. psoas

on the vena cava in a position that the dorsolateral border of the vessel is visible, even during pushing the cava medially (Fig. 106.11). The paracaval tissue is dissected horizontally with bipolar scissors up to the renal vein. The lymph vessels and the surrounding tissue at the cranial border at the renal vein should be cut horizontally with a vessel sealing device. In case of bleeding, bipolar forceps should be used immediately. In case of larger injuries sewing the wall of the vena cava should be conducted with non-absorbable monofil suture. In the next step, the interaortic fraction of the lymphatic tissue is harvested. To remove the ventral portion of the tissue no traction on the vessels is needed (Fig. 106.12). To reach the dorsal portion the second assistant between the legs takes a wet small swab to push the inferior vena cava laterally and inverted large forceps to push the aorta laterally. Removing the lymphatic tissue in the low paraaortic region (inferior of the inferior mesenteric artery (IMA)) and the high paraaortic region (cranial of the

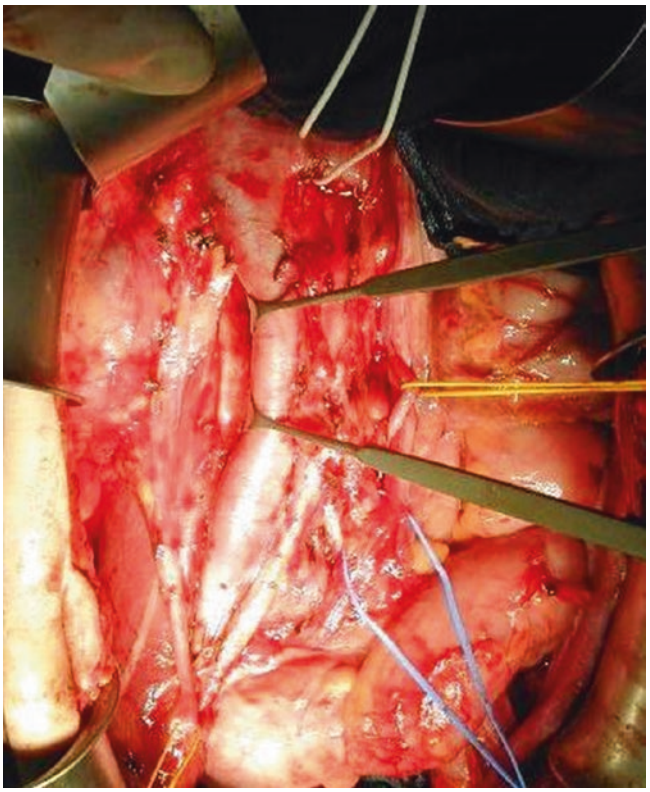


Fig. 106.11 Resection of the paracaval portion

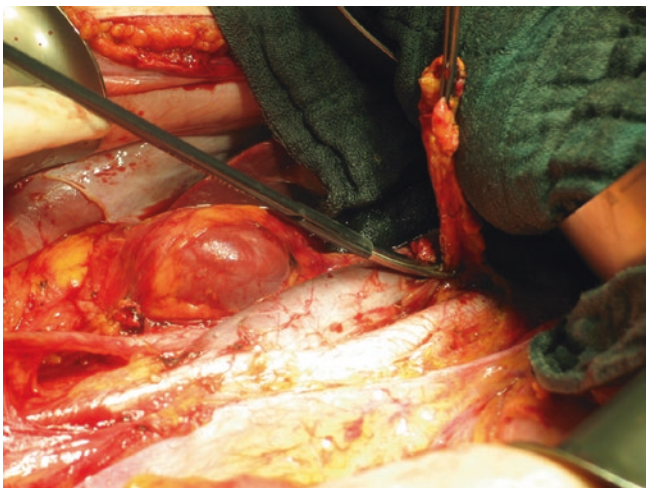


Fig. 106.12 To remove the ventral portion of the tissue, no traction on the vessels is needed

IMA) harbors the highest technical demand, as the meso of the descending colon is attached at the IMA and left the ureter takes course laterally very near, but is hidden by the meso. Sometimes it might be helpful to see-saw the descending colon with the meso to be sure to remove all lymphatic tissue, without injuring the ureter or the IMA (Fig. 106.13). Consecutively, the second assistant gets a large swab in the right hand to move the left kidney and the ureter laterally and an inverted large forceps to push the aorta medially. The paraaortic tissue is dissected vertically with bipolar scissors, primary between the common iliac artery and the IMA and in a second step between the IMA and the renal vein. The lymph vessels and the surrounding tissue at the cranial margin at the renal vein should be again cut horizontally with a vessel sealing device (Fig. 106.14).

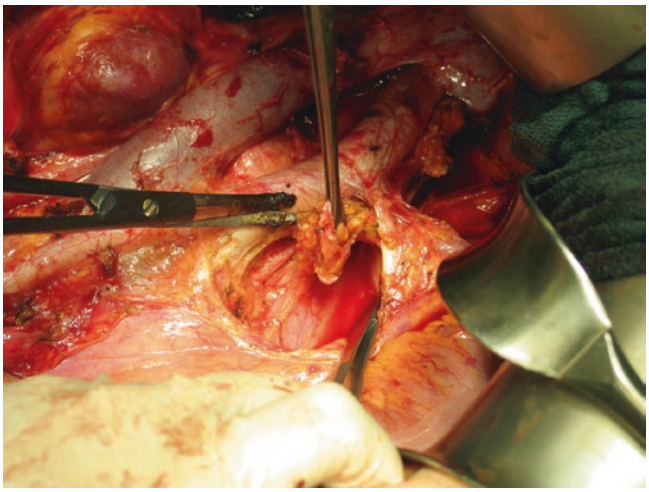


Fig. 106.13 The second assistant gets a large swab in the right hand to move the left kidney and the ureter laterally and an inverted large forceps to push the aorta medially

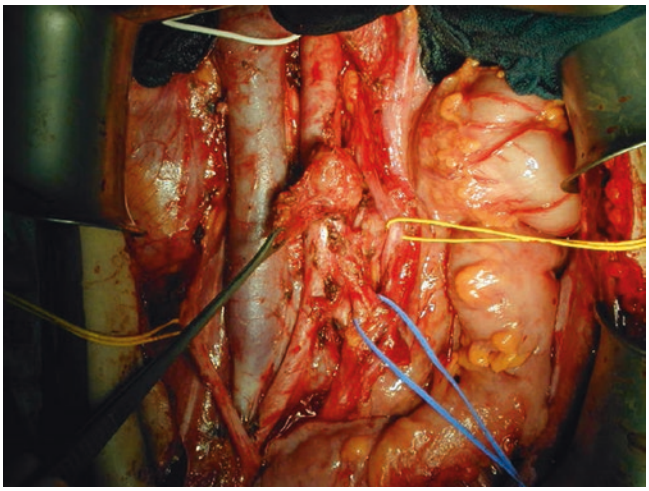


Fig. 106.14 The paraaortic tissue is dissected vertically with bipolar scissors, primary between the common iliac artery and the IMA and in a second step between the IMA and the renal vein

A thorough inspection of the key structures should take place and a sufficient hemostasis must be ensured before ceasing the operation. Drainage at the surgical field of pelvic lymphadenectomy is usually not necessary (Fig. 106.15).

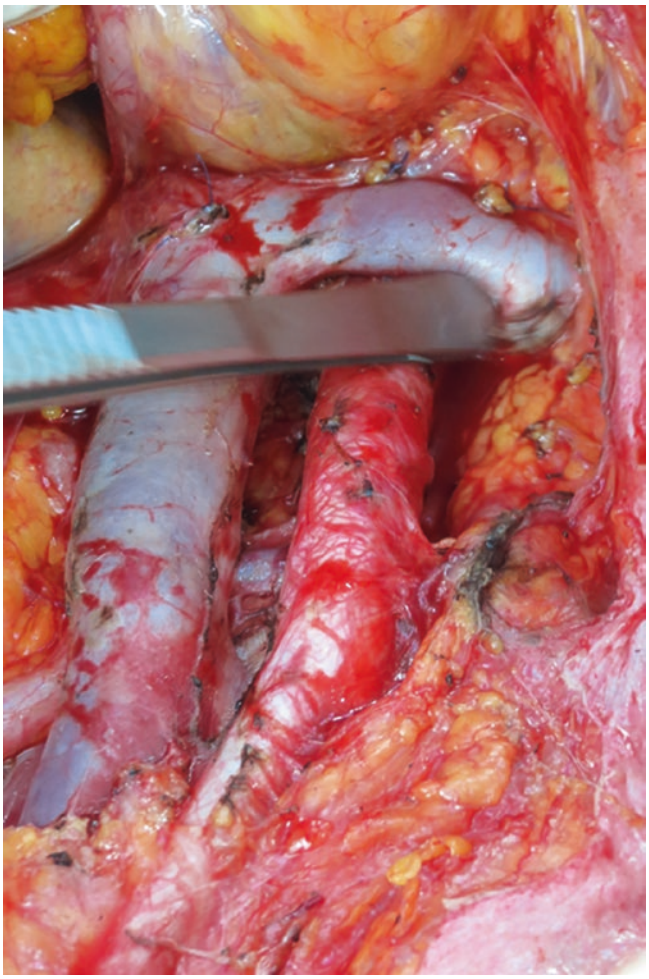


Fig. 106.15 It is not always indicated to remove all tissue from the ventral portion of the aorta and the ventral portion of the V. renalis sinistra. However, the insertion of the V. ovarica sinistra is shown explicitly

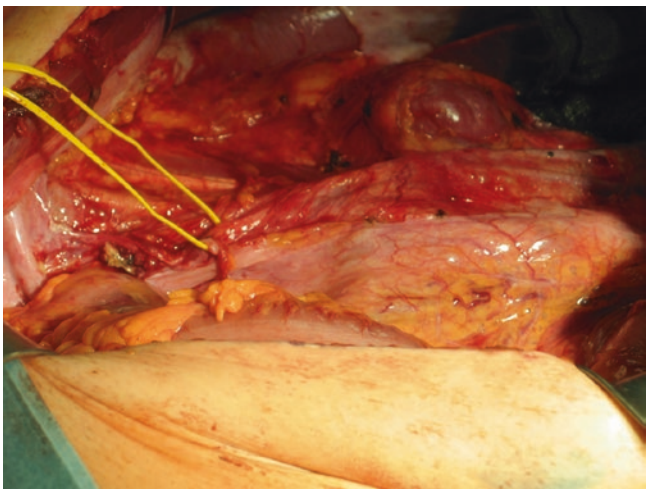


Fig. 106.16 The ureter is elevated and a vessel loop might be attached, to minimize direct and traumatic traction

Surgical Approach of Systematic Abdominal Pelvic LNE

Surgical Workflow

If there is no doubt that abdominal systematic pelvic lymphadenectomy will not be combined with abdominal systematic paraaortic lymphadenectomy or other staging procedures, a Pfannenstiel incision might be used. Otherwise, a complete median laparotomy should be conducted as described above.

The retroperitoneal space is opened laterally of the round ligament and is incised cranially on the ileopsoas muscle. The infundibulopelvic ligament is identified cranio-medially and the ureter is located dorsally. In case of adnexectomy, the infundibulopelvic ligament should be identified ventrally of the ureter and branched off by Overholt forceps. The infundibulopelvic ligament is cut between Overholt forceps and it is ligated. Thereafter, the ureter is elevated and a vessel loop might be attached, to minimize direct and traumatic traction (Fig. 106.16). The dorsal attachment to the connecting tissue is cut with bipolar scissors to move the ureters laterally.

In case of the preservation of the adnexa/ ovary but hysterectomy the fallopian tube and the utero- ovarian ligament is cut between clamps and the clamps are substituted by ligature. The mesovar and the mesosalpinx are cut with the bipolar scissors in mesenteric direction, cranially. Some cm cranially of the location of the ovary, the peritoneum is pulled ventrally-medially and the ureter is found dorsally at the crossing of the common iliac vessels. After identification of the ureter, the ventral portion including the ovary, the utero-ovarian ligament, the mesovar, the fallopian tube and the mesosalpinx are dissected from the peritoneum and the lateral connecting tissue and might be primary placed in the median abdominal cavity, before fixation at the lateral abdominal wall at the end of the surgery. At the beginning or end of this procedure we would perform a salpingectomy. Thereafter, the ureter is elevated and a vessel loop might be attached, to minimize direct and traumatic traction. The dorsal attachment of the ureter to the connecting tissue is cut with bipolar scissors to move the ureters laterally (Fig. 106.17).

Four compartments are going to be dissected for systematic pelvic lymphadenectomy: (1) the tissue surrounding the common iliac vessels, (2) the tissue surrounding the external iliac vessels, (3) the tissue surrounding the internal iliac vessels and (4) the tissue in the obturatoric fossa. The pelvic lymphadenectomy is started cranially at the bifurcatio aortae and the ventral portion of the perivascular tissue of the common iliac artery is cut with bipolar scissors. If no paraaortic LNE is conducted, the cranial resection should take place with a vessel sealing instrument to reduce the risk of lymphatic spillage and lympoceles. The superficial tissue is removed laterally to the genitofemoral nerve and medio-dorsal under the external common iliac vein (Fig. 106.18). The

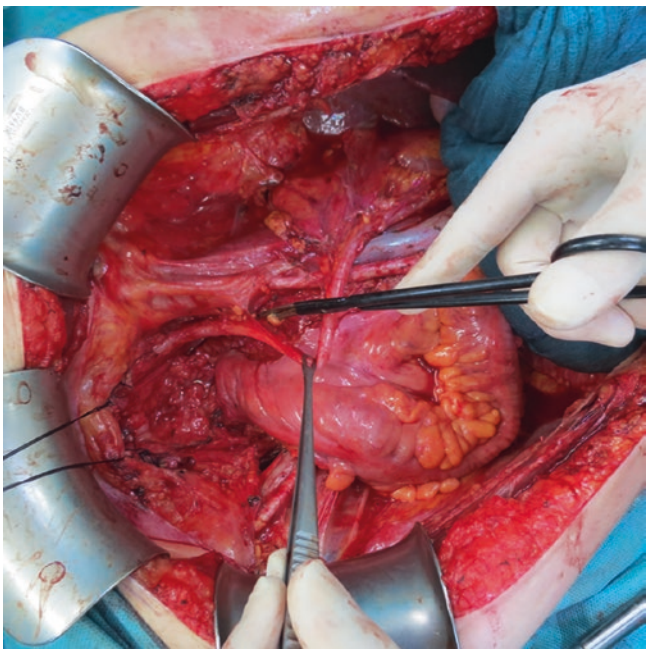


Fig. 106.17 The dorsal attachment of the ureter to the connecting tissue is cut with bipolar scissors to move the ureters laterally

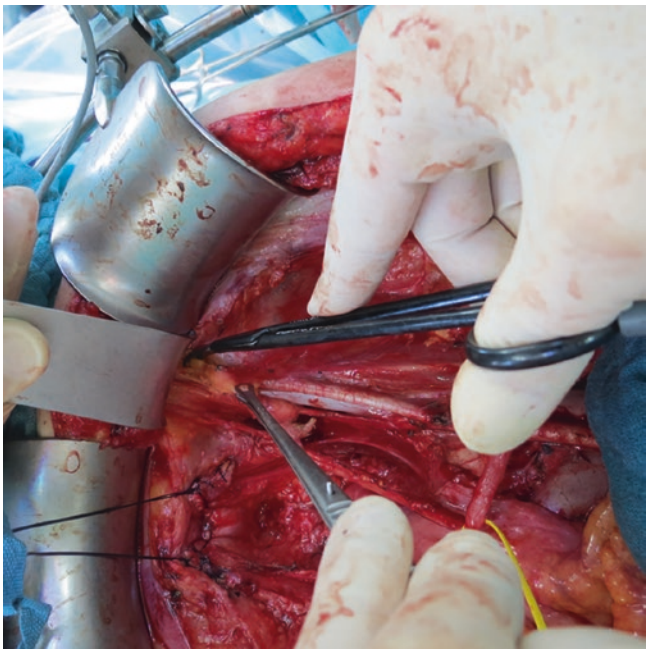


Fig. 106.19 To obtain a good insight into the abdominal inguinal ring, the abdominal fat tissue and abdominal wall is lifted with a Roux retractor

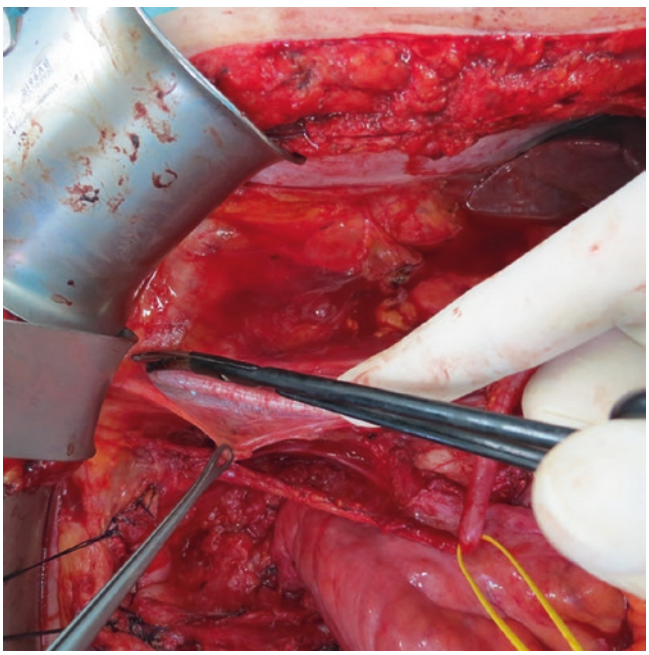


Fig. 106.18 The superficial tissue is removed laterally to the genitofemoral nerve and medio-dorsal under the external common iliac vein

medially located hypogastric plexus should be preserved. At the bifurcation of the common iliac vessels the common iliac portion of the pelvic lymphadenectomy is cut and the removal of the tissue surrounding the external vessels is conducted. The presacral space is only opened in the case of palpable lymphnodes. To obtain a good insight into the abdominal inguinal ring, the abdominal fat tissue and abdominal wall is lifted with a Roux retractor (Fig. 106.19). The caudal resectionmargin is the Rosenmuller node. At this stage the ramus pubicus of the inferior epigastric artery must be carefully prepared to avoid bleeding, which is often rather difficult to stop. The obturator fossa is opened with cutting the fascia of the psoas muscle along the vessel direction and the connecting tissue between the external iliac artery and the psoas fascia, respectively. Sometimes it helps to dilate the space in the obturator fossa with the index finger, tenderly. Traction to open the obturator fossa should be given with a large Breisky retractor to push the psoas muscle laterally and a small Breisky retractor to push the external vessels medially (Fig. 106.20). The caudo-dorsal margin is the obturator nerve and the cranial margin the crossing of the ureter (Fig. 106.21). The resection cranially and caudally should be conducted with a vessel sealing device. Before starting the preparation of the lymphatic tissue surrounding the internal iliac artery the ureter should be mobilized adequately medially and caudally near to the insertion of the obturator vessels and nerve to the obturator foramen. Thereafter, the dissection of the perivascular tissue containing the lymph nodes along the vessel direction is conducted with bipolar scissors (Fig. 106.22). The caudal resection should be conducted again with vessel sealing device.

A thorough inspection of the key structures should take place and a sufficient hemostasis must be ensured before ceasing the operation. A drainage at the surgical field of paraaortic lymphadenectomy is usually inserted.

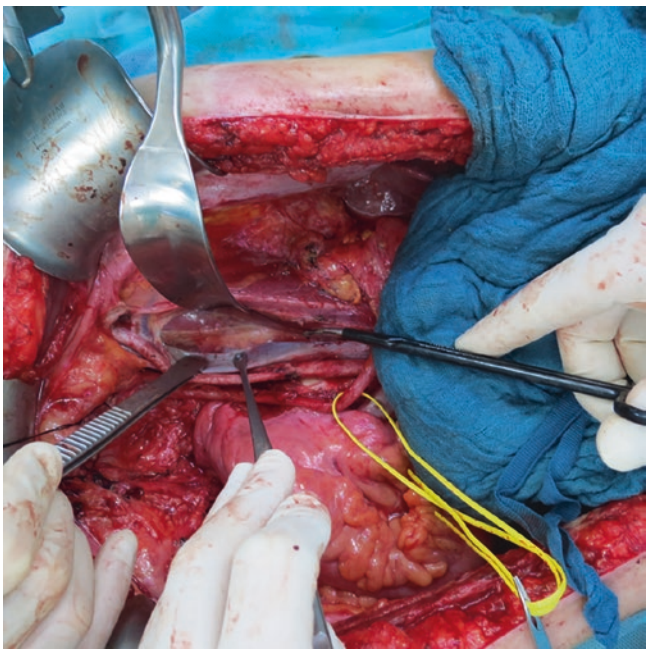


Fig. 106.20 Traction to open the obturator fossa should be given with a large Breisky retractor to push the psoas muscle laterally and a small Breisky retractor to push the external vessels medially

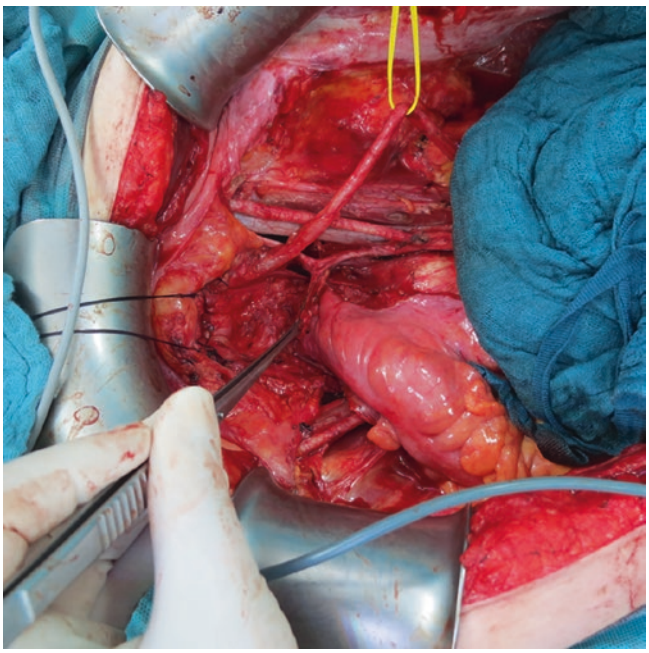


Fig. 106.22 The dissection of the perivascular tissue containing the lymph nodes along the vessel direction is conducted with bipolar scissors

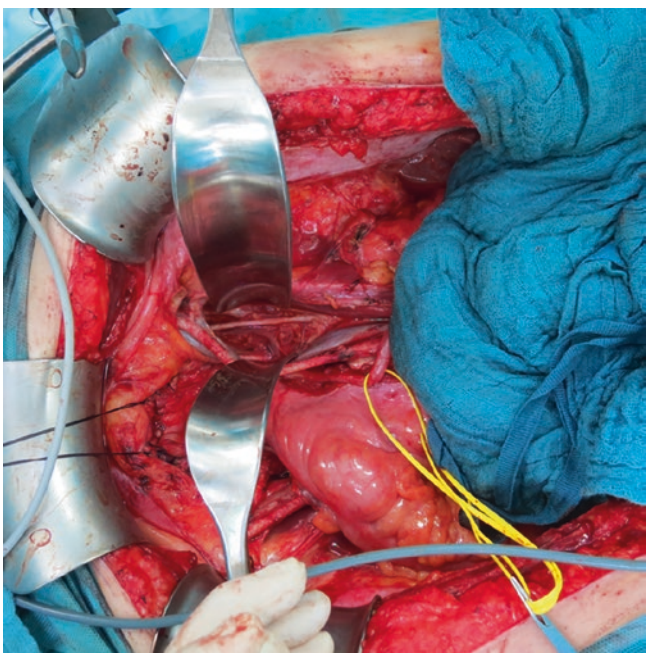


Fig. 106.21 The caudo-dorsal margin is the obturator nerve and the cranial margin the crossing of the ureter

Omentectomy

107

Katherine A. Nixon and Christina Fotopoulou

Anatomical Landmarks and Aims of Omentectomy

The large omentum constitutes a double layer of peritoneum covered by fatty tissue and consists mostly of fibroblasts and mesothelial cells. It hangs from the large curvature of the stomach, attaches to the transverse colon and covers parts of the small bowel. Embryologically the omentum develops from the posterior part of the Dorsal Mesogastrium: the stomach undertakes a 90° rotation, which produces a duplication of peritoneum, this will later represent the omentum. The vascular supply of the large omentum consists of an anastomosis between the right gastroomental artery (which originates from the Gastroduodenal artery, a branch of the Common Hepatic artery) and the left gastroomental artery (arising from the splenic artery).

The lesser omentum also develops from the peritoneal layers and lies between the stomach, proximal duodenum and porta hepatis and represents the anterior border of the omental bursa (lesser sac). It can be divided into two parts: the hepatogastric and the hepatoduodenal ligaments.

The omentectomy is a significant part of surgical staging for malignant ovarian tumors. In cases of advanced disease, tumour involving the omentum builds an "omental cake", therefore omentectomy is part of the cytoreductive procedure aiming at total macroscopic clearance of the malignant disease. Omentectomy in the case of epithelial ovarian cancer should be infragastric and extend to the inferior splenic pole. Depending on the extent of the disease the vascular arcade on the large gastric curvature will either be resected or preserved. In early borderline ovarian tumours, in the absence of peritoneal implants, an infracolic omentectomy is sufficient for staging; whereas in epithelial ovarian cancer, especially in the presence of an omental cake omentectomy should be performed at the level of the large curvature.

The correct timing for the omentectomy, during an operation that involves hysterectomy, depends on the tumour dissemination pattern and intraoperative findings. In the case of an extensive "omental cake" it would be advisable to proceed to the omentectomy in the beginning of the operation in order to clear the field, stop the bleeding from the omental tumour plaque and be able to work with better conditions in the pelvis.

Surgical Steps for the Omentectomy

The omentectomy should start by freeing any potential adhesions to neighbouring structures like bowel loops, especially in the case of extensive disease. It would then be advisable to free any connections to the splenic pole to avoid any tearing and bleeding of the splenic capsule. To facilitate this, the left colic flexure needs to be completely mobilized by dividing the Lienocolic ligament between the inferior splenic pole and the left colic flexure. In order to further avoid tearing and bleeding of the splenic capsule it may be helpful to carefully place a swab behind the spleen to provide a posterior support. In the case of a splenic tear with bleeding, haemostasis can be achieved by bipolar coagulation ± the use of haemostatic agents like Floseal® or Tachosyl®. Often compression alone is enough to achieve control of bleeding. However, if the bleeding does not stop despite all attempts then one should proceed to splenectomy to avoid further haemorrhage. Emergency splenectomy has a higher risk of pancreatic injuries.

The next step is the mobilization of the omentum from the right colic flexure; this is usually easier compared to the left side, unless the patient has undergone previous liver or gall bladder surgery, in which case adhesions and/or infection

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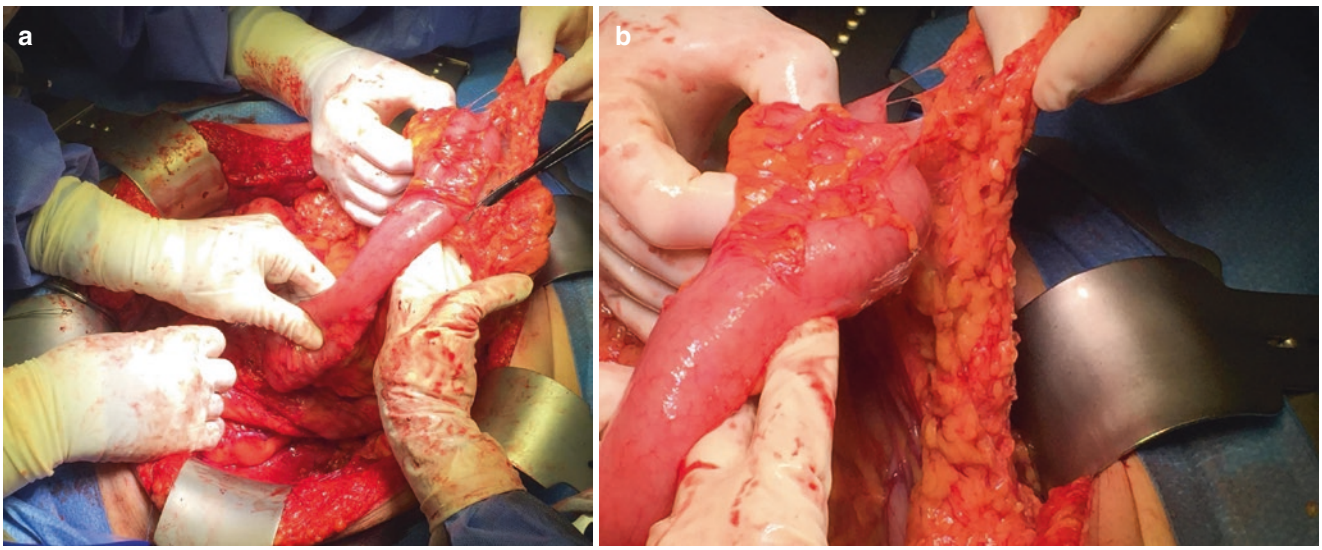


Fig. 107.1 (**a**) Dissection of the greater omentum from the transverse colon. (**b**) Dissection of the greater omentum from the transverse colon

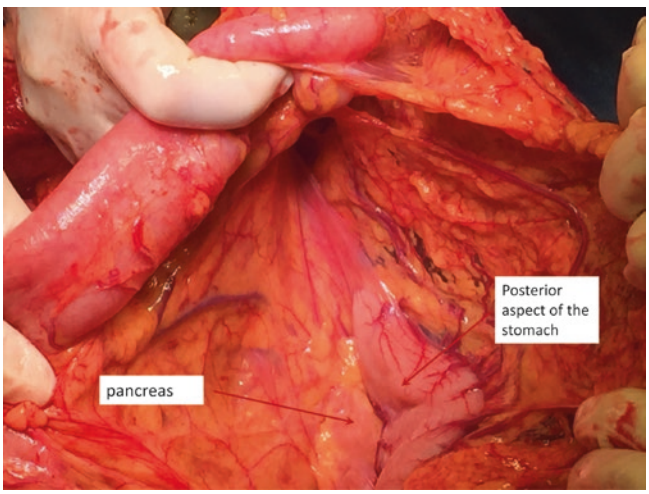


Fig. 107.2 Dissection of the omental bursa

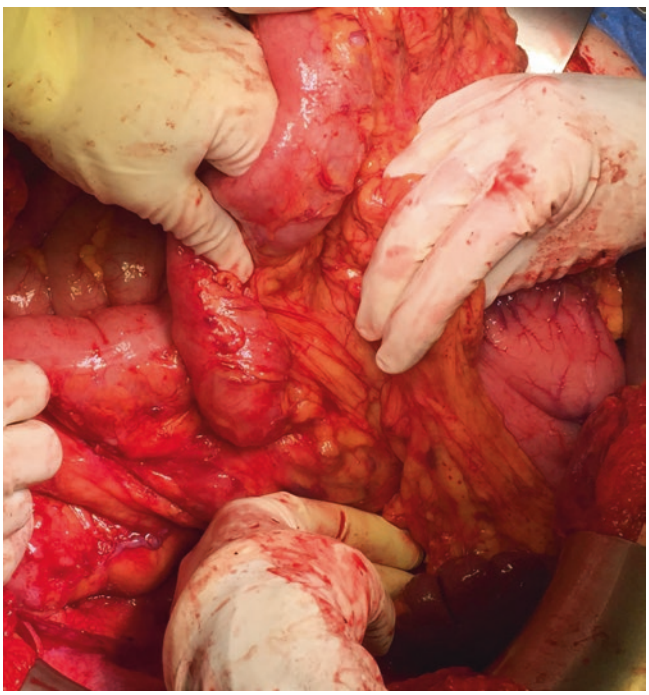


Fig. 107.3 Dissection of the greater omentum from the inferior splenic pole

may impede dissection. In this case it might be necessary to mobilize the omentum from the duodenum, gallbladder or porta hepatis. Here one needs to pay attention to avoid accidental injury to the pancreatic head and the biliary duct (Figs. 107.1, 107.2, 107.3, 107.4, and 107.5).

Proceed with the dissection of the omentum off the transverse colon. This can be achieved through use of diathermy or with sharp dissection with Mcindoe scissors by dividing the physiologic avascular adhesion layer between the omentum and transverse colon. The dissection should occur exactly in the avascular space to avoid bleeding and injuries of the transverse mesentery (Figs. 107.1 and 107.5). If diathermy instruments are used to perform the dissection one should be careful to avoid unintended thermic injuries to the bowel serosa and/or mesentery which may lead to a bowel perforation in the postoperative period. Any bowel serosal injuries should be repaired immediately with PDS 4.0 or 5.0, as, especially in smaller lesions, it might be difficult to identify them again later.

After sharp dissection of this physiologic adhesion layer a blunt approach can be taken to dissect the gastrocolic ligament from the dorsal side of the transverse mesentery. Via this method one opens the omental bursa and can identify

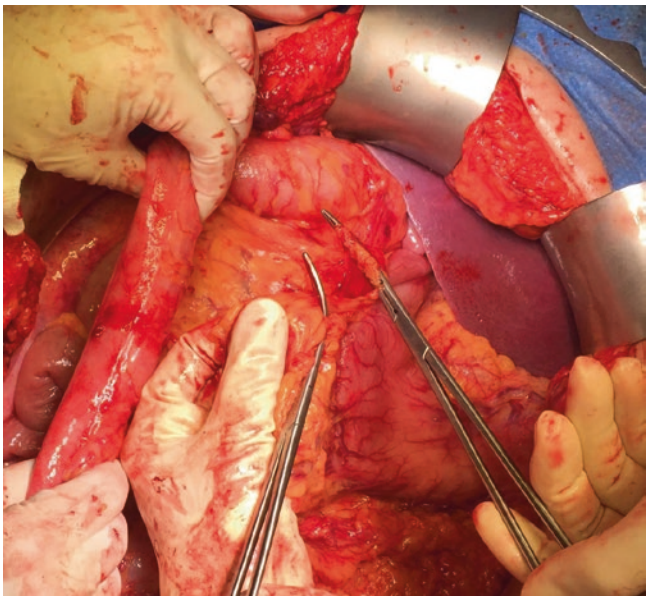


Fig. 107.4 Dissection of the greater omentum from the large curvature of the stomach

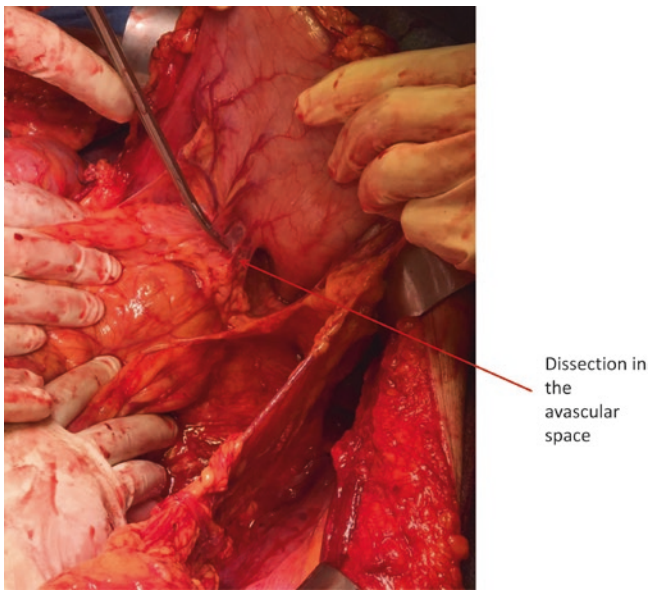


Fig. 107.5 Dissection of the physiological adhesions of the posterior gastric wall in the omental bursa for better sight in the entire omental bursa

and inspect the pancreas. At this step one should be careful not to enter the wrong layer and injure the transverse mesentery and its vessels, especially branches of the middle colic artery. During the dissection at the level of the mesenteric root is it important not to injure the superior mesenteric vessels which will impair the vascular supply from the distal duodenum to the left colic flexure. An injury of the Middle colic artery, which comes from the superior mesenteric artery, can result in prolonged or segmental necrosis of the transverse colon.

The omentum is now completely freed up from all sides and can be safely dissected off the large curvature of the stomach. This can be performed either with clamps and ligations or with special coagulation and cutting devices. In cases of extensive tumor involvement the gastroepiploicae vessels along the large curvature of the stomach may have to be resected, paying attention not to cause ischemic injuries to the gastric wall. By resecting the gastropepiploical vessels the vasculature of the stomach is not impaired, since the stomach is sufficiently supplied via the Right and Left Gastric arteries and the Short Gastric artery from the Splenic artery. During the dissection of the Gastrosplenic artery, which connects the large curvature of the stomach with the spleen and along which runs the Left Gastroomental artery, one should pay particular attention to avoid injuries of the pancreatic capsule and the pancreatic tail.

Resection of the Lesser Omentum

This is not part of the routine staging but may be necessary in cases of tumour infiltration along the small curvature of the stomach/omental bursa. The resection of the lesser omentum can occur either by resecting or preserving the vessels along the small curvature, depending on the extent of the disease. Even if both the gastric and gastroepiploic vessels need to be resected the stomach still has sufficient supply from the Short Gastric artery; which however needs to be preserved otherwise there will be ischemic damage to the stomach. If a splenectomy is additionally performed then at least one of the other two ways of vascular supply (gastroepiploic vessels vs gastric vessels) need to be preserved.

The resection of the lesser omentum is not part of the staging and should occur only if there is tumor involvement. In this case only the cancerous part should be removed paying attention to the preserve the vessels in the upper rand of the pancreas, the liver and the stomach.

References

1. du Bois A, Reuss A, Pujade-Lauraine E, Harter P, Ray-Coquard I, Pfisterer J. Role of surgical outcome as prognostic factor in advanced epithelial ovarian cancer: a combined exploratory analysis of 3 prospectively randomized phase 3 multicenter trials: by the Arbeitsgemeinschaft Gynaekologische Onkologie Studiengruppe Ovarialkarzinom (AGO-OVAR) and the Groupe d'Investigateurs Nationaux Pour les Etudes des Cancers de l'Ovaire (GINECO). Cancer. 2009;115(6):1234–44.
2. Vernooij F, Heintz P, Witteveen E, et al. The outcomes of ovarian cancer treatment are better when provided by gynecologic oncologists and in specialized hospitals: a systematic review. Gynecol Oncol. 2007;105:801–12.

3. Trillsch F, Mahner S, Vettorazzi E, Woelber L, Reuss A, Baumann K, Keyver-Paik MD, Canzler U, Wollschlaeger K, Forner D, Pfisterer J, Schroeder W, Muenstedt K, Richter B, Fotopoulou C, Schmalfeldt B, Burges A, Ewald-Riegler N, de Gregorio N, Hilpert F, Fehm T, Meier W, Hillemanns P, Hanker L, Hasenburg A, Strauss HG, Hellriegel M, Wimberger P, Kommoss S, Kommoss F, Hauptmann S, du Bois A. Surgical staging and prognosis in serous borderline ovarian tumours (BOT): a subanalysis of the AGO ROBOT study. Br J Cancer. 2015;112(4):660–6. doi:10.1038/bjc.2014.648. Epub 2015 Jan 6.

Abdominal Closure at Longitudinal and Horizontal Abdominal Incisions

108

Markus C. Fleisch and Philip M. Hepp

Introduction

Most surgical procedures in gynecology including most hysterectomies are nowadays performed using minimally invasive techniques. One of the major advantages of the laparoscopic approach is the use of smaller incision avoiding major incision-related complications. These include minor or major wound infections, incisional hernias or abdominal bursts, cosmetically undesirable hypertrophic scarring or nerve transection or entrapment.

However, in some cases a longitudinal ("midline") or horizontal ("Pfannenstiel-") incision might still be necessary. The utilization of a conventional access by laparotomy can be owed to a lack of surgeons experience with laparoscopic techniques, to technical reasons (e.g. size of the uterus/specimen to be removed) or to oncologic concerns.

Open surgery raises the question of the optimal way of abdominal closure. In general, interrupted or continuous sutures, using various commercially available braided or monofilament suture material, which might be antibacterially coated or not, layer by layer or as a mass closure are at hand (Table 108.1). The ideal way of closure should provide reliable mechanical stability of the abdominal wall to prevent incisional hernia or abdominal bursts, a desirable cosmetic result and should be time saving and cost effective.

Potential Wound Complications

There are various potential wound related complications which might occur early or late during postoperative course [1]. The most frequent type of wound failure is a superficial brake down. Superficial separation is frequently preceded by a hematoma or seroma with or without bacterial infection. This should be distinguished from (partial) fascial dehiscence or complete fascial brake down. The most severe form of wound brake down is a burst abdomen with abdominal contents protruding through the fascial and skin defect. This severe complication is still afflicted with a significant morbidity and mortality. If skin stays intact fascial defects may cause symptomatic or asymptomatic hernias.

It is believed that transverse incisions have a lower fascial dehiscence rate than midline, however, some speculate that this is not true when cases are controlled for infection, as postoperative wound infection appears to foster fascial dehiscence [2, 3].

Wound infections are the most frequent type of nosocomial infection in surgical patients. Therefore one must employ medicinal as well as surgical means in order to reduce their incidence. As for prevention by application of antibiotics timing seems to play a pivotal role. In a study comprising 2874 patients undergoing surgery it could be demonstrated that Infection rates are the lowest if prophylactic antibiosis is given up to 2 h before incision. Any other timing increases the odds for wound infection (Table 108.2) [4].

Table 108.1 Technical principles and materials for (fascial) closure

Surgical technique	Suture material
Interrupted vs. continuous	Braided vs. monofilament
Layered vs. mass closure	Antibacterially coated vs. not
	Rapidly vs. delayed vs. non-absorbable

Table 108.2 Relation of timing between antibiotic prophylaxis and wound infection [4]

Time of administration	% of infection	Odds ratio (95 % CI)
24 till 2 h before incision	3.8	4.3 (1.8–10.4)
Less than 2 h before incision	0.6	
Within 3 h after incision	1.4	2.1 (0.6–7.4)
3 up to 24 h after incision	3.3	5.8 (2.4–13.8)

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It is controversial which antibiotic agent to use as resistance patterns and predominant microbiotic strains vary from country to country and even from region to region. In general the antibiotic of choice should cover skin flora like streptococci and staphylococci. Cefazolin is the antibiotic agent most widely used for infection prophylaxis in the setting of abdominal incisions. Beside its efficacy against skin germs it is also inexpensive and has a favorable side-effect profile except for rare allergic reactions. In uncomplicated hysterectomy the use of anaerobic bacteria targeting agents like metronidazole seems dispensable.

Good surgical technique during closure can also add to reduced wound complications. In general measures for reduction of "dead" tissue and prevention of fluid accumulation are advisable. Furthermore obese patients seem to benefit from closure of subcutaneous dead space by subcutaneous suture as explained further below [5].

Considerations When Choosing Closure Technique

Peritoneum

Closure of the peritoneum does not contribute to the strength of closure. Furthermore peritoneum is capable of defect closure by growth from the wound rims within 72 h after incision. In review of the evidence at hand for longitudinal as well as transversal incision for various indications there is no advantage in performing a peritoneal closure [6]. In addition convincing evidence exists from the obstetric setting, that closure of peritoneum by suture has detrimental effects in terms of adhesion formation and postoperative fever. The Cochrane analysis thereto, "Closure versus non-closure of the peritoneum at caesarean section", concludes that "There is at present no evidence to justify the time taken and cost of peritoneal closure" [7].

Fascia

Closure of the fascia is the crucial point when it comes to abdominal closure and yet daily practice shows a variety of different approaches mostly driven by personal experience. However there is a growing body of evidence about techniques best suited to reduce the impressingly high reported complication rates especially incisional hernias. Pfannenstiel laparotomy obviously has a low incisional hernia rate ranging between 0 and 2.1 % [8]. Evidence regarding best way of fascial closure for midline incisions is somewhat contradictory and many of the studies published so far suffer from bias. Diener et al. published a remarkable metaanalysis reporting on 7711 patients with abdominal incision (6752 midline). They saw a significantly higher incidence of incisional hernia in the interrupted compared with continuous closure group (12.6 versus 8.4 %) regardless of the type of suture material used [9].

Table 108.3 Comparison of interrupted vs. continuous slowly absorbable sutures for closure of midline abdominal incisions

Method	Interrupted	Continuous with elasticity	Continuous without elasticity
Hernias after 1 year	15.9 %	8.4 %	12.5 %
Wound infection	12.7 %	19.4 %	16.3 %
Burst abdomen	2.0 %	3.0 %	4.0 %
Mortality	7.9 %	5.5 %	7.9 %
Time for closure[a]	17.5 min	14.5 min	12.9 min

[a]Sig; according to [10]

Recently a multicenter trial investigated the optimal way of fascial closure randomizing 625 patients undergoing non-emergency surgery via midline incision [10]. Primary endpoint was the frequency of incisional hernias measured clinically and verified by ultrasound 1 year after the scheduled surgery. Other complications and safety were secondary endpoints. Surgeons were trained in standardized abdominal closure procedure and patients were randomized in three treatment arms according to the way of fascial closure: (a) an "interrupted suture" group using braided absorbable material, and two "continuous suture" groups with slowly absorbable monofilament material (b) one with longitudinal elasticity and (c) one without. As a surprising result the overall incisional hernia rate was 12 % and therefore higher than expected despite a standardized training protocol. Comparison of the three arms revealed no significant differences regarding hernia, burst abdomen wound infection rate or other investigated complications between treatment groups. Table 108.3 gives an overview about the study results [10]. These results were confirmed in a prospective study where 191 patients undergoing midline laparotomy for gynecologic cancers were randomized in three different arms regarding abdominal closure [11]. With the primary endpoint occurrence of incisional hernia and the secondary endpoint infection and wound dehiscence neither running nor interrupted suturing nor different suturing materials showed a significant benefit [11].

Regarding the stiches size and intervals to be used with continuous sutures there is consistent proof, that a "suture length" to "wound length" ratio (SL:WL) of >=4:1 has a significantly smaller risk of hernia formation compared with <4:1 (Fig. 108.1) [12]. Based on that work, there is data indicating a detrimental effect of very high SL:WL in obese patients. This statement has been challenged by Millbourn et al. [13]. Their data showed decreasing rates of incisional hernias with increasing SL:WL even for exceptional high SL:WL up to 16:1. In contrast to antecedent studies they

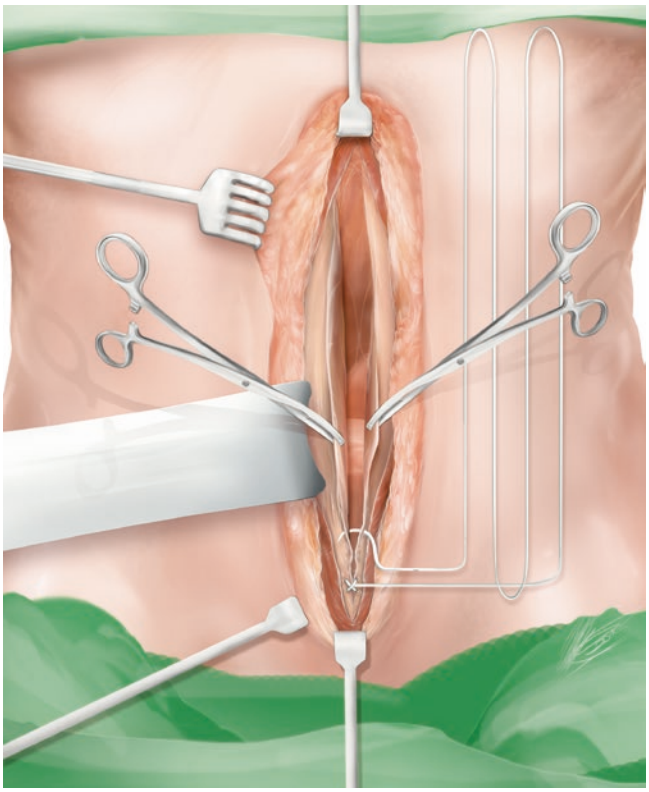


Fig. 108.1 Closure of the abdominal wall in consideration of wound-to-thread ratio

also controlled for stitch interval as well as stich length (meaning the size of the bite of fascia taken by every single stich), therefore preventing an increase in SL:WL mere by bigger bites containing more soft subcutaneous, fatty tissue which is prone to compression effects than by shortened intervals. With this approach they failed to show higher complication rates in obese patients using high and very high SL:WL [13]. This is in line with results from a pig study examining the effect of small interval /small bites (0.5/0.5 cm) stiches vs large interval/large bites stiches (1/1 cm) [13, 14].

In summary there is a growing body of evidence supporting the use of continuous, slowly absorbable monofilament material with small bites (0.5–1 cm) and intervals (0.5–1 cm).

Subcutaneous Tissue

Although application of subcutaneous sutures is a routine practice in many institutions there is little evidence about it. A Cochrane review reported on 815 patients out of six trials. All of these trials were prone to bias. In the metaanalysis there were no significant advantages or disadvantages by the application of subcutaneous sutures. Therefore no change of practice can be advised based on this data [15]. Nevertheless there is evidence that obese patients undergoing hysterectomy may profit from subcutaneous closure. One prospective study found less wound complications after subcutaneous closure in patients with more than 2.5 cm subcutaneous tissue than without closure [5].

Skin

Several options exist for skin closure. Beside the mere medical aspect of wound closure it is pivotal for a satisfying cosmetic result of the procedure. In general transverse incisions heal well due to the lack of skin tension. Skin closure may be performed with steel staples, subcuticular suture, subcuticular absorbable staples, surgical tape, or wound adhesive glue.

Staples provide a very fast way of skin closure which is also is the main advantage. In contrast to continuous sutures they also allow for opening of small portions of the wound, for example in order to drain a seroma. Nevertheless their cosmetic result seems inferior compared to all other alternatives available due to the traumatic penetration of skin [16], and there is also more wound pain [17]. In addition the steel staples need to be removed in the course of healing. In contrast to that self-resolving thread can be used in subcuticular sutures. In addition it is less costly and more comfortable to the patient [16]. Subcuticular absorbable staples on the other hand seem to combine the advantages of staples and subcuticular sutures since they can be applied in a fast manner without the staples typically appearance of the skin. Alternatively adhesive tapes or tissue glue may be employed.

Kolt performed a literature review to compare skin closure with adhesive tapes, subcuticular suturing and the combination of both [18]. Taped closure alone has advantages of lower wound infection rates and greater wound tensile strength, but disadvantages of epidermal reaction, skin edge inversion, doubtful safety and time required for meticulous surgical technique. The use of the continuous absorbable subcuticular suture allows accurate skin edge approximation, which increases the safety margin. The combination closure has a slightly superior cosmetic result to sutureless techniques but no study has been performed so far comparing the results of combined subcuticular suture and tape vs. tape or subcuticular suture alone [18].

Tissue glue may be time saving and have wound infection rates and cosmetic results that are equivalent to subcuticular sutures. However tissue glue may be associated with a slightly higher rate of wound dehiscence than observed with other techniques [19].

Drainages

The placement of prophylactic drains remains controversial. Possible complications comprise hernia, infection and bleeding. Therefore thorough evaluation of possible advantages of

drain placement needs to be practiced. Usually intraabdominal drains have no added benefit for patients undergoing hysterectomy for benign conditions. In radical hysterectomy with or without lymph node sampling on the other hand drainages could be of added value to control for postoperative bleeding and drainage of lymphatic fluids and therefore preventing formation of lymphocele [20]. Recently a large systematic review and metaanalysis has been published investigating the effect of a subcutaneous vs. no drainage in 52 studies with a total of 6930 operations [21]. Placement of a prophylactic subcutaneous drainage offered a statistically significant advantage only for (a) prevention of hematomas in breast biopsy procedures and (b) prevention of seromas in axillary node dissections. In all other procedures studied, drainage did not offer any advantage.

Dressings

Except for tissue glue a sterile dressing is mandatory after wound closure to avoid bacterial colonisation of the wound in the first 24–48 h and absorption of wound liquids. Traditionally dry sterile compresses or plasters are used for wound coverage. Nevertheless it can be reasonable to use semi occlusive dressings since a moist environment seems to foster wound healing [22].

References

1. Hogston P. Abdominal wound closure: How to avoid complications. In: O'Donovan P, editor. Complications in Gynecological Surgery. New York: Springer; 2008. p. 43–51.
2. Greenall MJ, Evans M, Pollock AV. Midline or transverse laparotomy? A random controlled clinical trial. Part I: influence on healing. Br J Surg. 1980;67(3):188–90.
3. Hendrix SL, Schimp V, Martin J, Singh A, Kruger M, McNeeley SG. The legendary superior strength of the Pfannenstiel incision: a myth? Am J Obstet Gynecol. 2000;182(6):1446–51.
4. Classen DC, Evans RS, Pestotnik SL, Horn SD, Menlove RL, Burke JP. The timing of prophylactic administration of antibiotics and the risk of surgical-wound infection. N Engl J Med. 1992;326(5):281–6.
5. Kore S, Vyavaharkar M, Akolekar R, Toke A, Ambiye V. Comparison of closure of subcutaneous tissue versus non-closure in relation to wound disruption after abdominal hysterectomy in obese patients. J Postgrad Med. 2000;46(1):26–8.
6. Gurusamy KS, Cassar DE, Davidson BR. Peritoneal closure versus no peritoneal closure for patients undergoing non-obstetric abdominal operations. Cochrane Database Syst Rev. 2013;(7):CD010424.
7. Bamigboye AA, Hofmeyr GJ. Closure versus non-closure of the peritoneum at caesarean section. Cochrane Database Syst Rev. 2003;(4):CD000163.
8. Luijendijk RW, Jeekel J, Storm RK, Schutte PJ, Hop WC, Drogendijk AC, et al. The low transverse Pfannenstiel incision and the prevalence of incisional hernia and nerve entrapment. Ann Surg. 1997;225(4):365–9.
9. Diener MK, Voss S, Jensen K, Buchler MW, Seiler CM. Elective midline laparotomy closure: the INLINE systematic review and meta-analysis. Ann Surg. 2010;251(5):843–56.
10. Seiler CM, Bruckner T, Diener MK, Papyan A, Golcher H, Seidlmayer C, et al. Interrupted or continuous slowly absorbable sutures for closure of primary elective midline abdominal incisions: a multicenter randomized trial (INSECT: ISRCTN24023541). Ann Surg. 2009;249(4):576–82.
11. Berretta R, Rolla M, Patrelli TS, Piantelli G, Merisio C, Melpignano M, et al. Randomised prospective study of abdominal wall closure in patients with gynaecological cancer. Aust N Z J Obstet Gynaecol. 2010;50(4):391–6.
12. Israelsson LA, Jonsson T, Knutsson A. Suture technique and wound healing in midline laparotomy incisions. Eur J Surg. 1996;162(8):605–9.
13. Millbourn D, Cengiz Y, Israelsson LA. Risk factors for wound complications in midline abdominal incisions related to the size of stitches. Hernia. 2011;15(3):261–6.
14. Harlaar JJ, van Ramshorst GH, Nieuwenhuizen J, Ten Brinke JG, Hop WC, Kleinrensink GJ, et al. Small stitches with small suture distances increase laparotomy closure strength. Am J Surg. 2009;198(3):392–5.
15. Gurusamy KS, Toon CD, Davidson BR. Subcutaneous closure versus no subcutaneous closure after non-caesarean surgical procedures. Cochrane Database Syst Rev 2014;(1):CD010425.
16. Frishman GN, Schwartz T, Hogan JW. Closure of Pfannenstiel skin incisions. Staples vs. subcuticular suture. J Reprod Med. 1997;42(10):627–30.
17. Ranaboldo CJ, Rowe-Jones DC. Closure of laparotomy wounds: skin staples versus sutures. Br J Surg. 1992;79(11):1172–3.
18. Kolt JD. Use of adhesive surgical tape with the absorbable continuous subcuticular suture. ANZ J Surg. 2003;73(8):626–9.
19. Chow A, Marshall H, Zacharakis E, Paraskeva P, Purkayastha S. Use of tissue glue for surgical incision closure: a systematic review and meta-analysis of randomized controlled trials. J Am Coll Surg. 2010;211(1):114–25.
20. Boesch CE, Umek W. Effects of wound closure on wound healing in gynecologic surgery: a systematic literature review. J Reprod Med. 2009;54(3):139–44.
21. Kosins AM, Scholz T, Cetinkaya M, Evans GR. Evidence-based value of subcutaneous surgical wound drainage: the largest systematic review and meta-analysis. Plast Reconstr Surg. 2013;132(2):443–50.
22. Pearl ML, Rayburn WF. Choosing abdominal incision and closure techniques: a review. J Reprod Med. 2004;49(8):662–70.

Abdominal Hysterectomy: Postoperative Care

109

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Postoperative Care

Optimal postoperative care is an important step of surgical treatment, especially after open surgery as in case of abdominal hysterectomy, which is associated with various postoperative complications; for example more postoperative infections; a higher rate of incisional hernia, a higher rate of thromboembolic complications and higher blood loss and a three times higher morbidity and mortality rate compared to vaginal or laparoscopic hysterectomy [1, 2].

Routine postoperative care includes monitoring of a patient's hemodynamic and fluid status, pain control and resumption of normal diet and activity. A standardized management is recommended to minimize postoperative complications and avoid a prolonged hospitalization of the patient. Table 109.1 show an overview of the postoperative care recommendations, which are explained in detail below.

Postoperative Monitoring After general anesthesia a monitoring of hemodynamic and fluid status is recommended during the first three to four postoperative hours at an intermediate care station when available.

Blood check and postoperative bleeding At least one postoperative hemoglobin check should be performed after 12–24 h depending on the intraoperative blood loss and the patient's condition. Detailed laboratory blood tests are optional and depend on the patient's symptoms. In case of a postoperative hemoglobin drop <10 g/dl (normal hemoglobin levels for wome: 12–16 g/dl) and an iron deficiency anemia patients can be treated with iron replacement products orally or intravenously. In case of an excessive blood loss with hemoglobin <8 g/dl or symptoms of dizziness blood transfusion should be considered. Furthermore the bleeding source should be identified by checking the amount and texture of the fluid in the drainages and using intravaginal and abdominal ultrasound to exclude an abdominal hematoma. If there is a reasonable suspicion of a postoperative bleeding with excessive blood loss a laparoscopy or re-laparotomy should be also taken into account.

Wound management Wounds bandages should be renewed daily and an inspection of the wound should be performed by the surgeon. If signs of a wound infection (as redness, hyperthermia, swelling and pain) are observed, a microbiological wound swab should be performed. The swab should be taken from the bottom of the wound or abscess and not superficially

Table 109.1 Recommendations for postoperative care management

Monitoring of the hemodynamic and fluid status during the first 3 to 4 postoperative hours at an intermediate care station when available
At least one postoperative hemoglobin check after 12–24 h depending on the intraoperative blood loss
Detailed laboratory blood tests are optional
Inspection of the wounds and wounds bandages should be renewed daily
A standardized pain control regime helps in the daily routine
Obstipation prophylaxis and antiemetics are optional
Removing of the bladder catheter during the first 24 h
Removing of drainages after 24–48 h depending on the amount of fluid flowing off
Early feeding and no special diet
Thromboembolic prophylaxis with low-molecular-weight heparin under frequent control of the thrombocytes
Fast mobilization
Gynecologic examination, transvaginal ultrasound and ultrasound of the kidneys before discharge
Discharge instructions (avoiding heavy lifting (> 5 kg), exercises and vaginal intercourse for 6–8 weeks)
follow-up visit 2 weeks after surgery
Removing of skin stitches or staples 10–14 days after surgery

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from the surface of the dermis where microbes occupying the dermis are found physiologically. A calculated antibiotic therapy should be started for example with a combination of a cephalosporin (e.g. Cefuroxim 3 × 1,5 g i.v.) and metronidazole (e.g. Clont 2 × 500 mg i.v.). After microbiological analysis the antibiotic therapy can be adjusted according to the pathogenic agent and its resistances. The therapy should be given for at least 5–7 days. Infections are distinguished in superficial infections of the dermis and subcutaneous abscesses. In case of subcutaneous abscess an incision of the abscess capsule is necessary.

Prevention of postoperative infections A calculated postoperative treatment with antibiotics is not recommended in routine cases. In case of clinical suspicion of a postoperative infection (fever, shivering) blood samples should be drawn and inflammatory markers should be assessed. A calculated antibiotic therapy should be started and inflammatory markers should be checked regularly. Furthermore an infected abdominal hematoma should be excluded using intravaginal ultrasound. A bowel injury can be excluded by performing a computer tomography with application of oral contrast agent. In case of persistent suspicion of a bowel injury or signs of peritonitis a laparoscopy or re-laparotomy should be performed.

Postoperative pain management Management of postoperative pain decreases suffering and leads to earlier mobilization. This leads to a shorter hospital stay, reduced hospital costs and increases patients` satisfaction. Pain control regimes can be used standardized. Although it is postulated to tailor the medication to the needs of the individual patient, a standardized pain control regime helps in the daily routine and can be easily adapted to the patient's needs if the standardized protocol is not adequate. A multimodal attempt is recommended, for example a combination of an opioid based drug (e.g. Oxycodone hydrochloride and Naloxone hydrochloride 10/5 mg 2 × 1 p.o. per day), Metamizole (3 × 1 g p.o. per day) and non-steroidal anti-inflammatory drugs (NSAID) (e.g. Ibuprofen 400 mg 3 × 1 p.o. per day) can be used. An obstipation prophylaxis is obligatory when opioids are prescribed. Antiemetics can be helpful in cases of nausea.

Bladder catheter and drainage management The bladder catheter can be removed during the first 24 h postoperatively to reduce the risk of an urinary tract infection. An intraoperatively placed drainage (e.g. Robinson or Penrose drainage) can be removed after 24–48 h depending on the amount of fluid measured and the fluid's texture.

Postoperative diet A special postoperative diet is not necessary after an abdominal hysterectomy, except in cases of bowel injury during the surgery. An early feeding (oral intake within 24 h) and fast mobilization stimulate the bowel and prevent stasis and postoperative paralytic ileus [3, 4, 5]. Diet protocols for patients undergoing bowel surgery depend on the localization and extent of the removed bowel and the recommendation of the surgeon. Usually it is possible to start with small amounts of oral intake of fluids within 24 h after surgery, a soup or yoghurt ca also be chosen. After return of bowel function (e.g. presence of bowel sounds or flatus) oral intake of foods can be started with mashed potatoes or white bread and be adapted to normal food depending on patient's well-being.

Intestinal paralysis and postoperative ileus The intestinal motility is often reduced after open surgery [6, 7]. This can lead to an ileus. Ileus is a blockage of the intestines caused by a lack of peristaltic (paralytic ileus) or the bowel movement is inhibited due to a mechanical blockage (mechanical ileus). In case of paralytic ileus, muscle or nerve problems disrupt the normal coordinated muscle contractions of the intestines, slowing or stopping the movement of food and fluid through the digestive system. A paralytic ileus is often caused by trauma (e.g. abdominal surgery), lack of activity, or as a side effect of certain pain medications, such as morphine. A mechanical ileus is often caused by postoperative adhesions, inflammation, tumor or volvulus (twisted colon). The most common symptoms of ileus are discomfort in the abdomen due to cramping, bloating, diarrhea, or obstipation related symptoms. Nausea and vomiting are also common symptoms. Ileus is considered a serious medical emergency and should be treated as such. If symptoms appear, further investigations should be initiated immediately. Medical anamnesis and physical examination are needed to diagnose an ileus. The presence of bowel sounds should be checked consecutively via auscultation. Furthermore a X-ray or a computer tomography using oral contrast agents can be performed to exclude a mechanical ileus. Therapeutic treatment varies according to these different types of ileus with different patho-mechanisms [8, 9]. In case of paralytic ileus a nasogastric tube can be placed and the patient should obtain drugs stimulating the intestinal motility (e.g. Neostigmine, Metoclopramide, laxatives and suppositories). In case of mechanical ileus surgical removal of the intestinal blockage should be performed. If left untreated, ileus could lead to death of tissue or cause peritonitis. This infection can be serious and potentially life-threatening.

Thromboembolic prophylaxis Thromboembolic prophylaxis with low-molecular-weight heparin (e.g. Enoxaparine 40 mg, s.c. once a day) under frequent control of the thrombocytes is fundamental. In case of a benign uterine pathology it should be continued for 5–7 days, in case of malignancy for 4–5 weeks [10]. Without thromboembolic prophylaxis

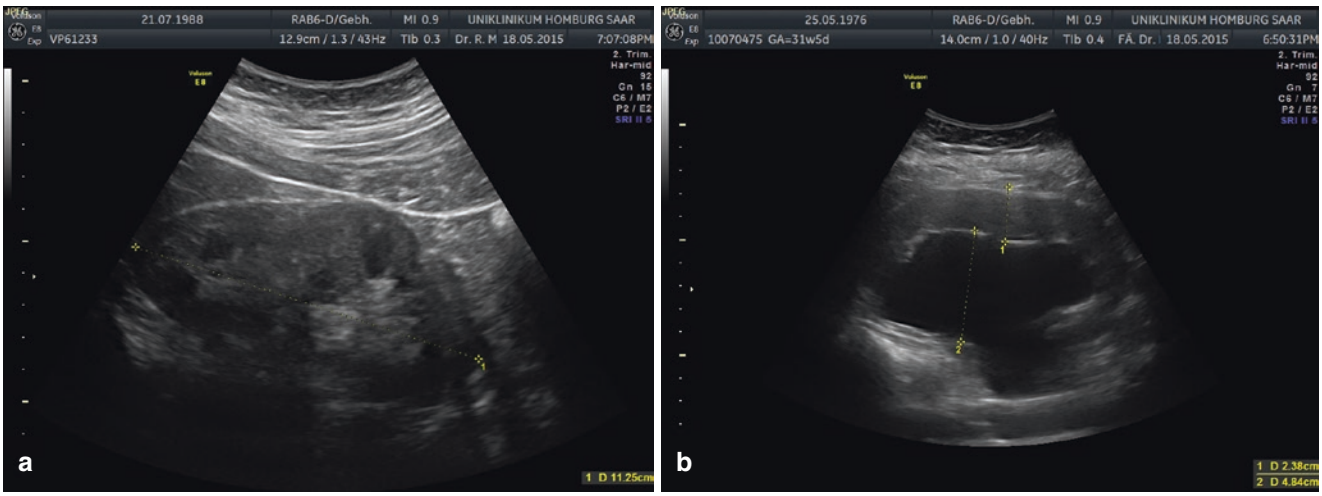


Fig. 109.1 (**a**) Ultrasound of a normal kidney, (**b**) Ultrasound of a kidney with grade III renal calyx reflux

the risk of deep vein thrombosis in patients after major general or gynecologic surgery is 15–30 %; the risk of lethal pulmonary embolism is 0.2–0.9 % [11].

Mobilization A fast mobilization is important for the postoperative outcome, a physiotherapist can be involved and help the patient with mobilization instructions.

Postoperative adhesions Postoperative adhesions have important consequences for patients, surgeons and the health system. Abdominal hysterectomy is a surgical procedure with a high risk of adhesion-related complications. Postoperative adhesions have been observed in up to 94 % of patients after laparotomy [12]. Ellis et al. reported of 34.6 % patients who underwent open abdominal or pelvic surgery were readmitted a median 2.1 times over 10 years for a disorder directly or possibly related to adhesions [13]. Pelvic adhesions can be the result of inflammation or surgical trauma. Several measures to prevent adhesion, for example placing of barrier agents between the pelvic structures [14, 15], have been proposed, but up to now none has been successful enough to find widespread acceptance. Laparoscopic lysis of adhesions is proposed for patients who have failed conservative measures [16].

Hospital stay The length of hospital stay after abdominal hysterectomy depends on the patient's mobility and is in average 3–5 days.

Examinations All patients should undergo gynecologic examination, transvaginal ultrasound and ultrasound of the kidneys before being discharged to exclude a vaginal cuff dehiscence, a renal calyx reflux and a postoperative abdominal hematoma. Figure 109.1a shows an example of a normal kidney, and Fig. 109.1b shows an example of a grade III renal calyx reflux which is pathologic. A vaginal cuff dehiscence is a rare complication of total hysterectomy (0.24–0.31 %) [17, 18]. Possible sites of origin can be poor wound healing, excessive intra-abdominal pressure at the vaginal incision site or pelvic floor defects. Prompt surgical and medical intervention is required to avoid bowel evisceration and sequelae including peritonitis, bowel injury, necrosis and sepsis. It is important to know that this is a complication which occurs mostly few weeks after surgery. Patients should be advised to avoid vaginal intercourse for 6–8 weeks. An iatrogenic ureter injury is generally asymptomatic and can lead to a renal calyx reflux after weeks, which is associated with consistent pain. An ultrasound of the kidney or an urography may help to identify this complication, prevent renal damage and is also important forensically. A postoperative abdominal hematoma or pelvic fluid accumulation can also occur as postoperative complications. A small hematoma or a small amount of pelvic fluid accumulation do not need further surgical intervention, but should be observed via sonography. In case of distinct hematoma a laparoscopy or re-laparotomy should be considered.

Discharge instructions Patients should avoid heavy lifting (> 5 kg) and exercises for 6–8 weeks to minimize traction on the fascia and prevent an abdominal hernia. Vaginal intercourse should be avoided for 6–8 weeks to prevent vaginal cuff infections and allow the vaginal cuff to heal completely.

In 2011, a panel of 12 experts used the modified Delphi method and literature review to develop multidisciplinary recommendations for graded resumption of activity after laparoscopic, vaginal and abdominal hysterectomies and adnexal surgery (Vonk Noordegraaf et al. [19]). The panel considered 65 activities and judged 38 to be relevant for convalescence

recommendations. The recommendations were then judged as feasible by 63 physicians. Examples of recommendations after vaginal hysterectomy include avoiding lifting or carrying over 10 kg, bicycle riding and vacuum cleaning for 3 weeks, and avoiding lifting or carrying over 15 kg and "standing and walking during the entire working day" for 4 weeks.

Restrictions for the same sets of activities were changed to 3–4 weeks and 6 weeks, respectively, after abdominal hysterectomy, and to 2–3 weeks, respectively, after laparoscopic supracervical hysterectomy. The Dutch authors point out that the optimum lengths of inability to work after laparoscopic, vaginal and abdominal hysterectomy are 4, 4 and 6 weeks, respectively for sedentary work and 10, 10 and 12 weeks, respectively, for physically demanding jobs.

Follow-up An ambulant follow-up visit is recommended 2 weeks after surgery in gynecologic out-patient practice. The follow-up visit should include an evaluation for potential complications (e.g. wound healing problems, postoperative abdominal hematoma, vaginal cuff dehiscence or a renal calyx reflux) and an examination of the abdomen, wound and vaginal cuff in case of a total hysterectomy. Skin stitches or staples should be removed 10–14 days after surgery. As the patients are often discharged before the arrival of histopathological results, the gynecologist should give the patient a review of the histo-pathologic results. In case of a malignant pathology further treatment should be initiated.

Long-term outcome Hysterectomy can be associated with an earlier onset of menopause [20, 21, 22]. Patients should be informed about the risk of osteoporosis and the options of prevention such as vitamin D and calcium substitution.

On the other hand, there are reports of improved overall sexual functioning after hysterectomy [23, 24]. These effects can be explained by postoperative symptom relief.

Several studies report an association of urinary incontinence following hysterectomy irrespective of the surgical technique. Due to this fact the risk for subsequent uro-gynecological surgery is increased, a fact which should be mentioned in the preoperative counselling of the patients [25, 26].

Conflict of Interest Statement The authors organize laparoscopic training workshops and take part in presentations supported by Storz, Erbe, Johnson & Johnson and Takeda (category A).

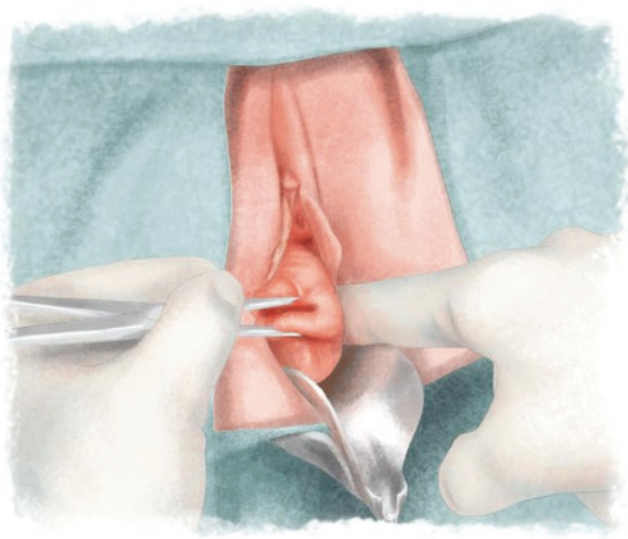
References

1. Clarke-Pearson DL, Geller EJ. Complications of Hysterectomy. Obstet Gynecol [Internet]. 2013;121:654–73. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00006250-201303000-00023
2. Wiser A, Holcroft CA, Tulandi T, Abenhaim HA. Abdominal versus laparoscopic hysterectomies for benign diseases: evaluation of morbidity and mortality among 465,798 cases. Gynecol Surg. 2013;10:117–22.
3. Andersen HK, Lewis SJ, Thomas S. Early enteral nutrition within 24 h of colorectal surgery versus later commencement of feeding for postoperative complications. Cochrane Database Syst Rev. 2006;(4):CD004080.
4. Zhao YQ, Tong WH, Wang Q. Fast-track colorectal surgery. World Chinese J Dig. 2011;19:2048–52.
5. Lewis SJ, Egger M, Sylvester PA, Thomas S. Early enteral feeding versus "nil by mouth" after gastrointestinal surgery: systematic review and meta-analysis of controlled trials. BMJ. 2001;323:773–6.
6. Livingston EH, Passaro EP. Postoperative ileus. Dig Dis Sci. 1990;35:121–32.
7. Baig MK, Wexner SD. Postoperative ileus: a review. Dis Colon Rectum. 2004;47:516–26.
8. Mattei P, Rombeau JL. Review of the pathophysiology and management of postoperative ileus. World J Surg. 2006;30:1382–91.
9. Luckey A, Livingston E, Taché Y. Mechanisms and treatment of postoperative ileus. Arch Surg. 2003;138:206–14.
10. AWMF. Prophylaxe der venösen Thromboembolie. Eur J Vasc Med. 2009; AWMF 003/0(38):76.
11. Greer IA. Epidemiology, risk factors and prophylaxis of venous thrombo-embolism in obstetrics and gynaecology. Baillieres Clin Obstet Gynaecol. 1997;11:403–30.
12. Bolnick A, Bolnick J, Diamond MP. Postoperative adhesions as a consequence of pelvic surgery. J Minim Invasive Gynecol [Internet]. 2014. Available from: http://linkinghub.elsevier.com/retrieve/pii/S155346501401601X.
13. Ellis H, Moran BJ, Thompson JN, Parker MC, Wilson MS, Menzies D, et al. Adhesion-related hospital readmissions after abdominal and pelvic surgery: a retrospective cohort study. Lancet. 1999;353:1476–80.
14. Farquhar C, Vandekerckhove P, Watson A, Vail A, Wiseman D. Barrier agents for preventing adhesions after surgery for subfertility. Cochrane Database Syst Rev 2000;(2):CD000475.
15. Watson A, Vandekerckhove P, Lilford R. Liquid and fluid agents for preventing adhesions after surgery for subfertility. Cochrane Database Syst Rev. 2000;(3):CD001298.
16. Szomstein S, Lo Menzo E, Simpfendorfer C, Zundel N, Rosenthal RJ. Laparoscopic lysis of adhesions. World J Surg. 2006;30:535–40.
17. Hur HC, Guido RS, Mansuria SM, Hacker MR, Sanfilippo JS, Lee TT. Incidence and patient characteristics of vaginal cuff dehiscence after different modes of hysterectomies. J Minim Invasive Gynecol. 2007;14:311–7.
18. Hur H-C, Donnellan N, Mansuria S, Guido R, Lee T. Vaginal cuff dehiscence after different modes of hysterectomy. Obstet Gynecol. 2012;119:382–3.
19. Vonk Noordegraaf A, Huirne JAF, Brölmann HAM, Van Mechelen W, Anema JR. Multidisciplinary convalescence recommendations after gynaecological surgery: a modified Delphi method among experts. BJOG Int J Obstet Gynaecol. 2011;118:1557–67.
20. Farquhar CM, Sadler L, Harvey SA, Stewart AW. The association of hysterectomy and menopause: A prospective cohort study. BJOG Int J Obstet Gynaecol. 2005;112:956–62.
21. Riedel HH, Lehmann-Willenbrock E, Semm K. Ovarian failure phenomena after hysterectomy. J Reprod Med. 1986;31:597–600.
22. Oldenhave A, Jaszmann LJ, Everaerd WT, Haspels AA. Hysterectomized women with ovarian conservation report more severe climacteric complaints than do normal climacteric women of similar age. Am J Obstet Gynecol. 1993;168:765–71.

23. Rhodes JC, Kjerulff KH, Langenberg PW, Guzinski GM. Hysterectomy and sexual functioning. JAMA. 1999;282: 1934–41.
24. Radosa JC, Meyberg-Solomayer G, Kastl C, Radosa CG, Mavrova R, Gräber S, Baum SRM. Influences of different hysterectomy techniques on patients' postoperative sexual function and quality of life. J Sex Med. 2014;11:2342–50.
25. Brown JS, Sawaya G, Thom DH, Grady D. Hysterectomy and urinary incontinence: a systematic review. Lancet. 2000;356: 535–9.
26. Altman D, Granath F, Cnattingius S, Falconer C. Hysterectomy and risk of stress-urinary-incontinence surgery: nationwide cohort study. Lancet. 2007;370:1494–9.

Part XI

Vaginal Hysterectomy and Extended Procedures for Benign and Malignant Indications



Indications and Contraindications of Vaginal Hysterectomy

110

Shalini Rajaram and Bindiya Gupta

Introduction

Hysterectomy remains the most common gynaecological surgery performed in women worldwide with rates ranging from 180/100,000 woman years to 540/100,000 woman years in the western world [1–3]. The choice of hysterectomy as a therapeutic procedure depends on the patient's age and most importantly the indication. Medical therapy or conservative surgery is possible in most cases of abnormal uterine bleeding due to non -structural causes. Structural abnormalities like fibroids, polyps and adenomyosis may respond to conservative therapy but hysterectomy may be required in many women. The most common benign indications for hysterectomy are uterine fibroids (40–55 %), abnormal uterine bleeding (25 %), endometriosis (17.7 %) and uterine prolapse (15 %) [1, 3, 4].

Safety and cost effectiveness are the two important determinants while choosing the route of hysterectomy. In a recent analysis of trends in routes of hysterectomy, rates of abdominal hysterectomy have reduced while vaginal hysterectomy rates have increased from 15/100,000 to 75/100,000 woman years and the rates of laparoscopic hysterectomy have increased from 10/100,000 woman years to 36/100,000 woman years [1]. There has also been an increase in the rates of robotic hysterectomy for benign indications from 0.5 to 9.5 % in USA [5].

Evidence states that vaginal hysterectomy should be the first choice of surgical approach for most benign indications for hysterectomy [6, 7]. There are well documented health and economic benefits such as reduced morbidity, fewer postoperative complications like unspecified infections and febrile episodes, shorter duration of hospital stay and shorter recovery time as compared to abdominal hysterectomy [8]. Vaginal hysterectomy also has a shorter operating time when compared to laparoscopic hysterectomy [9]. The American College of Obstetricians and Gynecologists "has identified the preferred method for hysterectomies to be vaginal whenever feasible" [8, 10]. A leading insurance company United Healthcare quoted the college as stating that "evidence demonstrates that in general, vaginal hysterectomy is associated with better outcomes and fewer complications than laparoscopic or abdominal hysterectomies. United Healthcare will now require prior authorization for all hysterectomies except those performed vaginally on an outpatient basis beginning April 2015 [11]. In April 2014, the FDA recommended that surgeons no longer use laparoscopic power morcellators for hysterectomy or myomectomy in most women with uterine fibroids because of the risk of disseminating occult cancer [12]. FDA estimated that every 1 in 350 women undergoing power morcellation to remove fibroids has an unsuspected uterine sarcoma such as leiomyosarcoma. Therefore it becomes imperative that gynaecologists are trained to perform vaginal hysterectomies for most benign conditions and understand indications and contraindications for the procedure.

Factors to Be Considered While Choosing Vaginal Hysterectomy

Uterine Size, Mobility and Descent

According to ACOG, vaginal hysterectomy is indicated in upto 12 weeks size (< 280 gm) mobile uterus [13]. Preoperative measurement of uterine size in grams can be determined with the radiologic measurements of uterus (length, width, anteroposterior diameter at fundus × 0.52) (Fig. 110.1) [14].

However, reduction techniques such as coring, corporeal bisection and wedge morcellation facilitate the removal of bigger size uteri upto 20 weeks vaginally (Fig. 110.2) [15].

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More than the size, mobility of uterus, degree of descent, position of the uterus and the amount of lateral bulk are important. Mobility of the uterus should be assessed antero-posteriorly and laterally to assess parauterine space. Descent of the uterus should be reassessed under anaesthesia using the "traction test" (Fig. 110.3). Some surgeons feel nulliparity to be a deterrent for vaginal hysterectomy, but it must be understood that under anesthesia and after transection of the utero-sacral ligaments, the uterus descends, facilitating completion of the procedure. Thus nulliparity alone is not a contraindication to surgery. Success of vaginal hysterectomy in nulliparous females ranges from 92–97 % [16, 17].

Vaginal Parameters

A vagina narrower than two fingerbreadths, especially at apex and a narrow pubic arch are not contraindications to vaginal hysterectomy but may increase the level of difficulty of the procedure [13]. Vaginal narrowing in postmenopausal women especially at the vault and a cervix flushed with the vagina must be kept in mind while deciding on the route of surgery for this group of women as surgery may prove difficult.

Extrauterine Disease and Previous Abdomino-Pelvic Surgery

In case of extrauterine involvement on preoperative workup, laparoscopic evaluation should be done before proceeding to vaginal hysterectomy. In patients with previous surgery, it is essential to ascertain the nature of surgery and postoperative complications if any [13]. Various methods like sharp dissection have been advocated for safe dissection of vesico-uterine space and bladder mobilization in those with previous

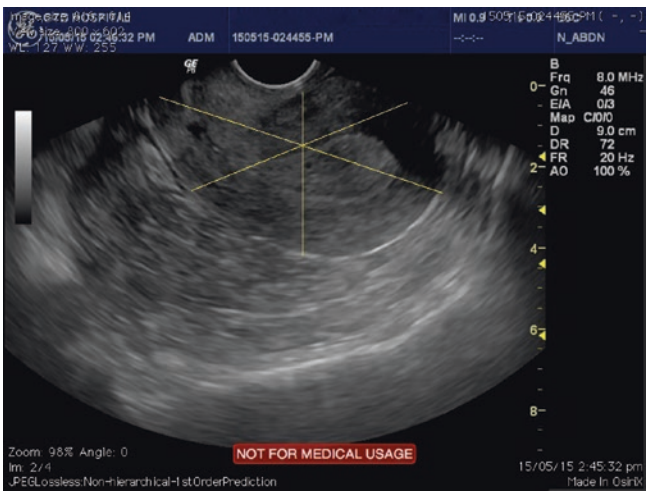


Fig. 110.1 Estimation of uterine volume on transvaginal ultrasound

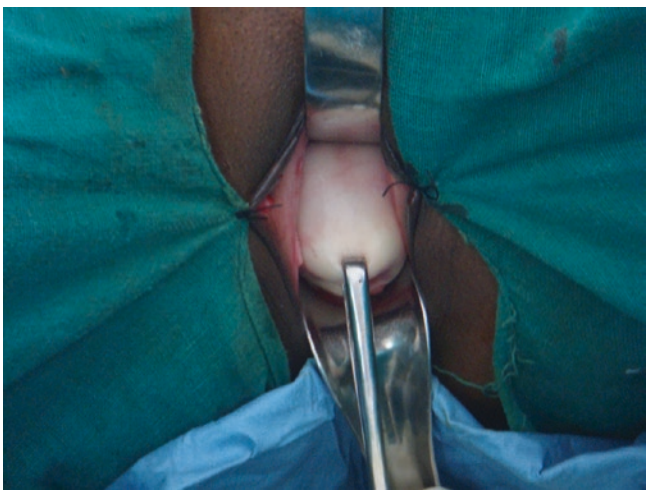


Fig. 110.3 Traction test

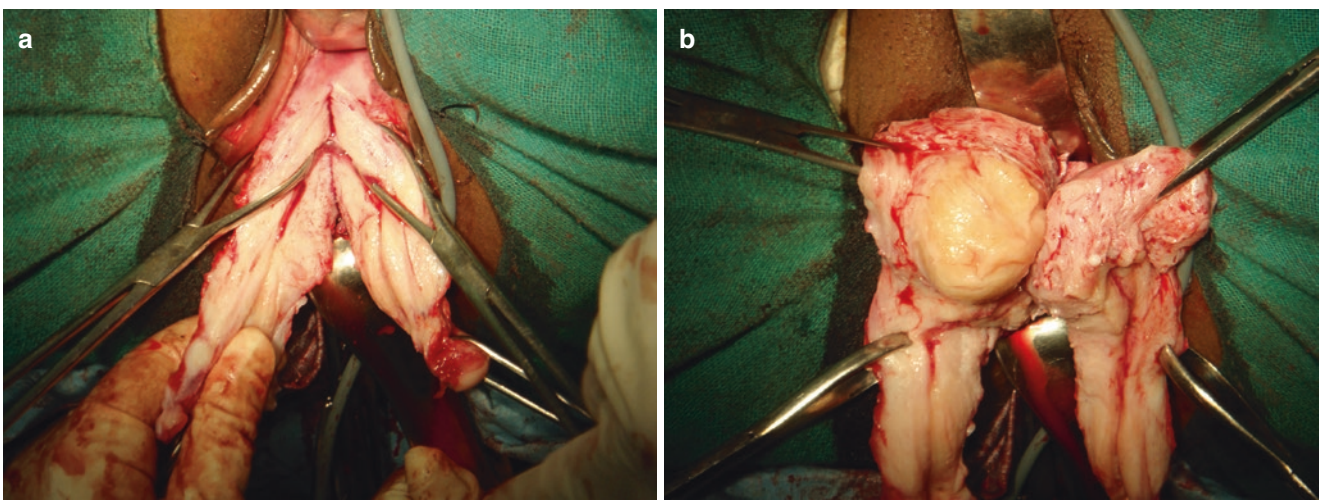


Fig. 110.2 Uterine volume reduction techniques. (**a**) Bisection; (**b**) Myomectomy

caesarean sections. The lateral window approach as described by Sheth SS is a good technique in cases of previous caesarean [18]. In case of extensive adhesions or endometriosis, laparoscopic ablation of implants and adhesiolysis may be done before vaginal hysterectomy Thus laparoscopy is complementary to vaginal surgery especially in endometriosis and previous surgeries. In endometriosis, division of infundibulo-pelvic ligaments after visualizing and isolating the ureters is probably the safest technique to adopt before proceeding with the vaginal approach.

Need for Concurrent Procedures

In a few cases mobile ovarian cysts such as simple cysts and dermoids can be removed vaginally during a vaginal hysterectomy. Most ovaries are readily accessible at the time of vaginal hysterectomy and bilateral salpingo-oophorectomy can be safely performed, provided the ovaries can be brought down beyond the ischial spines by applying moderate traction. This is assessed after division of the round ligaments laterally and gaining access to the avascular window in the broad ligament (Fig. 110.4). In case descent is inadequate, laparoscopic division of infundibular pelvic ligaments can be done. Grading of ovarian descent is done according to the position of the ovary in relation to the long axis of vagina after stretching the infundibulopelvic ligament (Table 110.1) [19]. Fallopian tubes are readily accessible at the time of vaginal hysterectomy and prophylactic salpingectomy is recommended for prevention of high grade serous ovarian tumors [20].

Surgeon's Expertise

The surgeon's list of indications not only reveals his attitude towards the operation but also the confidence or lack of it. The learning curve consists of a step ladder pattern of learning. We have tentatively divided the indications of non descent vaginal hysterectomy into four levels of learning according to the feasibility of the procedure, positive attitude, experience and confidence of the surgeon and patient consent. The levels are as follows:

Level 1: The uterine size ranges from normal size to 10 weeks. The surgeon should do at least 5–10 cases to be able to remove this size of uterus.

Level 2: The uterine size is upto 12–14 weeks' with or without nulliparity/ obesity. The surgeon usually becomes accomplished after carrying out 5–10 procedures. This size may be accomplished by bisection of the uterus or enucleation or slicing of the bulky myometrium to facilitate access to the lateral uterine structures.

Level 3: The uterine size is over 14–16 weeks' and/or previous abdominal surgeries like cesarean, myomectomy, hysterotomy or surgery on tubes and ovary. In this

Table 110.1 Grading of ovarian descent [19] (With permission)

Grade 0	No descent. Infundibulopelvic ligament has little or no stretchability, ovaries are positioned at lateral pelvic wall or above the ischial spines and cannot be pulled into the long axis of vagina with traction
Grade 1	The infundibulopelvic ligament is stretchable, and the ovaries can be brought into the long axis of vagina, with traction, halfway between the ischial spines and midvagina
Grade 2	Ovaries can be brought into the long axis of vagina, with traction between the midportion of the vagina and the hymenal ring
Grade III	The infundibulopelvic ligament is highly stretchable, the ovaries can be brought into the long axis of vagina with traction, past the hymenal ring

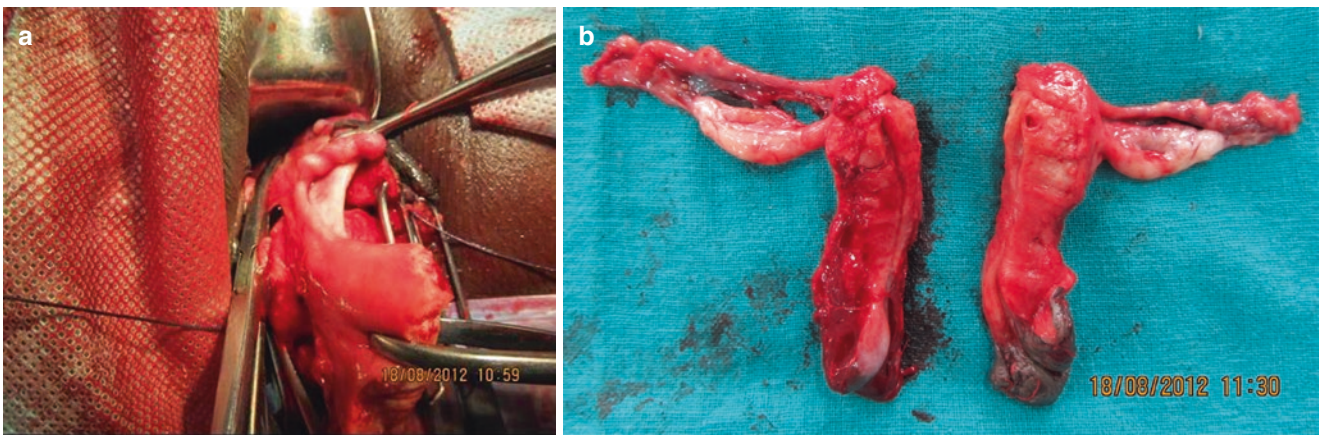


Fig. 110.4 Vaginal salpingo-oophorectomy. (**a**) Technique: clamping the infundibulopelvic ligament through a lateral window in the round ligament. (**b**) Vaginal hysterectomy with salpingo-oophorectomy specimen

category the surgeon may expect to convert to a laparoscopic or abdominal route.

Level 4: The uterine size can be any (upper limit cannot be defined) and/or previous 2–3 cesareans, vaginal surgeries like Fothergill's, sling operation, anterior or posterior colporrhaphy, with or without concomitant oophorectomy.

Patient Preference and Hospital Infrastructure

These are also important aspects to be considered in selecting the route of hysterectomy. In developing countries with a long waiting list for surgeries and insufficient laparoscopic facilities, vaginal hysterectomy is probably better in terms of cost, hospital stay, ease of surgery and safety. ACOG also re-iterates that vaginal hysterectomy is the preferred method of hysterectomy [8].

Indications of Vaginal Hysterectomy

Vaginal hysterectomy should be the technique of choice in routine practice for the management of women with non-malignant pelvic disease involving the uterus. Even early stage cervical and endometrial malignancy is not a contra-indication to vaginal hysterectomy [21, 22]. The indications should however be selected carefully on a case-to-case basis. The vaginal route is particularly useful as a good cuff of vagina is best removed vaginally. Trans-abdominal approach should be only left for those cases where vaginal hysterectomy is either contraindicated, in cases of advanced malignancy or when it may be technically impossible to perform a hysterectomy vaginally. As surgical skill improves, the indications of hysterectomy by vaginal route increase. Vaginal hysterectomy can be easily done under regional anesthesia which is very useful in women with medical illness, contraindications to general anesthesia, morbid obesity and older patients [23]. With this background knowledge and several studies supporting the feasibility of choosing vaginal route for all indications of hysterectomy unless absolutely contraindicated, the indications are as follows.

Abnormal Uterine Bleeding (AUB)

It accounts for 30–50 % of all the indications. Indications for hysterectomy for AUB have decreased in the recent past because a number of safe, easy, effective conservative methods such as hormone therapy, intrauterine device (Mirena), thermal balloon or radiofrequency ablation are now available [24]. However, when hysterectomy is required due to failure of conservative management, vaginal route is the choice because the uterus is usually < 10 weeks' size, mobile, gross adnexal pathology is rare and oophorectomy is not routinely warranted as most women are in the reproductive age group.

Adenomyosis

Adenomyosis is usually less responsive to conservative treatment and is a common indication for hysterectomy. Uterus is firm in consistency, uniformly enlarged, globular, usually not exceeding 12–14 weeks' size and volume of <300 cm^3 on ultrasound. The uterus is hard and scirrhous because of an increased fibrous component brought about by intramyometrial bleeds [25]. This will cause difficulty in debulking procedures such as coring and morcellation as the fibrous myometrium offers resistance to cutting.

Fibroid Uterus

Fibroids that cause symptoms need to be operated upon unless patient is nearing menopause with benign endometrial histopathology. Evidence advocates vaginal hysterectomy for myoma upto 12 weeks' size and uterine volume of 250–300 ml [8, 13, 26]. With experience, size can be increased and in the literature vaginal hysterectomy has been done for bigger uteri [27, 28]. In the author's experience, 18–20 weeks size uterii can be successfully removed vaginally. Apart from size, the location and accessibility of fibroids, access to pouch of Douglas, cervical descent on traction and available lateral parauterine space to free vascular pedicles are important [29]. Usually a three dimensional assessment on ultrasound should be done in cases of large uteri, and the distance of the largest fibroid from the endometrium and internal os should be determined [30]. Intramural, submucus, single fibroid present in posterior wall are dealt with ease. Fibroids increasing transverse diameter of fundus and body of uterus to more than 10 cm, anterior and distal fibroids, large degenerated fibroids, or those present in broad ligament or in cervix making uterine artery ligation difficult are problematic [15]. Vaginal morcellation techniques (with scalpel and not power morcellators) and vaginal myomectomy can be used for debulking taking care to remove each piece vaginally without entering peritoneal cavity. Multiple small fibroids can be safely removed by lateral tunneling i.e. removal from inside the uterus unless there is a presence of an obvious external bulge [15].

In case of fibroid polyps, vaginal hysterectomy can be done after removal of the fibroid polyp. Small posterior wall cervical fibroids are amenable to vaginal hysterectomy after vaginal myomectomy. The most important aspect in cervical fibroids is to determine the ease of access to uterine vessels.

Uterine Prolapse

The major indication for vaginal hysterectomy in India is utero-vaginal prolapse. Traditionally, treatment of uterovaginal prolapse is accompanied by a concomitant hysterectomy

as most women are postmenopausal and anterior and posterior colporrhaphy can be accomplished at the same sitting. Vaginal hysterectomy can also be offered to premenopausal women beyond 40 years if there is a concomitant uterine or cervical pathology and marked cervical elongation [31]. The ease of surgery and short hospital stay are other advantages. Vaginal hysterectomy with descent is technically easy and is the initial step to learn the technique. Uterus sparing techniques like sacrohysteropexy, sacrospinous hysteropexy and uterosacral hysteropexy have been advocated in women who desire uterine preservation. However, these are reserved for younger women, there is more recurrence and is limited by lack of evidence [32, 33].

Preneoplastic Conditions

Vaginal hysterectomy with concomitant bilateral oophorectomy is ideal for complex hyperplasia with atypia of the endometrium. An attempt should be made to avoid debulking techniques. Hysterectomy can be done vaginally in cases of cervical intraepithelial neoplasia grade 3, in older women not desirous of preserving uterus, provided a detailed colposcopic examination has been done of the cervix and vagina.

Neoplasia

Cervical Malignancy

Carcinoma in situ can be managed with vaginal hysterectomy. This route has the advantage of removing a cuff of the vagina especially if disease extends onto the vagina as seen on colposcopy. For microinvasive cervical cancer (stage 1 A1) with no lymphovascular space invasion, vaginal hysterectomy with partial removal of vagina can be done post conization [34]. In a woman who has undergone conization, the bulk of the cervix which is normally available for traction is lost and dissection especially of the bladder anteriorly must be done carefully. Inadvertant cystotomy has occurred in the authors' experience at the time of bladder dissection as there is only a thin cervix on which the bladder rests.

Newer minimally invasive techniques like Laparoscopically assisted vaginal radical vaginal hysterectomy (LAVRH) and laparoscopic lymphadenectomy in combination with radical vaginal hysterectomy are gaining popularity for cervical cancer stage Ib1 and select cases of Ib2 and IIa [35].

Endometrial Cancer

Vaginal hysterectomy with laparoscopic lymphadenectomy can be done in stage 1, grade 1 & 2 well differentiated endometrioid adenocarcinoma [22]. This route is especially useful in women with impaired cardiorespiratory efforts, morbid obesity, hypertensive and diabetic woman or in those with concomitant vaginal prolapse. Vaginal hysterectomy with bilateral salpingo-oophorectomy has shown to have equivalent results to abdominal route in select cases with well differentiated or moderately differentiated carcinoma confined to endometrium [36].

Table 110.2 Indications of vaginal hysterectomy

Abnormal uterine bleeding
Fibroid uterus, adenomyosis
Cervical polyp or fibroid
Chronic pelvic pain, chronic uterine inversion
Postmenopausal bleeding, pyometra
Cervical dysplasia, microinvasive cervical cancer (Stage Ia1)
Complex hyperplasia with atypia, Stage 1a G1 & 2 well differentiated endometrial cancer
Prolapse uterus

Other Indications

Other indications include chronic pelvic pain, chronic uterine inversion and recurrent post menopausal bleeding. Vaginal route is advisable in patients with morbid obesity, medical high risk cases like poor cardiac status and impaired pulmonary function and after ventral incisional hernia repair [37, 38]. The indications have been summarized in Table 110.2.

Contraindications

Absolute contraindications of vaginal hysterectomy are as follows:

1. Uterus more than 20 weeks' size: Although ACOG recommends vaginal hysterectomy up to 12 weeks uterine size [8], but size as a limitation depends on surgical skill.
2. Very limited vaginal space: vaginal hysterectomy is difficult if vagina is narrow especially at the apex.
3. Cervix completely flushed with uterus.
4. Severely restricted uterine mobility: Uterine mobility can be a limiting factor in cases with grade 4 endometriosis, post cesarean cases, previous abdominal surgeries and pelvic inflammatory disease. These conditions have the highest rate of conversion to abdominal route [39].
5. Previous vesico-vaginal or recto-vaginal fistula repair
6. Previous rectosigmoid resection with low anastomosis
7. Genital malignancies: In high grade, clear cell and papillary serous or advanced endometrial cancer vaginal route is not recommended. Cervical cancer more than stage Ia_1 upto IIa is not an indication for radical vaginal hysterectomy.
8. Gross adnexal pathology or suspected malignancy

The relative contraindications are mainly based on surgeon's experience and expertise.

1. *Uterine size >12 weeks (>280 cc volume):* In case of a uniformly enlarged large uterus, if all the three dimensions are ≥10 cm and the angle between the lateral border of the uterus and the cervix is ≥ 90°, it is a contraindication to vaginal route [30, 40].
2. *Short cervix*: In post menopausal women the cervix is flushed with vagina. Following cervical amputation and conization, there is difficulty in holding the cervix. In these cases traction can be given with Allis tissue forceps and careful sharp dissection of the vesico-uterine pouch should be done.
3. *Broad ligament fibroid*: These are usually not amenable to vaginal removal. It is suggested that if the surgeon can reach the infundibulopelvic ligament, he can access the medially placed broad ligament fibroid [26]. This is because the lateral limit of broad ligament is restricted by bony pelvis and the medial extent is similar to the distance of ovary from uterus. Difficulty in delineating the ureter is a major drawback with the vaginal route for accessing broad ligament fibroids.
4. *Endometriosis*: The level of difficulty, as mentioned above depends on disease severity. In cases of endometrioma, vaginal aspiration can be done before attempting salpingo-oophorectomy.
5. *Benign adnexal disease*: The contents of the cyst can be aspirated before salpingo-oophorectomy. Laparoscopic removal of the adenexa can also be done followed by vaginal hysterectomy.

To conclude, vaginal hysterectomy is a gynecologist's domain and the approach of choice for benign pathology and early cervical and endometrial cancers. The indications are many and contraindications few.

References

1. Lykke R, Blaakær J, Ottesen B, Gimbel H. Hysterectomy in Denmark 1977-2011: changes in rate, indications, and hospitalization. Eur J Obstet Gynecol Reprod Biol. 2013;171:333–8.
2. Stang A, Merrill RM, Kuss O. Prevalence-corrected hysterectomy rates by age and indication in Germany 2005–2006. Arch Gynecol Obstet. 2012;286:1193–200.
3. Whiteman MK, Hillis SD, Jamieson DJ, et al. Inpatient hysterectomy surveillance in the United States, 2000–2004. Am J Obstet Gynecol. 2008;198(1):34. e1–7
4. Hammer A, Rositch AF, Kahlert J, Gravitt PE, Blaakaer J, Søgaard M. Global epidemiology of hysterectomy: possible impact on gynecological cancer rates. Am J Obstet Gynecol. 2015;213(1):23–9. S0002-9378(15)00155-6.
5. David E. The rise and rise of robotic hysterectomy. BMJ. 2013; 346:f1116.
6. Sesti F, Cosi V, Calonzi F, Ruggeri V, Pietropolli A, Di Francesco L, Piccione E. Randomized comparison of total laparoscopic, laparoscopically assisted vaginal and vaginal hysterectomies for myomatous uteri. Arch Gynecol Obstet. 2014;290(3):485–91.
7. Kives S, Lefebvre G, Wolfman W, et al. Supracervical hysterectomy. J Obstet Gynaecol Can. 2010;32(1):62–8.
8. The American college of obstetrician's and Gynecologists. ACOG committee opinion no. 444: choosing the route of hysterectomy for benign disease. Obstet Gynecol. 2009;114:1156–8.
9. Nieboer TE, Johnson N, Lethaby A, et al. Surgical approach to hysterectomy for benign gynecological disease. Cochrane Database Syst Rev. 2009;8(3):CD003677.
10. AAGL Advancing Minimally Invasive Gynecology Worldwide. AAGL position statement: route of hysterectomy to treat benign uterine disease. J Minim Invasive Gynecol. 2011;18(1):1–3.
11. United health restricts use of nonvaginal hysterectomies. www.medscape.com/viewarticle/840650. Accessed on 6 Mar 2015.
12. UPDATED laparoscopic uterine power morcellation in hysterectomy and myomectomy: FDA safety communication. www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm424443.htm. Accessed on 7 Mar 2015.
13. Kovac SR. Clinical opinion: guidelines for hysterectomy. Am J Obstet Gynecol. 2004;191:635–40.
14. Kung FT, Chang SY. The relationship between ultrasonic volume and actual weight of pathologic uterus. Gynecol Obstet Invest. 1996;42(1):35–8.
15. Goel N, Rajaram S, Agarwal R. Volume reductive vaginal hysterectomy. In: Goel N, Rajaram S, Mehta S, editors. State of art vaginal surgery. 2 ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2013.
16. Tohic AL, Dhainaut C, Yazbeck C, et al. Hysterectomy for benign uterine pathology among women without previous vaginal delivery. Obstet Gynecol. 2008;111:829–37.
17. Agostine A, Bretelle F, Cravello L, et al. Vaginal hysterectomy in nulliparous women without prolapse: a prospective comparative study. Int J Obstet Gynecol. 2003;110:515–8.
18. Seth SS, Shah VM. Chapter 10. Hysterectomy after previous abdomino pelvic surgery. In: Shirish SS, editor. Vaginal hysterectomy. 2nd ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2014.
19. Kovac SR, Cruikshank SH. Guidelines to determine the route of oophorectomy with hysterectomy. Am J Obstet Gynecol. 1996;175: 1483–8.
20. Kurman RJ, le M S. The origin and pathogenesis of epithelial ovarian cancer: a proposed unifying theory. Am J Surg Pathol. 2010; 34:433–43.
21. Marin F, Plesca M, Bordea CI, Moga MA, Blidaru A. Types of radical hysterectomies: from Thoma Ionescu and Wertheim to present day. J Med Life. 2014;7(2):172–6.
22. Smith SM, Hoffman MS. The role of vaginal hysterectomy in the treatment of endometrial cancer. Am J Obstet Gynecol. 2007;197: 202. e1–6
23. Roy RC. Choosing general versus regional anesthesia for the elderly. Anesthesiol Clin North America. 2000;18(1):91–104.
24. Matteson KA, Abed H, Wheeler 2nd TL, Society of Gynecologic Surgeons Systematic Review Group, et al. A systematic review comparing hysterectomy with less-invasive treatments for abnormal uterine bleeding. J Minim Invasive Gynecol. 2012;19(1):13–28.
25. Ferenczy A. Pathophysiology of adenomyosis. Hum Reprod Update. 1998;4(4):312–22.
26. Seth S, Paghdiwalla K, Hajari A. Vaginal route: a gynecological route much more than hysterectomy. Best Pract Res Clin Obstet Gynaecol. 2011;25:115–32.
27. Pelosi MAIII, Pelosi MA. The Pryor technique of uterine morcellation. Int J Gynecol Obstet. 1997;58:299–303.
28. Li Z, Leng J, Tang J. Vaginal hysterectomy for patients with moderately enlarged uterus of benign lesions. Chin Med Sci J. 2004;19:60–3.
29. Ghumman S. Indications and contraindications for non descent vaginal hysterectomy. In: Goel N, Rajaram S, Agarwal R, Mehta S,

editors. Step by step Non descent vaginal hysterectomy. 2 ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2010.
30. Seth SS. Uterine fibroids. In: Seth SS, Studd JWW, editors. Vaginal hysterectomy. 1 ed. London: Martin Dunitz Ltd; 2002. p. 79–94.
31. Goolab BD. Vaginal hysterectomy and relative merits over abdominal and laparoscopically assisted hysterectomy. Best Pract Res Clin Obstet Gynaecol. 2013;27(3):393–413.
32. Giarenis I, Robinson D. Prevention and management of pelvic organ prolapse. F1000Prime Rep. 2014;6:77.
33. Marschalek J, Trofaier ML, Yerlikaya G, et al. Anatomic outcomes after pelvic-organ-prolapse surgery – comparing uterine preservation with hysterectomy. Eur J Obstet Gynecol Reprod Biol. 2014;183:33–6.
34. Seth SS. Vaginal hysterectomy. Best Pract Res Clin Obstet Gynaecol. 2005;19(3):307–32.
35. Pergialiotis V, Rodolakis A, Christakis D, Thomakos N, Vlachos G, Antsaklis A. Laparoscopically assisted vaginal radical hysterectomy: systematic review of the literature. J Minim Invasive Gynecol. 2013;20(6):745–53.
36. Zanagnolo V, Magrina JF. Carcinoma of the endometrium treated only by vaginal route. Best Pract Res Clin Obstet Gynaecol. 2011;25:239–45.
37. Shah DK, Vitonis AF, Missmer SA. Association of body mass index and morbidity after abdominal, vaginal, and laparoscopic hysterectomy. Obstet Gynecol. 2015;125(3):589–98.
38. Sheth SS, Ghoshal AA. Vaginal hysterectomy after previous ventral scar hernia repair. J Obstet Gynaecol. 2002;22(4):430–1.
39. Ray A, Pant L, Magon N. Deciding the route for hysterectomy: Indian triage system. J Obstet Gynaecol India. 2015;65(1):39–44.
40. Newbold P, Vithayathil M, Fatania K, Yoong W. Is vaginal hysterectomy is equally safe for the enlarged and normally sized non-prolapse uterus? A cohort study assessing outcomes. Eur J Obstet Gynecol Reprod Biol. 2015;185:74–7.

Preparation for Vaginal Hysterectomy: History, Preoperative Assessment, Operative Set-up, Table, Antibiotics

111

Bindiya Gupta and Shalini Rajaram

Introduction

Optimising surgical outcome is a surgeon's priority and careful patient selection, systematic preoperative preparation and work up is the key to a good outcome, along with fine surgical skills and technique. Surgical intervention should always be the last resort and done when all other conservative methods fail. For instance in cases with abnormal uterine bleeding conservative options like levonorgesterl intrauterine system or endometrial ablation should be tried before considering surgery. The patient should be explained in detail the benefits, risks and complications associated with surgery. A thorough patient evaluation with investigations is imperative to accurate diagnosis of the underlying pathology and helps in appropriate selection of surgical procedure. The various components of preoperative care and evaluation for vaginal hysterectomy will be discussed in the chapter.

Consent

It is the most crucial component before planning any surgical procedure. The woman should have a clear understanding of the surgical procedure and its associated risks. For consent to be valid, patient must be competent to make treatment decisions on her own behalf. She should have received appropriate information to make the choice and decision must be voluntary without coercion [1]. It is usually given by adults over the age of 18 years, before the proposed procedure and before any sedation is given.

The components of an informed written consent form besides patient particulars should include specific sections for documentation i.e. the name of the procedure and brief details of the procedure like incisions, extent of surgery, expected outcome, impact on fertility, any necessary concomitant extra procedures, use of prophylactic antibiotics and thromboembolic prophylaxis. [2] The other components include intended benefits, serious and frequent risks of the procedure, implications of no treatment, type of anaesthesia and availability of alternative treatments [2].

Consent should be obtained by person capable of performing the procedures themselves or who have received specialist training in advising patients about the procedure [1]. It is usually obtained by the doctor who is the operating surgeon or by his junior associate.

Preoperative Evaluation and Planning

Once the surgical intervention is decided and the woman gives consent, a detailed surgical planning should be instituted. The goals of preoperative evaluation are to reduce surgical morbidity, minimize expensive delays and cancellations, evaluate and optimize patient's health status and fitness for surgery, detect anticipated complications and prepare to tackle them, facilitate the planning of anesthesia and perioperative care and reduce patient anxiety [3].

The components of preoperative evaluation include assessment of patient's health, evaluate factors that can influence the operative outcome, and decide the route and type of surgery best suited for the problem [4]. It includes a complete history and thorough physical examination, laboratory testing and imaging procedures as well as consultations to promote optimal outcomes.

History

The entire history must be reviewed and re-evaluated in detail before finally deciding the surgical intervention. Key components include a review of symptomatology, detailed

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Table 111.1 Preoperative history taking

History
Symptomatology
Menstrual history (amount and duration of flow, cyclicity, last menstrual period)
Obstetric history
Acute or chronic medical illness, previous history of surgery
Family history
Personal history: smoking and other addictions, dietary history and socio economic status

menstrual and obstetric history, associated medical and surgical conditions and family history. An insight into personal history of smoking and other addictions, dietary history and socio economic status must be taken as it has a significant impact on post operative recovery. The key points in history taking are summarized in Table 111.1.

Examination

A systematic physical examination must be done to assess well being, anaesthesia fitness and nutritional status of the patient. A detailed preoperative gynaecologic examination is carried out keeping in mind indications and contraindications of vaginal hysterectomy.

The following points should be noted while doing a pelvic examination:

(a) Local examination of vulva and perineum should be done to exclude local pathology and infections like warts and fungal infections. Assess levator ani tone and perineal body especially in cases of uterine prolapse.
(b) Assess size and mobility of the uterus. The descent of the cervix should be assessed without traction and then by giving traction using a vulsellum (Traction test). The length of the portio vaginalis portion of the cervix should also be noted. The depth of the fornices, subpubic angle and intertuberous diameter also need assessment.
(c) Assess width of vagina, especially at the fornix and it should accommodate at least two fingers. Mobility of vagina is evaluated by applying upward and downward traction on cervix with vulsellum and looking for any puckering of vaginal mucosa which may indicate underlying adhesions. Displacing the bladder sulcus with a moistened sponge on a holder also helps in assessing mobility of vaginal mucosa.
(d) A cervix that is flushed with the vagina is a contraindication to vaginal hysterectomy
(e) In case of fibroids the number, location, position and lateral bulk of the uterus is assessed.
(f) The uterine free pelvic space around the uterus is palpated and assessed.

Table 111.2 Perooperative score under anesthesia for vaginal hysterectomy [7]

Score	0	1	2
Size of uterus	<8 weeks	8–10 weeks	>10 weeks
Mobility of uterus	Good	Fair	Poor
Inter tuberous distance	>4 knuckles	4 Knuckles	<4 Knuckles
Sub pubic arch	>90°	90°	<90°
Digital exam of vagina	3 finger loose	3 finger tight	2 finger tight
Mobility of vaginal mucosa	Good	Fair	Poor
Fornix depth	>1 finger crease	1 finger crease	<1 finger crease
Descent with volsellum	>1°	1°	<1°
Surgeons experience	>10 years	5–10 years	<5 years
History of previous surgery	Nil	One	>one

Score classification: very easy (0–5), easy (6–10), difficult (11–15), and very difficult (>16)

(g) In cases of previous surgery, non descent of the cervix below the ischial spine on applying traction is a contraindication for vaginal surgery.
(h) Seth's cervicofundal sign: When the cervix is not visualised on introducing a large full length speculum and only visualised when anterior vaginal wall retractor is used along with a pulled up posterior wall indicates adhesions between the uterus, cervix and lower abdominal wall. A positive sign is a contraindication to vaginal hysterectomy [5, 6].

The preoperative score for non descent vaginal hysterectomy can be calculated as shown in Table 111.2 [7]. The score ranges from 0 to 20 and higher the score, the difficulty level of surgery increases. It is classified as very easy (0–5), easy (6–10), difficult (11–15), and very difficult (>16).

Investigations (specific)

Examination can be supplemented by detailed assessment of the uterus by ultrasound. Other imaging modalities like computed tomography (CT)/ Magnetic resonance imaging (MRI) are rarely required. An assessment of uterine volume, size, location and size of fibroids, endometrial thickness and adnexal pathology are a few parameters to be noted. Endometrial sampling should be done in all women with abnormal uterine bleeding or abnormal endometrial imaging using a Piplle or Vabra aspirator, or a Karman's cannula. Screening for cervical cancer should be done in all women.

Anesthesia Evaluation and Preoperative Investigations

The anaesthetic risk assessment of patient's preoperative physical status for all surgeries is established by the American Society of Anesthesiologists. It is a subjective assessment of patient's overall health and is divided into six classes (Table 111.3) [8]. The ASA category has been closely related with surgical outcomes, operating time, complications, blood transfusions, and overall morbidity and mortality [9–11]. Patients for an elective procedure with an ASA grade 3 or 4 need consultation with a senior anesthetist [8].

The purpose of laboratory tests is to detect a medical disease or defect that could adversely affect anaesthetic and surgical outcome. Initially, these tests were done in all patients, irrespective of age or concurrent medical or surgical pathologies which were not cost effective, and led to unnecessary interventions. Evidence indicates that, 60–70 % of laboratory tests ordered preoperatively are not required based on a review of the history and/or physical examination and only 1 % or less of routinely performed preoperative tests reveal abnormalities that might influence perioperative management [12, 13]. Thus, universal use of "routine" preoperative tests is not beneficial in terms of good and cost effective patient care and does not offer any legal protection [14, 15]. Focal and selective preoperative testing is more useful and laboratory tests should be individualised based on patient's age, history, examination, review of medical records and the type and extent of surgery. [16]In asymptomatic healthy women, hemoglobin or hematocrit must be measured in all patients over the age of 6 months; an electrocardiograph on all women over the age of 40 years; and a blood urea nitrogen test and a glucose test in all women over the age of 65 years. Additionally, a pregnancy test should be done in all reproductive age women who are at risk of early pregnancy [17]. In our hospital we do a minimal investigative work-up which includes blood glucose and kidney function tests apart from haemoglobin, blood grouping and cross-matching, electrocardiograph (ECG) and X-ray Chest. We also screen all women undergoing surgery for HIV, Hepatitis B and Hepatitis C.

In women who are symptomatic and/or have other medical or surgical pathologies, preoperative tests should be done to determine the current status of medical or surgical co morbidities and determine their effect on the outcome of the proposed surgery. This would also help perform necessary medical interventions to minimize adverse outcomes. Recommendations for selective preoperative laboratory testing are summarized in Table 111.4 [16, 17].

Table 111.3 Classification of physical status, established by the American Society of Anesthesiologists 1962, amended 1980 [8]

Class	Description
ASA PS1	Normal healthy and fit patient
ASA PS2	Patient has mild systemic disease
ASA PS3	Patient with severe systemic disease not incapacitating
ASA PS4	Patient with severe incapacitating systemic disease that is a constant threat to life
ASA PS5	Moribund patient who is not expected to survive 24 h with or without surgery
ASA PS6	Declared brain dead patient whose organs are being removed for donor purposes
E	Emergency surgery, suffixed after ASAPS

Medical/Gynecologic Management

Preoperative planning also includes any medical or gynecological management in the months preceding the surgical procedure to help achieve maximum physical status, optimal surgical outcome and minimize complications. Examples

Table 111.4 Preoperative testing in special situations [16, 17]

Preoperative test	Medical condition
ECG	Cardiac disease, hypertension, COPD[a], Central Nervous System disorder, Thyroid and parathyroid disorder, morbid obesity, diabetes, poor nutrition, digoxin therapy, males>45 years, females> 55 years
X ray chest	Congestive heart failure, hypertension, valvular heart disease, COPD[a], Morbid obesity, heavy smoker, radiation therapy, aortic aneurysm, cardiomegaly
Complete blood counts	Major surgery, neonates, males>70 years, females>45 years, chronic renal, liver and lung disease, anemia and other hematological disorders, coagulopathies, CNS disorders (stroke, seizures, tumor), malignancy, cushing's syndrome, addison's disease, poor nutrition, steroids, chemotherapy
Electrolytes	Hypertension (on diuretics), diabetes, heart disease, renal disease, stroke, seizures, thyroid disease, cushing's disease, addison's disease, hyperparathyroidism, poor nutrition, diuretics use, digoxin therapy, steroids, chemotherapy
Renal profile	Hypertension, diabetes, renal disease, poor nutrition, diuretics
Glucose	Diabetes, family history of diabetes, stroke, seizures, cushing's and addison's disease, marked obesity, poor nutrition, steroid therapy
Coagulation profile	Hepatic disease, family history of coagulopathy, anticoagulant therapy, renal dysfunction
Liver function test	Liver disease
Calcium levels	Hyperthyroid, parathyroid disease

[a]*COPD* chronic obstructive pulmonary disease

include use of preoperative vaginal estrogen cream for 4–6 weeks before surgery for increasing vaginal mucosal thickness in postmenopausal women. This facilitates dissection, post-operative repair of tissues, reduces urinary tract infection and postoperative morbidity.

Another important aspect is the regulation of medications taken by the patients prior to the surgery. For example, modification of insulin dose in the diabetic women, appropriate timing of surgery in women taking anticoagulants or continuation/discontinuation of oral contraceptive pills. Warfarin should be stopped 5–6 days prior to surgery if the pre procedure International normalised ration (INR) is 2.0–4.5. Repeat INR within 24 h of surgery to ensure that it is less than 1.5 or lower and patient should be started on unfractionated heparin. [18, 19, 20] In case the cardiovascular risk is high or moderate, aspirin can be continued before and during surgery, but in case the risk is low aspirin is stopped 7–10 days prior to surgery [19, 20]. Estrogen containing oral contraceptive pills or hormone therapy should be discontinued 4 weeks prior to surgery [21]. In cases of emergency surgery in patients on estrogen containing pills, use of intravenous heparin, graduated compression stockings and early mobilization is recommended [21].

Preoperative Care

Antibiotic Prophylaxis

Postoperative infections remain a major source of morbidity and a potential cause of mortality in surgical patients. All major gynecological surgeries, either vaginal or abdominal carry a significant risk of infectious morbidity (20 %) [22].Infections after hysterectomy include operative site infections, vaginal cuff cellulitis, pelvic cellulitis, pelvic abscess, urinary tract infections and generalised sepsis [23]. These prolong hospital stay and increase health care costs. Risk factors for infection after hysterectomy include older age, diabetes, obesity, peripheral vascular disease, coagulation disorder, anemia, poor nutritional state, past h/o surgical infection, presence of malignancy, prior radiotherapy, long duration of surgery and presence of indwelling catheters [24].

Operative-site infections after a hysterectomy result from the ascending spread of microorganisms from the upper vagina and endocervix to the vaginal cuff and paravaginal tissues dissected during the procedure. Postoperative infections following vaginal hysterectomy are polymicrobial, with enterococci, aerobic gram-negative bacilli, and *Bacteroides* species isolated most frequently. [25] Bacterial vaginosis, a complex alteration of vaginal flora resulting in an increased concentration of potentially pathogenic anaerobic bacteria, is associated with an increased risk of posthysterectomy cuff cellulitis [26]. However, there is a lack of data showing that pre-treatment for bacterial vaginosis before hysterectomy reduces the rate of postoperative cuff cellulitis.

The most critical factors in the prevention of postoperative infections, although difficult to quantify, are the sound judgment and proper technique of the surgeon and the surgical team, as well as the general health and disease state of the patient. Antibiotic prophylaxis is increasingly used to augment host defence mechanism and reduce infectious complications in patients by almost 50 % [22]. A meta-analysis found that the rate of postoperative infection (surgical and pelvic sites) in women undergoing vaginal hysterectomy who received placebo or no prophylactic antimicrobial ranged from 14 to 57 %, which was significantly higher than the 10 % rate reported with antimicrobials [27].

Principle of Antimicrobial Prophylaxis

The principle of antibiotic prophylaxis is to reduce the colonization of microorganisms to the extent that the patient's natural immune-defence mechanisms are able to overcome the bacterial load in the wound. [28] Only a narrow window of antimicrobial efficacy is available, requiring the administration of antibiotics either shortly before or at the time of bacterial inoculation (e.g., when the incision is made, viscus entered, or pedicles clamped); i.e. at least 15–60 mins before skin incision [29]. A delay of only 3–4 h can result in ineffective prophylaxis. The induction of anesthesia represents a convenient time for initiating antibiotic prophylaxis such that serum and tissue levels are adequate before the incision is made, the levels are maintained during surgery and few hours after the incision is closed [30, 31]. For lengthy procedures (>3 h) and for procedures with increased blood loss (>1500 ml), a second intraoperative dose of antibiotic can be repeated at intervals of one or two times the half-life of the drug (3–4 h after first dose) to maintain adequate levels throughout surgery [29, 30].

Antimicrobial of Choice

The administration and the choice of antibiotic depend on wound classification. Vaginal hysterectomy is classified as "clean-contaminated" wound and prophylactic antibiotics have reduced the incidence of febrile morbidity from 40–50 to 5–20 % [28, 31, 32]. First or second generation cephalosporin's have emerged as the drugs of choice for the vast majority of operative procedures because of their broad antimicrobial spectrum and low incidence of allergy and side effects [24, 29]. The recommended regimen is a single dose of cefazolin (1 or 2 g single dose IV), but alternative agents

such as Cefoxitin, cefotetan, or ampicillin–sulbactam may also be used. [24]In case the patient is allergic to β lactams, either of the following regimens can be used [23, 24, 29].

1. Clindamycin or vancomycin plus an aminoglycoside (or aztreonam, or a fluoroquinolone)
2. Metronidazole plus an aminoglycoside (or fluoroquinolone)
3. Clindamycin monotherapy.

Screening for bacterial vaginosis is not recommended prior to surgery. However, treatment of bacterial vaginosis using metronidazole 4 days prior to vaginal hysterectomy did reduce the incidence of vaginal cuff cellulitis from 59 to 27 % in one study [33].The recommendations are similar for surgery for prolapse and stress urinary incontinence.

Patients who have specific cardiac conditions should be offered infective endocarditis prophylaxis [30]. Postoperative respiratory infections can be reduced by optimization of lung functions by medication and physiotherapy, cessation of smoking and early mobilization with good pain control. To reduce urinary tract infections, indications for the use and duration of indwelling catheters may be optimised.

Adjunctive Techniques to Prevent Postoperative Infections

Preoperative shaving of pubic and abdominal hair prior to gynaecological surgery is not recommended; in fact preoperative shaving is associated with a significantly higher surgical site infection rate, particularly when completed the night before surgery. When hair removal is required, hair clipping is recommended at the time of surgery [31].

Surgical site antisepsis is a crucial step to prevent post operative surgical site infections. The only recommended solution is povidone iodine (PVP-I) for vaginal cleaning before surgery [34]. It is a non irritant and has less reported sensitivity reactions. However, iodophors are inactivated in presence of blood and may cause hypersensitivity reactions in patients allergic to iodine [28, 34]. In known cases of PVP-I allergy, 4 % solution of chlorhexidine gluconate is a safe and effective alternative. Chlorhexidine gluconate causes destruction of bacterial cell membranes, has a greater residual effect than iodine and does not get inactivated in presence of blood. [35] The chlorhexidine solution with 70 % alcohol concentration used for abdominal skin preparation is contraindicated for vaginal use as it causes excessive mucosal irritation [34].

A shower with antiseptic soap in the evening before surgery remains a helpful adjunct to infection prevention [31]. Vaginal douching the night before surgery has been shown to be less effective than thorough cleansing of vagina with a povidone iodine solution immediately prior to surgery in the operation theatre. Most vaginal procedures do not require a rigorous bowel preparation; however, it is useful in pelvic surgery to try to ensure that a loaded colon does not limit access. A proctoclysis enema or two rectal suppositories are given the night before surgery.

The recommendations for prevention of surgical site infections (SSI) and health care associated infections have been developed and updated by National Institute of Health and Care excellence in 2008 and Centre of disease Control (CDC) in 2012 respectively (Table 111.5). [31, 36].

Thromboembolism Prophylaxis

Most of the gynecological surgeries are associated with a moderate risk of thromboembolism. In absence of prophylaxis, the risk is 7 % after vaginal hysterectomy, 14 % after abdominal hysterectomy, 38 % after Wertheim's hysterectomy and there is upto 0.4 % risk of fatal pulmonary embolism. [37] Risk factors include older age, obesity, malignancy, previous venous thrombolembolism, estrogen treatment, previous chemotherapy or radiotherapy and complex and increased duration of the procedure [38]. All patients should be individually assessed for risk of thromboembolism and treated appropriately. Low risk patients do not require specific prophylaxis other than early ambulation, while moderate and high risk gynecologic surgery candidates should be offered thromboprophylaxis [39–41]. The recommendations are summarised in Table 111.6. Evidence suggests that unfractionated heparin and low molecular weight heparin are equally effective in preventing venous thrombosis [41].

Operative Set up

Optimal positioning and illumination of the surgical field is essential to obtain optimal exposure in order to ensure a safe and effortless surgery. Every surgeon must have basic knowledge regarding operating tables and light fittings in the operating theatre.

Operating Table

An operating table consists of a table top supported by the column which in turn is attached to the base. The table top is a rectangular metal top usually made up of stainless steel or aluminium, while the column contains lifting mechanisms which can be hydraulic or electro-hydraulic. The base and column are also usually covered with stainless steel fittings for hygiene and durability. The table top is X-ray translucent and is covered by self-adhering, sectional and conductive rubber mattresses.

Table 111.5 Guidelines to prevent infections after surgery

Top CDC recommendations to prevent healthcare associated infections (HAI)36
Before surgery
Administer antimicrobial prophylaxis in accordance with evidence-based standards and guidelines
Treat remote infections-whenever possible before elective operations
Avoid hair removal at the operative site unless it will interfere with the operation; do not use razors
Use appropriate antiseptic agent and technique for skin preparation
During surgery
Keep OR doors closed during surgery except as needed for passage of equipment, personnel, and the patient
After surgery
Maintain immediate postoperative normothermia
Protect primary closure incisions with sterile dressing
Control blood glucose level during the immediate post-operative period (cardiac)
Discontinue antibiotics according to evidence-based standards and guidelines
Also consider
Before surgery
Screen preoperative blood glucose levels and maintain tight glucose control
During surgery
Redose antibiotic at the 3 h. interval in procedures with duration >3 h
Adjust antimicrobial prophylaxis dose for obese patients (body mass index >30)
Use at least 50 % fraction of inspired oxygen intraoperatively and immediately postoperatively in select procedure(s)
To prevent catheter associated Urinary tract infections
Insert catheters only for appropriate indications using aseptic technique and sterile equipment
Leave catheters in place only as long as needed
Ensure that only properly trained persons insert and maintain catheters
Maintain a closed drainage system and maintain unobstructed urine flow
Comply with CDC hand hygiene recommendations and Standard Precautions
Also consider
Alternatives to indwelling urinary catheterization
Use of portable ultrasound devices for assessing urine volume to reduce unnecessary catheterizations
Use of antimicrobial/antiseptic-impregnated catheters
NICE guidelines for Prevention and treatment of surgical site infection 2008 31
Preoperative phase
Advise patients to shower or have a bath using soap, either the day before, or on the day of, surgery
Do not use hair removal routinely to reduce the risk of surgical site infection. If hair has to be removed, use electric clippers with a single-use head on the day of surgery. Do not use razors for hair removal
Give patients specific theatre wear that is appropriate for the procedure and clinical setting, and that provides easy access to the operative site and areas for placing devices, such as intravenous cannulas. Consider also the patient's comfort and dignity
All staff should wear specific non-sterile theatre wear in all areas where operations are undertaken
Staff wearing non-sterile theatre wear should keep their movements in and out of the operating area to a minimum
Do not use nasal decontamination with topical antimicrobial agents aimed at eliminating *Staphylococcus aureus* routinely to reduce the risk of surgical site infection
Do not use mechanical bowel preparation routinely to reduce the risk of surgical site infection
The operating team should remove hand jewellery, artificial nails and nail polish before operations
Antibiotic prophylaxis
Give antibiotic prophylaxis to patients before clean surgery involving the placement of a prosthesis or implant, clean-contaminated surgery, contaminated surgery. Do not use antibiotic prophylaxis routinely for clean non-prosthetic uncomplicated surgery
Use the local antibiotic formulary and always consider potential adverse effects when choosing specific antibiotics for prophylaxis.
Consider giving a single dose of antibiotic prophylaxis intravenously on starting anaesthesia. However, give prophylaxis earlier for operations in which a tourniquet is used
Before giving antibiotic prophylaxis, consider the timing and pharmacokinetics (for example, the serum half-life) and necessary infusion time of the antibiotic. Give a repeat dose of antibiotic prophylaxis when the operation is longer than the half-life of the antibiotic given
Give antibiotic treatment (in addition to prophylaxis) to patients having surgery on a dirty or infected wound
Inform patients before the operation, whenever possible, if they will need antibiotic prophylaxis, and afterwards if they have been given antibiotics during their operation

Table 111.5 (continued)

Intraoperative phase
Hand decontamination
The operating team should wash their hands prior to the first operation on the list using an aqueous antiseptic surgical solution, with a single-use brush or pick for the nails, and ensure that hands and nails are visibly clean
Before subsequent operations, hands should be washed using either an alcoholic hand rub or an antiseptic surgical solution. If hands are soiled then they should be washed again with an antiseptic surgical solution
Maintaining patient homeostasis
Maintain patient temperature intraoperatively, avoid hypothermia
Maintain optimal oxygenation during surgery. In particular, give patients sufficient oxygen during major surgery and in the recovery period to ensure that a haemoglobin saturation of more than 95 % is maintained
Maintain adequate perfusion during surgery
Do not give insulin routinely to patients who do not have diabetes to optimise blood glucose postoperatively as a means of reducing the risk of surgical site infection
Others
Do not use non-iodophor-impregnated incise drapes routinely for surgery as they may increase the risk of surgical site infection
If an incise drape is required, use an iodophor-impregnated drape unless the patient has an iodine allergy.
The operating team should wear sterile gowns in the operating theatre during the operation
Consider wearing two pairs of sterile gloves when there is a high risk of glove perforation and the consequences of contamination may be serious
Prepare the skin at the surgical site immediately before incision using an antiseptic (aqueous or alcohol-based) preparation: povidone-iodine or chlorhexidine are most suitable
If diathermy is to be used, ensure that antiseptic skin preparations are dried by evaporation and pooling of alcohol-based preparations is avoided
Do not use diathermy for surgical incision to reduce the risk of surgical site infection
Do not use wound irrigation to reduce the risk of surgical site infection
Do not use intracavity lavage to reduce the risk of surgical site infection
Do not use intraoperative skin re-disinfection or topical cefotaxime in abdominal surgery to reduce the risk of surgical site infection
Cover surgical incisions with an appropriate interactive dressing at the end of the operation
Postoperative phase
Use an aseptic non-touch technique for changing or removing surgical wound dressings
Use sterile saline for wound cleansing up to 48 h after surgery
Advise patients that they may shower safely 48 h after surgery
Do not use topical antimicrobial agents for surgical wounds that are healing by primary intention to reduce the risk of surgical site infection

Table 111.6 Classification of risk and prophylaxis for thromboembolism in patients for gynecologic Surgery

Risk category	Patient and surgery characteristics	Prophylaxis
Low risk group	Minor surgery (<30 min), no risk factor other than age Major surgery (>30 min). Age <40 years, no other risk factor, Minor trauma or surgical illness	Early ambulation
Moderate risk group	Major surgery, age ≥40 years or other risk factors Major medical illness; heart or lung disease, cancer, Inflammatory Bowel disease Minor surgery, trauma, illness in patients with previous thromboembolism or thrombophilia	[a](a) Thigh-high graduated compression stockings/ Pneumatic compression or/and (b) Unfractionated heparin (5000 U) administered 2 h before surgery and continued postoperatively every 8 h until discharge Or Low-molecular-weight heparin (dalteparin, 2500 U, or enoxaparin, 40 mg) administered 12 h before surgery and once a day postoperatively until discharge (c) Fondaparinux
[b]High risk group	Major pelvic or abdominal surgery for cancers Major surgery, trauma, illness in patients with previous thromboembolism or thrombophilia, Lower Limb Paralysis	[a]Pneumatic compression Unfractionated heparin (5000 U) administered 8 h before surgery and continued postoperatively until 4 weeks Or Dalteparin (5000 U)/ Enoxaparin (40 mg) administered 12 h before surgery and then once a day thereafter × 4 weeks

[a]Placed intraoperatively and continued until the patient is fully ambulatory
[b]A combination of mechanical and pharmacologic methods is used

The table top consists of three or more hinged parts namely, head, body (trunk) and leg sections which can be flexed or extended to achieve the desired position [42]. These joints can also be detached (breaking the table) or the entire table can be raised, lowered, laterally tilted or positioned in Trendelenburg or reverse Trendelenburg positions. Operating tables also have accessories such as arm rest, stirrups, leg supports/padded knee crutches, bowls etc. Arms should be placed with palm up and should never be abducted beyond an angle of 90° from shoulder to prevent stretching of ulnar nerve and brachial plexus. The hands must never be placed under the body to avoid compression. To make a lithotomy position, metal stirrups are fixed in holders on both sides of the operating table. Leg supports with clamps are available which are padded and have Velcro straps and a ball joint or occasionally the feet are supported by sling stirrups.

The Yellofins® stirrup enables safe and easy positioning while providing better surgical site access. Yellofins Stirrups allow for easy adjustment of abduction and lithotomy in patients up to 500 lbs. (227 kg) while maintaining the sterile field. The boot is extended along its lateral side (referred to as a "lateral fin") and is padded on the interior. The purpose of this fin is to cover and protect the head of the fibula and the peroneal nerve. The boot is self-adjusting to minimize pressure on the calf when moving the stirrup and the pad completely covers the foot. These stirrups also feature lift assist technology to provide easy movement of the leg into the desired position.

All operating tables have control mechanisms to achieve desired positions by manipulating different parts. Some are manually controlled (hydraulic mechanism), whereas movements of others are electrically controlled by remote hand or foot control switches (control unit). All operating tables are movable and can be locked for stabilization by a brake or floor lock.

Positions

Lithotomy

This position is the most favourable for vaginal surgeries as it facilitates surgical access to the perineum as the patient lies supine and the knees and hips are flexed, and the hips are abducted. The buttocks lie at the edge and knees are flexed and the feet are placed in canvas slings of the stirrups or in the leg supports and strapped (Fig. 111.1). Movement of both the limbs must be simultaneous and excessive abduction or external rotation of limbs is avoided. Femoral neuropathy or compartment syndrome has been reported following prolonged surgery in lithotomy position due to compression of blood supply of femoral nerve leading to local ischemia and decreased perfusion pressure of nerve

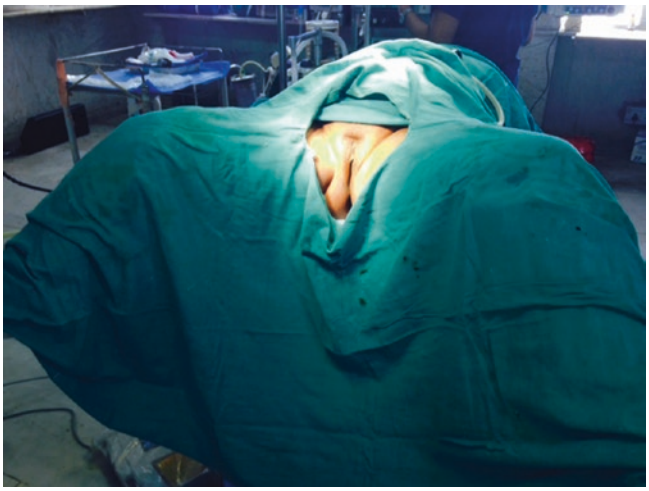


Fig. 111.1 Low lithotomy position for vaginal hysterectomy

trunk. [43] Nerve damage can also occur due to improper positioning and due to undue pressure on patient's legs especially if the duration is more than 2 h [44]. Common peroneal nerve damage can occur due to compression between the head of the fibula and lithotomy pole, use of the yellowfins stirrups prevents this injury In patients who require additional general anesthesia due to ineffective regional anesthesia, risk of regurgitation and thus aspiration is increased in lithotomy position due to increased intra-abdominal pressure. In such cases the position should be preferably changed to supine. As the vital capacity is decreased in lithotomy, respiration should be carefully monitored in sedated, spontaneously breathing patients [45]. The preload to the heart is increased due to limb elevation. Hence, in case of significant surgical bleeding, when legs are lowered at the end of surgery, depending on degree of vasodilatation, 500–800 ml of blood may drain back into lower limbs causing sudden hypotension. [46].

Other Positions

For procedures, like laparoscopic gynecological procedures, the preferred position is modified lithotomy with a considerable degree of head-down tilt (Trendelenburg) with the patient's buttocks overhanging the end of the operating table, also known as the Lloyd-Davies position). Other positions commonly used for vescico-vaginal fistula repair are knee-chest position and reverse lithotomy with head-up tilt.

Operative Field Lighting

Adequate lighting is essential for a safe and easy surgery. There should be even illumination of the room using white fluorescent ceiling lights and the ratio of intensity of general room lighting to that at the surgical site should not exceed

1:5 to minimise eye fatigue [47]. Illumination of the surgical site depends upon balance between the quality of light from an overhead source and reflection from drapes and tissues. Usually the operating lights have halogen bulbs which emit light with a pale bluish cast which is very intense but causes less eye fatigue, have an adequate colour temperature and are safe to be used near tissues as more of the energy is released as light than as heat [48]. Lamps should produce less than 25,000 μW/cm^2 of radiant energy. Most lights focus on a central point which is surrounded by a wider, less intense area and to avoid shadows, the beams of light should be produced from a various angles or multiple light sources or reflectors can be used.

To conclude, a proper preoperative evaluation and planning for appropriate surgery as well as indicated and appropriate use of prophylactic measures to prevent surgical complications like sepsis and thromboembolism go a long way to achieve the successful outcome of gynecological surgical procedures. Preoperative care is as important as intraoperative management and postoperative care and should be carried out thoroughly and completely for optimal results. Besides a basic knowledge of the operating room set up including its table, lights and surgical positions are crucial for a successful surgical outcome.

References

1. Anderson OA, Wearne JA. Informed consent for elective surgery-what is the best practice. J Royal Soc Med. 2007;100:97–100.
2. Royal College of Obstetricians and Gynaecologists. Consent advice no.5. London: RCOG; 2009. Available at: https://www.rcog.org.uk/globalassets/documents/.../ca5-15072010.pdf. Accessed on 15 June 2015.
3. Fischer SP. Cost effective preoperative evaluation and testing. Chest. 1999;115:96S–100S.
4. Roizen MF, Foss JF, Fischer SP. Preoperative evaluation. In: Miller RD, editor. Anesthesia. 5 ed. Philadelphia: Churchill Livingstone; 2000. p. 824–83.
5. Seth SS, Goyal MV, Shah N. Uterocervical displacement following adhesions after caesarean section. J Gynecol Surg. 1997;13:143–6.
6. Seth SS. Vaginal hysterectomy. Best Prac Res Clin Obstet Gynecol. 2005;19:307–32.
7. Ghumman S. Preoperative and preoperative assessment. In: Goel N, Rajaram S, Mehta S, editors. State-of –the –art vaginal surgery. 2 ed. New Delhi: Jaypee Brothers medical publishers; 2013. p. 355–8.
8. Shah J, Henry JF. The ASA classification and perioperative risk. Ann R Coll Surg. 2011;93:185–7.
9. Wolters U, Wolf T, Stützer H, Schröder T. ASA classification and perioperative variables as predictors of postoperative outcome. Br J Anaesth. 1996;77(2):217–22.
10. Menke H, Klein A, John KD, Junginger T. Predictive value of ASA classification for the assessment of the perioperative risk. Int Surg. 1993;78(3):266–70.
11. Voney G, Biro P, Roos M, Frielingsdorf B, Shafighi M, Wyss P. Interrelation of peri-operative morbidity and ASA class assignment in patients undergoing gynaecological surgery. Eur J Obstet Gynecol Reprod Biol. 2007;132:220–5.
12. Golub R, Cantu R. Sorrento JJ. Efficacy of preadmission testing in ambulatory surgical patients. Am J Surg 1992; 163:565-571.
13. Johnson RK, Montimer AJ. Routine Preoperative blood testing: Is it necessary? Anaesthesia. 2002;57:914–7.
14. Monro J, Booth A, Nicholl J. routine preoperative testing: a systemic review of evidence. Health Tech Assess. 1997;1:1–63.
15. Allison JG, Bromley HR. Unnecessary preoperative investigations evaluation and cost analysis. Am Surg. 1996;62:686–9.
16. Kumar A, Srivastava U. Role of routine laboratory investigations in preoperative evaluation. J Anaesthesiol Clin Pharm. 2011;27:174–9.
17. National Institute for Health and Clinical Excellence (NICE). Clinical guideline CG3 preoperative tests: the use of routine preoperative tests for elective surgery. Available at: http://www.nice.org.uk/guidance/cg3/chapter/1-recommendations. Accessed 22 June 2015.
18. Douketis J. Perioperative anticoagulation managment in patients who are receiving oral anticoagulant therapy: a practical guide for clinicians. Thromb Res. 2002;108:3–13.
19. Douketis JD, Spyropoulos AC, Spencer FA, et al. Perioperative management of antithrombotic therapy: antithrombotic therapy and prevention of thrombosis: American College of Chest Physicians Evidence based clinical practice guidelines (9th edition). Chest. 2012;141:e326S–50S.
20. Periprocedural anticoagulation – adult – inpatient and ambulatory–clinical practice guideline. Available at: http://www.uwhealth.org/files/uwhealth/docs/anticoagulation. Accessed 23 June 2015.
21. National Institute for Health and Clinical Excellence (NICE). Reducing the risk of venous thromboembolism. Available at: http://www.nice.org.uk. Accessed 23 June 2015.
22. Mittendorf R, Aronson MP, Berry RE. Avoiding serious infections associated with abdominal hysterectomy. A meta analysis of antibiotic prophylaxis. Am J Obstet Gynecol. 1993;169:1119–24.
23. Diaz V, Newman J. Surgical site infection and prevention guidelines: a primer for certified registered nurse anesthetists. AANA J. 2015;83(1):63–8.
24. Bratzler DW, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, Bolon MK, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J H Sys Pharm. 2013;70(3):195–283.
25. Soper DE. Infections of the female pelvis. In: Mandell GL, Bennett JE, Dolin R, editors. Mandell, Douglas and Bennett's principles and practice of infectious diseases. 7 ed. New York: Churchill Livingstone; 2009. p. 1514–6.
26. Soper DE, Bump RC, Hurt WG Bacterial vaginosis and trichomoniasis vaginitis are risk factors for postoperative cuff cellulitis after abdominal hysterectomy. Am J Obstet Gynecol 1990;163:1016–21; discussion 1021–3.
27. Duff P. Antibiotic prophylaxis for abdominal hysterectomy. Obstet Gynecol. 1982;60:25–9.
28. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Centers for Disease Control and Prevention (CDC) Hospital Infection Control Practices Advisory Committee. Am J Infect Control. 1999;27:97–134.
29. Van Eyk N, van Schalkwyk J, Infectious Diseases Committee. Antibiotic prophylaxis in gynaecologic procedures. J Obstet Gynaecol Can. 2012;34:382–91.
30. American College of Obstetricians and Gynecologists. ACOG practice bulletin no. 104: antibiotic prophylaxis for gynecologic procedures. Obstet Gynecol. 2009;113:1180–9.
31. National Institute of Health and Clinical Excellence (NICE). Prevention and treatment of surgical site infection. Available at: http://www.nice.org.uk/guidance/cg74/.../guidance-surgical-site-infection-pdf. Accessed 29 June 2015.
32. Hodges KR, Davis BR, Swaim LS. Prevention and management of hysterectomy complications. Clin Obstet Gynecol. 2014;57(1):43–57.

33. Larsson PG, Carlsson B. Does pre and postoperative metronidazole lower vaginal cuff infection rate after abdominal hysterectomy among women with bacterial vaginosis? Infect Dis Obstet Gynecol. 2002;10:133–40.
34. American College of Obstetricians and Gynecologists Women's Health Care Physicians; Committee on Gynecologic Practice. Committee Opinion No. 571: solutions for surgical preparation of the vagina. Obstet Gynecol. 2013;122:718–20.
35. Lewis C, Cullingan P. Gynecologic surgical site infections: simple strategies for prevention. Female Patient. 2011;36(2):14–5.
36. United state Centres for disease control and prevention. Top CDC Recommendations to Prevent Healthcare associated Infections (HAI). Available at: http://www.cdc.gov/HAI/pdfs/hai/top-cdc-recs-factsheet.pdf. Accessed 30 June 2015.
37. Bergqvist D. Thromboprophylaxis in gynaecologic surgery. Thromb Res. 2009;123:S5–7.
38. Swenson CW, Berger MB, Kamdar NS, Campbell Jr DA, Morgan DM. Risk factors for venous thromboembolism after hysterectomy. Obstet Gynecol. 2015;125(5):1139–44.
39. Committee on Practice Bulletins--Gynecology, American College of Obstetricians and Gynecologists. ACOG practice bulletin no. 84: prevention of deep vein thrombosis and pulmonary embolism. Obstet Gynecol. 2007;110(2 Pt 1):429–40.
40. Geerts WH, Bergqvist D, Pineo GF, Heit JA, Samama CM, Lassen MR, et al. Prevention of venous thromboembolism: American College of Chest Physicians Evidence-based clinical practice guidelines (8th edition). Chest. 2008;133(6 Suppl):381S–453S.
41. Prandoni P. Prevention and treatment of venous thromboembolism with low-molecular-weight heparins: clinical implications of the recent European guidelines. Thromb J. 2008;6:13.
42. Mohta M, Bhagchandani T. Operating tables, OT lighting and positions for vaginal surgery. In: Goel N, Rajaram S, Mehta S, editors. State-of –the –art vaginal surgery. 2 ed. New Delhi: Jaypee Brothers medical publishers; 2013. p. 60–8.
43. Bauer EC, Koch N, Janni W, Bender HG, Fleisch MC. Compartment syndrome after gynecologic operations: evidence from case reports and reviews. Eur J Obstet Gynecol Reprod Biol. 2014; 173:7–12.
44. Warner MA, Warner DO, Harper CM, Schroeder DR, Maxson PM. Lower extremity neuropathies associated with lithotomy positions. Anesthesiology. 2000;93:938–42.
45. Choi SJ, Gwak MS, Ko JS, Lee H, Yang M, Lee SM, et al. The effects of the exaggerated lithotomy position for radical perineal prostatectomy on respiratory mechanics. Anaesthesia. 2006;61(5): 439–43.
46. Halliwill JR, Hewitt SA, Joyner MJ, Warner MA. Effect of various lithotomy positions on lower-extremity blood pressure. Anesthesiology. 1998;89(6):1373–6.
47. Atkinson LJ, Fortunato NH. Physical facilities. In: Berry and Kohn's operating room technique. 8 ed. New York: Mosby; 1996. p. 129–39.
48. Fuller JK. Operating room environment. In: Surgical technology: principles and practice. 4 ed. Elsevier Saunders: St. Louis/Missouri; 2005. p. 60–72.

