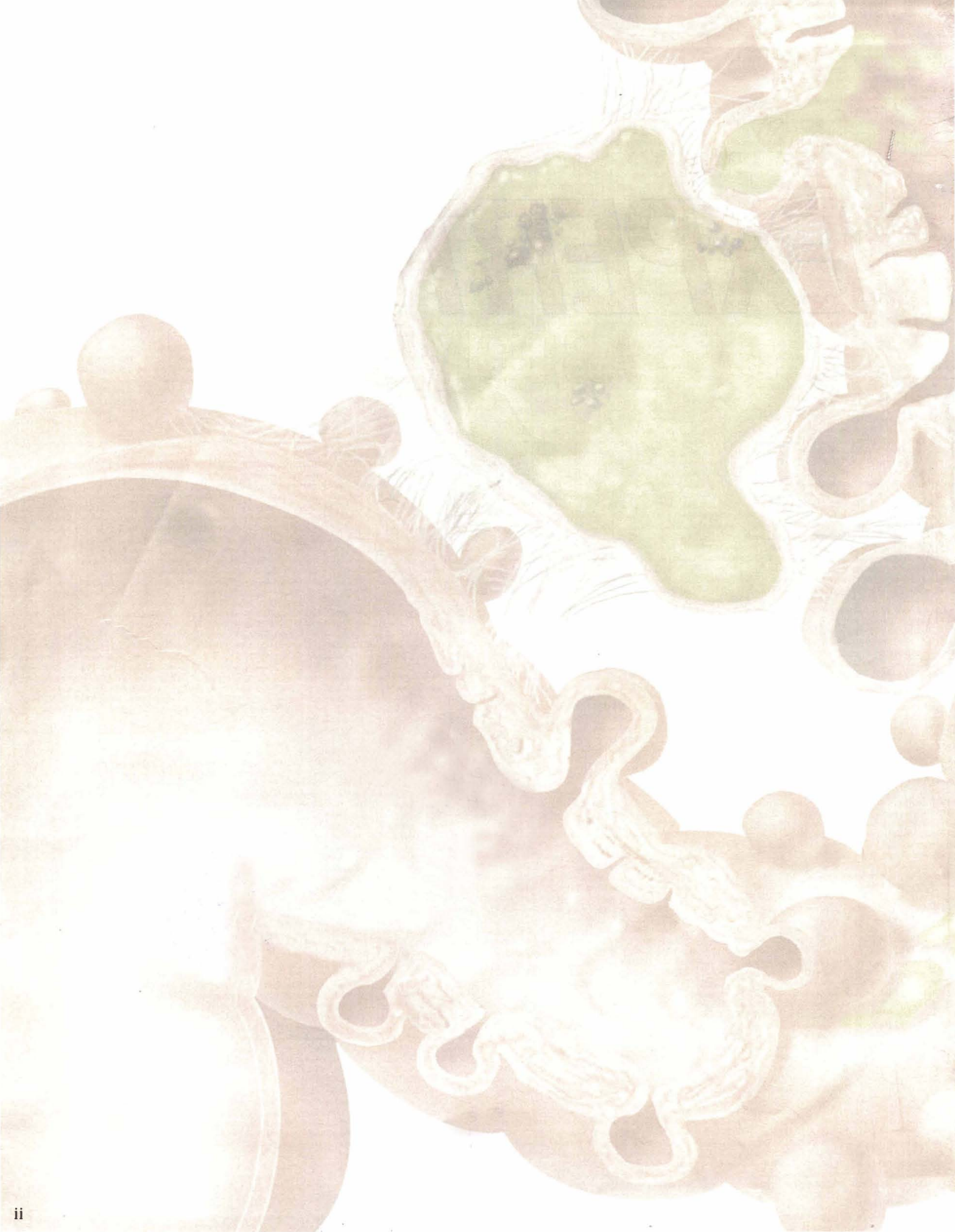
EXPERTddx™

ABDOMEN



EXPERTddx™
ABDOMEN

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AMIRSYS®
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First Edition

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This book is dedicated to Karen Pealer, BA, CCRC, who has been my research associate for many years. Karen has been instrumental in accumulating, refining, and organizing data and images for all the books, manuscripts, and lectures that we have created over the past 10 years.

MPF

EXPERTddx™
ABDOMEN

Once the appropriate technical protocols have been delineated, the best quality images obtained, and the cases queued up on PACS, the diagnostic responsibility reaches the radiology reading room. The radiologist must do more than simply "lay words on" but reach a real conclusion. If we cannot reach a definitive diagnosis, we must offer a reasonable differential diagnosis. A list that's too long is useless; a list that's too short may be misleading. To be useful, a differential must be more than a rote recitation from some dusty book or a mnemonic from a lecture way back when. Instead, we must take into account key imaging findings and relevant clinical information.

With these considerations in mind, we at Amirsys designed our Expert Differential Diagnoses series—EXPERTddx for short. Leading experts in every subspecialty of radiology identified the top differential diagnoses in their respective fields, encompassing specific anatomic locations, generic imaging findings, modality-specific findings, and clinically based indications. Our experts gathered multiple images, both typical and variant, for each EXPERTddx. Each features at least eight beautiful images that illustrate the possible diagnoses, accompanied by captions that highlight the pertinent imaging findings. Hundreds more are available in the eBook feature that accompanies every book. In classic Amirsys fashion, each EXPERTddx includes bulleted text that distills the available information to the essentials. You'll find helpful clues for diagnoses, ranked by prevalence as Common, Less Common, and Rare but Important.

Our EXPERTddx series is designed to help radiologists reach reliable—indeed, expert—conclusions. Whether you are a practicing radiologist or a resident/fellow in training, we think the EXPERTddx series will quickly become your practical "go-to" reference.

Anne G. Osborn, MD
Executive Vice President and Editor-in-Chief, Amirsys Inc.

Paula J. Woodward, MD
Executive Vice President and Medical Director, Amirsys Inc.

PREFACE

The radiologist in training or in practice is challenged frequently with making an imaging diagnosis armed only with knowledge of the patient's clinical presentation (e.g., "right upper quadrant pain") or an imaging finding (e.g., a hepatic mass with a central or eccentric scar). In order to narrow the differential diagnosis he (or she) may consult a gamut-style book that might list all conceivable causes of these findings, but often without accompanying text or images that would help in distinguishing among the possibilities. The radiologist might consult a standard text or journal article, but this usually presupposes knowledge of at least one plausible diagnosis to look up as a starting point. The more computer-savvy radiologists often start with an internet search, but they still need a diagnosis or symptom to "Google", and one is never sure of the reliability of the information retrieved, often incurring several diversions to unproductive internet sites.

The Amirsys motto is "Names you know. Content you trust". Our authors are all very experienced academic and clinical radiologists who have combed the literature and their own decades of experience to prepare this series of "Expert Differential Diagnoses" texts. For this book, I set out to determine the 150 or so most common and important diagnostic challenges in abdominal imaging. I gave each a title and then compiled the possible diagnoses in order of likelihood. With our distinctive Amirsys style of bulleted text and extensive images, we are able to provide at a glance the factual information (clinical and imaging) for nearly every condition listed in the differential diagnoses. My goal is to empower the radiologist to make a specific diagnosis or to narrow the diagnostic possibilities to a very few, along with providing advice on any additional diagnostic steps that might prove useful.

We hope and believe that the Expert Differential Diagnoses series will be seen as complementary to the other Amirsys books, including the Imaging Anatomy series that provides the fundamental bases for understanding normal and pathologically altered anatomy through the use of medical illustrations and modern cross-sectional imaging. The Diagnostic Imaging series provides a more comprehensive discussion and illustration of individual diseases and conditions that are cited in the "EXPERTddx" books.

We set out some 7 years ago to produce our "legacy" projects, somewhat audaciously planning to commit what we know and how we practice to print and electronic media. We hope that our trio of books and the additional resource of STATdx will prove as instructive and helpful to the readers as they have to us in their preparation.

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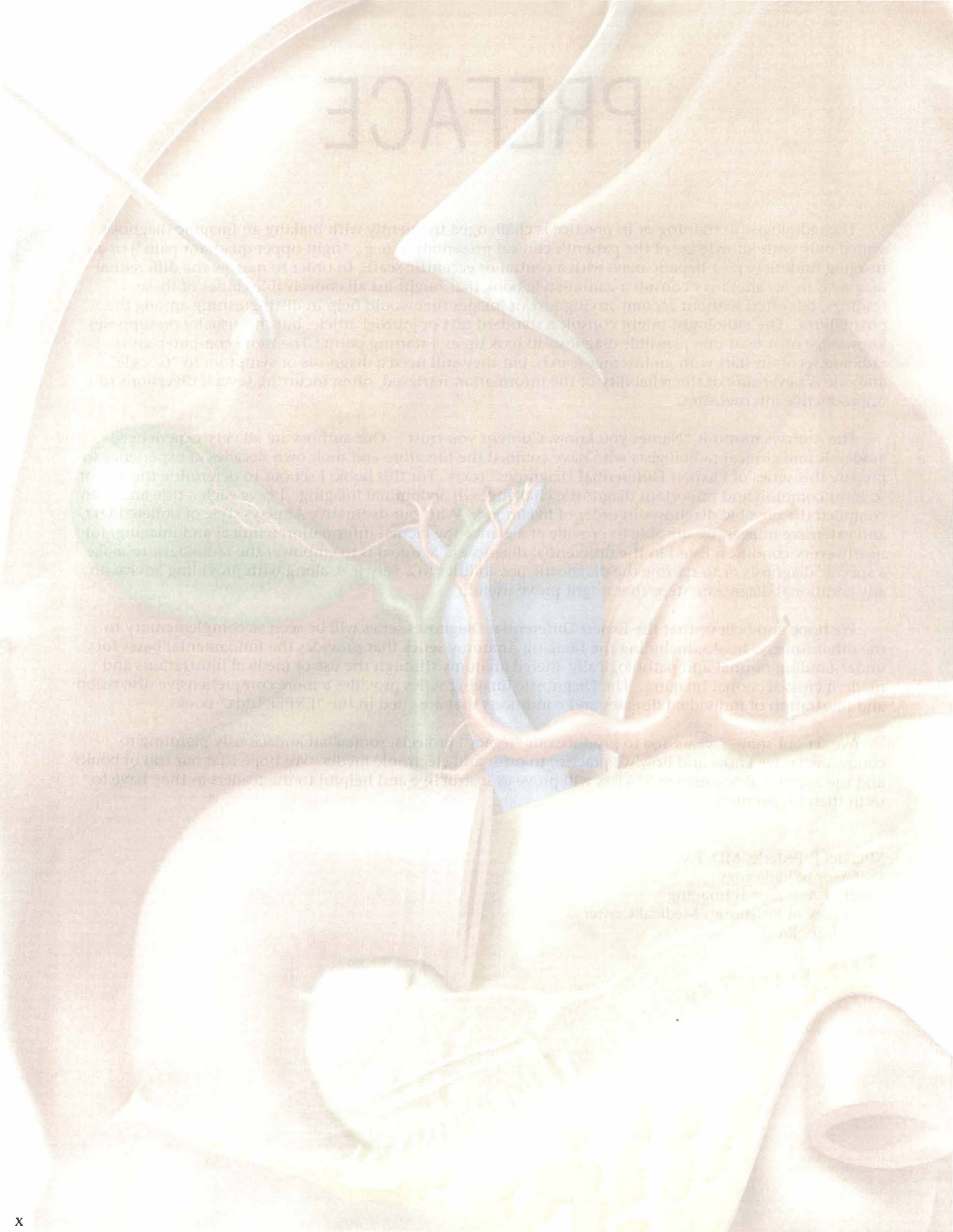

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MESENTERIC OR OMENTAL MASS (SOLID)

DIFFERENTIAL DIAGNOSIS

Common
- Lymphoma
- Lymphadenopathy, Mesentery
- Peritoneal Metastases
- Pancreatitis, Acute
- Diaphragm Insertions (Mimic)
- Mesenteric Hematoma

Less Common
- Mesothelioma
- Desmoid
- Sclerosing Mesenteritis
- Tuberculous Peritonitis
- Carcinoid Tumor
- Splenosis

Rare but Important
- Papillary Serous Carcinoma of Mesentery
- Small Bowel Stromal Tumor
- Sarcoma of Mesentery or Retroperitoneum
- Weber-Christian Disease
- Inflammatory Pseudotumor
- Solitary Fibrous Tumor
- Desmoplastic Small Round Cell Tumor
- Benign Mesenchymal Tumors
- Leukemic Peritoneal Implants

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Peritoneal metastases are, by far, the most common etiology for solid omental masses
- Lymphadenopathy by far most common etiology for solid mesenteric masses
- CT is useful for detection, characterization, staging, & guiding biopsy (which is often necessary for specific diagnosis)

Helpful Clues for Common Diagnoses
- **Lymphoma**
  - NHL is most common cause of mesenteric lymphadenopathy
  - Usually associated with other sites of lymphadenopathy
  - Peritoneal or omental lymphoma is uncommon; is suggestive of immunocompromised state (e.g., AIDS)
    - May have associated ascites
- **Lymphadenopathy, Mesentery**
  - Many potential infectious, inflammatory, and neoplastic etiologies
  - May be discrete or confluent
  - Consider opportunistic infections, bowel and pelvic malignancies
- **Peritoneal Metastases**
  - Metastases to mesenteric peritoneal surface often appear as nodular masses
  - Often associated with omental metastases
  - Gastrointestinal and ovarian cancers are most common etiologies
- **Pancreatitis, Acute**
  - Inflammation of mesentery may appear as a solid mass ("phlegmon")
  - Hemorrhage into mesentery or a pseudocyst may appear as a heterogeneous hyperdense mass
- **Diaphragmatic Insertions (Mimic)**
  - "Slips" of diaphragm may insert on ribs & costal cartilages
  - Simulate nodular peritoneal tumors on axial section
  - Key is to visualize the elongated shape & continuity with rest of diaphragm
- **Mesenteric Hematoma**
  - Usually with a history of trauma or coagulopathy
  - Nonenhancing mass of high density (45-65 HU)

Helpful Clues for Less Common Diagnoses
- **Mesothelioma**
  - Accounts for 20% of all mesotheliomas
  - Associated with asbestos exposure (look for pleural plaques)
  - Infiltrates and stiffens mesentery
  - May have associated ascites
- **Desmoid**
  - Intra-abdominal aggressive fibromatosis
  - Benign but locally aggressive
    - Usually infiltrates small bowel mesentery, often occluding mesenteric vessels and bowel
  - Occurs sporadically and in patients with Gardner syndrome
- **Sclerosing Mesenteritis**
  - Spectrum from infiltration to a solid fibrotic mass
  - Usually affects small bowel mesentery
- **Tuberculous Peritonitis**
  - Nodular or symmetric thickening of peritoneum and mesentery
  - Usually with ascites and low density (caseated) mesenteric nodes

- **Carcinoid Tumor**
  - Spiculated mesenteric mass in right lower quadrant, often with central calcification
  - Desmoplastic effect on mesentery and bowel segments
- **Splenosis**
  - Traumatic rupture of spleen may result in implantation of splenic tissue throughout peritoneal cavity
  - These enhancing nodules closely simulate metastases

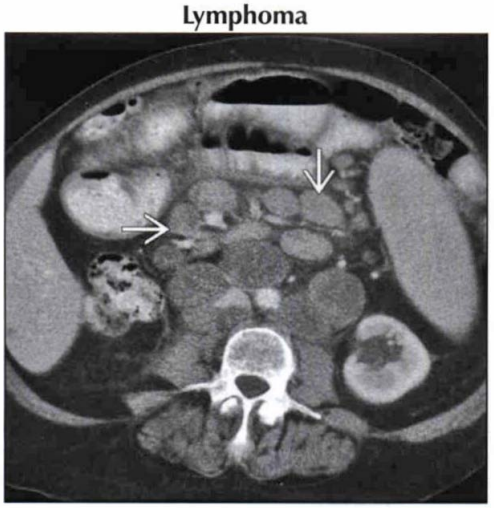
Helpful Clues for Rare Diagnoses

- **Papillary Serous Carcinoma of Mesentery**
  - Mostly in postmenopausal women
  - Multicentric, mostly omental, may calcify
  - Imaging appearance similar to ovarian carcinoma metastases
- **Small Bowel Stromal Tumor**
  - GIST may arise from small bowel with extensive mesenteric component
  - May be associated with neurofibromatosis, type 1
- **Sarcoma of Mesentery or Retroperitoneum**
  - May arise in mesentery or retroperitoneum
  - Includes fibro-, lipo-, leiomyosarcomas, malignant fibrous histiocytoma
- **Weber-Christian Disease**
  - Rare, systemic inflammatory disease of fat
  - Skin nodules, myalgias, arthralgia, fat necrosis
- **Inflammatory Pseudotumor**
  - May affect lung, orbit, mesentery
  - Unknown etiology
  - Infiltrating or encapsulated mass on CT, may affect bowel
- **Solitary Fibrous Tumor**
  - May arise from peritoneum
  - Mostly solid mass; may have cystic components
- **Desmoplastic Small Round Cell Tumor**
  - Often affects adolescents & young adults
  - Multiple rounded peritoneal masses
  - Heterogeneous enhancement ± ascites
- **Benign Mesenchymal Tumors**
  - Hemangiomas (look for phleboliths)
  - Lipoma or dermoid (teratoma) (fat density)
  - Nerve sheath tumor
    - Mesenteric plexiform neurofibromatosis in NF1
- **Leukemic Peritoneal Implants**
  - Leukemia can rarely infiltrate & thicken peritoneum
  - Granulocytic sarcoma ("chloroma") can cause focal peritoneal mass
  - Associated with acute myeloid leukemia

SELECTED REFERENCES

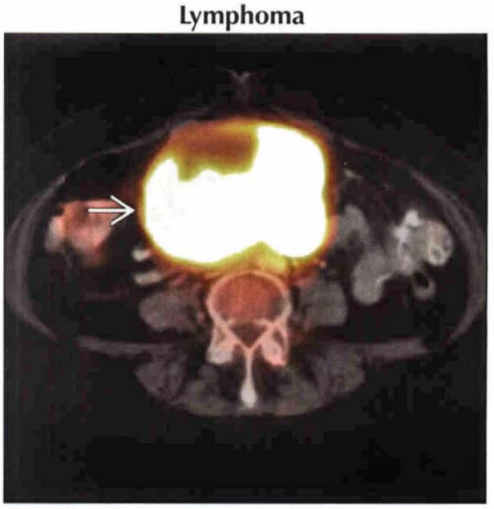
1. Levy AD et al: From the archives of the AFIP: benign fibrous tumors and tumorlike lesions of the mesentery: radiologic-pathologic correlation. Radiographics. 26(1):245-64, 2006
2. Lucey BC et al: Mesenteric lymph nodes seen at imaging: causes and significance. Radiographics. 25(2):351-65, 2005
3. Sheth S et al: Mesenteric neoplasms: CT appearances of primary and secondary tumors and differential diagnosis. Radiographics. 23(2):457-73; quiz 535-6, 2003

Lymphoma



Axial CECT shows extensive lymphadenopathy surrounding the aorta & IVC and in mesenteric nodes ➡ of a patient with non-Hodgkin lymphoma.

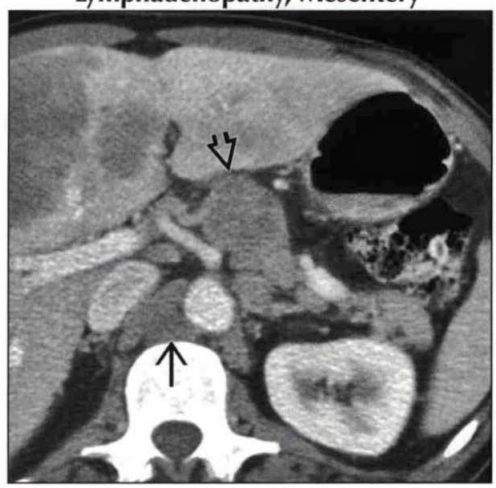
Lymphoma



Axial PET shows a very FDG-avid, large, isolated mesenteric mass ➡ in a patient with non-Hodgkin lymphoma.

MESENTERIC OR OMENTAL MASS (SOLID)

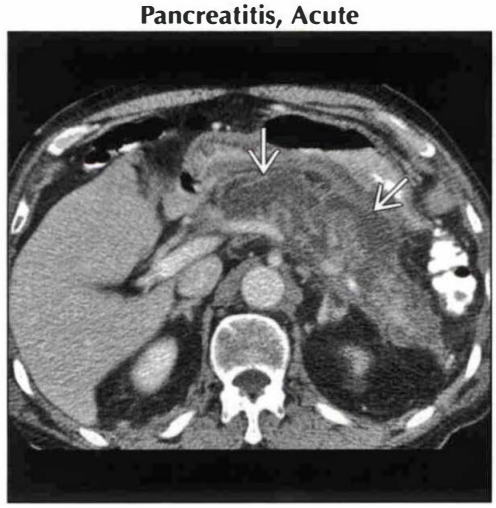
Lymphadenopathy, Mesentery



(Left) *Axial CECT shows lymph node metastases in the gastrohepatic ligament and retrocrural spaces. Liver mets also present; gastric carcinoma.* ***(Right)*** *Axial CECT shows ascites and a soft tissue density "omental cake" indicating malignant seeding of omentum; metastatic melanoma. Mesothelioma could have an identical appearance.*

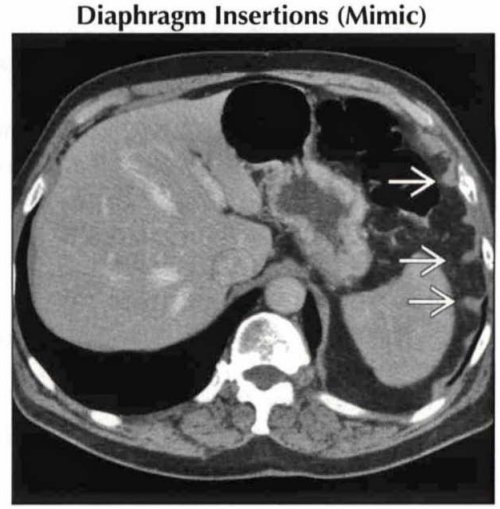
Peritoneal Metastases

Pancreatitis, Acute



(Left) *Axial CECT shows a heterogeneous mass infiltrating the mesentery in a patient with necrotizing pancreatitis. There is almost no enhancement of the pancreatic parenchyma.* ***(Right)*** *Axial CECT shows numerous "nodular" densities that mimic peritoneal implants. Here, they represent finger-like slips of diaphragm as they near their abdominal wall insertions.*

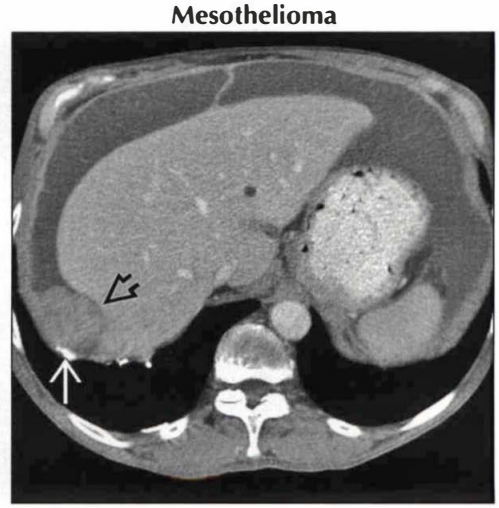
Diaphragm Insertions (Mimic)



Mesenteric Hematoma

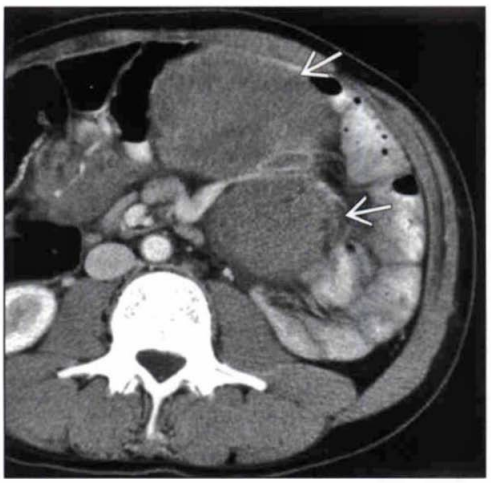
(Left) *Axial CECT shows a hematoma in the base of the mesentery and adjacent to the neck of the pancreas, with a focus of active bleeding. Isolated blunt injury to mesentery at surgery.* ***(Right)*** *Axial CECT shows a peritoneal tumor mass, ascites, and pleural, calcified, asbestos plaques in a patient with mesothelioma.*

Mesothelioma

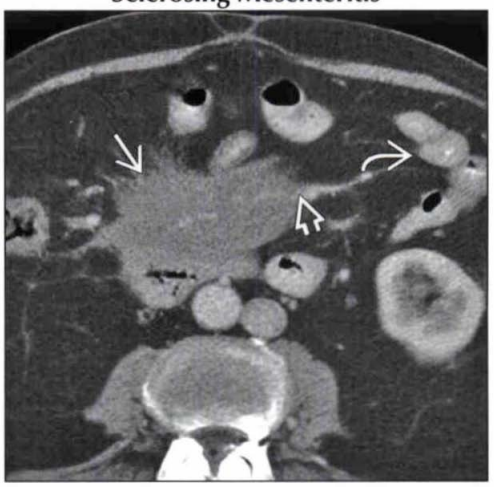


MESENTERIC OR OMENTAL MASS (SOLID)

Desmoid

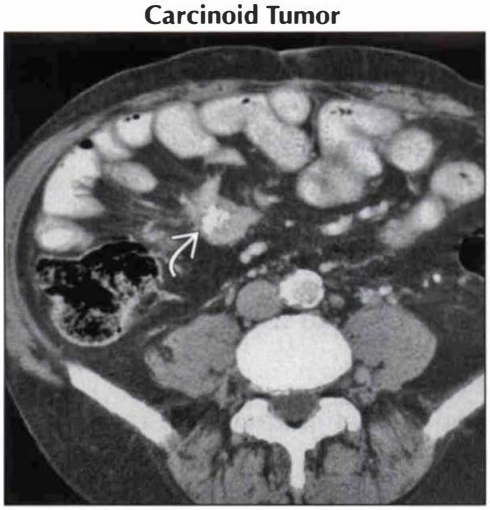


Sclerosing Mesenteritis

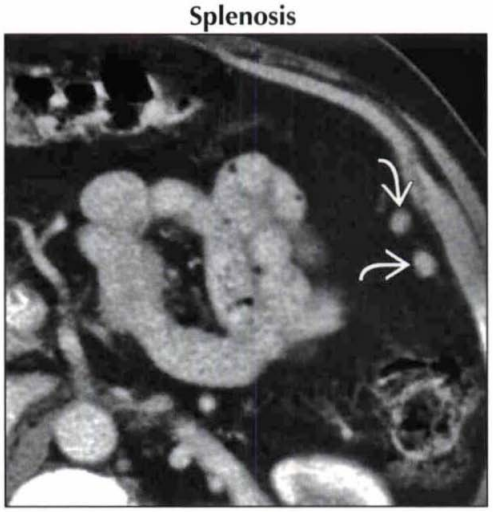


(Left) *Axial CECT shows two large masses that encase the mesenteric vessels. These masses grew rapidly over a few months and necessitated a complete resection and transplantation of small bowel.* ***(Right)*** *Axial CECT shows a soft tissue mass that encases the mesenteric vessels, resulting in engorged veins & small bowel wall edema. This is the advanced form of fibrosing mesenteritis.*

Carcinoid Tumor

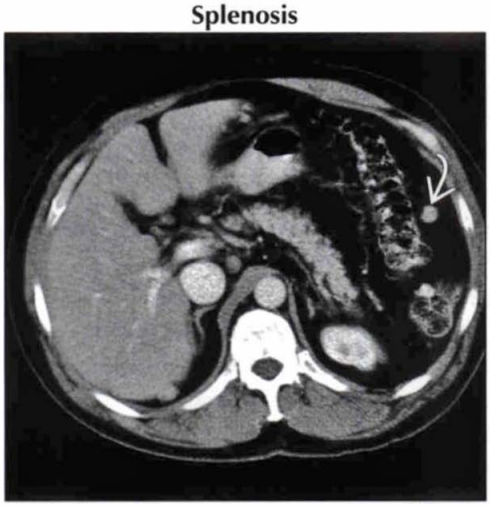


Splenosis

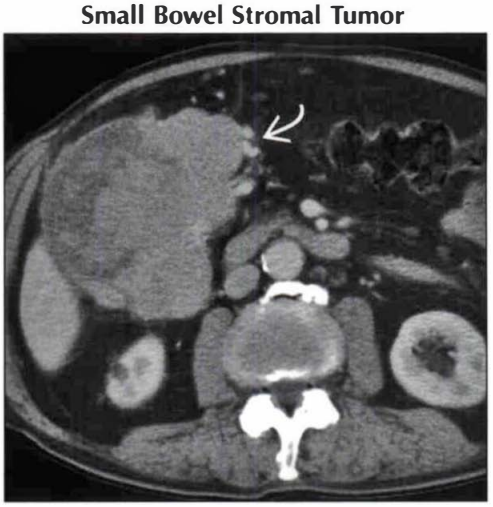


(Left) *Axial CECT shows a soft tissue mass in the ileal mesentery with a calcified focus. Note also desmoplastic scarring of the mesentery & small bowel.* ***(Right)*** *Axial CECT shows two omental nodules representing splenosis, following splenectomy for blunt trauma.*

Splenosis



Small Bowel Stromal Tumor



(Left) *Axial CECT shows a surgical absence of the spleen and an omental nodule just lateral to the transverse colon. Splenosis following splenectomy for blunt trauma.* ***(Right)*** *Axial CECT shows a large mass arising from the duodenum. Note the foci of necrosis and the large feeding & draining blood vessels.*

MESENTERIC OR OMENTAL MASS (CYSTIC)

DIFFERENTIAL DIAGNOSIS

Common

- Ascites, Loculated
  - Peritonitis
  - Sclerosing Peritonitis
- Abscess, Abdominal
- Pancreatic Pseudocyst
- Peritoneal Metastases

Less Common

- Pseudomyxoma Peritonei
- Mesenteric Cyst
- Urachal Remnant
- Dermoid (Mature Teratoma)
- Lymphadenopathy, Cystic or Caseated
- Peritoneal Inclusion Cyst

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Try to distinguish location of mass/fluid collection
  - Omentum, greater peritoneal cavity, lesser sac
  - Helps to narrow the differential diagnosis
- Any infectious, inflammatory, or neoplastic peritoneal process may result in loculated ascites and may simulate a cystic mass
- Cystic masses (e.g., metastases from ovarian cystadenocarcinoma; or "dermoid cyst") may simulate loculated ascites, and vice versa

Helpful Clues for Common Diagnoses

- **Ascites, Loculated**
  - Ascites may become loculated due to adhesions, peritonitis, or peritoneal malignancy
  - Peritonitis may be infectious (bacterial, viral, fungal, etc.) or inflammatory (e.g., bile peritonitis)
    - Spontaneous bacterial peritonitis is common in patients with renal or liver failure (cirrhosis)
    - These patients often have transudative ascites that becomes infected
  - Chronic ambulatory peritoneal lavage almost invariably results in some degree of peritonitis with loculations of fluid
    - Most severe form is sclerosing peritonitis ("cocoon syndrome")
    - Bowel becomes encased in fibrotic, possibly calcified, layer of thickened peritoneum (serosa)
  - Lesser sac ascites may be perceived as a cystic mass
  - Multiple possible etiologies for lesser sac ascites
    - Pancreatitis
    - Perforated gastric ulcer
    - Generalized peritonitis
    - Peritoneal carcinomatosis
    - Tense, generalized, transudative ascites may also enter lesser sac
- **Abscess, Abdominal**
  - By definition, a loculated collection of pus
  - May simulate loculated ascites or cystic mass
- **Pancreatic Pseudocyst**
  - Encapsulated by an inflammatory, non-epithelialized wall
  - Can occur almost anywhere in abdomen, including lesser sac & mesentery, simulating mesenteric cyst
  - Aspiration and fluid analysis are key, along with history of alcohol abuse, gallstones or trauma
  - Pancreatic pseudocysts change size over short term follow-up
    - Helps to distinguish from cystic neoplasm
- **Peritoneal Metastases**
  - Any peritoneal malignancy may result in loculated ascites
    - Tumors arising from the gastrointestinal tract, uterus or ovaries are especially common sources of peritoneal metastases
    - Peritoneal metastases may be solid, but the loculated ascites may simulate a cystic mesenteric mass
  - Cystic primary tumors (e.g., ovarian cystadenocarcinoma) and their metastases may appear as cystic masses

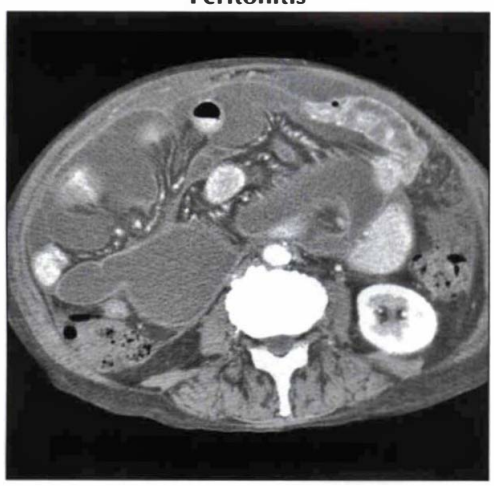
Helpful Clues for Less Common Diagnoses

- **Pseudomyxoma Peritonei**
  - Almost always result of ruptured appendical mucinous adenocarcinoma
  - Simulated by other peritoneal metastases
  - Look for scalloped indentation of surface of liver and spleen
- **Mesenteric Cyst**

- Descriptive term for any cystic mesenteric mass, usually lymphangioma
- Often presents as a large, thin-walled, septate mass
  - Mass is indented by mesenteric vessels and bowel
  - Insinuates around structures without causing obstruction

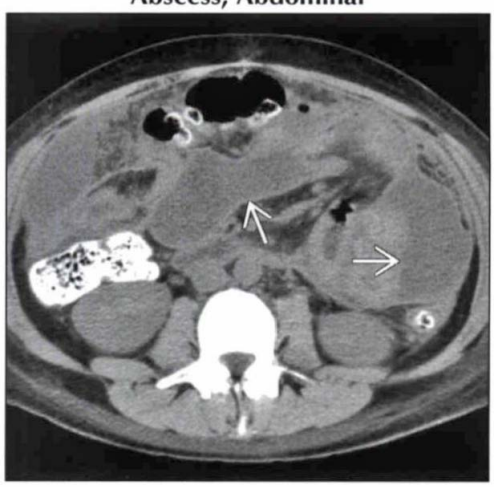
- **Urachal Remnant**
  - Patent urachus may result in a cylindrical or spherical cystic mass, especially if infected
  - Look for mass in midline between dome of bladder and umbilicus
    - Location is key for diagnosis
    - If solid components seen there is concern for urachal carcinoma
- **Dermoid (Mature Teratoma)**
  - Usually has several tissue elements
    - Fat
    - Soft tissue
    - Calcifications including bone and teeth
  - Fat is usually fluid at body temperature
    - May be mistaken for water density fluid if attenuation is not measured
    - Compare with other fluid-containing structures
- **Lymphadenopathy, Cystic or Caseated**
  - Multiple causes of "cystic", caseated or necrotic mesenteric nodes
    - Whipple disease
    - Mycobacterial disease
    - Sprue-celiac disease
  - Other sources of lymphadenopathy may result in low attenuation nodes due to hypovascularity or necrosis
    - Especially common after treatment
- **Peritoneal Inclusion Cyst**
  - Also called benign cystic mesothelioma
  - Occurs in premenopausal women with prior gynecologic surgery or infection that results in peritoneal scarring
  - Hormonally active ovaries secrete fluid that becomes loculated in the pelvis, usually adjacent to ovary
  - Usual appearance is septate pelvic fluid collection
    - May extend up out of pelvis on occasion
  - By ultrasound may see ovary "trapped" with the septate fluid collection

Peritonitis



Axial CECT shows multiple, loculated, thick-walled fluid collections. Bile peritonitis following partial hepatic resection.

Abscess, Abdominal



Axial NECT shows multiple, loculated, thick-walled, infected fluid collections ➡ from Crohn disease with perforation.

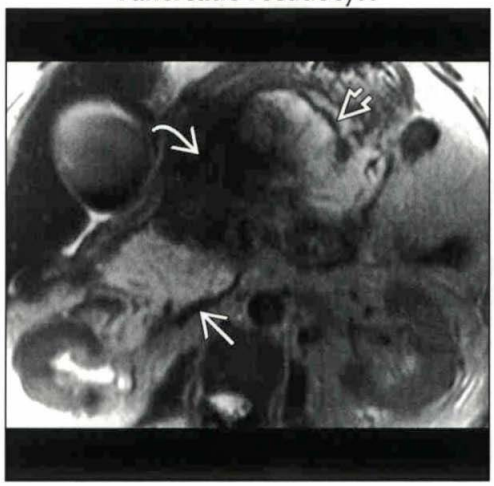
MESENTERIC OR OMENTAL MASS (CYSTIC)

Abscess, Abdominal

*(**Left**) Axial CECT shows a cystic mass or loculated fluid collection. Abscess following perforated appendicitis, drained percutaneously. (**Right**) Axial CECT shows an oval cystic mass in the pancreatic bed and base of mesentery.*

Pancreatic Pseudocyst

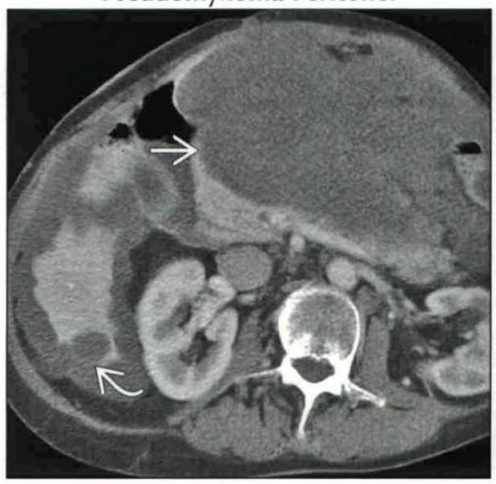
Pancreatic Pseudocyst



*(**Left**) Axial T2WI MR shows a high signal intensity pseudocyst between the head of the pancreas & the right kidney. The body of the pancreas is necrotic, accounting for its high signal intensity. (**Right**) Axial CECT shows loculated fluid collections between loops of bowel. Nodular thickening of the peritoneum & omentum confirm malignant ascites.*

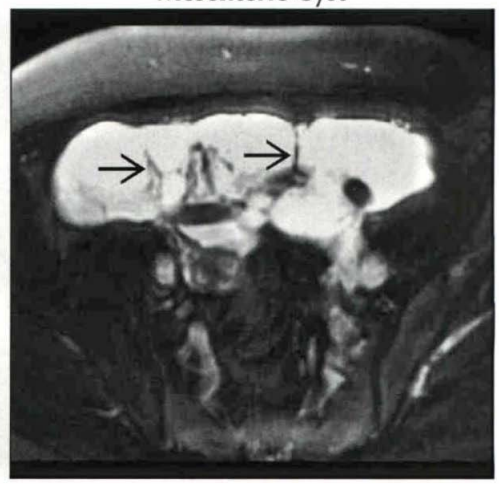
Peritoneal Metastases

Pseudomyxoma Peritonei



*(**Left**) Axial CECT shows a complex cystic "mass" in addition to loculated ascites that "scallops" the surface of the liver. (**Right**) Axial T2WI MR shows a multiseptate, mesenteric cystic mass with bright intensity on T2WI. Note the thin septations within the mass.*

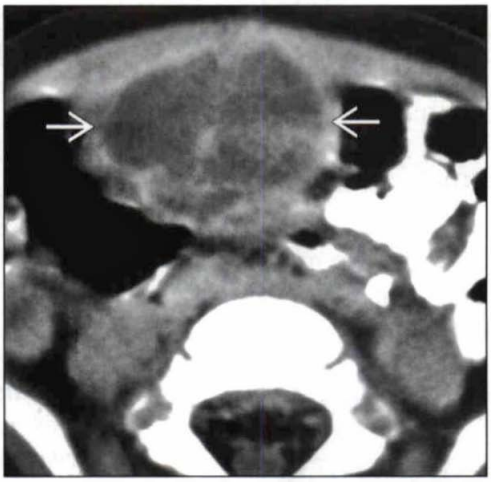
Mesenteric Cyst



MESENTERIC OR OMENTAL MASS (CYSTIC)

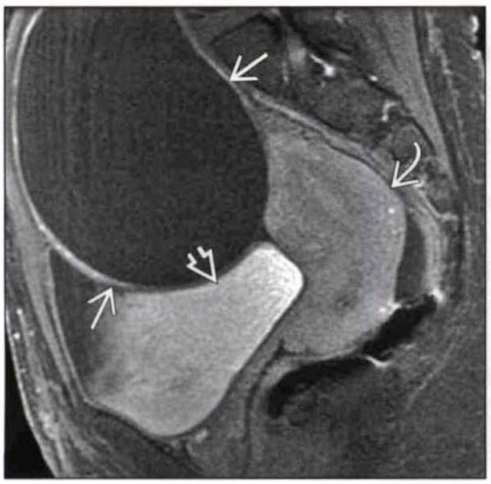
Mesenteric Cyst

Urachal Remnant

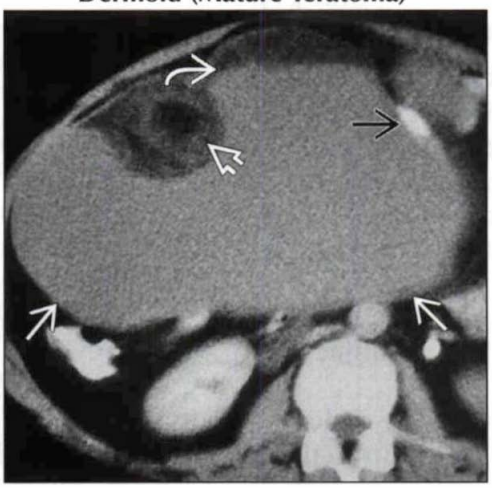


(Left) *Axial CECT shows a complex but thin-walled cystic mass that "sandwiches" a segment of small bowel. Calcific foci are present in walls & septa. Lymphangioma.* ***(Right)*** *Axial CECT shows an infected urachal cyst as a complex cystic mass located between the bladder dome & the umbilicus.*

Urachal Remnant

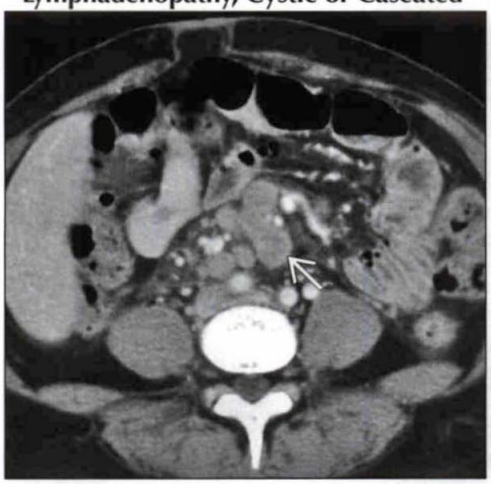


Dermoid (Mature Teratoma)

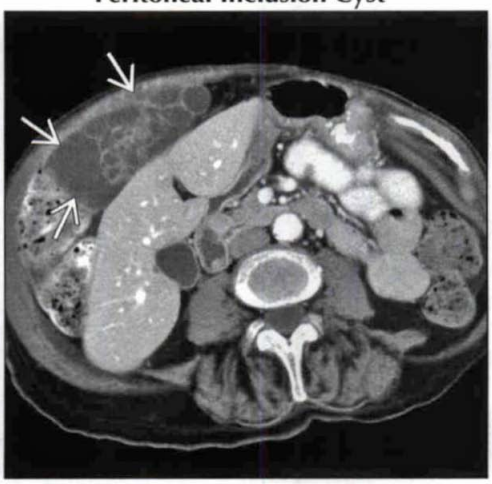


(Left) *Sagittal T1 C+ FS MR shows a large urachal cyst that indents the dome of the bladder & displaces the uterus. The bladder urine is opacified by gadolinium IV injection.* ***(Right)*** *Axial CECT shows a large mass of near water attenuation with a fat-fluid level. foci of calcification & mature fat.*

Lymphadenopathy, Cystic or Caseated



Peritoneal Inclusion Cyst



(Left) *Axial CECT shows low attenuation ("caseated") lymph nodes in the retroperitoneum & mesentery due to Mycobacterial enteritis in a patient with AIDS.* ***(Right)*** *Axial CECT shows an atypically multiseptate cystic mass that displaces the liver. Most peritoneal inclusion cysts are in the pelvis in women who have had prior pelvic surgery.*

FAT-CONTAINING LESION, PERITONEAL CAVITY

DIFFERENTIAL DIAGNOSIS

Common
- Sclerosing Mesenteritis
- Omental Infarct
- Epiploic Appendagitis
- Fibrofatty Mesenteric Proliferation
- Intussusception
- Dermoid (Mature Teratoma)

Less Common
- Retroperitoneal Sarcoma (Liposarcoma)
- Metastatic Malignant Teratoma
- Cystic Fibrosis, Pancreas (Mimic)
- Lipoma, Intestine
- Lipomatous Infiltration, Ileocecal Valve

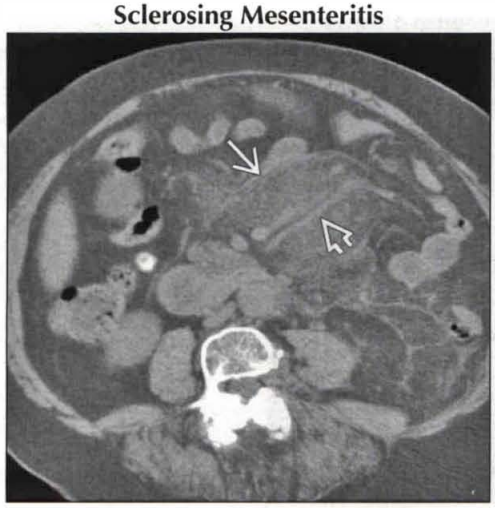
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Many of these lesions have a characteristic imaging and clinical presentation

Helpful Clues for Common Diagnoses
- **Sclerosing Mesenteritis**
  - Causes chronic abdominal pain
  - Usually involves jejunal mesentery
  - Thin capsule, mesenteric lymph nodes
  - Envelopes superior mesenteric vessels
- **Omental Infarct**
  - Causes acute abdominal pain
  - Primary form almost always adjacent to ascending colon
  - Secondary form anywhere in abdomen
    - Near site of surgery or inflammation
  - Larger fatty "mass" (3-10 cm) than epiploic appendagitis
- **Epiploic Appendagitis**
  - Causes acute abdominal pain
    - Usually adjacent to descending or sigmoid colon
    - Can affect any part of colon
  - Oval fatty mass adjacent to colon
    - 2-4 cm diameter with thin hyperdense rim & central dot (vessel)
- **Fibrofatty Mesenteric Proliferation**
  - Common in longstanding Crohn disease
  - Check for radiologic signs, medical history of Crohn disease
- **Intussusception**
  - Mesenteric fat is drawn into the intussuscipiens along with the bowel (intussusceptum)
  - Appears as a crescent of fat density within the intussuscipiens (cross section)
- **Dermoid (Mature Teratoma)**
  - "Dermoid" with fat, soft tissue, calcification

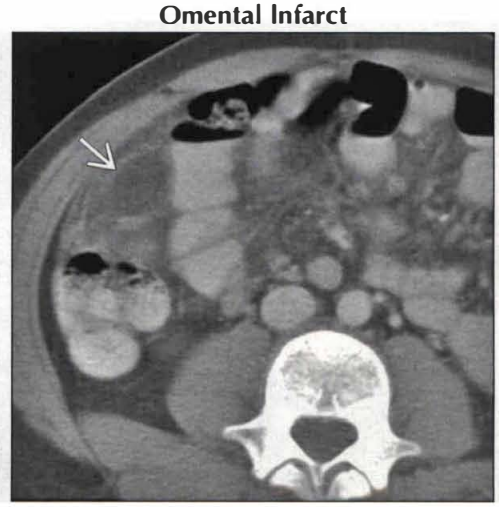
Helpful Clues for Less Common Diagnoses
- **Cystic Fibrosis, Pancreas (Mimic)**
  - Lipomatous pseudohypertrophy of the pancreas
- **Lipoma, Intestine**
  - May arise in stomach, small bowel or colon
  - Fat density spherical mass
- **Lipomatous Infiltration, Ileocecal Valve**
  - May appear as intraluminal fatty mass

Sclerosing Mesenteritis



Axial CECT shows a heterogeneous infiltration of the mesenteric fat with a thin capsule ➡ and mesenteric vessels ➡ coursing through, uninvolved.

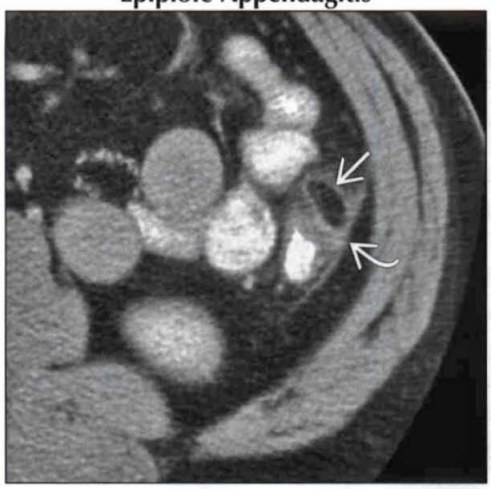
Omental Infarct



Axial CECT shows an oval mass ➡ of fat density adjacent to the ascending colon in a child with focal tenderness.

FAT-CONTAINING LESION, PERITONEAL CAVITY

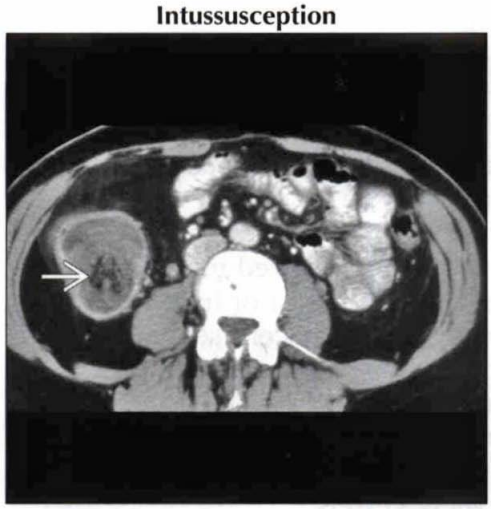
Epiploic Appendagitis



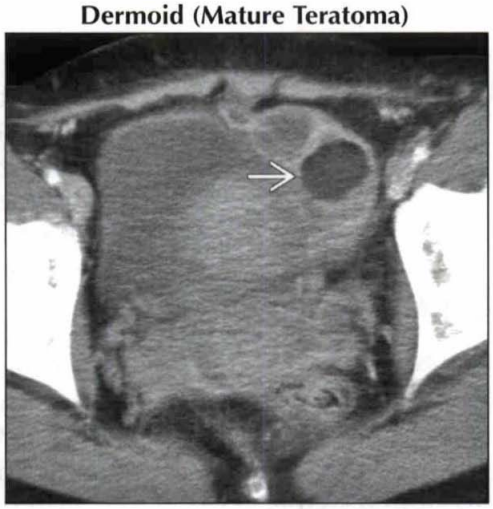
Fibrofatty Mesenteric Proliferation

(Left) *Axial CECT shows a small oval mass ➡ of fat density adjacent to the descending colon, with surrounding inflammatory changes ➡.* ***(Right)*** *Axial CECT shows a thick-walled terminal ileum ➡ (Crohn disease) with proliferation of fat in the adjacent mesentery.*

Intussusception

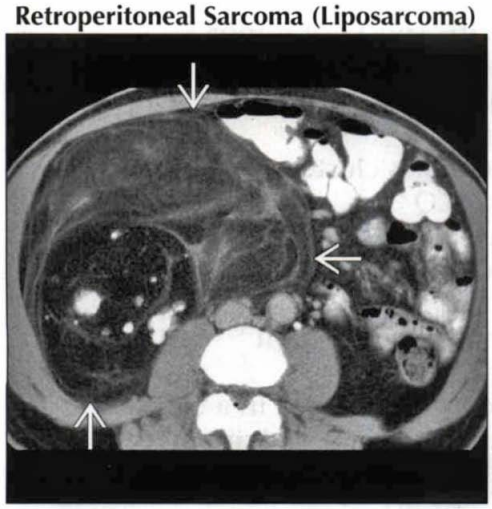


Dermoid (Mature Teratoma)

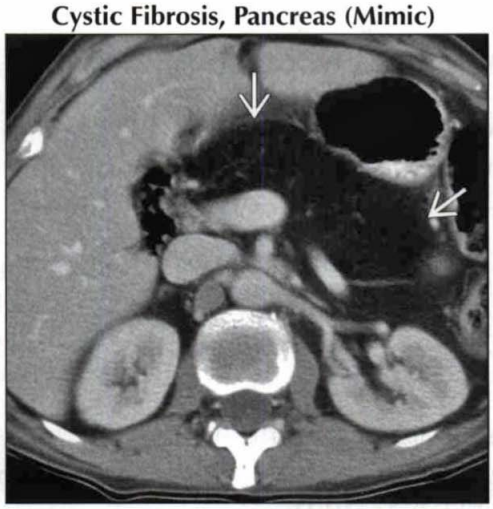


(Left) *Axial CECT shows a right lower quadrant mass. The crescentic fat ➡ is the intussuscepted mesentery of the terminal ileum.* ***(Right)*** *Axial CECT shows a fat density mass in the left ovary ➡.*

Retroperitoneal Sarcoma (Liposarcoma)



Cystic Fibrosis, Pancreas (Mimic)



(Left) *Axial CECT shows a huge mass ➡ arising from the retroperitoneum. The displacement of the bowel and extension into the mesentery may simulate an intraperitoneal mass. Liposarcoma.* ***(Right)*** *Axial CECT shows complete replacement of the pancreas ➡ by lipomatous pseudohypertrophy, typical findings of cystic fibrosis.*

MESENTERIC LYMPHADENOPATHY

DIFFERENTIAL DIAGNOSIS

Common

- Lymphoma
- Metastases
  - Colon Carcinoma
  - Pancreatic Ductal Carcinoma
  - Carcinoid Tumor
  - Small Bowel Carcinoma
- Appendicitis
- Mesenteric Adenitis
- Crohn Disease
- Sclerosing Mesenteritis
- Mononucleosis
- AIDS, Abdominal Manifestations
  - Kaposi Sarcoma
  - Mycobacterial Infection, Intestinal
- Sarcoidosis, Abdominal Signs

Less Common

- Ulcerative Colitis
- Diverticulitis
- Scleroderma, Intestinal
- Mastocytosis
- Sprue-Celiac Disease
- Whipple Disease
- Castleman Disease

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Determine the site, size and attenuation of the involved nodes
  - Localized
    - Right lower quadrant: Appendicitis, cecal diverticulitis, carcinoid tumor, cecal carcinoma, mesenteric adenitis, Crohn disease
    - Mesocolon: Colon carcinoma > diverticulitis
  - Generalized: Systemic tumor, infection, or inflammation (e.g., lymphoma, mononucleosis)
  - Size
    - Normal: Up to 4 or 5 mm in short axis (tend to be most prominent in children and young adults)
    - Enlarged, discrete: Nonspecific
    - Massive, confluent: Usually malignant, especially with non-Hodgkin lymphoma
  - Attenuation
    - Soft tissue (muscle) density: Nonspecific
    - Water density (or lower): Tuberculosis, celiac-sprue, Whipple disease
    - Hypervascular/enhancing: Kaposi sarcoma or Castleman disease
    - Calcified: Carcinoid tumor or treated/inactive disease (lymphoma, tuberculosis most commonly)

Helpful Clues for Common Diagnoses

- **Lymphoma**
  - Non-Hodgkin lymphoma is the most common malignant cause of mesenteric lymphadenopathy
    - Present in 50% of patients at diagnosis
    - Hodgkin disease affects mesenteric nodes in about 5%
  - Often results in lymphadenopathy in other areas of body
    - Chest, abdomen, axilla, and neck
  - Enlarging nodes often coalesce, become confluent
  - Nodes grow around structures but usually do not cause obstruction (e.g., of vessels or bowel)
  - Calcification of nodes can occur, usually after treatment
- **Metastases**
  - May be part of generalized metastases
    - e.g., melanoma, breast or lung cancer
  - Look for tumor in adjacent segment of bowel; often more subtle than the lymphadenopathy
    - Carcinoid tumor: Mesenteric mass with central calcification, desmoplastic effect on bowel & vessels
    - Colon cancer: Adjacent mesenteric lymph nodes very suggestive of lymphatic spread of tumor
    - Pancreatic cancer: Nodes in base of mesentery, lesser omentum
- **Appendicitis**
  - Commonly has cluster of mildly enlarged nodes in RLQ
  - Also need direct signs of appendicitis
    - Dilated lumen
    - Thick wall
    - Adjacent inflammation
- **Mesenteric Adenitis**
  - RLQ nodes are enlarged in a cluster
  - Usually related to underlying infection of terminal ileum (e.g., viral, Yersinia)

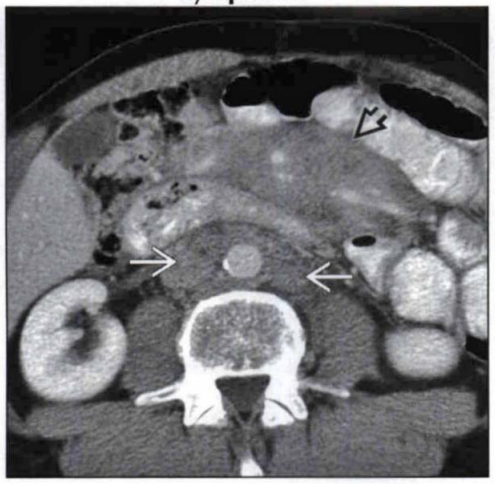
- Usually affects children & young adults; self-limited

- **Crohn Disease**
  - Common signs
    - Mesenteric nodes
    - Fibrofatty proliferation
    - Direct signs of bowel wall thickening, etc.
- **Sclerosing Mesenteritis**
  - Probably an underdiagnosed cause of persistent or recurrent abdominal pain
  - Hazy infiltration of small bowel mesentery, plus cluster of mesenteric nodes
  - Thin capsule surrounds the inflamed mesentery; halo of spared fat around mesenteric vessels
- Mononucleosis
  - May cause generalized lymphadenopathy, including mesenteric
  - Consider in young adult with fever, malaise
  - Look for accompanying splenomegaly
- **AIDS, Abdominal Manifestations**
  - Direct HIV infection
    - Usually minimally enlarged nodes
  - Opportunistic infection: Especially in patient with CD4 count < 50/mL
    - Mycobacterial infection: Look for low density center of caseated nodes (especially with M. avium complex)
    - M. tuberculosis usually results in soft tissue density lymphadenopathy
  - Lymphoma
    - Increased incidence in AIDS
  - Kaposi sarcoma
    - Soft tissue density or hyperenhancing nodes
- **Sarcoidosis, Abdominal Signs**
  - Mesenteric & retroperitoneal adenopathy in addition to chest involvement
  - May affect liver & spleen as well
    - Usually multifocal small hypodense foci

Helpful Clues for Less Common Diagnoses

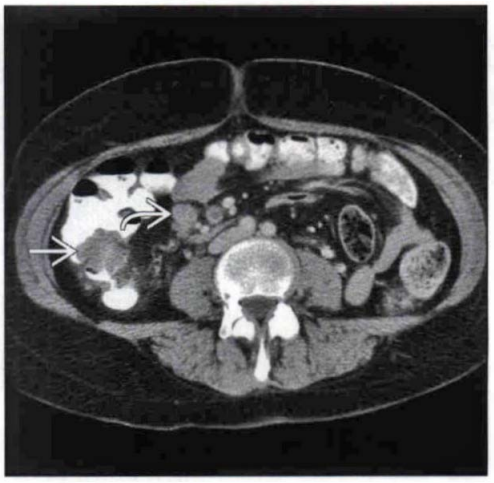
- **Diverticulitis**
  - Rarely results in prominent adenopathy
  - Colonic wall thickening with regional lymphadenopathy should be considered colon cancer until proven otherwise
- **Sprue-Celiac Disease**
  - May result in cavitated (low attenuation) mesenteric nodes
  - Nodes regress on gluten-free diet
  - Persistence of nodes, especially with soft tissue density, should suggest underlying lymphoma (higher incidence in sprue)
- **Whipple Disease**
  - Systemic bacterial infection (Tropheryma whippelii)
  - Nodes have high fat content and low density (0-20 HU)
  - Associated small bowel wall thickening

Lymphoma



Axial CECT shows retroperitoneal ➡ and mesenteric ➪ adenopathy in a confluent pattern, typical of non-Hodgkin lymphoma.

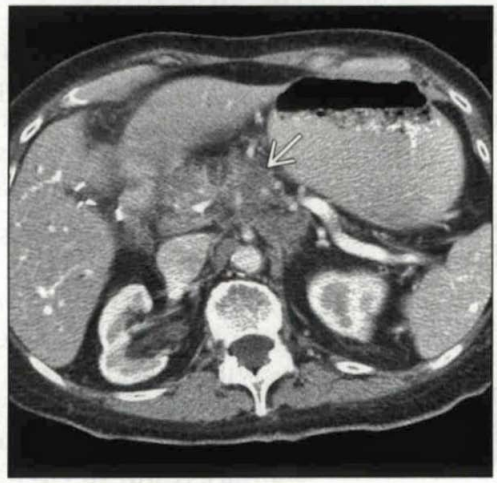
Colon Carcinoma



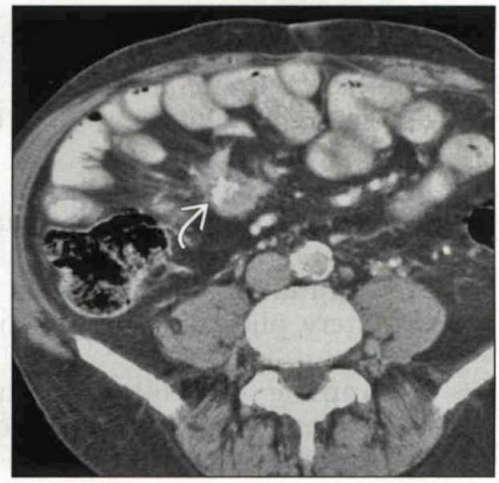
Axial CECT shows a mass in the ascending colon ➡ and ileocolic mesenteric lymphadenopathy ➡.

MESENTERIC LYMPHADENOPATHY

Pancreatic Ductal Carcinoma

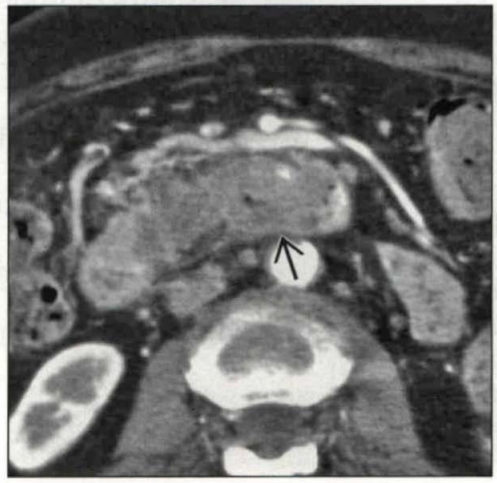


Carcinoid Tumor



(Left) *Axial CECT shows a hypodense mass in the pancreatic neck* ➡ *with extension into the base of the mesentery & vascular encasement.* ***(Right)*** *Axial CECT shows a mesenteric mass* ➡ *with central calcification & desmoplastic scarring of the bowel & mesentery.*

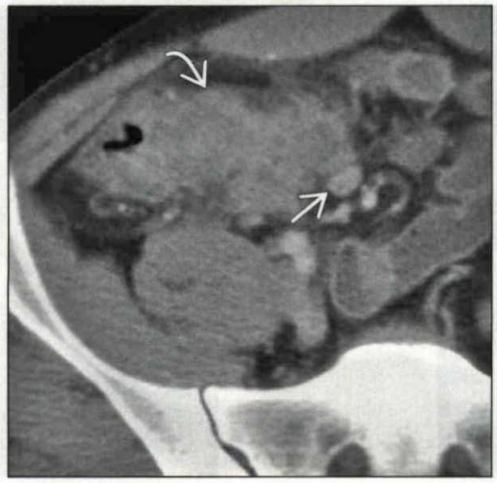
Small Bowel Carcinoma



Small Bowel Carcinoma

(Left) *Axial CECT shows a mass* ➡ *that fills the lumen of the third portion of the duodenum, a primary carcinoma. Lymphadenopathy is present in the retroperitoneum & base of the mesentery (other sections).* ***(Right)*** *Axial CECT shows a nodal metastasis* ➡ *behind the pancreatic head in a patient with duodenal carcinoma.*

Crohn Disease

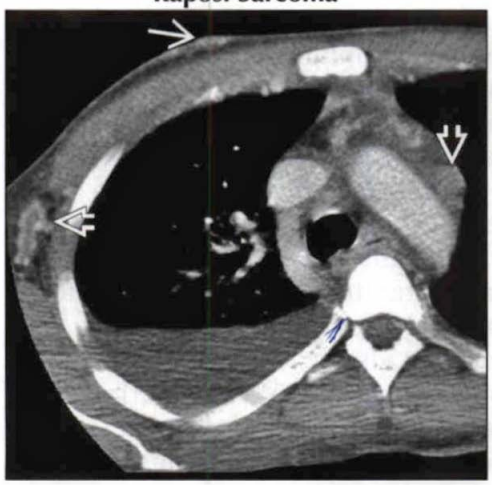


Sclerosing Mesenteritis

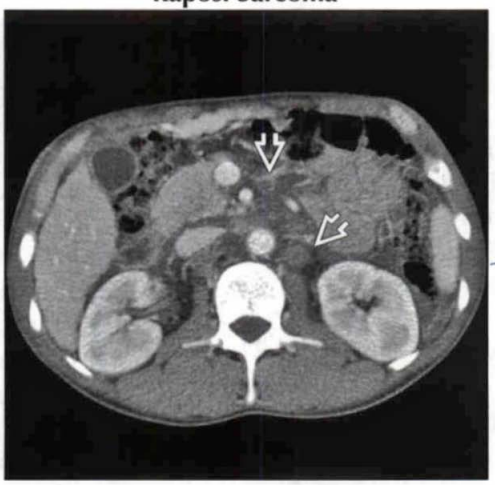
(Left) *Axial CECT shows a thick-walled terminal ileum* ➡ *with a narrowed lumen, and mesenteric lymphadenopathy* ➡. ***(Right)*** *Axial CECT shows mass-like thickening of the jejunal mesentery with a thin capsule* ➡ *and lymphadenopathy* ➡.

MESENTERIC LYMPHADENOPATHY

Kaposi Sarcoma

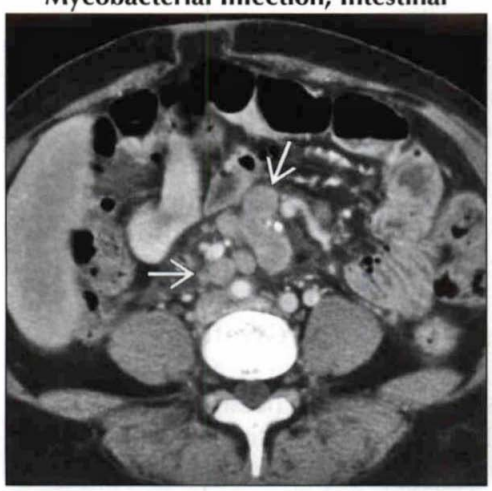


Kaposi Sarcoma



(Left) Axial CECT shows skin lesions and prominent enhancement of axillary & mediastinal nodes in a patient with Kaposi sarcoma & AIDS. (Right) Axial CECT shows retroperitoneal & mesenteric lymphadenopathy in a patient with Kaposi sarcoma and AIDS.

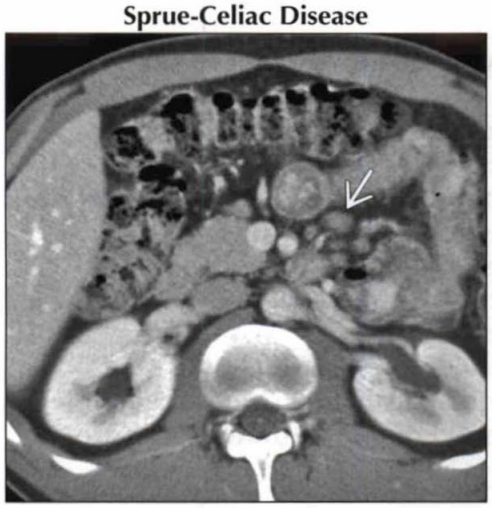
Mycobacterial Infection, Intestinal



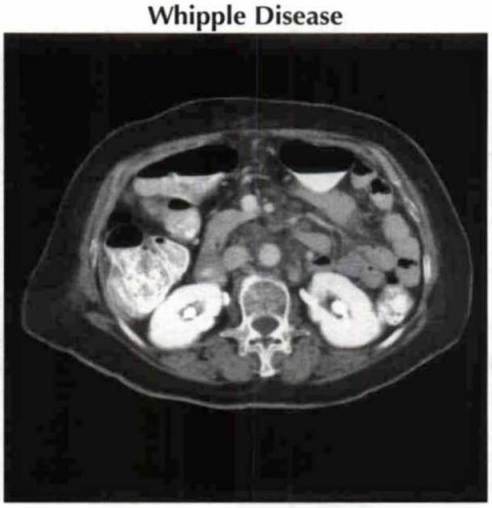
Sarcoidosis, Abdominal Signs

(Left) Axial CECT shows mesenteric nodes with a peculiar low density or caseated appearance, characteristic of Mycobacterial infection in this patient with AIDS. (Right) Axial CECT shows hepatosplenomegaly and diffuse lymphadenopathy, all due to sarcoidosis.

Sprue-Celiac Disease



Whipple Disease



(Left) Axial CECT shows mesenteric lymphadenopathy in a patient who also had multiple intussusceptions and a reversal of fold pattern of the small bowel (not shown). (Right) Axial CECT shows mesenteric & retroperitoneal lymphadenopathy with peculiar low attenuation, typical of Whipple disease.

ABDOMINAL CALCIFICATIONS

DIFFERENTIAL DIAGNOSIS

Common

- Gallstones
- Urolithiasis
- Abdominal Incision & Injection Sites
- Pancreatitis, Chronic
- Arterial Calcification and Aneurysm
- Costal Cartilage Calcification (Mimic)
- Uterine Leiomyoma (Fibroid)
- Vas Deferens Calcification
- Splenic & Hepatic Granulomas
- Phleboliths
- Calcified Mesenteric Lymph Nodes
- Renal Cyst
- Appendicolith (Fecalith)

Less Common

- Bladder Calculi
- Prostatic Calcifications
- Ovarian Carcinoma
- Ovarian Teratoma
- Pseudomyxoma Peritonei
- Peritonitis
- Sclerosing Peritonitis
- Porcelain Gallbladder
- Calcinosis Syndromes
- Hydatid Disease
- Renal Tumors
  - Renal Cell Carcinoma
  - Multilocular Cystic Nephroma
- Polycystic Disease
- Calyceal Diverticulum
- Adrenal Cyst
  - Infection, Adrenal Cyst, Adrenal Carcinoma, Pheochromocytoma
- Tuberculosis, Abdominal Manifestations
  - Adrenal &/or Renal Calcifications
- Mesenteric Cyst
- Metastases and Lymphoma, Hepatic
- Calcified/Ossified Scar
- Mucinous Cystic Pancreatic Tumor
- Mucocele of the Appendix

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- List includes conditions with calcifications visible on plain radiography (CT detects calcifications less obvious, such as focal calcifications within certain hepatic masses)
- Metastatic calcification: Deposition of calcium salts in normal tissue
  - Requires hypercalcemia and alkaline pH environment
  - Usual cause: Renal failure with secondary hyperparathyroidism
- Dystrophic calcification: Deposition of calcium salts in tissue damaged by trauma, ischemia, infarction, infection, tumor; normal serum calcium
- Ossification: Formation of bone in damaged tissue (ovarian teratoma; scar from incision)
- Concretion: Calcified precipitates inside a vessel or hollow viscus
  - Have continuous edge of calcification along perimeter; may be laminated (e.g., gallstones, renal calculi, phleboliths, pancreatic concretions)
- Conduit wall calcification: Calcification in wall of fluid-conducting tube
  - Ring-like or tram track linear calcification, often discontinuous (e.g., arterial calcification, aneurysm, vas deferens)
- Cystic calcification: Calcified wall of abnormal fluid-filled mass
  - Smooth curvilinear calcification; larger diameter than conduit wall calcification (e.g., renal, adrenal or hepatic cyst, hydatid cyst, mucocele of appendix)
- Solid mass calcification: Greatest variety of etiologies and appearance (e.g., mottled, multiple sites = calcified mesenteric nodes; whorled, heterogeneous, flocculent = uterine fibroid; faint, poorly defined in liver = mucinous carcinoma metastases)

Helpful Clues for Common Diagnoses

- **Gallstones**
  - May have central nidus &/or peripheral rim
  - Can be densely calcified (calcium bilirubinate stones); faceted
  - Gallstones may be dropped into peritoneal cavity during laparoscopic cholecystectomy
    - Usually lodge in dependent recesses (e.g., Morison pouch)
- **Urolithiasis**
  - Only larger & calcified stones are visible on plain radiography (urate stones are lucent)

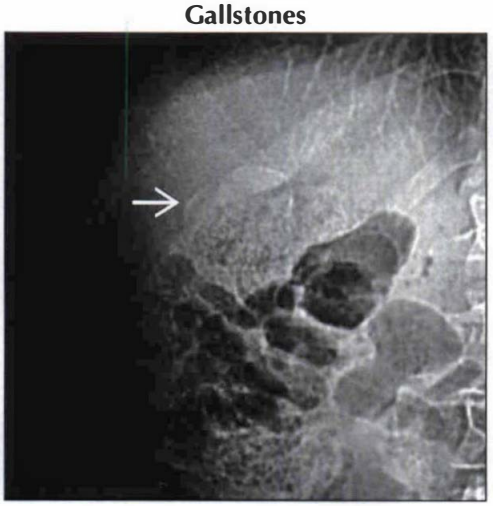
- All renal calculi are opaque on CT (except indinavir-induced stones)

- **Abdominal Incision & Injection Sites**
  - Subcutaneous fat over buttocks, often calcify, usually as oval rim
  - May be misinterpreted as intra-abdominal calcification
- **Costal Cartilage Calcification (Mimic)**
  - Irregular bilateral, symmetrical, cartilaginous calcification
  - Usually seen in older women
- **Uterine Leiomyoma (Fibroid)**
  - Common; usually midline, but can vary
  - Variety of appearances: Whorled, flocculent, heterogeneous, "popcorn"
- **Vas Deferens Calcification**
  - Paired tubular "conduit" calcifications in pelvis extending to near midline
  - Usually insulin-dependent diabetic patients
- **Splenic & Hepatic Granulomas**
  - Multiple small punctate calcifications
  - Due to healed histoplasmosis or TB
- **Calcified Mesenteric Lymph Nodes**
  - Small, multiple, flocculent
  - Usually in older adults
- **Appendicolith (Fecalith)**
  - Small, often laminate, may be multiple; usually in right lower quadrant
  - More common on CT than on radiography

Helpful Clues for Less Common Diagnoses

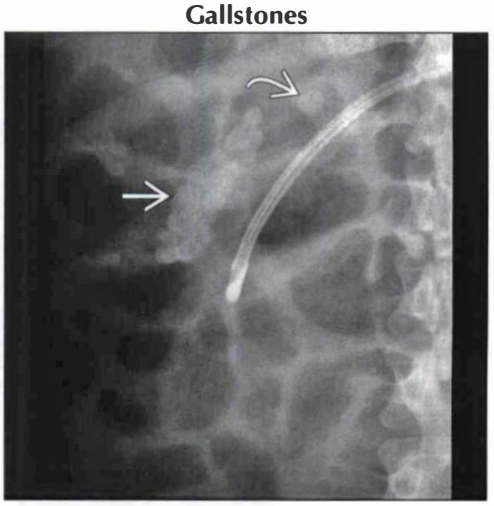
- **Bladder Calculi**
  - Often large, smooth, oval
- **Ovarian Teratoma**
  - Calcification (or ossification, tooth), soft tissue, & fat
- **Peritonitis**
  - Chronic fibrosing peritonitis from peritoneal dialysis, or barium spilled into peritoneal cavity
- **Porcelain Gallbladder**
  - RUQ oval eggshell calcification
- **Calcinosis Syndromes**
  - Associated with connective tissue diseases (e.g., scleroderma, CREST syndrome, systemic lupus, dermatomyositis)
  - Calcifications in subcutaneous tissues
- **Renal Tumors**
  - Renal cell carcinoma, Wilms tumor, multilocular cystic nephroma
- **Polycystic Disease**
  - Cysts in liver & kidneys
  - Thin eggshell calcifications
- **Adrenal Cyst**
  - Healed TB, histoplasmosis or old hemorrhage
  - Adrenal carcinoma
  - Adrenal cyst (eggshell)
  - Pheochromocytoma
- **Calcified/Ossified Scar**
  - Incision can calcify or even ossify; usually vertical orientation
- **Mucinous Cystic Pancreatic Tumor**
  - May have peripheral rim calcification
  - Islet cell & serous (microcystic) tumors often have central nidus of calcification

Gallstones



Frontal radiograph shows a rim calcified ("eggshell") gallstone in the right upper quadrant.

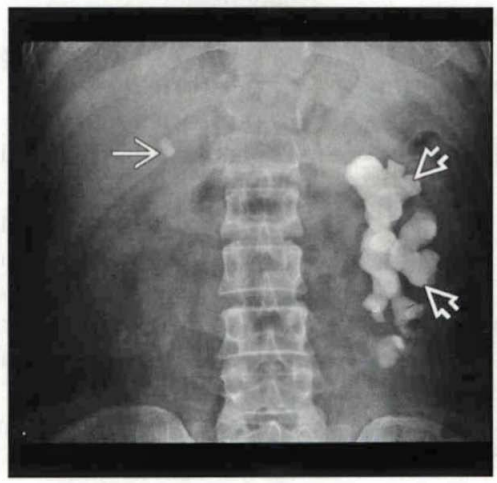
Gallstones



Frontal radiograph shows a feeding tube in the duodenum and a cluster of dozens of gallstones that fill the gallbladder and obstructed the GB neck.

ABDOMINAL CALCIFICATIONS

Urolithiasis



(Left) Anteroposterior radiograph shows a typical punctate calcified stone ➡ in the right kidney & a large "staghorn" calculus ➡ in the left. (Right) Axial CECT shows a linear ossified scar ➡ at the site of a prior midline abdominal incision with both cortical & medullary bone evident.

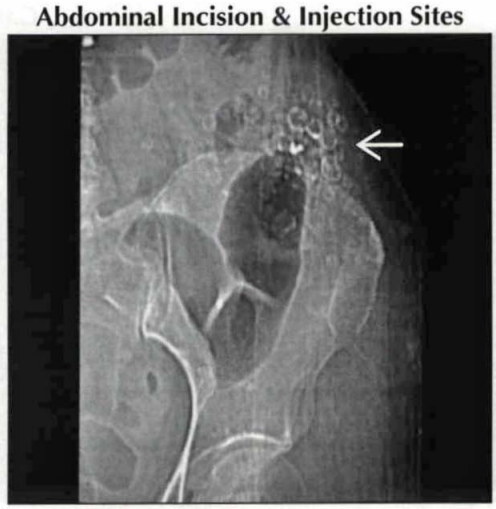
Abdominal Incision & Injection Sites

Abdominal Incision & Injection Sites

(Left) Coronal CECT shows a linear ossified scar ➡ along a prior midline abdominal incision. (Right) Axial NECT shows multiple calcified injection granulomas ➡ in the subcutaneous fat of the buttocks.

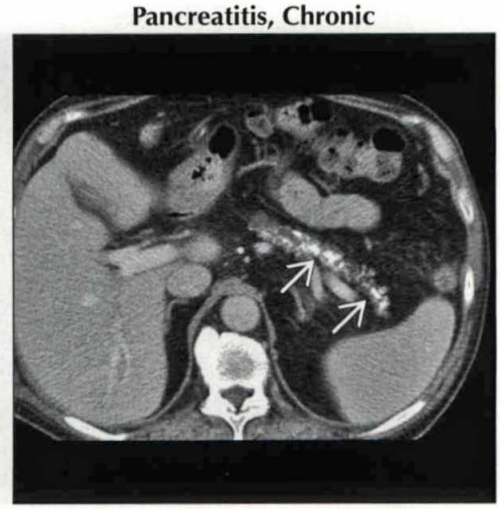
Abdominal Incision & Injection Sites

Abdominal Incision & Injection Sites



(Left) Frontal radiograph shows a cluster of calcified injection granulomas ➡ overlying the lower abdomen, but located within the subcutaneous fat of the buttocks. (Right) Axial CECT shows marked atrophy of the pancreatic parenchyma & calcified concretions ➡.

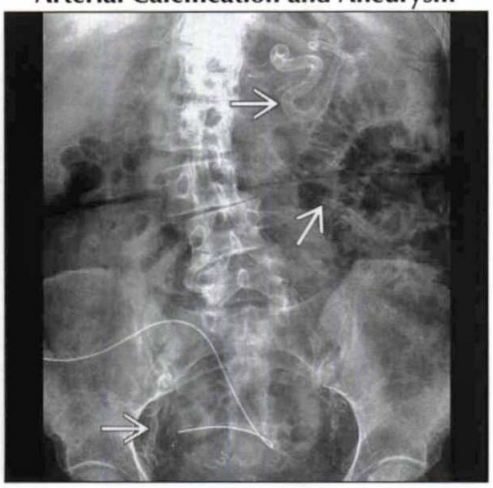
Pancreatitis, Chronic



ABDOMINAL CALCIFICATIONS

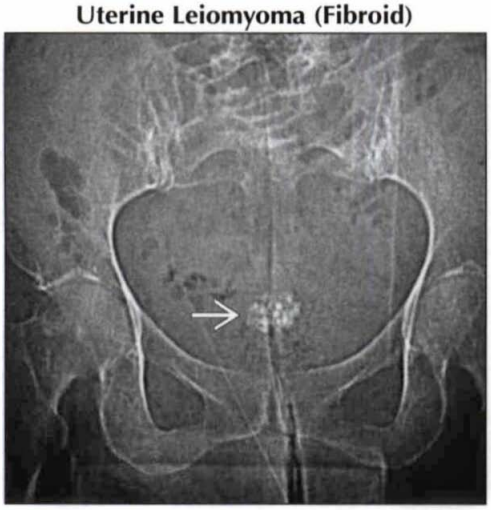
Arterial Calcification and Aneurysm

Arterial Calcification and Aneurysm

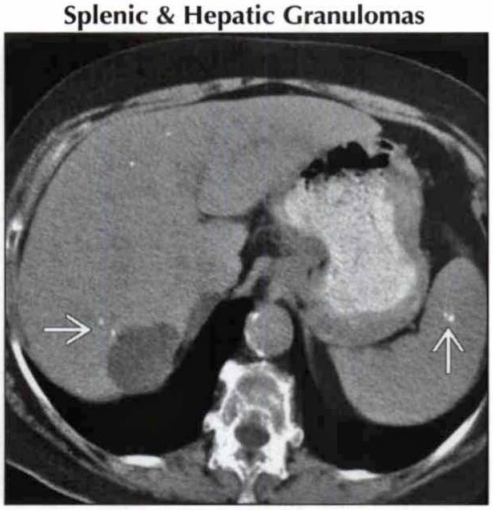


(Left) Frontal radiograph shows a spherical eggshell calcification in the pelvis; large common iliac artery aneurysm. (Right) Frontal radiograph shows a peritoneal dialysis catheter in this diabetic patient with renal failure. There is heavy, continuous calcification of the walls of all the medium size & large arteries.

Uterine Leiomyoma (Fibroid)

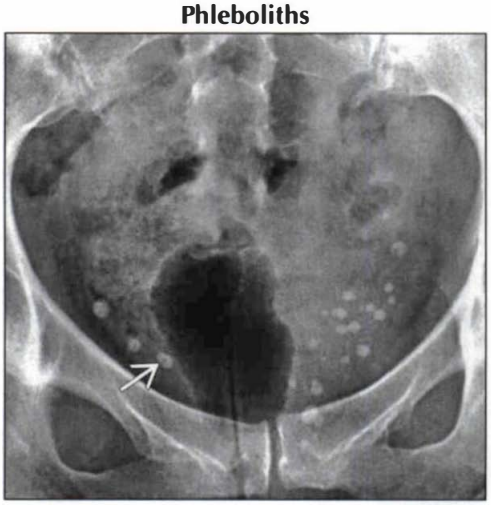


Splenic & Hepatic Granulomas

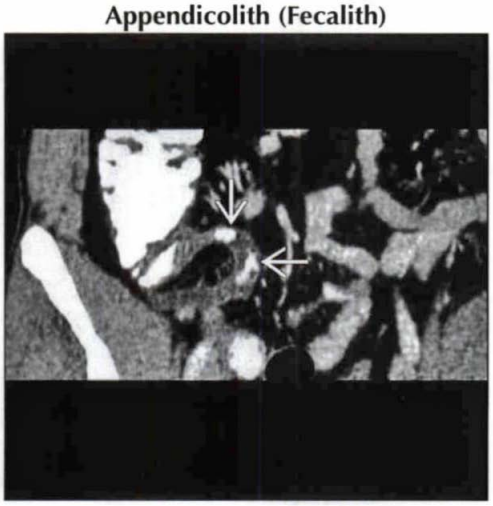


(Left) Frontal radiograph shows a small pelvic "popcorn" type calcification, one of the common forms of calcification in a degenerated uterine fibroid (leiomyoma). (Right) Axial NECT shows dozens of small dense calcifications in the liver and spleen, characteristic of granulomas, probably healed histoplasmosis.

Phleboliths



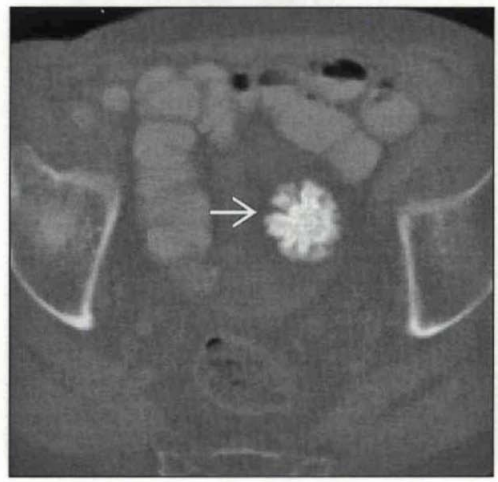
Appendicolith (Fecalith)



(Left) Frontal radiograph shows multiple phleboliths in the pelvis, having their typical distribution, mainly below the iliac spines, some with central lucency. (Right) Coronal CECT shows multiple calcified appendicoliths within a dilated appendix.

ABDOMINAL CALCIFICATIONS

Bladder Calculi

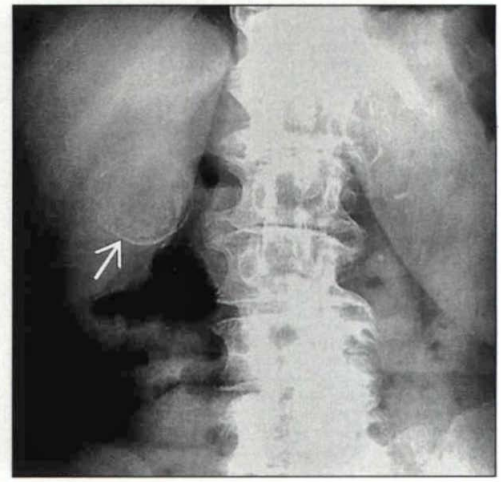


Bladder Calculi

(Left) Axial NECT shows a bladder calculus that has a classic "jackstone" spiculated appearance ➡ resembling the pointed surface of toy jacks. (Right) Frontal radiograph shows multiple bladder calculi ➡ having the smooth rounded shape, characterized as "river stones", a common appearance.

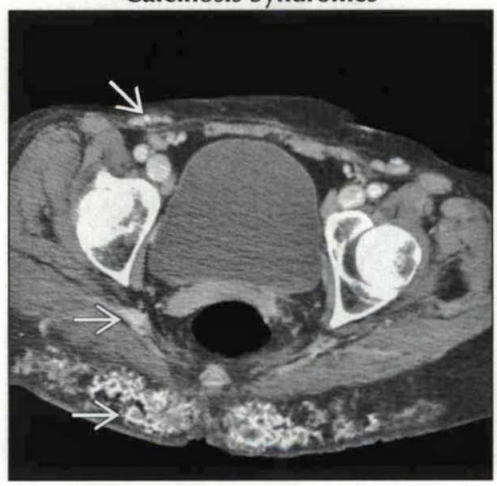
Ovarian Teratoma

Porcelain Gallbladder

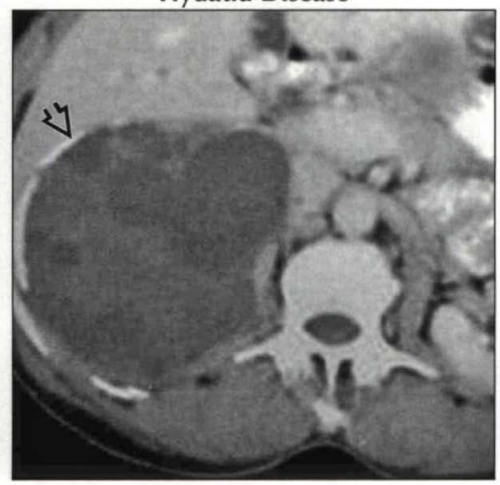


(Left) Anteroposterior radiograph shows a tooth-like calcification ➡ in the pelvis, a small part of a much larger "dermoid cyst" (mature teratoma). (Right) Anteroposterior radiograph shows classic eggshell calcification ➡ in the right upper quadrant.

Calcinosis Syndromes



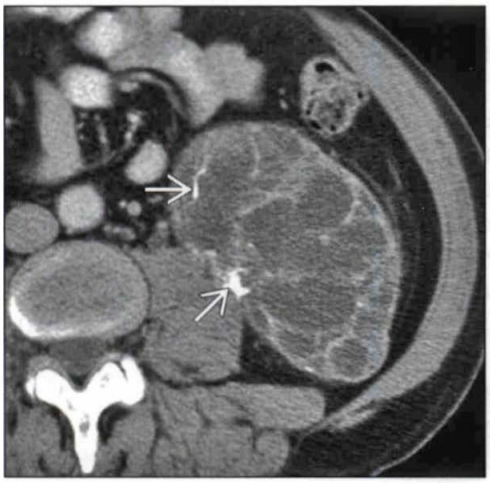
Hydatid Disease



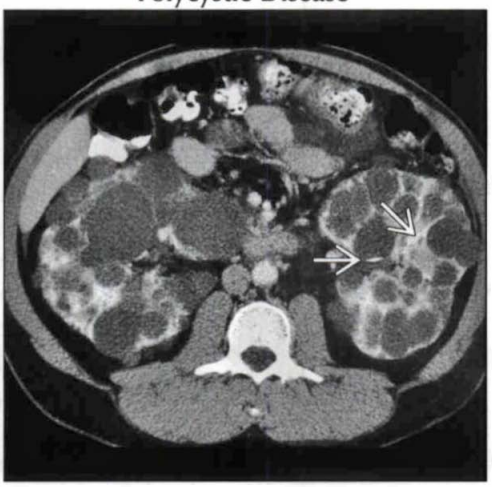
(Left) Axial CECT shows extensive calcifications ➡ in the fat & ligaments of the abdominal wall & pelvis, in a patient with dermatomyositis. (Right) Axial CECT shows peripheral rim calcification ➡ of a large hydatid cyst. Note daughter cysts (scolices) inside.

ABDOMINAL CALCIFICATIONS

Renal Cell Carcinoma

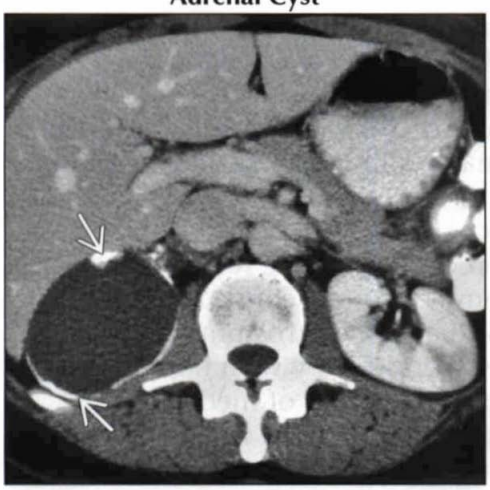


Polycystic Disease

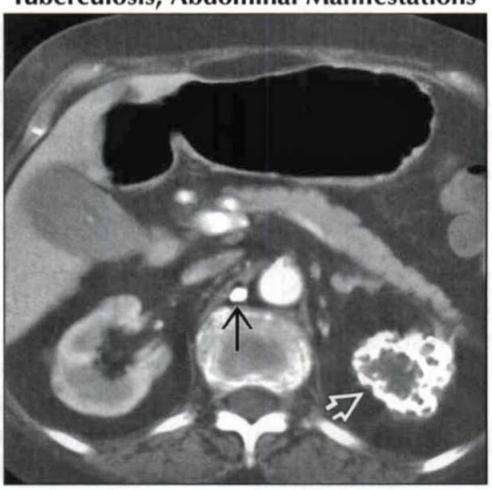


(Left) *Axial CECT shows multicystic renal mass with calcified septa & peripheral walls. The appearance is very similar to that seen with some multilocular cystic* ***nephromas.*** ***(Right)*** *Axial CECT shows massively enlarged kidneys with innumerable cysts, some of which have calcified walls due to prior hemorrhage.*

Adrenal Cyst

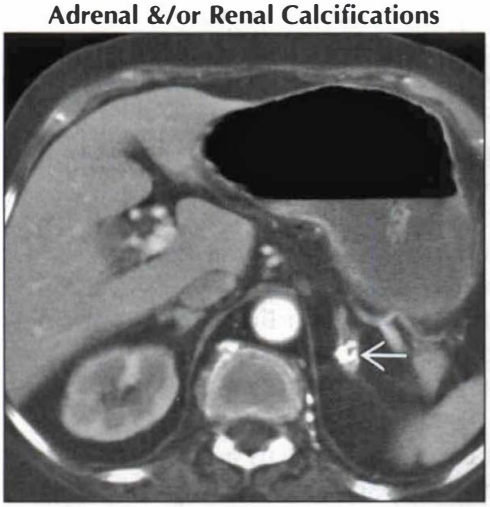


Tuberculosis, Abdominal Manifestations

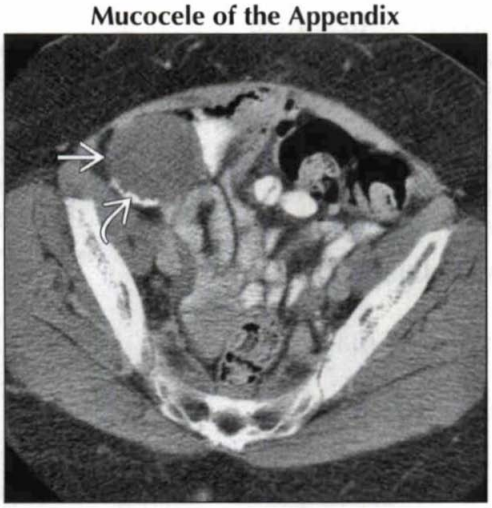


(Left) *Axial CECT shows a water density, nonenhancing, suprarenal mass with peripheral eggshell calcification (adrenal cyst).* ***(Right)*** *Axial CECT shows a calcified, nonfunctional left kidney, a classic "putty kidney" from tuberculosis. The patient also had calcified granulomas in the lungs, adrenal gland & nodes.*

Adrenal &/or Renal Calcifications



Mucocele of the Appendix



(Left) *Axial CECT shows a calcified adrenal gland in a patient with known tuberculosis & similar lesions in the kidney & lungs.* ***(Right)*** *Axial CECT shows an oval fluid density mass arising from the tip of the cecum, with calcification within its wall.*

PNEUMOPERITONEUM

DIFFERENTIAL DIAGNOSIS

Common
- Duodenal Ulcer
- Gastric Ulcer
- Diverticulitis
- Intestinal Trauma
- Iatrogenic
  - Iatrogenic Injury: Feeding Tubes
  - Post-Operative
  - Bowel Anastomotic Leak
- Thoracic Processes (Mimics)
  - Pneumothorax
  - Atelectasis, Subsegmental
  - Cystic Lung Disease
  - Barotrauma
- Colonic Interposition (Mimic)
- Subphrenic Fat (Mimic)

Less Common
- Perforated Colon
- Peritonitis
- Abdominal Abscess
- Pneumatosis of the Intestine
- From Female Genital Tract
- Small Bowel Diverticula
- Foreign Body Perforation

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Evaluate for amount & location of gas collections
- Perforated ulcers and diverticulitis usually result in relatively small amounts of free air
  - Perforation of obstructed colon or misplaced feeding tubes = massive free air
- Bubbles of gas can usually be found near site of perforation of GI tract
- Free intraperitoneal gas is difficult to detect on supine radiographs
  - Especially the "portable" films typically obtained at the patient bedside (often underexposed with respiratory blurring)

Helpful Clues for Common Diagnoses
- **Duodenal Ulcer**
  - Gas bubbles & infiltration of planes adjacent to duodenal bulb
  - Gas & fluid may be both intra- and extraperitoneal (anterior pararenal space)
- **Gastric Ulcer**
  - Often perforate into lesser sac; look for retrogastric gas, blood, extravasated oral contrast medium
  - Fluid & gas usually exit through epiploic foramen (of Winslow) into peritoneal cavity
- **Diverticulitis**
  - Omentum usually walls off perforated diverticulum
    - Usually do not get generalized peritonitis or free air
  - Typical appearance: Extraluminal gas (few bubbles) and infiltration adjacent to colon (usually sigmoid)
  - Some patients develop large pneumoperitoneum and generalized peritonitis, especially elderly and those on steroid medication
- **Intestinal Trauma**
  - Pneumoperitoneum following blunt trauma usually indicates bowel injury
  - Most common sites are duodenum & proximal jejunum
  - Caution: Preceding diagnostic peritoneal lavage may result in free intraperitoneal air & fluid
- **Iatrogenic**
  - Common causes include recent laparotomy or laparoscopy, peritoneal lavage or dialysis, gastrostomy tube placement, endoscopy with bowel perforation, injection of medication
  - Endoscopy may result in free air even without bowel perforation if bowel becomes very distended
- **Bowel Anastomotic Leak**
  - Any intraperitoneal bowel-to-bowel anastomosis may leak gas
  - Consider whether free air is from surgery itself
- Thoracic pathology may mimic or cause pneumoperitoneum
  - **Pneumothorax**
    - Gas within thorax lies outside the confines of diaphragm
    - Gas within abdomen lies within confines of diaphragm
  - **Atelectasis**
    - "Plate-like", basal subsegmental atelectasis may result in a curvilinear density that parallels the diaphragm

- Aerated lung below atelectatic segment may simulate pneumoperitoneum
- **Cystic Lung Disease**
  - Bullae and other cysts near diaphragm may simulate free air
- **Barotrauma**
  - Positive pressure ventilation
  - Pneumothorax & gas in mediastinum may dissect into abdomen
  - May result in or simulate pneumoperitoneum
  - Gas may lie in abdominal wall or extraperitoneally

- **Colonic Interposition (Mimic)**
  - Sometimes called Chilaiditi syndrome
  - Hepatic flexure of colon lies above liver, beneath right hemidiaphragm, may simulate free air
- **Subphrenic Fat (Mimic)**
  - Collections of fat in subxiphoid and perihepatic regions may be quite radiolucent & may be misinterpreted as free air on radiography

Helpful Clues for Less Common Diagnoses

- **Perforated Colon**
  - Perforation of a dilated, obstructed colon usually results in massive pneumoperitoneum
- **Peritonitis**
  - Intraperitoneal gas & fluid may result from pyogenic infection with gas-forming organisms (usually enteric)
- **Abdominal Abscess**
  - Gas-containing subphrenic abscess may simulate free abdominal gas on an upright radiograph
- **Pneumatosis of the Intestine**
  - Gas "cysts" may rupture into peritoneal cavity
- **From Female Genital Tract**
  - Air may enter peritoneal cavity via fallopian tubes following sexual intercourse, cunnilingus, douching, pelvic examination, water sports (e.g., water skiing)
- **Small Bowel Diverticula**
  - Diverticula arising from the duodenum or small intestine may perforate spontaneously or as a result of intubation
  - Perforation of small bowel diverticula may not result in peritonitis nor require surgery

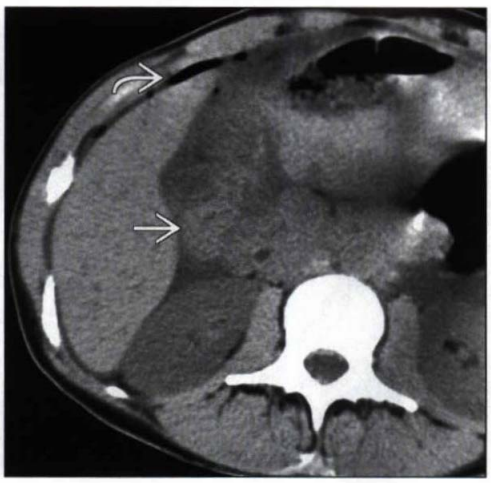
Other Essential Information

- CT is much more reliable than plain radiography, ultrasonography or MR in depicting free peritoneal gas
- Free air may persist for 3-5 days, even longer if peritoneum is scarred (becomes poor absorptive surface)

Alternative Differential Approaches

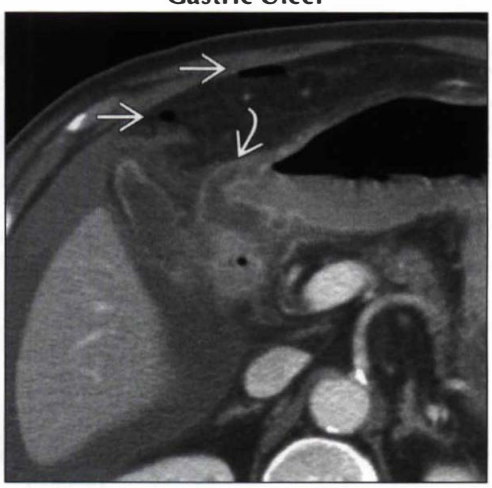
- Free intraperitoneal air in a neonate
  - Necrotizing enterocolitis
  - Cystic fibrosis, GI tract
  - Duodenal atresia or stenosis
  - Hirschsprung disease

Duodenal Ulcer



Axial NECT shows mural thickening of the 2nd part of the duodenum, with infiltration of adjacent fat planes and free intraperitoneal gas.

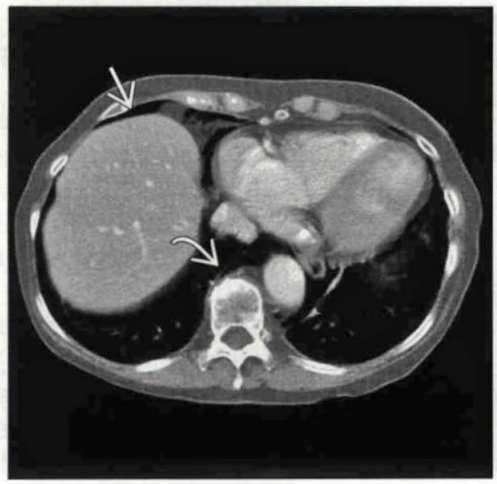
Gastric Ulcer



Axial CECT shows a small amount of free intraperitoneal gas and a thick-walled gastric antrum; perforated prepyloric ulcer.

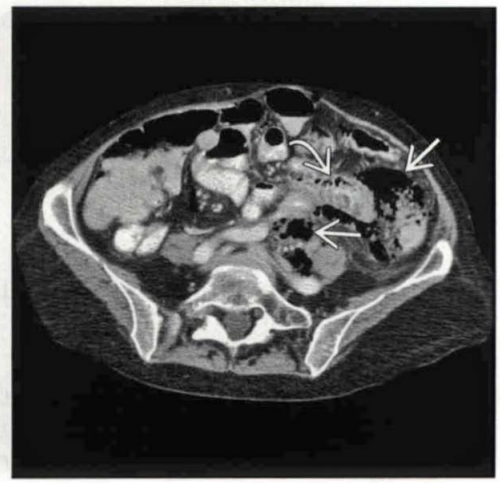
PNEUMOPERITONEUM

Diverticulitis



*(Left) Axial CECT shows free intraperitoneal gas ➡ dissecting up into the mediastinum ➡ in a patient with "perforated" diverticulitis. **(Right)** Axial CECT shows mural thickening of the sigmoid colon ➡, infiltration of the sigmoid mesocolon, and extraluminal gas ➡: "perforated" diverticulitis.*

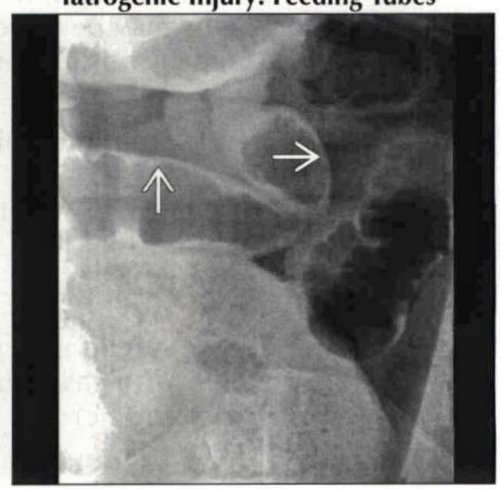
Diverticulitis



Intestinal Trauma

*(Left) Axial CECT shows extraluminal fluid & gas ➡ in the right lower quadrant, in a patient injured in a motor vehicle crash. Transected distal ileum. **(Right)** Frontal radiograph shows a segment of small bowel ➡ with gas outlining its wall both intraluminally and from outside (the Rigler sign of pneumoperitoneum). Recent placement of a percutaneous gastrostomy tube.*

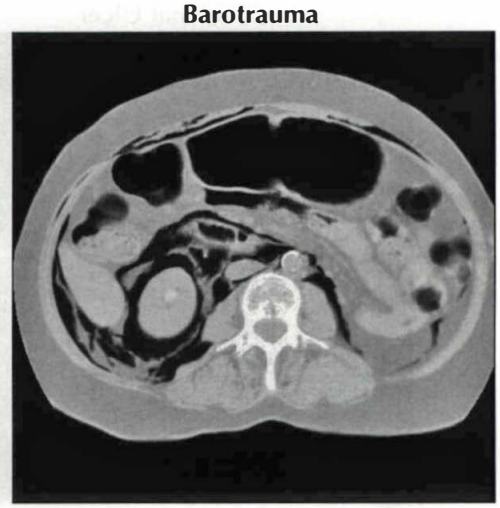
Iatrogenic Injury: Feeding Tubes



Post-Operative

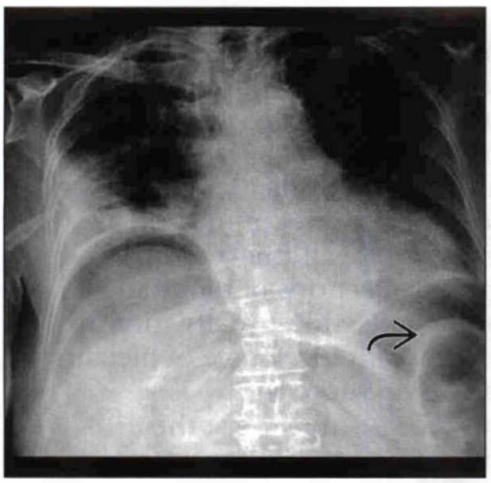
*(Left) Axial NECT shows free intraperitoneal fluid and gas ➡, following surgery for bleeding varices. Note cirrhotic liver & midline skin staples ➡. **(Right)** Axial CECT shows extensive extraluminal gas in the retroperitoneum and peritoneal cavity as a result of barotrauma; pneumothorax and positive pressure ventilation.*

Barotrauma

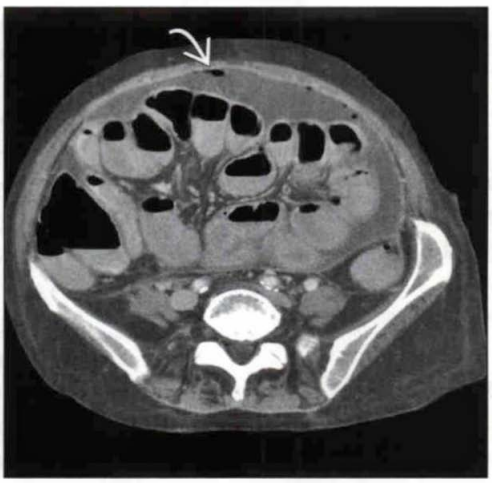


PNEUMOPERITONEUM

Perforated Colon



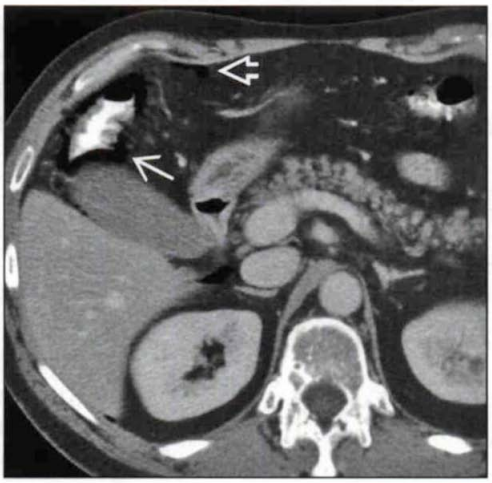
Peritonitis



(Left) *Frontal radiograph shows massive pneumoperitoneum due to colonic perforation. An obstructing colon cancer was found at surgery. Gas outlines the undersurface of the diaphragm and the surface of the liver and splenic flexure of colon.* ***(Right)*** *Axial CECT shows loculated ascites with thickened peritoneal lining and bubbles of extraluminal gas; spontaneous bacterial peritonitis in a patient with cirrhosis.*

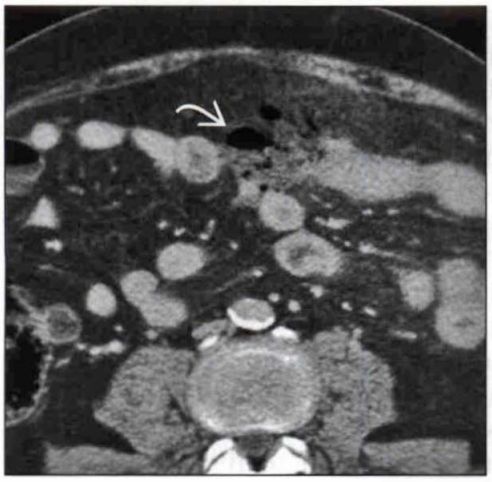
Abdominal Abscess

Pneumatosis of the Intestine



(Left) *Axial CECT shows an extensive collection of gas & fluid (abscess) in the right retroperitoneal spaces due to iatrogenic perforation of the duodenum at ERCP. Free intraperitoneal gas & a percutaneously placed drainage catheter are also noted.* ***(Right)*** *Axial CECT shows gas in the wall of the ascending colon and free intraperitoneal gas in an asymptomatic patient receiving steroids for severe psoriasis. Resolved without treatment.*

Small Bowel Diverticula



Foreign Body Perforation

(Left) *Axial CECT shows extraluminal gas and fluid adjacent to the mid small bowel. Perforated small bowel diverticula were found at surgery.* ***(Right)*** *Axial CECT shows extraluminal gas and fluid near the ileocecal valve. At surgery a swallowed toothpick was found to have led to the perforation of the terminal ileum.*

HEMOPERITONEUM

DIFFERENTIAL DIAGNOSIS

Common

- Abdominal Trauma
  - Trauma, Spleen
  - Trauma, Hepatic
  - Trauma, Intestinal
  - Trauma, Mesenteric
- Complication of Surgery
- Coagulopathic Hemorrhage
- Obstetric & Gynecological Source
  - Ruptured Ovarian Cyst
  - Ruptured Ectopic Pregnancy
  - HELLP Syndrome
- Bladder Trauma (Mimic)
- Ruptured Aneurysm

Less Common

- Neoplastic Hemorrhage
  - Hepatic Adenoma
  - Hepatocellular Carcinoma
  - Metastases and Lymphoma, Hepatic
- Ruptured Spleen
  - Mononucleosis
  - Lymphoma, Retroperitoneal & Mesenteric

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Start with history (or evidence of) trauma, recent surgery, anticoagulation, pregnancy status
- Look for evidence of abnormal viscus
  - Organomegaly or mass
- Look for aneurysm
  - Aortic aneurysm usually obvious
  - Visceral aneurysm: Look for tram track or eggshell calcification (splenic, hepatic, mesenteric arteries)
- Hemoperitoneum
  - Attenuation of blood usually 35-45 HU
    - "Sentinel clot": > 60 HU; heterogeneous
- Density of blood may decreased be due to pre-existing anemia, or dilution by urine, bile, bowel contents

Helpful Clues for Common Diagnoses

- **Abdominal Trauma**
  - Look for irregular laceration/hematoma within organ
    - Spleen and liver are most common injuries resulting in hemoperitoneum
    - Intestinal and mesenteric trauma result from direct blows or crush injuries
  - May see active extravasation of contrast-opacified blood
    - Isodense with opacified vessels
  - Look for "sentinel clot" sign (heterogeneous higher density clot near source of bleeding)
  - Duodenum and proximal jejunum most common sites of bowel injury
    - Look for bowel wall thickening
    - Triangular collections of blood in mesenteric reflection usually indicate bowel or mesenteric source of bleeding
- **Complication of Surgery**
  - Ask about recent surgery or other intervention (biopsy, endoscopy, angiography)
- **Coagulopathic Hemorrhage**
  - Most common sites of spontaneous bleeding are iliopsoas compartment and rectus sheath
  - Bleeding may originate from or enter peritoneal cavity
  - Look for multiple sites of bleeding, hematocrit sign (cell-fluid level), active extravasation
- **Obstetric or Gynecologic Source**
  - **Ruptured Ovarian Cyst**
    - Look for spherical mass in adnexa
    - Sentinel clot in pelvis
  - **Ruptured Ectopic Pregnancy**
    - Check β-hCG level (urine pregnancy test may be falsely negative)
  - **HELLP Syndrome**
    - Complication of toxemia
    - Disseminated intravascular coagulation, hemolysis, elevated liver enzymes, hepatic infarction &/or hemorrhage
- **Bladder Trauma (Mimic)**
  - Intraperitoneal rupture of urinary bladder results in intraperitoneal fluid
    - Attenuation varies from water density (unopacified urine), to "soft tissue density" (blood & opacified urine), to very dense (opacified urine)
  - Installation of positive contrast material into bladder (cystography) still the most definitive test
  - Can be combined with standard abdominal trauma CT scan

- Instill diluted (to about 5%) contrast material into bladder prior to CT

- **Ruptured Aneurysm**
  - Aortic or visceral artery
    - Bleeding from ruptured AAA is contiguous with aneurysm, which is often large, eccentric, & may have disrupted intimal calcification
    - Bleeding usually starts in retroperitoneum, but may extend into peritoneal cavity
    - Any visceral arterial aneurysm may rupture, especially in pregnancy

Helpful Clues for Less Common Diagnoses

- **Ruptured Spleen**
  - At risk if enlarged by infection or tumor
  - Mononucleosis is most common specific cause in western societies
    - Often injured in minor trauma, such as sports activities; may result in massive bleeding
  - Also consider splenic lymphoma & leukemia

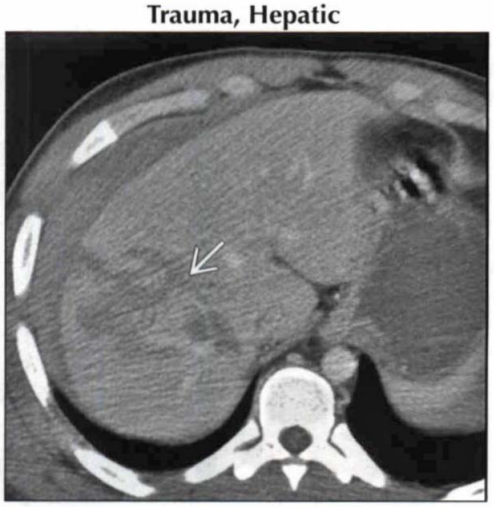
Alternative Differential Approaches

- Causes of spontaneous abdominal hemorrhage
  - Anticoagulation or bleeding diathesis
  - Ruptured abdominal aortic (or visceral) aneurysm
  - Ruptured viscus (usually enlarged, such as splenomegaly)
  - Ruptured visceral neoplasm (usually renal or hepatic)
  - OB-gynecologic
    - Pregnant patient (ruptured ectopic, HELLP syndrome)
    - Ruptured ovarian cyst
- Other causes of high attenuation ascites
  - Vicarious excretion
    - Ascites opacified by prior intravascular administration of contrast material
    - Common on CT scans performed more than 10 minutes after contrast administration
  - Ruptured urinary bladder
  - Perforation of gastrointestinal tract
    - Ascites due to extraluminal bowel contents & blood
  - Peritonitis
    - Especially with frank pus in peritoneal cavity
    - Usually loculated with contrast enhanced capsule
  - Malignant ascites
    - Pseudomyxoma peritonei is especially dense, heterogeneous, and loculated
    - Attenuation about 10-25 HU
    - Often with low level echogenicity and more evident septa on ultrasonography

Trauma, Spleen

Axial CECT shows splenic parenchymal laceration ⇨ with sentinel clot around the spleen and lower density blood around the liver (& lower in the abdomen, not shown).

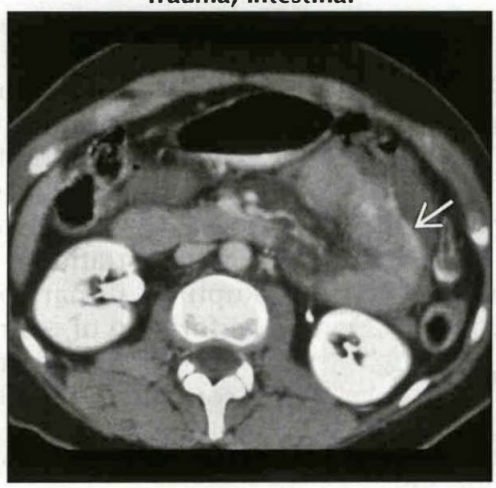
Trauma, Hepatic



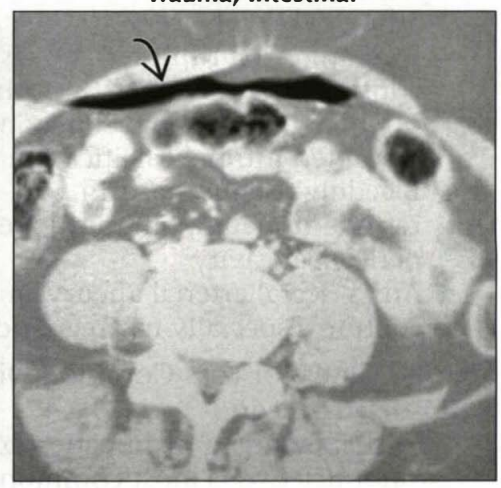
Axial CECT shows a deep hepatic laceration ➡ with blood surrounding the liver. Note the higher attenuation of the blood, compared with fluid in the stomach.

HEMOPERITONEUM

Trauma, Intestinal

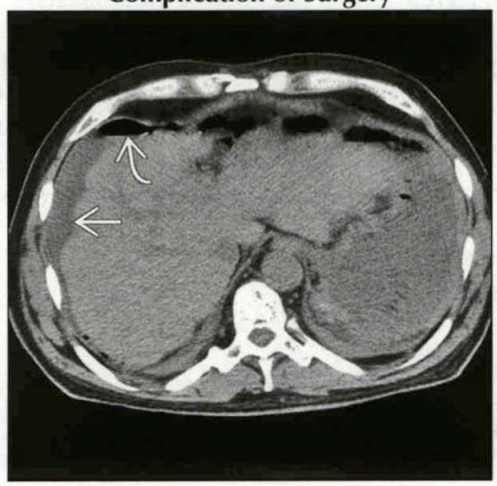


Trauma, Intestinal

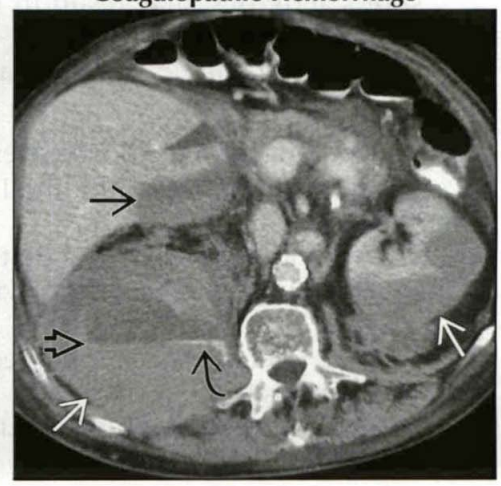


(Left) *Axial CECT shows thick-walled jejunum with focus of active bleeding and adjacent hemoperitoneum.* ***(Right)*** *Axial CECT shows free intraperitoneal gas in a patient with jejunal laceration who also had active bleeding & hemoperitoneum.*

Complication of Surgery

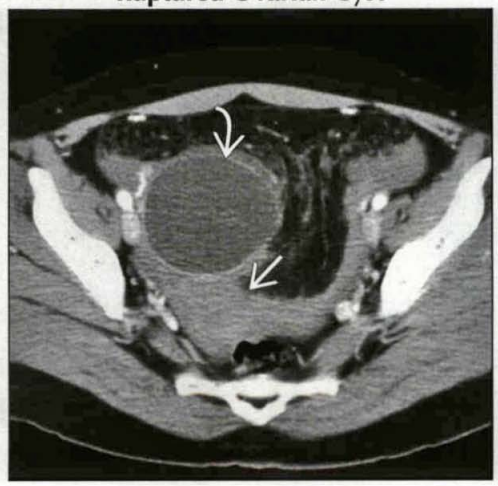


Coagulopathic Hemorrhage

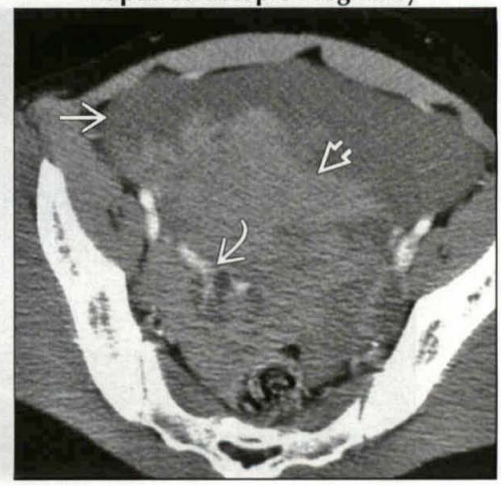


(Left) *Axial NECT shows a small amount of intraperitoneal fluid (blood) and gas following recent laparotomy. These are common and nonspecific findings in this setting.* ***(Right)*** *Axial CECT shows hemorrhage within multiple retroperitoneal and intraperitoneal spaces. Hematocrit sign and active bleeding = anticoagulation.*

Ruptured Ovarian Cyst



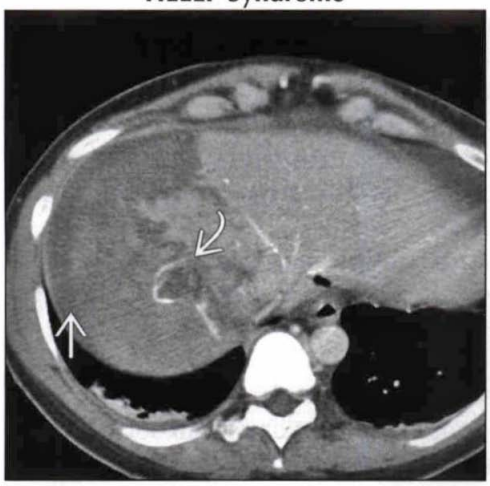
Ruptured Ectopic Pregnancy



(Left) *Axial CECT shows an adnexal cyst with adjacent sentinel clot; ruptured ovarian cyst.* ***(Right)*** *Axial CECT shows active bleeding from a source in the pelvis. Note the "sentinel clot" and generalized hemoperitoneum; ruptured ectopic pregnancy.*

HEMOPERITONEUM

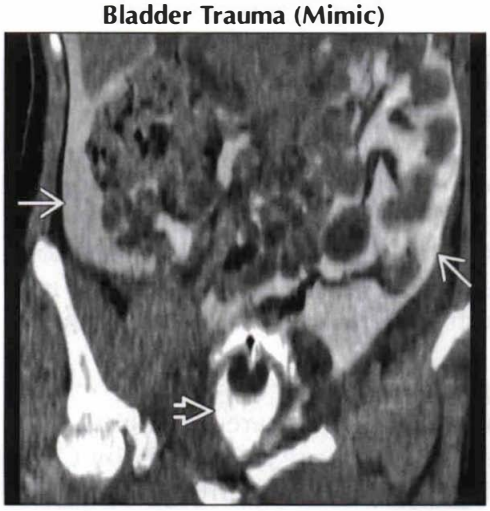
HELLP Syndrome



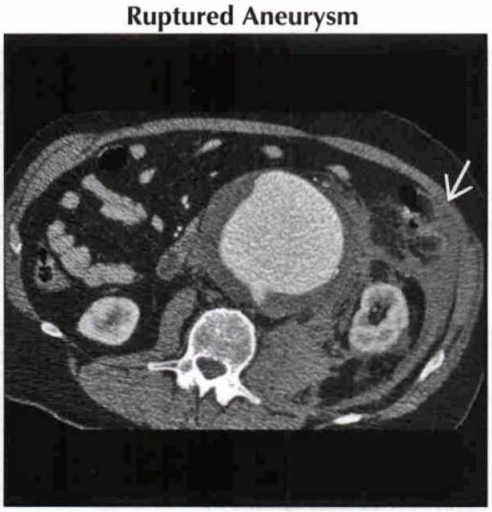
Bladder Trauma (Mimic)

(Left) *Axial CECT shows infarction of the right lobe of liver, with active bleeding and hemoperitoneum.* ***(Right)*** *Axial CECT shows dense contrast material in the peritoneal recesses due to intraperitoneal rupture of the bladder. CT cystogram.*

Bladder Trauma (Mimic)

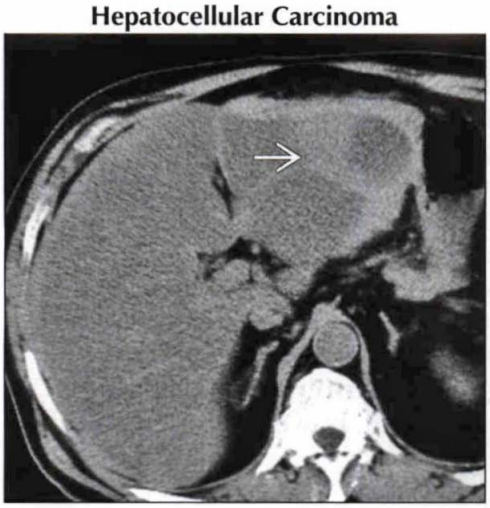


Ruptured Aneurysm

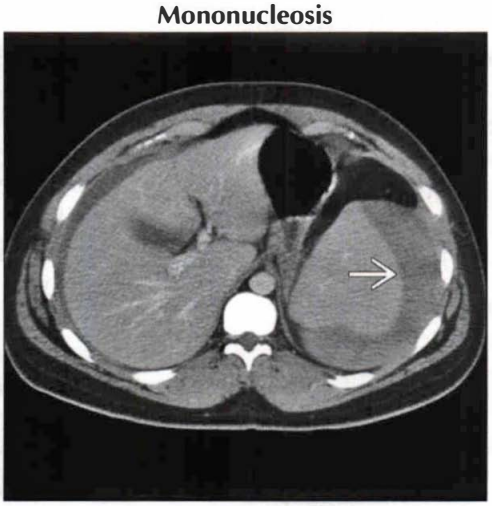


(Left) *Coronal CECT shows dense contrast medium in the peritoneal recesses following CT cystography with installation of contrast into the bladder. Intraperitoneal rupture.* ***(Right)*** *Axial CECT shows large AAA with rupture into the retroperitoneum. Some blood enters the left paracolic gutter (intraperitoneal).*

Hepatocellular Carcinoma



Mononucleosis



(Left) *Axial NECT shows hemorrhage around the left lobe of liver and an underlying mass (HCC). CECT showed heterogeneous enhancement of the HCC.* ***(Right)*** *Axial CECT shows an enlarged spleen with adjacent sentinel clot and lower density blood around the liver. Spontaneous rupture of spleen due to mononucleosis.*

MISTY (INFILTRATED) MESENTERY

DIFFERENTIAL DIAGNOSIS

Common

- Portal Hypertension, Varices
- Acute Pancreatitis
- Heart Failure
- Renal Failure
- Peritonitis
- Lymphoma
- Sclerosing Mesenteritis
- Diverticulitis
- Crohn Disease
- Ischemic Enteritis
- Post-Surgical Mesenteric Infiltration
- Carcinoid Tumor

Less Common

- Mesenteric Trauma
- Vasculitis, Small Intestine
- Radiation Enteritis
- Peritoneal Metastases
- Portal Vein Thrombosis
- Thrombosis of Superior Mesenteric Vein
- Small Bowel Transplantation
- Mesothelioma
- Lymphangiectasia, Intestinal
- Coagulopathic Hemorrhage
- Leukemic Infiltration, Peritoneum

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Consider etiological categories for misty mesentery
  - Edema: Portal hypertension, heart failure, renal failure, hypoalbuminemia, congenital, post-surgical, radiation therapy
  - Inflammation: Pancreatitis, diverticulitis, Crohn disease, sclerosing mesenteritis, peritonitis, vasculitis
  - Hemorrhage: Bowel & mesenteric trauma, anticoagulation, ischemic enteritis
  - Neoplastic: Lymphoma, leukemia, peritoneal metastases, mesothelioma, direct extension from GI tract

Helpful Clues for Common Diagnoses

- **Portal Hypertension, Varices**
  - Cirrhosis often results in portal hypertension and hypoproteinemia, both of which result in edema of the mesentery
  - If portal or superior mesenteric vein becomes thrombosed, mesenteric edema is increased
- **Acute Pancreatitis**
  - Fluid & inflammation spread from inflamed pancreas laterally (throughout anterior pararenal space) & ventrally-inferiorly through leaves of small bowel mesentery & transverse mesocolon
- **Heart Failure**
  - CHF or constrictive pericarditis
  - May lead to generalized edema, including mesentery
- **Renal Failure**
  - Organ failure resulting in generalized edema (anasarca) may cause mesenteric edema as well
- **Peritonitis**
  - Inflammation of the peritoneal lining may result in edema of the mesenteric fat planes as well
  - Infectious (pyogenic, TB) or chemical (bile, peritoneal dialysis)
- **Lymphoma**
  - Early mesenteric or peritoneal lymphoma, or lymphomatous mesenteric lymphadenopathy that has responded to chemo or radiation therapy may result in permanent infiltration of mesenteric fat planes
- **Sclerosing Mesenteritis**
  - Sometimes regarded as rare, but being recognized much more frequently by CT
  - Infiltration of jejunal mesentery with thin capsule and cluster of mesenteric nodes
- **Diverticulitis**
  - Infiltration of adjacent mesocolon (e.g., sigmoid) is most common clue for this diagnosis
- **Crohn Disease**
  - Often causes infiltration and even proliferation of mesenteric fat adjacent to site of inflamed bowel
- **Ischemic Enteritis**
  - Bowel ischemia, especially that due to venous thrombosis, often results in pronounced mesenteric infiltration
- **Post-Surgical Mesenteric Infiltration**
  - Usually following bowel or pancreatic surgery
- **Carcinoid Tumor**

- Infiltration of RLQ mesentery with desmoplastic reaction and small bowel wall thickening
- Often see mesenteric mass (metastasis) with central calcification

Helpful Clues for Less Common Diagnoses

- **Mesenteric Trauma**
  - Infiltrated mesentery ± focal blood collections between mesenteric leaves (usually angular collections)
  - Look for injury to adjacent bowel
- **Vasculitis, Small Intestine**
  - Henoch-Schönlein, lupus, etc.
  - Marked mural thickening of adjacent small bowel segments
- **Radiation Enteritis**
  - Often accompanies radiation injury to bowel
  - Most often in low abdomen and pelvis, following radiation for primary pelvic malignancy
- **Peritoneal Metastases & Mesothelioma**
  - Nodular thickening is almost always of malignant etiology
  - Ovarian and GI tract are most common etiologies
  - Primary mesothelioma can have identical appearance
  - Carcinoma of pancreas, stomach, or bowel can invade mesentery directly
- **Portal & Mesenteric Venous Thrombosis**
  - Leads to leaking of fluid from lymphatics
  - Bowel wall often thickened, may become ischemic
- **Small Bowel Transplantation**
  - Mesenteric edema is often striking
  - Due to transection of lymphatics ± rejection of bowel & its mesentery
- **Lymphangiectasia, Intestinal**
  - Look for associated mural thickening of small intestine
- **Coagulopathic Hemorrhage**
  - Mesentery & peritoneal cavity are rare sites of isolated hemorrhage
  - Hemorrhage originating in retroperitoneum or abdominal wall muscles may extend into peritoneal cavity & mesentery
- **Leukemic Infiltration, Peritoneum**
  - May cause diffuse infiltration of peritoneal cavity
  - Thickens peritoneum, including "leaves" of mesentery

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3. Mindelzun RE et al: The misty mesentery on CT: differential diagnosis. AJR Am J Roentgenol. 167(1):61-5, 1996
4. Lynch MA et al: CT of peritoneal lymphomatosis. AJR Am J Roentgenol. 151(4):713-5, 1988

Portal Hypertension, Varices

Axial CECT shows a cirrhotic liver with signs of portal hypertension including ascites, splenomegaly & varices ➡.

Portal Hypertension, Varices

Axial CECT shows mesenteric edema ➡, *causing the mesenteric vessels & fat to stand out in contrast. Periumbilical varices* ➡ *and ascites are also noted.*

MISTY (INFILTRATED) MESENTERY

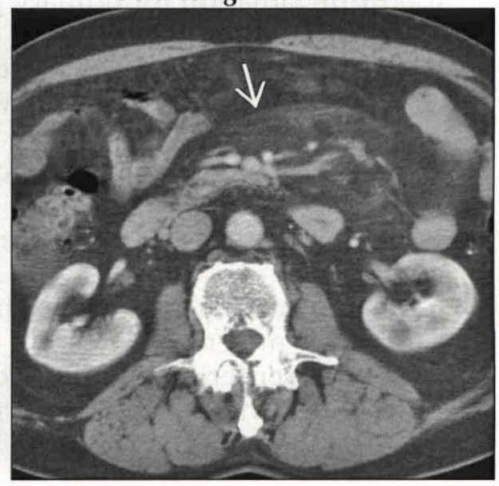
Acute Pancreatitis

Acute Pancreatitis

(Left) *Axial CECT shows infiltration of the peripancreatic fat planes* ➡ *including the anterior pararenal space & mesentery.* ***(Right)*** *Coronal CECT shows a swollen pancreas* ➡ *with infiltration of the peripancreatic fat planes including the mesentery & the anterior pararenal space, causing wall thickening of the 2nd duodenum* ➡.

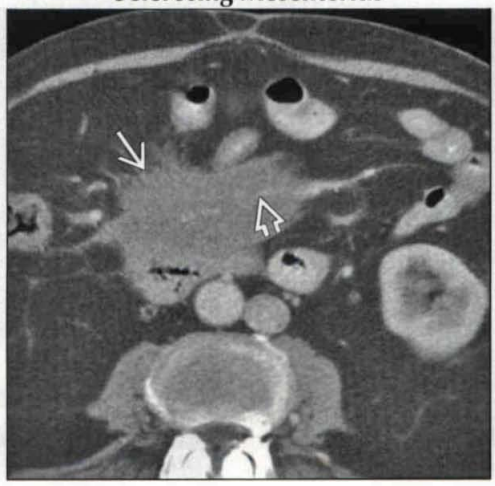
Peritonitis

Sclerosing Mesenteritis



(Left) *Axial CECT shows diffuse infiltration of the mesentery & loculated fluid collections in a patient with bile peritonitis.* ***(Right)*** *Axial CECT shows typical findings of mesenteritis with infiltration of the jejunal mesentery, a thin capsule* ➡, *& enlarged nodes (better on other sections). Treated lymphoma could have a similar appearance.*

Sclerosing Mesenteritis

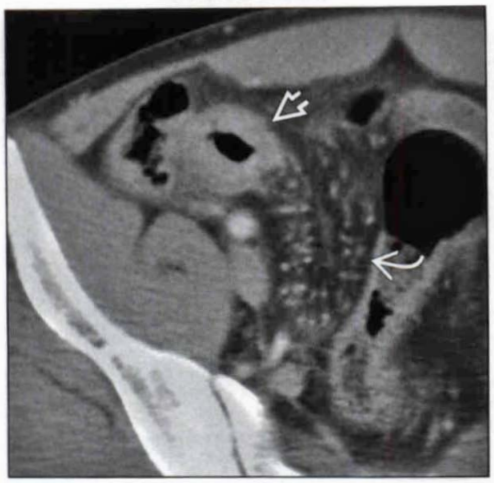


Diverticulitis

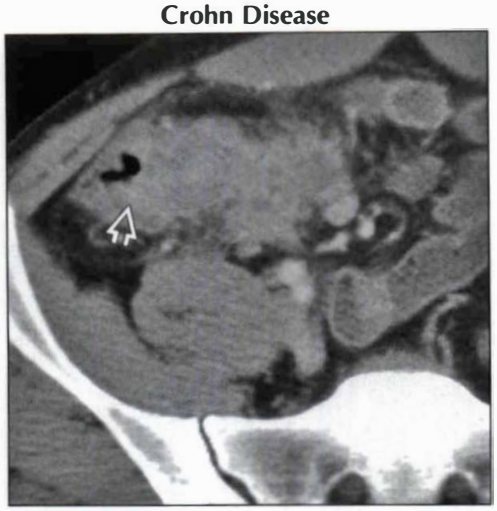
(Left) *Axial CECT shows extensive infiltration of the jejunal mesentery* ➡ *with encasement of the mesenteric vessels* ➡ *that results in bowel wall edema. This is an advanced case of mesenteritis; treated lymphoma could have an identical appearance.* ***(Right)*** *Axial CECT shows a thick-walled sigmoid colon* ➡ *with infiltration of surrounding mesenteric fat. Subtle extraluminal gas* ➡.

MISTY (INFILTRATED) MESENTERY

Crohn Disease

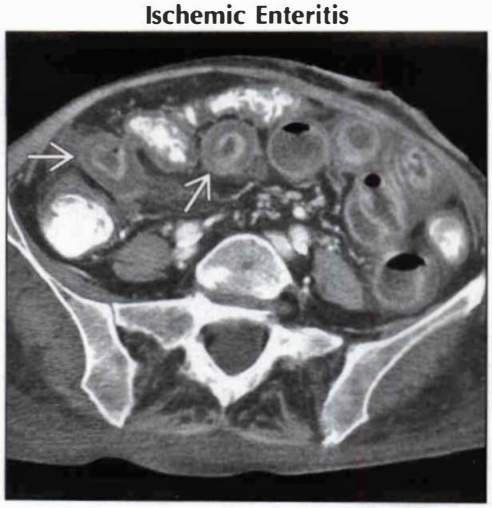


Crohn Disease



*(**Left**) Axial CECT shows a thick-walled terminal ileum with mesenteric hyperemia indicating active disease. (**Right**) Axial CECT shows a thick-walled terminal ileum with infiltration & thickening of its mesentery.*

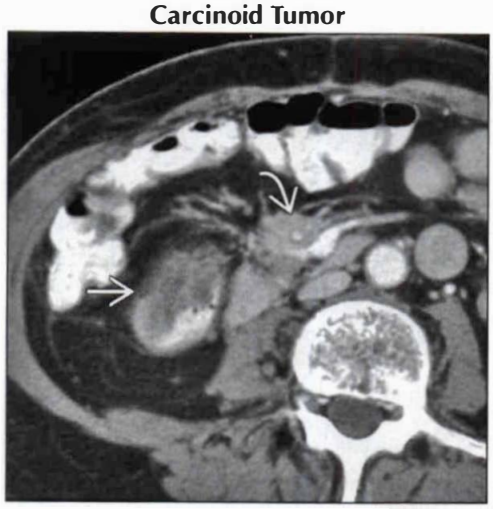
Ischemic Enteritis



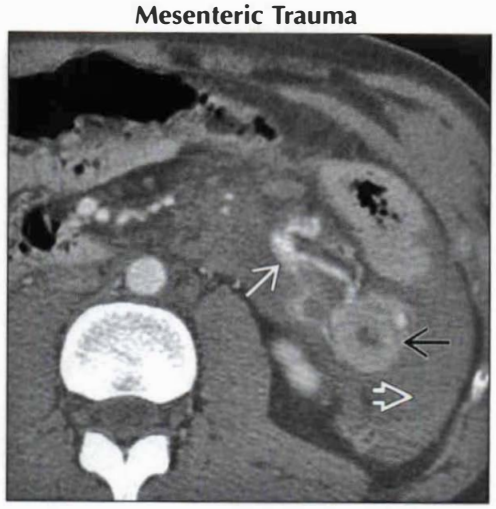
Carcinoid Tumor

*(**Left**) Axial CECT shows mesenteric edema and marked mural thickening of the small bowel segments. Bowel ischemia in an elderly patient following a hypotensive episode. (**Right**) Coronal CECT shows an unusually large mass that encases the superior mesenteric vessels. SMV branch occlusion or narrowing causes small bowel wall edema.*

Carcinoid Tumor



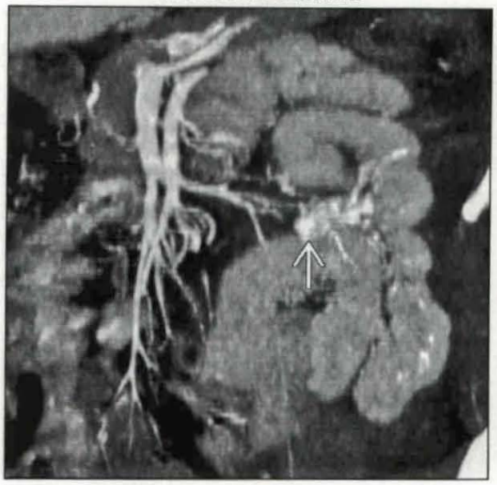
Mesenteric Trauma



*(**Left**) Axial CECT shows a mesenteric mass with infiltration and a desmoplastic (scarring) effect of the mesentery. Primary carcinoid tumor in the distal ileum. (**Right**) Axial CECT shows infiltration of the mesentery, hemoperitoneum, bowel wall thickening, and active mesenteric bleeding.*

MISTY (INFILTRATED) MESENTERY

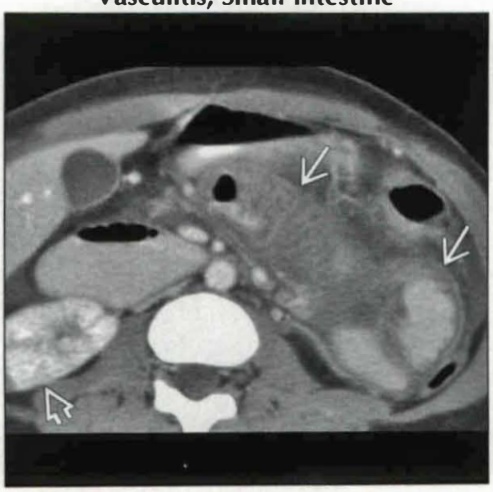
Mesenteric Trauma



(Left) *Coronal CECT shows active bleeding from the jejunal branch arteries, along with mesenteric edema and hemoperitoneum.* ***(Right)*** *Axial NECT shows marked mural thickening of a long segment of jejunum and mesenteric edema. Henoch-Schönlein purpura.*

Vasculitis, Small Intestine

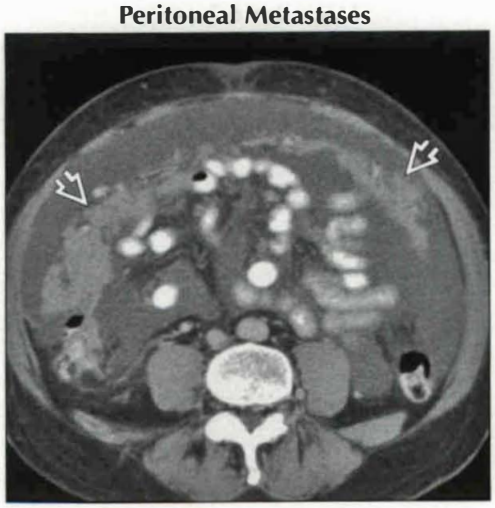
Vasculitis, Small Intestine



(Left) *Axial CECT shows mural thickening of the jejunum & infiltration of the mesentery; also striated nephrogram. Renal biopsy: Polyarteritis nodosa.* ***(Right)*** *Axial CECT shows extensive mesenteric edema, bowel wall edema and ascites due to radiation enteritis following external beam radiation for cervical carcinoma.*

Radiation Enteritis

Peritoneal Metastases

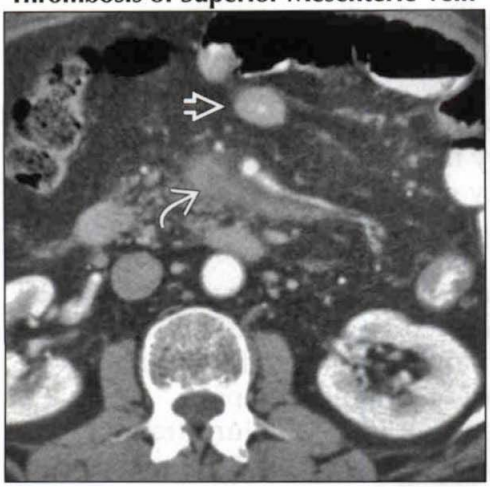


(Left) *Axial CECT shows ascites, omental metastases and mesenteric edema due to metastatic melanoma.* ***(Right)*** *Axial CECT shows thrombosis of the superior mesenteric vein with mesenteric edema. Factor V Leiden deficiency.*

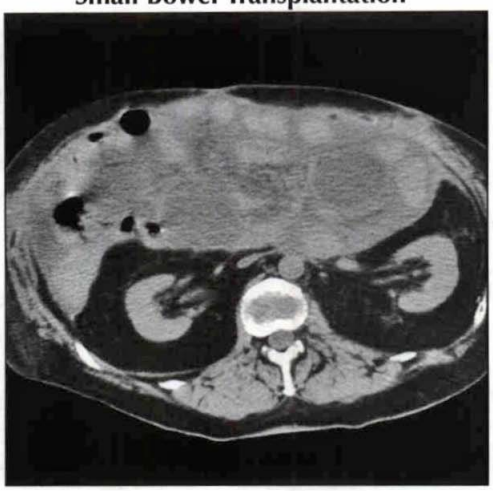
Thrombosis of Superior Mesenteric Vein

MISTY (INFILTRATED) MESENTERY

Thrombosis of Superior Mesenteric Vein

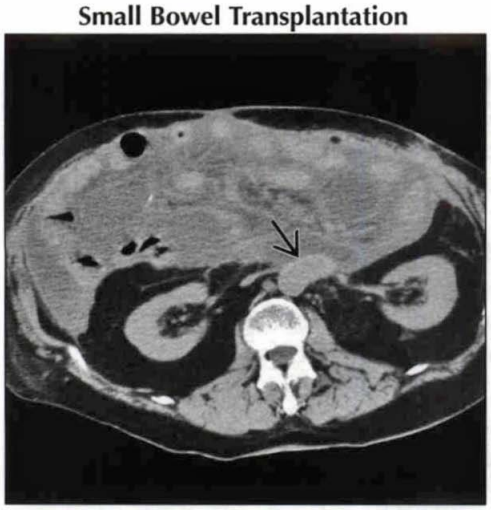


Small Bowel Transplantation



*(**Left**) Axial CECT shows a thrombosed mesenteric vein tributary with mesenteric & bowel wall edema (ischemia). Patient with factor V Leiden deficiency. (**Right**) Axial NECT shows extensive infiltration of the mesentery of the small bowel allograft, a nonspecific finding, not necessarily indicative of rejection or ischemia.*

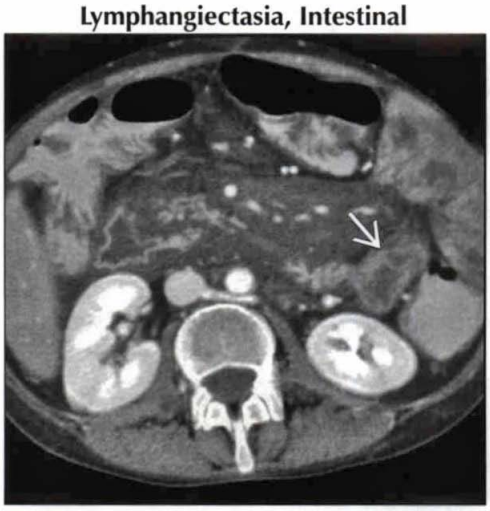
Small Bowel Transplantation



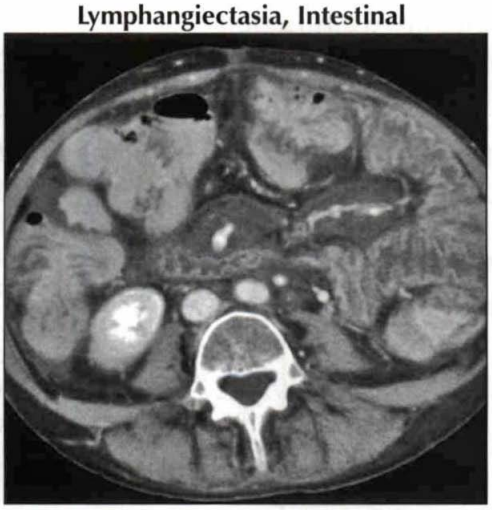
Mesothelioma

*(**Left**) Axial NECT shows extensive infiltration of the mesentery of the small bowel allograft. Note the aorto-aortic graft to the allograft. (**Right**) Axial CECT shows ascites and a "pleated" appearance of the mesentery, caused by a peritoneal tumor. Peritoneal carcinomatosis could have an identical appearance.*

Lymphangiectasia, Intestinal



Lymphangiectasia, Intestinal



*(**Left**) Axial CECT shows extensive infiltration of the mesentery and small bowel submucosa in a young woman with congenital lymphangiectasia of the small bowel. (**Right**) Axial CECT shows extensive infiltration of the SB submucosa and mesentery; congenital lymphangiectasia.*

HIGH ATTENUATION (HYPERDENSE) ASCITES

DIFFERENTIAL DIAGNOSIS

Common

- Hemoperitoneum
  - Traumatic
    - Trauma, Spleen
    - Trauma, Hepatic
    - Trauma, Intestinal
    - Trauma, Mesenteric
  - Gynecologic or Obstetric Sources
    - Ectopic Pregnancy, Rupture
    - Ovarian Cyst, Ruptured
    - Endometriosis
  - Coagulopathy
    - Coagulopathic ("Retroperitoneal") Hemorrhage
    - HELLP Syndrome
  - Tumor-Associated
    - Hepatic Adenoma
    - Hepatocellular Carcinoma
    - Vascular Metastases
  - Ruptured Visceral Artery Aneurysm
- Vicarious Excretion
- Bladder Trauma
- Perforation of GI Tract
  - Duodenal Ulcer
  - Gastric Ulcer

Less Common

- Peritonitis
- Pseudomyxoma Peritonei

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Ascites = intraperitoneal fluid
  - Transudative (simple) ascites usual type
  - Most common etiologies are dysfunction of the liver, heart, or kidneys
  - Usual attenuation of simple ascites is 0-30 HU
  - Usual location of ascites is in subphrenic spaces, Morison pouch, paracolic gutters, pouch of Douglas
  - Check for attenuation & loculation of fluid

Helpful Clues for Common Diagnoses

- **Traumatic Hemoperitoneum**
  - Most common cause of higher density (attenuation) ascites
  - Starts near the site of injury
  - Flows along expected anatomic pathways, paracolic gutters to pouch of Douglas (most dependent peritoneal recess)
  - Sentinel clot
    - Higher density (40-70 HU), more heterogeneous, located near bleeding site
  - Free-flowing, lysed blood
    - Usually measures 30-45 HU
    - Density may be lower in anemia, or dilution from bile, urine, bowel contents
  - Active arterial bleeding
    - Isodense to nearby arteries; hyperdense to enhanced viscera on CECT
    - Important clue to need for intervention (surgery or embolotherapy)
  - Most common visceral, blunt traumatic injuries causing hemoperitoneum = spleen > liver > bowel &/or mesenteric
  - Trauma can be blunt, penetrating or iatrogenic (e.g., percutaneous liver biopsy, laparoscopy, post-operative)
- **Nontraumatic Causes of Hemoperitoneum**
  - **Gynecologic or Obstetric Sources**
    - Rupture of an ovarian cyst or ectopic pregnancy > endometriosis
    - Check for pregnancy test in woman of reproductive age
  - **Coagulopathy**
    - **Coagulopathic ("Retroperitoneal") Hemorrhage**
    - Often in, e.g., patients on heparin or Coumadin; hemophiliacs
    - Spontaneous bleeding usually starts in iliopsoas compartment or rectus sheath
    - Can occur anywhere & may extend into peritoneal cavity
    - Rarely limited to peritoneal cavity alone
    - Look for hematocrit sign (fluid-cellular level) and multiple sites of bleeding out of proportion to any history of trauma
    - HELLP Syndrome: Peripartum complication of toxemia, possibly including hemolysis, low platelets, hepatic infarction & hemorrhage
  - **Tumor-Associated**
    - May complicate highly vascular visceral tumors
    - Usually hepatic adenoma > HCC > vascular metastases (renal, neuroendocrine, melanoma, choriocarcinoma)

- Vicarious Excretion
  - Occurs in over 50% of patients with ascites
    - Significant enhancement of ascites fluid on scans performed more than 10 minutes after intravascular administration of contrast material
    - Occurs regardless of etiology of the ascites (benign or malignant)
    - Smaller amounts of ascites = more enhancement
    - May occur more frequently & to greater extent in patients with renal impairment (& less renal excretion of contrast)
- **Bladder Trauma**
  - Intraperitoneal rupture of the bladder
  - Can result in ascites of any density
    - Water density: On scans performed soon after rupture of bladder with only unopacified urine in abdomen
    - Higher than water density: Urine mixed with blood &/or contrast-opacified urine
    - Very dense: Scans performed after direct installation of contrast medium into bladder (CT cystography)
  - Less common: Urine leak from an ileal conduit or other post-operative bladder diversion or replacement
- **Perforation of GI Tract**
  - Can result in ascites of any density
    - Water density: Fluid enteric contents extravasated into abdomen
    - Higher than water density: Enteric contents plus blood
    - Very dense: Oral (enteric) contrast medium extravasation
  - Location may indicate perforation source
    - **Duodenal Ulcer**: Intra- and retroperitoneal gas & fluid, usually near duodenal bulb
    - **Gastric Ulcer**: Gas & fluid in lesser sac & greater peritoneal cavity

Helpful Clues for Less Common Diagnoses

- **Peritonitis**
  - Exudative ascites may be higher than water density
  - Frank pus (abscess): Loculated fluid with a contrast-enhancing rim, mass effect, ± gas
- **Pseudomyxoma Peritonei**
  - Progressive accumulation of mucinous ascites
  - Usually due to rupture of appendiceal carcinoma or adenoma
  - Similar imaging & pathologic findings reported in some cases of ovarian & other intraperitoneal malignancies
  - Look for mass effect on surface of liver & spleen ("scalloping"), displacement, and encasement of bowel

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2. Pickhardt PJ et al: Unusual nonneoplastic peritoneal and subperitoneal conditions: CT findings. Radiographics. 25(3):719-30, 2005
3. Gayer G et al: Dense ascites: CT manifestations and clinical implications. Emerg Radiol. 10(5):262-7, 2004

Trauma, Spleen

Axial NECT shows heterogeneous high density blood around the spleen (sentinel clot) & lower density blood around the liver. Spleen injured during laparoscopic hernia repair.

Trauma, Hepatic

Axial CECT shows hepatic lacerations ■ and blood in Morison pouch.

HIGH ATTENUATION (HYPERDENSE) ASCITES

(Left) Axial CECT shows linear hepatic laceration & blood around the liver in a patient who also has small bowel injury. (Right) Axial CECT shows higher density blood near the jejunum. The wall of the jejunum is "C-shaped" instead of a circle, due to partial transection.

Trauma, Intestinal

Trauma, Intestinal

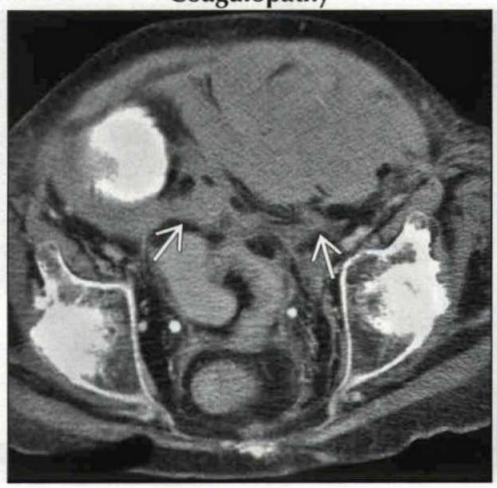
(Left) Axial CECT shows hemoperitoneum, with a sentinel clot surrounding a focus of active extravasation in the pelvis; ruptured ectopic pregnancy. (Right) Axial CECT shows a high density focus within the dependent position of a left adnexal cyst. Hemoperitoneum is also noted, with a sentinel clot around the ruptured cyst.

Ectopic Pregnancy, Rupture

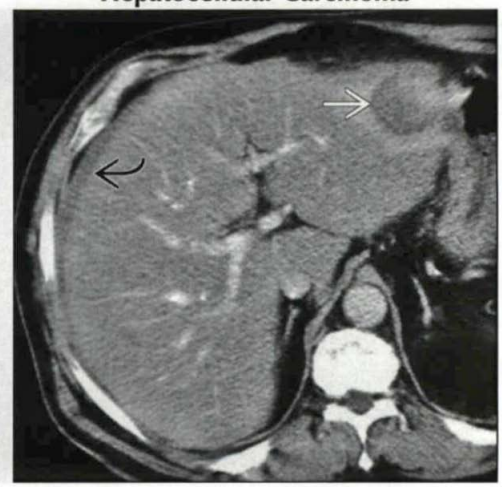
Ovarian Cyst, Ruptured

(Left) Axial NECT shows a massive rectus sheath hematoma with some extension into retroperitoneal & intraperitoneal spaces. (Right) Axial CECT shows a mass in the lateral segment, with adjacent & remote hemoperitoneum.

Coagulopathy

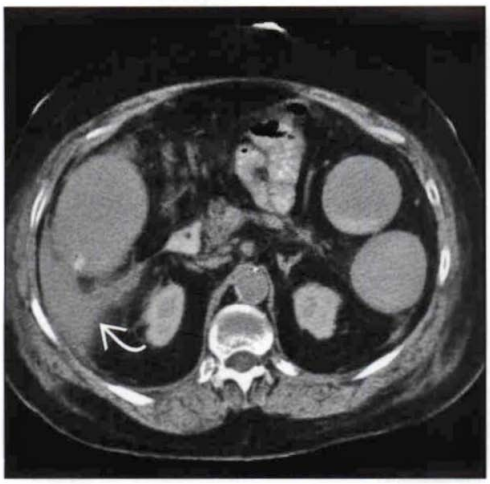


Hepatocellular Carcinoma

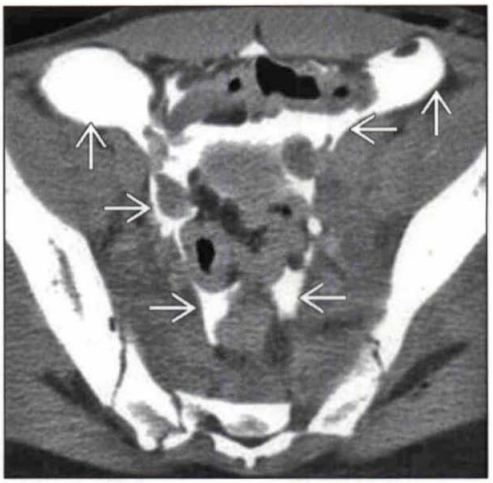


HIGH ATTENUATION (HYPERDENSE) ASCITES

Vicarious Excretion

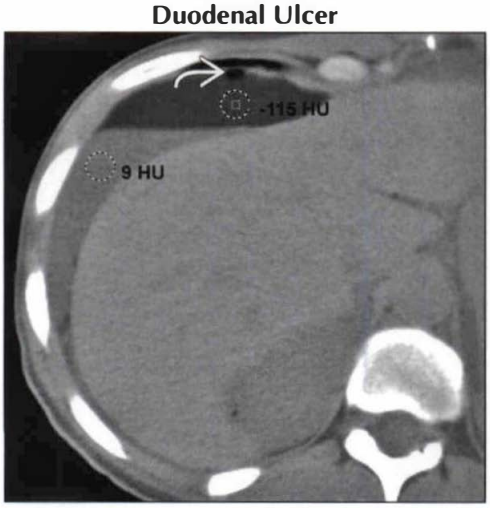


Bladder Trauma

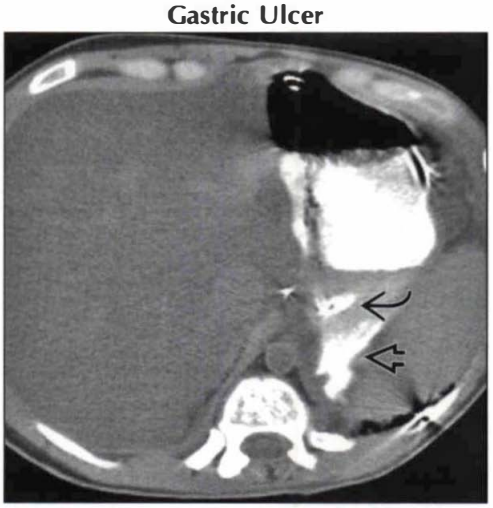


(Left) *Axial NECT shows persistent bilateral nephrograms from a preceding CECT, complicated by contrast induced nephropathy & acute renal failure. The ascites measures 30 HU, due to vicarious excretion of iodine from the liver & peritoneum.* ***(Right)*** *Axial CECT shows intraperitoneal contrast media surrounding the bowel loops & extending up paracolic gutters. CT cystogram with intraperitoneal rupture of bladder.*

Duodenal Ulcer

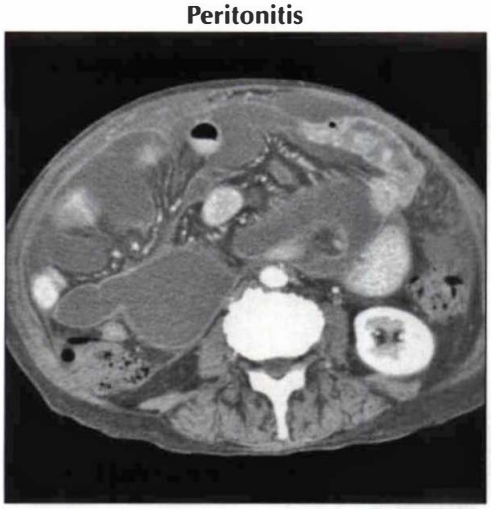


Gastric Ulcer

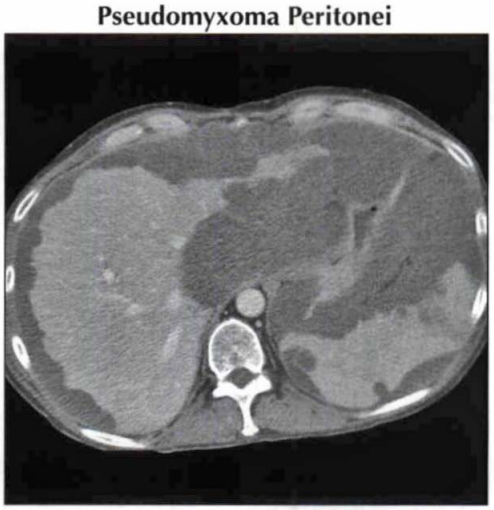


(Left) *Axial NECT shows layering of fat density fluid (-115 HU) on top of water density ascites. Bubble of free air; perforated duodenal ulcer, with extravasation of milk and bowel contents.* ***(Right)*** *Axial NECT shows an NG tube in the stomach through which contrast medium was instilled. Presence of contrast in lesser sac indicates perforation of gastric ulcer, posterior wall.*

Peritonitis



Pseudomyxoma Peritonei



(Left) *Axial CECT shows loculated collections of fluid (25 HU). Bile peritonitis following hepatic surgery.* ***(Right)*** *Axial CECT shows classic scalloped surface of liver & spleen and loculated ascites of higher than water attenuation.*

SECTION 2
Abdominal Wall

Anatomically Based Differentials

Abdominal Wall Mass	2-2
Mass in Iliopsoas Compartment	2-6
Groin Mass	2-8
Elevated or Deformed Hemidiaphragm	2-10
Defect in Abdominal Wall (Hernia)	2-12

ABDOMINAL WALL MASS

DIFFERENTIAL DIAGNOSIS

Common

- Inguinal Hernia
- Ventral Hernia
- Umbilical Hernia
- Spigelian Hernia
- Femoral Hernia
- Lumbar Hernia
- Abdominal Wall Abscess
- Sebaceous Cyst
- Lipoma
- Keloid
- Hematoma
- Paraumbilical Varices
- Muscle Asymmetry
- Injection Site

Less Common

- Endometriosis
- Calcinosis Syndromes
- Metastases
- Lymphoma and Leukemia
- Desmoid
- Sarcoma
- Rhabdomyolysis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Physical exam and CT are key in distinguishing among hernias and various abdominal wall masses
- Most masses have characteristic appearance on CT
  - Some nonspecific "soft tissue density" masses require biopsy or excision

Helpful Clues for Common Diagnoses

- **Inguinal Hernia**
  - Contains fat and/or bowel; may extend into scrotum or labia
- **Ventral Hernia**
  - Through midline (linea alba); most common after surgery
  - May be off midline at site of incision
- **Umbilical Hernia**
  - Through umbilical ring; common in patients with ascites
- **Spigelian Hernia**
  - Through defect lateral to rectus sheath
  - Often covered by external oblique muscle and aponeurosis
- **Femoral Hernia**
  - Medial to and compresses femoral vein; likely to strangulate
- **Lumbar Hernia**
  - Through defect where abdominal wall muscles insert on iliac crest or thoracolumbar fascia (inferior lumbar triangle)
  - Defect in oblique and transverse abdominal muscles, often covered by latissimus dorsi muscle
- **Abdominal Wall Abscess**
  - Encapsulated ± gas = abscess
  - Diffuse, nonencapsulated = cellulitis
  - Also consider enterocutaneous fistula (e.g., from diverticulitis)
- **Sebaceous Cyst**
  - Common, usually small spherical or oval, well-encapsulated
  - Low density, non-enhancing contents without surrounding infiltration
- **Lipoma**
  - Common in subcutaneous tissues and between muscle planes
  - Uniform fat density with no visible blood vessels
  - Liposarcoma
    - More complex appearing with visible blood vessels
    - May be of near water attenuation (myxoid elements of tumor)
- **Keloid**
  - Overgrowth of scar tissue at site of cutaneous injury
  - More common in African-Americans
- **Hematoma**
  - Heterogeneous, relatively high density focal mass (becomes more uniformly low density as it lyses)
  - More diffuse, without mass effect = ecchymosis
  - In response to focal trauma or anticoagulation (look for fluid level within hematoma)
- **Parumbilical Varices**
  - Common in severe cirrhosis with portal hypertension
  - Serpiginous enhancing structures that connect to falciform ligament
- **Muscle Asymmetry**
  - Common after surgery, paralysis, polio

- **Injection Site**
  - Common in subcutaneous tissues of anterior abdominal wall and buttocks
  - May contain gas, soft tissue density; may calcify (injection site granuloma)

Helpful Clues for Less Common Diagnoses

- **Endometriosis**
  - May implant in abdominal wall at site of prior Cesarian section or hysterectomy
  - Ask about history of cyclical pain and swelling at site of mass
- **Calcinosis Syndromes**
  - Dystrophic: Response to tissue injury, such as implanted medical device; or connective tissue diseases (scleroderma, dermatomyositis, CREST); or severe pancreatitis with fat necrosis (most often in breasts)
  - Metastatic: In patients with calcium-phosphate imbalance (renal failure, milk-alkali syndrome)
  - Tumoral calcification: Large globular deposits near joints
- **Metastases**
  - Melanoma + renal cell most common
  - Mass(es) in subcutaneous fat or muscle
  - Often subtle or overlooked on CT; more apparent on PET CT
  - May occur at site of surgery (e.g., for gallbladder, renal or colon cancer)
- **Lymphoma and Leukemia**
  - Cutaneous T cell lymphoma (also known as mycosis fungoides or Sézary syndrome)
    - Skin second most common site of extranodal lymphoma (after GI tract)
  - Leukemia cutis (also known as chloroma, or granulocytic sarcoma)
- **Desmoid**
  - Also known as fibromatosis; histologically benign but very aggressive growth
  - May occur sporadically, but more often in association with Gardner syndrome
- **Sarcoma**
  - Rare; heterogeneous vascular tumor with foci of necrosis
- **Rhabdomyolysis**
  - Muscle necrosis in response to crush injury, seizures, statin medications
  - Poorly defined and minimally enhancing lesion within skeletal muscle
  - Commonly leads to severe renal damage due to release of myoglobin into bloodstream

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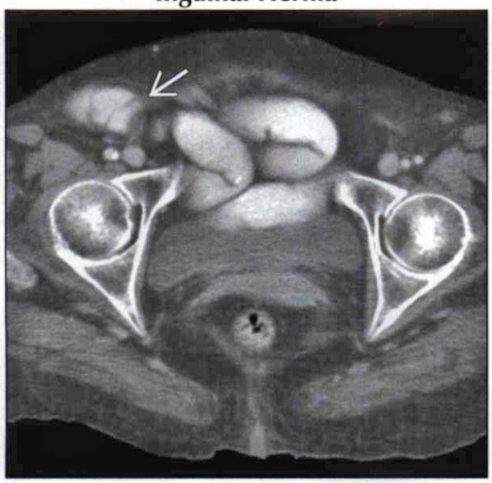
3. Aguirre DA et al: Abdominal wall hernias: imaging features, complications, and diagnostic pitfalls at multi-detector row CT. Radiographics. 25(6):1501-20, 2005
4. Shadbolt CL et al: Imaging of groin masses: inguinal anatomy and pathologic conditions revisited. Radiographics. 21 Spec No:S261-71, 2001

Inguinal Hernia



Axial CECT shows the hernia sac, lying anterior to the right femoral vessels. Contrast-opacified small bowel ➡ is present within the hernia.

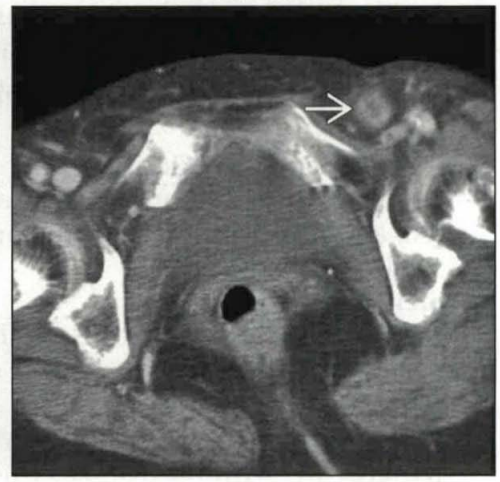
Ventral Hernia

Axial CECT shows herniation of small bowel through a midline defect ➡ (ventral hernia) that results in small bowel obstruction.

ABDOMINAL WALL MASS

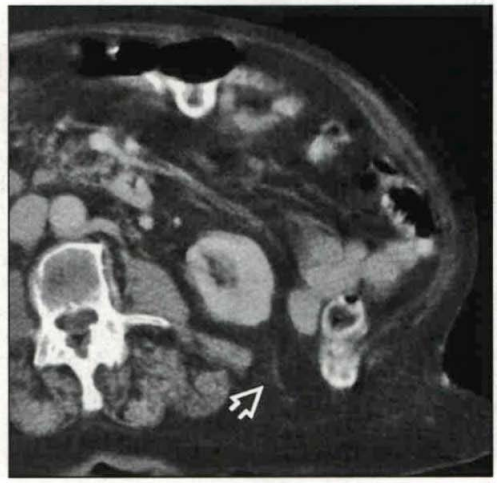
Spigelian Hernia

Femoral Hernia

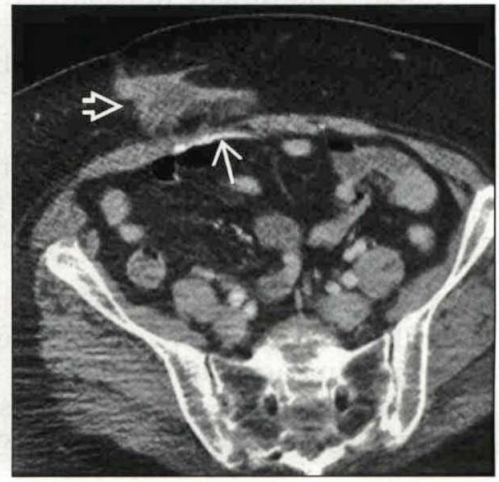


*(**Left**) Axial CECT shows a Spigelian hernia. Note the herniation of colon through a defect in the abdominal wall lateral to rectus muscle with intact overlying external oblique muscle. (**Right**) Axial CECT shows a left femoral hernia that lies lateral to the pubic tubercle + medial to the femoral vein, which is compressed. This hernia resulted in small bowel obstruction.*

Lumbar Hernia

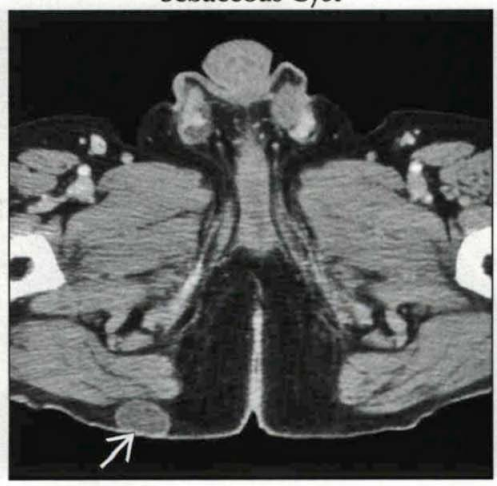


Abdominal Wall Abscess

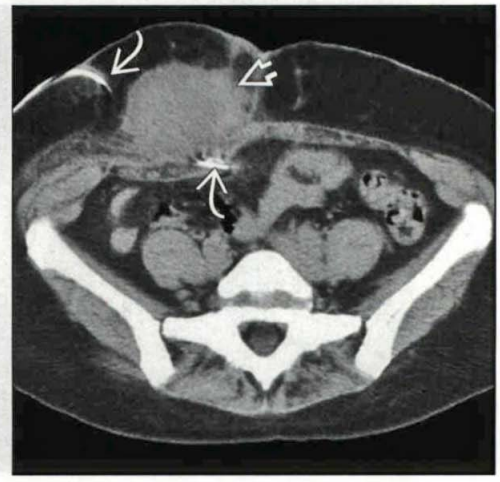


*(**Left**) Axial CECT shows herniation of fat + bowel through a defect in the thoracolumbar fascia near the left iliac crest. (**Right**) Axial CECT shows surgical mesh in the abdominal wall used to repair an incisional hernia. There is a loculated collection of fluid in the subcutaneous fat representing an abscess.*

Sebaceous Cyst



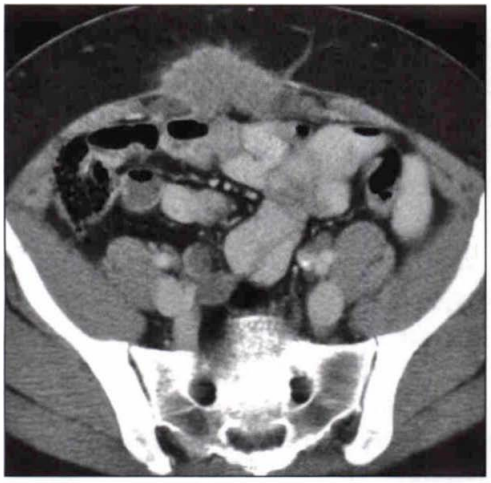
Hematoma



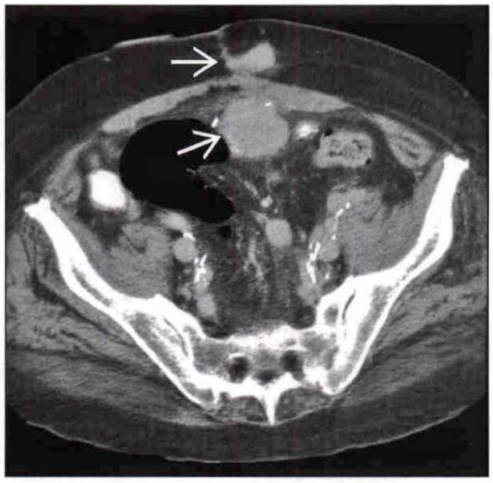
*(**Left**) Axial CECT shows an encapsulated, near water density mass in the left buttock. (**Right**) Axial NECT shows a peritoneal dialysis catheter with an adjacent high attenuation mass that represents an abdominal wall hematoma.*

ABDOMINAL WALL MASS

Endometriosis



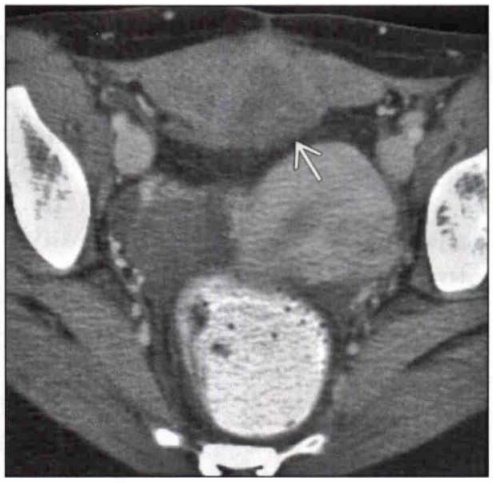
Metastases



(Left) *Axial CECT shows a soft tissue density mass in the abdominal wall midline at the site of a scar from Caesarian section. The mass caused cyclical pain + was resected, showing endometriosis.* ***(Right)*** *Axial CECT shows 2 soft tissue density masses ➡ in the subcutaneous tissue + just deep to the rectus muscle. Note clips from prior node dissection + cystectomy for bladder carcinoma.*

Metastases

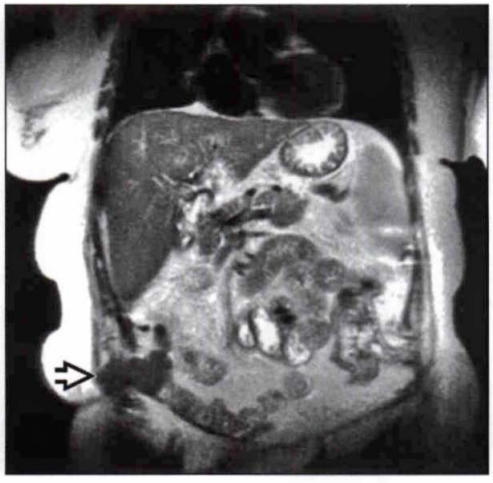
Desmoid



(Left) *Axial CECT shows a hypervascular mass ➪ with a necrotic center in the abdominal wall of a young man who had amputation of his left leg for sarcoma; metastatic sarcoma.* ***(Right)*** *Axial CECT shows a solid mass ➡ in the lower rectus muscle. Surgically proven desmoid tumor in a patient with Gardner syndrome who had prior colectomy.*

Sarcoma

Sarcoma



(Left) *Axial NECT shows a bilobed mass ➪ within the abdominal wall of a 52 year-old woman; surgically proven primary sarcoma.* ***(Right)*** *Coronal T1 C+ MR shows a bilobed mass ➪ within the lower lateral abdominal wall that is a primary sarcoma. 52 year-old woman.*

MASS IN ILIOPSOAS COMPARTMENT

DIFFERENTIAL DIAGNOSIS

Common
- Hematoma/Hemorrhage
- Asymmetric Muscles (Mimic)
- Retroperitoneal Fibrosis
- Abscess, Paraspinal

Less Common
- Primary Infection
- Primary Neoplasm
- Secondary Neoplasm

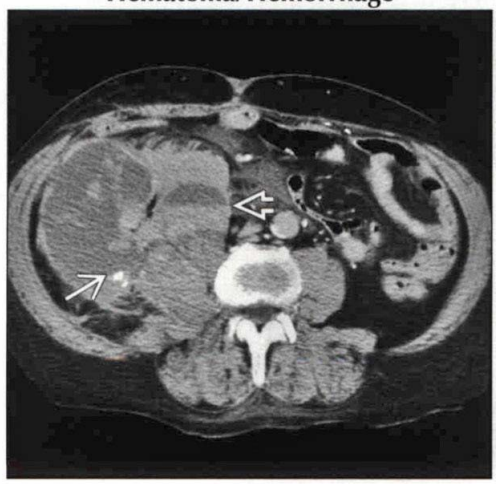
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Consider signs of infection, hemorrhage
- Check for adjacent disease (e.g., spine)

Helpful Clues for Common Diagnoses
- **Hematoma/Hemorrhage**
  - Iliopsoas is most common site for spontaneous "retroperitoneal" hemorrhage
    - Hematocrit sign = anticoagulation
  - Ruptured abdominal aortic aneurysm may bleed into iliopsoas
    - Blood adjacent to large aneurysm with focal bulge
- **Asymmetric Muscles (Mimic)**
  - Iliopsoas muscles are often quite asymmetric in size due to leg amputation or paralysis, arthritis of leg joints or spine
- **Retroperitoneal Fibrosis**
  - Mantle of tissue encasing aorta, IVC, ureters
- **Abscess, Paraspinal**
  - Look for infectious spondylitis (TB or pyogenic), opportunistic infections, iliac osteomyelitis, prior vertebroplasty
  - Infection may spread to iliopsoas from renal/perirenal abscess, or xanthogranulomatous pyelonephritis
  - Infection may spread from bowel (duodenal ulcer, appendicitis, diverticulitis, Crohn disease)

Helpful Clues for Less Common Diagnoses
- **Primary Infection**
  - Iliopsoas compartment is rarely the primary site of infection
    - May be idiopathic
    - May occur in immunocompromised patients (e.g., HIV)
    - Consider direct inoculation of muscle in IV drug users
- **Primary Neoplasm**
  - Iliopsoas is a rare site of primary mesenchymal tumor (liposarcoma, fibrosarcoma, etc.)
- **Secondary Neoplasm**
  - Rarely the site of hematogenous metastasis (e.g., melanoma)
  - May be directly invaded by retroperitoneal sarcoma, lymphoma, abdominal or pelvic malignancy, neurogenic tumors, adjacent bone tumor
  - Plexiform neurofibroma (in neurofibromatosis) may involve psoas compartment

Hematoma/Hemorrhage



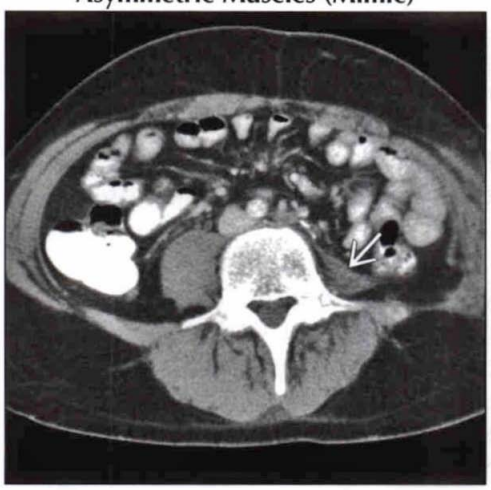
Axial CECT shows a large retroperitoneal mass arising from the iliopsoas compartment. A focus of active bleeding ⇨ and hematocrit levels ⇨ confirm coagulopathic hemorrhage.

Hematoma/Hemorrhage

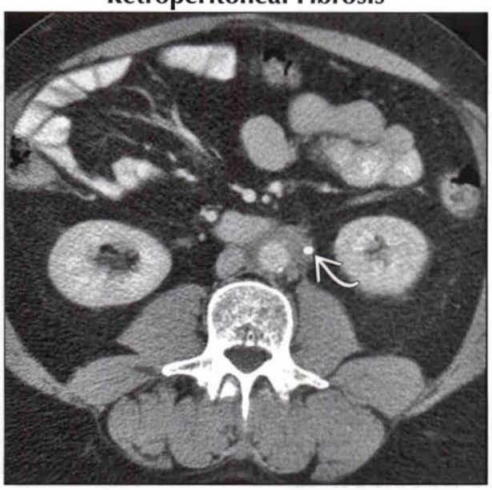
Axial CECT shows a large abdominal aortic aneurysm that has ruptured into the psoas compartment and retroperitoneum. Blood dissects along left psoas and throughout the retroperitoneal planes.

MASS IN ILIOPSOAS COMPARTMENT

Asymmetric Muscles (Mimic)

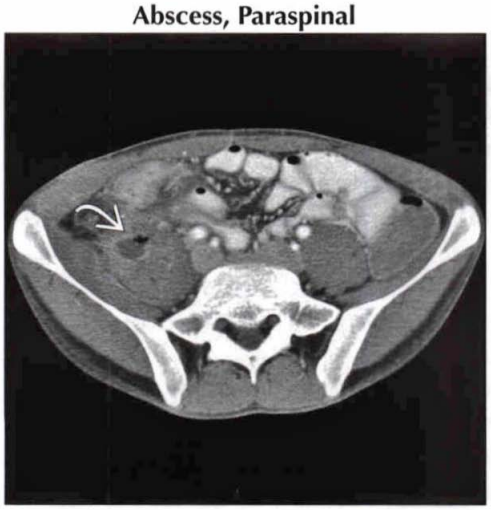


Retroperitoneal Fibrosis

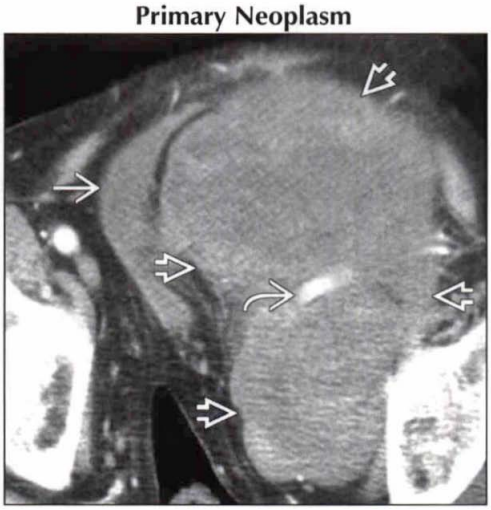


(Left) *Axial CECT shows marked asymmetry of the psoas muscles. The left psoas* → *is atrophic due to left leg amputation.* ***(Right)*** *Axial CECT shows mantle of soft tissue encasing aorta, IVC, & ureter (with stent* ↔*).*

Abscess, Paraspinal

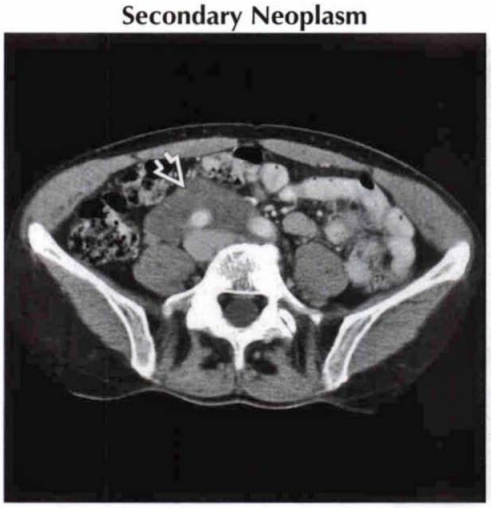


Primary Neoplasm

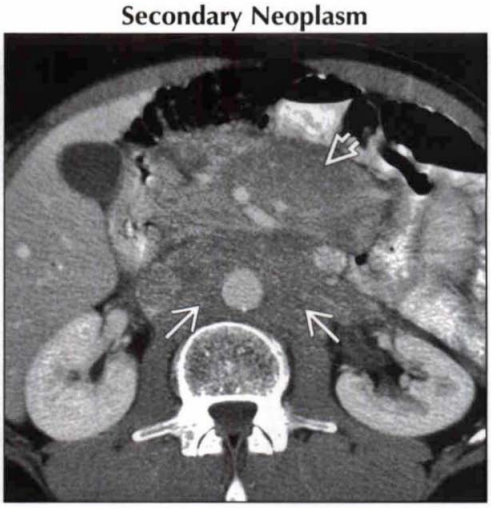


(Left) *Axial CECT shows a small collection of gas and fluid* ↔ *within the psoas muscle due to Crohn disease with a sinus tract from the terminal ileum.* ***(Right)*** *Axial CECT shows large heterogeneous tumor* ⇔ *which displaces the bladder* → *and external iliac artery* ↔*. This is a leiomyosarcoma, arising from the psoas muscle.*

Secondary Neoplasm



Secondary Neoplasm



(Left) *Axial CECT shows a soft tissue mass* ⇔ *that extends along the aorta, IVC and right psoas. Biopsy showed ganglioneuroma arising from the sympathetic neural chain.* ***(Right)*** *Axial CECT shows retroperitoneal* → *psoas compartment, & mesenteric* ⇔ *lymphadenopathy. Non-Hodgkin lymphoma.*

GROIN MASS

DIFFERENTIAL DIAGNOSIS

Common
- Inguinal Hernia
- Femoral Hernia
- Hematoma, Abdominal Wall
- Pseudoaneurysm, Groin
- Inguinal Lymphadenopathy
- Varicocele

Less Common
- Cryptorchidism
- Aneurysm, Groin
- Iliopsoas Bursitis
- Bone Tumor
- Abdominal Wall Abscess

ESSENTIAL INFORMATION

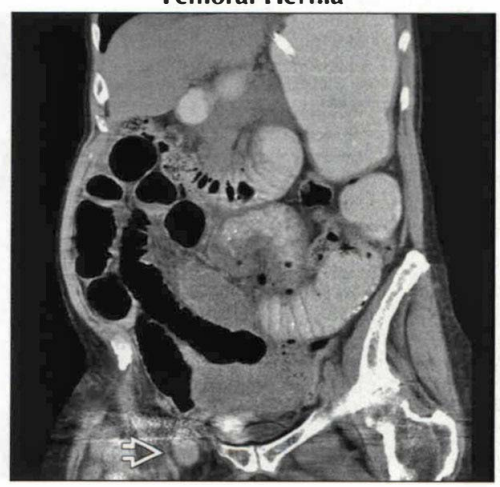
Key Differential Diagnosis Issues
- Most groin masses are easily diagnosed on clinical exam alone
- Atypical or unusual masses should have US or CT investigation
  - US best for vascular & male reproductive (e.g., cryptorchidism, varicocele)
  - CT or MR best for musculoskeletal lesions such as bursitis, bone tumor
  - US-guided aspiration or biopsy useful for abscesses and neoplasms, respectively

Helpful Clues for Common Diagnoses
- **Inguinal Hernia**
  - Can be direct or indirect (defined by relation to inferior epigastric vessels)
  - Extends anterior to pubic tubercle & femoral vessels; rarely compresses femoral vein
  - Bowel, including appendix, may be trapped in hernia
  - Sonography and CT may be helpful, but clinical diagnosis usually suffices
- **Femoral Hernia**
  - Originates medial to & often compresses femoral vein
  - Extends lateral to pubic tubercle
  - More likely to become incarcerated
- **Hematoma, Abdominal Wall**
  - Often results from catheterization of femoral artery or vein
  - Should show no enhancement (CT) or flow (US)
- **Pseudoaneurysm, Groin**
  - Potential complication of angiography
  - Key is Doppler US with turbulent flow
  - Treat with compression or thrombin injection
  - Aneurysm of femoral artery usually more cylindrical and has endothelial lining
- **Inguinal Lymphadenopathy**
  - Common and nonspecific site of enlarged nodes
  - Usually are mobile and easily distinguished from hernia by clinical exam
- **Varicocele**
  - Can extend into inguinal canal (as can hydrocele)
  - Characteristic venous flow pattern on US, accentuated during Valsalva maneuver

Inguinal Hernia

Axial CECT shows an inguinal hernia ➡ containing only fat. Hernia is anterior to pubic tubercle, and there's no compression of femoral vessels ➡.

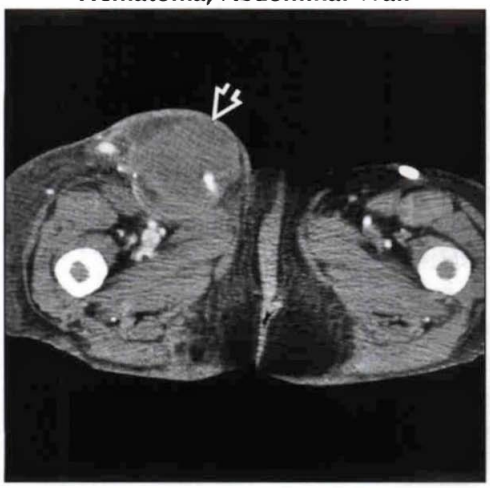
Femoral Hernia



Coronal CECT shows a "knuckle" of small bowel ➡ that is incarcerated within a femoral hernia, resulting in small bowel obstruction.

GROIN MASS

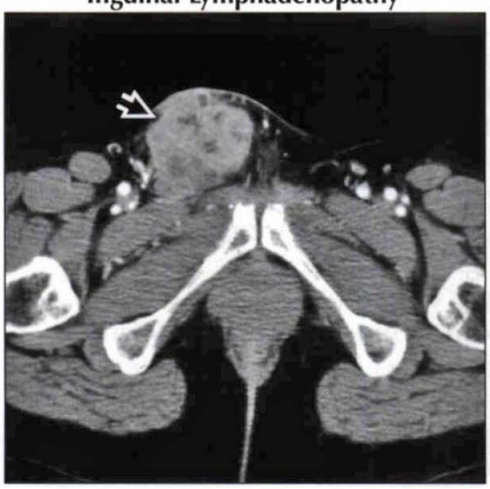
Hematoma, Abdominal Wall



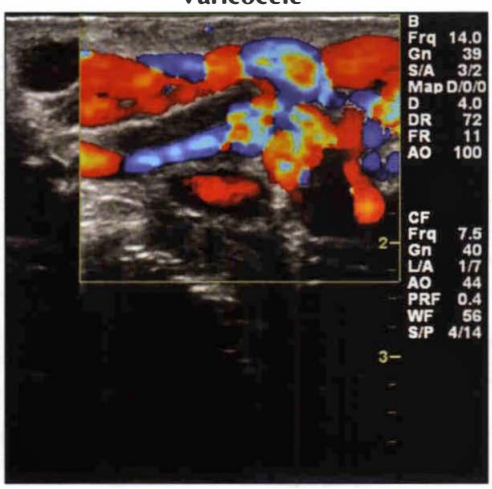
Pseudoaneurysm, Groin

*(Left) Axial CECT shows a groin hematoma ⇨ that resulted from surgical revision of an AV fistula for dialysis. Unlike a pseudoaneurysm, there is no enhancement of the mass. **(Right)** Sagittal color Doppler ultrasound shows a "yin-yang" or to-and-fro flow of blood within a spherical common femoral artery pseudoaneurysm, resulting from cardiac catheterization.*

Inguinal Lymphadenopathy

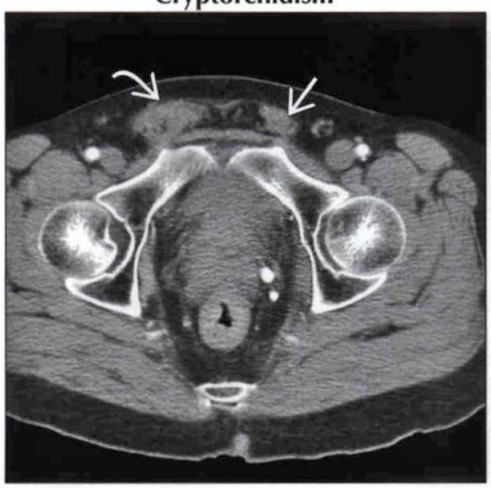


Varicocele



*(Left) Axial CECT shows a heterogeneously enhancing groin mass ⇨ that was biopsied and found to represent metastatic squamous cell carcinoma. **(Right)** Sagittal color Doppler ultrasound shows a classic tangle of tortuous vessels within the upper part of the scrotum. Flow and vessel dilation are accentuated by Valsalva maneuver.*

Cryptorchidism



Iliopsoas Bursitis

*(Left) Axial CECT shows a small soft tissue mass ⇨ within the right inguinal ring. The right hemiscrotum was small and empty. The normal left spermatic cord ⇨ is seen. **(Right)** Axial CECT shows a cylindrical fluid collection ⇨ along the right iliopsoas muscle, near its insertion on the femur.*

ELEVATED OR DEFORMED HEMIDIAPHRAGM

DIFFERENTIAL DIAGNOSIS

Common

- Paralyzed Diaphragm
- Eventration of Diaphragm
- Hiatal Hernia
- Bochdalek Hernia
- Morgagni Hernia
- Traumatic Diaphragmatic Hernia
- Subdiaphragmatic Mass
  - Splenomegaly and Hypersplenism
  - Hepatomegaly
  - Abscess, Abdominal
- Subpulmonic Pleural Effusion (Mimic)

ESSENTIAL INFORMATION

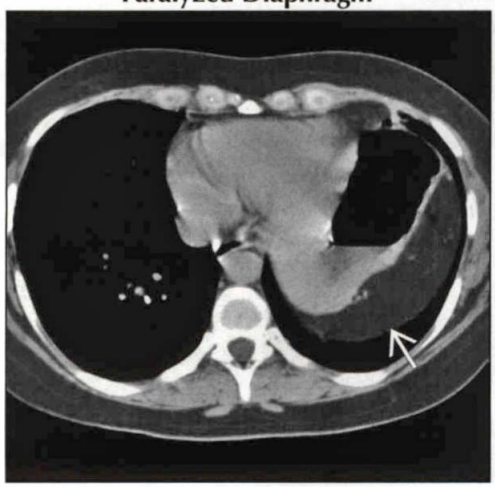
Key Differential Diagnosis Issues

- Axial CT is not ideal for distinguishing diaphragm from spleen, liver, muscle
- Sonography in sagittal plane easily identifies diaphragm and location of peridiaphragmatic fluid collection
- MR easily demonstrates diaphragm in multiple planes
- Ascites and abdominal contents lie medial to and within the confines of the diaphragm
- Pleural fluid and thoracic contents lie outside the confines of the diaphragm

Helpful Clues for Common Diagnoses

- **Paralyzed Diaphragm**
  - Injury to phrenic nerve by trauma or surgery or thoracic malignancy; paradoxical movement with forced inspiration
- **Eventration of Diaphragm**
  - Congenital weakness of a portion of the diaphragm
- **Hiatal Hernia**
  - Results in intrathoracic migration of portions of the stomach, omental fat
- **Bochdalek Hernia**
  - Congenital defect in diaphragm near vertebrocostal junction
  - Abdominal fat, gut, and kidney may herniate into chest
- **Morgagni Hernia**
  - Congenital defect in paramedian diaphragm near sternocostal junction
  - More often in right, often large
- **Traumatic Diaphragmatic Hernia**
  - Left more common than right
  - "Dependent viscus" and "collar sign"
- **Subdiaphragmatic Mass**
  - Tumor, hepatomegaly, splenomegaly
- **Abscess, Abdominal**
  - Subphrenic abscess causes mass displacement of diaphragm as well as "splinting", decreased motion of diaphragm due to pain
- **Subpulmonic Pleural Effusion (Mimic)**
  - Pleural fluid loculated in subpulmonic pleural space will displace lung upward
  - May simulate elevated diaphragm on radiographs

Paralyzed Diaphragm



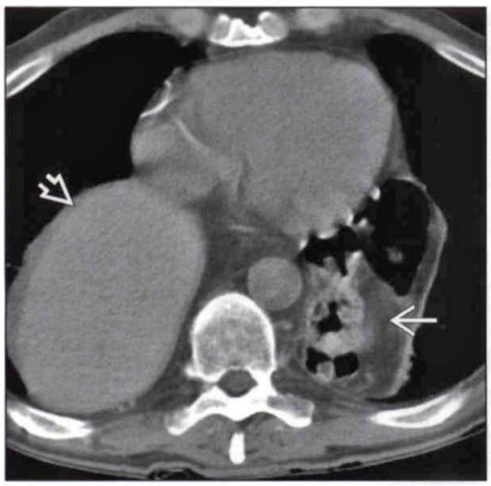
Axial NECT shows elevation of the left hemidiaphragm ⇒, without focal bulge or eventration. The abdominal contents do not "fall" dependently, but are suspended by the intact diaphragm.

Eventration of Diaphragm

Sagittal CECT shows a focal bulge of the liver ⇨ through a weakened eventration of the right hemidiaphragm.

ELEVATED OR DEFORMED HEMIDIAPHRAGM

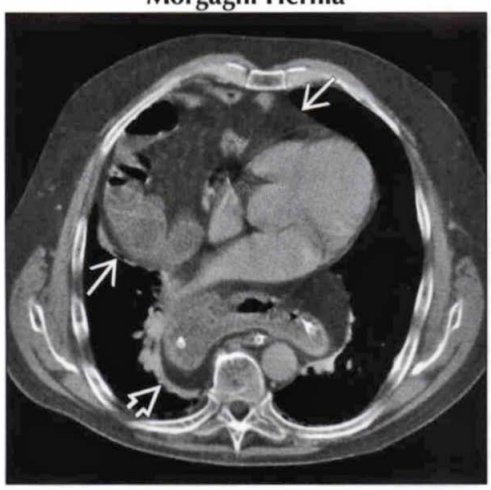
Hiatal Hernia



Bochdalek Hernia

(Left) Axial NECT shows herniation of most of the stomach as well as the splenic flexure of colon through a massive hiatal hernia. (Right) Axial CECT shows bilateral defects in the postero-medial portions of the diaphragm, with herniation of omental fat.

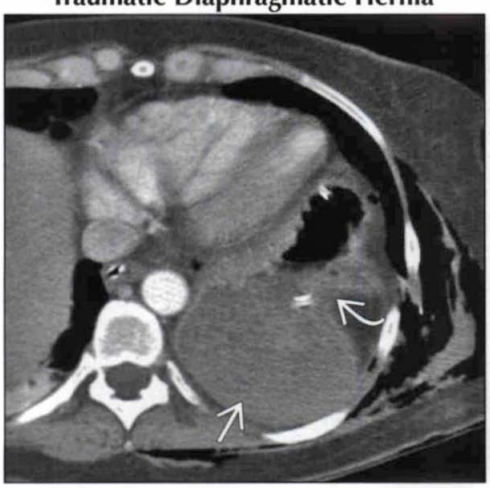
Morgagni Hernia



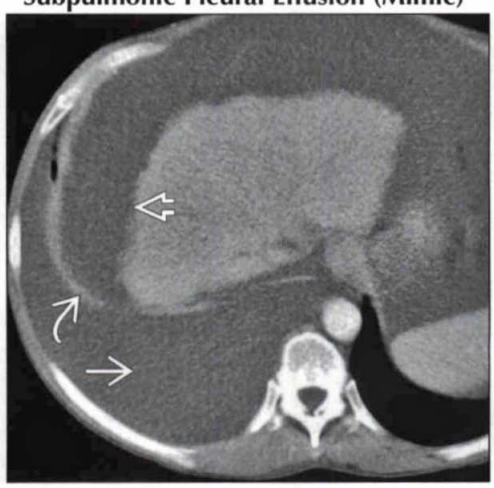
Traumatic Diaphragmatic Hernia

(Left) Axial NECT shows a large hiatal hernia that contains much of the stomach. There is also a large Morgagni hernia lateral to and displacing the heart, containing omental fat and colon. (Right) Coronal T2WI MR shows herniation of the stomach (and omental fat) through a defect in the left hemidiaphragm. The stomach is "pinched" as it traverses the defect in the diaphragm.

Traumatic Diaphragmatic Hernia



Subpulmonic Pleural Effusion (Mimic)



(Left) Axial CECT shows herniation of the stomach through a defect in the left hemidiaphragm. The stomach has "fallen" to lie against the postero-medial chest wall and is pinched. (Right) Axial CECT shows pleural effusion below the lung and lateral to the diaphragm. Ascites lies medial to the diaphragm and adjacent to the cirrhotic liver.

DEFECT IN ABDOMINAL WALL (HERNIA)

DIFFERENTIAL DIAGNOSIS

Common
- Inguinal Hernia
- Femoral Hernia
- Ventral Hernia
- Incisional Hernia
- Spigelian Hernia
- Lumbar Hernia
- Rectus Sheath Hematoma (Mimic)
- Inguinal Lymphadenopathy (Mimic)

Less Common
- Traumatic Abdominal Wall Hernia
- Abdominal Wall Trauma (Mimic)
- Cryptorchidism (Mimic)
- Enterocutaneous Fistula (Mimic)
- Urachal Remnant (Mimic)
- Abdominal Wall Mass (Mimic)

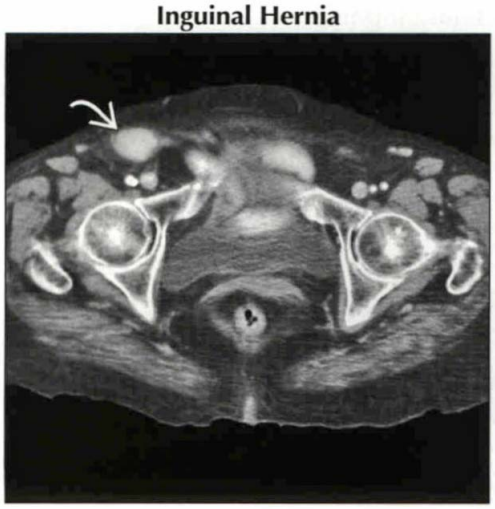
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Physical exam and CT are keys to distinguish among hernias and masses
- Evaluate all hernias for evidence of bowel obstruction, incarceration, and strangulation

Helpful Clues for Common Diagnoses
- **Inguinal Hernia**
  - Most common type of external hernia
  - Anterior to pubic tubercle
  - More common in males, children and adults
- **Femoral Hernia**
  - Medial to and compresses femoral vein; lateral to pubic tubercle
  - More common in females
- **Ventral Hernia**
  - Includes umbilical, paraumbilical, epigastric and hypogastric
  - All occur through linea alba
- **Incisional Hernia**
  - Through any site of abdominal incision, including laparoscopy ports
  - Parastomal hernias are quite common, adjacent to ileostomy or colostomy
- **Spigelian Hernia**
  - External oblique layer of muscle and aponeurosis may be intact over defect
  - Along lateral margin of rectus sheath
- **Lumbar Hernia**
  - Through defects in lumbar muscle or thoracolumbar fascia
  - Below 12th rib and above iliac crest
  - Similar but larger hernia though incision site in flank for renal surgery

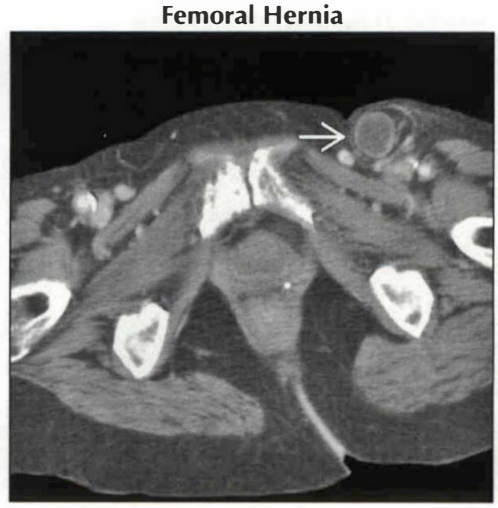
Helpful Clues for Less Common Diagnoses
- **Traumatic Abdominal Wall Hernia**
  - At site of focal trauma (e.g., "handlebar hernia") or diffuse avulsion of muscles from iliac crest
- **Subcutaneous Mass**
  - Any subcutaneous mass may be mistaken for a hernia
  - Consider inguinal lymphadenopathy, abdominal wall tumors, even enterocutaneous fistulas

Inguinal Hernia



Axial CECT shows herniated small bowel that extends anterior and inferior to the pubic tubercle and anterior to the femoral vessels without vascular compression.

Femoral Hernia



Axial CECT shows herniated small bowel lateral to the pubic tubercle and medial to the femoral vessels, with compression of the femoral vein. A small bowel obstruction was present.

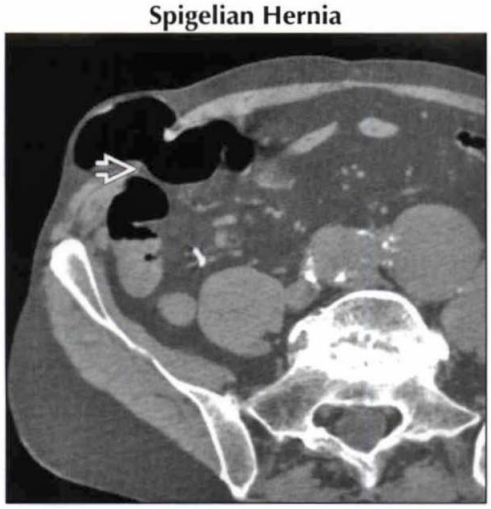
DEFECT IN ABDOMINAL WALL (HERNIA)

Ventral Hernia

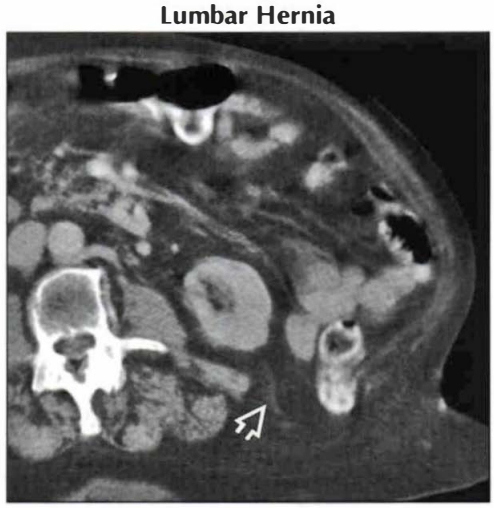
Incisional Hernia

(Left) *Axial CECT shows a wide opening in the linea alba through which small bowel and fat herniate. There is no bowel obstruction.* ***(Right)*** *Axial CECT shows herniation of the colon through a post-surgical incision site in the right flank.*

Spigelian Hernia

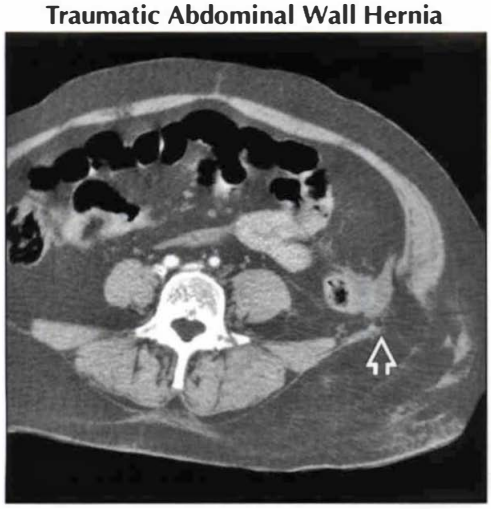


Lumbar Hernia



(Left) *Axial CECT shows a defect in the anterior abdominal wall just lateral to the rectus sheath. Bowel is herniated but not obstructed.* ***(Right)*** *Axial CECT shows herniation of fat and bowel through a defect in the thoracolumbar fascia near the iliac crest.*

Traumatic Abdominal Wall Hernia



Enterocutaneous Fistula (Mimic)

(Left) *Axial CECT shows disruption of the musculofascial plane near the insertion into the iliac crest and thoracolumbar fascia. Note the subcutaneous hematoma. The spleen was also lacerated.* ***(Right)*** *Axial CECT shows an abdominal wall abscess due to a fistula (sinus tract) from sigmoid diverticulitis. The pre-CT clinical diagnosis was "ventral hernia".*

SECTION 3
Esophagus

Generic Imaging Patterns

Intraluminal Mass, Esophagus	3-2
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Mucosal Nodularity, Esophagus	3-10
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Clinically Based Differentials

Odynophagia	3-20

INTRALUMINAL MASS, ESOPHAGUS

DIFFERENTIAL DIAGNOSIS

Common
- Esophageal Carcinoma
- Esophageal Foreign Body
- Intramural Benign Esophageal Tumors

Less Common
- Thrombosed Esophageal Varix
- Inflammatory Polyp, Esophagus
- Candida Esophagitis
- Viral Esophagitis
- Papilloma, Esophagus

Rare but Important
- Fibrovascular Polyp
- Esophageal Metastases and Lymphoma
- Esophageal Adenoma

ESSENTIAL INFORMATION

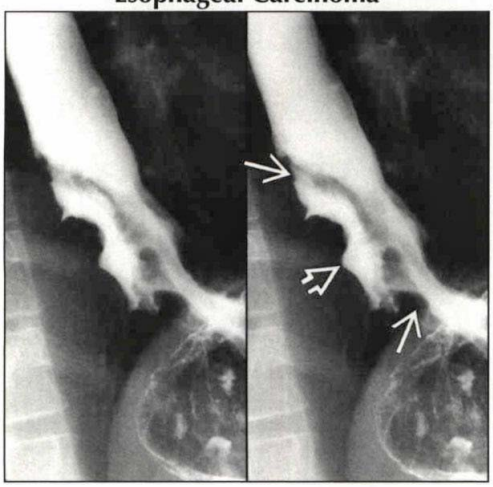
Key Differential Diagnosis Issues
- Intraluminal masses usually have irregular surface & acute angles with wall

Helpful Clues for Common Diagnoses
- **Esophageal Carcinoma**
  - Most common tumor of esophagus
  - Luminal narrowing with nodular, ulcerated mucosa
- **Esophageal Foreign Body**
  - Check for history of sudden dysphagia
  - Usually lodges just above point of physiologic or pathologic narrowing (e.g., Schatzki ring)
  - Repeat barium esophagram or endoscopy after removal or passage of foreign body
- **Intramural Benign Esophageal Tumors**
  - Leiomyoma > lipoma > neuroma & others
  - Peristalsis may draw mass into esophageal lumen, simulating an intraluminal mass
  - Overlying mucosa may ulcerate

Helpful Clues for Less Common Diagnoses
- **Thrombosed Esophageal Varix**
  - May be indistinguishable from carcinoma ("varicoid" carcinoma)
- **Inflammatory Polyp, Esophagus**
  - Polypoid protuberance just above esophago-gastric junction
  - Appears as single, prominent fold or rounded mass
  - Associated with hiatal hernia, reflux
- **Candida or Viral Esophagitis**
  - May result in intraluminal sloughed cells, organisms & debris that appear as a mass
- **Papilloma, Esophagus**
  - Benign; small (0.5-1.5 cm diameter)

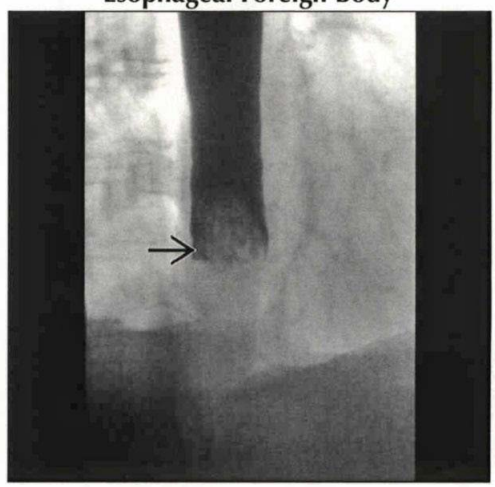
Helpful Clues for Rare Diagnoses
- **Fibrovascular Polyp**
  - Rare benign mass arises from cervical esophagus but grows into a giant, sausage-like polypoid mass that may fill much of the esophageal lumen
- **Esophageal Metastases and Lymphoma**
  - Gastric or lung cancer may extend into wall of esophagus
  - Other metastases and lymphoma are rare

Esophageal Carcinoma



Esophagram shows a mass in the distal esophagus, with the tumor causing a filling defect ⇨ and the ulceration a collection of barium ⇨ within the mass.

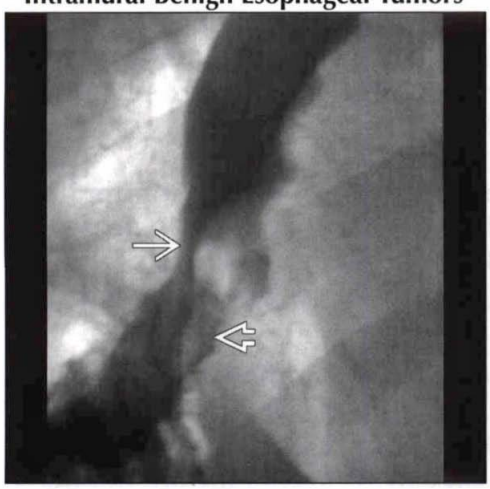
Esophageal Foreign Body



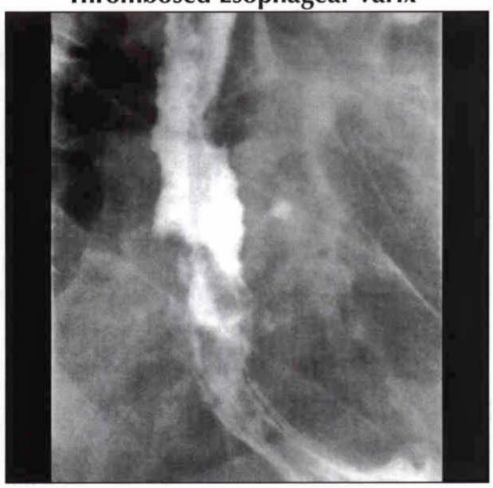
Esophagram shows a filling defect ⇨ within the distal esophagus and complete obstruction to distal flow of the barium. Endoscopic findings: Piece of meat stuck above a Schatzki ring.

INTRALUMINAL MASS, ESOPHAGUS

Intramural Benign Esophageal Tumors

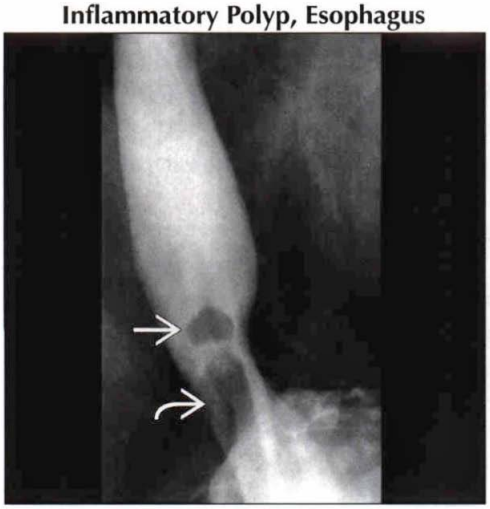


Thrombosed Esophageal Varix

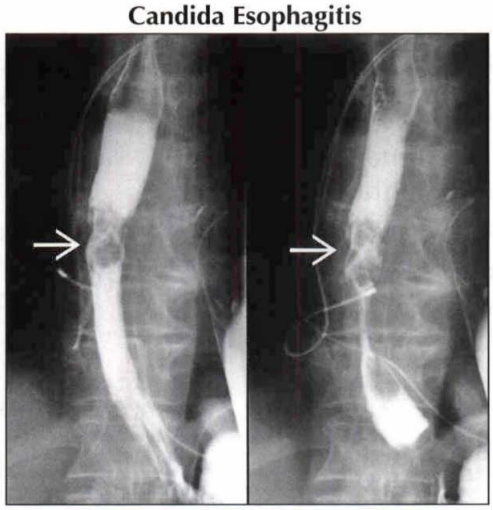


*(**Left**) Esophagram shows a mass ➡ within the distal esophagus with smooth overlying mucosa. The thick herniated gastric folds ➪ could be mistaken for distorted folds over the mass. Leiomyoma. (**Right**) Esophagram shows fixed irregular luminal narrowing that mimics a large mass. These are thrombosed esophageal varices.*

Inflammatory Polyp, Esophagus

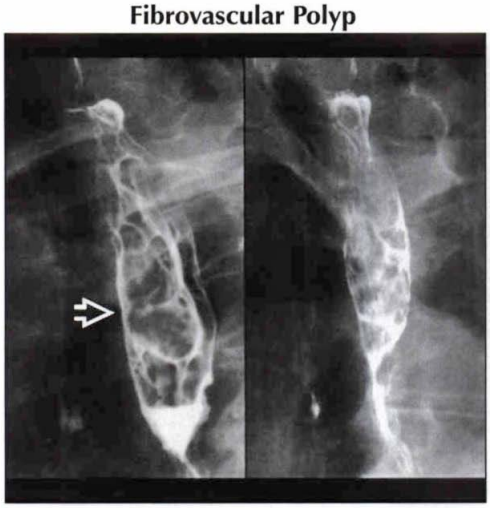


Candida Esophagitis

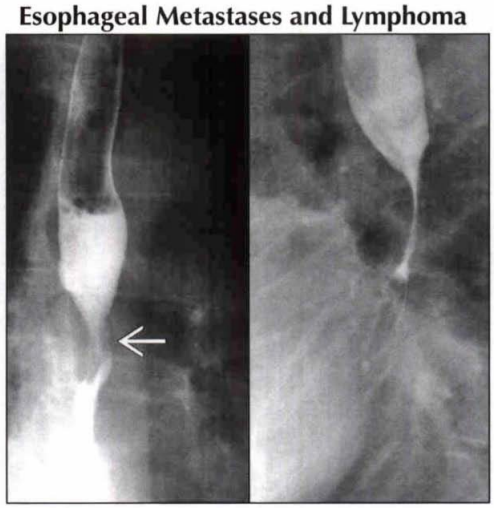


*(**Left**) Oblique esophagram shows a polypoid lesion in the distal esophagus ➡ that is contiguous with a nodular, thickened fold ➪ that traverses the EG junction. (**Right**) Esophagram shows an irregular filling defect ➡ closely simulating an esophageal cancer. At endoscopy, this was a mass of inflammatory debris in a patient with Candida esophagitis.*

Fibrovascular Polyp



Esophageal Metastases and Lymphoma



*(**Left**) Oblique esophagram shows a huge mass ➪ that originates in the cervical esophagus and fills most of the lumen. (**Right**) Esophagram shows abrupt narrowing of the mid esophagus. The tapered margins and intact mucosal folds ➡ correctly suggest an extrinsic process, lung cancer, rather than primary tumor.*

EXTRINSIC MASS, ESOPHAGUS

DIFFERENTIAL DIAGNOSIS

Common
- Left Main Bronchus
- Aortic Arch
- Aortic Aneurysm
- Heart
- Cervical Osteophytes
- Hiatal Hernia
- Mediastinal Lymph Nodes
- Aberrant Right Subclavian Artery
- Metastases and Lymphoma, Esophageal
- Enlarged Thyroid

Less Common
- Intramural Benign Esophageal Tumors
- Esophageal Carcinoma (Mimic)
- Gastric Carcinoma (Mimic)
- Bronchogenic Cyst
- Esophageal Varices

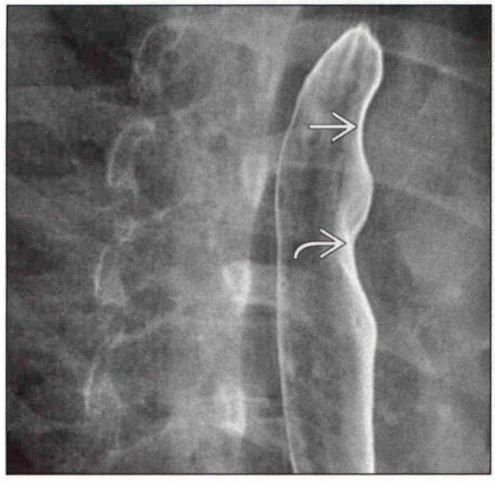
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Extrinsic "lesions": Smooth, intact mucosa and obtuse angles at the indentation; entire lumen may be displaced or constricted

Helpful Clues for Common Diagnoses
- **Left Main Bronchus & Aortic Arch**
  - Normal indentations along left lateral margin
- **Aortic Aneurysm**
  - Usually distal esophagus
- **Hiatal Hernia**
  - Large paraesophageal hernia may displace or compress esophagus
- **Mediastinal Lymph Nodes**
  - Enlarged by benign or malignant disease
- **Aberrant Right Subclavian Artery**
  - Compresses posterior wall of esophagus obliquely
- **Enlarged Thyroid**
  - Goiter may extend into mediastinum (look for cervico-thoracic mass with increased attenuation on CT)
  - Thyroid nodules or cancer: Focal mass effect

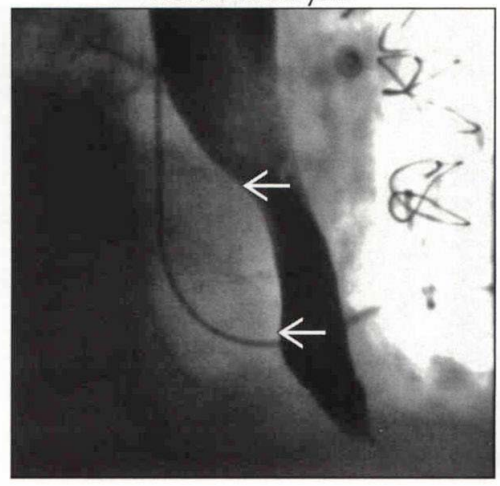
Helpful Clues for Less Common Diagnoses
- **Intramural Benign Esophageal Tumors**
  - Often difficult on barium esophagram to distinguish extrinsic from intramural mass
  - Usually easier with CT
- **Esophageal Carcinoma (Mimic)**
  - Mucosal lesion may be inapparent
  - Submucosal extension and mediastinal spread may mimic extrinsic lesion
- **Gastric Carcinoma (Mimic)**
  - May spread into submucosal esophagus and mediastinal nodes
- **Bronchogenic Cyst**
  - Density of cyst contents may vary from water to calcific
  - Look for spherical shape; tethered to subcarinal region
- **Esophageal Varices**
  - Large or thrombosed varices often simulate mediastinal mass

Left Main Bronchus



Oblique esophagram shows normal esophagus with indentations along the left anterolateral wall by the aortic knob ➡ & left main bronchus ➡.

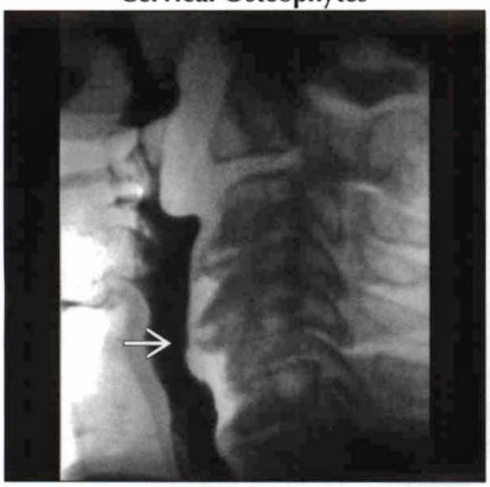
Aortic Aneurysm



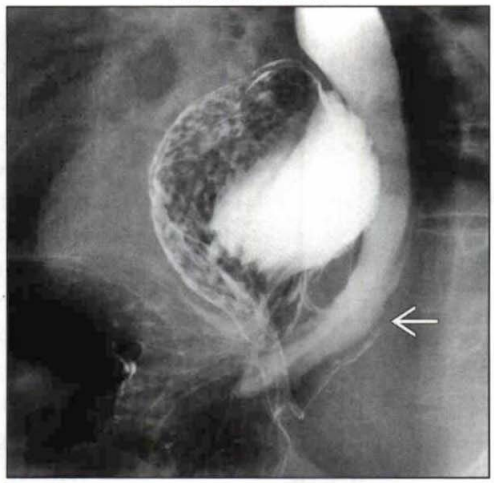
Oblique esophagram shows extrinsic indentation ➡ along the posterior wall of the distal esophagus by a dilated, ectatic aorta, in an elderly man.

