A Colour Atlas of

Conservative Dentistry

J. Ralph Grundy
BDS, (B'ham), LDS, RCS(Eng), MDS, VU (Manc)

Senior Lecturer and Tutor in
Conservation Techniques, University
of Birmingham Dental School
Consultant Dental Surgeon,
Birmingham Area Health
Authority (Teaching)

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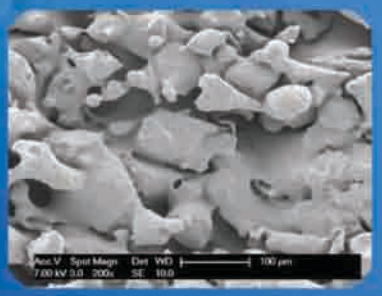

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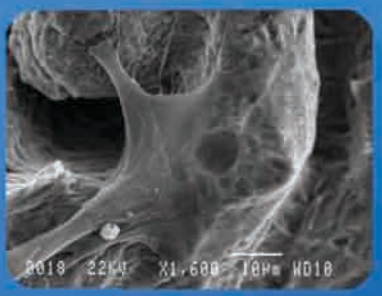

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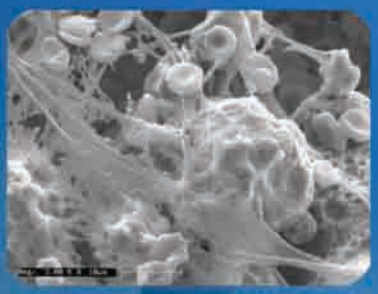
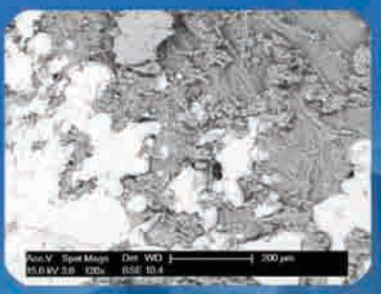


Fast bone growth (dark) inside the surface (clear)



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المنـار

لأجهزة ومستلزمات طب الأسنان

المركز الرئيسي، صنعاء الدائري الغربي

ت، 628948 - 406077 موبايل 711187320

فرع عدن، ت، 396973

info@awas1.com

المسئول العلمي

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NOVAXATEAM


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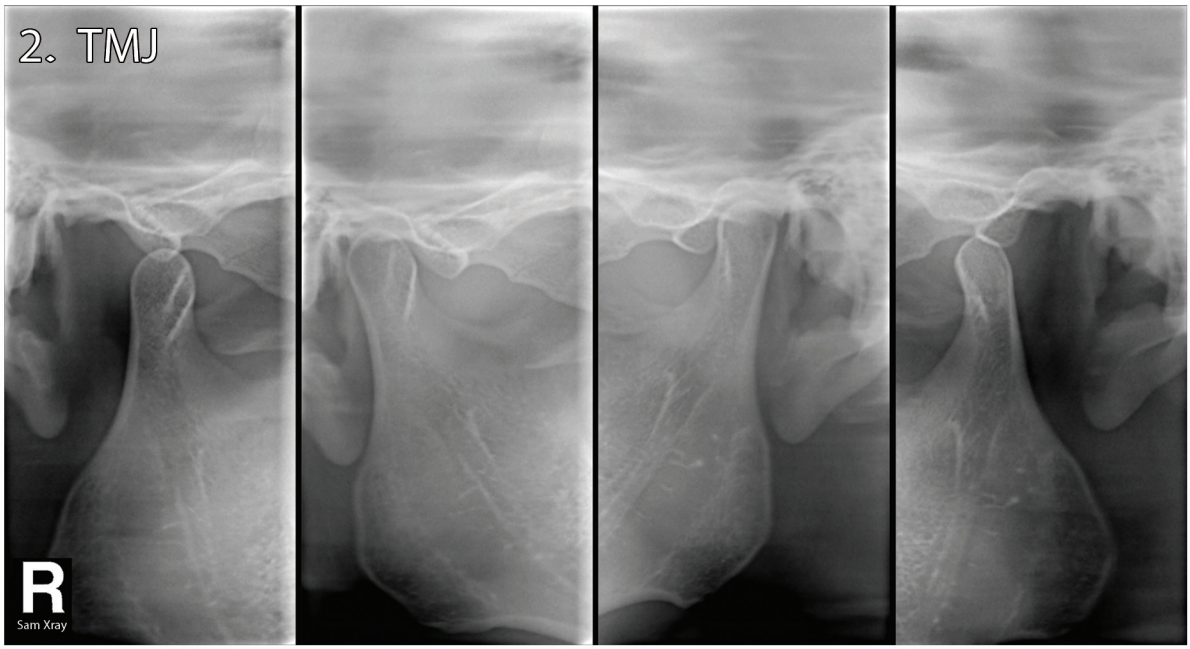
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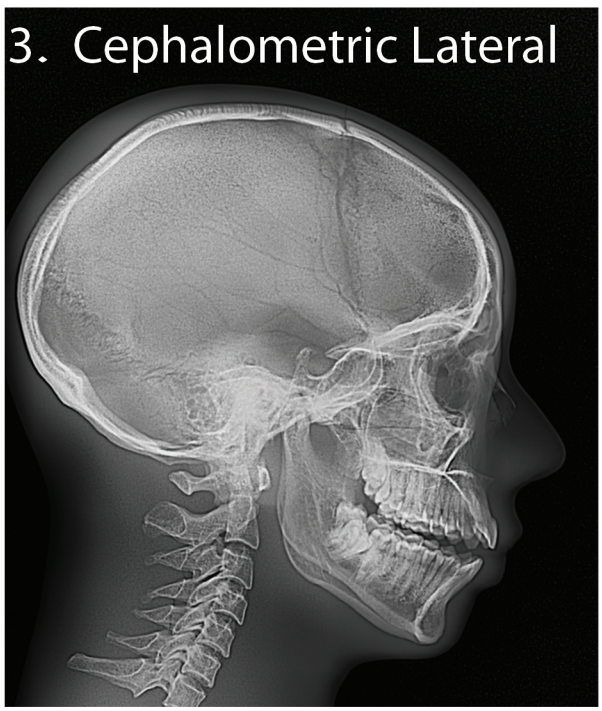

3. Cephalometric Lateral


4. CARPUS
V
Sam Xray

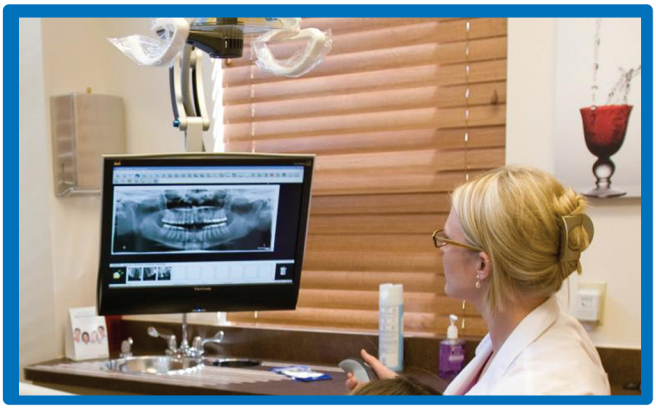
سام للأشعة الرقمية أول مركز رقمي متخصص في الجمهورية اليمنية حرصا منا على تقديم خدمة ذات جودة عالية تساعد بشكل كبير في دقة التشخيص و المعالجة للمرضى و مميزات كثيرة اخرى مثل:

- صور ذات دقة عالية مطبوعة أو على أقراص سيدي.
- يتعرض المريض لجرعة أشعة منخفضة جدا مقارنة بالأشعة العادية (الأفلام).
- سهولة الأرشفة بالكمبيوتر لصور الأشعة وكذلك سهولة استرجاع الصور من قبل الطبيب.
- ثبات دائم في جودة الصور حيث لا تتغير معا الوقت.
- سهولة الشرح والتواصل لإقناع المرضى بحالتهم والخطة العلاجية المناسبة.
- سهولة التبادل الكترونيا لصور الأشعة حيث تستطيعون استلامها و إرسالها بالبريد الالكتروني أي وقت.
- سهولة عمل نسخ متعددة لنفس الصورة .
- سهولة معالجة الصورة باستخدام برنامج Easydent4 المرفق لكم في السيدي لتشخيص أفضل.
- سهولة إجراء أي قياسات بدقة عالية لتحديد مكان وطول الزرعات وأي قياسات أخرى.
- المحافظة على البيئة بعدم استخدام مواد كيميائية في التحميض وغيره.

-عمل تحليل سيفالومترك رقمي للحالات ببرنامج Orthovision وإعطائكم تقارير مفصلة.

- سهولة تصفح الأشعة بمستعرض الصور العادي أو مطبوعة.
- يوجد أخصائية أشعة للنساء.

كذلك بمناسبة الافتتاح :

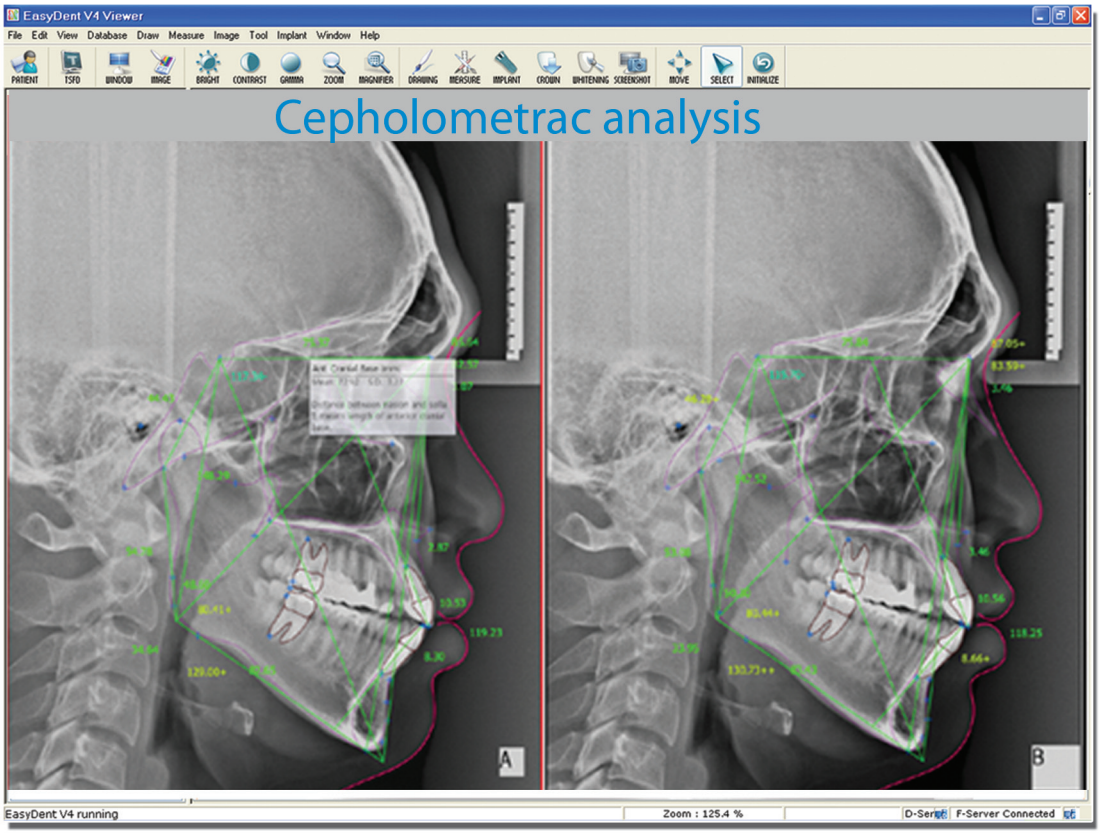


1- أول صورة أشعة مجانا.

3- تدريبكم على طريقة استخدام برنامج EasyDent 4 والتمتع بكافة مزاياه مجاناً.

4. تصميم شعار عيادتكم على غلاف السيدي لكي يكون دعاية لكم عند مرضاكم.