Vaginal Hysterectomy: Instrumentation and Apparatuses

112

Carl W. Zimmerman

Introduction

Successful vaginal surgery is dependent on several factors including the skills and experience of the surgeon, adequate surgical assistance, lighting, proper anesthesia, and medical care of the patient pre-, intra-, and postoperatively. Even when all of these factors are optimized, surgical instrumentation can significantly facilitate completion of a challenging operation and, if properly chosen, can extend the skills and efficiency of the surgeon to the benefit of the patient. Instruments used in vaginal hysterectomy are exceptionally important because the size of the operating field is determined by the patient's anatomy, not by the size of an incision that is made by the surgeon. The caliber, depth, and axis of the vagina are of primary importance in defining the operative field. Instrumentation used in abdominal or endoscopic hysterectomy may or may not be useful when adapted to vaginal work; however, an innovative surgeon is not hesitant to use instruments that have previously been developed for other operative approaches or for use by other specialties elsewhere in the body. In this chapter, discussion will be developed for basic instrumentation for the routine hysterectomy and more specialized instrumentation will be discussed for more difficult or unique cases [1].

Basic and Advanced Instrumentation for Vaginal Hysterectomy

Successful performance of a vaginal hysterectomy includes retraction, lighting, incision, transection of surrounding structures, and removal of the organ. Each of these components of surgery will be considered separately.

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Retraction

A variety of instruments can be used for retraction. The most widely used retractors are hand held. Heaney retractors are widely available, ergonomic due their right angle design, and are available in different sizes (Fig. 112.1). Briesky-Navratil retractors are preferred by many surgeons because of the variety of sizes, depths, widths. The angulation of the handle is oriented so that the assistant's hand is well away from the operative field (Fig. 112.2). In the posterior colpotomy, a weighted Steiner-Auvard retractor is often used, so that the blade of the instrument is inserted into the peritoneal cavity through the incision and exposes the posterior wall of the uterus and cul de sac, while holding the anorectum safely out of harm's way (Fig. 112.3a, b). Two examples of self-retaining tools are illustrated. The Martin's arm attaches to the side of the operating table and allows the surgeon to attach a retractor, usually anteriorly to retract the bladder out of the operative field. The retractor is held in place passively, under constant tension, and without tiring an assistant (Fig. 112.4). Variations on the popular Bookwalter® retractor system that is commonly used abdominally are available for the vaginal approach to hysterectomy. Magrina-Bookwalter ™ (Symmetry Medical, Antioch, TN) and Jordon-Simpson™ (Marina Medical, Sunrise, FL) are two examples with the latter being illustrated without implying preference (Fig. 112.5). Experts in the use of all these systems report that the learning curve for each of them is shortened by frequent use. The utility of these self-retaining systems is that once in place, a variety of attached retractors available in differing sizes can virtually eliminate the need for assistants. There is a learning curve for efficient placement with these self-retaining retractors; however, the rewards can be significant especially when there is a need to minimize the number of assistants. The cost is greater than more simple devices; however, if used repeatedly, the cost factor can be attenuated.

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Fig. 112.1 Heaney Retractor is shown here with suction attachment; a smaller blade size is also available (With permission of Marina Medical, Sunrise, FL)

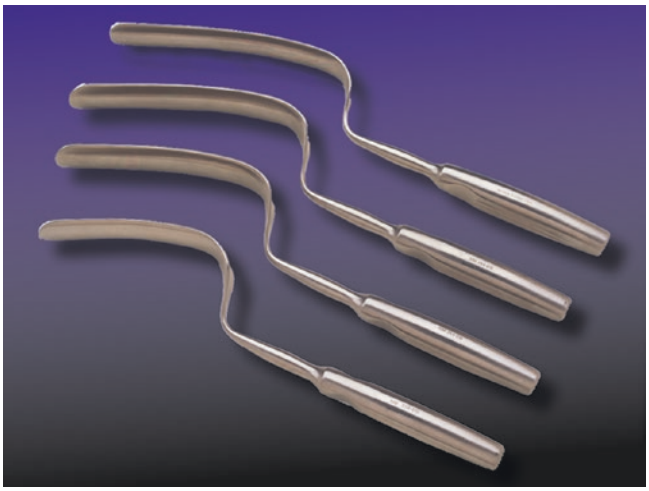


Fig. 112.2 Briesky-Navratil Retractors; blade widths vary as do the lengths available (With permission of Marina Medical, Sunrise, FL)



Fig. 112.3 (**a**) Steiner Auvard Weighted Retractor; standard width and depth, adequate for most cases and given the best exposure. Other widths and lengths are also available; (**b**) Has greater depth, but sacrifices some width; it is especially useful in deep cul de sac or obese patients (With permission of Marine Medical, Sunrise, FL)



Fig. 112.4 Martin's Arm (With permission of Marina Medical, Sunrise, FL)

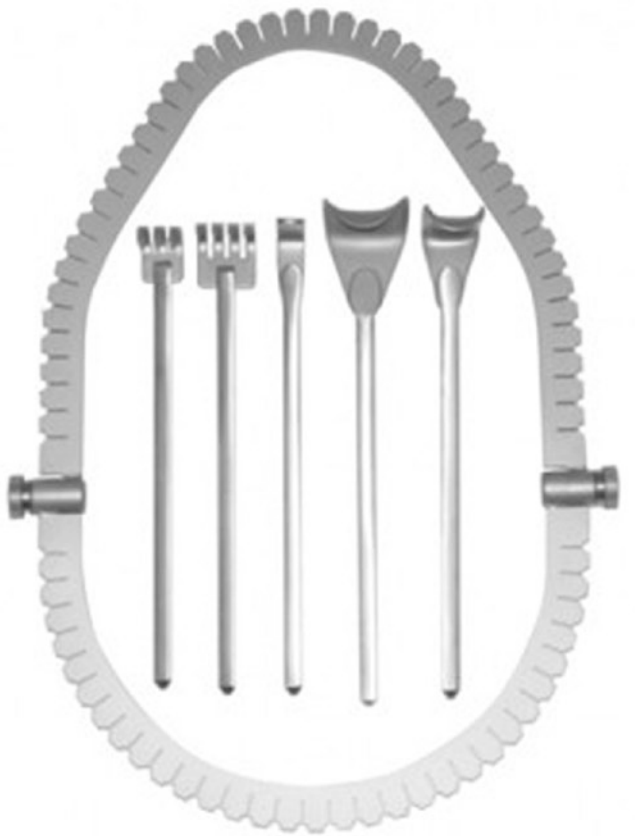


Fig. 112.5 A self-retaining vaginal perineal retractor; Jordan-Simpson™ Retractor (With permission of Marina Medical, Sunrise, FL). One of several variations of the BookWalter™ retractor (Symmetry Medical, Antioch, TN)

Lighting

Light and visibility of the operative field are often at a premium in vaginal surgery. Surgeons are familiar with headlights which are useful for directing light into a deep operative field (examples are not pictured here). In addition, two other products may be useful. Versalight® (Cura Surgical, Geneva, IL) is a combination fiber optic (cool) light, suction, and retraction instrument that is useful in delivery of light combined with the other two functions from the hand of an assistant. High density plastic construction of this instrument is strong enough to allow the instrument to function as a retractor without damage, and the suction function replaces the commonly used Yankauer suction tip (Fig. 112.6). Also available are flat light transmitting pads, Lightmat® (Cura Surgical, Geneva, IL), that can be applied directly to retraction instruments to deliver a constant source of lighting when the retractor is in place without occupying any significant space in the operative field (Fig. 112.7).



Fig. 112.7 Light Mat™, a light transmitting pad (With permission of Cura Surgical)

Incision

An incision may be made with either a scalpel, scissors, or electrocautery at the preference of the surgeon and with respect to the specifics of the case. Whatever approach is used, the full thickness of the vaginal epithelium should be incised at the proper level of the cervix in order to gain access to the required structures for extirpation of the uterus. No special instruments are needed for cervical incision unless the cervix is high in the vagina or its position is distorted by a fibroid. In that circumstance, an extended length electrocautery, curved Jorgensen or Dean scissors, or an angled knife may be helpful. I tend to use the extended cautery unless a specific clinical circumstance, e.g. limited vision, prohibits safe application of that technique.



Fig. 112.6 Versalight™ is a lighting, suction, irrigating and retracting device that has maximum function and minimal intrusition within the vaginal operative field (With permission of Cura Surgical)

Transection of Surrounding Structures

The key to successful removal of the uterus is transection of the ligamentous structures of the paracolpium (uterosacral, cardinal, and pubocervical ligaments), ligation of the uterine blood supply, and, finally, successful and secure transection of the adnexal connection to the uterus. Traditionally surgical clamps have been used, and they remain the most widely used, available, and versatile method of performing vaginal hysterectomy used today. N. Sproat Heaney was a pioneer vaginal hysterectomist who developed several useful instruments that are still available today (see Fig. 112.1 as an example). Heaney hysterectomy clamps are more useful abdominally than vaginally. While adequate and subsequently improved by people like Ballentine, their gripping capacity can be tested in difficult vaginal cases. Typically the instruments are available in one length, with only straight and slightly curved alternatives. The cross-hatching is shallow, and if cross cleats are present, they are sometimes not adequate to hold tissue under the tensions that may be necessary in vaginal hysterectomy (Fig. 112.8). Atraumatic Hysterectomy Clamps, available from several manufacturers, were originally based on thoracic surgery instruments and are available in several lengths and

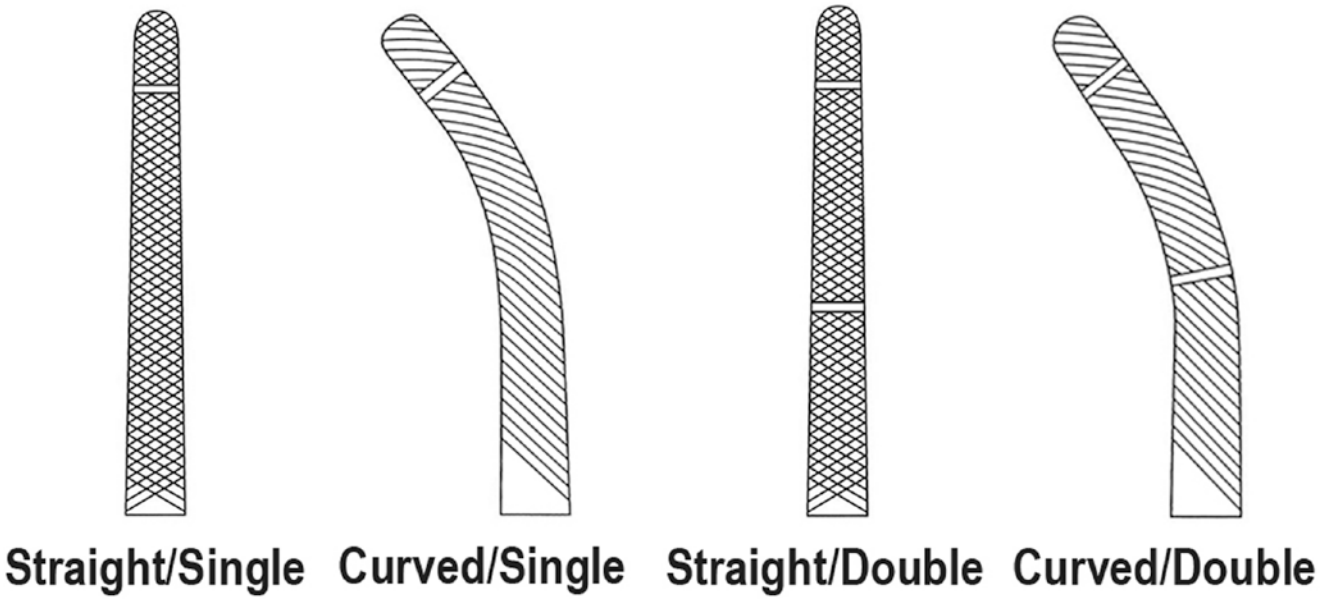


Fig. 112.8 Heany Hysterectomy Clamp™ with detail (With permission of Marina Medical, Sunrise, OH)

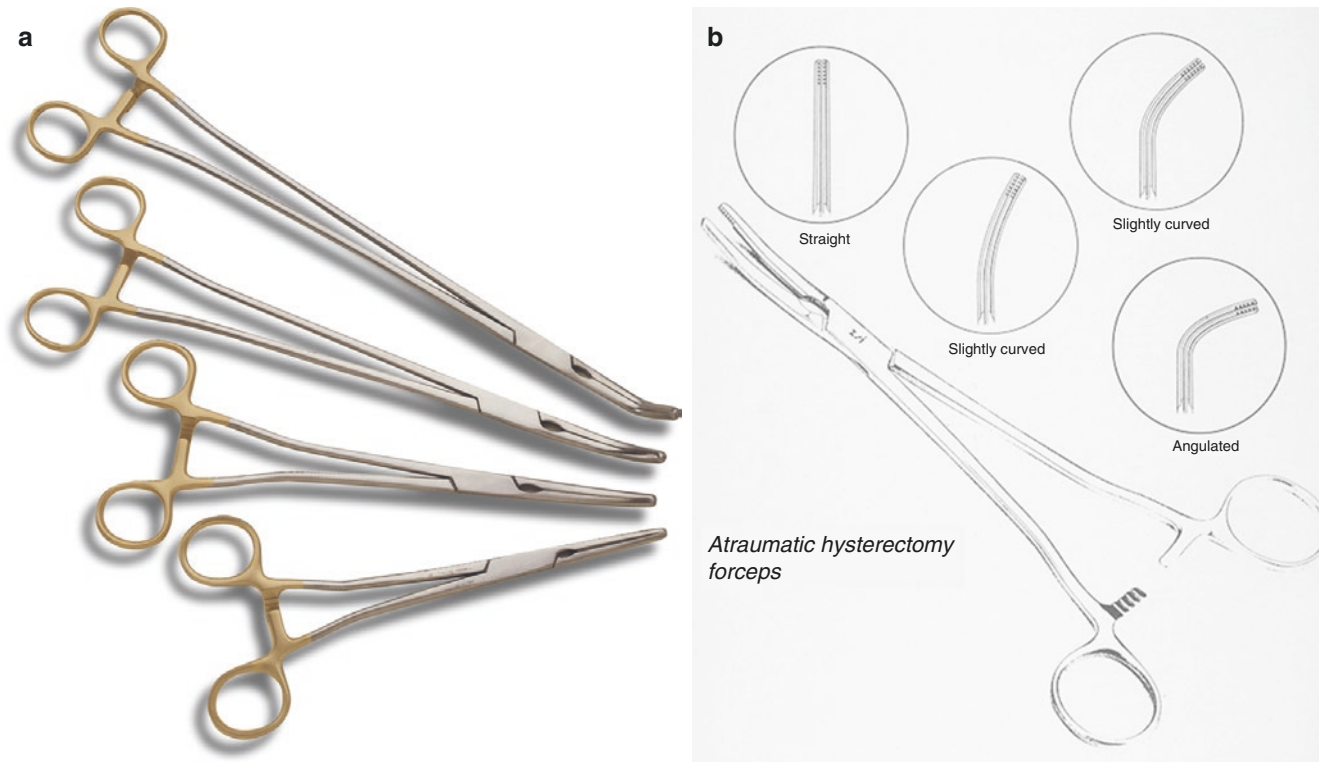


Fig. 112.9 (**a**) Atraumatic Hysterectomy Clamps; note the various lengths and curvatures available; (**b**) Detail of the grip pattern and available curvatures (With permission of Marine Medical, Sunrise, FL)

curvatures that make them very useful and safe for vaginal hysterectomy (Fig. 112.9a). The longitudinal deep grips are designed to minimize trauma to tissue, and the cleats located at the end of the grip help to prevent tissue slippage out of the clamp, a feature that is very useful and reassuring in vaginal hysterectomy (Fig. 112.9b). The Atraumatic Hysterectomy Clamps are also bulky enough that, in the usual circumstance, no lateral retraction is needed when securing a pedicle with these instruments. When rotated outward, they create sufficient exposure for safe and secure pedicle ligation.

Ligament and vessel bipolar sealing devices, while costly, can shorten operating time and facilitate completion of a vaginal hysterectomy. These devices are particularly useful when speed is important, as, for example, in a medically-compromised patient. They are also useful to secure pedicles in the absence of prolapse, or in the presence of obesity, and especially hyperobesity, where visibility and access are typically compromised. Normally, in vaginal hysterectomy, the uterosacral pedicles are suture ligated so they may be incorporated into the cuff at the time of repair. Thermal sealing of the uterosacral is not contraindicated; however, a suture would simply need to be added at the end of the case for reincorporation of suspensory function of those ligaments into the incisional cuff prior to closure (colpopexy). In addition, the adnexal pedicle at the fundus of the uterus is often not completely visible, and the potential for thermal injury to bowel and other structures is a possibility at that level of hysterectomy. For that reason, bipolar thermal sealing devices should be used with caution at that level of the uterine adnexal attachment. The technology used in these devices was developed initially for endoscopic and abdominal work and many devices are available.

Removal of the Uterus

With a normal sized uterus and a normal amount of vertical mobility, simply clamping the adnexal pedicle and transecting medially releases the organ from its last attachments and permits removal. With enlargement from either leiomyomata or andenomyosis, special instrumentation and techniques can be used to advantage. Uteroreductive techniques include cervicectomy, coring, myomectomy, and morcellation. Except in unusual circumstances, e.g., a large cervical myoma or other dominant myoma blocking access to the structures surrounding the uterus, these maneuvers should only be used after the pericolpium and uterine blood supply have been secured and after entry into the peritoneal cavity has unequivocally been demonstrated. Cervicectomy is useful when the cervix blocks the operative field. Generally performed at the level of the isthmus, a scalpel or electrocautery is sufficient for removal of the cervix. Coring may be performed after the above-mentioned criteria are met for uteroreductive techniques. The technique is described by Kovac [2], and simply employs a long handle scalpel with a #10 or other suitable large scalpel blade. No other special instrumentation is used. The processes of vaginal myomectomy and morcellation are safe and effectve if the above mentioned surgical criteria are met before beginning the process. Of course, a malignant tumor should not be morcellated. Reducing the overall size of the uterus permits removal of much larger uteri that the size of the vaginal canal would normally permit. Typically the cervix is grasped with Lahey thyroid clamps and the cervix is incised vertically along the path of the endocervical canal. Downward traction is maintained on the cervix in order to minimize blood loss; however, if the uterine vessels are ligated, bleeding is commonly not a problem during morcellation. As the fundus is approached, myomata are exposed (Fig. 112.10). Depending on the number, size, and location of myomata, various techniques can be used. Vulsellum clamps, e.g., a Gordon or Zimmerman myoma grasper™ (Marina Medical, Sunrise, FL), both longer than a Lahey, are useful for grasping and securing fibroids that are deep within the operative field (Fig. 112.11). Zimmerman myotomes™ (Marina Medical, Sunrise, FL) are instruments derived from the Cobb and Langenbeck periosteal elevators (Figs. 112.12, 112.13, and 112.14). Periosteal elevators are usually used to separate the periosteum from the surface of flat or long bones. These instruments were developed for use in orthopedics and neurosurgery; however they have been modified by adding a handle that is more ergonomic and easily manipulated for the gynecologic surgeon. As a result, they are useful when removing fibroids because the tip is designed to dissect without cutting. That ability to dissect without cutting makes the design of myotomes ideal for enucleating myomas while not risking injury to deeper structures. After a myoma has been identified and grasped with a vulsellum clamp, the myotomes can be used to separate the tumor along the cleavage plane of its capsule with relative ease and with minimal blood loss. Enucleation can then be accomplished if the myoma is small enough (Fig. 112.15). If a myoma is too

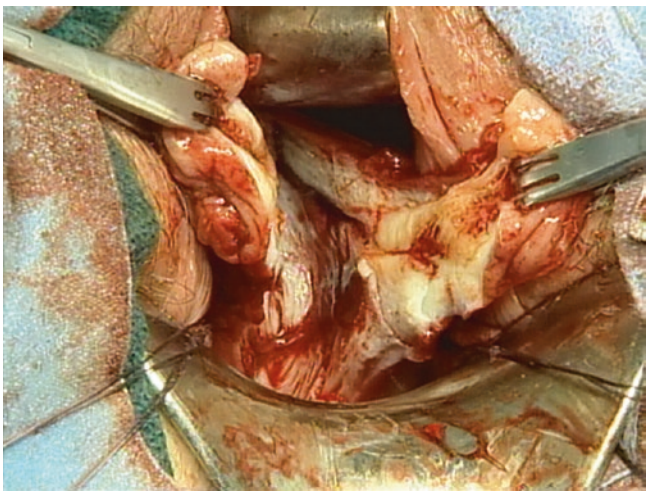


Fig. 112.10 Lahey clamps on the cervix after cervicotomy and exposure of a dominant intramurals myoma in the fundus of the uterus (Courtesy of Carl Zimmerman, MD)



Fig. 112.11 Gordon or Zimmerman myoma grasper (Marina Medical, Sunrise, FL)

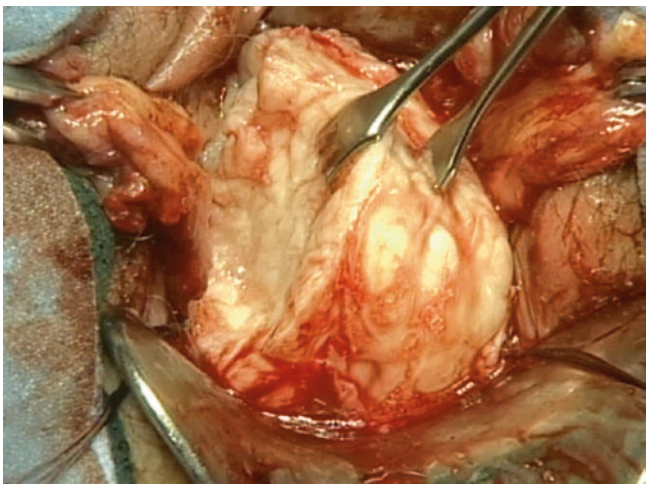


Fig. 112.12 Myotome grasper in use, after enucleation of a dominant myoma (Courtesy of Carl Zimmerman, MD)



Fig. 112.13 Chisel-tipped Zimmerman myotome™ (With permission of Marina Medical, Sunrise, FL)

large to easily enucleate, another useful orthopedic instrument is the Martin Cartilage Scissors (Marina Medical, Sunrise, FL) (Fig. 112.16). The tip is pointed and sharp so that it can be thrust into a myoma, even one that is calcified. The cutting edges of these scissors are serrated and designed to be strong enough to transect cartilage, similar to the texture of a typical fibroid. They can be used to wedge resect the bulk of a dominant myoma with the process continuing until extraction is possible (Fig. 112.17). A long handle scalpel may also be used to reduce larger myomata by wedge resection. Care should be taken to avoid injuring deeper structures such as bowel if a scalpel is used.



Fig. 112.14 Spoon-tipped Zimmerman myotome™ (With permission of Marina Medical, Sunrise, FL)



Fig. 112.16 Martin cartilage scissors (With permission of Marina Medical, Sunrise, FL)

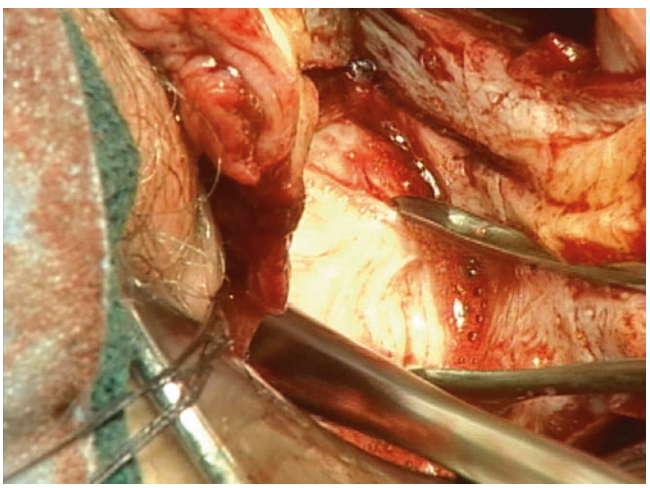


Fig. 112.15 Myotome enucleating a dominant myoma (Courtesy of Carl Zimmerman, MD)

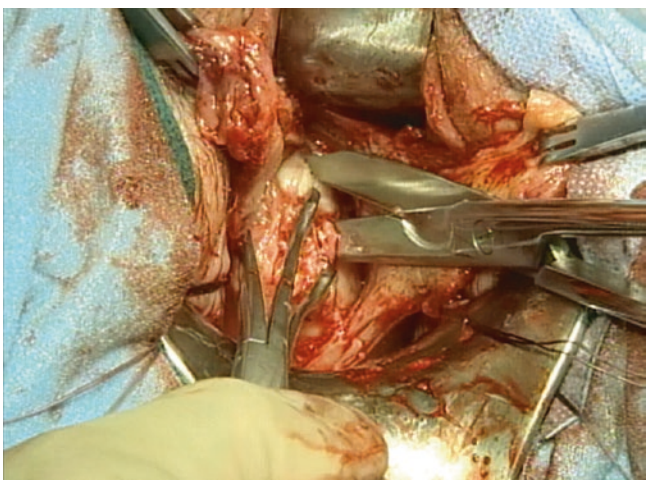


Fig. 112.17 Martin cartilage scissors wedge resecting a dominant myoma (Courtesy of Carl Zimmerman, MD)

Removal of the Adnexa

The indications for removal of the adnexa should not change regardless of the approach used for hysterectomy. Typically the atraumatic hysterectomy clamps mentioned earlier in this chapter are sufficient to secure release of the adnexal structures (Fig. 112.9). Especially useful are the 30 and 45° curvatures at the level of the infundibulopelvic ligaments. The ability of these clamps to secure tissue without slippage is exceptionally important during this portion of a hysterectomy. A specially-designed Kovac (Marina Medical, Sunrise, FL) or Sheth clamp (Cooper Surgical®, Trumbull, CT) is also useful because of its curved design which allows the clamp to rotate laterally so that manipulation of the adnexa within the clamp becomes easier [3] (Fig. 112.18). A particularly challenging maneuver in removal of the adnexa is securing the infundibulopelvic ligament containing the ovarian artery and veins. The Endoloop® (Ethicon, Cincinnati, OH), developed for endoscopic work is ideal for this stage of the case especially when the infundibulopelvic ligament is isolated and a large bulky pedicle is avoided. It easily slips into place with equal upward push and downward traction so that the pedicle is secured with no tension, often deep within the operative field.



Fig. 112.18 Sheth adnexa clamp (With permission of Cooper Surgical®, Trumbull, CT)

Conclusion

Instrumentation is a key resource in completion of vaginal hysterectomy. Often, innovative use of instruments developed for use in other fields can be useful in completing vaginal hysterectomy efficiently and safely. Use of the proper instruments allows the surgeon to expand her or his skill set, and allow patients who need hysterectomy to have the minimally invasive vaginal approach. The utilization of the vaginal approach to hysterectomy is currently being emphasized in the United States by our national organizations. The cost of endoscopic and robotic approaches has come to the attention of insurers. There are signs that the vaginal approach will be incentivized, if so, the technique of vaginal hysterectomy will be poised to assume its rightful place as the primary approach for benign hysterectomies not only in practice, but also in training programs. Properly emphasized, the vaginal approach will then hopefully attract the same type of attention to innovations that the more invasive endoscopic approaches have attracted.

References

1. Kovac SR, Zimmerman CW. Instruments for vaginal hysterectomy. In: Kovac SR, Zimmerman CW, editors. Advances in reconstructive vaginal surgery. Baltimore: Lippincott Williams & Wilkins; 2006. p. 87–94.
2. Kovac SR. Intramyometrial coring as an adjunct to vaginal hysterectomy. Obstet Gynecol. 1986;67(1):131–6.
3. Sheth SS. The place of oophorectomy at vaginal hysterectomy. Br J Obstet Gynaecol. 1991;98:662–6.

Colpotomy and the Modalities for Closure

113

Oz Harmanli

Set-Up

Good exposure sets the surgeon up for success. A combination of optimal factors including patient positioning, assistance, retraction, and lighting can improve the exposure and make even a complex appearing case feasible. If one has to pick one factor which influences the success the most during vaginal hysterectomy, it is the surgical positioning. The procedure should not begin until the patient's lower extremities are safely positioned to provide comfortable space for two assistants and the surgeon between the patient's legs. Similarly, patient's buttocks should extend 2–3 cm over the edge of the table for a successful vaginal hysterectomy. Stirrups supporting the entire leg or candy cane stirrups, which hold the foot up with straps, are both appropriate as long as the minimum angle between thigh and torso is 60°, and 90° at the knee. Trendelenburg position should not be exaggerated (Fig. 113.1).

Retractors should not be in the surgeon's way. Self-retaining ring retractor sets may be advantageous for gynecologists who have limited access to assistants. We prefer fluid movement of retractors by assistants accommodating the surgeon's needs. The right angle shape of a Heaney retractor, which was originally designed to deflect the posterior vaginal wall, is not ideal for retraction of the bladder because it is not well-suited for the curvature of anterior pelvic compartment and can result in bladder injury in the hands of inexperienced assistants. The versatility of malleable ribbon retractors have made them our retractors of choice as it is possible to change their curve, angle, and retracting depth according to the anatomy of each specific patient. If they are not available or fail to retract collapsing tissue, Breitsky-Navratil retractors of various sizes may also be used (Fig. 113.2).

Not every weighted speculum is appropriate for all patients. The length and angle of the speculum has to fit the patient's anatomy. For instance, a suitable size Sims retractor may be preferred in a woman with prolapse. A Steiner-Auvard weighted speculum with its longer, curved blade which fits the sacral hallow is essential and should always be used after, but never before, posterior colpotomy to deflect the rectum and expose the uterosacral ligaments (Fig. 113.2). If the weighted speculum is too long, it will push away the apex and make colpotomy difficult. In fact, with correct positioning and optimal exposure, long instruments for suturing, clamping and cutting will hardly be necessary.

The bladder is drained partially with an indwelling catheter before the procedure. The catheter is then clamped to allow bladder to fill spontaneously. We deliberately do not empty the bladder completely as this may enable immediate recognition of accidental cystotomy. The catheter is unclamped intermittently during the procedure to monitor urinary output.

Optimum illumination of the surgical field is paramount to the successful vaginal surgeon. This may be by means of a variety of tools such as a lighted suction irrigation device, headlight, light attachment to a retractor or by simply holding a cystoscopy fiber optic light cable with a Babcock clamp as needed.

Injection into the cervical stroma with Vasopressin or Lidocaine including Epinephrine for initial incision may be a good step when teaching, however; it is not necessary for an experienced surgeon especially if this incision is made with electrocautery. The bleeding from this incision will stop with the swift placement of the first clamps on each side.

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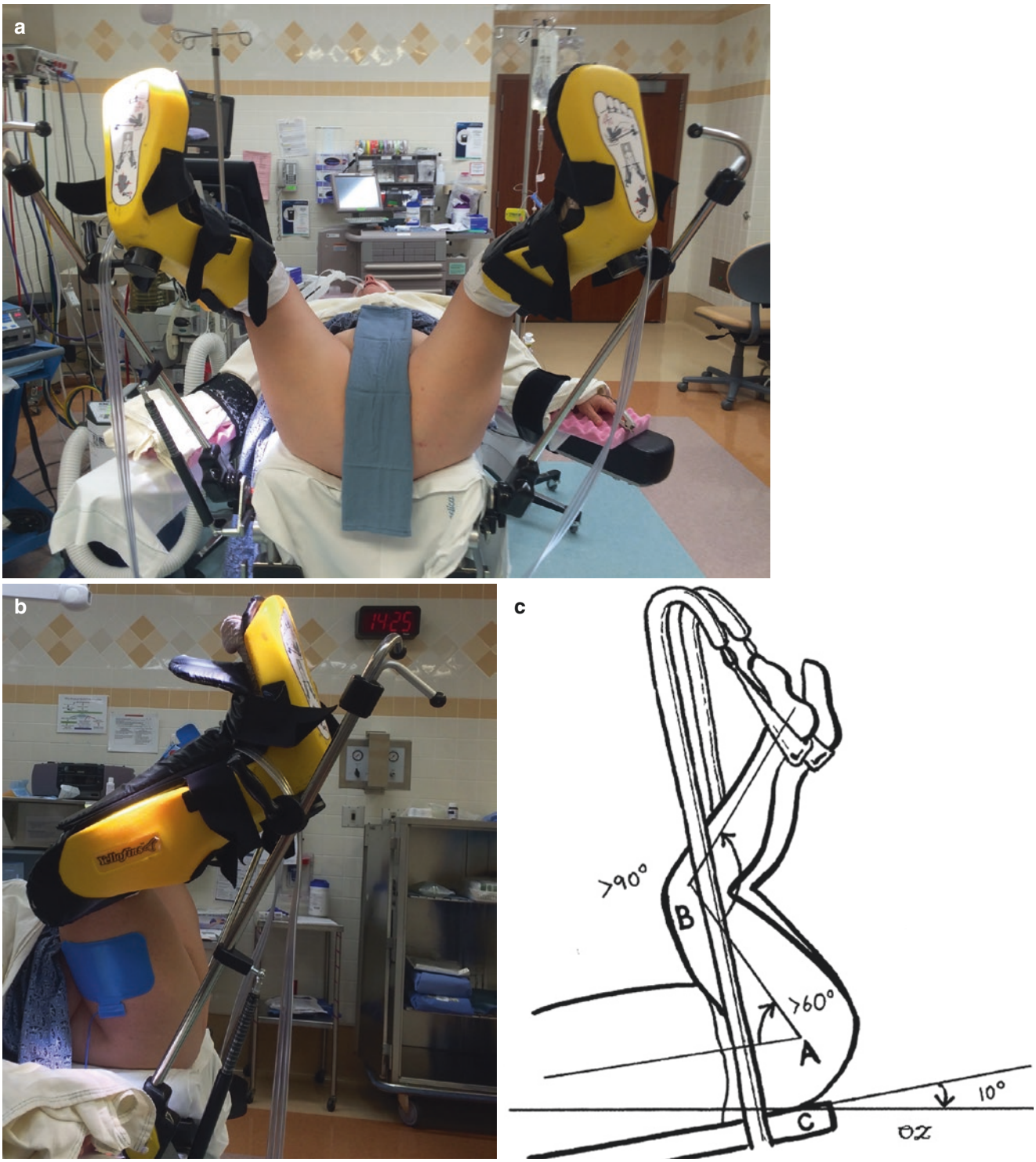


Fig. 113.1 Surgical positioning. (**a**) The position should provide comfortable space for two assistants and the surgeon between the patient's legs. The patient's buttocks should extend 2–3 cm over the edge of the table. (**b**) Stirrups supporting the entire leg or (**c**) candy cane stirrups, which hold the foot up with straps, are both appropriate as long as the minimum angle between thigh and torso is 60°, and 90° at the knee. Trendelenburg position should not be exaggerated

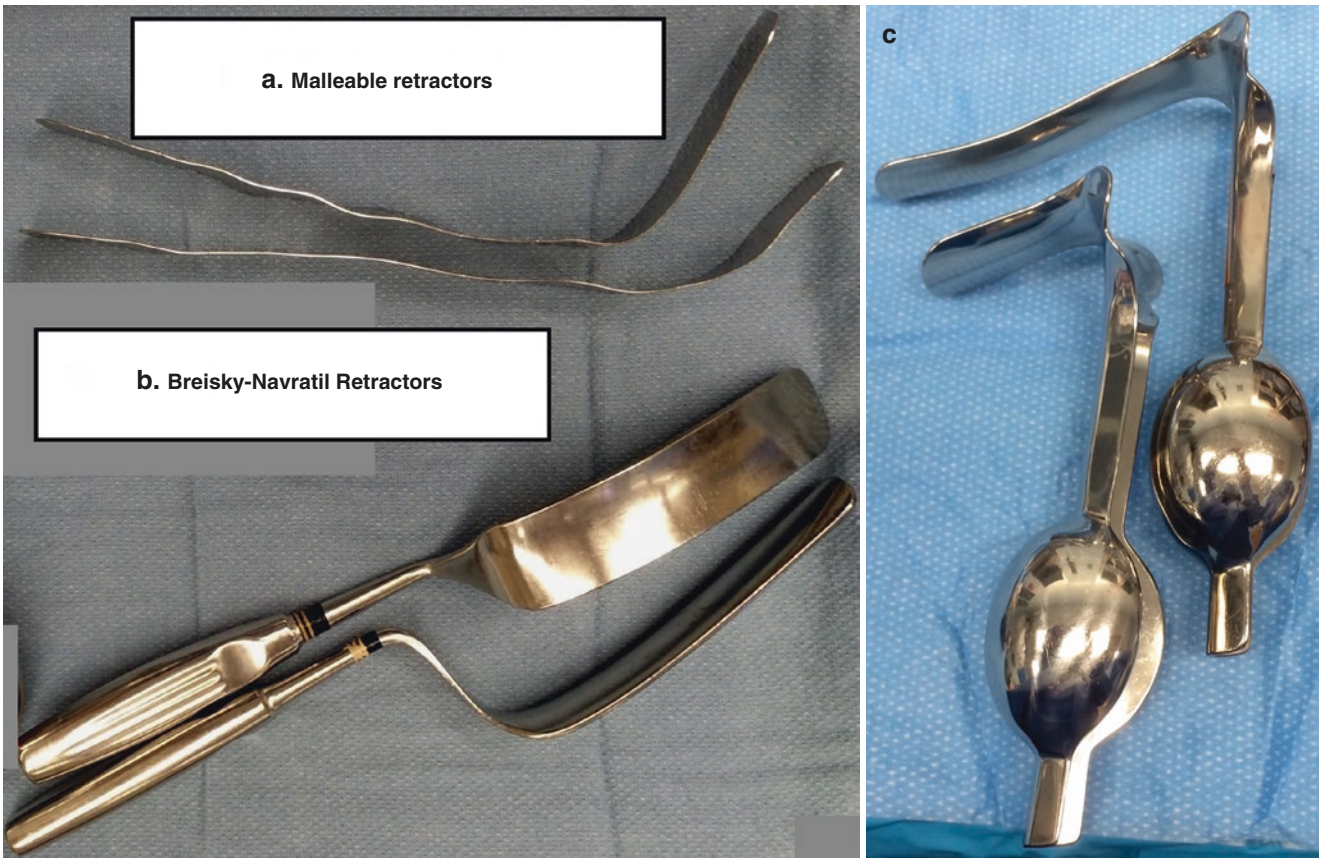


Fig. 113.2 Retractors. (**a**) The versatility of malleable ribbon retractors have made them very suitable for vaginal hysterectomy. (**b**) If they are not available or fail to retract collapsing tissue, Breitsky-Navratil retractors of various sizes may also be used. (**c**) After posterior colpotomy, a Steiner-Auvard weighted speculum with its longer, curved blade fits the sacral hallow and deflect the rectum very well. In the picture it is placed next to a regular weighted speculum to demonstrate its specifications

Colpotomy

The conventional approach to colpotomy is a circumferential incision on the cervix. In our institution, we prefer an entry from the posterior aspect before making the circumferential incision.

First, a weighted speculum is inserted in the vagina. It should not be too long but has to be long enough to deflect the entire posterior vagina. After the speculum is inserted, the surgical drape on each side of can be clamped together over the weighted portion to prevent it from slipping out. A malleable retractor is bent approximately at a 5 cm distance from one end with about a 90° angle to expose the entire cervix. The cervix is grasped with two short Lahey tenacula at its anterior and posterior portions. It is important to hold both portions with a good grip. The cervix is pulled up to expose the posterior fornix and then moved up and down and in and out to visualize the creases forming in this area. This delineates exact location of the bilateral uterosacral ligaments as well as the dimple forming immediately at the edge of posterior cervix (Fig. 113.3). This area represents the part of the cul-de-sac where the only structures separating the vaginal and abdominal cavities are the peritoneum and the vaginal wall. If there is no previous history of a pelvic infection or severe endometriosis, the thickness of vaginal wall and the peritoneum together is about 3–4 mm. Location of this free area can also be confirmed by palpation of this the posterior fornix or pressing a blunt surgical instrument against the posterior cervix and moving it down and visualizing a drop-off effect where the cervix ends. The full thickness vaginal wall is held with a longer Allis clamp at approximately 2 cm from the demarcation signifying where the cervix ends. If grasped appropriately, the peritoneum is also included in this grip. Using traction and counter-traction between the Allis clamp and the tenacula holding the cervix, a vertical line is formed in the most apical portion of the posterior fornix. Mayo scissors are then used to cut the full thickness vaginal wall firmly in the middle of and perpendicular to this line. This typically allows direct entry into the cul-de-sac between the uterosacral ligaments (Fig. 113.4). We switch to a longer Steiner-Ouvard weighted speculum after the entry into the cul-de-sac. Even though bleeding

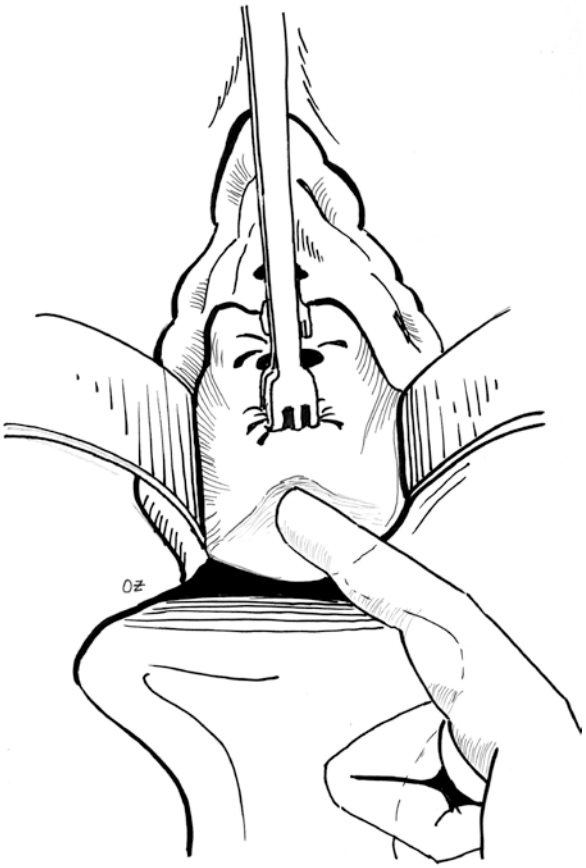


Fig. 113.3 The cervix is moved up and down and in and out. Creases and dimple forming in the posterior fornix during this maneuver delineates exact location of the uterosacral ligaments and the edge of posterior cervix

from the cut edge of the posterior cuff is typically not significant, some surgeons choose to suture this edge with a running suture at this time.

A rectal injury with this approach is extremely unlikely as the rectum and vagina are not adjoining in the proximal 3–4 cm of the posterior vaginal wall (Fig. 113.4). In cases when this free area cannot safely be identified or peritoneum is spared from this initial cut with Mayo scissors, we choose to use the conventional layer-by-layer technique in which a scalpel is used to incise the full thickness vaginal wall and then the peritoneum is found and elevated with a well-grasping forceps or Allis clamp and then peritoneal cavity is entered sharply with Metzenbaum scissors.

Possible technical difficulty with this approach is being unable to cut the peritoneum at the first attempt. It often happens with the fear of a novice cutting too close to the cervix and getting into the visceral peritoneum/serosa of the cervix. When that happens, the peritoneum can be grasped with the technique described above and entered sharply. If the peritoneum is pushed away by a novice, it is ok to start clamping the uterosacral and cardinal ligaments extraperitoneally. Usually the peritoneal cavity will be entered effortlessly and spontaneously with this latter approach.

When posterior entry is presumed to be difficult, an alternative approach can be attempted. First the posterior cervix is held with two tenacula on each side. Then it is infiltrated with a diluted vasoconstrictive solution and bisected until cul-de-sac peritoneum is entered (Fig. 113.5).

Location of the anterior colpotomy incision is important. It should not be too close to either the bladder or the cervical os.

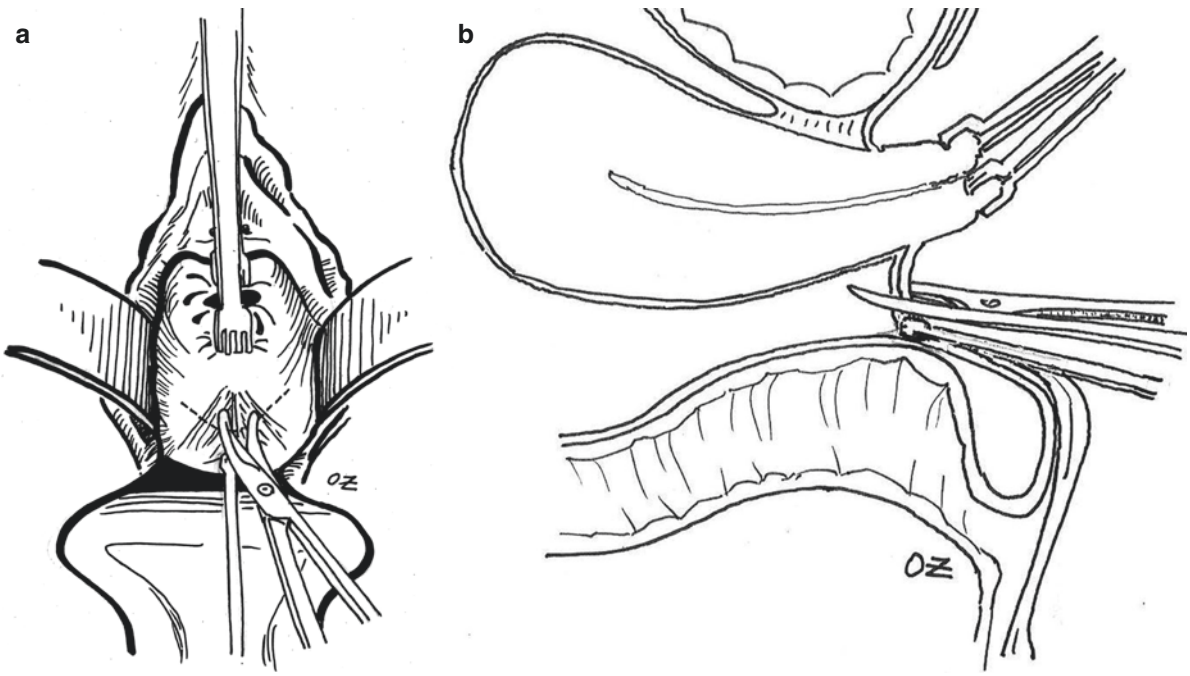


Fig. 113.4 Posterior colpotomy. (**a**) Using traction and countertraction between the Allis clamp and the tenacula holding the cervix, a vertical line is formed. Mayo scissors are held firmly and perpendicular to the midpoint of this line. A full thickness cut typically allows direct entry into the cul-de-sac. (**b**) A rectal injury with this approach is extremely unlikely as the rectum and vagina are not adjoining in the proximal 3–4 cm of the posterior vaginal wall

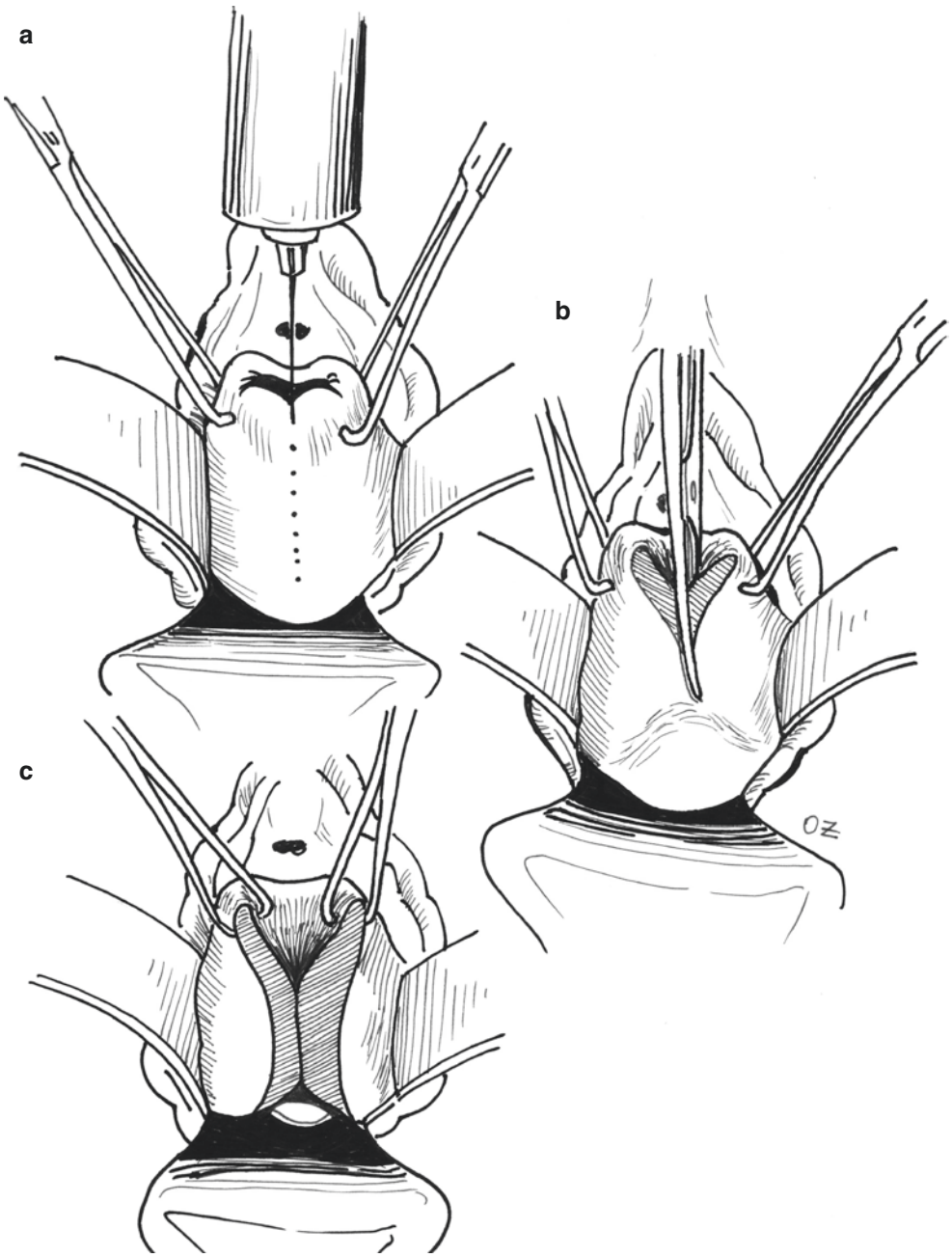


Fig. 113.5 Alternative approach to posterior colpotomy: (**a**) First the posterior cervix is held with two tenacula on each side. (**b**) Then it is infiltrated with a diluted vasoconstrictive solution and (**c**) bisected until cul-de-sac peritoneum is entered

The bladder location can be determined by the appearance of the rugae in the anterior vagina (Fig. 113.6). The anterior incision can be made exactly where the rugae end. We typically make our anterior incision with pure cutting function of the electrocautery on the smooth surface of the anterior cervix paying particular attention to stay outside the transformation zone. It typically happens to be about 5–8 mm away from the tenaculum on the anterior cervical lip. In our experience, we have realized that accurate identification of the bladder reflection takes some time. When teaching beginners, we simply instruct them to make the incision about 5 mm cephalad to the anterior cervical tenaculum (Fig. 113.7). This approach is more reproducible for a novice who is yet to develop familiarity with vaginal tissue planes. It is important to cut down to the vesicouterine separation plane between 10 and 2 o'clock but the rest of the incision on the sides should be more superficial. The correct plane almost always shows itself by the "falling away" of the bladder. This incision is extended along each side more superficially and connected to posterior colpotomy incision. Then the vaginal side of this incision is held with an Allis clamp and elevated while Mayo scissors are used to develop this plane further. It is critical to hold the scissors parallel to the cervical axis and press them against the firm surface of the cervix and lower uterine segment (Fig. 113.8). After the so-called "vesicouterine septum", a 1.5–2 cm connective tissue band which firmly attaches the bladder to the lower uterine segment, is divided, the avascular vesicouterine space opens leaving only a thin sheet of peritoneum

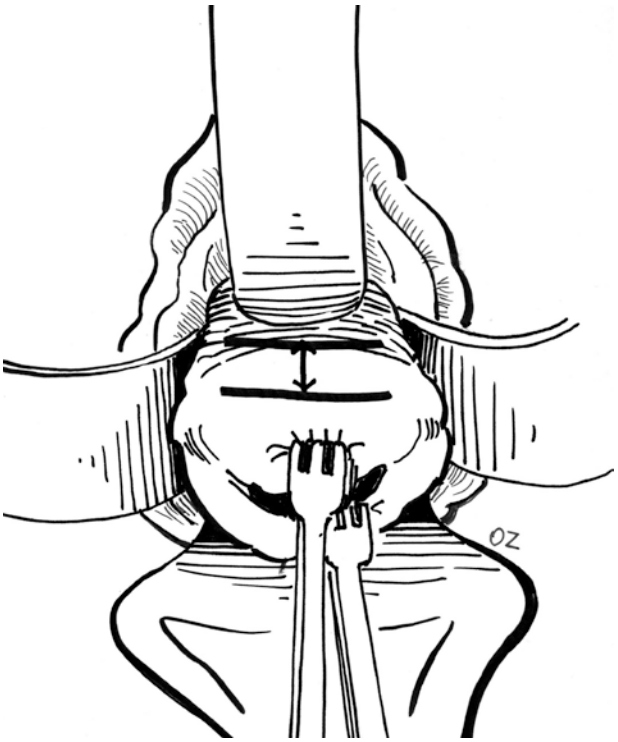


Fig. 113.6 Anterior colpotomy. Location of the anterior colpotomy incision is important. It should not be too close to either the bladder or the cervical os. The bladder location can be determined by the appearance of the rugae in the anterior vagina.

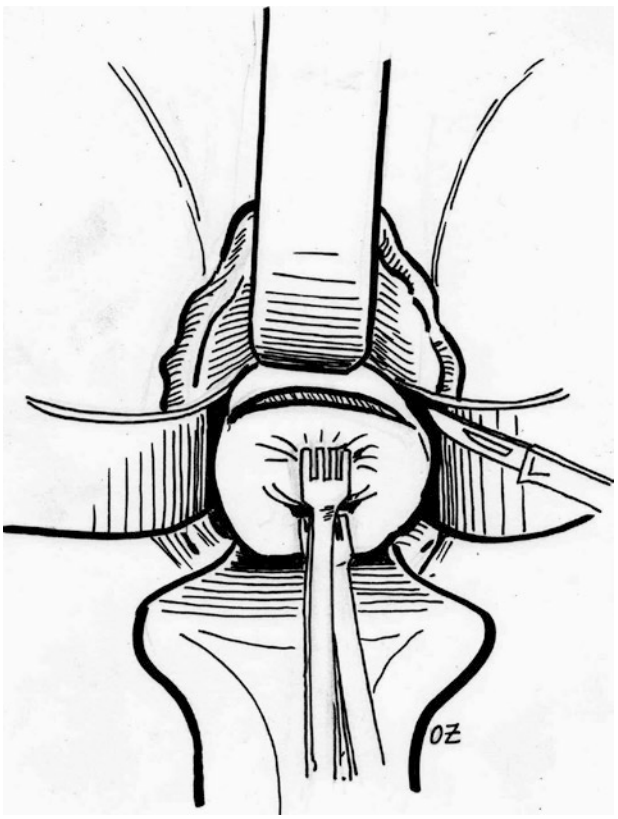


Fig. 113.7 In our experience, we have realized that accurate identification of the bladder reflection takes some time. When teaching beginners, we simply instruct them to make the incision about 5 mm cephalad to the anterior cervical tenaculum

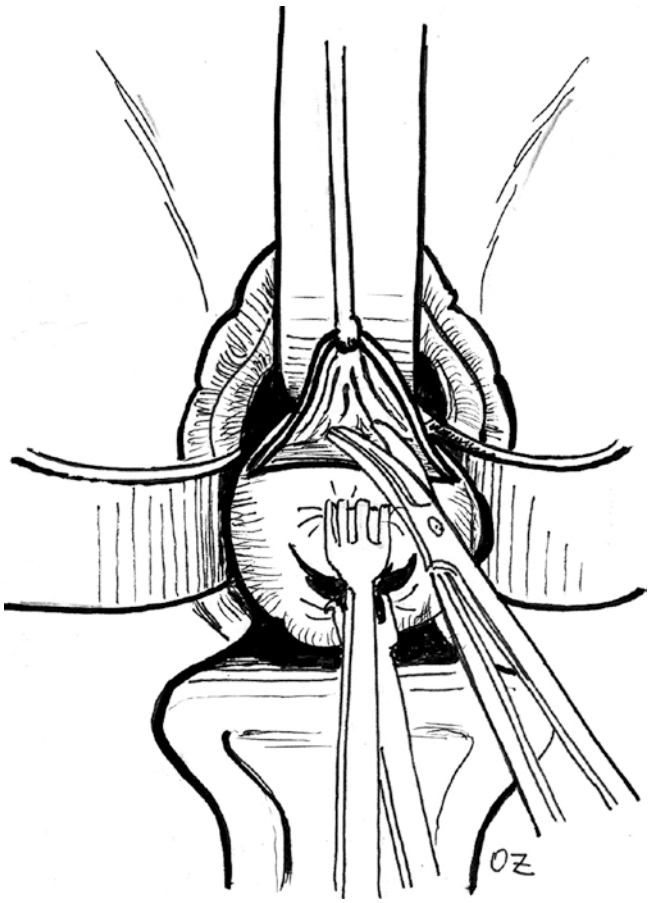


Fig. 113.8 It is critical to hold the Mayo scissors parallel to the cervical axis and press them against the firm surface of the cervix and lower uterine segment when developing the vesicovaginal plane

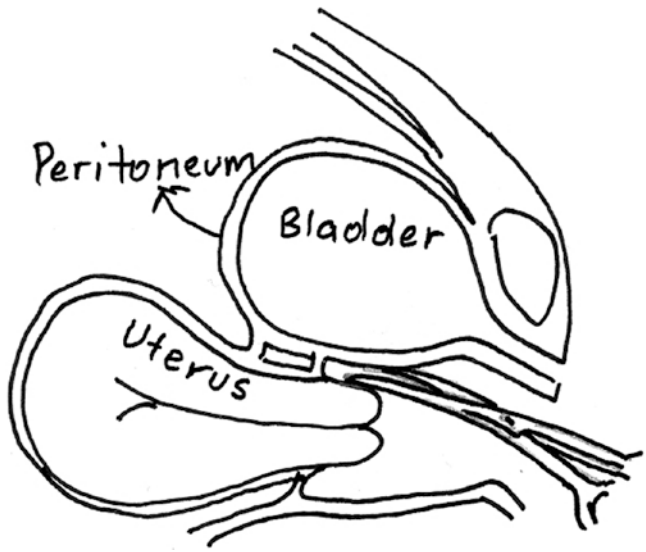


Fig. 113.9 After the so-called "vesicouterine septum", a 1.5–2 cm connective tissue band which firmly attaches the bladder to the lower uterine segment, is divided, the avascular vesicouterine space opens leaving only a thin sheet of peritoneum intact

intact (Fig. 113.9). This space is the same as the so-called "bladder flap" area during an abdominal procedure such as Cesarean delivery. An expert vaginal surgeon may be able to

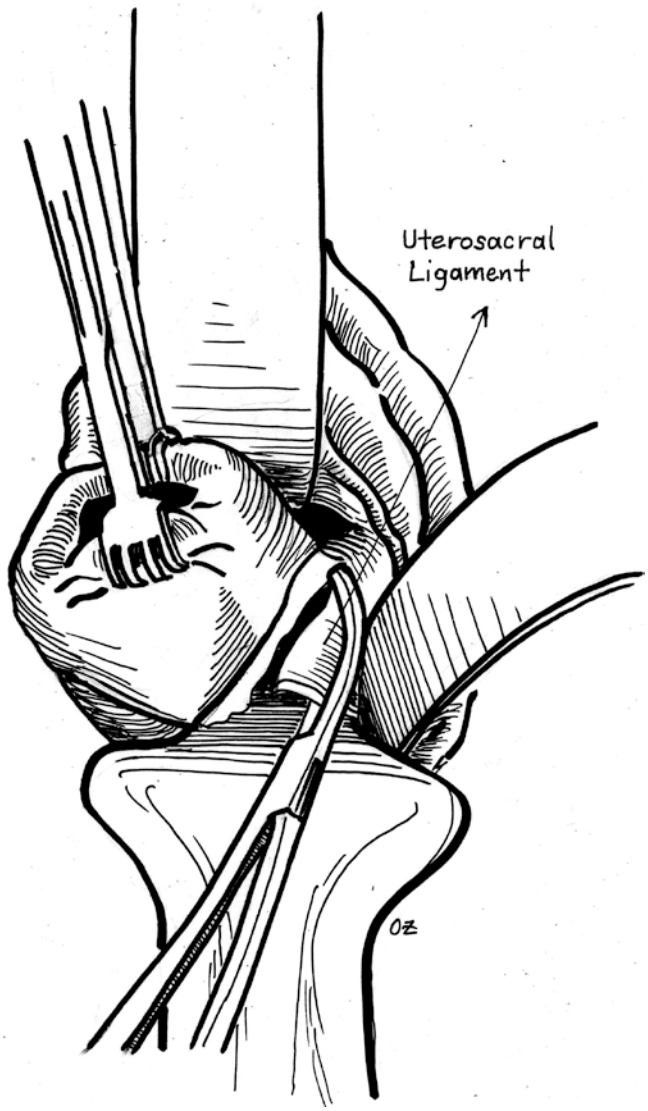


Fig. 113.10 After entry into the avascular vesicovaginal space, even when the peritoneum is still intact, it is safe to start clamping the uterosacral and cardinal ligaments as long as a retractor is placed appropriately deflecting the bladder and down and outward traction is applied to the cervix with the tenacula

determine the vesicouterine plane precisely and may prefer to complete the anterior colpotomy by identifying the peritoneum floating freely over the lower uterine segment although this is not necessary as it is safe to start clamping the uterosacral and cardinal ligaments as long as a retractor is placed appropriately deflecting the bladder and down and outward traction is applied to the cervix with the tenacula (Fig. 113.10). In many cases, we have deferred anterior entry into the peritoneal cavity until after the division and ligation of the uterosacral and cardinal ligaments. If the size of the uterus allows, the fundus is delivered posteriorly and the surgeon's index finger can be advanced behind the uterine fundus toward the anterior compartment and bring the peritoneal sheet into view for safe entry (Fig. 113.11).

Some vaginal surgeons just make an incision anteriorly and posteriorly but leave the area in between intact. After

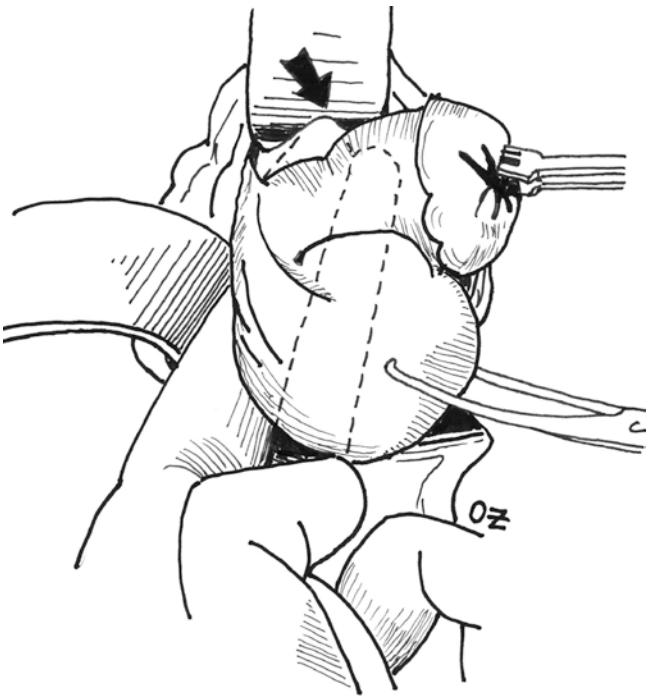


Fig. 113.11 If the size of the uterus allows, the fundus is delivered posteriorly and the surgeon's index finger can be advanced behind the uterine fundus toward the anterior compartment and bring the peritoneal sheet into view for safe entry

deflecting the rectum and bladder away through these incisions, they simply incorporate these lateral intact epithelial surfaces between the anterior and posterior incisions within their uterosacral ligament clamps and cut them together (Fig. 113.12).

Anterior entry is potentially more complicated in women with previous cesarean deliveries. Even though the bladder border can be identified with a transurethrally inserted rigid metal instrument such as a uterine sound or a metal urinary catheter or by retro-filling the bladder, these steps are rarely necessary as long as one does not deviate from using sharp technique with the tips of the scissors against the cervix and lower uterus and the body of the scissors always pressing down.

A novice may also err on the uterine side too much and enter into myometrium and even the uterine cavity with this technique. Even though it is better to invade into the uterine tissue rather than the bladder wall, this may be avoided by advancing the sharp dissection parallel to the cervico-uterine axis.

Closure

Optimal closure of the colpotomy incision is important to prevent cuff dehiscence and pelvic organ prolapse. Vaginal cuff dehiscence is hardly ever a concern after a vaginal hysterectomy. However, this dramatic complication has become a legitimate concern with the increasing popularity of laparoscopic

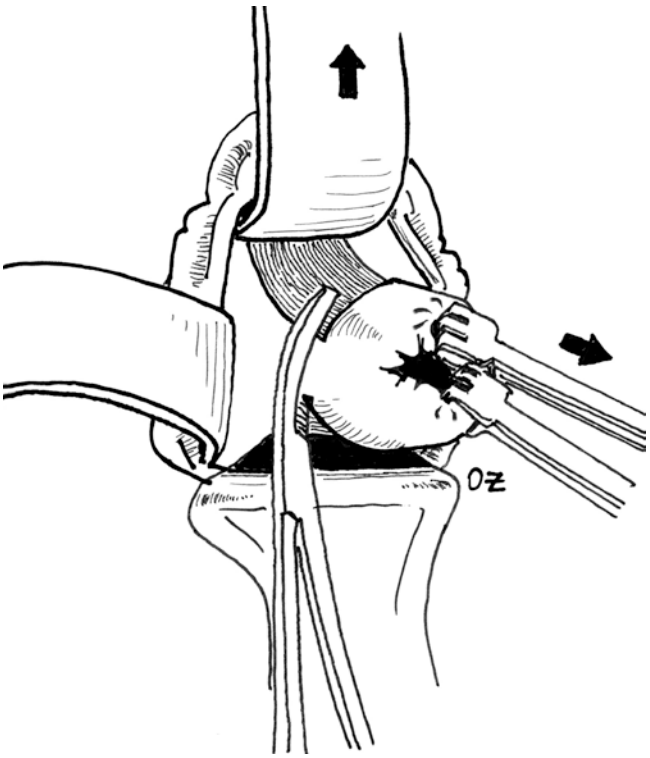


Fig. 113.12 Some vaginal surgeons just make an incision anteriorly and posteriorly but leave the area in between intact. After deflecting the rectum and bladder away through these incisions, they simply incorporate these lateral intact epithelial surfaces between the anterior and posterior incisions within their uterosacral ligament clamps and cut them together

and robotic gynecologic surgery. A group in Italy has demonstrated that transvaginal cuff closure after laparoscopic hysterectomy can significantly reduce the dehiscence risk.

Many different cuff closure techniques have been proposed. The only absolute consensus of these techniques is the emphasis on reattaching the cuff to the natural suspensory mechanisms of the vaginal apex, the uterosacral ligaments. Everything else including peritoneal closure, leaving the cuff partially open, and the sagittal versus transverse direction of closure are still debatable.

A cuff closure method described by McCall is commonly considered the most appropriate choice when apical support is not optimal. The goal of this approach is to obliterate the cul-de-sac for prevention of future enteroceles, plication of the uterosacral ligaments, and connecting the cuff to the uterosacral ligaments for a secure apical support. In a traditional McCall Culdoplasty, the uterosacral ligaments and intervening peritoneal surfaces are sutured together intraperitoneally with two running permanent sutures. A third suture is placed through the ligament intraperitoneally and then brought out through the posterior vaginal cuff edge and tied outside after the rest of the cuff is closed horizontally (Fig. 113.13).

In some closure techniques, after the peritoneum is closed and all the pedicles are exteriorized, the cuff is not closed in the middle, the edges of this 1–2 cm opening is run with a suture for hemostasis only. Some gynecologists place a drain through this opening. For example, in an approach described in a German textbook by Reiffenstuhl, Platzer and Knapstein, the peritoneum is closed with a purse string absorbable suture which also brings the uterosacral, cardinal and adnexal pedicles together in the midline. Sutures are placed on the posterior cuff edge for hemostasis. They note that this is optional on the anterior cuff edge. This closure technique leaves the cuff open but closes the peritoneal cavity.

The following outlines our closure technique for women who have adequate apical support: Before closure, all pedicles should be carefully inspected for hemostasis with a systematic approach (Fig. 113.14). First the area between the uterosacral and utero-ovarian pedicles must be hemostatic. This area on each side is where sutures have been placed to ligate the cardinal ligaments, and the ascending branch of the uterine vessels within the lower end of the broad ligament. With one retractor in the anterior compartment deflecting the bladder, and another one retracting the vaginal sidewall, the utero-ovarian and uterosacral pedicles are held on gentle traction. We routinely leave the suture ligatures of these pedicles longer and label them. To avoid any inadvertent slippage, the vascular utero-ovarian pedicles are double ligated and only the distal ligature is labelled. Once hemostasis of the pedicles and the intervening surfaces is ensured, the rest of the bleeding should typically be from the cuff edge and will be controlled with cuff closure.

We have stopped closing the peritoneum in simple vaginal hysterectomies for several reasons. First, it is a time-consuming and difficult skill to acquire and safely perform in the early learning curve. It may potentially risk ureteral occlusion and bleeding. Additionally, a randomized study, though underpowered, did not show any difference in complications or dyspareunia after peritoneal closure. We came to the conclusion that if peritoneal closure is not essential during open or laparoscopic transabdominal approaches, it should not be so for vaginal hysterectomy either. By eliminating it, we feel that vaginal hysterectomy has become less intimidating for the beginners without any apparent increase in morbidity.

We close the cuff vertically using two continuous delayed absorbable zero sutures (Fig. 113.15). To start the closure, we hold the midpoint of the posterior cuff edge and the posterior peritoneum together with an Allis clamp. We then continuously suture the full thickness cuff edge and the peritoneum on each side of this Allis together. Before alternating to the other side, we also include the intervening peritoneum of the cul-de-sac with each bite. After three to four of these bites, we tie this running suture at the uterosacral ligaments ensuring that they are also incorporated in the closure (Fig. 113.15). This technique obliterates the cul-de-sac,

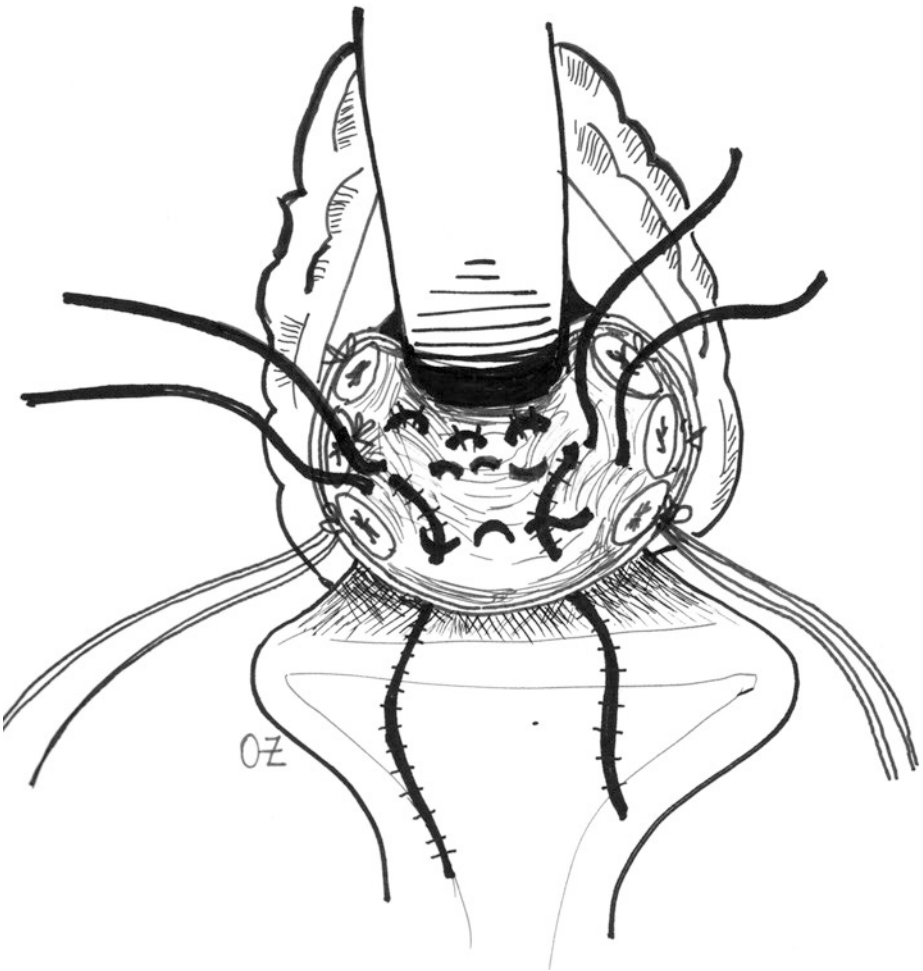


Fig. 113.13 McCall culdoplasty. This method is commonly considered when apical support is not optimal. The goal of this approach is to obliterate the cul-de-sac for prevention of future enteroceles, plication of the uterosacral ligaments, and connecting the cuff to the uterosacral ligaments for a secure apical support. In a traditional McCall Culdoplasty, the uterosacral ligaments and intervening peritoneal surfaces are sutured together intraperitoneally with two running permanent sutures. A third suture (*marked with cross lines*) is placed through the ligament intraperitoneally and then brought out through the posterior vaginal cuff edge and tied outside after the rest of the cuff is closed horizontally

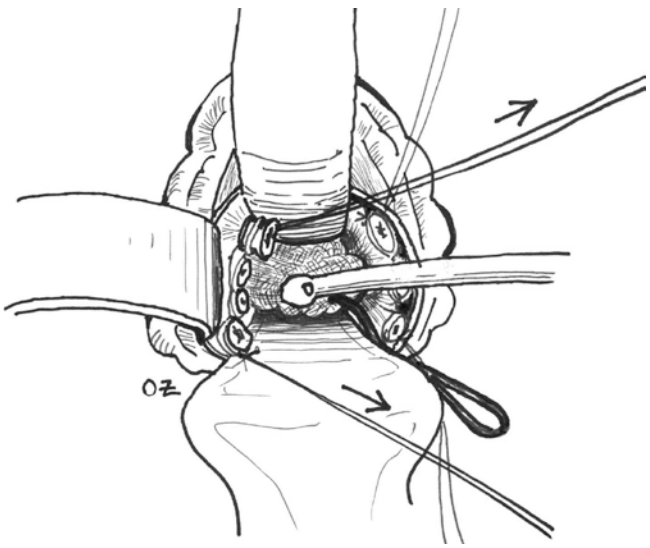


Fig. 113.14 Hemostasis check. Before closure, all pedicles should be carefully inspected for hemostasis with a systematic approach

brings the uterosacral ligaments together in the midline, and attaches the cuff to the uterosacral ligaments similar to the McCall culdoplasty. The rest of the cuff is closed starting from the midpoint of the anterior cuff edge with full thickness purchases from each side and completed at the uterosacral ligaments. If there is an anterior compartment defect, we begin the anterior compartment repair from the anterior cuff and close it at the end. If there is apical prolapse, we add an apical suspension procedure such as high uterosacral ligament suspension or sacrospinous ligament fixation. It is important to rule out a posterior apical vaginal defect causing an enterocele. When this exists, posterior compartment should be opened as in a posterior vaginal repair and attach the torn apical edge of the posterior vaginal muscularis layer to the uterosacral ligaments as well.

At the end of the procedure, we place an indwelling bladder catheter, though not always necessary, but do not use vaginal packing unless a vaginal prolapse repair is also performed.

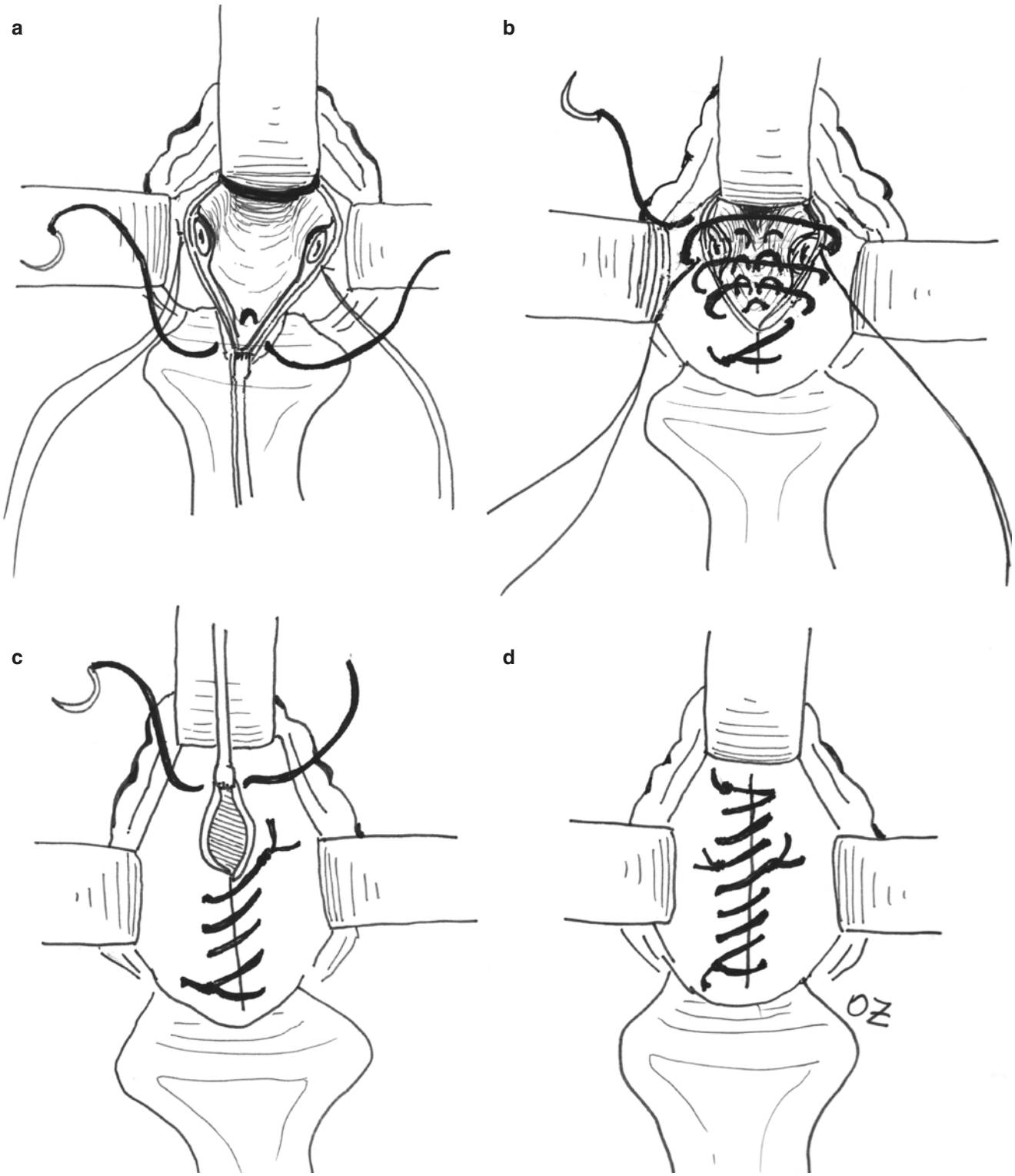


Fig. 113.15 We close the cuff vertically using two continuous delayed absorbable 0 sutures. To start the closure, (**a**) we hold the midpoint of the posterior cuff edge and the posterior peritoneum together with an Allis clamp. (**b**) We then continuously suture the full thickness cuff edge and the peritoneum on each side of this Allis together. Before alternating to the other side, we also include the intervening peritoneum of the cul-de-sac with each bite. After 3–4 of these bites, we tie this running suture at the uterosacral ligaments ensuring that they are also incorporated in the closure. (**c**)The rest of the cuff is closed starting from the midpoint of the anterior cuff edge with full thickness purchases from each side and (**d**) completed at the uterosacral ligaments

Adhesions

114

Shirish S. Sheth

Introduction

If you want to grow roses, you also have to water the thorns!

Adhesions bind tissues and organs to each other. They can make the organ to be dealt with – uterus, and/or its appendages attached to one another and the adherent area can easily get traumatized. For adheseolysis, the principle of treatment is always to proceed from the non- adherent site to the adherent site and then to carefully start separating the adhesions.

Adhesions present a similar problem during vaginal surgery as they do during abdominal surgery and should be managed in the same fashion, as safely as possible. Routinely, one finds gynecologists deal with them laparoscopically and/or abdominally but almost always remain away from it vaginally. Adhesions, particularly flimsy ones may spring a surprise during surgery and often "suspected adhesions" are totally absent. Small ovarian endometriotic cysts can often be without adhesions, just as not all the women with history of caesarean delivery in the past, have a bladder adherent to the uterocervical surface. The surgeon must learn to deal with it vaginally, keeping women's safety and his operative capabilities in mind [1].

Unexpected tuboovarian pathologies, pelvic inflammatory disease, benign ovarian cyst, or endometriomas, hydrosalpinx and tubo-ovarian mass can cause concern and difficulty in treatment. Sonography will not pick up all adhesions and are not always reliable as it is a combination of man-n-machine. Reliable preoperative sonography, and a highly reliable sonologist are essential, particularly, when the pelvic findings are not normal. Sonography findings get confirmed at every surgery which is performed. An examination under anesthesia before the start of surgery can make the surgeon suspect the possibility of adhesions and even cause a change in route and/or technique. However, if in doubt, instead of changing the route, it may be preferable to perform a laparoscopic evaluation to make a definitive decision. Once the route chosen is vaginal hysterectomy, adhesions are likely to hamper or interfere: (1) while getting an access to the anterior and/or posterior peritoneum or pouch or cul-de-sac and /or the, Anterior uterocervical surface with bladder or posterior cervico uterine surface with rectum; (2) flimsy adhesions around the fundus or upper uterine body; (3) a strong or firm band from the lateral posterior uterine surface; (4) Between the fundus or upper uterine body with intestines and/or omentum; (5) uterus with tube and/or ovary; (6) tube and ovary with each other and/ or with surrounding structures; Careful blunt dissection will facilitate salpingectomy or oophorectomy.

Sharp dissection must be carefully performed only under direct vision. However, if the surgeon thinks that it will not be possible to excise the pathologic mass or separate the adhesions safely per vaginam, he or she should have no hesitation in taking the abdominal route, preferably laparoscopically than by laparotomy as lesser invasion is the prime consideration. After a failed vaginal, the abdominal surgery becomes remarkably easy, as most of the lateral pedicles have already been secured during the vaginal attempt.

Uterine Mobility

Clinically, the uterus is mobile in four directions. Restriction of uterine mobility raises the suspicion of adhesions. Testing the anatero-posterior mobility and side-to-side mobility gives an idea about the available uterus-free pelvic space. This estimation, along with the degree of descent or ascent with an upward push, is a better guideline than the distance between the ischial tuberosities which Nichols [2] recommends. The latter can be as fallacious as external pelvimetry in obstetrics [3].

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At an abdominal hysterectomy, there are occasions when we have to separate loops of bowel from the abdominal wall, from one another, from omentum, and finally if required, from the uterus. However, when one reaches the uterus it is often surprising how easily the uterus delivers or enters the abdominal cavity from the pelvis leaving all the adhesions higher up [1, 4, 5].

Often, the mere history of some abdominal or pelvic surgery makes the operator think twice or even deters him from undertaking the vaginal route for hysterectomy. Previous pelvic surgery per se is not a contraindication to vaginal hysterectomy as the nature of the previous operations is the deciding factor. Most operations in past, abdominal or vaginal, are unlikely to cause disturbing adhesions [3].

Previous Abdominal Surgery

These operations can be broadly divided into four categories as in Table 114.1:

1. Operations performed on the uterus are caesarean section, hysterotomy and myomectomy. They are common, important to deal with and do not constitute a contraindication (Table 114.2) [6]. Ventrofixation, contraindicates vaginal hysterectomy, but by experienced gynecologist it can be successfully performed without resorting to the abdominal access. No doubt it demands extra care and effort. At present, laparoscopic adheseolysis to assist VH will solve the problem and spare abdominal opening [6–8].
2. Sling operations for prolapse also make vaginal hysterectomy difficult. Needs back up of experience to perform and spare the abdominal access.
3. Operations performed on the tubes, ovaries and broad ligament tissues in past can give a few flimsy adhesions. They are easily separable as one reaches close to upper pedicle. They should never contraindicate vaginal route, as often done in situations which can be easily dealt with vaginally.
4. Operations performed beyond the genital tract, as appendix, intestines, gall bladder, urinary tract (except bladder) should not hinder or deter and be given undue importance as they are miles away from contraindication.

Encountering any adhesion that holds the uterus inseparably or fear of traumatizing a hollow organ should serve as a contraindication for the vaginal route, an indication to abandon the vaginal route, and to complete the operation with abdominal access.

Previous Vaginal Operations

History of vaginal operation in past is not a contraindication to vaginal hysterectomy. It warrants the surgeon to take extra care. Vaginal operations are (Table 114.1):

1. On the vaginal epithelium and around it, e.g. anterior colporrhaphy, vaginal wall cyst.
2. Cervical amputation. Needs skill and gentleness for accessing anterior and posterior cul-de-sac. It can contraindicate vaginal route for hysterectomy.
3. Fothergill's operation: Past surgery almost makes cervix look like 'nothing on earth' and contraindicates vaginal hysterectomy
4. Operations wherein the peritoneum is entered, e.g. on the tube and/or ovary or myomectomy etc.; need extra care to access and open anterior or posterior peritoneum.
5. Sites slightly away from the site of hysterectomy, e.g. posterior colpoperineorrhaphy, Bartholin's cyst etc.

Though uncommon, bladder or rectal repair done in the past can contraindicate the vaginal route for hysterectomy.

Cervical amputation distorts the anatomy considerably and thus to attempt vaginal hysterectomy after a previous Fothergill's operation is to invite bladder and/or rectal injury. Therefore it can contraindicate the vaginal route for hysterectomy. The other categories only merit special or extra attention.

In day to day practice, situations which hinder the decision to undertake VH are: (1) History of caesarean delivery(ies) / section(s) in past; (2) Ovarian cyst, particularly endometriotic cyst and (3) select surgeries abdominal and/or vaginal performed in the past.

Favourable Pelvic Findings Under Anaesthesia

1. Absence of contraindication to the vaginal route for hysterectomy
2. Mobility of the uterus in all planes
3. Physiologic uterine descent particularly, under anaesthesia, irrespective of parity.
4. Adequate uterus-free pelvic space around the uterus
5. Free vaginal mucosa around the site of both pouches
6. Normal cervical length of portio vaginalis with deep fornices.

Unfavourable Findings Under Anaestehsia Because of Adhesions

1. Restricted uterine mobility in one or more directions
2. Palpable adnexal pathology
3. Cervix flush with the vaginal mucosa
4. Short cervix and shallow fornices; bladder and/or rectum almost on the cervical lip
5. Loss of mobility of the vaginal skin or obvious restriction at the site to get access to the anterior or posterior pouches.

If there is adhesion between the uterus – fundus or body with bowel and/or omentum, it can be easily and

Table 114.1 Previous surgery on the genital organs and place of vaginal hysterectomy

Previous operation	Routine VH	Needs extra care at VH	Trial VH	LAVH	LH	TAH
Abdominal uterine						
Caesarean section		•	□			
Myomectomy		•				
Caesarean delivery (section) + myomectomy		•	□			
Caesarean delivery + rupture uterus repaired			•	□		
Hysterotomy		•				
Metroplasty		•		□		
Sling operation			□	•	•	
Ventrofixation			□		•	
Tubes and ovaries						
Tubal sterilization	•					
Salpingectomy	•					
Tubal microsurgery	•					
Ovarian cystectomy	•					
Oophorectomy	•					
Salpingo-oophorectomy	•					
Vaginal, cervix						
Internal os tightening	•					
Amputation					•	□
Conization		•				
Anterior colporrhaphy		•				
Posterior colpoperineorraphy	•					
Colpotomy-tubal sterilization		•				
Fothergill's operation					•	□
Shirodkar's operation for prolapse		•				
Bartholin's cyst excision	•					
Extragenital organs bladder						
VVF repair				□	•	•
RVF repair					•	•
Extragenital organs						
Cystotomy					•	•
Bladder neck repair		•				
Rectum						
RVF Repair		•		□	•	
Abscess		•				
Piles	•					
Abdominal contents						
Appendectomy	•					
Intestinal	•					
Cholecystectomy	•					

• First choice, □ Second choice

Table shows preference of the route in patients with history of abdominopelvic surgery in the past. *LAVH* laparoscopically assisted vaginal hysterectomy, *VH* vaginal hysterectomy, *TAH* total abdominal hysterectomy, *VVF* vesicovaginal fistula, *RVF* rectovaginal fistula

safely separated and pushed away with blunt or sharp dissection.

For enthusiastic to advance vaginal surgical skill, it is a great opportunity to plunge forward and deal with it but within parameters of safety. This will be a step in the right direction. Careful blunt-n-sharp dissection will lyse the adhesions and make the surgery possible.

Blunt dissection with tip of the finger using tactile sensation provides the safest method of entering the right plane of cleavage, allowing separation of adherent structures. Feeling a bit of ovary and then ovarian surface with finger and finger(s) continuing on that surface easily frees most of the adherent ovary. Sharp dissection must be performed carefully only under vision, which can separate the adherent ovary [3, 5, 7].

Table 114.2 Previous abdominal surgeries in 7324 vaginal hysterectomies [6]

Caesarean section	954[a]
Myomectomy	94
Caesarean section plus myomectomy	52
Caesarean section plus ruptured uterus	3
Appendectomy	310
Tubo-ovarian	184
Intestines	58
Tuboplasty	52
Ventrofixation	10
Ventral suspension	22
Ectopic	30
Failures	7
Total	**1776**

[a]Includes 24 cases with ventral scar herniorrhaphy
Tubal sterilization: 2180
Failure to open both pouches: 0

Cesarean Section Adhesions

Women who have had caesarean section(s) may develop adhesions. They may be flimsy, around the operated area of the lower uterine segment with bladder, omentum and/or intestine(s) or with tube and/or ovary. However, one specific area that bugs the surgeon is in the vesico-uterine area when doing a hysterectomy on a woman with cesarean section(s) in past. For getting an access to the vesico-uterine peritoneum or anterior peritoneum or anterior pouch (cul-de-sac), the bladder needs to be safely separated from the uterocervical surface and this causes anxiety in the surgeon's mind when hysterectomy is considered via the vaginal route [6, 8–13].

No less an advocate of vaginal hysterectomy than Heaney [14] believed that a history of previous pelvic surgery precluded removal of the uterus through the vagina. Coulam and Pratt [15] mention that the chief concern in such cases is the risk of injury to the bladder and difficulty in gaining entry through the scarred anterior cul-de-sac. Carpenter and Silva [16] compared vaginal and abdominal hysterectomies after previous pelvic surgery and concluded: 'vaginal hysterectomy following pelvic operation is technically easy and without an increase in morbidity'. Kovac et al. [17] have discussed the role of LAVH in women with caesarean delivery in past. However there is no doubt that LAVH is more invasive than vaginal hysterectomy [12, 18].

On the basis of observations in women with history of caesarean delivery(ies) in past, it can be said that (1) if the bladder is adherent, it is always in the central 3/5ths and not the lateral 1/5th, and (2) magnetic resonance imaging (MRI) studies at the isthmic level through different planes show a distinct vacant space medial to the line joining the maximally bulging uterus above and the cervix below, with its continuity medially between the uterocervical surface and the bladder, until they come extremely close to each other in the midline and continue laterally between the two leaves of the broad ligament (Figs. 114.1 and 114.2) [3, 9, 10, 12, 19]. Separation is from

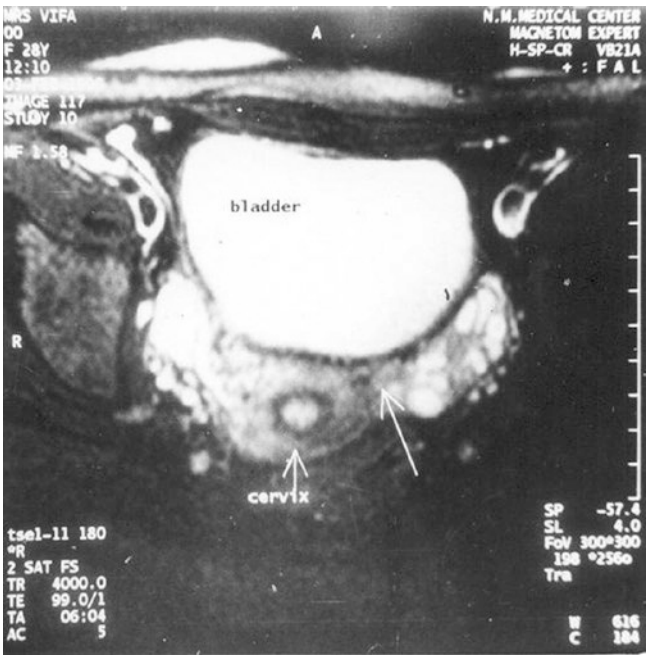


Fig. 114.1 Magnetic resonance imaging (MRI) study showing distinctly the presence of free space laterally between bladder and uterocervical surface (Sheth [10])

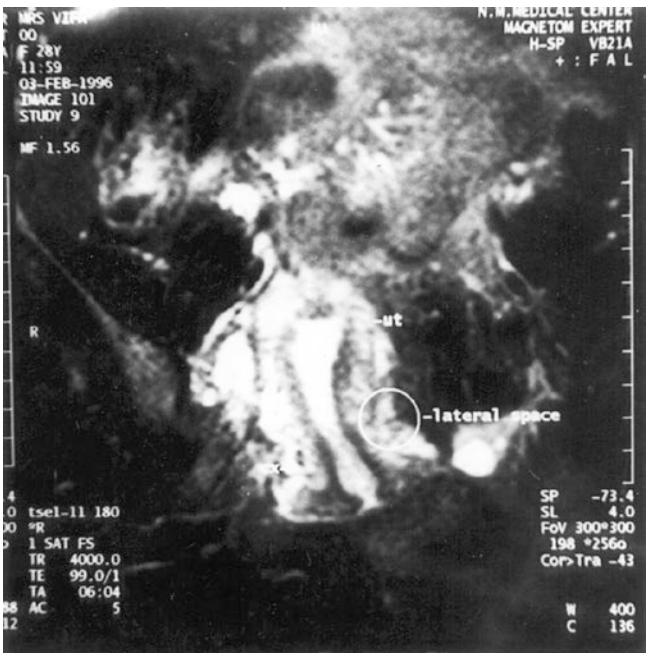


Fig. 114.2 Magnetic resonance imaging (MRI) study confirming the presence of free space surgical window laterally between bladder and uterocervical surface (uterocervical-broad ligament space) (Sheth [10])

non adherent lateral to adherent medial adhesions, and the, occasionally depressed adherent scarred surface guides the operator to the correct site. Familiarity with this and the normal uterine serosal surface is helpful [9, 10, 12] (Fig. 114.3).

John M. Monaghan, an eminent gynaecological oncologist from UK (personal communication) writes' I find Sheth's

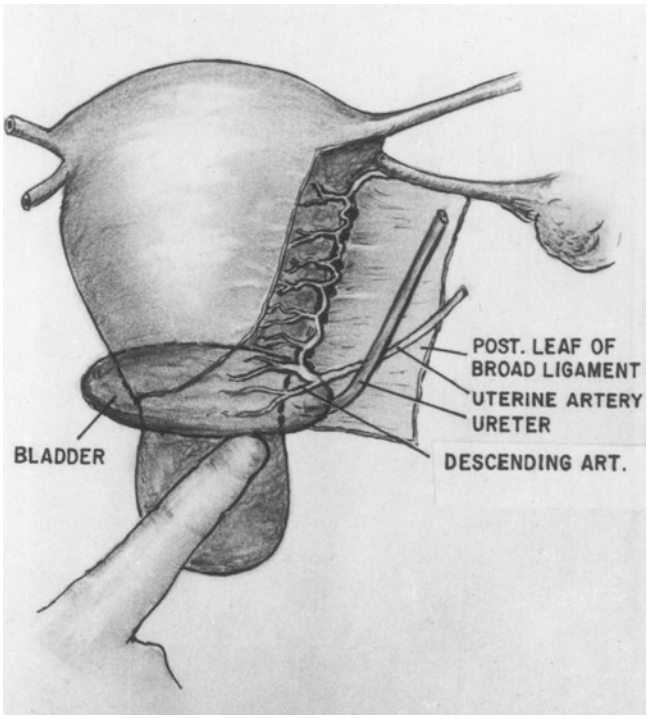


Fig. 114.3 The finger is on the normal uterocervical surface, the site of dissection between the bladder anteriorly and the uterocervical surface posteriorly, finger guides the dissection. The distally placed ureter is also seen (Sheth [10])

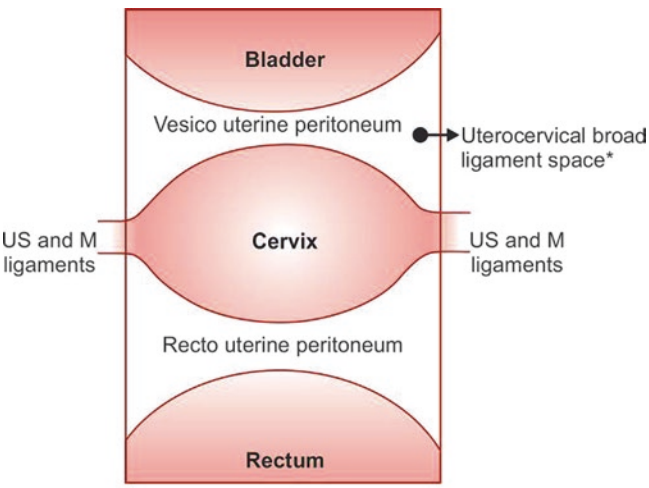


Fig. 114.4 Distinctly shows the space between bladder and cervix or cervicouterine surface, which is much more under lateral one fifth of bladder when compared with central three fifths of bladder (Sheth [19])

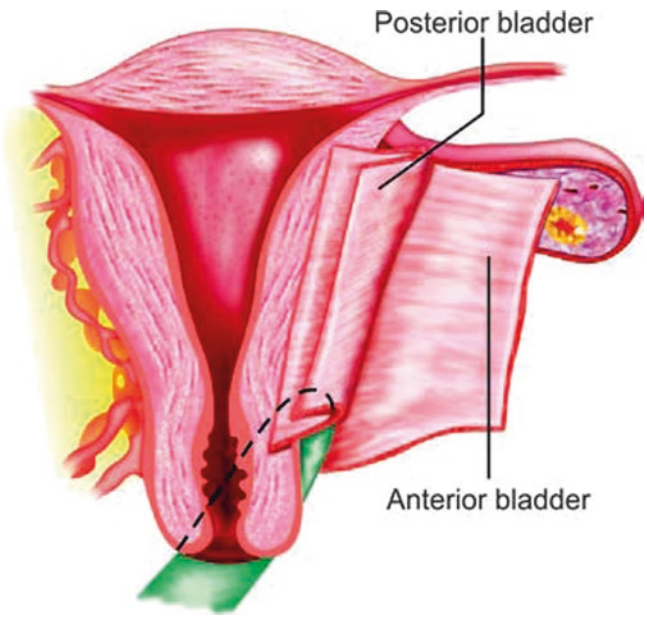


Fig. 114.5 Sagittal section of uterus seen from behind. The leader lines indicate the site of the uterocervical broad ligament space or surgical window going laterally between two leaves of broad ligament (Allahbadia and Sheth [7])

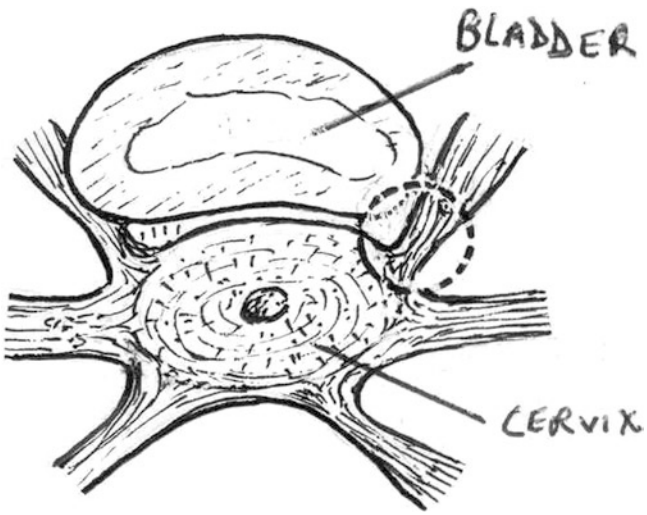


Fig. 114.6 At the lateral angle of the uterovesical junction there is more room, a window or uterocervico broad ligament space (*circle of dotted lines*), to enter the uterovesical space and begin the bladder separation from uterocervical surface (Sheth [3])

space useful for accessing the vesico-uterine peritoneum. At VH in a patient with history of cesarean(s) in the past, Khung chooses to separate the lateral non-adherent portion of the bladder through a surgical window lateral to the midline on the anterior cervix or Sheth's uterocervical broad ligament space (Figs. 114.4, 114.5, 114.6, and 114.7) [3, 6, 10, 19, 20] and the same space is utilized at the time of laparoscopic hysterectomy or abdominal hysterectomy when separation of the bladder in its central portion is difficult or risky by Sizzi and Rossetti [21] who write that "a safer approach is from the lateral, the surgical window described by Sheth which allows a safe, sharp dissection also through laparoscopy, starting from both sides going medially towards the medial portion of the vesico-uterine space". Methylene blue is injected in the described space (Fig. 114.8). Finding the access point from the central area where the bladder is more likely to be adherent in women who have had previous caesarean sections (deliveries) will only increase the risk of traumatizing the bladder as it

is more likely to be adherent in the central 3/5th. All gynecologists who genuinely want to learn and progress can initially choose to practice such sound anatomical access in five to 10 vaginal hysterectomies in women who have had no uterine, particularly previous caesarean sections or caesarean deliveries in the past and therefore are without such adhesions.

The author has routinely used this surgical window for more than 20 years to obtain access to the vesico-uterine space during vaginal hysterectomy in women with a previous history of cesarean section, including many with multiple previous cesarean sections and/or myomectomy in the past including women with a history of uterine rupture following caesarean deliveries [12, 22].

Intra-operatively, when bladder separation is difficult, despite that an attempt must be made to dissect the bladder angle and the uterocervical space as described and if uterine descent and space permit, the index and middle fingers of the left hand can be inserted through the posterior cul-de-sac and brought to the front (preferably near cornual area) or utero-vesical reflection so as to permit an incision of the thin peritoneum as it rests on the fingers under direct vision, followed by severance of the upper pedicles (Fig. 114.9) [6, 19, 22].

The decision to carry out vaginal hysterectomy in women who have had previous caesarean sections should be guided by two questions: 'with the same pelvic findings in a woman, in the absence of caesarean section in the past would I attempt vaginal hysterectomy?' If the response is yes, than the second question is 'will I be able to access the vesico-uterine peritoneum?' Gynaecologists need to remember that previous caesarean sections per se should never contraindicate

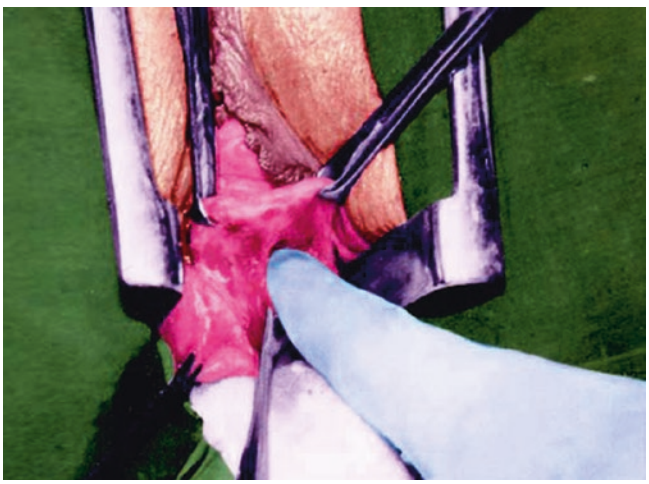


Fig. 114.7 The uterocervical-broad ligament space. The tip of the finger remains on the uterocervical surface, with the bladder anteromedially, as it insinuates further laterally between the two leaves of the broad ligament (Sheth [10])

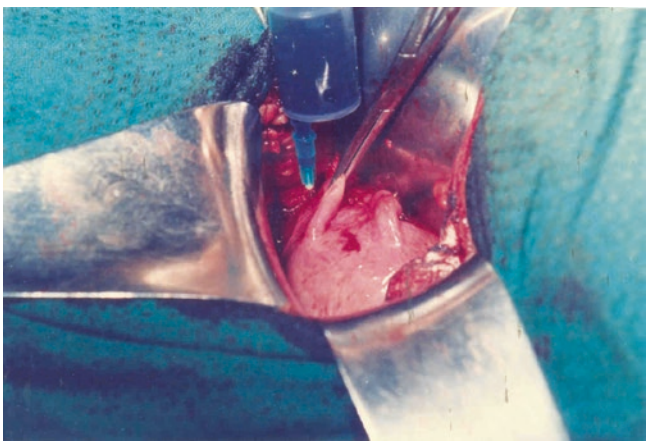


Fig. 114.8 With laparotomy, uterus is seen with its round ligament held by the artery forceps and methylene blue being injected through uterocervical broad ligament space to picturise or demonstrate the same plus its continuity between bladder and uterocervical surface

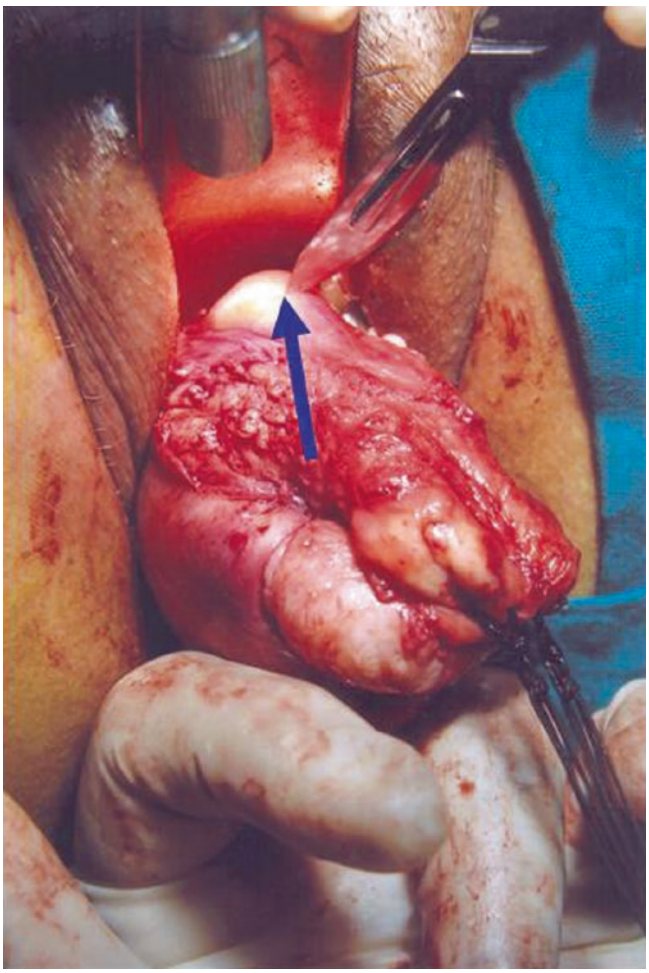


Fig. 114.9 Access to the vesicouterine peritoneum via posterior. After the uterine vessels are secured and the uterine fundus is brought out of the pouch of Douglas (POD) or posterior cul-de-sac and pulled as anteriorly as possible. Finger almost reaches the round ligament laterally, then passes through the POD and exits near the right cornual area. Finally, the finger covered by thin peritoneum insinuates itself and appears anteriorly, near right cornual area. The peritoneum is then incised to allow the finger to pass through it (Figure reproduced with permission granted by FIGO from: Sheth [22])

hysterectomy via the vaginal route. Quite often the adhesions are in the operator's mind and not in patient's pelvis [10, 23].

Surgical technique to access the vesicouterine peritoneum (VUP) in women with history of two or more c deliveries (sections) in the past [13, 19, 22]:

The Technique consists of four operative steps. They are as follows: (1) To enter the cervicouterine surface from both the uterocervical broad ligament spaces; (2) for uteri not enlarged beyond 8–10 weeks, after creating a larger bare cervicouterine surface, access to the VUP is achieved by reaching the lateral uterine serosal surface; (3) when the fundus is reachable and access is still not achieved, an approach is made from EITHER (A) the pouch of Douglas through one of the two techniques given below. This approach is made to achieve bladder separation either by bringing the uterine fundus out from the posterior cul-de-sac anteriorly. A Drooping bladder facilitates separation of the VUP, preferably close to the cornual area and thus leads to the required access (Fig. 114.10) [19], OR the finger is passed from the POD laterally in one of the cornual areas and with the help of tactile sensation emerges anteriorly and the moving finger covered by thin VUP is now incised. The Access so obtained permits placing the bladder retractor and keep the bladder away. Guidance comes from the distance at which the fundus is OR (B) by separating the centrally adherent bladder that is already made free laterally and shows folds and the plane of cleavage. If required, debulking can bring the fundus proximally and (4) when above steps fail the cervix is bisected upward to get a plane of cleavage and access [13, 19, 22].

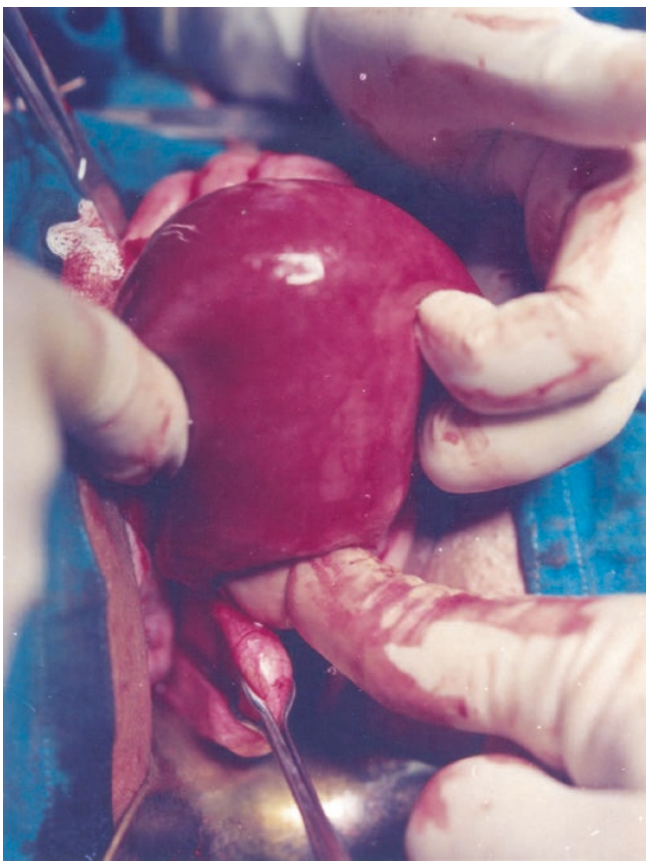


Fig. 114.10 Uterine fundus is delivered from the pouch of Douglas or posterior cul-de-sac and pulled in front. Babcock's forceps clearly show the bladder and site of vesicouterine peritoneum to be accessed – the reverse of what is done at the abdominal hysterectomy for similar access (Allahbadia and Sheth [7])

Adhesions: Pouch of Douglas

Opening the pouch of Douglas or getting access to it is simple and straight-forward (Fig. 114.11). The posterior cul-de-sac is explored with the index finger to exclude adhesions or any other pathology. As a rule, rectal trauma is much less likely than bladder trauma at vaginal hysterectomy. However, when the site is not normal, and when access is difficult, tactile sensation and anatomical planes should be used more carefully to access the pouch of Douglas.

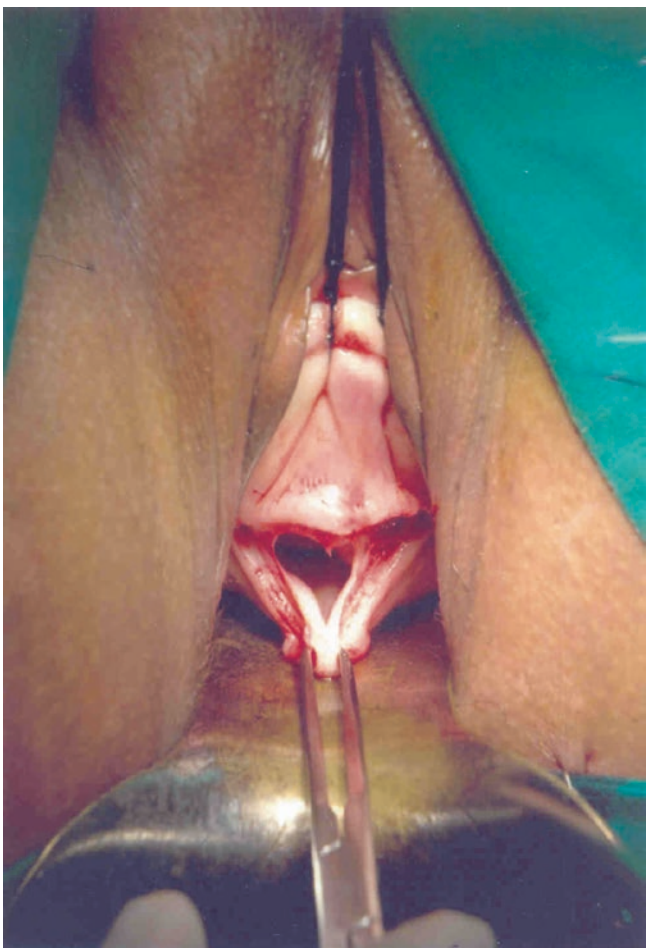


Fig. 114.11 Opening the pouch of Douglas or posterior cul-de-sac is simple and straightforward. Once the peritoneal cavity is reached, speculum is inserted to facilitate further instrumentation and required surgery

In cases of previous pelvic inflammatory disease (PID) or subclinical PID, if a firm band is felt posterolateral to the uterus, cutting it immediately provides 'give' with the required descent. On reaching the highest pedicle in the absence of uterine enlargement, if the uterus does not descend at all, the probable reasons are intestino-omental adhesions with the uterus or sling or previous surgery for prolapse or suspension or band from the abdominal wall to the uterocervical surface. This needs gentle perseverance and if not favourable, a serious consideration be given for changing the technique to either an LAVH or to laparotomy [18].

Posterior uterocervical broadligament space—a surgical space: This is to get an access to obliterated posterior cul-de-sac for VH and perform concomitant salpingo-oophorectomy at VH for ovarian endometriotic cyst.

The safest and most effective approach in these cases is subcervical extraperitoneal tunneling, a tunnel beneath the posterior cervical surface towards the uterine serosa using digital palpation, until the affected area has been passed. It is vital to keep pressure on the posterior cervico-uterine surface and push the soft tissue, if any, away to avoid rectal trauma and mobilize the obliterated area, facilitating dissection until free peritoneal space is encountered. If required, rectal examination is a good guide in these cases. To feel bare the posterior cervico uterine surface is reassuring. Occasionally, even the uterine arteries need to be ligated extraperitoneally as long as they are close to the utero-cervical border. A drop of peritoneal fluid or chocolate-like material should delight the operator as it means access to the peritoneal cavity is obtained. Insertion of a finger or artery forcep through the same opening will then provide further access. Colpotomy performed through the vagina may actually have a lesser potential for morbidity than colpotomy through an abdominal or laparoscopic approach.

Unexpected tubo-ovarian pathological conditions may be recognized while attempting to opening the pouch of douglas; pelvic inflammatory disease, benign ovarian cyst, or ovarian endometriosis, with or without adhesions, can lead to difficulty in surgery [5].

Patients with endometriosis, previous genital tuberculosis, pelvic inflammatory disease, or previous surgery like tubal sterilization, ovarian cystectomy, or oophorectomy via the pouch of Douglas are often found to have distorted or obliterated cul-de-sac. Under these conditions, the distortion of normal anatomical planes increases the risk of standard techniques of colpotomy. Experience through perseverance in contraindicated cases showed that an open space existed in women with a retroverted, retroflexed uterus and space, (described by the author as a posterior uterocervical broad ligament space) for experienced colleagues to attempt a relatively safe and effective approach [13, 19, 24] (Figs. 114.12 and 114.13). Such cases are suitable for LAVH or abdominal hysterectomy, when vaginal route is assessed as difficult or contraindicated.

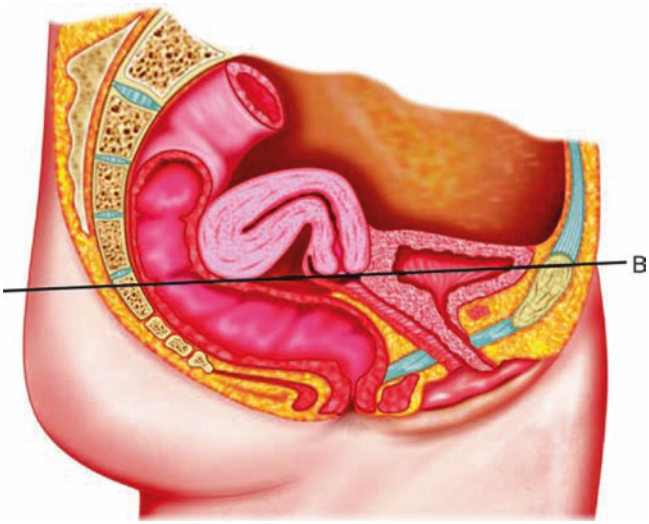


Fig. 114.12 A marked retroversion with retroflexion creates a space between the uterocervical junction and the B line. (Prepared by surgeon, Dr. RD Prabhu, Shimoga, Karnataka India.) (Figure reproduced with permission granted by FIGO from: Sheth [24])

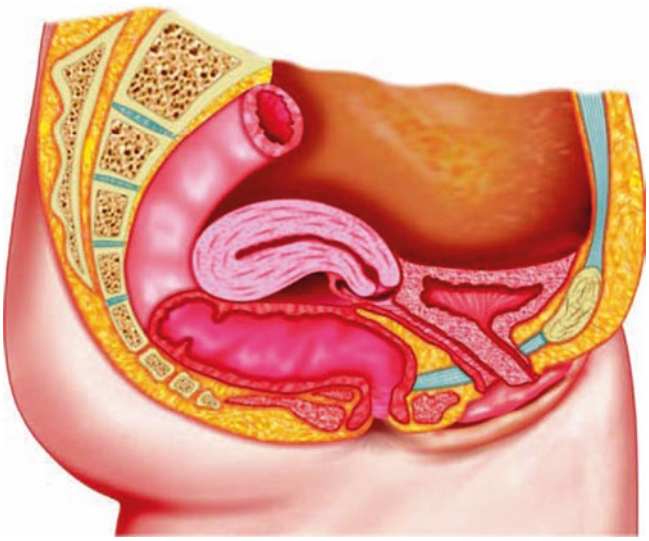


Fig. 114.13 Adherent mass in the posterior uterocervical-broad ligament space. (Prepared by surgeon, Dr. RD Prabhu, Shimoga, Karnataka, India.) (Figure reproduced with permission granted by FIGO from: Sheth [24])

In our experience, adhesions separate easily from below upwards than going from above downwards and allows surgery to be carried out. Entry in an obliterated POD can be obtained by sub-tunnelling and with the use of the posterior surgical window (posterior uterocervical broad ligament space) to separate adhesions above and below , and to gain access to the Pouch of Douglas [24]. The author has utilized the vaginal approach when an endometrial cyst is of 5 cm or

less. Confidence was gained from the past experience of concomitant bilateral salpingo-oophorectomy for mobile, benign adnexal pathology at vaginal hysterectomy and finding many endometrial cysts without any adhesions and/or cysts so small in size that they gave no difficulty in performing salpingo-oophorectomy [12, 24].

Transcervical Access

It is utilized in those cases when the access is risky or impossible by the above methods. The cervix is pulled anteriorly with firm traction. With stout scissors, the surgeon initiates a full-thickness division of the posterior cervical wall in the midline, with one blade inserted in the cervical canal, cutting from canal to external wall, keeping the rectum away until the peritoneum of the cul-de-sac is entered [11, 13, 24].

In some cases of pelvic endometriosis, involving one or both ovaries, there is retraction of the posterior vaginal wall adjacent to the pouch of Douglas. This is demonstrable as a 'Dimple sign', dimpling when the cervix is pulled up with a tenaculum. From the central dimple, the vaginal wall fans out for 1 cm or more in diameter, feels thickened and irregular, and adheres to underlying tissues; beyond this, it assumes its normal free and supple nature. The presence of a dimple in the posterior vaginal wall, adjacent to the pouch of Douglas denotes adhesions due to ovarian endometriosis. Such cases need second thoughts even for the experienced vaginal surgeon. Vaginal hysterectomy is contraindicated in patients with a positive 'Dimple sign' [25]. Attempts to open the pouch of Douglas are attended by a great deal of difficulty because there is no free space and no plane of cleavage; such attempts can result either in the release of chocolate-coloured material OR trauma to the rectum [13, 18, 24].

Adhesions may cover the vaginal mucosa overlapping the anterior or posterior cervical lip and this should not discourage the surgeon, as it needs only a small dissection close to the respective lip to find the space and reach the peritoneum. Rectal examination is a useful guide when the vaginal mucosa overlaps the posterior cervical lip.

Utero Abdominal Wall Adhesions

Uncommonly, caesarean delivery(ies) in past, can result in specific dense adhesions between lower abdominal wall and uterocervical surface (Fig. 114.14), which are diagnosable clinically and sonographically [11, 26]. This contraindicates the vaginal route for hysterectomy even for experienced vaginal surgeons.

Clinical diagnosis comes from the described 'cervico fundal sign' [11, 26] (Fig. 114.15), wherein speculum and bimanual examination findings give (1) the stretched posterior vaginal wall pulled upward in its upper half and inability to clearly visualize the cervix even after the use of an anterior vaginal wall retractor and/or vulsellum, and (2) the cervix is high and almost behind, or close to, the pubic symphysis facing the upper vaginal wall. Traction on the cervix, if possible, pulls the lower abdominal wall inwards, almost dimpling it or tucking it in on speculum examination. It is not possible to palpate the uterus and a highly placed fundus.



Fig. 114.14 Abdomen is opened by infra umbilical right paramedian incision upto pubic symphysis. In the small opened part, peritoneum is held to show the site of uterine fundus. Fundus of the normal uterus is seen placed too high because of adhesions

A positive clinical sign guides the examining gynecologist to suspect dense adhesions, which are classically between the uterocervical surface and the overlying urinary bladder with the surface of lower anterior abdominal wall, with an obliterated uterovesical pouch of the peritoneum (Fig. 114.16) [26]. Consequently, the uterocervical surface almost becomes one with the lower abdominal wall, with a resultant altered anatomy, which is not easily understood even on laparoscopy.

On abdominopelvic sonography in women with suspected intraperitoneal adhesions, altered sonography findings were (1) an elongated, pulled up cervix, (2) easy to identify, a long



Fig. 114.15 Speculum examination in a woman with cesarean sections in past shows a stretched and pulled up posterior vaginal wall and unseen cervix, high up behind pubic symphysis.(Sheth [11])

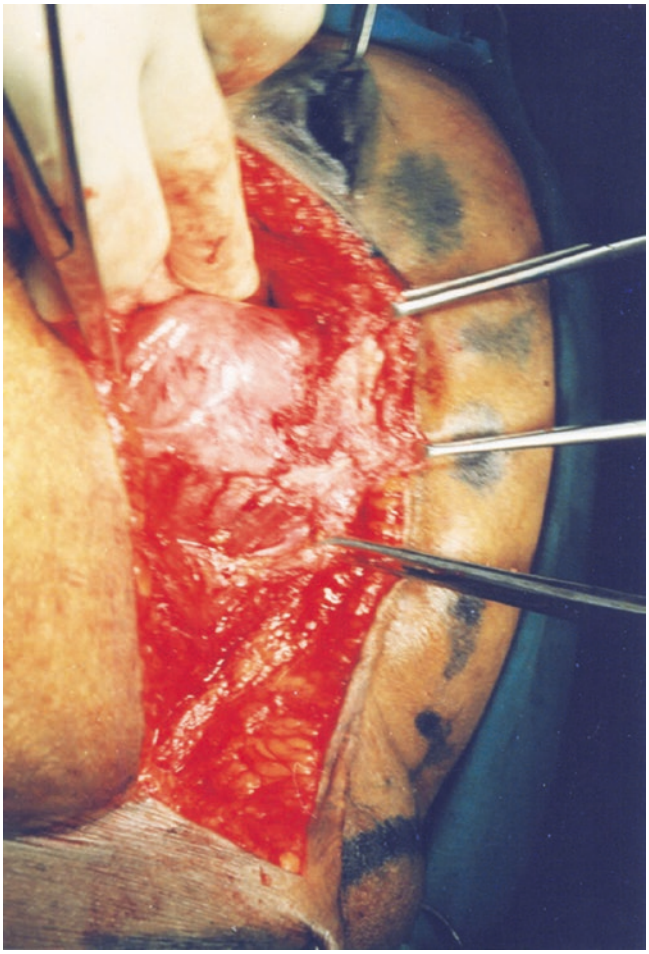


Fig. 114.16 Classic adhesions following cesarean section seen at laparotomy. Deaver's retractor and Allis forceps on the skin marking at the umbilical level close to the upper end of the right paramedian incision. The uterine fundus of normal uterus shown by fingers is well above half way between the symphysis pubis and the umbilicus (Sheth et al. [26])

cervix classically raises the suspicion of adhesions (Fig. 114.17) [27], (3) even a full or overdistended bladder does not appear between the fundus of the uterus and anterior abdominal wall (Fig. 114.18) [27], and (4) the uterus may tend to show retroflexion, forming an angle with the distended urinary bladder [27]. However, still rarer adhesions may manifest with a band binding the same uterocervical surface to the lower abdominal wall and not the uterocervical surface glued to lower abdominal wall surface. The above clinical sign, for glued surfaces, is absent when surfaces are not glued to each other but only a band binds them. Sonography findings will be: Attempt to move the uterus at sonography on releasing probe pressure gives restricted anteroposterior movement, as if it is adherent. Normally after applying probe pressure on the uterus and then releasing it, the uterus moves away from the abdominal wall surface, which is not observed when a band is binding the two.

Figure 114.19 [26] shows that the uterus (5.8 × 5.2 × 6.3 cm), close to 6 weeks size with the fundus located at the L4–5 intervertebral disc level, 14 cm above the symphysis pubis, and about midway between the symphysis pubis and the umbilicus. The anterior wall of the uterus is adherent to the anterior abdominal wall, as evidenced by obliteration of the fat plane on MRI study.

Diagnosis of the adhesions described above has the following advantages: (1) it explains the cause of pain; (2) acts as a warning for laparoscopy particularly the insertion of the Verres needle and trocar; (3) contraindicates VH; (4) it explains the difficulty in performing hysteroscopy and/or curettage; and (5) spares the patient from trauma to the bladder etc.

It should become a routine for every gynecologist who examines a patient with history of cesarean section(s) in the past, to have a careful speculum examination to exclude the 'cervico fundal sign' and the existence of described adhesions. Similarly, the sonologist should make it a routine (1) for every woman with a history of cesarean section

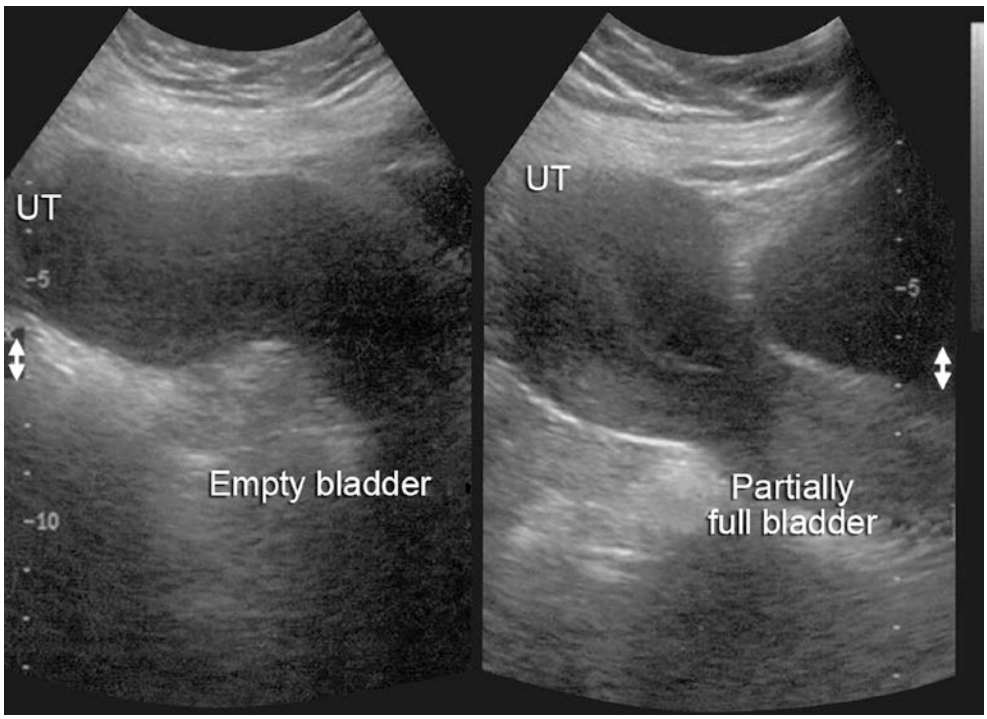


Fig. 114.17 Transabdominal pelvic sonography with empty bladder and partially full bladder in a patient with cesarean section(s) in past shows effect of elongated cervix (Sheth et al. [27])

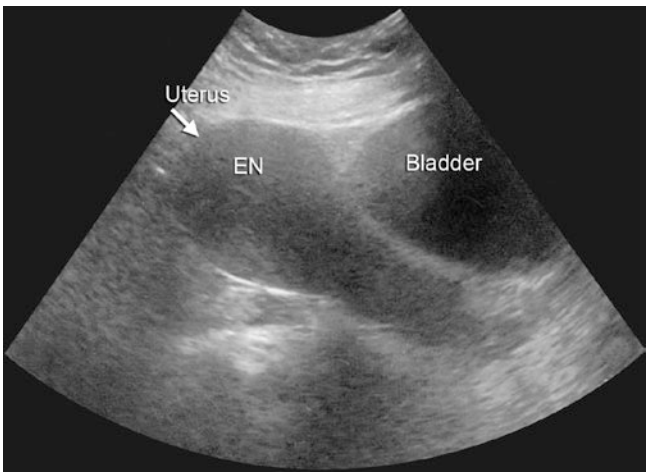


Fig. 114.18 Transabdominal pelvic sonography with full bladder in a patient with prior casarean sections. There is absence of a distended urinary bladder between the fundus of the uterus and the anterior lower abdominal wall (Sheth et al. [27])

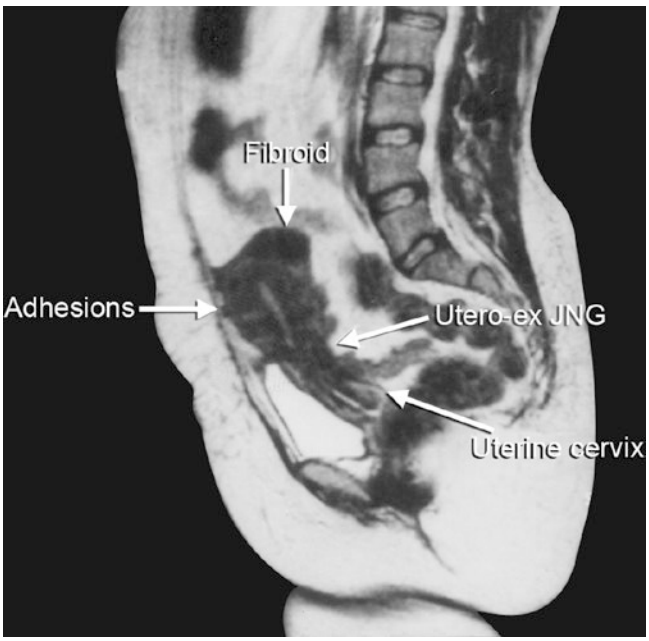


Fig. 114.19 Magnetic resonance imaging (MRI) shows elongated, displacedcervix behind the symphysis pubis facing the upper third of the vaginal wall and adhesions between the bladder and cervical surfaces (Sheth et al. [26])

in the past to look for altered sonography findings and (2) if present, report the possibility of adhesions between surface and surface to the gynecologist including sonography pictures showing an elongated cervix OR restricted antero-posterior movement on releasing probe pressure and the uterus not moving away from the abdominal wall, with absence of clinical cervico fundal sign. Elongated cervix in absence of prolapse, should inspire sonologists to look for each possibility.

The clinical sign and diagnosis are something akin to prenatal diagnosis of placenta percreta with the aid of sonography, based totally on the presence of placenta previa in a woman and a history of one or more cesareans in the past [27, 28].

Adnexal Mass: Adhesions

For benign adnexal pathology, concomitant adnexectomy at VH can be attempted and performed.

Today, the surgical scenario has changed drastically with the availability of a wide range of antibiotics, highly advanced surgical and anesthesia technology, and accurate definition of parameters from the laboratory and imaging sciences. This is adequate reason to consider strongly, reevaluate and even reject old contraindications, if an adnexal mass qualifies for removal vaginally and the pelvic examination findings endorse such a removal; adnexectomy for such pathology should be looked on as a current surgical advance. Thus, presence of an adnexal mass should not be a contraindication to VH but is to be managed vaginally when possible without invasion from a laparoscope.

Benign, mobile adnexal pathology will usually not deter the experienced surgeon who is likely to complete the excision vaginally with patience and perseverance. Suspicion of malignancy or the possibility of tuberculosis will be a contraindication. Success is very satisfying because surgery is with minimal access and is the least invasive. The presence of any adhesion that makes the uterus inseparable or risks traumatizing a hollow organ should be an indication to abandon the 'TRIAL VH' or 'TRIAL vaginal route' and complete the operation with abdominal access, laparoscopic or laparotomy [29].

If a benign adnexal mass is present and the gynecologist chooses to remove it concomitantly at VH, certain prerequisites should be met with. This starts with, case being taken as 'TRIAL VAGINAL ROUTE'.

- Preoperative investigations such as ultrasonography, Doppler studies, and blood CA-125 to indicate the benign nature of the mass.
- Accessibility and free mobility of the mass, which can bring the mass medially into the operative field when held with a Babcock's and/or Ellis' forceps.
- Visibly benign pathology.
- Facilities for frozen histopathology, laparoscopic assistance, and/or laparotomy are available.
- The surgeon has back up experience of vaginal surgery, particularly concomitant salpingo-oophorectomy at VH.
- The woman and her family have been adequately counseled and informed consent taken for a "Trial vaginal route" [30].

For a tubo-ovarian mass, in case of doubt and/or litigious surroundings, counseling, informed consent, and facility for frozen HP are mandatory. The author's experience of VH with concomitant bilateral salpingo-oophorectomy for a twisted gangrenous ovarian cyst in a nullipara was inspirational and should encourage colleagues to plunge more into this challenging sphere [31–34]. When treatment includes hysterectomy and if this is possible via the vaginal route, then let the anxiety and fright of dealing with a twisted ovarian cyst to perform salpingo-oophorectomy via the vaginal route [35] not be a contraindication or an obstacle. Backup experience of BSO at VH as well as dealing with benign adnexal pathology like teratoma or serous cystadenoma concomitantly at VH tilts the balance in favor of the present approach – TRIAL VAGINAL ROUTE – even for such a complicated condition. However, all the enumerated prerequisites must be fulfilled.

Carrying out the entire procedure of hysterectomy with concomitant BSO via the vaginal route, without laparoscopic assistance or laparotomy, would be of great advantage due to reduced morbidity, faster recovery, and shorter hospitalization, besides minimizing invasion and cost. There is no iota of doubt about the superiority of VH over its alternatives, when it can be safely performed [11, 30, 36, 37].

Place of Laparoscopy

An informed consent is obtained for evaluatory or diagnostic laparoscopy or for laparoscopic surgery or laparotomy; hence the patient should be fit for general anaesthesia. Under anaesthesia, a bimanual examination is done and the mobility of the uterus is assessed with and without traction with a vulsellum. If adhesions are expected and present, they are assessed laparoscopically and lysed if required, to make the vaginal surgery easier.

When an experienced vaginal surgeon plans to excise a benign, mobile, adnexal mass vaginally at vaginal hysterectomy, laparoscopy if needed, will confirm the earlier findings, exclude malignancy and tuberculosis, and enhance the possible removal via the vaginal route. A laparoscopic evaluation needs to be differentiated from laparoscopic surgical assistance in carrying out a vaginal hysterectomy. Laparoscopic evaluation is diagnostic and provides information to encourage the surgeon to use the vaginal route or to choose alternatives such as trial vaginal route, LAVH, or laparotomy [13, 18, 23].

Much can be learned from the experience of Kovac, who assessed all his patients scheduled for abdominal hysterectomy by performing a laparoscopy before opening the abdomen and interestingly changed the route to vaginal in large number, thereafter [17].

Place of LAVH

In the USA, a country where litigation is common, the American College of Obstetricians and Gynecologists (ACOG) recommends the following indications to use

the laparoscope to assist vaginal hysterectomy, i.e. by LAVH [38]:

- Lysis of adhesions
- Treatment of pelvic endometriosis
- Difficult oophorectomy
- Fibroid that complicates VH
- Evaluation of abdominal/pelvic cavity.

However, it must be noted that laparoscopic surgery comes into the picture only when oophorectomy is difficult. Let us not make every oophorectomy difficult but instead reduce their number to a minimum and feel satisfied.

Vaginal Assisted Laparoscopic Hysterectomy (VALH)

In select situations, there are times when part of laparoscopic hysterectomy needs to be assisted vaginally to ease and complete the hysterectomy [39].

Role of Anaesthesiologist

Peritoneal traction during salpingo-oophorectomy occasionally induces reflex straining and vomiting because of peritoneal irritation and visceral pain. It is essential that the pelvic structures be well relaxed during this step to provide maximal exposure, and the anesthetist's vigilance and help are of utmost importance in these circumstances. Because of them, for the vaginal surgeon, contraindications get reduced and become interesting indications to innovate and advance the realms of simplified surgery. Success in "difficult situations" leads to a second look at contraindications and helps in the advancement of surgical techniques [1, 13, 23].

References

1. Sheth SS. Vaginal hysterectomy following failed abdominal hysterectomy. J Gynecol Surg. 1998;14:191–3.
2. Nichols DH. Update on surgery. Contemp J Obstet Gynecol. 1987;29:92–109.
3. Sheth SS. Vaginal hysterectomy. In: Studd J, editor. Progress in obstetrics and gynecology. 10 ed. London: Churchill Livingstone; 1993. p. 317–40.
4. Cohen J. Abdominal and vaginal hysterectomy: new techniques based on time and motion studies. 1 ed. London: Heinemann Medical; 1972. p. 72–132.
5. Sheth SS, Malpani A. Technique of vaginal oophorectomy during vaginal hysterectomy. J Gynecol Surg. 1994;10:197–202.
6. Sheth SS¸ Shah VM. Hysterectomy after previous abdominopelvic surgery. In: Sheth SS Vaginal hysterectomy, 2 edition. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2014: 110-115.
7. Allahbadia GN, Sheth SS. Access to vesicouterine and rectouterine pouches. In: Sheth SS, Studd JWW, editors. Vaginal hysterectomy. London: Martin Dunitz Ltd.; 2002. p. 29–41.
8. Wong WSF, Lee TCE. In: Sheth SS, editor. Vaginal hysterectomy. 2 ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2014. p. 180–9.
9. Sheth SS, Malpani AN. Vaginal hysterectomy following previous caesarean section. Int J Gynecol Obstet. 1995;50:165–9.
10. Sheth SS. An approach to vesicouterine peritoneum through a new surgical space. J Gynecol Surg. 1996;12:135–40.
11. Sheth SS. Vaginal hysterectomy. In: Arulkimaran S, editors. Best practice & research – clinical obstetrics & gynaecology UK. Vol. 19 (3), Elsevier; 2005. p. 307–332.
12. Sheth SS, Paghdiwalla KP, Hajari AR, Vaginal route: a gynaecological route for much more than hysterectomy. In: Arulkumaran S ed. Best practice & research – clinical obstetrics & gynaecology UK. Vol. 25 (2), Elsevier; 2011. p.115–132.
13. Sheth SS. Newer perspectives. In: Sheth SS, editor. Vaginal hysterectomy. 2 ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2014. p. 225–34.
14. Heaney NS. Vaginal hysterectomy – its indications and technique. Am J Surg. 1940;48:284–8.
15. Coulam CB, Pratt JH. Vaginal hysterectomy. Is previous pelvic operation a contraindication? Am J Obstet Gynecol. 1973;116:252–6.
16. Carpenter RJ, Silva P. Vaginal hysterectomy following pelvic operation. Obstet Gynecol. 1967;30:394–8.
17. Kovac SR, Cruiskshank SH, Retto HF. Laparoscopy-assisted vaginal hysterectomy. J Gynecol Surg. 1990;6:185–92.
18. Sheth SS, Allahbadia GN. Hysterectomy after previous abdominopelvic surgery. In: Sheth SS, Studd JWW, editors. Vaginal hysterectomy. London: Martin Dunitz Ltd.; 2002. p. 127–36.
19. Sheth SS. Access to vesicouterine and rectouterine pouches. In: Sheth SS, editor. Vaginal hysterectomy. 2 ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2014. p. 31–50.
20. Khung TTG. Use of Sheth's uterocervical broad ligament space for vaginal hysterectomy in a patient with history of caesarean section. Malaysian J Obstet Gynaecol. 1995;4:39–42.
21. Sizzi O, Rossetti A. Overcaming technical limits to laparoscopic hysterectomy. J Gynecol Surg Endoscopy. 2006. http://thetrocar.net/viewNew.asp?ID=7&IDArticolo=39.
22. Sheth SS. Vaginal hysterectomy in women with a history of 2 or more cesarean deliveries. Int J Gynecol Obstet. 2013;122:70–4.
23. Sheth SS. Vaginal route: primary route for hysterectomy. In: Mettler l, editor. Manual of new hysterectomy techniques. New Delhi: Jaypee Br.Med. Publishers (P) Ltd.; 2007. p. 14–24.
24. Sheth SS. A surgical window to access the obliterated posterior cul-de-sac at vaginal hysterectomy. Int J Gynecol Obstet. 2009;107:244–7.
25. Sheth SS. Vaginal dimple – a sign of ovarian endometriosis. J Obstet Gynecol. 1991;11:292.
26. Sheth SS, Goyal MV, Shah N. Uterocervical displacement following adhesions after caesarean section. J Gynecol Surg. 1997;13:143–7.
27. Sheth SS, Shah NM, Varaiya D. A sonographic and clinical sign to detect specific adhesions following caesarean section. J Gynecol Surgery. 2008;24:27–35.
28. Paterson-Brown S (on behalf of the Guidelines and Audit Committee of the Royal College of Obstetricians and Gynecologists). Placenta praevia and placenta praevia accreta: diagnosis and management. RCOG Guideline. 2005;27:1
29. Sheth SS. Adnexectomy for benign pathology at vaginal hysterectomy without laparoscopic assistance. Br J Obstet Gynecol. 2002;109:1401–5.

30. Sheth SS. Concomitant Salpingo-Oophorectomy at Vaginal Hysterectomy. In: Sheth SS, editor. Vaginal hysterectomy. 2 ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2014. p. 137–49.
31. Sanfilippo JS, Rock JA. Surgery for benign disease of the ovary. In: Rock JA, Jones HW, editors. Telinde's operativegynecology, vol. 1. 10 ed. Philadelphia: LippincottWilliams & Wilkins; 2008. p. 629–47.
32. Cohen SB, Wattiez A, Seidman DS, et al. Laparoscopy versus laparotomy for detorsion and sparing of twisted ischemic adnexa. JSLS. 2003;7:295–9.
33. Mage G, Canis M, Manhes H, Pouly JL, Bruhat MA. Laparoscopic management of adnexal torsion: a review of 35 cases. J Reprod Med. 1989;34:520–4.
34. Shalev E, Peleg D. Laparoscopic treatment of adnexal torsion. Surg Gynecol Obstet. 1993;176:448–50.
35. Sheth SS, Srinivasan R, Darda P. Twisted ovarian cyst treated via the vaginal route. Int J Gynecol Obstet. 2011;113:245–6.
36. American College of Obstetrician and Gynecologists. Clinical issues: vaginal hysterectomy often better option than abdominal. ACOG Today. USA: American College of Obstetricians and Gynecologists Bulletin. November/December. 2009:14.
37. Adanu RMK, Hammoud MM. Contemporary issues in women's health. Int J Obstet Gynecol. 2010;109:3–4.
38. ACOG. Appropriate use of laparoscopically assisted vaginal hysterectomy (Committee Opinion). Compendium of selected publication. Washington: The American College of Obstetricians & Gynecologists Women's Health Care Physicians. 2006:13–4.
39. Gayon-Vera E, Simon-Pereira LA. Vaginally assisted laparoscopic hysterectomy vs. abdominal hysterectomy initial experience. Ginecol Obstet Mex. 1999;67:164–8.

Comorbidities Associated with Vaginal Hysterectomy

115

Laila Najjari

The patients selected for vaginal hysterectomy (VH) often have similar concomitants which include Pelvic Organ Prolapse and an overall weakness of the connective tissue as well as adhesions and endometriosis. Further, there are general concomitants such as metabolic syndrome, age, smoking and thromboembolism.

Pelvic Organ Prolapse

One of the main indications of vaginal hysterectomy is Pelvic organ Prolapse (POP). The overall incidence to develop postoperative POP is 4.4 %; the risk to redevelop POP after VH is 11.6 % [1]. Risk factors for recurrent POP include age <60 years and more advanced prolapses [2].

We can differentiate different forms of prolapses depending on the respective location. A common location for a prolapse arising after VH is the anterior vaginal wall. The resultant cystocele can be divided into lateral and central defects (Fig. 115.1). Equally the posterior vaginal wall can be affected, thus causing a rectocele (Fig. 115.2). Enteroceles are quite rare in this context, the incindence is around 1 %.

Finally, vaginal vault prolapses can occur, especially when the vault has not been appropiatley fixed to the uterosacral and cardinal ligaments. In order to prevent a prolapse, studies have shown that suspension of the vaginal apex to the uterosacral ligaments (McCall culdoplasty) or to the sacrospinous ligaments at the time of vaginal hysterectomy is efficient [3].

Urinary Incontinence

Women selected for VH often already suffer preoperatively from urinary incontinence. These women, mostly complaining of urge incontinence, often find that their symptoms improve after the operation due to the absence of the uterus which was formerly applying pressure onto the bladder. Other patients however, experience symptoms of stress incontinence after the operation. These can evolve for two different reasons: either the urinary stress incontinence was

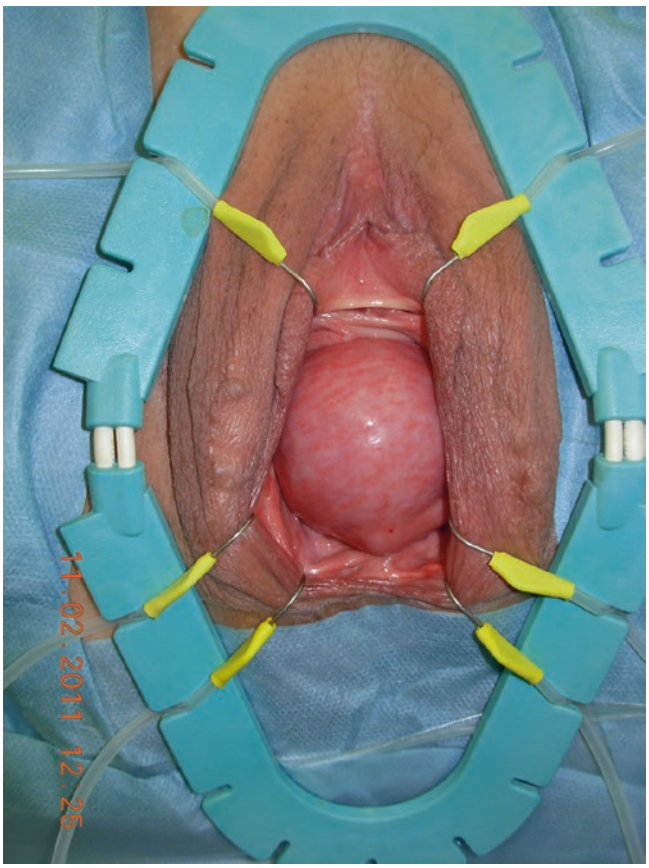


Fig. 115.1 Cystocele, central defect (4.88 × 6.79 cm)

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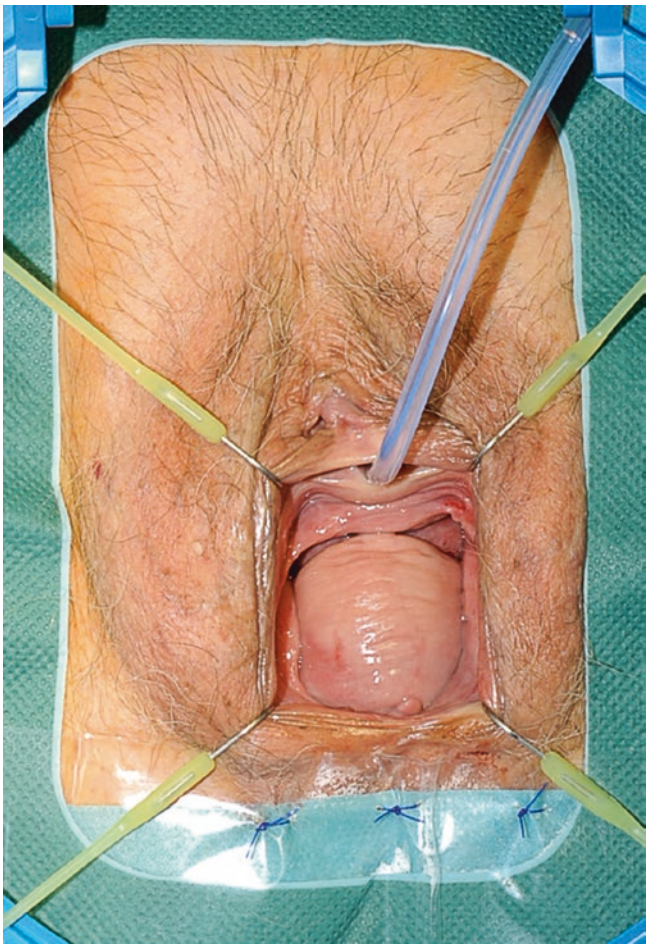


Fig. 115.2 Rectocele (4.88 × 6.79 cm)

there beforehand, this would be a masked incontinence which became symptomatic after the operation, or a de novo stress incontinence which developed due to VH.