EXTRINSIC MASS, ESOPHAGUS

Cervical Osteophytes

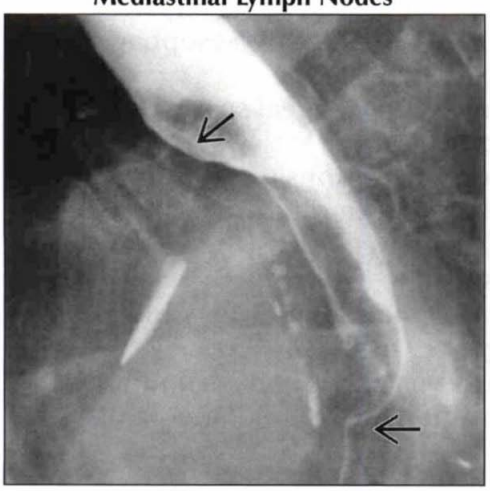


Hiatal Hernia

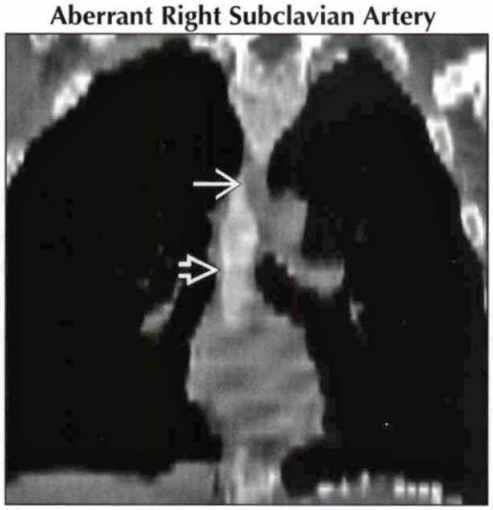


(Left) Lateral esophagram shows cervical osteophytes ➡ indenting the posterior wall of the pharyngo-esophageal junction. (Right) Esophagram shows displacement of the distal esophagus by a large type 3 paraesophageal hernia. The gastroesophageal junction ➡ is in the chest.

Mediastinal Lymph Nodes

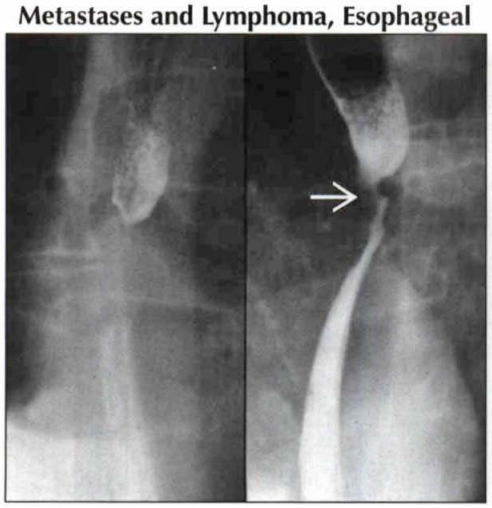


Aberrant Right Subclavian Artery

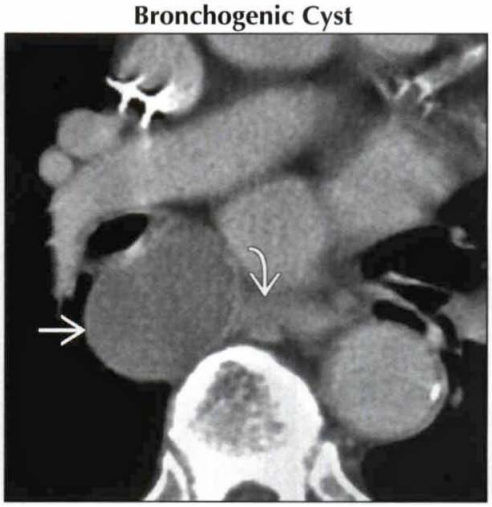


(Left) Esophagram shows a broad indentation ➡ of the anterior wall of the esophagus by enlarged mediastinal nodes; metastases from primary lung cancer. (Right) Coronal NECT shows a barium opacified esophagus ➡ that is indented obliquely along its posterior surface by an aberrant right subclavian artery ➡.

Metastases and Lymphoma, Esophageal



Bronchogenic Cyst



(Left) Esophagram shows abrupt but smooth tapering ➡ of the esophagus at the carinal level, with intact mucosal folds, indicating extrinsic involvement; direct invasion from lung cancer. (Right) Axial CECT shows a spherical water density mass ➡ in the middle mediastinum that abuts the esophagus ➡ at a level just below the carina.

LESION AT PHARYNGO-ESOPHAGEAL JUNCTION

DIFFERENTIAL DIAGNOSIS

Common
- Achalasia, Cricopharyngeal
- Cervical Osteophytes

Less Common
- Esophageal Webs
- Esophageal Carcinoma
- Esophagitis, Drug-Induced
- Neck Mass

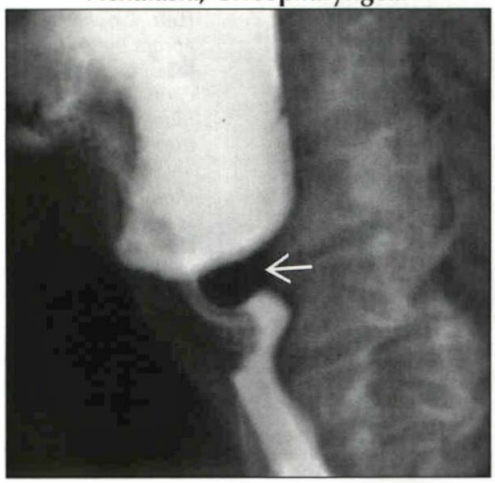
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Determine which side(s) of lumen are indented

Helpful Clues for Common Diagnoses
- **Achalasia, Cricopharyngeal**
  - Smooth indentation of posterior wall at C5-C6 vertebral level
  - May be intermittent or persistent finding
  - Prominent or persistent contraction may result in dilated pharynx with retained barium
  - Usually associated with various forms of esophageal dysmotility
- **Cervical Osteophytes**
  - May or may not be ossified
  - Indent the posterior wall of esophagus, often at several levels
  - Usually asymptomatic, but may be large enough to cause dysphagia
  - Post-operative changes (cervical laminectomy, fusion) may have similar effects on esophagus

Helpful Clues for Less Common Diagnoses
- **Esophageal Webs**
  - Thin, shelf-like indentation of lumen
  - May be congenital or acquired (e.g., as a result of scarring from epidermolysis bullosa)
  - May be associated with glossitis and iron-deficiency anemia (Plummer Vinson syndrome)
  - Arise from anterolateral wall, unlike the more common causes of posterior wall indentation
- **Esophageal Carcinoma**
  - Irregular mucosal surface, eccentric or concentric narrowing of lumen
- **Esophagitis, Drug-Induced**
  - Oral medications may have impaired passage through pharyngo-esophageal junction
  - May result in esophageal spasm, ulceration, stricture
  - Ask about medications (especially tetracycline and cardiac drugs), and odynophagia
- **Neck Mass**
  - Any paraesophageal mass may indent the esophagus
  - Near the pharyngo-esophageal junction, most common are thyroid and parathyroid masses

Achalasia, Cricopharyngeal



Esophagram shows a mass-like indentation ➡ of the posterior wall of the pharyngoesophageal junction (C5-6 level), with distention of the pharynx above.

Achalasia, Cricopharyngeal

Lateral esophagram shows deep indentation of the posterior wall at the PE junction ➡, and distention of the pharynx.

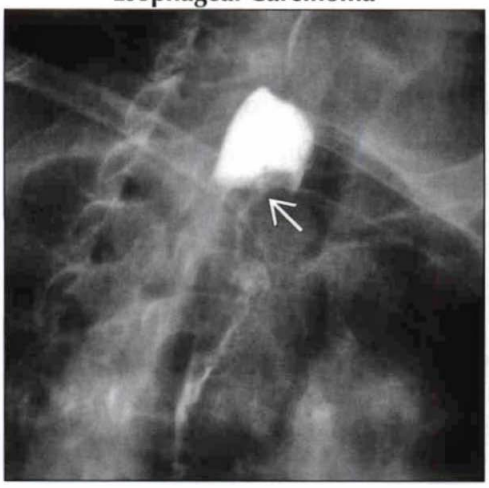
LESION AT PHARYNGO-ESOPHAGEAL JUNCTION

Cervical Osteophytes

Esophageal Webs

(Left) Lateral esophagram shows indentation of the posterior wall of the pharyngo-esophageal junction by cervical osteophytes. (Right) Lateral esophagram shows thin shelf-like indentation of antero-lateral wall of PE junction. The pharynx is mildly dilated above this web. Posterior osteophytes are also noted.

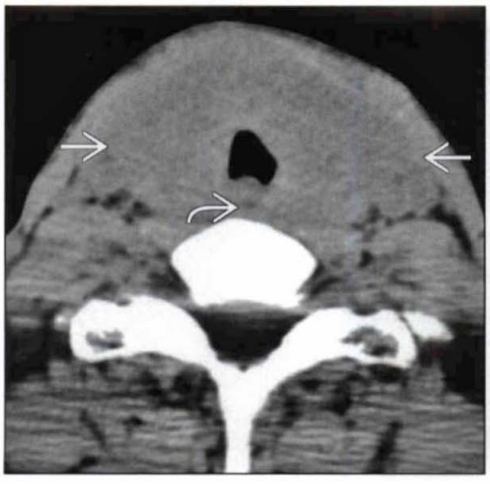
Esophageal Carcinoma



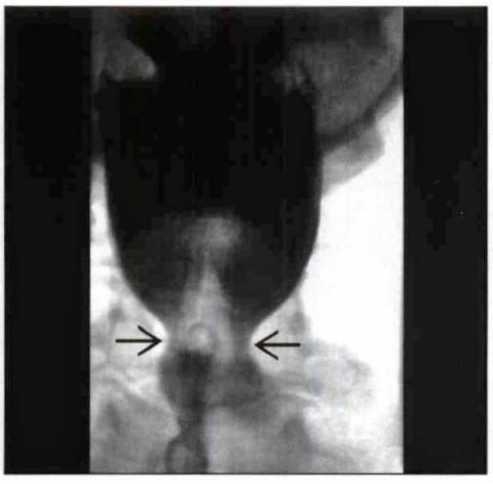
Esophagitis, Drug-Induced

(Left) Oblique esophagram shows an apple core, abrupt, high grade obstructing lesion at the thoracic inlet. (Right) Esophagram shows tight stricture and ulceration at PE junction, caused by oral medication. Pills more commonly "stick" at points of physiological narrowing, such as the aortic knob.

Neck Mass



Neck Mass



(Left) Axial NECT shows a markedly enlarged thyroid, due to autoimmune thyroiditis, that compresses the pharyngo-esophageal junction from all sides. (Right) Frontal esophagram shows distention of the pharynx and compression of the proximal esophagus due to an enlarged thyroid (autoimmune thyroiditis).

ESOPHAGEAL ULCERATION

DIFFERENTIAL DIAGNOSIS

Common
- Reflux Esophagitis
- Candida Esophagitis
- Drug-Induced Esophagitis
- Viral Esophagitis

Less Common
- Caustic Esophagitis
- Radiation Esophagitis
- Nasogastric Intubation
- Crohn Disease

Rare but Important
- Behcet Disease
- Epidermolysis Bullosa Dystrophica & Pemphigoid

ESSENTIAL INFORMATION

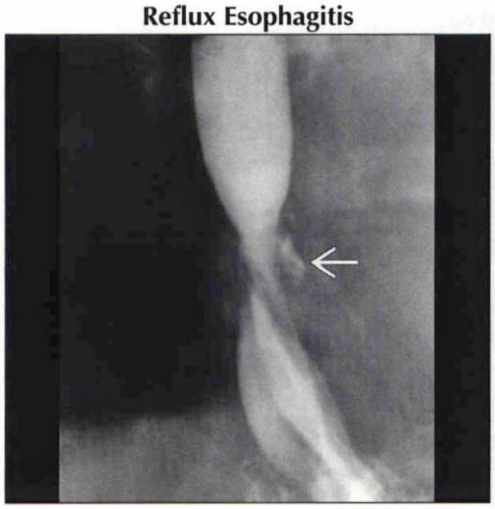
Key Differential Diagnosis Issues
- History is often key (e.g., AIDS, caustic ingestion, other known diseases)

Helpful Clues for Common Diagnoses
- **Reflux Esophagitis**
  - Most common etiology
  - Shallow, punctate or linear ulcers
  - Check for gastroesophageal reflux
- **Candida Esophagitis**
  - Ulcers & diffuse raised plaques ("shaggy")
  - Odynophagia in immunocompromised patients
  - Often have oral thrush (candida)
- **Drug-Induced Esophagitis**
  - Discrete, superficial ulcers
  - Usually near aortic arch or left main bronchus
  - Odynophagia in patients taking oral medications (tetracycline, KCl, heart medications)
- **Viral Esophagitis**
  - Herpes, CMV, HIV
  - Superficial, often large flat ulcers
  - Odynophagia in immunocompromised patient

Helpful Clues for Less Common Diagnoses
- **Caustic Esophagitis**
  - Immediate ulceration and spasm
  - Often leads to long stricture of esophagus
- **Nasogastric Intubation**
  - Long term NG tube leads to reflux and direct trauma to esophagus
  - May cause shallow or long ulcers ± stricture
- **Crohn Disease**
  - Usually in patients with advanced disease
  - Aphthous ulcers (as in stomach and bowel)

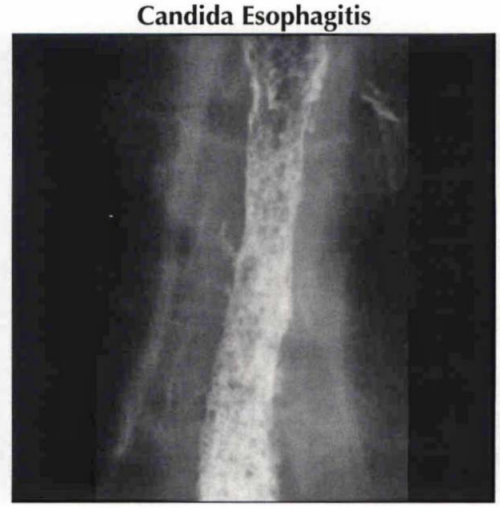
Helpful Clues for Rare Diagnoses
- **Behcet Disease**
  - Ulceration of oral, esophageal and genital mucosa
  - Associated vasculitis
- **Epidermolysis Bullosa Dystrophica & Pemphigoid**
  - Fragile skin and mucous membranes
  - Easily blister, ulcerate, scar

Reflux Esophagitis



Esophagram shows stricture & large ulcer ➡ at gastroesophageal junction, with shortened esophagus & hiatal hernia.

Candida Esophagitis

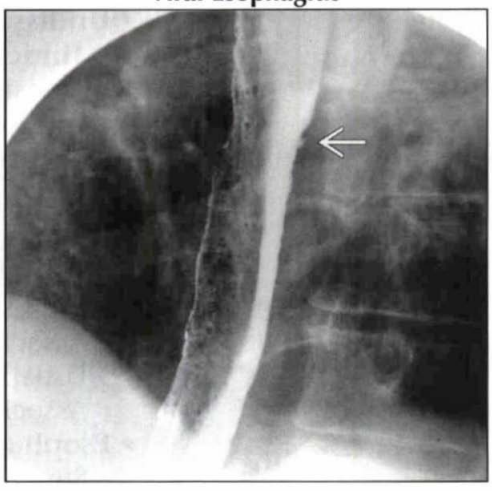


Esophagram shows a shaggy or "tree bark" surface of the esophagus due to diffuse ulceration & raised plaques, typical of severe Candida esophagitis.

ESOPHAGEAL ULCERATION

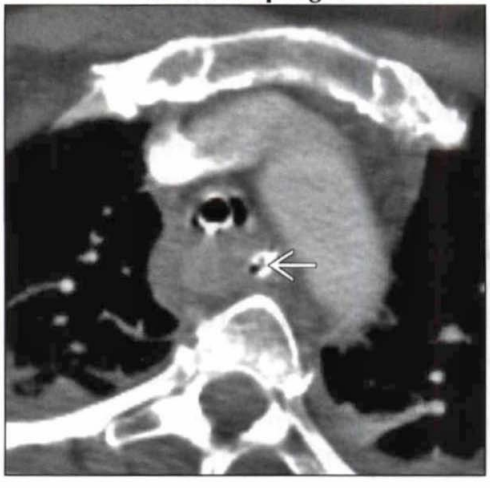
Drug-Induced Esophagitis

Viral Esophagitis



(Left) Esophagram shows multiple shallow ulcerations due to tetracycline-induced esophagitis. (Right) Esophagram shows multiple small, superficial ulcers herpes esophagitis.

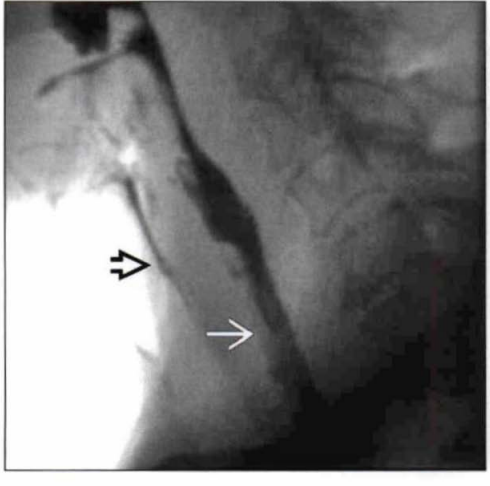
Caustic Esophagitis



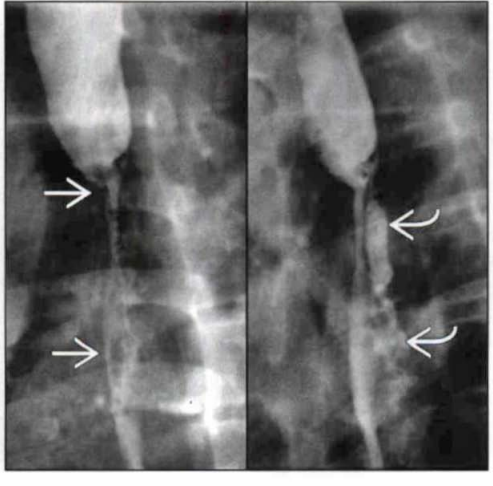
Radiation Esophagitis

(Left) Axial CECT shows massive thickening of the esophageal wall, with its lumen marked by an NG tube. An endotracheal tube is also noted with widespread pulmonary infiltrates. Lye ingestion. (Right) Axial CECT shows damage to the lungs along the radiation port (upper lobe lung cancer). The esophageal wall is thick & the lumen narrowed.

Radiation Esophagitis



Epidermolysis Bullosa Dystrophica & Pemphigoid



(Left) Esophagram shows luminal narrowing & mucosal ulceration of the proximal esophagus, along with aspiration of barium into the trachea. Radiation stricture; upper lobe lung cancer. (Right) Oblique esophagram shows an ulcerated stricture of the mid esophagus due to epidermolysis. Following balloon dilation of the stricture, the esophagus was perforated, with extraluminal contrast extravasation noted.

MUCOSAL NODULARITY, ESOPHAGUS

DIFFERENTIAL DIAGNOSIS

Common
- Reflux Esophagitis
- Candida Esophagitis
- Viral Esophagitis
- Glycogenic Acanthosis
- Undissolved Gas Granules, Bubbles (Mimics)

Less Common
- Barrett Esophagus
- Esophageal Carcinoma

Rare but Important
- Papillomatosis, Esophageal
- Acanthosis Nigricans
- Cowden Disease
- Leukoplakia

ESSENTIAL INFORMATION

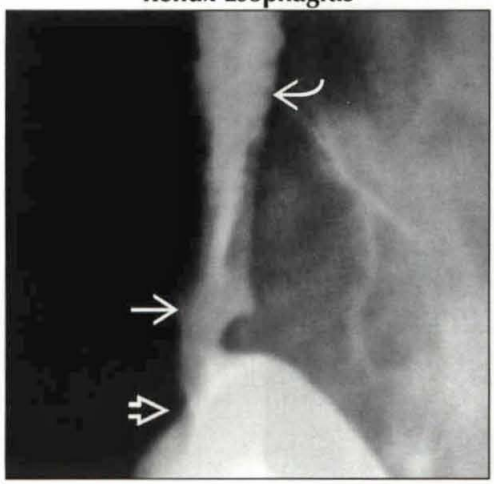
Key Differential Diagnosis Issues
- Consider clinical setting (symptoms, age of patient, AIDS, etc.)

Helpful Clues for Common Diagnoses
- **Reflux Esophagitis**
  - Poorly defined nodules; granular mucosa
  - Usually affects distal third of esophagus
  - Gastroesophageal reflux, hiatal hernia
- **Candida Esophagitis**
  - Discrete plaques & ulcers; shaggy mucosa
  - May be localized or diffuse
  - Odynophagia in immunocompromised
- **Glycogenic Acanthosis**
  - Numerous small nodules or plaques; less well-defined than candidiasis
  - Localized or diffuse; asymptomatic
- **Undissolved Gas Granules, Bubbles (Mimics)**
  - Transient finding, usually with first swallows during air-contrast esophagram

Helpful Clues for Less Common Diagnoses
- **Barrett Esophagus**
  - Fine surface nodularity is characteristic, but difficult to distinguish from other causes
  - Associated esophageal ulceration, stricture
  - Usually distal third of esophagus
  - Associated GE reflux and hiatal hernia
- **Esophageal Carcinoma**
  - Superficial spreading carcinoma can appear as poorly defined, coalescent nodules or plaques
  - Localized more often than diffuse
  - Often asymptomatic

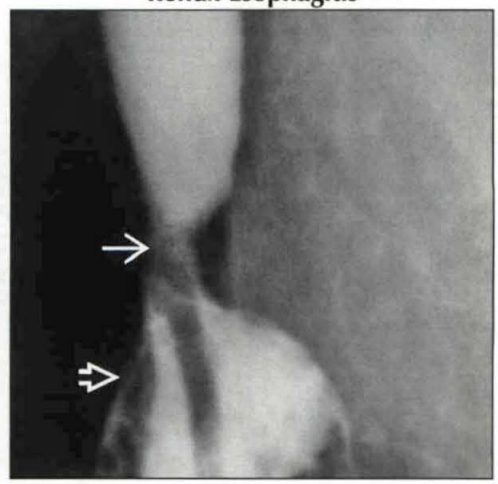
Helpful Clues for Rare Diagnoses
- **Papillomatosis, Esophageal**
  - More commonly affects the larynx
  - Related to human papilloma viral infection
- **Cowden Disease**
  - Tiny nodules = hamartomatous polyps
  - Hereditary with associated tumors of skin, GI tract, and thyroid
- **Leukoplakia**
  - Common in mouth, rare in esophagus
  - Hyperkeratosis, dysplasia on biopsy

Reflux Esophagitis



Oblique esophagram shows a stricture at the EG junction ➡, a small hiatal hernia ➪, and nodular mucosal surface ➡ of the esophagus, all due to GERD.

Reflux Esophagitis

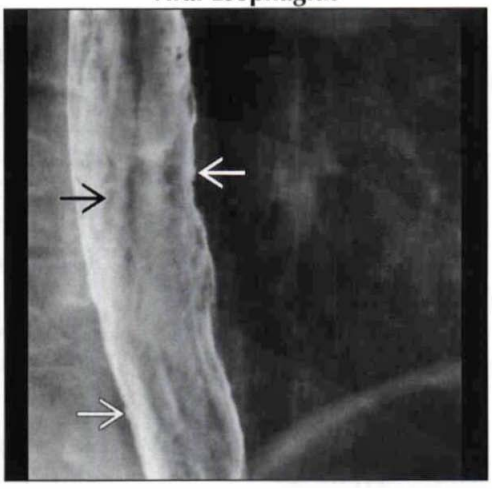


Oblique esophagram shows a peptic stricture ➡ of the esophagus, along with a small hiatal hernia ➪. Nodularity of the esophageal mucosa is less evident with full distention of the lumen.

MUCOSAL NODULARITY, ESOPHAGUS

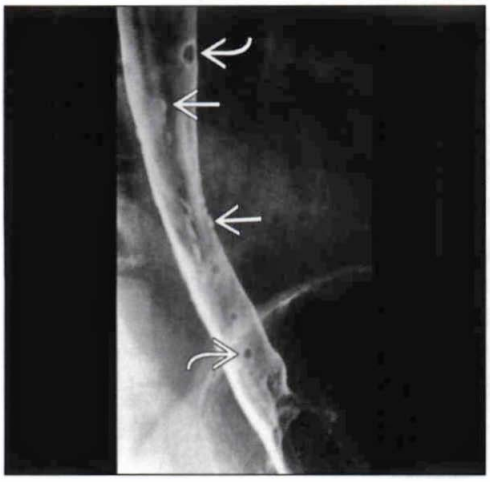
Candida Esophagitis

Viral Esophagitis

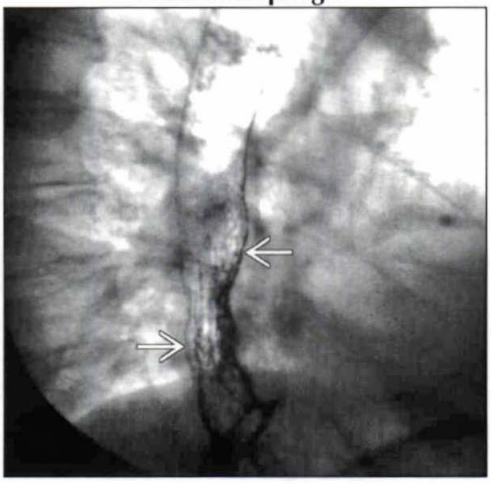


(Left) *Esophagram shows a shaggy "tree bark" appearance of the esophagus, due to ulcerations and plaques from Candida esophagitis.* ***(Right)*** *Oblique esophagram shows multiple superficial ulcerations and raised plaques in a patient with AIDS. Viral esophagitis (but indistinguishable from Candida esophagitis by imaging alone).*

Undissolved Gas Granules, Bubbles (Mimics)

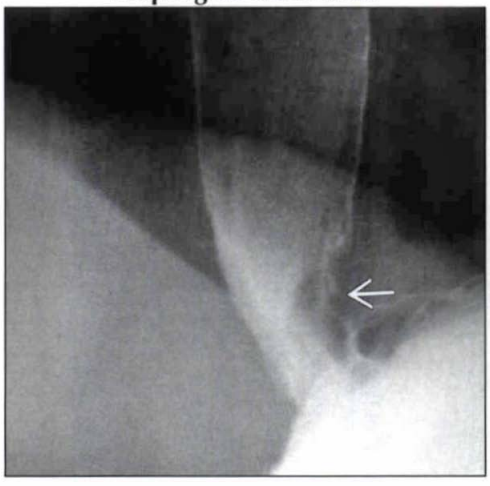


Barrett Esophagus



(Left) *Oblique esophagram shows multiple radiolucent filling defects that represent gas bubbles that are adherent to the esophageal surface. Also present are multiple ulcerations due to tetracycline-induced esophagitis.* ***(Right)*** *Oblique esophagram shows nodular distal esophageal mucosa due to Barrett esophagus. A hiatal hernia and reflux were also demonstrated.*

Esophageal Carcinoma



Papillomatosis, Esophageal

(Left) *Esophagram shows nodular thickened folds in the distal esophagus and fundus of stomach. These nodules are much larger than those seen in most infectious conditions.* ***(Right)*** *Esophagram shows clusters of small, irregular nodules that represent biopsy-proved squamous papillomas.*

ESOPHAGEAL STRICTURES

DIFFERENTIAL DIAGNOSIS

Common
- Reflux Esophagitis
- Barrett Esophagus
- Esophageal Carcinoma
- Scleroderma, Esophagus

Less Common
- Esophageal Metastases and Lymphoma
- Radiation Esophagitis
- Caustic Esophagitis
- Drug-Induced Esophagitis
- Candida Esophagitis
- Nasogastric Intubation

Rare but Important
- Crohn Disease
- Graft-Versus-Host Disease (GVHD)
- Glutaraldehyde-Induced Injury
- Epidermolysis & Pemphigoid
- Esophagitis, Eosinophilic

ESSENTIAL INFORMATION

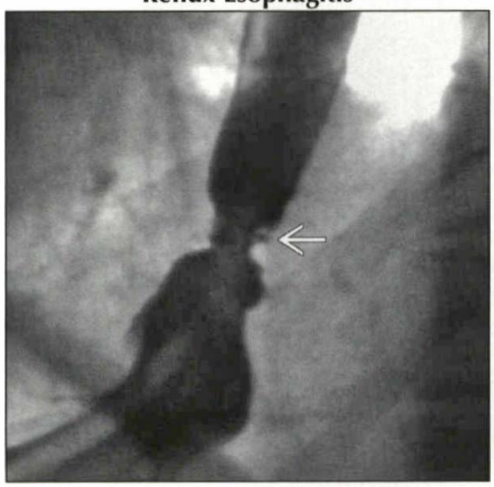
Key Differential Diagnosis Issues
- History is key (e.g., radiation therapy, caustic or drug ingestion, bone marrow transplant)

Helpful Clues for Common Diagnoses
- **Reflux Esophagitis**
  - Peptic stricture of distal 3rd
  - Hiatal hernia, reflux, short esophagus
  - Often with ulceration
  - Short, tapered, symmetric or asymmetric
- **Barrett Esophagus**
  - Distal or mid-esophagus
  - Often with ulceration
  - Short or moderate length, symmetric or asymmetric
- **Esophageal Carcinoma**
  - Middle 3rd (50%), lower 3rd (30%), upper 3rd (20%)
  - Abrupt narrowing, "apple core"
  - Irregular nodular surface; ulceration
  - Moderate length; asymmetric
- **Scleroderma, Esophagus**
  - Distal 3rd
  - Short or moderate length; symmetric taper
  - Diminished or absent peristalsis

Helpful Clues for Less Common Diagnoses
- **Esophageal Metastases and Lymphoma**
  - Lung or gastric cancer may invade esophagus
  - Hematogenous mets & lymphoma are rare
- **Radiation Esophagitis**
  - Long stricture of mid esophagus
  - Check for history of radiation therapy (lymphoma, lung, or breast cancer)
- **Caustic Esophagitis**
  - Long, high grade stricture
- **Nasogastric Intubation**
  - Mimics caustic ingestion stricture

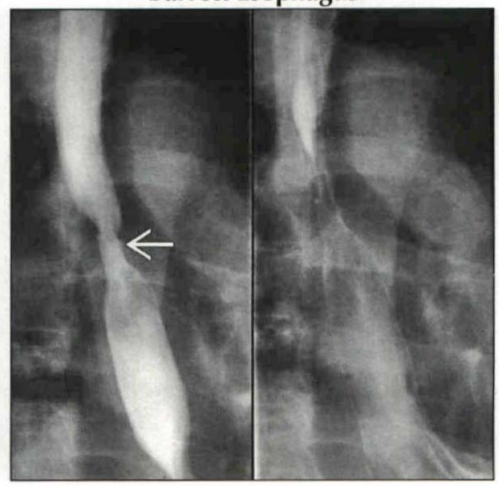
Helpful Clues for Rare Diagnoses
- **Glutaraldehyde-Induced Injury**
  - Agent used to sterilize endoscopes is very caustic if not thoroughly removed

Reflux Esophagitis



Oblique esophagram shows a small hiatal hernia, shortened esophagus, and a stricture of the distal esophagus with ulceration ➡

Barrett Esophagus

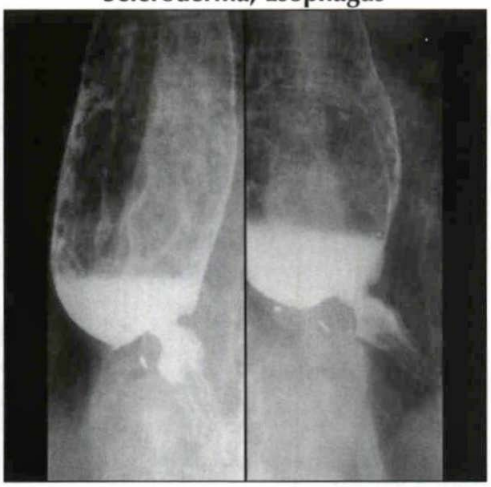


Oblique esophagram shows a stricture and ulceration ➡ *of the distal 3rd of the esophagus.*

ESOPHAGEAL STRICTURES

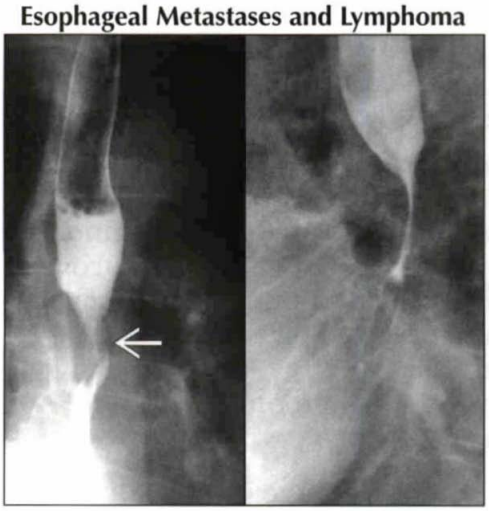
Esophageal Carcinoma

Scleroderma, Esophagus

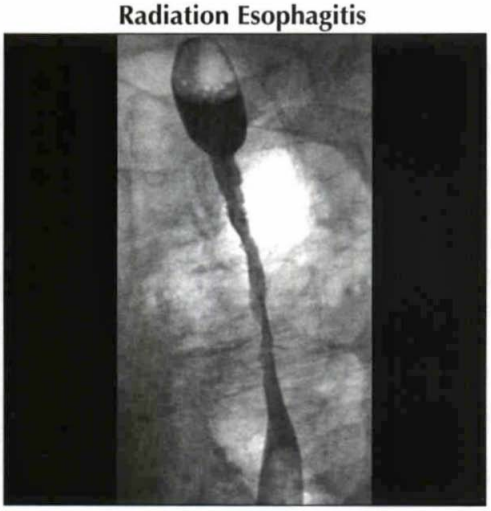


(Left) Oblique esophagram shows an apple core narrowing ➔ of the distal esophagus, with nodular, destroyed mucosal surface. (Right) Oblique esophagram shows a tight stricture of the distal esophagus with a markedly dilated, atonic esophagus. The appearance mimics achalasia, but the stricture is more abrupt and irregular.

Esophageal Metastases and Lymphoma

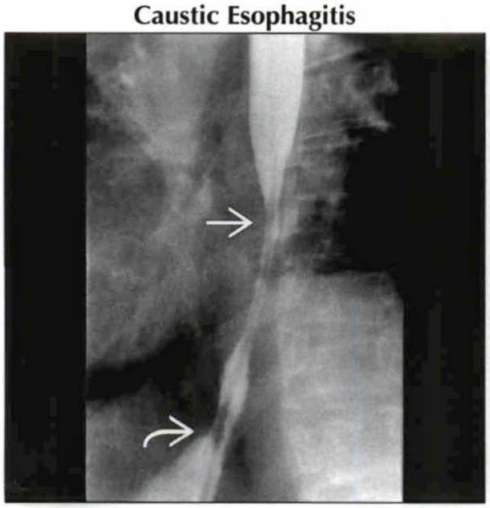


Radiation Esophagitis

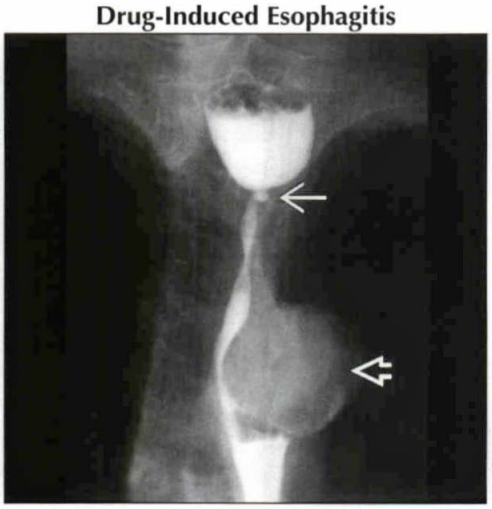


(Left) Oblique esophagram shows a tight but smoothly tapered stricture ➔ of the mid esophagus. Direct invasion by lung cancer. (Right) Oblique esophagram shows medium length stricture of mid esophagus, 8 months after radiation therapy for right lung cancer and mediastinal lymph node metastases.

Caustic Esophagitis



Drug-Induced Esophagitis



(Left) Oblique esophagram shows long smooth stricture ➔ of distal half of esophagus, with a shortened esophagus causing hiatal hernia ➔. (Right) Frontal esophagram shows high grade stricture and ulceration ➔ of the proximal esophagus, just above the aortic knob ➔, in this elderly woman with odynophagia.

DILATED ESOPHAGUS

DIFFERENTIAL DIAGNOSIS

Common
- Achalasia, Esophagus
- Scleroderma, Esophagus
- Post-Vagotomy State
- Fundoplication Complications
- Reflux Esophagitis
- Esophageal Carcinoma
- Hiatal Hernia (Mimic)
- Post-Esophagectomy (Mimic)

Less Common
- Gastric Carcinoma
- Metastases and Lymphoma, Esophageal
- Chagas Disease

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Check for history of prior surgery

Helpful Clues for Common Diagnoses
- **Achalasia, Esophagus**
  - Primary motility disorder; aperistaltic
  - Grossly dilated esophagus; often elongated
  - Ends in smooth taper; "bird beak"
  - Onset in younger patients (20-40)
- **Scleroderma, Esophagus**
  - Collagen vascular disorder of skin, smooth muscle
  - Diminished or absent peristalsis
  - Stricture and esophageal dilation are late findings
  - More common in women
- **Post-Vagotomy State**
  - Vagotomy often performed for acid peptic disease
  - Reflux (peptic) stricture may contribute to dilation
- **Fundoplication Complications**
  - Fundoplication wrap may be excessively tight, impairing esophageal emptying
- **Reflux Esophagitis**
  - Esophagitis may cause diminished peristalsis
  - Peptic stricture contributes to dilation
- **Esophageal Carcinoma**
  - Narrowed lumen may cause dilation of esophagus upstream
- **Hiatal Hernia (Mimic)**
  - Intrathoracic part of stomach may be mistaken for dilated esophagus
- **Post-Esophagectomy (Mimic)**
  - Stomach may be pulled into thorax, anastomosed to proximal esophagus
  - May be mistaken for dilated esophagus on esophagram, CT, etc.

Helpful Clues for Less Common Diagnoses
- **Gastric Carcinoma**
  - Cancer arising in gastric cardia or fundus may invade distal esophagus submucosa
  - Involvement of intramural nerves may result in diminished peristalsis
- **Chagas Disease**
  - Parasitic disease common in South America and Mexico

Achalasia, Esophagus

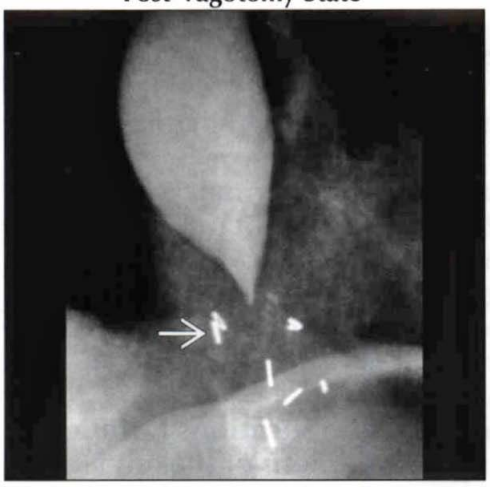
Frontal esophagram shows marked dilation of the esophagus in a 28 year-old woman. Classic bird beak narrowing ➡ of distal esophagus and absent peristalsis.

Scleroderma, Esophagus

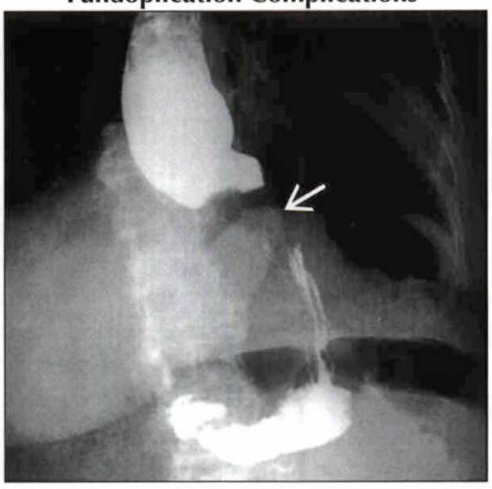
Frontal esophagram shows marked dilation and atony of the esophagus with stasis of barium in the upright position, and a tight stricture ➡ at the GE junction.

DILATED ESOPHAGUS

Post-Vagotomy State

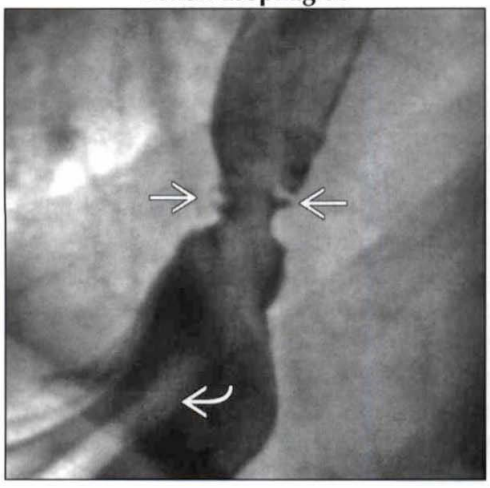


Fundoplication Complications

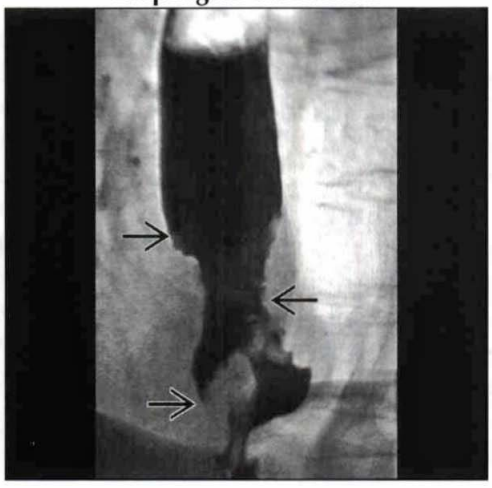


(Left) *Oblique esophagram shows a dilated esophagus with a smooth tapered stricture just above the esophagogastric junction. Note clips from vagotomy* ➡. ***(Right)*** *Esophagram shows a dilated esophagus with stasis of food and barium on this upright view. Stricture of the distal esophagus* ➡ *is due to a tight fundoplication wrap.*

Reflux Esophagitis

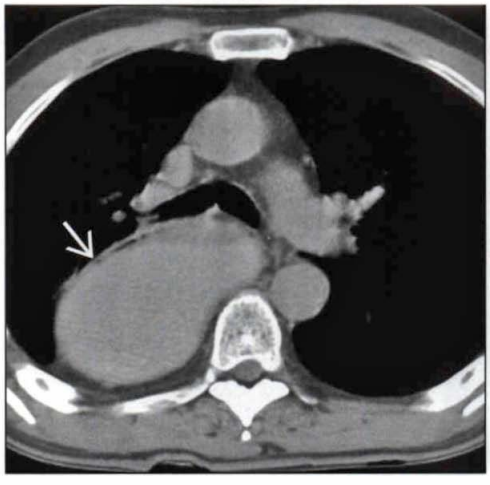


Esophageal Carcinoma

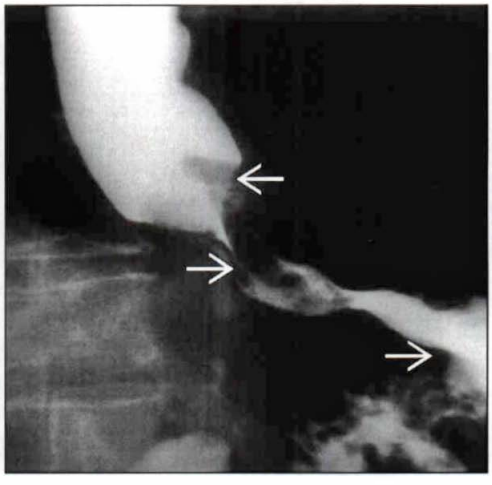


(Left) *Oblique esophagram shows a stricture at the GE junction with ulcerations* ➡. *The esophagus was dilated with poor peristalsis. Gastric folds* ➡ *within hiatal hernia.* ***(Right)*** *Esophagram shows a dilated atonic esophagus with abrupt transition to a narrowed lumen with an apple core, nodular surface pattern* ⇨.

Hiatal Hernia (Mimic)



Gastric Carcinoma



(Left) *Axial NECT shows a dilated tubular structure* ➡ *in the thorax with oral contrast. On axial CT it would be difficult to recognize this as a hiatal hernia, and not a dilated esophagus.* ***(Right)*** *Oblique esophagram shows a dilated esophagus with abrupt narrowing at the EG junction. A mass causes constriction of the gastric cardia & fundus* ➡ *and extends into the submucosa of the esophagus.*

ESOPHAGEAL OUTPOUCHINGS (DIVERTICULA)

DIFFERENTIAL DIAGNOSIS

Common
- Zenker Diverticulum
- Traction Diverticulum
- Pulsion Diverticulum
- Hiatal Hernia (Mimic)
- Post-Esophagectomy (Mimic)
- Fundoplication Complications (Mimic)

Less Common
- Killian-Jamieson Diverticulum
- Intramural Pseudodiverticulosis
- Boerhaave Syndrome (Mimic)

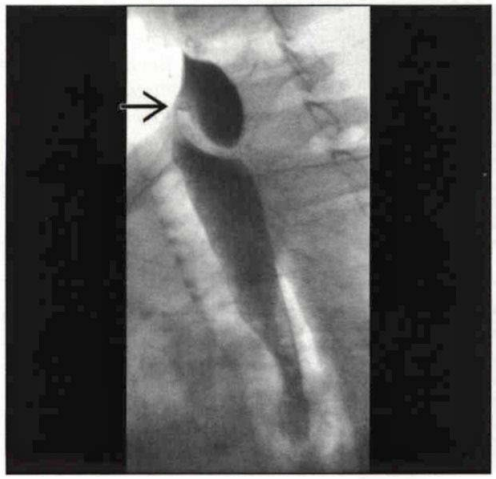
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Most diverticula are pulsion & are associated with abnormalities of esophageal peristalsis

Helpful Clues for Common Diagnoses
- **Zenker Diverticulum**
  - Outpouching from posterior wall of pharyngoesophageal junction; just above cricopharyngeus muscle
  - Usually starts at C5 vertebral level
  - Increased prevalence with aging
- **Traction Diverticulum**
  - Usually mid esophagus near carina
  - Acquired due to adherence to subcarinal or perihilar granulomatous lymph nodes
  - Look for calcified nodes and granulomas in lungs
- **Pulsion Diverticulum**
  - Saccular, often large, outpouching
  - Distal (epiphrenic) is most common
  - Strongly associated with esophageal motility disturbances (e.g., presbyesophagus, diffuse esophageal spasm)
  - Easily mistaken for a hiatal hernia and vice versa
- **Post-Esophagectomy (Mimic)**
  - Often with gastric conduit pulled into chest and anastomosed to stump of esophagus
  - Outpouching at anastomosis or dilation of gastric conduit may mimic diverticulum or dilated esophagus
- **Fundoplication Complications (Mimic)**
  - Barium may fill portions of the fundal wrap, resembling a diverticulum

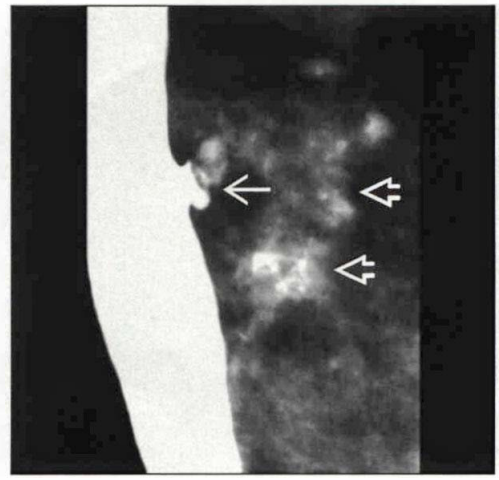
Helpful Clues for Less Common Diagnoses
- **Killian-Jamieson Diverticulum**
  - Originate from anterolateral wall of cervical esophagus (higher, more anterior and usually smaller than Zenker diverticulum)
- **Intramural Pseudodiverticulosis**
  - Barium trapped in dilated excretory ducts of deep mucous glands
  - Multiple, tiny (1-4 mm depth), flask-like outpouchings
- **Boerhaave Syndrome (Mimic)**
  - Or any cause of esophageal perforation
  - May result in a para-esophageal collection of gas, fluid, or contrast medium

Zenker Diverticulum



Oblique esophagram shows a moderate size diverticulum ⇨ originating at the pharyngo-esophageal junction that extends into the upper mediastinum.

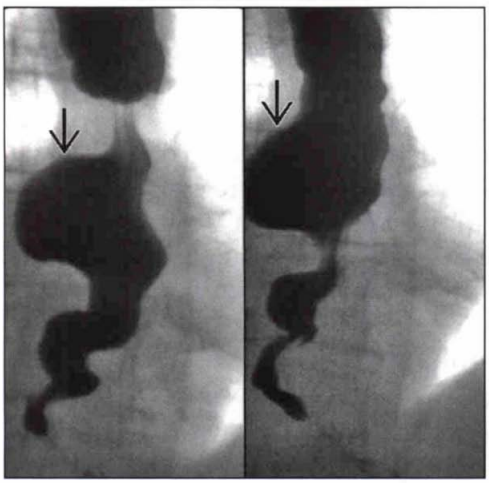
Traction Diverticulum



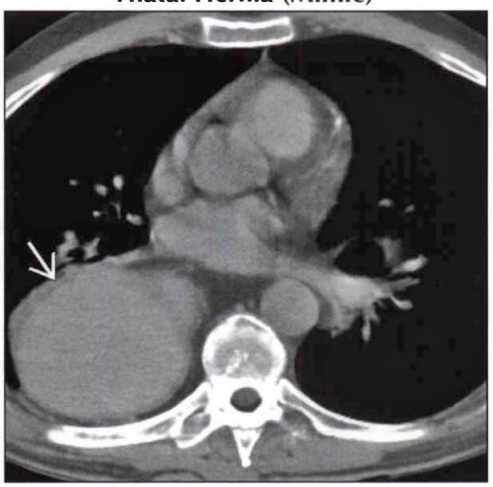
Oblique esophagram shows an outpouching ➡ from the mid esophagus (carinal level). Note the calcified perihilar lymph nodes ⇨.

ESOPHAGEAL OUTPOUCHINGS (DIVERTICULA)

Pulsion Diverticulum

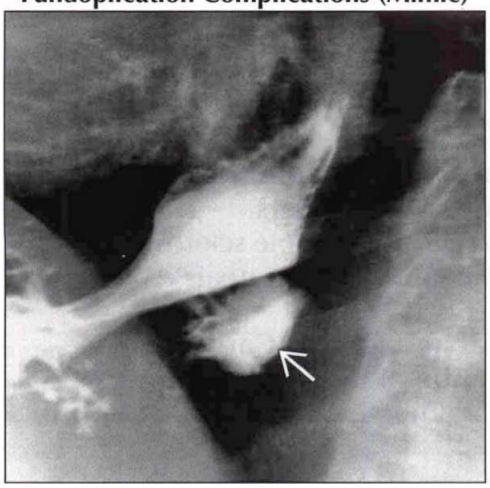


Hiatal Hernia (Mimic)

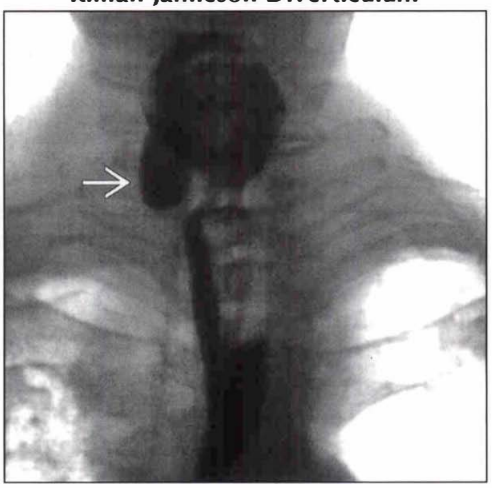


(Left) Oblique esophagram shows deep tertiary contractions and a pulsion diverticulum ⇨, in an elderly patient with severe dysphagia. (Right) Axial NECT shows a structure containing oral contrast in the distal thorax, a hiatal hernia ➡. A pulsion diverticulum, gastric pull-through or achalasia could have a similar appearance on CT.

Fundoplication Complications (Mimic)

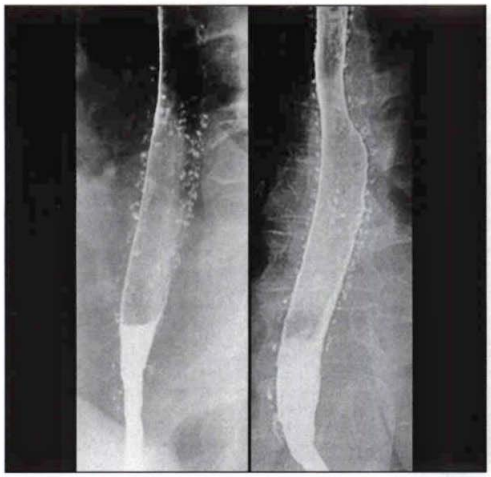


Killian-Jamieson Diverticulum

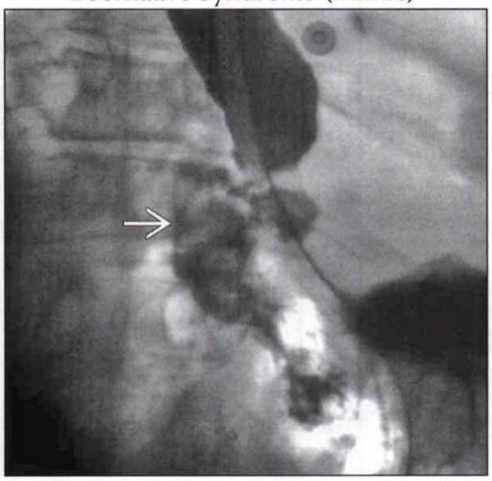


(Left) Oblique esophagram shows a collection of barium ➡ within the fundoplication wrap, which has slipped into the thorax. (Right) Frontal esophagram shows an outpouching ➡ from the anterolateral wall of the cervical esophagus.

Intramural Pseudodiverticulosis



Boerhaave Syndrome (Mimic)



(Left) Oblique esophagram shows innumerable tiny flask-shaped outpouchings of barium within the wall of the esophagus. (Right) Oblique esophagram shows an irregular collection of contrast (& gas) ➡ in the lower mediastinum, which has leaked out of the perforated distal esophagus.

ESOPHAGEAL DYSMOTILITY

DIFFERENTIAL DIAGNOSIS

Common

- Presbyesophagus
- Diffuse Esophageal Spasm
- Achalasia, Esophagus
- Scleroderma, Esophagus
- Reflux Esophagitis
- Fundoplication Complications
- Post-Vagotomy State

Less Common

- Neuromuscular Disorders
- Esophageal Carcinoma
- Gastric Carcinoma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Manometry and barium esophagram are complementary

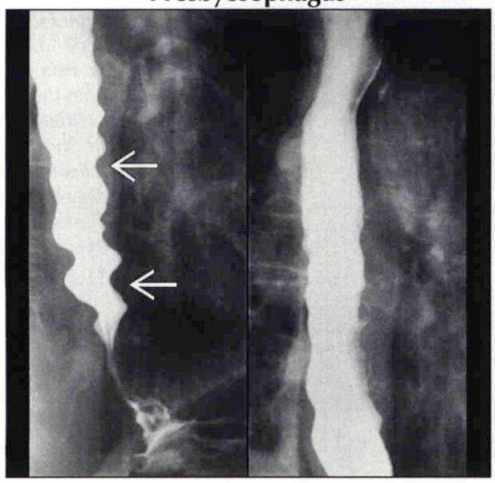
Helpful Clues for Common Diagnoses

- **Presbyesophagus**
  - "Nonspecific esophageal motility disorder"
  - Increased prevalence with aging
  - Decreased primary peristalsis; frequent tertiary (nonpropulsive) contractions
- **Diffuse Esophageal Spasm**
  - Intermittent disruption of primary peristalsis with focally obliterative secondary or tertiary contractions
  - May impart "corkscrew" appearance to esophagram
  - May cause chest pain simulating angina
- **Achalasia, Esophagus**
  - Absent primary peristalsis
  - May have tertiary contractions early in disease
  - Dilated esophagus ending in tapered "bird beak" deformity
- **Scleroderma, Esophagus**
  - Multisystem collagen vascular disease
  - Early disease: Nonperistaltic esophagus with patulous GE junction
  - Late disease: Dilated esophagus with peptic stricture at GE junction; simulates achalasia
- **Reflux Esophagitis**
  - Esophagus is often foreshortened (spasm of longitudinal muscles); usually normal caliber
  - Distal peptic stricture; possible ulcerations and nodular mucosa
  - Esophagitis itself impairs normal peristalsis
- **Surgical Complications**
  - Fundoplication or vagotomy may result in narrowed distal esophagus and poor esophageal emptying

Helpful Clues for Less Common Diagnoses

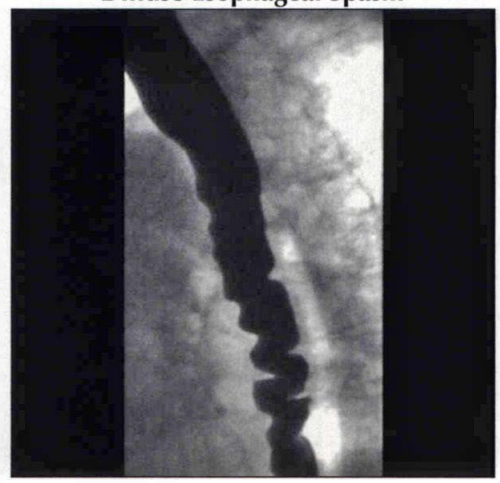
- **Neuromuscular Disorders**
  - Diseases such as multiple sclerosis, ALS, myasthenia gravis may impair esophageal motility
- **Esophageal and Gastric Carcinoma**
  - Combination of luminal narrowing & submucosal nerve plexus destruction

Presbyesophagus



Oblique esophagram shows 2 views of the esophagus in an elderly man with dysphagia and food sticking. Note the inconstant tertiary contractions ⇒. Primary peristalsis was absent.

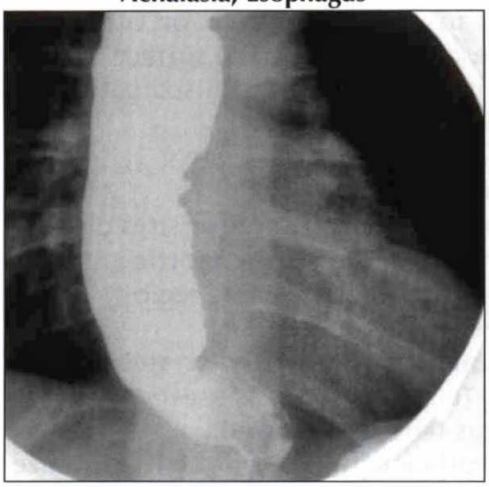
Diffuse Esophageal Spasm



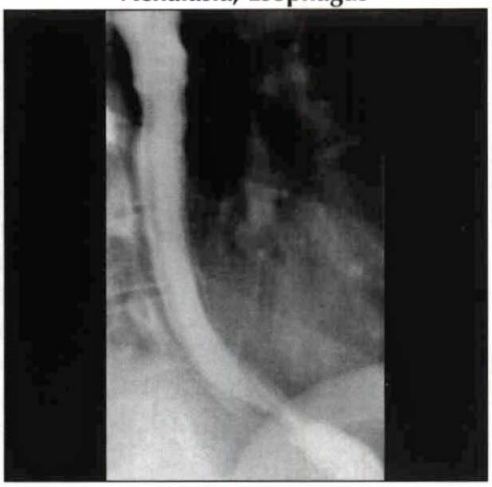
Oblique esophagram shows persistent deep contractions of the esophagus, in an elderly patient with dysphagia & chest pain. This has been described as a "corkscrew esophagus".

ESOPHAGEAL DYSMOTILITY

Achalasia, Esophagus



Achalasia, Esophagus



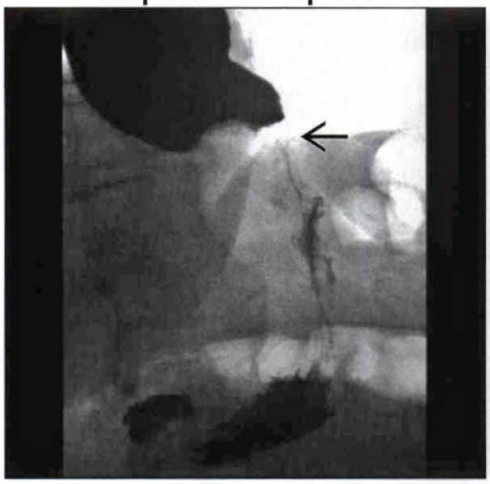
(Left) *Frontal esophagram shows a very dilated and atonic esophagus terminating in a bird beak narrowing at the GE junction; 28 year old woman with chronic dysphagia.* ***(Right)*** *Oblique esophagram shows a normal caliber esophagus that emptied readily in the upright position; 28 year old woman who had been treated with Heller myotomy.*

Scleroderma, Esophagus

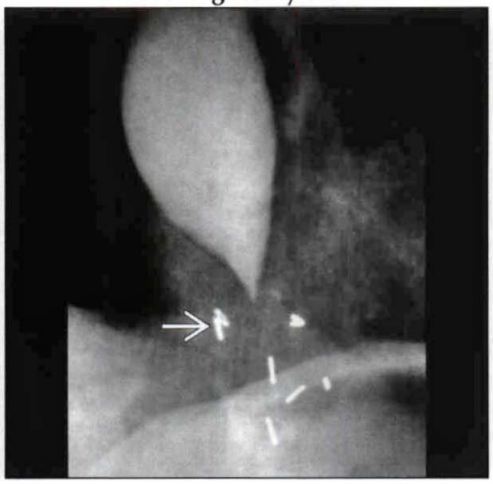
Reflux Esophagitis

(Left) *Esophagram shows moderate dilation of the lumen, absent primary peristalsis, and deep tertiary contractions.* ***(Right)*** *Esophagram shows a deep ulcer ➡ at the GE junction, and a shortened esophagus with hiatal hernia ➡. Primary peristalsis was minimal.*

Fundoplication Complications



Post-Vagotomy State



(Left) *Oblique esophagram shows a dilated esophagus that had minimal peristalsis, with prolonged retention of barium; fundoplication that is too tight, ➡ especially in this elderly patient.* ***(Right)*** *Oblique esophagram shows a dilated esophagus with a smooth, distal, tapered obstruction. Note clips ➡ from vagotomy.*

ODYNOPHAGIA

DIFFERENTIAL DIAGNOSIS

Common
- Pharyngitis
- Reflux Esophagitis
- Candida Esophagitis
- Viral Esophagitis
- Drug-Induced Esophagitis
- Esophageal Foreign Body

Less Common
- Caustic Esophagitis
- Radiation Esophagitis

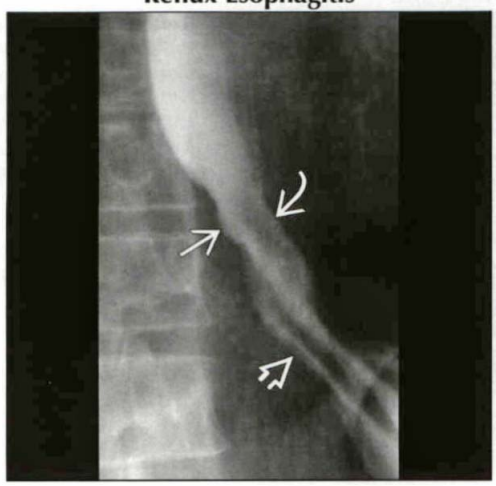
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Odynophagia almost always indicates mucosal irritation or ulceration
- Clinical setting & history are key elements in differential diagnosis

Helpful Clues for Common Diagnoses
- **Pharyngitis**
  - Inflammation of the pharyngeal mucosa, associated with several common viral and bacterial infections
  - Clinical, not radiographic, diagnosis
- **Reflux Esophagitis**
  - Distal ulcers/erosions, hiatal hernia, reflux
- **Candida Esophagitis**
  - Common cause of odynophagia in immunocompromised patients (can occur in immunocompetent as well)
  - Usually associated with oral thrush
  - Shaggy esophageal surface; raised plaques & shallow ulcers
- **Viral Esophagitis**
  - Usually causes shallow ulcers on otherwise normal esophageal mucosal surface
  - Occurs in immunocompromised patients
- **Drug-Induced Esophagitis**
  - Causes sudden onset of severe odynophagia
  - Ulceration, spasm, stricture at sites of normal luminal narrowing (aortic arch, left main bronchus, retrocardiac region)
- **Esophageal Foreign Body**
  - Fish or chicken bones often scratch the pharynx (e.g., pyriform sinuses) or esophagus when swallowed
  - May be sufficiently radiopaque to visualize in radiography
  - May need to have patient swallow cotton swab soaked in barium to identify luminal projection of foreign body

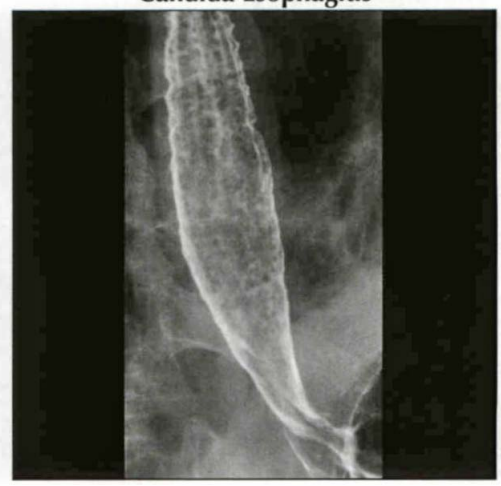
Helpful Clues for Less Common Diagnoses
- **Caustic Esophagitis**
  - Odynophagia is severe and immediate following ingestion of strong acid or alkaline material
  - May prevent immediate evaluation by barium esophagram
  - CT is good alternative to demonstrate esophageal wall thickening, any evidence of perforation, aspiration pneumonitis

Reflux Esophagitis



Oblique esophagram shows a small hiatal hernia and a shortened esophagus, with a distal esophageal stricture and a broad-based ulcer.

Candida Esophagitis

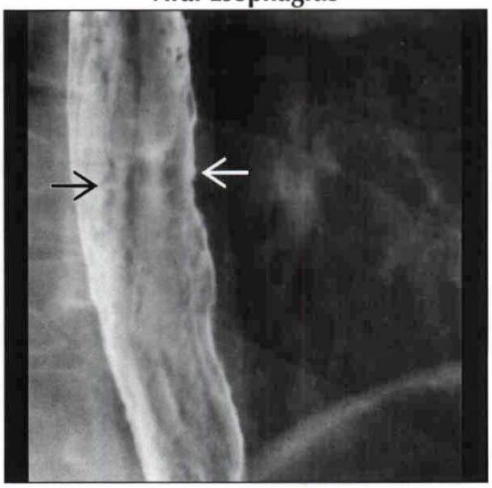


Oblique esophagram shows a markedly irregular mucosal surface, due to raised plaques and superficial ulcerations.

ODYNOPHAGIA

Viral Esophagitis

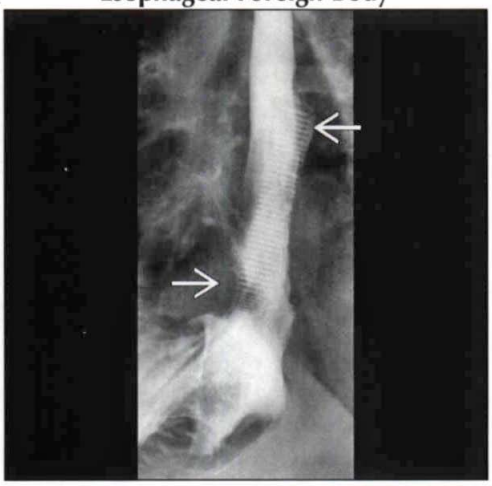
Viral Esophagitis



(Left) Oblique esophagram shows a large, shallow ulcer ➡ in an otherwise normal esophagus, in a patient with AIDS; HIV-induced ulceration. (Right) Oblique esophagram shows both superficial ulcerations ➡ and raised plaques ⇨, proven to be due to viral (herpes) esophagitis, but indistinguishable from Candida esophagitis by imaging.

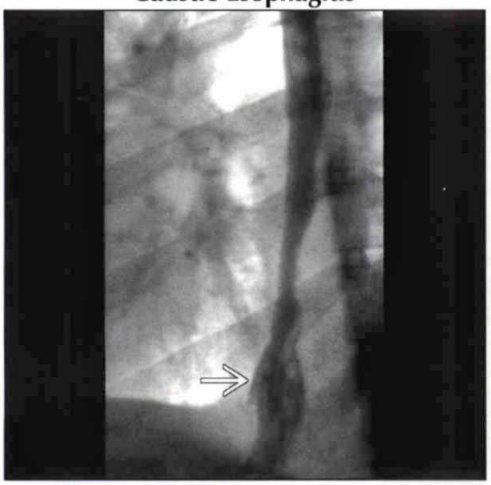
Drug-Induced Esophagitis

Esophageal Foreign Body

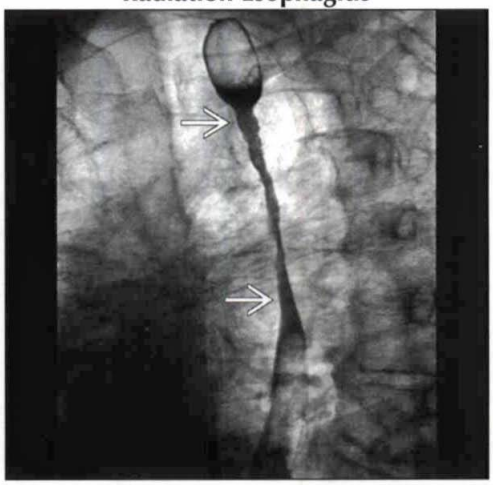


(Left) Oblique esophagram shows multiple ulcerations ➡ due to tetracycline; middle-aged woman with severe odynophagia. (Right) Oblique esophagram shows a comb ➡ within the distal esophagus. This mentally disturbed patient complained of odynophagia and dysphagia, and the foreign body had not been anticipated.

Caustic Esophagitis



Radiation Esophagitis



(Left) Oblique esophagram shows a long stricture & shortening of the distal two thirds of the esophagus, result of lye ingestion several days before. Stomach ➡ is pulled up into the chest as a result of spasm of the longitudinal esophageal muscles. (Right) Oblique esophagram shows a long stricture ➡ of the mid esophagus, due to radiation injury, following treatment for lung cancer with mediastinal lymphadenopathy.

SECTION 4
Stomach

Generic Imaging Patterns

Gastric Mass Lesions	4-2
Intramural Mass, Stomach	4-8
Target or "Bull's Eye" Lesions, Stomach	4-10
Gastric Ulceration (without Mass)	4-12
Intrathoracic Stomach	4-14
Thickened Gastric Folds	4-16
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Clinically Based Differentials

Epigastric Pain	4-34
Left Upper Quadrant Mass	4-40

GASTRIC MASS LESIONS

DIFFERENTIAL DIAGNOSIS

Common

- Gastric Carcinoma
- Hyperplastic Polyps
- Artifacts
  - Air (Gas) Bubbles
  - Apposed Walls of Stomach
- Adenomatous Polyp
- Intramural Benign Gastric Tumors
- Bezoar (Mimic)
- Perigastric Mass (Mimic)
  - Splenomegaly and Hypersplenism
  - Renal Cell Carcinoma
  - Hepatocellular Carcinoma
  - Splenosis
- Gastric Varices

Less Common

- GIST, Gastric
- Gastric Metastases and Lymphoma
- Gardner Syndrome
- Hamartomatous Polyposis Syndromes
- Other Mesenchymal Tumors
- Ectopic Pancreatic Tissue
- Hematoma, Gastric
- Duplication Cyst, Stomach

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Primary gastric mucosal lesion
  - Irregular surface; acute angles with inner wall of stomach
- Intramural mass lesion
  - Smooth mucosal surface; sharp obtuse angle with inner wall
- Extrinsic mass lesion
  - Smooth mucosal surface; shallow obtuse angles with gastric wall

Helpful Clues for Common Diagnoses

- **Gastric Carcinoma**
  - Variable morphological features
  - Nodular folds, polypoid mass, ulceration are common in advanced disease
  - Lack of peristalsis and limited distensibility of affected part of stomach are key features
  - CT usually shows extension outside stomach (lymphatic, direct invasion, liver metastasis)
- **Hyperplastic Polyps**
  - Round, small, sessile polyps; most common polyps
  - Usually multiple in fundus and body
  - Not premalignant
- **Air (Gas) Bubbles**
  - Swallowed air or dissolving gas granules may simulate small polypoid lesions
- **Apposed Walls of Stomach**
  - On air contrast UGI series, anterior & posterior walls of stomach may temporarily "stick together", mimic a mass lesion in barium pool or a mass coated with barium
- **Adenomatous Polyp**
  - Usually solitary, lobulated, or on stalk
  - Usually in antrum
  - Considered premalignant
- **Intramural Benign Gastric Tumors**
  - Any component of gastric wall may give rise to benign or malignant tumor
  - Gastric lipoma is most common lesion, recognized by fat content
  - Often arise in gastric antrum; may prolapse through pylorus, causing intermittent obstruction
- **Bezoar (Mimic)**
  - History of prior surgery (e.g., partial gastrectomy), psychiatric disease
  - Adolescent girls may chew on ends of their hair; results in trichobezoar
  - Movable large mass which fills stomach
- **Perigastric Mass (Mimic)**
  - Mass arising from any adjacent structure may simulate a gastric mass
  - On upper GI series, extrinsic masses are especially likely to simulate intramural masses of the stomach
  - On CT or MR look for fat plane separating the stomach from an extrinsic mass
    - Multiplanar imaging is often useful
- **Gastric Varices**
  - In a patient with portal hypertension or splenic vein occlusion
  - Easy to recognize on CECT; may mimic a tumor on NECT or UGI series

Helpful Clues for Less Common Diagnoses

- **GIST, Gastric**
  - Gastric stromal tumor
  - Most common cause of large exophytic mass arising from gastric wall
  - Mucosa stretched over mass, may ulcerate

- CT: Large exophytic mass with central necrosis; may contain gas, oral contrast medium
- May be benign or malignant

- **Gastric Metastases and Lymphoma**
  - Metastases may be nodular (e.g., melanoma, Kaposi sarcoma) or infiltrative (e.g., breast)
  - Lymphoma: Usually massive, confluent thickening of gastric wall without causing obstruction
    - Wall thickening from lymphoma usually exceeds that caused by carcinoma
- **Gardner Syndrome**
  - Familial adenomatous polyposis of colon plus osteomas, desmoid tumors, adrenal, thyroid & liver carcinomas, etc.
  - May also have adenomatous polyps in stomach (less common than colonic and small bowel polyps)
- **Hamartomatous Polyposis Syndromes**
  - Peutz-Jeghers syndrome, Cronkite-Canada, Cowden, etc.
  - Hamartomatous polyps more common in small bowel & colon
    - Usually multiple, small broad-based masses
    - Usually not carpeting bowel (unlike familial polyposis)
  - Polyps are not premalignant, but patients are at increased risk for carcinomas of GI tract (as well as of pancreas, breast, reproductive tract)
- **Other Mesenchymal Tumors**
  - Any tissue component of the gastric wall can give rise to a benign or (less commonly) malignant mass
- **Ectopic Pancreatic Tissue**
  - Typical appearance is small mass along greater curvature of antrum
  - May have central umbilication (opening of primitive pancreatic duct)
- **Hematoma, Gastric**
  - From blunt or penetrating trauma
  - Prior placement of percutaneous gastrostomy tube should be considered
- **Duplication Cyst, Stomach**
  - May or may not communicate with stomach
  - May have water density or more proteinaceous contents
  - No enhancement of contents after contrast administration

Alternative Differential Approaches

- Causes of multiple gastric masses
  - Hyperplastic polyps
  - Gastric metastases and lymphoma
  - Gardner syndrome
  - Hamartomatous polyposis syndromes

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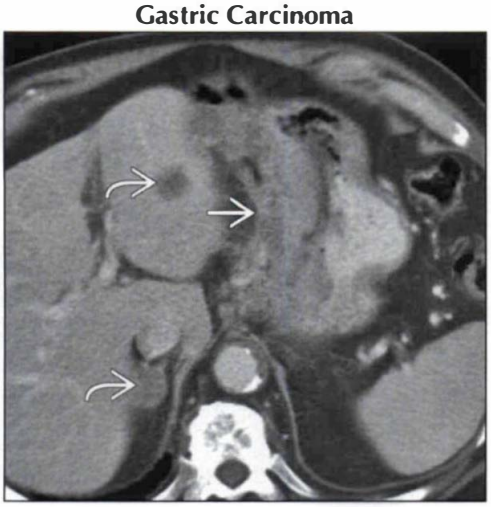
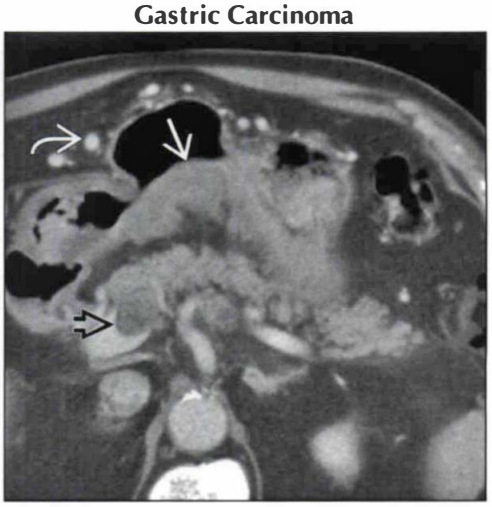
2. Horton KM et al: Current role of CT in imaging of the stomach. Radiographics. 23(1):75-87, 2003
3. Fishman EK et al: CT of the stomach: spectrum of disease. Radiographics. 16(5):1035-54, 1996

Gastric Carcinoma



Axial CECT shows an eccentric, soft tissue density mass ➡ growing along the lesser curve of the stomach. Note hepatic & adrenal metastases ➡.

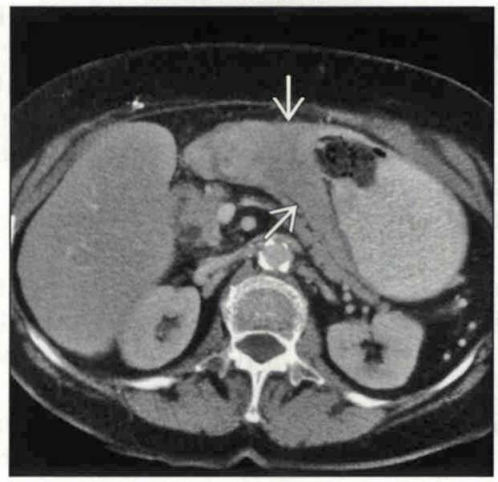
Gastric Carcinoma



Axial CECT shows extension of the mass ➡ along the posterior wall of the stomach to the pylorus. Extension into the splenic vein ⇨ results in perigastric varices ➡.

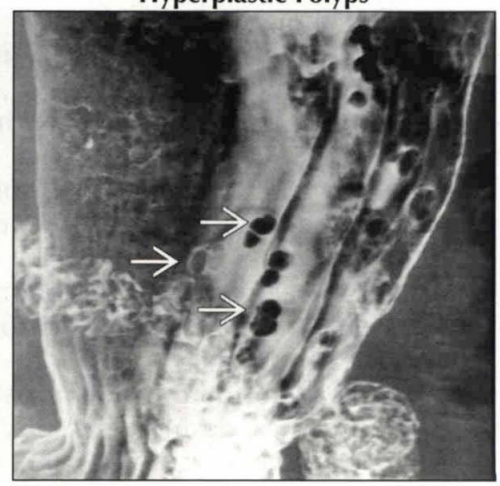
GASTRIC MASS LESIONS

Gastric Carcinoma

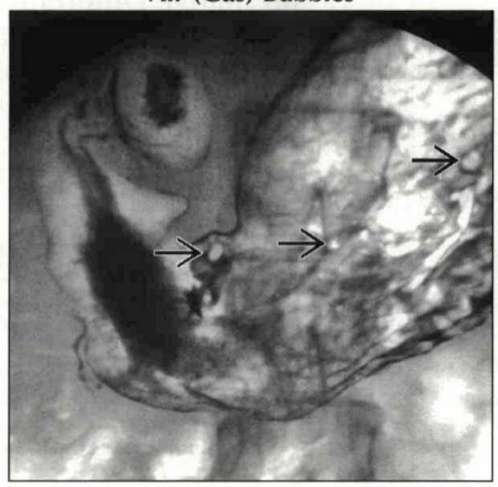


*(**Left**) Axial CECT shows a circumferential mass ➡ of soft tissue density that causes gastric outlet obstruction; note retained food and distention of the proximal portion of the stomach. These are typical features of gastric carcinoma, although some metastases (e.g., breast cancer) may have a similar appearance. (**Right**) Upper GI shows multiple, sharply defined polyps ➡ of similar small size, typical of hyperplastic polyps.*

Hyperplastic Polyps

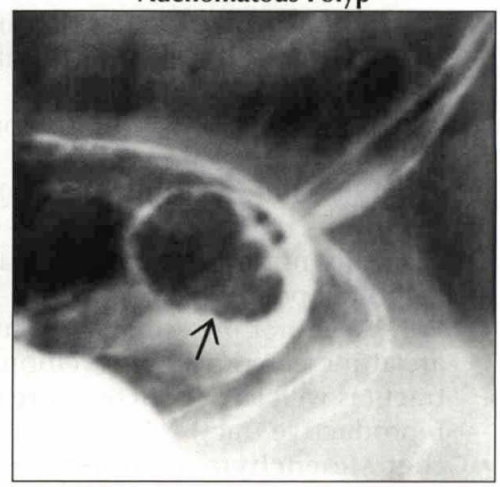


Air (Gas) Bubbles

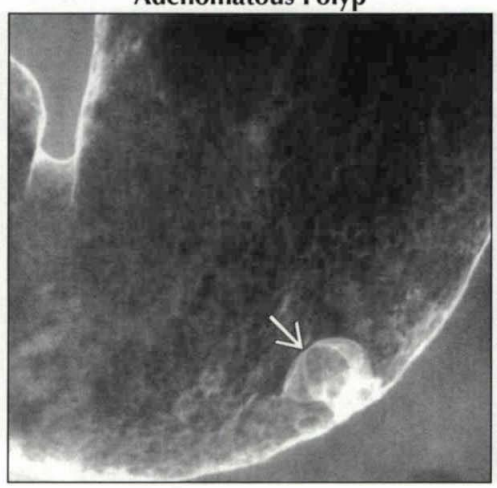


*(**Left**) Frontal upper GI shows what seem to be multiple barium-lined polyps ➡, but these were mobile and transient, representing air bubbles. Upper endoscopy results were normal. (**Right**) Upper GI shows a well-defined, sessile polyp ➡ just caudal to the esophagogastric junction, proven to be an adenomatous polyp on endoscopy and resection.*

Adenomatous Polyp

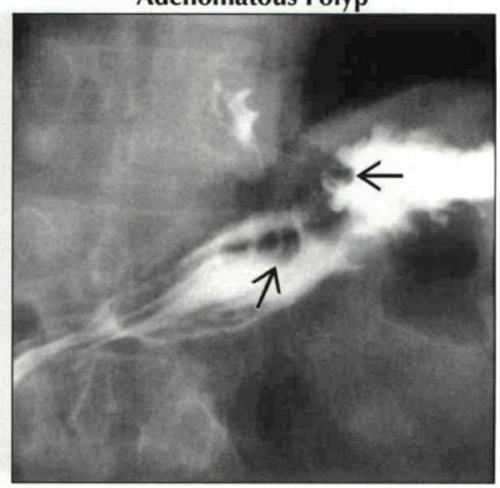


Adenomatous Polyp



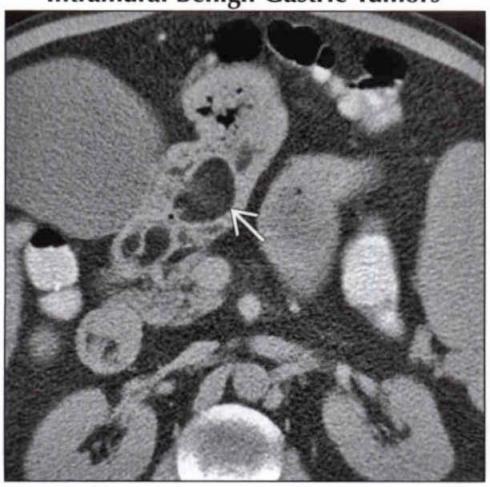
*(**Left**) Upper GI shows a well-defined sessile polyp ➡ with acute angles at its interface with the gastric wall. (**Right**) Upper GI shows one ➡ of several sessile and pedunculated gastric polyps in an elderly woman that proved to be adenomatous polyps with villous architecture.*

Adenomatous Polyp

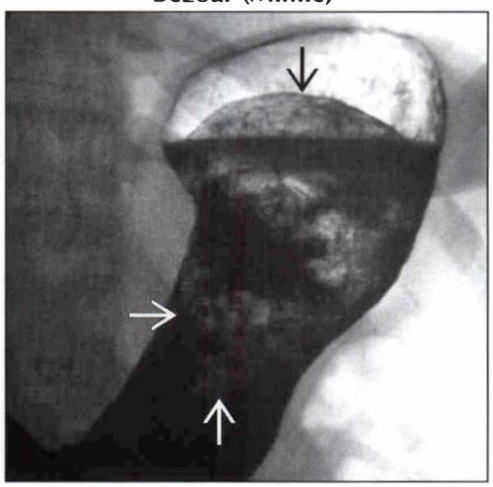


GASTRIC MASS LESIONS

Intramural Benign Gastric Tumors

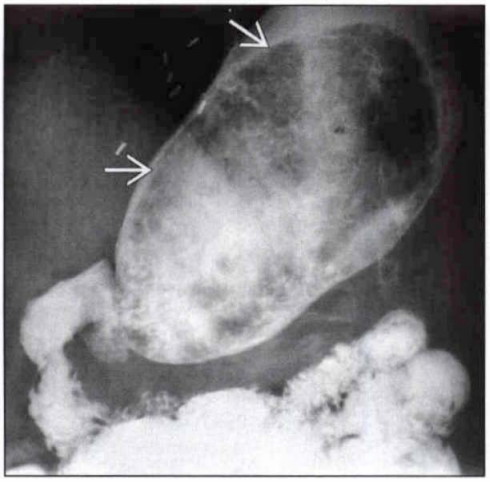


Bezoar (Mimic)

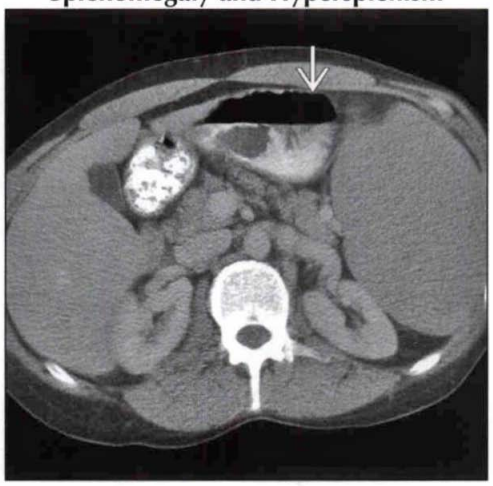


(Left) *Axial NECT shows one* ➡ *of several fat density masses (lipomas) within the stomach, but actually arising from the gastric wall. Intramural masses of the stomach and GI tract are frequently drawn into the gut lumen by peristalsis.* ***(Right)*** *Upper GI shows a large mass* ➡ *within the distended stomach that seems to conform to the shape of the stomach. Note the rounded superior margin of the mass* ➡ *on this upright film.*

Bezoar (Mimic)

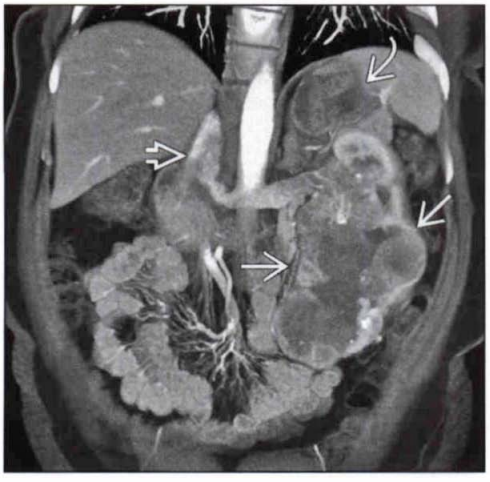


Splenomegaly and Hypersplenism



(Left) *Upper GI shows a large mobile filling defect or mass* ➡ *within the stomach. This patient had a prior vagotomy and distal antrectomy (Billroth 1 procedure) for peptic ulcer disease.* ***(Right)*** *Axial CECT shows massive enlargement of the spleen due to chronic lymphocytic leukemia. Note displacement and mass effect on the stomach* ➡.

Renal Cell Carcinoma

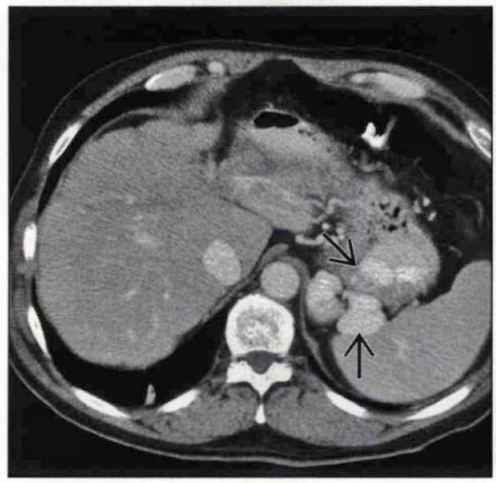


Splenosis

(Left) *Coronal CECT shows a* ***huge mass*** ➡ ***arising from*** *the left kidney with invasion of the renal vein and IVC* ➡. *Large masses like this may extrinsically compress the stomach* ➡ *and mimic intramural gastric masses.* ***(Right)*** *Axial CECT shows an* ***intramural mass*** ➡ *(splenosis) in a patient who had splenectomy for traumatic splenic rupture some years previously.*

GASTRIC MASS LESIONS

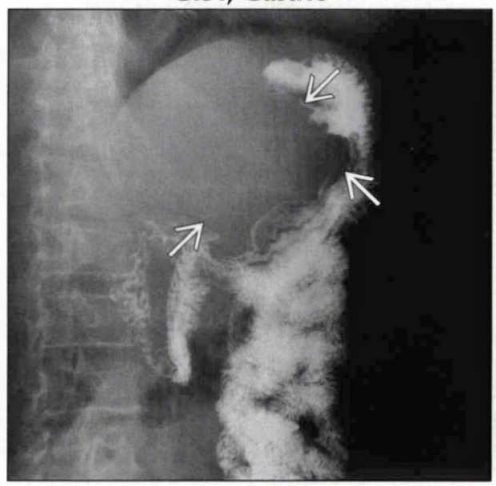
Gastric Varices



(Left) *Axial CECT shows large varices ⇨ that distort the fundus of the stomach, in a patient with cirrhosis and portal hypertension. On an unenhanced CT or an UGI series, these could mimic a neoplastic mass.* ***(Right)*** *Axial CECT shows a classic intramural mass ⇨, with obtuse angles and intact gastric mucosa. The central necrosis in the mass is a clue as to its etiology, a gastric GIST.*

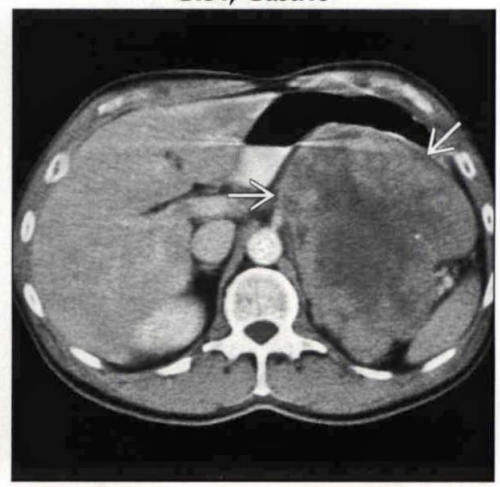
GIST, Gastric

GIST, Gastric

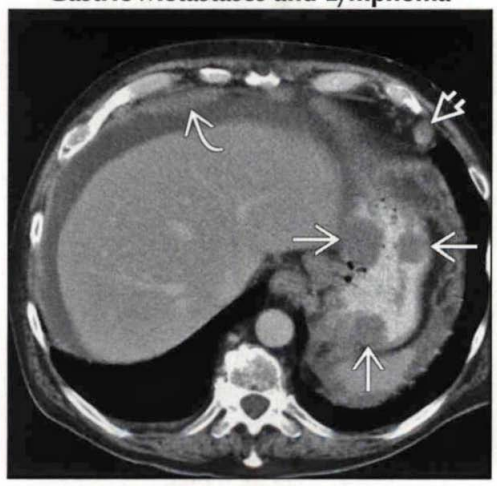


(Left) *Oblique upper GI shows a large mass ➡ that displaces the fundus and upper body of the stomach, with intact overlying gastric folds. CT showed a large, centrally necrotic intramural mass, a malignant GIST.* ***(Right)*** *Axial CECT shows a large mass ➡ that displaces the stomach, with apparently intact gastric folds; malignant GIST. The central necrosis is a typical feature of GIST.*

GIST, Gastric



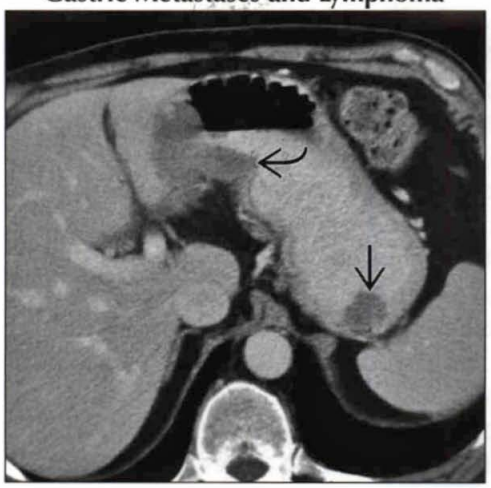
Gastric Metastases and Lymphoma



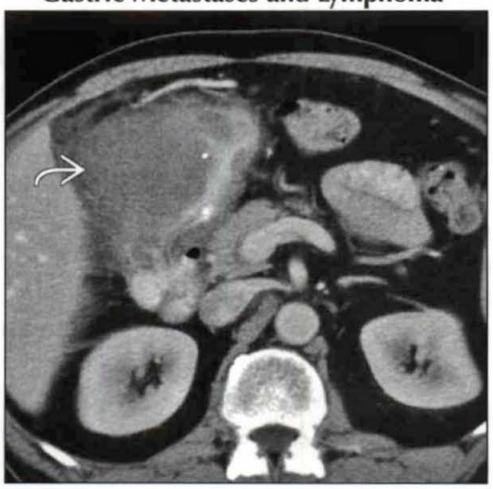
(Left) *Axial CECT shows several intramural gastric masses ➡, along with metastases to nodes ➡ and the peritoneal surface ➡; malignant melanoma.* ***(Right)*** *Axial CECT shows circumferential, marked, soft tissue density thickening of the gastric wall ➡ and extensive perigastric lymphadenopathy ➡, typical features of gastric lymphoma.*

Gastric Metastases and Lymphoma

Gastric Metastases and Lymphoma

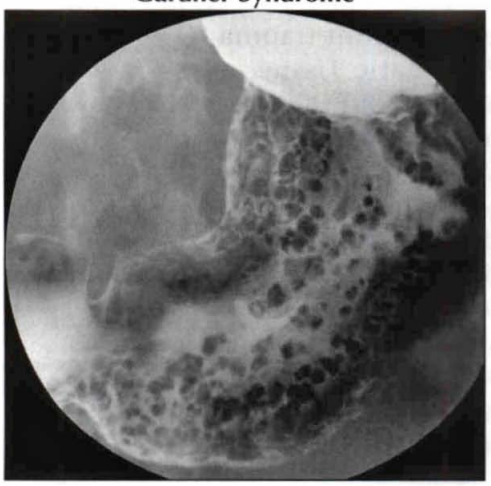


Gastric Metastases and Lymphoma



(Left) Axial CECT shows two soft tissue density masses in the stomach representing gastric lymphoma. One is a sessile polyp and the other a bulky, circumferential antral mass. (Right) Axial CECT shows a bulky, circumferential antral mass that is due to gastric lymphoma. There was no gastric outlet obstruction due to the soft nature of lymphomatous masses.

Gardner Syndrome

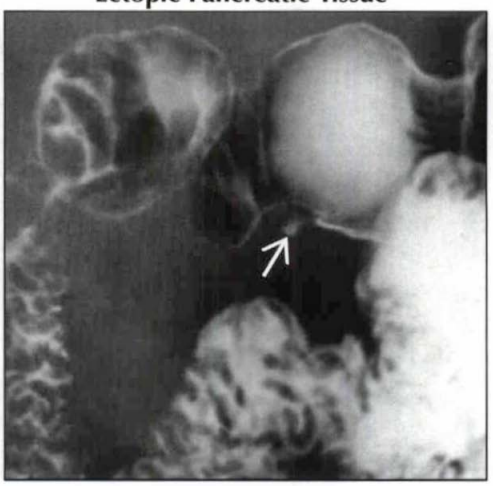


Hamartomatous Polyposis Syndromes

(Left) Upper GI shows innumerable small polyps that are larger & more irregular than usually seen w/hyperplastic polyps. These are adenomatous (premalignant) polyps in a patient w/familial polyposis (Gardner syndrome). (Right) Frontal upper GI shows innumerable small gastric polyps of similar size. In the general population, these would probably be hyperplastic polyps, but patient has Peutz-Jeghers syndrome, & these are hamartomatous polyps.

Other Mesenchymal Tumors

Ectopic Pancreatic Tissue



(Left) Axial CECT shows a highly vascular mass in the posterior wall of the stomach as an incidental finding in a patient who had CT evaluation for chronic pancreatitis. Surgically-proven neurolemmoma. (Right) Upper GI shows a classic appearance with a small intramural mass in the greater curve antrum, with a central umbilication representing the orifice of a primitive pancreatic duct.

INTRAMURAL MASS, STOMACH

DIFFERENTIAL DIAGNOSIS

Common
- Gastric Varices
- Pancreatic Pseudocyst
- Gastric Stromal Tumor
- Intramural Benign Gastric Tumors
- Metastases and Lymphoma, Gastric

Less Common
- Gastric Intramural Hematoma
- Ectopic Pancreatic Tissue
- Accessory Spleen or Splenosis
- Gastric Duplication Cyst

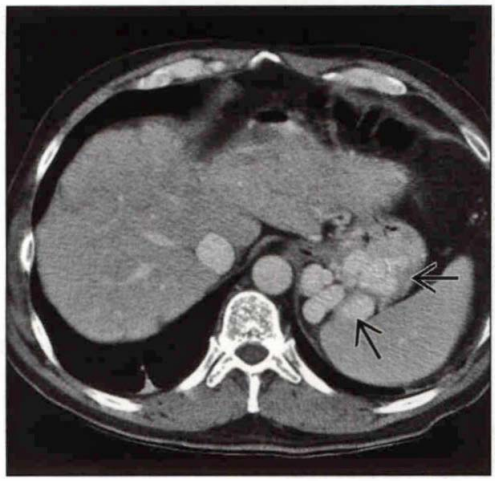
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Difficult to distinguish intramural from extrinsic masses
  - Even mucosal lesions (e.g., gastric carcinoma) may have overlapping features

Helpful Clues for Common Diagnoses
- **Gastric Varices**
  - CECT: Tortuous enhancing vessels
  - Seen in portal hypertension or splenic vein occlusion
- **Pancreatic Pseudocyst**
  - Indents posterior wall of stomach
  - Nonenhancing cyst contents
  - Thin wall
  - Gastric mucosal folds over pseudocyst are often thickened due to inflammation
- **Gastric Stromal Tumor**
  - GIST; well-circumscribed submucosal mass with large exophytic component
  - Central necrosis
  - May have mucosal ulceration
- **Intramural Benign Gastric Tumors**
  - Lipoma; characteristic fat density
  - Other mesenchymal tumors (neuroma, fibroma, hemangioma, etc.)
    - Any component of the gastric wall may give rise to benign or malignant tumor
    - Except for lipoma, have overlapping & nonspecific imaging features
- **Metastases and Lymphoma, Gastric**
  - May be nodular and multiple (melanoma) or diffuse (breast cancer)
  - Lymphoma: Usually large, homogeneous tumor that does not obstruct the stomach

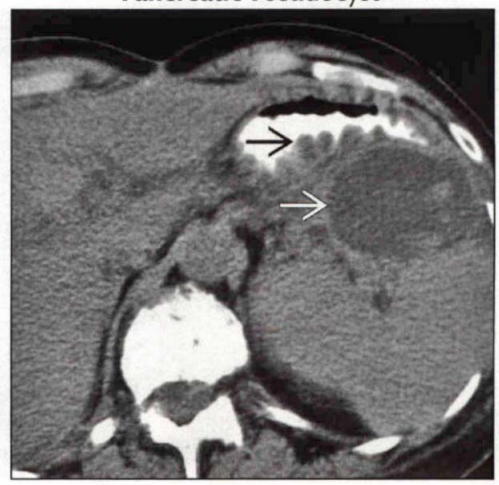
Helpful Clues for Less Common Diagnoses
- **Gastric Intramural Hematoma**
  - Following endoscopy, biopsy, PEG tube placement, or blunt trauma
- **Ectopic Pancreatic Tissue**
  - Small mural nodule along greater curvature of antrum with central umbilication
- **Accessory Spleen or Splenosis**
  - May indent or implant on gastric wall
  - Splenosis, following traumatic rupture of spleen, may implant anywhere on peritoneal surface
- **Gastric Duplication Cyst**
  - Rare; may or may not communicate with gastric lumen

Gastric Varices



Axial CECT shows massive varices ⇨ that deform the fundus of the stomach. On NECT or UGI series, these would appear as a soft tissue density intramural mass.

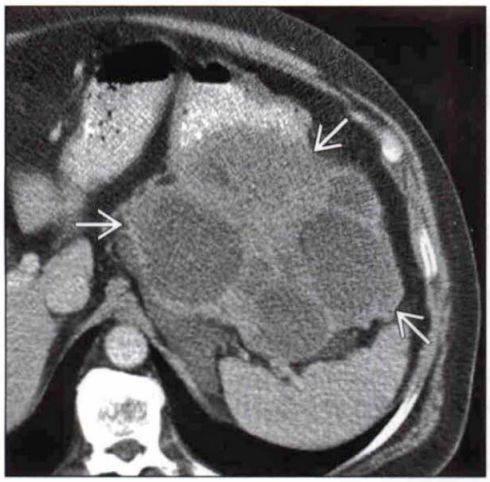
Pancreatic Pseudocyst



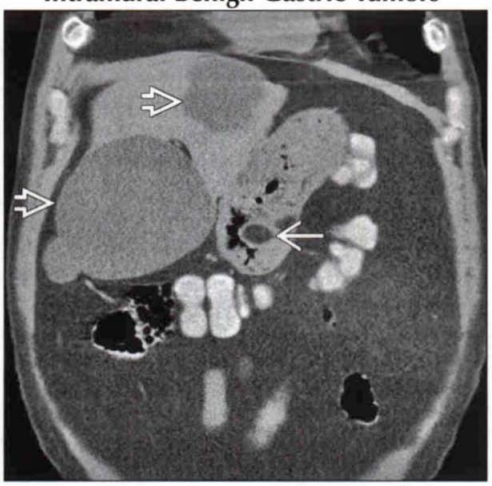
Axial NECT shows a pseudocyst ➡ that indents the posterior gastric wall. Note the thickened gastric folds ⇨, suggesting intramural involvement by the pseudocyst.

INTRAMURAL MASS, STOMACH

Gastric Stromal Tumor



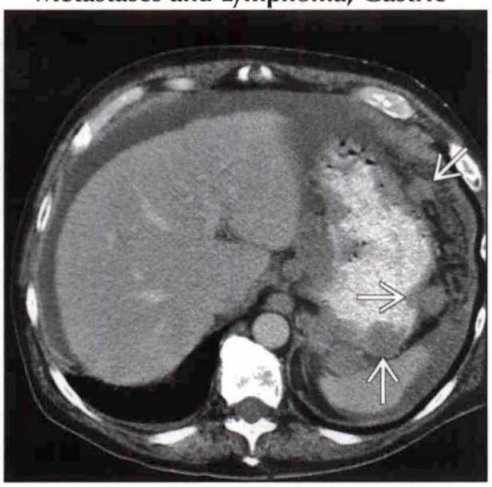
Intramural Benign Gastric Tumors



(Left) Axial CECT shows a large intramural gastric mass ➡ with both solid and cystic components; malignant GIST. (Right) Coronal NECT shows a fat density mass ➡, a lipoma, within the gastric wall. There are two large benign cysts ➪ in the liver as unrelated lesions.

Metastases and Lymphoma, Gastric

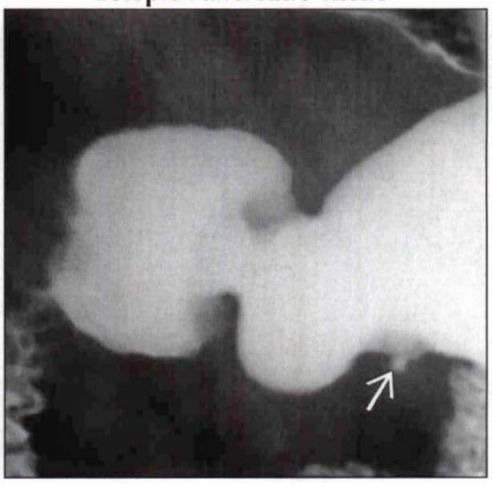
Metastases and Lymphoma, Gastric



(Left) Axial CECT shows a large soft tissue density mass ➡ that envelopes the gastric antrum but does not cause gastric outlet obstruction. These are typical findings for gastric lymphoma. (Right) Axial CECT shows peritoneal and gastric wall metastases as discrete nodules ➡ in this patient with metastatic melanoma. Omental metastases and malignant ascites were also evident.

Metastases and Lymphoma, Gastric

Ectopic Pancreatic Tissue



(Left) Axial CECT shows a circumferential soft tissue density mass ➡ that envelopes and obstructs the gastric antrum. Note the retained food and debris within the proximal stomach. Metastatic breast cancer (but indistinguishable from primary gastric cancer by imaging). (Right) Upper GI shows a small intramural mass along the greater curve at the antrum, with a central umbilication ➡, representing the opening of a primitive pancreatic duct.

TARGET OR "BULL'S EYE" LESIONS, STOMACH

DIFFERENTIAL DIAGNOSIS

Common
- Gastric Metastases
- Gastric Lymphoma
- Kaposi Sarcoma

Less Common
- Gastric Carcinoma
- Ectopic Pancreatic Tissue
- Carcinoid, Stomach
- Gastric Stromal Tumor

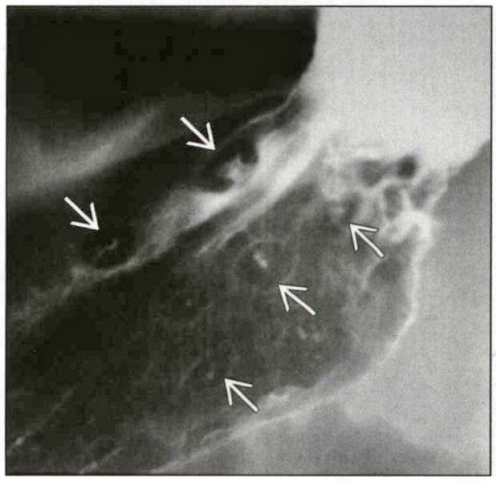
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Target or "bull's eye" lesions are raised nodules or masses with a central ulceration
  - Etiology is a submucosal mass with ulceration of the overlying mucosa
  - Highly suggestive of malignant gastric lesion (or ectopic pancreas)
    - Multiple lesions are almost always malignant
  - Target lesions are different from aphthous lesions (shallow erosions with small edematous mound; seen in gastritis)

Helpful Clues for Common Diagnoses
- **Gastric Metastases**
  - Most common cause of "bull's eye" pattern of metastases is malignant melanoma
- **Gastric Lymphoma**
  - GI tract lymphoma can also cause "bull's eye" lesions
    - Stomach is the most common site
- **Kaposi Sarcoma**
  - Usually in homosexual men with AIDS
  - Stomach is most common site of GI tract involvement

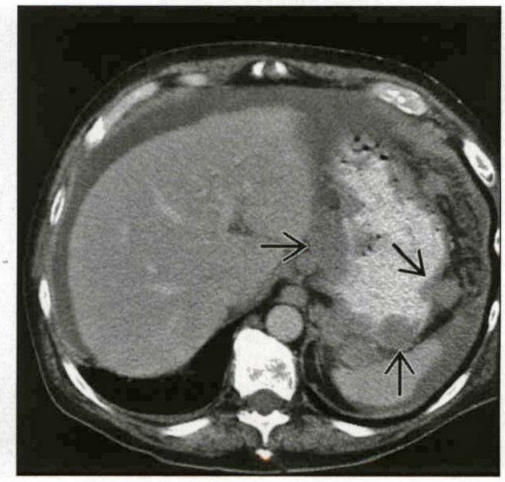
Helpful Clues for Less Common Diagnoses
- **Gastric Carcinoma**
  - Rarely appears as a single target lesion
  - Central ulceration is common, but surrounding tissue is more irregular and nodular than with other etiologies
- **Ectopic Pancreatic Tissue**
  - Usually a single umbilicated lesion in the gastric antrum
  - Does not result in multiple "bull's eye" lesions
- **Carcinoid, Stomach**
  - From chromograffin cells in gastric mucosa
  - Does not produce "carcinoid syndrome"
  - Increased frequency in Zollinger-Ellison syndrome and atrophic gastritis
- **Gastric Stromal Tumor**
  - Stomach is most common site of GIST
  - Usual appearance: Large exophytic mass arising from gastric wall
  - Erosion of overlying mucosa can result in "bull's eye" appearance
    - Gas, fluid, and oral contrast medium may enter central necrotic area of GIST

Gastric Metastases



Upper GI shows multiple "bull's eye" lesions ➡ due to metastatic melanoma. This pattern can be seen with lymphoma and Kaposi sarcoma as well. Correlation with clinical findings is usually sufficient.

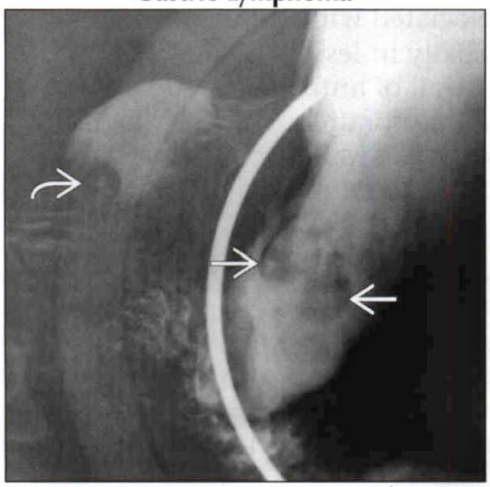
Gastric Metastases



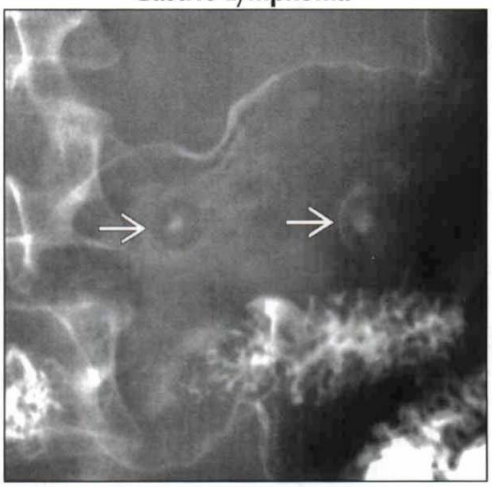
Axial CECT shows multiple intramural gastric masses ➡ due to metastatic melanoma. When the mucosa overlying one of these lesions ulcerates, the result is a "bull's eye" lesion, best seen on UGI.

TARGET OR "BULL'S EYE" LESIONS, STOMACH

Gastric Lymphoma

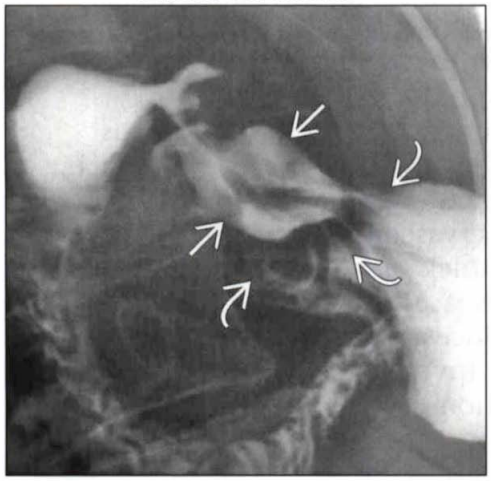


Gastric Lymphoma

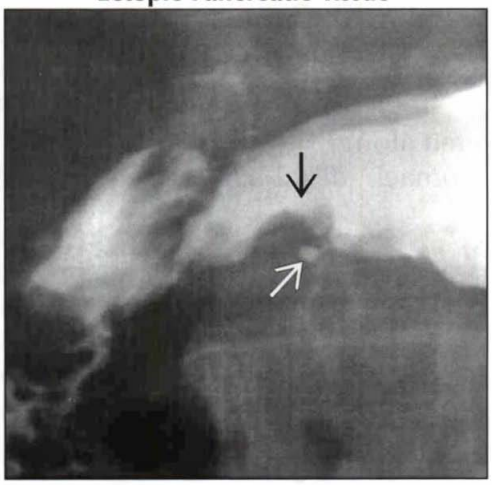


(Left) Upper GI shows multiple classic "bull's eye" lesions in the stomach and duodenum of this patient with lymphoma. (Right) Upper GI shows classic "bull's eye" lesions in the stomach on this air-contrast study, with small masses and central umbilication.

Gastric Carcinoma

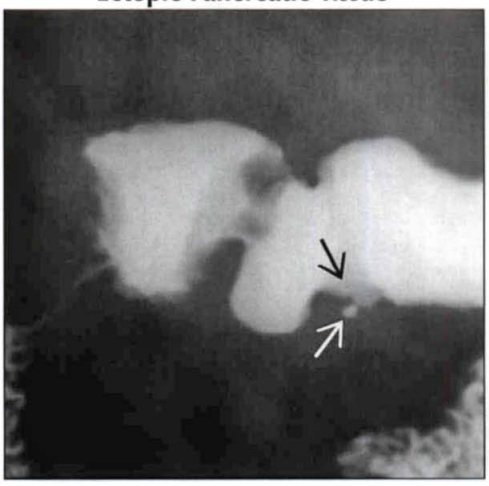


Ectopic Pancreatic Tissue

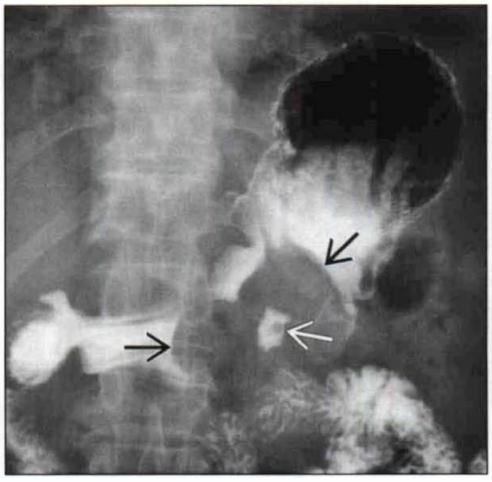


(Left) Upper GI shows a large ulcer (persistent collection of barium) in a larger mass. This is not what is usually referred to as a "bull's eye" lesion, but it is very suggestive of gastric carcinoma. (Right) Upper GI shows a pathognomonic appearance of ectopic pancreas with a small mural mass in the antrum with an umbilication, representing the orifice of a primitive pancreatic duct, in this 36 year old man.

Ectopic Pancreatic Tissue



Gastric Stromal Tumor



(Left) Upper GI shows a typical small intramural mass along the greater curve of the antrum with a central umbilication, representing filling of a rudimentary pancreatic duct; 60 year old woman. (Right) Upper GI shows a large intramural mass with a central ulceration, a typical appearance for a gastric GIST. This lesion would be considered by many to be too large to constitute a "bull's eye" lesion.

GASTRIC ULCERATION (WITHOUT MASS)

DIFFERENTIAL DIAGNOSIS

Common
- NSAID-Induced Gastritis
- Gastritis (Other Causes)
- Gastric Ulcer

Less Common
- Gastric Carcinoma
- Zollinger-Ellison Syndrome
- Crohn Disease
- Caustic Gastroduodenal Injury

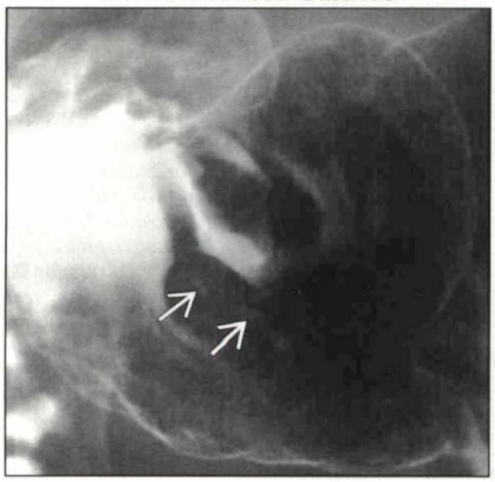
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Gastritis is, by far, the most common cause of gastric erosions or ulcerations

Helpful Clues for Common Diagnoses
- **NSAID-Induced Gastritis**
  - Non-steroidal anti-inflammatory drugs, including aspirin
  - Gastric erosion may be varioliform, linear or serpiginous
  - Erosions may be clustered along dependent surface of stomach, distal body or antrum
- **Gastritis (Other Causes)**
  - Other medications, alcohol, uremia, idiopathic
  - Appearance similar to NSAID-induced gastritis, regardless of etiology
  - CT shows thick gastric wall, submucosal edema
- **Gastric Ulcer**
  - Deeper erosion, into submucosa or even through wall of stomach
  - Often associated with H. pylori infection
  - Ulcers usually in lesser curvature or posterior wall of antrum or body
  - May cause perforation, often through posterior gastric wall into lesser sac
  - CT: Look for extraluminal gas, fluid, contrast medium

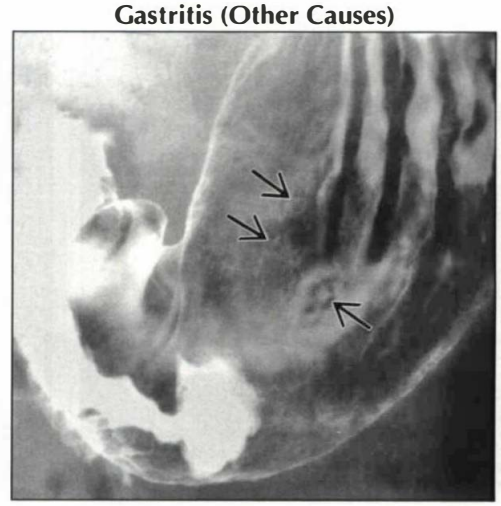
Helpful Clues for Less Common Diagnoses
- **Gastric Carcinoma**
  - Often causes ulceration; usually a mass with irregular nodular folds around ulcer crater
  - Superficial or early cancer may have no visible mass
    - But this form is rarely ulcerated
  - CT: Soft tissue density thickening of gastric wall, infiltration of omentum, nodal, peritoneal or liver mets
- **Zollinger-Ellison Syndrome**
  - Gastrin-producing islet call (neuroendocrine) tumor of pancreas
  - Intractable, multiple ulcers in stomach, duodenum, even proximal jejunum
  - CT: Hypervascular pancreatic mass (arterial phase), thick gastric folds, metastases
- **Crohn Disease**
  - May induce aphthoid erosions in stomach
  - Chronic involvement: "Ram's horn" contraction of distal body and antrum

NSAID-Induced Gastritis



Upper GI shows thickened antral folds with linear erosions ➡ along the peaks of the folds, diagnostic of some form of gastritis.

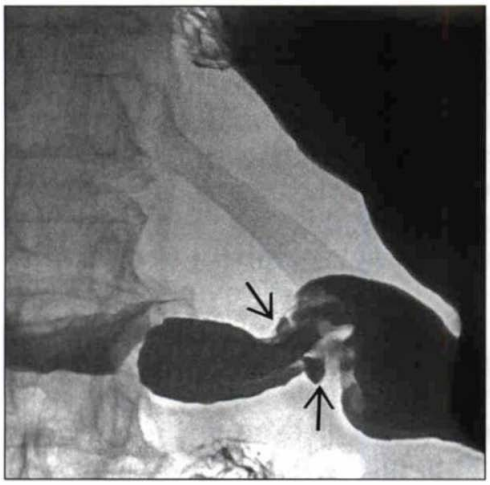
Gastritis (Other Causes)



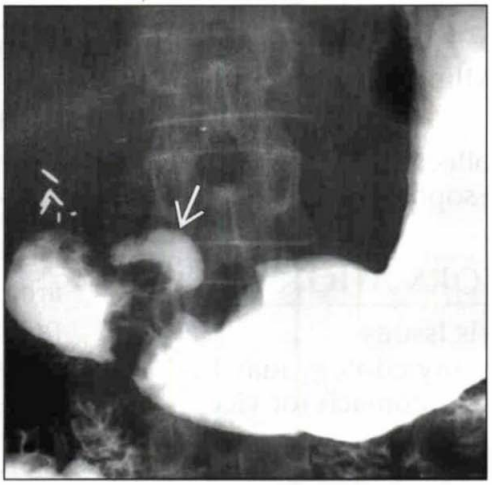
Upper GI shows superficial rounded and linear erosions ➔ (superficial ulcerations). On endoscopy these were interpreted as "erosive gastritis", cause not specified.

GASTRIC ULCERATION (WITHOUT MASS)

Gastric Ulcer

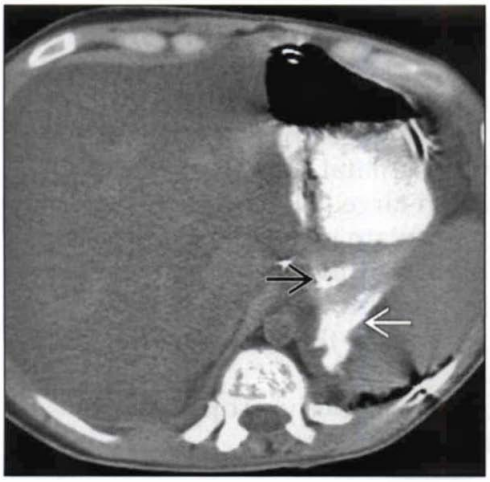


Gastric Ulcer

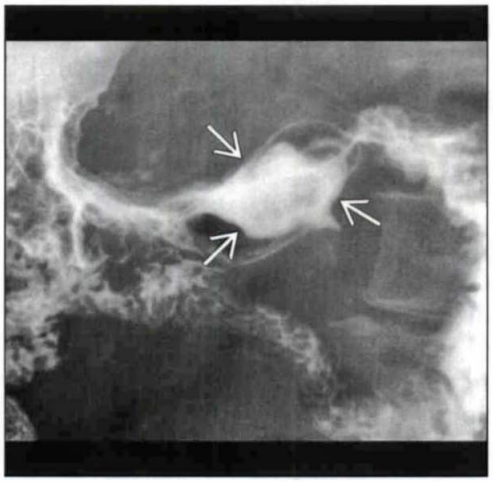


(Left) Upper GI shows contraction of the antrum and thickened folds that extend to the edges of 2 discrete ulcers. (Right) Upper GI shows a fixed collection of barium extending beyond the confines of the gastric wall. This was a perforated prepyloric ulcer. Note spasm and distortion of the antrum.

Gastric Ulcer

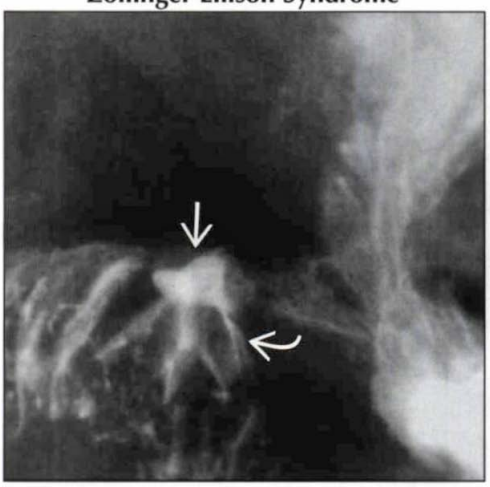


Gastric Carcinoma

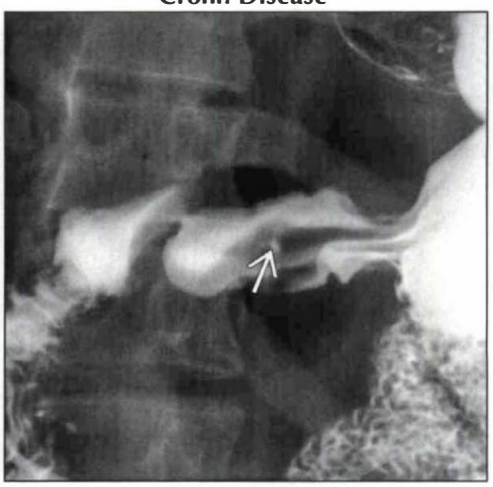


(Left) Axial NECT shows oral (enteric) contrast medium extravasated into the lesser sac through a perforated gastric ulcer. A nasogastric tube marks the dependent surface of the stomach. (Right) Upper GI shows a large antral ulcer (fixed collection of barium). The surrounding mass is less evident, although fluoroscopy showed a stiff, nonperistaltic distal body and antrum that was found to be a large carcinoma at surgery.

Zollinger-Ellison Syndrome



Crohn Disease



(Left) Upper GI shows an ulcer at the site of a gastroenteric anastomosis following partial gastrectomy & vagotomy for ulcers. Note folds radiating to edge of ulcer. Recurrent ulcers were a common feature of ZES prior to improved diagnosis & therapy. (Right) Upper GI shows an aphthous erosion of a thickened antral fold in a young man with proven Crohn gastritis, who also had small bowel involvement.

INTRATHORACIC STOMACH

DIFFERENTIAL DIAGNOSIS

Common
- Hiatal Hernia
- Post-Esophagectomy
- Achalasia, Esophagus (Mimic)

Less Common
- Post-Operative Fluid Collection (Mimic)
- Pulsion Diverticulum, Esophagus (Mimic)

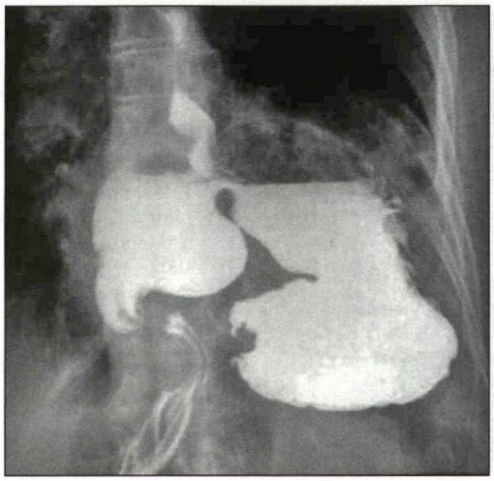
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Dilated esophagus from any etiology may be mistaken for intrathoracic stomach (or vice versa)
  - Look for evidence of surgery (suture lines; portions of stomach "missing" from abdomen)
- Post-operative conditions can mimic or cause intrathoracic stomach
- Epiphrenic esophageal diverticulum can mimic stomach on upper GI series, CT or MR

Helpful Clues for Common Diagnoses
- **Hiatal Hernia**
  - Paraesophageal hernias may result in much or all of stomach lying in thorax
  - Type IV hernia = intrathoracic stomach which may or may not undergo volvulus & gastric outlet obstruction
    - Type III = paraesophageal hernia with GE junction in thorax
  - Gastric volvulus with obstruction demands immediate decompression
- **Post-Esophagectomy**
  - Common surgical procedure for esophageal carcinoma
  - Much of the stomach is pulled into thorax to replace resected portion of esophagus
    - Stomach is usually divided longitudinally first, to reduce volume of the "gastric conduit"
    - Distention & slow emptying of conduit are relatively common complications of procedure
  - Esophago-gastric anastomosis usually near thoracic inlet
- **Achalasia, Esophagus (Mimic)**
  - May result in marked dilation of esophagus
  - Distended lumen with air-fluid levels may simulate intrathoracic stomach, especially on axial CT

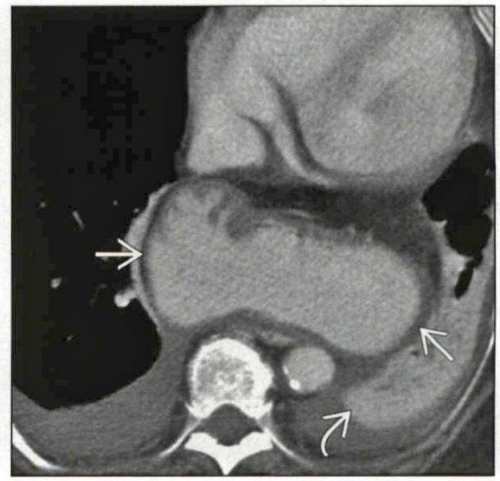
Helpful Clues for Less Common Diagnoses
- **Post-Operative Fluid Collection (Mimic)**
  - Following esophagectomy, fundoplication, repair of large hiatal hernia
  - May result in large collection of fluid ± gas that may simulate intrathoracic stomach
- **Pulsion Diverticulum, Esophagus (Mimic)**
  - Epiphrenic diverticula may be large
  - Retention of food, fluid, and gas simulates stomach
  - Associated with elderly; esophageal dysmotility syndromes

Hiatal Hernia



Upper GI shows an "upside down", completely intrathoracic stomach, a type IV paraesophageal hernia, without volvulus or obstruction; 73 year old woman.

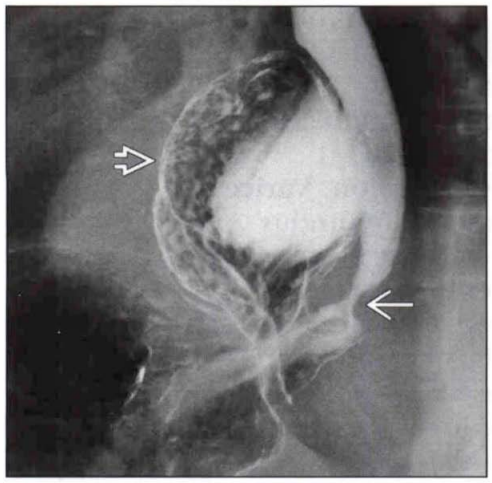
Hiatal Hernia



Axial CECT shows a large type IV paraesophageal hernia ➡ (intrathoracic stomach); 73 year old woman. Note compressed, atelectatic lung ➡.

INTRATHORACIC STOMACH

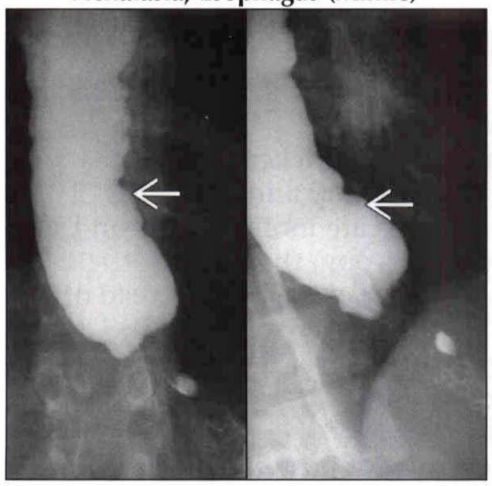
Hiatal Hernia



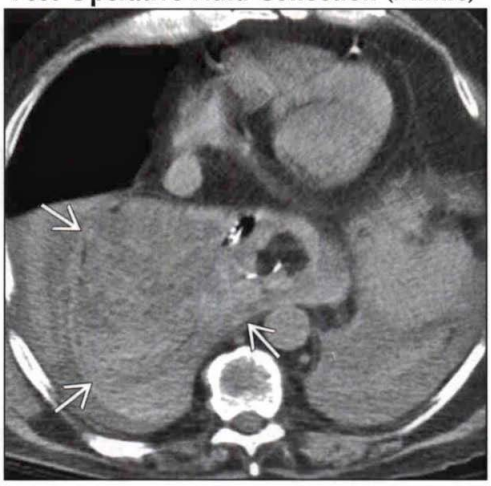
Post-Esophagectomy

(Left) Lateral upper GI shows a large type III paraesophageal hernia, with the gastroesophageal junction and much of the stomach in the thorax. (Right) Esophagram shows a dilated "gastric conduit", a portion of the stomach that has been placed into the chest to replace the resected esophagus in a patient who had esophageal carcinoma. This conduit is abnormally dilated and slow to empty, a relatively common complication of this procedure.

Achalasia, Esophagus (Mimic)

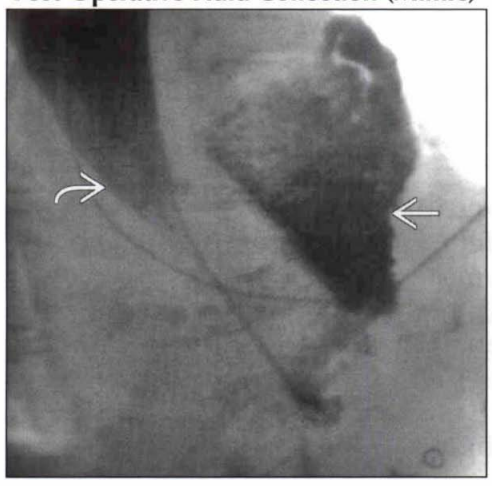


Post-Operative Fluid Collection (Mimic)

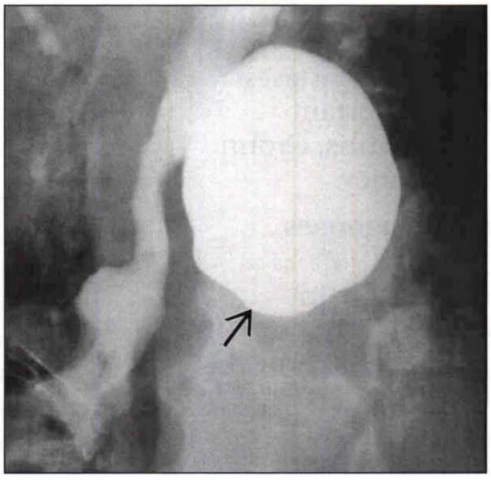


(Left) Esophagram shows massive dilation of the esophagus with a tapered, constricting distal segment, classic appearance of achalasia in a 23 year old woman with progressive dysphagia. (Right) Axial NECT shows a heterogeneous high density fluid collection (hematoma) in the mediastinum following fundoplication surgery for hernia & reflux.

Post-Operative Fluid Collection (Mimic)



Pulsion Diverticulum, Esophagus (Mimic)



(Left) Esophagram shows extravasation of water-soluble contrast material from the distal esophagus or proximal stomach into the mediastinum, following surgical fundoplication for hernia and reflux. (Right) Esophagram shows a large pulsion diverticulum and signs of esophageal dysmotility in this elderly man with dysphagia.

THICKENED GASTRIC FOLDS

DIFFERENTIAL DIAGNOSIS

Common
- Gastritis
- Gastric Ulcer
- Portal Hypertension, Varices
- Gastric Carcinoma
- Pancreatitis, Acute
  - Pancreatic Pseudocyst
- Portal Hypertensive Gastropathy

Less Common
- Gastric Metastases and Lymphoma
- Menetrier Disease
- Zollinger-Ellison Syndrome
- Caustic Gastroduodenal Injury
- Crohn Disease

Rare but Important
- Tuberculosis
- Radiation Gastritis
- Amyloidosis
- Eosinophilic Gastritis
- Chemotherapy-Induced Gastritis
- Sarcoidosis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- CT helps to narrow the differential diagnosis by showing disease beyond the stomach
  - Examples: Metastatic tumor; signs of pancreatitis
- CT can show nature of submucosal thickening that is the usual source of "thick folds"
  - Edema: Near water attenuation = inflammatory or infectious
  - Soft tissue density = more likely to be neoplastic
    - Carcinoma, lymphoma or metastases
- Correlation with history is important
  - Examples: History of pancreatitis, Crohn disease, extragastric malignancy

Helpful Clues for Common Diagnoses
- **Gastritis**
  - Symptomatic with abdominal pain
  - Antrum affected most commonly
  - Look for erosions, especially along rugal folds; limited distensibility
  - Many potential causes, most often NSAIDS, alcohol, H. pylori infection
- **Gastric Ulcer**
  - Folds of uniform thickness radiate from edge of ulcer crater
  - CT may show signs of erosion or perforation (into lesser sac or greater peritoneal cavity)
  - Look for extraluminal gas or enteric contrast medium
- **Portal Hypertension, Varices**
  - Varices mostly in fundus
    - Portal hypertensive gastropathy can affect entire stomach
  - Associated with portal hypertension (cirrhosis, splenomegaly, ascites)
  - Also caused by splenic vein occlusion (pancreatic carcinoma, chronic pancreatitis)
  - CECT: Usually distinguishes varices from other etiologies of thickened folds; shows underlying cause
    - Varices enhance like vessels on portal venous phase CECT
    - Thick folds enhance like wall of stomach
- **Gastric Carcinoma**
  - Irregular, nodular, thickened folds
  - Limited distensibility and peristalsis
    - These findings are more evident on UGI series (fluoroscopy) than on CT
  - CT usually shows extragastric spread of tumor
    - Enlarged nodes, liver metastases, omental seeding
- **Pancreatitis, Acute**
  - Fold thickening of posterior wall of stomach, adjacent to pancreas
  - CT signs of pancreatitis: Enlarged gland, peripancreatic infiltration, fluid collections
  - **Pancreatic Pseudocyst**
    - Back wall of stomach is often "draped" over pseudocyst
    - Gastric folds in contact with pseudocyst are thickened

Helpful Clues for Less Common Diagnoses
- **Gastric Metastases and Lymphoma**
  - Lymphoma
    - Massive nodular thickening of folds but usually normal distensibility
  - Metastases may cause nodular intramural masses, ± ulceration, ± limited distensibility

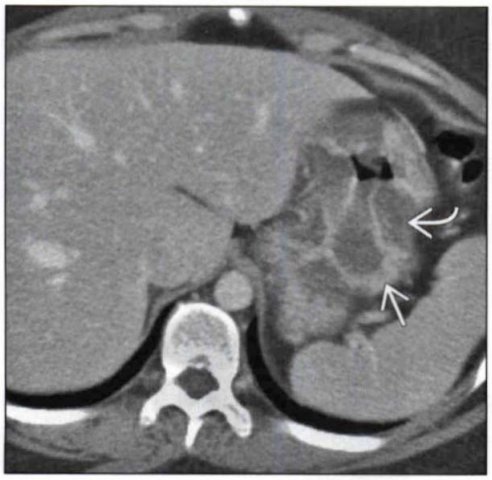
- Breast cancer especially likely to result in thick folds, limited distensibility

- **Menetrier Disease**
  - Massive fold thickening in fundus and body
    - Antrum is usually spared
  - Hypersecretion of protein; hyposecretion of acid
    - May result in dilution and poor coating of barium on UGI
- **Zollinger-Ellison Syndrome**
  - Hypersecretion of acid & thick folds, multiple & recurrent ulcers
  - Gastrin-secreting neuroendocrine (islet cell) tumor of pancreas
    - CECT often shows hypervascular pancreatic tumor
  - May be part of multiple endocrine neoplasia syndrome
- **Caustic Gastroduodenal Injury**
  - Ingestion of strong alkali or acid
  - Acute findings = massive wall edema ± ulceration of mucosa
    - Difficult & potentially dangerous to perform UGI series; CT shows pertinent findings in esophagus & stomach, including wall injury & possible perforation
  - End result is often perforation or linitis plastica appearance of stomach
- **Crohn Disease**
  - May cause gastritis with erosions and thickened folds
  - Long-standing involvement may cause "ram's horn" appearance
    - Nondistensible distal body and antrum with tapered curve toward pylorus

Helpful Clues for Rare Diagnoses

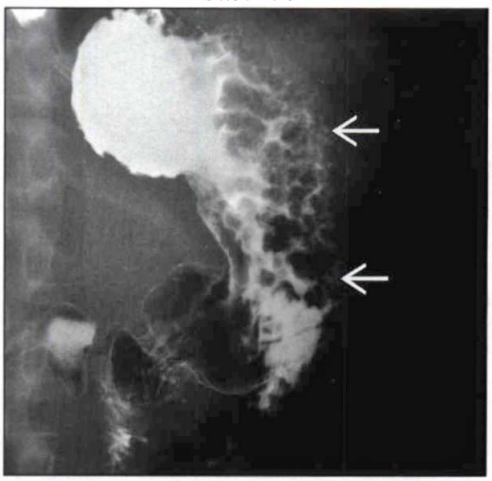
- **Tuberculosis**
  - Classic appearance is thickened folds & limited distensibility of stomach & duodenum
  - Relatively common in some populations (e.g., Native Americans)
- **Radiation Gastritis**
  - Nonspecific fold thickening & limited distensibility
  - History of upper abdominal radiation therapy is essential to diagnosis
- **Amyloidosis**
  - Look for evidence of systemic amyloid
  - Usually involves antrum
- **Eosinophilic Gastritis**
  - Mostly affects antrum
  - Check for peripheral blood eosinophilia
  - History of allergic diseases
- **Chemotherapy-Induced Gastritis**
  - Usually due to inadvertent perfusion of stomach during hepatic arterial infusion of floxuridine
- **Sarcoidosis**
  - Usually affects antrum
  - Check for pulmonary & hepatic involvement

Gastritis



Axial CECT shows massive thickening of gastric folds ➡ with submucosal edema ➡, due to NSAID-induced gastritis.

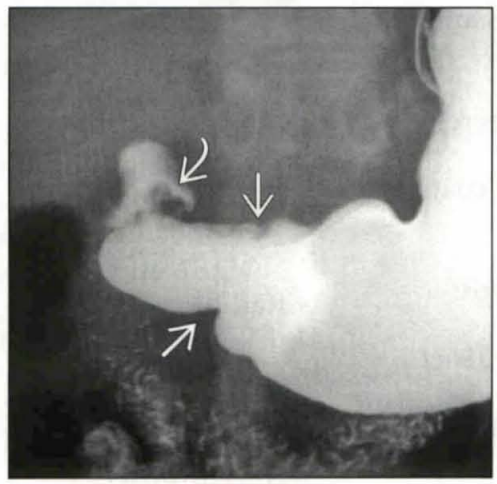
Gastritis



Upper GI shows striking fold thickening ➡ throughout the stomach in a 60 year old woman with gastritis due to uremia (acute renal failure).

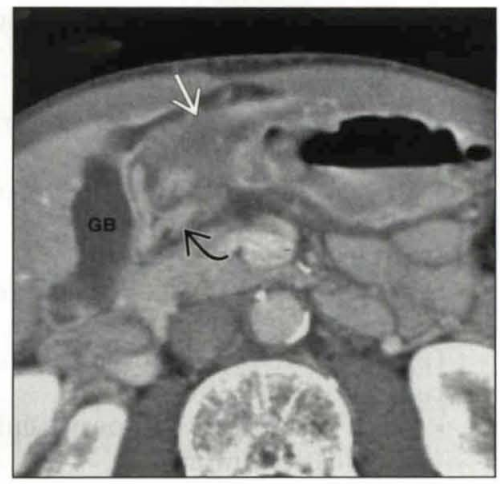
THICKENED GASTRIC FOLDS

Gastritis



(Left) Upper GI shows nodular, thickened folds in the gastric antrum, some of which herniate through the pylorus into the duodenal bulb. The antrum is not completely distensible; 54 year old man with gastritis. (Right) Axial CECT shows submucosal edema causing thickening of antral folds, some of which herniate into the duodenal bulb through the pylorus. Gallbladder (GB); 54 year old man with gastritis.

Gastritis

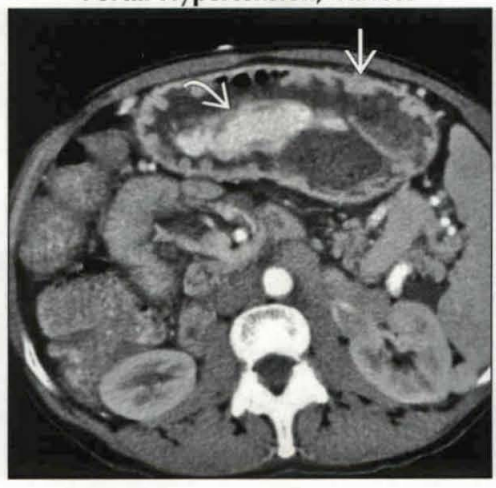


Gastric Ulcer

(Left) Axial NECT shows thick gastric folds and extraluminal gas; 64 year old man with a perforated gastric ulcer. (Right) Axial NECT shows free intraperitoneal gas and extravasation of gastric contrast medium, indicating a perforated gastric ulcer.

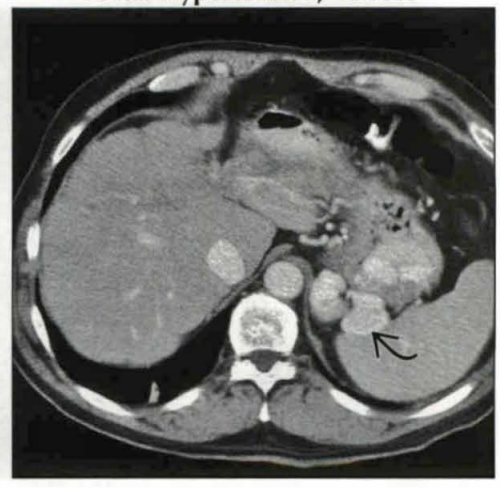
Gastric Ulcer

Portal Hypertension, Varices



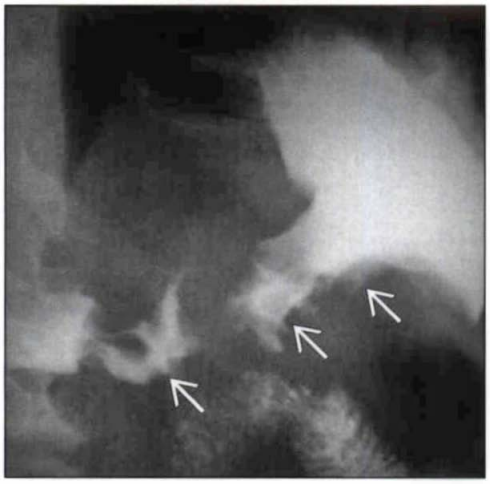
(Left) Axial CECT shows active bleeding (extravasation of IV contrast) into stomach due to portal hypertensive gastropathy from cirrhosis. Note thick folds. (Right) Axial CECT shows massive gastric wall varices in the fundus due to cirrhosis. On UGI series or NECT these may simulate a gastric mass or nonspecific fold thickening.

Portal Hypertension, Varices

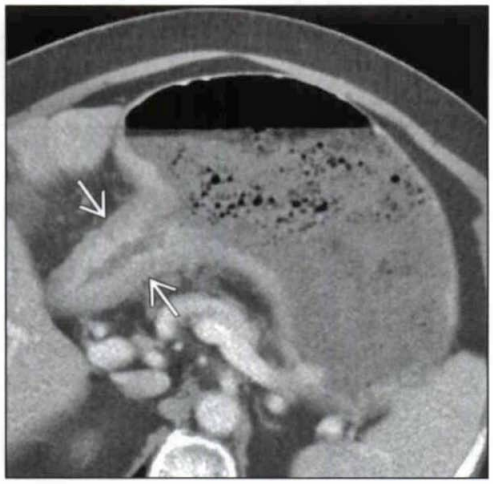


THICKENED GASTRIC FOLDS

Gastric Carcinoma

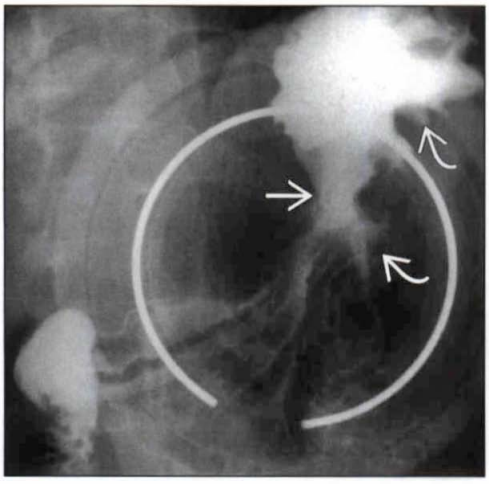


Gastric Carcinoma

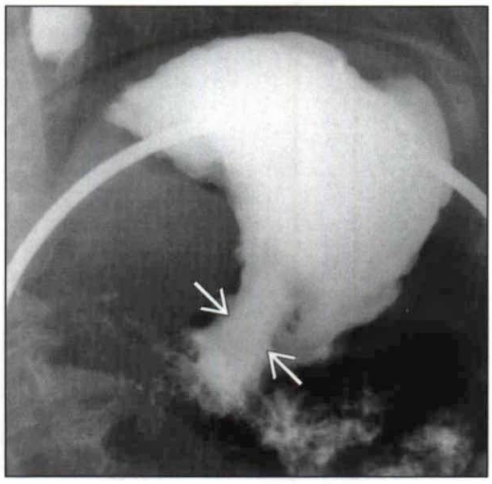


***(Left)** Upper GI shows markedly thickened, nodular folds ➡ in the gastric body & antrum with lack of distensibility; 71 year old woman with symptoms of early satiety & weight loss. No peristalsis was seen at fluoroscopy through the affected area. **(Right)** Axial CECT shows gastric wall thickening ➡ of soft tissue density through the distal body and antrum. Note signs of gastric outlet obstruction; 71 year old woman with early satiety.*

Gastric Carcinoma

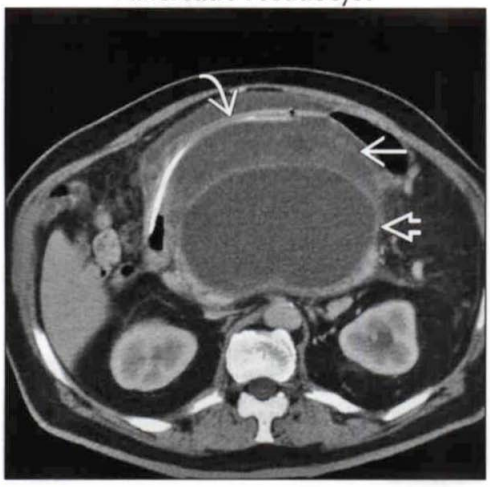


Gastric Carcinoma

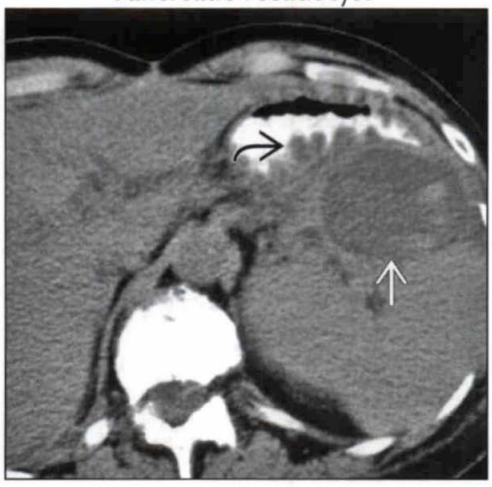


***(Left)** Upper GI shows markedly thickened, nodular folds ➡ throughout the fundus and body with a large ulcer crater ➡; 58 year old man. **(Right)** Upper GI shows a large gastric ulcer ➡ surrounded by thickened, nodular folds. The lack of distensibility of the gastric body and antrum is an important clue to the malignant nature of the disease process in this 80 year old man.*

Pancreatic Pseudocyst



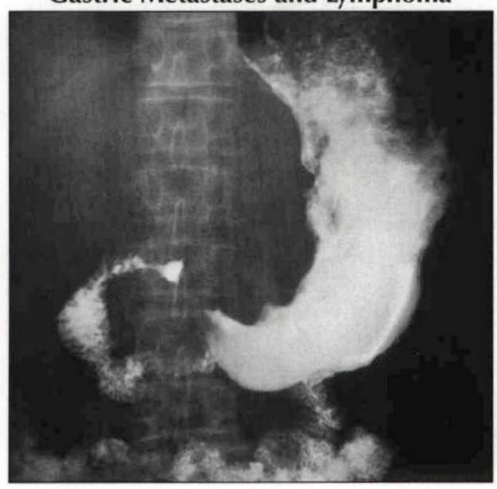
Pancreatic Pseudocyst



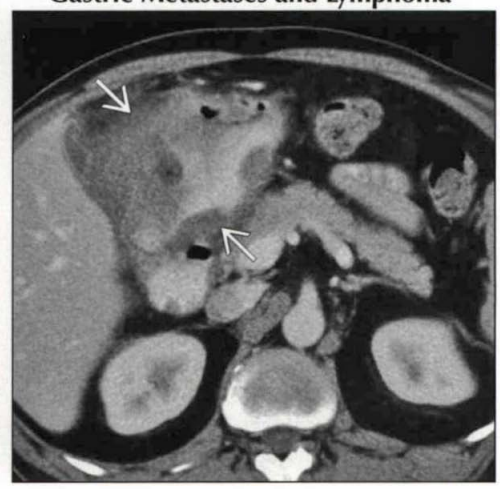
***(Left)** Axial CECT shows a large midline pancreatic pseudocyst ➡ with the stomach draped over it. Note the NG tube ➡ within the stomach and the marked gastric wall thickening ➡. **(Right)** Axial NECT shows a pancreatic pseudocyst ➡ that displaces the posterior wall of the stomach and results in thickened gastric folds ➡; 65 year old woman.*

THICKENED GASTRIC FOLDS

Gastric Metastases and Lymphoma



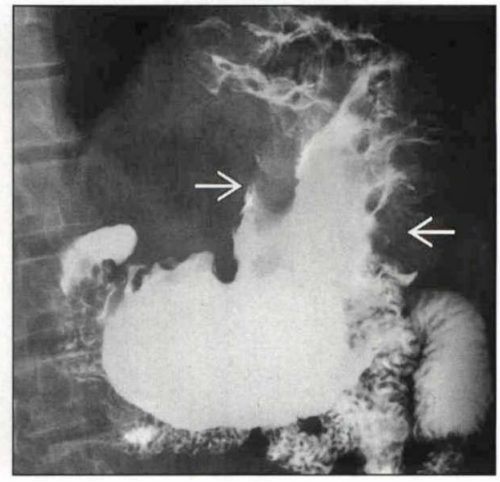
Gastric Metastases and Lymphoma



(Left) *Frontal upper GI shows grossly thickened folds throughout the stomach, probably extending into the duodenum, but normal distensibility of the stomach and no outlet obstruction; typical features of gastric lymphoma in an 80 year old woman.* ***(Right)*** *Axial CECT shows massive fold/wall thickening of the gastric antrum ➡ without outlet obstruction, classic signs of lymphoma.*

Menetrier Disease

Menetrier Disease



(Left) *Axial CECT shows massive fold thickening ➡ that was limited to the gastric fundus and body. Note the absence of a "tumor" mass in this 71 year old woman.* ***(Right)*** *Upper GI shows massive fold thickening ➡ limited to the gastric fundus and body, with sparing of the antrum. There are indirect signs of excess fluid secretion with poor coating of the gastric mucosa by the barium.*

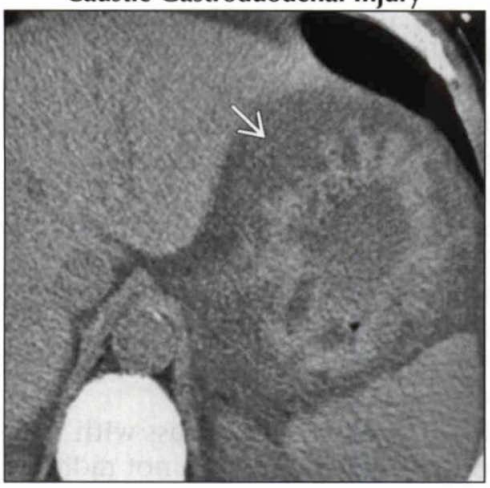
Zollinger-Ellison Syndrome

Zollinger-Ellison Syndrome

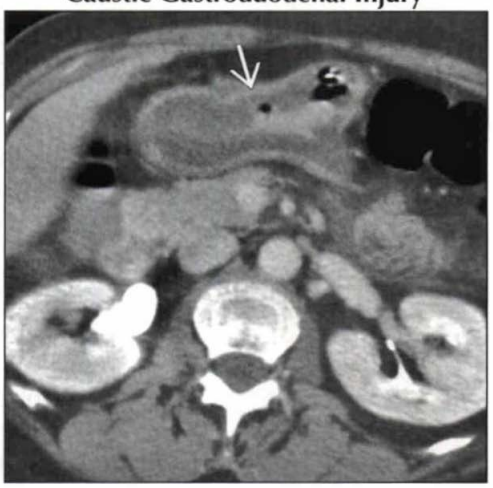
(Left) *Axial CECT shows thick gastric folds ➡ in a 55 year old man with chronic dyspepsia and elevated serum gastrin levels. A gastrinoma was found in the pancreatic head.* ***(Right)*** *Axial CECT shows a markedly thickened & hyperemic gastric wall ➡ and numerous liver metastases ➡ due to metastatic malignant gastrinoma. This 55 year old woman had MEN1 syndrome, as well as parathyroid adenomas.*

THICKENED GASTRIC FOLDS

Caustic Gastroduodenal Injury

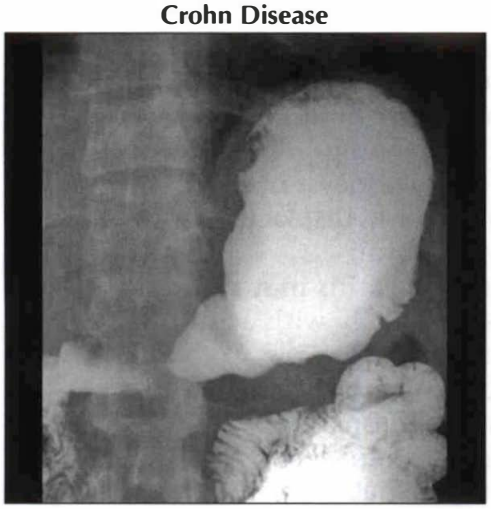


Caustic Gastroduodenal Injury

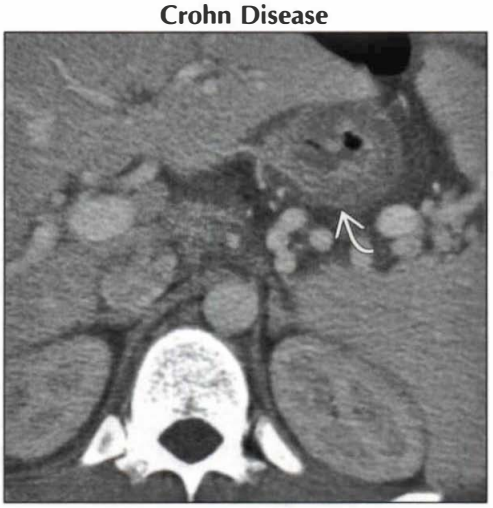


(Left) *Axial NECT shows marked gastric fold thickening* ⇨ *that was present throughout the entire stomach and esophagus; 34 year old man who drank drain cleaner (lye) in a suicide attempt.* ***(Right)*** *Axial CECT shows gastric submucosal edema* ⇨ *in a 64 year old woman who drank drain cleaner (strong alkali) in a suicide attempt.*

Crohn Disease

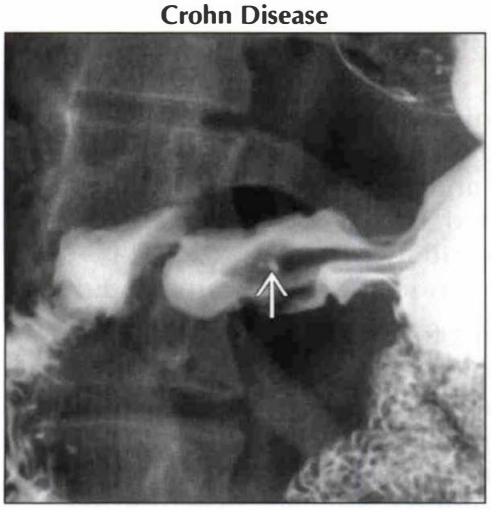


Crohn Disease



(Left) *Upper GI shows decreased distensibility of the stomach with a "ram's horn" shape of the contracted body and antrum. Also note thickened folds; 24 year old man with chronic Crohn disease of stomach and bowel.* ***(Right)*** *Axial CECT shows a nondistended, edematous, thick-walled antrum* ⇨ *due to Crohn disease; 24 year old man with long-standing small bowel involvement.*

Crohn Disease



Amyloidosis

(Left) *Upper GI shows antral fold thickening and one of several aphthous erosions* ⇨ *in a 26 year old woman with proven Crohn disease, causing gastritis.* ***(Right)*** *Axial NECT shows hepatosplenomegaly and thickened gastric folds due to amyloidosis. Liver biopsy and endoscopy were used to confirm the histologic diagnoses.*

GASTRIC ANTRAL NARROWING

DIFFERENTIAL DIAGNOSIS

Common
- Gastritis
- Normal Variant
- Gastric Ulcer
- Gastric Carcinoma
- Acute Pancreatitis
- Post-Gastric Surgery State
- Hypertrophic Pyloric Stenosis

Less Common
- GIST, Stomach
- Metastases and Lymphoma, Gastric
- Caustic Gastroduodenal Injury
- Crohn Disease

Rare but Important
- Tuberculosis
- Syphilis, Stomach
- Sarcoidosis, Gastric
- Opportunistic Infections, Gastric

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Most processes that result in gastric fold thickening can also cause antral narrowing
  - Inflammation
    - Primary to stomach (gastritis)
    - From sites extrinsic to stomach (e.g., acute pancreatitis)
  - Neoplasm
    - Primary gastric carcinoma
    - Metastatic: Breast cancer is especially prone to scirrhous metastases to stomach
- Many processes that cause gastric antral narrowing can also cause gastric dilation and outlet obstruction
  - Some processes that result in outlet obstruction cause neither fold thickening nor antral narrowing
    - e.g., gastroparesis or duodenal obstruction

Helpful Clues for Common Diagnoses
- **Gastritis**
  - Any cause: H. pylori, alcohol, NSAIDs, etc.
  - Nodular fold thickening ± erosions
  - Submucosal thickened layer is of low (near water) attenuation
- **Normal Variant**
  - Antral wall may appear thick on CT
    - Circular muscle layer is thickened through the antral-pyloric region
    - No associated signs of disease (outlet obstruction, nodes, inflammation)
- **Gastric Ulcer**
  - Usually due to H. pylori or NSAIDs
  - "Gastritis" findings plus ulcer crater
  - Extraluminal gas or contrast material indicate perforation
    - Most often posteriorly into lesser sac
- **Gastric Carcinoma**
  - Fixed narrowing with absence of peristalsis through involved segment
    - This finding is most evident on fluoroscopic UGI series
  - Polypoid or circumferential mass with irregular nodular folds that do not radiate to an ulcer crater
  - Submucosal layer of thickening is of soft tissue density similar to gastric muscle
- **Acute Pancreatitis**
  - Gastric wall adjacent to inflamed pancreas often shows spasm (luminal narrowing) and fold thickening
  - Pancreatic pseudocyst may also cause mass effect, lifting and displacing gastric antrum and posterior wall
  - Chronic pancreatitis may cause similar findings, especially with acute exacerbation
- **Post-Gastric Surgery State**
  - Following pyloroplasty, Billroth 1 type of partial gastrectomy, etc.
    - Gastroduodenal or gastroenteric anastomosis may ulcerate or scar, leading to fixed narrowing or even outlet obstruction
    - Gastric bezoar is a known complication
    - Gastric carcinoma may develop years after initial surgery for benign peptic ulcer disease
  - Antrum and pylorus should not be constricted, but will be deformed
- **Hypertrophic Pyloric Stenosis**
  - Common in male infants, rare in adults

Helpful Clues for Less Common Diagnoses
- **GIST, Stomach**
  - Intramural and exophytic mass
  - Does not cause circumferential wall thickening nor gastric outlet obstruction
    - May compress stomach from outside

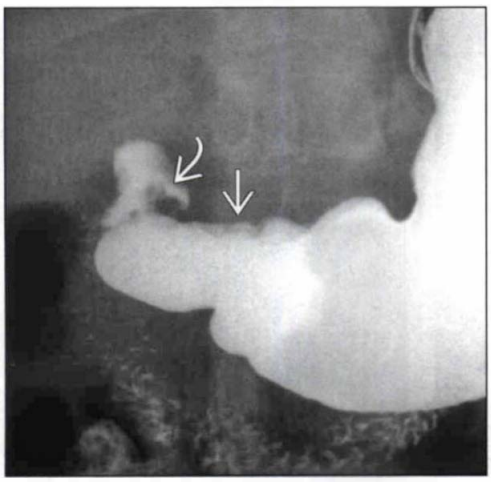
- Often has stretched and ulcerated gastric mucosa
  - May allow gastric contents into necrotic center of GIST

- **Metastases and Lymphoma, Gastric**
  - Lymphoma, CT signs
    - Marked wall thickening (> 3 cm)
    - Submucosal thickening of soft tissue density
    - No gastric outlet obstruction (preserved peristalsis)
    - Prominent perigastric lymphadenopathy ± other sites of involvement
  - Metastases, CT signs
    - Wall thickening < 3 cm
    - Isolated nodular metastases (e.g., melanoma, Kaposi sarcoma)
    - Scirrhous, diffuse metastases (e.g., breast cancer) may result in outlet obstruction or even linitis plastica appearance
- **Caustic Gastroduodenal Injury**
  - History of ingestion is key to diagnosis
  - Acute injury
    - Massive wall thickening of esophagus and stomach
    - Submucosal layer is edematous, low density
    - Perforation is common within first few weeks
  - Chronic injury
    - Small fibrotic stomach (linitis plastica)
- **Crohn Disease**
  - Long-standing
    - Classically causes "ram's horn" distortion and narrowing of antrum
    - May have associated mucosal ulceration
    - Usually associated with other sites of Crohn disease, especially distal small bowel &/or colon

Helpful Clues for Rare Diagnoses

- **Tuberculosis**
  - Narrowing and thickening of stomach and duodenum
  - More common in certain populations, including Native Americans
- **Syphilis, Stomach**
  - Rare
  - Acute disease may cause gastric fold thickening and mucosal ulceration
  - Chronic (tertiary) syphilis may cause funnel-shaped antrum or even linitis plastica appearance
- **Sarcoidosis, Gastric**
  - Uncommonly affects stomach
  - May cause mucosal nodularity or thickened, irregular folds
  - Advanced cases may result in cone-shaped antrum
- **Opportunistic Infections, Gastric**
  - Cytomegalovirus (CMV), cryptosporidiosis, toxoplasmosis
  - May cause mucosal ulceration, fold thickening, luminal narrowing
  - Affects immunocompromised patients, such as those with AIDS

Gastritis



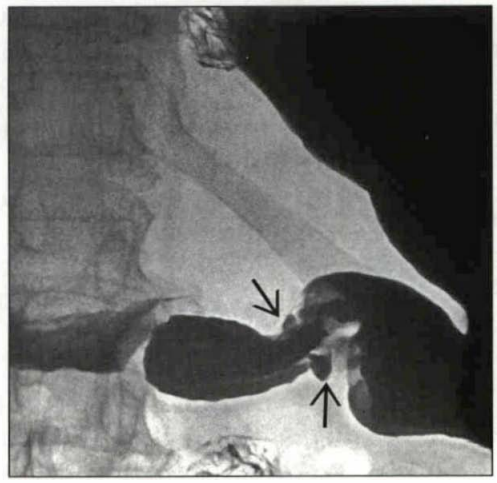
Upper GI shows nodular thickened antral folds, some of which herniate into the duodenal bulb through the pylorus. The antrum is not fully distensible.

Gastritis

Axial CECT shows luminal narrowing and wall thickening of the antrum with submucosal edema. The thickened gastric folds indent the base of the duodenal bulb. Gastric mucosa is hyperemic.

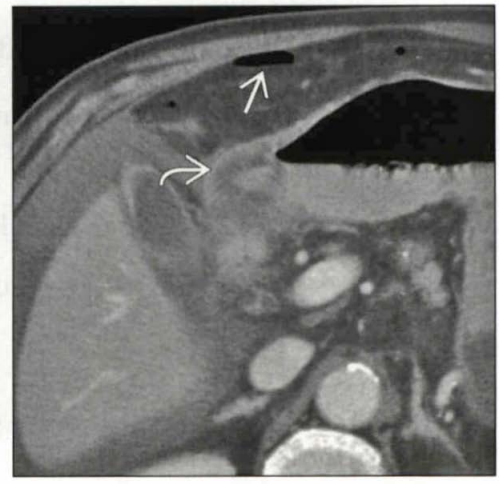
GASTRIC ANTRAL NARROWING

Gastric Ulcer

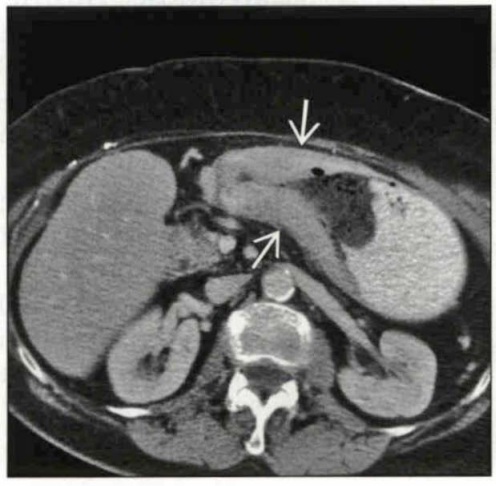


(Left) Upper GI shows nodular thickened folds and a nondistensible gastric antrum with at least 2 discrete ulcers ➔ as persistent collections of barium. (Right) Axial CECT shows gastric antral wall thickening and luminal narrowing ➡. Free air ➡ and fluid indicate perforation, with a prepyloric ulcer confirmed at surgery.

Gastric Ulcer

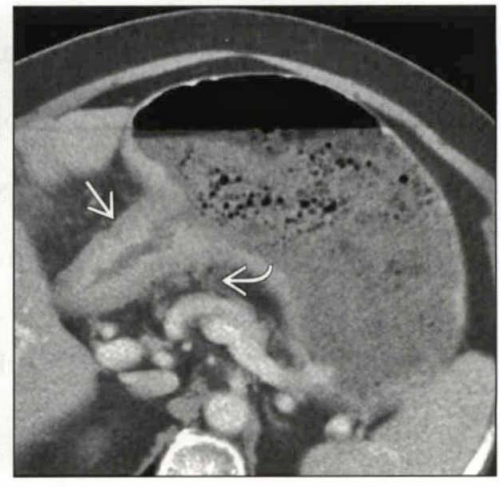


Gastric Carcinoma



(Left) Axial CECT shows circumferential thickening of the gastric antrum and distal body ➡ with gastric outlet obstruction. Note soft tissue density of wall thickening, and retained food in stomach. (Right) Axial CECT shows circumferential thickening of gastric antrum ➡ and partial gastric outlet obstruction. Note soft tissue density of submucosal layer, and perigastric lymphadenopathy ➡.

Gastric Carcinoma



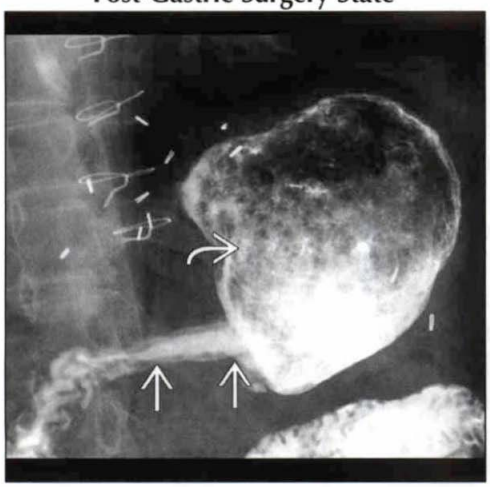
Acute Pancreatitis

(Left) Axial CECT shows narrowing and external compression of the gastric antrum ➡ by an inflammatory mass arising from the pancreas. The pancreatic ductal dilation ➔ and calcifications indicate chronic pancreatitis, while the peripancreatic infiltrated fat planes ➡ are due to acute exacerbation. (Right) Axial CECT shows patchy enhancement of the pancreas ➡ due to necrotizing pancreatitis, also causing antral narrowing ➡ and fold thickening.

Acute Pancreatitis

GASTRIC ANTRAL NARROWING

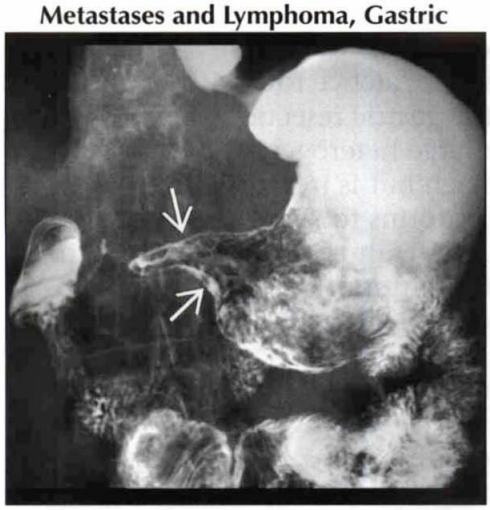
Post-Gastric Surgery State



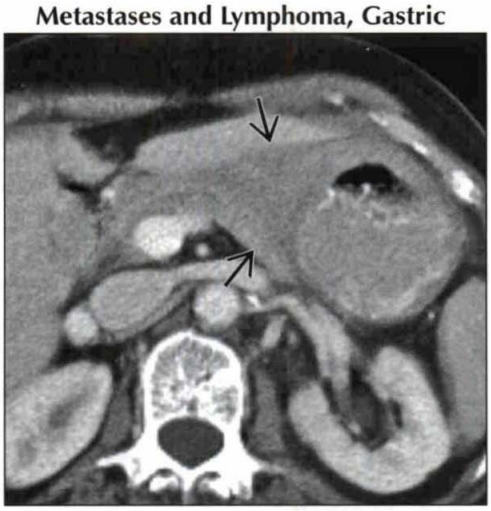
GIST, Stomach

(Left) Upper GI shows a small stomach with a collapsed, deformed distal body, as a result of a prior antrectomy (Billroth I procedure with vagotomy). A complication of this procedure is development of a gastric bezoar, the fixed filling defect within the stomach. (Right) Axial CECT shows an exophytic mass that compresses the gastric body and antrum. The central necrosis of the mass is a clue as to its etiology.

Metastases and Lymphoma, Gastric

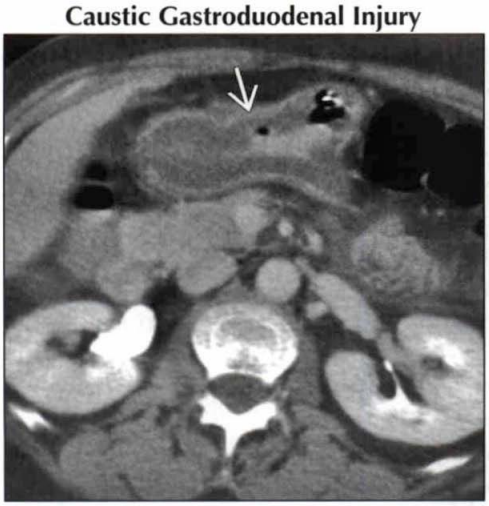


Metastases and Lymphoma, Gastric

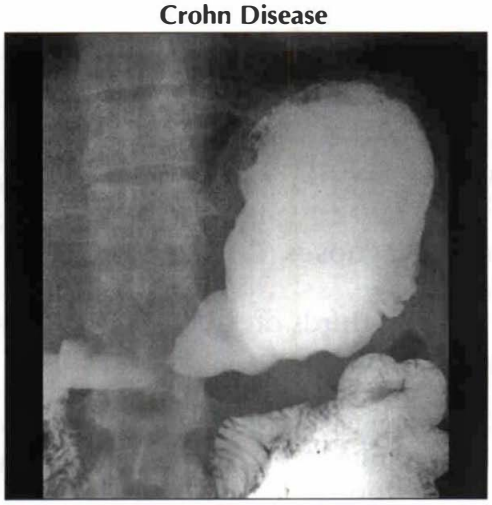


(Left) Frontal upper GI shows constriction of the antrum with a partial gastric outlet obstruction; metastatic breast cancer. (Right) Axial CECT shows marked circumferential thickening of the gastric antrum and body, but no gastric outlet obstruction, classic findings for gastric lymphoma.

Caustic Gastroduodenal Injury



Crohn Disease



(Left) Axial CECT shows gastric antral luminal narrowing and submucosal edema, due to acute ingestion of lye as a suicide attempt. (Right) Upper GI shows a stomach of reduced volume with a constricted, tapered antrum, due to long-standing Crohn disease. Note "ram's horn" shape of distal stomach.

GASTRIC DILATION OR OUTLET OBSTRUCTION

DIFFERENTIAL DIAGNOSIS

Common
- Gastric or Duodenal Ulcer
- Gastric Carcinoma
- Gastroparesis
- Post-Operative State, Stomach
  - Gastric Bezoar
  - Fundoplication Complications
- Gastric Volvulus
- Hypertrophic Pyloric Stenosis
- Gastric Ileus

Less Common
- Pancreatitis, Acute
- Pancreatitis, Chronic
- Metastases and Lymphoma, Gastric
- Duodenal Mass or Stricture
  - Duodenal Carcinoma
  - Annular Pancreas
  - Metastases and Lymphoma, Duodenal
- Gastric Polyps
- SMA Syndrome

Rare but Important
- Infiltrating Lesions
  - Crohn Disease (Gastric)
  - Sarcoidosis, Gastric
  - Tuberculosis, Gastroduodenal
  - Syphilis, Stomach
  - Amyloidosis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Look for mass or stricture in stomach or proximal bowel
- Recent onset of gastric outlet obstruction without a long preceding history of "ulcer pain" should suggest malignant etiology
  - Inquire about
    - Recent or chronic symptoms
    - Any known malignancy
    - Recent weight loss

Helpful Clues for Common Diagnoses
- **Gastric or Duodenal Ulcer**
  - Peptic ulcers account for two-thirds of cases of gastric outlet obstruction
  - Prepyloric ulcer may cause spasm, edema, and scarring that obstruct the gastric outlet
  - Duodenal ulcer can do the same
  - Outlet obstruction is a late finding
    - Should be preceded by long history of pain attributable to peptic ulcer disease
- **Gastric Carcinoma**
  - Second most common cause of gastric outlet obstruction
    - Accounts for almost one-third of cases of gastric outlet obstruction
  - Involvement of antrum may obstruct outlet
  - Gastric carcinoma is often scirrhous
    - "Hard" inflexible mass that limits distensibility and peristalsis
    - Lack of peristalsis is most evident at fluoroscopic UGI series
- **Gastroparesis**
  - Common sequela of diabetes, narcotic analgesics
  - Flaccid stomach without peristalsis
  - Radionuclide gastric emptying study is best diagnostic tool
- **Gastric Bezoar**
  - Increased prevalence following vagotomy and partial gastric resection
  - Look for large heterogeneous mass that fills stomach but is freely movable
    - Mass conforms to shape of stomach
    - May be difficult to distinguish from food from a recent meal
- **Fundoplication Complications**
  - Limits ability to belch
  - May result in distention of stomach with swallowed air
- **Gastric Volvulus**
  - Intrathoracic stomach (paraesophageal hernia, type IV)
  - May twist on itself
    - Organoaxial or mesenteroaxial volvulus
  - More important to determine if gastric outlet is obstructed
    - Obstruction may constitute a surgical emergency or require endoscopic decompression
- **Hypertrophic Pyloric Stenosis**
  - Common cause in baby boys
  - Rare in adults
  - May be same disease process with delayed diagnosis
  - Over 50% of adults with pyloric stenosis also have gastric ulcers
    - Thought to be due to outlet obstruction and hyperacidity

GASTRIC DILATION OR OUTLET OBSTRUCTION

- **Gastric Ileus**
  - Usually accompanied by dilation of small and large bowel
  - Common sequela of
    - Trauma
    - Post-operative state (usually abdominal surgery)
    - Electrolyte disorder
    - Narcotic analgesic use

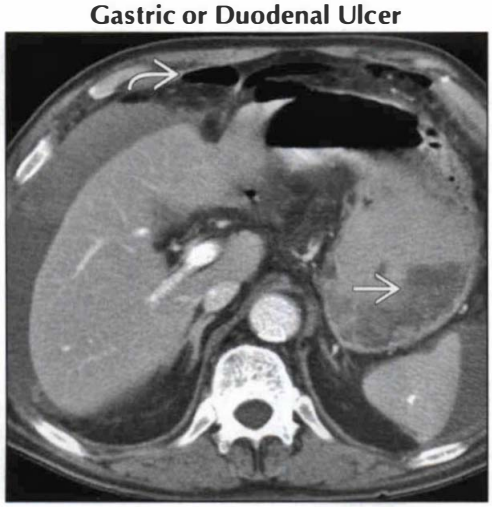
Helpful Clues for Less Common Diagnoses

- **Pancreatitis, Acute**
  - Gastric dilatation from several possible etiologies
    - Duodenal inflammation
    - Pain (ileus)
    - Narcotics
- **Pancreatitis, Chronic**
  - May result in stricture of second portion of duodenum
  - Pancreatic pseudocysts can also contribute to functional gastric outlet obstruction
- **Duodenal Mass or Stricture**
  - Any process that narrows the lumen of the duodenum may result in "gastric outlet obstruction" and distention
  - Examples
    - Duodenal carcinoma: Scirrhous circumferential or intraluminal mass
    - Annular pancreas: Characteristic appearance of pancreatic tissue encircling second portion of duodenum
    - Metastases: Carcinomatous metastases or direct invasion from adjacent tumor (e.g., pancreatic carcinoma)
- **Gastric Polyps**
  - Antral polyp may prolapse through and obstruct pylorus
  - Leads to intermittent outlet obstruction
- **SMA Syndrome**
  - Lumen of third portion of duodenum may be compressed as it passes between aorta (& lumbar spine) and the superior mesenteric root
  - Any condition that narrows the aortomesenteric angle will accentuate the compression
    - Recent weight loss
    - Prolonged bed rest
    - Immobilization in supine position
    - Collagen vascular diseases (scleroderma, lupus, etc.) that may also cause decreased duodenal peristalsis

Helpful Clues for Rare Diagnoses

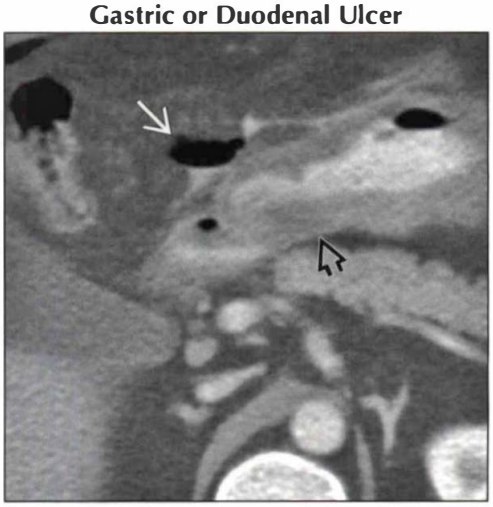
- **Infiltrating Lesions**
  - May cause narrowing of gastric antrum and subsequent outlet obstruction
  - Multiple possible etiologies
    - Crohn disease
    - Sarcoidosis
    - Tuberculosis
    - Syphilis
    - Amyloidosis

Gastric or Duodenal Ulcer



Axial CECT shows distended stomach with retained food ➡ plus free intraperitoneal gas ➡ and fluid; perforated prepyloric ulcer.

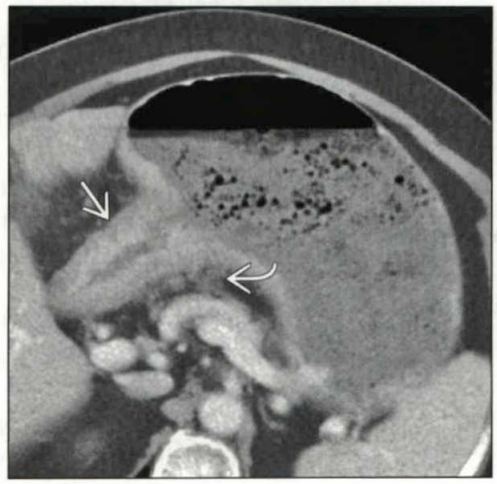
Gastric or Duodenal Ulcer



Axial CECT shows extraluminal gas & enteric contrast ➡ near the duodenal bulb, due to a perforated duodenal ulcer. The gastric antral wall is also thickened and edematous ⇨ due to gastritis.

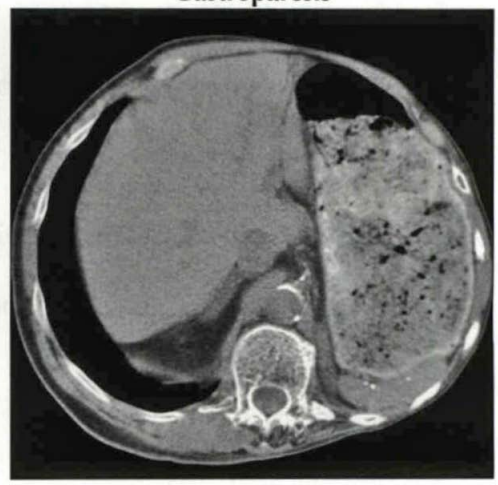
GASTRIC DILATION OR OUTLET OBSTRUCTION

Gastric Carcinoma

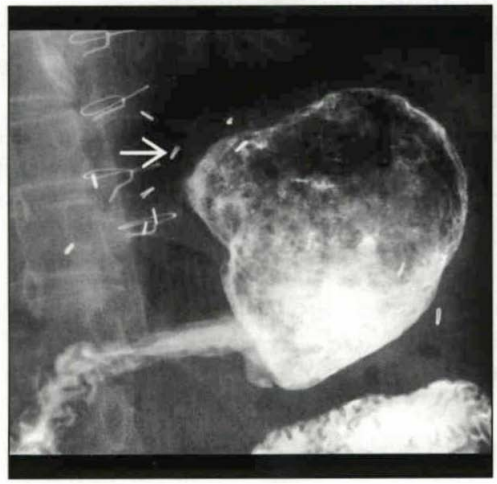


(Left) Axial CECT shows circumferential thickening of the gastric antrum ➡ of soft tissue attenuation. Note distended stomach with food debris, & perigastric nodes ➡. (Right) Axial NECT shows massive distention of the stomach and retained food debris, with no obstructing mass or ulcer found. Diabetic gastroparesis in a 62 year old man.

Gastroparesis

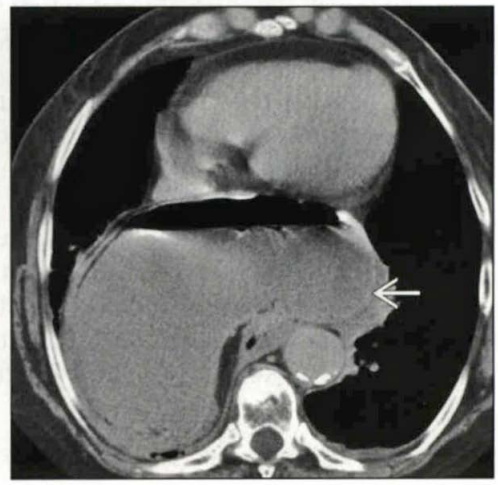


Gastric Bezoar

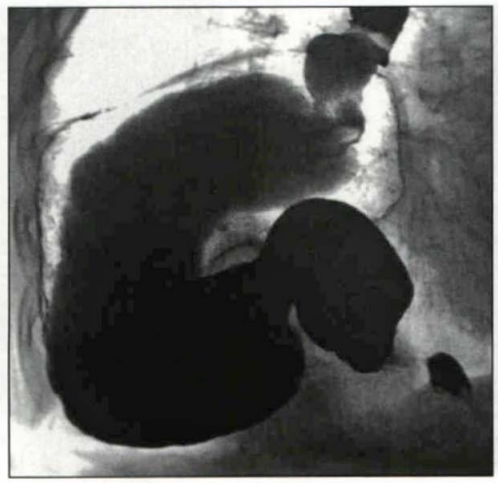


(Left) Upper GI shows a small stomach, the result of a prior antrectomy (Billroth 1 procedure) with vagotomy clips seen ➡. The stomach is distended with a bezoar of undigested vegetable matter. (Right) Axial NECT shows a massively distended intrathoracic stomach ➡, a type 4 paraesophageal hernia, with outlet obstruction due to volvulus.

Gastric Volvulus



Gastric Volvulus



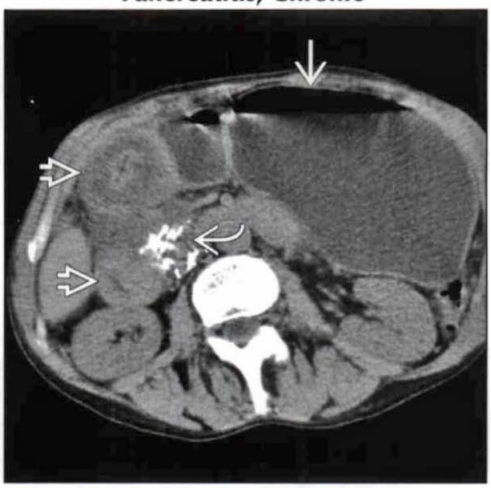
(Left) Upper GI shows a completely intrathoracic stomach (type 4 paraesophageal hernia) with an organoaxial volvulus, resulting in gastric outlet obstruction and massive dilation. (Right) Axial CECT shows a distended stomach ➡ and an atrophic pancreas ➡ in a 57 year old man with chronic pancreatitis.

Pancreatitis, Chronic

GASTRIC DILATION OR OUTLET OBSTRUCTION

Pancreatitis, Chronic

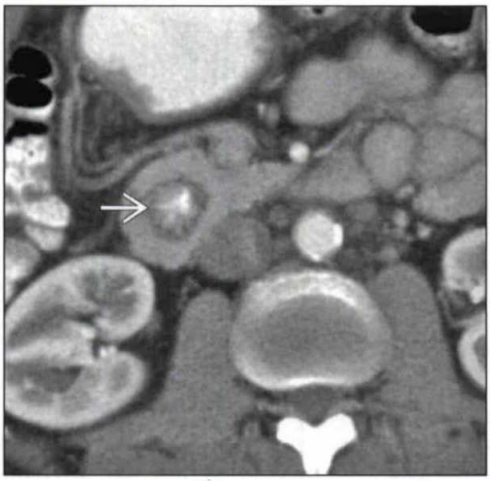
Pancreatitis, Chronic



(Left) *Axial NECT shows distention of the stomach and evidence of chronic pancreatitis (parenchymal atrophy and calcifications); 59 year old man who also had duodenal inflammation from pancreatitis.* ***(Right)*** *Axial NECT shows gastric distention and calcifications in the head of the pancreas from chronic pancreatitis. Also note mural thickening of the antrum and duodenum from acute exacerbation of pancreatitis.*

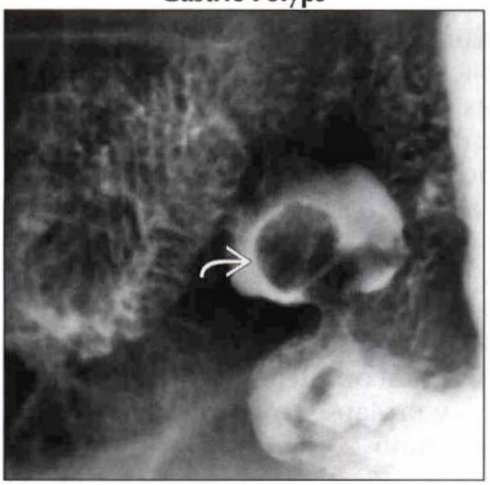
Metastases and Lymphoma, Gastric

Annular Pancreas

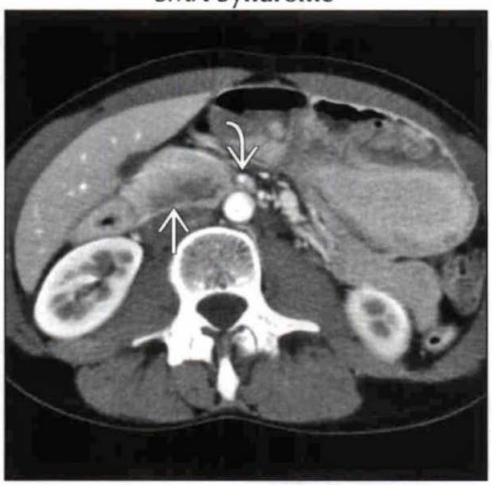


(Left) *Axial CECT shows gastric distention and food debris from outlet obstruction. The antral wall is thickened & the lumen narrowed due to metastatic breast cancer.* ***(Right)*** *Axial CECT shows the second portion of duodenum completely encircled by pancreatic tissue.*

Gastric Polyps



SMA Syndrome



(Left) *Upper GI shows a polyp within the duodenal bulb that has its base in the prepyloric antrum. It periodically herniated through the pylorus, causing partial gastric outlet obstruction.* ***(Right)*** *Axial CECT shows a distended stomach with retained food, and a dilated duodenum that abruptly narrows as it passes between the superior mesenteric trunk and the aorta.*

LINITIS PLASTICA, LIMITED DISTENSIBILITY

DIFFERENTIAL DIAGNOSIS

Common
- Gastric Carcinoma
- Metastases and Lymphoma, Gastric

Less Common
- Gastritis
- Caustic Gastroduodenal Injury
- Peritoneal Metastases
- Opportunistic Infection, Gastric

Rare but Important
- Crohn Disease, Gastric
- Following Gastric Freezing
- Syphilis, Stomach
- Radiation-Induced Gastritis
- Infiltrative Granulomatous Diseases
  - Tuberculosis
  - Sarcoidosis
  - Amyloidosis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Linitis plastica is a descriptive term, not a pathologic diagnosis
  - Refers to a rigid, nondistensible, "leather bottle" stomach
  - Usually due to one of 3 etiologies
    - Gastric carcinoma
    - Metastases to stomach (especially breast cancer)
    - Caustic gastric injury
  - Many more etiologies for mild to moderate nondistensibility of stomach
    - Malignant neoplasm (primary carcinoma or lymphoma, or metastatic to stomach or peritoneal surfaces)
    - Gastritis (many infectious and inflammatory types)
    - Iatrogenic (radiation therapy or gastric freezing for control of variceal bleeding)
    - Diffuse infiltrative, granulomatous diseases (TB, sarcoid, syphilis, amyloidosis)

Helpful Clues for Common Diagnoses
- **Gastric Carcinoma**
  - Most common cause worldwide
  - May invade and diffusely infiltrate submucosal layer and produce scirrhous, fibrotic response
  - May have minimal mucosal or intraluminal component
    - Can be missed on endoscopy and biopsy
  - Gastric wall only moderately thick (1-2 cm)
  - Peristalsis and distensibility are markedly diminished
    - Often the most striking finding
    - Best recognized on fluoroscopic UGI series
    - Gastric outlet obstruction may also occur
    - Patients complain of early satiety & weight loss, rather than pain
- **Metastases and Lymphoma, Gastric**
  - Some metastases cause scirrhous infiltration of gastric wall and fibrotic reaction
  - May cause linitis plastica appearance indistinguishable from gastric carcinoma
  - Breast cancer is the most common primary source for this pattern
    - In North America, breast mets may be a more common cause of linitis plastica than gastric carcinoma
  - Lymphoma often diffusely infiltrates the gastric wall but only causes mild limitation of gastric distention, usually
    - Gastric outlet obstruction is a rare occurrence with lymphoma

Helpful Clues for Less Common Diagnoses
- **Gastritis**
  - Many etiologies
    - Use of NSAID analgesics
    - Infestation by Helicobacter pylori bacteria
    - Alcohol
    - Tobacco
    - Opportunistic infections (viral, mycobacterial, protozoan, etc.) in patients with AIDS or transplant recipients
    - Radiation therapy
  - Limited ability to suggest a specific etiology based on imaging findings
  - May have superficial erosions or ulceration of mucosa
  - Gastric folds are thickened, especially in antrum with incomplete distensibility
    - Folds may prolapse through pylorus into duodenal bulb

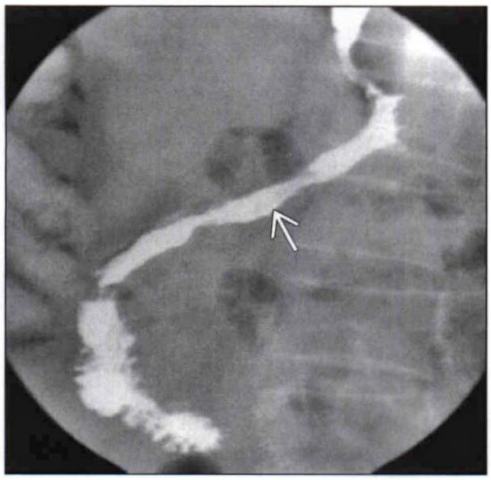
- CT shows low density edematous submucosa
  - Distinguished from the soft tissue density seen with malignant infiltration of gastric wall

- **Caustic Gastroduodenal Injury**
  - Often accompanied by similar injury to esophagus
  - Accidental or intentional ingestion of strong alkali (lye), acid, or formaldehyde
  - Acute findings
    - Gastric atony and delayed emptying
    - Striking wall thickening and edema
  - Subacute or chronic findings
    - Perforation of stomach
    - Marked loss of gastric size and distensibility; classic linitis plastica appearance
- **Peritoneal Metastases**
  - Serosal surface of stomach may be coated with peritoneal metastases, limiting distensibility
  - Peritoneal & omental mets and malignant ascites can compress stomach
  - Usual sources: Ovarian, endometrial, GI tract cancers
  - CT much better than radiography or UGI series in detecting and characterizing these findings

Helpful Clues for Rare Diagnoses

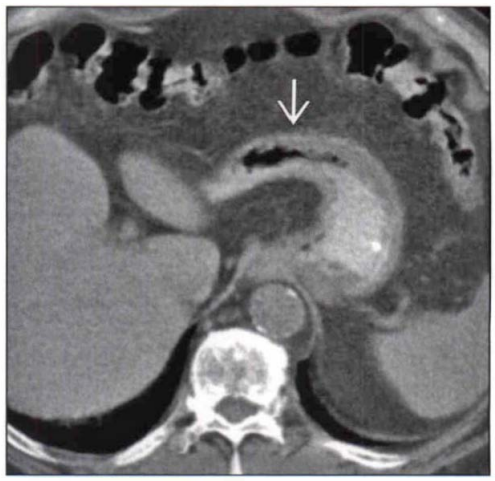
- **Crohn Disease, Gastric**
  - Uncommonly affects stomach, usually in patients with small bowel &/or colon involvement as well
  - Acute
    - Gastric fold thickening and erosions
    - Similar appearance as other causes of gastritis
  - Chronic
    - Limited distensibility of stomach
    - Conical contraction of antrum with a "ram's horn" configuration
- **Following Gastric Freezing**
  - Gastric infusion of iced saline may be used to control GI bleeding
  - If used excessively, can freeze stomach and lead to scarring
- **Infiltrative Granulomatous Diseases**
  - All are rare and probably indistinguishable by imaging alone
    - Syphilis
    - Sarcoidosis
    - TB
    - Amyloidosis
  - All tend to cause fold thickening and limited distention without gastric erosions or ulceration

Gastric Carcinoma



Upper GI shows a remarkably contracted and nondistensible stomach due to diffusely infiltrative gastric carcinoma, a classic linitis plastica appearance in an 82 year old man.

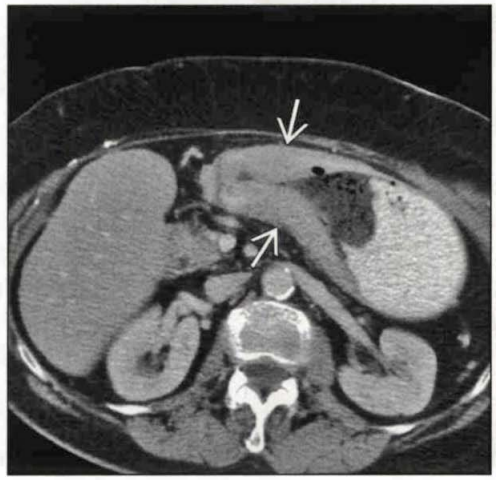
Gastric Carcinoma



Axial NECT shows the contracted stomach due to diffusely infiltrative gastric carcinoma in an 82 year old man. As depicted by CT, there was no spread beyond the stomach at gastric resection.

LINITIS PLASTICA, LIMITED DISTENSIBILITY

Gastric Carcinoma



Gastric Carcinoma

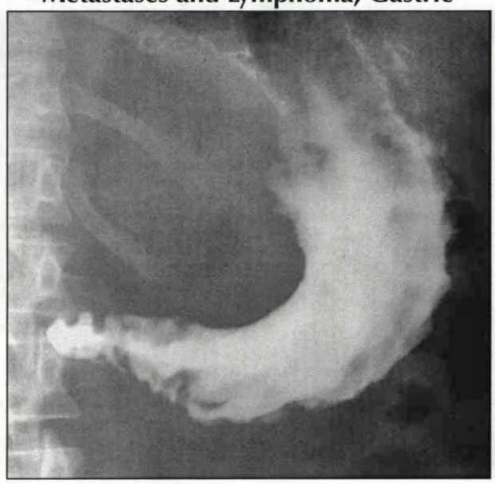
(Left) *Axial CECT shows diffuse tumor infiltration* ➡ *and lack of distensibility of the gastric antrum and distal body. Retained food debris and distention of the proximal stomach indicate gastric outlet obstruction; 81 year old woman.* ***(Right)*** *Surgical photograph shows the gross appearance of the resected stomach with extensive pale-colored tumor infiltration and fibrosis throughout the gastric wall that accounts for the scirrhous nature of this tumor.*

Metastases and Lymphoma, Gastric

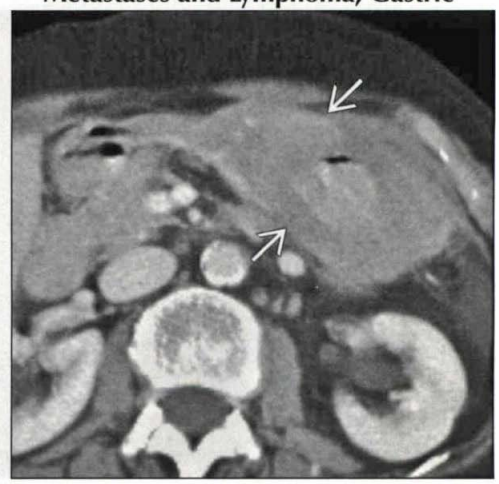
Metastases and Lymphoma, Gastric

(Left) *Upper GI shows a markedly contracted distal body and antrum of the stomach* ➡ *that was also very slow to empty (outlet obstruction); 84 year old woman with metastatic breast cancer.* ***(Right)*** *Axial CECT shows a markedly contracted and nondistensible distal body and antrum of the stomach* ➡ *with soft tissue density of the submucosa. The retained food and distended proximal stomach indicate outlet obstruction; 84 year old woman.*

Metastases and Lymphoma, Gastric



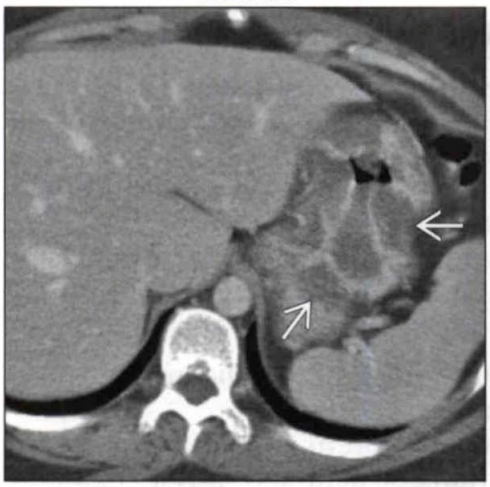
Metastases and Lymphoma, Gastric



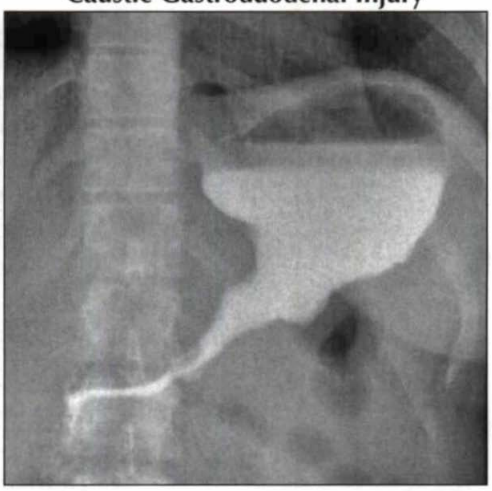
(Left) *Frontal upper GI shows diffusely thickened and nodular folds and mildly reduced distention of the stomach, but no gastric outlet obstruction; 75 year old man with gastric lymphoma.* ***(Right)*** *Axial CECT shows diffuse, marked, soft tissue density thickening of the gastric wall* ➡ *due to lymphoma. There was no clinical or radiographic evidence of gastric outlet obstruction; 75 year old man with gastric lymphoma.*

LINITIS PLASTICA, LIMITED DISTENSIBILITY

Gastritis

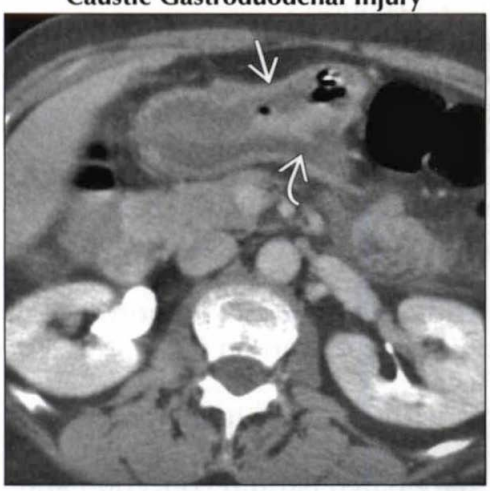


Caustic Gastroduodenal Injury

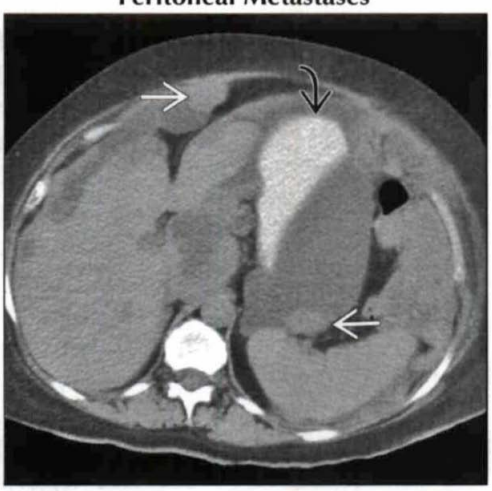


***(Left)** Axial CECT shows striking gastric intramural edema, causing wall thickening and luminal narrowing of the entire stomach. 30 year old man with NSAID-induced gastritis that resolved with antacids & cessation of analgesic use. **(Right)** Frontal upper GI shows a shrunken, nondistensible stomach with evidence of gastric outlet obstruction in a 24 year old man 2 weeks after ingestion of lye (strong alkali) in a suicide attempt.*

Caustic Gastroduodenal Injury

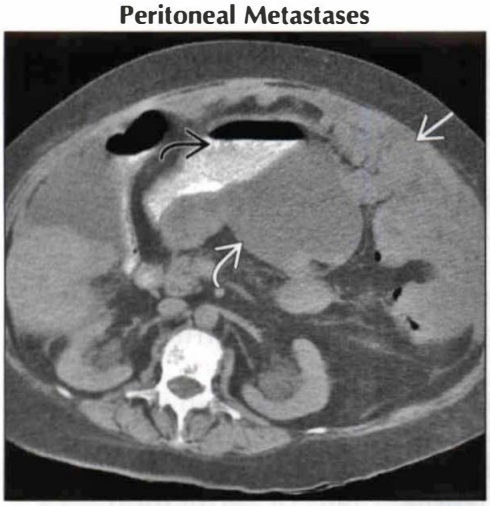


Peritoneal Metastases

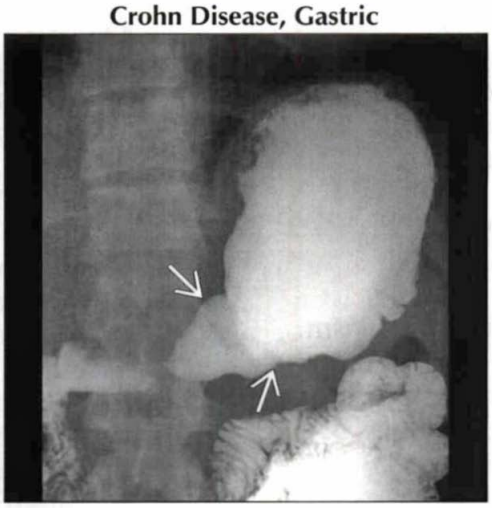


***(Left)** Axial CECT shows wall thickening and nondistensibility of the body and antrum, with an edematous submucosal layer, in a 67 year old woman who ingested lye a few days prior to this CT scan. **(Right)** Axial CECT shows compression of the stomach by nodular peritoneal metastases and malignant ascites, involving the lesser sac and general peritoneal cavity.*

Peritoneal Metastases



Crohn Disease, Gastric



***(Left)** Axial CECT shows a large omental "cake" of tumor and malignant lesser sac ascites that compress the stomach; 69 year old woman with endometrial carcinoma. **(Right)** Frontal upper GI shows a conical antrum and reduced distensibility of the stomach due to chronic Crohn gastritis.*

EPIGASTRIC PAIN

DIFFERENTIAL DIAGNOSIS

Common

- Functional Dyspepsia
- Reflux Esophagitis
- Duodenal Ulcer
- Gastric Ulcer
- Gastritis
- Cholecystitis
- Choledocholithiasis
- Cholangitis, Ascending
- Hepatitis
- Pancreatitis, Acute
- Pancreatitis, Chronic
- Pancreatic Pseudocyst
- Coronary Artery Disease
- Gastric Carcinoma
- Pancreatic Ductal Carcinoma
- Sphincter of Oddi Dysfunction
- Psychosomatic Disorders
- Trauma
  - Hepatic Trauma
  - Pancreatic Trauma
- Abdominal Hernia
  - Hiatal Hernia
  - Ventral Hernia

Less Common

- Crohn Disease
- Other Gastric Causes
  - Menetrier Disease
  - Caustic Gastroduodenal Injury
  - GIST, Stomach
  - Metastases and Lymphoma, Gastric
- Other Hepatic Causes
  - Metastases and Lymphoma, Hepatic
  - Hepatic Adenoma
  - Hepatic Pyogenic Abscess
  - Hepatocellular Carcinoma
  - AD Polycystic Disease, Liver
  - Hepatic Amebic Abscess
  - Hepatic Hydatid Cyst
  - HELLP Syndrome
  - Budd-Chiari Syndrome
- Other Pancreatic Causes
  - Pancreas Divisum
  - Solid & Pseudopapillary Neoplasm, Pancreas
  - Mucinous Cystic Pancreatic Tumor
  - Serous Cystadenoma, Pancreas
- Other Duodenal Causes
  - Duodenal Carcinoma
  - Duodenal Metastases and Lymphoma
- Musculoskeletal Etiologies

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

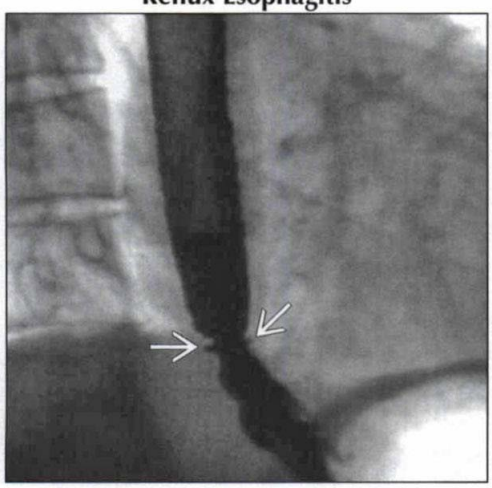
- Choice of initial imaging study should be on basis of clinical judgment
  - Barium UGI series: Best for GERD, peptic ulcer disease
  - Ultrasound: Good choice when acute biliary abnormality is considered likely
  - CT: Best for most other considerations

Helpful Clues for Common Diagnoses

- **Functional Dyspepsia**
  - Pain or discomfort in absence of demonstrable structural or physiologic abnormalities
  - Probably due to abnormal motility, sensation, perception
- **Reflux Esophagitis**
  - Irregular ulcerated mucosa of distal esophagus on barium esophagram
- **Duodenal Ulcer**
  - Sharply marginated barium collection (niche) with folds radiating to edge of ulcer crater on double-contrast barium study
  - Complications: Perforation, hemorrhage, obstruction may be seen on CT
- **Gastric Ulcer**
  - Associated with H. pylori infection, NSAIDs
  - Sharply marginated barium collection and folds radiating to edge of ulcer crater on double contrast barium study
- **Gastritis**
  - Heterogeneous group of disorders causing inflammation of gastric mucosa
    - Erosive, medication-related, eosinophilic, etc.
  - UGI: Antral fold thickening, erosions
  - CECT: Mucosal enhancement, submucosal edema
- **Cholecystitis**
  - 95% secondary to stone obstructing cystic duct
  - US: Gallstone(s), distended GB with thick wall; positive Murphy sign
  - CT: Same, plus pericholecystic inflammation ± signs of perforation

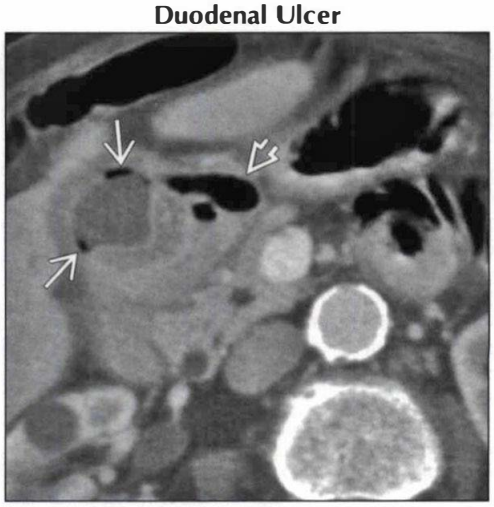
- **Choledocholithiasis**
  - Pain following heavy meal; presenting symptom in 80% of patients
  - Gallstone produces visceral pain by obstructing cystic duct or ampulla of Vater, resulting in distention of the gallbladder or biliary tree
    - 95% of bile duct stones are due to passage from GB into CBD
    - Pain is relieved when the stone migrates back into the gallbladder, passes through the ampulla, or falls back into the CBD
    - No systemic signs of infection
  - Imaging: Discrete low signal filling defect within bile duct on MRCP
  - MRCP superior to US or CT for visualizing stones
- **Cholangitis, Ascending**
  - Irregular contour, branching pattern, dilation of bile ducts
  - Due to gallstones or biliary-enteric communication
- **Hepatitis**
  - "Starry-sky" appearance: ↑ Echogenicity of portal venous walls
  - Hepatomegaly, gallbladder wall thickening, periportal lucency
- **Pancreatitis, Acute**
  - Enlarged pancreas, peripancreatic fluid or infiltrated fat planes and thickened fascia
  - Heterogeneous enhancement on CECT, non-enhancing necrotic areas
- **Pancreatitis, Chronic**
  - Atrophy of gland, dilated main duct, intraductal calculi, thickening of peripancreatic fascia
- **Pancreatic Pseudocyst**
  - Collection of pancreatic fluid & inflammatory exudate encapsulated by fibrous & granulation tissue
- **Coronary Artery Disease**
  - Inferior wall ischemia/infarction may present by epigastric pain in absence of chest pain
- **Gastric Carcinoma**
  - Polypoid or circumferential mass with no peristalsis through lesion on barium study
  - Focal wall thickening & mucosal irregularity on CECT
- **Pancreatic Ductal Carcinoma**
  - 75% of all pancreatic tumors
  - Irregular, heterogeneous, poorly-enhancing mass with abrupt obstruction of pancreatic duct ± CBD ("double duct" sign)
  - Extensive local invasion & regional metastases
- **Sphincter of Oddi Dysfunction**
  - Due to papillary stenosis or sphincter of Oddi dyskinesia
  - Opioids may cause spasm of sphincter of Oddi
- **Psychosomatic Disorders**
  - More commonly seen in children with anxiety disorders

Reflux Esophagitis



Esophagram shows a type 1 hiatal hernia with a stricture at the esophagogastric junction. Two outpouchings ➡ indicate ulcerations of the mucosa.

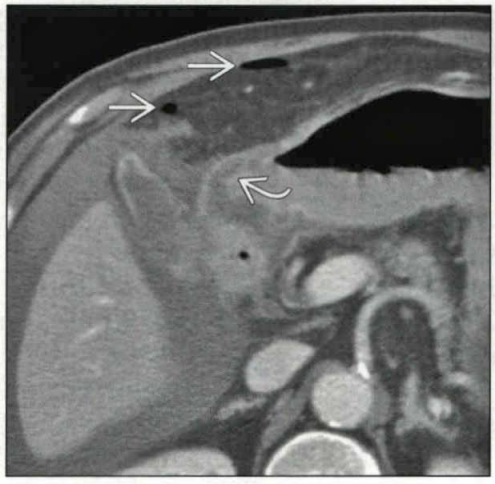
Duodenal Ulcer



Axial CECT shows gas within a distorted duodenal bulb ➡ and extraluminal gas ➡ that surrounds the gallbladder.

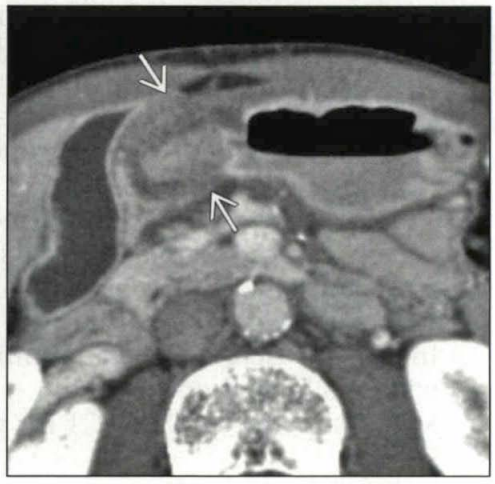
EPIGASTRIC PAIN

Gastric Ulcer



(Left) Axial CECT shows a thick-walled gastric antrum and free intraperitoneal fluid & gas due to a perforated antral ulcer. (Right) Axial CECT shows a thick-walled gastric antrum with low density submucosal edema, narrowing of the lumen, and bright enhancement of the mucosa.

Gastritis



Cholecystitis

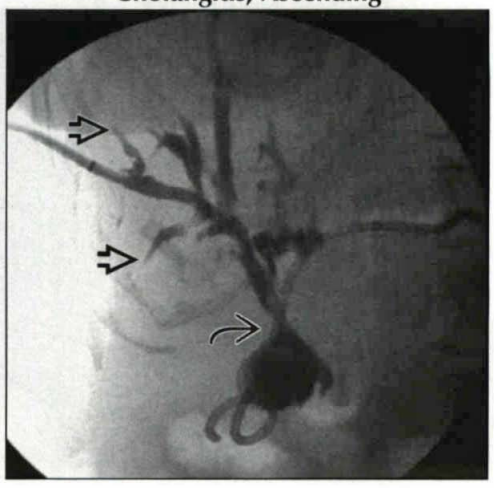
(Left) Oblique ultrasound shows a large echogenic gallstone within a distended gallbladder that has a thickened wall (cursors). (Right) Sagittal ultrasound shows a dilated common duct ending abruptly at an echogenic intraluminal stone.

Choledocholithiasis

Cholangitis, Ascending

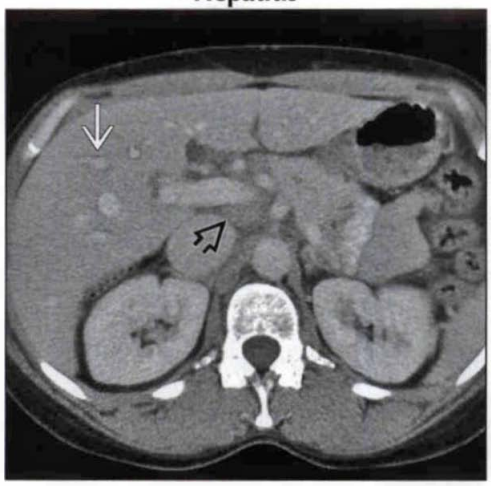
(Left) Axial CECT shows dilated intrahepatic ducts with pneumobilia & a biliary stent in place. This female patient presented with fever, chills, & pain following biliary-enteric anastomosis for a biliary stricture. (Right) Frontal transhepatic cholangiography shows 2 internal-external biliary stents crossing a biliary-enteric anastomosis. Note the irregular arborization & abrupt terminations of the intrahepatic ducts, indicating cholangitis.

Cholangitis, Ascending



EPIGASTRIC PAIN

Hepatitis



Pancreatitis, Acute

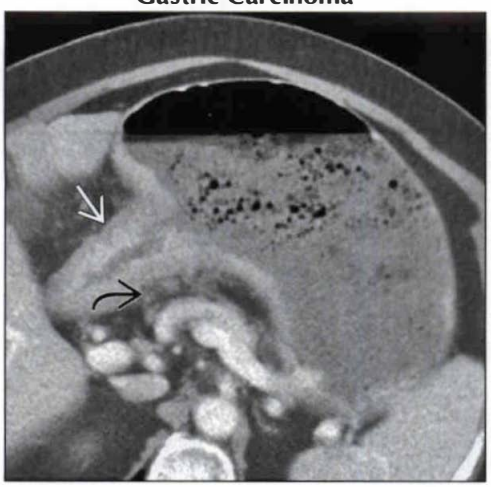
(Left) Axial CECT shows periportal edema ➡ and lymphadenopathy ⇨ in a patient with acute viral hepatitis, which may cause epigastric pain due to stretching of the liver capsule. (Right) Axial CECT shows edematous infiltration of the peripancreatic fat planes ▬. a typical feature of uncomplicated acute pancreatitis.

Pancreatitis, Chronic

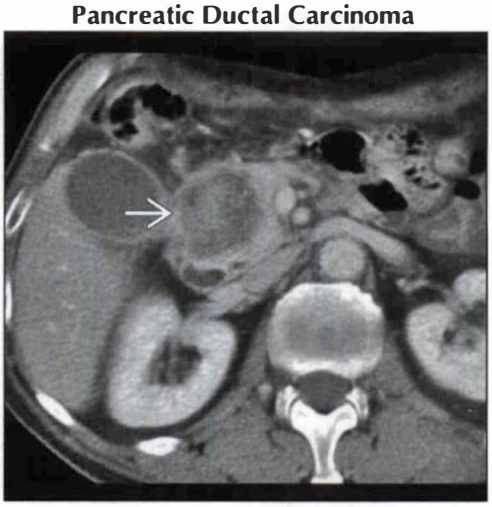
Pancreatic Pseudocyst

(Left) Axial CECT shows an atrophic and heavily calcified pancreas ▬ with dilated intrahepatic ducts ▬ due to stricture of the intrapancreatic portion of the common duct. (Right) Axial CECT shows several small pseudocysts ▬ in the pancreatic head, along with coarse calcifications ▬ indicating chronic pancreatitis.

Gastric Carcinoma



Pancreatic Ductal Carcinoma



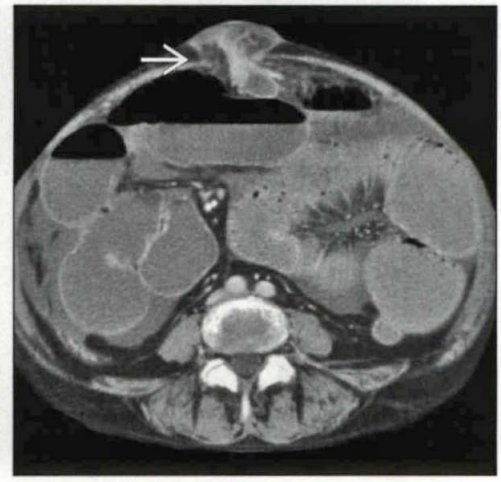
(Left) Axial CECT shows a circumferential soft tissue density thickening of the gastric antrum ▬ that results in gastric outlet obstruction. Note the perigastric infiltrated fat and enlarged nodes ⇨. (Right) Axial CECT shows a hypodense mass ➡ in the pancreatic head that caused obstruction of the pancreatic and biliary ducts, a classic appearance for pancreatic ductal carcinoma.

EPIGASTRIC PAIN

Hepatic Trauma

(Left) Axial CECT shows an irregular fracture plane through the left lobe of the liver. Injuries to the left lobe result from direct epigastric trauma and are often accompanied by injury to the pancreas & duodenum. (Right) Axial CECT shows a ventral hernia that contains a strangulated segment of bowel, resulting in small bowel obstruction.

Ventral Hernia



Caustic Gastroduodenal Injury

(Left) Axial NECT shows marked thickening of the gastric wall and ascites, suggesting transmural injury & likely perforation in this young man who ingested lye (drain cleaner) in a suicide attempt. (Right) Axial CECT shows a large exophytic mass arising from the posterior wall of the stomach. The center of the tumor is necrotic with an air-fluid level, indicating communication with the gastric lumen.

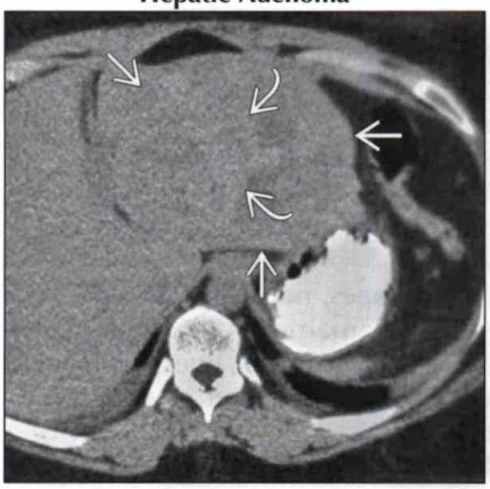
GIST, Stomach

Metastases and Lymphoma, Gastric

(Left) Axial CECT shows soft tissue density, circumferential thickening of the gastric antrum resulting in gastric outlet obstruction. The appearance is indistinguishable from primary gastric carcinoma, but this obstruction was due to metastatic breast cancer. (Right) Axial CECT shows low density, necrotic liver metastases & the primary pancreatic body ductal carcinoma. Pain may result from stretching of hepatic capsule, obstruction of ducts, or hemorrhage.