معاً يداً بيد في عالم الثورة الرقمية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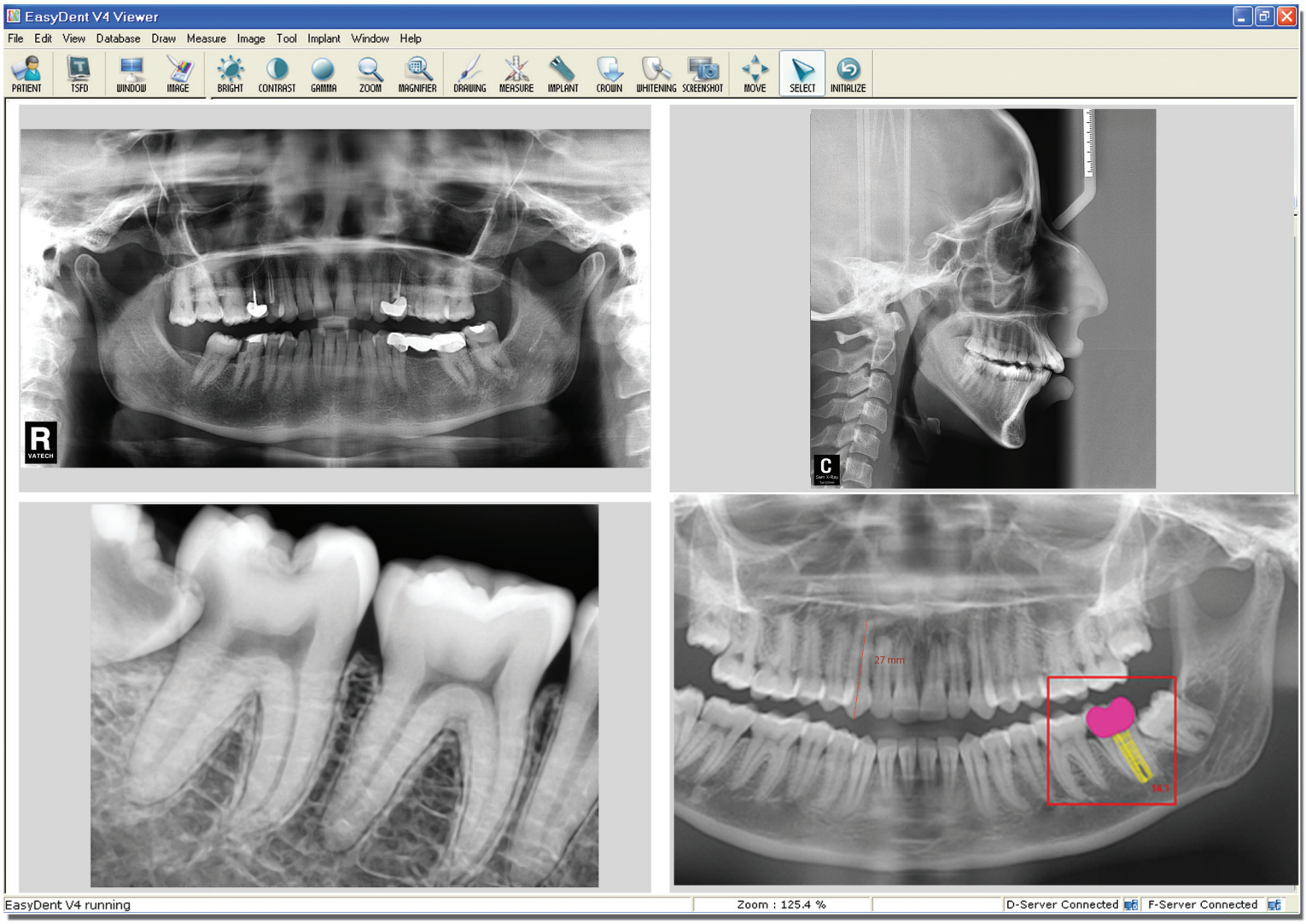
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Contents

Appendix

Preface

The title, *A Colour Atlas of Conservative Dentistry*, implies something more than Operative Dentistry but less than Restorative Dentistry. For instance, patient assessment, plaque control, crowns and bridges are included whereas periodontal surgery and the provision of dentures are not.

It is hoped that the Atlas will provide vivid graphic support for dental students embellishing their clinical experience and offer some fresh views and ideas for qualified practitioners. The latter might use some of the pictures to explain certain forms of treatment to their patients. It is not claimed, however, that this Atlas is in any way a testimonial to the dental paragon; indeed a number of less than satisfactory outcomes to treatment are included to stress that all practitioners of this most exacting art, Conservative Dentistry, experience difficulty, on occasion, in achieving perfection!

Although some aspects of the author's philosophy on his specialty are included by way of introduction, the Atlas is designed predominantly to be complementary to the many excellent textbooks on conservative dentistry and not a complete text in its own right. Pictures in this Atlas have been chosen where they might illustrate points better than black and white pictures found in the standard textbooks. Where appropriate, references are made to some of these textbooks and to the dental literature so that when read in conjunction with the Atlas, a full description of each topic may be obtained.

Acknowledgements

The author wishes to express his gratitude to many colleagues for their contribution of photographs for inclusion in the atlas, in particular to Mr A S Britton, Professor R M Browne, Dr J C Davenport, Dr F J Fisher, Dr A R Grieve, Mrs M C Grundy, Mr N Hall, Mr P S Hull, Dr J C Glyn Jones, Dr M A Mansfield, Mr D K Partington, Dr W P Rock and Professor D S Shovelton and to the staffs of the Clinical Illustration Department of the Birmingham Dental Hospital and the Photographic section of the Oral Pathology Department of the Birmingham Dental School who produced them; to Mr M Sharland of the Oral Pathology Department for taking many of the non-clinical photographs; to Mr T C Rowbotham of Manchester Dental School for permission to reproduce figure **145**, and to the publishers, John Wright & Sons, Bristol, for permission to use figures **408** and **410** which appear in *Inlays, Crowns and Bridges*, edited by G F Kantorowicz.

Particular thanks are due to Dr J C Davenport for his skilful interpretation and reproduction of the author's scribbled line drawings.

The forebearance of the many staff, students and their patients in allowing frequent interruptions by the author and his camera is also much appreciated.

Finally, grateful thanks are offered to Mrs M Bailey for her indefatigable work in producing the typescript and to my wife and Professor D S Shovelton for reading it and making many helpful suggestions.

1 Patient assessment and treatment planning

Before starting any restorative work, it is sound policy to assess the patient first as a whole person. This is because identical clinical conditions are not necessarily treated in identical ways. A multitude of factors may influence the treatment plan of the dentist, not least of which are the patient's wishes, availability for treatment, age and general health. The mouth should also be regarded as a whole before work is started on a single unit within it. Diseased teeth may be treated in a variety of ways, the choice being influenced for instance by the condition of the other teeth and the supporting structures.

In order to consider quickly and efficiently the multiplicity of factors involved in a thorough dental assessment, it is advisable to have a set procedure of HISTORY and EXAMINATION to follow (see Appendix 1).

Full information obtained from a comprehensive scheme of enquiry will allow the formulation of a TREATMENT PLAN and this may vary considerably for superficially similar patients. It should not be assumed that there is a standard form of treatment for each manifestation of dental disease. For example, for a patient with extensive caries, the treatment plan may be to remove the caries and restore the teeth with the best filling materials available. On the other hand, for a patient who has ineffective or poorly motivated oral hygiene, it may be necessary to make a two-stage treatment plan, the first part of which is to aim for good oral hygiene. The second part would be dependent on the outcome of the first – success leading to advanced restorative work and failure leading to basic minimal restorations or even extractions. Thus, the patient's motivation is a critical factor in determining a treatment plan. In this context it is useful to employ a Plaque Index or a Gingival Index, which can give numerical value to progress made in oral hygiene improvement. This can be of help in improving the patient's motivation, especially when associated with a disclosing solution which enables the patient to monitor his or her progress at home.

Age is another moderating factor in treatment planning. One example of this relates to the occlusal fissure which is found to be sticky on probing. This would probably be filled without hesitation when found in a first permanent molar of a child aged seven, having probably become carious after being at risk for only one year. Finding exactly the same clinical evidence in a patient of say 46 would lead one to keep the tooth under review rather than filling a tooth which in 40 years had produced only a sticky fissure!

Although this Atlas deals mainly with the conservation of the teeth, this subject must never be considered in isolation to the neglect of other specialties. Simply because it is technically possible to restore a tooth does not mean that the tooth must be restored. In the concept of treating the mouth as a whole, reference to the patient's needs of orthodontic or prosthetic treatment for instance may lead to the decision of extracting a tooth which was capable of being restored. Inter-relationships between specialties must also be borne in mind for instance in the design of a partial denture, which may in turn influence the design of a restoration if rest seats and retentive undercuts are involved.

Many personal factors can modify a treatment plan as, for example, the availability of a patient to attend for a lengthy series of appointments. The ideal treatment plan might include the provision of crowns, bridges and inlays but the patient may be unable to find the time for this advanced work to be done. The time involvement could then be reduced by restoring the smaller lesions with amalgam or composite, extracting the teeth needing more complex restorative work and providing partial dentures to replace these. The possible permutations of Treatment Plans are far too numerous to list here but a few general principles are given as a guide to priorities.

1. The treatment of pain must take precedence over all else.
2. Teeth of doubtful vitality or with extensive carious lesions should be thoroughly investigated before a definitive treatment plan is made. Large lesions should be stabilised at an early stage with zinc oxide/eugenol dressings so that the lesions do not progress whilst waiting their turn for treatment.
3. Scaling, polishing and plaque control should precede all other treatment, except that for pain and stabilisation, for the following reasons
   a. It gives the opportunity for the patient's motivation and effectiveness in plaque control to be monitored at succeeding visits.
   b. The patient's response to plaque control may have a bearing on the rest of the treatment plan.
   c. Being comparatively pleasant and painless, scaling and polishing is a good introduction to a course of dental treatment and helps to establish a good operator/patient relationship.
   d. The improvement in appearance and freshness of the mouth following scaling and polishing can raise the patient's interest in, and appreciation of, dentistry.
   e. It often results in a pleasanter mouth for the operator to work in.
   f. It should remove certain impediments to operative dentistry – for instance, the likelihood of gingival haemorrhage should be reduced, the true shade of the teeth can be seen for accurate colour matching, the true gingival margin will be established before teeth are prepared for crowns, calculus will be removed to allow the proper application of a matrix band.
   g. The need for periodontal surgery can be decided.
4. Where a partial denture and restorative work are both required, the denture should be designed before restorative work is started but the restorative work should be completed before impressions are taken for the denture.

Bearing these priorities in mind, the majority of treatment plans for restorative dentistry resolve themselves into straightforward periodontal treatment, the filling or restoring of teeth and the occasional extraction, bridge and partial denture.

However, certain conditions can make treatment planning a little more complex, as for instance, where there is unusual or gross tissue loss involving several teeth or where there is mal-formation, mal-position or congenital absence of teeth.

Tooth notation

Throughout this Atlas, teeth are designated by Palmer's Notation. The four quadrants are indicated viewing the patient from in front, thus ⌊Q is the upper left quadrant. The permanent teeth are numbered from 1 to 8, from central incisor to third molar and the primary teeth from A to E, from central incisor to second molar. Thus the upper left first permanent molar is shown as ⌊6. Palmer's Notation and that of the Fédération Dentaire International (FDI) are given below for comparison.

Patient's Right								Patient's Left							
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

2 Plaque

For any particular patient, the amount of plaque retained on the teeth can vary considerably according to the inter-relationship between dietary intake, and the frequency and effectiveness of the plaque removal methods employed. Whilst it is not intended that this Atlas should act in any way as a text on Preventive Dentistry or Periodontics, nevertheless it must be emphasised that effective plaque control should be the precursor of the restoration of teeth. In this endeavour, it is important for the dentist to be able to monitor the plaque state of the mouth. Such monitoring is more meaningful to the dentist and dramatic for the patient if it can be measured, and there are several plaque and gingival indices that can be used for this purpose. One such plaque index (Appendix 2) is the Patient Hygiene Performance (PHP index) of Podshadley and Haley (1968). The significance of this index will of course be influenced by the time interval since the patient last cleaned his or her teeth, and this must be borne in mind when discussing it with the patient. A similar sampling technique is used in the plaque index of Silness and Löe (1964). Areas of gingivitis based on numerical values of degrees of inflammation can also be counted, although Silness and Löe stated that the presence and amount of plaque alone gives adequate expression of the state of oral hygiene.

1 The gingivae seen here are as nearly perfect as can be achieved with the conscientious use of plaque control methods. The gingivae meet the teeth in a 'knife-edge' margin, the contour of which follows the amelo-cemental junction around all teeth. The interdental spaces are well filled and the gums are light pink and show stippling.

1

2 Most surfaces of the teeth of this patient are free of plaque but a disclosing solution reveals very light deposits which might otherwise have gone undetected, particularly inter-proximally in the upper right quadrant and lower incisor region.

2

3 & 4 Without the aid of a disclosing solution, the plaque deposits on these teeth are barely detectable. Occasional slight signs of gingival inflammation indicate where deposits might be (**3**). After the use of a disclosing solution, widespread plaque deposits against the gingival margins are revealed (**4**).

3

4

5 & 6 A thin film of plaque near the gingival margin – Silness and Löe Grade 1 – is detectable by running a probe across the tooth surface (**5**). The plaque is however better seen by the more sensitive method of applying a disclosing solution (**6**).

5

6

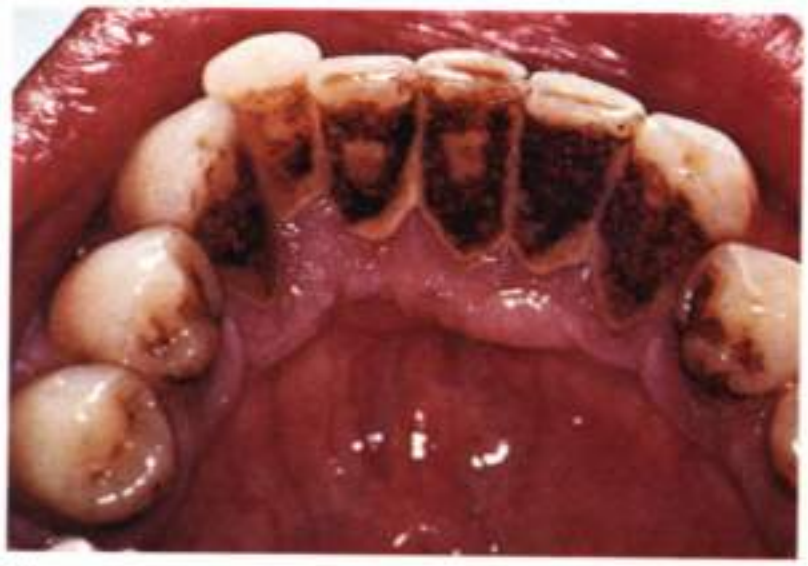
7 & 8 These gross plaque deposits near the gingival margin are obvious to the naked eye – Silness and Löe Grade 3 – resulting in universal marginal gingivitis. This is recognised by the 'rolled' gingival margins, the swollen interdental papillae due to the oedema and the reddening of the free gingivae due to hyperaemia. The use of Neutral Red as a disclosing solution is recommended more to shock the patient than to inform the dentist (**8**).

7

8

9 Heavy deposits of calculus are usually seen without recourse to disclosing solutions as on the lingual surfaces of $\overline{321|123}$. The heavy staining, possibly by tobacco, tea or coffee, indicate that the deposits are longstanding ones. It is necessary for the dentist to remove this calculus to allow the patient to get access to the teeth to keep them free of plaque deposits by home care. Smaller deposits of unstained calculus which match the colour of the teeth are readily revealed with the air spray. This reflects the gingivae to give a good view into the pocket, and by drying the calculus turns it to a chalky appearance which contrasts clearly with the enamel.