Further voiding disorders appearing after VH include dysuria, nycturia and frequent urination.

Vesicovaginal Fistula

Vesicovaginal fistulas are rare with an incidence between 0–0.2 %. They can result from any damage caused to the bladder during the operation. Complaints normally arise around 5–10 days later and can be detected by vaginal inspection or imaging methods such as Cystoscopy, CT, MRT. Treatment normally consists of an early operational closure of the fistula. Depending on its diameter, flaps e.g. from the deep fatty tissue of the labias can be necessary.

Granulation Tissue

Granulation tissue at the end of the vaginal cuff develops quite frequently after vaginal hysterectomy. It is a harmless wound healing disorder and occurs in over 50 % if the vaginal cuff is left open, rarely however if the cuff is closed. The usual treatment is cauterization with silver nitrate. Studies have shown however, that lesions smaller than five millimeters rarely have to be treated as most regress spontaneousley [4]. A rare differential diagnosis is a prolapse of the tubes.

Cysts

Cysts can develop from vaginal epithelium in the vaginal cuff.

Dyspareunia

Dyspareunia can arise from a short, scarred vagina, or a deviation of the vagina, resulting from the closure of the vaginal cuff.

Post-hysterectomy Syndrome

This syndrome shows effects like psychosexual problems and depressions but also symptoms like hot flushes, headaches, dizziness and extreme postoperative tiredness. Most of these symptoms are attributed to a dysfunction of the ovaries but are influenced by psychological, social and cultural factors. To prevent this syndrome a thorough preoperational discussion is essential. Early studies (Richards 1974) have described post-hysterectomy syndrome in up to 70 % of patients. More recent prospective studies however, have found that the postoperative general mood has improved [5].

Dysfunction of the Ovaries

Damage of the ovaries during the operation (e.g. by too much traction) can result in dysfunction. An early menopause can arise from this as well as changes in the lipid and bone metabolism. A topic that is discussed very controversially in this context is the question if removement of the tubes can also cause ovarial dysfunction. Specialists supporting this thesis fear that by removing the tubes the blood supply could be

impaired and thus cause a dysfunction of the ovaries. On the other hand, there is also the opinion that if the right technique is applied, blood supply shouldn't be reduced [6].

Chronic Pelvic Floor Pain

This is defined as vague pain in the lesser pelvis which lasts longer than 6 months. It is rarely treatable.

Pelvic Infection

Vaginal hysterectomy is generally associated with fewer infections than abdominal hysterectomy or laparoscopic hysterectomy. Pelvic infection however, occurs more often in connection with VH than with AH or LH [7].

Removement of Fallopian Tubes

As normally the adnexa are not removed during vaginal hysterectomy, an opportunistic salpingectomy for cancer prevention is not possible. Currently, there is no significant data to say if removal of the fallopian tubes has a protective effect against the development of ovarian or endometrial cancers, so it is not clear if vaginal hysterectomy goes hand in hand with higher risk for cancer [8].

Morcellation

Because morcellation is associated with the spreading of cellular material, it is essential to rule out any malign tumors before morcellation. It has been shown that intra-abdominal morcellation of an unseen leimyosarcoma can correlate with a higher recurrence rate and worse prognosis [9]. The international consensus (SGO [10], FDA [11], ACOG [12], AAGL [13], ESGE [14]) is firstly, that the patient should be thoroughly informed about morcellation, the advantages of this technique, the potential risk of spreading cellular material and any alternatives and secondly, that any uterus with suspicion of malignity should not be morcellated.

References

1. Karram et al. Am J Obstet Gynecol. 2001;185:1339 (Elliott DS. Diagnosis and management of apical prolapse. Humana Press Inc. 2007; Webb MJ et al. Obstet Gynecol 1998).
2. James L, Whiteside MD, et al. Risk factors for prolapse recurrence after vaginal repair. Am J Obstet Gynecol. 2004;191:1533–8.
3. Segev Y, Auslander R, et al. Post hysterectomy vaginal vault prolapse: diagnosis prevention and treatment. Harefuah. 2008;147(5): 406–12. 478
4. Saropala N, Ingsirorat C. Int J Gynecol Obstet. 1998;62:1–116.
5. BJOG. Int J Obstet Gynaecol. 1991;98(11):1129–36. doi:10.1111/j.1471-0528.1991.tb15365.x.
6. http://www.frauenheilkunde-aktuell.ch/frauenheilkunde-d/PDF-Ordner-FHA-Frauenheilkunde-aktuell/Frauenheilkunde-Aktuell-Ausgabe-12-01/FHA-Artikel_Pro-und-Contra.pdf. (FHA, 21/1/2012); Stand: 21.09.15.
7. Brummer TH. FINHYST, a prospective study of 5279 hysterectomies: complications and their risk factors. Hum Reprod. 2011;26(7):1741–51. doi:10.1093/humrep/der116. First published online: 3 May 2011
8. Pölcher M, Hauptmann S, Fotopoulou C, et al. Should fallopian tubes be removed during hysterectomy procedures? – A statement bei AGO Ovar. Geburtshilfe Frauenheilkd. 2015;4:339–40.
9. Bogani G et al. Gynecol Oncologia. 2015;137:167–72.
10. Society of Gynecologic Oncology. SGO position statement: morcellation. Online: https://www.sgo.org/newsroom/position-statements-2/morcellation/. Stand:15.07.2014.
11. U.S. Food and Drug Administration. Updated laparoscopic uterine power morcellation in hysterectomy and myomectomy: FDA safety communication. Online: http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm424443.htm; Stand: 24.11.2014.
12. American College of Obstetricians and Gynecologists. Power morcellation and occult malignancy in gynecologic surgery. Online: http://www.acog.org/Resources-And-Publications/Task-Force-and-Work-Group-Reports/Power-Morcellation-and-Occult-Malignancy-in-Gynecologic-Surgery; Stand: 15.07.2014.
13. AAGL Advancing Minimally Invasive Gynecology Worldwide. AAGL practice report: morcellation during uterine tissue extraction. J Minim Invasive Gynecol. 2014;21:517–30.
14. Brölmann H, Tanos V, Grimbizis G, et al. Options on fibroid morcellation; a literature review. Gynecol Surg. 2015;12:3–15. doi:10.1007/s10397-015-0878-4.

Vaginal Total Hysterectomy in Benign Indications: Hysterectomy Techniques in the Normal-Sized Uterus

116

Michael Stark and Dragan Belci

Introduction

Vaginal hysterectomy was introduced already by Langenbeck in 1813 [1], and over the years many different methods were described, such as the Heaney [2], Porges [3], Falk [4], von Theobald [5], Joel-Cohen [6] methods, and the Chicago technique [7], which is a variation of the Heaney method. Each of these methods became the origin of many variations, and in certain hospitals local traditions prevailed.

Vaginal hysterectomy was developed prior to the introduction of antibiotics, and it became very popular in German-speaking countries. With accumulated experience, surgeons became able to remove uteri without prolapse and with large size [8].

For many years, different rates of abdominal or vaginal hysterectomies were performed in different institutions according to local experience and developing traditions. All this changed when endoscopy was introduced and with it the laparoscopic trend of hysterectomy [9].

These days, less vaginal hysterectomies are performed, and in countries with limited resources, where endoscopy has not yet been introduced, hysterectomies are mostly done abdominally.

Many comparisons are made between vaginal and abdominal hysterectomy. In many studies, the outcomes of both methods are compared, but mostly without detailed description of the operative steps.

Obviously, outcomes of surgeries performed by different surgeons and in different hospitals cannot be compared to each other unless the clinical profiles of the study groups (age, weight, size of the uterus, indication etc.) are similar and exactly the same techniques are used by surgeons with a similar level of experience [10].

In each operation, even minor variations can be reflected in big outcome differences. This includes the use of prophylactic antibiotics, the types of anaesthesia and analgesics, suturing or non-suturing of the peritoneum, etc.

Therefore, each step in each operation should firstly be evaluated for its necessity and, if applicable, for its optimal way of performance.

In the last years, many methods were developed in order to reduce the necessity for hysterectomy. These are focused ultrasound [11], the use of GNRA analogues [12], cryomyolysis [13] and microwave treatment of the endometrium [14].

Also the use of abdominal hysterectomy in developed countries has been reduced since it was partially replaced by laparoscopically assisted vaginal hysterectomy. However, in a randomised prospective study, no difference between vaginal hysterectomy and laparoscopically assisted vaginal hysterectomy was found concerning estimated blood loss, postoperative complications and convalescence. The costs of laparoscopically assisted vaginal hysterectomy, however, are considerably higher [15].

Due to all these considerations, it is important to revisit the traditional vaginal hysterectomy in normal-size but also in fibroid uteri and in uteri with or without prolapse in order to find out if this operation can still be simplified and optimised. This chapter is dedicated to normal-sized uteri with or without prolapse, however the principles which are described apply for larger uteri as well.

The Ten-Step Vaginal Hysterectomy

In the line of the idea to find out which steps are essential, six different methods in use were analysed for their way of performance. It became obvious that the number of steps (14–20) as well as their sequence during the operation was different. Only 12 steps were common to all the methods, and therefore they were obviously the most essential. Two of

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them, the separate handling of the sacro-uterine ligaments as well as the closure of the peritoneum, were considered unnecessary and were abandoned by us. The remaining ten steps were critically examined for their optimal way of performance, and the restructured operation, as will be described later, has been subject to prospective studies in Italy, Croatia and Bangladesh. In all these studies the Heaney method served as the point of reference for the sake of standardisation. In the Heaney method, after circumcision of the cervix or, in case of cystocele, an inverted c-incision is done and the excess vaginal wall is excised. The anterior peritoneum is opened (occasionally, when technical difficulties occur, the posterior one is opened first). The sacro-uterine ligaments are clamped and sutured and thereafter the lower part of the broad ligament. The uterine arteries are clamped, sutured and cut, followed by the handling of the upper part of the parametrium and the ovarian ligaments. After removal of the uterus, a suture is passed through the anterior vaginal cuff in order to pick up the anterior fold of the peritoneum. The peritoneum is closed and the sacro-uterine ligaments are fixed to the vaginal vault and then tied together to obliterate the cul-de-sac. The rest of the vaginal vault is closed with interrupted sutures.

All the studies comparing the ten-step vaginal hysterectomy to the Heaney method show that the ten-step vaginal hysterectomy results in shorter operation time with reduced need for analgesics and earlier mobilisation.

Method Description

The following description of the ten-step vaginal hysterectomy includes the logic behind the steps and the optimal way to perform them next to the instruments needed for each step.

In many institutions, vaginal hysterectomy is performed in presence of a certain degree of prolapse, and some surgeons prefer the vaginal route in absence of prolapse using the laparoscopically assisted vaginal hysterectomy (LAVH). The ten-step vaginal hysterectomy, however, is suitable for prolapsed as well as non-prolapsed uteri because every non-prolapsed uterus will become prolapsed after completion of step 4.

Positioning of the Patient and the Surgeon

Optimally, the surgeon performing vaginal hysterectomy sits in front of the patient while the assistant stands on his left side. The right-handed surgeon should have access with his right hand to the instrument tray, and the nurse should stand behind him on his right side. Some surgeons prefer working with two assistants, which is not really necessary but enables young gynaecologists to become more familiar with the operative method. The assistant's task is to enable good exposure (Fig. 116.1), help in haemostasis and pull the ligaments when necessary.

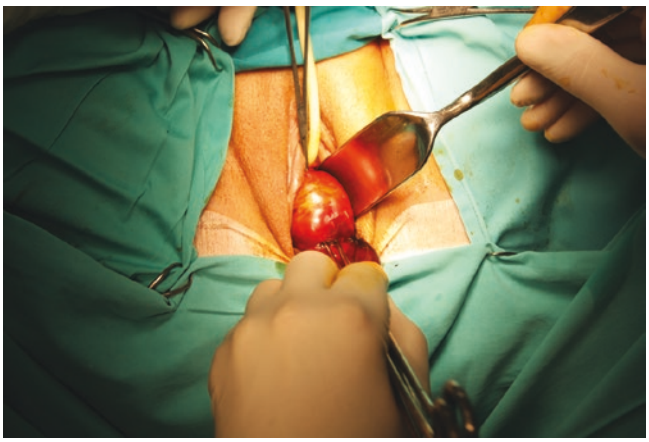


Fig. 116.1 The exposure of the cervix by the assistant

Step 1: Incision of the Vaginal Wall

In a Patient Without Prolapse

The cervix is grasped with two single-toothed tenaculi, and in case of a non-prolapse uterus, the left parametrium is massaged while pulling the tenaculi down in order to get better access. A circular incision is made around the cervix, a few millimetres above the external os. When the right cleavage is reached, the vaginal wall is separated from the cervix, just by pushing it up using a surgical forceps or a swab. The anatomical conditions among women can vary, and occasionally more vaginal retractors are needed in order to expose the cervix to the surgeon. This step should be done under optimal vision.

In a Patient with a Prolapse

Traditionally, most of the described methods begin with a circular incision around the cervix. Thereafter, the vaginal wall is incised vertically toward the orificium urethrae externum. Allis clamps or forceps grasp the edges of the vertical incision and gently the vaginal wall is separated from the bladder by lifting the vaginal wall up and pushing the bladder wall down using a swab on the finger, occasionally assisted by round-tip scissors. Thereafter, the redundant vaginal wall is cut away, leaving a free triangle with its basis on the cervix and its apex below the orificium urethrae externum. After making sure to be in the right cleavage, the scissors are pushed between the bladder and the vaginal wall, with their tips pointing toward the vaginal wall, and then the scissors are opened and pulled out. If performed in this way, this step is bloodless. The figures shown in this article represent a uterus with the prevalent grade II prolapse.

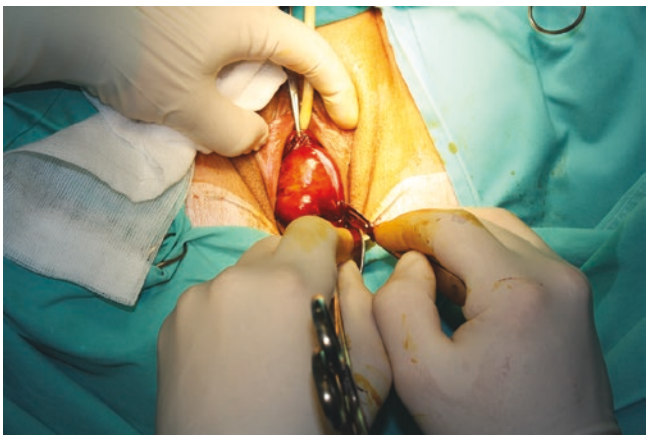


Fig. 116.2 A droplike incision of the vaginal wall starts under the external orifice of the urethra

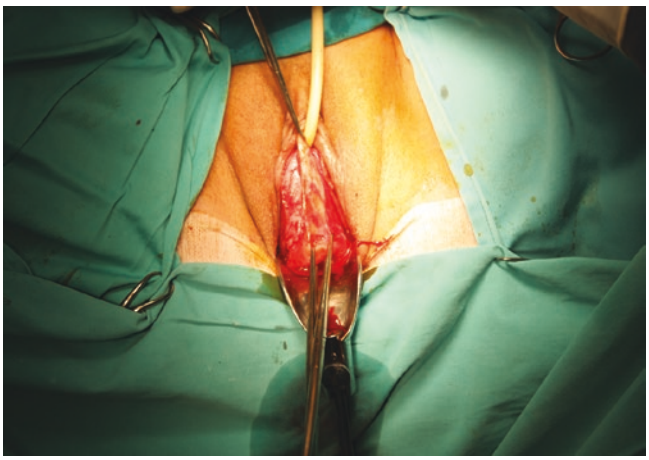


Fig. 116.4 Grasping and lifting the tip of the incised vaginal wall

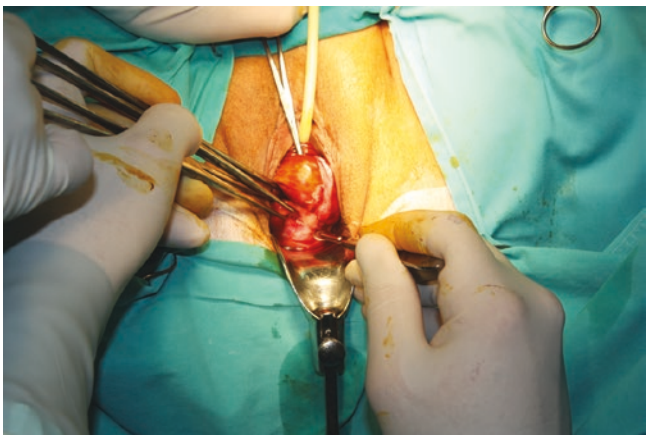


Fig. 116.3 Continuation of the droplike incision behind the cervix



Fig. 116.5 In case of adhesions, using Metzenbaum scissors is needed to separate the vaginal wall from the bladder

Other methods start the separation undermining the vaginal wall after the transverse incision before extending the incision cranially. All variations were analysed, and the simplest and easiest method is the one described by Joel Cohen [6]. In this method, the separation of the vaginal wall starts below the orificium urethrae externum (Fig. 116.2), continuing droplike lateral and caudal around the external os (Fig. 116.3), returning on the other side mediocranial until reaching the starting point.

This approach seems to be easy and logic, mainly in multiparae, where sometimes there are adhesions around the external os and entering the right cleavage when starting from above the cervix might be difficult and there is even a risk of penetrating the bladder.

Now the tip of the triangle is grasped (Fig. 116.4) and pulled toward the surgeon, exposing the lower part of the uterus. Sometimes, adhesions are found around the cervix, and Metzenbaum scissors are needed to separate the vaginal wall from the bladder (Fig. 116.5).

Instruments

Speculum, two single-tooth tenaculi, scalpel, surgical forceps.

Step 2: The Detachment of the Bladder from the Uterus

The border between the wall of the uterus and the bladder must be identified before starting to separate them. A cleavage exists between both structures, and pushing the bladder up without entering it might cause damage. When the right cleavage is identified, the bladder is pushed up with a swab (Fig. 116.6) will separate it from the uterus and also from the lateral vaginal walls. The bladder should be pushed until the anterior peritoneum is exposed. Opening the anterior peritoneum in this stage is not recommended, not just because this disturbs the dynamics of the operation but also because it might cause damage to the bladder when the inter-anatomical relations are not completely clear due to adhesions resulting from previous operations.

Instruments

Allis clamp, scalpel, occasionally scissors.

Step 3: Opening the Posterior Peritoneum

In prolapsed as well as in non-prolapsed uteri it is usually easy to identify the posterior peritoneum, as it is movable over the posterior aspect of the lower part of the uterus and therefore easily movable using surgical forceps. The tenaculi holding the uterus should be pulled up and after making sure that the posterior peritoneum has been correctly identified it should be opened with the tip of a pair of scissors (Fig. 116.7). It is recommended to use long scissors with curved tips like the Metzenbaum scissors, and after cutting the peritoneum the closed scissors should be inserted into the pouch of Douglas, while their tips point towards the uterus. The handles should be opened with two hands and pulled out while the assistant elevates the cervix. Doing so, the insertions of the sacro-uterine ligaments will be exposed. There is no risk of bleeding as there are no blood vessels in the vicinity.

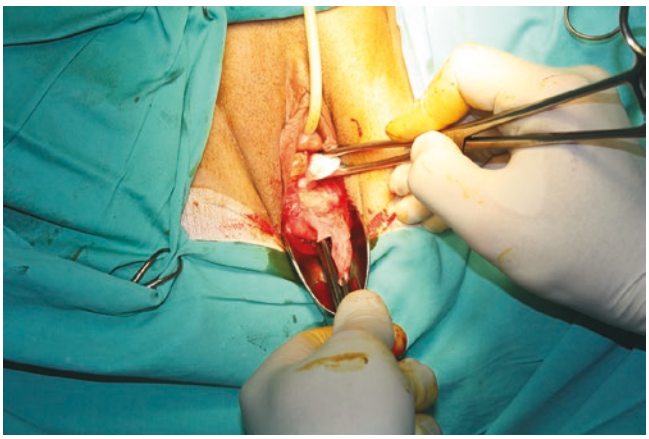


Fig. 116.6 Using a swab the surgeon pushes the bladder up, separating it from the anterior wall of the uterus

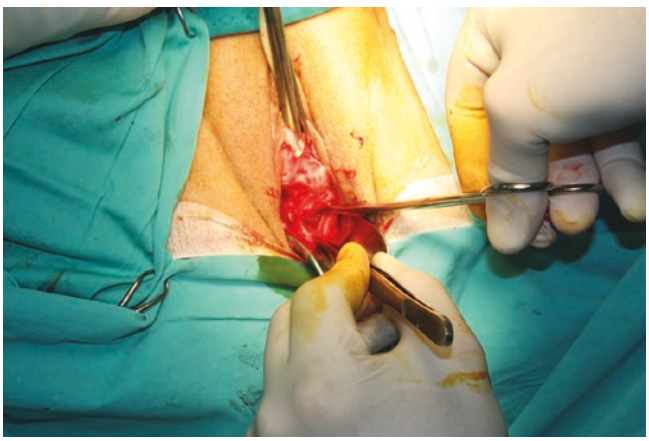


Fig. 116.7 Lifting the uterus up, grasping the peritoneum with surgical forceps and opening it

Instruments

Two tenaculi, cervical forceps, scissors.

Step 4: Dissection of the Lower Part of the Uterus

Conrad Langenbeck as well as his followers used an anatomy-based surgical approach. Therefore each anatomical structure during vaginal hysterectomy was dealt with separately. The sacro-uterine ligaments were firstly clamped, cut and sutured followed by clamping the lower paracervical tissues.

Our approach is functional. The sacro-uterine ligaments are not rich in blood vessels and, although in different anatomical plains, can be clamped together with the paracervical tissues (Fig. 116.8). This is done by a designed manoeuvre when one blade of an open Heaney clamp is placed beneath the insertion of the sacro-uterine ligament (lifting the clamp will assure the surgeon that he is in the right location), and the uterus, still held with the two tenaculi, is rotated toward the clamp while the clamp rotates toward the uterus; doing so, both structures are clamped together. The same is repeated on the other side (Fig. 116.9). A suture is placed as medial as possible, taking both structures, the sacrouterine ligament and the paracervical tissue together. The suturing material is kept long until the end of the operation (Fig. 116.10).

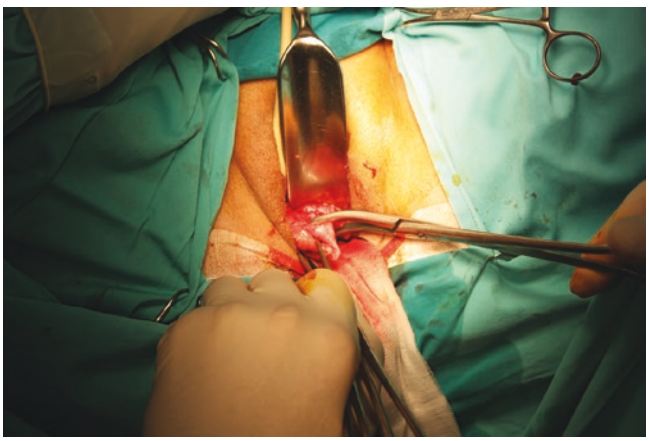


Fig. 116.8 Grasping both sacrouterine ligament and paracervical tissue with one instrument

Cutting both structures will transform any non-prolapsed uterus into a prolapsed one. After the ligation and removal of the Heaney clamp the uterus can be pulled gently to ascertain the access to the uterine arteries. Occasionally in nulliparae or in women with a long cervix an additional step should be made. From this stage and onward no significant difference between prolapsed and non-prolapsed uteri exists.

In the methods based on anatomical structures, anyhow the sacro-uterine ligaments and the parametrium will be sutured together at the end of the operation.

Instruments

Heaney clamp, needle holder, surgical forceps, scissors, two sutures.

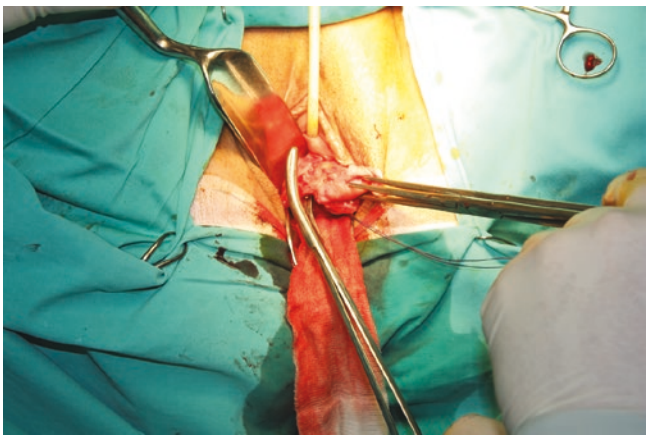


Fig. 116.9 While rotating the uterus toward the Heaney clamp, the sacrouterine ligament and the paracervical tissues of the right side are clamped together

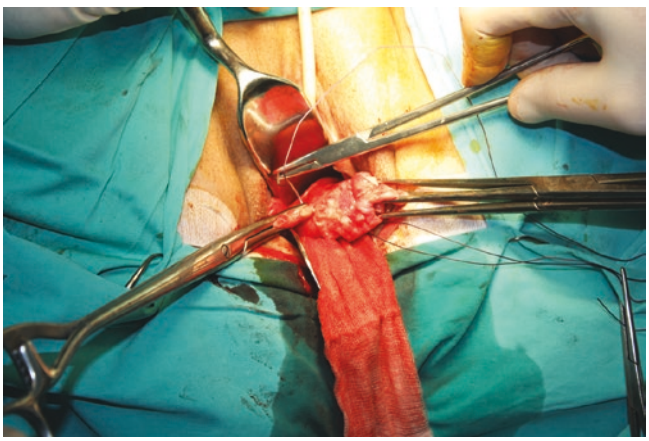


Fig. 116.10 Both structures, the sacrouterine ligament and the paracervical tissue, are sutered together; the thread is left long for the final stage

Step 5: Cutting and Ligating the Uterine Arteries

Pulling the uterus gently, both uterine arteries will be easily exposed. It is very important to identify them, and then to clamp, cut and double-ligate them (Fig. 116.11).

Instruments

Heaney clamp, needle holder, scissors, two sutures.

Step 6: Opening the Anterior Peritoneum

The uterus is pulled down while being slightly rotated. At that stage, with small uteri the fundus can easily be luxated posteriorly and the surgeon can introduce a finger of his left hand behind the fundus in order to lift the anterior peritoneum. It is important that he identifies the peritoneum and reassures himself about the position of the bladder. The peritoneum opens usually during this manoeuvre and under direct vision, and rarely scissors are necessary to cut it (Fig. 116.12). In any operation, each step should be done under direct vision. This applies also to the opening of the anterior peritoneum. Therefore, without or with adhesions which result from previous surgeries, this is the optimal and only method which should be used to open the anterior peritoneum.

This chapter deals with hysterectomy in normal-size uteri, but rotating the uterus and pulling it down can be very helpful also in bigger uteri. And with gained experience, morcellation of the uterus becomes unnecessary. In general, even bigger uteri should not be an absolute contraindication for vaginal hysterectomy.

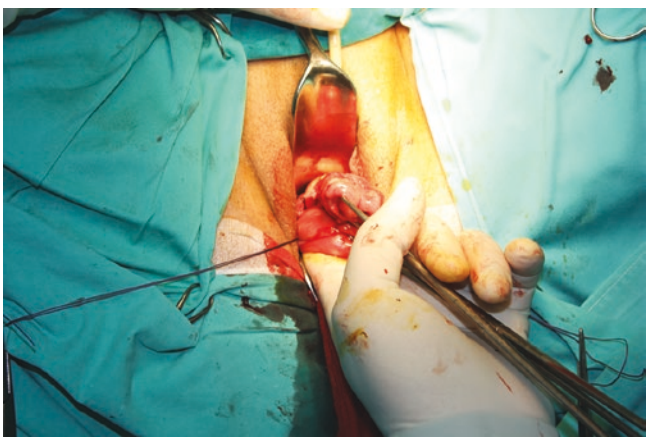


Fig. 116.11 After cutting the uterine arteries, a double suturing is done

Instruments

Scissors (occasionally).

Step 7: Dissection of the Upper Part of the Uterus

The round and ovarian ligaments are clamped together and ligated (Figs. 116.13 and 116.14), while the ligature is placed as lateral as possible from the clamp, leaving the ovarian ligaments as long as possible. While tying the ligature, the Heaney clamp should be gently opened and closed again. This will ensure that the blood vessels will be tied properly (Fig. 116.15). The uterus is now cut away from the ligaments medially from the instrument, and the stump is now transfixed laterally from the instrument and medially from the first ligature. This will prevent bleedings and the ligature guarantees no bleeding in case the transfixion loosens, and the needle should be inserted only after the ligature and after removal of the uterus in order to prevent occasional bleeding in the parametrium (Figs. 116.16, 116.17, and 116.18). The uterus can now be removed, and if oophorectomy is indicated, it can be followed by double clamping the ovarian arteries before removal of the ovary. Oophorectomy often needs more experience and should always be done under vision.

Instruments

Heaney clamp, scissors, needle holder, surgical forceps, four suture materials.

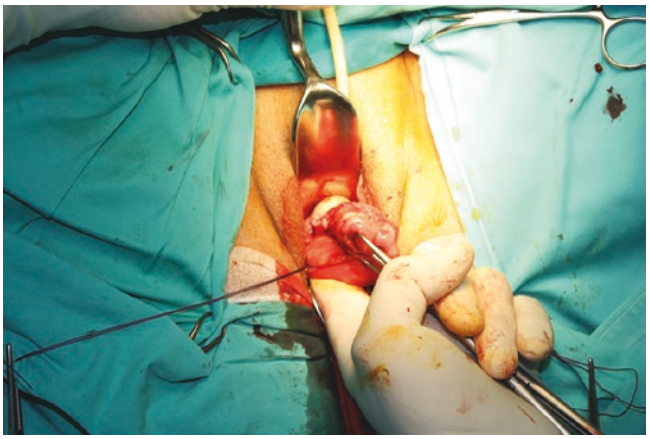


Fig. 116.12 The surgeon inserts his finger behind the uterus lifting the anterior peritoneum and penetrating it

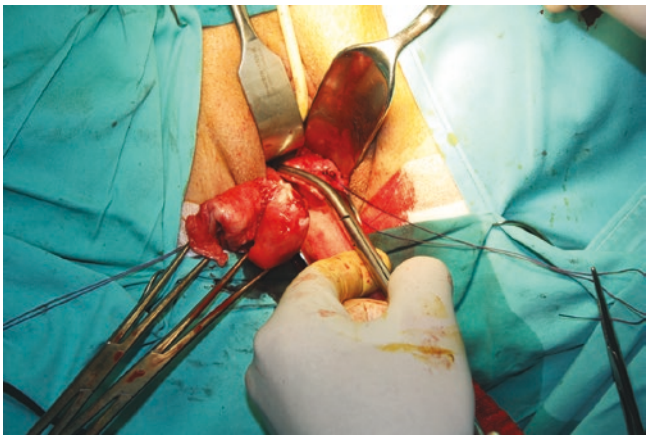


Fig. 116.14 The round and ovarian ligaments are cut and ligated

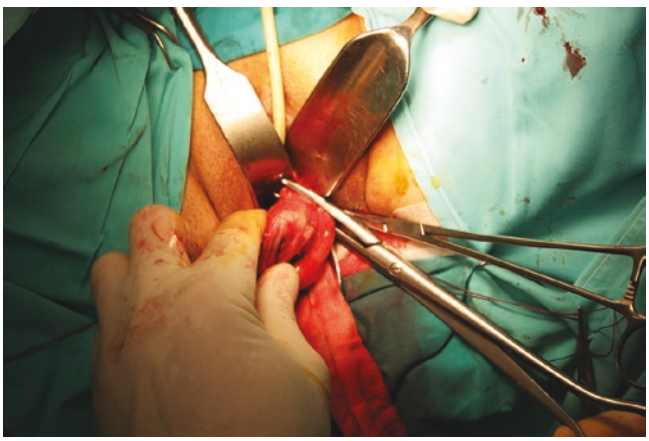


Fig. 116.13 The round and ovarian ligaments are clamped together and ligated

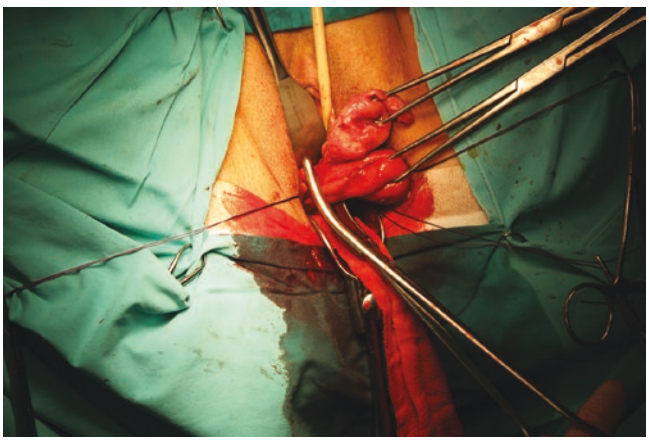


Fig. 116.15 A suture is made first around the ligaments in order to prevent bleeding

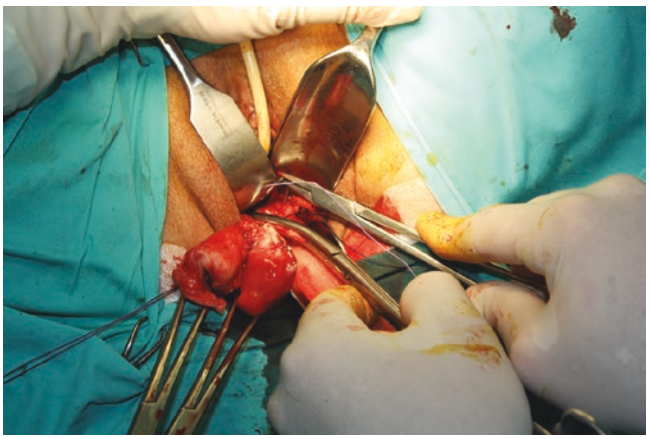


Fig. 116.16 The needle is inserted medially to the ligature in order to prevent haematoma in the parametrium



Fig. 116.17 After removing the uterus, the needle is inserted between the ligature and the Heaney clamp

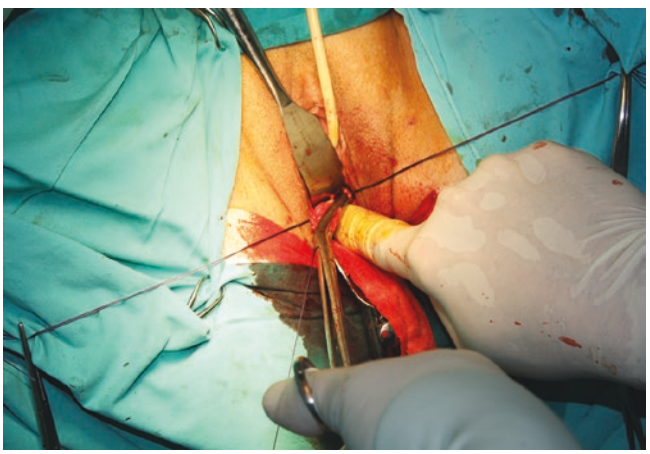


Fig. 116.18 Suturing both the round and ovarian ligaments leaving the suture long

Step 8: The "Non-stage": Leaving the Peritoneum Open and Correcting the Anatomy

In 1980, Harold Ellis suggested that closing the peritoneum is unnecessary. When left open, a new peritoneum will form within days from the coelum cells. Vascular bridges, when the peritoneum is sutured, are formed over sutures and are focus for ischemia and adhesions. In caesarean section, leaving the peritoneum open proved to result in less adhesions [16], and it was shown that its closure is not necessary in vaginal hysterectomy. The British Royal College of Obstetrics and Gynaecology recommended to leave the peritoneum open in its guideline no. 15 of July 2002 with evidence level Ib.

The pelvic parietal peritoneum follows and covers the pelvic ligaments. As will be seen later in step 9, at the end of the operation the ligaments are tied together bringing together the edges of the peritoneum. Leaving the peritoneum open is also an advantage for the free drainage into the peritoneal cavity, where blood can be absorbed by the peritoneum and the lymph channels.

Now is the time to reconstruct anatomy in case of the existence of enterocoele before the continuation of the operation [17].

Step 9: Reconstruction of the Pelvic Floor

The left and right sutures holding the sacro-uterine ligaments together with the paracervical tissues as well as the sutures of the ovarian ligaments are ligated to each other respectively (Figs. 116.19 and 116.20). Sometimes, according to individual anatomical conditions, an extra suture may be necessary to join the ligaments together.

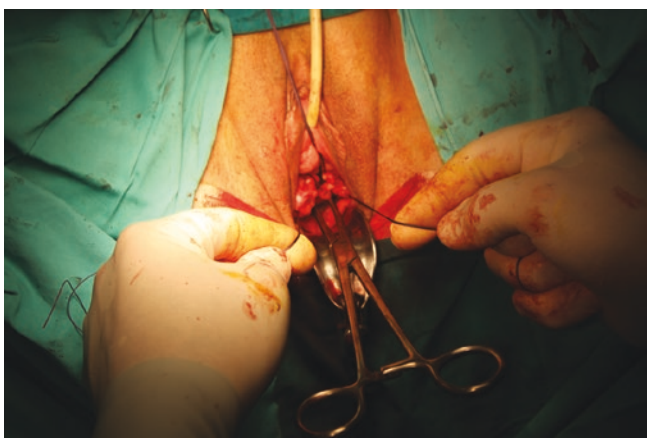


Fig. 116.19 The ovarian ligaments are sutured to each other

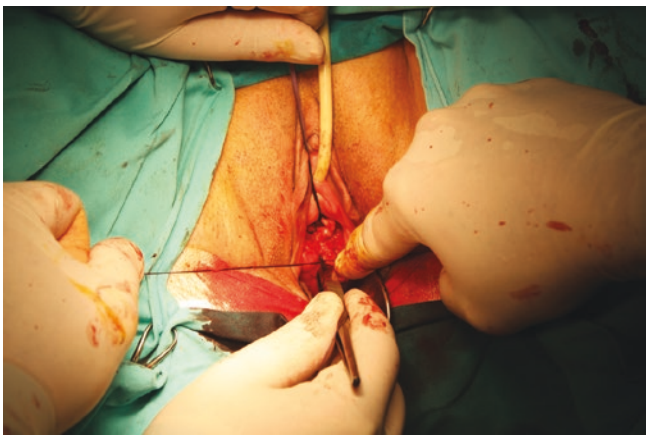


Fig. 116.20 The sacrouterine ligaments and the paracervical tissues are sutured to each other

Instruments

Scissors, needle holder, surgical forceps, one suture (optional).

Step 10: Closing the Vaginal Wall

The vaginal wall should be sutured continuously. In a sexually active woman, it is recommended to suture the vagina transversely. This might prevent dyspareunia, because the suture line will be placed on the upper side of the anterior wall.

Instruments

Allis clamp, needle holder, surgical forceps, scissors, one suture.

Discussion

Each new or modified surgical method should add value to existing ones. In an extensive literature research using Pubmed, there are studies comparing laparascopic and abdominal, or vaginal hysterectomies [18] but no single comparison between different techniques of vaginal hysterectomies was found, in contrast to other surgical methods like caesarean section, where the operation outcomes following different operative details like the way the uterus is opened are compared [19]. The reason is probably the insistence of some surgeons and institutions to adhere to local traditions. Sometimes many variations are made by different surgeons in one hospital. This is the reason why no valid comparison is possible, because results of different methods can only be compared when the surgical steps have been standardised [10].

In the time-honoured abdominal or endoscopic hysterectomy, the surgeon benefits from direct vision of the anatomical structures. The round ligaments, the plica of the bladder, the uterine arteries and the sacro-uterine ligaments are visible during the operation, and the surgeon can and should localise the course of the ureters, and in case of radical surgery be able to open the ureteric canals under vision.

In vaginal hysterectomy, however, a precise knowledge of the anatomy is of utmost importance. The anatomical structures should never be grasped, ligated or cut without being visualised first, but the surgeon must be aware of their location and know how to define them in normal-sized as well as in myomatous uteri, where the anatomy might be distorted.

Therefore, it is optimal that vaginal hysterectomy should be performed by surgeons who are already familiar with different methods of performing hysterectomy.

It is recommended that vaginal hysterectomy should not be part of the first stages of surgical training because the young surgeon has to become familiar at first with the topographic anatomy and its variation, but when he starts operating, it should be under guidance of an experienced surgeon. It is important to start with easy cases where the uterus is relatively mobile and with experience more difficult cases can be performed. The exposure of the surgical field is the key for good orientation and success. Paradoxically, sometimes it is easier to operate nulliparae than multigravidae, where the vaginal walls are relaxed and block the sight. An experienced assistant will be able to guarantee a good exposure.

Until the development of endoscopy, most gynaecologists were trained to do abdominal hysterectomy. Endoscopy opened a new era, firstly because today surgeons can be trained using simulators before starting to operate, and secondly, the tying and haemostasis are done completely differently, and therefore the skills acquired in training are different. Indeed, coagulation can be used also in open surgery, but suturing is done completely differently, and young surgeons that started their training with endoscopic operations do not have the same skills as older surgeons who started their career with open surgery. Indeed, some vaginal surgeons use similar equipment for vessel sealing, like LigaSure, and certain vaginal hysterectomy techniques were developed based on this equipment [20].

Optimally, vaginal hysterectomy should be performed using simple techniques which can be repeated in developed countries in well-equipped facilities as well as in countries with limited resources.

The vaginal hysterectomy for a normal-size uterus can be also used in combination with laparoscopic lymphadenectomy in the Schauta operation [21], can be done partially

using the laparoscopically assisted vaginal hysterectomy [22], but also when using this approach knowledge of the topographic anatomy is important.

One of the main problems are bleedings occurring during the surgery. During the circumcision of the cervix and/or separating the bladder from the body of the uterus, bleedings are not significant and can be easily controlled under direct vision. Bleedings from the uterine arteries after non-optimal ligature, however, are dangerous and difficult to control as the source of the bleeding is usually difficult to determine. It is therefore important that an experienced vaginal surgeon will perform the operation or assist a younger surgeon. Usually, the pulling down of the sacro-uterine ligament and the exposition of the anterior part of the uterus will help to locate the origin of the bleeding. An optimal technique to expose the origin of the bleeding is pulling back the sacro-uterine ligament and pushing up the ovarian ligament. Doing so, a distension of the parametrium occurs, and the stump of the artery becomes visible. Sometimes just the pulling will diminish or even stop the bleeding, which will resume when the tension is relieved. Therefore, the pulling should be done gently with optimal visibility and a good light source.

Re-suturing of the uterine arteries should be done very precisely, keeping in mind constantly the location of the ureter and avoiding the inclusion of any other structure. After separating the sacro-uterine ligament as well as the uterine arteries, together with the paracervical tissues, which include the parametrium, usually the uterus becomes mobile and can be pulled down easily by gently pulling while rotating the cervix.

Separating the sacro-uterine ligament and the paracervical tissues might be difficult for an unexperienced surgeon, but once it becomes customary, there is no obvious difference between prolapsed and non-prolapsed uteri and the ligation of the upper parts becomes easy in both cases.

Oophorectomy, when indicated, should be done by an experienced surgeon with long instruments, with the necessity to make secure suturing in the depth, which also implies the risk of including within the instrument other structures. It is very important to perform this stage only under good vision. It is not a shame to convert the operation to an endoscopic one even in this stage in case of an existing indication for oophorectomy but with technical difficulties to perform it.

When the first study was done comparing two standardised surgical methods for vaginal hysterectomy, the Heaney and the ten-step methods, the result was shorter operation time with reduced need for analgesics (Table 116.1). No variations were tolerated, and if they occurred they were excluded from the study. Due to its simplicity, the fact that only ten instruments and ten suture materials are needed makes this operation optimal also for countries with limited resources, as was shown by a prospective study which was carried out in Bangladesh (Table 116.2a, b). This method is now distributed in Africa, where it has been proven as a valid alternative to abdominal hysterectomy where endoscopy is not available, and even as an alternative for endoscopy where it is available.

One of the main advantages of this method is the ability to perform it using peridural rather than general anaesthesia. This is safer and simple to perform and reduces the need for analgesics in the first hours after surgery.

Table 116.1 Prospective, randomised comparison of vaginal hysterectomies performed by the Heaney and the ten-step vaginal hysterectomy methods [23]

	Heaney method *n* = 52 Median (25th–75th percentile)	Ten-step Vaginal hysterectomy *n* = 44 Median (25th–75th percentile)
Age (Years)	61.6(46–75.9)	66.2(53–77)
Operation time (min)	52.3(23.3–90)	34.1(20.5–50)[a]
Pain killers needed (h)	48.7(19–86)	29.6(8–75)[a]
Average hospital stay (range)	5.8(4–8)	5.9(4–8)

The data were stored in a database. The evaluation was done using SPSS for Windows. Frequencies and standard differences were calculated as mean variations

Chi square analysis was used

[a]Statistically significant difference ($P < 0.05$)

Table 116.2 Comparison between the Heaney method and the ten-step vaginal hysterectomy [24]

A. Demographics of the patients

Characteristics	**Heaney's method (n = 54)**	**Ten step vag. hyst. (n = 56)**	
Age	55.6(45–70.4)	56.1(46–71.6)	
Parity	5.25(4.0–8.0)	5.5(5.0–9.0)	
Non Prolapse	2(3.7 %)	2(3.5 %)	
Prolapse-I	5(9.2 %)	4(7 %)	
Prolapse-II	46(85 %)	47(84 %)	
Prolapse-III	1(1.9 %)	1(1.8 %)	

B. Comparison of the heaney methods and ten-step vaginal hysterectomy

Characteristics	**Heaney methods N = 54**	**Ten-step vag. hyst. N = 56**	**P–value (P < 0.05)**
Age (Years)	55.6(45–70.4)	56.1(46–71.6)	P > 0.05(NS)
Operation time (min)	52.5(30.2–90)	30.2(23.5–45.0)[a]	P > 0.05(NS) P < 0.05
Average blood loss (ml)	400(200–600)	80–(30–200)[a]	P < 0.05
Uterine weight (gm)	210(180–300)	215(175–320)	P > 0.05(NS)
Pain Killers needed (days)	5.8(4.0–8.3)	3.9(3.0–6.5)[a]	P < 0.05
Average hospital stay (range)	5.9(4–8)	5.9(4.–8)	P > 0.05(NS)

Data in parameters of percentage (%)

P-value not significant

[a]Statistically significant ($P < 0.05$)

A surgical method which has been found optimal, easy to learn, perform and teach should be used not just in countries with limited resources but practically everywhere. The New European Surgical Academy initiates surgical workshops concerning the ten-step vaginal hysterectomy in many countries. Recently, the method has been introduced to Croatia, Armenia, Senegal and Burkina Faso. FIGO and SAGO – the African society of gynaecology and obstetrics – are supporting these activities. The introduction of this method is suggested in any surgical service.

Although vaginal hysterectomy is occasionally done in presence of endometrial cancer [25], it is highly recommended to use this operation for benign conditions, and therefore no vaginal hysterectomy should be done unless the endometrium has been evaluated prior to the operation.

References

1. Tobre H. A renaissance for vaginal hysterectomy. Acta Obstet Gynecol Scand Suppl. 1997;164:85–7.
2. Heaney NS. Vaginal hysterectomy–its indications and technique. Am J Surg. 1940;56:284–8.
3. Paldi E, Filmar S, Naiger R, Weisseman A, Feldman EJ. Vaginal hysterectomy using the Porges method. Report on 100 cases. J Gynecol Obstet Biol Reprod. 1988;17:233–6.
4. Falk HC, Soichet S. The technique of vaginal hysterectomy. Clin Obstet Gynecol. 1972;15:703–54.
5. Von Theobald P. Simplified vaginal hysterectomy. J Chir. 2001;138:93–8.
6. Joel-Cohen SJ. Abdominal and vaginal hysterectomy. New techniques based on time and motion studies. London: Heinemann; 1972.
7. Lash AF, Stepto RC. Chicago technique for vaginal hysterectomy at the Cook County Hospital. Clin Obstet Gynecol. 1972;15:755–68.
8. Switala I, Cosson M, Lanvin D, Querleu D, Crepin G. Is vaginal hysterectomy important for large uterus of more than 500 g? Comparison with laparotomy. J Gynecol Obstet Biol Reprod (Paris). 1998;27(6):585–92.
9. Schollmeyer T, Elessawy M, Chastamouratidhs B, Alkatout I, Meinhold-Heerlein I, Mettler L, Jonat W, MT W. Hysterectomy trends over a 9-year period in an endoscopic teaching center. Int J Gynaecol Obstet. 2014;126(1):45–9.
10. Stark M, Gerli S, Di Renzo GC. The importance of analyzing and standardizing surgical methods. J Minim Invasive Gynecol. 2009;16(2):122–5.
11. Clark NA, Mumford SL, Segars JH. Reproductive impact of MRI-guided focused ultrasound surgery for fibroids: a systematic review of the evidence. Curr Opin Obstet Gynecol. 2014;26(3):151–61.
12. Kamath MS, Kalampokas EE, Kalampokas TE. Use of GnRH analogues pre-operatively for hysteroscopic resection of submucous fibroids: a systematic review and meta-analysis. Eur J Obstet Gynecol Reprod Biol. 2014;177:11–8.
13. Zupi E, Marconi D, Sbracia M, Exacoustos C, Piredda A, Sorrenti G, Townsend D. Directed laparoscopic cryomyolysis for symptomatic leiomyomata: one-year follow up. J Minim Invasive Gynecol. 2005;12(4):343–6.
14. Zhang J, Feng L, Zhang B, Ren J, Li Z, Hu D, Jiang X. Ultrasound-guided percutaneous microwave ablation for symptomatic uterine fibroid treatment – a clinical study. Int J Hyperth. 2011;27(5):510–6.
15. Summitt Jr RL, Stovall TG, Lipscomb GH, Ling FW. Randomized comparison of laparoscopy-assisted vaginal hysterectomy with standard vaginal hysterectomy in an outpatient setting. Obstet Gynecol. 1992;80(6):895–901.
16. Stark M. Clinical evidence that suturing the peritoneum after laparotomy is unnecessary for healing. World J Surg. 1993;17(3):419.
17. Cruikshank SH, Kovac SR. Randomized comparison of three surgical methods used at the time of vaginal hysterectomy to prevent posterior enterocele. Am J Obstet Gynecol. 1999;180(4):859–65.
18. Garry R, Fountain J, Mason S, Hawe J, Napp V, Abbott J, Clayton R, Phillips G, Whittaker M, Lilford R, Bridgman S, Brown J. The eVALuate study: two parallel randomised trials, one comparing laparoscopic with abdominal hysterectomy, the other comparing laparoscopic with vaginal hysterectomy. BMJ. 2004;328(7432):129.
19. Xu LL, Chau AM, Zuschmann A. Blunt vs. sharp uterine expansion at lower segment cesarean section delivery: a systematic review with metaanalysis. Am J Obstet Gynecol. 2013;208(1):62.e1–8.
20. Gizzo S, Burul G, Di Gangi S, Lamparelli L, Saccardi C, Nardelli GB, D'Antona D. LigaSure vessel sealing system in vaginal hysterectomy: safety, efficacy and limitations. Arch Gynecol Obstet. 2013;288(5):1067–74. doi:10.1007/s00404-013-2857-1.
21. Dargent D, Mathevet P. Schauta's vaginal hysterectomy combined with laparoscopic lymphadenectomy. Baillieres Clin Obstet Gynaecol. 1995;9(4):691–705.
22. Reich H. Laparoscopic hysterectomy. Surg Laparosc Endosc. 1992;2(1):85–8.
23. Stark M, Gerli S, Di Renzo GC. The ten-step vaginal hysterectomy. In: Studd J, Tan SL, Chervenak FA, editors. Progress in obstetrics and gynaecology, vol. 17. Edinburgh: Elsevier; 2006. p. 358–68.
24. Bina I, Akhter D. The ten-step vaginal hysterectomy – a newer and better approach. J Bangladesh Coll Physicians and Surg. 2012;30(2):71–7.
25. Susini T, Massi G, Amunni G, Carriero C, Marchionni M, Taddei G, Scarselli G. Vaginal hysterectomy and abdominal hysterectomy for treatment of endometrial cancer in the elderly. Gynecol Oncol. 2005;96(2):362–7.

Hysterectomy Techniques for the Large Uterus

117

Stephen R. Kovac

Introduction

Fibroids are the most frequent benign growths of the uterus, and symptomatic fibroids are the most frequent indication for hysterectomy. Present treatment alternatives of fibroids for women who wish to preserve their fertility include management with oral contraceptives, GnRH agonists, or nonsteriodal antii-flammatory agents. Alternatives to traditional myomectomy include radiographic uterine artery embolization, laparoscopic uterine artery occlusion, and magnetic resonance imaging –guided high frequency ultrasound. Esmya, ulipristal acetate, has been used in Europe to reduce myomas size prior to myomsctomy. However, hysterectomy is the standard approach for symptomatic patients with large fibroid uteri who do not desire uterine preservation.

Uterine Size

The normal uterus weighs approximately 70–125 g. Most patients (80 %) undergoing hysterectomy do not have uteri that exceed the 280 g limit suggested by ACOG as an indication for abdominal removal, yet the most frequent indication for abdominal hysterectomy is leiomyomata or an "enlarged uterus" (Table 117.1).

What is considered an enlarged uterus must be accurately determined as many gynecologic surgeons consider that an "enlarged uterus" demand the abdominal approach. It is our experience when the uterus is weighed in the pathology lab that the presumed "enlarged uterus" may not be well documented. Currently the definition of an "enlarged uterus" is >280 g (12 week gestational size).

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I believe it is more appropriate to measure and describe the size of the uterus in grams rather than by gestational size, which is really an obstetrical measurement. In the U.S. 80 % of all uteri removed for all indications were <280 g [1]. Thus, in contrast to the belief that many uteri are enlarged and require abdominal-type approaches for hysterectomy, have not really been proven. This chapter discusses the techniques for removal of uteri >280 g by the vaginal route. The only indications that make the uterus enlarged are fibroids and adenomyosis. In my personal study of 10,808 hysterectomies, 2593 were performed for leiomyomata with uterine weight/mean range was 255.8 g (90–2928 g), only 502 had uterine weights >280 g. For 308 cases of adenomyosis the uterine weight/mean range was 163.2 g (60–425 g) with only 11 cases exceeding 280 g. All other indications for uterine removal were <280 g (Table 117.2).

Uterine size reduction methods were only required when the uterus was >280 g.

Pelvic examination alone can frequently overestimate uterine size that is considered a contraindication to VH. Therefore, ultrasonic measurement of the uterus can accurately measure uterine size with 98 % accuracy and should be performed preoperatively before presuming a uterine size that is too enlarged and requires abdominal or laparoscopic-type approaches. In an article published in 1991, it was suggested that there were some inconsistencies in the preoperative assessment of uterine size [4]. The size

Table 117.1 Uterine weight and gestational size

Size of uterus	Weight (g)
Normal uterus	
Nulliparous	70
Multiparous	75–125
Enlarged uterus (Gestational size) (week)	
8	125–150
12	280–320
24	580–620
Term	1000–1100

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Table 117.2 Indications for hysterectomy 1970–2005

Indication		Numbers (%)
Leiomyomata		2593 (25.4 %)
Prolapse		4433 (43.5 %)
Abnormal uterine bleeding		1427 (14.0 %)
Adenomyosis		896 (8.7 %)
Carcinoma in situ cervix		308 (3.0 %)
Pelvic inflammatory disease (HX of)		195 (1.9 %)
Chronic pelvic pain		528 (5.1 %)
(HX of) Endometrosis		333 (3.2 %)
(HX of) Pelvic inflammatory disease		195 (1.9 %)
Indication	**Uterine weight/ mean (Range)**	**LOS (Range)**
Leiomyomata no. 2593	255.8 (90–2,2928)	2.77 (2–6)
Prolapse no. 4433	149.6 (16–165)	3.06 (2–10)
AUB no. 1427	145.9 (53–235)	2.31 (1–5)
Adenomyosis no. 896	153.2 (60–425)	2.14 (1–4)
Carcinoma in situ (cervix) no. 308	100.4 (47–237)	2.03 (1–5)
Chronic pelvic pain no. 528		
Endometriosis (HX of) no. 333	128.6 (40–208)	2.6 (2.7)
Pelvic inflammatory disease (HX of) no. 195	114.1 (42–194)	2.43 (2–4)

HX history

or weight of the uterus in vivo often can be more accurately and objectively measured by preoperative ultrasonography. An algebraic formula is used to determine uterine size expressed in measurements and weights. By multiplying the three dimensions of the uterus in centimeters (length × width × anterioposterior diameter at the fundus) × 0.52, a more accurate assessment of preoperative estimate of uterine size can be obtained. ACOG and other investigators over the last 100 years assert that a vaginal hysterectomy is appropriately indicated in women with mobile uteri< 12 weeks of gestational size, thus suggesting that removal of uteri heavier than 280 g is appropriately performed by the abdominal route. However, uterine size may be frequently overestimated with pelvic examination and without more objective criteria, Because 80 % of uteri removed in the United States for various indications weigh<280 g [1] and many are removed by the abdominal route, because of the belief they are too enlarged for vaginal removal suggests that the abdominal approach is overutilized in many cases where the actual size of the uterus is really not a contraindication to the vaginal route (Do not delete!.). Accurate and objective evaluation of uterine size may allow surgeons to perform vaginal hysterectomy on uteri thought to be too enlarged when they are not, so they might gain experience with the vaginal method and may move on with confidence with to remove larger uteri vaginally as they gain experience with size reduction techniques. (Do not delete) Vaginal hysterectomy for the enlarged uterus is a concept of more than 100 years old, yet today is considered a difficult method to learn. In the nineteenth century, when laparotomy was dangerous because of suboptimal knowledge of anesthesia, blood transfusions and antibiotic therapy, this procedure was particularly relevant. Although considered a heroic procedure at the time, these techniques have greatly assisted to the development of vaginal surgery.

The pioneer surgeons in gynecology, especially in the days before aseptic techniques, found that they could remove major growths thru the vagina with greater safety than they could thru the abdominal wall. In the earliest days of gynecology, death regularly followed laparotomy. Recovery from vaginal self-removal of the uterus had been observed, so several of the early, braver gynecologists began their attempts to relieve those suffering women by planned vaginal hysterectomy. There was intense opposition to their efforts, but they persisted despite it. Soon, almost all types of serious pelvic disease, ranging from acute to chronic adnexal inflammation to large uterine and ovarian tumors, were being approached successfully through the vagina [4–7].

By the late nineteenth century vaginal hysterectomy had become a safe operation and was favored over the abdominal route because of the risk of laparotomy. Morcellation originated as a means for the removal of large, pedunculated, submucosal myomas.

Morcellation

Morcellation of the uterus was pioneered in the 1830s by Dupuytren and Velapeau, and by Anussat of France who removed a 440 g uterus in1840. Viennese surgeons Czerny, Billroth, Miller and others beginning in1879 published the first description of vaginal hysterectomy by hemisection in 1882. This was followed by Pean, Segond and Richelot of Paris, and by Jacobs of Brussels, between 1883 and 1890 [8]. A series of cases appeared in the 1860s and 1870s, and in 1881 Haiden reported 52 cases with a mortality of 32 %. By 1879 Czerny progressed to the point of standardized his own technique, and from then on the risks dropped rapidly to 5 % in his series reported in the 1890s. This procedure gained popularity among French gynecologists, and in 1895 Garceau reported more than 400 Vaginal hysterectomies with morcellation with a 1.7 % mortality rate [9]. Pean reported 60 cases of vaginal hysterectomy with large fibroids in 1886, and all patients survived the operation. This was in contrast to a study Pean published in 1881 of 51 women with large fibroids, treated by abdominal hysterectomy in which 18 died for a mortality rate of 35 %.

Siginicant contribution to morcellation techniques were made by Pryor of New York and Doyen of Paris in the 1890s [10]. Pryor popularized vaginal hysterectomy hemisection as an effective approached to the treatment of advanced pelvic inflammatory disease, achieving a remarkable 0.4 % mortality rate in 228 consecutive cases. Doyen described a very efficient method of morcellating enlarged, solid myomas with coring tubes [11]. Intramyometrial coring was introduced by Lash, of Chicago, in 1941 [12].

In the modern era, morcellation continues to be a useful approach for attacking increasingly larger uteri in skilled hands. The 1000 g mark has been surpassed by many, most notably by Kudo of Japan who reported 108 cases among 9230 vaginal hysterectomies between 1955 and 1987 [13], and by Pelosi who surpassed the 2000 g mark with the removal of a 2003 g fibroid uterus by total vaginal hysterectomy in 1996 [14], and by the author who removed a 2928 g fibroid uterus by vaginal hysterectomy in 1999 [15].

Indications for Morcellation

In the case of a slightly enlarged uterus larger than the adult fist in size, the need for size reduction techniques are dictated by clinical observation, during surgery. When it is deemed impossible to access the upper pedicles by simple traction or flipping the uterus through the posterior fornix. When the surgeon continues to place clamps above the uterine artery, the available space becomes more restricted and attempts to place sutures around the clamps become more difficult. Suturing of the broad ligament above the uterine is really unnecessary because of the few blood vessels within the leaves of the broad ligament do not require suturing. This unfortunate and incorrect misconception has been a major stumbling block for transvaginal removal of the uterus and a source of criticism of the vaginal approach to uterine removal. No clamping is needed above the uterine artery until the adnexal.

During abdominal hysterectomy the upper leaves of the broad ligament are infrequently clamped. This older technique of vaginal hysterectomy of sequential clamping the broad ligament should recognize why size reduction methods are successful. Regardless of the size of the uterus, the main blood supply come from the uterine vessels located at the level of the cervix and isthmic region, and accessible for ligation in the great majority of cases.

Sometimes a patient with a small uterus may present difficulty for removal of the uterus in to, either because of limited vaginal exposure or resistance of the uterine supporting structures. In cases such as this, efforts must concentrate on fragmenting the uterus in the midline by hemisection, anterior wedge resection, or coring instead of insisting on an inefficient and sometimes dangerous lateral approach or abandoning the vaginal approach.

Hemisection Technique

Hemisection consists of anterioposterior division of the uterus in two halves, and is a very efficient method for the removal of uteri containing fundal and/or midline fibroids (Fig. 117.1).

The cervix is grasped with clamps at the 3 and 9 o'clock position and traction is applied. A knife is preferable to heavy scissors for incising the cervix anteriorly, then posteriorly with retractors protecting the bladder and rectum. The incision is carried superiorly toward the fundus, always under direct vision, and always through the uterine cavity to assure anatomical orientation. The apex of the incision is pulled into view with clamps applied bilaterally to each edge and the process continued until the uterus is divided into two halves. Sometimes it is useful to place one half of the hemisectioned uterus back inside the pelvic cavity so that surgical exposure is improved, allowing clamping and cutting of the contralateral adnexal pedicle. The remaining half is exteriorized and then removed.

Hemisection also permits removal of relatively small uteri less than 280 g. For uteri > 280 g it may be necessary to combine other size reduction methods. When properly performed, blood loss is minimal during the procedure as a

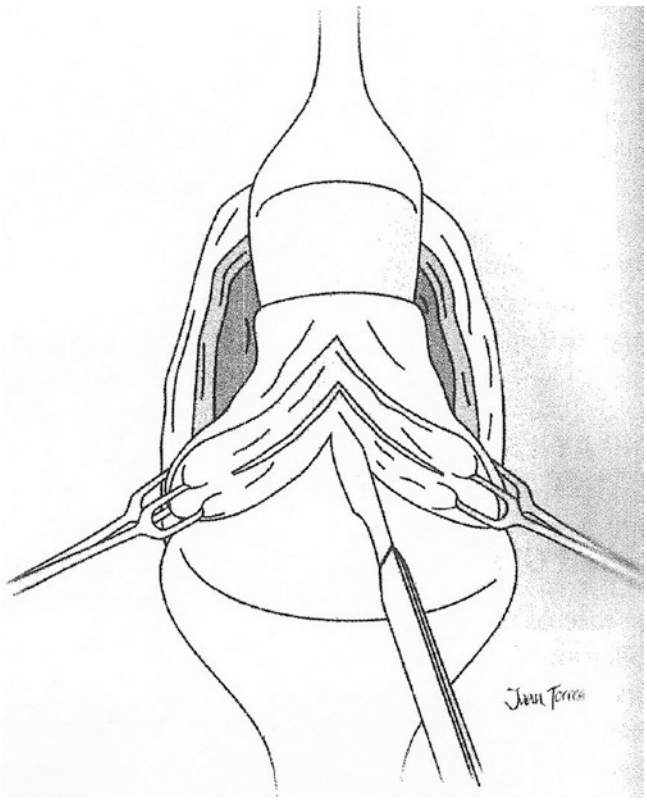


Fig. 117.1 Hemisection of the Uterus (From Kovac and Zimmerman [2, 3] Permission granted from Netto)

result of preliminary ligation of the uteri vessels and compression on the edges of the vaginal cuff by the enlarged uterus, as strong traction is applied. I have no such pictures.

Intramyometrial Coring

Abrahan Lash introduced this technique. Later, the author popularized this procedure in the United States in 1986. Coring is considered best suited of the moderately enlarged globular uterus, The author prefers this technique as the initial method to the start of any size reduction techniques which exposes the inner part of the uterus when the uterus is quite enlarged allowing resection of individual myomas to be grasped and removed or by wedge resection or hemisection (Fig. 117.2a–c).

The procedure begins at the level of the isthmus, below the peritoneal reflection. The myometrium is circularly incised with a scalpel, midway between the serosa and the uterine cavity, after the uterine vessels have been ligated. The drawings and description of the techniques clearly show that coring and hemisection are not similar at all. .As a result the anterioposterior and transverse diameters of the fundus acquires an elongated cylindrical shape. It is important to avoid multiple planes of the incision. As traction is placed on the cervix, the concentric incisions will eventually reach the fundus, and the uterus is progressively exteriorized thru the vagina. The advantages of this method is that the uterine cavity is not penetrated, so there is less chance of injury to adjacent organs, since the circular incisions in the myometrium do not reach the serosa of the uterus. Coring becomes easier once the corpus comes closer to the vaginal introitus. For small or medium size uteri that do descend well, intramyometrial coring can quickly result in delivering the uterus through the vagina and exposing the upper pedicles for clamping. Several examples of intramyometrial coring combined with wedge resection and enucleation of individual fibroids are presented for term-size uteri preoperatively determined to weigh in excess of 1000 g (Fig. 117.3).

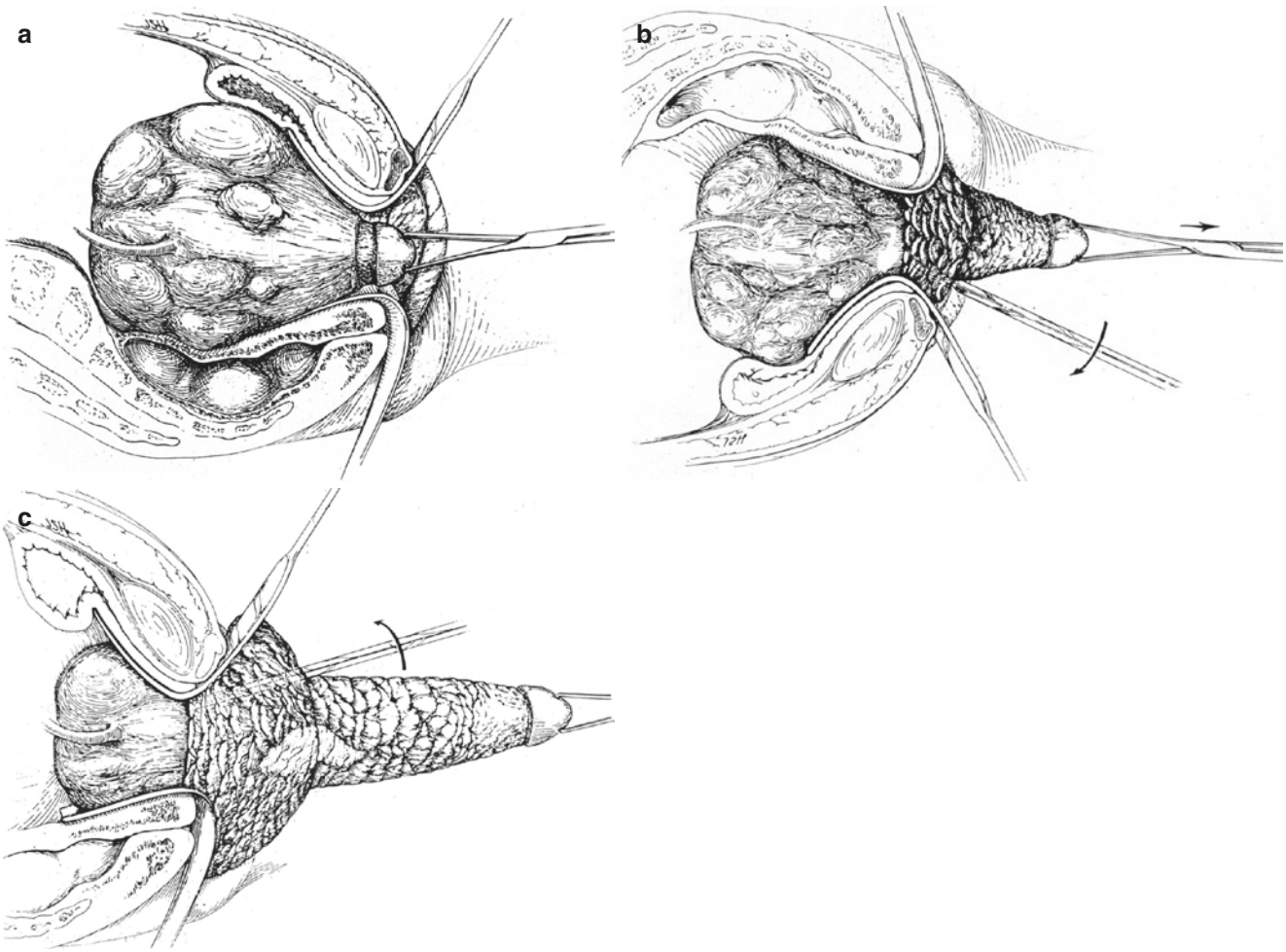


Fig. 117.2 (**a**) The cervix has been circumscribed through the full thickness of the vagina around the cervix, the anterior and posterior entered, and the uterosacral and cardinal ligaments secured. (**b**) After ligation of the uterine arteries, an incision is made in a circumferential fashion parallel to the endometrial cavity, and into the outer superficial myometrium in the same plane. Constant traction on the tenaculum while coring assists in developing the proper plane. (**c**) Continued coring and traction reduces the size of the uterus by exteriorizing the inside of the uterus with an intact endometrial cavity through the introitus. Intramyomural myomas are sometimes transected during the coring process (From Kovac [16])

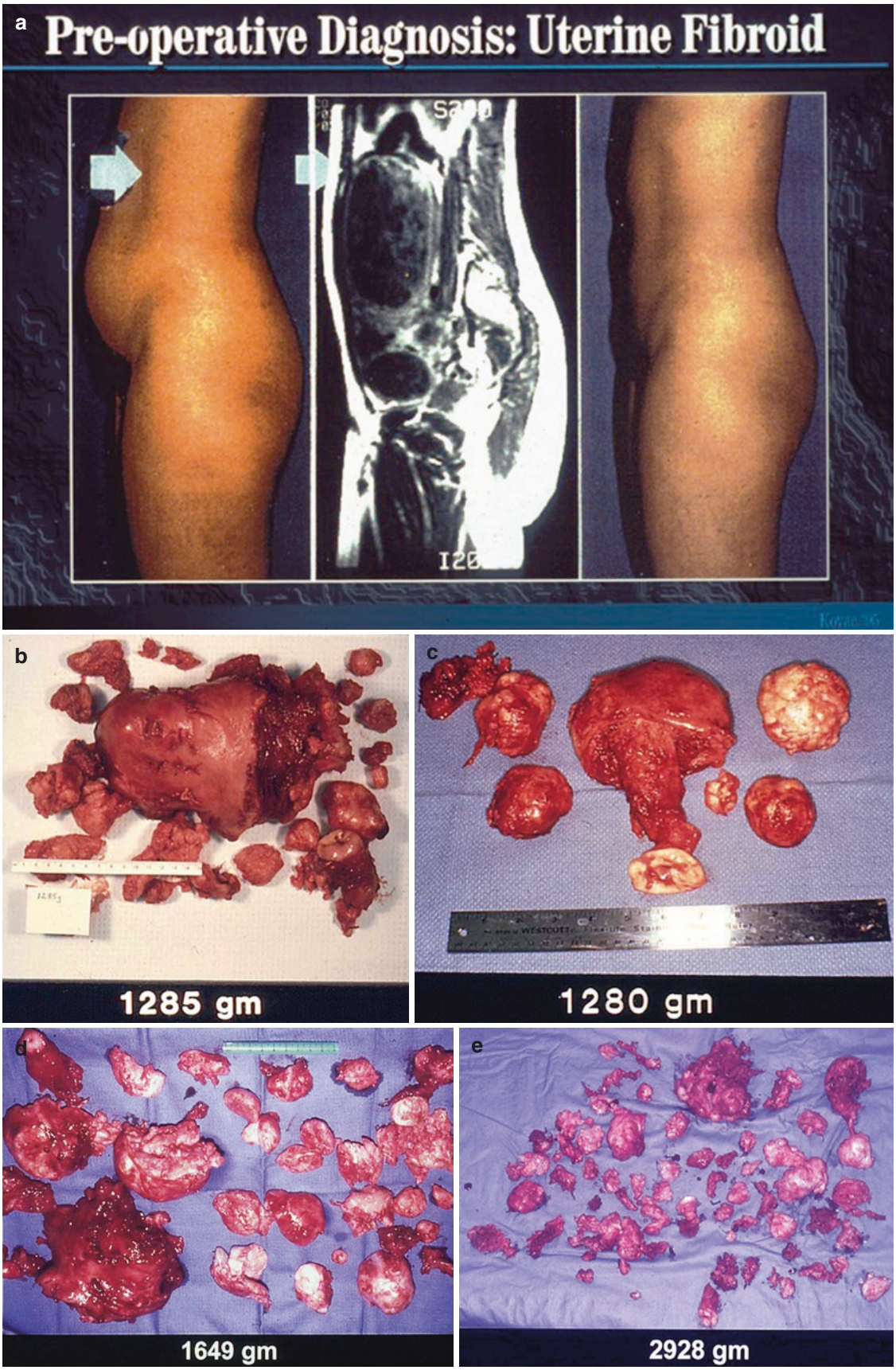


Fig. 117.3 (**a**) Pre and post operative photos after removal of the enlarged fibroid uterus seen on CAT Scan. Preoperative weight by ultrasonography was estimated to be 1200 g. (**b**) Photo of removed uterus from Fig. 117.5. Estimated weight and pathologic weight were quite similar (1285 g). (**c**) Removal of 1280 g uterus with Intrayometrial Coring. (**d**) Removal of 1649 g uterus with Coring and transection of intramural fibroids. (**e**) Removal of 2928 g uterus with coring a transection of many myometrial fibroids (Photo permission granted from Kovac, SR)

Wedge Resection

This is technique of choice for the grossly enlarged particularly when coring and simple hemisection have accomplished all that can do. It is a versatile method, but may require some experience before it is mastered. Wedge resection usually begins with a midline incision and progresses with the removal of small or large incisions of uterine tissue at the apex of these incisions. The central uterine mass is grasped with sturdy clamps or tenaculums and a long scalpel creates oval or triangular wedges of tissue that are removed in the midline (Fig. 117.4).

When the uterus is relatively soft, sometimes it is possible to extract larger pieces of tissue by using coring incisions from partially completed wedges. It is useful to effect bulking symmetrically in the midline of the uterus as this usually results in a rapid access to the adnexal pedicles by avoiding lateral deviation away from one adnexa. One needs to be patient during morcellation with wedge resection of large uteri removing sometimes-small wedges until the uterine mass becomes small enough to be exteriorized from the pelvic cavity. Re: comment:I have no such pictures or drawings.

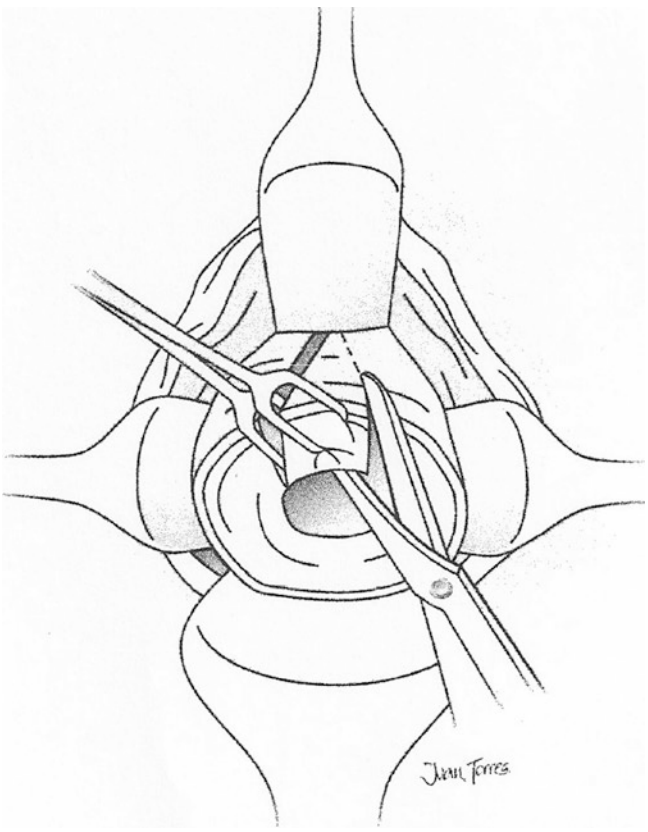


Fig. 117.4 Wedge resection of anterior uterine wall at the level of the isthmus (From Kovac and Zimmerman [2, 3] Permission granted from Netto)

Posterior Fundal Morcellation

This approach is useful after exteriorization of the posterior fundus that does not allow adequate space available for the application of clamps on the superior pedicles. A longituidinal wedge of myometrium can reduce a portion of the uterus containing a fibroid with the greatest volume that widens the space for the placement of clamps on the upper pedicles, and delivery of the remaining specimen (Fig. 117.5a, b).

Cervical Amputation and Myomectomy

In order to facilitate posterior rotation of the uterus, the cervix nay be amputated. Myomas are frequently encountered during the morcellation process regardless of the size reduction techniques employed. Large myomas require morcellation, while small or medium size may be enucleated increasing the mobility of the uterus.

Pryor's Technique

William Rice Pryor of New York described this technique in 1899 and is more of historical value infrequently performed today. This technique is performed, by flipping the uterus, anteriorly. Using this method the uterus is removed similar to the Doderlein-Kronig technique. After ligation of the uterine arteries, the bladder is retracted and the anterior uterine wall incised vertically in the midline. Starting at the level of the cervix, symmetrical pieces of myometrium are resected bilaterally from the midline incision as high as possible. Wedge-shaped pieces of uterine wall are cut bilaterally from the edges of the midline incision, as the everted edges are serialy grapsed and pulled downward, exposing more uterine tissue (Fig. 117.6).

What appears of the uterine tissue is again split in the midline from each side a wedge of tissue is symmetrically removed. Once the corneal regions are visualized, it is useful to excise an extensive wedge at the fundus exposing the adnexa. If anterior morcellation cannot be completed, the cervix is amputated and the posterior wall is morcelleted as for the anterior wall. The remaining uterine attachments are then transected and the uterus removed.

Doyen Method

This method was described by Doyen in 1920 consists of the removal of cylindrical columns of tissue from the myometrium and large fibroids, using a metallic tube with a cutting edge. The cutting portion of the tube is pressed against the central portion of tissue and with rotating

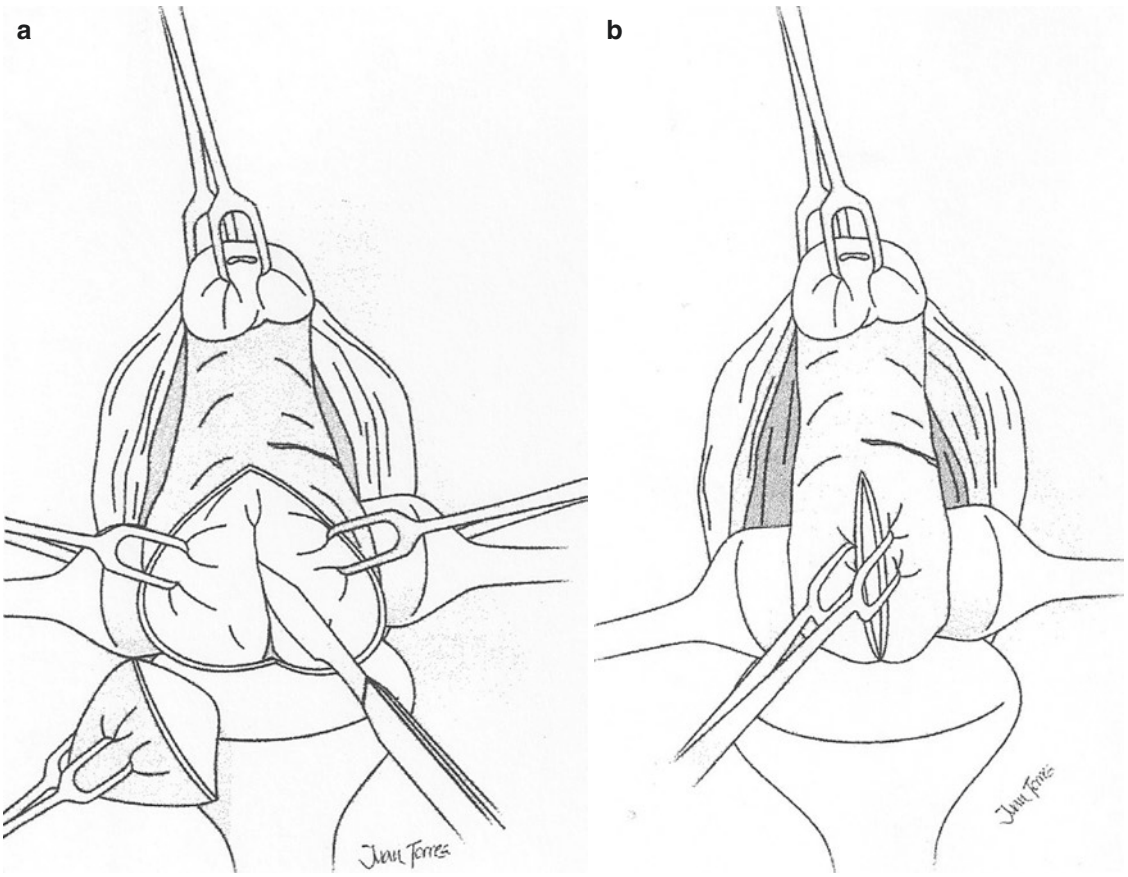


Fig. 117.5 (**a**) Uterus has been rotated posteriorly. If more room is required for rotation the cervix can be amputated. (**b**) After posterior rotation of the uterus, if more space is needed to clamp the upper pedicles, an incision into the posterior wall can remove any posterior wall fibroids restricting the space for upper pedicle clamping (From Kovac and Zimmerman [2, 3] Permission granted from Netto)

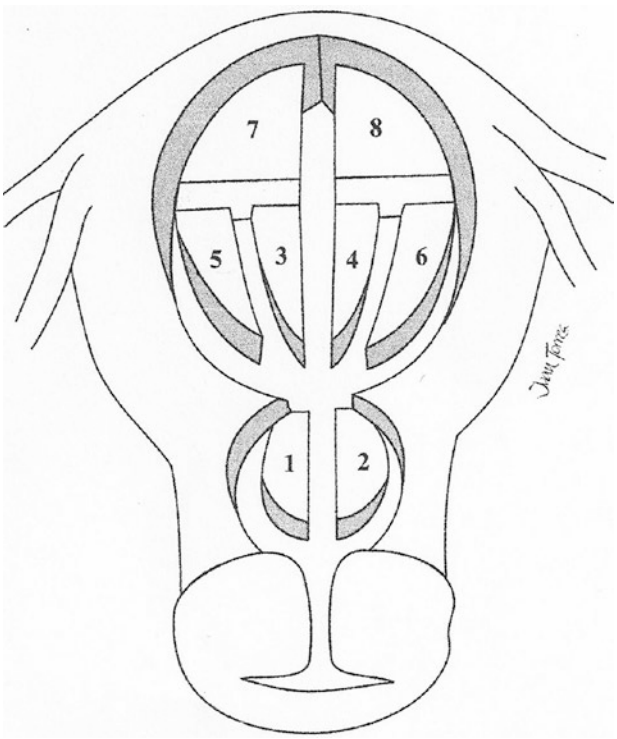


Fig. 117.6 Pryor Technique of uterine morcellation (From Kovac and Zimmerman [2, 3] Permission granted from Netto)

movements, it is advanced to a depth of 3–4 cm. Many columns of tissue can be removed in this fashion, reducing uterine volume through the creation of an artificial cavity (Fig. 117.7).

This method is also of historical value and is infrequently practiced today. The Doyen cylindrical morcellation tube is a tool rarely found for purchase by gynecologic instrumentation companies.

The overwhelming majority of well-selected cases are successfully performed and the confidence and experience of the surgical team increases accordingly. Sometimes a conversion of a vaginal hysterectomy to laparotomy should not be regarded as a complication, but as a demonstration of prudence and, above all, a focus on the patient's well being. Uncontrollable hemorrhage, a pelvic adhesion process of difficult dissection, an extremely enlarged uterus, or an unexpected adnexal tumor normally dictates a change to an abdominal approach. In my experience of 10,808 vaginal hysterectomies I had to convert to a laparotomy in eight cases (.07 %), not all because of an enlarged uterus. In fact a very small uterus because of fixation of the uterus to the anterior abdominal wall required conversion to a laparotomy. When change in approach is necessary, laparotomy should be performed without hesitation Excessive confidence, ostentation or

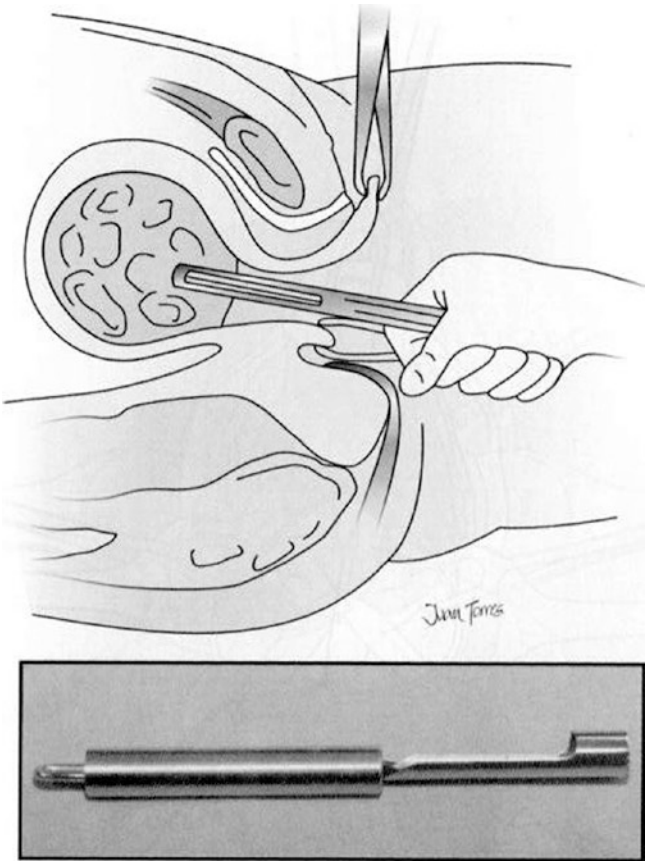


Fig. 117.7 Uterine morcellation using the Doyen Method (From Kovac and Zimmerman [2, 3] Permission granted from Netto)

pride have no place in this type of decision-making as additional problems for the patient may be created. The possibility of conversion to laparotomy should be a part of the informed consent process.

References

1. American College of Obstetricians and Gynecologists. Quality assurance in obstetrics and gynecology. Washington, DC: ACOG; 1989.
2. Kovac SR. Guidelines for hysterectomy. In: Kovac SR, Zimmerman CW, editors. Advances in reconstructive vaginal surgery. 2 ed. Philadelphia: Lippincott Williams & Wilkons; 2012. p. 111–29.
3. Kung FT, Chang SV. The relationship between ultrasonic volume and actual weight of the pathologic uterus. Gynecol Obstet Invest. 1996;42:35–8.
4. Kovac SR, Christie SJ, Bindbeutel GA. Abdominal versus vaginal hysterectomy: a statistical model for determining physician decision making and patient outcoms. Med Decis Making. 1991;11:19–26.
5. Kennedy JW. History of vaginalhysterectomy. In: Kennedy JW, Campbell AD, editors. Vaginal hysterectomy. Philadelphia: FA Davis; 1942. p. 1–25.
6. Garceau E. Vaginal hysterectomy as done in France. Am J Obstet Gynecol. 1895;31:305–24.
7. Henrotin F. Vaginal hysterectomy in nbilateral peri-uterine suppuration. Am J Obstet Gynecol. 1892;26:418–60.
8. Allen E. The vaginal approach to gynecologic surgery. Surg Clin North Am. 1953;1953-207
9. Pean JE. DeL'hysterectomie vaginale totale applique au traitment des tuneurs, fibresuses multiples de l'uterus, morcellement de tumerus, pinccement definitive des ligaments larges, absence de fermenture du vagin. Gaz d Hop Par. 1886;59:950.
10. Pryor WR. The treatment of pelvic inflammations through the vagina. Philadelphia: WB Saunders; 1899. p. 209–15.
11. Doyen E. Surgical therapeutics and operative techinique. Vol. 3, translated by Spencer-Browne H. London: Bailliree, Tindall $Cox; 1920.
12. Lash AF. A method of reducing the size of the uterus in vaginal hysterectomy. Am J Obstet Gynecol. 1941;42:452–9.
13. Kudo R, Yamuchi O, Okazaki T, et al. Vaginal hysterectomy without ligation of the ligaments of the cervix uteri. Surg Gynecol Obstet. 1990;170:299–305.
14. Pelosi MA, Pelosi III MA. Should uterine size alone require laparoscopic assistance? Vaginal Hysterectomy for a 2003-gram uterus. J Laparoendosc Surg ADV Surg Tech. 1998;8(2):99–103.
15. Kovac SR. Guidelines for Hysterectomy. In: Kovac SR, Zimmerman CW, editors. Advances in reconstructive vaginal Surgery. Philadelphia: Lippincott Williams & Wilkins; 2011. p. 111–28.
16. Kovac SR. Intramyometrial coring as an adjunct to vaginal hysterectomy. Obstet Gynecol. 1986;67:131–6.

Vaginal Total Hysterectomy in Benign Indications: Hysterectomy Techniques with Bipolar Diathermy System

118

Sumita Mehta and Anshuja Singla

Hysterectomy for benign gynecological disease is one of the most common gynecological procedure and almost 30 % of women by the age of 60 years are hysterectomized. This surgery can be done through several routes; abdominal, vaginal, laparoscopic assisted and more recently robotically; however abdominal hysterectomy has been the preferred route by a 3:1 ratio compared to vaginal hysterectomy [1]. According to the Cochrane review for women undergoing hysterectomy for benign disease, vaginal route appears to be superior to abdominal or laparoscopic route as it is associated with benefits of shorter hospitalization, fewer complications and lower costs [2]. Vaginal hysterectomy has one major drawback of limited space for surgical access. Increased traction applied to the tissues during surgery leads to increased postoperative micturition symptoms and shortened vagina, vis-à-vis total laparoscopic intrafascial hysterectomy (TLIH) which encompasses the benefits of total and sub-total hysterectomy with few complications. Using a uterine manipulator and colpotomizer, the uterosacral ligaments are incised higher and the cervix is circumscribed while preserving the entire uterosacral ligaments and cardinal ligaments. This results in a longer vagina and excellent pelvic support [3, 4].

The number of oophorectomies done with hysterectomy has been increasing and 37 % of women below 45 years and 68 % of women over 45 years now have bilateral oophorectomy. Vaginal adnexectomy is often thought to be a difficult procedure because of restricted access and limited visibility of the Infundibulopelvic ligament but the need to perform salpingo-oophorectomy should not be considered a contraindication to vaginal hysterectomy [5].

With the advent of new hemostatic systems, total vaginal hysterectomy is now a more viable option. Overall success rate of oophorectomy at vaginal hysterectomy varies between 88 and 96 % and using various techniques, this rate can be increased to 97.5 % [6, 7, 8, 9]. Using coagulation techniques and now more recently vessel sealing systems, adnexectomy during vaginal hysterectomy has become easy and feasible. The new hemostatic systems which are safe alternatives to conventional suturing techniques include the high frequency electro-surgery, ultrasonic and laser. Monopolar, bipolar and laser are inherently risky to use because of considerable lateral thermal spread beyond area of treatment (up to 2 mm with electrocautery) and unreliable hemostasis (seen mainly with Laser) [10]. With electro-surgical bipolar vessel sealing (EBVS) system, the mean lateral thermal spread is 144.18 μm as compared to 215.79 μg with monopolar diathermy [11].

EBVS technique is an alternative method to conventional suturing and stapling techniques. By using this technique large caliber vessels can be secured using a single clamp which shortens the operative time as well as decreases the post- operative pain due to less traction on the tissues [12]. Mean arterial burst strength with vessel sealing systems has been shown to be similar to ligatures and higher than ultrasonic or bipolar sealed blood vessels [13].

The initial traditional electrosurgical generators used radio frequency electric current to heat and coagulate the blood vessels. But this method is adequate to seal vessels only up to 2 mm in diameter [14]. To seal blood vessels of larger caliber, advances in electrosurgical techniques have been specifically designed. The ideal vessel sealing device is the one which fulfills the following criteria:

(i) Consistency: Independent of user, the device must consistently perform the same way with every procedure.
(ii) Reliability: The device does not change its sealing capabilities for vessels up to 7 mm diameter with repetitive uses.

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(iii) Efficiency: The treatment time needed to seal the tissue does not prolong the operation unnecessarily.
(iv) Safety: Lateral thermal spread is not excessive and does not exceed the recommended safety of >5 mm.

There are three important factors to achieve sealing of larger vessels. These have been incorporated in the EBVS system [15]. They are:

- Electro-surgical output- The bipolar current is higher compared with conventional electro-cautery.
- Electrosurgical generator- The vessel seal is achieved using a closed feedback loop to monitor the effect of current by measuring tissue impedance. Different generator models use different algorithms or tissue impedance values which may lead to some variability between different generator models and may affect the seal quality and thermal spread (Fig. 118.1).
- Forceps- An adequate seal depends upon optimal jaw pressure which in turn depends on the jaw distance. The forceps have stronger jaws and a welded positive electrode in the stationary jaw used in this system. The pressure with these forceps is higher and more evenly applied along the entire length than which is achieved using standard bipolar forceps [16] (Fig. 118.2).



Fig. 118.1 Electrosurgical generator



Fig. 118.2 Bipolar forceps

Variation in the design of any one of these factors can affect the surgical outcome. For example, the Triad feedback loop is faster and impedance calculations are performed in real time compared with the Ligasure which does retrospective calculations of the next energy pulse and has a slower sample rate [17].

Mechanism of Action

EBVS system delivers a high current (4 A) and very low voltage (<200 V) to the tissue. It monitors tissue impedance between jaws of the forceps and continuously adjusts delivery of energy. The system diagnoses the type of tissue in the jaws of the instrument and delivers the appropriate amount of energy needed to seal it. Collagen and elastin fibres in the vessel wall denature during the cool down phase and cross-linking which occurs creates a new solid wall of collagen and elastin tissue (Fig. 118.3). Algorithm in the generator determines the optimal energy and time required to seal vessels as large as 7 mm.

EBVS system is unique because of the fact that it works by applying a precise amount of pressure and energy to transform collagen and elastin fibers present in the vessel wall to create a permanent seal. Computer controlled bipolar diathermy system utilizes combination of pressure and bipolar energy incorporating impedance based feedback loops to modify energy. An acoustic signal informs the surgeon when the vessel obliteration is complete and its division possible. The obliterated lumen can be identified once the jaws of the forceps are released. This system does not

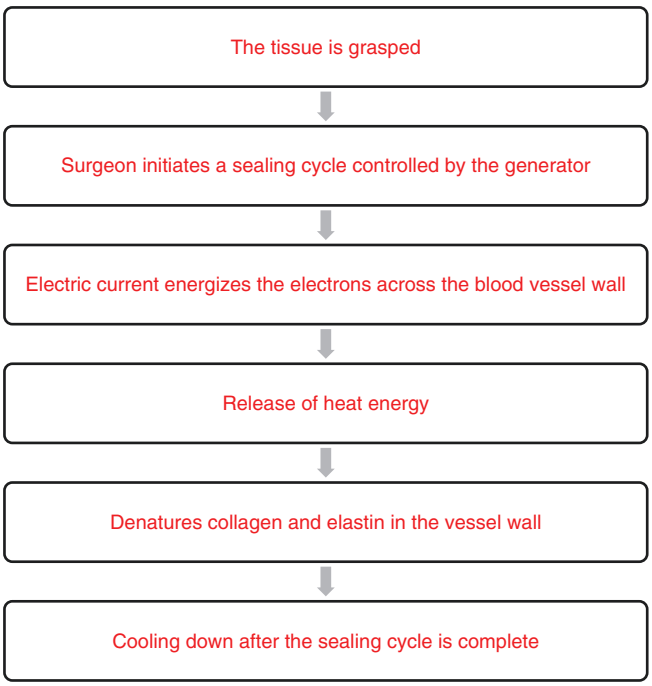


Fig. 118.3 Working of EBVS system

work consistently in tissues where the blood supply is predominantly through capillaries which have low collagen content. Also, while EBVS system may seal arteries up to 7 mm, the size limit for vein sealing is lower as their walls contain less collagen [17].

Operative Technique

The probability of adnexectomy by vaginal route can be graded pre-operatively using the scoring system given by Kovac et al. [18].

Grade 0: No descent of ovaries. Infundibulopelvic ligament has little or no stretchability. Ovaries are positioned at the lateral pelvic wall at or above the ischial spines and cannot be brought by traction into the long axis of the vagina.
Grade I: Ligament stretchability with traction brings the descent of the ovaries to the long axis of the vagina midway between the ischial spines and mid vagina.
Grade II: Traction brings the ovaries to midway between mid vagina and hymenal ring.
Grade III: Traction brings the ovaries beyond the hymenal ring.

Any ovary that is Grade I or more is generally accessible and visible for transvaginal removal.

Factors affecting the feasibility of adnexectomy during vaginal hysterectomy:

- Age: Relaxation of adnexae because of weakness of IP ligaments improves visibility and access of ovaries in such women.
- Obesity: Kammeran-Doak et al. found lower rates of successful oophorectomy in obese women [19].
- Stage of pelvic prolapse: Higher the grade of prolapse, the easier it is to carry out adnexectomy.
- Shorter cervical length: Karp et al. found cervical elongation >7 cm or exteriorized cervix to be associated with lower likelihood of salpingo-oophorectomy [20].

Position of Patient

Lithotomy position with both the hips and the knees being flexed is preferred for vaginal hysterectomy. The buttocks should be at the edge of the table to facilitate posterior vaginal wall retraction without hindrance to the instruments.

Step 1

The external genitalia, lower abdomen up to umbilicus, medial aspect of thigh, perineum and finally vagina and cervix are cleaned with betadine. Labial sutures are applied with silk to facilitate exposure. A metal catheter is used to empty the bladder. A careful pelvic examination is performed to confirm the pre-operative findings, find some unrecognized pelvic pathology and anticipate degree of operative difficulty.

The size, shape and mobility of the uterus is confirmed. Also, the position and depth of pouch of Douglas (POD), depth of vagina in resting position, length of uterosacrals and thickness of perineal body is noted.

Aqua Dissection: To decrease the intraoperative blood loss 30–40 ml of 1:200,000 epinephrine or 100–200 ml of



Fig. 118.4 Saline injection anteriorly



Fig. 118.5 Submucosal saline bleb

sterile saline may be injected submucosally around the cervix (Figs. 118.4, 118.5, 118.6, 118.7 and 118.8).

Advantages of aqua dissection (AD): Aqua dissection compresses the vascular plane and creates a fluid tourniquet in the injected area which prevents hemorrhage during surgery. Also various planes become easily separable which decreases the operative time [21].

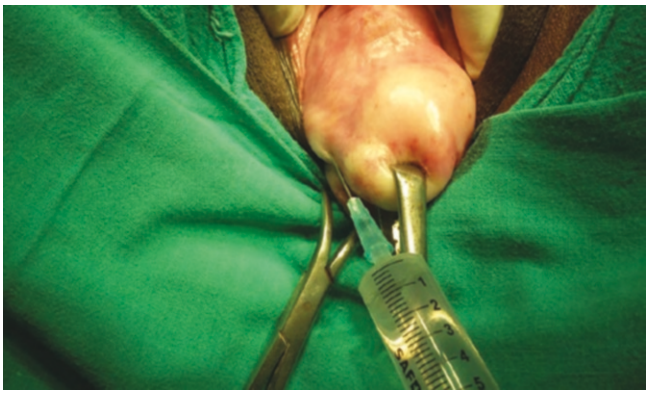


Fig. 118.6 Saline injection on left lateral side



Fig. 118.7 Saline injection on right lateral side

Step 2: Incision

The cervix is held with vulsellum and the lower limit of the bladder is identified, incision is made at the cervicovaginal junction using scalpel or scissors. Incision can be started either anteriorly or posteriorly (preferable as blood flow will not hinder vision in the operative area). The incision is deepened through the entire length with simultaneous traction on the cervix (Figs. 118.9 and 118.10). Vesicovaginal space is dissected and vaginal flaps are created on both sides (Figs. 118.11, 118.12 and 118.13).



Fig. 118.8 Saline injection posteriorly

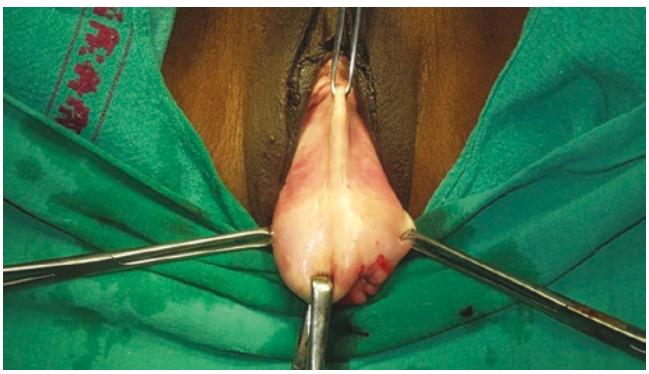


Fig. 118.9 Vaginal mucosa held at four cardinal points

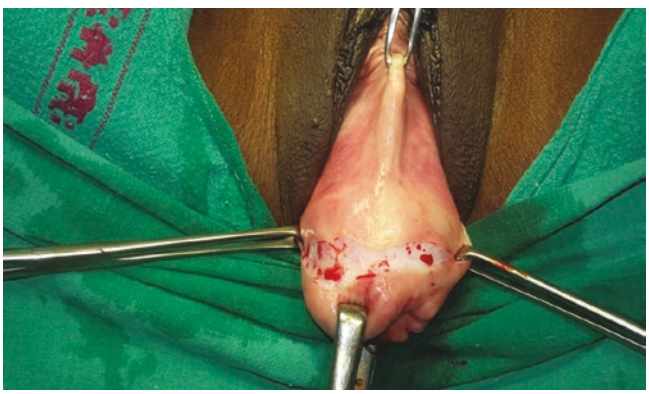


Fig. 118.10 Incision on anterior vaginal wall

Step 3: Opening the Anterior Pouch

While pulling down the cervix hold the anterior vaginal wall incision with Allies or toothed forceps. This will help to identify the vertical running fibres of vesico-cervical ligaments (also called bladder pillars). These are cut and ligated and the bladder can now be pushed up on the anterior surface of cervix using steady traction with a gauze or sponge on a holder till the shiny peritoneum of the uterovesical fold

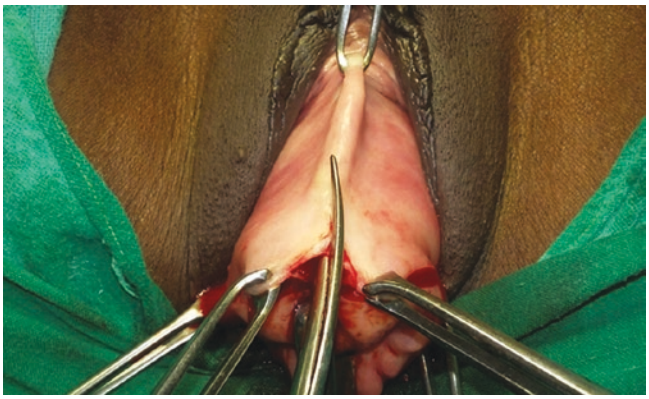


Fig. 118.11 Creation of anterior vaginal flap

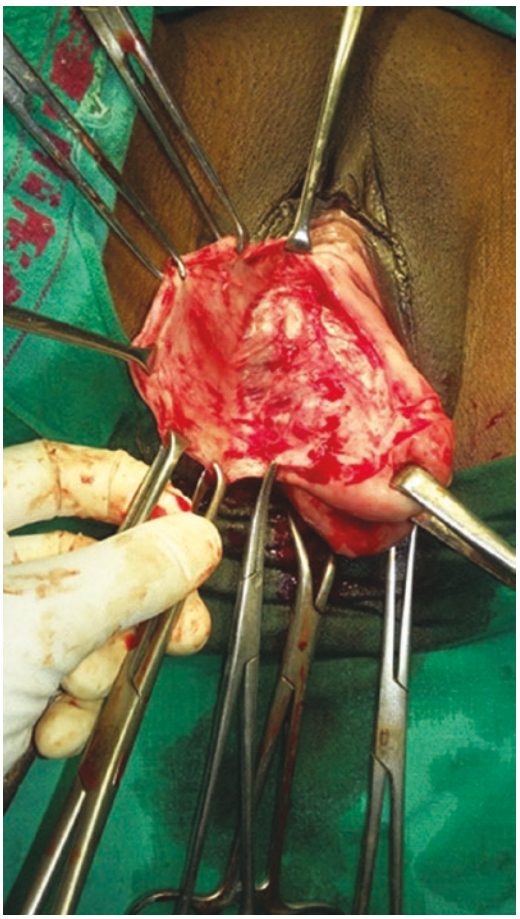


Fig. 118.12 Vesicovaginal dissection done on right side

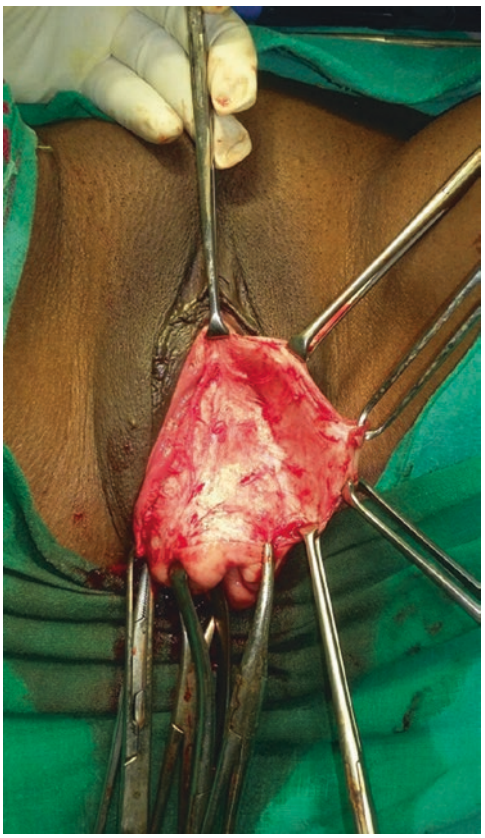


Fig. 118.13 Vesicovaginal dissection done on left side



Fig. 118.14 Anterior peritoneal reflection

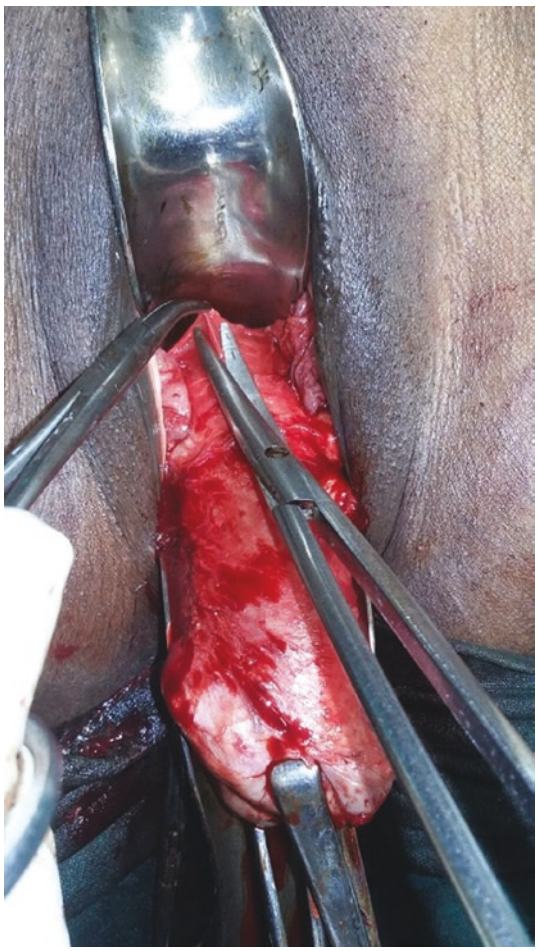


Fig. 118.15 Anterior peritoneum being cut

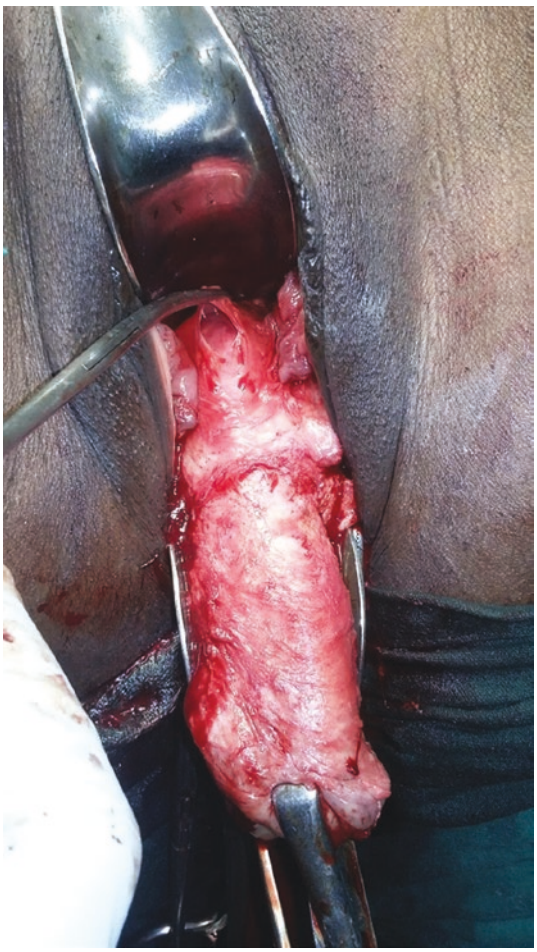


Fig. 118.16 Open anterior pouch

(UV fold) is seen (Fig. 118.14). When using scissors, be careful to direct the tip downwards to ensure that it does not injure the undersurface of bladder. Palpate with two fingers and peritoneum will feel slippery.

The peritoneum is held with artery forceps and cut with scissors (Figs. 118.15 and 118.16). The peritoneum should only be incised under vision. The bladder can then be elevated which would allow the ureters to be safely pushed upwards and outwards. In cases of difficulty in identifying the anterior pouch, the posterior pouch may be opened first. Introduce index and middle fingers through the posterior pouch into the anterior one, identify the peritoneum and then incise under vision. Once the peritoneum is incised, the incision is extended on either side and a Deaver's or Sim's speculum is introduced.

Step 4: Opening the Pouch of Douglas

Holding the posterior lip of the cervix, it is elevated and cut edge of posterior fornix is drawn using Allis forceps. A bold incision is given towards the back of the cervix in between the two uterosacral ligaments. Holding the vaginal edge, peritoneum is identified between the uterosacrals and posterior pouch is opened (Figs. 118.17 and 118.18).

Step 5: Division of Mackenrodt's and Uterosacral Ligaments

The Uterosacral-Mackenrodt's ligament complex is lifted with index finger and the electrodes on the hand piece are placed across the pedicle in such a way that the tissue is interposed between the jaws of the hand piece in the centre. The clamp is applied close to the uterus in the so called 'cheek to cheek surgery'(Figs. 118.19 and 118.20). Then close the handle in the tightest ratchet position and is pressed until a characteristic two-tone sound from the machine confirms complete coagulation of tissue. The handle of the handset is released and the electrode is removed.

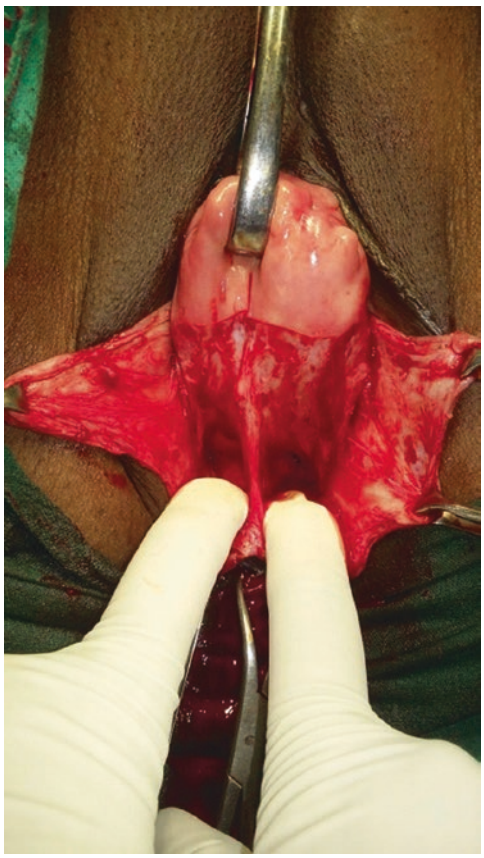


Fig. 118.17 Posterior peritoneal reflection

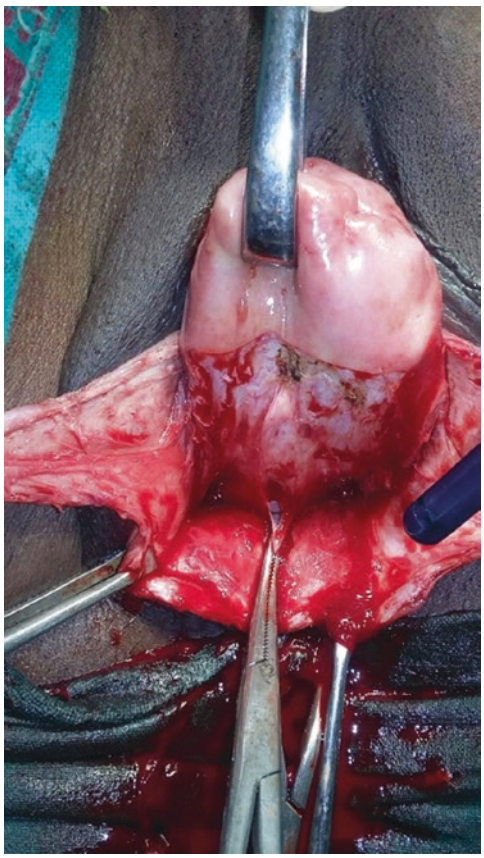


Fig. 118.18 Open posterior pouch

Step 6: Division of Uterine Vessels

The next step is to secure the uterine vessels and this pedicle contains the uterine artery, vein and anterior and posterior folds of the peritoneum (Fig. 118.21). The artery should be clamped medially to avoid thermal damage to the ureter (Figs. 118.22 and 118.23). The uterine vessels are coagulated twice, both applications placed close to each other. The coagulated area will turn white and is then cut close to the uterus.

Step 7: Division of Round Ligament

The clamp is applied to the round ligament and part of broad ligament inferior to it. The clamp is applied as lateral as possible (4–5 cm from the uterus) to prevent bunching of the fundal pedicles and better visualization of infundibulopelvic ligament (Figs. 118.24 and 118.25).

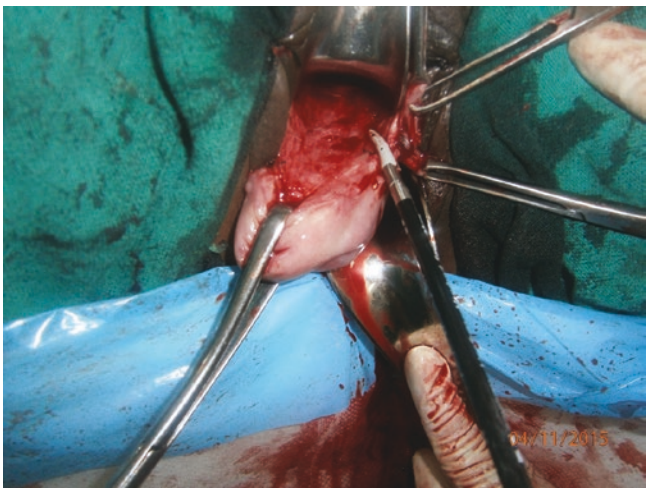


Fig. 118.19 Left Mackenrodt's ligament clamp on left

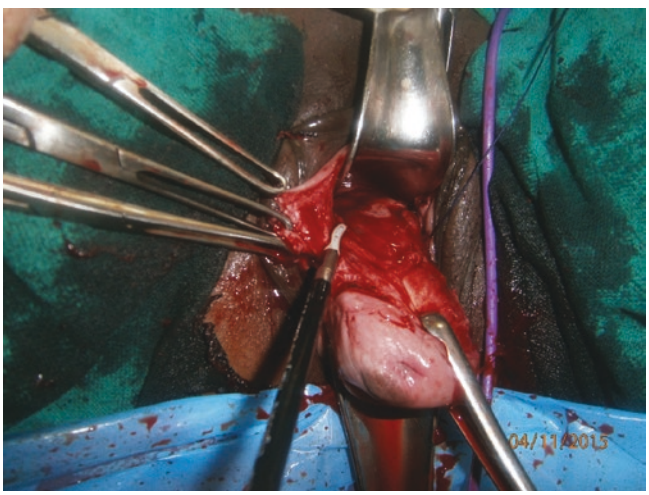


Fig. 118.20 Right Mackenrodt's ligament clamped

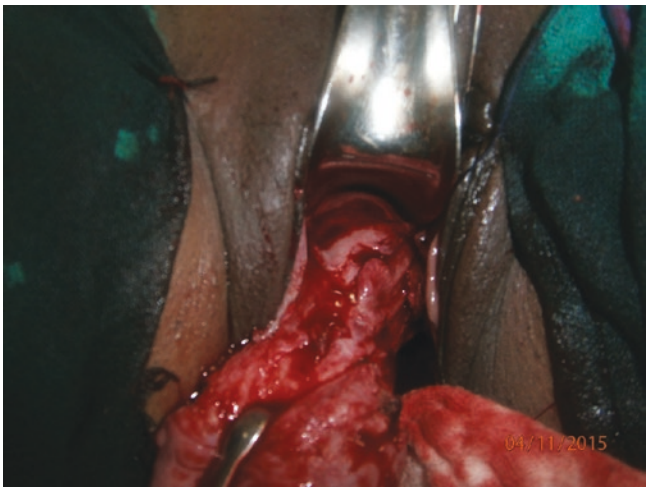


Fig. 118.21 Knuckle of uterine artery



Fig. 118.24 Clamp on right round ligament

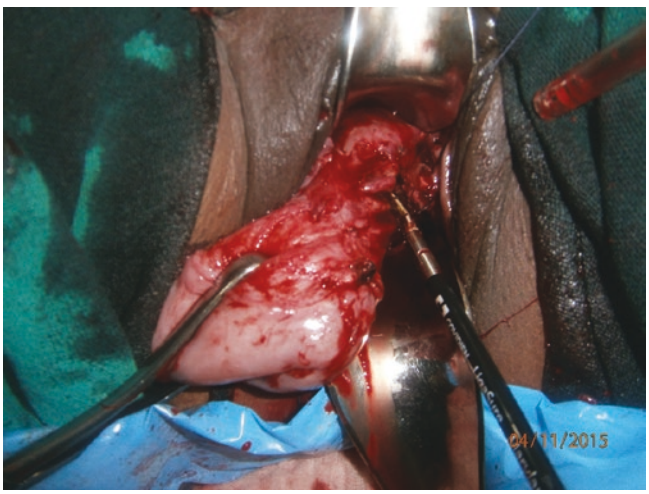


Fig. 118.22 Clamp on left uterine artery

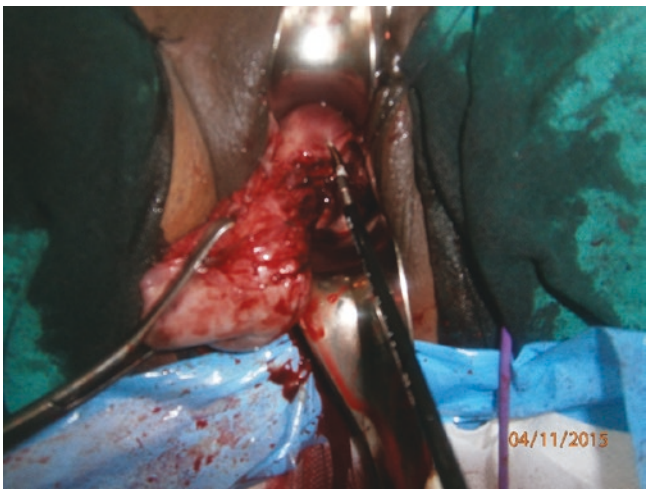


Fig. 118.25 Clamp on left round ligament

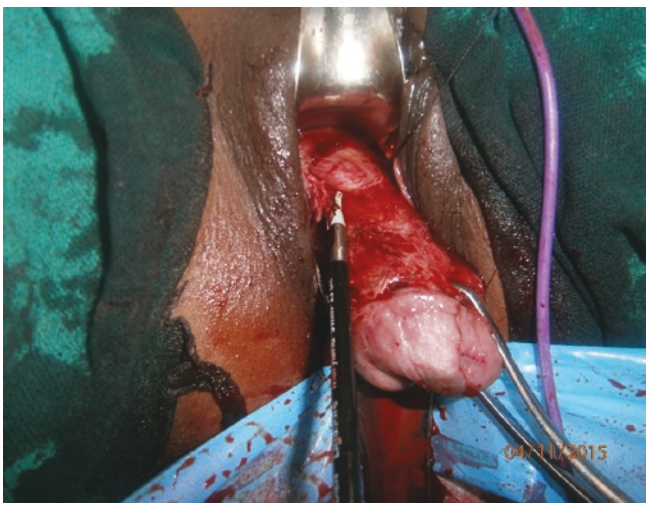


Fig. 118.23 Clamp on right uterine artery

Step 8: Division of Infundibulopelvic Ligament

Next the infundibulopelvic ligament is clamped. Downward traction is applied to the round ligament suture and the ovary is grasped in a sponge holder and gently pulled down. This will help in exposing the infundibupelvic ligament and the clamp can then be applied across it. Alternatively, traction on the uterine fundus delivers the fundus into the vagina and places tension on the IP ligament. A finger can then be inserted under the ligament and the clamp applied across it (Fig. 118.26). Always ensure that the end of the clamp is clearly visible and use a small sponge on holder to push away the intestinal loops coming in the operative area. Also, do not coagulate if the tissues are under traction as they can tear before complete hemostasis is achieved (Fig. 118.27).

If a salpingo-oophorectomy is difficult because of limited space or inaccessible IP ligament, only oophorectomy can be

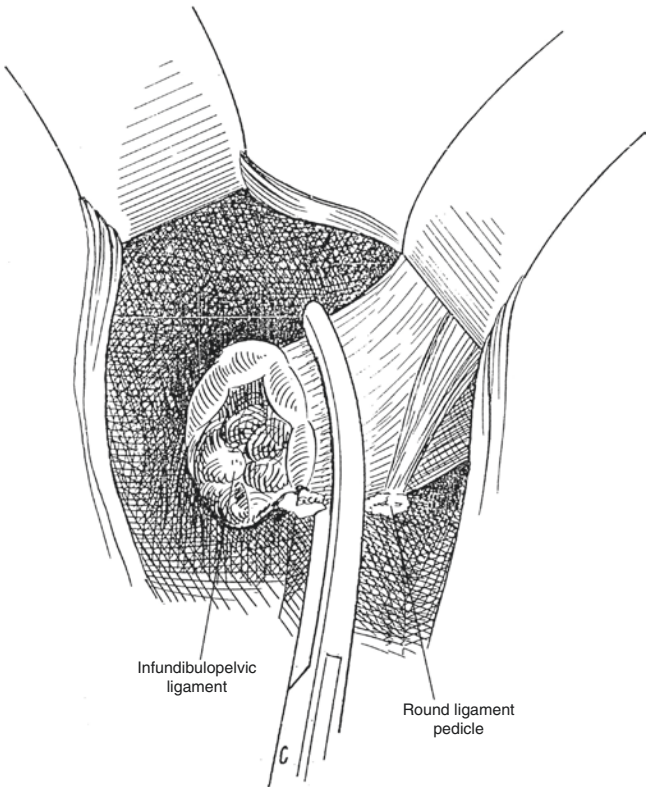


Fig. 118.26 Traction on the round ligament to facilitate clamping of the infundibulopelvic ligaments



Fig. 118.27 Clamp on right infundibulopelvic ligament

done. The ovary is gently pulled down with the help of Babcock's forceps and the diathermy clamp is applied on the mesovarium while keeping the fallopian tube away (Fig. 118.28).

Step 9: Reperitonization

The main goal of peritoneal closure following vaginal hysterectomy is to incorporate the strength of the sub-peritoneal

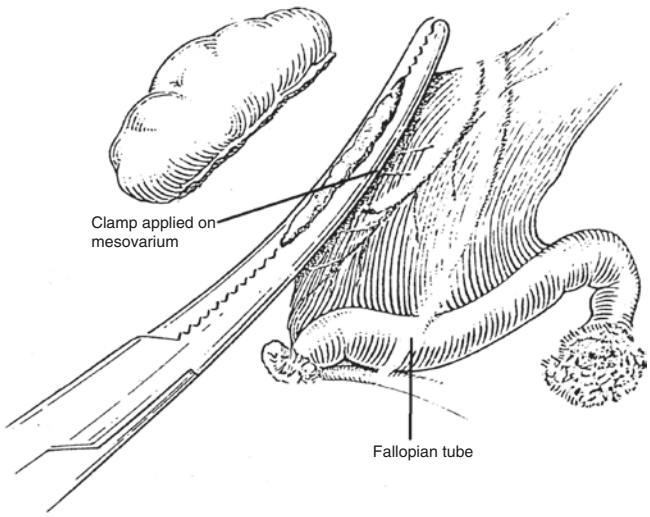


Fig. 118.28 Clamp on the mesovarium

connective tissue retinaculum into a firm scar at the bottom of the pelvis which resists increases in intra-abdominal pressure. A stitch is taken through the peritoneal side of left Uterosacral-Mackenrodt's ligament complex, the posterior peritoneum is reefed in a linear fashion in a series of bites till the same level on the right Uterosacral-Mackenrodt's ligament complex is reached. The suture is then passed through uterosacral ligament and adjacent peritoneum (Fig. 118.29). Then grasping the right adnexal pedicle, gentle traction is applied to bring round ligament into view and the stitch is passed through the round ligament proximal and medial to the previously placed pedicle ligature. The anterior peritoneum is reefed by series of bites which continue through the opposite round ligament. The purse string suture is then tightened and tied. The vaginal vault is then closed using continuous interlocking sutures in a longitudinal direction. Closing in this direction rather than from front to back provides an additional 2–3 cm of vaginal length.

Advantages of EBVS

Less Operative Hemorrhage

Levy B et al. compared procedure time and blood loss in 60 women undergoing vaginal hysterectomy with EBVS versus hysterectomy using sutures. They concluded that EBVS results in shorter procedure time as well as less blood loss (68.9 ml vs 126 ml; $p = 0.005$) [17]. Elhao et al. also found decreased blood loss in patients in whom vaginal hysterectomy was done using bipolar vessel sealing system (230 ml vs 360 ml; $p < 0.001$) [22]. Cronje et al. did not find any significant differences regarding blood loss (median blood loss 100 ml vs 160 ml) [23]. In a meta-analysis by Pergialiotis et al. which included eight randomized trials and 772 patients

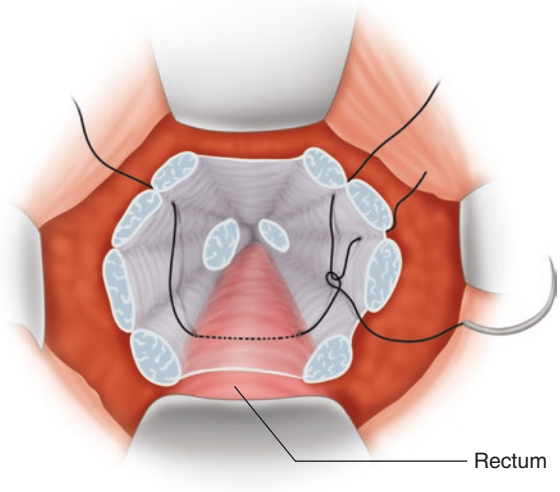


Fig. 118.29 Reperitonization

concluded that the intra-operative blood loss was significantly lower in the bipolar vessel sealing treated group (MD −49.4 versus 67.6). They did not find any significant difference in the operative duration or intra-operative complication rate [24].

Decrease in Operative Time

Vaginal hysterectomy using EBVS is associated with shorter operating time. Hefni et al. found the mean operating time to be 30 min in Ligasure group compared to 61 min in control group [25]. Silva-Filho Al et al. compared 45 women undergoing vaginal hysterectomy using EBVS with same number undergoing VH with conventional suture ligature. They found a significantly reduced operating time and operative blood loss (84 ml vs 136.4 ml; $p = 0.001$) [26]. Elhao et al. also found shorter surgery time (52.5 min vs 90 min; p<0.001) and less blood loss (230 ml vs 360 ml; $p < 0.001$) in participants undergoing vaginal hysterectomy using EBVS than those having conventional surgery [22]. Agrawal et al. also found significant reduction in operative time in the women who underwent VH using vessel sealing system as compared to the women in the conventional suturing technique. There was also a significant difference between the two groups in operative blood loss ($p = 0.0001$) and postoperative pain ($p = 0.0001$) [27]. None of the patients had any major surgical complications. Allam et al. compared total laparoscopic hysterectomy, vaginal and abdominal hysterectomy using vessel sealing technique in 90 women. They concluded that operative time for vaginal hysterectomy using this technique was shortened as compared to abdominal or laparoscopic hysterectomy (100.4 ± 35.8 min) [28].

Table 118.1 Operating time: comparative data from various studies

Author	VH using sutures (min)	VH using EBVS (min)	No. of hysterectomies in study (sutures: EBVS)
Agrawal et al.	70.03	57.34	60:65
Lakeman et al. [12]	76	60.5	50:50
Silva-Filho et al. [26]	75.2 ± 5	29.2 ± 2.1	45:45
Elhao et al. [22]	90	52	103
Cronje et al. [23]	40	32	31:37
Hefni et al. [25]	61	30	59:57
Levy et al. [17]	60	48	30:30

Significant reductions in operative time were found in various other studies also (Table 118.1).

Makes access easy EBVS system makes vaginal hysterectomy possible in situations of difficult access. In patients who are morbidly obese, have narrow vaginal canals or contracted pelvis can pose a surgical challenge. But as the space requirement is less while using this technique for vaginal hysterectomy, so it is the procedure of choice in such women.

Decrease in Post-operative Micturition Symptoms

In conventional vaginal hysterectomy traction is applied to the uterus to allow better visualization of tissues. This causes increased pain in the post- operative period and nerve damage which leads to micturition problems. While using bipolar sealing device the traction required on the uterus is less and also the tissues are cut closer to the uterus, which prevents innervational damage. This helps to decrease micturition symptoms in the post-operative period [3].

Decrease in Post-operative Pain

Gizzo et al. (2013) found EBVS to be significantly better than conventional vaginal hysterectomy in terms of intraoperative bleeding, number of sutures, surgical time and postoperative pain on day 1 and day 3 of surgery [29]. Lakeman MH et al. also reported significant less pain (5.7 versus 4.5 on scale of 0–10; $p = 0.03$) on first post-operative day but pain score were similar on subsequent days [15]. Vinita et al. also found significant reduction in post-operative pain in the group of patients who underwent vaginal hysterectomy using EBVS system [27].

Reduction in Thermal Spread

In spite of the high heat which is produced with its application, it produces minimal eschar and so minimizes the amount of lateral heat produced and hence the damage to surrounding tissue [30]. In a study by Kim et al., mean temperature of harmonic scalpel was 121.3 ± 97 ° C, LigaSure 76 ± 2.9 ° C (for liver). In the peritoneum, the Harmonic had a temperature of 195.9 ° C versus LigaSure which developed a mean temperature of 88.9 ° C [31]. The system also has no adverse influence on histology of margins of the resected tissue. Tissue adhesions are also rare with EBVS.

Learning Curve for Doing Vaginal Hysterectomy Using this Technique Is Easy

The forceps or the clamp of the EBVS system resembles the Heaney's hysterectomy clamp very closely. So, the vaginal surgeon needs no special training in the use of this instrument. Hefni et al. considered the use of EBVS as "operator independent" in contrast to suturing in vaginal hysterectomy which requires a high level of skill [25].

Facilitation of Oophorectomy at Vaginal Hysterectomy

As the vessel sealing achieved with EBVS system is reliable and the tissues more easily accessible, so the surgeon can do oophorectomy with more ease and confidence. Compared with women undergoing hysterectomy alone, those who underwent unilateral salpingo-oophorectomy had a hazard ratio for ovarian cancer of 0.58 and women who underwent bilateral salpingo-oophorectomy had a hazard ratio of 0.12 [32]. Also, prophylactic salpingectomy which is recommended for women at average risk for ovarian cancer is facilitated using EBVS technique [31].

Safe for Surgeon

It is also safe for the surgeon as it significantly reduces the risk of needle stick injury.

The Seal Achieved with EBVS Resists Dislodgement

The seal formed by the diathermy system is intrinsic to the vessel wall and so cannot be dislodged unlike the seals achieved with conventional suturing which can slip or dislodge.

Decrease in Hospital Stay

In the study by Silva et al. the hospital stay in women who underwent vaginal hysterectomy using the bipolar technique was significantly less (25.6 h versus 33.2 h; $p < 0.001$) [26]. Similar results were found in various other studies [33, 34]. Malinowski A et al. found the duration of hospital stay and complication rate similar in the women having vaginal hysterectomy via bipolar or conventional suturing technique [35]. Cronje et al. also found no significant differences regarding hospital stay in both the groups. (Median 2 days versus 2 days $p = 0.03$) [23]. Table 118.2 shows the comparative data regarding postoperative hospital stay.

In a meta-analysis done by Kroft J and Selk A which included seven studies and 662 women concluded that energy based vessel sealing devices decreased operative time by a mean of 17.2 min (seven studies, 662 patients; 95 % CI 7.5–27.0) and blood loss by a mean of 47.7 ml (five studies, 437 patients; 95 % CI 15.5–79.9) and postoperative hospital stay by 0.25 days(five studies, 554 patients; 95 %CI 0.13–0.37). They did not find any increase in the complication rate in their meta-analysis [36].

Complications of EBVS

Overall complication rate has been quoted as between 10–15 % in various studies [25, 36, 37].

Skin or mucosal burns: These are usually first degree thermal burns caused by prolonged contact of the forceps with the skin or vaginal wall. They can be prevented by keeping the forceps as close as possible to the uterus in the middle of the vagina and by taking greater care while maneuvering the instrument [38].

Table 118.2 Hospital Stay: comparative data from various studies

Author	VH using sutures (days)	VH using EBVS (days)	No. of hysterectomies in study (sutures: EBVS)
Silva-Filho Al et al. [26]	2	1	45:45
Cronje et al. [23]	2	2	31:37
Hefni et al. [25]	3	1.2	59:57
Zubke et al. [34]	7.1	5.8	40:40

Operative Hemorrhage

It can be prevented by not interrupting the flow of current too early. If necessary, coagulation must be repeated to ensure complete coagulation. The tissue after complete coagulation appears white, dry and parchment like. Also, too much traction should not be applied to the tissues because if coagulation is done on tissue which is already under tension, then it can tear before hemostasis is complete.

Post-operative Hemorrhage

Post-operative bleeding is seen in 1–2 % cases. The main causes [3] for this are:

Ignoring the "failed seal" tone given by the generator.

If the artery to be sealed is calcified.

Attempt to seal tissues with low amount of collagen such as veins.

Thermal Damage to Ureter

This can occur if uterine pedicle is clamped too laterally.

Thermal Damage to Bowel

These are caused if the tip of the clamp comes in contact with an intestinal loop or with wall of the colon during coagulation. This can be prevented by always keeping the tip of clamp under vision and keeping the bowel away with a mounted sponge during coagulation.

Tissue Sticking

This is a significant concern in electrosurgery as it increases the electrical resistance which inhibits energy delivery to the target tissue leading to ineffective hemostasis. Reduced sticking seen with EBVS system contributes to the consistent sealing seen with multiple firings also. Tissue sticking is generally seen in 1.39 % of vessels transected with ENSEAL and 13.3 % with Ligasure [39].

No Influence on Myoreduction Techniques

Techniques for myoreduction like morcellation, wedge resection, coring etc. may be required in vaginal hysterectomy to complete the surgery but they have not been shown to be influenced by the EBVS system.

The efficacy of vessel sealing system on atheromatous vessels is questionable. A normal artery consists of outermost layer called tunica externa which is composed of connective tissue made up of collagen fibres. Inside this is a tunica media of smooth muscles and elastin tissue. The innermost layer is tunica intima mainly made up of endothelial cells. However, in veins and atheromatous vessels the tunica media is thin because of less smooth muscles and elastin fibres, thereby decreasing the efficiency of EBVS on these vessels [40].

Conclusion

The use of energy based tissue sealing and cutting instruments is becoming popular in gynecological surgery. EBVS system is uniquely suited to vaginal surgery as it enables large caliber vessels to be sealed effectively and safely. The use of EBVS has enabled vaginal hysterectomy to be done in more complex cases. Its use during vaginal hysterectomy reduces the operative time and intra-operative blood loss without compromising on patient safety. EBVS is also associated with reduced post-operative pain and decreased hospital stay which translates into higher economic savings.

References

1. Kovac R. Evidence- based hysterectomy. Gynecol Obstet. 2013; 3(1):e110.
2. Aarts JW, Nieboer TE, Johnson, Tavender E, Garry R, Mol BW et al. Surgical approach to hysterectomy for benign gynecological disease. Cochrane Database Syst Rev. 2015;(8):CD003677.
3. Lakeman MM, van der Vaart CH, Roovers JP. Hysterectomy and lower urinary tract symptoms: a non- randomized comparison of vaginal and abdominal hysterectomy. Gynecol Obstet Invest. 2010;70:100–6.
4. Lee PI. Total laparoscopic intrafascial hysterectomy. J Am Assoc Gynecol Laparosc. 1996;3:S25.
5. Camanni M, Mistrangelo E, Febo G, Ferrero B, Deltetto F. Prophylactic bilateral oophorectomy during vaginal hysterectomy for benign pathology. Arch Gynecol Obstet. 2009;280(1): 87–90.
6. Robert M, Cenaileo D, Sepandj J, Lwanicki S. Success and complications of salpingectomy at the time of vaginal hysterectomy. JMIG. 2013;22:864–9.
7. Sheth SS. The place of oophorectomy at vaginal hysterectomy. Br J Obstet Gynaecol. 1991;98:662–6.
8. Sizzi O, Paparella P, Bonito C, et al. Laparoscopic assistance after vaginal hysterectomy and unsuccessful access to the ovaries or failed uterine mobilization: changing trends. JSLS. 2004;8: 339–46.
9. Purohit R, Shikha J, Gopal S. Adnexectomy during vaginal hysterectomy for benign indications using bipolar hemostasis of lateral pedicles and transvaginal adnexa mobilization. J Gynecol Surg. 2015;31(2):86–91.
10. Kennedy JS, Stranahan PL, Taylor KD, Chandler JG. High burst strength, feedback controlled bipolar vessel sealing. Surg Endosc. 1998;12:876–8.

11. Druzijanic N, Pogorelec Z, Perko Z, et al. Comparison of lateral thermal damage of human peritoneum using monopolar diathermy, harmonic scalpel and Liga Sure. Can J Surg. 2012;55:317–21.
12. Lakeman MM, The S, Schellart RP, et al. Electrosurgical bipolar vessel sealing versus clamping and suturing for vaginal hysterectomy: a randomized controlled trial. BJOG. 2012;119:1473–82.
13. Manouras A, Markoqiaakis HHE, Kekis PB, Laquidiaakis EE, Flemig E, et al. Novel hemostatic devices in thyroid surgery: electrothermal bipolar vessel sealing system and harmonic scalpel. Expert Rev Med Devices. 2008;14:447–66.
14. MDA 02037. Low/medium power electrosurgery review 2002. Medical devices agency. Accessible on www.pasa.nhs.uk/cep.
15. CEP 07019. Electrosurgical vessel sealing in vaginal hysterectomy 207. Centre for Evidence – based purchasing. www.pasa.nhs.uk/cep.
16. Kondrup JD, Anderson F, Quick B. Use of ENSEAL G2 tissue sealer in gynecologic surgery. Surg Technol Int. 2013;23:191–5.
17. Levy B, Emery L. Randomized trial of suture versus electrosurgical bipolar vessel sealing in vaginal hysterectomy. Obstet Gynecol. 2003;102(1):147–51.
18. Kovac SR, Cruikshank SH. Guidelines to determine the route of oophorectomy with hysterectomy. Am J Obstet Gynecol. 1996;175:1483–8.
19. Kammerer D, Dorothy N, Magrina J, Weaver A, et al. Vaginal hysterectomy with and without oophorectomy: the mayo clinic experience. J Pelvic Surg. 1996;2(6):304–9.
20. Karp DR, Mukati M, Smith AL, Suciu G, et al. Predictors of successful salpingo-oophorectomy at the time of vaginal hysterectomy. J Minim Invasive Gynecol. 2012;19(1):58–62.
21. Mehta S. Aqua dissection in NDVH. In: Goel N, Rajaram S, Agarwal R, Mehta S, editors. Step by step non-descent vaginal hysterectomy. 2 ed. Delhi: Jaypee Publishers; 2010.
22. Elhao M, Abdallah K, Seraq I, et al. Efficacy of using electrosurgical bipolar vessel sealing during vaginal hysterectomy in patients with different degrees of operative difficulty: a randomized control trial. Eu J Obstet Gynecol Reprod Biol. 2009;147(1):86–90.
23. Cronje HS, de Coning EC. Electrosurgical bipolar vessel sealing during vaginal hysterectomy. Int J Gynecol Obstet. 2005;91(3):243–5.
24. Pergialiotis V, Vlachos D, Rodolakes A, et al. Electrosurgical bipolar vessel sealing for vaginal hysterectomies. Arch Gynecol Obstet. 2014;290(2):215–22.
25. Hefni MA et al. Safety and efficacy of using the Ligasure vessel sealing system for securing the pedicles in vaginal hysterectomy: randomized controlled trial. BJOG. 2005;112(3):329–33.
26. Silva-Filho AL, Rodriques AM, de Castro Monteiro V, et al. Randomized study of bipolar vessel sealing system versus conventional suture ligature for vaginal hysterectomy. Eu J Obstet Gynecol Reprod Biol. 2009;146(2):200–3.
27. Agrawal VB, Agrawal A, Agrawal SB. Comparison of efficacy of bipolar electrosurgical vessel sealing with conventional suturing in securing vascular pedicles during vaginal hysterectomy. Int J Med Sci Public Health. 2014;3(11):1325–8.
28. Allam IS, Makled AS, Gomma IA, et al. Total laparoscopic hysterectomy, vaginal hysterectomy and total abdominal hysterectomy using electrosurgical bipolar vessel sealing system: a randomized controlled trial. Arch Gynecol Obstet. 2015;291(6):1341–5.
29. Gizzo S, Burul G, Di Gangi S, et al. Ligasure vessel sealing system in Vaginal hysterectomy: safety, efficacy and limitations. Arch Gynecol Obstet. 2013;288(5):1067–74.
30. Slaky DP. Laparoscopic liver resection using a bipolar vessel sealing device: Liga Sure. HPB (Oxford). 2008;10(4):253–5.
31. Kim FJ, Chammas MF, Gewehr E, Morihisa M, Caldas F, et al. Temperature safety profile of laparoscopic devices: harmonic ACE, Liga Sure V and plasma trisector (PT). Surg Edosc. 2007;22:1464–9.
32. Chan JK, Renata U, Angela C, Vanessa J, et al. Ovarian cancer rates after hysterectomy with or without salpingo-oophorectomy. Obstet Gynecol. 2014;123(1):65–72.
33. Kho RM, Magrina JF. Round ligament technique and use of vessel sealing device to facilitate complete salpingectomy at time of vaginal hysterectomy. J Minim Invasive Gynecol. 2015;22(6):1084–7.
34. Zubke W et al. Vaginal hysterectomy: a new approach using bicoagulation forceps. Gynecol Surg. 2004;1:179–82.
35. Malinowski A, Pawlowska N, Wojciechowskin M. The use of thermostapler bipolar vessel sealing system in vaginal hysterectomy. Gine Kol Pol. 2008;79(12):850–5.
36. Kroft J, Selk A. Energy based vessel sealing in vaginal hysterectomy: a systematic review and meta-analysis. Obstet Gynecol. 2011;118(5):1127–36.
37. Makinen J, Johansson J, Tomas C, et al. Morbidity of 10110 hysterectomies by type of approach. Hum Reprod. 2005;16(7):1473–8.
38. Garry R, Fontain J, Mason SV, et al. The eVALuate Study: two parallel randomized trials, one comparing laproscopic hysterectomy with abdominal hysterectomy, the other laproscopic with vaginal hysterectomy. BMJ. 2004;328:129.
39. Clave H, Baar H, Niccolai P. Painless vaginal hysterectomy with thermal hemostasis: results of a series of 152 cases. Gynecol Surg. 2005;2:101–5.
40. Chekan EG, Davison MA, et al. Consistency and sealing of advanced bipolar sealers. Med Devices. 2015;8:193–9.

119 The Advantages in the Selection and Use of Bipolar Vessel Sealing Devices in Vaginal Hysterectomy, Dependent on the Different Degrees of Operative Difficulty

Mohamed Ellaithy and Wael Agur

In General, Vaginal Hysterectomy Is the Preferred Route for Hysterectomy

Current evidence demonstrates that vaginal hysterectomy (VH) is generally associated with fewer complications and better outcomes. A Cochrane review of 34 randomized trials of VH, abdominal hysterectomy, and, laparoscopic hysterectomy including 4495 women, concluded that among these three routes, VH has the best outcomes [1].

Compared to abdominal hysterectomy, VH is associated with quicker return to normal activities, fewer postoperative infections and febrile morbidities and a shorter hospital stay [1–3]. Compared to laparoscopic hysterectomies, vaginal hysterectomies are not lengthy operations and carry a less risk of bladder and ureteric injuries and a lower rate of substantial bleeding [1]. Based on its well-documented advantages and lower rates of complication, ACOG Committee on Gynecologic Practice recommended VH as the approach of choice [4].

The Challenging VH

VH constitutes only 23 % of the hysterectomies performed in the United States. Traditionally, so many gynecologists have avoided VH and used it only in carefully selected women [5]. Uterine enlargement, previous pelvic surgery, absence of uterine descent, a narrow pubic arch (<90°), limited vaginal and pelvic spaces, nulliparity, obesity, and the need for concomitant oophorectomy should no longer be considered as contraindications to VH [5–9].