Metastases and Lymphoma, Hepatic

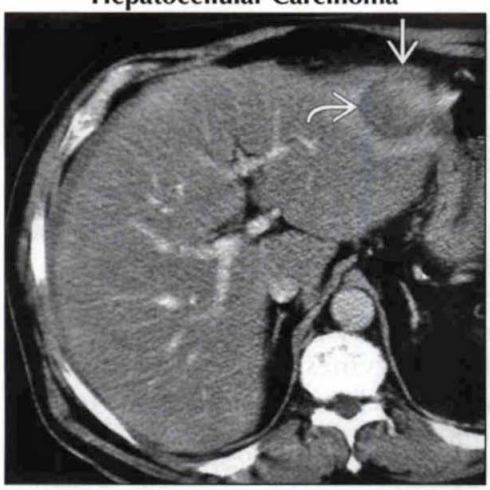
Hepatic Adenoma



Hepatic Pyogenic Abscess

(Left) *Axial NECT shows subtle high attenuation hemorrhage within a left lobe hepatic mass, a typical feature of hepatic adenoma in this young woman.* ***(Right)*** *Axial CECT shows a typical multiloculated mass in a man with fever and upper abdominal pain. Liver abscess due to diverticulitis.*

Hepatocellular Carcinoma

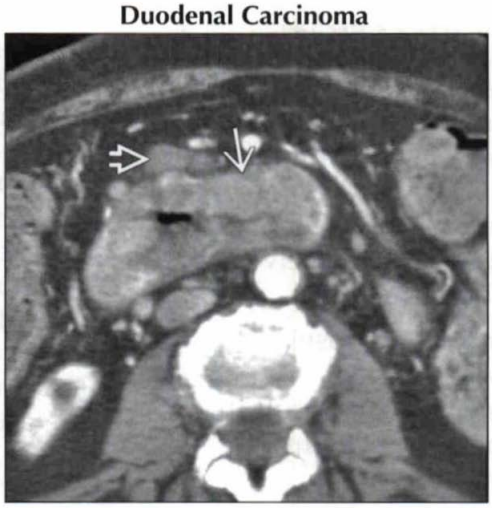


AD Polycystic Disease, Liver

(Left) *Axial CECT shows a heterogeneous mass in the left lobe that presented with spontaneous hemorrhage and epigastric pain.* ***(Right)*** *Axial T2WI MR shows massive enlargement of the liver with innumerable cysts of varying intensity, due to episodes of spontaneous intracyst hemorrhage.*

Serous Cystadenoma, Pancreas

Duodenal Carcinoma



(Left) *Axial CECT shows a large pancreatic head mass with a honeycomb or sponge appearance. Some of the thin septa contain foci of calcification.* ***(Right)*** *Axial CECT shows a bulky intraluminal mass in the third portion of duodenum with adjacent lymphadenopathy.*

LEFT UPPER QUADRANT MASS

DIFFERENTIAL DIAGNOSIS

Common

- Splenomegaly & Splenic Masses
- Hepatomegaly & Hepatic Masses
- Gastric Masses & Distention
  - Gastric Carcinoma
  - Metastases and Lymphoma, Gastric
  - Gastric Stromal Tumor
  - Gastric Bezoar
- Pancreatic Masses
  - Pancreatic Pseudocyst
  - Mucinous Cystic Pancreatic Tumor
  - Solid and Papillary Neoplasm, Pancreas
- Adrenal Masses
  - Adrenal Carcinoma
  - Adrenal Metastases and Lymphoma
  - Adrenal Cyst
  - Pheochromocytoma
- Abdominal Abscess
- Hematoma/Seroma
- Peritoneal Metastases
- Renal Masses
  - Renal Cyst
  - Renal Cell Carcinoma
  - Renal Angiomyolipoma

Less Common

- Gastric Diverticulum
- Retroperitoneal Sarcoma
- Pseudomyxoma Peritonei
- Abdominal Wall Masses
  - Abdominal Wall Hernia (Mimic)
  - Abdominal Wall Hematoma (Mimic)
- Gastric Volvulus
- Loculated &/or Malignant Ascites

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Determine whether mass arises from abdominal wall (e.g., neoplasm or hernia) or within abdomen
- Distention, enlargement, or mass of any upper abdominal viscus may be perceived as a left upper quadrant (LUQ) mass

Helpful Clues for Common Diagnoses

- **Splenomegaly & Splenic Masses**
  - Any cause of splenomegaly may result in a palpable or radiographically evident LUQ mass
  - Consider accessory spleen and splenosis which may cause enlarging mass(es) after splenectomy
    - These should have same attenuation & enhancement pattern as normal spleen
  - Also consider splenic masses, metastases, and lymphoma
- **Hepatomegaly & Hepatic Masses**
  - An enlarged left lobe of liver is often perceived or palpated as an epigastric or LUQ mass
  - On axial CT images, may appear to be separated from remainder of liver, as heart indents cephalic surface of liver
  - Any mass in left lobe of liver may be a palpable LUQ mass
- **Gastric Masses & Distention**
  - Any gastric tumor (carcinoma, lymphoma, GIST, metastases) may result in LUQ mass
    - Exophytic masses (e.g., GIST) may not have an obvious gastric origin
  - Also consider gastric distension (gastroparesis, volvulus, gastric outlet obstruction) and gastric bezoar
- **Pancreatic Masses**
  - Pancreatic masses usually displace splenic vein posteriorly & may obstruct it (ductal cancer & chronic pancreatitis)
  - Pseudocyst is most common
    - Check for history of pain, elevated pancreatic enzymes
    - Will typically change size over short term follow-up (days to weeks), unlike cystic tumors
  - Pancreatic ductal cancer usually does not cause a palpable mass
    - Hypovascular lesion causing pancreatic ± biliary ductal obstruction is more common
  - Mucinous cystic pancreatic tumor most common large neoplasm in adults
  - Solid and papillary neoplasm in young women
  - Pancreatic metastases and lymphoma are not rare
- **Adrenal Masses**
  - Usually displace splenic vein ventrally
  - Cyst, adenoma, carcinoma, myelolipoma, metastases, pheochromocytoma

- Most have characteristic appearance, but must consider clinical and laboratory findings
  - Cyst: Water density, no enhancement
  - Adenoma: Near water attenuation on NECT; loses signal on opposed phase GRE images
  - Enhances with IV contrast administration
  - Pheochromocytoma: Heterogeneous, brightly enhancing; may be bright on T2WI

- **Abdominal Abscess**
  - Left subphrenic space is common location for seroma or pus after trauma or surgery (e.g., splenectomy)
  - Seroma or abscess in left subphrenic space can be mistaken for spleen

- **Renal Masses**
  - Most have characteristic appearance on imaging
  - Look for "claw sign" of an expansile renal mass
    - Focal loss of renal parenchyma, with other parenchyma draped around mass
    - Includes cysts, renal cell carcinoma, oncocytoma, angiomyolipoma, metastases (plus renal abscess)
    - Cyst: Water density, no enhancement, sonolucent, acoustic enhancement deep to cyst
    - Renal cell carcinoma: Heterogeneous enhancing lesion
    - Angiomyolipoma: Foci of fat, prominent blood vessels
  - Infiltrating renal masses
    - Transitional cell carcinoma, lymphoma, renal infections (pyelonephritis and xanthogranulomatous pyelonephritis)
    - Renal vein thrombosis may simulate infiltrative mass

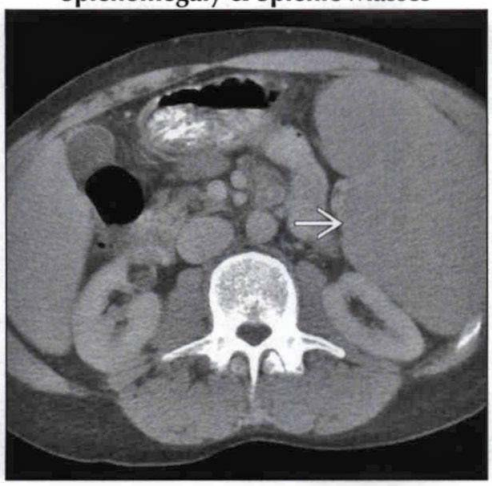
Helpful Clues for Less Common Diagnoses

- **Retroperitoneal Sarcoma**
  - Rarely localized to LUQ
  - Most common is liposarcoma
    - Usually has foci of variable attenuation, including some of near fat density
  - Distinguishing liposarcoma from renal AML or adrenal myelolipoma
    - Liposarcoma is less vascular and displaces retroperitoneal organs, but does not arise from them (e.g., no "claw sign" in kidney)

- **Abdominal Wall Masses**
  - External hernias and hematomas may be mistaken for LUQ mass
  - Most hernias have characteristic features allowing easy diagnosis

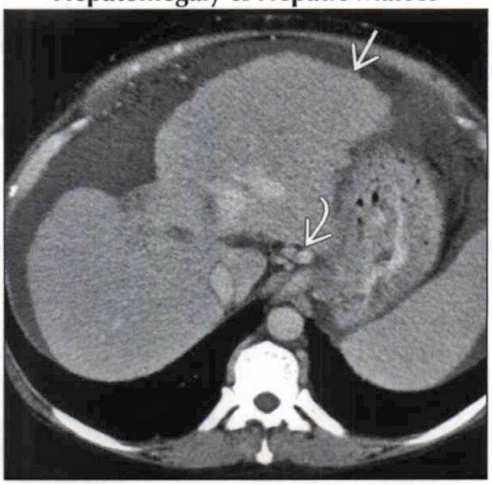
- **Loculated &/or Malignant Ascites**
  - Loculated collection of fluid may simulate a LUQ mass
  - Malignant ascites, especially pseudomyxoma peritonei, may appear heterogeneous and exert mass effect
    - May cause scalloped surface of liver & spleen; displace other organs

Splenomegaly & Splenic Masses



Axial CECT shows a markedly enlarged spleen ➡, the presenting sign and only imaging abnormality in a 54 year old man with chronic myelogenous leukemia.

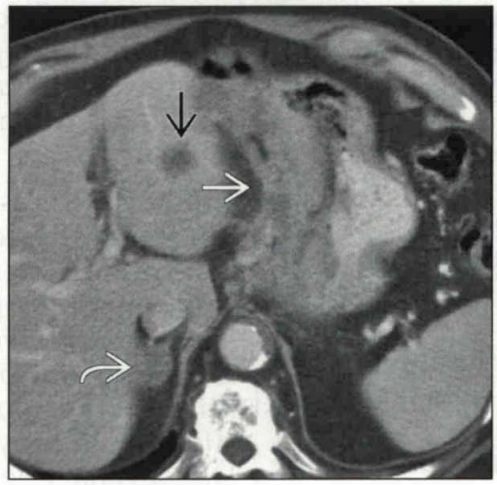
Hepatomegaly & Hepatic Masses



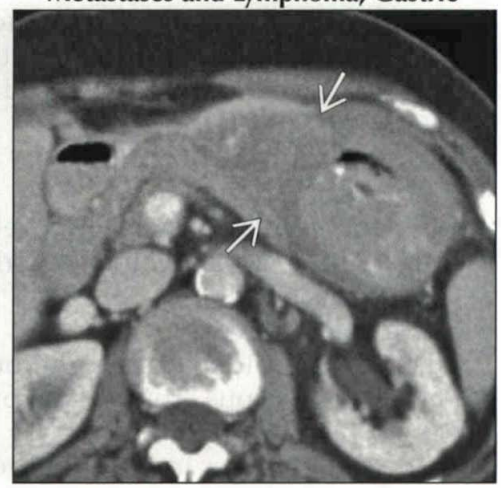
Axial CECT shows an enlarged lateral segment ➡ of liver, while the rest of the liver is fibrotic and small, due to cirrhosis. Also note ascites and varices ➡.

LEFT UPPER QUADRANT MASS

Gastric Carcinoma

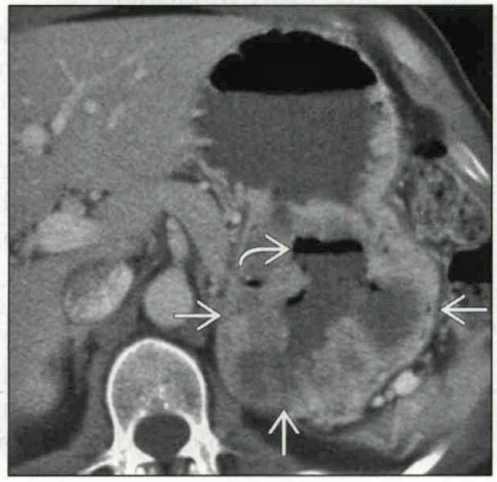


Metastases and Lymphoma, Gastric

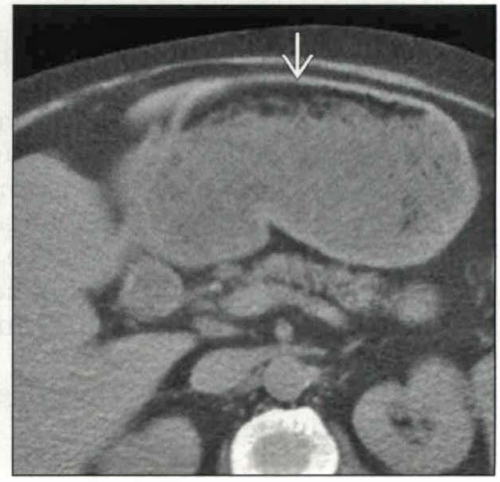


(Left) *Axial CECT shows a large mass arising from the lesser curve of the stomach, with metastases to liver and adrenal.* ***(Right)*** *Axial CECT shows classic gastric lymphoma as a bulky, infiltrating mass that does not cause gastric outlet obstruction.*

Gastric Stromal Tumor

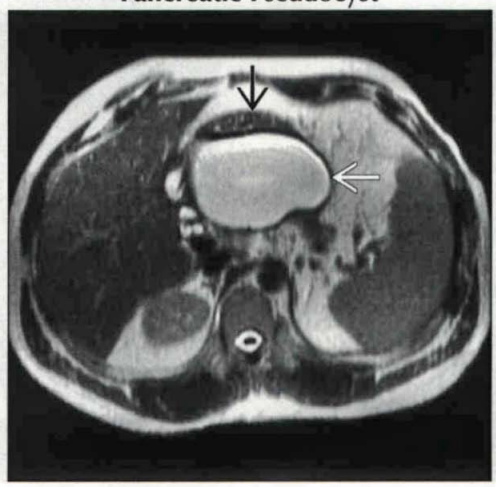


Gastric Bezoar

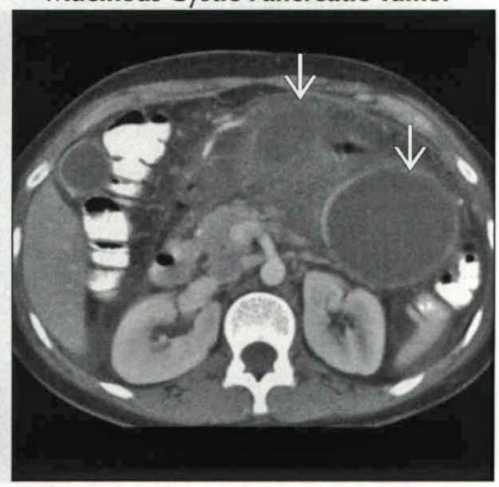


(Left) *Axial CECT shows a large exophytic mass arising from the posterior gastric wall. The gastric origin is suggested by the presence of an air-fluid level within the necrotic center of the mass, indicating communication with the gastric lumen.* ***(Right)*** *Axial CECT shows a markedly distended stomach with food debris in spite of 12 hours fasting prior to CT; man with diabetic gastropathy.*

Pancreatic Pseudocyst



Mucinous Cystic Pancreatic Tumor



(Left) *Axial T2WI MR shows a large lesser sac pseudocyst that displaces the stomach (and later spontaneously decompressed into the stomach).* ***(Right)*** *Axial CECT shows an unusually large, bilobed, mucinous cystic tumor of the pancreas in a 20 year old woman. The appearance of the larger locule is fairly typical of this neoplasm, as a well-encapsulated mass with nonenhancing contents.*

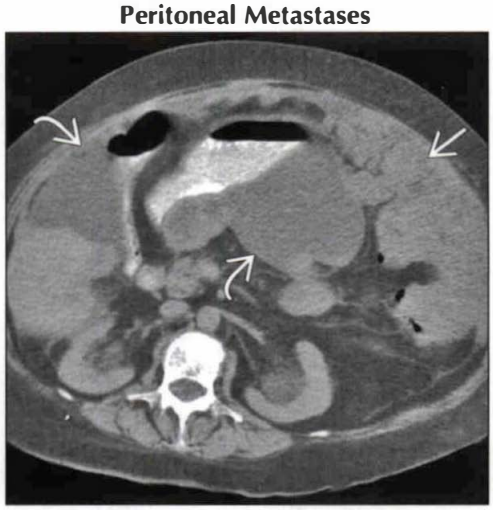
Solid and Papillary Neoplasm, Pancreas

Pheochromocytoma

(Left) Axial CECT shows a large, well-encapsulated mass in a 13 year old girl, a typical presentation for this neoplasm. (Right) Coronal T2WI MR shows a complex hyperintense suprarenal mass whose size and appearance are typical for, but not diagnostic of, pheochromocytoma.

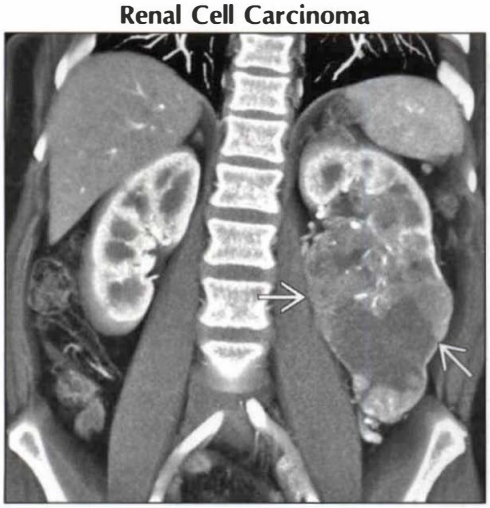
Hematoma/Seroma

Peritoneal Metastases

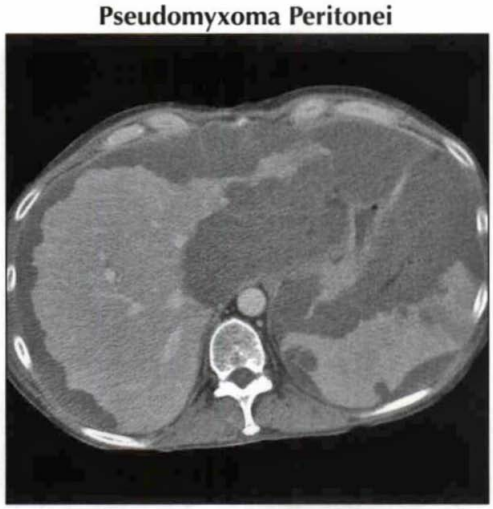


(Left) Axial NECT shows a massive left rectus sheath hematoma with a focus of active bleeding, due to anticoagulation therapy. (Right) Axial CECT shows a classic omental cake and malignant, loculated ascites; metastatic endometrial carcinoma.

Renal Cell Carcinoma



Pseudomyxoma Peritonei



(Left) Coronal CECT shows a large hypervascular mass that replaces all but the upper pole of the left kidney. (Right) Axial CECT shows a classic scalloped surface of the liver and spleen and complex "ascites" filling the abdomen, and presenting as a doughy left upper quadrant mass. Metastatic appendiceal mucinous carcinoma.

SECTION 5
Duodenum

Generic Imaging Patterns

Duodenal Intramural or Extrinsic Mass	5-2
Dilated Duodenum	5-6
Thickened Duodenal Folds	5-8
Duodenal Filling Defects	5-10

DUODENAL INTRAMURAL OR EXTRINSIC MASS

DIFFERENTIAL DIAGNOSIS

Common
- Pancreatic Pseudocyst
- Pancreatic Ductal Carcinoma
- Cholecystitis
- Gallbladder Carcinoma

Less Common
- Hepatomegaly
- Duodenal Hematoma and Laceration
- Annular Pancreas
- Pancreatic Tumors, Other
  - Pancreatic Islet Cell Tumors
  - Serous Cystadenoma, Pancreas
- Duodenal Masses
  - Duodenal Carcinoma
  - Duodenal Metastases and Lymphoma
  - Duodenal GI Stromal Tumor
- Groove Pancreatitis
- Colon Carcinoma
- Kidney Masses
  - Renal Cyst
  - Renal Cell Carcinoma

Rare but Important
- Choledochal Cyst
- Duplication Cyst, Duodenum

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Barium UGI series may suggest the diagnosis or indicate the finding
- CT, MR, or US (including endoscopic US) are essential to characterize nature of intramural or extrinsic lesions

Helpful Clues for Common Diagnoses
- **Pancreatic Pseudocyst**
  - Compresses medial wall of duodenum
  - Widens the duodenal "C loop"; may displace ligament of Treitz inferiorly
  - Spherical collection with nonenhancing contents, defined wall
    - Look for imaging and clinical history of pancreatitis
- **Pancreatic Ductal Carcinoma**
  - May cause fixed indentation of medial wall
  - "Reverse 3" configuration on upper GI series
  - Hypoenhancing mass with signs of invasiveness (obstructed ducts, vascular invasion, nodes, metastases)
- **Cholecystitis**
  - Extrinsic compression of bulb or proximal duodenum from superolateral side
  - May narrow lumen due to spasm, edema
  - Distended GB lumen, thick enhancing wall, gallstones; focal tenderness
    - May develop fistula between GB and duodenum
    - Origin of "gallstone ileus"
- **Gallbladder Carcinoma**
  - May encase duodenum with fixed narrowing of lumen
  - Focal or diffuse GB wall thickening, gallstones, invasion of liver, adjacent tissues, nodes, bile ducts

Helpful Clues for Less Common Diagnoses
- **Hepatomegaly**
  - Generalized, or exophytic liver mass may compress bulb or proximal duodenum from superolateral side
- **Duodenal Hematoma and Laceration**
  - CT: High attenuation blood in wall; narrowed lumen
  - Laceration: Extraluminal gas, fluid, enteric contrast medium
  - Hematoma: More common in children
    - Laceration: More common in adults
- **Annular Pancreas**
  - Narrowed and stretched descending duodenum
  - Circumferential mass around 2nd portion of duodenum; easily identified on CT, MR
    - Enhances like rest of pancreas
  - May present in childhood or as adult
    - Symptoms of duodenal obstruction and/or pancreatitis
- **Pancreatic Tumors, Other**
  - **Pancreatic Islet Cell Tumors**
    - Gastrinomas are especially likely to arise in or adjacent to descending duodenum
    - Benign lesions are usually diagnosed before attaining large size (early symptoms)
    - Do not usually cause much mass effect on duodenum
  - **Serous Cystadenoma, Pancreas**
    - Usually presents with a larger mass

- Sponge or honeycomb appearance due to innumerable small cysts & septa ± focal calcifications

- **Duodenal Metastases and Lymphoma**
  - Metastases: Lung, breast, melanoma
    - Other mets are usually evident clinically and/or on imaging
    - Carcinomatous mets tend to obstruct lumen
  - Lymphoma: Bulky mass, possibly with aneurysmal dilation of duodenal lumen
    - Rarely obstructs duodenal lumen
  - Tumors from adjacent organs
    - e.g., Cancer of hepatic flexure of colon, may directly invade duodenum
- **Duodenal GI Stromal Tumor**
  - Duodenum is 2nd most common site (after stomach)
  - Bulky, exophytic mass, possibly with aneurysmal dilation of lumen (similar to lymphoma)
  - Mass may cavitate and communicate with duodenal lumen
- **Groove Pancreatitis**
  - Often causes localized mass and inflammation in groove between duodenum and pancreatic head
  - Often with associated cystic degeneration in wall of duodenum
- **Kidney Masses**
  - Large renal cell carcinoma or polycystic kidney
  - May displace duodenum from lateral side
  - Renal cell cancer may invade and obstruct duodenum

Helpful Clues for Rare Diagnoses

- **Choledochal Cyst**
  - Type III and IVB have cystic dilation of distal duct (choledochocele)
  - May indent medial wall of duodenum
  - Spherical or cylindrical fluid-containing structure
  - MRCP or ERCP are definitive imaging techniques
- **Duplication Cyst, Duodenum**
  - Uncommon to rare; smooth intramural mass effect
  - Spherical or elliptical mass with nonenhancing contents
  - Rarely may communicate with lumen of duodenum

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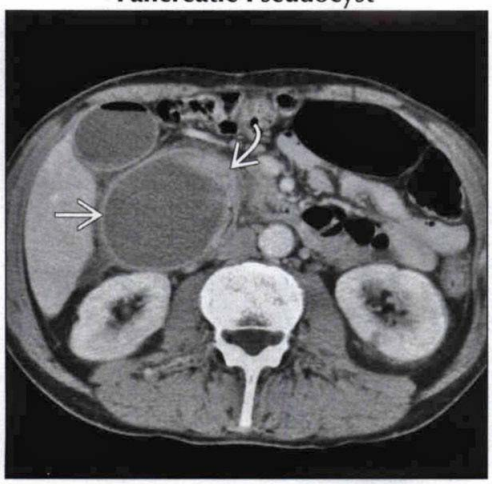
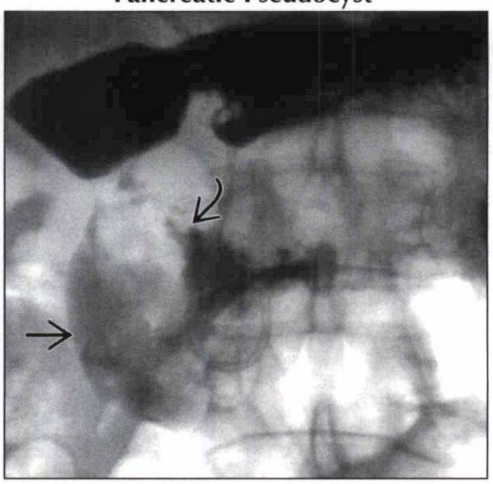
2. Kim YH et al: Imaging diagnosis of cystic pancreatic lesions: pseudocyst versus nonpseudocyst. Radiographics. 25(3):671-85, 2005
3. Jayaraman MV et al: CT of the duodenum: an overlooked segment gets its due. Radiographics. 21 Spec No:S147-60, 2001
4. Levy AD et al: Gallbladder carcinoma: radiologic-pathologic correlation. Radiographics. 21(2):295-314; questionnaire, 549-55, 2001
5. Hahn PF et al: Duodenal hematoma: the ring sign in MR imaging. Radiology. 159(2):379-82, 1986

Pancreatic Pseudocyst



Axial CECT shows a cystic mass ➡ that lies lateral to, and distorts the lumen of the 2nd portion of duodenum ➡; 44 year old man with intramural pseudocyst.

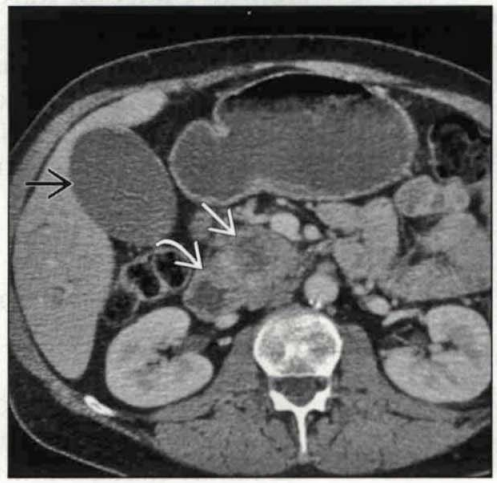
Pancreatic Pseudocyst



Frontal upper GI shows the distorted lumen of the 2nd portion of duodenum ➡ and filling of a pancreatic pseudocyst ➡ that had spontaneously decompressed into the duodenum in the same patient.

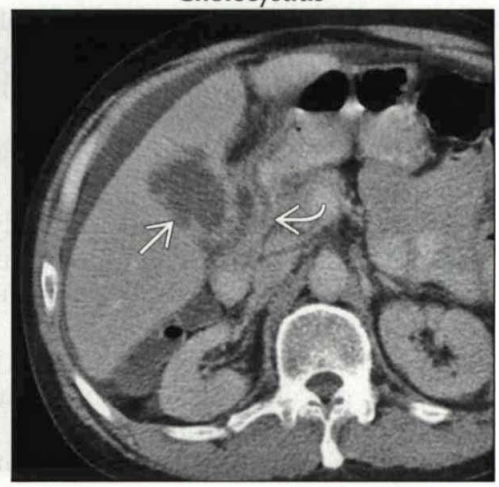
DUODENAL INTRAMURAL OR EXTRINSIC MASS

Pancreatic Ductal Carcinoma

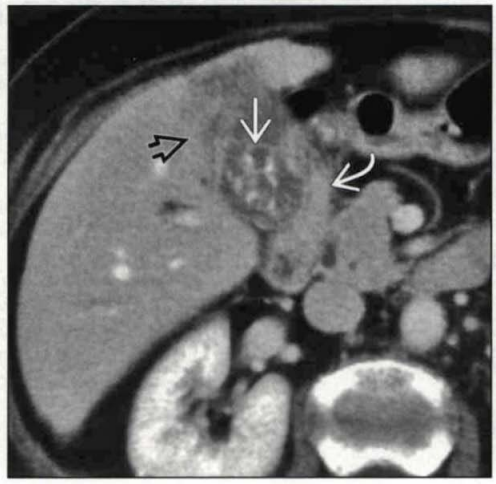


(Left) Axial CECT shows a hypodense mass in the pancreatic head that invades the duodenum with partial duodenal and biliary obstruction. Note distended gallbladder and stomach. (Right) Axial CECT shows medial deviation of the 2nd portion of duodenum and a crescentic fluid density paralleling its lateral wall. Note irregular GB wall thickening and ascites. Gangrenous, perforated cholecystitis.

Cholecystitis

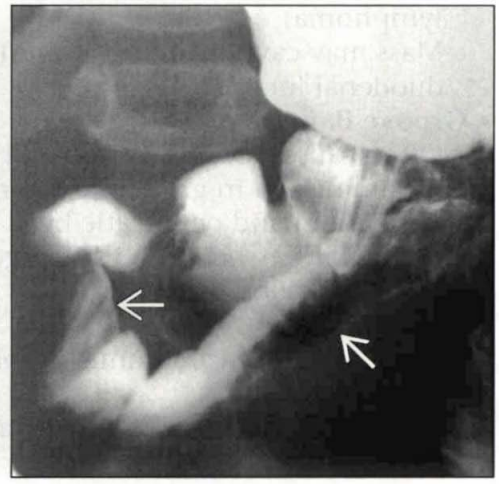


Gallbladder Carcinoma

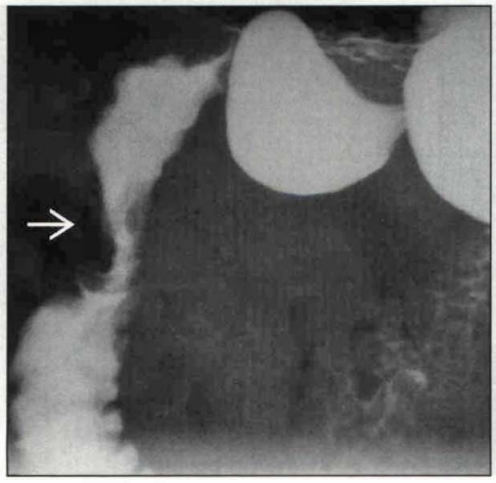


(Left) Axial CECT shows medial deviation of the 2nd portion of duodenum due a gallbladder mass that also invades the adjacent liver. Ring-calcified gallstones are seen. (Right) Upper GI shows an intramural mass that distorts and narrows the lemen of the 2nd & 3rd portions of duodenum: intramural hematoma in a 7 year old boy injured in a motor vehicle crash.

Duodenal Hematoma and Laceration



Annular Pancreas



(Left) Upper GI shows circumferential constriction of the 2nd portion of duodenum due to annular pancreas in a 19 year old boy. (Right) Axial CECT shows narrowing of the lumen of the 2nd portion of the duodenum that is surrounded by pancreatic tissue; classic annular pancreas in a 19 year old boy.

Annular Pancreas

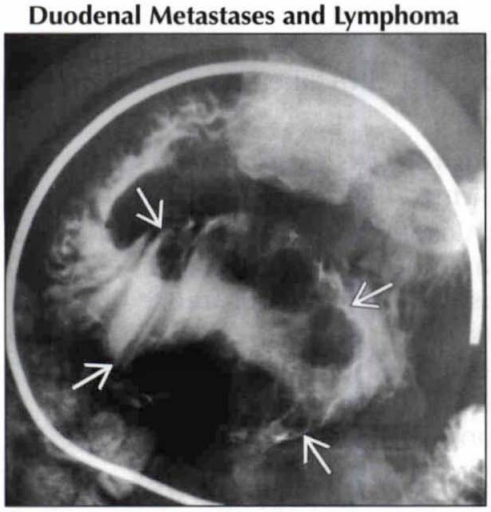
DUODENAL INTRAMURAL OR EXTRINSIC MASS

Serous Cystadenoma, Pancreas

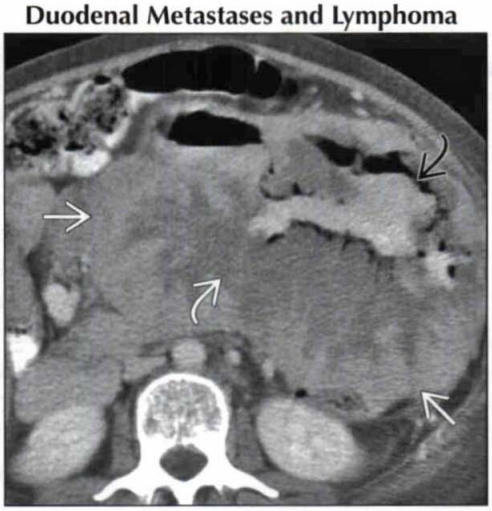
Duodenal Carcinoma

(Left) Axial CECT shows a large mass in the pancreatic head that displaces the 2nd portion of duodenum. The mass has a characteristic honeycomb or sponge appearance due to innumerable small cysts, with scattered calcifications in the septa. (Right) Axial NECT shows eccentric narrowing of the 2nd portion of duodenum with invasion of adjacent vascular structures. This elderly man presented with gastric outlet obstruction.

Duodenal Metastases and Lymphoma

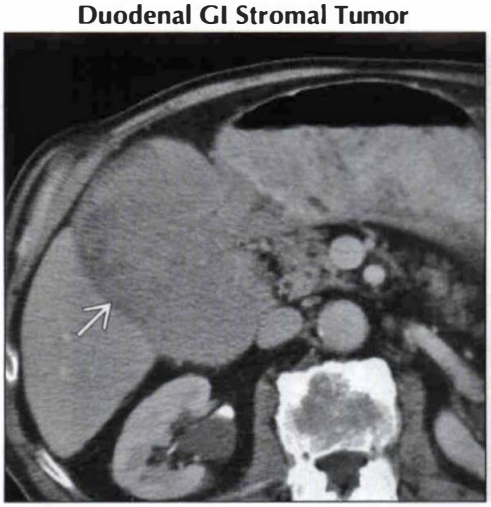


Duodenal Metastases and Lymphoma

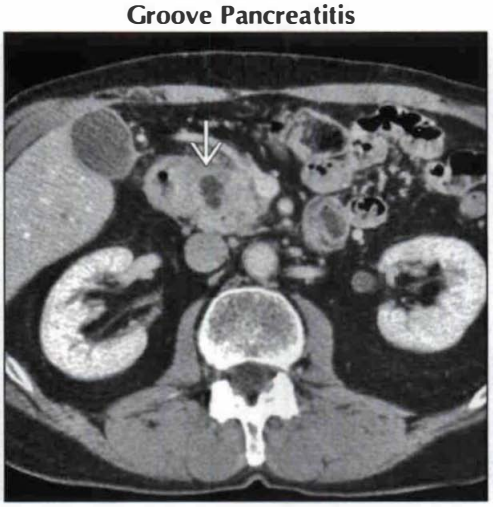


(Left) Upper GI shows aneurysmal dilation of the 3rd portion of duodenum with a large intramural mass due to malignant melanoma. Lymphoma can appear identical. (Right) Axial CECT shows classic aneurysmal dilation of the 4th portion of duodenum with a huge soft tissue density mass (lymphoma) with central necrosis communicating with duodenal lumen. Note absence of bowel obstruction or gastric distention.

Duodenal GI Stromal Tumor



Groove Pancreatitis



(Left) Axial CECT shows a large mass arising from the wall of the 2nd portion of duodenum, that causes partial gastric outlet obstruction. The duodenum is 2nd only to the stomach as a primary site for GISTs. (Right) Axial CECT shows cysts and mural thickening within the medial wall of the duodenum; 68 year old man with chronic upper abdominal pain & abnormal liver function due to partial biliary obstruction by this inflammatory process.

DILATED DUODENUM

DIFFERENTIAL DIAGNOSIS

Common
- Ileus
- Small Bowel Obstruction
- Pancreatitis, Acute
- SMA Syndrome
- Post-Vagotomy
- Scleroderma, Intestinal
- Sprue-Celiac Disease

Less Common
- Strongyloides
- Zollinger-Ellison Syndrome

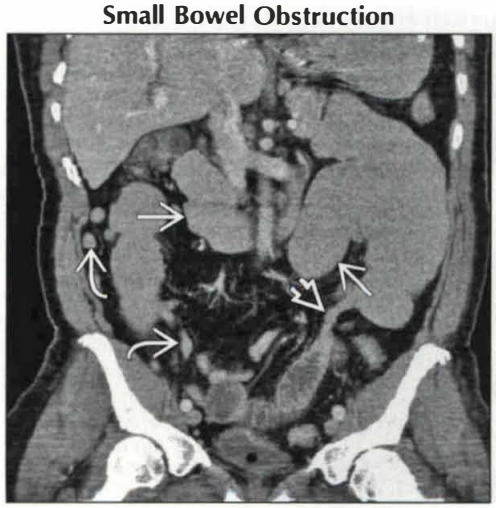
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Fluoroscopy and CT/MR have complementary roles in evaluation of duodenal dilation

Helpful Clues for Common Diagnoses
- **Small Bowel Obstruction**
  - Post-operative, metabolic imbalance, medication
  - Obstruction of small bowel "downstream" from duodenum
- **Pancreatitis, Acute**
  - Often causes focal ileus of adjacent bowel
  - May narrow lumen of 2nd and 3rd portion of duodenum (spasm & wall edema)
- **SMA Syndrome**
  - 3rd duodenum becomes compressed as it passes between aorta and superior mesenteric artery
  - Common in thin, bedridden patients, especially with recent weight loss
  - Look for linear crossing defect on 3rd duodenum (barium UGI study); narrow angle between aorta and SMA on CT, MR, angio (best seen in sagittal plane)
- **Post-Vagotomy**
  - Stomach and duodenum become dilated, atonic
- **Scleroderma, Intestinal**
  - Dilated, decreased peristalsis; "megaduodenum"
  - Look for characteristic changes in esophagus, small bowel, skin
- **Sprue-Celiac Disease**
  - Look for dilated small bowel with decreased folds in jejunum and signs of malabsorption
  - Correlate with clinical evidence of gluten intolerance

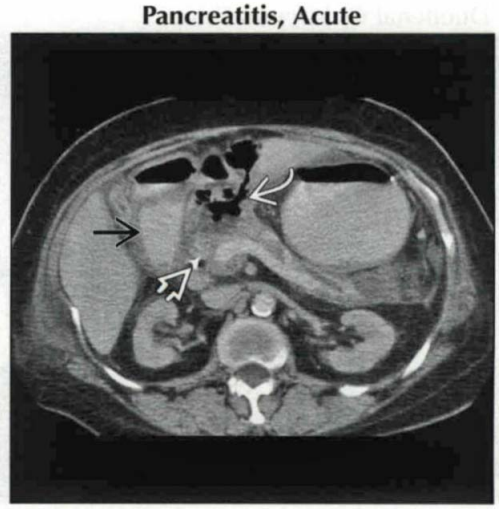
Helpful Clues for Less Common Diagnoses
- **Strongyloides**
  - Causes thickened or effaced folds in duodenum and small bowel
  - May cause "lead pipe" appearance of same segments
- **Zollinger-Ellison Syndrome**
  - Thickened folds, increased secretions, ulcerations in stomach and duodenum
  - Gastrin-producing islet cell tumor

Small Bowel Obstruction



Coronal CECT shows dilated proximal small bowel segments, including duodenum and jejunum, while distal small bowel is collapsed; obstruction due to adhesions.

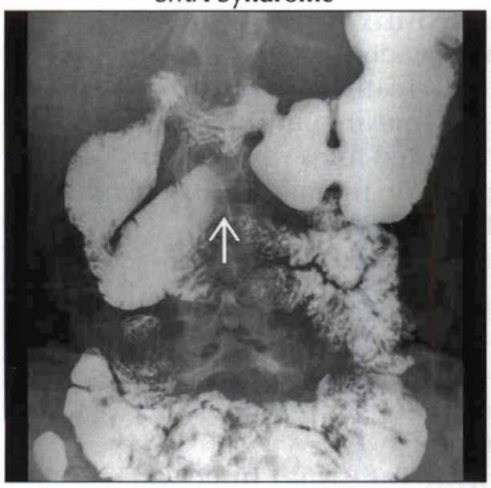
Pancreatitis, Acute



Axial CECT shows dilation of the stomach and second portion of duodenum. Peripancreatic inflammation is evident, and there is a collection of gas and fluid, an abscess. Common duct stent is also seen.

DILATED DUODENUM

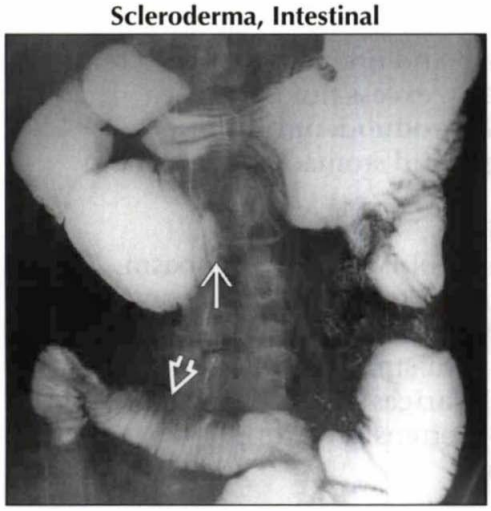
SMA Syndrome



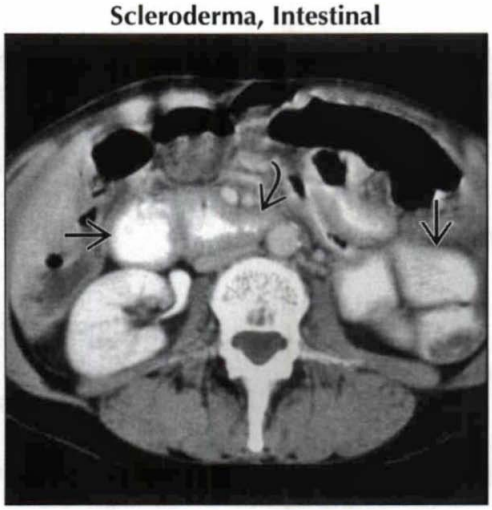
SMA Syndrome

(Left) *Frontal small bowel follow through shows marked dilation of the 2nd and 3rd portions of duodenum with abrupt narrowing as it crosses the spine, with a vertical straight* ***line demarcation*** *.* ***(Right)*** *Axial CECT shows marked dilation of the duodenum which is compressed with luminal narrowing as it passes between the aorta and the root of the mesenteric vessels .*

Scleroderma, Intestinal

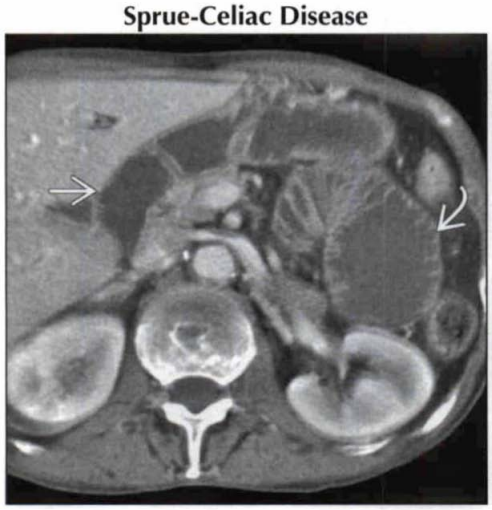


Scleroderma, Intestinal

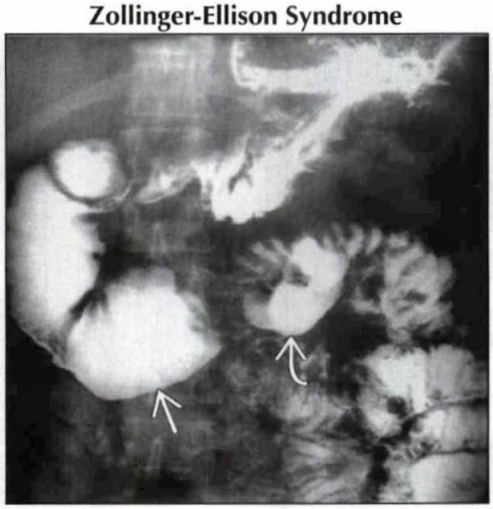


(Left) *Frontal small bowel follow through shows marked dilation of the duodenum up to where it crosses the spine . The appearance is similar to SMA syndrome, but the abnormal, closely spaced fold pattern of the small bowel helps to confirm the diagnosis of scleroderma.* ***(Right)*** *Axial CECT shows a dilated lumen of the duodenum and small bowel with fold thickening of the duodenal wall : proven scleroderma.*

Sprue-Celiac Disease



Zollinger-Ellison Syndrome



(Left) *Axial CECT shows fluid distention of dilated* ***duodenum*** *and jejunum, and some atrophy of the* ***jejunal folds*** *.* ***(Right)*** *Frontal upper GI shows a dilated duodenum and thick gastric folds with dilution of the barium, due to excess fluid (acid). A large* ***jejunal ulcer is seen*** *. A pancreatic islet cell tumor (gastrinoma) was subsequently found.*

THICKENED DUODENAL FOLDS

DIFFERENTIAL DIAGNOSIS

Common
- Duodenitis
- Duodenal Ulcer
- Brunner Gland Hyperplasia
- Acute Pancreatitis
- Duodenal Hematoma and Laceration
- Chronic Renal Failure

Less Common
- Zollinger-Ellison Syndrome
- Opportunistic Intestinal Infections
- Caustic Gastroduodenal Injury
- Crohn Disease
- Sprue-Celiac Disease
- Metastases and Lymphoma, Duodenal
- Duodenal Varices

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Barium UGI & CT: Complementary studies
- Imaging findings are uncommonly pathognomonic (e.g., duodenal varices); need clinical correlation

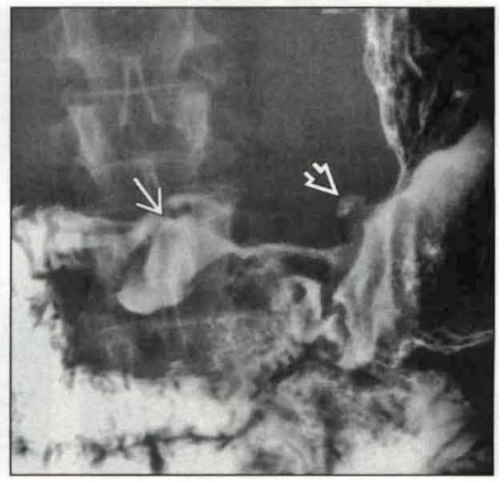
Helpful Clues for Common Diagnoses
- **Duodenitis**
  - Inflammation without frank ulceration
  - Similar to and same etiologies as gastritis
  - Occasionally see aphthous erosions
- **Duodenal Ulcer**
  - Discrete ulcer crater with marked spasm of wall and distortion of lumen
- **Brunner Gland Hyperplasia**
  - Thick, nodular folds in duodenal bulb
  - Usually associated with duodenitis
- **Acute Pancreatitis**
  - Thick folds, widening of "C loop"
  - Signs of pancreatitis usually evident on CT
- **Duodenal Hematoma and Laceration**
  - Thick spiculated folds
  - Focal, epigastric trauma or anticoagulation
- **Chronic Renal Failure**
  - Thick, nodular folds

Helpful Clues for Less Common Diagnoses
- **Zollinger-Ellison Syndrome**
  - Gastrin-producing islet cell tumor
  - Thick folds & ulcers of stomach & duodenum
- **Opportunistic Intestinal Infections**
  - Giardiasis, strongyloides, cryptosporidiosis
  - More common in immunosuppressed patients
  - Thickened and nodular or effaced folds plus spasm, excess fluid, diarrhea
- **Caustic Gastroduodenal Injury**
  - Esophagus and stomach usually more affected
- **Crohn Disease**
  - Thickened folds, ulceration, spasm
  - Usually with known disease in small bowel
- **Sprue-Celiac Disease**
  - Usually with small bowel disease
- **Duodenal Varices**
  - Portal hypertension &/or portal vein occlusion

Duodenitis

Axial CECT shows edematous mural thickening & luminal narrowing of the duodenum ➡ that was diagnosed as duodenitis on endoscopy. Note the pancreatic head calcification ➪ and gastric distention.

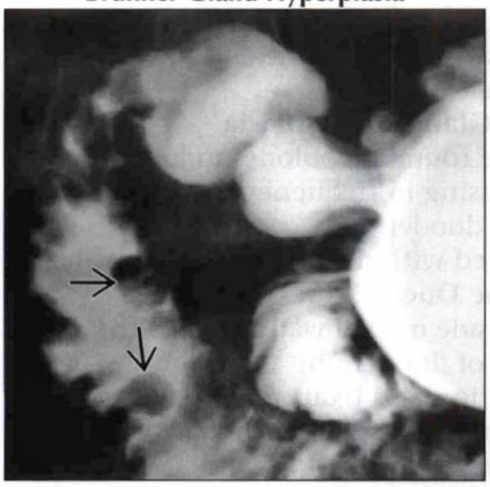
Duodenal Ulcer



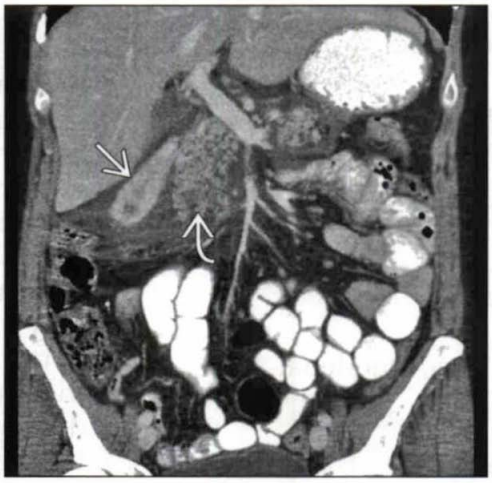
Upper GI shows duodenal ➡ & gastric ➪ ulcers, both with thickened folds radiating to the base of the ulcer craters.

THICKENED DUODENAL FOLDS

Brunner Gland Hyperplasia

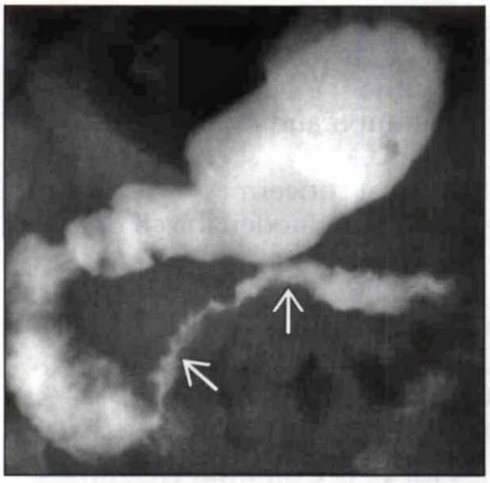


Acute Pancreatitis

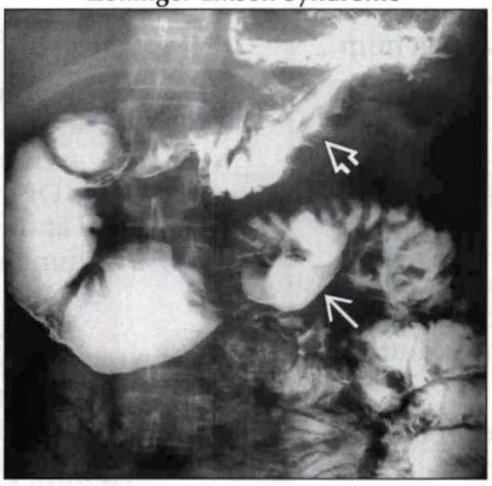


(Left) Upper GI shows nodular, thickened and polypoid folds ⇨ in the bulb and 2nd portion of duodenum, proven to represent Brunner gland hyperplasia with some foci of hamartomatous change in some of the nodules. (Right) Coronal CECT shows infiltrative changes around the pancreatic head ➡ with mural thickening and luminal narrowing of the 2nd portion of duodenum ■, which shares the anterior pararenal space with the pancreas.

Duodenal Hematoma and Laceration

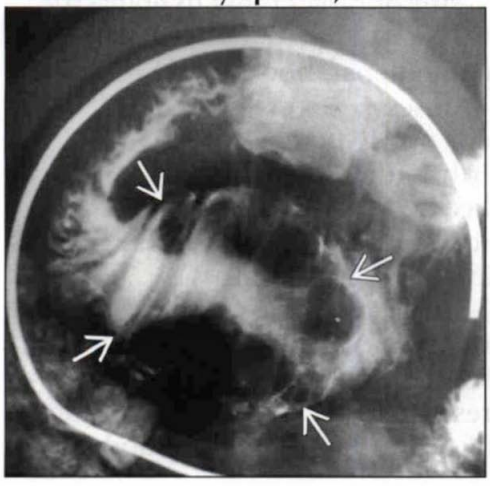


Zollinger-Ellison Syndrome

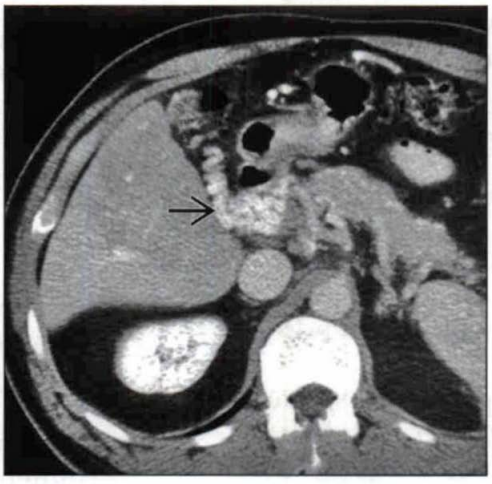


(Left) Upper GI shows thickened folds and narrowed lumen ➡ of the distal duodenum, due to spontaneous coagulopathic hemorrhage into the duodenal wall in this 70 year old woman on Coumadin therapy. (Right) Upper GI shows a large distal duodenal or jejunal ulcer ■, along with a dilated, partially obstructed 2nd duodenum, & thickened folds with excess fluid (acid) in the stomach ⇄.

Metastases and Lymphoma, Duodenal



Duodenal Varices



(Left) Upper GI shows aneurysmal dilation of the lumen and thickening of the folds of the 3rd portion of duodenum, due to an intramural mass ➡; metastatic melanoma. (Right) Axial CECT shows a collection of varices ⇨ around the 2nd duodenum and pancreatic head in this man with cirrhosis and portal vein thrombosis with cavernous transformation of the portal vein.

DUODENAL FILLING DEFECTS

DIFFERENTIAL DIAGNOSIS

Common
- Prolapsed Antral Mucosa
- Flexural Pseudotumor (Mimic)
- Duodenal Polyps
- Brunner Gland Hyperplasia
- Pancreatic Ductal Carcinoma
- Duodenal Lipoma

Less Common
- Duodenal Hematoma
- Ectopic Gastric Mucosa
- Duodenal Carcinoma
- Metastases and Lymphoma, Duodenal
- GIST, Duodenal
- Ampullary Tumor
- Hamartomatous Polyposis
- Gardner Syndrome
- Choledochal Cyst

Rare but Important
- Mesenchymal Tumor, Duodenum
- Duplication Cyst, Duodenum
- Carcinoid Tumor

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Barium UGI series better for diagnosing intraluminal and mucosal lesions
- CT, MR, US better for intramural and extrinsic lesions

Helpful Clues for Common Diagnoses
- **Prolapsed Antral Mucosa**
  - Often an intermittent finding on UGI
  - Common in gastritis
  - Look for thick gastric folds, erosions, contracted antrum as signs of gastritis
- **Flexural Pseudotumor (Mimic)**
  - Filling defect at apex of bulb due to angulation of lumen, redundant mucosa
  - Duodenum is folded back on itself
    - Often disappears in standing position
- **Duodenal Polyps**
  - May be hyperplastic, adenomatous, or hamartomatous
    - Hyperplastic are usually nonsyndromic, benign, sporadic
    - Adenomatous polyps may be sporadic or part of familial polyposis (Gardner) syndrome; have malignant potential
    - Hamartomatous polyps are usually a manifestation of Peutz-Jeghers (P-J) syndrome
  - May become clinically evident due to duodenal or biliary obstruction or GI bleeding
- **Brunner Gland Hyperplasia**
  - Multiple rounded, oblong nodules in bulb
    - Decreasing in frequency along the course of the duodenum
  - Associated with duodenitis, hyperacidity
- **Pancreatic Ductal Carcinoma**
  - May invade medial wall of 2nd or 3rd portion of duodenum
  - Indentation and fixation of medial wall of duodenum can resemble a "backward 3" on UGI series
  - May resemble primary duodenal carcinoma on UGI series
    - CT and MR usually show obvious pancreatic mass and local invasion
    - Obstruction of pancreatic & biliary ducts
- **Duodenal Lipoma**
  - Relatively common and usually asymptomatic
    - Of little clinical concern
  - Fat density mass in duodenal wall or lumen
    - Arises in wall but often drawn into lumen by peristalsis
    - Mass is soft & malleable, does not obstruct (unless it causes intussusception)

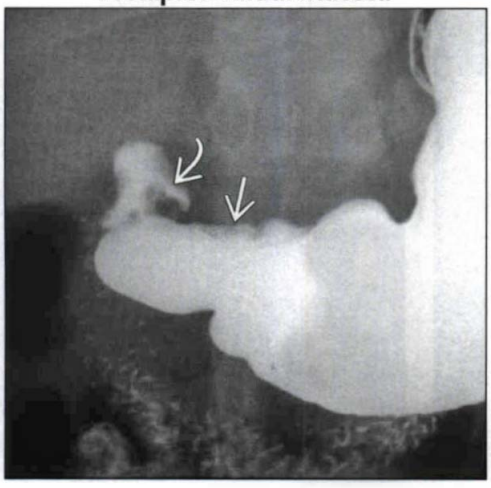
Helpful Clues for Less Common Diagnoses
- **Duodenal Hematoma**
  - More common in children than adults
  - Usually result of direct blow to epigastric region
    - Bicycle handlebar, hockey stick are typical causes
  - Thick folds on UGI ("stack of coins"); high density intramural mass on CT
- **Ectopic Gastric Mucosa**
  - 1 to 5 mm diameter filling defects (multiple) in duodenal bulb
- **Duodenal Carcinoma**
  - Irregular, "apple core" narrowing of lumen or polypoid mass distal to ampulla
  - Often presents with obstruction of biliary system (if periampullary) &/or duodenal lumen

- **Metastases and Lymphoma, Duodenal**
  - Metastases
    - Can mimic primary carcinoma (concentric, obstructing mass)
    - May cause bull's eye lesions or aneurysmal dilation of lumen (melanoma and lymphoma)
  - Direct invasion: Gallbladder, renal cancer
  - Lymphoma: Bulky mass without obstruction
- **GIST, Duodenal**
  - Duodenum is 2nd most common site of GI stromal tumors
  - Can be benign or malignant
  - Large exophytic mass ± mucosal ulceration and central cavitation
    - May communicate with duodenal lumen
    - Gas, fluid, enteric contrast seen within necrotic center of mass
- **Ampullary Tumor**
  - Benign adenoma, malignant mass, or various degrees of dysplasia
  - Irregular mass at ampulla
  - Clinical presentation: Jaundice ± pancreatic duct obstruction
  - Higher incidence in Gardner syndrome
- **Hamartomatous Polyposis**
  - Peutz-Jeghers syndrome (P-J) and others (Cowden disease, Cronkhite-Canada syndrome, etc.)
    - P-J may rarely lead to extra-gastrointestinal malignancies
  - Other manifestations may include malignant tumors of the pancreas, breast, and reproductive tract
  - Duodenal polyps are less common site than small bowel and colon
  - Appearance and morphology: Small to large; isolated, clustered, or carpet-like
- **Gardner Syndrome**
  - Along with familial adenomatous polyposis
  - Duodenum 2nd most common site of polyps, after colon
  - Also associated with ampullary tumors
- **Choledochal Cyst**
  - Type 3 (choledochocele) or 4 may cause intramural or intraluminal mass in ampullary portion of duodenum
  - Nonspecific on UGI; usually definitive on MRCP

Helpful Clues for Rare Diagnoses

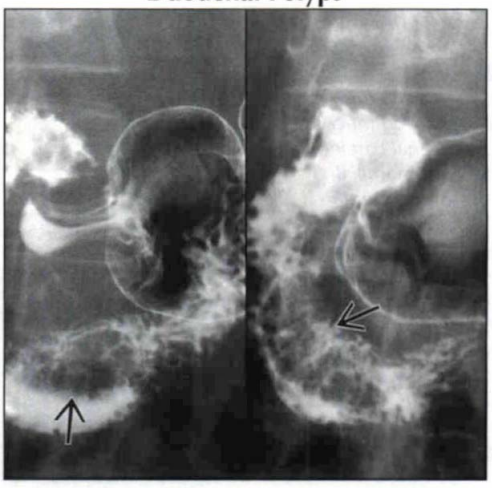
- **Mesenchymal Tumor, Duodenum**
  - Any component of the duodenal wall (fat, muscle, nerve, etc.)
  - Benign or malignant
- **Duplication Cyst, Duodenum**
  - Smooth encapsulated intramural mass
  - May communicate with lumen
- **Carcinoid Tumor**
  - Duodenum is 2nd most common site after distal ileum
  - Imaging: resembles other masses; need biopsy for diagnosis

Prolapsed Antral Mucosa



Upper GI shows a lack of complete distention of the gastric antrum and nodular thickened gastric folds ➡, some of which have prolapsed into the duodenal bulb ➡. These are typical features of gastritis.

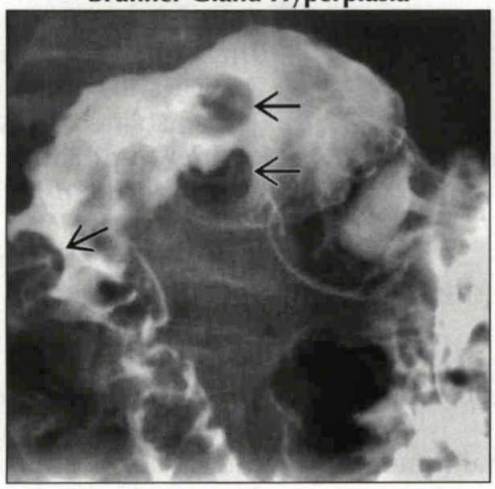
Duodenal Polyps



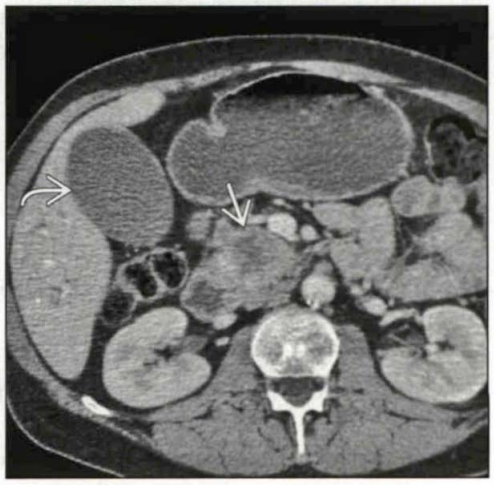
Upper GI shows a large oval filling defect or mass ➡ within the lumen of the duodenum, an adenomatous polyp.

DUODENAL FILLING DEFECTS

Brunner Gland Hyperplasia



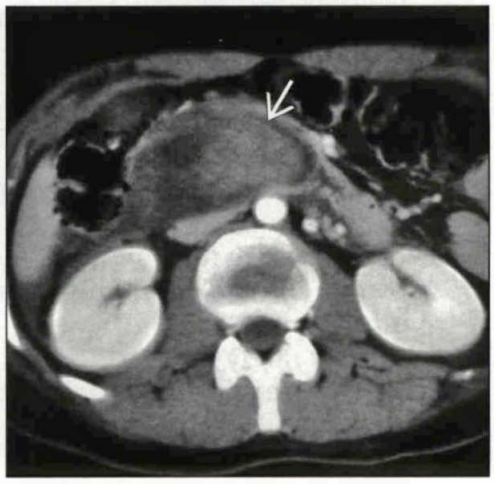
Pancreatic Ductal Carcinoma



(Left) Upper GI shows multiple polypoid filling defects ➔ in the duodenal bulb and 2nd portion of duodenum. Endoscopy & biopsy revealed Brunner gland hyperplasia and hamartomatous change in a patient with hyperacidity. (Right) Axial CECT shows a hypodense mass in the pancreatic head ■ that invades & partially obstructs the 2nd & 3rd portions of duodenum, causing biliary and gastric outlet obstruction. Note distended gallbladder ■ & stomach.

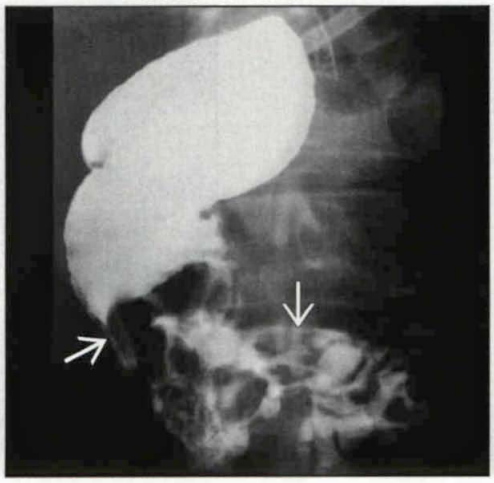
Duodenal Lipoma

Duodenal Hematoma

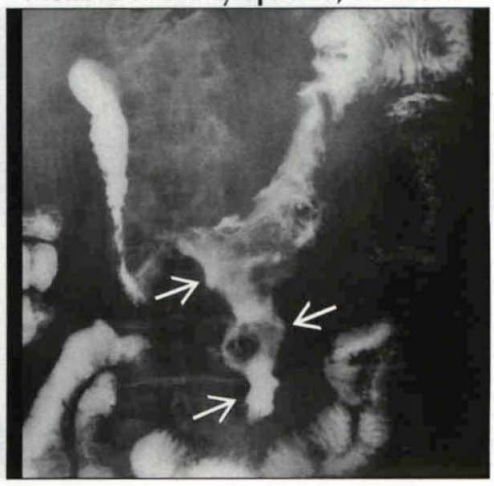


(Left) Axial CECT shows a fat density mass ■ within the lumen of the duodenum, diagnostic of lipoma, and a fairly common incidental finding on CT. (Right) Axial CECT shows an intramural mass ■ within the 2nd & 3rd portions of duodenum, a hematoma due to epigastric blunt trauma in a 16 year old boy. Note the heterogeneous high attenuation of the hematoma.

Duodenal Carcinoma



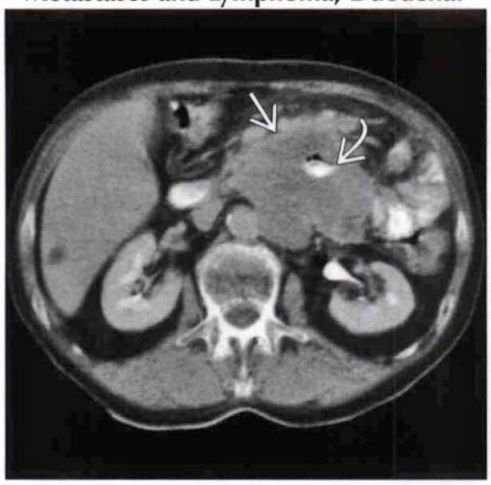
Metastases and Lymphoma, Duodenal



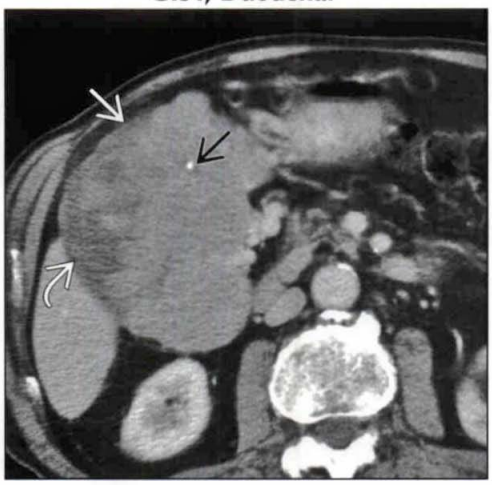
(Left) Upper GI shows an apple core appearance of a mass ■ in the 2nd & 3rd portions of duodenum with irregular, destroyed mucosal pattern; duodenal carcinoma in a patient with familial polyposis. (Right) Upper GI shows a large amorphous collection of barium ■ in continuity with the lumen of the duodenum, but no luminal obstruction; classic "aneurysmal dilation" of the lumen due to bowel lymphoma; PTLD in a patient with a liver transplant.

DUODENAL FILLING DEFECTS

Metastases and Lymphoma, Duodenal



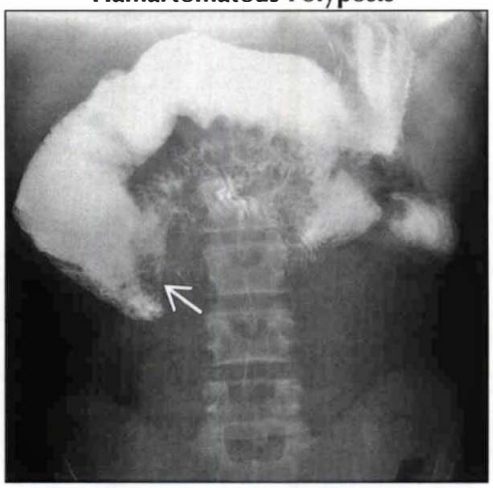
GIST, Duodenal



(Left) *Axial CECT shows a large soft tissue mass* ➡ *encasing, but not obstructing the duodenum* ➡; *PTLD in a patient with a liver transplant.* ***(Right)*** *Axial CECT shows a large mass* ➡ *arising from and distorting the duodenum. Note the partial necrosis* ➡ *and focal calcification* ➡, *common features of this tumor.*

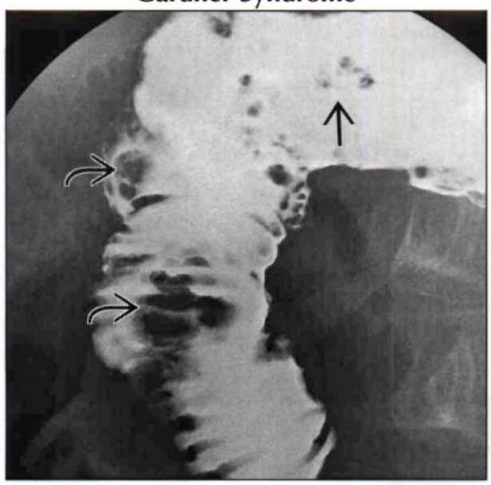
Ampullary Tumor

Hamartomatous Polyposis

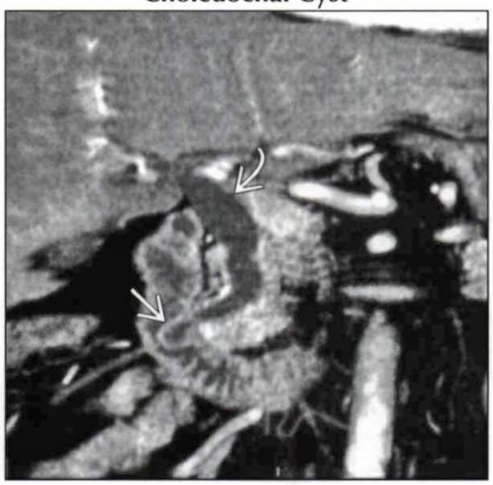


(Left) *Axial CECT shows a small mass* ➡ *at the ampulla; ampullary adenoma with dysplasia; 85 year old man with jaundice. The bile ducts* ➡ *were dilated upstream.* ***(Right)*** *Frontal small bowel follow through shows a large, partially obstructing mass* ➡ *in the 3rd portion of duodenum, later proven to be metastatic testicular germ carcinoma. This 28 year old man has Peutz-Jeghers syndrome, along with other small bowel hamartomatous polyps.*

Gardner Syndrome



Choledochal Cyst



(Left) *Upper GI shows multiple polyps in the distal stomach* ➡ *and duodenum* ➡ *in a patient with familial polyposis.* ***(Right)*** *Multiplanar reformation CECT shows dilation of the common duct* ➡, *ending in a choledochocele* ➡ *that causes a water density filling defect within the duodenal lumen; 58 year old woman.*

SECTION 6
Small Intestine

Generic Imaging Patterns

Multiple Masses or Filling Defects, Small Bowel 6-2
Cluster of Dilated Small Bowel 6-4
Aneurysmal Dilation of Small Bowel Lumen 6-6
Stenosis, Terminal Ileum 6-8
Irregular Diffuse Small Bowel Fold Thickening 6-10
Segmental or Diffuse Small Bowel Wall Thickening 6-12
Pneumatosis of Small Intestine or Colon 6-16

Clinically Based Differentials

Occult GI Bleeding 6-20
Small Bowel Obstruction 6-22

MULTIPLE MASSES OR FILLING DEFECTS, SMALL BOWEL

DIFFERENTIAL DIAGNOSIS

Common
- Food, Pills
- Lymphoid Follicles, Small Bowel
- Intestinal Parasitic Disease

Less Common
- Intestinal Metastases and Lymphoma
- Intramural Benign Intestinal Tumors
- Hamartomatous Polyposis Syndromes
- Gardner Syndrome
- Familial Polyposis

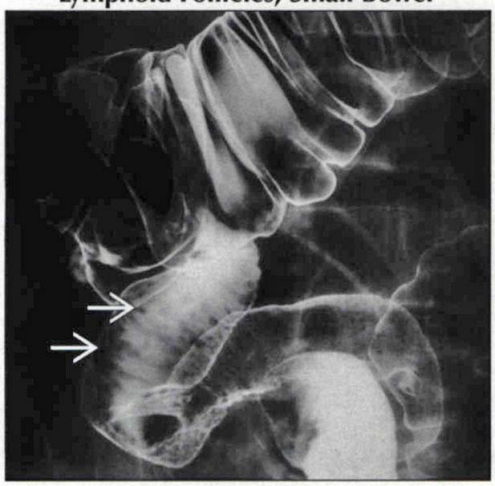
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Most filling defects are food or pills

Helpful Clues for Common Diagnoses
- **Food, Pills**
  - Pills usually have recognizable round or oval shape
  - Corn and other vegetables are common sources of filling defects
  - Especially common in elderly, edentulous patients
- **Lymphoid Follicles, Small Bowel**
  - Prevalent in distal small bowel (SB), especially in children
  - Uniform size (2-4 mm), ill-defined borders due to submucosal location
- **Intestinal Parasitic Disease**
  - Common in some developing countries
  - Ascariasis: Curvilinear filling defects up to 35 cm long

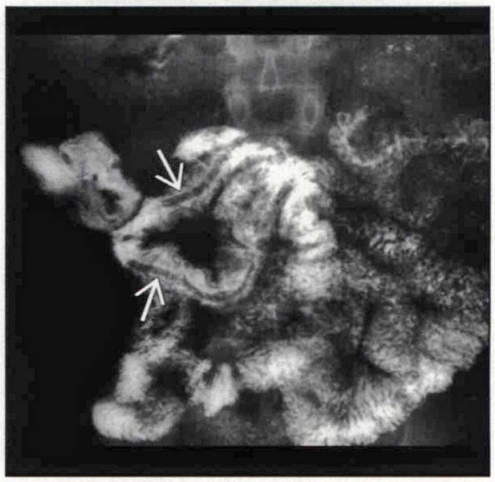
Helpful Clues for Less Common Diagnoses
- **Intestinal Metastases and Lymphoma**
  - Both can lead to multiple polyps, may ulcerate → bull's eye (target) lesions
  - Melanoma most common etiology of SB metastases
- **Intramural Benign Intestinal Tumors**
  - Any mesenchymal component of SB wall
  - Lipoma is most commonly recognized due to fat density on CT
  - Multiple neurofibromas in neurofibromatosis
- **Hamartomatous Polyposis Syndromes**
  - Peutz-Jeghers syndrome: Jejunum & ileum > duodenum > colon > stomach
    - Mucocutaneous pigments lesions, lips and skin
  - Cowden disease: Colonic polyps > SB
  - Cronkhite-Canada syndrome: Stomach & colon > SB
- **Gardner Syndrome**
  - Adenomatous polyps in colon, SB, stomach
  - Extracolonic neoplasms (osteomas, ampullary tumors, desmoids, adrenal, thyroid, liver carcinomas)
- **Familial Polyposis**
  - Adenomas in colon > stomach > duodenum > SB

Lymphoid Follicles, Small Bowel



Contrast enema shows a double contrast view of the right colon and distal small bowel. Note the multiple, small SB nodules ➡ of uniform size and appearance, that represent lymphoid follicles.

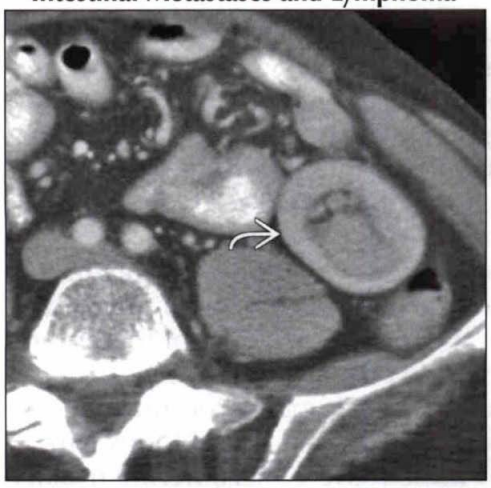
Intestinal Parasitic Disease



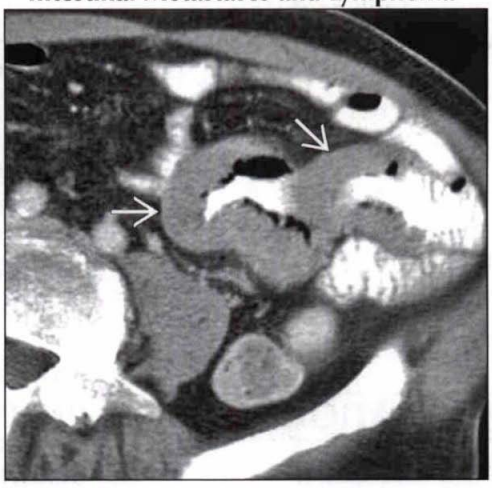
Small bowel follow through shows a long vermiform filling defect ➡ within the SB lumen, a typical appearance for ascaris infestation.

MULTIPLE MASSES OR FILLING DEFECTS, SMALL BOWEL

Intestinal Metastases and Lymphoma



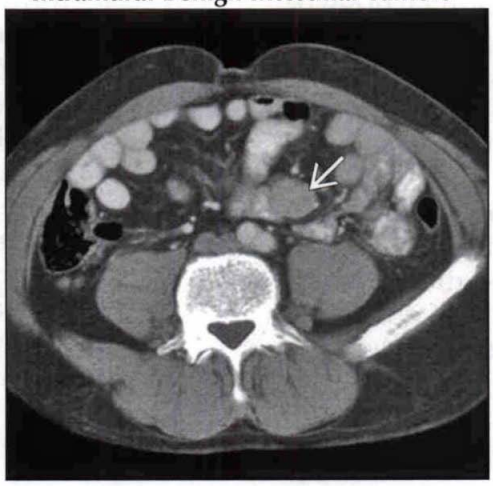
Intestinal Metastases and Lymphoma



(Left) *Axial CECT shows a jejunal intussusception in a patient with malignant melanoma who had multiple hepatic, mesenteric and bowel metastases, with one of these serving as the lead point of the intussusception.* ***(Right)*** *Axial CECT shows two of many small bowel metastases from melanoma, with intramural masses and mucosal ulceration.*

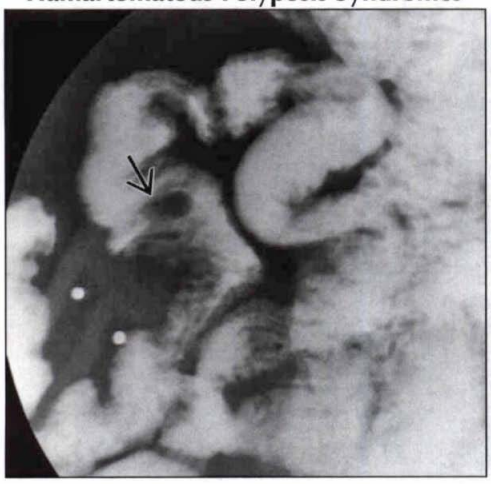
Intramural Benign Intestinal Tumors

Intramural Benign Intestinal Tumors

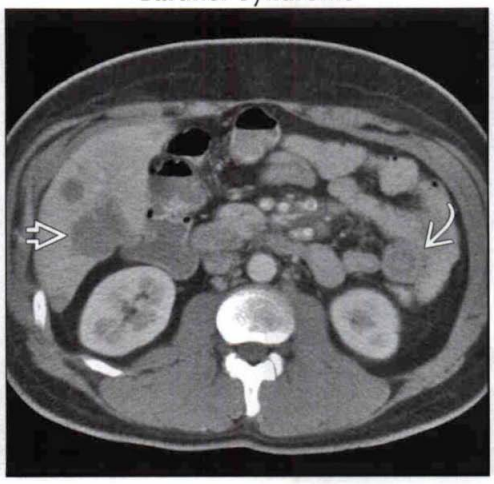


(Left) *Axial NECT shows two of several fat density lesions within the small bowel, diagnostic of lipomas. These appear to be intraluminal, though they arise in the bowel wall, subsequently being drawn into the lumen by peristalsis.* ***(Right)*** *Axial CECT shows one of several soft tissue density nodules within the SB wall, representing neurofibromas, in a patient with neurofibromatosis.*

Hamartomatous Polyposis Syndromes



Gardner Syndrome



(Left) *Small bowel follow through shows one of many small bowel hamartomatous polyps in a patient with Peutz Jeghers syndrome.* ***(Right)*** *Axial CECT shows a small bowel intussusception but not the adenomatous polyp that was the likely cause. Liver metastases are present from a colon carcinoma (not shown on this section).*

CLUSTER OF DILATED SMALL BOWEL

DIFFERENTIAL DIAGNOSIS

Common
- Simple Adhesive Small Bowel Obstruction
- Closed Loop Small Bowel Obstruction
- External Hernia

Less Common
- Peritoneal Metastases
- Sclerosing Peritonitis
- Transmesenteric Post-Operative Hernia
- Paraduodenal Hernia (PDH)
- Transplantation, Small Intestine
- Other Types of Internal Hernia

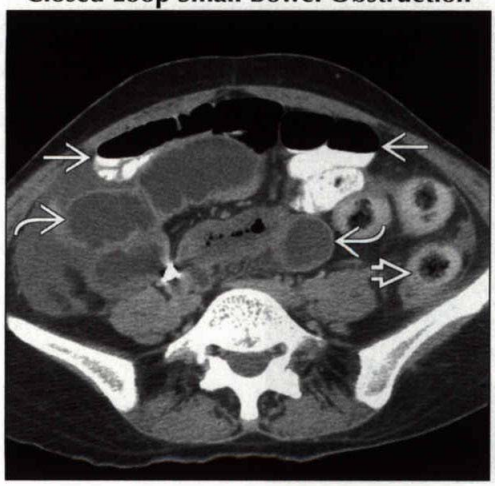
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Check for internal or external hernia
- Check for peritoneal infection or tumor

Helpful Clues for Common Diagnoses
- **Simple Adhesive Small Bowel Obstruction**
  - Gas & fluid-distended small bowel loops (> 3 cm) proximal to collapsed loops
  - Transition zone, but no mass, hernia or other visible cause
- **Closed Loop Small Bowel Obstruction**
  - Markedly distended segment of fluid-filled small bowel, stretched mesenteric vessels converging toward site of obstruction
  - Bowel proximal & distal to closed loop usually not dilated
- **External Hernia**
  - Gas & fluid-filled bowel loops, omental fat, & vessels in ventral, inguinal, or other external hernia sac

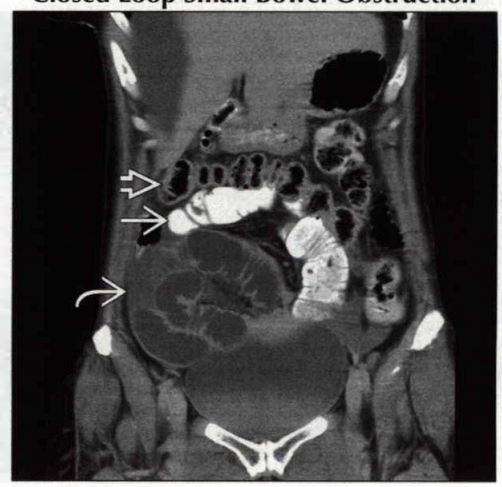
Helpful Clues for Less Common Diagnoses
- **Peritoneal Metastases**
  - Serosal metastases encase & obstruct SB
- **Sclerosing Peritonitis**
  - Results from chronic peritoneal dialysis
  - Fibrotic & often calcified serosal encasement of SB ("cocoon")
- **Transmesenteric Post-Operative Hernia**
  - Protrusion of small bowel loops through congenital or acquired defect of mesentery
  - Most cases are post-operative (e.g., liver transplant, gastric bypass procedure)
  - Cluster of dilated small bowel loops with distorted mesenteric vessels, hernia usually not encapsulated
- **Paraduodenal Hernia (PDH)**
  - Protrusion of bowel loops through congenital paraduodenal fossae
  - Left PDH (75%): Lateral to 4th part of duodenum, between pancreas & stomach
  - Right PDH (25%): Via jejunal mesentericoparietal fossa of Waldeyer
  - Cluster of dilated bowel loops in an abnormal location; with crowded, distorted mesenteric vessels
- **Transplantation, Small Intestine**
  - Usually accompanied by considerable mesenteric infiltration & scarring

Closed Loop Small Bowel Obstruction



Axial CECT shows fluid distended, unopacified SB within the closed loop. These are dilated out of proportion to more proximal SB or colon.

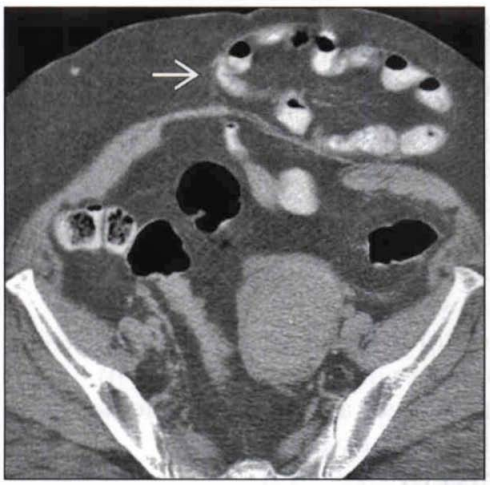
Closed Loop Small Bowel Obstruction



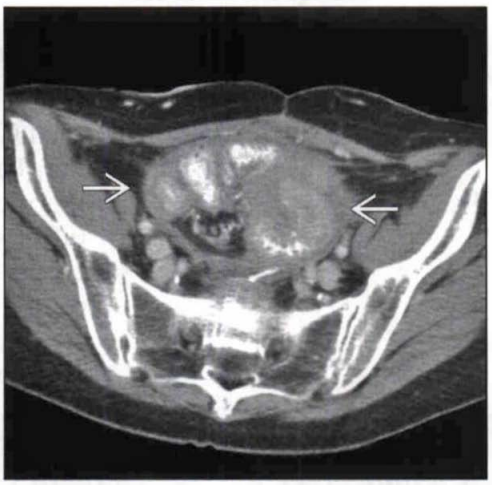
Coronal CECT shows a radial distribution of the closed loops, which are dilated out of proportion to proximal small bowel or colon.

CLUSTER OF DILATED SMALL BOWEL

External Hernia

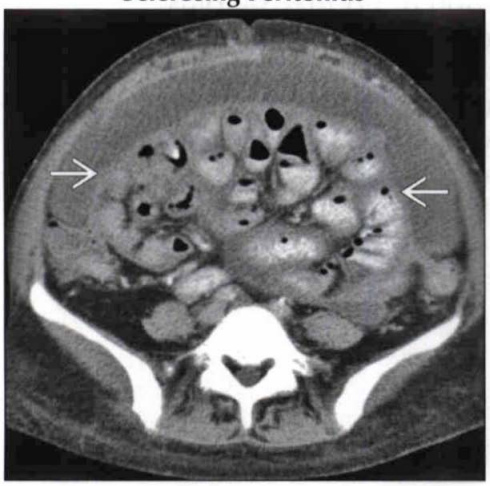


Peritoneal Metastases

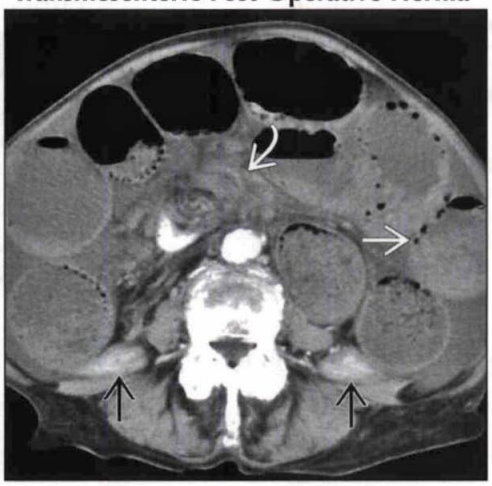


(Left) *Axial CECT shows a cluster of small bowel* ➡ *within a large ventral hernia.* ***(Right)*** *Axial CECT shows a tight cluster of SB* ➡ *that produced a functional SBO, due to peritoneal metastases from ovarian carcinoma that encased the bowel.*

Sclerosing Peritonitis



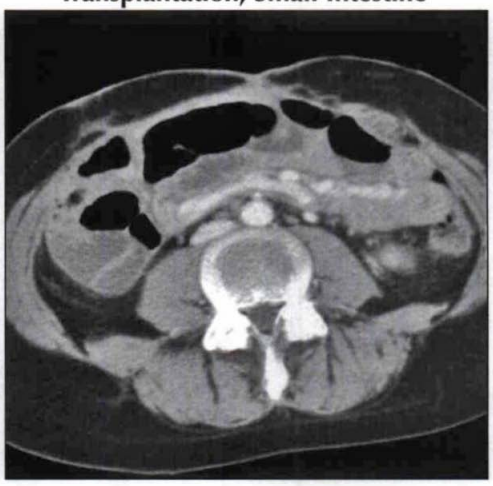
Transmesenteric Post-Operative Hernia



(Left) *Axial CECT shows a cluster of SB that produced chronic symptoms of SBO in a patient with renal failure on chronic ambulatory peritoneal dialysis, who developed sclerosing peritonitis. Note peritoneal thickening* ➡ *that encases the SB.* ***(Right)*** *Axial CECT shows massive dilation & pneumatosis of SB loops* ➡, *with twisting of their mesenteric vessels* ➡. *The vertical colon segments* ➡ *are collapsed and displaced medially.*

Paraduodenal Hernia (PDH)

Transplantation, Small Intestine



(Left) *Axial CECT shows a "sac of bowel" appearance* ➡ *of proximal bowel segments to the left of the ligament of Treitz, displacing the stomach forward. Their mesenteric vessels are displaced toward the center of the hernia.* ***(Right)*** *Axial CECT shows mild dilation of the small bowel allograft, along with infiltration of its mesentery, both common & nonspecific findings.*

ANEURYSMAL DILATION OF SMALL BOWEL LUMEN

DIFFERENTIAL DIAGNOSIS

Common
- Lymphoma, SB
- Metastases, SB
- Bowel-Bowel Anastomosis

Less Common
- GIST, Intestinal
- Small Bowel Obstruction
- Diverticula, Small Bowel
- Meckel Diverticulum

Rare but Important
- Duplication Cyst, GI Tract

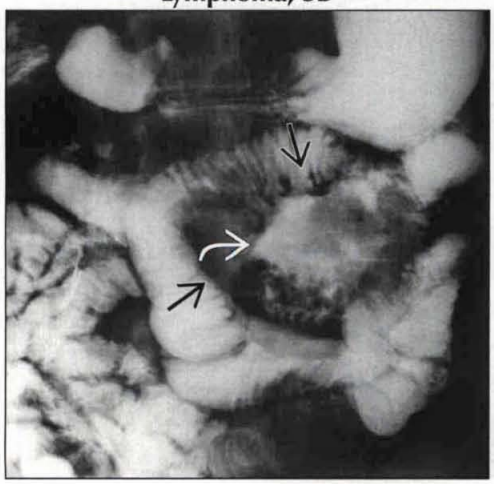
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Luminal dilation plus intramural mass = lymphoma, metastases or GI stromal tumor

Helpful Clues for Common Diagnoses
- **Lymphoma, SB**
  - Classic etiology of aneurysmal dilation
  - Destroys wall of SB
    - Necrotic tumor forms cavity in communication with bowel lumen
  - Danger of free perforation into peritoneal cavity if tumor is treated with chemo- or radiation therapy
- **Metastases, SB**
  - Malignant melanoma is especially likely to cause aneurysmal dilation, similar to lymphoma
  - Usually see other metastases to bowel, mesentery, etc.
- **Bowel-Bowel Anastomosis**
  - Common after prior SB resection, creation of Roux loop, or to bypass stricture
  - Look for staple line at anastomosis

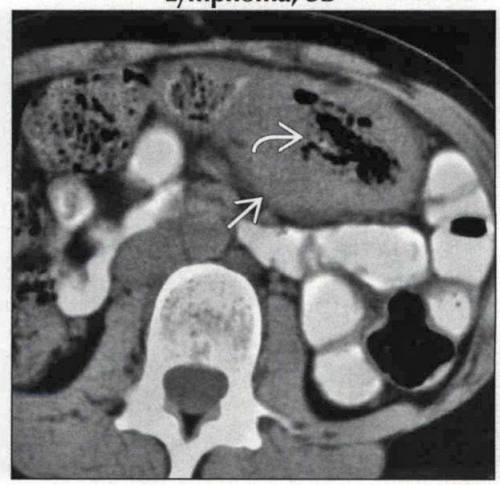
Helpful Clues for Less Common Diagnoses
- GIST, **Intestinal**
  - Duodenum is second most common site (after stomach)
  - Large, exophyte mass arising from duodenal wall
  - Ulceration of mucosa and central necrosis of tumor are common; may result in intra-tumoral gas and contrast media, resembling aneurysmal dilation
- **Small Bowel Obstruction**
  - Chronically dilated SB may attain large diameter (> 6 cm)
  - Preservation of normal SB folds distinguishes this from aneurysmal dilation
- **Diverticula, Small Bowel**
  - Outpouching from duodenum are very common; uncommon, but not rare, in remainder of SB
  - Perforation of SB diverticula can result in "SB diverticulitis", with abscess cavity

Lymphoma, SB



Frontal small bowel follow through shows a large mass ⇨ that encases but does not obstruct a segment of jejunum. Note aneurysmal dilation ⇨ (tumor necrosis that fills with barium).

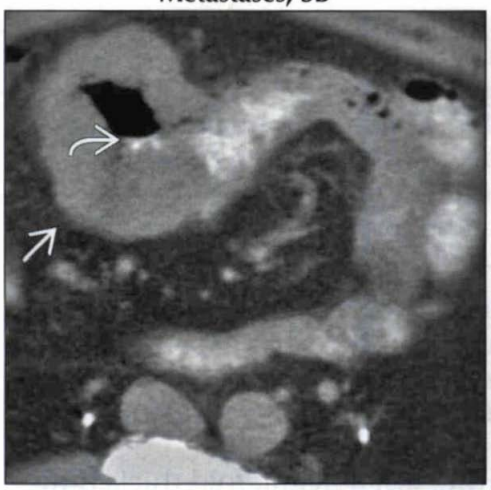
Lymphoma, SB



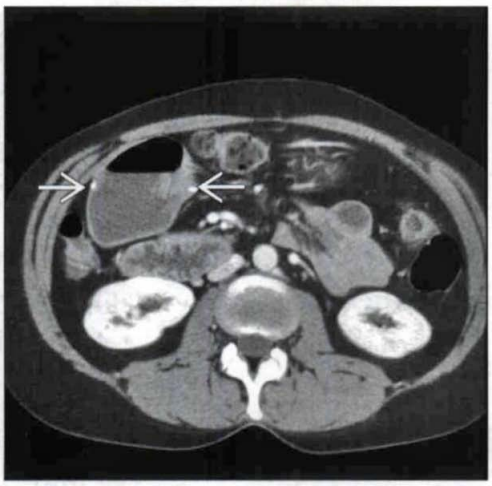
Axial NECT shows a large mass ⇨ that encases but does not obstruct the jejunum, with central necrosis of the mass that fills with gas ⇨ from the SB lumen.

ANEURYSMAL DILATION OF SMALL BOWEL LUMEN

Metastases, SB

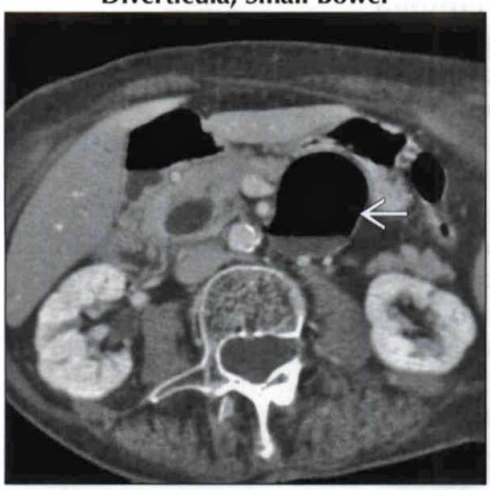


Bowel-Bowel Anastomosis

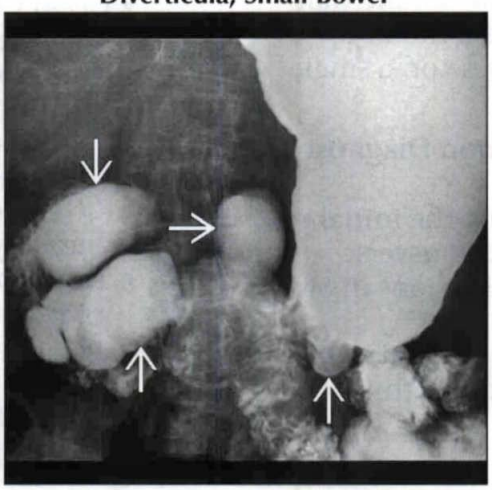


***(Left)** Axial NECT shows a soft tissue mass that encases but does not obstruct the SB, with a central necrotic cavity that fills with gas & enteric contrast; malignant melanoma. **(Right)** Axial CECT shows focal dilation of SB without evidence of obstruction. The metallic staple line helps to identify this as the site of a side-to-side SB anastomosis.*

Diverticula, Small Bowel

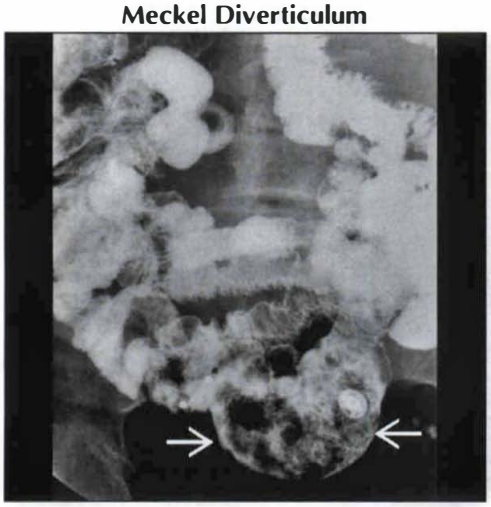


Diverticula, Small Bowel

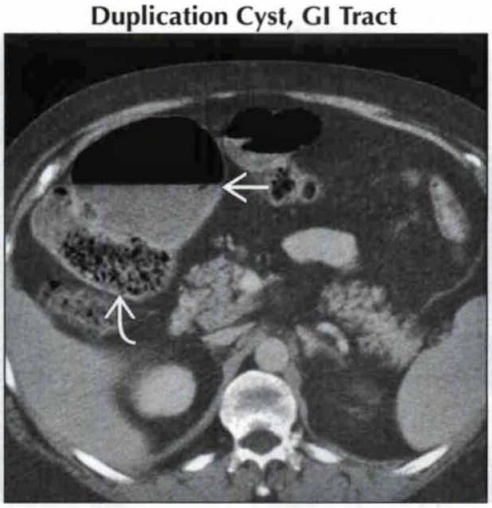


***(Left)** Axial CECT shows one of several duodenal & jejunal diverticula with a thin wall and an air-fluid level present. **(Right)** Frontal upper GI shows several duodenal and small bowel diverticula.*

Meckel Diverticulum



Duplication Cyst, GI Tract



***(Left)** Small bowel follow through shows an unusually large Meckel diverticulum as a blind-ending pouch arising from the distal ileum, filled with a mixture of barium and food debris. **(Right)** Axial CECT shows a cystic structure that communicates with the lumen (air-fluid level) and causes partial SB obstruction (SB feces sign).*

STENOSIS, TERMINAL ILEUM

DIFFERENTIAL DIAGNOSIS

Common
- Crohn Disease
- Infectious Enteritis
- Acute Appendicitis

Less Common
- Abdominal Abscess
- Cecal Carcinoma
- Carcinoid Tumor
- Tuberculosis
- Metastases and Lymphoma, Intestinal
- Radiation Enteritis
- Small Bowel Carcinoma

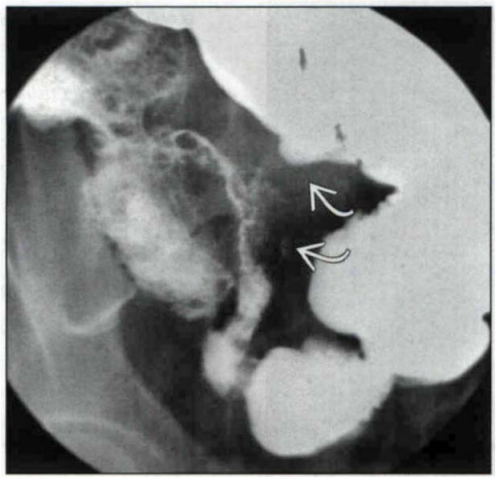
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Stenosis (stricture) of the terminal ileum is much less common than simple wall thickening, but may be difficult to distinguish between these on a single imaging study

Helpful Clues for Common Diagnoses
- **Crohn Disease**
  - Terminal ileum usually the initial site
  - SBFT: Longitudinal & transverse ulcerations, aphthous lesions in SB & colon
  - CT: Wall thickening, luminal narrowing, mesenteric lymphadenopathy & fibrofatty proliferation
- **Infectious Enteritis**
  - Yersinia (gram negative bacterium) produces radiographic findings similar to Crohn disease
    - Usually resolves quickly, without stricture
- **Acute Appendicitis**
  - SB & colon adjacent to inflamed appendix often have wall thickening & luminal narrowing
  - Key is to identify abnormal appendix on CT, US or MR

Helpful Clues for Less Common Diagnoses
- **Abdominal Abscess**
  - Pus from any abdominal or pelvic source (appendicitis, diverticulitis, adnexal abscess)
  - May "bathe" distal ileum; fold thickening & luminal narrowing simulates primary SB inflammation
- **Cecal Carcinoma**
  - May extend into distal SB wall, serosa
- **Carcinoid Tumor**
  - Common in appendix, distal SB
  - Marked desmoplastic infiltration of SB mesentery
  - CT: Mesenteric mass (± calcification) usually more evident than primary tumor
- **Tuberculosis**
  - May involve cecum & terminal ileum
  - Look for signs of peritonitis & caseated nodes
- **Radiation Enteritis**
  - Usually pelvic SB loops, not terminal ileum

Crohn Disease



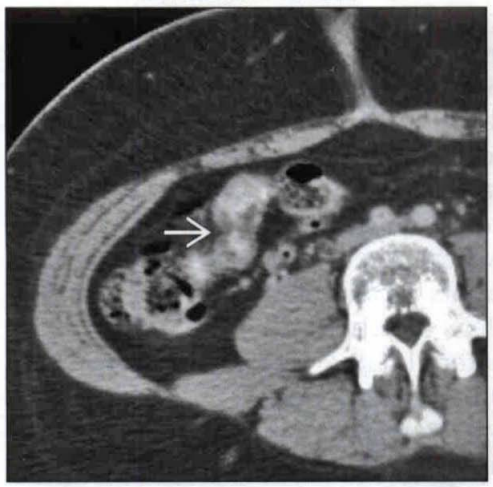
Small bowel follow through shows luminal narrowing and mucosal ulceration of the distal ileum and ascending colon. Also noted are mass effect and fistulas ➡ in the mesenteric fat.

Crohn Disease

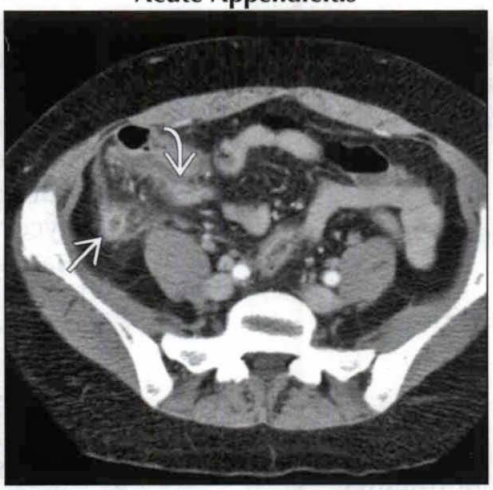
Coronal CECT shows luminal narrowing and wall thickening (of fat density) in the terminal ileum ➡, due to chronic Crohn disease.

STENOSIS, TERMINAL ILEUM

Infectious Enteritis

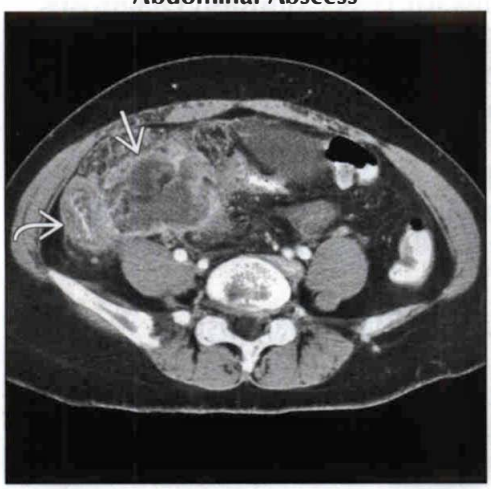


Acute Appendicitis

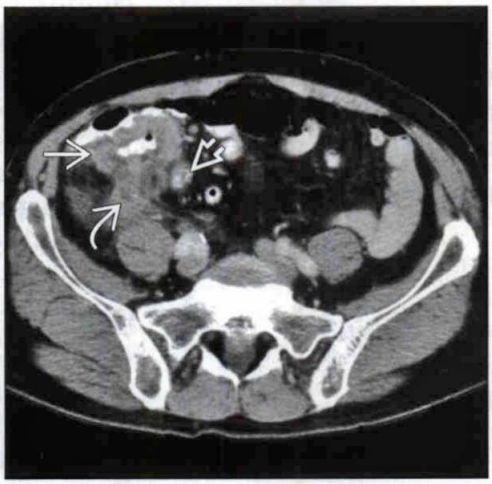


(Left) *Axial CECT shows mural thickening and luminal narrowing of the terminal ileum, that resolved spontaneously in this young woman. Probably due to mesenteric adenitis or infectious enteritis.* ***(Right)*** *Axial CECT shows a dilated lumen and thickened wall of the appendix, with inflammatory infiltration of the mesenteric fat & secondary inflammation of the terminal ileum.*

Abdominal Abscess

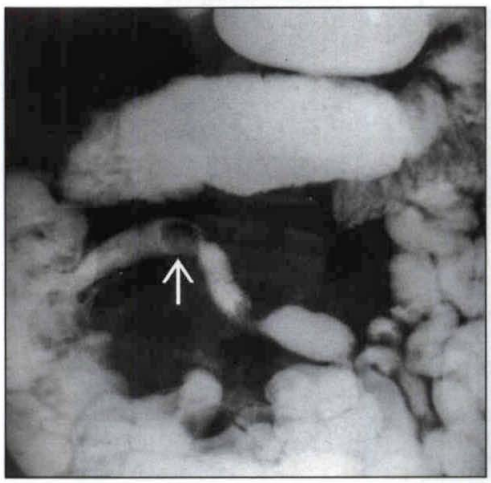


Cecal Carcinoma

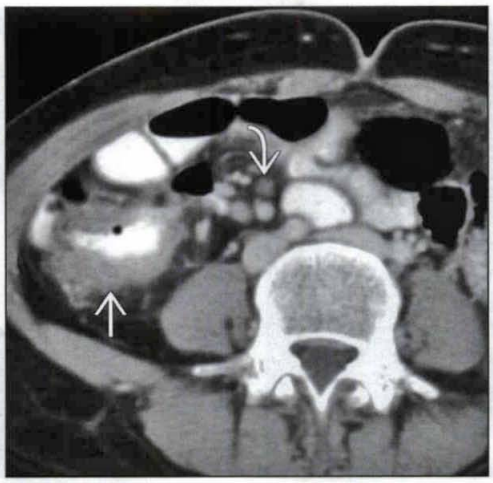


(Left) *Axial CECT shows a right lower quadrant abscess with mural thickening & luminal narrowing of the cecum and terminal ileum. A perforated appendix was found at surgery.* ***(Right)*** *Axial CECT shows a mass that causes circumferential thickening of the cecal wall and obstruction of the base of the appendix. There is infiltration of adjacent fat planes and the wall of the terminal ileum.*

Carcinoid Tumor



Tuberculosis



(Left) *Frontal small bowel follow through shows a polyp in the distal ileum, the primary carcinoid tumor. Also note luminal narrowing and mass effect in the mesentery.* ***(Right)*** *Axial CECT shows mural thickening and luminal narrowing of the cecum and terminal ileum, with mesenteric adenopathy. Proven ileocecal TB in an young female Indian immigrant.*

IRREGULAR DIFFUSE SMALL BOWEL FOLD THICKENING

DIFFERENTIAL DIAGNOSIS

Common
- Sprue-Celiac Disease
- Malabsorption Conditions
- Opportunistic Intestinal Infections
- Portal Hypertension, Varices

Less Common
- Ischemic Enteritis
- Metastases and Lymphoma, Intestinal

Rare but Important
- Lymphangiectasia, Intestinal
- Whipple Disease
- Mastocytosis
- Tropical Sprue
- Abetalipoproteinemia
- Waldenstrom Macroglobulinemia

ESSENTIAL INFORMATION

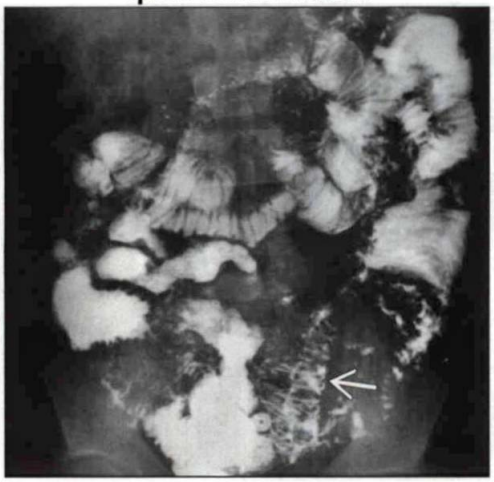
Key Differential Diagnosis Issues
- Diffuse = > 40 cm length of involvement
- Limited ability to distinguish among the many etiologies without clinical input

Helpful Clues for Common Diagnoses
- **Sprue-Celiac Disease**
  - Most common SB disease producing "malabsorption pattern"
  - Decreased fold height in jejunum, increased height in ileum
- **Malabsorption Conditions**
  - Other causes: Short gut syndrome, cystic fibrosis, lymphangiectasia, bacterial overgrowth (e.g., patient with numerous SB diverticula)
- **Opportunistic Intestinal Infections**
  - Common in patients with AIDS & other immune compromised conditions
  - Can be caused by viruses (e.g., CMV) protozoa (Giardia, cryptosporidium), mycobacterium (MAI)
  - Giardiasis can occur in immune competent hosts; favors proximal SB; common cause of traveler's diarrhea
  - Mycobacterial: Look for caseated (low density) mesenteric nodes
- **Portal Hypertension, Varices**
  - Cirrhosis ± portal vein or SMV thrombosis can cause SB fold thickening, mesenteric edema, ascites

Helpful Clues for Less Common Diagnoses
- **Ischemic Enteritis**
  - Tends to involve moderately long segment of SB, rather than all of SB ("diffuse")
  - "Shock bowel": Diffuse wall edema, mucosal enhancement
- **Metastases and Lymphoma, Intestinal**
  - Multifocal fold & wall thickening; rarely "diffuse"

Helpful Clues for Rare Diagnoses
- **Whipple Disease**
  - Associated low density mesenteric nodes
  - Correlate with clinical (arthralgias, weight loss, etc.)

Sprue-Celiac Disease



Small bowel follow through shows dilution & segmentation of the barium & a jejunal intussusception. The jejunal fold pattern is blunted while the ileal fold pattern is prominent.

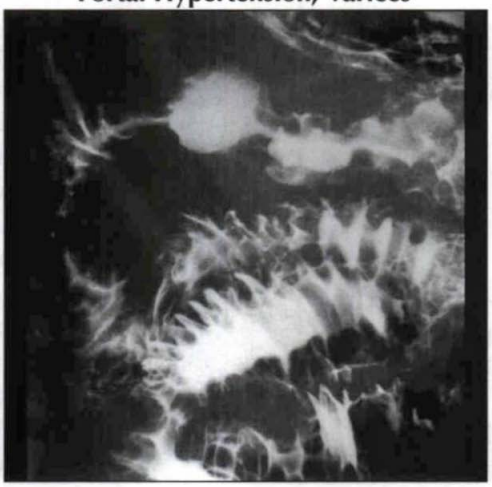
Sprue-Celiac Disease

Axial CECT shows reversal of fold pattern, with prominent ileal folds, but abnormally effaced jejunal folds. Dilation of the jejunal lumen by fluid is part of the malabsorption pattern.

IRREGULAR DIFFUSE SMALL BOWEL FOLD THICKENING

Opportunistic Intestinal Infections

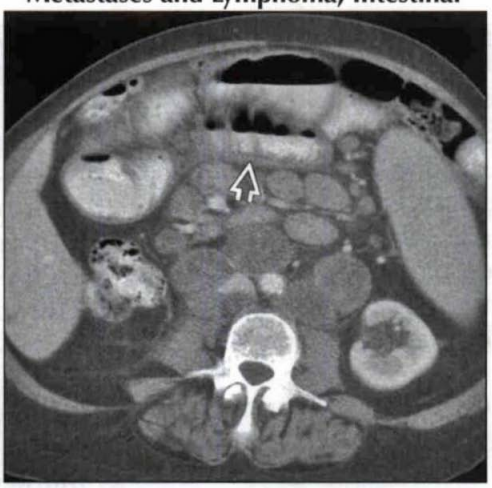
Portal Hypertension, Varices



*(Left) Axial CECT shows diffuse SB fold thickening and mesenteric lymphadenopathy in a young man with AIDS; mycobacterial enteritis. **(Right)** Small bowel follow through shows diffuse marked SB fold thickening due to portal hypertension and hypoproteinemia in a patient with cirrhosis.*

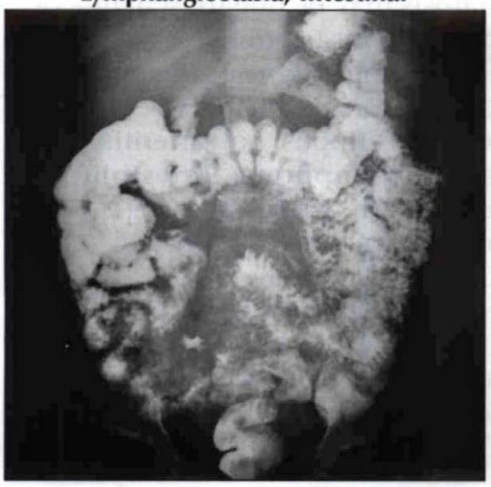
Ischemic Enteritis

Metastases and Lymphoma, Intestinal

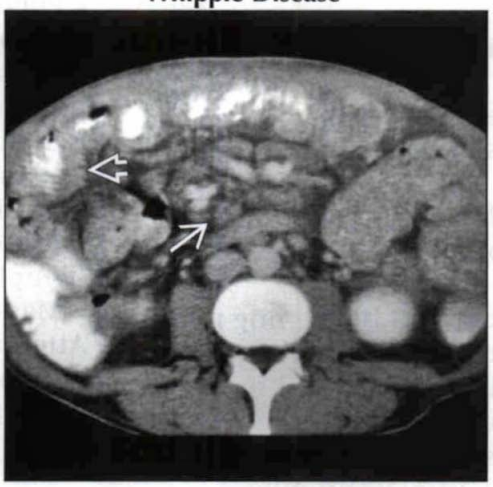


*(Left) Axial CECT shows a classic "shock bowel" pattern of marked submucosal wall thickening and mucosal enhancement, with mesenteric & peripancreatic fat plane infiltration. This is usually a transient finding in patients who have been hypotensive due to head or spine trauma or hypovolemia. **(Right)** Axial CECT shows a long segment of SB fold thickening and very large mesenteric & retroperitoneal nodes due to non-Hodgkin lymphoma.*

Lymphangiectasia, Intestinal



Whipple Disease



*(Left) Frontal small bowel follow through shows diffuse fold thickening throughout the entire SB in a 15 year old boy with congenital intestinal lymphangiectasia. **(Right)** Axial CECT shows diffuse SB fold thickening and mesenteric & retroperitoneal lymphadenopathy. The nodes are lower in attenuation than would be expected for lymphoma, but a mycobacterial infection could have a very similar appearance.*

SEGMENTAL OR DIFFUSE SMALL BOWEL WALL THICKENING

DIFFERENTIAL DIAGNOSIS

Common
- Crohn Disease
- Ischemic Enteritis
- Intramural Hemorrhage
- Shock Bowel
- Portal Hypertension
- Hypoalbuminemia

Less Common
- Radiation Enteritis
- Opportunistic Intestinal Infections
- Vasculitis, Small Intestine
- Metastases and Lymphoma, Intestinal
- Carcinoid Tumor
- Angioedema, Intestinal
- Lymphangiectasia, Intestinal
- Endometriosis
- Graft-Versus-Host Disease (GVHD)

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Characterize wall thickening by length & degree of involvement, attenuation of submucosal layer, pattern of enhancement & associated findings (e.g., mesenteric)
- CT findings are best seen with distension of SB lumen by water or neutral contrast agent, rapid IV contrast administration, multiplanar viewing
- Associated findings in mesentery are key
  - Vessel engorgement or thrombosis; lymph nodes, etc.

Helpful Clues for Common Diagnoses
- **Crohn Disease**
  - Segmental with skip lesions
  - Attenuation: Edema in acute; fat density in chronic
  - Enhancement: Marked mucosal enhancement in sites of active inflammation
  - Associated findings: Mesenteric hyperemia, fibrofatty proliferation, lymphadenopathy
- **Ischemic Enteritis**
  - Segmental with marked wall thickening in venous obstruction, minimal wall thickening in arterial occlusion
  - Attenuation: Air to edema to blood density
  - Enhancement: Intense mucosal in venous thrombosis; absent in arterial thrombosis
  - Associated findings: Thrombosis of mesenteric vessels, ascites
- **Intramural Hemorrhage**
  - Segmental with marked thickening
  - Attenuation: Blood density
  - Associated findings: Signs of trauma or coagulopathic bleeding
- **Shock Bowel**
  - Diffuse with marked thickening
  - Attenuation: Water density
  - Enhancement: Intense mucosal enhancement
  - Associated findings: Mesenteric & peripancreatic edema; visceral &/or cerebral traumatic injuries
- **Portal Hypertension**
  - Diffuse
  - Attenuation: Edema (water density)
  - Associated findings: Cirrhosis, ascites, splenomegaly, varices

Helpful Clues for Less Common Diagnoses
- **Radiation Enteritis**
  - Segmental in pelvis
  - Attenuation: Water to soft tissue
  - Associated findings: Evidence of surgery &/or brachytherapy beads in pelvis
- **Opportunistic Intestinal Infections**
  - Segmental with moderate thickening
  - Attenuation: Water to soft tissue
  - Associated findings: Lymphadenopathy (low density in mycobacterial disease)
- **Vasculitis, Small Intestine**
  - Segmental or diffuse with moderate to marked thickening
  - Attenuation: Air to water to soft tissue to blood
    - Pneumatosis may be due to ischemia or from medications (steroids)
  - Associated findings: Skin & subcutaneous purpura (Henoch-Schönlein), visceral ischemic lesions (lupus, polyarteritis)
- **Metastases and Lymphoma, Intestinal**
  - Multifocal discrete (metastases, e.g., melanoma); segmental or diffuse (lymphoma)
    - Marked thickening at sites of tumor
  - Attenuation: Soft tissue (not edema)
  - Enhancement: Heterogeneous, nodular (in mass itself)

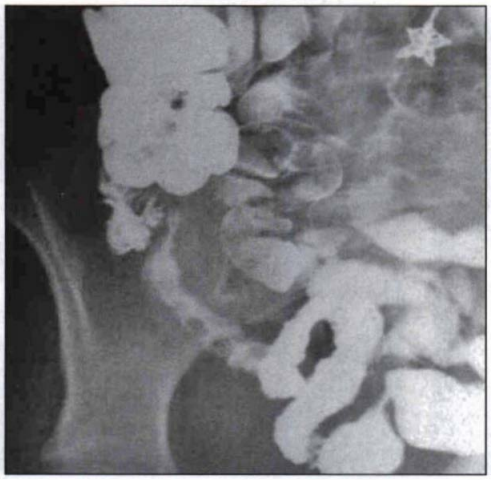
- Associated findings: Other metastatic foci (e.g., liver, spleen); lymphadenopathy, splenomegaly (lymphoma)

- **Carcinoid Tumor**
  - Segmental, usually distal ileum
  - Attenuation: Soft tissue for the primary tumor site; edema or soft tissue for SB segments involved by desmoplastic reaction
  - Associated findings: Mesenteric mass with calcification; desmoplastic effect on adjacent SB loops; liver metastases
- **Angioedema, Intestinal**
  - Segmental, associated with medications (e.g., ACE inhibitors), hepatitis, etc.
  - Attenuation: Edema (water density)
  - Associated findings: Ascites
- **Endometriosis**
  - Segmental with skip areas
  - Attenuation: Blood density
  - Associated findings: Pelvic mass; characteristic features of blood on MR scanning
- **Graft-Versus-Host Disease (GVHD)**
  - Usually diffuse
  - Attenuation: Water to soft tissue
  - Associated findings: Usually none (but patients have skin & liver involvement by clinical & laboratory testing)

Alternative Differential Approaches

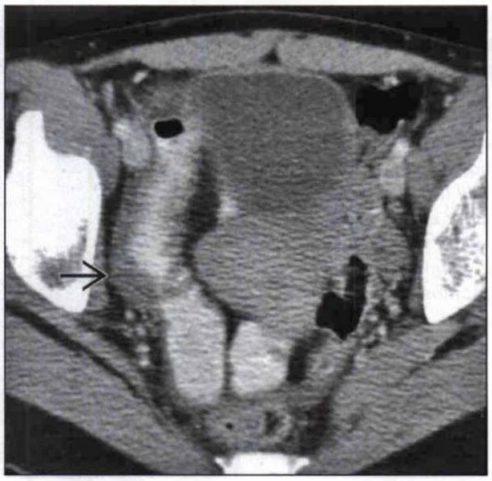
- Length of involvement: Short (focal), < 5 cm; segmental, 6-40 cm; diffuse, > 40 cm
  - Short (neoplasm, endometriosis, Crohn disease)
  - Segmental (hemorrhage, Crohn disease, infection, lymphoma, radiation, ischemia, angioedema)
  - Diffuse (vasculitis, hypoalbuminemia, ischemia, shock)
- Degree of thickening
  - Arterial ischemia causes much less mural thickening than venous thrombosis
  - Marked thickening (> 10 mm): Hemorrhage, venous thrombosis, vasculitis or neoplasm
- Attenuation (density) of submucosal layer
  - Air density: Pneumatosis
  - Fat density: Chronic Crohn disease; chemotherapy (may be normal in ileum)
  - Water density: Acute inflammation or ischemia
    - Not seen with neoplastic causes of wall thickening
  - Soft tissue density: Edema or neoplasm (wall > 2 cm; probably tumor)
    - Least specific category of attenuation
  - High (blood) density: Acute hemorrhage
    - Collapsed lumen & enhanced mucosa may simulate high density submucosa)
- Pattern of enhancement
  - Most striking mucosal enhancement in shock bowel, acute inflammation (including Crohn), venous thrombosis
  - Heterogeneous enhancement suggests neoplasm

Crohn Disease



Frontal small bowel follow through shows fold thickening and luminal narrowing of the terminal ileum and cecum, with ulcerated mucosa, typical of active Crohn disease.

Crohn Disease



Axial CECT shows wall thickening ⇨ along a long segment of distal ileum.

SEGMENTAL OR DIFFUSE SMALL BOWEL WALL THICKENING

Ischemic Enteritis

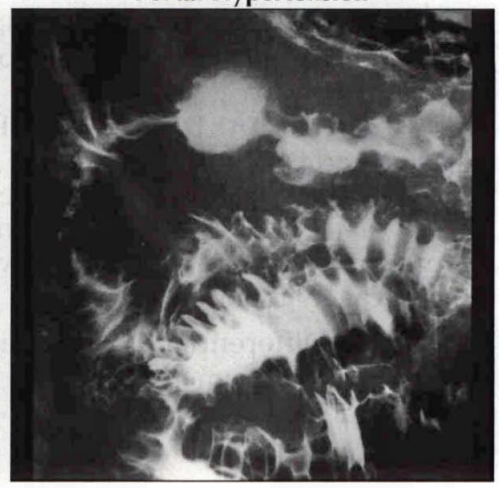
(Left) Axial CECT shows marked mural thickening ➡ of a long segment of small bowel, due to ischemia following a hypotensive episode. (Right) Axial CECT shows high density material (blood) within the submucosal SB layer ➡, due to Henoch Schönlein purpura.

Intramural Hemorrhage

Shock Bowel

(Left) Axial CECT shows striking enhancement of mucosa and submucosal edema ("shock bowel") in this young patient. All findings resolved spontaneously within 24 hours. (Right) Small bowel follow through shows diffuse fold thickening of the small bowel due to cirrhosis & portal hypertension, possibly accentuated by hypoproteinemia.

Portal Hypertension



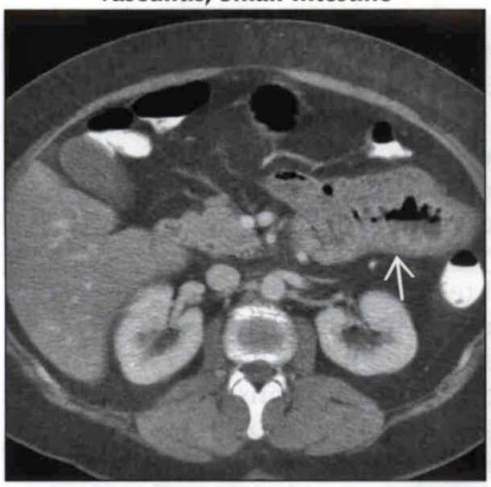
Radiation Enteritis

(Left) Axial CECT shows extensive small bowel mural thickening ➡ and ascites due to external radiation therapy for cervical carcinoma. (Right) Axial CECT shows extensive small bowel wall thickening ➡, due to CMV enteritis in a patient with cystic fibrosis who had a lung transplantation.

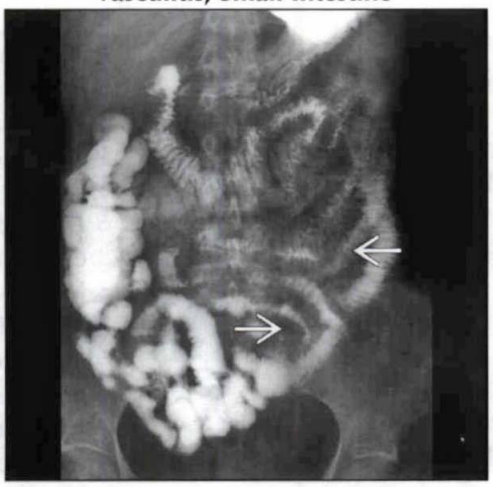
Opportunistic Intestinal Infections

SEGMENTAL OR DIFFUSE SMALL BOWEL WALL THICKENING

Vasculitis, Small Intestine



Vasculitis, Small Intestine



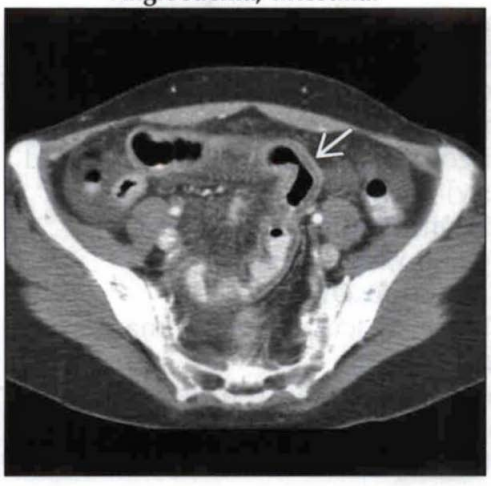
*(Left) Axial CECT shows intramural hemorrhage and luminal narrowing, due to Henoch Schönlein purpura. A coagulopathic or traumatic intramural bleed could have an identical appearance. **(Right)** Anteroposterior small bowel follow through shows diffuse fold thickening and separation of loops, proved to be due to an allergic form of vasculitis.*

Metastases and Lymphoma, Intestinal

Carcinoid Tumor

***(Left)** Axial CECT shows marked wall thickening a several segments of small bowel. In spite of the large masses, there is no luminal obstruction; typical findings of small bowel lymphoma. **(Right)** Axial CECT shows mural thickening of multiple contiguous small bowel segments in the right lower quadrant and a mesenteric mass, typical of carcinoid tumor.*

Angioedema, Intestinal



Lymphangiectasia, Intestinal

***(Left)** Axial CECT shows submucosal edema of a long segment of jejunum. Angioedema due to an adverse reaction to ACE inhibitor medication. **(Right)** Axial CECT shows extensive SB mural edema and infiltration of the mesentery, due to congenital lymphangiectasia of the bowel.*

PNEUMATOSIS OF SMALL INTESTINE OR COLON

DIFFERENTIAL DIAGNOSIS

Common

- Ischemic Enteritis
- Ischemic Colitis
- Post-Operative State, Bowel
- Post-Endoscopy
- Medication-Induced Pneumatosis
- Pseudopneumatosis (Mimic)
- Pulmonary Causes
  - Barotrauma, Abdominal Manifestations
  - Asthma
  - Chronic Obstructive Lung Disease
  - Cystic Fibrosis
- Small Bowel Obstruction
- Collagen Vascular Disease
- Necrotizing Enterocolitis

Less Common

- Pneumatosis Cystoides Intestinalis
- Intestinal Trauma
- Small Bowel Transplantation
- Inflammatory Bowel Disease
- Toxic Megacolon
- Graft vs. Host Disease
- Caustic Gastroduodenal Injury
- Gas in Wall of Ileal Conduit

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Pneumatosis is a radiographic finding, not a disease process
  - Must correlate with patient history, clinical signs & symptoms to determine its significance
  - If pneumatosis is due to ischemia, patient will be ill
    - Check for laboratory abnormalities (leukocytosis, acidosis, elevated serum amylase)
  - Patients with "benign" (non-ischemic) pneumatosis are usually asymptomatic

Helpful Clues for Common Diagnoses

- **Ischemic Enteritis & Colitis**
  - Spherical or linear collections of gas in submucosa of affected bowel
  - Often associated with portal venous gas
  - SB ischemia usually due to occlusion of SMA or SMV
    - Colonic ischemia more often due to hypoperfusion; not thrombotic
- **Post-Operative State, Bowel**
  - Bowel-to-bowel anastomosis
  - Gastrostomy, jejunostomy tubes
  - Either may cause gas to leak from bowel lumen into wall
  - Patients are usually asymptomatic unless there is associated SB obstruction
- **Post-Endoscopy**
  - Upper or lower endoscopy
  - Also after barium or hydrogen peroxide enema
  - Mucosal tear may allow gas leak into wall
- **Medication-Induced Pneumatosis**
  - Corticosteroids, chemotherapy, anti-rejection medications
  - Any organ or bone marrow transplant recipient
  - Medications may cause tiny perforations of mucosa by inducing atrophy of submucosal lymphoid follicles
- **Pseudopneumatosis (Mimic)**
  - Gas may be trapped against the inner wall of bowel, simulating pneumatosis
  - Very common in cecum, ascending colon
    - Usually not seen above the air-feces level within colon
  - SB feces sign (in SB obstruction)
    - Gas may be trapped within lumen, up against inner wall of small bowel
- **Pulmonary Causes**
  - Asthma, COPD, pulmonary fibrosis, cystic fibrosis, ventilator
  - Gas dissects down mediastinum, into retroperitoneum, out mesentery, into bowel wall
- **Small Bowel Obstruction**
  - Gas may enter wall of SB, especially if there has been prior SB surgery or intrinsic SB disease (e.g., Crohn disease)
  - Check for signs of closed loop obstruction (disproportionate dilation of a cluster of SB loops, engorged vessels, ascites, infiltrated mesentery)
  - Correlate with clinical & laboratory evidence of bowel ischemia
- **Collagen Vascular Disease**
  - Any "collagen vascular disease" may cause pneumatosis
  - Intramural gas may result from the bowel disease itself, associated medications (e.g., corticosteroids), or ischemia

- Must correlate with clinical & laboratory evidence of disease exacerbation or ischemia

- **Necrotizing Enterocolitis**
  - Common cause of pneumatosis in neonates

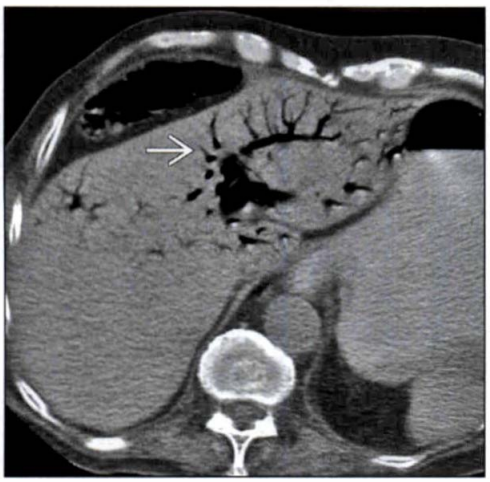
Helpful Clues for Less Common Diagnoses

- **Pneumatosis Cystoides Intestinalis**
  - Idiopathic, asymptomatic, usually colonic
  - Usually appears as large gas "cysts" in wall of colon
    - May be mistaken for polyps, if gas density is not appreciated
- **Intestinal Trauma**
  - Serosa of bowel may be avulsed ("degloving injury")
  - Leads to devascularization & ischemia of bowel
- **Small Bowel Transplantation**
  - These patients frequently develop "benign" pneumatosis
  - Many potential causes
    - Medications
    - Bowel-to-bowel anastomoses
    - Rejection
    - Infarction
  - Often requires endoscopic evaluation to distinguish from ischemia
- **Inflammatory Bowel Disease**
  - Crohn disease, ulcerative colitis, others
  - Any disease that causes ulceration of bowel mucosa can cause pneumatosis
  - Patients are often on steroid medications that may also cause pneumatosis
- **Graft vs. Host Disease**
  - Bone marrow transplant recipients
  - Clinical triad: Damage to gut, skin, liver
  - Pneumatosis does not necessarily indicate ischemia
    - Patients are receiving medications (steroids, immunosuppression) associated with "benign pneumatosis"
- **Caustic Gastroduodenal Injury**
  - Usually limited to esophagus & stomach
  - Duodenum may also be injured
  - Mucosal or transmural necrosis may cause pneumatosis &/or perforation of bowel
- **Gas in Wall of Ileal Conduit**
  - Following cystectomy
  - Ureters may be anastomosed to ileal conduit
  - Nonischemic gas may collect transiently within the bowel wall
  - Check for gas-forming infection of urine (may release gas into lumen, or, rarely, into wall of conduit)

SELECTED REFERENCES

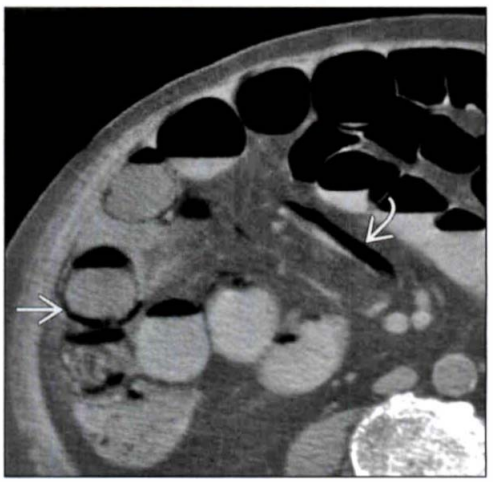
1. Rha SE et al: CT and MR imaging findings of bowel ischemia from various primary causes. Radiographics. 20(1):29-42, 2000
2. Feczko PJ et al: Clinical significance of pneumatosis of the bowel wall. Radiographics. 12(6):1069-78, 1992

Ischemic Enteritis



Axial CECT shows extensive portal venous gas ➡ with its characteristic peripheral distribution. Due to small bowel infarction following a hypotensive episode.

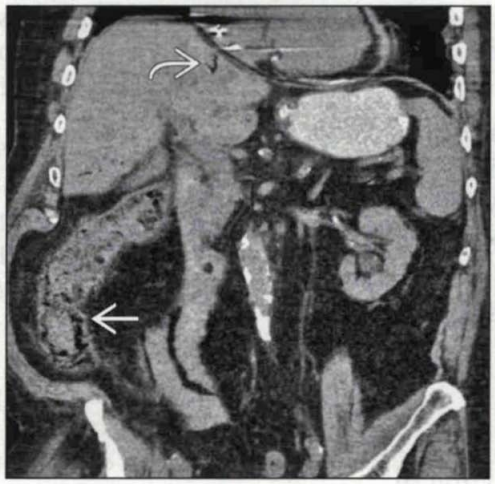
Ischemic Enteritis



Axial CECT shows pneumatosis in dilated small bowel ➡ and gas within the mesenteric veins ➡ draining the affected portions of bowel.

PNEUMATOSIS OF SMALL INTESTINE OR COLON

Ischemic Colitis



Ischemic Colitis

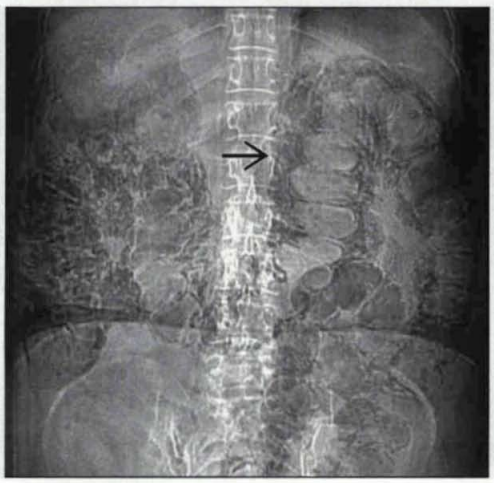
*(Left) Coronal NECT shows gas within the wall of the ascending colon and portal venous gas due to acute colonic infarction. **(Right)** Coronal reformatted CECT shows extensive pneumatosis of the small bowel and ascending colon due to acute infarction. Note the generalized ileus.*

Post-Operative State, Bowel

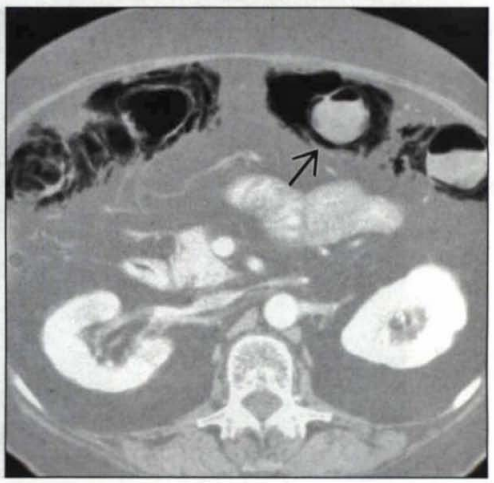
Medication-Induced Pneumatosis

*(Left) Axial CECT shows pneumatosis near the site of prior bowel resection, but also within bowel some distance removed from the operative site. The patient had signs of sepsis and ischemia was confirmed at surgery. **(Right)** Axial CECT shows pneumatosis of the hepatic flexure. Note absence of ileus in this asymptomatic patient with chronic pneumatosis, attributed to steroid medication (for severe psoriasis).*

Medication-Induced Pneumatosis



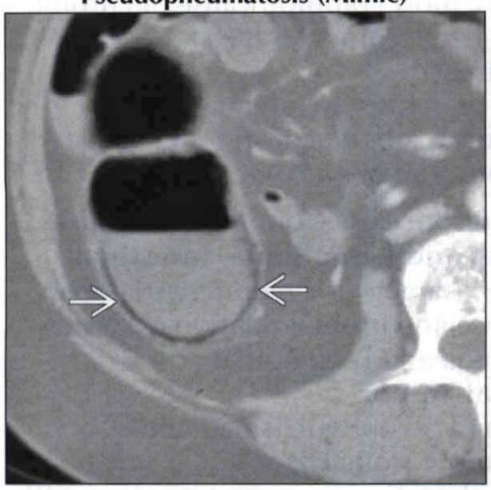
Medication-Induced Pneumatosis



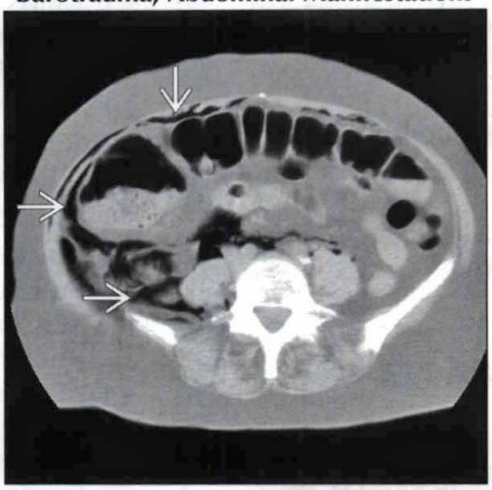
*(Left) Frontal radiograph shows extensive colonic pneumatosis in an asymptomatic patient who had a bone marrow transplant for leukemia; presumed to be due to steroids and other medications. **(Right)** Axial CECT shows extensive colonic pneumatosis in an asymptomatic patient who had a bone marrow transplant for leukemia. Note absence of ileus or ascites. Presumed due to steroids and immunosuppressive medications.*

PNEUMATOSIS OF SMALL INTESTINE OR COLON

Pseudopneumatosis (Mimic)

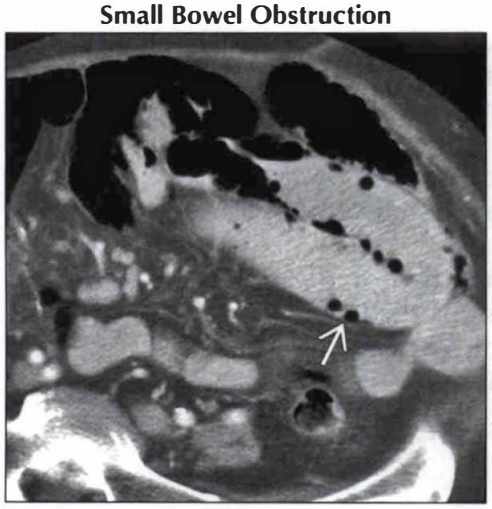


Barotrauma, Abdominal Manifestations

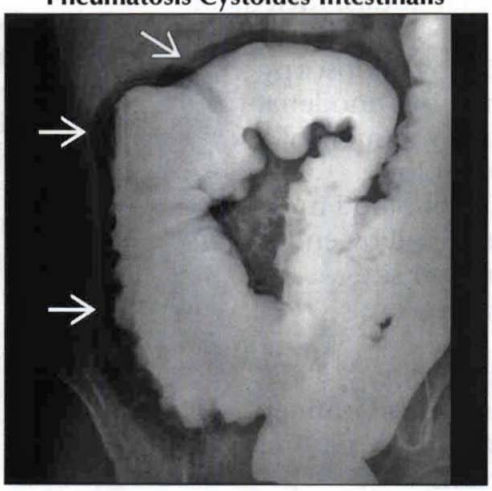


*(Left) Axial CECT shows gas trapped against the wall of the ascending colon, simulating pneumatosis. Note that this finding is not present in the nondependent colon, where the fluid stool is not in contact with the bowel wall. **(Right)** Axial CECT shows extensive gas dissecting throughout the abdomen, some of which may be in bowel wall, due to barotrauma in a patient on positive pressure ventilation.*

Small Bowel Obstruction

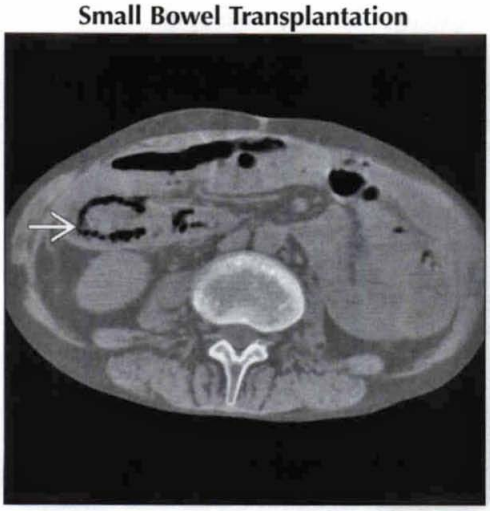


Pneumatosis Cystoides Intestinalis

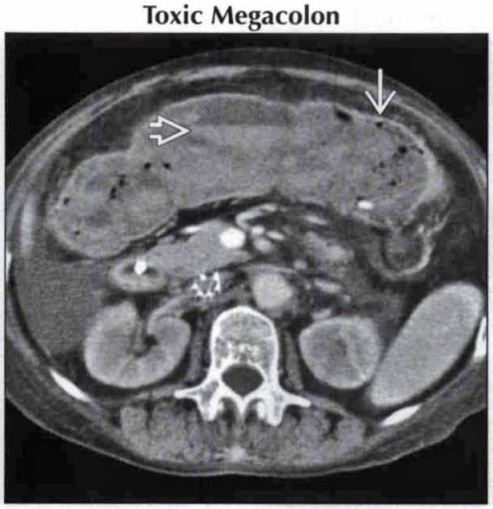


*(Left) Axial CECT shows pneumatosis within dilated small bowel, upstream from a mechanical obstruction. The bowel was found to be ischemic but viable at surgery. **(Right)** Frontal contrast enema shows extensive intramural gas within an otherwise normal-appearing colon. Asymptomatic man with chronic primary pneumatosis.*

Small Bowel Transplantation



Toxic Megacolon



*(Left) Axial NECT shows pneumatosis within the small bowel allograft. The patient had no evidence of ischemia on endoscopic biopsy, and the pneumatosis is due to medications (or the bowel-to-bowel anastomosis). **(Right)** Axial CECT shows a grossly dilated transverse colon with loss of haustration. There is gas within the wall of the colon, hemorrhagic debris within the lumen, and ascites. All findings confirmed at colectomy.*

OCCULT GI BLEEDING

DIFFERENTIAL DIAGNOSIS

Common
- Vascular Ectasia, Intestinal
- Crohn Disease

Less Common
- Metastases and Lymphoma, Intestinal
- GI Stromal Tumor
- Carcinoid Tumor
- Small Bowel Carcinoma
- Vasculitis, Small Intestine
- Ischemic Enteritis
- Mesenteric Varices
- Intramural Benign Tumor, Intestinal
- Radiation Enteritis

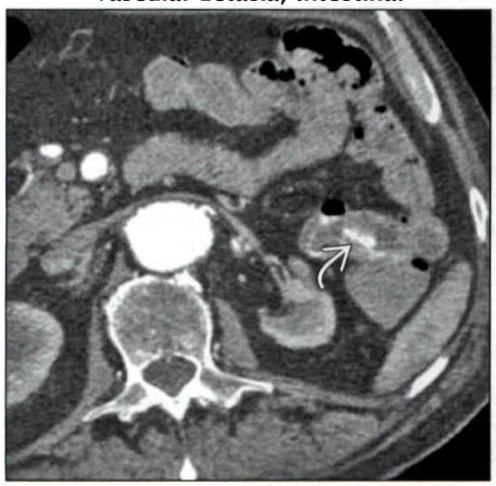
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Overt GI bleeding = hematemesis, melena or hematochezia
  - Bleeding site detectable by endoscopy
  - Common sources: Gastric & duodenal ulcers, esophageal varices, tumors of esophagus, stomach or colon
- Occult GI bleeding = loss of blood in which source has not been identified by endoscopy
  - Small intestine is common site
  - CT and capsule endoscopy are complementary
- CT technique = CT enterography
  - Distend bowel with water or Volumen
  - Rapid (3-5 mL/sec) bolus of IV contrast
  - Multiplanar reformations

Helpful Clues for Common Diagnoses
- **Vascular Ectasia, Intestinal**
  - AVMs are most common cause of chronic, obscure GI bleeding (40-80%)
- **Crohn Disease**
  - Usually presents with abdominal symptoms (pain, diarrhea) unlike most other causes of obscure GI bleeding

Helpful Clues for Less Common Diagnoses
- **Metastases and Lymphoma, Intestinal**
  - Bull's eye (target) or circumferential mass
  - May cause aneurysmal dilation of lumen (melanoma and lymphoma)
- **GI Stromal Tumor**
  - Bulky mass, exophytic (small bowel < duodenum < stomach)
  - Central ulceration in communication with lumen
- **Small Bowel Carcinoma**
  - Constricting lesion, causes obstruction
- **Vasculitis, Small Intestine**
  - Segmental involvement, thick SB folds
- **Ischemic Enteritis**
  - Occlusion of SMA or SMV branches
  - Abnormal enhancement & thickening of SB wall
  - Infiltrated mesentery, ascites, especially with venous thrombosis
- **Mesenteric Varices**
  - In portal hypertension
  - Usually at site of prior bowel surgery

Vascular Ectasia, Intestinal



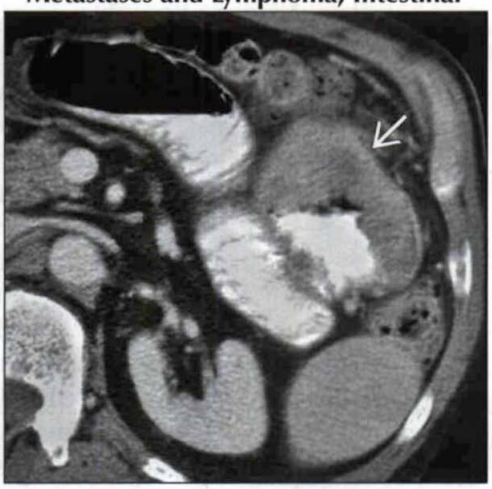
Axial CECT shows active extravasation of contrast-opacified blood into the jejunum. Note that water was used to distend the bowel. A jejunal angiodysplastic lesion was cauterized at surgery.

Vascular Ectasia, Intestinal

Coronal CECT shows active extravasation into the jejunum from a bleeding AVM in its submucosa.

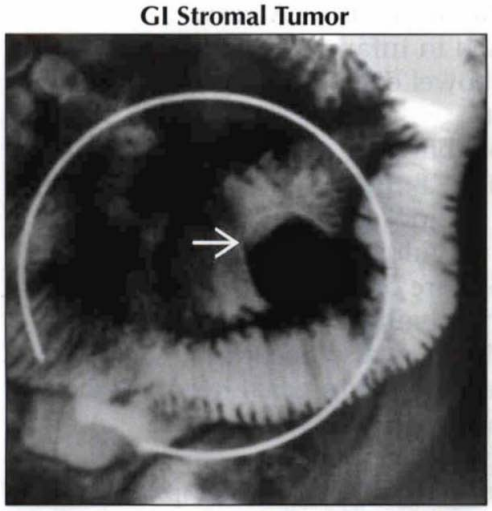
Crohn Disease

Metastases and Lymphoma, Intestinal

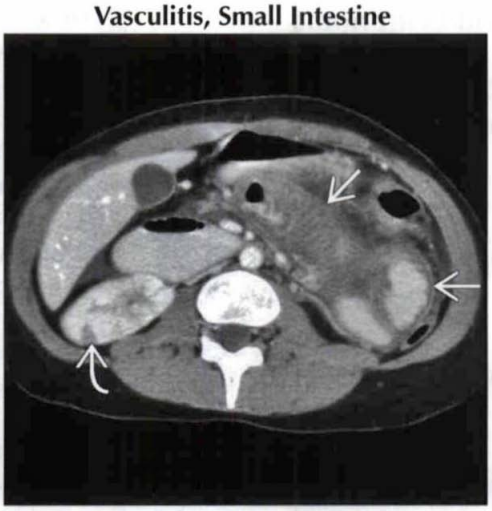


(Left) Axial CECT shows severe distortion of small bowel segments with angulation, mural thickening, luminal narrowing and mesenteric infiltration. Acute & chronic Crohn disease. (Right) Axial CECT shows an ulcerated mass in the wall of the jejunum; metastatic melanoma.

GI Stromal Tumor

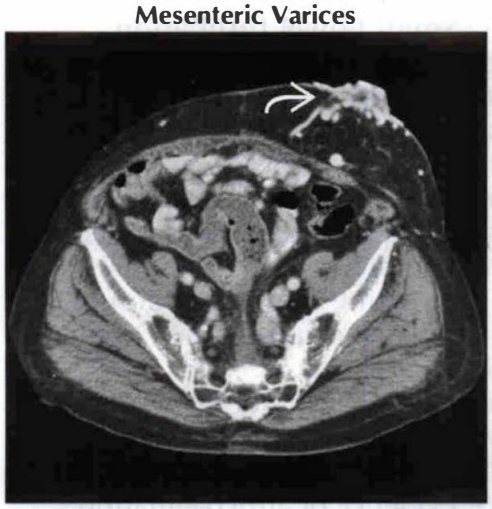


Vasculitis, Small Intestine

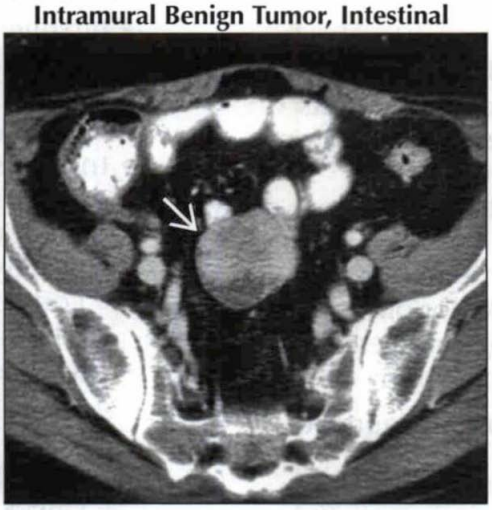


(Left) Frontal small bowel follow through shows a mass in the wall of small intestine; proven at surgery to represent a GI stromal tumor. (Right) Axial CECT shows marked mural thickening and luminal narrowing of the jejunum . Also note multifocal renal parenchymal defects ; mixed vasculitis (rheumatoid and polyarteritis features).

Mesenteric Varices



Intramural Benign Tumor, Intestinal



(Left) Axial CECT shows large varices adjacent to the ileostomy in a patient with ulcerative colitis and cirrhosis due to primary sclerosing cholangitis. Varices can also form in the mesentery of bowel after prior surgery or inflammation. (Right) Axial CECT shows a heterogeneous mass in the wall of distal small bowel. The mass caused chronic GI bleeding but not obstruction; leiomyoma.

SMALL BOWEL OBSTRUCTION

DIFFERENTIAL DIAGNOSIS

Common
- Adhesions
- External Hernias
  - Femoral Hernia
  - Inguinal Hernia
  - Obturator Hernia
  - Ventral Hernia
- Crohn Disease
- Congenital Stenosis or Atresia
- Malrotation, Bands
- Cystic Fibrosis

Less Common
- Iatrogenic; Small Bowel Intubation
  - Iatrogenic Injury: Feeding Tubes
- Intussusception
- Intestinal Trauma
- Carcinoid Tumor
- Intestinal Metastases and Lymphoma
- Internal Hernias
  - Transmesenteric Post-Operative Hernia
  - Paraduodenal Hernia
- Vasculitis
- Gallstone Ileus
- Radiation Enteritis
- Small Bowel Carcinoma
- Ischemic Enteritis

Rare but Important
- Intestinal Parasitic Disease
- Meckel Diverticulum

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Obstruction vs. ileus
  - Obstruction: Abrupt transition from dilated to nondilated bowel
    - Air-fluid levels at varying heights
    - Obstructing process usually evident (except for adhesions)
  - Ileus: No or gradual transition from dilated to nondilated bowel
    - Descending colon often collapsed in ileus; do not mistake for obstruction if there is no pathologic process in proximal descending colon

Helpful Clues for Common Diagnoses
- **Adhesions**
  - Most common cause of SBO in adults
  - Sharp transition, acute angulation of bowel
  - Often a diagnosis of exclusion
    - No obstructing mass or other cause identified
- **External Hernias**
  - Any defect in abdominal or pelvic muscles or fascial boundary (inguinal, ventral, obturator, etc.)
  - Many patients have hernias that are not the etiology of bowel obstruction
    - Key to diagnosing hernia as etiology of SB obstruction: Dilated bowel enters hernia; collapsed bowel leaves hernia
- **Crohn Disease**
  - Favors terminal ileum, may have skip lesions
  - Mesenteric fatty proliferation & cluster of small nodes
- **Congenital Stenosis or Atresia**
  - Diagnosed in infancy
  - Gasless bowel distal to stenotic or atretic segment
    - "Double bubble" on upright film
- **Malrotation, Bands**
  - Usually diagnosed in childhood
  - Midgut volvulus may occur in adults
    - SB loops are often twisted with a "whirl" sign in volvulus
    - Volvulus may also occur in transmesenteric internal hernia & closed loop obstruction
- **Cystic Fibrosis**
  - Children or adults may develop SBO due to thick secretions in SB

Helpful Clues for Less Common Diagnoses
- **Iatrogenic; Small Bowel Intubation**
  - If a balloon-tipped catheter is used for enteral feeding, it may lead to intussusception &/or obstruction
- **Intussusception**
  - Short, transient, non-obstructing, intussusception is of no clinical concern, usually idiopathic
  - Longer, obstructing intussusception in an adult is usually associated with a lead mass
- **Intestinal Trauma**
  - Blunt injury of bowel &/or hematoma in bowel wall may cause luminal narrowing and obstruction
  - Check for evidence of anticoagulation

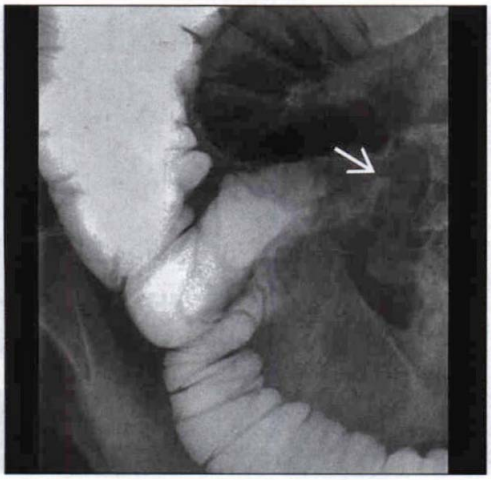
- Children more prone to duodenal & SB intramural hematomas than are adults

- **Intestinal Metastases and Lymphoma**
  - Carcinoid often starts in distal ileum; may obstruct due to tumor or mesenteric mets
  - Primary carcinoma is uncommon
  - Lymphoma & metastases are more common, especially melanoma, lung, breast cancer
  - Lymphoma less likely to cause obstruction than carcinoma (primary or metastatic)
    - Any tumor may cause intussusception & obstruction
- **Transmesenteric Post-Operative Hernia**
  - Protrusion of small bowel through an acquired defect in the mesentery
  - Usually follows surgery in which a Roux limb has been created
    - Examples: Liver transplantation; Roux-en-Y gastric bypass
  - Cluster of dilated SB loops with distorted mesenteric vessels
    - Dilated bowel lies adjacent to abdominal wall, displacing colon medially
- **Paraduodenal Hernia**
  - Protrusion of SB loops through a congenital or acquired defect in the mesentery
    - Left side more common (75%) than right (25%)
    - Look for spherical or ovoid cluster of dilated SB between the pancreatic body and the posterior gastric wall
    - Mesenteric vessels are crowded and distorted
- **Vasculitis**
  - Henoch-Schönlein purpura & others
  - Cause bowel wall hemorrhage &/or edema, luminal narrowing
  - Angioedema can produce identical findings
    - Check for C1 esterase deficiency, use of ACE inhibitors
- **Gallstone Ileus**
  - Triad of intraluminal stone, SB obstruction, biliary gas
  - Almost always in elderly women
- **Radiation Enteritis**
  - Irregular fold thickening & luminal narrowing, usually in pelvic loops
  - Ask about history of prior radiation for pelvic malignancy
- **Ischemic Enteritis**
  - Acute: Fold thickening, submucosal edema, hemorrhage, pneumatosis
  - Chronic: Stricture with tapered margins

Helpful Clues for Rare Diagnoses

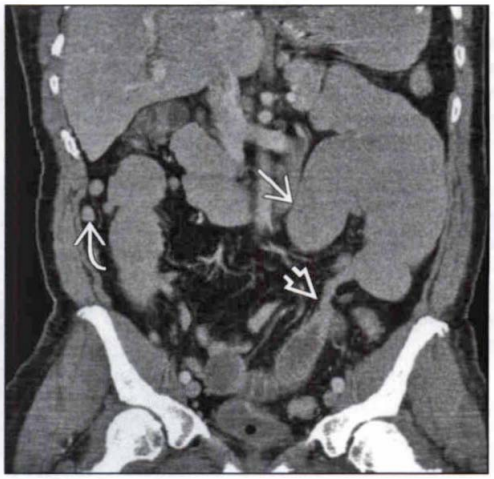
- **Intestinal Parasitic Disease**
  - Ascariasis is a common cause of SB obstruction in some developing countries
  - Mass of tangled worms may obstruct SB lumen
- **Meckel Diverticulum**
  - An "inverted" Meckel diverticulum may cause distal SB intussusception and obstruction

Adhesions



Contrast enema shows angulation & distorted SB folds directed toward the point of obstruction. There is an abrupt change in caliber of the SB. Retrograde injection of barium; prior colectomy.

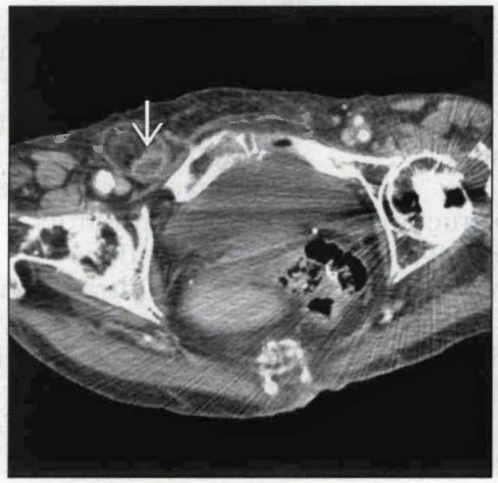
Adhesions



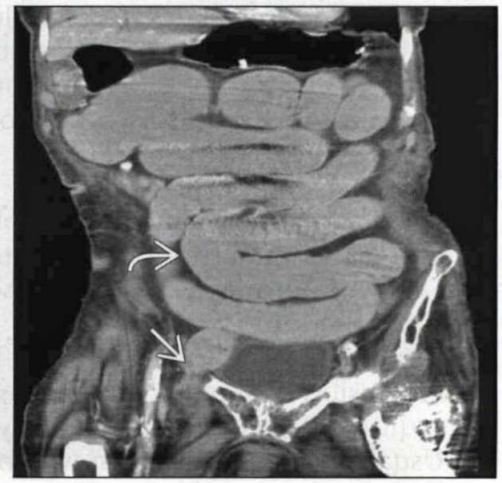
Coronal CECT shows dilated proximal SB loops and collapsed distal SB & colon. At the point of transition there is no mass, hernia, etc.

SMALL BOWEL OBSTRUCTION

Femoral Hernia



Femoral Hernia



(Left) *Axial CECT shows a "knuckle" of SB in a femoral hernia, compressing the femoral vein.* ***(Right)*** *Coronal CECT shows a knuckle of small bowel in a femoral hernia with abrupt transition to dilated SB above this point.*

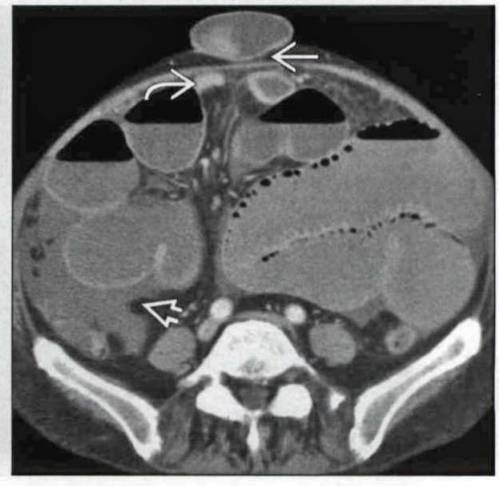
Inguinal Hernia

Obturator Hernia

(Left) *Axial CECT shows a right inguinal hernia containing SB with mild dilation of bowel upstream from the hernia. Note that the hernia contents extend anterior to the femoral vessels.* ***(Right)*** *Axial CECT shows dilated proximal and collapsed distal SB loops, with an obturator hernia as the point of obstruction (separate image).*

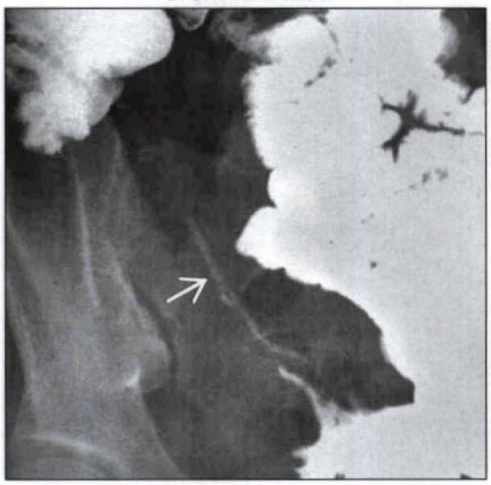
Obturator Hernia

Ventral Hernia

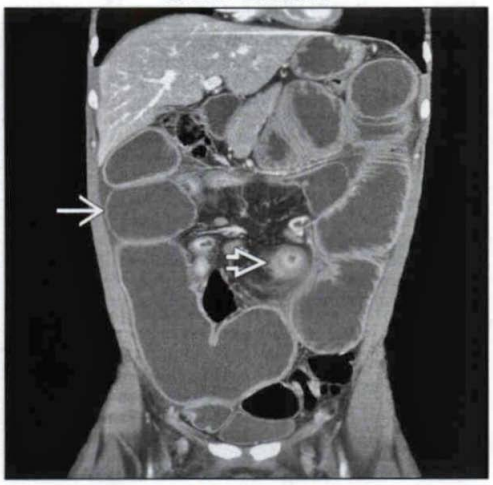


(Left) *Axial CECT shows a segment of distal SB herniated between the obturator externus and pectineus muscles.* ***(Right)*** *Axial CECT shows a ventral hernia with markedly dilated bowel leading into the hernia and collapsed bowel leaving it. Also note ascites; a segment of ischemic bowel was resected as the hernia was repaired.*

Crohn Disease

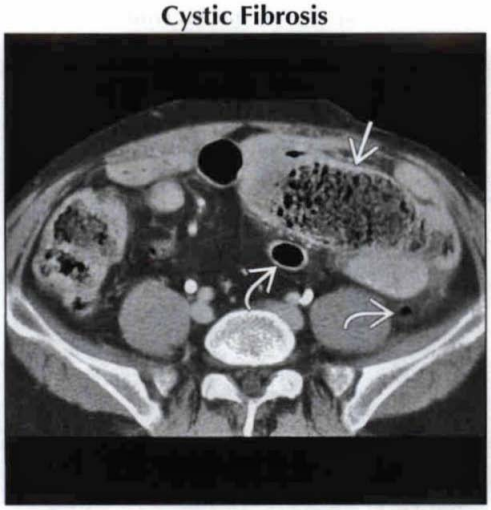


Crohn Disease

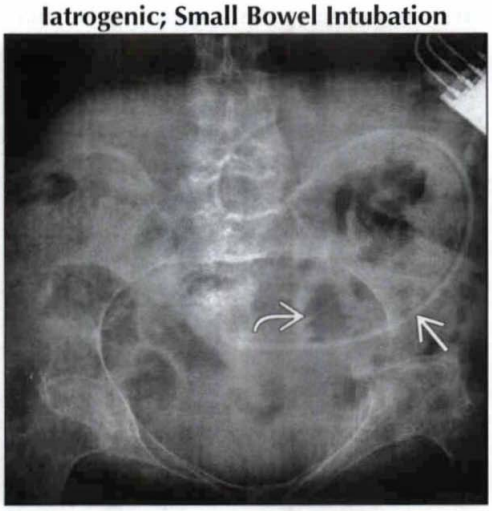


(Left) Small bowel follow through shows striking luminal narrowing of the terminal ileum, causing partial SB obstruction. (Right) Coronal CECT shows marked dilation of SB proximal to SB loops that have active and chronic Crohn disease, marked by mucosal enhancement, wall thickening, and luminal narrowing.

Cystic Fibrosis

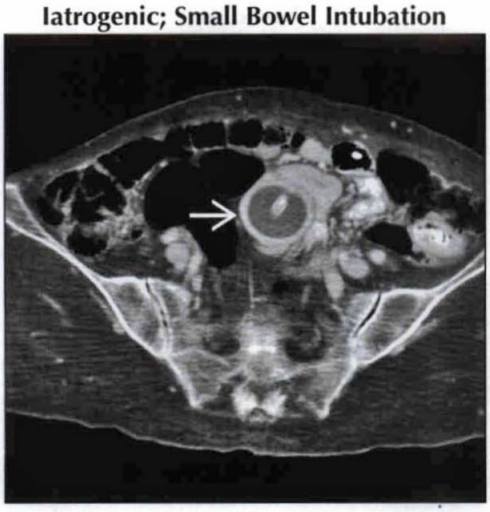


Iatrogenic; Small Bowel Intubation

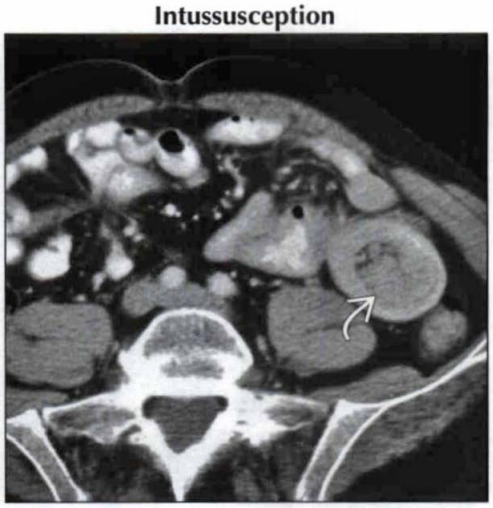


(Left) Axial CECT shows a markedly distended small bowel with the "SB feces" sign of obstruction, in an adult patient with cystic fibrosis. Note the collapsed left colon. (Right) Frontal radiograph shows a gastroenteric feeding tube and dilated small intestine in a patient whose balloon-tipped tube was inflated within the SB, causing obstruction.

Iatrogenic; Small Bowel Intubation



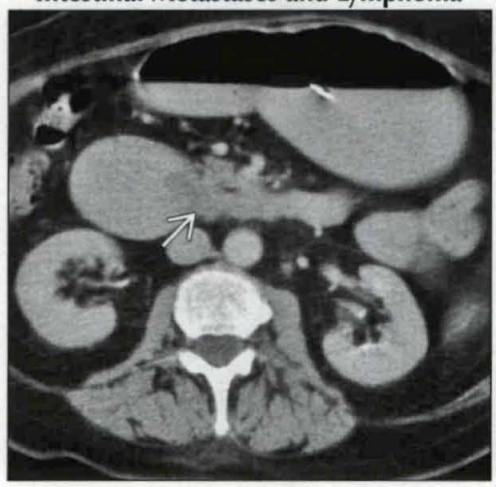
Intussusception



(Left) Axial CECT shows the balloon of the feeding tube inflated inappropriately within the SB, causing SBO. (Right) Axial CECT shows a small bowel intussusception causing a partial SBO. The lead mass was a metastatic melanoma deposit in the bowel wall.

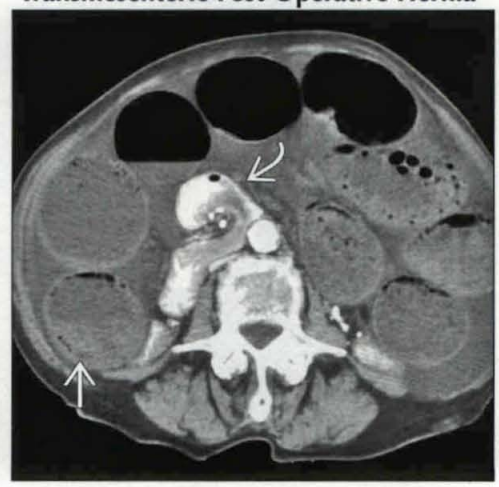
SMALL BOWEL OBSTRUCTION

Intestinal Metastases and Lymphoma

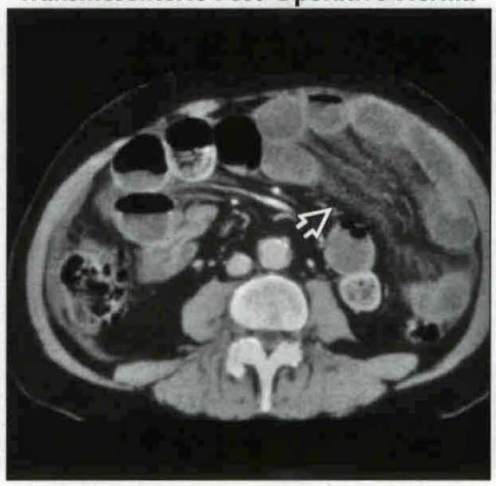


(Left) Axial CECT shows abrupt obstruction of the third portion of the duodenum by a circumferential mass: metastatic breast cancer. (Right) Axial CECT shows gross dilation of small bowel with pneumatosis. Also note "whirl sign" with twisting of mesenteric vessels & bowel. A transmesenteric hernia was found at surgery with ischemic bowel.

Transmesenteric Post-Operative Hernia

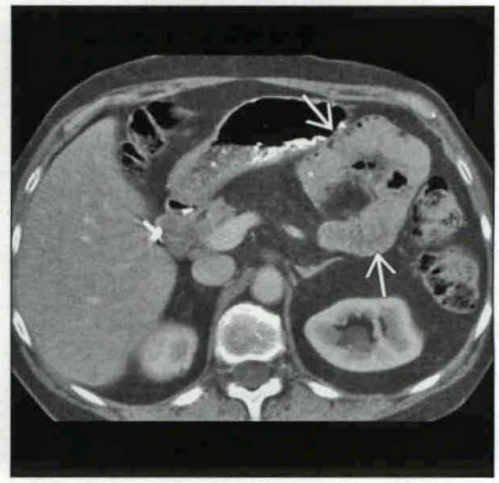


Transmesenteric Post-Operative Hernia



(Left) Axial CECT shows a cluster of dilated fluid-filled SB, displaced against the abdominal wall with stretched mesenteric vessels and edema. (Right) Axial CECT shows a cluster of dilated small bowel loops that displace the stomach ventrally. Note the sharp curvilinear outer margin of the hernia, formed by a peritoneal reflection.

Paraduodenal Hernia



Paraduodenal Hernia

(Left) Axial CECT shows a cluster of dilated bowel loops in the left upper quadrant. Note the central crowding of mesenteric vessels to these segments. (Right) Axial CECT shows luminal dilation and wall thickening of the jejunum, due to polyarteritis nodosa.

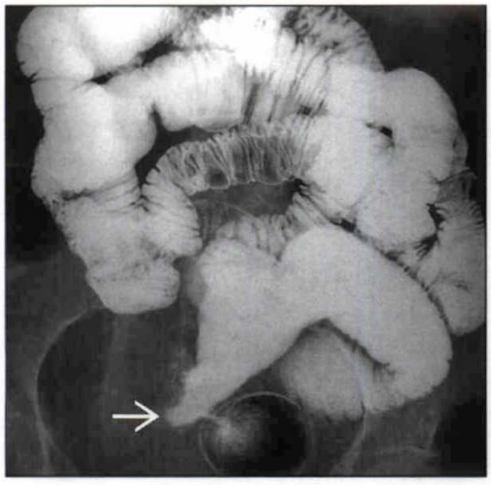
Vasculitis

Gallstone Ileus

Gallstone Ileus

(Left) Axial CECT shows gas within a thick-walled gallbladder and enhancement of the adjacent liver due to inflammation. SBO was also present in this elderly woman. (Right) Axial CECT shows a large laminated gallstone at the point of SBO in the distal small bowel. Gas was present in the gallbladder of this elderly woman.

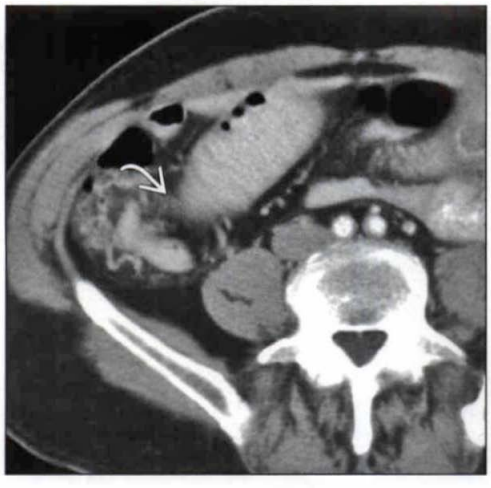
Radiation Enteritis



Small Bowel Carcinoma

(Left) Frontal small bowel follow through shows an abrupt angulation and stricture of the distal small bowel, simulating an adhesive SBO. At surgery a radiation-induced stricture was found, due to prior therapy for uterine carcinoma. (Right) Oblique upper GI shows abrupt stricture of the duodenum, due to a primary carcinoma.

Ischemic Enteritis



Meckel Diverticulum

(Left) Axial CECT shows a distal small bowel stricture with SBO, due to acute and chronic bowel ischemia, proved at surgery. (Right) Axial CECT shows a distal small bowel intussusception due to an "inverted" or intraluminal Meckel diverticulum.

SECTION 7
Colon

Generic Imaging Patterns

Solitary Colonic Filling Defect	7-2
Multiple Colonic Filling Defects	7-4
Mass or Inflammation of Ileocecal Area	7-6
Colonic Ileus or Dilation	7-12
Colonic Fistula	7-14
Segmental Colonic Narrowing	7-16
Colonic Thumbprinting	7-20
Colonic Submucosal Wall Thickening	7-22
Smooth Ahaustral Colon	7-26

Clinically Based Differentials

Acute Right Lower Quadrant Pain	7-28
Acute Left Lower Quadrant Pain	7-34

SOLITARY COLONIC FILLING DEFECT

DIFFERENTIAL DIAGNOSIS

Common
- Colonic Polyps
- Colon Carcinoma
- Rectal Carcinoma
- Villous Adenoma
- Feces

Less Common
- Inverted Appendical Stump
- Endometrioma
- Abdominal Abscess
- Metastases and Lymphoma, Colonic
- Tuberculoma
- Ameboma
- Intramural Hematoma
- Solitary Rectal Ulcer Syndrome
- Foreign Body
- Varix, Hemorrhoidal
- Diverticulitis
- Mesenchymal Tumor

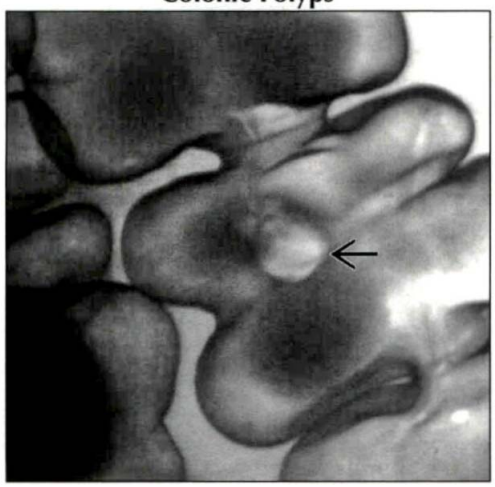
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Is this an intraluminal/mucosal lesion? Or is it an intramural or extrinsic mass?

Helpful Clues for Common Diagnoses
- **Colonic Polyps**
  - Adenomatous > hyperplastic > hamartomatous
- **Colon or Rectal Carcinoma**
  - Sessile or pedunculated polyp, or apple core lesion
- **Villous Adenoma**
  - Frond-like surface; bulky mass without causing obstruction

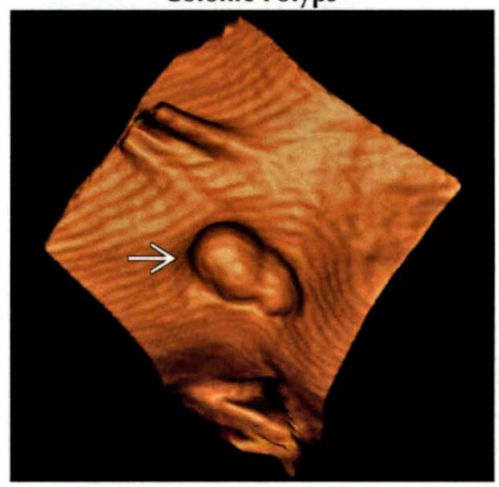
Helpful Clues for Less Common Diagnoses
- **Inverted Appendiceal Stump**
  - May appear as discrete polyp in cecal tip
- **Endometrioma**
  - Implants may cause intramural mass in sigmoid or any part of colon
- **Abdominal Abscess**
  - Perforated appendix, diverticulitis, other
  - May cause mass effect & spasm simulating colorectal cancer
- **Metastases and Lymphoma, Colonic**
  - Usually drop mets or direct invasion
  - Usually eccentric mural mass, anterior wall of rectum
- **Tuberculoma and Ameboma**
  - Either can cause apple core lesion indistinguishable from colon carcinoma
- **Intramural Hematoma**
  - From blunt or penetrating trauma
- **Foreign Body**
  - May cause intramural hematoma, perforation
  - History is key
- **Varix, Hemorrhoidal**
  - May simulate rectal carcinoma, especially if thrombosed
- **Mesenchymal Tumor**
  - Lipoma, neuroma, fibroma, etc.

Colonic Polyps



Contrast enema shows a small, fixed filling defect ⇨ in the barium pool, a typical appearance of a polyp.

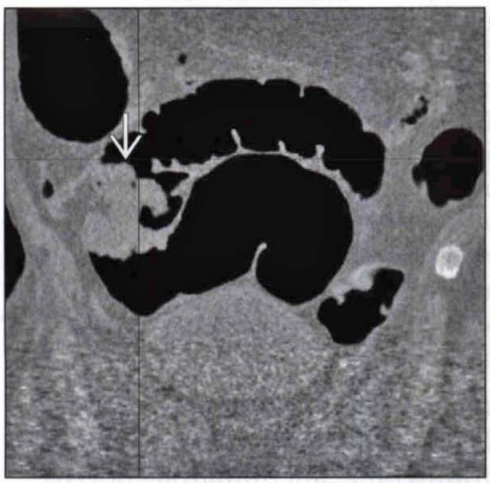
Colonic Polyps



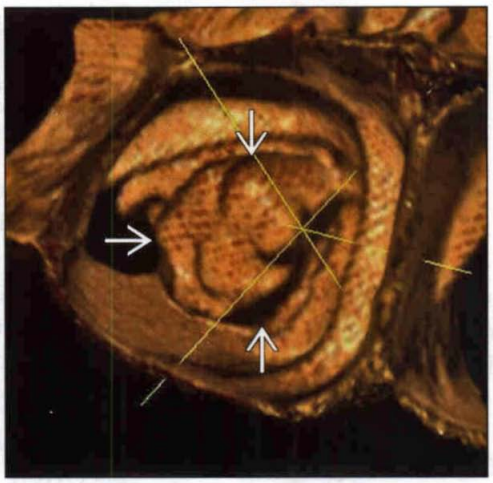
3D endoluminal view CT colonography shows a sessile, fixed raised lesion ➡ on the surface of the colon, a typical polyp.

SOLITARY COLONIC FILLING DEFECT

Colon Carcinoma

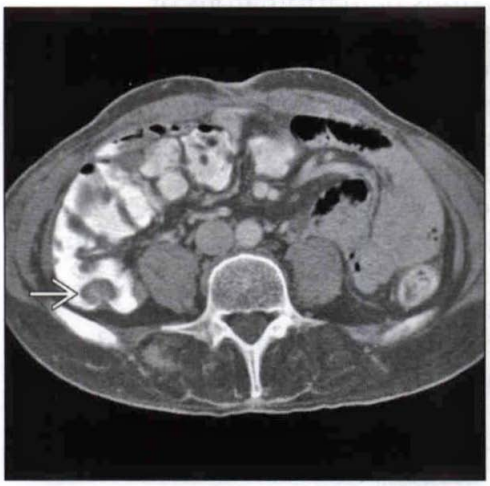


Colon Carcinoma



(Left) *Coronal CT colonography shows a large irregular mass ➡ in the sigmoid colon.* ***(Right)*** *3D endoluminal CT colonography shows a large irregular mass ➡ in the sigmoid colon, a typical appearance for carcinoma.*

Villous Adenoma



Rectal Carcinoma

(Left) *Axial CECT shows a mass ➡ in the ascending colon on a short stalk.* ***(Right)*** *Axial NECT shows a large mass ➡ arising from the right lateral wall of the rectum.*

Endometrioma

Mesenchymal Tumor

(Left) *Axial CECT shows a fixed eccentric mass ➡ that partially obstructs the lumen of the sigmoid colon. While raising concern for colon cancer, this proved to be due to endometriosis.* ***(Right)*** *Axial CECT shows a spherical fat density mass ➡ within the cecum, a typical lipoma.*

MULTIPLE COLONIC FILLING DEFECTS

DIFFERENTIAL DIAGNOSIS

Common
- Feces
- Air Bubbles
- Colonic Polyps
- Colon Carcinoma
- Ulcerative Colitis

Less Common
- Familial Polyposis
- Gardner Syndrome
- Metastases and Lymphoma, Colonic
- Pseudomembranous Colitis, Diverticulitis
- Lymphoid Follicles (Mimic)
- Hemorrhoids
- Diverticulosis (Mimic)
- Mesenchymal Tumor, Colon
- Pneumatosis (Mimic)
- Endometriosis
- Colonic Varices
- Urticaria, Colon
- Colonic Parasites

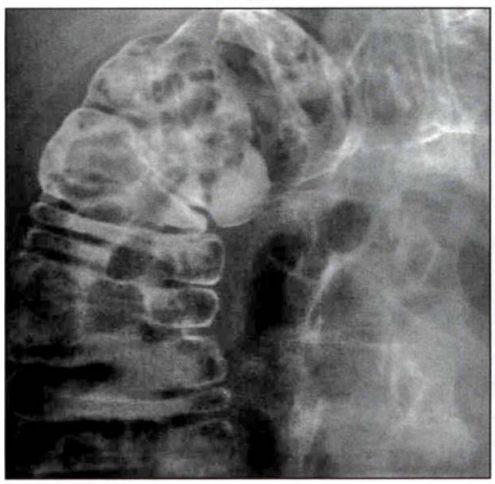
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Are defects movable (gas or feces)?

Helpful Clues for Common Diagnoses
- **Feces**
  - Usually more irregular in shape and size
  - Usually well-coated by barium
- **Air Bubbles**
  - On barium enema
  - Key is change in shape, size location with positioning
- **Colonic Polyps**
  - Small polyps of uniform size in younger patients are often hyperplastic
  - May be sessile or on a stalk (pedunculated)
- **Colon Carcinoma**
  - Rarely multifocal, but commonly with other colonic polyps
- **Ulcerative Colitis**
  - Along with granulomatous colitis (Crohn) may result in inflammatory polyps
  - May grow into a filiform, pedunculated appearance

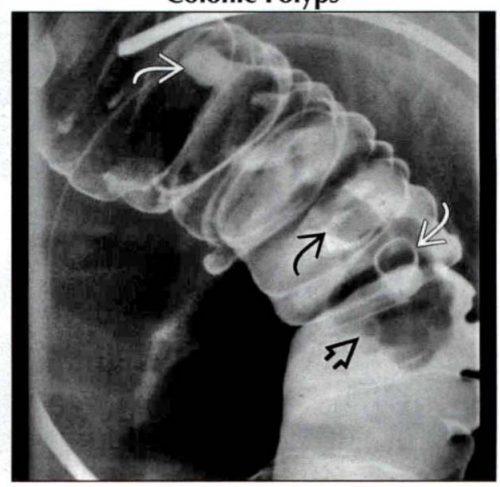
Helpful Clues for Less Common Diagnoses
- **Familial Polyposis and Gardner Syndrome**
  - Often innumerable adenomatous polyps, may carpet colon
  - Other syndromes may result in multiple adenomatous hamartomatous or hyperplastic polyps
- **Pseudomembranous Colitis, Diverticulitis**
  - Any infectious or inflammatory colitis may result in thickened folds that might be mistaken for polypoid lesions
- **Lymphoid Follicles (Mimic)**
  - Small (2-4 mm), submucosal, numerous; more in right colon
- **Diverticulosis (Mimic)**
  - On air-contrast enema, barium-lined diverticulum may simulate barium-coated polyp

Feces



Contrast enema shows innumerable filling defects of varying size in the ascending colon; typical appearance of stool in an unprepped colon.

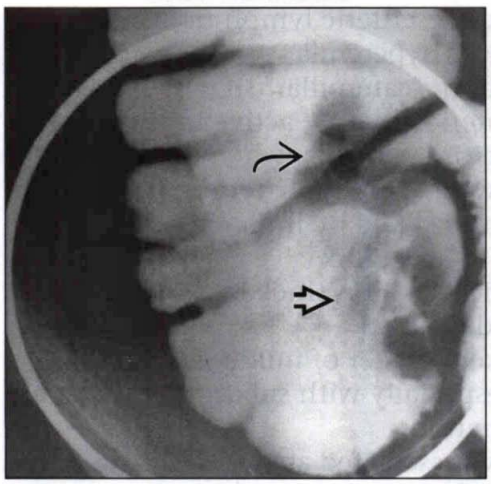
Colonic Polyps



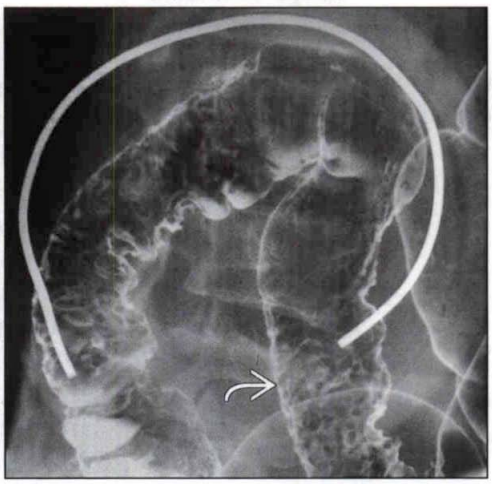
Contrast enema shows a pedunculated polyp on a long stalk. Also note diverticula, some filled with barium & some with air that might be mistaken for polyps.

MULTIPLE COLONIC FILLING DEFECTS

Colon Carcinoma

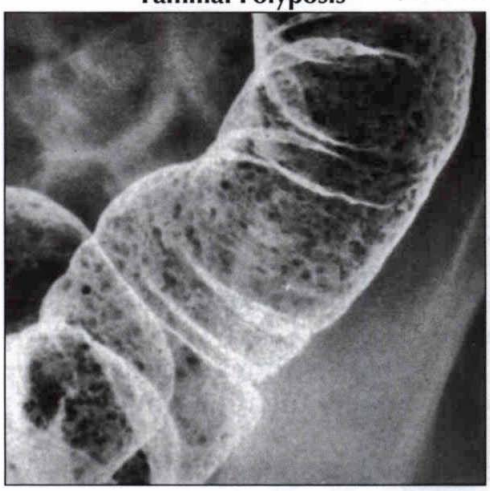


Ulcerative Colitis

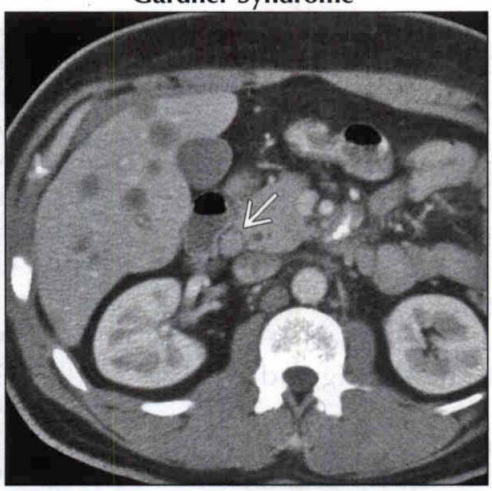


(Left) *Frontal contrast enema shows 2 polypoid lesions in the cecum. The lesion at the ileocecal valve is a lipoma, and the one with the irregular surface is a carcinoma.* ***(Right)*** *Oblique contrast enema shows multiple filiform polyps within the colon, in a patient with chronic but quiescent ulcerative colitis.*

Familial Polyposis

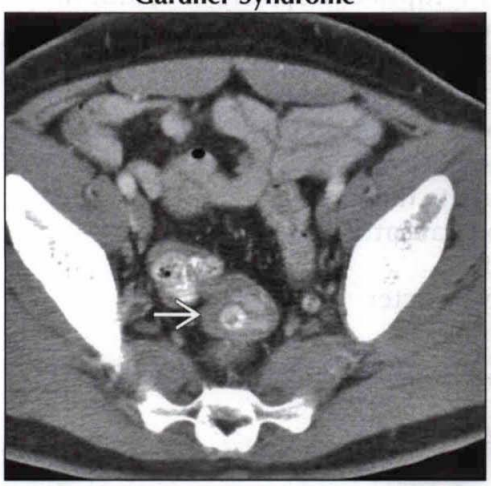


Gardner Syndrome

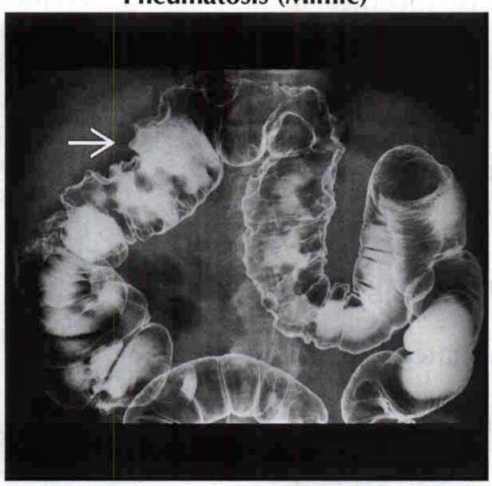


(Left) *Anteroposterior contrast enema shows thousands of small polyps that carpet the surface of the colon.* ***(Right)*** *Axial CECT shows multiple liver metastases and an ampullary carcinoma in a patient with colonic polyps & carcinoma, all due to Gardner syndrome.*

Gardner Syndrome



Pneumatosis (Mimic)



(Left) *Axial CECT shows a sigmoid carcinoma in a patient who also had an ampullary carcinoma and liver metastases. Initial presentation in a 25 year-old woman with no prior knowledge of her condition.* ***(Right)*** *Frontal contrast enema shows what appear to be numerous polyps throughout the colon. These are due to intramural blebs of gas due to idiopathic pneumatosis in this asymptomatic patient.*

MASS OR INFLAMMATION OF ILEOCECAL AREA

DIFFERENTIAL DIAGNOSIS

Common

- Crohn Disease
- Appendicitis
- Prominent Ileocecal Valve
  - Lipomatous Infiltration of IC Valve
  - Lipoma of IC Valve
- Colon Carcinoma
- Mesenteric Adenitis
- Infectious Ileocolitis

Less Common

- Carcinoid Tumor
- Cecal Diverticulitis
- Metastases and Lymphoma, Intestinal
- Appendiceal Carcinoma
- Intussusception
- Mucocele of the Appendix
- Typhlitis (Neutropenic Colitis)
- Tuberculosis, Colon
- Cecal Volvulus
- Endometriosis
- Ischemic Colitis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- CT: Optimal for evaluation of intra- and extramural disease in RLQ
  - Try to characterize the distribution of disease, nature of wall thickening and associated findings
  - Fat density mural thickening
    - Normal variant or chronic inflammation
  - Water density
    - Acute inflammation or ischemia
  - Soft tissue density: Least specific
    - Infection
    - Ischemia
    - Inflammation
    - Tumor
- Barium studies: Optimal for mucosal detail (e.g., early inflammatory changes of Crohn disease)

Helpful Clues for Common Diagnoses

- **Crohn Disease**
  - Most common inflammatory process of terminal ileum & cecum
  - Homogeneous attenuation of thickened bowel wall on CECT
  - Mural stratification lost: Indistinct mucosa, submucosa, muscularis propria
  - Mesenteric fibrofatty proliferation
  - Enlarged mesenteric lymph nodes
  - Mesenteric hyperemia
    - "Comb" or "caterpillar" sign of engorged mesenteric vessels = active inflammation
- **Appendicitis**
  - Medial wall of cecum & terminal ileum may be thickened by inflammation starting in appendix
  - Appendiceal wall is thickened & lumen usually distended
  - Often have cluster of mildly enlarged nodes, especially with subacute inflammation
  - May have associated abscess following perforation of appendix
- **Prominent Ileocecal Valve**
  - Often a normal variant
  - Submucosal fat is usually evident on CT within the "lips" of the valve
  - Lipoma is a benign neoplasm common in this area
    - Spherical mass of fat
    - Usually seen as an eccentric mass near ileocecal valve
- **Colon Carcinoma**
  - Cecum accounts for 25% of colon adenocarcinoma
  - Usually bulky mass without obstruction
    - Surface irregularity identifies mucosal origin
  - May occlude base of appendix
    - May simulate appendicitis clinically and on imaging (dilated lumen of appendix)
  - Adjacent lymphadenopathy is common
- **Mesenteric Adenitis**
  - Idiopathic, self-limited inflammation with cluster of enlarged nodes in RLQ
  - Common in children & adolescents
- **Infectious Ileocolitis**
  - Causes acute diarrhea
  - Common causative agents
    - Yersinia
    - Campylobacter
    - Salmonella
  - Mural thickening of cecum & terminal ileum
  - RLQ adenopathy

- Imaging findings indistinguishable from mesenteric adenitis (may be same disease)

Helpful Clues for Less Common Diagnoses

- **Carcinoid Tumor**
  - Thickening of distal ileal wall & mesenteric mass
    - Mesenteric mass often has focus of calcification
    - Desmoplastic response in mesentery
    - Small bowel loops and mesenteric vessels may have stellate configuration and distorted course
- **Cecal Diverticulitis**
  - Can usually identify other diverticula & normal appendix
  - Cecal wall thickened with adjacent inflammatory changes
- **Metastases and Lymphoma, Intestinal**
  - Lymphoma may cause dramatic bowel wall thickening
  - May have significant adenopathy or involvement of other organs
- **Intussusception**
  - Due to tumor or inflammation of ileum or ileocecal valve
  - May identify mass within lumen
  - Intraluminal crescent of intussuscepted ileal mesenteric fat
  - Ileocecal intussusceptions in adults are usually obstructive and due to a lead mass (neoplastic, benign or malignant)
- **Mucocele of the Appendix**
  - Round or oval, thin-walled, cystic mass near tip of cecum
  - May have curvilinear calcifications in wall
- **Typhlitis (Neutropenic Colitis)**
  - Massive mural thickening of cecal ± ascending colon wall
  - Presents as fever, RLQ tenderness in immunosuppressed patient
- **Tuberculosis, Colon**
  - GI infection generally follows pulmonary infection
    - Obtain chest X-ray in suspected cases
  - Symptoms more chronic than in other causes of infectious colitis
  - Involvement varies from mild thickening to "apple core" lesion
  - Mesenteric adenopathy common

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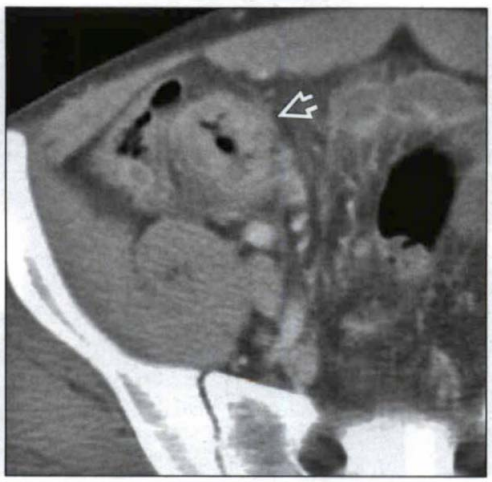
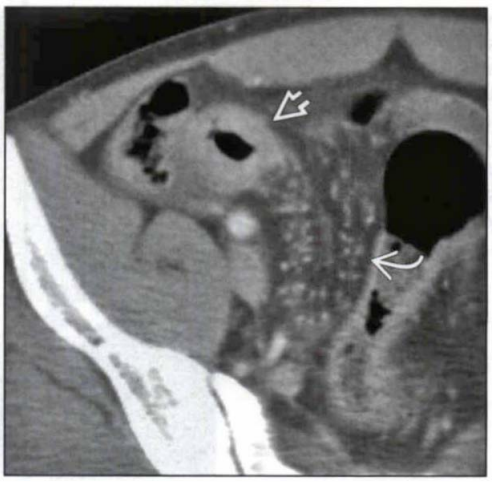
4. Hoeffel C et al: Multi-detector row CT: spectrum of diseases involving the ileocecal area. Radiographics. 26(5):1373-90, 2006
5. Harris A et al: Appendicitis imaging. Radiol Technol. 77(2):111-7; quiz 118-20, 2005
6. Pinto Leite N et al: CT evaluation of appendicitis and its complications: imaging techniques and key diagnostic findings. AJR Am J Roentgenol. 185(2):406-17, 2005

Crohn Disease



Axial CECT shows classic findings in a 19 year old boy, with mural thickening of terminal ileum ➪ and mesenteric hyperemia.

Crohn Disease



Axial CECT shows classic findings in a 19 year old boy, with mural thickening ➪ and mesenteric hyperemia ➪.

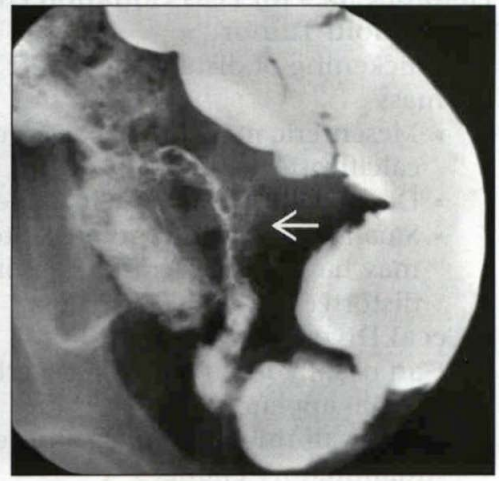
7

MASS OR INFLAMMATION OF ILEOCECAL AREA

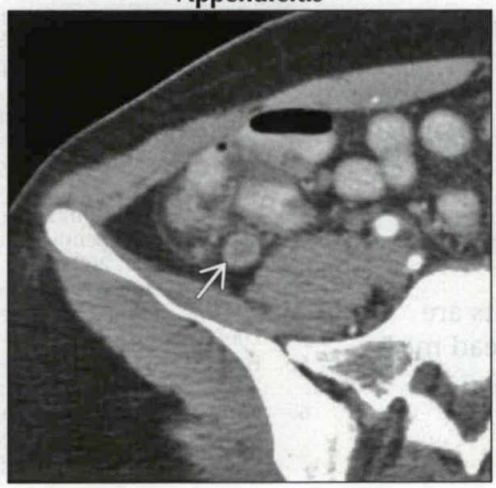
Crohn Disease

*(**Left**) Axial CECT shows classic findings in a 19 year old boy with a long segment of terminal ileum wall thickening. (**Right**) Small bowel follow through shows classic findings in a 19 year old boy with luminal narrowing and wall thickening of the terminal ileum and cecum, cobblestone mucosal ulcerations, and sinus tracks into the thickened mesenteric fat.*

Crohn Disease

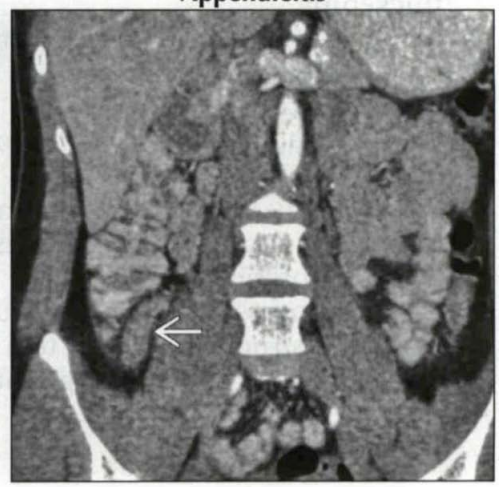


Appendicitis

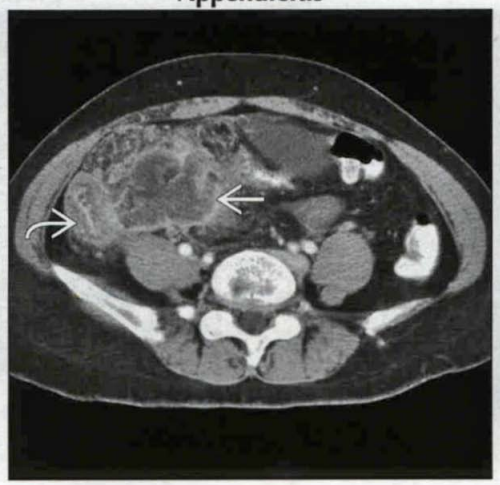


*(**Left**) Axial CECT shows a dilated lumen and thickened wall of the retrocecal appendix with infiltration of the mesenteric fat. (**Right**) Coronal CECT shows the thick-walled retrocecal appendix ascending medial to the colon.*

Appendicitis



Appendicitis



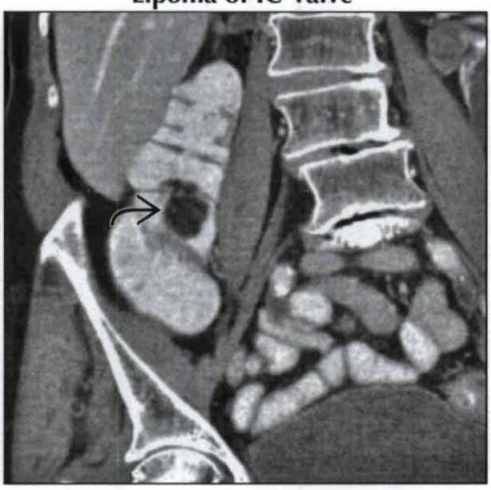
*(**Left**) Axial CECT shows an abscess medial to a thick-walled cecum, both the result of appendiceal perforation. (**Right**) Axial CECT shows lipomatous infiltration of both lips of the ileocecal valve as the terminal ileum enters the colon.*

Lipomatous Infiltration of IC Valve

MASS OR INFLAMMATION OF ILEOCECAL AREA

Lipoma of IC Valve

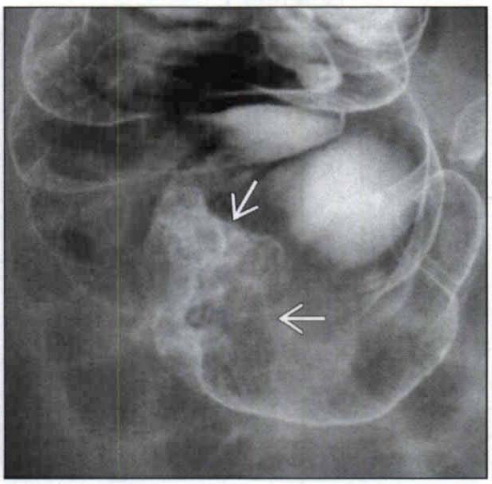
Lipoma of IC Valve



(Left) Axial CECT shows a spherical fat density mass in the ascending colon; lipoma. (Right) Coronal CECT shows a spherical fat density mass in the ascending colon; lipoma.

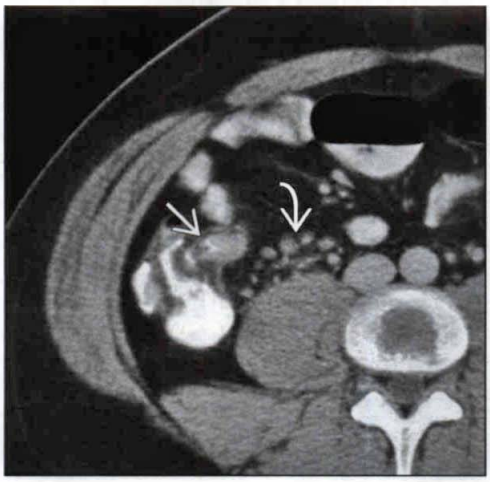
Colon Carcinoma

Colon Carcinoma

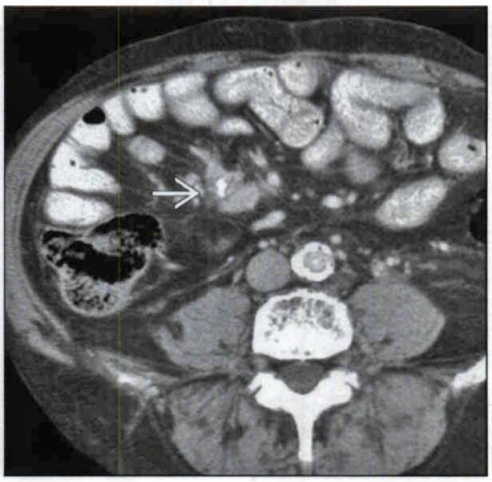


(Left) Axial CECT shows circumferential thickening of the wall of the cecum. A dilated appendix was seen, along with local lymphadenopathy and omental metastases. This patient presented with signs and symptoms of appendicis. (Right) Contrast enema shows a polypoid mass in the cecum that has an irregular surface, characteristic of carcinoma.

Mesenteric Adenitis



Carcinoid Tumor

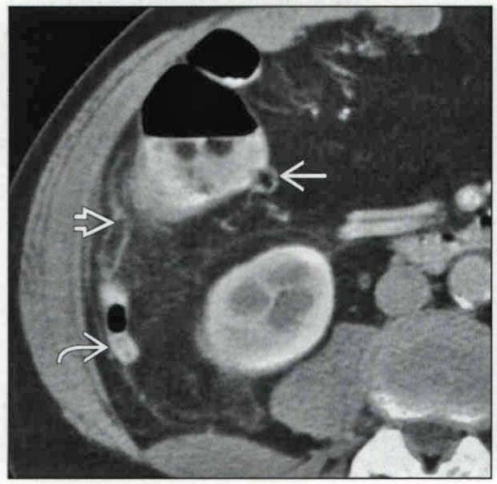


(Left) Axial CECT shows mild thickening of the wall of the terminal ileum and a cluster of slightly enlarged nodes. The appendix was normal. (Right) Axial CECT shows a partially calcified mesenteric mass and a tethered appearance of distal small bowel segments, with mesenteric stranding pointing toward the metastasis.

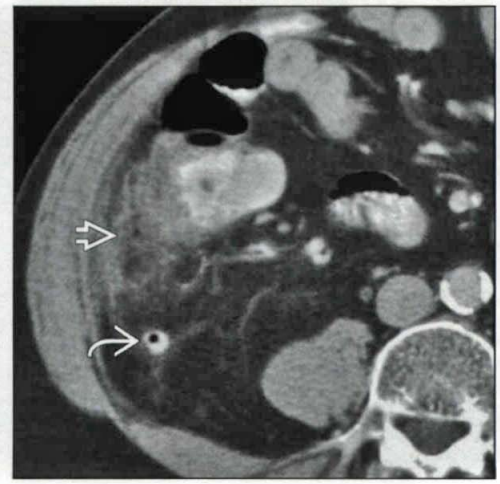
MASS OR INFLAMMATION OF ILEOCECAL AREA

(Left) Axial CECT shows a normal appendix and a cecal diverticulum, with pericolonic inflammatory changes. (Right) Axial CECT shows a normal appendix and extensive pericecal inflammatory infiltrates.

Cecal Diverticulitis

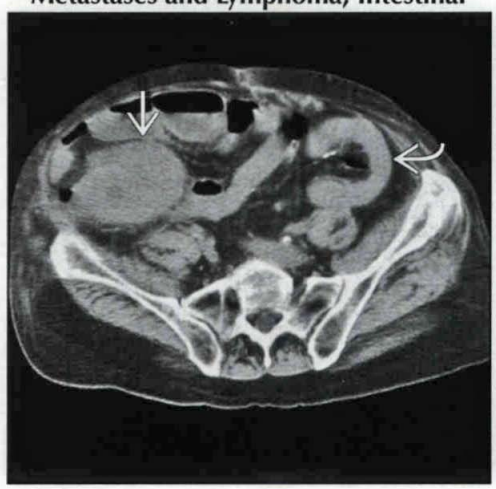


Cecal Diverticulitis

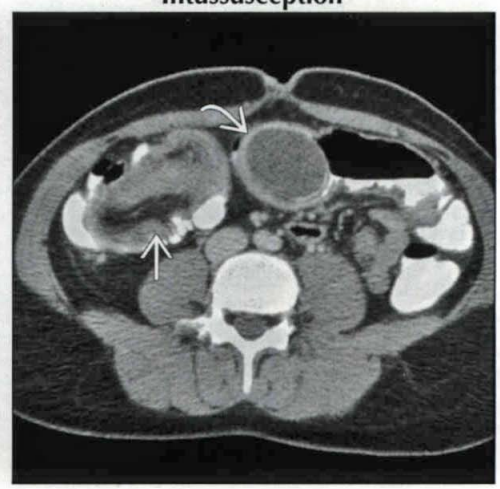


(Left) Axial NECT shows a soft tissue mass in the ileocecal region; lymphoma (PTLD) of the appendix in a renal transplant recipient. (Right) Axial CECT shows an ileocolic intussusception and the lead mass, an appendiceal mucocele (in the transverse colon).

Metastases and Lymphoma, Intestinal

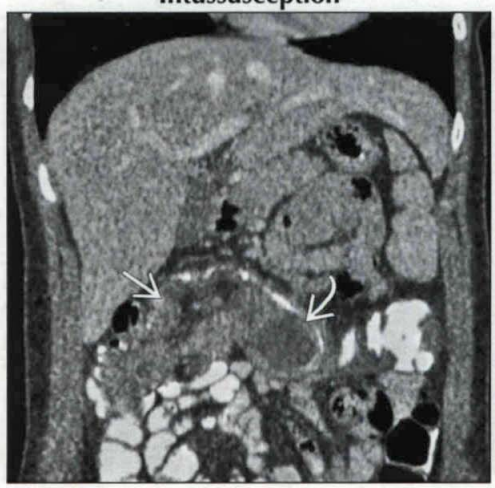


Intussusception

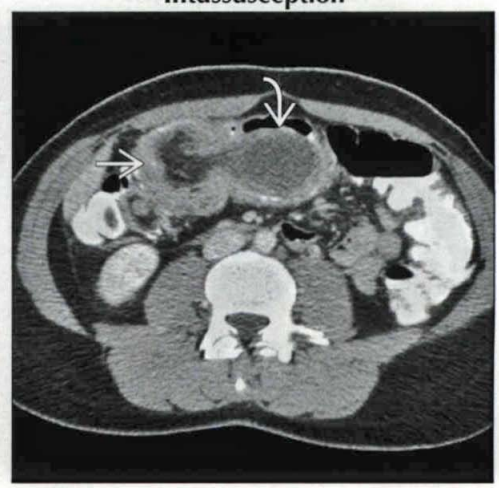


(Left) Coronal CECT shows an ileocolic intussusception with a mucocele as the lead mass. (Right) Axial CECT shows an ileocolic intussusception with the lead mass in the transverse colon, a mucocele.

Intussusception

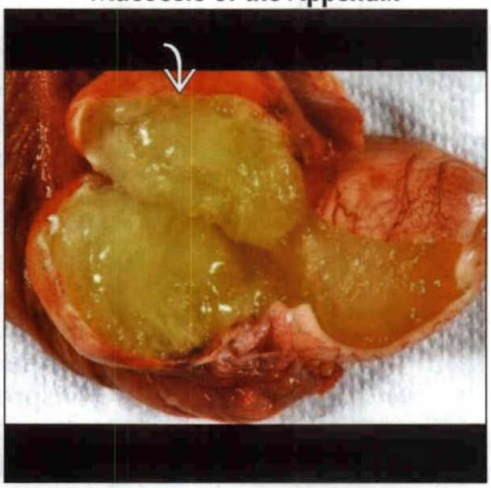


Intussusception



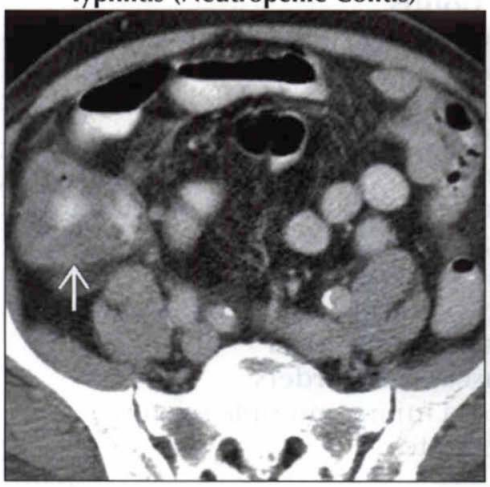
Mucocele of the Appendix

Mucocele of the Appendix

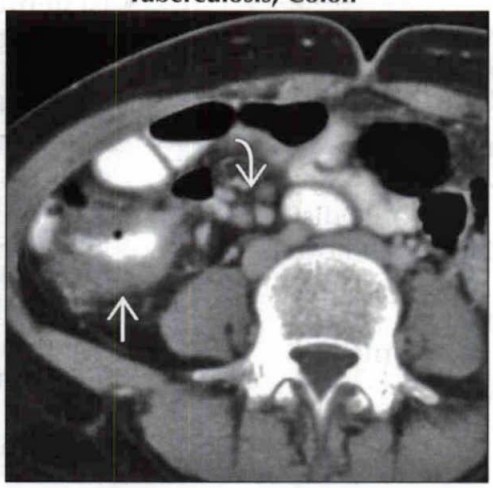


(Left) Gross pathology shows an intussuscepting mass (a mucocele) within the colon, causing obstruction of the small intestine. (Right) Gross pathology shows a bivalved mucin-filled mucocele, that was the lead mass causing intussusception.

Typhlitis (Neutropenic Colitis)

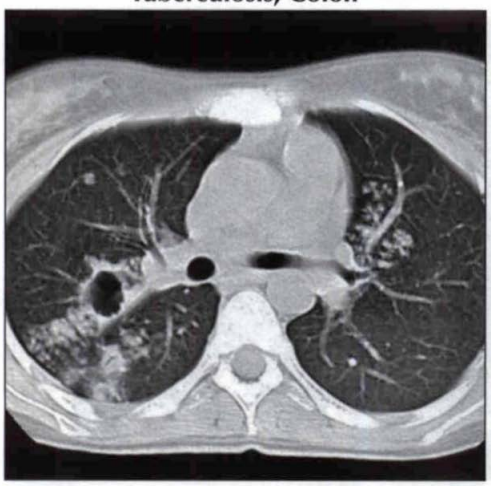


Tuberculosis, Colon

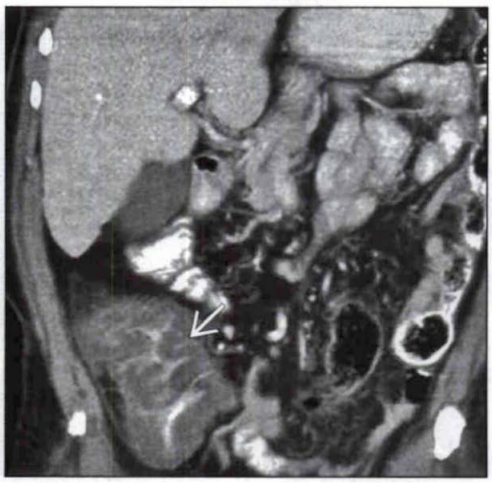


(Left) Axial CECT shows a thick-walled cecum and ascending colon. (Right) Axial CECT shows a thick-walled cecum and terminal ileum, with mesenteric lymphadenopathy; young female immigrant from India with tuberculosis (enteric and pulmonary).

Tuberculosis, Colon



Ischemic Colitis



(Left) Axial CECT shows active cavitary pulmonary tuberculosis in a young woman with ileocecal TB. (Right) Coronal CECT shows marked mural thickening ("thumbprinting") of the cecum and ascending colon. Note the compressed lumen, submucosal edema and intense mucosal enhancement. These findings indicate ischemia or inflammation.

COLONIC ILEUS OR DILATION

DIFFERENTIAL DIAGNOSIS

Common
- Ileus
- Colon Carcinoma
- Rectal Carcinoma
- Sigmoid Volvulus
- Cecal Volvulus
- Diverticulitis
- Ogilvie Syndrome
- Fecal Impaction

Less Common
- Ischemic Colitis
- Toxic Megacolon
- Endocrine Disorders
- Distended Urinary Bladder
- Neuromuscular Disorders

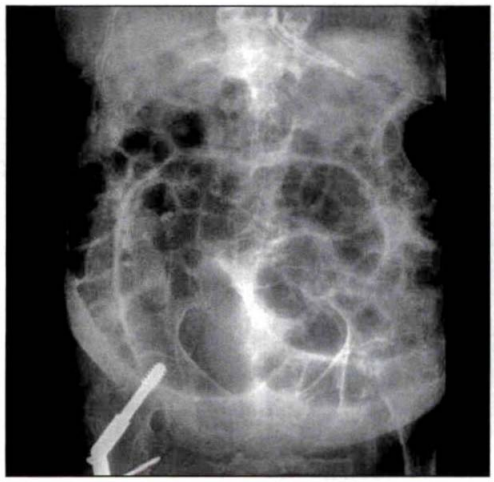
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Use prone or decubitus film to visualize gas through rectum & exclude distal obstruction

Helpful Clues for Common Diagnoses
- **Ileus**
  - Most common cause of colonic distention
  - Usually accompanied by small bowel dilation
- **Colo-Rectal Carcinoma**
  - Most common cause of colonic obstruction in adults
- **Sigmoid Volvulus**
  - Very elongated, dilated sigmoid, folded back on itself ("coffee bean", "football" shape)
  - Entire colon (except rectum) is dilated, but less than sigmoid
- **Cecal Volvulus**
  - Ascending colon twists on mesentery; becomes obstructed, dilated, displaced toward left upper quadrant
- **Diverticulitis**
  - Inflammation narrows lumen
  - Long segment involvement with pericolonic infiltration
- **Ogilvie Syndrome**
  - Disproportionate dilation of cecum and ascending colon without obstruction
- **Fecal Impaction**
  - Common in elderly

Helpful Clues for Less Common Diagnoses
- **Ischemic Colitis**
  - May result in stricture (chronically) or spasm & ileus (acutely)
- **Toxic Megacolon**
  - Mucosal ulceration, often transmural necrosis
  - Look for loss of haustral pattern, sloughed mucosa, signs of perforation
- **Endocrine Disorders**
  - Hypothyroidism, diabetes, other endocrine and metabolic disorders
- **Neuromuscular Disorders**
  - Spinal cord injury, multiple sclerosis, Parkinson, etc.

Ileus



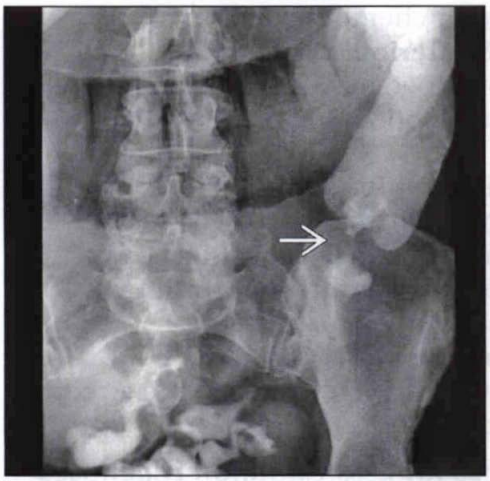
Frontal radiograph shows diffuse dilation of large & small bowel without transition, in an elderly woman recently post-operative for hip fracture stabilization.

Colon Carcinoma

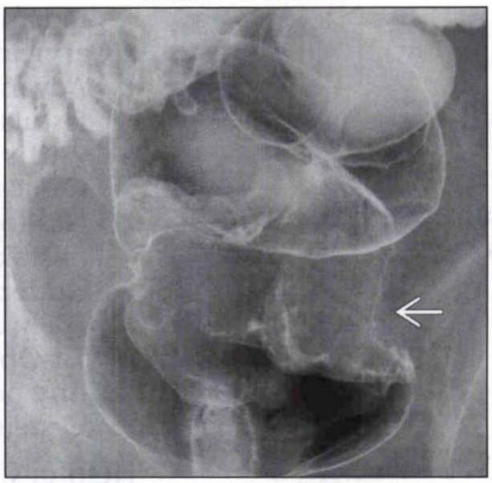
Coronal CECT shows a classic apple core lesion ➡ causing obstruction of the descending colon.

COLONIC ILEUS OR DILATION

Colon Carcinoma

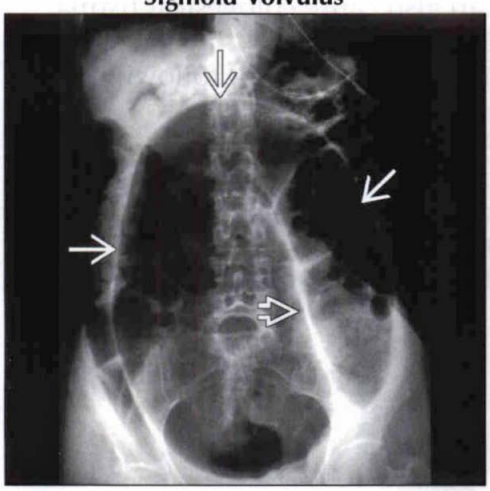


Rectal Carcinoma

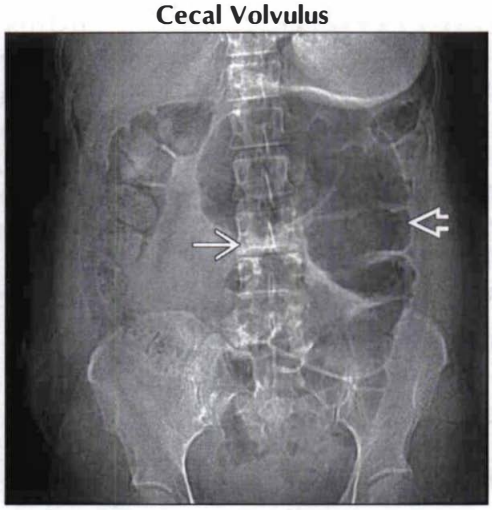


(Left) *Frontal contrast enema shows a classic apple core lesion ➡ of the descending colon causing high grade obstruction.* ***(Right)*** *Anteroposterior contrast enema shows a large mass ➡ arising from the left lateral wall of the rectum.*

Sigmoid Volvulus



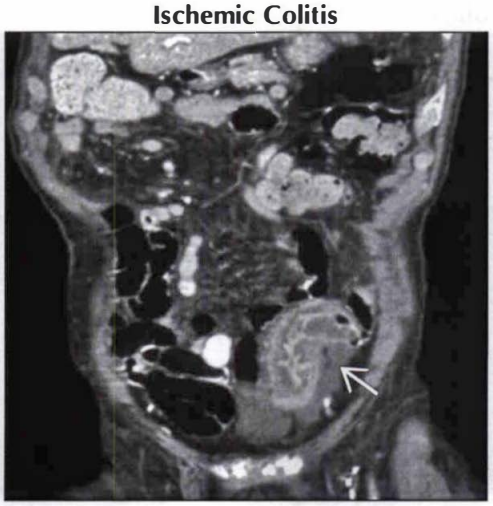
Cecal Volvulus



(Left) *Frontal radiograph shows classic appearance of sigmoid volvulus as an inverted U or coffee bean shape. The apposed walls ➪ of the twisted, dilated sigmoid colon ➡ form the seam in the bean shape and account for the thicker line.* ***(Right)*** *Frontal radiograph shows marked dilation of the cecum and a portion of the ascending colon ➪, which is inverted and points to the left upper quadrant. The ileocecal valve ➡ helps to identify the cecum.*

Ogilvie Syndrome

Ischemic Colitis



(Left) *Axial NECT shows dilation of the cecum and ascending colon ➡, out of proportion to remaining colon or small bowel. No obstruction was present.* ***(Right)*** *Coronal CECT shows marked mural thickening and luminal narrowing of the sigmoid colon ➡ due to ischemic colitis, which resulted in functional bowel obstruction.*

COLONIC FISTULA

DIFFERENTIAL DIAGNOSIS

Common
- Diverticulitis
- Colon Carcinoma
- Cervical Carcinoma
- Endometrial Carcinoma
- Ovarian Cancer
- Cystitis
- Bladder Instrumentation (Mimic)
- Post-Operative State, Bowel

Less Common
- Crohn Disease
- Bladder Carcinoma
- Abscess, Abdominal
- Infectious Colitis
- Foreign Body
- Trauma, Colorectal

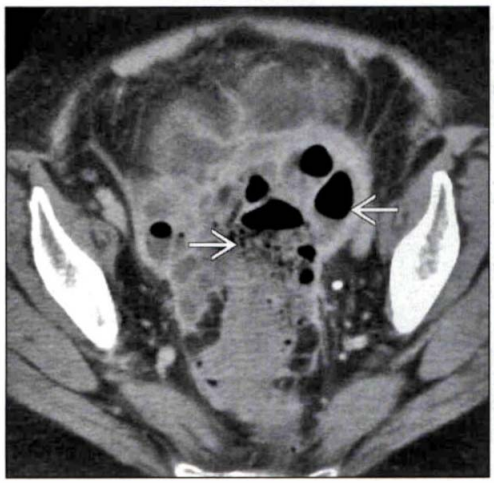
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Gas in urinary bladder may be due to colovesical fistula, gas-forming infection within the bladder or instrumentation that introduces gas into the bladder
- Check for extensive coliform bacterial infection, pneumaturia

Helpful Clues for Common Diagnoses
- **Diverticulitis**
  - Most common etiology in industrialized nations
  - Fistula to skin, bladder, vagina, etc.
- **Colon Carcinoma**
  - Usually from sigmoid or rectum
  - May be spontaneous or follow surgery, radiation or chemotherapy
- **Cervical & Uterine Carcinoma**
  - Advanced stage may invade bladder
  - Fistula may follow surgery or therapy
- **Cystitis**
  - Can cause or mimic fistula
  - Gas-forming infection in urine may be mistaken for colovesical fistula
- **Bladder Instrumentation (Mimic)**
  - Foley catheter, cystoscopy, etc.
- **Post-Operative State, Bowel**
  - Any pelvic surgery or resection (e.g., rectal, hysterectomy, cesarean section)

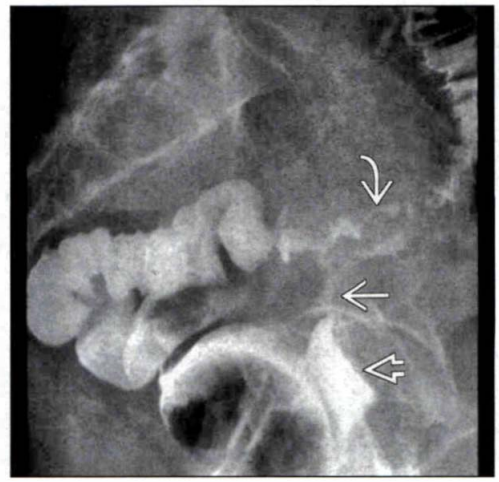
Helpful Clues for Less Common Diagnoses
- **Crohn Disease**
  - Most common cause of enterovesical fistula; can also cause colovesical fistula
- **Bladder Carcinoma**
  - Fistula from tumor itself or following therapy
- **Abscess, Abdominal**
  - Abdominal or pelvic abscess may erode into into bladder & colon
- **Foreign Body**
  - In bladder, vagina, or rectum can lead to fistula

Diverticulitis



Axial CECT shows sigmoid diverticula and extensive inflammatory changes, with multiple pelvic abscesses. A colovaginal fistula subsequently developed.