9



10 The complete absence of any oral hygiene in this mouth is emphasised by the layers of desquamated epithelium, which have been left undisturbed on the attached gingivae.

10

11 This patient has exceptionally heavy deposits of calculus on both upper and lower teeth on the right and no obvious deposits elsewhere. This condition is brought about by the avoidance of chewing on the right side and should warn the dentist to look for some underlying cause for this.

11

Plaque control

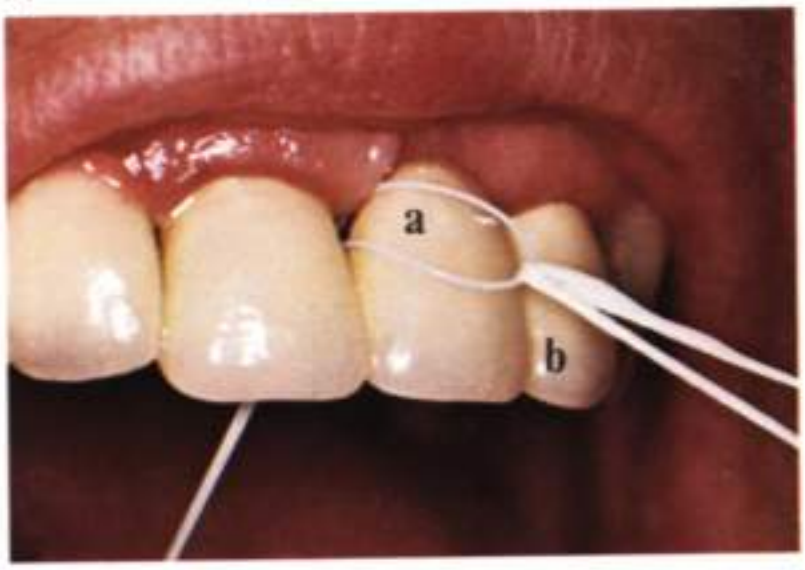
12–16 Following removal of all deposits from the teeth, it is essential to guide the patient in methods of plaque control if rapid re-deposition is to be prevented. Ideally, before any course of conservative treatment is started, the patient should demonstrate his toothbrushing technique (**12**) and this should be improved by the dentist where it is found to be inefficient and checked at subsequent visits throughout the course of treatment.

Interproximally, the teeth are not usually accessible to the toothbrush. Where there is evidence that plaque is causing inflammation of a papilla, the proximal tooth surfaces can be cleaned by dental floss (**13**) which wipes off the plaque deposits from each tooth in turn. Where there is difficulty in introducing dental floss, for instance between the abutment teeth of the bridge seen here (**14**), it may be assisted by a floss threader. The floss threader (a) is passed from the buccal to the lingual side of the space, after which the floss (b) is fed through the loop of the threader and is pulled through in the manner of threading a needle.

12

13

14



It is possible to use a wood stick interproximally where there is space to introduce one (**15**). Patients often find sticks easier to use than floss but being straight and rigid, they do not clean convex surfaces as effectively. At regular intervals, patients should monitor the effectiveness of their plaque control by the application of a disclosing solution (**16**). Food dyes are cheap, non-toxic and readily available or alternatively, a simple non-irritant dye such as neutral red may be prescribed by the dentist. After thoroughly cleaning the teeth, the disclosing solution is applied by the patient with a cotton bud stick and the excess is rinsed away. The dye will stain any remaining plaque which will then readily be seen and can be removed by the patient. A small disposable dental mirror is essential to enable lingual aspects to be checked.

15

16

17 & 18 The benefit of proper home care of the teeth is demonstrated well by this patient who showed marked signs of marginal gingivitis (**17**). Solely by the adoption of plaque control methods, the gingivae were restored to health within seven weeks (**18**).

17

18

19 Over-zealous use of the toothbrush should be curbed, however, to avoid causing abrasion of the necks of the teeth. Here the distribution of the abrasions is confined to $\frac{5432|}{43}$ which indicates a faulty brushing technique, which should be corrected by the dentist or hygienist.

19

20 The gingival papilla between $\underline{|12}$ has been burnt by the application of 20% chlorhexidine. This drug has been found useful for the prevention of plaque formation when applied in the proper dosage in gel form or in mouthwashes. However, too strong a dose can be damaging to the soft tissues.

20

21–24 Plaque formation is likely to be encouraged by faulty dental treatment as, for instance, by use of the wrong restorative materials, by leaving restorations unpolished, with marginal deficiencies or positive edges and by creating situations where access for plaque removal is difficult. It is important to realise that faulty dentistry, or lack of proper instruction to the patient, can result in soft tissue inflammation where none existed before.

21 This poorly made acrylic crown with ill-fitting margins, for instance, makes plaque removal difficult. The condition is further aggravated by the 'percolation' effect resulting from the different thermal coefficients of expansion between tooth substance and acrylic. This condition can be remedied by remaking a good fitting crown in porcelain and by instituting effective plaque control.

21

22 & 23 The bridge carrying the porcelain-fused-to-gold pontic replacing the 4 is retained by a full veneer crown on the 6 and a three quarter crown on the 5. The gingival condition is sound at the time of cementation (**22**).

Six weeks after cementation, however, plaque accumulation between the retainers on 65 has caused inflammation of the papilla (**23**). This is a situation where a threader is required in order to introduce floss beneath the soldered joint connecting the gold units.

22

23

24 The mucosa under the pontics replacing the 1|12 was found to be severely inflamed and ulcerated when the bridge was removed, due to a combination of factors. The pontics were made of acrylic which is badly tolerated by the mucosa – either due to residual monomer or the difficulty in obtaining a smooth surface. Furthermore, the pontics in the 1|2 areas have too broad a contact with the mucosa which creates difficulty in cleaning adequately. It is also possible that the technician 'socketed' the model before making the pontics, a technique which is not recommended.

24

3 Caries

Caries diagnosis

The gross carious lesion is readily diagnosed by the patient or any other lay person and does not warrant inclusion here. The early lesion, however, is often far from obvious, especially the Class II interproximal cavity, and careful observation is necessary if such a lesion is to be identified and treated whilst still small.

The Class II lesion in its infancy is not usually detectable by simple clinical means unless the absence of the adjacent tooth allows the 'white spot' lesion to be seen. There is no actual cavitation for the probe to detect at this early stage, and it is therefore necessary to rely on bitewing radiographs wherever posterior teeth are in contact if the smaller lesions are to be diagnosed.

25 This stained ground section shows on the left an early lesion confined to enamel and probably too small to register radiographically. On the right, the carious process as well as affecting the appearance of the enamel has also spread at the amelodentinal junction and caused a reaction within the adjacent dentinal tubules. There is still no cavitation at the enamel surface and this size of lesion would be the smallest to be detected on a bitewing radiograph (see **33**). This is due to the comparative insensitivity of the radiographic evidence of caries which lags behind the actual lesion (Gwinnett 1971).

25

26 & 27 Premolars and molars cannot therefore be pronounced free from caries by visual examination alone. These teeth, for instance, are apparently caries – free, (**26**). On bitewing examination, however, the $\overline{7}|$ is seen to have a large carious lesion mesially, (**27**).

26

27

28 & 29 The early Class I lesion rarely shows radiographically and is usually detected by probing the occlusal surface. The efficiency of this method will vary with the sharpness of the probe, the sharper it is the more early lesions will be detected. Some 'sticky fissures' may turn out to be non-carious, (**28**) while others are quite extensively carious (**29**) despite an apparently intact occlusal surface. However, if all sticky fissures are filled, the majority will have constituted a real treatment need. An exception to filling may be made in patients over the caries prone age with clean mouths or recently erupted teeth, which may preferably be fissure sealed.

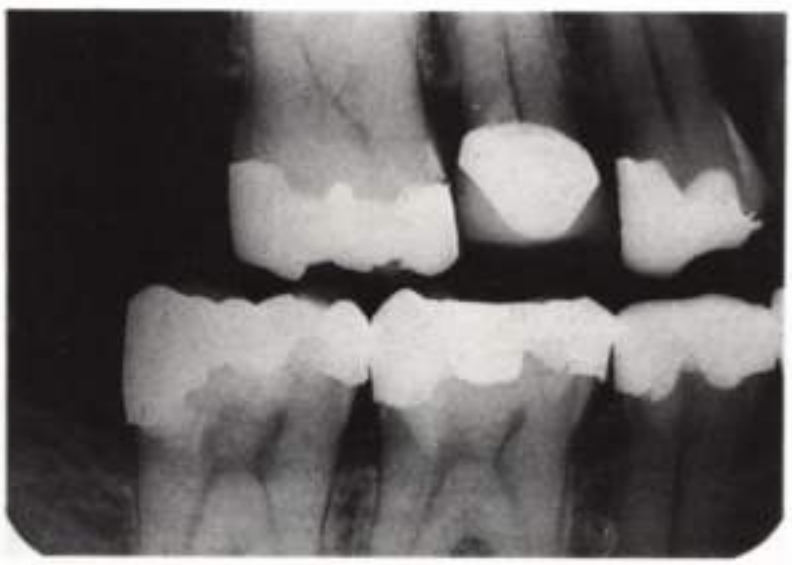
28

29

30, 31 & 32 Bitewing radiographs are preferable to periapicals for caries assessment, because apart from reducing radiation to the patient by reducing the number of films required, the bitewing view of the coronal area is likely to be less distorted than on a periapical film. A more accurate assessment of bone levels is also possible. These points can be confirmed by comparing these two periapical views (**30 & 32**) with the bitewing radiograph of the same area (**31**).

30

31



32

33, 34 & 35 The rate of growth of an untreated interproximal lesion is very variable. It is reported by Berman and Slack, 1973, as being surprisingly slow, but it can be quite rapid as seen on this series of bitewing x-rays taken at yearly intervals. The lesion mesially on $\overline{6}|$ has developed to a considerable size and a lesion has also started in the adjacent $\overline{5}|$. If any doubt exists about the advisability of filling a minimal lesion, it would seem reasonable to monitor its progress at least annually.

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35

36 & 37 Bitewing radiographs are not essential to detect early carious lesions in anterior teeth as they are thin enough to show carious lesions by means of transillumination. In reflected light, there is no evidence of caries mesially on $|\underline{1}$ in this patient (**36**).

If a bright light is used and the anterior teeth are examined from the palatal aspect, a carious lesion will show readily as a slight shadow within the body of the crown (**37** – arrowed). It is, of course, necessary to polish off any surface stain before transilluminating to avoid confusion.

36

37

38 This sectioned upper central incisor shows a minimal caries lesion on the left, similar to that which would have created the shadow seen in the previous figure. The lesion has spread at the amelo-dentinal junction, but has not yet caused actual cavitation by breakdown of the overlying enamel. The earlier lesion seen on the right might just be detectable using transillumination.

38

39 Larger Class III lesions can be seen by reflected light as is the case with the mesial lesions in 1|1.

39

40, 41 & 42 Recurrent caries is readily detected if unsupported enamel breaks away from the margin of a restoration, to reveal the carious dentine below as seen bucco-cervically to the amalgam in $\overline{7}|$ (**40**).

Before the collapse of unsupported enamel, the colour changes indicative of carious dentine can often be seen, by the observant operator, through the semi-translucent enamel. An extensive example of recurrent caries is shown here (**41**) around the amalgam restoration in |5.

Recurrent caries in the depth of a cavity or at the cervical margin may not be seen clinically, although it may be suspected when a history indicative of pulpitis is given by the patient. Bitewing radiographs will often show recurrent caries under such conditions (**42**) as is the case cervically to the amalgam restorations in $\overline{65}|$.

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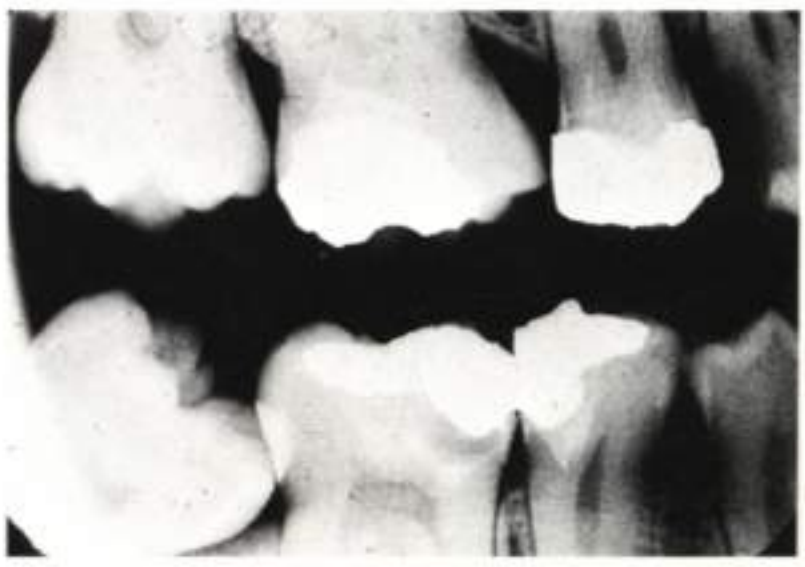

43 Unexpected caries confined to a few teeth in the mouth often indicates a specific local factor. The cause of the extensive Class V lesions in |123 has been traced to mint sweets which were allowed to dissolve slowly in the adjacent buccal sulcus.

43

44 The search for caries is frequently initiated by the pathognomonic pain picture obtained from the patient. On occasion, however, a thorough examination fails to discover any exposed dentine to account for the symptoms. A possible explanation may be found in the 'cracked tooth syndrome' which was the case in respect of this |6. The enamel is cracked through its full thickness disto-palatally in two places, allowing slight movement of the enamel during mastication which stimulates the underlying dentine. This syndrome is becoming recognised as a frequent cause of previously mysterious toothaches (Cameron 1964 and 1976). Removal of the cracked enamel and replacement with a suitable filling may result in relief of the symptoms if the crack is confined to enamel.