Many women who have not given vaginal birth and many nulliparous women, have sufficient vaginal caliber to allow a successful completion of VH [10]. When the uterine descent is minimal, if the vagina allows access to divide the uterosacral and Mackenrodt's ligaments uterine mobility is improved enough to allow VH [6]. When the uterus is enlarged, VH often can be completed safely by using uterine debulking techniques (Figs. 119.1, 119.2, 119.3 and 119.4) [11]. The need for salpingoophorectomy is not a contraindication to perform VH as the success rate of performing a salpingoophorectomy during VH is reported to range from 65 to 97.5 % [12–15].

Of great importance for the vaginal surgeon is the ability to easily access, visualize, and ligate pedicles and maintain an

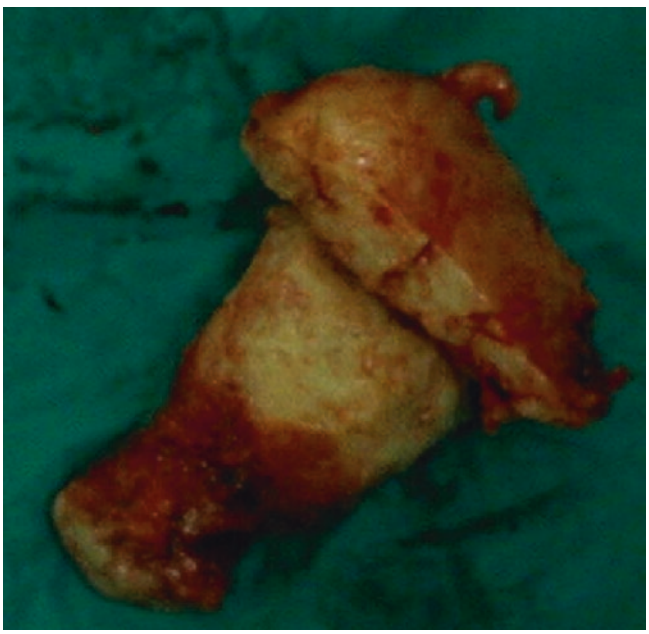


Fig. 119.1 Debulking techniques – uterine coring

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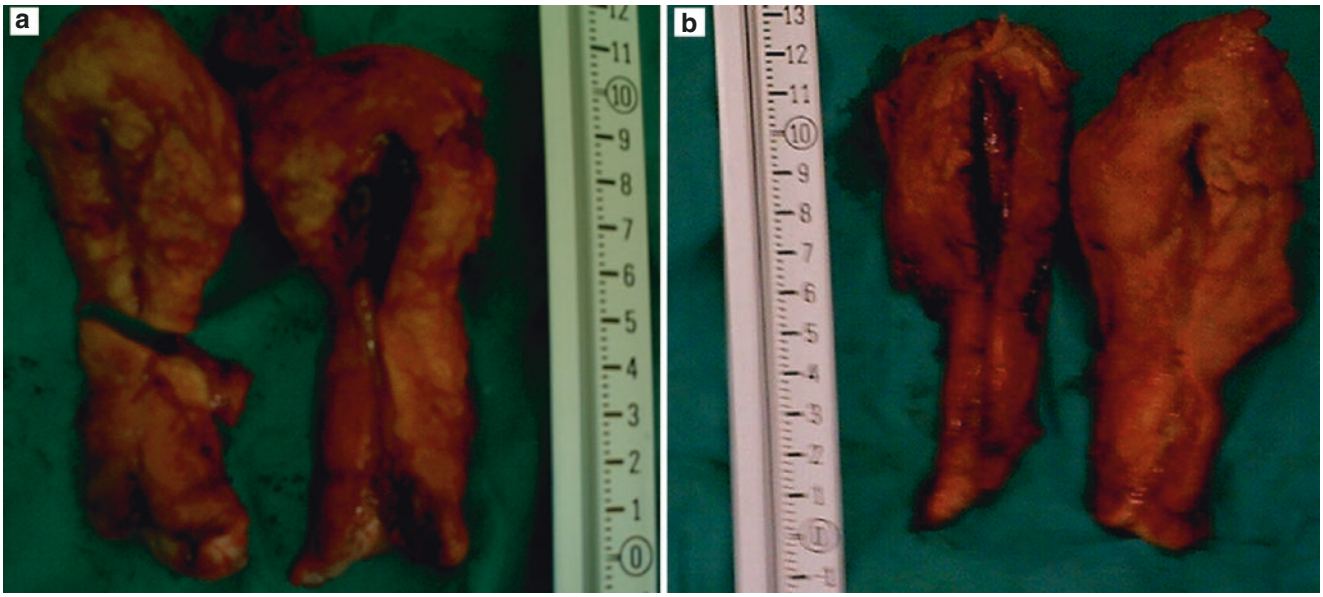
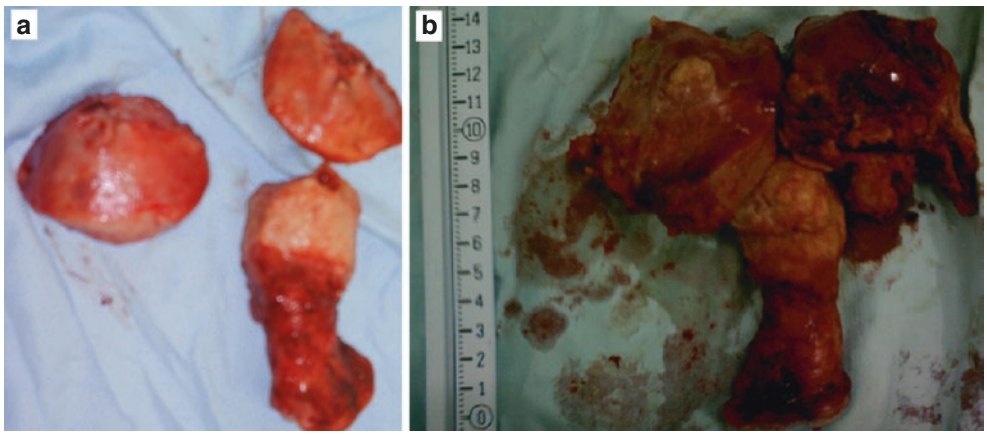


Fig. 119.2 Debulking techniques – uterine bisection technique [two cases (**a**) and (**b**)]

Fig. 119.3 Debulking techniques – uterine coring and bisection [two cases (**a**) and (**b**)]



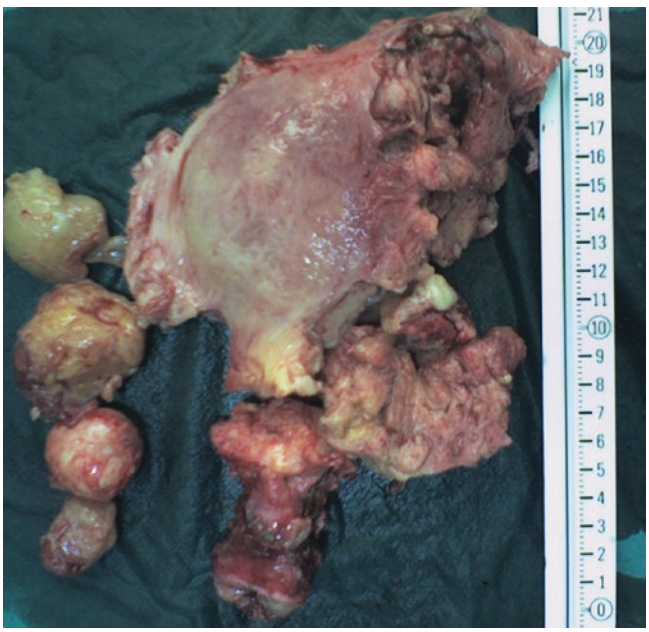


Fig. 119.4 Debulking techniques – uterine morcellation (Piecemeal removal of a large uterus)

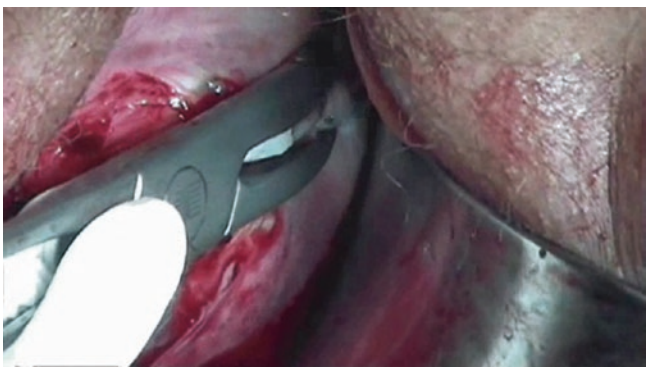


Fig. 119.5 Difficult access (bulky uterus and narrow space)

adequate hemostasis. During challenging VH, there is a limited space to access the vascular pedicles, specifically for suture ligation. The introduction of Electrobipolar vessel sealing (EBVS) systems, in VH, has facilitated the achievement of proper hemostasis in situations of difficult access (Figs. 119.5 and 119.6) into the pelvis, allowing vessels sealing with great ease and safety while reducing blood loss and operating time [16].

The Advantages of Using EBVS in VH with the Different Degrees of Operative Difficulty

VH solely using sutures is a challenging surgical technique and placing sutures on distant pedicles deep in the pelvis is problematic [17]. Hereby, the advantages of using EBVS in performing VH are thoroughly discussed:

- **EBVS is unique among the other hemostatic methods:**

Unlike the mechanical methods (suturing, clips, staples), EBVS does not introduce foreign bodies into the patient and is not cumbersome for the gynecologist faced with limited vaginal visibility and access. The bipolar current used in EBVS technology, eliminates the risk of capacitive coupling and unintentional injury to alternate sites that can occur with monopolar systems. As EBVS rapidly delivers a lower voltage electrical current, it is able to effectively seal the pedicles without sticking, tissue charring (Fig. 119.7) or significant thermal spread [16, 18].

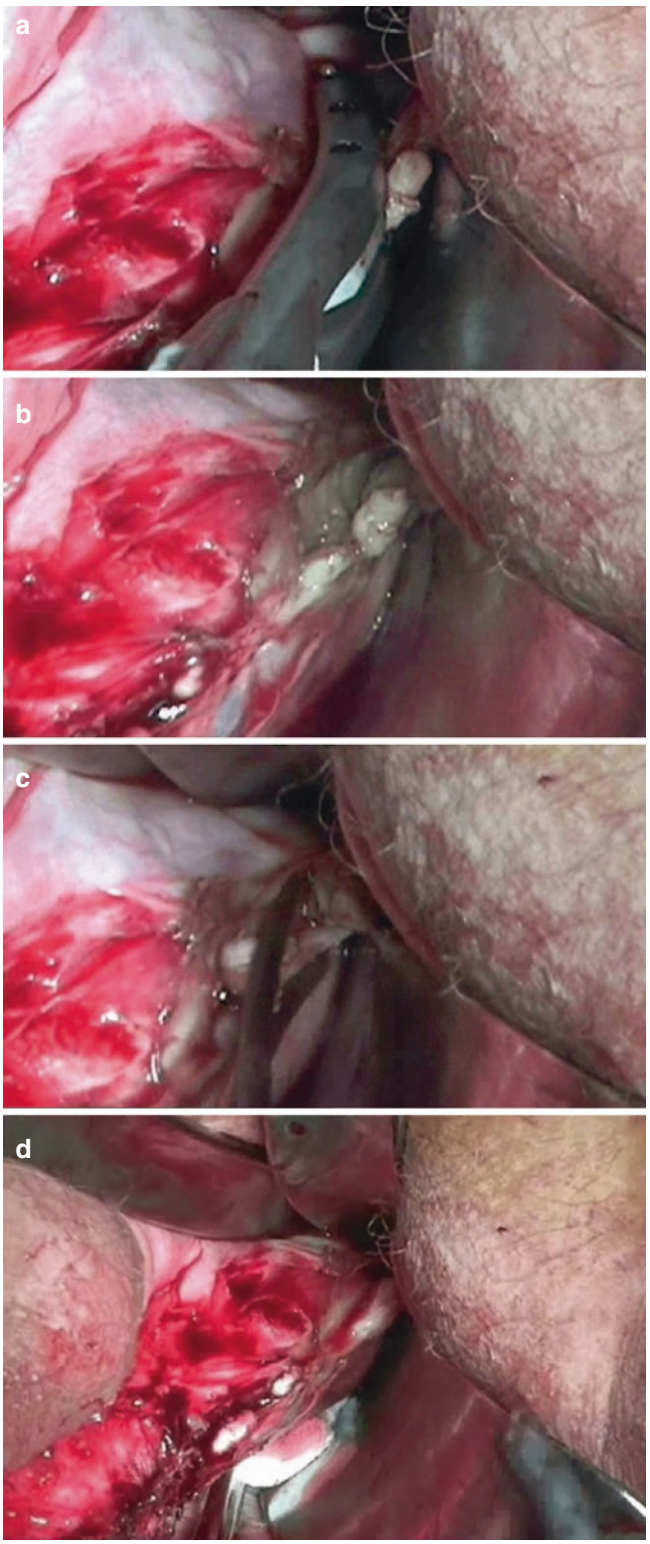


Fig. 119.6 EBVS is ideal in performing VH especially in situations of difficult access (**b**, **d**) (fewer instruments are used simultaneously (**a**, **c**))

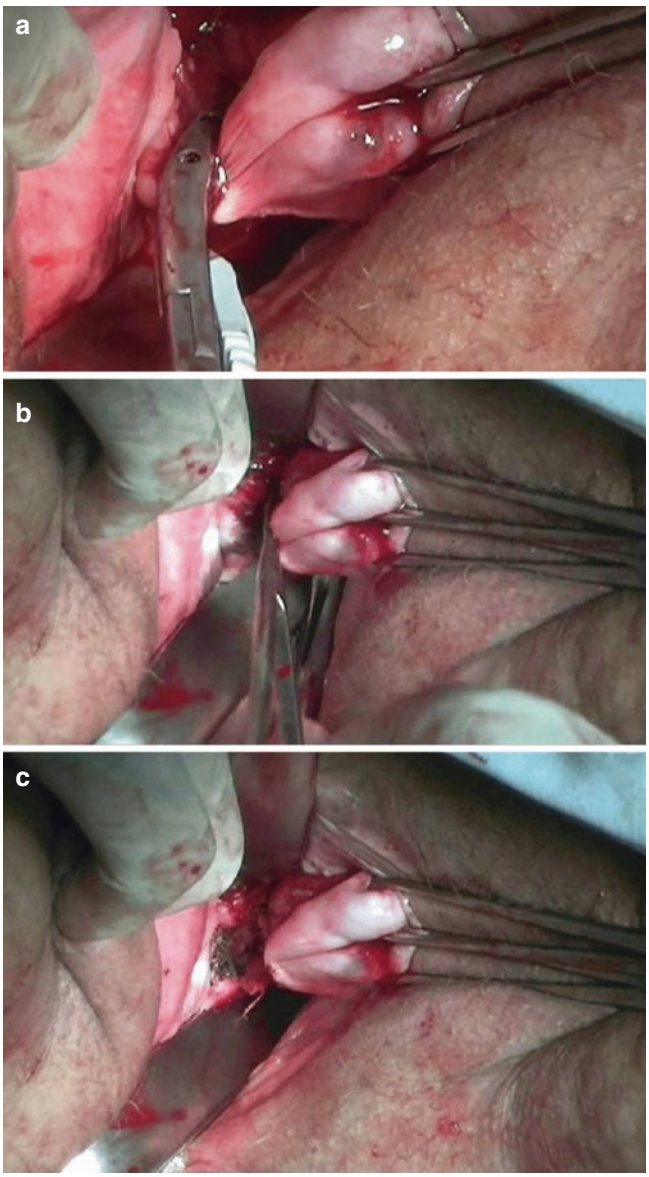


Fig. 119.7 Use of EBVS (**a**, **b**) is associated with minimal tissue charring (**c**)

- **EBVS can effectively secure all vascular pedicles during VH:**

The device can effectively seal all pedicles during VH including the transverse cervical ligament, the broad ligament containing the uterine arteries, the round ligament and the infundibulopelvic ligament [19]. EBVS is also effective on the bladder and rectal pillars, the transverse cervical ligament, and the paravaginal vascular bundles even without dissection. EBVS may occasionally fail to provide adequate hemostasis from the first attempt in structures with more connective tissue content such as the utero-ovarian and utero-sacral ligament and the vagina [20, 21].

- **EBVS saves operative time:**

Shorting of the pedicle dissection time could effectively decrease the total operative time during VH. In comparison to the traditional suture technique, EBVS could reduce the operating time by 8–37 min. This is particularly valuable when performing the challenging cases of VH with large, bulky uteri and/or a narrow pelvis [16, 19, 22–24]. From an economic point of view, the decrease in operating time can be utilized to increase the number of cases done on each theatre list.

- **EBVS decreases blood loss:**

As EBVS can rapidly and effectively secure the vascular pedicles during VH with significant shortening in the operative time, with subsequent significant reduction in the blood loss. The role of EBVS in reducing the operative blood loss was more pronounced in the difficult cases of VH [16, 19, 22].

- **EBVS has minimal lateral thermal damage and good safety profile:**

When compared with the traditional suturing technique, EBVS has been proven to be a safe and effective technique to perform VH. The complications rate was not significantly different between both techniques. Notably in the challenging cases of VH, EBVS decreases intra-operative conversion from vaginal to abdominal hysterectomy [24].

Thermal effects are usually limited to <1.5 mm beyond the grasped tissues [25]. This minimal lateral thermal spread enables the device to be safely used near important pelvic structures [19, 20]. However, positioning of the tip of the instrument near to forceps, metal clips or wet tissues (sponge) and fluid collections should be avoided, since heat may be transferred into tissues resulting in inadvertent organ injury [26]. During VH, the activated hand-piece, which is hot, should not contact the patient skin as it can lead to a labial burn [24]. As the steam from the EBVS devices (Fig. 119.8) may also cause burns; a suction device and a wet Ray Tec sponge must be used when the clamp is in close proximity to the vaginal sidewalls or labia.

- **EBVS produces strong seals:**

EBVS technology rapidly produces strong seals, using lower voltages and subsequently causes no significant sticking or tissue charring [27]. EBVS effectively seals vessels and maintains closure with one application at a level of pressure appropriate for clinical use. Validation in bench and animal models shows that EBVS systems can effectively seal blood vessels up to 7 mm in diameter. These seals can withstand a systolic blood pressure ≥360 mmHg for a minimum of 10 s. The pressure required to burst the sealed vessels is 1025 mmHg [28].

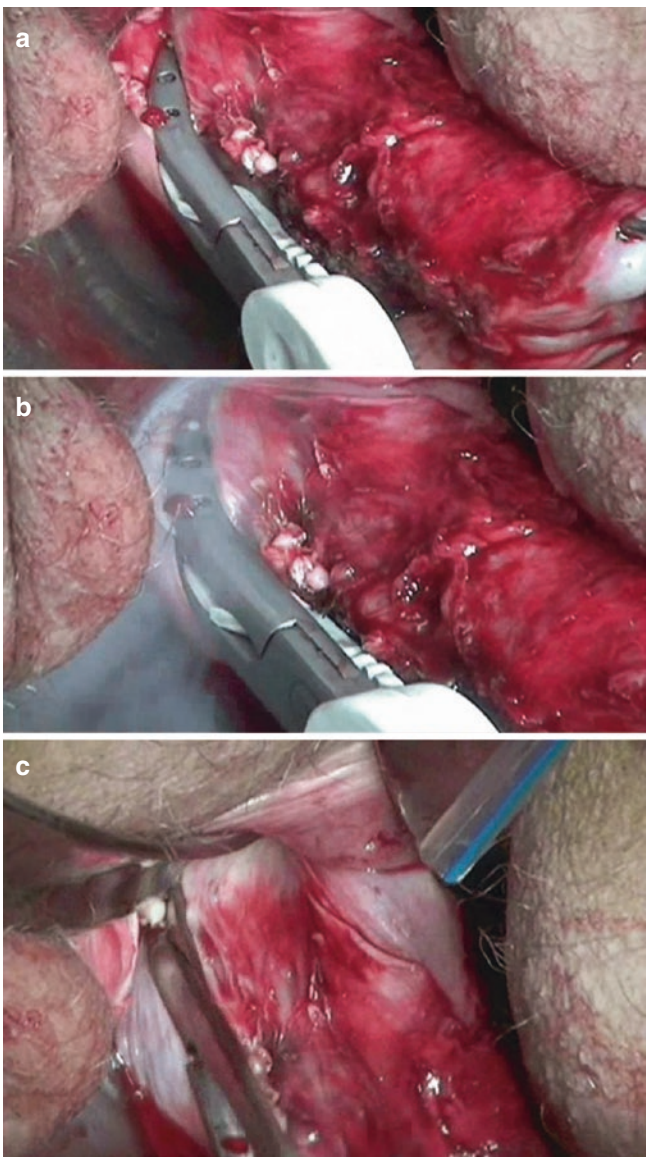


Fig. 119.8 Hot steam (**b**) is released from the EBVS devices (**a**) during VH, use of suction devices is recommended (**c**)

Recent studies, comparing EBVS with bipolar coagulation, ultrasonic coagulation, and surgical sutures and clips, demonstrated that EBVS creates seals stronger than other energy-based methods, and similar, in strength, to the mechanical techniques [25].

- **EBVS minimizes postoperative pain:**

EBVS reduces the pain perception during the immediate postoperative period. This can be attributed to: (a) Decreased intraoperative manipulation, compression and traction. (b) No foreign materials (e.g. clips or sutures) are left in the pelvic cavity. (c) No ischemic tissues are left distal to the suture or clip (including nerves) which can necrose post-operatively causing pain and infection [29].

- **EBVS reduces postoperative stay (outpatient VH)**

When using EBVS for VH, it is possible to reduce the hospital stay by 1 day, compared with using sutures alone. Furthermore, EBVS encourages gynecologists to switch to the vaginal route for hysterectomy with further reduction in the hospital stay by at least 2–3 days, compared with the abdominal route [30].

Nowadays, outpatient surgery is becoming one of the most important evolution axes of the surgery. The use of EBVS reduces the operative time and postoperative pain and makes outpatient VH possible. A recent French study, about outpatient VH, 36.7 % of women were very satisfied, 53.3 % were satisfied and 10 % were not much satisfied. Overall, 83.3 % of women agreed to repeat the procedure in the ambulatory care sector. The authors concluded that outpatient VH is a possible and a safe technique and is associated with a high patient's satisfaction [31].

In addition to the patient benefit, the reduction in the hospital stay can provide a financial incentive for using EBVS in hysterectomy.

- **EBVS facilitates difficult and challenging VH and facilitates the procedure for the less experienced surgeons:**

During VH, Space requirements are less for EBVS than when using traditional sutures (Figs. 119.5 and 119.6), because fewer instruments need to be used simultaneously. EBVS can also reduce bleeding and facilitate hemostasis especially at the sites of difficult access. This will be of great value especially while performing difficult cases of VH and also while training less experienced surgeons to perform VH. EBVS and the use of debulking techniques would enable many surgeons to complete the operation of VH in women with no uterine descent and bulky uteri [22].

- **EBVS facilitates Adnexectomy at time of VH:**

At the time of hysterectomy, the decision to perform prophylactic oophorectomy should be based solely on the patient's age and risk factors. VH should not be a barrier to remove the ovaries during hysterectomy (Fig. 119.9) [4]. EBVS can effectively facilitate oophorectomy at the time of VH even in less experienced hands. In one study salpingoophorectomy was performed successfully in 20 % cases either unilateral or bilateral, if needed, according to the clinical situation [22].

- **EBVS, is it cost effective?**

The initial EBVS generator investment cost and the ongoing annual consumable costs should be weighed against the potential cost savings from reducing the patient hospital stay and reducing the consumed suture materials. EBVS systems using reusable forceps (ERBE and Martin) have the lowest annual running cost, assuming that the reusable forceps needs to be replaced only after performing 50 cases. For the other systems, the increased cost spent in disposable forceps is usually cost effective if accompanied by reducing the patient's hospital stay. Some systems (ERBE, BOWA & Martin) use general purpose electrosurgical units with

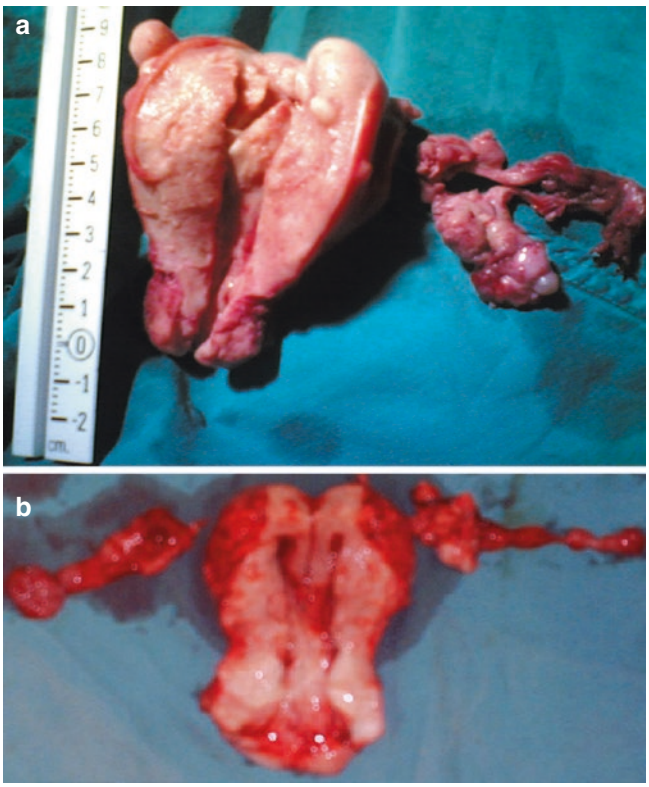


Fig. 119.9 Salpingoophorectomy can be easily performed during VH using EBVS [two cases (**a**) and (**b**)]



Fig. 119.10 VH using EBVS requires only one suture for vaginal cuff closure

specific modes designed for specialist vessel sealing instruments. Others (Valleylab LigaSure & Gyrus PK System) are based on specialist bipolar electrosurgical units [18].

Although there are great variations can exist regarding patient's hospital stay, according to the surgeon and patients expectations, EBVS can play a great role to minimize the duration of hospital stay after hysterectomy by 1–3 days [18]. EBVS patients require only one suture for closure of the vaginal vault (Fig. 119.10), with subsequent saving of ±6 sutures per case [19, 23].

Three additional factors can add to the cost effectiveness of using EBVS in performing VH. First, EBVS decreases intra-operative conversion from vaginal to abdominal hysterectomy [24], this is an important additional factor in the overall cost saving while performing VH using EBVS especially in the challenging cases [18] The same apply when using EBVS technology to preoperatively schedule these cases for VH rather than AH or LAVH. Second, EBVS consistently reduces operating time for VH, this can increase the number of cases scheduled in the OR list every day [18] Third, EBVS reduces pain in the immediate postoperative period resulting in reduced use of morphine [32, 33].

Preoperative Assessment for the Feasibility and Expected Difficulty of VH

- **Uterine size**, there is no universal agreement about the upper limit of uterine size suitable for VH, however some surgeons consider 16-week uterine size as a practical cut-off [34]. When vaginal access is adequate and the lower uterine segment is surgically accessible, VH can be accomplished for large uteri (up to 22-week size) using uterine debulking techniques (myomectomy, morcellation, bisection, and/or coring) by an appropriately skilled surgeon [3, 22].
- **Uterine accessibility**, some authors claims that the presence of narrow subpubic angle (<90°), narrow vagina, undescended uterus, and nulliparity are all solid contraindications for VH [4]. However, it is more wise to say that if the surgeon has an adequate space to divide the uterosacral and cardinal ligaments then the uterine mobility can be improved to allow completion of procedure [6].
- **Extrauterine pathology**, extrauterine diseases e.g. adnexal pathology, endometriosis, obliterated cul-de-sac or pelvic adhesions, may preclude VH. VH is not preferred when thorough examination of the abdomen is needed.
- **Prior cesarean delivery**, previous cesarean section is not a contraindication to VH. However, the presence of previous pelvic surgery with lower uterine segment scarring, can result in bladder trauma, excessive bleeding, and ultimate failure to perform the hysterectomy procedure vaginally.
- **Nulliparity**, VH is not contraindicated in case of nulliparity. Women who do not have vaginal deliveries and nulliparous women can undergo VH safely [35].
- **Obesity**, VH is not contraindicated in case of obesity [36].
- **Clinician and patient preferences**, the surgeon's preference and practice style can influence the choice of hysterectomy route. Additionally, an appropriately informed patient who is aware about the advantages and disadvantages of each type of hysterectomy can aid the surgeon to arrive at the best surgical route suitable for patient's disease and circumstances [37].
- **Preoperative investigation**, a preoperative ultrasonography is done to assess the size of the uterus, number, site and size of fibroid and any adnexal pathology. Preoperative hemoglobin, hematocrit and blood grouping are measured for every patient.

Intraoperative Assessment of the Feasibility and Expected Difficulty of VH

- **Examination under anaesthesia**, Examination under anaesthesia forms an integral part of assessment of feasibility of the hysterectomy by vaginal route. It confirms the preoperative findings and evaluates uterine size, mobility and descent to finalize the decision about route of hysterectomy and also about the expected degree of difficulty of VH if feasible. The size of the uterus is evaluated meticulously, mobility of uterus is also assessed both anteroposteriorly as well as laterally, to provide an accurate assessment of parauterine space. Descent of Cervix is an important factor in the feasibility of VH. If the cervix is visualized on introduction of the Sim's speculum it indicates good descent. Descent of cervix can also

Table 119.1 Modified Seth's score used for per-operative assessment of VH procedural difficulty

	0	1	2
Uterine size	≤8 weeks	9–10 weeks	≥12 weeks
Previous abdominal surgery (e.g. CS)	None	–	Present
Vaginal width	>3 fingers	3 fingers	<3 fingers
POPQ stage	2	1	0
Uterine mobility	Good	Fair	Poor
Subpubic angle	>90°	90°	<90°
Fornices depth	> 1 finger	1 finger	< 1 finger
Surgeon grade	Senior consultant	Junior consultant	Trainee
The score varies from a minimum of 0 to a maximum of 16			

assessed by the volsellum test (Volsellum is applied on the anterior lip under anaesthesia and cervix is pulled downwards). The length of the vaginal fornices is assessed by measuring the distance between the lateral fornix and the cervix at the level of the external os. Fibroids, if any, are assessed. Size, accessibility and position of the fibroid are evaluated meticulously. The breadth of the vagina is assessed with fingerbreadths at the fornix and the pelvis is evaluated by measuring the subpubic angle.

- **Per-operative Scoring**, Several clinical scoring systems have been evolved taking into consideration all factors responsible for the success of the surgery and its difficulty, Table 119.1 illustrates modified Seth's scoring system used for per-operative assessment of procedural difficulty. Procedures can classified into either: 'straightforward' or 'difficult'. A score of less than eight categorised the procedure as 'straightforward' [22].

Using EBVS in VH, Intraoperative Surgical Considerations

EBVS is an energy based technology that use an alternate electrosurgery form to denature the vessel wall content of collagen and elastin and subsequently convert these proteins into a hemostatic seal. This remodeling requires the combined application of mechanical energy (pressure) in conjunction with the electrical energy. During activation, the electrosurgical generator is designed to monitor tissue response through measuring the voltage and current. The resistive heating will change the tissue impedance and subsequently the voltage and current will vary. A cool cycle starts once the tissue impedance indicates a successful seal. After cooling, the generator will emit an audible tone to indicate cycle completion. On average, it takes approximately 5 s to complete one sealing/cooling cycle, during which the device position should be maintained in place [16].

The EBVS clamp is used in exactly the same fashion as standard hysterectomy clamps. Pedicles are clamped, sealed, and

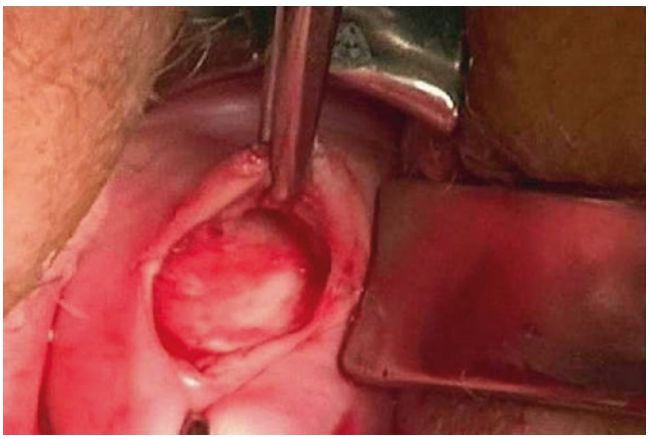


Fig. 119.11 Anterior colpotomy and creating the bladder flap. While doing a downward traction on the cervix, incision is made into the anterior vaginal mucosa at the level of the cervico-vaginal mucosa, this is followed by blunt and/or sharp dissection to push the urinary bladder away from the cervix. Later on during VH, the anterior peritoneal reflection will be identified and the anterior cul-de-sac (vesico-vaginal space) will be entered

then cut on the uterine side before the clamp is released and advanced to the next pedicle (another option is to release the clamp and divide the sealed tissue to avoid back bleeding from the uterine specimen). Traction on the cervix and any tissue traction should be avoided while sealing all pedicles as the surface of clamp in contact with the grasped tissue is smooth and can be easily slipped once the sealing cycle is activated. Supporting the EBVS clamp during the sealing cycle is also beneficial to ensure that the clamp is in contact with grasped pedicle and does not slip. The device can be used on all pedicles beginning with the cardinal ligament, the broad ligament including the uterine arteries, and the round and uteroovarian ligaments. After completing the colpotomy, creating the bladder flap (Fig. 119.11) and opening the Douglas pouch (Fig. 119.12), continue as the following:

1. Clamp, avoid tissue traction and support EBVS clamp, seal, and divide uterosacral ligaments and cardinal ligaments (Fig. 119.13).

2. Clamp, avoid tissue traction and support EBVS clamp, seal, and divide uterine vessels (Fig. 119.14).
3. Clamp, avoid tissue traction and support EBVS clamp, seal, and divide broad ligaments (Figs. 119.15, 119.16 and 119.17).
4. Clamp, avoid tissue traction and support EBVS clamp, seal, and divide utero-ovarian pedicles (Fig. 119.18).

After excision of the uterus (Fig. 119.19), the closure of the vaginal cuff is performed in a way identical to that of the classic VH (Fig. 119.20). Suturing the sealed parts of the uterosacral and cardinal ligaments into the vaginal apex, if feasible, would aid the support of vaginal vault.



Fig. 119.12 Posterior colpotomy and opening the Douglas pouch. The posterior pelvic cul-de-sac is incised and sharp scissors are used to go into the vagina through the posterior cul-de-sac

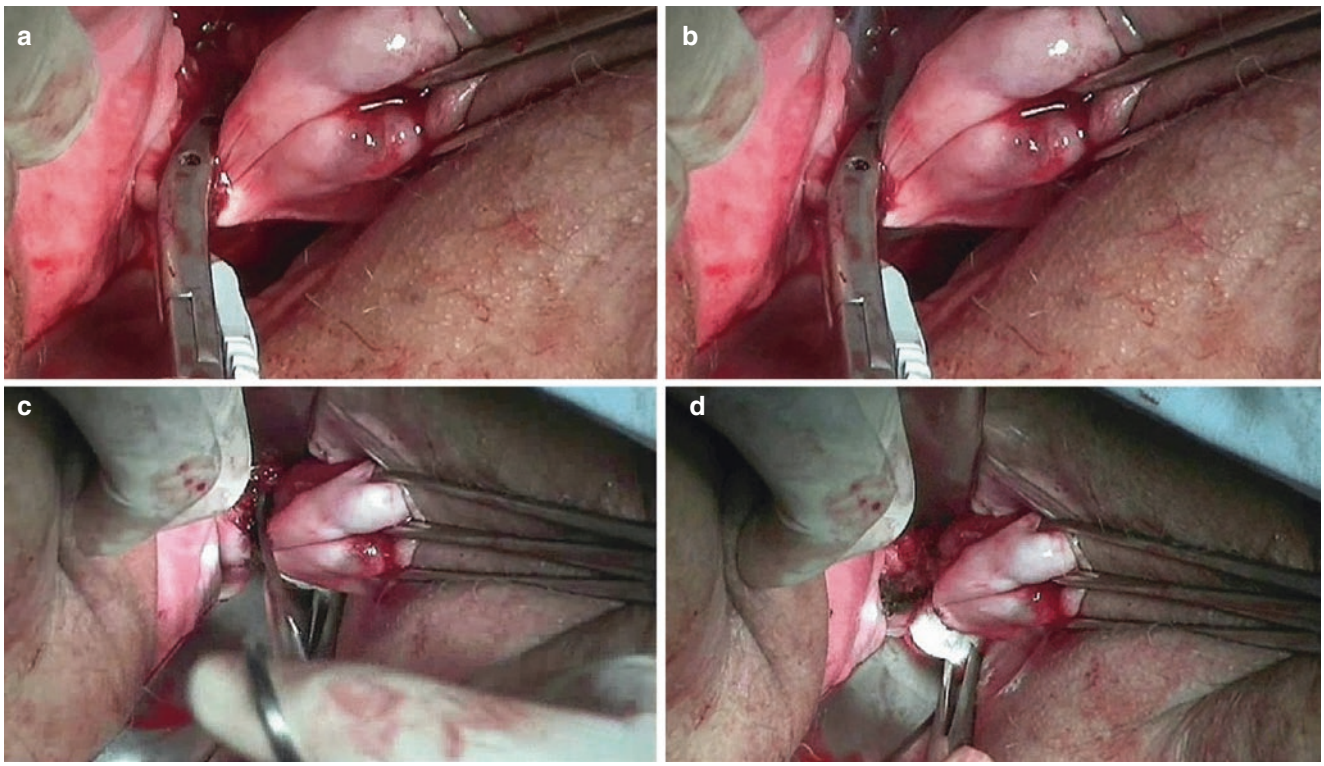


Fig. 119.13 Management of the left uterosacral ligaments and cardinal ligaments using EBVS. Clamping (**a**), sealing (**b**) (while releasing the tissue traction and supporting EBVS clamp) and cutting (**c**, **d**) of the left uterosacral and cardinal ligaments using EBVS

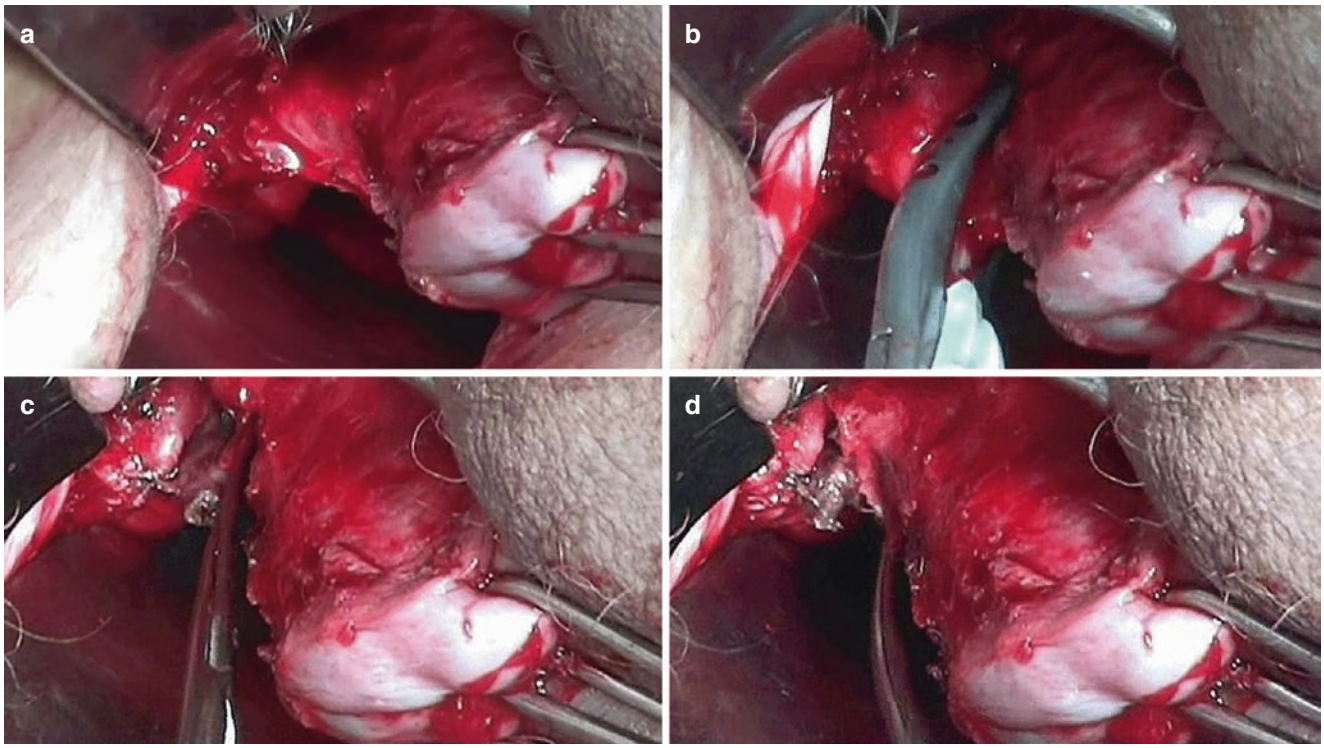


Fig. 119.14 Management of the left uterine artery (**a**) using EBVS. Clamping (**b**), sealing (**b**) (while releasing the tissue traction and supporting EBVS clamp) and cutting (**c**, **d**) of left the uterine vasculature during VH

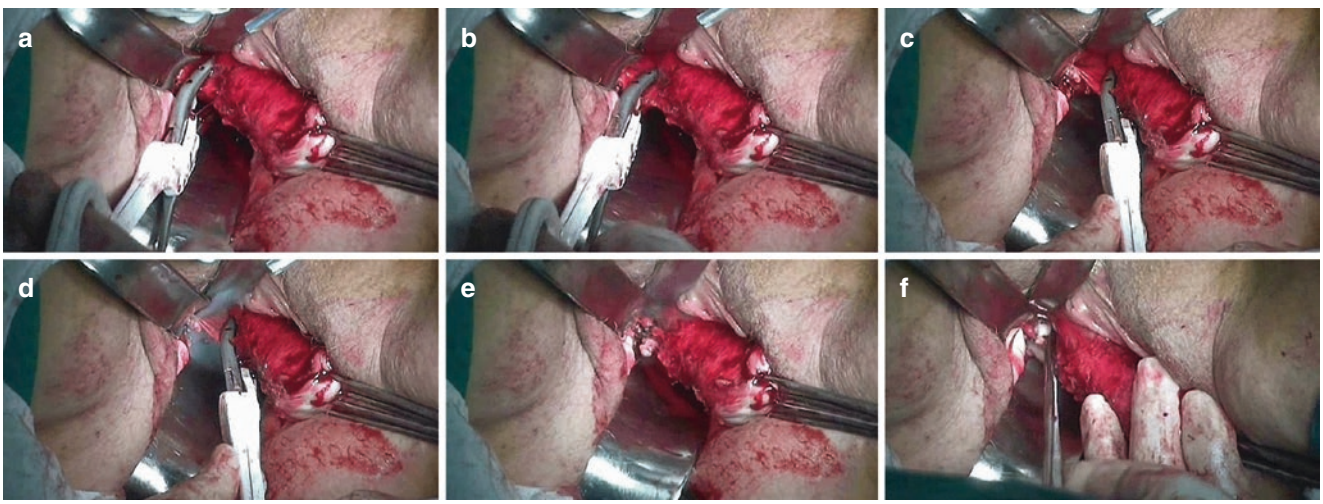


Fig. 119.15 Management of remaining portions of left broad ligament using EBVS. Clamping (**a**, **b**), sealing (**c**, **d**) and then cutting (**e**, **f**). Make sure that all the remaining branches of the uterine vessels have been properly sealed. Note that the EBVS is kept supported close to the uterus during the sealing cycle (**c**, **d**)

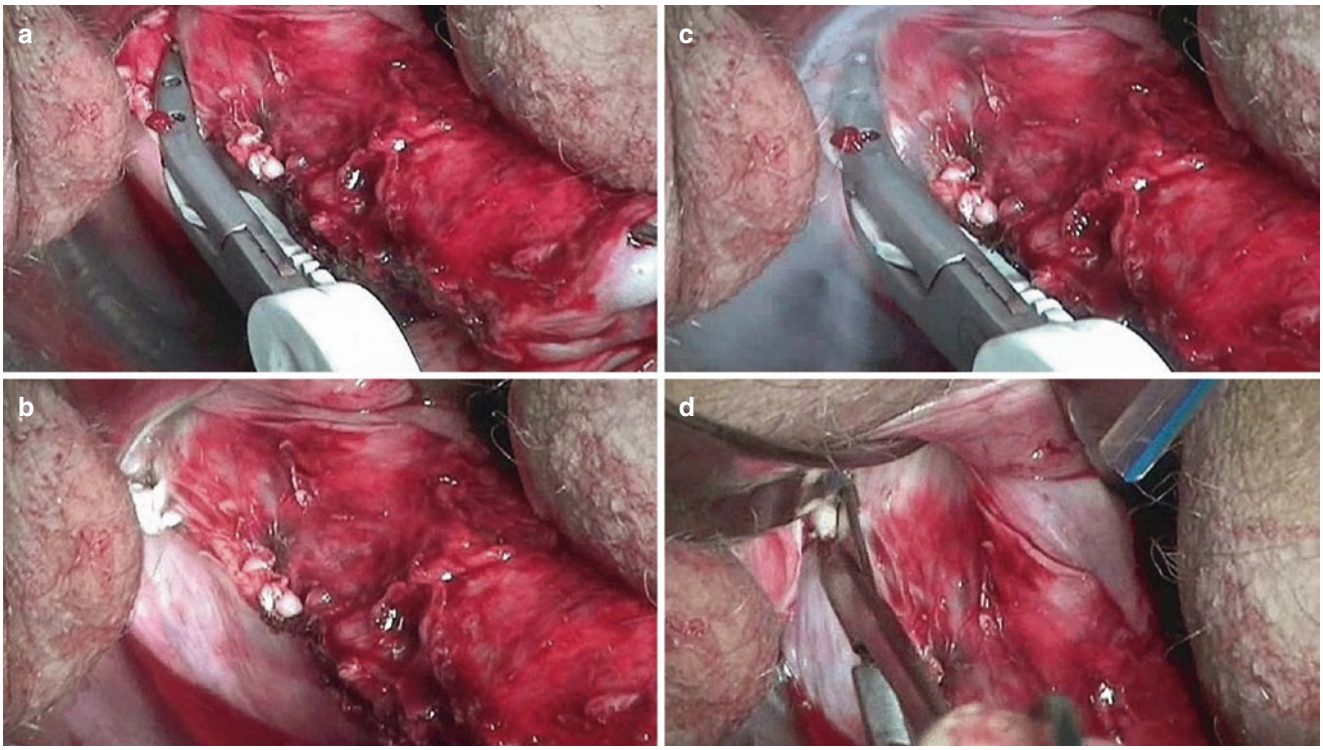


Fig. 119.16 Management of remaining portions of left broad ligament using EBVS. Clamping (**a**), sealing (**b**, **c**) and then cutting (**d**).

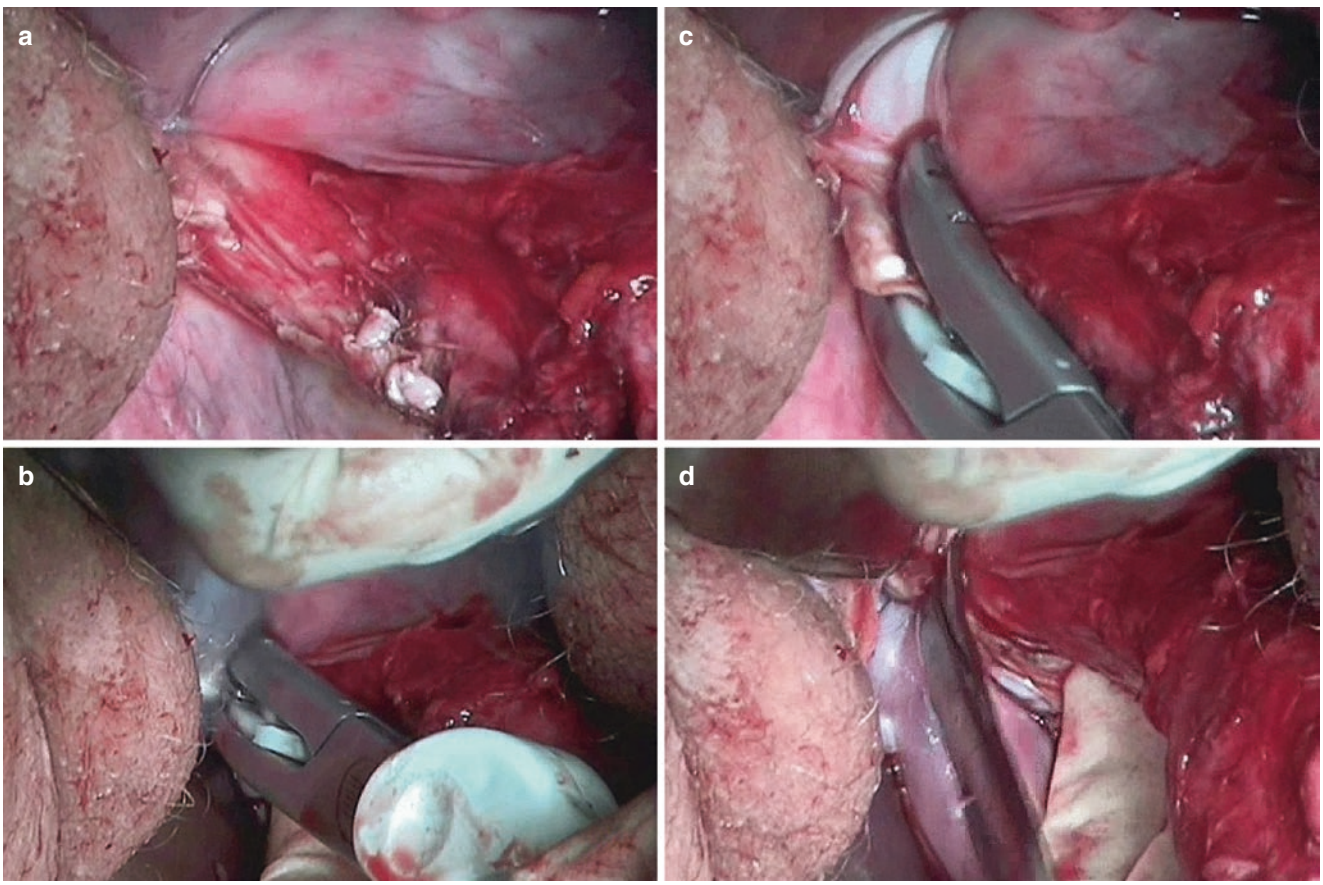


Fig. 119.17 Management of remaining portions of left broad ligament using EBVS. Clamping (**a**), sealing (**b**, **c**) and then cutting (**d**).

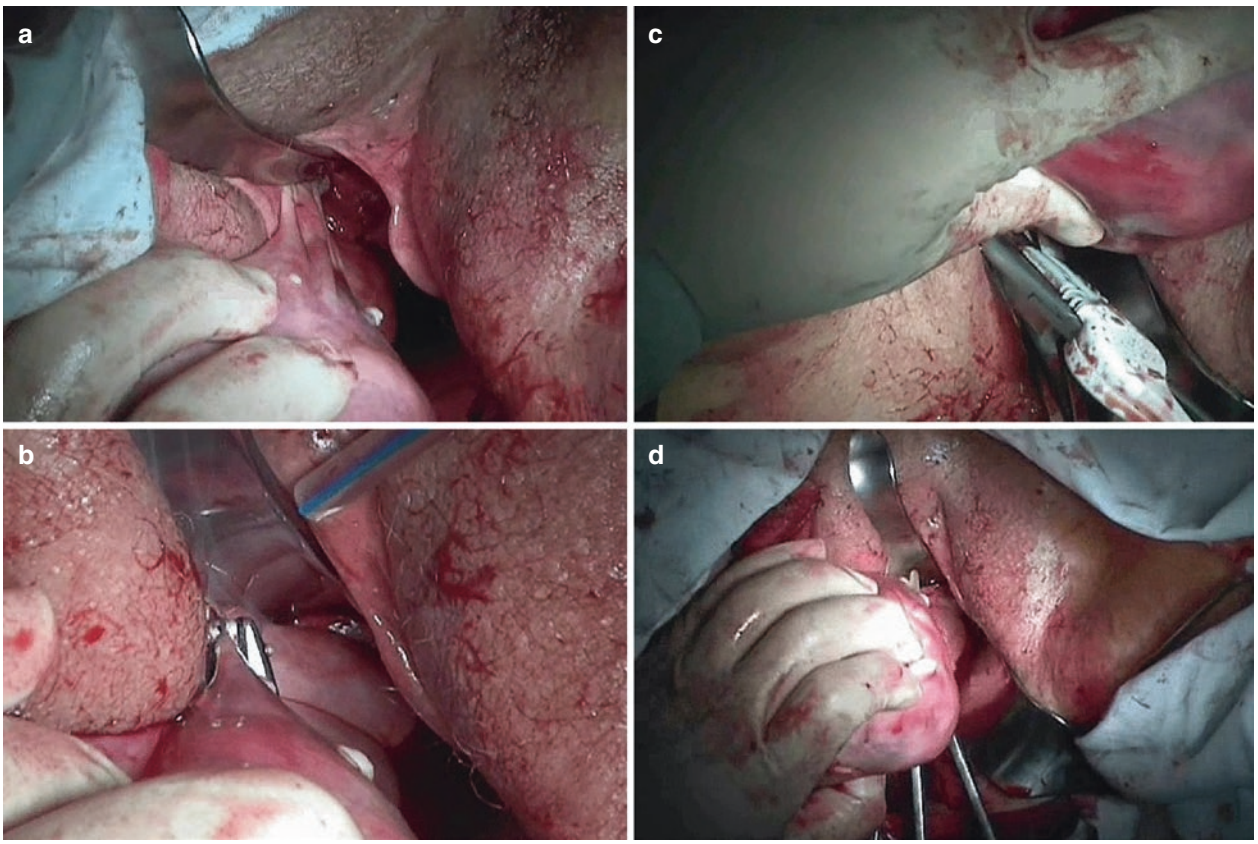


Fig. 119.18 Management of the left utero-ovarian ligament using EBVS. Exposure (**a**), clamping (**b**), sealing (**c**) and then cutting (**d**)

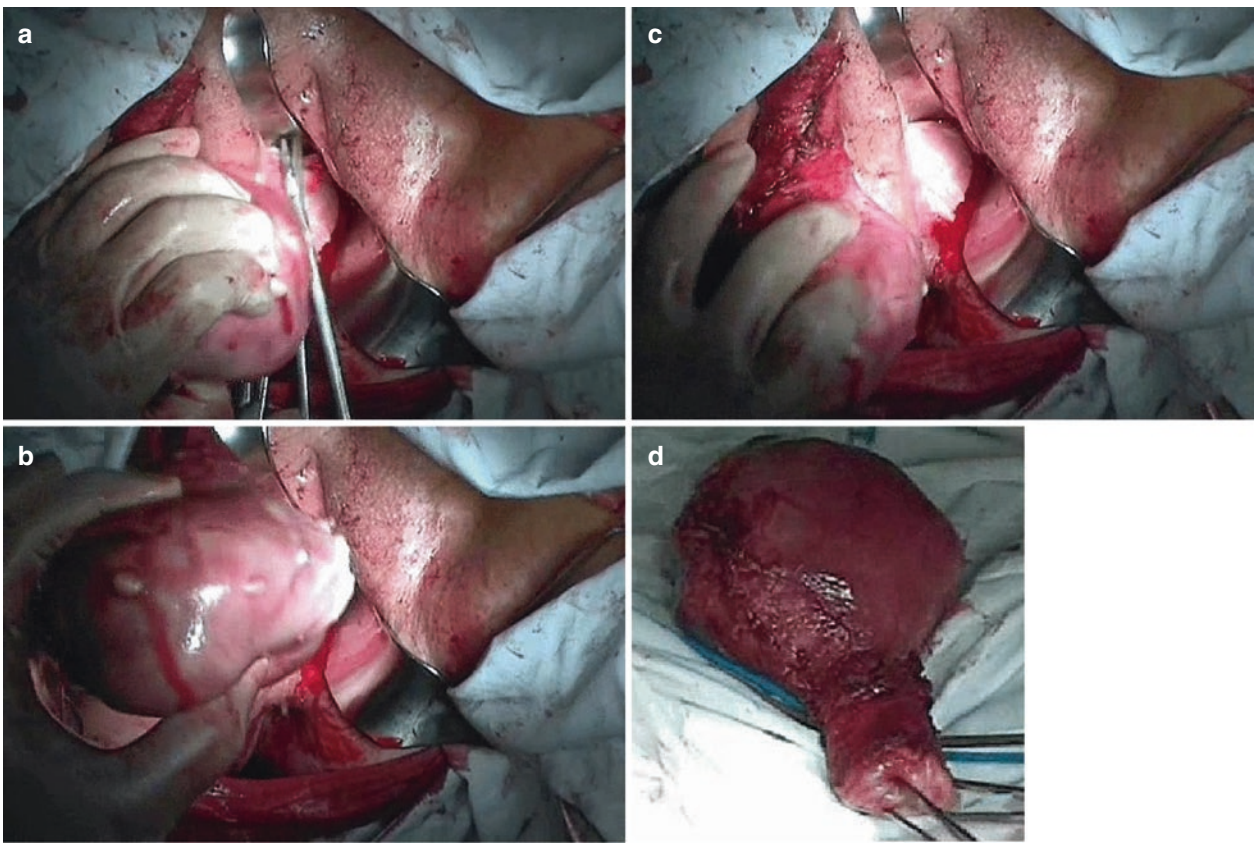


Fig. 119.19 Delivery of the uterine specimen (**a**–**d**)



Fig. 119.20 Closure of the vaginal mucosa and peritoneum (**a**, **b**)

References

1. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev 2009;(3): CD003677.
2. Dicker RC, Greenspan JR, Strauss LT, Cowart MR, Scally MJ, Peterson HB, et al. Complications of abdominal and vaginal hysterectomy among women of reproductive age in the United States. The Collaborative Review of Sterilization. Am J Obstet Gynecol. 1982;144(7):841–8.
3. Benassi L, Rossi T, Kaihura CT, Ricci L, Bedocchi L, Galanti B, et al. Abdominal or vaginal hysterectomy for enlarged uteri: a randomized clinical trial. Am J Obstet Gynecol. 2002;187(6): 1561–5.
4. ACOG Committee on Gynecologic Practice. ACOG Committee Opinion No. 444: choosing the route of hysterectomy for benign disease. Obstet Gynecol. 2009;114(5):1156–8.
5. Kives SL, Levy BS, Levine RL. Laparoscopic-assisted vaginal hysterectomy: American Association of Gynecologic Laparoscopists' 2000 membership survey. J Am Assoc Gynecol Laparosc. 2003; 10(2):135–8.
6. Doucette RC, Sharp HT, Alder SC. Challenging generally accepted contraindications to vaginal hysterectomy. Am J Obstet Gynecol. 2001;184(7):1386–9.
7. Magos A, Bournas N, Sinha R, Richardson RE, O'Connor H. Vaginal hysterectomy for the large uterus. Br J Obstet Gynaecol. 1996;103(3):246–51.
8. Richardson RE, Bournas N, Magos AL. Is laparoscopic hysterectomy a waste of time? Lancet. 1995;345(8941):36–41.
9. Darai E, Soriano D, Kimata P, Laplace C, Lecuru F. Vaginal hysterectomy for enlarged uteri, with or without laparoscopic assistance: randomized study. Obstet Gynecol. 2001;97(5 Pt 1):712–6.
10. Tohic AL, Dhainaut C, Yazbeck C, Hallais C, Levin I, Madelenat P. Hysterectomy for benign uterine pathology among women without previous vaginal delivery. Obstet Gynecol. 2008;111(4): 829–37.
11. Marshall DD, Park, AJ. The challenging vaginal hysterectomy. Postgraduate Obstet Gynecol 2010;30(22):6.
12. Ballard LA, Walters MD. Transvaginal mobilization and removal of ovaries and fallopian tubes after vaginal hysterectomy. Obstet Gynecol. 1996;87(1):35–9.
13. Davies A, O'Connor H, Magos AL. A prospective study to evaluate oophorectomy at the time of vaginal hysterectomy. Br J Obstet Gynaecol. 1996;103(9):915–20.
14. Sheth SS. Vaginal route for breast cancer induced hysterectomy with oophorectomy. J Obstet Gynaecol. 2011;31(6):533–4.
15. Sheth SS. The place of oophorectomy at vaginal hysterectomy. Br J Obstet Gynaecol. 1991;98(7):662–6.
16. Levy B, Emery L. Randomized trial of suture versus electrosurgical bipolar vessel sealing in vaginal hysterectomy. Obstet Gynecol. 2003;102(1):147–51.
17. Dunn TS, Weaver A, Wolf D, Goodard W. Vaginal hysterectomies performed in a residency program: can we increase the number? J Reprod Med. 2006;51(2):83–6.
18. Peirce SC, Edwards SD, Hedges A, Crawford DC. Evidence review, electrosurgical vessel sealing in vaginal hysterectomy. Centre for evidence-based purchasing. NHS Purchasing and Supply Agency (CEP 07019); 2007. 2009.
19. Ding Z, Wable M, Rane A. Use of Ligasure bipolar diathermy system in vaginal hysterectomy. J Obstet Gynaecol. 2005;25(1): 49–51.
20. Sah BK, Yang J, Yang G, Zhang X. Clinical uses of ligasure vessel sealing system(LVSS) in surgery. J Nanjing Med University. 2008;22(2):102–6.
21. Schulze S, Krisitiansen VB, Fischer HB, Rosenberg J. Sealing of cystic duct with bipolar electrocoagulation. Surg Endosc. 2002; 16(2):342–4.
22. Elhao M, Abdallah K, Serag I, El-Laithy M, Agur W. Efficacy of using electrosurgical bipolar vessel sealing during vaginal hysterectomy in patients with different degrees of operative difficulty: a randomised controlled trial. Eur J Obstet Gynecol Reprod Biol. 2009;147(1):86–90.
23. Cronje HS, de Coning EC. Electrosurgical bipolar vessel sealing during vaginal hysterectomy. Int J Gynaecol Obstet. 2005; 91(3):243–5.
24. Hefni MA, Bhaumik J, El-Toukhy T, Kho P, Wong I, Abdel-Razik T, et al. Safety and efficacy of using the LigaSure vessel sealing system for securing the pedicles in vaginal hysterectomy: randomised controlled trial. BJOG. 2005;112(3):329–33.
25. Kennedy JS, Stranahan PL, Taylor KD, Chandler JG. High-burst-strength, feedback-controlled bipolar vessel sealing. Surg Endosc. 1998;12(6):876–8.
26. Landman J, Kerbl K, Rehman J, Andreoni C, Humphrey PA, Collyer W, et al. Evaluation of a vessel sealing system, bipolar

electrosurgery, harmonic scalpel, titanium clips, endoscopic gastrointestinal anastomosis vascular staples and sutures for arterial and venous ligation in a porcine model. J Urol. 2003;169(2): 697–700.
27. Hay DJ. Electrosurgery. Surgery (Oxford). 2005;23(2):73–5.
28. Presthus JB, Brooks PG, Kirchhof N. Vessel sealing using a pulsed bipolar system and open forceps. J Am Assoc Gynecol Laparosc. 2003;10(4):528–33.
29. Douay N, Belot F, Bader G, Guyot B, Heitz D, Fauconnier A. Postoperative pain after hysterectomy through vaginal routes using electro surgical bipolar vessel sealing versus conventional suture ligature. Gynecol Obstet Fertil. 2007;35(7–8):632–6.
30. Penketh R, Griffiths A, Chawathe S. A prospective observational study of the safety and acceptability of vaginal hysterectomy performed in a 24-hour day case surgery setting. BJOG. 2007;114(4):430–6.
31. Pizzoferrato AC, Bader G, Nyangoh TK, Andriamafidy-Berti C, Villefranque V. Outpatient vaginal hysterectomy, feasibility and morbidity: an observational study on thirty patients. Gynecol Obstet Fertil. 2014;42(2):67–70.
32. Clave H, Baar H, Niccolai P. Painless vaginal hysterectomy with thermal hemostasis (results of a series of 152 cases). Gynecol Surg. 2005;2(2):101–5.
33. Zubke W, Becker S. Kr+ñmer B, Wallwiener D. Vaginal hysterectomy: a new approach using bicoagulation forceps. Gynecol Surg. 2004;1(3):179–82.
34. Shiota M, Kotani Y, Umemoto M, Tobiume T, Hoshiai H. Indication for laparoscopically assisted vaginal hysterectomy. JSLS. 2011; 15(3):343–5.
35. Tohic AL, Dhainaut C, Yazbeck C, Hallais C, Levin I, Madelenat P. Hysterectomy for benign uterine pathology among women without previous vaginal delivery. Obstet Gynecol. 2008;111(4): 829–37.
36. Rafii A, Samain E, Levardon M, Darai E, Deval B. Vaginal hysterectomy for benign disorders in obese women: a prospective study. BJOG. 2005;112(2):223–7.
37. Kovac SR. Decision-directed hysterectomy: a possible approach to improve medical and economic outcomes. Int J Gynaecol Obstet. 2000;71(2):159–69.

Hysterectomy Techniques in Prolapse Situations

120

Stephen T. Jeffery

Introduction

Physicians have been obsessed by the cure of a prolapsed uterus since the second century BC, and for many years this "wandering womb" was considered to be the cause of hysteria in women [1]. Aretaeus is noted to have said: "In the middle of the flanks of women lies the womb, a female viscus, closely resembling an animal; for it is moved of itself hither and thither in the flanks, also upwards in a direct line to below the cartilage of the thorax, and also obliquely to the right or to the left, either to the liver or the spleen, and it likewise is subject to prolapsus downwards, and in a word, it is altogether erratic" [2]. In 120 AD Soranus of Ephesus was the first physician to perform a vaginal hysterectomy to cure a women of this problem of hysteria caused by a "wandering womb" [3].

Despite the wide array of modern options that are now available for uterine prolapse, including the laparoscopic and robotic approaches, a vaginal hysterectomy and vault repair remains one of the safest and most effective treatments for this condition. The technique is simple, has a relatively short learning curve, does not require any advanced equipment and is a relatively inexpensive compared to other approaches.

It is important to appreciate that a prolapsing uterus is always associated with distorted pelvic anatomy. The weakened pelvic support often results in concomitant prolapse of the bladder, rectum and small bowel and the location of important structures is therefore difficult to predict. As a result, there are significant risks of bladder and ureteric injury. As an example, the location of the ureters could be at any of the depicted locations in Figs. 120.1 and 120.2.

Safely performing a vaginal hysterectomy in women with advanced uterine prolapse requires a systematic, step by step approach. This includes safe entry into the anterior and posterior cul-de-sacs followed by hysterectomy using standard sequential pedicle ligation. Suspension of the vaginal vault then follows and finally the prolapse of the anterior and posterior compartments is addressed.



Fig. 120.1 The possible location of the ureter in an advanced uterine prolapse



Fig. 120.2 The ureter is occasionally pulled down substantially by the prolapsed uterus

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Surgical Options for Uterine Prolapse

In selecting an operative technique for uterine prolapse, we are faced with a broad range of options, from archaic interventions such as the Manchester Repair and colpocleisis, to modern, state-of-the-art robotic and mesh procedures. The first decision is whether a vaginal or abdominal approach is optimal. The surgeon will also need to decide if a hysterectomy should be performed or whether a uterine preservation and suspension technique should be utilised. If the operation is being done vaginally, some surgeons still make use of mesh in managing women with uterine prolapse and so a decision needs to be on the appropriateness of using one of these devices. There remains very little comparative data on the various techniques. The factors that may influence the approach include the severity of the prolapse, the age of the patient, the presence of co-morbidities and whether the woman is sexually active or not. Table 120.1 contextualises the vaginal hysterectomy relating to other options for uterine prolapse.

Despite the large number of options available to us for uterine prolapse, a vaginal hysterectomy and vault suspension remains one of the best options for even the most extensive prolapse. It is essential to remember that simply performing a hysterectomy for uterine prolapse is usually not enough and that the vaginal vault always needs to be supported.

Choosing Between an Abdominal and Vaginal Approach

For women with post-hysterectomy vaginal vault prolapse, sacrocolpopexy (SCP) has been shown to be better in terms of anatomical outcomes and sexual function. This conclusion was reached in the Cochrane review when comparing sacrospinous fixation (SSF) and SCP. In particular, the abdominal SCP was associated with a vaginal axis that more closely resembled the normal anatomy, and a better vaginal length to the vaginal SSF [4]. The superiority of the SCP for vault prolapse has prompted increasing interest in performing a sacrocolpopexy-type procedure for uterine prolapse.

Table 120.1 Surgical options for uterine prolapse

Vaginal approach	Abdominal /laparoscopic/robotic approach
High uterosacral ligament suspension (with or without hysterectomy) Sacrospinous fixation (with or without hysterectomy) Manchester repair Mesh kit procedure (e.g. Uphold, Elevate, Nuvia) Colpocleisis	Supra-cervical hysterectomy and sacrocolpopexy Total hysterectomy and sacrocolpopexy Sacrohysteropexy

The most popular approach is to perform either a total or subtotal hysterectomy followed by a mesh sacrocolpopexy. A uterine-sparing alternative is the mesh sacrohysteropexy.

There are relatively few data comparing the outcomes of the abdominal to the vaginal approach in women with uterine prolapse. Roovers et al. [5] randomized 84 women with uterine prolapse into an abdominal sacrohysteropexy or vaginal hysterectomy and uterosacral ligament suspension. Those women who had vaginal surgery had better outcomes in multiple domains on the quality of life questionnaires. The abdominal approach was also associated with a much higher re-operation rate (22 % vs 2 %). They concluded that vaginal hysterectomy with anterior and/or posterior colporraphy is preferable to abdominal sacrocolpopexy with preservation of the uterus as surgical correction in patients with uterine prolapse grades 2–4. De la Cruz et al. [6] compared the change from pre- to postoperative total vaginal length (TVL) in women who underwent either a total vaginal hysterectomy (TVH) with uterosacral ligament suspension or a robotic hysterectomy with SCP. Recurrent prolapse (defined as any prolapse at or beyond the hymen) was not different between groups. Vaginal length was decreased in the vaginal hysterectomy group compared with the robotic group but this did not make a difference to postoperative sexual or pelvic floor function between the groups.

Prolapse surgery is more of an art than a science and this remains true when managing women with uterine prolapse. Before embarking on a specific technique, a large number of factors should be considered. The abdominal approach is most suited to young, fit women who are sexually active. An abdominal or laparoscopic hysterectomy and sacrocolpopexy will however be much more difficult in women with a high BMI and previous abdominal surgery. The potential morbidity of sacrocolpopexy is significant. Patients should be counseled regarding the risk of bladder and bowel injury, severe haemorrhage from the sacral venous plexus and spondilodiscitis. These are all potentially life-changing events and also place the surgeon at risk for litigation if they do occur.

Many surgeons are not proficient at the abdominal approach to uterine prolapse. For these doctors, the current data would support the use of the vaginal approach, rather than embarking on potentially difficult surgery without adequate training and experience.

The rest of this chapter will focus on the most important practical steps in achieving a safe and durable result when performing a hysterectomy for uterine prolapse.

Practical Approach to Vaginal Hysterectomy in Prolapse Situations

Pre-operative Examination

There are two aspects that require assessment before embarking on a vaginal hysterectomy for uterine prolapse, including

ascertaining the severity of the prolapse and determining the uterine size.

Severity of Uterine Prolapse

In a woman with a large cystocele, it is often difficult to assess the extent of uterine prolapse. When observing a large cystocele as depicted in Fig. 120.3, it is often erroneously assumed that the main part of the prolapse is in the anterior compartment. As demonstrated in Fig. 120.4, by using two Simms speculae with the patient in the left lateral position, the cervix is easily visualised and the extent of uterine prolapse is determined by asking the patient to bear down. This maneuverer will allow the surgeon to assess the necessity of performing a hysterectomy in addition to repair of the anterior and posterior compartment. Remember, where there is substantial uterine prolapse and one is planning on repairing a cystocele or rectocele, performing a hysterectomy followed by a vault suspension procedure will ensure a better result than simply performing a prolapse procedure.



Fig. 120.3 Using a Sims speculum to visualise a cystocele that often accompanies uterine prolapse



Fig. 120.4 Using two Sims specula, it is possible to evaluate the extent of uterine prolapse

Assessing the Uterine Size

The prolapsed uterus is in most cases small and atrophic, however if it is enlarged and myomatous it will result in challenging surgery. Every surgeon should therefore ensure that an appropriate assessment has been made of the uterine size prior to commencing the operation. A clinical evaluation by bimanual examination (Fig. 120.5) is usually adequate, but if there is doubt, an ultrasound examination should be done. It remains an excellent habit to repeat the bimanual examination under anaesthesia in the operating room prior to commencing the surgery. An unexpected enlarged uterus is not a pleasant surprise for any vaginal surgeon!

Catheterisation of Bladder

A full prolapsed bladder will always make the surgery more difficult and it is therefore important to catheterise the patient and ensure the bladder is empty at the start of the surgery. In advanced prolapse, it is also a good idea to reduce the anterior vaginal wall using a vaginal retractor, to ensure that bladder emptying is complete. It is also useful to place a bag



Fig. 120.5 It is essential to do a Bimanual examination to evaulaute uterine size

on the catheter to allow it to drain and remain empty during the procedure. An indwelling catheter also allows the urine to be checked intermittently for haematuria, which is a useful early warning of a possible bladder injury. This is particularly important in the anterior dissection of women with a large uterine prolapse.

Placement of the Initial Clamps

In prolapse surgery, the surgical planes are most easily identified by applying traction and countertraction to the prolapsing structures. In order to provide adequate traction to the cervix, two Vulsella are placed on the cervix, one on the anterior lip and another on the posterior lip. In addition, an Allis or Littlewood clamp is placed at the apex of the tear-drop incision, which is shown in Fig. 120.6. It is also easier to do the tear-drop incision if two Allis clamps are positioned at 9 and 3 'o clock on the vagina, alongside the cervix.

Infiltration

Infiltration is performed using a dilute mixture of Bupivicaine and a vasoconstrictor agent, either Adrenaline, Vasopressin or Ornipressin. Inject the infiltration solution into the pericervical tissues going around the full circumference and ensure adequate infiltration of the anterior vaginal wall. It is important to inform the anaesthetist when this is done since the vasoconstrictor can result in changes in pulse and blood pressure (Figs. 120.7 and 120.8).



Fig. 120.6 The upside V- incision is a useful technique to commence the vaginal hysterectomy in prolapse situations

Initial Incision and Accessing the Vesico-Uterine Pouch and Peritoneal Cavity

Remember that injury to the bladder and ureter are avoided by meticulous dissection of the bladder from the entire length of the cervix and lower part of the uterus prior to placing any pedicle clamps. A non-descent vaginal hysterectomy is usually commenced by performing a circumferential incision of the cervix, but in women with advanced uterine prolapse, it may be wise to deviate from this since there is often profound anterior and posterior vaginal wall prolapse. A "tear-drop" shape vaginal incision is often useful in these circumstances (Figs. 120.9 and 120.10).

Where there is minimal anterior and posterior compartment prolapse as in the example provided in Fig. 120.11, then a simple circumcision of the cervix may remain a suitable option.

After performing the "tear-drop" incision, the anterior triangular flap of skin is dissected away from the bladder by starting at the apex of the triangle. A useful technique is to place an Allis or Littlewood clamp at the top point of this



Fig. 120.7 Injection of a dilute solution of a vasoconstrictor into the anterior compartment

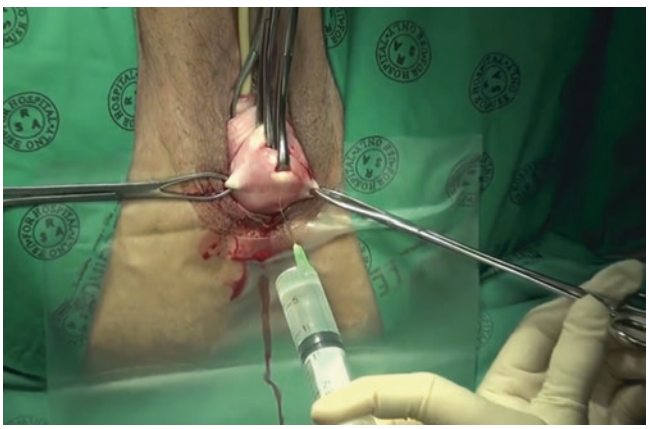


Fig. 120.8 Injection of a dilute solution of a vasoconstrictor into the posterior compartment

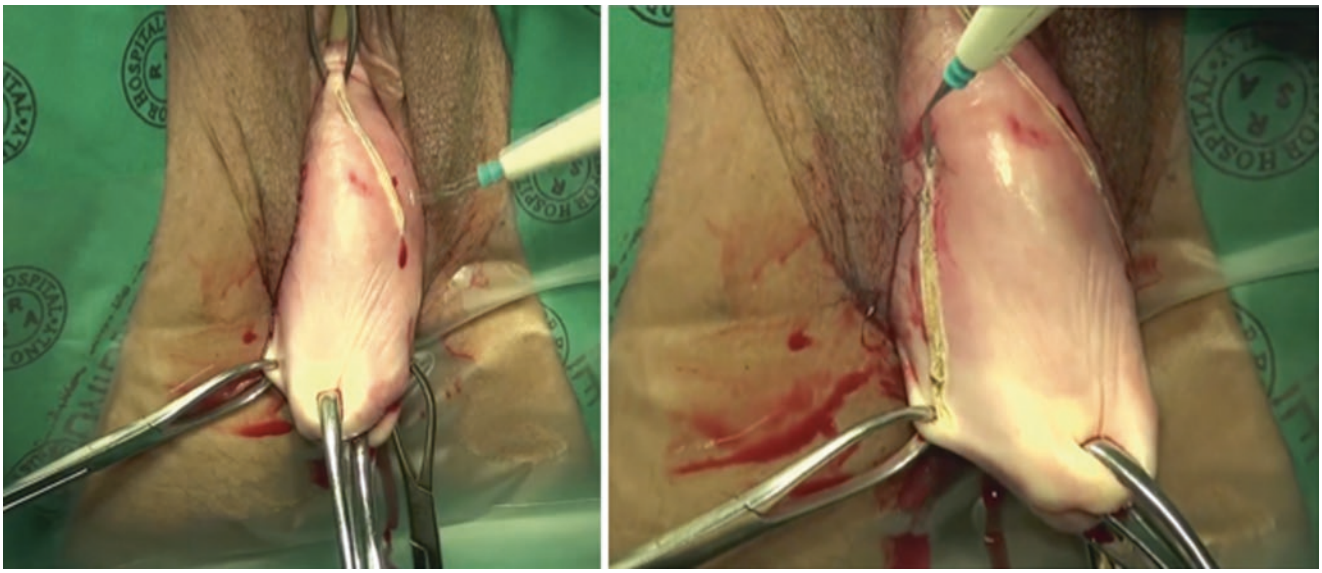


Fig. 120.9 (**a**, **b**) Commencement of the operation with an incision in the anterior compartment

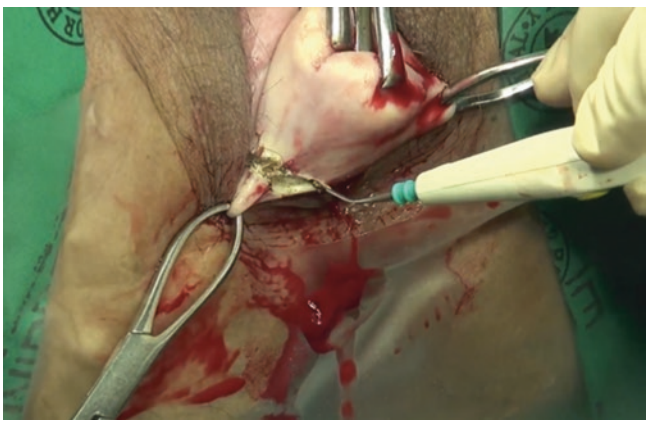


Fig. 120.10 Extension of the incision around posteriorly

skin flap and to apply traction towards yourself with the forefinger exerting countertraction on the outside of the vaginal skin (Fig. 120.12). A sharp Metzenbaum scissors is used to dissect this flap of skin off the bladder (Fig. 120.13). An assistant applies traction to the bladder with a Gillis forceps and this will reveal the most appropriate plane of dissection (Fig. 120.14). Once the skin flap dissection has reached the cervix, it is cut away horizontally between the 3 and 9 o'clock clamps (Fig. 120.15).

The next step includes an attempt at dissecting into the anterior pouch of peritoneal cavity between the bladder and cervix. The plane is most easily revealed by applying upward traction with a Gillis forceps to the bladder, while dissecting onto the cervix and looking for the peritoneal reflection of the

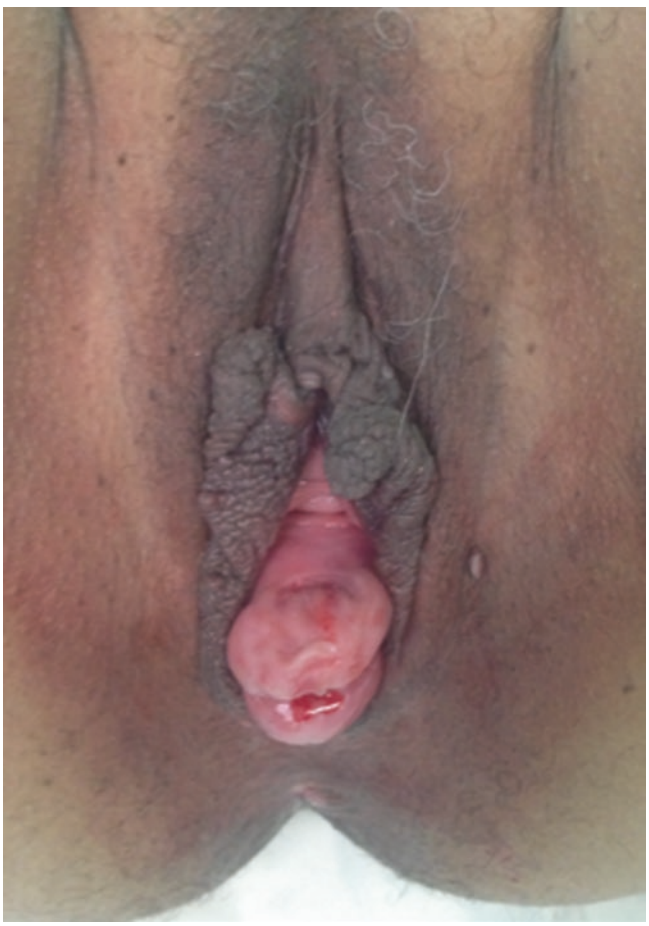


Fig. 120.11 In a case as depicted in this figure, a simple cervical circumcision may be suitable instead of the V-incision

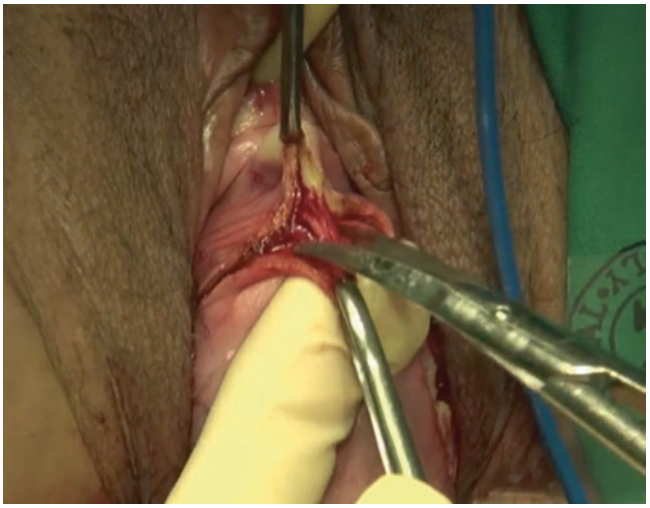


Fig. 120.12 Commencing the anterior dissection involves countertraction with the non-dominant hand

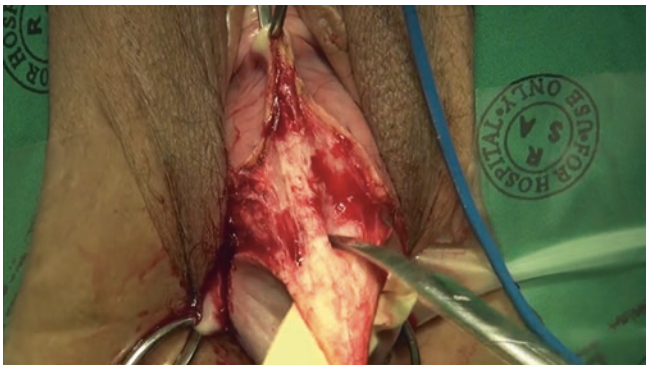


Fig. 120.13 Sharp dissection of the anterior triangle of skin created by the inverted V –incision

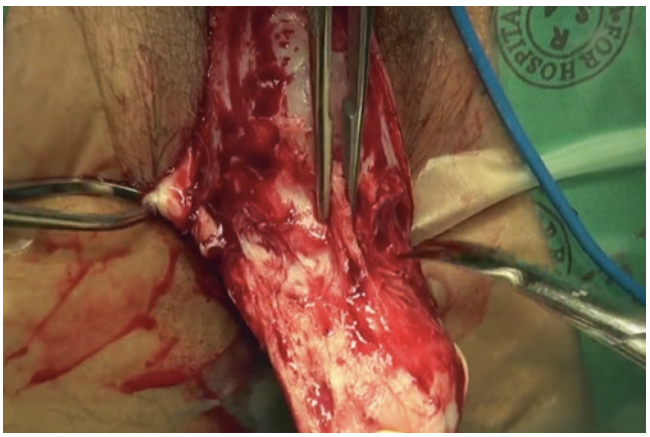


Fig. 120.14 The dissection of the triangular skin flap is extended down to the cervix

bladder onto the uterus. Sharp dissection for this step is preferable, but many experienced surgeons use a blunt dissection technique and push on the cervix with a Raytec swab draped

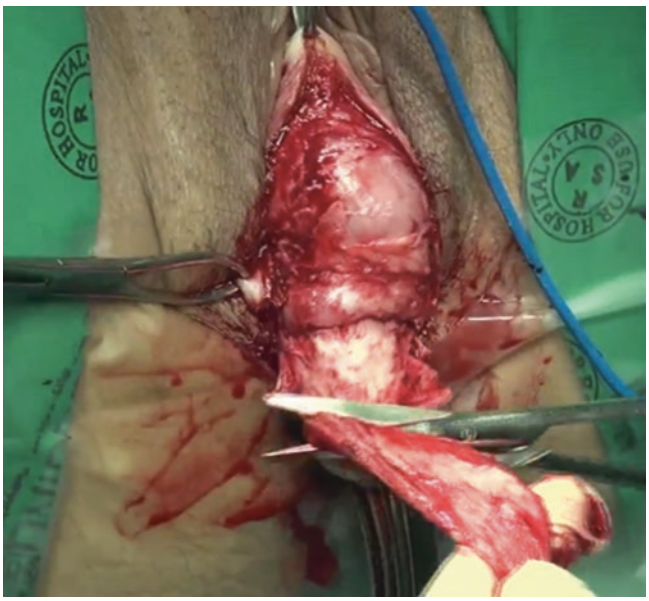


Fig. 120.15 The skin flap is excised at the level of the cervix



Fig. 120.16 Blunt dissection of the bladder from the cervix using a finger

over the index finger (Fig. 120.16). The disadvantage of this technique is that there is a greater risk of bladder injury.

The peritoneal reflection between the uterus and the bladder will be noted to be a clear shiny membrane and once this is clearly seen, a bold incision into this layer will take you into the vesico-uterine pouch. Once you have made your incision and are sure you are in the peritoneal cavity, place the end of

the retractor (Wertheims or Landon or equivalent) inside the peritoneum and ask your assistant to retract anteriorly.

Accessing the peritoneal cavity anterior to the uterus is often a challenging aspect of the vaginal hysterectomy and the dissection is often made even more difficult by a large concomitant cystocele. It helps if your assistant provides good retraction anteriorly over the bladder with the Wertheim (or equivalent) retractor. This pulls the bladder out of the operative field and provides good traction on the peritoneal tissues as you dissect upwards towards the fundus of the uterus. It is also made easier by pushing the front end of the retractor against the cervix and sliding it in a cephalad direction into the anterior pouch. The wider anterior tear-drop incision makes it easier to identify the bladder tissues in these circumstances. It is also important to ensure that the assistant is providing firm downward traction on the cervix by pulling on the vulsella.

Occasionally it is not possible to immediately access the peritoneal cavity in the anterior pouch. In these circumstances it is advisable to defer this and to move onto the next step, which includes accessing the posterior cul-de-sac.

Accessing the Recto-Uterine Pouch and Peritoneal Cavity

The posterior dissection is commenced by stretching the lower skin edge with two Allis clamps. Countertraction is provided by pulling upwards on the Vulsellum that is attached to the posterior cervix. This usually reveals the posterior peritoneal sac which is easily incised (Fig. 120.17). This incision is easily and safely enlarged by stretching laterally with the forefingers of both hands. A Simms speculum is usually placed into the posterior pouch once the peritoneal cavity has been opened.

If the anterior pouch has not been accessed as yet, by placing a finger into the posterior dissection and over the fundus, the anterior peritoneum is often easily distinguished from bladder tissue and incised on the surgeon's finger.

Difficulties Entering the Anterior and Posterior Cul-de-sac

In situations of extensive prolapse, it is occasionally impossible to gain access to the peritoneal cavity following the initial vaginal dissection. The bladder is also often tightly adherent to the cervix when the women has had a previous Cesarean Section. Under these circumstances, it is appropriate to ligate the uterosacral ligaments prior to gaining access to the cul-de-sac. Following this, a further attempt can be made. It remains important to ensure that enough of the bladder has been dissected from the cervix before any clamps are applied.

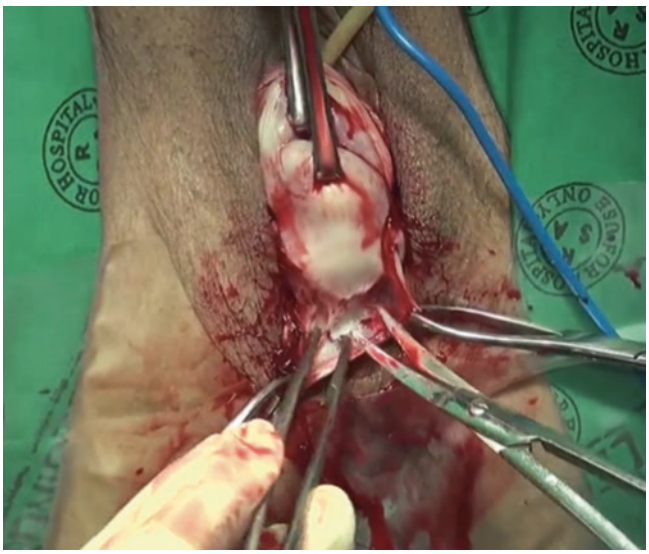


Fig. 120.17 Accessing the pouch of Douglas by applying traction to the vaginal skin to expose the peritoneum

Uterosacral Ligaments

With a Wertheim's retractor in the anterior dissection and Simms speculum in the posterior dissection, the uterosacral ligaments are clamped and tied. A Maingot or Heaney clamp is most suitable for this. A delayed absorbable Polydioxone 0 or 1 suture is used and both ends are kept long and tagged so that they can be attached onto the vaginal vault at the end of the procedure (Fig. 120.18).

Uterine Artery Pedicles

The next step includes the ligation of the uterine artery pedicle (Fig. 120.19). Using a Maingot or Heaney, place the clamp parallel to the uterine corpus. If you have entered the peritoneal cavity already, make sure you include the shiny surfaces of the peritoneum anteriorly and posteriorly in your clamp. This neatens the further dissection and pulls the uterine artery further into the pedicle. Ligate and tie the uterine pedicle with a Polyglycolic acid suture (Eg Vicryl 1). If the women has a particularly long cervix, a number of additional lateral pedicles may be required and this is performed in a similar manner to the uterine pedicle. If the uterus is very large, at this point it is possible to resect a wedge of uterine tissue in the midline to create space.

Bisection of Uterus

Another very useful step is to bisect the uterus after ligation of the uterine pedicles. This enables the surgeon to access the fundus of the uterus more easily and safely and is particularly

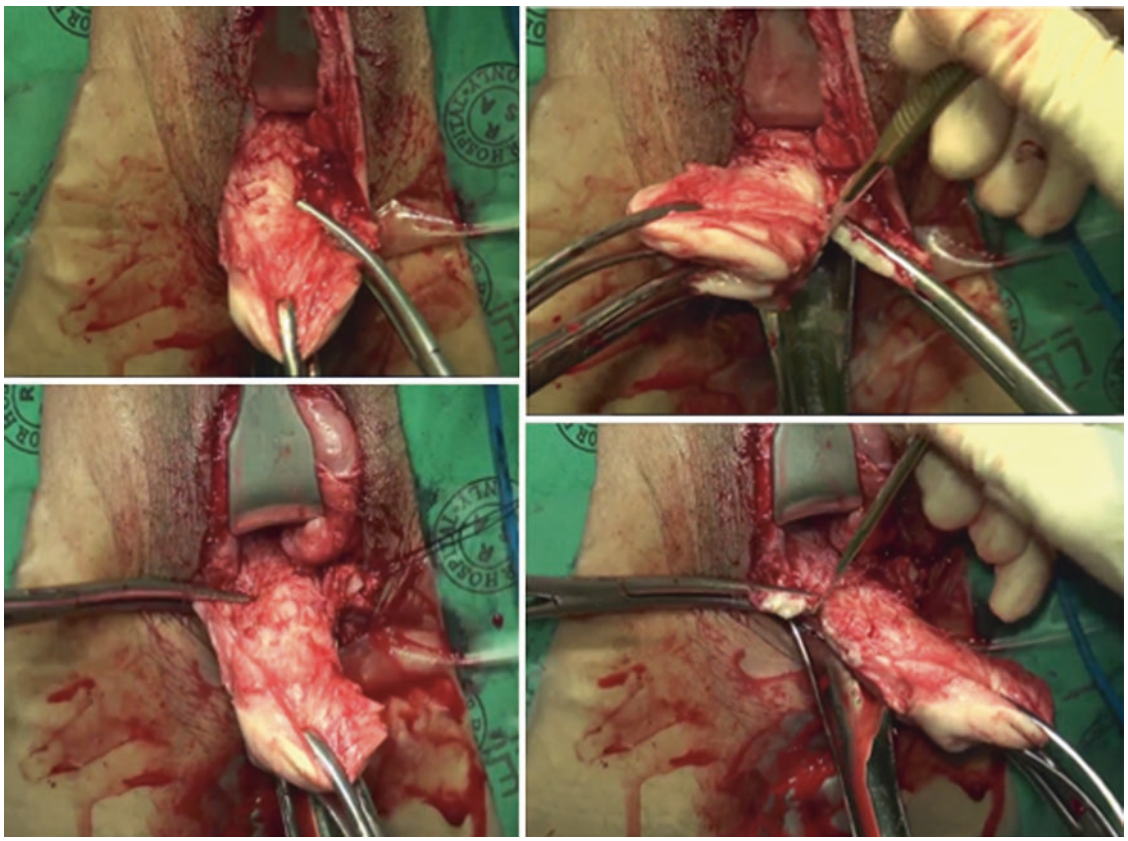


Fig. 120.18 (clockwise from the top left) The clamping and cutting of the right and left uterosacral ligaments

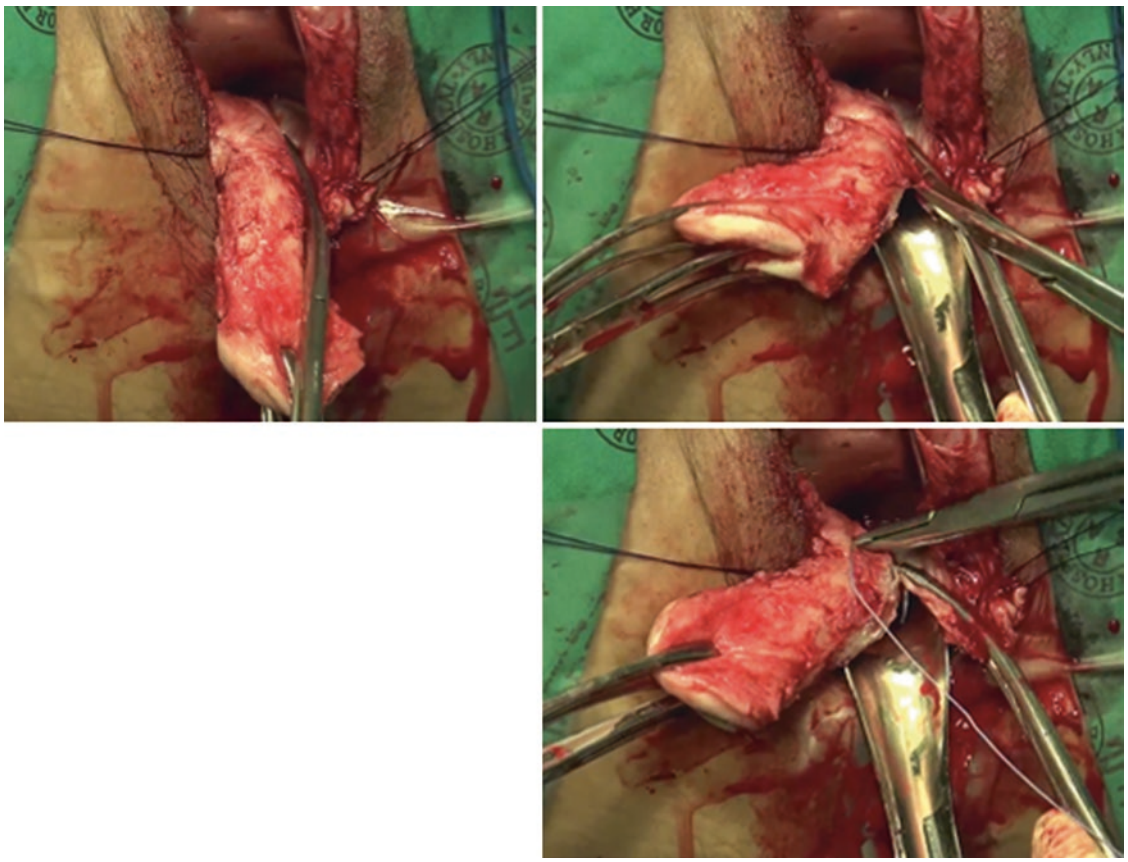


Fig. 120.19 Clamping, cutting and ligation of the left uterine artery pedicle

indicated when the uterus is large. To do this, move the two vulsella to the lateral aspects of the cervix and use a knife to cut the uterus in half from anterior to posterior. Continue up towards the fundus. It is essential to have retractors placed anteriorly and posteriorly. Once you are close to the fundus, place the forefinger of your non-dominant had in the back and over the top of the uterus and onto the fundus and pull down towards yourself. Cut the uterus onto your finger with a curved Mayo scissors and it will now be easy to complete the bisection.

Infundibulo-Pelvic Ligaments

The next step is to clamp and ligate the Infundibulo-pelvic ligaments and broad ligaments. Place two Maingots or Heaneys clamps on the remaining part of the broad ligament and infundibulo-pelvic ligament to create a pedicle and cut the uterus off on both sides. Use Polyglycoloic acid (Vicryl 1) for this step. It is useful to apply two ties on this pedicle, since slippage of this knot could result in haemorrhage which is difficult to access vaginally.

Salpingectomy

The Fallopian Tubes have recently been implicated in the aetiology of the development of ovarian cancers [7]. There is now excellent evidence to support a bilateral salpingectomy when performing a hysterectomy for benign conditions. This is easily done on completion of the hysterectomy by pulling the tube into the vagina using one or two Babcock clamps. A long curved artery forceps is then clamped over the tube and a Polyglycolic acid suture is used to ligate the pedicle.

Oopherectomy

Depending on the age of the patient and her ovarian cancer risk status, it may be necessary to perform a bilateral oophorectomy. A heavily curved Moynihan clamp is most suited to this step. Simply place the clamp over the ovary, cut and tie the pedicle.

Inspection of Pedicles and Ensuring Haemostasis

Once the uterus has been removed and before commencing with the vault suspension procedures, it is essential to take a minute or two to inspect all the pedicles and to ensure adequate haemostasis has been achieved. In order to obtain a better view, a wet pack should be placed into the vagina and peritoneal cavity. Using three lateral vaginal retractors, the pedicles are easily inspected.

Providing Adequate Vault Support

At this point, it is essential to re-emphasise that simply performing a hysterectomy for uterine prolapse is usually not adequate and that the vaginal vault always needs to be supported following the removal of the uterus. The most frequently employed vaginal vault suspension techniques include either a sacrospinous fixation (SSF) or a high uterosacral ligament suspension (HUSLS). Irrespective of whether a HUSLS or SSF has been done, a Modified Mccall culdoplasty should also always be performed as part of a vaginal hysterectomy for prolapse.

Modified Mccall Culdoplasty

The aim of a Mccall Culdoplasty is to place a purse-string suture that plicates the two uterosacral ligaments to each other and onto the posterior aspect of the vaginal vault (Fig. 120.20). This step also closes off the space of a potential enterocele. You will need a Polydioxone (PDS) 1 or 0 for this procedure. Littlewood clamps are placed on the remnants of the right and left uterosacral ligaments. Two long artery forceps are applied to the skin and peritoneum of the posterior vaginal vault, about 1 cm from the midline on either side. A Wertheim retractor in the posterior vagina, outside the incision, enables the surgeon to easily identify the posterior skin edge of the vault. By exerting traction on the two artery forceps that are attached to the vault, a suture is placed in the vagina, from exterior to interior at about a 4 o'clock position. Include some peritoneum in this bite as you come out on the peritoneal side of the incision.

Place the Wertheim retractor now into the incision and ask your assistant to retract posteriorly so that you can see the left uterosacral ligament clearly. Suturing is continued by taking a bite of the left uterosacral ligament. Now take a bite of the inside aspect of the posterior vaginal vault in the midline, including peritoneum and vaginal tissue in the suture (see Fig. 120.20). This closes off the cul de sac (hence the term culdoplasty) and prevents prolapse recurrence in the form of an enterocele. Continuing with the same suture, take another bite from the right uterosacral ligament and complete the Mccall's culdoplasty by coming out again through the vagina on that side, at about the 8 o'clock position.

Cut off the needle and place an artery on the end of this suture that has entered at 4 o'clock and exited the vault 8 o'clock. The McCall culdoplasty suture should be tied at the end of the operation after the vaginal vault has been closed.

Sacrospinous Fixation

This procedure, originally described by Amreich and Richter, was originally used to address post-hysterectomy vault pro-

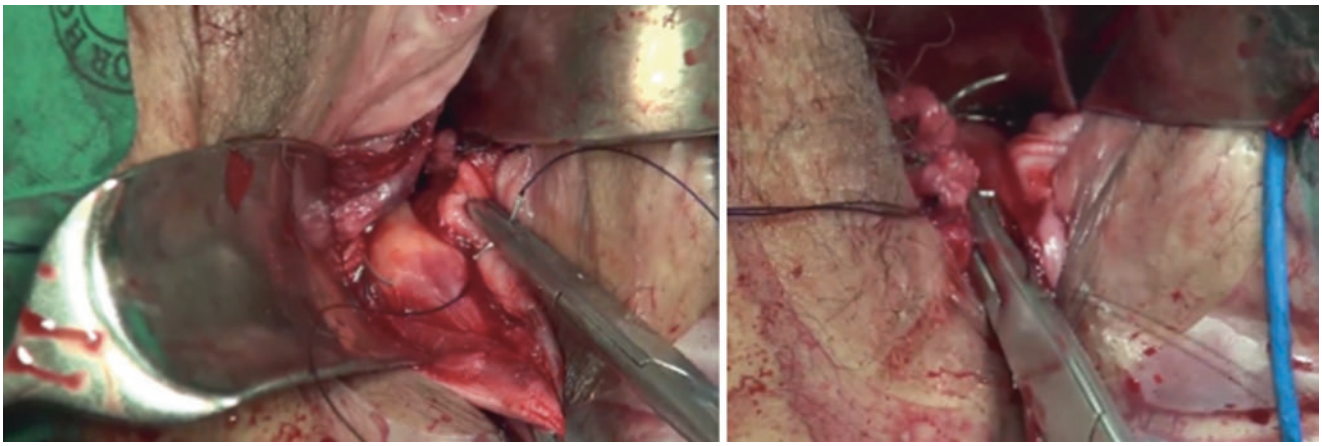


Fig. 120.20 Two steps of the McCall culdoplasty involving (**a**) including a part of the posterior peritoneal edge and (**b**) the right uterosacral ligament

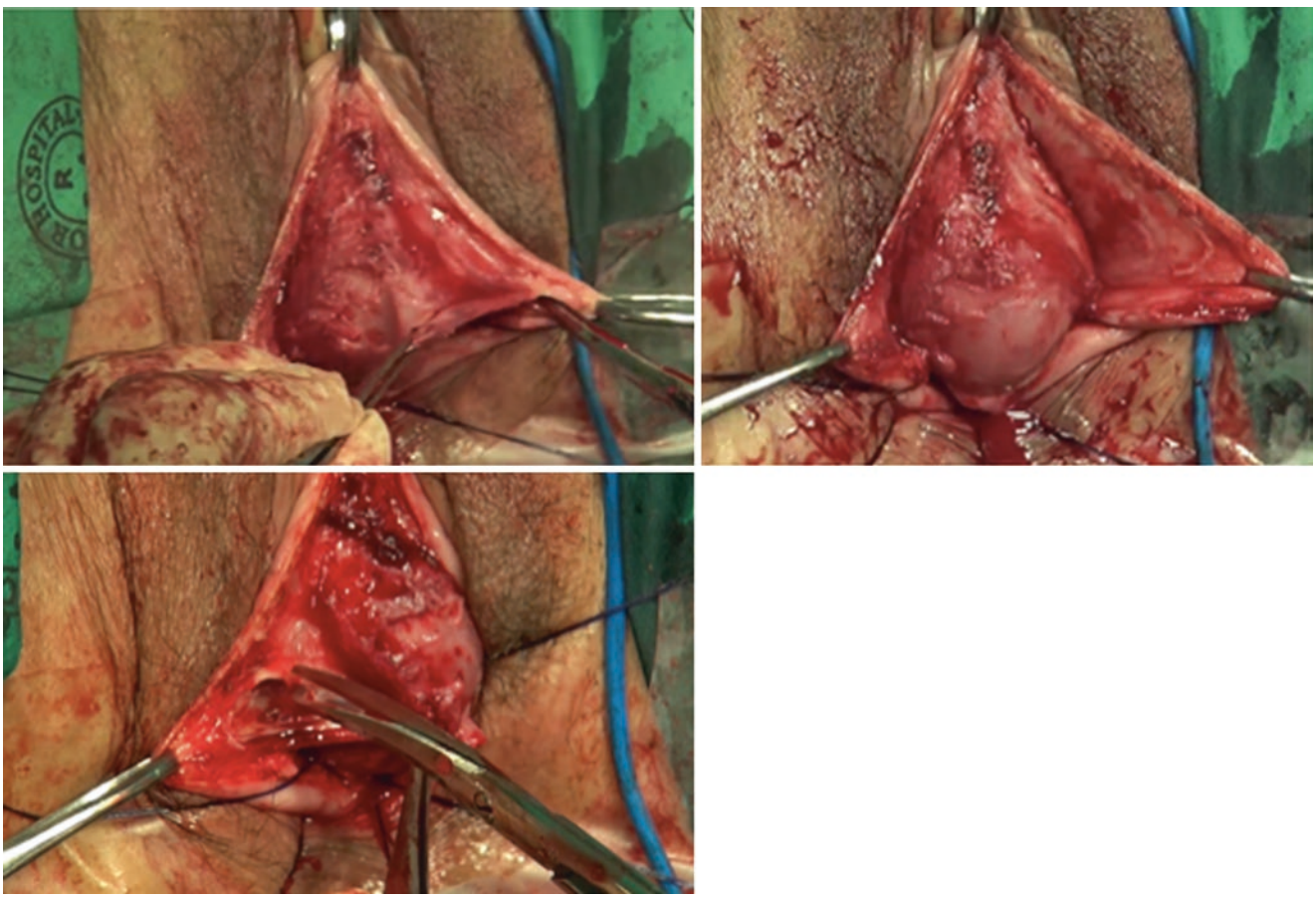


Fig. 120.21 (**a**–**c**) Dissection of the anterior compartment to access the sacrospinous ligament

lapse, but it has been shown to be a successful procedure for vaginal vault suspension following hysterectomy for uterine prolapse [8].

When performing a SSF for vault support at hysterectomy, it is possible to approach the ligament through an incision in the anterior or posterior compartment. My personal preference is to extend the vaginal vault incision anteriorly towards the urethra and bladder neck, in the midline, and then to continue the paravaginal dissection toward the Obturator fascia and Sacrospinous Ligament (SSL) (see Fig. 120.21).

Exposure of the ligament is commenced using sharp dissection, and once the Ischial Spine is palpated, the remainder of the dissection is completed with digital stripping of the tissues overlying the ligament. It is acceptable to perform a

unilateral fixation. This usually results in an asymmetrical vaginal axis, but this has not been shown to be associated with any functional disturbance. [9] It may be possible to restore a normal anatomical vaginal axis by performing a bilateral fixation, but this in turn has the potential risk for increased vaginal tension.

The advantage of performing the SSF through an anterior incision is that it may result in less de novo post-operative anterior prolapse. This has long been cited as a significant complication of a SSF when it is performed through a posterior approach [10]. It may, however, be easier to access the ligament posteriorly.

Attaching a suture to the SSL is one of vaginal reconstructive surgery's great challenges. The ligament is usually visualized using two or three long retractors. The suture is then secured using a Miya Hook, a Deschamps Ligature Carrier, or a long needle holder with sutures. The placement of the SSF suture has been made considerably easier by the introduction of a number of new devices that facilitate the suture attachment by digital palpation. These instruments include the Capio (Boston Scientific) (Fig. 120.22), Fixt (Bard) (Fig. 120.23), Digitex (Coloplast) (Fig. 120.24) and I-stitch (Akacia Surgical) (Fig. 120.25). The amount of dissection required to access the ligament using these minimally invasive devices is significantly less, making the operation quicker and with reduced morbidity (Figs. 120.26, 120.27, 120.28, 120.29, 120.30, 120.31, 120.32, 120.33, and 120.34 demonstrate the placement of the sutures using these



Fig. 120.22 The Miya Hook



Fig. 120.23 The Capio Slim device for sacrospinous fixation



Fig. 120.24 The Fixt device for sacrospinous fixation

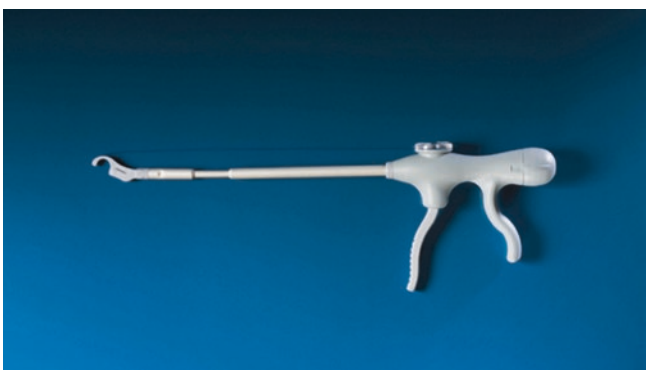


Fig. 120.25 The Digitex device for sacrospinous fixation



Fig. 120.26 The I-Fix device for sacrospinous fixation

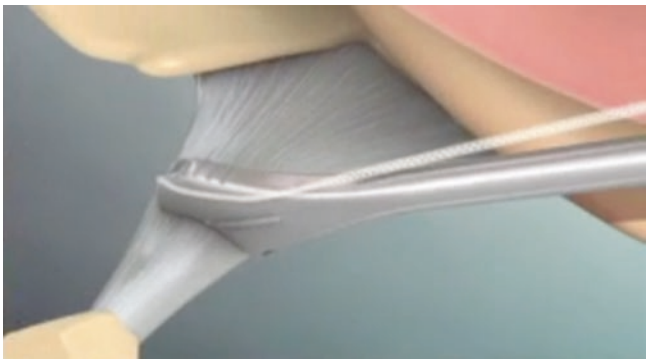


Fig. 120.27 The Fixt device on the sacrospinous ligament



Fig. 120.28 The Fixt device on the sacrospinous ligament



Fig. 120.30 The mechanism of the Fixt device

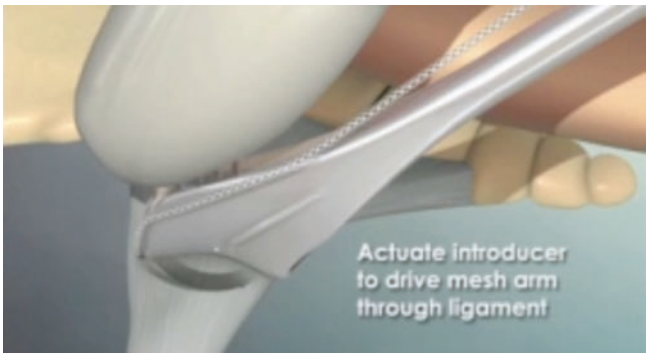


Fig. 120.31 The mechanism of the Fixt device



Fig. 120.32 The mechanism of the Fixt device



Fig. 120.29 The technique of placement of sacrospinous suture



Fig. 120.33 The mechanism of the Fixt device

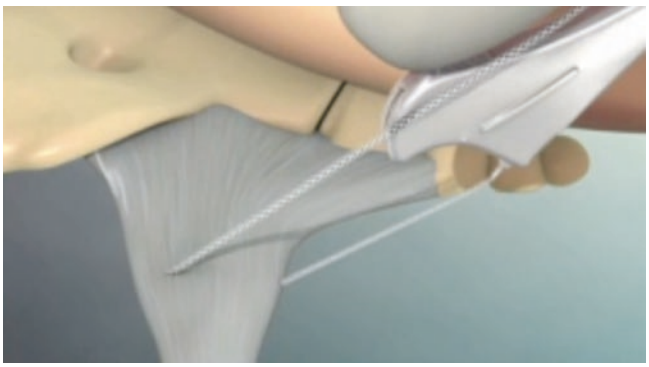


Fig. 120.34 The mechanism of the Fixt device

devices). It is essential to note that the sutures should be placed at least 2 cm from the Ischial spine to avoid entrapment of the Pudendal Nerve.

A recent randomized controlled trial (RCT) comparing the attachment of the SSF suture using the Capio to a traditional suture and needle-holder technique showed a 30 % reduction in operating times in the group where the Capio was used. [11].

A broad range of suture options is available when performing a SSF at vaginal hysterectomy for uterine prolapse. I prefer to use a delayed absorbable polydioxanone (PDS) suture. The advantage of using the PDS is that the suture can be brought out through the vaginal skin and tied outside the vault and this allows for a more secure vault fixation. Other options include a monofilament non-absorbabale suture (Prolene), or a non-absorbable braided suture (Ethibond). It is advisable to avoid using Ethibond since it has been shown to be associated with abscess formation [12]. The other advantage of the PDS suture is that it is possible to pull the suture through the vault in a more lateral position, i.e. further away from the skin edge, and this results in less vaginal tension when doing a bilateral fixation.

SSF is associated with excellent anatomic outcomes, as demonstrated in a review by Beer and Kuhn [10] of 2239 women, reporting success rates of up to 98 %. The greatest risk of sacrospinous fixation is long term buttock and perineal pain. This may be due to Pudendal or Inferior Rectal Nerve entrapment. If this occurs post-operatively, early recourse to suture removal is essential.

High Uterosacral Ligament Suspension (HUSLS)

The uterosacral ligaments connect the cervix and proximal portions of the vagina to the sacrum at about level S2 to S3. They provide the most important endopelvic support to the uterus and vagina. It therefore makes physiological sense to reattach the remaining portion of the vaginal vault to these ligaments when performing a hysterectomy for uterine prolapse.

For every surgeon embarking on a HUSLS, it is essential to appreciate the anatomical relationship between the uterosacral ligament and the ureter. As it descends in the pelvis, the ureter converges with the uterosacral ligament. In its distal portion it is only 1 cm from the ureter. More superiorly and closer to the sacrum it is about 4 cm from the ureter. When performing this procedure it is therefore safer to place the suture higher and closer to the sacrum.

From a technical perspective, the classic HUSLS procedure is commenced after the uterus has been removed. In order to visualise the appropriate site for suture placement, it is essential to use long narrow vaginal retractors and good lighting.

I prefer to use two Navritel-Briesky retractors, but narrow Deavor retractors also work. The original HUSLS technique was popularized by Dr. Bob Shull, and this involved the placement of six uterosacral sutures, three on each side. I prefer to start by placing a suture at the right corner of the posterior vaginal vault at about the 4 o'clock position. The next bite is high on the uterosacral ligament. It needs to be re-emphasized that the uterosacral ligament should be taken as high as possible to avoid ureteric involvement. The next step is to take a bite from the anterior aspect of the vaginal vault. This suture is kept in an artery forceps to be tied at the end of the procedure. Three individual sutures are placed in this manner, sequentially on each side of the vault so that six sutures have been placed to support the vault. These are then tied following vault closure. It is essential to confirm ureteric patency after performing the HUSLS. This is best done by performing a cystoscopy and inspecting the ureteric orifii for efflux. By injecting an intravenous dose of either Methylene-Blue or Indigo-Carmine, the ureteric efflux is easier to see. If a blue or green jet is not observed from either ureters, it is essential to remove the HUSLS sutures sequentially until ureteric patency is confirmed (Fig. 120.35).

There is some debate concerning the type of suture that should be used for the HUSLS. In a study comparing Prolene to PDS, Kasturi et al. [13] showed that there was no difference in anatomical outcomes between the two groups. There was, however, a high incidence of suture erosion (22 %) in those women in the Prolene group. I therefore prefer to use a monofilament delayed absorbable suture such as PDS.



Fig. 120.35 Cystoscopy with efflux of methylene blue confirming ureteric patency

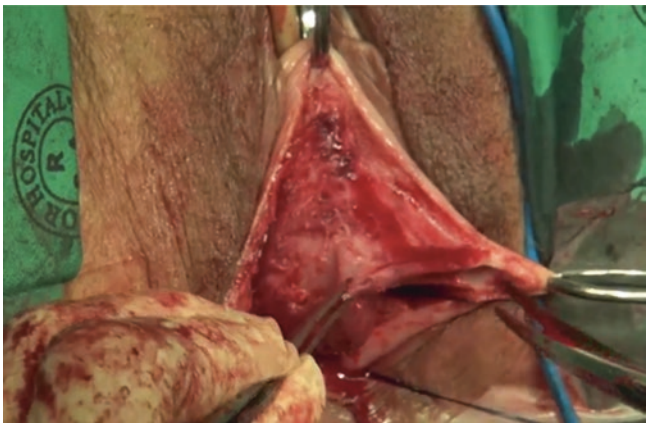


Fig. 120.36 Exposure of the bladder fascia for anterior repair

The HUSLS has been shown to be associated with excellent outcomes. In a review of the outcomes of HUSLS for uterine prolapse, Khunda et al. [14] reported anatomical success rates of between 87 % and 100 %, and in a systematic review of transvaginal uterosacral ligament suspension, Margulies et al. [15] reported a re-operation rate of 9.4 % and ureteric re-implantation rate of 0.6 %.

High Uterosacral Ligament Suspension Versus Sacrospinous Fixation

Both the SSF and HUSLS have been shown to be associated excellent functional and anatomical outcomes when done in women with uterine prolapse. Both procedures, however, have their own technical challenges and complications. These two procedures were looked at in a beautifully constructed RCT by Barber et al. [16] that was recently published in the JAMA. In their comparison of the HUSLS and SSF, they demonstrated no difference in anatomical or functional outcomes between the two groups. The success rates were 59 % and 60 % for the HUSLS and SSF respectively, but they did use very strict anatomical outcome measures. The re-operation rate was, however, very low in both groups, with 3 % of the HUSLS and 2.6 % of the SSF group requiring repeat surgical intervention for prolapse.

Barber et al. have shown the two procedures to be of equal efficacy, but the majority of the women in that trial had grade 2 uterine prolapse. In my opinion the SSF may be a better option in women with more extensive uterine prolapse. It makes anatomic sense that a more secure and higher suspension can be achieved with the SSF. In their systematic review, Margulies et al. [Marguiles] report a successful anatomic outcome in 92 % of women with pre-operative grade 2 prolapse compared to 67 % in those with pre-operative grade 3, which further suggests that the HUSLS should be reserved for smaller degrees of uterine prolapse.

It is also important to consider the complication profile of each of these procedures, which was also elegantly demonstrated by the Barber trial. [Barber] They reported a ureteric injury rate of 3.2 % in the HUSLS group compared to 0 % in the SSF group. Most of these were recognized intra-operatively and in only 0.5 % of the HUSLS cohort was there a need for post-operative intervention for a ureteric re-implantation. One of the potential concerns with the SSF is long term pain due to nerve damage. Barber et al. reported that 4.3 % of the SSF cohort had persistent pain, compared to only 0.5 % of the HUSLS cohort.

Anterior and Posterior Repair When Doing a Vaginal Hysterectomy

It is essential to address all prolapsing compartments when performing a vaginal hysterectomy in prolapse situations. This is usually easiest to do once the uterus has been removed. In order to proceed to the anterior repair, it is usually easiest to extend the original colpotomy incision, that was made for the vaginal hysterectomy, in the midline towards the urethral meatus. Para-vaginal dissection is then done (Figs. 120.36 and 120.37) followed by fascial plication (Fig. 120.38).

The incision and dissection can also be extended posteriorly if a rectocele is the predominant part of the prolapse. If one is using a Miya Hook or a suture and needle holder for the sacrospinous fixation, a posterior approach is also easier than an anterior approach. As stated earlier, approaching the ligament from an anterior dissection is only possible using the newer sacrospinous fixation devices such as the Capio.

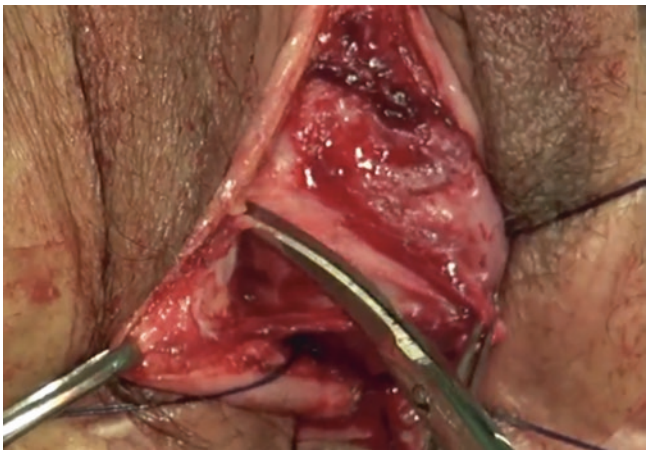


Fig. 120.37 Further dissection of vaginal skin from bladder fascia

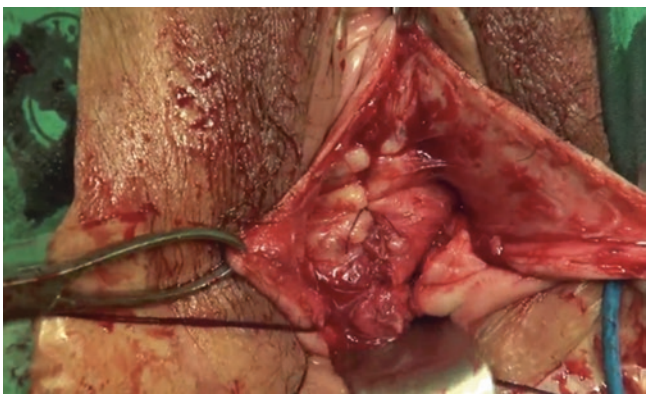


Fig. 120.38 Plication of vesical fascia to complete anterior repair

Attachment of Support Sutures to the Vaginal Vault

If a sacrospinous fixation was done, these sutures are exteriorised and brought separately through the vaginal vault at the apex. When a High Uterosacral Ligament Suspension is done, each suture is brought through the vaginal vault anteriorly and posteriorly. These are tied on completion of closure of the vault.

Closure of the Colpotomy

The vaginal incision is closed following the completion of the anterior and/or posterior repair. This usually involves a midline-type continuous non-locking suture. A transverse closure may be more suitable when an anterior repair has not been done or if a HUSLS has been performed.

Concomitant Stress Incontinence Surgery

Women with uterine prolapse often require a retropubic or transobturator mid-urethral sling for stress incontinence. This should be done on completion of the prolapse procedure and once the vault suspension sutures have been tied. A separate mid-urethral is made for this part of the operation.

Post-operative Care

A vaginal pack is placed on completion of the surgery. The catheter and vaginal pack are removed 24 h post-operatively.

References

1. Gilman, Sander L.. Hysteria Beyond Freud. University of California Press. 1993: 118. ISBN 9780520080645.
2. Lefkowitz, Mary R., and Maureen B. Fant. Women's life in greece and rome: a source book in translation. JHU Press. 2005:248. ISBN 9780801883095.
3. Sutton C. Hysterectomy: a historical perspective. Baillieres Clin Obstet Gynaecol. 1997;11(1):–22.
4. Maher CM, Feiner B, Baessler K, Glazener CM. Surgical management of pelvic organ prolapse in women: the updated summary version Cochrane review. Int Urogynecol J. 2011;22(11):1445–57.
5. Roovers JP, van der Vaart CH, van der Bom JG, van Leeuwen JH, Scholten PC, Heintz AP. A randomised controlled trial comparing abdominal and vaginal prolapse surgery: effects on urogenital function. BJOG. 2004;111(1):50–6.
6. De La Cruz JF, Myers EM, Geller EJ. Vaginal versus robotic Hysterectomy and Concomitant pelvic Support surgery: a comparison of postoperative vaginal length and sexual function. J Minim Invasive Gynecol. 2014;21:S1553–4650. doi:10.1016/j.jmig.2014.04.011.
7. Matthews CA. A critical evaluation of the evidence for ovarian conservation versus removal at the time of hysterectomy for benign disease. J Women's Health. 2013;22(9):755–9.
8. Neeser E, Keller E, Hirsch HA. Prevention of vaginal prolapse in hysterectomy by suspension of the vaginal stump. Geburtshilfe Frauenheilkd. 1990;50(10):789–93.
9. Kuhn A, Brunnmayr G, Stadlmayr W, Kuhn P, Mueller MD. Male and female sexual function after surgical repair of female organ prolapse. J Sex Med. 2009;6(5):1324–34.
10. Beer M, Kuhn A. Surgical techniques for vault prolapse: a review of the literature. Eur J Obstet Gynecol Reprod Biol. 2005;119(2):144–55.
11. Leone Roberti Maggiore U, Alessandri F, Remorgida V, Venturini PL, Ferrero S. Vaginal sacrospinous colpopexy using the Capio suture-capturing device versus traditional technique: feasibility and outcome. Arch Gynecol Obstet. 2013;287(2):267–74.
12. Patel M, Currie J, Tulikangas PK. Abdominal extraperitoneal excision of a foreign body in the pararectal space. Female Pelvic Med Reconstr Surg. 2011;7(3):144–6.
13. Kasturi S, Bentley-Taylor M, Woodman PJ, Terry CL, Hale DS. High uterosacral ligament vaginal vault suspension: comparison of absorbable vs. permanent suture for apical fixation. Int Urogynecol J. 2012;23(7):941–5.

14. Khunda A, Vashisht A, Cutner A. New procedures for uterine prolapse. Best Pract Res Clin Obstet Gynaecol. 2013;27(3):363–79.
15. Margulies RU, Rogers MA, Morgan DM. Outcomes of transvaginal uterosacral ligament suspension: systematic review and metaanalysis. Am J Obstet Gynecol. 2010;202(2):124–34.
16. Barber MD, Brubaker L, Burgio KL, Richter HE, Nygaard I, Weidner AC, Menefee SA, Lukacz ES, Norton P, Schaffer J, Nguyen JN, Borello-France D, Goode PS, Jakus-Waldman S, Spino C, Warren LK, Gantz MG, Meikle SF. Eunice Kennedy Shriver National Institute of Child Health and Human Development Pelvic Floor Disorders Network. Comparison of 2 transvaginal surgical approaches and perioperative behavioral therapy for apical vaginal prolapse: the OPTIMAL randomized trial. JAMA. 2014;311(10):1023–34.

Trachelectomy: Removal of Cervical Stump Following Supracervical Hysterectomy

121

Margaret G. Mueller and Kimberly Kenton

Introduction

Cervical stump extirpation (trachelectomy) is the removal of the cervix following supracervical hysterectomy. Subtotal or supracervical hysterectomy is an alternative to total hysterectomy (removal of uterine fundus and cervix) in women undergoing hysterectomy for many benign indications. There are several benefits to supracervical hysterectomy including reduced complications, shorter hospital stay, and faster resumption of activity; in addition, mesh complications are reduced when hysterectomy is done in conjunction with an abdominal sacrocolopexy Tan-Kim et al. [1], Bensinger et al. [2]. However, women considering supracervical hysterectomy should be counseled regarding risks of cervical retention, including need for cervical screening according to current guidelines, as well as the potential need for future surgery to remove the cervical stump. With increases in minimally invasive surgical techniques, many women will elect to undergo supracervical hysterectomy: therefore, it is likely that most gynecologists will encounter patients that require trachelectomy. In this chapter, we will review the indications for trachelectomy, advantages and disadvantages of different routes of access for trachelectomy, as well as complications associated with removing the cervix following subtotal hysterectomy.

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Historical Perspective

The first successful abdominal supracervical hysterectomy was performed in 1853 for the treatment of uterine fibroids Thom et al. [3]. In the early half of the twentieth century, surgeons favored supracervical hysterectomy over total abdominal hysterectomy owing to the almost doubled complication rates of total compared to supracervical hysterectomy. However, by 1960 with advantages in surgical technique, anesthetic delivery and the discovery of antibiotics, most gynecologic surgeons abandoned supracervical hysterectomy as they were now able to safely perform total abdominal hysterectomy Jones et al. [4, 5]. It was not until the 1990s that surgeons began to reconsider supracervical hysterectomy for the surgical management of benign gynecologic conditions. Touted benefits included decreased risk of development of pelvic organ prolapse, sexual dysfunction and lower urinary tract symptoms Brown et al. [6], Kilkku et al. [7]. In addition, supracervical hysterectomy was thought to decrease intra and postoperative complications such as bladder and/or ureteral injury and cuff abscess/hematoma. However, recent randomized controlled studies do not support these benefits Learman et al. [8]; Greer et al. [9]. A US multicenter randomized trial of supracervical and total abdominal hysterectomy reported no difference in symptoms of pelvic pain/pressure, urinary incontinence, or voiding dysfunction 2-years after surgery Learman et al. [8]. In addition, they found no differences in complications, including blood loss/transfusion, lower urinary tract injury or fever, or sexual function Learman et al. [10]; Kuppermann et al. [11]. Long-term follow up using symptom assessments showed no difference in urinary incontinence, pelvic organ

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prolapse or sexual function 9-years after surgery Greer et al. [9]. Similarly, a multicenter trial in UK showed no difference in urinary or pelvic floor symptoms 1-year after supracervical or total hysterectomy, but found quicker recovery and fewer short-term complications in the supracervical hysterectomy group Thakar et al. [12].

The first report of one of the more common long-term complications of supracervical hysterectomy (carcinoma of the cervical stump) came 50 years following the first successful supracervical hysterectomy [13]; Decker et al. [14]. A major proven disadvantage to supracervical hysterectomy is the development of cervical stump complications Gimbel et al. [15]; Boosz et al. [16]. In 1959, the Mayo Clinic reported their experience with cervical stump extirpation in 514 patients dating back to 1940 Welch et al. [17]. Most common complications requiring delayed removal of the cervix include pelvic organ prolapse, cyclical bleeding, and uterine and/or cervical abnormalities. One retrospective case series of 300 women who underwent supracervical hysterectomy for benign disease reported a 3 % re-operation for removal of cervix. Only one woman had re-operation for cervical bleeding; the majority underwent cervical stump removal for cervical or uterine abnormalities Boosz et al. [18].

Indications

While early case series suggest cervical carcinoma was the primary complication associated with supracervical hysterectomy [19], modern case series suggest the most common indications for this cervical stump removal are prolapse, bleeding, pelvic mass, abnormal cervical pathology, and pain [13]; Hilger et al. [20, 21]. In 1931, Mayo brothers reported a case series of nearly 100 women who presented with cervical cancer after supracervical hysterectomy; however, with modern cervical cancer screening, trachelectomy for cervical cancer is less common. In 2001, Okaro et al. reported that nearly one quarter (22.8 %) of women undergoing laparoscopic supracervical hysterectomy for pelvic pain inevitably required trachelectomy Okaro et al. [22]. Based on several large case series, the most common Indications for this procedure include prolapse, bleeding, pelvic mass, abnormal cervical pathology, and pain (Table 121.1) [13, 21]; Hilger et al. [20]. In addition with the increase in supracervical hysterectomies done at the time of open, laparoscopic, or robotic sacrocolpoepxies with permanent mesh, trachelectomy for foreign body complications or mesh extrusion from the cervical stump are more common. These procedures are often quite difficult secondary to the mesh suspending the cervical stump to the anterior longitudinal ligament of the sacrum.

Table 121.1 Indications for removal of cervical stump

Indication	Pratt and Jeffrey [13] N = 262	Pasley [21] N = 55	Hilger [20] N = 310 (patients had multiple indications)
Prolapse	101	47	161
Pelvic mass	47	0	78
Abnormal cervical cytology	57	6	36
Non-cervical cancer	6	0	19
Bleeding	42	1	28
Pelvic Pain	3	0	31
Other	6	1	23

Surgical Techniques

Route

When possible, the vaginal route is the preferred route of trachelectomy for benign gynecologic indications owing to its significantly lower rates of intra- and perioperative complications compared to the abdominal route (20 % vs 43 %) Hilger et al. [20]. The vaginal route also provides a minimally invasive option to the abdominal approach with its inherent benefits including quicker recovery and shorter hospital length of stay Hilger et al. [20]. Certainly, there are some clinical scenarios when an abdominal approach is favored, such as in the case of a large pelvic mass or a prior abdominal sacrocolpopexy with permanent mesh. As focus on minimally invasive surgery continues to grow, laparoscopic and/or robotic trachelectomy for benign disease are gaining popularity. Nezhat described laparscopic trachelectomy for pelvic pain following SCH in six women and noted no intra or postoperative complications Nezhat et al. [23].

Vaginal Trachelectomy

The technique that we use for trachelectomy is similar to Welch's initial description in 1959. Prior to induction of anesthesia, the patient is given preoperative antibiotic prophylaxis. The patient is then placed in dorsal lithotomy using supportive yellow-fin stirrups. A Foley catheter is inserted to drain the bladder throughout the procedure. The anterior and posterior lips of the cervix are grasped with two Jacob's tenacula. A circumferential colpotomy is performed with a Bovie electrosurgical device. Gentle upward traction is applied to the anterior vaginal epithelium to facilitate exposure of the vesico-uterine plane. With downward countertraction, the bladder is sharply dissected off of the cervix until the vesicouterine peritoneum is identified and incised. Once

intra-peritoneal entry is confirmed, a right angle Heaney retractor is placed in the anterior cul-de-sac. Next, we turn our attention to posterior entry. Again with gentle traction on the posterior vaginal epithelium and upward counter traction of the cervix, the posterior cul-de-sac is identified and entered sharply. At this point, gentle manual exploration is performed to ensure that there are no adhesions between the cervical stump and bowel and/or omentum.

Next, the uterosacral ligaments on each side are identified, grasped with a Heaney clamp and suture ligated. Serial pedicles are suture ligated, including the cardinal ligament complex. Once the cardinal ligaments are suture ligated, the cervical stump is freed; however, there might be adhesions that need to be carefully lysed at this time. Once the cervix is removed, the vaginal cuff is re-suspended with a uterosacral ligament suspension and closed hemostatically Shull et al. [24].

Cystoscopy is routinely performed to ensure lower urinary tract safety paying particular attention to the integrity of the urothelium and brisk bilateral efflux of urine.

Open Abdominal, Laparoscopic or Robotic Trachelecomy

In rare cases, an abdominal approach via laparotomy, laparoscopy, or robotic assisted laparoscopy is appropriate. These routes of access should be considered based on indication for trachelectomy, particularly in cases of pelvic mass or prior sacrocolpopexy with permanent mesh, which preclude vaginal approach. The cervix is often difficult to identify using an abdominal approach due to dense bowel and bladder adhesions over the cervix. In cases of a prior sacrocolpopexy with mesh, the graft material extending from the cervix and vagina to the sacrum can be visualized and used to guide dissection and identification of the cervix. Placement of a Lucite stent in the vagina is also useful to facilitate identification of the cervix. Once the cervix is palpated, the bladder is sharply dissected to allow placement of Heaney clamps across the cervico-vaginal junction. Prior to removing the cervix, the uterosacral ligaments are identified bilaterally. These ligaments will be used to suspend the vaginal cuff. Once the cervix is removed, the cuff is closed hemostatically and suspended to the uterosacral ligaments. Cystoscopy is routinely performed to ensure lower urinary tract safety paying particular attention to the integrity of the urothelium and brisk bilateral efflux of urine.

Complications

Data on complications of trachelectomy are derived from several small case series. The largest retrospective case series included 335 women undergoing trachelectomy following supracervical hysterectomy. Trachelectomies performed via an abdominal route were associated nearly double the rate of intra- and perioperative complications compared to those performed via a vaginal route including infection, perioperative bleeding, intraoperative injury and venous thromboembolism. Moreover, in 47 women who underwent vaginal trachelectomy without other concomitant surgery, only 3 women (7 %) suffered complications (2 women with postoperative infections and 1 woman with postoperative bleeding).Hilger et al. [20].

Conclusion

Indications for supracervical hysterectomy change over time based on patient and surgeon preferences and skill; however, some women will develop complications associated with retention of the cervical stump that require trachelectomy. While cervical malignancy is the most concerning indication for cervical stump removal, it is uncommon secondary to modern cervical screening techniques. Trachelectomy for benign indications is more common with a recent rise in trachelectomy for mesh related complications after sacrocolpopexy. When feasible, a vaginal route of access for trachelectomy is preferred secondary to low rate of complications when compared to the abdominal route. In cases of malignancy, pelvic mass, or prior sacrocolpopexy, an abdominal route may be indicated.

References

1. Tan-Kim J, Menefee SA, Luber KM, Nager CW, Lukacz ES. Prevalence and risk factors for mesh erosion after laparoscopic-assisted sacrocolpopexy. Int Urogynecol J. 2011;22(2):205–12. doi:10.1007/s00192-010-1265-3.
2. Bensinger G, Lind L, Lesser M, Guess M, Winkler HA. Abdominal sacral suspensions: analysis of complications using permanent mesh. Am J Obstet Gynecol. 2005;193(6):2094–8. doi:10.1016/j.ajog.2005.07.066.
3. Thom CH, Dunne TJ, Livornese G. Vaginal cervicectomy. Obstet Gynecol. 1967;30(4):473–80.
4. Jones DE, Shackelford DP, Brame RG. Supracervical hysterectomy: back to the future? Am J Obstet Gynecol. 1999;180(3 Pt 1):513–5.
5. Munro MG. Supracervical hysterectomy: a time for reappraisal. Obstet Gynecol. 1997;89(1):133–9.
6. Brown JS, Sawaya G, Thom DH, Grady D. Hysterectomy and urinary incontinence: a systematic review. Lancet. 2000;356(9229):535–9. doi:10.1016/S0140-6736(00)02577-0.
7. Kilkku P, Gronroos M, Hirvonen T, Rauramo L. Supravaginal uterine amputation vs. hysterectomy. Effects on libido and orgasm. Acta Obstet Gynecol Scand. 1983;62(2):147–52.
8. Learman LA, RL Jr S, Varner RE, McNeeley SG, Goodman-Gruen D, Richter HE, Lin F, Showstack J, Ireland CC, Vittinghoff E, Hulley SB, Washington AE. Total or Supracervical Hysterectomy Research G. A randomized comparison of total or supracervical hysterectomy: surgical complications and clinical outcomes. Obstet Gynecol. 2003;102(3):453–62.

9. Greer WJ, Richter HE, Wheeler TL, Varner RE, Szychowski JM, Kuppermann M, Learman LA. Long-term outcomes of the total or supracervical hysterectomy (TOSH) trial. Female Pelvic Med Reconstr Surg. 2010;16(1):49–57. doi:10.1097/SPV.0b013e3181cec343.
10. Learman LA, RL Jr S, Varner RE, Richter HE, Lin F, Ireland CC, Kuppermann M, Vittinghoff E, Showstack J, Washington AE, Hulley SB. Medicine or Surgery Research G. Hysterectomy versus expanded medical treatment for abnormal uterine bleeding: clinical outcomes in the medicine or surgery trial. Obstet Gynecol. 2004;103(5 Pt 1):824–33. doi:10.1097/01.AOG.0000124272.22072.6f.
11. Kuppermann M, Summitt Jr RL, Varner RE, McNeeley SG, Goodman-Gruen D, Learman LA, Ireland CC, Vittinghoff E, Lin F, Richter HE, Showstack J, Hulley SB, Washington AE. Total or Supracervical Hysterectomy Research G. Sexual functioning after total compared with supracervical hysterectomy: a randomized trial. Obstet Gynecol. 2005;105(6):1309–18. doi:10.1097/01.AOG.0000160428.81371.be.
12. Thakar R, Ayers S, Clarkson P, Stanton S, Manyonda I. Outcomes after total versus subtotal abdominal hysterectomy. N Engl J Med. 2002;347(17):1318–25. doi:10.1056/NEJMoa013336.
13. Pratt JH, Jefferies JA. The retained cervical stump. A 25-year experience. Obstet Gynecol. 1976;48(6):711–5.
14. Decker DG, Hunt AB, Fricke RE, Nelson GA. Carcinoma of the cervical stump. American journal of obstetrics and gynecology. 1957;73(5):974–81. discussion, 981–74
15. Gimbel H, Zobbe V, Andersen BM, Filtenborg T, Gluud C, Tabor A. Randomised controlled trial of total compared with subtotal hysterectomy with one-year follow up results. BJOG: Inter J Obstet Gynaecol. 2003;110(12):1088–98.
16. Boosz A, Lermann J, Mehlhorn G, Loehberg C, Renner SP, Thiel FC, Schrauder M, Beckmann MW, Mueller A. Comparison of re-operation rates and complication rates after total laparoscopic hysterectomy (TLH) and laparoscopy-assisted supracervical hysterectomy (LASH). Eur J Obstet Gynecol Reprod Biol. 2011a;158(2):269–73. doi:10.1016/j.ejogrb.2011.04.021.
17. Welch JS, Counseller VS, Malkasian Jr GD. The vaginal removal of the cervical stump. Surg Clin North Am. 1959;39(4):1073–84.
18. Boosz A, Lermann J, Mehlhorn G, Renner SP, Thiel FC, Hartmann A, Beckmann MW, Mueller A. Is laparoscopic extirpation of the cervical stump after laparoscopic supracervical hysterectomy justified in women with incidentally found atypical endometrial hyperplasia? J Laparoendosc Adv Surg Tech A. 2011b;21(8):705–9. doi:10.1089/lap.2010.0497.
19. Mayo CH, Mayo C. Carcinoma of the cervical stump following subtotal hysterectomy. Ann Surg. 1931;93(6):1215–9.
20. Hilger WS, Pizarro AR, Magrina JF. Removal of the retained cervical stump. Am J Obstet Gynecol. 2005;193(6):2117–21. doi:10.1016/j.ajog.2005.07.015.
21. Pasley WW. Trachelectomy: a review of fifty-five cases. Am J Obstet Gynecol. 1988;159(3):728–32.
22. Okaro EO, Jones KD, Sutton C. Long term outcome following laparoscopic supracervical hysterectomy. BJOG: Inter J Obstet Gynaecol. 2001;108(10):1017–20.
23. Nezhat CH, Nezhat F, Roemisch M, Seidman DS, Nezhat C. Laparoscopic trachelectomy for persistent pelvic pain and endometriosis after supracervical hysterectomy. Fertil Steril. 1996;66(6):925–8.
24. Shull BL, Bachofen C, Coates KW, Kuehl TJ. A transvaginal approach to repair of apical and other associated sites of pelvic organ prolapse with uterosacral ligaments. Am J Obstet Gynecol. 2000;183(6):1365–73. discussion 1373-64 doi:10.1067/mob.2000.110910.

Vaginal Salpingo-Oophorectomy

122

Shirish S. Sheth

Introduction

The female pelvic organs have two portals of entry: One, natural and the other artificially created at surgery. None other than a gynaecologist will have the in-depth knowledge of the art and science of making optimum use of the natural orifice for *per vias naturales* i.e. vaginal or gynaecological route for any surgery on the pelvic organs.

The vaginal approach has always been the hallmark of the gynaecological surgeon. For hysterectomy, the vaginal route has proved its supremacy over all other alternatives. Only when this natural route is unsafe or not possible, should the gynaecologist choose an alternative i.e. an abdominal access, either by laparoscopy or laparotomy [1, 2].

The most common secondary procedure performed in conjunction with hysterectomy is prophylactic oophorectomy and/or salpingectomy. Although there is controversy even today about prophylactic oophorectomy, there has been debate on the subject from the end of the nineteenth century, since Tait, the foremost advocate of spaying in women-and Spencer Wells slugged out their acrimonious differences on the subject [3, 4]. Even those who removed benign ovarian cysts were labeled "gelders" with a resultant ruined reputation. Be that as it may, the American College of Obstetricians and Gynecologists has recommended that women over the age of 50 years undergoing hysterectomy should consider with their physicians, the risk and benefits of concomitant oophorectomy [5]. The probability of a 40 year old woman developing ovarian cancer by age 85 ranges from 1.2 % (95 % CI 0.8–1.4 %) if she has no risk factors, to 6.6 % (95 % CI 5.0–8.6 %) if she has five or more risk factors [6, 7].

Low-risk women undergoing hysterectomy for benign indications should not be subjected to prophylactic oophorectomy, especially if lesser than 55 years of age. The author does not hesitate to perform prophylactic salpingo-oophorectomy after the age of 50–54 years as several other factors besides risk, hypertension, obesity, diabetes, resorting to Hormonal replacement therapy (HRT) and contraindication to HRT are to be accounted for. A clear advantage of prophylactic oophorectomy is demonstrated in women with endometriosis who have a 47 % chance of further surgery if the ovaries are preserved at hysterectomy for endometriosis [8]. J Donald Woodruff (personal communication) has said that if the ovaries warrant removal, they should be removed whether the hysterectomy is by the vaginal or abdominal route and even after age of 40 years [9]. The decision to perform prophylactic oophorectomy should not be influenced by the route of hysterectomy and is not a contraindication to perform hysterectomy by the vaginal route [5]. There is no place for risky surgical acrobatics, and only if transvaginal oophorectomy or salpingo-oophorectomy can be performed safely and under vision, should it be done. There appears to be some reluctance to combine vaginal hysterectomy (VH) with oophorectomy because it is thought to be a risky and difficult procedure. The correct paradigm substantiated by clinical evidence is to first attempt ovarian removal transvaginally [10, 11].

Incidence

A bilateral oophorectomy was carried out in 92 % for abdominal hysterectomy, and only 9.4 % during VH respectively in women between 55 and 60 years age group [12]. Concomitant oophorectomy at hysterectomy presented by Gross et al. [13] was in 89 % in total abdominal hysterectomy (TAH), 86 % in laparoscopic hysterectomy and 27 % at vaginal hysterectomy. This is accentuated by the fact that usually 75 % of hysterectomies are not performed by the vaginal route.

The test of our progress lies in overcoming what obstacles our fellow men.

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Interestingly, 39 of 40 cases [14] had ovarian removal managed successfully per vaginum using the transvaginal endoscopic technique at hysterectomy without laparoscopic assistance. Obviously, where there is a 'will' there is a way. In the author's earlier series of 740 VHs, there was 95 % success in associated salpingo-oophorectomy [15–18].

The American College of Obstetrics and Gynecology guidelines recommend the use of laparoscopic assistance only for difficult oophorectomy at vaginal hysterectomy [19]. Removal of the ovaries at vaginal hysterectomy is usually not difficult and should not be made difficult to 'fit in' with ACOG's Guideline.

Routine prophylactic oophorectomy for postmenopausal women at abdominal hysterectomy is a standard practice but, paradoxically, not if the hysterectomy is performed by the vaginal route. This is often done without the slightest hesitation by gynecologists, who have double standards for prophylactic ovarian removal when the approach is vaginal compared to hysterectomy performed by laparoscopic technique or by opening the abdomen. Gynecologists today are stretching to add three or four abdominal punctures to perform laparoscopic oophorectomy or salpingo-oophorectomy to assist vaginal hysterectomy but are not willing to learn an additional step to perform oophorectomy or salpingo-oophorectomy concomitantly at vaginal hysterectomy [20, 21].

The trend is towards fashionable laparoscopic surgery. Quite often, the gynecologist's inability to perform and/or indifference to learn, adds to it. Scientifically, laparoscopic is obviously more invasive than per via naturales. Let us remain scientific, have maximum interest in what is best for the patient, cost, invasion, availabilities etc. and above all develop the art of vaginal surgery. It is useful to ask the question before every hysterectomy: 'if I were to carry out the hysterectomy abdominally, would I have retained or removed her ovaries and the same reply must be implemented at vaginal surgery.'

Oophorectomy or Salpingo-Oophorectomy?