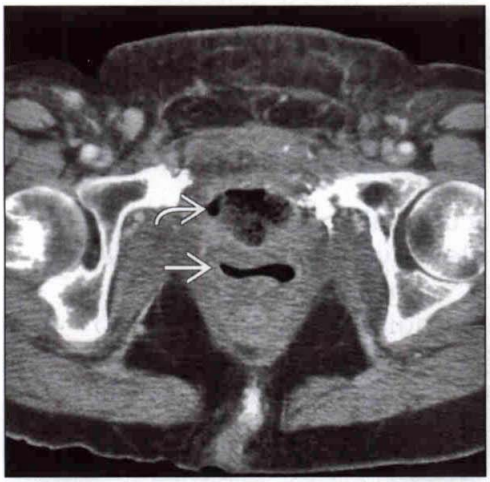
Diverticulitis



Lateral contrast enema shows extensive colonic disease from diverticulitis and a fistulous track to the vagina.

COLONIC FISTULA

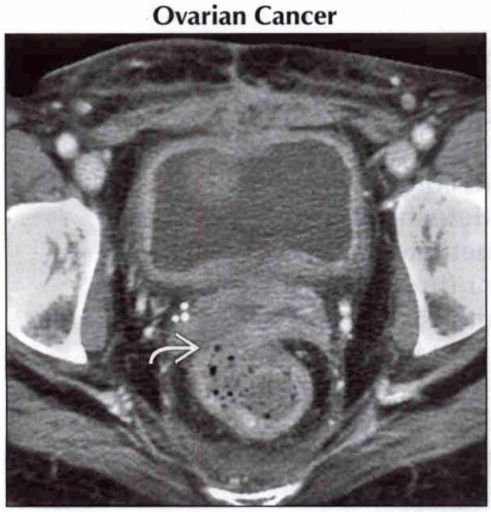
Cervical Carcinoma



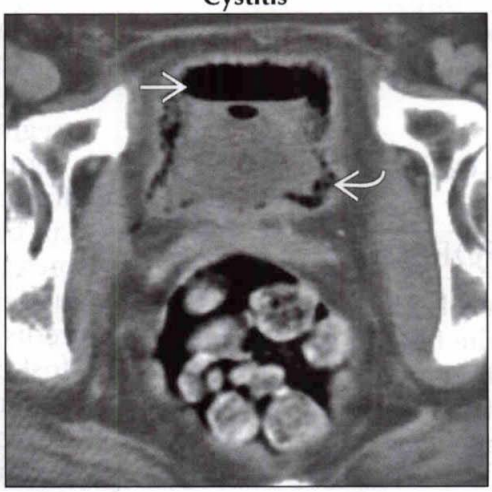
Cervical Carcinoma

*(**Left**) Axial CECT shows gas in the vagina ➡ and bladder ➡ due to rectovaginal and -vesical fistulas due to cervical carcinoma, status post resection and radiation therapy. (**Right**) Axial CECT shows a large recurrent malignant and inflammatory pelvic mass ➡ following resection and radiation therapy for cervical carcinoma, in a woman with rectovaginal and rectovesical fistulas.*

Ovarian Cancer

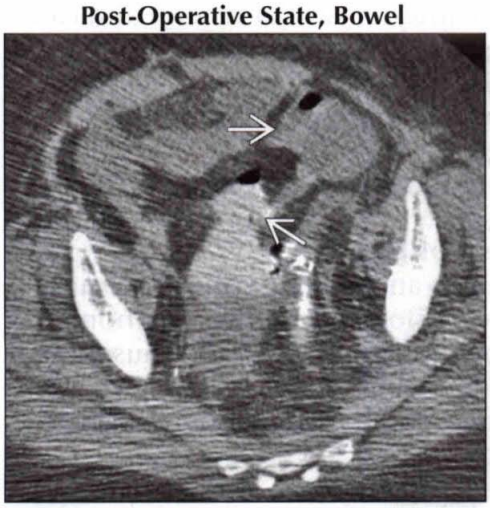


Cystitis

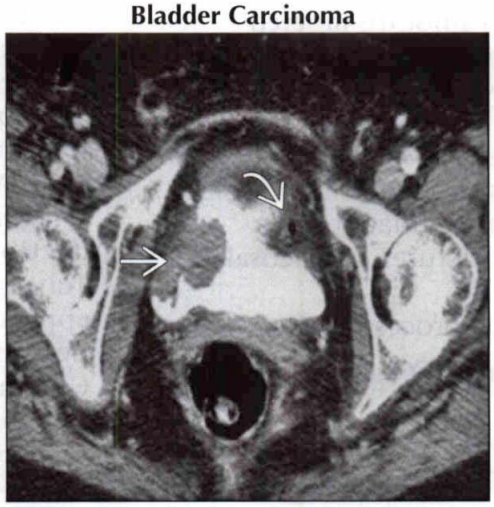


*(**Left**) Axial CECT shows loss of the fat plane between the rectum and vagina ➡. History of ovarian cancer with surgery and radiation therapy causing recto-vaginal fistula. (**Right**) Axial NECT shows gas within the lumen ➡ and wall of the bladder ➡ due to emphysematous cystitis. This might be mistaken for a fistula to the colon.*

Post-Operative State, Bowel



Bladder Carcinoma



*(**Left**) Axial NECT shows opacification of the sigmoid colon by rectal contrast medium, with extravasation ➡ of gas, fluid & contrast. Preceding sigmoid colectomy for diverticulitis with primary anastomosis as the site of leak. (**Right**) Axial CECT shows a bulky mass ➡ along the right side of the bladder. The left side of the bladder is indented by sigmoid colon ➡, but there is no communication between the bladder & the colon.*

SEGMENTAL COLONIC NARROWING

DIFFERENTIAL DIAGNOSIS

Common
- Colon Carcinoma
- Diverticulitis
- Ischemic Colitis
- Colonic Metastases and Lymphoma
- Colonic Spasm
- Infectious Colitis
- Ulcerative Colitis
- Crohn (Granulomatous) Colitis

Less Common
- Pancreatitis
- Extrinsic or Intramural Masses
  - Endometriosis
  - Uterine Fibroid
  - Pericolic Abscess
- Post-Operative Stricture
- Cathartic Abuse
- Typhlitis (Neutropenic Colitis)
- Rectal Mucosal Prolapse
- Tuberculosis, Colon
- Amebic Colitis
- Radiation Colitis
- Intramural Hematoma, Colon

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Important to describe the length, site, and nature of the narrowed segment
  - Abrupt narrowing with "shoulders" or "apple core" appearance = carcinoma until proven otherwise
    - May rarely result from infectious or ischemic etiology
  - Longer strictures with smooth, tapered margins are usually benign
- Colon may be narrowed by extrinsic inflammatory process, such as pancreatitis, cholecystitis, abscess, endometriosis
  - Also by extrinsic mass (e.g., uterine fibroid) or even distended urinary bladder
- Barium enema shows strictures & mucosal lesions better than CT
  - CT shows extracolonic processes better

Helpful Clues for Common Diagnoses
- **Colon Carcinoma**
  - Most common cause of colonic stricture and obstruction in adults
  - Short segment of narrowing (< 10 cm); little pericolonic infiltration
  - Regional lymphadenopathy suggests carcinoma (or infection)
- **Diverticulitis**
  - Usually causes longer segment (> 10 cm) narrowing, more pericolonic inflammation, no lymphadenopathy
- **Ischemic Colitis**
  - May be acute, subacute or chronic
  - Might follow hypoperfusion episode or arterial or venous occlusion
    - Imaging findings vary according to etiology & acuity of ischemia
    - Arterial thrombosis/embolism usually causes small bowel ischemia/ischemic injury limited to distribution of superior/inferior mesenteric artery, with limited bowel wall/mesenteric edema
    - Hypoperfusion is the most common etiology for colonic ischemia; usual manifestation is wall thickening & luminal narrowing of "watershed" segments of colon (splenic flexure > sigmoid colon)
- **Colonic Metastases and Lymphoma**
  - Can be hematogenous or lymphatic spread, or direct invasion (e.g., from duodenum, stomach, kidneys, gallbladder, uterus, prostate)
  - Most common is direct invasion from a primary pelvic malignancy
  - Drop metastases = intraperitoneal spread of tumor
    - Common site is to pouch of Douglas (rectovesical or rectouterine recess); mass indents anterior wall of rectum and can be palpated on physical exam
- **Colonic Spasm**
  - May exactly simulate carcinoma on imaging
  - Give IV glucagon to relieve spasm; repeat imaging
- **Infectious Colitis**
  - Tuberculosis and amebic colitis can cause apple core lesion exactly like carcinoma
  - Lymphogranuloma venereum (caused by Chlamydia trachomatis)
    - Rectosigmoid involvement due to anal intercourse

- Luminal narrowing, mucosal ulceration, perirectal abscess, rectal fistula
- Other infectious colitides
  - Clostridium difficile & Campylobacter colitis usually involve entire colon, but may be segmental

- **Ulcerative or Granulomatous Colitis**
  - May result in diffuse or segmental stricture of colon
    - Short, focal stricture should raise concern for colon carcinoma as a complication of chronic colitis

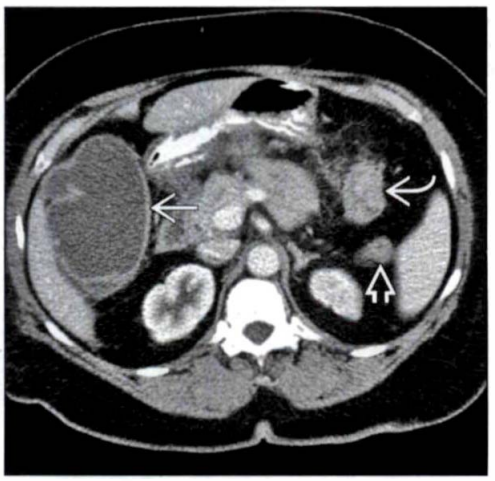
Helpful Clues for Less Common Diagnoses

- **Pancreatitis**
  - Inflammation often spreads laterally within anterior pararenal space to contact the proximal descending colon
  - "Colon cutoff sign" = proximal descending colon is narrowed due to spasm & inflammation caused by pancreatitis
- **Endometriosis**
  - Endometrial tissue may implant on any part of intraperitoneal bowel, involving rectosigmoid area in 75-95% of cases
  - Typical findings: Extrinsic mass effect on anterior wall of rectosigmoid junction
    - Less common: Polypoid mass, annular constricting lesion (indistinguishable for primary colonic carcinoma)
- **Post-Operative Stricture**
  - Usually web-like short strictured segment with smooth edges
- **Cathartic Abuse**
  - Due to chronic use of stimulant laxatives
  - Results in neuromuscular damage of colon
  - Ahaustral, shortened colon (simulates chronic ulcerative colitis)
    - Irregular & transient segmental narrowing, primarily in ascending & transverse colon
- **Typhlitis (Neutropenic Colitis)**
  - Luminal narrowing and wall thickening of cecum & ascending colon
  - Due to polymicrobial infiltration of colonic wall
  - Encountered only in severely neutropenic patines (leukemia, bone marrow transplant recipient)
- **Rectal Mucosal Prolapse**
  - "Solitary rectal ulcer syndrome"
  - Usually in women with pelvic floor laxity
  - Repeated episodes of rectal prolapse injure the antero-lateral walls of the rectum, leading to edema & ulceration
  - May also cause spasm, mural thickening ("colitis cystica profunda"), stricture
- **Radiation Colitis**
  - Usually follows radiation therapy for pelvic primary malignancy (e.g., cervical or prostate carcinoma)
  - Leads to long stricture of rectosigmoid colon with tapered margins

Colon Carcinoma

Coronal CECT shows a mass at the splenic flexure, causing obstruction & fluid distention of large & small bowel. Note adjacent lymphadenopathy

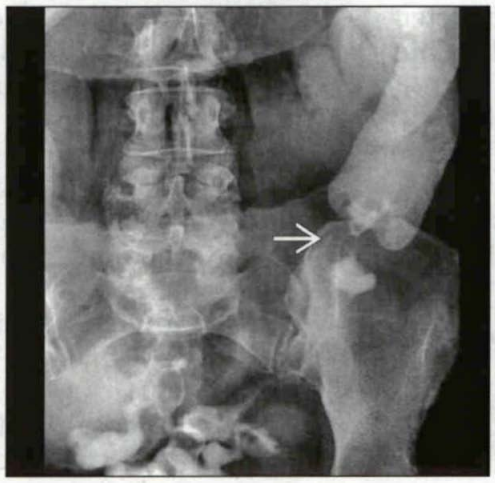
Colon Carcinoma



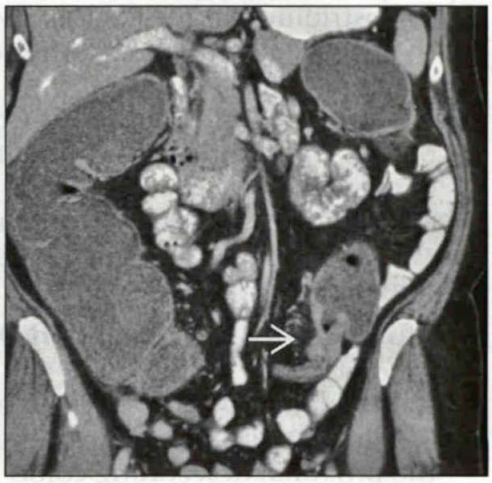
Axial CECT shows a mass at the splenic flexure with adjacent lymphadenopathy. Note dilated, fluid-filled proximal colon

SEGMENTAL COLONIC NARROWING

Colon Carcinoma

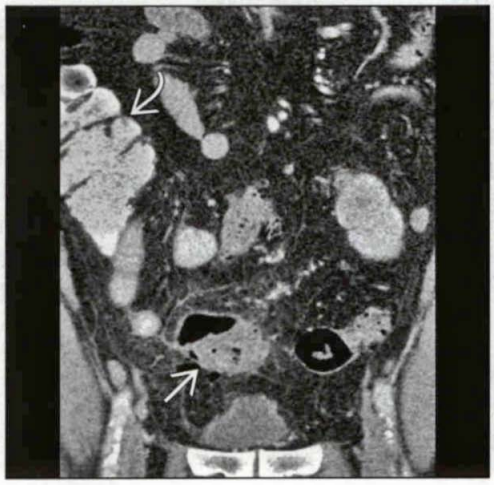


Colon Carcinoma

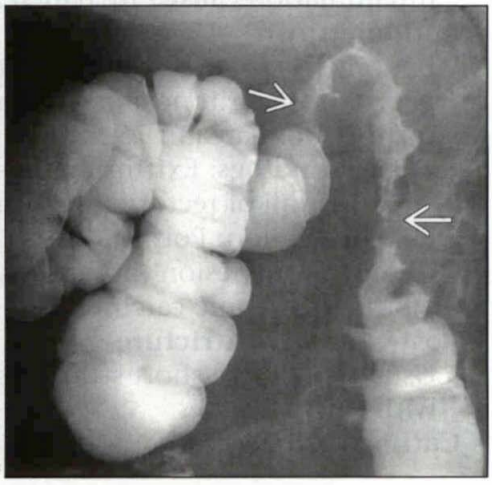


(Left) Frontal contrast enema shows a classic "apple core" obstructing lesion of the descending colon. (Right) Coronal CECT shows a classic "apple core" cancer of the descending colon with dilation of the proximal colon.

Diverticulitis



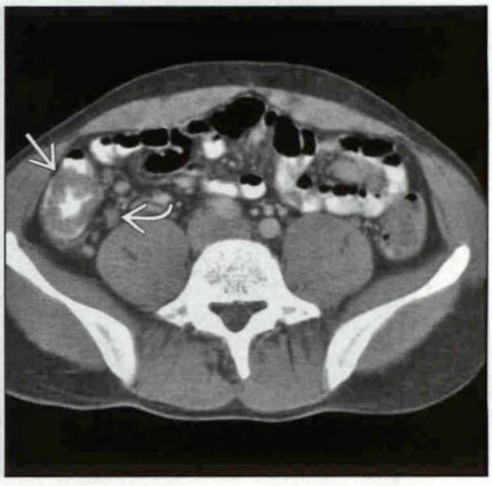
Ischemic Colitis



(Left) Coronal CECT shows a collection of gas & fluid (abscess) in the wall of the sigmoid colon, causing partial colonic obstruction. Note dilated ascending colon. (Right) Oblique contrast enema shows luminal narrowing and fold thickening of the splenic flexure region of colon. This is a characteristic location and appearance for hypoperfusion etiology ischemic colitis.

Colonic Spasm

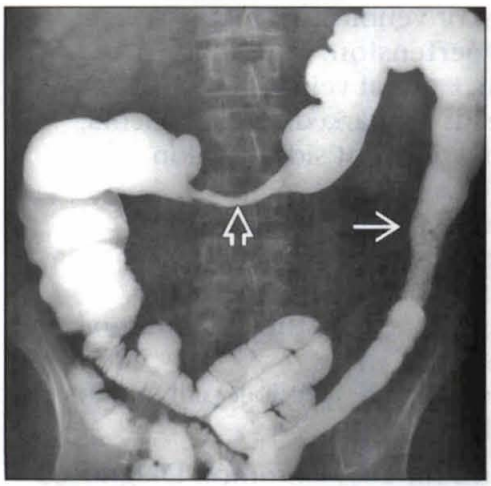
Infectious Colitis



(Left) Axial CECT shows an apparent stricture of the sigmoid colon. This was normal at colonoscopy and probably represented simple spasm. Note normal wall thickness and no infiltration of adjacent fat. (Right) Axial CECT shows luminal narrowing and wall thickening of the ascending colon due to Yersinia colitis. Also note some mesocolic lymphadenopathy.

SEGMENTAL COLONIC NARROWING

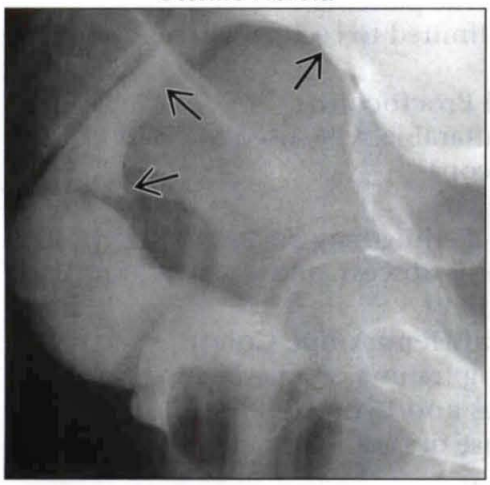
Ulcerative Colitis



Pancreatitis

(Left) *Frontal contrast enema shows a shortened ahaustral left colon, due to chronic ulcerative colitis. The short, focal stricture in the transverse colon is a carcinoma.* ***(Right)*** *Frontal radiograph shows dilation of the transverse colon with abrupt narrowing of the anatomic splenic flexure, due to pancreatitis that had spread to the colon. This is a classic plain film finding of pancreatitis, called the "colon cutoff" sign.*

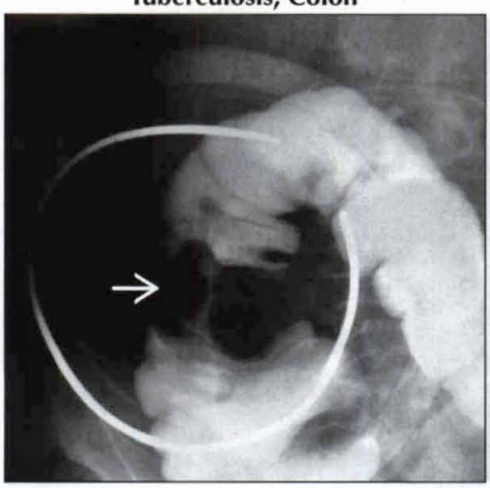
Uterine Fibroid



Cathartic Abuse

(Left) *Lateral contrast enema shows narrowing of the rectosigmoid colon due to extrinsic mass. This proved to be a large uterine fibroid (leiomyoma).* ***(Right)*** *Frontal contrast enema shows focal and long strictures of the colon due to chronic laxative abuse.*

Tuberculosis, Colon



Radiation Colitis

(Left) *Contrast enema shows a classic apple core lesion of the ascending colon, indistinguishable from carcinoma. Proven at surgery to be due to tuberculous infection of the colon.* ***(Right)*** *Frontal contrast enema shows a high grade stricture of the rectum that resulted from radiation therapy for a sacral metastatic focus.*

COLONIC THUMBPRINTING

DIFFERENTIAL DIAGNOSIS

Common
- Pseudomembranous Colitis
- Ischemic Colitis
- Portal Hypertension, Varices
- Ulcerative Colitis
- Infectious Colitis

Less Common
- Typhlitis (Neutropenic Colitis)
- Chemical Proctocolitis
- Diverticulitis
- Intramural Hematoma, Colon
- Metastases and Lymphoma, Colonic
- Pneumatosis of the Intestine

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- "Thumbprinting" describes rounded thickening of the transverse colonic folds; usually due to edema or hemorrhage
- Basically the same differential diagnosis as for submucosal thickening, as seen on CT, but generally requires more extensive thickening to cause thumbprinting

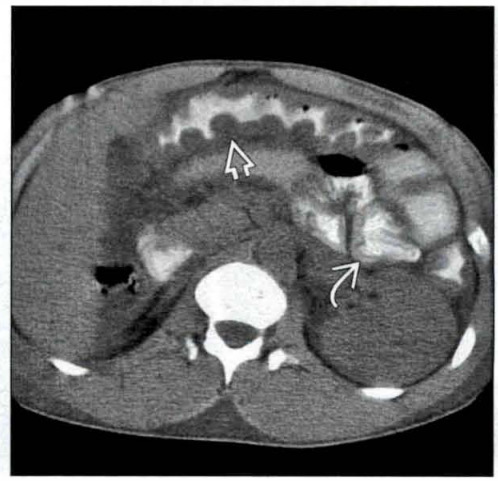
Helpful Clues for Common Diagnoses
- **Pseudomembranous Colitis**
  - Caused by C. difficile infection of colon
  - Has become the most common cause of thumbprinting
- **Ischemic Colitis**
  - Often due to hypoperfusion (favors splenic flexure & sigmoid)
  - May be due to arterial thrombosis or embolus, or venous thrombosis
- **Portal Hypertension, Varices**
  - Cirrhosis ± portal vein thrombosis
  - Often leads to marked colonic edema, usually favors right side of colon
- **Ulcerative Colitis**
  - Or granulomatous colitis (Crohn)
  - Look for ulceration of mucosa
- **Infectious Colitis**
  - Cytomegalovirus & others in immune suppressed
  - Campylobacter, Staphylococcal, amebic, Strongyloides, etc.

Helpful Clues for Less Common Diagnoses
- **Typhlitis (Neutropenic Colitis)**
  - Neutropenic colitis, in severely neutropenic patients
  - Usually limited to cecum & ascending colon
- **Chemical Proctocolitis**
  - From glutaraldehyde, used to clean colonoscopes
- **Diverticulitis**
  - Wall thickening may be due to infection, pericolonic abscess, and/or circular muscle hypertrophy
- **Intramural Hematoma, Colon**
  - Following trauma or anticoagulation
- **Metastases and Lymphoma, Colonic**
  - Rare cause of thumbprinting

Pseudomembranous Colitis

Coronal CECT shows marked thickening of folds throughout the entire colon. Submucosal edema alternating with the compressed lumen & enhancing mucosa ➡ = thumbprinted or accordion appearance.

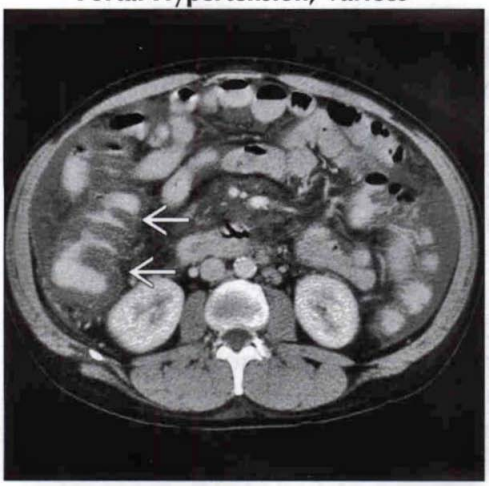
Ischemic Colitis



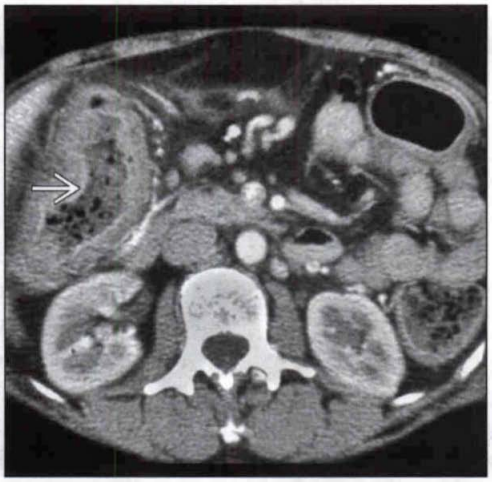
Axial CECT shows classic thumbprinting of the transverse colon ➪ and less impressive SB fold thickening ➪. Ischemia due to near drowning and cardiac arrest.

COLONIC THUMBPRINTING

Portal Hypertension, Varices

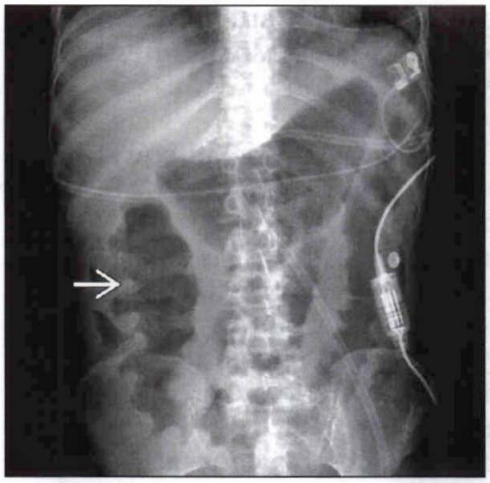


Ulcerative Colitis

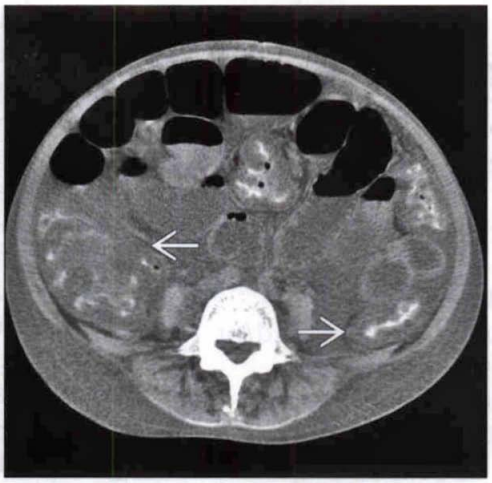


(Left) Axial CECT shows thumbprinting ➡ of ascending colon due to cirrhosis and portal hypertension, not colitis. (Right) Axial CECT shows marked thickening of the colonic wall, especially the ascending colon, with intense mucosal enhancement ➡. This degree of wall thickening is unusual for UC.

Infectious Colitis

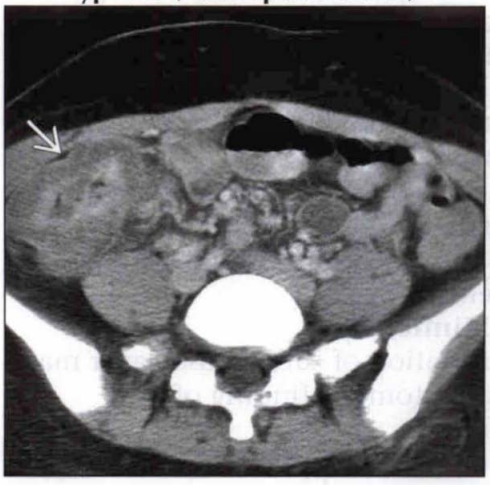


Infectious Colitis



(Left) Frontal radiograph shows classic thumbprinting of the ascending colon ➡ due to CMV colitis in a young man with AIDS. (Right) Axial CECT shows massive wall thickening of the entire colon ➡, especially the ascending colon, due to CMV colitis in a young man with AIDS.

Typhlitis (Neutropenic Colitis)



Pneumatosis of the Intestine

(Left) Axial CECT shows marked colonic wall thickening with edematous submucosa ➡, limited to the ascending colon & cecum. Acute leukemia with fever, abdominal pain & diarrhea. (Right) Oblique contrast enema shows thumbprinted pattern. The presence of gas blebs ➡ in the colonic wall indicates benign colonic pneumatosis in this asymptomatic patient.

COLONIC SUBMUCOSAL WALL THICKENING

DIFFERENTIAL DIAGNOSIS

Common
- Diverticulitis
- Pseudomembranous Colitis
- Ischemic Colitis
- Portal Hypertension
- Ulcerative Colitis
- Crohn Disease
- Infectious Colitis
- Obesity (Mimic)

Less Common
- Colon Carcinoma
- Typhlitis (Neutropenic Colitis)
- Chemical Proctocolitis
- Colonic Metastases and Lymphoma
- Intramural Hemorrhage
- Pneumatosis of the Intestine
- Hemolytic Uremic Syndrome
- Angioedema, Intestinal

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Characterize the length & site of involvement
  - Pancolonic with sparing of small intestine: Pseudomembranous, infectious or ulcerative colitis (not ischemic)
  - "Watershed" areas (splenic flexure and/or sigmoid): Hypoperfusion, ischemia
  - Right colon & small intestine: Crohn disease, embolic or thrombotic ischemic, portal hypertension, infectious
  - Segmental (10-15 cm length): Diverticulitis most common
- Characterize the attenuation of the submucosal layer
  - Air density: Pneumatosis (various causes, including ischemia)
  - Fat density: Chronic ulcerative or granulomatous colitis, obesity
  - Near water density: Inflammation or ischemia
  - Soft tissue density: Diverticulitis, inflammation, ischemia, tumor
  - High attenuation: Hemorrhage

Helpful Clues for Common Diagnoses
- **Diverticulitis**
  - Wall is thickened over 10-15 cm length by edema & smooth muscle hypertrophy
    - Usually no distinct submucosal layer of low density
  - See diverticula, pericolonic infiltration, ± gas & fluid
- **Pseudomembranous Colitis**
  - Most impressive wall thickening
    - Submucosal edema with compressed lumen & intense mucosal enhancement may result in "accordion sign" or "thumbprinting"
  - Segmental or pancolitis
  - Caused by C. difficile toxin, endemic in health care facilities
    - No longer confined to hospitalized patients who have received broad spectrum antibiotics
- **Ischemic Colitis**
  - Most common in "watershed" regions when caused by hypoperfusion
    - Splenic flexure > sigmoid colon
  - Embolic or thrombotic arterial occlusion more commonly affects small intestine and right side of colon
- **Portal Hypertension**
  - Edema of colonic wall ± small bowel
    - Portal hypertensive "colopathy", not inflammatory
  - Look for signs of cirrhosis, ascites
  - (May occur with heart & renal failure)
- **Ulcerative or Granulomatous Colitis**
  - Acute: Wall edema, pericolonic infiltration, mesenteric hyperemia ("comb" or "caterpillar" sign)
  - Chronic: Submucosal layer is fat density
  - Ulcerative colitis favors rectum & distal colon
  - Granulomatous (Crohn) colitis favors distal ileum with skip areas in SB & colon; perianal involvement
- **Infectious Colitis**
  - Difficult to distinguish among etiologies from imaging alone
  - Campylobacter, amebic, Shigella, etc.
  - Long segmental or pancolitis
    - Pericolonic infiltration & mesenteric hyperemia
- **Obesity (Mimic)**
  - Fatty infiltration of submucosal layer may be an asymptomatic finding of no significance
  - Ask about history of prior colitis

COLONIC SUBMUCOSAL WALL THICKENING

Helpful Clues for Less Common Diagnoses

- **Colon Carcinoma**
  - Wall thickening is soft tissue attenuation
  - Usually short segment involvement (< 10 cm)
  - Often with regional adenopathy (strong predictor of cancer with lymphatic spread)
- **Typhlitis (Neutropenic Colitis)**
  - Neutropenic colitis; leukemia & bone marrow transplant patients
  - Limited to cecum & ascending colon
  - Wall thickening is marked; wall may perforate
    - Extraluminal gas &/or fluid is ominous sign; usually requires surgery
- **Chemical Proctocolitis**
  - Glutaraldehyde used to sterilize endoscopes
  - If not thoroughly washed from surface of scope, can damage colonic mucosa
- **Colonic Metastases & Lymphoma**
  - Wall thickening is soft tissue density
  - Quite rare; less common than small bowel involvement
- **Intramural Hemorrhage**
  - Uncommon in colon
  - Etiologies: Trauma (including endoscopy), anticoagulation
  - Attenuation is greater than soft tissue (may be apparent only on non-enhanced CT)
- **Pneumatosis of the Intestine**
  - Spherical or linear air density
  - From infarction, idiopathic pneumatosis cystoides, or other causes of "benign" pneumatosis
    - Steroid and immunosuppressive medications are common etiology
- **Hemolytic Uremic Syndrome**
  - Primarily a disease of infants & small children
  - Caused by toxin of E. coli (or other organisms)
  - Diarrhea, hemolytic anemia, thrombocytopenia, acute renal failure
- **Angioedema, Intestinal**
  - Inherited deficiency of inhibitor of C1 esterase (part of complement cascade)
  - Similar pathology can be induced by reactions to medications (e.g., ACE inhibitors), and in some patients with viral hepatitis
  - Small bowel involvement more common than colonic

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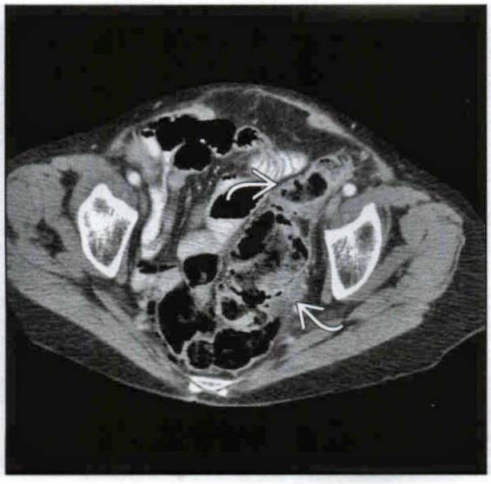
1. Wittenberg J et al: Algorithmic approach to CT diagnosis of the abnormal bowel wall. Radiographics. 22(5):1093-107; discussion 1107-9, 2002
2. Horton KM et al: CT evaluation of the colon: inflammatory disease. Radiographics. 20(2):399-418, 2000

Diverticulitis



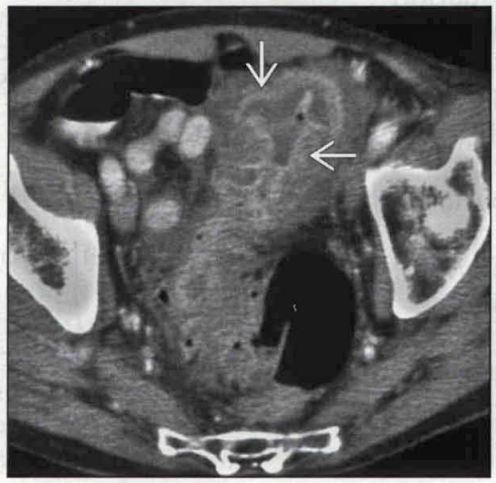
Axial CECT shows mural thickening and luminal narrowing ➡ of the sigmoid colon over a long segment (> 10 cm).

Pseudomembranous Colitis

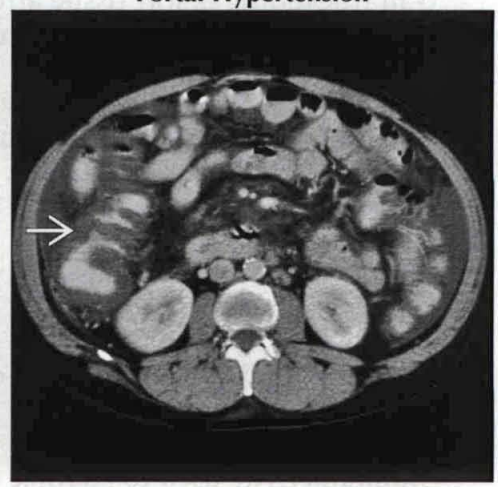
Axial CECT shows pancolitis ➡ with marked submucosal edema and ascites, findings typical of severe C. difficile colitis.

COLONIC SUBMUCOSAL WALL THICKENING

Ischemic Colitis

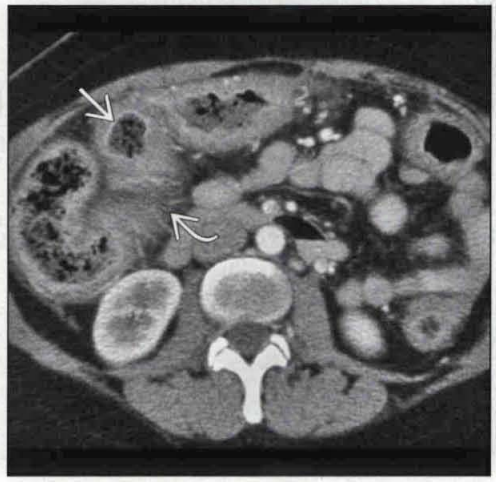


Portal Hypertension



(Left) *Axial CECT shows marked submucosal wall edema and luminal narrowing ➡ of the sigmoid colon, one of the "watershed" zones prone to ischemic colitis (due to hypoperfusion).* ***(Right)*** *Axial CECT shows marked thickening of the wall of the ascending colon ➡ in a patient with cirrhosis and ascites. This represents portal hypertensive colopathy, not colitis.*

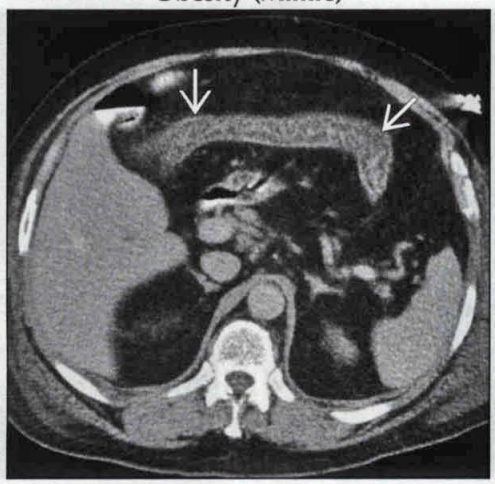
Ulcerative Colitis



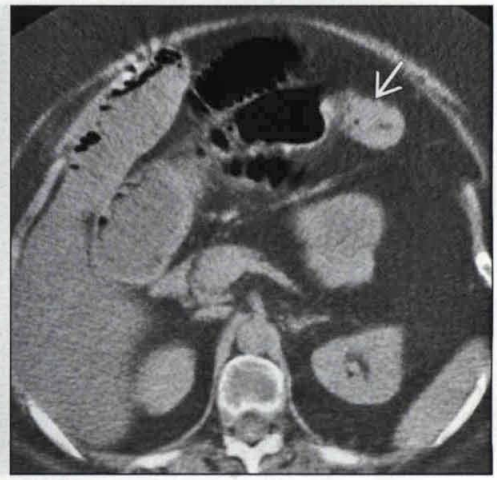
Infectious Colitis

(Left) *Axial CECT shows intense mucosal enhancement ➡ and submucosal edema ➡ of the colon due to acute ulcerative colitis.* ***(Right)*** *Axial CECT shows marked thickening of the colonic wall with intense mucosal enhancement ➡ and mesenteric hyperemia ➡. The entire colon was involved, but not the small bowel; Campylobacter colitis.*

Obesity (Mimic)



Colon Carcinoma

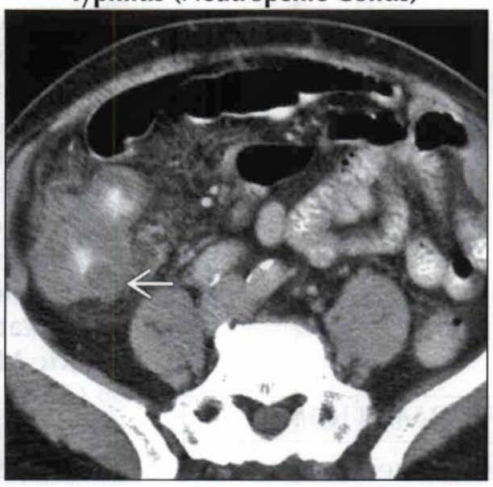


(Left) *Axial CECT shows apparent thickening of the wall of the transverse colon ➡, with submucosal fat density proliferation. No history of colitis in this patient; normal variant in obese and elderly patients.* ***(Right)*** *Axial NECT shows a soft tissue density mass ➡ in the transverse colon causing a short stricture and high grade obstruction.*

COLONIC SUBMUCOSAL WALL THICKENING

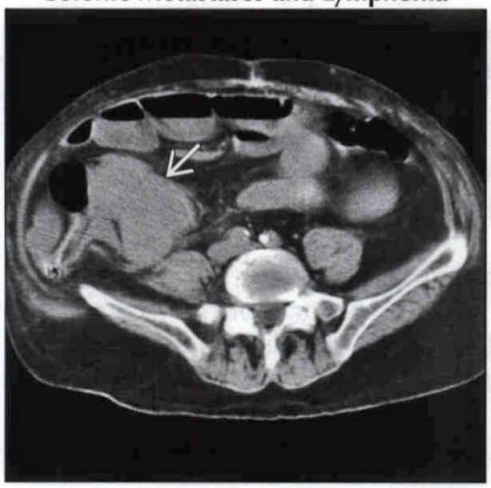
Colon Carcinoma

Typhlitis (Neutropenic Colitis)

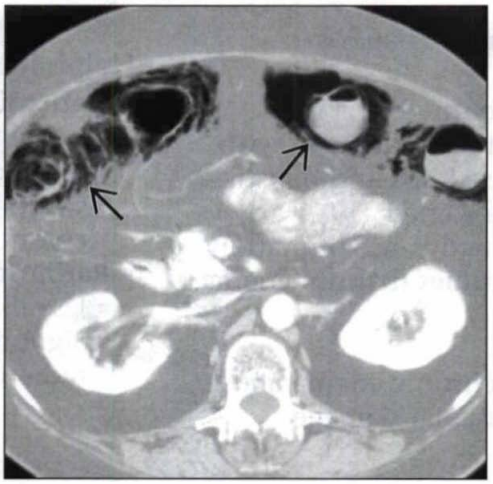


(Left) Axial CECT shows colon with luminal narrowing and wall thickening of soft tissue density. Adjacent lymphadenopathy helps confirm malignant nature of lesion. (Right) Axial CECT shows submucosal edema and luminal narrowing limited to the ascending colon and cecum.

Colonic Metastases and Lymphoma

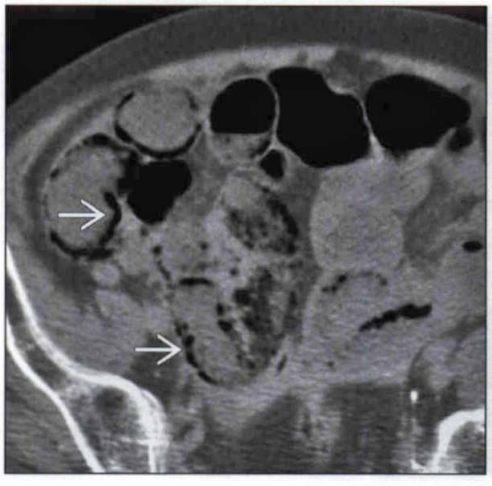


Pneumatosis of the Intestine

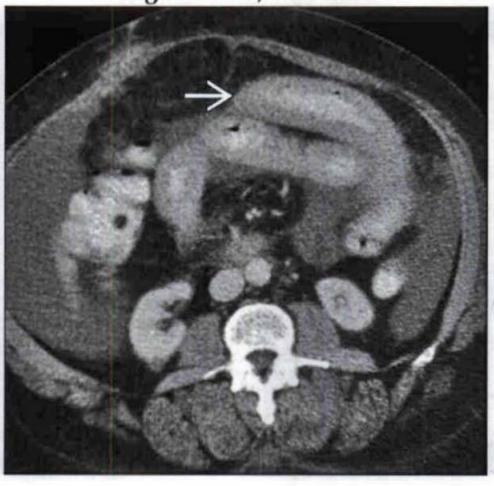


(Left) Axial NECT shows a soft tissue density mass in the cecum and appendix; lymphoma (posttransplant lymphoproliferative disorder) in a renal transplant recipient. (Right) Axial CECT shows extensive gas density in the colonic submucosa; benign pneumatosis in a young woman with leukemia, presumably due to steroid and antirejection medications.

Pneumatosis of the Intestine



Angioedema, Intestinal



(Left) Axial CECT shows extensive pneumatosis in small bowel and colon due to acute embolic infarction. The ileus helps to confirm the ischemic etiology, but correlation with clinical signs of bowel ischemia is essential. (Right) Axial CECT shows ascites & marked edema of small bowel wall and, to a lesser extent, the colon. This patient has viral hepatitis and was found to have a complement-mediated angioedema related to the hepatitis.

SMOOTH AHAUSTRAL COLON

DIFFERENTIAL DIAGNOSIS

Common
- Ulcerative Colitis
- Cathartic Abuse
- Crohn Disease (Granulomatous Colitis)
- Senescent Change, Colon
- Toxic Megacolon

Less Common
- Ischemic Colitis
- Radiation Colitis
- Amyloidosis
- Schistosomiasis

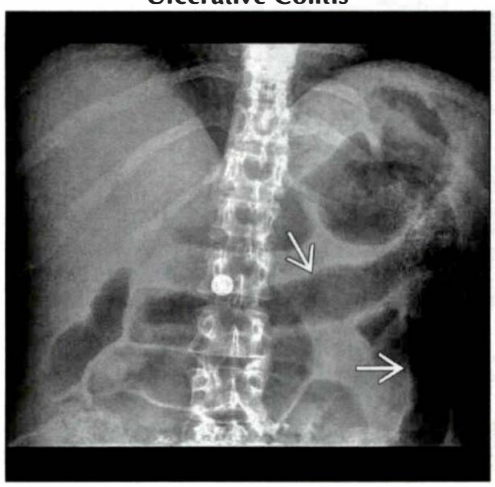
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Haustra should always be present in proximal colon, but can be absent normally in distal colon

Helpful Clues for Common Diagnoses
- **Ulcerative Colitis**
  - Usually in chronic, "burned out" phase
  - Colon may appear smooth, tubular, with loss of usual transverse folds and haustra
  - Colon may be foreshortened
  - Look for evidence of active inflammation on current or prior studies (barium enema, CT, endoscopy)
- **Cathartic Abuse**
  - Can also occur with chronic enema abuse
    - Results in neuromuscular damage
  - Look for bizarre contractions & spasm of right colon; no ulcerations
- **Crohn Disease (Granulomatous Colitis)**
  - Chronic phase of granulomatous colitis can resemble "burned out" ulcerative colitis
- **Senescent Change, Colon**
  - Elderly persons often have loss of colonic folds, especially in descending colon
  - Unlike with chronic colitis, colon is not foreshortened
  - Asymptomatic and uncertain etiology
    - Some are probably due to chronic laxative & enema use
- **Toxic Megacolon**
  - Colon (especially transverse) loses normal transverse folds
  - Surface irregularity = ulceration, sloughed mucosa, inflammatory pseudopolyps
  - Wall may be thin or thickened, more apparent on CT
  - Medical/surgical emergency; may perforate

Helpful Clues for Less Common Diagnoses
- **Ischemic Colitis**
  - Usually in healing or healed phase
  - Segmental loss of folds and haustra
  - Often affects splenic flexure and sigmoid colon
- **Radiation Colitis**
  - Usually takes weeks or months to develop
  - Sigmoid colon most affected, following radiation therapy for pelvic malignancies

Ulcerative Colitis



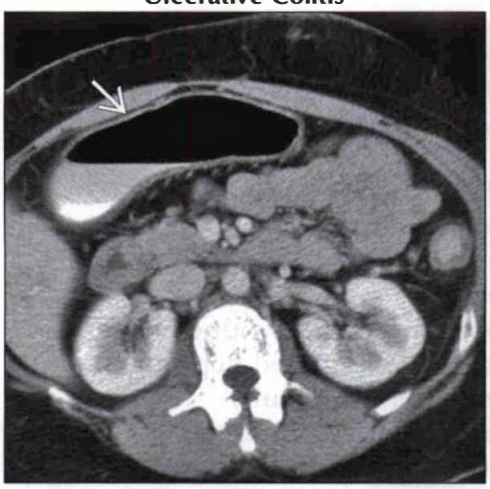
Frontal radiograph shows an ahaustral, shortened transverse & descending colon in a patient with chronic UC, but no current evidence of severe exacerbation.

Ulcerative Colitis

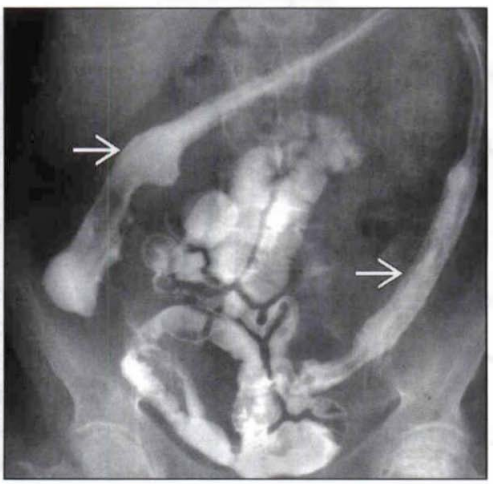
Frontal radiograph shows a shortened, ahaustral sigmoid colon; chronic UC.

SMOOTH AHAUSTRAL COLON

Ulcerative Colitis

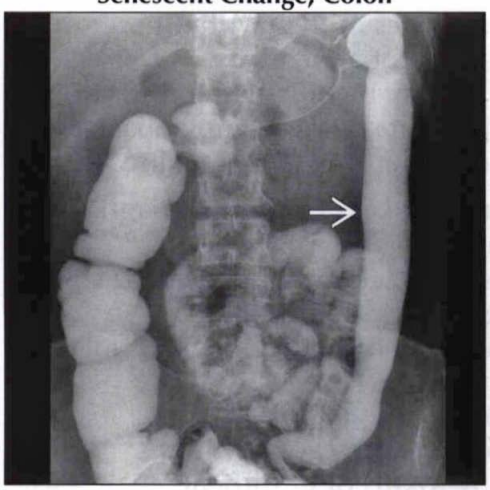


Cathartic Abuse

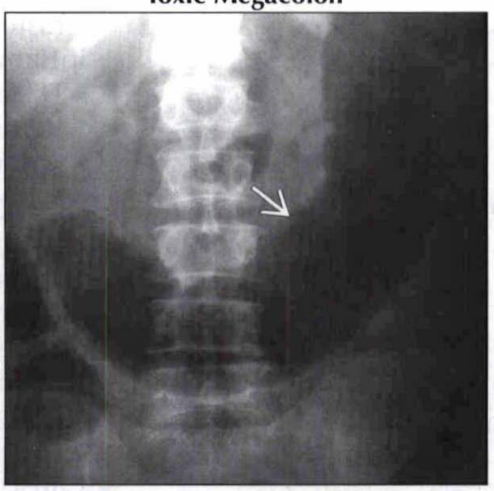


(Left) Axial CECT shows a dilated, featureless transverse colon in a patient with chronic UC. (Right) Frontal contrast enema shows an ahaustral colon, but no significant shortening. Intermittent segmental contractions were observed at fluoroscopy.

Senescent Change, Colon

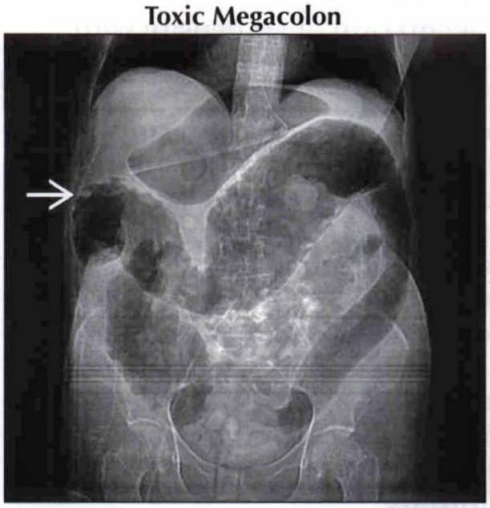


Toxic Megacolon

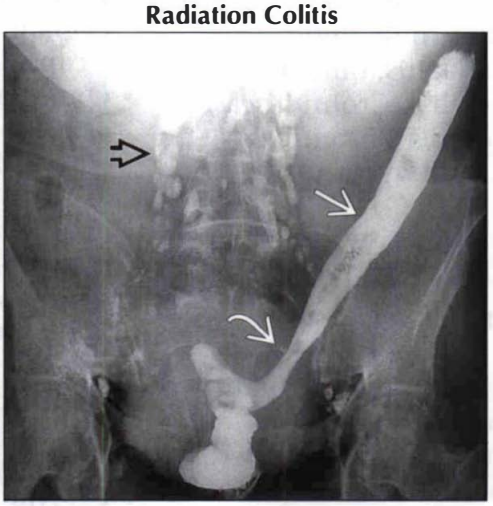


(Left) Frontal contrast enema shows an ahaustral distal transverse and descending colon in an elderly patient with no clinical symptoms of colitis. (Right) Anteroposterior radiograph shows a dilated ahaustral transverse colon with a suggestion of mucosal irregularity. Only correlation with clinical input (severe abdominal pain and guarding) distinguish this as toxic megacolon, rather than ileus.

Toxic Megacolon



Radiation Colitis



(Left) Frontal radiograph shows a shortened, ahaustral colon due to chronic granulomatous colitis (Crohn disease). Note the pseudopolyps and gross dilation of the transverse colon, which along with severe acute symptoms, indicated toxic megacolon. (Right) Anteroposterior contrast enema shows a shortened, ahaustral left side of colon with a short stricture. Note lymphangiographic opacification of retroperitoneal nodes.

ACUTE RIGHT LOWER QUADRANT PAIN

DIFFERENTIAL DIAGNOSIS

Common
- Appendicitis
- Crohn Disease
- Pelvic Inflammatory Disease
- Pyelonephritis
- Urolithiasis (Renal Calculi)
- Mesenteric Adenitis

Less Common
- Diverticulitis
- Pseudomembranous Colitis
- Epiploic Appendagitis
- Omental Infarct
- Cholecystitis
- Gynecologic & Obstetric Causes
  - Uterine Fibroids
  - Hemorrhagic Ovarian Cyst
  - Ovarian Torsion
  - Endometriosis
  - Ruptured Ectopic Pregnancy
- Ischemic Enteritis
- Ischemic Colitis
- Infectious Colitis
- Colon Carcinoma
- Appendiceal Carcinoma
- Pancreatitis, Acute

Rare but Important
- Intussusception
- Meckel Diverticulitis
- Typhlitis (Neutropenic Colitis)
- Mucocele of the Appendix

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Young man: Appendicitis, mesenteric adenitis, epiploic appendagitis, omental infarction, acute pancreatitis, Crohn disease
- Young woman: Also consider obstetric & gynecologic etiologies, cholecystitis, pyelonephritis
- Older adults: Cancer & bowel ischemia become more common considerations

Helpful Clues for Common Diagnoses
- **Appendicitis**
  - Dilated, thick-walled, blind-ending tube arising from cecal tip
  - Appendicolith in 1/3 to 1/2 of patients
  - Periappendiceal inflammation
- **Crohn Disease**
  - Thick wall, narrow lumen of distal ileum
  - Fibrofatty proliferation of mesentery
  - Cluster of RLQ mesenteric nodes
  - Mesenteric hyperemia; engorged vessels
- **Pelvic Inflammatory Disease**
  - Second most common etiology in young women
  - Loss of fat planes in pelvis
  - Inflamed, pus-distended fallopian tubes
  - Possible tubo-ovarian abscess
- **Pyelonephritis**
  - More common in girls, young women
  - Wedge-shaped or striated nephrogram
- **Urolithiasis (Renal Calculi)**
  - Stones in renal pelvis or ureter
  - Dilated collecting system/ureter
  - Perirenal infiltration, renal swelling
- **Mesenteric Adenitis**
  - Common in children & adolescents
  - Cluster of nodes in RLQ without inflammation of appendix
    - Distal SB may be inflamed in infectious ileitis (Yersinia, viral, Campylobacter)
    - Some consider this the same disease

Helpful Clues for Less Common Diagnoses
- **Diverticulitis**
  - May arise from cecum or ascending colon, or elongated sigmoid colon
  - Can usually identify diverticula & adjacent inflammation
- **Pseudomembranous Colitis**
  - Endemic in health care facilities
  - Caused by toxins of C. difficile
  - Segmental or diffuse colitis; wall edema
- **Epiploic Appendagitis**
  - Small (2-4 cm) oval of fat density with capsule & inflammation near colon
- **Omental Infarct**
  - > 90% of primary type occur near ascending colon
  - 3 to 8 cm rounded mass of heterogeneous fat density with enhancing "capsule" and adjacent inflammation
- **Cholecystitis**
  - Inflamed, distended GB may project into RLQ
    - Perforated cholecystitis may extend inflammation to adjacent organs, including ascending colon
- **Uterine Fibroids**

- May infarct, twist or bleed, leading to acute pain

- **Hemorrhagic Ovarian Cyst or Ovarian Torsion**
  - High attenuation (CT) or echogenic material within a spherical adnexal mass; young women
- **Endometriosis**
  - Chronic or episodic pain with menses
- **Ruptured Ectopic Pregnancy**
  - Life-threatening
  - Always consider in woman of reproductive age
  - Check β-hCG pregnancy test
  - 1st imaging evaluation of pregnant patient should be by US
- **Ischemic Enteritis**
  - Embolic or thrombotic occlusion of ileocolic artery
  - Thrombosis of ileocolic or superior mesenteric vein
    - Venous thrombosis is usually in patient with prothrombotic condition
- **Ischemic Colitis**
  - Right colon involved with thromboembolic disease, rather than hypoperfusion ischemia
- **Infectious Colitis**
  - Multiple possible pathogens, especially in immunocompromised patients
  - Focal, segmental or pancolitis with wall edema, pericolonic inflammation
- **Colon or Appendiceal Carcinoma**
  - Cecal carcinoma may obstruct appendix, mimic appendicitis
    - May also perforate, with extraluminal gas & fluid
  - Look for mass in cecal or appendiceal lumen
- **Pancreatitis, Acute**
  - Inflammation may spread to ascending colon, simulating colitis
  - Characteristic inflammation of peripancreatic tissue & lab findings are key

Helpful Clues for Rare Diagnoses

- **Intussusception**
  - Ileocecal is most common site
  - Long segment, obstructing intussusception in adult usually has lead mass
- **Meckel Diverticulitis**
  - Difficult to diagnose unless diverticulum from distal SB is recognized with surrounding inflammatory changes
- **Typhlitis (Neutropenic Colitis)**
  - Neutropenic colitis, in severely immunocompromised patients
  - Massive wall thickening of cecum & ascending colon
- **Mucocele of the Appendix**
  - Oval cystic lesion arising from tip of cecum
    - May have eggshell calcification

Appendicitis

Axial CECT shows a dilated, thick-walled appendix ➡ with inflammation of the surrounding fat planes ➡.

Appendicitis

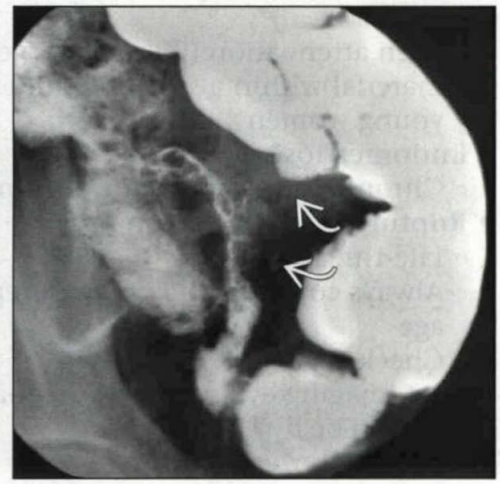
Coronal CECT shows an appendicolith ➡ within the dilated, inflamed appendix. Note surrounding inflammatory changes, including extrinsic inflammation of terminal ileum ➡.

ACUTE RIGHT LOWER QUADRANT PAIN

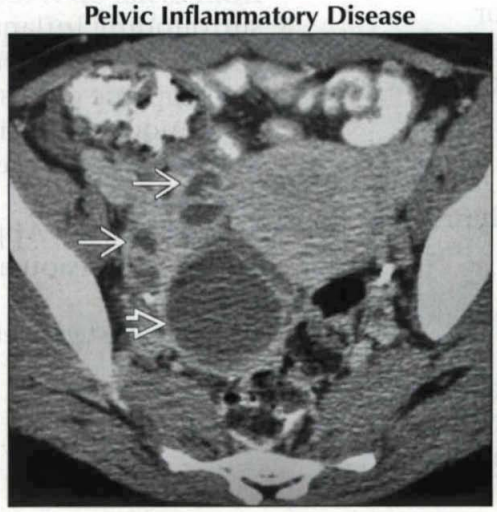
Crohn Disease

(Left) Axial CECT shows a thick-walled terminal ileum with increased enhancement of thickened mucosa. Also note engorged mesenteric blood vessels to the affected portion of the bowel. (Right) Frontal small bowel follow through shows wall thickening & luminal narrowing of terminal ileum & cecum, & mass effect separating diseased bowel from other bowel in the right lower quadrant. Cobblestoned mucosa (ulcerations) & sinus tracts are noted.

Crohn Disease

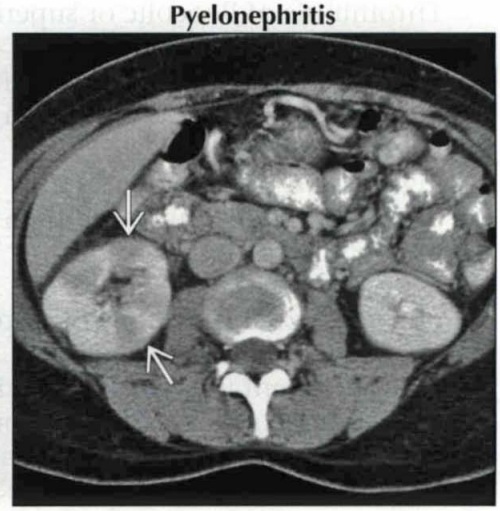


Pelvic Inflammatory Disease

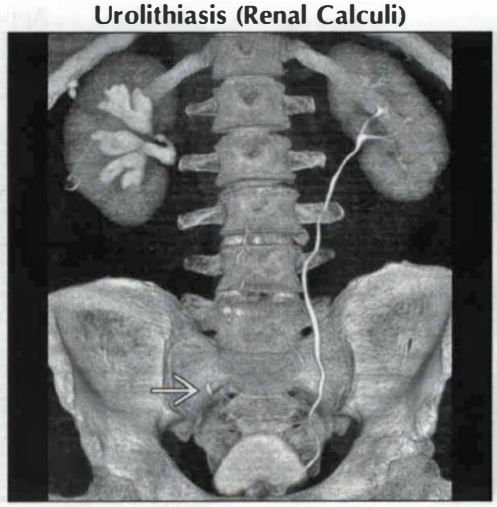


(Left) Axial CECT shows a convoluted, dilated right pyosalpinx and a tubo-ovarian abscess. (Right) Axial CECT shows wedge-shaped and striated zones of decreased enhancement of the right kidney, along with infiltration of the perirenal space.

Pyelonephritis

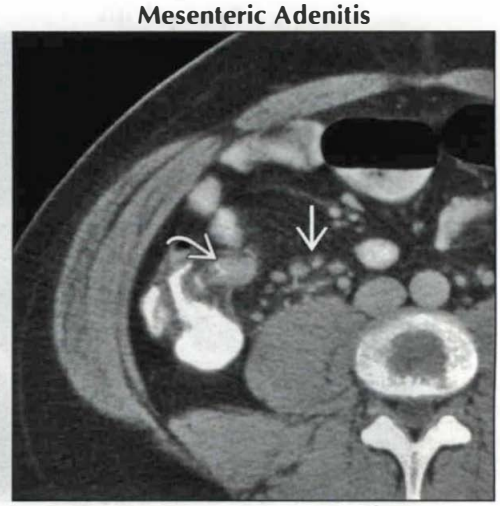


Urolithiasis (Renal Calculi)



(Left) Coronal CECT shows dilation of the right renal collecting system and delayed opacification of the right ureter, due to an obstructing ureteral calculus. Both were evident on NECT as well. (Right) Axial CECT shows mild thickening of the wall of the terminal ileum and a cluster of minimally enlarged mesenteric nodes. Resolved spontaneously in this 24 year-old woman.

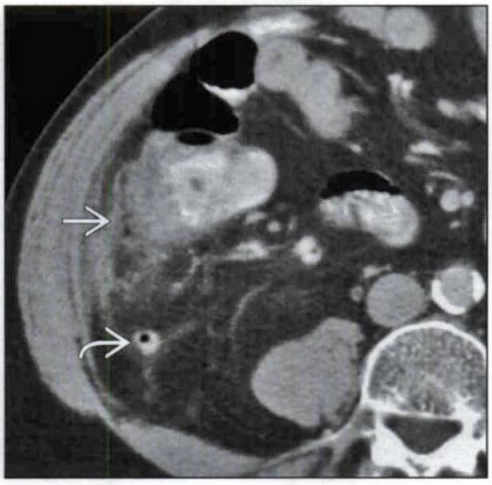
Mesenteric Adenitis



ACUTE RIGHT LOWER QUADRANT PAIN

Diverticulitis

Diverticulitis



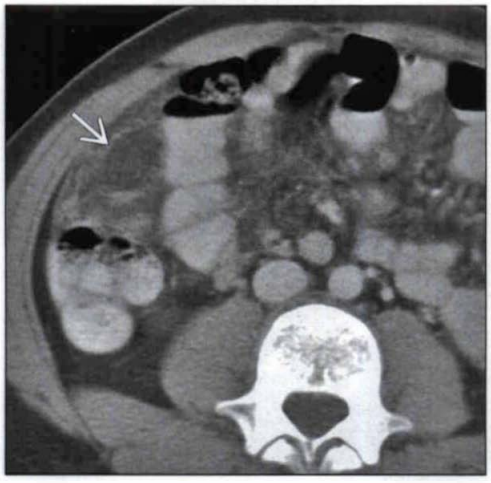
(Left) Axial CECT shows wall thickening of the cecum and diverticula, with adjacent inflammation. (Right) Axial CECT shows cecal wall thickening and infiltration of adjacent fat. Note normal appendix. Cecal diverticula were seen on adjacent sections.

Pseudomembranous Colitis

Epiploic Appendagitis

(Left) Axial CECT shows marked mural thickening of the entire colon and ascites, raising concern for colonic perforation. (Right) Axial CECT shows a small oval fat density lesion adjacent to the colon in the RLQ, with inflammation of adjacent fat.

Omental Infarct



Cholecystitis

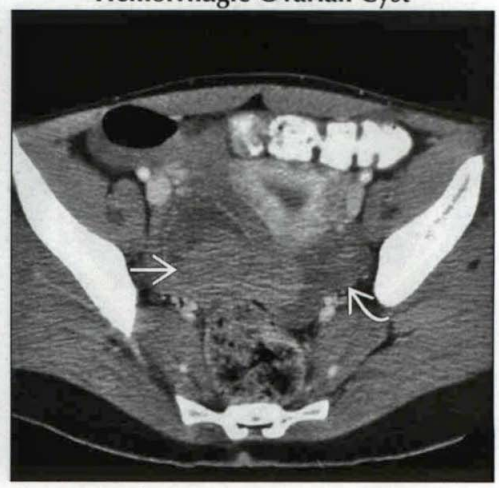
(Left) Axial CECT shows a large oval fat density lesion adjacent to the ascending colon with inflammation of the surrounding fat. (Right) Axial CECT shows a thick-walled gallbladder with adjacent inflammation and septate fluid collections. Perforated cholecystitis.

ACUTE RIGHT LOWER QUADRANT PAIN

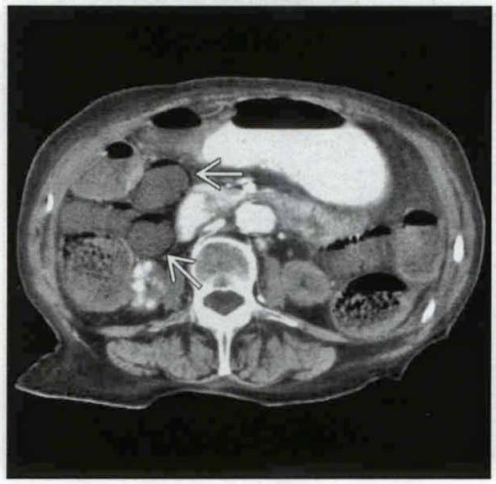
Uterine Fibroids

*(**Left**) Axial CECT shows multiple subserosal fibroids (leiomyomas) with cystic and calcified degeneration; 51 year old woman presenting with acute RLQ pain. (**Right**) Axial CECT shows clot within a right adnexal cyst ➡ and adjacent sentinel clot, plus hemoperitoneum ➡.*

Hemorrhagic Ovarian Cyst

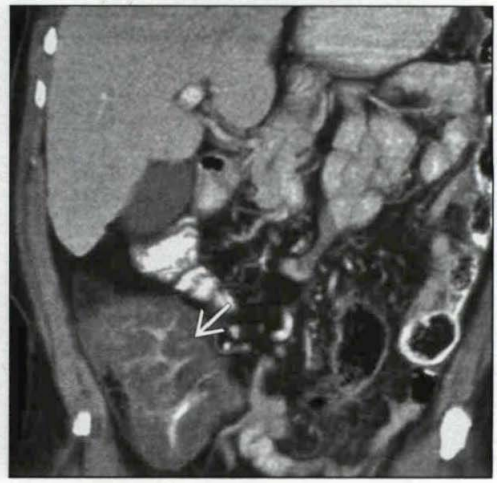


Ischemic Enteritis

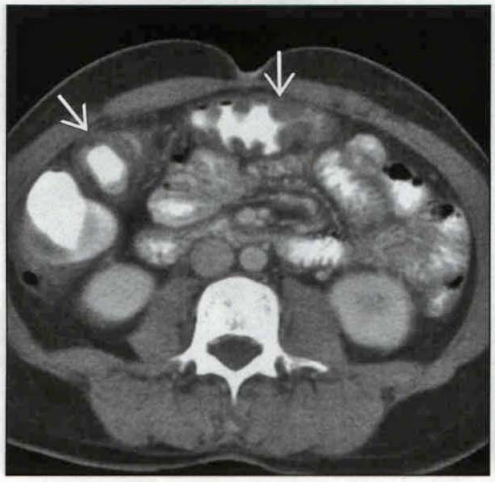


*(**Left**) Axial CECT shows diffuse ileus and gas within the wall of distal small bowel ➡; infarcted bowel found at surgery. (**Right**) Coronal CECT shows marked cecal mural thickening with submucosal edema ➡ and luminal narrowing.*

Ischemic Colitis



Infectious Colitis



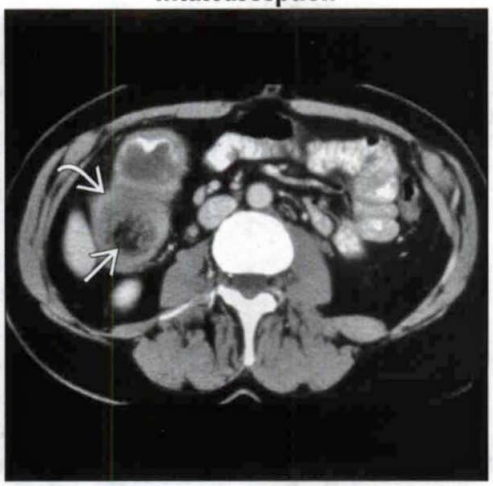
*(**Left**) Axial CECT shows mural thickening of the ascending and transverse colon ➡; Campylobacter colitis in an otherwise normal 26 year old man. (**Right**) Axial CECT shows circumferential thickening of the wall of the cecum ➡ with a distended appendix ➡. Omental metastases were noted on adjacent sections.*

Colon Carcinoma

ACUTE RIGHT LOWER QUADRANT PAIN

Appendiceal Carcinoma

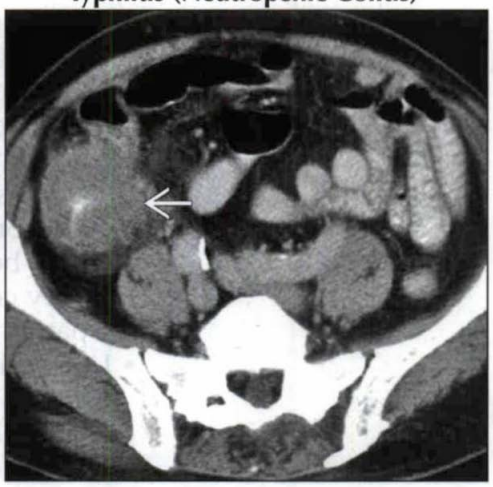
Intussusception



(Left) *Axial CECT shows a dilated, thick-walled appendix with infiltration of surrounding fat. Liver metastases were also seen on this CT scan.* ***(Right)*** *Axial CECT shows an ileocolic intussusception due to an appendiceal mucocele. Note the small bowel mesenteric fat within the lumen of the ascending colon.*

Meckel Diverticulitis

Typhlitis (Neutropenic Colitis)



(Left) *Axial CECT shows a blind ending pouch arising from the distal small bowel, containing a laminated stone, with inflammation of the surrounding fat. Perforated Meckel diverticulum.* ***(Right)*** *Axial CECT shows marked mural thickening of the ascending colon in an elderly man receiving chemotherapy for acute myelogenous leukemia.*

Mucocele of the Appendix

Mucocele of the Appendix

(Left) *Axial CECT shows a very distended elongated appendix in a 46 year old woman with only vague right lower quadrant pain. Called mucocele of appendix at surgical pathology.* ***(Right)*** *Axial CECT shows a pericecal mass with eggshell, though incomplete, calcification.*

ACUTE LEFT LOWER QUADRANT PAIN

DIFFERENTIAL DIAGNOSIS

Common

- Diverticulitis
- Colon Carcinoma
- Epiploic Appendagitis
- Pseudomembranous Colitis
- Infectious Colitis
- Ulcerative Colitis
- Gynecologic Causes
  - Adnexal Torsion
  - Endometriosis
  - Salpingitis
  - Tubo-Ovarian Abscess
  - Uterine Fibroids
- Urolithiasis
- Post-Operative State, Bowel

Less Common

- Ischemic Colitis
- Omental Infarct
- Uterine Fibroids
- Sclerosing Mesenteritis
- Crohn Disease
- Abdominal Abscess
- Sigmoid Volvulus
- Appendicitis
- Fecal Impaction
- Peritonitis
- Pyelonephritis
- Renal Cell Carcinoma
- Renal Infarction
- Coagulopathic ("Retroperitoneal") Hemorrhage
- Spigelian Hernia
- Inguinal Hernia

Rare but Important

- Bladder Fistulas

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Most etiologies are of bowel origin, but consider genitourinary; don't forget to check the mesentery & omentum
- CECT is the imaging modality of choice, after pregnancy is taken into account

Helpful Clues for Common Diagnoses

- **Diverticulitis**
  - Most common cause in middle-aged and elderly
    - Can affect patients as young as 25
  - Usually long (10-15 cm) segment of wall thickening, luminal narrowing, pericolonic infiltration
  - Extraluminal collections of gas or fluid help confirm diagnosis
- **Colon Carcinoma**
  - Usually short segment without much pericolonic infiltration
  - Regional lymphadenopathy has strong association with carcinoma, rarely seen in diverticulitis
  - Acute symptoms may be due to colonic obstruction ± colitis proximal to the obstructing mass
- **Epiploic Appendagitis**
  - Small oval, fatty lesion (2-4 cm) with infiltration of omental fat
  - Lies immediately adjacent to colonic surface
  - Important to distinguish from diverticulitis, as epiploic appendagitis resolves without specific treatment
- **Pseudomembranous or Infectious Colitis**
  - Usually diffuse, pancolonic with impressive colonic wall thickening ("accordion sign")
  - May be segmental, including distal colon
  - Very common, especially in hospitalized patients, and those in nursing homes
- **Ulcerative Colitis**
  - Favors rectum and distal colon
  - Colonic wall is usually not very thickened
  - Look for loss of haustral pattern, infiltration of pericolonic fat
  - Ask about history of prior episodes
- **Gynecologic Causes**
  - Many, including adnexal infection & masses, torsed ovary, endometriosis, etc.
  - Look for evidence of mass &/or inflammation centered on adnexa, rather than bowel
  - **Uterine Fibroids**
    - May torse, undergo degeneration or infarction, lead to acute pain
    - Heterogeneous soft tissue masses within enlarged uterus, ± focal calcifications within masses
- **Urolithiasis**
  - Distal left ureteral stone may cause left lower quadrant pain

- Diagnosis usually evident on CT
  - Ureteral calculus, hydronephrosis, perinephric stranding

- **Post-Operative State, Bowel**
  - Following bowel (& other surgeries) ileus may result in bowel distention & pain
  - May see just bowel distention on CT, but small amount of peritoneal fluid is common in immediate post-op state
    - Anastomotic site narrowing & pericolonic infiltration are also expected in post-op period

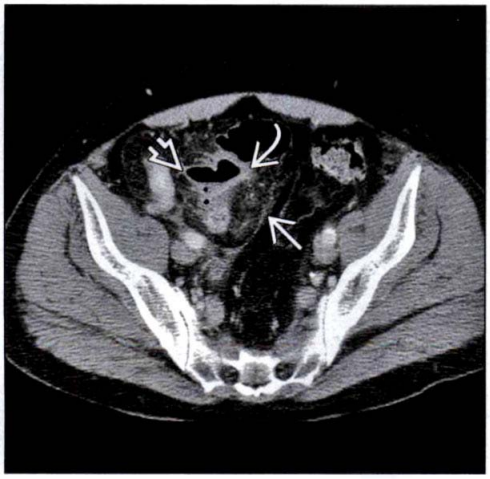
Helpful Clues for Less Common Diagnoses

- **Ischemic Colitis**
  - Sigmoid colon is 2nd most common site for hypoperfusion-induced ischemia
  - Wall thickening & luminal narrowing
  - Ask about prior hypotensive episode or cardiac disease
- **Omental Infarct**
  - Primary omental infarction occurs near the ascending colon
  - Secondary form may occur anywhere near site of surgery, infection, radiation, etc.
  - Heterogeneous fatty mass, larger than epiploic appendagitis
    - Usually farther removed from surface of colon than for epiploic appendagitis
  - Usually resolves without specific treatment
- **Sclerosing Mesenteritis**
  - Being diagnosed much more commonly as cause of recurrent abdominal pain, usually poorly localized
  - "Misty mesentery" with cluster of jejunal mesentery nodes with surrounding thin capsule
  - Often with history of prior similar episodes
  - May respond to steroid therapy or resolve on its own
- **Abdominal Abscess**
  - Usually in post-operative patient, or following appendicitis, diverticulitis
- **Sigmoid Volvulus**
  - Very elongated & dilated sigmoid colon, folded back on itself ("coffee bean" or "football" signs)
  - Colon proximal to sigmoid will be dilated, but not as much as sigmoid
  - CT will show twisting of vessels in base of sigmoid mesocolon
- **Appendicitis**
  - Appendix may be very long or may arise from a malrotated colon, lead to left-sided symptoms
- **Fecal Impaction**
  - Common, but can lead to stercoral ulceration with erosion through colonic wall

SELECTED REFERENCES

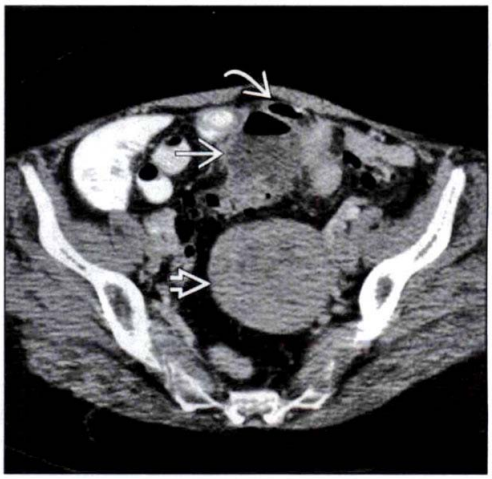
1. Singh AK et al: Acute epiploic appendagitis and its mimics. Radiographics. 25(6):1521-34, 2005
2. Horton KM et al: CT findings in sclerosing mesenteritis (panniculitis): spectrum of disease. Radiographics. 23(6):1561-7, 2003
3. Horton KM et al: CT evaluation of the colon: inflammatory disease. Radiographics. 20(2):399-418, 2000

Diverticulitis



Axial CECT shows mural thickening of the sigmoid colon and infiltration of the sigmoid mesocolon. Also noted is a gas containing pericolic abscess.

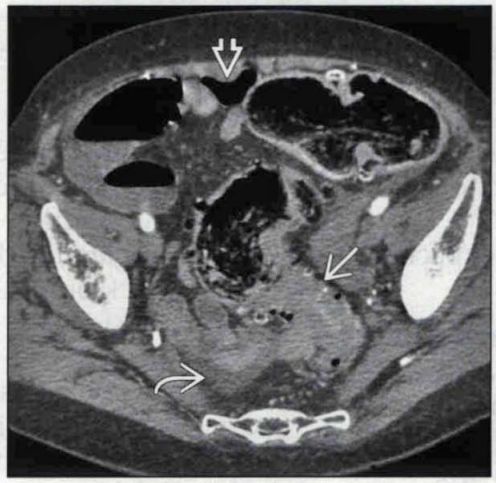
Diverticulitis



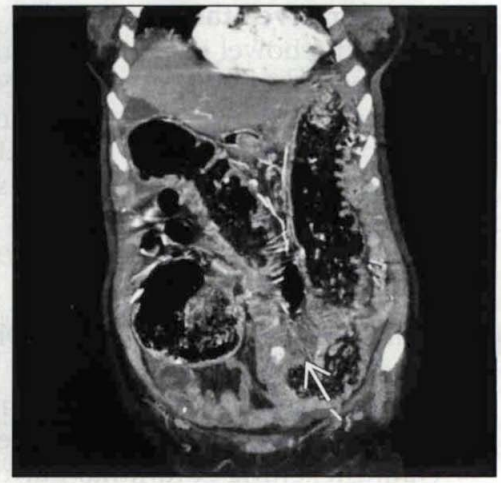
Axial NECT shows sigmoid diverticula with an adjacent abscess and free gas. Uterine fibroid also noted.

ACUTE LEFT LOWER QUADRANT PAIN

Colon Carcinoma

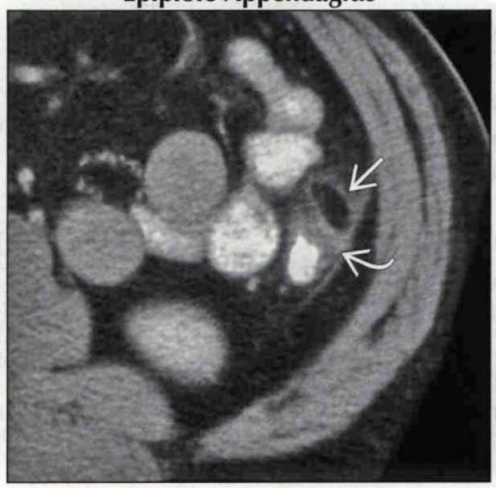


Colon Carcinoma



*(**Left**) Axial CECT shows an obstructing mass in the sigmoid colon with free intraperitoneal gas and fluid. (**Right**) Coronal CECT shows an obstructing mass in the sigmoid colon. Free air and fluid were noted on the axial sections.*

Epiploic Appendagitis



Pseudomembranous Colitis

*(**Left**) Axial CECT shows a small, oval, fat density mass adjacent to the descending colon with surrounding inflammatory changes. (**Right**) Axial CECT shows marked mural thickening limited to the sigmoid colon, an unusual feature of pseudomembranous colitis. Also noted, inflammation of the presacral fat planes.*

Pseudomembranous Colitis

Infectious Colitis

*(**Left**) Coronal CECT shows marked mural thickening, limited to the sigmoid colon, an unusual feature of pseudomembranous (C. difficile) colitis. (**Right**) Axial CECT shows marked mural thickening of the sigmoid colon, along with ascites and small bowel dilation. Other sections showed similar involvement of most of the colon; CMV colitis in a young man with AIDS.*

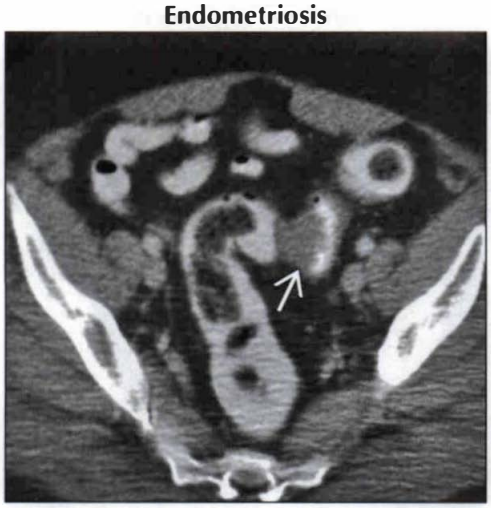
ACUTE LEFT LOWER QUADRANT PAIN

Ulcerative Colitis

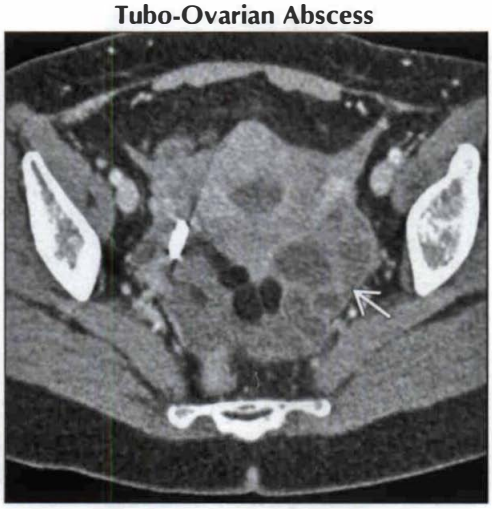
Adnexal Torsion

(Left) Axial CECT shows marked mural thickening of the sigmoid colon and loss of normal haustration. Acute flare of chronic ulcerative colitis. (Right) Axial CECT shows an enlarged ovary identified by the presence of normal follicles. The ovary is swollen and poorly enhancing due to torsion and ischemia.

Endometriosis

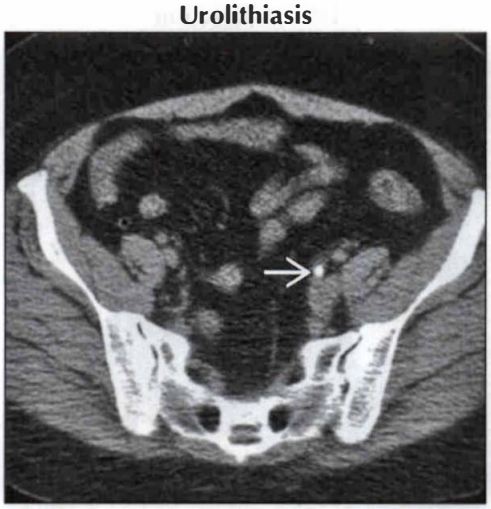


Tubo-Ovarian Abscess

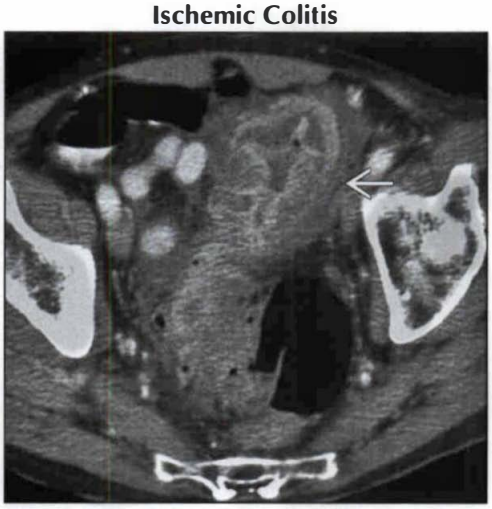


(Left) Axial CECT shows focal eccentric narrowing and mass effect in the sigmoid colon simulating colon cancer; proven endometriosis. (Right) Axial CECT shows a multiloculated tubo-ovarian abscess in the left adnexal region in a woman presenting with acute left lower quadrant pain.

Urolithiasis



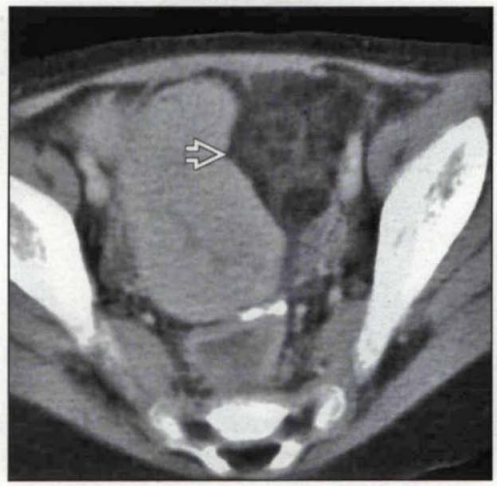
Ischemic Colitis



(Left) Axial NECT shows a calculus within the left ureter as it crosses the iliac vessels, in a patient presenting with left lower quadrant and flank pain. (Right) Axial CECT shows marked mural thickening of the sigmoid colon in an elderly man with acute pain & hematochezia. The watershed areas of the splenic flexure and sigmoid colon are most vulnerable to the hypoperfusion type of ischemic colitis.

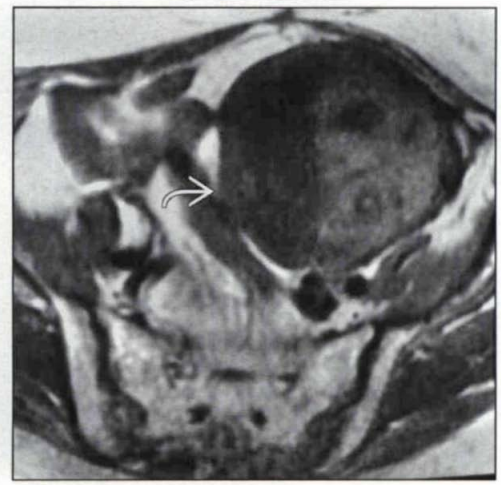
ACUTE LEFT LOWER QUADRANT PAIN

Omental Infarct

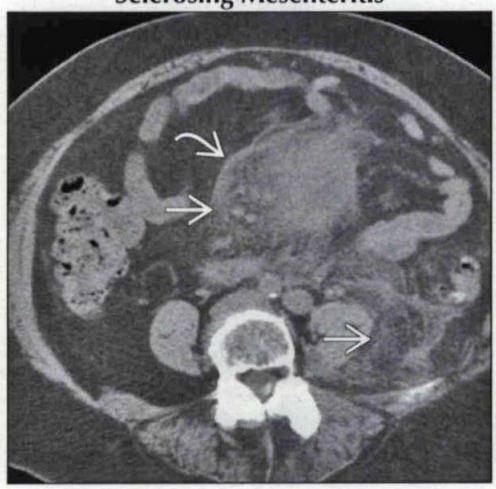


*(**Left**) Axial CECT shows a mottled fat density mass in the left lower quadrant in an adolescent who had a recent colectomy. This omental infarct caused local pain, tenderness and mass effect. (**Right**) Axial T1WI MR shows a large, heterogeneous, exophytic mass arising from the uterus, a degenerated subserosal fibroid (leiomyoma).*

Uterine Fibroids

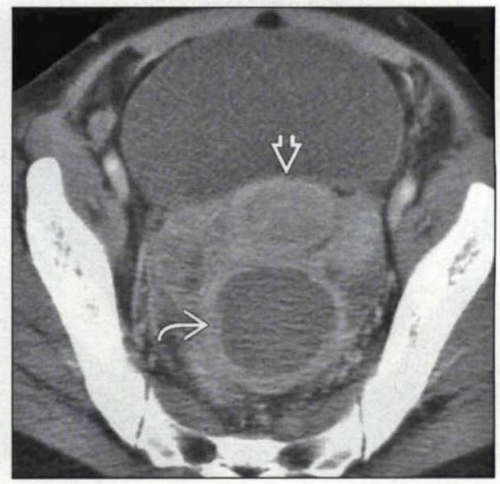


Sclerosing Mesenteritis



*(**Left**) Axial CECT shows extensive infiltration of the jejunal and sigmoid mesenteries with a thin capsule and clusters of minimally enlarged mesenteric nodes. (**Right**) Axial CECT shows a well loculated abscess in the pelvic recess, just dorsal to the uterus. This proved to be a tubo-ovarian abscess.*

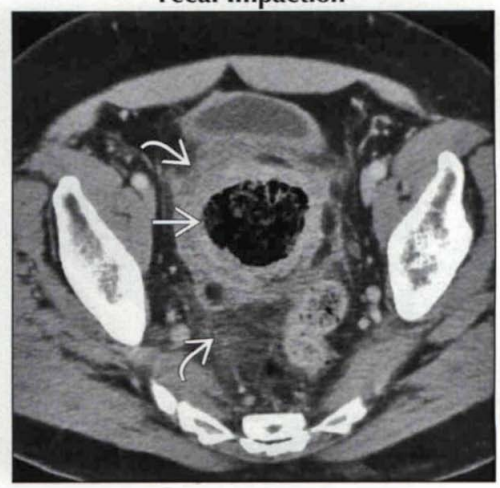
Abdominal Abscess



Sigmoid Volvulus

*(**Left**) Frontal radiograph shows a classic sigmoid volvulus, with an inverted U-shape of a massively dilated sigmoid colon. (**Right**) Axial CECT shows a large amount of inspissated feces within the rectosigmoid colon, with wall thickening & inflammation of adjacent fat suggesting stercoral ulceration.*

Fecal Impaction



ACUTE LEFT LOWER QUADRANT PAIN

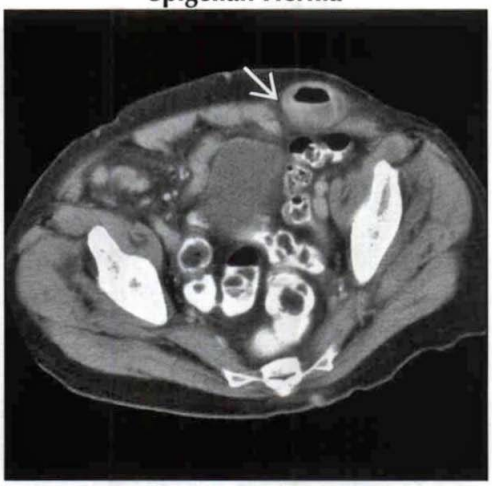
Renal Cell Carcinoma

Renal Infarction

*(**Left**) Coronal CECT shows a huge mass ➡ arising from and infiltrating the left kidney, with tumor thrombus in the left renal vein ➡. (**Right**) Axial CECT shows a sharply defined zone of swelling & poor enhancement ➡ in the left kidney in a young patient with renal ischemia due to vasculitis.*

Coagulopathic ("Retroperitoneal") Hemorrhage

Spigelian Hernia



*(**Left**) Axial NECT shows a massive rectus sheath hematoma with foci of active bleeding ➡, and some extension into the retroperitoneal spaces ➡. (**Right**) Axial CECT shows herniation of a portion of the descending colon through an abdominal wall defect ➡, just lateral to the rectus sheath.*

Inguinal Hernia

Inguinal Hernia

*(**Left**) Axial CECT shows colon and fat within a large left inguinal hernia ➡ that extends into the scrotum. (**Right**) Coronal CECT shows colon ➡ and fat within a large left inguinal hernia, extending into the scrotum.*

SECTION 8
Spleen

Generic Imaging Patterns

Splenomegaly 8-2
Multiple Splenic Calcifications 8-6
Solid Splenic Mass or Masses 8-8
Cystic Splenic Mass 8-10

Modality-Specific Imaging Findings

Diffuse Increased Attenuation, Spleen 8-12

SPLENOMEGALY

DIFFERENTIAL DIAGNOSIS

Common

- Cirrhosis with Portal Hypertension
- Congestive Heart Failure
- AIDS
- Splenic Metastases and Lymphoma
- Hemoglobinopathies
- Leukemia
- Sarcoidosis
- Mononucleosis
- Myeloproliferative Disorders
- Splenic Trauma

Less Common

- Splenic Tumors (Primary)
- Systemic Infection and Abscesses
- Splenic Vein Occlusion
  - Pancreatic Ductal Carcinoma
  - Pancreatitis, Chronic
- Splenic Infarction
- Malaria
- Collagen Vascular Diseases
  - Rheumatoid Arthritis
  - Scleroderma
  - Dermatomyositis
  - Polyarteritis Nodosa
- Storage Diseases
  - Amyloidosis
  - Glycogen Storage Disease
- Peliosis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Splenomegaly can usually be attributed to one of five general etiologies
  - Congestion
    - Right heart failure
    - Cirrhosis
    - Portal or splenic vein thrombosis
  - Hematologic
    - Polycythemia vera
    - Leukemia
    - Myelofibrosis
    - Hemoglobinopathies
    - Acute infarction
  - Inflammatory/infectious
    - Mononucleosis
    - Hepatitis
    - AIDS
    - IV drug abuse
    - Sarcoidosis
    - Collagen vascular disease
    - Malaria
  - Tumor
    - Cyst
    - Lymphoma and metastases
    - Benign tumors
  - Infiltrative diseases
    - Gaucher disease
    - Diabetes
    - Amyloidosis
    - Glycogen storage disease
    - Hemosiderosis

Helpful Clues for Common Diagnoses

- **Cirrhosis with Portal Hypertension**
  - Look for morphologic changes in liver (widened fissures; caudate hypertrophy)
  - Other signs of portal hypertension: Varices, ascites
- AIDS
  - Spleen may be enlarged due to chronic viremia, or any microbial infection of the spleen
  - Splenomegaly may also result from lymphoma, common in AIDS
  - Splenomegaly alone is not specific for AIDS even if patient is HIV positive
- **Splenic Metastases and Lymphoma**
  - Lymphoma (non-Hodgkin or Hodgkin) may cause splenomegaly ± focal splenic masses
  - Most cases of lymphoma result in splenomegaly with diffuse infiltration & no focal mass
  - Spleen may harbor lymphoma (or leukemia) without splenomegaly
- **Hemoglobinopathies**
  - Heterozygous sickle cell, thalassemia, spherocytosis
  - Homozygous sickle cell anemia results in infarction by age 20 and small, calcified, infarcted spleen
- **Leukemia**
  - Any form, especially chronic myelogenous leukemia (CML) in older adults
  - Asymptomatic splenomegaly may be only sign of CML
- **Sarcoidosis**
  - Generalized splenomegaly, often with innumerable small hypodense granulomas (on CT, US or MR)

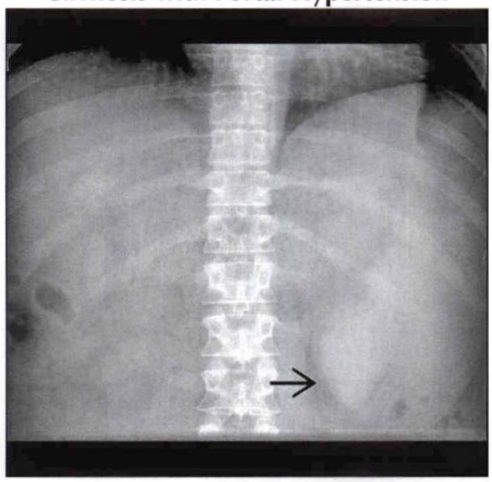
- Hepatomegaly also often present with similar small granulomas evident
- Look for adenopathy and characteristic thoracic abnormalities (usually present)

- **Myeloproliferative Disorders**
  - Polycythemia vera, myelofibrosis
  - Correlate with hematologic abnormalities
- **Splenic Trauma**
  - Acute: Intrasplenic, subcapsular, perisplenic hematoma
  - May be misinterpreted as splenomegaly on plain radiography; unlikely to be missed on CT evaluation

Helpful Clues for Less Common Diagnoses

- **Splenic Tumors (Primary)**
  - Benign tumors: Hemangioma, lymphangioma, hamartoma
    - Difficult to distinguish among these by imaging criteria alone
  - Malignant tumors: All rare; angiosarcoma, malignant fibrous histiocytoma, sarcoma
    - Angiosarcoma is the most common of these, usually coexists with liver tumors of similar appearance
- **Systemic Infection and Abscesses**
  - Spleen is often enlarged in patients with persistent bacteremia or viremia (e.g., IV drug users, patients with hepatitis, sepsis)
- **Splenic Vein Occlusion**
  - Often accompanies chronic pancreatitis & carcinoma of pancreatic body
  - Spleen becomes "congested"
- **Splenic Infarction**
  - Acute infarction can be associated with splenic enlargement
  - Conversely, splenomegaly of many etiologies predisposes to splenic infarction
  - Chronic focal or global splenic infarction leads to volume loss in spleen
- **Malaria**
  - Splenomegaly is often an impressive feature of this disease
- **Collagen Vascular Diseases**
  - Also known as connective tissue disorders
  - Includes a variety of related disorders that have somewhat overlapping features
  - Includes: Rheumatoid arthritis, scleroderma, dermatomyositis, polyarteritis
  - Felty syndrome: Rheumatoid arthritis, splenomegaly & granulocytopenia
    - Splenectomy may be required to treat the "hypersplenism" that causes low white blood cell or platelet count
- **Storage Diseases**
  - **Amyloidosis**
    - Metabolic disease associated with deposition of abnormal proteins in one or more organs
    - May be primary or associated with other diseases (multiple myeloma, lymphoma, osteomyelitis, rheumatoid arthritis)
    - Often causes hepatosplenomegaly
  - **Glycogen Storage Disease**
    - Many related metabolic diseases, all caused by enzymatic defect that alters the metabolism of glycogen, resulting in its storage in various tissues

Cirrhosis with Portal Hypertension



Frontal radiograph shows a left upper quadrant mass, with the inferior tip of the spleen ⇨ outlined; 34 year old man with cirrhosis & portal hypertension causing splenomegaly.

Cirrhosis with Portal Hypertension

Axial CECT shows a nodular, small liver with widened fissures due to cirrhosis in the same patient. Splenomegaly and ascites are due to portal hypertension.

SPLENOMEGALY

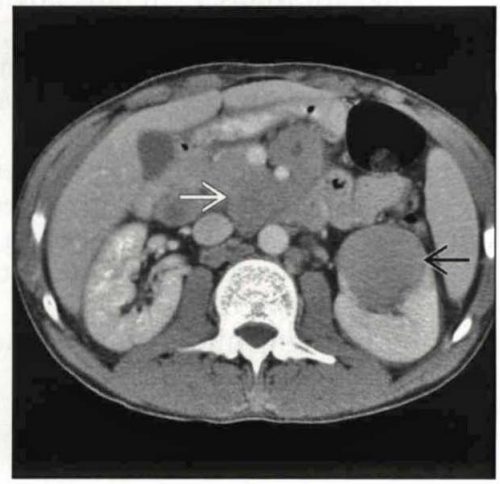
AIDS

AIDS

(Left) *Axial CECT shows hepatosplenomegaly with innumerable small low density foci in the spleen, due to Mycobacterial infection; 35 year old man with AIDS.* ***(Right)*** *Axial CECT shows hepatosplenomegaly and low density foci in the spleen and in enlarged mesenteric & retroperitoneal nodes ➡, all due to Mycobacterial infection; 35 year old man with AIDS.*

AIDS

AIDS



(Left) *Axial CECT shows hepatosplenomegaly with scattered focal lesions ➡: NHL in a 34 year old man with multiorgan lymphoma. Splenomegaly alone is a common & nonspecific finding in HIV-positive patients.* ***(Right)*** *Axial CECT shows lymphadenopathy ➡, splenomegaly, and a solid renal mass ➡, all due to lymphoma in a 34 year old man with AIDS.*

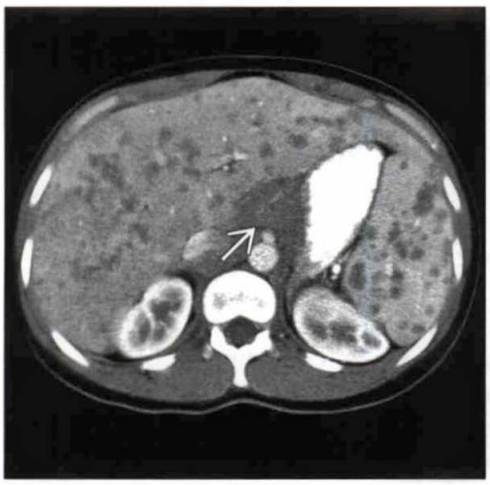
Splenic Metastases and Lymphoma

Leukemia

(Left) *Axial CECT shows splenomegaly and massive lymphadenopathy, including mesenteric nodes ➡, as an important clue for the diagnosis of non-Hodgkin lymphoma; 73 year old woman.* ***(Right)*** *Axial CECT shows "isolated", massive splenomegaly with no lymphadenopathy or other signs of disease. Chronic myelogenous leukemia in a 54 year old man. Marked splenomegaly is often the presenting sign of CML in older adults.*

SPLENOMEGALY

Sarcoidosis



Mononucleosis

(Left) Axial CECT shows hepatosplenomegaly with innumerable low density granulomas. Also note celiac lymphadenopathy. These findings are typical of abdominal sarcoidosis, but could be simulated by opportunistic infection or lymphoma. (Right) Axial CECT shows an enlarged spleen with a "sentinel clot" around it. This spontaneous rupture of the spleen was the presenting complaint of a 21 year old man with mononucleosis.

Myeloproliferative Disorders

Splenic Tumors (Primary)

(Left) Axial NECT shows marked splenomegaly and indirect evidence of anemia with low density blood vessels (relative to liver); myelofibrosis. (Right) Axial CECT shows a large complex splenic mass that was resected and found to be an epithelioid tumor with no malignant signs in this elderly woman. The appearance is nonspecific and could be seen with other benign or malignant masses.

Splenic Vein Occlusion

Amyloidosis

(Left) Axial CECT shows extensive pancreatic calcification from chronic pancreatitis which also led to splenic & portal vein thrombosis and splenomegaly. Cavernous transformation of the portal vein is marked by collateral vessels in the porta hepatis. (Right) Axial CECT shows hepatosplenomegaly in a patient with multiple myeloma, and amyloidosis. The CT findings are nonspecific in this case.

MULTIPLE SPLENIC CALCIFICATIONS

DIFFERENTIAL DIAGNOSIS

Common
- Histoplasmosis
- Tuberculosis
- Arterial Calcification and Aneurysm
- Pneumocystis Carinii
- Splenic Infarction
- Splenic Cyst

Less Common
- Echinococcal (Hydatid) Cyst
- Healed Abscess

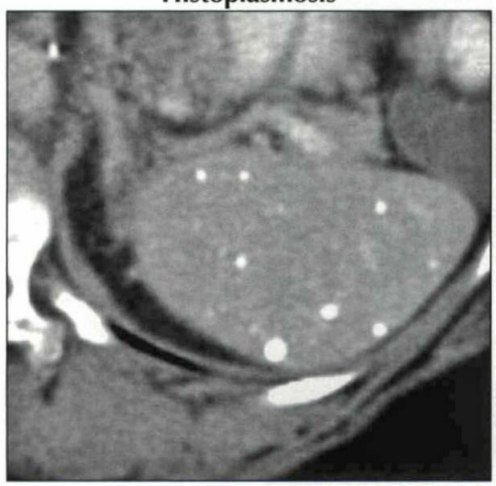
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Morphology of calcification usually suggests origin

Helpful Clues for Common Diagnoses
- **Histoplasmosis**
  - Most common cause for multiple (> 6), small, rounded calcified lesions (granulomas)
  - Commonly see similar lesions in liver
- **Tuberculosis**
  - Usually not as many calcified granulomas as with histoplasmosis
  - May have involvement of liver, adrenals, mesenteric nodes
  - Other mycobacterial (e.g., M. Avium complex) in immunocompromised patients
- **Arterial Calcification and Aneurysm**
  - Common cause of parallel (tram track) calcification in left upper quadrant
  - Splenic artery commonly very tortuous
  - Consider splenic artery aneurysm for rounded "eggshell" calcifications near splenic hilum
- **Pneumocystis Carinii**
  - Healed phase of Pneumocystis (or other opportunistic infections, usually associated with AIDS)
  - May result in diffuse or multifocal calcifications in spleen
- **Splenic Infarction**
  - Homozygous sickle cell anemia often results in small calcified spleen after multiple infarctions
  - Other hemoglobinopathies or other causes of infarction can result in focal, diffuse or subcapsular splenic calcifications
- **Splenic Cyst**
  - Often displays eggshell calcification
  - Congenital (epithelial lined) or acquired (post-traumatic or post-infarction) cysts cannot be distinguished by imaging

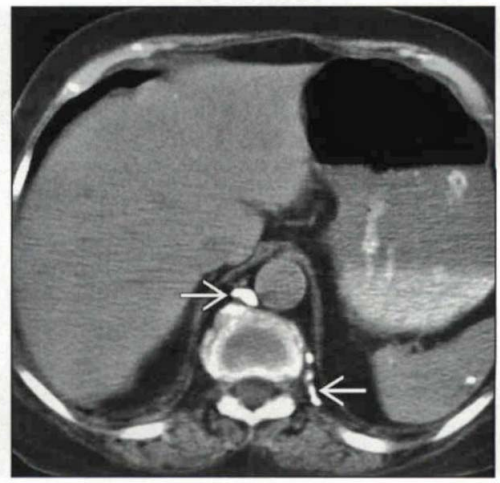
Helpful Clues for Less Common Diagnoses
- **Echinococcal (Hydatid) Cyst**
  - Common in sheep herding populations
  - Eggshell calcifications in spleen (uncommonly), liver, peritoneal cavity
- **Healed Abscess**
  - Any form of splenic infection may heal as a calcified scar

Histoplasmosis



Axial CECT shows dozens of small punctate calcifications in the spleen, typical of healed histoplasmosis granulomas.

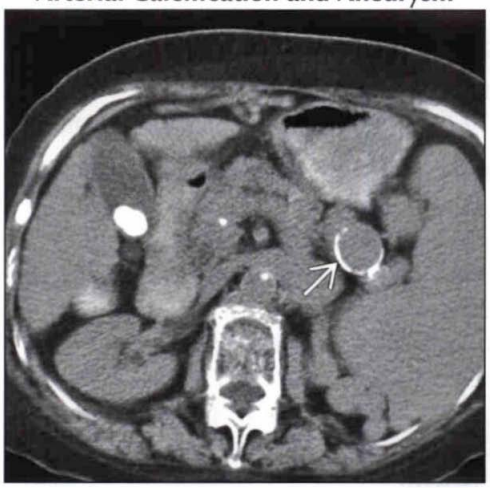
Tuberculosis



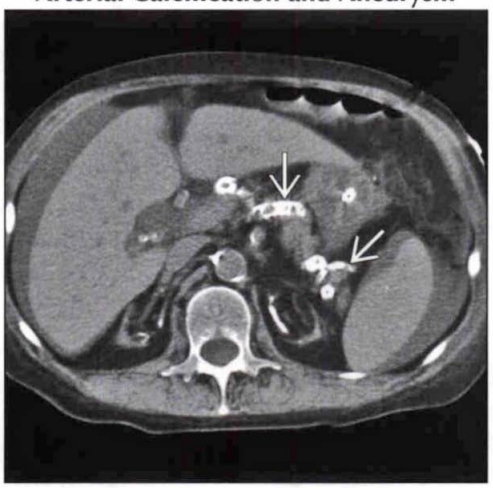
Axial NECT shows several punctate splenic calcified granulomas in a 75 year old woman who also had calcified abdominal nodes ➡ and renal & adrenal lesions from TB.

MULTIPLE SPLENIC CALCIFICATIONS

Arterial Calcification and Aneurysm

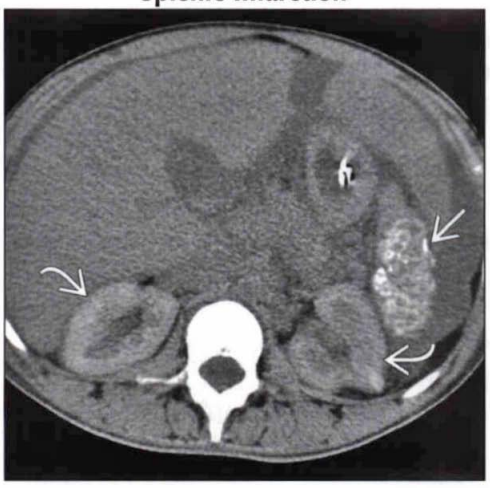


Arterial Calcification and Aneurysm

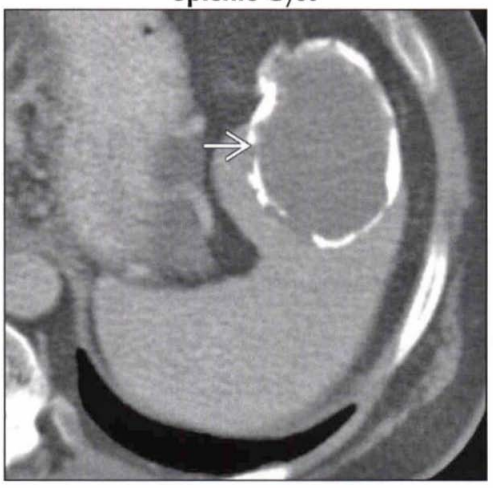


(Left) *Axial NECT shows an eggshell calcification ➡ near the splenic hilum that represents a splenic artery aneurysm.* ***(Right)*** *Axial NECT shows extensive arterial atherosclerotic calcifications, including the splenic artery ➡, in a 65 year old man with type 1 diabetes mellitus. Note the tram track, linear configuration of arterial calcifications.*

Splenic Infarction

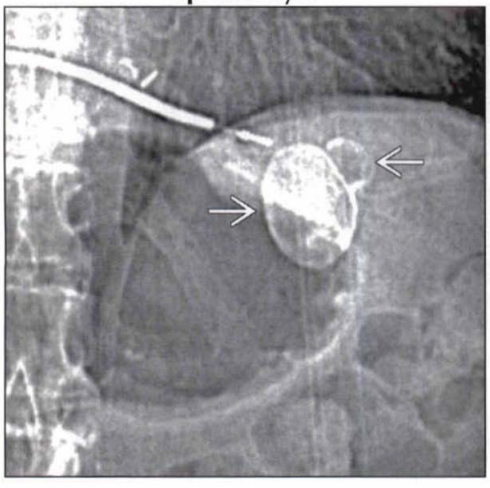


Splenic Cyst



(Left) *Axial NECT shows diffuse calcification in a small, infarcted spleen ➡ in this patient with sickle cell anemia. Also note renal cortical calcification ➡ of the same etiology.* ***(Right)*** *Axial CECT shows an eggshell calcified cyst ➡ within the spleen, probably due to prior infection or infarction; asymptomatic middle-aged woman.*

Splenic Cyst



Echinococcal (Hydatid) Cyst

(Left) *Frontal radiograph shows 2 eggshell calcified splenic cysts ➡, probably due to prior infection or infarction, in an elderly man.* ***(Right)*** *Axial CECT shows multiple spherical lesions ➡ in the spleen, some of which have calcified walls, representing hydatid cysts in an elderly man who had similar lesions in his liver and peritoneal cavity.*

SOLID SPLENIC MASS OR MASSES

DIFFERENTIAL DIAGNOSIS

Common
- Splenic Trauma
- Splenic Infarction
- Splenic Metastases and Lymphoma
- Perfusion Artifact

Less Common
- Sarcoidosis
- Splenic Infection and Abscess
- Splenic Tumors
- Peliosis

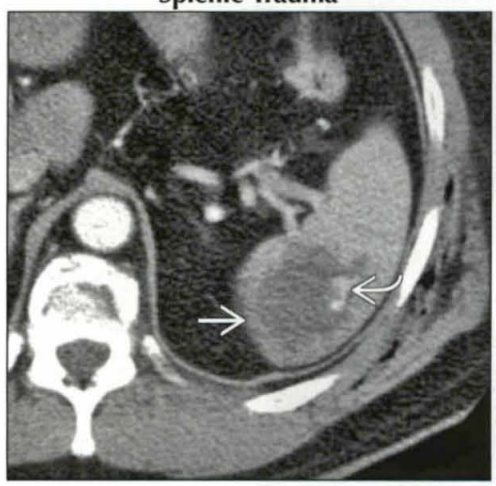
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Solid neoplastic splenic masses are rare, except for lymphoma & metastases

Helpful Clues for Common Diagnoses
- **Splenic Trauma**
  - Acute splenic laceration
    - Hematoma appears heterogeneous, hyperdense on NECT
    - Echogenic on US
- **Splenic Infarction**
  - Acute appears as heterogeneous, hypodense on CECT
  - Often multifocal, wedge-shaped; extends to capsular surface of spleen
- **Splenic Metastases and Lymphoma**
  - Usually multifocal; hypodense on CECT
  - Lymphoma, melanoma, myeloma
  - Direct invasion of spleen by cancer of stomach or pancreas
- **Perfusion Artifact**
  - Only seen on arterial phase CECT or MR; homogeneous spleen on later phases
  - Zebra stripe or moire pattern
  - Especially common in portal hypertension

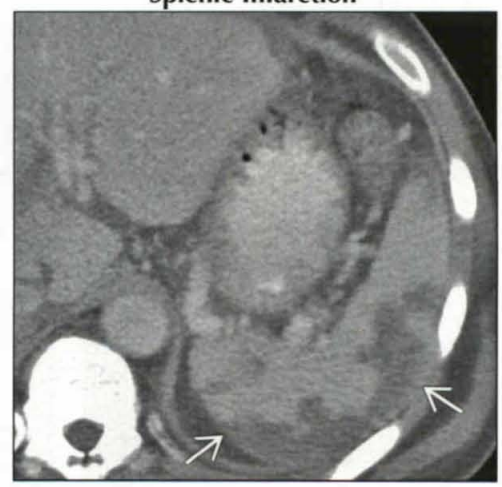
Helpful Clues for Less Common Diagnoses
- **Sarcoidosis**
  - May cause splenomegaly ± multifocal hypodense (CECT), hypoechoic (US), small splenic lesions
- **Splenic Infection and Abscess**
  - Any opportunistic infection in AIDS & transplant recipients (viral, protozoan, bacterial, mycobacterial, fungal)
- **Splenic Tumors**
  - Primary benign tumors (lymphangioma, hemangioma, hamartoma); nonspecific imaging appearance; often with cystic components
    - Hamartoma: Hypervascular, may have uptake of Tc sulfur colloid
  - Multiple splenic & systemic angiomas in Kasabach-Merritt & other syndromes
  - Primary malignant tumor: angiosarcoma, usually heterogeneous hypervascular mass
    - Usually have similar tumor in liver
- **Peliosis**
  - Rare disorder; blood filled spaces within liver ± spleen
  - Associated with immunocompromise, chronic illness, certain medications

Splenic Trauma



Axial CECT shows a hypodense hematoma within the enhanced splenic parenchyma, and a focus of active bleeding. There was no intraperitoneal bleeding in this patient.

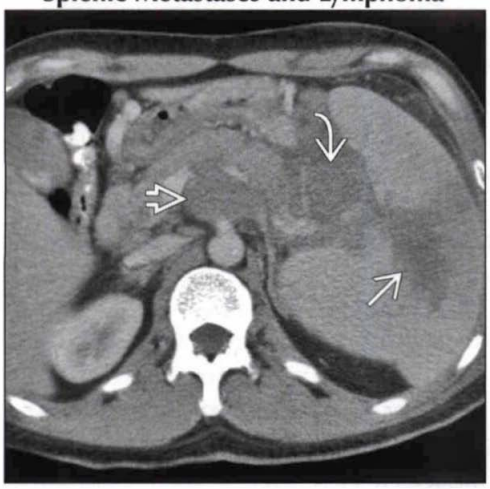
Splenic Infarction



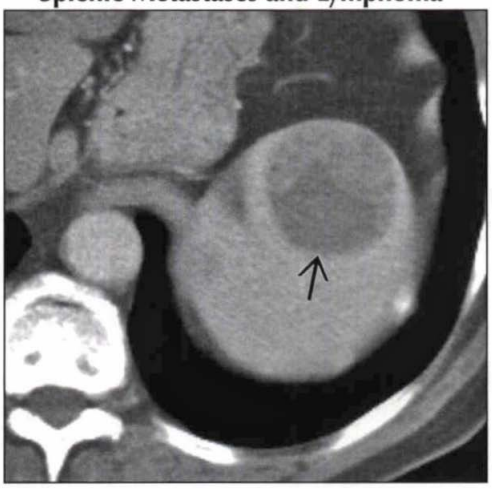
Axial CECT shows multiple subcapsular, hypoenhancing foci in the spleen in a patient with portal hypertension who recently had liver transplantation; typical acute splenic infarctions.

SOLID SPLENIC MASS OR MASSES

Splenic Metastases and Lymphoma

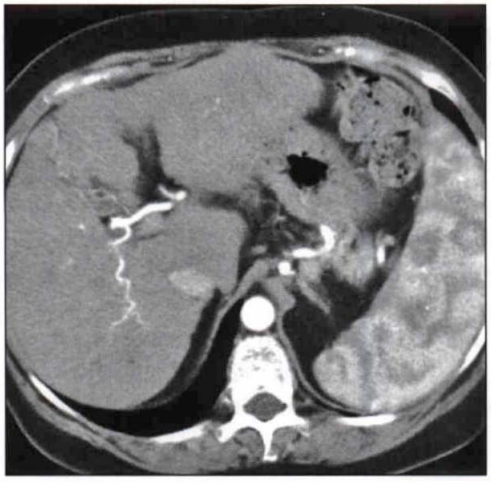


Splenic Metastases and Lymphoma

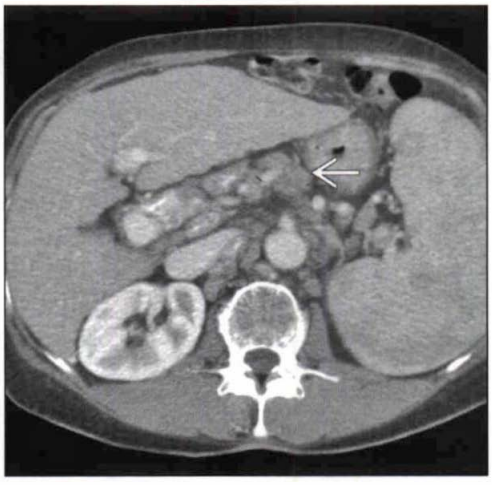


(Left) *Axial CECT shows a heterogeneous mass within the splenic parenchyma ➡, splenic hilum ➡ and abdominal nodes ➡; large cell lymphoma.* ***(Right)*** *Axial CECT shows one ➡ of several splenic masses that represent metastatic melanoma. The known skin tumor and presence of similar lesions in other organs and nodes allowed diagnosis.*

Perfusion Artifact

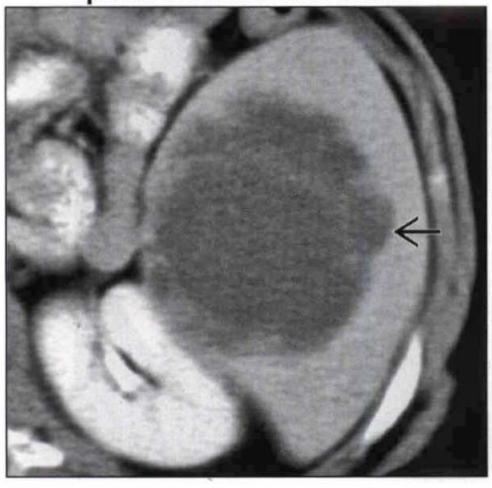


Sarcoidosis



(Left) *Axial CECT shows heterogeneous enhancement of the spleen, a common normal variant on arterial phase CECT, especially in patients such as this, who have cirrhosis and portal hypertension. The spleen appeared normal on portal venous phase CECT.* ***(Right)*** *Axial CECT shows enlargement and heterogeneity of the spleen, with lymphadenopathy ➡ & a dysmorphic, cirrhotic-appearing liver, all due to sarcoidosis.*

Splenic Infection and Abscess



Splenic Tumors

(Left) *Axial CECT shows a heterogeneous splenic mass ➡ that proved to be a pyogenic abscess, possibly the result of an infected infarct in a patient with a history of IV drug abuse.* ***(Right)*** *Axial CECT shows a large, heterogeneous splenic mass in a 72 year-old woman who presented with left upper quadrant discomfort. Benign epithelioid tumor on resection, although the imaging appearance is nonspecific.*

CYSTIC SPLENIC MASS

DIFFERENTIAL DIAGNOSIS

Common
- Splenic Cyst (Acquired)
- Splenic Cyst (Congenital)
- Splenic Trauma
- Splenic Infarction

Less Common
- Splenic Metastases and Lymphoma
- Splenic Infection and Abscess
- Splenic Tumors
- Pancreatic Pseudocyst

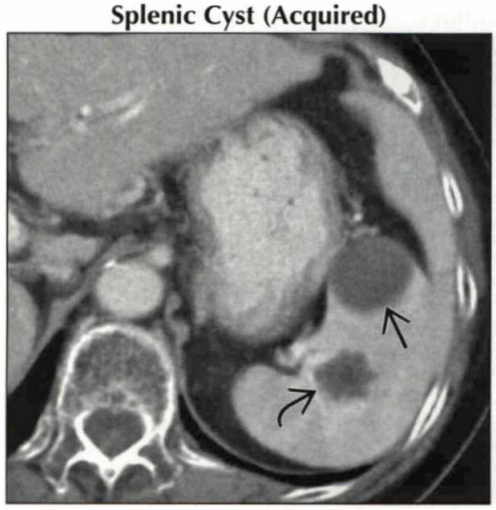
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Cannot distinguish between congenital and acquired cyst by imaging

Helpful Clues for Common Diagnoses
- **Splenic Cyst (Acquired)**
  - Result of prior trauma, infection, infarction (= 80% of cysts)
  - May have calcified wall
- **Splenic Cyst (Congenital)**
  - Same appearance as acquired cyst
  - Has epithelial lining
- **Splenic Trauma**
  - Acute splenic hematoma is hyperechoic (US), heterogeneous, hyperdense (NECT)
  - May evolve into sonolucent, hypodense, cystic lesion
- **Splenic Infarction**
  - May evolve into splenic cyst after a few days to weeks

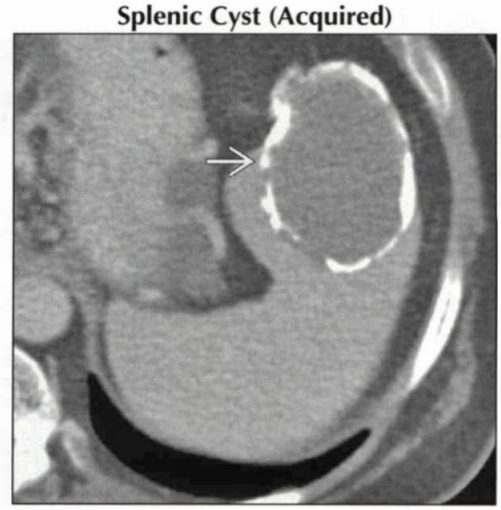
Helpful Clues for Less Common Diagnoses
- **Splenic Metastases and Lymphoma**
  - From cystic primary tumors (e.g., ovarian)
  - Other metastatic lesions & lymphoma are solid lesions but may be homogeneously hypovascular and mimic cyst on imaging (CT, US and MR)
  - Check for involvement of liver, nodes; consider biopsy
- **Splenic Infection and Abscess**
  - Microabscesses usually due to Candida albicans; immunocompromised patients
  - Pyogenic abscess uncommon; often result of infection of infarcted splenic tissue
  - Hydatid abscesses are rare
- **Splenic Tumors**
  - Primary splenic tumors are uncommon
  - Usually lymphangioma or hemangioma
  - Appearances are variable and nonspecific; often include cystic and solid components
  - Angiosarcoma: Rare primary splenic tumor
    - Usually heterogeneously hypervascular
    - Usually have liver tumors as well
- **Pancreatic Pseudocyst**
  - Pancreatitis involving tail segment can easily spread into spleen via splenorenal ligament
  - May evolve into intrasplenic pseudocyst
  - Crescentic, subcapsular cystic lesion with compression & distortion of parenchyma

Splenic Cyst (Acquired)



Axial CECT shows a larger simple-appearing cyst ⇨ with no visible wall, and a smaller lesion ⇨ with mural nodularity and subtle septation that probably represents a lymphangioma or hemangioma.

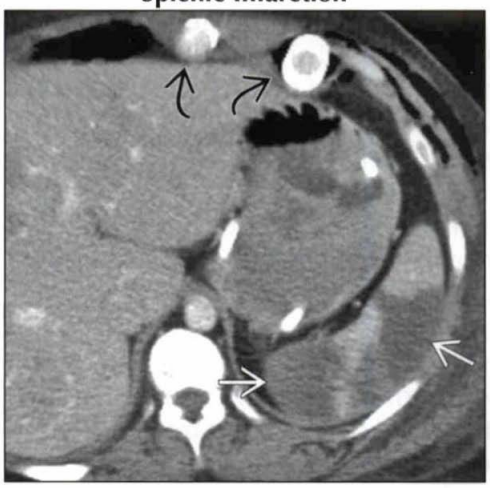
Splenic Cyst (Acquired)



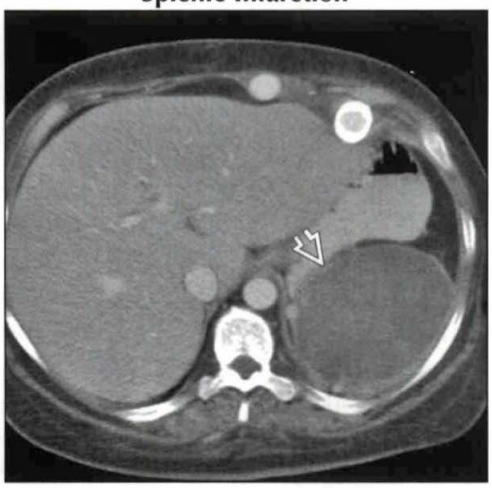
Axial CECT shows eggshell calcification surrounding an acquired (probably post-traumatic) cyst ➡

CYSTIC SPLENIC MASS

Splenic Infarction

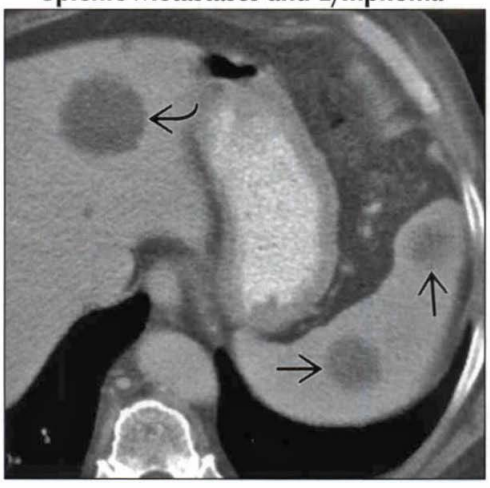


Splenic Infarction

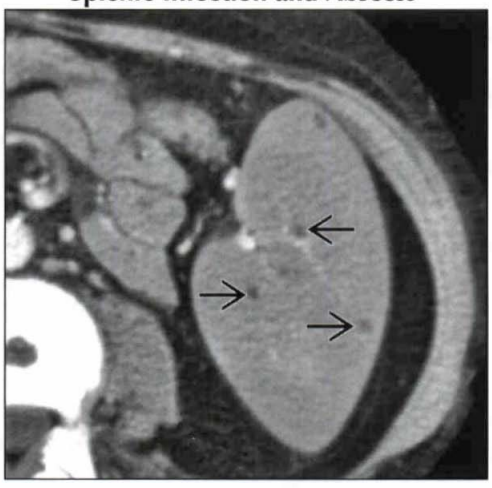


(Left) *Axial CECT shows typical acute splenic infarcts ➡, as wedge-shaped zones of decreased enhancement, that evolved into splenic cysts. Note tubing ⇨ for a ventricular assist device in a 37 year-old woman with cardiomyopathy.* ***(Right)*** *Axial CECT shows the acquired splenic cyst ⇨ that was the result of splenic infarction in the same patient. The cyst developed within 6 weeks of the acute infarction.*

Splenic Metastases and Lymphoma

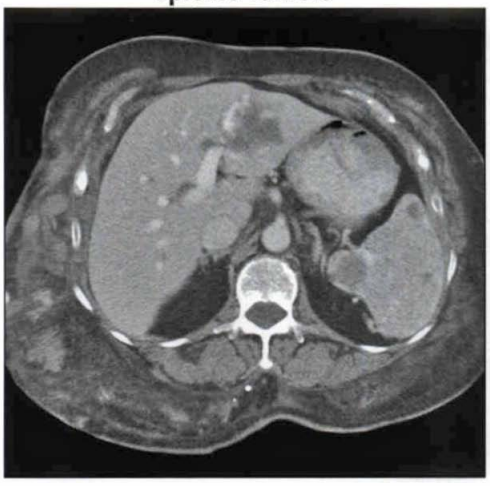


Splenic Infection and Abscess



(Left) *Axial CECT shows two lesions ⇨ in the spleen that are slightly complex and higher than water density, compared with the simple hepatic cyst ⇨; metastatic melanoma.* ***(Right)*** *Axial CECT shows a few ⇨ of the innumerable tiny hypodense lesions in the spleen of a young woman with Candida microabscesses, who was recovering from recent renal transplantation.*

Splenic Tumors



Pancreatic Pseudocyst

(Left) *Axial CECT shows multiple splenic, hepatic, and subcutaneous hemangiomas in a patient with Kasabach-Merritt syndrome, characterized by multiple hemangiomas, thrombocytopenia, and coagulopathy.* ***(Right)*** *Axial CECT shows 2 pancreatic pseudocysts, one ➡ of which lies within the splenic capsule, causing mass effect and compression of the spleen. Acute pancreatic inflammation affecting the tail segment can extend into the splenic hilum.*

DIFFUSE INCREASED ATTENUATION, SPLEEN

DIFFERENTIAL DIAGNOSIS

Common
- Hemochromatosis
- Splenic Infarction
  - Sickle Cell Anemia

Less Common
- Opportunistic Infection
- Thorotrast

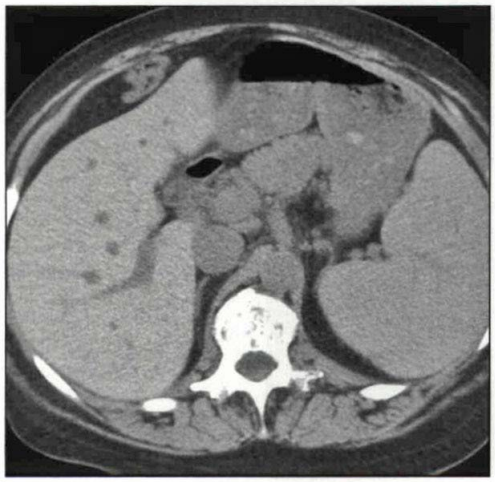
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Spleen is often used as a standard on CT and MR by which to recognize liver pathology
  - Splenic attenuation not altered by metabolic processes, other than calcification and iron deposition
  - Normal attenuation of spleen on NECT is 8 to 10 HU less than that of liver
  - Normal spleen is of higher signal than liver on T2WI
  - Normal spleen is slightly less intense than liver, greater than muscle on T1WI
  - Active infection or tumor within spleen is usually of increased signal on T2WI

Helpful Clues for Common Diagnoses
- **Hemochromatosis**
  - Primary form: Inherited; increased absorption of dietary iron
    - Does not result in deposition in spleen
  - Secondary form: Hemoglobinopathies, transfusions, portocaval shunt
    - Iron is deposited in reticuloendothelial system, including spleen
  - CT shows increased attenuation in liver and in spleen for secondary form
  - MR shows decreased signal intensity in liver (± spleen) relative to muscle on both T1- and T2WI
- **Splenic Infarction**
  - **Sickle Cell Anemia**
    - Results in repeated episodes of splenic infarctions; by adulthood, usually small, diffusely calcified spleen ("autosplenectomy")
  - Other hemoglobinopathies and other causes of splenic infarction result in segmental or subcapsular infarction which may calcify

Helpful Clues for Less Common Diagnoses
- **Opportunistic Infection**
  - Healed phase of many splenic infections results in multifocal calcifications (histoplasmosis, mycobacterial diseases, CMV, herpes)
  - Diffuse calcification more likely to result from Pneumocystis carinii infection
  - Earlier phase of infection usually shows multiple low attenuation lesions within an enlarged spleen on CECT
  - Active lesions are usually of intermediate signal on T1WI and of high signal intensity on T2WI
  - Look for similar involvement of liver, lymph nodes, adrenal glands

Hemochromatosis



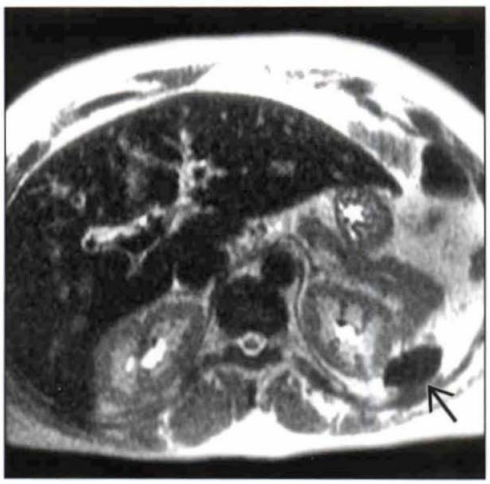
Axial NECT shows subtle increased attenuation of both liver and spleen in this 49 year old woman who has received multiple transfusions because of multiple myeloma.

Hemochromatosis

Axial T1WI GRE shows markedly decreased signal in the liver and spleen due to transfusion-induced hemochromatosis in this 49 year old woman with multiple myeloma.

DIFFUSE INCREASED ATTENUATION, SPLEEN

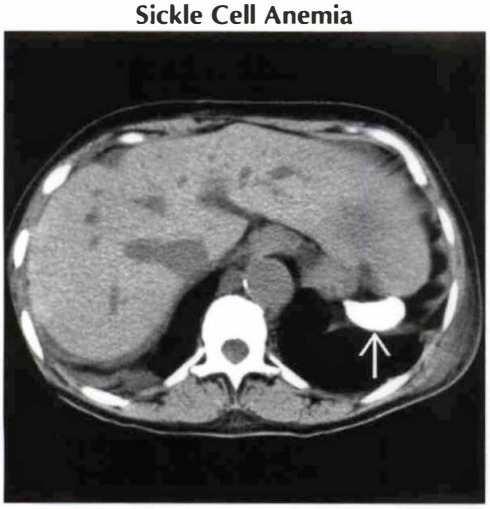
Hemochromatosis



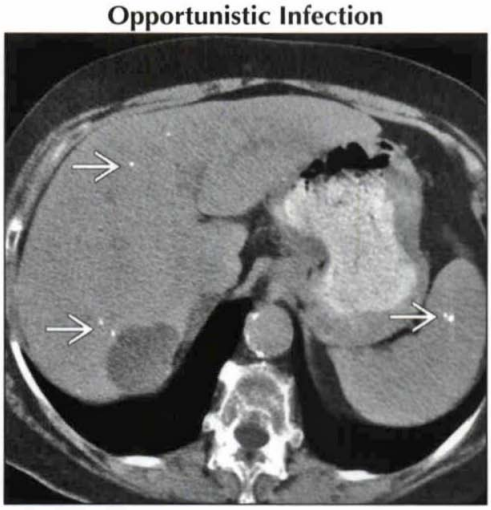
Sickle Cell Anemia

*(**Left**) Axial T1WI FS MR shows marked signal loss in liver and spleen in a 25 year old woman with sickle cell disease. The liver appearance is due to transfusion hemochromatosis, while the spleen ⇨ has a combination of excess iron and calcium, with chronic splenic infarction. (**Right**) Axial NECT shows a small calcified spleen ➡ in a 26 year old woman with sickle cell disease. Note the peripheral calcification in the kidneys ➡ due to cortical necrosis.*

Sickle Cell Anemia

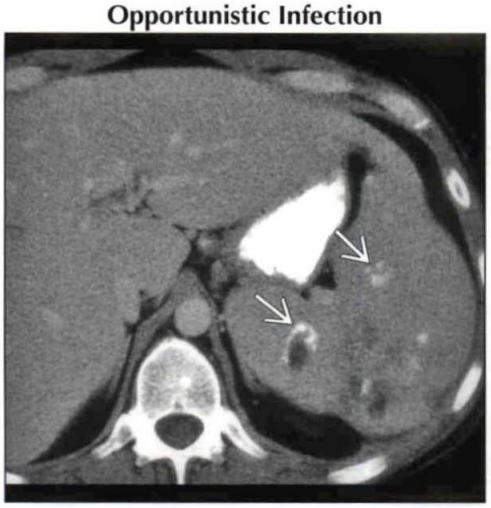


Opportunistic Infection

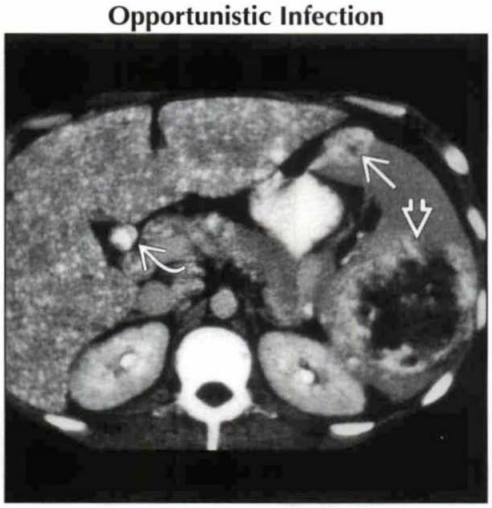


*(**Left**) Axial NECT shows a very small, densely calcified spleen ➡ in a 35 year old woman with sickle cell disease. This is a classic example of "autosplenectomy" due to repeated splenic infarctions. (**Right**) Axial NECT shows multiple small calcifications ➡ in the liver and spleen, probably due to healed histoplasmosis in this asymptomatic 27 year old man.*

Opportunistic Infection



Opportunistic Infection



*(**Left**) Axial CECT in a HIV positive patient with Pneumocystis pneumonia shows multiple calcifications ➡ within the spleen, some of which surround low density abscesses. (**Right**) Axial CECT shows a more dramatic case of opportunistic infection. There are calcifications ➡ and an abscess ⇨ within the spleen, as well as diffuse punctate calcifications within the liver & lymph nodes ➡. The spleen was removed & multiple organisms cultured, including Pneumocystis.*

SECTION 9
Liver

Generic Imaging Patterns

Liver Mass with Central or Eccentric Scar	9-2
Focal Liver Lesion with Hemorrhage	9-4
Liver "Mass" with Capsular Retraction	9-6
Fat-Containing Liver Mass	9-8
Cystic Hepatic Mass	9-10
Focal Hypervascular Liver Lesion	9-14
Mosaic or Patchy Hepatogram	9-20
Hepatic Calcifications	9-22
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Portal Venous Gas	9-28
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Dysmorphic Liver with Abnormal Bile Ducts	9-32
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Modality-Specific Imaging Findings

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Hyperechoic Liver, Diffuse	9-76

LIVER MASS WITH CENTRAL OR ECCENTRIC SCAR

DIFFERENTIAL DIAGNOSIS

Common
- Focal Nodular Hyperplasia
- Hepatic Cavernous Hemangioma

Less Common
- Fibrolamellar HCC
- Hepatocellular Carcinoma
- Cholangiocarcinoma (Peripheral)
- Hepatic Adenoma
- Hepatic Metastases
- Epithelioid Hemangioendothelioma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Characterize size of scar, pattern of mass enhancement, associated findings

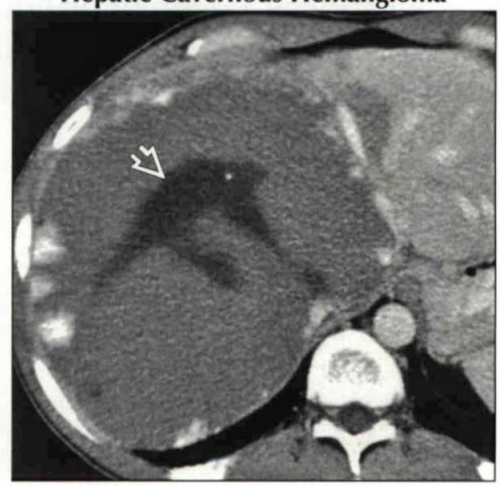
Helpful Clues for Common Diagnoses
- **Focal Nodular Hyperplasia**
  - Larger FNH lesions (> 3 cm) usually have a small central scar ± thin radiating septa
  - Bright, homogeneous enhancement on arterial phase
  - Nearly isodense (isointense) to liver on all other phases
  - Central scar bright on T2WI; shows delayed persistent enhancement on MR and CT
- **Hepatic Cavernous Hemangioma**
  - Large hemangiomas (> 5 cm) commonly have fibrotic scar that may calcify
  - Non-scarred portions of hemangioma have typical nodular enhancement

Helpful Clues for Less Common Diagnoses
- **Fibrolamellar HCC**
  - Large, heterogeneous mass on all phases of imaging; large, calcified scar
  - Local invasion (vessels, bile ducts) and metastases (nodes, lung) at presentation
- **Hepatocellular Carcinoma**
  - Large tumors, especially in noncirrhotic liver, may resemble fibrolamellar HCC
  - Central necrosis or scar, heterogeneous hypervascular mass
  - Vascular invasion and metastases are common
- **Cholangiocarcinoma (Peripheral)**
  - May have extensive fibrous stroma with typical delayed persistent enhancement
  - Overlying capsular retraction, hepatic volume loss
  - Biliary and portal venous obstruction
- **Hepatic Adenoma**
  - Low density foci due to fat, necrosis, old hemorrhage; not scar
- **Hepatic Metastases**
  - Target appearance; necrosis, not scar
  - Breast and other metastases may have substantial fibrous stroma, especially following treatment
- **Epithelioid Hemangioendothelioma**
  - Multiple, coalescent, peripheral nodules with target appearance
  - Capsular retraction over lesions

Focal Nodular Hyperplasia

Axial CECT shows a homogeneously and brightly enhancing mass with a central scar on this arterial phase image. The mass became isodense with liver on portal venous phase CT.

Hepatic Cavernous Hemangioma

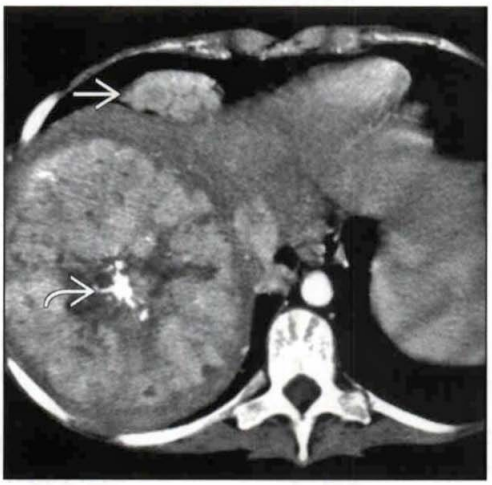


Axial CECT shows a large mass with peripheral nodular enhancement, isodense to vessels. A central scar with a small focus of calcification, did not "fill in" on delayed imaging.

LIVER MASS WITH CENTRAL OR ECCENTRIC SCAR

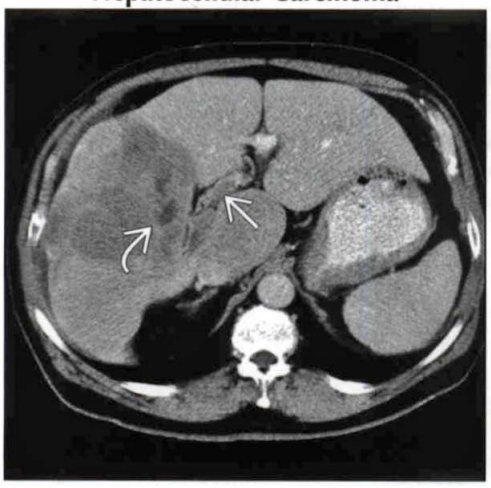
Hepatic Cavernous Hemangioma

Fibrolamellar HCC

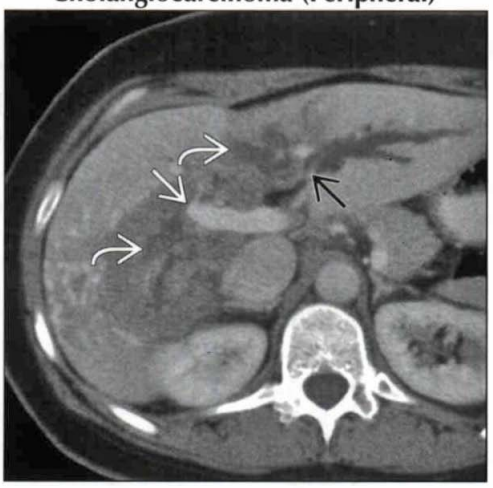


(Left) *Axial T2W1 MR demonstrates a large mass ➡ that is very bright and well-defined on T2W1. A central scar ➡ is even more intense, typical of a large cavernous hemangioma.* ***(Right)*** *Axial CECT shows a heterogeneous hypervascular mass with a large calcified central scar ➡ in a 22 year old man. Note the similar enhancement of tumor in a cardiophrenic node ➡.*

Hepatocellular Carcinoma



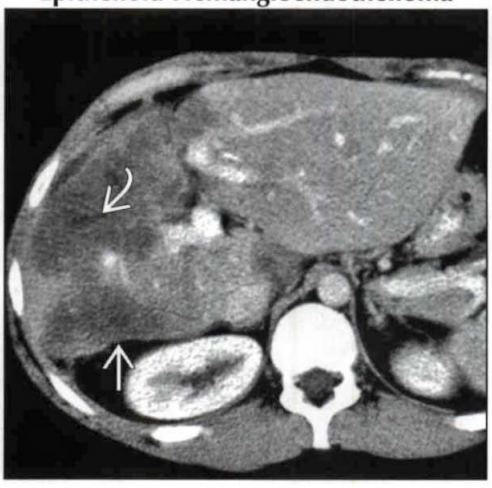
Cholangiocarcinoma (Peripheral)



(Left) *Axial CECT shows a large mass with an eccentric "scar" ➡ or necrotic area. Tumor invasion of portal vein ➡ helps to identify this as HCC.* ***(Right)*** *Axial CECT shows a large hepatic mass with foci of scar or necrosis ➡. Capsular retraction and occlusion of the portal vein ➡ and bile duct ➡ help confirm cholangiocarcinoma.*

Hepatic Adenoma

Epithelioid Hemangioendothelioma



(Left) *Axial NECT shows heterogeneous mass in the left lobe. At resection the focus of high attenuation ➡ was hemorrhage, and the lower density foci ➡ were necrosis and fibrosis.* ***(Right)*** *Axial CECT shows confluent masses in the periphery of the liver with capsular retraction ➡ and central scar ➡.*

FOCAL LIVER LESION WITH HEMORRHAGE

DIFFERENTIAL DIAGNOSIS

Common
- Hepatic Trauma
- Hepatic Adenoma
- Hepatocellular Carcinoma
- Hepatic Cyst
- AD Polycystic Disease, Liver

Less Common
- Coagulopathic Hemorrhage, Liver
- Hepatic Metastases
- HELLP Syndrome

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Hemorrhage may be detected as heterogeneous high attenuation (> 60 HU on NECT), or high intensity foci on T1WI or spin density images, and on T2WI

Helpful Clues for Common Diagnoses
- **Hepatic Trauma**
  - Blunt or penetrating (including biopsies, TIPS, etc.)
  - Hepatic lacerations usually have linear or stellate configuration
- **Hepatic Adenoma**
  - Foci of hemorrhage within tumor is common feature on MR, less common on CT
  - Spontaneous bleeding within or around a hepatic mass in a young woman without cirrhosis is almost diagnostic of adenoma
- **Hepatocellular Carcinoma**
  - Spontaneous hemorrhage within tumor is uncommon
  - Spontaneous rupture through capsule is relatively common for large HCC
- **Hepatic Cyst**
  - Isolated or part of AD polycystic disease
  - Clotted blood in cyst may be mistaken for tumor; but will not show enhancement

Helpful Clues for Less Common Diagnoses
- **Coagulopathic Hemorrhage, Liver**
  - Spontaneous intrahepatic or perihepatic hemorrhage is rare manifestation of coagulopathy, or anticoagulant therapy
  - Spherical hematoma within liver may simulate tumor
- **Hepatic Metastases**
  - Hemorrhage is uncommon, usually associated with hypervascular metastases
  - May occur following chemotherapy or transhepatic ablation of metastatic lesions
- **HELLP Syndrome**
  - Hemolysis, Elevated Liver Enzymes, Low Platelets
  - Severe variation of toxemia of pregnancy
  - Foci of infarction and bleeding within liver

Hepatic Trauma

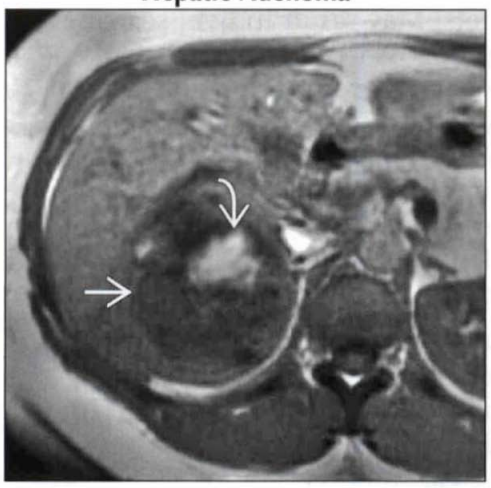
Axial CECT shows a deep hepatic laceration with parenchymal and perihepatic hemorrhage.

Hepatic Adenoma

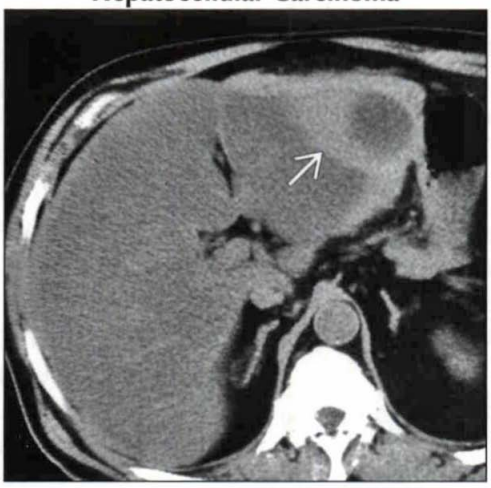
Axial NECT shows a heterogeneous hyperdense mass ⇒ in the liver that had heterogeneous enhancement on CECT; hepatic adenoma. The hyperdense foci are due to hemorrhage.

FOCAL LIVER LESION WITH HEMORRHAGE

Hepatic Adenoma

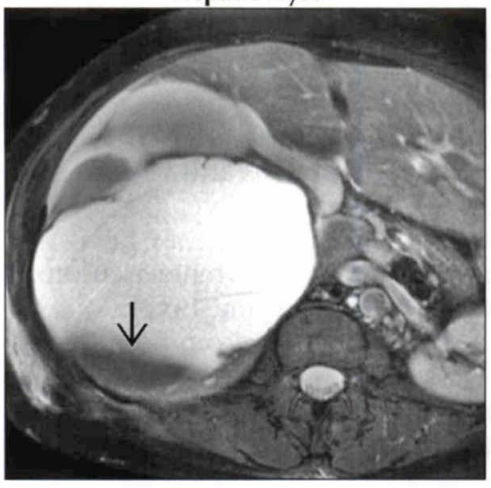


Hepatocellular Carcinoma

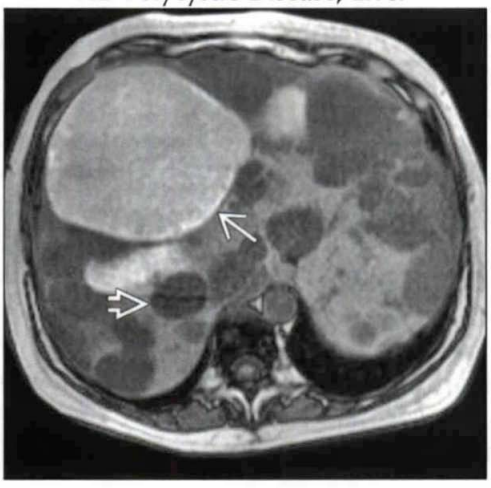


(Left) *Axial T1WI FSE MR shows a heterogeneous mass in the right lobe with foci that are hyperintense on T1WI (and on T2WI, not shown), representing hemorrhage within an hepatic adenoma.* ***(Right)*** *Axial NECT shows hyperdense hemorrhage surrounding the left lobe with a heterogeneous mass ; HCC.*

Hepatic Cyst

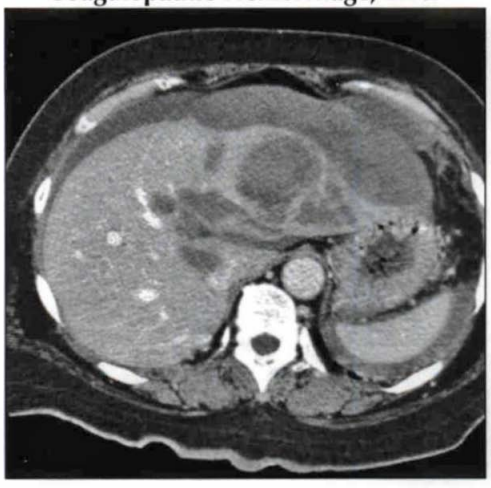


AD Polycystic Disease, Liver



(Left) *Axial fat suppressed T2WI shows a large complex cystic mass with dependent settling of material that is hyperintense on T2WI, indicating subacute hemorrhage.* ***(Right)*** *Axial T1WI GRE opposed phase shows many cysts within an enlarged liver. Many of the cysts are of "water intensity" (dark on this T1WI), while others are bright, due to hemorrhage.*

Coagulopathic Hemorrhage, Liver



HELLP Syndrome

(Left) *Axial CECT shows parenchymal and perihepatic hemorrhage in a patient on anticoagulation drugs. There is no underlying tumor or primary hepatic pathology.* ***(Right)*** *Axial CECT shows an area of infarcted liver , foci of active bleeding , and perihepatic hemorrhage in this pregnant woman with toxemia and HELLP syndrome.*

LIVER "MASS" WITH CAPSULAR RETRACTION

DIFFERENTIAL DIAGNOSIS

Common
- Focal Confluent Fibrosis
- Cholangiocarcinoma (Peripheral)
- Metastases and Lymphoma, Hepatic
- Hepatocellular Carcinoma
- Peritoneal Metastases (Mimic)

Less Common
- Epithelioid Hemangioendothelioma
- Hepatic Cavernous Hemangioma
- Primary Sclerosing Cholangitis
- Inflammatory Pseudotumor, Liver

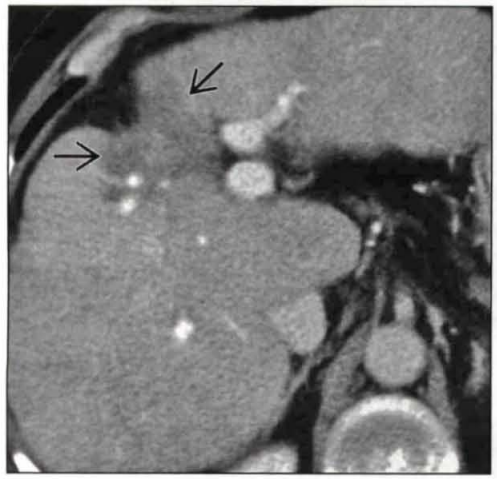
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Capsular retraction = focal hepatic volume loss, usually associated with fibrotic scarring
  - Benign and malignant processes may have similar imaging features

Helpful Clues for Common Diagnoses
- **Focal Confluent Fibrosis**
  - Usually affects anterior and medial segments, in cirrhotic liver
  - Delayed, persistent enhancement, like all fibrotic lesions
- **Cholangiocarcinoma (Peripheral)**
  - Marked volume loss of liver distal to tumor
  - Often obstructs bile ducts and vessels
- **Metastases and Lymphoma, Hepatic**
  - Untreated mets rarely causes hepatic volume loss or capsular retraction
  - Peripheral hepatic metastases or lymphoma result in volume loss and capsular retraction after treatment
  - Breast mets: May result in liver scarring and volume loss ("pseudo-cirrhosis")
- **Hepatocellular Carcinoma**
  - HCC following treatment (ablation, transarterial chemoembolization) often results in capsular retraction
- **Peritoneal Metastases (Mimic)**
  - May indent liver surface and simulate capsular retraction

Helpful Clues for Less Common Diagnoses
- **Epithelioid Hemangioendothelioma**
  - Rare tumor but classically causes multiple, peripheral, confluent hepatic masses with overlying capsular retraction
- **Hepatic Cavernous Hemangioma**
  - Common tumor that rarely causes capsular retraction
  - Capsular retraction may result from fibrosis (hyalinization) of hemangioma
    - Especially within cirrhotic liver
- **Primary Sclerosing Cholangitis**
  - Peripheral hepatic fibrosis and volume loss with rounded contours of liver
  - Focal areas of hepatic injury may be mistaken for or mask cholangiocarcinoma
- **Inflammatory Pseudotumor, Liver**
  - May be indistinguishable from peripheral or hilar cholangiocarcinoma
  - Peripheral lesions result in capsular retraction; show delayed enhancement

Focal Confluent Fibrosis



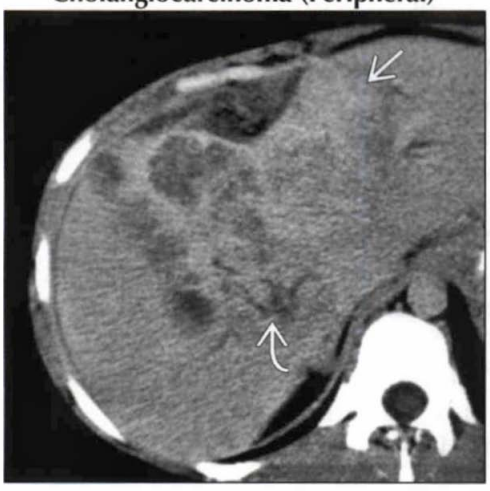
Axial CECT shows a wedge-shaped hypodense lesion ⇒ with "crowded" blood vessels and capsular retraction, due to volume loss and focal confluent fibrosis of the anterior and medial segments.

Cholangiocarcinoma (Peripheral)

Axial CECT shows a heterogeneous mass in the left lobe with capsular retraction ⇒. Note bile duct dilation ➡ and satellite lesion ➡ in right lobe.

LIVER "MASS" WITH CAPSULAR RETRACTION

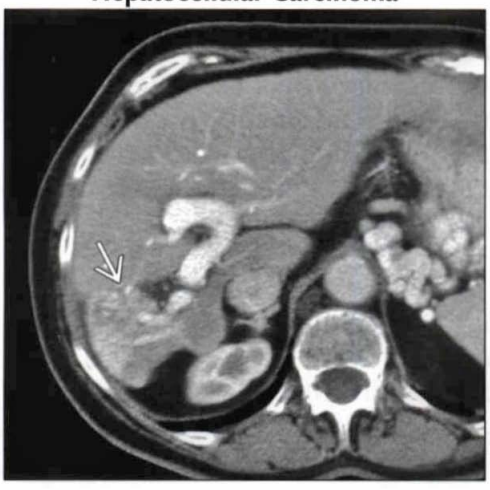
Cholangiocarcinoma (Peripheral)



Metastases and Lymphoma, Hepatic

(Left) *Axial CECT shows a heterogeneous mass with capsular retraction. On this 10 minute delayed scan note the persistent hyperenhancement of the mass and the obstructed bile ducts.* ***(Right)*** *Axial CECT shows a cirrhotic-appearing liver in a woman whose hepatic metastases from breast cancer have responded to treatment, with fibrosis and volume loss and with capsular retraction.*

Hepatocellular Carcinoma

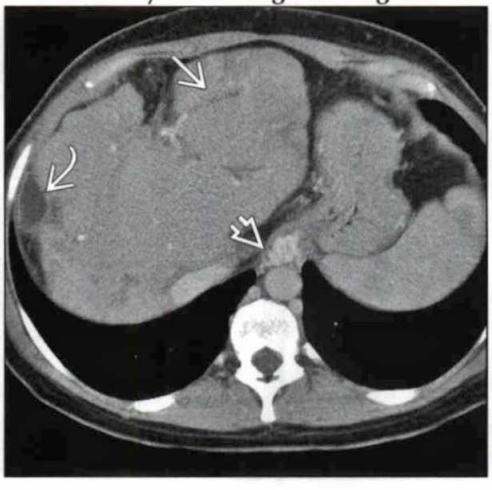


Peritoneal Metastases (Mimic)

(Left) *Axial CECT shows marked volume loss and capsular retraction in the right lobe with delayed, persistent enhancement. This is the fibrotic remnant of successfully treated HCC.* ***(Right)*** *Axial CECT shows a scalloped surface of the liver due to extrinsic compression by peritoneal metastases (pseudomyxoma peritonei), in this patient with appendiceal carcinoma.*

Epithelioid Hemangioendothelioma

Primary Sclerosing Cholangitis



(Left) *Axial CECT shows multiple peripheral "target" type lesions with flattening or retraction of the hepatic capsule. findings characteristic of EHE.* ***(Right)*** *Axial CECT shows a small liver with concave margins due to cirrhosis resulting from chronic PSC. Note irregularly dilated intrahepatic bile ducts and esophageal varices.*

FAT-CONTAINING LIVER MASS

DIFFERENTIAL DIAGNOSIS

Common
- Steatosis (Fatty Liver) (Mimic)
- Pericaval Fat Deposition

Less Common
- Hepatocellular Carcinoma
- Hepatic Adenoma
- Hepatic Metastases
- Hepatic Angiomyolipoma
- Alcohol-Ablated Liver Tumors (Mimic)
- Fat within Hepatic Surgical Defect (Mimic)

Rare but Important
- Teratoma or Liposarcoma
- Focal Nodular Hyperplasia
- Xanthomatous Lesions in LCH

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Compare attenuation (CT), intensity (MR), echogenicity (US) of lesion to internal standards (e.g., sites of fat and fluid)
  - Many lesions simulate fat on one modality or sequence, but not others

Helpful Clues for Common Diagnoses
- **Steatosis (Fatty Liver) (Mimic)**
  - Focal steatosis is usually closer to water attenuation, not fat on CT
  - Vessels traverse "lesion" undisturbed
  - Along fissures and ligaments within liver
- **Pericaval Fat Deposition**
  - Normal variant
  - May simulate fatty mass in liver or IVC

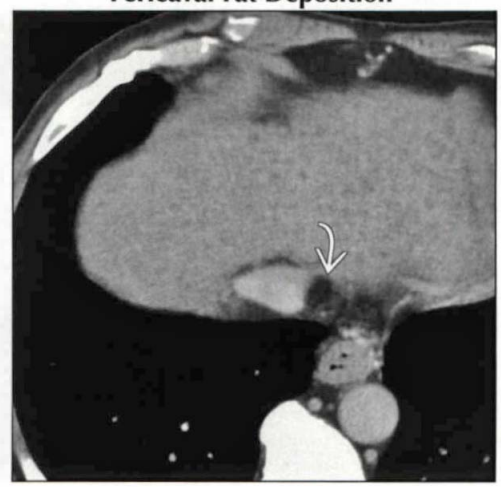
Helpful Clues for Less Common Diagnoses
- **Hepatocellular Carcinoma**
  - Usually small foci of fat
- **Hepatic Adenoma**
  - MR shows evidence of fat (lipid) in 35-75% of adenomas; CT < 20%
- **Hepatic Metastases**
  - From liposarcoma, malignant teratoma
- **Hepatic Angiomyolipoma**
  - In 6% of patients with tuberous sclerosis
  - Look for fat-containing AMLs and cysts in kidneys
- **Alcohol-Ablated Liver Tumors (Mimic)**
  - Alcohol has "fat" attenuation on CT
- **Fat within Hepatic Surgical Defect (Mimic)**
  - Omental fat may herniate or be placed into site of resection, ablation

Helpful Clues for Rare Diagnoses
- **Teratoma or Liposarcoma**
  - Primary teratoma of liver extremely rare
  - Retroperitoneal teratoma (or liposarcoma) may indent or invade liver
  - Look for fat, fluid, calcification, soft tissue
- **Focal Nodular Hyperplasia**
  - Fat within FNH is vary rare
  - May accompany diffuse steatosis
- **Xanthomatous Lesions in LCH**
  - Langerhans cell histiocytosis (LCH) is malabsorption disorder of variable severity
  - Hepatic lesions usually periportal location

Steatosis (Fatty Liver) (Mimic)

Axial CECT shows geographic distribution of steatosis, simulating a fat-containing mass. An opposed phase GRE MR scan showed selective loss of signal from this area, confirming steatosis.

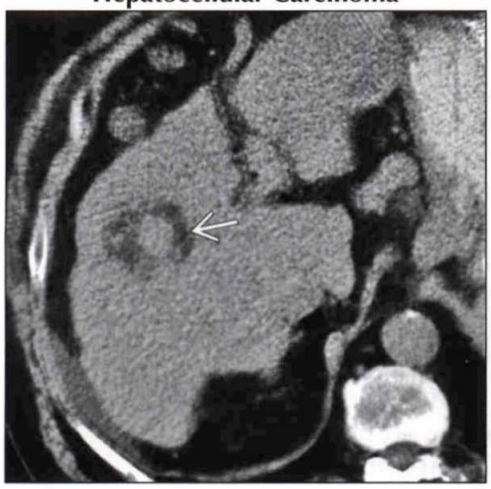
Pericaval Fat Deposition



Axial CECT shows fat density ➡ surrounding the IVC, a normal variant. Also present, cirrhosis, regenerative nodules and varices.

FAT-CONTAINING LIVER MASS

Hepatocellular Carcinoma

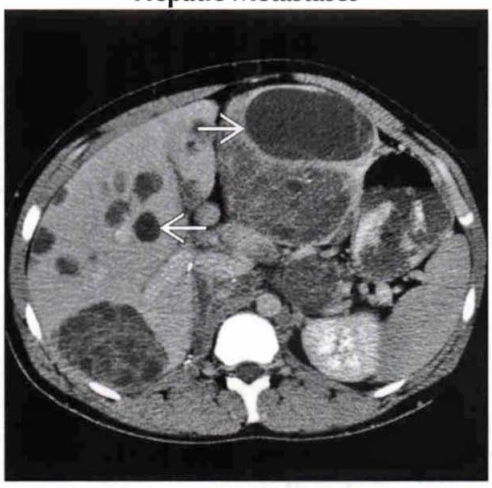


Hepatocellular Carcinoma

(Left) *Axial NECT shows cirrhotic liver with a focal mass that has some foci of very low attenuation indicating fatty metamorphosis.* ***(Right)*** *Sagittal ultrasound shows very echogenic mass with decreased through transmission. Hepatocellular carcinoma with fatty metamorphosis.*

Hepatic Adenoma

Hepatic Metastases



(Left) *Axial T1WI MR shows a focal mass that was almost isointense to liver on the in-phase T1WI, with marked signal loss on this opposed phase image, indicating lipid content.* ***(Right)*** *Axial CECT shows multiple metastases from testicular malignant teratoma, some with fat attenuation*

Hepatic Angiomyolipoma

Teratoma or Liposarcoma

(Left) *Axial CECT shows one of several fatty hepatic masses in addition to innumerable angiomyolipomas in the kidneys in this patient with tuberous sclerosis.* ***(Right)*** *Axial CECT shows a large abdominal mass of mixed soft tissue and fat density, a liposarcoma, that indents the liver.*

CYSTIC HEPATIC MASS

DIFFERENTIAL DIAGNOSIS

Common
- Hepatic Cyst
- AD Polycystic Disease, Liver
- Hepatic Pyogenic Abscess
- Hepatic Amebic Abscess
- Biliary Hamartoma
- Biloma/Seroma
- Steatosis (Fatty Liver) (Mimic)

Less Common
- Hepatic Hydatid Cyst
- Metastases and Lymphoma, Hepatic
- Biliary Cystadenocarcinoma
- Hepatic Candidiasis
- Caroli Disease
- Intrahepatic Pseudocyst
- Cholangiocarcinoma (Mucin-Producing Variant)

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Any mural nodularity or debris level within "cyst" should raise concern for tumor, abscess, or hematoma
- Essential to compare current study with priors to observe for interval change (simple cysts change size only slowly)

Helpful Clues for Common Diagnoses
- **Hepatic Cyst**
  - Water attenuation, no visible wall
    - No enhancement of cyst contents
    - MR: Very bright on T2WI, dark on T1WI; no enhancement or mural nodularity
    - US: Sonolucent with acoustic enhancement; no visible wall or nodularity
    - Hemorrhage within a simple cyst can be difficult to distinguish from cystic neoplasm
  - One or 2 thin septa may be seen
  - Often multiple, of varying sizes
- **AD Polycystic Disease, Liver**
  - Many cysts of varying sizes
  - Intracyst bleeding results in high attenuation fluid and calcified cyst walls
  - Often results in massive hepatomegaly, but rarely impairs liver function
  - May be associated with cysts in kidneys, seminal vesicles, pancreas
  - Usually have history of other family members with polycystic disease
- **Hepatic Pyogenic Abscess**
  - Multiloculated, multiseptated
  - Wall and septa may show contrast enhancement
  - Associated atelectasis and pleural effusion when abscess occurs in peripheral liver adjacent to diaphragm (frequently)
  - Usually result from prior surgery, or associated with cholecystitis/cholangitis, or delayed diagnosis and treatment of appendicitis or diverticulitis
- **Hepatic Amebic Abscess**
  - Usually solitary or few with shaggy wall
  - Endemic in certain populations
- **Biliary Hamartoma**
  - Multiple small (1-1.5 cm) low attenuation lesions ± echogenic nodules in walls
  - Asymptomatic; part of the spectrum of congenital hepatic fibropolycystic disease
    - May coexist with other manifestations, such as Caroli disease, or congenital hepatic fibrosis
    - May be associated with renal disease (autosomal dominant or recessive polycystic disease)
- **Biloma/Seroma**
  - Following trauma, partial liver resection, radiofrequency ablation
    - Uninfected biloma does not require drainage
    - Often takes weeks to months for large biloma or seroma to resolve
  - May result from hepatic artery thrombosis with biliary necrosis in setting of liver transplantation
    - Biloma in hepatic allograft is an ominous finding; often requires angiographic evaluation and emergency revascularization or even re-transplantation
- **Steatosis (Fatty Liver) (Mimic)**
  - Focal deposits may be near water density on NECT (but echogenic, not cystic, on US)
  - MR also definitive, showing selective signal dropout from focal steatotic areas on opposed phase GRE images

Helpful Clues for Less Common Diagnoses
- **Hepatic Hydatid Cyst**

- Discrete peripheral wall ± calcification with daughter cysts
- Daughter cysts may be smaller spheres within larger cyst, or appear as thick septations

- **Metastases and Lymphoma, Hepatic**
  - From primary cystic tumor (e.g., ovarian)
  - Sarcomas, GIST, others, especially after treatment
    - GIST metastasis treated with Gleevec may appear exactly as simple cyst (check history and prior studies)
  - Most have mural nodularity (CT, US, MR)
  - Lymphoma: Homogeneous masses simulate cysts on CT and ultrasound
  - Tumors that respond to treatment (with necrosis) often simulate cysts
- **Biliary Cystadenocarcinoma**
  - Multiseptated with discrete enhancing wall and septa
  - Rarely have no visible septa
  - Complete resection of all parts of tumor essential to prevent recurrence
- **Hepatic Candidiasis**
  - Innumerable microabscesses (< 1 cm) with target or wheel appearance
  - Usually occur in immune compromised patients
- **Caroli Disease**
  - Multiple cystic dilations of bile ducts
  - Communication with bile ducts is key feature distinguishing from other cystic masses
    - Recommend MRCP or ERCP
- **Intrahepatic Pseudocyst**
  - May dissect into liver along portal triads
  - Intrahepatic pseudocyst usually has adjacent cyst in pancreatic head
  - Check for imaging and clinical evidence of pancreatitis
- **Cholangiocarcinoma (Mucin-Producing Variant)**
  - Tumor within bile duct may rarely produce mucin that distends the ducts and may simulate a cystic mass

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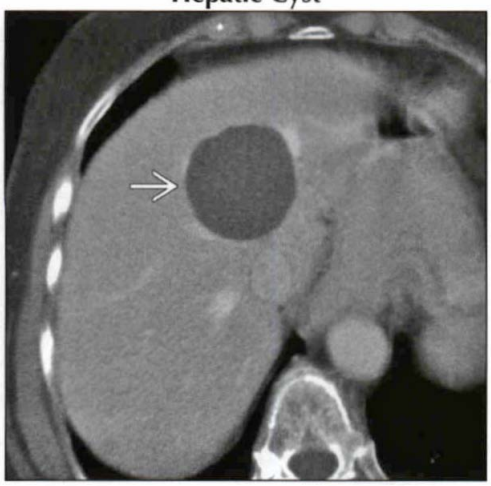
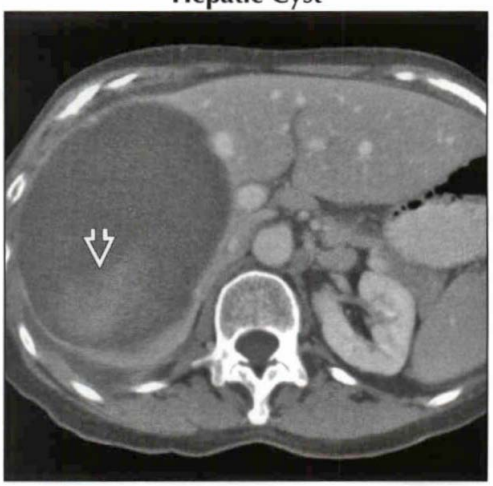
Hepatic Cyst



Axial CECT shows a spherical liver mass ➡ with water density, homogeneous contents. No internal debris or wall irregularities are present.

Hepatic Cyst



Axial CECT shows a large cyst with some heterogeneous amorphous material ➡ that represented intracystic hemorrhage. Benign cysts with bleeding may be difficult to distinguish from tumor.

CYSTIC HEPATIC MASS

AD Polycystic Disease, Liver

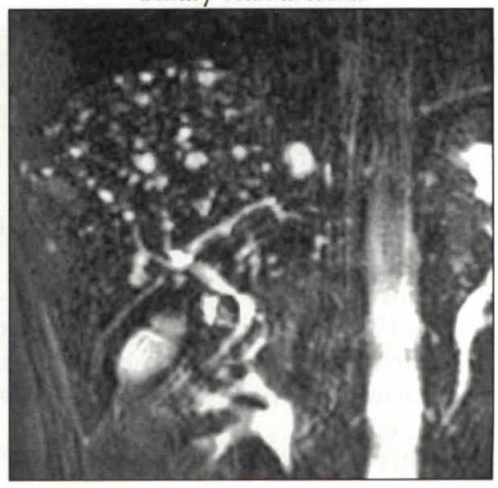
(Left) *Axial CECT shows innumerable hepatic cysts of water attenuation causing hepatomegaly. Only a few small renal cysts are present and renal function is normal.* ***(Right)*** *Axial CECT shows a thick-walled, septate, cystic mass ⇨ in the right lobe. Needle aspiration confirmed pyogenic abscess and this was drained under US guidance.*

Hepatic Pyogenic Abscess

Hepatic Amebic Abscess

(Left) *Axial CECT shows a unilocular, thick-walled cystic mass. A THAD (transient hepatic attenuation difference) was evident on the arterial phase images (hyperemia and PV compression).* ***(Right)*** *Coronal T2WI MR shows innumerable small cystic lesions that do not communicate with the biliary tree.*

Biliary Hamartoma



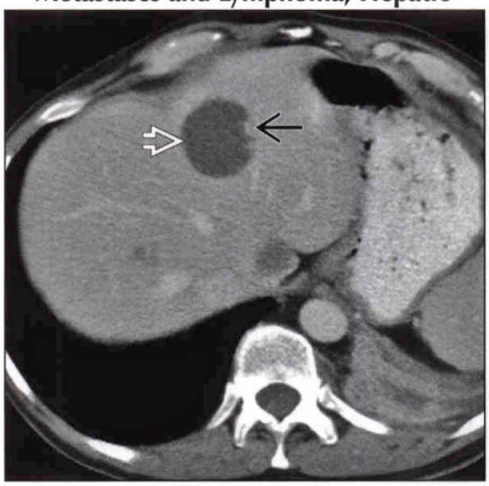
Biloma/Seroma

(Left) *Axial CECT shows a unilocular cystic mass containing a few gas bubbles. While the appearance suggests abscess, this is an uninfected biloma/seroma that resulted from a hepatic laceration.* ***(Right)*** *Axial CECT shows a large lesion of near water attenuation that represents focal severe fatty infiltration. The presence of blood vessels coursing through this area is characteristic.*

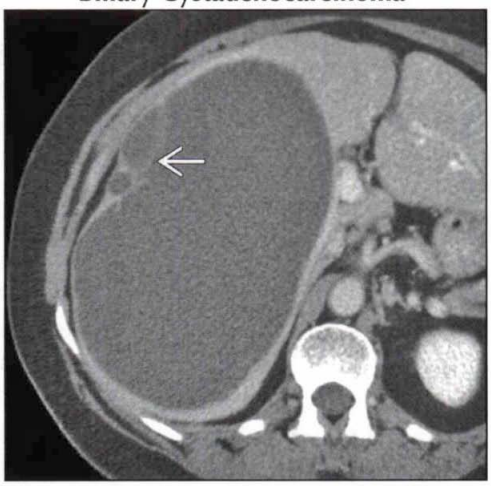
Steatosis (Fatty Liver) (Mimic)

CYSTIC HEPATIC MASS

Metastases and Lymphoma, Hepatic



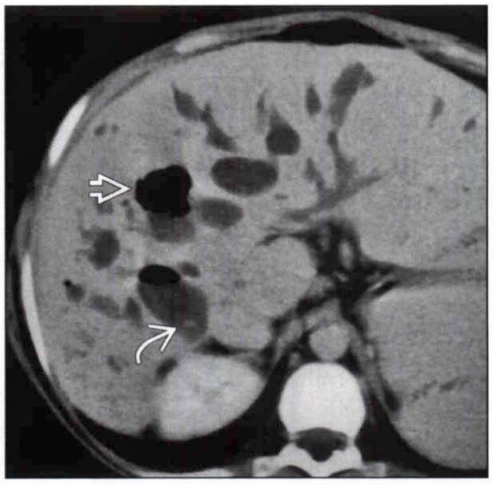
Biliary Cystadenocarcinoma



(Left) *Axial CECT shows several hypodense hepatic masses, including one cystic lesion. The subtle mural nodule is the clue that this is a neoplasm (metastatic thyroid cancer).* ***(Right)*** *Axial CECT shows a large cystic mass with only a few septa. Most biliary cystadenomas have more numerous septa.*

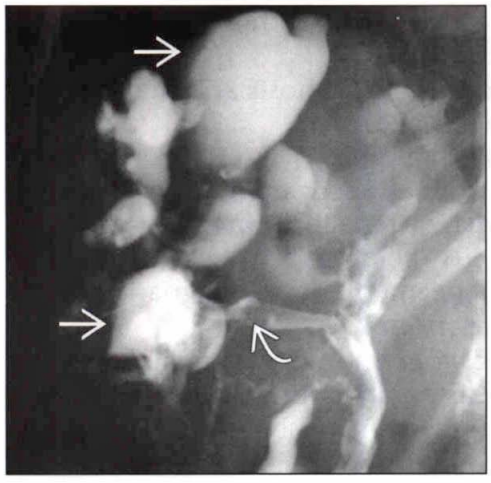
Hepatic Candidiasis

Caroli Disease



(Left) *Axial CECT shows innumerable small hypodense lesions throughout the liver, in an immunocompromised patient. The larger lesions have visible irregularity of their walls.* ***(Right)*** *Axial CECT shows multiple cystic masses, some of which contain gas. Note the "central dot" sign (vessel) and dilated bile ducts.*

Caroli Disease



Cholangiocarcinoma (Mucin-Producing Variant)

(Left) *Frontal ERCP shows large cystic spaces that opacify with injected contrast material, indicating communication with bile ducts. Stones are present within the ducts.* ***(Right)*** *Axial CECT shows dilated intrahepatic bile ducts and a cystic mass. ERCP showed opacification of the cyst with contrast and the presence of surface nodularity within the bile ducts.*

FOCAL HYPERVASCULAR LIVER LESION

DIFFERENTIAL DIAGNOSIS

Common

- Hepatic Cavernous Hemangioma
- Focal Nodular Hyperplasia
- Arterio-Portal Shunt
- Transient Hepatic Attenuation Difference (THAD)
- Hepatocellular Carcinoma
- Hepatic Metastases
- Hepatic Adenoma
- Hepatic AV Malformation (O-W-R)

Less Common

- Nodular Regenerative Hyperplasia
- Fibrolamellar HCC
- SVC Obstruction, Abdominal Manifestations
- Cholangiocarcinoma (Peripheral)
- Peliosis Hepatis
- Angiosarcoma, Liver

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- It is critical to characterize the morphology and hemodynamics of hepatic lesions to derive a specific diagnosis; examples
  - Cavernous hemangioma, arterioportal shunt, AVM: Isodense to blood vessels on all phases of imaging
  - FNH: Nearly isodense (isointense) to liver on nonenhanced, portal venous and delayed phases; homogeneously hyperdense on arterial phase
  - HCC: Hypodense to liver on NECT, portal venous and delayed phase imaging; heterogeneously hyperdense on arterial phase
  - Cholangiocarcinoma: Hypodense on NECT, hypo-, iso- or hyperdense on arterial phase, hyperdense on delayed phase imaging

Helpful Clues for Common Diagnoses

- **Hepatic Cavernous Hemangioma**
  - Small ("capillary") hemangiomas may enhance quickly and homogeneously
  - Enhanced portions of all hemangiomas remain nearly isodense to blood vessels on all phases of imaging (CT and MR)
  - Nodular, discontinuous peripheral enhancement with progressive centripetal fill in for larger hemangiomas
- **Focal Nodular Hyperplasia**
  - Common (~ 2-5%) among young women
  - Homogeneous bright enhancement on arterial phase of enhancement
  - Central scar seen in $^{2}/_{3}$ of FNH > 3 cm
  - Nearly isodense (and isointense) to normal liver or nonenhanced, portal venous, delayed images
- **Arterio-Portal Shunt**
  - Common cause of small, usually peripheral, hypervascular foci within cirrhotic liver
  - Isodense (and isointense) to liver on nonenhanced portal venous and delayed imaging
  - May result from percutaneous biopsy, percutaneous catheter placement, or other trauma
  - Look for early filling of portal vein branch
- **Transient Hepatic Attenuation Difference (THAD)**
  - Peripheral wedge-shaped hypervascular lesion seen only on arterial phase imaging (CT or MR)
  - Usually due to obstruction of portal vein branch with compensatory increased arterial flow to involved liver
  - Can usually ignore small subcapsular lesion
    - Larger or segmental THAD lesion usually due to mass causing occlusion or compression of portal vein branch (examples: Metastases, HCC, large benign mass, abscess)
- **Hepatocellular Carcinoma**
  - Usually heterogeneously hyperdense on arterial phase with washout to hypoattenuating on portal venous and delayed imaging
  - Look for signs of cirrhosis and invasion of veins and bile ducts
- **Hepatic Metastases**
  - Usually from endocrine primary, melanoma, or renal cell carcinoma
  - Multiplicity, heterogeneity, ring-enhancement favor malignancy
- **Hepatic Adenoma**
  - In young women on oral contraceptives or individuals on anabolic steroids
  - Usually heterogeneously hypervascular

- Often with foci of fat, necrosis, hemorrhage (more evident on MR than on CT)

- **Hepatic AV Malformation (O-W-R)**
  - May be isolated abnormality
  - May be part of multiorgan fibrovascular dysplasia (hereditary hemorrhagic telangiectasia, Osler-Weber-Rendu)
    - Telangiectasias and AVMs in liver and other organs (lungs, GI tract, brain, etc.)
    - Patients present with nosebleeds, GI bleeding, hemoptysis
    - Liver: Large hepatic arteries and draining veins with "vascular masses"

Helpful Clues for Less Common Diagnoses

- **Nodular Regenerative Hyperplasia**
  - In Budd-Chiari, congenital heart disease (after Fontan procedure)
  - "Large regenerative nodules" are common
  - Usually multiple, 1-3 cm; resemble FNH on imaging and pathology
  - Patients with Budd-Chiari also have hepatic and perihepatic venous collaterals that may appear as hypervascular lesions
- **Fibrolamellar HCC**
  - Large heterogeneous tumor with calcifications & metastases, young patient
- **SVC Obstruction, Abdominal Manifestations**
  - Collateral veins running along diaphragm may pass through liver to IVC
  - Broad area of hypervascularity in left lobe on arterial phase; no mass effect
- **Cholangiocarcinoma (Peripheral)**
  - Occasionally hypervascular
  - Look for delayed persistent enhancement and capsular retraction (not seen in HCC)
- **Peliosis Hepatis**
  - Associated with chronic wasting diseases and certain medications; also Bartonella infection
  - Variable appearance; sometimes resembles hemangioma
- **Angiosarcoma, Liver**
  - Associated with industrial toxins
  - Bizarre enhancement patterns; may resemble hemangioma
  - Multiple lesions in liver and spleen

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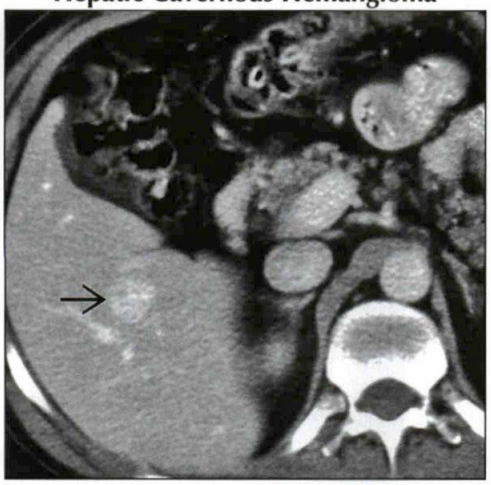
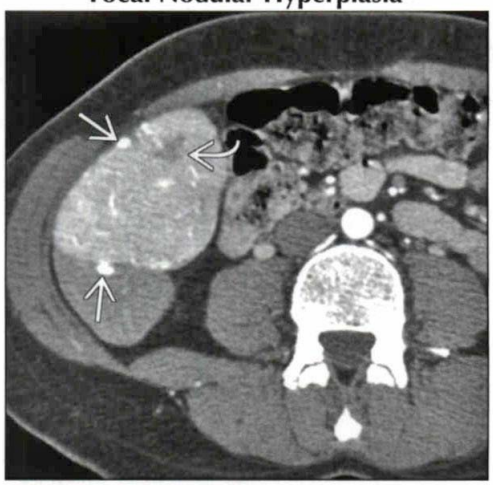
1. Colagrande S et al: Transient hepatic intensity differences: part 1, Those associated with focal lesions. AJR Am J Roentgenol. 188(1):154-9, 2007
2. Colagrande S et al: Transient hepatic intensity differences: part 2, Those not associated with focal lesions. AJR Am J Roentgenol. 188(1):160-6, 2007
3. Kamel IR et al: Incidental nonneoplastic hypervascular lesions in the noncirrhotic liver: diagnosis with 16-MDCT and 3D CT angiography. AJR Am J Roentgenol. 187(3):682-7, 2006
4. Coakley FV et al: Imaging of hepatocellular carcinoma: a practical approach. Semin Oncol. 28(5):460-73, 2001
5. Kim T et al: Discrimination of small hepatic hemangiomas from hypervascular malignant tumors smaller than 3 cm with three-phase helical CT. Radiology. 219(3):699-706, 2001

Hepatic Cavernous Hemangioma



Axial CECT shows a small hypervascular mass ➔ that was isodense to blood pool on NECT, arterial phase and this portal venous phase CECT.

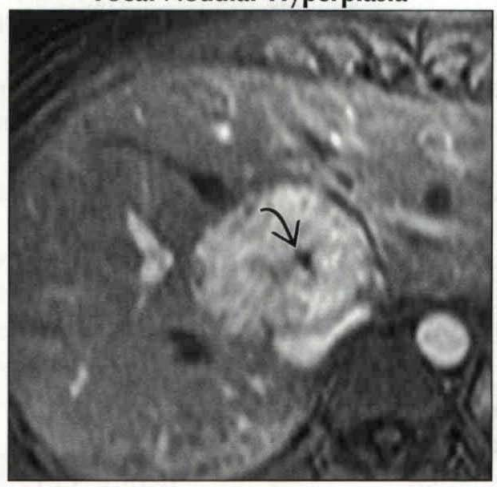
Focal Nodular Hyperplasia



Axial CECT shows homogeneously hypervascular mass on arterial phase CECT; isodense with liver on other phases. Central scar ➔ early draining veins ➔

FOCAL HYPERVASCULAR LIVER LESION

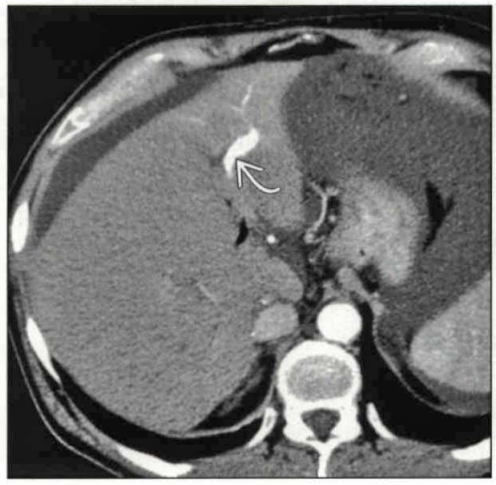
Focal Nodular Hyperplasia



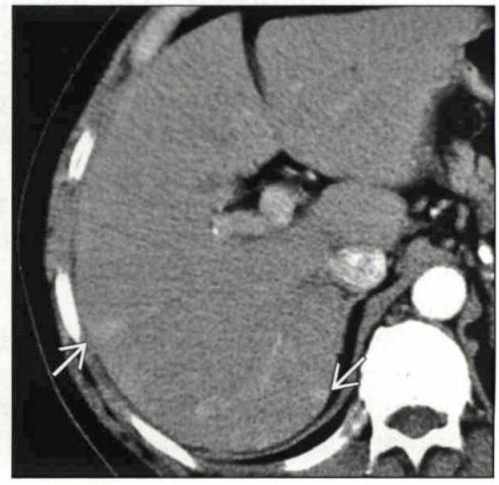
Focal Nodular Hyperplasia

(Left) *Axial T1 C+ FS MR shows homogeneous bright enhancement on this arterial phase contrast-enhanced MR. Note the central scar* ***(Right)*** *Axial T1 C+ FS MR shows the FNH is nearly isointense with normal liver. The central small scar is still well seen on this portal venous phase image.*

Arterio-Portal Shunt

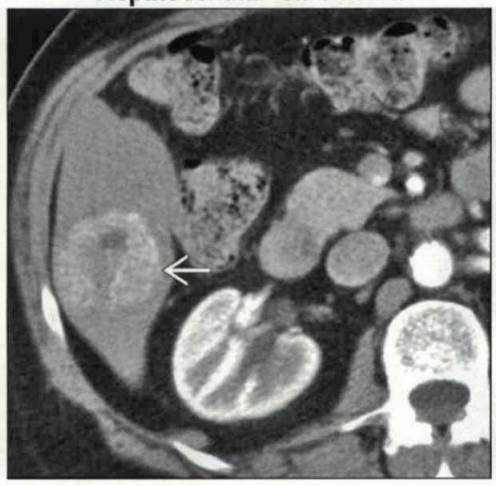


Transient Hepatic Attenuation Difference (THAD)



(Left) *Axial CECT shows hyperdensity within the left lobe on arterial phase CECT (isodense on portal venous phase). Early filling on left portal vein due to A-P fistula from biopsy.* ***(Right)*** *Axial CECT shows several small, peripheral, wedge-shaped, hypervascular lesions only seen on this arterial phase CECT, in a patient with cirrhosis. Typical THAD or AP shunt lesions.*

Hepatocellular Carcinoma

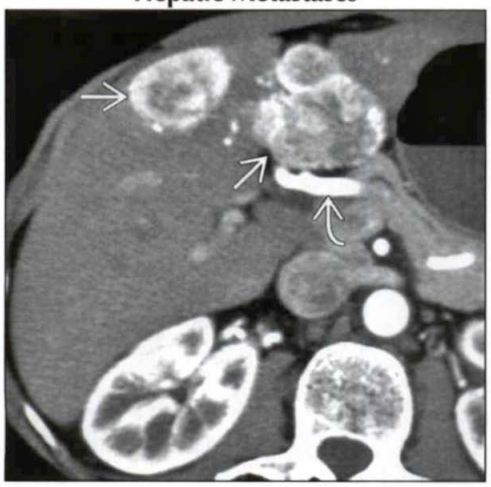


Hepatocellular Carcinoma

(Left) *Axial CECT shows a heterogeneously hypervascular mass in a cirrhotic liver, that "washed out" to become hypodense on portal venous phase.* ***(Right)*** *Axial CECT shows the HCC as a much less evident, iso- to hypodense lesion on portal venous phase imaging.*

FOCAL HYPERVASCULAR LIVER LESION

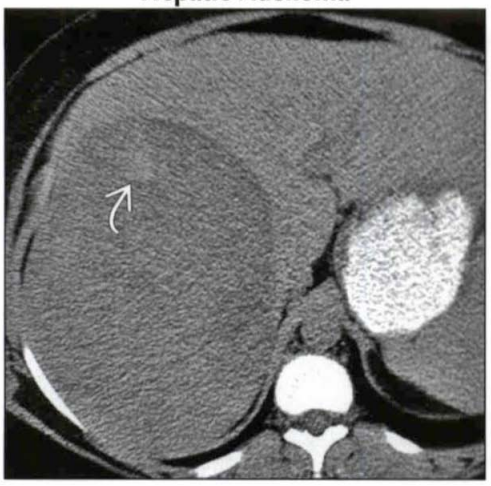
Hepatic Metastases



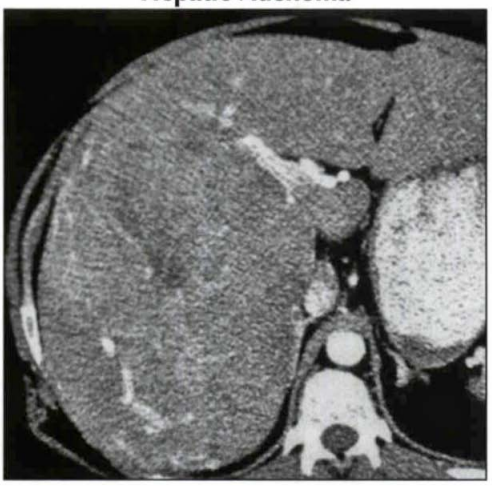
Hepatic Metastases

(Left) *Axial CECT shows two heterogeneously hypervascular metastases from neuroendocrine (islet cell) tumor. Note the enlarged hepatic artery.* ***(Right)*** *Axial CECT shows washout of contrast from the neuroendocrine metastases on portal venous phase imaging, though they remain hyperdense to liver.*

Hepatic Adenoma



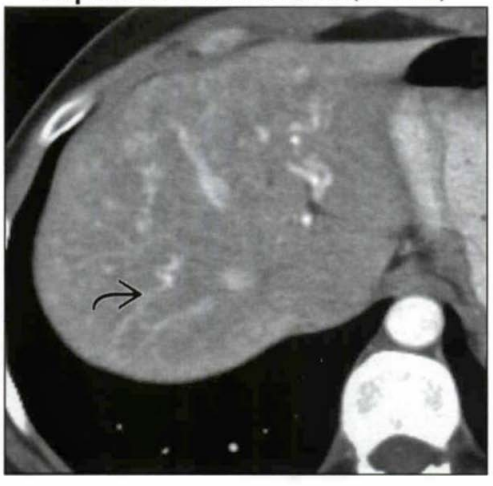
Hepatic Adenoma



(Left) *Axial NECT shows a large hypodense mass with a subtle area of hyperdensity representing hemorrhage.* ***(Right)*** *Axial CECT shows heterogeneous hypervascularity within the adenoma.*

Hepatic Adenoma

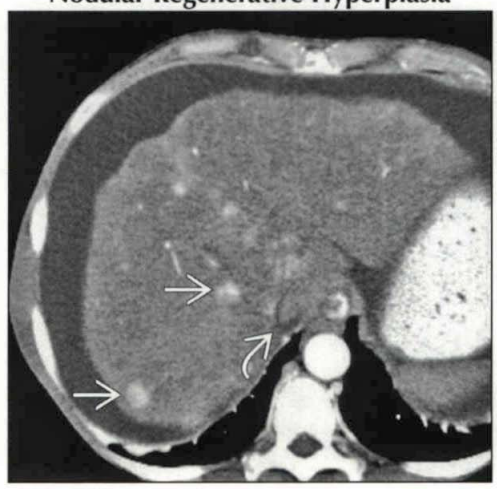
Hepatic AV Malformation (O-W-R)

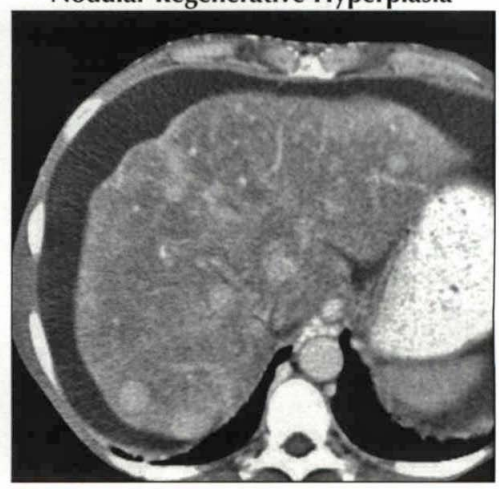


(Left) *Axial CECT shows that the mass is now hypodense to liver due to tumor "washout", on this portal venous phase image.* ***(Right)*** *Axial CECT shows many small vascular lesions, enlarged feeding arteries, and early filling of hepatic veins in a patient with hereditary hemorrhagic telangiectasia (Osler-Weber-Rendu).*

FOCAL HYPERVASCULAR LIVER LESION

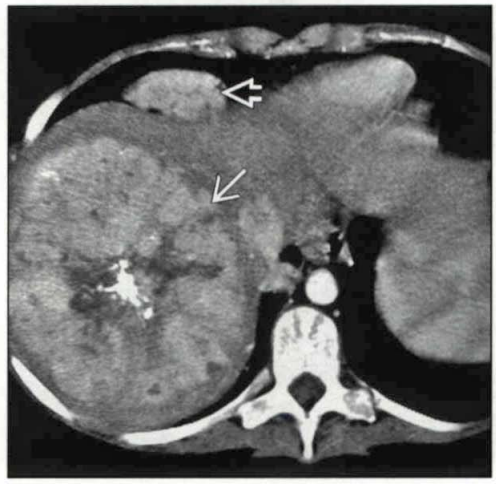
Nodular Regenerative Hyperplasia

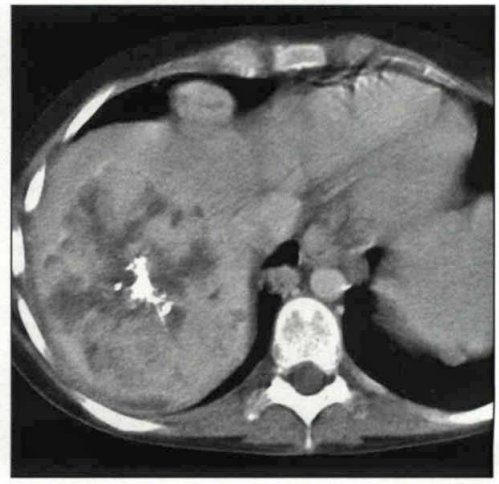




(Left) *Axial CECT shows many small hypervascular masses* ➡ *(large regenerative nodules) in a patient with Budd-Chiari syndrome. Note the occluded IVC* ➡ *and ascites.* ***(Right)*** *Axial CECT shows persistent hypervascularity of the large regenerative nodules (nodular regenerative hyperplasia) in this patient with Budd-Chiari syndrome.*

Fibrolamellar HCC





(Left) *Axial CECT shows a hypervascular mass* ➡ *with a large central scar and calcification. Metastases within cardiophrenic nodes* ➡ *have similar features.* ***(Right)*** *Axial CECT shows that the tumor has washed out and become nearly isodense with liver on this portal venous phase image, though still heterogeneous due to foci of necrosis and hemorrhage.*

Fibrolamellar HCC

(Left) *Axial CECT shows a large heterogeneously hypervascular mass in a 25 year old man. Central scar, fibrosis, and calcification* ➡ *are present.* ***(Right)*** *Axial CECT shows washout of contrast from the tumor, making the scar and its calcification* ➡ *easier to recognize.*

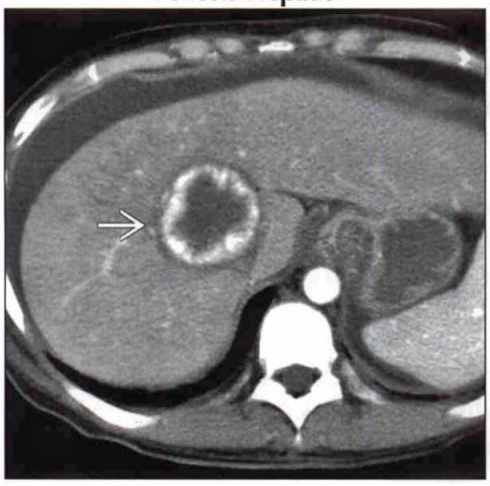
FOCAL HYPERVASCULAR LIVER LESION

SVC Obstruction, Abdominal Manifestations

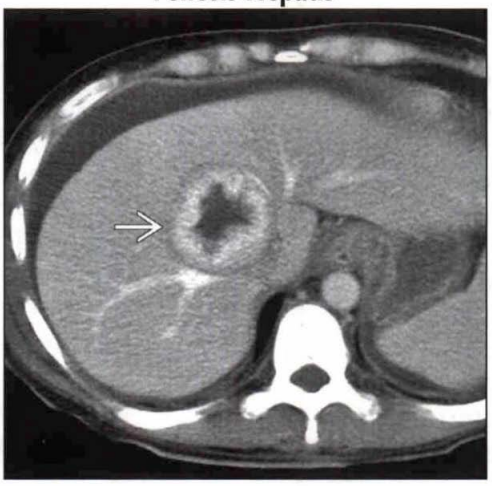
SVC Obstruction, Abdominal Manifestations

(Left) *Axial CECT shows bright enhancement within the medial segment ➡ on this arterial phase image. Note extensive collateral veins ⇒ in this patient with SVC obstruction.* ***(Right)*** *Axial CECT shows a homogeneous liver on this portal venous phase image in the patient with SVC obstruction. Some of the collateral veins are still opacified.*

Peliosis Hepatis



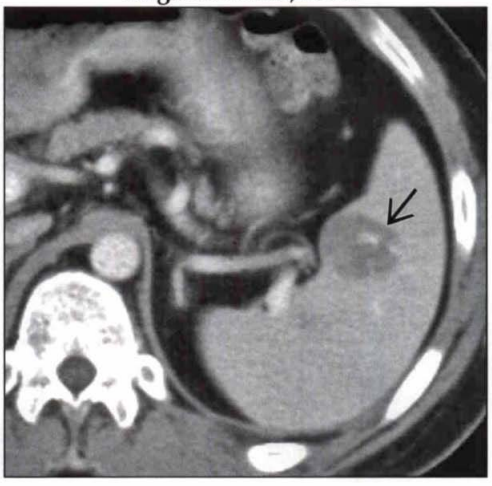
Peliosis Hepatis



(Left) *Axial CECT shows continuous ring enhancement ➡ on this arterial phase image. Also note ascites.* ***(Right)*** *Axial CECT shows progressive fill in ➡ of the peliosis lesion, in a pattern that is similar to that of cavernous hemangioma, although hemangiomas usually have nodular enhancement.*

Angiosarcoma, Liver

Angiosarcoma, Liver



(Left) *Axial CECT shows multiple tumor masses throughout the liver with peculiar eccentric enhancement.* ***(Right)*** *Axial CECT shows a splenic tumor ⇨ with the same enhancement characteristics as the multiple tumors in the liver; angiosarcoma.*

MOSAIC OR PATCHY HEPATOGRAM

DIFFERENTIAL DIAGNOSIS

Common
- Passive Hepatic Congestion
- Hepatitis
- Cirrhosis
- Steatosis (Fatty Liver)

Less Common
- Budd-Chiari Syndrome
- Hereditary Hemorrhagic Telangiectasia
- Congenital Hepatic Fibrosis
- Hepatic Sarcoidosis
- Congenital Heart Disease
- Hepatic Lymphoma
- Systemic Hypervolemia

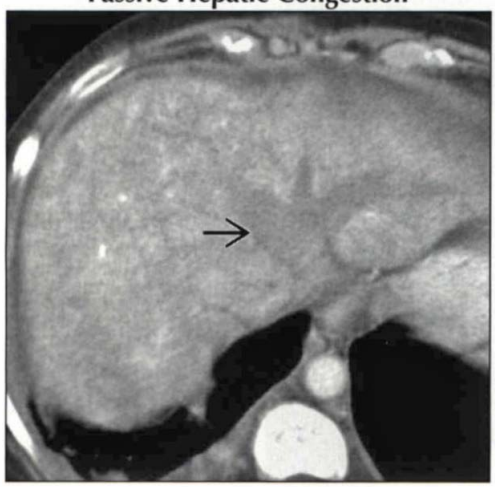
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Mosaic liver: Enhances heterogeneously without discrete masses

Helpful Clues for Common Diagnoses
- **Passive Hepatic Congestion**
  - Most common cause; CHF, tricuspid insufficiency, constrictive pericarditis
  - Hepatic veins and IVC are engorged
- **Hepatitis**
  - Acute viral and alcoholic: Enlarged liver, with periportal lymphedema
  - Hepatic and portal veins: Normal caliber and flow
  - Alcoholic hepatitis often has steatosis contributing to patchy hepatogram
- **Cirrhosis**
  - Fibrosis, regenerating nodules, steatosis all contribute to heterogeneity of liver
  - Hepatic veins normal; portal flow may be hepatofugal (reversed)

Helpful Clues for Less Common Diagnoses
- **Budd-Chiari Syndrome**
  - Obstruction of hepatic veins and/or IVC
  - Small veins (rather than dilated as in passive hepatic congestion)
  - Intrahepatic and perihepatic venous collaterals
  - Sparing and hypertrophy of caudate; peripheral atrophy
- **Hereditary Hemorrhagic Telangiectasia**
  - Osler-Weber-Rendu
  - Numerous AVMs and telangiectasias connect arteries and veins
  - Large hepatic arteries and veins
- **Congenital Hepatic Fibrosis**
  - Dysmorphic liver, big arteries, portal hypertension
- **Hepatic Sarcoidosis**
  - May simulate or cause cirrhosis
  - Hypodense granulomas and lymphadenopathy
- **Hepatic Lymphoma**
  - Homogeneous enlargement of liver ± subtle focal masses
- **Systemic Hypervolemia**
  - Excessive IV hydration: Periportal lymphedema and less often, a heterogeneous hepatogram

Passive Hepatic Congestion



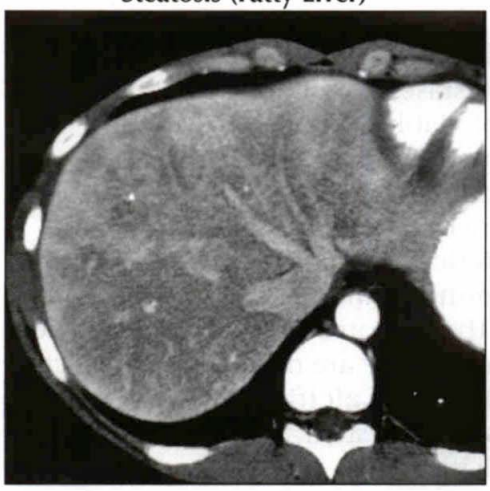
Axial CECT shows dilated but unopacified hepatic veins ⇒ on this "portal venous phase" CECT, on which the hepatic veins should be opacified.

Hepatitis

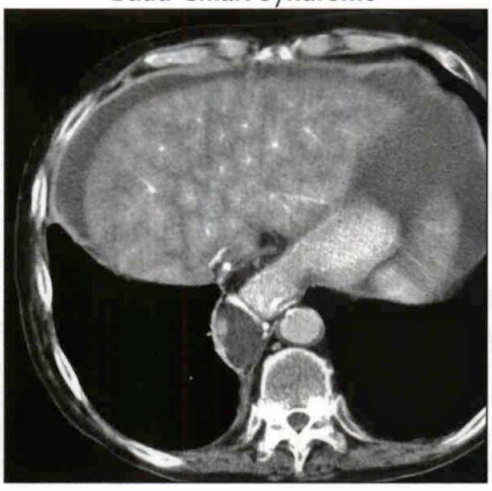
Axial CECT shows heterogeneous enhancement of the liver and periportal lymphedema. Biopsy showed severe acute and chronic viral hepatitis.

MOSAIC OR PATCHY HEPATOGRAM

Steatosis (Fatty Liver)

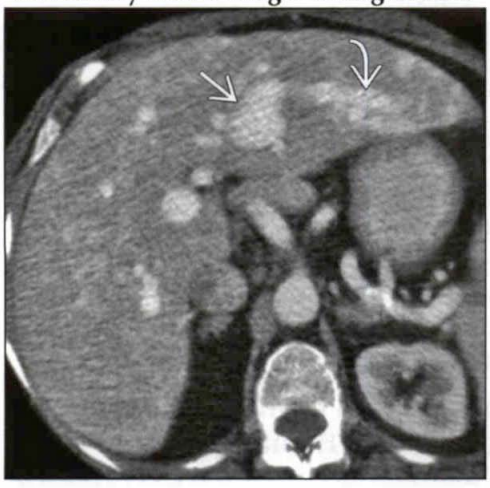


Budd-Chiari Syndrome



(Left) Axial CECT shows patchy appearance of liver, but blood vessels traverse the hypodense areas without deviation or compression. (Right) Axial CECT shows a mottled liver with a slit-like IVC and ascites in this patient with acute Budd-Chiari syndrome.

Hereditary Hemorrhagic Telangiectasia

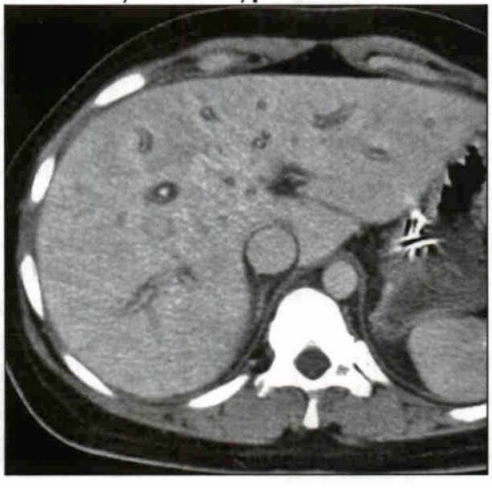


Congenital Hepatic Fibrosis

(Left) Axial CECT shows a mottled liver with an enlarged hepatic artery and arteriovenous malformations in the lateral segment as well as large vascular masses. (Right) Axial T1 C+ MR shows a very small right hepatic lobe (note gallbladder) and an enlarged left lobe. The kidneys are small with innumerable cysts.

Hepatic Sarcoidosis

Systemic Hypervolemia



(Left) Axial CECT shows innumerable small hypodense lesions in the liver and spleen. This patient also had lymphadenopathy in the chest and upper abdomen. (Right) Axial CECT shows an enlarged, heterogeneous liver with marked perivascular edema, all due to systemic hypervolemia (overhydration with IV fluids).

HEPATIC CALCIFICATIONS

DIFFERENTIAL DIAGNOSIS

Common
- Calcified Granuloma, Liver
- Hepatic Metastases
- Hepatic Arterial Calcification
- Ethiodol-Treated Tumor, Liver

Less Common
- Hepatic Cavernous Hemangioma
- Hepatic Hydatid Cyst
- Fibrolamellar HCC
- Cholangiocarcinoma (Peripheral)
- Hepatocellular Carcinoma
- Hepatic Adenoma
- Hepatic Opportunistic Infection
- Portal Vein Calcification
- Intrahepatic Biliary Calculi
- Pancreato-Biliary Parasites
- Extrahepatic Calcifications (Mimic)

Rare but Important
- Focal Nodular Hyperplasia
- Epithelioid Hemangioendothelioma
- Schistosomiasis, Hepatic

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Many more calcified hepatic lesions are evident on CT than on plain radiography
  - Due to greater sensitivity of CT for contrast differentiation
  - MR relatively insensitive to diagnosis of calcification
    - Visible only as focus of signal void due to immobile protons within calcified lesion
  - Ultrasound detects calcifications as brightly echogenic foci with acoustic shadow
- Characterize the pattern of the calcification
  - Examples: Punctate, amorphous, eggshell, tram track

Helpful Clues for Common Diagnoses
- **Calcified Granuloma, Liver**
  - Most common cause of hepatic calcifications
  - Histoplasmosis > tuberculosis > coccidioidomycosis, brucellosis
  - Multiple (few to dozens), small (few millimeters) punctate calcifications
  - Often present in spleen as well
  - Usually the entire lesion is densely calcified
- **Hepatic Metastases**
  - Usually faint and amorphous, rather than dense calcification
  - Any metastases may calcify, especially at border of viable and necrotic tumor
  - Mucinous carcinomas of colon, breast, ovary or stomach
    - Mixture of fat and calcification seen in metastatic malignant teratoma (uncommon tumor)
  - Tumors that become necrotic in response to chemotherapy are more likely to calcify
- **Hepatic Arterial Calcification**
  - Aneurysmal: Eggshell, rounded, or tram track calcification
  - Diabetic arteriopathy; long segmental calcifications of medium-sized arteries, including hepatic
- **Ethiodol-Treated Tumor, Liver**
  - Iodized poppy seed oil (Lipiodol) administered intra-arterially, localizes in hepatocellular carcinoma and other tumors
  - Used as adjunct to diagnosis and therapy
  - Spherical collection within tumor
  - Usually even more dense than calcified hepatic lesions
    - Check for history of angiographic treatment; check prior scans

Helpful Clues for Less Common Diagnoses
- **Hepatic Cavernous Hemangioma**
  - Large hemangiomas often have central scar that may calcify
  - Remainder of mass will show characteristic features of hemangioma
    - Peripheral nodular enhancement, progressive fill-in, isodense to blood vessels
- **Hepatic Hydatid Cyst**
  - Wall and contents may calcify
  - May get calcified "hydatid sand" in dependent portion of cyst
  - Complete wall calcification is usually a sign of inactive hydatid infection
- **Fibrolamellar HCC**
  - Typically affects young adults
  - Uncommon tumor, but usually (over 60%) has large central scar with calcification

- Tumor is large at presentation (> 10 cm) with heterogeneous enhancement
- Most have lymphatic and/or other metastases (lung, bone) at time of presentation

• **Cholangiocarcinoma (Peripheral)**
- Fibrotic mass arising from intrahepatic bile ducts
- Causes volume loss of affected part of liver with capsular retraction
- Calcification is an uncommon feature

• **Hepatocellular Carcinoma**
- Much more common than fibrolamellar HCC, but uncommonly has calcification
- May have punctate or irregular scar calcification

• **Hepatic Adenoma**
- Punctate or capsular calcification
- Other features include foci of hemorrhage and fat (more evident on MR than on CT)

• **Hepatic Opportunistic Infection**
- Cytomegalovirus, toxoplasma, pneumocystic, etc.
- Few to innumerable punctate calcifications
- Seen in patients with AIDS, bone marrow or organ transplantation

• **Portal Vein Calcification**
- Calcification of wall due to portal hypertension
- Portal vein thrombus may calcify
- May result from "bland" thrombus; may follow septic thrombophlebitis

• **Intrahepatic Calculi & Biliary Parasites**
- Often coexist; more in Asian populations
- Clonorchis (liver fluke) is common

• **Extrahepatic Calcifications (Mimic)**
- Calcification in pleura, peritoneum, gallbladder, kidney, etc.
- May overlap liver and mimic hepatic calcification

Helpful Clues for Rare Diagnoses

• **Focal Nodular Hyperplasia**
- Calcification in the central scar is rare and small relative to the size of the entire lesion

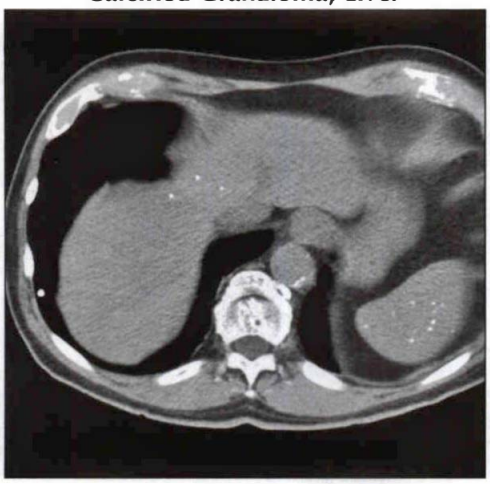
• **Epithelioid Hemangioendothelioma**
- Rare malignant tumor of lower aggressiveness
- Typically causes multiple confluent peripheral hepatic masses
  - Characteristic retraction of overlying hepatic capsule

• **Schistosomiasis, Hepatic**
- S. japonica is endemic in parts of Asia
- Causes dystrophic calcification and fibrosis in liver

SELECTED REFERENCES

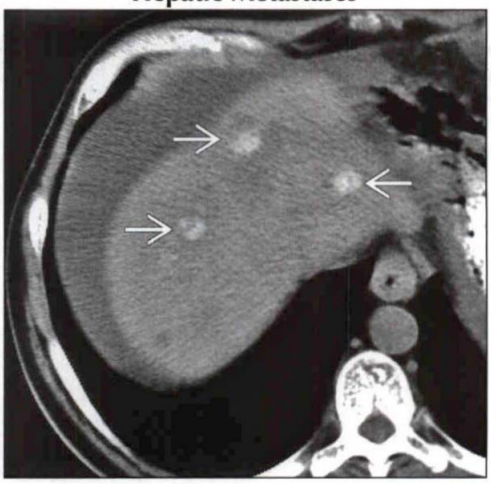
1. Hale HL et al: CT of calcified liver metastases in colorectal carcinoma. Clin Radiol. 53(10):735-41, 1998
2. Stoupis C et al: The Rocky liver: radiologic-pathologic correlation of calcified hepatic masses. Radiographics. 18(3):675-85; quiz 726, 1998
3. Jacoby JH et al: Calcified liver lesions. N J Med. 87(8):651-2, 1990

Calcified Granuloma, Liver



Axial NECT shows multiple small focal calcifications in the liver & spleen; typical healed granulomas, usually from histoplasmosis or tuberculosis.

Hepatic Metastases

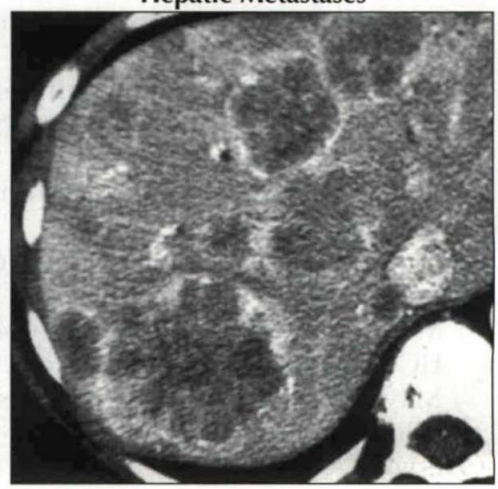


Axial NECT shows several calcified metastases ➡ from mucinous adenocarcinoma of the colon.