44

Caries prevention

As well as plaque control and dietary advice, two other methods of caries prevention can be considered, fissure sealing and topical fluoride application. Despite the proven value of systemic fluoride in preventing caries, it is not as effective for fissured surfaces as it is for smooth surfaces of the teeth. This is related to the difficulties of efficiently cleaning fissured areas, and a method of overcoming this problem is to obliterate the plaque retentive fissures by filling them with a resin as recommended by Gwinnett and Buonocore (1965).

Fissure sealing

45–51 The ⌈6 shown here is recently erupted and caries free (**45**) and is considered suitable for fissure sealing.

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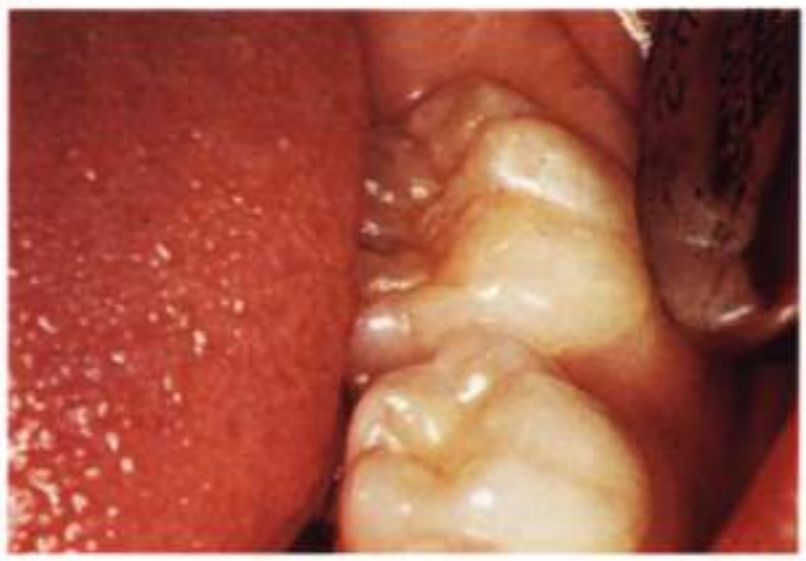

Its occlusal surface is cleaned as thoroughly as possible with a brush and polishing paste (**46**) in order to present a bare enamel surface to the etchant.

46

This is applied with a brush (**47**) or small pledget to the fissure and the enamel immediately surrounding it.

47

For the best result, the etching fluid is kept on the move, usually for about 60 seconds. After washing away the etchant and dissolved enamel with water, the surface is dried thoroughly, after which the etched surface will appear 'chalky' white when compared to the original surface (**48**). The effect on the enamel is demonstrated by this SEM picture of an etched enamel surface (**49**). The grossly irregular surface created provides an excellent mechanical lock for the resin. From this point onwards scrupulous moisture control must be maintained if the etched surface is not to be contaminated with saliva, which would interfere with the retention of the resin. The resin is flowed into the fissures and over the etched enamel using a small brush (**50**).

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Finally, the sealant is polymerised using an ultra-violet light source (**51**). Some sealants are polymerised chemically by mixing the resin with an activator.

Topical fluoride application

Fluoride can be added to the enamel surface by topical application, thus increasing the enamel's resistance to decalcification. This can be done daily by the patient through the use of a fluoride containing toothpaste or fluoride rinse. A boost to the surface fluoride can also be given by the dentist by periodic topical applications of a gel containing a high concentration of fluoride.

52 & 53 A typical fluoride application kit contains a series of different sized trays with partially inflated rubber linings. The appropriate size tray is chosen, into which is placed a paper liner which is then filled with the fluoride gel (**52**). This is placed into the patient's mouth. Closure onto the tray with the opposing teeth caused the rubber insert to apply pressure to the gel forcing it between the teeth. This is left in place, usually for two minutes, salivation being dealt with by drainage tube incorporated into the tray (**53**).

52

53

Stabilisation

Caries, being a progressive disease, extends further into the tooth with time. If this destructive process is to be minimised, it should be treated as soon as possible, preferably with a permanent restoration. On occasions, however, it is not possible to treat all the caries completely for several weeks, as for instance, in the case of a patient requiring multiple fillings. In this event, it is wise to prevent the further increase in size of any large carious lesions by temporarily dressing such teeth with a zinc oxide/eugenol cement – a process known as stabilisation. If stabilisation is to be fully effective, three simple criteria need to be satisfied:

1. The cavity created should be retentive.
2. The surrounding enamel should be strong enough to resist subsequent fracture.
3. The margins should be caries free.

Such minimal preparation can be quickly done for several teeth with chisels and excavators, and often without the need for rotary instruments or local anaesthesia. The carious lesion will thus be arrested by a combination of a marginal seal, which prevents further nutriment from reaching the bacteria, and by the antiseptic nature of the dressing. This procedure should also eliminate incubation areas for micro-organisms (McDonald 1960) and allay any pain attributable to dentine irritation. However, care should be taken with both history and examination to identify situations where the pain picture indicates severe pulpitis or apical periodontitis, associated with an open carious exposure of the pulp. If such a cavity were to be closed with a dressing, a severe reaction due to lack of drainage may ensue.

54

54 This ground section shows an extensive carious lesion occlusally of a size that would warrant stabilisation. The amount of enamel and caries removal required is indicated. Note that it is not necessary, at this stage, to make the cavity caries-free. As such preparation does not extend into sound dentine, there should be little discomfort caused and therefore no need for anaesthesia.

55

55 Large cavities in the lower molars have been stabilised with zinc oxide/eugenol dressings. Whilst still un-set, their occlusal surfaces are contoured by the opposing teeth so that a traumatic occlusal relationship is avoided.

4 Pulp capping and partial pulpectomy

If the pulp of a tooth becomes exposed, a choice has to be made from four possible methods of treating the condition:

Pulp capping

Partial Pulpectomy

Pulpectomy

Extraction of the tooth

The first decision to be made is whether the interests of the patient are best served by saving the exposed tooth. There should of course be no medical contra-indications existent such as valvular disease of the heart. If it is decided to save the tooth then usually the best prognosis follows pulpectomy and complete root filling. If, however, pulpectomy is complicated by an immature open apex or some other anatomical difficulty, it may be necessary to resort to pulp capping or partial pulpectomy.

Pulp capping

The technique of pulp capping involves covering the exposure with a suitable dressing material, in the expectation that the opening will be repaired by secondary dentine laid down by the pulp. Certain criteria therefore must be satisfied if this procedure is to be adopted with any hope of success.

1. The pulp should be vital and not infected
2. The exposure should be small (<1.0mm diameter)
3. There should be no associated symptoms

If all these criteria are satisfied, there is a reasonable chance that repair will occur without unpleasant sequelae. It may, however, be difficult to assess accurately the absence of infection, moreover the lack of symptoms does not always imply freedom from progressive pulpitis.

56–58 The pulp wound is first covered with a dressing – usually calcium hydroxide – that will induce calcific repair (**56**). This may be introduced with a probe and allowed to flow over the wound without causing pressure on the pulp itself.

A pulp cap, prefabricated in plastic or soft metal, is then placed over the dressing (**57**) and in such a position as to give protection to the exposure from pressure, during the subsequent stages of filling.

The base cement is placed in the usual way, care being taken not to dislodge the cap, and the tooth is then ready to receive a permanent filling (**58**). The tooth should be monitored over the next few months for any untoward symptoms. Periodic vitality tests and radiographs should be undertaken to indicate whether the pulp remains vital and whether calcific repair has taken place.

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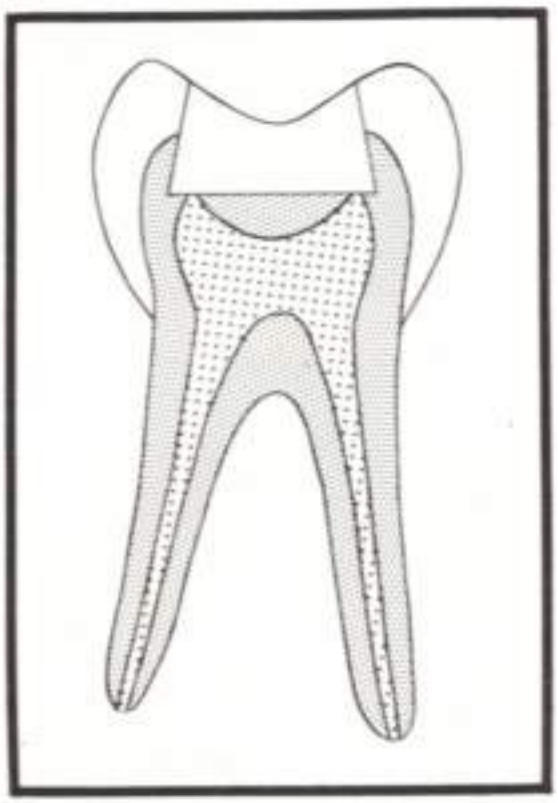
Partial pulpectomy

Where the criteria for pulp capping cannot be satisfied and pulpectomy is contra-indicated, then partial pulpectomy may be considered. The criteria for this to be successful are that the tissue in the pulp canals should be deemed vital and free from infection.

Partial pulpectomy involves removal of the coronal pulp tissue leaving a clean small wound at the entrance to each pulp canal, which is dressed with calcium hydroxide in order to induce calcific repair.

A technique for partial pulpectomy has been described by Britton (1976). He states that a successful outcome is dependent on the tooth being vital, with no history of pain, and on the absence of excessive bleeding at the time of pulpal excision which would suggest absence of inflammation in the pulp canals. The younger the patient the better the prognosis.

59

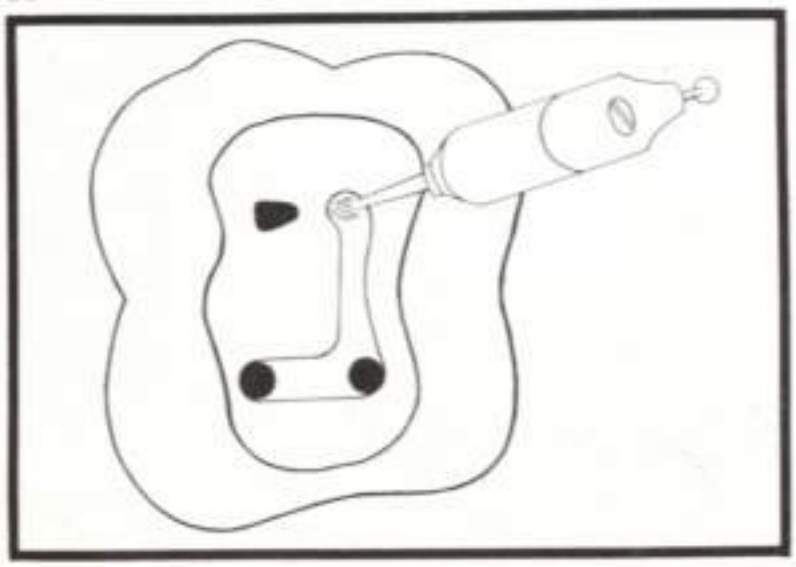


60

59–71 The first stage of this partial pulpectomy technique is to prepare a caries-free cavity giving a wide access to the pulp horns, which should just be exposed (**59 & 60**).

The roof of the pulp chamber is then separated from the tooth by a series of channels cut between the pulp horns (**61 & 62**). Care should be taken to restrain the depth of cutting to the thickness of the dentine, and to avoid unnecessary trauma to the pulp or introduction of debris into the pulp chamber.

61



62

The roof of the chamber can then be removed in one piece (**63**).

63

Amputation of the coronal portion of the pulp starts with its separation from the walls of the chamber by a sharp large excavator. This excavator is then introduced between the pulp and the chamber floor until it is in a position to sever the connection with the radicular pulp tissue. This should be done with a single clean cut across the entrance to each canal. The coronal pulp tissue can then be removed intact (**64 & 65**). This will result in slight haemorrhage which can be absorbed onto a small pledget of cotton wool. If haemorrhage at this stage is excessive, it is deemed to indicate an existing hyperaemia and the prognosis for the satisfactory formation of a calcific barrier would be poor. Complete extirpation and root filling should then be considered.

64

65

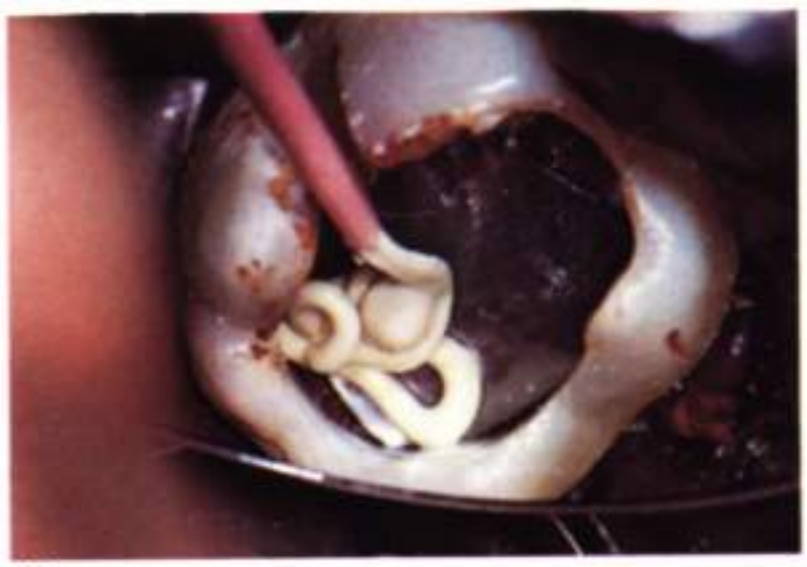
When haemorrhage has ceased, calcium hydroxide paste is introduced gently onto each pulp wound with a Jiffy tube (**66**). A small metal disc shaped from matrix band material is sterilised, and placed onto the floor of the cavity to create an artificial roof to the pulp chamber (**67**).