Recent histologic, molecular, and genetic studies indicate that many ovarian cancers may have originated in the fimbrial end of the tube. Therefore, tubal removal is an absolute must at hysterectomy i.e. not just bilateral oophorectomy but bilateral salpingo-oophorectomy.

Three strategies for risk reduction in women with BRCA mutations have been recently tried [22]. They are (1) bilateral salpingo-oophorectomy, (2) bilateral salpingectomy, and (3) bilateral salpingectomy with delayed oophorectomy to find benefits in years-of-life expectancy and quality-adjusted life-year expectancy, and the primary outcome was the incremental cost-effectiveness ratio. The model estimated the number of future breast and ovarian cancers and cardiovascular deaths attributed to premature menopause with each strategy.

- Bilateral salpingo-oophorectomy was associated with the lowest cost and highest life expectancy compared with the other two strategies. Bilateral salpingo-oophorectomy yielded the lowest number of future breast and ovarian cancers compared with the other two strategies. Thus, bilateral salpingo-oophorectomy offers the greatest risk reduction for breast and ovarian cancer among BRCA mutation carriers.
- Salpingectomy followed by delayed oophorectomy yielded the highest quality-adjusted life expectancy with incremental cost-effectiveness ratios, relative to salpingectomy alone.
- When considering quality-adjusted life expectancy, bilateral salpingectomy with delayed oophorectomy is a cost-effective strategy and may be an acceptable alternative for those unwilling to undergo bilateral oophorectomy.

Understanding and implementing the above guidelines, it is clear that one should prefer salpingo-oophorectomy to prophylactic oophorectomy at hysterectomy. However, if the ovaries are to be preserved, it is worth performing bilateral partial salpingectomy which must include the fimbrial ends of tubes.

Technique

Nichols [10] has described the steps of oophorectomy at hysterectomy. Cengiz et al. in residency training [23] used laparoscopic evaluation and followed this successfully in 64.7 % cases by performing vaginal hysterectomy using Heaney technique and salpingo-oophorectomy using Sheth's technique. Kovac and Cruikshank found oophorectomy at vaginal hysterectomy is possible in the great majority of cases and is superior to other approaches [24].

The technique for concomitant salpingo-oophorectomy at VH as given below has been practised by the author since 1977 for more than 2000 cases, with a 3 % failure rate at present, [15, 17, 21] (Fig. 122.1).

1. The vaginal hysterectomy is begun as usual. All uterine lateral connections, including the cornual structures are severed on one side and upto the cornual structures or upper pedicle on the contralateral side. After uterus is severed from all its pedicles on one side, it hinges or hangs on the support of the contralateral upper pedicle. The decision to perform salpingo-oophorectomy comes into action only after the cornual pedicle or uppermost pedicle, comprising of the round ligament, utero-ovarian ligament and fallopian tube, have been cut on one side [15, 20, 21] (Fig. 122.2).

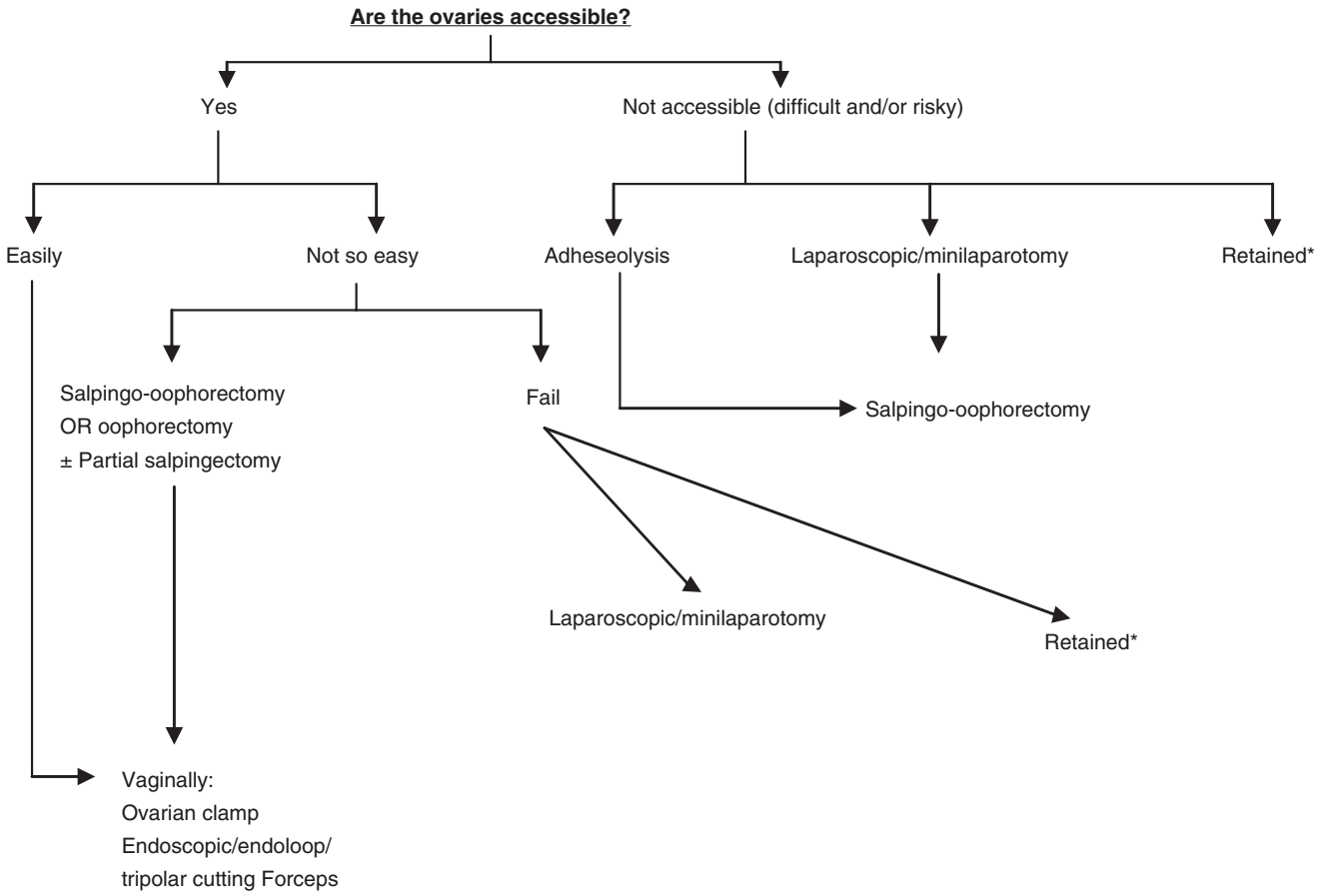


Fig. 122.1 Algorithm for prophylactic oophorectomy at VH, salpingo-oophorectomy at VH

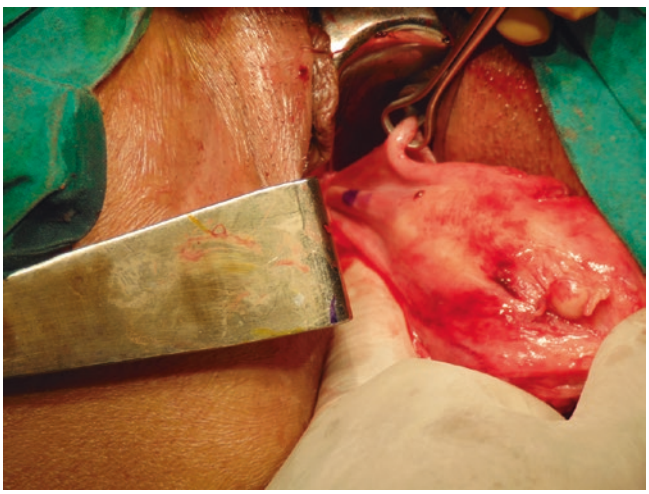


Fig. 122.2 Uterine anterior surface with all the lateral connections severed on left side and Babcock holding the right fallopian tube. Anatomically shows prominent round ligament with bit of anterior broad ligament, to be cut separately and distally from the uterus

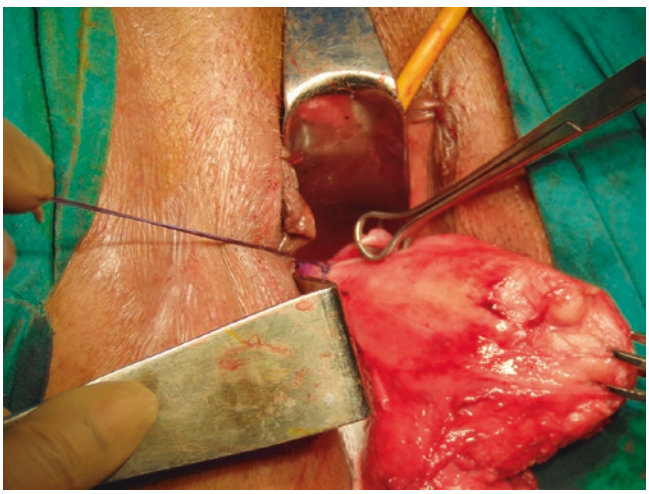


Fig. 122.3 Uterine anterior surface with all the lateral connections severed on left side and Babcock holding the right fallopian tube. Round ligament, seen distinctly is well secured with suture and will then be cut medially and separately away from the fallopian tube and mesosalpinx (tube is held with Babcock forceps)

2. The objective is to get an easy access to the infundibulopelvic ligament, for which it is mandatory that the round ligament is separately and distally clamped, cut, and ligated i.e. separated from other structures (Figs. 122.3 and 122.4). The round ligament of the intact upper pedicle is now severed, as laterally as possible – 4–5 cm away from the uterus after excising the inferiorly attached broad ligament. This makes the

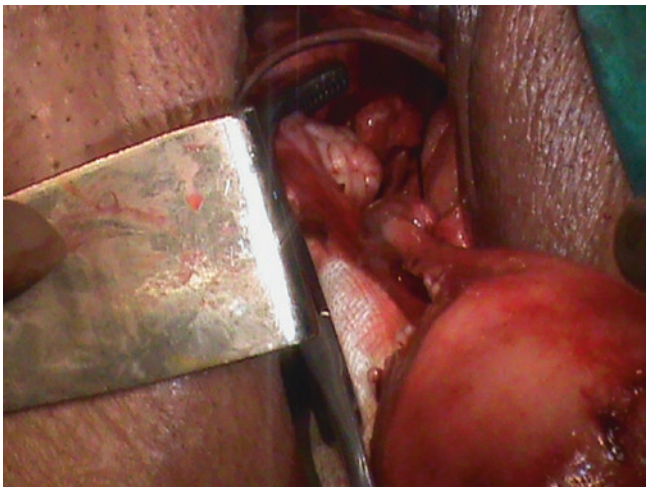


Fig. 122.4 Cutting round ligament paves the way to infundibulopelvic ligament for applying ovarian clamp. Well applied clamp is seen distally beyond the right ligament along with posterior uterine wall with right tube and part of ovary

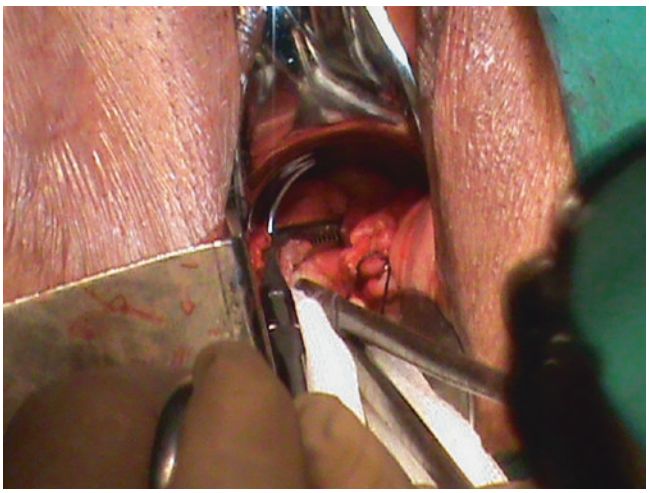


Fig. 122.5 Clamp applied to the right infundibulopelvic ligament with suture on pedicle to transfix and secure it

vascular pedicles as small as possible and leaves the tube and ovary attached only to the infundibulopelvic ligament [15, 16]. This is a vital step as it facilitates and paves the way to clamping of the infundibulopelvic ligament. Just as at an abdominal hysterectomy, the round ligament is cut separately and as laterally as possible to create space to facilitate clamping of the infundibulopelvic ligament well beyond the ovarian tissue (Fig. 122.4); for concomitant salpingo-oophorectomy at VH, the same principle is applied. Jones writes "that Sheth advocates clamping the round ligament and tube separately". The Author has repeatedly emphasized this for 35+ years [2, 15, 21]. The next step is to apply traction on the suture holding the round ligament laterally and on the tube and ovary medially with a Babcock forceps so as to have generous space between these two for application of the special ovarian clamp to the infundibulopelvic ligament and to proceed to complete salpingo-oophorectomy [15–17] (Figs. 122.4 and 122.5). The fibreoptic light of a laparoscope can illuminate the lateral vaginal wall, tube, the ovary and infundibulopelvic ligament, the bladder and bowel, and posterior loops of the small intestine, if popping out. A Sims speculum and bladder retractor, can have an attachment to fix a fiberoptic light (Figs. 122.6 and 122.7) [18, 25]. Trendelenburg position coupled with large roller gauze packing partially hanging out provides adequate exposure and safety, aided by excellent vaginal wall retraction, both laterally and anteroposteriorly, by experienced assistants. A Large sized Sim's speculum can be inserted anteriorly in reversed position to provide extra space and protect the bladder.



Fig. 122.6 Sim's vaginal speculum with attached fiberoptic light facility (With permission Sheth [25])



Fig. 122.7 Bladder retractor with attached fiberoptic light facility (With permission Sheth [25])

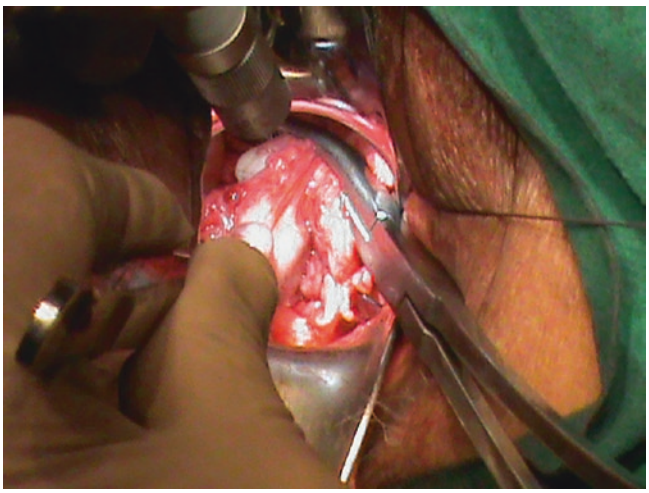


Fig. 122.8 After completion of salpingo-oophorectomy on right side, left round ligament is clamped to have it separated out from the left tube and ovary and create free space. Left tube and ovary are distinctly seen in the centre

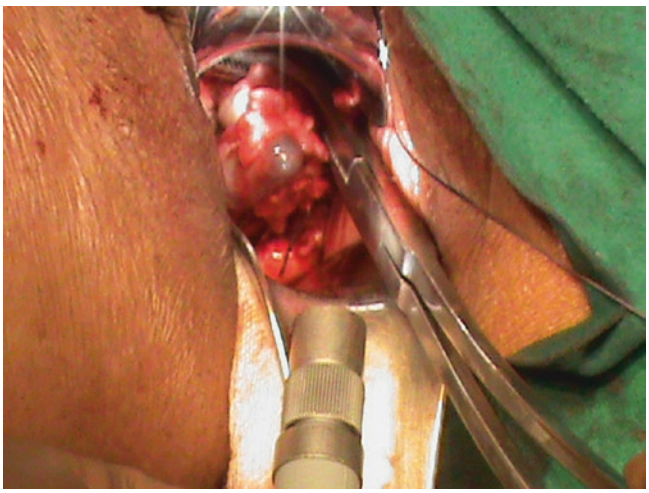


Fig. 122.10 After separating out left round ligament (suture is seen at approx. 3 O'clock position), ovarian clamp is easily applied to infundibulopelvic ligament with its tip well beyond the ligament to complete left salpingo-oophorectomy

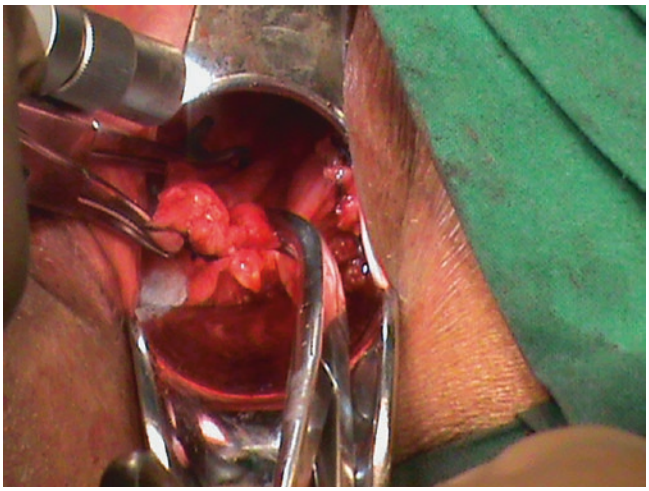


Fig. 122.9 After cutting left round ligament separately and distally (suture is seen at approx. 3 O'clock position), ovarian clamp is easily applied to infundibulopelvic ligament. Fibreoptic light facilitates and shows the tip of the clamp well beyond the ligament

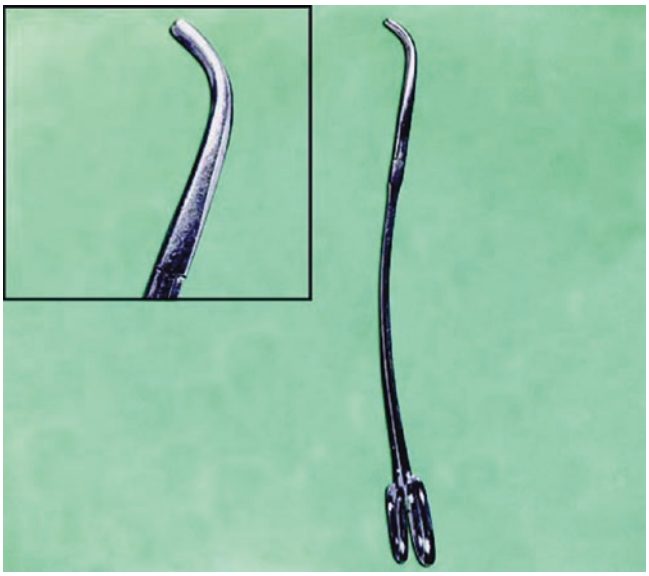


Fig. 122.11 Specially designed ovarian or adnexal clamp (Cooper Surgical, USA) (With permission Sheth [15])

Deaver's and Jayle's vaginal wall retractors are also useful, when required. Gentle handling and extra respect for the tissue is essential at this time to prevent tearing and bleeding.

3. Attention is now turned to the contralateral salpingo-oophorectomy of the remaining ovary and tube on the other side where all the uterine connections were severed earlier. The Round ligament is separated out from the earlier secured upper pedicle and the separated round ligament is cut laterally and distally, and pulled laterally; the tube and ovary are held with a Babcock forceps and are taken medially so as to get free space to permit application of the ovarian clamp on the infundibulopelvic ligament (Figs. 122.8, 122.9 and 122.10.). Separating out the round ligament after cutting it laterally paves the way to clamp the infundibulopelvic ligament and complete the contralateral salpingo-oophorectomy [15, 16, 21, 23, 26].

It is important to ensure that the pedicle is securely grasped by a specially designed clamp. The specially devised clamp(Fig. 122.11) [15, 16] a curved clamp of 2 cm, beginning 1 cm from the tip, facilitates and accommodates the infundibulopelvic ligament, which is well transfixed and doubly secured with a No.1 gauge polyglactin suture or 1/0 vicryl suture. Make sure that the clamp does not contain even a bit of

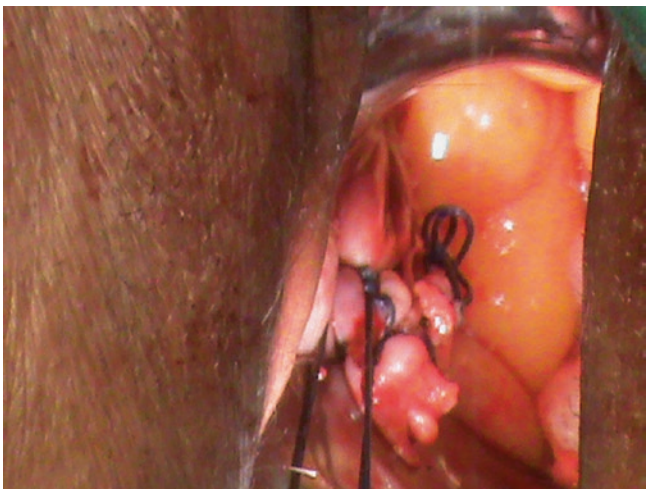


Fig. 122.12 Two sutures on round ligament and one medially on infundibulopelvic ligament (bunch of it) are seen. One on round ligament will be used to anchor vaginal vault (may be of no use). Haemostasis is well achieved

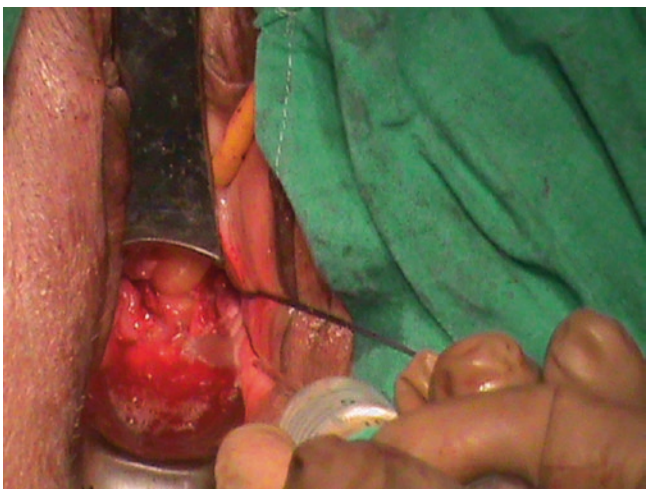


Fig. 122.13 Field is lavaged with saline via syringe

round ligament, as the rest of the tissue in the clamp is much thinner and makes application of the clamp improper. Single clamp application, at the first instance is most desirable.

After completion, it is essential to ensure that there is no raw area lateral to the sutures on the infundibulopelvic ligament that can bleed later [13, 15, 20] (Fig. 122.12). Thus, salpingo-oophorectomy is performed via two important steps (1) The round ligament being cut separately and laterally to create the space and access to the infundibulopelvic ligament and (2) applying an ovarian clamp carefully on the available infundibulopelvic ligament [2, 15, 16].

Closure of peritoneum is then performed in the routine fashion after lavage (Fig. 122.13), though the preferred option is to not close the peritoneum.

Special points to note are: (1) The round ligament cutting. (2) A specially designed clamp for the infundibulopelvic

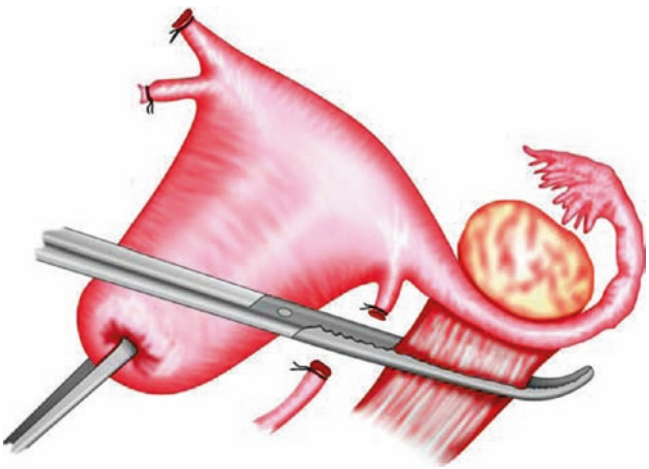


Fig. 122.14 Round ligament cut distally. A specially designed ovarian clamp is applied to the infundibulopelvic ligament (With permission Sheth [15])

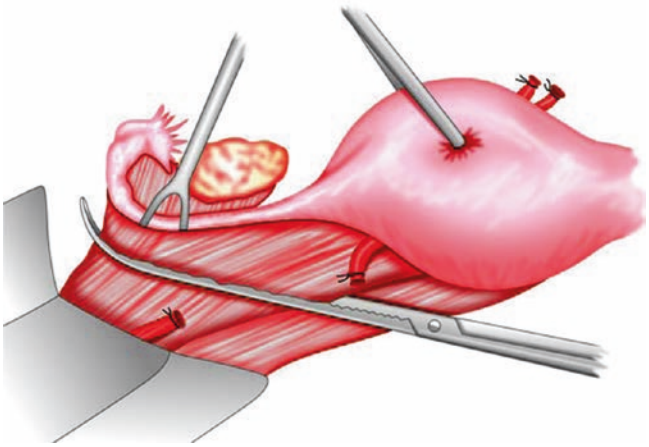


Fig. 122.15 A specially designed clamp is applied to infundibulopelvicligament for a salpingo-oophorectomy (With permission Sheth [20])

ligament, (3) Adequate exposure [15–18, 20, 26] (Figs. 122.14 and 122.15).

Preoperative

Pre-requisites: Normal tubes and ovaries.

Intraoperative: (1) easy access; (2) free mobility of the ovaries; (3) adequate exposure; (4) experienced assistants.

Factors like old age, nulliparity, obesity, reduced uterine descent, decreased space, and an enlarged uterus can lead to anxiety about performing VH and moreso concomitant salpingo-oophorecdtomy. In reality, they demand extra care, enhanced confidence and development of surgical skills.

In the age group of 60–70 years, the ovaries are likely to be placed at a greater distance than in the younger age group and at an even greater distance after the age of 70–75 years.



Fig. 122.16 Morbidly obese woman with BMI of 80, underwent a straightforward vaginal hysterectomy with bilateral salpingo-oophorectomy. She had a hospital stay of 48 h. A good look at the abdomen should ideally dissuade a surgeon to undertake the abdominal route for hysterectomy (With permission Sheth [27])

In other words, as age advances the distance between uterus and ovaries increases. Atrophy and shrinkage of tissues results in retraction of the infundibulopelvic ligament, a bit more atrophy than the utero-ovarian ligament, the uterine pull elongates the utero-ovarian ligament, distancing the ovaries and reducing access.

Nulliparous patients have decreased vaginal wall laxity and physiological uterine descent requires more traction. However, if it is possible to take out the uterus, there is no additional difficulty in taking out the ovaries. Nulliparity per se should not contraindicate or deter oophorectomy.

Obese patients are the surgeon's bugbear as it: (1) reduces access; (2) increases vascularity; (3) Tissue planes are less easy to access; (4) the ovaries may be enlarged; and (5) the patient may have decreased uterine descent. In obese woman with a narrow subpubic arch, the difficulty is accentuated and may demand LAVH.

Space is always at a premium and in reality, difficulties that obesity cause are much more at abdominal surgery when compared with similar difficulties during vaginal surgery [27]. In obese women especially, the labia increase the distance of the ovaries from the operator and the operative field, and therefore suturing the labia laterally and upward is helpful [27] (Fig. 122.16). Rarely, in the morbidly obese woman, a drooping mons needs suturing to the lower abdominal wall. The author has done this twice.

In obese and particularly the morbidly obese, when routine speculum examination does not yield satisfactory findings, speculum examination in "super flexion position" [28] will guide as well as persuade the operator to take the vaginal route.

Decreased ovarian accessibility can be because of short infundibulopelvic ligaments, unexpected periovarian adhesions or tubo-ovarian pathology, distally located ovaries, or very atrophic ovaries. The operator must analyse the reason or causative factor(s). Access is better when the ovary is still attached to the uterus through an intact upper pedicle rather than after severance of the upper pedicle. Occasionally, after extirpation of the uterus, keeping a Babcock's forceps or traction suture on the ovary helps to gain access.

If not, and the procedure appears risky, one needs to consider if removal of the ovaries is mandatory. If so, laparoscopic or mini laparotomy will help to complete the surgery. If not, they can they be left behind just as numerous colleagues do not attempt to remove them simply because hysterectomy is via the vaginal route. Any surgical procedure is likely to be associated with a small percentage of failures, but this will considerably decrease with passage of time and experience. [15, 20, 26].

When does oophorectomy fail?

- Inaccessibility
- Tubo-ovarian adhesions
- Risk of trauma and/or bleeding
- Poor assistance and/or fear and anxiety
- Inexperience
- Unfavourable findings

Adnexal Benign Pathology

For a benign ovarian mass, experience of concomitant salpingo-oophorectomy at VH as charted and shown in Fig. 122.17, permits an endeavour to deal with and tackle this pathology and to perform salpingectomy and/or oophorectomy at VH.

Examination under anesthesia (EUA) should suggest (a) free or minimally restricted mobility of the uterus; and (b) that the adnexal mass is freely mobile [21, 29]. Careful clinical examination, reliable ultrasound, CT or magnetic resonance imaging (MRI) scans and tumour markers can suggest the benign nature of the mass [30–33].

A mobile mass is not difficult to tackle and can be utilized as an opportunity to patiently persevere, cut the round ligament separately, and target the infundibulopelvic ligament as above to complete salpingo-oophorectomy; alternately, one can debulk the cyst and perform only cystectomy [17, 21, 34]. The size of an ovarian cyst is not by itself a limiting factor, as the cyst can usually be debulked by aspiration, exteriorized and excised if required. Exteriorisation of the ovary is easier vaginally with wider space than at laparotomy with a small incision, as there is added fear of a spill from the cyst into the open abdomen [10, 29, 34, 35] (Fig. 122.18).

In practice, as soon as a common ovarian endometrial cyst is suspected, vaginal hyseterctomy is ruled out even though, in reality, a significantly large number have only flimsy or no adhesions. In fact, salpingo-oophorectomy can

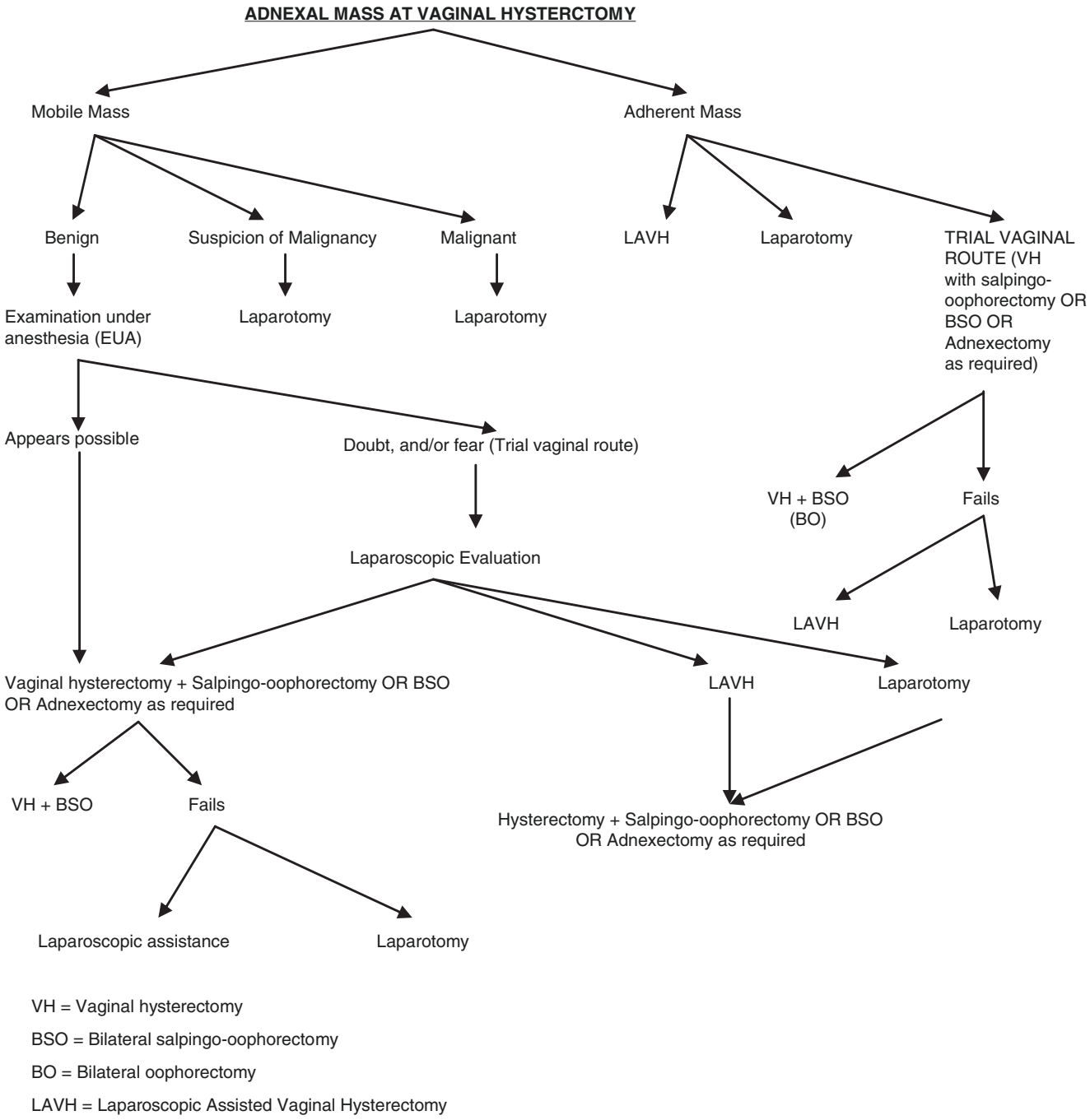


Fig. 122.17 Demonstrating clinical and surgical approach to deal with adnexal mass concomitantly at vaginal hysterectomy

be carried out in these cases as usual with excellent results. An ovarian cyst that is adherent will need something extra, and the vaginal surgeon may relish the challenge of accessing the posterior peritoneal cavity or posterior cul-de-sac through adheseolysis. Pre-operative counselling includes consent for a 'Trial' vaginal route and to have informed consent for frozen HP study, and a change to laparoscopic-assisted surgery or laparotomy if necessary. In case of doubt or anxiety, laparoscopic evaluation of the pelvic findings can be of great help [35, 36].

A surgeon with sufficient experience of vaginal hysterectomy and bilateral slapingo-oophorectomy can venture to consider VH with additional surgery for a benign, mobile adnexal pathology, , provided the prerequisites are complied with. This will greatly benefit the patient [34].

Undertaking this procedure regularly will enhance the gynaecologist's level of skill and enable him to deal even with conditions such as ovarian mass like fibroma, thecoma, broad ligament fibroid and other adnexal pathology concomitantly at vaginal hysterectomy without resorting to

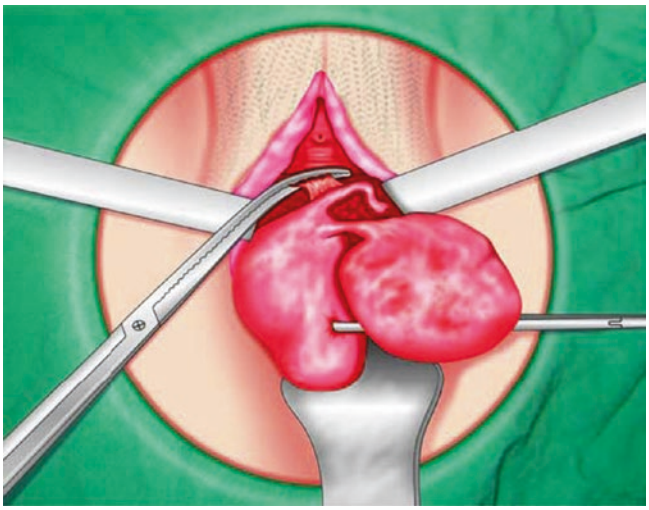


Fig. 122.18 With all connections on the normal right adnexal side severed, uterus with ovarian cyst with ovarian or adnexal clamp applied on infundibulopelvic ligament (With permission Sheth [29])

abdominal invasion. It will come to the rescue when an unexpected need arises during hysterectomy if the extirpated uterus shows endometrial malignancy or when the abdominal route is contraindicated due to previous incisional hernia repair with mesh following caesarean delivery(ies) in the past [1, 21].

During surgery, if the surgeon thinks that it will not be possible to remove the ovary or pathological mass vaginally, he or she should have no hesitation in resorting to laparoscopic assistance or perform a minilaparotomy for its removal, with the patient's safety as a prime consideration. Often, the abdominal surgery is remarkably easy to complete because all the pelvic pedicles have already been dealt with earlier during the vaginal surgery [21, 34]. He should later share the tubo-ovarian findings with the sonologist to verify whether they were correct or inaccurate.

Teng et al. [37] caution that before any vaginal approach via posterior culdotomy, laparoscopy is necessary.

This is a pessimistic precaution for the surgeon as he should develop, strong clinical sense and acumen. In select cases, frozen HP availability, take case as 'Trial vaginal route' and be prepared to change the route if the need arises.

Contraindications

- Woman wants to retain her ovaries. This is the strongest contraindication and must be respected.
- High and distally placed and/or immobile, atrophic distally placed ovaries
- Adhesions
- Tubal and ovarian pathology
- Risk of trauma and/or hemorrhage.
- The operator's lack of experience of vaginal hysterectomy.

Contraindicated situations for concomitant adnexectomy for pathological adnexa at VH are: an adherent mass; a suspicion of malignancy; frozen section facility not available; and insufficient informed consent.

If a benign adnexal mass is present and the gynecologist chooses to remove it concomitantly at VH, certain prerequisites should be satisfied. No doubt, case is to be taken as 'TRIAL VAGINAL ROUTE'

Prerequisites

- Preoperative investigations such as ultrasonography, Doppler studies, and blood CA-125.
- Accessibility and free mobility of the mass, which when held with a Babcock's and/or Ellis' forceps, brings the mass medially into the operative field.
- Visibly benign pathology
- Facilities for frozen histopathology, laparoscopic assistance, and/or laparotomy
- Surgeon with experience of vaginal surgery
- The woman and her family to be adequately counseled and informed consent taken for a "Trial vaginal route" [1, 34].

If removal is mandatory, barring the woman's wish to conserve, nothing contraindicates removal, unless surgery in itself is contraindicated.

If conventional surgery fails or is not be utilized, extirpation of the uterus totally or only on one side provides plenty of space to use an endoscope and reach the tubo-ovarian site on either side without difficulty.

Hoffman [38] suggests using an endoloop ligature of 0 plain catgut. Two endoloops were used on each pedicle. Surgeons experienced with Roeder's loop may use it freely to catch the mesovarium [14, 21]. This is followed by excision of the ovary and hemostasis. With due precautions, the mesovarium can be cut directly using bipolar cautery. Adequate exposure, isolation, and packing are essential. Hefni and Davies use an endoloop with the help of a Sheth's clamp, and two loops are usually applied before cutting. He finds this safe and easy to learn as an alternative to LAVH, in the absence of adhesions. A stapling device can occlude vessels in the mesovarium provided there is good exposure and it is done with care. High cost may not permit its liberal use. By using a stapler or seitsinger tripolar cutting forceps or endoloop, successful bilateral oophorectomy in 82 cases emphasized the endoscopic approach vaginally without using abdominal access [39].

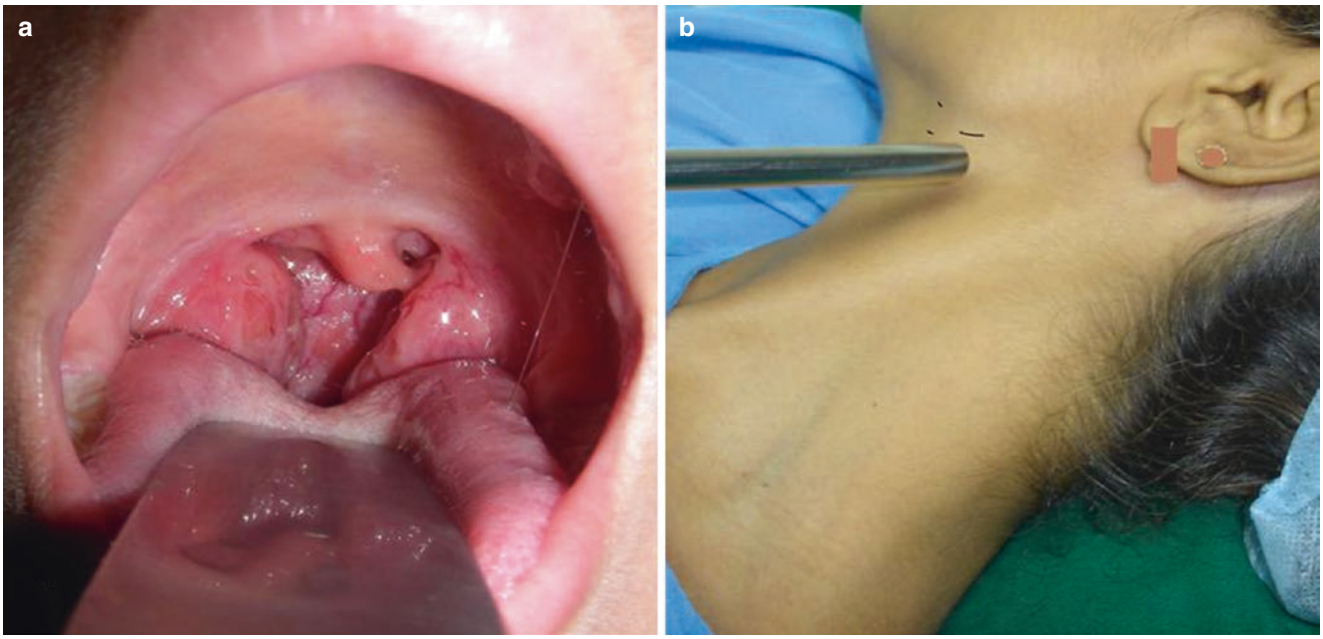


Fig. 122.19 (**a**) Tonsils are seen and can be easily removed from the natural orifice just as the uterus can be seen and removed vaginally. This are certainly less invasive than (**b**); (**b**) Tonsils removal via submandibular endoscopy and uterine removal via abdominally by laparoscope (With permission Sheth [2])

To perform an oophorectomy laparoscopically, at vaginal hysterectomy, when the same can be performed vaginally is only increasing surgical invasion [2] (Fig. 122.19). To avoid laparoscopy, all three laparoscopic methods [40], i.e. bipolar coagulation, pretied ligature placement, and automatic stapling devices, which are equally effective, with similar surgical operative times and uniformly good results for patients can be implemented vaginally.

With changing times, the era of prophylactic oophorectomy has changed to prophylactic salpingo-oophorectomy, with the need for extra vigilance and surgery.

Figure 122.1 shows the course of action to be taken for performing salpingo-oophorectomy at VH.

Hospital Stay

There is no difference in the duration of hospital stay, preoperative and postoperative management following with or without salpingo-oophoectomy at VH.

The operative time for additional salpingo-oophoectomy with VH increased generally by 5 to 15 min when compared with VH by itself. Laparotomy was required for reactionary hemorrhage in two and for bowel trauma in one out of first 1000 concomitant salpingo-oophorectomies at VH. In the next more than 500 such hysterectomies, not a single woman required post-operative laparotomy for reactionary hemorrhage. Laparotomy was required in eight cases of failed Trial vaginal route in 192 VH with surgery for concomitant adnexal pathology because of the adnexal pathology being either too adherent in four and ovarian malignancy in five on intraoperative frozen HP study [41]. Experience from those 192 cases has increased in following two decades. However, Trial VH OR Trial vaginal route is a totally different entity from routine prophylactic salpingo-oophorectomy at VH when at VH, tubes and ovaries are normal and non contraindicated.

Learning Comes From

1. A uterine prolapse particularly of a major degree will facilitate oophorectomy considerably by making the ovaries easily accessible. The slim, parous patient with a normal sized uterus and a third degree uterine prolapse is an ideal patient for learning concomitant salpingo-oophorectomy at VH. These ovaries are inviting and proximally placed for the surgeon to access the infundibulopelvic ligament.
2. At regular vaginal hysterectomy without concomitant salpingo-oophorectomy, the operator can put a Babcock's forcep on each ovary and tube to bring them medially into the central field and/or even cut only the round ligament laterally and access the infundibulopelvic ligament with an open clamp, without clamping the tissues. This is bound to instill confidence in performing salpingo-oophorectomy at vaginal hysterectomy. Experience always has to begin somewhere. Careful study of the

procedure through literature, video, and/or workshops can add to it [21].

Just as the gynecologist makes every attempt to remove the cervix completely at a technically difficult abdominal hysterectomy, I believe that the gynecologist should make every attempt to remove the ovaries vaginally, when indicated, at the time of vaginal hysterectomy. Sheth and Malpani [26] state that just as a supracervical abdominal hysterectomy is a subtotal operation and scientifically has limitation in gynecologic surgery, today, performing a simple vaginal hysterectomy for a postmenopausal woman without removing her ovaries, if and when required, is an incomplete operation.

I (**SSS**) [1] believe that every gynecologist can reach a stage when he or she should not be anxious about concomitant removal of ovaries at vaginal hysterectomy. The earlier this expertise is attained, the better.

Only Oophorectomy at Vaginal Hysterectomy When?

It is often less difficult or easier to remove the ovary only and leave the tube in situ [1, 20, 21, 42] (Fig. 122.20).

In cases where a salpingo-oophorectomy appears difficult – because of limited space or because of a long utero-ovarian ligament - access to the mesovarium could prove easier than access to the infundibulo-pelvic ligament, and a simple oophorectomy may be reluctantly performed. A compromise can be made by performing a simple oophorectomy by clamping, cutting, and ligating the mesovarium and not performing salpingo-oophorectomy. For oophorectomy alone, the ovary is gently pulled into the operative field and the mesovarium is clamped to include the space between the two leaves of the broad ligament. The fallopian tube is kept away. Access to the proximal mesovarium is easier than access to the infundibulopelvic ligament by the vaginal approach. The fallopian tube is then brought down to cover the raw area. However, the surgical method of choice is to perform as much of salpingectomy as possible and include its fimbrial end. The ovary is removed and clamped tissues are double sutured with No. One gauze polyglactin. The removal of either tube or as much of both tubes as possible depends on the ease of access [2, 21].

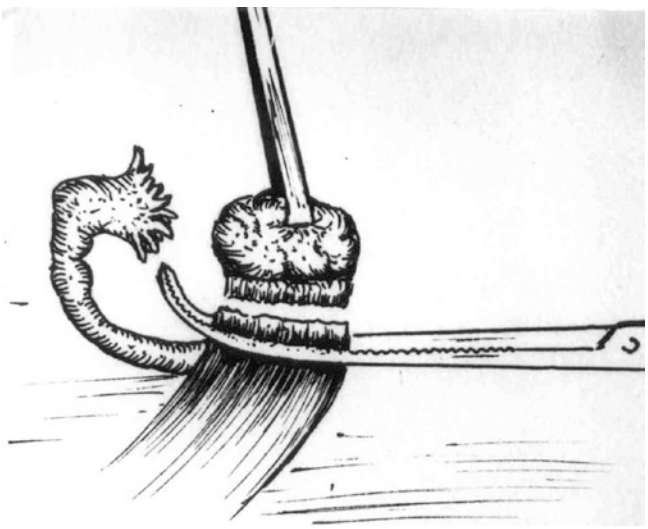


Fig. 122.20 Meso-ovarium is clamped so as to perform only oophorectomy (No salpingectomy) (With permission Sheth [20])

Oophorectomy Without Hysterectomy

In menstruating women with breast cancer, oophorectomy is a useful maneuver to manipulate the hormonal milieu. The risk is minimal and there are no long-term sequelae [43], apart from the standard response to oophorectomy in 40–50 % of patients [44]. Though Tamoxifen has changed the entire scenario, in some situations, the need for oophorectomy may arise and treating oncologists may advise it. The author has had the fortune of using the least invasive vaginal approach for oophorectomy without hysterectomy in more than 20 women with metastatic breast cancer, some high risk and some in the pre-laparoscopic days [45]. He has also used it to treat menorrhagia with normal pelvic findings in a woman with table risk to spare her from the otherwise recommended hysterectomy [46]. There is no doubt that the laparoscopic technique for oophorectomy is the preferred choice, but, in the absence of equipment and/or an endoscopist, this approach should be seriously considered in parous women, particularly if they are at high risk for the surgery. Removal of the ovaries with or without bilateral partial salpingectomy without hysterectomy by the vaginal route has the following advantages:

- Short hospital stay, < 24 h
- Easier convalescence
- Safer for frail or ill patients
- No risk of incisional hernia
- Avoidance of laparotomy and an abdominal scar
- Laparoscope not missed
- Economical.

Trial Vaginal Hysterectomy and Trial Vaginal Route

Trial vaginal hysterectomy was first described in 1993 [1]. Here, women with difficult or contraindicated hysterectomy via the vaginal route, are given the opportunity of undergoing

hysterectomy via the vaginal route but the options of laparoscopic assistance or laparotomy are kept open, if the attempt is unsuccessful. This is comparable to trial forceps delivery to prevent caesarean section in obstetrics. Large uteri, previous caesarean section and nulliparity are common indications to attempt a trial vaginal hysterectomy and adnexectomy. However, beyond the uterus, if an adnexal pathology complicates the vaginal route for hysterectomy, it becomes 'trial vaginal route' with or without 'trial vaginal hysterectomy' [13, 21, 34]. Such a choice provides a great learning opportunity for progressive gynaecological surgeons.

Gynecologists today are also stretching themselves to add three or four abdominal punctures to perform laparoscopic salpingo-oophorectomy at VH instead of learning an additional step to perform concomitant salpingo-oophorectomy or oophorectomy at VH and advance further.

If you give a man more than he can do
He will do it
If you only give him what he can do
He will do nothing
— R Kipling

References

1. Sheth SS. Vaginal hysterectomy. In: Studd JWW, editor. Progress in Obstetrics and Gynecology. 10th ed. London: Churchill Livingstone; 1993. p. 317–40.
2. Sheth SS, Paghdiwalla KP, Hajari AR, Vaginal route: a gynaecological route for much more than hysterectomy. In: Arulkumaran S. Best practice & research – clinical obstetrics & gynaecology, UK. Vol.25 (2): Elsevier, 2011; p. 115–32.
3. Tait L. The pathology and treatment of the disease of the ovaries. New York: William Wood; 1883.
4. Studd JWW. Hysterectomy and menorrhagia. Bailliere's Clin Obstet Gynecol. 1989;3:415–24.
5. ACOG. Choosing the route of hysterectomy for benign disease (Committee Opinion). Washington, DC: The American College of Obstetricians & Gynecologists Women's Health Care Physicians (Compendium). 2012:375–7.
6. Vitonis AF, Titus-Ernstoff L, Cramer DW. Assessing ovarian cancer risk when considering elective oophorectomy at the time of hysterectomy. Obstet Gynecol. 2011;117:1042–50.
7. El-Nashar SA, Magrina JF, Trabuco EC. Oophorectomy at the time of hysterectomy for benign indications. In: Sheth SS (Ed). Vaginal Hysterectomy, 2nd edition. New Delhi, India: Jaypee Brothers Medical Publishers (P) Ltd, 2014: 129–136.
8. Montgomery JC, Studd JWW. Oestradiol and testosterone implants after hysterectomy for endometriosis. Contrib Gynecol Obstet. 1987;15:241–6.
9. Studd J. Prophylactic oophorectomy commentary. Br J Obstet Gynecol. 1989;96:506–9.
10. Nichols DH. Update on surgery. Contemp J Obstet Gynecol. 1987;29:92–109.
11. Kovac SR. Vaginal hysterectomy. In: Rock JA, Jones HW (Eds). Te Linde's Operative Gynecology, 10th edn. Philadelphia: JB Lippincott (Indian Ed), 2010:744–762.
12. Maresh MJ, Metcalfe MA, McPherson K, et al. The VALUE national hysterectomy study: description of the patient and their surgery. Br J Obstet Gynecol. 2002;109:302–12.
13. Gross CP, Nicholson W, Powe NR. Factors affecting prophylactic oophorectomy in postmenopausal women. Obstet Gynecol. 1999;94:962–8.
14. Davies A, O'Connor H, Magos AL. A prospective study to evaluate oophorectomy at the time of vaginal hysterectomy. Br J Obstet Gynecol. 1996;103:915–20.
15. Sheth SS. The place of oophorectomy at vaginal hysterectomy. Br J Obstet Gynecol. 1991;98:662–6.
16. Sheth SS. The place of oophorectomy at vaginal hysterectomy. Obstet Gynec Surv. 1992;47:332–3.
17. Sheth SS. Vaginal hysterectomy. Arulkimaran S. Best practice & research – clinical obstetrics & gynaecology. Vol.19(3). Elsevier; 2005. p. 307–32.
18. Sheth SS. Fiberoptic light for oophorectomy at vaginal hysterectomy. Obstet Gynec Surv. 1999;54:171–172.
19. ACOG. Appropriate use of laparoscopically assisted vaginal hysterectomy (Committee opinion). Compendium of selected publication. Washington DC (USA): The American College of Obstetricians and Gynecologists Women's Health Care Physicians, 2006;13–14.
20. Sheth SS, Malpani A. Technique of vaginal oophorectomy during vaginal hysterectomy. J Gynecol Surg. 1994;10:197–202.
21. Sheth SS. Concomitant salpingo-oophorectomy at vaginal hysterectomy. In: Sheth SS. Vaginal Hysterectomy, 2nd edition. New Delhi/India: Jaypee Brothers Medical Publishers (P) Ltd, 2014: 137–149.
22. Kwon JS, Tinker A, Pansegrau G, et al. Prophylactic salpingectomy and delayed oophorectomy as an alternative for BRCA mutation carriers. Obstet Gynecol. 2013;121:14–24.
23. Cengiz B, Demirel LC, Dokmeci F, et al. Bilateral salpingo-oophorectomy during vaginal hysterectomy in cases with nonprolapsed uterus: role of laparoscopy in a residency training program without much vaginal salpingo-oophorectomy experience. Obstet Gynecol Surv. 2003;58:105–6.
24. Kovac SR, Cruikshank SH. Guidelines to determine the route of oophorectomy with hysterectomy. Am J Obstet Gynecol. 1996;175:1483–8.
25. Sheth SS. Fiberoptic light for oophorectomy at vaginal hysterectomy. J Gynecol Surg. 1998;14:119–22.
26. Sheth SS, Malpani A. Routine prophylactic oophorectomy at the time of vaginal hysterectomy in postmenopausal women. Arch Gynecol Obstet. 1992;251:87–91.
27. Sheth SS. Vaginal hysterectomy as primary route for morbidly obese women. Acta Obstet Gynecol. 2010;89:971–4.
28. Sheth SS. Super flexion position for difficult speculum examination. Int J Gynaecol Obstet. 2013;121:92–3.
29. Sheth SS. Adnexal pathology. In: Sheth SS, Studd JWW, editors. Vaginal Hysterectomy. London: Martin Dunitz; 2002. p. 165–78.
30. Shalev E, Eliyahu S, Peleg D, et al. Laparoscopic management of adnexal cystic masses in post-menopausal women. Obstet Gynecol. 1994;83:594–6.
31. Shalev E, Bustan M, Romano S, et al. Laparoscopic resection of ovarian benign cystic teratomas: experience with 84 cases. Human Reprod. 1998;13:1810–2.
32. Goldhirsch A, Triller JK, Geiner R, et al. Computed tomography prior to second look operation in advanced ovarian cancer. Obstet Gynecol. 1983;62:630–3.
33. Weinreb JC, Barkoff ND, Megibow A, et al. The value of MR imaging in distinguishing leiomyoma's from other solid pelvic masses when sonography is indeterminate. AJR. 1990;154:295.
34. Sheth SS. Adnexectomy for benign pathology at vaginal hysterectomy without laparoscopic assistance. Br J Obstet Gynecol. 2002;109:1401–5.
35. Sheth SS. Management of ovarian dermoid without laparoscopy or laparotomy. Eur J Obstet Gynecol Reprod Biol. 2001;99:106–8.

36. Sheth SS, Sonkawde R. Surgical importance of round ligament. J Gynecol Surg. 1990;15:163–7.
37. Teng FY, Muzsnai D, Perez R, et al. A comparative study of laparoscopy and colpotomy for the removal of ovarian Dermoid cysts. Obstet Gynecol. 1996;87:1009–13.
38. Hoffman MS. Transvaginal removal of ovaries with endoloop sutures at the time of transvaginal hysterectomy. Am J Obstet Gynecol. 1991;165:407–8.
39. Hefni MA, Davies AE. Vaginal endoscopic oophorectomy with vaginal hysterectomy—a simple minimal access surgery technique. Br J Obstet Gynecol. 1997;104:621–2.
40. Daniell JF, Kurtz BR. Lee (Ji-yun). Laparoscopic oophorectomy—comparative study of ligatures, bipolar coagulation and automatic stapling devices. J Obstet Gynecol. 1992;80: 325–8.
41. Sheth SS. The scope of vaginal hysterectomy. Eur J Obstet Gynecol Rep Bio. 2004;115:224–31.
42. Cohen J. Abdominal and vaginal hysterectomy: new techniques based on time and motion studies. 1st ed. London: Heinemann Medical; 1972. p. 72–132.
43. Schwartz SI. Principles of surgery. 4th ed. New York/London: McGraw-Hill; 1984. p. 550–1.
44. Sabiston DC. The textbook of surgery – the biological basis of modern surgical practice. 13th ed. Philadelphia, PA: WB Saunders; 1986. p. 564–9.
45. Sheth SS. Vaginal oopherectomy for breast cancer. J Obstet Gynecol. 1989;9:236–8.
46. Dalvi SA, Agarwal S, Thakur Y, Sheteh SS. Place of vaginal oophorectomy for high risk menorrhagia. Indian J Obstet Gynec. 1993;43:301–2.

The Mayo Technique for Vaginal Hysterectomy

123

John A. Occhino

I would like to begin this chapter with an excerpt from a manuscript titled *Vaginal Hysterectomy at the Mayo Clinic* published in 1961 by Dr. John S. Welch and Dr. Lawrence M. Randall [1].

> Great interest in vaginal hysterectomy has developed during the last 25 yr. With broadening of indications for this operation, numerous techniques have been developed, presented, and modified, each recommended for some real or assumed advantage over those preceding it; but most have not been retained in modern gynecologic practice. The Mayo vaginal hysterectomy is a good example of this evolutionary change. Proposed by Dr. Charles H. Mayo for distressing uterine prolapse and cystocele, this operation united the broad ligaments, after hysterectomy, to support the bladder and form a floor for the pelvic viscera. Many gynecologists recall the dismaying postoperative incidence of enterocele, which followed with especial frequency if care had not been directed toward complete ligamentous closure of the space between the joined broad ligaments and the rectum. This Mayo vaginal hysterectomy, in fact, has long been absent from the operative armamentarium of the gynecologic surgeons at the Mayo Clinic. The succeeding clamp-and-ligature technique, modified by the experience of several thousand repetitions, is a rather standardized procedure offering anatomic simplicity, wide application, and great safety.

Despite the continuous barrage of new technologies for hysterectomy, the vaginal hysterectomy remains the safest and most cost-effective approach and is supported by numerous organizations including the American College of Obstetrics and Gynecology [2].

The Mayo technique for vaginal hysterectomy has been refined over the years and incorporates several basic principles of surgery. Foremost is adequate exposure. Especially when operating in a small space. It is imperative that one is able to visualize the important structures and landmarks. The Mayo technique utilizes sharp dissection for avoidance of inadvertent damage to adjacent structures that can occur with blunt dissection. Mobilization and retraction of the bladder and rectum help to ensure their safety during vaginal hysterectomy. Hysterectomy is one of the most common surgeries leading to ureteral injury [3]. Identification of the ureter by palpation during hysterectomy is essential for avoidance of iatrogenic injury or obstruction. Re-support of the vaginal apex at the time of vaginal hysterectomy is essential in the avoidance of post-hysterectomy vaginal vault prolapse. Lastly, adequate assistance is vital to the successful completion of any surgery, especially vaginal hysterectomy.

Patient Positioning

Proper patient positions can help with visualization and avoidance of nerve injury. The dorsal lithotomy position is best and the author prefers legs in candy-cane stirrups as they afford the surgeon and assistants more space. The patient's hips should be flexed and mildly abducted and the knees flexed as well. The patient's buttocks should be on the edge of the table when the foot of the bed is removed.

Surgical Instrumentation

The surgical instruments used during the procedure include:

- Short weighted speculum
- 3 narrow Deaver retractors
- Right-angle Heaney retractor
- 2 non-perforating towel clamps
- 2 uterine tenacula (Henrontin Uterine Vulsellum forceps)
- Surgical scalpel (#10 blade)
- Mayo scissors (Mayo Harrington scissors, 8″ curved tip)
- 2 curved Heaney clamps
- Forceps with teeth (Walther tissue forceps)
- Russian forceps (8″)
- Kocher clamps
- Kelly (curved) clamps
- Suture scissor

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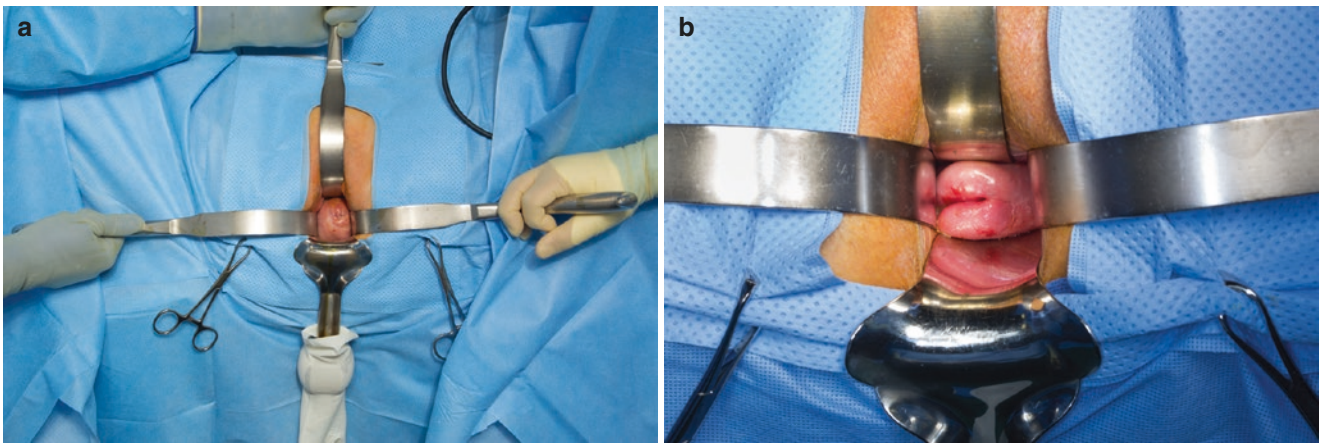


Fig. 123.1 (**a**) Setup for vaginal hysterectomy with Deaver retractors in place, (**b**) Close up view (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

Surgical Technique

Setup

After proper patient positioning and surgical cleansing, the procedure is begun. A short weighted speculum is placed in the vagina and two non-perforating towel clamps are attached to the drape, lateral to the speculum. These will later be used for managing tagged sutures. The authors prefer to empty the bladder with in-and-out catheterization prior to incision to decompress the bladder. Three narrow Deaver retractors are placed in the vagina at 12, 3, and 9 o'clock position to assist with retraction and visualization (Fig. 123.1). The surgeon is sitting on a stool with a magnetic pad on the lap and 2 assistants are used, one on each side. This is the routine setup for all vaginal hysterectomies at Mayo Clinic.

Vaginal Incision

The surgery begins with placement of two tenacula on the distal edges of the anterior and posterior lips of the cervix (Fig. 123.2). These are used for traction and manipulation of the specimen. Longitudinal incisions made along the cervix at 3 and 9 o'clock position. These are short (approximately 1–1.5 cm) and shallow (Fig. 123.3). These are done to identify the vaginal cuff angles during cuff closure, as their location tends to get distorted after re-suspension of the vaginal cuff. Firm traction on the tenacula is important as it allows the vaginal epithelium to separate fully as the incision is being made. A scalpel is used to make a circumferential incision around the cervix (Fig. 123.4). Posteriorly, this incision is brought to a "V" Fig. 123.5).

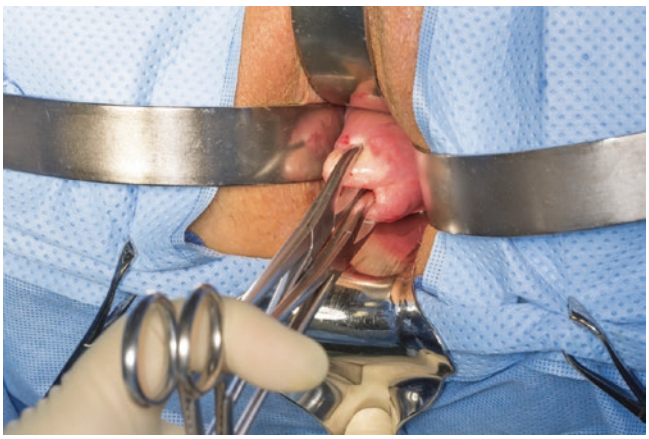


Fig. 123.2 Tenacula placed on the cervix for traction (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

Anterior Entry

An assistant continues to apply traction on the cervix while the surgeon grasps the cut edge of the vaginal epithelium with toothed-forceps (Fig. 123.6). Utilizing the Mayo scissor with the tips pointed toward the endocervical canal, sharp dissection is used to create a plane between the cervix inferiorly and the bladder superiorly (Fig. 123.7). Dissection continues until the peritoneum is visualized; only at this time will the surgeon insert a finger against the lower uterine segment and advance forward. Minimal resistance should be encountered when in the correct plane and the surgeon's finger should glide smoothly along the peritoneum of the anterior cul-de sac. The anterior Deaver retractor is now inserted to provide improved visualization and tooth forceps are used to grasp the peritoneum (Fig. 123.8). Note that there are 2 layers of peritoneum here and they merge to form the vesicouterine fold. They can be seen moving over each

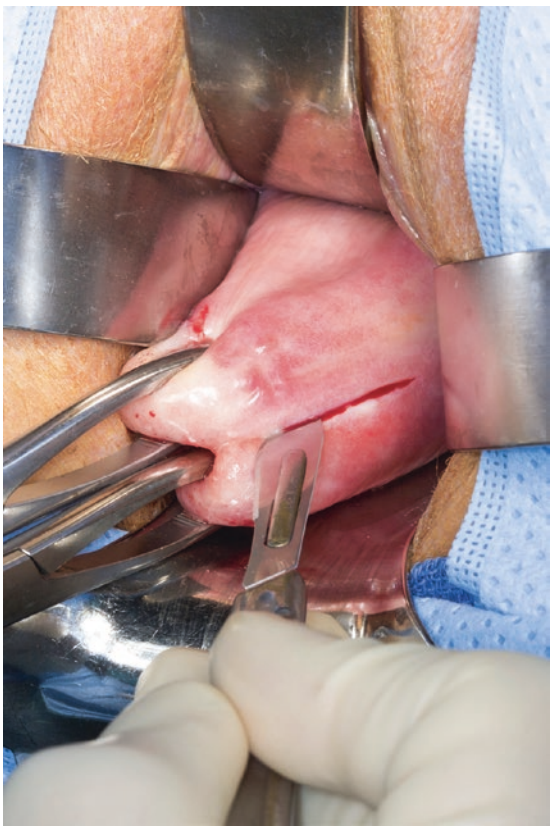


Fig. 123.3 Shallow, longitudinal incision (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

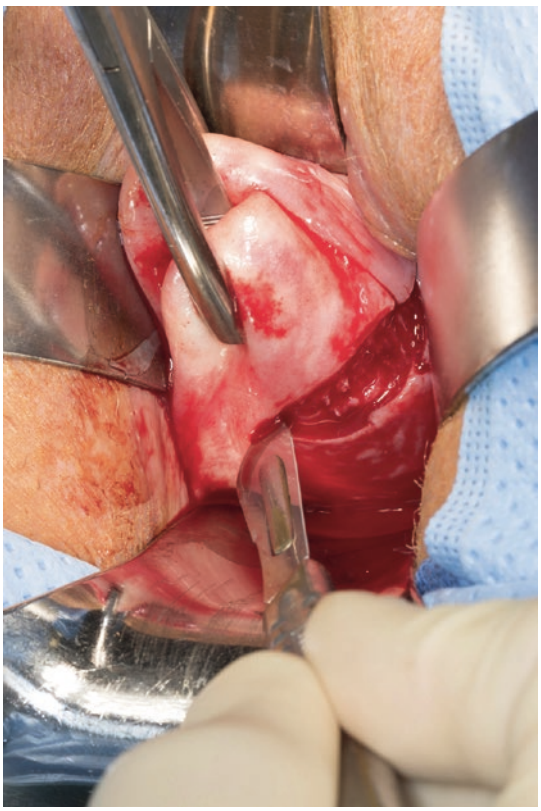


Fig. 123.5 Posterior vaginal mucosal incision (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

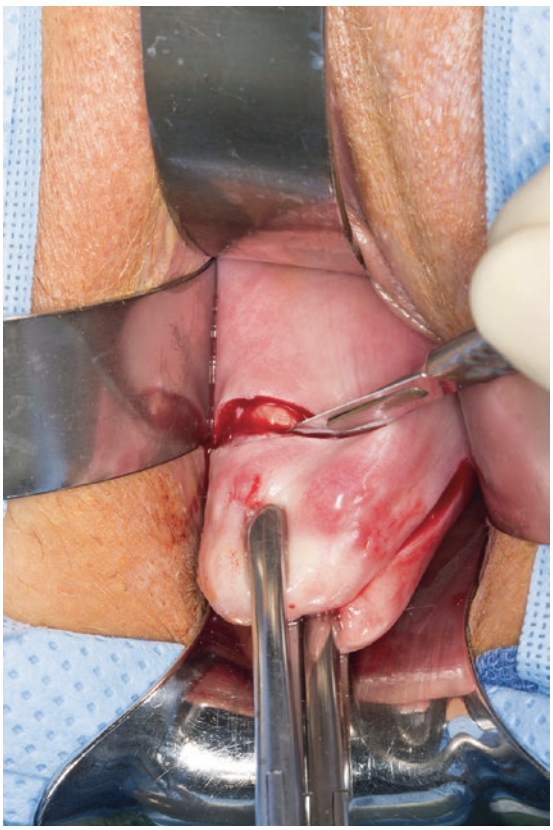


Fig. 123.4 Anterior vaginal mucosal incision (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

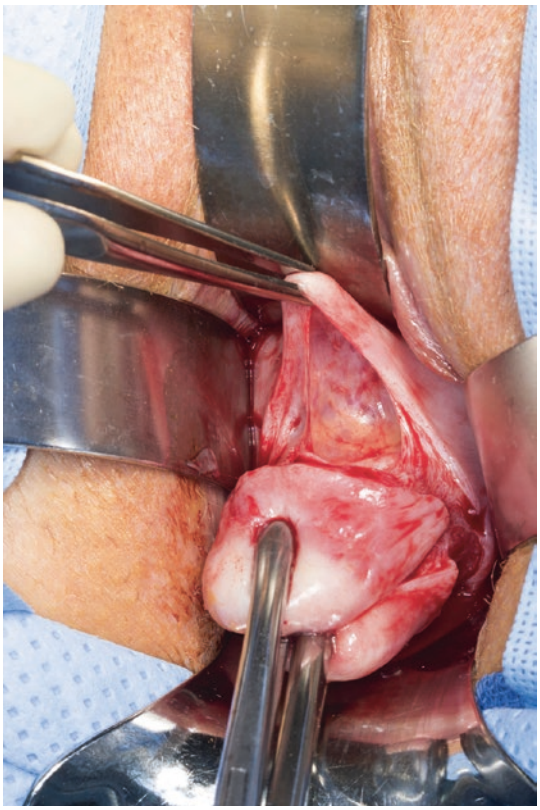


Fig. 123.6 Forceps grasping anterior vaginal mucosal incision (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

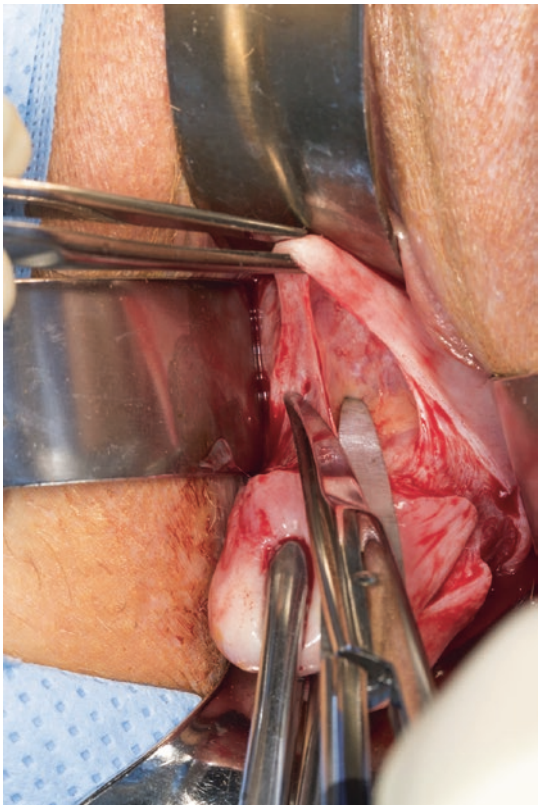


Fig. 123.7 Sharp dissection of the vesicouterine space (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

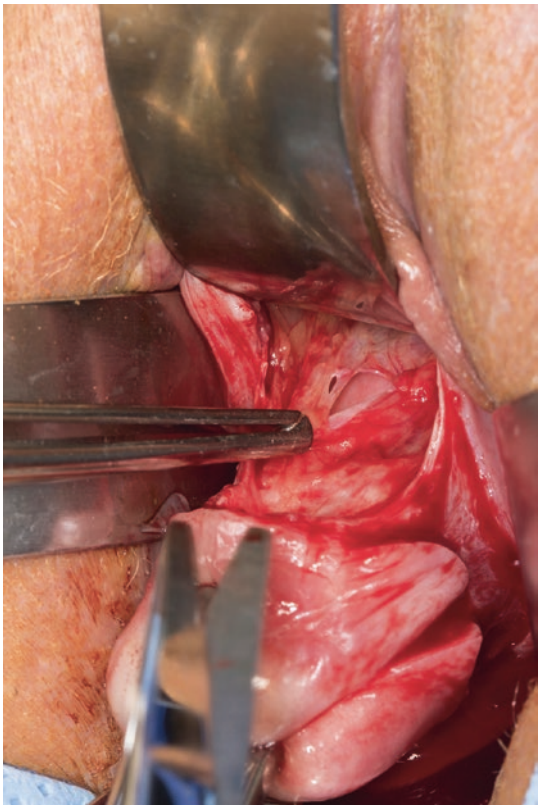


Fig. 123.9 Peritoneal incision into the anterior cul-de-sac (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

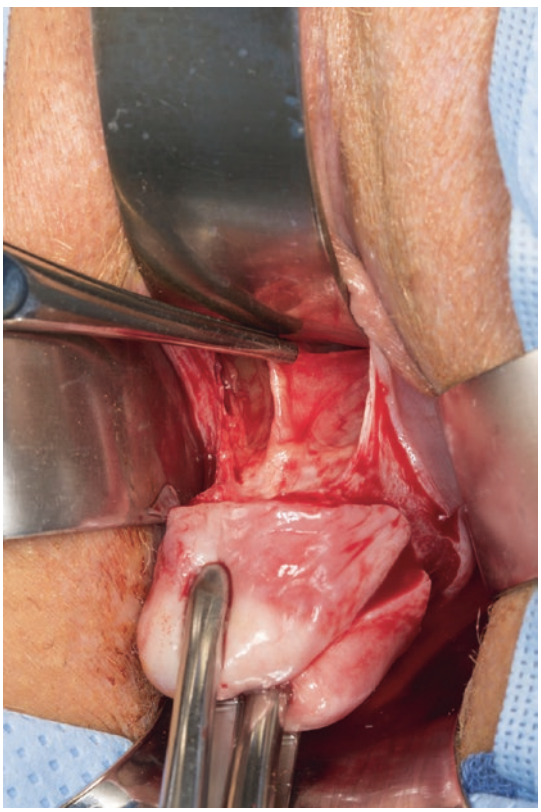


Fig. 123.8 Forceps grasping the peritoneum (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

other. The peritoneum is grasped with tooth forceps and scissors are used to incise the peritoneum superior to the where the peritoneum is grasped – this allows entry into the anterior cul-de-sac (Fig. 123.9). The incision is made superior to avoid undermining the peritoneum and failing to enter appropriately. Once the peritoneum is incised, the scissor is inserted into the peritoneal defect and spread (Fig. 123.10). This enlarges the peritoneal defect and allows the anterior Deaver to be inserted below the scissor and advanced into the peritoneal cavity. Appropriate location is checked using a right-angle Heaney retractor inserted into the peritoneal defect to visualize intra-abdominal organs (Fig. 123.11).

Posterior Entry

The assistant provides traction on the cervix in a superior direction to give access to the posterior vaginal fornix. Toothed-forceps are used to grasp the vaginal epithelium and give inferior traction (Fig. 123.12), while Mayo scissors are used to incise the fibromuscular tissue and peritoneum adjacent to the posterior uterus (Fig. 123.13). The tips of the scissors are pointing toward the body of the uterus and away from the rectum to avoid injury. Again, appropriate location is confirmed using a right-angle Heaney retractor.

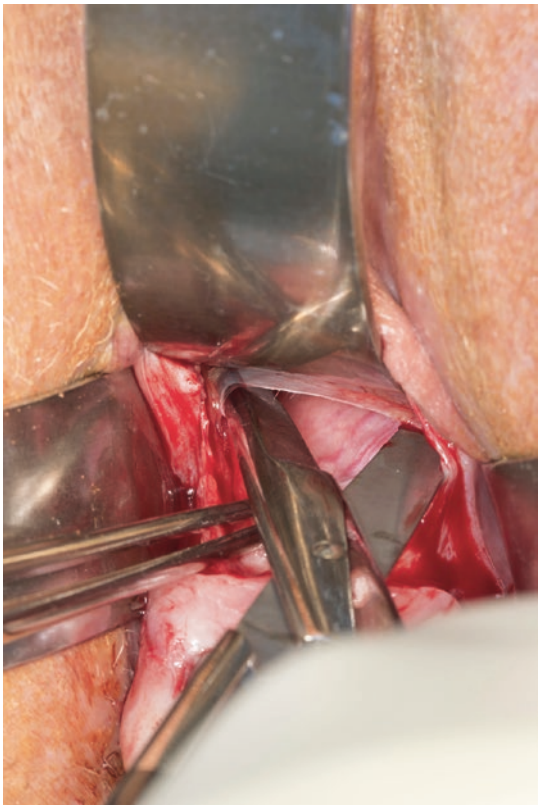


Fig. 123.10 Widening of the peritoneal incision with the scissors (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

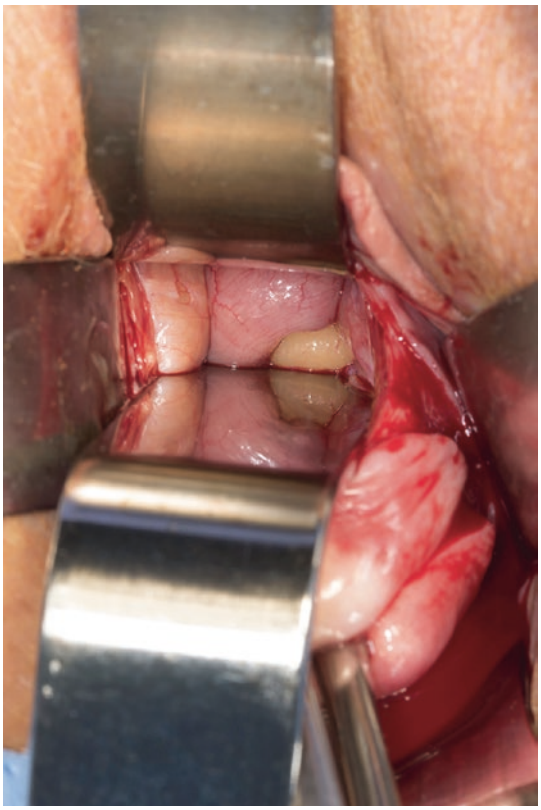


Fig. 123.11 Confirmation of peritoneal entry noted by visualization of intra-abdominal organs (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

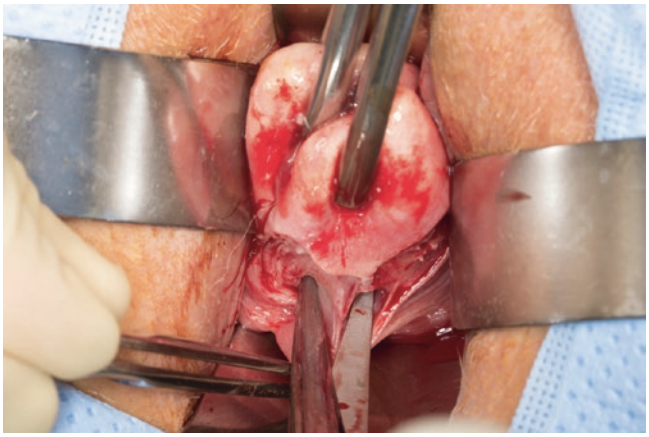


Fig. 123.12 Forceps grasping the vaginal epithelium prior to posterior cul-de-sac entry (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

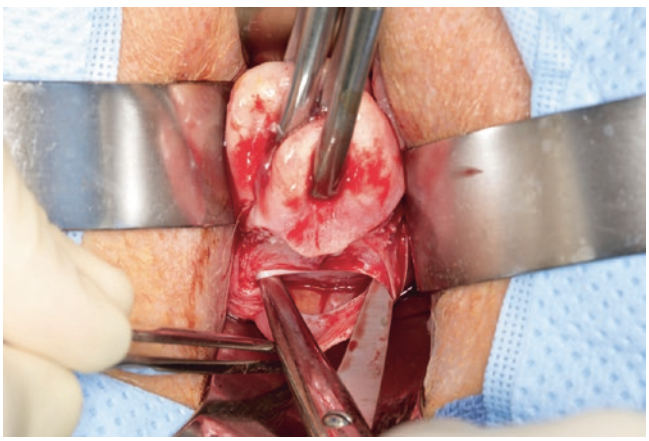


Fig. 123.13 Successful posterior cul-de-sac entry (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

Ligaments and Vascular Supply of the Uterus

Once entry into the anterior and posterior cul-de-sac is accomplished, one begins taking the ligamentous and vascular pedicles of the uterus. The surgeon ligates the uterosacral, cardinal and vascular pedicles on a single side of the uterus before addressing the opposite side. This aids in efficiency and flow of the procedure. The 9 o'clock Deaver is removed and the specimen is pulled towards the patient's right. The uterosacral ligament on the patient's left is skeletonized by sweeping the vaginal mucosal superiorly with a gauzed finger (Fig. 123.14). A Heaney clamp is placed on the ligament adjacent to the edge of the vaginal mucosa. When closed, the clamp should be perpendicular to the ligament itself (Fig. 123.15). The ligament is divided using Mayo scissors and with the incision taken just around/beyond the tip of the clamp (Fig. 123.16). Ligation of the pedicle is accomplished by placing a ligature through the middle of the pedicle (behind the Heaney clamp) after which a single tie is placed. One end of the suture is carried around the tip and the

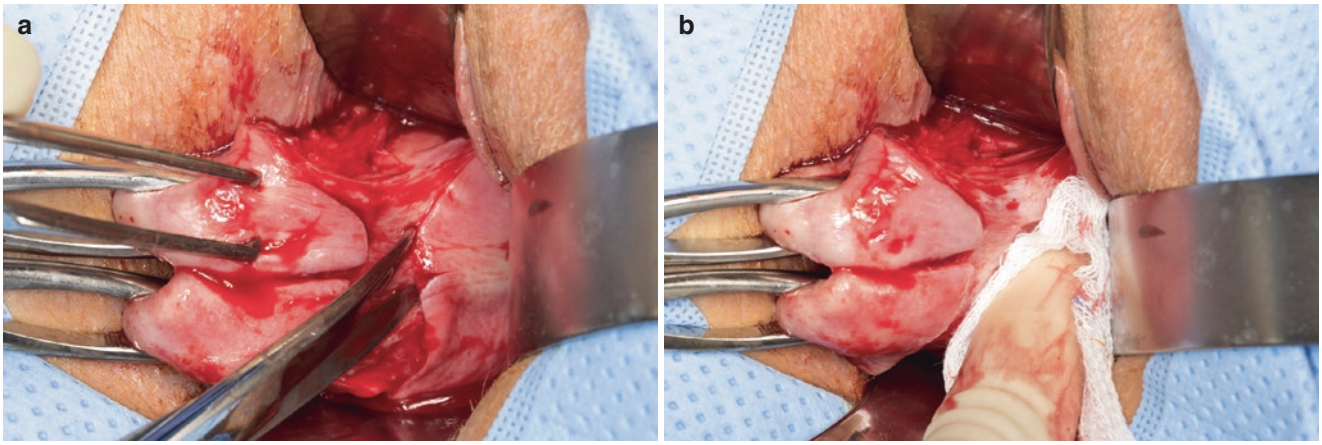


Fig. 123.14 (**a**) Sharp dissection of vaginal epithelium off of the uterosacral ligament; (**b**) Further exposure of the uterosacral ligament is performed with a gauzed finger (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

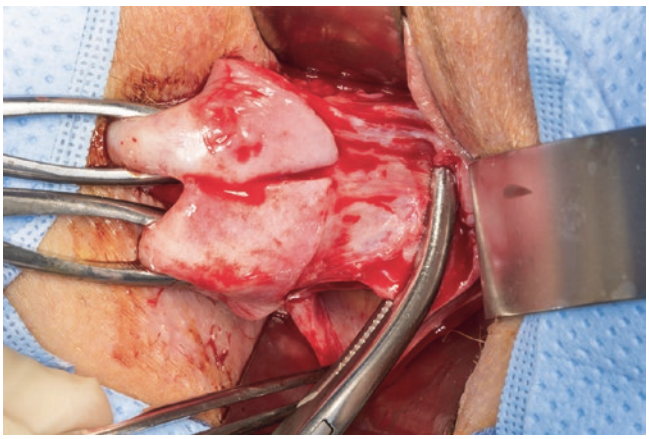


Fig. 123.15 Heaney clamp on the uterosacral ligament (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

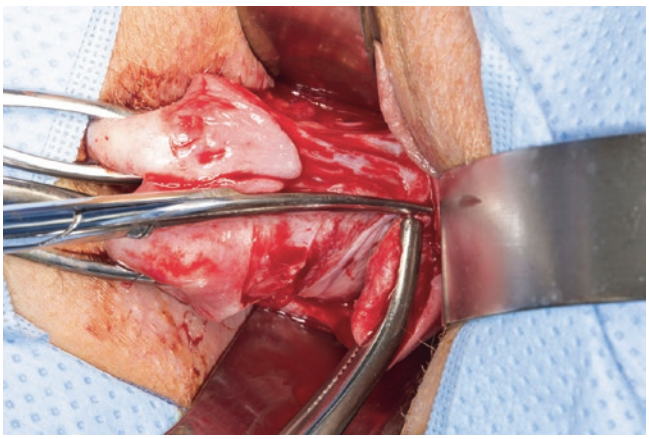


Fig. 123.16 Transection of the uterosacral ligament carried around the tip of the clamp (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

Heaney clamp is slowly opened with the first of the 3 additional ties (Fig. 123.17). The suture tail is tucked behind the side of the weighted speculum and tagged with a kocher clamp. This is done to allow identification of the uterosacral ligament later in the procedure for re-suspension of the vaginal cuff.

The surgeon's left index finger is inserted into the anterior cul-de-sac and the 3 o'clock Deaver is moved slight upward toward the 2 o'clock position. The surgeon slowly pulls their index finger along the retractor and this allows for the palpation of the left ureter against the retractor. A characteristic "snap" can be felt and heard. Identification of the ureter during hysterectomy is paramount in avoiding injury (Fig. 123.18a–c).

Once the ureter is identified, the Heaney clamp is placed on the lower portion of the cardinal ligament, with tips almost perpendicular to the cervix (Fig. 123.19). The ligament is incised, suture-ligated and tagged with a curved clamp. This suture tail is draped over the towel clamp on the drape for simple identification and separation from the uterosacral tag. The last clamp incorporates the peritoneum of the anterior and posterior cul-de-sac and typically transects the uterine artery (Fig. 123.20). This is transected a ligated in the same fashion and the suture tail is placed in the curved clamp along with the previous pedicle (Fig. 123.21).

An identical procedure is done on the right side of the uterus, taking the uterosacral, palpating the ureter (this time with the surgeon's right index finger), then taking the 2 cardinal pedicles. After this is completed, Fig. 123.22 shows the results. At this point, the uterus can be rotated and the fundus delivered through the posterior cul-de-sac into the vagina. The surgeon left hand is placed behind the uterus and the round and utero-ovarian ligaments on the right are clamped using a single Heaney clamp. The clamp is placed with the tips pointing inferiorly (Figs. 123.23 and 123.24). This is transected, however, ligation is delayed until the uterus is removed (Fig. 123.25). The same pedicle on the left is

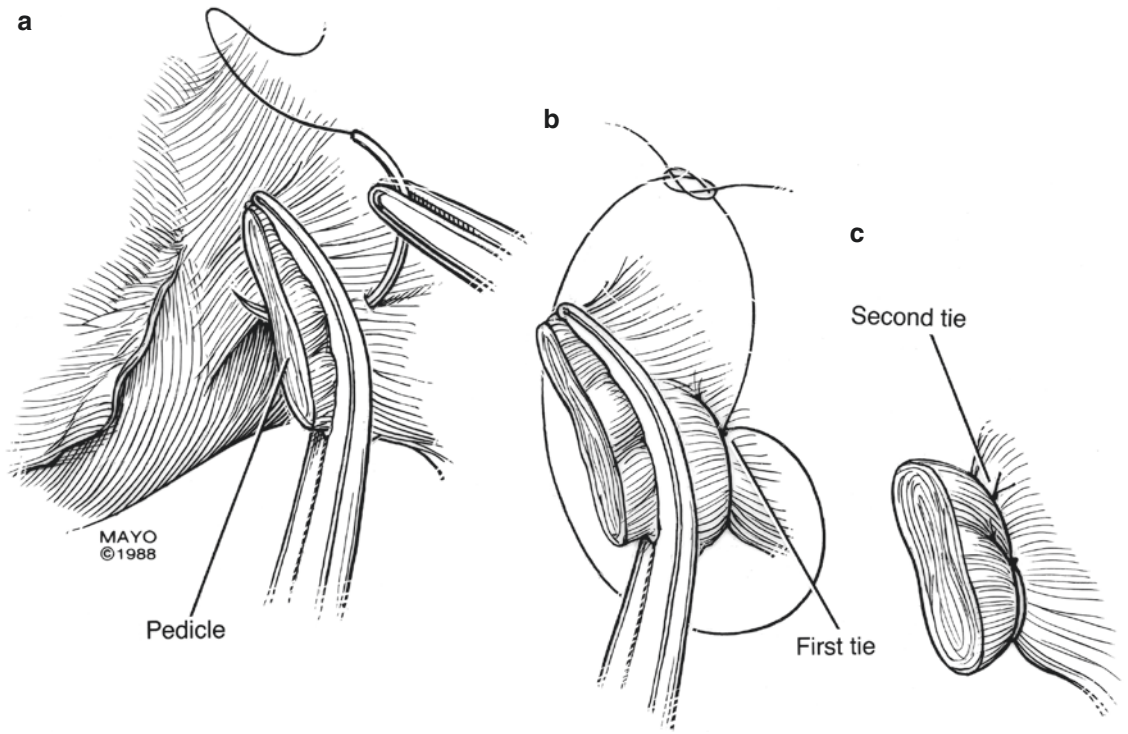


Fig. 123.17 Illustration of the suture ligation technique (From Lee [5] Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

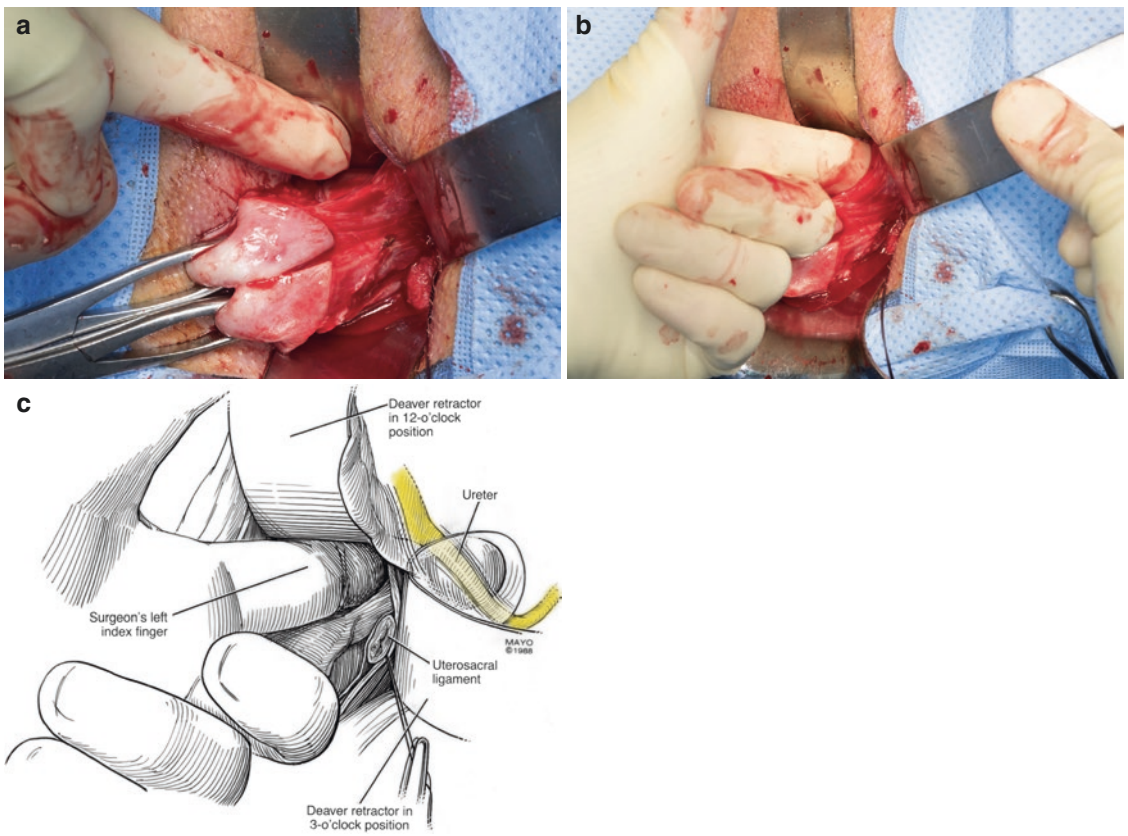


Fig. 123.18 (**a**) A finger being placed through the anterior cul-de-sac; (**b**) Palpation of the ureter against the Deaver retractor; (**c**) Illustration of ureteral palpation ((**a**, **b**) Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved. (**c**) From Lee [5] Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

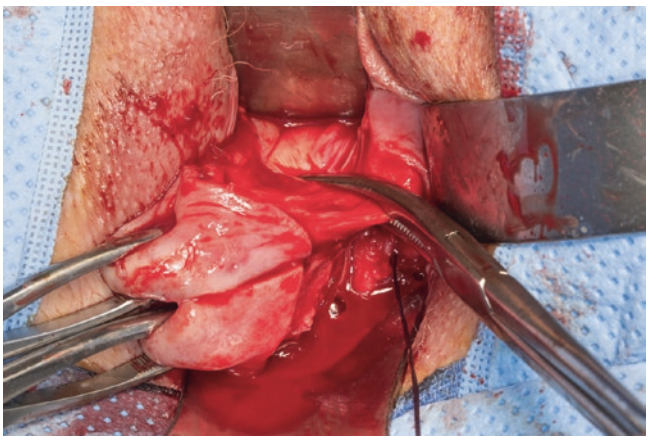


Fig. 123.19 Clamping of the cardinal ligament (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

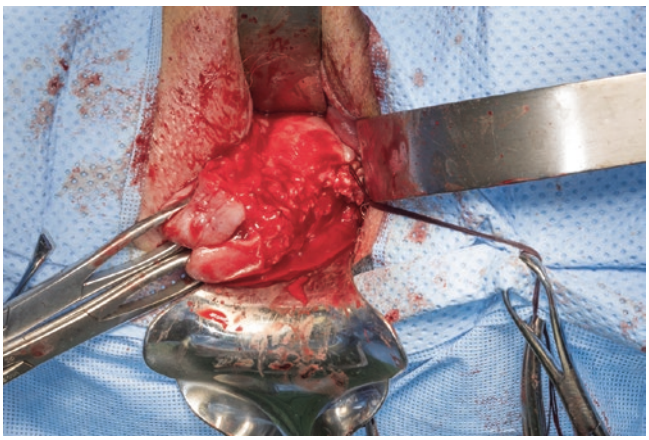


Fig. 123.21 The tails from the cardinal and uterine-vascular pedicles are tagged together and draped over the towel clamp (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

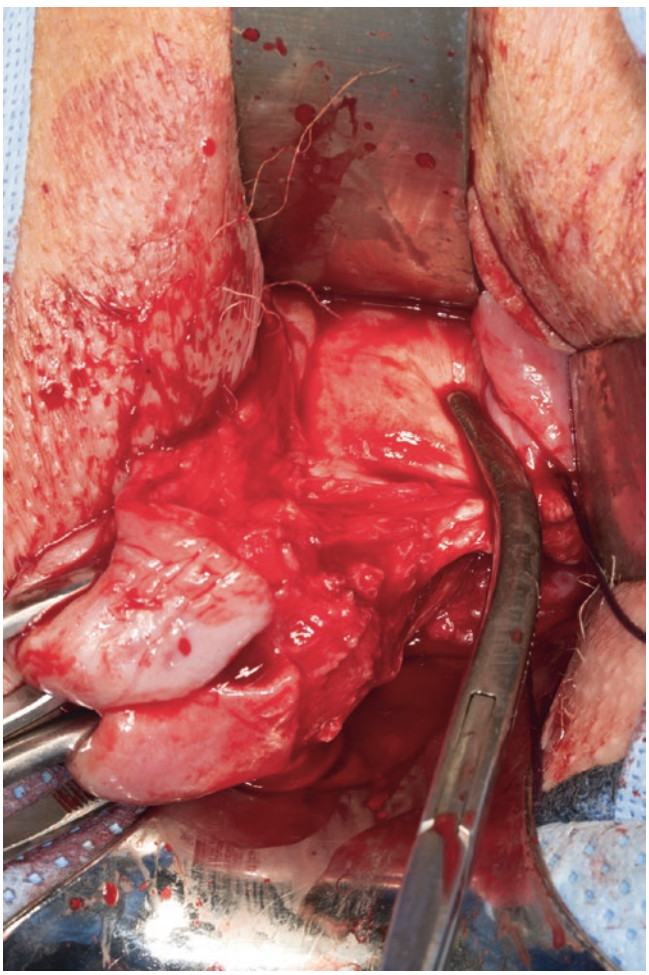


Fig. 123.20 Clamping of the uterine-vascular pedicle with incorporation of the anterior and posterior peritoneum (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

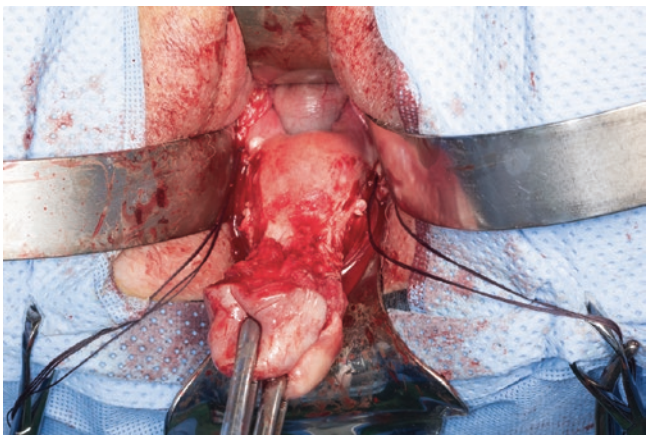


Fig. 123.22 After ligation and transection of the pedicles on the right side (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

clamped, however, the tips of the Heaney are pointed in a superior direction (Fig. 123.26). This is transected and the specimen delivered. Each pedicle is then ligated (Fig. 123.27) and tagged with a kocher which is placed over the patient's thigh on each side (Fig. 123.28). A pack is placed to elevate the bowel out of the pelvis (Fig. 123.29). Careful inspection of all pedicles is done and electrocautery is often used on the posterior vaginal cuff to obtain hemostasis (Fig. 123.30). In the appropriate patient, a salpingectomy or salpingo-oophorectomy can safely be accomplished at this point.

Salpingectomy

An Allis clamp is used to grasp the utero-ovarian pedicle; this contains the transected round ligament and fallopian

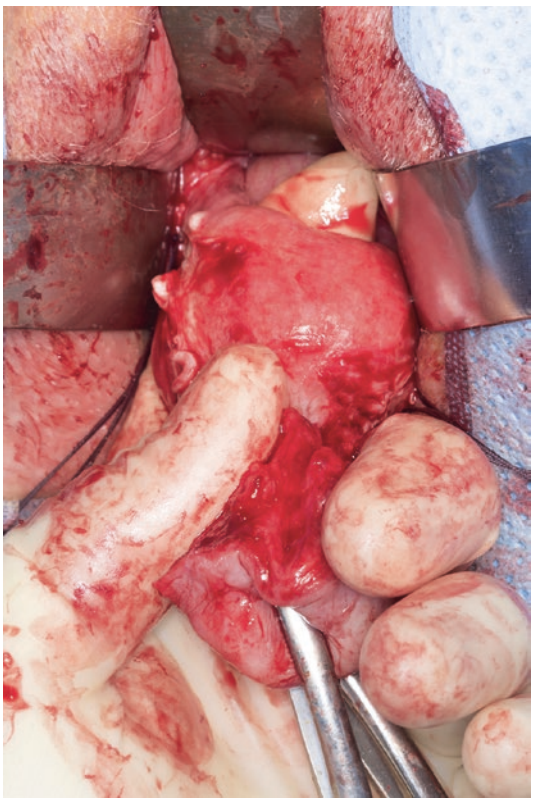


Fig. 123.23 Exposing the right utero-ovarian pedicles (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

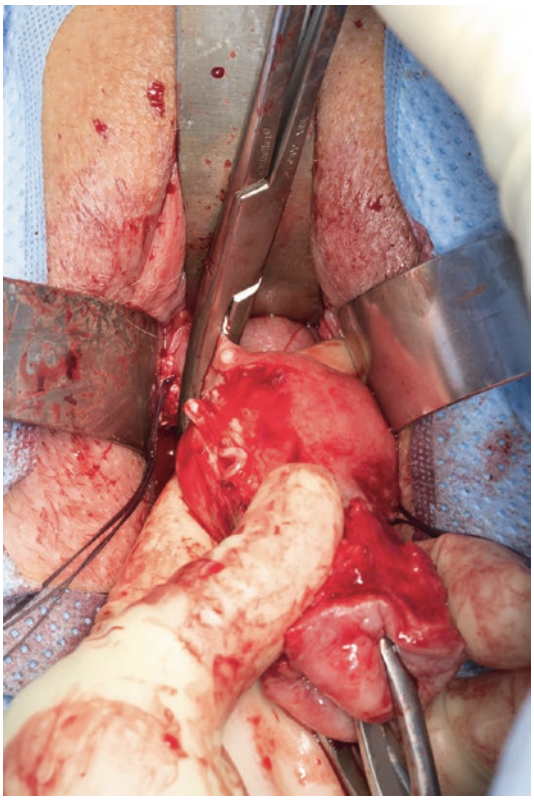


Fig. 123.24 Heaney clamp placement on the right utero-ovarian pedicle (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

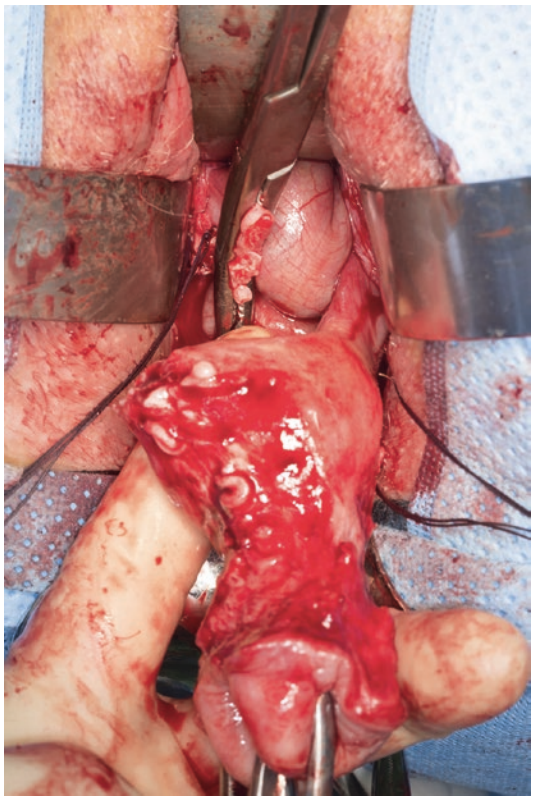


Fig. 123.25 The transected right utero-ovarian pedicle (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

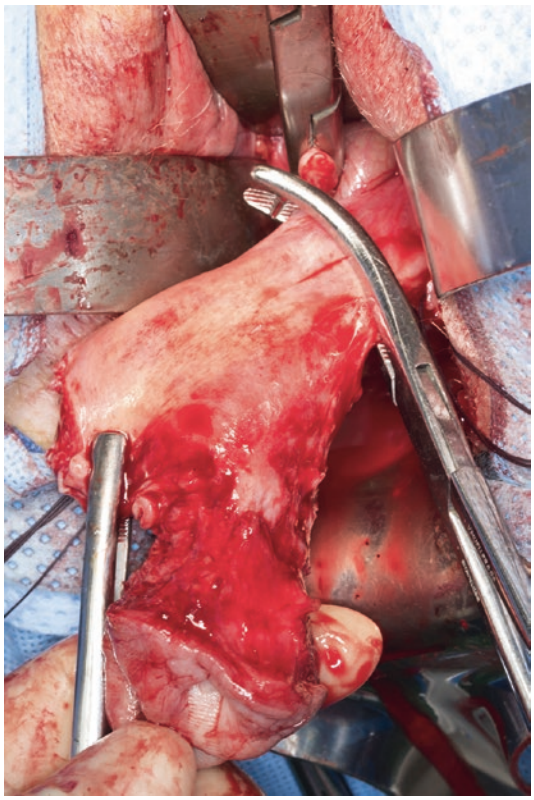


Fig. 123.26 Clamping of the left utero-ovarian pedicle (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

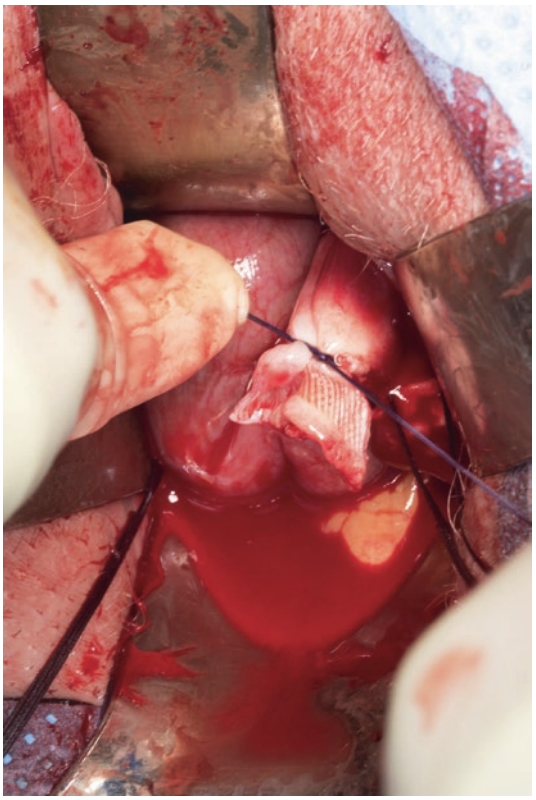


Fig. 123.27 Ligation of the utero-ovarian pedicles (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

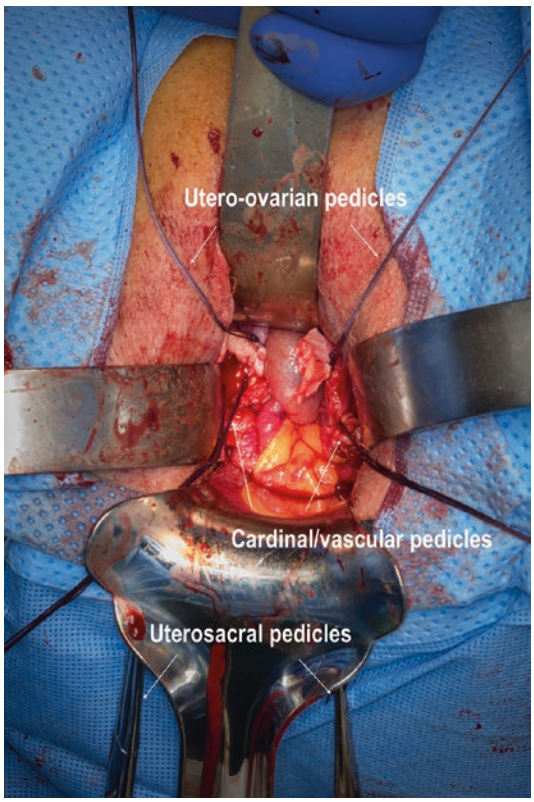


Fig. 123.28 Showing suture management with the utero-ovarian pedicles superiorly over the leg, the cardinal/vascular pedicles inferior, and the uterosacral ligaments tagged with a kocher lying behind the speculum (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

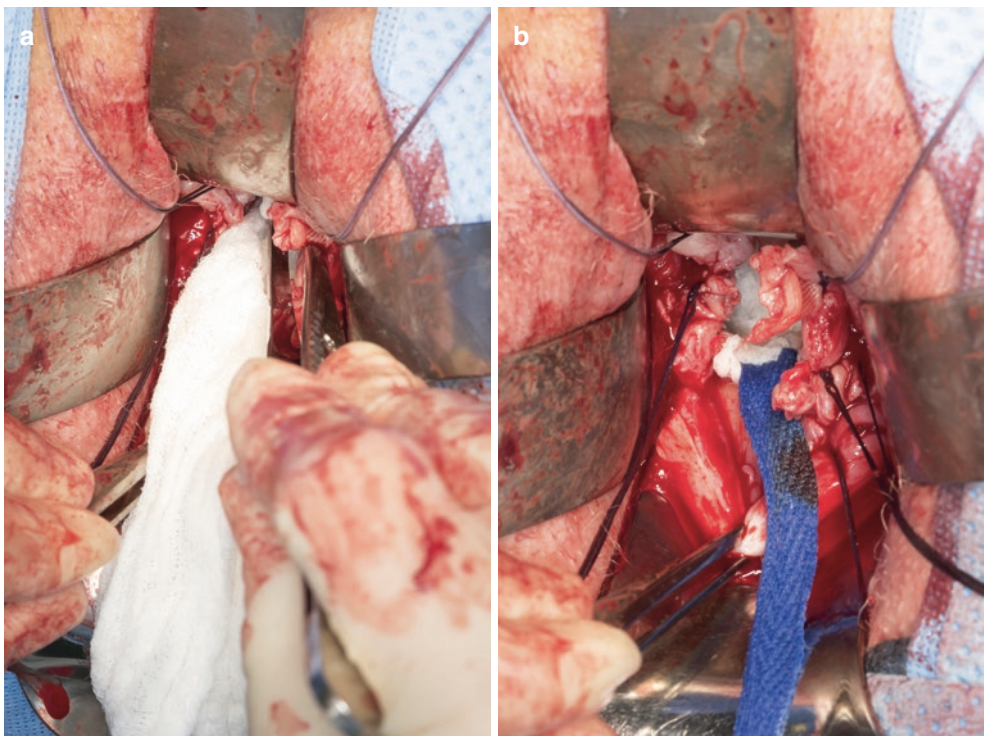


Fig. 123.29 (**a**) Placement of a bowel pack; (**b**) After the bowel pack has been placed (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

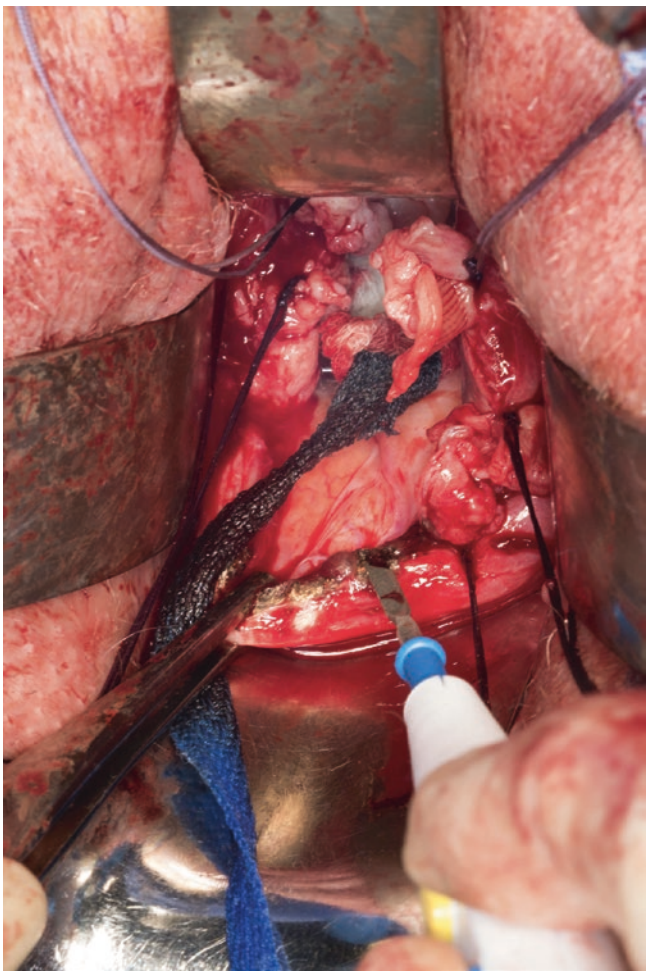


Fig. 123.30 Cauterization of the poster vaginal cuff for hemostasis (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

tube (Fig. 123.31). The fallopian tube is grasped with a Russian forceps and gentle traction is given toward the midline (Fig. 123.32). This exposes the mesosalpinx. An Allis clamp is used to grasp the fallopian tube and a Heaney clamp is placed across the mesosalpinx (Fig. 123.33). A free tie is passed around the tip of the Heaney (Fig. 123.34a) and tied as the assistant opens and closes the clamp (flash). Coordination with the assistant is imperative to avoid tearing the delicate mesosalpinx. The specimen is excised and removed (Fig. 123.34b, c) and one additional free tie is placed on the pedicle and the Heaney clamp is removed. Hemostasis is verified and the sutures are cut. The same is done on the opposite side.

Salpingo-Oophorectomy

An Allis clamp is used to grasp the utero-ovarian pedicle; this contains the round ligament and fallopian tube – see Fig. 123.31. A Russian forceps is used to grasp the fallopian tube and underlying ovary and gentle traction is given toward the

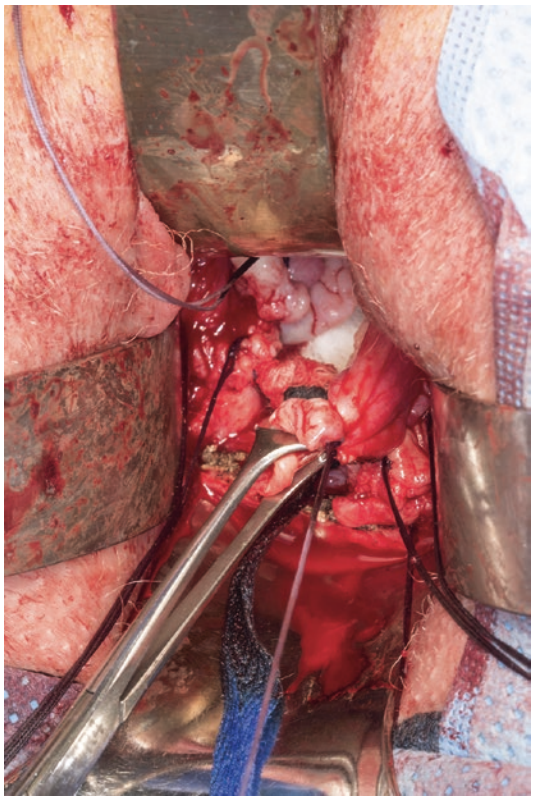


Fig. 123.31 Grasping the left utero-ovarian pedicle for traction (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

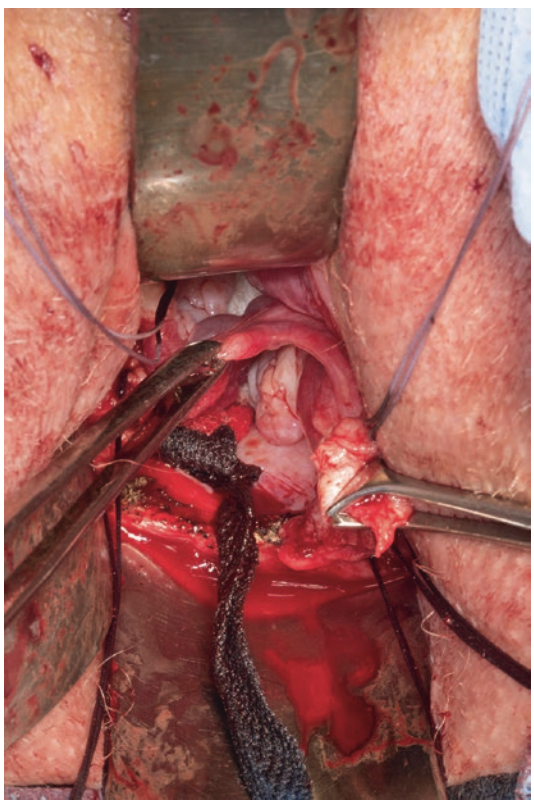


Fig. 123.32 Russian forceps are used to grasp the fallopian tube (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

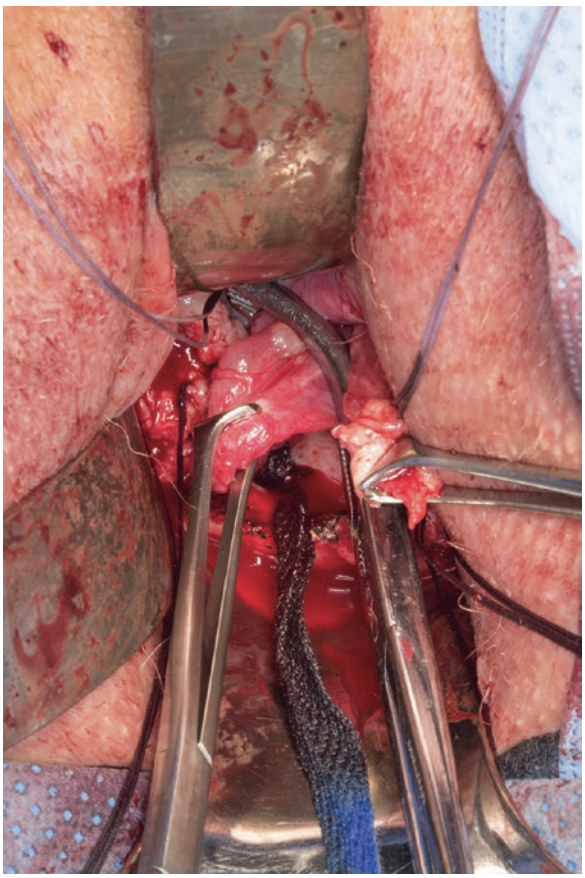


Fig. 123.33 A Heaney clamp being placed across the mesosalpinx (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

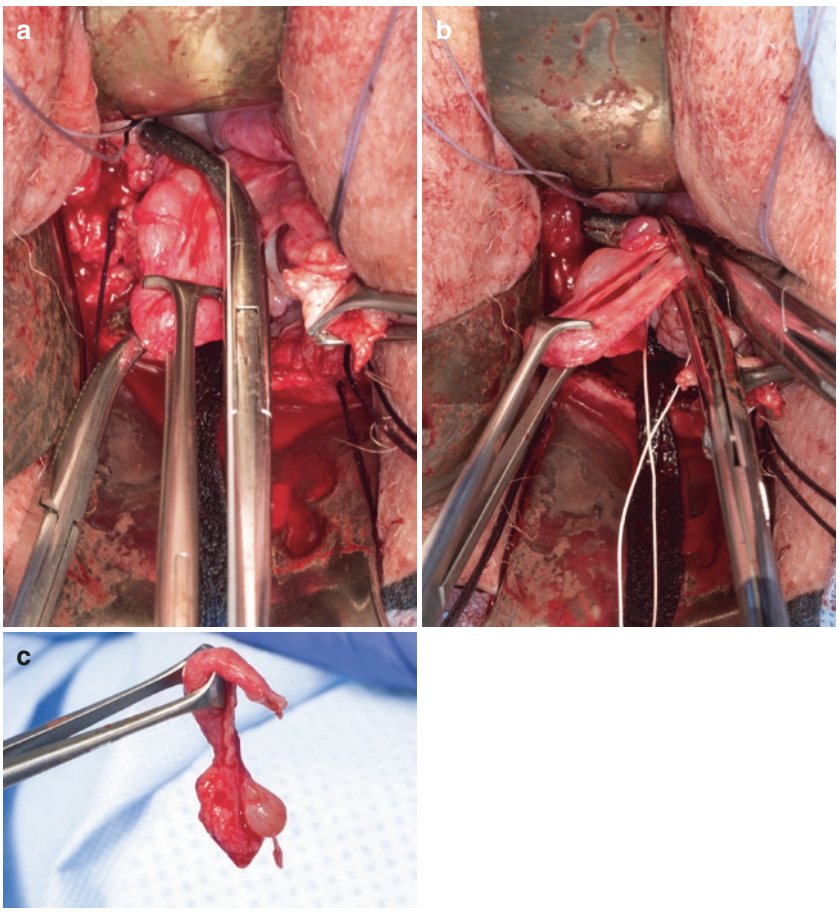


Fig. 123.34 (**a**) A free tie is passed around the tip if the Heaney clamp and tied; (**b**) The fallopian tube is excised; (**c**) The specimen (fallopian tube) (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

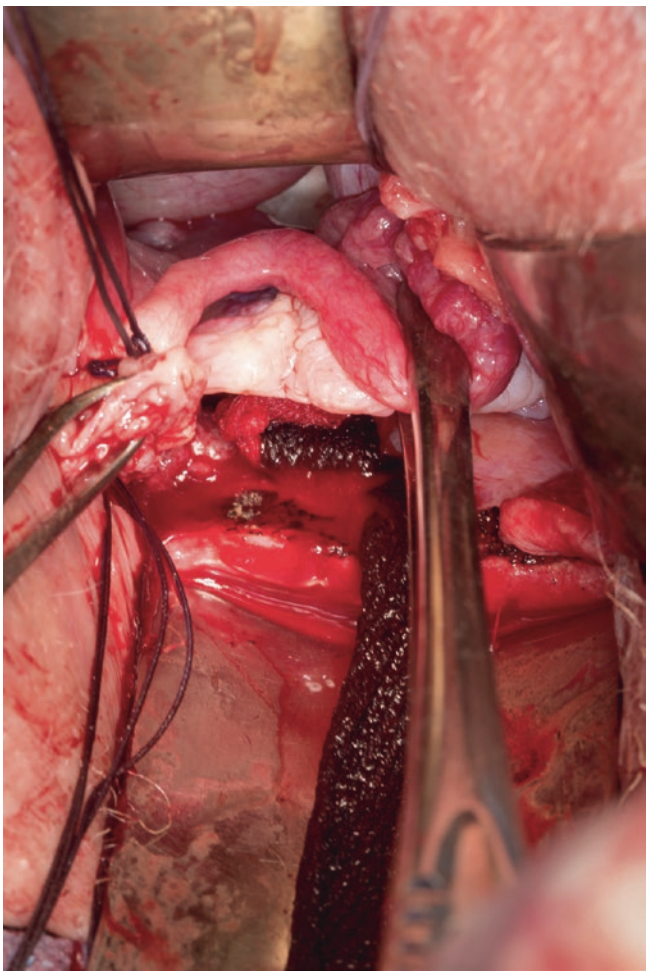


Fig. 123.35 Russian forceps are used to grasp the fallopian tube and the ovary (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

midline (Fig. 123.35). This exposes the infundibulo-pelvic ligament containing the ovarian vessels. An Allis clamp is used to grasp the tube and ovary and a Heaney clamp is placed across the infundibulo-pelvic ligament (Fig. 123.36). A free tie is passed around the tip of the Heaney (Fig. 123.37) and tied as the assistant opens and closes the clamp (flash). Coordination with the assistant is imperative to avoid tearing. The specimen is excised and removed and an additional suture ligation is performed followed by removal of the Heaney clamp. Hemostasis is verified and sutures are cut. The same is done on the opposite side.

Modified McCall Culdoplasty

Once all specimens have been secured, obliteration of the enterocele space and re-suspension of the vaginal cuff is begun. This incorporates techniques from Mayo, Torpin [4] and McCall [1] into a single procedure for closure of the enterocele sac and suspension of the vagina to the uterosacral ligaments.

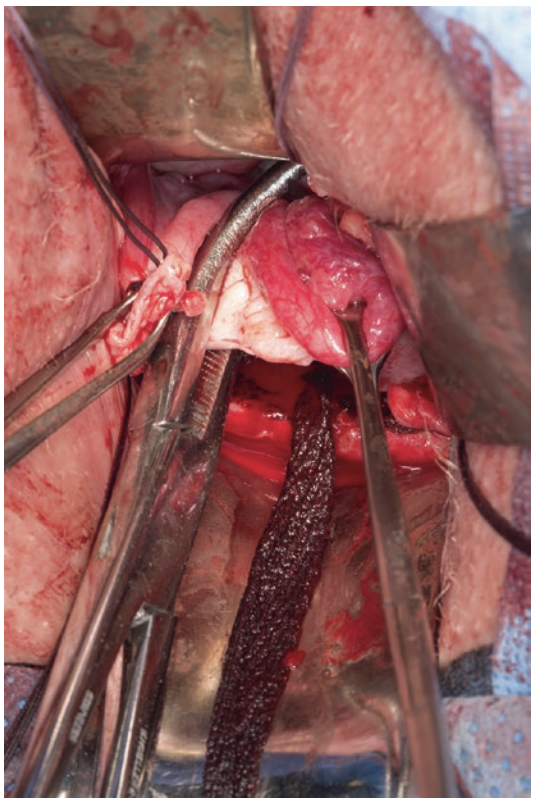


Fig. 123.36 A Heaney clamp being placed across the infundibulopelvic ligament containing the ovarian vessels (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

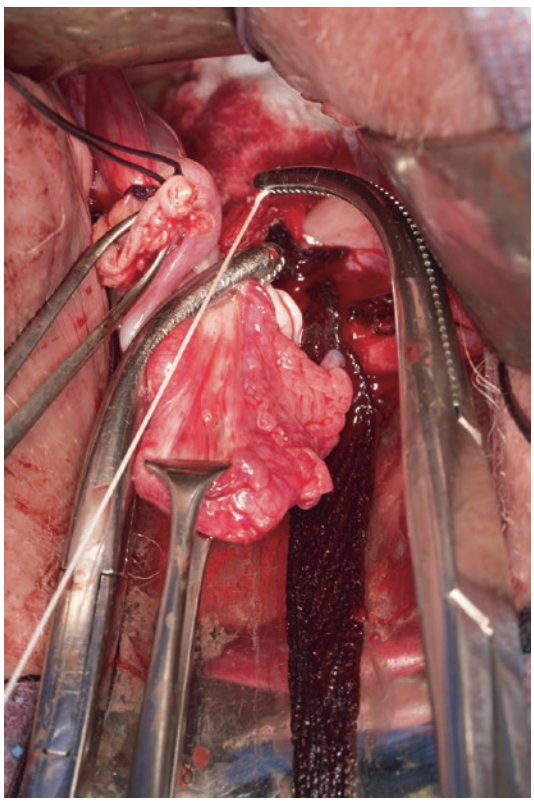


Fig. 123.37 Passage of a free tie around the Heaney clamp for ligation of the ovarian vessels (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

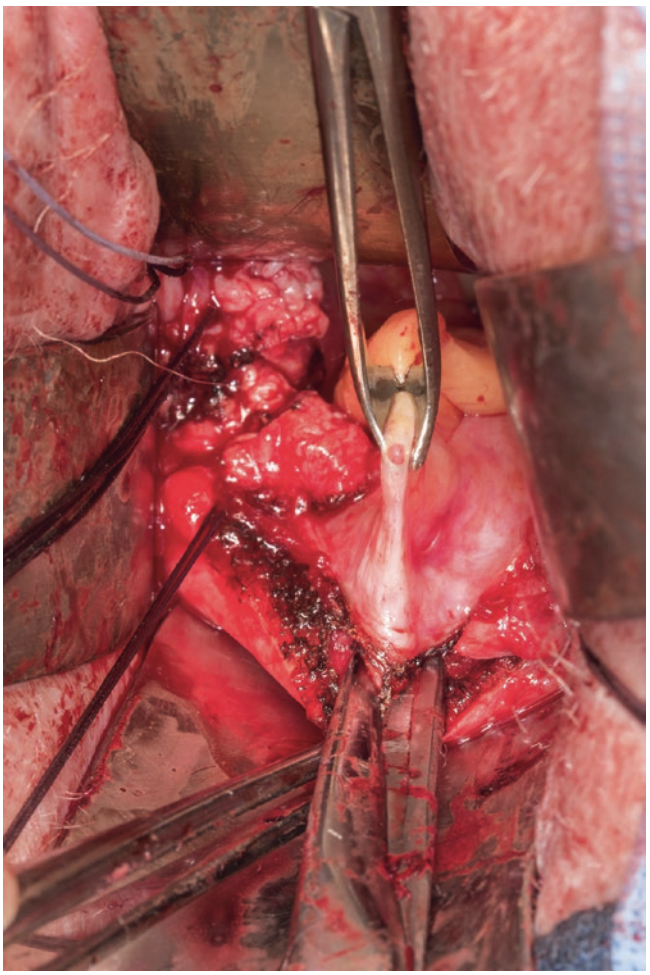


Fig. 123.38 Traction placed on the peritoneum using an Allis clamp and sharp dissection is begun (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

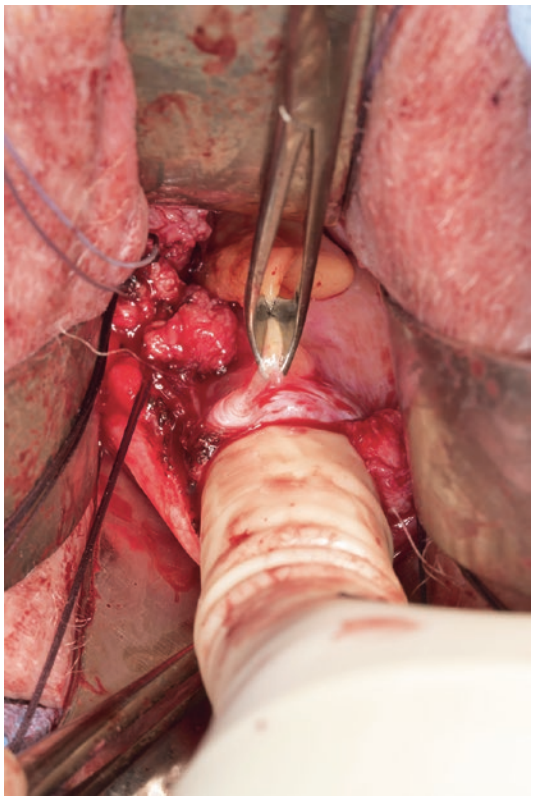


Fig. 123.39 Blunt dissection of the space after sharp dissection completed

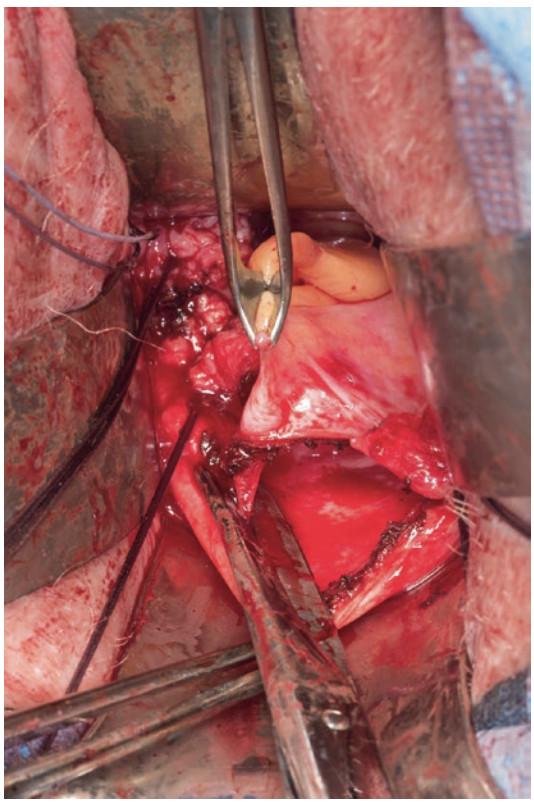


Fig. 123.40 Sharp dissection of the lateral peritoneal attachments (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

In many cases there is some redundancy along the posterior cul-de-sac, for which a wedge resection of a portion of the posterior fornix is taken. An Allis clamp is used to grasp the posterior peritoneum and sharp dissection is used to enter the avascular space and drop away the rectum from the posterior vaginal wall (Fig. 123.38). Once the space is entered, a single finger can be used to bluntly continue dissection (Fig. 123.39). Lateral attachments are further dissected sharply (Fig. 123.40) and a triangular wedge of the posterior vaginal wall is taken (Fig. 123.41a–d). Of note, if no redundancy is noted, then this step is not necessary.

Two external McCall sutures are placed using heavy absorbable suture. Grasping the cut edge of the posterior vaginal wall on the patient's left side, the first stitch is placed through the vaginal epithelium and peritoneum and exits intraperitoneally (Fig. 123.42). With traction placed on the uterosacral ligament by the assistant, the rectum is swept medially and the suture is placed through the uterosacral ligament and pararectal fascia (Fig. 123.43). Small bites continue across the anterior peritoneum of the rectum (Fig. 123.44) to the right uterosacral ligament/pararectal

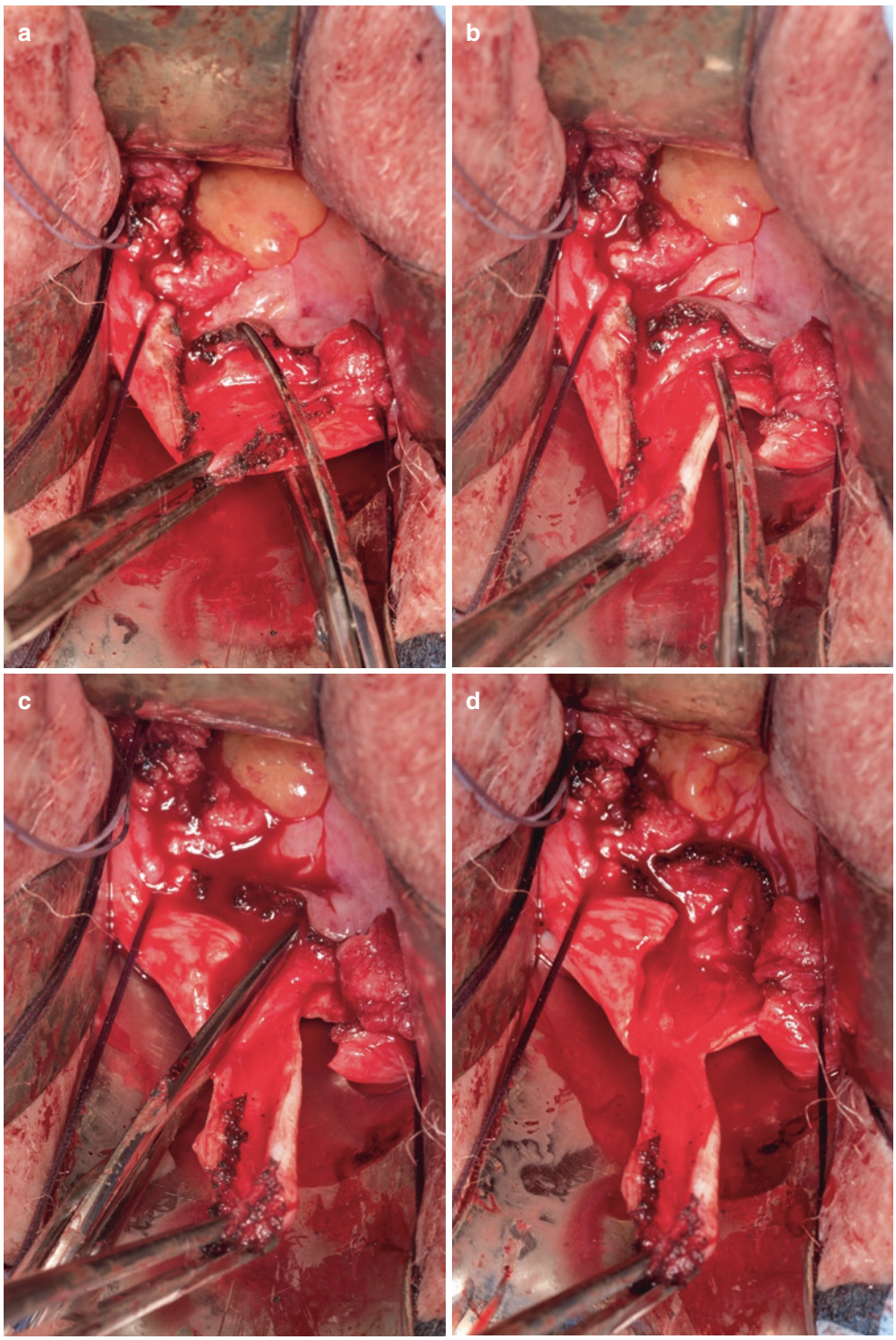


Fig. 123.41 (**a**) Beginning of removal of a wedge of the apical vagina; (**b**) After incision is made on one side; (**c**) After incision is made of the opposite side; (**d**) Completed wedge (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

fascia (Fig. 123.45). It is brought through the peritoneum and out through the vaginal epithelium on the right side (Fig. 123.46) and tagged with a Kocher clamp (Fig. 123.47). A second suture is placed in the same fashion beginning just superior to the first on the vaginal epithelium (Fig. 123.48). Entrapment of the first McCall should be avoided when placing the second (Fig. 123.49). This is tagged with a curved clamp (Fig. 123.50a, b) illustrates both modified-McCall sutures in place prior to peritoneal closure. Peritoneum closures is accomplished by placement of a third suture. This begins with a bite of the left uterosacral ligament cephalad to the highest McCall suture followed by incorporation of the pelvic sidewall peritoneum (Figs. 123.51 and 123.52). The anterior peritoneum of the bladder is incorporated and two knots are tied (Figs. 123.53 and 123.54). This closes the peritoneum from 5 o'clock to 12 o'clock. The same suture is brought inferior and the peritoneum of the rectum is incorporated in several small bites (Fig. 123.55) and finally it is

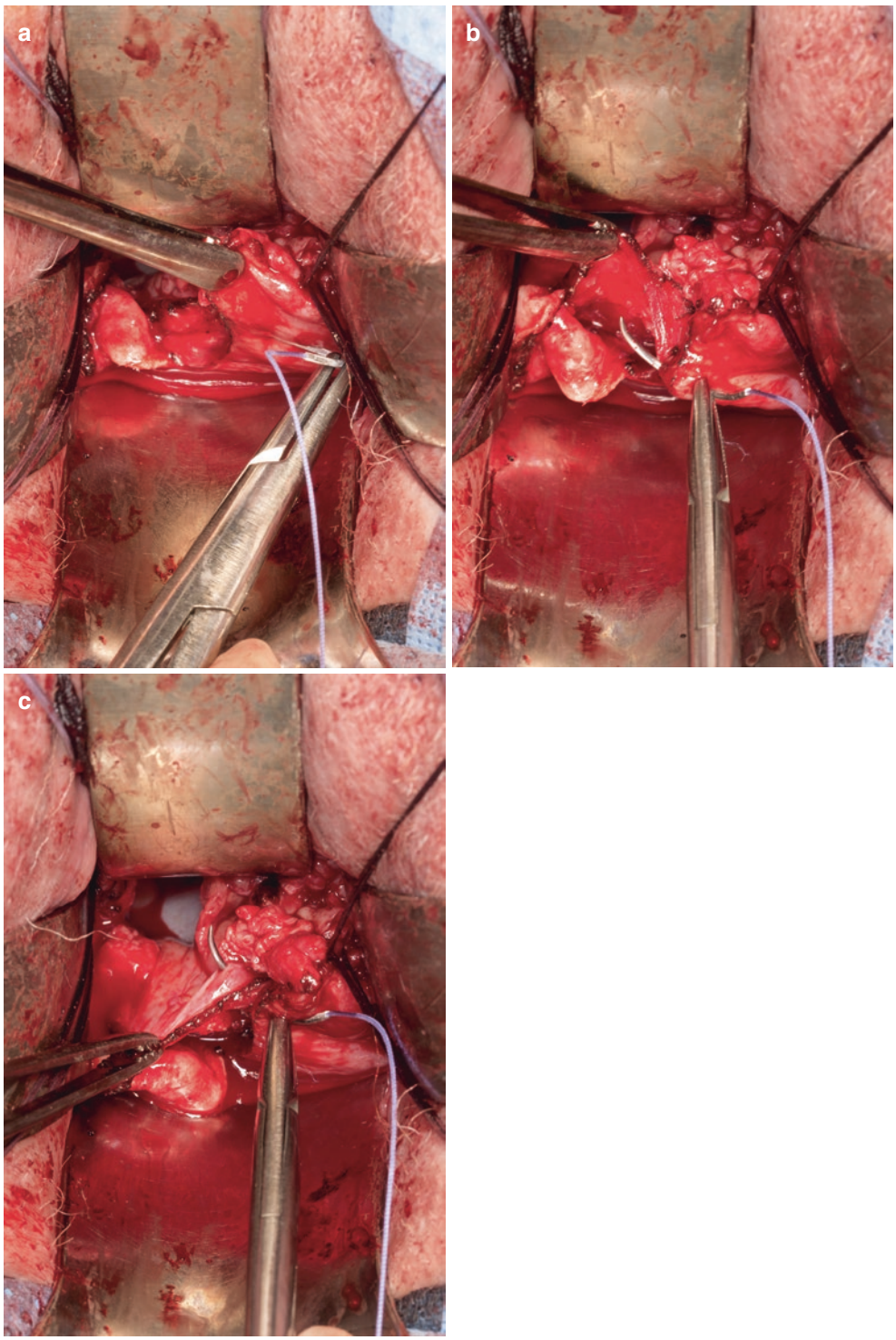


Fig. 123.42 (**a**) Starting point for placement of the first modified-McCall; (**b**) Placement through he vaginal epithelium; (**c**) Placement through the posterior peritoneum into the peritoneal cavity (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

brought through the uterosacral ligament on the right, again superior to the highest McCall. The pelvic sidewall peritoneum is incorporated (Fig. 123.56) followed by the anterior peritoneum of the bladder (Fig. 123.57). The pack is removed and traction is given on the suture to cinch it down, effectively closing the peritoneal; then the suture is tied. The suture end with the needle is brought through the vaginal epithelium (Fig. 123.58) on the patient's right side, while the free end is threaded through a bare needle and brought thought the vaginal epithelium on the left side (Fig. 123.59a, b). Each of the sutures placed can be visualized in Fig. 123.60a, b. The reperitonealizing suture is then tied once again, bringing the edges of the vaginal cuff together. The second McCall suture (curved tag) is tied followed by the

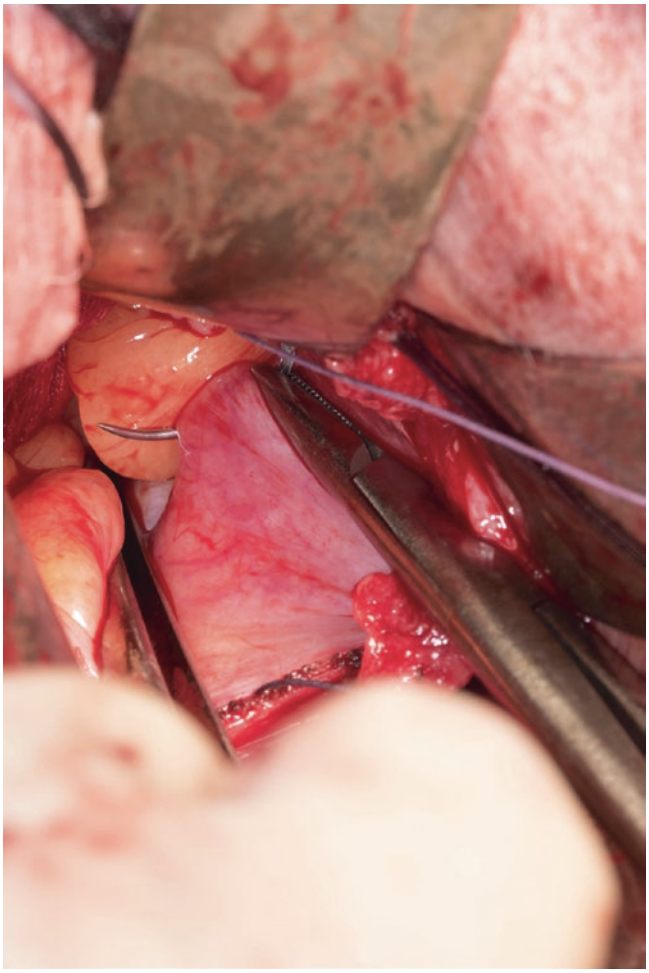


Fig. 123.43 Placement of the first modified-McCall suture through the left uterosacral ligament (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

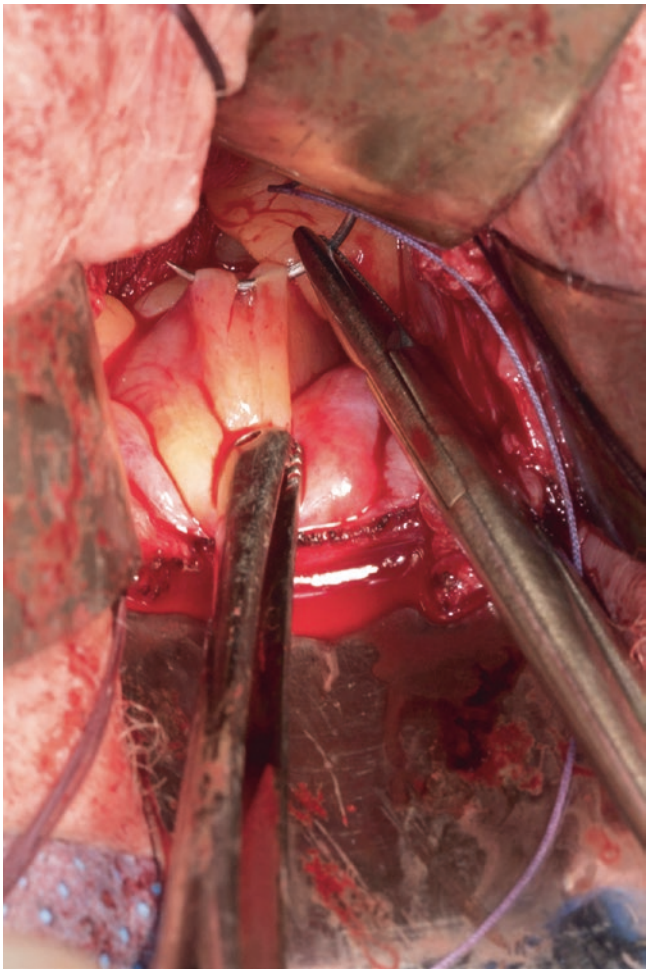


Fig. 123.44 Bites are taken across the peritoneum of the rectum to obliterate the enterocele space (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

first (Kocher tag). Cystoscopy is performed utilizing a 70-degree cystoscope for visualization of ureteral patency (Fig. 123.61).

Cuff Closure

Closure of the cuff begins on the patient's left side. The uterosacral tag is placed in the midline and the assistant on the right provides traction on the contralateral tagged sutures. After support of the vaginal apex, the vaginal cuff angles may be pulled inferiorly, however, identification of the angle is made easy by locating the area of the longitudinal incision made at the start of the case. A suture is passed through the inferior cuff angle, brought through the uterosacral ligament and out the vaginal epithelium, superior to the cuff angle and tied (Fig. 123.62). Additional interrupted sutures are placed to close the vaginal cuff until the midline is reached. The same is done on the right side, incorporating the uterosacral ligament into the corner of the cuff (Fig. 123.63a–c). The remainder of the cuff is closed in an interrupted fashion.