HEPATIC CALCIFICATIONS

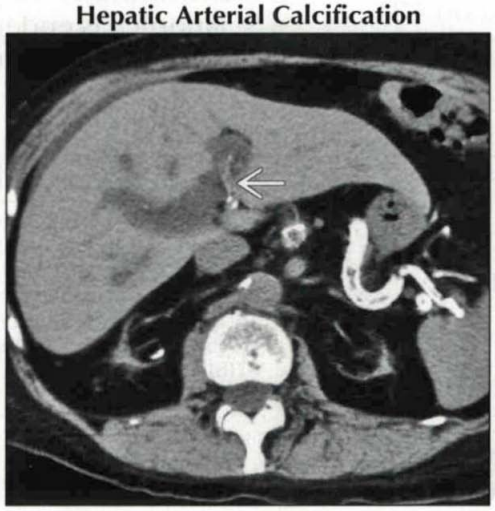
Hepatic Metastases

Hepatic Metastases

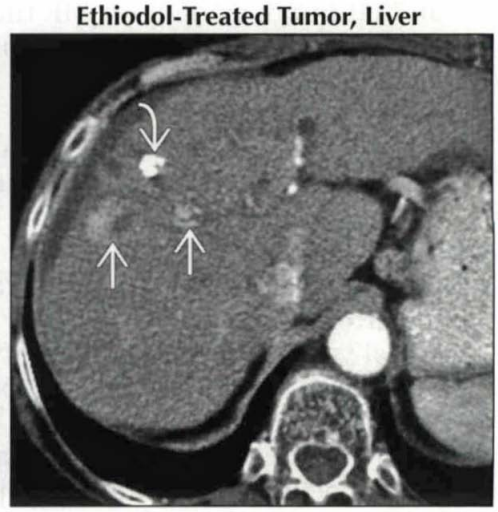


(Left) *Axial NECT shows faint calcification within several metastatic foci. Colon carcinoma primary.* ***(Right)*** *Axial CECT shows rim enhancement of the metastases. Note that the calcification is much less evident after contrast administration. Colon carcinoma primary.*

Hepatic Arterial Calcification

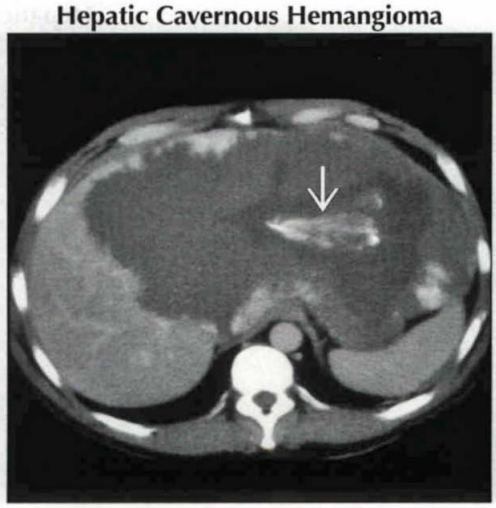


Ethiodol-Treated Tumor, Liver

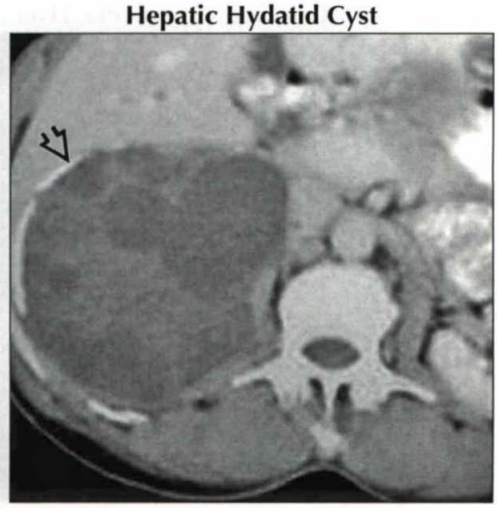


(Left) *Axial NECT shows calcification of medium-sized arteries, including the left hepatic in a pattern characteristic of diabetic vasculopathy. Also note end stage kidneys.* ***(Right)*** *Axial CECT shows vascular foci of viable HCC on this arterial phase CECT. The very dense focus is residual Lipiodol that had been given as part of intra-arterial chemotherapy.*

Hepatic Cavernous Hemangioma



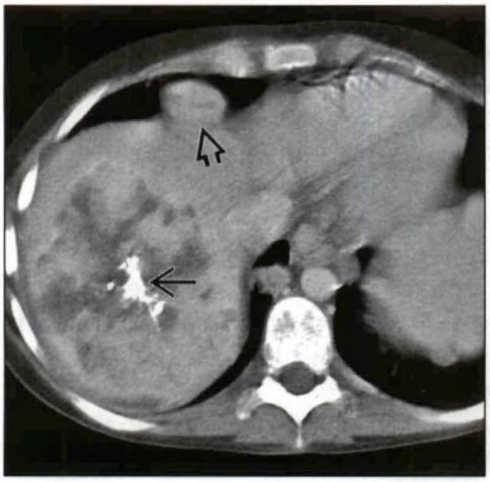
Hepatic Hydatid Cyst



(Left) *Axial CECT shows a huge hepatic cavernous hemangioma with typical peripheral nodular enhancement. Note calcification within large central scar.* ***(Right)*** *Axial CECT shows a large hydatid cyst with lower density daughter cysts (scolices) within, and partial calcification of the wall.*

HEPATIC CALCIFICATIONS

Fibrolamellar HCC



Hepatocellular Carcinoma

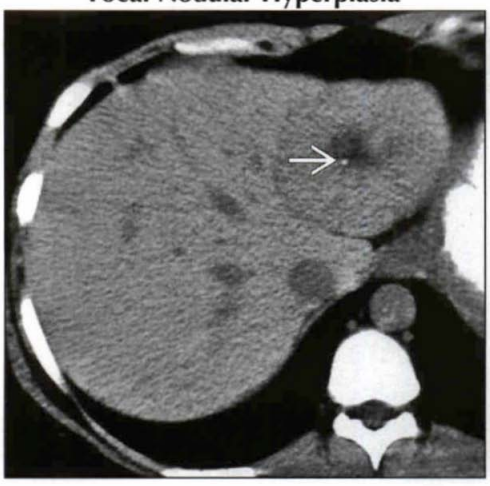
*(Left) Axial CECT shows a large mass in the right lobe in this adolescent boy. Note the calcification ⇨ within the large, poorly enhancing scar, and cardiophrenic lymphadenopathy ⇨. **(Right)** Axial CECT shows a heterogeneous left lobe mass that contains foci of near fat density ➡ as well as focal calcifications ⇨.*

Hepatic Adenoma

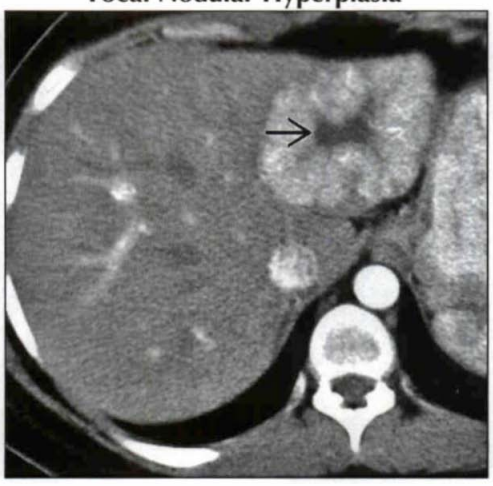
Intrahepatic Biliary Calculi

*(Left) Axial CECT shows a hypervascular mass with eccentric calcification ➡ on this arterial phase CECT; hepatic adenoma. **(Right)** Axial CECT shows calculi ⇨ within massively dilated cystic dilations of the intrahepatic ducts; Caroli disease.*

Focal Nodular Hyperplasia



Focal Nodular Hyperplasia



*(Left) Axial NECT shows a tiny focus of calcification ➡ in the central scar of an otherwise typical FNH, that showed bright homogeneous enhancement on arterial phase CECT. **(Right)** Axial CECT shows bright homogeneous enhancement of a large FNH with a central scar ⇨ that had a tiny focus of calcification on NECT. Arterial phase CECT.*

LIVER LESION CONTAINING GAS

DIFFERENTIAL DIAGNOSIS

Common
- Hepatic Pyogenic Abscess
- Hepatic Infarction
- Hepatic Tumor Following Treatment
  - Hepatocellular Carcinoma
  - Metastases and Lymphoma, Hepatic
  - Hepatic Adenoma

Less Common
- Biloma
- Hepatic Amebic Abscess
- Hepatic Hydatid Cyst
- Retained Foreign Body

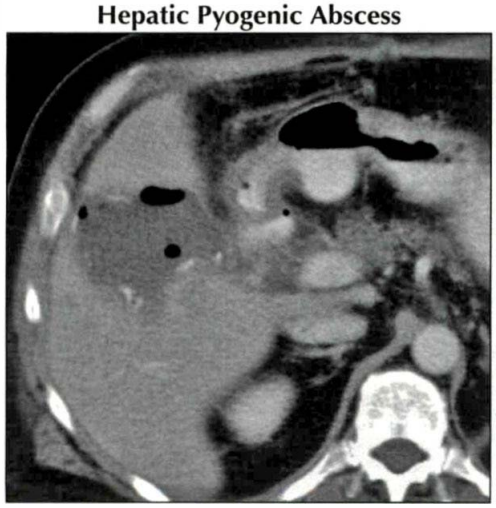
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- 4 pathways to developing gas
  - Infection by a gas-forming organism
  - Infarction of liver or lesion
  - Open wound or surgical drain
  - Reflux of gas into lesion from biliary tree

Helpful Clues for Common Diagnoses
- **Hepatic Pyogenic Abscess**
  - Four major routes
    - Portal vein thrombophlebitis (diverticulitis, appendicitis)
    - Ascending cholangitis (gallstones or biliary obstruction)
    - Direct extension (perforated ulcer)
    - Traumatic (blunt or penetrating)
  - Multiseptated, or "cluster of grapes"
- **Hepatic Infarction**
  - Uncommon due to dual blood supply
    - Usually requires interruption of both portal venous and hepatic arterial supply
  - Etiologies
    - Iatrogenic (cholecystectomy, hepatobiliary surgery, TIPS)
    - Liver transplantation (hepatic artery stenosis or thrombosis)
    - Blunt trauma
    - Hypercoagulable states and vasculitis
- **Hepatic Tumor Following Treatment**
  - Any treatment that results in sudden death of a substantial amount of tissue (benign or malignant)
    - Chemoembolization > RF or cryoablation > chemotherapy > surgical ligation of hepatic arterial branch
  - Imaging, symptoms and laboratory signs closely mimic hepatic abscess

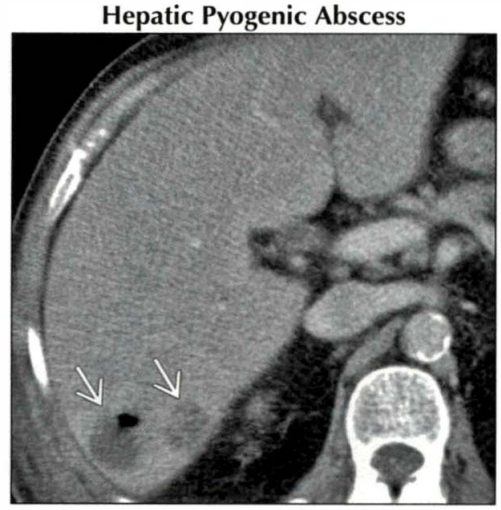
Helpful Clues for Less Common Diagnoses
- **Biloma**
  - Communication with bile ducts may allow gas to enter biloma
- **Amebic or Hydatid Abscess**
  - With secondary bacterial infection
- **Retained Foreign Body**
  - Retained surgical sponge: Will have opaque stripe
  - Oxidized surgical gelatin (Surgicel): Used to control bleeding
    - Multifocal gas without fluid component
    - Does not imply infection

Hepatic Pyogenic Abscess



Axial CECT shows a mass with fluid and gas contents, representing a hepatic abscess, following complicated cholecystectomy.

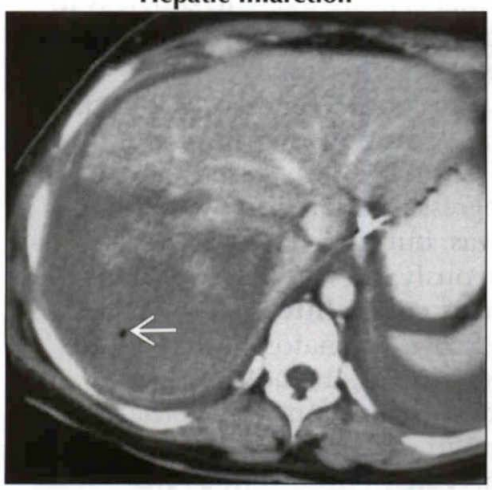
Hepatic Pyogenic Abscess



Axial CECT shows 2 abscesses ➡ one of which contains gas. Patient has ascending cholangitis, & gas may enter the abscesses from gas-containing ducts or result from infection itself.

LIVER LESION CONTAINING GAS

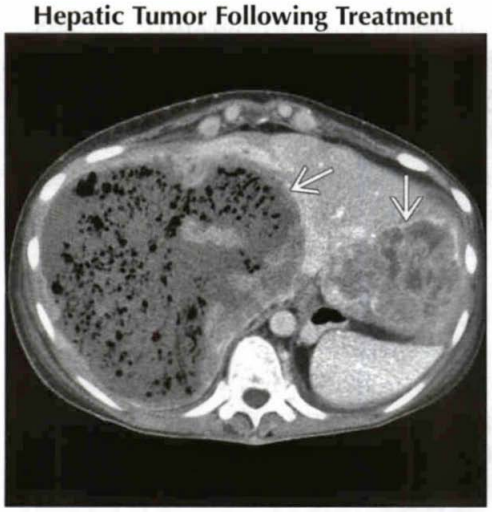
Hepatic Infarction



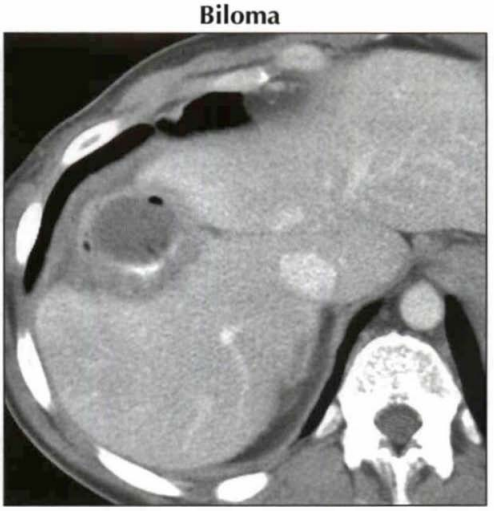
Hepatic Tumor Following Treatment

*(**Left**) Axial CECT shows devascularization of the right lobe from blunt trauma. The hepatic artery & veins to the right lobe were avulsed. The gas bubble → is due to infarction, not infection. (**Right**) Axial CECT shows nonenhancement of the left lobe → with portal venous gas →: infarction following attempted resection of peripheral cholangiocarcinoma.*

Hepatic Tumor Following Treatment

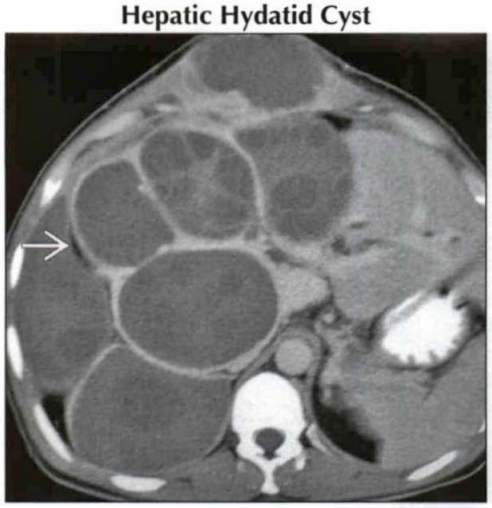


Biloma



*(**Left**) Axial CECT shows two large hepatic masses → (metastatic breast cancer). The larger lesion has gas due to tumor infarction as a result of chemotherapy; no infection. (**Right**) Axial CECT shows a focal collection of fluid & gas that was the result of a deep liver laceration several days prior.*

Hepatic Hydatid Cyst



Retained Foreign Body

*(**Left**) Axial CECT shows multiple hepatic hydatid cysts, many with daughter cysts within. Gas may be present in one cyst →, possibly due to secondary pyogenic infection. (**Right**) Axial CECT shows a surgical clip & collection of gas → in or adjacent to liver. This is oxidized surgical gelatin (Surgicel) that was used as a hemostatic device & left in place.*

PORTAL VENOUS GAS

DIFFERENTIAL DIAGNOSIS

Common
- Ischemic Enteritis
- Ischemic Colitis
- Pneumatosis of the Intestine
- Post-Operative State, Bowel
- Medication-Induced
- Pneumobilia (Mimic)

Less Common
- Diverticulitis
- Appendicitis
- Endoscopy-Induced
- Vasculitis, Small Intestine
- Small Bowel Obstruction
- Pancreatitis, Acute
- Abdominal Abscess
- Intestinal Trauma
- Hepatic Infarction

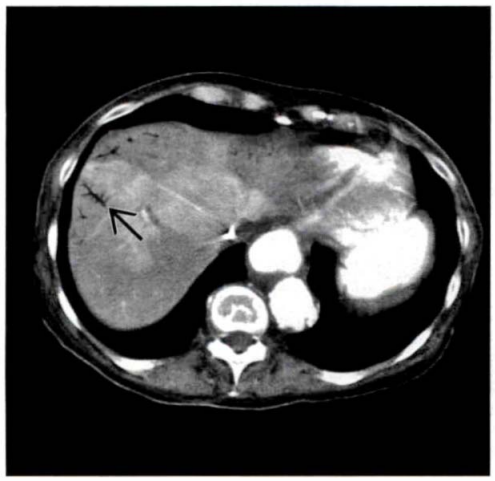
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Almost any cause of infection, inflammation, trauma or ischemia of any part of the GI tract, including pancreas, may result in portal venous gas
- CT and ultrasound (US) detect portal venous gas more commonly than radiography
  - Portal venous gas detected by CT or US has a better patient prognosis (75% survival); by radiography (75% mortality)

Helpful Clues for Common Diagnoses
- **Ischemic Enteritis**
  - SB ischemia is more likely to progress to infarction than colonic ischemia
  - Intramural pneumatosis usually accompanies portal venous gas, but these are late and ominous signs of infarction
- **Ischemic Colitis**
  - May progress to infarction with portal venous gas, but more likely to resolve spontaneously or evolve into stricture
- **Pneumatosis of the Intestine**
  - Any cause of pneumatosis may lead to portal venous gas, including bowel obstruction or anastomosis, steroids
  - Even benign pneumatosis cystoides of the colon can cause portal venous gas
- **Pneumobilia (Mimic)**
  - Gas within bile ducts may be mistaken for portal venous gas on radiography, CT, US
  - Gas within bile ducts tends to collect more centrally within the liver; portal venous gas flows toward the periphery of this liver

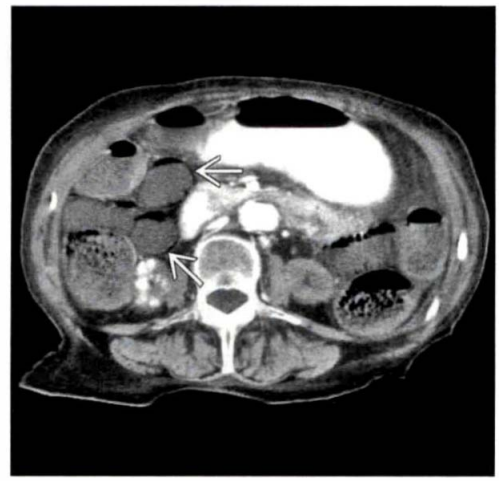
Helpful Clues for Less Common Diagnoses
- **Diverticulitis and Appendicitis**
  - Chronic untreated inflammation of the colon, appendix or small bowel may result in mesenteric and portal vein thrombophlebitis
  - Veins may have thickened walls, luminal gas, progress to thrombosis
  - Look for associated pyogenic liver abscess

Ischemic Enteritis



Axial CECT shows gas ⇨ within peripheral branches of the portal vein in a patient with small bowel infarction. Also note the mottled perfusion of the liver.

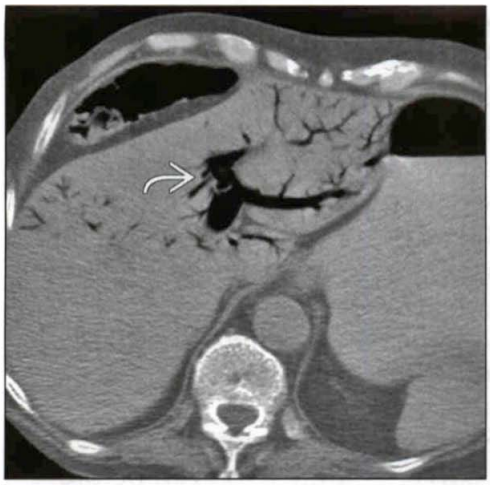
Ischemic Enteritis



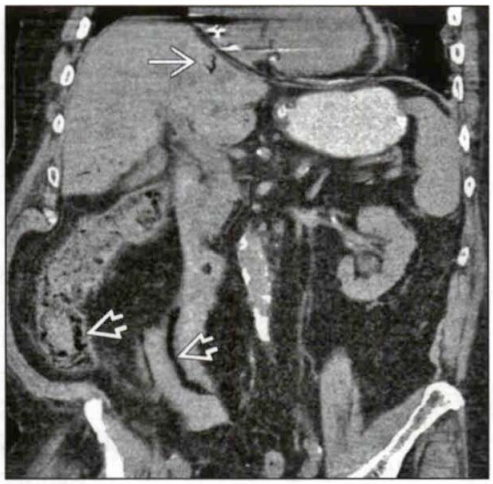
Axial CECT shows gas ➡ within the wall of several segments of dilated, infarcted small bowel.

PORTAL VENOUS GAS

Ischemic Enteritis

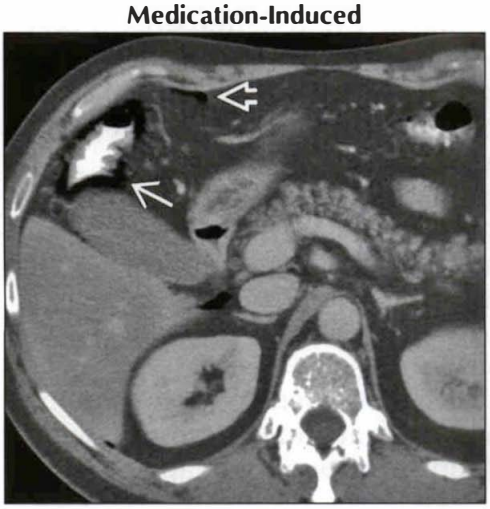


Ischemic Colitis

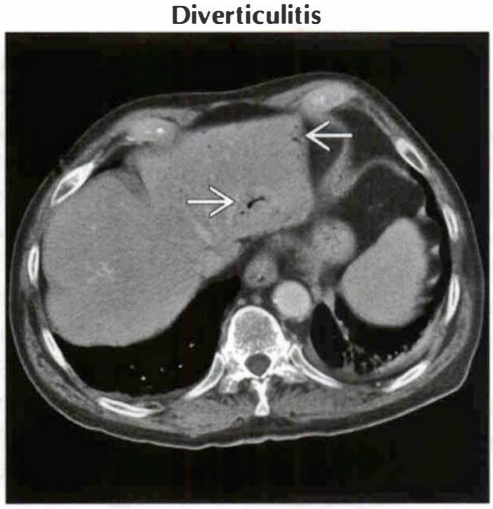


(Left) Axial CECT shows extensive portal venous gas in an elderly man, who had a preceding hypotensive episode. SB pneumatosis was also present. All signs and symptoms resolved spontaneously. (Right) Coronal NECT shows gas within the wall of ascending and transverse colon, and within portal vein in this elderly patient with surgically proven infarction of the colon.

Medication-Induced

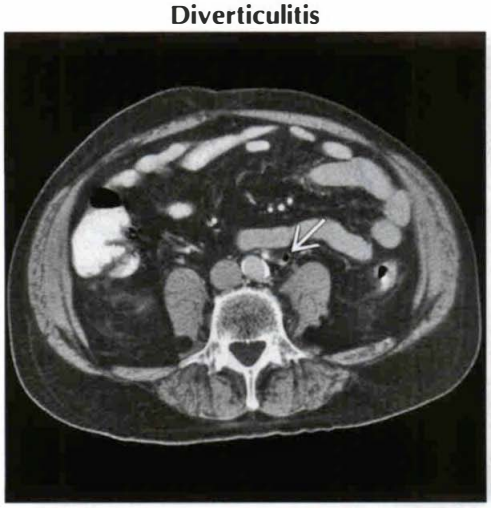


Diverticulitis

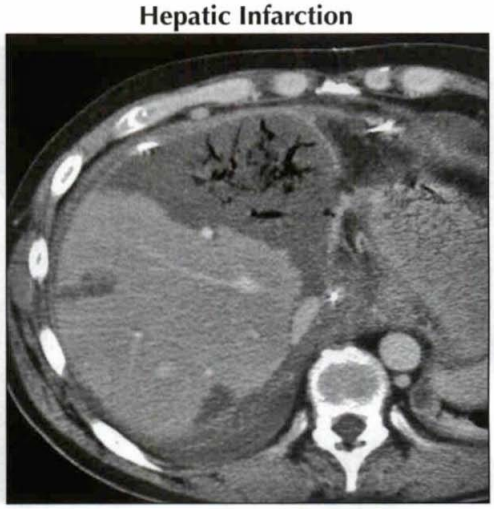


(Left) Axial CECT shows free intraperitoneal and intramural gas in an asymptomatic patient on steroid medication. Benign portal venous gas can also result in this setting. (Right) Axial CECT shows portal venous gas due to diverticulitis with portal vein thrombophlebitis. Resolved with antibiotics alone.

Diverticulitis



Hepatic Infarction



(Left) Axial CECT shows gas in the inferior mesenteric vein in this patient with sigmoid diverticulitis (who also had portal venous gas). Resolved with antibiotics alone. (Right) Axial CECT shows extensive gas in the left portal veins and infarction of the left lobe, following an aborted attempt to resect a left lobe tumor.

WIDENED HEPATIC FISSURES

DIFFERENTIAL DIAGNOSIS

Common
- Cirrhosis
- Focal Confluent Fibrosis
- Senescent Change
- Post-Surgical (Mimic)

Less Common
- Congenital Absence of Hepatic Segments
- Liver Metastases
- Primary Sclerosing Cholangitis
- Congenital Hepatic Fibrosis
- Schistosomiasis

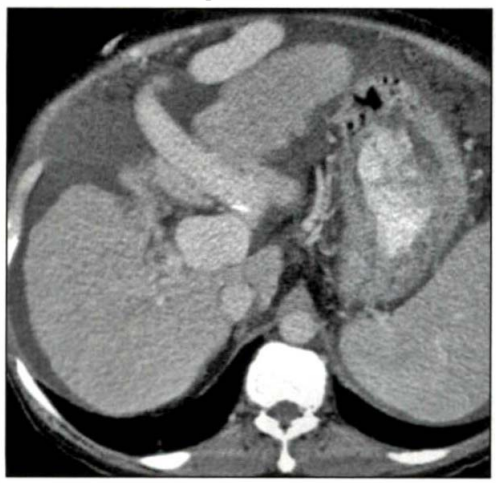
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Widened fissures = congenital, acquired or iatrogenic loss of hepatic parenchyma

Helpful Clues for Common Diagnoses
- **Cirrhosis**
  - Widening of fissures indicates fibrosis and volume loss; sensitive sign of cirrhosis
  - Look for enlarged caudate and signs of portal hypertension (varices, ascites)
- **Focal Confluent Fibrosis**
  - Common in advanced cirrhosis
  - Favors anterior and medial segments with volume loss and capsular retraction
- **Senescent Change**
  - Elderly (> 70) often have asymptomatic volume loss of liver and widened fissures
  - Don't label older patient as cirrhotic without clinical correlation
- **Post-Surgical (Mimic)**
  - Liver segments may be resected or tumors may have been ablated

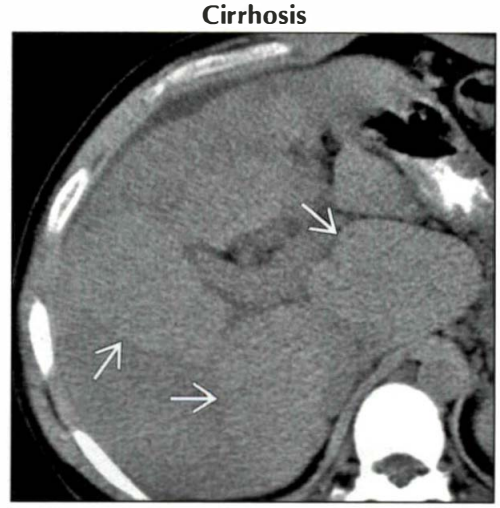
Helpful Clues for Less Common Diagnoses
- **Congenital Absence of Hepatic Segments**
  - Most commonly affects anterior and medial segments
- **Liver Metastases**
  - Some cancers (e.g., breast) induce fibrosis and volume loss de novo
  - Tumor volume loss and hepatic fibrosis may result from IV or arterial chemoembolization
- **Primary Sclerosing Cholangitis**
  - Results in liver volume loss even before true cirrhosis has developed
  - Look for irregular dilation and strictures of bile ducts; history of inflammatory bowel disease
- **Congenital Hepatic Fibrosis**
  - Associated with autosomal recessive polycystic disease
  - Leads to portal hypertension; may simulate or develop into cirrhosis
  - Look for associated biliary or renal abnormalities
  - Hepatic arteries are enlarged and tortuous
- **Schistosomiasis**
  - S. japonica causes extensive fibrosis of liver
  - Look for periportal and pericapsular septal calcifications ("tortoise shell" appearance)

Cirrhosis



Axial CECT shows a shrunken liver with wide fissures, ascites, and varices.

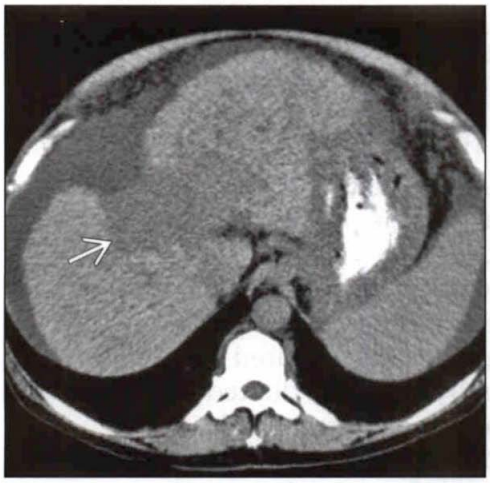
Cirrhosis



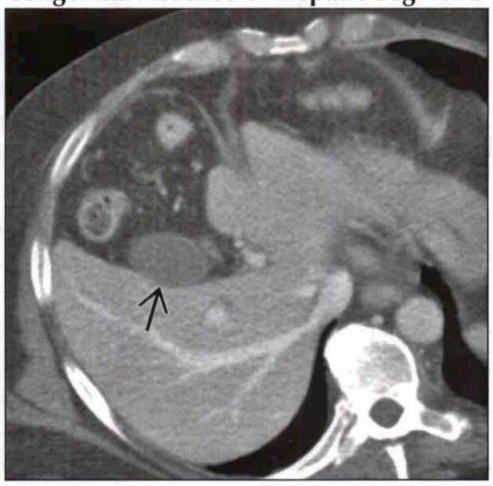
Axial NECT shows a wide porta hepatis with focal areas of volume loss. Some areas of liver are less affected and show normal attenuation and relative hypertrophy ➡

WIDENED HEPATIC FISSURES

Focal Confluent Fibrosis

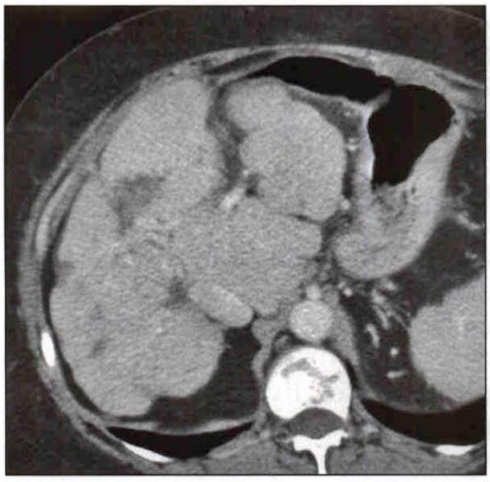


Congenital Absence of Hepatic Segments



(Left) *Axial NECT shows a cirrhotic liver with a wedge-shaped low density lesion ➡ with capsular retraction, that showed delayed persistent enhancement on CECT; focal confluent fibrosis.* ***(Right)*** *Axial CECT shows absence of the medial segment, with omental fat and colon herniating into the space between the right lobe and lateral segment. The gallbladder ⇨ marks the interlobar plane.*

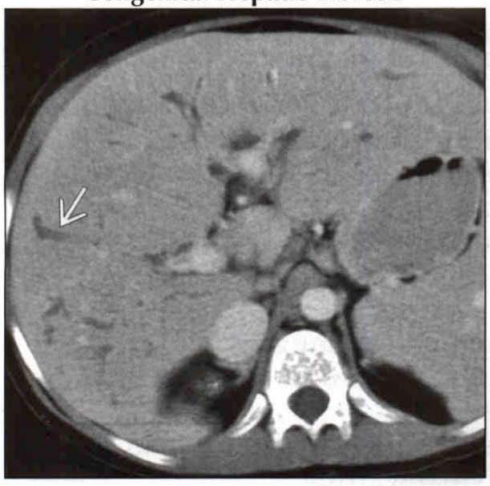
Liver Metastases



Primary Sclerosing Cholangitis

(Left) *Axial CECT shows a nodular liver with foci of capsular retraction and widened fissures that simulates cirrhosis, but is due to metastatic breast cancer that has responded to chemotherapy.* ***(Right)*** *Axial CECT shows a dysmorphic liver with widened fissures and foci of hepatic volume loss. The caudate lobe ⇨ is relatively spared and is hypertrophied. Liver injury due to chronic PSC.*

Congenital Hepatic Fibrosis



Congenital Hepatic Fibrosis

(Left) *Axial CECT shows a dysmorphic liver with widened fissures and dilated, ectatic bile ducts ➡, due to Caroli disease and congenital hepatic fibrosis.* ***(Right)*** *Transhepatic cholangiography shows dilation of the intrahepatic bile ducts with cystic dilation of the terminal ducts. Caroli disease in a patient who also had congenital hepatic fibrosis.*

DYSMORPHIC LIVER WITH ABNORMAL BILE DUCTS

DIFFERENTIAL DIAGNOSIS

Common

- Primary Sclerosing Cholangitis
- Cirrhosis (Mimic)
  - Hepatitis
  - Peribiliary Cysts
- Portal Vein Thrombophlebitis (Mimic)
  - Diverticulitis
  - Hepatic Pyogenic Abscess
- Cholangiocarcinoma (Peripheral)

Less Common

- Budd-Chiari Syndrome (Mimic)
- Chemotherapy Cholangitis
- Ascending Cholangitis
- AIDS Cholangiopathy
- Fibropolycystic Liver Diseases
  - Congenital Hepatic Fibrosis
  - Caroli Disease
  - Choledochal Cyst
  - Biliary Hamartoma
  - AD Polycystic Disease, Liver
- Recurrent Pyogenic Cholangitis
- Hepatic Hydatid Disease

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Dysmorphic liver refers to distortion and scarring of the parenchyma
  - May result from inflammation, infection, ischemia, tumor (or the effects of treatment for these conditions)
- Distinguish among dilated ducts, periportal edema and thrombosed portal or hepatic veins
  - Appearance will vary by modality
    - US: Dilated hepatic artery in cirrhosis may simulate dilated ducts
    - CT or MR: Periportal edema may simulate dilated ducts
    - CECT: Unopacified veins may simulate ducts
    - Cholangiography: Intrahepatic ducts may be distorted by masses or regenerating nodules, simulating cholangitis

Helpful Clues for Common Diagnoses

- **Primary Sclerosing Cholangitis**
  - Often results in chronic liver damage
    - Lobular contour of liver with preferential scarring of periphery, sparing and hypertrophy of caudate and deep right lobe
  - Intrahepatic bile ducts show varying degrees of stricture and dilation with abnormal arborization (branching pattern)
- **Cirrhosis (Mimic)**
  - Rarely causes ductal dilation, but may cause pathologic processes that simulate dilated ducts
    - Regenerating nodules may compress and distort intrahepatic ducts
  - Peribiliary cysts are dilated peribiliary glands; may simulate dilated ducts ± small cystic masses in portal triads
  - Periportal edema may simulate ducts
  - Thrombosed portal vein branches may simulate dilated ducts on CECT or MR
    - Primary thrombosis of PV (hypercoagulable) produces characteristic distortion of liver that simulates cirrhosis
- **Portal Vein Thrombophlebitis (Mimic)**
  - May be primary process in hypercoagulable states
  - May result from subacute diverticulitis or appendicitis
  - Thrombosed portal veins may simulate dilated ducts
  - Liver may be damaged by infection or ischemia
    - Pyogenic abscesses, liver infarction, volume loss, etc.
- **Cholangiocarcinoma (Peripheral)**
  - Arising from confluence (Klatskin) or branch ducts (peripheral)
  - Ducts are dilated "upstream"
  - Liver parenchyma shows volume loss ± visualization of the tumor

Helpful Clues for Less Common Diagnoses

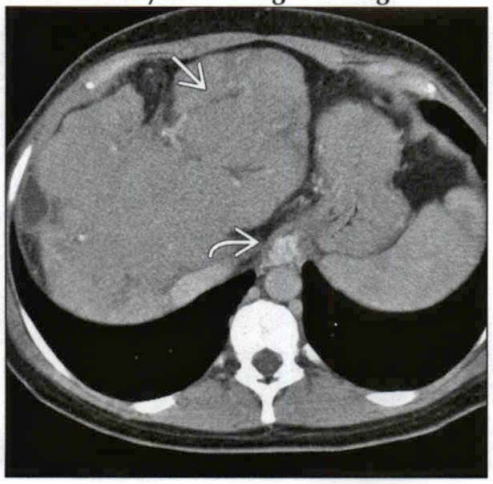
- **Budd-Chiari Syndrome (Mimic)**
  - Thrombosed hepatic veins may simulate dilated ducts
  - Liver is distorted with peripheral > central volume loss, scarring, hepatocellular necrosis and steatosis
- **Chemotherapy Cholangitis**
  - Chemotherapy used for primary HCC or metastases
  - Liver distortion due to tumors and parenchymal scarring

DYSMORPHIC LIVER WITH ABNORMAL BILE DUCTS

- Ducts are damaged and strictured with appearance like primary sclerosing cholangitis

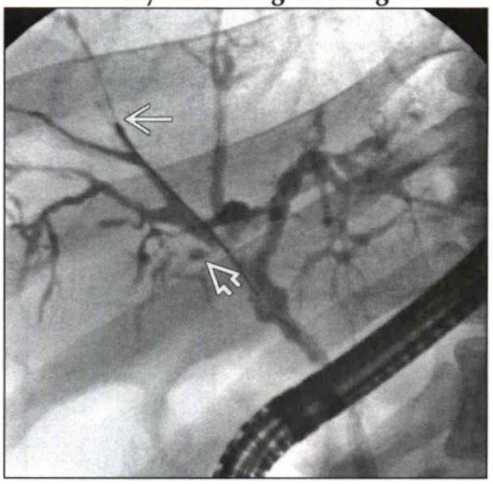
- **Ascending Cholangitis**
  - May lead to duct strictures; rarely to chronic liver injury
- **AIDS Cholangiopathy**
  - Liver may be distorted by infection and/or tumor
  - Intra- and extrahepatic ducts may be strictured by infection
- **Fibropolycystic Liver Diseases**
  - Encompasses spectrum of related lesions of liver and biliary tract caused by abnormal embryologic development of ductal plates
  - Lesions may occur in isolation or in any combination; may be clinically silent or cause cholangitis, portal hypertension, GI bleeding, infection, etc.
  - Liver may be distorted by congenital fibrosis (simulates cirrhosis) or by scarring (especially with Caroli disease)
    - Bile ducts may be primary site of pathology (e.g., Caroli), coexist with primary parenchymal disease (e.g., fibrosis), or be distorted by extrinsic mass effect
  - **Congenital Hepatic Fibrosis**
    - Dysmorphic liver, portal hypertension
    - Enlarged and possibly supranumerary hepatic arteries
  - **Caroli Disease**
    - Cystic or fusiform dilation of intrahepatic ducts
    - Liver often progressively damaged by cholangitis, obstruction
  - **Choledochal Cyst**
    - Fusiform or cystic dilation of intrahepatic ± extrahepatic bile duct
  - **Biliary Hamartoma**
    - Multiple "cysts" of nearly uniform size, up to 15 mm; no biliary connection
    - Liver and bile ducts are normal, unless coexisting disease, such as Caroli or congenital fibrosis
  - **AD Polycystic Disease, Liver**
    - Distorts liver with innumerable cysts
    - Bile ducts intrinsically normal but may have extrinsic compression by cysts
- **Recurrent Pyogenic Cholangitis**
  - Usually in Asian poor populations
  - Liver distorted by chronic infection and biliary obstruction (abscesses, cirrhosis)
  - Bile ducts enormously dilated by pus and stones
- **Hepatic Hydatid Disease**
  - Cysts may distort liver
  - Cysts may communicate with ducts, leading to cholangitis

Primary Sclerosing Cholangitis



Axial CECT shows a small liver with deep scars and lobular contour, typical of cirrhosis due to PSC. Note the irregular dilation of intrahepatic ducts ➡ and esophageal varices ➡.

Primary Sclerosing Cholangitis

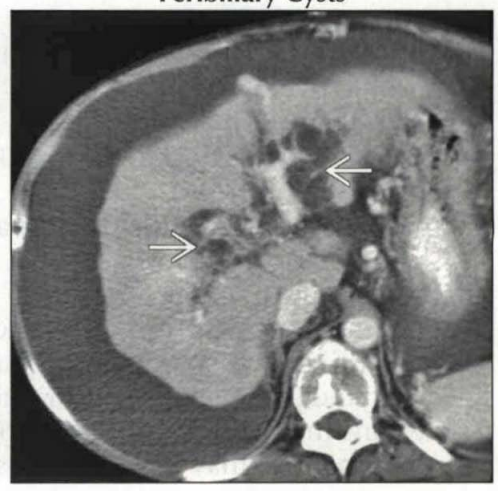


Anteroposterior ERCP shows segmental strictures ➡ and "diverticula" ➡ involving the intra and extrahepatic bile ducts resulting in a beaded appearance of the ducts.

DYSMORPHIC LIVER WITH ABNORMAL BILE DUCTS

Hepatitis

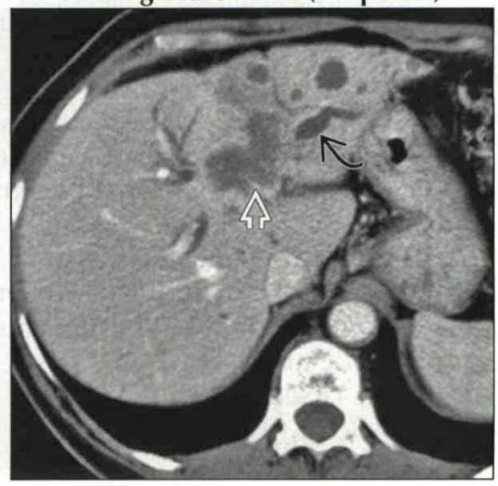
Peribiliary Cysts



(Left) *Axial CECT shows a mottled distorted liver due to acute and chronic hepatitis. Periportal edema ➡ might be mistaken for dilated ducts.* ***(Right)*** *Axial CECT shows saccular and spherical cystic lesions ➡ (peribiliary cysts) paralleling the portal triads, in a patient with advanced cirrhosis and ascites.*

Peribiliary Cysts

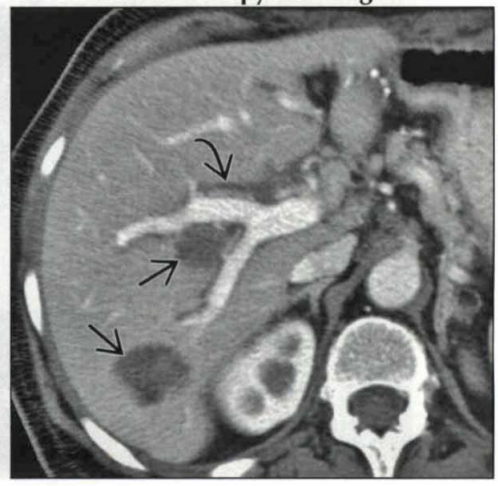
Cholangiocarcinoma (Peripheral)



(Left) *Transverse ultrasound shows sonolucent saccular and spherical cystic lesions paralleling the portal triads, representing peribiliary cysts in a patient with cirrhosis and ascites.* ***(Right)*** *Axial CECT shows a heterogeneous left lobe mass ➡ that obstructs intrahepatic ducts ⇨ and causes volume loss of the left lobe.*

Budd-Chiari Syndrome (Mimic)

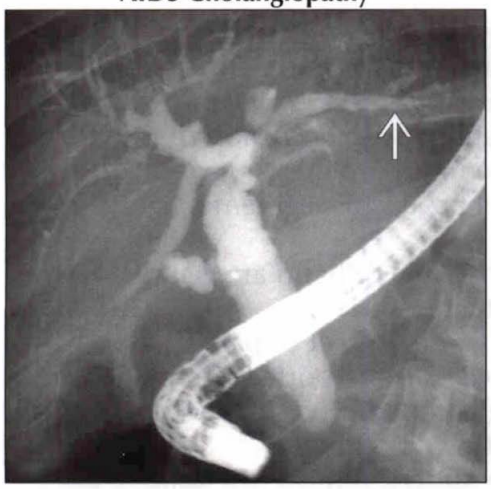
Chemotherapy Cholangitis



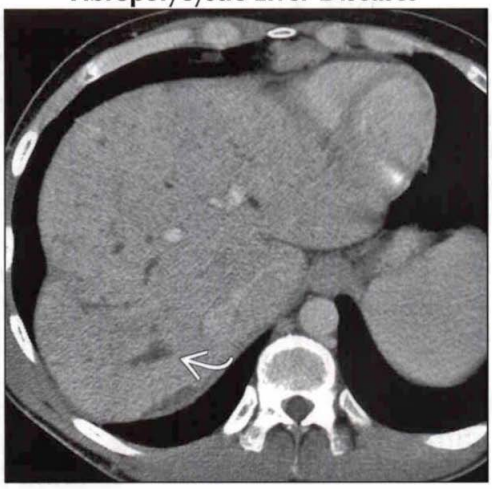
(Left) *Axial CECT shows thrombosed hepatic veins ➡ that simulate dilated ducts on CECT. Ascites, peripheral hepatic damage, and central hypertrophy are typical findings of Budd-Chiari.* ***(Right)*** *Axial CECT shows two necrotic metastases ⇨ (from colon cancer) and mild dilation of the bile ducts ⇨ as a result of intra-arterial chemotherapy.*

DYSMORPHIC LIVER WITH ABNORMAL BILE DUCTS

AIDS Cholangiopathy



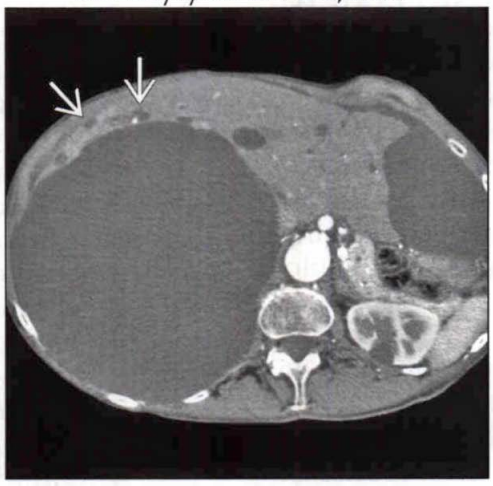
Fibropolycystic Liver Diseases



(Left) *Frontal ERCP shows a dilated common duct due to a distal stricture, and strictures of the intrahepatic ducts due to opportunistic infectious cholangitis in AIDS.* ***(Right)*** *Axial CECT shows a dysmorphic liver with irregular dilation of intrahepatic ducts. On lower sections, hepatic arteries were enlarged and small cystic kidneys were noted.*

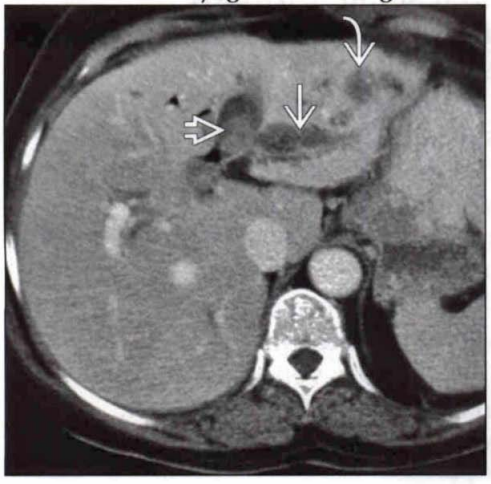
Caroli Disease

AD Polycystic Disease, Liver

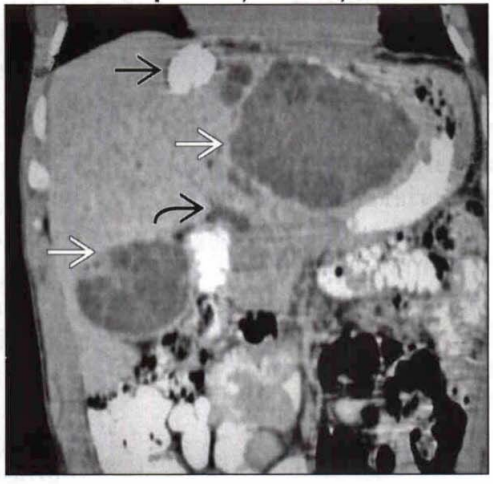


(Left) *Axial T2WI MR shows cystic and irregular cylindrical dilation of intrahepatic bile ducts, characteristic of Caroli disease. Progressive liver failure resulted in transplantation.* ***(Right)*** *Axial CECT shows two dominant cysts, among many smaller ones lower in the liver. Intrahepatic ducts are dilated due to extrinsic compression.*

Recurrent Pyogenic Cholangitis



Hepatic Hydatid Cyst



(Left) *Axial CECT shows dilated ducts with a large pigment calculus and a small liver abscess.* ***(Right)*** *Coronal CECT shows two large cystic masses with daughter cysts, and a densely calcified cyst. Bile ducts are dilated due to communication of one of the cysts with the ducts.*

FOCAL HYPERPERFUSION ABNORMALITY (THAD OR THID)

DIFFERENTIAL DIAGNOSIS

Common

- Transient Hepatic Attenuation Difference
- Liver Metastases
- Hepatocellular Carcinoma
- Liver Biopsy or Trauma
- Arterioportal Shunt, Cirrhosis
- Anomalous Blood Supply

Less Common

- Hepatic Pyogenic Abscess
- Hepatic Cavernous Hemangioma
- Focal Nodular Hyperplasia
- Cholecystitis
- Hepatic AV Malformation
- SVC Obstruction, Abdominal Manifestations
- Portal Vein Occlusion
- Extrinsic Compression of Liver

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Transient hepatic attenuation or intensity differences (THAD or THID, respectively)
  - Are focal areas of hepatic parenchymal enhancement visible only on the arterial phase of contrast-enhanced imaging
    - Unique to liver, due to its dual blood supply
  - 3 major etiologies
    - Portal vein branch compression or occlusion (e.g., metastases, hepatocellular carcinoma (HCC), benign masses, portal vein thrombosis)
    - Arterioportal shunt or anomalous blood supply; diversion and mixing of blood (and contrast medium) from high pressure arteries to low pressure portal vein distribution (e.g., liver biopsy, HCC, hemangiomas, congenital)
    - "Siphoning" or "sump" effect; hypervascular mass or inflammatory process draws more arterial flow into segment of liver (e.g., pyogenic abscess, FNH, HCC, capillary hemangioma)
- Most THAD lesions are not visible on nonenhanced CT or MR
  - Exceptions: Slight increased signal on T2WI may result from excess free water within zone of THID
  - Long-standing alterations of arterioportal supply may result in altered metabolism (e.g., focal fatty infiltration or focal sparing)

Helpful Clues for Common Diagnoses

- **Transient Hepatic Attenuation Difference**
  - Presumably due to occlusion of small portal venous branch
  - Wedge-shaped, sub-segmental, abuts liver capsule
  - "Lesion" visible only on arterial phase
- **Liver Metastases**
  - Usually from GI tract or pancreas
  - Cause occlusion of portal vein branch, eliciting compensatory increased hepatic arterial flow to segment
  - Look for spherical mass (metastasis) at apex of triangular defect (THAD or THID)
  - Hypervascular metastases may cause THAD by occlusion of portal vein and/or by drawing more arterial flow into involved segment
- **Hepatocellular Carcinoma**
  - Three mechanisms to cause THAD
    - Portal vein occlusion (tumor invasion)
    - Arteriovenous shunting through tumor
    - Siphon or sump effect of hypervascular tumor
- **Liver Biopsy or Trauma**
  - Arteriovenous or arterioportal shunt is a common, usually transient, result
  - See early filling of veins that drain involved segment
  - Can follow any hepatic trauma or intervention (e.g., RF ablation; percutaneous biliary drainage catheter)
- **Arterioportal Shunt, Cirrhosis**
  - Often idiopathic, very common in cirrhosis
  - Usually small, peripheral
  - Larger, spherical, more central lesions are difficult to distinguish from HCC and other hypervascular tumors
  - Recommendation: Just follow small lesions on sequential scans
    - Often resolve spontaneously
- **Anomalous Blood Supply**
  - Anomalous hepatic venous drainage; common along falciform ligament, surrounding gallbladder fossa, and in segment IV

- Common areas of THAD and also of focal fat and/or focal sparing

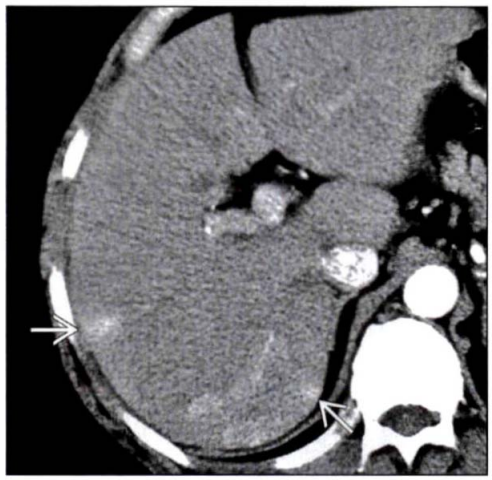
Helpful Clues for Less Common Diagnoses

- **Hepatic Pyogenic Abscess**
  - May compress portal vein and draw increased arterial flow into involved segment of liver
- **Hepatic Cavernous Hemangioma**
  - Any hepatic mass may compress a portal vein branch, leading to a THAD
  - Hemangiomas (even small) may have arterioportal shunts within mass
- **Focal Nodular Hyperplasia**
  - Uncommonly causes THAD, due to mass effect on portal vein or hypervascularity of FNH lesion (sump effect)
- **Cholecystitis**
  - Severe acute cholecystitis may cause inflammation and hyperemia of the adjacent liver
  - Origin of the hot spot or rim sign surrounding gallbladder fossa on Tc-HIDA scan
- **Hepatic AV Malformation**
  - May be isolated anomaly or part of systemic disorder
  - Osler-Weber-Rendu or hereditary hemorrhagic telangiectasia
  - Multisystemic inherited disorder with AV malformations in nose, lungs, GI tract, liver, brain
  - See large hepatic arteries and hepatic veins with premature opacification of veins
  - Vascular masses and telangiectasias within the liver
- **SVC Obstruction, Abdominal Manifestations**
  - Peridiaphragmatic collateral veins traverse left lobe of liver to return blood to IVC
  - Large zone of hypervascularity without mass effect
  - Collateral veins will be evident
- **Portal Vein Occlusion**
  - e.g., Hypercoagulable state; portal vein thrombophlebitis
    - Thrombophlebitis often due to undiagnosed diverticulitis or appendicitis
- **Extrinsic Compression of Liver**
  - e.g., Subcapsular hematoma; may decrease portal perfusion, increase arterial flow
    - Tends to affect periphery of liver in lentiform, rather than wedge-shaped, pattern

SELECTED REFERENCES

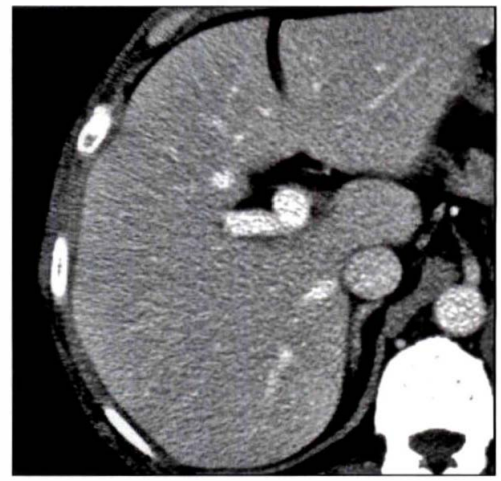
1. Colagrande S et al: Transient hepatic intensity differences: part 1, Those associated with focal lesions. AJR Am J Roentgenol. 188(1):154-9, 2007
2. Colagrande S et al: Transient hepatic intensity differences: part 2, Those not associated with focal lesions. AJR Am J Roentgenol. 188(1):160-6, 2007

Transient Hepatic Attenuation Difference



Axial CECT shows several small, triangular, capsular-based foci of hyperattenuation ➡, seen only on this arterial phase CECT; typical idiopathic, benign THADs.

Transient Hepatic Attenuation Difference

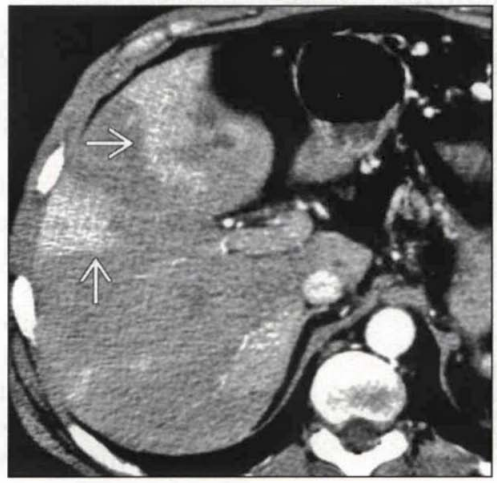


Axial CECT shows disappearance of the peripheral hyperdensities on this portal venous phase CECT, identifying them as foci of "transient hepatic attenuation difference".

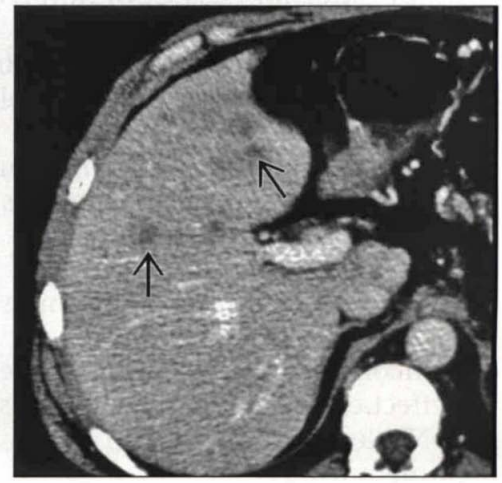
FOCAL HYPERPERFUSION ABNORMALITY (THAD OR THID)

*(Left) Axial CECT shows several wedge-shaped foci of hyperdensity ➡ on this arterial phase CECT. The metastatic foci that are blocking the portal venous tributaries are less clearly seen. **(Right)** Axial CECT shows multiple hypodense metastases ➔ (pancreatic cancer) on this portal venous phase CECT. The THAD foci have disappeared.*

Liver Metastases

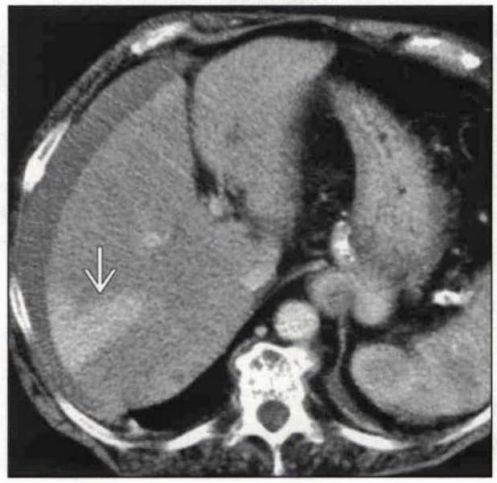


Liver Metastases



*(Left) Axial CECT shows a wedge-shaped focus of hyperperfusion ➡ in the right lobe on this arterial phase CECT, due to a metastasis that is occluding a branch of the right portal vein. **(Right)** Axial CECT shows disappearance of the THAD on this portal venous phase CECT, but the metastases ➡ are better seen; pancreatic carcinoma.*

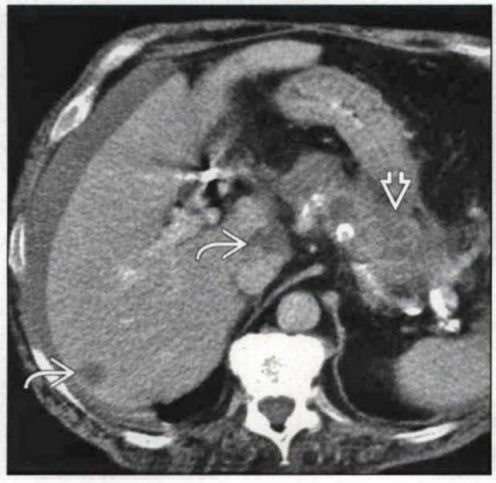
Liver Metastases



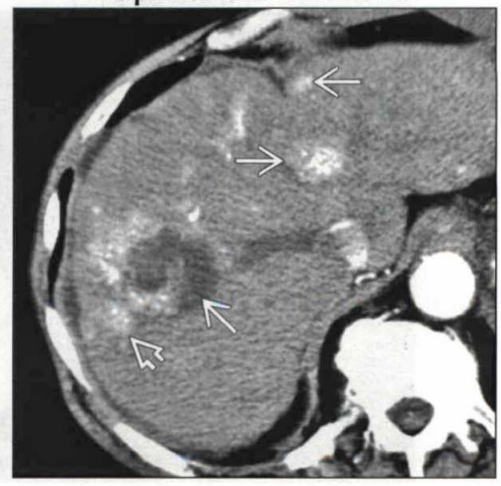
Liver Metastases

*(Left) Axial CECT shows multiple metastases ➡ on this portal venous phase CECT. Primary pancreatic body carcinoma ➪. **(Right)** Axial CECT shows several foci of tumor (HCC) ➡, one with a zone of hypervascularity ➪ distal to the mass, that is due to portal vein branch occlusion by the tumor.*

Liver Metastases



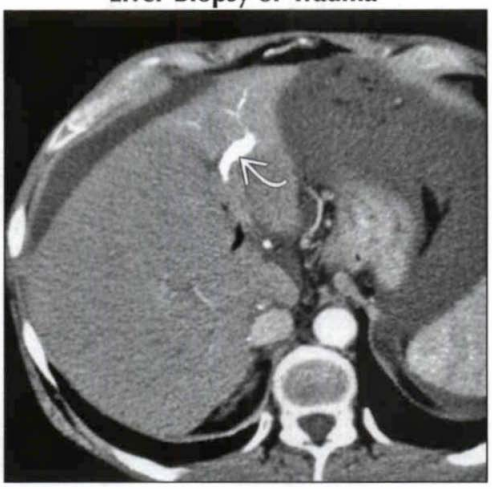
Hepatocellular Carcinoma



FOCAL HYPERPERFUSION ABNORMALITY (THAD OR THID)

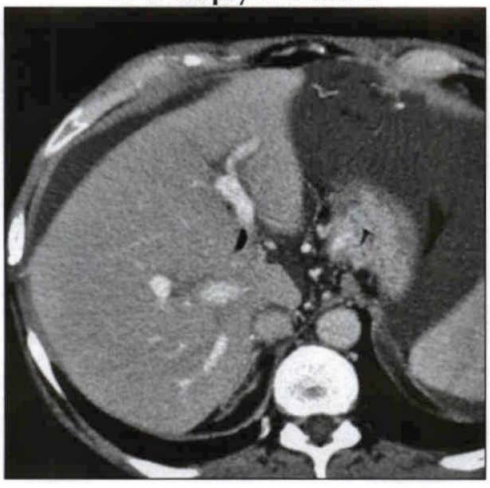
Hepatocellular Carcinoma

Liver Biopsy or Trauma

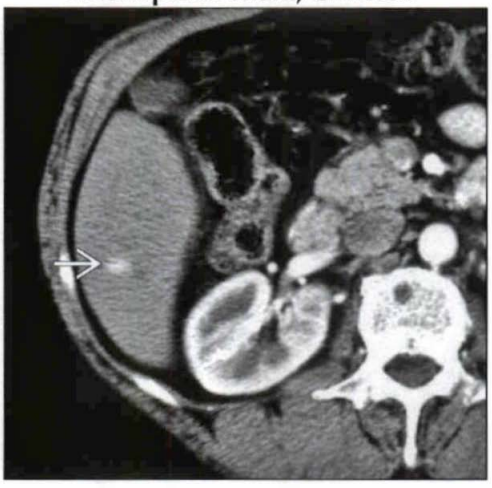


(Left) *Axial CECT shows a portal venous phase image with the HCC nodules ➡ washing out to become hypodense to the liver. Much of the THAD zone of hyperdensity is now isodense to liver.* ***(Right)*** *Axial CECT shows arterial phase image with hyperdensity of the lateral segment and early opacification of the left portal vein ➡: result of a percutaneous liver biopsy with arterial-portal shunt.*

Liver Biopsy or Trauma

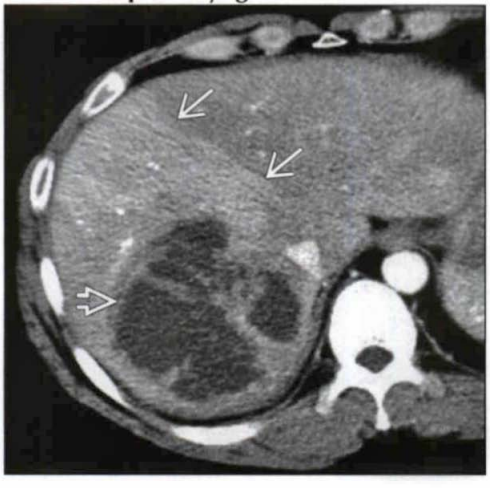


Arterioportal Shunt, Cirrhosis

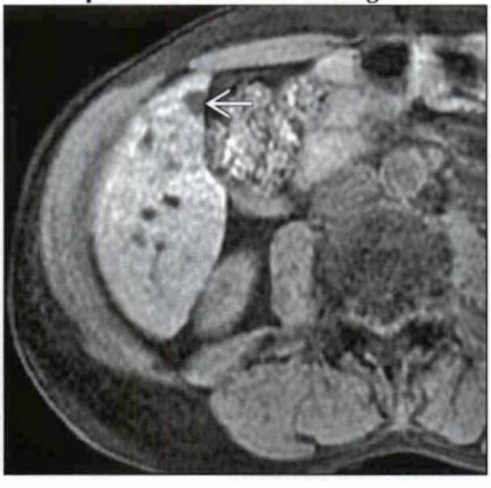


(Left) *Axial CECT shows a portal venous phase image with homogeneous enhancement of the left lobe with resolution of the THAD.* ***(Right)*** *Axial CECT shows a small rounded focus of hypervascularity ➡ on this arterial phase CECT, that disappeared on the portal venous phase and on subsequent CT scans; presumed AP shunt.*

Hepatic Pyogenic Abscess



Hepatic Cavernous Hemangioma



(Left) *Axial CECT shows a multiloculated pyogenic abscess ➡, with hyperperfusion of the right lobe ➡, likely due to "sump effect" and compression or occlusion of the right portal vein.* ***(Right)*** *Axial T1WI MR shows a small hypointense focus ➡ in segment 5, a cavernous ("capillary") hemangioma.*

FOCAL HYPERPERFUSION ABNORMALITY (THAD OR THID)

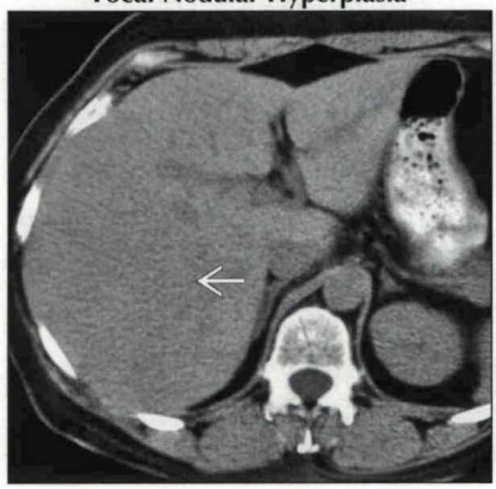
(Left) Axial T1 C+ MR shows a brightly enhancing lesion (hemangioma) and a surrounding region of transient hepatic hyperperfusion, a "THID". (Right) Axial T1 C+ MR shows homogeneous enhancement of the hemangioma and surrounding parenchyma on this portal venous phase CEMR.

Hepatic Cavernous Hemangioma

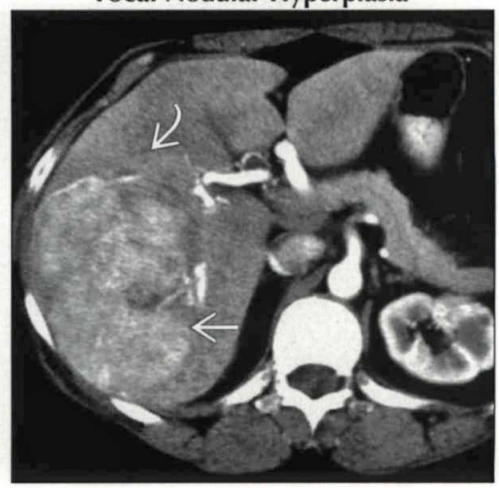
Hepatic Cavernous Hemangioma

(Left) Axial NECT shows a subtle mass that is almost isodense with the liver. (Right) Axial CECT shows large hypervascular FNH with increased density of the surrounding right lobe due to "sump effect".

Focal Nodular Hyperplasia

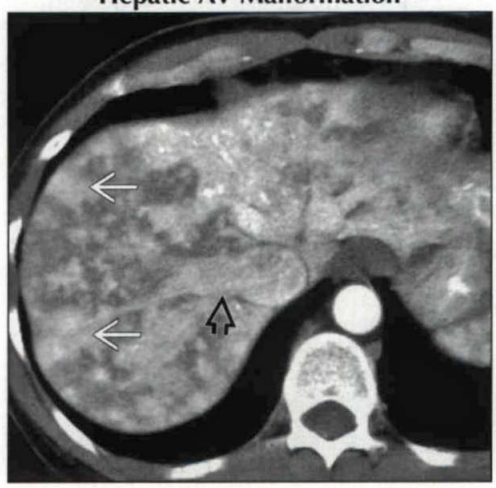


Focal Nodular Hyperplasia

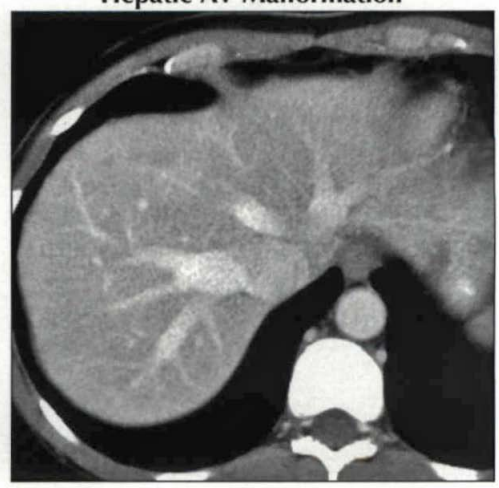


(Left) Axial CECT shows multiple foci of increased hepatic enhancement and early filling of enlarged hepatic veins on this arterial phase CECT. (Right) Axial CECT shows no focal lesions on this portal venous phase CECT, and only the enlarged hepatic veins. The transiently hyperdense lesions were foci of telangiectasias and AV malformations.

Hepatic AV Malformation



Hepatic AV Malformation



FOCAL HYPERPERFUSION ABNORMALITY (THAD OR THID)

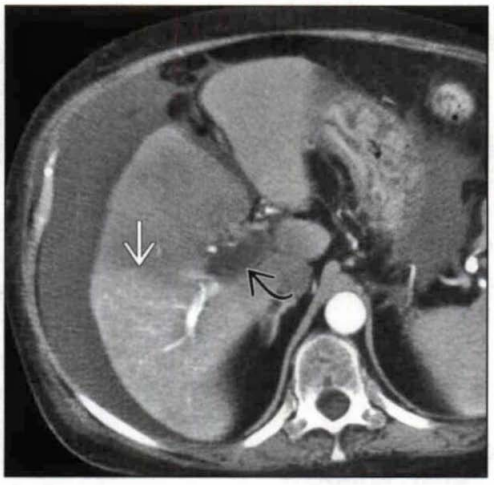
SVC Obstruction, Abdominal Manifestations

SVC Obstruction, Abdominal Manifestations

(Left) Axial CECT shows marked enhancement of the medial ("quadrate") segment due to collateral vessels traversing the liver in a patient with SVC obstruction. Note collaterals. (Right) Axial CECT shows homogeneous enhancement of the liver on this portal venous phase CECT. Note collaterals in left kidney and aortic dissection.

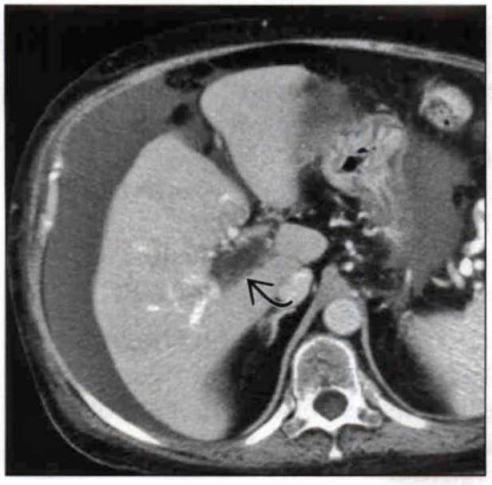
Portal Vein Occlusion

Portal Vein Occlusion



(Left) Axial NECT shows low density (steatosis) limited to the posterior segments of the right lobe, due to thrombosis of the segmental right portal vein. (Right) Axial CECT shows a hyperperfused focus (THAD) limited to the posterior right lobe segments, due to thrombosis of the segmental portal vein.

Portal Vein Occlusion



Portal Vein Occlusion

(Left) Axial CECT shows homogeneous enhancement of the liver on this portal venous phase CECT. The thrombosed right portal vein is well shown. (Right) Axial CECT shows a THAD limited to the anterior segments of the right lobe, due to thrombosis of the segmental portal vein. Arterial phase CECT.

MULTIPLE HYPODENSE LIVER LESIONS

DIFFERENTIAL DIAGNOSIS

Common
- Metastases and Lymphoma, Hepatic
- Simple Hepatic Cysts
- Hepatic Cavernous Hemangioma
- Multifocal Fatty Infiltration
- Hepatic Pyogenic Abscess
- AD Polycystic Disease, Liver
- Hepatocellular Carcinoma
- Hepatic Sarcoidosis

Less Common
- Hepatic Adenoma
- Hepatic Amebic Abscess
- Hepatic Hydatid Cyst
- Hepatic Candidiasis
- Biliary Hamartoma
- Nodular Regenerative Hyperplasia

Rare but Important
- Hepatic Angiomyolipoma
- Epithelioid Hemangioendothelioma
- Caroli Disease

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- On portal venous and delayed phase CECT, almost all detectible hepatic lesions are hypodense (hypoattenuating)
- In order to narrow the DDx, need to characterize the contents and margins of the lesions
  - e.g., water density = cysts, cystic metastases, polycystic liver, biliary hamartomas
  - Neoplasms and abscesses have less distinct walls than cysts
- Very helpful to compare with NECT and arterial phase CECT, if available
  - e.g., contents of cysts and abscesses do not enhance; all (non-necrotic) tumors do
  - Lesion that is hyperdense on HAP phase but becomes hypodense on portal venous phase is definitely neoplastic

Helpful Clues for Common Diagnoses
- **Metastases and Lymphoma, Hepatic**
  - Most common cause for multiple solid hypodense lesions in adult
  - Most common primary sites: Colorectal, pancreas, breast, lung, stomach, eye
  - Most common histology: Adenocarcinoma, squamous cell, neuroendocrine, lymphoma, sarcoma
  - Almost all are hypo- or isodense to liver on portal venous phase and delayed imaging
    - Many will have hypervascular rim on HAP (not considered hypervascular)
- **Simple Hepatic Cysts**
  - Commonly are multiple
  - Larger ones will measure water density and have sharply defined walls, no or few septa
    - Small lesions: Indistinct walls and uncertain density due to volume averaging
    - Thin CT section minimizes this problem
- **Hepatic Cavernous Hemangioma**
  - Multiple lesions are not rare
    - May be innumerable and in other organs and body wall (Kasabach-Merritt syndrome)
  - CT criteria: Blood pool density on NECT; nodular peripheral enhancement, isodense to blood pool on CECT
- **Multifocal Fatty Infiltration**
  - May closely simulate metastases
  - Often has perivascular distribution or follows fissures
    - Blood vessels traverse lesion without mass effect
- **Hepatic Pyogenic Abscess**
  - Pyogenic are more common and multiple than with amebic or hydatid
  - Associated pleural effusion, atelectasis, portal vein thrombophlebitis
- **AD Polycystic Disease, Liver**
  - Innumerable cysts, many with calcified walls and higher density (blood)
  - Associated cysts in kidneys and other organs; family history
- **Hepatocellular Carcinoma**
  - Usually in cirrhotic liver or one damaged by chronic hepatitis
  - Associated signs of portal hypertension, venous invasion
  - Most lesions are heterogeneously hypervascular on arterial phase CECT

Helpful Clues for Less Common Diagnoses
- **Hepatic Adenoma**
  - Uncommon disease but lesions are often multiple, may be innumerable (adenomatosis)

- Larger lesions usually heterogeneous due to presence of fat, hemorrhage or necrosis
- Associated history of oral contraceptives, anabolic steroids, glycogen storage disease

- **Hepatic Amebic Abscess**
  - Usually isolated or no more than a few
- **Hepatic Candidiasis**
  - Innumerable "microabscesses" in immunocompromised patient
- **Biliary Hamartoma**
  - Usually multiple to innumerable, rarely more than 15 mm diameter
  - Fibrotic tissue in walls may cause peripheral enhancement on CECT or CEMR, and echogenicity on US
- **Nodular Regenerative Hyperplasia**
  - Usually occurs in Budd-Chiari syndrome
  - "Large regenerative nodules"
    - Benign hyperplastic nodules that resemble FNH on imaging and histology
  - Usually multiple, 1-4 cm diameter, may have hypodense halo or rim, central scar

Helpful Clues for Rare Diagnoses

- **Hepatic Angiomyolipoma**
  - Multiple lesions are seen almost exclusively in tuberous sclerosis syndrome
  - AMLs in kidney, cystic lesions in lungs
- **Epithelioid Hemangioendothelioma**
  - Multiple, peripheral, confluent hepatic masses
  - Often with target appearance and overlying hepatic capsular retraction
- **Caroli Disease**
  - Multiple cyst-like spaces within liver that communicate with biliary tree

Other Essential Information

- In non-oncology patient, appearance of benign lesions on CECT is often sufficiently characteristic to obviate additional evaluation
  - Oncology patient: Most metastases have characteristic appearance and biological behavior (e.g., interval growth or regression on therapy) to not require additional imaging evaluation
- Cysts, hemangiomas and multifocal steatosis have characteristic appearance on MR, allowing confident diagnosis

Alternative Differential Approaches

- Lesions that may be hyperdense on arterial phase, but hypo- or isodense on portal venous and delayed phase
  - Benign: Adenomas, focal nodular hyperplasia, nodular regenerative hyperplasia
    - Note: Different types of benign lesions may coexist (cysts, hemangiomas, FNH, adenomas)
  - Malignant: HCC and metastases (especially from endocrine, renal, sarcoma primaries, and occasionally from primary tumors in ovary, choriocarcinoma, breast, melanoma)

Metastases and Lymphoma, Hepatic

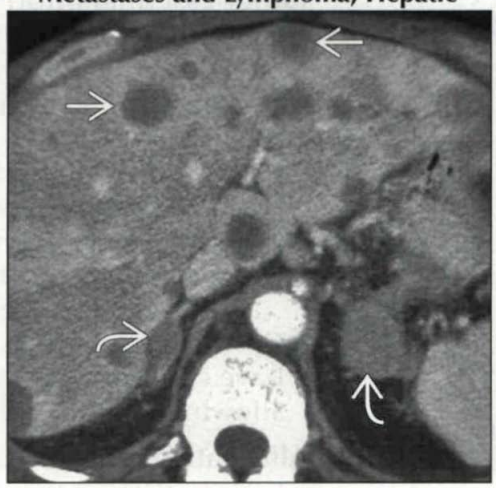
Axial CECT shows multiple hypodense liver metastases. The lesions are almost cystic in appearance, reflecting the cystic nature of the primary tumor, ovarian carcinoma.

Metastases and Lymphoma, Hepatic

Axial CECT shows multiple hypodense liver metastases. Note similar-appearing retroperitoneal nodal mets, and a hydronephrotic left kidney due to invasion of the distal ureter.

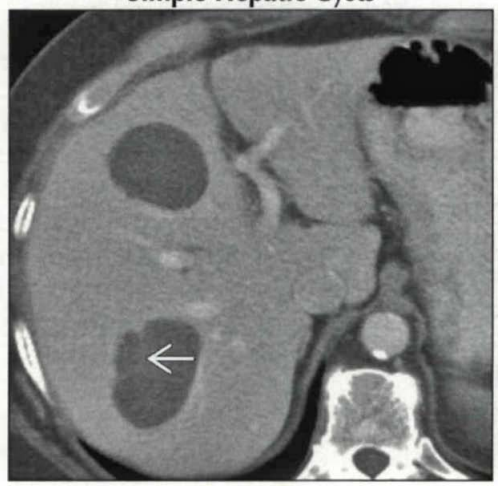
MULTIPLE HYPODENSE LIVER LESIONS

Metastases and Lymphoma, Hepatic

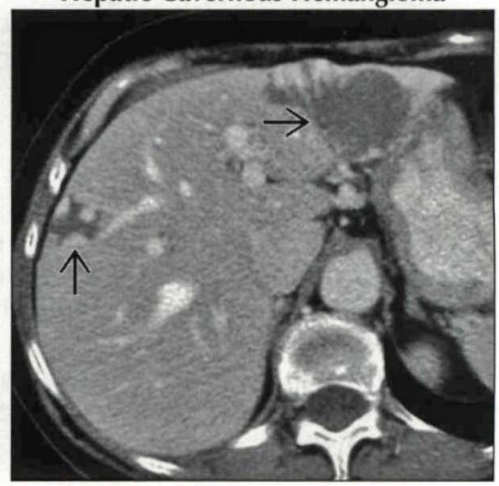


(Left) *Axial CECT shows multiple hypodense liver metastases with poorly defined margins. Also note bilateral adrenal metastases: pancreatic carcinoma.* ***(Right)*** *Axial CECT shows multiple hepatic masses in a patient with AIDS; hepatic lymphoma.*

Simple Hepatic Cysts

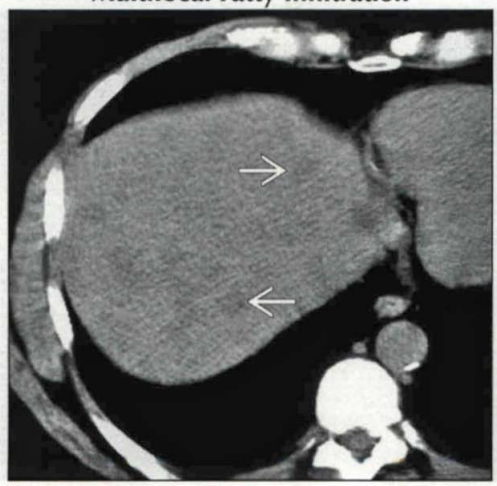


Hepatic Cavernous Hemangioma



(Left) *Axial CECT shows multiple water density hepatic lesions with no discernible walls. One of the larger cysts has a thin septum but there is no nodularity of the wall.* ***(Right)*** *Axial CECT shows 2 hepatic masses each with characteristic peripheral nodular enhancement isodense with blood vessels.*

Multifocal Fatty Infiltration

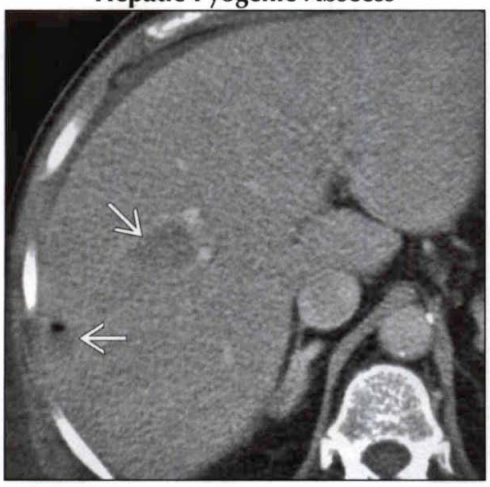


Multifocal Fatty Infiltration

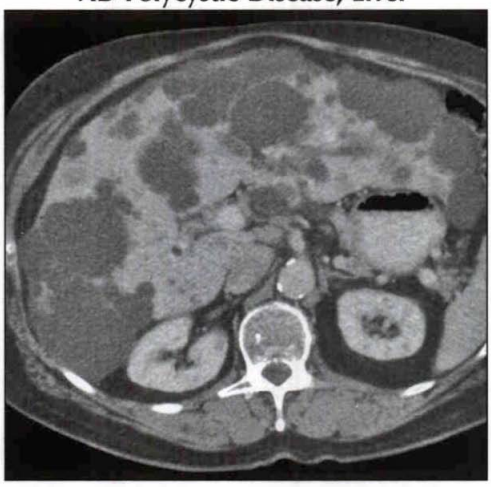
(Left) *Axial NECT shows numerous spherical hypodense lesions that simulate metastases. MR with opposed phase imaging, confirmed multifocal steatosis (fatty infiltration).* ***(Right)*** *Axial T1WI GRE opposed phase shows innumerable small "masses" that were almost isodense with liver on in phase images, but show selective signal dropout on opposed phase GRE.*

MULTIPLE HYPODENSE LIVER LESIONS

Hepatic Pyogenic Abscess

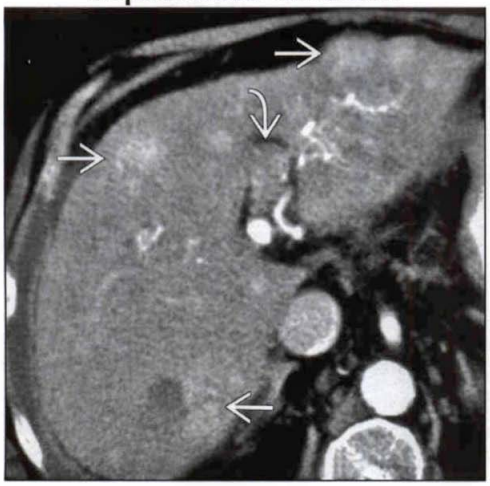


AD Polycystic Disease, Liver

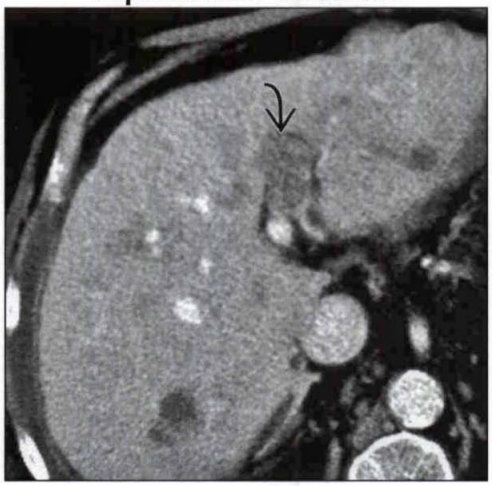


(Left) *Axial CECT shows two of many hypodense lesions, one of which contains gas. Pyogenic abscesses due to ascending cholangitis.* ***(Right)*** *Axial CECT shows innumerable hepatic cysts, with only small cysts noted in normally functioning kidneys.*

Hepatocellular Carcinoma

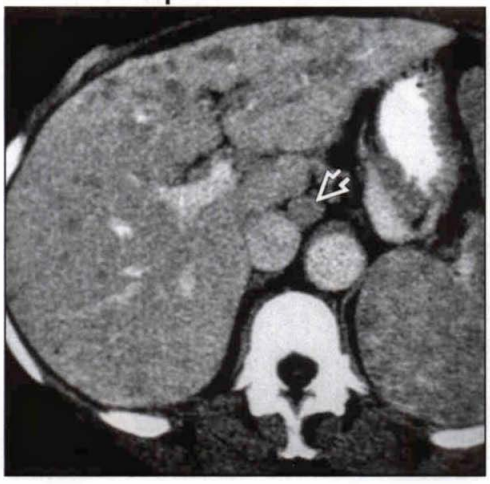


Hepatocellular Carcinoma

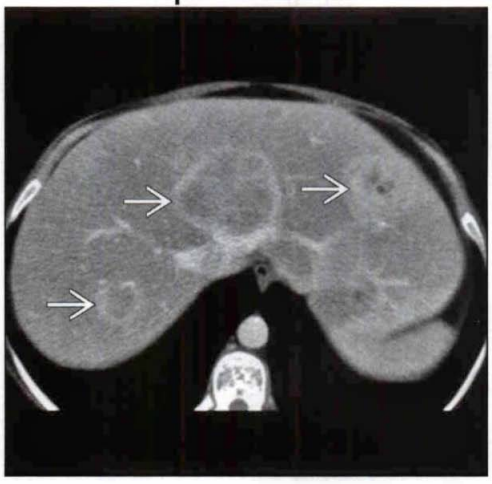


(Left) *Axial CECT shows multiple hypervascular masses on this arterial phase CECT. Also note enhancing tumor within the left portal vein.* ***(Right)*** *Axial CECT shows multiple hypodense lesions on this portal venous phase CECT, indicating tumor washout. Also note hypodense tumor within the dilated left portal vein.*

Hepatic Sarcoidosis



Hepatic Adenoma

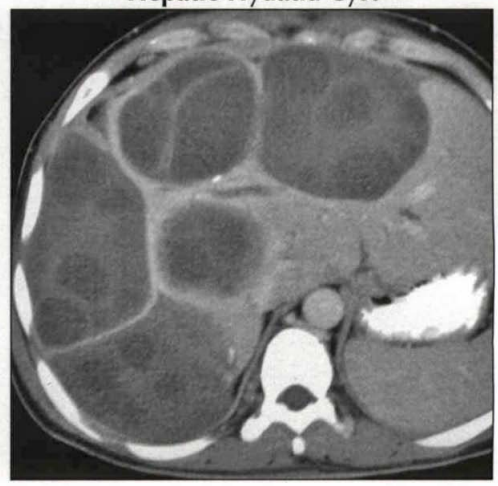


(Left) *Axial CECT shows innumerable hypodense lesions in liver and spleen. Note upper abdominal adenopathy. Patient had known pulmonary sarcoid.* ***(Right)*** *Axial CECT shows multiple hypodense but enhancing masses with encapsulation. Multiple adenomas may occur sporadically or in patients with glycogen storage disease.*

MULTIPLE HYPODENSE LIVER LESIONS

Hepatic Amebic Abscess

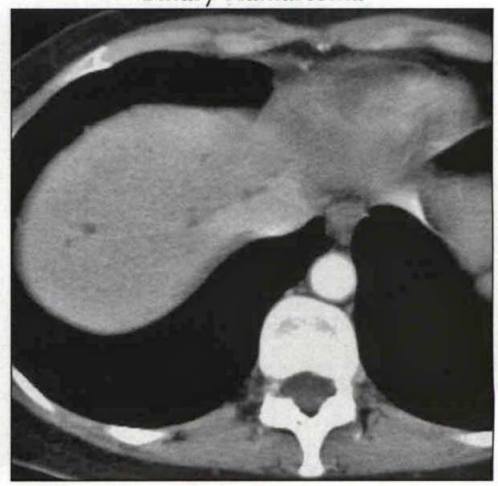
Hepatic Hydatid Cyst



(Left) *Axial CECT shows multiple hypodense hepatic lesions, most with indistinct borders. These amebic abscesses are unusually numerous in this patient; one or several abscesses are typical.* ***(Right)*** *Axial CECT shows multiple large complex cystic masses, with typical daughter cysts within.*

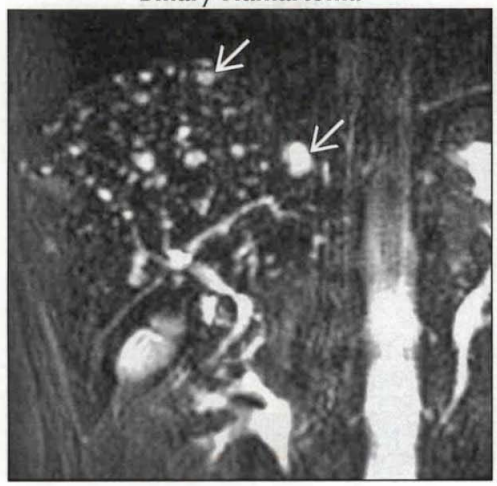
Hepatic Candidiasis

Biliary Hamartoma



(Left) *Axial CECT shows innumerable small (< 2 cm) irregular hypodense lesions in this immunocompromised patient.* ***(Right)*** *Axial CECT shows innumerable tiny (< 1.5 cm) hypodense lesions that were present throughout the liver in this healthy, asymptomatic patient.*

Biliary Hamartoma

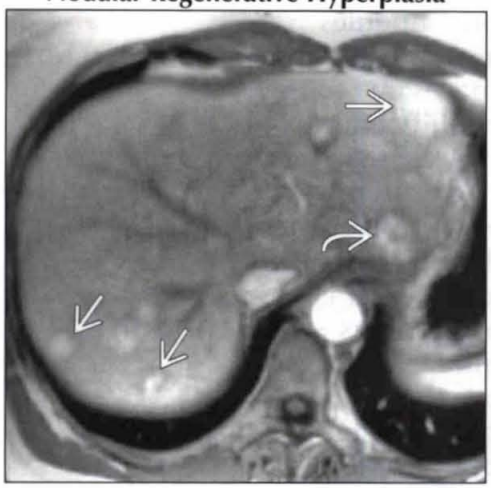


Nodular Regenerative Hyperplasia

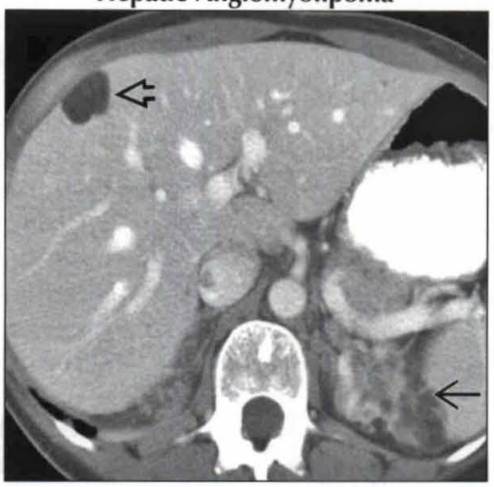
(Left) *Coronal T2WI MR shows innumerable tiny "cysts" ➡ within the liver of this healthy, asymptomatic patient, with no communication with the biliary tree.* ***(Right)*** *Axial CECT shows multiple, heterogeneous, hypodense masses ➡ in this patient with Budd-Chiari syndrome; nodular regenerative hyperplasia (large regenerative nodules); better shown on MR.*

MULTIPLE HYPODENSE LIVER LESIONS

Nodular Regenerative Hyperplasia



Hepatic Angiomyolipoma



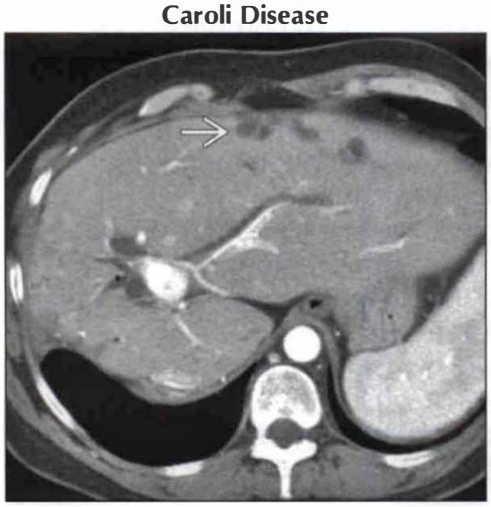
(Left) *Axial T1 C+ MR shows multiple, enhancing, large, regenerative nodules in this patient with Budd-Chiari syndrome. Some have a* ***hypointense halo*** *and others have a central scar* ***(Right)*** *Axial CECT shows fat density masses in the liver and kidneys in this patient with tuberous sclerosis.*

Hepatic Angiomyolipoma

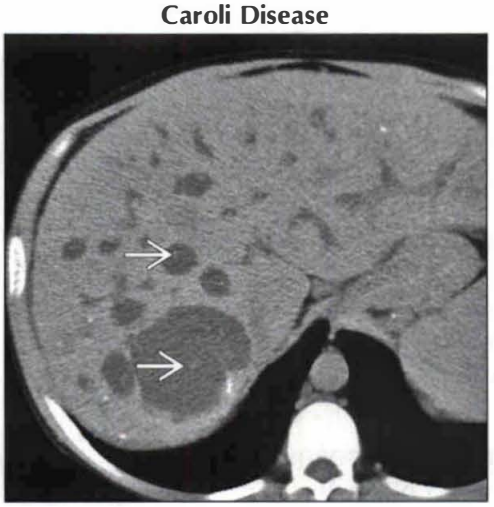
Epithelioid Hemangioendothelioma

(Left) *Axial CECT shows fat density masses within the liver and kidneys in this patient with tuberous sclerosis; angiomyolipomas.* ***(Right)*** *Axial CECT shows multiple peripheral lesions with a target appearance and retraction of the overlying* ***hepatic capsule***.

Caroli Disease



Caroli Disease



(Left) *Axial CECT shows cystic dilation of the intrahepatic bile ducts with some peripheral lesions simulating hypodense masses. Prior right hepatic lobectomy for infected bile ducts and liver.* ***(Right)*** *Axial CECT shows multiple cystic lesions in the liver. Note the* ***central dot sign***, *representing the hepatic artery enveloped by the cystic bile duct dilations.*

MULTIPLE HYPOINTENSE LIVER LESIONS (T2WI)

DIFFERENTIAL DIAGNOSIS

Common
- Regenerating ("Cirrhotic") Nodules
- Calcified Granulomas
- Pneumobilia

Less Common
- Hepatic Metastases
- Hepatocellular Carcinoma
- Dysplastic Nodules (Cirrhosis)
- Hepatic Adenoma
- Cholangiocarcinoma (Peripheral)
- Fibrolamellar HCC
- Nodular Regenerative Hyperplasia
- Hepatic Sarcoidosis
- Hepatic Hematoma
- Hereditary Hemorrhagic Telangiectasia
- Portal Vein Gas
- Hepatic Portal or Venous Collaterals

Rare but Important
- Peliosis Hepatis
- Hepatic Angiomyolipoma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Most hepatic lesions are hyperintense on T2WI due to excess water content (inflammatory or neoplastic)
- Sources for hypointense appearance
  - Blood degradation products
    - Almost any liver lesion that undergoes necrosis or hemorrhage may show foci of hypointensity on T2WI
  - Macromolecules (smooth muscle, fibrosis, mucin, fibrinogen, keratin)
  - Necrosis (especially coagulative necrosis)
  - Melanin
  - Calcium
  - Flowing blood
- Relative hypointensity on T2WI
  - Lesions with a fatty component
  - Depends on MR sequence used to achieve fat suppression
    - May cause signal loss from lesions that contain lipid or macroscopic fat
    - Examples: Some HCC, adenomas, angiomyolipomas, teratomas)

Helpful Clues for Common Diagnoses
- **Regenerating ("Cirrhotic") Nodules**
  - Usually not apparent on T1WI
  - Hypointense on T2WI, especially GRE
    - Due to the presence of iron within these "siderotic" nodules
    - Lesions may "bloom" (appear larger) on GRE images due to increased susceptibility effects of iron
  - Usually < 1 cm diameter, hypovascular
- **Calcified Granulomas**
  - Common in histoplasmosis, healed TB
  - Similar lesions in spleen
  - Remainder of liver is normal
  - No mobile protons = signal void on T2WI
- **Pneumobilia**
  - Gas in bile ducts
  - More linear distribution when seen in longitudinal section
  - Signal void in air-containing structures

Helpful Clues for Less Common Diagnoses
- **Hepatic Metastases**
  - Especially likely following therapy
  - Foci of old hemorrhage or necrosis may appear hypointense on T2WI
    - Coagulative necrosis = hypointense (e.g., following ethanol or RF ablation)
    - Liquefactive necrosis = hyperintense on T2WI
  - Tumors with large mucin content may appear hypointense
    - Colorectal, gastric, pancreatic, ovarian
  - Metastatic melanoma
    - Melanin within mets may cause hypointensity on T2WI, hyperintensity on T1WI (opposite of usual pattern)
- **Hepatocellular Carcinoma**
  - Usually hyperintense on T2WI
  - Potential causes for hypointense foci
    - Necrosis, old hemorrhage, iron deposits
- **Dysplastic Nodules (Cirrhosis)**
  - Premalignant lesions in cirrhotic liver
  - Hyperintense on T1WI, hypointense on T2WI (opposite of HCC)
    - Hypointensity due to iron or sinusoidal blood flow within lesions
  - Usually 1 to 4 cm diameter, hypovascular
- **Hepatic Adenoma**
  - Usually nearly isointense or slightly hyperintense on T2WI
    - May have foci of hypointensity due to "old" hemorrhage and/or necrosis

t-suppressed T2WI sequences may cause
gnal loss in adenomas with large
nounts of lipid
langiocarcinoma (Peripheral)
tensive fibrosis in tumor may account
r hypointense foci
sociated with focal hepatic volume loss;
layed persistent enhancement
olamellar HCC
rge mass with eccentric bands of scar
sue (fibrosis) and calcification that are
pointense on T2WI
lolescents and young adults
lular Regenerative Hyperplasia
arge regenerating nodules" are the
acroscopic form of NRH
ommon in Budd-Chiari syndrome,
ngenital heart disease
pervascular nodules, 1-4 cm diameter; ±
lo of enhancement
ually more numerous and greater
nspicuity on contrast-enhanced T1WI
The few that are detectable on T2WI are
ypically hypointense
atic Sarcoidosis
ver often diffusely abnormal with
numerable ≤ 1 cm nodules
ay be indistinguishable from cirrhosis
th regenerating nodules
ok for lymphadenopathy, lung disease
atic Hematoma
d hemorrhage may appear dark on T2WI
editary Hemorrhagic Telangiectasia
ler-Weber-Rendu syndrome
- Large feeding hepatic arteries and draining veins with telangiectasias and arteriovenous malformations
  - Flowing blood accounts for hypointense foci
- Check for history of epistaxis, family history

- **Portal Vein Gas**
  - Signal void in vessel due to gas
  - Usually due to bowel ischemia or infection (e.g., diverticulitis)
- **Hepatic Portal or Venous Collaterals**
  - Portal vein thrombosis with cavernous transformation
  - Also increased hepatic arterial supply to compensate for decreased portal flow
    - Flowing blood accounts for foci of hypointensity
  - Hepatic vein occlusion, with intra- or perihepatic collaterals (Budd-Chiari syndrome)

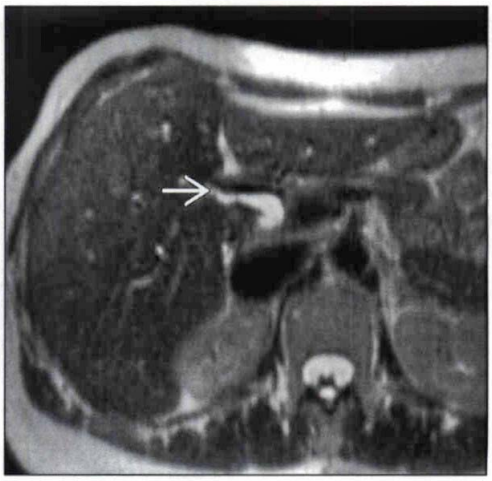
Helpful Clues for Rare Diagnoses

- **Peliosis Hepatis**
  - Rare, associated with drugs, chronic illness
  - Presence of sinusoidal blood pools may account for hypointensity on T2WI
- **Hepatic Angiomyolipoma**
  - Presence of smooth muscle (macromolecules) and fat may account for foci of hypointensity

Regenerating ("Cirrhotic") Nodules

Axial T2WI MR shows innumerable tiny hypointense regenerative nodules ➡ within a cirrhotic liver. These are usually not visible on T1WI.

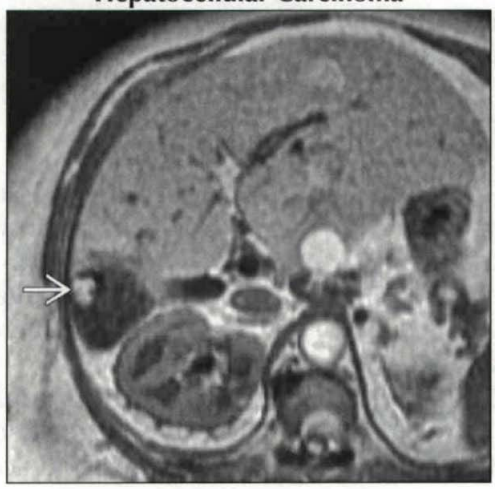
Pneumobilia



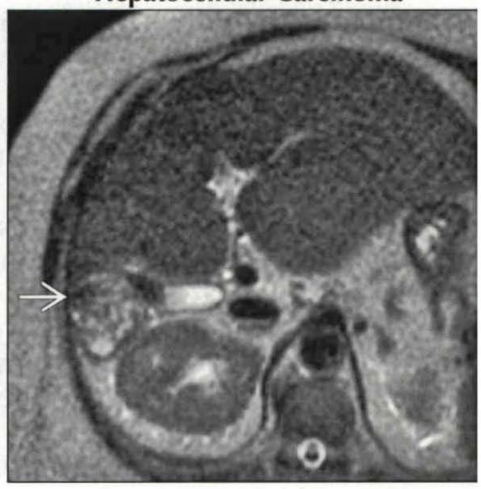
Axial T2WI FS MR shows a gas fluid level within the common duct ➡, with the gas floating above the bile as a signal void.

MULTIPLE HYPOINTENSE LIVER LESIONS (T2WI)

Hepatocellular Carcinoma

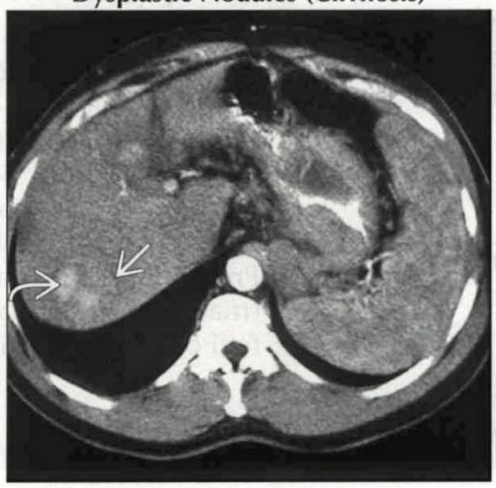


Hepatocellular Carcinoma



(Left) *Axial T1WI MR shows a heterogeneous mass in the right lobe of a cirrhotic liver, an HCC nodule that has partly responded to arterial chemotherapy. The hyperintense focus is the more necrotic site.* ***(Right)*** *Axial T2WI MR shows the partially necrotic HCC nodule, with the hypointense focus representing coagulative necrosis.*

Dysplastic Nodules (Cirrhosis)



Dysplastic Nodules (Cirrhosis)

(Left) *Axial CECT shows a hypervascular focus (HCC) within a larger, less vascular dysplastic nodule on this arterial phase image; classic "nodule in nodule" sign.* ***(Right)*** *Axial T1 C+ FS MR shows the hypervascular HCC within the hypovascular dysplastic nodule.*

Dysplastic Nodules (Cirrhosis)

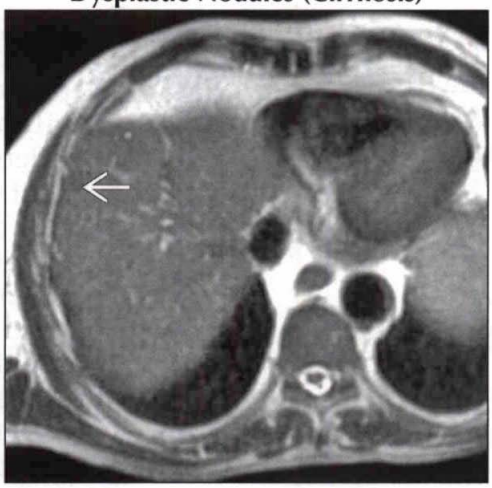
Dysplastic Nodules (Cirrhosis)

(Left) *Axial T1WI MR shows a well-defined hyperintense dysplastic nodule with a smaller hypointense nodule of HCC within it.* ***(Right)*** *Axial T2WI MR shows hypointensity of the dysplastic nodule and hyperintensity of the HCC nodule, each with the typical findings of the "nodule in nodule" sign.*

MULTIPLE HYPOINTENSE LIVER LESIONS (T2WI)

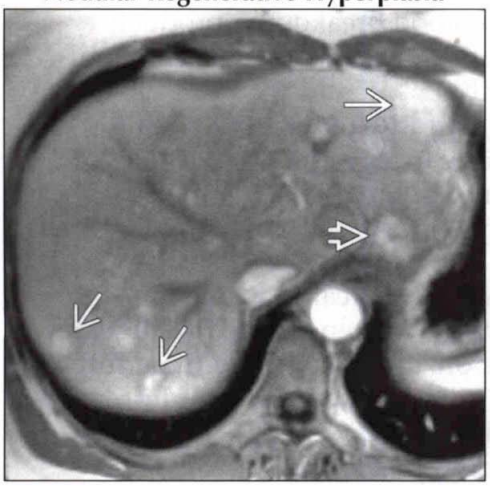
Dysplastic Nodules (Cirrhosis)

Dysplastic Nodules (Cirrhosis)

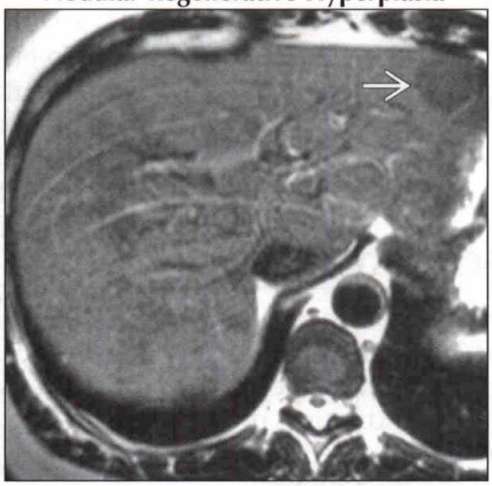


(Left) *Axial T1WI MR shows a hyperintense nodule* ➡ *within a cirrhotic liver, that was hypointense on T2WI. Note that this is the opposite of what would be expected of a hepatocellular carcinoma.* ***(Right)*** *Axial T2WI MR shows a subtle hypointense nodule* ➡ *in a cirrhotic liver that was very hyperintense on T1WI.*

Nodular Regenerative Hyperplasia



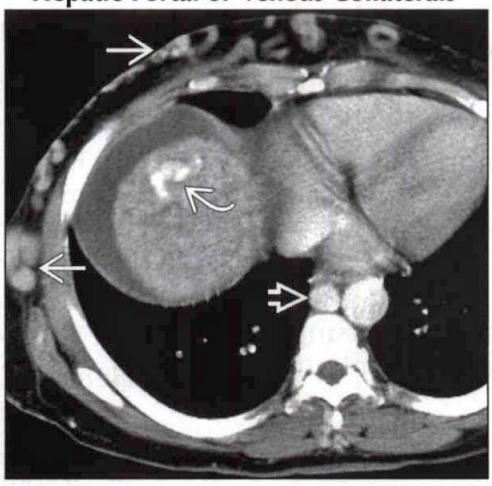
Nodular Regenerative Hyperplasia



(Left) *Axial T1 C+ MR shows many hypervascular lesions* ➡ *within the liver of a patient with Budd-Chiari syndrome. At least one of the lesions* ➪ *has a central scar & a hypointense halo, a characteristic feature of this disorder (though also seen in FNH).* ***(Right)*** *Axial T2WI MR shows one* ➡ *of many focal liver lesions in a patient with Budd Chiari syndrome. The lesion is hypointense on T2WI, but many more lesions were apparent on Gd-enhanced T1WI.*

Hepatic Sarcoidosis

Hepatic Portal or Venous Collaterals



(Left) *Axial CECT shows innumerable sarcoid granulomas in the liver & spleen, along with abdominal adenopathy* ➡. *Hepatic granulomas are usually hypointense on T2WI, unlike most inflammatory & malignant focal hepatic masses.* ***(Right)*** *Axial CECT shows intrahepatic venous collaterals* ➡ *in a patient with Budd-Chiari syndrome. Also note subcutaneous collateral veins* ➡ *& a dilated azygous vein* ➪ *due to IVC thrombosis.*

HYPERINTENSE LIVER LESIONS (T1WI)

DIFFERENTIAL DIAGNOSIS

Common
- Steatosis (Fatty Liver)
- Hepatic Adenoma
- Hepatocellular Carcinoma
- Hemorrhagic Hepatic Cyst
- Dysplastic and Regenerative Nodules
- Liver Hematoma
- Hepatic Metastases

Less Common
- Hepatic Pyogenic Abscess
- Post-Operative Packing Material
- HELLP Syndrome
- Focal Nodular Hyperplasia
- Nodular Regenerative Hyperplasia
- Hepatic Angiomyolipoma
- Peliosis Hepatis

Rare but Important
- Lipoma, Liver
- Liposarcoma, Liver
- Xanthoma, Liver
- Hepatic Adrenal Rest Tumor
- Hepatic Pseudolipoma
- Teratoma, Liver

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Only 4% of liver lesions T1WI hyperintense
- Any lesion containing fat, hemorrhage, high protein content, or sinusoidal dilation may appear hyperintense on T1WI
- Focal signal dropout on opposed phase T1WI indicates intra- or intercellular lipid
- Focal signal dropout on fat-suppressed images indicates macroscopic fat
- High signal on T1WI without signal dropout on these techniques indicates presence of blood, protein, or sinusoidal dilation

Helpful Clues for Common Diagnoses
- **Steatosis (Fatty Liver)**
  - Focal fatty infiltration, can simulate mass(es)
  - Focal signal dropout, opposed phase T1WI
  - Presence of normal vessels coursing through "lesion" excludes neoplasm
- **Hepatic Adenoma**
  - Heterogeneous mass with ↑ signal intensity on T1WI due to fat and recent hemorrhage
  - 35-75% have evidence of fat on opposed phase or fat-suppressed sequences
  - Lesion with these characteristics in a young woman without cirrhosis is almost diagnostic of adenoma
- **Hepatocellular Carcinoma**
  - Only about 5-10% of HCCs have MR evidence of fat content
  - Small (< 1.5 cm) well-differentiated HCCs often associated with a diffuse-type fatty change (signal suppression on opposed phase)
  - Larger tumors may have macroscopic fat (lose signal on fat-suppressed sequence)
  - Heterogeneous, hypervascular mass in a cirrhotic liver with these features is diagnostic of HCC
- **Hemorrhagic Hepatic Cyst**
  - Will be variably bright on both T1- and T2WI
    - Due to blood breakdown products
  - No enhancement of contents or mural nodularity
- **Dysplastic and Regenerative Nodules**
  - In cirrhotic liver, dysplastic nodules are considered pre-malignant lesions
  - Typically appear bright on T1WI, dark on T2WI
    - Opposite of typical HCC
  - Most cirrhotic regenerating nodules are invisible on T1WI; some are hyperintense on T1WI due to excess iron and/or copper (siderotic nodules)
- **Liver Hematoma**
  - Due to trauma; much less frequently coagulopathy or HELLP syndrome
  - Subacute hemorrhage appears hyperintense on T1WI, but does not lose signal with opposed phase or fat-suppressed sequences
- **Hepatic Metastases**
  - Rarely are bright on T1WI, except for melanoma mets (due to melanin protein)
  - Mets may contain fat (liposarcoma) or hemorrhage (hypervascular mets, particularly endocrine primary tumors, especially after chemotherapy)

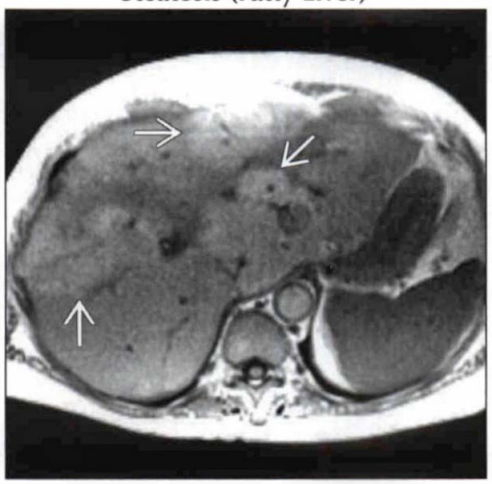
Helpful Clues for Less Common Diagnoses
- **Hepatic Pyogenic Abscess**
  - May have bleeding within the abscess to account for hyperintense portions

- **Post-Operative Packing Material**
  - Omental fat is used as packing material in hepatobiliary surgeries (e.g., focal resection or RF ablation)
- **HELLP Syndrome**
  - Complication of toxemia of pregnancy, with spontaneous hepatic infarction & hemorrhage
- **Focal Nodular Hyperplasia**
  - Presence of fat in FNH is rare, usually patchy distribution
  - May occur in diffusely steatotic liver
  - May also have bright signal on T1WI due to sinusoidal dilation within lesion
- **Nodular Regenerative Hyperplasia**
  - Also known as large (multiacinar) regenerative nodules
  - Usually encountered as multiple small masses in liver damaged by Budd-Chiari syndrome or congenital heart disease with Fontan circulation
  - 75% of lesions are bright on T1WI, iso- or hypointense on T2WI, ± halo of low signal on T1WI
- **Hepatic Angiomyolipoma**
  - Benign mesenchymal tumor composed of variable amounts of smooth muscle, fat, and proliferating blood vessels
  - Fatty component of tumor results in hyperintense foci on T1WI; signal dropout on fat-suppressed sequence, but not on opposed phase images
- **Peliosis Hepatis**
  - Uncommon to rare benign disorder causing sinusoidal dilation & presence of multiple blood-filled lacunar spaces
  - Associated with immunocompromised states, chronic illness, medications

Helpful Clues for Rare Diagnoses

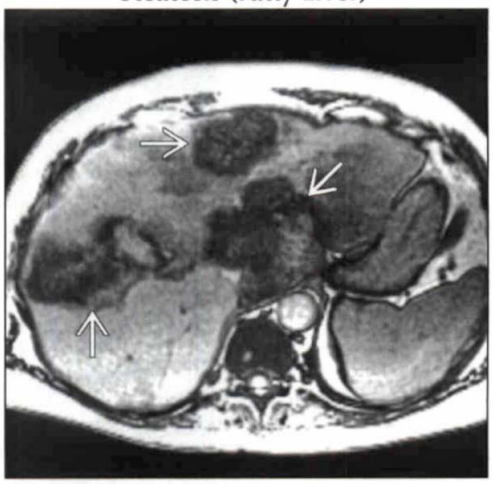
- **Lipoma, Liver**
  - Rare; may have similar appearance as hepatic angiomyolipoma
- **Liposarcoma, Liver**
  - Rare, as primary hepatic tumor or metastasis or local invasion from retroperitoneal tumor
- **Xanthoma, Liver**
  - In Langerhans cell histiocytosis
  - Multisystem disorder with rare hepatic involvement
  - Uniformly hyperechoic on US, low attenuation on CT
- **Hepatic Adrenal Rest Tumor**
  - Ectopic collection of adrenocortical cells
  - May be functional or nonfunctional
- **Hepatic Pseudolipoma**
  - Pseudolipoma of Glisson capsule; detached colonic epiploic appendix
  - Contains degenerated fat enveloped by liver capsule
- **Teratoma, Liver**
  - Hepatic lesion is usually invasion or metastasis from malignant tumor outside liver

Steatosis (Fatty Liver)



Axial T1WI MR shows a heterogeneous liver with geographic foci of high intensity ➡ on non-fat-suppressed T1WI, representing multifocal steatosis.

Steatosis (Fatty Liver)



Axial T1WI MR shows selective signal dropout from the foci of focal fatty infiltration ➡ on this opposed phase T1 GRE image.

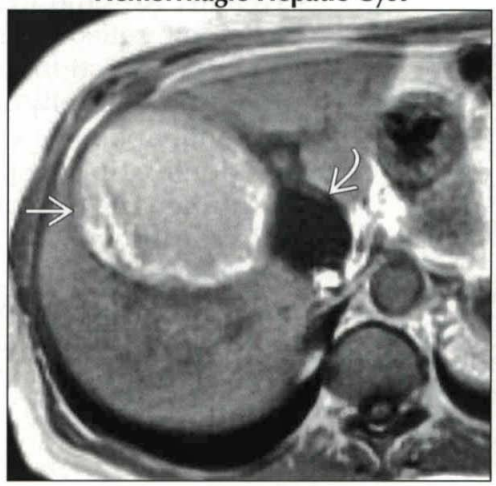
HYPERINTENSE LIVER LESIONS (T1WI)

Hepatic Adenoma

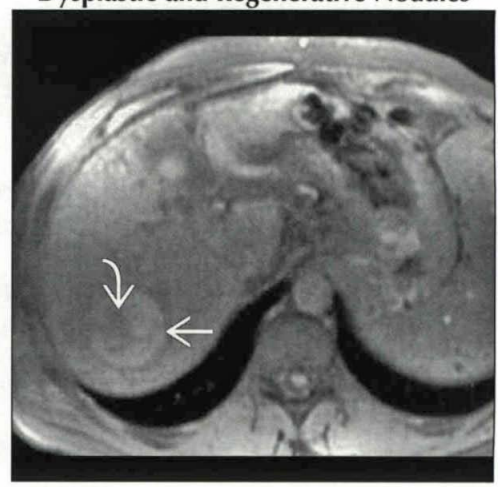
Hepatocellular Carcinoma

(Left) *Axial T1WI MR shows an exophytic hepatic mass that is hyperintense to liver on T1WI, reflecting the presence of fat within lesion. Also note capsule.* ***(Right)*** *Axial T1WI MR shows two foci of HCC, one that is hyperintense with a capsule and one that is hypointense. HCC may also appear isointense on T1WI, but untreated tumors are usually hyperintense on T2WI.*

Hemorrhagic Hepatic Cyst

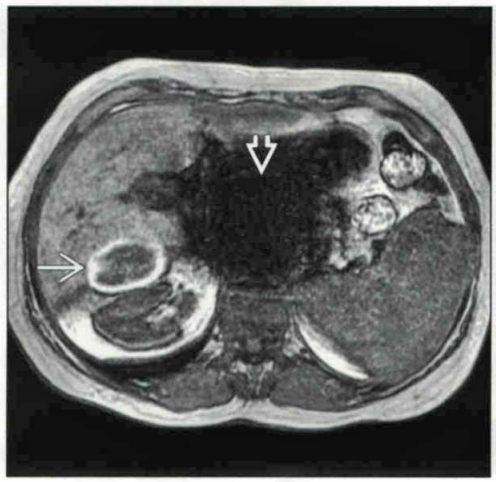


Dysplastic and Regenerative Nodules

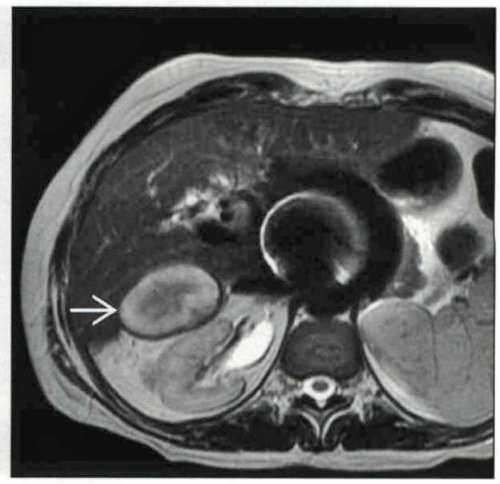


(Left) *Axial T1WI MR shows a large, somewhat complex, hyperintense cystic lesion that is a hemorrhagic cyst. The smaller lesion is a typical simple cyst, hypointense on this sequence.* ***(Right)*** *Axial T1WI MR shows a hyperintense mass with a peripheral capsule, representing a dysplastic nodule (that was hypointense on T2WI). Within the nodule is a hypointense lesion representing HCC. This is the classic "nodule in nodule" sign.*

Liver Hematoma



Liver Hematoma

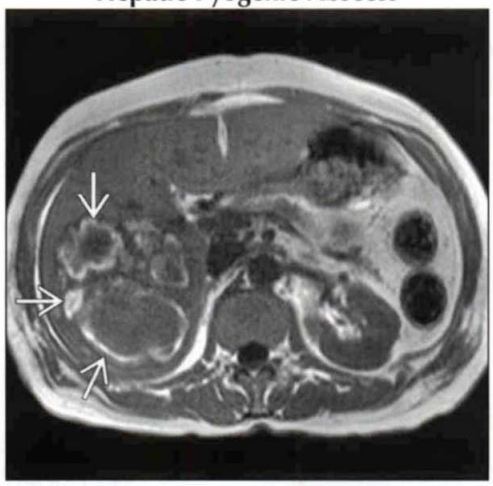


(Left) *Axial T1WI MR shows an oval lesion in the liver or Morison pouch with a bright rim on T1WI; subacute hematoma. The signal void is an artifact from a metallic stent.* ***(Right)*** *Axial T2WI MR shows the hematoma remains bright on T2WI, helping to distinguish it from fat.*

HYPERINTENSE LIVER LESIONS (T1WI)

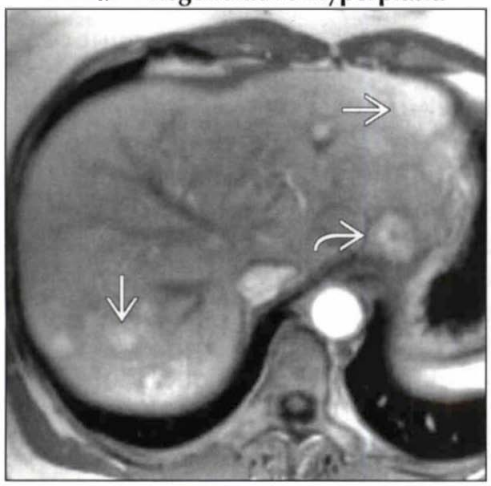
Hepatic Metastases

Hepatic Pyogenic Abscess

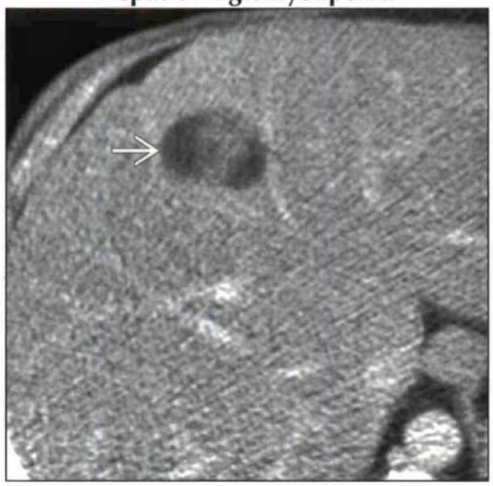


(Left) *Axial T1WI MR shows multiple hyperintense masses* ➡, *typical of melanoma, which is due to the melanin content of the metastases. Most common hepatic metastases are hypointense on T1WI.* ***(Right)*** *Axial T1WI MR shows a cluster of lesions in the right hepatic lobe that are mostly isointense with liver parenchyma, but contain hyperintense foci* ➡ *representing hemorrhage (confirmed on needle aspiration of the abscesses).*

Nodular Regenerative Hyperplasia

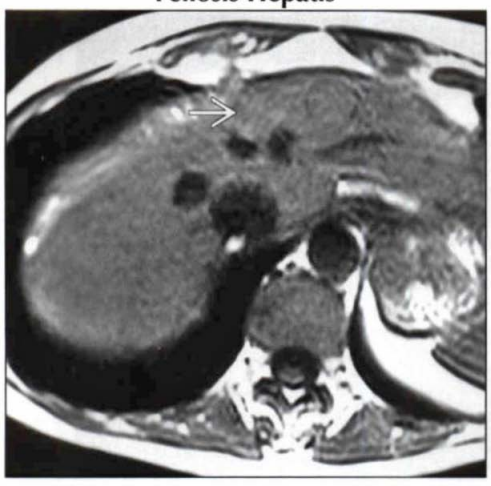


Hepatic Angiomyolipoma



(Left) *Axial T1 C+ MR shows multiple lesions* ➡ *on arterial phase CEMR that were also slightly hyperintense on pre-contrast MR. One lesion* ➡ *has a capsule and central scar, simulating FNH.* ***(Right)*** *Axial CECT shows a mass* ➡ *that was discovered as an incidental finding. It has both fat and soft tissue components and represents an hepatic AML. Fat-containing masses are often hyperintense on T1WI.*

Peliosis Hepatis



Peliosis Hepatis

(Left) *Axial T1WI MR shows a subtle mass* ➡ *that is just slightly hyperintense to liver. CT and contrast-enhanced MR showed multiple hypervascular foci that simulated metastases in this 42 year old woman using birth control pills.* ***(Right)*** *Axial CECT shows peripheral nodular enhancement of one* ➡ *of several poorly-defined hepatic masses* ➡ *in the same patient. Lesions resolved following cessation of oral contraceptive use.*

LIVER LESION WITH CAPSULE OR HALO ON MR

DIFFERENTIAL DIAGNOSIS

Common
- Hepatic Metastases
- Hepatic Pyogenic Abscess
- Hepatocellular Carcinoma
- Hepatic Hematoma

Less Common
- Hepatic Adenoma
- Hepatic Hydatid Cyst
- Hepatic Amebic Abscess
- Focal Nodular Hyperplasia
- Nodular Regenerative Hyperplasia

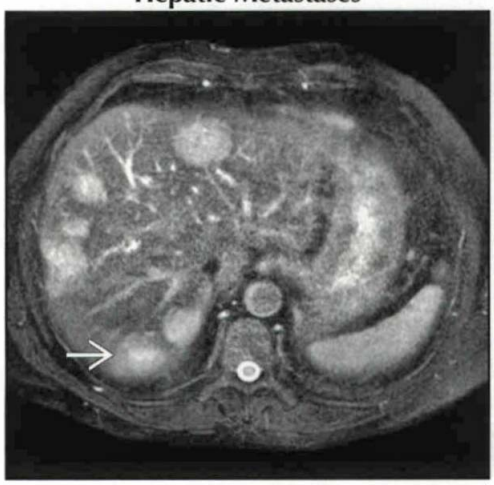
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Most benign hepatic masses do not have a capsule or circumferential rim evident on MR or CT
  - Most cysts, cavernous hemangiomas, FNH
- Halo = edema or compressed liver

Helpful Clues for Common Diagnoses
- **Hepatic Metastases**
  - Most common etiology for lesions with circumferential rim on MR or CT
  - Metastases are usually heterogeneously hyperintense on T2WI
  - Often have peritumoral halo with a double ring pattern
- **Hepatic Pyogenic Abscess**
  - Usually multiloculated
  - Abscess is hyperintense with thick perilesional edema, also bright on T2WI
- **Hepatocellular Carcinoma**
  - May have similar appearance as metastases
  - Look for signs of cirrhosis, ascites, portal vein invasion
- **Hepatic Hematoma**
  - Following blunt or penetrating trauma, including iatrogenic injuries
  - Chronic hematoma may have hemosiderin in rim that is hypointense on T1WI, often hyperintense on T2WI

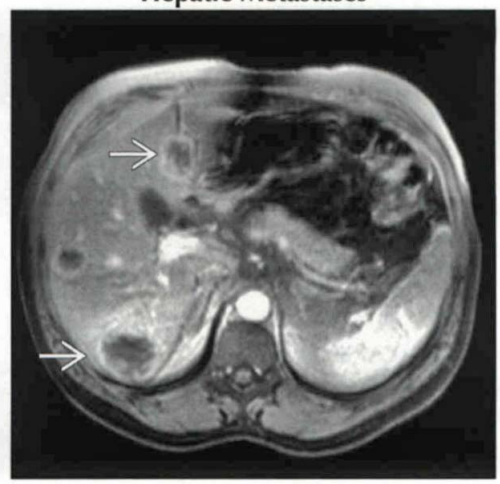
Helpful Clues for Less Common Diagnoses
- **Hepatic Adenoma**
  - May have thin, usually incomplete capsule that is hypointense on T2WI
  - Look for evidence of hemorrhage, fat, necrosis within mass
- **Hepatic Hydatid Cyst**
  - Rim (pericyst) is hypointense on T2WI
  - Contents (daughter cysts), very bright on T2WI
- **Hepatic Amebic Abscess**
  - Usually one or few lesions
  - Contents bright on T2WI; hypointense rim but perilesional edema bright on T2WI
- **Focal Nodular Hyperplasia**
  - May have pseudocapsule of prominent draining veins
- **Nodular Regenerative Hyperplasia**
  - In Budd-Chiari: Hypervascular nodules ± hypointense halo
  - "Large regenerative nodules"

Hepatic Metastases



Axial T2WI MR shows multiple hepatic metastases from colon cancer, some of which have a peritumoral "halo"

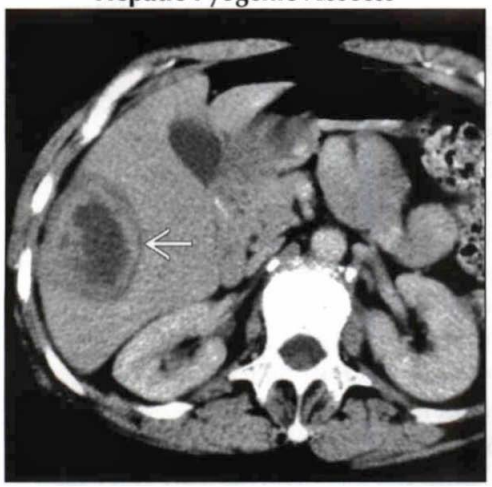
Hepatic Metastases



Axial T1 C+ MR shows multiple hepatic metastases from colon cancer, with a peritumoral capsule or "halo"

LIVER LESION WITH CAPSULE OR HALO ON MR

Hepatic Pyogenic Abscess

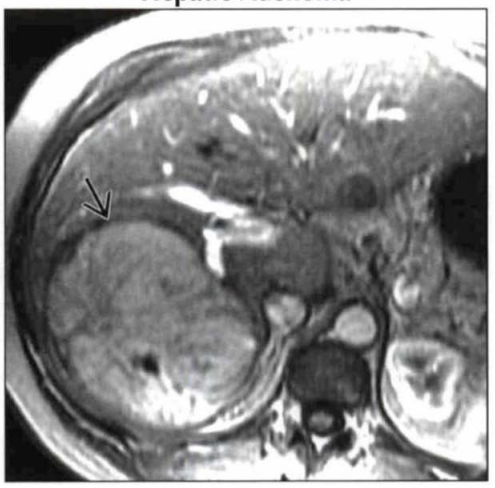


Hepatocellular Carcinoma

(Left) *Axial CECT shows a pyogenic liver abscess with a capsule and a peripheral halo of edema.* ***(Right)*** *Axial CECT shows an encapsulated HCC with a "mosaic" pattern of internal enhancement. MR usually shows a more evident peritumoral halo than CT.*

Hepatic Hematoma

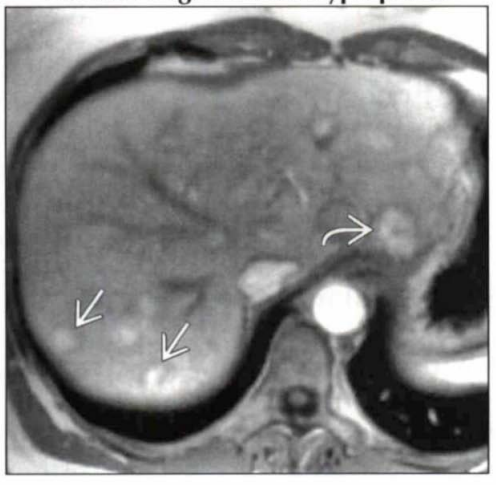
Hepatic Adenoma



(Left) *Axial T1WI FSE MR shows a subacute subhepatic hematoma with a bright rim or capsule.* ***(Right)*** *Axial T1 C+ MR shows a partially encapsulated, hypervascular mass; hepatic adenoma. The capsule is hypointense on this contrast-enhanced T1WI.*

Focal Nodular Hyperplasia

Nodular Regenerative Hyperplasia



(Left) *Axial CECT shows a mass that is isodense to liver on this portal venous phase CECT. Note the central scar and a pseudocapsule, comprised of large draining veins.* ***(Right)*** *Axial T1 C+ MR shows hypervascular masses in a patient with Budd-Chiari. Some of the lesions show a hypointense halo and a central scar. NRH or "large regenerative nodules".*

FOCAL HYPERDENSE HEPATIC MASS ON NONENHANCED CT

DIFFERENTIAL DIAGNOSIS

Common

- Cirrhotic Regenerating Nodule
- Any Mass in Fatty Liver (Mimic)
- Focal Sparing in Fatty Liver
- Hepatic Metastases
- Hepatic Hematoma

Less Common

- Hemorrhage within Hepatic Tumor
  - Hepatic Adenoma
  - Hepatocellular Carcinoma
- Calcification within Primary Hepatic Tumor
  - Hepatic Cavernous Hemangioma
  - Fibrolamellar HCC
- "Hepatic Pseudotumor"
  - Budd-Chiari Syndrome
  - Primary Sclerosing Cholangitis
- HELLP Syndrome

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Consider whether the "mass" is abnormally dense (hyperattenuating), or whether the surrounding liver is abnormally low in attenuation (steatosis)
- Abnormally increased attenuation due to a variety of causes
  - Excessive iron
    - Siderotic regenerating nodules
  - Blood
    - Spontaneous hemorrhage in an hepatic tumor
    - Trauma
    - Coagulopathic hemorrhage
    - HELLP syndrome
  - Calcification
    - Punctate or more amorphous calcification in hepatic tumors
- The "mass" may represent relatively normal liver, surrounded by liver of abnormally low attenuation
  - Focal area of sparing in a diffusely steatotic liver
    - Anatomic distribution helpful in making diagnosis
  - Hepatic pseudotumor within liver with extensive damage
    - Spared area may hypertrophy and simulate a mass

Helpful Clues for Common Diagnoses

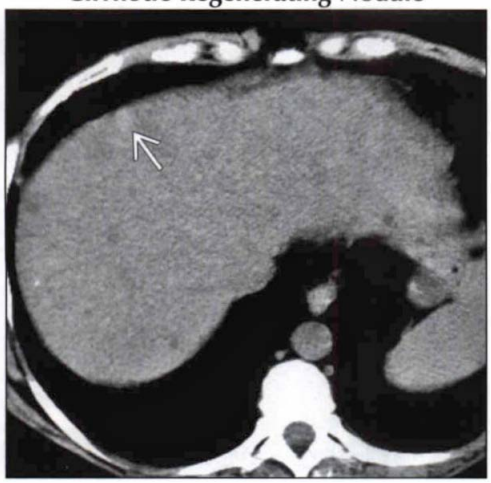
- **Cirrhotic Regenerating Nodule**
  - May be hyperattenuating, due to excess iron and copper
  - Essential to recognize on NECT
    - Avoid characterizing as "hypervascular", because these may remain hyperattenuating on CECT
    - Regenerating nodules usually become isodense to cirrhotic liver on portal venous and delayed CECT
  - MR good problem solver
    - Regenerating nodules appear as hypointense (black) lesions on T2WI and, especially, on GRE
- **Any Mass in Fatty Liver (Mimic)**
  - Mass of "soft tissue" attenuation may be hyperdense within fatty liver
  - Even water attenuation cyst may appear hyperdense within severely steatotic liver
- **Focal Sparing in Fatty Liver**
  - Regions of liver surrounding gallbladder fossa and medial segment (#4) are often spared from diffuse steatosis
  - Appears hyperdense on NECT
  - Hypoechoic on US, compared to hyperechoic fatty liver
  - Spared area has normal intensity on MR sequences
    - Rest of fatty liver will show signal dropout on opposed-phase GRE
- **Hepatic Metastases**
  - Mucinous adenocarcinoma mets (calcification)
    - Colon carcinoma most common
    - Others include ovarian cystadenocarcinoma, malignant teratoma and osteogenic carcinoma
  - Malignant melanoma
    - Melanin within metastatic foci may appear hyperdense on NECT
    - These metastases also may appear hyperintense on T1WI (unlike most metastases that are hypo- to isointense on T1WI)
- **Hepatic Hematoma**
  - Clotted blood may be hyperdense to normal liver
  - Result of blunt or penetrating trauma, including liver biopsy or other interventions

- Rarely; spontaneous hepatic bleeding due to anticoagulation

Helpful Clues for Less Common Diagnoses

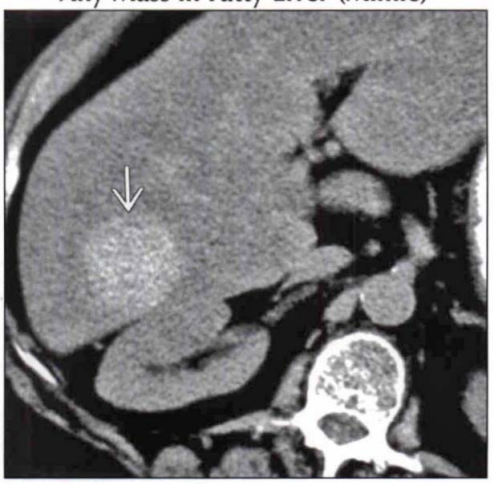
- **Hemorrhage within Hepatic Tumor**
  - Hepatic adenoma and HCC are the two neoplasms most likely to exhibit spontaneous hemorrhage
  - Rarely seen with hypervascular metastases, primary angiosarcoma, and others
- **Calcification within Primary Hepatic Tumor**
  - Conventional HCC
    - Calcification is rare, usually punctate
  - Fibrolamellar HC
    - Two thirds have calcification in large, irregular, stellate scar
    - Lymph node and lung metastases may be present
    - Young adult
  - Adenoma
    - Calcification in only about 5-10%, punctate
    - Young woman on oral contraceptives
  - Hemangioma
    - Calcification rare
    - When present, usually within central scar in a large (> 10 cm) hemangioma with other typical features
- **"Hepatic Pseudotumor"**
  - In Budd-Chiari and primary sclerosing cholangitis
  - Caudate and deep right lobe are usually spared
    - These areas may hypertrophy but normal attenuation is maintained
  - Central spared areas appear relatively dense compared with peripheral portions of the liver that are abnormally low in density
    - Peripheral low density from necrosis, fat and fibrosis
- **HELLP Syndrome**
  - Complication of pregnancy with toxemia and disseminated intravascular coagulation
  - Hemolysis, elevated liver enzymes, low platelets (HELLP)
  - Foci of infarction ± hemorrhage within liver
    - Hematoma may be intrahepatic or subcapsular
    - May bleed into peritoneal cavity

Cirrhotic Regenerating Nodule



Axial NECT shows a heterogeneous cirrhotic liver with both hypo- and hyperdense nodules. The hyperdense nodule ↖ was not visible on CECT and is a benign, siderotic, regenerative nodule.

Any Mass in Fatty Liver (Mimic)

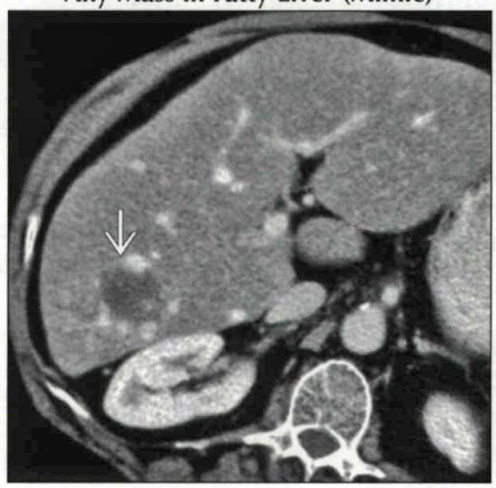


Axial NECT shows a mass ➡ that is hyperdense to the steatotic liver and isodense to the blood pool; cavernous hemangioma.

FOCAL HYPERDENSE HEPATIC MASS ON NONENHANCED CT

(Left) Axial CECT shows a mass ➡ with nodular peripheral enhancement that is isodense to the blood pool; cavernous hemangioma. (Right) Axial CECT shows a diffusely steatotic liver with a "mass" ➡ that represents an area of focal sparing (normal liver).

Any Mass in Fatty Liver (Mimic)



Focal Sparing in Fatty Liver

(Left) Axial NECT shows several lesions ➡ that are hyperdense (partially calcified) representing metastases from mucinous adenocarcinoma of the colon. (Right) Axial NECT shows high density clotted blood in a crescentic collection ➡ around the liver and in a deep linear collection ➡ within the liver, due to liver biopsy.

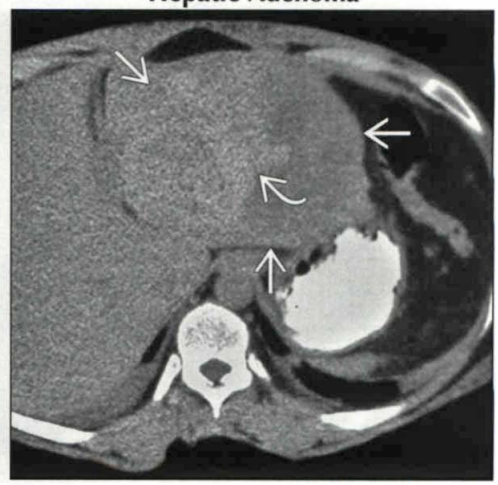
Hepatic Metastases

Hepatic Hematoma

(Left) Axial NECT shows a large heterogeneous mass ■ in the left lobe, representing a spontaneous hemorrhage in an anticoagulated patient. There was no underlying tumor. (Right) Axial NECT shows a mass ➡ in the left lobe with hyperdense foci ➡ representing areas of hemorrhage within an hepatic adenoma.

Hepatic Hematoma

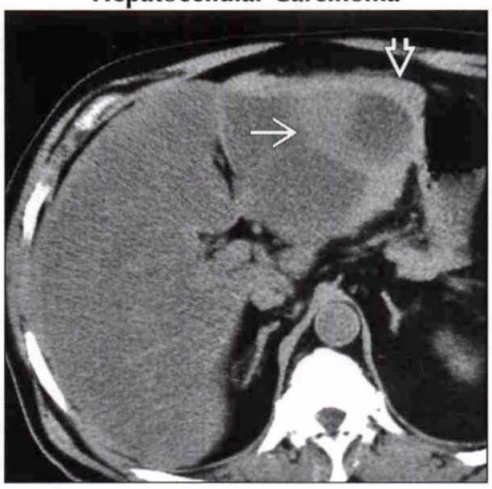
Hepatic Adenoma



FOCAL HYPERDENSE HEPATIC MASS ON NONENHANCED CT

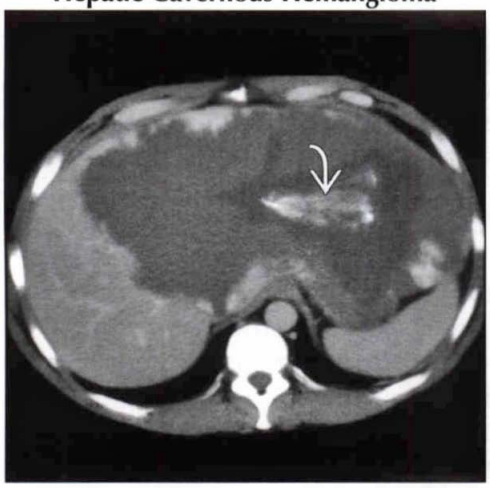
Hepatic Adenoma

Hepatocellular Carcinoma



(Left) *Axial CECT shows enhancement ➡ of the non-necrotic and nonhemorrhagic portions of this hepatic adenoma.* ***(Right)*** *Axial NECT shows a heterogeneous mass in the left lobe with hyperdense foci within the mass ➡ and around the liver ➡ representing hemorrhage. CECT showed an enhancing mass; HCC.*

Hepatic Cavernous Hemangioma



Fibrolamellar HCC

(Left) *Axial CECT shows a huge mass with peripheral nodular enhancement, typical of cavernous hemangioma. A central scar ➡ is partially calcified.* ***(Right)*** *Axial NECT shows a large mass in the left lobe of a 17 year old boy. Note large foci of calcification ➡.*

Fibrolamellar HCC

Budd-Chiari Syndrome

(Left) *Axial CECT shows heterogeneous hypervascularity within this left lobe mass in a 17 year old boy. Also note hypervascular enhancing porta hepatis lymph node metastases ➡.* ***(Right)*** *Axial CECT shows enlargement of caudate lobe which is hyperdense to the rest of liver, due to sparing of the caudate and peripheral atrophy and fibrosis. Thrombosed hepatic veins ➡.*

FOCAL HEPATIC ECHOGENIC LESION +/- ACOUSTIC SHADOWING

DIFFERENTIAL DIAGNOSIS

Common

- Focal Steatosis
- Calcified Granuloma, Liver
- Hepatic Cavernous Hemangioma
- Hepatic Metastases
- Pneumobilia
- Intrahepatic Biliary Calculi
- Pyogenic Hepatic Abscess
- Surgical Devices
- Portal Vein Gas
- Normal Anatomic Pitfalls
  - Hepatic Ligaments and Fissures
  - Diaphragmatic Leaflets
  - Refractile Artifact

Less Common

- Hepatocellular Carcinoma
- Fibrolamellar HCC
- Cholangiocarcinoma
- Hepatic Adenoma
- Amebic Hepatic Abscess
- Hepatic Hydatid Cyst
- Hepatic Infarction
- Biliary Hamartoma
- Hemangioendothelioma
- Hepatic Angiomyolipoma
- Post-Operative State
- Hepatic Trauma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Is the echogenic lesion a "mass" (usually spherical)? Or is it an echogenic focus (often linear such as TIPS or gas in bile ducts)?
- Significant overlap in many of these entities
  - CT and MR should be considered for further evaluation of echogenic masses

Helpful Clues for Common Diagnoses

- **Focal Steatosis**
  - Typically right lobe, caudate lobe, perihilar region
  - No mass effect, with vessels running undisplaced through the lesion
  - Varied appearances
    - Hyperechoic nodule/multiple confluent hyperechoic lesions (may simulate metastases)
    - Fan-shaped lobar/segmental distribution
  - CT or MR good problem-solving tools
- **Calcified Granuloma, Liver**
  - Histoplasmosis, TB, etc., usually small (few mm) and multiple
  - Spleen also usually involved
- **Hepatic Cavernous Hemangioma**
  - Hyperechoic mass in over two-thirds
    - Large lesions more heterogeneous
  - May have acoustic enhancement (due to fluid content)
- **Hepatic Metastases**
  - Hyperechoic metastases most commonly from GI tract (especially colon)
    - Others include vascular metastases from neuroendocrine tumors, melanoma, choriocarcinoma, renal cell carcinoma
  - "Target metastases" or "bull's eye" in aggressive primary tumors
    - Bronchogenic carcinoma classic example
- **Pneumobilia**
  - Echogenic shadowing foci in center of liver (biliary gas flows towards porta hepatis)
- **Intrahepatic Biliary Calculi**
  - Majority appear as highly echogenic foci with posterior acoustic shadowing
  - May have associated dilated ducts
- **Pyogenic Hepatic Abscess**
  - Gas within abscess may be echogenic
  - Most pyogenic abscesses are hypoechoic
- **Surgical Devices**
  - Clips, drains, shunts, catheters
  - Turn transducer to appreciate linear shape
- **Portal Vein Gas**
  - Echogenic, mobile, shadowing foci in periphery of liver
  - Gas in portal vein flows away from the porta hepatis
    - Very obvious on real time imaging
- **Normal Anatomic Pitfalls**
  - Hepatic ligaments, fissures, diaphragm slips
    - Infolding of fat along these normal structures creates echogenic focus near surface of liver
    - In short axis section, "lesions" can appear spherical and resemble masses
    - Turn US beam perpendicular to show linear shape of "lesion"
  - Refractile artifact
    - At junction of vessels, gallbladder neck

Helpful Clues for Less Common Diagnoses

- **Hepatocellular Carcinoma**

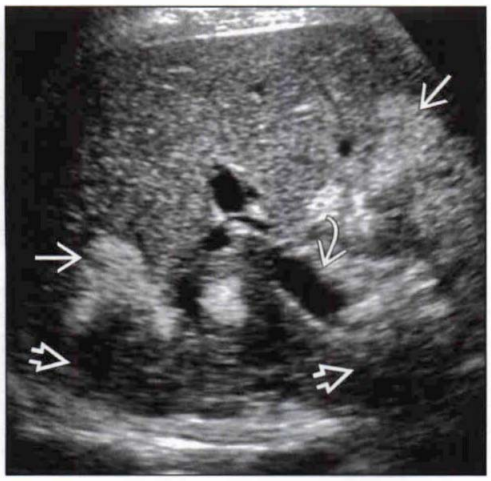
FOCAL HEPATIC ECHOGENIC LESION +/- ACOUSTIC SHADOWING

- Small lesion more likely to be hyperechoic
- May simulate hemangioma or focal steatosis
  - Look for background of abnormal (cirrhotic) liver
  - Generally irregular hypervascularity with Doppler
- **Fibrolamellar HCC**
  - Large heterogeneous mass in an adolescent or young adult
  - Look for central scar (may be hypo- or hyperechoic)
- **Cholangiocarcinoma**
  - Mass with ill-defined margin, mostly hyperechoic (75%) and heterogeneous
  - Causes proximal ductal obstruction
- **Hepatic Adenoma**
  - Hypervascular mass ± hemorrhage in a young woman on birth-control pills
- **Amebic Hepatic Abscess**
  - Usually homogeneous, hypoechoic
  - Hyperechoic if complicated by bacterial superinfection or fistula to bowel
- **Hepatic Hydatid Cyst**
  - Often cystic appearing but may see hyperechoic areas
    - "Hydatid sand", parenchymal invasion, calcified rim
- **Biliary Hamartoma**
  - Heterogeneous, hyperechoic foci on US
  - Better evaluated on CT/MR (multiple, predominately cystic, < 15 mm)
- **Hemangioendothelioma**
  - Infantile type: Well-defined, large hypervascular mass
  - Epithelioid (adult) type: Multiple peripheral confluent masses
- **Hepatic Angiomyolipoma**
  - Variable echogenicity, CT/MR better for showing fat
- **Post-Operative State**
  - Any procedure that introduces fat or gas into liver can create echogenic, shadowing lesion

Alternative Differential Approaches

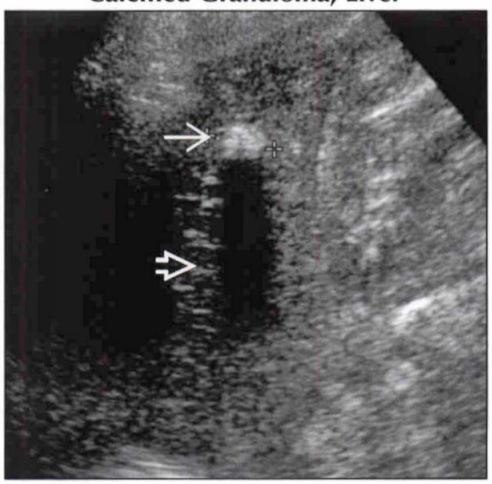
- Vascular masses
  - Cavernous hemangioma, hepatocellular carcinoma, hemangioendothelioma
- Fat-containing masses
  - Focal fatty infiltration, hepatic adenoma, HCC, lipid-containing metastases, angiomyolipoma, liposarcoma, teratoma (primary or metastatic to the liver)
- Gas-containing masses
  - Abscess, infarction, treated hepatic tumors with resulting sudden necrosis
- Solid masses
  - Primary liver tumors, metastases, cholangiocarcinoma
- Masses with calcified rim
  - Cystic masses
- Masses with a calcified scar
  - Fibrolamellar HCC, cavernous hemangioma (large ones)

Focal Steatosis



Transverse transabdominal ultrasound shows multiple hyperechoic areas ➡ with posterior acoustic shadowing ➡. Note lack of mass effect on hepatic vessels ➡.

Calcified Granuloma, Liver



Axial ultrasound shows a coarsely calcified liver granuloma ➡ with posterior acoustic shadowing ➡. Note the amorphous appearance of the calcification.

FOCAL HEPATIC ECHOGENIC LESION +/- ACOUSTIC SHADOWING

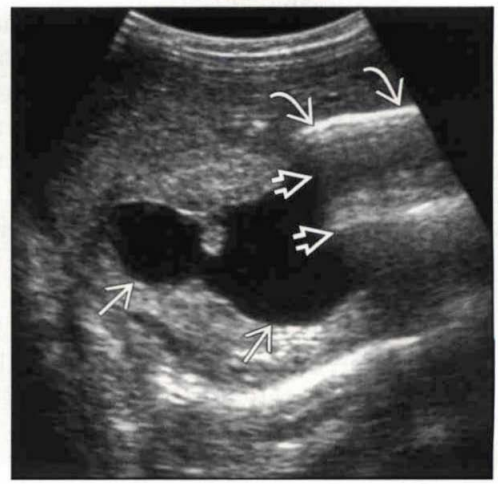
Hepatic Cavernous Hemangioma

Hepatic Metastases

(Left) *Oblique ultrasound shows two hemangiomas ➡ presenting as well-defined, homogeneous, hyperechoic rounded lesions. The appearance is typical (seen in two-thirds of hemangiomas) but is nonspecific; follow-up is usually required.* ***(Right)*** *Oblique transabdominal US shows multiple echogenic metastases ➡ from a colonic primary. Other hyperechoic mets include neuroendocrine tumor, choriocarcinoma, and melanoma.*

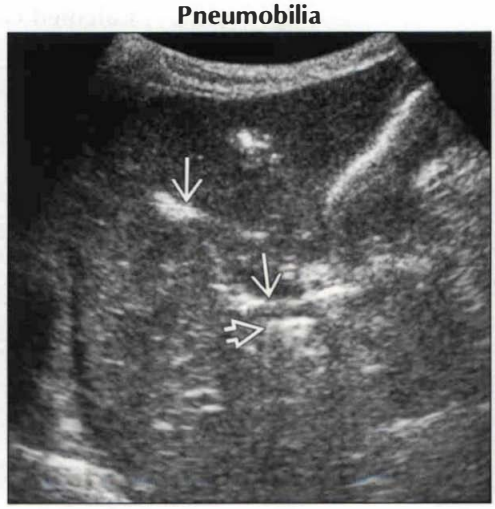
Hepatic Metastases

Pneumobilia

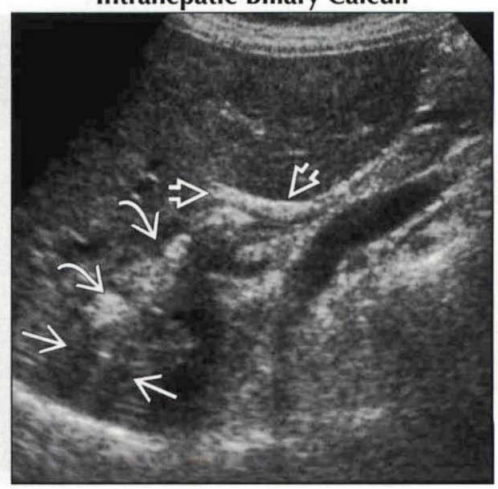


(Left) *Longitudinal transabdominal ultrasound shows target lesions in the liver representing metastases from lung carcinoma. The center ➡ is hyperechoic with a thick hypoechoic rim ➡.* ***(Right)*** *Oblique transabdominal ultrasound shows markedly dilated intrahepatic duct ➡ in Caroli disease containing some gas ➡. Note the echogenic linear reverberation artifact ➡ posterior to the gas.*

Pneumobilia



Intrahepatic Biliary Calculi



(Left) *Longitudinal transabdominal ultrasound shows linear hyperechoic structures indicating pneumobilia in an intra-hepatic ducts ➡. Note reverberation artifact ➡.* ***(Right)*** *Oblique transabdominal ultrasound shows multiple intrahepatic biliary calculi in recurrent pyogenic cholangitis. The echogenic stones ➡ show acoustic shadowing ➡. Note also pneumobilia in intrahepatic duct ➡.*

FOCAL HEPATIC ECHOGENIC LESION +/- ACOUSTIC SHADOWING

Pyogenic Hepatic Abscess

Surgical Devices

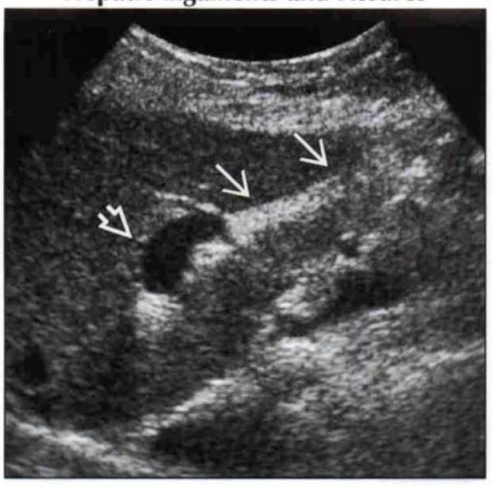
(Left) *Oblique transabdominal ultrasound shows a hypoechoic perihepatic abscess* ➡ *indenting the surface of the liver simulating an intra-hepatic mass.* ***(Right)*** *Longitudinal color Doppler ultrasound shows color flow within a TIPS shunt indicating patency. The echogenic stent* ➡ *does not obstruct ultrasound interrogation and has no acoustic shadow.*

Portal Vein Gas

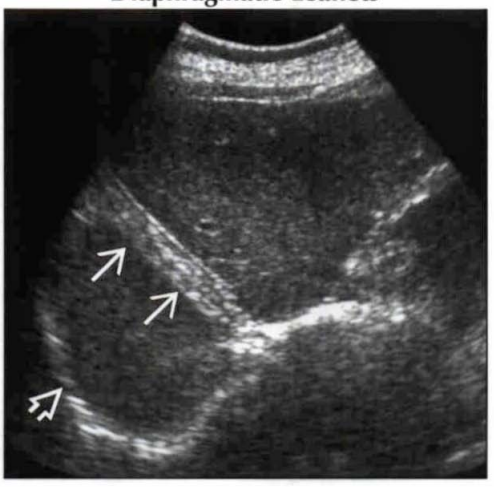
Hepatic Ligaments and Fissures

(Left) *Oblique transabdominal ultrasound shows tiny echogenic bubbles of gas* ➡ *within the portal vein. There are also echogenic patches of parenchymal gas* ➡. ***(Right)*** *Transverse transabdominal ultrasound shows cross-section of ligamentum teres* ➡, *which appears as a round echogenic focus in the left lobe of the liver. Its echogenicity increases with its age. It may mimic focal echogenic hepatic tumor.*

Hepatic Ligaments and Fissures



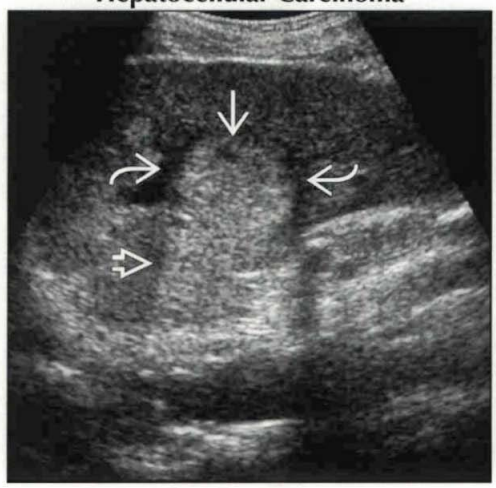
Diaphragmatic Leaflets



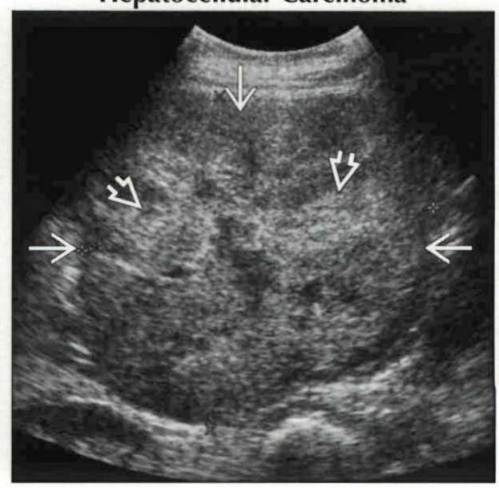
(Left) *Sagittal ultrasound in the same case as previous image, shows the ligamentum teres* ➡ *in a longitudinal view confirming it is not a mass. It runs from left portal vein* ➡ *to inferior tip of the left lobe.* ***(Right)*** *Oblique transabdominal ultrasound shows a tubular echogenic diaphragmatic leaflet* ➡ *near the dome of diaphragm* ➡. *This is seen in some patients when the transducer to be tilted up to the most cephalad portion of the right dome of the diaphragm.*

FOCAL HEPATIC ECHOGENIC LESION +/- ACOUSTIC SHADOWING

Hepatocellular Carcinoma

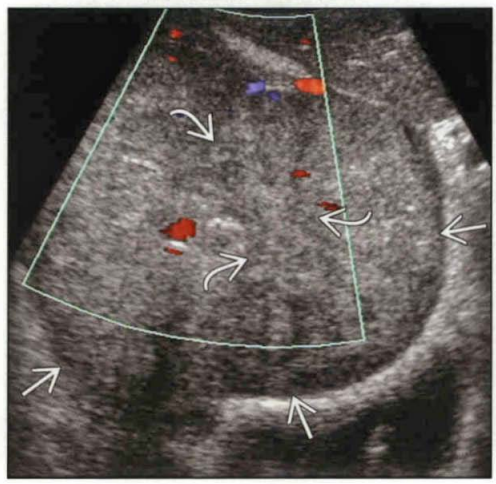


Hepatocellular Carcinoma



(Left) *Oblique ultrasound shows a small hyperechoic HCC. Small HCCs may be homogeneous in echotexture. There is even posterior acoustic enhancement in this case, making differentiation from a hemangioma difficult. Note that the lesion has a* ***thin hypoechoic halo****, which is generally not seen in hemangiomas.* ***(Right)*** *Transverse ultrasound shows the heterogeneous echotexture of a large hepatocellular carcinoma with hyperechoic areas.*

Fibrolamellar HCC

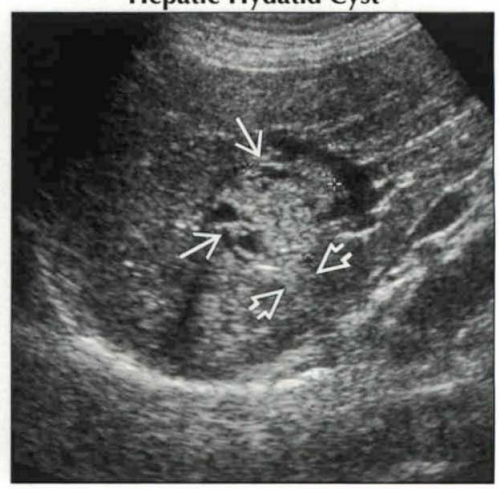


Cholangiocarcinoma

(Left) *Oblique color Doppler ultrasound shows a large echogenic mass representing a fibrolamellar hepatocellular carcinoma. Note the central hypoechoic* ***scar*** *which is typically seen in fibrolamellar HCC* ***but not specific.*** ***(Right)*** *Oblique transabdominal ultrasound shows a Klatskin* ***tumor*** *causing intrahepatic biliary ductal obstruction in both lobes of liver. Note enlarged intrahepatic ducts.*

Amebic Hepatic Abscess

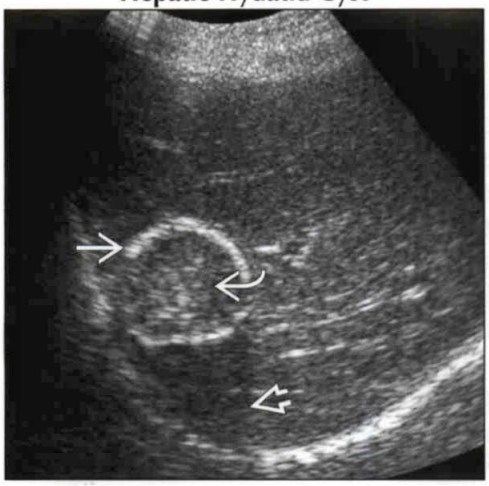
Hepatic Hydatid Cyst



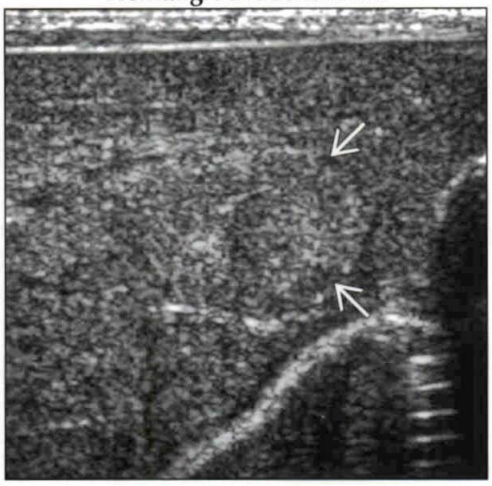
(Left) *Oblique transabdominal ultrasound shows ruptured amebic abscess which has fistulized with colon. Note hyperechoic gas locules within abscess & small* ***amount of ascites****.* ***(Right)*** *Oblique transabdominal ultrasound shows a ruptured hepatic echinococcus cyst. There is echogenic hydatid* ***sand*** *within and around the cyst.*

FOCAL HEPATIC ECHOGENIC LESION +/- ACOUSTIC SHADOWING

Hepatic Hydatid Cyst

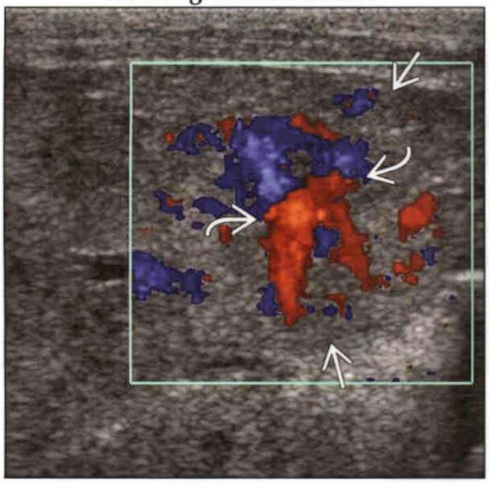


Hemangioendothelioma

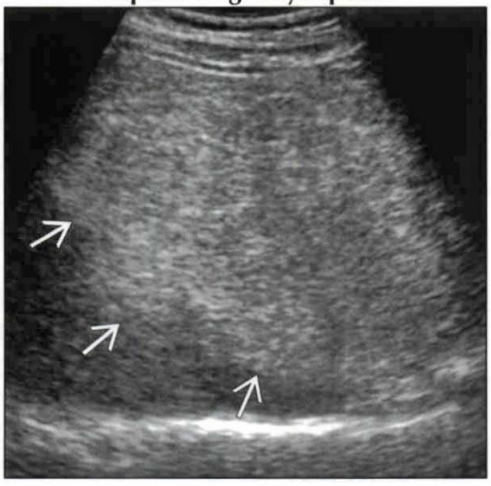


(Left) *Oblique transabdominal ultrasound shows the echogenic calcified wall of a hydatid cyst of liver with posterior acoustic shadowing. Note the echogenic content representing hydatid sand.* ***(Right)*** *Oblique transabdominal ultrasound shows an infantile hemangioendothelioma as a moderate size mildly hyperechoic mass.*

Hemangioendothelioma



Hepatic Angiomyolipoma



(Left) *Oblique color Doppler ultrasound shows the vascularity within the same infantile hemangioendothelioma. Note the large cavernous vascular channels filled by color flow. This is due to significant arteriovenous shunting.* ***(Right)*** *Oblique transabdominal ultrasound shows large hepatic angiomyolipoma which is hyperechoic and shows lobulated, geographic borders.*

Post-Operative State

Hepatic Trauma

(Left) *Oblique transabdominal ultrasound shows post-surgical appearance of liver after subsegmental resection for hepatocellular carcinoma. The resected area is packed with fat, giving it a heterogeneous appearance.* ***(Right)*** *Oblique transabdominal ultrasound shows a hyperechoic area of hemorrhage after hepatic trauma. The hematoma extends to the posterior surface of the liver, demonstrating the tract of laceration.*

PERIPORTAL LUCENCY OR EDEMA

DIFFERENTIAL DIAGNOSIS

Common

- Dilated Bile Ducts (Mimic)
- Systemic Hypervolemia
- Passive Hepatic Congestion
- Hepatitis (Acute)
- Ascending Cholangitis
- Post-Transplant Liver
  - Biliary Necrosis, Post-Transplantation
  - Lymphedema, Post-Transplantation
- Hepatic Trauma

Less Common

- Porta Hepatis Lymphadenopathy
- Cirrhosis
  - Peribiliary Cysts
- Portal Vein Thrombosis
- Primary Sclerosing Cholangitis
- Steatosis (Fatty Liver)
- AIDS Cholangiopathy
- Hepatocellular Carcinoma
- Cholangiocarcinoma
- Hepatic Metastases and Lymphoma
- Cholangitis, Chemotherapy-Induced
- Cholangitis, Recurrent Pyogenic

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Any process that increases the production of hepatic extracellular fluid, or impairs the capacity for lymphatics to carry this away, will result in periportal lymphedema
  - Loose areolar tissue in portal triads is easily distended by fluid
  - Common pathway for spread of fluid (lymph, bile, or blood)
- Common pitfalls
  - Mistake periportal fluid for dilated bile ducts
  - Mistake clotted portal vein branches for dilated ducts
- MRCP or ERCP best tool for distinguishing among etiologies for branching, nonenhancing structures

Helpful Clues for Common Diagnoses

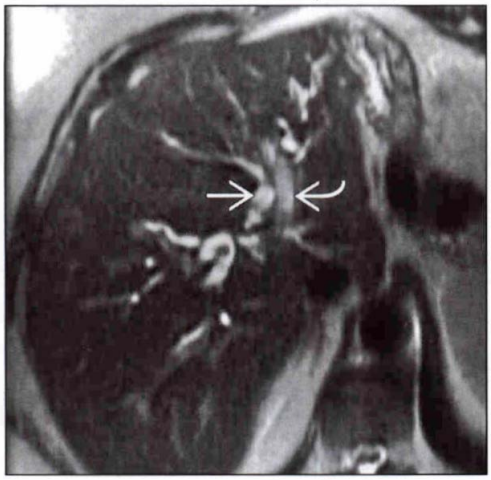
- **Dilated Bile Ducts (Mimic)**
  - Lie on only one side of portal triad
  - Periportal lucency, by definition, surrounds portal triad on all sides
  - Biliary obstruction may also cause periportal edema
  - Intrahepatic bile ducts should be less than half the diameter of adjacent portal vein branch
- **Systemic Hypervolemia**
  - Overhydration, as in rapid fluid resuscitation of a trauma patient
  - Liver produces lymph faster than lymphatics can carry it away
  - Clue: Look for distention of the IVC
- **Passive Hepatic Congestion**
  - Examples: Congestive heart failure, constrictive pericarditis, tricuspid valve incompetence
  - Results in periportal lymphedema
  - Look for distension and reflux into hepatic veins and IVC on arterial phase CECT
- **Hepatitis (Acute)**
  - Any cause (alcohol, viral, toxic)
  - Often results in striking periportal edema and/or gallbladder wall edema
- **Ascending Cholangitis**
  - Any form (ascending, primary sclerosing, recurrent pyogenic, AIDS, chemotherapy)
  - Bile duct wall thickening, periductal edema, and possibly ductal obstruction
    - Any or all of these may cause or simulate periportal edema
- **Post-Transplant Liver**
  - Lymphatics are severed during transplantation
    - Lymphatics reform connections, but this takes some time
    - Periportal lymphedema is common and may persist for weeks; not a sign of rejection
  - Biliary necrosis may occur as a complication of transplantation
    - Bile ducts receive only arterial supply; hepatic arterial stenosis or thrombosis causes biliary necrosis before hepatic infarction
    - Often takes form of intrahepatic fluid collections paralleling bile ducts; may be branching or spherical
- **Hepatic Trauma**
  - Blood may spread along portal tracts in a branching pattern
    - May be mistaken for dilated bile ducts or deep parenchymal laceration

- Periportal blood is almost never the only sign of hepatic trauma; usually limited to the lobe of liver with an intrahepatic hematoma or laceration

Helpful Clues for Less Common Diagnoses

- **Porta Hepatis Lymphadenopathy**
  - May result in lymphedema
- **Cirrhosis**
  - May cause periportal edema and/or simulate periportal edema
    - May cause peribiliary cysts (dilated peribiliary glands)
  - May cause portal vein obstruction
    - Look for nonenhancing branching structures in expected path of portal vein branches
    - Cavernous transformation of PV (collaterals) may also be mistaken for edema on NECT (but enhance like other vessels on CECT)
- **Portal Vein Thrombosis**
  - Portal vein branches that do not enhance on CECT are likely to be misinterpreted as dilated bile ducts or periportal edema
  - Thrombosis may result from cirrhosis (portal hypertension), hypercoagulable condition, or portal vein thrombophlebitis (e.g., from diverticulitis)
- **Primary Sclerosing Cholangitis**
  - Causes irregular strictures and upstream dilation of intra- and extrahepatic ducts
  - Biliary dilation may simulate or cause periportal edema
  - Bile duct wall thickening and periportal edema are often striking on ultrasound
- **Steatosis (Fatty Liver)**
  - May have perivascular distribution, simulate edema
    - More likely to be mistaken on CT; steatosis should not be mistaken for fluid on US or MR
  - Often appears spherical when sectioned in short axis in dome of liver
- **Hepatocellular Carcinoma**
  - May result in nonspecific lymphedema and/or invade or obstruct bile ducts or portal vein
  - HCC is prone to invade portal vein
    - Look for distention of portal vein, enhancing tumor thrombus, contiguity with parenchymal tumor
- **Cholangiocarcinoma**
  - Peripheral or hilar
  - Possible etiologies of branching, nonenhancing structures
    - Dilated bile ducts
    - Periportal edema
    - Thickened bile duct walls
- **Hepatic Metastases and Lymphoma**
  - Any hepatic malignancy may result in excess lymphatic output, periportal edema
  - Tumors may also obstruct intrahepatic bile ducts which may be difficult to distinguish from periportal edema in some cases

Dilated Bile Ducts (Mimic)



Axial T2WI FS MR shows dilated intrahepatic bile ducts ➡ running parallel to, and on one side only, of the portal venous branches ➡ in a patient with an obstructing ductal stone.

Dilated Bile Ducts (Mimic)

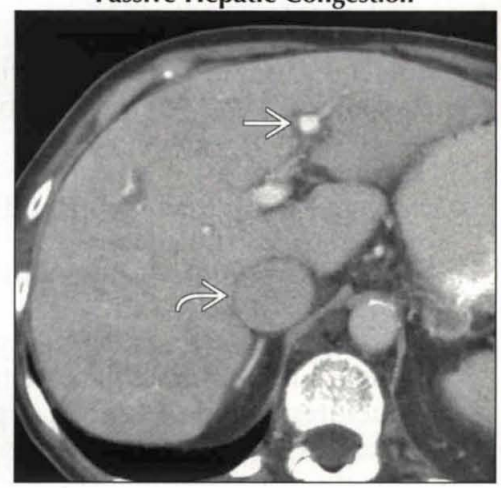
Axial CECT shows dilated intrahepatic bile ducts ➡ (due to carcinoma of the pancreatic head). The ducts lie on only one side (usually anteromedial) of the portal vein ➡ branches.

PERIPORTAL LUCENCY OR EDEMA

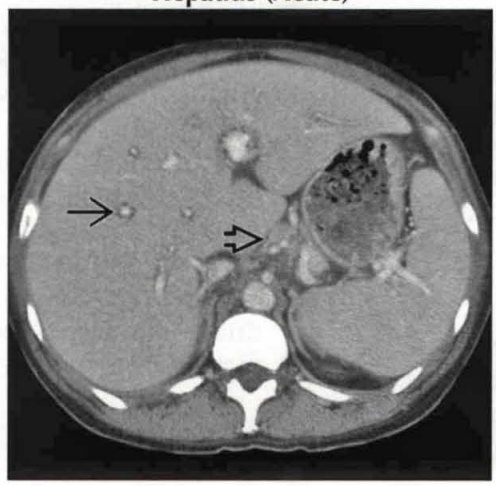
Systemic Hypervolemia

*(**Left**) Axial CECT shows a collar of low density edema ⇨ surrounding portal venous branches, caused by overhydration in a healthy 22 year old woman following a motor vehicle crash. Note distended IVC, also due to hypervolemia. (**Right**) Axial CECT shows periportal edema ➡ and a distended IVC ⇨ in a 78 year old woman with congestive heart failure.*

Passive Hepatic Congestion

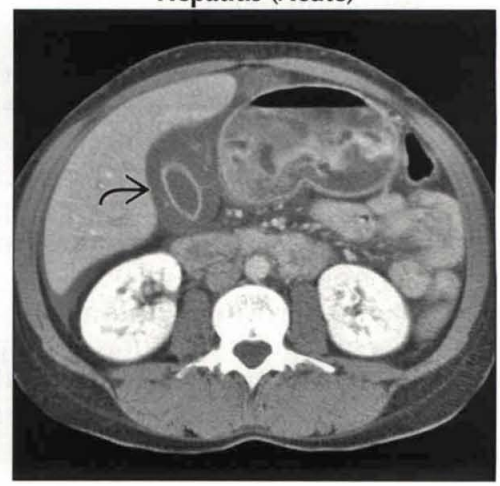


Hepatitis (Acute)



*(**Left**) Axial CECT shows a collar of periportal lymphedema ⇨ and porta hepatic lymphadenopathy ⇨ due to acute viral hepatitis in a 35 year old man. (**Right**) Axial CECT shows marked gallbladder wall edema ⇨ and a small amount of ascites, due to acute viral hepatitis, in a 35 year old man.*

Hepatitis (Acute)



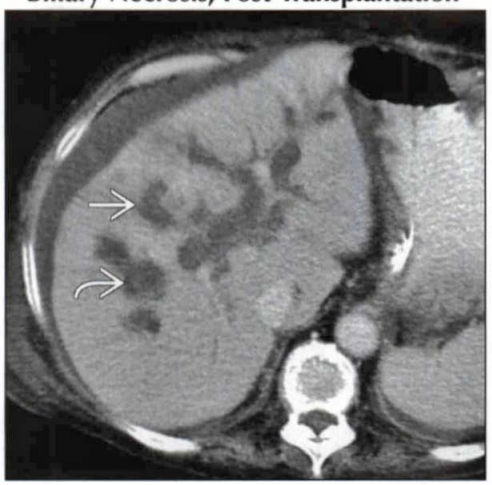
Ascending Cholangitis

*(**Left**) Axial CECT shows periportal edema ➡, mild dilation of ducts ⇨, and a pyogenic abscess ⇨, all due to ascending cholangitis following Whipple resection for pancreatic carcinoma. (**Right**) Axial CECT shows periportal lymphedema ➡ and gas within mildly dilated ducts ⇨, plus a liver abscess ⇨, all due to ascending cholangitis following Whipple resection for pancreatic carcinoma.*

Ascending Cholangitis

PERIPORTAL LUCENCY OR EDEMA

Biliary Necrosis, Post-Transplantation



Lymphedema, Post-Transplantation

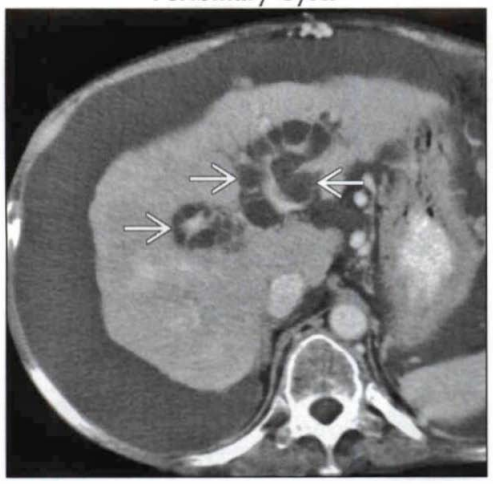
(Left) *Axial CECT shows dilated intrahepatic ducts with indistinct walls ➡ due to biliary necrosis. Intrahepatic bilomas ➡ and ascites are also noted. These are classic signs of hepatic artery stenosis or thrombosis following liver transplantation.* ***(Right)*** *Axial CECT shows classic periportal edema that surrounds the portal venous branches. This is a common finding in recent liver transplant recipients and does not imply injury to the allograft.*

Hepatic Trauma

Hepatic Trauma

(Left) *Axial CECT shows a left lobe hepatic hematoma ➡ in a 20 year old woman injured in a motor vehicle crash. Some of the blood tracks along the portal veins.* ***(Right)*** *Axial CECT shows the left lobe irregular laceration/hematoma, with some blood tracking along portal vein branches in the same patient.*

Peribiliary Cysts

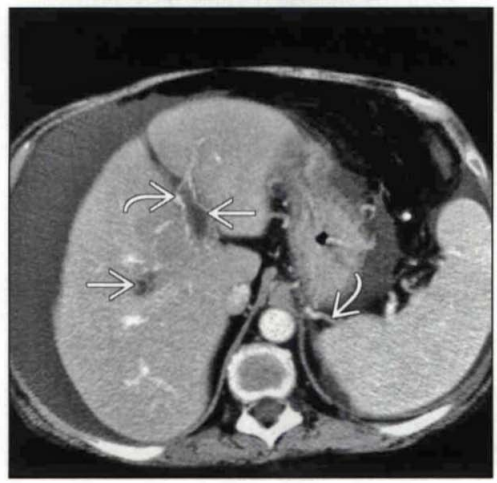


Peribiliary Cysts

(Left) *Axial CECT shows cystic and tubular water density structures ➡ that parallel the portal veins in this 45 year old woman with advanced cirrhosis. These are biliary cysts, not dilated ducts.* ***(Right)*** *Axial T2WI FS MR shows another view of the cystic and tubular water intensity lesions that parallel the portal veins and mimic dilated ducts in the same patient.*

PERIPORTAL LUCENCY OR EDEMA

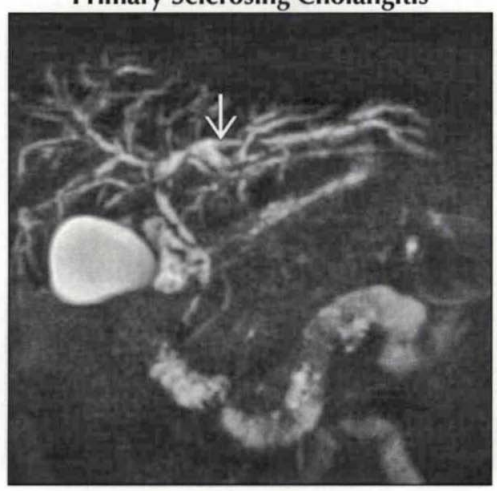
Portal Vein Thrombosis



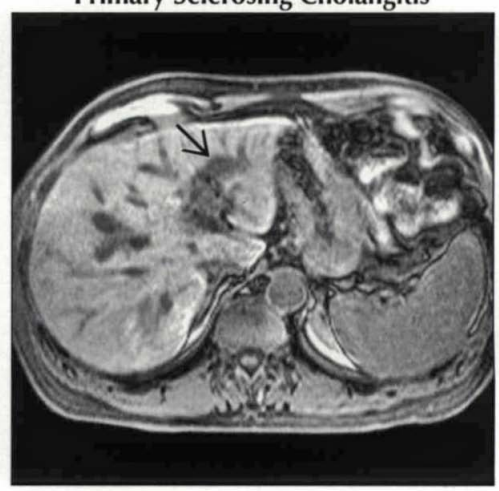
Portal Vein Thrombosis

*(**Left**) Axial CECT shows low density, branching structures ➡ that mimic dilated bile ducts, but represent occluded portal vein branches. Note collateral veins ➡ in this 58 year old woman who had an autologous bone marrow transplantation prior to becoming hypercoagulable. (**Right**) Axial CECT shows a thrombosed right portal vein ➡ that might be mistaken for a dilated duct in the same patient. Again, note collateral veins ➡.*

Primary Sclerosing Cholangitis

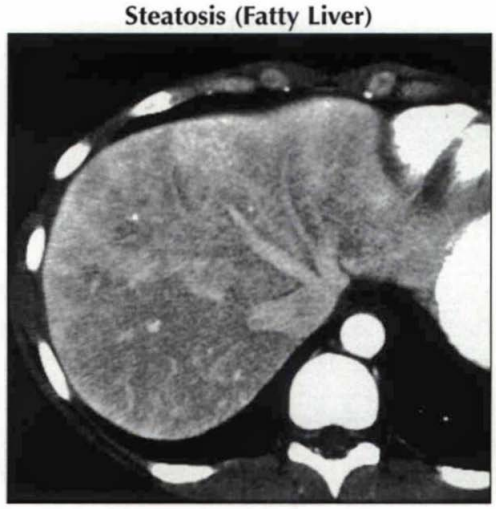


Primary Sclerosing Cholangitis

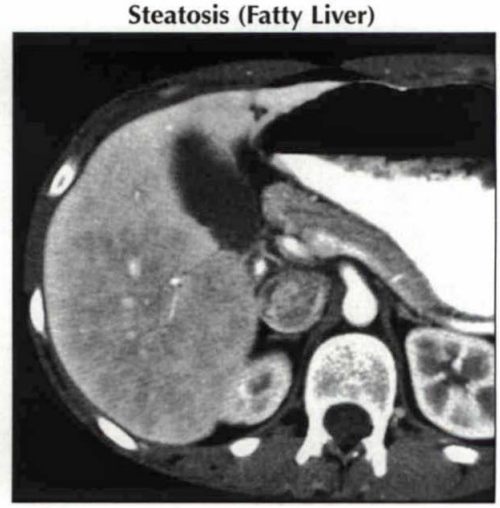


*(**Left**) Coronal MRCP shows irregular arborization of the intrahepatic ducts with a beaded appearance of some segments. In this 60 year old man with ulcerative colitis & PSC, portions of the left hepatic ducts ➡ are more dilated than the common duct. (**Right**) Axial T1WI FS MR shows low intensity fibrosis ➡ paralleling the portal veins and mimicking dilated bile ducts in the same patient.*

Steatosis (Fatty Liver)



Steatosis (Fatty Liver)

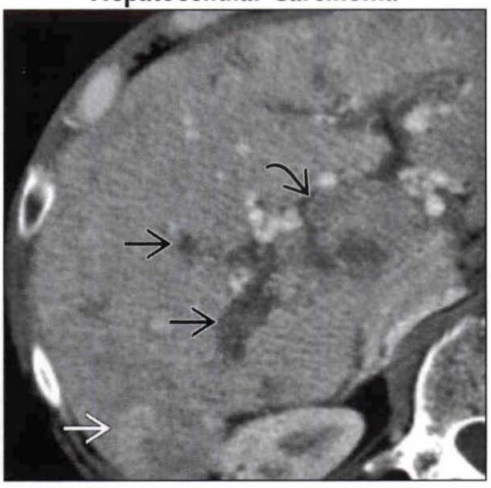


*(**Left**) Axial CECT shows mottled lucency in the liver, mostly in a perivascular distribution due to steatosis (fatty liver). Steatosis often favors the perivascular planes and "spares" the liver adjacent to the gallbladder fossa. (**Right**) Axial CECT shows mottled hepatic parenchymal lucency with a perivascular distribution, but normal-appearing liver near the gallbladder fossa, a common pattern of distribution for steatosis.*

PERIPORTAL LUCENCY OR EDEMA

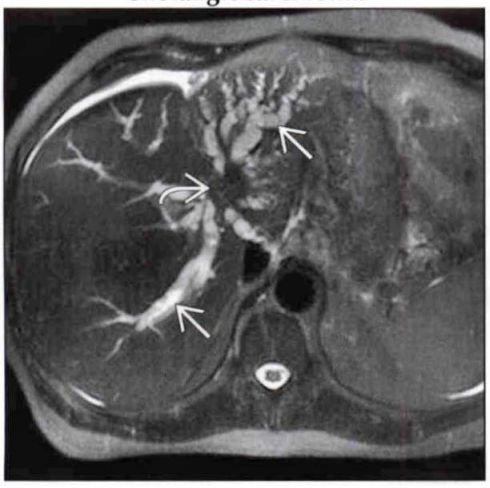
AIDS Cholangiopathy

Hepatocellular Carcinoma

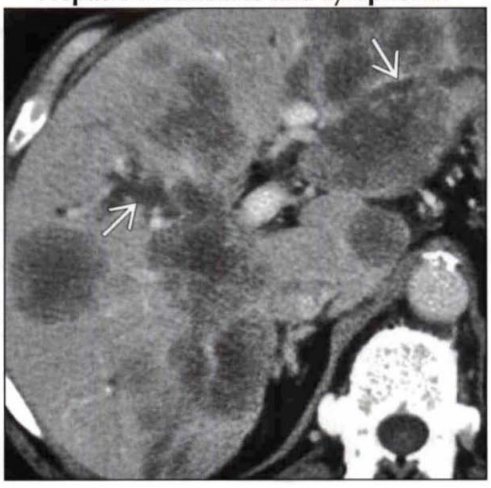


(Left) *Coronal oblique MRCP shows dilation and irregular arborization of the bile ducts and a stricture ➡ of the distal CBD, due to AIDS-related cholangiopathy. Similar findings could be seen with primary sclerosing cholangitis.* ***(Right)*** *Axial CECT shows enhancing tumor thrombus ➪ distending the main portal vein. Note thrombosed right portal vein ➪ simulating dilated ducts and the enhancing HCC ➡ on this arterial phase image.*

Cholangiocarcinoma

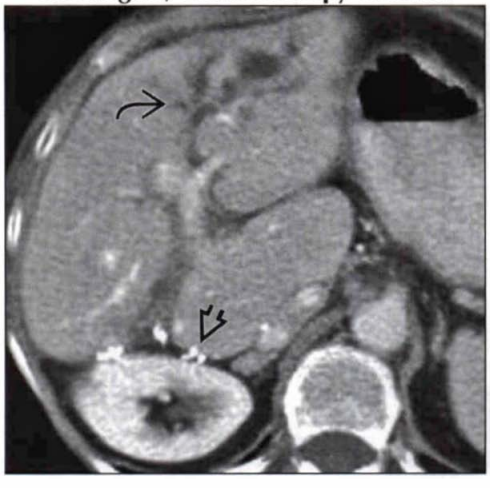


Hepatic Metastases and Lymphoma

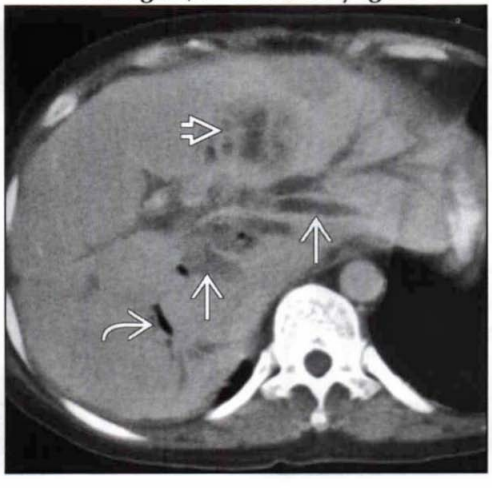


(Left) *Axial MRCP shows dilation of intrahepatic ducts ➡ with obstruction near the confluence of the right and left main ducts due to cholangiocarcinoma ➡. Malignant biliary obstruction may mimic or cause periportal edema.* ***(Right)*** *Axial CECT shows multiple hepatic metastases from colon carcinoma, with obstruction of intrahepatic bile ducts ➡. Metastases may also cause periportal lymphedema that may be mistaken for dilated, obstructed ducts.*

Cholangitis, Chemotherapy-Induced



Cholangitis, Recurrent Pyogenic



(Left) *Axial CECT shows surgical clips ➪ from right hepatic lobectomy (for metastases). Irregular dilation of intrahepatic ducts ➪ is result of hepatic intra-arterial chemotherapy.* ***(Right)*** *Axial CECT shows grossly dilated bile ducts ➡, some of which contain gas ➡, plus an hepatic abscess ➪; 45 year old Asian woman with recurrent bouts of cholangitis and sepsis.*

WIDESPREAD LOW ATTENUATION WITHIN LIVER

DIFFERENTIAL DIAGNOSIS

Common
- Steatosis (Fatty Liver)

Less Common
- Hepatitis
- Toxic Hepatic Injury
- Hepatic Infarction
- Hepatic Metastases and Lymphoma
- Hepatic Sarcoidosis
- Opportunistic Intestinal Infections
- Hepatocellular Carcinoma
- Wilson Disease
- Radiation Hepatitis
- Budd-Chiari Syndrome
- Glycogen Storage Disease

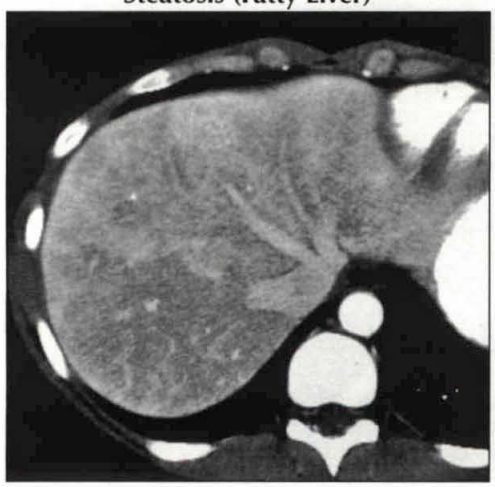
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Look for mass effect, usually absent in steatosis, present in neoplastic etiologies

Helpful Clues for Common Diagnoses
- **Steatosis (Fatty Liver)**
  - Diffuse, geographic or multifocal low attenuation
  - Localizes around fissures and hepatic veins
  - Blood vessels traverse low density focus without mass effect
  - Loss of signal intensity on opposed-phase GRE MR is best sign

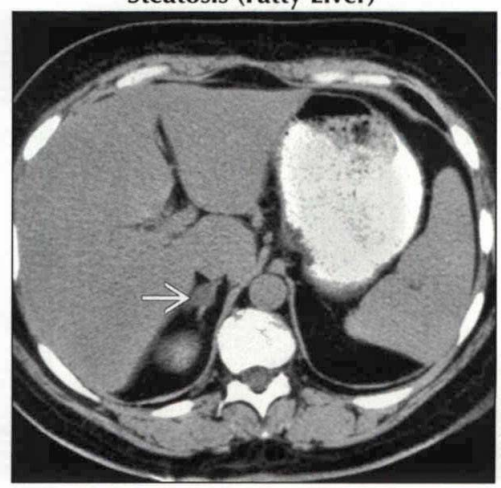
Helpful Clues for Less Common Diagnoses
- **Hepatitis**
  - Viral hepatitis usually does not alter the attenuation of the liver unless there is sudden, massive hepatic necrosis
- **Toxic Hepatic Injury**
  - Ingestion of poisonous mushrooms, carbon tetrachloride, or excess of certain medications (e.g., acetaminophen)
  - Can cause steatosis and/or necrosis
- **Hepatic Metastases and Lymphoma**
  - Lymphoma commonly causes diffuse hepatic infiltration
  - Breast, lung and melanoma are particularly likely to cause diffuse metastases
- **Hepatic Sarcoidosis**
  - Low density, enlarged liver or innumerable small hypodense granulomas
- **Opportunistic Intestinal Infections**
  - Viral, mycobacterial, etc., in AIDS or transplant recipients
- **Hepatocellular Carcinoma**
  - May simulate steatosis on NECT
  - Heterogeneity, vascular invasion and mass effect usually evident on CECT
- **Wilson Disease**
  - Causes low, not high, attenuation
- **Radiation Hepatitis**
  - Corresponding to field of external beam or distribution of radioactive embolic beads
- **Budd-Chiari Syndrome**
  - Areas of hepatocellular necrosis

Steatosis (Fatty Liver)



Axial CECT shows patchy low attenuation throughout the liver, favoring a perivascular distribution.

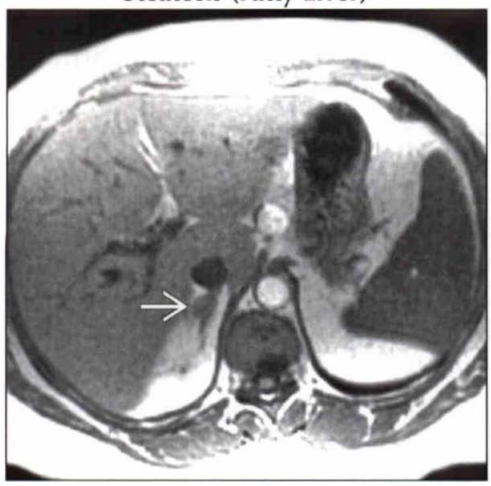
Steatosis (Fatty Liver)



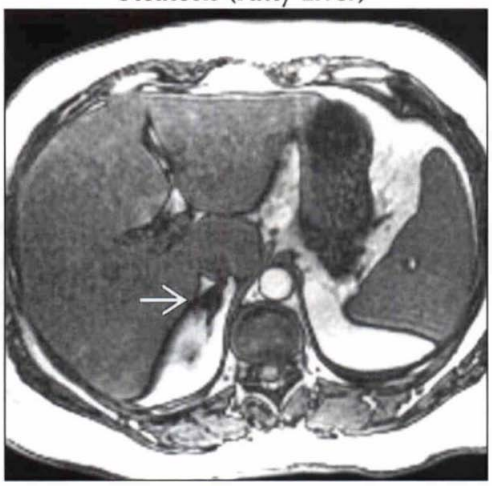
Axial NECT shows diffuse low attenuation of the liver (less than that of the spleen) and a small right adrenal nodule ➡ that is near water attenuation.

WIDESPREAD LOW ATTENUATION WITHIN LIVER

Steatosis (Fatty Liver)



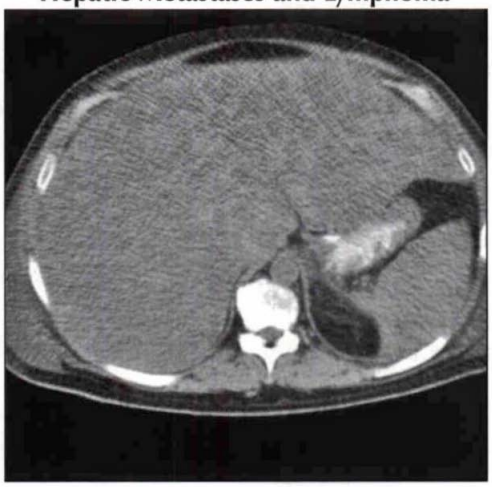
Steatosis (Fatty Liver)



(Left) *Axial T1WI GRE MR in phase shows a normal-appearing liver and a small right adrenal nodule* ➡ *in a patient with steatosis and an adrenal adenoma.* ***(Right)*** *Axial T1WI GRE MR opposed phase shows marked signal dropout from the liver and the adrenal lesion* ➡, *indicating that both contain a mixture of fat and water protons and are benign lesions.*

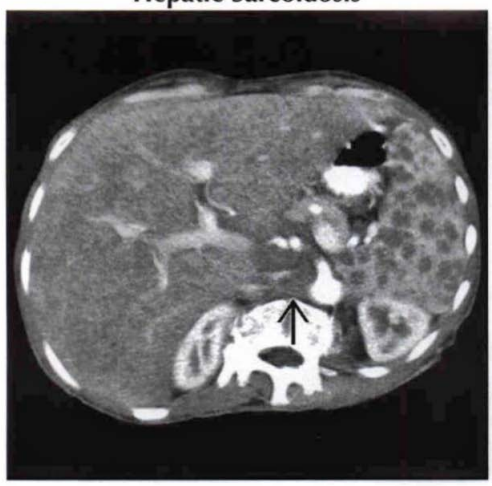
Hepatitis

Hepatic Metastases and Lymphoma



(Left) *Axial CECT shows low attenuation and volume loss of the left lobe in this patient with acute fulminant hepatitis. Note capsular retraction* ➡ *and ascites, both poor prognostic features.* ***(Right)*** *Axial NECT shows hepatomegaly with diffuse, though heterogeneous, low attenuation; biopsy-proved diffuse non-Hodgkin lymphoma.*

Hepatic Sarcoidosis



Radiation Hepatitis

(Left) *Axial CECT shows diffuse low attenuation of the liver with subtle, very small granulomas in the liver and much larger low density granulomas in the spleen, plus lymphadenopathy* ➡. ***(Right)*** *Axial CECT shows a broad zone of low attenuation through the center of the liver, sparing the peripheral right lobe, with straight line demarcation* ➡; *therapy for cholangiocarcinoma.*

HYPERECHOIC LIVER, DIFFUSE

DIFFERENTIAL DIAGNOSIS

Common
- Steatosis (Fatty Liver)
- Cirrhosis
- Hepatitis
- Metastases and Lymphoma, Hepatic
- Technical Artifact (Mimic)

Less Common
- Hepatocellular Carcinoma
- AIDS, Hepatic Involvement
- Hepatic Sarcoidosis
- Miliary Tuberculosis
- Schistosomiasis, Hepatic
- Biliary Hamartomas
- Mononucleosis
- Glycogen Storage Disease
- Wilson Disease

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Steatosis & cirrhosis account for most cases

Helpful Clues for Common Diagnoses
- **Steatosis (Fatty Liver)**
  - Diffuse increased echogenicity with acoustic shadowing
  - Liver often large with smooth contour
  - With increasing infiltration, vessels are pushed apart and hepatic veins take a more curved course
- **Cirrhosis**
  - Increased, irregular echogenicity plus altered flow dynamics in hepatic and portal veins
- **Hepatitis**
  - Chronic viral or acute alcoholic hepatitis causes increased echogenicity
  - Acute viral hepatitis usually causes decreased echogenicity
- **Metastases and Lymphoma, Hepatic**
  - Most are hypoechoic
  - Mucinous and vascular metastases may be hyperechoic
- **Technical Artifact (Mimic)**
  - Improper transducer or gain setting

Helpful Clues for Less Common Diagnoses
- **Hepatocellular Carcinoma**
  - May be multifocal, diffuse
  - Usually in cirrhotic liver
- **AIDS, Hepatic Involvement**
  - Opportunistic hepatic infections (CMV, mycobacterial, etc.)
- **Hepatic Sarcoidosis**
  - Diffuse heterogeneous echo pattern
  - Granulomas may be hypoechoic nodules
- **Miliary Tuberculosis**
  - Innumerable small echogenic granulomas
- **Schistosomiasis, Hepatic**
  - Diffuse involvement of periportal septal thickening causes increased echogenicity
- **Biliary Hamartomas**
  - When multiple or widespread
  - Tiny (< 1.5 cm) echogenic nodules (due to fibrous tissue in walls)

Steatosis (Fatty Liver)

Oblique transabdominal ultrasound shows moderate diffuse fatty infiltration, with increase in echogenicity ➡, posterior acoustic shadowing ➡, and impaired definition of intrahepatic vessels ➡.

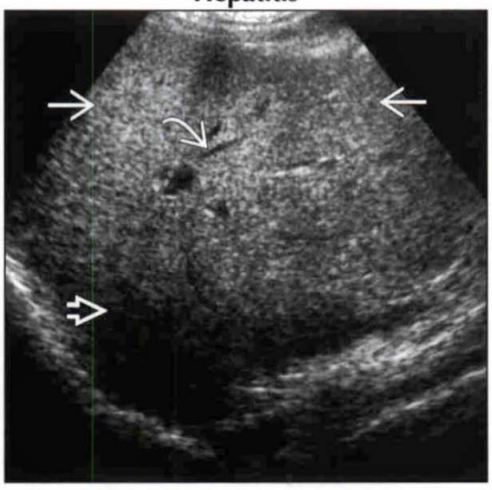
Steatosis (Fatty Liver)

Oblique transabdominal ultrasound shows mild fatty steatosis. Note diffuse increase in echogenicity ➡ compared with the hypoechoic renal cortex ➡, an internal reference used for diagnosis.

HYPERECHOIC LIVER, DIFFUSE

Cirrhosis

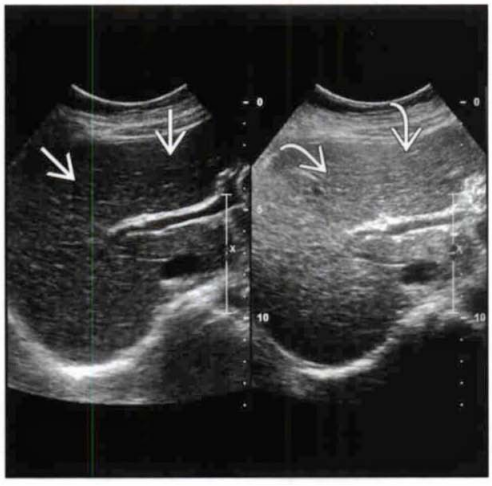
Hepatitis



(Left) Oblique ultrasound of a cirrhotic liver shows a small right lobe with increased echogenicity, coarsened architecture, and posterior acoustic shadowing. Note ascites. (Right) Oblique transabdominal ultrasound in a case of acute alcoholic hepatitis shows increased echogenicity and posterior shadowing. The hepatic veins have a curved course.

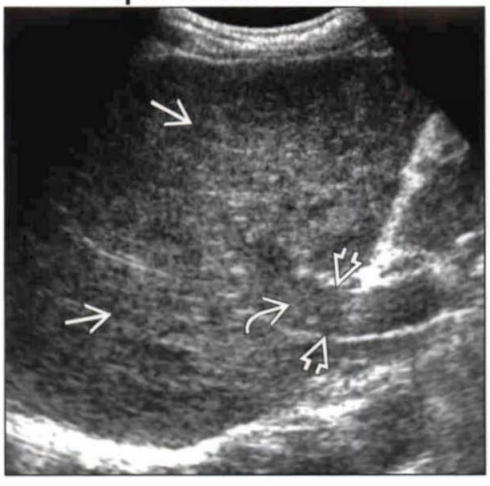
Metastases and Lymphoma, Hepatic

Technical Artifact (Mimic)



(Left) Oblique transabdominal ultrasound of diffuse infiltrative metastases shows heterogeneous increased echogenicity and distortion of the vascular architecture. (Right) Axial oblique ultrasound shows normal echogenicity of liver parenchyma on the left. Improper gain settings can cause an artifactually increased echogenicity as shown on the right.

Hepatocellular Carcinoma



Schistosomiasis, Hepatic

(Left) Oblique transabdominal ultrasound shows diffuse HCC, resulting in increased echogenicity and echogenic thrombus in the portal vein. Doppler is helpful for identifying tumor thrombus. (Right) Oblique transabdominal ultrasound shows diffuse schistosomiasis involvement of liver, resulting in periportal septal fibrosis, giving an echogenic, mottled appearance. Note thickened and hyperechoic portal vein walls.

SECTION 10
Gallbladder

Generic Imaging Patterns

Distended Gallbladder 10-2
Gas in Bile Ducts or Gallbladder 10-4
Diffuse Gallbladder Wall Thickening 10-8
Focal Gallbladder Wall Thickening 10-10

Modality-Specific Imaging Findings

High Attenuation (Hyperdense) Bile in Gallbladder 10-12

Clinically Based Differentials

Right Upper Quadrant Pain 10-14

DISTENDED GALLBLADDER

DIFFERENTIAL DIAGNOSIS

Common

- Cholecystitis
- Prolonged Fasting
- Hyperalimentation
- Post-Vagotomy State
- Anticholinergic Medication
- Diabetes Mellitus
- Obstruction of Common Bile Duct
  - Choledocholithiasis
  - Pancreatic Ductal Carcinoma
  - Cholangiocarcinoma
  - Ampullary Carcinoma
- Alcoholism
- Pancreatitis, Acute
- Hepatitis

Less Common

- Hydrops & Empyema, Gallbladder
- AIDS Cholangiopathy
- Choledochal Cyst (Mimic)

ESSENTIAL INFORMATION

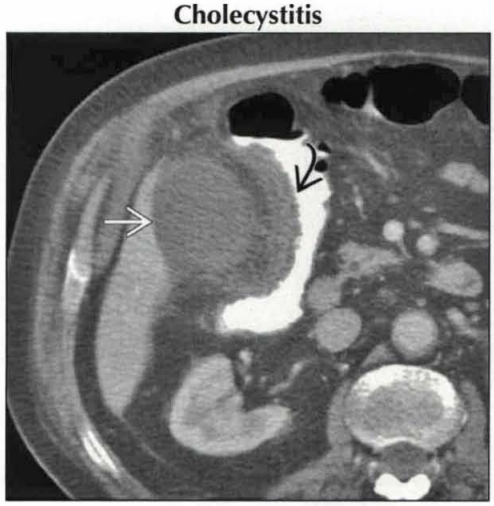
Key Differential Diagnosis Issues

- There are no absolute size criteria to diagnose a distended gallbladder (GB)
  - Usually no more than 4-5 cm in width, 7-10 cm in length
- GB contracts in response to vagal stimulation and cholecystokinin (secreted in response to fatty food intake)
- In order to empty GB, need a patent cystic duct & common bile duct
- Etiologies of GB distention
  - **Decreased Vagal Stimulation**
    - Post-vagotomy, anticholinergic medicines; diabetic neuropathy
  - **Decreased Cholecystokinin Secretion**
    - Prolonged fasting, hyperalimentation, low fat (and high alcohol) diet
  - **Obstructed Flow of Bile**
    - Cystic or common duct calculus; carcinoma of GB, bile duct, ampulla, or pancreas
  - **Inflammation of GB by Intrinsic or Adjacent Process**
    - AIDS cholangiopathy, hepatitis, pancreatitis, perforated duodenal ulcer
  - **Acalculous Cholecystitis**
    - Any severe illness, especially if patient is not eating
    - Common in ICU setting

Helpful Clues for Less Common Diagnoses

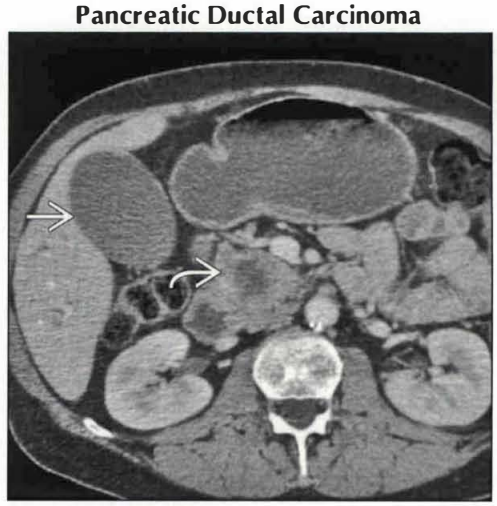
- **Hydrops (Mucocele) of GB**
  - Due to chronic obstruction of bile flow
  - GB distended with "white bile", clear watery or mucoid; GB wall is thin
- **Empyema of GB**
  - Bacterial contamination of hydropic GB
- **Choledochal Cyst (Mimic)**
  - Or other upper abdominal cysts (hepatic, renal, pancreatic)
  - May simulate distended GB

Cholecystitis



Axial CECT shows a distended GB ➡ with a thick wall and adjacent inflammatory changes, including mural thickening of the hepatic flexure ⇨. Acalculous cholecystitis.

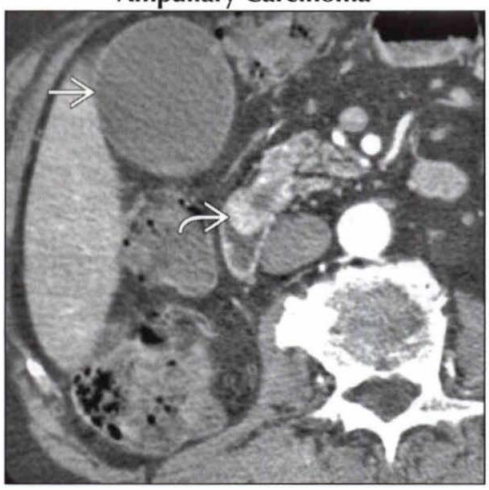
Pancreatic Ductal Carcinoma



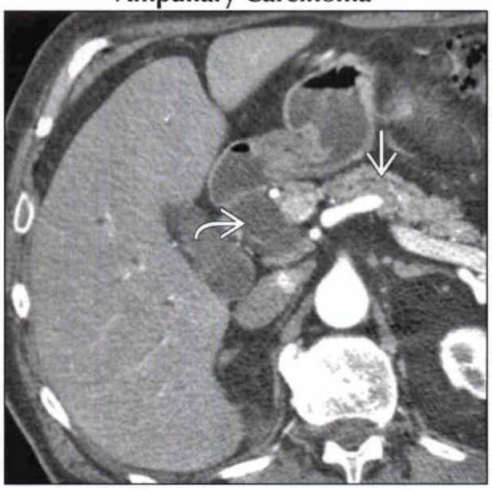
Axial CECT shows a hypodense mass ⇨ in the pancreatic head that was obstructing the common bile duct. Note the dilated, nontender ("Courvoisier") gallbladder ➡.

DISTENDED GALLBLADDER

Ampullary Carcinoma



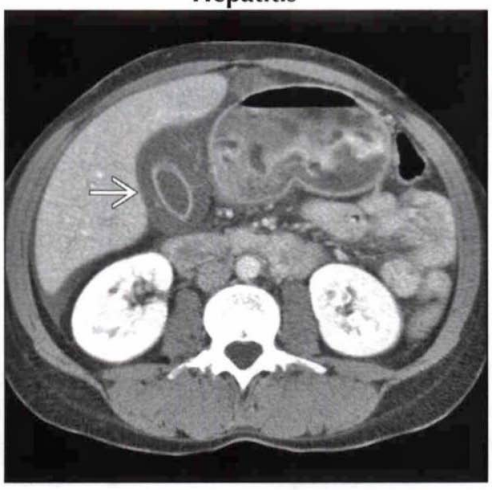
Ampullary Carcinoma



(Left) *Axial CECT shows a dilated but thin-walled GB and the small ampullary carcinoma that was obstructing the distal common bile and pancreatic ducts.* ***(Right)*** *Axial CECT shows a dilated common duct and mild dilation of the pancreatic duct in a patient with an ampullary carcinoma. The GB was markedly dilated (better seen on adjacent sections).*

Pancreatitis, Acute

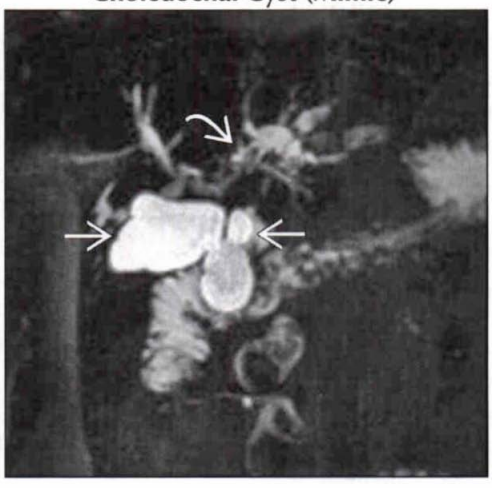
Hepatitis



(Left) *Axial CECT shows dilation of the GB due to acute and chronic pancreatitis. Note dilated pancreatic duct and extensive inflammation and mass effect around the pancreatic head.* ***(Right)*** *Axial CECT shows marked GB wall thickening that is more impressive than distention of the GB lumen in a patient with acute viral hepatitis.*

Hydrops & Empyema, Gallbladder

Choledochal Cyst (Mimic)



(Left) *Ultrasound shows ultrasound-guided placement of a pigtail catheter into a distended, hydropic gallbladder. Elderly woman with prolonged fasting following abdominal surgery.* ***(Right)*** *Coronal MRCP shows a complex cystic structure in the porta hepatis that might be mistaken for a dilated gallbladder. This is choledochal cyst that had been partially removed, along with the GB at surgery. Note dilation & strictures of intrahepatic ducts.*

GAS IN BILE DUCTS OR GALLBLADDER

DIFFERENTIAL DIAGNOSIS

Common
- Sphincterotomy
- Choledocholithiasis
- Patulous Sphincter of Oddi
- Biliary-Enteric Anastomosis
- Portal Vein Gas (Mimic)

Less Common
- Cholecystitis, Emphysematous
- Gas within Gallstones
- Duodenal Diverticulum
- Gallstone Ileus
- Crohn Disease
- Duodenal Ulcer
- Pancreatitis, Acute
- Cholangitis, Chemotherapy-Induced
- Cholangitis, Recurrent Pyogenic
- Pancreato-Biliary Parasites
- Duodenal Carcinoma
- Ampullary Carcinoma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Gas in biliary system is usually much more evident on CT than on other imaging modalities
- Very important to distinguish gas in bile ducts from gas in portal venous system
  - Portal venous gas is often a more serious condition
  - Most causes of biliary gas are benign
    - Usually result from iatrogenic or acquired incompetence of the biliary sphincter (of Oddi)

Helpful Clues for Common Diagnoses
- **Sphincterotomy**
  - At time of cholecystectomy or by ERCP
  - Used to facilitate removal or passage of common duct stones
  - Allows reflux of gas from duodenal lumen into bile ducts
  - Placement of a biliary stent results in more extensive reflux of duodenal gas into bile ducts & gallbladder
- **Choledocholithiasis**
  - Passage of stones may cause scarring and distortion of sphincter of Oddi
    - Leads to incompetence, allowing reflux of duodenal gas into bile duct
- **Patulous Sphincter of Oddi**
  - May occur spontaneously, especially in elderly
- **Biliary-Enteric Anastomosis**
  - Bile duct is anastomosed to a Roux limb of bowel
  - Examples: Liver transplantation, Whipple procedure
- **Portal Vein Gas (Mimic)**
  - May be mistaken for biliary gas
  - Portal venous gas flows toward and collects in the periphery of liver
  - Biliary gas collects near porta hepatis
  - Portal venous gas appears as mobile, small bubbles (on ultrasound)
    - Biliary gas is less mobile; larger collections

Helpful Clues for Less Common Diagnoses
- **Cholecystitis, Emphysematous**
  - Gas may be present in gallbladder lumen, GB wall, and/or within bile duct lumen
  - Severe form of cholecystitis caused by gas-forming organism
    - Usually Clostridium perfringens
  - Most commonly occurs in elderly, about 20-30% of whom have diabetes
  - Sonography: Diffuse "dirty" shadowing from gallbladder wall or lumen
  - Plain radiographs or CT allow more confident distinction from other echogenic lesions in GB fossa
- **Gas within Gallstones**
  - Often has a "Mercedes Benz" shape
    - Branching or chevron pattern
  - Does not imply infection or complication
- **Duodenal Diverticulum**
  - Bile duct may enter into or near duodenal diverticulum
  - Sphincter of Oddi often incompetent due to periampullary diverticulum
  - Diverticulum best demonstrated with fluoroscopic-guided barium study
- **Gallstone Ileus**
  - Large gallstone erodes through adherent walls of inflamed gallbladder and duodenum
    - GB lumen is usually collapsed, with thick wall
    - Occurs most commonly in elderly women

- Cholecysto-duodenal fistula can rarely result from other causes
  - Duodenal ulcer
  - Hepatic arterial chemotherapy with inflammation &/or ischemia of gallbladder & duodenum

• **Duodenal Ulcer**
- May erode into bile duct or gallbladder (choledocho-duodenal or cholecysto-duodenal fistula, respectively)

• **Inflammation Near Ampulla**
- May result in incompetence of sphincter, with reflux of gas
- Can be complication of any surrounding inflammatory process
  - Ulcer
  - Pancreatitis
  - Crohn disease
  - Duodenitis

• **Pus or Parasites in Bile Ducts**
- May release gas due to gas-forming organisms
- May also result in incompetent sphincter
- Recurrent pyogenic cholangitis
  - Chronic infection of biliary tree with coliform bacteria
  - Results in massive dilation of bile ducts, filled with pus and soft calcium bilirubinate stones
  - Occurs in malnourished populations, especially in southeast Asia (& immigrants from these countries)

• **Tumor Near Ampulla**
- Duodenal or ampullary; benign or malignant
- May result in incompetent sphincter

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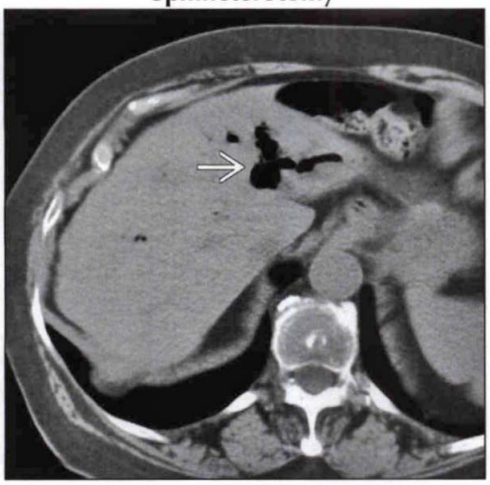
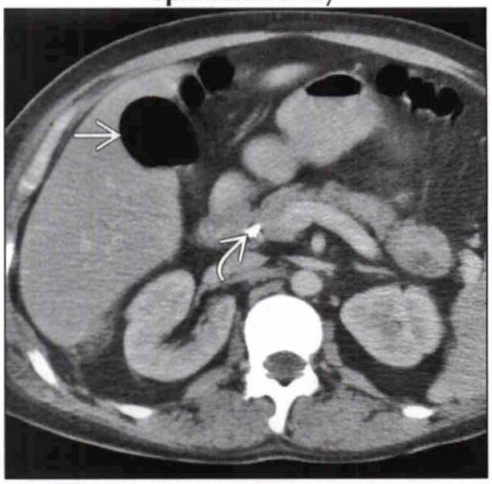
1. Sherman SC et al: Pneumobilia: benign or life-threatening. J Emerg Med. 30(2):147-53, 2006
2. Delabrousse E et al: Gallstone ileus: CT findings. Eur Radiol. 10(6):938-40, 2000
3. Shimono T et al: CT imaging of biliary enteric fistula. Abdom Imaging. 23(2):172-6, 1998
4. Bluemke DA et al: CT evaluation following Whipple procedure: potential pitfalls in interpretation. J Comput Assist Tomogr. 16(5):704-8, 1992
5. Harley WD et al: Gas in the bile ducts (pneumobilia) in emphysematous cholecystitis. AJR Am J Roentgenol. 131(4):661-3, 1978

Sphincterotomy



Axial NECT shows pneumobilia, mainly in the central, larger bile ducts ➡ in the nondependent portions of the liver.

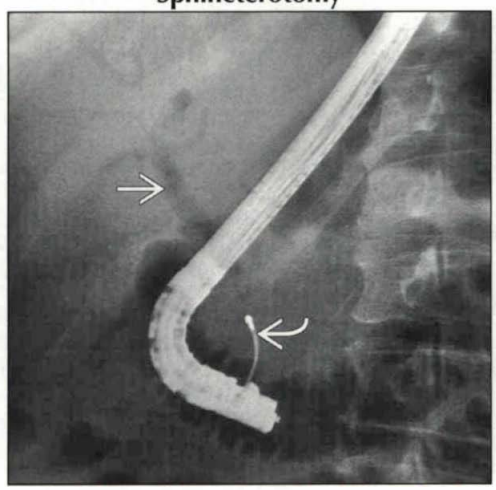
Sphincterotomy



Axial CECT shows an unusual degree of gas distention of the gallbladder lumen ➡, due to a biliary stent ➡.