66

67

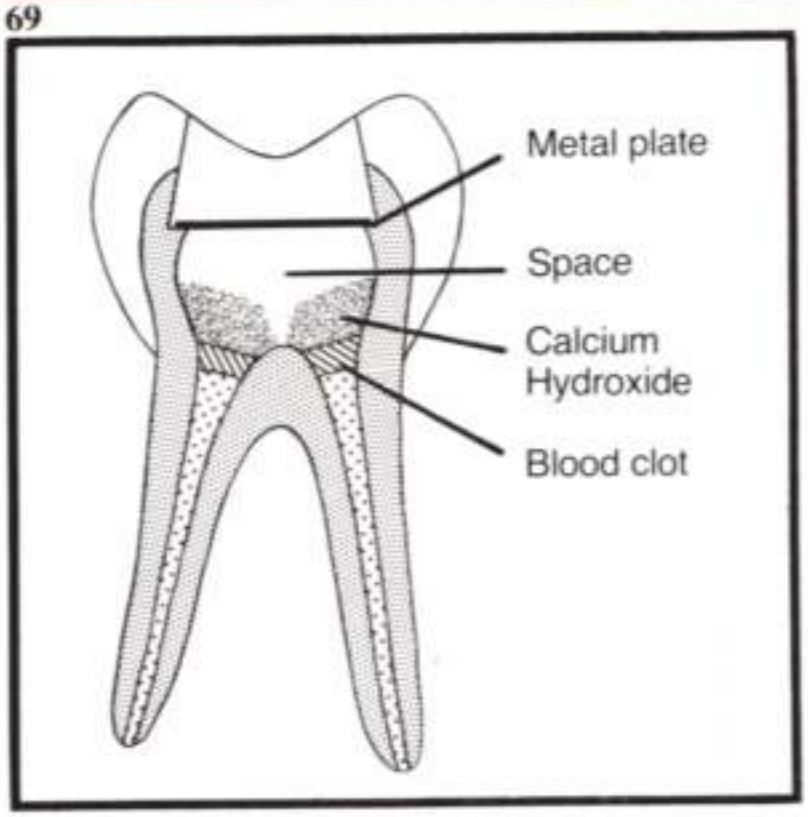
The metal disc should be well supported by the cavity floor which has been cut considerably wider than the pulp chamber. It is held in place with a zinc phosphate cement (**68**) and the remainder of the cavity is dressed with ZOE.

68



The completed partial pulpectomy is depicted in a line diagram (**69**) which shows the gap preserved between the wound dressing and the metal plate. This provides expansion space should it be required and thus prevents pressure being exerted on the healing pulp tissue. Advantages of this technique are that any heat from tooth cutting is confined to the pulp chamber roof, well away from the radicular pulp, and the secure metal plate protects this pulp tissue from pressure when the temporary cement is being compressed to achieve sound marginal adaptation.

69



Successful healing will result in the formation of a calcific barrier over each pulp wound (**70**). The vitality of the tissue in each pulp canal and the integrity of each dentine bridge should be checked individually by re-opening the pulp chamber at approximately eight weeks post-operatively. After washing away the calcium hydroxide and blood clot, the dentine bridges can be inspected (**71**) and an electric pulp test performed on each root in turn. Any canal that does not contain vital tissue should be root-filled. The bridge areas are then re-dressed with calcium hydroxide and the tooth filled permanently with fortified zinc oxide/eugenol and amalgam.

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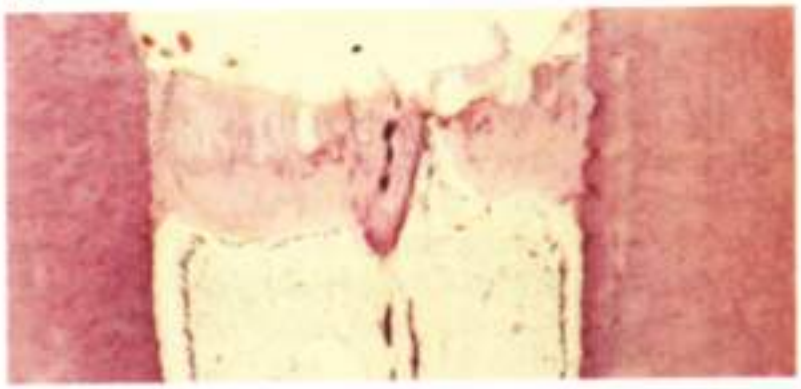


71

Masterton (1966) has pointed out that the anatomy of the molar tooth is such that it allows a clean cut to be made when amputating the coronal pulp tissue. Because of this, haemorrhage is minimal, and healing is by 'first intention' and tubular dentine formation.

5 Suspicion of non-vitality

It is important, during the examination of a patient, to identify any tooth that is non-vital in order that appropriate treatment may be carried out as soon as possible. There is always the risk that an infected pulp may exacerbate into an acute periapical abscess if left untreated. Even if the condition remains chronic, changes in the periapical bone may progress considerably making eventual treatment more difficult than it need be. In patients with certain medical conditions, such as valvular heart disease, such a potential nidus for infection can be a serious hazard to health. Thus a look-out should be kept for teeth which may be non-vital and where suspicion exists, tests for vitality should be made.

The following are some of the conditions under which a tooth may be suspected of being non-vital:

Tooth discolouration

72–74 This example (**72**) is an extreme one, probably resulting from the pulp being hyperaemic at the time of pulp death. The discolouration is due to breakdown products from the blood, the pigments of which enter the dentinal tubules and are then visible through the semi-translucent enamel. If there is not an excess of blood in the pulp when it dies, then the discolouration may be minimal.

72

Sometimes darkening of the crown (**73**) gives a false impression of non-vitality, when this is due to calcification within the pulp chamber interfering with the translucency of the crown. In this example the 1⌋ gave a vital pulp response. A radiograph shows that calcification has reduced the pulp size (**74**).

73

74

Signs of apical inflammation

75 & 76 An abscess is about to point through the mucosa buccally to the upper right central incisor (**75**). The source of this infection can be pulpal or periodontal. A negative response from 1] will confirm the origin as being pulpal. Of equal significance would be an existing sinus or, less obviously, a healed sinus which may show only as a small pinhead of scar tissue. A more widespread reaction (**76**) than the chronic and well defined lesion of the previous figure probably indicates an acute infection. It may well be periodontal in origin and it is of diagnostic importance to perform vitality tests on all the teeth in this region.

75

76

Excessively large restorations

77 Any restoration (or carious lesion) that is considerably larger than classical may well be associated with a non-vital tooth. Here suspicion of the large restorations is greater, due to the recurrent caries around the amalgams in 57.

77

Fractured incisors

78 Any unfractured teeth, upper or lower, which may have been affected by the blow causing the fracture should also be tested. Paradoxically, it is a frequent finding that the fractured tooth remains vital whilst adjacent unfractured teeth are non-vital.

78

Unlined silicate or composite restoration

79 & 80 This patient complained of tenderness of the ⌋2 which was restored with a large gold inlay (**79**). Routine vitality testing was performed on the upper front six teeth. This confirmed that the heavily filled ⌋2 was non-vital and further investigation showed this to be due to an exposure created during cavity preparation. The symptomless 2⌊ was also found to be non-vital though it had only a simple silicate restoration. Radiographs revealed the absence of a lining under the silicate and an extensive area of bone loss periapically (**80**).

79

80

Testing for vitality

A tooth is considered to be vital if a response can be elicited from a stimulus applied to the dentine or the pulp tissue. If a tooth's vitality is in doubt, therefore, the matter should be resolved before a local anaesthetic is administered. The simplest vitality procedure can be to start cavity preparation without anaesthesia and if a response is elicited from the dentine, this would indicate the presence of vital pulp tissue. Care must be taken in interpreting such a response from a multi-rooted tooth, where it is possible to have lost vitality in one root canal whilst maintaining it in another.

If stimulating the dentine with bur or probe is not conclusive or appropriate, other vitality tests may be applied to the dentine via the enamel.

81 The most reliable form of pulp testing is performed using an electric pulp tester of which there are many proprietary makes available. The stimulus from such an instrument is capable of gradual variation and can be measured. However, it is unwise to read too much significance into variations between teeth of response to the EPT as there are many factors which can affect this. The test is most useful in identifying a non-vital tooth through a nil response. The slow build-up of stimulus is an advantage in avoiding false results and for each tooth the level of response should be repeatable. It is important, if false results are to be avoided, to make a good moist contact between the operator's hand and the patient's soft tissues.

81

82 & 83 A response to a cold stimulus can be a simple method of determining vitality. A pledget of cotton wool soaked in a highly volatile liquid such as ethyl chloride (**82**) can be applied to a dried tooth (**83**) to evoke a response to cold. A negative response, however, does not always imply non-vitality due to numerous factors which might insulate the pulp from experiencing the cold stimulus, which itself will vary as evaporation ceases. False positive reactions may be obtained due to the pressure of application being elicited by the periodontal ligament, and mistaken by the patient for a vital response.

82

83

84 An alternative to cold is to apply a hot stimulus. Gutta percha can be heated and applied to the tooth. The tooth surface in this instance should be moist so that the gutta percha can be withdrawn quickly if pain is produced. This method has drawbacks similar to those of ethyl chloride, due to periodontal response and the variability in temperature of the stimulus.

84

Root canal therapy

Whilst root canal therapy is an integral part of conservative dentistry, its specialised nature makes monograph treatment more appropriate. There are several recommended textbooks, illustrated in black and white, devoted entirely to this topic.

6 Control of moisture and tissue retraction

Moisture in the mouth arises mainly from the saliva of the patient and the water introduced by the dentist for cooling or cleaning purposes. A minor source is from mucous glands, gingival haemorrhage and seepage of gingival fluid from the gingival crevice. Effective control of this moisture is essential for a variety of reasons.

Patient comfort

The patient cannot remain comfortable and relaxed whilst fluid is collecting in the mouth. This can be particularly distressing for the patient in the supine position. There is the risk that this might give rise to swallowing at a time when closing the mouth could be dangerous, for instance, during cavity preparation.

Operating efficiency

To avoid delays due to the patient wishing to empty his mouth at frequent intervals.

Visibility

The fine detail of much in restorative dentistry can only be seen when the tooth concerned is dry. During cavity preparation, however, a water spray is required to avoid overheating the dentine and pulp. At this time, one of the most difficult things to achieve is good visibility.

Avoidance of contamination

Unless adequately controlled, fluids can act as a separating medium between tooth substance and the dental material being applied – lining, base, fissure sealant, acid-etch composite or cement – and prevent proper adherence. The physical properties of many filling materials will deteriorate if moisture contamination is allowed to occur. Delayed expansion will follow moisture contamination of amalgam for instance. Impression materials will fail to record detail accurately if the surfaces concerned are not dry (see **363**). This is particularly so with silicone based impression materials which are mutually repellant with water.

Control of sepsis

Saliva, being highly infected, must be prevented from entering the pulp chamber during root canal therapy when sterility is to be achieved.

The problems set by these requirements of fluid control can be solved by the use of one or more of the following:

Suction – high speed
low speed
Air jet
Absorbant material
Isolation
Styptics and coagulants

85

85 During cavity preparation, the water coolant can be removed from the mouth with a high speed aspirator operated by a chairside assistant. If the apparatus is efficient and the working end properly placed, all water, together with tooth and filling debris, will be removed before it can fall to the back of the mouth, thus making other devices unneccessary.

86

86 The chairside assistant can also aid visibility by retracting soft tissues, in this case the cheek, with the aspirator nozzle and by keeping the mirror clear of water droplets with a continuous air jet from the air syringe.

87

87 During the insertion of materials, dryness of the teeth is obtained with an air jet and maintained most simply by the use of cotton wool rolls and saliva ejector. The cotton wool rolls are placed in the buccal sulci to absorb secretions from the parotid duct, and from mucous glands in the cheek. The saliva ejector should possess a tongue flange if lower teeth are being treated. It will remove secretions arising from the submandibular and sub-lingual glands. It will also act as a tissue retractor by holding the tongue away from the teeth and, with the patient's assistance, will prevent the floor of the mouth from lifting and wetting the site of operation.

88 Care should be exercised in removing cotton wool rolls especially if they have been in place for some time in a fairly dry mouth. This is because the roll may become adherent to the mucosa and if removed forcibly, can tear the soft tissue. Here it can be seen that the roll is well attached to the lip and will need to be sprayed with water to separate it without trauma.

88

89 & 90 Sometimes in young patients or patients with short upper lips, there is not room to place the cotton wool roll away from the operating area and it then obscures vision and access (**89**).

89

In this eventuality, a small roll of dental gauze may be substituted for the cotton wool roll. The less-bulky gauze can be placed well out of sight in the buccal sulcus. In this view the lips have had to be retracted to show it (**90**).

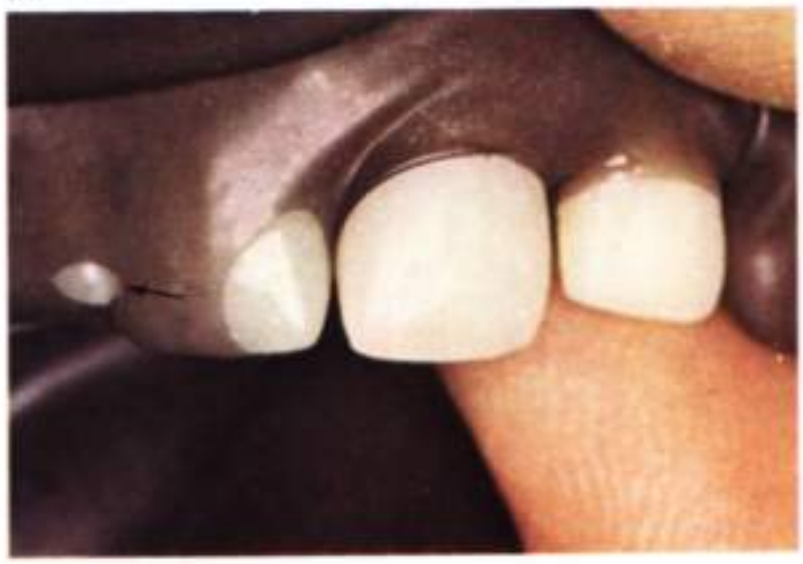
90

91 & 92 To obtain a perfectly dry and sterile field, protected even from the moisture in the patient's exhaled air, a rubber dam should be used. A series of appropriately spaced holes are punched in a sheet of rubber. The rubber dam is passed between the teeth by 'knifing' one edge of each interdental piece of rubber past the contact point (**91**).