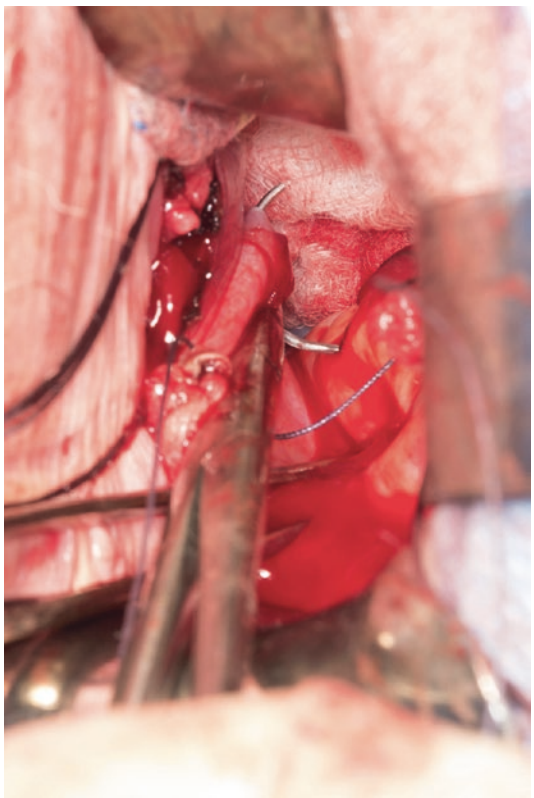


Fig. 123.45 A bite of the right uterosacral ligament is shown (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

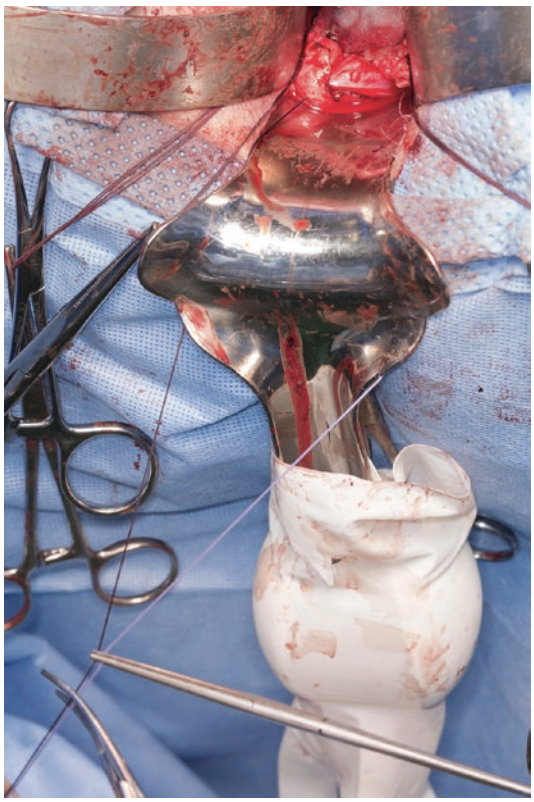


Fig. 123.47 Kocher clamp used to tag the first modified-McCall suture (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

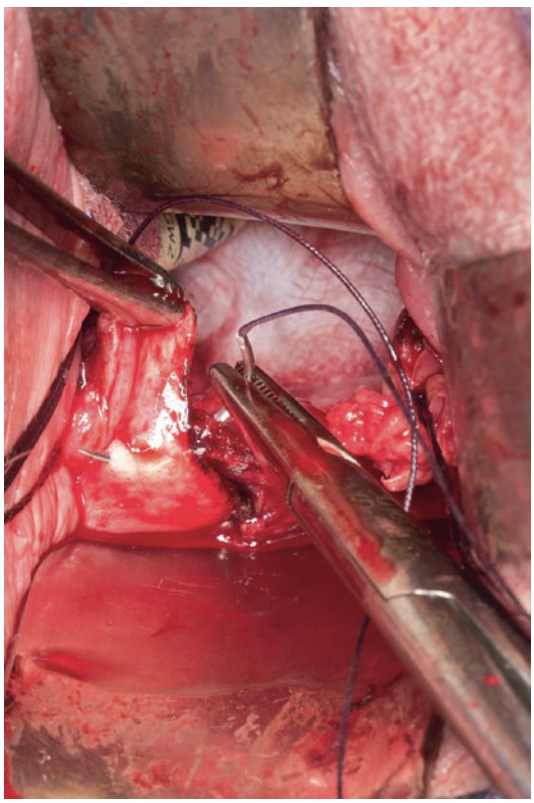


Fig. 123.46 The suture is brought through the peritoneum and vaginal epithelium (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

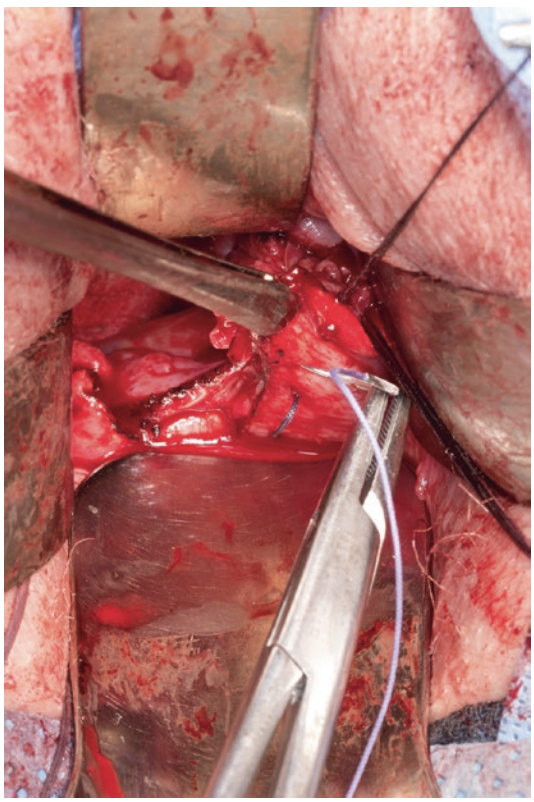


Fig. 123.48 Entry for the second modified-McCall suture (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

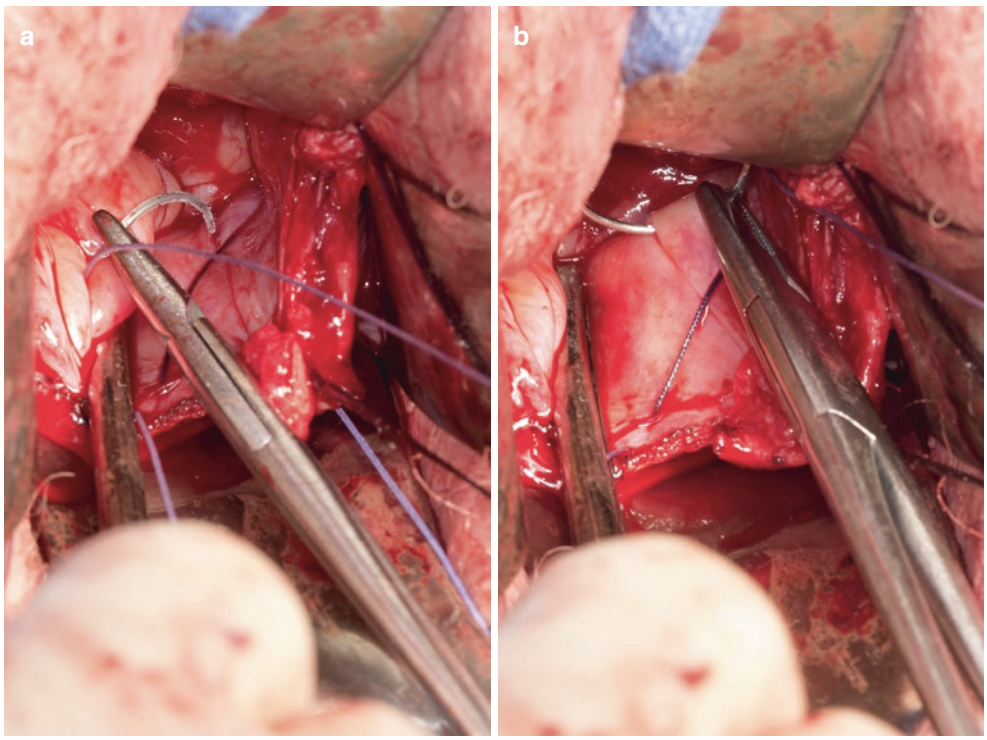


Fig. 123.49 (**a**) Location of entry for second modified-McCall; (**b**) Entrapment avoided by placement just medial to the first modified-McCall suture (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

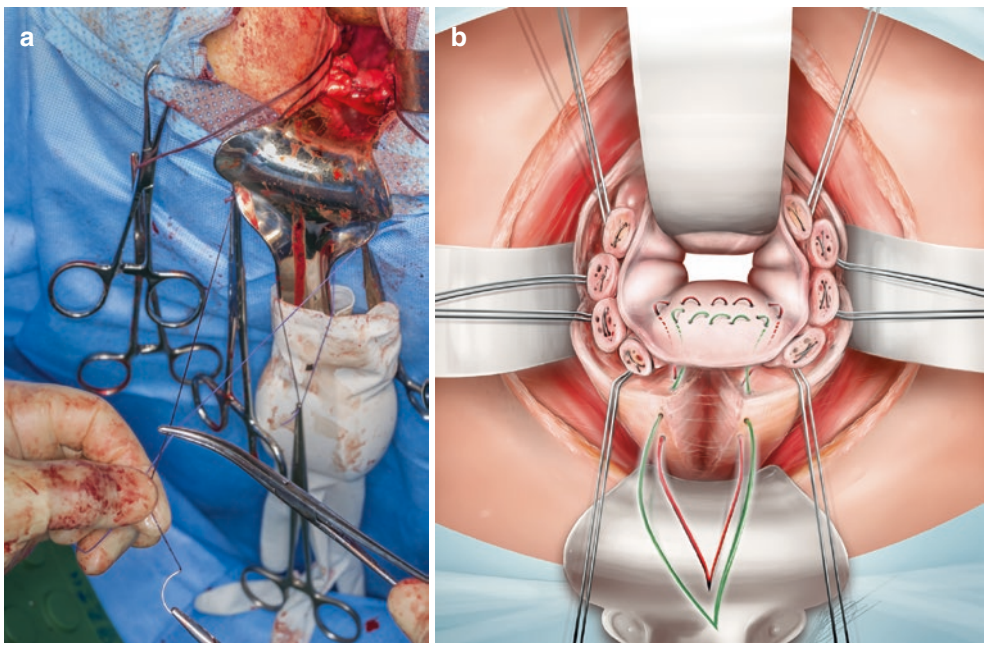


Fig. 123.50 (**a**) Curved clamp used to tag the second modified-McCall suture; (**b**) Illustration after the 2 modified-McCall sutures have been placed

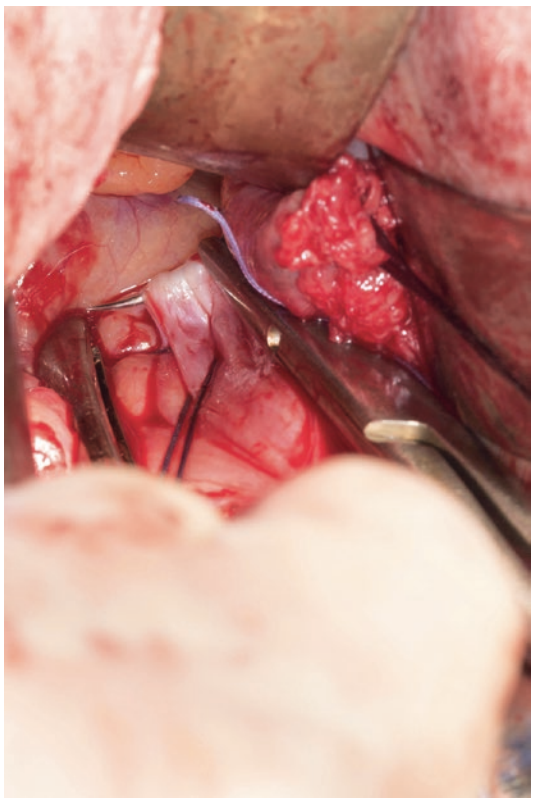


Fig. 123.51 Peritoneal closure beginning with a bite of the uterosacral ligament – superior to the 2 previous sutures (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

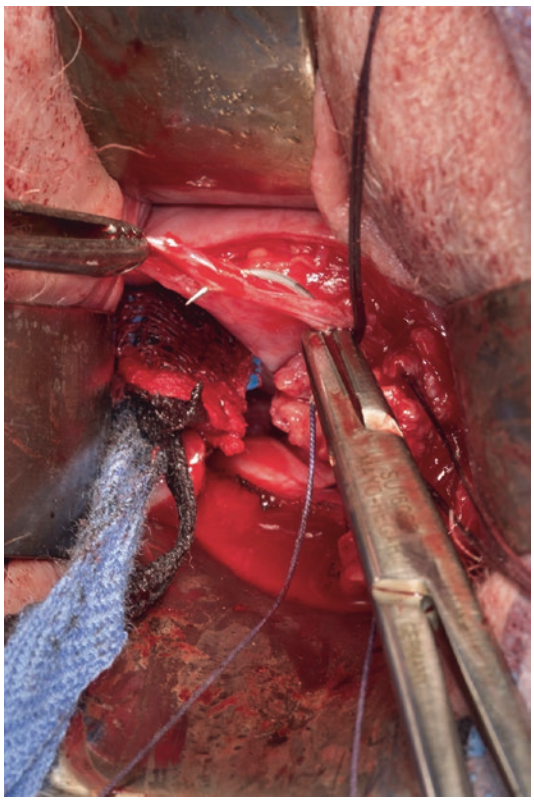


Fig. 123.53 Incorporation of the anterior peritoneum of the bladder (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

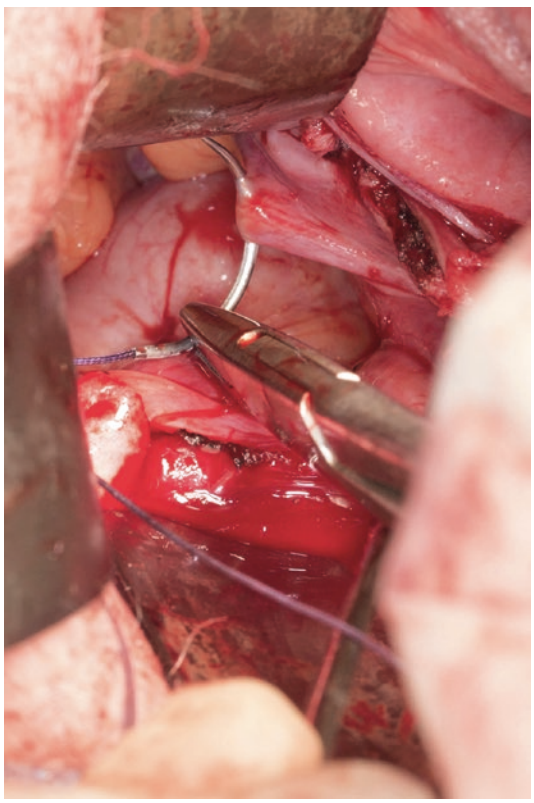


Fig. 123.52 Incorporation of the left pelvic sidewall peritoneum into the closure (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

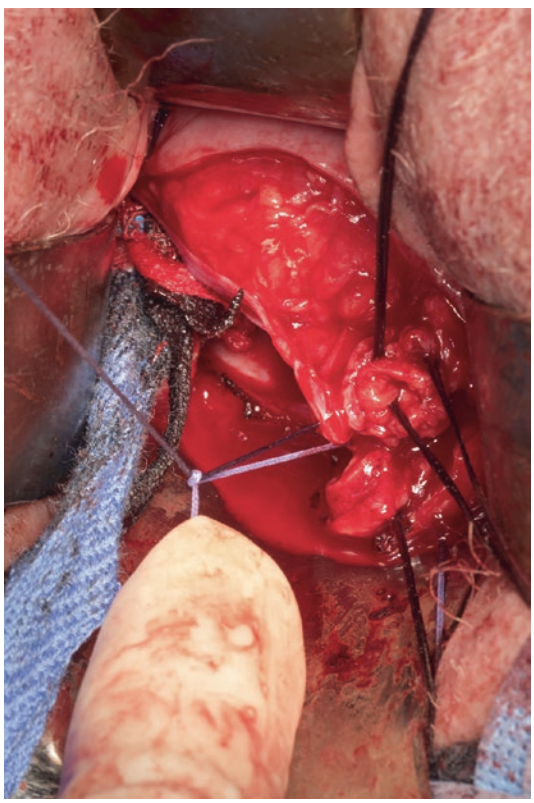


Fig. 123.54 Two knots are tied (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

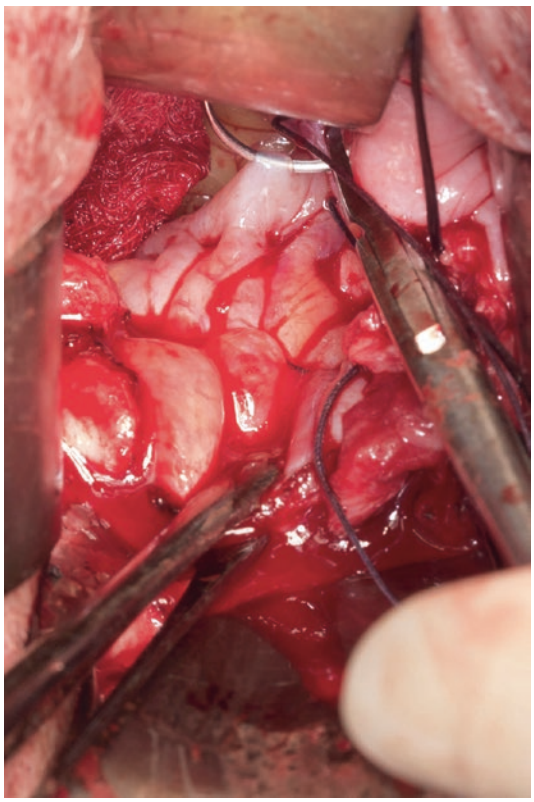


Fig. 123.55 Peritoneum of the rectum superior to the highest modified-McCall is incorporated (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

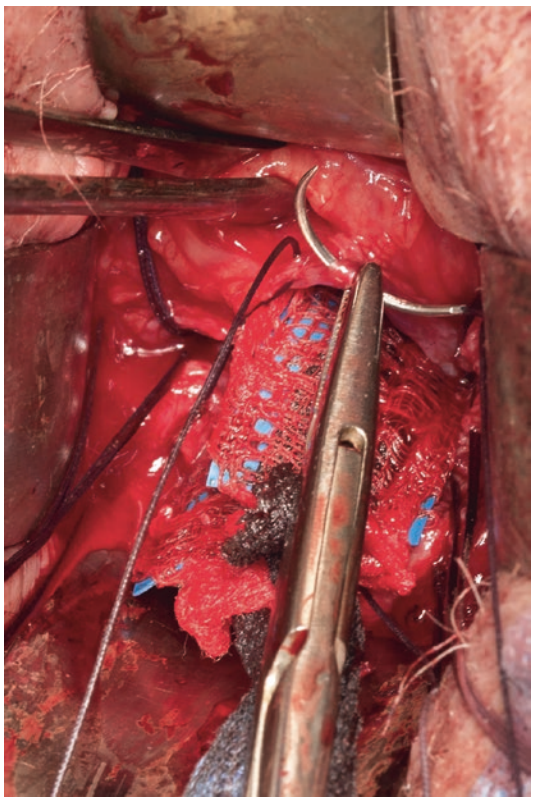


Fig. 123.57 Incorporation of the anterior peritoneum of the bladder completes the peritoneal closure (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

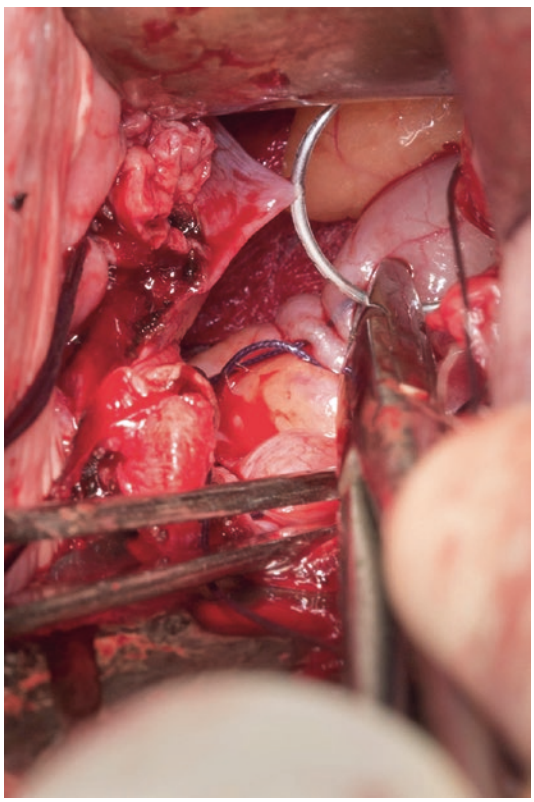


Fig. 123.56 Incorporation of the right pelvic sidewall peritoneum into the closure (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

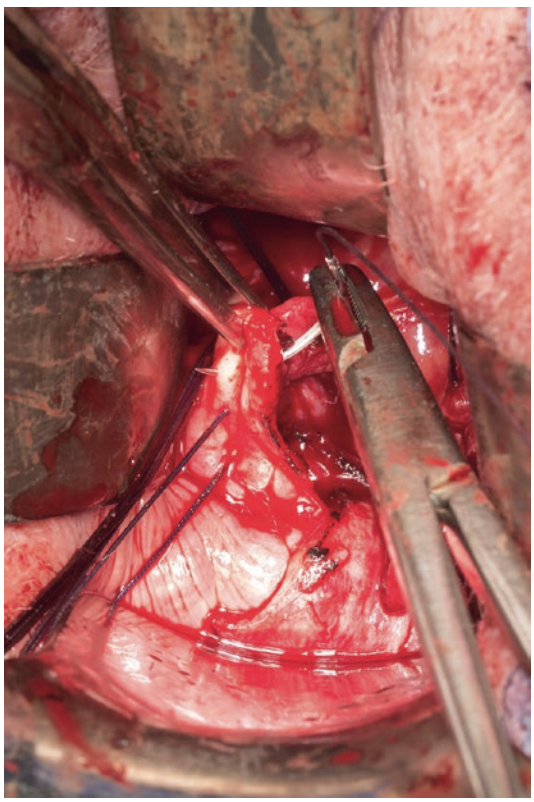


Fig. 123.58 Suture is brought through the vaginal epithelium on the patient's right side (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

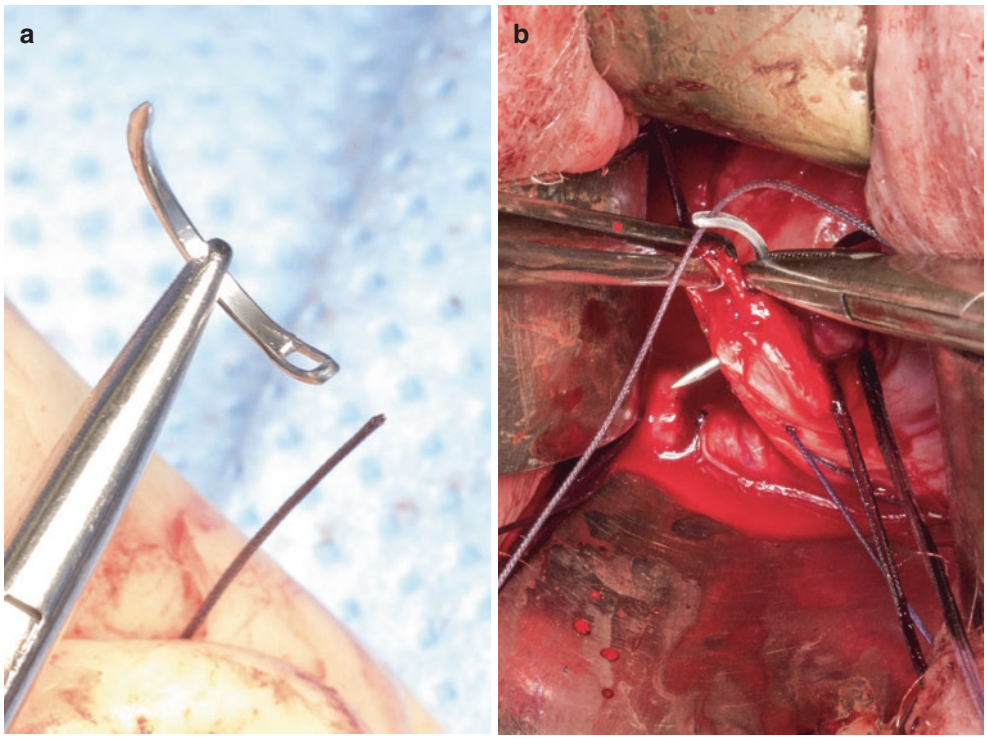


Fig. 123.59 (**a**) The bare needle; (**b**) The tail of the peritoneal closure suture being brought thought the vaginal epithelium (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

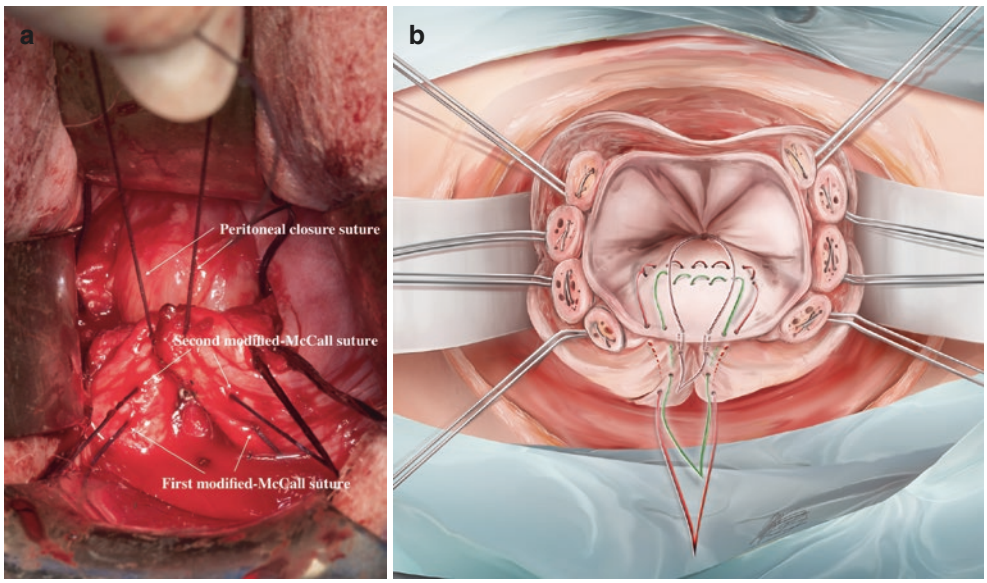


Fig. 123.60 (**a**) All suspension sutures identified; (**b**) Illustration after peritoneal closure visualizing all suspension sutures

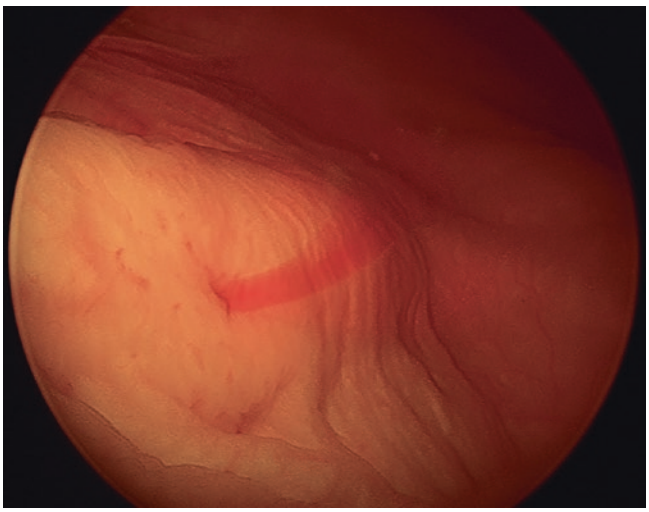


Fig. 123.61 Cystoscopic confirmation of ureteral function after peritoneal and modified-McCall sutures are tied (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

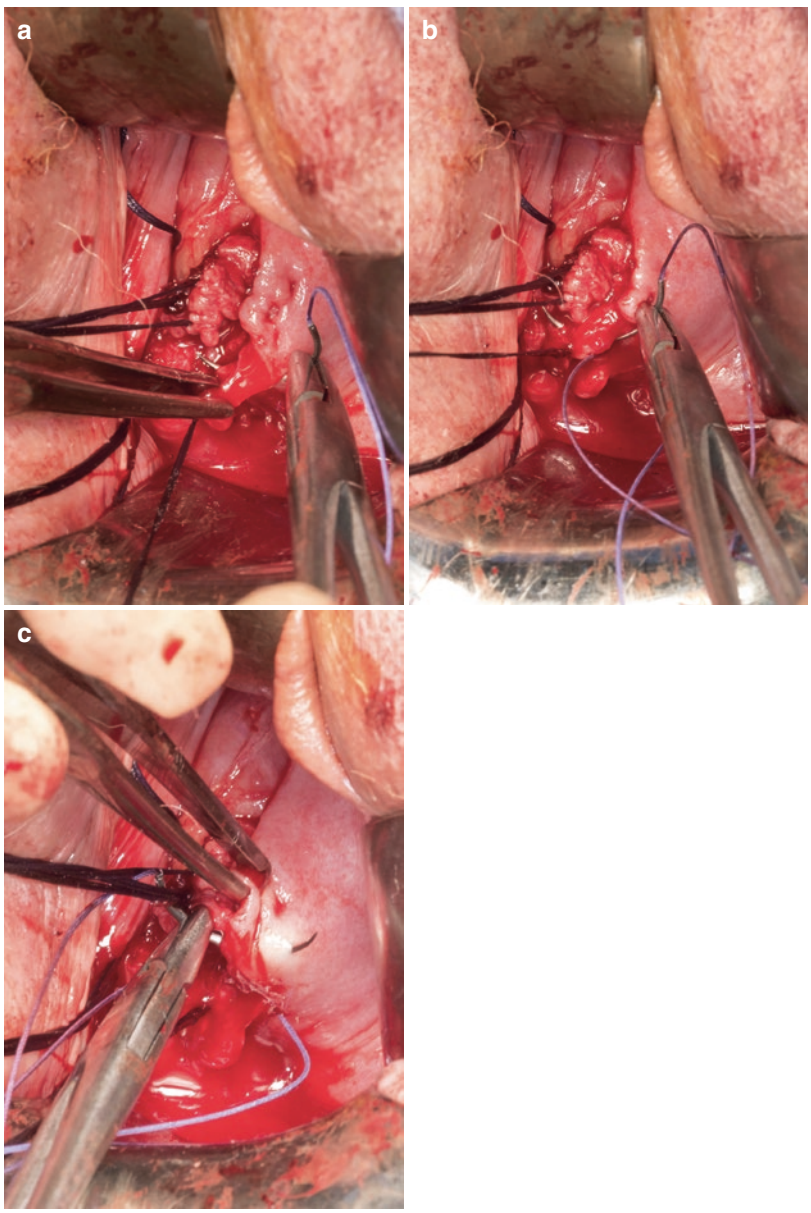


Fig. 123.62 (**a**) Left vaginal cuff angle closure – suture placed inferior to the longitudinal incision made at the beginning of the case; (**b**) A bite of uterosacral ligament is incorporated for further apical support; (**c**) The suture exits the vaginal epithelium above the longitudinal incision (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

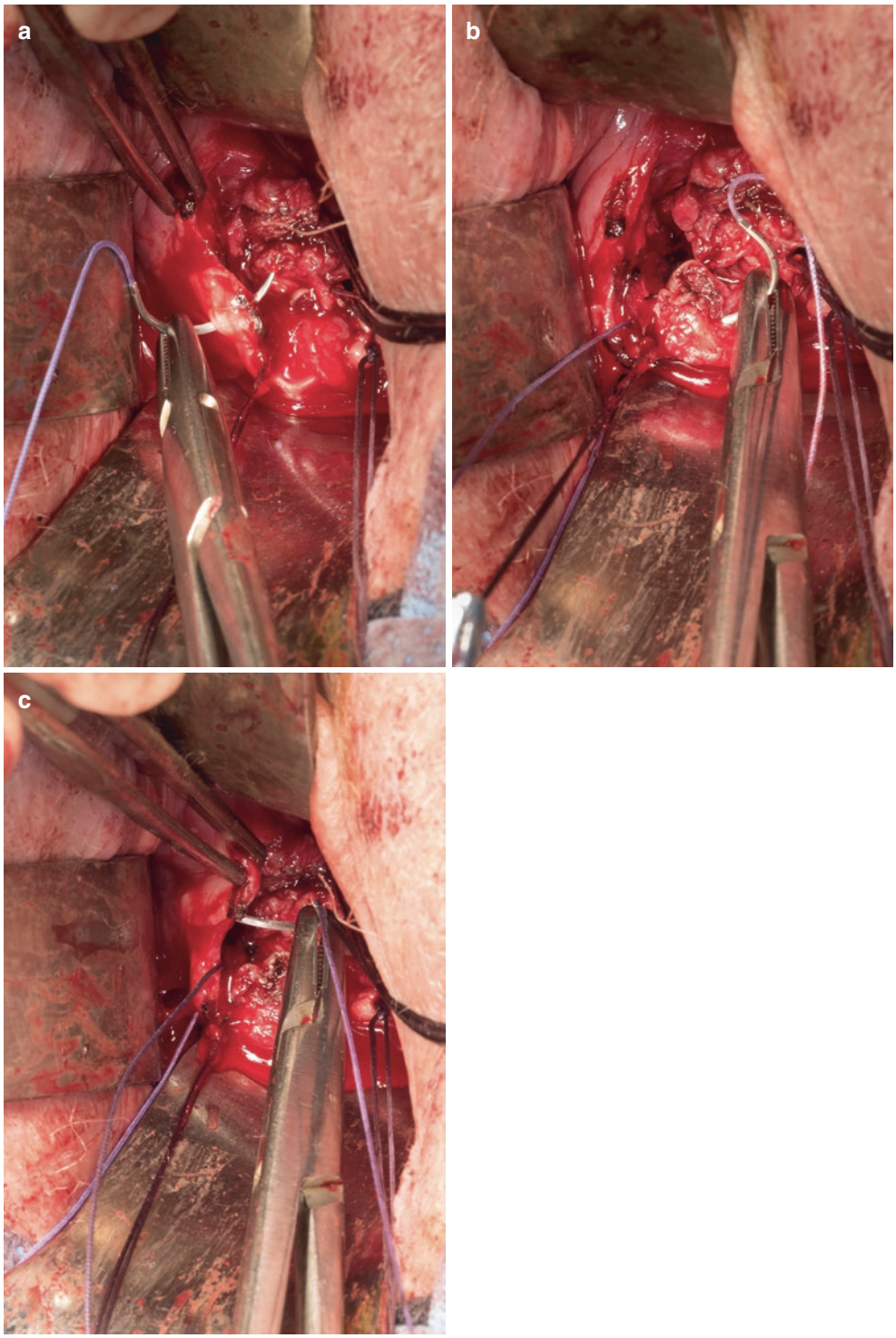


Fig. 123.63 (**a**) Right vaginal cuff angle closure – suture placed inferior to the longitudinal incision made at the beginning of the case; (**b**) A bite of uterosacral ligament is incorporated for further apical support; (**c**) The suture exits the vaginal epithelium above the longitudinal incision (Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved)

References

1. McCall M. Posterior culdeplasty; surgical correction of enterocele during vaginal hysterectomy; a preliminary report. Obstet Gynecol. 1957;10(6):595–602.
2. ACOG *C*ommittee Opinion No. 444: choosing the route of hysterectomy for benign disease. Obstet Gynecol. 2009;114(5):1156–8.
3. Liapis A et al. Ureteral injuries during gynecological surgery. Int Urogynecol J Pelvic Floor Dysfunct. 2001;12(6):391–3. discussion 394
4. Torpin R. Excision of the cul-de-sac of Douglas for the surgical cure of hernias, through the female caudal wall, including prolapse of the uterus. J Int Coll Surg. 1955;24(3 Part 1):322–30.
5. Lee RA. Atlas of gynecologic surgery. Philadelphia: WB Saunders; 1992.

Vaginal-Assisted Laparoscopic Radical Hysterectomy and Pelvic Lymphadenectomy

124

Christhardt Köhler, Giovanni Favero, and Achim Schneider

Preliminary Remarks – History

At the turn of the twentieth century two competing operative schools had been developed in Vienna for operative treatment of cervical cancer patients: radical vaginal hysterectomy by Friedrich Schauta [1] and radical abdominal hysterectomy by Ernst Wertheim, Schauta's disciple [2]. Using the vaginal technique it was impossible to remove pelvic lymph nodes, whereas the abdominal approach at this time was associated with a high mortality rate (11.4 % vs. 25.2 %). However, Wertheim could reach better oncologic results, probably due to removal of metastatic lymph nodes (recurrence-free survival rates 42.4 % vs. 34.6 %). Consequently, with improvement of perioperative monitoring and antibiosis abdominal radical hysterectomy became standard of care in the surgical treatment of patients affected by early stage cervical cancer. Despite some attempts of modification Schauta's procedure was nearly completely forgotten.

After safe and oncologic adequate ability to perform laparoscopic pelvic lymphadenectomy as demonstrated by Dargent and Querleu in 1989 and 1991 [3, 4] the way was open for a renaissance of Schauta's procedure in combination with laparoscopic pelvic (±paraaortic) lymphadenectomy (please see chapter 6.14 – pelvic and paraaortic lymph node dissection). This technique was named by French colleagues as laparoscopic assisted radical vaginal hysterectomy (LARVH) [5–7]. A couple of Anglo-american and European gynecologic centres embarked on this innovative technique, which, however, never reached major popularity.

Almost at the same time total laparoscopic radical hysterectomy [8] was described by Nezhat et al. In 1997 the first and only randomized comparison between radical hysterectomy and radiotherapy in early stage cervical cancer was reported by Landoni et al. [9]. In this study oncologic equality of radical hysterectomy and primary (only) radiation for the treatment of patients with cervical cancer stages IB1-IIA with different profiles of toxicity was demonstrated. A comparison between chemoradiation (the new radiooncologic standard since the new millennium) and surgery has never been done in patients with cervical cancer. Careful and individual selection of patients to one of these treatments, i.e. unimodal modality, is essential in order to avoid increased toxicity which is associated with bimodal or trimodal therapy.

Only surgical staging, best done by laparoscopy, can provide exact staging of disease and helps to identify patients with early stage cervical cancer without lymph node metastases, who mostly profit from radical hysterectomy alone and do not need adjuvant chemoradiation [10] (Fig. 124.1).

Nowadays various techniques for radical hysterectomy are described: abdominal (ARH) with and without nerve-sparing (e.g. Total mesometrial resection – TMMR), Total laparoscopic (TLRH), Laparoscopic assisted vaginal (LARVH), and robotic (RRH) procedures. Besides technical details all available publications provide prospective, retrospective, or match-paired data (with historical cohorts) to characterize the clinical impact of each procedure. Except one phase II randomised study comprising only 15 patients no large prospective randomised study exists comparing different radical hysterectomy approaches [11, 12].

All comparisons between open and laparoscopic based radical operations for the treatment of women with early cervical cancer favour laparoscopy with respect to blood loss, hospital stay, recovery, cosmetic result, and show an identical oncologic outcome, if reported [13–48]. LARVH and TLRH have been successfully performed in more than 2000

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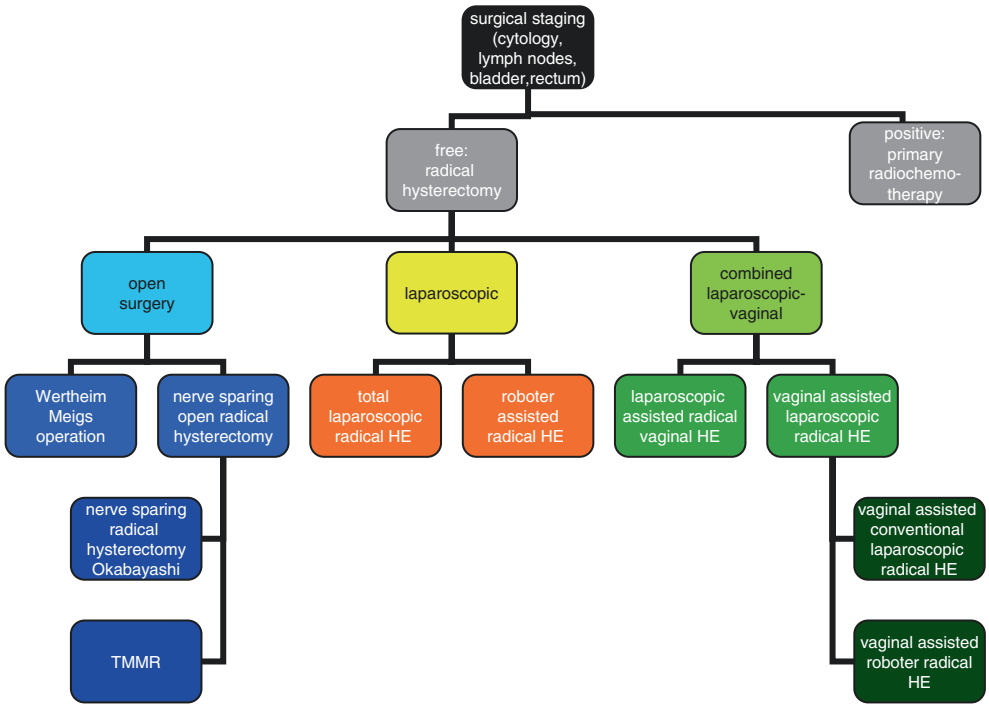


Fig. 124.1 Flowchart for staging and surgical options for patients with early stage cervical cancer. Comprehensive staging should encompass pevic (±paraaortic LNE), cytology fro cul-de-sac and biopsies from vesivocervical and rectovaginal septum

patients. TLRH is done using an uterine manipulator, which makes estimation of adequate vaginal resection difficult and can potentially lead to tumor spillage, especially when the vagina is opened and the tumor surface is exposed to circulating CO_2 [27, 30, 31, 35, 36]. First studies on RRH seem to overcome a few limitations of conventional laparoscopy such as two-dimensional visualization and limited degree of instrument motion which may lead to better acceptance of minimally invasive techniques in gynaecologic oncology [16, 22, 49–53]. However, with the roboter in place vaginal access is impossible and problems with vaginal cuff creation are similar to TLRH. Moreover, use of the robotic system is associated with high costs [54, 55].

Simultaneous with LeBlanc we modified LARVH into VALRH (vaginal assisted laparoscopic radical hysterectomy) which following laparoscopic staging ideally combines advantages of vaginal and laparoscopic approach after comprehensive staging [56]. In the current chapter we analyze the results of LARVH and describe the rationale for its modification into VALRH together with surgical and early oncologic data.

Laparoscopic Assisted Radical Vaginal Hysterectomy (LARVH)

Technique

For LARVH the patient is placed in deep Trendelenburg position (30°) with straight legs. After pneumoperitoneum is obtained five trocars are placed: a 10 mm trocar through the umbilicus, an additional 10 mm trocar in the left mediolavicular line two fingers above the umbilicus and three 5 mm trocars in the lower abdomen 2–3 cm below the umbilicus level bilaterally to the epigastric arteries and in the midline suprapubically. After careful inspection of the abdominopelvic cavity to rule out intraabdominal spread cytology is taken from the cul de sac. If present, adhesions are taken down.

The LARVH procedure can be subdivided into three steps: (1) laparoscopic lymphadenectomy and preparation of the vaginal part (2) radical vaginal hysterectomy and (3) relaparoscopy to control for haemostasis. Technique is described in detail by Roy and Plante [57].

During the first step paravesical as well as pararectal spaces are opened widely. After getting proof of tumor free lymph nodes from frozen section dissection, coagulation, and cutting of uterine arteries at their origin from the internal iliac artery is performed and the infundibulopelvic or ovarian proprium ligament are transected. The bladder peritoneum is now incised and the bladder separated from the uterine cervix down to the level of upper vagina in order to exclude involvement.

For the vaginal part the patient is placed in lithotomy position with hyperextended legs. A vaginal cuff is created by grasping the vaginal mucosa with six straight Kocher clamps 2 cm away from the lesion, depending on tumor size and location (Fig. 124.2). Diluted epinephrine solution is injected between clamps for haemostasis and aquadissection.

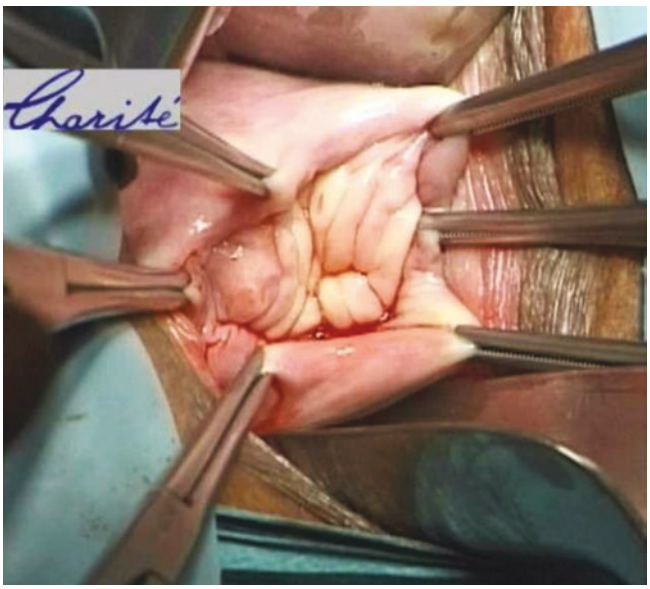


Fig. 124.2 Creation of tumor-adapted vaginal cuff

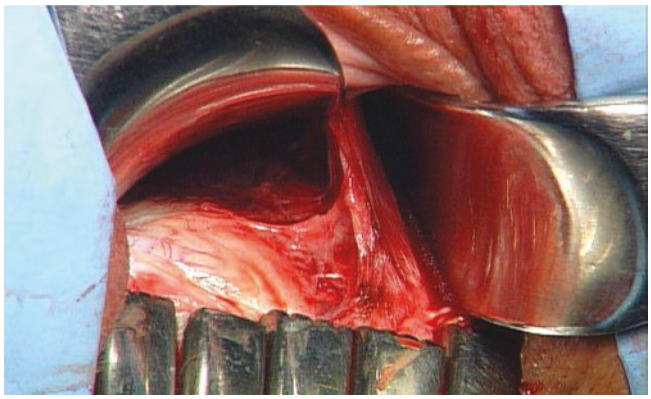


Fig. 124.3 The left bladder pillar limited by the paravesical space laterally and the vesico-cervical space medially

The vagina is now incised outside the clamps and the resulting vaginal cuff is closed with a running suture. Thus, the tumor is always covered. The vaginal cuff is put under tension using serrated clamps or Chrobak clamps. The vesico-cervical space is opened. The left paravesical space is accessed by placing a Kocher clamp at 1 o'clock and 3 o'clock at the transected vaginal mucosa and blunt dissection along the vaginal fascia using strongly curved scissors. Breisky specula are placed into the vesicovaginal and paravesical space. The tissue between both spaces, the bladder pillar, contains uterine vessels and ureter (Fig. 124.3).

Identification and dissection of the ureter is the key step of the operation. The bladder pillar is put under tension in order to facilitate dissection. The ureter is felt as a cord-like structure massaging the bladder pillar against the upper end of a pair of tweezers placed into the paravesical space (click-maneuver). Now, after the ureter has been

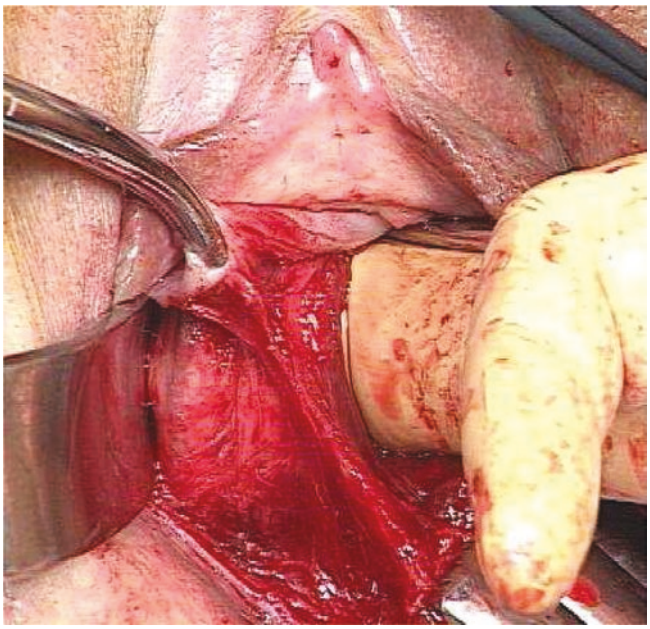


Fig. 124.4 Identification of the right ureter by click-maneuver

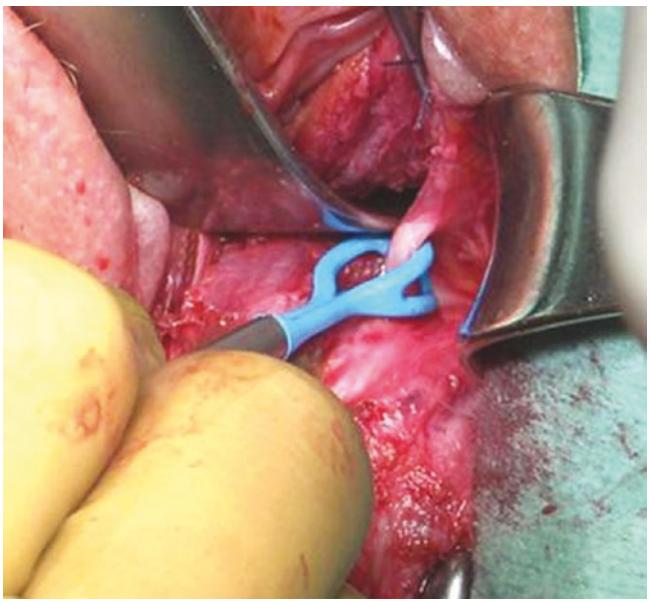


Fig. 124.5 Isolation of the left ureter

localized, the infraureteric bladder pillar is transsected (Fig. 124.4).

The ureter is now visualised by separating medial and lateral leaf of the bladder pillar and grasped with a silicone-covered Babcock clamp. The ureter can be secured with a silicone band and the ureteral tunnel is opened. The same procedure is carried out contralaterally (Fig. 124.5).

The cul-de-sac is opened, the peritoneum covering the rectovaginal ligament is incised, and the rectum is pushed down bluntly. Dissection and ligation of paracolpium and

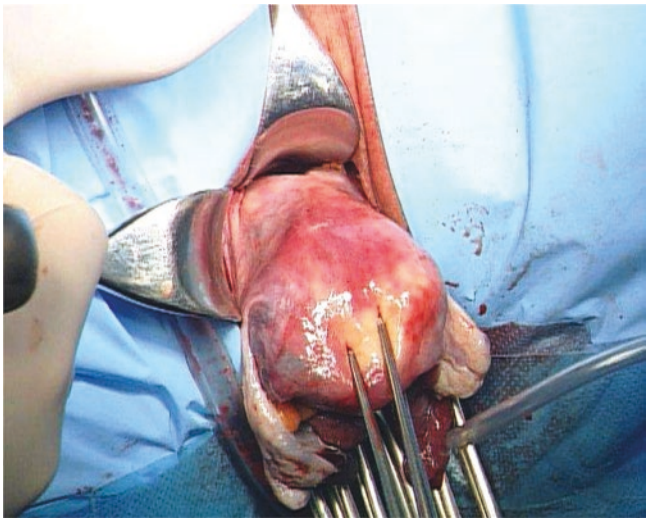


Fig. 124.6 Doederlein maneuver

distal rectovaginal ligaments are the next steps which are made easier by inverting the uterus (Döderlein-maneuver) in order to get more tension on the parametrium (Fig. 124.6).

The remaining parametrium is now transsected and ligated under permanent visualization of the course of the ureter. For a type III procedure the ureter is isolated completely from the bladder pillar, for a type II procedure only the medial part of the parametrium is transsected. Once the specimen is removed (Fig. 124.7a, b) the vagina is closed with interrupted sutures and a Foley catheter is placed again into the bladder. After this patient is repositioned for laparoscopy with extended legs in order to control haemostasis and place pelvic drain(s) (Table 124.1).

Table 124.1 Technique of LARVH step by step

Laparoscopy for:	Radical pelvic (and paraaortic) lymphadenectomy
	Opening of the para-rectal and para-vesical spaces
	Distal and proximal parametrectomy
	Section of the uterine arteries
	Section of the infundibulo-pelvic ligaments (when indicated)
Vaginal surgery for:	Vaginal cuff preparation
	Opening of the vesico-uterine space
	Opening of the para-vesical space
	Identification and dissection of the ureter
	Opening of the posterior cul de sac
	Section of the paracolpos and proximal parametrium
	Removal of the uterus
	Closure of the vagina
Laparoscopy for:	Verification of hemostasis

According to Renaud et al. [47]

Operative Results

Up to date operative data from more than 1000 operations are available (Table 124.2).

Conversion rate of planned LARVH varies between 0 and 16 %. Despite significant lower blood loss compared to abdominal radical hysterectomy transfusion rates are still considerably high (Table 124.3). Number of harvested lymph nodes is appropriate between 13 and 28. However, average operation time for LARVH is still long (Table 124.4). A number of possible intra- andapostoperative

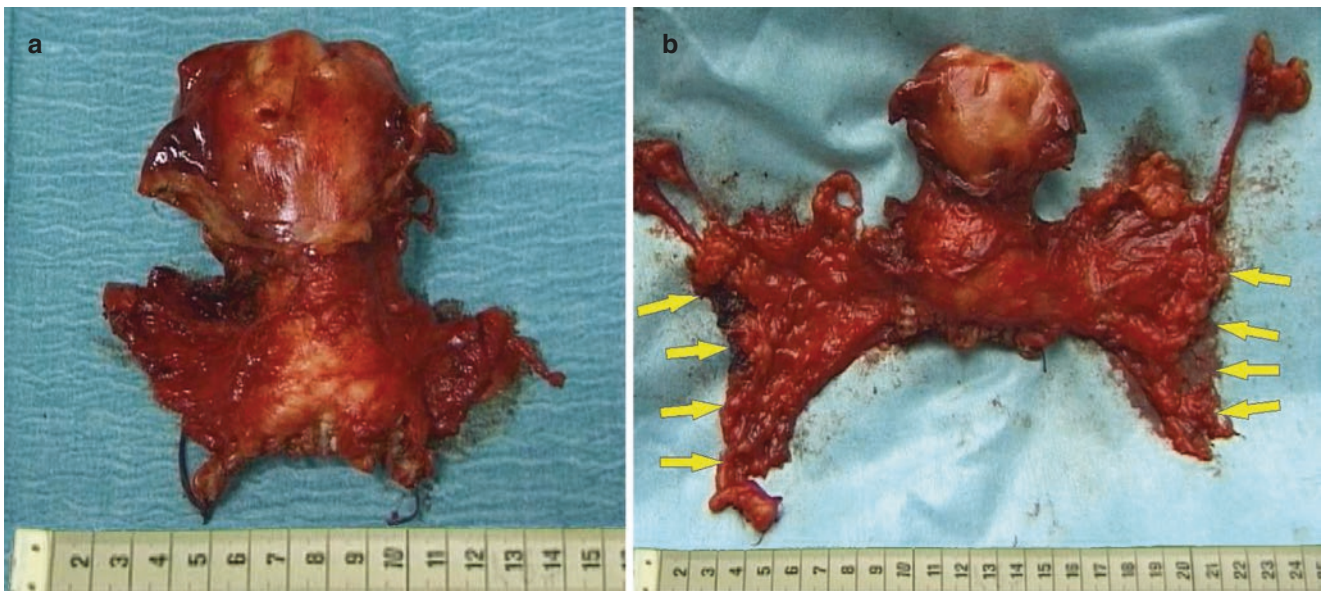


Fig. 124.7 (**a**) Specimen after type II LARVH. (**b**) Specimen after type III LARVH

Table 124.2 Numberf patients and tumor stages treated by LARVH

		Patients	Stage
Querleu	1993 [6]	8	IA2-IIB
Nezhat	1993 [42]	19	IA2-IIA
Lee	1997 [41]	24	IA-IIA (using ureteral stents)
Sardi	1999 [14]	56	IA2-IIB
Renaud	2000 [47]	57	IA2-IIA
Park	2002- [13]	52	IB1 <3 cm
Holub	2003 [46]	5	IA2 (using ultracision)
Hertel	2003 [15]	200	IA1 L1-IV
Steed	2004 [25]	71	IA1-IB2
Nam	2004 [26]	84	IA1-IB1 <2 cm
Jackson	2004 [43]	57	IA2-IB2
Sharma	2006 [28]	27	only IB1
Morgan	2007 [45]	30	IA-IB
Marchiole	2007 [44]	139	I – IIA
Mehra	2010 [37]	53	≤IB1
Pahisa	2010 [18]	67	IA2-IIA
Naik	2010 [12]	7	IB1<2 cm
Lee	2010 [33]	139	IA2-IIA
		Σ = 1095	**Different stages**

Table 124.3 Conversion rate, blood loss and transfusion rate of LARVH

		Conversions	Blood loss	Transfusion rate
Querleu [6]	1993	No	300 cc	24 %
Nezhat [42]	1993	1× (5.2 %)	200 cc	
Lee [41]	1997	No	540 cc	
Sardi [14]	1999	9× (16 %)		
Renaud [47]	2000	2× (3.5 %)	300 cc	4 %
Park [13]	2002	2× (3.8 %)		58 %
Holub [46]	2003	No		
Hertel [15]	2003	1× (0.5 %)		19.2 %
Steed [25]	2004	No	300 cc	7 %
Nam [26]	2004		↓Hb 1.7 g/dl	
Jackson [43]	2004	5× (8.7 %)	350 cc	16 %
Sharma [28]	2006		479 cc	5.8 %
Morgan [45]	2007	2× (6.7 %)		16.7 %
Marchiole [44]	2007			17.3 %
Mehra [37]	2010	No		
Pahisa [18]	2010	Blood loss + transfusion rate sign. Lower than abd. rad. HE		
Naik [12]	2010	2×	400 cc	
Lee [33]	2010		666 cc	44 %

complications can be encountered in LARVH (Tables 124.5 and 124.6) [53]. The rate of intra- and postoperative urologic complications is quite high [58]. Interestingly, there haven't been any new major series on LARVH published since 2010.

Table 124.4 OR-time and number of lymph nodes in patients undergoing LARVH

		OR-Time (min)	Hospital stay (days)	Lymph nodes
Querleu [6]	1993	283	5	13
Nezhat [42]	1993	315	2.1	22 (6 aort)
Lee [41]	1997	325	8.2	13
Sardi [14]	1999	267	4	17
Renaud [47]	2000	270	5	27 (3 aort)
Park [13]		380		28 (22 aort)
Hertel [15]	2003	333	14	22 (8 aort)
Steed [25]	2004	210	1	
Nam [26]	2004	232	10–15	26
Jackson [43]	2004	180	5	15
Sharma [28]	2006	160	5	24
Morgan [45]	2007	187	5.9	15
Marchiole [44]	2007	187		17
Mehra [37]	2010	210	5	23
Pahisa [18]	2010			15
Naik [12]	2010	180		
Lee [33]	2010	231		16

Table 124.5 Spectrum of possible perioperative complications in LARVH

Intraoperative Laparoscopic procedure	Trocar site injury (superficial epigastric vessels) Bowel injury Injury to the iliac vessels and obturator nerve Injury to the ureter
Intraoperative Vaginal procedure	Injury to the bladder and/or the ureter Hemorrhage from parametrial resection
Postoperative	Hemorrhage, Hematoma Pelvic abscess Lymphocysts Urinary fistulae (bladder or ureter) Bladder atony Vulvar edema

Oncologic Results

Available results clearly demonstrate oncologic equality to open radical hysterectomy especially in patients with tumors ≤4 cm (Table 124.7) [3].

Learning Curve

Intraoperative complication rate and operation time for LAVRH depend mainly on the skill and experience of the surgeon. Hertel et al. could demonstrate a significant reduction of complications after 100 operations [15], whereas Pahisa et al. and Sardi et al. see 20 operations as sufficient to familiarize with this technique

Table 124.6 Complications associated with LARVH procedure

		Total (%)	Intraop (%)	Postop (%)	Urologic
Querleu [6]	1993				
Nezhat [42]	1993				
Lee [41]	1997				
Sardi [14]	1999	8.5			1× ureter, 1× hydronephrosis
Renaud [47]	2000		7	10	3× bladder (5 %)
Park [13]	2002	7.7			2× ureter injury, 2× ureter stenosis
Holub [46]	2003				
Hertel [15]	2003	6	8		intra: bladder 7 %, ureter 3.5 % post: fistula 1 %, stenosis 3.5 %
Steed [25]	2004	13			7× bladder, 1× ureter injury, 2× ureteral fistula
Nam [26]	2004		21.6	25.5	1× bladder, 1× ureter stenosis, 1× ureter fistula
Jackson [43]	2004	8			3× bladder (6 %)
Sharma [28]	2006	22			4× urinary tract (15 %)
Morgan [45]	2007	13			Fistula (6.7 %)
Marchiole [44]	2007	5.8	19.4		2× bladder, 3× ureter, 4× fistula
Mehra [37]	2010				No fistula, no bladder or ureter injury, 12 % persistent voiding problems
Pahisa [18]	2010				6 % bladder, or ureter injury intraop
Lee [33]	2010		6	15	(mainly urologic)

Table 124.7 Oncologic results after LARVH

		Follow-up (min)	Recurrences	
Querleu [6]	1993	24	12	
Nezhat [42]	1993			
Lee [41]	1997			
Sardi [14]	1999	47	7.1 %	OS IA1 100 %, IB1 88 %
Renaud [47]	2000	36	4 %	
Park [13]	2002		3.8 %	
Holub [46]	2003			
Hertel [15]	2003	40		5y-OS 83 %, IB1 98 %
Steed [25]	2004			5y-RFS 94 %
Nam [26]	2004	34	8.5 %	3y-PFS 97 % (<2 cm)
Jackson [43]	2004	52		OS 94 %
Sharma [28]	2006	34	7.4 %	
Morgan [45]	2007	31	6.7 %	(Equal to abd. rad. hyst)
Marchiole [44]	2007	113	3.5 %	OS 95 %
Mehra [37]	2010	41		OS 89 %
Lee [33]	2010	92		DSF 91 % OS 93 %

[14, 18] The learning curve for the vaginal part has never been analysed separately, but in our own experience approximately 50 procedures are necessary in order to master the (more difficult) transvaginal part of the operation. Pergialiotis et al. confirm in their review slow learning curve for LARVH [59].

Rationale for Modification

Even though LARVH is associated with an acceptable oncologic outcome the rate of intra – and postoperative problems, especially urologic complications, is higher compared to ARH and TLRH [15, 18, 25, 26, 33]. Moreover, the key part of this operation, which is the vaginal part, is difficult to teach [60]. Therefore reasons for modifying LARVH into VALRH are:

- the rate of urologic complications can be diminished
- comprehensive laparoscopic staging is mandatory to select appropriate patients for radical hysterectomy
- creation of vaginal cuff can be easier and oncologic adequate done by vaginal route
- there is no need for any uterine manipulator during all parts of surgery.
- sparing of the autonomic nerve supply for bladder, rectum and vagina easy and safe
- new technique should be easy to learn by fellows and residents.

Vaginal Assisted Laparoscopic Radical Hysterectomy (VALRH)

Technique

VALRH also consists of three parts: (1) laparoscopic staging including lymphadenectomy, to evaluate lymph node status, and dissection of vesicocervical and vesicovaginal septum to evaluate tumor relation to adjacent organs, (2) vaginal creation of a tumor-adapted cuff, and (3) laparoscopic radical parametrial resection.

For laparoscopic staging positioning of patient and trocar placement are identical to LARVH. Depending on tumor size pelvic (± paraaortic) lymphadenectomy is performed as previously described [4, 10]. During pelvic lymphadenectomy paravesical and pararectal spaces are opened. All lymph nodes removed are sent for frozen section. While waiting for frozen section result dissection of the bladder up to the level of the ventral vaginal wall is done. In case of lymph node metastasis radical hysterectomy is abandoned and patients are referred to primary chemoradiation. If frozen section reveals tumor free lymph nodes the patient is placed in lithotomy position with extended legs for the vaginal part.

The only aim of the vaginal part is to create a tumor-adapted cuff and to open vesicovaginal and rectovaginal spaces. In relation to tumor size an adequate length of vagina is grasped with six straight clamps (Fig. 124.8a, b). Diluted solution of epinephrine is injected under the vaginal mucosa for vasoconstriction followed by monopolar incision distally to the clamps. The vaginal cuff is now closed with a continuous suture (Fig. 124.9a, b) and, thus, tumor is always covered to prevent spillage of cancer cells. With six serrated clamps tension is brought on the closed vaginal cuff in order to open the vesicocervical and rectovaginal spaces as well as the cul-de-sac. The most inferior part of the rectovaginal ligament is now transected bilaterally and the uterus can be pushed intraabdominally after removal of the serrated clamps (Fig. 124.10a, b). The vaginal stump is continuously sutured for haemostasis. Additionally, interrupted sutures are placed, but not knotted, for later closure of the vagina (Fig. 124.11a, b). To preserve pneumoperitoneum a moistened surgical towel is placed into the vagina.

For the third part of VALRH the patient is placed again into Trendelenburg position with straight, slightly abducted legs. Now the parametrium is getting resected. As a result of the vaginal route both bladder pillars and the transsected vagina are easy to identify (Fig. 124.12a, b). The operation starts by coagulation and transection of the uterine vessels at

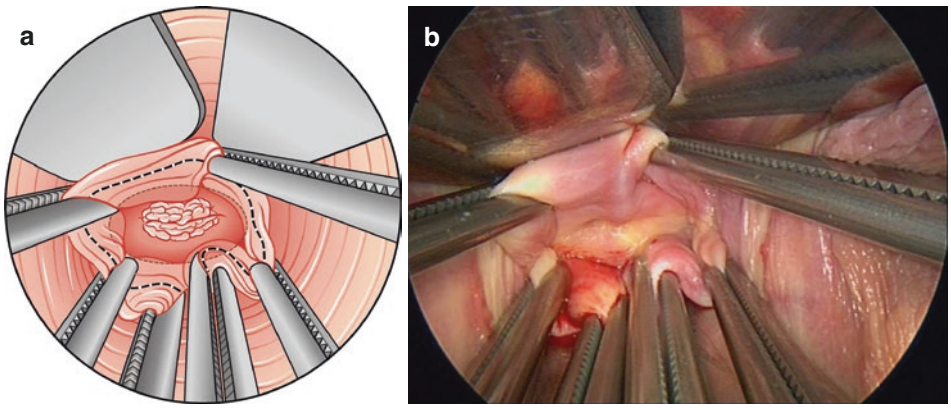


Fig. 124.8 (**a**, **b**) Creation of vaginal cuff

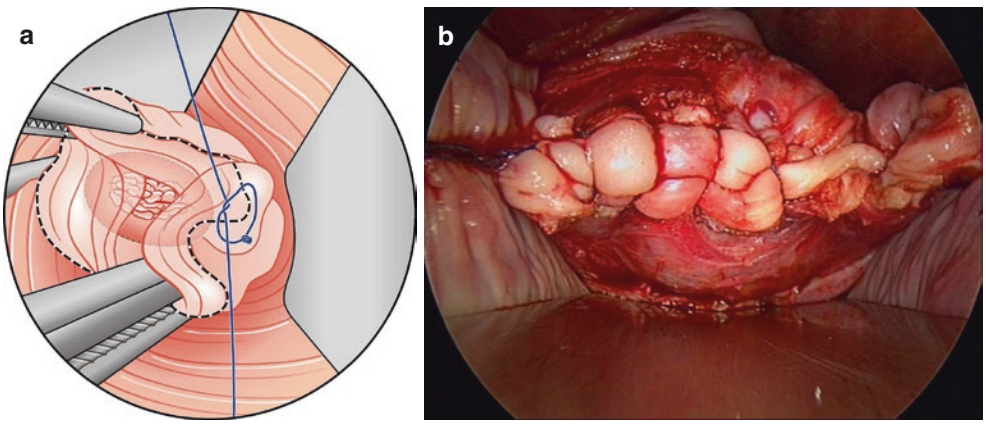


Fig. 124.9 (**a**, **b**) Closure of the vaginal cuff with a continuous suture

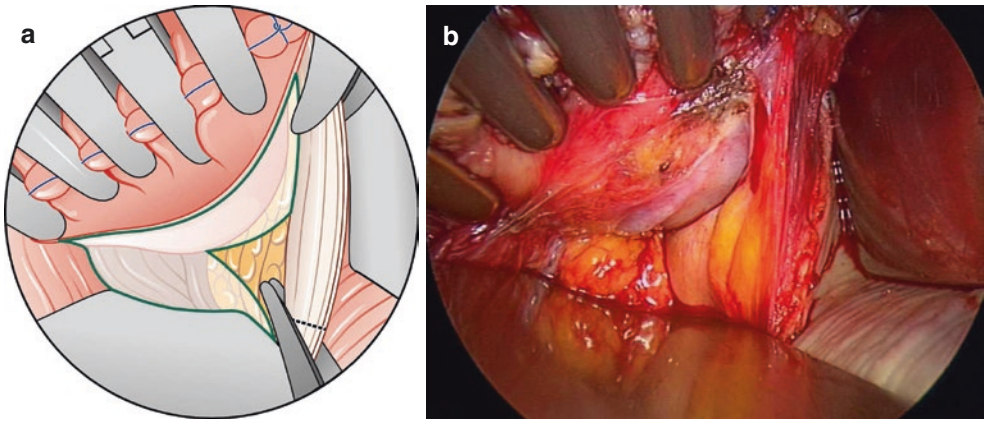


Fig. 124.10 (**a**, **b**) Transsection of distal rectovaginal ligament after opening of cul-de- sac

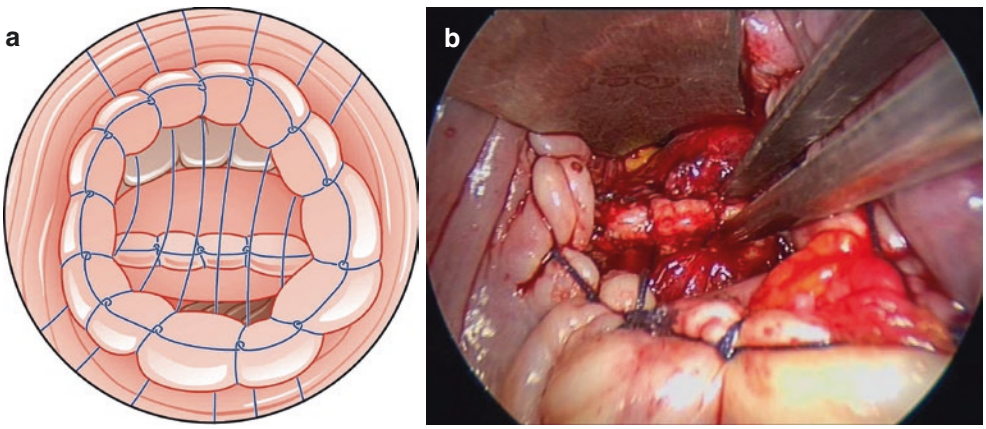


Fig. 124.11 (**a**, **b**) Vaginal margin is covered by a continuous suture. Six sutures are placed but not knotted for later closure of the vagina. Uterus with closed vaginal cuff is pushed intraabdominally.

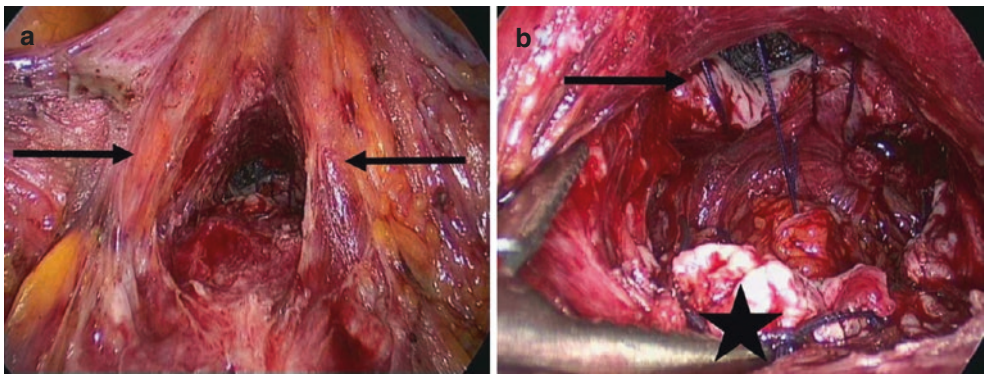


Fig. 124.12 (**a**, **b**) Laparoscopic situs after vaginal part. (**a**) Intraoperative situs after vaginal part. Both bladder pillars (*arrows*) are under tension. Vesicocervical and vesicovaginal septum are completely dissected. (**b**) Magnified view between bladder pillars to transsected vagina (*arrow*) and closed vaginal cuff (*star*)

their origin from the internal iliac vessels (Fig. 124.13a, b). In case of salpingoophorectomy the infundibulopelvic ligaments are coagulated and cut. By pulling the vascular part of the cardinal ligament medially, the ureter is freed out of its tunnel up to it's entry into the bladder. Now the remaining part of the paracervix is identified, coagulated, and transected under permanent visualisation of the ureter (Fig. 124.14a, b). For nerve spearing plexus pelvicus as well as nervi splanchnici and hypogastrici are separated and preserved. The suture of the vaginal cuff is easy to identify and marks the endpoint of resection. The specimen is removed transvaginally and the vagina is now closed using the preplaced interrupted sutures (Fig. 124.15). Finally hemostasis is verified and a suprapubic catheter and drain(s) are placed. Radicality of parametrial resection in correlation to tumor size according to a type II (B) or type III (C) radical hysterectomy is chosen by the surgeon intraoperatively. No uterine manipulator is used at any time.

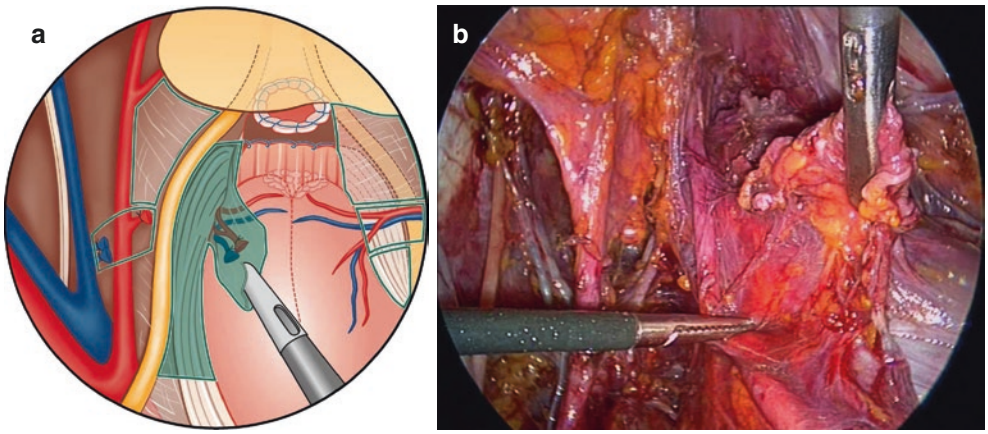


Fig. 124.13 (**a**, **b**) Transsection of uterine vessels and bladder pillar. The transsection area in a type II (**b**) procedure is marked in *green*

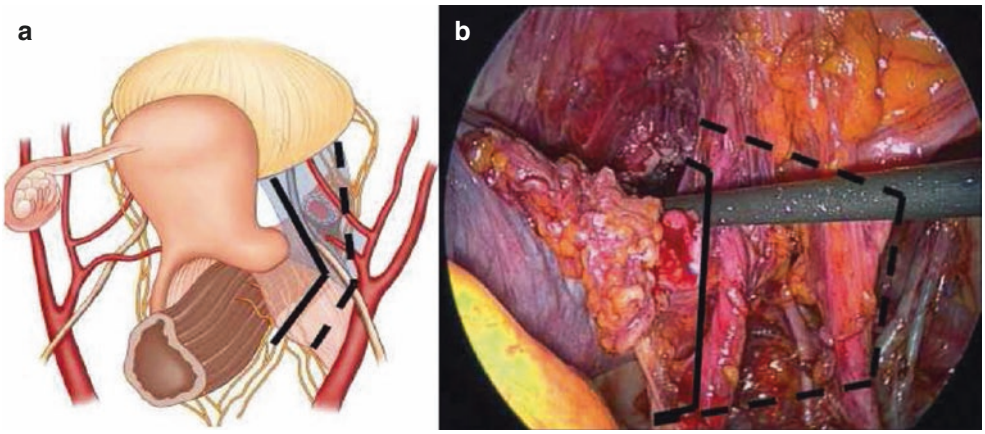


Fig. 124.14 (**a**, **b**) Tailoring of parametrial resection



Fig. 124.15 Postoperative specimen after type II (B) procedure. Vaginal cuff is marked with continuous *arrow*, parametria with *interrupted arrows*

Operative Results

Up to now the retrospective series of VALRH by our team comprising 122 patients has been the largest published with respect to VALRH [61]. Indications for VALRH were histologically proved cervical cancer (n = 109) or endometroid endometrial cancer stage II (n = 12). One patient requested to undergo radical hysterectomy type B in case of extensive CIN III lesion not completely resected by conization (Table 124.8).

All 122 patients underwent VALRH without conversion to laparotomy. Type II (B) and type III (C) operations were performed in 82 and 40 patients, respectively. VALRH was combined with pelvic lymphadenectomy in 37 patients, and with pelvic and paraaortic lymphadenectomy in 85 patients. Mean operating time was 301 min. Operation time was nearly identical for type B and C procedures. Duration of surgery differed significantly in two patients, one with infiltrative sigmoid endometriosis, who had to undergo simultaneously bowel resection (operating time 665 min) and one patient with a BMI of 46 (605 min).

The median number of lymph nodes harvested was 36 (4–83) with 21 (4–43) pelvic and 15 (2–36) paraaortic lymph nodes. One patient (cervical cancer pT1a2 N0 L0 V0 R0) opted for sentinel lymph node dissection only and four sentinel lymph nodes were removed, which were tumor free on histology (Table 124.9).

There was not a single intraoperative complication, especially neither bladder nor ureter injury. Mean blood loss was 123 cc (10–400). One patient required blood trans-

Table 124.8 Patient's characteristics

Number of women	122
Age	47 (27–82)
BMI (kg/m^2)	24.9 (17.3–46.3)
Parity	2 (0–6)
Histology	
Adenocarcinoma cervix	40 (32.8 %)
Squamous cell carcinoma cervix	67 (54.9 %)
Neuro-endocrine cervical carcinoma	2 (1.7 %)
CIN III	1 (0.8 %)
Endometrial cancer (diagnosed by D&C)	12 (9.8 %)

Table 124.9 Operative data

VALRH VALRH type II (B) VALRH type III (C)	n = 122 n = 82 n = 40
Operation time in min	301 (175–655)
Blood loss in cc	123 (10–400)
Median nodal yield (nodes) Pelvic Paraaortic	36 (4–83) 21 (4–43) 15 (2–36)
Median time to urine residuals <50 cc (days)	7.9 (2–40)
Median hospital stay (range)	10.4 (4–31)

fusion due to stress-induced cardiomyopathy and two patients due to preoperative anemia on demand of the anaesthesiologists. Postoperative complication rate was 13.1 % (Table 124.10). No patient required postoperative referral to an urogynaecologist for postoperative bladder dysfunction and only one patient needed longer than 25 days to void her bladder adequately. Median time to urine residuals < 50 cc was 7.9 days. Four patients had to undergo re-laparoscopy; one due to lost drainage, two for suspected ileus (which could not be verified intraoperatively), and one for chylascos. Histologically parametrial and vaginal resection with sound margins was confirmed in all patients. The majority of patients with proven cervical cancer were found to have FIGO stage IB1 (75.5 %). In 6 patients (5.5 %) final pathology revealed parametrial involvement. Histological types were distributed as follows: squamous cell carcinoma 60.9 %, adenocarcinoma 36.4 %, and neuro-endocrine carcinoma 1.8 % (Table 124.11). Five out of 110 (4.5 %) patients with cervical cancer had positive micrometastases/metastases in the final histopathological examination undetected by frozen section.

Up to now we have performed more than 400 VALRH with only one intraoperative bladder injury. Operation time decreased to 235 min and blood loss to less than 50 cc. There is no need to ask for banked blood anymore.

Table 124.10 Perioperative complication rates

Number of patients	n = 122
Blood transfusions	3 (not surgically related)
Intraoperative complications	0
Postoperative complications	16 (13.1 %) 4 re-laparoscopies 2× for suspected ileus 1× for lost drainage 1× for chylascos 2 pulmonary embolism in CT scan (without clinical evidence) 3 ureterovaginal fistula 1 vaginal suture dehiscence 1 cardiomyopathy 1 symptomatic lymphocele 4 fever 2× unknown reason 1× colitis ulcerosa 1× UTI (E.coli)

Oncologic Results

Postoperative adjuvant therapy (radiation, chemotherapy, chemoradiation) was recommended for 30/122 patients (24.6 %), 8 with endometrial cancer and 22 with cervical cancer. Recommendation for adjuvant chemoradiation or chemotherapy was given for cervical cancer patients with proved high risk factors (N1, stage IIB) or the combination of two intermediate risk factors (tumor size > 4 cm, LVSI, adenocarcinoma, G3, deep stromal invasion). In 2 out of 122 patients neuro-endocrine tumor was found which was treated according to a multimodal protocol.

Only one patient (0.9 %) underwent vaginal brachytherapy based on surgical result (close vaginal margin of 5 mm). Individualized protocols were performed in two patients: one patient with cervical cancer stage Ib2 was treated by neoadjuvant chemotherapy, VALRH and postoperative chemoradiation, another patient received brachytherapy due to grading 3. In one patient with ovarian metastasis six cycles of platin-based chemotherapy were administered. Two patients denied recommended chemoradiation. After a median follow up of 19 months (4–40) the total recurrence rate in the entire cohort is 6.7 % (8/120), for cervical cancer patients 6.4 % (7/110), and for endometrial cancer 8.3 % (1/12), respectively. DFS and OS for all 110 cervical cancer patients are 93.5 % and 98.1 %, for the subgroup of patients (n = 90) with tumors ≤ pT1b1 N0 V0 L0/1 R0 96.7 % and 97.8 %, respectively.

Learning Curve

The learning curve was not separately analyzed in our initial study because VALRH had to be standardized for 25

Table 124.11 Histologic results after VALRH

Cervical cancer n = 110	No (%)	Endometrial cancer n = 12	No (%)
Postoperative stage		Postoperative stage (new FIGO system)	
CIN III	1 (0.9)	1 A	9 (75)
IA1 L1	10 (9.1)	1B	1 (8.3)
IA2	5 (4.5)	2B	2 (16.7)
1B1	83 (75.5)		
ypT1B1	2 (1.8)		
1B2	2 (1.8)		
IIA	1 (0.9)		
IIB	6 (5.5)		
Grading		Grading	
1	14 (12.7)	1	4 (33.3)
2	61 (55.5)	2	8 (66.7)
3	27 (24.5)	3	0 (0)
unknown	8 (7.3)		
Histologic type			
CIN III	0.9 %		
Adenocarcinoma	60.9 %		
Squamous cell carcinoma	36.4 %		
Neuroendocrine carcinoma	1.8 %		
Lymphangiosis (L)		Lymphangiosis	
no	85 (77.3)	No	11 (91.7)
yes	25 (22.7)	Yes	1 (8.3)
Hemangiosis (V)		Hemangiosis	
no	103(93.6)	No	12 (100)
yes	7 (6.4)	Yes	0 (0)

operations and one side of lymphadenectomy and parametrial resection was performed by a resident or fellow. However, from 2007 to 2009 operating time decreased for VALRH type II and III from 317 to 268 min and from 345 to 303 min, respectively [61]. However, major advantages of the new technique compared to LARVH are easier standardisation reproducibility, less urologic complications and better preservation of the autonomic nerve-supply.

Comparison LARVH and VALRH

In a recently published match-pair analysis of our results from 109 patients with cervical cancer stage IA1 L1 to IIB who underwent VALRH compared to 200 patients after LARVH we could demonstrate a significant lower rate of blood transfusions, earlier resumption of bladder function and earlier discharge from hospital for the VALRH cohort. There was no intraoperative complication in the VALRH group compared to 7 % during LARVH. More importantly there was no difference in oncologic results [62].

Discussion

Today various techniques of radical hysterectomy are described: abdominal, laparoscopic assisted vaginal, total laparoscopic, robotic assisted, and vaginal assisted laparoscopic. LARVH was the first innovative technique in this field. Benefits of LARVH compared to abdominal radical hysterectomy include less blood loss, lower postoperative morbidity, shorter hospital stay, better cosmetic result, and earlier recovery after surgery. However, 20 years later it is time for a critical stock taking.

Three main criteria are used to evaluate and compare different techniques of radical hysterectomy: (1) possibility to triage patients and therefore avoid combined use of operation and chemoradiation, (2) complication rate and (3) oncologic outcome. Comprehensive operative staging including pelvic ± paraaortic lymphadenectomy is the key step to differentiate patients, who rather benefit from radical surgery from those, who are better treated by primary chemoradiation [9]. TLRH, RRH, LARVH, and VALRH offer the possibility to start with lymph node dissection (± sentinel node) and frozen section. We have abandoned radical hysterectomy in case of positive lymph nodes. However, frozen section

was not accurate in 4 out of 110 (3.6 %) patients with cervical cancer in our VALRH series. Bader et al. reported a false negative rate for frozen sections of up to 17 % [63].

Most published retro- or prospective studies on radical hysterectomy include cervical cancer patients with stages IA1 L1 – IIA (B) and only few patients with higher stages. This is in concordance with our study population of VALRH. Conversion rates are described in up to 5 %, 10 %, and 16 % for RRH, TLRH and LARVH, respectively. None of our planned VALRH-procedures had to be converted to open approach. ARH, LARVH, and our new technique of VALRH are done without any manipulator to create an adequate vaginal cuff, whereas all TLRH and RRH require a manipulator or sponge in the vagina. In our opinion creation of a vaginal cuff by transvaginal approach is easier and possible tumor distribution due to manipulator use is avoided [64]. With the described technique of VALRH, we are able to resect tumor always in sound vaginal margins in contrast to studies of ARH, TLRH and RRH where up to 20 % of positive vaginal margins are reported [16].

Blood loss in VALRH is low compared to ARH und LARVH and in the lower range of TLRH and RRH. In our series transfusion was given to only three patients, where the cause was not intraoperative blood loss. Operation time of 300 min in our VALRH series is in the range of LARVH but longer than the average time for ARH, TLRH, and RRH and therefore still a major argument against combined vaginal-laparoscopic techniques. However, one must consider that 85 out of 122 (69 %) of our patients in addition to VALRH also underwent paraaortic lymph node dissection with a duration of approximately 60 min. After more than 400 VALRH procedures mean operative time decreased to less than 4 h. The majority of radical hysterectomies in the literature are combined with pelvic lymph node dissection exclusively. Subsequently the mean number of harvested lymph nodes (n = 36) in our VALRH-cohort is in the upper range of all described studies and higher than in studies using open surgery.

Rate of operative complications is a major issue evaluating different types of radical hysterectomy. Intraoperative complications occur in 4 %–12.5 %, 0 %–11.8 %, 5.9 %–13.2 % and 0 %–14 % in ARH, TLRH, LARVH, and RRH, respectively. There was no one intraoperative complication in our study and in the extension of our experience to 400 patients only one patient with intraoperative bladder injury. Also postoperative complication rate after VALRH (13.1 %) is in the lower range of published data. Especially urologic intra – and postoperative complications are significantly lower compared to LARVH or TLRH [15] probably due modifying the vaginal part of the operation.

Oncologic data are difficult to compare because of different follow-up intervals and various oncologic cornerstones. Summarizing data from open, laparoscopic, laparoscopic-vaginal, and robotic series recurrence rates vary between of 0 and 13 %, and DFS between 82 and 100 % and OS between 89 and 100 %. Despite a relative short follow up of 19 months our DFS rate of 94 % and OS rate of 98 % for VALRH are promising. However, longer follow up is mandatory to confirm this observation.

In conclusion our new technique of VALRH is an oncologic valid alternative to ARH, LARVH, TLRH, and RRH in patients with cervical cancer FIGO stage < IB2 with low blood loss and few intraoperative complications. During the vaginal part of the operation it is always possible to create an adequate vaginal cuff and to avoid tumor spillage and disregard the use of any manipulators. LARVH should be replaced by VALRH due to less urologic complications, easier nerve-sparing and better teaching ability. The only argument for a gynecologic oncologist to continue with LARVH is to get familiar with its vaginal part to be able to perform radical vaginal trachelectomy or in special patients radical vaginal hysterectomy [65]. Further studies comparing the VALRH technique with other types of radical hysterectomies are necessary to underline the promising results of our monoinstitutional series.

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References

1. Schauta F. Die erweiterte vaginale Totalexstirpation des Uterus bei Kollumkarzinom. Wien/Leipzig: Josef Safár; 1908.
2. Wertheim E. Die erweiterte abdominale Operation bei Carcinoma colli uteri (auf Grund von 500 Fällen). Zentralblatt für Gynäkologie. 1911.
3. Dargent D, Salvat J. Envahissement ganglionaire pelvien: place de la pelviscopie retro-peritoneale. Paris: Medsi McGraw-Hill; 1989.
4. Querleu D, Leblanc E, Castelain B. Laparoscopic pelvic lymphadenectomy in the staging of early carcinoma of the cervix. Am J Obstet Gynecol. 1991;164(2):579–81.
5. Dargent D, Mathevet P. Radical laparoscopic vaginal hysterectomy. J Gynecol Obstet Biol Reprod (Paris). 1992;21(6):709–10.
6. Querleu D. Laparoscopically assisted radical vaginal hysterectomy. Gynecol Oncol. 1993;51(2):248–54.
7. Canis M, Mage G, Wattiez A, Pouly JL, Manhes H, Bruhat MA. Does endoscopic surgery have a role in radical surgery of cancer of the cervix uteri? J Gynecol Obstet Biol Reprod (Paris). 1990;19(7):921.
8. Nezhat CR, Burrell MO, Nezhat FR, Benigno BB, Welander CE. Laparoscopic radical hysterectomy with paraaortic and pelvic node dissection. Am J Obstet Gynecol. 1992;166(3):864–5.
9. Landoni F, Maneo A, Colombo A, Placa F, Milani R, Perego P, et al. Randomised study of radical surgery versus radiotherapy for stage Ib-IIa cervical cancer. Lancet. 1997;350(9077):535–40.
10. Kohler C, Klemm P, Schau A, Possover M, Krause N, Tozzi R, et al. Introduction of transperitoneal lymphadenectomy in a gynecologic oncology center: analysis of 650 laparoscopic pelvic and/or paraaortic transperitoneal lymphadenectomies. Gynecol Oncol. 2004;95(1):52–61.

11. Obermair A, Gebski V, Frumovitz M, Soliman PT, Schmeler KM, Levenback C, et al. A phase III randomized clinical trial comparing laparoscopic or robotic radical hysterectomy with abdominal radical hysterectomy in patients with early stage cervical cancer. J Minim Invasive Gynecol. 2008;15(5):584–8.
12. Naik R, Jackson KS, Lopes A, Cross P, Henry JA. Laparoscopic assisted radical vaginal hysterectomy versus radical abdominal hysterectomy – a randomised phase II trial: perioperative outcomes and surgicopathological measurements. BJOG. 2010;117(6):746–51.
13. Park CT, Lim KT, Chung HW, Lee KH, Seong SJ, Shim JU, et al. Clinical evaluation of laparoscopic-assisted radical vaginal hysterectomy with pelvic and/or paraaortic lymphadenectomy. J Am Assoc Gynecol Laparosc. 2002;9(1):49–53.
14. Sardi J, Vidaurreta J, Bermudez A, di Paola G. Laparoscopically assisted Schauta operation: learning experience at the Gynecologic Oncology Unit, Buenos Aires University Hospital. Gynecol Oncol. 1999;75(3):361–5.
15. Hertel H, Kohler C, Michels W, Possover M, Tozzi R, Schneider A. Laparoscopic-assisted radical vaginal hysterectomy (LARVH): prospective evaluation of 200 patients with cervical cancer. Gynecol Oncol. 2003;90(3):505–11.
16. Estape R, Lambrou N, Diaz R, Estape E, Dunkin N, Rivera A. A case matched analysis of robotic radical hysterectomy with lymphadenectomy compared with laparoscopy and laparotomy. Gynecol Oncol. 2009;113(3):357–61.
17. Li G, Yan X, Shang H, Wang G, Chen L, Han Y. A comparison of laparoscopic radical hysterectomy and pelvic lymphadenectomy and laparotomy in the treatment of Ib-IIa cervical cancer. Gynecol Oncol. 2007;105(1):176–80.
18. Pahisa J, Martinez-Roman S, Torne A, Fuste P, Alonso I, Lejarcegui JA, et al. Comparative study of laparoscopically assisted radical vaginal hysterectomy and open Wertheim-Meigs in patients with early-stage cervical cancer: eleven years of experience. Int J Gynecol Cancer. 2010;20(1):173–8.
19. Uccella S, Laterza R, Ciravolo G, Volpi E, Franchi M, Zefiro F, et al. A comparison of urinary complications following total laparoscopic radical hysterectomy and laparoscopic pelvic lymphadenectomy to open abdominal surgery. Gynecol Oncol. 2007;107(1 Suppl 1):S147–9.
20. Xu H, Chen Y, Li Y, Zhang Q, Wang D, Liang Z. Complications of laparoscopic radical hysterectomy and lymphadenectomy for invasive cervical cancer: experience based on 317 procedures. Surg Endosc. 2007;21(6):960–4.
21. Puntambekar SP, Palep RJ, Puntambekar SS, Wagh GN, Patil AM, Rayate NV, et al. Laparoscopic total radical hysterectomy by the Pune technique: our experience of 248 cases. J Minim Invasive Gynecol. 2007;14(6):682–9.
22. Nezhat FR, Datta MS, Liu C, Chuang L, Zakashansky K. Robotic radical hysterectomy versus total laparoscopic radical hysterectomy with pelvic lymphadenectomy for treatment of early cervical cancer. JSLS. 2008;12(3):227–37.
23. Chen Y, Xu H, Li Y, Wang D, Li J, Yuan J, et al. The outcome of laparoscopic radical hysterectomy and lymphadenectomy for cervical cancer: a prospective analysis of 295 patients. Ann Surg Oncol. 2008;15(10):2847–55.
24. Querleu D, Narducci F, Poulard V, Lacaze S, Occelli B, Leblanc E, et al. Modified radical vaginal hysterectomy with or without laparoscopic nerve-sparing dissection: a comparative study. Gynecol Oncol. 2002;85(1):154–8.
25. Steed H, Rosen B, Murphy J, Laframboise S, De Petrillo D, Covens A. A comparison of laparascopic-assisted radical vaginal hysterectomy and radical abdominal hysterectomy in the treatment of cervical cancer. Gynecol Oncol. 2004;93(3):588–93.
26. Nam JH, Kim JH, Kim DY, Kim MK, Yoo HJ, Kim YM, et al. Comparative study of laparoscopico-vaginal radical hysterectomy and abdominal radical hysterectomy in patients with early cervical cancer. Gynecol Oncol. 2004;92(1):277–83.
27. Spirtos NM, Eisenkop SM, Schlaerth JB, Ballon SC. Laparoscopic radical hysterectomy (type III) with aortic and pelvic lymphadenectomy in patients with stage I cervical cancer: surgical morbidity and intermediate follow-up. Am J Obstet Gynecol. 2002;187(2):340–8.
28. Sharma R, Bailey J, Anderson R, Murdoch J. Laparoscopically assisted radical vaginal hysterectomy (Coelio-Schauta): A comparison with open Wertheim/Meigs hysterectomy. Int J Gynecol Cancer. 2006;16(5):1927–32.
29. Gil-Moreno A, Puig O, Perez-Benavente MA, Diaz B, Verges R, De la Torre J, et al. Total laparoscopic radical hysterectomy (type II-III) with pelvic lymphadenectomy in early invasive cervical cancer. J Minim Invasive Gynecol. 2005;12(2):113–20.
30. Frumovitz M, dos Reis R, Sun CC, Milam MR, Bevers MW, Brown J, et al. Comparison of total laparoscopic and abdominal radical hysterectomy for patients with early-stage cervical cancer. Obstet Gynecol. 2007;110(1):96–102.
31. Ghezzi F, Cromi A, Ciravolo G, Volpi E, Uccella S, Rampinelli F, et al. Surgicopathologic outcome of laparoscopic versus open radical hysterectomy. Gynecol Oncol. 2007;106(3):502–6.
32. Maggioni A, Minig L, Zanagnolo V, Peiretti M, Sanguineti F, Bocciolone L, et al. Robotic approach for cervical cancer: comparison with laparotomy: a case control study. Gynecol Oncol. 2009;115(1):60–4.
33. Lee CL, Wu KY, Huang KG, Lee PS, Yen CF. Long-term survival outcomes of laparoscopically assisted radical hysterectomy in treating early-stage cervical cancer. Am J Obstet Gynecol. 2010;203(2):165.e1–7.
34. Chang WC, Lee LC, Huang SC, Sheu BC. Application of laparoscopic surgery in gynecological oncology. J Formos Med Assoc. 2010;109(8):558–66.
35. Pomel C, Atallah D, Le Bouedec G, Rouzier R, Morice P, Castaigne D, et al. Laparoscopic radical hysterectomy for invasive cervical cancer: 8-year experience of a pilot study. Gynecol Oncol. 2003;91(3):534–9.
36. Abu-Rustum NR, Gemignani ML, Moore K, Sonoda Y, Venkatraman E, Brown C, et al. Total laparoscopic radical hysterectomy with pelvic lymphadenectomy using the argon-beam coagulator: pilot data and comparison to laparotomy. Gynecol Oncol. 2003;91(2):402–9.
37. Mehra G, Weekes A, Vantrappen P, Visvanathan D, Jeyarajah A. Laparoscopic assisted radical vaginal hysterectomy for cervical carcinoma: morbidity and long-term follow-up. Eur J Surg Oncol. 2010;36(3):304–8.
38. Lee E, Kang H, Kim D. A comparative study of laparoscopic radical hysterectomy with radical abdominal hysterectomy for early-stage cervical cancer: a long-term follow-up study. Eur J Obstet Gynecol Reprod Biol. 2011;156(1):83–6.
39. Yan X, Li G, Shang H, Wang G, Han Y, Lin T, et al. Twelve-year experience with laparoscopic radical hysterectomy and pelvic lymphadenectomy in cervical cancer. Gynecol Oncol. 2011;120(3):362–7.
40. Vizza E, Pellegrino A, Milani R, Fruscio R, Baiocco E, Cognetti F, et al. Total laparoscopic radical hysterectomy and pelvic lymphadenectomy in locally advanced stage IB2-IIB cervical cancer patients after neoadjuvant chemotherapy. Eur J Surg Oncol. 2011;37(4):364–9.
41. Lee CL, Huang KG, Wang CW, Huang HY, Lai YM, Lai CH, et al. New approaches in laparoscopically assisted radical vaginal hysterectomy. Int Surg. 1997;82(3):266–8.
42. Nezhat CR, Nezhat FR, Burrell MO, Ramirez CE, Welander C, Carrodeguas J, et al. Laparoscopic radical hysterectomy and laparoscopically assisted vaginal radical hysterectomy with pelvic and paraaortic node dissection. J Gynecol Surg. 1993;9(2):105–20.

43. Jackson KS, Das N, Naik R, Lopes AD, Godfrey KA, Hatem MH, et al. Laparoscopically assisted radical vaginal hysterectomy vs. radical abdominal hysterectomy for cervical cancer: a match controlled study. Gynecol Oncol. 2004;95(3):655–61.
44. Marchiole P, Benchaib M, Buenerd A, Lazlo E, Dargent D, Mathevet P. Oncological safety of laparoscopic-assisted vaginal radical trachelectomy (LARVT or Dargent's operation): a comparative study with laparoscopic-assisted vaginal radical hysterectomy (LARVH). Gynecol Oncol. 2007;106(1):132–41.
45. Morgan DJ, Hunter DC, McCracken G, McClelland HR, Price JH, Dobbs SP. Is laparoscopically assisted radical vaginal hysterectomy for cervical carcinoma safe? A case control study with follow up. BJOG. 2007;114(5):537–42.
46. Holub Z, Lukac J, Kliment L, Urbanek S. Laparoscopically assisted modified radical vaginal hysterectomy (type II) with pelvic lymphadenectomy: ultrasonic operative technique. Eur J Gynaecol Oncol. 2003;24(5):391–2.
47. Renaud MC, Plante M, Roy M. Combined laparoscopic and vaginal radical surgery in cervical cancer. Gynecol Oncol. 2000;79(1):59–63.
48. Yu JJ, Yang WX, Wang XM. Laparoscopically-assisted radical vaginal hysterectomy with five years follow-up: a case-control study. Eur J Gynaecol Oncol. 2013;34:156–8.
49. Tinelli R, Malzoni M, Cosentino F, Perone C, Fusco A, Cicinelli E, et al. Robotics Versus Laparoscopic Radical Hysterectomy with Lymphadenectomy in Patients with Early Cervical Cancer: A Multicenter Study. Ann Surg Oncol. 2011;18(9):2622–8.
50. Nam EJ, Kim SW, Kim S, Kim JH, Jung YW, Paek JH, et al. A case-control study of robotic radical hysterectomy and pelvic lymphadenectomy using 3 robotic arms compared with abdominal radical hysterectomy in cervical cancer. Int J Gynecol Cancer. 2010;20(7):1284–9.
51. Schreuder HW, Zweemer RP, van Baal WM, van de Lande J, Dijkstra JC, Verheijen RH. From open radical hysterectomy to robot-assisted laparoscopic radical hysterectomy for early stage cervical cancer: aspects of a single institution learning curve. Gynecol Surg. 2010;7(3):253–8.
52. Persson J, Reynisson P, Borgfeldt C, Kannisto P, Lindahl B, Bossmar T. Robot assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy with short and long term morbidity data. Gynecol Oncol. 2009;113(2):185–90.
53. Sert B, Abeler V. Robotic radical hysterectomy in early-stage cervical carcinoma patients, comparing results with total laparoscopic radical hysterectomy cases. The future is now? Int J Med Robot. 2007;3(3):224–8.
54. Sert M, Abeler V. Robotic-assisted laparoscopic radical hysterectomy: comparison with total laparoscopic hysterectomy and abdominal radical hysterectomy; one surgeon's experience at the Norwegian Radium Hospital. Gynecol Oncol. 2011;121(3):600–4.
55. Cantrell LA, Mendivil A, Gehrig PA, Boggess JF. Survival outcomes for women undergoing type III robotic radical hysterectomy for cervical cancer: a 3-year experience. Gynecol Oncol. 2010;117(2):260–5.
56. Leblanc E. How I perform... vaginal preparation for a laparoscopic radical hysterectomy or the "Schautheim" procedure. Gynecol Obstet Fertil. 2007;35(3):263–4.
57. Roy M, Plante M. Place of Schauta's radical vaginal hysterectomy. Best Pract Res Clin Obstet Gynaecol. 2005;25(2):227–37.
58. Hwang JH. Urologic complication in laparoscopic radical hysterectomy: meta-analysis of 20 studies. Eur J Cancer. 2012;48:3177–85.
59. Pergialiotis V, Rodolakis A, Christakis D, Thomakos N, Vlachos G, Antsaklis A. Laparoscopically assisted vaginal radical hysterectomy: systemtic review of the literature. J Minim Invasive Gynecol. 2013;20:745–53.
60. Roy M, Plante M, Renaud MC. Laparoscopically assisted vaginal radical hysterectomy. Best Pract Res Clin Obstet Gynaecol. 2005;19(3):377–86.
61. Koehler C, Gottschalk E, Chiantera V, Marnitz S, Hasenbein K, Schneider A. From laparoscopic assisted radical vaginal hysterectomy (LARVH) to vaginal assisted laparoscopic radical hysterectomy (VALRH). BJOG. 2012;119:254–62.
62. Lanowska M, Brink-Spalink V, Mangler M, Grittner U, von Tucher E, Schneider A, Köhler C. Vaginal-assisted laparoscopic radical hysterectomy (VALRH) versus laparoscopic-assisted radical vaginal hysterectomy (LARVH) in the treatment of cervical cancer: surgical results and oncologic outcome. Arch Gynecol Obstet. 2014;289:1293–300.
63. Bader AA, Winter R, Moinfar F, Petru E, Pristauz G, Scholz HS, et al. Is intraoperative frozen section analysis of pelvic lymph nodes accurate after neoadjuvant chemotherapy in patients with cervical cancer? Gynecol Oncol. 2006;103(1):106–12.
64. Schneider A, Köhler C. Locoregional recurrence after laparoscopic radical trachelectomy: the vaginal cuff must be closed to avoid tumor cell contamination of the peritoneal cavity. Int J Gynecol Cancer. 2015;24:550.
65. Roy M, Plante M. Place of Schauta's radical vaginal hysterectomy. Best Pract Res Clin Obstet Gynaecol. 2001;25(2):227–37.

Radical Vaginal Trachelectomy

125

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and Achim Schneider

Preliminary Remarks

Cervical cancer is one of the most common cancers among women worldwide with approximately 530,000 incident cases and 275,000 deaths in 2008 [1]. More than other cancers, cervical cancer affects women younger than 45 years [1, 2]. However, in countries with high resources incidence of invasive cervical cancer is decreasing due to effective screening with a shift towards earlier stages of disease [3]. Additionally in western countries today first pregnancy is delayed until later age in the majority of women [4]. Thus, diagnosis of cervical cancer is more frequently detected in nulliparous women. Therefore, gynecologists are more increasingly faced with young patients affected by early stage cervical cancer who still seek motherhood. Sonoda et al. estimated that 48 % of women of reproductive age diagnosed with early stage cervical cancer would meet the criteria for treatment by RVT [5].

In 1952 Novak presented a radical trachelectomy operation for women of reproductive age with cervical carcinoma in situ, who insisted to be operated conservatively. His open surgical procedure comprised dissection of lymph nodes and radical extirpation of the cervix and upper part of the vagina, together with the corresponding paracervical and paravaginal tissues [6]. However, this operation did not become so known worldwide. With the feasibility to perform laparoscopic pelvic lymph node dissection safely, combination of laparoscopic lymphadenectomy with radical vaginal trachelectomy was developed and published by Daniel Dargent in the late eighties of the last century [7]. This procedure provided a fertility sparing alternative for women with early stage cervical cancer in contrast to radical hysterectomy, the standard procedure at this time. Due to significant higher recurrence rates in patients with invasive cancer larger than 2 cm in diameter, depth of infiltration of more than 10 mm, LVSI and close surgical margins careful selection of patients for RVT is mandatory [8].

The aim of radical trachelectomy is to remove residual tumor after biopsy and/or conization and or to reduce the risk of parametrial spread. After analyzing giant section of radical hysterectomy specimen in 180 patients with node negative early cervical cancer Winter et al. could find continuous tumor spread, discontinuous tumor spread, LVSI and parametric lymph node involvement in the medial and lateral parametrium in 0–2.2 % [9]. The real incidence of parametrial tumor involvement in cervical cancer <2 cm is low, but potentially life-threatening, if not recognized. Lanowska et al. found positive lymph nodes in parametria after RVT in 0.9 %, Brady et al. in 2.2 % and Schmeler et al. in 1 % [10–12], whereas others did not find any parametrial spread in low risk early cervical cancer [13–15]. Until results of ongoing randomized trials are pending, RVT should be considered as gold standard for fertility-sparing surgery in patients with early cervical cancer [16], because RVT can effectively reduce risk of parametrial tumor spread.

Multiple prospective and retrospective studies have reported that radical trachelectomy is feasible, safe and has equivalent disease free and overall survival rates when compared to radical hysterectomy (see Chap. 5). Different approaches for radical trachelectomy are described in Fig. 125.1.

Majority of data are available for RVT, less for abdominal radical trachelectomy [17–21] and total laparoscopic radical trachelectomy [22, 23] and only a few for robotic radical trachelectomy [24, 25].

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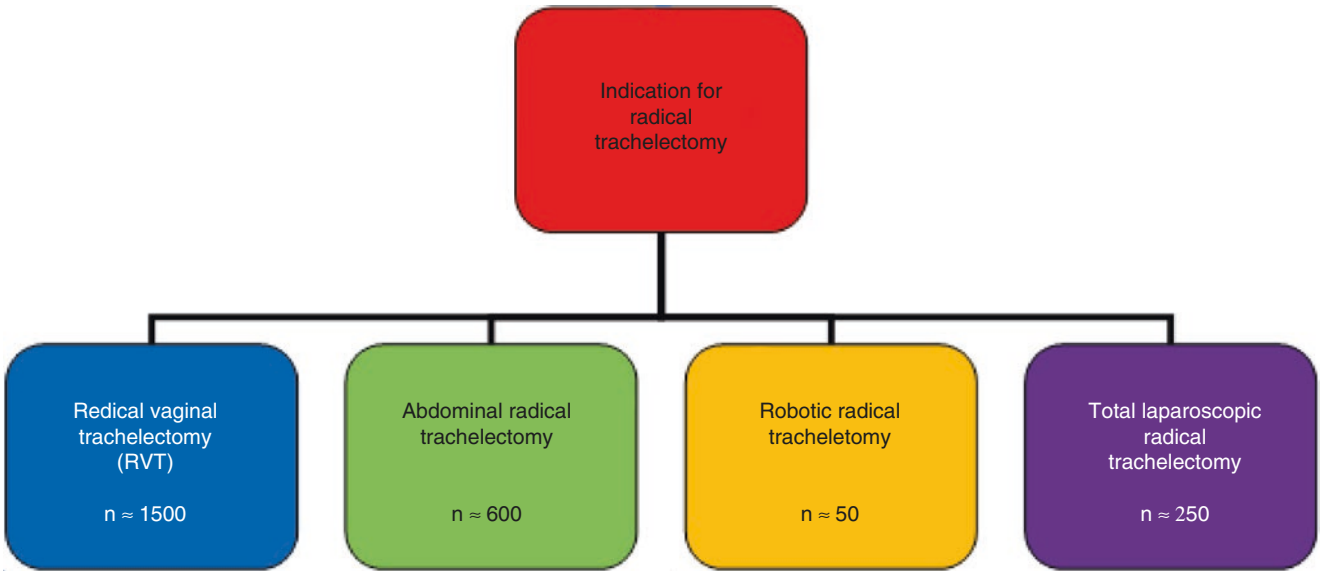


Fig. 125.1 Different approaches for radical trachelectomy

Indications for RVT and Pelvic Lymphadenectomy

Patient selection is very important for a safe oncologic outcome. Internationally there are established indications for radical trachelectomy. These are:

- planned pregnancy
- cervical cancer stages IA1 L1 – IB1 <2 cm
- no haemo-vascular space involvement (Fig. 125.2)
- tumor free pelvic lymph nodes
- tumor-free endocervical margin 0.5 cm
- length of remaining cervix approximately 8–10 mm
- no high risk histology (neuroendocrine, carcinosarcoma, clear-cell, serous-papillary) [26]

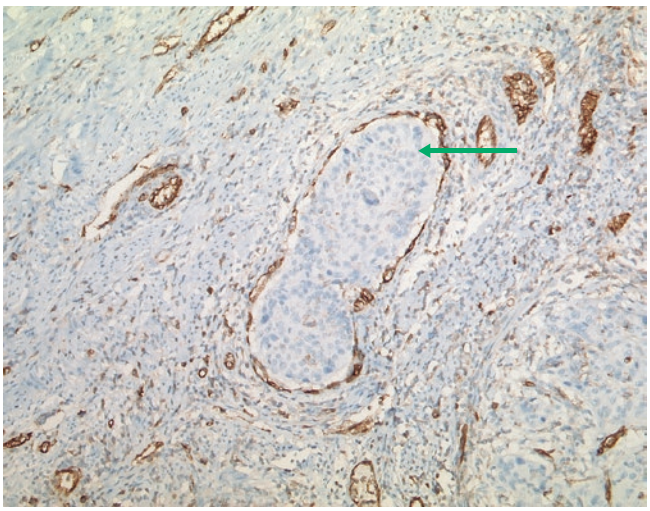


Fig. 125.2 Haemvascular space involvement (*green arrow*)

Technique of RVT

Technique of RVT is standardised and consists of three substeps: (1) laparoscopic pelvic lymphadenectomy and preparation for the vaginal part, (2) radical vaginal resection and (3) laparoscopic control of haemostasis.

1. After positioning of the patient in moderate lithotomy position, application of perioperative antibiotics, vaginal and skin desinfection and team time-out operation starts with subumbilical skin incision. Using Verres needle a sufficient pneumoperitoneum is created and a 10 mm trocar is placed in the lower umbilicus. Under visualisation three additional 5 mm trocars are inserted in the lower middle, right and left abdomen and a 10 mm trocar in the left upper abdomen. After exclusion of peritoneal spread and inspection of the whole abdominal cavity the patient is placed in deep Trendelenburg position. Cytology is taken from the cul-de-sac and the inner genital organs are inspected. By cutting the peritoneum lateral to the right infundibulopelvic ligament up to the pelvic rim the retroperitoneum is opened and the ureter is identified at its overcrossing with the common iliac vessels. Under preservation of the round ligament, the pararectal and paravesical fossae are opened widely after identification of the umbilical lateral ligament. Using a 10 mm sponge forceps the right ureter is always pushed medially. Following the identification of the oburator nerve complete pelvic lymphadenectomy is performed comprising

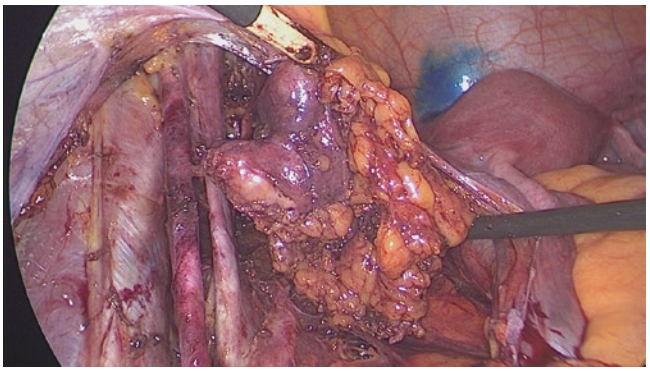


Fig. 125.3 Lymph node metastases in a patient with stage IA1 L1 cervical cancer and wish to preserve fertility

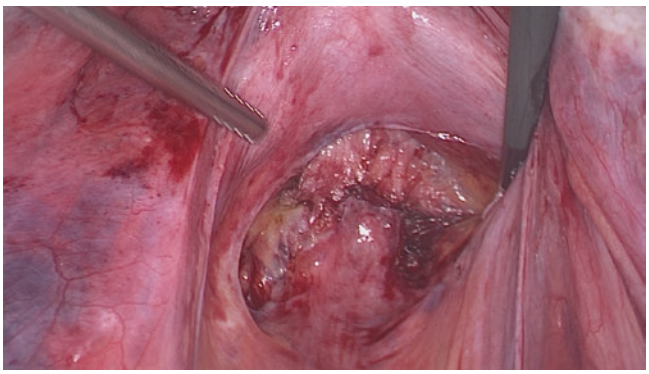


Fig. 125.5 Opened rectovaginal septum

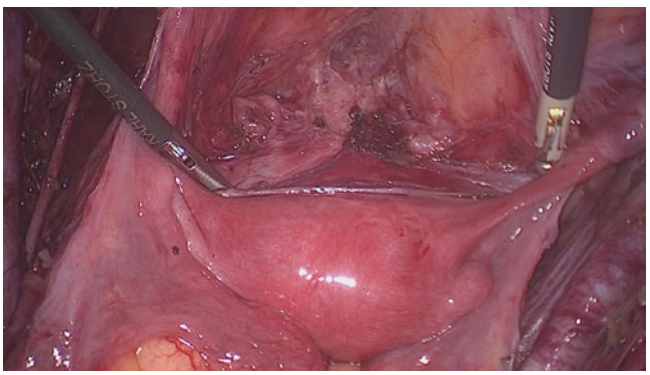


Fig. 125.4 Opened septum vesicouterinum and vesicovaginale

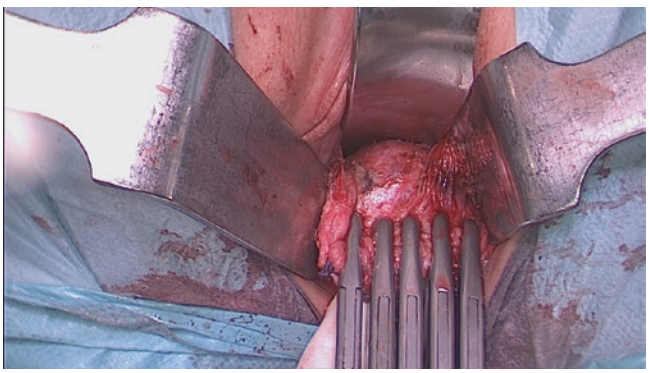


Fig. 125.6 Vaginal cuff under tension

common iliac, iliac external, obturator and iliac internal lymph nodes (please see chapter 106 – pelvic and paraaortic lymph node dissection and Fig. 125.3). Harvested lymph nodes are removed from the abdominal cavity using an endobag and send for frozen section. Identical procedure is done on the left side.

Waiting time for histologic result of lymph nodes can be used to prepare for the vaginal part of RVT. Under moderate filling of the bladder the vesicouterine peritoneal excavation is incised and bladder is brightly dissected away from the uterine cervix up to the upper vagina. During this procedure both uterine arteries are freed and become visible at their entry to the uterus. After voiding the bladder the uterus is elevated and the peritoneum of the cul-de-sac will be incised. Thus, the rectovaginal space is opened and rectum can be moderately pushed away from the posterior parametria. Finally the paravesical spaces on both sides are dissected to the level of levator ani muscle (Figs. 125.4 and 125.5). No uterine manipulator is used at any time of RVT.

2. For the transvaginal part of RVT the patient is placed in maximal lithotomy position. Only if pelvic lymph nodes are confirmed as histologic tumor free, the operation is continued. With six straight Kocher clamps an adequate vaginal cuff is grasped, that is large enough to cover the cervix with or without visible tumor. Between the clamps diluted adrenaline solution is injected for hemostasis and aquadissection. Following this vagina is incised between the clamps using monopolar diathermy. Afterwards a vaginal cuff is formed along the vaginal fascia over a distance of 7–8 mm circumferentially. Vaginal cuff is than closed using a continuous locking suture vicryl 0 that covers the cervix (with or without tumor) itself. The vaginal cuff is grasped with 5–6 serrated clamps. In order to avoid any tumor cell contamination instruments and gloves are changed at this point (Figs. 125.6 and 125.7).

The vaginal cuff is now brought under tension by pulling the serrated clamps. Under ventral tension it is easy to reach the former pouch of Douglas. With a large Breisky speculum rectum is pushed dorsally and therefore sacrouterine ligaments are tensed up. The rectum is pushed away from the sacrouterine ligaments using a small cotton swab. After removal of the posterior Breisky speculum the vagina is pulled down and vesicovaginal space is entered by sharp dissection. Bladder is now protected by middle-size speculum. Beginning on the left side transsected vagina skin is grasped

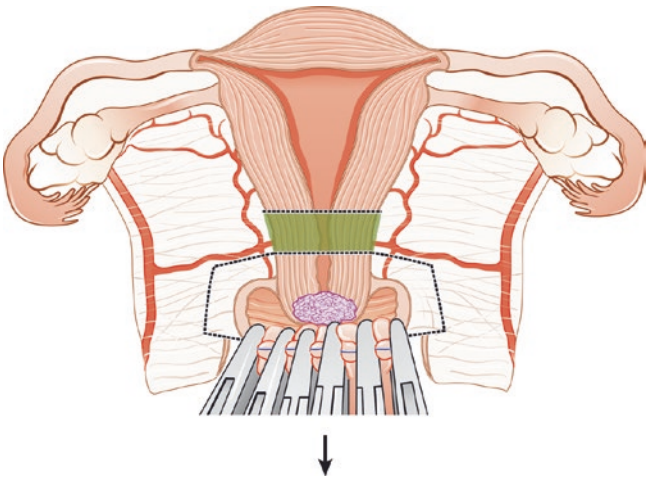


Fig. 125.7 Schema of resection during RVT and preserved cervical length

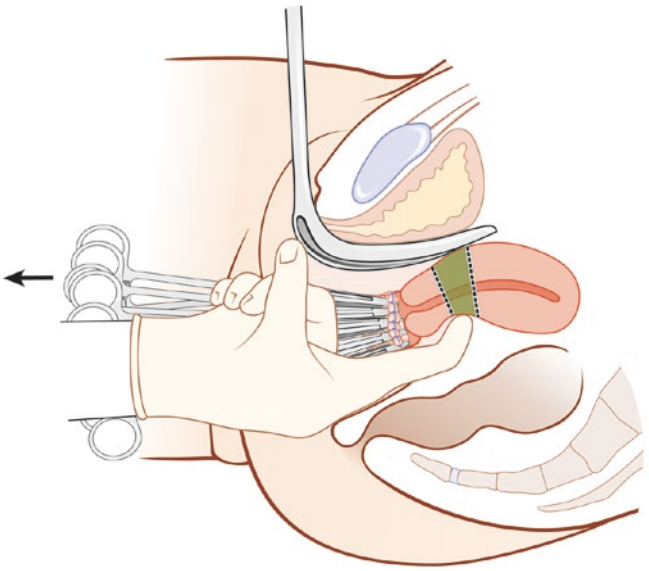


Fig. 125.9 Schema of vaginal examination for identification of the subsequent cervical resection line

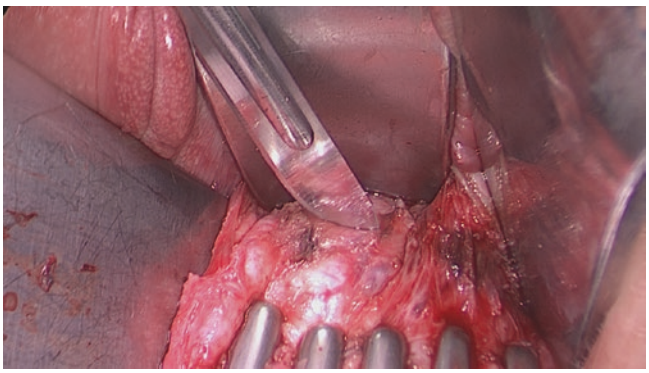


Fig. 125.8 Cervical incision is marked under direct palpation

at 01 and 03 o'clock with Mikulicz clamps. With strongly curved scissors blunt dissection is performed exactly along the vaginal fascia between the Mikulicz clamps in latero-ventral position. Thus, the paravesical space, that has already been prepared during laparoscopic part of RVT, is reached above the level of the levator muscle. A small Breisky speculum is inserted in this paravesical space and bladder pillar is now exposed between the anterior and lateral Breisky specula. Via click manoeuvre the knee of the left ureter can be identified. Familiar with the course of the ureter the surgeon can now perforate and transect the infra-ureteric bladder pillar. In order to know the necessary level of ureter dissection at this moment, the level of uterine cervix, where the resection has to be carried out, is now marked with a superficial scalpel incision (Fig. 125.8). To define this point surgeon introduces the index finger between posterior uterine wall and rectum and palpates exact in patients midline from uterine fundus in direction of the vaginal cuff (Fig. 125.9). Easily on can identify uterine isthmus and performs superficial incision 7–8 mm below the cervico-corporal junction to preserve cervical competence for further pregnancy.

In knowledge of this level surgeon has to decide, if ureter has to be mobilised more extensively. If necessary, bladder pillar can subdived into a medial and a lateral part using slightly curved Overhold dissector. It can be feasible to grasp ureter with a silicon covered Bebcock clamp and place a silicon loop around the distal ureter.

Following the identical operation contralaterally a large Breisky speculum is inserted in the posterior compartment (former cul-de-sac) in order to push the rectum dorsally and to put tension on the distal sacrouterine ligament. Using two slightly curved hysterectomy clamps the distal sacrouterine ligament is transsected and sutured. Using a 90° curved parametrial clamp the inferior part of the cardinal ligament is now be grasped und transected directly underneath the uterine artery. At this step it is important to have ureter's and uterine arterie's run under permanent visualisation. After same procedure on the other side, cervix is freed from paracervical structures up to the planned and marked resection line. The extent of paracervical resection is in accordance to type B radicality (Fig. 125.10).

Elevating the cervix the trachelectomy specimen is now transsected by cold knife in order to allow optimal histologic evaluation of the resection margins. Cervical curettage has always to be done. In patients with adenocarcinoma a small loop excision of the endocervical canal up to the level of the internal os is carried out using a 5 mm diameter loop. In order to prevent stenosis of the remaining cervix a temporary hard plastic catheter of 8 Ch is placed through the remaining cervix into the uterine cavum and fixed with a suture. Permanent cerclage according to the technique of McDonald is carried out circumferentially using non-resorbable prolene. Suture starts at 6 o'clock and after knotting the cerclage a

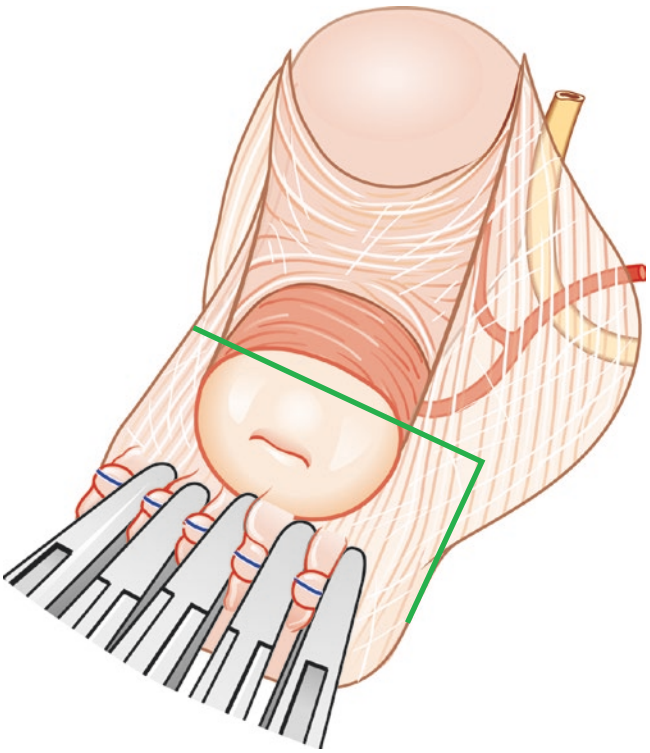


Fig. 125.10 Schema of parametrial resection during RVT according to type B radicality

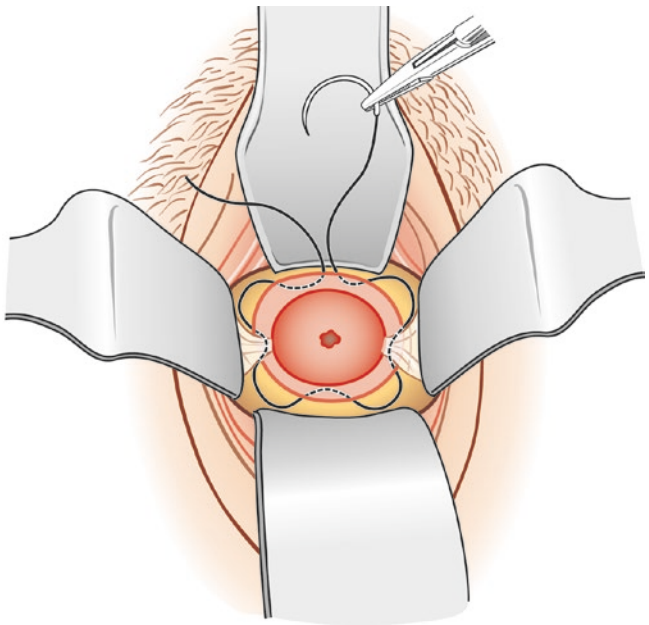


Fig. 125.11 Placement of permanent cerclage

last stich is done in direction to the uterine fundus to avoid perforation of the cerclage suture through the vaginal vault at a later date (Fig. 125.11).

Finally, the remaining vaginal skin is re-adapted to the remaining cervix with single sutures vicryl 0 at 1, 5, 7 and 11 o'clock. Colpotomy has to be closed to both sides and vagina is desinfected prior to re-insertion of a transurethral catheter (Fig. 125.12).

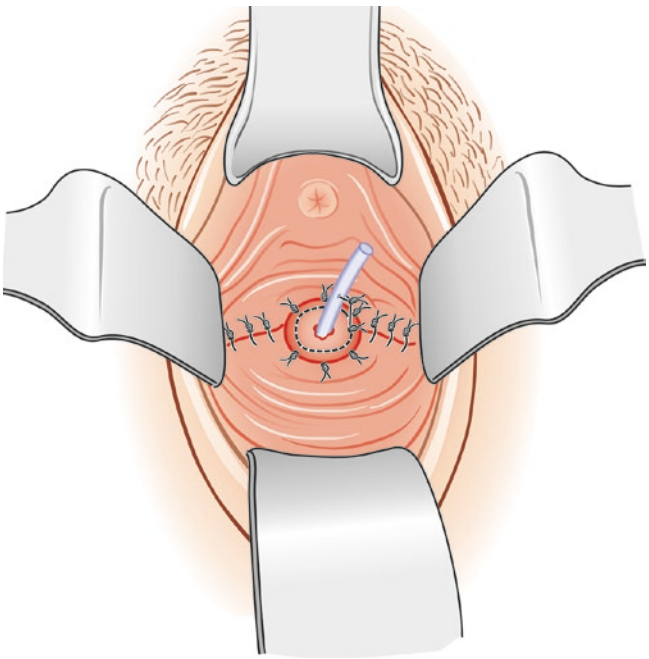


Fig. 125.12 Situs after vaginal part with indwelling catheter in situ

3. After re-positioning of the patient re-laparoscopy is performed via the trocars which are still in situ. Careful hemostasis and irrigation are performed. Intactness of the uterine arteries and regular function of both ureters are checked. Finally a 14 Ch Robinson drain is placed in the pelvis using a 5 mm trocar incision in the right or left lower abdomen (Fig. 125.13).

Up to 12 % of planned RVT have to be abandoned due to more extensive endocervical disease or positive lymph nodes [8, 27], which requires radical hysterectomy or chemoradiation. If pelvic lymph nodes or paracervical tissue are found to be tumor involved, RVT is aborted and paraaortic lymph node dissection has to be performed followed by primary chemoradiation. If permanent section confirms tumor-involved resection margins or endocervical tumor-free margin less than 5 mm or a tumor diameter of more than 20 mm (taking also into account the volume of tumor removed by prior conization), radical hysterectomy should be performed.

In comparison to abdominal radical trachelectomy, total laparoscopic radical trachelectomy and robotic radical trachelectom RVT is associated with clear advantages, but also disadvantages (Table 125.1). Analysing our cohort of 389 patients who underwent RVT major advantage in our opinion is the easy transvaginal definition of the extent of vaginal and cervical resection under direct palpation. A major

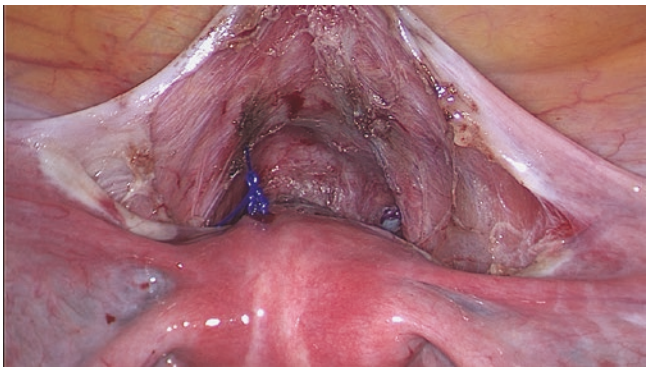


Fig. 125.13 Final laparoscopic situs showing the vesicouterine compartment with fixed knot of permanent cerclage at the level of uterine fundus

disadvantage is the difficulty to teach and learn the vaginal part of surgery. "Each of those approaches has advantages and disadvantages and requires different sets of skills. The surgical approach in and by itself does not matter that much, as long as the procedure is well done, that morbidity is low, that the oncologic and obstetrical outcome are good, and that patients are carefully selected" [28].

Intraoperative Complications and Postoperative Morbidity

Interestingly, more than 50 % of patients after RVT do not immediately attempt to get pregnant. Moreover, in small series by Carter et al., 20 % of women do not have sexual intercourse 12 months postoperatively due to miscellaneous reasons of fear [29].

Spectrum and incidence of perioperative morbidity of radical trachelectomy (3–6 %) is similar to radical hysterectomy in spectrum and incidence. Intraoperative complications such as injury to bladder, rectum, obturator nerve, pelvic autonomic nerves, and subcutaneous emphysema may occur. Postoperative complications such as infection, bleeding, leakage from urinary tract or rectum, urinary retention, urinary incontinence, lymphocele formation, ambulation problems, and ileus are observed [8, 27, 30]. Morbidity, specifically for this surgery may be secondary dysmenorrheal (up to 24 %), irregular bleedings (up to 17 %), problem with the permanent cerclage (up to 14 %), vaginal discharge (up to 14 %), cervical stenosis (up to 7 %) and deep dyspareunia

Table 125.1 Advantages and disadvantages of different trachelectomy techniques

Technique of radical trachelectomy	Advantages	Disadvantages
Radical vaginal trachelectomy	Best cosmesis – natural orificium surgery Probably less adheasions Highest pregnancy rate Minimal blood loss Best method to determine vaginal and cervical resection and place permanent cerclage Prevention of tumor spill and tumor cell contamination Preservation of uterine vessels and thus, optimal blood supply for potential pregnancy	History of conization – adverse vaginal anatomy Technical challenge due to narrow vagina Difficult to learn and to teach
Radical abdominal trachelectomy	Larger parametrial resection No special operative training necessary Easier placement of permanent cerclage	Large abdominal incision – thus suboptimal cosmesis Impairment of uterine blood supply Possible wound infection Possible adheasions – potential problem for further fertility Increased blood loss Longer hospital stay Lower pregnancy rate
Robotic radical trachelectomy	Good cosmesis Probably less adhaesions Minimal blood loss Better placement of permanent cerclage (?) Preservation of uterine arteries	High costs Need for extended robotic skills Difficulty to estimate vaginal and cervical resection Only few oncologic data Low pregnancy rate Possible intraabdominal spill of tumor cells
Total laparoscopic radical trachelectomy	Best cosmesis Probably less adhaesions Low blood loss Good pregnancy rate	Difficulty to estimate vaginal and cervical resection Advanced laparoscopic skills necessary Long learning curve Only few oncologic data available Risk of ureteric fistula formation Possible intraabdominal tumor spill

Table 125.2 Oncologic results after RVT

RVT	n	Median follow-up (months)	Recurrences	Death
Marchiole 2007 [8]	135	95 (31–234)	7 (5.7 %)	5 (4.2 %)
Plante 2005 [41]	72	60 (5–145)	3 (5 %)	2 (3 %)
Shepherd 2012 [42]	208	45 (1–120)	8 (3.8 %)	5 (2.4 %)
Covens 2013 [43]	180	30 (1–103)	9 (2.7 %)	2 (1.1 %)
Sonoda 2008 [44]	36	21 (3–60)	1 (2.7 %)	0
Schlaerth 2003 [45]	10	48 (28–84)	0	0
Dargent 2000 [46]	95	76 (4–176)	4 (4.2 %)	3 (3.1 %)
Mathevet 2003 [47]	109	76 (4–176)	4 (3.6 %)	3 (2.7 %)
Burnett 2003 [48]	21	31	0	0
Einstein 2009 [38]	26	25	n.s.	n.s.
Lanowska 2014 [49]	320	48 (0–216)	10 (3.1 %)	5 (1.6 %)
Massa 2015 [50]	28	54	3 (10.7)	0
Yoon 2015 [51]	21 (56 % tumor>2 cm size)	n.s.	3 (14.3)	2 (9.5)
Plante 2013 [28]	140	93 (4–225)	6 (4.8)	2 (1.6)
Kim 2012 [52]	51		2 (3.9)	1 (1.9)
Σ	1426			

(up to 5 %) [31, 32]. Cervical stenosis may be a relevant obstacle for planned pregnancy and requires individual solutions as described by Grund et al. [33].

Oncologic Results of RVT

Recurrence rate in tumors less than 2 cm is about 5 % and recurrence rate in tumors larger than 2 cm is about 20 % [34–38]. RVT combined with laparoscopic pelvic and parametric lymphadenectomy for the treatment of patients with early stage cervical cancer ≤2 cm results in a recurrence-free survival of 98 %. Mortality rate is about 2 % (Table 125.2). Histology, grade, and presence of LVSI are not associated with higher risk of recurrence. Majority of recurrences occur in the uterus, the parametrium or pelvic sidewall, whereas only few recurrences are reported in the pelvic, paraaortic, and/or supraclavicular lymph nodes or intraabdominally [39]. Therefore, the oncologic safety of radical hysterectomy and radical vaginal trachelectomy for patients with tumors of identical size appears to be comparable [40] (Table 125.2).

Obstetric Results

Ten percent of women for whom radical trachelectomy was planned could not have their fertility preserved due to histologic proven lymph node metastases or positive/close cervical resection margins [28, 53]. There is no clear consensus on interval waiting time between RVT and attempting pregnancy [54]. Complete healing of the vaginal wound may last up to 3 months. As the procedure usually is limited to small tumors, prognosis is excellent and there is need to wait longer to get pregnant. Between 10 and 15 % of patients after vaginal radical trachelectomy are diagnosed with impaired fertility. However, this rate is comparable to the general population and infertility might be existing before the operation or resulting from the operation [36, 55]. Fertility evaluation in trachelectomy patients revealed that 25 % have had a history of infertility before trachelectomy [56]. Patients who are subfertile or who had fertility problems prior to RVT should be managed by a gynecologist specialized in reproductive medicine. There is no contraindication against use of assisted reproductive methods.

In large monocentric studies 65–70 % of patients, who wish to get pregnant after RVT, were able to conceive (Table 125.3). The rate of first trimester miscarriage is similar compared to normal population but the risk of second trimester abortion is increased (9.5 % vs. 4 %). Preterm delivery is a major risk following radical trachelectomy (Table 125.3). The main cause of second trimester loss and premature delivery is PROM associated with ascending infection [57, 58]. The cervical length and shape has to be monitored in prenatal care. Vaginal infection must be excluded by regular assessment of vaginal pH and flora. Patients should abstain from physical strain and stress between 14th and 28th gestational weeks of gestation. Pregnancy after RVT has to be considered and managed as high-risk pregnancy. Therefore, there are specific recommendations of conduct

Table 125.3 Obstetrical outcome after RVT

Author	Pregnancies (n)	First trimester	Second trimester	Third trimester	<32 weeks	32–36.6 weeks	>37 weeks
Speiser 2011 [60]	60	5 (8 %)	3 (5 %)	50 (83 %)	3	15	32
Shepherd 2012 [54]	125	27 (22 %)	18 (14 %)	73 (58 %)	14	26	33
Plante 2011 [61]	106	21 (20 %)	3 (3 %)	77 (73 %)	4	15	58
Covens 2008 [62]	86	14 (16 %)	7 (8 %)	65 (76 %)	11	11	43
Mathevet 2003 [59]	56	9 (16 %)	8 (14 %)	34 (61 %)	2	3	29
Kim 2012 [63]	16	1 (5 %)	0	15 (78 %)	0	6	9

during pregnancy following RVT [59]. Delivery after RVT has always done by cesarean section due to the permanent cerclage (Table 125.3).

Follow-up after RVT

There are no consensus and no generally accepted guidelines on the follow-up protocol in patients after radical trachelectomy. We advocate that patients should be followed-up at 3 months interval for the first 2 years since the majority of recurrences occur in the first 24 months, then at 6 months for 3 years. Thereafter the patient goes back into normal screening (Fig. 125.14). In contrast to the follow-up protocol for patients having been treated for cervical cancer by radical hysterectomy or chemoradiation patients with a history of RVT need regular control of the remaining cervix which should be done by cytology, colposcopy and HPV testing [39, 64].

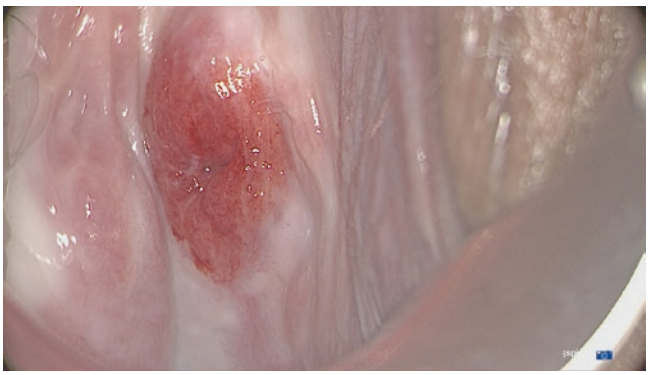


Fig. 125.14 Colpophotogram after RVT

Pending Questions

Due to the low rate of parametrial involvement (≈1 %) in cervical cancer with favorable pathologic characteristics and tumor-size <2 cm less radical surgical procedure may be discussed with women fulfilling these criteria [10, 65–68]. Moreover, 2/3 of radical trachelectomy specimens contain no residual disease. This issue is still under debate since controversial findings have been published on incidences of parametrial spread [9, 40, 69].

Radicality of RVT can be reduced either by less comprehensive lymphadenectomy (complete pelvic lymphadenectomy versus sentinel lymphadenectomy), and/or by less radical cervical resection (from radical trachelectomy versus simple trachelectomy versus conization) or both [70]. In a recently published study by Lindsay et al. 43 women underwent repeated conization and pelvic lymphadenectomy which lead to 5 % recurrences [71]. Therefore, prospective studies should be undertaken to determine the safety of simple conization or simple trachelectomy (like CONES study – ClinicalTrials.gov: NCT01048853) for the treatment of young women with early cervical cancer who wish to preserve their fertility.

RVT does not provide guarantee for later pregnancy. This is underlined by the fact, that 30–35 % of patients get not pregnant following TVZ for unknown reasons. This needs further investigation.

Another controversial topic is whether to perform of hysterectomy following completion motherhood. There is no international consensus to perform hysterectomy in general in this situation, nor any suggestion for extend of hysterectomy, if done.

Follow-up after RVT is not standardized and there is a couple of pending questions with respect to limited or extensive use of imaging modalities, tumor markers, cytology and/or HPV-testing. Moreover, best obstetric management of pregnancies after RVT (high-risk pregnancies) has not been defined. According to scanty data our recommendations and personal opinions are summaries by Lanowska et al. [72].

Finally, few patients with cervical cancer >2 cm may insist to preserve their uterus since they prioritize preservation of fertility above oncologic safety. In these patients neoadjuvant chemotherapy followed by RVT can be offered

after primary confirmation of tumor-free pelvic lymph nodes. However, this is still an experimental approach with very limited oncologic data on long-term follow up [72, 73].

Future of RVT

"Vaginal radical trachelectomy with pelvic lymphadenectomy is currently the standard fertility preserving procedure" [74]. This statement is still valid because RVT in combination with pelvic laparoscopic lymphadenectomy is a standardised gynaecologic-oncologic procedure with low complication rate, excellent oncologic safety according to large data with long-term follow-up and a good chance to get pregnant. However, criteria for less radicality of lymphadenectomy and parametrectomy in the concept of fertility-preserving surgery have to be defined in randomised trials. Patients with indication for RVT should be referred to experts who know the indication, perform the surgery frequently and monitor their results accurately with self-criticisms for the benefit of the patients and their families.

References

1. Arbyn M, Castellsaque X, de Sanjose S, Bruni L, Saraiya M, Bray F, Ferlay J. Worldwide burden of cervical cancer in 2008. Ann Oncol. 2011;12:2675–86.
2. Covens A, Rosen B, Murphy J, et al. Changes in the demographics and perioperative care of stage IA2/IB1 cervical cancer over the past 16 years. Gynecol Oncol. 2001;81:133–7.
3. Krebs in Deutschland 2007/2008. 8. Ausgabe. Robert Koch-Institut (Hrsg) und die Gesellschaft der epidemiologischen Krebsregister in Deutschland e.V. (Hrsg). Berlin; 2012.
4. Pötzsch O, Emmerling D. Geburten und Kinderlosigkeit in Deutschland. Wiesbaden: Statistisches Bundesamt; 2008 .http://www.destatis.de/DE/Publikationen/Thematisch/Bevoelkerung/Bevoelkerungsbewegung/Geburten
5. Sonoda Y, Abu-Rustum NR, Gemignani ML, et al. A fertility-sparing alternative to radical hysterectomy: how many patients may be eligible? Gynecol Oncol. 2004;95:534–8.
6. Novak FR. Radical abdominal subcorporeal extirpation of the cervix with bilateral pelvic lymph nodes dissection in cancer in situ of the cervix uteri. Acta Medica Iugoslavica. 1952;6:59–71.
7. Dargent D, Brun JL, Roy M. La trache'lectomie e'largie (T.E.). Une alternative a` l'hyste'rectomie radicale dans le traitement des cancers infiltrants de'veloppe's sur la face externe du col ute'rin. J Obstet Gynaecol. 1994;2:292–5.
8. Marchiole P, Benchaib M, Buenerd A, Lazlo E, Dargent D, Mathevet P. Oncological safety of laparoscopic-assisted vaginal radical trachelectomy (LARVT or Dargent's operation): a comparative study with laparoscopic-assisted vaginal radical hysterectomy (LARVH). Gynecol Oncol. 2007;106:132–41.
9. Winter R, Haas J, Reich O, Koemetter R, Tamussino K, Lahousen M, Petru E, Pickel H. Parametrial spread of cervical cancer in patients with negative pelvic lymph nodes. Gynecol Oncol. 2002;84:252–7.
10. Lanowska M, Morawietz L, Sikora A, Räber G, Mangler M, Speiser D, Hasenbein K, Chiantera V, Köhler C, Schneider A. Prevalence of lymph nodes in the parametrium of radical vaginal trachelectomy (RVT) specimen. Gynecol Oncol. 2011;121:298–302.
11. Schmeler KM, Frumovitz M, Ramirez PT. Conservative management of early stage cervical cancer: is there a role for less radical surgery? Gynecol Oncol. 2011;120:321–5.
12. Brady PC, Chen X, Burke WM, Deutsch I, Sun X, Herzog TJ, Wright JD. Detection and significance of parametrial micrometastases in early-stage cervical cancer. Anticancer Res. 2011;31:243–7.
13. Kim MK, Kim MA, Kim JW, Chung HH, Park NH, Song YS, Kang SB. Loop electrosurgical excision procedure findings for identification of patients with early-stage cervical cancer suitable for less radical surgery. Int J Gynecol Cancer. 2012;22:1214–9.
14. Al-Kalbani M, McVeigh G, Nagar H, McCluggage WG. Do FIGO stage IA and small (≤2 cm) IB1 cervical adenocarcinomas have a good prognosis and warrant less radical surgery? Int J Gynecol Cancer. 2012;22:291–5.
15. Gemer O, Eitan R, Gdalevich M, Mamanov A, Piura B, Rabinovich A, Levavi H, Saar-Ryss B, Halperin R, Finci S, Beller U, Bruchim I, Levy T, Ben Shachar I, Ben Arie A, Lavie O. Can parametrectomy be avoided in early cervical cancer? An algorithm for the identification of patients at low risk for parametrial involvement. Eur J Surg Oncol. 2013;39:76–80.
16. Rob L, Skapa P, Robova H. Fertility-sparing surgery in patients with cervical cancer. Lancet Oncol. 2011;12:192–200.
17. Cibula D, Slama J, Svarovsky J, Fischerova D, Freitag P, Zikan M, Pinkavova I, Pavlista D, Dundr P, Hill M. Abdominal radical trachelectomy in fertility-sparing treatment of early-stage cervical cancer. Int J Gynecol Cancer. 2009;19:1407–11.
18. Saso S, Ghaem-Maghami S, Chatterjee J, Naji O, Farthing A, Mason P, McIndoe A, Hird V, Ungar L, Del Priore G, Smith JR. Abdominal radical trachelectomy in West London. BJOG. 2012;119:187–93.
19. Wethington SL, Cibula D, Duska LR, Garrett L, Kim CH, Chi DS, Sonoda Y, Abu-Rustum NR. An international series on abdominal radical trachelectomy. Int J Gynecol Cancer. 2012;22:1251–7.
20. Nishio H, Fujii T, Sugiyama J, Kuji N, Tanaka M, Hamatani T, Miyakoshi K, Minegishi K, Tsuda H, Iwata T, Tanaka K, Fukuchi T, Takehara Y, Yoshimura Y, Aoki D. Reproductive and obstetric outcomes after radical abdominal trachelectomy for early-stage cervical cancer in a series of 31 pregnancies. Hum Reprod. 2013;128:1793–8.
21. Pareja R, Rendon GJ, Sanz-Lomana CM, Monzon O, Ramirez PT. Surgical, oncological and obstetrical outcomes after abdominal radical trachelectomy – a systematic literature review. Gynecol Oncol. 2013;131:77–82.
22. Lu Q, Zhang Y, Liu C, Wang S, Guo S, Zang Z. Total laparoscopic radical trachelectomy in the treatment of early squamous cell cervical cancer: a retrospective study with 8-year follow-up. Gynecol Oncol. 2013;130:275–9.
23. Ebisawa K, Takano M, Fukuda M, Fujiwara K, Hada T, Ota Y, Kurotsuchi S, Kanao H, Andou M. Obstetric outcomes of patients undergoing total laparoscopic radical trachelectomy for early stage cervical cancer. Gynecol Oncol. 2013;131:83–6.
24. Persson J, Imboden S, Reynisson P, Andersson B, Borgfeldt C, Bossmar T. Reproducibility and accuracy of robot-assisted laparoscopic fertility sparing radical trachelectomy. Gynecol Oncol. 2012;127:484–8.
25. Nick AM, Frumovitz MM, Soliman PT, Schmeler KM, Ramirez PT. Fertility sparing surgery for treatment of early-stage cervical cancer: open vs. robotic radical trachelectomy. Gynecol Oncol. 2012;124:276–80.
26. Hertel H, Köhler C, Grund D, Hillemanns P, Possover M, Michels W, Schneider A. Radical vaginal trachelectomy (RVT) combined with laparoscopic pelvic lymphadenectomy: prospective multicenter study of 100 patients with early cervical cancer. Gynecol Oncol. 2006;103:506–11.