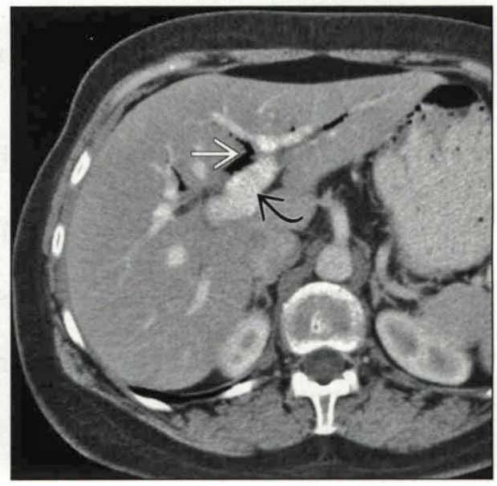
GAS IN BILE DUCTS OR GALLBLADDER

Sphincterotomy

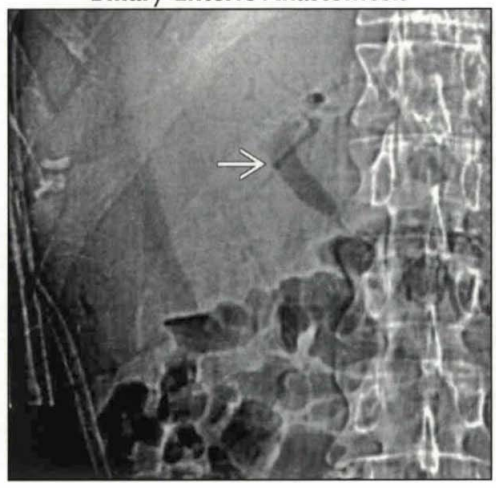


*(Left) Oblique ERCP shows gas in the bile ducts ➡ and the endoscope with a sphincterotomy device ➡ in place. **(Right)** Axial CECT shows gas in the bile ducts ➡, clearly separate from the contrast-opacified portal veins ➡. Stones were found within the common bile duct on MRCP.*

Choledocholithiasis



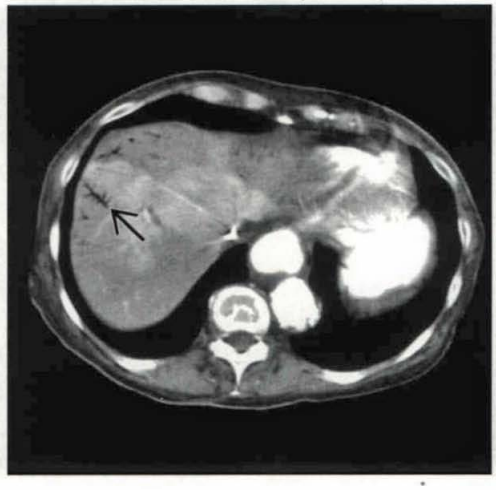
Biliary-Enteric Anastomosis



*(Left) Frontal radiograph shows classic radiographic appearance of pneumobilia with a branching gas pattern ➡ limited to the porta hepatis. Small bowel and liver transplantation. **(Right)** Axial NECT shows pneumobilia ➡ in a patient who had biliary-enteric anastomosis as part of a liver & small bowel transplantation.*

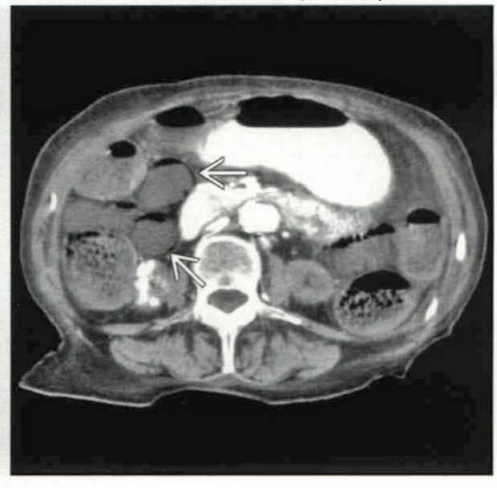
Biliary-Enteric Anastomosis

Portal Vein Gas (Mimic)



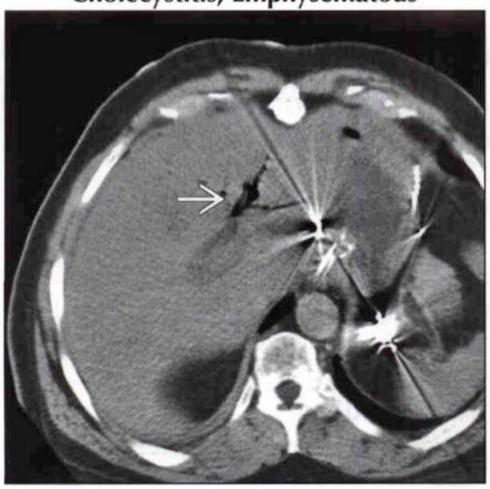
*(Left) Axial CECT shows branching gas pattern ➡ in the periphery of the liver and heterogeneous perfusion of the liver due to bowel infarction with portal venous gas. **(Right)** Axial CECT shows small bowel distention and pneumatosis ■ due to ischemia. Portal vein gas was also present.*

Portal Vein Gas (Mimic)

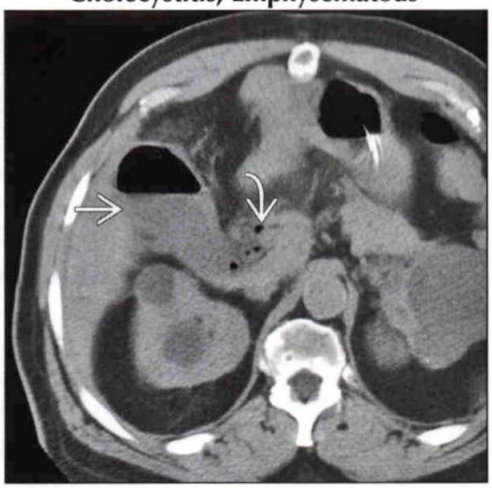


GAS IN BILE DUCTS OR GALLBLADDER

Cholecystitis, Emphysematous

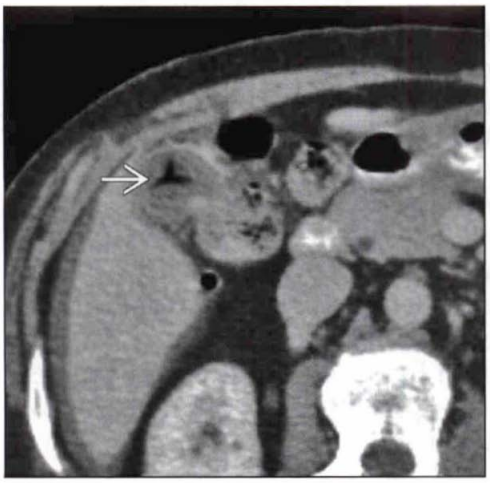


Cholecystitis, Emphysematous

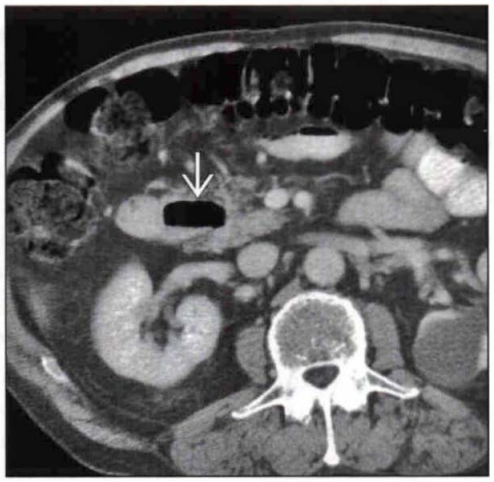


*(**Left**) Axial NECT shows pneumobilia ➡ in an elderly man with diabetes who also had gas within the GB lumen. (**Right**) Axial NECT shows gas within the GB lumen ➡ and pneumobilia ➡ due to emphysematous cholecystitis in an elderly diabetic man.*

Gas within Gallstones



Duodenal Diverticulum



*(**Left**) Axial CECT shows a classic "Mercedes Benz" shaped gas fissure ➡ within a gallstone. This should not be confused with emphysematous cholecystitis. (**Right**) Axial CECT shows gas within a duodenal diverticulum ➡ that may simulate or cause pneumobilia.*

Gallstone Ileus

Cholangitis, Recurrent Pyogenic

*(**Left**) Axial CECT shows a collapsed lumen of the GB ➡ with a fistula to the second portion of the duodenum ➡, resulting in gas within the GB lumen. (**Right**) Axial CECT shows gross dilation and distortion of the bile ducts ➡ which are filled with gas and pus. The left lobe is affected more than the right and shows parenchymal atrophy as a result of chronic infection.*

DIFFUSE GALLBLADDER WALL THICKENING

DIFFERENTIAL DIAGNOSIS

Common
- Cholecystitis
- Hepatitis
- Cardiac, Renal or Liver Failure
- Systemic Hypervolemia, Abdominal Signs

Less Common
- Hyperplastic Cholecystoses
- Gallbladder Carcinoma
- AIDS Cholangiopathy
- Cholangitis, Primary Sclerosing
- Pancreatitis, Acute
- Duodenal Ulcer
- Pyelonephritis
- Porcelain Gallbladder
- Gallbladder Wall Varices

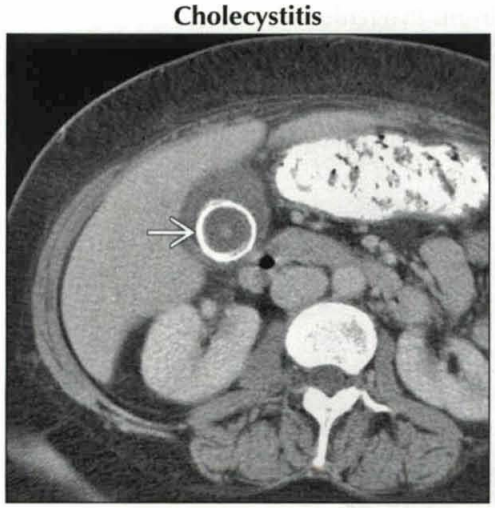
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Correlation with clinical presentation is key
  - Focal tenderness, systemic disease, fever

Helpful Clues for Common Diagnoses
- **Cholecystitis**
  - Usually causes mild to moderate thickening of GB wall
  - Distended lumen, gallstones, focal tenderness
- **Hepatitis**
  - Often causes marked GB wall thickening
  - Tender, swollen liver might be mistaken for GB pain
- **Cardiac, Renal, Liver Failure, Hypervolemia**
  - All can result in anasarca
  - Portal hypertension & hypoproteinemia also contribute to GB wall thickening

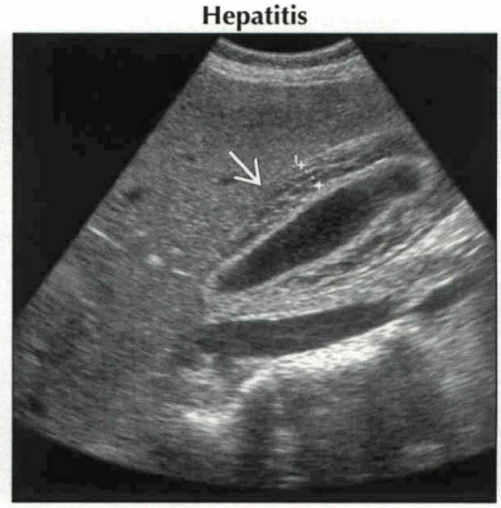
Helpful Clues for Less Common Diagnoses
- **Hyperplastic Cholecystoses**
  - Adenomyomatosis
  - Cholesterol crystals in Rokitansky-Aschoff sinuses
- **Gallbladder Carcinoma**
  - Look for eccentric thickening of GB wall, invasion of adjacent liver, big nodes, obstructed bile ducts
- **AIDS Cholangiopathy**
  - GB wall inflammation ± strictures of bile ducts
- **Cholangitis, Primary Sclerosing**
  - Bile duct strictures are usually more prominent, but GB may be inflamed
- **Pancreatitis, Acute**
  - Inflammation often spreads to GB
- **Duodenal Ulcer**
  - Penetrating or perforated ulcer may inflame GB wall
- **Pyelonephritis**
  - Infection of right kidney may spread to GB
- **Porcelain Gallbladder**
  - Wall is calcified; may be thickened
- **Gallbladder Wall Varices**
  - With portal hypertension & PV thrombosis
  - Key to diagnosis is color Doppler (venous flow pattern)

Cholecystitis



Axial CECT shows a large rim-calcified gallstone ➡ within a thick-walled gallbladder.

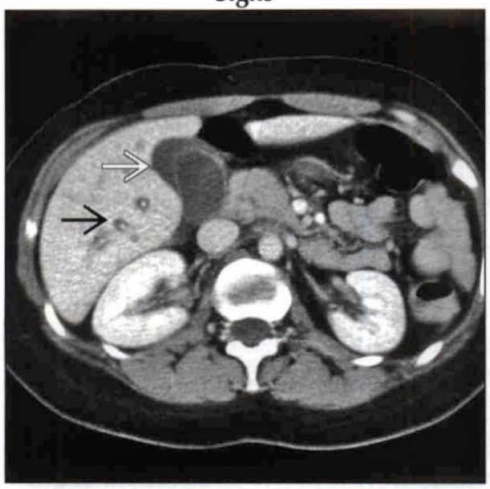
Hepatitis



Sagittal ultrasound shows a markedly thick-walled gallbladder ➡ with no calculi, in this patient with acute viral hepatitis.

DIFFUSE GALLBLADDER WALL THICKENING

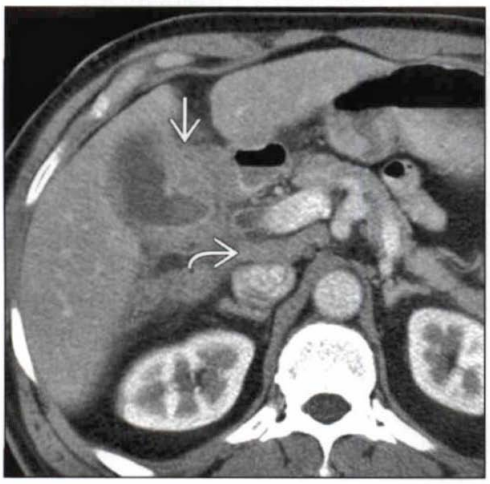
Systemic Hypervolemia, Abdominal Signs



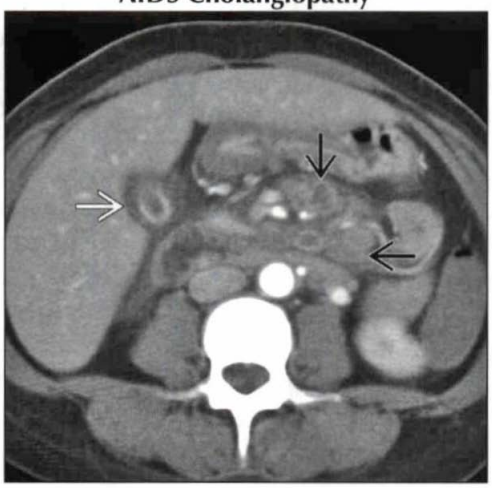
Hyperplastic Cholecystoses

(Left) Axial CECT shows a thick-walled gallbladder and periportal edema in this 22 year-old woman who had overly aggressive fluid resuscitation following abdominal trauma. (Right) Sagittal oblique transabdominal ultrasound shows numerous small echogenic foci within the GB wall without shadowing, findings typical of cholesterol crystals within the Rokitansky-Aschoff sinuses.

Gallbladder Carcinoma

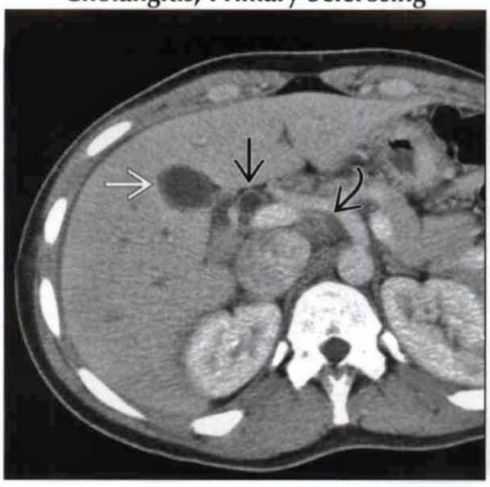


AIDS Cholangiopathy

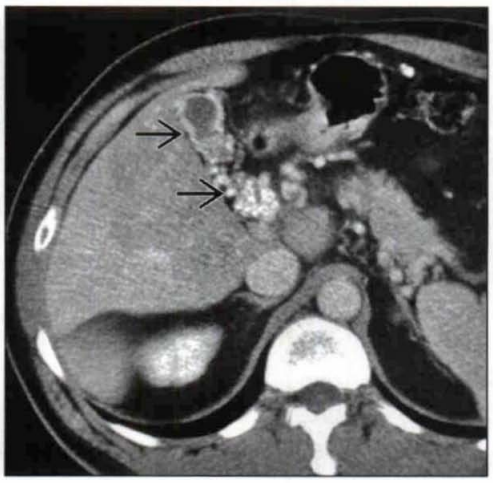


(Left) Axial CECT shows an eccentrically thickened GB wall with infiltration of the surrounding tissue planes. The thickening is of soft tissue density, unlike the near water density submucosa in inflammatory etiologies. Also note the portocaval lymph node metastases. (Right) Axial CECT shows diffuse GB wall thickening. Retroperitoneal and mesenteric nodes with a caseated low density appearance are due to Mycobacterial infection.

Cholangitis, Primary Sclerosing



Gallbladder Wall Varices



(Left) Axial CECT shows thickening of the walls of the GB and common duct, periportal lymphadenopathy and intrahepatic bile duct dilation and strictures (better seen on cholangiography). (Right) Axial CECT shows gallbladder wall varices in a patient with cirrhosis and portal vein thrombosis with cavernous transformation.

FOCAL GALLBLADDER WALL THICKENING

DIFFERENTIAL DIAGNOSIS

Common
- Hyperplastic Cholecystoses
- Gallbladder Carcinoma

Less Common
- Cholecystitis, Xanthogranulomatous
- Porcelain Gallbladder
- Metastases and Lymphoma, Gallbladder
- Gallbladder Wall Polyps
- Epithelial Polyp, Gallbladder
- Mesenchymal Tumor, Gallbladder
- Intramural Hematoma, Gallbladder

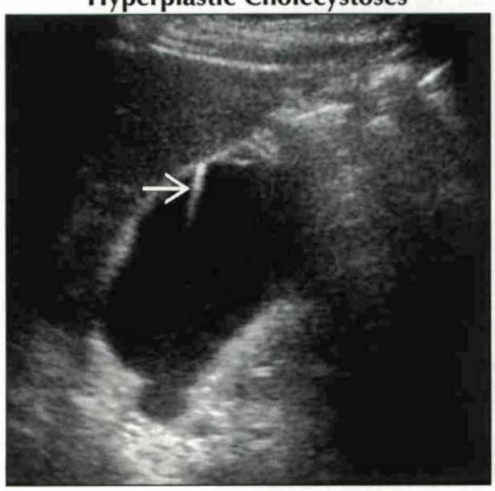
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Overlap of imaging findings between GB cancer, polyps, and xanthogranulomatous cholecystitis may preclude distinction, but polyps and cancer are more common

Helpful Clues for Common Diagnoses
- **Hyperplastic Cholecystoses**
  - Adenomyomatosis
  - Epithelial proliferation, muscular hypertrophy, intramural diverticula (Rokitansky-Aschoff sinuses)
  - Echogenic cholesterol crystals with comet-tail artifact
- **Gallbladder Carcinoma**
  - Eccentric GB wall thickening, calculi, invasion of adjacent liver, spread to nodes and peritoneal cavity
  - Eccentric & substantial gallbladder wall thickening distinguishes those with GB carcinoma from "simple" cholecystitis

Helpful Clues for Less Common Diagnoses
- **Cholecystitis, Xanthogranulomatous**
  - Very thick GB wall, often with hypoechoic (& hypoattenuating) foci = abscesses or xanthogranulomas
  - Imaging features often indistinguishable from GB carcinoma
- **Porcelain Gallbladder**
  - Calcified GB wall
  - Focal soft tissue mural nodule raises concern for GB carcinoma, but can occur without tumor
- **Metastases and Lymphoma, Gallbladder**
  - Melanoma is well known to metastasize to GB
  - Soft tissue focal mass
  - Usually part of widespread metastases
- **Gallbladder Wall Polyps**
  - Inflammatory or neoplastic polyps may arise in GB wall
  - Epithelial polyps include adenoma, cystadenoma, papilloma
  - Mesenchymal polyps include hemangioma, leiomyoma, neurofibroma
- **Intramural Hematoma, Gallbladder**
  - Uncommon result of blunt or penetrating trauma
  - May be associated with blood in GB lumen

Hyperplastic Cholecystoses



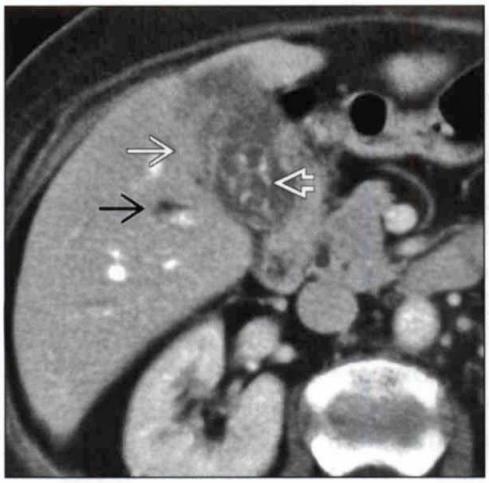
Oblique transabdominal ultrasound shows a classic comet tail artifact ➡ reverberating from a cholesterol polyp or deposition of crystals within the Rokitansky-Aschoff sinuses in the GB wall.

Hyperplastic Cholecystoses

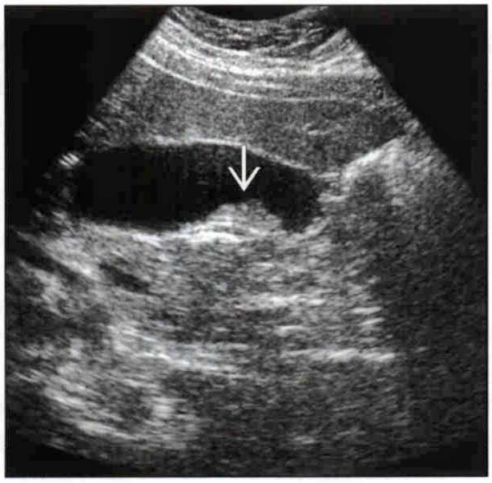
Ultrasound shows a focal heterogeneously echogenic mass ➡ in the gallbladder that proved to be focal adenomyomatosis.

FOCAL GALLBLADDER WALL THICKENING

Gallbladder Carcinoma

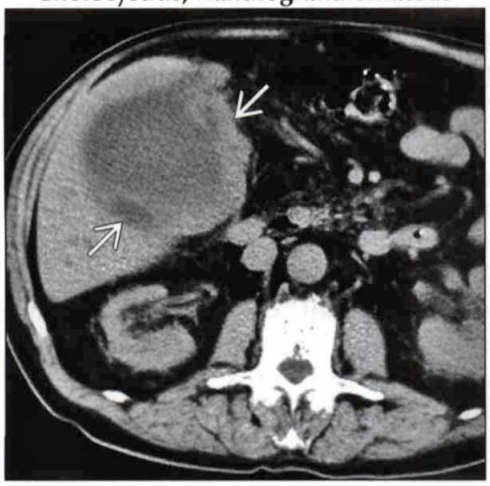


Gallbladder Carcinoma

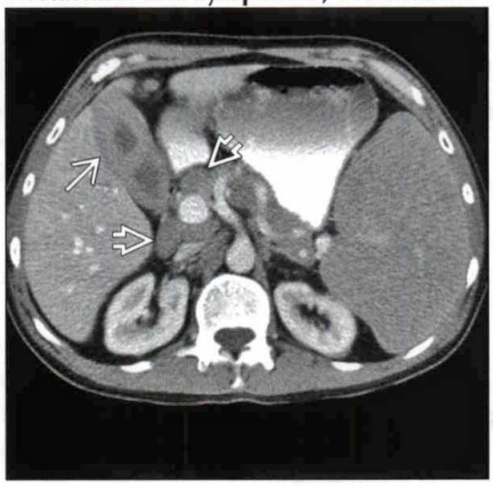


(Left) Axial CECT shows an eccentric soft tissue density mass ➡ arising from the GB with direct invasion of the liver. Note gallstones ➪ and dilated intrahepatic ducts ⇨. (Right) Ultrasound shows a sessile mass ➡ in the gallbladder without acoustic shadow. This is a carcinoma, but it is difficult to distinguish from a benign polyp.

Cholecystitis, Xanthogranulomatous



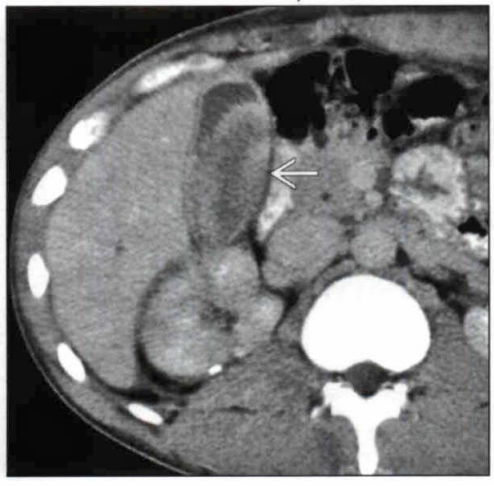
Metastases and Lymphoma, Gallbladder



(Left) Axial NECT shows a distended GB with an irregularly thickened GB wall ➡. This was resected and found to represent xanthogranulomatous cholecystitis, but it would be difficult to distinguish this from GB carcinoma by imaging. (Right) Axial CECT shows soft tissue density thickening of the GB wall ➡, splenomegaly, and extensive lymphadenopathy ➪. Non-Hodgkin lymphoma.

Gallbladder Wall Polyps

Intramural Hematoma, Gallbladder



(Left) Sagittal ultrasound shows an echogenic mass ➡ within the GB wall & lumen. Inflammatory fibroblastic polyp. (Right) Axial CECT shows an intraluminal and intramural hematoma ➪ in the gallbladder due to a gunshot wound to the liver and upper abdomen.

HIGH ATTENUATION (HYPERDENSE) BILE IN GALLBLADDER

DIFFERENTIAL DIAGNOSIS

Common
- Vicarious Excretion
- Layering of Small Gallstones
- Following Cholangiography
- Biliary Stent

Less Common
- Gallbladder Sludge
- Trauma, Biliary
- Trauma, Hepatic
- Milk of Calcium Bile
- Biliary-Enteric Fistula or Anastomosis
- Porcelain Gallbladder (Mimic)
- Gallbladder Carcinoma (Mimic)
- Hemorrhagic Cholecystitis

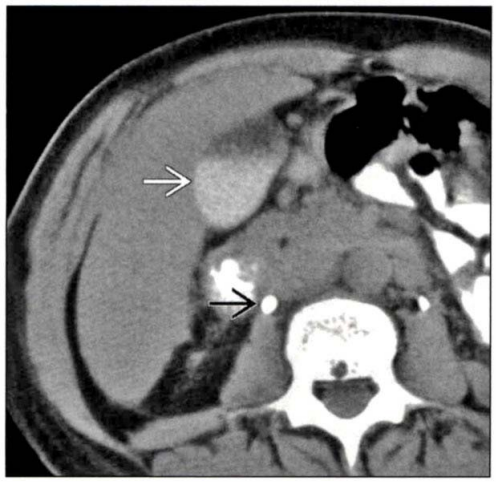
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Most common causes are iatrogenic (e.g., vicarious excretion, cholangiography, stents)

Helpful Clues for Common Diagnoses
- **Vicarious Excretion**
  - Hepatobiliary excretion of iodinated contrast media (CM)
  - Commonly seen hours to days after any intravascular administration of CM
  - If detected only on CT, does not imply renal insufficiency
  - Visible on radiography = renal failure
- **Layering of Small Gallstones**
  - View CT at wide window to distinguish from hyperdense bile
- **Following Cholangiography**
  - Prior ERCP, transhepatic cholangiogram
- **Biliary Stent**
  - May allow reflux of oral (enteric) CM into GB and bile ducts
  - Look for gas in GB and bile ducts

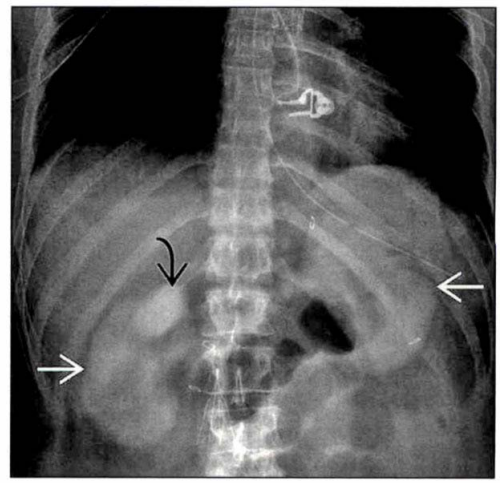
Helpful Clues for Less Common Diagnoses
- **Gallbladder Sludge**
  - Common cause of echogenic material within GB on sonography
  - Usually not hyperattenuating on CT (concentrations of cholesterol crystals)
- **Biliary or Hepatic Trauma**
  - May result in bleeding into GB (hemobilia)
  - Clotted blood: Attenuation near 60 HU
- **Milk of Calcium Bile**
  - Fluid-fluid level with dependent fluid of calcific density (> 250 HU)
  - Usually indicates chronic GB disease
- **Biliary-Enteric Fistula or Anastomosis**
  - Allows reflux of enteric CM (and gas) into GB and bile ducts
- **Porcelain Gallbladder (Mimic)**
  - Wall of GB is calcified, but may have milk of calcium bile as well
- **Gallbladder Carcinoma (Mimic)**
  - Mass is usually of "soft tissue" density, but may have foci of calcification or calcified gallstones
- **Hemorrhagic Cholecystitis**
  - Mucosa may slough and bleed

Vicarious Excretion



Axial NECT shows dense opacification of bile within the GB ➡ and opacified ureters ⇨ several hours after an arteriogram.

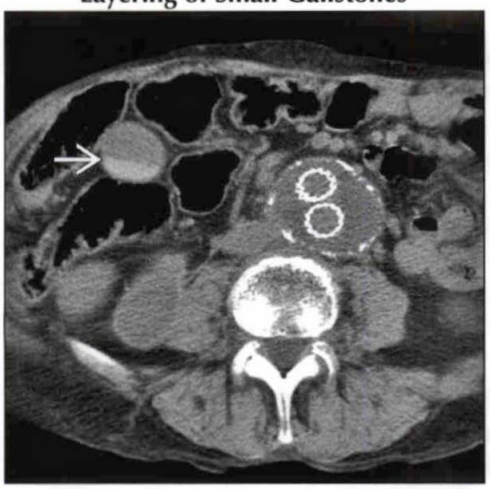
Vicarious Excretion



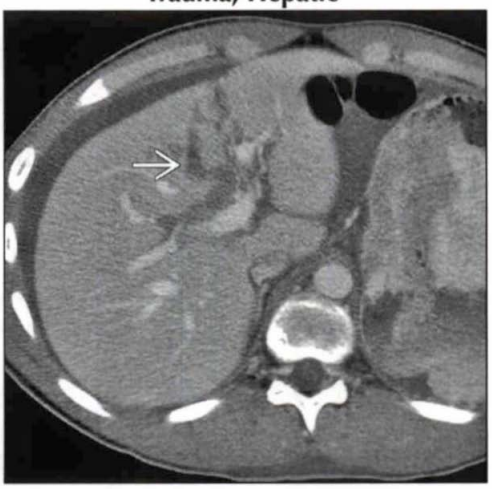
Frontal radiograph shows dense persistent enhancement of the kidneys ➡ and bile within the GB ⇨, following an angiogram that caused or contributed to acute renal failure.

HIGH ATTENUATION (HYPERDENSE) BILE IN GALLBLADDER

Layering of Small Gallstones



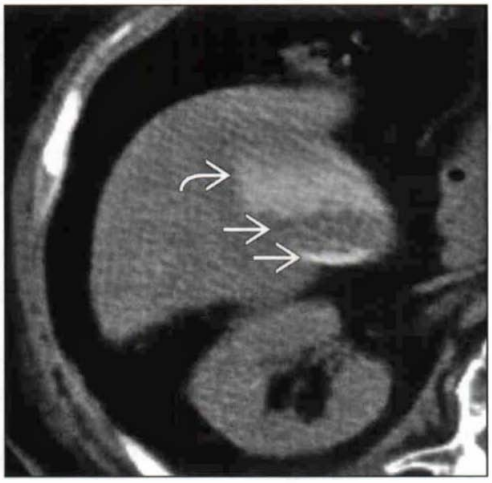
Trauma, Hepatic



(Left) *Axial NECT shows tiny gallstones layering posteriorly within the GB. Milk of calcium bile can have a similar appearance.* ***(Right)*** *Axial CECT shows a deep liver laceration in a patient who also had hemobilia.*

Trauma, Hepatic

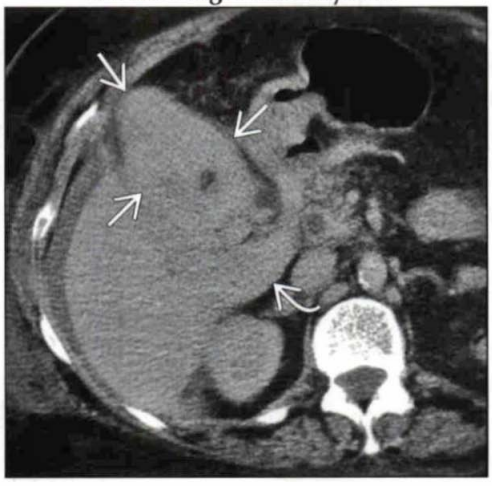
Milk of Calcium Bile



(Left) *Axial CECT shows dense bile layering posteriorly within the GB, representing hemobilia in a patient with a deep liver laceration.* ***(Right)*** *Axial NECT shows multiple layers within the GB, consisting of milk of calcium bile and layers of small stones.*

Porcelain Gallbladder (Mimic)

Hemorrhagic Cholecystitis



(Left) *Axial NECT shows a calcified wall of the GB (porcelain GB) as well as milk of calcium bile and gallstones.* ***(Right)*** *Axial NECT shows a blood-filled GB, as well as blood in the subhepatic space, in a patient with hemorrhagic cholecystitis with perforation.*

RIGHT UPPER QUADRANT PAIN

DIFFERENTIAL DIAGNOSIS

Common

- Cholecystitis
- Hepatitis
- Steatosis (Fatty Liver)
- Choledocholithiasis
- Cholangitis
  - Ascending Cholangitis
  - Primary Sclerosing Cholangitis
  - Recurrent Pyogenic Cholangitis
- Acute Pancreatitis
- Duodenal Ulcer

Less Common

- Acute Colitis
  - Pseudomembranous Colitis
  - Infectious Colitis
  - Ulcerative Colitis
  - Ischemic Colitis
- Appendicitis
- Omental Infarct
- Epiploic Appendagitis
- Hepatic Pyogenic Abscess
- Passive Hepatic Congestion
- Diverticulitis
- Pyelonephritis
- Thoracic Infection or Inflammation
  - Pneumonia Bacterial
  - Empyema
- Cardiac Ischemia
- Any Hepatic Tumor
  - Metastases and Lymphoma, Hepatic
  - Hepatic Cavernous Hemangioma
  - Hepatocellular Carcinoma
  - Hepatic Adenoma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Hepatobiliary causes are most common
  - Cholecystitis > hepatic inflammation, congestion or steatosis > cholangitis

Helpful Clues for Common Diagnoses

- **Cholecystitis**
  - 90-95% of patients with cholecystitis have gallstones
  - Distended gall bladder (GB) with focal tenderness, thick wall
  - Complications include gangrenous and emphysematous cholecystitis, perforation, abscess, fistula to gut
- **Hepatitis**
  - Any cause of hepatitis may cause liver swelling and stretch liver capsule causing pain
    - Alcoholic, viral, toxic
  - Also results in marked GB wall thickening
- **Steatosis (Fatty Liver)**
  - Acute fatty infiltration may stretch liver capsule, cause pain
  - Liver lower in attenuation than spleen on NECT
- **Choledocholithiasis**
  - Stones that obstruct bile duct cause biliary colic
  - Only 50-70% visible on US or CT, close to 100% on MRCP
- **Ascending Cholangitis**
  - Choledocholithiasis or reflux of bowel contents may cause inflammation and infection of biliary tree
    - Bile ducts may be dilated with wall thickening, irregular arborization; intraluminal gas &/or stones
    - Liver may be inflamed, possibly with pyogenic abscess
  - Primary sclerosing and recurrent pyogenic cholangitis may also cause acute RUQ pain
- **Acute Pancreatitis**
  - Pancreas swollen with infiltration of peripancreatic fat planes
  - Inflammation may spread toward gallbladder and right colon; result in RUQ pain
- **Duodenal Ulcer**
  - Especially if penetrating or perforated
    - Look for extraluminal gas or enteric contrast media; thickened wall of duodenum with deformed shape
  - Inflammation may spread to adjacent structures (colon & gallbladder)

Helpful Clues for Less Common Diagnoses

- **Acute Colitis**
  - Any form of acute colitis that affects the ascending colon
  - Pseudomembranous, infectious, ulcerative, ischemic
  - Thick wall with submucosal edema, "thumbprinting"
- **Appendicitis**
  - Tip of appendix may lie in RUQ, cause upper abdominal pain

- Appendiceal wall thick, lumen dilated, periappendiceal infiltration

- **Omental Infarct**
  - Much more common than usually realized
  - > 90% of primary cases of omental infarct affect fat adjacent to ascending colon
  - 3-8 cm diameter mass of inflamed (heterogeneous) fat with capsule, minimal inflammation of colon
- **Epiploic Appendagitis**
  - Less common on right side than in descending and sigmoid colon
  - Smaller (2-4 cm) oval focus of inflamed fat with hyperdense rim
- **Hepatic Pyogenic Abscess**
  - Any acute inflammation or infection of liver can cause RUQ pain
  - Multiseptated or cluster of hypodense lesions; associated right lower lobe pulmonary infiltrate & pleural effusion (due to irritation of diaphragm)
- **Passive Hepatic Congestion**
  - Swelling of liver may stretch capsule, cause pain and tenderness
  - Distended hepatic veins & IVC, with retrograde opacification on arterial phase imaging
  - Liver swollen with "mosaic" pattern of heterogeneous enhancement
- **Diverticulitis**
  - Affecting right side of colon or redundant sigmoid that extends into right side of abdomen
  - Gas or fluid-filled diverticula with colonic wall thickening & pericolonic infiltration
- **Pyelonephritis**
  - Of right kidney
  - Striated or wedge-shaped foci of decreased enhancement on CECT; renal enlargement; perirenal infiltration
- **Thoracic Infection or Inflammation**
  - Consider pneumonia, pulmonary infarct, empyema, myocardial infarct, pericarditis
  - All may present as acute abdominal pain & should not be ignored in radiology report
- **Any Hepatic Tumor**
  - Especially HCC and hepatic adenoma, which are prone to spontaneous bleeding or rupture through the liver capsule
  - Any tumor that is large or exophytic, stretching the hepatic capsule, is likely to cause pain

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2. Hanbidge AE et al: From the RSNA refresher courses: imaging evaluation for acute pain in the right upper quadrant. Radiographics. 24(4):1117-35, 2004
3. Mortele KJ et al: The infected liver: radiologic-pathologic correlation. Radiographics. 24(4):937-55, 2004
4. Rubens DJ: Hepatobiliary imaging and its pitfalls. Radiol Clin North Am. 42(2):257-78, 2004
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Cholecystitis

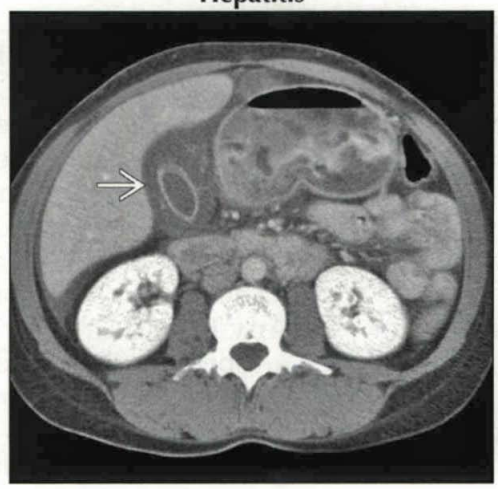
Sagittal ultrasound shows a thick-walled GB (cursors) that was tender to palpation and contains an echogenic stone ➡ with acoustic shadowing ➡.

Cholecystitis

Axial CECT shows a thick-walled, distended GB ➡ with inflammatory thickening of the adjacent wall of the ascending colon ➡. Acalculous cholecystitis.

RIGHT UPPER QUADRANT PAIN

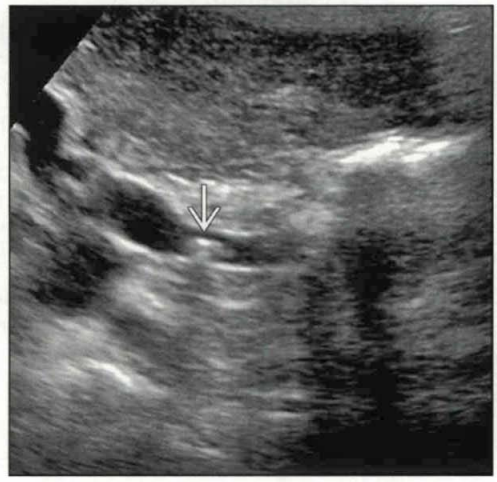
Hepatitis



*(**Left**) Axial CECT shows marked thickening of the GB wall ➡ and ascites in this patient with acute viral hepatitis, who presented with symptoms of acute right upper quadrant pain. (**Right**) Axial CECT shows heterogeneous low attenuation throughout the liver in this patient with steatosis.*

Steatosis (Fatty Liver)

Choledocholithiasis



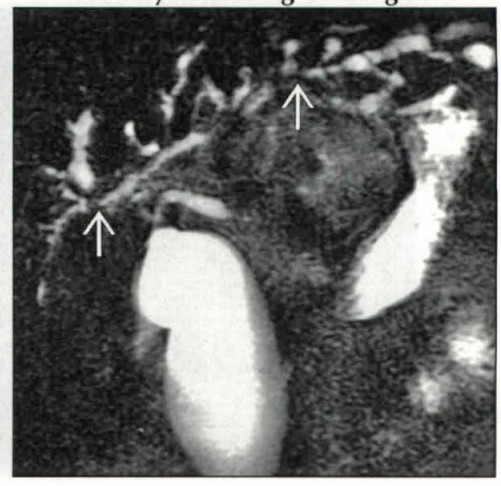
*(**Left**) Axial oblique transabdominal ultrasound shows an echogenic, shadowing stone ➡ within the dilated common bile duct. (**Right**) Axial CECT shows pneumobilia ➡ and hepatic abscesses ➡ in this patient with ascending cholangitis following a Whipple procedure (pancreatic & duodenal resection).*

Ascending Cholangitis

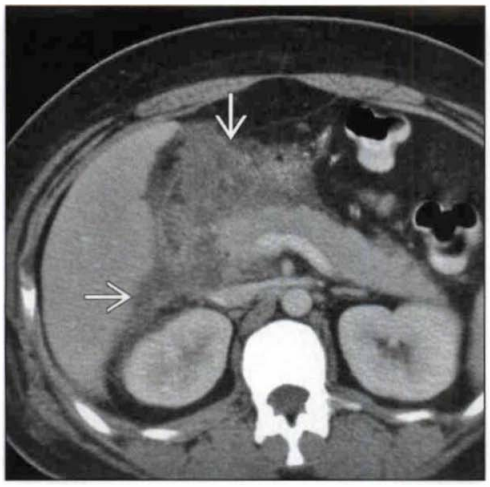
Primary Sclerosing Cholangitis

*(**Left**) Axial CECT shows irregular arborization and dilation of the intrahepatic bile ducts ➡, and hepatomegaly, in a 22 year-old man with acute right upper quadrant pain. (**Right**) Coronal oblique MRCP shows irregular arborization and alternating dilation & strictures of the intrahepatic ducts ➡ in this 22 year old man presenting with acute right upper quadrant pain and abnormal liver function.*

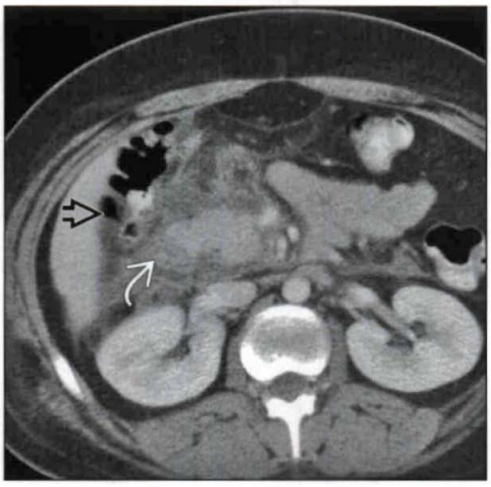
Primary Sclerosing Cholangitis



Acute Pancreatitis

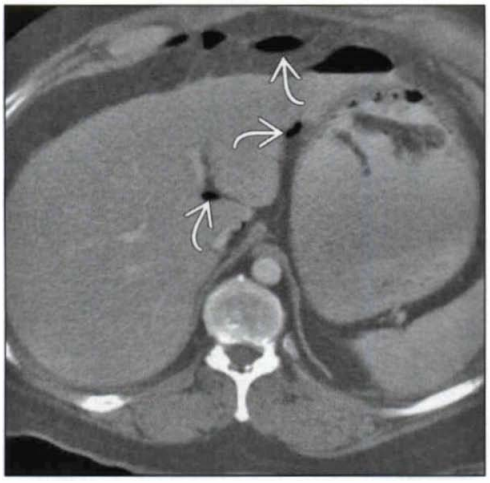


Acute Pancreatitis

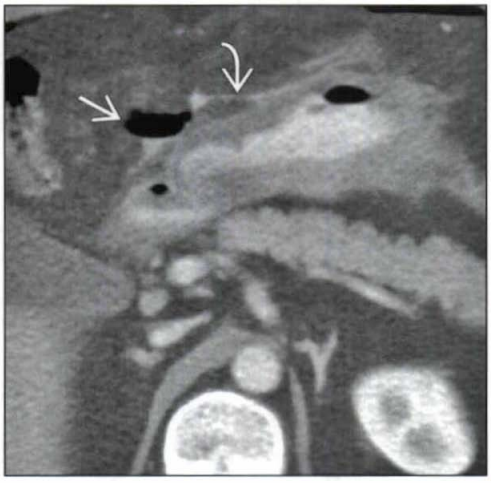


(Left) Axial CECT shows extensive infiltration of the fat planes in the right upper quadrant in a patient with acute pancreatitis. The inflammation spread to the ascending colon as well. (Right) Axial CECT shows extensive infiltration of fat planes in the right upper quadrant, starting in the pancreatic head and extending to the duodenum and colon.

Duodenal Ulcer

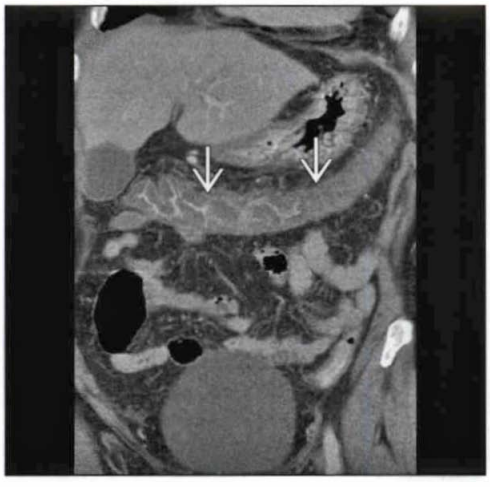


Duodenal Ulcer

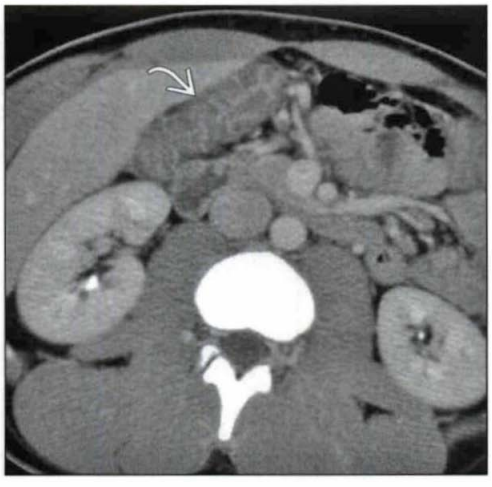


(Left) Axial CECT shows extraluminal gas under the diaphragm and in the porta hepatis from a perforated duodenal ulcer in a 42 year old man. (Right) Axial CECT shows extraluminal gas and enteric contrast media just ventral to the duodenal bulb and antrum. Perforated duodenal ulcer in a 42 year old man.

Pseudomembranous Colitis



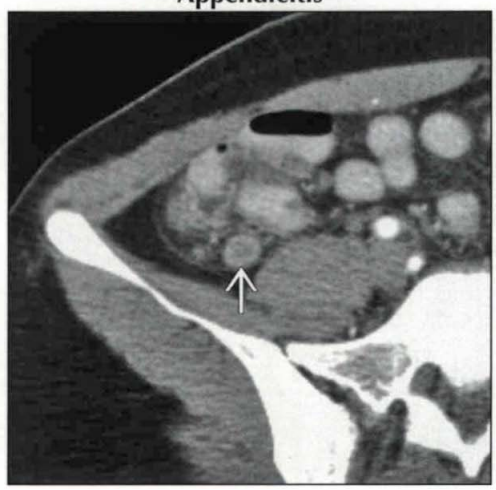
Infectious Colitis



(Left) Coronal CECT shows marked thickening of the colonic wall, including the hepatic flexure and transverse colon. (Right) Axial CECT shows right side colitis with mural edema and mucosal enhancement; 19 year old boy with Campylobacter colitis.

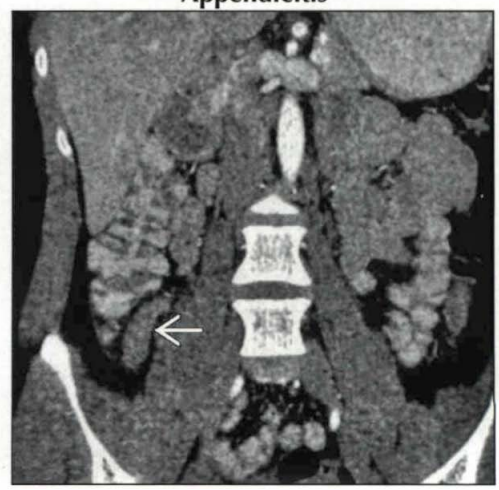
RIGHT UPPER QUADRANT PAIN

Appendicitis

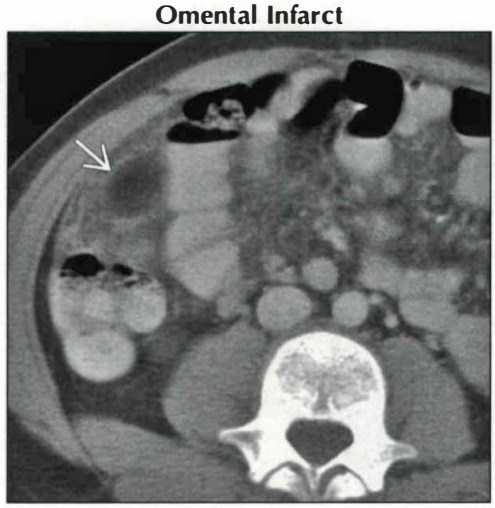


(Left) Axial CECT shows a thick-walled retrocecal appendix ➡ with adjacent inflammatory changes and lymphadenopathy. (Right) Coronal CECT shows a thick-walled retrocecal appendix ➡, its tip medial to the ascending colon.

Appendicitis

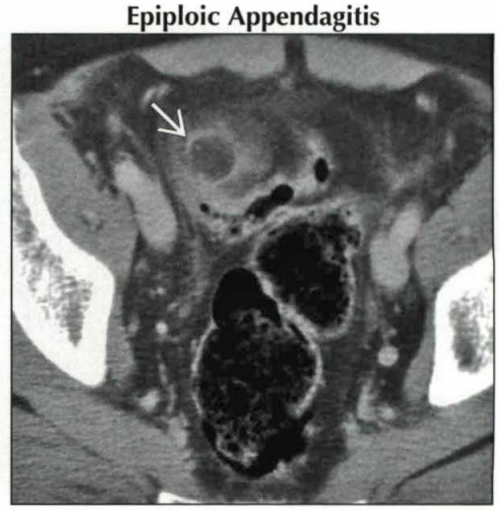


Omental Infarct

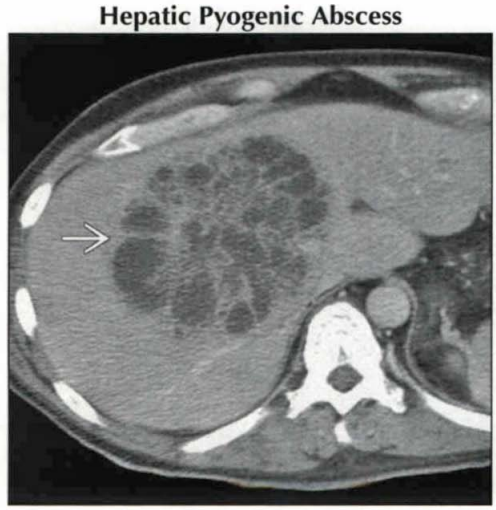


(Left) Axial CECT shows an oval, encapsulated fat density mass ➡ lateral to the ascending colon with adjacent inflammatory changes. (Right) Axial CECT shows a small oval fat density mass ➡ with a thin capsule and adjacent inflammatory infiltration, arising from the sigmoid colon.

Epiploic Appendagitis

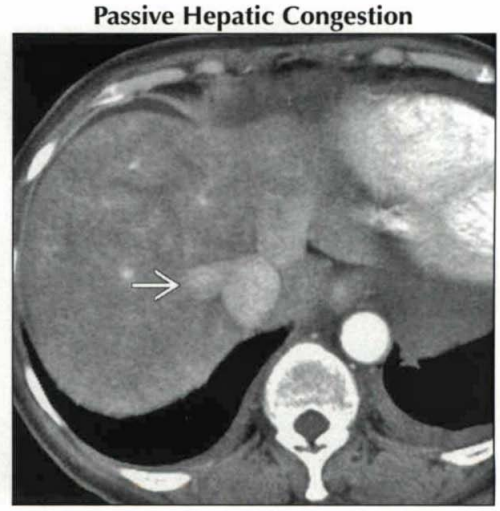


Hepatic Pyogenic Abscess

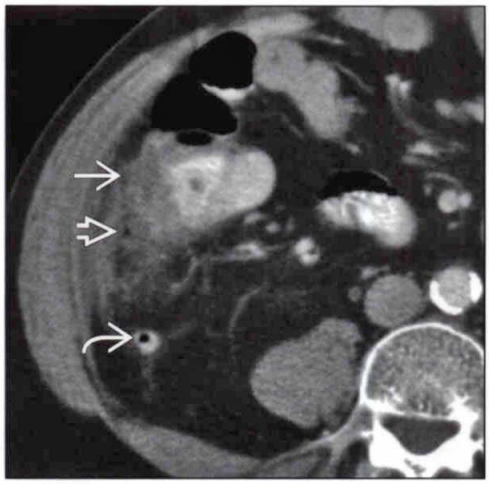


(Left) Axial CECT shows a large multiseptate hepatic mass ➡ in a patient with fever and acute RUQ pain. The etiology of the abscess was untreated diverticulitis. (Right) Axial CECT shows mottled enhancement of the liver and reflux of contrast into dilated hepatic veins ➡ on this late arterial phase CECT. Passive hepatic congestion in a 56 year old man with a recent myocardial infarction.

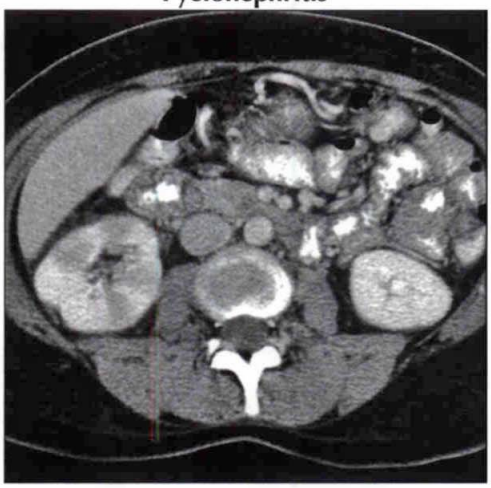
Passive Hepatic Congestion



Diverticulitis



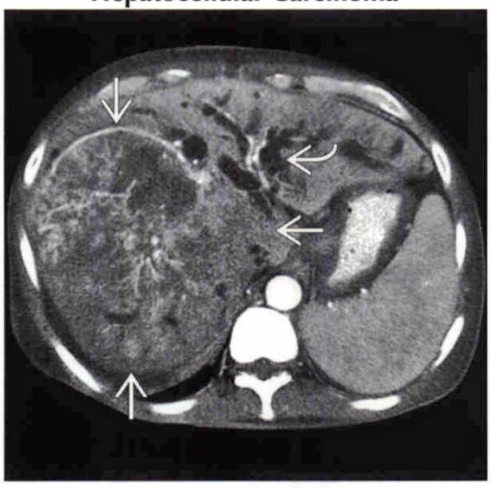
Pyelonephritis



(Left) Axial CECT shows mural thickening and extensive adjacent inflammatory changes around the ascending colon, with a small bubble of gas. Note the normal appendix. "Cecal" diverticulitis. (Right) Axial CECT shows wedge-shaped zones of decreased enhancement within the right kidney which is swollen relative to the normal left kidney. There is minimal right perirenal fat infiltration as well.

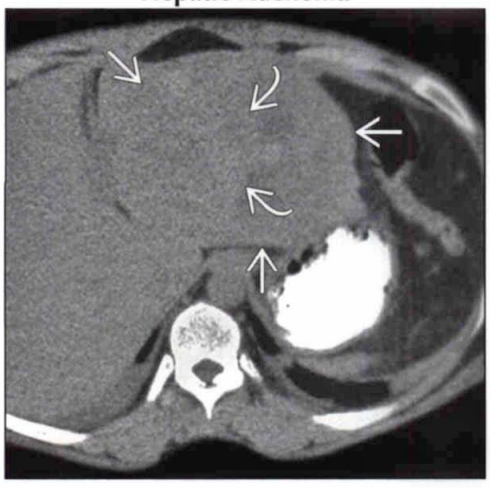
Hepatic Cavernous Hemangioma

Hepatocellular Carcinoma



(Left) Axial CECT shows a large cavernous hemangioma that caused chronic and acute right upper quadrant pain as the patient's presenting complaint. (Right) Axial CECT shows a large hypervascular hepatic tumor that obstructs the intrahepatic bile ducts. Arterial phase CECT.

Hepatic Adenoma



Hepatic Adenoma

(Left) Axial NECT shows a large mass that fills most of the lateral segment. Within the mass are high density foci representing spontaneous hemorrhage. (Right) Axial CECT shows that the large mass is heterogeneous on this portal venous phase image, due to the presence of hemorrhage and necrosis.

SECTION 11
Biliary Tract

Generic Imaging Patterns

Dilated Common Bile Duct 11-2
Asymmetric Dilation of Intrahepatic Bile Ducts 11-8
Biliary Strictures, Multiple 11-10

Modality-Specific Imaging Findings

Hypointense Lesion in Biliary Tree (MRCP) 11-12

DILATED COMMON BILE DUCT

DIFFERENTIAL DIAGNOSIS

Common
- Choledocholithiasis
- Post-Cholecystectomy Dilated CBD
- Senescent Change, CBD
- Pancreatic Ductal Carcinoma
- Chronic Pancreatitis

Less Common
- Other Pancreatic Neoplasms
  - Cholangiocarcinoma
  - Ampullary Tumor
  - Pancreatic Islet Cell Tumor
  - Mucinous Cystic Pancreatic Tumor
  - Serous Cystadenoma, Pancreas
  - Pancreatic Metastases and Lymphoma
- Gallbladder Carcinoma
- Primary Sclerosing Cholangitis
- Pancreatic Pseudocyst
- Infectious Cholangitis
  - AIDS Cholangiopathy
  - Pancreato-Biliary Parasites
  - Recurrent Pyogenic Cholangitis
  - Hydatid Disease
- Biliary Trauma
- Small Bowel Obstruction
- Choledochal Cyst

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Ask whether patient has abnormal liver function
- Ask whether patient has painless or painful jaundice
  - Painful: Choledocholithiases, hemobilia, infectious cholangitis, pancreatitis
  - Painless: Malignant obstruction, choledochal cyst, primary sclerosing cholangitis (PSC)

Helpful Clues for Common Diagnoses
- **Choledocholithiasis**
  - Gallstones: Any attenuation (CT), but almost all are echogenic (US) and are signal voids (MR)
  - Most have stones in GB
- **Senescent & Post-Operative Dilation**
  - Common duct seems to increase in diameter with advanced age & following cholecystectomy
    - Especially if CBD was dilated previously due to ductal stone
  - Correlate with symptoms & labs (e.g., elevated serum bilirubin)
- **Pancreatic Ductal Carcinoma**
  - Most common cause of painless jaundice
  - Look for abrupt narrowing of common duct as it enters a hypovascular mass in the pancreatic head
  - Pancreatic duct is also usually obstructed (double duct sign)
  - Most have invasion of adjacent blood vessels
- **Chronic Pancreatitis**
  - Look for gradual tapered narrowing of CBD as it traverses head of pancreas
  - Fibrotic mass, calcifications, beaded pancreatic duct
  - Often causes stricture of distal CBD, requiring biliary stent or surgery

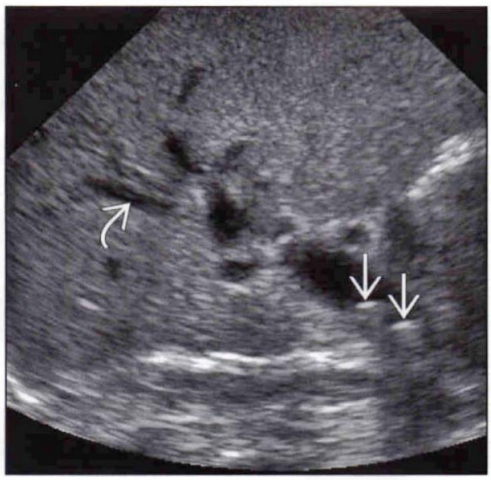
Helpful Clues for Less Common Diagnoses
- **Other Pancreatic Neoplasms**
  - **Cholangiocarcinoma**
    - Arising from CBD
    - Abrupt narrowing of CBD; small mass
    - Pancreatic duct is usually not affected
  - **Ampullary Tumor**
    - Benign or malignant
    - Abrupt narrowing of CBD and pancreatic duct with a small mass that protrudes into duodenal lumen at ampulla of Vater
  - **Pancreatic Islet Cell Tumor**
    - Uncommon cause of obstruction unless large & arising in pancreatic head
    - Look for hypervascular mass, small if "functional", large if "nonfunctional"
  - **Mucinous Cystic Pancreatic Tumor**
    - Most are in body-tail segment
    - Those in head may obstruct CBD
    - Look for encapsulated mass with nonenhancing fluid contents
  - **Serous Cystadenoma, Pancreas**
    - Often arise in head, but uncommonly obstruct CBD, in spite of large size
    - Look for encapsulated mass with appearance of a "sponge" or "honeycomb"
  - **Pancreatic Metastases and Lymphoma**
    - To pancreatic head, nodes, or CBD
    - May simulate primary pancreatic ductal carcinoma or cholangiocarcinoma

    - Correlate with history of other tumors
    - Lymphoma usually does not obstruct ducts because it is a soft tumor
- **Gallbladder Carcinoma**
  - May invade CBD directly or obstruct it due to nodal metastases
- **Primary Sclerosing Cholangitis**
  - Usually causes more impressive strictures than dilation
  - Prominent dilation of CBD or intrahepatic ducts should raise concern for superimposed cholangiocarcinoma
    - Need brush biopsy of biliary mucosa for diagnosis
- **Pancreatic Pseudocyst**
  - One arising in pancreatic head may compress CBD from outside
  - Ductal obstruction in this setting is often not cured by draining pseudocyst
- **Infectious Cholangitis**
  - **AIDS Cholangiopathy:** Can mimic PSC and/or papillary stenosis of distal CBD
  - **Recurrent Pyogenic Cholangitis:** Massive dilation of ducts usually with pneumobilia and large stones
    - Endemic in poor socioeconomic populations in Asia
  - **Hydatid Disease:** Cysts can rupture into ducts, lead to cholangitis & obstruction
- **Biliary Trauma**
  - Common duct may be injured in blunt or penetrating trauma
    - Hemobilia may obstruct CBD
  - Most common injury is iatrogenic, usually during cholecystectomy or biliary surgery
  - Duct may be transected, strictured, ligated
  - Look for sudden transition from dilated to collapsed duct, without mass
- **Small Bowel Obstruction**
  - If duodenum or Roux loop is obstructed, the increased intraluminal pressure may impair biliary drainage
- **Choledochal Cyst**
  - Cylindrical dilation of CBD as isolated abnormality (type I) or with dilation of intrahepatic ducts (type IV)

Alternative Differential Approaches

- Patient with inflammatory bowel disease
  - Primary sclerosing cholangitis
  - Cholangiocarcinoma
  - Hepatocellular carcinoma
- Trauma patient (blunt & iatrogenic)
  - Transected, strictured or ligated duct
  - Consider hemobilia as cause of obstruction
- Known or suspected tumor
  - Pancreatic ductal carcinoma
  - Cholangiocarcinoma
  - Ampullary carcinoma
  - Gallbladder carcinoma
  - Metastases and lymphoma
    - To pancreas, nodes or common duct
- Patients from sheep-raising populations
  - Consider hydatid disease
- Patients from endemic areas of Asia
  - Recurrent pyogenic cholangitis
  - Biliary parasites

Choledocholithiasis



Transverse transabdominal ultrasound shows dilated intrahepatic ducts with echogenic stones in a dependent position within the CBD.

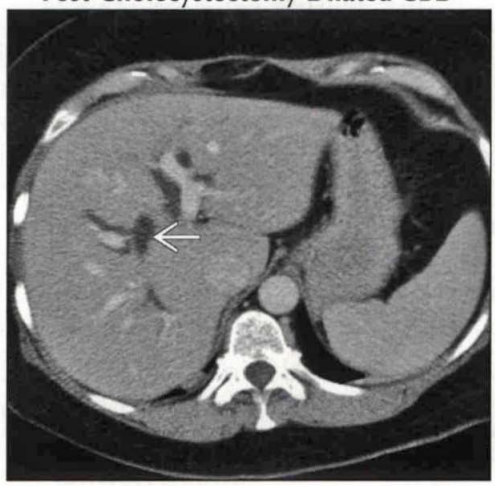
Choledocholithiasis

Axial oblique transabdominal ultrasound shows an echogenic stone with acoustic shadow, causing obstruction of the common duct.

DILATED COMMON BILE DUCT

(Left) Axial CECT shows dilation of the intrahepatic bile ducts in an elderly woman with a prior cholecystectomy, but no symptoms or signs of biliary obstruction. (Right) Axial CECT shows dilation of the common duct in the same patient. Again, there are neither signs nor symptoms of biliary obstruction.

Post-Cholecystectomy Dilated CBD



Post-Cholecystectomy Dilated CBD

(Left) Axial CECT shows dilation of the intrahepatic & common ducts, along with porta hepatis lymphadenopathy. (Right) Axial CECT shows a hypodense mass in the pancreatic head that caused the obstruction of the common duct. and the gallbladder: 58 year old man with painless jaundice.

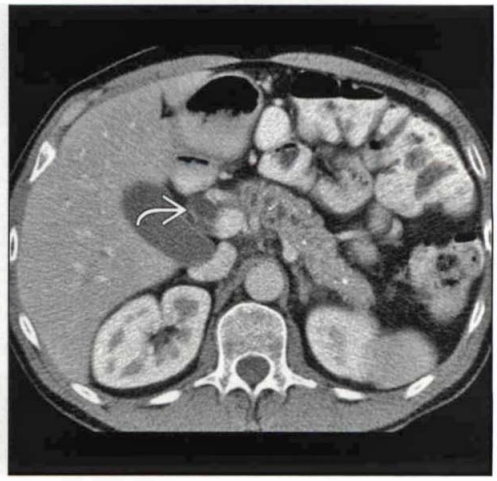
Pancreatic Ductal Carcinoma

Pancreatic Ductal Carcinoma

(Left) Coronal MRCP shows a tapered stricture of the intrapancreatic portion of the common duct, due to chronic pancreatitis. (Right) Axial CECT shows a dilated CBD and pancreatic duct, with multiple calcifications in the pancreatic parenchyma.

Chronic Pancreatitis

Chronic Pancreatitis



DILATED COMMON BILE DUCT

Ampullary Tumor

Ampullary Tumor

(Left) *Axial CECT shows dilation of the gallbladder & CBD, just proximal to the ampulla of Vater. Note fluid-filled duodenum in this 85 year old man with painless jaundice.* ***(Right)*** *Axial CECT shows the small mass at the ampulla that bulges into the duodenal lumen of the same 85 year old man.*

Mucinous Cystic Pancreatic Tumor

Serous Cystadenoma, Pancreas

(Left) *Axial CECT shows an encapsulated cystic mass in the pancreatic head that obstructs the pancreatic and biliary ducts; note stent in CBD. The location of the mass and the degree of ductal obstruction are unusual for a mucinous cystic neoplasm.* ***(Right)*** *Axial CECT shows a sponge-like mass in the pancreatic head that caused vague upper abdominal discomfort but no jaundice in this 73 year old man. Note foci of calcification in septa.*

Pancreatic Metastases and Lymphoma

Pancreatic Metastases and Lymphoma

(Left) *Axial CECT shows dilated intrahepatic ducts due to metastasis to the pancreatic head from renal cell carcinoma in an elderly woman.* ***(Right)*** *Axial CECT shows a hypervascular mass in the head of the pancreas that caused ductal obstruction in this elderly woman. Note the surgical clips from nephrectomy (many years prior). The mass is a metastasis, though it simulates a primary islet cell tumor.*

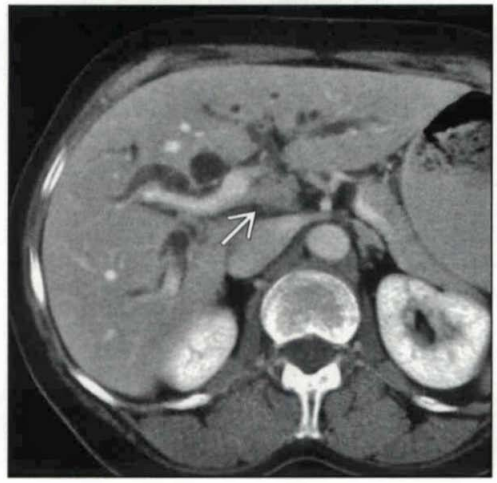
DILATED COMMON BILE DUCT

Pancreatic Metastases and Lymphoma

(Left) Coronal MRCP shows massive dilation of the bile ducts with abrupt obstruction of the extrahepatic duct, due to metastases to the pancreas & common duct. (Right) Percutaneous cholangiography shows massive dilation of the intrahepatic ducts with abrupt obstruction near the confluence, mimicking a Klatskin cholangiocarcinoma. This was due to carcinoma of the gallbladder neck invading the common duct.

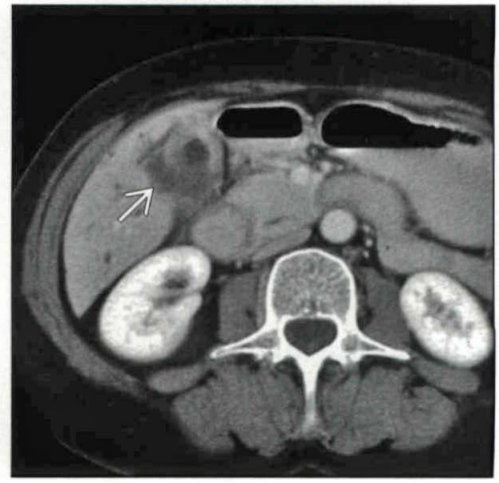
Gallbladder Carcinoma

Gallbladder Carcinoma

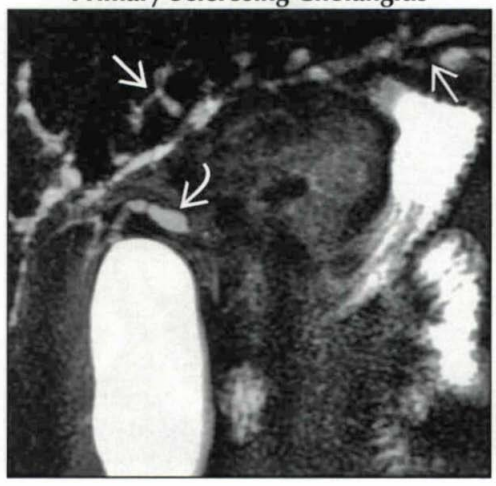


(Left) Axial CECT shows marked dilation of bile ducts due to a gallbladder carcinoma that invaded the common hepatic duct; ➡ 67 year old woman. (Right) Axial CECT shows the irregular mass arising from the gallbladder ➡ that invades the adjacent liver and common duct of the same patient.

Gallbladder Carcinoma



Primary Sclerosing Cholangitis

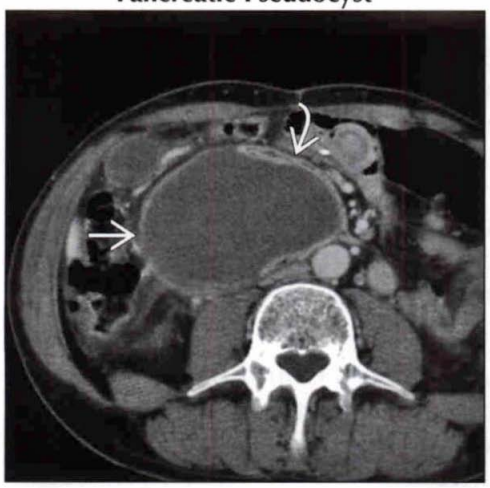


(Left) Coronal MRCP shows a beaded appearance of the intrahepatic ducts ➡ with alternating strictures and dilated segments. The proximal CBD ➡ is mildly dilated while the distal duct is strictured; 22 year old man. (Right) Axial CECT shows dilation and irregular arborization (branching pattern) of the intrahepatic ducts ➡; 22 year old man.

Primary Sclerosing Cholangitis

DILATED COMMON BILE DUCT

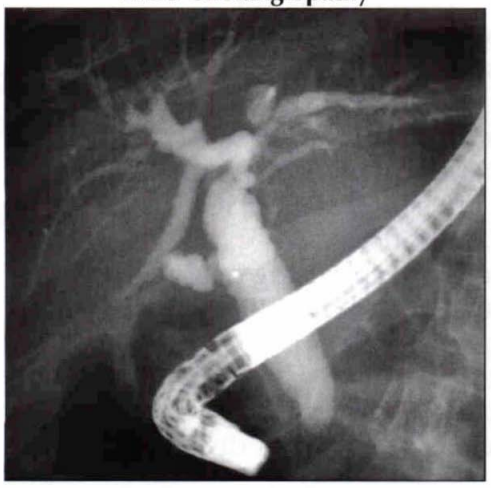
Pancreatic Pseudocyst



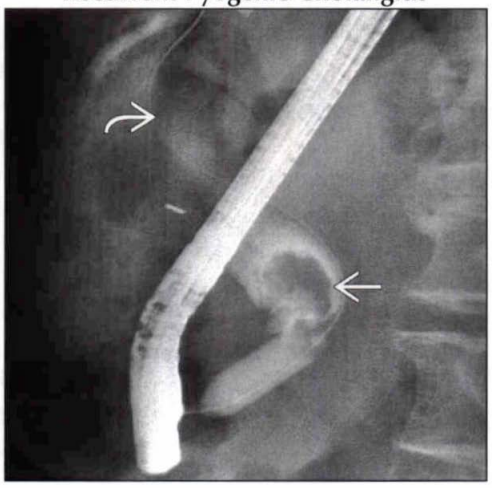
Pancreatic Pseudocyst

(Left) *Axial CECT shows a large pseudocyst ➡ that distorts the duodenum ➡ and obstructs the common bile duct. The cyst subsequently ruptured into the duodenum with relief of duodenal & biliary obstruction; 47 year old man.* ***(Right)*** *Axial CECT shows gas within dilated bile ducts, due to spontaneous rupture of a pseudocyst into the duodenum, causing a fistula from the ducts to the pseudocyst & duodenum; 47 year old man.*

AIDS Cholangiopathy

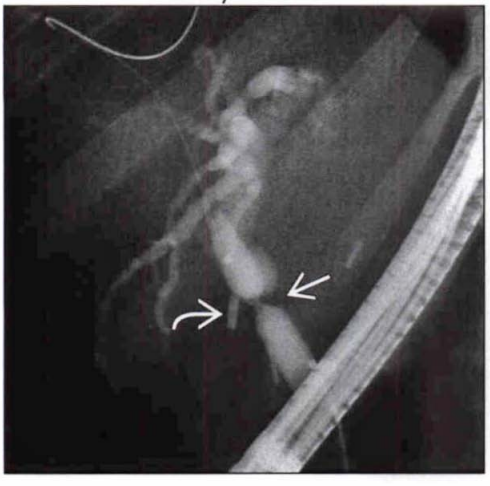


Recurrent Pyogenic Cholangitis



(Left) *Frontal ERCP shows irregular dilation of intrahepatic ducts and a dilated CBD due to a distal stricture.* ***(Right)*** *ERCP shows gross dilation of the common duct with pus and stones as filling defects ➡. There is also a large amount of gas ➡ within the ducts.*

Biliary Trauma



Choledochal Cyst

(Left) *ERCP shows a tight stricture ➡ of the common duct due to injury from a laparoscopic cholecystectomy. Note surgical clips ➡ near the stricture.* ***(Right)*** *Coronal MRCP shows fusiform dilation of the common duct and moderate dilation of the intrahepatic ducts near their confluence; type IV A choledochal cyst.*

ASYMMETRIC DILATION OF INTRAHEPATIC BILE DUCTS

DIFFERENTIAL DIAGNOSIS

Common
- Primary Sclerosing Cholangitis
- Cholangiocarcinoma
- Cholangitis, Ascending
- Hepatocellular Carcinoma
- Hepatic Metastases and Lymphoma
- AIDS Cholangiopathy

Less Common
- Cholangitis, Recurrent Pyogenic
- Pancreato-Biliary Parasites
- Chemotherapy Cholangitis
- Hepatic Hydatid Cyst
- IPMT, Biliary

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Dilation is usually due to some form of cholangitis or an obstruction by a hepatic mass

Helpful Clues for Common Diagnoses
- **Primary Sclerosing Cholangitis**
  - Usually associated with ulcerative colitis or Crohn disease
  - Irregular strictures, wall thickening, focal dilations of intrahepatic and extrahepatic bile ducts
- **Cholangiocarcinoma**
  - Klatskin or peripheral cholangiocarcinoma may cause asymmetric dilation of ducts upstream from tumor
- **Cholangitis, Ascending**
  - Bile duct stones or reflux of bowel contents (e.g., biliary-enteric anastomosis)
  - Results in strictures and dilation of intrahepatic ducts
- **Liver Tumors**
  - HCC, metastases, lymphoma may invade and obstruct intrahepatic ducts
  - Even large benign masses may displace and dilate ducts
- **AIDS Cholangiopathy**
  - Appearance like PSC or CBD stricture, but due to opportunistic infection

Helpful Clues for Less Common Diagnoses
- **Cholangitis, Recurrent Pyogenic**
  - Impoverished Asian patients and immigrants
  - Often results in marked dilation of bile ducts, filled with stones, pus, gas
- **Pancreato-Biliary Parasites**
  - Common in impoverished patients in Asia, Indian subcontinent
  - Clonorchis, ascaris
- **Chemotherapy Cholangitis**
  - Intra-arterial chemotherapy to liver can damage ducts; simulates PSC
- **Hepatic Hydatid Cyst**
  - Endemic in sheep-raising countries
  - Cyst may rupture into biliary tree, resulting in cholangitis
- **IPMT, Biliary**
  - Analogous to IPMT, pancreas
  - Mass secretes mucus that distends ducts

Primary Sclerosing Cholangitis

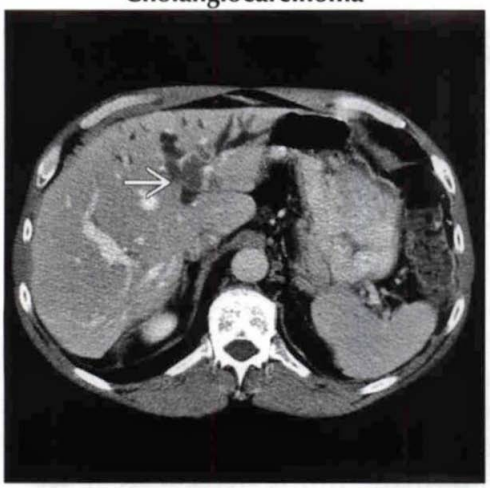
Axial T2WI FS MR shows irregular branching pattern of dilated intrahepatic ducts ➡ and periportal edema or fibrosis, seen as less hyperintense foci ➡ surrounding the ducts.

Primary Sclerosing Cholangitis

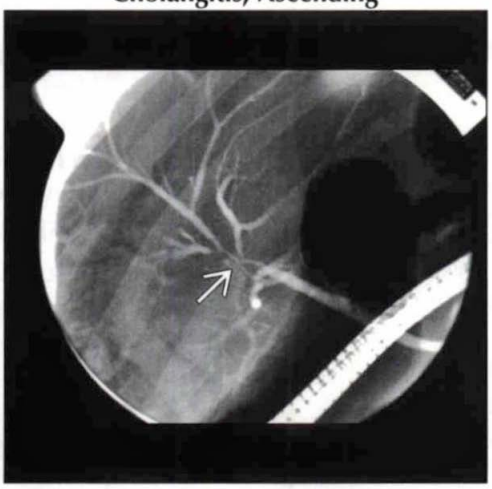
Coronal T2WI MR shows irregular and asymmetric dilation of intrahepatic ducts ➡ without a mass; typical findings of PSC.

ASYMMETRIC DILATION OF INTRAHEPATIC BILE DUCTS

Cholangiocarcinoma

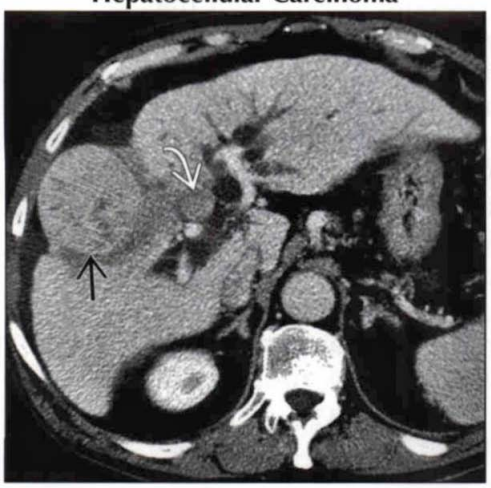


Cholangitis, Ascending

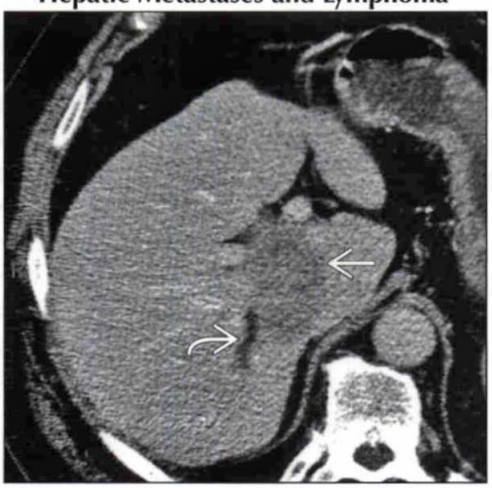


(Left) *Axial CECT shows asymmetric dilation of the left intrahepatic ducts with tumor in and around the ducts; peripheral cholangiocarcinoma.* ***(Right)*** *Anteroposterior ERCP shows a stricture at the confluence of the left and right hepatic ducts, an unusual finding for ascending cholangitis. This resolved with IV antibiotic therapy.*

Hepatocellular Carcinoma



Hepatic Metastases and Lymphoma



(Left) *Axial CECT shows a focal hepatic mass that has invaded the bile ducts, with an intraductal mass noted.* ***(Right)*** *Axial CECT shows a hypodense mass that causes obstruction of the right posterior hepatic duct; metastatic pancreatic carcinoma.*

AIDS Cholangiopathy

Cholangitis, Recurrent Pyogenic

(Left) *Coronal MRCP shows irregular arborization of the intrahepatic bile ducts and a stricture of the distal CBD; typical findings of AIDS cholangiopathy.* ***(Right)*** *Axial CECT shows gross dilation of the intrahepatic ducts, especially the left lobe ducts, with pneumobilia.*

BILIARY STRICTURES, MULTIPLE

DIFFERENTIAL DIAGNOSIS

Common
- Primary Sclerosing Cholangitis
- Cholangitis, Ascending
- AIDS Cholangiopathy
- Post-Transplant Liver
- Cirrhosis (Mimic)

Less Common
- Cholangiocarcinoma
- Cholangitis, Recurrent Pyogenic
- Congenital Hepatic Fibrosis
- Caroli Disease
- Chemotherapy Cholangitis
- Hepatic Metastases (Mimic)
- Pancreato-Biliary Parasites

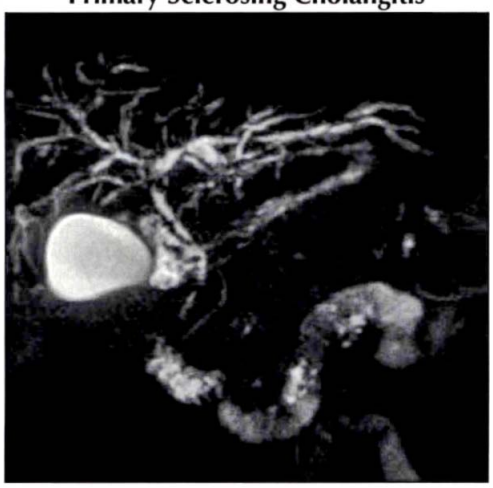
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Correlation with clinical history is essential (cholangitis, transplant, cancer)

Helpful Clues for Common Diagnoses
- **Primary Sclerosing Cholangitis**
  - Causes irregular strictures, alternating with focal dilation
  - Affects intra- and extrahepatic bile ducts
  - Associated with inflammatory bowel disease
- **Cholangitis, Ascending**
  - Strictures, mural thickening, ± gas in ducts
  - Associated with bile duct stones, biliary-enteric anastomoses
- **AIDS Cholangiopathy**
  - Due to viral or protozoan infestation
  - Biliary strictures (intrahepatic and/or extrahepatic), plus GB wall thickening
- **Post-Transplant Liver**
  - Strictures may be due to rejection, ischemia, infection
- **Cirrhosis (Mimic)**
  - Regenerating nodules, fibrosis distort and displace ducts

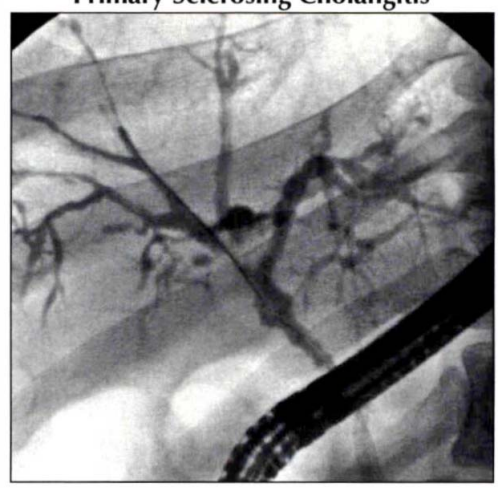
Helpful Clues for Less Common Diagnoses
- **Cholangiocarcinoma**
  - May narrow or obstruct bile ducts
  - When superimposed on PSC, hard to diagnose
- **Cholangitis, Recurrent Pyogenic**
  - Duct dilation and filling defects are more prominent than biliary strictures
- **Congenital Hepatic Fibrosis**
  - Larger ducts not affected but may be displaced by distorted liver
- **Caroli Disease**
  - Irregular bile ducts with cystic or saccular dilations of hepatic ducts
- **Chemotherapy Cholangitis**
  - Results from hepatic arterial chemotherapy
- **Hepatic Metastases (Mimic)**
  - Masses may distort and displace bile ducts, simulate strictures
- **Pancreato-Biliary Parasites**
  - May cause strictures and/or dilation

Primary Sclerosing Cholangitis



Coronal MRCP shows irregular arborization of the intrahepatic ducts with a beaded appearance of some segments. Portions of the left hepatic ducts are more dilated than the common duct.

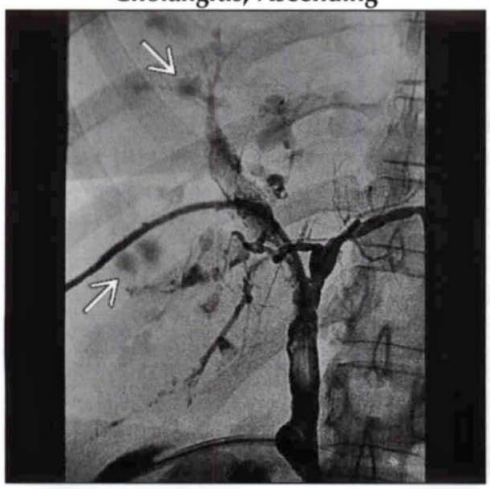
Primary Sclerosing Cholangitis



Anteroposterior ERCP shows irregular arborization of the intrahepatic ducts with a beaded appearance of the left hepatic and common bile ducts.

BILIARY STRICTURES, MULTIPLE

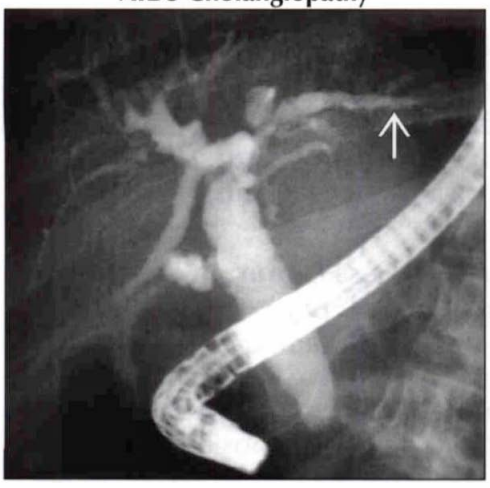
Cholangitis, Ascending



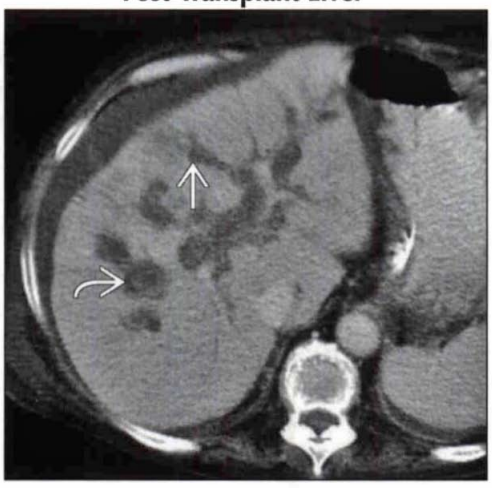
Cholangitis, Ascending

(Left) *Anteroposterior transhepatic cholangiography shows markedly irregular contour and arborization of the intrahepatic ducts and partial filling of abscess cavities.* ***(Right)*** *Axial CECT shows multiple hepatic abscesses with contrast-opacified walls. The abscesses were in communication with pus-filled ducts from ascending cholangitis.*

AIDS Cholangiopathy

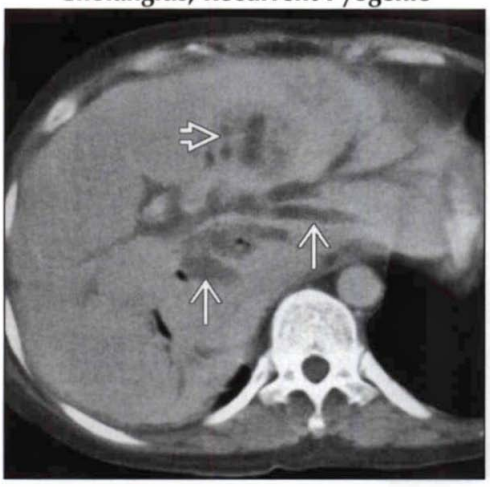


Post-Transplant Liver

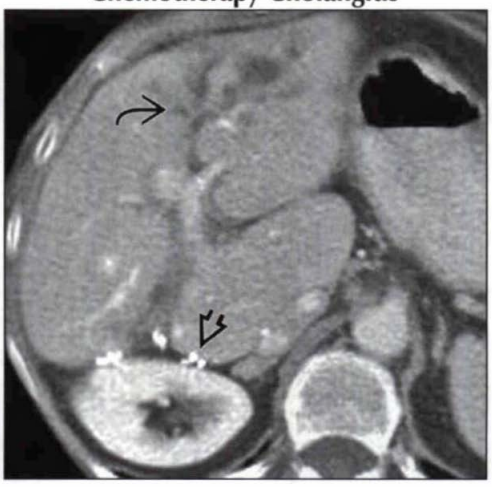


(Left) *Frontal ERCP shows abnormal arborization of intrahepatic ducts that terminate abruptly. The common duct is dilated due to a stricture of the distal CBD.* ***(Right)*** *Axial CECT shows dilated intrahepatic ducts with indistinct walls due to biliary necrosis caused by hepatic artery thrombosis. Intrahepatic bilomas and ascites also noted.*

Cholangitis, Recurrent Pyogenic



Chemotherapy Cholangitis



(Left) *Axial CECT shows irregular dilation of intrahepatic ducts and adjacent hepatic abscesses.* ***(Right)*** *Axial CECT shows surgical clips from right hepatic lobectomy (for metastases). Irregular dilation of intrahepatic ducts is result of hepatic intra-arterial chemotherapy.*

HYPOINTENSE LESION IN BILIARY TREE (MRCP)

DIFFERENTIAL DIAGNOSIS

Common

- Choledocholithiasis
- Pneumobilia
- Surgical Clip (Mimic)
- Contraction of Sphincter of Oddi (Mimic)
- Respiratory Motion Artifact (Mimic)
- Hemobilia
- Portal Vein Gas (Mimic)
- Incomplete Imaging Planes (Mimic)
- Gas in Stomach or Duodenum (Mimic)
- Flow Artifact (Mimic)
- Pulsatile Vascular Compression (Mimic)
- Cystic Duct Insertion (Mimic)

Less Common

- Transplantation, Hepatic
  - Biliary Stricture
  - Sloughed Mucosa & Debris

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Attention to MR technique and knowledge of pitfalls are essential to avoid errors
- Examine axial source images in addition to thin and thick slab MIP images

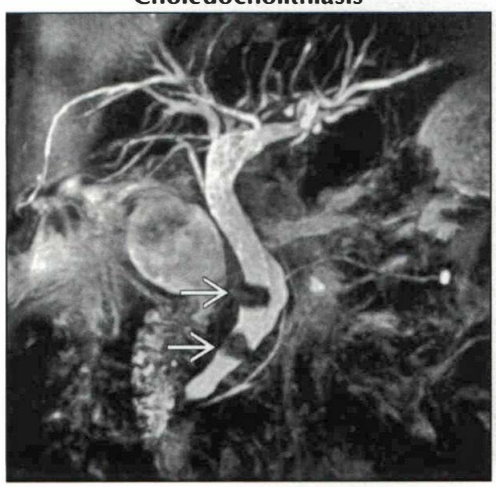
Helpful Clues for Common Diagnoses

- **Choledocholithiasis**
  - Most common etiology of hypointense (signal void) intraductal lesions on MRCP
  - Discrete, often multiple, present at all planes of section
- **Pneumobilia**
  - Gas bubbles float ventrally with air-fluid levels on axial plane images
- **Surgical Clip (Mimic)**
  - Signal void and susceptibility artifact may mimic or obscure biliary stone
- **Contraction of Sphincter of Oddi (Mimic)**
  - May mimic stone or stricture; distal CBD
- **Respiratory Motion Artifact (Mimic)**
  - Failure to breath-hold may result in signal loss from biliary and pancreatic ducts
- **Hemobilia**
  - From hepatic or biliary tumor or trauma
- **Portal Vein Gas (Mimic)**
  - On some MR sequences gas in portal vein may be mistaken for gas in ducts
- **Gas in Stomach or Duodenum (Mimic)**
  - Creates signal void larger than gas pocket itself due to susceptibility artifact
- **Flow Artifact (Mimic)**
  - Usually where cystic duct enters CBD
- **Pulsatile Vascular Compression (Mimic)**
  - Hepatic and gastroduodenal arteries may indent duct
- **Cystic Duct Insertion (Mimic)**
  - Adjacent walls of cystic and hepatic duct may simulate stone

Helpful Clues for Less Common Diagnoses

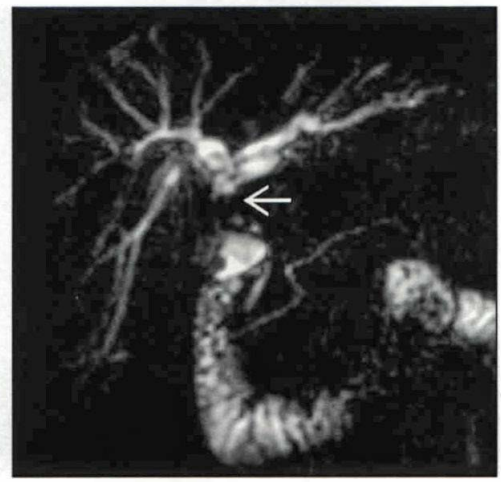
- **Transplantation, Hepatic**
  - Duct-to-duct anastomosis is always narrowed, sometimes strictured
  - Intraluminal debris: Consider hepatic artery stenosis or thrombosis

Choledocholithiasis



Coronal MRCP shows typical appearance of stones as hypointense foci ➡ within the dilated common duct.

Choledocholithiasis



Coronal oblique MRCP shows an abrupt obstruction & filling defect of the bile duct just beyond the confluence of right & left main ducts ➡. It simulates a Klatskin tumor but was caused by a common duct stone.

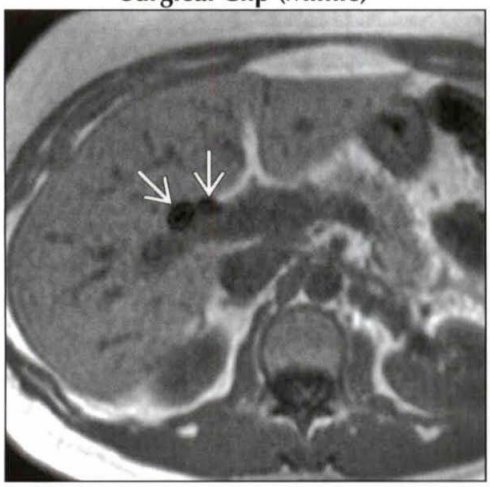
HYPOINTENSE LESION IN BILIARY TREE (MRCP)

Pneumobilia

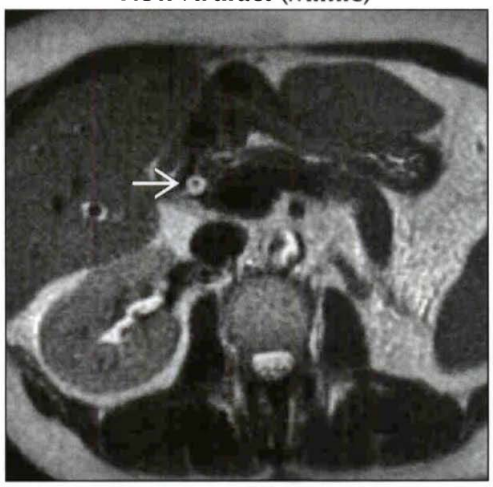
Pneumobilia

(Left) Axial T2WI MR shows an air-fluid level within the bile ducts as a signal void ➡ with a linear interface with the high signal bile in the dependent position of the bile duct. (Right) Coronal oblique MRCP shows a focal defect in the bile duct that represents a stone ➡, but also a broad signal void in the more proximal duct ➡ due to pneumobilia.

Surgical Clip (Mimic)

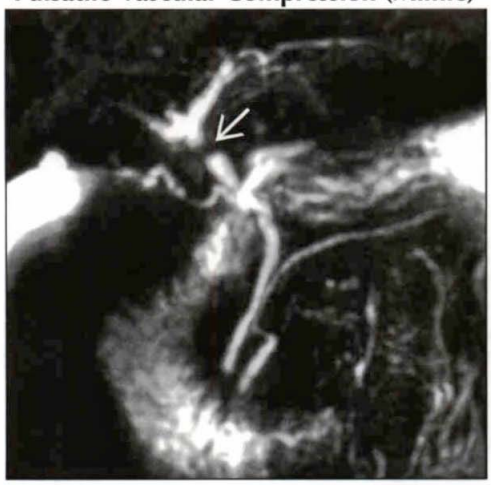


Flow Artifact (Mimic)



(Left) Axial T1WI MR in phase GRE image shows two hypointense lesions in the porta hepatis caused by cholecystectomy clips ➡. The distorted appearance is from susceptibility artifact, which occurs when two tissues with different magnetic susceptibilities are juxtaposed. (Right) Axial T2WI MR shows a signal void ➡ in the center of the bile duct that was not present on the coronal or MRCP sequences. This is a typical flow artifact.

Pulsatile Vascular Compression (Mimic)



Transplantation, Hepatic

(Left) Coronal MRCP shows a signal void ➡ in the common hepatic duct, due to compression by the hepatic artery that crosses the duct at this level. (Right) Coronal MRCP shows an apparent filling defect ➡ within the bile duct at the site of the duct-to-duct anastomosis, with mild dilation of the donor ducts upstream. At ERCP an anastomotic stricture was identified & dilated, and a plastic stent was placed across the anastomosis.

SECTION 12
Pancreas

Generic Imaging Patterns

Hypovascular Pancreatic Mass	12-2
Hypervascular Pancreatic Mass	12-8
Cystic Pancreatic Mass	12-10
Atrophy or Fatty Replacement of Pancreas	12-16
Dilated Pancreatic Duct	12-18
Infiltration of Peripancreatic Fat Planes	12-20
Pancreatic Calcifications	12-24

HYPOVASCULAR PANCREATIC MASS

DIFFERENTIAL DIAGNOSIS

Common
- Pancreatic Ductal Carcinoma
- Pancreatitis, Chronic
- Mucinous Cystic Pancreatic Tumor
- Normal Variants, Pancreas (Mimic)
- Peripancreatic Lymphadenopathy
- Unopacified Bowel (Mimic)
- Duodenal Diverticulum (Mimic)

Less Common
- Serous Cystadenoma, Pancreas
- Ampullary Carcinoma
- Pancreatic Metastases and Lymphoma
- Cholangiocarcinoma
- Pancreatic Islet Cell Tumors
- Solid and Papillary Neoplasm
- Pancreatitis, Acute
- Autoimmune Pancreatitis
- Groove Pancreatitis
- Gastric Tumors (Mimic)
  - Gastric Carcinoma
  - Gastric Stromal Tumor
- Agenesis of Dorsal Pancreas
- Adrenal Mass
  - Adrenal Carcinoma
  - Pheochromocytoma
- Adjacent Masses (Mimic)
  - Duodenal Carcinoma
  - Carcinoid Tumor
  - Desmoid Tumor
  - Retroperitoneal Sarcoma
  - Retroperitoneal Lymphoma
  - Vascular Lesions, Peripancreatic

Rare but Important
- Pancreatic Tumors, Atypical & Rare
  - Schwannoma
  - Osteoclastoma
  - Acinar Cell Carcinoma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Look for evidence of pancreatic parenchymal lesion (e.g., pancreatic or common bile duct obstruction, contiguity with or narrowing of splenic artery or vein)
- Masses that arise from any tissue adjacent to pancreas may simulate pancreatic mass (stomach, duodenum, adrenal, kidney)
- Pancreatitis may simulate carcinoma, especially chronic pancreatitis & its variants (autoimmune & groove pancreatitis)

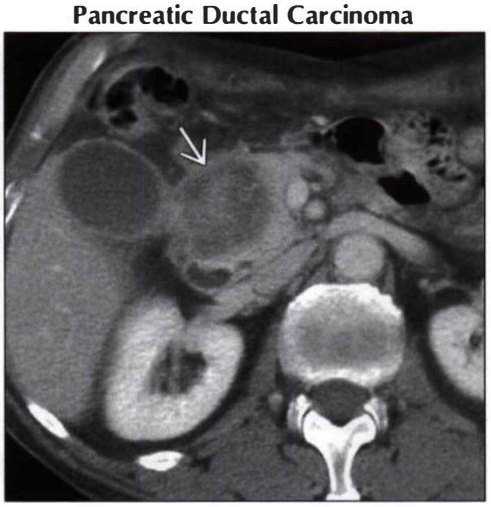
Helpful Clues for Common Diagnoses
- **Pancreatic Ductal Carcinoma**
  - Most common focal hypovascular mass
  - More common in pancreatic head
  - Usually obstructs pancreatic duct ± bile duct
  - Often invades adjacent blood vessels
- **Pancreatitis, Chronic**
  - Commonly results in asymmetric atrophy of pancreatic body
  - May leave fibrotic mass in pancreatic head
  - Look for focal calcifications
- **Mucinous Cystic Pancreatic Tumor**
  - Cystic component may not be recognized on NECT
  - Usually does not obstruct pancreatic duct
- **Normal Variants, Pancreas (Mimic)**
  - Pancreatic head is often lobulated and large
    - If it enhances like rest of gland and does not obstruct ducts or vessels, it is normal
  - May have asymmetrical fatty infiltration of body-tail segment vs. head-uncinate
    - More commonly the pancreatic head & uncinate are lower in attenuation (more "fatty")
    - May appear as hypodense (CT) or hypointense (MR) or hyperechoic (US) mass
    - Absence of ductal obstruction is key
- **Peripancreatic Lymphadenopathy**
  - Often from upper abdominal source (e.g., cancer of gallbladder, stomach)
  - Gallbladder cancer often results in peripancreatic adenopathy & jaundice; easily mistaken for primary pancreatic cancer
    - Look for GB mass and check level of ductal obstruction
- **Unopacified Bowel (Mimic)**
  - Collapsed redundant duodenum or jejunum

Helpful Clues for Less Common Diagnoses
- **Serous Cystadenoma, Pancreas**
  - Microcystic component may not be evident, especially without adequate contrast bolus

- Depending on size of cysts & septa, may appear cystic, hypovascular, or hypervascular

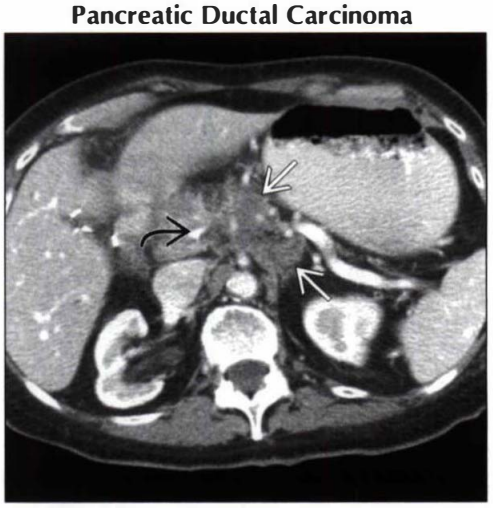
- **Ampullary Carcinoma**
  - Usually smaller than pancreatic ductal carcinoma
- **Pancreatic Metastases and Lymphoma**
  - Melanoma, lung, breast are most common hypovascular metastases
  - Lymphoma may be primary to pancreatic bed or part of generalized lymphoma
- **Cholangiocarcinoma**
  - Arising in distal common duct
  - Obstructs bile duct but usually not pancreatic duct
  - Usually not much mass effect
- **Pancreatic Islet Cell Tumor**
  - Usually hypervascular, but not always
  - May have focal calcification
  - Usually no ductal obstruction
- **Solid and Papillary Neoplasm**
  - Mostly solid with foci of necrosis
  - Usually in young women
- **Pancreatitis, Acute**
  - Focal areas of pancreatic necrosis simulate tumor, especially in pancreatic body
  - Infiltration of peripancreatic tissue may simulate local invasion by tumor
  - History, physical, laboratory are key
- **Autoimmune Pancreatitis**
  - "Sausage-shaped" enlarged pancreas; may cause focal mass
  - Encapsulated peripancreatic infiltration
  - No obstruction of pancreatic duct
- **Groove Pancreatitis**
  - Focal, chronic pancreatitis in pancreatic head
  - May have cystic lesion within adjacent wall of duodenum
- **Gastric Tumors (Mimic)**
  - Carcinoma, GIST, lymphoma
  - May protrude into pancreatic bed, simulating primary pancreatic mass
- **Agenesis of Dorsal Pancreas**
  - Head of pancreas is enlarged
  - On ERCP, pancreatic duct ends abruptly
- **Adjacent Masses (Mimic)**
  - **Duodenal Carcinoma**
    - May simulate tumor of head; may even result in pancreatic and bile duct obstruction
  - **Mesenteric Masses**
    - Carcinoid, desmoid, peritoneal metastases all may cause mass adjacent to pancreas
  - **Retroperitoneal Tumors**
    - Sarcomas & lymphoma may invade pancreas
  - **Vascular Lesions, Peripancreatic**
    - Aneurysmal or dilated arteries or veins especially if thrombosed or seen on NECT
    - Examples: Pseudoaneurysm of splenic or gastroduodenal artery in pancreatitis; large splenic or portal vein &/or varices in portal hypertension

Pancreatic Ductal Carcinoma



Axial CECT shows a heterogeneously hypovascular mass ➡ in the pancreatic head that caused abrupt obstruction of the biliary and pancreatic ducts.

Pancreatic Ductal Carcinoma



Axial CECT shows a hypodense mass ➡ arising from the neck-body portion of the pancreas with typical encasement of the celiac arterial axis and portal vein ➪.

HYPOVASCULAR PANCREATIC MASS

Pancreatitis, Chronic

Pancreatitis, Chronic

(Left) *Axial CECT shows a heterogeneous hypodense mass in the pancreatic body with occlusion of the splenic vein. Calcifications suggest the correct diagnosis of chronic pancreatitis, rather than pancreatic carcinoma.* ***(Right)*** *Axial CECT shows extensive perigastric varices and splenomegaly due to splenic vein occlusion in a patient with chronic pancreatitis. Similar findings are often due to pancreatic carcinoma.*

Mucinous Cystic Pancreatic Tumor

Mucinous Cystic Pancreatic Tumor

(Left) *Axial CECT shows a hypodense mass in the pancreatic body, not associated with ductal dilation or glandular atrophy. Note few septa and cystic spaces within the mass.* ***(Right)*** *Axial CECT shows a hypodense mass in the neck-body segment of pancreas without glandular atrophy or ductal dilation. Septa were suggested on CT and very evident on endoscopic ultrasound exam.*

Normal Variants, Pancreas (Mimic)

Normal Variants, Pancreas (Mimic)

(Left) *Axial CECT shows a hypodense head-uncinate segment of pancreas . but no mass effect or obstruction of ducts. The body-tail segments were of normal "soft tissue density". Asymmetrical fatty infiltration of "ventral pancreas" as a normal variant.* ***(Right)*** *Axial CECT shows a normal body-tail segment of pancreas in a patient who had a fatty infiltrated head-uncinate segment that simulated a mass.*

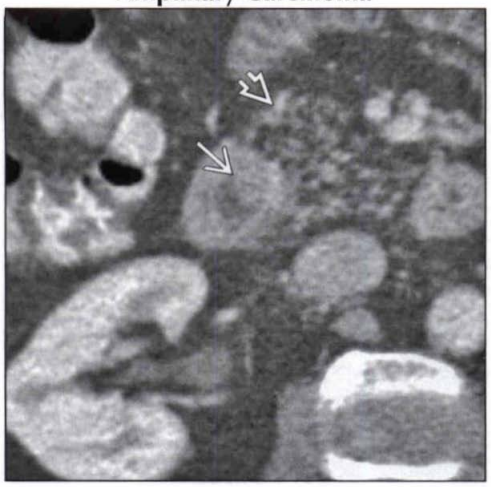
HYPOVASCULAR PANCREATIC MASS

Peripancreatic Lymphadenopathy

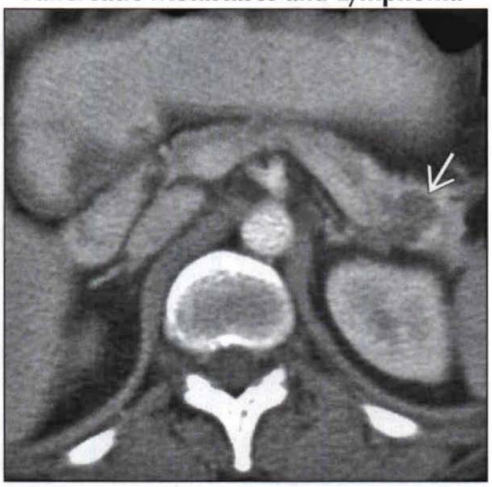
Serous Cystadenoma, Pancreas

(Left) Axial CECT shows hypodense masses within & around the pancreas, soft tissue density thickening of the gallbladder wall, & splenomegaly. Non-Hodgkin lymphoma. (Right) Axial CECT shows a hypodense mass in the neck of the pancreas, but normal pancreatic duct & gland upstream from the mass. The sponge or honeycomb appearance of the mass is typical for a serous ("microcystic") adenoma, confirmed by EUS & aspiration of cyst contents.

Ampullary Carcinoma

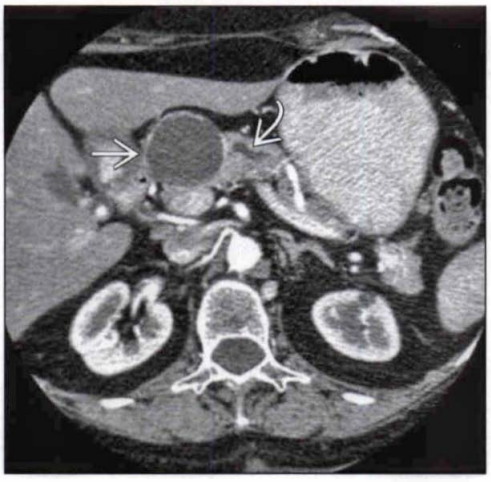


Pancreatic Metastases and Lymphoma



(Left) Axial CECT shows a small mass at the ampulla, projecting into the duodenal lumen. Compare with the normal head of pancreas. Obstructed pancreatic and bile ducts were noted on other sections. (Right) Axial CECT shows a hypodense mass in the tail of the pancreas in a young woman who also had lung mets from a primary sarcoma of the lower extremity.

Pancreatic Islet Cell Tumors



Solid and Papillary Neoplasm

(Left) Axial CECT shows a cystic appearing mass with a high density, possibly calcified, rim and dilation of the pancreatic duct. This proved to be an unusual manifestation of a pancreatic islet cell tumor. (Right) Axial CECT shows a hypodense mass with dilation of the pancreatic duct upstream. Only minimal necrosis or cystic component is evident. Only the youth and age of the patient (36 year old woman) suggested the correct diagnosis.

HYPOVASCULAR PANCREATIC MASS

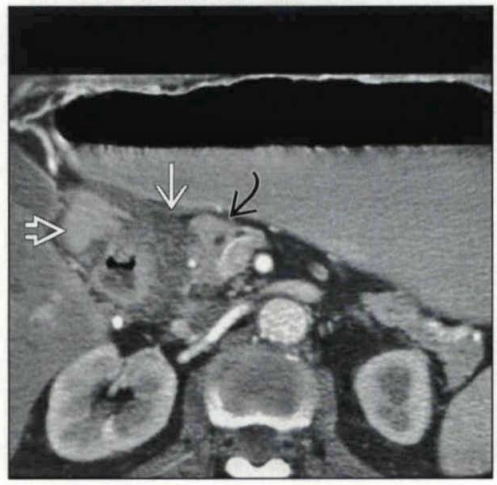
(Left) Axial CECT shows a heterogeneous hypodense mass effect throughout the pancreas due to necrotizing pancreatitis. Such patients are invariably very ill with metabolic derangements that help to distinguish them from patients with an infiltrating carcinoma of the pancreas. (Right) Axial CECT shows a hypodense "mass" in the pancreatic tail. The presence of an elevated serum IgG & resolution of all findings with steroid medication confirmed the dx.

Pancreatitis, Acute

Autoimmune Pancreatitis

(Left) Axial CECT shows a hypodense mass in the groove between the pancreatic head and second portion of duodenum along with gastric outlet obstruction due to duodenal luminal stricture. (Right) Axial CECT shows a LUQ mass with central necrosis and a vascular periphery. On axial sections alone, it is difficult to identify the organ of origin.

Groove Pancreatitis



Gastric Stromal Tumor

(Left) Axial CECT shows a heterogeneous LUQ mass with extensive necrosis but foci of hypervascularity. This simulates a GIST or pancreatic mass, but is a large adrenal pheochromocytoma. (Right) Axial NECT shows a mass that obstructs the lumen of the second portion of duodenum and is contiguous with the head-uncinate process of pancreas.

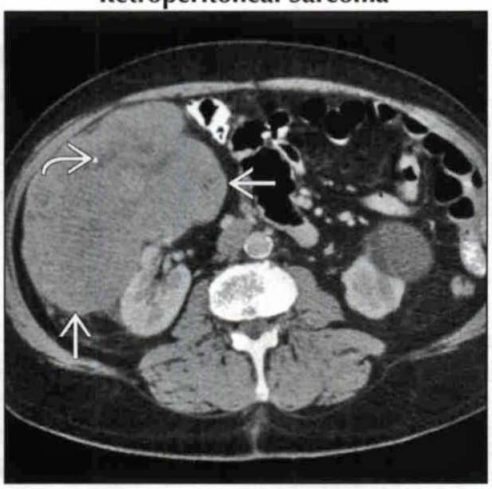
Pheochromocytoma

Duodenal Carcinoma

HYPOVASCULAR PANCREATIC MASS

Retroperitoneal Sarcoma

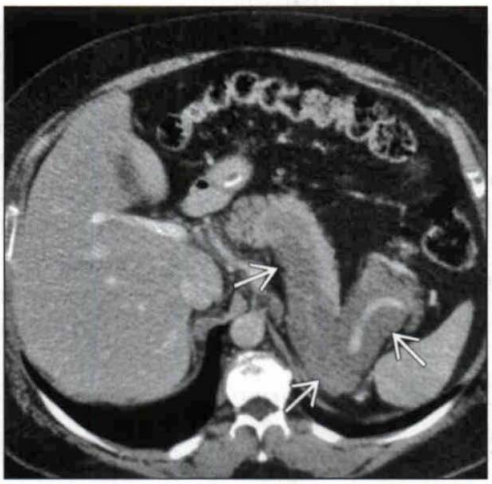
Retroperitoneal Sarcoma



(Left) Axial CECT shows a large retroperitoneal mass ⇒ that might simulate a primary pancreatic neoplasm. Note that the duodenum ➡ is displaced medially, rather than laterally as would be expected for a pancreatic mass. (Right) Axial CECT shows a large retroperitoneal leiomyosarcoma ➡, which is mostly soft tissue density with small foci of calcification ➡.

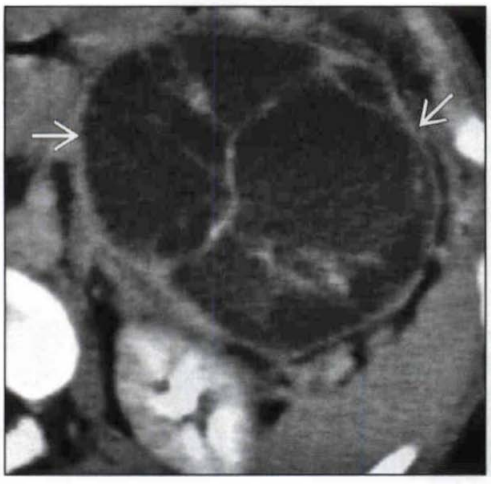
Retroperitoneal Lymphoma

Schwannoma

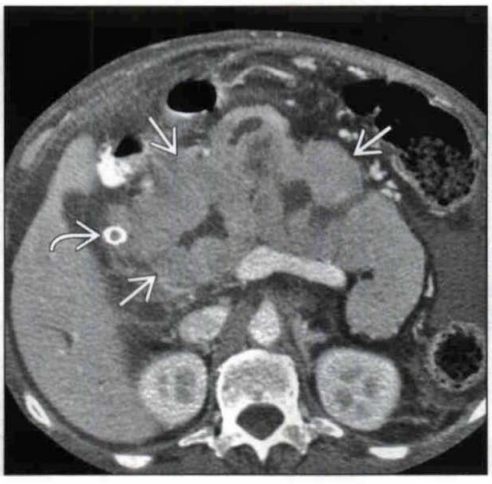


(Left) Axial CECT shows a diffuse hypodense mass that infiltrates the pancreas ➡, spleen, kidney, adrenal gland and nodes. Non-Hodgkin lymphoma. (Right) Axial CECT shows a long, cylindrical soft tissue density mass ➡ that follows the course of the splenic vessels within the pancreas. Schwannoma in a patient with NF1.

Osteoclastoma



Acinar Cell Carcinoma



(Left) Axial CECT shows a multicystic mass ➡ that simulates a mucinous cystic tumor, but proved to be an osteoclastoma of the pancreas. (Right) Axial CECT shows a large heterogeneous mass ➡ filling and distorting the pancreas and obstructing the common bile duct ➡.

HYPERVASCULAR PANCREATIC MASS

DIFFERENTIAL DIAGNOSIS

Common
- Pancreatic Islet Cell Tumors

Less Common
- Pancreatic Metastases
- Serous Cystadenoma, Pancreas
- Accessory Spleen (Mimic)
- Vascular Lesions, Peripancreatic
- Pheochromocytoma (Mimic)
- Renal Cell Carcinoma (Mimic)
- Gastric Stromal Tumor (Mimic)
- Carcinoid Tumor (Mimic)
- Splenic Tumors (Mimic)

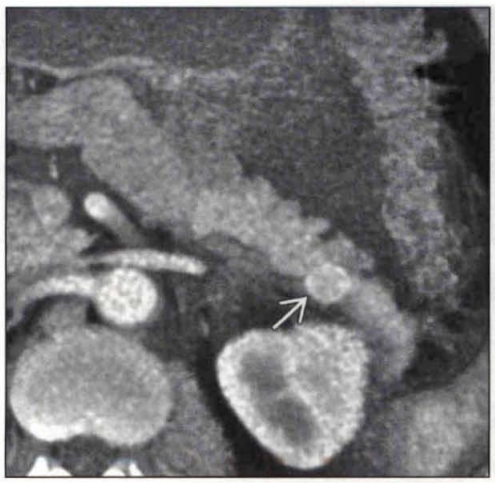
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Consider masses originating from adjacent organs (stomach, spleen, adrenal, kidney)
- Look for plane of demarcation between mass and pancreas or adjacent organ
- Pancreatic mass: Usually ventral to splenic V
- Consider multiplanar reformations, MR, US

Helpful Clues for Common Diagnoses
- **Pancreatic Islet Cell Tumors**
  - "Functional" tumors: Usually hypervascular and small when diagnosed
  - "Nonfunctional" tumors: Often large & malignant at diagnosis

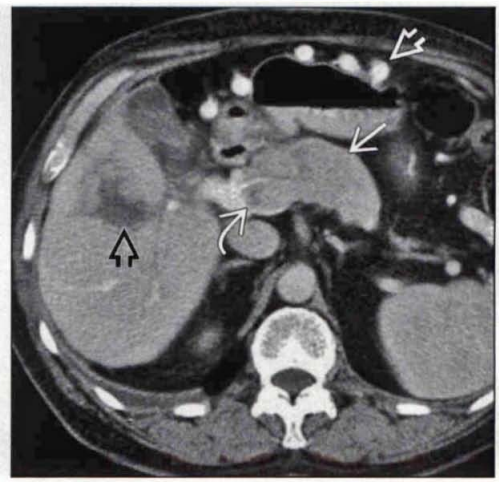
Helpful Clues for Less Common Diagnoses
- **Pancreatic Metastases**
  - Renal cell carcinoma most common etiology of hypervascular metastases
  - Can occur many years after nephrectomy
- **Serous Cystadenoma, Pancreas**
  - Septa between innumerable small cysts may enhance briskly and mimic a solid, hypervascular tumor
- **Accessory Spleen (Mimic)**
  - Can lie within pancreatic tail
  - Look for enhancement that is similar to spleen on multiphasic imaging
- **Vascular Lesions, Peripancreatic**
  - Pseudoaneurysms (following pancreatitis or surgery); aneurysms (e.g., splenic artery)
  - Large splenic or portal vein, varices (with cirrhosis & portal hypertension)
- **Pheochromocytoma (Mimic)**
  - Or other adrenal mass (e.g., carcinoma)
- **Renal Cell Carcinoma (Mimic)**
  - Arising from upper pole of kidney
- **Gastric Stromal Tumor (Mimic)**
  - GIST from stomach or duodenum
  - May simulate mass in pancreatic body or head, respectively
- **Carcinoid Tumor (Mimic)**
  - Arising from duodenum or mesenteric metastases adjacent to pancreas
- **Splenic Tumors (Mimic)**
  - Hemangioma, angiosarcoma or hypervascular metastases to the splenic hilum could simulate a mass in pancreatic tail

Pancreatic Islet Cell Tumors



Axial CECT shows a typical small hypervascular pancreatic mass ➡.

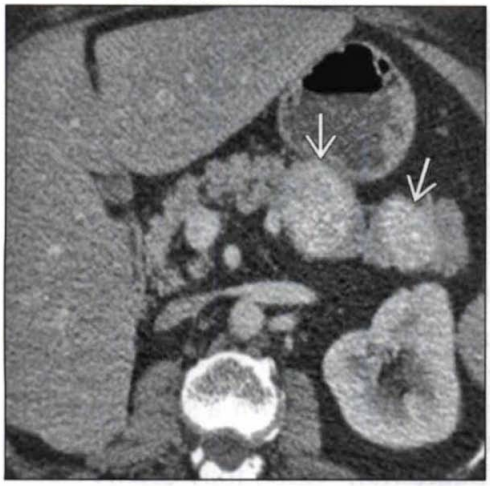
Pancreatic Islet Cell Tumors



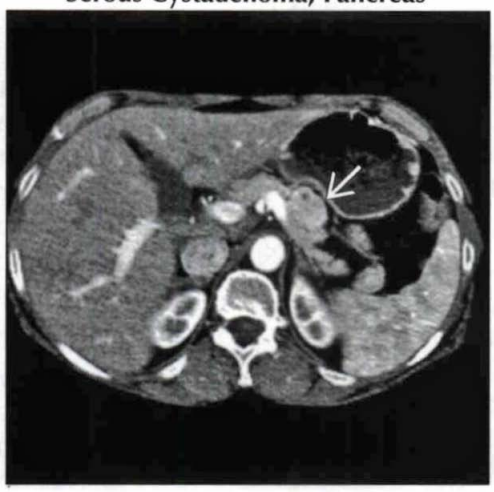
Axial CECT shows a large pancreatic mass ➡ with direct invasion of the splenic vein ➡, resulting in liver metastases ➡ and perigastric varices ➡.

HYPERVASCULAR PANCREATIC MASS

Pancreatic Metastases

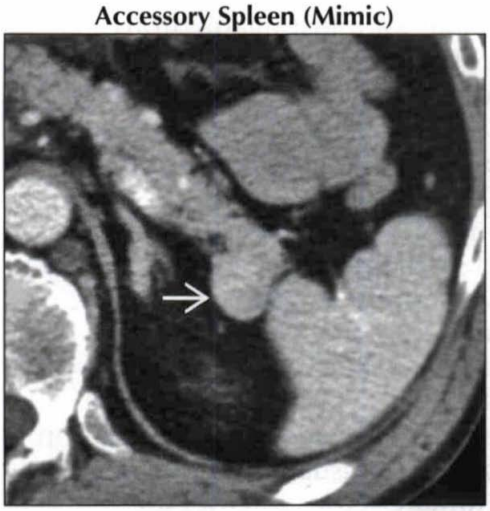


Serous Cystadenoma, Pancreas

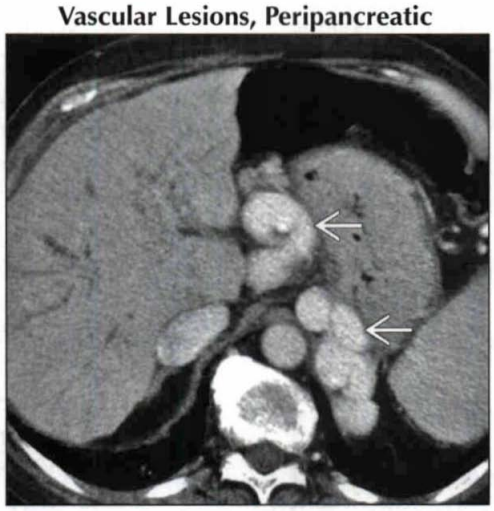


(Left) *Axial CECT shows multiple hypervascular pancreatic masses due to metastatic renal cell carcinoma. Note the surgically absent right kidney.* ***(Right)*** *Axial CECT shows a hypervascular mass in the body of the pancreas. Only a small cystic space is visible. The innumerable tiny cysts found at pathology were too small to resolve on CT, and the enhancing septa account for the solid appearance of this mass.*

Accessory Spleen (Mimic)

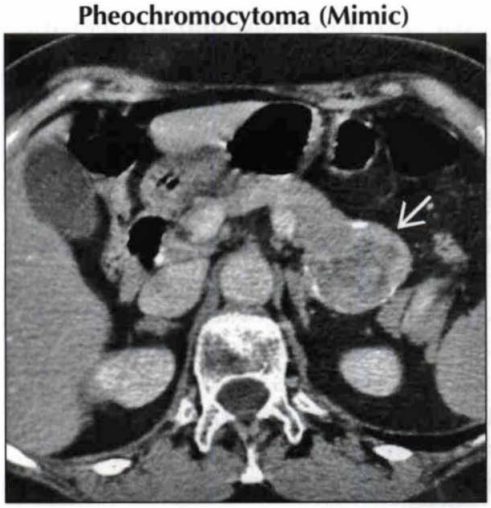


Vascular Lesions, Peripancreatic

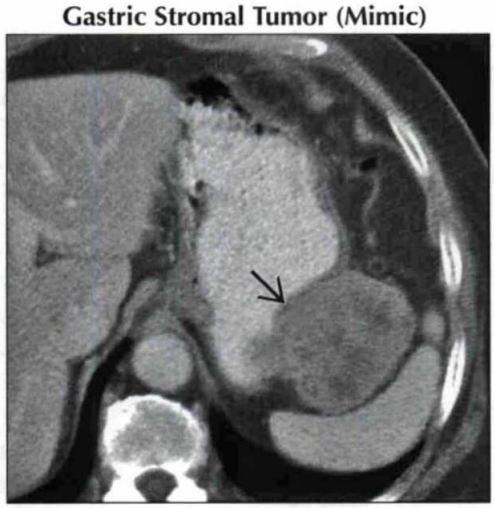


(Left) *Axial CECT shows a spherical mass in or adjacent to the tail of the pancreas that is isodense to the spleen (on arterial & portal venous phases) and showed uptake of Tc sulfur colloid on a radionuclide scan.* ***(Right)*** *Axial CECT shows large varices that could be mistaken for an adrenal or pancreatic mass.*

Pheochromocytoma (Mimic)



Gastric Stromal Tumor (Mimic)



(Left) *Axial CECT shows what appears to be a pancreatic mass with enhancing nodularity & peripheral rim calcification. This was a pheochromocytoma that arose from the left adrenal gland and indented, but did not invade the pancreas.* ***(Right)*** *Axial CECT shows a large moderately vascular LUQ mass that represents a gastric stromal tumor, but might be mistaken for a pancreatic mass.*

CYSTIC PANCREATIC MASS

DIFFERENTIAL DIAGNOSIS

Common
- Pancreatic Pseudocyst
- Lesser Sac Ascites (Mimic)
- Mucinous Cystic Pancreatic Tumor
- IPMT, Pancreas
- Pancreatic Ductal Carcinoma
- Duodenal Diverticulum (Mimic)

Less Common
- AD Polycystic Disease, Kidney
- Cystic Fibrosis, Pancreas
- Von Hippel-Lindau Disease
- Serous Cystadenoma, Pancreas
- Solid and Papillary Neoplasm
- Pancreatic Islet Cell Tumors
- Epithelial (True) Cyst, Pancreas
- Pseudoaneurysm (Mimic)
- Portal Vein Aneurysm (Mimic)
- Metastases and Lymphoma, Pancreas
- Gastric Stromal Tumor (Mimic)
- Choledochal Cyst (Mimic)
- Lymphoepithelial (True) Cyst, Pancreas
- Abscess, Pancreatic

Rare but Important
- Hydatid Cyst
- Teratoma, Retroperitoneum
- Anaplastic Carcinoma, Pancreas
- Duplication Cyst, Duodenum

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Pancreatic cystic lesions are being found commonly due to widespread use of CT & US for all abdominal conditions
- Rarely is it possible to make a specific diagnosis based on imaging alone
  - Clinical presentation important
    - Age & gender (e.g., young woman: SPEN or mucinous cystic; older man: Serous)
    - Location of lesion (e.g., head/neck for serous & side branch IPMT; body/tail for mucinous cystic neoplasm)
    - Calcification within lesion (e.g., peripheral in mucinous, central in serous cystadenoma)
    - Mural nodularity (enhancement = neoplastic)
    - Duct communication (favors IPMT; use multiplanar reformations to follow long axis of pancreatic duct)
  - Endoscopic US is complementary study, giving high resolution images of cyst and opportunity to sample contents of cyst
- Unless patient has clear history of pancreatitis, all cystic masses should be considered potential neoplasms
  - Although small lesions in elderly or ill patients may require no additional evaluation or treatment

Helpful Clues for Common Diagnoses
- **Pancreatic Pseudocyst**
  - Most common etiology for a symptomatic cystic mass
  - Has definable wall which may calcify
  - ± Septum; no mural nodules
- **Lesser Sac Ascites (Mimic)**
  - No definable wall, just ligamentous margins of lesser sac
  - Etiologies: Acute pancreatitis, gastric ulcer, peritonitis, peritoneal carcinomatosis
- **Mucinous Cystic Pancreatic Tumor**
  - Most common cystic neoplasm
  - Usually in middle-aged women, in body-tail segment
  - May have peripheral calcification
- **IPMT, Pancreas**
  - Main duct type: Marked distention of pancreatic duct
  - Side branch type: Causes "cystic" dilation of side branches, usually in head-uncinate
    - May simulate serous microcystic adenoma
- **Pancreatic Ductal Carcinoma**
  - Rarely cystic, but hypovascular or necrotic tumor may simulate cystic mass
- **Duodenal Diverticulum (Mimic)**
  - Fluid-filled tic may simulate cyst
  - Look for gas or enteric contrast within "cystic mass"

Helpful Clues for Less Common Diagnoses
- **AD Polycystic Disease, Kidney**
  - Asymptomatic multiple cysts in pancreas
  - Will have cysts in other organs as well
- **Cystic Fibrosis, Pancreas**
  - Lipomatous pseudohypertrophy
  - One or multiple cysts, usually late
- **Von Hippel-Lindau Disease**
  - Small, asymptomatic pancreatic cysts

CYSTIC PANCREATIC MASS

- Also prone to renal, spinal, brain tumors
- Increased prevalence of serous adenoma

- **Serous Cystadenoma, Pancreas**
  - Innumerable "microcysts" in spherical pancreatic mass
  - Innumerable thin septa, may coalesce and calcify in center of mass
  - Unilocular oligocystic variant with thin wall, usually in pancreatic head
    - This form is difficult to distinguish from mucinous cystic neoplasm
- **Solid and Papillary Neoplasm**
  - Usually mostly solid with necrotic, hemorrhagic foci
  - Usually in young women
- **Pancreatic Islet Cell Tumors**
  - Are uncommonly partially or almost completely cystic
- **Epithelial (True) Cyst, Pancreas**
  - Congenital, epithelial-lined, benign
  - Occurs in children & adults
  - No mural nodularity
- **Pseudoaneurysm (Mimic)**
  - Splenic or gastroduodenal artery
  - Usually results from prior severe pancreatitis or surgery
  - Key is contrast-enhancement, or flow on color Doppler
- **Portal Vein Aneurysm (Mimic)**
  - Portal vein can be markedly dilated, usually due to portal hypertension
  - Calcified rim or thrombosis of portal vein can simulate cystic mass in pancreas
- **Metastases and Lymphoma, Pancreas**
  - Metastases & lymphoma may appear cystic (homogeneous, hypovascular)
  - Also consider mets to nodes near pancreas from gastric & gallbladder cancer
  - Rare cystic metastases from ovarian or other cystic primary tumor
- **Gastric Stromal Tumor (Mimic)**
  - GIST of stomach or duodenum may simulate partially cystic pancreatic mass
- **Choledochal Cyst (Mimic)**
  - Cystic dilation of CBD may mimic cyst
  - Look for cylindrical shape; best seen on MRCP or ERCP
- **Lymphoepithelial (True) Cyst, Pancreas**
  - Very thin wall and septa
  - May occur in or near pancreas
- **Abscess, Pancreatic**
  - Clinical setting usually obvious
  - Follows episode of severe acute pancreatitis

Helpful Clues for Rare Diagnoses

- **Hydatid Cyst**
  - Rare, even in endemic areas
- **Teratoma, Retroperitoneum**
  - Usually has fat & soft tissue components
- **Duplication Cyst, Duodenum**
  - May communicate with duodenal lumen

SELECTED REFERENCES

1. Sahani DV et al: Cystic pancreatic lesions: a simple imaging-based classification system for guiding management. Radiographics. 25(6):1471-84, 2005
2. Hammond N et al: Imaging of cystic diseases of the pancreas. Radiol Clin North Am. 40(6):1243-62, 2002

Pancreatic Pseudocyst

Axial CECT shows a pseudocyst ➡ in the pancreatic neck-body segment that is indistinguishable from a cystic tumor by imaging alone.

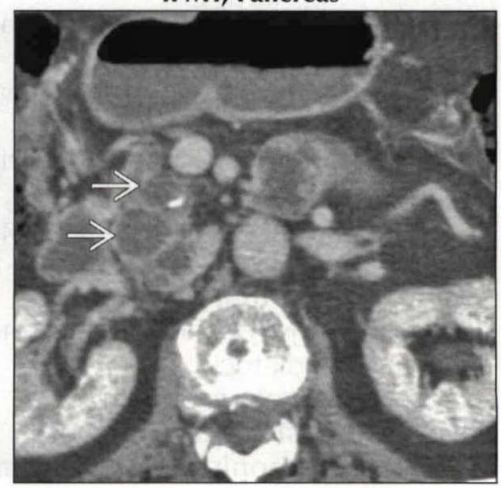
Mucinous Cystic Pancreatic Tumor

Axial CECT shows a classic mucinous cystic tumor in a 44 year-old woman. The mass ➡ is spherical with a contrast-enhancing wall and several septa, and is located in the body-tail segment.

CYSTIC PANCREATIC MASS

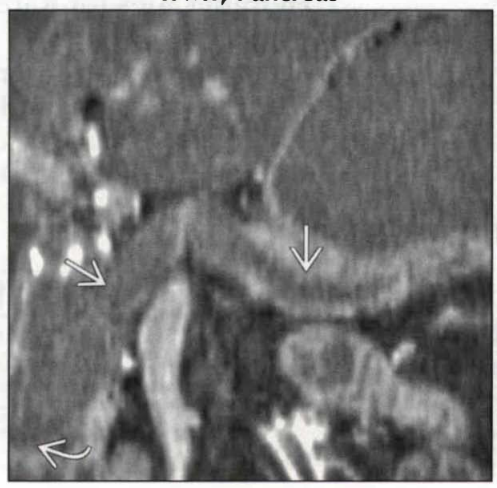
IPMT, Pancreas

IPMT, Pancreas



(Left) *Axial CECT shows marked dilation of the main pancreatic duct and atrophy of the parenchyma.* ***(Right)*** *Axial CECT shows cystic appearing dilations of the pancreatic duct branches within the head; main & side branch IPMN in a 71 year old woman.*

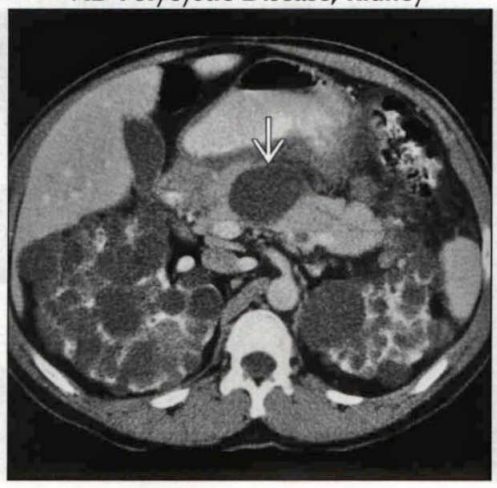
IPMT, Pancreas



Pancreatic Ductal Carcinoma

(Left) *Coronal reformation of CECT shows dilation of the main pancreatic duct and glandular atrophy. Within the pancreatic head, the ductal side branches are dilated, imparting a multicystic appearance, and the ampulla is bulging. Combined main & side branch IPMN.* ***(Right)*** *Axial CECT shows a remarkable cystic or necrotic pancreatic ductal carcinoma that encases the celiac axis.*

AD Polycystic Disease, Kidney



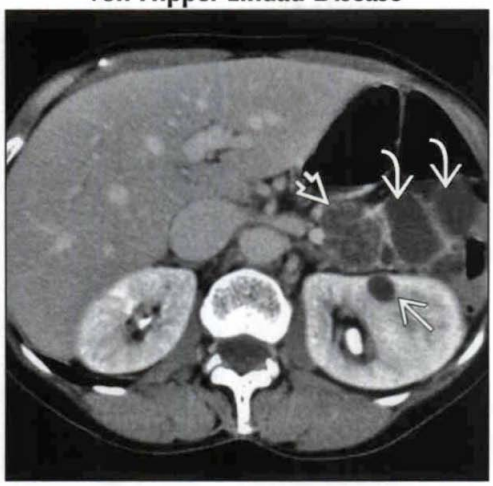
Cystic Fibrosis, Pancreas

(Left) *Axial CECT shows innumerable cysts within enlarged kidneys and one cyst in the pancreas that may be congenital (part of the syndrome) or due to pancreatitis, which is common in patients with renal failure.* ***(Right)*** *Axial CECT shows typical lipomatous pseudohypertrophy of the body-tail segment of pancreas in this 16 year old boy.*

CYSTIC PANCREATIC MASS

Cystic Fibrosis, Pancreas

Von Hippel-Lindau Disease



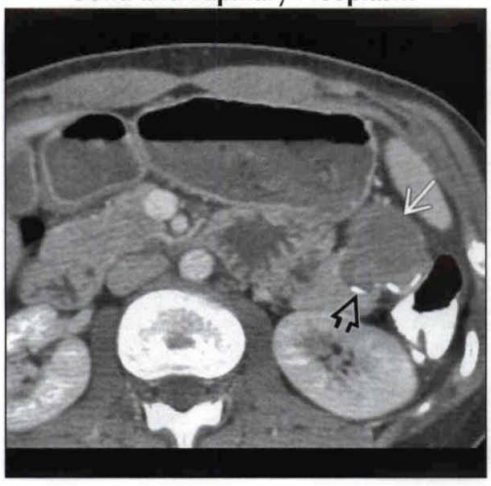
(Left) *Axial CECT shows a cyst in the pancreatic head in this 16 year old boy with cystic fibrosis.* ***(Right)*** *Axial CECT shows several simple-appearing cysts in the pancreatic tail, along with a multiseptate cystic mass (serous cystadenoma) and one of many renal cysts.*

Serous Cystadenoma, Pancreas

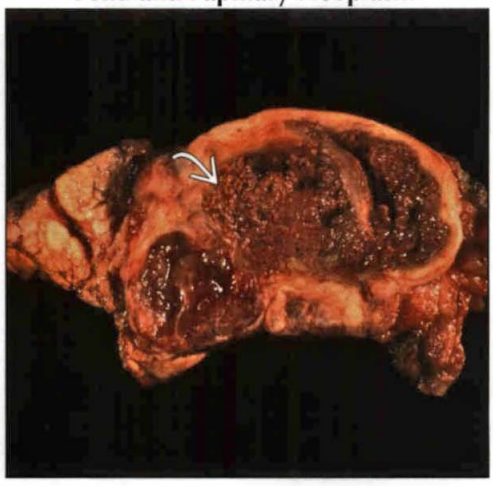
Serous Cystadenoma, Pancreas

(Left) *Axial CECT shows a spherical mass in the pancreatic neck that has a sponge-like appearance due to innumerable small cystic spaces and septa. The pancreatic duct is not dilated.* ***(Right)*** *Axial CECT shows a large mass in the pancreatic head in an elderly man with few symptoms. The mass has innumerable but subtle septa, some with calcifications.*

Solid and Papillary Neoplasm



Solid and Papillary Neoplasm

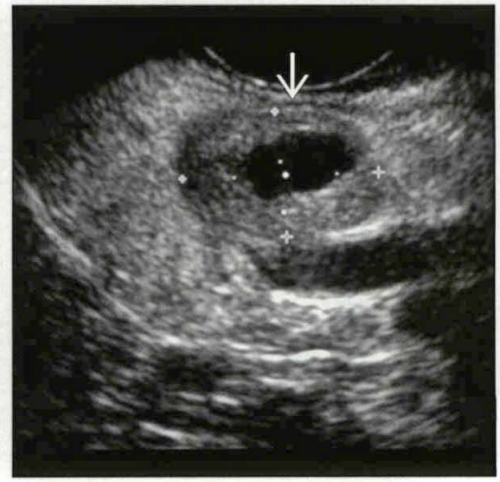


(Left) *Axial CECT shows a centrally necrotic mass arising from the pancreatic tail in a 21 year old woman. Mural calcifications are noted.* ***(Right)*** *Surgical photograph shows the resected specimen from a 21 year old woman with a SPEN. The mass has central necrosis and pseudopapillary projections.*

CYSTIC PANCREATIC MASS

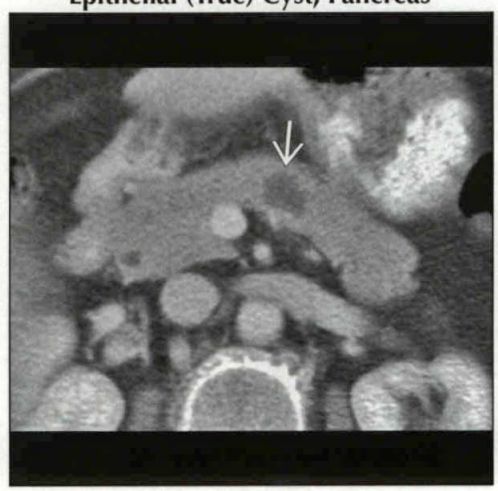
Pancreatic Islet Cell Tumors

Pancreatic Islet Cell Tumors

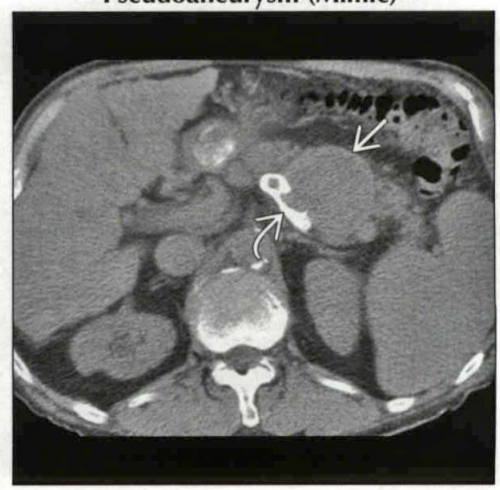


(Left) *Axial CECT shows a small mass ➡ in the pancreatic body with a cystic center and solid enhancing periphery;* ***gastrinoma.*** ***(Right)*** *Endoscopic ultrasound shows a small mass ➡ in the pancreatic body with a cystic center and solid periphery; gastrinoma.*

Epithelial (True) Cyst, Pancreas

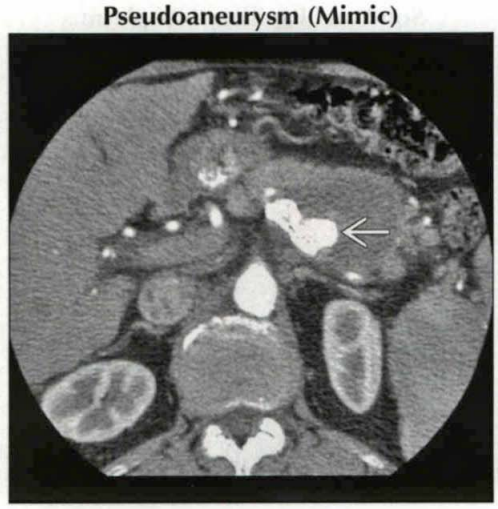


Pseudoaneurysm (Mimic)

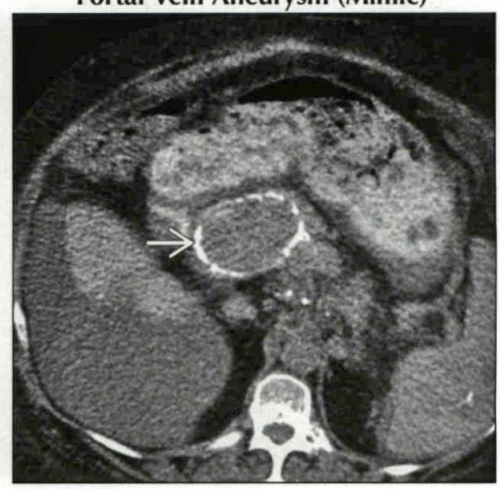


(Left) *Axial CECT shows a simple-appearing cyst ➡ in the pancreatic body that was resected because endoscopic US aspiration yielded fluid judged equivocal for malignant cells;* ***benign epithelial cyst.*** ***(Right)**** *Axial NECT shows a mass ➡ in the pancreatic body that mimics a cystic lesion. Note the adjacent calcification of the splenic artery ➡; splenic artery pseudoaneurysm.*

Pseudoaneurysm (Mimic)



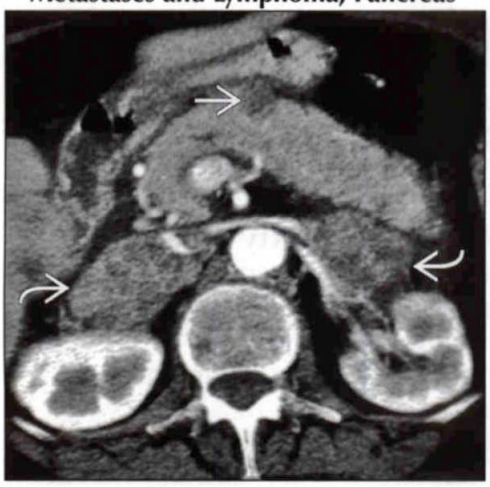
Portal Vein Aneurysm (Mimic)



(Left) *Axial CECT shows enhancement of part of the lumen of the splenic artery* ***pseudoaneurysm ➡.*** ***(Right)*** *Axial NECT shows a thrombosed portal vein* ***"aneurysm" ➡ with a*** *calcified wall, that mimics a cystic pancreatic mass. Underlying cirrhosis and portal hypertension.*

CYSTIC PANCREATIC MASS

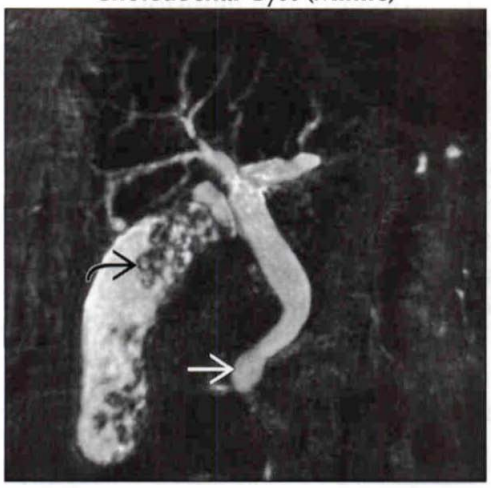
Metastases and Lymphoma, Pancreas



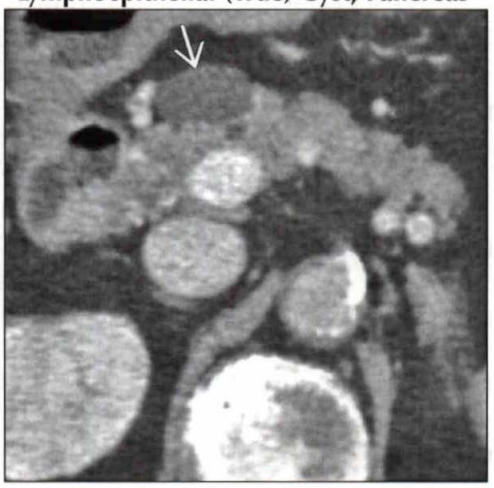
Gastric Stromal Tumor (Mimic)

*(Left) Axial CECT shows bilateral adrenal metastases and a smaller pancreatic metastasis as low density lesions; metastatic melanoma. **(Right)** Axial CECT shows a large left upper quadrant mass with central necrosis. The gas and fluid within the mass result from ulceration of the gastric mucosa overlying this large, exophytic gastric GIST.*

Choledochal Cyst (Mimic)

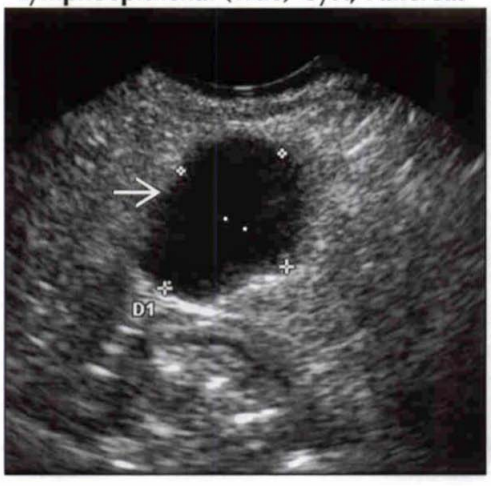


Lymphoepithelial (True) Cyst, Pancreas

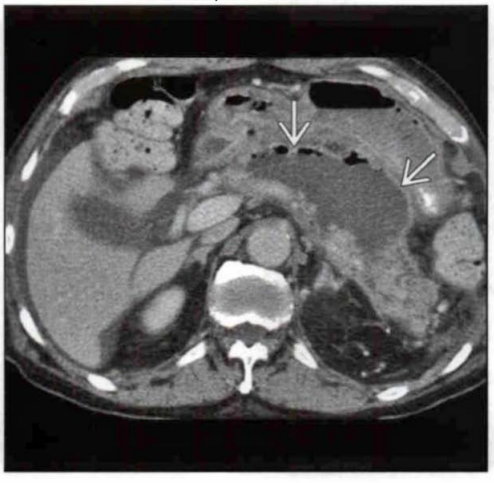


*(Left) Coronal MRCP shows diffuse dilation of the common duct as well as a cystic dilation of the distal duct (choledochocele). Gallstones also noted in gallbladder. **(Right)** Axial CECT shows a simple-appearing cyst in the pancreatic neck. Note the absence of mural nodularity or septa; 75 year-old woman.*

Lymphoepithelial (True) Cyst, Pancreas



Abscess, Pancreatic



*(Left) Endoscopic ultrasound shows a simple-appearing cyst in the pancreatic neck with no septa or mural nodularity. Aspiration yielded clear serous fluid. **(Right)** Axial CECT shows a well-encapsulated collection of fluid and gas in and adjacent to the pancreas; pancreatic abscess or infected pancreatic necrosis.*

ATROPHY OR FATTY REPLACEMENT OF PANCREAS

DIFFERENTIAL DIAGNOSIS

Common
- Pancreatitis, Chronic
- Senescent Change
- Obesity
- Diabetes Mellitus
- Cystic Fibrosis, Pancreas
- Steroid Medication

Less Common
- Cushing Syndrome
- Variant, Asymmetric Fatty Infiltration
- Lipomatous Pseudohypertrophy
- Shwachman-Diamond Syndrome
- Agenesis of Dorsal Pancreas

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Pancreas becomes more fat-infiltrated and less glandular with age, diabetes, obesity & certain medications

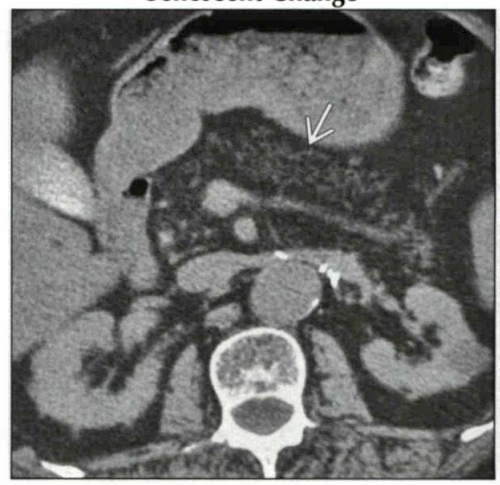
Helpful Clues for Common Diagnoses
- **Pancreatitis, Chronic**
  - Calcifications, gland atrophy, dilated duct
- **Senescent Change**
  - Elderly: Atrophy & fatty replacement of gland; mild ductal dilation
  - May even get several small calcifications
- **Obesity and Diabetes**
  - Prominent fatty infiltration; may correlate with type II diabetes
- **Cystic Fibrosis, Pancreas**
  - Fatty pseudohypertrophy of pancreas
  - May have associated pancreatic cysts
  - Lung damage (e.g., cystic bronchiectasis)
- **Steroid Medication**
  - Especially if sufficient to cause Cushing

Helpful Clues for Less Common Diagnoses
- **Cushing Syndrome**
  - Part of central deposition of fat in trunk of affected persons
- **Variant, Asymmetric Fatty Infiltration**
  - Dorsal (body-tail) and ventral (head-uncinate) develop as separate entities in fetal development
  - Head/uncinate often has more fatty infiltration
  - May simulate hypovascular or echogenic mass
- **Lipomatous Pseudohypertrophy**
  - Common feature in cystic fibrosis; rarely reported in Shwachman-Diamond syndrome & other diseases
  - Patients with alcoholic & post necrotic (viral) cirrhosis have been reported
- **Agenesis of Dorsal Pancreas**
  - Complete or partial agenesis in expected region of pancreatic body & tail
  - Pancreatic head & uncinate are preserved
    - Head may appear enlarged; ± focal calcifications
  - May be associated with polysplenia, midgut malrotation
  - ERCP shows no filling of pancreatic duct beyond neck

Pancreatitis, Chronic

Axial CECT shows marked glandular atrophy & numerous calcifications ➡ in the pancreas. The bile ducts ➡ are dilated due to stricture of the common duct within the pancreatic head.

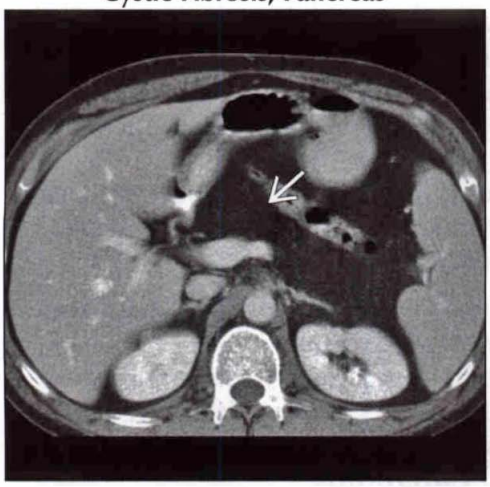
Senescent Change



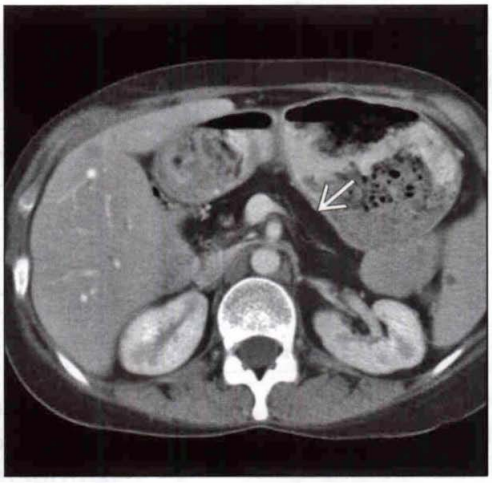
Axial NECT shows extensive fatty lobulation of the pancreas ➡ in an asymptomatic 80 year old woman with no clinical evidence of pancreatic disease.

ATROPHY OR FATTY REPLACEMENT OF PANCREAS

Cystic Fibrosis, Pancreas

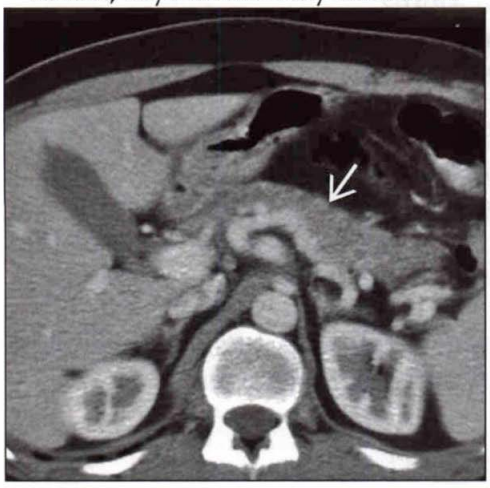


Steroid Medication

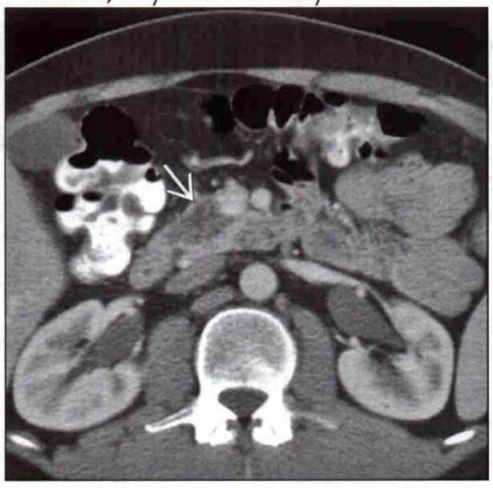


(Left) *Axial CECT shows classic lipomatous pseudohypertrophy of the pancreas ➡, associated with cystic fibrosis, in a 31 year old man.* ***(Right)*** *Axial CECT shows marked fatty replacement of the pancreas ➡ in a young woman with Crohn disease who is receiving steroid medications.*

Variant, Asymmetric Fatty Infiltration

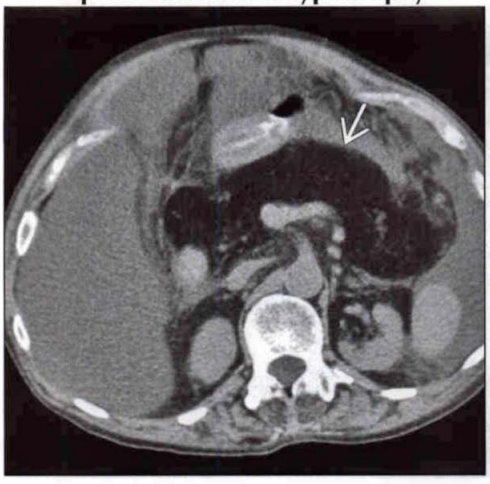


Variant, Asymmetric Fatty Infiltration

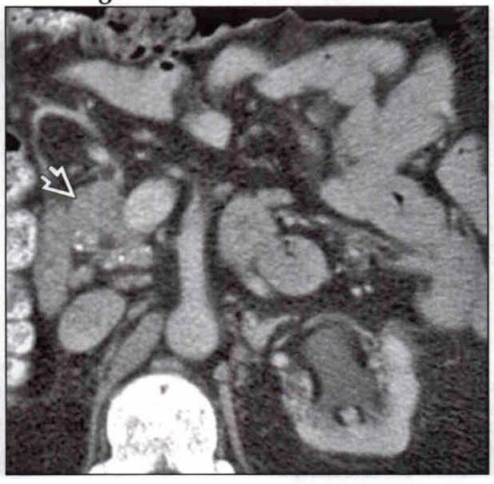


(Left) *Axial CECT shows a normal appearing body-tail segment of pancreas ➡ in a 33 year old man with fatty infiltration of the head-uncinate segment (normal variant).* ***(Right)*** *Axial CECT shows fatty infiltration of the head-uncinate segment ➡ of the pancreas in a 33 year old man with a normal appearing remainder of pancreas and no signs of pancreatic disease.*

Lipomatous Pseudohypertrophy



Agenesis of Dorsal Pancreas



(Left) *Axial NECT shows lipomatous pseudohypertrophy of the pancreas ➡ associated with chronic alcohol abuse and cirrhosis. Also note ascites.* ***(Right)*** *Axial CECT shows a prominent head-uncinate segment ➡, but no body-tail segment of pancreas.*

DILATED PANCREATIC DUCT

DIFFERENTIAL DIAGNOSIS

Common
- Pancreatic Ductal Carcinoma
- Pancreatitis, Chronic
- Senescent Change, Pancreas
- IPMT, Pancreas

Less Common
- Ampullary Carcinoma
- Duodenal Carcinoma
- Choledocholithiasis

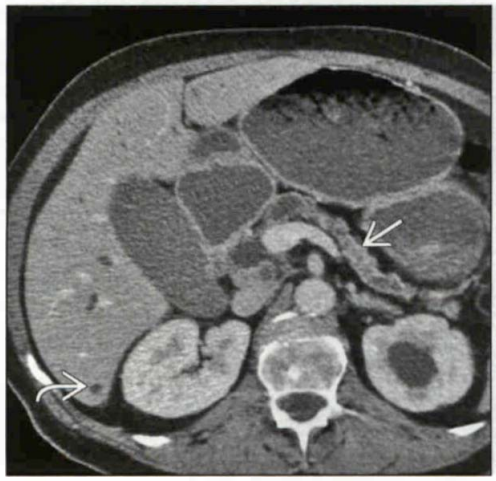
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Dilated pancreatic duct is usually a sign of intrinsic pancreatic disease
  - Islet cell, mucinous cystic, lymphoma & metastases of pancreas rarely cause ductal dilation

Helpful Clues for Common Diagnoses
- **Pancreatic Ductal Carcinoma**
  - Abrupt transition from dilated to narrowed
    - Hypoenhancing & hypoechoic mass at point of obstruction
    - Commonly associated with vascular invasion, nodes, liver metastases
- **Pancreatitis, Chronic**
  - Calcifications & atrophy of parenchyma
    - May cause fibrotic mass in pancreatic head that may obstruct bile duct; hard to distinguish from carcinoma
- **Senescent Change, Pancreas**
  - Elderly patients often have atrophy of gland, mild dilation of pancreatic duct
- **IPMT, Pancreas**
  - Intraductal pancreatic mucinous tumor (or neoplasm, IPMN)
  - Duct is often markedly dilated with mucous, causing bulging of papilla of Vater into duodenum
    - Main duct involvement, especially with polypoid lesions, indicates aggressive, often malignant lesion

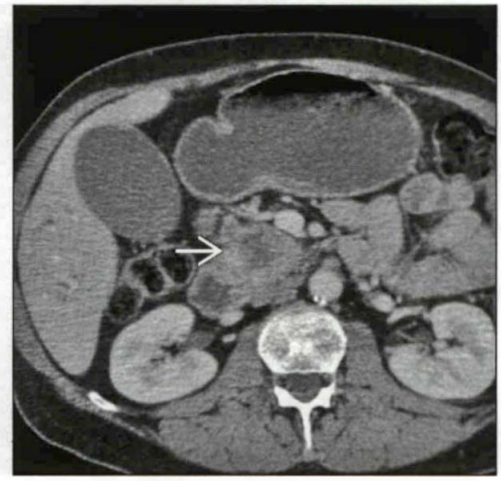
Helpful Clues for Less Common Diagnoses
- **Ampullary Carcinoma**
  - Often indistinguishable from pancreatic carcinoma except for smaller size & better prognosis
- **Duodenal Carcinoma**
  - Tumor that occludes ampulla of Vater may simulate all imaging features of pancreatic head carcinoma
  - Look for mass within lumen of duodenum (carcinoma, villous adenoma, carcinoid, etc.)
- **Choledocholithiasis**
  - Stone lodged in distal common channel can obstruct pancreatic & bile duct
  - Usually no mass, but may cause "gallstone pancreatitis" with swelling of pancreatic head
    - Correlate with history of sudden onset of pain; elevated pancreatic enzymes

Pancreatic Ductal Carcinoma



Axial CECT shows dilation of the duct and atrophy of the parenchyma ➡ in the pancreatic body-tail segments. Also noted: Dilated bile ducts & gallbladder and liver metastases ➡.

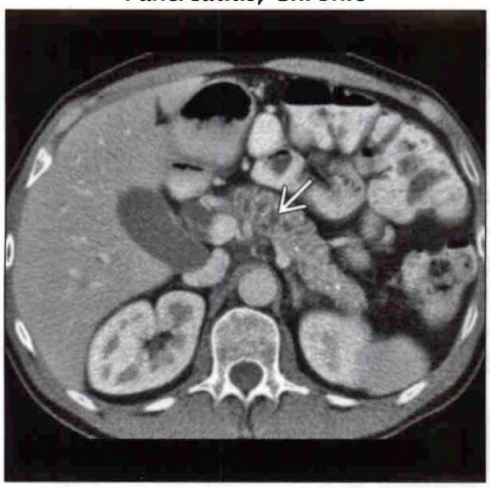
Pancreatic Ductal Carcinoma



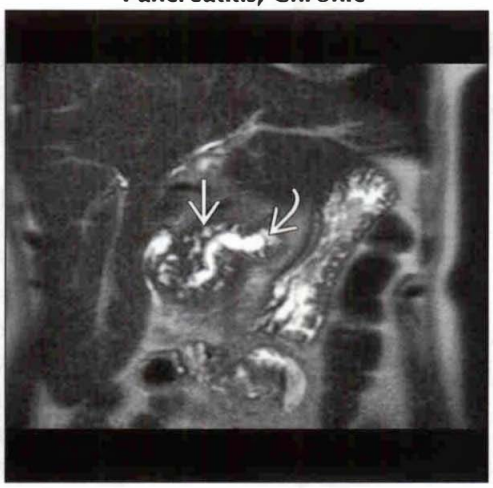
Axial CECT shows a hypodense mass ➡ in the pancreatic head that caused abrupt obstruction of the pancreatic and common bile duct.

DILATED PANCREATIC DUCT

Pancreatitis, Chronic



Pancreatitis, Chronic



(Left) *Axial CECT shows dilation and beading (irregularity) of the pancreatic duct, along with multiple parenchymal and ductal calculi.* ***(Right)*** *Coronal T2WI FS MR shows dilation and beading of the main and side branch pancreatic ducts.*

IPMT, Pancreas

IPMT, Pancreas

(Left) *Axial CECT shows gross dilation of the entire pancreatic duct and atrophy of the gland; main and side branch IPMN.* ***(Right)*** *Axial CECT shows gross dilation of the pancreatic duct and atrophy of the gland. In addition, there are papillary excrescences of tumor within the duct; malignant IPMN.*

Ampullary Carcinoma

Ampullary Carcinoma

(Left) *Axial CECT shows a dilated common duct and gallbladder in a patient with an ampullary tumor.* ***(Right)*** *Axial CECT shows dilation of the pancreatic and distal bile duct, along with an ampullary mass that bulges into the duodenal lumen.*

INFILTRATION OF PERIPANCREATIC FAT PLANES

DIFFERENTIAL DIAGNOSIS

Common
- Acute Pancreatitis
- Pancreatic Ductal Carcinoma
- Anasarca
- Portal Hypertension, Varices
- Traumatic Pancreatitis
- Duodenal Ulcer
- Gastric Ulcer

Less Common
- Shock Pancreas
- Sclerosing Mesenteritis
- Autoimmune Pancreatitis
- Groove Pancreatitis
- Metastases and Lymphoma, Pancreas
- Duodenal Diverticulitis
- Duodenal Diverticulum
- Diverticulitis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Any inflammatory or neoplastic process that arises in any of the structures abutting the pancreas may cause infiltration of fat planes
  - Especially viscera that share the anterior pararenal space (duodenum, ascending & descending colon)
  - Examples
    - Duodenal ulcer, trauma, or carcinoma
    - Diverticulitis or carcinoma of hepatic or splenic flexure

Helpful Clues for Common Diagnoses
- **Acute Pancreatitis**
  - Most common etiology
  - Inflammation throughout anterior pararenal space and mesentery
    - Ventral and lateral spread of inflammation
  - Often see thickening of anterior perirenal (Gerota) fascia
    - Forms the posterior border of anterior pararenal space
- **Pancreatic Ductal Carcinoma**
  - Infiltrates splenic, celiac and superior mesenteric vessels
    - Dorsal spread of tumor
  - About 5% of patients with pancreatic cancer develop clinical & biochemical signs of acute pancreatitis
    - May be the "presenting" signs & symptoms
- **Anasarca & Portal Hypertension**
  - Cause nonspecific and generalized edema and infiltration, especially of mesentery
  - Peripancreatic infiltration from anasarca or portal hypertension may be indistinguishable from that seen with acute pancreatitis
- **Traumatic Pancreatitis**
  - Imaging features same as for acute pancreatitis, plus "fracture plane"
  - If pancreatic duct is disrupted, leads rapidly to pseudocyst formation
    - Often requires distal pancreatectomy
- **Duodenal Ulcer**
  - Perforated ulcer may cause infiltration of anterior pararenal space (on right side), surrounding pancreatic head & neck
  - May penetrate into pancreas and cause pancreatitis
  - Look for extraluminal gas and enteric contrast material
- **Gastric Ulcer**
  - More commonly perforates into lesser sac
    - Look for extraluminal gas & fluid
  - May penetrate posteriorly into body of pancreas & cause pancreatitis

Helpful Clues for Less Common Diagnoses
- **Shock Pancreas**
  - Does not indicate pancreatic (or bowel) injury
  - Same setting as for "shock bowel"
    - Usually following head or spine trauma &/or significant blood loss
    - Often victims of blunt trauma who were hypotensive on arrival to the emergency department
    - Patients have usually been fluid resuscitated prior to CT scan, but the mesenteric, bowel wall, & peripancreatic edema remain (or get worse, temporarily)
    - Edematous changes usually resolve within 24 hours
  - Intense mucosal enhancement of small bowel with submucosal and mesenteric edema
  - Peripancreatic infiltration mimics traumatic pancreatitis; may be impossible to distinguish by imaging alone

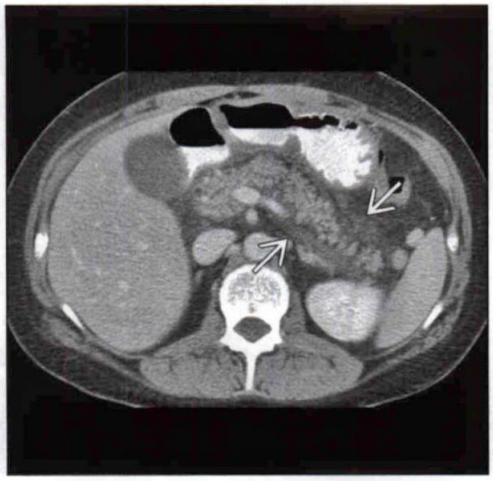
- Presence of "shock bowel" makes traumatic pancreatitis less likely
- No fracture plane through pancreatic parenchyma

- **Sclerosing Mesenteritis**
  - Autoimmune inflammation of mesentery
    - Also known as retractile mesenteritis, fibrosing mesenteritis, panniculitis, etc.
    - Usual appearance is fibrofatty mesenteric mass with thin capsule & sparing of fat halo around mesenteric vessels
    - Also with cluster of minimally enlarged mesenteric nodes
  - Infiltrated fat planes are usually in the jejunal mesentery, caudal to the pancreas, not truly "peripancreatic"
  - Any cause of "misty mesentery" can infiltrate peripancreatic fat planes as well
- **Autoimmune Pancreatitis**
  - Thin capsule around peripancreatic infiltration with "sausage-shaped" pancreas
  - Usually much less extensive peripancreatic infiltration than with other causes of acute pancreatitis
  - May cause biliary &/or pancreatic ductal dilation
    - Indistinguishable from primary sclerosing cholangitis
  - Often associated with other autoimmune diseases
    - Retroperitoneal fibrosis
    - Primary sclerosing cholangitis (PSC)
    - Thyroiditis
- **Groove Pancreatitis**
  - Inflammation and fibrosis arising in "groove" between 2nd portion of duodenum and head of pancreas
  - Often associated with cystic lesions in medial wall of duodenum
- **Metastases and Lymphoma, Pancreas**
  - Lymphoma, in particular, is liable to infiltrate pancreas & peripancreatic fat planes
  - May simulate pancreatitis on CT, but rarely clinically
- **Duodenal Diverticulum**
  - May perforate spontaneously or after intubation; "duodenal diverticulitis"
  - Imaging and clinical signs simulate pancreatitis
    - Identification of diverticulum & extraluminal gas or enteric contrast are key
- **Diverticulitis**
  - Involving ascending or descending colon
  - May spread laterally within the anterior pararenal space to the peripancreatic region

SELECTED REFERENCES

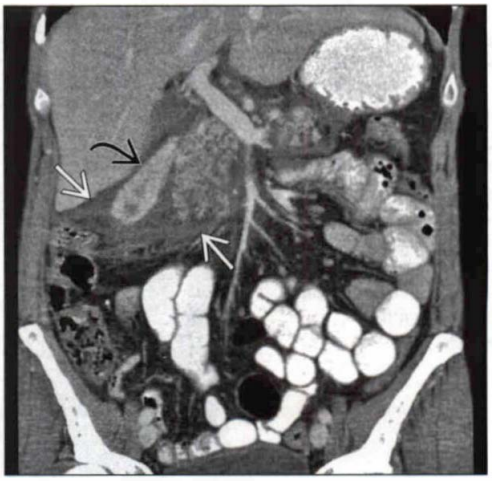
1. Ames JT et al: Perforated duodenal diverticulum: clinical and imaging findings in eight patients. Abdom Imaging.

Acute Pancreatitis



Axial CECT shows infiltration of the peripancreatic fat planes ventral and dorsal to the gland, while the pancreas itself appears unremarkable.

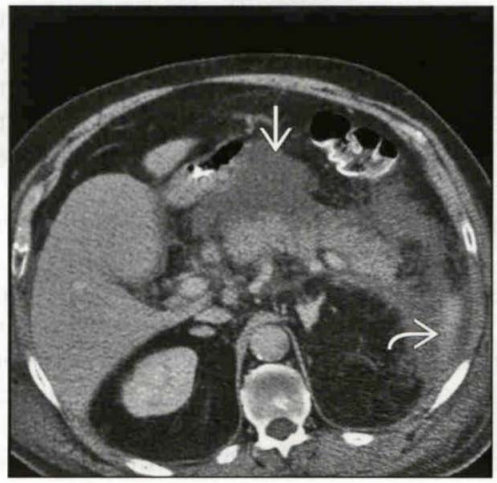
Acute Pancreatitis



Coronal CECT shows infiltration of the peripancreatic fat planes extending along the superior mesenteric vessels and duodenum with thickening of the duodenal walls & narrowing of its lumen.

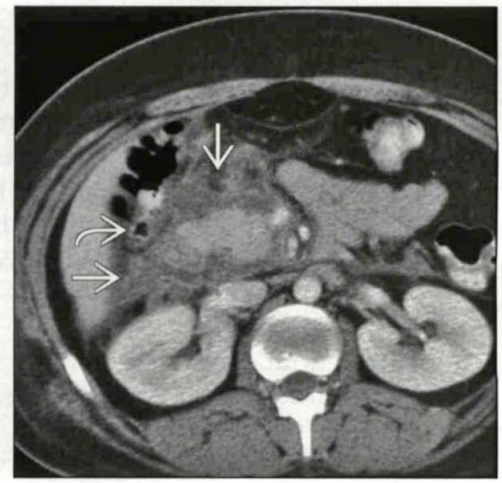
INFILTRATION OF PERIPANCREATIC FAT PLANES

Acute Pancreatitis



*(Left) Axial CECT shows infiltration of the peripancreatic fat planes, primarily ventrally and laterally, in this case extending to the descending colon, causing narrowing of its lumen. **(Right)** Axial CECT shows infiltration of the peripancreatic fat planes, in this patient more extensively on the right side with encasement of the ascending colon.*

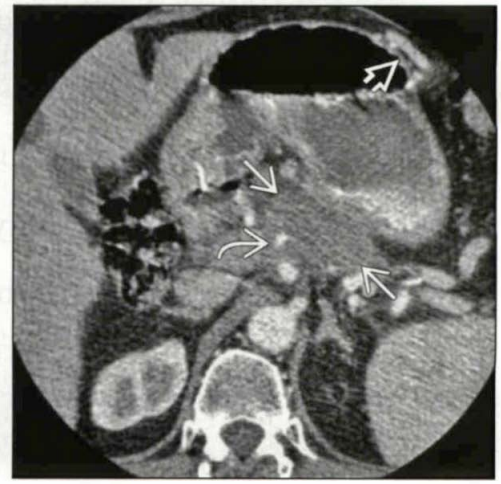
Acute Pancreatitis



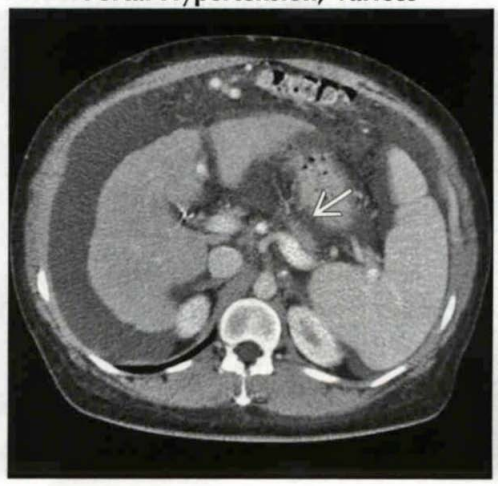
Pancreatic Ductal Carcinoma

*(Left) Axial CECT shows a pancreatic carcinoma with extensive infiltration of fat planes, primarily dorsal to the gland, with encasement of the celiac arterial axis and portal vein. **(Right)** Axial CECT shows a hypodense mass in the body of the pancreas with extension dorsally to encase the celiac axis and its branches. The splenic and portal veins were also narrowed, as indicated by enlarged collateral veins.*

Pancreatic Ductal Carcinoma



Portal Hypertension, Varices

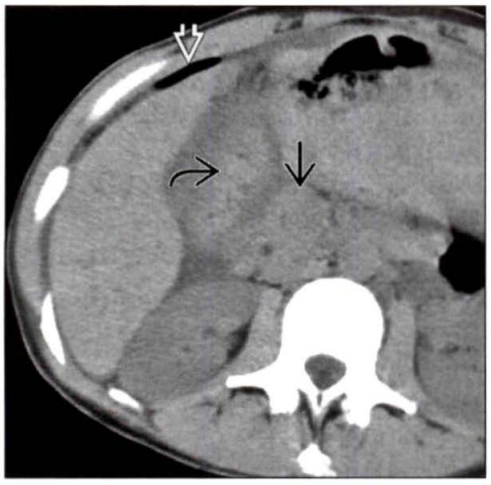


*(Left) Axial CECT shows cirrhosis with portal hypertension, evident as ascites, varices, and splenomegaly. In this setting, it is impossible to distinguish peripancreatic edema that might result from acute pancreatitis. **(Right)** Axial CECT shows a fracture plane through the mid pancreas with extensive peripancreatic edema and active bleeding.*

Traumatic Pancreatitis

INFILTRATION OF PERIPANCREATIC FAT PLANES

Duodenal Ulcer

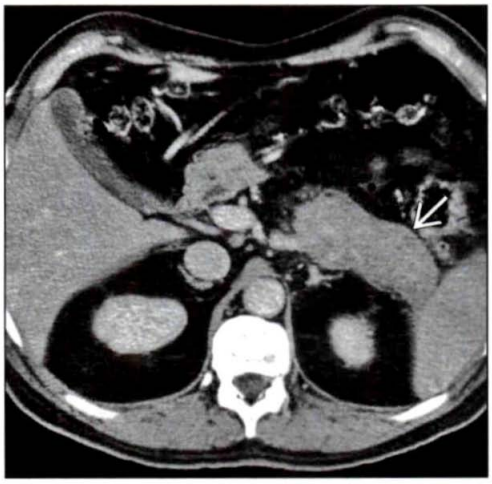


Shock Pancreas

(Left) *Axial NECT shows extensive infiltration of fat in the right anterior pararenal space, encasing the duodenum and head of pancreas. Free intraperitoneal gas & fluid help to identify a perforated duodenal ulcer as the cause.* ***(Right)*** *Axial CECT shows infiltration of fat planes around the pancreas & in the mesentery along with a "shock bowel" appearance of intense mucosal enhancement & submucosal edema.*

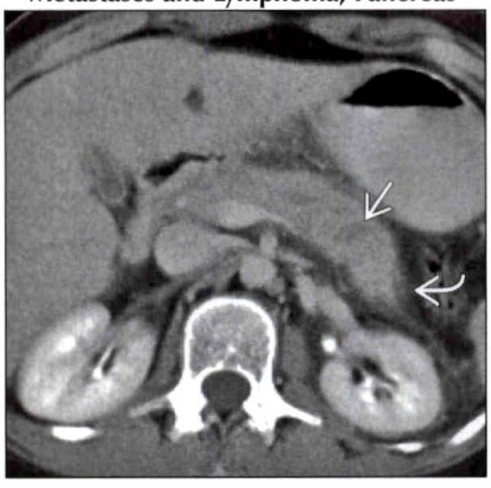
Sclerosing Mesenteritis

Autoimmune Pancreatitis

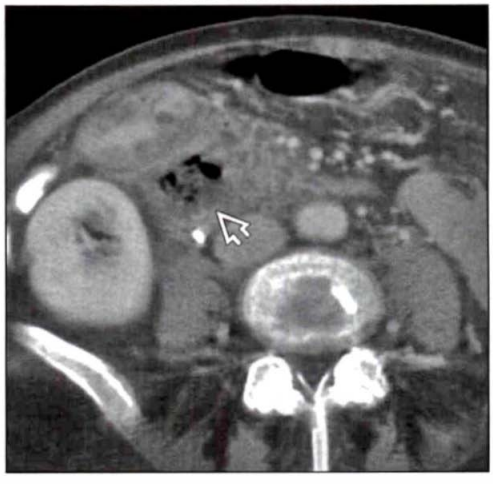


(Left) *Axial CECT shows extensive infiltration of the jejunal mesentery, caudal to the pancreas, with a thin capsule and small mesenteric nodes.* ***(Right)*** *Axial CECT shows a sausage-shaped enlargement of the pancreatic body with subtle infiltration of surrounding fat, seemingly limited by a thin capsule.*

Metastases and Lymphoma, Pancreas



Duodenal Diverticulitis



(Left) *Axial CECT shows one of several small hypodense pancreatic masses, along with infiltrated fat planes. The patient also had renal and subcutaneous masses that were FDG-avid on PET; acute lymphoblastic lymphoma.* ***(Right)*** *Axial CECT shows extraluminal gas & fluid near the 2nd portion of duodenum and pancreatic head, along with extensive inflammatory infiltration. Perforated duodenal diverticulum.*

PANCREATIC CALCIFICATIONS

DIFFERENTIAL DIAGNOSIS

Common
- Chronic Pancreatitis
- Pancreatic Pseudocyst
- Senescent Change, Pancreas
- Vascular Lesions, Peripancreatic
- Choledocholithiasis (Mimic)
- Duodenal Diverticulum (Mimic)

Less Common
- Mucinous Cystic Pancreatic Tumor
- Cystic Fibrosis, Pancreas
- Pancreatic Islet Cell Tumors
- Serous Cystadenoma, Pancreas
- Solid and Papillary Neoplasm
- IPMT, Pancreas
- Hereditary Pancreatitis

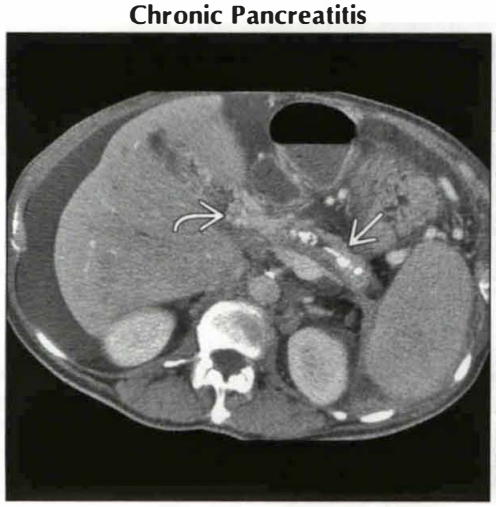
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Consider shape, number & distribution of calcifications

Helpful Clues for Common Diagnoses
- **Chronic Pancreatitis**
  - Alcoholic etiology is most common
  - Calcified protein plugs obstruct ducts
  - Size: 1 mm-1 cm; multiple
  - Glandular atrophy, dilated ducts
- **Senescent Change, Pancreas**
  - Patients older than 70, asymptomatic
  - Wall may calcify; curvilinear or eggshell; may have ductal calculi
  - Several small calculi (1-3 mm)
  - Uncommonly obstruct ducts
- **Vascular Lesions, Peripancreatic**
  - Splenic artery: "Tram track" calcification
  - Splenic artery aneurysm (oval, eggshell)
  - Splenic vein; wall or thrombus calcification in portal hypertension
- **Choledocholithiasis (Mimic)**
  - Calcified stone in distal common bile duct
- **Duodenal Diverticulum (Mimic)**
  - Oral contrast (or pills) within diverticulum

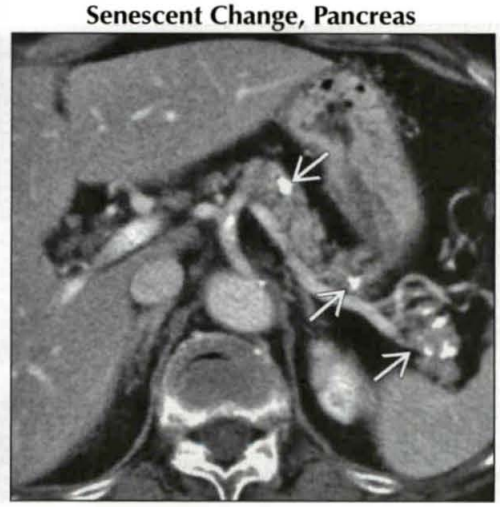
Helpful Clues for Less Common Diagnoses
- **Mucinous Cystic Pancreatic Tumor**
  - Curvilinear in wall & septa of cyst
  - Usually asymptomatic mass in middle-aged woman
- **Cystic Fibrosis, Pancreas**
  - Small calcifications, plus lipomatous pseudohypertrophy; ± cysts
- **Pancreatic Islet Cell Tumors**
  - Coarse, irregular, central or eccentric in solid, vascular mass
- **Serous Cystadenoma, Pancreas**
  - In central stellate confluence of septa
  - Large mass with "sponge" appearance
- **Solid and Papillary Neoplasm**
  - Eccentric or rim calcified around necrotic portion of tumor; young woman
- **Hereditary Pancreatitis**
  - Pancreatic calcifications in child or young adult
  - Large, multiple stones

Chronic Pancreatitis



Axial CECT shows calcifications ➡ along the course of the pancreatic duct & parenchymal atrophy. The liver is cirrhotic & the portal vein is thrombosed ➡ with cavernous transformation.

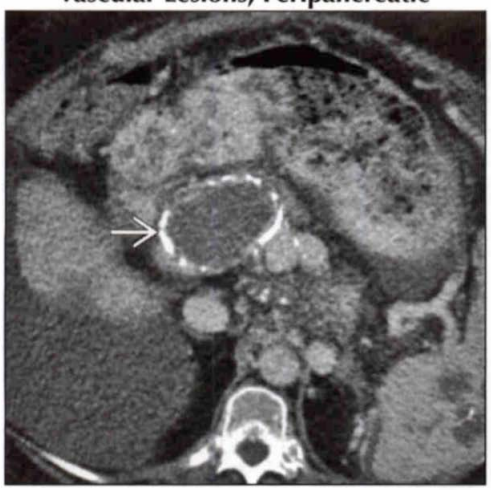
Senescent Change, Pancreas



Axial CECT shows several small calcifications ➡ in a mildly atrophic gland in this 88 year-old woman with no history or clinical evidence of chronic pancreatitis.

PANCREATIC CALCIFICATIONS

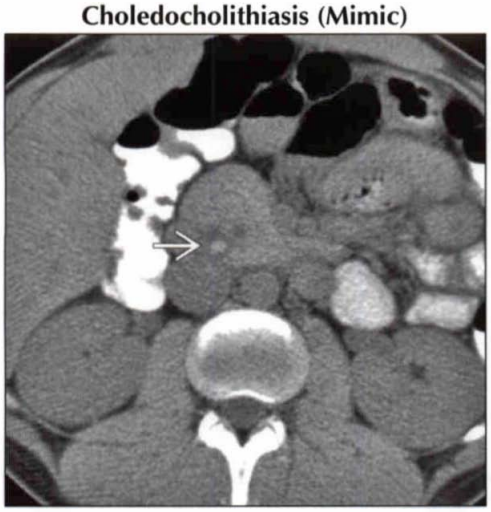
Vascular Lesions, Peripancreatic



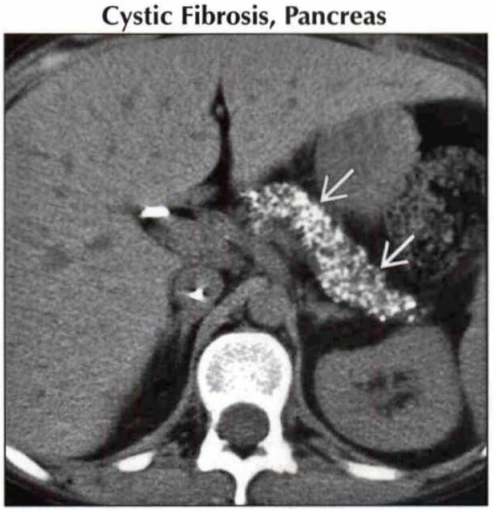
Vascular Lesions, Peripancreatic

(Left) *Axial CECT shows a rim-calcified lesion that represents a thrombosed portal vein aneurysm in a patient with cirrhosis and portal hypertension.* ***(Right)*** *Axial CECT shows a splenic artery pseudoaneurysm with calcification of the arterial wall, and both patent & thrombosed portions of the pseudoaneurysm.*

Choledocholithiasis (Mimic)

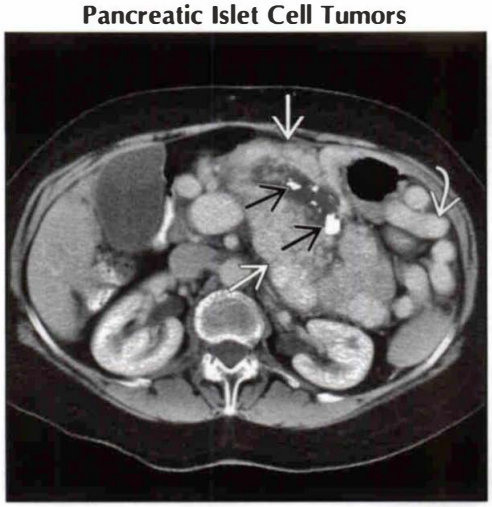


Cystic Fibrosis, Pancreas

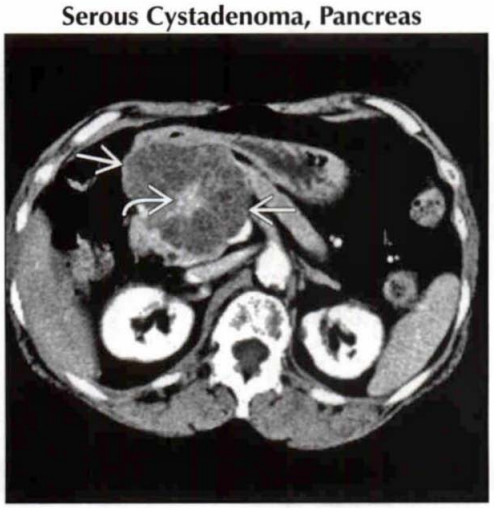


(Left) *Axial NECT shows a small calculus in the distal common bile duct that is faintly radiopaque on this NECT.* ***(Right)*** *Axial NECT shows extensive calcification throughout the pancreas in a young adult with cystic fibrosis. An IVC filter and clips from a cholecystectomy are noted incidentally.*

Pancreatic Islet Cell Tumors



Serous Cystadenoma, Pancreas



(Left) *Axial CECT shows an unusually large islet cell tumor with large focal calcifications. Large varices are due to splenic vein occlusion by the tumor.* ***(Right)*** *Axial CECT shows a classic serous cystadenoma in the pancreatic head, with innumerable small cysts imparting a sponge or honeycomb appearance of the mass. At the central confluence of the septa, there is focal calcification.*

SECTION 13
Retroperitoneum

Generic Imaging Patterns

Retroperitoneal Mass, Cystic	13-2
Retroperitoneal Mass, Soft Tissue Density	13-8
Retroperitoneal Mass, Fat-Containing	13-14
Retroperitoneal Hemorrhage	13-16

RETROPERITONEAL MASS, CYSTIC

DIFFERENTIAL DIAGNOSIS

Common

- Renal Cystic Masses
  - Renal Cyst
  - Renal Cell Carcinoma (Cystic)
  - Multilocular Cystic Nephroma
- Pancreatic Cystic Masses
  - Pancreatic Pseudocyst
  - Mucinous Cystic Neoplasm
  - Serous (Microcystic) Cystadenoma

Less Common

- Adrenal Cystic Masses
  - Adrenal Adenoma (Mimic)
  - Adrenal Cyst
  - Adrenal Seroma (Hematoma)
- Retroperitoneal Cystic Masses
  - Retroperitoneal Seroma (Hematoma)
  - Retroperitoneal Sarcoma (Mimic)
  - Retroperitoneal Lymphocele
  - Urinoma
  - Retroperitoneal Abscess
  - Lymphangioma

Rare but Important

- Cystic Retroperitoneal Mesothelioma
- Lymphangioleiomyomatosis, Retroperitoneum
- Tailgut Cyst
- Necrosis of Solid Neoplasm
- Pseudomyxoma Retroperitonei

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Most retroperitoneal cystic masses are easily recognized as arising from solid organs
  - Kidney
  - Pancreas
  - Adrenal
- "Cyst mass" may be a fluid collection
  - Evolving hematoma
  - Seroma
  - Urinoma
- Other retroperitoneal cystic masses are uncommon to rare

Helpful Clues for Common Diagnoses

- **Renal Cystic Masses**
  - **Renal Cyst**
    - By far, the most common "retroperitoneal" cystic mass (> 50% of older adults)
  - **Renal Cell Carcinoma (Cystic)**
    - Small percentage are cystic, but usually have mural nodularity to exclude simple cyst
    - Look for "claw sign" to determine renal origin
  - **Multilocular Cystic Nephroma**
    - Complex, multicystic mass with invagination into renal hilum
    - Indistinguishable from cystic renal cell carcinoma
    - Biphasic age distribution
    - Boys between 3 months & 2 years old (90% tumors)
    - Females: < 5 years and peak in 5th & 6th decades
- **Pancreatic Cystic Masses**
  - **Pancreatic Pseudocyst**
    - Most common mass, especially in symptomatic patient with history of alcohol abuse or gallstones
  - **Mucinous Cystic Neoplasm**
    - Most common cystic pancreatic tumor
    - Multiseptated mass in body/tail, with mural nodularity
    - Middle-aged or older woman
  - **Serous (Microcystic) Cystadenoma**
    - Sponge or honeycomb appearance of well-encapsulated mass
    - Much less common is macrocystic variant, with fewer & larger cystic spaces
  - Other pancreatic cystic masses
    - Islet cell tumor
    - Solid & pseudopapillary neoplasm
    - Metastases

Helpful Clues for Less Common Diagnoses

- **Adrenal Cystic Masses**
  - **Adrenal Adenoma (Mimic)**
    - Lipid-rich adenoma appears near water attenuation on NECT, but enhances, unlike cysts
  - **Adrenal Cyst**
    - Water density
    - No enhancement
    - No visible wall
  - **Adrenal Seroma (Hematoma)**
    - Evolving hematoma will become more homogeneous and lower in attenuation

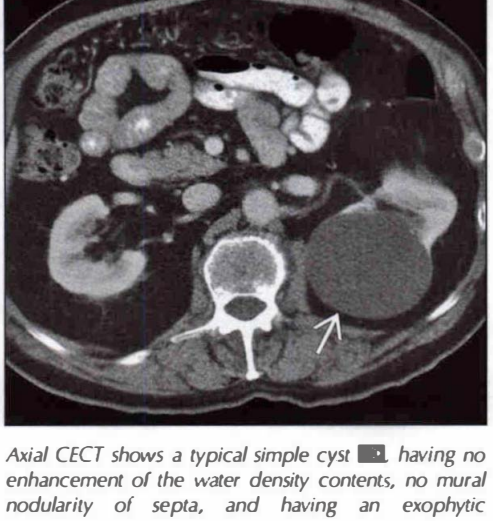
RETROPERITONEAL MASS, CYSTIC

- **Retroperitoneal Cystic Masses**
  - **Retroperitoneal Seroma (Hematoma)**
    - Evolving retroperitoneal hematoma (e.g., following ruptured aortic aneurysm, or anticoagulation-induced hemorrhage)
    - May become homogeneous, near water attenuation collection
    - Compare with prior studies, history of hemorrhage
  - **Retroperitoneal Sarcoma (Mimic)**
    - Myxoid liposarcoma may have near-water attenuation on CT, but it is a solid mass
    - Lower attenuation is myxoid element, or mixture of poorly differentiated fat & other tumor elements
  - **Retroperitoneal Lymphocele**
    - Lymph "pseudocyst" resulting from surgical disruption of pelvic or retroperitoneal lymphatics
    - Renal or pancreatic transplant
    - Common after node dissection/resection for prostate or bladder cancer
  - **Urinoma**
    - Perirenal or general retroperitoneal collection of urine, following ureteral obstruction & disruption of renal collecting system or ureter
  - **Retroperitoneal Abscess**
    - Complex appearing, may contain gas
    - Perirenal is most common
    - Retroperitoneal perforation of appendix or diverticulitis are also well-recognized sources
    - Patient is symptomatic (fever, increased white count)
  - **Lymphangioma**
    - Discrete, asymmetrical water (or less than water) density mass
    - Many thin septations, ± calcifications
    - Very soft, easily indented by adjacent vessels

Helpful Clues for Rare Diagnoses

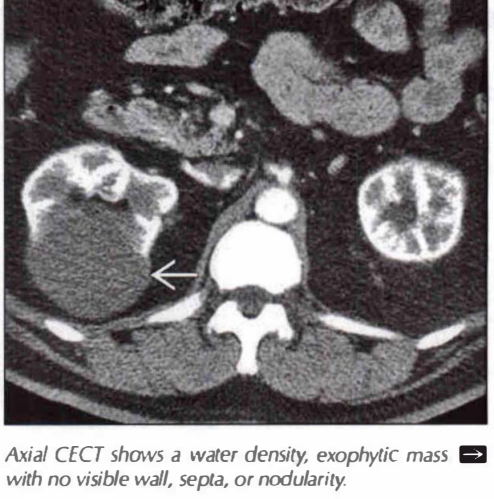
- **Cystic Retroperitoneal Mesothelioma**
  - Much less common than pleural or peritoneal mesothelioma
  - May be unilocular
- **Lymphangioleiomyomatosis, Retroperitoneum**
  - Proliferation of smooth muscle cells within lymphatics causes obstruction and mass
- **Tailgut Cyst**
  - Found in retrorectal (presacral) space
  - May be either unilocular or multilocular
  - Filled with mucoid material which may be echogenic on ultrasound
- **Necrosis of Solid Neoplasm**
  - Any retroperitoneal tumor may be hypovascular or necrotic enough to simulate a cystic mass
- **Pseudomyxoma Retroperitonei**
  - May occur in isolation, without intraperitoneal disease

Renal Cyst



Axial CECT shows a typical simple cyst ■ having no enhancement of the water density contents, no mural nodularity of septa, and having an exophytic component.

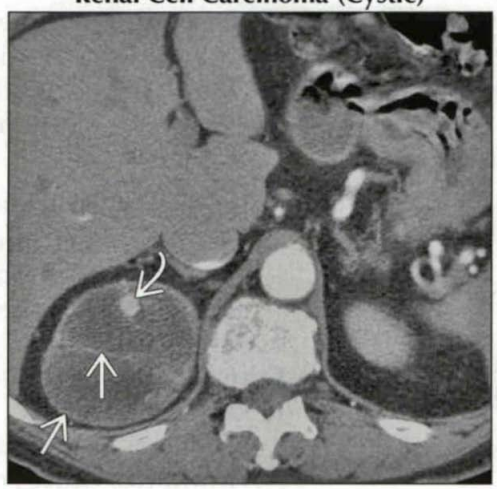
Renal Cyst



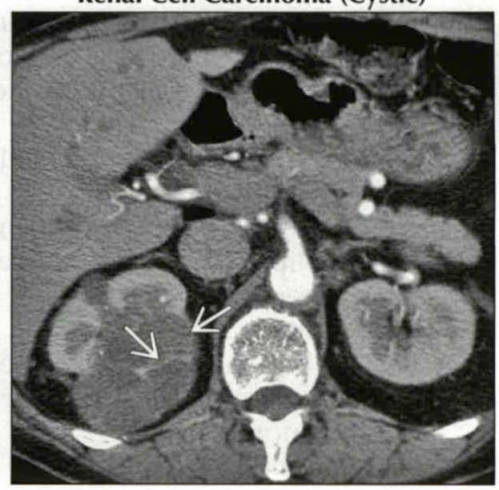
Axial CECT shows a water density, exophytic mass ➡ with no visible wall, septa, or nodularity.

RETROPERITONEAL MASS, CYSTIC

Renal Cell Carcinoma (Cystic)

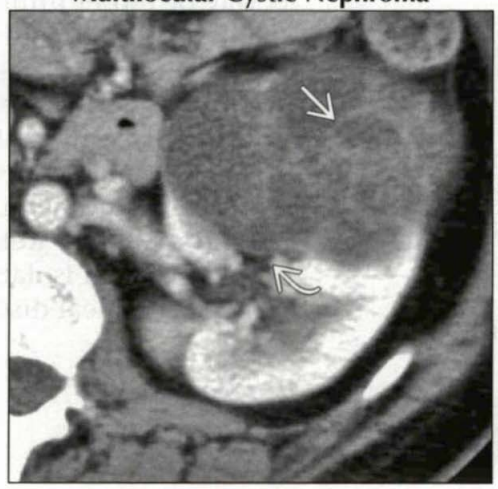


Renal Cell Carcinoma (Cystic)

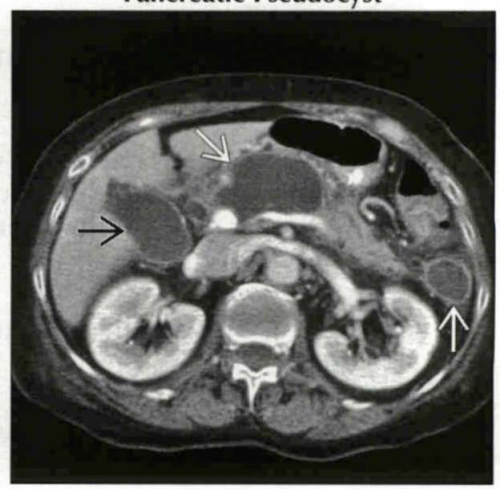


*(**Left**) Axial CECT shows a complex mass arising from the upper pole, having a visible and contrast-enhancing peripheral wall & septa plus enhancing nodularity. (**Right**) Axial CECT shows a complex cystic mass with enhancing septa and peripheral wall.*

Multilocular Cystic Nephroma



Pancreatic Pseudocyst



*(**Left**) Axial CECT shows a complex cystic mass with thin enhancing septa. Note invagination into the renal hilum, a characteristic feature of this tumor. (**Right**) Axial CECT shows two retroperitoneal cystic masses that are pseudocysts, following an episode of necrotizing pancreatitis. The pseudocyst dorsal to the descending colon has higher density contents and an enhancing wall due to infection. The gallbladder is also seen.*

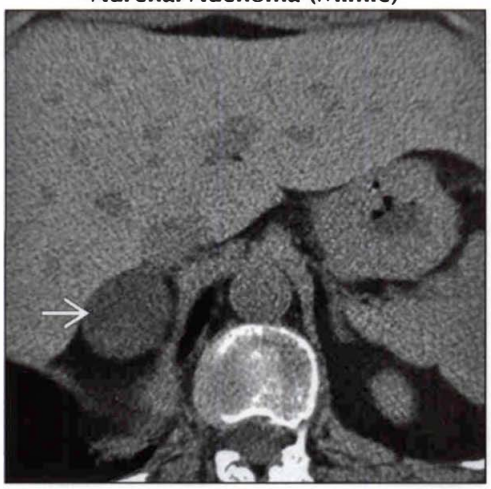
Mucinous Cystic Neoplasm

Serous (Microcystic) Cystadenoma

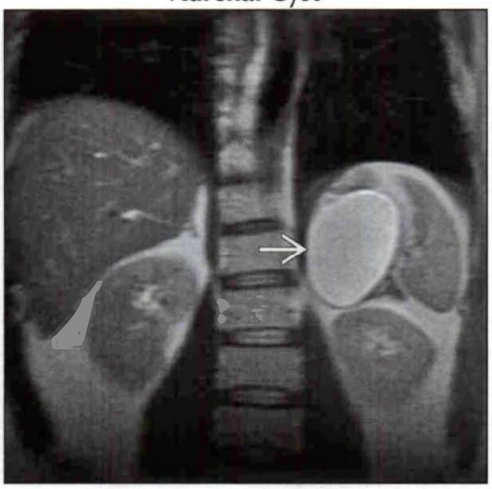
*(**Left**) Axial CECT shows a complex cystic pancreatic mass with relatively few and large cystic spaces separated by enhancing septa. There is minimal dilation of the upstream pancreatic duct and no parenchymal atrophy. (**Right**) Axial CECT shows a large mass arising from the pancreatic head, with a sponge or honeycomb appearance due to innumerable tiny cystic spaces. Some of the septa have focal calcifications.*

RETROPERITONEAL MASS, CYSTIC

Adrenal Adenoma (Mimic)

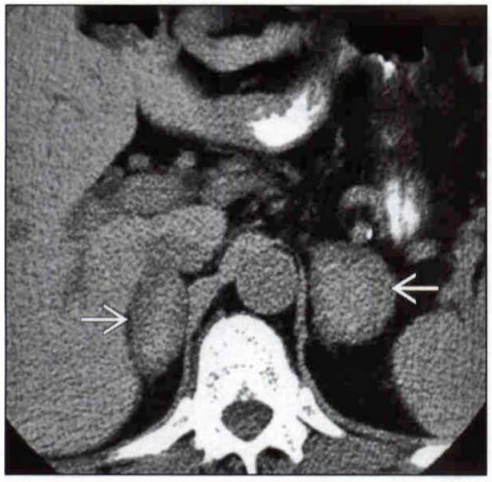


Adrenal Cyst



(Left) *Axial NECT shows a water density, but solid mass ➡ in the right adrenal, a typical appearance of a lipid-rich adenoma on NECT. The lesion enhanced to "soft tissue density" (40 HU) after contrast administration.* ***(Right)*** *Coronal T2WI MR shows a uniformly high intensity mass ➡ in the left suprarenal region, a typical appearance for an adrenal cyst.*

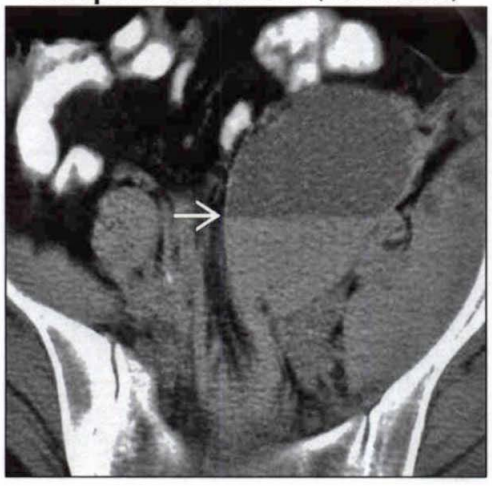
Adrenal Seroma (Hematoma)



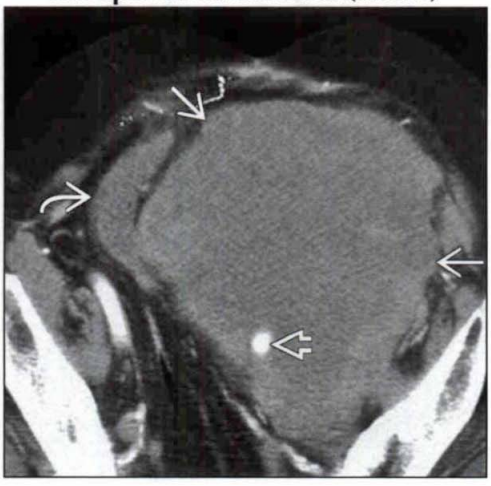
Adrenal Seroma (Hematoma)

(Left) *Axial NECT shows bilateral heterogeneously high attenuation masses ➡ in the adrenal glands due to acute hemorrhage. These evolved into water density seromas.* ***(Right)*** *Axial CECT shows bilateral small water density, nonenhancing masses ➡ in the adrenal glands, 12 weeks after a prior CT scan had shown larger, heterogeneously high attenuation masses due to acute hemorrhage.*

Retroperitoneal Seroma (Hematoma)



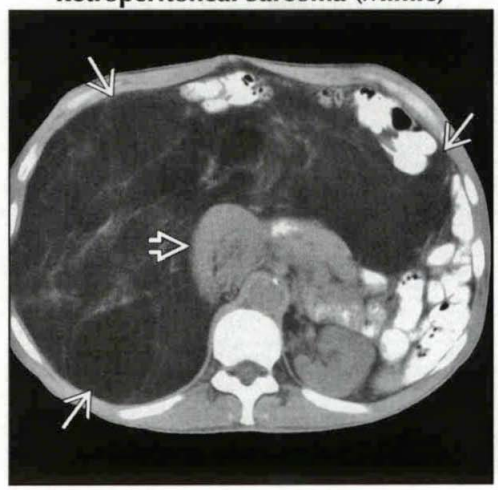
Retroperitoneal Sarcoma (Mimic)



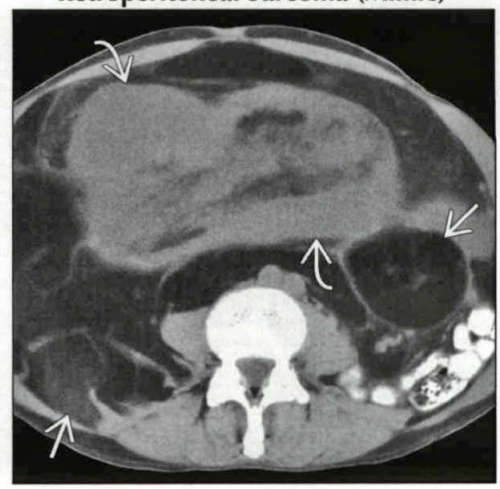
(Left) *Axial NECT shows a retroperitoneal hemorrhage centered in the iliopsoas compartment. Note the hematocrit sign ➡ with a cell-fluid level indicative of a coagulopathic hemorrhage.* ***(Right)*** *Axial CECT shows a large retroperitoneal mass ➡ that is of near water attenuation due to poorly differentiated liposarcoma with myxoid elements. The mass displaces the urinary bladder ➡ and left iliac vessels ➡.*

RETROPERITONEAL MASS, CYSTIC

Retroperitoneal Sarcoma (Mimic)

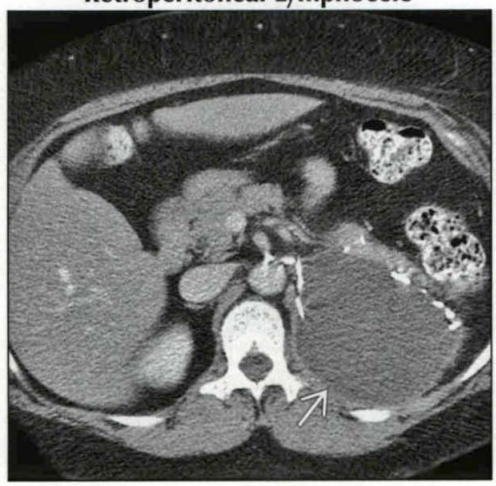


Retroperitoneal Sarcoma (Mimic)

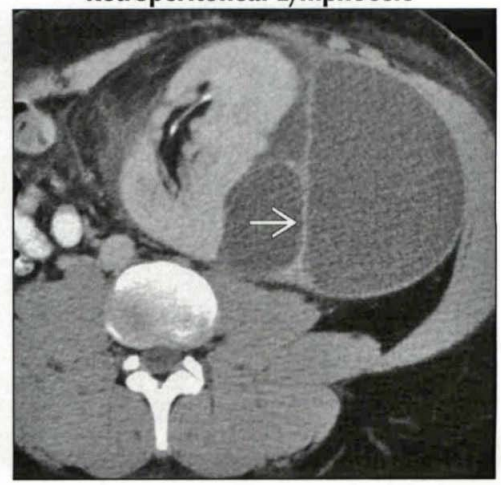


(Left) *Axial CECT shows a huge retroperitoneal mass that is mostly of near-fat density, representing a liposarcoma. Note displacement of retroperitoneal structures, including the right kidney and ascending colon.* ***(Right)*** *Axial CECT shows a huge retroperitoneal mass that contains large foci of fat density and others of soft tissue or "water" attenuation the latter representing myxoid or poorly differentiated sections of the tumor.*

Retroperitoneal Lymphocele

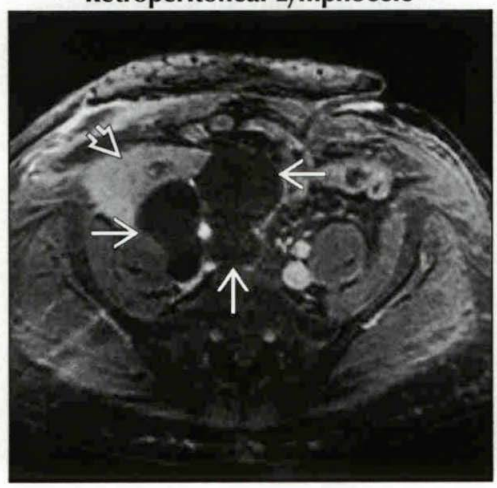


Retroperitoneal Lymphocele



(Left) *Axial CECT shows a water density, nonenhancing mass in the left nephrectomy bed. Asymptomatic patient following resection for renal cell carcinoma.* ***(Right)*** *Axial CECT shows a water density mass with several thin internal septa displacing a renal allograft.*

Retroperitoneal Lymphocele

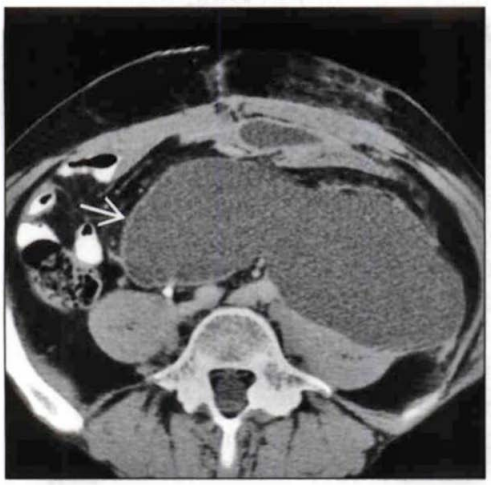


Retroperitoneal Lymphocele

(Left) *Axial T1 C+ FS MR shows a septate cystic mass medial and inferior to a renal allograft a typical appearance of a post-transplant lymphocele.* ***(Right)*** *Coronal T1 C+ FS MR shows a septate, cystic mass medial and inferior to a renal allograft that caused partial obstruction of the ureter and transplant dysfunction.*

RETROPERITONEAL MASS, CYSTIC

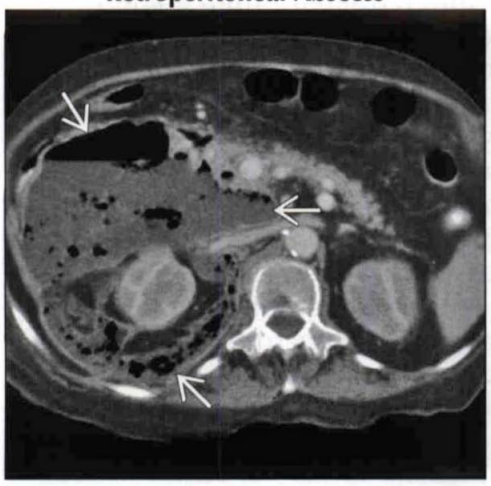
Urinoma



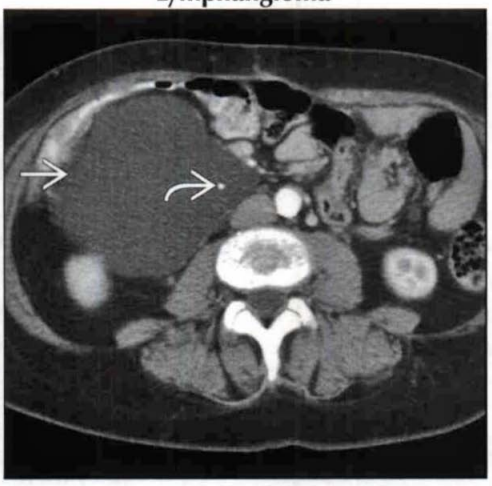
Urinoma

(Left) Axial NECT shows a large retroperitoneal cystic mass with no apparent enhancement. This was a urinoma that occurred following prior resection of a colon carcinoma. (Right) Axial CECT shows a water density retroperitoneal urinoma due to ureteral injury that occurred during resection of the left colon.

Retroperitoneal Abscess

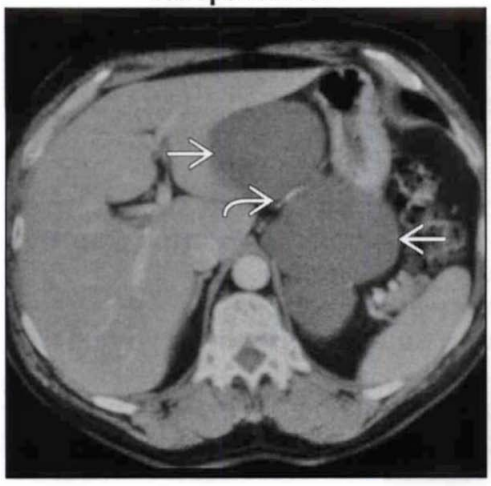


Lymphangioma

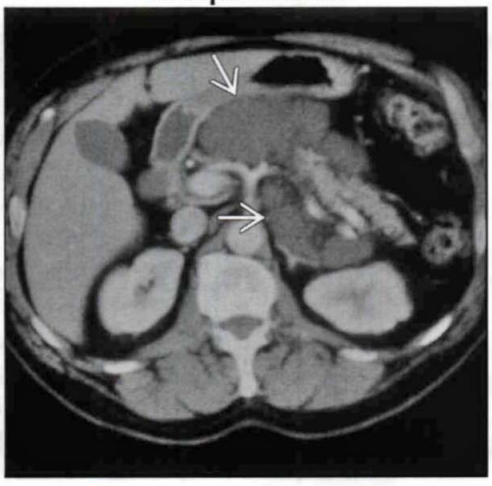


(Left) Axial CECT shows a huge collection of fluid (pus) and gas in the retroperitoneum as a result of duodenal perforation, caused by endoscopic papillotomy & biliary stone extraction. (Right) Axial CECT shows a large water density cyst that displaces abdominal & retroperitoneal structures. The presence of a small calcification suggests thin septa that are difficult to detect.

Lymphangioleiomyomatosis, Retroperitoneum



Lymphangioleiomyomatosis, Retroperitoneum



(Left) Axial CECT shows a septate cystic retroperitoneal (or lesser sac) mass that is indented by the left gastric artery, indicating its soft consistency; 53 year old man. (Right) Axial CECT shows contiguous cystic, septate retroperitoneal masses that surround the pancreas and celiac axis but cause no obstructive signs or symptoms; 53 year old man.

RETROPERITONEAL MASS, SOFT TISSUE DENSITY

DIFFERENTIAL DIAGNOSIS

Common
- Lymphoma
- Metastases
- Sarcoma
- Retroperitoneal Hemorrhage
- Post-Transplant Lymphoproliferative Disorder
- Infectious/Inflammatory Nodes
- Duplications and Anomalies of IVC
- Collateral Vessels and Varices
- Retroperitoneal Fibrosis
- Unopacified Bowel (Mimic)

Less Common
- Nerve Sheath Tumors
  - Neurofibroma
  - Ganglioneuroma
  - Plexiform Neurofibroma
  - Malignant Peripheral Nerve Sheath Tumor
  - Neurilemoma, Retroperitoneal
  - Paraganglioma
- Leukemia, Abdominal Manifestations
- Malignant Fibrous Histiocytoma
- Hemangiopericytoma, Retroperitoneal

Rare but Important
- Extramedullary Hematopoiesis
- Lymphangioleiomyomatosis
- Primary Retroperitoneal Seminoma
- Primary Retroperitoneal Teratoma
- Chordoma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- First determine the location and origin of the mass
  - Is it arising from a retroperitoneal organ (e.g., kidney, adrenal, pancreas)?
  - Look for "beak" sign (distortion of the contour of the organ by an exophytic mass arising from it)
  - If it causes anterior displacement of a retroperitoneal structure (e.g., ascending or descending colon, aorta, IVC), it is retroperitoneal
    - If not arising from an organ, it is considered a primary retroperitoneal mass
- Most retroperitoneal masses are malignant
  - Lymphoma > metastases > primary sarcoma

Helpful Clues for Common Diagnoses
- **Lymphoma**
  - Non-Hodgkin > Hodgkin for abdominal disease, especially with mesenteric nodes
  - Discrete or confluent nodes surrounding aorta & IVC; symmetrical
- **Metastases**
  - Most common primary sites: Pelvic malignancy > melanoma, breast, lung, others; asymmetrical
- **Sarcoma**
  - Large eccentric mass that displaces abdominal viscera
  - Liposarcoma is most common type
    - Often contains foci of near-fat density, but also areas of "water" or soft tissue density (representing the myxoid or poorly differentiated ["high grade"] portions of the tumor)
    - Myxoid regions appear hyperintense on T2WI and show delayed enhancement
    - However, other fibrous tumors may have similar delayed enhancement (neurogenic tumors, and malignant fibrous histiocytoma)
  - Leiomyosarcoma
    - Large, encapsulated, soft tissue density mass with foci of necrosis
- **Retroperitoneal Hemorrhage**
  - Coagulopathic or ruptured aneurysm
  - Fluid of high density dissects along fascial planes
- **Infectious/Inflammatory Nodes**
  - Hepatitis, mononucleosis, tuberculosis, sarcoid
- **Duplications and Anomalies of IVC**
  - Cylindrical shape, characteristic enhancement pattern
  - Left-sided IVC joins left renal vein
- **Collateral Vessels and Varices**
  - Bypassing occluded or absent IVC
  - Portal hypertension (varices often shunt to renal and gonadal veins)
- **Retroperitoneal Fibrosis**
  - Mantle of tissue encasing lower aorta, IVC, ureters
  - Often causes ureteral obstruction and medial deviation

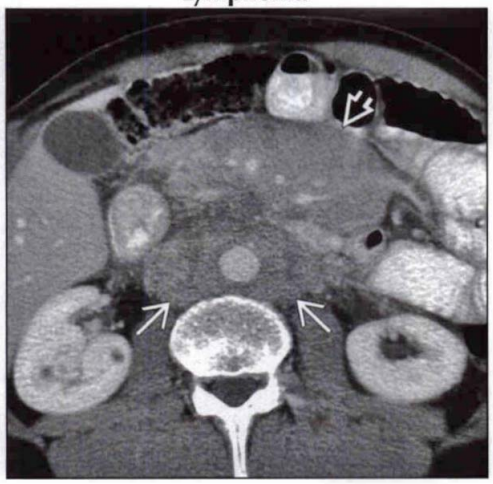
Helpful Clues for Less Common Diagnoses

- **Neurofibroma**
  - Benign nerve sheath tumor
  - May occur as isolated finding or as part of neurofibromatosis
  - High signal on T2WI
- **Plexiform Neurofibroma**
  - Invariably associated with neurofibromatosis, type 1
    - Other findings of NF1 include acoustic nerve schwannomas, meningiomas, cafe-au-lait skin pigmentation
  - Plexiform tumors are benign, elongated, symmetrical masses that parallel the psoas muscle; may extend into presacral pelvis
  - Usually hypodense to muscle on CECT; may have swirled pattern of enhancement
- **Malignant Peripheral Nerve Sheath Tumor**
  - Also part of NF1 complex
  - Suggested by asymmetrical retroperitoneal mass in patient with this syndrome
- **Neurilemoma, Retroperitoneal**
  - More often spherical (rather than elongated like other masses)
  - Well-encapsulated; central necrosis
- **Paraganglioma**
  - Occur along the sympathetic nerve chain
  - Often hypervascular with central necrosis
  - Very bright on T2WI
  - Same histology and biochemistry as pheochromocytoma
- **Malignant Fibrous Histiocytoma**
  - Most common soft tissue sarcoma in adults
  - But only 15% arise in retroperitoneum or abdomen
  - Nonspecific appearance of soft tissue density, asymmetric mass
- **Hemangiopericytoma, Retroperitoneal**
  - May extend into pelvis
  - Asymmetric large mass with foci of necrosis
  - Most characteristic feature is hypervascularity
    - Most other retroperitoneal tumors are hypovascular

Helpful Clues for Rare Diagnoses

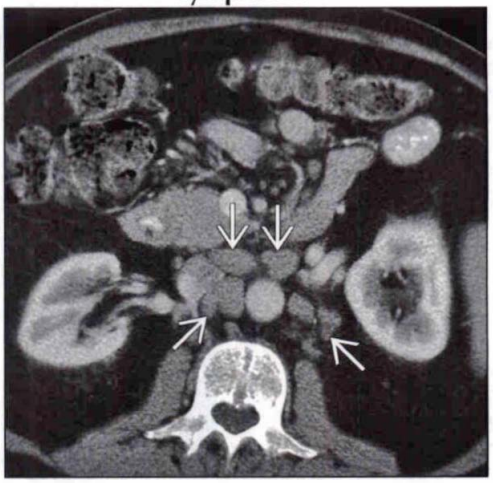
- **Extramedullary Hematopoiesis**
  - In patients with myelodysplastic conditions or hemoglobinopathies
  - Can affect virtually any organ or site
    - Paraspinal and perirenal masses may result
    - Other abdominal sites include the liver and spleen
- **Primary Retroperitoneal Seminoma**
  - Most or all represent metastases from testicular primary germ cell malignancy
  - Testicular mass is often clinically silent and may be represented only by a scarred lesion

Lymphoma



Axial CECT shows retroperitoneal lymphadenopathy ➡ that surrounds the aorta & IVC, and mesenteric adenopathy ➡ that surrounds the mesenteric vessels (the "sandwich sign").

Lymphoma



Axial CECT shows more discrete enlargement of individual retroperitoneal nodes ➡ in this patient with mantle cell NHL.