For good retention round anterior teeth, it is advisable to involve two teeth on either side of the one to be treated. Retention is further assisted with ligatures of dental floss tied with a double 'surgeons' knot (**92**). Before completing the knot, the ligature should be pushed past the cingulum onto the taper of the root. This will prevent the rubber dam from slipping towards the incisal margin and will carry the rubber well into the gingival crevice, keeping the whole of the crown fully isolated. Sterility is achieved when necessary by swabbing both the teeth and dam with a suitable antiseptic.

93 & 94 To remove the dam, the ligatures are first removed, the knots being quickly undone with the aid of a dental probe (**93**). Removal of the dam itself is facilitated by stretching the interdental sections in a buccal direction, where they can be cut with scissors (**94**).

91



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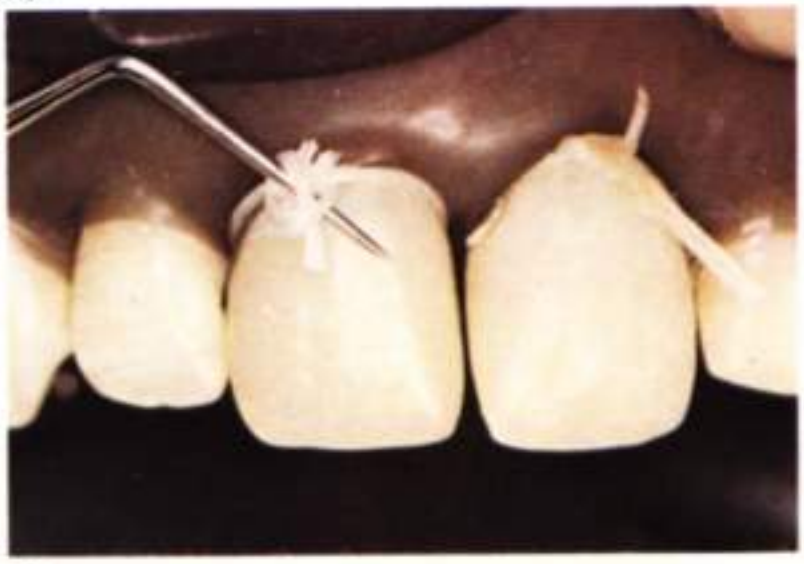


94

95 If there is the risk of the rubber dam being displaced by pressure from the patient's cheeks, the distal ends of the dam may be held firmly in place with rubber dam clamps. Here a premolar clamp has been applied to the first premolar and it will be noted that it is not essential to have this tooth through the dam.

96 & 97 An alternative to the clamp for this purpose is to use a thin strip of rubber dam which can be stretched (**96**) and then wedged past the contact between the central incisors (demonstrated here on central incisors) (**97**).

96

98 Molar teeth for root canal therapy are best isolated individually with a molar clamp. Retention and retraction of the dam is aided by means of a second clamp on the contra-lateral molar.

99 The so-called 'butterfly' clamp can be used on incisor teeth if ligaturing proves difficult. However, such a clamp does restrict access to the tooth and its superimposition on a radiograph may obscure some important detail.

95

97

98

99

100 & 101 A local papillitis (**100**) may make access for cavity preparation difficult, and consequent gingival haemorrhage and seepage may contaminate the restoration if the application of rubber dam is not contemplated.

100

Retraction of the papilla and a dry field may be obtained by the insertion of a length of adrenalin-impregnated string (**101**). The gingival blanching seen here indicates the effect of pressure from the string, which produces a local hyperaemia. Haemostasis will be further assisted by the adrenalin.

101

102 The creation of a dry gingival crevice, immediately prior to taking an impression of a sub-gingival preparation, can be greatly assisted by the use of an alum/adrenalin solution (Wilson and Tay 1977). A drop of this solution (Appendix 3) is picked up between the beaks of the tweezers (arrowed) and introduced into the gingival crevice. After a minute the crevice is washed and dried. The adrenalin acts as a haemostatic and the alum causes precipitation of gingival fluid, thus providing a dry field. The technique is also of value in obtaining dryness in the gingival region during the packing of amalgam cavities. Because of the possibility of absorbtion of adrenalin through the gum, this solution should not be used on patients for whom adrenalin is contra-indicated.

102

Protection of the airway

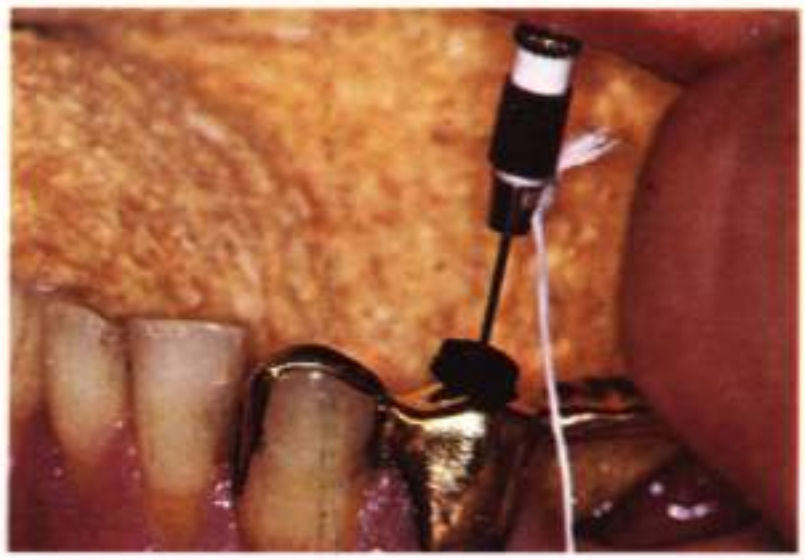
During dental treatment, it is important to ensure that foreign bodies do not pass via the pharynx into the gut or the trachea and lungs. The risk is particularly high when the patient is supine, and items dropped in the mouth can fall directly into the pharynx if this is not effectively sealed, at the time, by contact between the soft palate and the tongue.

The variety of such foreign bodies is considerable, including pieces of tooth or filling, burs, calculus, dentine pins, reamers and files, root filling points, crowns, bridges or inlays. The ideal protection is provided by rubber dam but this is not always practicable.

103

103 A 'butterfly' sponge, with a safety cord attached, may be used to protect the pharynx whenever there is the risk of a foreign body falling to the back of the mouth.

104



104 During root canal therapy when rubber dam is not in place, the further precaution should be taken of tying lengths of dental floss to each reamer and file, so that it may be recovered easily if dropped into the mouth.

7 Bases and varnishes

Bases and varnishes are materials placed in cavities, for a variety of reasons, before the final fillings or restorations are inserted (Appendix 4). Which material to use will vary with the size and depth of the cavity and the filling material to be inserted.

105 The minimal amalgam cavity cut only to classical depth i.e. just into dentine, requires only a varnish before insertion of the amalgam. If a base were to be included, the cavity would become too shallow and the resulting amalgam restoration would be weakened. Further deepening of the cavity solely to make room for a base is unwarranted.

105

106–109 The deep cavity, where the caries is judged to have approached closely to the pulp (**106**) needs to be lined in three stages.

106

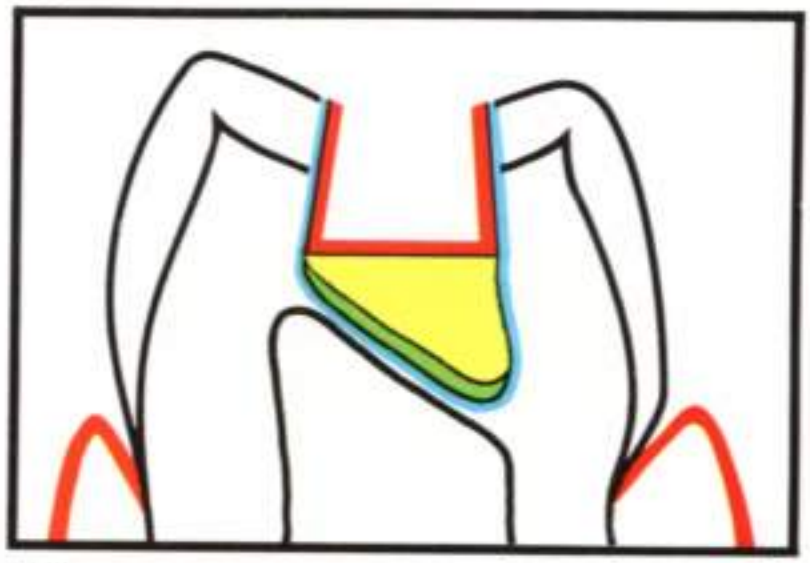
A wash of sub-base material is placed first on the pulpal floor (**107**). The depth of the cavity is next reduced to classical proportions with a base (**108**). Finally, the cavity surfaces are given a coat of varnish.

107

108

All three stages can be summarised in diagrammatic form (**109**). The cavity is indicated in blue, the sub-base in green, the base in yellow and the varnish in red.

109

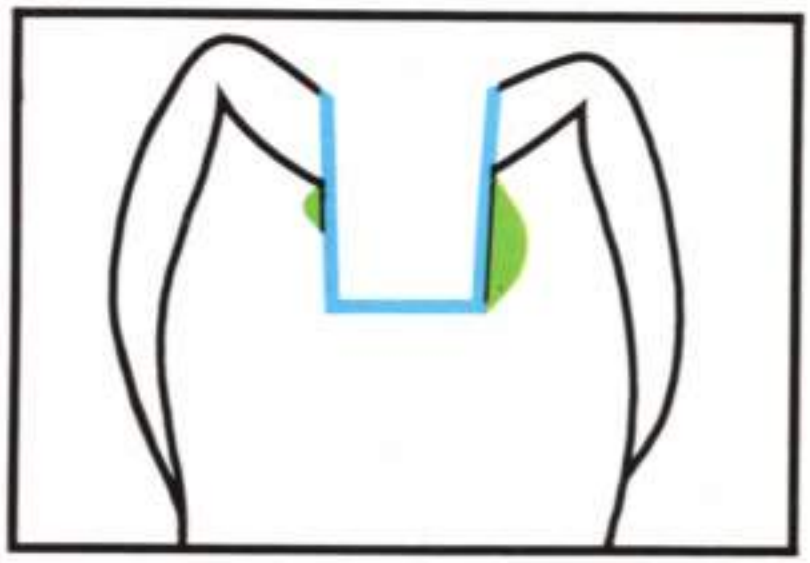


110 Chemical protection of the dentine and pulp is required beneath a composite or silicate restoration – this can be achieved most readily with a quick setting calcium hydroxide cement introduced with an applicator or small brush. In this view, a ball-ended applicator has placed a drop of calcium hydroxide cement on the axial floor of the cavity, and is spreading this to cover all the exposed dentine. Eugenol containing cements should be avoided for this purpose due to the deleterious effect of the eugenol on the filling material.

110

111 & 112 Minimal depth gold inlay cavities require no base. A certain amount of thermal insulation is provided by the cement with which the inlay is inserted. A cement base may be required however to eradicate an undercut. Minor undercuts should be removed during cavity preparation (**111 & 112** left). Where, however, an undercut is considerable, due to the extensive spread of caries at the amelo-dentinal junction (**111** right), a choice has to be made between cutting back or blocking out. To cut back the overlying enamel may so weaken a cusp that it has then to be capped (see **227**) and it may be preferable to achieve withdrawal form by eliminating the undercut with cement (**112** right).

111



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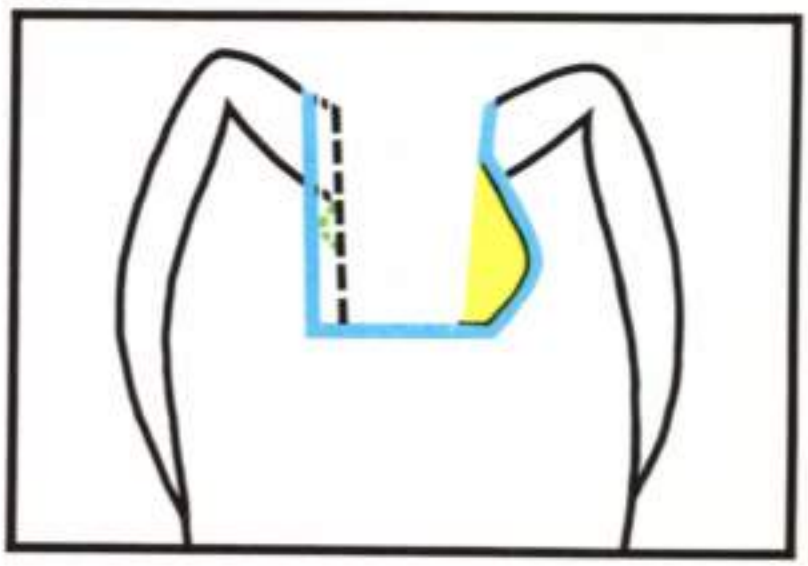
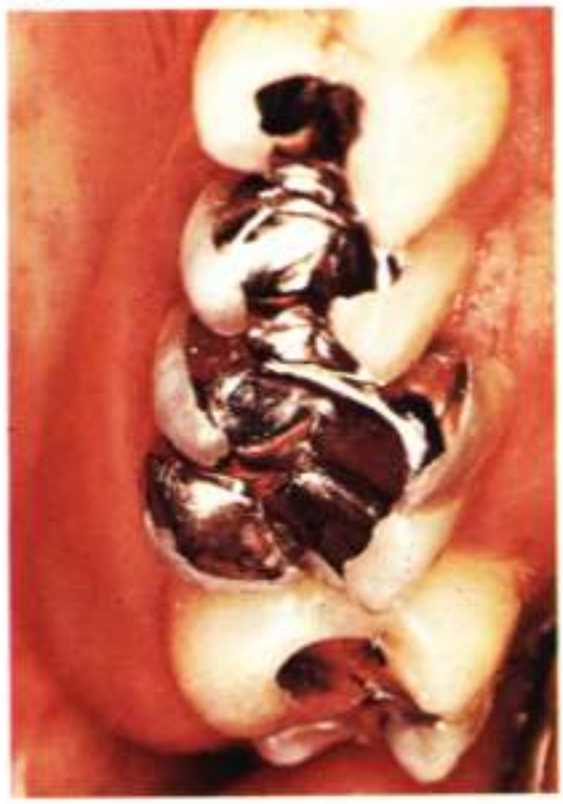


8 Amalgam restorations

Most textbooks of Restorative Dentistry deal at length with all aspects of the amalgam restoration. Some indeed deal exclusively with this topic (Gainsford 1976). It is not intended therefore to cover exhaustively such a large subject in this Atlas. A number of examples have been selected of points particularly worth visual emphasis.