27. Plante M, Renaud MC, François H, et al. Vaginal radical trachelectomy: an oncologically safe fertility-preserving surgery. An update series of 72 cases and review of the literature. Gynecol Oncol. 2004;94:614–23.
28. Plante M. Evolution in fertility-preserving options for early-stage cervical cancer. Int J Gynecol Cancer. 2013;23:982–9.
29. Carter J, Sonoda Y, Chi DS, Raviv L, Abu-Rustum NR. Radical trachelectomy for cervical cancer: postoperative physical and emotional adjustment concerns. Gynecol Oncol. 2008;111:151–7.
30. Froding LP, Ottosen C, Mosqaard BJ, Jensen PT. Quality of life, urogynecological morbidity, and lymphedema after radical vaginal trachelectomy for early-stage cervical cancer. Int J Gynecol Oncol. 2015;25:699–706.
31. Alexander-Sefre F, Chee N, Spencer C, et al. Surgical morbidity associated with radical trachelectomy and radical hysterectomy. Gynecol Oncol. 2006;101:450–4.
32. Ramirez PT, Schmeler KM, Soliman PT, Frumovitz M. Fertility preservation in patients with early cervical cancer: radical trachelectomy. Gynecol Oncol. 2008;110:S25–8.
33. Grund D, Köhler C, Krauel H, Schneider A. A new approach to preserve fertility by using a coated nitinol stent in a patient with recurrent cervical stenosis. Fertil Steril. 2007;87:1212.e13–6.
34. Diaz JP, Sonoda Y, Leitao MM, et al. Oncologic outcome of fertility-sparing radical trachelectomy versus radical hysterectomy for stage IB1 cervical carcinoma. Gynecol Oncol. 2008;111:255–60.
35. Beiner ME, Hauspy J, Rosen B, et al. Radical vaginal trachelectomy vs. radical hysterectomy for small early stage cervical cancer: a matched case-control study. Gynecol Oncol. 2008;110:168–71.
36. Carter J, Sonoda Y, Abu-Rustum NR. Reproductive concerns of women treated with radical trachelectomy for cervical cancer. Gynecol Oncol. 2007;105:13–6.
37. Shepherd JH, Spencer C, Herod J, et al. Radical vaginal trachelectomy as a fertility-sparing procedure in women with early-stage cervical cancer—cumulative pregnancy rate in a series of 123 women. BJOG. 2006;113:719–24.
38. Einstein MH, Park KJ, Sonoda Y, et al. Radical vaginal versus abdominal trachelectomy for stage IB1 cervical cancer: a comparison of surgical and pathologic outcomes. Gynecol Oncol. 2009;112:73–7.
39. Eday K, Denton K, Murdoch J. The role of cytological follow-up after radical vaginal trachelectomy for early-stage cervical cancer. Cytopathology. 2014;25:95–100.
40. Billingsley CC, Kohler MF, Creasman CT, Madory JE, Young JL. A case of parametrial lymph node involvement in stage IA2 squamous cell carcinoma of the cervix treated with radical hysterectomy and a review of the literature: a case report. J Low Genit Tract Dis. 2012;16:145–8.
41. Plante M, Renaud MC, Roy M. Radical vaginal trachelectomy: a fertility-preserving option for young women with early stage cervical cancer. Gynecol Oncol. 2005;99:143–6.
42. Shepherd JH. Cervical cancer. Best Pract Res Clin Obstet Gynaecol. 2012;26:293–309.
43. Covens A, Shaw P, Murphy J, et al. Is radical trachelectomy a safe alternative to radical hysterectomy for patients with stage IA-B carcinoma of the cervix? Cancer. 1999;86:2273–9.
44. Sonoda Y, Chi DS, Carter J, Barakat RR, Abu-Rustum NR. Initial experience with Dargent's operation: the radical vaginal trachelectomy. Gynecol Oncol. 2008;108:214–9.
45. Schlaerth JB, Spirtos NM, Schlaerth AC. Radical trachelectomy and pelvic lymphadenectomy with uterine preservation in the treatment of cervical cancer. Am J Obstet Gynecol. 2003;188:29–34.
46. Dargent D, Martin X, Sacchetoni A, Mathevet P. Laparoscopic vaginal radical trachelectomy: a treatment to preserve the fertility of cervical carcinoma patients. Cancer. 2000;88:1877–82.
47. Mathevet P, Laszlo de Kaszon E, Dargent D. Fertility preservation in early cervical cancer. Gynecol Obstet Fertil. 2003;31:706–12.
48. Burnett AF, Roman LD, O'Meara AT, Morrow CP. Radical vaginal trachelectomy and pelvic lymphadenectomy for preservation of fertility in early cervical carcinoma. Gynecol Oncol. 2003;88:419–23.
49. Mangler M, Lanowska M, Köhler C, Vercellino F, Schneider A, Speiser D. Patterns of cancer recurrence in 320 patients after radical vaginal trachelectomy. Int J Gynecol Cancer. 2014;24:130–4.
50. Massa AL, Orellana NS, Fredes MC, Astudillo KG, Burztyn DM, Martinez CP, Scheef MH, Hwang DY, Yunusic JB. Vaginal radical trachelectomy. A 10 years experience of 3 centers in Chile. Int J Gynecol Oncol. 2015;25(Suppl 1):28.
51. Yoon A, Choi CH, Lee YY, Kim TJ, Lee JW, Kim BG, Bae DS. Perioperative outcomes of radical trachelectomy in early-stage cervical cancer. Vaginal versus laparoscopic approaches. Int J Gynecol Cancer. 2015;25:1051–7.
52. Kim CH, Abu-Rustum NR, Chi DS, Gardner GJ, Leitao Jr MM, Carter J, Barakat RR, Sonoda Y. Reproductive outcomes of patients undergoing radical trachelectomy for early-stage cervical cancer. Gynecol Oncol. 2012;125(3):585–8.
53. Lucas R, Skapa P, Robova H. Fertility sparing surgery in patients with cervical cancer. Lancet Oncol. 2011;12:192–200.
54. Dursun P, LeBlanc E, Nogueira MC. Radical vaginal trachelectomy (Dargent's operation): a critical review of the literature. Eur J Surg Oncol. 2007;33:933–41.
55. Wong I, Justin W, Gangooly S, et al. Assisted conception following radical trachelectomy. Hum Reprod. 2009;24:876–9.
56. Bernardini M, Barrett J, Seaward G, et al. Pregnancy outcomes in patients after radical trachelectomy. Am J Obstet Gynecol. 2003;189:1378–82.
57. Plante M. Vaginal radical trachelectomy: an update. Gynecol Oncol. 2008;111:S105–10.
58. Lavie O, Peer G, Sagi S, et al. The management of an early-missed abortion after radical trachelectomy – a case report and a review of the literature. Int J Gynecol Cancer. 2006;16:1688–90.
59. Speiser D, Köhler C, Schneider A, Mangler M. Radical vaginal trachelectomy: a fertility preserving procedure in early cervical cancer in young women. Dtsch Arztebl Int. 2013;110(17):289–95.
60. Speiser D, Mangler M, Köhler C, et al. Fertility outcome after radical vaginal trachelectomy. A prospective study of 212 patients. Int J Gynecol Oncol. 2011;21:1635–9.
61. Plante M, Gregoire J, Renaud MC, Roy M. The vaginal radical trachelectomy: an update of a series of 125 cases and 106 pregnancies. Gynecol Oncol. 2011;121:290–7.
62. Covens A. Preserving fertility in early cervical cancer with radical trachelectomy. Contemp Ob/Gyn. 2008;108:214–9.
63. Kim CH, Abu-Rustum NR, Chi DS, Gardner GJ, Leitao Jr MM, Carter J, Barakat RR, Sonoda Y. Reproductive outcomes of patients undergoing radical trachelectomy for early-stage cervical cancer. Gynecol Oncol. 2012;125(3):585–8.
64. Lanowska M, Mangler M, Grittner U, Akbar GR, Speiser D, von Tucher E, Köhler C, Schneider A, Kühn W. Isthmic-vaginal smear cytology in the follow-up after radical vaginal trachelectomy for early stage cervical cancer: is it safe? Cancer Cytopathol. 2014;122:349–58.
65. Jadoul P, Querleu D, Squifflet JL, Donnez J. Recurrence during pregnancy of a conservatively treated early-stage cervical squamous cell carcinoma. Fertil Steril. 2011;95:e13–6.
66. Palaia I, Musella A, Bellati F, Marchetti C, Di Donato V, Perniola G, Benedetti-Panici P. Simple extrafascial trachelectomy and pelvic lymphadenectomy in early stage cervical cancer. Gynecol Oncol. 2012;126:78–81.
67. Biliatis I, Kucukmetin A, Patel A, Ratnavelu N, Cross P, Chattopadhyay S, Galaal K, Nauk R. Small volume stage Ib1 cervi-

cal cancer: is radical surgery still necessary? Gynecol Oncol. 2012;126:73–7.
68. Klat J, Sevcik L, Simetka O, Graf P, Dvorackova J, Kraft O. What is the risk for parametrial involvement in womenwith early-stage cervical cancer with tumour <20 mm and with negative sentinel lymph nodes? Aust N Z J Obstet Gynaecol. 2012;52:540–4.
69. Baalbergen A, Smedts F, Helmerhorst TJ. Conservative therapy in microinvasive adenocarcinoma of the uterine cervix is justified: an analysis of 59 cases and a review of the literature. Int J Gynecol Cancer. 2011;21:1640–5.
70. Ramirez PT, Pareja R, Rendon GJ, Millan C, Frumovitz M, Schmeler KM. Management of low-risk early-stage cervical cancer: should conization, simple trachelectomy, or simple hysterectomy replace radical surgery as the new standard of care? Gynecol Oncol. 2014;132:254–9.
71. Lindsay R, Burton K, Shanbhag S, Tolhurst J, Millan D, Siddiqui N. Fertility conserving management of early cervical cancer: our experience of LLETZ and pelvic lymph node dissection. Int J Gynecol Cancer. 2014;24:118–23.
72. Plante M, Lau S, Brydon L, et al. Neoadjuvant chemotherapy followed by vaginal radical trachelectomy in bulky stage IB1 cervical cancer: case report. Gynecol Oncol. 2006;101:367–70.
73. Lanowska M, Mangler M, Speiser D, Bockholdt C, Schneider A, Köhler C, Vasiljeva J, Al-Hakeem M, Vercellino F. Radical vaginal trachelectomy after laparoscopic staging and neoadjuvant chemotherapy in women with early-stage cervical cancer over 2 cm: oncologic, fertility, and neonatal outcome in a series of 20 patients. Int J Gynecol Cancer. 2014;24:586–93.
74. Rob L, Skapa P, Robova H. Fertility-sparing surgery in patients with cervical cancer. Lancet Oncol. 2011;12:192–200.

Difficult Vaginal Hysterectomy

126

Shikha Seth and Narendra Malhotra

Traditional vaginal hysterectomy represents operation that is suited for removal of prolapsed organ with pelvic floor repair and non-prolapsed organ in favourable situations. In prolapse cases it is mandatory to preoperatively check all the pelvic defects and repair them, while in non-descent cases one needs to identify the difficulty levels. Since inception, out of enthusiasm many reproducible techniques have been described to permit safety and bypass the limitations of vaginal hysterectomy by Pean (1886), Schroeder (1880) [1] Richelot, (1894) [2], Doyen [3] and others. In 1909 Schauta [4] first described radical vaginal hysterectomy, and Mitra combined it with extraperitoneal lymphadenectomy to achieve cure in cervical malignancy, which is now a days done laparoscopically [5, 6]. This chapter deals with the difficulty aspects of the vaginal hysterectomy and simple techniques of tackling them without increasing the complication rate and morbidity.

As with any surgery plan patient selection is the important aspect and the gynaecologist must know how to assess the suitability of a case for the vaginal surgery. There are few absolute contra-indications to vaginal approach such as:

1. Advanced pelvic malignancy,
2. Severe endometriosis,
3. Fixed uterus,
4. Adnexal mass – Tubo-ovarian mass
5. History of
   (i) Fistula repair as recto-vaginal or vesico-vaginal (RVF, VVF)
   (ii) Perineal tear repair
   (iii) Suspension operations as sling, or ventrosuspension.
   (iv) Vaginal procedures as Brachytherapy, Fothergill's operation etc. (relative)

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Difficult Situations

Problems are anticipated if there is (1) enlarged uterus i.e., greater than 10–12 weeks size (2), restricted mobility (3), previous pelvic surgery (4), caesarean delivery (5), chronic pelvic inflammatory disease (PID) (6), nulliparity (7), android pelvis (8), parametritis or (9) short cervix with shallow fornices. But with skill, patience and experience difficult vaginal hysterectomy can be made comfortable. Although challenging, but the safety can be largely secured if we judge all the difficulty aspects by history, detailed pelvic bimanual examination, a good sonography and imaging reports [7]. Today with the advent of laparoscopy and robotics the rate of vaginal hysterectomy is reducing in difficult situations. Only 21.8 % are performed vaginally in United States with no substantial increase in rate in the last 13 years [8]. The reason is, it is difficult to teach and learn because of limited exposure.

Benefits should be considered before deciding the mode of hysterectomy. Vaginal approach is better compared to abdominal, laparoscopy and robotics as it is minimally invasive, has fast recovery, no post-operative discomfort, requires shorter hospital stay of 48–72 h, few surgical instruments and has less complications due to early mobilization. It is cost effective for developing countries and more suitable in some high risk women with medical disorders like obesity and diabetes etc. [9, 10].

Main problems with vaginal approach to hysterectomy are [11]:

1. Exposure
2. Entry to cul de sac; anterior and posterior
3. Securing Vascular pedicles
4. Delivering out the enlarged or less mobile uterus.
5. Adnexectomy if required
6. Avoiding visceral injury in previous surgery cases.

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A difficult situation requires pertinent modifications in the conventional vaginal technique individualized based on patient's anatomy or the underlying disease process. Following are the major precautions and steps to successfully tackle the vaginal route challenges.

Assessment the Difficulties

History

First part of any clinical case assessment is the thorough history taking. Ask for any abdominal, pelvic, or vaginal surgeries in past and check for the findings/notes if available as it may distort the pelvic anatomy, have chances of fibrous adhesions considerably and few are the contra-indications as mentioned earlier. Past history of repeated Lower Reproductive Tract Infections (RTI), Pelvic inflammatory disease (PID), Pelvic or genital tuberculosis, trauma, septic abortions and treatment taken should also be noted. Check for medical disorders as Diabetes mellitus, Hypertension, pulmonary tuberculosis, respiratory tract infections, constipation, urinary tract infections etc. as they may affect the surgery or post operative healing.

Pre-operative Work Up

Pre-operative work up should be done step by step noting the three important points:

1. Uterus (size, shape, contour, consistency, pathology)
2. Mobility (free, limited, restricted, frozen pelvis)
3. Available space (vaginal capacity, distencibility, adnexal mass, pubic arch)

Inspection: Any examination starts with 'Inspection', which in gynaecology is done via Sim's speculum. Cervix normally seen hanging in the vagina up to the level of the ischeal spine or may be low in cases of uterine descent. All the compartments anterior, posterior & apical be checked for the degree of descent and quantified by the standard Pelvic Organ Prolapse Quantification (POPQ) system. Anterior vaginal wall have three distinguishable grooves on it, 1st just below the urethra (Submeatal sulcus), 2nd at the junction of urethra with bladder neck (Transverse sulcus), and 3rd lower most (Bladder sulcus) defines the bladder extent and descends down in cases of cystocele. These cases should also be evaluated for the stress urinary incontinence (SUI) and if present Bonney's test be done for the prediction of success of mid urethral sling surgery, which can be easily combined with the vaginal hysterectomy.

Any dimpling seen on the lateral or posterior fornix (Dimple sign) is highly suggestive of thick dense adhesions either due to endometriosis or previous surgeries. Thin dry vaginal mucosa in cases of chronic long standing uterine prolapse needs local estrogen therapy and reposition of prolapsed part.

Next step is to check for the mobility which is done by grasping both lips of cervix with vulsellum and try to pull it by gentle traction in downward direction. Normally cervix can be pulled down by 1 cm (one station), but in pathological situations (as fixity, huge size, adnexal mass) it may not be possible. If while pulling, patient feels pain or suprapubic abdominal depression appears (**Cervico-fundal sign**); one should get alert for possibility of adhesions with anterior abdominal wall. Cervix should be manoeuvred in opposite direction to assess mobility and visualize the fornices completely. i.e., to visualize the posterior fornix pull the cervix up towards patient's abdomen.

Palpation

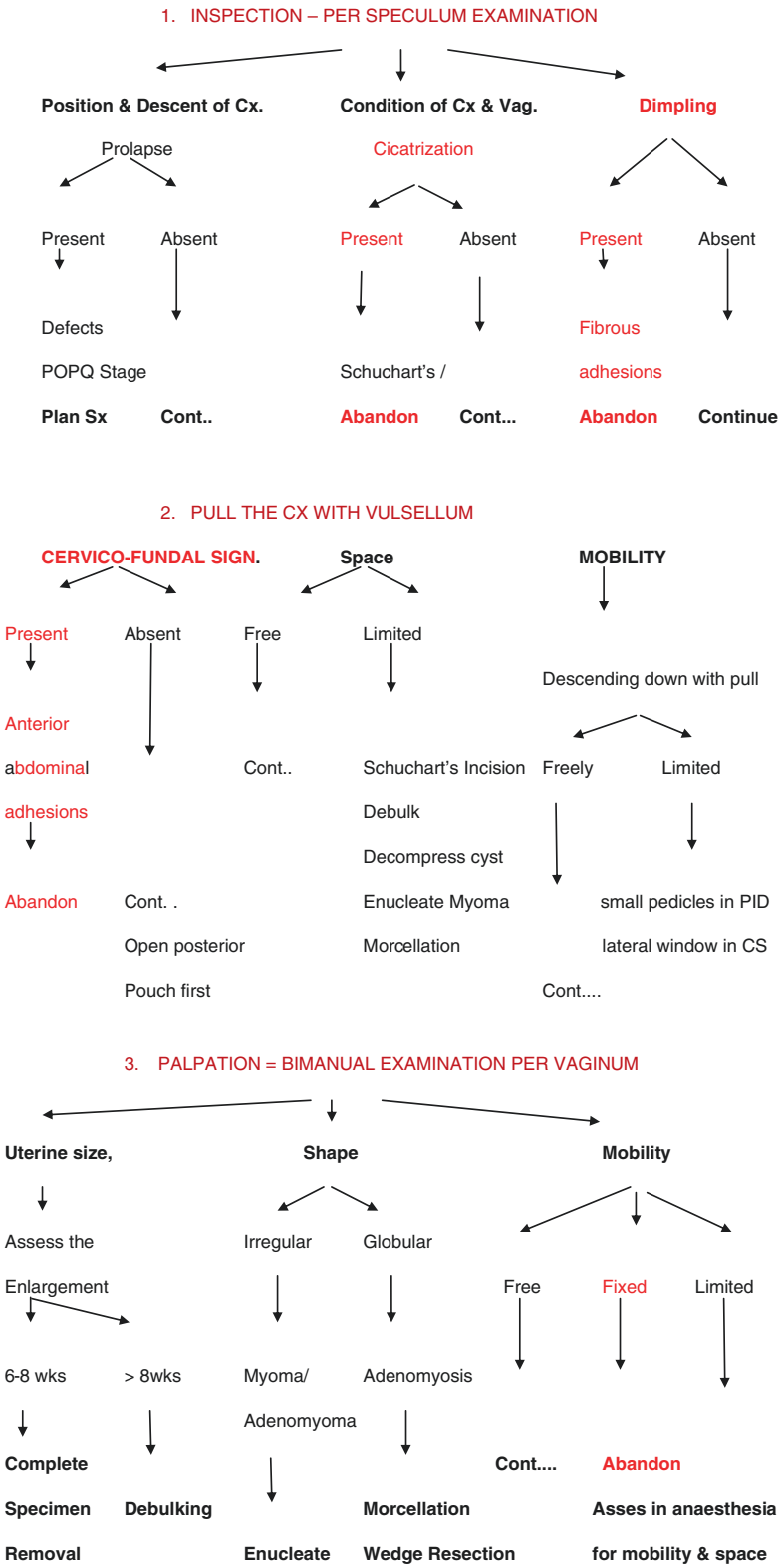
Speculum examination is always followed by thorough bimanual pelvic examination with empty bladder to assess the size, shape, contour, consistency, position and mobility. Restricted mobility is a sign of difficulty and ideally tackled by an expert hand. Fixed, completely non motile uterus with tubo-ovarian mass is a contraindication for vaginal route and these steps should never be taken casually while pre-operative assessment. Restricted mobility cases needs requantification after regional anaesthesia (spinal/epidural) immediately prior to surgery. Re-evaluation of case just prior to surgery, under anaesthesia (EUA) confirms the previous findings, gives additional idea of mobility and adnexal pathologies as patient does not resist examination.

Some recommends Laparoscopic visualization and adhesiolysis if required in difficult cases followed by vaginal delivery of uterus. All the difficulty aspects judged properly during pre-operative workup, dissection skills and knowledge of pelvic anatomy are all that is needed to successfully manage a case vaginally in complicated scenerios.

Tackling Principles

1. **Uterus**: size can be reduced by different morcellation techniques after ligating the uterine vessels. Irregular shape and bossilations due to myomas specially lateral wall reduce the available work space and proper application of clamps. Localization, type and size of myomas should be clearified by clinical examination and imaging. They should be enucleated first if required to create space and mobility.

Chart 126.1 Preoperative workup



2. **Mobility**: It should be checked in all directions and compartments. Limited or restricted mobility is due to dense, fibrotic adhesion bands developing in cases of Endometriosis, pelvic tuberculosis, previous surgeries etc. Mobility is achieved as we start dividing supporting ligaments. Assistant pulls the cervix to opposite side while the surgeon palpates the uterosacral ligament by his left index finger in posterior fornix and places the posterior

prong of clamp grasping it and then close it by sliding over the cervix anteriorly (Fig. 126.1). This is followed by transverse cervical ligament that too in two bites (Small & Multiple clamping) in a large adherent uterus to make it descend.

There is no fixed rule in difficult cases which pouch to be opened first, whichever is easily assessable should be opened first and then surgeon's finger guides the way for the other. The key is to start from the comparatively free side to get the necessary plane and advance. Example: In previous caesarean cases, there is high chance of adhesions anteriorly at utero-vesicle area that too in centre where the incision was made. Mobilisation by sharp dissection is recommended compared to blunt finger dissection, as finger may poke the bladder taking the path of least resistance in cases of adhesion bands (Fig. 126.2). In such cases to avoid bladder injury we start the dissection laterally near the broad ligament folds to identify the utero-vesicle plane. (**Sheth's Lateral Window**). In endometriosis chances are more for posterior adhesions –rectal probe or the assistant can put a finger in rectum and manipulate to get free area to start with without injuring the bowel. If no plane is found, last resort is leaving a thin layer of uterine serosa in situ to avoid visceral injury.

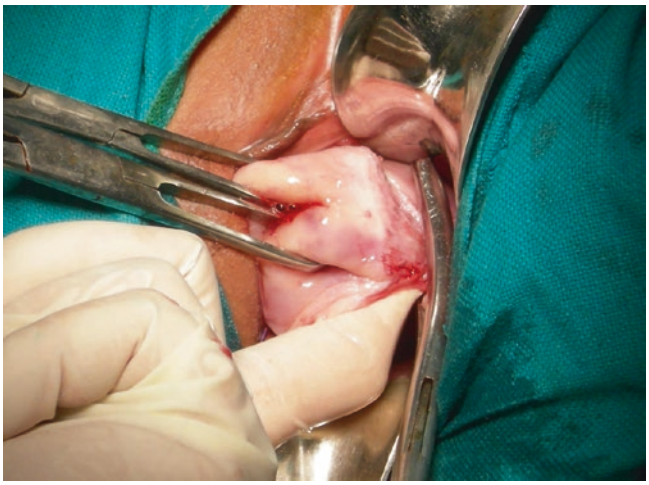


Fig. 126.1 Uterosacral Mackenrodt's ligament clamping

3. **Space**: Vaginal walls should be retracted by proper retractors. Correct size and angled retractors helps the surgeon a lot in easing the procedure. We prefer Posterior single bladed weighted Sims, anteriorly bladder retractor and long bladed Deaver's retractor once the pouch is opened and lateral obtuse angled retractors. Self retaining Magrina-Bookwalter vaginal retractor can also be used (Fig. 126.3). Cicatrizing vagina, narrow introital space can be enlarged to some extent by posterior vaginal 'Schuchardt's incision'. Fibroids coming in way should be enucleated for easy manoeuvrability. Ovarian cysts can be punctured but they should be tackled in the end after hysterectomy to get ample space and avoid pulling the infundibulo-pelvic ligaments.

Vaginal approach is facilitated by knowing the exact dimensions, mobility, space, compartment wise defects and experience of the surgeon. Clinically a mobile uterus just

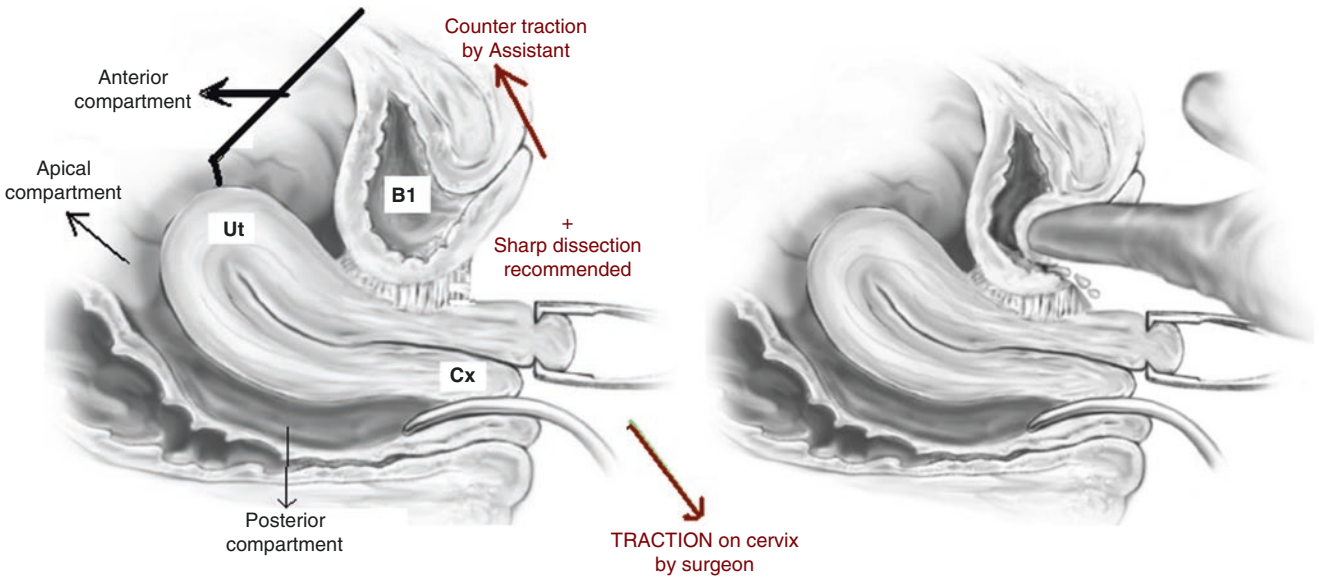


Fig. 126.2 Pelvic compartments and traction & counter traction directions (*Left*), avoid blunt finger dissection to avoid cystostomy (*right*). *Ut* Uterus, *B1* Bladder, *Cx* Cervix



Fig. 126.3 Retractors used for vaginal hysterectomy. (**a**) Sim's weighted single blade. (**b**) Bladder retractor, (**c**) Lateral obtuse angle retractors, (**d**) Self-retaining retractor Magrina-Bookwalter

palpable abdominally or less than 12 week's gestational age size is the best case for vaginal hysterectomy. One can make use of the sonography and other imaging modalities like MRI if available to be clear of the anatomical distortions.

Tentative or Trial Vaginal Hysterectomy

When vaginal approach is planned in difficult and borderline conditions, there is always the chance of conversion (more for beginners) which should be relayed to patient beforehand during the pre-operative discussions, saying that clinical findings will be re-evaluated under anaesthesia in operation theatre, and the final decision of best route of hysterectomy will be taken at that time only. Explained consent should be there.

Stepwise Surgical Considerations in Difficult Cases

1. **Positioning:** Modified lithotomy positioning and the procedure is best accomplished under regional anaesthesia. We use manoeuvrable fully padded stirrups as they avoid nerve compressions and allows surgeon and assistants to



Fig. 126.4 Fully padded stirrups with hand held control

position it themselves if required during surgery to gain optimal exposure, avoid hyperflexion or extreme external rotation and abduction (Fig. 126.4). Regional anaesthesia is best choice for

2. Conventional procedure describes emptying the bladder before surgery with catheter to avoid injury, but we prefer to keep post void urine to be left in bladder in difficult cases as it better delineates the boundaries of the bladder and inadvertent injury results in gush of urine for intra-operative identification. Urethral sounding or filling the bladder retrograde with methylene blue should be done to evaluate the suspected injury site per-operatively.
3. **Anaesthesia:** Regional or general, proper lightening source (fibre optic cable) with suction irrigation and appropriate traction and debulking instruments on traully must be checked.
4. **EUA:** Always reassess the pelvic findings under anaesthesia (EUA) before start so that surgical plan be finalized. We don't prefer self retaining fixed vaginal retractors in difficult enlarged uteri cases as they occupy the space and specific manipulations may be required time to time which is not possible with them. They are really good for freely mobile average size uterus. Avoid using long bladed specula posteriorly as they increase the distance to the cervix. Bladder extent ideally be noted by the bladder sulcus, palpating the bladder reflection on the cervix and should be confirmed by the bladder sound pushed through urethral meatus**.**
5. **Hydrodissection:** Submucousal fluid infiltration is recommended using 100 ml saline (0.9 %) or antibiotic solution with local anaesthetic (0.5–1 % lignocain) and 1: 200,000 adrenaline or 20 unit vasopressin. The goal is to create an area of circumferential blanching around the cervix of approx 4 cm wide and along the length of utero-sacral ligaments, avoiding intra-vascular injection [12]. Saline takes the path of least resistance and separates the planes, lyse filmsy adhesions, pushes the bladder up, antibiotic takes care of post operative infections, anaesthetic relaxes the pelvic floor and adrenalin reduces the bleeding.
6. In nullipara, vaginal cicatrisation or cases with limited introital opening (less than 2.5 cm) a 2–3 cm longitudinal incision can be made either in midline or laterally in distal portion of posterior vaginal wall (Gynaecological episiotomy or Schuchartd's incision) to allow better exposure.
7. **Sharp dissection** is preferred while dissecting between the two viscera as it maintains surgical planes and avoids inuring the soft tissue. Blunt dissection using finger or the gauze on instrument at utero-vesicle junction have the higher chances of cystotomy in previously operated cases (Fig. 126.2). Always keep the tip of scissors towards the cervix.
8. **'Traction and counter-traction mechanism'** be used judiciously. Cervix is kept on continuous traction downward by left hand by surgeon himself and assistant pulls the bladder up which clearly shows the bladder pillars at both sides. These pillars are cut near the cervical side with Mayo's scissors and bladder is pushed up gently in cephalad direction. Dense white adhesive bands can be found in previous caesarean cases which should be tackled from lateral broad ligament to medial side (Sheth's Lateral Window). If no plane can be identifiable a thin serosal layer of uterus can be left towards the bladder.
9. **Cul de sac entry:** Pelosi has described that a posterior small midline cervical colpotomy done first with the stout scissors at the level of cervico –vaginal junction is safe, avoids rectal injury, facilitates entry without unnecessary tissue stripping, blood loss and operating time. While taking the posterior incision, the cervix is pulled up & cephalad by the assistant and the surgeon picks up the loose vaginal mucosa at posterior cervico-vaginal junction in centre with Allie's forceps and pulls down to give a bold nick just above the allies keeping the tip directing towards uterus to open the posterior pouch in one go if possible and then this nick is extended bilaterally. Sims speculum is now placed in the opened cul de sac (Fig. 126.5).

There is no hard and fast rule about which cul de sac be opened first. Surgeon should decide this on his own, based on findings of individual case. The dictum is to start with the easier section to facilitate entry on the difficult sac later. In inaccessible or thick pelvic peritoneum anteriorly, open the pouch of douglas first and insinuate the finger around the fundus of the uterus to make the anterior peritoneum bulge

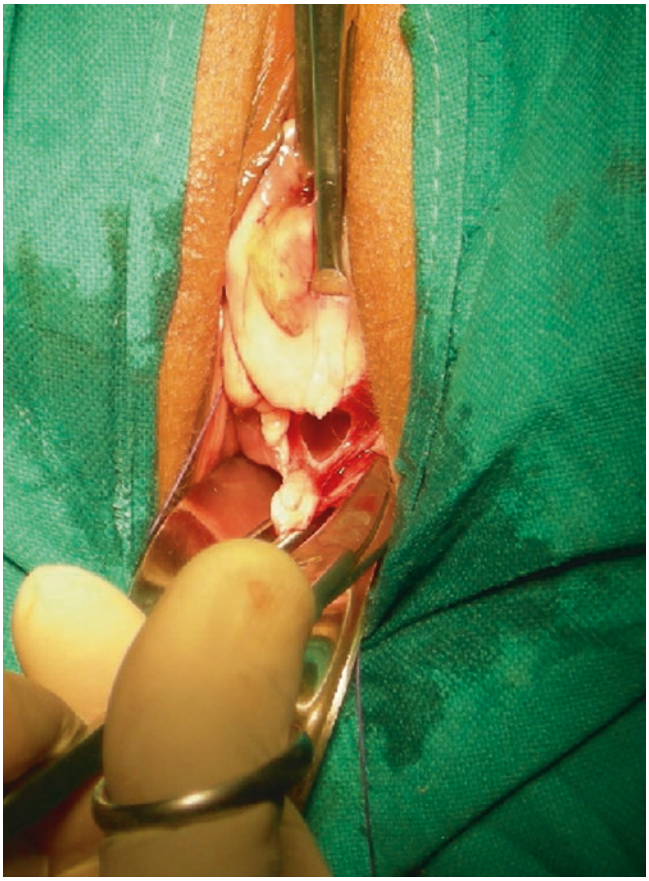


Fig. 126.5 Posterior colpotomy via single bold nick



Fig. 126.6 Access to anterior pouch adhesions from posteriorly

against surgeon's fingers, where it is incised under vision (Fig. 126.6).

During dissection, the scissors tip is always pointed towards the uterine side as it is better to cut into the uterus than to go superficially and end up opening the urinary bladder anteriorly or rectum posteriorly. Keep high index of suspicion during whole surgery. Once any of the cul de sac is opened, re-evaluate the exact uterine size, shape, mobility, associated prolapse, adhesions and adnexal mass if any before proceeding further.

Entry to the peritoneal pouch should never be struggled much, transverse cervical and uterine pedicles can be ligated securely extra-peritonealy also and this paves the way to the pelvic cavity. Once these support ligament complex is separated bilaterally, uterus becomes more free and descends down on manipulate.

Rarely if plane is not found and cystotomy does occur inadvertently, one should not panic, and it should be utilized to determine the appropriate plane through which anterior cul de sac be entered. Cystotomy area is marked by suture for later identification. Bladder extent is better identified through the cystotomy and dissection is done. Hysterectomy should be completed first and the bladder repair is made at the end following the guidelines of repair of the fistula in two layers using 3-0 delayed absorbable suture. In cases of suspected injury, bladder can be filled retrograde with diluted methylene blue solution to check the integrity. Cystoscopy helps in testing the water- tightness, ureteral distance and their patency. After vaginal cystotomy repair, the urinary bladder should be continuously drained for at least 10 days post-operatively through foley's catheter for proper healing

10. **Vaginal Pillars:** Laterally, we prefer cardinal ligament to be divided enmass with vaginal wall thus creating bilateral 'pillars' having strong ligament support to prevent vault prolapse in future. Otherwise if circumferential incision is given on vaginal mucosa then keep the uterosacral- cervical ligament ligatures long to be tied to the vaginal angle in the end. If difficult, take the utero-sacral separately and only cardinal ligament is tied with the vaginal angle**.** Enmass clampless (Fig. 126.7) *or sutureless* division using electro-coagulation of para-cervical attachments has substantial benefits when exposure is limited and there is no space available for applying the clamp [12].
11. **Securing vascular pedicles:** Uterine artery enters the uterus at the level of isthmus identified by the anterior peritoneal reflection. Ascending and descending branches run a tortuous course along the lateral border or uterus. Cervix is pulled to the opposite side and downward to view the stretched out the broad ligament. One should feel the uterine artery pulsations with left index finger and the clamp should be applied at broad ligament as close to the uterus as possible with the tip overlapping the anterior isthmus. Don't transfix the vascular pedicle as one may prick the artery or vein and invite bleeding (Fig. 126.8). Vascular pedicle should be well skeletonised well, before ligation to avoid reactionary haemorrhage later from slippage or retraction of vessels from ligature.

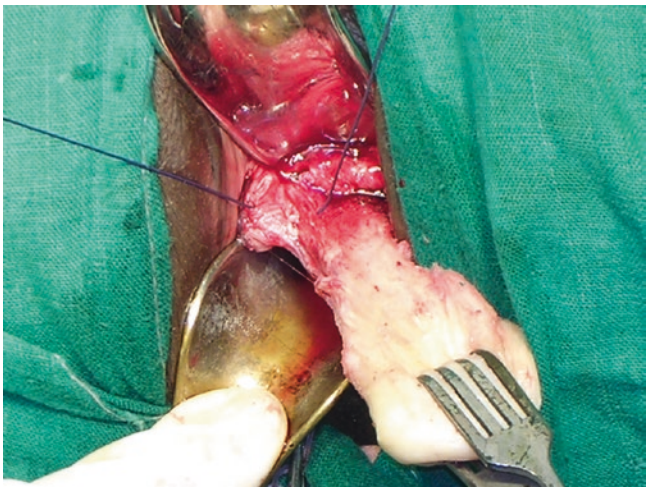


Fig. 126.7 Clampless approach of ligation of pedicles in limited space cases

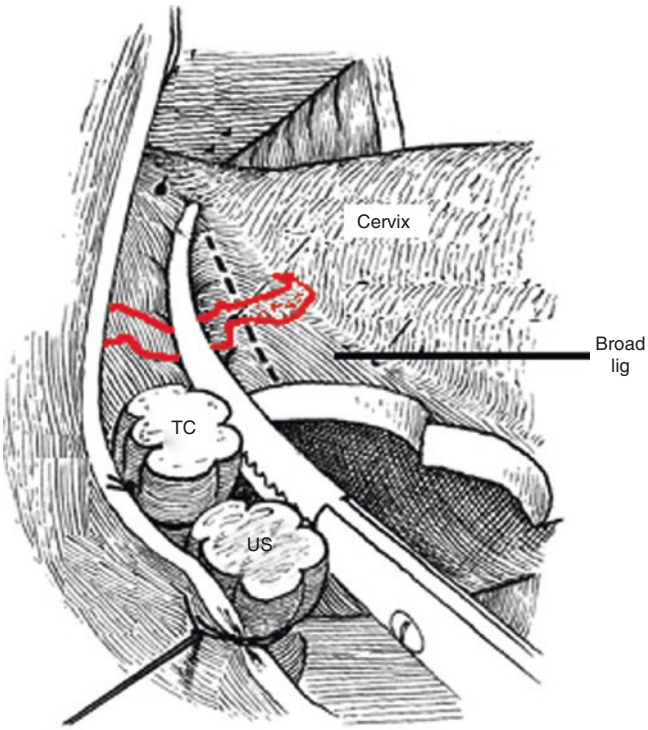


Fig. 126.8 Uterine artery ligation in broad ligament

It is often difficult to place the suture around the clamp and tying it with fingers deep in the vagina with limited space. Endoloops, bipolar coagulation or use of electrosurgical vessel sealing devices helps the surgeon a lot in situations of restricted space. They reduce surgical time, post operative pain, fever and discomfort by reducing necrotic tissue [13].

Ureteric injury although rare but possible by the tip of clamp at the level of cardinal and infundibular ligament clamping. Tips to avoid that are: (1) Apply the clamp as near to uterus as possible. (2) Don't try to take blind sutures in case of pedicle slippage (3) Once the utero-vesicle peritoneum is opened surgeon should palpate the ureters with index finger at 2 and 10 'O'clock against the curved retractor placed outside peritoneum on lateral vaginal wall and then make them out of surgical field by retractors.

12. **Delivering the uterus:** It is impossible to predict whether a grossly enlarged uterus can be removed vaginally or not until the actual attempt is made. With experience even 26 weeks size uterus or up to 1–1.5 kg weight can be removed vaginally using basic principles of debulking or morcellation with experience. Debulking should always be started only after ligating the uterine vessels bilaterally. Commonest procedure is bisection or hemisection, starting at the level of lower uterine segment towards the cervix in midline to divide the uterus and gain access to the cornual structures [14]. Many other debulking procedures are described below.

Forceful traction on the cervix or struggle to deliver out the fundus must be avoided during debulking as this can result in the avulsion of vascular infundibulo-pelvic pedicle. Anatomic orientation should be maintained while morcellating and avoid going far laterally as it may tear or avulse the pedicle. Patiently surgeon should continue morcellation as long as descent of the uterus is maintained or until utero-ovarian pedicle is visible.

13. **Enterocele:** Medial reinforcement of potential space to avoid herniation should be provided by 'vaginal Mc Call culdoplasty' using non-absorbable sutures which are left untied until vaginal mucosa is repaired. Traction on the dependent part of posterior pelvic peritoneum is applied with allies and two to three rows of transverse sutures are taken in it starting from one Mckenrodt's ligament pedicle and ending into another (Fig. 126.9).
14. **Re-peritonization:** Peritoneal closure is debatable but should preferably be done as it exteriorises the pedicles to avoid intra-peritoneal collection later and early identification of the secondary haemorrhage. Any other compartmental defect is repaired if there.
15. **Vault suspension:** Further reinforcement can be done to enforce durability of vault support and making it more anatomical is high utero-sacral attachment of vaginal apex. To locate the uterosacral, palpate the pelvic structures posterior to ischeal spine at 4 and 8 'O'clock and grasp the strong tissue originating from sacrum, keeping the vaginal apex pulled on opposite side. Non-absorbable suture is passed through the medial end of uterosacral and then through the pubocervical and recto –vaginal tissue. Bilateral uterosacrals are plicated in the midline and these sutures move the vaginal apex towards the

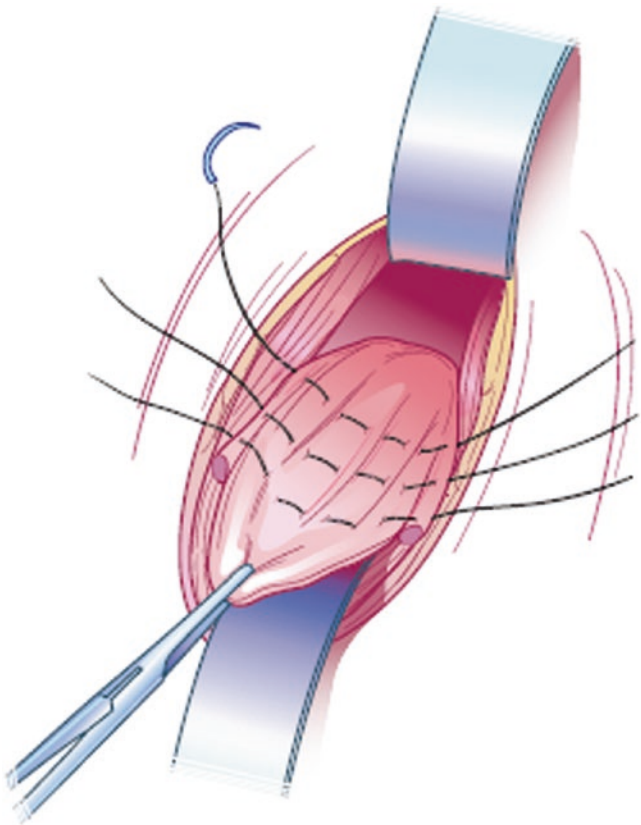


Fig. 126.9 McCall's culdoplasty for enterocele repair

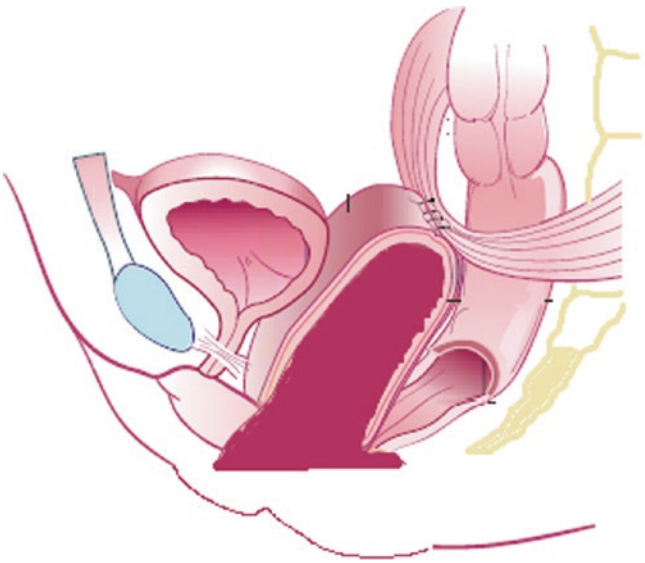


Fig. 126.10 Vault advancement to Utero-sacrals and placation

sacrum and establish continuity of pubocervical and rectovaginal tissues (Fig. 126.10).

16. **Vault closure:** Edges are closed by three interrupted sutures, two at the vaginal angles and one central to allow space for drainage of any collection. Others suggest keeping the vault open.

Conversion in Tentative Vaginal

One should be diligent enough to identify the time to abort vaginal approach and convert it to abdominal in borderline cases. Such conversion is recommended when

- Descent can not be achieved despite morcellation,
- Profuse bleeding.

Conversion is required frequently in cases where

- Pre-op workup and judgment is inadequate or wrongly done,
- Slippage of vascular pedicle with retraction of bleeder in pelvic side wall,
- Lack of experience and Overconfidence.

This has to be differentiated from conversions made in tentative or trial vaginal hysterectomies where possibility was anticipated [15].

Debulking procedures have the major role in removing the enlarged, irregular shaped, adherent uterus.

1. Bisection (Fig. 126.11),
2. Morcellation,
3. Myomectomy,
4. Wedge resection (Fig. 126.12),
5. Coring (Fig. 126.13),
6. Lash procedure (Fig. 126.14),
7. Cervical amputation

Pre-requisites: Debulking should be attempted only after uterine vessels are secured to avoid haemorrhage. Until the anterior cul de sac is opened extra care should be exercised to keep the bladder away. Blood should be kept handy in challenging cases. Literature reports vaginal hysterectomies in 780–1000 cm^3 volumic uterus without laparoscopic assistance [16].

Volumetric landmarks for debulking related to uterine size are;

1. 100–200 cm^3:- easy or average,
2. 201–300 cm^3 = 12–14 weeks size:– expert can do,
3. 301–400 cm^3:- always needs debulking,
4. 401–500 cm^3:- be scheduled as tentative or trial vaginal hysterectomy.

Bisection/Hemisection/Bivalving: means dividing the uterus and cervix longitudinally in two equal halves (Fig. 126.11). It is the first and the commonest debulking procedure tried by gynaecologists to gain access to upper pedicles in chronic pelvic inflammation, enlarged uterus and fibroid for enucleation. In moderate size cases partial bisection often serves the purpose but for larger ones uterus is completely divided into two halves by gradually moving up and up from

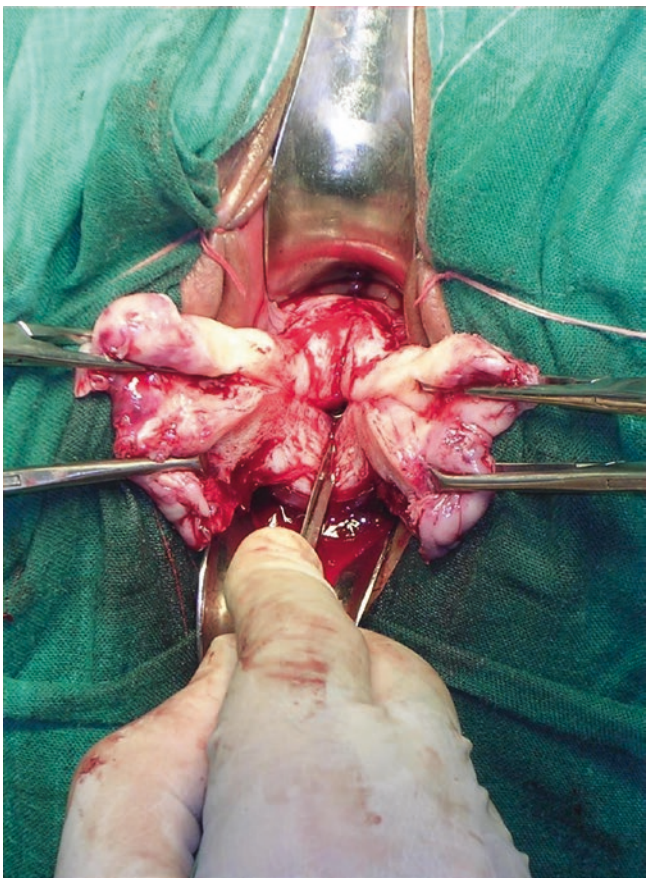


Fig. 126.11 Uterine Bisection

the isthmic region under vision grasping cut edges at higher ends with moderate traction. After hemisection one half is internalized which increases the exposure of cornual structures and mobility of contra-lateral half through introitus [17].

Morcellation: Concept pioneered by Dupuytren, but Amussat first used it in vaginal hysterectomy small elliptical or wedge shaped tissues are cut under vision from the required area to reduce the bulk in transversely enlarged or globular adenomyotic uteri. **Pryor's Technique** of '*systematic anterior wedge morcillation'* on both sides of midline after anterior wall bisection avoids complications. Always take care of reaching the serosa while debulking as it may increase chances of visceral injury.

Myomectomy: Fibroid is the commonest cause of enlarged uterus followed by adenomyosis, and chronic inflammation [18]. Both size and location of fibroid plays important role in decision making. Urography or if feasible MRI should be prescribed in cases with uterus more than 24 weeks size, rapid growth, marked vascularity, adnexal pathology, cervical or lateral wall fibroid, suspected adenomyosis or history of episodic retention of urine [19]. Ureteric catheterization has not much role in vaginal approach as in abdominal one.

- ***Very large fibroid*** of more than 8 cm , fundal or cornual fibroids, those causing transverse enlargement of corpus, large broad ligament fibroids are usually inaccessible and pose real challenge in delivering out because, cornual and infundibular vascular pedicle may tear or bleed. In such cases one should select the most accessible fibroid first, incise at the maximal bulging on uterine wall anteriorly or posteriorly and try to enucleate as a whole or piecemeal using myoma screw or any other stabilizing instrument.
- Large fundal ***fibroid*** inaccessible from below can be approached either from compressed posterior surface or through cavity after bivalving.
- ***Posterior wall myoma*** are accessed from incision on posterior wall. If placed high, first bisect partially to gain better access followed by enucleation.
- In cases of ***multiple fibroids*** central proximal fibroids are removed first followed by the lateral wall fibroids from proximal to distal.
- ***Medical debulking*** can be tried by using GnRH analogues as leuprolide acetate 3.75 mg/month for two doses intramuscularly or low dose Mifepristone 20–25 mg or Ulipristil acetate 5 mg daily orally in medically unfit or severely anaemic women. Maximal effect is seen at 12 weeks.

Wedge Resection: good for irregular uterine enlargement. Wedge shaped tissues are excised from the most accessible part with apex being carried from the highest level surgeon can reach with the scalpel. Continued gentle traction on cervix and simultaneous supra-pubic pressure helps in the procedure (Fig. 126.12).

Coring = Core Enucleation: Doyen described that removing cylindrical column of tissue from the centre of dense myometrium leaving just the thin layer, works well in delivering the fundus. Incise at the lines of tension produced y downward traction results in descent further & further. Coring aims to convert a globular enlarged uterus into an elongated sausage like structure (Fig. 126.13). Coring tube can also be pressed into the centre of tissue and advanced to the depth of 3–4 cm by firm rotation [20].

Lash Procedure/Spiral Incisions: Lash advocated the method of multiple zig zag or z shaped"spiral intra -myometrial incisions" up to two third the depth of myometrium (Fig. 126.14) for reducing size without entering the uterine cavity for pyometra or endometrial cancer cases [21].

Cervical Amputation: in cases of grossly hypertrophied cervix or where the uterocervical angle is obtuse as a consequence of solid big myoma trapped above brim, access can not be achieved through hemisection and requires amputation followed by other morcellation techniques.

Adenexectomy: Recommended to be done after completion of hysterectomy as for infundibulo-pelvic ligaments long curved clamps are required which needs space for manipulation. Traditional/Classical approach is through "Lateral pedicle technique" which has a high risk of vessel retraction, incomplete removal (Fig. 126.15). Difficult to do with uterus in situ when fundus is pulled to the opposite side and surgeon passes

his finger around infundibulo-pelvic ligament to pass a clamp around it laterally and high chances of ureteric entrapment.

Recently "Round ligament medial approach" is preferred to remove the adnexal structures, in which tube and ovary are placed on traction using Babcock while round ligament is secured and divided first. Broad ligament is then incised laterally, preferably by electrocautery to skeletonise the infundibular vessels and long curved clamp is placed across it medially to secure ovarian vessels (Fig. 126.16). Polyglactin endoloop ligatures can be used instead of routine sutures

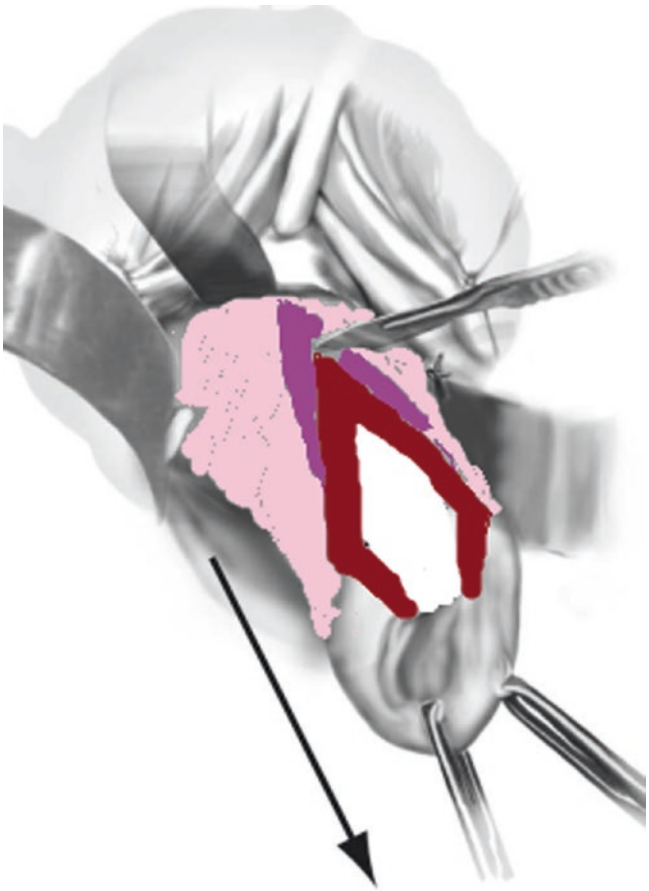


Fig. 126.12 Wedge Resection

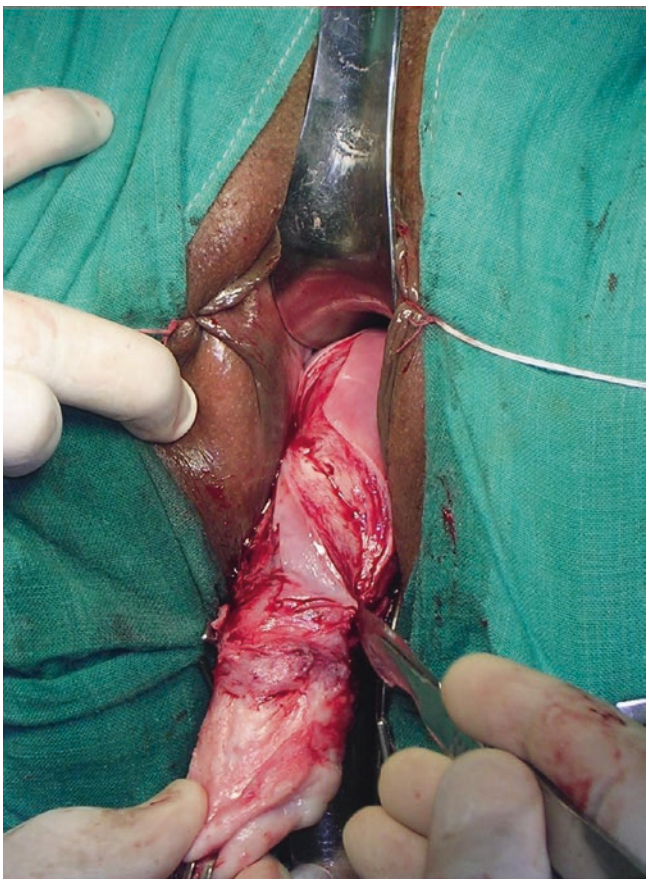
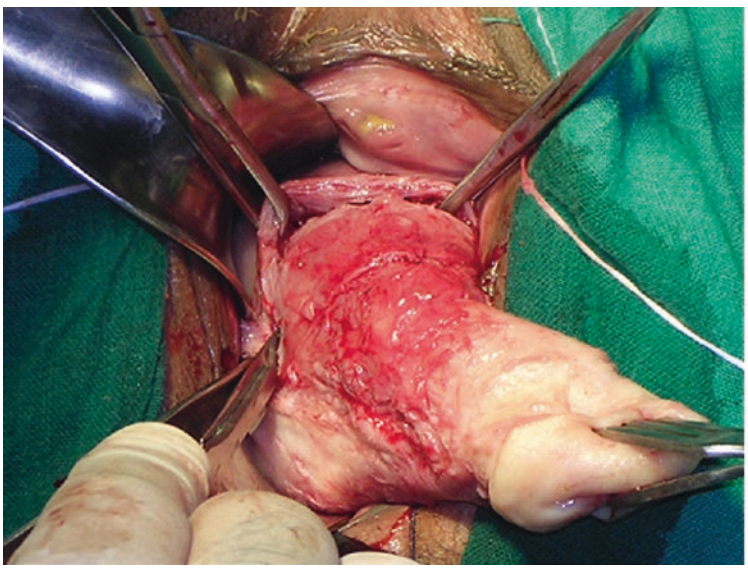


Fig. 126.14 Spiral incision for uterine delivery



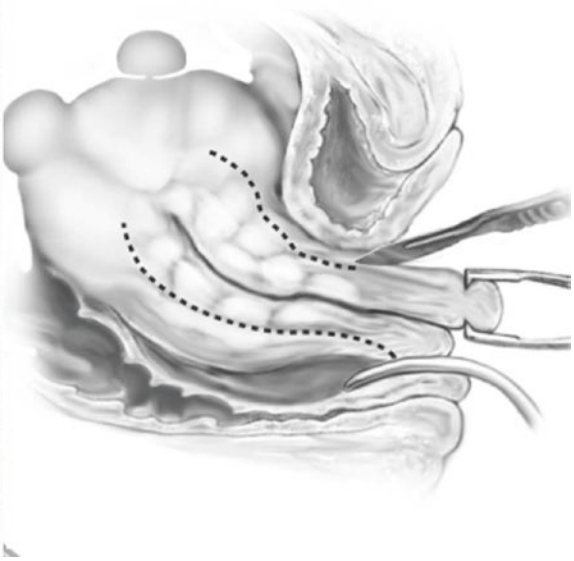


Fig. 126.13 Coring a method of debulking globularly enlarged uterus

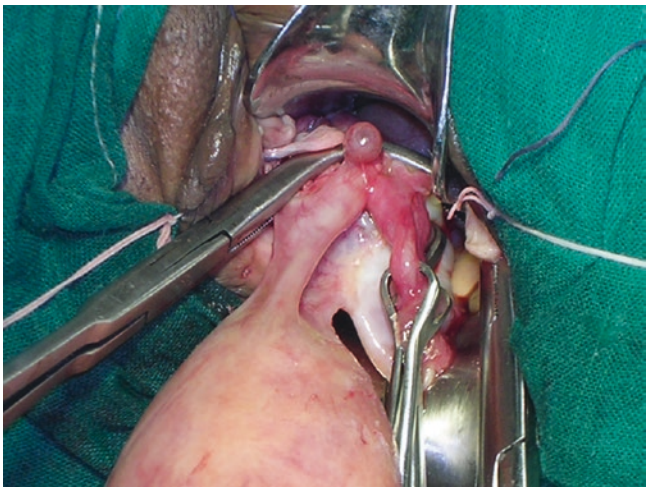


Fig. 126.15 Traditional lateral approach to salpingo-opherectomy

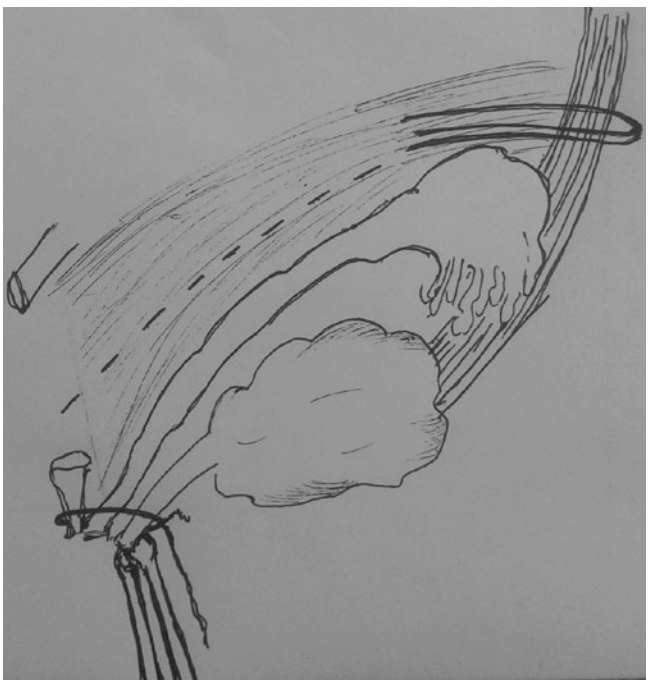


Fig. 126.16 New medial round ligament approach to salpingo-opherectomy

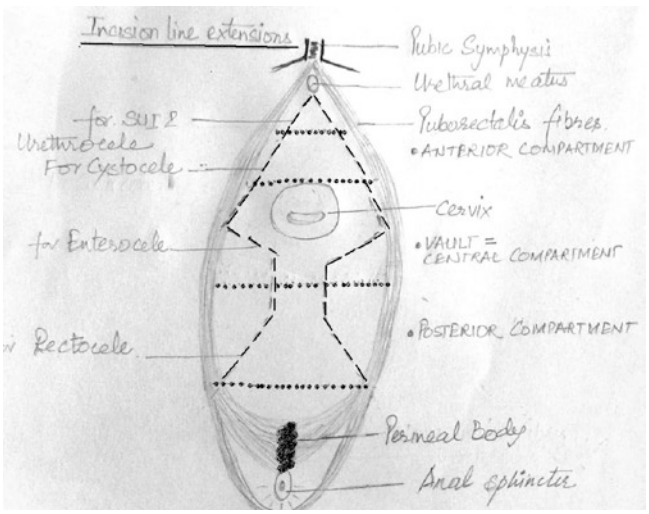


Fig. 126.17 Racquet shaped incision in cases of Utero-vaginal prolapse

around the infundibular ligament to facilitate tying deep within the vagina [22, 23].

Ward Mayo's operation is another type of vaginal hysterectomy which includes thorough reconstitution of endopelvic fascia and pelvic floor musculature in cases of utero-vaginal prolapse. Most of the steps are similar to non-descent hysterectomy except a few as follows.

1. Pre-operative assessment of defects of all the compartments needs to be analyzed properly by Pelvic Organ prolapse Quantification (POPQ) system along with evaluation of stress urinary incontinence (SUI), perineal body and anal sphincter to decide the surgical plan of colporrhaphy, colpo-perineorrhaphy and enterocele repair vaginally.
2. Instead of circumferential incision all around the cervix, it is preferred to give a "racquet shaped incision" (Fig. 126.17).
3. There is increased chances of bladder and ureteric injuries specially in procedentia cases which should be dealt with as described above by assessing the location and extent of both.
4. After hysterectomy by hooking the index finger in pouch of douglas any potential hernia sac should be defined and dissected from the rectum below. This Enterocele sac should be excised as far as its upper limit after pushing the bowel loops and edges are transfixed at highest point with utero-sacral ligaments and left untied for the end.
5. Cystocele and rectocele occurs due to facial defects and weakness which needs buttressing and excision of redundant vaginal mucosa (Fig. 126.18) while in recurrent and severe cases one can use the mesh strips along with buttressing for the better support and prevention of recurrence.
6. For stress urinary incontinence, bladder neck and urethra should be dissected from vaginal wall laterally up to the anterior fibres of puborectalis is seen. Continuous fascial buttress is created in front of bladder neck using series of Lambert sutures. In severe cases this can be reinforced with second layer of sutures inserted in puborectalis termed as 'Pacey technique'. We prefer to do the Transobturator tape (TOT) in same sitting if patient had demonstrable Incotinence on cough impulse and urethral hypermobility on sonography.

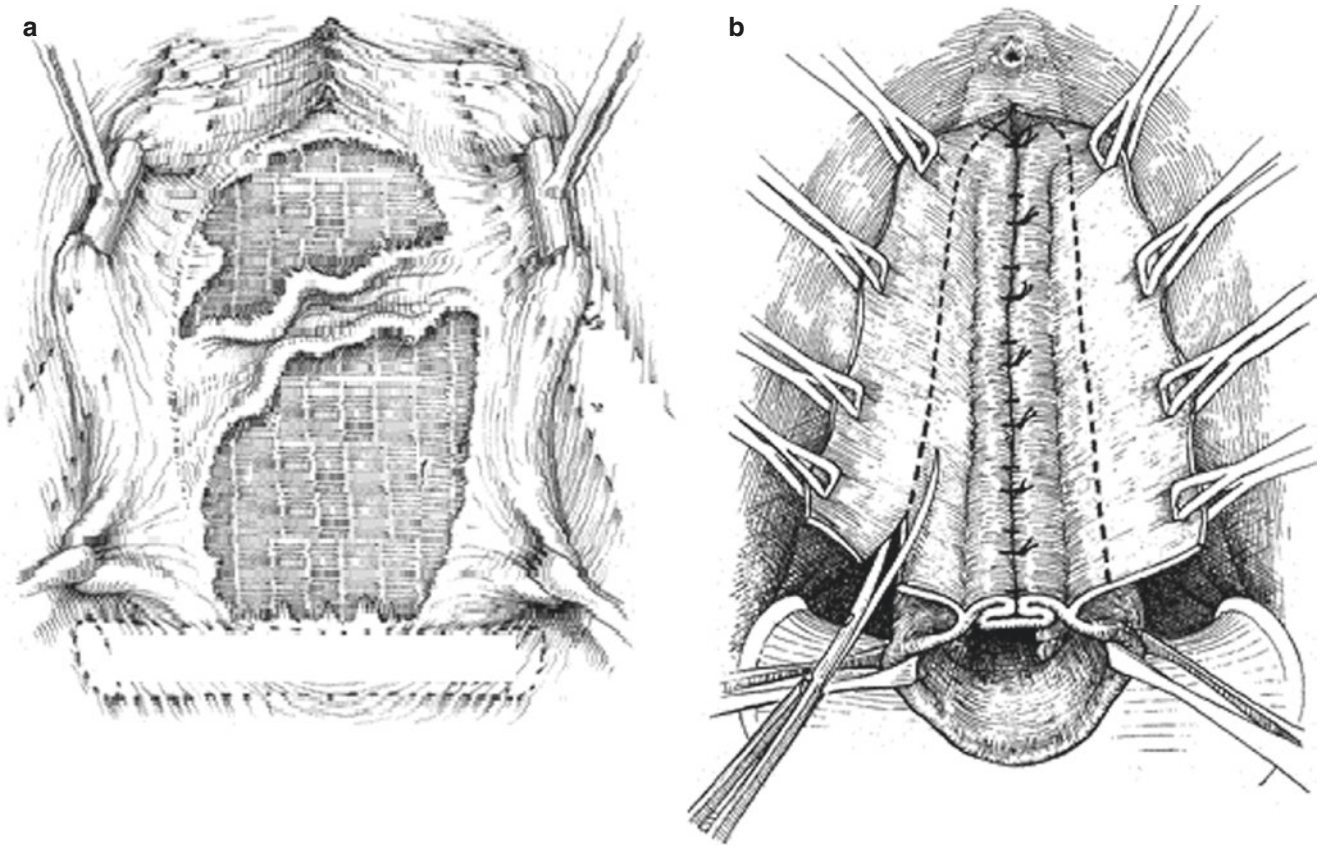


Fig. 126.18 Fascial tears in posterior wall – Rectocele (**a**) and buttressing of fascia done in Cystocele (**b**)

Complications: complication rates are least in vaginal route (7.8 %) compared to the abdominal (9.1 %) or laparoscopy (8.8 %) [24, 25].

Haemorrhage: requirement of blood transfusion is less 8.3 % in vaginal route compared to 15.4 % in the abdominal [26].

- Primary Haemorrhage occurs due to retracted uterine or infundibular vessels. In such cases try to relocate the vessel but there is high chances of ureteric injury on blind clamping or ligature. If difficult, convert to abdominal route.
- Reactionary haemorrhage occurs due to slippage of ligature later leading to intra-abdominal bleed, pain, and shock which can be confirmed by sign, symptoms, sonography and paracentesis. If bleeding is continuous or profuse and causing haemodynamic instability, reopen the case in emergency, identify bleeder & secure it or go for internal iliac artery ligation or embolization if facility available.
- Pelvic haematoma – explore vaginally for bleeding, create tunnel for drainage, give antibiotics and haemostatics to manage.
- Secondary haemorrhage due to sepsis occurs after 1–2 weeks, which requires cleaning of the vault, antibiotics and at times drainage under anaesthesia.

Viceral Injuries: Bladder, Bowel & Ureteric injury (0.2/1000) incidence is less in vaginal hysterectomy compared to other routes. Bowel is prone in chronic PID, pelvic tuberculosis, endometriosis, malignancy, crohn's disease, ulcerative colitis & in previous surgery cases [27].

Nerve injuries due to poor positioning in prolonged surgeries – femoral, sciatic & paroneal [28].

Vault prolapse if proper suspensory precautions as vault fixation with cardinal ligaments, placation of uterosacrals, enterocele repair etc. are not used during surgery. Right sacrospinous colpopexy can be done along with hysterectomy to avoid it [29].

Infection leading to febrile morbidity. Pre-op cleaning, intra-op antibiotic infiltration and post-op prophylactic antibiotics can decrease the incidence.

Vault Evisceration first reported by McGregor in 1907 of bowel, omentum and tubes through ruptured vault [30]. Reposition the content if non-necrotic under anaesthesia and re-suture the vault.

Late squeal: Granulation tissue causes blood stained discharge. If large, requires excision followed by chemical cauterization by silver nitrate. Dysparunea, sexual dysfunction, depression due to shortened and constricted vagina, residual ovary syndrome, and postmenopausal symptoms occurs after 1–2 years [31].

Lately Jacob analysed mode of hysterectomy in US and found 64 % are done abdominally 22 % vaginally and 14 % by laparoscopy with increasing trend in laparoscopic approach from 1997 to 2005 [32, 33]. In economically poor developing countries, where facilities for regular check up are not available to the masses, it may then be prudent to opt for hysterectomy rather than conservative approach requiring regular monitoring. Vaginal route is best for them as it saves time, money, energy and does not require advanced technology and instrumentation. Technology advancement should be used as adjuvant in selected cases to help completing vaginal hysterectomy safely and securely [34].

Conclusion

Cochrane database suggests that vaginal hysterectomy should be the procedure of choice when technically feasible as it has significantly better outcome on all parameters. Routine use of laparoscopy or robotics should be avoided as it is unnecessary expense of time, money, resource and morbidity.

References

1. Schroeder CLE. Uber totale extirpation des uterus von der Scheide us. AllgWien Med Ztg. 1880;25:423–52.
2. Richelot LG. In: Doin O, ed. Hysterctomie Vaginale: Indications et Mannuel Operatoire. Paris; 1894.
3. Doyen. Cited in Green Armytage CB. Vaginal hysterectomy: new technique –followup of 500 cases for haemorrhage. J Obstet Gynaecol Br Emp. 1939;46:848–56.
4. Schauta F. Die Daurresultate der Erweiterten Vainalen total extirpation des uterus bei kollumkrebs. Dtsch Med Wochenschr. 1909;35:1682–5.
5. Mitra S. Extraperitoneal lymphadenectomy and radical vaginal hysterectomy for cancer of cervix. Am J Obstet Gynecol. 1959;78:191–6.
6. Sutton CJG. Hysterectomy: a historical perspective. In: Wood C, Maher P, editors. Bailliere's clinical obstetrics and gynaecology, Hysterectomy, vol. 11. London: Bailliere Tindall; 1997. p. 1–23.
7. Kovac SR, Barhan S, Lister M, Tucker L, Bishop M, Das A. Guidelines for the selection of the route of hysterectomy: application in a resident clinic population. Am J Obstet Gynecol. 2002;187:1521.
8. Wu JM, Wechter ME, Geller EJ, Nguyen TV, Visco AG. Hysterectomy rate in US 2003. Obstet Gynecol. 2007;110(5):1091–5.
9. Colaco J, Campos AP, Nunes F, Pereira A, Retto H. Route of hysterectomy: vaginal versus abdominal. J Pelvic Med Surg. 2003;9:63–73.
10. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2009;(3):CD0037677.
11. Rosanne M. Kho. Simplifying the difficult vaginal hysterectomy. Female Patient. 2008;33:30–6.
12. Pelosi MA III, Pelosi MA. Simplified vaginal hysterectomy. NJ Med. 1997;94:33–9.
13. Levy B, Emery L. Randomized trial of suture versus electrosurgical bipolar vessel sealing in vaginal hysterectomy. Obstet Gynecol. 2003;102(1):147–51.
14. Parulekar SV. Practical gynecology and obstetrics. 5th ed. Mumbai: Vora Medical Publications; 2011.
15. Sheth SS. Vaginal hysterectomy. In: Studd L, editor. Progress in obstetrics & gynaecology. 10th ed.
16. Sheth SS. Vaginal or abdominal hysterectomy. In: Sheth SS, Sutton C, editors. Menorrhagia. Oxford: Isis Medical Medi; 1999. p. 213–37.
17. Pryor WR. The treatment of pelvic inflammation through vagina. Philadelphia: WB Saunders; 1899. p. 209–14.
18. Carlson KJ, Nichols DH, Schiff I, et al. Indications for hysterectomy. N Engl J Med. 1993;328:856–8.
19. Togashi K, Nishimura K, Itoh K, et al. Adenomyosi: diagnosis with MRI. Radiology. 1988;166:111.
20. Kovac SR. Intramyometrial coring as an adjunct to vaginal hysterectomy. Obstet Gynecol. 1986;67:131–6.
21. Lash AF. A method of reducing the size of uterus in vaginal hysterectomy. Am J Obstet Gynecol. 1941;42:452–9.
22. Magrin JF, Cornella JL, Lee RA. Vaginal salpingo –oopherectomy: sufgical techniques. J Pelvic Surg. 1999;5:348–54.
23. Kovac SR. Vaginal hysterectomy. In: Rock JA, Jones HW III, editors. Te Linde's operative gynecology. 10th ed. New Delhi: Wolter Kluwer Health – Lippincott Williams & Wilkins; 2008. p. 744–62.
24. Weber AM, Lee J. Use of alternative technique of hysterectomy in Ohio, 1988-1994. N Engl J Med. 1996;335:483–9.
25. Pratt JH. Operative & post operative difficulties of vaginal hysterectomy. Obstet Gynecol. 1963;21:220–6.
26. Harris WJ. Early complication of abdominal and vaginal hysteresctomy. Obstet Gynecol Surv. 1995;50:795–805.
27. Krebs HB. Intestinal injury in gynaecologic surgery: 10 year experience. Am J Obstet Gynecol. 1986;155:509–14.
28. Dunnihoo D, Huddleson H, North S. Femoral nerve palsy a complication of vaginal hysterectomy: review of world literature. J Gynecol Surg. 1994;10:1.
29. Nicholas DH. Sacrospinous fixation for massive eversion of vagina. Am J Obstet Gynecol. 1982;142:901–4.
30. McGregor AN. Rupture of vaginal vault with protrusion of the small intestines. Obstet Gynaecol Br Commonwlth. 1907;11:252–8.
31. Cruikshank SH, Pixley RL. Methods of vaginal cuff closure and preservation of vaginal depth during transvaginal hysterectomy. Obstet Gynecol. 1987;70:61–3.
32. Jacoby VL, Autry A, Jacobson G. Nationwide use of lap hysterectomy compared with abdominal and vaginal approaches. Obstet Gynecol. 2009;114:1041–8.
33. Parulekar SV. Difficult vaginal hysterectomy: a new approach. JPGO. 2014;1(1):45–8.
34. Niebuhr, et al. Cochrane Database Syst Rev. 2009;CD003677.

Hysterectomy in Women Without Previous Vaginal Delivery

127

Kurush P. Paghdiwalla

If you are going to have your tonsils removed, would you prefer they be taken out through your throat or through an incision on the side of your neck? J. Chassar Moir, MD

There are numerous reports of vaginal hysterectomy performed as early as AD by the Greek physician Soranus, but there is some doubt that the entire uterus was removed. In 1813, the German surgeon Langenbeck performed the first planned and successful removal of the uterus through the vaginal route. Langenbeck must be credited with helping to establish an important surgical procedure, as he had to devise his own plan for the first vaginal removal of the uterus. On September 15, 1815, Joseph Glover of South Carolina performed a vaginal hysterectomy in a nulliparous woman and removed a solid tumour mass weighing five pounds and measuring 11 in. from the fundus in a direct line to the point of section and was 15–18 in. circumference at its greatest diameter. This was the first report of a vaginal hysterectomy in a nulliparous woman. It was Langenbeck in Europe and Glover in the United States who deserve the honour of performing the first planned and successful vaginal hysterectomies [1].

A Nulliparous patient is one, who has never given birth to a viable child, by any route, vaginal birth or caesarean delivery. For the sake of vaginal access, these women could be further categorized, as, those who have been sexually active and those who have never had sex.

Even women, who are parous as a result of a caesarean delivery, and by strict definition, not nulliparous, fall into the category of nulliparous, as far as their vaginal dimensions and access are concerned. Hence it would be best to address this issue as "Vagina Hysterectomy in Women without previous Vagina Delivery"

This chapter will address, issues and minutiae's of vaginal hysterectomy, for benign pathology, (barring Pelvic Organ Prolapse) amongst such women.

Hysterectomy for benign uterine pathology is one of the most practiced surgical interventions in women. The advantages of the vaginal approach in terms of morbidity, operative length of time, post-operative pain, duration of hospital stay, and costs have been very well documented and defined [2–4].

The most common factors limiting the use of vaginal hysterectomy have been a lack of uterine prolapse, nulliparity, history of pelvic surgery, enlarged uterine size, obesity and the need for prophylactic oophorectomy. These criteria have greatly limited the use of the vaginal route and have supported a high frequency of abdominal and laparoscopically assisted or laparoscopic hysterectomies in women without a uterine prolapse. None of them is an absolute contraindication to vaginal hysterectomy [5]. The large variations in practice indicate that the route of surgery is more dependent on the surgeon's skill, and training and mind set, rather than on scientifically defined guidelines, particularly, if considered in the best interest of patients.

This chapter is not a treatise, on the superiority of the vaginal route over all other routes, if practically and technically feasible. There are enough references in the literature to support the claim.

Cochrane database systemic evidence based review, [6] and evidence based studies distinctly conclude that vaginal hysterectomy has the best outcomes and that, when vaginal hysterectomy is not possible, laparoscopic hysterectomy has advantages over abdominal hysterectomy. Reich, who

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pioneered the first laparoscopic hysterectomy, recommended vaginal hysterectomy when it can be safely carried out in preference to laparoscopic hysterectomy [7]. Donnez et al. [8] presented a series of 3190 laparoscopic hysterectomies for benign disease from 1990 to 2006, wherein complications of TLH/LAVH were compared with those of AH and VH. The authors concluded that in experienced hands, TLH is safe, cost-effective, and without any increase in major complication rates. However, when VH can be performed safely, laparoscopic method does not come into picture. In other words, TLH can replace AH. Remarkably, TLH has reduced the incidence of AH to a paltry 3.8 % but only in hands of Donnez.

USA: 264,758 hysterectomies in 2007–2010: [4]

- Abdominal 40 %
- Vaginal 20 %
- Laparoscopic 30 %
- Robotic 10 %

The VALUE national hysterectomy study [9] surveyed 37,298 cases, which is estimated to reflect about 45 % of hysterectomies performed during the period studied. The median age was 45 years, and the most common indication for surgery was dysfunctional uterine bleeding (46 %). Most hysterectomies were carried out by consultants (55 %). The proportions of women having abdominal, vaginal or laparoscopically-assisted hysterectomy were 67 %, 30 % and 3 %, respectively. Forty-three percent of women had no ovaries conserved after surgery. The median length of stay was 5 days. The overall operative complication rate was 3.5 %, and highest for the laparoscopic techniques. The overall post-operative complication rate was 9 %. One percent of these was regarded as severe, with the highest rate for severe in the laparoscopic group (2 %). There were no operative deaths; 14 deaths were reported within the 6-week post-operative period: a crude mortality rate soon after surgery of 0.38 per thousand (95 % CI 0.25–0.64).

> It is interesting to note that those who persist in perfecting themselves in the technique of vaginal hysterectomy gradually disregard more and more of the contraindications so intensely laid down by those with little to no familiarity with the operation. N. Sproat Heaney, MD.

Nulliparity

Absence of prior vaginal delivery, has historically been viewed, if not as an absolute contraindication to the vaginal route, but as a very formidable, unfavourable clinical challenge.

It does have its difficulties, making the procedure less comfortable for the operator, particularly when the space or access is diminished. But this in itself should not encourage the gynaecologists to opt for the laparoscopic or abdominal route, unless there is a clear cut contraindication for the vaginal route.

Although nulliparous patients have narrower or less patulous vaginal dimensions and lesser descent than multiparous may have; in the absence of pelvic pathology when examined under anaesthesia every nullipara with normal pelvic findings will show physiological descent to permit start of a vaginal hysterectomy and each further step facilitates the next one.

Examination under Anaesthesia, invariably allows an experienced vaginal surgeon to complete the procedure successfully.

EUA is ideally performed after placing the patient in Extended Lithotomy position, by careful speculum examination using a vulsellum or tenaculum on the cervix, which gives an accurate estimate of the possible descent. An inaccessible cervix, in this position, should immediately arouse suspicion of some pathology. Another important finding to look for is the accessibility of the posterior pouch. A freely mobile lax posterior sulcus assures the operator of no pathology in the POD, whereas a high dimpled depression in the posterior isthmus, should definitely alert the surgeon to the possibility of an obliterated pouch. Such examination also provides valuable information, about uterine size, adnexal normalcy and uterus-free pelvic space. This coupled with preoperative sonography findings like adnexal normalcy and uterine volume are very reassuring.

Vaginal Accessibility

The initial assessment in determining the route of hysterectomy is vaginal accessibility for transvaginal removal of the uterus. In a study to determine why physicians make decisions regarding abdominal hysterectomy, it was reported that those predisposed to the abdominal route were less likely to take note of uterine mobility or vaginal accessibility in their preoperative examinations, as these factors do not appear to be issues in their decision making [10].

Nulliparity is also not an absolute indication for abdominal hysterectomy. Although access to the vagina may be restricted in some nulliparous women, lack of vaginal accessibility cannot be assumed in all cases. In fact, there is no evidence in the literature to support the widely held belief that nulliparity makes vaginal hysterectomy difficult [11]. In fact, in 1815 Glover [1] performed a vaginal hysterectomy on a nulliparous woman of a considerable size uterus.

Virginity may represent a relative contraindication to the vaginal route. In addition, orthopaedic conditions may restrict the lithotomy position as well as a vagina that is narrower than the two finger-breaths, especially at the vaginal

apex. If the vagina is inaccessible, is the vaginal route deemed not feasible? Even though inaccessibility of the vaginal passageway may be frequently offered as justification to avoid the vaginal approach, one study documented that of 617 women, only 1 % of patients had a vaginal passageway that excluded the performance of the vaginal route [12]. Therefore, abdominal-type or laparoscopic-type hysterectomies are only indicated when vaginal inaccessibility is accurately confirmed.

Sheth et al. have reported the largest series of successful vaginal hysterectomies in 120 young nulliparous women with intact hymen, who were with severe mental handicap or learning disability, that too without any perineal enlarging incisions [13].

Chauveaud et al. in a large series from August 1991 to June 2000 compared the different techniques of hysterectomy for a nonprolapsed benign uterus in 148 women without vaginal deliveries. Forty-four patients had previous caesarean sections (29.7 %), and 104 (70.3 %) were nulliparous. Twenty-four patients had had abdominal myomectomies (16.2 %). The vaginal route (group 1) was used for 77 patients (52 %), 56 (37.8 %) had laparotomies (group 2), and 15 (10.2 %) had laparoscopically assisted Vaginal hysterectomies (group 3). The uterine weight was 275 (+/− SD 140) g in group 1, 830 (+/− SD 1620) in group 2 and 331 (+/− SD 160) in group 3. Mean operation time was 87 (+/− SD 76) min in group 1, 96 (+/− SD 41) in group 2 and 112 (+/− SD 56) in group 3. There was one serious complication with the vaginal route (sigmoid injury). The hospital stay was 4 (+/− SD 3.1) days in group 1, 7.1 (+/− SD 3.8) in group 2 and 4.3 (+/− SD 1.5) in group 3 [14].

Agostini et al., have reported a prospective series, comparing vaginal hysterectomies in nulliparous and multiparous women. Three hundred and forty-five consecutive patients without genital prolapse requiring hysterectomy for benign conditions and without previous pelvic surgery or caesareans were treated prospectively by vaginal hysterectomy. Fifty-two patients were nulliparous and 293 were primiparous or multiparous. The mean operative time was significantly longer in nulliparous patients [95 (55.2) vs 79.9 (34.9) min, $P < 0.01$]. The overall complication rate was significantly higher [7/52 (13.46 %) vs 13/293 (4.44 %), $P = 0.02$, RR = 3.03 (1.27–7.23)] as was the haemorrhage rate in nulliparous compared with the primiparous and multiparous women [4/52 (7.69 %) vs 5/293 (1.7 %), $P = 0.03$, RR = 4.51 (1.25–16.23)]. Vaginal hysterectomy was successfully performed in 96.2 % (50/52) of the nulliparous and 99.7 % (292/293) of the parous patients [$P = 0.06$, RR = 1.04 (0.98–1.09)] [15].

Thus concluding that the success rate of vaginal hysterectomy in nulliparous women is high. However, the risk of complications seems higher than in the parous women, particularly in early learning phase.

Although we are enthusiastic about vaginal hysterectomy in the nulliparous patient, this can be a difficult operation. Needs a level of training, from the easy hysterectomies to the difficult ones. In Figueiredo's series, three hundred consecutive women with nonprolapsed uteri requiring hysterectomy for benign uterine conditions, without suspected adnexal disease, were treated prospectively by vaginal hysterectomy. Twenty-one women (7 %) were nulliparous, and 219 (73 %) had history of pelvic surgery (150 had previous caesareans). Operating time, estimated blood loss, surgical techniques (Heaney, Pelosi, uterine morcellation) operative complications, conversion to laparoscopy or laparotomy, and length of hospital stay were recorded for each case. Vaginal hysterectomy was successful in 297 women (99 %). Morcellation (hemisection, Intramyometrial coring, myomectomy, and wedge resection) was done in 170 cases (56.7 %). The mean operating time was 51 min (range 20–130 min), mean estimated blood loss was 180 mL (range 50–1050 mL), and mean length of hospitalization was 22 h (range 16–72 h). Four operative complications occurred (three cystotomies, one rectal laceration) and were repaired transvaginally. One woman needed a blood transfusion. Eleven urinary tract infections occurred. Two conversions to laparotomy and one conversion to laparoscopy were necessary. This shows that vaginal hysterectomy is an effective and safe procedure for benign nonprolapsed uteri irrespective of nulliparity, previous pelvic surgery, or uterine enlargement. This should make us question the need for laparoscopic or laparotomy route, for a large majority of cases [11].

When uterine enlargement is the only impediment to removal of a relatively mobile uterus, the critical uterine size that predicts morcellation ranges from 10 to 12 weeks gestational equivalent, depending on operators experience and pelvic factors in form of ease of descent, laxity and patulousness, all-round uterus free space, myoma location and adnexal normalcy. However, if the uterus is relatively immobile, morcellation is needed even with a smaller uterine size. The advantage of morcellation in both settings is improved access to the broad ligament attachments and proximal adnexal pedicles. The morcellation technique most commonly used in this study was simple hemi-section. Few uteri needed additional or alternate maneuvers, progressive wedge morcellation of thick uterine walls, techniques that demand more experience but which are readily learned. Supported by these findings, we believe that if hemisection alone were taught and practiced widely and then applied to the majority of contraindicated vaginal hysterectomies, when conventional intact uterine removal was not possible, most surgeons would be able to complete vaginal hysterectomies more safely and effectively.

Careful assessment of the pelvic findings, particularly under anaesthesia, and the operator's ability to deal with it

are essential. Experienced assistance, favourable pelvic tissues and importantly, surgeon's inclination to use the vaginal route are important to accomplish identical results as in the multiparous [16].

Patient Review

Patient evaluation should begin with a good and thorough history of any current problems and should include a detailed gynaecologic medical and surgical histories should be obtained along with a family history of gynaecologic, gastrointestinal tract, or breast malignancies. A sexual history, noting any reports of dyspareunia, should be obtained before surgery. Need for adnexal removal should be ascertained. A thorough physical examination should include general abdominal and pelvic examinations. During the pelvic examination, particular attention should be paid to the size and mobility of the uterus and its physiological descent, associated pelvic relaxation, adnexal masses, uterosacral tenderness, and any areas of pelvic pain during the examination. Patients quite often may not permit a thorough examination, in the clinic setting, so a final review under anaesthesia, is to be considered as a very necessary step. Imaging and laboratory testing should be obtained for anaesthetic fitness.

Practical Steps

- EUA
- Laparoscopic Evaluation, if in doubt, or start procedure vaginally and complete laparoscopically if required
- Smaller instruments
- Schuchardt's Incision or any other perineal enlarging incision (Figs. 127.1 and 127.2).
- Morcellation/Bisection/(Figs. 127.3, 127.4, and 127.5)

However, as one learns and advances some of the steps may be needed lesser and lesser.

Intra-operative

Uterocervical Broad Ligament Space

In cases with suspected anterior uterine adhesions, a surgical window or Sheth's space [17]. Uterocervical broad ligament space can provide required access to the uterovesical peritoneum during vaginal hysterectomy [18].

Clamps and Sutures

Clampless technique allows the operative field to be roomier, facilitating the surgery, and crushing, necrosis, pain, infection and chance of clamp slippage are avoided. However, common practice is to clamp, cut, and ligate.

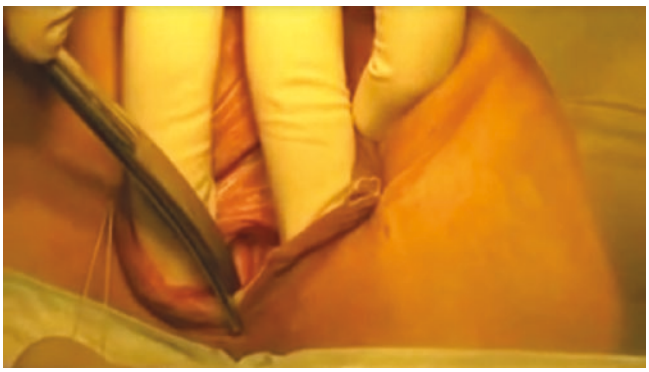


Fig. 127.1 Starting midline episiotomy



Fig. 127.2 Final perineal enlargement

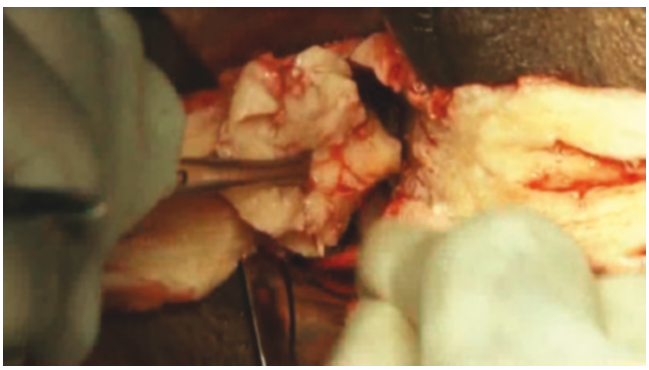


Fig. 127.3 Uterine morcellation



Fig. 127.4 Starting uterine bisection

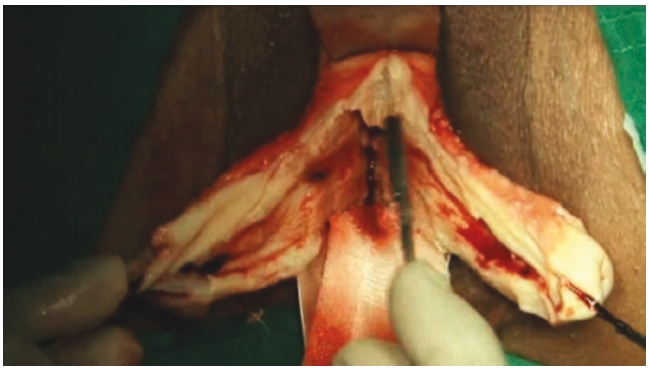


Fig. 127.5 Uterine bisection, increasing access

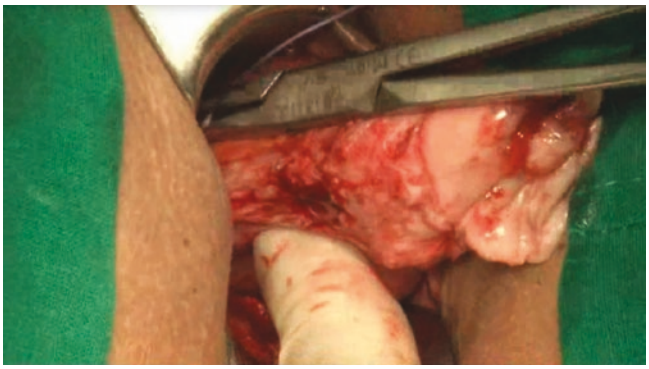


Fig. 127.6 Clamp, cut & ligation technique

Debulking

Debulking is gratifying and easier in a myomatous rather than an adenomyomatous uterus. Debulking either by myomectomy and/or by morcellation is to be carried out only after and never before the uterine vessels are properly secured, so that bleeding, if at all, is negligible [19].

Place of Laparoscopy

Laparoscopic assistance in form of surgery is indicated in patients to undo the contraindication or obstacle [20] and permit vaginal hysterectomy. However, laparoscopic assistance, only to evaluate is indicated in patients in whom there is reason to fear trauma or possible failure to complete vaginal hysterectomy or one that is contraindicated or during formative period to gain the confidence.

Technique

Vaginal hysterectomy involves two important major steps:

- Getting an access to the anterior and posterior peritoneum i.e.: Access to both pouches
- Severance of all lateral connections of the uterus.

It is necessary to have expertise and great familiarity with the anatomy of the tissues to reach both the pouches and for safely securing all lateral connections respectively.

Narrow bladed and/or long reaching vaginal retractors, in some cases, Jayle's self-retaining lateral vaginal wall retractor, different sizes of Sim's and Auward's heavy speculum are useful. Sutures inserted directly are preferred; the clampless technique saves space occupied by the clamps and provides better grip on tissues though latter is practiced by most (Fig. 127.6). After emptying the bladder, careful bimanual examination under anaesthesia confirms the presence or absence of contraindications to the surgery. If required, rectovaginal abdominal examination can be done. The drape is



Fig. 127.7 Circumferential incision on the anterior vaginal wall

anchored to the perineal skin just above the anus. The cervix is preferably seized by two traction sutures with thick silk instead of a vulsellum. Infiltration of the sub epithelial tissues around cervix with 10–15 ml of 0.005 % phenylephrine in saline after receiving clearance from the anaesthesiologist or 100–150 ml of sterile saline to act as an internal tourniquet to reduce bleeding facilitates the planes for dissection and reduces post-operative infection from phenylephrine.

Access to the Anterior Pouch: Vesico-Uterine Peritoneum

The intra-operative identification of correct planes and space depends on the surgeon's knowledge of surgical anatomy and especially the surgical landmarks as seen in the operative fields. The surgeon takes separate anterior and posterior incisions or has a circumferential incision around the cervix below the line of the bladder (Fig. 127.7). Making the incision anteriorly, first and getting access to the peritoneum is more reassuring with less bleeding, than getting access from the posterior edge. For the correct plane of dissection between the bladder and utero-cervical surface, note the point of attachment of the vaginal mucosa to the cervix and the bladder bulge above it (Fig. 127.8). The bladder margin on the anterior

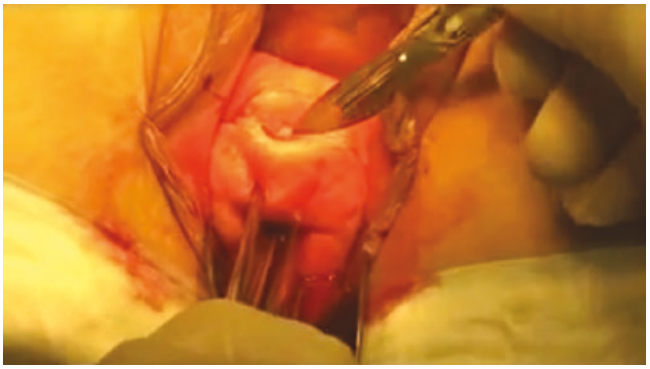


Fig. 127.8 Correct plane for bladder separation, between vagina and cervico-vaginal fascia



Fig. 127.10 Creating proper plane of cleavage between bladder and cervix

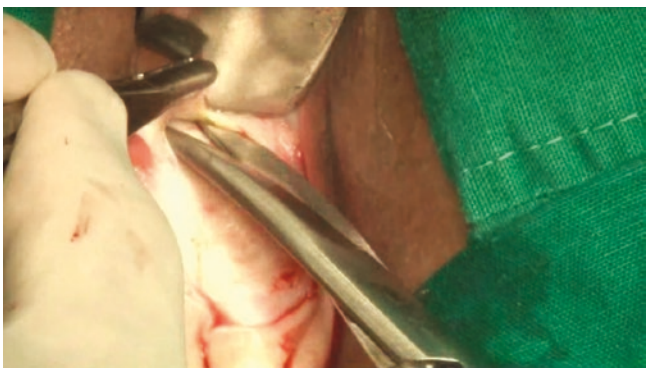


Fig. 127.9 Correct depth of dissection, by retraction of vaginal mucosa

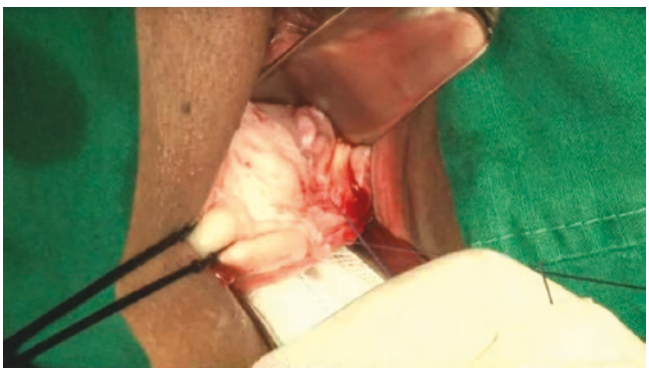


Fig. 127.11 Visualization and severance of lateral uterine attachments

cervical surface typically forms a crease in the overlying vaginal epithelium, which can be accentuated by in-and-out displacement of the cervix with the vulsellum. The incision is above the border between the smooth cervical mucosa and the vaginal rugae and at the same time below the bulge of the bladder. Retracting mucosa guides the depth of the incision (Fig. 127.9). Strong traction on the cervix and counter pressure on the upper vaginal mucosal margin with Allis forceps will display cervico- vesical ligaments stretching from the bladder to the cervical surface to be divided with scissors. A central approach should be the routine but in those with a history of caesarean the approach should always be from lateral space. Familiarity with these strands acts as a useful guide. A pair of scissors with point directed downward against the uterus now cuts the strands of fibres close to the cervix, which paves the way for the next stroke of the scissors to obtain a proper plane of cleavage between the bladder and the cervix. A bladder retractor or the tip of the index finger (Fig. 127.10), flexed at the first metacarpal joint, pressing hard on the cervix, and pushed upwards, and the uterine body is well felt and seen covered by thin peritoneum – the bladder is separated. A similar motion is carried out using a sponge holder at the time of an abdominal hysterectomy. Avoid oozing by pushing upwards with a gauze-covered index finger. A retractor must be placed

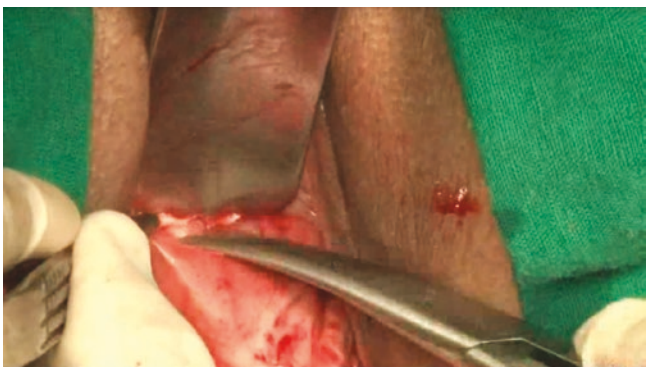


Fig. 127.12 Opening the anterior pouch or utero-vesical peritoneal fold

into the anterior cul-de-sac to retract the bladder superiorly, and to place the lateral uterine attachment on tension to protect the ureters and to facilitate severance of lateral pedicles (Fig. 127.11). A gentle feel with the finger clearly confirms that only a thin pearly white translucent layer of peritoneum is lying on the V shaped with wider arms, shiny serosal surface of the uterus, which is easily picked up with a toothed forceps (Fig. 127.12). The peritoneum may be opened now or later.

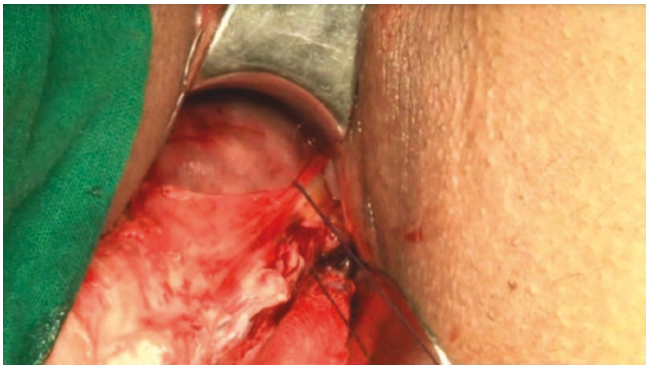


Fig. 127.13 Severance of the upper uterine pedicle

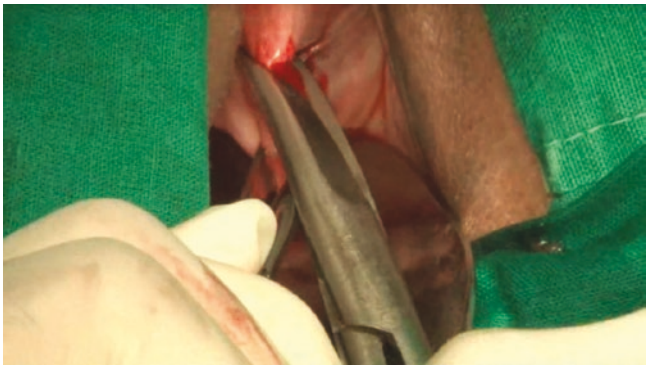


Fig. 127.14 Posterior crease for accessing Posterior Pouch of POD

Occasionally, peritoneal fluid escapes freely and the surgeon is tempted to check once again that all is right.

When not being able to reach the peritoneal site earlier, careful severance of the cardinal, uterosacral, vesicouterine ligaments and uterine vessels bilaterally, will lead to the anterior peritoneal reflection, provided angles of the bladder and the bladder are retracted laterally and superiorly away from the uterus by a bladder retractor between the utero-cervical surface and bladder. When at this stage, if an anterior access is difficult the index and middle fingers of the left hand can be inserted through the posterior cul-de-sac and brought to the front or uterovesical reflection so as to permit an incision of the thin peritoneum as it rests on the fingers under direct vision followed by severance of upper pedicles (Fig. 127.13).

During early parts of the learning curve or in case of the occasional difficulty, bladder sound or metal catheter or instilling a few milliliters of methylene blue in the bladder can act as a guide to get the plane of dissection.

Special Situations

Previous Abdominal Pelvic Surgery

No less an advocate of vaginal hysterectomy than Heaney [21] believed that a history of previous pelvic surgery precluded removal of the uterus through the vagina. This has proved to be totally unacceptable. Coulam and Pratt [22] mention that the chief concern in such cases is the risk of injury to the bladder and difficulty in gaining entry through the scarred anterior cul-de-sac.

Based on observations in women with caesarean section in the past that if the bladder is adherent, it is always in the central 3/5 and not the lateral 1/5 and MRI studies at the isthmic level through different planes show a distinct vacant space medial to the line joining the maximally bulging uterus above and the cervix below, with its continuity medially between the uterocervical surface and the bladder, until they come extremely close to each other in the midline and continue laterally between the two leaves of the broad ligament. This non-adherent portion of bladder can be easily approached for separation through Sheth's utero-cervical broad ligament space or a surgical window [18]. Separation is from lateral to medial, occasionally depressed adherent scarred surface guides. Familiarity with this and normal serosal surface are helpful.

Access to the Posterior Pouch: Recto-Vaginal Peritoneum

This access was once the primary method of peritoneal evaluation in infertile women and tubal sterilization, and to date remains a convenient and effective route for retrieval of myomas and ovarian cysts during laparoscopic surgery. The cervix is drawn anteriorly and upwards using traction sutures or a vulsellum, whereas the posterior vaginal wall is retracted with a Sims' speculum. Next, the uterosacral ligaments are noted and the junction of the cervix with the epithelium of the posterior vaginal fornix is identified by pushing the cervix slightly inwards and looking for the characteristic transverse rugosity or crease (Fig. 127.14).

A depression is seen between the two utero-sacral ligaments, which indicate the situation of the floor of the pouch of Douglas. In most, it lies about 3–4 cms from the external os and the pouch of Douglas lies approximately 1–2 cms posterior to or below the first rugosity.

For access to the POD, the posterior vaginal mucosa is incised in one of the two ways:

1. The experienced surgeon may give a bold transverse cut of 3–4 cms just above Allis forceps firmly grasping a chunk of vaginal mucosa including underlying the peritoneum, 1–2 cms posterior to or below the first rugosity or crease on the vaginal mucosa. This straightaway gives gratifying entry into the peritoneal cavity (Fig. 127.15) OR

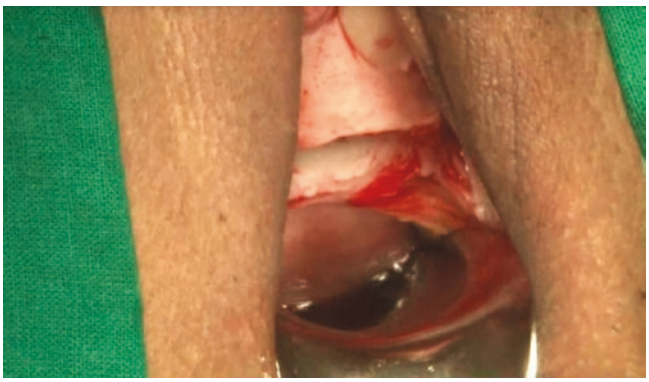


Fig. 127.15 One snip access to the POD

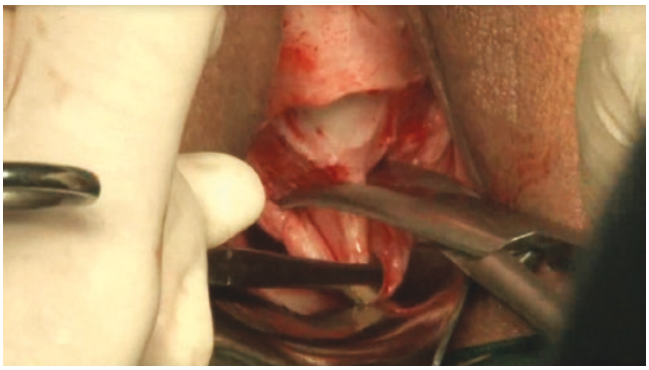


Fig. 127.16 Dissection of the vagina and identifying posterior peritoneum

2. Gently incise 3–4 cms of vaginal mucosa at the same site and the posterior vaginal fornix is exposed. The vaginal skin is then separated with a swab on a sponge holding forceps or the forefinger, to open the cellular tissue between the vagina and rectum and to separate the vagina from the rectum (Fig. 127.16). With a swab firmly pressing and pushing away the tissue from the posterior cervical surface and backwards, this provides the space that distinctly displays bulging thin peritoneum or bulging perirectal tissue containing the peritoneum. Fingers can palpate or experience confirms that the thin bulging translucent tissue is indeed peritoneum. The thin cellular tissue and subjacent peritoneum is picked up in dissecting forceps and opened carefully with scissors, to avoid injury to the rectum. Peritoneal entry is usually heralded by the efflux of a small amount of straw-coloured peritoneal fluid and the characteristic, shiny, white appearance of the peritoneum that lines the cul-de-sac and posterior serosal surface of the uterus. The posterior cul-de-sac is explored with the index finger to exclude adhesions or other pathology and for considering the need to convert the surgery to abdominal approach or to take laparoscopic assistance. Bleeding from the posterior vaginal cuff must be controlled and weighted retractor of appropriate width and length be placed in the cul-de-sac.

Usually a smooth opening of the pouch heralds smooth sailing for the hysterectomy; in fact, obtaining entry to both the pouches is like a trump card for the surgeon. Anyone wanting to learn vaginal hysterectomy will need to be familiar with the anatomy for access to the pouches. Anyone who masters this access will master vaginal hysterectomy.

Special Situations

Presence of a dimple in the posterior vaginal wall adjacent to the pouch of Douglas denotes adhesions due to ovarian endometriosis. Such cases need a second thought even for the experienced vaginal surgeon. Vaginal mucosa overlapping the anterior or posterior cervical lip should not discourage the surgeon, as it needs small dissection close to the respective lip to find the space to reach the peritoneum. Rectal examination is a useful guide in such cases.

Obliterated Pouch of Douglas

Sub-cervical Extra-peritoneal Tunneling

Patients with endometriosis, previous genital tuberculosis, pelvic inflammatory disease, or previous surgery are often found to have an obliterated cul-de-sac. Such cases are ideal for LAVH or abdominal hysterectomy. The safest and most effective approach is to tunnel beneath the posterior cervical surface towards the uterine serosa using digital palpation, until the affected area has been passed. It is vital to remain hugging with pressure to the posterior cervico-uterine surface to avoid rectal trauma and mobilize the obliterated area, facilitate dissection until the free peritoneal space is encountered. Rectal examination is a good guide in these cases. Occasionally, even the uterine arteries must be ligated extraperitoneally, as long as they are close to the uterocervical border. A drop of peritoneal fluid or chocolate like material should delight the operator as access to the peritoneal cavity is obtained. Insertion of a finger or artery forceps through the same opening will then provide further access. Colpotomy performed through the vagina may actually have a lesser potential for morbidity than colpotomy through an abdominal or laparoscopic approach.

Transcervical Access

The cervix is then pulled anteriorly with firm traction. With stout scissors, the surgeon initiates a full-thickness division

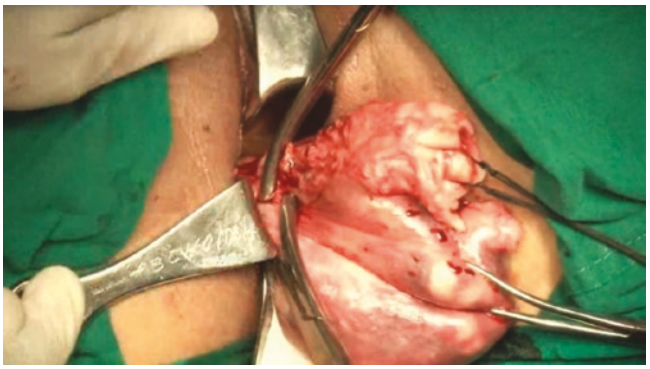


Fig. 127.17 Cornual clamping in case of ovarian conservation

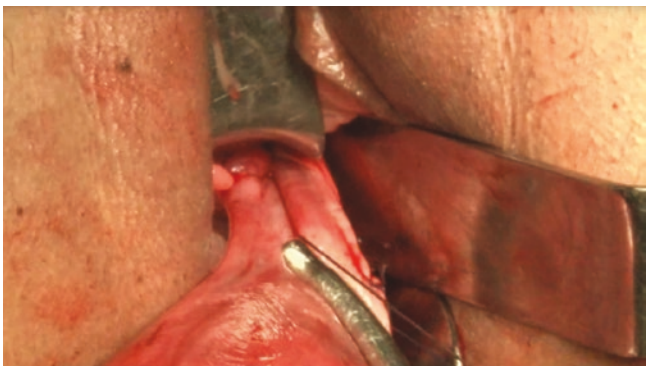


Fig. 127.18 Separate ligation of round ligament to access infundibulo-pelvic ligament

of the posterior cervical wall in the midline – with one blade inserted in the cervical canal, cut from canal to external wall, keeping the rectum away until the peritoneum of the cul-de-sac is entered.

Severance of Uterine Supports and Lateral Connections:

The following three to five pedicles are to be secured on both sides.

If the ovaries are to be preserved, the tubo-ovarian and round ligament as one pedicle (Fig. 127.17).

If not, the tubo-ovarian and round ligament as two separate pedicles (Figs. 127.18 and 127.19). The uterine vessels the cardinal and uterosacral ligament complex pedicle or as two pedicles, approximated later as one. The operator's left index finger enters the peritoneal cavity behind the cardinal and uterosacral ligaments and puts them on stretch. The surgeon has the choice of applying a clamp to the utero-sacral ligament, dividing it and securing the pedicle with a No.1 Vicryl or No. 2 catgut suture, OR placing a direct suture to pierce the upper limit of the pedicle with a needle, to tie and cut it medially.

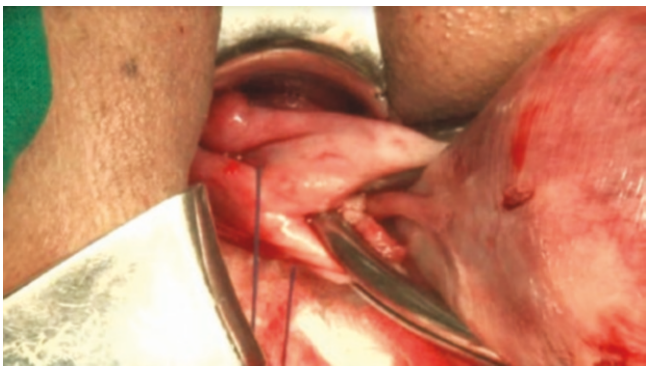


Fig. 127.19 Clamping infundibulo-pelvic ligament through broad ligament window

A suture on a heavy round body needle loaded with vicryl or chromic catgut is passed from front with the left finger in the peritoneal cavity behind the pedicle and with its medial surface of finger in close contact with the lateral border of the uterus. The gloved finger easily senses the progress of the needle and gets reflexly withdrawn as the needle moves forward, and presents its tip for needle holder and thus surrounds the ligament with a suture, away from the cervix and close to vaginal mucosa. Alternatively, the same pedicles are clamped, cut and transfix sutures placed. The pedicles are uterosacral – Mackenrodt's complex, uterine artery, round ligament and infundibulo-pelvic ligament OR round ligament along with tube and utero-ovarian ligament. The uterine vessels, which may include ligamentous tissue, are secured in a similar fashion. Then after, if the open mouth of the cut end of the uterine artery can be seen or uterine vessel with surrounding ligamentous tissue is sutured and secured again i.e. doubly secured but without use of clamp. , it should be picked up with pressure forceps and ligated separately. After the uterine vessels are ligated on each side and threads cut short, the remaining portions of the broad ligament, including the anterior and posterior peritoneum of the broad ligaments on each side are secured and the level of round ligaments is reached. If the operator's fingers at this stage can easily reach the fundal surface, it is apt to deliver the uterus. If not, after rechecking on the uterine size and uterine volume further lateral severance or debulking is required, till the fundus is well felt or else the alternative is to bisect the uterus from cervix upwards and deliver each half to complete hysterectomy. The uterus is delivered from anterior or posterior pouch, though it is simpler, from the spacious posterior pouch. Bulldog vulsellum or large towel clip or Leahey's thyroid clamps may be used for traction on the fundus for uterine delivery (Fig. 127.20). Using undue traction to deliver the uterus puts strain and the risk of tearing the upper pedicle. Ligatures on utero-sacral and cardinal ligament pedicle and upper pedicle on each side are held for suspending the vaginal vault. The surgeon should always doubly ligate all the pedicles. A careful



Fig. 127.20 Uterine fundal delivery for severance of upper pedicles

watch for adherent intestine close to the fundus is necessary. A Roller gauze or recently introduced pneumo pack will keep the field clear [23]. Releasing adnexal adhesions vaginally is easy but must be done cautiously and gently. Before the start of surgical closure, the tubes and ovaries must always be inspected and the extirpated uterus opened in the theatre in order to exclude endometrial carcinoma. Suspicious findings require recourse to frozen section histopathology. Though rare, there is no way to avoid an unfortunate finding of malignancy and this must be kept in mind to spare another surgery for salpingo-oophorectomy in future. If this be found, both appendages must be removed. The basic principles of meticulous haemostasis, copious irrigation, gauze or mop count and elimination of dead space and devitalized tissue in wound closure should be observed. Since the last few years, we prefer to keep the peritoneum open [24] and reconstitute it only if hysterectomy is followed by bladder neck suspension or sacrospinous fixation, to keep encroachment away. If peritoneum is closed purse string closure through transfixing upper and lower pedicles with required bites on utero vesical and Pouch of Douglas peritoneum, should easily place all the pedicles extraperitoneal and provide watertight closure. If peritoneum is kept open, the vaginal cuff must be closed. Surgeon has an option to close the peritoneum and if he does, he has the option to keep vault open, though preferably this is to be closed. After the uterus is removed, restoration of normal anatomy and support must be a major concern. The vaginal vault is closed using the secured pedicles, as anchoring supports. The ideal method is Lower pedicle comprising of uterosacral and cardinal ligament complex of two sides are approximated to each other and then after anchored to anterior vaginal wall margin near its angles, keeping long ligature uncut.

If salpingo-oophorectomy is performed, ligature, on both sides, holding infundibulo-pelvic ligament is approximated and tied to that holding round ligament. Ligature holding round ligament is next approximated and tied to that of opposite side and anchored to posterior vaginal wall margin near its angle on both sides and left uncut. If only oophorectomy is done, ligature is cut short. In the absence of prophylactic oophorectomy, ligature holding upper pedicle comprising of importantly round ligament, tube and utero-ovarian ligament is anchored to posterior vaginal wall margin near its angle on both sides and left uncut. Not crisscrossing ligatures and pedicles from one side to the other will avoid bringing the ovaries towards the midline. Additionally, it is worth approximating the distal part of two utero-sacra's, include intervening posterior peritoneum and obliterate the dead space. Support for the vaginal vault and upper posterior vaginal wall especially must be such as to secure permanent normal position for the vaginal walls. As peritoneum is not routinely closed, prefer to close vaginal mucosa with continuous suture using two zero vicryl. Having anchored upper and lower pedicles to vaginal margins, ligatures on each side anchoring anterior and posterior vaginal walls are tied to each other and this visibly pulls up vaginal vault. We must approximate the uterosacral and cardinal ligament bundles of the two sides to each other and use these sutures to anchor the anterior vaginal margin near angles. Similarly, in an oophorectomised case, approximate the round ligament pedicles to each other and use this to anchor posterior vaginal wall margin near its angles. When ovaries are preserved, each upper pedicle is anchored, similarly to the posterior vaginal wall separately on the same side. Not crisscrossing ligatures and pedicles from one side to the other will avoid bringing the ovaries towards the midline. It is worth to additionally approximate the distal part of uterosacrals, include intervening posterior peritoneum and obliterate the dead space. Support for the vaginal vault and upper posterior vaginal wall especially must be such as to secure permanent normal position for the vaginal walls. Rarely, in a nullipara, limited exposure requires a median episiotomy or a small Schuchardt's incision, which is sutured. There is no need for a vaginal pack unless the field is oozy. Instruments and assistance play a very important role. An indwelling catheter for 24 h helps the patient, nursing and resident staff, but this is optional.

Special Clinical Situation

Large size demands debulking [19].Surgically, enucleation of myoma, morcellation of adenomyotic walls, bisecting cervix or from cervix to fundus, coring, Lash's technique and/or medical debulking using GnRH agonist's earlier [25].

Endoscopic But Vaginally

Magos [26] used an endoscope through the space created by extirpation of the uterus at VH.

Hefni [27] used stapler or bipolar forceps or endoloop for successful bilateral oophorectomy with vaginal endoscopic approach. Surgeons experienced with Roeder's loop may use it freely to catch the meso-ovarium and excise the ovary.

Above is preferred to laparoscopic oophorectomy by one of bipolar coagulation, pre-tied ligature placement, and automatic stapling devices [28] Sheth [29] reported 95 % success while performing prophylactic oophorectomy at vaginal hysterectomy in 740 cases.

Certain prerequisites which should be satisfied in order to safely perform oophorectomy at VH.

1. Experience of vaginal hysterectomy.
2. Normal tubes and ovaries,
3. Easy accessibility and free mobility of the ovaries.
4. It is mandatory to cut the round ligament separately and as laterally as possible, similar to the procedure while performing a salpingo-oophorectomy at abdominal hysterectomy.
5. Better exposure with a steep trendelenburg position, and by using a long roller gauze pack or pneumo pack.

   Post-menopausal women with third degree uterine prolapse form ideal candidates for learning and mastering this technique and avoiding misuse of LAVH or laparotomy.

Subtotal Hysterectomy (Doderlein's Hysterectomy)

Leaving the cervix behind makes laparoscopic or abdominal hysterectomy safer and easier unlike VH, wherein, preservation of the cervix makes the hysterectomy less easy besides advantages of retained cervix are nebulous and disadvantages are disturbing [30, 31]. It is not easy for the inexperienced at vaginal hysterectomy to perform this. Leaving behind the cervix offers no advantage and invites the complications of a retained cervix. Can and should only be used in case of obliteration of the pouch of Douglas, with no contraindication to leave the cervix in-situ. However, if woman is keen, it still avoids an abdominal invasion, and or laparoscopy.

Benign Adnexal Pathology

Can be dealt vaginally concomitantly at VH even in nulliparа. No doubt prerequisites are to be met with before attempting. For example, for a benign, mobile dermoid (Teratoma) cyst, one can without difficulty perform salpingo-oophorectomy at VH. In fact, hysterectomy provides adequate space for the required surgery. Therefore, let mere nulliparity not contraindicate adnexectomy at VH, provided gynecologist is well experienced with BSO at VH[32].

Conclusion

Nulliparity, does not impede successful vaginal hysterectomy, if carried out by an experienced vaginal surgeon. As the surgical skills improve, nulliparity along with other relative risk factors, such as previous caesarean deliveries, obesity, non-prolapsed uteri, and bulky uteri can be successfully tackled through the vaginal route, with or without oophorectomy, without increasing the risk of bladder or bowel injury, or the need of blood transfusions as compared to laparoscopic or abdominal hysterectomies.

Probably the most important aspect, is Examination under Anaesthesia (EUA) and a readiness to convert to a laparoscopic or abdominal route if necessary.

Surgical steps, in addition to routine steps, would be perineal enhancing incisions, uterine bisection, or morcellation.

Difficult is what I do today, the impossible tomorrow!!

References

1. Kennedy JW, Campbell AD. History of vaginal hysterectomy. Vaginal hysterectomy. Philadelphia: FA Davis; 1942. p. 1–55.
2. Den Eeden V, Glasser M, Mathais SD, et al. Quality of life health care utilization and costs among women undergoing hysterectomy in a managed care setting. Am J Obstet Gynecol. 1998;178:91–110.
3. Sheth SS. Vaginal hysterectomy. Best practice & research – clinical obstetrics & gynaecology. Edited by Prof. S. Arulkumaran, (Guest editors R. Thakar & I. Manyonda) 2005; 19(3): 307–332.
4. Jones HW. Choosing the correct hysterectomy technique. In: Sheth SS, editor. Vaginal hysterectomy. 2 ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2014. p. 337–44.
5. Sheth SS. Vaginal hysterectomy. In: Studd J, editor. Progress in obstetrics and gynecology. 10 ed. London: Churchill Livingstone; 1993. p. 317–40.
6. Nieboer TE, Johnson N, Lethaby A. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2009;(3): CD003677.
7. Reich HA. Laparoscopic hysterectomy. In: Hulka JF, Reich H, editors. Textbook of Laparoscopy. Philadelphia: WB Saunders Co; 1998. p. 363–79.
8. Donnez O, Jadoul P, Squifflet J, Donnez J. A series of 3190 laparoscopic hysterectomies for benign disease from 1990 to 2006: evaluation of complications compared with vaginal and abdominal procedures. BJOG. 2009;116:492–500.
9. Maresh MJ, Metcalfe MA, McPherson K, et al. The VALUE national hysterectomy study: description of the patient and their surgery. Br J Obstet Gynecol. 2002;109:302–12.
10. Kovac SR, Christie SJ, Bindbeutel GA. Abdominal versus vaginal hysterectomy: a statistical model for determining physician decision making and patient outcomes. Med Decis Mak. 1991;11:19–28.
11. Figueiredo O, Figueiredo PG, Figueiredo P. Vaginal removal of the benign nonprolapsed uterus: experience with 300 consecutive operations. Obstet Gynecol. 1999;94:348–51.
12. Kovac SR. Guidelines to determine the route of hysterectomy. Obstet Gynecol. 1995;85:18–23.
13. Sheth SS, Malpani A. Vaginal hysterectomy for the management of menstruation in mentally retarded women. Int J Gynaecol Obstet. 1991;35:319–21.
14. Chauveaud A, de Tayrac R, Gervaise A, Anquetil C, Fernandez H. Total hysterectomy for a nonprolapsed, benign uterus in women without vaginal deliveries. J Reprod Med. 2002;47(1):4–8.

15. Agostini A, Bretelle F, Cravello L, Maisonneuve AS, Roger V, Blanc B. Vaginal hysterectomy in nulliparous women without prolapse: a prospective comparative study. BJOG. 2003;110(5): 515–8.
16. Sheth SS. The nulliparous patient. In: Sheth SS, Studd JWW, editors. Vaginal Hysterectomy. London: Martin Dunitz Ltd.; 2002. p. 69–77.
17. Sheth SS. Preoperative sonographic estimation of uterine volume: an aid to determine the route of hysterectomy. J Gynecol Surg. 2002;18:13–22.
18. Sheth SS, Malpani AN. Vaginal hysterectomy following previous caesarean section. Int J Gynecol Obstet. 1995;50:165–9.
19. Pelosi MA., Pelosi MA. A comprehensive approach to morcellation of the large uterus. Contemp Obstet Gynecol. 1997;42:106–25.
20. Kovac SR, Cruiskshank SH, Retto HF. Laparoscopy-assisted vaginal hysterectomy. J Gynecol Surg. 1990;6:185–92.
21. Heaney NS. Vaginal hysterectomy – its indications and technique. Am J Surg. 1940;48:284–8.
22. Coulam CB, Pratt JH. Vaginal hysterectomy. Is previous pelvic operation a contraindication? Am J Obstet Gynecol. 1973;116:252–6.
23. Sheth SS. Pneumo-surgical pack – a preliminary report. Int J Obstet Gynecol. 2003;81:213–5.
24. Royal College of Obstetricians and Gynaecologists (RCOG) guideline no. 15. March 1998. London, U.K.
25. Stovall TG. Gonadotropin-releasing hormone agonist's utilization before hysterectomy. Clin Obstet Gynecol. 1993;36:642–9.
26. Davies A, O'Conner H, Magos AL. A prospective study to evaluate oophorectomy at the time of vaginal hysterectomy. Br J Obstet Gynecol. 1996;103:915–20.
27. Hefni MA, Davies AE. Vaginal endoscopic oophorectomy with vaginal hysterectomy – a simple minimal access surgery technique. Br J Obstet Gynecol. 1997;104:621–2.
28. Daniell JF, Kurtz BR, Lee J-Y. Laparoscopic oophorectomy – comparative study of ligatures, bipolar coagulation and automatic stapling devices. J Obstet Gynecol. 1992;80:325–8.
29. Sheth SS. The place of oophorectomy at vaginal hysterectomy. Br J Obstet Gynecol. 1991;98:662–6.
30. Okaro EO, Jones KD, Sutton C. Long-term outcome following laparoscopic supra-cervical hysterectomy. Br J Obstet Gynecol. 2001;108:1017–20.
31. Learman L, Summit RL, Varner E. A randomized comparison of total or supra-cervical hysterectomy: surgical complications and clinical outcomes. Obstet Gynecol Survey. 2004;59:90–1.
32. Sheth SS. Adnexectomy for benign pathology at vaginal hysterectomy without laparoscopic assistance. Br J Obstet Gynecol. 2002;109:1401–5.

Vaginal Hysterectomy in the Obese Patient

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Karl Tamussino

All types of hysterectomy are more challenging in the obese patient. This applies to the technical aspects of access and getting the operation done, to the comorbidities encountered in these patients, and to the increased risk of postoperative complications.

Since obesity is a major risk factor for abdominal surgical site infections, avoiding abdominal incisions per se will reduce complications in overweight women requiring hysterectomy. Accordingly, the vaginal approach has long been considered the procedure of choice for benign hysterectomy in obese women [1] and this has been borne out in recent analyses.

Shah et al. [2] analyzed complications according to BMI in 55,409 hysterectomies for benign conditions in the National Surgical Quality Improvement Project in the United States. For abdominal hysterectomy, women with BMIs of ≥40 had an odds ratio of about five for wound dehiscence or wound infection and an OR of 1.9 for sepsis. The magnitude of the association between wound infection and BMI was smaller after vaginal hysterectomy and the authors concluded that in obese women vaginal or laparoscopic hysterectomy should be performed whenever feasible. Osler et al. [3] revewed 20,353 hysterectomies in Denmark and found an association between BMI and increased bleeding and postoperative infection for abdominal hysterectomy but not vaginal hysterectomy. Similarly, a recent Committee Opinion on gynecologic surgery in obese women from the American College of Obstetricians and Gynecologists reconfirmed that in obese patients, as in others, vaginal hysterectomy is associated with better outcomes and fewer complications than laparoscopic or abdominal hysterectomy [4].

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Obesity is a risk factor for endometrial cancer and these patients will require hysterectomy. While vaginal hysterectomy does not provide access to the rest of the abdomen or to lymph nodes, it is certainly an option for selected women with this disease [5].

The technique and the tips described below derive from the descriptions of vaginal hysterectomy by Reiffenstuhl [6, 7] and Lee [8]. Bipolar vessel sealing has advantages for vaginal hysterectomy [9] and appears particularly useful for more difficult vaginal hysterectomy, as is frequently the case in the obese patient [10].

Practical Aspects

- When performing a curettage (or hysteroscopy) in a woman who may subsequently require hysterectomy, the surgical note on the examination under anesthesia should indicate whether a vaginal approach would be feasible.
- During the preoperative consent explain that the plan is to remove the uterus vaginally but that lapaoscopic assistance or laparotomy may become necessary.
- Good surgical assistants are particularly valuable for vaginal hysterectomy in the obese patient.
- It may be helpful to have one or both of the assistants to stand outside the patient's legs, to provide more room for the surgeon.
- Vessel sealing appears particularly useful in the obese patient in whom exposure at vaginal hysterectomy may be limited [10].
- Instruments. Posteriorly a weighted speculum. The assistants will be asked to guide three Breisky specula. A variety of Breisky specula in different lengths and widths is helpful. Remember that large instruments take up space.
- During vessel sealing there should be no tension on the tissue being sealed: relax traction during vessel sealing.

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Step-By-Step Vaginal Hysterectomy in the Obese Patient/Tips and Tricks

- Adequate anesthesia and positioning.
- Antibiotic prophylaxis (preferably single dose of a first generation cephalosporin).
- Empty the patient's bladder – but not completely. Leaving a bit of urine in the bladder may alert one to a bladder injury, should one occur.
- Examination under anesthesia. Confirm that vaginal hysterectomy appears feasible.
- Place tenacula on the uterine cervix. Use as few tenacula as possible -- they take up valuable space.
- Paracervical infiltration with a local anesthetic (preemptive analgesia) [11, 12].
- Circumcision of the cervix with a scalpel or cautery.
- Development of the vesicocervical space. If the vesicouterine peritoneum can be opened, do so. Confirm entry into the abdomen (not the bladder) by visualizing bowel or omentum; consider bladder injury if opening the "peritoneum" yields fluid. Put a slender Breisky retractor in the anterior cul de sac and leave it there for the rest of the operation.
- Posteriorly, open the pouch of Douglas. Tag the posterior vaginal wall with a suture.
- Division of the uterosacral ligaments. We try to do this with the conventional clamp-and-suture technique to attach the vaginal vault to the uterosacral ligaments and provide support. If space is very limited and uterine descent modest this step can be done with a vessel sealing instrument.
- Division of the parametrial tissue and uterine arteries. Vessel sealing instruments are useful here. We go back and forth between the right and left sides of the uterus, as space permits. The uterine arteries are usually identifiable.
  - If the vesicouterine peritoneum has previously been opened, proceed as far up the lateral margins of the uterus as possible.
  - If the vesicouterine peritoneum has not been opened, attempt to do so after having "crossed" the uterine artery. Again, confirm the correct space by visualizing bowel or omentum.
  - Once the vesicouterine peritoneum is open and demonstrated with a Breisky retractor continue division of the parametrial tissue with vessel sealing as far as feasible.
- When as much as possible of the parametrial tissue on both sides bas been divided it is time to develop the uterus through the posterior cul de sac.
- Once the uterine has been rotated through the posterior cul de sac it needs to be detached from the round ligaments and the adnexa (tubes and ovarian ligaments). Because the specimen is usually under traction at this point, particularly in the obese patient, and because having a tag on these pedicles can be useful later, we recommend placing a single curved clamp across the left round ligament, tube and ovarian ligament and cutting the pedicle. Then we do the same on the patient's right side. Thus, the uterus is detached and removed.
- If after complete division of the parametrial tissue the uterus cannot be delivered through the cul de sac it needs to be bivalved and possibly morcellated. This usually works, and progress towards completing the hysterectomy can be made. If despite the best efforts of the surgical team progress towards mobilizing the uterus cannot be made, consider converting the operation to an open procedure.
- Once the uterus has been removed, consider salpingectomy or salpingo-oophorectomy as appropriate (we recommend salpingectomy with vessel sealing for all benign hysterectomies). The adnexa are more easily mobilized and visualized if their attachments to the uterus have been clamped and tied and the sutures tagged with a small clamp.
- If the tubes and ovaries cannot be visualized safely, leave them alone.
- Check the pedicles and the vaginal margins for bleeding. If there is oozing consider leaving atransvaginal 18- or 20-F Foley catheter in the abdomen.
- Closure of the peritoneum and vaginal cuff. If there is a large potential enterocele we perform routine high closure of the peritoneum with two semicircular pursestring sutures. If there is little descensus of the vagina and little room we close the vaginal, usually with two full-thickness mattress sutures in an anterior-posterior fashion.
- We do not routinely pack the vaginal or place a catheter in the bladder.

Postoperative Care

We try to avoid bladder catheters and vagnal packs in patients with vaginal hysterectomy without concomitant procdures for prolapse or incontinence. DVT prophylaxis with compression stockings, early mobilization and low-molecular-weight heparin is appropriate. Oral pain medication usually suffices and lets patients be mobilized quickly. Most patients leave the hospital 1–2 days after the operation [13]. Extended LMWH prophylaxis may be appropriate for patients at high risk of DVT.

We encourage a quick return to normal activity, excluding intercourse, and a follow-up examination at 4–6 weeks. Issues to be addressed at discharge from the hospital include a review of the procedure and what was removed, pain medications, postoperative restrictions, what happens with the

space previously occupied by the uterus (can be compared to taking something from the bottom of a salad bowl – something else moves into the space), reviewing that menstrual bleeding will no longer occur, and that there is no reason to expect marked deterioration in bladder, bowel or sexual function after hysterectomy. The patient is instructed to come back to our unit promptly if signs such as pain, fever or bleeding develop, although these problems are uncommon.

References

1. Pratt JH, Daikoku NH. Obesity and vaginal hysterectomy. J Reprod Med. 1990;35:945–9.
2. Shah DK, Vitonis AF, Missmer SA. Association of body mass index and morbidity after abdominal, vaginal, and laparoscopic hysterectomy. Obstet Gynecol. 2015;125:589–98.
3. Osler M, Daugbjerg S, Freeriksen BL, Ottesen B. Body mass index and risk of complications after hysterectomy on benign indications. Hum Reprod. 2011;26:1512–8.
4. American College of Obstetricians and Gynecologists. Committee opinion no. 619. Gynecologic surgery in the obese woman. Obstet Gynecol. 2015;125:274–8.
5. Smith SM, Hoffman MS. The role of vaginal hysterectomy in the treatment of endometrial cancer. Am J Obstet Gynecol. 2007;197:202.e1–6.
6. Reiffenstuhl G, Platzer W. Die vaginalen Operationen. Munich/ Berlin/ Vienna; 1974. p. 732.
7. Reiffenstuhl G, Platzer W, Knapstein P. Vaginal operations: surgical anatomy and technique. 2 ed. Baltimore: Williams & Wilkins; 1996. p. 303.
8. Lee RA. Atlas of gynecologic surgery. Philadelphia: W.B. Saunders; 1992. p. 353.
9. Kroft J, Selk A. Energy-based vessel sealing in vaginal hysterectomy: a systematic review and meta-analysis. Obstet Gynecol. 2011;118:1127–36.
10. Elhao M, Abdallah K, Serag I, El-Laithy M, Agur W. Efficacy of using electrosurgical bipolar vessel sealing during vaginal hysterectomy in patients with different degrees of operative difficulty: a randomised controlled trial. Eur J Obstet Gynecol Reprod Biol. 2009;147:86–90.
11. Long JB, Eiland RJ, Hentz JG, Mergans PA, Magtibay PM, Kho RM, Magrina JF, Cornella JF. Randomized trial of preemptive local analgesia in vaginal surgery. Int Urogynecol J. 2009;20:510.
12. Neal MG, Beste T, Shackelford DP. Utility of preemptive local analgesia in vaginal hysterectomy. Am J Obstet Gynecol. 2003;189:153942.
13. Reif P, Drobnitsch T, Aigmüller T, et al. Decreasing length of stay after vaginal hysterectomy. Geburthsh Frauenheilk. 2014;74: 449–53.

Vaginal Cuff Dehiscence Following Hysterectomy

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Michael L. Sprague, Katrin S. Arnolds,
Stephen E. Zimberg, and Tommaso Falcone

Introduction

Vaginal cuff dehiscence after total hysterectomy is a rare, but serious postoperative adverse event. The incidence of vaginal cuff dehiscence in general is reported to be very low, with an overall incidence approximating 0.30–0.39% [1–3]. Although multiple risk factors have been proposed, the incidence of vaginal cuff dehiscence is reported to be higher following conventional and robot-assisted laparoscopic hysterectomies compared to abdominal and vaginal procedures. The mean time to occurrence ranges from 6.1 weeks to 1.6 years following total hysterectomy [4] and ranges in severity from mild separation (Fig. 129.1) to evisceration (Fig. 129.2) of abdominal contents. Most commonly, the intestine is the eviscerating organ, however, the fallopian tube, omentum, and appendix have also been reported [5]. Vaginal cuff dehiscence is potentially life threatening if associated with intestinal ischemia or intra-abdominal infection and must be managed appropriately to limit adverse long-term sequella [6].

Clinical Manifestations

Patients with vaginal cuff dehiscence typically complain of specific, acute onset symptoms, including abdominopelvic pain (58–100 %), vaginal bleeding or watery discharge (33–90 %), and vaginal pressure (30 %). In a significant number of cases, evisceration is present (70 %) [4]. Events commonly preceding vaginal cuff dehiscence include valsalva (16–30 %) and coitus (8–48 %). However, no significant event is definable in 70 % of patients who present with vaginal cuff dehiscence [4]. Therefore, it is clinically prudent to promptly evaluate all patients with symptoms possibly consistent with vaginal cuff dehiscence.

Risk Factors

Patient characteristics that are associated with poor wound healing, surgical technique, perioperative complications, factors leading to increased intra-abdominal pressure, and trauma are generally cited as primary risk factors for vaginal cuff dehiscence. Although the proposed factors are reasonable, it is difficult to draw firm conclusions about the significance of each of these proposed risk factors due to the relatively low incidence of vaginal cuff dehiscence, the inconsistency of reporting risk factors, and selection bias, as many studies are case reports. Many recent reports, however, cite the surgical technique as being a risk factor for vaginal cuff dehiscence (Table 129.1) [1, 3].

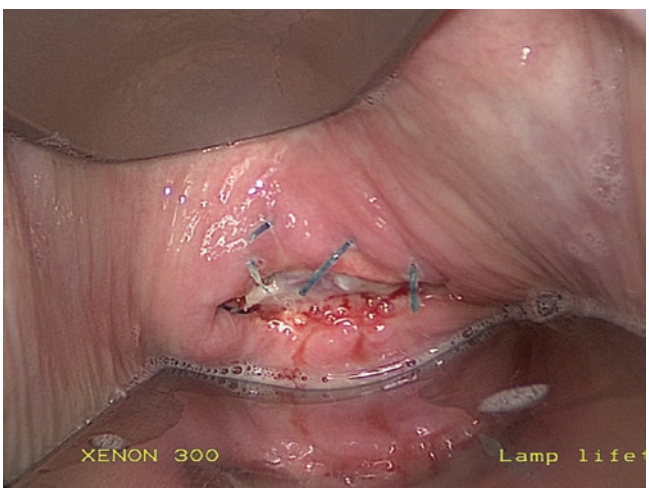


Fig. 129.1 Vaginal cuff separation

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Fig. 129.2 Vaginal cuff evisceration

Table 129.1 Proposed risk factors for vaginal cuff dehiscence [7]

Increased age	Previous radiation	Postoperative hematoma
Obesity	Malignancy	Postoperative infection
Menopausal status	Surgical approach	Valsalva
Vaginal atrophy	Poor surgical technique	Coitus before healing
Previous vaginal surgery	Poor wound healing	

Table 129.2 Incidence of cuff dehiscence based on surgical approach

Abdominal	0.21–0.25 %	[1, 3]
Vaginal	0.13–0.15 %	[1, 3]
Laparoscopic	0.64–0.80 %	[1, 3]
Robotic	0.40–4.10 %	[8–10]

Mode of Hysterectomy

Two large, multicenter, retrospective studies demonstrate trends in vaginal cuff dehiscence based on the mode of hysterectomy. Ceccaroni et al. reported surgical outcomes from 8635 patients who underwent total hysterectomy at four large centers in Italy over 14 years. A total of 34 vaginal cuff dehiscences were observed, corresponding to an overall incidence of 0.39 %. Of these 34 patients, 8 (0.25 %) had undergone abdominal hysterectomy, four underwent transvaginal hysterectomy (0.15 %), and 22 underwent total laparoscopic hysterectomy (0.80 %) [3]. Subsequently, Uccella et al. reported the outcomes of 12,398 patients undergoing surgery at six centers in Italy over 14 years. They observed a total of 38 vaginal cuff dehiscences corresponding to an overall incidence of 0.30 percent. Similarly, they observed a trend in which the greatest incidence of vaginal cuff dehiscence occurred in the total laparoscopic hysterectomy group (0.64 %), compared to the vaginal hysterectomy (0.13 %), and abdominal hysterectomy (0.21 %) groups [1]. Robot-assisted hysterectomy has likewise been associated with increased risk of vaginal cuff dehiscence. Different groups have published retrospective analyses of their center-specific experience, with estimated incidences of vaginal cuff dehiscence to ranging from 0.4 to 4.1 % (Table 129.2) [8–10].

Approach for Colpotomy and Cuff Closure

The role of energy use in promoting vaginal cuff dehiscence is unclear. Researchers have proposed that the use of energy devices to perform colpotomy during laparoscopic hysterectomy is the primary reason for the observed increased incidence of vaginal cuff dehiscence [11].

Subset analysis of the total laparoscopic hysterectomy group from Uccella's study demonstrated a different trend. The patients from the total laparoscopic hysterectomy group were subcategorized based on the approach for cuff closure. Although colpotomy was made with monopolar energy in each of the patients from the total laparoscopic hysterectomy group, cuff closure was performed by either laparoscopic or transvaginal approaches. The incidence of vaginal cuff dehiscence for patients who underwent laparoscopic colpotomy repair was greater than the patients who underwent transvaginal repair (0.86 % vs. 0.24 %, respectively; $p = 0.028$). The incidence of vaginal cuff dehiscence following total laparoscopic hysterectomy with transvaginal colpotomy repair was compared to the transvaginal hysterectomy group and the difference in relative incidences was not statistically significant [3].

A retrospective analysis of data entered into a prospective database compared patients who underwent either total laparoscopic hysterectomy or laparoscopic-assisted vaginal hysterectomy. Colpotomy was made using an ultrasonic scalpel in the total laparoscopic hysterectomy group and a monopolar pencil in the LAVH group. Cuff closure was performed laparoscopically in the total laparoscopic hysterectomy group and transvaginally in the LAVH group. Again, the incidence of cuff dehiscence was greater in the patients who underwent laparoscopic cuff closure (4 %) compared to those who underwent transvaginal cuff closure (0 %) [12].

These data suggest that the laparoscopic approach for cuff closure may be a greater risk factor for vaginal cuff dehiscence than a laparoscopic approach for colpotomy.

Prevention of Vaginal Cuff Dehiscence

Perioperative Considerations

Vaginal cuff dehiscence may result from activities such as coitus and strenuous physical exertion and most patients should be advised to avoid both for approximately 6–8 weeks

following surgery. Additionally, optimization of medical conditions associated with vaginal cuff dehiscence is important during the perioperative period. Specifically, management of conditions that are associated with increased intra-abdominal pressure, poor wound healing, and infection should be identified and addressed.

Increased intra-abdominal pressure exerts force on the vaginal tissues that displace them towards the introitus, which can lead to traumatic separation of the vaginal cuff during the postoperative period. Postoperative constipation resulting from intraoperative bowel manipulation, intra-abdominal inflammation, and postoperative narcotic use is common and may be treated with liberal use of stool softeners and osmotic laxatives. Pre-existing conditions resulting in repetitive cough, such as chronic obstructive pulmonary disease, asthma, and gastroesophageal reflux disease, should be addressed preoperatively by consultant physicians to minimize their impact on the patient's postoperative course.

Certain medical conditions that result in poor wound healing may likewise increase a patient's risk for vaginal cuff dehiscence. Patient-specific factors such as obesity and smoking are easily identified and potentially modifiable prior to non-emergent surgery. Medical conditions such as diabetes and thyroid disorders affect the rate of wound healing and must be tightly controlled medically during the perioperative period. Medications that affect wound healing such as corticosteroids should be tapered when feasible. Vaginal atrophy is another proposed risk for delayed vaginal wound healing and perioperative estrogen therapy has been employed to address this potential risk factor.

Post-hysterectomy pelvic infection is a commonly cited risk factor for vaginal cuff dehiscence. Bacterial vaginosis, specifically, has been linked to postoperative vaginal cuff cellulitis and subsequent abscess formation. Bacterial vaginosis is associated with increased concentrations of potentially pathogenic microorganisms within the vagina that may compromise vaginal cuff health through ascending infection of the healing tissues. A study in which patients with preoperative bacterial vaginosis were randomized to receive perioperative metronidazole or no treatment demonstrated a significantly greater risk for vaginal cuff infection for those patients who did not have their bacterial vaginosis treated [13]. Other risk factors for postoperative vaginal cuff infection include postoperative hematoma or untreated pelvic inflammatory disease and should be promptly addressed. It is required that all patients receive preoperative antibiotics prior to skin incision to minimize surgery-related superficial and organ space infections. Continuation of antibiotics during the postoperative period is not generally recommended. It may be reasonable to extend activity restrictions and vaginal rest if patient deemed to be high risk for vaginal cuff dehiscence.

Surgical Technique

Colpotomy and cuff closure are two steps of total hysterectomy in which a surgeon's technique impacts a patient's risk for vaginal cuff dehiscence. The goal for colpotomy is efficient tissue division while preserving tissue integrity and vascular supply of the vaginal tissues. Whereas colpotomy is most oftentimes performed sharply in abdominal and vaginal procedures, laparoscopic colpotomy is usually performed using energy devices.