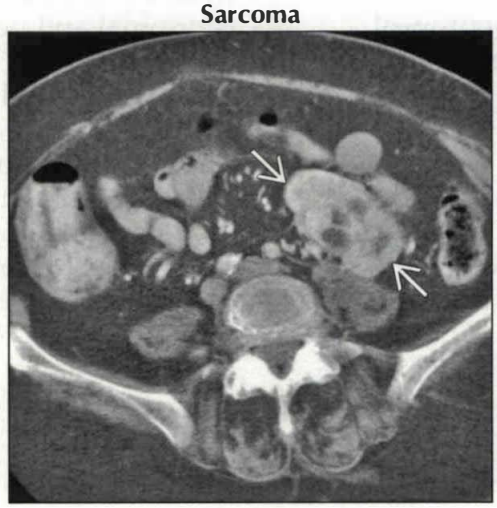
RETROPERITONEAL MASS, SOFT TISSUE DENSITY

Metastases

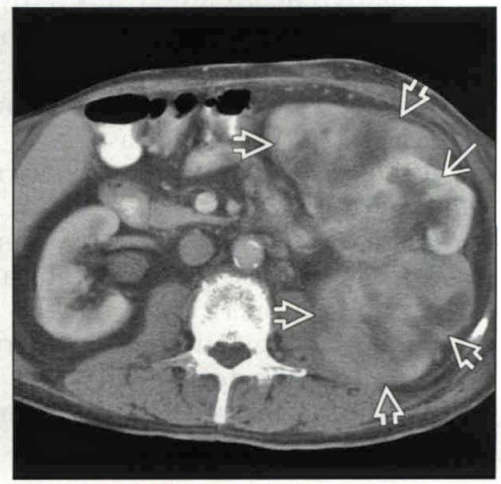
Metastases

(Left) *Axial CECT shows a huge mass of retroperitoneal nodes ➡ from metastatic testicular carcinoma. Note the low density and asymmetric shape of the nodal mass, both common features of this disease, but would be unusual for lymphoma.* ***(Right)*** *Axial CECT shows periaortic and retrocaval adenopathy ➡ from metastatic bladder carcinoma.*

Sarcoma

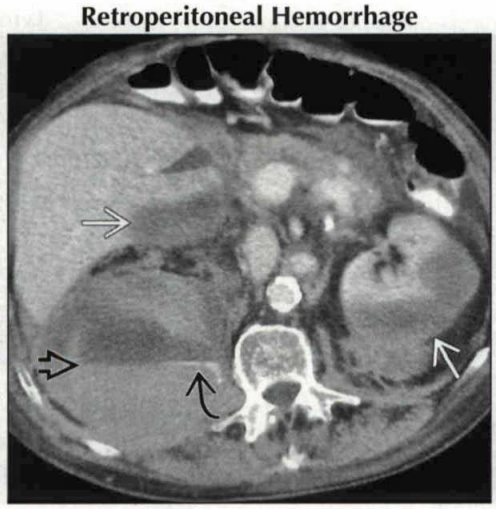


Sarcoma

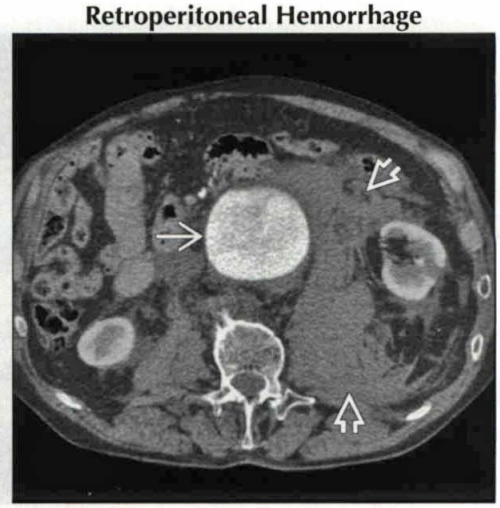


(Left) *Axial CECT shows a hypervascular solid mass ➡ with foci of necrosis just ventral to the psoas muscle; primary leiomyosarcoma.* ***(Right)*** *Axial CECT shows a huge mass ⇄ that displaces and envelopes the kidney ➡. In spite of the apparent absence of fat-density tissue, this was a liposarcoma, predominantly poorly differentiated (pleomorphic; myxoid).*

Retroperitoneal Hemorrhage

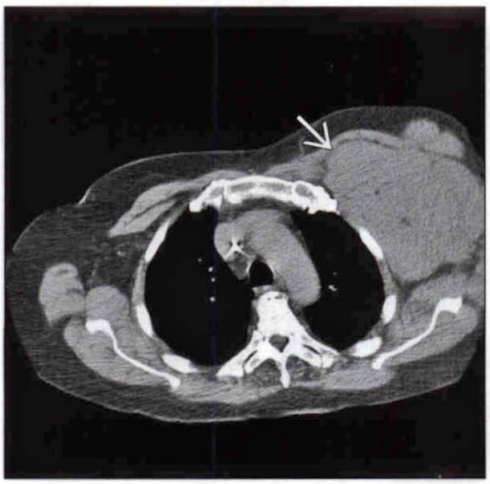


Retroperitoneal Hemorrhage

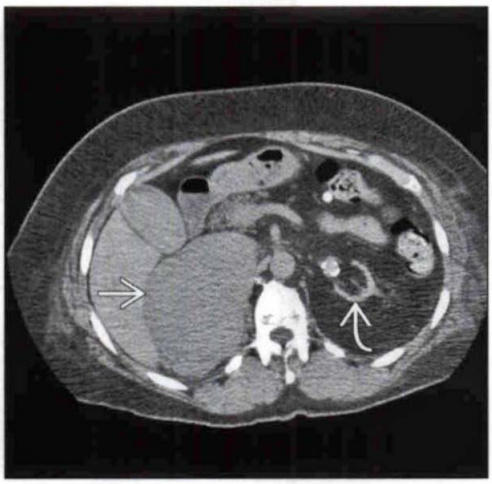


(Left) *Axial CECT shows multiple classic signs of a coagulopathic hemorrhage, including involvement of the iliopsoas compartment, the "hematocrit sign" ⇄, multiple sites of hemorrhage ➡, and active bleeding ⇄.* ***(Right)*** *Axial CECT shows a classic retroperitoneal hemorrhage due to a ruptured abdominal aortic aneurysm, including a large aneurysm ➡ and contiguous blood that tracks through multiple compartments of the retroperitoneum ⇄.*

Post-Transplant Lymphoproliferative Disorder

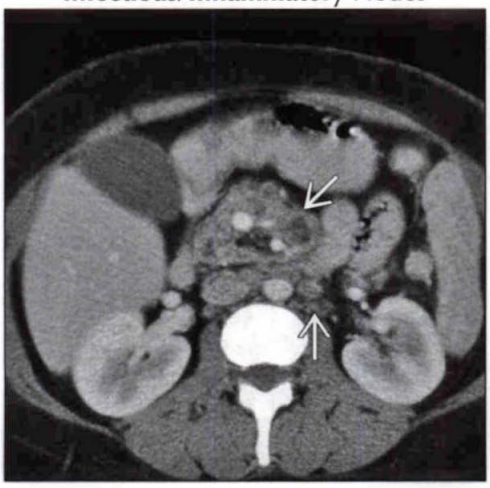


Post-Transplant Lymphoproliferative Disorder

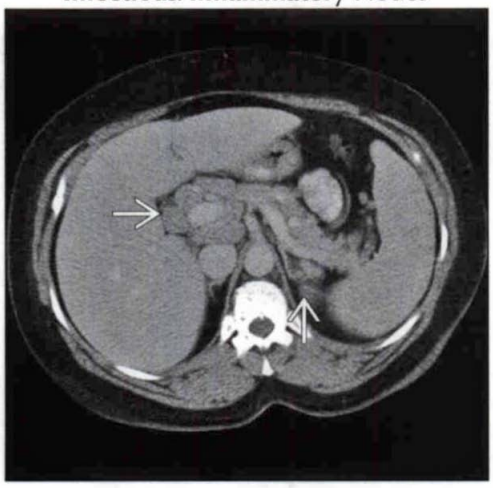


(Left) *Axial NECT shows massive axillary adenopathy in a patient with a renal transplantation who had generalized PTLD.* ***(Right)*** *Axial NECT shows massive right retroperitoneal adenopathy due to PTLD in a patient with a renal transplant. Note end stage left kidney.*

Infectious/Inflammatory Nodes

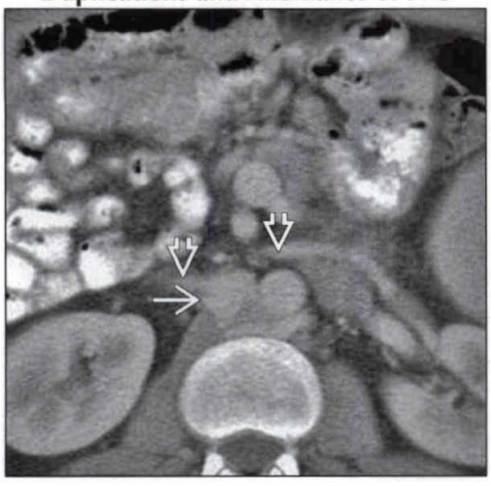


Infectious/Inflammatory Nodes

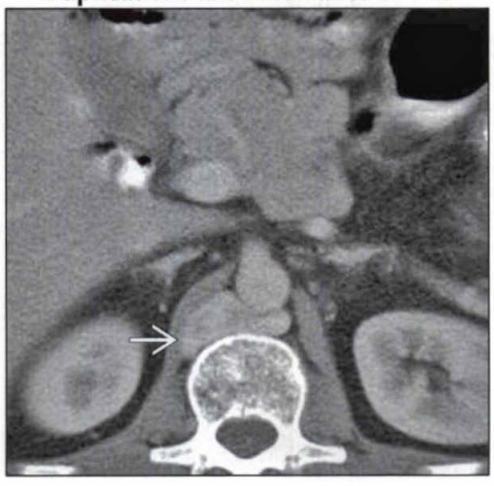


(Left) *Axial CECT shows enlarged retroperitoneal and mesenteric nodes in a patient with AIDS, due to systemic HIV infection.* ***(Right)*** *Axial CECT shows portocaval and retroperitoneal lymphadenopathy, plus an enlarged and heterogeneous liver and spleen, all due to sarcoidosis.*

Duplications and Anomalies of IVC



Duplications and Anomalies of IVC

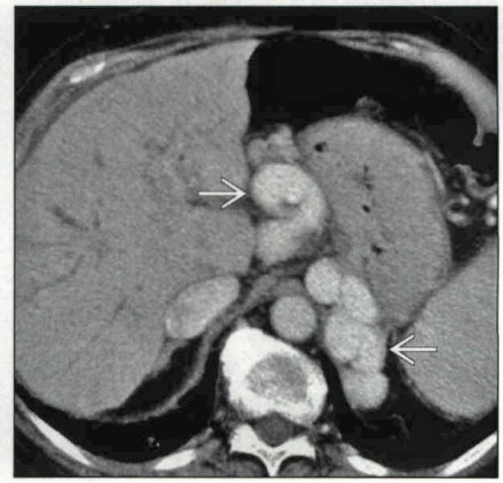


(Left) *Axial CECT shows both renal veins draining into the IVC, which does not continue cephalad, but extends behind the right crus as an azygous continuation.* ***(Right)*** *Axial CECT shows azygous continuation of an interrupted IVC, simulating a retrocrural mass.*

RETROPERITONEAL MASS, SOFT TISSUE DENSITY

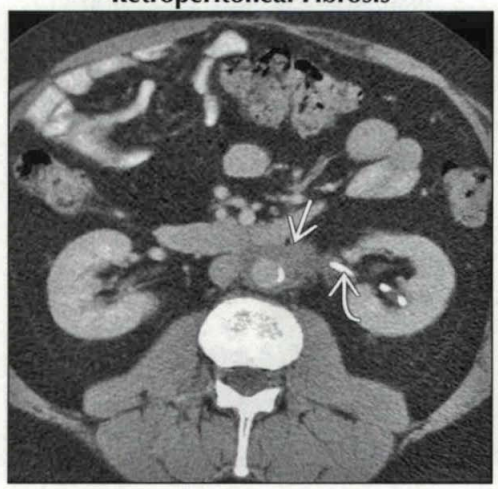
Collateral Vessels and Varices

Collateral Vessels and Varices

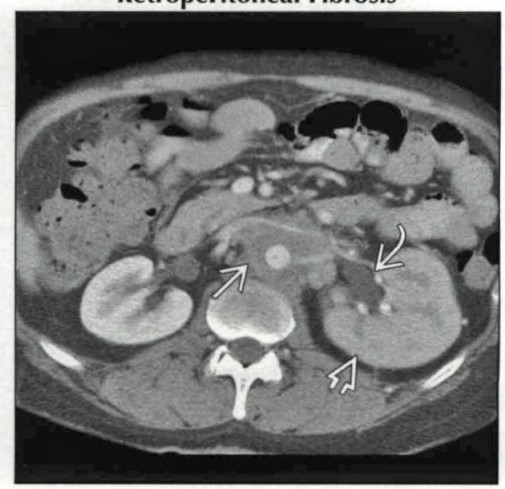


(Left) *Axial CECT shows enormous varices that surround the left kidney and empty into the IVC through a spontaneous splenorenal shunt. If the varices had not been opacified by an adequate IV bolus of contrast media, they might have been mistaken for a retroperitoneal mass.* ***(Right)*** *Axial CECT shows large varices medial and posterior to the stomach that are easily recognized on this CECT, but would simulate a mass on NECT.*

Retroperitoneal Fibrosis

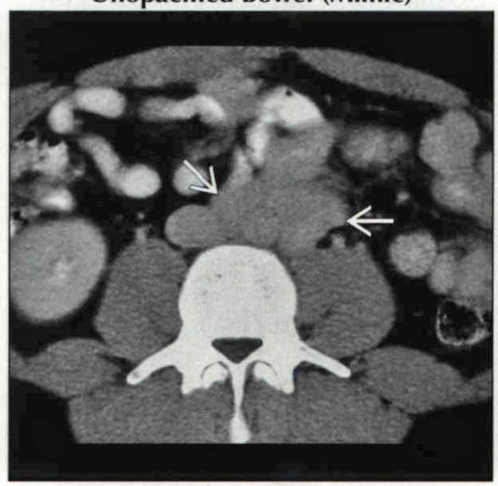


Retroperitoneal Fibrosis



(Left) *Axial CECT shows the classic appearance of a mantle of soft tissue that encases the aorta & IVC, and which obstructs the ureters. Note the left ureteral stent.* ***(Right)*** *Axial CECT shows a mass that encases the aorta & IVC, partially obstructing the left renal artery, leading to decreased perfusion of the left kidney and the left ureter, leading to hydronephrosis.*

Unopacified Bowel (Mimic)

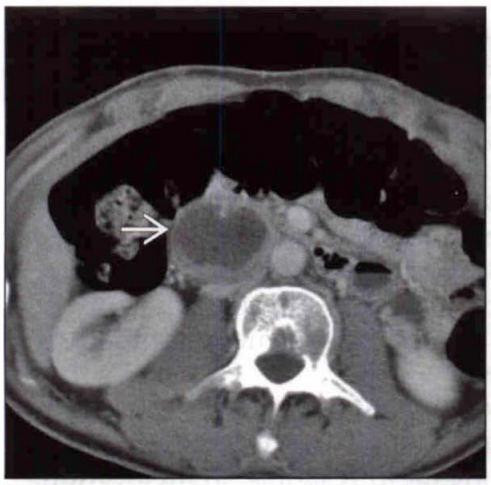


Ganglioneuroma

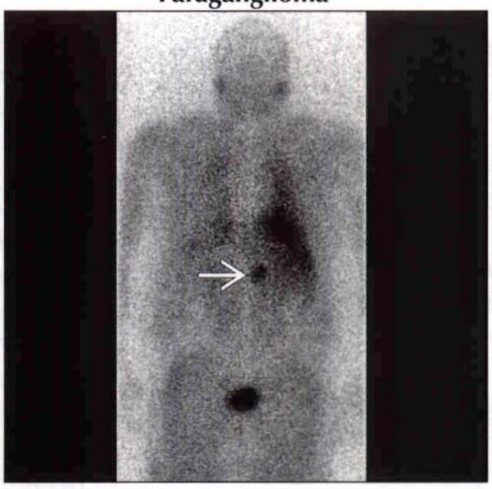
(Left) *Axial CECT shows what appears to be a soft tissue density mass around the aorta that actually represents unopacified bowel.* ***(Right)*** *Axial CECT shows an eccentric soft tissue density mass that had a cylindrical shape and paralleled the IVC and right iliac vessels, but did not invade or obstruct the ureters; ganglioneuroma.*

RETROPERITONEAL MASS, SOFT TISSUE DENSITY

Plexiform Neurofibroma

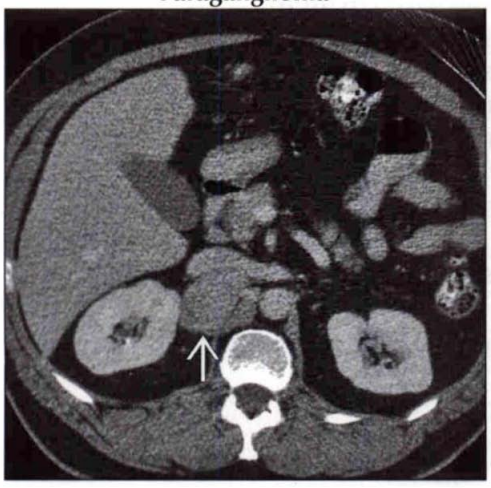


Paraganglioma

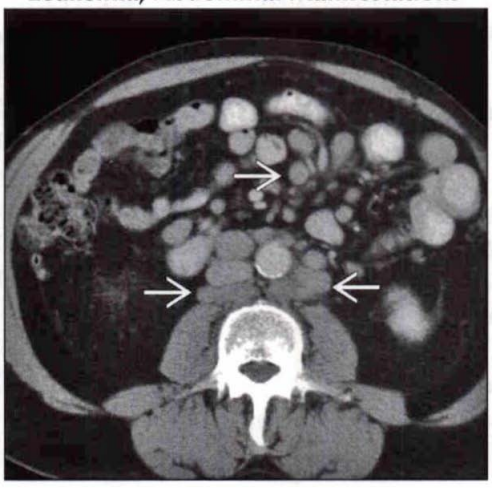


*(Left) Axial CECT shows part of an extensive abdominal and retroperitoneal mass in a patient with neurofibromatosis, type 1, representing plexiform neurofibroma. **(Right)** Coronal MIBG scintigraphy shows a focal uptake of MIBG in the right paraspinal region, suggesting a pheochromocytoma in the adrenal gland, or a paraganglioma in extra-adrenal tissue along the sympathetic axis.*

Paraganglioma

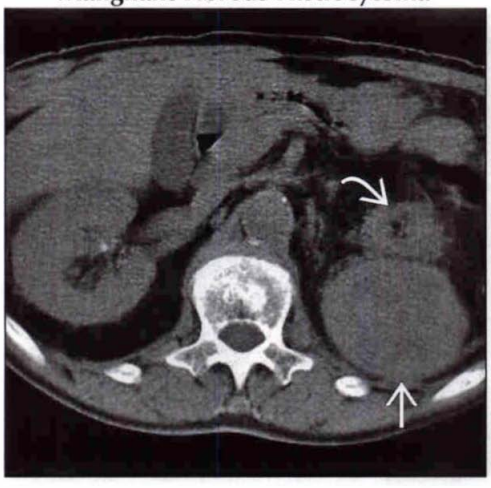


Leukemia, Abdominal Manifestations

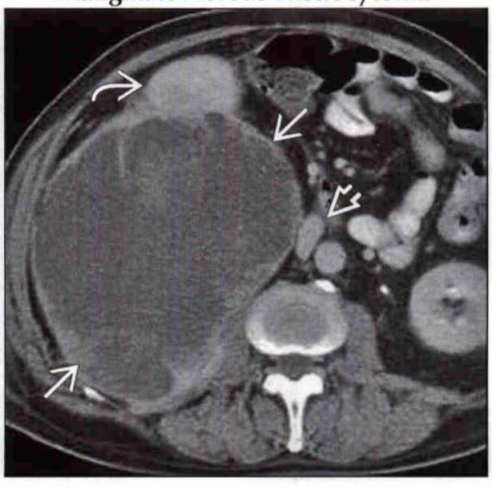


***(Left)** Axial CECT shows a right retroperitoneal mass that proved to be a paraganglioma on MIBG scan and resection. **(Right)** Axial CECT shows retroperitoneal and mesenteric adenopathy resembling that typical of lymphoma, but in a patient with chronic lymphocytic leukemia.*

Malignant Fibrous Histiocytoma



Malignant Fibrous Histiocytoma



***(Left)** Axial NECT shows a large soft tissue density mass that displaces the kidney forward. There is no means of distinguishing this from other retroperitoneal tumors, such as a leiomyosarcoma, on imaging alone. **(Right)** Axial CECT shows a large, heterogeneous retroperitoneal mass that displaces the kidney forward and the IVC to the left.*

RETROPERITONEAL MASS, FAT-CONTAINING

DIFFERENTIAL DIAGNOSIS

Common
- Liposarcoma
- Angiomyolipoma, Renal
- Adrenal Myelolipoma

Less Common
- Metastases, Retroperitoneal
- Pyelonephritis, Xanthogranulomatous
- AIDS Lipodystrophy
- Lipoma, Retroperitoneal
- Teratoma, Retroperitoneum
- Pelvic Lipomatosis

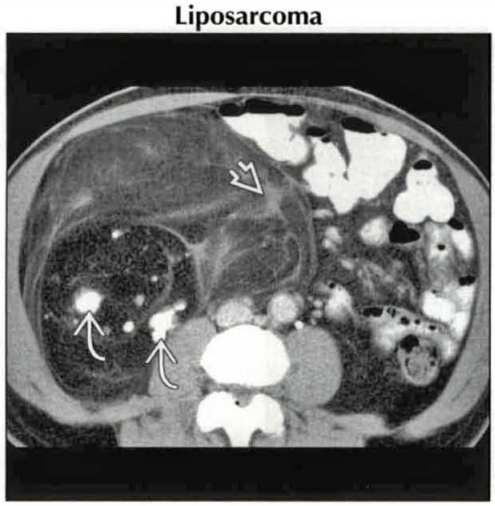
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Two key features distinguish liposarcoma from renal angiomyolipoma (AML)
  - Liposarcoma is less vascular than AML
  - AML will replace part of kidney ("claw sign")

Helpful Clues for Common Diagnoses
- **Liposarcoma**
  - Usually large when discovered
  - Usually has fat & soft tissue density (myxoid) components
  - Usually compresses & displaces retroperitoneal organs; invasion is uncommon
- **Angiomyolipoma, Renal**
  - Benign hamartoma comprised of blood vessels, muscle & fat
- **Adrenal Myelolipoma**
  - Fat & soft tissue components ± calcification; benign

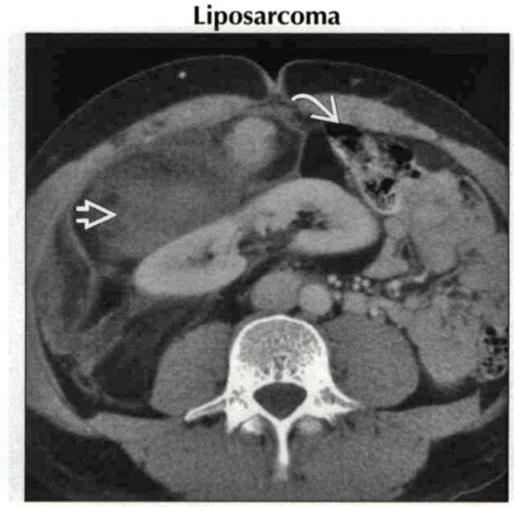
Helpful Clues for Less Common Diagnoses
- **Metastases, Retroperitoneal**
  - Testicular or ovarian malignant teratomas
  - Growing retroperitoneal mixed fatty density mass in patient with treated nonseminomatous germ cell tumor may represent residual teratoma
- **Pyelonephritis, Xanthogranulomatous**
  - Chronic obstruction & infection
  - Closely related: Replacement lipomatosis of kidney
- **AIDS Lipodystrophy**
  - Proliferation of retroperitoneal & mesenteric fat in response to medications used to treat AIDS
  - No discrete focal mass
- **Lipoma, Retroperitoneal**
  - Less heterogeneous than liposarcoma
  - May arise from duodenum
- **Teratoma, Retroperitoneum**
  - Uncommon to rare, as primary retroperitoneal tumor
- **Pelvic Lipomatosis**
  - Nonencapsulated overgrowth of benign fatty tissue in perirectal & perivesical spaces
  - Straightens & lifts rectosigmoid colon & urinary bladder

Liposarcoma



Axial CECT shows a mass that displaces the right kidney & ascending colon. The mass is mostly of fat density, but has foci of calcification ➡ & soft tissue ➡ density.

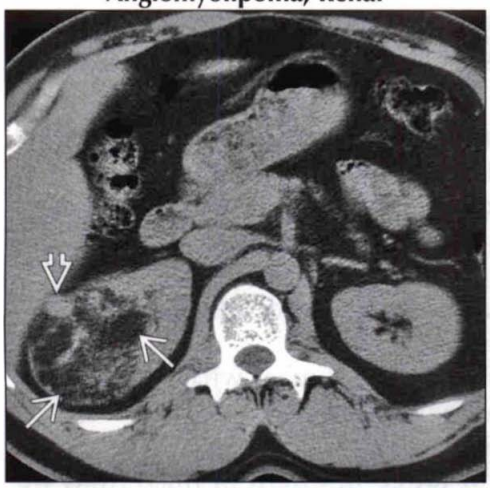
Liposarcoma



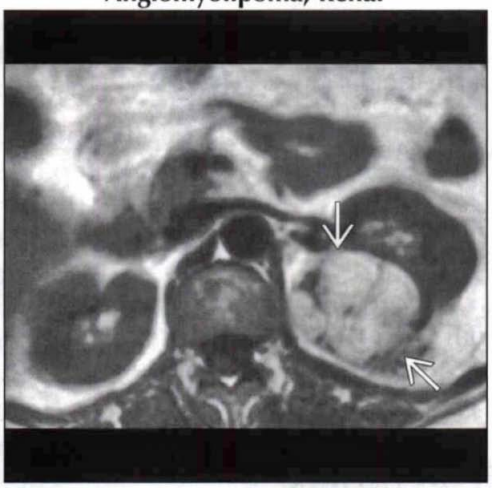
Axial CECT shows a heterogeneous mass that displaces and flattens the right kidney and displaces the ascending colon ➡. The mass is composed of fat & myxoid (soft tissue) ➡ elements.

RETROPERITONEAL MASS, FAT-CONTAINING

Angiomyolipoma, Renal



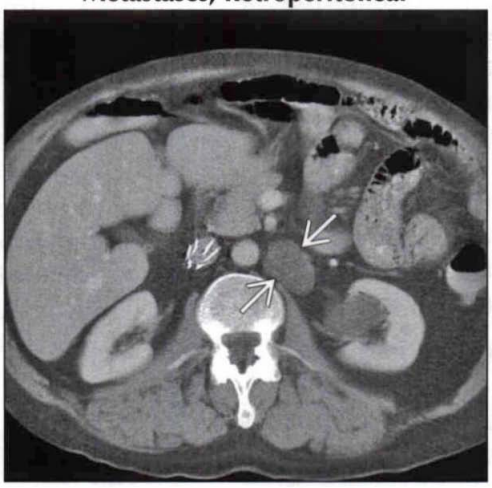
Angiomyolipoma, Renal



(Left) *Axial NECT shows a heterogeneous renal mass that contains fat ➡ and soft tissue density ➪, a typical AML.* ***(Right)*** *Axial T1WI MR shows a heterogeneous left renal mass ➡ that contains fat, of similar signal characteristics as the retroperitoneal and mesenteric fat.*

Adrenal Myelolipoma

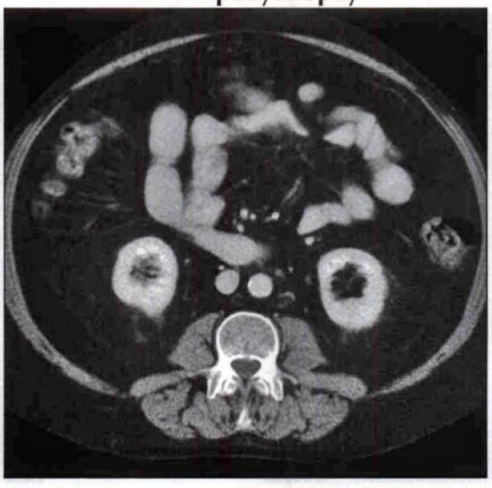
Metastases, Retroperitoneal



(Left) *Axial CECT shows a large suprarenal mass ➡, made up mostly of fat and with large foci of calcification ➪.* ***(Right)*** *Axial CECT shows a low density mass ➡, which proved to be a mature benign teratoma in a young man who had testicular carcinoma (mixed cell types, including teratomatous) & prior retroperitoneal nodal metastases. All other metastatic disease resolved with chemotherapy, leaving this teratoma to persist & enlarge.*

Pyelonephritis, Xanthogranulomatous

AIDS Lipodystrophy



(Left) *Axial CECT shows a nonfunctional right kidney with a large obstructing calculus ➡. Note the proliferation of heterogeneous fatty tissue in and around the kidney, especially in the perirenal space. Compare with the normal left side.* ***(Right)*** *Axial CECT shows massive, generalized proliferation of retroperitoneal and mesenteric fat, out of proportion to the subcutaneous fat, in a young man with AIDS who noted increasing abdominal girth.*

RETROPERITONEAL HEMORRHAGE

DIFFERENTIAL DIAGNOSIS

Common
- Renal Trauma
- Pelvic Trauma
- Coagulopathic ("Retroperitoneal") Hemorrhage
- Ruptured Abdominal Aortic Aneurysm

Less Common
- Hepatic Trauma
- Perirenal Hemorrhage
  - Renal Cell Carcinoma
  - Angiomyolipoma, Renal
- Adrenal Hemorrhage
- Adrenal Carcinoma

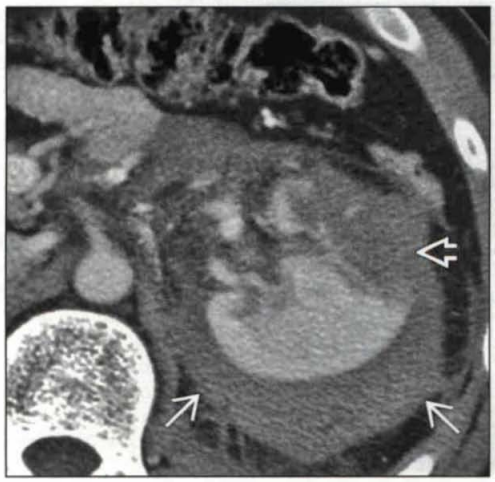
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Key to distinguishing ruptured aneurysm (AAA) from coagulopathic hemorrhage
  - Coagulopathic: Hematocrit sign (cellular-fluid level); multiple sites; blood limited to iliopsoas or involving rectus muscles
  - Ruptured AAA: Aneurysm > 4 cm diameter; interrupted intimal calcification; eccentric shape of aneurysm; blood contiguous with > 3 cm length of aneurysm

Helpful Clues for Common Diagnoses
- **Renal Trauma**
  - Perirenal hemorrhage accompanies any significant renal injury
  - Linear wedge-shaped parenchymal defect ± active extravasation of blood or urine
- **Pelvic Trauma**
  - Extraperitoneal bleeding often extends cephalad along anterior margin of spine & psoas muscles into retroperitoneum

Helpful Clues for Less Common Diagnoses
- **Hepatic Trauma**
  - Injury to bare area of liver may result in retroperitoneal hemorrhage
- **Perirenal Hemorrhage**
  - Renal tumors may bleed spontaneously or after trauma
    - Look for spherical mass with "claw sign" (parenchymal defect)
  - Angiomyolipoma
    - Look for fat component of mass (may be obscured by bleeding)
- **Adrenal Hemorrhage**
  - Common in neonates
  - May result from trauma, sepsis, shock, post-partum, coagulopathy, underlying tumor or cyst, surgery
  - Bilateral hemorrhage is usually not due to direct trauma, tumor or surgery
  - Liver transplantation often results in asymptomatic right adrenal hemorrhage
- **Adrenal Carcinoma**
  - Any adrenal mass (pheochromocytoma, mets, cyst) may bleed

Renal Trauma



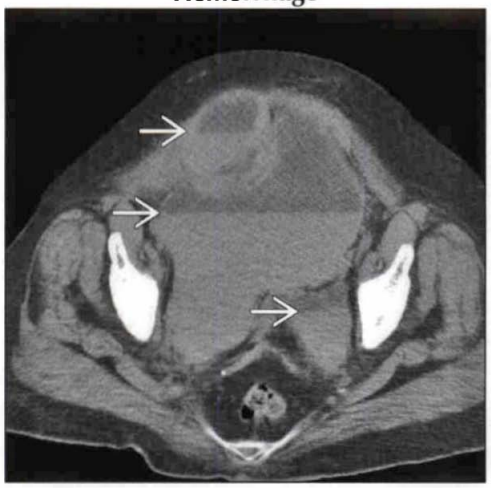
Axial CECT shows a laceration/hematoma of the ventral half of the kidney and hemorrhage that fills the perirenal space.

Coagulopathic ("Retroperitoneal") Hemorrhage

Axial CECT shows a large hemorrhage into the posterior abdominal wall & retroperitoneum. Note the hematocrit sign and foci of active bleeding.

RETROPERITONEAL HEMORRHAGE

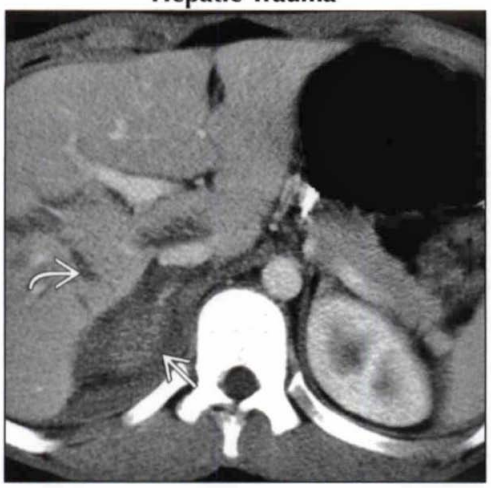
Coagulopathic ("Retroperitoneal") Hemorrhage



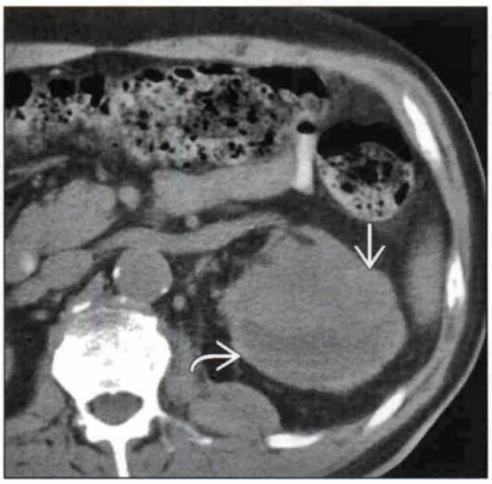
Ruptured Abdominal Aortic Aneurysm

(Left) Axial CECT shows a large hemorrhage that originated in the rectus sheath and then extended into the extraperitoneal pelvis. Note the hematocrit sign and multiple sites of bleeding. (Right) Axial CECT shows a large aneurysm with hemorrhage into the retroperitoneum and contiguous with the aorta. Note the probable site of rupture.

Hepatic Trauma

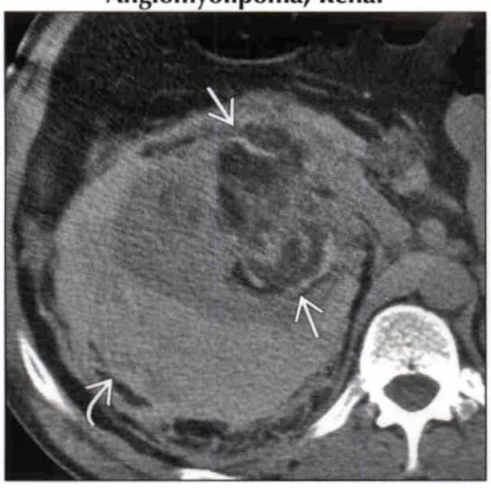


Renal Cell Carcinoma

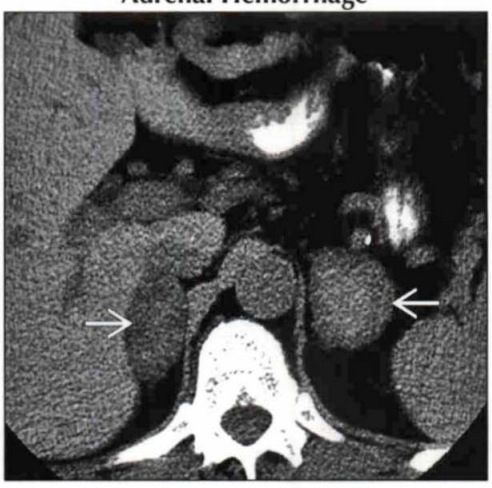


(Left) Axial CECT shows suprarenal hemorrhage following a traumatic liver laceration that extended to the bare area of the liver. The bleeding is probably from the hepatic, rather than adrenal, injury. (Right) Axial NECT shows a small end-stage left kidney surrounded by spontaneous perirenal hemorrhage. An exophytic mass is seen. The mass proved to be renal cell carcinoma in this dialysis-dependent patient.

Angiomyolipoma, Renal



Adrenal Hemorrhage



(Left) Axial NECT shows extensive bleeding into the perirenal space from an angiomyolipoma, which is the underlying, heterogeneous, fat density mass. (Right) Axial NECT shows bilateral hyperdense adrenal "masses". They represent spontaneous adrenal hemorrhage, following a hypotensive episode during complex surgical procedure elsewhere in the abdomen. This adrenal hemorrhage resulted in acute adrenal insufficiency.

SECTION 14
Adrenal

Generic Imaging Patterns

Adrenal Mass 14-2

ADRENAL MASS

DIFFERENTIAL DIAGNOSIS

Common
- Adrenal Adenoma
- Metastases and Lymphoma, Adrenal
- Adrenal Hemorrhage
- Pheochromocytoma
- Adrenal Cyst
- Retroperitoneal Varices or Vessels (Mimic)

Less Common
- Adrenal Myelolipoma
- Adrenal TB and Fungal Infection
- Adrenal Carcinoma
- Renal Cell Carcinoma (Mimic)
- Gastric Diverticulum (Mimic)
- Adrenal Hyperplasia
- Adrenal Ganglioneuroma

Rare but Important
- Adrenal Collision Tumor
- Adrenal Hemangioma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Combination of imaging (CT or MR) and clinical findings usually allows confident diagnosis
- Cushing syndrome: Excess cortisol; 75-80% due to pituitary adenoma secreting excess ACTH
- Conn syndrome: Excess aldosterone; 75-80% due to adrenal adenoma (small)
- Addison syndrome: Adrenal insufficiency; due to autoimmune disease (80% in Western countries), bilateral metastases, adrenal hemorrhage, or systemic infection

Helpful Clues for Common Diagnoses
- **Adrenal Adenoma**
  - Well-circumscribed, round or oval, homogeneous, low density (0-20 HU) mass on NECT
  - Enhances and "de-enhances" rapidly
  - Absolute washout value > 50% is highly sensitive and specific
  - Out of phase T1WI: Signal drop-out = lipid-rich adenoma
    - Lipid-rich adenomas are detected well on NECT and MR
    - Lipid-poor adenomas are best diagnosed on CT, with unenhanced, enhanced, & delayed imaging to calculate "washout"
- **Metastases and Lymphoma, Adrenal**
  - Metastases: Primary sites include lung, breast, kidney, melanoma
    - Cannot always be distinguished from a lipid-poor adenoma by imaging alone
    - PET CT very useful in oncology patients; may help to identify adrenal metastases (FDG-avid masses)
  - Lymphoma: NHL most common
    - Rounded or triangular shape; mild enhancement
    - FDG-avid on PET CT
- **Adrenal Hemorrhage**
  - Homogeneous, round, non-enhancing, hyperdense mass (50-90 HU)
  - Unilateral, usually due to direct trauma or iatrogenic (e.g., liver transplantation)
  - Bilateral usually in response to shock; post-partum; severe burns, sepsis
- **Pheochromocytoma**
  - Well-circumscribed, round, 3-5 cm diameter (symptomatic lesions)
    - Pheochromocytoma that occurs as part of a syndrome may be detected as smaller, asymptomatic mass
    - Syndromes associated with pheochromocytoma: Multiple endocrine neoplasia (types II & III); neurofibromatosis; von Hippel Lindau; Carney syndrome; tuberous sclerosis
  - Hyperintense on T2WI with heterogeneous bright enhancement
  - ± Hemorrhage, necrosis, calcification
- **Adrenal Cyst**
  - Well-defined, non-enhancing water-density mass ± calcification (eggshell)
  - Rarely a large lesion ± internal hemorrhage
- **Retroperitoneal Varices or Vessels (Mimic)**
  - Tortuous splenic artery & varices often lie in suprarenal space
  - Contrast-enhanced CT or MR, or color Doppler US can usually establish the diagnosis

Helpful Clues for Less Common Diagnoses
- **Adrenal Myelolipoma**

- Uncommon benign tumor (fat & hematopoietic elements), 2-10 cm, echogenic on US
- Hyperintense on T1WI, focal areas of signal loss on fat-suppressed techniques
  - Interface between fat & soft tissue elements will lose signal on opposed phase GRE series
- Imaging findings are diagnostic of this benign lesion in most cases; no treatment needed

- **Adrenal TB and Fungal Infection**
  - Heterogeneous, poorly enhancing mass(es) during acute infection
  - Acute: Mild to marked enlargement of adrenal glands with preserved contour
  - Chronic: Small calcified adrenal glands
    - Adrenal TB = most common cause of Addison syndrome (adrenal insufficiency) in 3rd world countries
- **Adrenal Carcinoma**
  - > 6 cm when initially diagnosed, heterogeneously enhancing mass
  - Early invasion of IVC accounts for poor prognosis
  - ± Necrosis, hemorrhage, calcification (30%)
- **Renal Cell Carcinoma (Mimic)**
  - Large tumor from upper pole of kidney may simulate an adrenal carcinoma
  - Look for "claw sign" (defect in renal cortex at origin of mass)
- **Gastric Diverticulum (Mimic)**
  - Rounded "mass" in suprarenal site
  - May contain fluid, gas, contrast material
  - Give extra oral contrast or gas granules; place patient prone to make diagnosis
- **Adrenal Hyperplasia**
  - Adrenal glands may appear normal; normal shape but increased thickness (> 10 mm); or may be nodular
  - Nodular hyperplasia can be difficult to distinguish from small adrenal adenomas or other lesions (e.g., metastases)
  - Hyperplasia or swelling may occur in response to stress, pituitary ACTH-secreting tumor (accounts for 75-80% of Cushing syndrome cases), congenital adrenal hyperplasia, or ectopic source of ACTH

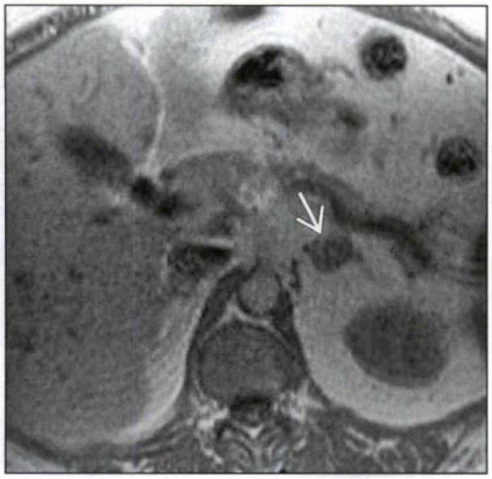
Helpful Clues for Rare Diagnoses

- **Adrenal Collision Tumor**
  - Coexistence of 2 contiguous but histologically distinct tumors within the same adrenal gland
  - Adenoma & myelolipoma; adenoma & metastases most common combinations
- **Adrenal Hemangioma**
  - > 10 cm, central low attenuation (necrosis or fibrosis) ± calcification

Alternative Differential Approaches

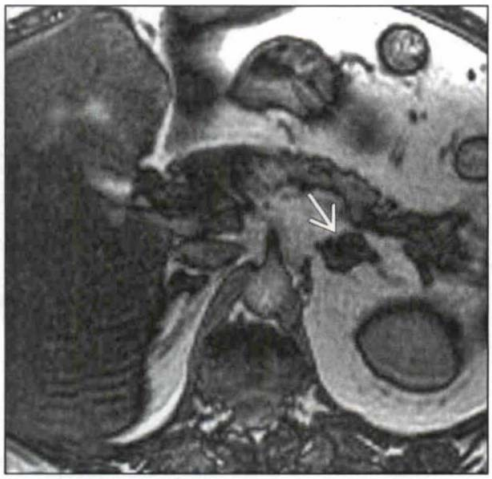
- Bilateral adrenal masses: Metastases, hyperplasia, lymphoma, hemorrhage, TB or fungal infection, pheochromocytoma (10%), adenoma (10%), or combination of 2 types of masses (e.g., adenoma on one side, myelolipoma on other)

Adrenal Adenoma



Axial T1WI MR shows a small spherical mass ➡ in the left adrenal gland with intensity similar to that of the kidney.

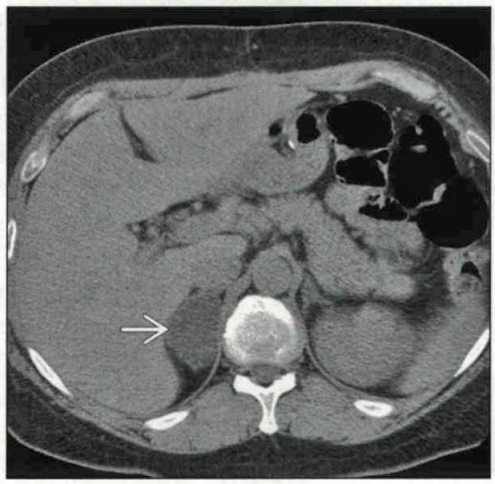
Adrenal Adenoma



Axial T1WI MR shows drop of signal ➡ on this opposed phase image, indicating the presence of lipid and water protons in the same voxels (intracellular lipid), typical of adenomas.

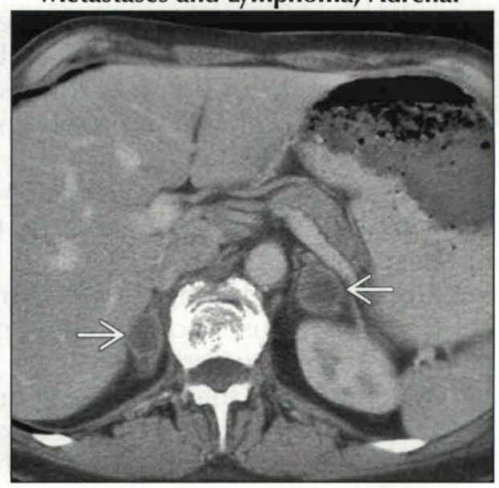
ADRENAL MASS

Adrenal Adenoma

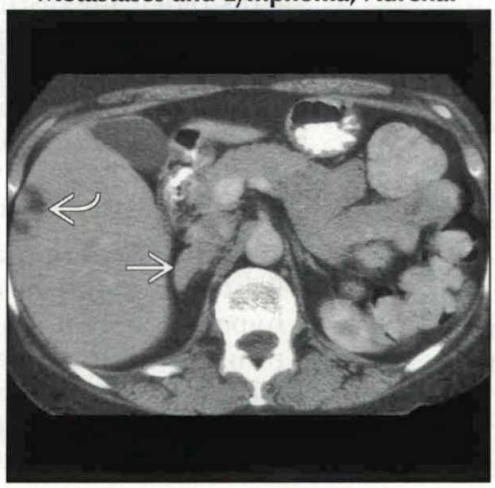


*(**Left**) Axial NECT shows a 3 cm homogeneously low attenuation mass ➡ (10 HU); typical lipid-rich adenoma. (**Right**) Axial CECT shows bilateral, somewhat heterogeneous adrenal masses ➡; metastatic small cell carcinoma.*

Metastases and Lymphoma, Adrenal

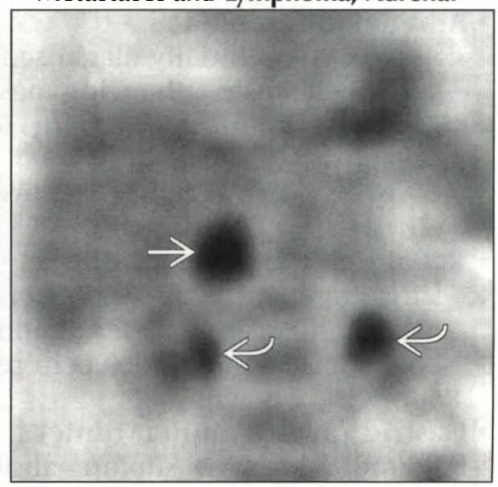


Metastases and Lymphoma, Adrenal

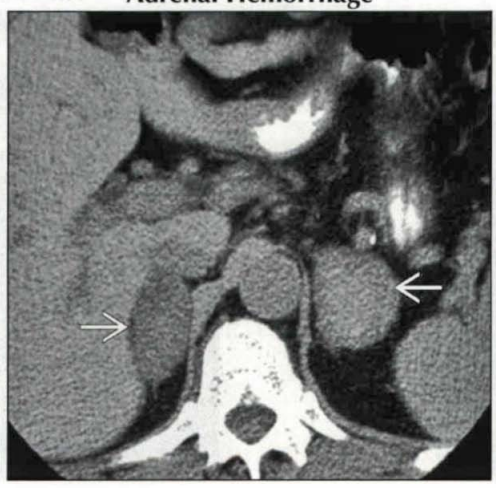


*(**Left**) Axial CECT shows a "soft tissue density" right adrenal mass ➡; metastatic colon carcinoma. The hepatic lesion ➡ is a hemangioma. (**Right**) Coronal PET shows an FDG-avid lesion ➡ in the right adrenal gland; metastatic colon cancer. Bilateral normal FDG activity ➡ in the kidneys & urine.*

Metastases and Lymphoma, Adrenal

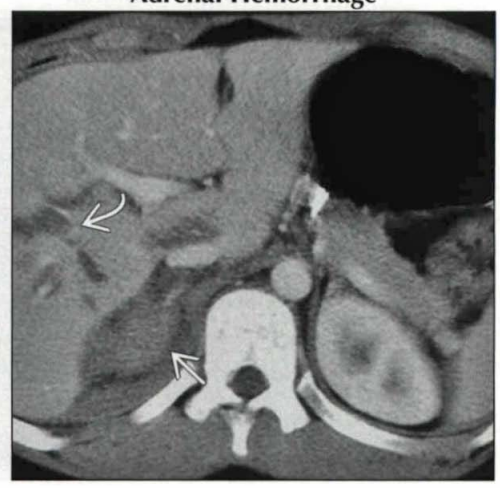


Adrenal Hemorrhage

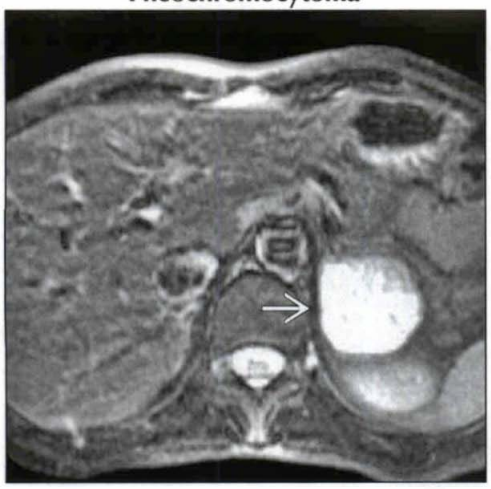


*(**Left**) Axial NECT shows bilateral heterogeneously high attenuation adrenal masses ➡, typical of adrenal hemorrhage; often as a complication of sepsis or shock. (**Right**) Axial CECT shows a liver laceration ➡ and hemorrhage in the suprarenal region ➡, which may represent injury to the adrenal or retroperitoneal bleeding from the bare area of the liver.*

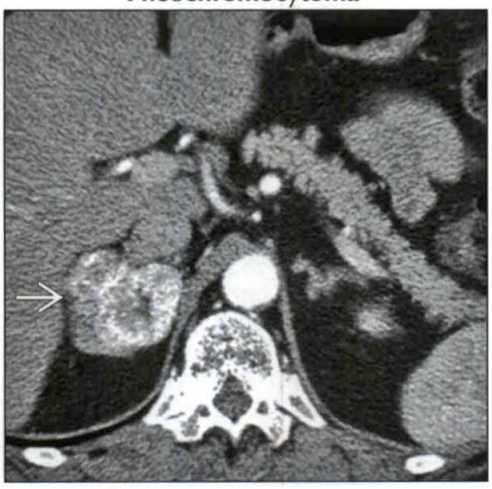
Adrenal Hemorrhage



Pheochromocytoma



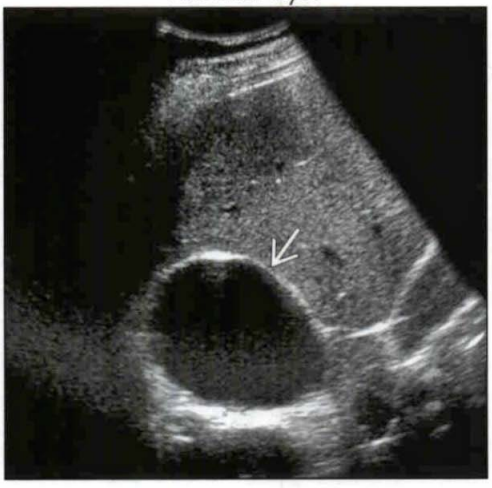
Pheochromocytoma



*(**Left**) Axial T2WI MR shows a large left adrenal mass ➡ that is very intense on T2WI, typical for pheochromocytoma. (**Right**) Axial CECT shows a heterogeneously hypervascular right adrenal mass ➡, fairly typical in size and appearance for pheochromocytoma.*

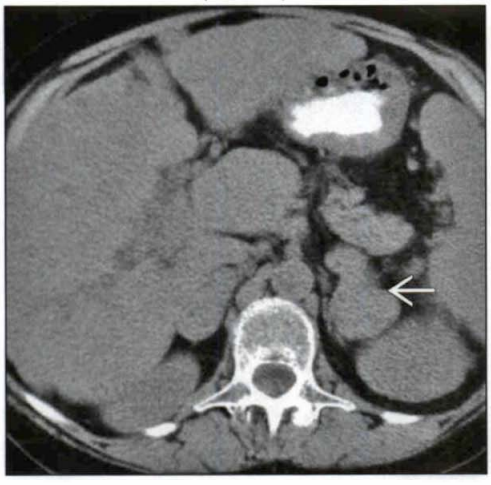
Adrenal Cyst

Adrenal Cyst

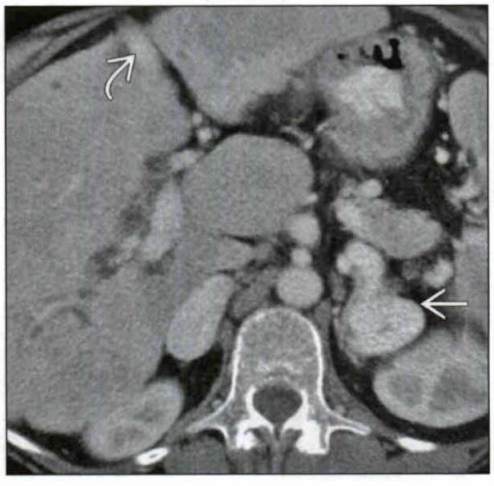


*(**Left**) Axial CECT shows a water density right adrenal mass ➡ with no visible wall or complexity. An adenoma could have a similar appearance on NECT, but would have enhanced with contrast. (**Right**) Sagittal oblique ultrasound shows a sonolucent adrenal cyst ➡ with acoustic enhancement and no visible complexity, such as mural nodules.*

Retroperitoneal Varices or Vessels (Mimic)



Retroperitoneal Varices or Vessels (Mimic)

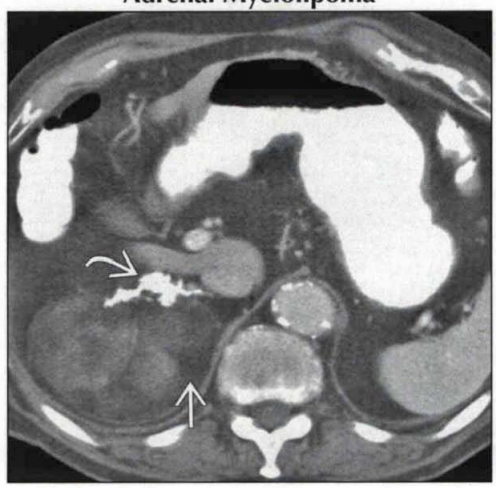


*(**Left**) Axial NECT shows a left suprarenal mass with a shape & location that suggests an adrenal mass ➡, but actually represents varices, proven on CECT. Note the cirrhotic liver. (**Right**) Axial CECT shows contrast-opacified varices ➡ as the etiology of a left suprarenal mass. Note cirrhotic liver and recanalized paraumbilical vein ➡.*

ADRENAL MASS

***(Left)** Axial CECT shows a large adrenal mass with fat ➡, soft tissue & calcified ➡ components, typical of myelolipoma. **(Right)** Axial fat-saturated FSPGR shows loss of signal on fat-suppressed sequence, indicating macroscopic fat component of this myelolipoma ➡. There was no signal loss on opposed phase images.*

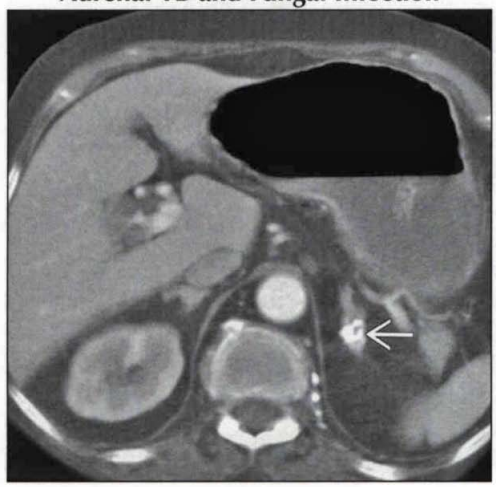
Adrenal Myelolipoma



Adrenal Myelolipoma

***(Left)** Axial CECT shows calcification within the left adrenal gland ➡ in a patient with classic renal TB as well. **(Right)** Axial CECT shows a classic "putty kidney" ➡ that is calcified & nonfunctional due to chronic TB.*

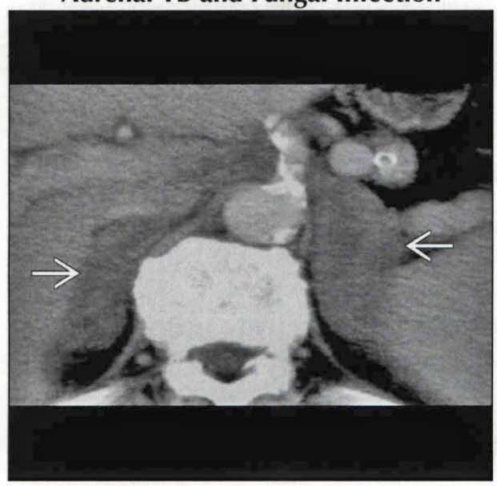
Adrenal TB and Fungal Infection



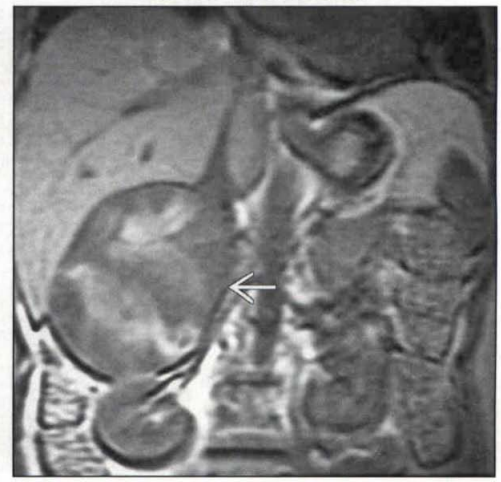
Adrenal TB and Fungal Infection

***(Left)** Axial CECT shows bilateral soft tissue density adrenal masses ➡ due to acute tuberculous infection. Metastases or hemorrhage would be more common in developed countries. **(Right)** Coronal T1WI MR shows a large adrenal mass ➡ with foci of increased intensity due to necrosis & hemorrhage, typical features of adrenal carcinoma.*

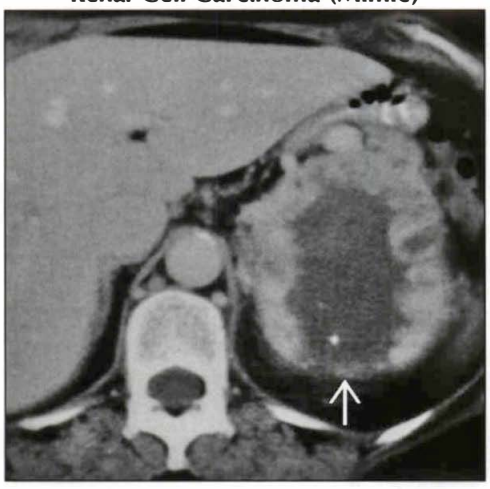
Adrenal TB and Fungal Infection



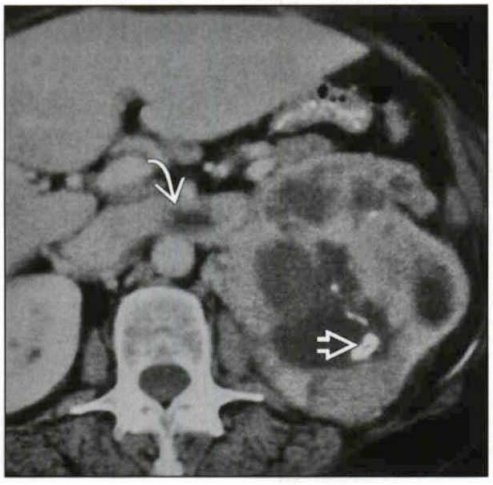
Adrenal Carcinoma



Renal Cell Carcinoma (Mimic)



Renal Cell Carcinoma (Mimic)



*(**Left**) Axial CECT shows a large, partially necrotic left upper quadrant mass ➡ that displaces the stomach forward. On a single section, it is impossible to determine the organ of origin. (**Right**) Axial CECT shows that the tumor has invaded the renal vein ➡, supporting the diagnosis of renal cell carcinoma. Note calcifications ➡ & foci of necrosis in the tumor.*

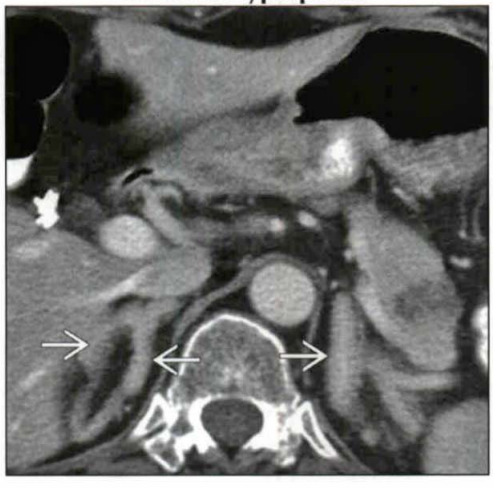
Gastric Diverticulum (Mimic)

Gastric Diverticulum (Mimic)

*(**Left**) Axial CECT shows a "cystic mass" ➡ in the suprarenal region, dorsal to the pancreas & splenic vein. The gastric origin of this diverticulum cannot be recognized on this section. (**Right**) Axial CECT shows an air-fluid level within the gastric diverticulum ➡, helping to make this diagnosis.*

Adrenal Hyperplasia

Adrenal Hyperplasia



*(**Left**) Axial CECT shows unusually large and nodular adrenal glands ➡ due to adrenal hyperplasia. (**Right**) Axial CECT shows maintenance of the normal shape of the adrenal glands ➡, but diffuse enlargement.*

SECTION 15
Kidney

Generic Imaging Patterns

Solid Renal Mass	15-2
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SOLID RENAL MASS

DIFFERENTIAL DIAGNOSIS

Common
- Renal Cell Carcinoma
- Wilms Tumor (Nephroblastoma)
- Column of Bertin (Mimic)
- Fetal Lobation
- Pyelonephritis

Less Common
- Hyperdense Renal Cyst (Mimic)
- Angiomyolipoma, Renal
- Renal Oncocytoma
- Metastases and Lymphoma, Renal
- Transitional Cell Carcinoma
- Pyelonephritis, Xanthogranulomatous
- Renal Trauma
- Aneurysm, Renal Artery (Mimic)
- Arteriovenous Malformation, Renal (Mimic)

Rare but Important
- Renal Medullary Carcinoma
- Renal Tumors, Atypical & Rare
  - Mesenchymal Tumor, Renal
  - Juxtaglomerular Tumor
  - Plasmocytoma, Renal
  - Small Cell Carcinoma, Renal

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Solid, expansile mass in adult is usually renal cell carcinoma, unless
  - Mass contains fat (probably angiomyolipoma)
  - Patient has a fever, urosepsis (consider pyelonephritis & renal abscess)
  - Patient is immunocompromised (consider lymphoma, PTLD)
  - Patient has known other primary cancer (consider metastases)
- There is probably no such thing as a renal "adenoma", just a small renal cancer that is too small to metastasize
- Role of biopsy is evolving, but definitely has a role in diagnosing renal lymphoma and metastases
  - Useful in diagnosing oncocytoma, AML
  - Morphology & immunohistochemical features are key pathologic findings
- Clinical history is key in diagnosing renal trauma, infection, metastases, lymphoma
  - Not usually helpful in diagnosing primary renal tumors
- CT or MR evaluation of renal mass must include nonenhanced and parenchymal phase images
  - Arterial phase good for diagnosing column of Bertin; pyelographic phase essential for diagnosing transitional cell cancer

Helpful Clues for Common Diagnoses
- **Renal Cell Carcinoma**
  - Usually discovered as an incidental finding
    - May have hematuria or flank pain
  - Variable appearance and histology
    - From mostly cystic, to hypovascular (papillary), to hypervascular (most RCCs)
    - Large tumors may have lipoid degeneration, invade renal sinus or perirenal fat, simulate angiomyolipoma
    - Large tumors may also have osseous metaplasia
  - Commonly invades renal vein with thoracic metastases
- **Wilms Tumor (Nephroblastoma)**
  - Most common solid renal mass in children
  - Highly variable appearance
- **Column of Bertin (Mimic)**
  - Hypertrophied column of septal cortex that protrudes into renal sinus
    - Usually between upper and middle calyces
  - Same enhancement characteristics (& echogenicity) as renal cortex
- **Fetal Lobation**
  - Persistent cortical lobulation, reflecting fetal renal development as multiple separate lobes
  - Enhances like normal cortex & medulla
- **Pyelonephritis**
  - Severe focal pyelonephritis, renal abscess, or xanthogranulomatous pyelonephritis may be indistinguishable from tumor by imaging alone
  - Consider clinical presentation; needle aspiration & drainage of abscess

Helpful Clues for Less Common Diagnoses
- **Hyperdense Renal Cyst (Mimic)**
  - High density ("hyperdense" or "hemorrhagic") renal cyst is indistinguishable from tumor on either NECT or CECT alone

- Cyst will not enhance while viable tumor almost always enhances ≥ 20 HU
- Sonography useful to show sonolucent contents & acoustic enhancement of hyperdense cyst
- Large cyst with extensive hemorrhage may be impossible to distinguish from necrotic tumor

- **Angiomyolipoma, Renal**
  - Most common benign renal solid mass
  - 95% have identifiable fat on CT or MR
    - Use NECT or MR to identify small foci of fat
    - AML without fat is difficult or impossible to distinguish from RCC by imaging (often hyperdense to kidney on NECT)
  - Multiple & bilateral in tuberous sclerosis
  - May result in spontaneous bleeding
- **Renal Oncocytoma**
  - Benign epithelial tumor
  - Often has central stellate scar (30-50%)
  - Imaging can only suggest this diagnosis
- **Metastases and Lymphoma, Renal**
  - Often multiple, in patient with known primary tumor
  - Usually less vascular and less exophytic than RCC
- **Transitional Cell Carcinoma**
  - More infiltrative, less expansile than RCC
  - May be part of multifocal tumor
    - Bladder > kidney > ureter
- **Renal Trauma**
  - Renal hematoma may be indistinguishable from tumor
    - History (including possible invasive procedure like biopsy) is key
  - Traumatic injury will evolve quickly
- **Aneurysms and Arteriovenous Malformations (AVM) (Mimic)**
  - Vascular lesions can mimic tumor
  - Key is multiphasic CT or MR during rapid bolus of contrast medium or color Doppler

Helpful Clues for Rare Diagnoses

- **Renal Medullary Carcinoma**
  - Rare, highly aggressive tumor
  - Usually affects men with sickle cell trait
- **Renal Tumors, Atypical & Rare**
  - May arise from any mesenchymal component of renal capsule, cortex, or medulla
  - Generally cannot be diagnosed by imaging

Alternative Differential Approaches

- Lesions that may be hyperdense on NECT: Hyperdense cyst, RCC, oncocytoma, AML, transitional cell carcinoma

SELECTED REFERENCES

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2. Curry NS: Imaging the small solid renal mass. Abdom Imaging. 27(6):629-36, 2002
3. Davidson AJ et al: Radiologic assessment of renal masses: implications for patient care. Radiology. 202(2):297-305, 1997

Renal Cell Carcinoma

Coronal CECT shows a large hypervascular but partially necrotic mass ➡ replacing all but the upper pole of the left kidney.

Renal Cell Carcinoma

Coronal CECT shows a large RCC ➡ replacing the lower two thirds of the kidney, with invasion of the renal vein ➡ and IVC ➡.

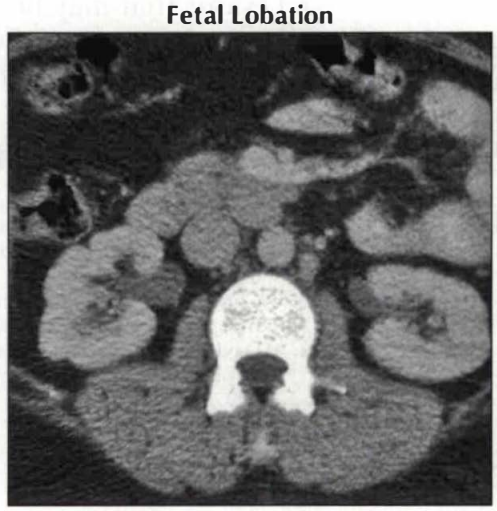
SOLID RENAL MASS

Column of Bertin (Mimic)

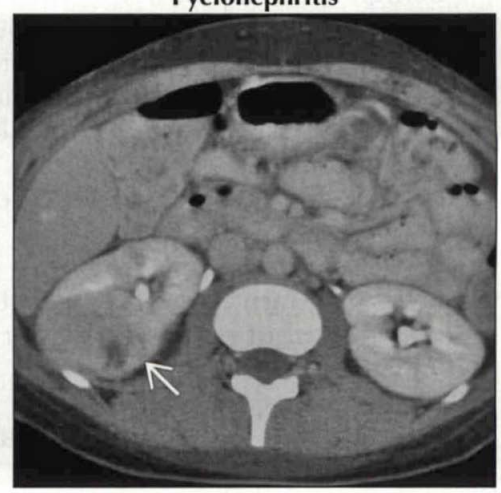
Column of Bertin (Mimic)

(Left) *Sagittal ultrasound shows a hypoechoic "mass" that protrudes into the renal sinus fat. CT showed this to be normal renal tissue, a column of Bertin.* ***(Right)*** *Axial CECT shows normal renal cortex, a column of Bertin protruding into the renal sinus. This is a common anomaly and usually occurs at the junction of the upper & middle thirds of the kidney.*

Fetal Lobation

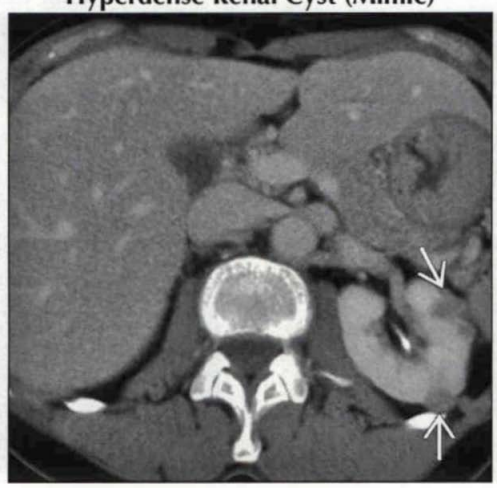


Pyelonephritis

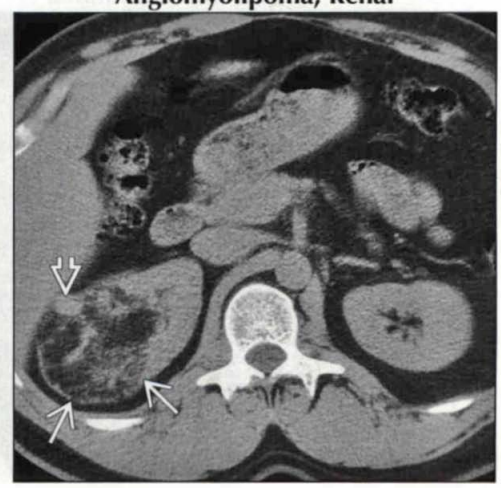


(Left) *Axial CECT shows an undulating surface of the right kidney in a healthy 42 year old woman with no history of renal disease.* ***(Right)*** *Axial CECT shows a heterogeneous left renal mass that represents focal, severe pyelonephritis. An infection this severe usually evolves into an abscess or resolves with antibiotic therapy, leaving a deep renal scar.*

Hyperdense Renal Cyst (Mimic)

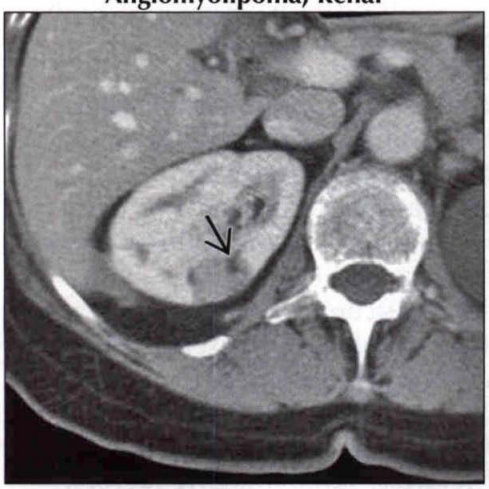


Angiomyolipoma, Renal

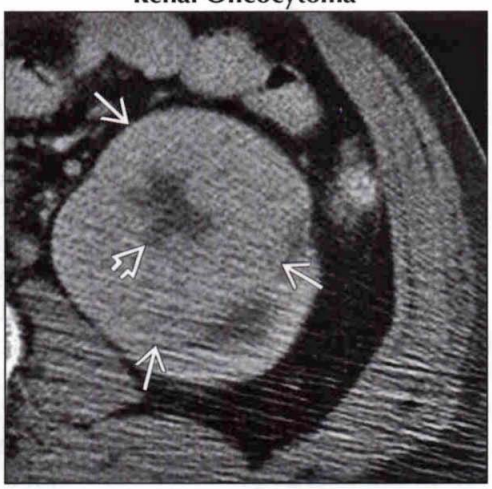


(Left) *Axial CECT shows three spherical lesions that each have an attenuation of about 90 HU, simulating renal tumor; however, they were hyperdense to kidney on NECT and showed no enhancement, confirming these as hyperdense cysts.* ***(Right)*** *Axial NECT shows a large right renal mass that is primarily of fat attenuation, though soft tissue nodules are also seen.*

Angiomyolipoma, Renal

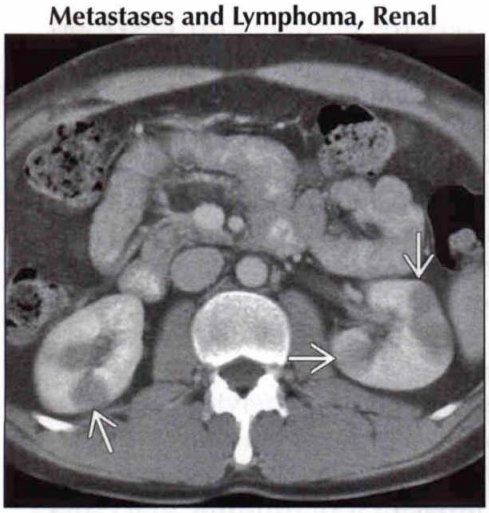


Renal Oncocytoma

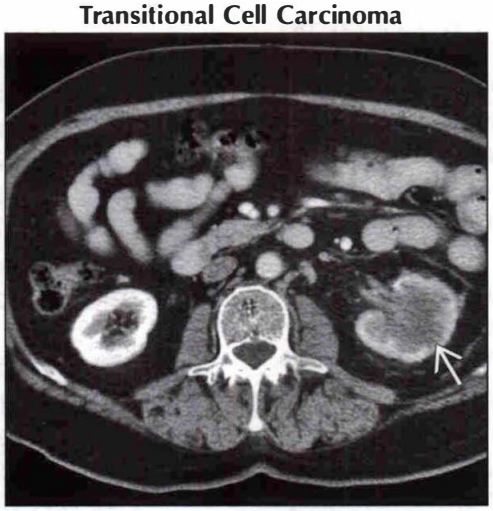


(Left) *Axial CECT shows a small mass with only a small focus of fat ⇨ to identify it as an AML. The fat was more evident on NECT.* ***(Right)*** *Axial CECT shows a large spherical mass ➡ with almost the same attenuation as the kidney. There is a central scar ⇨ within the mass, a characteristic, but uncommon (and nonspecific) sign of oncocytoma.*

Metastases and Lymphoma, Renal

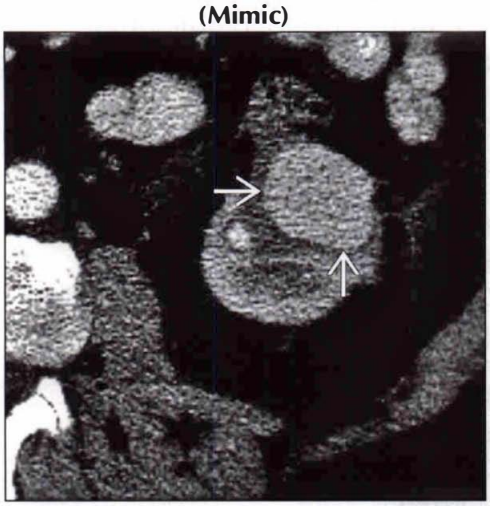


Transitional Cell Carcinoma

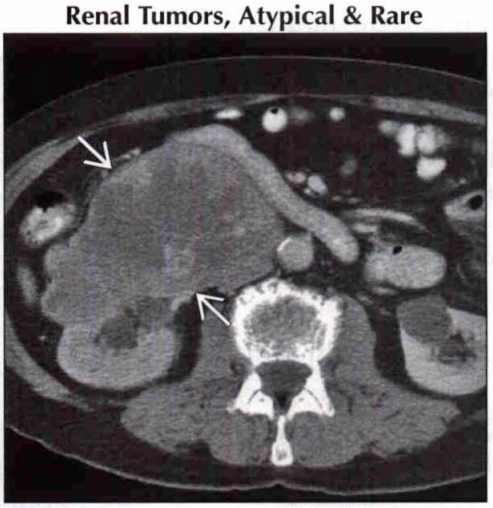


(Left) *Axial CECT shows multiple soft tissue density renal masses ➡ that do not distort the contour of the kidneys; non-Hodgkin lymphoma.* ***(Right)*** *Axial CECT shows a mass ➡ that infiltrates the lower pole of the left kidney, without altering its contour.*

Arteriovenous Malformation, Renal (Mimic)



Renal Tumors, Atypical & Rare



(Left) *Axial CECT shows a brightly enhancing mass ➡ that was demonstrated on sonography (color Doppler) and angiography to represent a renal AVM.* ***(Right)*** *Axial CECT shows a solid mass ➡ arising from the kidney (proven by the claw sign). This proved to be a primary leiomyosarcoma of the kidney, but this lesion cannot be distinguished from RCC by imaging alone.*

CYSTIC RENAL MASS

DIFFERENTIAL DIAGNOSIS

Common

- Renal Cysts
- Renal Sinus Cysts
- AD Polycystic Disease, Kidney
- Renal Cell Carcinoma
- Wilms Tumor
- Abscess, Renal
- Focal Hydronephrosis
- Trauma, Renal

Less Common

- Multilocular Cystic Nephroma
- Metastases and Lymphoma, Renal
- Angiomyolipoma, Renal
- Localized Cystic Renal Disease
- Segmental Multicystic Dysplastic Kidney
- Renal Tumors, Atypical & Rare

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Bosniak classification of renal cysts
  - I: Benign, simple cyst
    - Spherical, near water attenuation (or sonolucent), no enhancement, no visible wall
  - II: Minimally complicated, benign
    - Hyperdense cyst; spherical, non-enhancing, partially exophytic
    - Septate cyst: But no enhancing mural nodularity
  - III: Complicated cyst; possibly malignant
    - Thick wall or septa; enhancement of wall or septum (includes multilocular cystic nephroma and some cystic renal cell carcinomas; often indistinguishable by imaging)
    - Usually requires excision
  - IV: Cystic neoplasm; probably malignant
    - Enhancing mural nodularity (enhancing tissue is always neoplastic)
    - Usually = renal cell carcinoma in adult
- Sonography is good complementary study when CT suggests cyst
  - Caution
    - Homogeneous tumor (like papillary RCC or lymphoma) can appear cystic on US
    - US tends to accentuate thickness of septa, may make a Bosniak type II cyst look like type III

Helpful Clues for Common Diagnoses

- **Renal Cysts**
  - Extremely common, increased prevalence and size with age
  - Typical appearance
    - Ultrasonography: Sonolucent with acoustic enhancement; no mural nodularity; no or thin septa
    - CT: Near water attenuation; no enhancement; no mural nodularity; no or thin septa or calcification; "pseudoenhancement" is a problem with helical CT (often see apparent increase in attenuation by up to 15 HU)
    - To make valid assessment of enhancement of a mass, must use same slice thickness, same imaging factors, same scanner on the same day
    - MR: Homogeneously hypointense on T1WI, very hyperintense on T2WI; no enhancement
  - Most are cortical, exophytic
  - Thin, non-enhancing septa are not worrisome, even with thin calcification
    - Usually the result of prior infection or hemorrhage within the cyst
  - Large cyst with extensive hemorrhage may be impossible to distinguish from necrotic tumor
- **Renal Sinus Cysts**
  - Includes peri- and parapelvic cysts, & parapelvic lymphangiectasia
  - No clear distinction between these
  - May be single cyst or multiple cysts that surround the calices & renal vessels
    - Easily mistaken for hydronephrosis on US or CT, unless pyelographic phase images are obtained
- **AD Polycystic Disease, Kidney**
  - Multiple, bilateral cysts, increase in size and number with age
  - Cysts often have high density content and calcified walls due to hemorrhage
- **Renal Cell Carcinoma**
  - Some RCC are predominantly cystic, even when small
    - Imaging will almost always show wall irregularity & enhancement with IV contrast administration
  - Some RCC are hypovascular (especially papillary type)

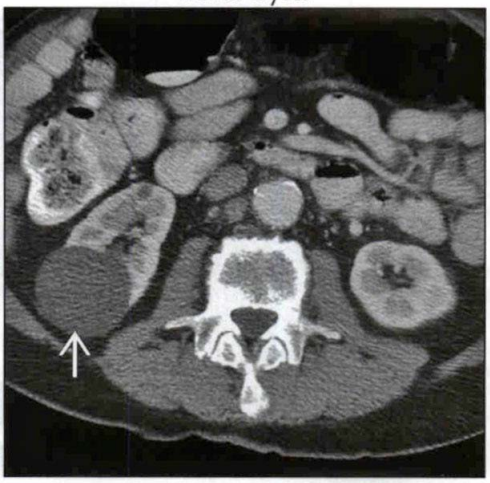
- These are homogeneous and low density (CT); intensity (T1W MR); hypoechoic (US) and easily mistaken for cysts
- CT will usually show 20 to 30 HU enhancement

- **Wilms Tumor**
  - Many morphological variations, including partially cystic
  - Some tumors have foci of calcification, &/or fat
- **Abscess, Renal**
  - Usually has shaggy, enhancing wall and infiltration of perirenal fat
  - Clinical history and needle aspiration are keys to diagnosis
- **Focal Hydronephrosis**
  - Obstructed calyx or infundibulum (e.g., TB, transitional cell carcinoma)
  - Duplicated collecting system with obstruction of ureter from upper pole moiety
  - May be mistaken for upper pole renal cystic mass
- **Trauma, Renal**
  - Evolving renal hematoma or urinoma may simulate cystic mass

Helpful Clues for Less Common Diagnoses

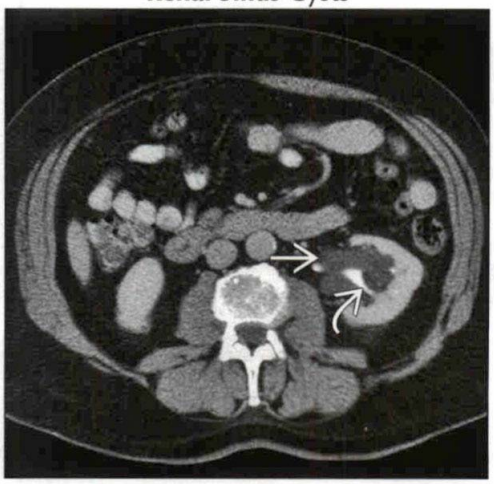
- **Multilocular Cystic Nephroma**
  - Benign mass comprised of multiple noncommunicating cysts
  - Wall and septa enhance and may calcify
  - Cystic mass herniates into renal hilum
  - Cannot be distinguished from RCC by imaging alone
- **Metastases and Lymphoma, Renal**
  - May be homogeneous, minimally enhancing, multiple
  - Dedicated renal mass imaging protocols (CT, MR, US) will confirm solid nature of masses
- **Angiomyolipoma, Renal**
  - Fat component may be mistaken for water density on CT, especially if small and evenly distributed
  - US: Highly echogenic, unlike cyst
- **Localized Cystic Renal Disease**
  - Old term "unilateral polycystic disease"
  - Unilateral conglomerate mass consisting of multiple thin-walled cysts
    - May be separated by normal renal parenchyma
  - May involve entire kidney
  - Not related to autosomal dominant polycystic disease
- **Segmental Multicystic Dysplastic Kidney**
  - Conglomeration of different-sized cysts with little or no renal parenchyma in affected portion of kidney
- **Renal Tumors, Atypical & Rare**
  - Other rare tumors, such as renal angiosarcoma, may appear as a complex cystic mass

Renal Cysts



Axial CECT shows a water attenuation mass with no enhancement, mural nodularity or internal debris; typical simple cyst.

Renal Sinus Cysts



Axial CECT shows renal sinus (peripelvic) cysts that are distinguished from hydronephrosis on this pyelographic phase CECT by the contrast-opacified urine in the collecting system.

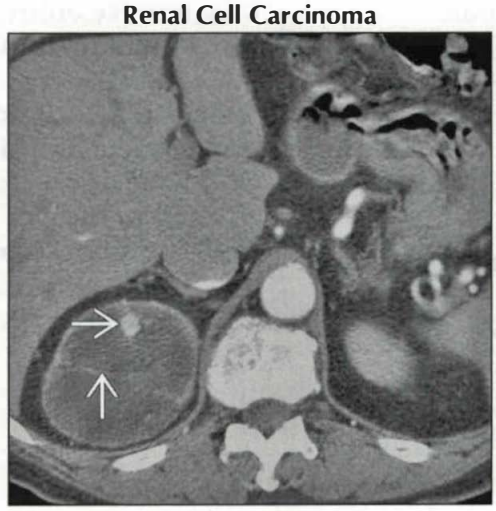
CYSTIC RENAL MASS

Renal Sinus Cysts

(Left) Axial CECT shows a parapelvic cyst → that displaces other structures in the renal hilum. (Right) Axial CECT shows enlarged, nonfunctional kidneys that are deformed by innumerable cysts, some of which have calcified walls ⇀, better seen on NECT.

AD Polycystic Disease, Kidney

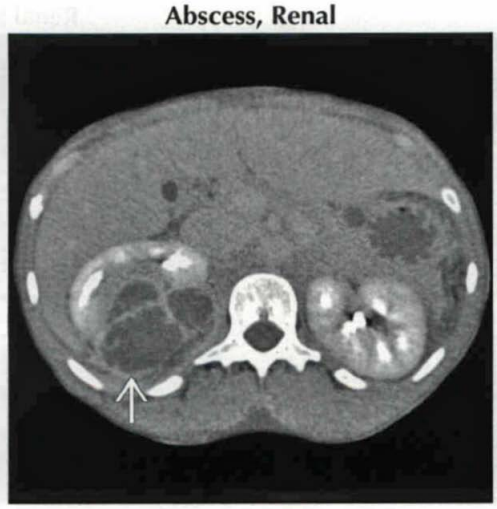
Renal Cell Carcinoma



(Left) Axial CECT shows a partially cystic upper pole renal mass with visible septal & nodular thickening & enhancement →: cystic RCC. (Right) Coronal CECT shows a partially cystic mass arising from the lower pole of the left kidney. Enhancing nodularity → confirms that the mass is neoplastic.

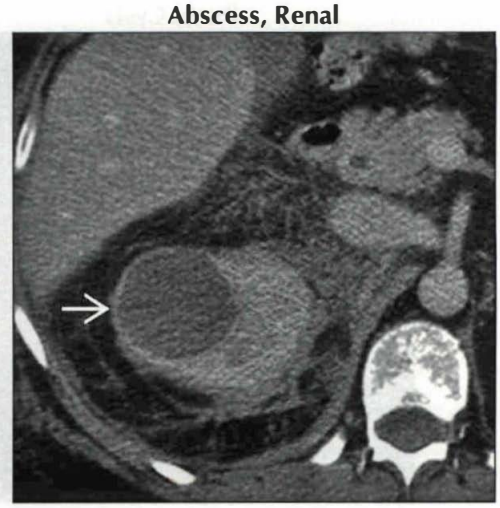
Renal Cell Carcinoma

Abscess, Renal



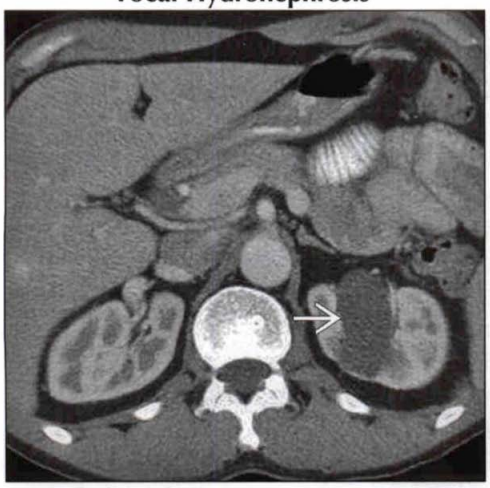
(Left) Axial CECT shows a multiseptate left renal mass → with enhancement of the internal & peripheral walls. Clinical correlation & percutaneous drainage are needed for diagnosis and therapy. (Right) Axial CECT shows a unilocular, but thick-walled renal cystic mass → with extensive infiltration of the perirenal space.

Abscess, Renal

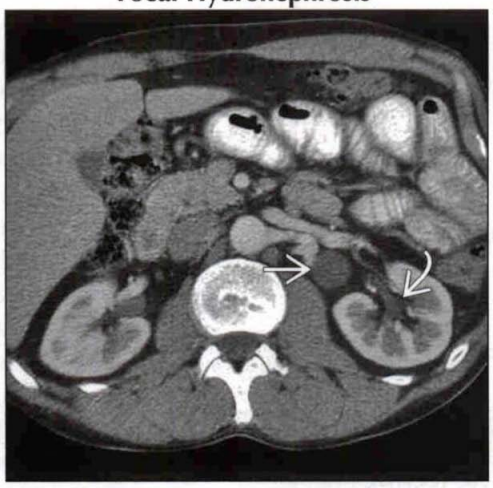


CYSTIC RENAL MASS

Focal Hydronephrosis

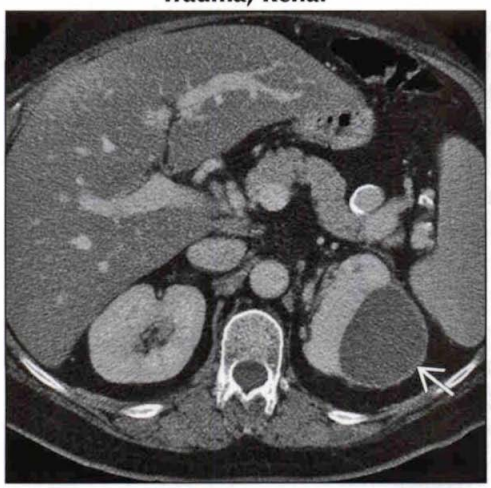


Focal Hydronephrosis



(Left) *Axial CECT shows a cystic appearing lesion* ➡ *that represents dilation of the collecting system in a patient with duplication of the ureter & obstruction of the upper pole ureter.* ***(Right)*** *Axial CECT shows a dilated ureter* ➡ *from the upper pole moiety, while the pelvis* ➡ *& calices of the lower pole are normal.*

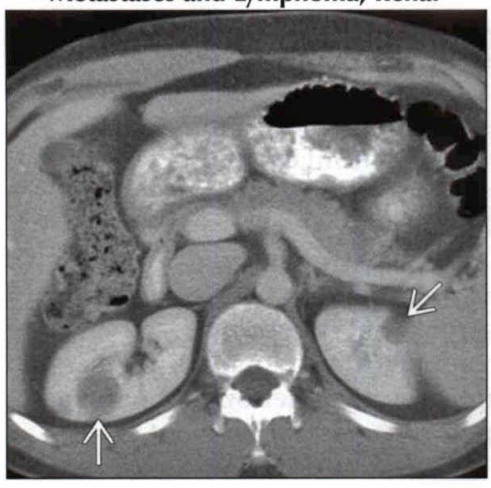
Trauma, Renal



Multilocular Cystic Nephroma

(Left) *Axial CECT shows a cystic appearing mass* ➡ *that represents a subacute subcapsular hematoma resulting from extracorporeal lithotripsy.* ***(Right)*** *Axial CECT shows a multiseptate mass* ➡ *that herniates into the renal sinus, a classic example of multilocular cystic nephroma.*

Metastases and Lymphoma, Renal



Localized Cystic Renal Disease

(Left) *Axial CECT shows multiple low density (but > water density) renal masses* ➡*; non-Hodgkin lymphoma.* ***(Right)*** *Axial CECT shows a conglomerate mass of thin-walled cysts throughout the left kidney, separated by normally functioning renal tissue.*

BILATERAL RENAL CYSTS

DIFFERENTIAL DIAGNOSIS

Common
- Simple Renal Cysts
- AD Polycystic Disease, Kidney (ADPKD)
- Acquired Cystic Disease of Uremia
- Von Hippel-Lindau
- Tuberous Sclerosis

Less Common
- Medullary Cystic Disease
- Lithium Nephropathy

Rare but Important
- Glomerulocystic Disease

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Late stage acquired cystic disease closely simulates AD polycystic disease
- Often difficult to distinguish among various etiologies of renal cysts based only on the appearance of the cysts and kidneys
  - Consider ancillary imaging findings
    - e.g., presence of renal tumors; presence of cysts or tumors in other organs
  - Consider clinical factors
    - e.g., presence, degree, and type of renal dysfunction
    - Use of medications such as lithium

Helpful Clues for Common Diagnoses
- **Simple Renal Cysts**
  - Often multiple and bilateral
    - Number of cysts is not a reliable distinguishing feature of simple vs. polycystic disease
  - Cysts of variable size
    - Usually of water attenuation
    - "Hyperdense" cysts are not uncommon, usually coexist with simple cysts
    - Cannot distinguish a hyperdense cyst from a renal neoplasm on either NECT or CECT alone (need both to determine if lesion enhances, which indicates neoplasm)
  - Kidneys are normal in size & function
  - Usually less numerous than in congenital cystic syndromes
- **AD Polycystic Disease, Kidney (ADPKD)**
  - Kidneys become progressively enlarged, lose function
    - Usually dialysis-dependent by 5th decade
  - Cysts also usually enlarge over time
  - ADPKD type 2 may have innumerable small cysts and preservation of renal function
  - Hyperdense contents & calcified wall due to prior hemorrhage
    - Renal cysts are variable in size and signal intensity
    - More evident on MR than on CT
  - Cysts in other organs (liver, pancreas, seminal vesicles) & family history are keys to diagnosis
    - Genetic testing can also reveal chromosomal abnormalities linked to ADPKD
- **Acquired Cystic Disease of Uremia**
  - Present in most patients treated with long term dialysis
    - Patients are almost always dialysis-dependent
    - Cysts will persist even if patient receives renal transplantation
  - Kidneys are usually small, but cysts (and kidneys) may become larger
    - Advanced cases of acquired cystic disease may be indistinguishable from ADPKD
  - Cysts in both cortex & medulla
    - Of variable size up to several centimeters
  - Increased risk of renal carcinoma
    - Enhancing mass in end-stage kidneys = renal cell carcinoma (until proven otherwise)
  - Prone to spontaneous bleeding into cysts or perirenal space
- **Von Hippel-Lindau**
  - Multisystem disorder, autosomal dominant
  - Cysts and tumors of kidneys, adrenal, pancreas, brain, spinal cord
  - 50-75% of patients have renal cysts; 25-50% develop renal carcinoma
    - Renal cell carcinomas often develop sequentially; requires lifelong surveillance
    - Often treated with nephron-sparing surgery (ablation or partial nephrectomy) to preserve renal function
  - Pheochromocytoma, pancreatic cysts, and serous (microcystic) adenoma of pancreas
  - Other organ system involvement

- Pancreas: Cysts, serous microcystic adenomas, neuroendocrine (islet cell) tumors
- Adrenal: Pheochromocytoma (often recurrent, multiple)
- CNS: Hemangioblastomas (angiomatous tumors) of the cerebellum, brain stem, spinal cord

- **Tuberous Sclerosis**
  - Multisystem disorder, autosomal dominant
  - Hamartomatous tumors in brain, lung, heart, skin, kidneys
  - Kidneys: Hamartomas = angiomyolipomas (often multiple and bilateral); also have multiple cysts, rarely renal cell carcinoma
    - Solid mass without obvious fat in a patient with TS is still most likely to be AML, not RCC or other tumor

Helpful Clues for Less Common Diagnoses

- **Medullary Cystic Disease**
  - Nephronophthisis, or salt-wasting nephropathy
  - Small kidneys with cysts in medulla & corticomedullary junction, with thinned cortex
  - Progressive renal failure and anemia in young patient
  - Diagnosis is usually apparent
- **Lithium Nephropathy**
  - Occurs in patients who take lithium long term (for bipolar disease or other affective disorders)
  - Causes diabetes insipidus & renal insufficiency
    - Patients are rarely dialysis-dependent, unlike patients with acquired cystic disease of uremia
  - Kidneys are normal to small in volume with multiple (several to innumerable) tiny cysts, usually 2 to 5 mm in diameter
    - These "microcysts" distinguishable from larger cysts associated with acquired cystic disease of uremia

Helpful Clues for Rare Diagnoses

- **Glomerulocystic Disease**
  - Sporadic or familial occurrence
  - Rare condition associated with renal insufficiency, but rarely end-stage renal failure
  - Affects children & young adults
  - Small cysts in renal cortex
    - Arise from proximal convoluted tubules and Bowman space

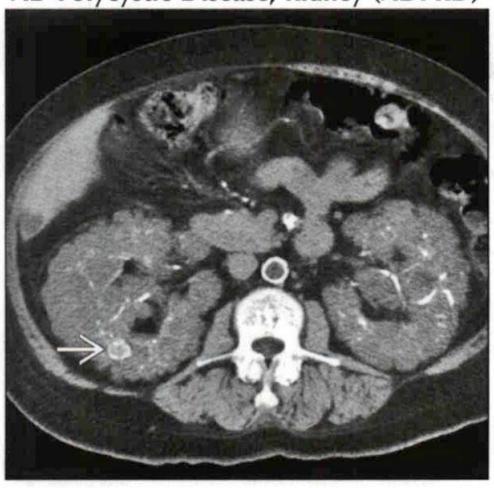
Alternative Differential Approaches

- Multicystic renal diseases associated with tumors
  - Acquired cystic disease of uremia (renal cell carcinoma, especially papillary type)
  - Von Hippel-Lindau syndrome (renal cell carcinoma plus tumors of pancreas, adrenal (pheochromocytoma) and CNS (hemangioblastomas)
  - Tuberous sclerosis (angiomyolipomas and, rarely, leiomyosarcoma & renal cell carcinoma)

Simple Renal Cysts

Axial NECT shows multiple, bilateral cysts but preservation of normal cortex (and function) in this 86 year old man.

AD Polycystic Disease, Kidney (ADPKD)



Axial NECT shows bilateral enlarged, nonfunctional kidneys with innumerable cysts, in a 58 year old man. Note calcified wall of some cysts ➡.

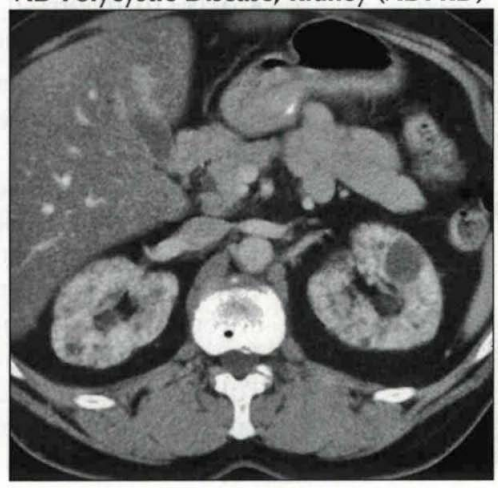
BILATERAL RENAL CYSTS

AD Polycystic Disease, Kidney (ADPKD)

(Left) Axial NECT shows massive enlargement of both kidneys with innumerable cysts of varying size and attenuation, some of which have internal hemorrhage ➡. (Right) Axial NECT shows innumerable cysts of varying size and attenuation in the kidneys and liver.

AD Polycystic Disease, Kidney (ADPKD)

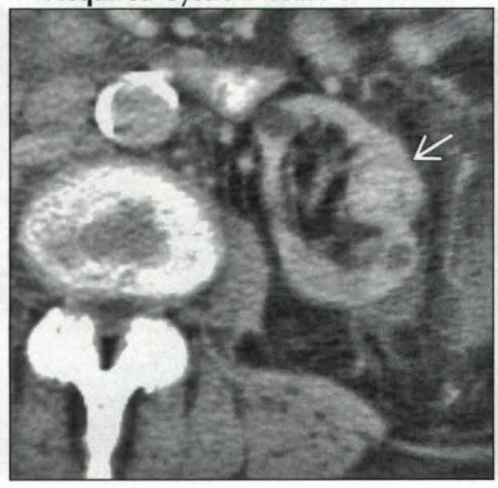
AD Polycystic Disease, Kidney (ADPKD)



(Left) Axial CECT shows innumerable small cysts, mostly in the cortex, in this 62 year old man with preserved renal function and presumed type 2 ADPKD. (Right) Axial NECT shows small kidneys with innumerable cysts. Gastric wall ➪ is thickened due to gastritis induced by immunosuppressive drugs in this patient who had a renal transplant following years of dialysis therapy.

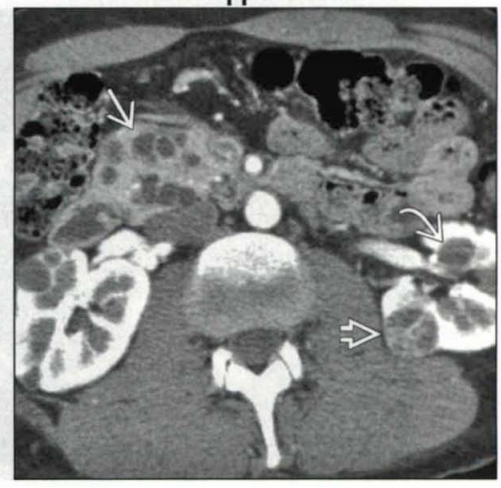
Acquired Cystic Disease of Uremia

Acquired Cystic Disease of Uremia



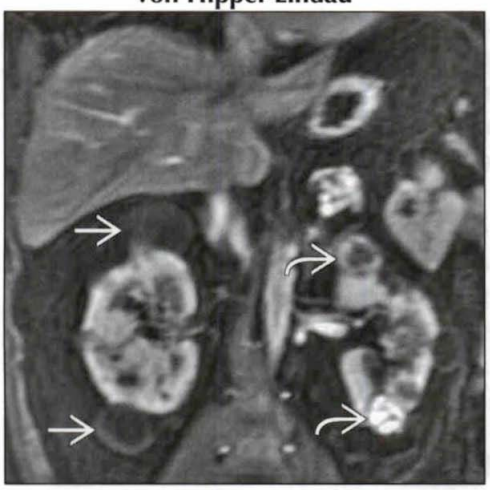
(Left) Axial CECT shows a brightly enhancing solid mass ➡ (renal cell carcinoma) in a patient with dialysis-dependent renal failure. Note the small kidney with innumerable cysts. (Right) Axial CECT shows multiple cysts in the pancreas ➡ and kidneys ➡ as well as one of several solid enhancing masses ➪ (renal cell carcinoma). These are classic features of von Hippel-Lindau syndrome.

Von Hippel-Lindau



BILATERAL RENAL CYSTS

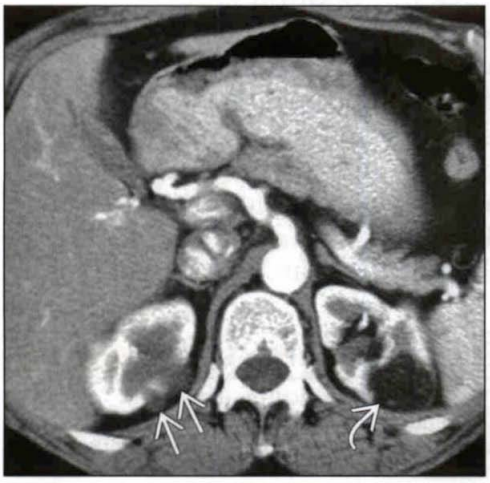
Von Hippel-Lindau



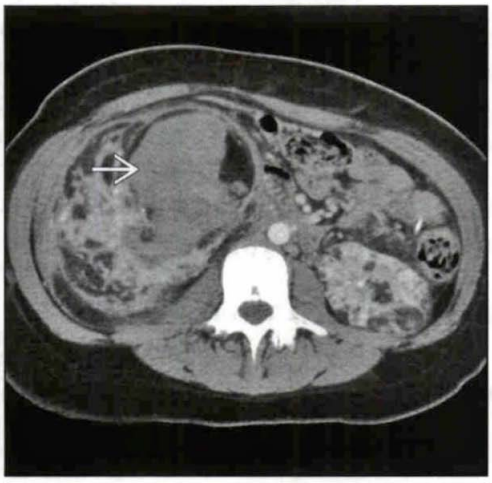
Von Hippel-Lindau

(Left) *Coronal T1 C+ FS MR shows multiple simple renal cysts and at least two enhancing masses that represent renal cell carcinomas.* ***(Right)*** *Axial CECT shows multiple renal cysts and a solid enhancing mass (renal cell carcinoma) in a patient with von Hippel-Lindau.*

Tuberous Sclerosis

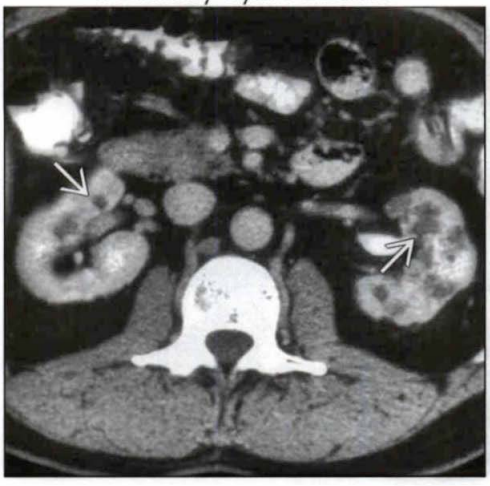


Tuberous Sclerosis



(Left) *Axial CECT shows 2 of many simple renal cysts and a fat-containing mass (angiomyolipoma) in the left kidney.* ***(Right)*** *Axial CECT shows innumerable small fat density angiomyolipomas (AMLs) in both kidneys. Spontaneous hemorrhage is associated with one of the larger AMLs. Due to partial volume averaging it is difficult (but unnecessary) to distinguish small AMLs from simple cysts, both of which are usually present in patients with tuberous sclerosis.*

Medullary Cystic Disease



Lithium Nephropathy

(Left) *Axial CECT shows multiple medullary and cortical cysts in a patient with progressive renal failure, anemia, and "salt-wasting nephropathy", all of which are typical imaging and clinical features of medullary cystic disease.* ***(Right)*** *Axial T2WI MR shows innumerable tiny cysts throughout the cortex and medulla of both kidneys in a 69 year old woman receiving long term lithium therapy for bipolar disorder. The kidneys are somewhat diminished in size and function.*

INFILTRATIVE RENAL LESIONS

DIFFERENTIAL DIAGNOSIS

Common
- Pyelonephritis
- Transitional Cell Carcinoma
- Metastases and Lymphoma, Renal
- Renal Cell Carcinoma

Less Common
- Pyelonephritis, Xanthogranulomatous
- Renal Infarction
- HIV Nephropathy
- Renal Tuberculosis

Rare but Important
- Renal Medullary Carcinoma
- Extramedullary Hematopoiesis
- Squamous Cell Carcinoma, Renal
- Collecting Duct Carcinoma
- Sarcoma, Renal

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Infiltrative refers to processes that replace renal parenchyma without distorting its reniform shape
  - Unlike expansile masses, these lesions lack sharp border of demarcation with normal parenchyma
- Diagnosis requires imaging characterization, plus clinical data

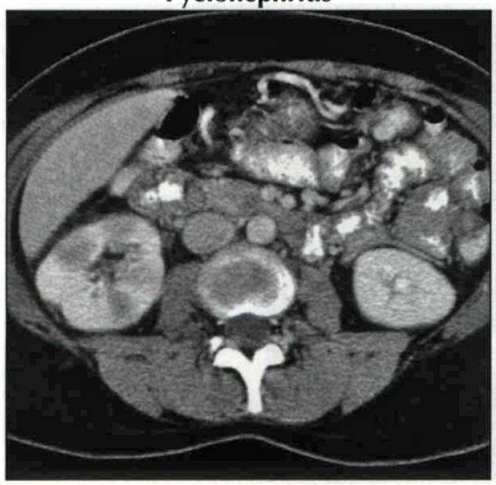
Helpful Clues for Common Diagnoses
- **Pyelonephritis**
  - Enlarged kidney with striated or wedge-shaped foci of decreased enhancement on CECT
  - More common in young women; usually have high fever and bacteria in urine
- **Transitional Cell Carcinoma**
  - Renal mass much less common than polypoid uroepithelial tumor of urinary bladder or renal pelvis
  - Infiltration of renal parenchyma is more common with TCC than with RCC, but RCC is a more common tumor
- **Metastases and Lymphoma, Renal**
  - Lymphoma and leukemia more likely to cause infiltration or multiple, poorly defined renal masses
- **Renal Cell Carcinoma**
  - Usually an expansile mass, but may infiltrate diffusely

Other Essential Information
- Consider other infectious processes (e.g., HIV nephropathy, renal tuberculosis, xanthogranulomatous pyelonephritis)
- Other rare neoplasms (e.g., renal medullary carcinoma in young patient with sickle cell trait; squamous cell in patient with chronic calculus disease)
- Vascular (e.g., renal infarction, vasculitis)

SELECTED REFERENCES

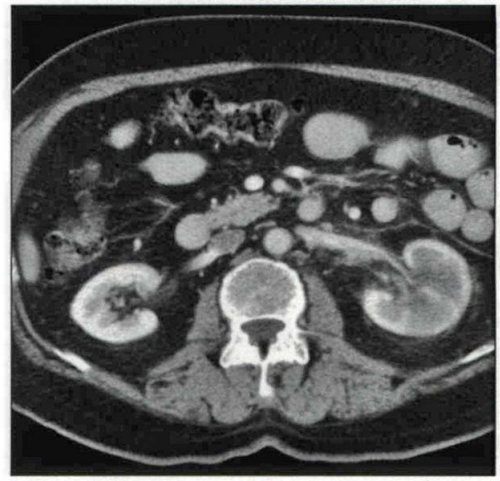
1. Pickhardt PJ et al: From the archives of the AFIP. Infiltrative renal lesions: radiologic-pathologic correlation. Armed Forces Institute of Pathology. Radiographics. 20(1):215-43, 2000

Pyelonephritis



Axial CECT shows an enlarged right kidney with the striated nephrogram pattern, characteristic, but not diagnostic of acute pyelonephritis. The perirenal space is inflamed as well.

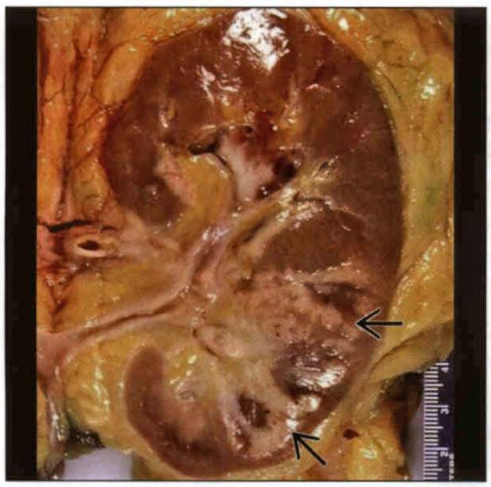
Transitional Cell Carcinoma



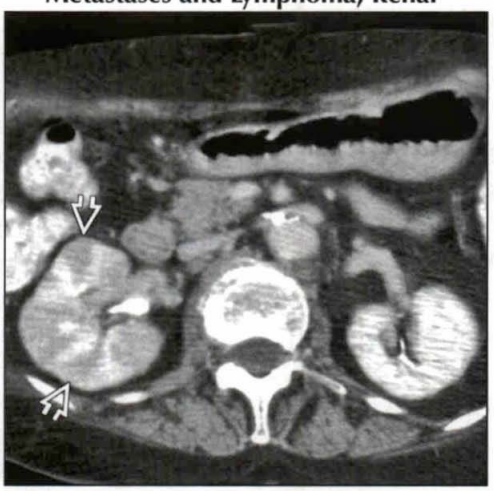
Axial CECT shows classic infiltration and enlargement of the medullary portions of the lower pole of the left kidney by transitional cell carcinoma; 79 year old man.

INFILTRATIVE RENAL LESIONS

Transitional Cell Carcinoma

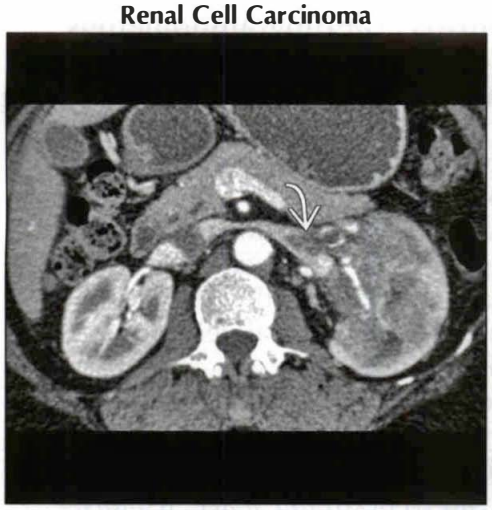


Metastases and Lymphoma, Renal

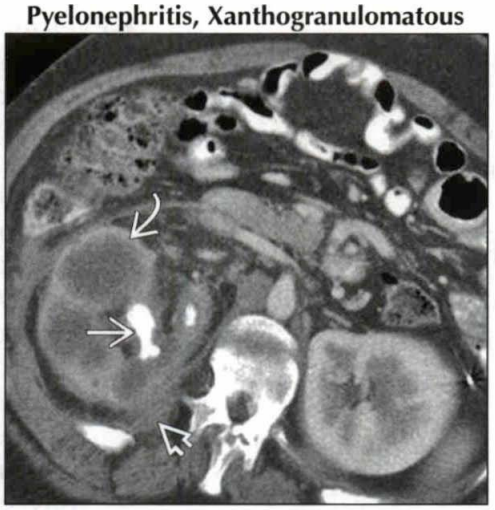


(Left) *Coronal gross pathology, section shows infiltration of the medullary portion of the lower pole with sparing of the cortex in this 79 year old man.* ***(Right)*** *Axial CECT shows an enlarged heterogeneously enhancing right kidney in an elderly woman with no urinary tract infection; proven lymphoma of the kidney. The imaging features simulate pyelonephritis.*

Renal Cell Carcinoma

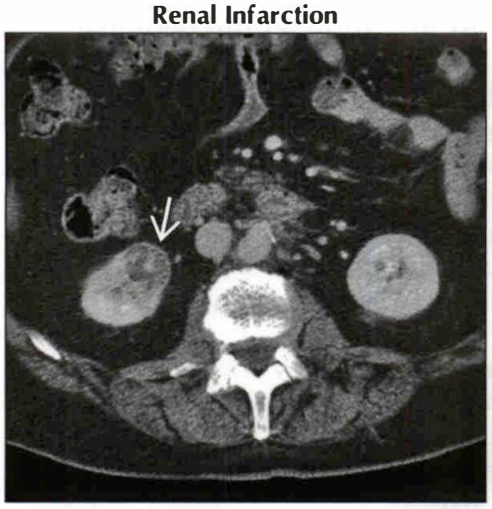


Pyelonephritis, Xanthogranulomatous

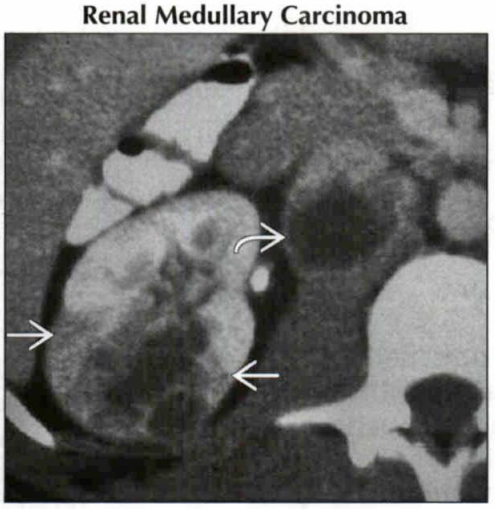


(Left) *Axial CECT shows infiltration of the left kidney by a mass. The hypervascularity of the mass and the invasion of the renal vein suggest the diagnosis of RCC, rather than TCC.* ***(Right)*** *Axial CECT shows a nonfunctioning right kidney with an obstructing calculous. Low density xanthomatous inflammation replaces the renal parenchyma and spreads to the perirenal space.*

Renal Infarction



Renal Medullary Carcinoma



(Left) *Axial CECT shows heterogeneous decreased enhancement of the lower pole of the right kidney. simulating an infiltrative mass, but proved to be due to acute renal infarction.* ***(Right)*** *Axial CECT shows an infiltrative mass in the lower pole with direct invasion of the IVC in a young man with sickle cell trait.*

PERIRENAL AND SUBCAPSULAR MASS LESIONS

DIFFERENTIAL DIAGNOSIS

Common

- Perirenal & Subcapsular Hemorrhage
  - Renal Trauma
  - Coagulopathic ("Retroperitoneal") Hemorrhage
  - Angiomyolipoma, Renal
  - Renal Cell Carcinoma
- Renal Metastases and Lymphoma
- Renal, Perirenal Abscess

Less Common

- Pyelonephritis, Xanthogranulomatous
- Pancreatitis, Acute
- Extramedullary Hematopoiesis
- Urinoma
- Accessory Spleen
- Retroperitoneal Fibrosis
- Nephroblastomatosis

Rare but Important

- Renal Lymphangiomatosis
- Multiple Myeloma
- Rosai-Dorfman Disease
- Erdheim-Chester Disease

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Key to DDx: Imaging plus clinical
  - Seek evidence for
    - Trauma
    - Infection
    - Tumor (primary or metastatic)

Helpful Clues for Common Diagnoses

- **Perirenal & Subcapsular Hemorrhage**
  - Trauma, blunt, penetrating, or iatrogenic
    - Renal biopsy
    - Retrograde pyelography or ureteral catheterization
    - Percutaneous nephrostomy
    - Lithotripsy
  - Spontaneous coagulopathic
    - Hemophilia
    - Anticoagulant therapy
  - Tumor
    - Angiomyolipoma and renal cell carcinoma are most common
    - Large tumors extend into perirenal space
    - May bleed into perirenal space
    - Metastases quite uncommon
  - Vasculitis
    - Polyarteritis nodosa
    - Lupus erythematosus
    - Other small and medium vessel arteritides
  - Ruptured aneurysm or AV fistula: Aortic or renal artery
- **Renal Metastases and Lymphoma**
  - Metastases: More often discrete masses within kidney &/or perirenal space
    - Melanoma is the most common primary tumor
  - Lymphoma: More often confluent masses
- **Renal, Perirenal Abscess**
  - Marked infiltration of perirenal space; thickened perirenal fascia
  - Abscess contents do not enhance
    - May contain gas

Helpful Clues for Less Common Diagnoses

- **Pyelonephritis, Xanthogranulomatous**
  - Usually infiltrates & replaces kidney and perirenal space with heterogeneous, low density mass
    - Low density is due to lipid-laden macrophages
    - Attenuation is usually lower than water but higher than "pure" fat
  - Almost always associated with large calculus obstructing renal pelvis or infundibulum
    - Affected portion (or entire) kidney is usually nonfunctional
- **Pancreatitis, Acute**
  - May spread to perirenal space, usually through the renal hilum (rarely through perirenal fascia)
  - Pseudocyst may form within perirenal space
    - Density of pseudocyst may vary; often higher than water density when acute due to blood & proteinaceous contents
- **Extramedullary Hematopoiesis**
  - Associated with chronic anemia, leukemia, extensive bone tumor
  - May infiltrate the kidney and perirenal space
  - May also see other sites
    - Spleen, paraspinal masses, etc.
- **Urinoma**
  - Due to obstruction of ureter and rupture of renal fornix

- Urine collects within perirenal space, usually caudal to kidney
- Density of "mass" depends on use of contrast media
  - On NECT will be near water density
  - On CECT, pyelographic phase, should see densely opacified urine within perirenal space

- **Accessory Spleen**
  - May "migrate" along splenorenal ligament to result in perirenal mass
  - Similar density & enhancement pattern as spleen
  - Tc sulfur colloid scan is definitive test
- **Retroperitoneal Fibrosis**
  - Causes a confluent mass that encases the distal aorta, IVC, and ureters
  - Fibrotic mass may extend into perirenal spaces
  - Caliectasis, hydronephrosis, and urinoma may all result from ureteral obstruction
- **Nephroblastomatosis**
  - Multiple masses in renal cortex & perirenal space, bilateral; precursor of Wilms tumor

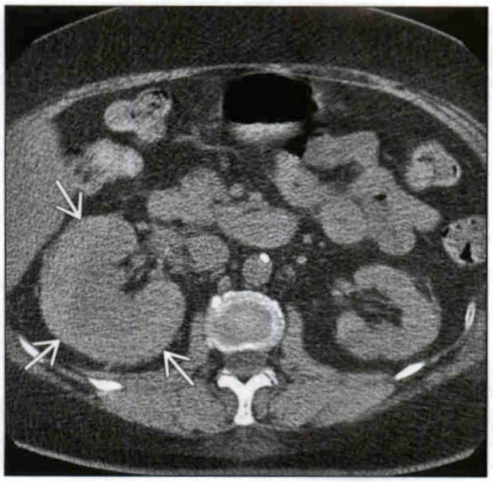
Helpful Clues for Rare Diagnoses

- **Renal Lymphangiomatosis**
  - Rare benign malformation of perirenal lymphatics
  - Unilateral or bilateral perirenal & peripelvic septate cystic collections
    - Anechoic on US
    - Innumerable cystic, water attenuation cystic spaces on CECT
- **Multiple Myeloma**
  - Perirenal spaces may be involved with masses of proliferating plasmacytes
- **Rosai-Dorfman Disease**
  - Rare disorder that results in proliferation & accumulation of histiocytes (WBC) in lymph nodes & extranodal tissues
  - Sites of extranodal disease include skin, CNS, kidney/perirenal, & gut
- **Erdheim-Chester Disease**
  - Rare multisystem disease characterized by progressive involvement of bones, organs & tissues by xanthogranulomatous infiltration (lipid-laden histiocytes & giant cells)
  - Presents with leg pain & shows sclerosis of metaphyses of lower extremities
  - Kidneys, lungs, orbits, CNS involved

SELECTED REFERENCES

1. Westphalen A et al: Differential diagnosis of perinephric masses on CT and MRI. AJR Am J Roentgenol. 183(6):1697-702, 2004

Renal Trauma



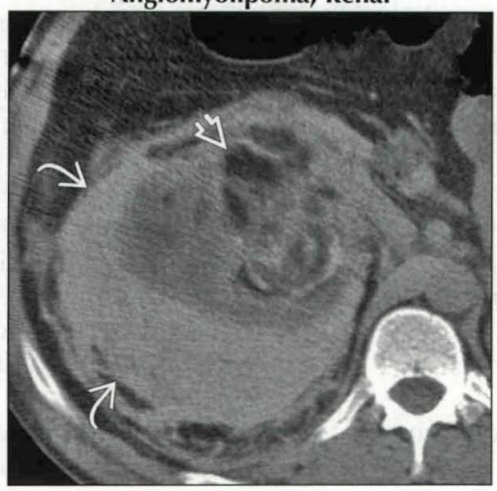
Axial NECT shows a lentiform collection of blood ■ in the perirenal space that is hyperdense to the unopacified renal parenchyma.

Coagulopathic ("Retroperitoneal") Hemorrhage

Axial CECT shows a large hematoma ➡ that distends the perirenal space, due to spontaneous hemorrhage in a patient receiving heparin for anticoagulation.

PERIRENAL AND SUBCAPSULAR MASS LESIONS

Angiomyolipoma, Renal



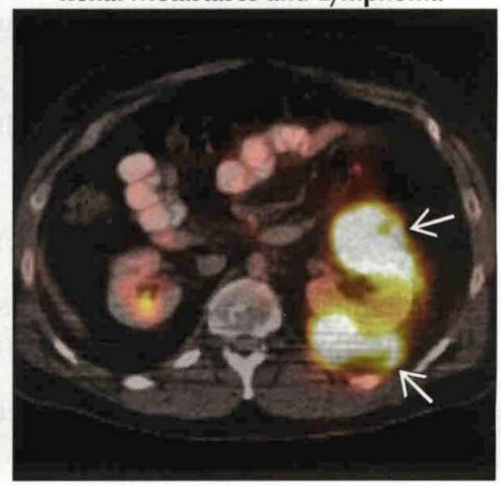
(Left) Axial NECT shows blood filling the perirenal space that is hyperdense to the renal parenchyma. Note the heterogeneous fat density mass, an AML, that was the source of the hemorrhage. (Right) Coronal CECT shows an exophytic mass arising from the lower pole of the left kidney that is confined within the perirenal space.

Renal Cell Carcinoma

Renal Metastases and Lymphoma

(Left) Axial CECT shows a soft tissue density mass filling the perirenal space, and retroperitoneal lymphadenopathy, both due to non-Hodgkin lymphoma. (Right) Axial PET shows intense FDG uptake in and around the left kidney due to metastatic melanoma.

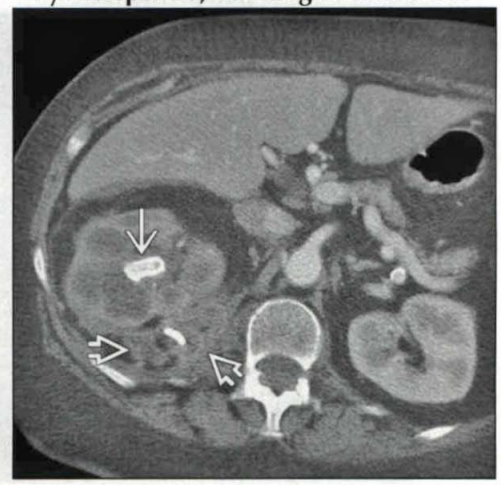
Renal Metastases and Lymphoma



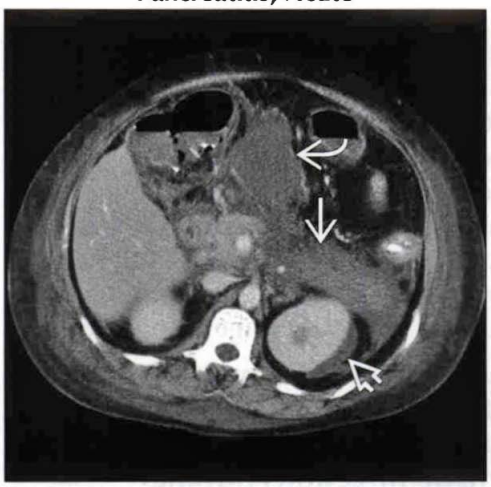
Renal, Perirenal Abscess

(Left) Axial CECT shows a multiseptate renal & perirenal mass, a typical appearance of an abscess. (Right) Axial CECT shows a nonfunctional right kidney with a large central calculous. The proliferated, chronically inflamed fat and pus distend the perirenal space.

Pyelonephritis, Xanthogranulomatous



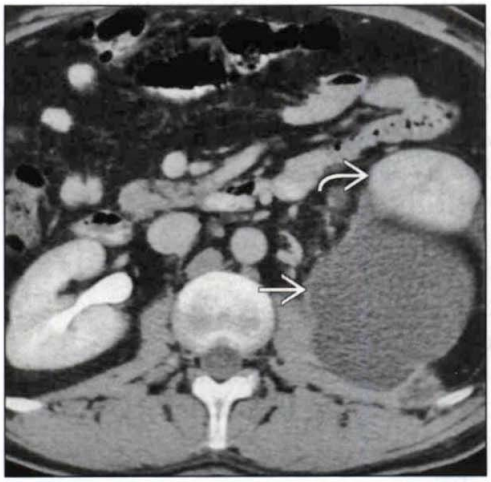
Pancreatitis, Acute



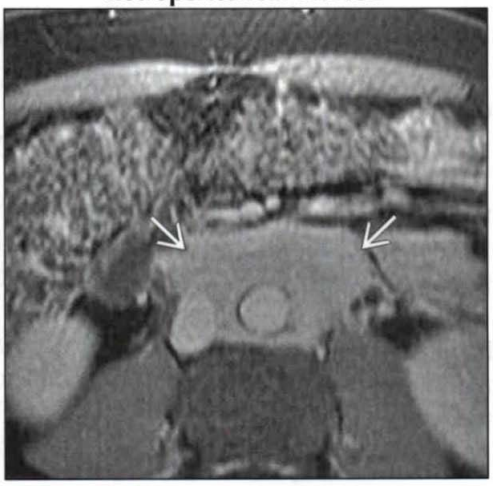
Extramedullary Hematopoiesis

(Left) Axial CECT shows severe pancreatitis with necrosis of the body/tail segments and spread of inflammation into the mesentery, retroperitoneum, & even the left perirenal space. (Right) Axial CECT shows infiltration of both kidneys and perirenal spaces from what proved to be extramedullary hematopoiesis in a patient with a myeloproliferative disorder.

Urinoma

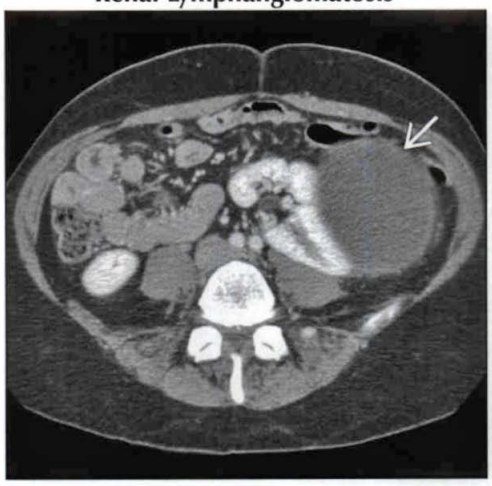


Retroperitoneal Fibrosis

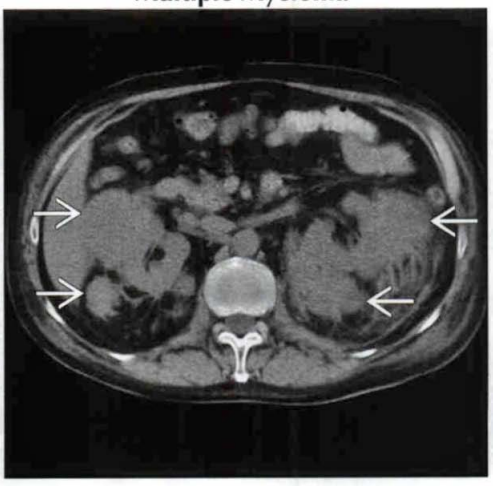


(Left) Axial CECT shows a water density mass in the left perirenal space that displaces the kidney. The left ureter had been injured during a colonic resection, causing a stricture and urinary leak. (Right) Axial T1 C+ FS MR shows an unusually large mass of fibrotic tissue that encases the aorta & IVC and that extends along the renal hila into the perirenal spaces.

Renal Lymphangiomatosis



Multiple Myeloma



(Left) Axial CECT shows a perirenal water density mass that indents and displaces the kidney. (Right) Axial NECT shows multiple masses in the perirenal spaces bilaterally due to deposits of multiple myeloma.

RENAL CORTICAL NEPHROCALCINOSIS

DIFFERENTIAL DIAGNOSIS

Common
- Renal Cortical Necrosis
- Renal Allograft Rejection
- Chronic Glomerulonephritis
- Sickle Cell Anemia, Abdominal Signs

Less Common
- Chronic Hypercalcemia
- Opportunistic Infections (Mimic)
- Oxalosis (Primary or Secondary)
- Alport Syndrome
- Ethylene Glycol (Antifreeze) Poisoning
- Tuberculosis (Mimic)

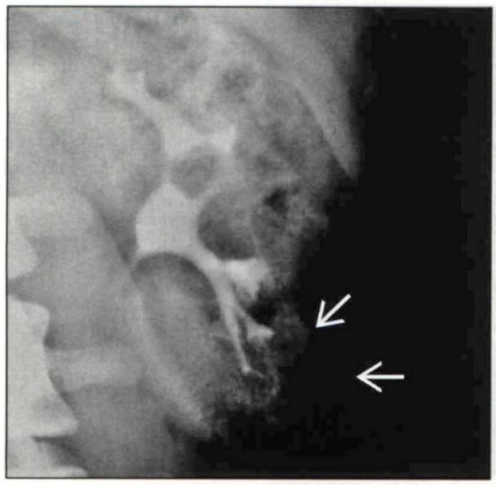
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Cortical nephrocalcinosis much less common than medullary
- Shock & renal transplant rejection are most common causes

Helpful Clues for Common Diagnoses
- **Renal Cortical Necrosis**
  - Usually due to shock (e.g., placental abruption or severe hypotensive episode)
  - Thin peripheral rim of calcification just beneath renal capsule; may extend into septum of Bertin
  - CECT: Hypoattenuating band between cortical calcification and opacified medulla; no or minimal concentration and excretion of contrast medium
  - US: Hyperechoic rim, loss of cortico-medullary differentiation
- **Renal Allograft Rejection**
  - Allograft usually in iliac fossa
  - Calcification: Cortex or entire organ
  - Allograft diminished in size
- **Chronic Glomerulonephritis**
  - Punctate & curvilinear, cortical
  - Decreased renal size and function
- **Sickle Cell Anemia, Abdominal Signs**
  - Chronic ischemic injury may result in small, peripherally calcified kidneys
  - Analogous to spleen changes in sickle cell

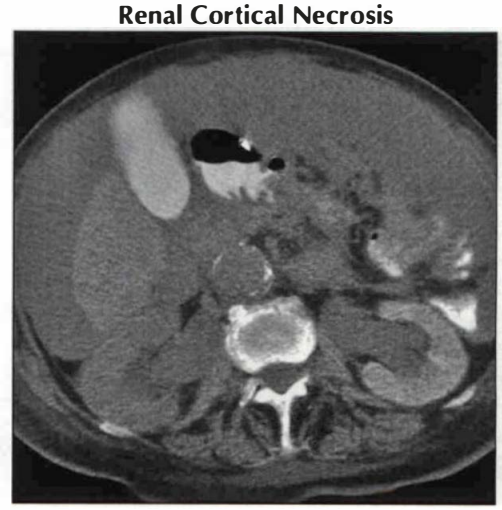
Helpful Clues for Less Common Diagnoses
- **Chronic Hypercalcemia**
  - Milk-alkali ingestion; vitamin D excess
- **Opportunistic Infections (Mimic)**
  - Usually in patients with AIDS
  - Cytomegalovirus, MAI, Pneumocystis
  - Usually multiple punctuate calcifications in cortex and medulla
- **Oxalosis (Primary or Secondary)**
  - Dense calcification of cortex ± medulla
  - Kidneys normal to small size
  - Bones also hyperdense
- **Alport Syndrome**
  - Hereditary glomerulonephritis and interstitial fibrosis
  - Associated with deafness
- **Tuberculosis (Mimic)**
  - Focal or diffuse calcification and scarring
  - Global decreased size with calcification = "putty kidney"

Renal Cortical Necrosis



Anteroposterior excretory urography shows thin curvilinear calcifications ➡ just beneath the renal surface, imparting a lobular appearance to the kidney.

Renal Cortical Necrosis

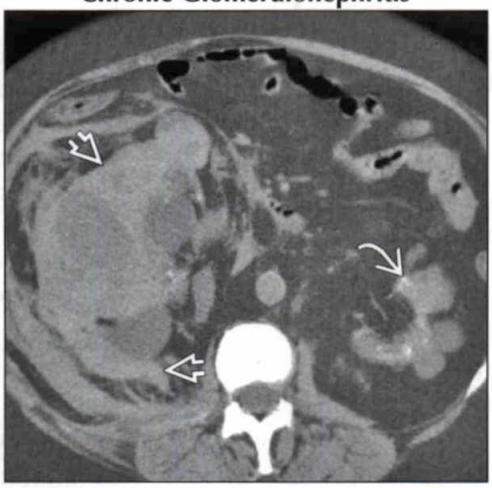


Axial NECT shows cortical nephrocalcinosis, left > right, in a patient in shock following rupture of a splenic artery aneurysm. Note vicarious excretion, accounting for dense bile in gallbladder.

RENAL CORTICAL NEPHROCALCINOSIS

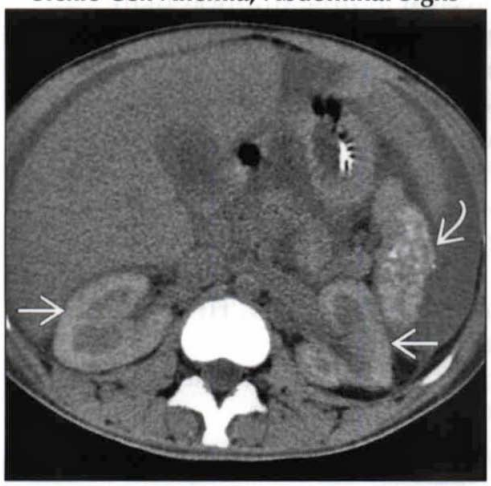
Renal Allograft Rejection

Chronic Glomerulonephritis

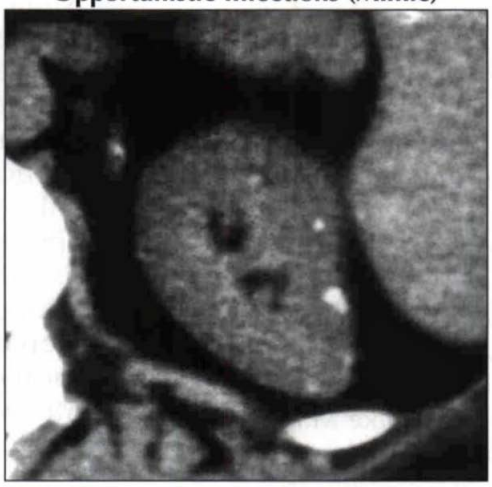


(Left) Axial NECT shows calcifications within a small, nonfunctional, renal allograft in the left iliac fossa. (Right) Axial NECT shows a small left kidney with cortical calcification due to chronic glomerulonephritis. The multiple cysts & perirenal hemorrhage are due to acquired cystic disease of uremia.

Sickle Cell Anemia, Abdominal Signs



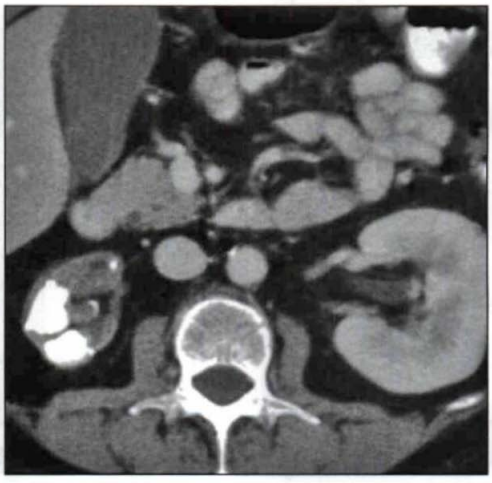
Opportunistic Infections (Mimic)



(Left) Axial NECT shows cortical calcification of both kidneys and the spleen along with dense bones and ascites. (Right) Axial NECT shows multiple, small, focal calcifications in the renal cortex in this young man with AIDS, due to Pneumocystis carinii infection (healed phase).

Oxalosis (Primary or Secondary)

Tuberculosis (Mimic)



(Left) Axial NECT shows small, densely calcified and nonfunctional kidneys along with dense bones, typical findings for oxalosis. Alport syndrome can have identical imaging findings. (Right) Axial CECT shows a small, nonfunctional right kidney with cortical & medullary calcifications.

MEDULLARY NEPHROCALCINOSIS

DIFFERENTIAL DIAGNOSIS

Common
- Hyperparathyroidism
- Renal Tubular Acidosis
- Medullary Sponge Kidney
- Hypercalcemia

Less Common
- Oxalosis
- Sickle Cell Anemia; Abdominal Signs
- Medications
- Thyroid Dysfunction
- Pyelonephritis, Chronic
- Opportunistic Infections
- Syndromic (e.g., Alport Syndrome)
- Tuberculosis, Renal

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Most conditions that cause medullary nephrocalcinosis also cause nephrolithiasis
  - Imaging is limited in distinguishing among numerous etiologies

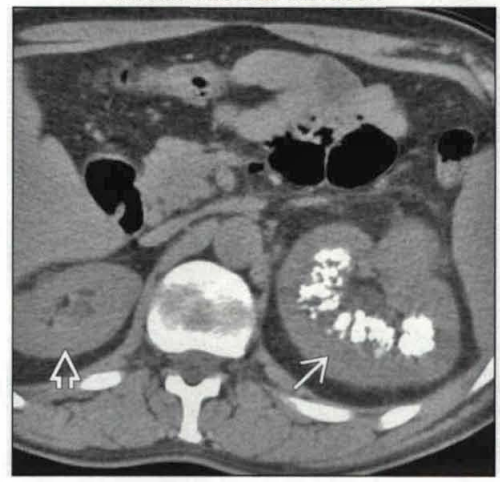
Helpful Clues for Common Diagnoses
- **Hyperparathyroidism**
  - Primary form accounts for 40% of all cases of medullary nephrocalcinosis
  - Clusters of round calcifications primarily in renal pyramids; may fill ureters
  - Still visible on CT and radiographs after IV contrast administration (unlike MSK)
- **Renal Tubular Acidosis**
  - Imaging findings identical to hyperparathyroidism
- **Medullary Sponge Kidney**
  - Renal tubular ectasia; tiny calculi within diluted tubules; disappear after IV contrast administration
  - Delayed CECT & urography: Renal pyramid "brush", dilated tubules
- **Hypercalcemia**
  - Of many potential causes
  - May cause cortical and medullary calcinosis

Helpful Clues for Less Common Diagnoses
- **Oxalosis**
  - Dense calcification of cortex ± medulla
  - Kidneys normal to small size
  - Skeletal hyperdensity
  - Alport syndrome: Similar appearance
- **Medications**
  - Numerous, including amphotericin, furosemide, acetazolamide
- **Pyelonephritis, Chronic**
  - Punctate or focal calcifications in cortex and medulla
  - Cortical thinning over dilated calyces
  - Kidneys decreased in size and function
- **Opportunistic Infections**
  - Usually in patients with AIDS
  - MAI, pneumocystis, CMV, HIV
- **Tuberculosis, Renal**
  - Focal or diffuse amorphous calcification at sites of caseated infection

Hyperparathyroidism

Axial NECT shows bilateral extensive medullary nephrocalcinosis ➡, due to hyperparathyroidism.

Renal Tubular Acidosis

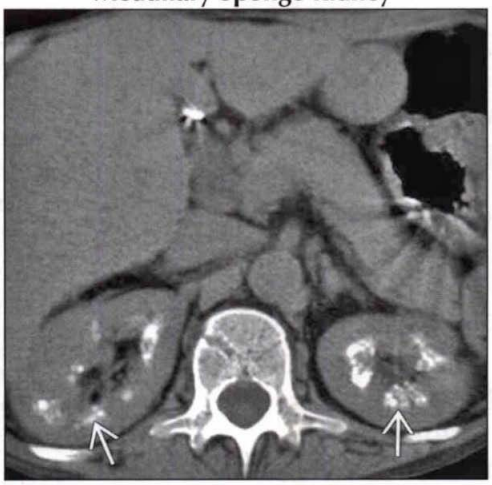


Axial NECT shows dense medullary nephrocalcinosis in the left kidney ➡ but little or no involvement of the right ➡, an unusual degree of asymmetry in medullary nephrocalcinosis.

MEDULLARY NEPHROCALCINOSIS

Renal Tubular Acidosis

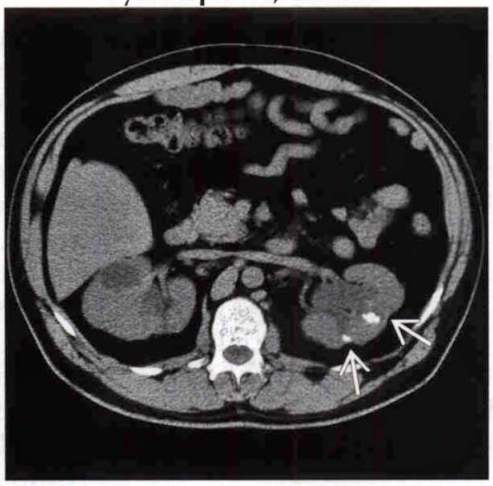
Medullary Sponge Kidney



*(**Left**) Coronal NECT shows dense bilateral & symmetrical medullary calcifications in this 52 year old man who has had 32 lithotripsy procedures for obstructing renal & ureteral calculi. (**Right**) Axial NECT shows clusters of small calcifications ➡ limited to the renal pyramids.*

Medullary Sponge Kidney

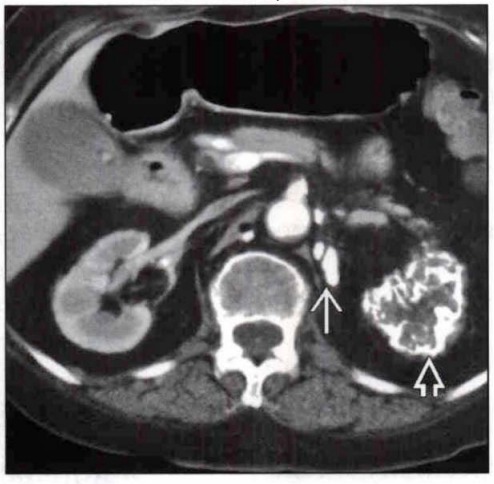
Pyelonephritis, Chronic



*(**Left**) Frontal excretory urography shows a classic "paint brush" appearance of the dilated renal tubules in the renal pyramids bilaterally. The many small calculi within the tubules are obscured by the opacified urine. (**Right**) Axial NECT shows small kidneys. Note the cortical scarring overlying the parenchymal calcifications ➡ and the dilated calices, all due to chronic reflux and infection.*

Syndromic (e.g., Alport Syndrome)

Tuberculosis, Renal



*(**Left**) Axial NECT shows dense calcification of both kidneys, both cortical & medullary, in a patient with Alport syndrome, a congenital anomaly associated with deafness and renal disease (oxalosis has a similar appearance in the kidneys). (**Right**) Axial CECT shows a nonfunctional left kidney with diffuse calcification and scarring ("putty kidney") ➡, and calcified retroperitoneal nodes ➡.*

PERIRENAL HEMORRHAGE

DIFFERENTIAL DIAGNOSIS

Common
- Renal Trauma
- Angiomyolipoma, Renal
- Renal Cell Carcinoma
- Ruptured Abdominal Aortic Aneurysm
- Coagulopathic ("Retroperitoneal") Hemorrhage
- Acquired Cystic Disease of Uremia
- Adrenal Hemorrhage
- Renal Abscess (Mimic)
- Renal Metastases & Lymphoma (Mimic)

Less Common
- Vasculitis, Abdominal Manifestations
- AD Polycystic Disease, Kidney
- Renal Artery Aneurysm
- Arteriovenous Malformation, Renal
- Acute Pancreatitis
- Adrenal Pheochromocytoma
- Adrenal Carcinoma
- Hemorrhagic Fever with Renal Syndrome

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Check for trauma, tumor, or anticoagulation
- Trauma
  - May be either blunt or penetrating
  - Kidneys more often injured than adrenals in blunt trauma
  - Look carefully at other organs
    - Other injuries in up to 80% of cases
- Tumor
  - Look for claw sign identifying mass arising from kidney
  - Tumors may cause spontaneous hemorrhage or bleed with trauma
    - Always consider underlying tumor if the amount of perirenal hemorrhage exceeds what would be expected based on severity of trauma
- Anticoagulation
  - Look for other sites of bleeding, especially into abdominal wall muscles
    - Iliopsoas and rectus muscles common sites
  - Hematocrit sign (cellular-fluid level) strongly suggests coagulopathy as cause of hemorrhage
    - Sensitivity > 85%; specificity > 95%

Helpful Clues for Common Diagnoses
- **Renal Trauma**
  - Most common cause of perirenal hemorrhage
  - Look for extravasation of contrast indicating active bleeding
  - Perirenal fluid may be combination of blood and urine
    - For any renal laceration evident on CT, it is vital to obtain 8-10 minute delayed scans to evaluate for urinary extravasation
  - Consider iatrogenic causes
    - Percutaneous biopsy
    - Nephrostomy
    - Retrograde ureteral catheterization
    - Lithotripsy
- **Angiomyolipoma, Renal**
  - Accounts for almost 50% of all cases of spontaneous perirenal hemorrhage
    - Hemorrhage more common in tumors > 4 cm
  - Look for fat-containing mass in kidney
    - Mass may be obscured by hemorrhage
  - May confuse heterogeneous fatty mass with hemorrhage in the perirenal space
- **Renal Cell Carcinoma**
  - Slightly fewer cases of bleeding than AML
  - Soft tissue density exophytic renal mass
  - May have calcifications, which would be very unusual for an AML
- **Ruptured Abdominal Aortic Aneurysm**
  - Can bleed into any or all retroperitoneal compartments
    - May follow the renal vessels into the perirenal space
  - Bleeding contiguous with large or eccentric aneurysm
- **Coagulopathic ("Retroperitoneal") Hemorrhage**
  - Usually patients receiving heparin or Coumadin
  - Bleeding usually starts in iliopsoas compartment; spreads into retroperitoneum
  - Look for hematocrit sign
- **Acquired Cystic Disease of Uremia**
  - Spontaneous bleeding into cysts & perirenal space
  - Look for underlying tumor also
- **Adrenal Hemorrhage**

- More common in neonates but can be seen in children and adults
- Secondary to traumatic & nontraumatic causes
- Unilateral hemorrhage more common in trauma
- Nontraumatic etiologies typically present with bilateral hemorrhage
  - Stress (including recent surgery or hypotension)
  - Hemorrhagic diathesis or coagulopathy
  - Bleeding adrenal tumor
  - Sepsis (Waterhouse-Friderichsen syndrome)

- **Renal Abscess (Mimic)**
  - High attenuation pus may simulate blood
  - Present clinically with fever, flank pain, and increased white cell count
- **Renal Metastases & Lymphoma (Mimic)**
  - NHL may cause perirenal infiltrative mass that might mimic hemorrhage
  - Look for lymphadenopathy and other sites of lymphoma
  - Consider post transplant lymphoproliferative disorder (PTLD)

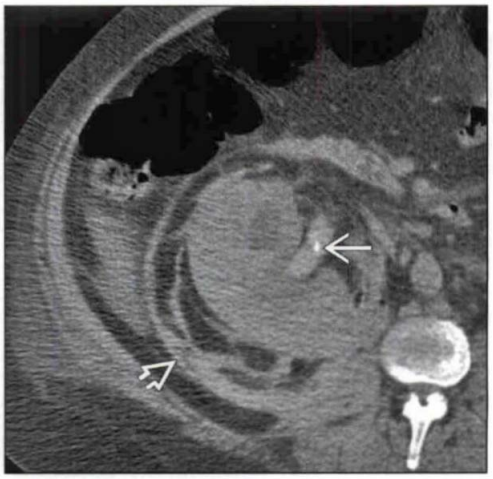
Helpful Clues for Less Common Diagnoses

- **Vasculitis, Abdominal Manifestations**
  - Most likely diagnosis in absence of renal trauma, mass, aneurysm or anticoagulation
  - Most common causes
    - Polyarteritis
    - Lupus
    - Wegener granulomatosis
- **AD Polycystic Disease, Kidney**
  - Bleeding into cysts is common; less often into perirenal space
- **Renal Artery Aneurysm**
  - Increased risk of rupture in pregnancy
- **Arteriovenous Malformation, Renal**
  - Dense enhancement during the arterial phase with premature opacification of renal vein
  - May have remote history of penetrating trauma (including iatrogenic, such as biopsy)
- **Acute Pancreatitis**
  - May infiltrate perirenal (& other retroperitoneal) spaces
  - May mimic perirenal hemorrhage
- **Adrenal Pheochromocytoma**
  - Highly vascular adrenal tumor prone to hemorrhage, necrosis
    - Hemorrhage may extend into perirenal space
  - Clinical presentation & lab data may be helpful in making diagnosis
- **Adrenal Carcinoma**
  - Large suprarenal mass often containing hemorrhagic, cystic & calcific areas
  - Look vascular invasion
    - Renal vein, IVC
- **Hemorrhagic Fever with Renal Syndrome**
  - Multisystem infectious disease caused by Hanta viruses (carried by rodents)

Renal Trauma

Axial CECT shows a large perirenal hemorrhage due to a parenchymal laceration through the dorsal half of the kidney. Note extravasation of contrast-opacified blood.

Renal Trauma



Axial NECT shows perirenal hemorrhage and a small stone in the renal pelvis following lithotripsy and previous placement of a nephrostomy tube in an attempt to clear the renal calculi.

PERIRENAL HEMORRHAGE

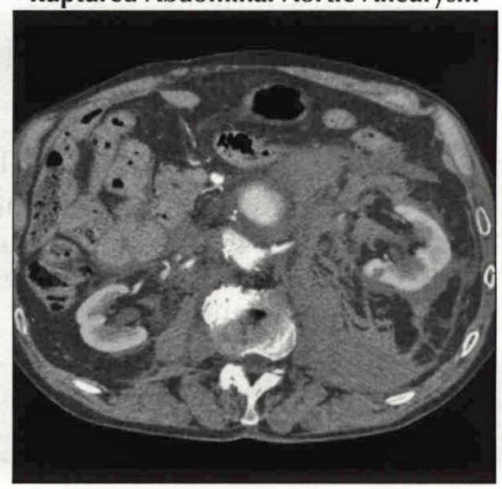
Angiomyolipoma, Renal

Renal Cell Carcinoma

(Left) Axial NECT shows hyperdense blood throughout the perirenal space due to spontaneous rupture of an AML, marked by its heterogeneous fat density compared with the soft tissue density of the kidney. (Right) Axial CECT shows an exophytic, hypervascular, renal mass with extensive, spontaneous perirenal hemorrhage.

Ruptured Abdominal Aortic Aneurysm

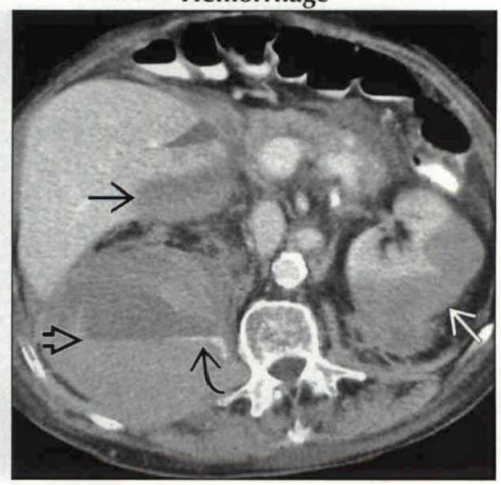
Ruptured Abdominal Aortic Aneurysm



(Left) Axial CECT shows a large abdominal aortic aneurysm with hemorrhage that dissects throughout the retroperitoneum, including the left perirenal space. (Right) Axial CECT shows the lower end of a large AAA that ruptured into the retroperitoneum with bleeding into the perirenal and other spaces.

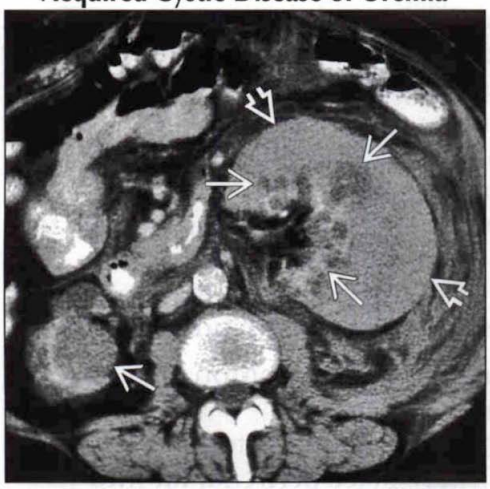
Coagulopathic ("Retroperitoneal") Hemorrhage

Coagulopathic ("Retroperitoneal") Hemorrhage

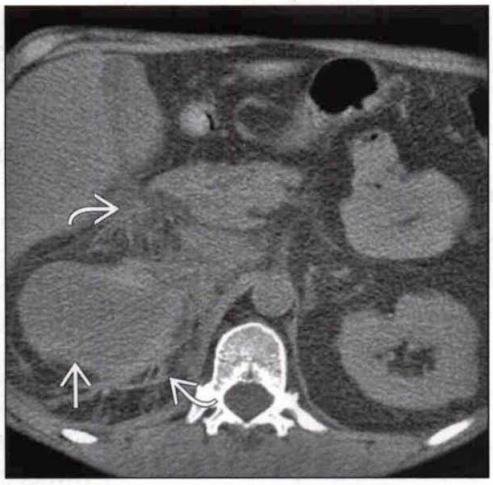


(Left) Axial CECT shows a large perirenal hemorrhage due to spontaneous bleeding in a patient receiving heparin for anticoagulation therapy. (Right) Axial CECT shows perirenal hemorrhage around the left kidney, but also bleeding into the subhepatic and iliopsoas compartments. Note the hematocrit sign and active extravasation of blood, all signs of a coagulopathic hemorrhage.

Acquired Cystic Disease of Uremia

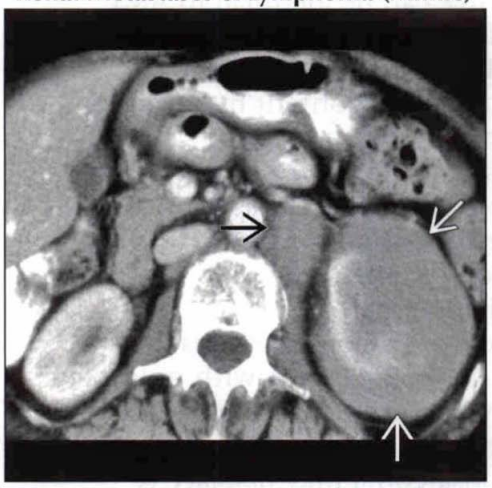


Renal Abscess (Mimic)

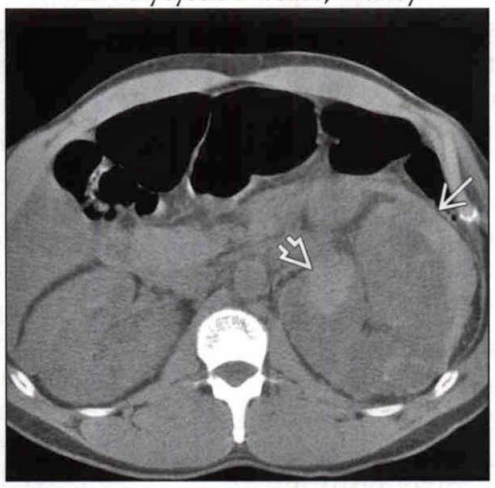


(Left) *Axial CECT shows small kidneys with innumerable cysts. The left perirenal space is distended with acute spontaneous hemorrhage.* ***(Right)*** *Axial NECT shows extensive infiltration of the perirenal space and an exophytic mass from the right kidney in a patient who presented with acute flank pain. A repeat CECT after antibiotic therapy showed an evolving renal abscess.*

Renal Metastases & Lymphoma (Mimic)



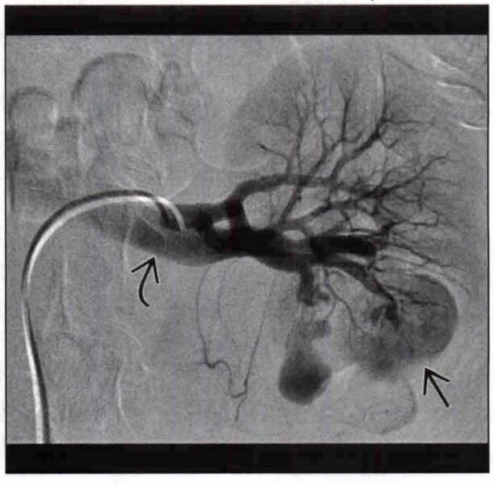
AD Polycystic Disease, Kidney



(Left) *Axial CECT shows high density homogeneous tissue distending the perirenal space. The presence of similar tissue in retroperitoneal lymph nodes helps to identify this as renal & perirenal lymphoma.* ***(Right)*** *Axial NECT shows enlarged kidneys with innumerable cysts. High density clotted blood is present within some of the cysts and the perirenal space in this patient with AD polycystic disease of the kidney who presented with acute flank pain.*

Arteriovenous Malformation, Renal

Arteriovenous Malformation, Renal



(Left) *Axial CECT shows a mass within the left kidney that is nearly isodense with blood vessels. Subsequent sonography confirmed a renal AVM and this was embolized via angiographic catheterization.* ***(Right)*** *Catheter angiography shows contrast injection of the renal artery with premature opacification of the renal vein due to a large arteriovenous malformation that was subsequently embolized to occlude the AVM.*

FAT-CONTAINING RENAL MASS

DIFFERENTIAL DIAGNOSIS

Common
- Renal Angiomyolipoma
- Wilms Tumor

Less Common
- Fat in Renal Scar
- Renal Cell Carcinoma
- Retroperitoneal Liposarcoma (Mimic)
- Adrenal Myelolipoma (Mimic)
- Xanthogranulomatous Pyelonephritis (Mimic)
- Renal Lipomatosis
- Renal Oncocytoma
- Normal Variants
  - Renal Junction Line

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- An expansile renal mass that contains fat in an adult is diagnostic of angiomyolipoma (AML), with rare exceptions
  - Suspect malignancy, not AML, with following criteria
    - Intratumoral calcifications
    - Invasion of perirenal or sinus fat
    - Large necrotic mass with foci of fat
    - Nodal or venous invasion

Helpful Clues for Common Diagnoses
- **Renal Angiomyolipoma**
  - May need thin section NECT to recognize fat deposit (< -20 HU) in tumor
    - May need to look at "pixel printout" to detect multiple contiguous pixels with significantly low attenuation measurements (may be too small to measure in a larger region of interest cursor)
    - Lipid-poor AMLs are often hyperdense to kidney on NECT
  - Mass will have "claw sign" to indicate renal parenchymal origin
    - Also a vascular tumor, which helps to differentiate it from liposarcoma and explains its tendency to bleed
  - MR: High signal on T1WI; decreased signal with fat suppressed sequence (or on out-of-phase GRE, for diffuse minimal fat)
  - Ultrasound: Hyperechoic mass, but not reliable in distinguishing AML from other renal masses, including renal carcinoma
- **Wilms Tumor**
  - Always consider Wilms in a child with a fat-containing renal mass
  - Wilms tumor may have multiple morphologic features, including cystic, fat-containing, etc.
  - Ask about or check other imaging tests for signs of tuberous sclerosis
    - These or signs of multiple fat-containing masses in a child would indicate AML

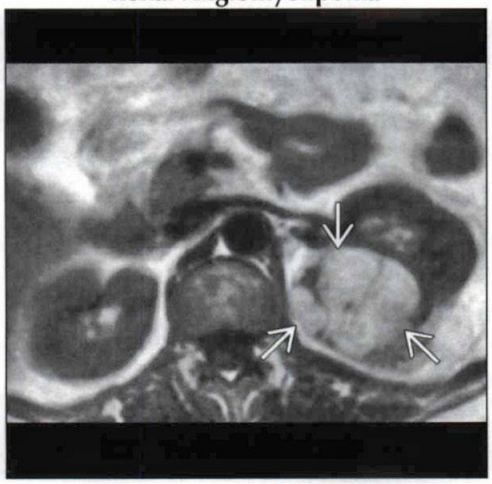
Helpful Clues for Less Common Diagnoses
- **Fat in Renal Scar**
  - Following partial nephrectomy
  - Surgeons may place perirenal fat into surgical defect to prevent leak of blood or urine
  - Appearance can be identical to AML
    - Look for surgical clips in or near defect
- **Renal Cell Carcinoma**
  - May simulate fat content by invading renal sinus or perirenal fat
  - May have lipid-producing necrosis or intratumoral bone metaplasia in large RCC
  - Look for other signs of RCC
    - Invasion of renal vein
    - Lymphadenopathy
    - Thoracic or osseous metastases
  - Case report of 2 patients with multiple papillary RCCs with small foci of fat
- **Retroperitoneal Liposarcoma (Mimic)**
  - Large liposarcoma may displace & compress kidney
  - Clues to suggest liposarcoma and not AML
    - Liposarcoma will not have claw sign
    - Liposarcoma is not vascular (few or no visible vessels on imaging)
- **Adrenal Myelolipoma (Mimic)**
  - Is suprarenal; no claw sign to indicate renal origin
  - Coronal & sagittal views are helpful
    - See displacement of kidney
    - Confirm absence of renal claw sign
- **Xanthogranulomatous Pyelonephritis (Mimic)**
  - Deposition of fat in macrophages due to chronic obstruction (calculus) & inflammation of kidney

- Usually is not really "fat density" (< -80 HU)
- Typically just below water density (but is solid, not fluid consistency)
- Absence of fluid usually evident on US

- Much more perirenal infiltration than with AML
- Other signs of XGP
  - Obstructing calculus, often large
  - Lack of function of the obstructed part (often all) of the kidney
  - Infiltration and proliferation of fat in perirenal space
  - Invasion of posterior abdominal wall (psoas, quadratus lumborum muscles)

- **Renal Lipomatosis**
  - In response to chronic inflammation &/or obstruction
    - Renal calculi present in 70% (often staghorn)
  - Deposition of fat & inflammatory tissue in renal hilum and perirenal space
    - Analogous to "creeping", proliferating mesenteric fat in Crohn disease
    - Response to chronic inflammation
  - Outer contours and volume of kidney may be normal, decreased, or even increased
    - But functioning renal tissue is decreased or even absent
  - Some degree of renal sinus lipomatosis is considered normal in elderly and obese
    - Usually no clinical relevance in this setting
  - In advanced stages, very similar to xanthogranulomatous pyelonephritis
    - Both may have infection, sinus tracts or fistulas
    - Both have lipid-laden macrophages ("foam cells")
    - Only replacement fibrolipomatosis has true fat
    - XGP: Lipid-laden macrophages infiltrate the renal parenchyma (interstitium)
    - Lipomatosis: True fat & macrophages in renal sinus and perirenal space, adjacent to parenchyma
- **Renal Oncocytoma**
  - Rarely contains fat; would be indistinguishable from AML on imaging
  - Not of much clinical importance, since both are benign masses
- **Normal Variants**
  - **Renal Junction Line**
  - Also called junctional parenchymal defect
  - Normal variant of no clinical significance
    - Infolding of capsule & perirenal fat or outward bulging of renal sinus fat
    - Has similar fat density or echogenicity as renal sinus
    - May have triangular shape
    - Often at junction of upper & middle thirds of the kidney

Renal Angiomyolipoma



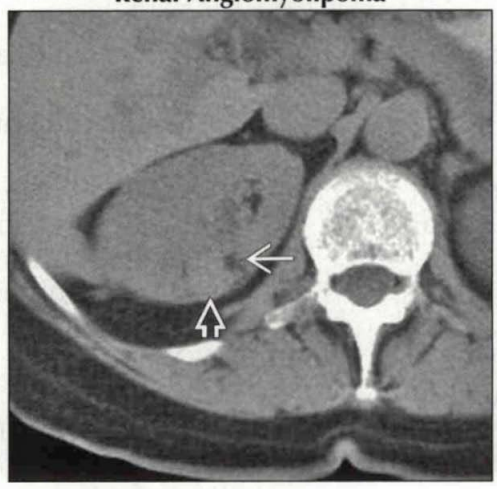
Axial T1WI MR shows a lobulated mass ⇨ in the interpolar region that is hyperintense and similar to other fat deposits. On fat-suppressed T2WI, there was signal dropout from the mass.

Renal Angiomyolipoma

Axial T2WI FS MR shows a heterogeneous mass ⇨ in the interpolar region of the kidney that has low signal intensity on this fat-suppressed T2WI, similar to other fat deposits.

FAT-CONTAINING RENAL MASS

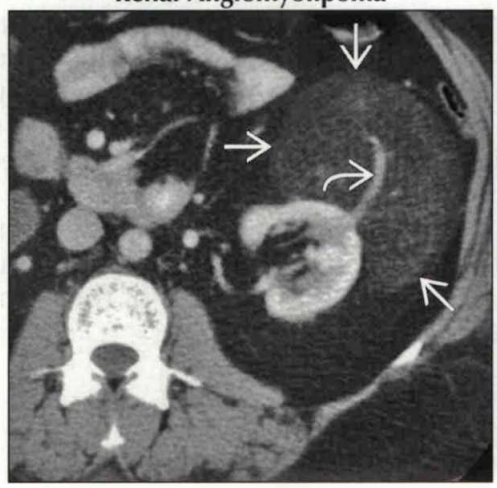
Renal Angiomyolipoma



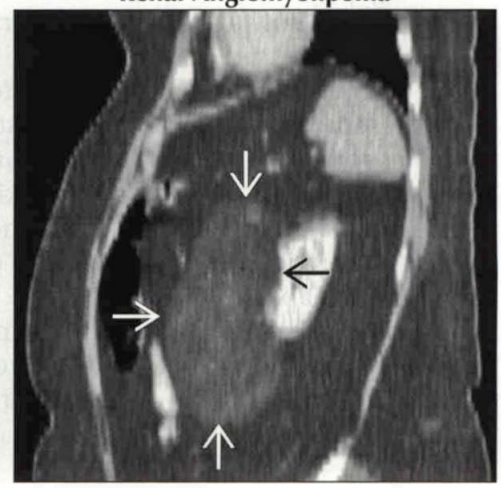
Renal Angiomyolipoma

(Left) *Axial NECT shows a small focus of fat ➡ within a slightly larger mass ➪ that is slightly hyperdense to the kidney on this NECT.* ***(Right)*** *Axial CECT shows a small vascular mass ➪ with a small focus of fat ➡ that was more apparent on the NECT images.*

Renal Angiomyolipoma

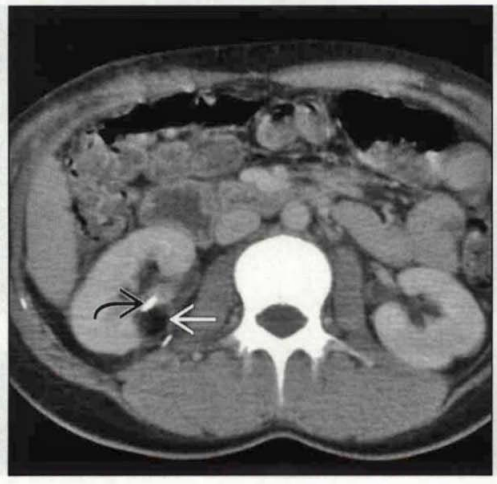


Renal Angiomyolipoma

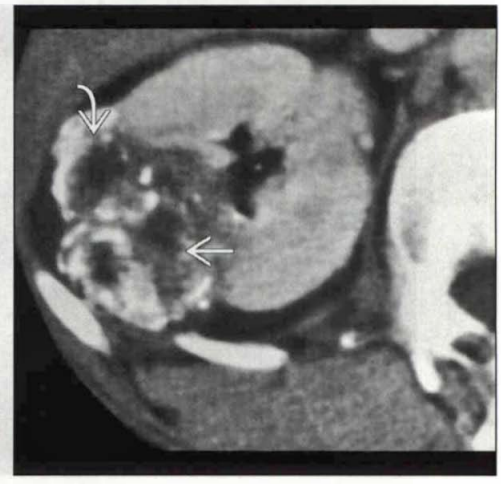


(Left) *Axial CECT shows a large heterogeneous fat density mass ➡ arising from the kidney. The prominent vascularity ➪ helps to identify it as an angiomyolipoma, rather than a retroperitoneal liposarcoma.* ***(Right)*** *Sagittal CECT shows a a large heterogeneous fat density mass ➡ with a subtle claw sign ➪, identifying it as an angiomyolipoma of renal origin.*

Fat in Renal Scar



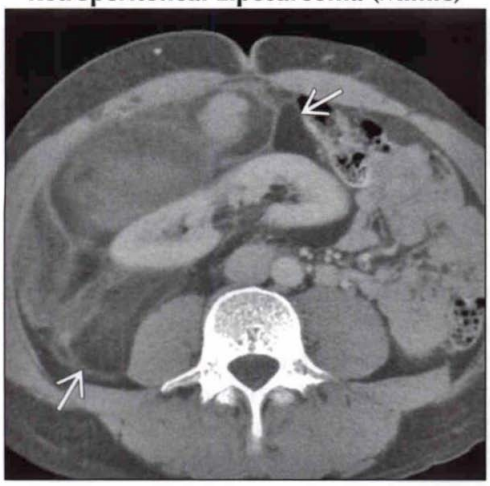
Renal Cell Carcinoma



(Left) *Axial CECT shows a small focus of fat ➡ that was placed in the kidney at the site of resection of a small renal carcinoma. Note the surgical clips ➪.* ***(Right)*** *Axial CECT shows a complex renal mass with foci of calcification ➪ and other areas that are less than water attenuation ➡. RCC may undergo lipid-producing necrosis or osseous metaplasia to account for these findings.*

FAT-CONTAINING RENAL MASS

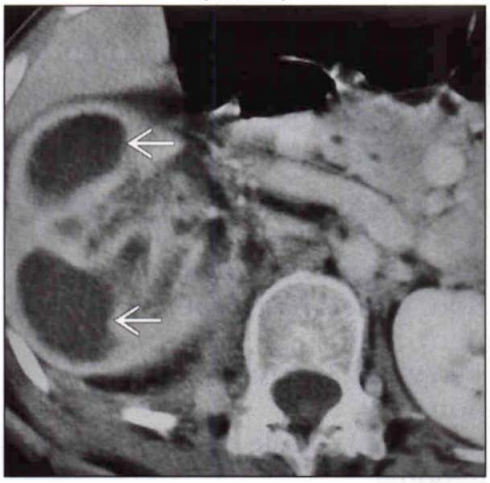
Retroperitoneal Liposarcoma (Mimic)



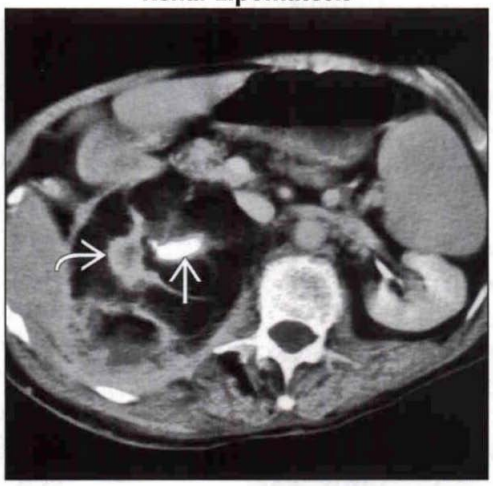
Adrenal Myelolipoma (Mimic)

(Left) *Axial CECT shows displacement and deformation of the kidney by a mass* ➡ *that has mixed fat and soft tissue density. The absence of a claw sign helps to identify this as a primary retroperitoneal liposarcoma, not a renal AML.* ***(Right)*** *Axial CECT shows a predominantly fat density left suprarenal mass* ➡. *The absence of a claw sign helps to exclude a renal origin of the mass.*

Xanthogranulomatous Pyelonephritis (Mimic)

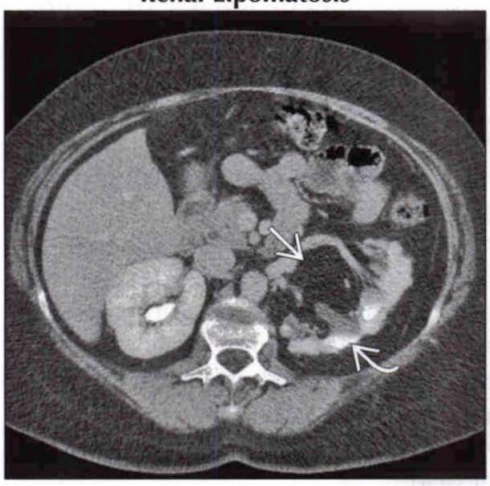


Renal Lipomatosis

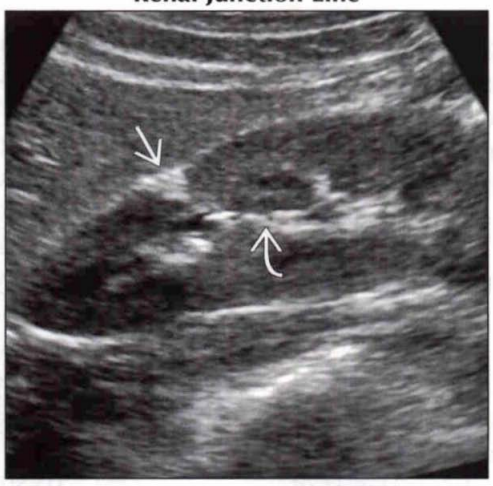


(Left) *Axial CECT shows a deformed, nonfunctional right kidney with a large obstructing staghorn calculous (lower section). The low density xanthomatous debris* ➡ *might be mistaken for a fat density AML.* ***(Right)*** *Axial CECT shows a distorted, nonfunctional right kidney* ➡ *surrounded by proliferated fibrofatty tissue that simulates a renal or perirenal neoplasm. Note the large renal pelvic stone* ➡ *that was the underlying cause.*

Renal Lipomatosis



Renal Junction Line



(Left) *Axial CECT shows expansion of the left renal hilum with fibrolipomatous tissue* ➡ *and dilated calices* ➡ *with urine-contrast levels. Findings were due to a chronically obstructing left renal pelvis calculus.* ***(Right)*** *Sagittal ultrasound shows an echogenic focus* ➡ *in the renal cortex at the junction of the upper and middle thirds of the right kidney. This is contiguous with and of similar appearance to the renal sinus fat* ➡.

CALCIFIED SMALL LESION IN KIDNEY

DIFFERENTIAL DIAGNOSIS

Common
- Urolithiasis (Renal Calculi)
- Renal Artery Calcification
- Nephrocalcinosis
- Medullary Sponge Kidney

Less Common
- Renal Cyst
- AD Polycystic Disease, Kidney
- AIDS, Opportunistic Infection
- Renal Papillary Necrosis
- Calyceal Diverticulum
- Chronic Glomerulonephritis
- Chronic Pyelonephritis
- Renal Cell Carcinoma
- Transitional Cell Carcinoma
- Renal Tuberculosis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Size, shape, number and distribution of calcifications are important
- Association with soft tissue "mass" is important

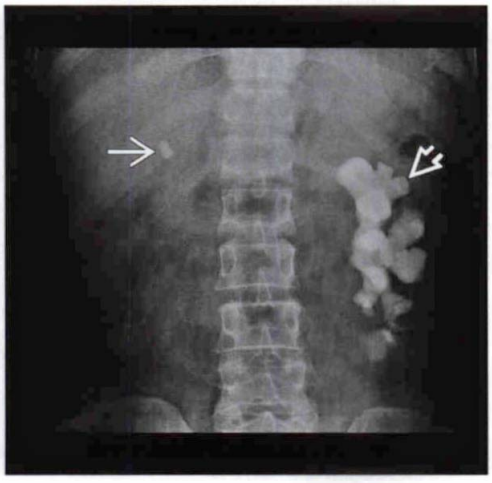
Helpful Clues for Common Diagnoses
- **Urolithiasis (Renal Calculi)**
  - Often small, multiple
  - All renal calculi are opaque on CT except for indinavir-induced stones (in patients with HIV/AIDS)
  - Renal calculi may not cause signs of obstruction, but may cause symptoms including hematuria and intermittent flank pain
    - Pain may be due to intermittent obstruction at ureteropelvic junction
- **Renal Artery Calcification**
  - Linear, parallel, branching pattern
    - Pattern depends on whether CT section is along long or short axis of vessel
  - Eggshell, curvilinear = renal artery aneurysm
  - Lumen enhancement variable
    - May enhance completely, partially, or not at all
- **Nephrocalcinosis**
  - May be either cortical or medullary
  - Cortical nephrocalcinosis
    - Usually from shock, hypotension
    - Small kidneys with irregular cortical calcification
    - Often impaired renal function
  - Medullary nephrocalcinosis
    - Usually from hyperparathyroidism, renal tubular acidosis, or medullary sponge kidney
    - Punctate calcifications localized to the renal pyramids
    - May also have calculi within collecting system
    - Kidneys usually have normal size and function
- **Medullary Sponge Kidney**
  - Multiple tiny calculi within dilated tubules in papillae and/or calices
  - Generally bilateral but may be unilateral or asymmetric
  - Dilated tubules are best seen in pyelographic phase (either excretory or CT urography)
  - Renal pyramids appear hyperechoic on ultrasound
    - Tiny calculi may not cause posterior acoustic shadowing

Helpful Clues for Less Common Diagnoses
- **Renal Cyst**
  - Usually curvilinear or eggshell calcification, rather than small, punctate calcification
  - 1-2% of benign cysts have peripheral calcifications
    - CECT important to rule out cystic renal cell carcinoma
    - Look for areas of enhancement or nodularity within the wall
  - Hyperdense cyst may be greater than renal attenuation, but rarely of calcific density
- **AD Polycystic Disease, Kidney**
  - Usually curvilinear or eggshell calcification of cyst walls
    - Generally occurs after prior intracyst bleeding
  - Typically multiple cysts of varying size
  - Kidneys may become grossly enlarged
  - Patients often have end stage renal disease
    - Heavy arterial atherosclerosis is another source of intrarenal calcification
  - May develop renal calculi
    - May be source of pain & acute renal dysfunction

CALCIFIED SMALL LESION IN KIDNEY

- **AIDS, Opportunistic Infection**
  - Multiple causative organisms
    - Pneumocystis carinii
    - Mycobacterial infection
    - Cytomegalovirus (CMV)
  - Often multiple, small, cortical calcifications
  - This represents the "healed" phase of the disease
    - During active infection, the foci are hypodense to renal parenchyma (definitely on CECT, possibly on NECT)
- **Renal Papillary Necrosis**
  - Curvilinear, ring-shaped or triangular calcifications in sloughed papillae
  - Calcifications arranged in an arc conforming to position of papillary tips
  - Associated with clubbed and irregular calices
  - Often encountered in patients with history of chronic analgesic use/abuse
- **Calyceal Diverticulum**
  - Usually 1-3 cm in diameter
  - May be filled with milk of calcium or small stones
  - Contrast fills the diverticulum on delayed images (either CT or urography)
- **Chronic Glomerulonephritis and Pyelonephritis**
  - Small scarred kidneys ± small focal calcifications
  - Chronic pyelonephritis is often associated with cysto-ureteral reflux
  - May be unilateral or bilateral
- **Renal Cell Carcinoma**
  - Foci of calcification in ≈ 10%
    - Amorphous central calcification (most common)
    - Curvilinear (peripheral or central)
    - Dense or diffuse calcification
    - Osseous metaplasia may occur in large tumor
  - If a renal mass in an adult patient has both calcification & fat density, it is probably RCC, not angiomyolipoma
    - In a child with similar findings, it is probably Wilms tumor, not AML
- **Transitional Cell Carcinoma**
  - Small flecks of calcium within soft tissue mass in renal pelvis or parenchyma
  - On NECT, TCC is often hyperdense to renal parenchyma, but not due to calcification
- **Renal Tuberculosis**
  - Calcifications common and variable in appearance
    - Punctate (healed granulomata) to diffuse
  - Amorphous calcification within an atrophic kidney most common presentation
    - Often associated with low-density or cavitary lesions within the kidney
    - Can progress to a "putty kidney" (heavily calcified caseous mass replacing renal parenchyma)
  - May see calcified sloughed papillae from papillary necrosis

Urolithiasis (Renal Calculi)



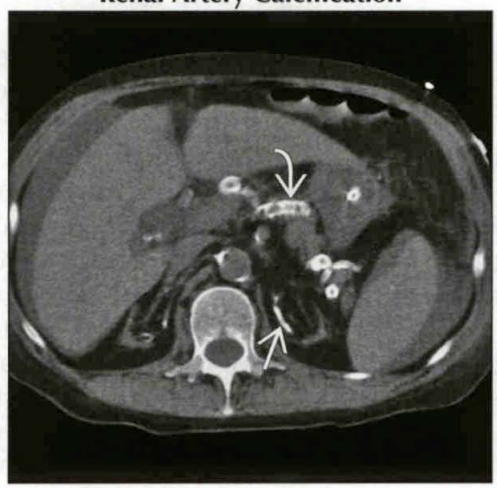
Anteroposterior radiograph shows a small opaque stone in the upper pole of the right kidney & a "staghorn" calculus in the left (conforming to the collecting system).

Urolithiasis (Renal Calculi)

Axial NECT shows small stones in the left kidney, without evidence of ureteral obstruction.

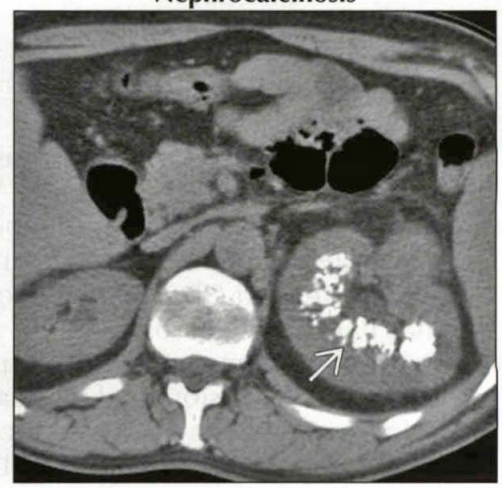
CALCIFIED SMALL LESION IN KIDNEY

Renal Artery Calcification

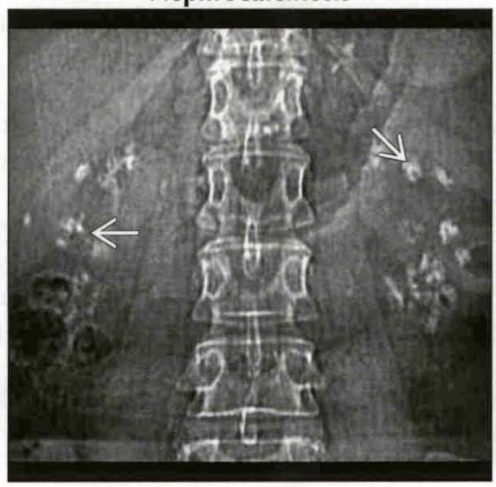


(Left) Axial NECT shows extensive arterial calcification in this patient with diabetes, including the splenic ➡ and renal ➡ arteries. Note end-stage renal failure.
***(Right)** Axial NECT shows extensive medullary calcifications ➡ in the left kidney while the right kidney appears normal, in a patient with renal tubular acidosis. Note the unusual degree of asymmetry.*

Nephrocalcinosis

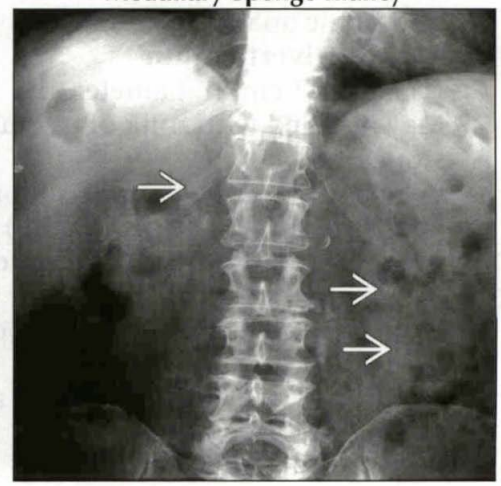


Nephrocalcinosis

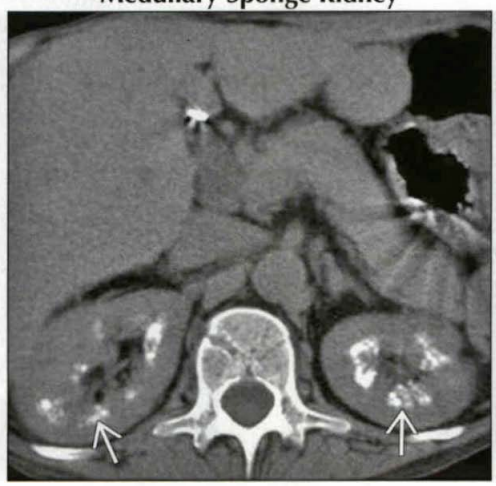


(Left) Anteroposterior radiograph shows medullary nephrocalcinosis, with the calcifications ➡ located deep within the kidney, rather than in the cortex.
***(Right)** Anteroposterior radiograph shows multiple renal calculi ➡ in a patient with medullary sponge kidney (renal tubular ectasia).*

Medullary Sponge Kidney

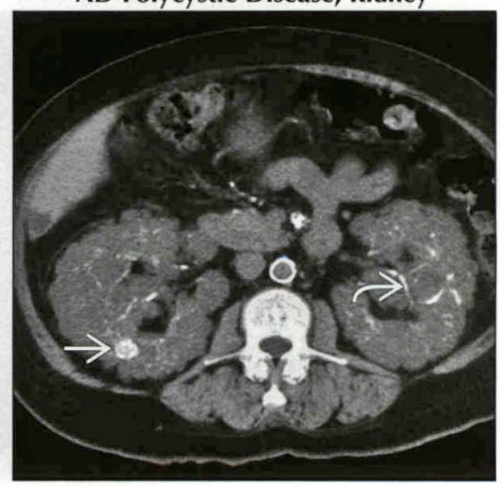


Medullary Sponge Kidney



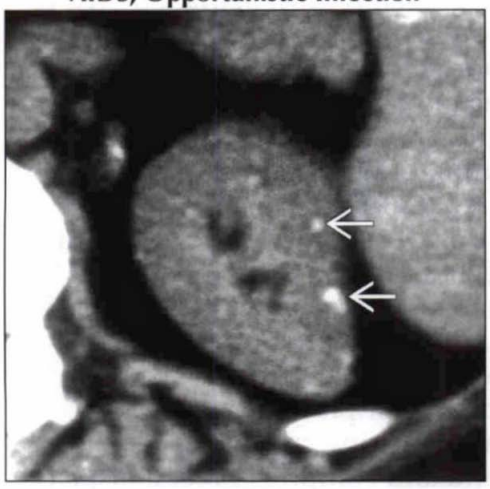
(Left) Axial NECT shows innumerable tiny calculi, ➡ located within the renal pyramids. These were obscured within the opacified tubules on pyelographic phase CECT.
***(Right)** Axial NECT shows enlarged polycystic kidneys in a patient on dialysis for end-stage renal disease. Note calcifications in one of the cyst walls ➡ and in renal arteries ➡.*

AD Polycystic Disease, Kidney

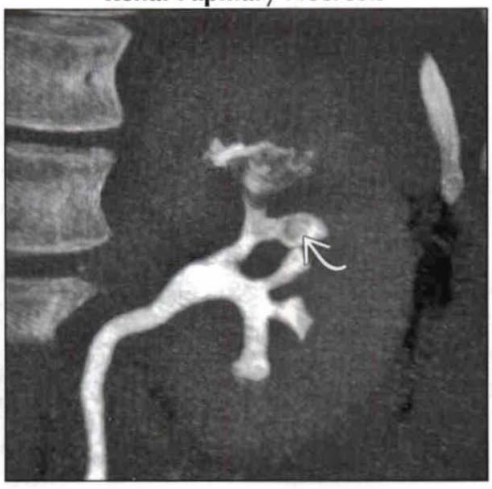


CALCIFIED SMALL LESION IN KIDNEY

AIDS, Opportunistic Infection

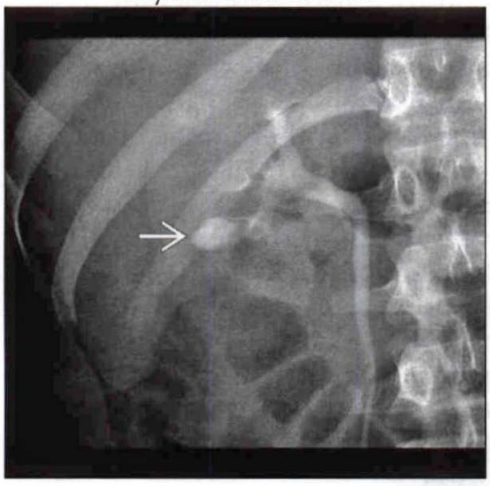


Renal Papillary Necrosis

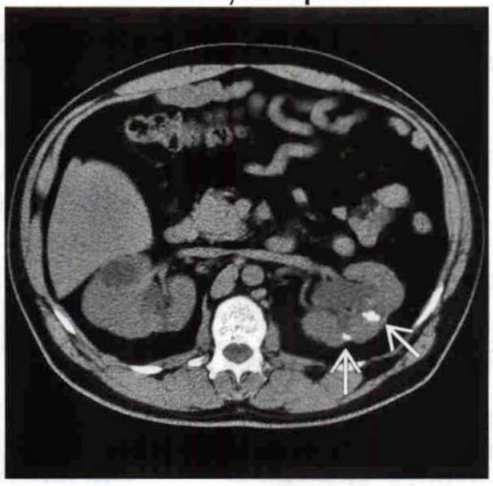


*(**Left**) Axial NECT shows multiple punctate calcifications in the left kidney; extrapulmonary Pneumocystis carinii infection. Other opportunistic renal infections (mycobacterial, fungal, etc.) may have a similar appearance. (**Right**) Coronal CECT shows a sloughed papilla within a deformed calyx. Amorphous debris is present within the upper pole calices, & all calices are clubbed. The soughed papillae may calcify.*

Calyceal Diverticulum

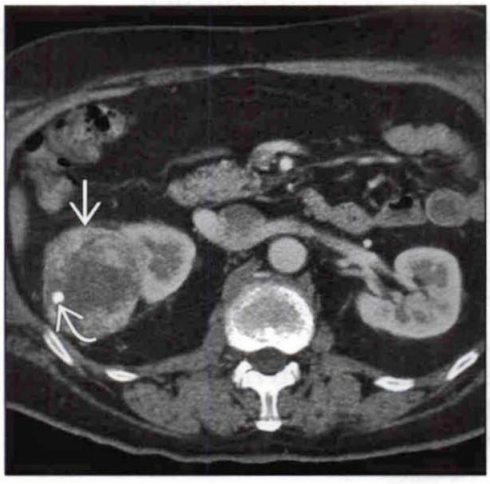


Chronic Pyelonephritis



*(**Left**) Anteroposterior IVP shows a typical caliceal diverticulum that was filled with small calculi or milk of calcium on the plain radiograph and NECT. (**Right**) Axial NECT shows focal calcifications in the left kidney with atrophy of the overlying cortex, characteristic findings of chronic pyelonephritis due to reflux. The calices are also dilated in this patient who was born with extrophy of the bladder, repaired in infancy.*

Renal Cell Carcinoma



Renal Tuberculosis

*(**Left**) Axial CTA shows a heterogeneous, enhancing, exophytic right renal mass with a focus of calcification. (**Right**) Axial CECT shows a small, nonfunctional, right kidney with focal, but amorphous calcification of the parenchyma.*

RENAL SINUS LESION

DIFFERENTIAL DIAGNOSIS

Common

- Renal Sinus Lipomatosis
  - Renal Lipomatosis
- Renal Sinus Cysts
- Urolithiasis
- Renal Trauma
- Coagulopathic ("Retroperitoneal") Hemorrhage
- Vascular Lesions
  - Renal Artery Aneurysm
  - Arteriovenous Malformation, Renal
  - Renal Hilar Varices or Shunt
- Transitional Cell Carcinoma

Less Common

- Lymphoma
- Other Renal Tumors
  - Renal Cell Carcinoma
  - Multilocular Cystic Nephroma
  - Renal Metastases
  - Squamous Cell Carcinoma
  - Rare Renal Tumors
- Xanthogranulomatous Pyelonephritis
- Fungal Infection, Renal

Rare but Important

- Sarcoma, Retroperitoneal
- Neurogenic Tumor, Retroperitoneum

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Renal sinus is extension of perirenal space
  - Contains multiple structures, any one of which can give rise to a mass lesion
    - Pelvo-calyceal system (e.g., transitional cell carcinoma, blood clot, fungus ball)
    - Major vessels (e.g., renal artery aneurysm, AVM, varices)
    - Lymphatics (e.g., lymphoma, lymph node metastases)
    - Nerves (e.g., neurogenic tumor)
  - CT, MR, & US easily distinguish many lesions that have similar appearance on IV urography
    - Can depict blood vessels, parenchymal lesion extent, etc.
    - Urography or pyelography may still be the best means of studying lesions of the renal pelvis (collecting system)

Helpful Clues for Common Diagnoses

- **Renal Sinus Lipomatosis**
  - Increases gradually with aging, obesity, & loss of parenchyma due to disease
- **Renal Lipomatosis**
  - In setting of chronic infection or obstruction
  - Proliferation of fibrofatty tissue may expand renal sinus
    - May displace calyces, vessels in hilum
  - Some degree of renal sinus fibrolipomatosis is found in all causes of renal parenchymal atrophy
- **Renal Sinus Cysts**
  - Peripelvic = multiple confluent, noncommunicating cysts
    - Surround and compress calices, displace blood vessels
    - Often bilateral
    - Easily confused with hydronephrosis on US & NECT
  - Parapelvic = usually solitary, spherical
    - Usually unilateral
    - Often found with other simple cortical cysts
- **Urolithiasis**
  - All are very dense (& echogenic) on CT, US
    - Except indinavir-induced stone in AIDS
  - Uric acid and xanthine stones are lucent on radiography
    - May appear as lucent filling defects within contrast-opacified renal pelvis on urography
- **Renal Trauma**
  - May result in clot in renal pelvis, renal hilar hematoma or urinoma
    - Consider iatrogenic trauma (e.g., extracorporeal or percutaneous lithotripsy)
- **Coagulopathic ("Retroperitoneal") Hemorrhage**
  - May rarely result in spontaneous renal bleeding limited to blood filling renal pelvis
  - Blood will have attenuation of 45 to 65 HU on NECT, will not enhance
- **Vascular Lesions**
  - Consider aneurysm, arteriovenous malformation (AVM), renal varices, & splenorenal shunt (portal hypertension)

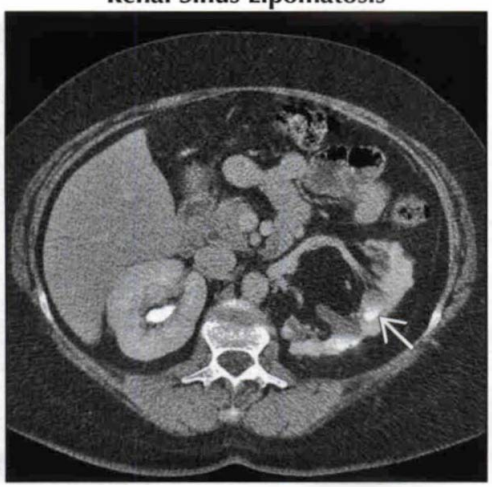
- Aneurysm: Look for calcification in arterial wall
- AVM: Look for turbulent flow on color Doppler US, premature filling of renal vein on CECT and angiography
- Renal varices: Varices & spontaneous or surgically-created splenorenal shunts are common in patients with cirrhosis & portal hypertension

- **Transitional Cell Carcinoma**
  - Often slightly hyperdense on NECT, may have speckled calcification
    - Enhanced moderately with IV contrast administration
    - Often amputates (prevents filling of) calyces
  - Difficult to distinguish from squamous cell or mesenchymal tumors of renal pelvis
  - Higher incidence in patients who have had TCC of bladder or ureter previously

Helpful Clues for Less Common Diagnoses

- **Lymphoma**
  - Generalizes abdominal involvement by non-Hodgkin lymphoma
  - Often involves renal hilar nodes
  - May extend into renal parenchyma
  - May invade parenchyma from outside or involve only the renal parenchyma (uncommon)
    - In latter case, consider immunocompromised state (e.g., AIDS or transplant recipient)
- **Other Renal Tumors**
  - **Renal Cell Carcinoma**
    - Arises in cortex but may extend into renal sinus
    - May invade renal vein and IVC
    - May invade renal pelvis
    - More vascular and exophytic than TCC
  - **Multilocular Cystic Nephroma**
    - Multiseptate mass in young boy or middle-aged woman
    - Usually herniates into & distorts renal sinus
    - Cyst contents do not enhance but septa do
  - **Rare Renal Tumors**
    - Squamous cell, mesenchymal (e.g., sarcoma), etc.
    - Have overlapping features with renal cell carcinoma
    - Usually cannot be diagnosed confidently by imaging alone
- **Xanthogranulomatous Pyelonephritis**
  - Some overlapping features with fibrolipomatosis, but XGP has more replacement of parenchyma with the foam cells (lipid-laden macrophages)
  - Kidney, or affected portion, is usually nonfunctional & obstructed by a large calculous
- **Fungal Infections, Renal**
  - Usually in debilitated patients
  - May form "fungus ball" in renal pelvis
  - Diagnosis made by obtaining tissue & culture from urine & uroepithelium

Renal Sinus Lipomatosis



Axial CECT shows mass-like expansion of the left renal sinus with fibrolipomatous tissue, & dilated calices due to a chronic partial obstruction of the left ureteropelvic junction by calculi.

Renal Sinus Cysts

Axial CECT shows left peripelvic cysts. The renal vessels and calices are stretched around these cysts.

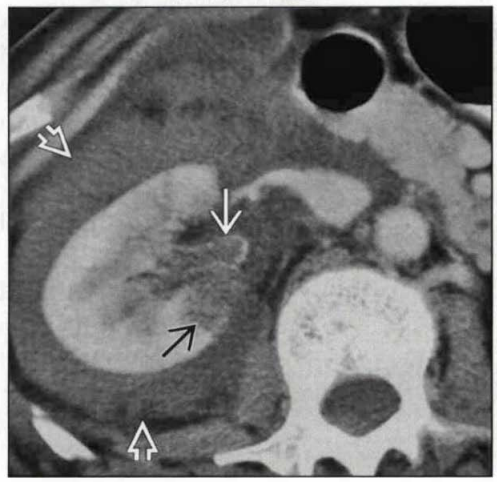
RENAL SINUS LESION

Renal Sinus Cysts

(Left) *Axial CECT shows a large parapelvic cyst ⇨ that distorts the renal sinus.* ***(Right)*** *Frontal excretory urography shows marked scarring of the right renal pelvis with a stricture ⇨ causing dilation of the upper pole calices, due to recurrent renal calculi treated with lithotripsy.*

Urolithiasis

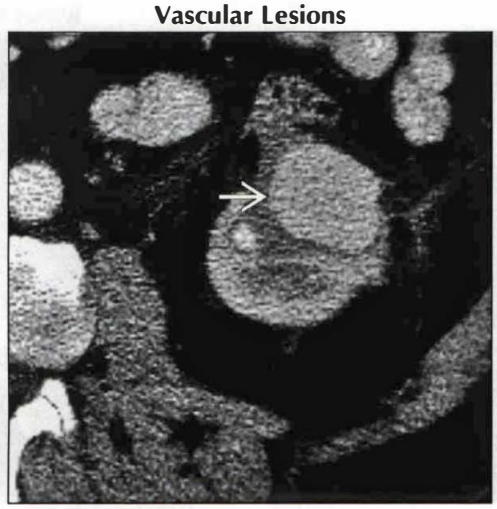
Renal Trauma



(Left) *Axial CECT shows a renal parenchymal laceration ⇨ from blunt trauma. Note perirenal hemorrhage ⇨ and clot in the renal pelvis ⇨.* ***(Right)*** *Axial CECT shows distention of the left renal pelvis with blood ⇨. Patient was receiving heparin therapy and had spontaneous renal bleeding.*

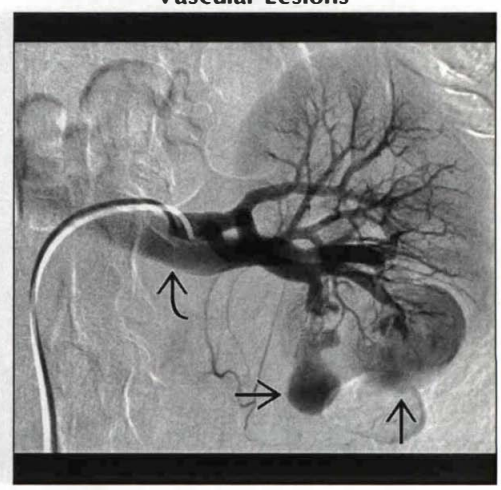
Coagulopathic ("Retroperitoneal") Hemorrhage

Vascular Lesions



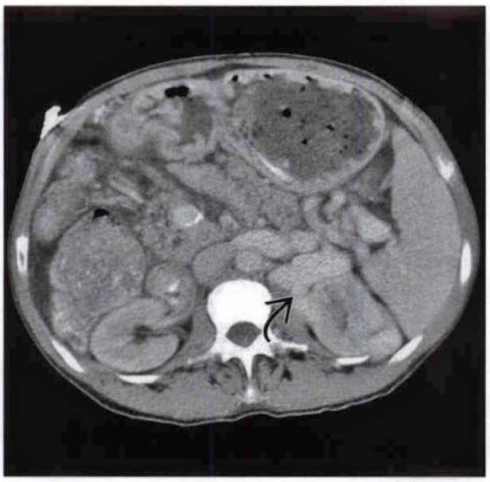
(Left) *Axial CECT shows a spherical mass ⇨ that is isodense to blood vessels and represents an arteriovenous malformation in this 59 year old man.* ***(Right)*** *Frontal catheter angiography shows a large arteriovenous malformation ⇨ with early filling of the left renal vein ⇨ in a 59 year old man.*

Vascular Lesions

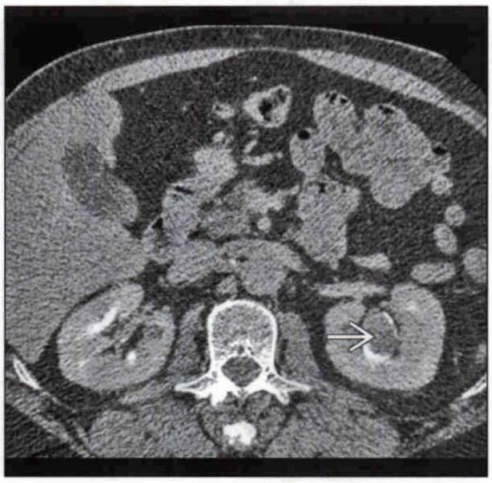


RENAL SINUS LESION

Renal Hilar Varices or Shunt

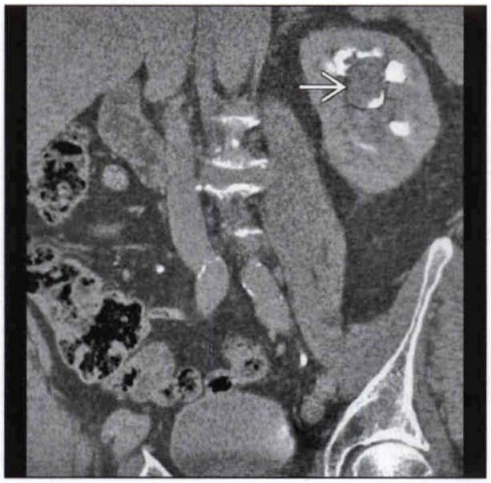


Transitional Cell Carcinoma

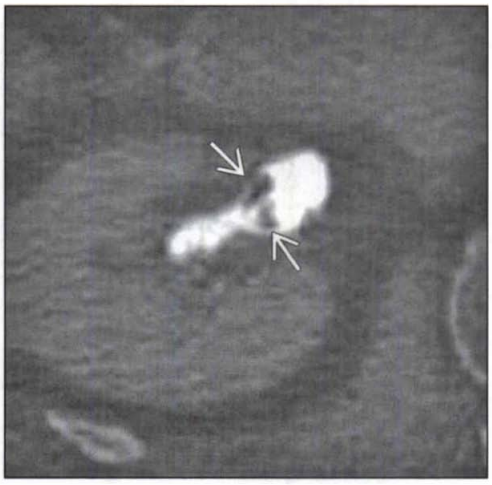


(Left) *Axial CECT shows large varices near the left renal hilum and a spontaneous splenorenal shunt in this patient with cirrhosis and portal hypertension.* ***(Right)*** *Axial CECT shows a soft tissue density filling defect within an upper pole infundibulum on this excretory (pyelographic) phase CECT; 69 year old man.*

Transitional Cell Carcinoma



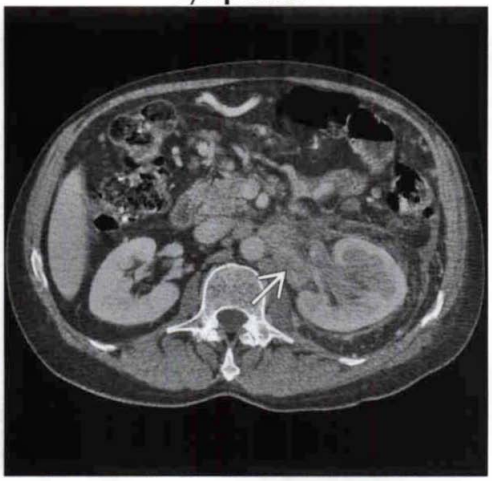
Transitional Cell Carcinoma



(Left) *Coronal CECT shows a soft tissue density filling defect within the upper pole infundibulum; 69 year old man who had both renal and bladder TCC tumors.* ***(Right)*** *Axial CECT shows soft tissue density irregular filling defects within the renal pelvis, a typical presentation of TCC in a 59 year old man with gross hematuria.*

Transitional Cell Carcinoma

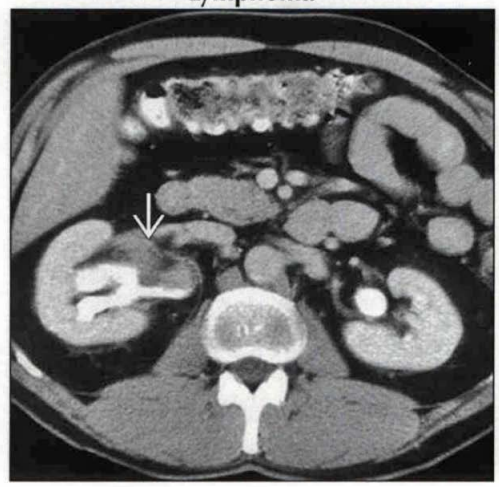
Lymphoma



(Left) *Coronal CECT shows amputation or distortion of calices and a filling defect in the renal pelvis; TCC in a 59 year old man.* ***(Right)*** *Axial CECT shows extensive retroperitoneal lymphadenopathy, including the renal hilum, resulting in partial obstruction of the right ureter & a delayed nephrogram.*

RENAL SINUS LESION

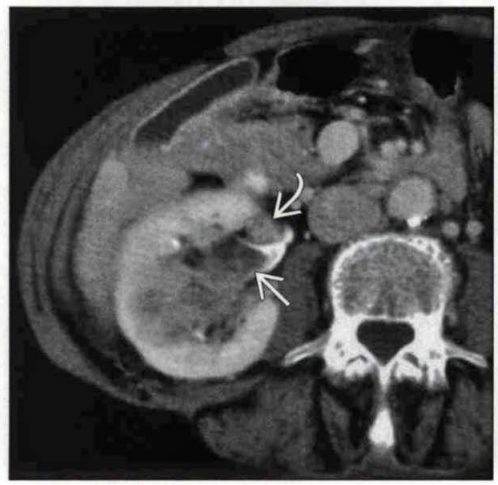
Lymphoma



Lymphoma

(Left) *Axial CECT shows a soft tissue density mass ➡ arising from the renal pelvis; a rare case of lymphoma of the ureteropelvic junction, this is indistinguishable from TCC.* ***(Right)*** *Axial CECT shows a heterogeneous soft tissue density mass ➡ that distorts the renal sinus, but also extends exophytically. This proved to be primary lymphoma of the kidney in this young man with AIDS, but the imaging appearance is indistinguishable from that of renal cell carcinoma.*

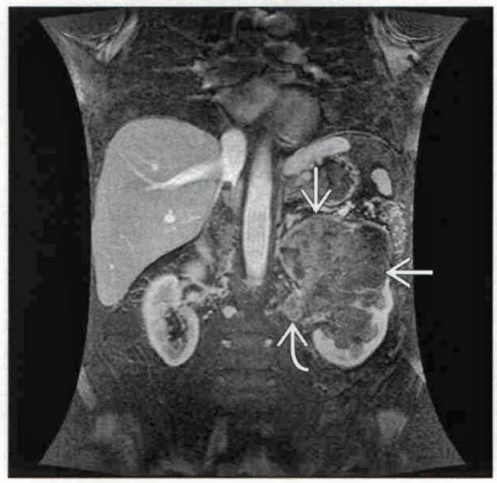
Renal Cell Carcinoma



Renal Cell Carcinoma

(Left) *Axial CECT shows the renal parenchymal tumor extending directly into the renal pelvis ➡. Also note adenopathy ➡ in the renal hilum; 77 year old woman.* ***(Right)*** *Coronal T1 C+ MR shows a large left renal mass ➡ that invades the left renal vein ➡ and IVC ➡.*

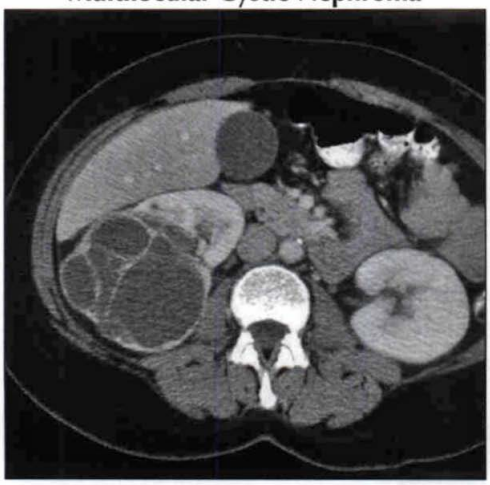
Renal Cell Carcinoma



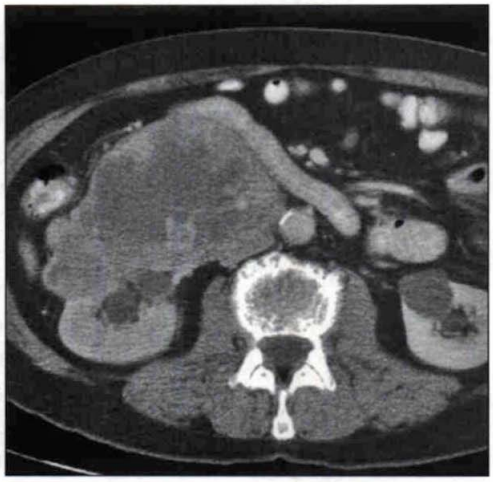
Multilocular Cystic Nephroma

(Left) *Coronal T1 C+ MR shows a large infiltrative and exophytic mass ➡ that invades the renal sinus ➡, filling both the renal pelvis and the renal vein.* ***(Right)*** *Axial CECT shows a multiseptate renal mass that herniates into the renal sinus.*

Multilocular Cystic Nephroma

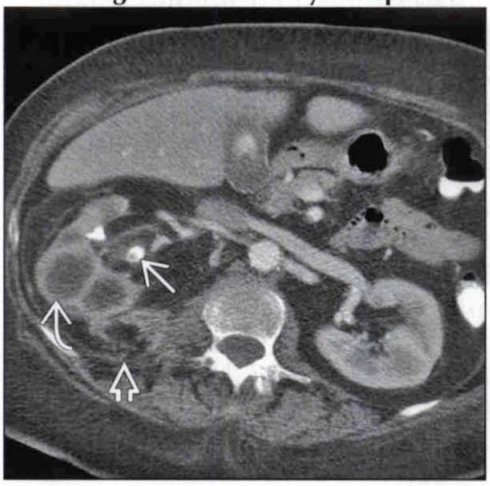


Rare Renal Tumors

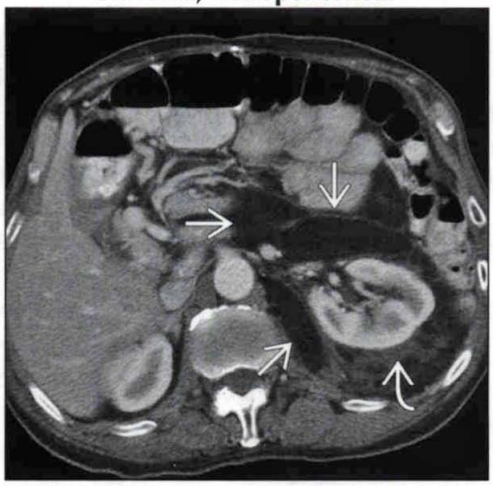


(Left) Axial CECT shows a multiseptate mass that invaginates the renal sinus, a classic MCN in a 48 year old woman. (Right) Axial CECT shows a large heterogeneous mass arising from the right kidney. The renal pelvis is dilated due to extrinsic invasion of the proximal ureter; leiomyosarcoma of the kidney.

Xanthogranulomatous Pyelonephritis

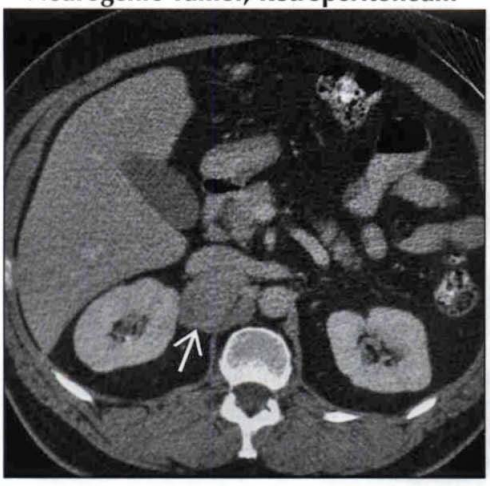


Sarcoma, Retroperitoneal

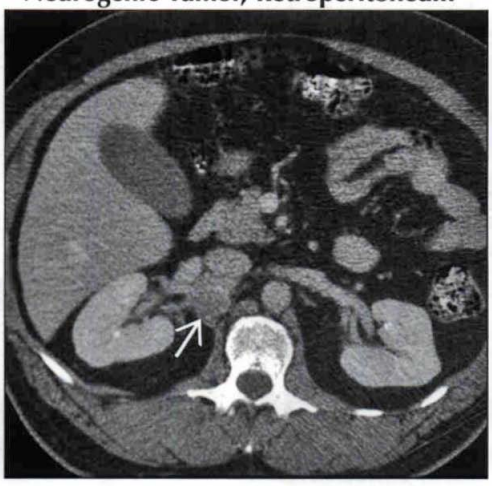


(Left) Axial CECT shows decreased or nonfunction of the right kidney with low density material representing destroyed parenchyma filled with lipid-laden macrophages. Note the obstructing renal calculi and inflammation extending into the perirenal space. (Right) Axial CECT shows a liposarcoma that encases the left kidney, with distortion of the renal hilum. The mass contains well-differentiated fat as well as myxoid elements.

Neurogenic Tumor, Retroperitoneum



Neurogenic Tumor, Retroperitoneum



(Left) Axial CECT shows a soft tissue density mass near the right renal hilum that displaces the IVC & renal vein; ganglioneuroma in a 50 year old man. Neurogenic tumors commonly arise along the retroperitoneal path of the sympathetic ganglia. (Right) Axial CECT shows a soft tissue density, retroperitoneum mass near the right renal hilum, a ganglioneuroma in a 50 year old man. This mass showed positive activity on a radionuclide MIBG scan.

GAS IN OR AROUND KIDNEY

DIFFERENTIAL DIAGNOSIS

Common
- Pyelonephritis, Emphysematous
- Renal Abscess
- Emphysematous Pyelitis
- Renal Infarction
- Instrumentation
- Post-Operative State, Kidney

Less Common
- Duodenal Ulcer or Perforation
- Duodenal Laceration
- Pancreatic Sources
  - Pancreatic Abscess
  - Necrotizing Pancreatitis
- Barotrauma

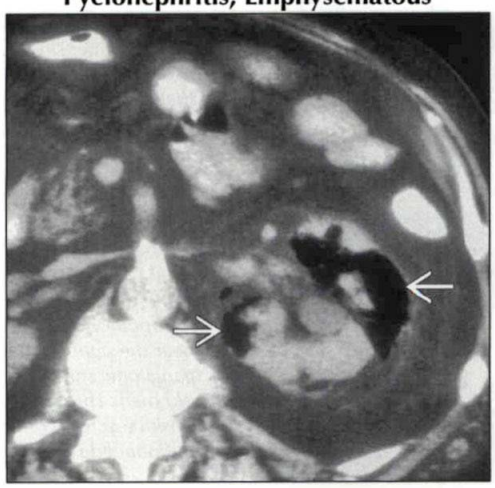
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Always check for recent instrumentation, surgery, angiography for iatrogenic cause

Helpful Clues for Common Diagnoses
- **Pyelonephritis, Emphysematous**
  - Usually in diabetics; infection of ischemic renal tissue
  - Parenchyma is replaced by gas with little fluid
  - Usually requires urgent nephrectomy
- **Renal Abscess**
  - Gas within spherical collection of pus
  - Usually managed with percutaneous catheter drainage
- **Emphysematous Pyelitis**
  - Gas from infection of urine; limited to bladder, ureters, renal collecting system
  - Usually managed with antibiotics
- **Renal Infarction**
  - Sudden death of renal tissue from arterial occlusion or avulsion can release intracellular gas from infarcted tissue
    - Examples: Traumatic renal artery occlusion; renal artery embolization; RF or cryoablation of tumor
  - Does not imply infection, but clinical symptoms are similar
- **Instrumentation**
  - Ureteral stent, nephrostomy, cystoscopy
  - Often introduces air into collecting system, ureters

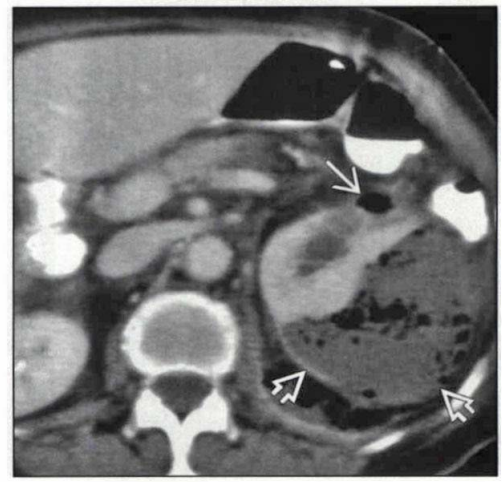
Helpful Clues for Less Common Diagnoses
- **Duodenal Ulcer or Perforation**
  - Gas in retroperitoneum from duodenal source can extend through renal hilum into right perirenal space
  - Examples: Perforation from blunt trauma, ERCP, feeding tube
- **Pancreatic Sources**
  - Gas from necrotizing pancreatitis or pancreatic abscess may extend through renal hilum into perirenal space
- **Barotrauma**
  - Tension pneumothorax or mediastinal gas can dissect into abdomen, including into perirenal space

Pyelonephritis, Emphysematous



Axial CECT shows collections of gas ➡ that essentially replace the renal parenchyma, while other portions of the kidney remain uninvolved.

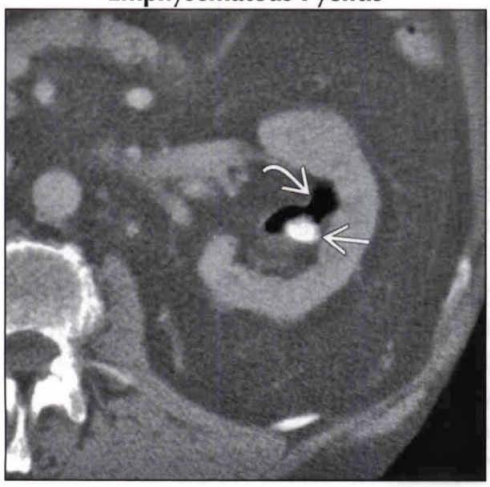
Renal Abscess



Axial CECT shows gas ➡ and fluid within the kidney, but much more pus within the perirenal space ➡.

GAS IN OR AROUND KIDNEY

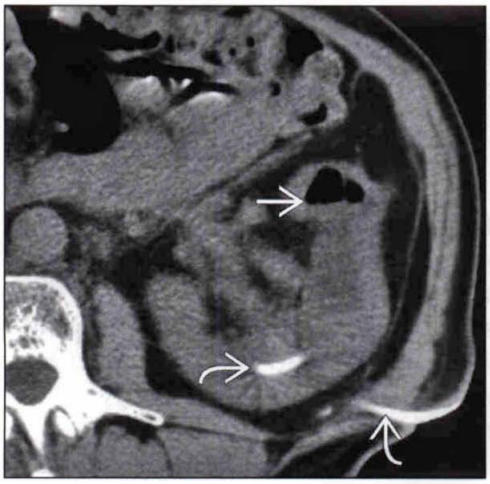
Emphysematous Pyelitis



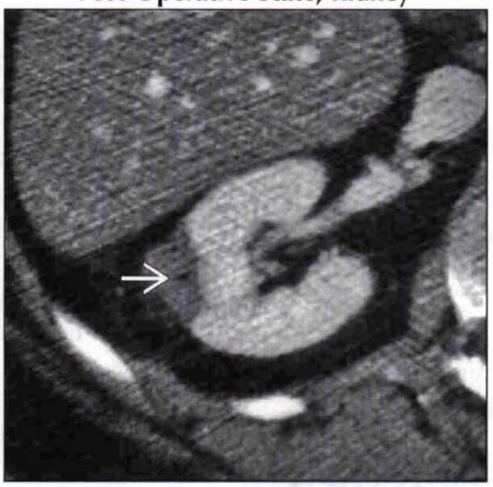
Renal Infarction

(Left) *Axial CECT shows gas* ⇨ *and a calculous* ➡ *in the renal pelvis, but no gas in the renal parenchyma. The infection cleared with removal of the stone and antibiotic therapy.* ***(Right)*** *Axial CECT shows lack of enhancement of the left kidney and parenchymal gas* ➡. *Infarction followed attempted partial nephrectomy, complicated by renal arterial occlusion.*

Instrumentation



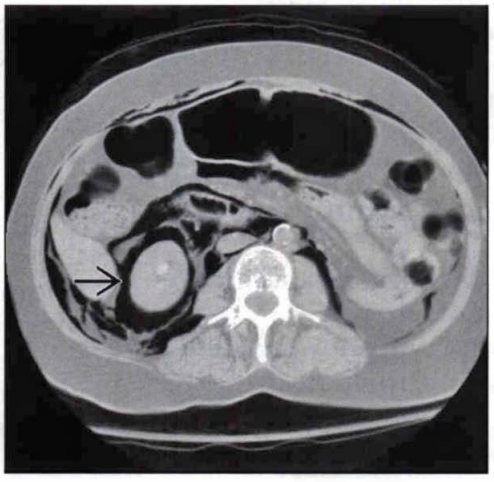
Post-Operative State, Kidney



(Left) *Axial NECT shows a percutaneous nephrostomy catheter* ⇨ *that had been placed to decompress an obstructed kidney. Gas within the nondependent calices* ➡ *is due to the catheter, not infection or infarction.* ***(Right)*** *Axial CECT shows a small bubble of gas* ➡ *within a necrotic renal mass, as the result of percutaneous cryoablation therapy for a small renal cell carcinoma. There was no infection.*

Duodenal Ulcer or Perforation

Barotrauma



(Left) *Axial CECT shows gas surrounding the right kidney that originated from a perforated ulcer* ➡ *in the second portion of the duodenum.* ***(Right)*** *Axial CECT shows gas around the right kidney* ⇨, *as well as throughout the retroperitoneal and intraperitoneal spaces; due to mediastinal and pleural gas dissecting into the abdomen under positive pressure ventilation.*

DILATED RENAL CALICES

DIFFERENTIAL DIAGNOSIS

Common

- Ureteral Obstruction
  - Ureteral Stone
  - Transitional Cell Carcinoma
  - Periureteral Metastases
  - Retroperitoneal Fibrosis
  - Primary Pelvic Malignancy
    - Prostate Carcinoma
    - Rectal Carcinoma
    - Cervical & Endometrial Carcinoma
- Ureterectasis of Pregnancy
- Ureteral Duplication
- Distended Urinary Bladder
- Overhydration, Diuresis
- Vesicoureteral Reflux
- Prominent Extrarenal Pelvis (Mimic)
- Renal Sinus (Peripelvic) Cysts (Mimic)
- Renal Sinus Blood Vessels (Mimic)
- Ureteropelvic Junction Obstruction
- Pyonephrosis

Less Common

- Renal Papillary Necrosis
- Renal Tuberculosis
- Pyelonephritis, Xanthogranulomatous
- Megacalices, Megaureter
- Caliceal Diverticulum
- Renal Cysts (Mimic)
- AD Polycystic Disease, Kidney
- Renal Metastases and Lymphoma
- Blood-Filled Renal Pelvis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Determine if all calices are dilated & in communication with a dilated renal pelvis & ureter
- CT & MR are complementary to US
  - Include pyelographic (delayed) phase enhanced images

Helpful Clues for Common Diagnoses

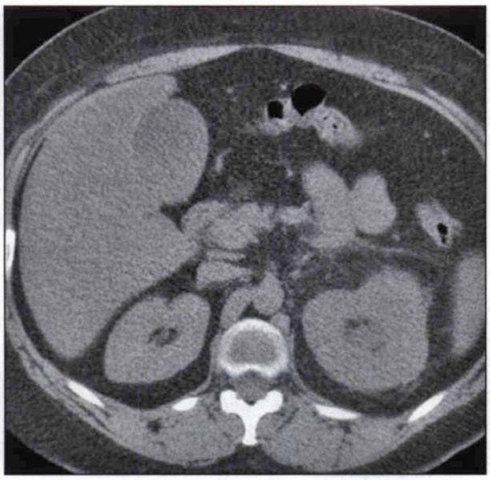
- **Ureteral Obstruction**
  - Most common cause with several specific etiologies (calculi, tumor, etc.)
  - CT and MR better than US at showing the etiology of the ureteral obstruction
  - **Ureteral Stone**
    - Dilated ureter ends at high density intraluminal focus
  - **Transitional Cell Carcinoma**
    - Small soft tissue density mass within the lumen or wall of the ureter
    - May see "goblet sign"; dilation of the ureteral lumen proximal and distal to obstructing tumor
  - **Retroperitoneal Fibrosis**
    - Encases and obstructs ureters through lumbar region
    - Mantle of soft tissue surrounds aorta and IVC
    - Retroperitoneal nodal metastases may have a similar appearance and may rarely cause ureteral obstruction
  - **Primary Pelvic Malignancy**
    - Dilated ureter ends in a soft tissue density mass or retroperitoneal nodes that encase the ureter
- **Ureterectasis of Pregnancy**
  - Due to hormonal influence plus mass effect of gravid uterus
  - Affects right kidney more than left
  - May persist after pregnancy
  - Rarely associated with rupture of the collecting system (usually with an underlying renal disease, such as infection)
- **Ureteral Duplication**
  - Upper pole ureter is more often ectopic in insertion and dilated
  - Look for 2 ureters on one side; upper pole ureter will have delayed concentration & excretion of contrast medium if it is obstructed
  - Either ureter can be obstructed by calculi and other etiologies
- **Distended Urinary Bladder**
  - May cause back pressure and dilation of ureters and calices
  - Re-image after emptying bladder
    - Should return to normal caliber
- **Vesicoureteral Reflux**
  - Acute or chronic dilation of ureter and calices; scarred parenchyma
- **Prominent Extrarenal Pelvis (Mimic)**
  - Calices and ureter not dilated
  - Common and asymptomatic
- **Renal Sinus (Peripelvic) Cysts (Mimic)**
  - Coronal view (US) shows lack of communication of cysts with renal pelvis and proximal ureter

- Delayed imaging on CECT often necessary to distinguish renal sinus cysts from hydronephrosis
  - Contrast-opacified urine distinguished from the water density peripelvic cysts
  - Coronal reformations are also helpful
- **Renal Sinus Blood Vessels (Mimic)**
  - Sonolucent, but show flow on Doppler
  - May also be a mimic of hydronephrosis on "black blood" MR image sequences
    - Usually not a problem on CT
    - Even on NECT, blood vessels are different attenuation than calices
- **Ureteropelvic Junction Obstruction**
  - Relatively common congenital narrowing at the UPJ that often results in striking dilation of the pelvis & calices, especially with a fluid or diuretic challenge
  - May be due to a crossing vessel that compresses the UPJ
- **Pyonephrosis**
  - Hydronephrosis plus infected urine = urgent need for drainage
  - Fluid may be higher than water density on CT; diffusely mildly echogenic
  - Consider pelvic inflammatory conditions that may involve the ureter (e.g., diverticulitis, Crohn disease, gynecologic infections)

Helpful Clues for Less Common Diagnoses

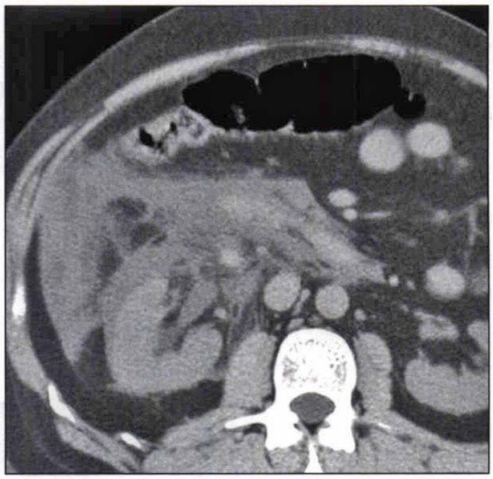
- **Renal Papillary Necrosis**
  - Calices may appear blunted and dilated due to sloughed papillae
- **Renal Tuberculosis**
  - May cause stricture of infundibula and focal hydronephrosis
  - Caseous infection of parenchyma may mimic caliectasis
- **Pyelonephritis, Xanthogranulomatous**
  - Underlying calculi may cause hydro- or pyonephrosis
  - Xanthomatous replacement of parenchyma may be low density, mimicking caliectasis
- **Megacalices, Megaureter**
  - Rare congenital anomalies
  - Renal function may remain normal
- **Caliceal Diverticulum**
  - Outpouching from a calyx may simulate focal caliectasis
- **Renal Cysts (Mimic)**
  - Multiple simple cysts or polycystic disease
  - If numerous, may simulate dilated calices
  - Usually spherical
- **Renal Metastases and Lymphoma**
  - TCC, metastases, lymphoma may infiltrate pelvis; cause or simulate hydronephrosis
  - Lymphoma is especially likely to be homogeneous and hypodense (CT), and sonolucent (US)
- **Blood-Filled Renal Pelvis**
  - Trauma or coagulopathic hemorrhage may distend renal pelvis and calices with blood

Ureteral Stone



Axial CECT shows left-sided hydronephrosis, renal enlargement, and perinephric stranding, due to a distal ureteral stone.