113 Amalgam is by far the most commonly used material for the restoration of teeth and as seen here, the result can be very satisfactory. To achieve such a high standard demands close attention to detail at all stages of the technique – cavity preparation, marginal finish, condensation with effective moisture control, carving and polishing.

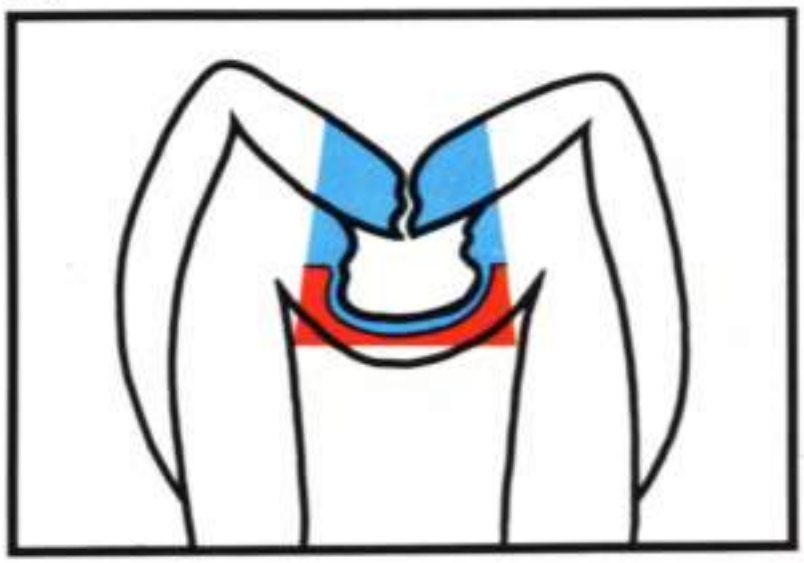
113



Cavity preparation

114 For reasons both of pulpal integrity and for maximum preservation of sound tissue, the depth of the cavity should be cut, in the first instance, just into dentine to give a cavity depth of about 2.5mm. When the outline form is established, any remaining pulpal caries is removed by the careful use of a large sharp excavator, directed so as to avoid direct pressure towards the pulp. Some operators prefer to use for this a slowly rotating large round bur. The resultant cavity form is shown in blue. It is dangerous to cut the outline form at the maximum depth in a single stage, as this is to risk causing a pulpal exposure, and furthermore unneccessarily removes sound dentine (shown in red).

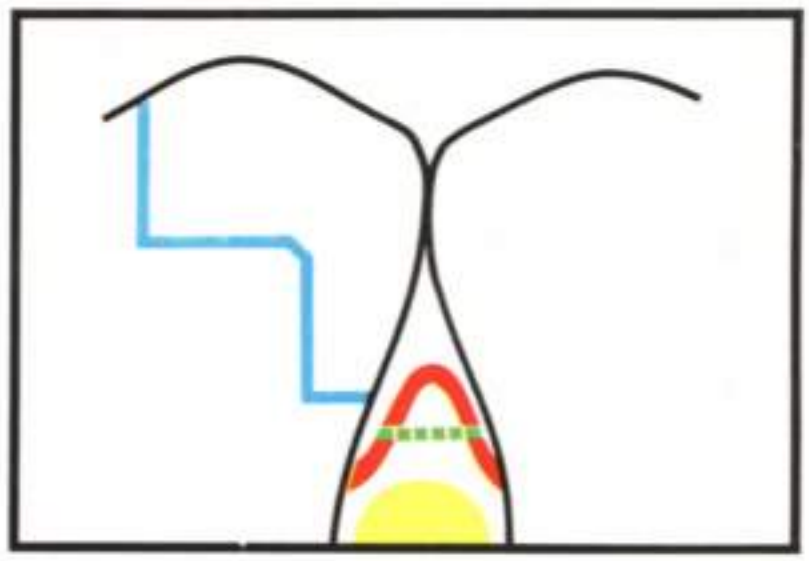
114



115 The cervical margin of a Class II cavity may be placed slightly supra-gingival to the gum margin. Several benefits will accrue from this. Gingival trauma during cavity preparation and matrix placement should not occur, thus eliminating problems of gingival haemorrhage during insertion of base and filling. The cervical margin of the restoration will be readily accessible to the patient's plaque control, and periodontal irritation from a sub-gingival margin will be avoided.

Extensive caries, however, often extends sub-gingivally and may be the cause of a periodontal pocket. In such instances, the supra-gingival relationship can be restored, by removal of gingival tissue as indicated by the green line. This can most readily be done with the surgical diathermy (see **209**).

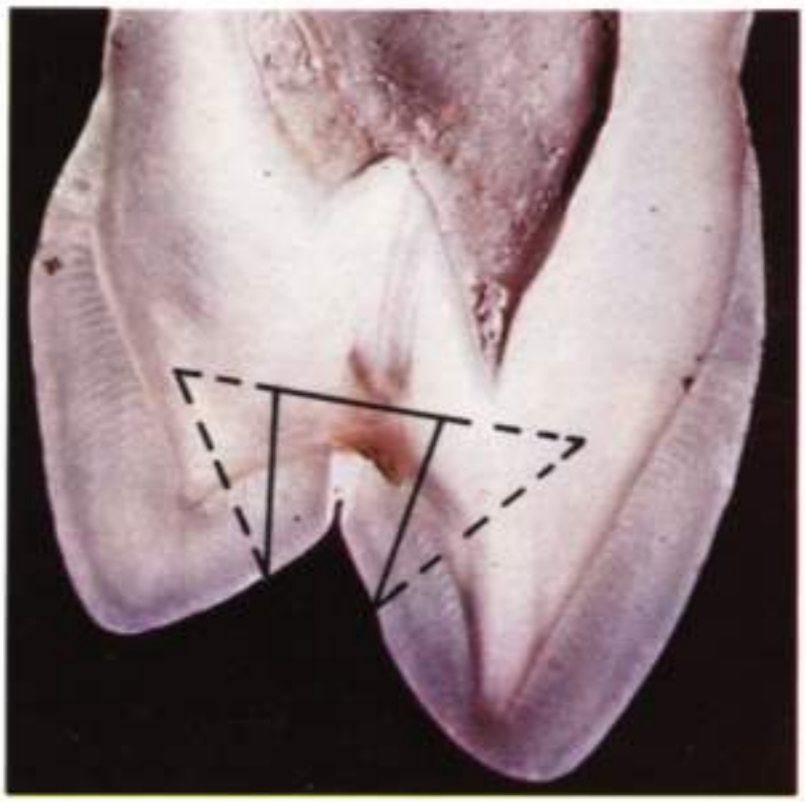
115



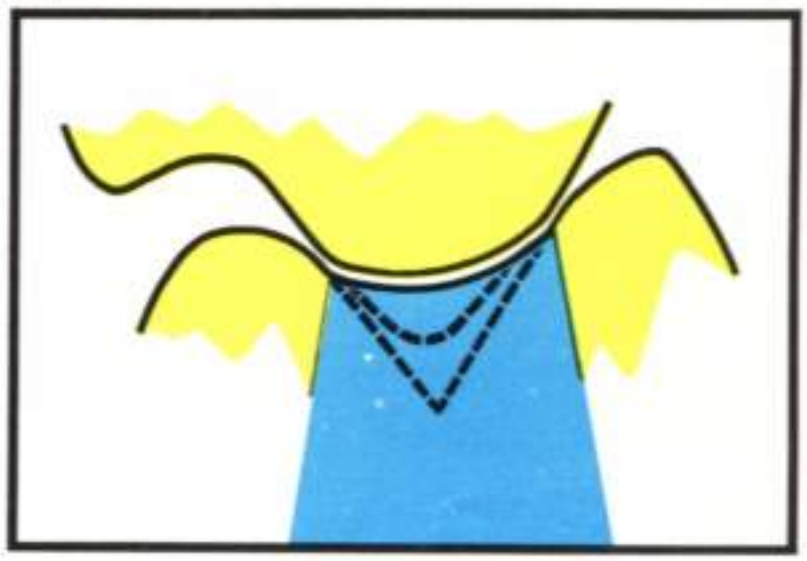
116 & 117 Ideally the cavo-surface line angle of an amalgam restoration should be 90°, to provide a sound butt-joint between the amalgam and the enamel.

In teeth with steep cusp slopes, as in this upper first premolar (**116**), creation of a 90° cavo-surface line angle (broken line) would result in an excessively wide cavity floor and considerable weakening of the cusps. This is avoided by cutting as indicated by the solid line. In order to achieve a strong 90° margin in the finished amalgam restoration, it should be carved as depicted in **117** and, if necessary, the opposing cusp should be reduced to make room for the restoration. Any attempt to reproduce the original occlusal contour (broken line, **117**) would result in a weak margin to the restoration.

116



117



118 Diamond and tungsten carbide cutting burs can leave cavity margins rough and irregular (Boyde et al, 1972) and these require smoothing with finishing burs. The finishing burs depicted here have distinct advantages for doing this over more traditional finishing burs. They are used in the turbine handpiece, the high speed of which allows very smooth application to the enamel without snatching or running out of the cavity; being without blades they smooth the margins without dislodging enamel prisms (Baker and Curson, 1974).

Minimally extended box walls may not allow access to a finishing bur and these margins can be smoothed with chisels or fine cuttlefish discs.

Packing, carving and polishing the Class II amalgam restoration

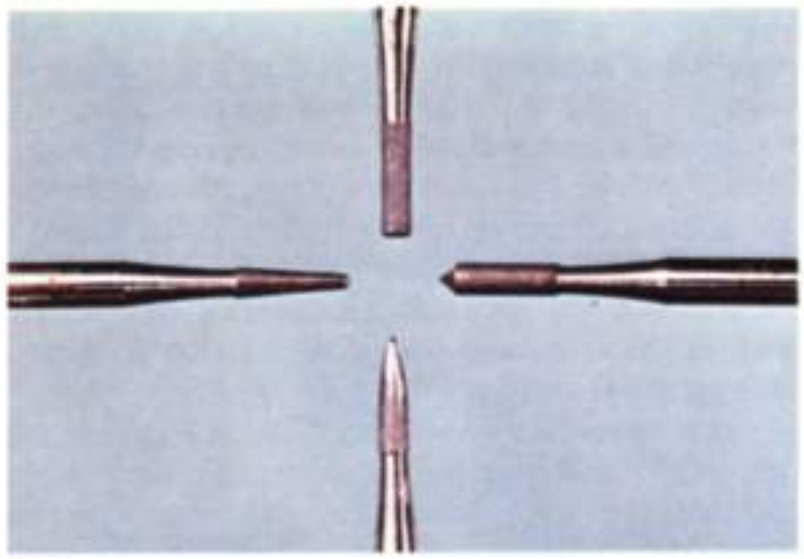
119–126 A Class II cavity requires a matrix band to support the amalgam during condensation. This should be contoured to mimic the original tooth shape, especially in the contact region, and be tightly wedged cervically to prevent extrusion of excess amalgam. Packing of amalgam should start in the deepest part of the cavity (**119**).

Good adaptation without porosity is achieved through firm hand pressure with small pluggers of appropriate cross-sectional shape. To adapt into the line angles of the box this shape should be rhomboidal or lozenge. Condensation, in the later stages, is obtained using larger diameter pluggers, and may be aided by mechanical vibration. It should continue until there is a considerable excess of amalgam (**120**).

The gross excess is then removed, and the accessible portions roughly carved before removal of the matrix (**121**).

This is particularly critical in the marginal ridge region if the ridge is not to fracture unfavourably when the matrix band is withdrawn.

118



119

120

121

Carving is completed with a sharp hand instrument such as a Wards (**122**) or Hollenback carver. Occlusally, this should be worked parallel to the cavity margin (arrowed) with the blade held partly on the cusp slope whilst cutting the amalgam. In this way, the cusp slopes act as a template to reproduce the required shape in the amalgam, and negative margins are thus avoided. Articulating paper is an aid in detecting any high spots which should be removed before dismissing the patient.

122

Finishing and polishing cannot be started until a future visit of the patient when the amalgam has set hard. Any sizeable reduction may be undertaken with a carborundum point (**123**). The use of this should, however, be kept to a minimum as it deeply scores the surface. Final shaping is achieved with a finishing bur (**124**).

123

124

Polishing can be undertaken with a series of abrasive pastes of diminishing grit size, applied with a softened polishing brush (**125**) and a final high lustre can be obtained using jewellers rouge.

Care must be taken not to overheat and create a false polish by drawing mercury to the surface. Alternatively a good polish can be created with Baker-Curson finishing burs (**118**). A highly polished amalgam restoration feels smooth and is easy for the patient to keep clean. It should also be pleasing and satisfying to the operator (**126**).