Monopolar electrodes and ultrasonic devices are typically employed for laparoscopic colpotomy. In the context of monopolar electrosurgery, factors such as current waveform, electrode manipulation, and dwell time impacts the overall tissue effect. The electrosurgical unit should be set to a low-voltage, uninterrupted waveform such as pure cut. The tissue should be divided by linear vaporization, which is a non-touch technique in which energy arcs from the electrode tip to the target tissue (Fig. 129.3). Linear vaporization leads to a sharp increase in intracellular temperature and rapid division of tissue, with minimal thermal spread. Tissue dwell time should be minimized to avoid unintended thermal injury and compromise to the adjacent vaginal cuff tissue.

Ultrasonic scalpels transduce radiofrequency energy into mechanical energy to achieve tissue effect. Typically, these devices have a 'min' and 'max' setting, which refers not to the speed of the active blade, but to the excursion distance of the active blade. The 'max' setting favors rapid tissue division over hemostasis, which is preferred for laparoscopic colpotomy. The surgeon can also increase the rate of tissue division by applying traction and counter-traction to the tissue, as well as by squeezing the device hand piece more firmly (Fig. 129.4).

Colpotomy during total hysterectomy disrupts the pericervical ring, a coalescence of fascial and ligamentous

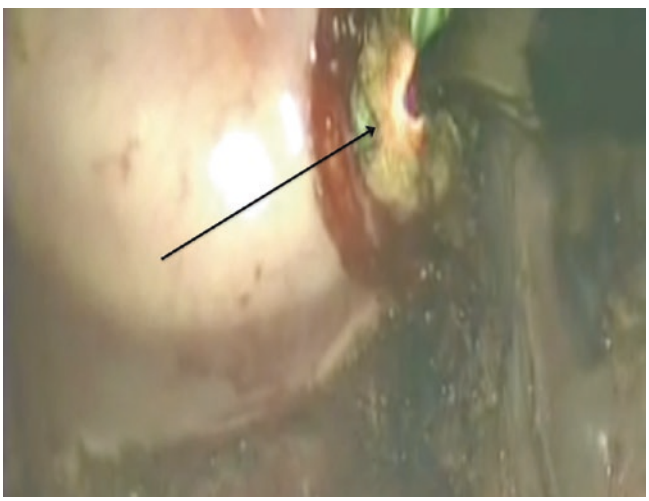


Fig. 129.3 Colpotomy using monopolar vaporization. Note the arcing of energy from the electrode tip to the tissue (*arrow*)

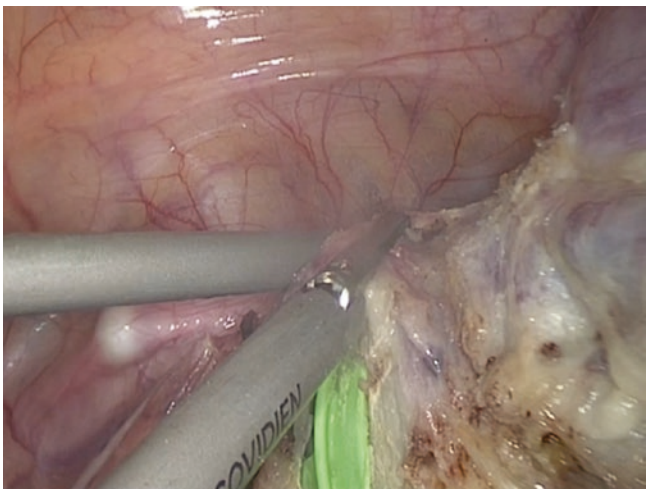


Fig. 129.4 Colpotomy using ultrasonic scalpel

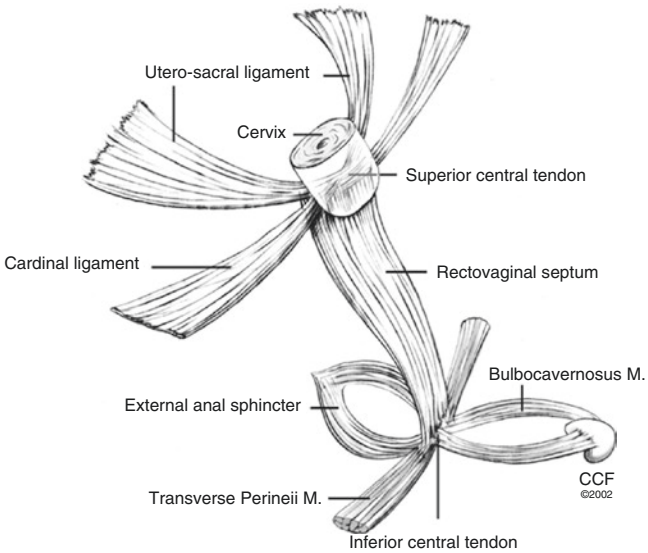


Fig. 129.5 Anatomy of the pericervical ring (pubocervical fascia is not pictured)

tissues that provide support and integrity for the vaginal apex. Anatomically, the pericervical ring lies at the level of the ischial spines and is comprised of the pubocervical fascia, rectovaginal septum, and cardinal-uterosacral ligament complexes (Fig. 129.5). Disruption of the pericervical ring compromises apical support, leaving the vaginal walls vulnerable to intrabdominal forces that drive them toward the vaginal hiatus.

Durable cuff closure hinges upon proper reconstruction of the pericervical ring and restoration of the vaginal apex to the level of the ischial spines. Following colpotomy, the surgeon should palpate the ischial spines to determine the target final position of the vaginal apex. Using delayed absorbable suture, the angles of the vagina are approximated by incorporating purchases of the uterosacral ligament, the rectovaginal septum, the cardinal ligament and the pubocervical fascia. Vaginal cuff closure is then completed in figure-of-eight or running fashion by taking full-thickness tissue purchases that incorporate and approximate the vaginal epithelium and fascial planes (Fig. 129.6a–c). These principles for vaginal cuff closure are applicable to all approaches for total hysterectomy.

Care must be taken to take adequate purchases of tissue, approximately 1 cm from the cuff edge, with each suture. Likewise, the surgeon must not place sutures too great of distance apart. Typically, tissue purchases 1 cm from the cuff margin separated by one-half centimeter is adequate. Obtaining adequate tissue purchases is particularly problematic during laparoscopic or robotic cuff closure as magnification of the surgical field distorts a surgeon's perception of distance. At the completion of cuff closure, the surgeon palpates the suture line transvaginally to evaluate for areas of inadequate approximation within the vaginal cuff and, if necessary, additional sutures are placed to reinforce the weak areas. At present, randomized studies that indicate the optimum suture material and closure technique for prevention of dehiscence are not available.

Management of Cuff Dehiscence

Vaginal cuff dehiscence ranges in severity from separation of the vaginal epithelium to evisceration. Abdominal examination is performed to assess for peritonitis. Careful digital and speculum vaginal examinations are performed to confirm the presence and extent of the vaginal cuff dehiscence, as well as evisceration. The location, size, and depth of any defect should be specifically documented. Additionally, assessment of the cuff for tissue viability and possible infection is likewise important. Basic laboratory evaluation includes a complete blood count and metabolic profile. Computed tomography scan with contrast is indicated for patients who demonstrate symptoms or signs of systemic infection, abscess, peritonitis, bowel compromise, or hematoma. As there is currently no consensus for a single management algorithm for vaginal cuff dehiscence, optimal management depends on the clinical features of each individual patient [14].

Small separations of the vaginal cuff measuring without evidence of infection, hematoma, or evisceration can be observed for spontaneous closure over the course of 6–8 weeks. For larger vaginal cuff separations (Fig. 129.7), transvaginal repair using 0 gauge, monofilament, delayed-absorbable suture in interrupted fashion following cuff debridement is advised [14] (Fig. 129.8). A laparoscopic or abdominal approach is indicated when transvaginal suturing is not feasible, or if cuff hematoma or infection is suspected. Patients are typically observed in the hospital overnight and discharged home on postoperative day one if clinically stable.

Vaginal cuff evisceration is a surgical emergency and must be managed properly and efficiently to avoid long-

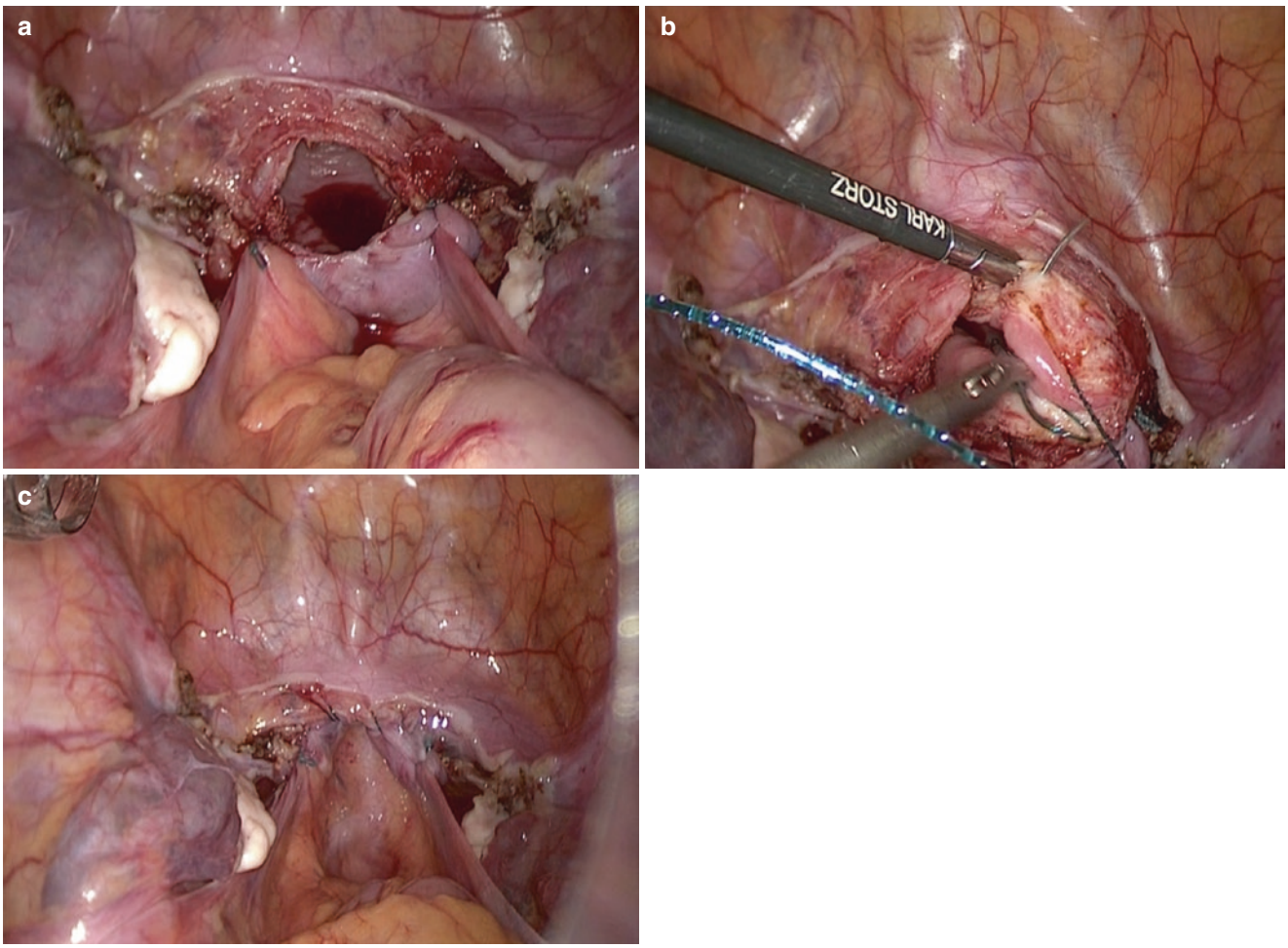


Fig. 129.6 (**a**) Durable cuff closure: completion of vaginal angle sutures. (**b**) Durable cuff closure: suturing of vaginal cuff. (**c**) Durable cuff closure: completion of vaginal cuff closure

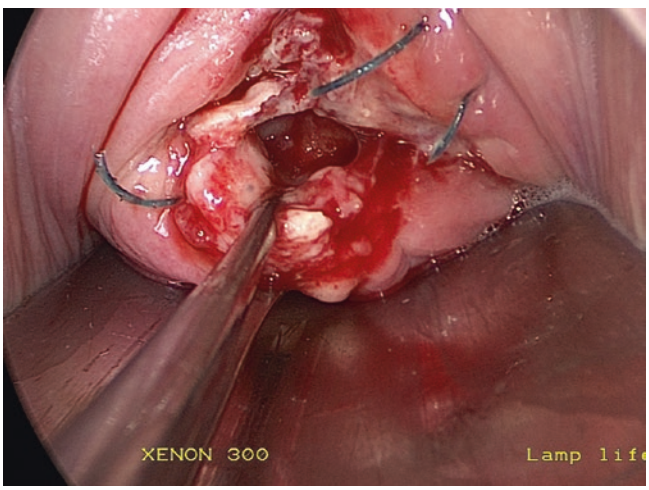


Fig. 129.7 Vaginal cuff separation requiring operative repair

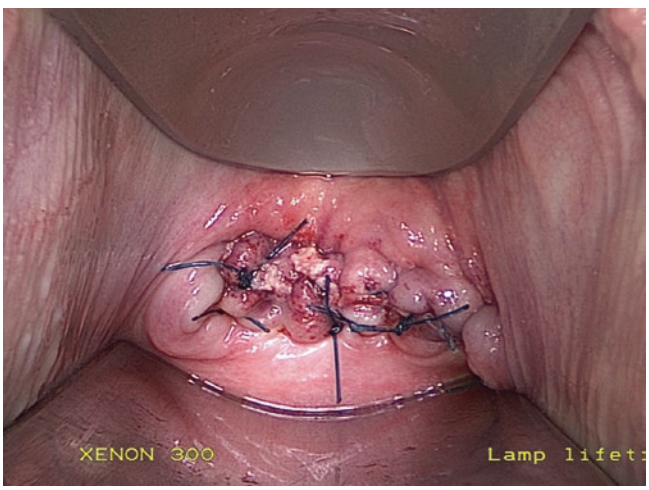


Fig. 129.8 Completed repair of vaginal cuff separation

term sequellae. If evisceration is detected at the time of initial examination, bowel present beyond the vaginal orifice should be immediately wrapped in gauze saturated with warm sterile saline. Broad-spectrum antibiotics should be initiated while diagnostic studies are obtained and the patient is prepared for surgery. For patients without signs or

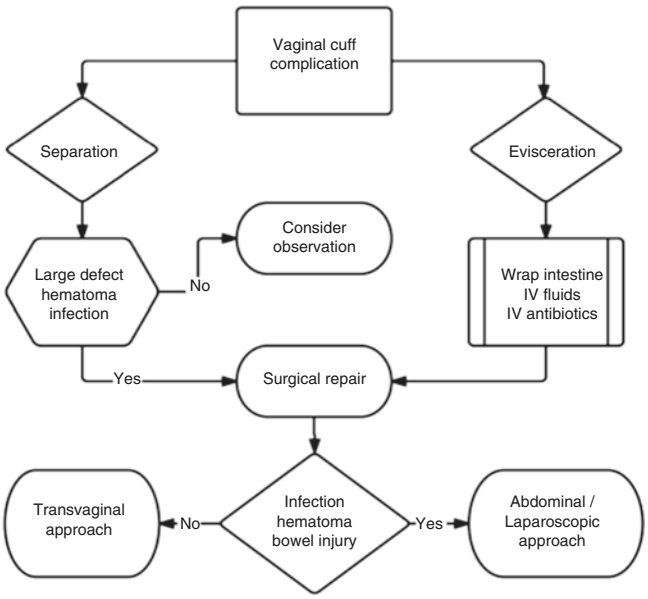


Fig. 129.9 Algorithm for management of vaginal cuff dehiscence

symptoms of infection, hematoma, or bowel compromise, the eviscerated bowel is visually inspected for viability and injury while the patient is under anesthesia. If the bowel appears intact, pink, and well perfused, a transvaginal repair is feasible. The intestine is copiously irrigated with warm saline. The patient is placed in Trendelenburg position and the eviscerated bowel carefully reduced through the vaginal cuff. The vaginal cuff is sharply debrided until all necrotic tissue is excised and viable tissue observed at the cuff margin. The vaginal cuff is then reapproximated with 0 gauge, monofilament, delayed-absorbable suture in interrupted fashion. The surgeon must ensure that adequate purchases of the tissue are taken and that knots are secure, but do not strangulate the tissue. Care must be taken not to injure the bladder, ureter, or intestines during cuff debridement and repair. If concern for injury exists, cystoscopy or laparoscopy is indicated. Again, a laparoscopic or abdominal approach is indicated if transvaginal suturing is not feasible. Likewise, a laparoscopic or abdominal approach should be employed if the patient demonstrates signs of infection, hematoma, or bowel compromise. Of note, bowel surgery was required in 14.7 % of evisceration cases in a large multicenter retrospective study [3]. Pelvic drain may be placed if clinically indicated. Co-management with a consultant surgeon may be considered if bowel compromise is suspected (Fig. 129.9).

Inpatient management is indicated following repair of vaginal cuff evisceration. The patient is observed for excessive vaginal bleeding and signs of systemic infection. White blood cell count is monitored with the aim of detecting early abdominopelvic infection or mesenteric ischemia. Clear liquid diet is initiated immediately following surgery and advanced as tolerated. Anti-emetics are provided as needed, but persistent nausea and vomiting should not be ignored and further evaluation and imaging considered. Nasogastric tubes are generally not indicated, with the exception of severe bloating or emesis refractory to medications. The patient may be discharged home following return of bowel function if stable clinically. Patients are typically evaluated in the outpatient setting 2, 6 and 10 weeks following surgery. Conditions that may lead to increased intraabominal pressure such as asthma, chronic cough, and constipation are tightly managed. Vaginal estrogen cream may be considered to aid healing for women with vaginal atrophy. Patients are instructed to maintain pelvic rest for 12 weeks, or until adequate healing of the vaginal cuff has been observed.

Conclusion

Vaginal cuff dehiscence is a significant, albeit infrequent, complication following total hysterectomy. Although many risk factors have been proposed in the literature to account for this complication, a laparoscopic approach for cuff closure may be the most relevant due to the increasing frequency of conventional and robot-assisted laparoscopic hysterectomy procedures performed today. The optimal management strategy must be individualized for the patient and their unique clinical picture. Minimizing long-term complications depends on early diagnosis and prompt management, with consultation of consultant surgeons when appropriate.

References

1. Uccella S et al. Vaginal cuff dehiscence in a series of 12,398 hysterectomies: effect of different types of colpotomy and vaginal closure. Obstet Gynecol. 2012;120(3):516–23.
2. Croak AJ et al. Characteristics of patients with vaginal rupture and evisceration. Obstet Gynecol. 2004;103(3):572–6.
3. Ceccaroni M et al. Vaginal cuff dehiscence after hysterectomy: a multicenter retrospective study. Eur J Obstet Gynecol Reprod Biol. 2011;158(2):308–13.
4. Cronin B, Sung VW, Matteson KA. Vaginal cuff dehiscence: risk factors and management. Am J Obstet Gynecol. 2012;206(4):284–8.
5. Iaco PD et al. Transvaginal evisceration after hysterectomy: is vaginal cuff closure associated with a reduced risk? Eur J Obstet Gynecol Reprod Biol. 2006;125(1):134–8.
6. Koo YJ et al. Vaginal cuff dehiscence after hysterectomy. Int J Gynaecol Obstet. 2013;122(3):248–52.
7. Somkuti SG et al. Transvaginal evisceration after hysterectomy in premenopausal women: a presentation of three cases. Am J Obstet Gynecol. 1994;171(2):567–8.
8. Kashani S et al. Vaginal cuff dehiscence in robotic-assisted total hysterectomy. JSLS. 2012;16(4):530–6.
9. Nick AM et al. Rate of vaginal cuff separation following laparoscopic or robotic hysterectomy. Gynecol Oncol. 2011;120(1):47–51.

10. Kho RM et al. Incidence and characteristics of patients with vaginal cuff dehiscence after robotic procedures. Obstet Gynecol. 2009;114(2 Pt 1):231–5.
11. Hur HC et al. Vaginal cuff dehiscence after different modes of hysterectomy. Obstet Gynecol. 2011;118(4):794–801.
12. Fanning J et al. Effects of electrosurgery and vaginal closure technique on postoperative vaginal cuff dehiscence. JSLS. 2013;17(3):414–7.
13. Larsson PG, Carlsson B. Does pre- and postoperative metronidazole treatment lower vaginal cuff infection rate after abdominal hysterectomy among women with bacterial vaginosis? Infect Dis Obstet Gynecol. 2002;10(3):133–40.
14. Matthews CA, Kenton K. Treatment of vaginal cuff evisceration. Obstet Gynecol. 2014;124(4):705–8.

Postoperative Care

130

Karl-Günter Noé

The postoperative care is related to the technique performed by the surgeon. The traditional technique with a subtotal closure of the vaginal cuff is different to the nowadays performed procedure closing the cuff completely.

The postoperative care considers the risks of surgical strategy. The possible complications after the operation are:

- Urinary infection
- Heavy bleeding
- Hematoma
- Stump-Infection
- Damage to surrounding organs (bladder, ureters or bowel)
- Tubal prolapse
- Wound dehiscence
- Vault-prolapse
- Blood clots in the legs or lungs

Surgical risks are higher in women who are obese or who have diabetes or high blood pressure.

Urinary infections after gynecological surgery occur frequently. We can find a range from 10 to 25 % in Literature [1]. Usually they are clinical relevant in the first days after surgery. To minimize the risk, catheterization and other manipulation should be performed as less as possible. If a catheterization is required it is useful to introduce an additional sterilization procedure. Before placing the catheter the orifice of the urethra should be disinfected three times and the catheter should be introduced by using a sterile pair of tweezers. We could reduce our own rate [2] with this simple procedure by 50 %. An unproblematic infection can often be cured with a single shot of Fosfomycin. Multi-morbid patients and in case of a larger surgical field, (combined surgery) the treatment has to be designed after a microbiological examination.

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If the uterine artery starts bleeding after surgery, high blood loss can occur. Even if this complication is rare (0.1–1.4 %), it is an important thread for the live of the patient. Therefore a clinical observation for the first 24 h is to recommend [3]. Drainage is not required.The contact of blood with the peritoneum often causes pain and in case of a late bleeding the patient will attract attention on herself. If the bleeding will occur early after the surgery the pain can be masked by the analgesic treatment. A bleeding of an artery causes a high volume loss in a short time so that it will lead to a shock syndrome. A vaginal or laparoscopic revision of the bleeding should only be done by very experienced vaginal or laparoscopic surgeons. To deal with a large quantity of blood can be extremely challenging. In a life-threatening situation a laparotomy may be the safest way. The slow bleedings by small vessels or late bleedings most of the time cause hematoma. If the surgeon is used to close the peritoneum, most of the time you will find them retroperitoneal.

Hematoma at the vaginal stump can cause problems as an optimal habitat for bacteria and resulting infection with the risk of peritonitis. As they can be clinical silent it is important to know the complication. A hematoma can easily be diagnosed with a vaginal ultrasound during the examination before release. In hematomas larger 2 cm a revision must be considered. Large hematomas regularly cause pressure sensations in the pelvis and need a long resorption time. Therefore a surgical treatment by vaginal or laparoscopic route is required.

An antibiotic prophylaxis is given at the beginning of the surgery as a single shot (cephalosporin). Infection after vaginal Hysterectomy has to be estimated in 4–10 % [4]. Pain and fever (>38 C) should be treated early. In case of an abscess formation a surgical drainage is essential. Most of the time an abscess can be opened by vaginal route. If there is no pus after the opening of the vaginal suture, a laparoscopy should be considered. As an adhesion of the bowel has to be estimated always, a forced vaginal approach has a high risk and should be avoided.

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Damage to surrounding organs (bladder, ureters or bowel) is rare but can be serious for the patient. (Ureter 0–0.1 % / bladder 0.5–2 % {all Hysterectomies}). In case of doubt an imaging method is required. Therefore in most clinics a postoperative ultrasound of the kidneys is a standard. By the ligature of parametric tissue an obstruction of the ureter is possible and can be visualized by ultrasound. (According to some case-reports a reflective anuria is possible). By usage of bipolar ligation instruments a thermic damage can occur. Clinical signs most of the time will come to surface after demission of the patient.

If a ligature is the reason for the obstruction, most of the time an early surgical intervention can save the ureter (Don't hesitate – in case of doubt).

To summarize, it should be emphasized that a minimum postoperative observation of 24 h is to be ensured. In case of signs of infection an early antibiotic therapy is to be started. Uncomplicated urinary infection can be treated by single dose Fosfomycin. Other and stump-infections should be treated after micro-biological examination. Ultrasound of the kidney can point on an obstructive complication of the ureter and is useful 1 day after surgery. Low dose heparin has to be given pre and postoperatively. For an early recovery of the vaginal flora a combination of estrogen and lactobacillus is useful. During the examination before release, wound dehiscence and tubal prolapse should be excluded. The vaginal stump, the bladder and adnexa should be examined by vaginal ultrasound. If the cuff is not close completely the patients are to inform that it is normal to have bloody vaginal discharge for several days to weeks after a hysterectomy.

A full recovery may take 3–4 weeks. As the uterine ligaments in the apex are cut during the procedure, lifting more than 20 pounds (9.1 kg) or having vaginal intercourse until 6 weeks after surgery is not required. Sports and intensive exercises of the pelvic floor should be avoided in this period. During the consultation before discharge the problematic of anxiety around sexual dysfunction should be addressed [5]. It is important to clarify possible expectations according to the procedure. The latter can be influenced by reports of friends and lay press. If not all questions around sexuality and influence on the pelvic health are answered before the surgery, it is problematic to clear doubts retrospectively.

References

1. Falagas ME, Athanasiou S, Iavazzo C, Tokas T, Antsaklis A. Urinary tract infections after pelvic floor gynecological surgery: prevalence and effect of antimicrobial prophylaxis. A systematic review. Int Urogynecol J Pelvic Floor Dysfunct. 2008;19(8):1165–72. doi:10.1007/s00192-008-0584-0. Epub 2008 Apr 10.
2. Banerjee C, Noé GK. Complications, re-prolapse rates and functional results after laparoscopic sacropexy: a cohort study. Geburtshilfe Frauenheilkd. 2010;70:379–84.
3. White SC, Wartel J, Wade ME. Comparison of abdominal and vaginal hysterectomies. A review of 600 operations. Obstet Gynecol. 1971;37(4):530–7.
4. Rice CN, Howard CH. Complications of hysterectomy. US Pharm. 2006;31(9):HS-16–24.
5. Rhodes JC, Kjerulff KH, Langenberg PW, Guzinski GM. Hysterectomy and sexual functioning. JAMA. 1999;282:1934–41.

Part XII

Conservative Management



What Is the Place of Myoma Surgery with the Advent of Selective Progesterone Receptor Modulators (SPRMs)?

131

Jacques Donnez, Olivier Donnez, and Marie-Madeleine Dolmans

Introduction

Uterine fibroids are the most common benign uterine tumors in women of reproductive age, occurring in 20–25 % of women [1, 2]. Depending on localization, the symptoms include pelvic pain, pressure, dysmenorrhea, anemia caused by heavy bleeding, reduced quality of life, and infertility [3].

Current management strategies involve mainly surgical interventions, but the choice of treatment is guided by the patient's age and desire to preserve fertility and avoid "radical" surgery such as hysterectomy [3, 4]. In the early 1980s, hysterectomy was routinely proposed to women with submucous fibroids who did not wish to conceive. Since then, other surgical and nonsurgical approaches, including myomectomy by laparotomy or laparoscopy or hysteroscopy, uterine artery embolization, and other interventions performed under radiologic or ultrasound guidance [3–5], have been proposed.

Medical therapies with progestin, progestin-releasing intrauterine devices, and gonadotropin-releasing hormone (GnRH) agonist are also available [6–8], the use of oral progestin may cause breakthrough bleeding and promote myoma growth [6]. GnRH agonist can be used [7–8], but such treatment is approved only for short-term therapy because of safety concerns linked to artificially induced menopause (severe side effects like loss of libido, vaginal dryness, hot flushes, loss of bone mineral density) [7–8].

Progesterone plays an important role in promotion of myoma growth [9, 10]. Modulating the progesterone pathway [11, 12] represents one of the possibilities of medical therapy, opening the way to use of selective progesterone receptor modulators (SPRMs) [10, 13–19].

The chapter presents new algorithms of myoma management in 2015, taking into account recent developments in long-term intermittent therapy with SPRMs [15, 16].

Hysteroscopic Myomectomy

Over the last 30 years, advances in instruments and techniques have promoted hysteroscopic myomectomy to the rank of a standard minimally invasive surgical procedure for submucous myomas (for review, see [20]).

There is some evidence suggesting that fibroids may impede fertility [3, 21]. Although the absence of randomized studies does not allow any firm conclusions to be drawn, many authors report an improvement in spontaneous fertility after hysteroscopic myomectomy, especially when the uterine cavity is distorted by the presence of submucous myomas.

More recently, the FIGO classification [22] was published describing eight types of fibroids, including a hybrid class (association of two types of myomas) (Fig. 131.1). As different types of fibroids are often present at the same time (according to the site), this classification offers a more representative 'map' of fibroid distribution.

Use of GnRH agonist before surgery is still a matter of debate, but "preoperative use of GnRH agonist appears to be relevant and beneficial in patients with submucous fibroids."Benefits include resolution of preoperative anemia, decrease in fibroid

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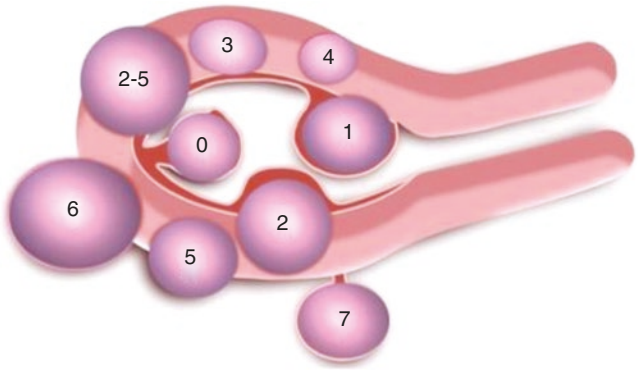


Fig. 131.1 FIGO classification according to Munro et al. (2011) (Adapted from Munro et al. [22], Copyright 2011, with permission from Elsevier). Fibroid types range from 0 to 7: *0* Pedunculated, intracavitary; *1* Submucosal, <50 % intramural; *2* Submucosal, ≥50 % intramural; *3* Contact with endometrium, 100 % intramural; *4* Intramural; *5* Subserosal, ≥50 % intramural; *6* Subserosal, <50 % intramural; *7* Subserosal, pedunculated

size, reduction of endometrial thickness and vascularization with subsequently improved visibility and reduced fluid absorption, and the possibility of surgical scheduling [7].

Conversely, this preoperative treatment is associated with some side effects, like hot flushes and post-injection endometrial bleeding due to the flare-up effect.

Myomectomy by Laparoscopy/Laparotomy

Despite the fact that studies investigating intramural myomas have suggested a negative effect on fertility outcome, the evidence remains far from conclusive. On the other hand, studies found adverse pregnancy outcomes associated not only with submucous and intramural fibroids distorting the uterine cavity, but also those not distorting the uterine cavity [23].

In case of symptomatic myomas, myomectomy is clearly indicated. Laparoscopic myomectomy is a minimally invasive alternative to conventional laparotomy. Reports of uterine rupture after laparoscopic myomectomy emphasize the importance of adequate closure of the myometrial defect. Contraindications to laparoscopic myomectomy usually include: (1) the presence of an intramural myoma > 10–12 cm in size, (2) multiple myomas (≥4) in different sites of the uterus requiring numerous incisions, and (3) anemia (this contraindication is also valid for laparotomy). In some cases, uterine artery ligation may be beneficial to reduce bleeding during sugery.

Recurrence of leiomyomas has been reported to be greater after laparoscopic myomectomy than after laparotomy. However, in a randomized study, 81 patients assigned to either abdominal or laparoscopic myomectomy were observed postoperatively for 40 months to compare recurrence rate. Nine recurrences (23 %) were observed in the abdominal myomectomy group, compared with 11 recurrences (27 %) in the laparoscopic myomectomy group.

Postoperative morbidity is less severe and recovery faster with laparococoscopic procedures. Studies comparing reproductive outcomes after laparoscopic or abdominal myomectomy (by minilaparotomy) show no significant difference ([3], for review see [20]), but laparoscopic myomectomy is perceived by many gynecologic surgeons to be more difficult.

Depending on the skill of the surgeon and his/her ability to suture the myometrial defect without delay, either laparoscopy of minilaparotomy may be chosen.

Hysterectomy: Which Approach?

Hysterectomy has long been considered standard surgical treatment for symptomatic intramural and submucous fibroids, particularly for women not wishing to conceive or those of premenopausal age (40–50 years). In the United States, hysterectomyis associated with a substantial impact on healthcare systems that amounts to approximately $2.2 billion/year. Fibroids are the main indication for hysterectomy and, in this last decade, laparoscopic hysterectomy (LH) has become the ideal surgical route to replace laparotomy. In some departments, the rate of LH exceeds 90 %. Vaginal hysterectomy (VH) still remains indicated in some conditions, depending on the skill and habits of the surgeon.

Some studies have reported an increased risk of complications after LH, but in a very large series, similar rates of major complications were found after LH, VH, and abdominal hysterectomy (less than 1 % [0.44 %] of major complications) [24, 25]. In a recent report, it was demonstrated that laparoscopic hysterectomy has become more common and is associated with decreased complication rates, despite the higher preoperative risk for patients. Of course, a uterine volume of ≥13–14 weeks represents a relative contraindication. In such cases, preoperative treatment with GnRH agonist may be effective to reduce the size of myomas and facilitate surgery.

In a very recent publication, O. Donnez et al. [26] demonstrated that THL (total laparoscopic hysterectomy) is a feasible procedure, allowing same-day discharge and generating low levels of pain. Of course, lower the weight of the uterus is, easier the procedure is.

Conclusions on the Surgical Approach in Cases of Uterine Myomas

From a recent review, it can be concluded that:

1. Laparoscopic myomectomy is indicated in cases of:
   (a) Myomas <10–12 cm in size.
   (b) No more than three to four intramural myomas.
   (c) Intramural myomas >3–5 cm in size with cavity distortion in cases of infertility.

2. Hysteroscopic myomectomy in indicated in cases of:
   (a) Submucous myomas ≤5 cm in size.
   (b) Partially submucous intramural myomas >5–6 cm in size (two steps).
3. Laparoscopic hysterectomy (if no desire to conceive) is indicated if the volume of the uterus is <13–14 weeks.

In all other circumstances, laparotomy (or minilaparotomy) shoud be considered.

Because SPRMs are now available and have proved effective, it is time to focus on a very important question: what is the remaining role of surgery with the advent of these drugs? If surgery remains indicated, do these drugs enable less invasive surgery? Indeed, the real question is whether SPRMs (UPA) allow less invasive surgery or complete avoidance of surgery.

With the Advent of SPRMs, What Is the Place of Myoma Surgery in Current Practice?

Since SPRMs are now available and have proved effective, it is time to focus on a very important question: what is the remaining role of surgery with the advent of these drugs?

Mode of Action of SPRM

SPRMs and the Progesterone Receptor

The effects of progesterone on target tissues are mediated by the progesterone receptor (PR), which belongs to the nuclear receptor family. PRs are known to be upregulated in uterine fibroids compared with adjacent myometrium at the mRNA and protein levels [16]. Very recently, PR-B mRNA and PR-A and PR-B proteins were found to be more concentrated [17] and more abundant in fibroids than in adjacent myometrium.

SPRMs are synthetic compounds that compete at the PR binding site, displaying either agonist or antagonist activity on PRs [27–29]. When bound, this also results in dimerization and binding to the progesterone response element sequence, but induces an intermediate conformation, allowing the receptors to interact with co-activators and/or co-repressors [18, 19].

Whether a SPRM acts more as an antagonist or agonist depends on its structure and how it alters the PR conformation, leading to exposure or inactivation of particular binding domains, which affect the association of co-repressors and/or coactivators with the PR [19]. This is impacted by the presence of co-regulators in a particular cell type and by the ratio of co-activators and co-repressors. The activity of an SPRM varies with tissue type and physiological context (e.g. pregnancy) and may be different from one cell type to another [27].

SPRMs and Their Mechanism of Action on Uterine Fibroids: Uterine Fibroid Size Reduction

In vitro studies have demonstrated that progesterone stimulates fibroid cell proliferation, while SPRMs such as asoprisnil, telapristone acetate and UPA inhibit cell proliferation and induce apoptosis selectively in fibroid cells by down-regulating anti-apoptotic factors and anti-fibrotic activity and reducing or blocking growth factor expression [30, 31, 32].

In a recent publication, Courtoy et al. [33] reported findings of cellular and tissue analysis of UPA-treated myomas and compared them with untreated myomas, evaluating proliferation, apoptosis, extracellular matrix components, and matrix metalloproteinase-2 expression. The authors demonstrated multifactorial and successive events involving maintenance of a low proliferation rate, transitory stimulation of cell death that is not caspase-3 dependent, and a dramatic reduction in the ECM, essentially after long-term treatment, which may be partially explained by increased MMP-2 expression. This suggests direct regulation of MMP-2 expression by UPA in myomas. It also identified MMP-2 as an important player in ECM resorption in myomas to reduce their volume (Fig. 131.2).

SPRMs and Control of Uterine Bleeding and Ovulation

It should be stressed that the interest of SPRM treatment for uterine fibroids is also its impressive capacity to reduce uterine bleeding and control ovulation and the menstrual cycle. A high rate of bleeding control is reported with all SPRMs, with frequent occurrence of amenorrhea. This amenorrhea has been suggested to be due to a direct effect on the endometrium, and also partly related to anovulation [34, 35]. Indeed, the administration of UPA blocked the LH surge, but does not inhibit FSH secretion.

However, the exact mechanism of action by which daily SPRM administration inhibits ovulation and leads to amenorrhea is not yet entirely clear [36]. Single-dose SPRM treatment in the follicular phase or around the LH peak can delay ovulation and follicular maturation, as demonstrated with UPA and mifepristone [37, 38]. Chronic low-dose SPRM treatment (5 or 10 mg UPA) results in anovulation and amenorrhea in most women, without reducing endogenous estrogen secretion [13–16].

Therapeutic Potential of SPRMs

A main advantage of UPA therapy is that estradiol remained at mid follicular phase level avoiding menopause symptomas (hot flushes, bone loss), as frequently observed in women

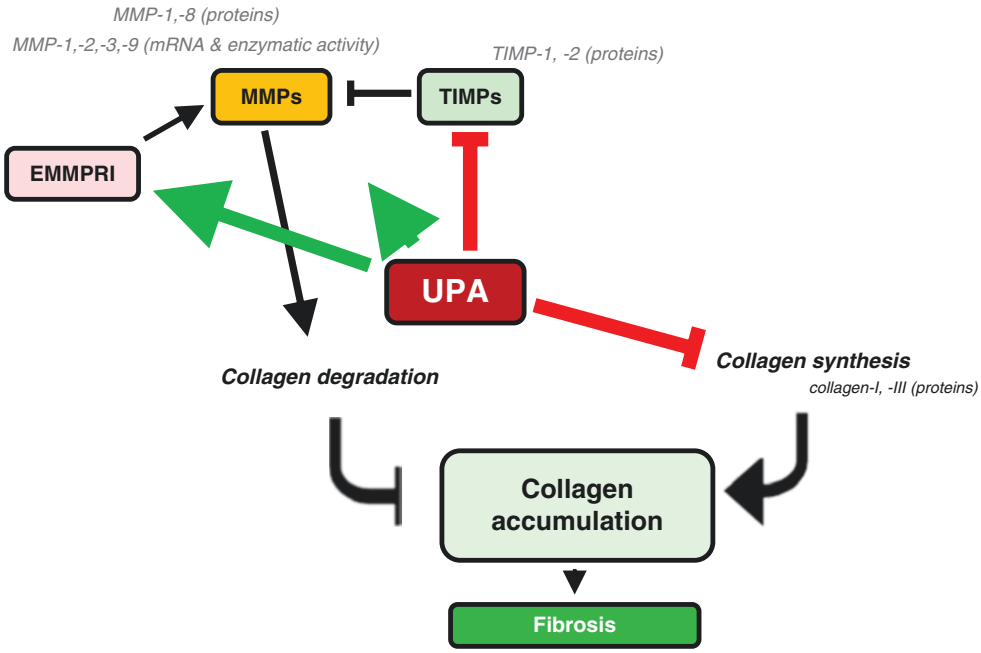


Fig. 131.2 In vivo mechanisms explaining the action of UPA on myomas

treated bye GnRHa. The main side effect is the induction of PAEC (selective progesterone receptor modulator associated endometrial changes) [39]. The different PEARL studies [13–16] clearly demonstrated that the changes are benign and reversible.

Use of UPA for Preoperative Management of Uterine Fibroids: Results from PEARL I and PEARL II Clinical Trials

PEARL I [13] was a randomized, double-blind, placebo-controlled trial evaluating 3-month treatment with UPA tablets (5 or 10 mg daily) in women with symptomatic fibroids, excessive uterine bleeding and anemia. By 13 weeks, uterine bleeding was under control in more than 90 % of women receiving 5 mg UPA, or 10 mg UPA (Fig. 131.3a). More patients achieved correction of anemia (hemoglobin >12 g/dL) by the end of the 3-month treatment period. This effect is of high clinical relevance, given that it has been well documented that preoperative anemia , even to a mild degree, is associated with an increased risk of morbidity and mortality in patients undergoing surgery [40].

In a similar setting, PEARL II [14] compared 5 and 10 mg UPA tablets with the existing standard medical treatment with GnRHa (3.75 mg leuprolide acetate depot injection once monthly).

The key findings of this study demonstrated that uterine bleeding was controlled in 90 % of patients receiving 5 mg UPA, 98 % of those receiving 10 mg UPA, and 89 % of those receiving leuprolide acetate. Median times to controlled bleeding were 5–7 days for patients receiving UPA (5 and 10 mg respectively), and 21 days for those receiving leuprolide acetate. In both UPA groups, plasma estradiol levels were maintained in the mid-follicular range, while patients in the leuprolide group on average showed a significant reduction to postmenopausal levels.

Follow-up in a subgroup of women who did not undergo surgery after the 3-month study period showed that UPA had a sustained effect (up to 6 months) after the end of treatment (Fig. 131.3b). By contrast, GnRHa-treated women experienced rapid regrowth of fibroids, reaching almost pre-therapy dimensions by 6 months post-treatment. Key efficacy results from the PEARL I and II trials are summarized in Fig. 131.3.

Long-Term Medical Management of Uterine Fibroids: Results of PEARL III and PEARL IV Clinical Trials

Thanks to the sustained effect observed in PEARL I and II, additional intermittent courses of 12-week UPA treatment with off-treatment intervals are a potential option for the long-term medical management of fibroids.

The **PEARL III** study [15] was designed to evaluate the efficacy and safety of long-term intermittent open-label 3-month courses of 10 mg/day UPA for the treatment of symptomatic uterine myomas, each course followed by randomized, double-blind treatment with norethisterone acetate (NETA) or a placebo in order to explore any effect on the reversibility of PAECs or timing and magnitude of the next off-treatment menstruation.

After the first UPA course, amenorrhea occurred in 79 % of women. Amenorrhea rates were respectively 89 %, 88 %,

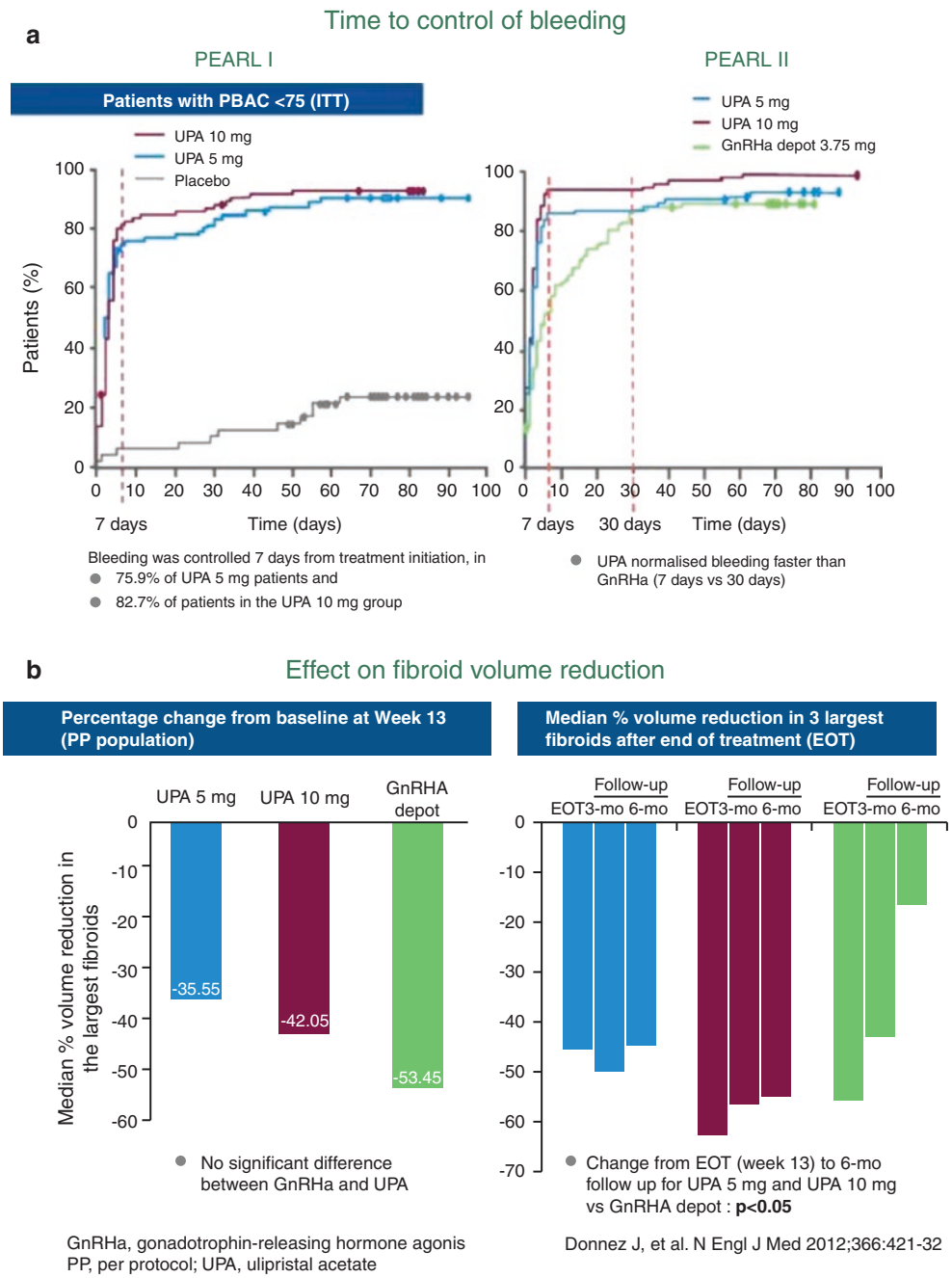


Fig. 131.3 Effects of UPA on bleeding control (**a**) and on fibroid volume reduction (**b**) (From Donnez et al. [13], Copyright © 2012 Massachusetts Medical Society, reprinted with permission from Massachusetts Medical Society; and Donnez et al. [14], Copyright © 2012 Massachusetts Medical Society, reprinted with permission from Massachusetts Medical Society)

and 90 % in women who received 2, 3 and 4 treatment courses. Median time to amenorrhea was 3.5 days from the start of treatment.

Median fibroid volume reduction from the baseline was 49.9 %, 63.2 %, 67.0 %, and 72.1 % after 1,2, 3, and 4 treatment courses respectively (Fig. 131.4).

All endometrial biopsies showed benign histology without hyperplasia [39]. NETA did not affect fibroid volume or endometrial histology, including PAECs. A 10-day course of progestin, administered immediately after each UPA treatment course, was associated with a significantly reduced and earlier occurrence of menstrual bleeding during off-treatment periods. However, these findings are probably insufficient to suggest that progestins should be routinely used in conjunction with UPA treatment, unless there is a need to control the timing or amount of menstrual bleeding, for example, before a planned invasive procedure.

In conclusion, the results of PEARL III and its extension study indicate that administration of more than one course of UPA maximizes the potential benefits of treatment in terms of bleeding control and fibroid volume reduction, while the association of NETA is of limited clinical benefit.

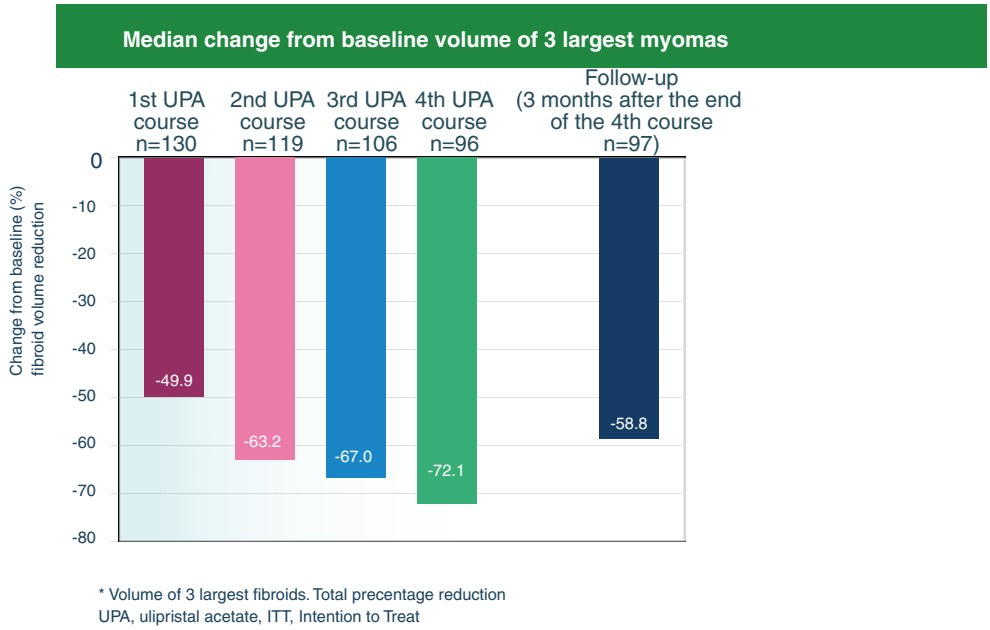


Fig. 131.4 Fibroid volume reduction in the PEARL III trial (Reprinted with permission) (Reprinted from Donnez et al. [15], Copyright 2014, with permission from Elsevier)

The last clinical trial, PEARL IV [16], investigated the efficacy and safety of repeated 12-week courses of 5 or 10 mg UPA daily for intermittent treatment of symptomatic uterine fibroids. In the 5 and 10 mg treatment groups, respectively 62 % and 73 % of patients achieved amenorrhea. The proportion of patients achieving controlled bleeding was indeed >80 % in both cases. After the second treatment course, the median reduction in fibroid volume from the baseline was 54 % and 58 % in patients receiving 5 and 10 mg UPA respectively. Pain and quality of life improved in both groups.

Based on these results, the dose of 5 mg should be recommended.

Will Intermittent Use of UPA Change our Approach to the Management of Uterine Fibroid?

Because SPRMs are now available and have proved effective, it is time to focus on a very important question: what is the remaining role of surgery with the advent of these drugs?

If surgery remains indicated, do these drugs enable less invasive surgery? Indeed, the real question is whether SPRMs (UPA) allow less invasive surgery or complete avoidance of surgery.

So the question remains open: will intermittent use of UPA change the approach to the management of uterine fibroids? To answer this question, it is important to consider the factors influencing the choice of therapy, such as the severity of symptoms (pain, bleeding), infertility related to myomas, tumor characteristics (volume, localization), age, wish to preserve the uterus, and wish to preserve fertility. Based on these factors, two new treatment algorithms can be proposed:

Women < 40 Years of Age Presenting with Symptomatic Myomas Distorting the Uterine Cavity and Infertility (Fig. 131.5)

If type 0 myomas (FIGO classification) are present, cutting the pedicle by hysteroscopy is indicated and no preoperative treatment is required [20]. For type 1 myomas (<3 cm), two options exist: either hysteroscopic myomectomy or UPA treatment in one or two courses of 3 months, followed by hysteroscopic myomectomy in case of inadequate response. In the majority of cases, hysteroscopic myomectomy for type 1 myomas is relatively easy to perform.

If (as is often the case) myomas are of type 1 but larger than 3 cm, or of type 2, UPA may be given in one or two courses of 3 months. Type 1 and 2 myomas often respond to this preoperative therapy and regress in size. This reduction allows a hysteroscopic approach that can be planned after the first menstrual bleed induced by NETA (10 mg/10 days), administered immediately after UPA treatment [20]. It should be pointed out that in some cases (if myomas regress so much that they no longer distort the uterine cavity), surgery may not be required. If the myomas are multiple (two to six) or of different classes (class 2–5), as is frequently observed, UPA can be given in two courses of 3 months.

After these two courses of 3 months, there are four possible outcomes:

1. Myoma regression is very significant (>50 % decrease in volume). The uterine cavity is no longer distorted, and the patient can try to conceive naturally or undergo assisted reproductive techniques, if indicated. Recently, a first series of pregnancies after UPA was reported [41] (Figs. 131.6 and 131.7).

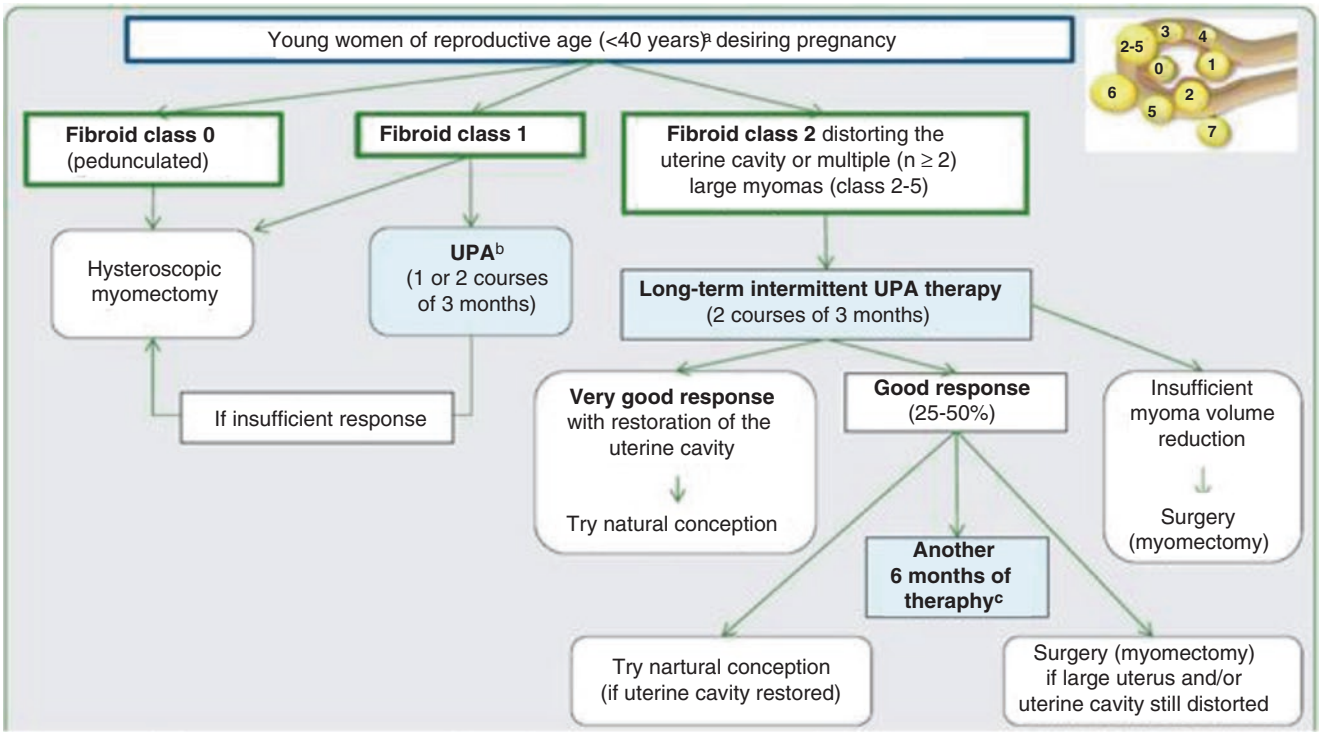


Fig. 131.5 Women <40 years presenting with symptomatic myomas distorting the uterine cavity and infertility. [a]After 40 years of age, any discussion about medical or surgical therapy should take into account the ovarian reserve and possible delay due to medical therapy. [b]Depending on the size (Reprinted from Donnez et al. [20], Copyright 2014, with permission from Elsevier)

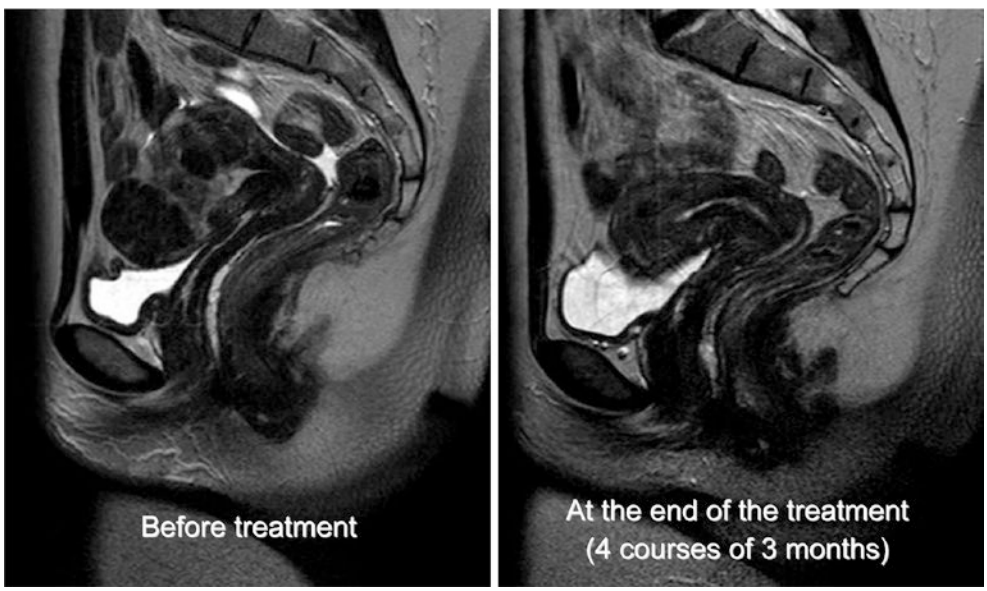


Fig. 131.6 After four courses of 3 months, myoma disappeared

2. Myoma regression is significant (>25 % but <50 %), but the baseline volume is so great that the indication for surgery remains. In this case, UPA may allow surgery to be performed by a laparoscopic approach once the hemoglobin level is normalized, avoiding laparotomy.
3. Myoma regression is moderate (>25 % but <50 %), but the uterine cavity remains distorted. In this instance, two options should be discussed with the patient: either [1] prolong medical therapy for another two courses of 3 months or [2] proceed with surgery.
4. Myoma regression is insufficient. Surgical indications should then be followed according to the size and site of myomas and treatment needs.

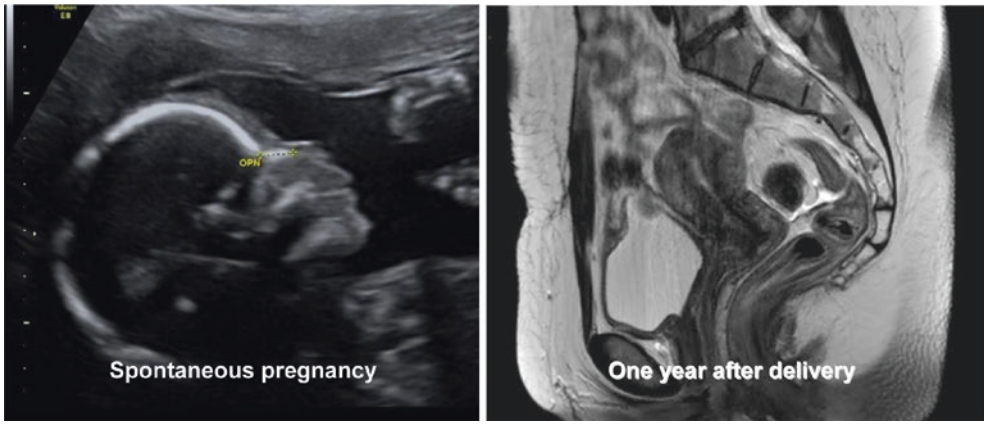


Fig. 131.7 The patient was pregnant and delivered. There was no regrowth during pregnancy. One year after delivery, the uterus was normal as well as the uterine cavity

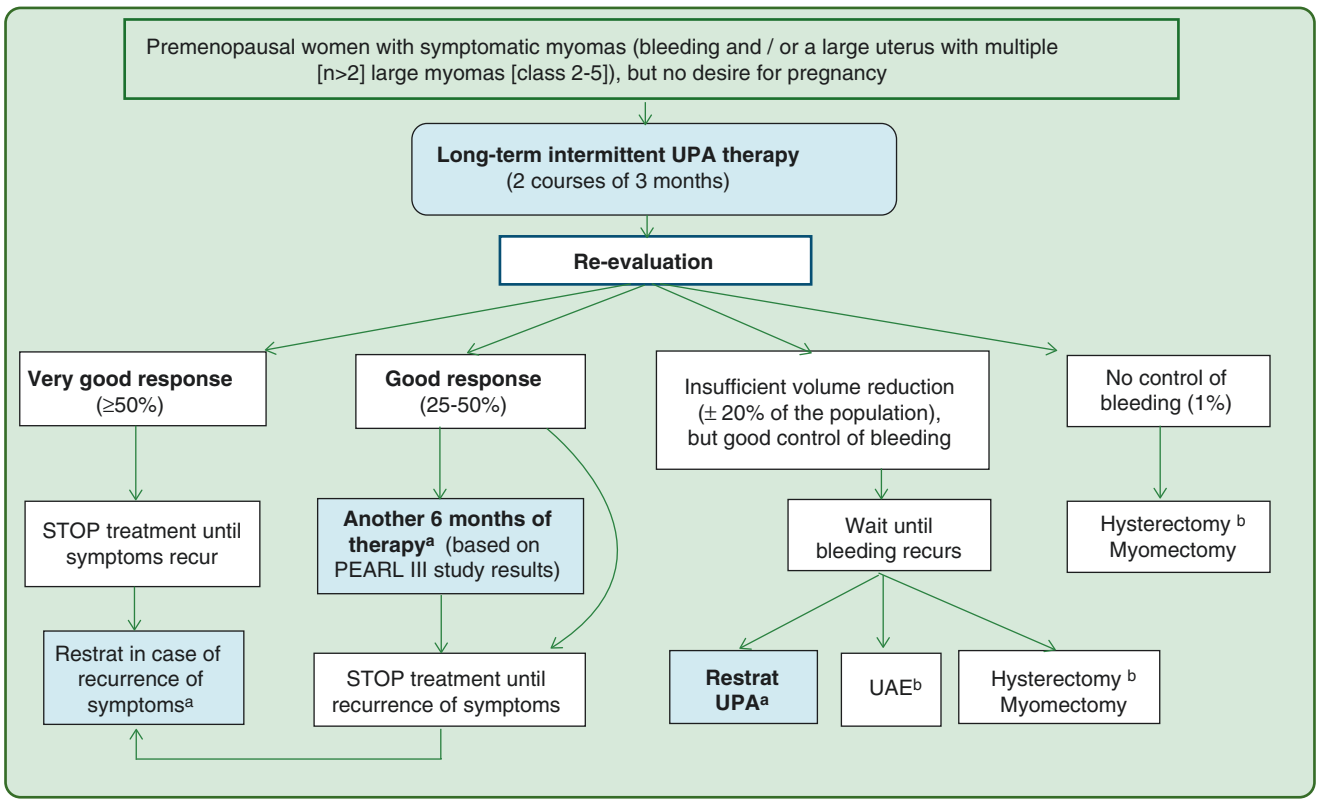


Fig. 131.8 Premenopausal women presenting with symptomatic myomas but no desire for pregnancy who wish to keep their uterus. [a]Currently approved. [b]Depending on wish to preserve fertility (Reprinted from Donnez et al. [20], Copyright 2014, with permission from Elsevier)

Premenopausal Women Presenting with Symptomatic Myomas but no Desire for Pregnancy, Who Wish to Keep Their Uterus (Fig. 131.8)

If type 0 or type 1 myomas are present, the algorithm in Fig. 131.1 can be applied. In case of type 2 fibroids distorting the uterine cavity or multiple (R2) large myomas (class 2–5), long-term intermittent therapy may be proposed in the knowledge that the PEARL-III study clearly demonstrated that repeated courses of UPA maximize the effect. If after two courses of 3 months myoma regression (>50 %) is such that the patient is free of symptoms, she can be observed until symptoms recur. Further courses of UPA may then be proposed. No data are so far available to determine the interval before recurrence, but a sustained effect was observed after treatment completion [14–16].

This proposed treatment could well prove beneficial in some instances. Indeed, if a young woman of 20 years were to present with multiple myomas and severe bleeding, she

could undergo UPA treatment not only to restore hemoglobin levels, but also to avoid surgery. It is well known that myomas frequently recur after myomectomy (25 % after 3 years), especially in young patients with a genetic predisposition, such as the African population. By treating these women medically, repeated surgery responsible for pelvic adhesions and subsequent infertility, as well as the risk of uterine rupture during pregnancy, may be avoided.

We are not suggesting that UPA will eradicate all indications for myomectomy, but it does mean that surgery can be avoided in case of a very good response, or at least be postponed until the patient wishes to become pregnant. In case of insufficient fibroid volume reduction or persistent bleeding, surgery (myomectomy) is indicated.

In premenopausal women with symptomatic myomas, long-term intermittent therapy may be proposed. In case of a moderate response (>25 but <50 % reduction), another two UPA courses can be given based on the results of the PEARL-III study , which showed that efficacy can be maximized this way. However, stopping UPA treatment until recurrence of symptoms may be considered another option.

In case of insufficient response in terms of fibroid reduction but good control of bleeding, it may be feasible to wait until bleeding recurs. In this instance, restarting UPA treatment or performing hysterectomy or uterine artery embolization may be three different options. In case of persistent heavy bleeding (1 % of the intent-to-treat population), surgery is of course indicated.

In conclusion, among the latest possible therapeutic options [32], UPA has proved to be most effective for the medical management of fibroids and will undoubtedly serve to modify the surgical approach.

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References

1. Fernandez H. Uterine fibroids [in French]. Rev Prat. 2014;64:540–4.
2. Ciavattini A, Di Giuseppe J, Stortoni P, Montik N, et al. Uterine fibroids: pathogenesis and interactions with endometrium and endomyometrial junction. Obstet Gynecol Int. 2013;2013:173–84.
3. Donnez J, Jadoul P. What are the implications of myomas on fertility? A need for a debate? Hum Reprod. 2002;17:1424–30.
4. Practice Committee of American Society for Reproductive Medicine in collaboration with Society of Reproductive Surgeons. Myomas and reproductive function. Fertil Steril. 2008;90(5 Suppl):S125–30.
5. Clark NA, Mumford SL, Segars JH. Reproductive impact of MRI-guided focused ultrasound surgery for fibroids: a systematic review of the evidence. Curr Opin Obstet Gynecol. 2014;26:151–61.
6. Sayed GH, Zakherah MS, El-Nashar SA, Shaaban MM. A randomized clinical trial of a levonorgestrel-releasing intrauterine system and a low-dose combined oral contraceptive for fibroid-related menorrhagia. Int J Gynaecol Obstet. 2011;112:126–30.
7. Lethaby A, Vollenhoven B, Sowter M. Pre-operative GnRH analogue therapy before hysterectomy or myomectomy for uterine fibroids. Cochrane Database Syst Rev. 2001;(2):CD000547.
8. Tan YH, Lethaby A. Pre-operative endometrial thinning agents before endometrial destruction for heavy menstrual bleeding. Cochrane Database Syst Rev. 2013;(11):CD010241.
9. Nisolle M, Gillerot S, Casanas-Roux F, et al. Immunohistochemical study of the proliferation index, oestrogen receptors and progesterone receptors A and B in leiomyomata and normal myometrium during the menstrual cycle and under gonadotrophin-releasing hormone agonist therapy. Hum Reprod. 1999;14:2844–50.
10. Kim JJ, Sefton EC. The role of progesterone signaling in the pathogenesis of uterine leiomyoma. Mol Cell Endocrinol. 2012;358:223–31.
11. Bulun SE. Uterine fibroids. N Engl J Med. 2013;369:1344–55.
12. Walker CL, Stewart EA. Uterine fibroids: the elephant in the room. Science. 2005;308:1589–92.
13. Donnez J, Tatarchuk TF, Bouchard P et al; PEARL I Study Group. Ulipristal acetate versus placebo for fibroid treatment before surgery. N Engl J Med. 2012;366:409–20.
14. Donnez J, Tomaszewski J, Vazquez F, et al; PEARL II Study Group. Ulipristal acetate versus leuprolide acetate for uterine fibroids. N Engl J Med. 2012;366:421–32.
15. Donnez J, Vazquez F, Tomaszewski J, et al; for the PEARL III and PEARL III Extension Study Group. Long-term treatment of uterine fibroids with ulipristal acetate. Fertil Steril. 2014;101(6):1565–73.
16. Donnez J, Hudecek R, Donnez O, et al. Efficacy and Safety of repeated use of ulipristal acetate in uterine fibroids. Fertil Steril. 2015;103(2):519–27.
17. Tsigkou A, Reis FM, Lee MH, Jiang B, Tosti C, Centini G, Shen FR, Chen YG, Petraglia F. Increased progesterone receptor expression in uterine leiomyoma: correlation with age, number of leiomyomas, and clinical symptoms. Fertil Steril. 2015;104(1):170–5.
18. Horne FM, Blithe DL. Progesterone receptor modulators and the endometrium: changes and consequences. Hum Reprod Update. 2007;13(6):567–80.
19. Bouchard P, Chabbert-Buffet N, Fauser BC. Selective progesterone receptor modulators in reproductive medicine: pharmacology, clinical efficacy and safety. Fertil Steril. 2011;96(5):1175–89.
20. Donnez J, Donnez O, Dolmans MM. With the advent of selective progesterone receptor modulators, what is the place of myoma surgery in current practice? Fertil Steril. 2014;102(3):640–8.
21. Somigliana S, Vercellini P, Daguati R, Pasin R, De Giorgi O, Crosignani PG. Fibroids and female reproduction: a critical analysis of the evidence. Hum Reprod Update. 2007;13:465–76.
22. Munro MG, Critchley HO, Broder MS, Fraser IS, FIGO Working Group on Menstrual Disorders. FIGO classification system (PALM-COEIN) for causes of abnormal uterine bleeding in nongravid women of reproductive age. Int J Gynaecol Obstet. 2011;113:1–2.
23. Lam SJ, Best S, Kumar S. The impact of fibroid characteristics on pregnancy outcome. Am J Obstet Gynecol. 2014;211:395.
24. Donnez O, Jadoul P, Squifflet J, Donnez J. A series of 3190 laparoscopic hysterectomies for benign disease from 1990 to 2006: evaluation of complications compared with vaginal and abdominal procedures. BJOG. 2009;116:492–500. 60.
25. Donnez O, Donnez J. A series of 400 laparoscopic hysterectomies for benign disease: a single centre, single surgeon prospective study of complications confirming previous retrospective study. BJOG. 2010;117:752–5.
26. Donnez O, Donnez J, Dolmans MM, Dethy A, Baeyens M, Mitchell J. Low pain score after total laparoscopic hysterectomy and same-day discharge within less than 5 hours: results of a prospective observational study. J Minim Invasive Gynecol. 2015;22(7):1293–9.

27. Chabbert-Buffet N, Meduri G, Bouchard P, Spitz IM. Selective progesterone receptor modulators and progesterone antagonists: mechanisms of action and clinical applications. Hum Reprod Update. 2005;11:293–307.
28. Madauss KP, Grygielko ET, Deng SJ, Sulpizio AC, Stanley TB, Wu C, et al. A structural and in vitro characterization of asoprisnil: a selective progesterone receptor modulator. Mol Endocrinol. 2007;21:1066–81.
29. Spitz IM. Progesterone receptor antagonists. Curr Opin Investig Drugs. 2006;10:882–90.
30. Morikawa A, Ohara N, Xu Q, et al. Selective progesterone receptor modulator asoprisnil down-regulates collagen synthesis in cultured human uterine leiomyoma cells through up-regulating extracellular matrix metalloproteinase inducer. Hum Reprod. 2008;23(4):944–51.
31. Xu Q, Ohara N, Wei C, et al. Progesterone receptor modulator CDB-2914 down regulates vascular endothelial growth factor, adrenomedullin and their receptors and modulates progesterone receptor content in cultured human uterine leiomyoma cells. Hum Reprod. 2006;21(9):2408–16.
32. Islam MS, Protic O, Giannubilo SR, et al. Uterine leiomyoma: available medical treatments and new possible therapeutic options. J Clin Endocrinol Metab. 2013;98:921–34.
33. Courtoy G, Donnez J, Marbaix E, Dolmans MM. In vivo mechanisms of uterine myoma volume reduction with ulipristal acetate treatment. Fertil Steril. 2015;104(2):426–34.
34. Chabbert-Buffet N, Pintiaux-Kairis A, Bouchard P. Effects of the progesterone receptor modulator VA2914 in a continuous low-dose on the hypothalamic-pituitary-ovarian axis and endometrium in normal women: a prospective, randomized, placebo-controlled trial. J Clin Endocrinol Metab. 2007;92(9):3582–9.
35. Chwalisz K, Larsen L, Mattia-Goldberg C, et al. A randomized, controlled trial of asoprisnil, a novel selective progesterone receptor modulator, in women with uterine leiomyomata. Fertil Steril. 2007;87(6):1399–412.
36. Brache V, Cochon L, Jesam C, et al. Immediate pre-ovulatory administration of 30 mg ulipristal acetate significantly delays follicular rupture. Hum Reprod. 2010;25(9):2256–63.
37. Stratton P, Hartog B, Hajizadeh N, et al. A single mid-follicular dose of CDB-2914, a new antiprogestin, inhibits folliculogenesis and endometrial differentiation in normally cycling women. Hum Reprod. 2000;15(5):1092–9.
38. Mutter GL, Bergeron C, Deligdisch L, et al. The spectrum of endometrial pathology induced by progesterone receptor modulators. Mod Pathol. 2008;21(5):591–8.
39. Williams AR, Bergeron C, Barlow DH, Ferenczy A. Endometrial morphology after treatment of uterine fibroids with the selective progesterone receptor modulator, ulipristal acetate. Int J Gynecol Pathol. 2012;31(6):556–69.
40. Richards T, Musallam KM, Nassif J, Ghazeeri G, Seoud M, Gurusamy KS, Jamali FR. Impact of preoperative anaemia and blood transfusion on postoperative outcomes in gynaecological surgery. PLoS One. 2015;6:10.
41. Luyckx M, Squifflet JL, Jadoul P, et al. First series of 18 pregnancies after ulipristal acetate treatment for uterine fibroids. Fertil Steril. 2014;102(5):1404–9.

Part XIII

Future Perspectives



Future Perspectives in Hysterectomy

132

Artin Ternamian and Liselotte Mettler

Introduction

Hysterectomy has been practiced for different reasons over centuries and despite contemporary medical and surgical advancements, there remains marked regional and international differences in hysterectomy rates, methods and costs.

Although universally accepted evidence based indications, practice guidelines and less disabling contemporary remedies, there appears to be no consensus on what constitutes an acceptable operative rate, as significant global, national, regional and practitioner differences continue to render this most important health index elusive.

Considering that hysterectomy remains the second most frequently performed major gynecological operation after Caesarean Section, it is important that we invest time and effort to better understand why such differences remain, so as to better advise our patients, improve quality of care, manage health funds and fulfill our societal and academic obligations.

Globally, women stand a 20–40 % life time risk of having a hysterectomy for benign, non-life threatening medical conditions; where prevalence variances, reflect local clinical practice patterns rather than pathological differences between regions.

While academic institutions and health organizations grapple with integrating emerging technologies and contemporary surgical remedies, in an ever expanding and changing teaching curriculum; it remains critical to remember that a considerable number of conditions that used to require extirpative surgery, have now alternate non-surgical, cost effective and less disabling remedies.

As Gynecology heads towards an uncertain future, when societal expectations are shifting, national practice guidelines are changing and payer scrutiny is ubiquitous, our discipline should be leery of investing precious, ever shrinking health and education resources, on training surgical technocrats who deliver *outdated remedies* using *innovative technologies*, to well informed clients, under the watchful eyes of learned health executives.

It is clear that new technology cost scrutiny and its impact on health outcomes may undermine unchecked expansion and adoption of emerging surgical technologies and innovations, as risk-based pressures and quality indicators heighten emphasis on competency standards.

Historical Perspective

The earliest recorded emergency hysterectomy is purported to have been performed by Themision of Athens in 50 BC.

Often, patients developed fistulas, infections and subsequently succumbed as these procedures inadvertently excised part of the patient's bladder.

By 1880, abdominal hysterectomy became common practice; however, mortality remained high, close to 70 %. Eventually, advances in blood transfusion, anesthesia, antibiotics and operative methods led to hysterectomy becoming a widespread and much safer operation.

Mortality rates following hysterectomy improved steadily and by 1910 the rates had dropped to 2.5 % for vaginal hysterectomy, while rates for abdominal hysterectomy lagged behind, until early in the twentieth century, when subtotal abdominal hysterectomy was practiced, and post operative mortality rates toppled to 3.5 %. Eventually this trend got replaced in the 1950s, by total abdominal hysterectomy and the mortality rates of both vaginal and abdominal hysterectomy settled to about 0.1 % [1].

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Global Perspectives

Several decades of improved patient safety, enhanced surgical methods and innovative operative techniques resulted in a significant global increase in the number of surgical operations performed; by mid 2000, hysterectomy became the most common major gynecologic surgery performed. According to the United States National Center for Health Statistics-CDC, 617,000 hysterectomies were performed in 2004, with 73 % having an oopherectomy as well [2].

This corresponds to an annual 20 % hysterectomy rate by 40 years of age, 33 % by 65 year of age and a staggering 43 % by 85 years of age for United States women [3–5].

Interestingly, lifetime risk of having a hysterectomy differs considerably between countries and regions alike. In Europe, there are about 100,000 hysterectomies performed every year in the United Kingdom [6], 60,000 in France [7], 10,000 in Finland [8] and about 5000 in Denmark [9]. The annual hysterectomy rate ranges from a high of 3.7 per 1000 Italian women [10], to a low of 1.8 per 1000 Norwegian women [11]; comparatively the rate is much different in the United States, with a rate of 5.38 per 1000 women per year [12].

According to the Centers for Disease Control and Prevention (CDC), United States women appear to have the highest hysterectomy rates in the entire industrialized world and rates remain higher on the West compared with the East Coast [13].

Measuring and interpreting global hysterectomy rates as straight comparisons of national rates is often difficult if not misleading; as significant differences in definition and interpretation exists. When publishing hysterectomy rates, considerable variances in the choice of numerators exist; authors may include or exclude outpatient operations, may refer to all procedures or include operations for benign disease only, and denominator may include women of all ages or those of a specific age group, among others.

Given that a majority of hysterectomies are performed electively, for non-malignant reasons, some have suggested that 10–90 % of hysterectomies performed in the United States may not be medically necessary [14].

At this point, it is difficult to explain which of these operative rates is 'correct' and why an observed fourfold difference in incidence exists; however, it is clear that most of these non cancerous surgeries are performed for treatment of uterine fibroids, abnormal uterine bleeding (AUB), pelvic organ prolapse (POP) or endometriosis (chronic pelvic pain).

Although we do not understand the exact etiology why these condition occur, it is clear that an ever increasing menu of conservative non-surgical treatment options are developed that have proven to be less disabling and more cost effective.

As risk based pressures mount and yearly total hospital costs for operative procedures near five billion US dollars, administrators, quality improvement specialists and health policy experts will increasingly question use of operative remedies to treat benign conditions, when non-surgical treatments exist [15, 16].

Although alternative remedies, careful application of "appropriateness criteria" and a host of other societal factors helped decrease the overall hysterectomy rate, their overutilization is purported to remain between 16 and 70 % [17].

Our practice patterns do not appear to be concordant with current American College of Obstetricians and Gynecologists (ACOG) clinical practice guidelines, where non-surgical and uterine-sparing alternatives to hysterectomy are espoused (Table 132.1). [18].

It is no wonder that more recent USA hysterectomy statistics reflect this downward trend, to about 400,000 inpatient procedures performed annually, where one in three North American women are expected to have a hysterectomy by the time they turn 60 years old [12, 19, 20].

Notwithstanding this marked drop in hysterectomy rates, appropriateness of all methods of hysterectomy remains an important national quality improvement concern that deserves serious consideration, before further time and resources are invested in adopting prohibitively costly newer operative remedies.

Table 132.1 American College of Obstetricians and Gynecologists (ACOG) clinical practice guidelines

Summary of Recommendations & conclusions based on limited or inconsistent scientific evidence (Level B)
Levonorgestrel IUD effective in AUB & should be considered for all age groups
Medical treatment options for AUB-O (oligo-ovulation or anovulation) include progestin therapy & combined hormonal contraceptives
Women who completed childbearing, were medical therapy failed, or have contraindications to medical therapy are candidates for total hysterectomy
As AUB-O is endocrinologic abnormality, underlying disorder should be treated medically instead of surgically. Surgical therapy rarely indicated for AUB-O, unless medical therapy fails, is contraindicated, is not tolerated or patient has concomitant intracavitary lesions
Following recommendations & conclusions based primarily on consensus and expert opinion (Level C)
Medical management failure requires more investigation, including imaging or hysteroscopy
Choice of treatment of AUB-O guided by goals of therapy, which may be to stop acute bleeding, avoid future irregular-heavy bleeding, simultaneously provide contraception & prevent complications, such as anemia, unnecessary surgical intervention & diminished quality of life
Endometrial ablation not recommended as first line AUB-O therapy
Physicians must provide thorough informed consent & adequate counseling to women with AUB-O who desire endometrial ablation

Practice Bulletin No. 136. Non-surgical and uterine-sparing alternatives to hysterectomy

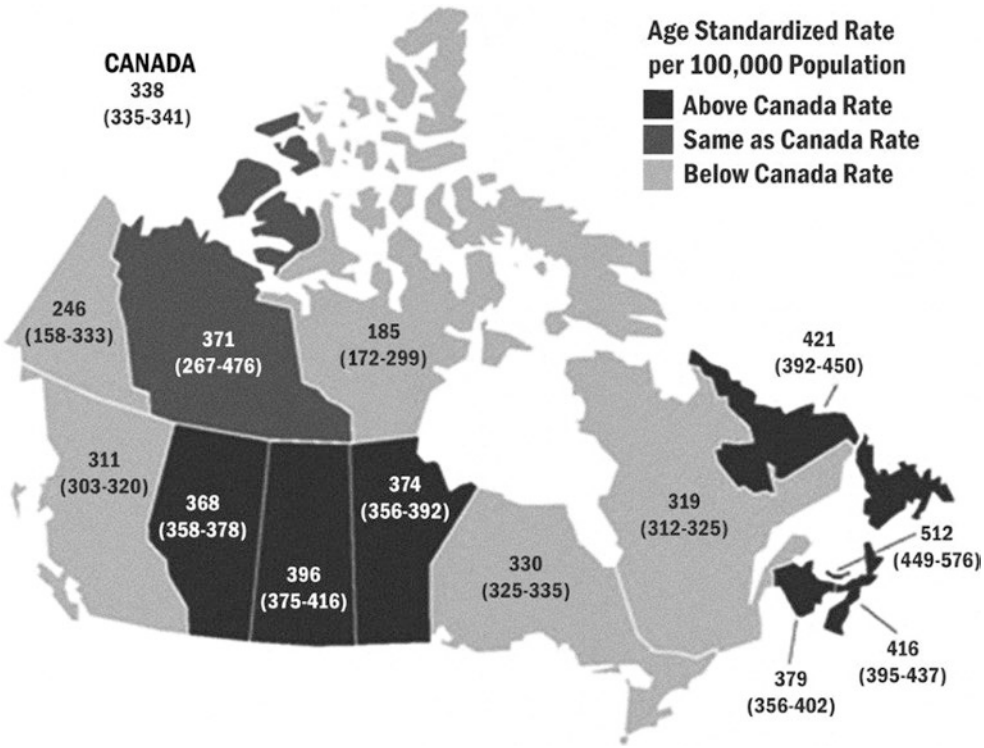


Fig. 132.1 Age-Standardized Hysterectomy Rates by Province & Territory, Canada, 2008–2009. Hysterectomy Rate: 338/100,000 women aged 20 years or older, down from 484/100,000 women in 1997 (By permission of the Canadian Institute for Health Information, Health Care in Canada 2010)

In a recent publication, Corona et al., observed that the commonest indication for hysterectomy in the USA remains AUB and an effective treatment for this condition is use of the Levo Norgestril medicated intrauterine device (Mirena ®); however, its use is greatly underutilized.

Given that as much as 18 % of surgical pathology results fail to demonstrate need for a hysterectomy, they remain convinced that if ACOG practice guidlines are carefully followed, further decrease in hysterectomy rates is real and attainable [21].

The situation in Canada is similar to its southern neighbor, although Canadian hysterectomy rates for benign and malignant gynecological conditions have gradually slumped since early 1980s; it remains the second-most frequently performed operation on women, second to Caesarean Section [22].

According to the Canadian Institute for Health Information, the most recent 2012-2013 figure is 47,127 operations; about 338 hysterectomies for every 100,000 women age 20 years or older, down from 484 per 100,000 women in 1997 (see Fig. 132.1).

Although evidence-based national clinical practice guidelines are published and hysterectomy indications are clearly articulated in Canada, considerable differences abound among provincial hysterectomy rates [23, 24].

These age-standardized hysterectomy rates differed threefold inter-provincially, ranging from a low of 185 per 100,000 in Nunavut to a high of 512 per 100,000 women age 20 or older in Prince Edward Island.

The west coast province of British Columbia has the lowest rate among all regions; 311 per 100,000. These rate variations may indicate differences within and between jurisdictions in care provider culture, patient expectations, practice patterns and approaches to this operative remedy [22, 25].

Besides considerable inter-provincial variation, age-standardized hysterectomy rates are more frequent for women living in rural areas; 464 per 100,000, compared to those living in urban areas; 318 per 100,000 women. These rate differences may be due to urban area dwellers having better access to alternate non-operative treatment options, compared to rural dwellers. Most urban dwellers elected to have a hysterectomy due to uterine myomas whereas rural dwellers for menstrual disorders [22].

Irrespective, when clinical practice fails to follow evidence-based guidelines and clinical consensus, questions about inappropriate practice patterns and quality assurance-may be suggested.

Current guidelines do not provide a benchmark for hysterectomy rates to be measured against; though, rate variation itself may suggest overuse in some jurisdictions and underuse in others [26]. Contemporary clinical guidelines provide clear recommendations on how to best treat benign gynecological conditions, where hysterectomy is touted as being one of several less disabling options.

Despite significant decline in the overall hysterectomy rate in Canada between 2000–2001 and 2006–2007 (22 %), clearly there remains considerable variation across the country and there is plenty of work to be done, to further improve treatment of benign gynecological conditions.

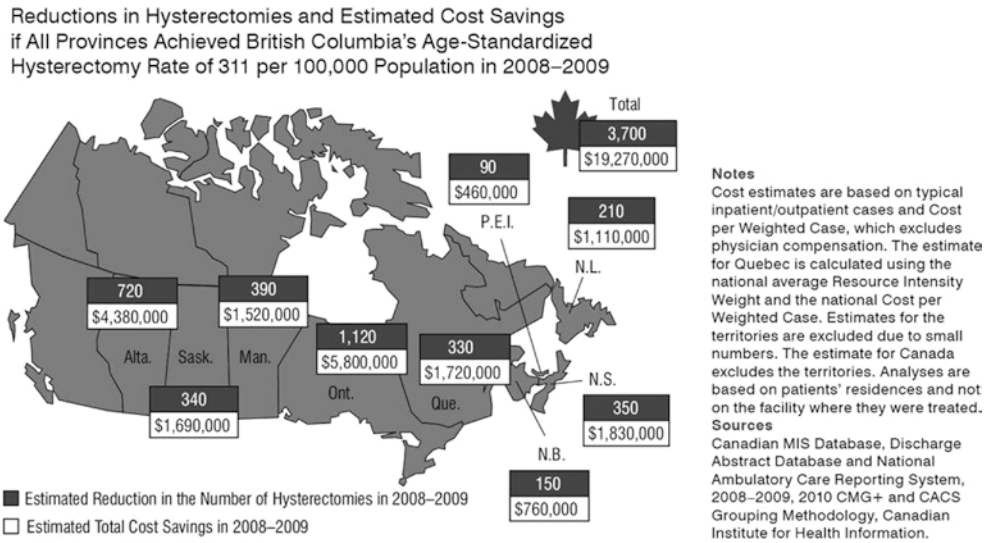


Fig. 132.2 Reductions in Hysterectomies and Estimated Cost Savings if All Provinces Achieved British Columbia's Age-Standardized Hysterectomy Rate of 311/100,000 population in 2008–2009. Hysterectomy Rate reduction results on health care cost (By permission of the Canadian Institute for Health Information, Health Care in Canada 2010)

In general, evaluating how much rate reduction will impact quality of care and health care costs is challenging. If all Canadian provinces had similar hysterectomy rates as the west coast province of British Columbia (*311 per 100,000 women*), there would be around 3700 hysterectomies performed nationally, an 11 % reduction; resulting in >19 million $CD in hysterectomy hospitalization savings, of an estimated total hospitalizations cost, 2008–2009, of 192 million $CD (see Fig. 132.2) [22].

Globally, there is a growing perception that some hysterectomies are performed unnecessarily and in many cases, too many are carried out overall, without offering women available non-surgical or at the very least less invasive surgical options to remedy non-malignant gynecological conditions [15].

In 2002, The Ontario Women's Health Council suggested a road map to reduce hysterectomy rates in the province that include; offering non-surgical medical alternatives prior to entertaining surgery; empowering and educating women about available treatment options and access to contemporary medical and non-extirpatory surgical remedies; implementing regular quality assurance checks, such as internal and external chart audits, with feedback on appropriateness of practice; and ongoing continuing professional education for practicing gynecologists, about new surgical and non-surgical alternatives to hysterectomy [27].

In Germany, like elsewhere in the world, about 80 % of hysterectomies are performed to treat non-malignant gynecological conditions [28–30].

National hysterectomy rates have shown regional differences as well; where the prevalence is higher in West compared to East Germany. As elsewhere, there is an inverse association between levels of education, employment and prevalence of hysterectomy [31, 32].

Although population-based hysterectomy rates in the 16 Federal German States between 1970-2004, are not available, their hysterectomy rate appears to have remained relatively stable to 2006, when a total of about 149,456 operations were performed, among a population of 42 million women. Those between ages 40 and 49 accounted for 50 % of hysterectomies, while those between ages 50 and 59 accounted for 20 % [33].

More recently, in 2007, the number of hysterectomies performed decreased slightly to 138,164 operations [34]. It is suggested that introduction of emerging non-operative advancements and wider adoption of endoscopic remedies, may have influenced this recent downward trend [35].

A recent nationwide German analysis indicated that the peak hysterectomy rate remains between 44-47 years of age [36]. Admittedly, prevalence-corrected, age-standardized hysterectomy rates provide more accurate statistics on use of this form of therapy.

Although hysterectomy rates in Britain have slowly fallen over the last few years (42/100,000 population) and is now lower than North America and some European countries, they suffer from similar widely varying rates between regions and individual gynecologists.

It is difficult to explain these disparities as several factors determine the lower hysterectomy rate including health care resource differences; compensation plans; surgeons' attitudes; health care organization variances and differences in patients' expectations.

The 2006 UK Chief Medical Officers Report suggests that one in five women will have a hysterectomy by age 60 and about 20 % will have had their ovaries removed as well. The main recommendation of this report is to develop clear clinical guidelines for hysterectomy based on evidence based criteria and empower women to make informed choices [37].

In England, 38,000 hysterectomies were performed 2004-2005 and a great majority of them were performed for non-cancerous benign conditions [38].

The commonest reason for surgery was AUB, which accounted for 46 % of all hysterectomies; pelvic organ prolapse accounted for 20 %, while uterine myomas for an additional 18–21 % [6].

As in other jurisdictions, UK hysterectomy rates are inversely related to social class and education with sizeable geographic regional variations in operative rates, where lower socio-economic regions demonstrated a higher hysterectomy rates compared to more affluent areas [39].

The Royal College of Obstetricians and Gynaecologists give the following recommendation on hysterectomy for AUB; hysterectomy of all forms, remain an effective and established remedy for menorrhagia, however; its use should be tempered by societal norms, costs and potentially serious morbidity and mortality [40]. Admittedly, conventional dilatation and curettage may not be therapeutic, whereas outpatient endometrial ablative remedies are.

The 2006 Cochrane review on hysterectomy conceded that vaginal hysterectomy should take precedence over abdominal hysterectomy whenever possible, as it is clearly less disabling and associated with less morbidity; at the time, no outstanding benefit was observed with laparoscopic hysterectomy over vaginal hysterectomy, although laparoscopic approach appeared to have a longer operative time [41].

The present health care cost implications as it relates to hysterectomy cannot be overstated. On average, surgical cost for this surgery is about £2362, whereas Levo Norgestril medicated intrauterine device (Mirena ®), including insertion and removal fees is about £227; resulting in an annualized cost of £70 to the National Health Services, which is significantly less than the cost of hysterectomy.

Given that about three-quarters of hysterectomies are performed for non-cancerous AUB, it is clear that a good percentage of these can be managed successfully by less invasive, non-surgical remedies, averting close to 34 % of non-cancerous hysterectomies; incurring a significant amount of health care savings [42].

An exact cost comparison between hysterectomy and use of some of the more recent medical remedies, such as selective progesterone receptor modulators (SPRMs), is not readily available; however, they are not inexpensive at the moment. Their ability to reversibly block progesterone receptors in target tissues such as endometrium and act quickly as a potent, orally active anti-progestational agent, promises to be an important additional medical treatment option available.

Besides, irrespective of surgical method, hysterectomy is not without its own risks, the literature suggests that one in 30 women will have intra-operative complications, while one in ten patients can succumb to post-operative complications of all sorts [6].

Additionally, the VALUE study demonstrated that of the 46 % of patients having a hysterectomy for AUB; only 4 % of women had a less invasive endometrial ablation-resection attempt.

A majority of women with AUB with non-malignant gynaecological pathology, can be successfully treated with a variety of less invasive endometrial ablative remedies and use of non-extirpative techniques, forestalling up to 75 % of hysterectomies [6].

Irrespective, uterus removal with whatever means or method will remain a desirable option for some women, as about half of women who try the Levo Norgestril medicated intrauterine device (Mirena ®), go on to have a hysterectomy [43].

Given that vaginal hysterectomy is less disabling than abdominal hysterectomy, one would expect that it is the commonest method used by gynecologists, however the VALUE study demonstrated that, like in many developed countries, more than two third of hysterectomies are still being performed abdominally [1, 6].

The newer minimally invasive surgical methods in all its forms, including robotically assisted and single port hysterectomy, show promise but no evidence of a clear advantage over vaginal hysterectomy; additionally, they appear to require longer operative time [44].

Generally, a small minority of patients find long-term medical treatments compatible with their expectations and more than half who start oral medication, progress on to having a hysterectomy [45].

In Northwestern European countries, hysterectomy remains the commonest gynecological operation; their rate has been relatively stable though a resent slow decreas is observed.

The Netherlands appears to have a low hysterectomy rate compared to other developed industrialized countries, *(1995–2005, average yearly crude hysterectomy rate, for benign conditions only; 17.2 per 10,000 women of all ages),* where a significant, 50.8 % are performed vaginally; they remain convinced that given their regional differences, further decrease in hysterectomy rate is possible and further increase in vaginal hysterectomy proportion is feasible [46].

Not only is hysterectomy rates in the Netherlands low when compared with other Western countries, those operations performed specifically for AUB, dropped by about a quarter percent between 1995 and 2005. It is suggested that this substantial decrease is mainly because of introduction of less invasive contemporary treatment alternatives, such as endometrial ablation-resection, interventional Magnetic Resonance guided Focused Ultrasound myoma ablation, uterine arteries embolization and Levo Norgestril medicated intrauterine device (Mirena ®), among others [44, 47–49].

The same is true in Denmark and other Scandinavian-Nordic countries, where hysterectomy rates for benign conditions remained steady for several decades and now appears

to have further declined slightly for similar reasons [50–52]. Admittedly, their operative rates are much lower (lifetime hysterectomy prevalence is only 10.4 %), than reported rates from North America [53], and Germany [36].

As European society embraces increasing numbers of immigrants from different parts of the world and become less homogenous, women of different ethnicity will influence their future operative rates; women of African ancestry, will have a higher incidence of uterine fibroids, with associated increased prevalence of AUB, requiring treatment [54, 55].

As in other jurisdictions, women's socio-economic status appears to determine operative rates; women with a lower socio-economic status are more likely to have a hysterectomy [56, 57].

Several papers indicate that despite the fact that socio-economic and ethnic demographics account for variances in hysterectomy rates within and among nations, operative rates and surgical method is also influenced by gynecologist's training, age, academic setting and compensation structure [58–60].

When analyzing hysterectomy rates for a specific benign condition like pelvic organ prolapse, several papers from Denmark, Sweden, UK and USA, demonstrated a marked increase is the vaginal hysterectomy rates [50, 53, 61–63].

It is suggested that this increase of hysterectomy for POP could be attributed to changes in patent's attitude or a higher prevalence of POP risk factors, such as obesity and delivery of larger size babies [64].

While reliable hysterectomy rates for benign disease and related statistics is published in industrialized countries such as Australia, Canada, North Europe and the United states, consistent data from Southern and Eastern European countries, are difficult to compile or compare, given their different reproductive and socio-cultural environments.

A paper by Materia et al., studied the connection between inpatient hysterectomy rates for benign disease and socio-economic status in the city of Rome, they determined that the operative rate for all methods was 30.2 per 10,000 women aged 35 years or more.

They demonstrated that affluent women may receive minimally invasive remedies, compared with those from a lower socio-economic status; that are more prone to undergo unnecessary hysterectomies irrespective of their reproductive age [10].

As elsewhere, the overall hysterectomy rates in Northern Italy has steadily declined over the last decade, where younger patients <55 years had their surgery for treatment of fibroids and older ones for POP; with a considerably increased incidence of vaginal hysterectomy route and a marked decrease in abdominal hysterectomy rates [65].

These changes are ascribed to a widespread use of hysteroscopic ablative methods where the number of these procedures increases significantly during the same time [66, 67]. Interestingly, the impact of Levo Norgestril medicated intrauterine device (Mirena ®) is less clear, as intra uterine contraceptive device use in Italy, has been notoriously very unpopular.

Hysterectomy rates elsewhere in the non-industrialized or underdeveloped world is more challenging to estimate and nuanced to interpret, let alone to compare. Although isolated centers of health-care excellence exist; large populated regions of Asia or Africa, have precarious health care systems, where local practice statistics are inaccessible and rates difficult to measure [68].

In a paper by Chao et al., a panel of experts reviewed claims submitted to the Taiwan National Health Insurance Bureau; discovered that about 75 % of women had hysterectomy for apparent acceptable reasons, 5 % for uncertain reasons and 20 % for inappropriate reasons. These latter operations were mostly performed in younger women for chronic pelvic pain (42.9 %), AUB (37 %), and endometriosis (27 %).

Their study reveals a significantly high hysterectomy rate in Taiwan and urges better patient selection, as these operative interventions, irrespective of method, results in increase patient morbidity, mortality and health-care costs [69].

In an effort to improve quality of care and control escalating health-care expenditure, the Taiwan National Health Insurance Bureau, introduced a simplified case payment system, based on diagnosis-related groups (DRG); compensating health centers at a fixed rate for certain surgical procedures and related inpatient care, determined according to hospital accreditation level.

So as to steer gynecologists towards less invasive methods, laparoscopically assisted and conventional non-laparoscopic total hysterectomy, are defined in the payment plan by the Bureau of NHI as separate procedure items; where reimbursement for the former method is approximately 1.5 times that of non-laparoscopic total hysterectomy [70].

As in other jurisdictions worldwide, the frequency of laparoscopically assisted hysterectomy is steadily increasing, at the expense of conventional abdominal methods; 31.4 % in the United States [63, 71], >29 % in Finland [72], 12 % in Germany [30], and 10 % in the Netherlands [73]. The rate of laparoscopically assisted hysterectomy in Taiwan evolved from 5.2 % in 1996 to 40.4 % in 2005 [74].

The recent Cochrane collaborative meta-analysis suggests the recommended order of hysterectomy method preferences to be the vaginal route, followed by the laparoscopically assisted method and finally the abdominal hysterectomy way [75].

There are no reliable audits published recently in India, as there are no available national statistics for hysterectomy and the number of operations performed every year appear to be vastly under-reported. A publication from the northern region of Haryana suggests incidence of hysterectomy to be about 7 % amongst married women older than 15 years of age [76].

A paper by Desai et al., from the western state of Gujarat, estimated that more than 7 % of rural and about 5 % of urban women already had a hysterectomy, at an average age of 37 years [77].

The recent British Broadcasting Corporation world service depiction by Jill McGivering of unscrupulous hysterectomies performed in India may appear comparatively excessive, however one has to appreciate the vastly different societal and economic challenges women and practitioners endure in impoverished remote areas, where contemporary health remedies are lacking and oversight difficult http://www.bbc.co.uk/go/em/fr/-/news/magazine-21297606. *[accessed 26 March 2015].*

As an exact contemporary global hysterectomy rate remains elusive, it could be argued that regions with lower hysterectomy rates, such as Nordic countries, may be denying women an operation that could significantly enhance quality of life, while areas with higher hysterectomy rates, such as India, are subjecting women to unnecessary procedure, with known risks and complications.

Simple locally crafted guidelines can have noteworthy effects towards assuring that patients are offered surgery only when absolutely necessary and operations are not denied when it can significantly improve quality of life.

Understandably, patient participation in decision-making prior to surgery remains fundamental, as research determined that when women are engaged in these important health related decisions, their post-operative satisfaction with hysterectomy is higher; as such life altering procedures impact the very core of womanhood.

Gynecologists practicing in underdeveloped regions must be seriously attentive and vigilant about their current hysterectomy rates, while those in industrialized regions cannot remain content with their wildly varying hysterectomy rates, as substantial and difficult work remains to be had in both extremes.

Hysterectomy is usually performed to improve a patient's quality of life; however sometimes they are performed for life saving purposes; as with all surgical operations, intraoperative and postoperative complications are inevitable and they do occur with all methods of hysterectomies; generally reported to vary from 0.5 to 43 % [78].

Hysterectomy mortality rate is roughly 0.38 (0.25–0.64) per 1000 women, where serious intraoperative complications include soft tissue injuries, such as ureter, bowel, bladder, excessive bleeding and reoperation; incidences vary, 3.6 % during abdominal and 3.1 % during vaginal hysterectomy, where an additional 1 % will have serious complications during the post operative period, irrespective of method [60].

These relatively reduced peri-operative morbidity and mortality rates and purported cost-effectiveness renders hysterectomy, an attractive, definitive and *contemporary* treatment option for several gynaecological conditions [79].

A recent publication from Sweden by Lundholm et al., confirms that hysterectomy in younger pre-menopausal women aged 50 years or less, substantially increases risk of cardio-vascular events later in life; oopherectomy further adds to this risk for stroke and coronary heart disease, which may have significant and important societal health consequences.

In addition, contemporary hysterectomy trends for managing benign conditions show both a worrying inclination towards broadening indications for surgery, as well as a move towards offering younger aged (reproductive and peri-menopausal) patients a more definitive operative remedy for their gynaecological conditions [61].

Research has determined that following hysterectomy, patients grapple with considerable psycho-sexual, emotional issues [80], pelvic floor laxity and increased vaginal prolapse; it is suggested that ovarian endocrine function declines progressively following removal of the internal genitalia. The mean age of onset of the climacteric in women who had a hysterectomy is 3.7 years earlier than average, even with ovarian preservation [81].

A paper by Pandey et al., from Manipal University, Kasturba Medical College teaching hospital, in Southern India, determined that most of their hysterectomies (98.9 %) were justified, based on the postoperative patho-histologic reports; however, they conceded that out of a total of 527 hysterectomies performed in 2012, only 76 cases could have been avoided. More than three quarters had abdominal hysterectomy, 17.8 % had vaginal hysterectomy and only 6.6 % had laparoscopic hysterectomy [82].

More than 15 years ago, Broder et al., published a paper describing frequency of inappropriate non-emergency and non-oncologic hysterectomies in the USA [15]. Sadly, there is some truth to the statement by Magon, that hysterectomy, is a surgery which continues to be used and misused, underused, and abused at different times in the practice of gynecology [83].

Amin et al., from Mercy Teaching Hospital, Peshawar Medical Collage, Pakistan, retrospectively reviewed as a quality assurance initiative their 2010–2012 hysterectomies, they determined that 91.1 % of all operations were justified. The clinical diagnoses were related to presenting complaints and histo-pathologic findings were confirmed ($p = 0.000$); the majority of their operations were performed abdominally as few of their patients presented with POP [84].

Their commonest presenting complaint was AUB (52 %) and POP (30 %) of patients; whereas the commonest indication for surgery was uterine fibroids followed by POP. These are similar to observation by Qamar-un-Nisa et al., at Muhammad Medical College Hospital, Mirpurkhas [85], and by Iftekhar et al., at the Karachi Hospital, where AUB related to uterine myomas was the commonest complaint (30 %) and most common histo-pathological diagnosis [86].

However, Ahsan et al., from Liaquat National Hospital, Karachi, found adenomyosis to be their most common histopathological diagnosis, followed by uterine myomas [87].

Admittedly, economic and ethno-social demographics temper some of the differences in hysterectomy rates between and within regions, it appears that operative route choices and rates are mostly prejudiced by surgeons' inclinations and financial considerations of a given healthcare environment [58, 59]. It appears that younger surgeons are less likely to opt for a hysterectomy compared with older gynecologists, and those practicing in academic settings tend to prefer a surgical solution significantly less often than those in community settings; reflecting differences in training and ability [60].

The Robotic Paradigm

Addition of robot-assisted surgery to the minimally invasive palette certainly provides significant advantages, to our ability to perform, technically challenging procedures with less patient disability; however, it has the potential of confounding the complex *hysterectomy rate* conundrum further. A pressing issue with this emerging technology is not whether robotics has any role in gynecological endoscopy, but rather to clearly articulate and define the role it plays in an academic and clinical institutional environment.

Although adoption of the robotic assisted platform appears to contributed to a significant decrease in the overall *abdominal* hysterectomy rates, institutions must be cautious not to disproportionately endorse robotic methods, at the expense of other forms of hysterectomy, as they run the risk of allowing volume and quality of vaginal or conventional laparoscopic surgery to dwindle; where delivery of health become hostage to its own advertising practices, to the advantage of industry and detriment of patient care.

Notwithstanding the reality that robot-assisted surgery is *just* an evolutionary offshoot of contemporary minimally invasive surgery, considerable unabashed efforts and capital has been dedicate by industry to steer the complex and usually non-medical conversation towards institutional marketing, faculty-resident training and recruitment [88].

The commercially available robotic platform in use to date is the da Vinci (Intuitive Surgical, Inc., Sunnyvale, California); it is equipped with twin optic capability to offer surgeons at the work console only, 3-dimensional vision. This enabling aspect compensates for loss of tactile haptic feedback when using a robotic arm. Generally, access ports have a comparatively larger diameter (8 mm robotic arm ancillary ports and 12 cm primary ports), and are required to be inserted higher in the abdomen, resulting in more cosmetically conspicuous port sites.

Magrina et al., in a case series confirmed that expert robotic endoscopists can perform radical hysterectomy with results similar to laparotomy, a significantly shorter operative time than conventional laparoscopy, with equivalent lymph node harvest, appreciably less blood loss and shorter length of post-operative hospital stay [89].

Moreover, several recently published, peer-reviewed, randomized controlled trials have demonstrated that in the hands of expert endoscopists, no significant clinical improvement or cost-effective advantage is evident, when using a robotic platform to perform a hysterectomy or other benign gynecologic operations, over traditional laparoscopy [90–92].

Ever since the Food and Drug Administration approved its use in gynecology in 2008, several serious questions, regarding its applications for benign conditions remain; it is unclear if a robotic platform is best reserved for accomplished endoscopic surgeons or is an enabling technology, to help transition conventional open surgeons to advanced "expert" laparoscopists.

While it is true that a robotic platform is an important addition to gynecologic surgery, the exact role it plays in an institutional environment must be seriously pondered; as it remains hard to determine whether it can simultaneously sustain or enhance safe application of vaginal and laparoscopic surgery in an integrated minimally invasive program.

Institutions offering robotically assisted endoscopic surgery must institute a clearly articulated and independent oversight mechanism, to remain insulated from ancillary manufacturer's pressures to preferentially support robotic over other conventional forms of endoscopic or vaginal surgeries.

A worrying recent publication from Arizona, suggested that the proportion of hysterectomies performed vaginally, significantly decreased when institutions adopted robotic technology and more importantly, they observed that the proportion of hysterectomies with resident involvement decreased compared to when other routes were practiced [93].

Although robotic technology was designed to minimize complications of conventional surgery, inadvertent mishaps have been reported and investigated by the FDA; where the very first product liability was for the defendant [94]. Soon after, several spectacular attention-grabbing web sites announcements began appearing on the net, attempting to lure disgruntled patients (BadRobotSurgery.com), *"da Vinci Robot Allegedly Marketed to Less-Skilled Doctors" LawyerandsandSettlements.com. 23 April 2013. Retrieved 24 November 2016.*

Despite their considerable purchase and maintenance costs (about 2 million USA dollars, with limited-use ancillary instruments; $2000 each and related support costs), there are close to 2500 units operational globally, according to industry statistics.

The technology has been adopted quickly over the past few years by endoscopists of all shades, in Europe and the United States. The number of overall robot-assisted operations performed globally tripled since 2007 and number of Intuitive

Surgical, da Vinci units installed in U.S. institutions increased by 75 % 2007–2009, while the number installed elsewhere in the world doubled, according to the manufacturer.

Even though early publications are encouraging, further comparative trials should be undertaken prior to wider acceptance [1]. When cost differences among robotic and other methods of hysterectomy are compared, it appears that the overall, vaginal hysterectomy is less costly than robotically assisted hysterectomy. Abdominal hysterectomy and robotically assisted hysterectomy appeared to have similar costs [95].

One must consider that new additional costs incurred will be compensated for by reductions in postoperative hospital costs, length of stay and productivity gains, as patients recover quicker and return to work sooner.

Estimates of the net per-procedure cost of robotic surgery varies with utilization; when all published robot-assisted procedure's cost studies are examined since 2005, it appears that on average, across a range of 20 types of operations, the additional variable cost of using a robotic-platform is about $1600 (6 % of procedure cost); if the platform's amortized cost is also added, then the total cost per operation increased to about $3200 (13 % of procedure cost). Additionally, it is generally accepted that their use will require longer operating time than conventional or laparoscopic alternatives [96].

As several robotic operations (hysterectomy, myomectomy) were previously being carry out laparoscopically; introduction of this new technology influences institutional expenses, principally by escalating cost per procedure. Whereas operations that were frequently carry out as conventional open laparotomy, introduction of robots possibly will affect both operative cost and frequency of operations performed.

Moreover, there are no published large-scale randomized trials of robot-assisted operations, and the few observational publications do not demonstrate that long-term outcomes of robot-operations are better than conventional operations in different disciplines [97].

Where as in conventional surgery, skill sets of individual surgeons determine outcomes, the same is not true in a more integrated and interdependent robotic environment, where proficiency of the entire team is important for seamless efficient performance.

Furthermore, skills acquisition and maintenance of competence simulation programs will be required to shorten the learning curve, especially in centers where a limited number of procedures are performed.

Several contemporary publications have supported the importance and usefulness of simulation and skill laboratories when evolving technologies are introduced, such as robotic surgery, where a considerable learning curve is observed [98].

Ultimately, specific minimally invasive surgical methods, conventional or robotic, must be adapted to accommodate patient preferences, operator skills and technological availability [99, 100].

It is accepted that surgeons must perform 150 to 250 robotically assisted procedures to become adept in their use; the absolute yearly minimum procedure number, to remain proficient is not known or determined.

Given these realities, one wonders if it is justifiable to invest educational capital and scarce health funds to support training and credentialing residents and faculty, in a yet unproven and costlier method, when we have hardly completed transition from conventional to endoscopic operations.

Other Considerations Prior to Surgery for Benign Disease

National Institute for Health and Clinical Excellence (NICE guideline) advocates hysterectomy should be entertained only when other treatment remedies have proved unsuccessful, are contraindicated, is refused by patient, or when client specifically wishes a hysterectomy [101].

Several established national organizations including The American College of Obstetricians and Gynecologists (ACOG) supports use of alternate treatments instead of hysterectomy, including hormonal management, hysteroscopic remedies and use of Levo Norgestril medicated intrauterine device (Mirena ®) as first line management for a variety of benign gynecological conditions [18, 102–104].

Although use of these alternative treatments, including uterine artery embolization and MR Guided Ultrasound, helped temper hysterectomy rates, assessing appropriateness of hysterectomy continues to be a target for quality improvement [15, 17].

Clearly, alternatives to hysterectomy appear to be grossly underutilized among patients having hysterectomy for AUB, myomas, pelvic pain or endometriosis; these practice patterns are inconsistent with guidelines from ACOG that clearly recommends use of alternate medical rather than surgical therapy for primary management where indicated.

Effectively, observance of management guidelines and documentation of nonsurgical treatment attempts prior to hysterectomy may become essential, not only for improving outcomes, but also for reimbursement and maintenance of privileges.

During the past several years, there has been a significant decrease in the number of hysterectomies performed annually in the United States.

The annual *inpatient* hysterectomy rates demonstrated an impressive 36.4 % decrease in number of hysterectomies performed in 2010 (433,621) as compared to 2002 (681,234); however, this does not account migration numbers to *outpatient* endoscopic hysterectomies performed; consequently, numbers may appear better than they actually are. As a result, appropriateness of the overall hysterectomy rates in the United States is still generating considerable debate [20].

Innovative systems-based quality improvement initiatives to reduce unnecessary hysterectomies have been quite effective; Hullfish et al., demonstrated that when a pre-operative hysterectomy checklist is instituted for benign indications, rates fell significantly with a 50 % reduction of unsupportive pathology [16].

Application of the highly effective Levo Norgestril medicated intrauterine device (Mirena ®), for treatment of pelvic pain and AUB, represents an invaluable cost-saving method that is considered by only 12 % of patients, where only one third of these women actually trialed treatment.

While some believe that up to 42 % of those treated may eventually require a hysterectomy, 58 % will not. Consequently, underutilization of the Levo Norgestril medicated intrauterine device (Mirena ®), in the United States represents another important quality improvement and cost savings opportunity to be pursued.

Uterine Artery Embolization

Uterine artery embolization and myomectomy are safe and successful alternatives to hysterectomy in women with symptomatic fibroids (ACOG guideline) [104, 105].

Ever since its description more than 15 years ago, this uterine sparing minimally invasive remedy has generated considerable controversy in the treatment of symptomatic myomas [106].

Increasing patient interest in uterine preservation coupled with significant innovative advances in interventional radiology, motivated gynecologists to consider this alternative instead of conventional operative treatment options [107].

Uterine artery embolization is now a safe and well-accepted therapeutic alternative for women with symptomatic uterine myomas; however its use in those desirous of preserving reproductive competence remains controversial. Patients who are not interested in fertility preservation or cannot tolerate operative myomectomy; uterine artery embolization is recommended.

In patients wishing to preserve fertility and reduce miscarriage potential, it remains prudent to recommend laparoscopic myomectomy if technically feasible.

Uterine artery embolization and myomectomy are analogous as far as symptomatic effectiveness, technical success rate and frequency of early or late complications are concerned.

Although the former appears to be less-invasive compared with laparoscopic myomectomy (shorter hospital stay, recovery period, lower acute phase markers), a cautious approach in recommended in patients desirous of future pregnancy, until further evidence is available [108].

As it relates to hysterectomy, some preliminary publications indicate that uterine artery embolization can reduce size, decrease menstrual flow and relieve pressure symptoms related to uterine myomas. A small RCT comparing uterine artery embolization with abdominal hysterectomy, demonstrated that women who have embolization experience shorter hospitalization and earlier return to normal activities compared with those who had abdominal hysterectomy [109].

Magnetic Resonance Guided Focused Ultrasound Surgery

This new minimally invasive method was introduced in 2004, as a less disabling treatment for uterine fibroids.

It uses highly focused sound waves to generate thermal ablation by heating the mapped tissue to a critical 55 °C, to result in thermo-coagulation, cell death and tissue necrosis.

Magnetic Resonance Imaging (MRI) guidance offers precise target identification and provides real-time thermal mapping, that measure thermal does delivery to targeted tissue and spares thermal build up in non-targeted organs.

In effect, this United States Food and Drug Administration (FDA) approved treatment for uterine fibroids requires no arterial puncture, no endoscopic incisions, is less disabling, shrinks fibroids and producing symptom relief.

When compared with Uterine Artery Embolization or operative hysterectomy, Kong et al., suggested that Magnetic Resonance guided Focused Ultrasound Surgery, is the most cost effective remedy, when compared with the former options; in effect it is a short outpatient procedure, with few adverse events or minor complications associated with its use [110].

Cost Consideration

Health care technological innovations are often credited for an important driver of health cost growth; as newly adopted technologies are often more expensive to purchase and maintain, compared to previously practised treatment options.

It has been described that introduction of innovative technologies invariably leads to a significant increase in the types and volume of patients treated with the new technology; additionally, some less rigorous trialed remedies may result in substantial additional medico-legal costs (electric morcellator, non-absorbable mesh) from their use.

As risk-based pressures escalate, institutions will increasingly analyse costs of incorporating new technology, the effect it has on quality of care and patient outcomes; besides, shifting market dynamics can undermine adoption of innovative surgical remedies and intensify emphasis on competency standards [111].

Ever since the German gynecologist Kurt Semm carried out the first laparoscopic appendectomy in 1983, surgeons

around the world quickly adopted laparoscopic methods and today, it represents the preferred standard for several surgical procedures in all disciplines [112, 113].

Although endoscopic operations are not new and are practised everywhere to different degrees, institutional managers continue to pursue the concept of establishing integrated minimally invasive surgery centers.

In an increasingly competitive health market, administrators are lured to the minimally invasive surgery center model given its marketing potential; branding facilities as a specialized minimally invasive surgi-center can improve market appeal and draw women in search of less invasive alternatives and faster recovery.

Unlike disease-based integrated multidisciplinary care centers, where patient approach is anchored by a defined disease condition, the main impetus of these endoscopic centers remain innovative technology-driven care; hence their independent clinical implementation can sometimes be difficult to justify in comparison. Moreover, pending radical health care risk-based payment reforms, may compel institutions to re-embrace disease-centered programs, at the expense of technology-centered costly initiatives.

Though emerging innovative surgical technologies will prevail, the climate in which they are scrutinized and utilized will change, given an evolving global healthcare funding landscape, with more rigorous utilization scrutiny and credentialing oversight.

Furthermore, parameters used to appraise new clinical technologies will expand to accommodate risk-based payment pressures that highlight long term disease management; where emerging technological investments may recruits an ancillary role, at a time when population health management demands more attention and commitment to healthcare cost containment along with quality concerns, overriding other considerations [96].

As healthcare improvement efforts take effect and cost cutting measures are weighed, it is expected that institutions will adopt a more seasoned, cost-savvy, and unadventurous position concerning adoption of new, expensive and sometimes unproven technologies.

It is apparent that surgeons and patients frequently hasten to adopt new treatment methods before merits and risks are fully explored, which raises the question of credentialing and competency. Often, when a new technology is introduced, no standard credentialing guidelines are available, which raises concerns about surgeon competence and maintenance of proficiency; all of which have to do with training, education and quality of care.

Given our present day technology, it is unlikely that robot-assisted operations will entirely overtake conventional gynecological operations any time soon; if theoretically such a changeover were to happen in general surgery alone, it is estimated that it could amount to an additional $1.5 billion health care cost annually. When the robot's amortization costs are also included, the grand total could amount to be more than $2.5 billion. If increased utilization by different disciplines is factored in addition, the total additional health cost burden would be prohibitive.

As it stands, local hospitals determine to establish a robotic facility, with little discussion with payers, where individual health centers vie to draw patients and surgeons with no regional coordination or oversight; competing institutions, are unable and unwilling to pass the technology lure, seeking to enhance their surgical volume and keep up with market demands, so as not to lose patients, even when favorable direct reimbursement is lacking.

Future Considerations

After enduring 150 years as the main procedure of our discipline, it appears that the era of hysterectomy, as a first line of treatment has ended and we are finally moving towards applying more innovative, less disabling methods and technologies to treat non-cancerous conditions that affect a significant segment of our population.

Our clients have also evolved, and are generally better informed, more demanding, wish to understand their treatment options and available alternatives. They are open to evaluate relative benefits and shortcomings of alternative therapies to extirpative surgery; they wish to make shared informed decisions about their reproductive health [114].

Ultimately, the future of health care is tempered by quality of service rendered, patient safety and health costs to society.

Regional hysterectomy rate variations is not new, what appears to be emerging as an important quality determinant is the relative cost of procedures; where surgical outcomes and cost in low-volume versus high-volume surgeons may temper outcomes and hospital privileging.

Departments may soon be compelled to include practitioner's case volume data in their operating room privileging processes, to improve patient outcomes, reduce costs and strive for highest quality of care [115].

Undoubtedly, hysterectomy in most of its forms is here to stay; however, its global prevalence is bound to change. Surgical rates will not be as high as in previous decades and it is anticipated that hysterectomy will be a much safer operation [116, 117].

As always, when dealing with global rates and statistics, one must remain vigilant as interpreting and comparing national and regional hysterectomy rates can often be difficult if not confusing; as considerable differences in definition and interpretation abounds, such as choice of numerators [118].

Effectively there may be no 'true' hysterectomy rates as numerous non-medical and clinical factors, such as local

customs, patient attitudes, socio-economic status, patient affluence, age and practitioner biases need to be considered.

Interestingly, significant technological improvements in endoscopic surgery coincided with a time of markedly decreasing hysterectomy need, when several effective non-extirpatory remedies for AUB, myomas and endometriosis, among others have been introduced [119].

This timely development is much encouraging, however, when non extirpative treatments become unsuccessful; hysterectomy then remains the only viable and definitive alternative again.

Although hysterectomy rates in certain jurisdiction may have already reached an absolute *ideal rate*, a new study from Michigan reveals that alternate non-operative remedies are markedly underused and treatment guidelines are often not followed.

Post-operative pathology results revealed that 1 in 5 (18 %) of operations done for benign indications were "unnecessary", and that nearly 2 in 5 (37.8 %) of women aged younger than 40 years had unsupportive pathology; they concluded that it appears that surgical rates are nowhere close to an ideal hysterectomy rate in North America [21].

Given that a great majority of hysterectomies with benign disease, are performed to enhance quality of life rather than to save lives, essential outcome measures must comprise cost-effectiveness and effect on quality of life.

Decreasing the number of operations performed in patients who may not necessarily need surgery in the first place, may potentially have a more significant impact in diminishing adverse outcomes and cost, than optimisation of postoperative care. As reimbursement policies shift, suitability for surgery will undoubtedly become an even greater imperative for patients and payers.

Given current client expectations, fiscal constraints and medico-legal concerns, clinicians and administrators must acknowledge that minimally invasive complex solutions and evolving medical technologies entail new innovation-specific vulnerabilities that may result in inadvertent patient harm with considerable additional costs [120].

Future discussions will consider how to administer the least invasive technique, to provide maximal clinical outcome, with minimal disruption of patient's life; driven by client satisfaction and payment reform that incorporates quality care and 'disability time', under total cost of care.

Equipment advances and consumer pressures will make innovative technologies affordable and highly specialized surgical techniques will be performed only by techno-surgeons, who do sufficient volumes to maintain expertise.

Operating rooms will be enabled to support integrated peri-operative imaging with dye and marker capabilities, in addition to teleconferencing, tele-mentoring, virtual reality projection and digital archiving connectivity, among others.

In a three part recent publication about the future of gynecology, Lagrew and Jenkins describes the coming onslaught and suggests that leadership and compassion is required to navigate these uncertain and treacherous currents [121].

As surgeons embark on to this *post minimally invasive era*, we need to empower future residents to the absolute best of our teaching capabilities, create a climate of knowledge exchange-transfer and invest in emerging medical and surgical educational technologies, so as to improve outcomes, restrain cost, and enhance patient experiences [122].

The advent of minimally invasive surgery has been a defining moment for all and it is time to amend *procedure based surgical teaching curriculums* and implement contemporary, *competency based teaching* initiatives; as we embrace patients advocacy and students stewardship [123].

It appears that the slow global transition toward minimally invasive and less disabling endoscopic hysterectomy, in all its methods and forms, has finally taken root to the benefit of our patients. It is now essential that we remain diligent, as a lot more hard work is required, to achieve our respective regional and elusive absolute ideal hysterectomy rates.

Given the context of unprecedented global financial constraint and dwindling health care expenditure; calls for improving efficiency-quality while reducing costs-savings appear indispensible and inevitable. However, framing health care discussion in terms of efficiency and costs risks alienating clinical practitioners as it tends to discourage willing participation in the challenge of altering the way health care is delivered.

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References

1. Sutton C. Past, present, and future of hysterectomy. J Minim Invasive Gynecol. 2010;17(4):421–35.
2. DeFrances CJ, Lucas CA, Buie VC, Golosinskiy A. 2006 National Hospital Discharge Survey. Natl Health Stat Rep. 2008(5):1–20.
3. Vessey MP, Villard-Mackintosh L, McPherson K, Coulter A, Yeates D. The epidemiology of hysterectomy: findings in a large cohort study. Br J Obstet Gynaecol. 1992;99(5):402–7.
4. Wilcox LS, Koonin LM, Pokras R, Strauss LT, Xia Z, Peterson HB. Hysterectomy in the United States, 1988–1990. Obstet Gynecol. 1994;83(4):549–55.
5. Merrill RM. Prevalence corrected hysterectomy rates and probabilities in Utah. Ann Epidemiol. 2001;11(2):127–35.

6. Maresh MJA, Metcalfe MA, McPherson K, et al. The VALUE national hysterectomy study: description of patients and their surgery. Br J Obstet Gynaecol. 2002;109:302–12.
7. Cosson M, Lambaudie E, Boukerroum M, Querleu D, Crepin G. Vaginal, laparoscopic or abdominal hysterectomy for benign disorders immediate and early postoperative complications. Eur J Obstet Gynecol Reprod Biol. 2001;98:231–6.
8. Makinen J, Johansson J, Tomas C, et al. Morbidity of 10,110 hysterectomies by type of approach. Hum Reprod. 2001;16:1473–8.
9. Moller C, Kehlet H, Utzon J, Ottesen B. Hysterectomy in Denmark. An analysis of postoperative hospitalization morbidity and readmission. Dan Med Bull. 2002;49:353–7.
10. Materia E, Rossi L, Spadea T, et al. Hysterectomy and socioeconomic position in Rome, Italy. J Epidemiol Community Health. 2002;56:461–5.
11. McPherson K, Wennberg JE, Hovind OB, Clifford P. Small-area variations in the use of common surgical procedures. An international comparison of New England, England and Norway. N Engl J Med. 1982;307:1310–4.
12. Wu JM, Wechter ME, Geller EJ, Nguyen TV, Visco AG. Hysterectomy rates in the United States, 2003. Obstet Gynecol. 2007;110(5):1091–5.
13. Centers for Disease Control and Prevention Online. "Hysterectomy Surveillance" United States, 1994–1999–2002. http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5105a1.htm.
14. The Boston Women's Health Book Collective. Our bodies, ourselves: a new edition for a new era. New York: Touchstone; 2005.
15. Broder MS, Kanouse DE, Mittman BS, Bernstein SJ. The appropriateness of recommendations for hysterectomy. Obstet Gynecol. 2000;95(2):199–205.
16. Hullfish KL, Henry E, Ferguson II JE. The effect of preoperative checklists on final histology & rates of hysterectomy for benign conditions. Female Pelvic Med Reconstr Surg. 2012;18:143–7.
17. Lawson EH, Gibbons MM, Ingraham AM, Shekelle PG, Ko CY. Appropriateness criteria to assess variations in surgical procedure use in the United States. Arch Surg. 2011;146:1433–40.
18. ACOG Committee on Practice Bulletins-Gynecology. Management of abnormal uterine bleeding associated with ovulatory dysfunction. ACOG Practice bulletin no. 136. Obstet Gynecol. 2013;122:176–85.
19. Agency for Healthcare Research and Quality. Health services research on hysterectomy and alternatives. http://archive.ahrg.gov/research/hysterec.htm. Accessed 7 Mar 2015.
20. Wright J, Herzog T, Tsui J, et al. Nationwide trends in the performance of inpatient hysterectomy in the United States. Obstet Gynecol. 2013;122:233–41.
21. Corona LE, Swenson CW, Sheetz KH, et al. Use of other treatments before hysterectomy for benign conditions in a statewide hospital collaborative. Am J Obstet Gynecol. 2015;212:304.e1–7.
22. Canadian Institute for Health Information. Health Indicators 2010. Ottawa: CIHI; 2010.
23. Lefebvre G, Allaire C, Jeffrey J, Vilos G, Arneja J, Birch C, et al. SOGC clinical guidelines: hysterectomy. J Obstet Gynaecol Can. 2002;24:37–61.
24. Nieber TE. et al., Surgical approach to hysterectomy for benign gynaecological disease (review). Cochrane Database Syst Rev. 2009:(3). http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD003677.
25. Hall RE, Cohen MM. Variations in hysterectomy rates in Ontario: does the indication matter? CMAJ. 1994;151(12):1713–9.
26. Elshaug A et al. Identifying existing health care services that do not provide value for money. Med J Aust. 2009;190(5):269–73.
27. Ontario Women's Health Council. Achieving best practices in the use of hysterectomy: report of Ontario's Expert Panel on best practices in the use of hysterectomy. OWHC: Ottawa; 2002.
28. Stang A, Kluttig A, Moebus S,Volzke H, Berger K, Greiser K H, Stockl D, Jockl K-H, Meisinger C. Educational level, prevalence of hysterectomy, and age at amenorrhoea: a cross-sectional analysis of 9536 women from six population-based cohort studies in Germany. BMC Women's Health. 2014:14:10. http://www.biomedcentral.com/1472-6874/14/10.
29. Merrill RM. Hysterectomy surveillance in the United States, 1997 through 2005. Med Sci Monit. 2008;14:CR24–31.
30. Stang A, Merrill RM, Kuss O. Nationwide rates of conversion from laparoscopic or vaginal hysterectomy to open abdominal hysterectomy in Germany. Eur J Epidemiol. 2011;26:125–33.
31. Harlow BL, Barbieri RL. Influence of education on risk of hysterectomy before age 45 years. Am J Epidemiol. 1999;150:843–7.
32. Cooper R, Lucke J, Lawlor DA, Mishra G, Chang JH, Ebrahim S, et al. Socioeconomic position and hysterectomy: a cross-cohort comparison of women in Australia and great Britain. J Epidemiol Community Health. 2008;62:1057–63.
33. Wolfrum C. Vorschnelle Schnitte. In: Apotheken Umschau vom 1. Jun 2008. Wort & Bild Verlag, Baierbrunn. ohne ISSN.
34. Müller A, Thiel FC, Renner SP, Winkler M, Häberle L, Beckmann MW. Hysterectomy-a comparison of approaches. Dtsch Arztebl Int. 2010;107(20):353–9.
35. Mettler L, Ahmed-Ebbiary N, Schollmeyer T. Laparoscopic hysterectomy: challenges and limitations. Minim Invasive Ther Allied Technol. 2005;14(3):145–59.
36. Stang A, Merrill RM, Kuss O. Hysterectomy in Germany: a DRG-based nationwide analysis, 2005–2006. Dtsch Arztebl Int. 2011;108:508–14.
37. Chief Medical Officers Report. UK Department of Health. 2006. www.gov.uk/dh.
38. Edozien L. Hysterectomy for benign conditions. BMJ. 2005;330:1457–8.
39. Marshall SF, Hardy RJ, Kuh D. Socioeconomic variation in hysterectomy up to age 52, national, population based, prospective cohort study. BMJ. 2000;320:1579.
40. Royal College of Obstetricians & Gynaecologists. Evidence based clinical guidelines: the initial management of menorrhagia. 1998. http://www.rcog.org.uk/.
41. Johnson N, Barlow D, Lethaby A, Tavender E, Curr E, Garry R. Cochrane Database of Systematic reviews: surgical approach to hysterectomy for benign gynaecological disease (Review Issue 2, 2006) Art no.:CD003677.
42. Croydon PCT, Sutton & Merton PCT, Richmond & Twickenham PCT, Kingston PCT & Wandsworth Teaching PCT; Jointly published. Effective Commissioning Initiative – South West London Public Health Network. November 2006.
43. Reid PC, Mukri F. Trends in the number of hysterectomies performed in England for menorrhagia: examination of health episode statistics 1989–2002–2003. BMJ. 2005;330:938–9.
44. Lethaby A, Shepperd S, Cooke I, Farquhar C. Cochrane Database of Systematic reviews: endometrial resection and ablation versus hysterectomy for heavy menstrual bleeding. 1999:(Issue 2). Art No.: CD000329.
45. Marjoribanks J, Lethaby A, Farquhar C. Cochrane Database of Systematic reviews: surgery versus medical therapy for heavy menstrual bleeding. 2006:(Issue 2). Art No. CD003855.
46. Burger MJ, Timmermans A, Burger MP. Regional and temporal variation in hysterectomy rates and surgical routes for benign diseases in the Netherlands. Acta Obstet Gynecol Scand. 2012;91(2):220.
47. Hehenkamp WJ, Volkers NA, Donderwinkel PF, de Blok S, Birnie E, Ankum WM, et al. Uterine artery embolization versus hysterectomy in the treatment of symptomatic uterine fibroids (EMMY trial): peri- and post-procedural results from a randomized controlled trial. Am J Obstet Gynecol. 2005;193:1618–29.

48. Heli¨ovaara-Peippo S, Halmesm¨aki K, Hurskainen R, Teperi J, Grenman S, Kivel¨a A, et al. The effect of hysterectomy or levonorgestrel-releasing intrauterine system on lower abdominal pain and back pain among women treated for menorrhagia: a five-year randomized controlled trial. Acta Obstet Gynecol Scand. 2009;88:1389–96.
49. van der Kooij SM, Ankum WM, Hehenkamp WJ. Review of non-surgical/minimally invasive treatments for uterine fibroids. Curr Opin Obstet Gynecol. 2012;24(6):368.
50. Nielsen SL, Daugbjerg SB, Gimbel H, Settnes A. Steering committee of Danish hysterectomy database, use of vaginal hysterectomy in Denmark: rates, indications and patient characteristics. Acta Obstet Gynecol Scand. 2011;90:978–84.
51. NOMESCO. Health statistics in the Nordic countries; 2011. http://nomescoeng.nom-nos.dk/filer/publikationer/Helsstat%202011.pdf.
52. Gimbel H, Settnes A, Tabor A. Hysterectomy on benign indication in Denmark 1988–1998. Acta Obstet Gynecol Scand. 2001;80(3):267–72.
53. Jacobson GF, Shaber RE, Armstrong MA, Hung YY. Hysterectomy rates for benign indications. Obstet Gynecol. 2006;107:1278–83.
54. Powell LH, Meyer P, Weiss G, Matthews KA, Santoro N, Randolph Jr JF, et al. Ethnic differences in past hysterectomy for benign conditions. Womens Health Issues. 2005;15:179–86.
55. Armstrong A, Maddox YT. Health disparities and women's reproductive health. Ethn Dis 2007:17(2 Suppl 2):S2–4, S2–7.
56. Erekson EA, Weitzen S, Sung VW, Raker CA, Myers DL. Socioeconomic indicators and hysterectomy status in the United States; 2004. J Reprod Med. 2009;54:553–8.
57. Daugbjerg SB, Ottesen B, Diderichsen F, Frederiksen BL, Osler M. Socioeconomic factors may influence the surgical technique for benign hysterectomy. Dan Med J. 2012;59:A4440.
58. Gimbel H, Ottesen B, Tabor A. Danish gynecologists' opinion about hysterectomy on benign indication: results of a survey. Acta Obstet Gynecol Scand. 2002;81:1123–31.
59. Davies A, Magos A. The hysterectomy lottery. J Obstet Gynaecol. 2001;21:166–70.
60. Brummitt K, Harmanli OH, Gaughan J, Dandolu V, Chatwani AJ, Hernandez E. Gynaecologists' attitudes toward hysterectomy: is the sex of the clinician a factor? J Reprod Med. 2006;51:21–5.
61. Lundholm C, Forsgren C, Johansson AL, Cnattingius S, Altman D. Hysterectomy on benign indications in Sweden 1987–2003: a nationwide trend analysis. Acta Obstet Gynecol Scand. 2009;88:52–8.
62. Hilton P, Cromwell D. The risk of vesico-vaginal and urethra-vaginal fistula after hysterectomy performed in the English National Health Service-a retrospective cohort study examining patterns of care between 2000 and 2008. BJOG. 2012;119:1447–54.
63. Whiteman MK, Hillis SD, Jamieson DJ, et al. Inpatient hysterectomy surveillance in the United States, 2000–2004. Am J Obstet Gynecol. 2008;198(34):e1–7.
64. Lykke R, Blaakær J, Ottesen B, Gimbel H. Hysterectomy in Denmark 1977–2011: changes in rate, indications, and hospitalization. Eur J Obstet Gynecol Reprod Biol. 2013;171:333–8.
65. Parazzini F, Ricci E, Bulfoni G, Cipriani S, Chiaffarino F, Malvezzi M, Frigerio L. Hysterectomy rates for benign conditions are declining in Lombardy, Italy: 1996–2010. Eur J Obstet Gynecol. 2014;178:107–13.
66. Lombardy Region. General Health Directorate. Regione Lombardia. I ricoveri ginecologici negli ospedali della Lombardia, anno 1999 con riferimenti al triennio 1996–1998 (Admissions for gynecologic reasons in Lombardy hospitals, 1999 and comparison to1996–1998). http://www.sanita.regione.lombardia.it/cs/Satellite?c=Page&childpagename=DG_Sanita%2FDGLayout&cid=1213480043116&packedargs=stype%3Dlist&pagename=DG_SANWrapper&numr=1201. Accessed Feb 2015.
67. Arisi E. Consumo e compliance dei contraccettivi ormonali (Use and compliance of hormonal contraceptives). Riv It Ost Gin. 2004;2:63.
68. Butt JL, Jeffery ST, Van derSpuy ZM. An audit of indications and complications associated with elective hysterectomy at a public service hospital in South Africa. Int J Gynecol Obstet. 2012;(2):112–6.
69. Chao YM, Tseng TC, Su CH, Chien LY. Appropriateness of hysterectomy in Taiwan. J Formos Med Assoc. 2005;104(2):107–12.
70. Chun-Che Huang, Ming-Ping Wu, Yu-Tung Huang. Gynecologists' characteristics associated with the likelihood of performing laparoscopic-assisted hysterectomy: a nationwide population-based study. Eur J Obstet Gynecol Reprod Biol. 2012;161(2):209–14.
71. Einarsson JI, Matteson KA, Schulkin J, Chavan NR, Sangi-Haghpeykar H. Minimally invasive hysterectomies – a survey on attitudes and barriers among practicing gynecologists. J Minim Invasive Gynecol. 2010;17(2):167–75.
72. Brummer TH, Seppälä TT, Härkki PS. National learning curve for laparoscopic hysterectomy and trends in hysterectomy in Finland 2000–2005. Hum Reprod. 2008;23(4):840–5.
73. Twijnstra AR, Kolkman W, Trimbos-Kemper GC, Jansen FW. Implementation of advanced laparoscopic surgery in gynecology: national overview of trends. J Minim Invasive Gynecol. 2010;17(4):487–92.
74. Wu MP, Huang KH, Long CY, Tsai EM, Tang CH. Trends in various types of surgery for hysterectomy and distribution by patient age, surgeon age, and hospital accreditation: 10-year population-based study in Taiwan. J Minim Invasive Gynecol. 2010;17(5):612–9.
75. Nieboer TE, Johnson N, Lethaby A, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev 2010;(3):CD003677.
76. Singh A, Arora K. Why hysterectomy rate are lower in India? Indian J Community Med. 2008;33(3):196–7.
77. Desai S, Sinha T, Mahal A. Prevalence of hysterectomy among rural and urban women with and without health insurance in Gujarat, India. Reprod Health Matters. 2011;19(37):42–51.
78. Lee N, Dicker R, Rubin G, Ory H. Confirmation of the preoperative diagnoses for hysterectomy. Am J Obstet Gynecol. 1984;150(3):283–7.
79. Ingelsson E, Lundholm C, Johansson ALV, Altman D. Hysterectomy and risk of cardiovascular disease: a population-based cohort study. Eur Heart J. 2011;32:745–50.
80. McPherson K, Herbert A, Judge A, et al. Psychosexual health 5 years after hysterectomy: population-based comparison with endometrial ablation for dysfunctional uterine bleeding. Health Expect. 2005;8(3):234–43.
81. Farquhar CM, Sadler L, Harvey SA, Stewart AW. The association of hysterectomy and menopause: a prospective cohort study. Int J Obstet Gynaecol. 2005;112(7):956–62.
82. Pandey D, Sehgal K, Saxena A, Hebbar S, Nambiar J, Bhat RG. An audit of indications, complications, and justification of hysterectomies at a Teaching Hospital in India. Int J Repro Med. 2014: Article ID 279273:6–11.
83. Magon N, Divakar H, Kriplani A. Editorial: the use, misue, and abuse of hysterectomy. J Mid Life Health. 2013;4(1):40–1.
84. Amin A, Ali A, Amin Z, Sani FN. Justification for hysterectomies and frequency of histo-pathological lesions of hysterectomy at a Teaching Hospital in Peshawar, Pakistan. Pak J Med Sci. 2013;29(1):170–2.
85. Qamar-ur-Nisa H, Habibullah, Memon F, Shaikh TA, Memon Z. Hysterectomies: an audit at a tertiary care hospital. Prof Med J. 2011;18(1):46–50.
86. Iftikhar R. The outcome of subtotal abdominal hysterectomy. J Coll Physicians Surg Pak. 2005;15(10):594–6.

87. Ahsan S, Naeem S, Ahsan A. A case note analysis of hysterectomies performed for non neoplastic indications Liaquat National Hospital Karachi. J Pak Med Assc. 2001;51(10):346–9.
88. Rardin CR. The debate over robotics in benign gynecology. Am J Obstet Gynecol. 2014;210:418–22.
89. Magrina JF, Kho R, Weaver L, Montero P, Magtibay P. Robotic radical hysterectomy: comparison with laparoscopy and laparotomy. Gynecol Oncol. 2008;109:86–91.
90. Paraiso MF, Ridgeway B, Park AJ, et al. A randomized trial comparing conventional and robotically assisted total laparoscopic hysterectomy. Am J Obstet Gynecol. 2013;208:368.e1–7.
91. Sarlos D, Kots L, Stevanovic N, et al. Robotic compared with conventional laparoscopic hysterectomy: a randomized controlled trial. Obstet Gynecol. 2012;120:604–11.
92. Paraiso MF, Jelovsek JE, Frick A, Chen CC, Barber MD. Laparoscopic compared with robotic sacro-colpopexy for vaginal prolapse: a randomized controlled trial. Obstet Gynecol. 2011;118:1005–13.
93. Jeppson PC, Rahimi S, Gattoc L, et al. Impact of robotic technology on hysterectomy route and associated implications for resident education. Am J Obstet Gynecol. 2015;212:196.e1–6.
94. Carlson J, Lee J. Medical boon or bust? Suits raise allegations of defects in da Vinci robot. Mod Healthc. 2013;43:8–9.
95. Woelk JL, Borah BJ, Trabuco EC, Heien HC, Gebhart JB. Cost differences among robotic, vaginal, and abdominal hysterectomy. Obstet Gynecol. 2014;123(2):255–62.
96. Barbash G, Glied S. New technology and health care costs-the case of robot-assisted surgery. N Engl J Med. 2010;363(8):701–4.
97. Hu JC, Gu X, Lipsitz SR, et al. Comparative effectiveness of minimally invasive vs open radical prostatectomy. JAMA. 2009;302:1557–64.
98. Abboudi H, Khan MS, Aboumarzouk O, et al. Current status of validation for robotic surgery simulators: a systematic review. BJU Int. 2012;111:194–205.
99. Culligan P, Gurshumov E, Lewis C, et al. Predictive validity of a training protocol using a robotic surgery simulator. Female Pelvic Med Reconstr Surg. 2014;20:48–51.
100. Gala RB, Margulies R, Steinberg A, et al. Systematic review of robotic surgery in gynecology: robotic techniques compared with laparoscopy and laparotomy. J Minim Invasive Gynecol. 2014;21:353–61.
101. Lumsden MA, et al. BMJ. 2007:334:175. www.nice.org.uk/CG44.
102. ACOG Committee on Practice Bulletins-Gynecology. Diagnosis of abnormal uterine bleeding in reproductive-aged women. ACOG Practice bulletin no. 128. Obstet Gynecol. 2012;120:197–206.
103. American College of Obstetricians and Gynecologists. Management of endometriosis. ACOG Practice bulletin no. 114. Obstet Gynecol. 2010;116:223–36.
104. American College of Obstetricians and Gynecologists. Alternatives to hysterectomy in the management of leiomyomas. ACOG Practice bulletin. Obstet Gynecol. 2008;112:387–400.
105. National Institute for Health and Clinical Excellence: NICE clinical guideline 44: heavy menstrual bleeding. London: National Institute for Health and Clinical Excellence; 2007:2-5-2011.
106. Ravina JH, Herbreteau D, Ciraru-Vigneron N, et al. Arterial embolization to treat uterine myomata. Lancet. 1995;346:671–2.
107. Malzoni M, Sizzi O, Rossetti A, Imperato F. Laparoscopic myomectomy: a report of 982 procedures. Surg Technol Int. 2006;15:123–9.
108. Mara M, Maskova J, Fucikova Z, et al. Midterm clinical and first reproductive results of a randomised controlled trial comparing uterine fibroid embolization and myomectomy. Cardiovasc Intervent Radiol. 2008;31:73–85.
109. Pinto I, Chimeno P, Roma A, Paul L, Haya J, de la Cal M. Uterine fibroids: uterine artery embolization versus abdominal hysterectomy for treatment—a prospective randomised and controlled clinical trial. Radiology. 2003;226:425–31.
110. Kong CY, Omer ZB, Pandharipande PV, Shannon Swan J, Srouji S, Scott Gazelle G, Fennessy FM. MRI-guided focused ultrasound surgery for uterine fibroid treatment: a cost-effectiveness analysis. Am J Roentgenol. 2014;203(2):361–71.
111. Tsui C, Klein R, Garabrant M. Minimally invasive surgery: national trends in adoption and future directions for hospital strategy. Surg Endosc. 2013;27:2253–7.
112. Bhattacharya K. Kurt Semm: a laparoscopic crusader. J Minim Access Surg. 2007;3(1):35–6.
113. Kelley WE. The evolution of laparoscopy and the revolution in surgery in the decade of the 1990s. JSLS. 2008;12:351–7.
114. Learman LA. Hysterectomy 2014: indications and techniques. Clin Obstet Gynecol. 2014;57(1):1–2.
115. Doll KM, Milad MP, Gossett DR. Surgeon volume and outcomes in benign hysterectomy. J Am Assoc Gynecol Laparosc. 2013;20(5):554–61.
116. Roberts TE, Tsourapas A, Middleton LJ, et al. Hysterectomy, endometrial ablation, and levonorgestrel releasing intrauterine system (Mirena) for treatment of heavy menstrual bleeding: cost effectiveness analysis. BMJ. 2011;342:2202.
117. Qvistad E, Langebrekke A. Should we recommend hysterectomy more often to premenopausal and climacteric women? Acta Obstet Gynecol Scand. 2011;90:811–4.
118. Harlow BL, Barbieri RL. Influence of education on risk of hysterectomy before age 45 years. Am J Epidemiol. 1999;150:843–7.
119. Donnez O, Jadoul P, Squifflet J, et al. A series of 3190 laparoscopic hysterectomies for benign disease from 1990 to 2006: evaluation of complications compared with vaginal and abdominal procedures. BJOG. 2009;116:492–500.
120. Ternamian A. Risk management in gynecological endoscopy. In: Schollmeyer T, Mettler L, Rüther D, Alkatout I, editors. Practical manual for laparoscopic & hysteroscopic gynecological surgery. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2013.
121. Lagrew DC, Jenkins TR. 2020: the future of obstetrics/gynecology in a clearer vision. Why is change needed? Am J Obstet Gynecol. 2014;(211):470–4.
122. Mettler L, Clevin L, Ternamian A, Puntambekar S, Schollmeyer T, Alkatout I. The past, present and future of minimally invasive endoscopy in gynecology: a review and speculative outlook. Minim Invasive Ther Allied Technol. 2013;22(4):210–26.
123. Singh SS, Marcoux V, Ternamian AM, Cheung V, Martin D. Core competencies for gynecologic endoscopy in residency training: a National Consensus project. J Minim Invasive Gynecol. 2009;16(1):1–7.

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