Ureteral Stone



Axial NECT shows right-sided hydronephrosis and extensive infiltration of the perirenal space, due to forniceal rupture, caused by a small stone at the ureterovesical junction.

DILATED RENAL CALICES

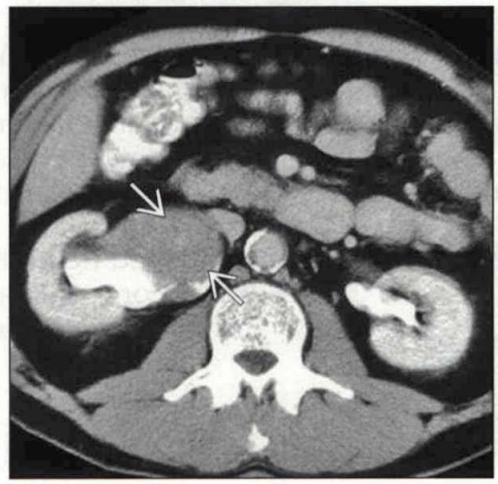
(Left) Axial CECT shows dilated renal pelvis & calices in the right kidney, due to a transitional cell carcinoma of the distal ureter. (Right) Axial CECT shows a soft tissue mass ➡ in the distal right ureter, a primary transitional cell carcinoma.

Transitional Cell Carcinoma

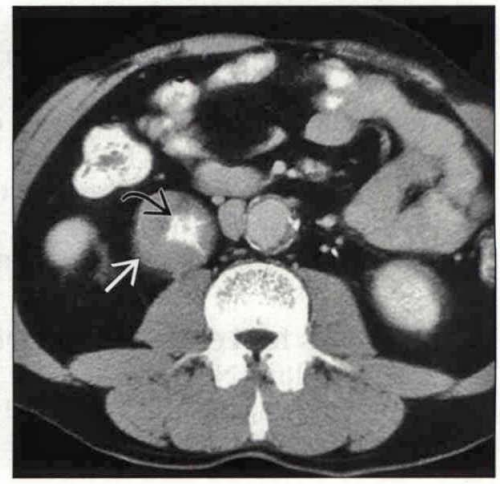
Transitional Cell Carcinoma

(Left) Axial CECT shows a soft tissue mass ➡ within the lumen or wall of the renal pelvis with dilated calices; lymphoma. (Right) Axial CECT shows soft tissue mass ➡ within the wall of the proximal ureter; lymphoma. The ureteral lumen ➡ is "aneurysmally dilated".

Periureteral Metastases

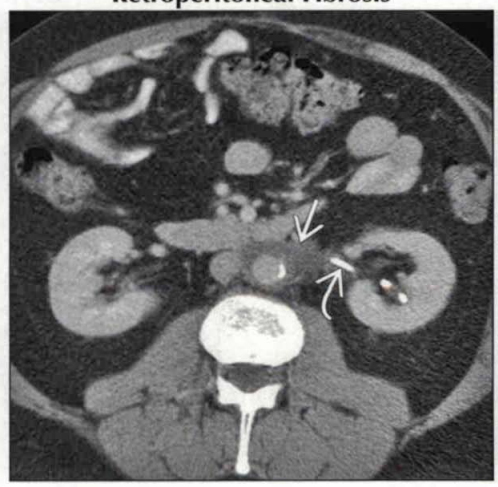


Periureteral Metastases

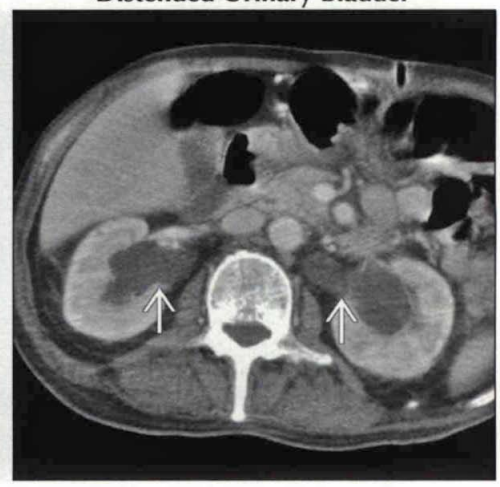


(Left) Axial CECT shows a ureteral stent ➡ that was placed to decompress an obstructed left ureter. Mantle of soft tissue ➡ around the aorta is classic for retroperitoneal fibrosis. (Right) Axial CECT shows bilateral dilation of the calices and ureters ➡ in an 80 year old man with prostatism and a distended urinary bladder. These findings resolved after catheterization of the bladder.

Retroperitoneal Fibrosis



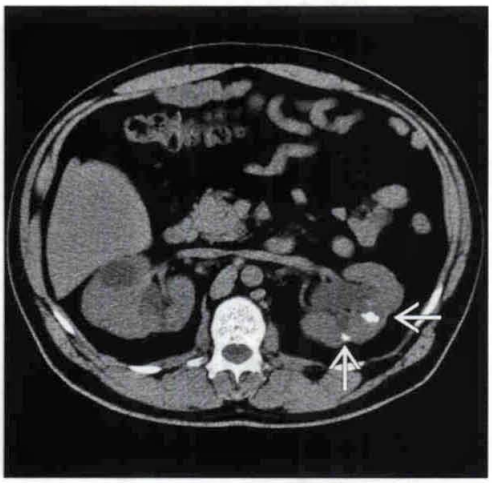
Distended Urinary Bladder



DILATED RENAL CALICES

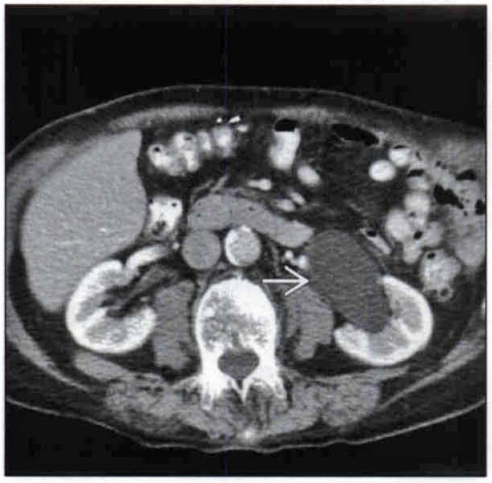
Distended Urinary Bladder

Vesicoureteral Reflux

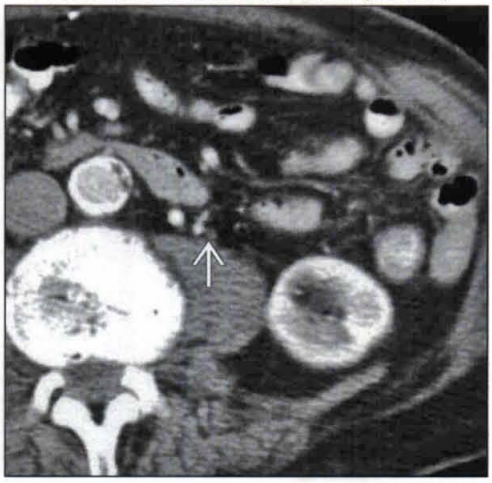


(Left) *Axial CECT shows distention of the urinary bladder ➡ due to prostatic hypertrophy in an 80 year old man who also had hydronephrosis that resolved upon catheterization of the bladder.* ***(Right)*** *Axial NECT shows dilated calices bilaterally due to chronic reflux. Note the cortical calcifications ➡ associated with the cortical scarring.*

Prominent Extrarenal Pelvis (Mimic)



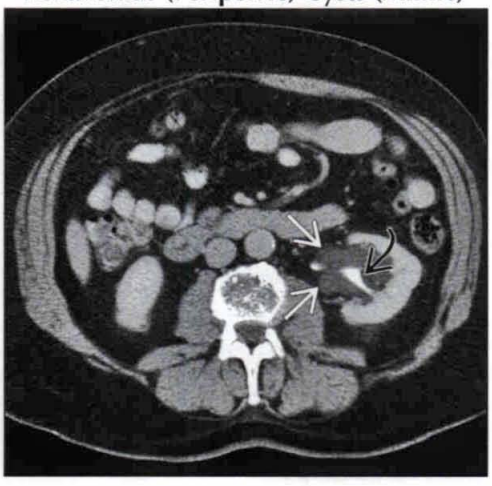
Prominent Extrarenal Pelvis (Mimic)



(Left) *Axial CECT shows a dilated left renal pelvis ➡ but no caliectasis, delayed nephrogram, or renal scarring, in this 83 year old man.* ***(Right)*** *Axial CECT shows a normal caliber left ureter ➡ in an 83 year old man with an incidental prominent extrarenal pelvis.*

Renal Sinus (Peripelvic) Cysts (Mimic)

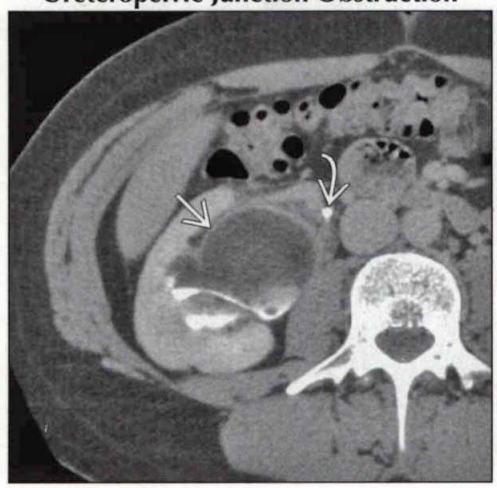
Renal Sinus (Peripelvic) Cysts (Mimic)



(Left) *Sagittal oblique ultrasound shows sonolucent foci ➡ in the renal sinus simulating dilated calices, but representing renal sinus (peripelvic) cysts.* ***(Right)*** *Axial CECT shows renal sinus (peripelvic) cysts ➡ that are distinguished from hydronephrosis on this pyelographic phase CECT by contrast-opacified urine ➡ in the collecting system.*

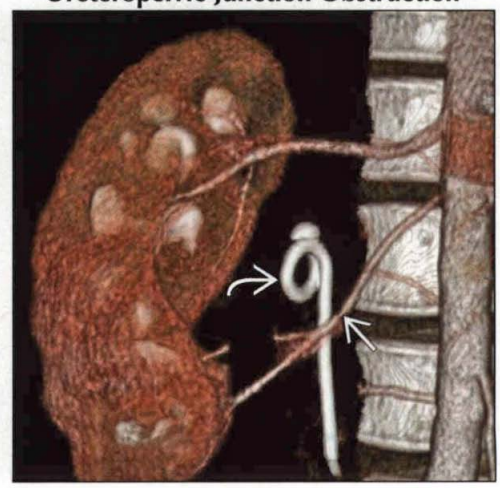
DILATED RENAL CALICES

Ureteropelvic Junction Obstruction

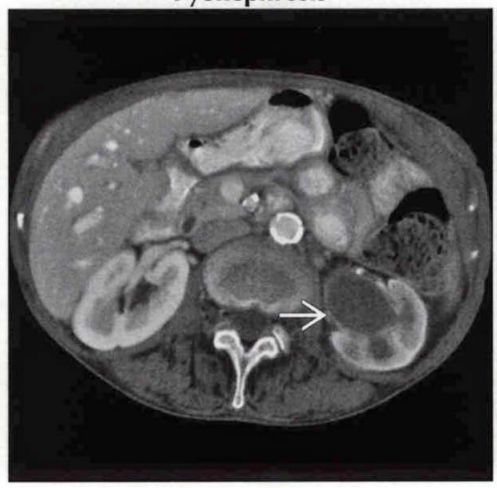


(Left) Axial CECT shows dilated pelvis & calices ➡ with the denser contrast-opacified urine layering dependently. A ureteral stent ➡ is in place. (Right) Coronal CECT shows the ureteral stent ➡ within the dilated renal pelvis. Note the lower pole renal artery ➡ that crosses the ureteropelvic junction. This may be considered a contributory factor in the UPJO and certainly needs to be considered if endoureteral repair of the UPJO is contemplated.

Ureteropelvic Junction Obstruction

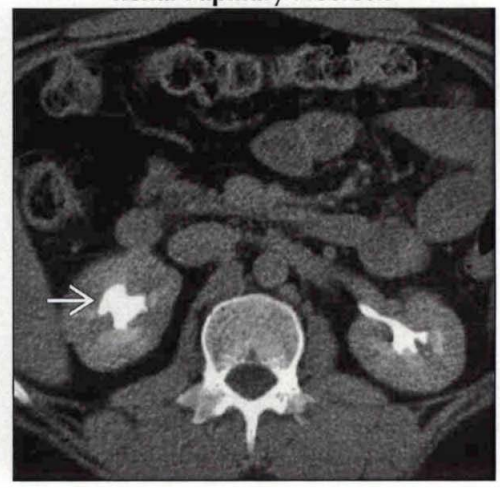


Pyonephrosis

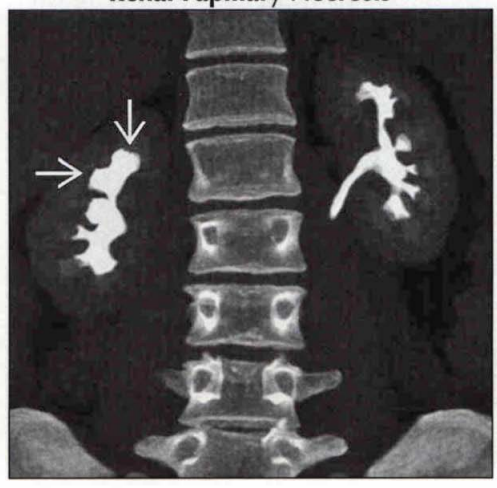


(Left) Axial CECT shows dilation of the left renal pelvis and calices and a delayed nephrogram. Note the enhanced, thickened uroepithelium ➡ indicating infection. The distal left ureter was inflamed by sigmoid diverticulitis. (Right) Axial CECT shows dilation and blunting of the calices ➡ in the upper pole of the right kidney due to papillary necrosis and sloughing of the papillae. Note the absence of opacified renal tubules in the affected region.

Renal Papillary Necrosis

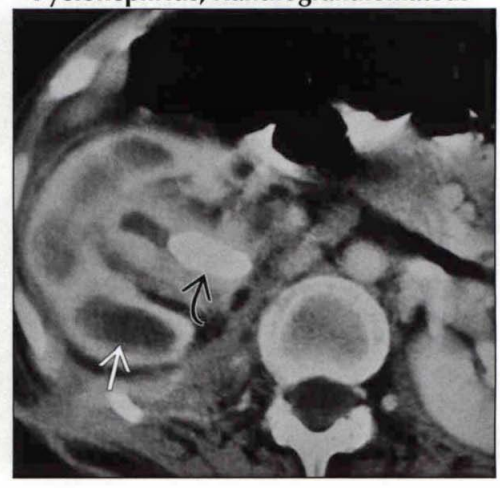


Renal Papillary Necrosis



(Left) Coronal CECT shows dilation and blunting of the calices in the upper pole of the right kidney ➡ due to sloughed papillae; 33 year old man with papillary necrosis due to IV drug abuse. (Right) Axial CECT shows low density replacement of renal parenchyma &/or hydronephrosis ➡, as well as a large obstructing stone ➡ and infiltration of the perirenal space.

Pyelonephritis, Xanthogranulomatous



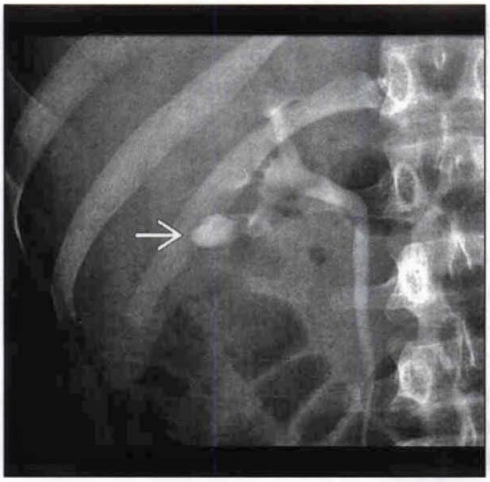
DILATED RENAL CALICES

Pyelonephritis, Xanthogranulomatous

Megacalices, Megaureter

(Left) *Axial CECT shows dilated collecting system ➡ &/or low density replacement of renal parenchyma. Note calculus ➡ & perinephric inflammatory changes ➡.* ***(Right)*** *Axial CECT shows dilated calices and stasis of urine ➡ in the left kidney. The renal pelvis, ureter, and renal function were all normal.*

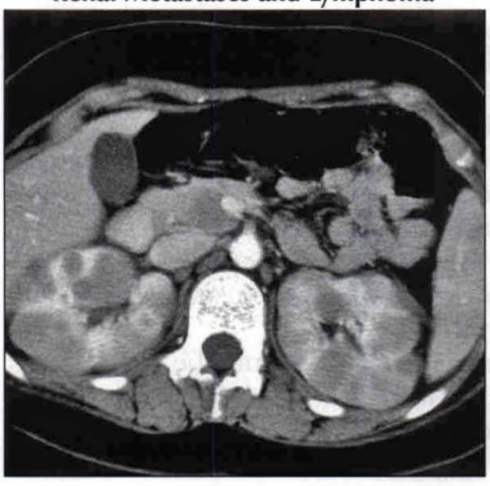
Caliceal Diverticulum



AD Polycystic Disease, Kidney

(Left) *Anteroposterior IVP shows a collection ➡ of contrast-opacified urine in communication with a lower pole calyx. CT showed a stone within this caliceal diverticulum.* ***(Right)*** *Axial CECT shows polycystic disease of the kidneys and liver. The central cysts in the left kidney ➡ might be mistaken for dilated calices, especially on sonography. The left renal pelvis is dilated ➡ due to an obstructing ureteral calculus.*

Renal Metastases and Lymphoma



Blood-Filled Renal Pelvis

(Left) *Axial CECT shows numerous low density masses throughout the kidneys; non-Hodgkin lymphoma. On US lymphoma is hypoechoic & can mimic fluid collection, including hydronephrosis.* ***(Right)*** *Axial CECT shows a blood-filled left renal pelvis ➡ with a delayed nephrogram, due to spontaneous bleeding induced by anticoagulation therapy.*

DELAYED OR PERSISTENT NEPHROGRAM

DIFFERENTIAL DIAGNOSIS

Common

- Ureteral or Renal Pelvic Obstruction
  - Obstructing Calculus
  - Obstructing Tumor
    - Transitional Cell Carcinoma
    - Renal Cell Carcinoma
    - Retroperitoneal Metastases
    - Colorectal Carcinoma
    - Pelvic Malignancies
    - Retroperitoneal Lymphoma
  - Retroperitoneal Fibrosis
  - Ureteral Stricture
  - Renal Trauma
- Renal Artery Stenosis
- Renal Vein Stenosis/Thrombosis
- Acute Tubular Necrosis
- Hypotension, Shock
- Pyelonephritis

Less Common

- Contrast-Induced Nephropathy
- Multiple Myeloma
- Rhabdomyolysis
- Leukemia
- Ureteral Stricture
- Renal Papillary Necrosis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Nephrogram that persists for more than 30 minutes, or becomes more dense after 5 minutes following IV or intraarterial contrast administration, is abnormal
- Causes: Obstruction of urine or vein outflow, arterial inflow, or decreased renal (nephron) function

Helpful Clues for Common Diagnoses

- **Obstructing Calculus**
  - Usually ureteral
    - Ureterovesical or ureteropelvic junction or at crossing of iliac vessels
  - Stone is almost always evident on CT as hyperdense focus with dilated ureter
  - Pelvocaliectasis & perirenal stranding
- **Obstructing Tumor**
  - **Transitional Cell Carcinoma**
    - May obstruct renal pelvis &/or ureter
    - Dilated collecting system upstream
    - Soft tissue density mass in wall & lumen of collecting system
  - **Renal Cell Carcinoma**
    - May extend into renal pelvis with obstruction
    - Bleeding from tumor may cause obstruction or renal pelvis
    - Renal vein invasion may slow renal venous outflow
  - **Retroperitoneal Metastases**
    - Displace, may obstruct ureters
    - Nodal mets from prostate and other tumors may simulate retroperitoneal fibrosis
    - Metastases may be to ureteral wall itself
    - Almost any malignant tumor may cause unilateral or bilateral ureteral obstruction by hematogenous, lymphatic, or direct extension to ureter
  - **Pelvic Malignancies**
    - May encase and obstruct ureters (e.g., rectal or endometrial carcinoma)
  - **Retroperitoneal Lymphoma**
    - Usually displaces, but can obstruct renal pelvis or ureter
- **Retroperitoneal Fibrosis**
  - Usually a mantle of soft tissue that encases the aorta and IVC
  - Draws ureters in toward midline and encases them with fibrous tissue
  - Unilateral or bilateral ureteral obstruction
- **Renal Trauma**
  - Blunt, penetrating or iatrogenic
  - Blood clot may obstruct renal pelvis or ureter
- **Renal Artery Stenosis**
  - Atherosclerosis, fibromuscular dysplasia, arteritis, dissection, embolism
  - Delayed "inflow" causes decreased and delayed nephrogram
- **Renal Vein Stenosis/Thrombosis**
  - "Outflow" obstruction can cause decreased & delayed nephrogram
  - Can be unilateral or bilateral
  - "Benign" (dehydration, nephrotic syndrome) or malignant (usually renal cell carcinoma)
  - Intraluminal thrombus may be visualized by CT, US, or MR
- **Acute Tubular Necrosis**

- Usually causes bilateral persistent nephrograms (& acute renal failure)
- Follows shock, placental abruption, nephrotoxic drugs

- **Pyelonephritis**
  - Leukocytes & bacteria (pus) may plug renal tubules
  - Decreased nephron function can also contribute to decreased & delayed nephrogram
  - Usually unilateral

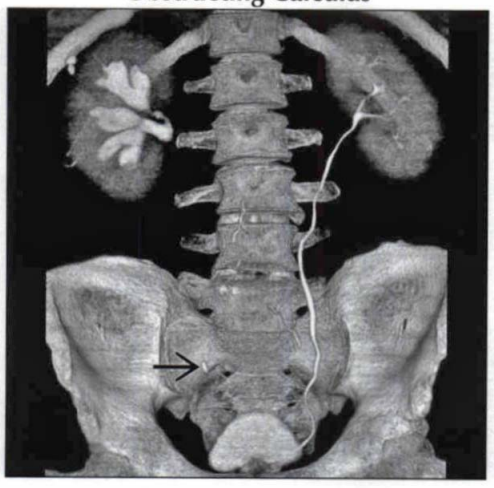
Helpful Clues for Less Common Diagnoses

- **Contrast-Induced Nephropathy**
  - Much more common after arterial rather than IV administration of contrast
  - Risk factors include
    - Prior renal insufficiency, dehydration, hypertension, diabetes, heart failure, advanced age, large doses of contrast media
- **Multiple Myeloma**
  - Renal tubules can become obstructed by myeloma protein
- **Rhabdomyolysis**
  - Death of muscle tissue may release myoglobin into circulation
  - Renal tubules can become blocked by protein plugs
- **Leukemia**
  - Massive tumor necrosis from chemotherapy may release uric acid into circulation
    - Can lead to calculi or plugging of tubules by uric acid
  - Masses of leukemic tissue (chloroma) may directly obstruct ureters
- **Ureteral Stricture**
  - Usually due to post operative scarring (often from surgery to adjacent organs)
  - May follow infection or inflammation of ureter itself
    - Or adjacent inflammatory conditions (e.g., Crohn disease, diverticulitis)
- **Renal Papillary Necrosis**
  - Sloughed papilla may obstruct UPJ or ureter
  - Characteristic deformities of calices on urography

Alternative Differential Approaches

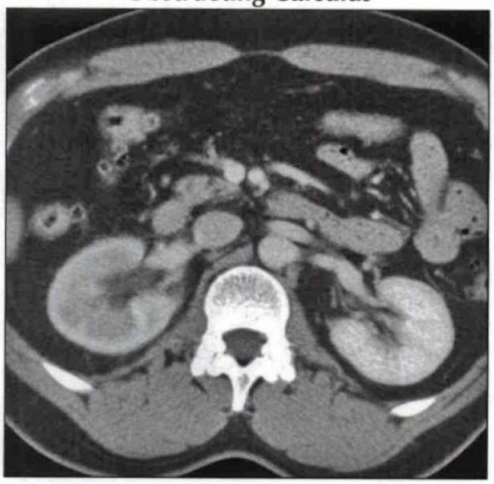
- Unilateral persistent nephrogram
  - Obstructed ureter (stone > tumor > other)
  - Renal Artery Stenosis
  - Renal Vein Stenosis/Thrombosis
  - Unilateral decreased nephron function (usually pyelonephritis)
- Bilateral persistent nephrogram
  - Hypotension, Shock
  - Acute Tubular Necrosis
  - Bilateral ureteral stenosis (tumor, retroperitoneal fibrosis)
  - Bilateral arterial stenosis
  - Bilateral venous stenosis or thrombosis

Obstructing Calculus



Coronal CECT shows prompt concentration & excretion of urine from the left kidney, while the right kidney has a delayed nephrogram and dilated calices, due to an obstructing ureteral stone ➔.

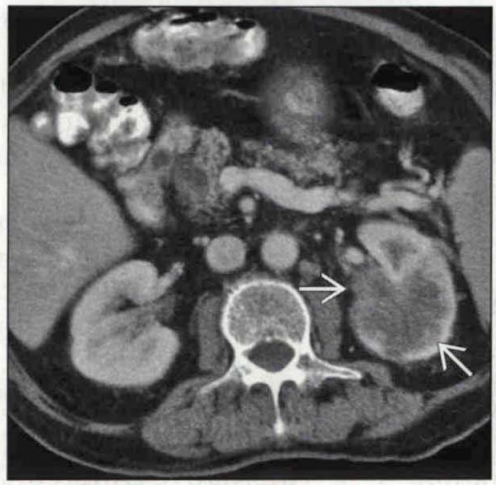
Obstructing Calculus



Axial CECT shows a delayed right nephrogram and caliectasis due to a distal ureteral stone.

DELAYED OR PERSISTENT NEPHROGRAM

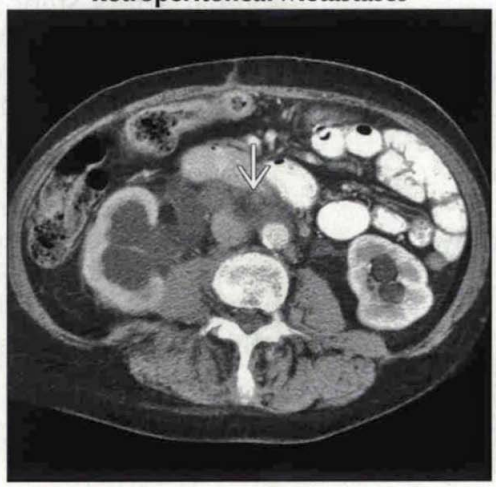
Transitional Cell Carcinoma



Renal Cell Carcinoma

(Left) *Axial CECT shows a tumor ➡ that infiltrates the left kidney and extends into the renal pelvis, a transitional cell carcinoma. Note delayed left nephrogram (still in cortico-medullary phase, while right kidney is in nephrographic phase).* ***(Right)*** *Coronal T1 C+ MR shows a large renal cell carcinoma ➡ with invasion of the left renal vein & IVC ➡. Note delayed nephrogram on left side.*

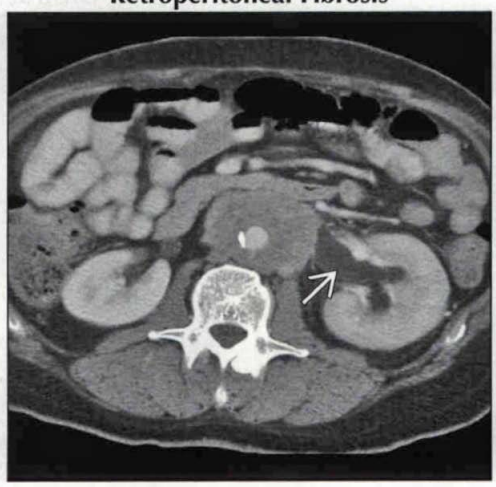
Retroperitoneal Metastases



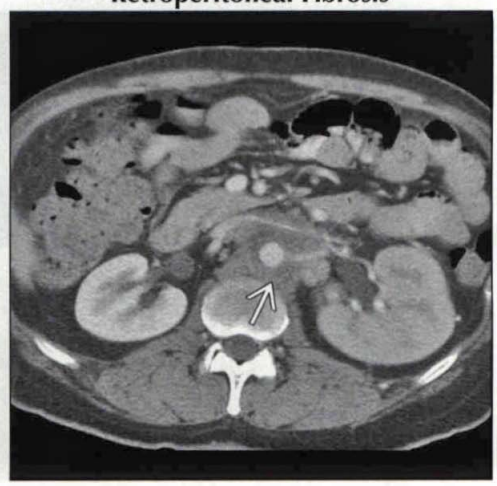
Retroperitoneal Lymphoma

(Left) *Axial CECT shows bilateral hydronephrosis and delayed nephrograms, right > left, due to retroperitoneal lymph node metastases ➡ from ovarian carcinoma.* ***(Right)*** *Axial CECT shows a delayed left nephrogram ➡ due to extensive retroperitoneal lymphadenopathy ➡ that compressed the ureter; non-Hodgkin lymphoma.*

Retroperitoneal Fibrosis



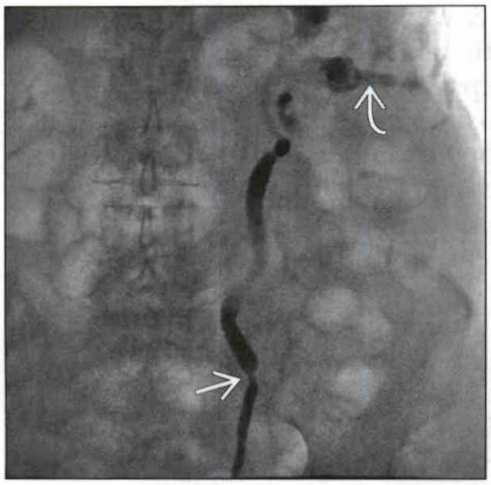
Retroperitoneal Fibrosis



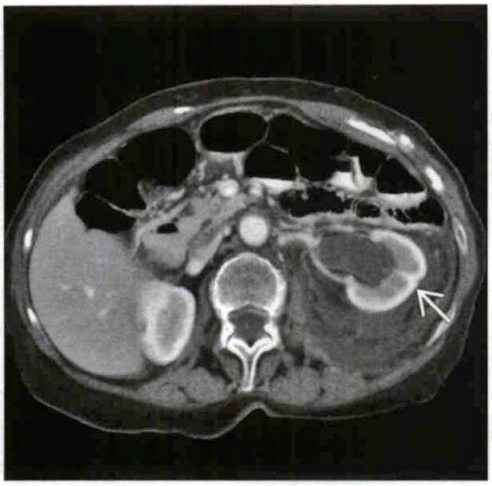
(Left) *Axial CECT shows left-sided pelvocaliectasis ➡ due to obstruction of the left ureter by the fibrotic mass at a more caudal level; 50 year old woman.* ***(Right)*** *Axial CECT shows a soft tissue density mass ➡ that envelopes the aorta. Narrowing of the left renal artery & vein contributes to the decreased and delayed left nephrogram. The left ureter was also obstructed by the fibrotic mass; 50 year old woman.*

DELAYED OR PERSISTENT NEPHROGRAM

Ureteral Stricture

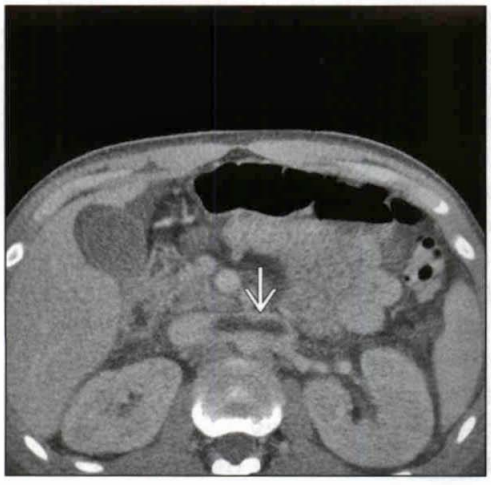


Ureteral Stricture



(Left) *Retrograde pyelogram shows a tight ureteral stricture* ➡ *that was due to injury during a left colectomy. There was marked hydronephrosis prior to placement of a nephrostomy catheter* ➡. ***(Right)*** *Axial CECT shows a delayed nephrogram* ➡, *hydronephrosis, and a urinoma due to a ureteral stricture as a complication of a colectomy in an 86 year old woman.*

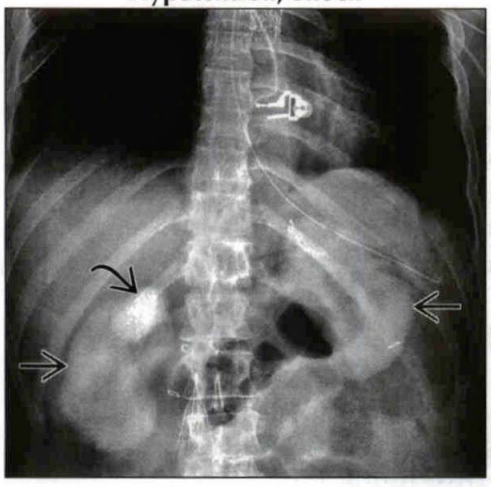
Renal Vein Stenosis/Thrombosis



Acute Tubular Necrosis

(Left) *Axial CECT shows bilateral delayed nephrograms, due to thrombosis* ➡ *extending into both renal veins (shown on adjacent sections); 24 year old man with nephrotic syndrome.* ***(Right)*** *Axial NECT shows dense persistent nephrograms* ➡ *(L > R) and dense bile* ➡ *due to vicarious excretion; 85 year old woman one day following catheter angiography, which showed a ruptured splenic artery aneurysm that resulted in shock.*

Hypotension, Shock



Contrast-Induced Nephropathy

(Left) *Frontal radiograph shows dense persistent nephrograms* ➡ *and opacified bile in the gallbladder* ➡ *(due to vicarious excretion). This 33 year old patient had been in shock due to blunt trauma and had a CECT the previous day.* ***(Right)*** *Axial NECT shows dense bilateral nephrograms one day following coronary angiography in an elderly patient with congestive heart failure.*

WEDGE-SHAPED OR STRIATED NEPHROGRAM

DIFFERENTIAL DIAGNOSIS

Common

- Acute Pyelonephritis
- Renal Trauma
- Renal Infarction
- Medullary Sponge Kidney
- Acute Ureteral Obstruction

Less Common

- Vasculitis, Abdominal Manifestations
- Multiple Myeloma
- Rhabdomyolysis
- Renal Cell Carcinoma
- Metastases and Lymphoma, Renal
- Radiation Nephritis
- Renal Vein Thrombosis
- Autosomal Recessive Polycystic Disease

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Acute renal inflammatory, traumatic, infectious, or vascular diseases
  - Tend to manifest as wedge-shaped &/or striated areas of diminished enhancement on CECT or CEMR, reflecting lobular architecture of the kidney & the presence of collecting tubules that comprise the renal medulla
- Striated pattern: Tubules plugged with casts of
  - White blood cells: Acute pyelonephritis
  - Red blood cells: Trauma
  - Protein: Multiple myeloma, rhabdomyolysis
- Wedge-shaped pattern
  - More potential etiologies
  - Anything that can injure or replace a portion of the kidney
- Straight line demarcation between normal & abnormal kidney
  - Usually has a vascular etiology
  - Ischemia or infarction most common cause

Helpful Clues for Common Diagnoses

- **Acute Pyelonephritis**
  - Kidney swollen with striated & wedge defects
  - Infiltration of perirenal fat is also common
  - Typical clinical setting
    - Acute flank pain, dysuria, high fever
    - More common in young women
- **Renal Trauma**
  - Contusion & renal hematoma may cause striated & wedge defects, respectively
  - Traumatic renal arterial injury can cause similar appearance, but different mechanism
    - Stretched intima may tear & dissect
    - Platelet emboli cause scattered zones of decreased renal perfusion
  - Typical clinical setting: Blunt injury due to motor vehicle crash
    - Renal arterial injury usually follows rapid deceleration injury (fall or high speed motor vehicle crash)
- **Renal Infarction**
  - Arterial dissection or emboli may result in wedge-shaped parenchymal defects
    - Cortical scarring & volume loss over time
  - Straight line demarcation of normal/abnormal kidney indicates vascular etiology
  - "Cortical rim" sign
    - Preserved perfusion of subcapsular rim of tissue
    - Seen only in subacute infarction, not acute or chronic
  - Typical clinical settings
    - Embolic: Cardiac valve vegetations; prior myocardial infarction; atrial fibrillation
    - Thrombotic: Aortic &/or renal artery dissection; atherosclerosis
- **Medullary Sponge Kidney**
  - Renal tubules are dilated; tiny calculi in pyramids & calyces
  - Tends to impart more of a striated appearance only of the medulla (not cortex)
    - Most evident on pyelographic phase of urography (excretory or CTU)
  - Typical clinical setting: Intermittent episodes of flank pain due to ureteral obstruction by small calculi originating in dilated tubules
- **Acute Ureteral Obstruction**
  - Usually causes delayed nephrogram
  - Nephrogram may be heterogeneous, even striated, with infectious complication

Helpful Clues for Less Common Diagnoses

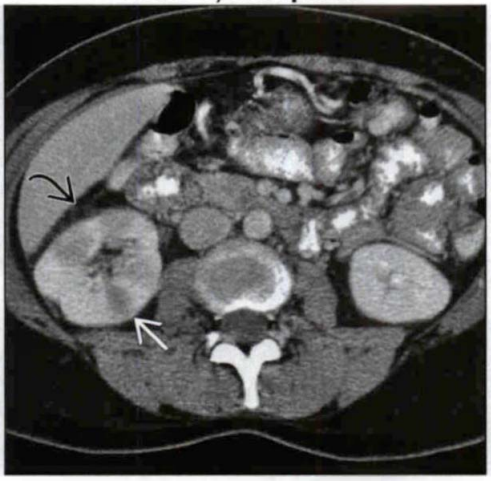
- **Vasculitis, Abdominal Manifestations**
  - Polyarteritis, lupus, etc.

WEDGE-SHAPED OR STRIATED NEPHROGRAM

- Striated & wedge-shaped lesions indistinguishable from acute pyelonephritis on imaging
- Clinical setting: Patient with known autoimmune ("collagen vascular") disease
  - Episodes of symptoms referable to visceral ischemia or spontaneous hemorrhage

- **Multiple Myeloma**
  - Collecting tubules may be plugged with excreted myeloma protein
  - Imaging findings similar to acute pyelonephritis
    - But clinical presentation is very different (no fever; known or easily confirmed myeloma)
- **Rhabdomyolysis**
  - Release of massive amounts of myoglobin into the serum from damaged skeletal muscle may block renal tubules
    - Clinical: May cause acute renal failure
    - Imaging: Decreased or striated nephrogram, usually bilateral
  - Clinical setting: Crush injury, muscle trauma, certain drug effects
    - Especially drug overdose with prolonged muscle hypoxia
- **Renal Cell Carcinoma**
  - Or other tumors (metastases, lymphoma)
  - May have a wedge shape but are usually spherical
    - Do not expect striated nephrogram
  - Clinical setting: Incidental discovery (renal cell carcinoma) or flank pain, hematuria
    - Metastases or lymphoma: Primary tumor is usually known; extrarenal tumor is usually evident
- **Radiation Nephritis**
  - Wedge shape correlates with field of external beam
    - Radiation therapy to midline structures (e.g., nodal or spine metastases) may injure medial portions of kidneys
    - Clinical setting: Should be able to elicit or deduce history of prior radiation therapy
  - Often does not correspond to the expected wedge shape of renal lobules
- **Renal Vein Thrombosis**
  - Acute RVT may cause striated or wedge-shaped defects
  - Kidney usually swollen, may have delayed nephrogram
  - Clinical setting: Nephrotic syndrome, hypercoagulable condition
    - Acute flank pain
- **Autosomal Recessive Polycystic Disease**
  - Usually manifest & diagnosed in childhood

Acute Pyelonephritis



Axial CECT shows swelling of the right kidney with wedge-shaped zones of decreased enhancement ■. Also note infiltration of the perirenal fat ⇄.

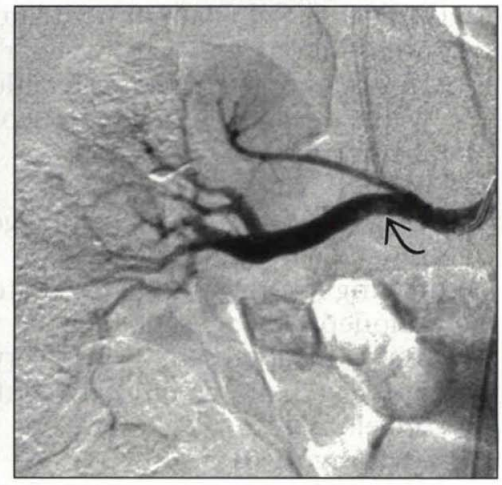
Acute Pyelonephritis

Coronal CECT shows wedge-shaped zones of decreased enhancement ■ of the cortex and medulla.

WEDGE-SHAPED OR STRIATED NEPHROGRAM

Renal Trauma

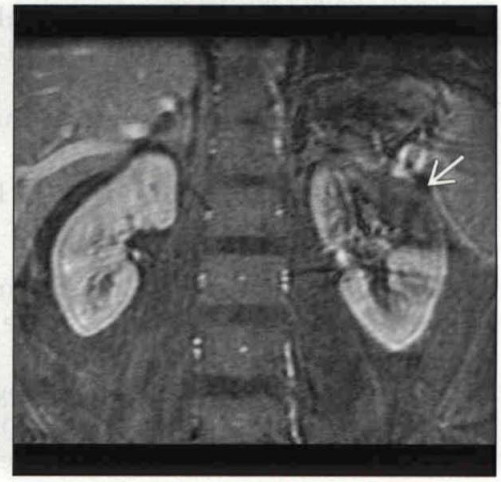
Renal Trauma



(Left) *Axial CECT shows wedge-shaped zones of decreased renal enhancement ➡ in the right kidney, due to renal arterial injury with dissection. Note subcutaneous gas from chest injury ⇨ to this 34 year old man in a car crash.* ***(Right)*** *Anteroposterior catheter angiography shows an intimal flap & luminal clot ⇨ in the right renal artery; 34 year old man injured in car crash. He was treated with an arterial stent with preservation of renal perfusion & function.*

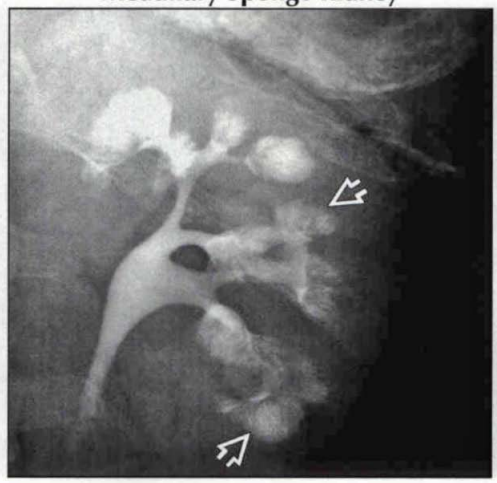
Renal Trauma

Renal Infarction



(Left) *Axial NECT shows a striated appearance ➡ of the left kidney, due to renal contusion on this scan performed several hours after administration of IV contrast medium.* ***(Right)*** *Coronal T1 C+ FS MR shows a large wedge-shaped zone of decreased cortical & medullary enhancement ➡ due to renal infarction.*

Medullary Sponge Kidney



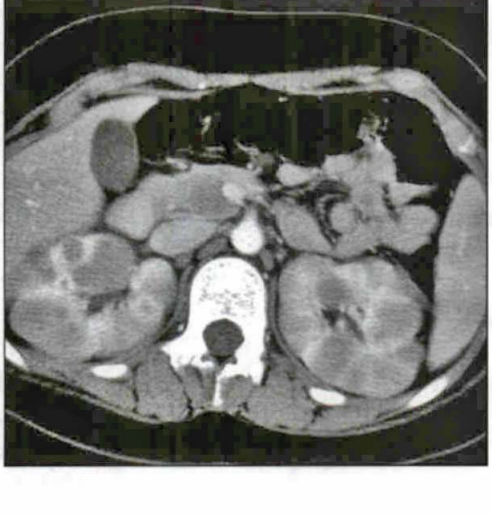
Vasculitis, Abdominal Manifestations

(Left) *Frontal excretory urography shows a classic "paint brush" appearance of dilated, contrast-opacified dilated tubules ⇨ in the renal pyramids, giving a striated appearance to the renal medulla.* ***(Right)*** *Axial CECT shows multiple wedge-shaped parenchymal defects ➡ in the right kidney due to renal ischemic injury; 70 year old woman with Wegener granulomatosis (vasculitis).*

WEDGE-SHAPED OR STRIATED NEPHROGRAM

Vasculitis, Abdominal Manifestations

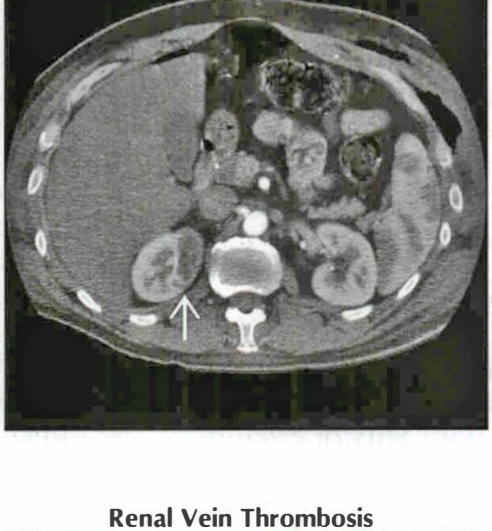
Metastases and Lymphoma, Renal



(Left) *Coronal CECT shows a wedge-shaped zone of decreased enhancement due to vasculitis and renal ischemia; 40 year old man. Note the straight line demarcation sign of a vascular injury.* ***(Right)*** *Axial CECT shows a mottled appearance of both kidneys due to parenchymal deposits of lymphoma. Most of the lesions have a spherical, rather than wedge, shape.*

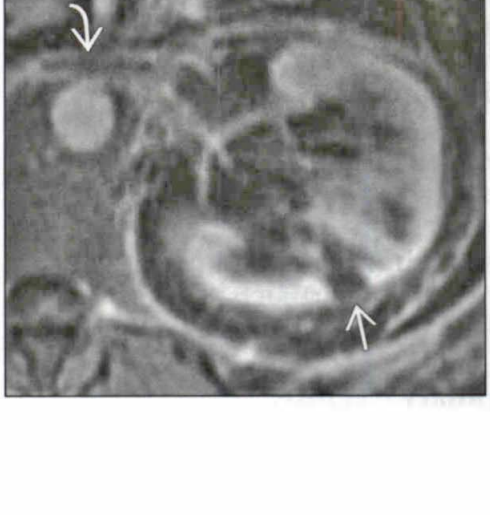
Radiation Nephritis

Radiation Nephritis



(Left) *Axial CECT shows decreased parenchymal enhancement and subtle volume loss in the medial half of the left kidney due to radiation nephritis that followed treatment for vertebral metastasis.* ***(Right)*** *Axial CECT shows decreased parenchymal enhancement of the medial half of the right kidney due to radiation nephritis that followed therapy for vertebral metastasis. The left kidney was involved at a different level with the same features.*

Renal Vein Thrombosis



Renal Vein Thrombosis

(Left) *Axial T1 C+ FS MR shows heterogeneous and focal decreased renal parenchymal enhancement due to renal vein thrombosis in this patient with nephrotic syndrome.* ***(Right)*** *Coronal T1 C+ FS MR shows thrombus in the left renal vein in a patient with nephrotic syndrome and acute flank pain. Wedge-shaped zones of decreased parenchymal enhancement were present on the axial sections.*

HYPERECHOIC RENAL MASS

DIFFERENTIAL DIAGNOSIS

Common
- Renal Angiomyolipoma (AML)
- Renal Cell Carcinoma (RCC)
- Wilms Tumor

Less Common
- Fat in Renal Scar
- Milk of Calcium Cyst
- Renal Junctional Line/Cortical Parenchymal Defect
- Renal Calculi
- Renal Papillary Necrosis
- Abscess, Renal
- Emphysematous Pyelonephritis
- Renal Metastases

Rare but Important
- Focal Bacterial Nephritis
- Xanthogranulomatous Pyelonephritis
- Tuberculosis, Urinary Tract
- Renal Oncocytoma
- Renal Trauma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- The same lesions that cause fat density (intensity) lesions on CT and MR usually cause echogenic lesion on US
  - However, echogenicity alone is not a reliable indication of fat content
  - Other sources of renal echogenicity include calcification & gas
  - Lesions with calcification: Milk of calcium cyst, RCC, Wilms tumor
  - Lesions with gas: Renal abscess, emphysematous pyelonephritis

Helpful Clues for Common Diagnoses
- **Renal Angiomyolipoma (AML)**
  - Well-defined hyperechoic mass, similar to renal sinus
  - Echogenicity created by high fat content and multiple vessel-tissue interfaces
  - May have posterior shadowing not typically seen with other masses
  - Small lesion: AML has much higher echogenicity than RCC
  - Larger tumors usually have prominent vascularity, evident on color Doppler
  - May have central necrosis simulating malignant lesion
  - US alone is not reliable in diagnosing AML; requires CT confirmation (perform NECT and CECT)
- **Renal Cell Carcinoma (RCC)**
  - 30% of small RCCs appear as hyperechoic masses, mimic AML
    - Presence of necrosis in mass or anechoic rim favors RCC but large overlap
  - Larger RCC may have foci of calcification (also echogenic), rarely fat
  - Mass with calcification & fat in adult = RCC, not AML
- **Wilms Tumor**
  - Highly variable morphology, including echogenic foci (fat &/or calcification)
  - Heterogeneous echotexture with areas of necrosis or hemorrhage
  - Consider Wilms for any renal mass in a child (most present before age 5)

Helpful Clues for Less Common Diagnoses
- **Fat in Renal Scar**
  - Example: Following partial nephrectomy
    - Fat may be placed into cortical defect
- **Milk of Calcium Cyst**
  - Echogenic lesion associated with characteristic comet-tail/ring-down artifact
  - Calcification may layer creating a fluid/debris level
- **Renal Junctional Line/Cortical Parenchymal Defect**
  - Echogenic line at anterosuperior aspect, upper pole of right kidney, lower pole of left kidney
    - Infolding of renal capsule and fat creates hyperechoic line or "mass"
  - Also can see extension of renal sinus fat into same location
  - Less commonly appears as a triangular focus known as parenchymal defect
- **Renal Calculi**
  - Usually hyperechoic with sharp shadowing
  - Calculi or milk of calcium may form within a calyceal diverticulum, mimic a hyperechoic mass
  - Most stones show color and power Doppler twinkling artifacts
    - Useful ancillary finding in equivocal cases
- **Renal Papillary Necrosis**

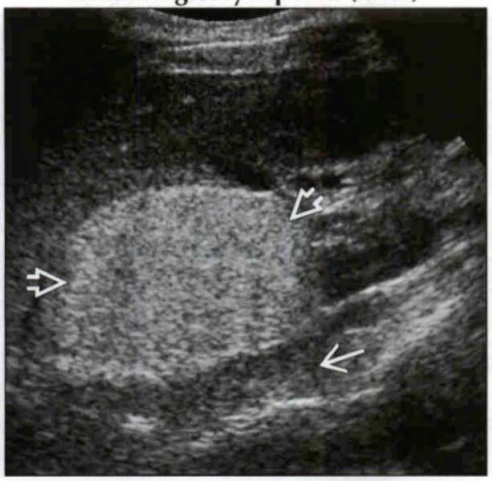
- Early stage: Echogenic "ring" in medulla = necrotic papillae, surrounded by rim of fluid
- Late stage: Multiple cystic cavities in medullary pyramids ± nonshadowing echogenic sloughed papillae
- Calcified sloughed papilla with strong acoustic shadowing simulates stone, may cause obstructive hydronephrosis

- **Abscess, Renal**
  - Gas-forming abscess will be echogenic
- **Emphysematous Pyelonephritis**
  - Gas within infarcted, infected parenchyma is echogenic
    - Non-dependent linear echogenic lines with strong distal posterior acoustic shadowing
  - Clinically extremely ill patient with fever, flank pain and electrolyte imbalance
  - Different from emphysematous pyelitis where gas is limited to renal pelvis and calyces (less serious diagnosis)
- **Renal Metastases**
  - Variable echogenicity, typically hypoperfused masses
  - Look for metastases in other organs
  - Most common primary tumors include lung carcinoma, breast carcinoma, contralateral RCC

Helpful Clues for Rare Diagnoses

- **Focal Bacterial Nephritis**
  - Increased echogenicity is related to hemorrhage
  - Usually wedge-shaped, poorly defined margin, ↓ focal vascularity on power Doppler
  - Can be hypoechoic, related to liquefaction and abscess formation
  - Can be multiple lesions with patchy heterogeneous renal parenchyma
  - Other associated features of renal inflammation: Renal enlargement, urothelial thickening of renal pelvis
- **Xanthogranulomatous Pyelonephritis**
  - Highly reflective central echo complex with strong shadowing corresponding to large staghorn stone
  - Echogenicity depends on amount of debris and necrosis within the masses
- **Tuberculosis, Urinary Tract**
  - Active stage: Papillary destruction with echogenic masses near calyces
  - Late stage: Calcified granuloma or dense dystrophic calcification associated with shrunken kidneys
- **Renal Oncocytoma**
  - Cannot be differentiated from RCC on imaging
  - Variable in echogenicity, may contain central scar, central necrosis or calcification
- **Renal Trauma**
  - Hematoma can be hyperechoic or heterogeneous during acute phase
  - Regional distortion of corticomedullary differentiation

Renal Angiomyolipoma (AML)



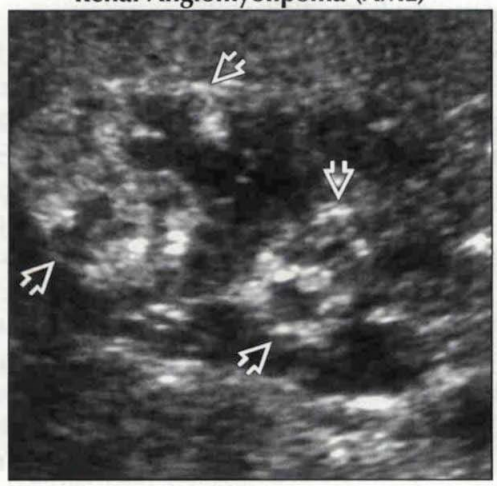
Longitudinal transabdominal ultrasound shows a typical large, homogeneous, hyperechoic mass ⇔ at the upper pole of right kidney. Note the faint posterior shadowing →.

Renal Angiomyolipoma (AML)

Oblique transabdominal ultrasound shows a typical small, homogeneous, echogenic lesion ⇔ at the lower pole of the kidney without alternation of renal contour. A small RCC would not typically be this hyperechoic.

HYPERECHOIC RENAL MASS

Renal Angiomyolipoma (AML)

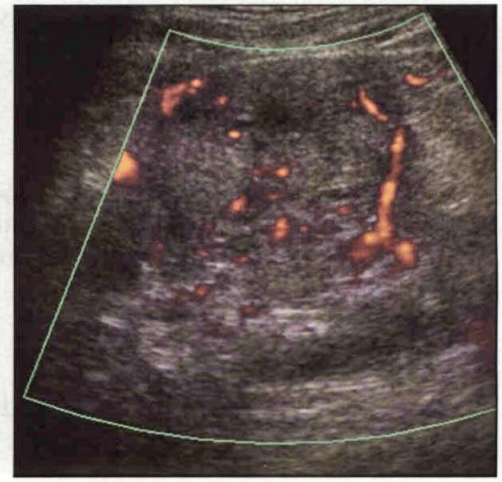


Renal Cell Carcinoma (RCC)

(Left) *Longitudinal ultrasound shows two irregular large echogenic AML lesions in a patient with tuberous sclerosis. These lesions are heterogeneous in appearance and may mimic malignant lesions.* ***(Right)*** *Longitudinal ultrasound shows a mildly echogenic lesion in the upper pole of the right kidney. It is not as echogenic as most small AMLs. A tiny intralesional cystic component is present.*

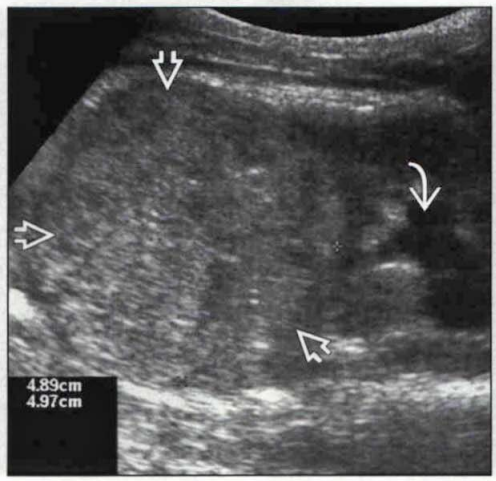
Renal Cell Carcinoma (RCC)

Renal Cell Carcinoma (RCC)

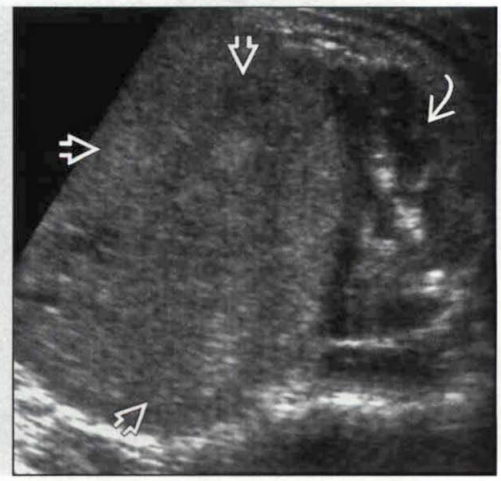


(Left) *Longitudinal ultrasound shows a large, exophytic, heterogeneous RCC. It is mildly hyperechoic with tiny cystic and calcific foci. The tumor disrupts central sinus echoes. (**Right**) Longitudinal power Doppler ultrasound shows rich internal vascularity. RCC is typically hypervascular, helping to differentiate it from hypovascular lesions such as renal metastasis, lymphoma, and transitional cell carcinoma.*

Wilms Tumor



Wilms Tumor

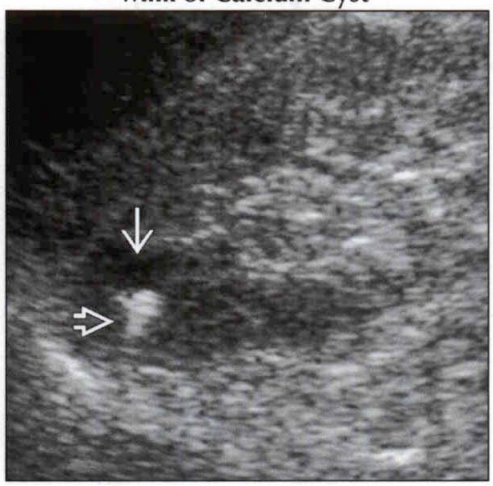


(Left) *Longitudinal transabdominal ultrasound shows a large, slightly hyperechoic lesion at the upper pole of the right kidney in a 3 year old boy. It is causing obstructive* ***hydronephrosis****.* ***(Right)*** *Oblique transabdominal ultrasound shows the Wilms tumor is heterogeneous and mildly hyperechoic compared to the normal renal parenchyma, which is being displaced.*

HYPERECHOIC RENAL MASS

Fat in Renal Scar

Milk of Calcium Cyst



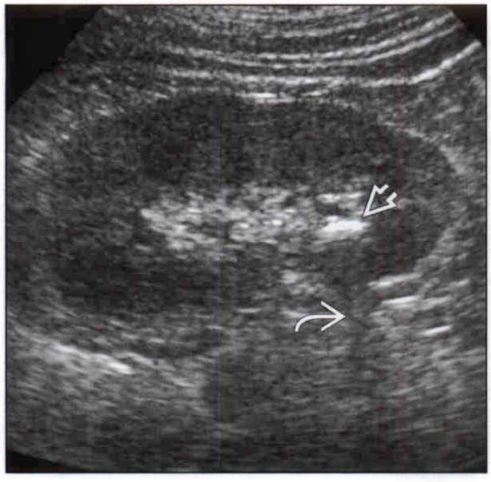
(Left) *Oblique ultrasound shows an echogenic focus with focal contour depression in the interpolar region of the right kidney, compatible with a focal renal scar.* ***(Right)*** *Oblique transabdominal ultrasound shows a bright echogenic focus with ring-down artifact. compatible with calcium layering within a cyst.*

Renal Junctional Line/Cortical Parenchymal Defect

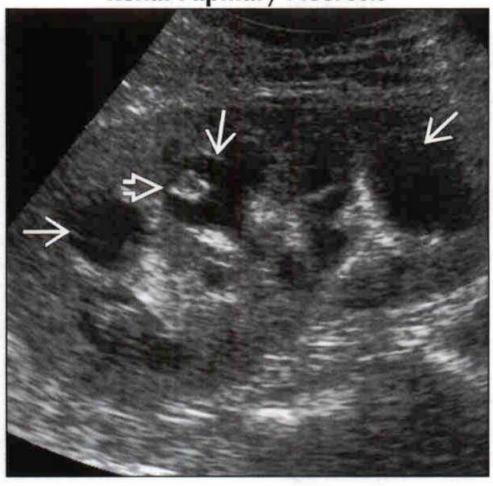
Renal Junctional Line/Cortical Parenchymal Defect

(Left) *Longitudinal transabdominal ultrasound shows the typical appearance of a renal junction line at the classic location of the anterosuperior aspect of the right kidney.* ***(Right)*** *Longitudinal transabdominal ultrasound shows a junctional parenchymal defect as a triangular echogenic focus near the junction of the upper and middle thirds of the kidney.*

Renal Calculi



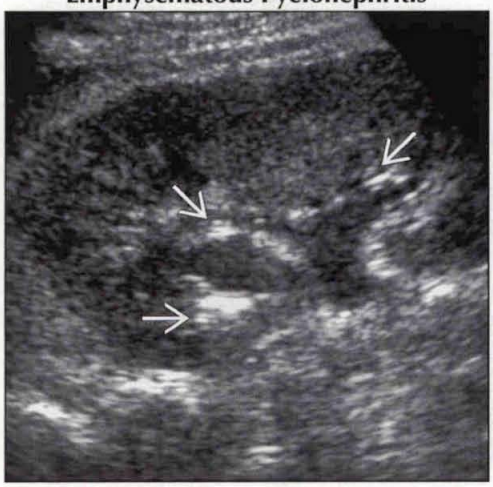
Renal Papillary Necrosis

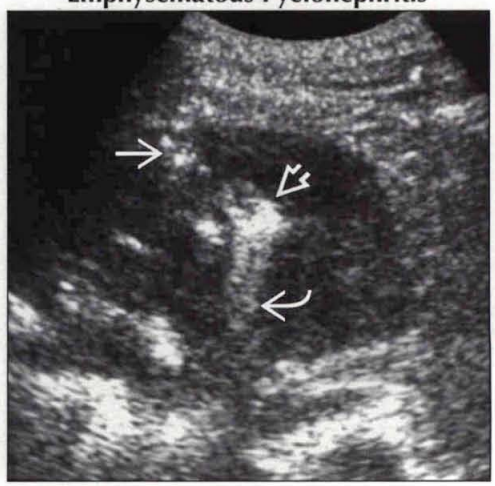


(Left) *Longitudinal transabdominal ultrasound shows an echogenic focus at the lower pole of left kidney associated with posterior acoustic shadowing. There is no associated obstructive calyceal dilatation.* ***(Right)*** *Longitudinal transabdominal ultrasound shows a necrotic papilla appearing as an echogenic focus with "ring" calcification in the medullary pyramid. It is surrounded by a rim of fluid from the dilated and clubbed calyces.*

HYPERECHOIC RENAL MASS

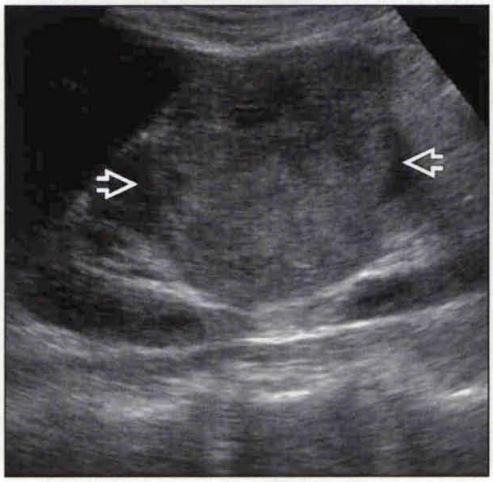
Emphysematous Pyelonephritis





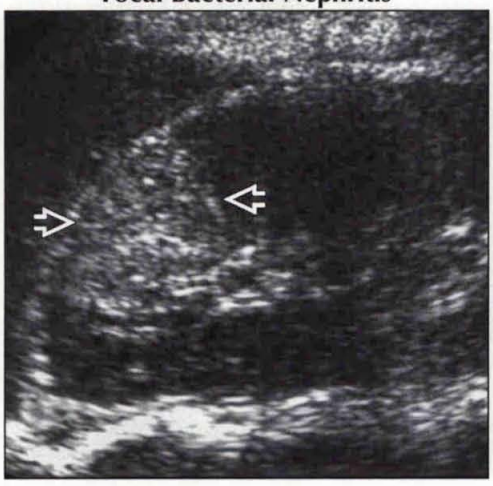
(Left) *Oblique ultrasound shows multiple foci of echogenic gas ⇨ around the renal pelvis and within the renal sinus.* ***(Right)*** *Transverse transabdominal ultrasound shows echogenic gas within the renal cortex ⇨ and collecting system ⇨. Note the ring down artifacts ⇨ compatible with air bubbles trapped in fluid.*

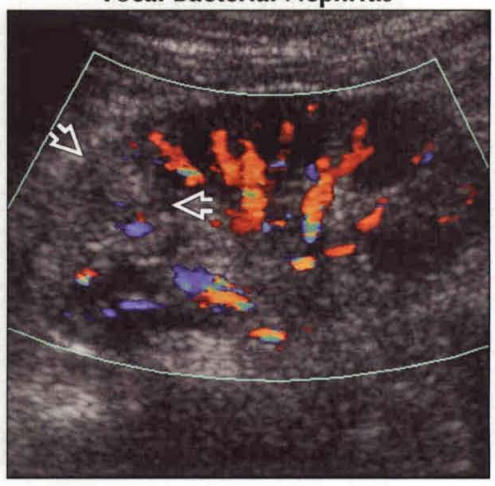
Renal Metastases



(Left) *Longitudinal ultrasound shows a large echogenic mass ⇨ at the interpolar region of right kidney. Similar lesions were found in the contralateral kidney in a patient with known rhabdomyosarcoma.* ***(Right)*** *Transverse color Doppler ultrasound shows an echogenic mass ⇨ at the mid-right kidney in a patient with carcinoma of the lung and multiple liver metastases. There is no evidence of increased vascularity of the lesion, typical of renal metastasis.*

Focal Bacterial Nephritis

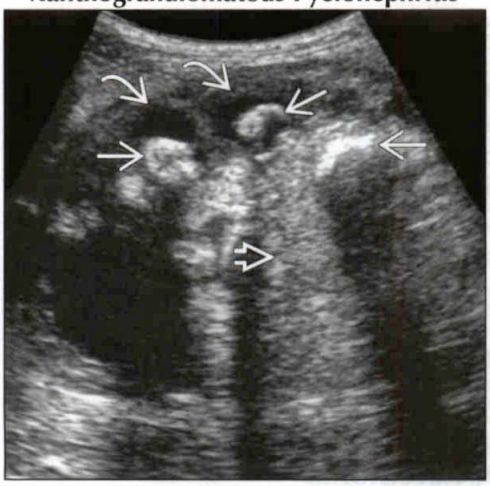




(Left) *Longitudinal transabdominal ultrasound shows a wedge-shaped echogenic mass ⇨ in a febrile patient with flank pain. Increased echogenicity in focal bacterial nephritis is related to hemorrhage. It may mimic a neoplastic lesion. Clinical correlation is important in the differentiation.* ***(Right)*** *Longitudinal color Doppler ultrasound shows a parenchymal vascular defect ⇨ in the echogenic area of focal bacterial nephritis.*

HYPERECHOIC RENAL MASS

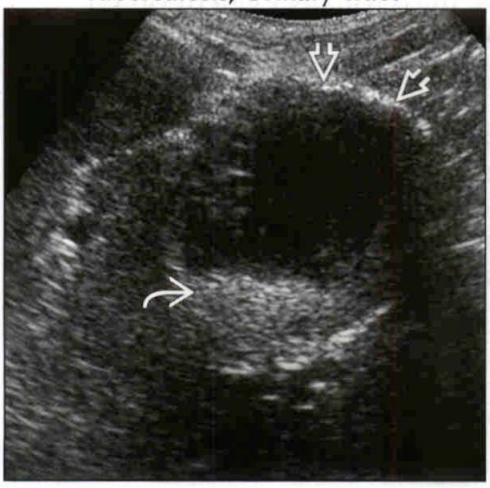
Xanthogranulomatous Pyelonephritis



Xanthogranulomatous Pyelonephritis

(Left) *Longitudinal ultrasound shows extensive peripelvic fat infiltration secondary to xanthogranulomatous pyelonephritis. Multiple echogenic calculi are present associated with* **hydrocalycosis**. ***(Right)*** *Longitudinal ultrasound shows renal parenchymal replacement by echogenic xanthogranulomatous tissue with generalized cortical thinning. A large central calculus is present.*

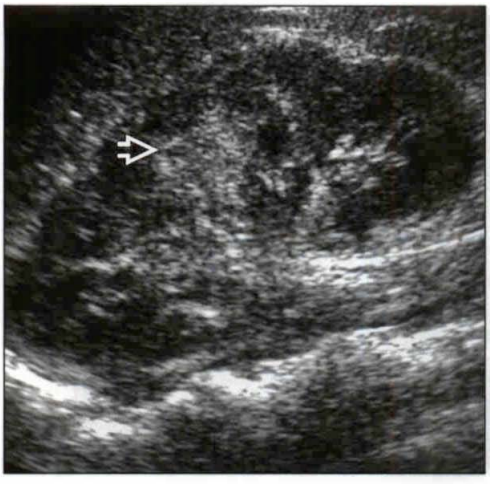
Tuberculosis, Urinary Tract



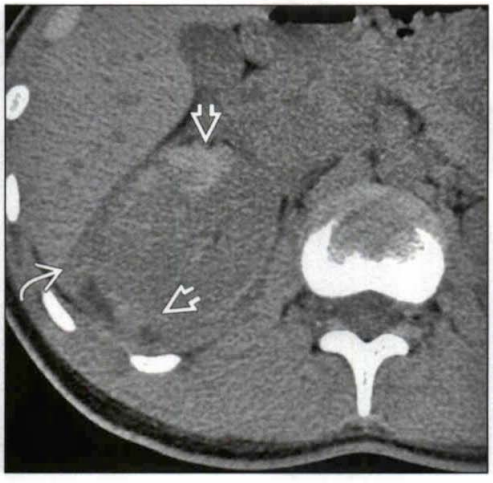
Renal Oncocytoma

(Left) *Transverse ultrasound shows a renal TB abscess with a calcified wall and internal echogenic debris. Abscess formation is secondary to stricture at the calyceal infundibulum.* ***(Right)*** *Longitudinal ultrasound shows a large, mildly hyperechoic mass within the right kidney. It has a spiculated, central hypoechoic scar. which is very suggestive of an onocytoma; however, a renal cell carcinoma cannot be excluded, and excision is required.*

Renal Trauma



Renal Trauma



(Left) *Longitudinal ultrasound shows a focal poorly-defined area of hyperechogenicity in the mid-pole of the right kidney compatible with a contusion. Note there is loss of corticomedullary differentiation at the mid-pole when compared with the lower pole.* ***(Right)*** *Axial NECT (same case as previous image) shows the hyperdense hemorrhagic contusions in the right kidney. There is also a small perinephric hematoma.*

RADIOLUCENT FILLING DEFECT, RENAL PELVIS

DIFFERENTIAL DIAGNOSIS

Common
- Urolithiasis
- Blood Clot
  - Trauma, Renal
  - Coagulopathic ("Retroperitoneal") Hemorrhage
- Fungus Ball
- Transitional Cell Carcinoma
- Gas in Collecting System
  - Emphysematous Pyelitis or Pyelonephritis
  - Instrumentation of Kidney
- Renal Papillary Necrosis

Less Common
- Renal Cell Carcinoma
- Foreign Bodies
- Papilloma
- Metastases and Lymphoma, Renal

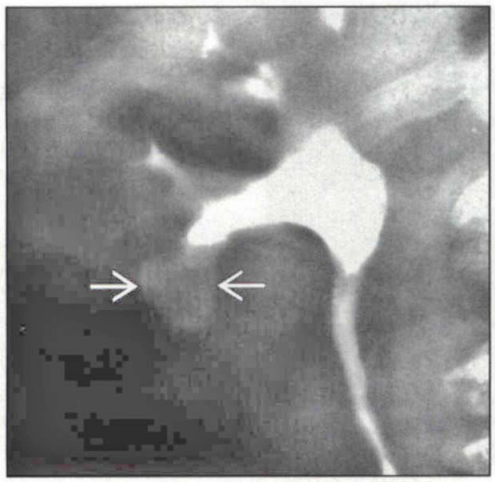
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Usually easier to characterize the attenuation of filling defects by CT; urography (excretory, retrograde, or CT) best for complete evaluation

Helpful Clues for Common Diagnoses
- **Urolithiasis**
  - Many calculi (especially uric acid and xanthine) are radiolucent by radiography but very dense on CT and easy to distinguish from other etiologies
  - Indinavir stones are lucent on CT
- **Blood Clot**
  - Should lyse and dissolve within days
- **Fungus Ball**
  - Usually in debilitated, elderly patients
- **Transitional Cell Carcinoma**
  - Irregular filing defect; "amputates" calices
- **Gas in Collecting System**
  - Iatrogenic: Ureteral stent, nephrostomy
  - Emphysematous pyelitis: Gas, infection limited to urine
- **Renal Papillary Necrosis**
  - Sloughed papilla with cavitation of adjacent calyx; "club-shaped" calices
  - Associated with analgesic abuse

Helpful Clues for Less Common Diagnoses
- **Renal Cell Carcinoma**
  - RCC: May protrude into pelvis or cause hemorrhage as filling defect
  - Expansile mass usually evident on CT
- **Foreign Bodies**
  - Pieces of nephrostomy or ureteral stent
  - Usually radiopaque
- **Papilloma**
  - Benign soft tissue, uroepithelial neoplasm
  - No renal parenchymal mass
  - Other rare tumors may have similar appearance
    - Fibroepithelial polyp, lipoma, fibroma

Urolithiasis



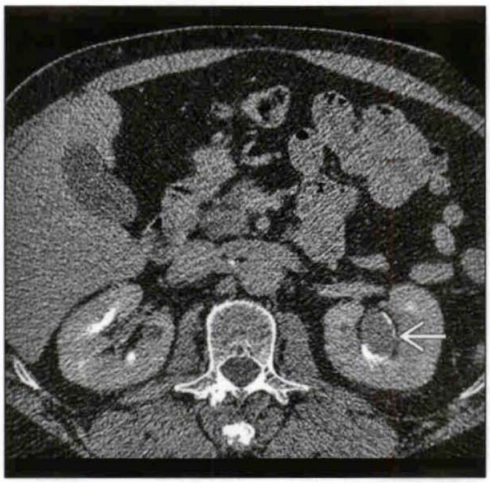
Excretory urography shows a radiolucent filling defect ➡ in the lower pole calices & infundibulum. CT showed this as a calculus (uric acid); 35 year old man with microhematuria and hyperuricemia.

Blood Clot

Axial CECT shows heterogeneous blood filling the left renal pelvis ➡: spontaneous renal hemorrhage in a patient receiving heparin anticoagulant therapy.

RADIOLUCENT FILLING DEFECT, RENAL PELVIS

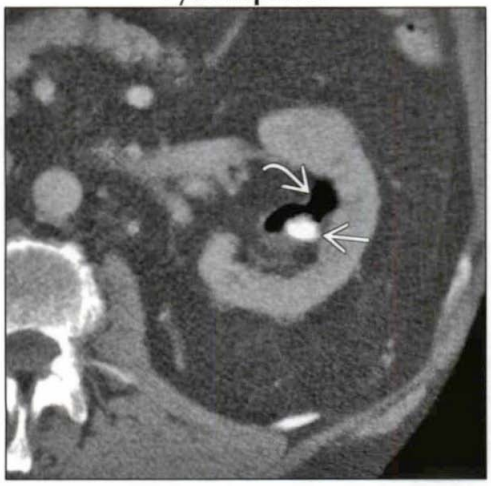
Transitional Cell Carcinoma



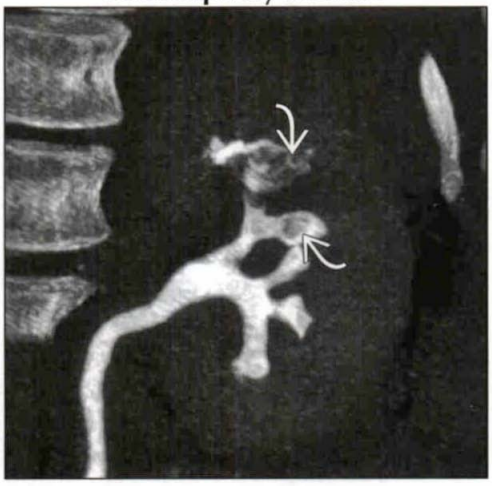
Transitional Cell Carcinoma

*(**Left**) Axial CECT shows a soft tissue density filling defect in the renal pelvis on this excretory (pyelographic) phase image. (**Right**) Coronal CECT shows an irregular filing defect within the upper pole calices and infundibulum in an elderly man with persistent hematuria, but no coagulopathy.*

Emphysematous Pyelitis or Pyelonephritis

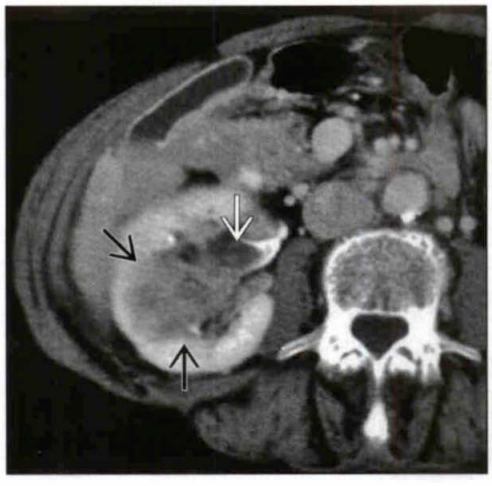


Renal Papillary Necrosis



*(**Left**) Axial CECT shows gas within the renal pelvis, but not in the parenchyma in this elderly man with emphysematous pyelitis and a renal stone. (**Right**) Coronal CECT shows filling defects within the upper pole calices, representing sloughed papillae (and, possibly, hemorrhage) in this patient with papillary necrosis due to sickle cell anemia.*

Renal Cell Carcinoma



Papilloma

*(**Left**) Axial CECT shows a heterogeneous hypervascular renal cell carcinoma that extends into the renal pelvis. A transitional cell carcinoma could have a similar appearance, but this lesion also extended into the renal vein, which would be unusual for TCC. (**Right**) Excretory urography shows a subtle, but persistent filling defect in the lower pole infundibulum in a 21 year old man with hematuria; benign papilloma.*

SECTION 16
Ureter

Generic Imaging Patterns

Ureteral Filling Defect or Stricture 16-2
Cystic Dilation of Distal Ureter 16-6

URETERAL FILLING DEFECT OR STRICTURE

DIFFERENTIAL DIAGNOSIS

Common
- Urolithiasis (Calculi)
- Ureteral Blood Clot
- Ureteral Air Bubbles
- Post-Operative Ureteral Stricture
- Transitional Cell Carcinoma

Less Common
- Vascular Impression
- Diverticulitis
- Ureteral Metastases or Direct Invasion
  - Colon Carcinoma
  - Cervical Cancer, Stage IIB-IVB
  - Lymphoma
- Crohn Disease
- Endometriosis
- Infectious Stricture
- Ureteritis Cystica
- Ureteral Papilloma
- Ureteral Fibroepithelial Polyp

Rare but Important
- Mesenchymal Tumor, Ureter
- Ureteral Valves
- Congenital Ureteral Stenosis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- In order of frequency: Stones > clot > air bubbles > tumor
  - All have characteristic features that allow identification in most cases
  - Need to correlate with clinical information
    - e.g., known or prior history of pelvic or renal malignancy
    - Check for recent instrumentation (may explain air bubbles or blood clot within ureter)
  - CT gives best information about extrinsic processes that may involve the ureters
    - e.g., pelvic tumors or inflammatory processes
    - CT also definitive for ureteral calculi
    - CT urography has replaced IV urography ("IVP") for almost all indications
  - Retrograde pyelography still essential for best depiction of ureteral lumen pathology
    - Also allows brush biopsy of urothelial tumors
    - Also essential for placement of ureteral stents for therapy

Helpful Clues for Common Diagnoses
- **Urolithiasis (Calculi)**
  - CT: Hyperdense (> 200 HU) focus with hydronephrosis, perinephric stranding
  - "Rim sign": Ureteral wall edema creates a soft tissue rim around stone
    - Helps to differentiate from a phlebolith
    - May not be present with large stones (wall is stretched too thin)
  - Stone may appear hypodense relative to contrast-opacified urine
    - On IV urography, retrograde or antegrade pyelography
- **Ureteral Blood Clot**
  - 50-90 HU, no enhancement
  - "Stipple sign" on pyelogram
  - May be encountered in any patient with hematuria who has a pyelogram
  - Resolves on follow-up studies
- **Ureteral Air Bubbles**
  - Mobile, do not elevate epithelium
  - Commonly seen on retrograde or antegrade pyelograms
    - e.g., patient with a nephrostomy catheter or ureteral stent
- **Post-Operative Ureteral Stricture**
  - Following many forms of abdominal or pelvic surgery
    - Gynecologic or obstetric
    - Hysterectomy and Caesarian section are the most common
    - Colon resection
    - Retroperitoneal dissection of nodes (e.g., testicular, cervical, prostatic carcinoma; lymphoma)
  - Ureter may be ligated, transected, or suffer ischemic stricture
    - Ureteral vascular supply from numerous short, fragile vessels, easily disrupted in course of surgery
- **Transitional Cell Carcinoma**
  - Fixation of ureter with irregular narrowing of lumen, non tapering margins
  - Smooth or frond-like surface ("stipple sign")
  - "Goblet" or "champagne glass" sign
    - Cup-shaped contrast collection distal to filling defect on retrograde pyelography

- This sign may be evident on IV or CT urography as well
- Implies distention & partial obstruction of the ureteral lumen by a mass

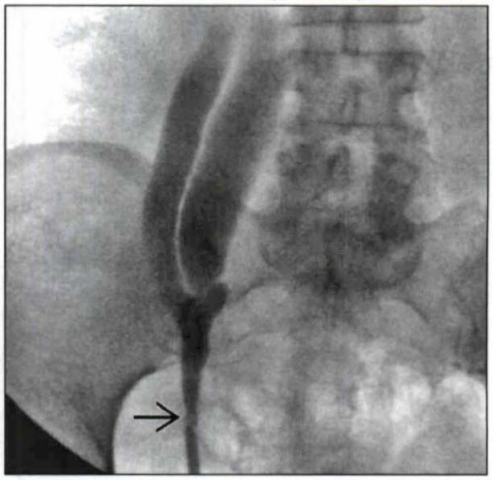
Helpful Clues for Less Common Diagnoses

- **Vascular Impression**
  - By artery, vein or lymphatic
  - Look for aneurysm, collateral vessels
  - Vascular impressions are common in renal anomalies, such as ectopic or horseshoe kidney
    - Supernumerary vessels often cross, and may obstruct collecting system
- **Diverticulitis**
  - Inflammatory process may cause spasm, stricture or even coloureteral fistula
  - Patients may present with pyuria and flank pain more than typical symptoms of diverticulitis
- **Ureteral Metastases or Direct Invasion**
  - Direct invasion by adjacent tumor is more common
    - Colon and cervical carcinoma most common
  - Hematogenous metastases generally appear as intramural masses
    - Primary sites include lung, breast and GI tract
  - Consider lymphoma if there is smooth circumferential wall thickening
    - Often see adenopathy elsewhere
- **Crohn Disease**
  - Inflammation may extend to ureter with stricture or spasm
  - Right ureter affected more commonly, since terminal ileum is most common site of bowel involvement
- **Endometriosis**
  - Involves ureter below the pelvic brim
  - Compression from adjacent disease (80%), involvement of ureter wall or lumen (20%)
  - May also involve dome of bladder
- **Infectious Stricture**
  - TB causes multiple findings including irregularity, intraluminal filling defects, ulcerations and strictures
    - Kidney and renal pelvis also generally involved
  - Schistosomiasis more often involves distal ureter and bladder
    - Calcifications common
- **Ureteritis Cystica**
  - Multiple subepithelial cysts in ureter wall
  - Usually in proximal ⅓ of ureter
  - Smooth small nodular filling defects (< 5 mm)
- **Ureteral Papilloma**
  - Most common benign tumor of ureter
  - Soft, usually in distal ½ of ureter
- **Ureteral Fibroepithelial Polyp**
  - Usually seen in children & young adults
  - Usually in proximal ½ of ureter
  - Thick core of loose fibrous tissue beneath normal urothelium
  - May appear as a long pedunculated filling defect

Urolithiasis (Calculi)

Excretory urography shows a tight stricture at the right UPJ with dilation of the upper pole calices. This was the result of multiple episodes of renal calculi treated with lithotripsy.

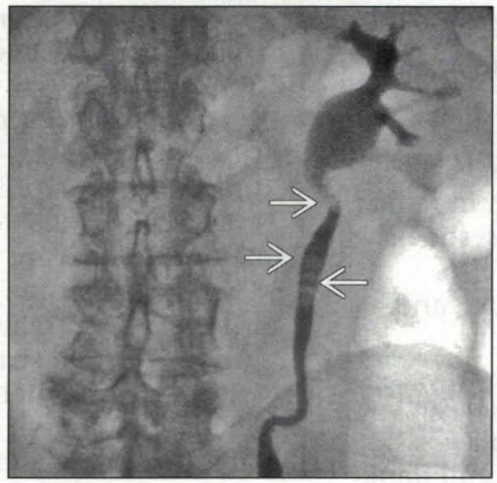
Urolithiasis (Calculi)



Retrograde pyelogram shows a filling defect (stone) causing obstruction of the ureter. The ureter is bifid (duplicated) above the point of obstruction with dilation of both components.

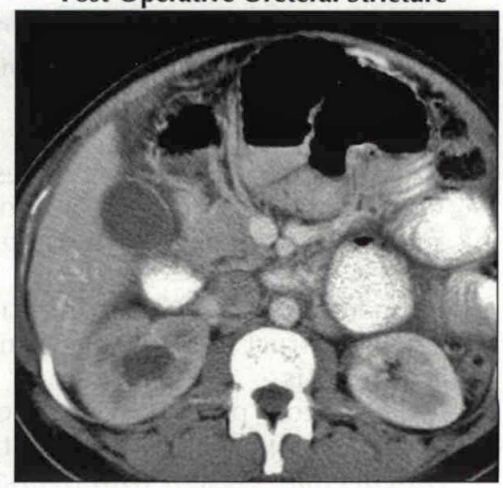
URETERAL FILLING DEFECT OR STRICTURE

Ureteral Air Bubbles

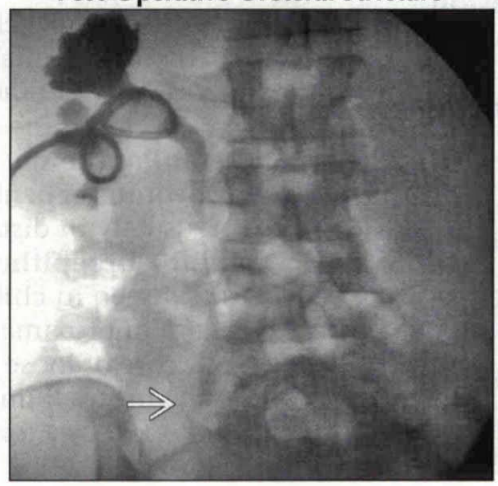


(Left) Retrograde pyelogram shows multiple mobile filling defects ➡ in the ureter. These are usually easy to recognize at fluoroscopy but may be more difficult to distinguish from other filling defects on static films. ***(Right)*** *Axial CECT shows a delayed right nephrogram and hydronephrosis in a young woman who recently had a Caesarian section delivery, complicated by a ureteral stricture.*

Post-Operative Ureteral Stricture

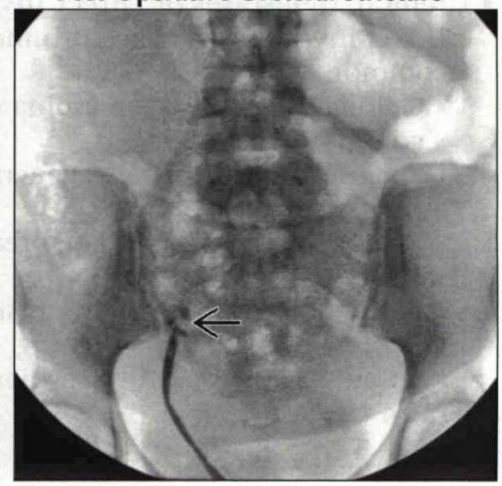


Post-Operative Ureteral Stricture



(Left) Antegrade pyelography shows the complete obstruction of the pelvic ureter ➡ in the same young woman who had a ureteral stricture following Caesarian section. ***(Right)*** *Retrograde pyelogram shows complete obstruction of the pelvic ureter ➡ as a result of a complication from Caesarian section.*

Post-Operative Ureteral Stricture



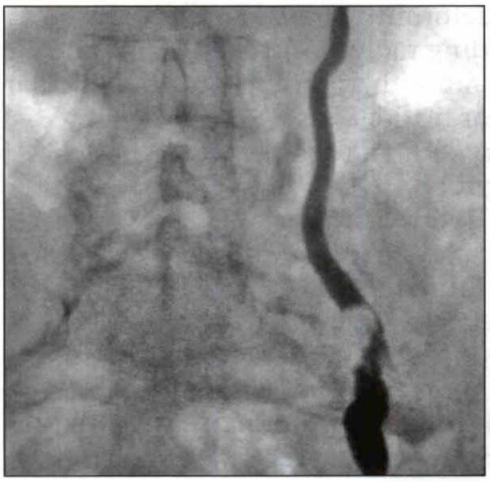
Transitional Cell Carcinoma

(Left) Coronal CT urography shows a soft tissue density mass ➡ that expands and partially obstructs the ureteral lumen. Note the goblet sign of TCC in this 63 year old man. ***(Right)*** *Axial CECT shows the irregular intraluminal mass that expands and partially obstructs the distal ureter ➡ in the same patient.*

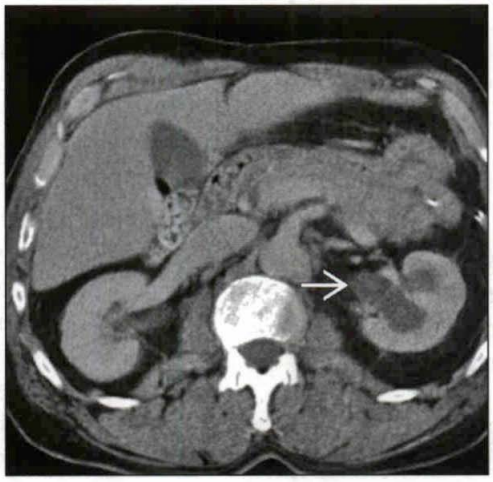
Transitional Cell Carcinoma

URETERAL FILLING DEFECT OR STRICTURE

Transitional Cell Carcinoma

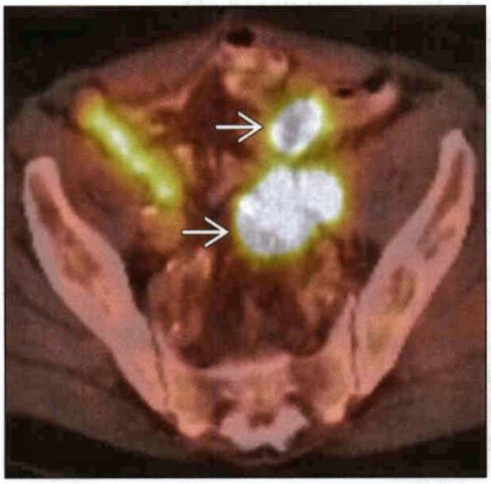


Colon Carcinoma

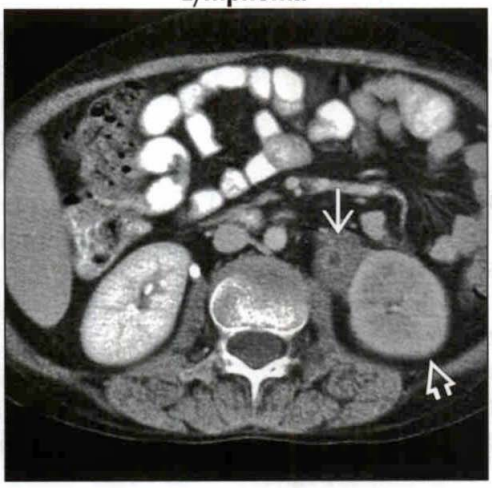


(Left) Retrograde pyelogram shows partial obstruction of the ureteral lumen by a mass that has both smooth and irregular surface components. Brush biopsy revealed transitional cell carcinoma. (Right) Axial CECT shows a delayed nephrogram and dilated collecting system of the left kidney, due to ureteral encasement by colon cancer; 66 year old man.

Colon Carcinoma

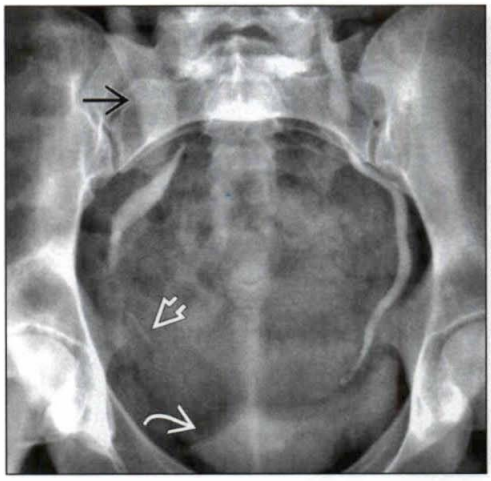


Lymphoma

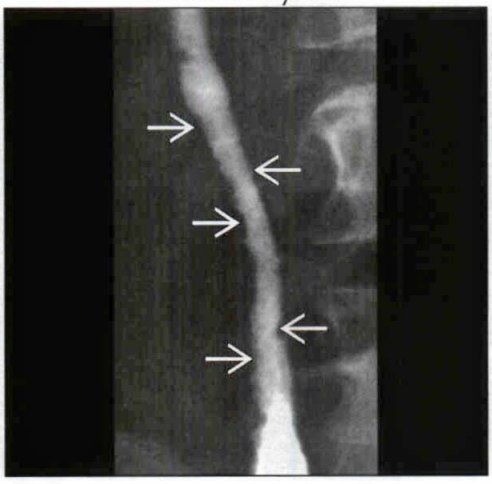


(Left) Axial PET CT image shows an FDG-avid pelvic mass that encased and obstructed the left ureter; colon carcinoma in a 66 year old man. (Right) Axial CECT shows marked circumferential thickening of the left ureter. This was causing obstruction and subsequently a delayed nephrogram.

Endometriosis



Ureteritis Cystica



(Left) Excretory urography in a woman with known endometriosis shows irregular narrowing of the distal right ureter and dome of the bladder. This tight stricture was causing hydronephrosis. The distal ureter was resected and endometriosis confirmed at histology. (Right) Retrograde pyelogram shows a "bubbly" appearance of the ureter with multiple, small, smooth filling defects indenting the lumen.

CYSTIC DILATION OF DISTAL URETER

DIFFERENTIAL DIAGNOSIS

Common
- Ureteral Obstruction
  - Stone
  - Tumor
- Ectopic Ureter
- Ureterocele
- Bladder Diverticulum

Less Common
- Seminal Vesicle Cyst (Mimic)
- Gartner Duct Cyst (Mimic)
- Congenital Megaureter
- Congenital Ureteral Stricture

ESSENTIAL INFORMATION

Helpful Clues for Common Diagnoses
- Try to identify "ureteral jet", turbulent flow from unobstructed ureteral orifice
- **Ureteral Obstruction**
  - Urolithiasis > bladder tumor > ureteral tumor
  - CT and MR superior to US
- **Ectopic Ureter**
  - 70-80% associated with complete ureteral duplication
  - Prostatic urethra most common insertion site in male
  - Urethra or vestibule most common insertion site in female
  - Complete duplication
    - Ectopic ureter drains upper pole moiety
- **Ureterocele**
  - Cystic dilation of distal ureter with prolapse into bladder lumen
  - Orthotopic: "Cobra-head" or "spring onion" deformity of distal ureter with surrounding radiolucent halo
  - Ectopic: Smooth, radiolucent intravesicular mass near bladder base
  - Excretory or CT urography is the best imaging tool
- **Bladder Diverticulum**
  - Perivesical cystic mass with connection to bladder lumen
  - Near ureterovesical junction
  - Color Doppler: Color jet connecting to bladder very useful to distinguish diverticulum from other paravesical masses
  - May contain stones, debris, or tumor

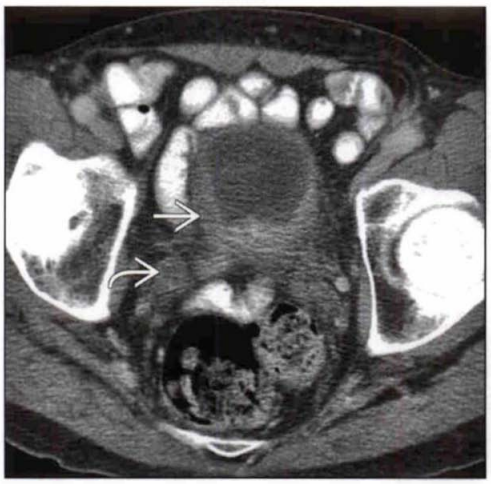
Helpful Clues for Less Common Diagnoses
- **Seminal Vesicle Cyst (Mimic)**
  - Associated with renal agenesis
- **Gartner Duct Cyst (Mimic)**
  - Inclusion cyst in lateral wall of vagina, remnant of mesonephric duct
- **Congenital Megaureter**
  - Rare congenital anomaly
  - Favors dilation of distal ureter, all of ureter + even real pelvis + calices may be dilated
  - Renal function usually normal
- **Congenital Ureteral Stricture**
  - Distal congenital obstruction most commonly at ureterovesicle junction
    - Not as common as ureteropelvic junction obstruction

Sagittal ultrasound shows dilation of distal right ureter ⇨ due to bladder carcinoma, in a 65 year old woman.

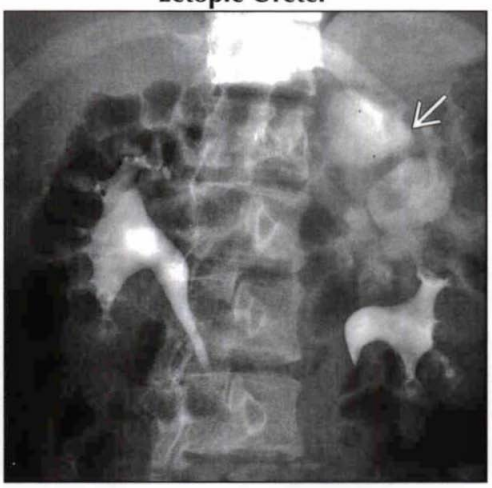
Axial ultrasound in the same patient shows the mass ➡ within the bladder that straddles the ureterovesical junction and obstructs the ureter ⇨.

CYSTIC DILATION OF DISTAL URETER

Tumor

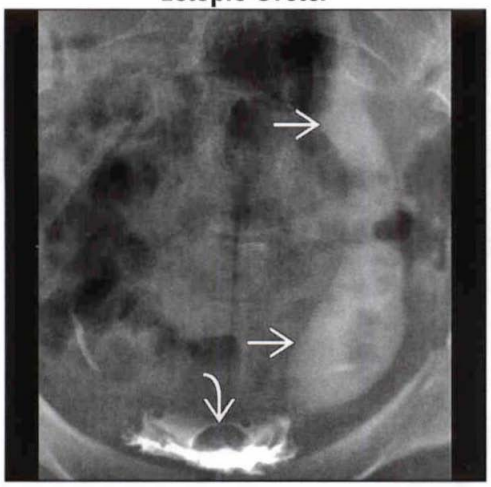


Ectopic Ureter

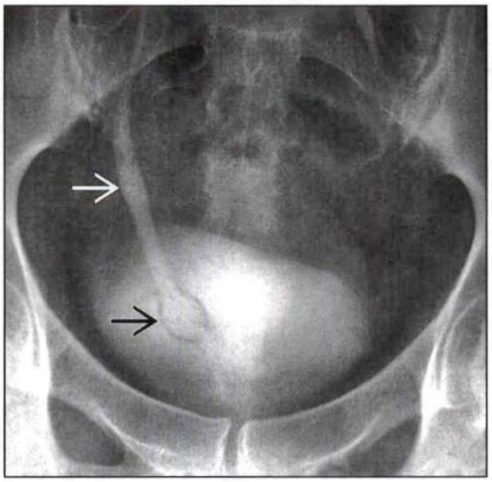


(Left) Axial CECT shows asymmetric thickening of the bladder wall due to carcinoma, with obstructive dilation of the distal right ureter in a 75 year old man. (Right) Oblique excretory urography shows the "drooping lily" sign in a 19 year old girl. Note that the lower pole calices of the left kidney are displaced downward by the hydronephrotic upper pole collecting system. The duplicated upper pole ureter had an ectopic insertion with obstruction.

Ectopic Ureter

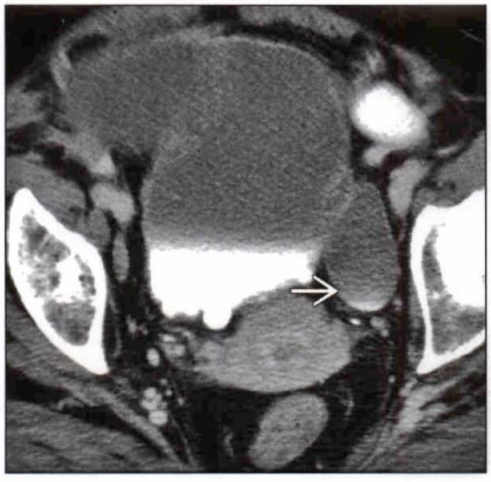


Ureterocele

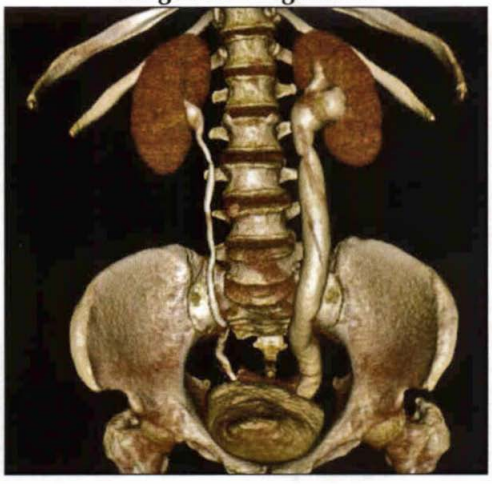


(Left) Frontal excretory urography shows massive dilation of the upper pole ureter with a bulbous insertion seen as a filling defect in the bladder floor. (Right) Frontal excretory urography shows a right-sided simple ureterocele with dilation of the ureter.

Bladder Diverticulum



Congenital Megaureter



(Left) Axial CECT shows a left-sided bladder diverticulum with delayed and only partial contrast opacification of the dependent urine within it. This might be confused with a dilated ureter or even a cystic pelvic mass. (Right) Coronal CECT shows diffuse dilation of the left ureter and calices in a 55 year old woman with repeated urinary tract infections, but no reflux. Note the absence of renal scarring or decreased function.

SECTION 17
Bladder

Generic Imaging Patterns

Filling Defect in Urinary Bladder	17-2
Urinary Bladder Outpouching	17-8
Gas within Urinary Bladder	17-10

FILLING DEFECT IN URINARY BLADDER

DIFFERENTIAL DIAGNOSIS

Common

- Bladder Carcinoma
- Bladder Calculi
- Ureterocele
- Blood Clot
- Benign Prostatic Hypertrophy
- Diverticulitis
- Bladder Fistulas
- Foreign Body, Bladder
- Extravesical Pelvic Mass
  - Prostate Carcinoma
  - Rectal Carcinoma
  - Cervical Carcinoma
  - Endometrioma
- Cystitis
  - Emphysematous Cystitis

Less Common

- Urachal Carcinoma
- Inverted Papilloma, Bladder
- Inflammatory Pseudotumor or Sarcoma
- Mesenchymal Tumors, Bladder
- Pheochromocytoma

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues

- Mobility, location, and shape of lesion suggest the diagnosis or limit the differential
  - Enhancement of lesion = neoplastic or inflammatory, excludes calculi, blood clot, debris
  - Cystoscopy and biopsy often necessary
  - Chronic inflammation of bladder leads to clinical and imaging features that are difficult to distinguish from neoplastic disease without cystoscopy & biopsy

Helpful Clues for Common Diagnoses

- **Bladder Carcinoma**
  - Sessile or pedunculated soft tissue mass projecting into the lumen
  - Similar density to bladder wall on CECT
  - Can never exclude cancer by imaging
    - Patient with unexplained hematuria requires cystoscopy
- **Bladder Calculi**
  - Smooth round or ovoid; can be spiculated ("jack stone"), laminated or faceted
  - US: Mobile, echogenic, shadowing foci
  - Most are radiopaque on plain films; all on CT
- **Ureterocele**
  - Orthotopic: "Cobra-head" or "spring onion" deformity of distal ureter with surrounding radiolucent halo
  - Ectopic: Smooth, radiolucent intravesicular mass near bladder base
- **Blood Clot**
  - US: Mobile mass, does not cast an acoustic shadow
  - Attenuation value in the range of 50-60 HU, no enhancement on CECT
- **Benign Prostatic Hypertrophy**
  - Displaces the floor of the bladder cephalad
  - Classic finding on urography is upward deviation of distal ureters
    - "J-shaped" ureters
  - Often accompanied by clinical symptoms of dysuria and hematuria, raising concern for bladder cancer
    - Trabeculation of bladder wall from chronic outlet obstruction may also simulate signs of bladder cancer
    - Cystoscopy usually necessary for definitive diagnosis
- **Diverticulitis**
  - Commonly causes inflammatory thickening of adjacent wall of bladder
  - Abscess arising from sigmoid diverticulitis especially prone to involve bladder
  - May give rise to colovesical fistula (most common cause in industrialized countries)
- **Bladder Fistulas**
  - Enterovesical: Gas in bladder; bladder ± adjacent bowel wall thickening
    - Diverticulitis most common cause
    - Other causes include Crohn disease, radiation (cystitis &/or enteritis), carcinomas of bladder, bowel or other pelvic viscera, especially after radiation therapy
  - Vesicovaginal: Contrast-opacified urine opacifies vagina
- **Foreign Body, Bladder**
  - Bladder catheter ("Foley") is extremely common in hospitalized patients
  - Next most common cause is introduction during autoeroticism or child abuse
    - Pieces of catheters, hairs, sutures, and other causes are recognized

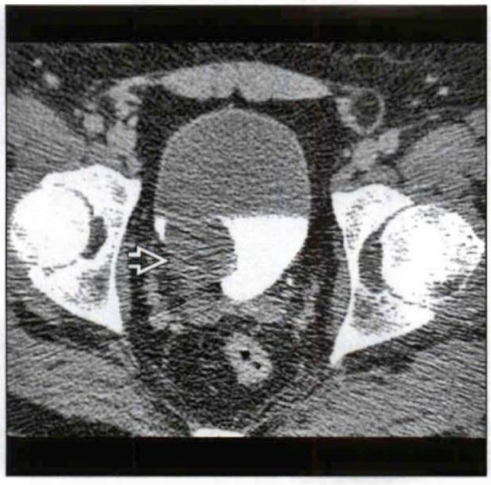
- Can become a nidus for calcification

- **Extravesical Pelvic Mass**
  - Any neoplastic (or inflammatory) process arising in pelvis can indent or invade the bladder
    - Neoplastic examples: Carcinoma of prostate, rectum, cervix
    - Inflammatory: Endometriosis, pelvic abscess
- **Prostate Carcinoma**
  - Mass effect of tumor may indent bladder floor similar to BPH
  - Tumor may invade bladder, causing intramural or even intraluminal mass
- **Cystitis**
  - Many causes
    - Infectious: Bacterial, viral, fungal, parasites (Schistosoma hematobium)
    - Medication induced: Chemotherapy, especially with cyclophosphamide (Cytoxan); antibiotics
    - Interstitial (idiopathic); urine is sterile
    - Eosinophilic: May cause "pseudotumoral cystitis", especially in children
    - Radiation therapy
- **Emphysematous Cystitis**
  - Most commonly seen in patients with long standing & poorly controlled diabetes mellitus
  - Caused by bacterial fermentation of glucose in urine or uroepithelium
    - Can release gas (carbon dioxide) within bladder lumen and/or wall
    - Gas limited to lumen is difficult to recognize on radiography, & cause is more often iatrogenic (catheterization)

Helpful Clues for Less Common Diagnoses

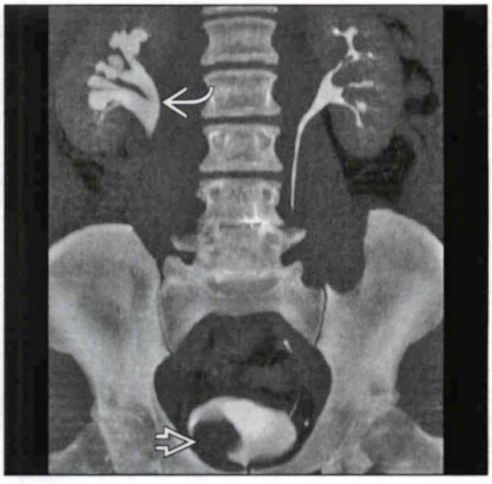
- **Urachal Carcinoma**
  - Mass ± calcification extending up from dome of bladder toward umbilicus
  - Infected urachal cyst may have similar appearance
- **Inverted Papilloma, Bladder**
  - May arise in bladder (or ureter or renal pelvis)
  - Usually small sessile or pedunculated mass
- **Inflammatory Pseudotumor or Sarcoma**
  - Pseudotumor is also known as myofibroblastic tumor
  - Sarcoma has worse prognosis, but difficult to distinguish between these lesions on imaging or pathology (gross or microscopic)
  - Usual appearance is vascular, bulky mass in patient with gross hematuria
- **Pheochromocytoma**
  - May arise in pelvis, even within wall of bladder
  - May be accompanied by symptoms of headache & palpitations on urination

Bladder Carcinoma



Axial CECT shows a large mass in the bladder near the trigone that was causing hematuria and ureteral obstruction in this 69 year old man.

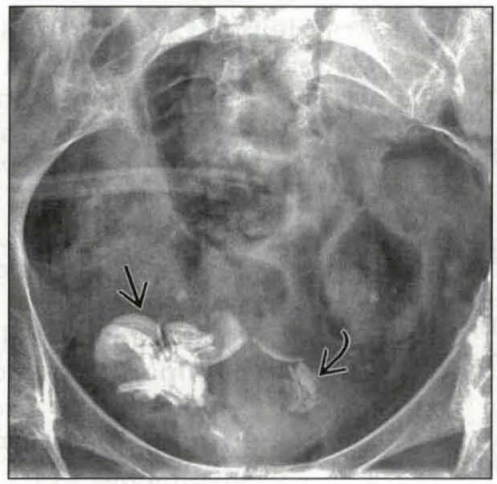
Bladder Carcinoma



Coronal CECT shows the large mass in the bladder near the trigone with right-sided hydronephrosis in the same patient.

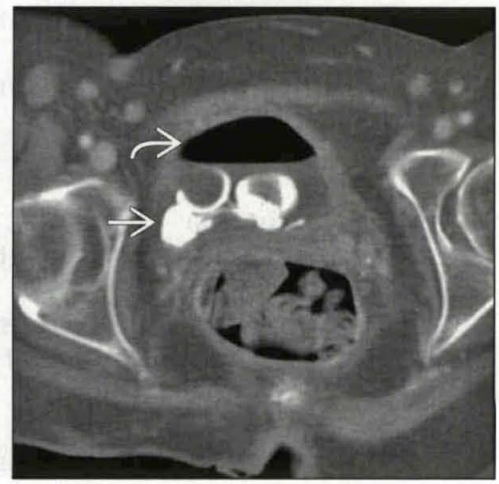
FILLING DEFECT IN URINARY BLADDER

Bladder Calculi

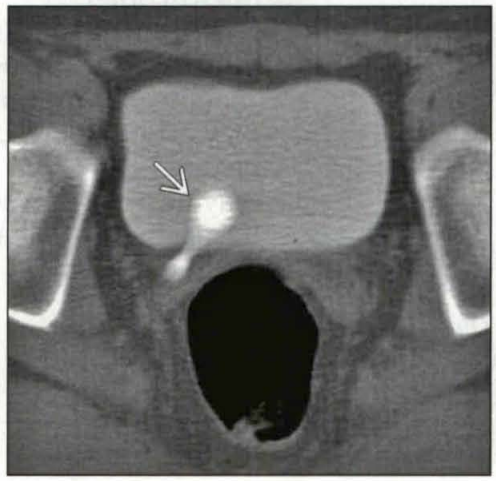


(Left) Frontal radiograph shows multiple calcified bladder stones, some rounded ⇨ and others irregular in shape ⇨. This young woman had paraplegia and repeated, chronic bladder infections.
***(Right)** Axial CECT shows multiple calcified stones ⇨ and gas ⇨ within the urinary bladder of the same patient. Repeated urinary infections are a predisposing cause for calculi.*

Bladder Calculi

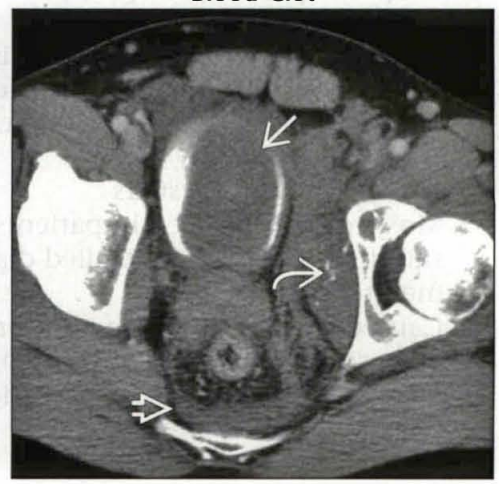


Ureterocele

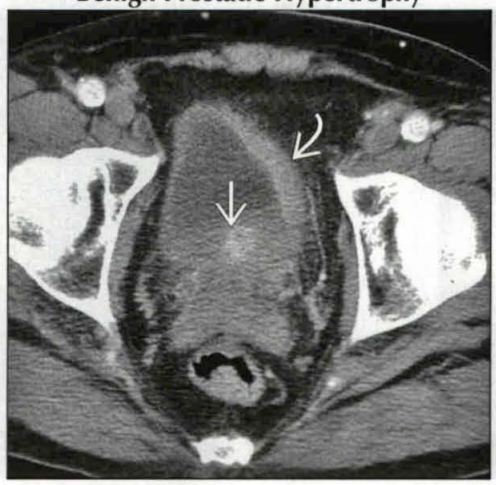


(Left) Axial CECT shows a simple, orthotopic ureterocele ⇨ with a "spring onion" shape at the right ureterovesical junction. The ureterocele is filled with contrast-opacified urine on this excretory phase image.
***(Right)** Axial CECT shows a large filling defect ⇨ within the bladder that represents blood clot, following a gunshot wound to the pelvis. Note bone fragments ⇨ and extraperitoneal pelvic hemorrhage ⇨.*

Blood Clot

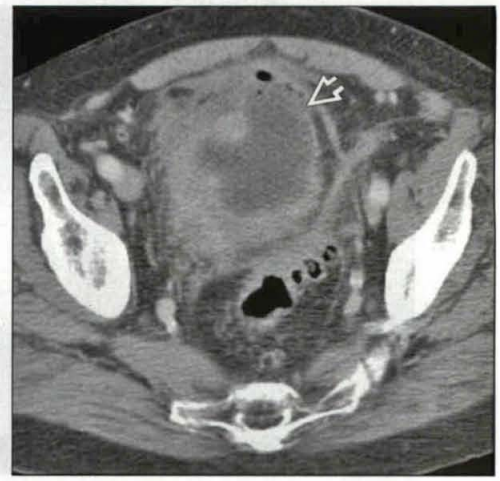


Benign Prostatic Hypertrophy



(Left) Axial CECT shows hypertrophy of the median lobe of the prostate ⇨ that indents the postero-inferior bladder wall. The bladder wall is also thickened ⇨ due to bladder outlet obstruction, although the asymmetry raised a concern for prostate or bladder carcinoma.
***(Right)** Axial CECT shows a large abscess ⇨ arising from perforated sigmoid diverticulitis, that abutted the dome of the bladder and led to marked bladder wall thickening simulating a bladder wall mass.*

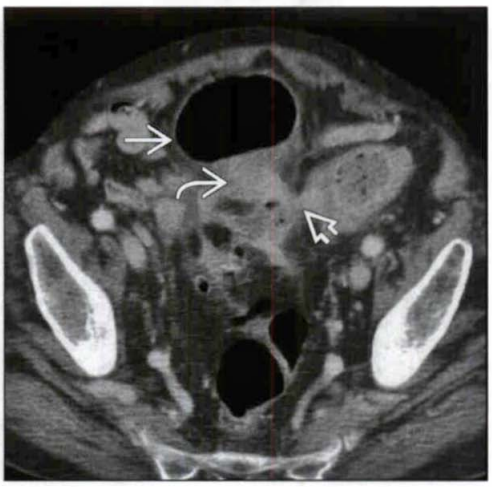
Diverticulitis



FILLING DEFECT IN URINARY BLADDER

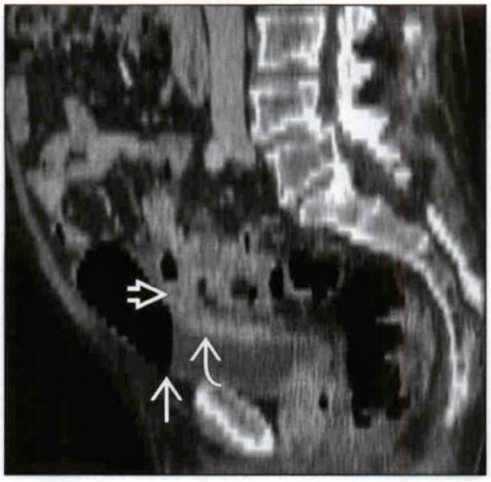
Diverticulitis

Bladder Fistulas



(Left) Axial CECT shows marked asymmetric thickening of the bladder wall adjacent to sigmoid diverticulitis with a pericolic and perivesical abscess, causing inflammation of the bladder wall & predisposing to colovesical fistula. (Right) Axial CECT shows intraluminal gas and mural thickening of the bladder with a fistula to the sigmoid colon, due to diverticulitis in an 80 year old man.

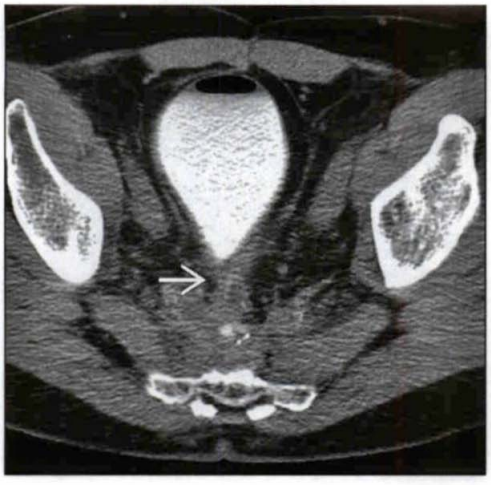
Bladder Fistulas



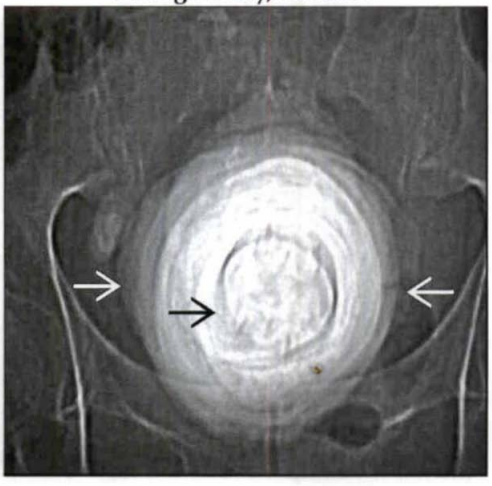
Bladder Fistulas

(Left) Sagittal CECT shows a gas-fluid level and mural thickening within the bladder, with a fistula to the sigmoid colon in the same patient. (Right) Axial NECT shows extravasation of contrast medium from the bladder through a fistula to the rectosigmoid colon at an anastomotic site, following a prior resection & radiation therapy for rectal carcinoma.

Bladder Fistulas



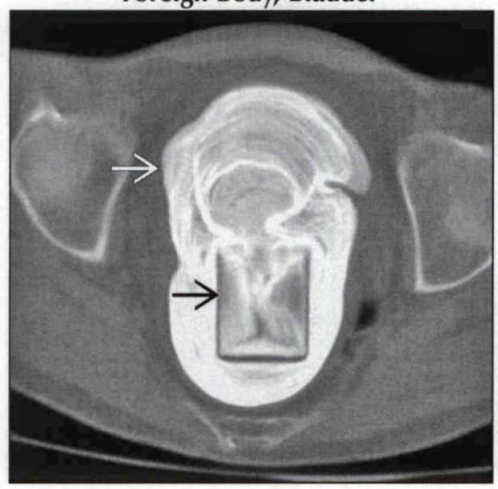
Foreign Body, Bladder



(Left) Axial NECT shows a deformed bladder with gas and a soft tissue density tract extending toward the rectum. Colovesical fistula due to rectal cancer that had been treated with low anterior resection and radiation therapy. (Right) Frontal radiograph shows a large, heavily calcified mass surrounding a foreign body, a glass bottle that had been inserted into the vagina months before, with erosion into the bladder and chronic urinary tract infections.

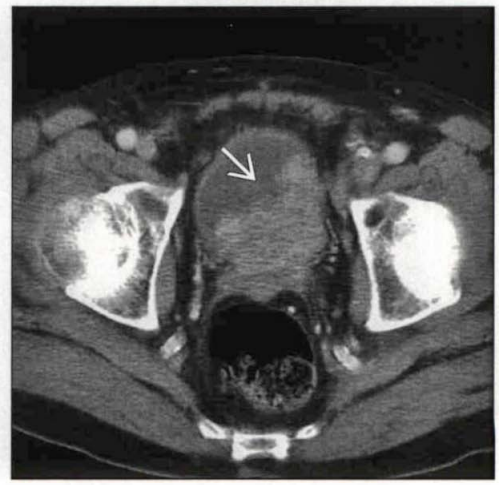
FILLING DEFECT IN URINARY BLADDER

Foreign Body, Bladder

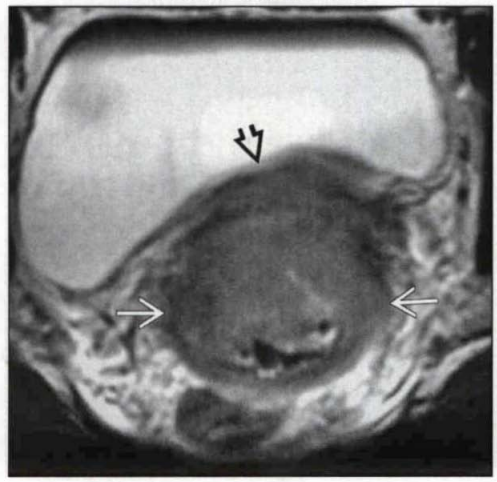


*(Left) Axial NECT shows a heavily calcified mass surrounding a foreign body (glass bottle) in the vagina that had eroded into the bladder causing chronic urinary infection; 38 year old woman. **(Right)** Axial CECT shows an eccentric mass arising from the prostate and indenting or invading the bladder, an unusually advanced and locally invasive form of prostate cancer.*

Prostate Carcinoma



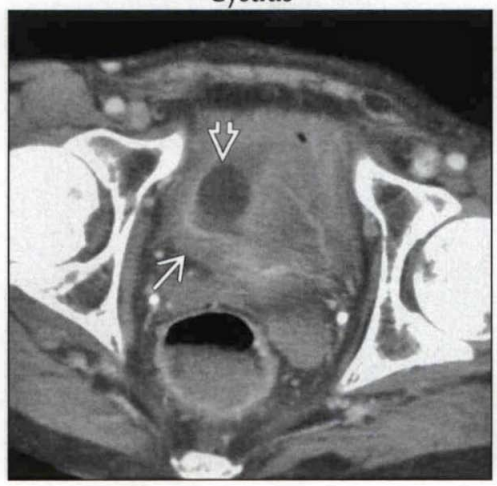
Cervical Carcinoma



*(Left) Axial T2WI MR shows a bulky cervical mass that invades the posterior wall of the bladder **(Right)** Sagittal T2WI MR shows a bulky mass of intermediate signal intensity that indents or invades the posterior wall of the bladder; stage IVa cervical carcinoma, subsequently treated with radiation therapy.*

Cervical Carcinoma

Cystitis

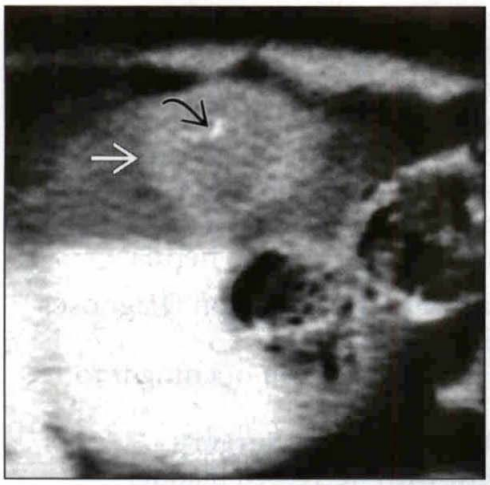


*(Left) Axial CECT shows a spherical water density Foley catheter bulb within the bladder, that has a markedly thickened and irregular wall due to chemotherapy-induced cystitis. **(Right)** Axial NECT shows gas within the lumen and wall of the urinary bladder. Some gas is suspended within particulate debris within the lumen; 80 year old woman with diabetes and emphysematous cystitis.*

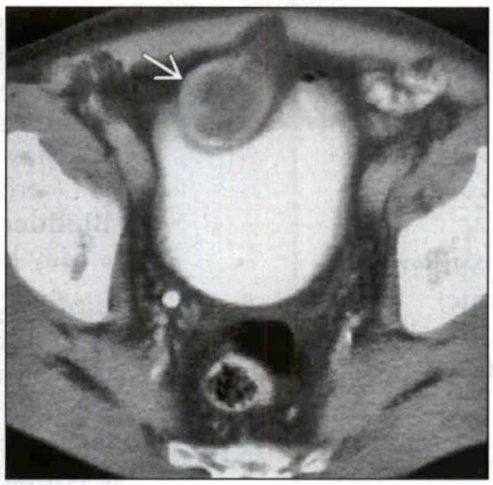
Emphysematous Cystitis

FILLING DEFECT IN URINARY BLADDER

Urachal Carcinoma

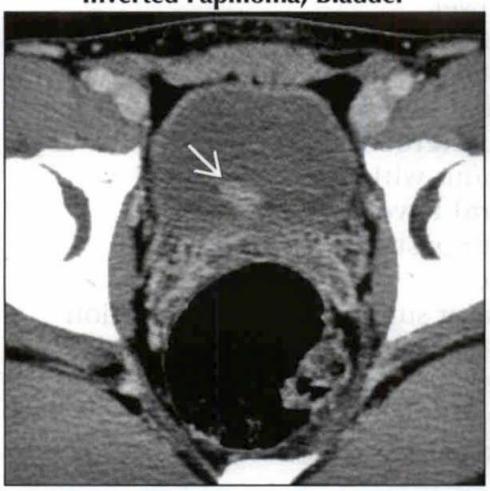


Urachal Carcinoma

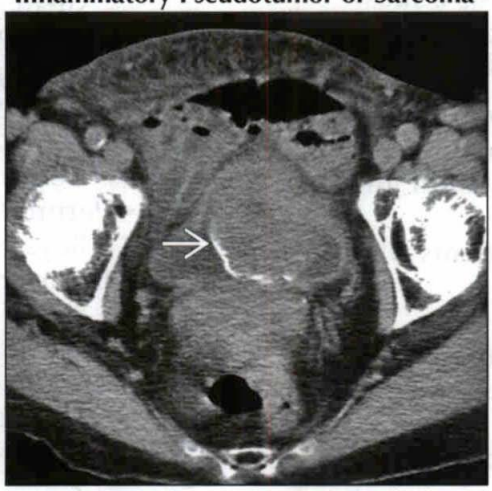


*(**Left**) Axial CECT shows a midline mass in the dome of the bladder with a tract to the umbilicus on more cephalic images. Note a calcific focus within the mass; 25 year old man with urachal adenocarcinoma. (**Right**) Axial CECT shows a heterogeneous, near-midline mass that indents the dome of the bladder; adenocarcinoma arising in a urachal remnant.*

Inverted Papilloma, Bladder

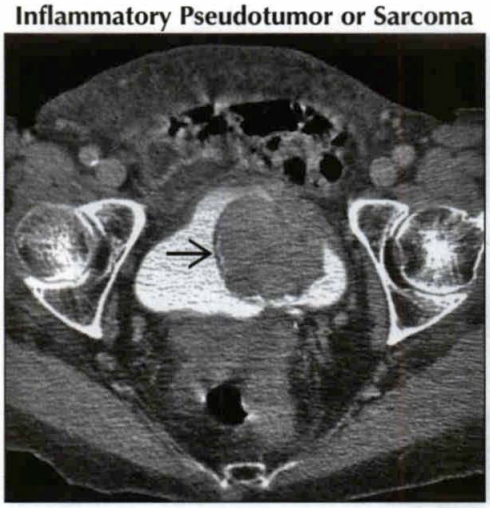


Inflammatory Pseudotumor or Sarcoma

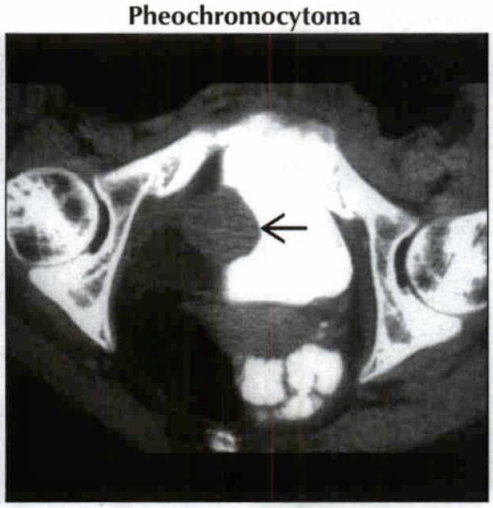


*(**Left**) Axial CECT shows a small polypoid mass arising from the posterior bladder wall; 18 year old boy with gross hematuria. (**Right**) Axial NECT shows a large mass in the bladder that has a calcified surface; 76 year old woman with inflammatory pseudotumor-sarcoma. Pathology findings are often equivocal in these cases.*

Inflammatory Pseudotumor or Sarcoma



Pheochromocytoma



*(**Left**) Axial CECT shows enhancement of a large bladder mass in this 76 year old woman. At surgery the mass was vascular & extremely firm and was very difficult to resect. It was interpreted as an inflammatory pseudotumor, though sarcoma could not be excluded. (**Right**) Axial CECT shows a soft tissue density mass in the wall of the urinary bladder. This patient had symptoms of excess catecholamine release with every emptying of the bladder.*

URINARY BLADDER OUTPOUCHING

DIFFERENTIAL DIAGNOSIS

Common
- Bladder Diverticulum
- Bladder Fistulas
- Neurogenic Bladder
- Bladder Trauma
- Bladder Herniation

Less Common
- Urachal Remnant
- Bladder Augmentation Surgery
- Cystic Pelvic Mass (Mimic)
- Everted Ureterocele
- Periureteral Diverticula
- Iatrogenic
- Urethral Diverticulum

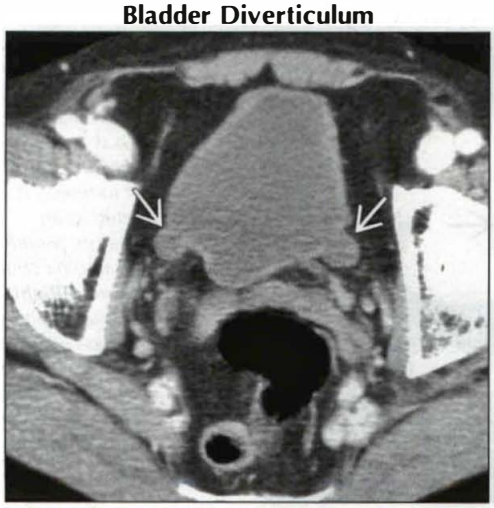
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Does cystic structure communicate with or just contact urinary bladder?

Helpful Clues for Common Diagnoses
- **Bladder Diverticulum**
  - Usually near ureterovesical junction; can be multiple and large
  - More common in patients with bladder outlet obstruction
- **Bladder Fistulas**
  - To bowel, colon, vagina, skin
  - Look for gas in bladder, thick wall
- **Neurogenic Bladder**
  - "Christmas tree" or "pine cone" shape
  - Pseudodiverticula or diverticula are common
- **Bladder Trauma**
  - Intraperitoneal rupture of dome: Surgical emergency
  - Extraperitoneal: Flame-shaped collection of extravasated urine
    - May extend beyond perivesical space (scrotum, thigh, retroperitoneum, etc.)
- **Bladder Herniation**
  - May herniate into inguinal hernia

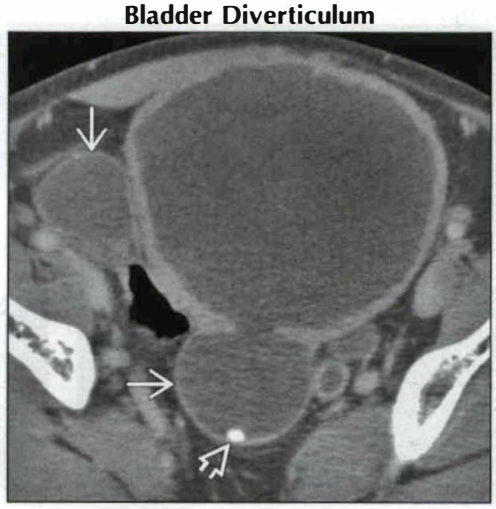
Helpful Clues for Less Common Diagnoses
- **Urachal Remnant**
  - Midline cystic collection opening into bladder dome
- **Bladder Augmentation Surgery**
  - For patient with decreased bladder capacity (e.g., neurogenic)
  - May anastomose segment of cecum or small bowel
- **Cystic Pelvic Mass (Mimic)**
  - Any cystic perivesical mass may mimic
  - Examples: Seminal vesicle or ovarian cyst
- **Everted Ureterocele**
  - Continuous with ureter
- **Periureteral Diverticula**
  - Boys with posterior urethral valve
- **Iatrogenic**
  - Site of prior suprapubic catheterization
- **Urethral Diverticulum**
  - Localized outpouching of urethra into anterior vaginal wall
  - Can lead to infection, calculi, carcinoma

Bladder Diverticulum



Axial CECT shows bilateral small diverticula ➡ near the ureteral orifices, probably representing congenital "Hutch" diverticula.

Bladder Diverticulum



Axial CECT shows multiple bladder diverticula, ■ one of which contains a stone ➡ that accounted for this patient's hematuria.

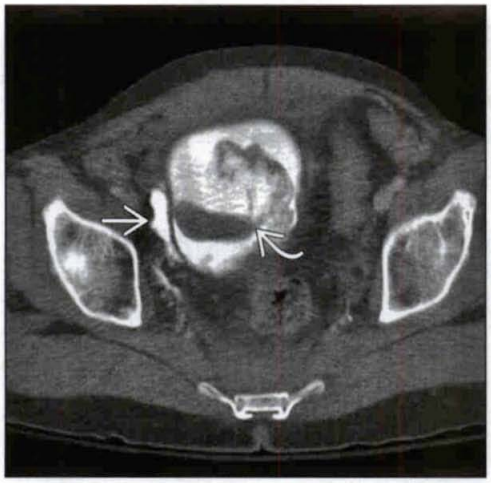
URINARY BLADDER OUTPOUCHING

Bladder Fistulas

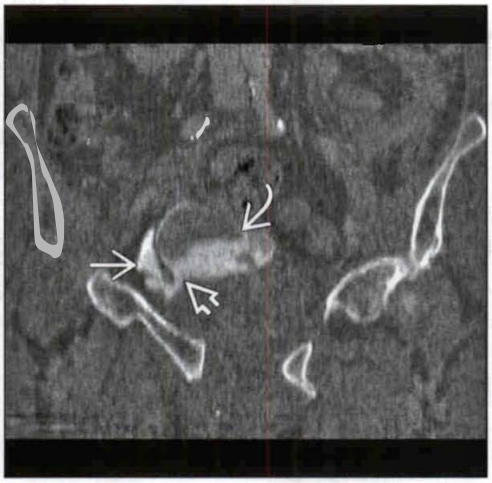
Neurogenic Bladder

*(Left) Axial CECT shows extravasation of contrast-opacified urine from the bladder ➡ into the vagina ➡; 71 year old woman with a vesico-vaginal fistula following hysterectomy. **(Right)** Frontal cystogram shows a classic "pine cone" or "Christmas tree" appearance of a neurogenic bladder; 20 year-old an with spina bifida.*

Bladder Trauma

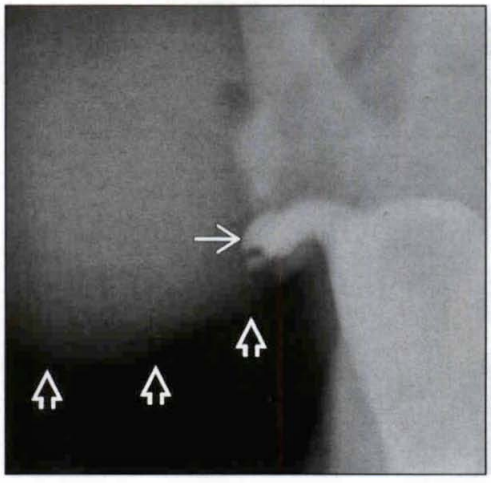


Bladder Trauma

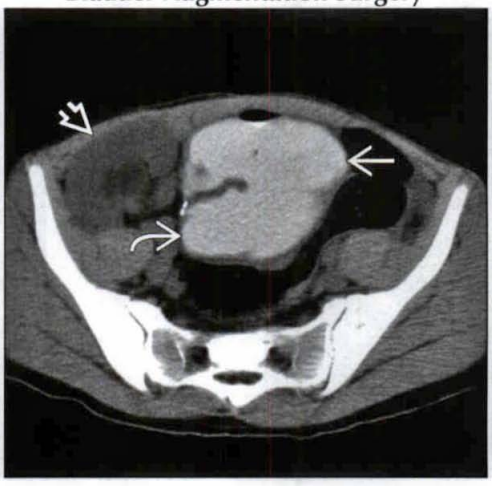


*(Left) Axial CECT shows an extraperitoneal collection of opacified urine ➡ due to pelvic fractures in a 63 year old man. Note clot within bladder ➡. **(Right)** Coronal CECT shows extraperitoneal rupture of the bladder with a collection of opacified urine ➡ collecting next to the bladder. Note site of rupture ➡ & blood clot in ➡ bladder; 63 year old man with pelvic fractures.*

Urachal Remnant



Bladder Augmentation Surgery



*(Left) Lateral voiding cystourethrogram shows an outpouching of the dome of the bladder ➡ that extends toward the umbilicus in this 8 year old boy with an unrepaired omphalocele ➡ and other congenital anomalies. **(Right)** Axial CECT shows augmentation of the bladder in a 20 year old man with a neurogenic bladder and a renal transplant. The anastomosed pouch of bowel ➡ lies along the ventral surface of the bladder ➡. Renal allograft ➡.*

GAS WITHIN URINARY BLADDER

DIFFERENTIAL DIAGNOSIS

Common
- Iatrogenic
- Bladder Fistulas
- Cystitis

Less Common
- Emphysematous Cystitis

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Do not dismiss importance of gas in bladder
  - Look for evidence of bladder fistula
- Ask about clinical signs and symptoms of infected urine or fistula
  - Dysuria, pneumaturia, heavy growth of multiple coliform bacteria from urine

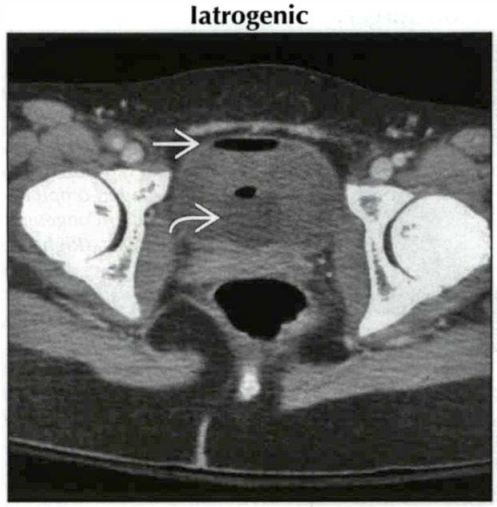
Helpful Clues for Common Diagnoses
- **Iatrogenic**
  - Check for presence or history of recent instrumentation
    - Foley catheter, suprapubic bladder catheter
    - Cystoscopy
    - Usually not very much gas; should not have gas bubbles suspended within urine (this would suggest infection &/or fistula)
- **Bladder Fistulas**
  - Secondary to inflammatory or neoplastic process in bladder or adjacent organs
    - Also can be caused by trauma or iatrogenic injury
    - May result from hysterectomy, proctocolectomy or other pelvic surgery
  - Diverticulitis is most common cause in Western countries
    - Colonic wall thickening, diverticula, abscess adjacent to bladder
  - Gas in bladder is a common finding in enterovesical fistula
  - Extravesical soft tissue mass is seen in 75%
- Cystitis
  - Bladder wall thickening ± hypodense wall
  - Hypoechoic bladder wall on US
  - Usually involves entire bladder wall

Helpful Clues for Less Common Diagnoses
- **Emphysematous Cystitis**
  - Most commonly seen in patients with long-standing & poorly controlled diabetes mellitus
  - Due to bacterial fermentation of excessive glucose within the urothelium and urine
  - Gas in bladder wall and/or lumen
  - Responsible organisms are: E. coli, Aerobacter aerogenes, Candida albicans

SELECTED REFERENCES

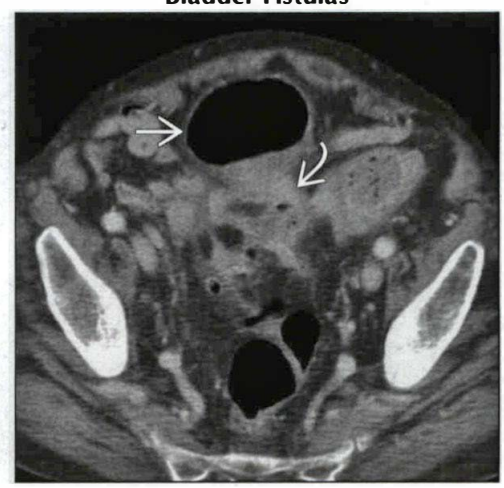
1. Joseph RC et al: Genitourinary tract gas: imaging evaluation. Radiographics. 16(2):295-308, 1996

Iatrogenic



Axial NECT shows gas ➡ within the bladder due to placement of a bladder (Foley) catheter ➡. The catheter bulb is spherical and usually has water density fluid and a gas bubble within it.

Bladder Fistulas



Axial CECT shows gas ➡ within the bladder and a fistulous tract ➡ to the sigmoid colon that showed extensive signs of diverticulitis; 80 year old man.

GAS WITHIN URINARY BLADDER

Bladder Fistulas

Bladder Fistulas

(Left) Axial CECT shows gas within the bladder due to a fistulous connection to the sigmoid colon. Note extensive diverticular disease. (Right) Axial NECT shows contrast-opacified urine extravasated from the bladder through a fistulous tract into the recto-sigmoid colon, due to prior resection & radiation therapy for rectal cancer. Note gas in bladder.

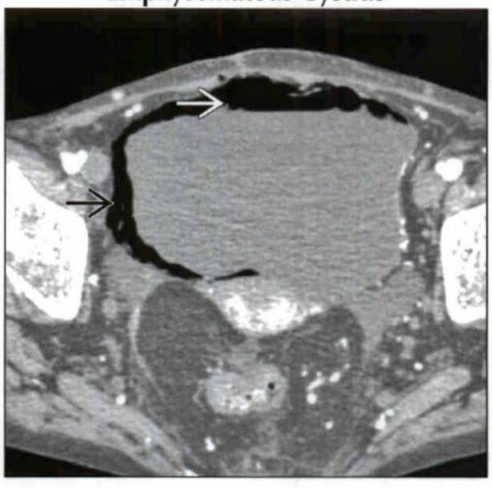
Bladder Fistulas

Bladder Fistulas

(Left) Axial CECT shows a sigmoid colon carcinoma that led to a spontaneous colovesical fistula, a relatively uncommon etiology (without prior surgery or radiation therapy); 67 year old man. (Right) Axial CECT shows gas within a colovesical fistulous tract. The etiology was a sigmoid carcinoma in this 67 year old man. No prior surgery or radiation therapy.

Cystitis

Emphysematous Cystitis



(Left) Axial CECT shows gas within the bladder of a 22 year old woman with bacterial cystitis. It is difficult to determine whether the gas is due to the infection or the indwelling bladder catheter. (Right) Axial CECT shows gas within the lumen and wall of the bladder in a 33 year old woman with a urinary infection and a prior small bowel transplantation. The infection and gas collections cleared with antibiotic therapy.

SECTION 18
Urethra

Generic Imaging Patterns

Urethral Stricture 18-2

URETHRAL STRICTURE

DIFFERENTIAL DIAGNOSIS

Common
- Infectious Stricture, Urethra
- Iatrogenic Stricture, Urethra
- Urethral Trauma
- Extrinsic Tumor Invasion

Less Common
- Urethral Carcinoma
- Reiter Syndrome
- Malakoplakia/Leukoplakia
- Cowper Gland Adenocarcinoma

Rare but Important
- Non-Epithelial Neoplasms

ESSENTIAL INFORMATION

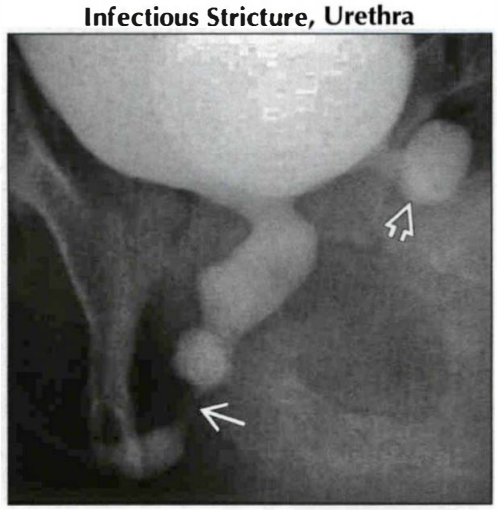
Key Differential Diagnosis Issues
- Presence & cause of stricture are usually evident to urologist performing cystoscopy

Helpful Clues for Common Diagnoses
- **Infectious Stricture, Urethra**
  - Filling of the glands of Littré is highly suggestive of an infectious process
  - Gonorrhea: Multifocal strictures
  - Non-gonococcal: E. coli, Chlamydia, Mycoplasma, HSV, CMV
  - TB is rare, causes multiple fistulas ("water can" perineum)
- **Iatrogenic Stricture, Urethra**
  - Mostly at penoscrotal junction, membranous portion, other narrow sites (bladder neck, meatus)
  - Secondary to passage of instruments, open surgery, indwelling catheter
  - Can be due to radiation therapy (for prostate cancer), periurethral Teflon injection (for incontinence)
- **Urethral Trauma**
  - Secondary to partial or complete urethral tears
  - Most often at membranous urethra
  - Solitary short segment stricture
- **Extrinsic Tumor Invasion**
  - Prostate, bladder, penile carcinoma

Helpful Clues for Less Common Diagnoses
- **Urethral Carcinoma**
  - SCC > TCC > adenocarcinoma
  - 60% in bulbomembranous urethra
- **Reiter Syndrome**
  - Urethritis, balanitis, conjunctivitis, arthritis
  - 5 times more common in men than in women
- **Malakoplakia/Leukoplakia**
  - Malakoplakia: Rare granulomatous inflammation, mostly in females
  - Leukoplakia: Squamous metaplasia
- **Cowper Gland Adenocarcinoma**
  - Arise from bulbourethral glands in males
  - PSA positive

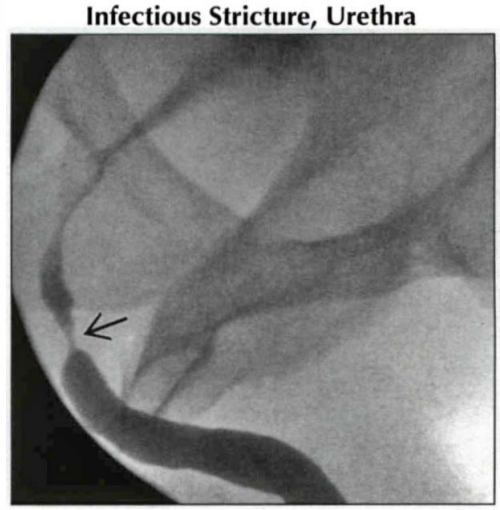
Helpful Clues for Rare Diagnoses
- **Non-Epithelial Neoplasms**
  - Extremely rare
  - Rhabdomyosarcoma (children) and leiomyosarcoma (adult) are most common

Infectious Stricture, Urethra



Oblique voiding cystourethrogram shows a tight stricture ■ of the bulbar urethra in a 21 year old man, probably post-infectious. Note bladder diverticulum ➪ from chronic outlet obstruction.

Infectious Stricture, Urethra

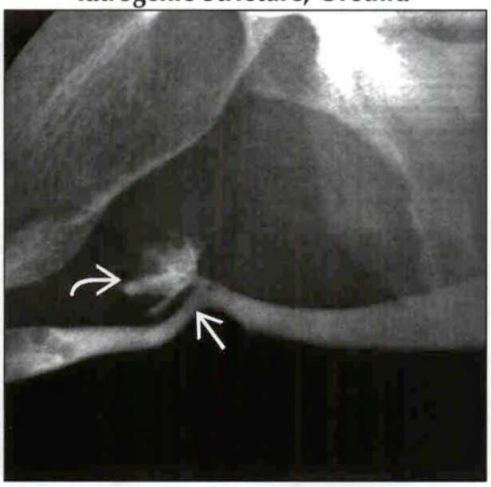


Oblique retrograde urethrogram shows a tight stricture ➔ of the bulbar urethra in a 25 year old man, post-gonococcal.

URETHRAL STRICTURE

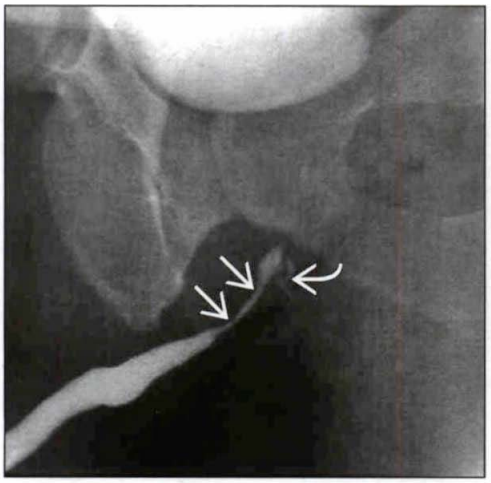
Infectious Stricture, Urethra

Iatrogenic Stricture, Urethra

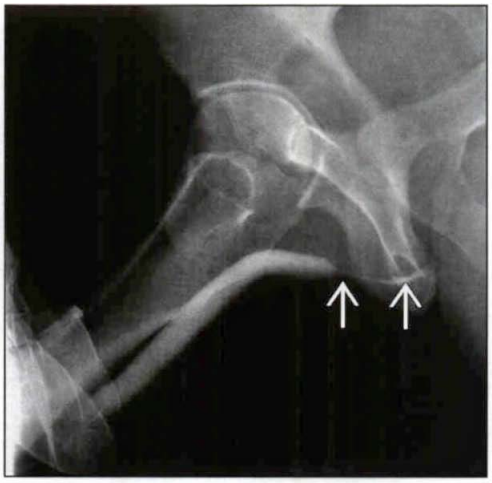


(Left) Oblique retrograde urethrogram shows a long segment irregular narrowing of the penile and bulbous urethra, with filling of the glands of Littré. Filling of these small submucosal mucus-secreting glands is highly associated with an infection's process. (Right) Oblique retrograde urethrogram shows a smooth stricture of the urethra and contrast filling of a cavity in the penis due to passage of an instrument through the wall of the urethra.

Urethral Trauma



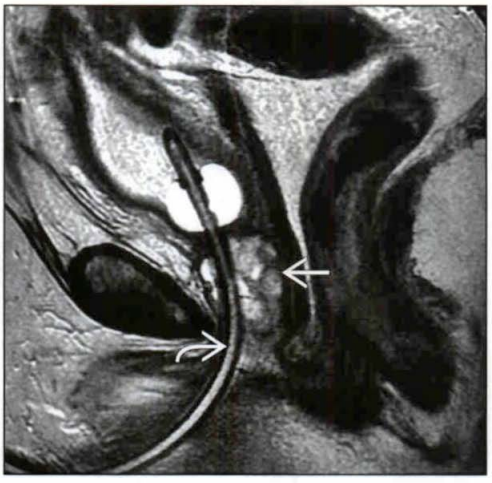
Urethral Trauma



(Left) Oblique retrograde urethrogram shows long smooth urethral stricture in a man with a prior history of pelvic trauma. Note filling of Cowper duct. (Right) Anteroposterior retrograde urethrogram shows a long smooth urethra stricture due to a prior straddle injury of the pelvis; 32 year old man.

Urethral Trauma

Urethral Carcinoma

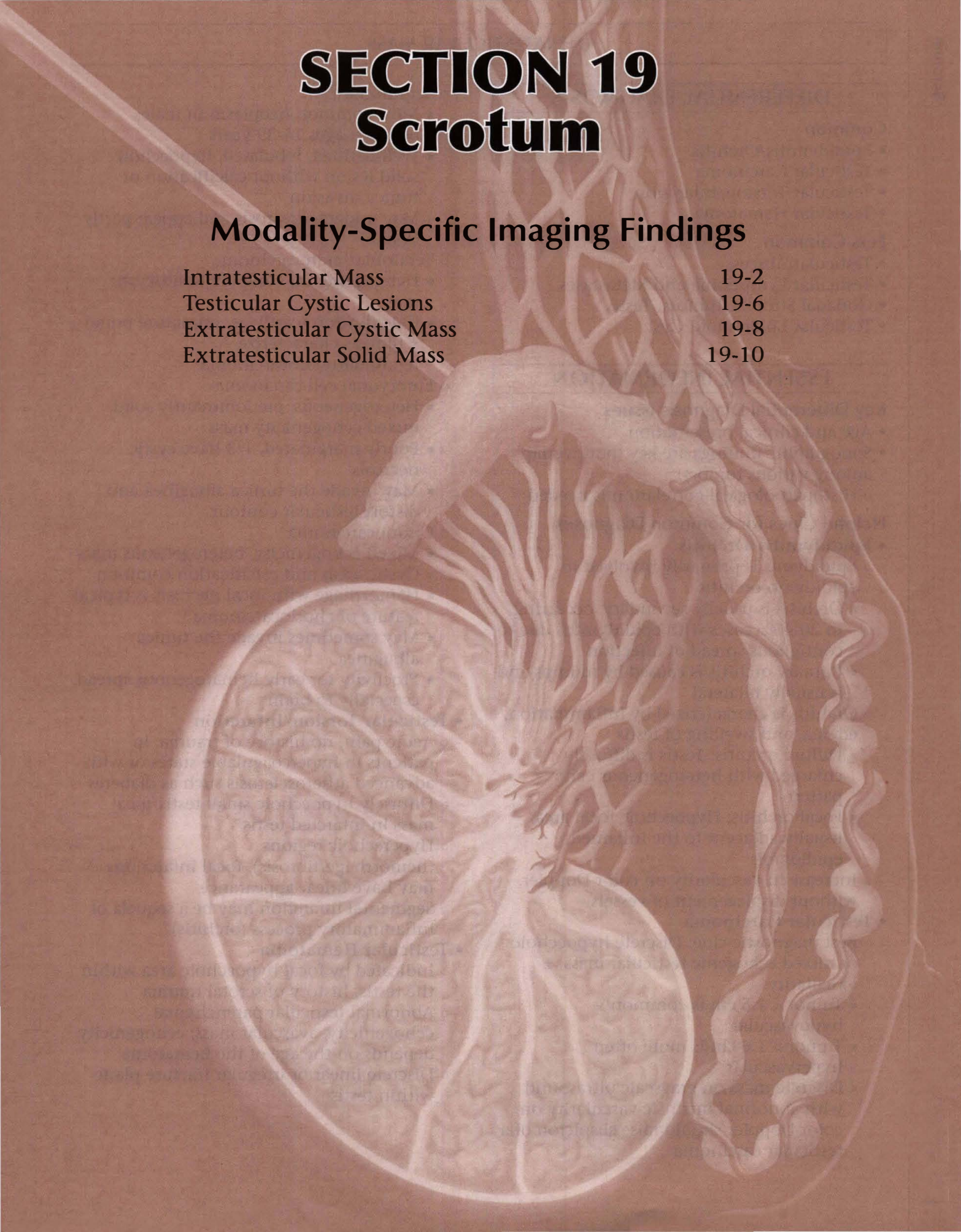


(Left) Simultaneous suprapubic and retrograde urethrogram shows a post-traumatic stricture extending from the prostatic to the bulbous urethra. This is the area of the urogenital diaphragm which is the most common site of injury in blunt pelvic trauma. (Right) Coronal T2WI MR shows a heterogeneous mass arising from the urethra in this 63 year old woman. This had caused bladder outlet obstruction and dysuria; note bladder catheter.

SECTION 19
Scrotum

Modality-Specific Imaging Findings

Intratesticular Mass	19-2
Testicular Cystic Lesions	19-6
Extratesticular Cystic Mass	19-8
Extratesticular Solid Mass	19-10



INTRATESTICULAR MASS

DIFFERENTIAL DIAGNOSIS

Common
- Epididymitis/Orchitis
- Testicular Carcinoma
- Testicular Torsion/Infarction
- Testicular Hematoma

Less Common
- Testicular Abscess
- Testicular Lymphoma and Metastases
- Gonadal Stromal Tumors, Testis
- Testicular Epidermoid Cyst

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Age and clinical presentation
- Sonographic findings are key (but overlap among various tumors)
  - Histopathological correlation is needed

Helpful Clues for Common Diagnoses
- **Epididymitis/Orchitis**
  - Epididymis is primarily involved in epididymo-orchitis
    - Orchitis is usually secondary, occurring in 20-40% cases with epididymitis due to contiguous spread of infection
    - Primary orchitis is caused by mumps and is usually bilateral
  - Orchitis is characterized by inflammation, edema, and swelling of testis
    - Diffuse orchitis: Testis is diffusely enlarged with heterogeneous echo pattern
    - Focal orchitis: Hypoechoic focal area, usually adjacent to the inflamed epididymis
  - Increase in vascularity on color Doppler, without displacement of vessels
- **Testicular Carcinoma**
  - Best diagnostic clue: Discrete hypoechoic or mixed echogenic testicular mass, ± vascularity
    - Tumor < 1.5 cm is commonly hypovascular
    - Tumor > 1.6 cm is more often hypervascular
    - Discrete mass on grayscale ultrasound with abnormal intrinsic vascularity on color Doppler should raise suspicion of a testicular carcinoma
  - Seminoma
    - Most common neoplasm in males between ages 15-39 years
    - Well-defined, lobulated, hypoechoic solid lesion without calcification or tunica invasion
    - May undergo necrosis and appear partly cystic
  - Teratoma/teratocarcinoma
    - Heterogeneous, complex, solid/cystic mass
    - Calcification (cartilage, immature bone) ± fibrosis characterize teratoma/teratocarcinoma
  - Embryonal cell carcinoma
    - Heterogeneous, predominantly solid, mixed echogenicity mass
    - Poorly marginated, 1/3 have cystic necrosis
    - May invade the tunica albuginea and distort testicular contour
  - Choriocarcinoma
    - Mixed echogenicity, heterogeneous mass
    - Cystic areas and calcification common
    - Hemorrhage with focal necrosis is typical feature of choriocarcinoma
    - May sometimes invade the tunica albuginea
    - Proclivity for early hematogenous spread, especially to brain
- **Testicular Torsion/Infarction**
  - Acute pain, no history of trauma, in patients in hypercoagulable states or with advanced atherosclerosis such as diabetes
  - Diffusely hypoechoic small testis/focal mass in infarcted testis
  - Hyperechoic regions (hemorrhage/fibrosis), focal infarctions may have linear appearance
  - Segmental infarction may be a sequela of inflammatory process (orchitis)
- **Testicular Hematoma**
  - Indicated by focal hypoechoic area within the testis, history of scrotal trauma
  - Abnormal testicular parenchymal echogenicity, avascular mass; echogenicity depends on the age of the hematoma
  - Discrete linear or irregular fracture plane within testis

- Distorted intratesticular vascularity with interruption of vessels in the area of hematoma or injury

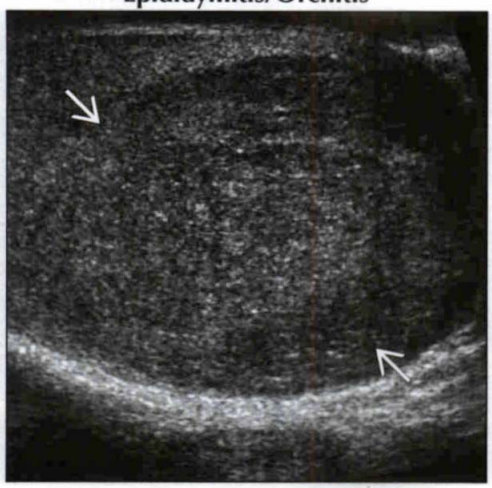
Helpful Clues for Less Common Diagnoses

- **Testicular Abscess**
  - Epididymal abscess = 6%, testicular abscess = 6%
  - Microabscess formation is usually seen in low-grade infections (e.g., tuberculosis) and in immunocompromised host
  - Well-defined, discrete, rounded, hypoechoic lesion/lesions in the testicular parenchyma
  - Necrotic center shows no vascularity on color Doppler studies
- **Testicular Lymphoma and Metastases**
  - Lymphoma
    - Most common testicular tumor in men > 60, multiple lesions; 50% of cases bilateral
    - Often large in size at the time of diagnosis, commonly occurs in association with disseminated disease
    - Ill-defined, predominantly hypoechoic lesions
    - Very vascular on color Doppler
    - Involvement of epididymis and spermatic cord is common; hemorrhage or necrosis is rare
  - Metastases are rare; most common sites include prostate, lung, and GI tract
  - Testis is a frequent site of relapse in male patients with acute leukemia
- **Gonadal Stromal Tumors, Testis**
  - Bilateral in 3%
    - < 3 cm usually benign
    - > 5 cm malignant
  - Leydig cell tumor
    - Small solid hypoechoic testicular mass
    - In larger tumor hemorrhage or necrosis leads to heterogeneous echo pattern
  - Sertoli cell tumor
    - Small hypoechoic mass, solid and cystic components
    - Punctate calcification may be present; large calcified mass in calcifying Sertoli cell tumor
    - Hemorrhage may lead to heterogeneity
  - Indistinguishable from other testicular tumors by ultrasound findings
- **Testicular Epidermoid Cyst**
  - Cystic cavity lined by stratified squamous epithelium
  - "Onion skin" appearance on US due to alternating layers of keratin and desquamated squamous cells
  - May have peripheral calcified rim

SELECTED REFERENCES

1. Dogra V et al: Acute painful scrotum. Radiol Clin North Am. 42(2):349-63, 2004
2. Woodward PJ et al: From the archives of the AFIP: tumors and tumorlike lesions of the testis: radiologic-pathologic correlation. Radiographics. 22(1):189-216, 2002

Epididymitis/Orchitis



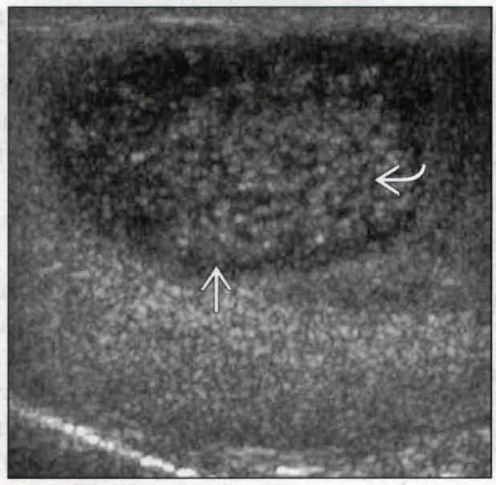
Oblique ultrasound shows an enlarged, diffusely hypoechoic testis. A history of acute onset scrotal pain, combined with these sonographic findings, suggests acute orchitis.

Epididymitis/Orchitis

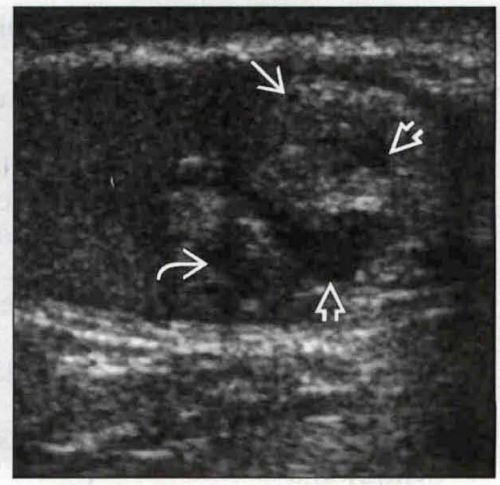
Oblique color Doppler ultrasound in the same patient shows marked increase in overall vascularity. Note the undisplaced course of the intratesticular vessels.

INTRATESTICULAR MASS

Testicular Carcinoma

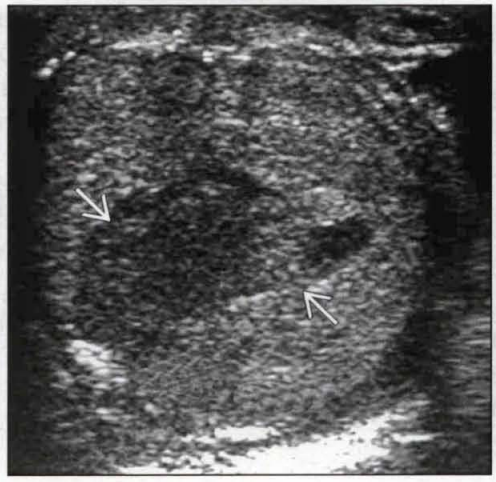


Testicular Carcinoma

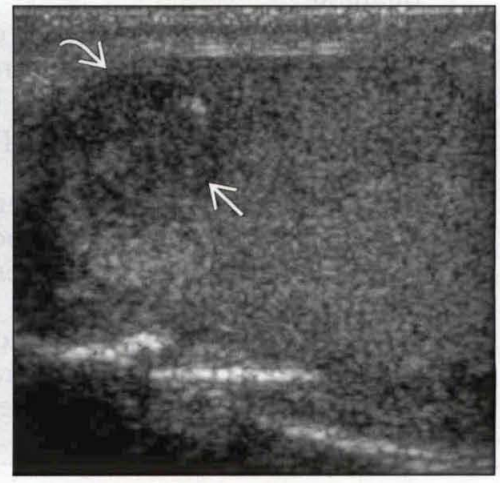


(Left) Oblique ultrasound shows a homogeneous, hypoechoic, and solid testicular seminoma. Note the typical lobulated appearance of the tumor without any calcification or necrosis. (Right) Longitudinal ultrasound shows a large heterogeneous solid intratesticular mass. Foci of intrinsic calcification cause posterior shadowing. Note ill-defined areas of necrosis within this mass. Final diagnosis: Teratoma.

Testicular Carcinoma

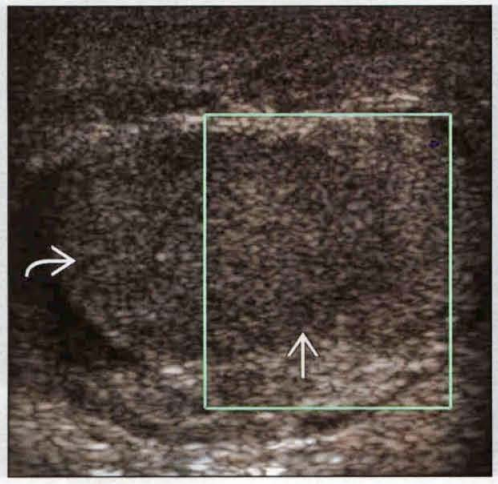


Testicular Carcinoma

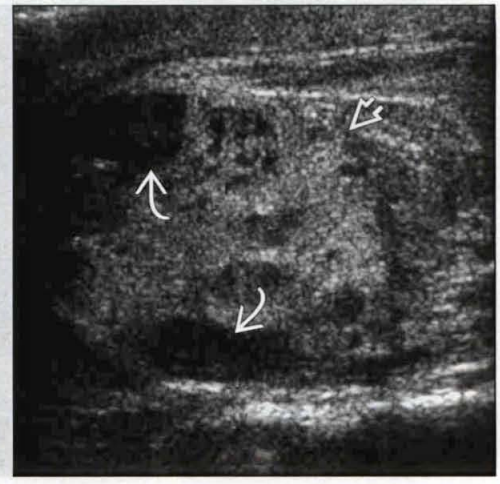


(Left) Transverse ultrasound shows a well-defined, hypoechoic, intratesticular mass with neither intrinsic calcification nor central necrosis. The features are nonspecific and suggest testicular carcinoma. Final diagnosis: Mixed germ cell tumor. (Right) Longitudinal ultrasound shows an ill-defined, hypoechoic, heterogeneous intratesticular mass. Note the close proximity of this mass to tunica albuginea. Final diagnosis: Embryonal cell carcinoma.

Testicular Torsion/Infarction



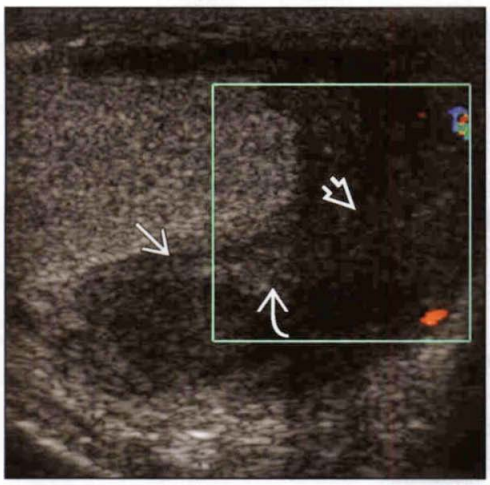
Testicular Hematoma



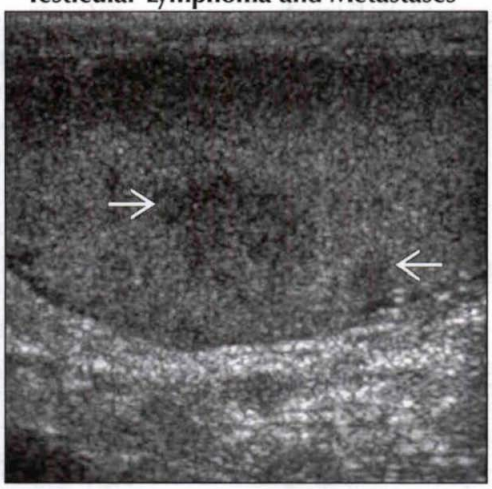
(Left) Oblique color Doppler ultrasound shows a diffusely enlarged, hypoechoic testis with nearly absent blood flow, suggesting an acute infarction due to acute torsion. (Right) Oblique ultrasound shows a heterogeneous testicular echo pattern with a few poorly-defined hypoechoic areas within. Sonographic features suggest testicular hematoma in this patient with scrotal trauma.

INTRATESTICULAR MASS

Testicular Abscess

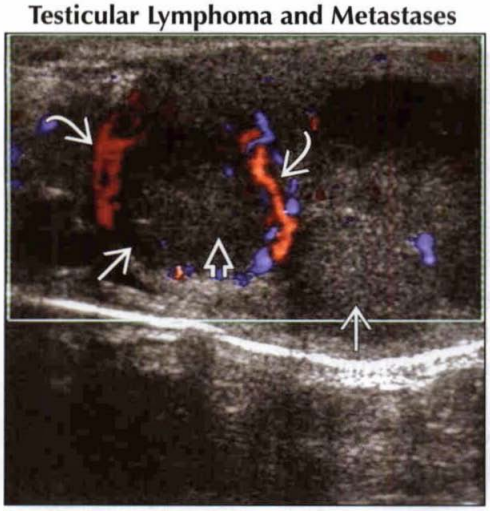


Testicular Lymphoma and Metastases

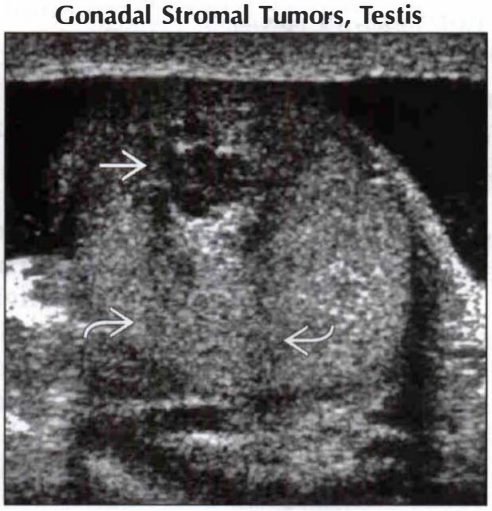


(Left) Oblique color Doppler ultrasound shows an ill-defined hypoechoic area in the testis with irregular thick walls. Note the lack of vascularity within this lesion. Features suggest a testicular abscess. (Right) Longitudinal ultrasound shows ill-defined hypoechoic lesions within the testis. Final diagnosis: Testicular lymphoma. In more than 50% of patients, lesions are multiple and involve both testes.

Testicular Lymphoma and Metastases

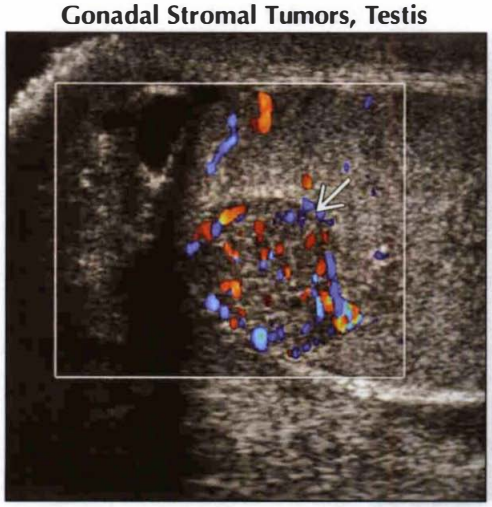


Gonadal Stromal Tumors, Testis

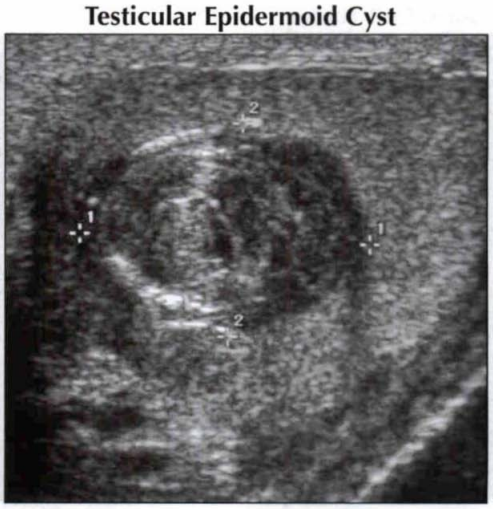


(Left) Oblique color Doppler ultrasound shows multiple, large, well-defined, hypoechoic intratesticular masses. Note the hypovascularity of these lesions and the displacement of adjacent vessels. (Right) Oblique ultrasound shows a heterogeneous solid testicular mass in a 6 year old boy. Note areas of shadowing due to rim calcification. Final diagnosis: Sertoli cell tumor.

Gonadal Stromal Tumors, Testis



Testicular Epidermoid Cyst



(Left) Longitudinal color Doppler ultrasound shows a well-defined, hypoechoic, significantly vascular, intratesticular mass. Final diagnosis: Gonadal stromal tumor. (Right) Transverse ultrasound shows a hypoechoic mass within the testis that has a characteristic lamellated or "onion-skin" appearance. Because an epidermoid cyst is filled with keratin rather than fluid, the cysts will often have a solid appearance on ultrasound.

TESTICULAR CYSTIC LESIONS

DIFFERENTIAL DIAGNOSIS

Common
- Non-Seminomatous Germ Cell Tumor
- Intratesticular Cyst
- Tubular Ectasia of Rete Testis
- Tunica Albuginea Cyst
- Testicular Abscess

Less Common
- Tunica Vaginalis Cyst
- Necrosis or Hemorrhage in Tumor
- Epidermoid Cyst

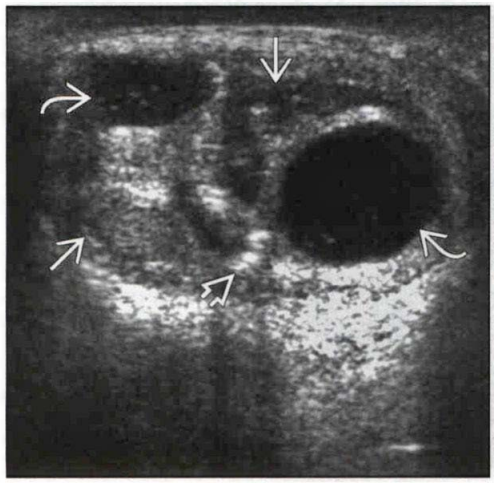
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Testicular cysts are common (8-10% of men)
- Most cystic neoplasms have "complex" features
  - Mural nodularity, hemorrhage, or necrosis
  - Flow on color Doppler imaging

Helpful Clues for Common Diagnoses
- **Non-Seminomatous Germ Cell Tumor**
  - Teratomas are usually well-defined complex masses
    - Cysts are a common feature and may be anechoic or complex, depending on the cyst contents
  - Cystic necrosis of the tumor is not uncommon in other NSGCTs
- **Intratesticular Cyst**
  - Simple cyst
  - 2-18 mm diameter
  - Near mediastinum testis
- **Tubular Ectasia of Rete Testis**
  - Variable size cystic lesions near mediastinum testis
    - Turn transducer to elongate into tubular channels
  - No flow on color Doppler
  - May be bilateral, asymmetrical
  - Often with associated spermatocele
- **Tunica Albuginea Cyst**
  - Within the tunica surrounding testis
  - Usually solitary, 2-3 mm diameter, can be septate
- **Testicular Abscess**
  - Usually complication of epididymo-orchitis
  - Enlarged testis with hypoechoic or mixed pattern
  - Imaging alone cannot distinguish from tumor

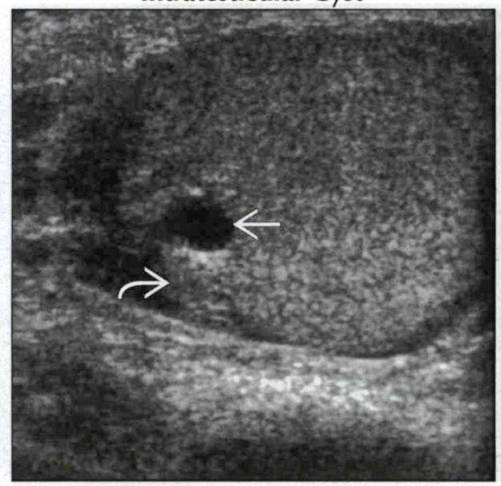
Helpful Clues for Less Common Diagnoses
- **Tunica Vaginalis Cyst**
  - Rare, arises from visceral or parietal layer of tunica vaginalis
  - Usually anechoic; may have septations or may contain echoes due to hemorrhage
- **Epidermoid Cyst**
  - Contents are "cheesy" keratin
  - Occasionally anechoic but layered keratin often creates a lamellated, "onion skin" appearance
  - May have a calcified capsule
  - Presents as painless nodule in young man

Non-Seminomatous Germ Cell Tumor



Transverse ultrasound shows a large, heterogeneous, intratesticular mass ⇨ with internal calcification ⇨ and intervening cysts ⇨. Features suggest teratoma or teratomatous components in a mixed germ cell tumor.

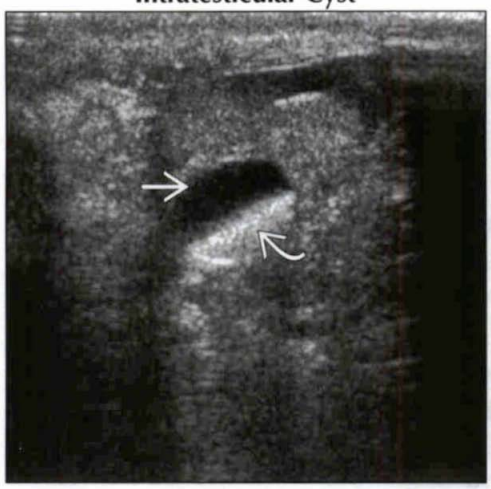
Intratesticular Cyst



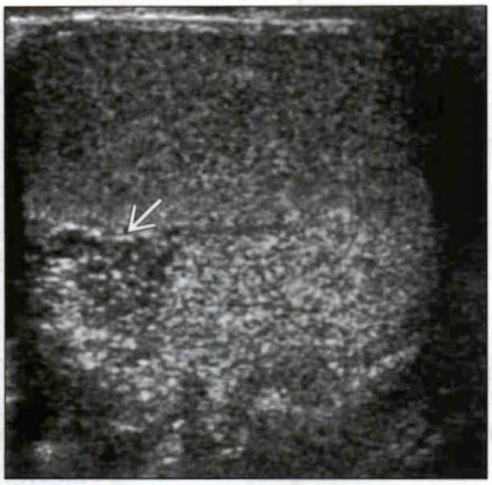
Oblique ultrasound shows a well-defined, intratesticular, anechoic cyst ⇨ with an imperceptible wall and posterior enhancement ⇨, all features are of a simple testicular cyst.

TESTICULAR CYSTIC LESIONS

Intratesticular Cyst

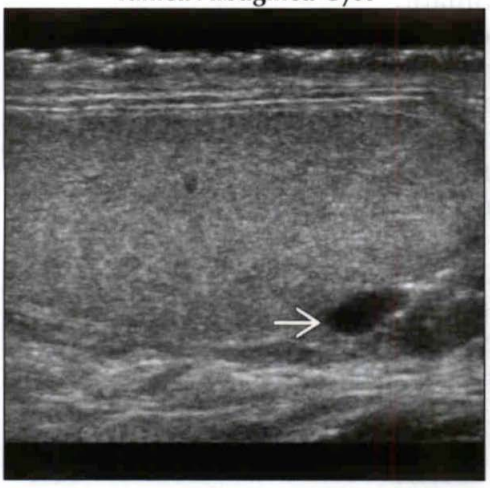


Tubular Ectasia of Rete Testis

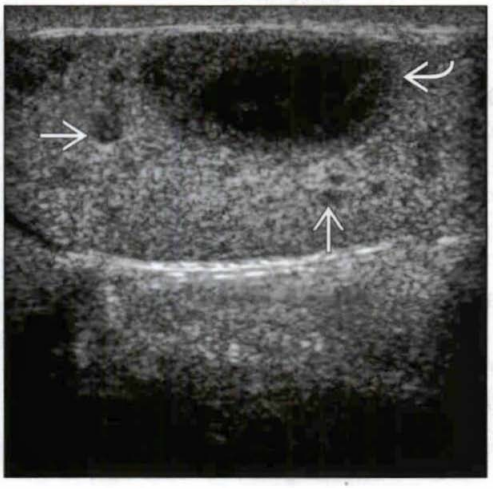


(Left) Oblique ultrasound shows a small spermatocele in the head of the epididymis, with layered echogenic debris. (Right) Oblique ultrasound shows multiple small, branching, tubular, anechoic structures adjacent to the mediastinum testis, suggestive of mild to moderate tubular ectasia.

Tunica Albuginea Cyst



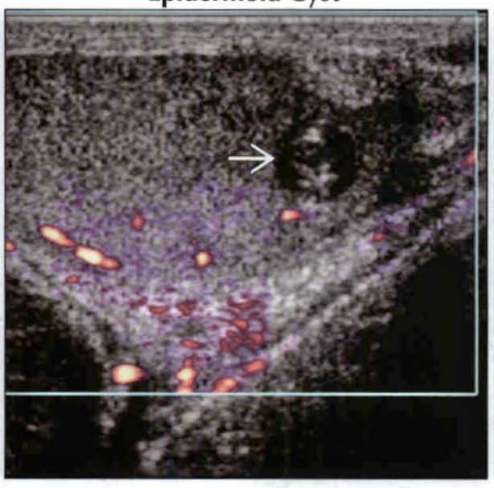
Testicular Abscess



(Left) Longitudinal ultrasound shows a small well-defined anechoic cyst in the periphery of the testis, suggesting a tunica albuginea cyst. (Right) Oblique ultrasound in a patient with epididymo-orchitis shows an ill-defined hypoechoic area with an irregular thick wall. Features suggest testicular abscess. Note several small abscesses/granulomas in the remainder of the testis.

Necrosis or Hemorrhage in Tumor

Epidermoid Cyst



(Left) Oblique ultrasound shows an ill-defined variegated intratesticular mass with areas of central necrosis. Normal testicular tissue is barely identifiable. Final diagnosis: Teratoma. (Right) Longitudinal power Doppler ultrasound shows a well-circumscribed, avascular, hypoechoic "mass" with a concentric lamellar pattern referred to as an "onion-ring" appearance. This is characteristic of epidermoid cysts.

EXTRATESTICULAR CYSTIC MASS

DIFFERENTIAL DIAGNOSIS

Common
- Hydrocele
- Varicocele
- Spermatocele
- Epididymal Cyst
- Tubular Ectasia of Rete Testis

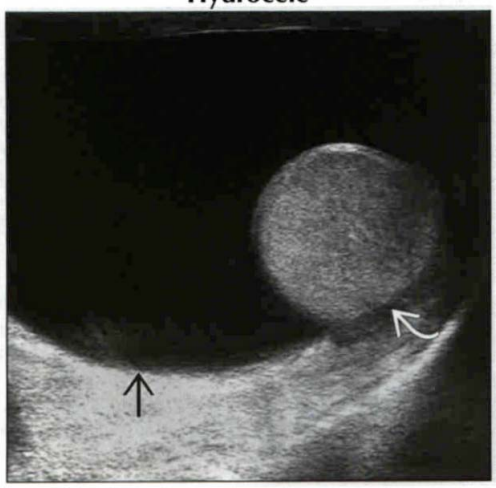
Less Common
- Tunica Albuginea Cyst
- Hematocele, Acute
- Pyocele

ESSENTIAL INFORMATION

Helpful Clues for Common Diagnoses
- **Hydrocele**
  - Congenital or acquired
  - Fluid collection in the tunica vaginalis
  - Envelopes testis except for the "bare area" where the tunica vaginalis is deficient
- **Varicocele**
  - Dilation of veins of pampiniform plexus > 2-3 mm in diameter due to retrograde flow in internal spermatic vein
  - Dilated serpiginous veins behind superior pole of testis on color Doppler US, the best imaging tool
  - Enlarge with Valsalva maneuver
- **Spermatocele**
  - Retention cyst of tubules connecting rete testis to head of epididymis
  - Located in head of epididymis; contains spermatozoa
  - Large spermatoceles have low-level echoes and septations
- **Epididymal Cyst**
  - Located in epididymal head, body, tail; shows all features of a simple cyst
  - Anechoic, does not contain spermatozoa
- **Tubular Ectasia of Rete Testis**
  - Normal variant of dilated seminiferous tubules in mediastinum of testis
  - Intratesticular but dilation often associated with spermatocele, giving appearance of a complex intra/extratesticular mass
  - No flow on color Doppler

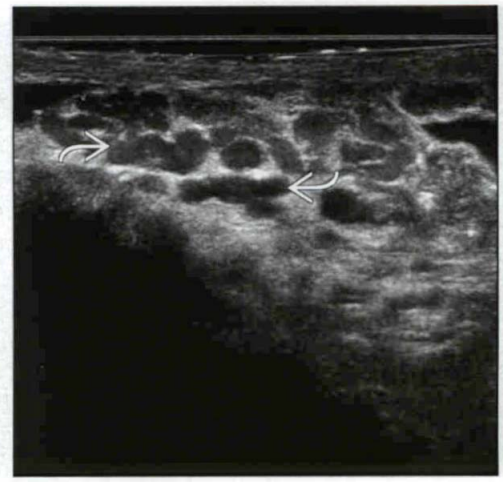
Helpful Clues for Less Common Diagnoses
- **Tunica Albuginea Cyst**
  - Located within the layers of tunica albuginea
  - Usually solitary but can be multiple; 2-3 mm diameter
  - Asymptomatic
- **Hematocele, Acute**
  - Associated with trauma, torsion and infarction
  - Varies in appearance with evolution of blood products
  - Look for associated testicular injury
- **Pyocele**
  - Sequela of scrotal infections
  - Septate fluid with low-level internal echoes
  - Chronicity may lead to thickening of the tunica and the scrotal wall

Hydrocele



Longitudinal ultrasound of scrotum shows anechoic fluid ⇨ within the tunica vaginalis, indicative of a simple hydrocele. Fluid in the tunica vaginalis envelopes the testis except posteriorly ➡, where it is deficient.

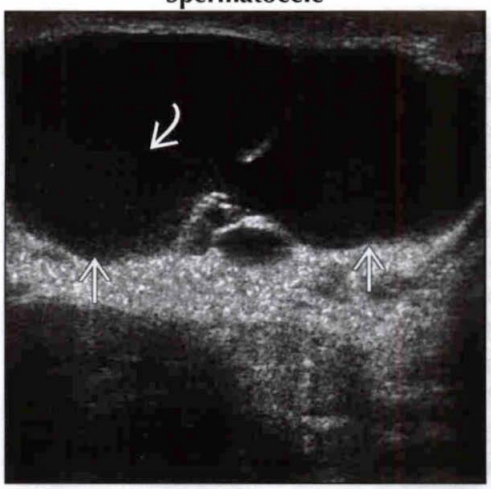
Varicocele



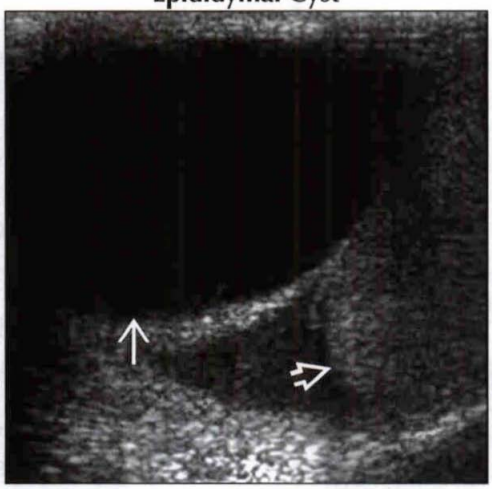
Oblique ultrasound of the scrotum shows multiple, serpiginous dilated veins ➡ in the pampiniform plexus of the cord, located along the posterosuperior aspect of the testis.

EXTRATESTICULAR CYSTIC MASS

Spermatocele

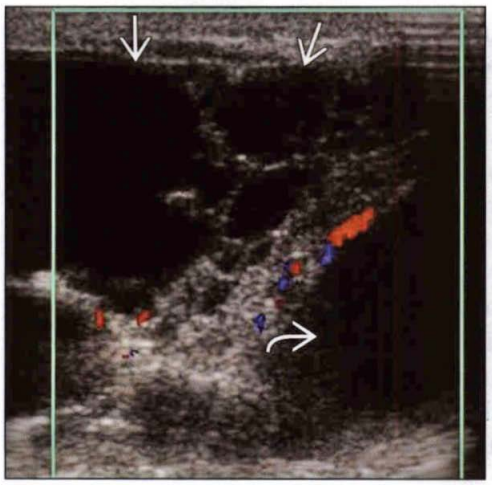


Epididymal Cyst

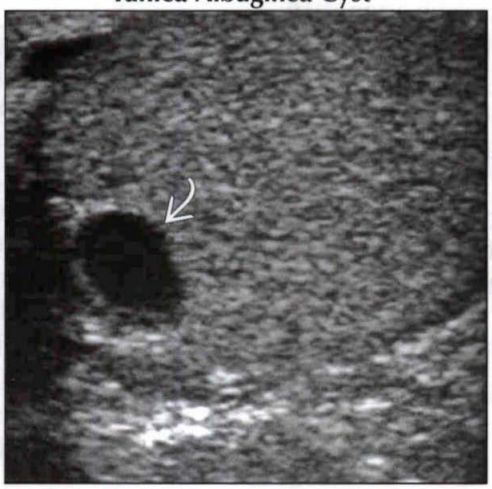


*(**Left**) Longitudinal ultrasound shows a large septate cyst in the epididymal head, suggesting a spermatocele. Note the floating internal echoes representing spermatozoa. (**Right**) Oblique ultrasound shows a well-defined cyst in the head of the epididymis (testis). Note the anechoic nature of the cyst, a feature differentiating it from a spermatocele. Aspiration of fluid to rule out spermatozoa is diagnostic but seldom necessary, as both are benign.*

Tubular Ectasia of Rete Testis

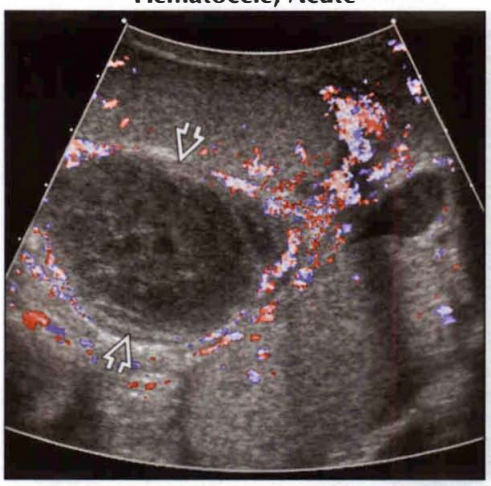


Tunica Albuginea Cyst

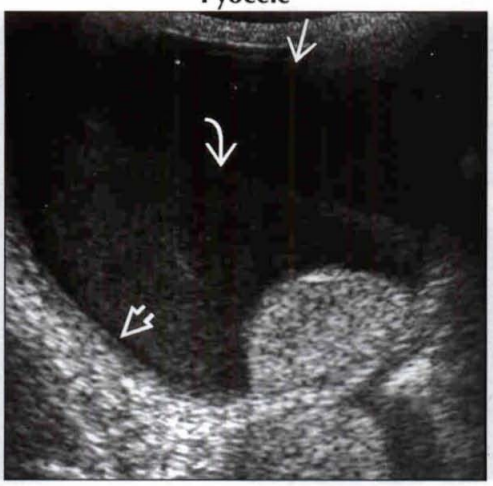


*(**Left**) Transverse color Doppler ultrasound shows multiple, avascular, circular structures of varying size in the scrotum, representing tubular ectasia (cystic transformation) of the rete testis. A spermatocele is also seen, which is a common associated finding. (**Right**) Oblique ultrasound shows a small, well-defined cyst in the anterior aspect of the testis, a characteristic location of a tunica albuginea cyst.*

Hematocele, Acute



Pyocele



*(**Left**) Coronal color Doppler ultrasound of the scrotum shows an avascular, complex, extratesticular fluid collection in a man who had recently had a vasectomy. The hematoma resolved on follow-up studies. (**Right**) Longitudinal ultrasound shows moderate-sized fluid collection within the tunica vaginalis with layering of low-level echoes and debris . There is also associated thickening of the scrotal wall . all features of a pyocele.*

EXTRATESTICULAR SOLID MASS

DIFFERENTIAL DIAGNOSIS

Common
- Epididymitis
- Hematocele, Chronic
- Inguinal Hernia
- Scrotal Pearl
- Adenomatoid Tumor
- Fibrous Pseudotumor

Less Common
- Mesenchymal Tumors, Scrotum
- Papillary Cystadenoma, Epididymis

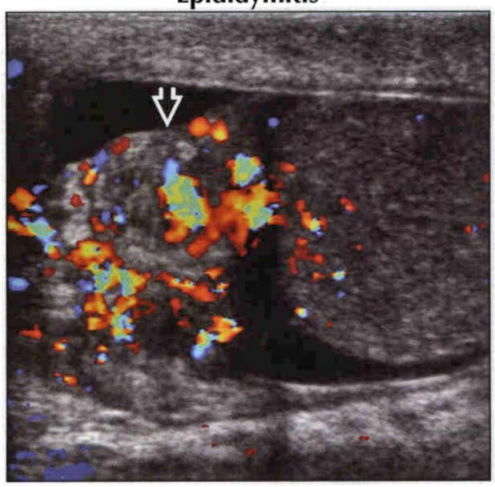
ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Clinical presentation + US findings key

Helpful Clues for Common Diagnoses
- **Epididymitis**
  - Increase or decrease in echogenicity depending upon acute or chronic stage
  - Enlarged, hyperemic epididymis and/or testis on color Doppler US
  - Compare with contralateral side
- **Hematocele, Chronic**
  - Associated with trauma, torsion, infarct
  - Complex echogenic fluid
    - May be chronic and fibrotic, appearing as a solid mass
  - No intrinsic vascularity demonstrable
  - Ipsilateral testis should be separately identified to exclude injury
- **Inguinal Hernia**
  - Inguino-scrotal hernia; indirect type
  - Bowel or echogenic omental fat seen within scrotum
    - Important to identify vascularity of bowel to exclude strangulation
- **Scrotal Pearl**
  - Detached and calcified testicular appendages post-inflammatory or secondary to prior torsion
- **Adenomatoid Tumor**
  - Most common epididymal tumor
    - 30% of all extratesticular neoplasms
  - Well-defined, solid, hypoechoic mass
  - Peripheral vascularity on color Doppler
- **Fibrous Pseudotumor**
  - Reactive fibrous proliferation, usually associated with tunica albuginea
  - Generally hypoechoic with strong posterior shadowing
  - Can be as large as 8 cm in diameter

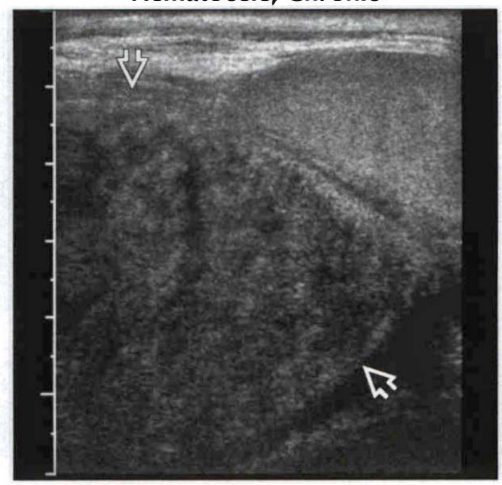
Helpful Clues for Less Common Diagnoses
- **Mesenchymal Tumors, Scrotum**
  - Lipoma most common benign neoplasm
    - Often appear hypoechoic
  - Most common malignant tumors include rhabdomyosarcoma and liposarcoma
    - Large, irregular, heterogeneous masses
- **Papillary Cystadenoma, Epididymis**
  - Epididymal component of the von Hippel-Lindau syndrome
    - Seen in 65% of patients with VHL
  - Often bilateral; found in young adults
  - Ill-defined solid mass with scattered cysts

Epididymitis



Longitudinal color Doppler ultrasound shows an enlarged and hyperemic epididymis in a man who reported 2 days of scrotal pain and swelling.

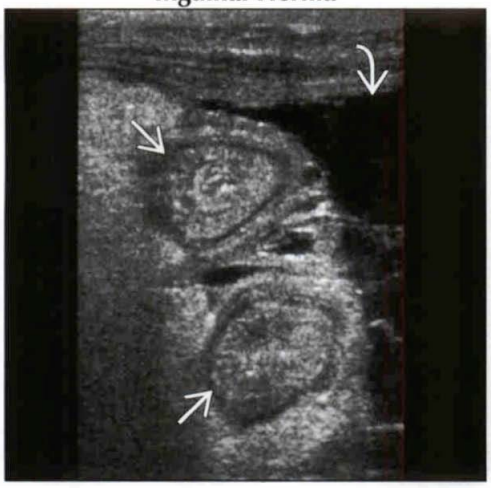
Hematocele, Chronic



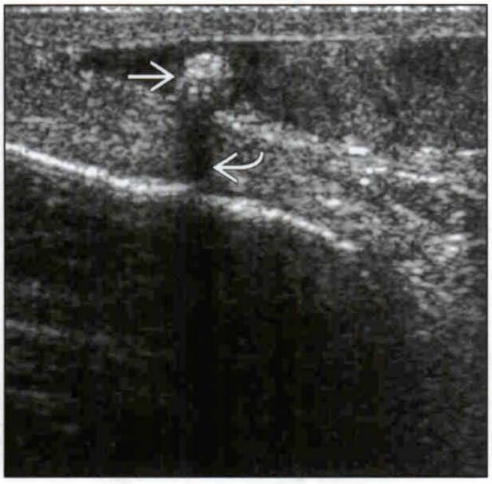
Sagittal ultrasound shows a large, solid-appearing extratesticular mass, which the patient said had not changed in years. It was excised, and pathology showed a chronic, fibrosed hematoma.

EXTRATESTICULAR SOLID MASS

Inguinal Hernia

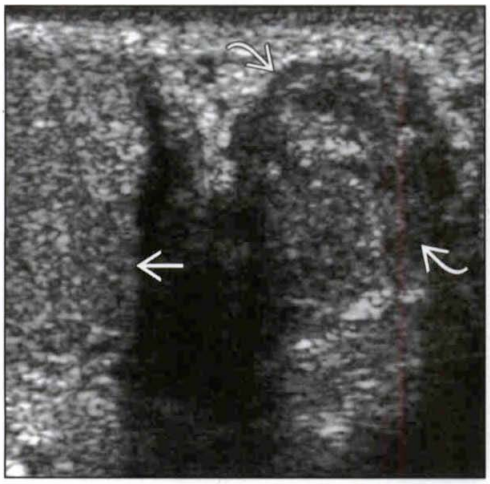


Scrotal Pearl

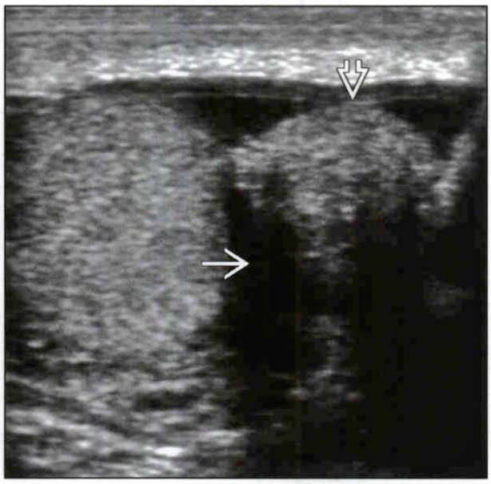


(Left) Oblique ultrasound shows herniated bowel loops in the scrotum in this chronic inguino-scrotal hernia. Note moderate chronic hydrocele. Vascularity of the herniated omentum and bowel wall should be demonstrable to exclude strangulation. (Right) Oblique ultrasound shows a small intrascrotal (extratesticular) calcified body causing posterior acoustic shadowing. This is typical of a scrotal pearl (scrotolith).

Adenomatoid Tumor

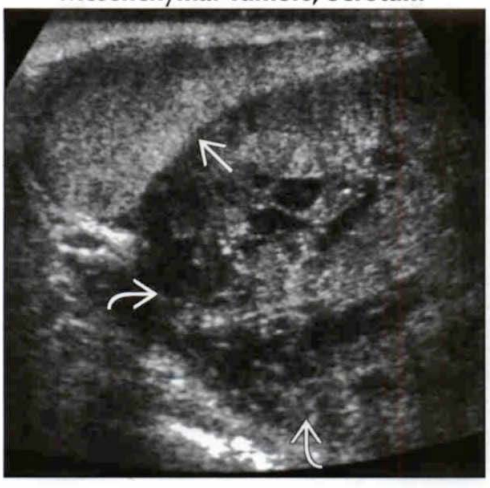


Fibrous Pseudotumor

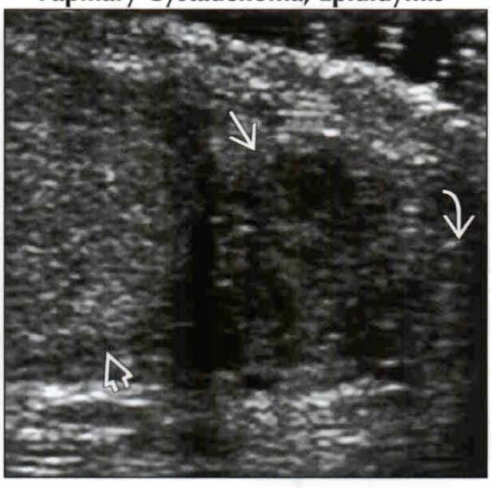


(Left) Transverse ultrasound shows a well-defined hypoechoic solid mass in the head of the epididymis. This lesion showed peripheral vascularity on color Doppler studies. Note the normal testis. (Right) Transverse ultrasound shows a well-defined, hypoechoic, extratesticular mass. Note the marked posterior shadowing, which is often seen with these fibrous masses.

Mesenchymal Tumors, Scrotum



Papillary Cystadenoma, Epididymis



(Left) Oblique ultrasound shows a large heterogeneous paratesticular mass compressing the testis. The epididymis could not be seen separately. Final diagnosis: Epididymal rhabdomyosarcoma. (Right) Longitudinal ultrasound shows an ill-defined, solid, heterogeneous mass with scattered small cysts in the epididymal tail. Note the normal testis.

SECTION 20
Prostate

Generic Imaging Patterns

Focal Lesion in Prostate 20-2

FOCAL LESION IN PROSTATE

DIFFERENTIAL DIAGNOSIS

Common
- Benign Prostatic Hyperplasia (BPH), Hyperplastic Nodules
- BPH, Cystic Degeneration
- Prostatic Calcification
- Prostatic Carcinoma (CA)
- Retention Cyst
- Utricle Cyst
- Müllerian Duct Cyst

Less Common
- Prostatitis, Focal
- Prostatic Abscess
- Metastases and Lymphoma, Prostate
- Ejaculatory Duct Cyst or Diverticulum
- Seminal Vesicle Cyst or Ductal Ectasia
- Vas Deferens Cyst

Rare but Important
- Prostatic CA, Cystic
- Multilocular Prostatic Cystadenoma
- Hydatid Cyst
- Prostatic Urethral Diverticulum

ESSENTIAL INFORMATION

Key Differential Diagnosis Issues
- Focal lesion might be discovered by palpation (digital rectal exam) as incidental finding or part of screening exam
- Or in patient with symptoms, signs, or abnormal laboratory evaluation
  - Fever, pain, dysuria, hemospermia, painful ejaculation
  - ↑ PSA (prostate specific antigen)
- Location of cystic lesion helps in diagnosis
  - EDC and utricle cysts normally communicate with the urethra; müllerian duct cysts rarely do

Helpful Clues for Common Diagnoses
- **Benign Prostatic Hyperplasia (BPH), Hyperplastic Nodules**
  - Hyperechoic nodules in an enlarged gland
  - May undergo cystic degeneration
  - Located in the transitional and periurethral zones
  - May be confused with prostatic carcinoma
- **BPH, Cystic Degeneration**
  - Typically located in transitional zone
  - Arises within hyperplastic nodules
- **Prostatic Calcification**
  - Common feature of chronic prostatitis
  - Caused by calcium precipitation inside acini whose ducts are obstructed by inflammation
  - Intraglandular or periurethral
  - In young patients, calcifications are usually periurethral
- **Prostatic Carcinoma (CA)**
  - > 90% are hypoechoic (less commonly iso- or hyperechoic)
  - About 70% occur in peripheral zone
  - 30% of tumors not evident on ultrasound
    - Indistinguishable from hyperplastic nodules in the transitional zone
  - Extracapsular extension common in advanced disease
- **Retention Cyst**
  - Results from obstructed glandular acinus
  - Unilocular with smooth walls
  - Location variable; size ≈ 1 to 2 cm
  - May be indistinguishable from BPH
- **Utricle Cyst**
  - Cystic dilatation of prostatic utricle, acquired or congenital
    - Congenital results from abnormality in regression of müllerian duct system
  - Intraprostatic; midline, arises from verumontanum
  - Usually small; tubular or pear-shaped
  - Normally communicates with the urethra
  - Associated with hypospadias, undescended testes, and unilateral renal agenesis
- **Müllerian Duct Cyst**
  - Originates from remnant of müllerian duct
  - Extraprostatic; midline
  - Usually large; extends above prostatic base
  - Oval/teardrop shaped; rarely communicates with the urethra
  - Though rare, may contain calculi
  - Differentiation from utricle cyst is difficult

Helpful Clues for Less Common Diagnoses
- **Prostatitis, Focal**
  - Clinical: Tender and warm to palpation
  - Acute: Size may be normal but often enlarged; ill-defined margin; hypoechoic areas with ↑ vascularity
  - Chronic: Normal-sized gland; heterogeneous echo pattern ± calculi
- **Prostatic Abscess**
  - As a complication of prostatitis

- One/multiple prostatic cystic lesions with internal debris ± septae ± gas

- **Metastases and Lymphoma, Prostate**
  - Metastases most frequent from direct extension from carcinoma of rectum, bladder, seminal vesicle
  - Lymphoma: Usually part of disseminated disease
- **Ejaculatory Duct Cyst or Diverticulum**
  - Intraprostatic, along ejaculatory duct
  - Paramedian at base, midline at verumontanum
  - Normally communicates with the urethra
  - Intracystic calculi are common
  - Ejaculatory duct diverticulum is rare
- **Seminal Vesicle Cyst or Ductal Ectasia**
  - Variable in size; rarely bilateral
  - Unilocular or multilocular
  - Associated with renal agenesis/dysgenesis
  - Ductal ectasia caused by ejaculatory duct or vas deferens obstruction
- **Vas Deferens Cyst**
  - Extraprostatic, superior to the gland
  - Associated with ectopic vas deferens with abnormal vas-ureteral communications

Helpful Clues for Rare Diagnoses

- **Prostatic CA, Cystic**
  - Complex cyst contains solid and cystic components
  - Predominantly peripheral in location
  - Extracapsular extension is definitive for malignancy, differentiating it from other cystic lesions
- **Multilocular Prostatic Cystadenoma**
  - Rare benign prostatic tumor
  - Can enlarge to cause urinary obstruction
- **Hydatid Cyst**
  - Simple or multiloculated with endocysts
  - Egg-shell/cyst wall calcification common
- **Prostatic Urethral Diverticulum**
  - Anterior: Commonly due to instrumentation trauma or infection
  - Posterior: Commonly related to rupture of a prostatic abscess
  - May be single or multiple
  - Wide or narrowed neck with smooth or ragged walls

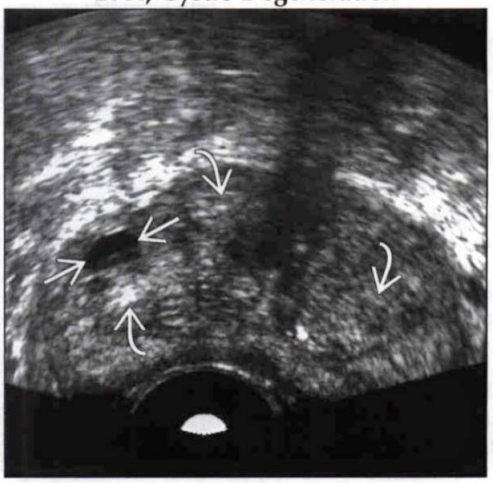
Alternative Differential Approaches

- Cystic lesion
  - Midline: Utricle cyst, müllerian duct cyst, prostatic urethral diverticulum, EDC or diverticulum
  - Paramedian: Vas deferens cyst, EDC or diverticulum
  - Lateral: Seminal vesicle cyst, BPH cystic degeneration (transitional zone)
  - Variable: Retention cyst, abscess, hydatid cyst, cystic prostatic CA
- Solid lesion
  - Central: BPH hyperplastic nodules (transitional zone)
  - Peripheral: Prostatic CA (70%)
  - Variable: Calcifications, focal prostatitis, metastasis or lymphoma, multilocular cystadenoma, prostatic CA (30%)

Benign Prostatic Hyperplasia (BPH), Hyperplastic Nodules

Coronal TRUS of the prostate shows BPH with enlargement of the transitional zone ➡ and presence of hyperechoic nodules ➡. These lesions, though typical of BPH, can sometimes mimic prostatic CA.

BPH, Cystic Degeneration



Coronal TRUS of the prostate shows BPH with multiple hyperplastic nodules ➡ in the transitional zone. Note that one of them contains a small degenerative cyst ➡.

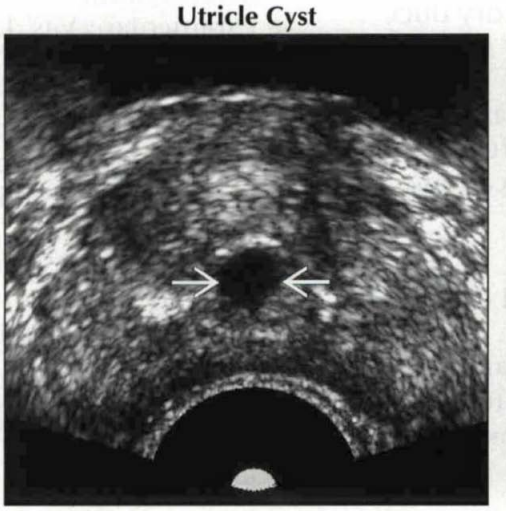
FOCAL LESION IN PROSTATE

Prostatic Calcification

(Left) Coronal TRUS of the prostate shows dense periurethral calcifications with characteristic shadowing. This feature is common in young patients with chronic prostatitis due to calcium precipitation in obstructed acini. (Right) Longitudinal TRUS of the prostate shows an irregular hypoechoic lesion in the peripheral zone, suspicious for prostatic CA. Over 90% of prostatic CA are hypoechoic, and about 70% are in the peripheral zone.

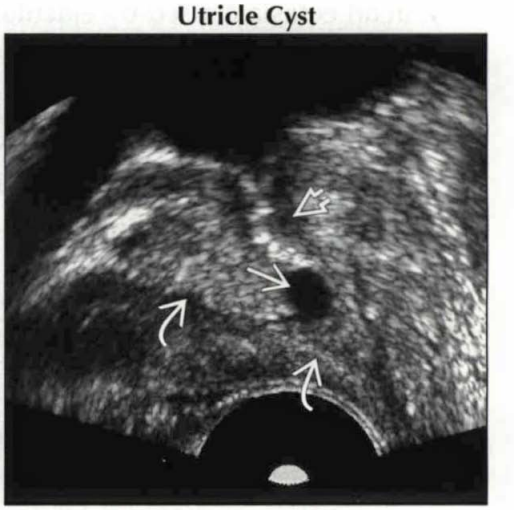
Prostatic Carcinoma (CA)

Utricle Cyst

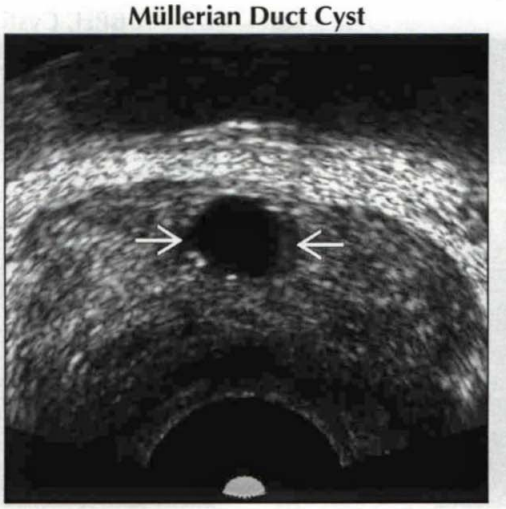


(Left) Coronal TRUS of the prostate shows a midline cyst. To distinguish among EDC, utricle cyst, or Müllerian duct cyst, examine the relationship of the cyst with the urethra. (Right) Longitudinal TRUS in the same case shows the cyst cephalic to, but separate from, the ejaculatory duct and communicating with the urethra. Features favor an utricle cyst.

Utricle Cyst



Müllerian Duct Cyst

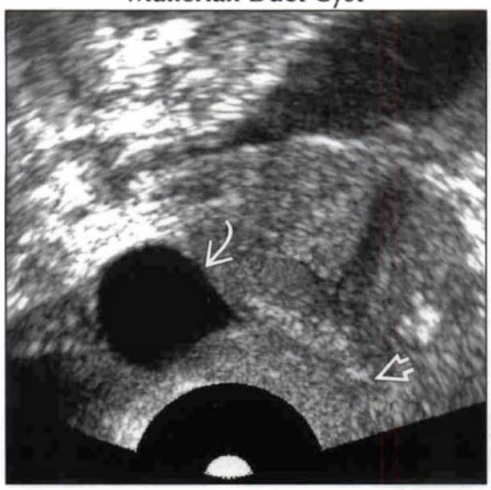


(Left) Coronal TRUS of the prostate shows a midline cyst at the level of the prostatic base suggestive of a Müllerian duct cyst. An EDC is less likely, because an EDC at this level should be paramedian instead of median. (Right) Longitudinal TRUS of the prostate shows the same cyst posterior to the bladder neck with no obvious communication with the urethra. A müllerian duct cyst is usually larger than a utricle cyst and rarely communicates with the urethra.

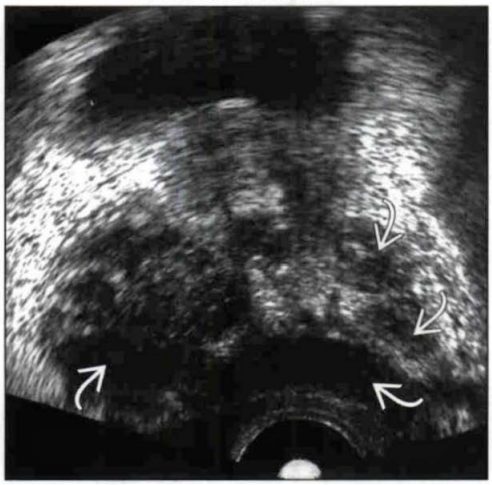
Müllerian Duct Cyst

FOCAL LESION IN PROSTATE

Müllerian Duct Cyst

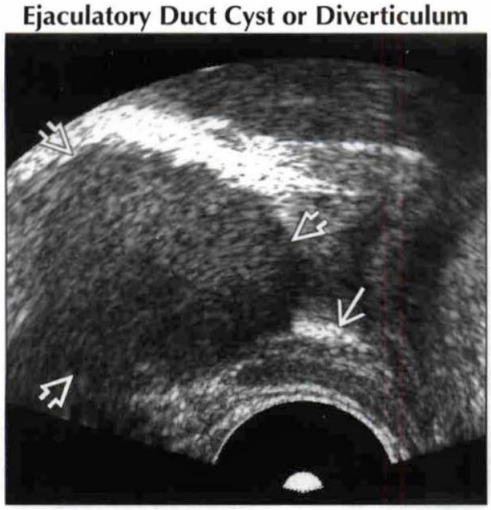


Prostatic Abscess

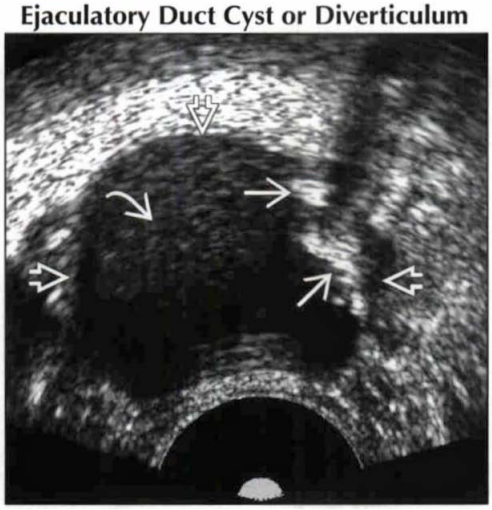


(Left) Longitudinal TRUS of the prostate shows a teardrop-shaped cystic lesion typical of a Müllerian duct cyst lying posterior to the verumontanum. When large, such cysts may extend cephalad above the prostatic base. (Right) Coronal TRUS shows an enlarged prostate deformed by multiple cystic lesions in a patient with acute prostatitis. Note the cysts contain internal debris with features suggestive of abscesses.

Ejaculatory Duct Cyst or Diverticulum

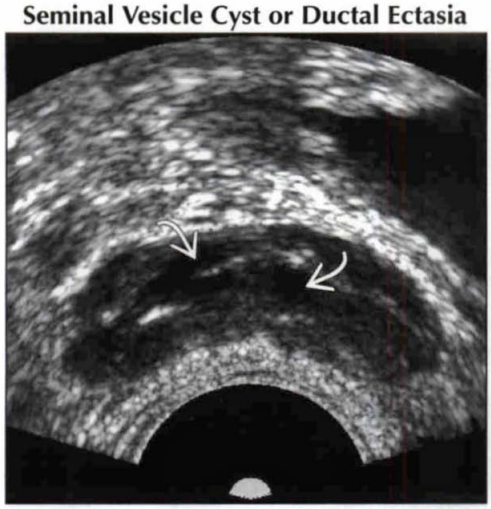


Ejaculatory Duct Cyst or Diverticulum

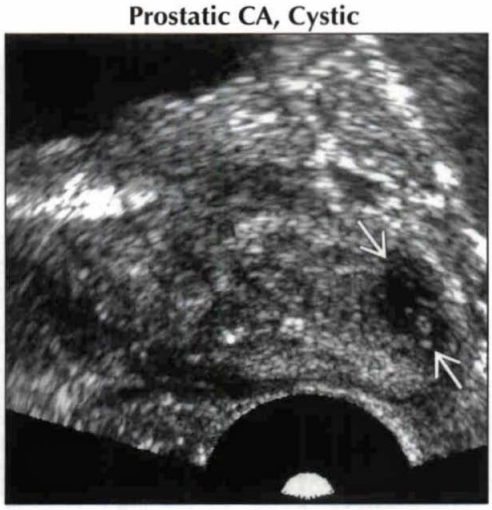


(Left) Longitudinal TRUS of the prostate shows a large cyst in a patient complaining of hemospermia. The cyst is seen arising from the ejaculatory duct and extending beyond the prostatic base. The aspirate contained spermatozoa confirming it to be an EDC. (Right) Coronal TRUS of the prostate in the same case shows internal echoes within the cyst which represent hemorrhage and calcifications, common findings in an EDC.

Seminal Vesicle Cyst or Ductal Ectasia



Prostatic CA, Cystic



(Left) Coronal TRUS of the seminal vesicles shows ductal ectasia, which may be caused by ejaculatory duct obstruction due to calculi, large midline cysts, and congenital causes, such as agenesis of the ejaculatory duct or vas deferens. (Right) Longitudinal TRUS of the prostate shows a histologically proven cystic prostatic CA. Note the cystic lesion has an irregular wall and internal echoes with an appearance resembling an abscess.

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