125

126

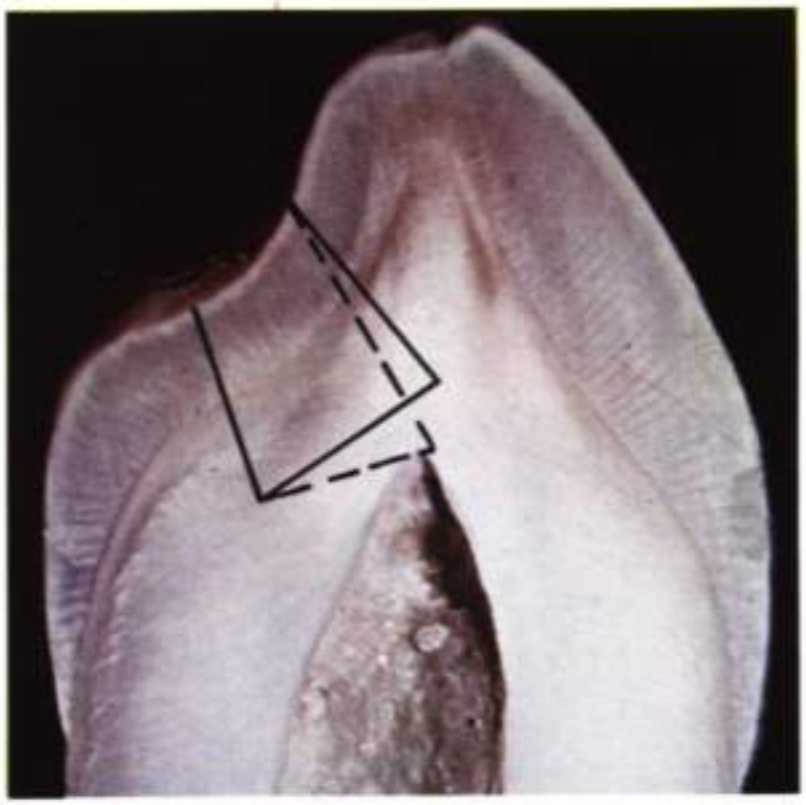
127 & 128 After the initial carving of an amalgam restoration, close examination will often reveal 'feathers' of excess amalgam overlying the surface enamel (**127** arrowed). This is particularly prone to happen where it has not been advisable to eradicate all fissures or surface irregularities. If left, these thin sections of amalgam will eventually fracture, leaving plaque retentive positive edges. Feathers of excess can be recognised readily if a mental image is retained of the original cavity outline (**128**).

127

128

129 The imbalance between the size of cusps in a lower first premolar, and the consequent position of the pulp requires a variation in the angulation of the occlusal lock and dovetail in these teeth, as shown by the solid black line. Failure to appreciate this need can run the risk of a pulp exposure as indicated by the dotted line.

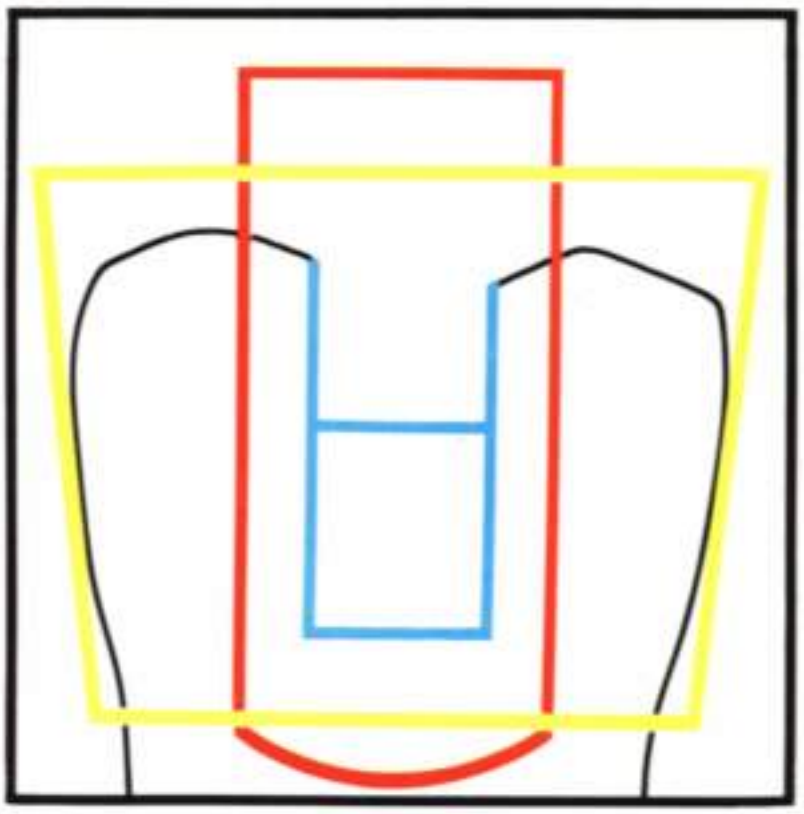
129



130–133 The buccal and palatal contours of molar teeth are such, that it is often difficult to obtain the close adaptation of the matrix band to the buccal (or palatal) extension of an occlusal cavity (**130**). The difficulty can be overcome by the use of a supplementary short piece of matrix band material. This is trimmed to size, and positioned so that it is gripped cervically between the encircling matrix band and the tooth (**131**). Close adaptation to the walls of the extension is achieved by the application of greenstick composition between the matrix band and the extra piece (**132** and **133**).

130

131



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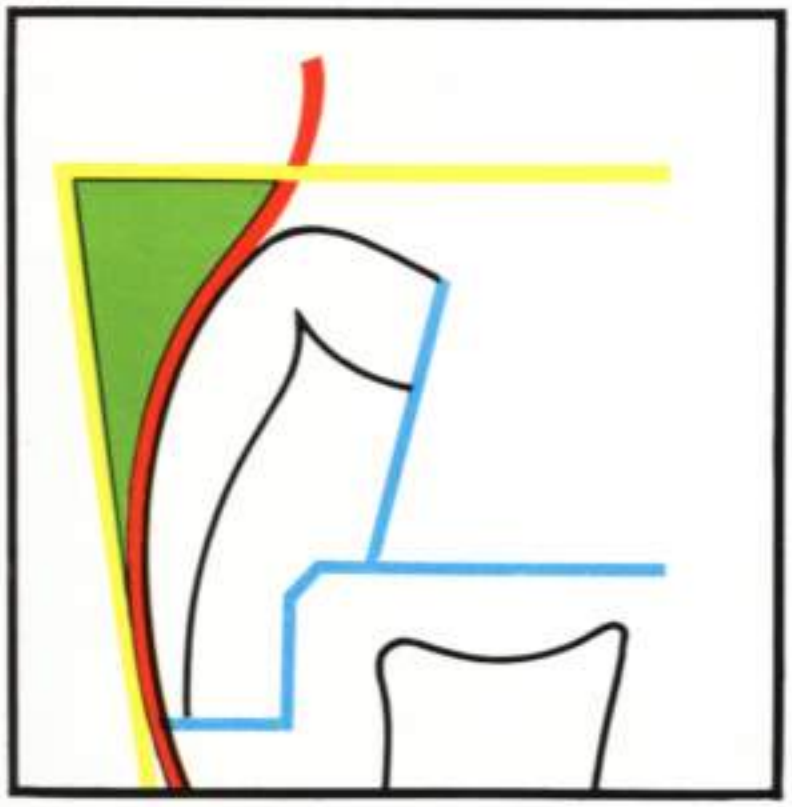


133

Some faults in amalgam technique

134 A frequent observation, when examining amalgam restorations that have been placed for some time, is the 'guttering' effect around the margins. This is usually due to a fault at the butt-joint between amalgam and enamel. It can be due to the fracture and loss of enamel prisms, resulting from residual or recurrent peripheral caries. It is more likely, however, to be attributed to the fracture of an acute angle of amalgam at the restoration margin, created either by poor cavity design or over-contouring of the amalgam (Elderton, 1975).

135 Failure to run out occlusal fissures to fulfill the principle of extension for prevention may result in recurrent caries.

136 Recurrent caries can also occur inter-proximally if the embrasure margins of a Class II restoration are not regularly cleaned. Cleansing is usually aided by extending the box walls to within the reach of the toothbrush bristle. In the more conservative approach adopted here, the recurrent caries could possibly have been prevented by meticulous flossing.

137 The loss of any restoration should prompt a diagnosis of the cause of the loss before replacement is undertaken. Here the mesial box has broken from the rest of the restoration because of lack of bulk in the keyway. This in turn was due to the use of too thick a base. Before replacing this filling, therefore, it is necessary to reduce the base to create space for an adequate bulk of amalgam. It might also be advisable to cut retention channels in the dentine of the box walls, and to adjust any opposing cusp that might damage the new restoration.

134

135

136

137

138 A common finding where occlusal relationships were not checked carefully at the carving stage is the burnished 'high spot'. The situation may be self-adjusting by the reduction through wear of the excess amalgam. However, this process may cause unwelcome symptoms, such as tenderness of the tooth in its socket or sensitivity due to pulpal hyperaemia. Furthermore, fracture of the filling may also occur as seen here. If occlusal relationships are such that the adjustments required would weaken the filling, then selective grinding of the opposing tooth would be justified. Such grinding should be followed by polishing of the enamel with a polishing paste containing fluoride.

138

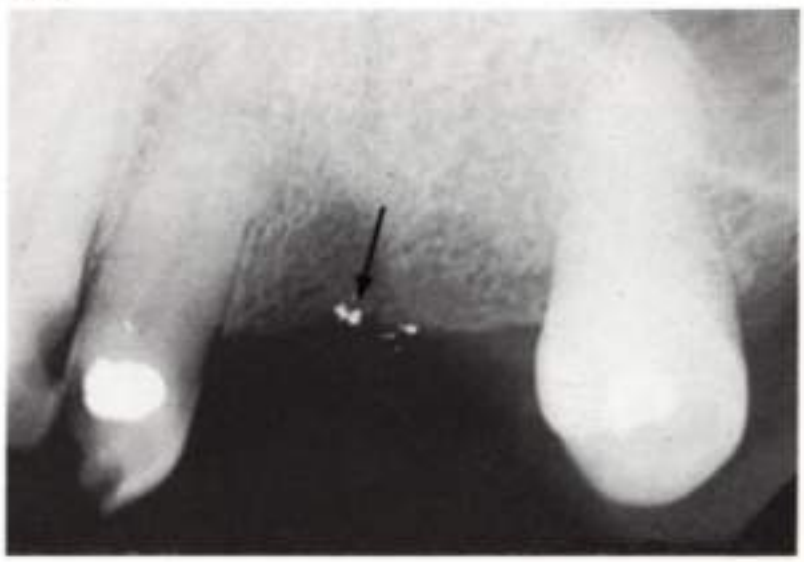
139 Failure to burnish the matrix band so that it mimics the external contour of the original tooth and lack of cervical wedging will result in a poorly contoured restoration with cervical excess as seen here. This will result in periodontal disease due to plaque retention and food packing.

139

140 & 141 An unsightly amalgam tattoo (**140**) can be caused by the careless introduction of amalgam remnants into a tooth socket, if both an extraction and an amalgam restoration are undertaken on the same occasion. The amount of amalgam need only be quite slight as the radiograph of the condition in the previous figure indicates (**141**).

140

141



The hazard of mercury

142–146 It is well established that mercury can be very damaging to health (Vroom and Greer, 1972) and it is most important that the dentist and his staff take the maximum precautions possible to avoid contact with it (Gronka et al., 1970). Mercury should not be left in open contact with the air of the surgery. Good ventilation should be maintained to prevent any build up in concentration of mercury vapour that may inevitably be produced. Carpets should be avoided in areas where mercury spillage might occur.

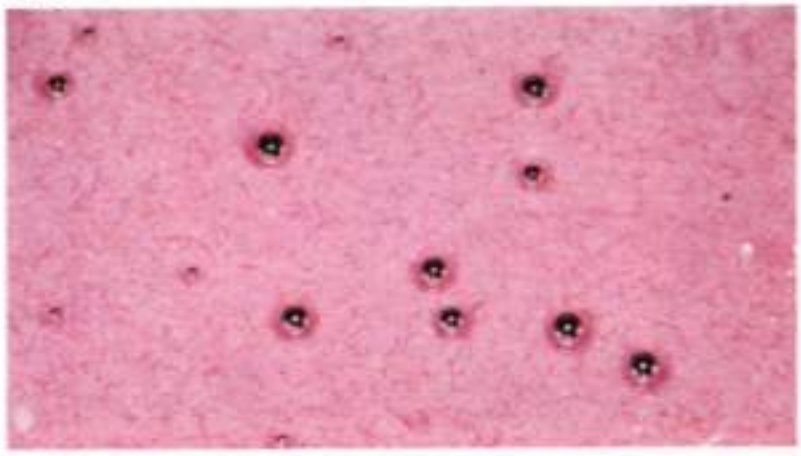
Waste amalgam and mercury should be collected in a jar containing water (**142**) which will prevent the dissipation of mercury vapour.

This jar should stand in an appropriate dish that will catch any accidental spillage and prevent it from falling to the floor where its recovery would be difficult. Any spillage (**143**) should be cleared up as soon as possible to reduce the amount of mercury vapour that will contaminate the surrounding air. This can readily be done using sheets of foil taken from radiographic films (**144**) which can then be disposed of safely.

There is always the risk that the seal of a capsule used in an automatic amalgamator may not be good enough to prevent the escape of fine globules of mercury as demonstrated here by high speed photography (**145**). Such a container can be made safe by fixing the cap to the capsule with a strip of sticking plaster (**146**). It is safer, however, to use an amalgamator where all dispensing and trituration takes place within the machine.

142

143



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145

146

9 Composite and glass ionomer cement restorations

In many cases, composite resins and glass ionomer cements have superceded silicate cements. This is due mainly to their superior physical properties, particularly strength and reduced solubility. Composites and glass ionomers are also being used in new situations, when their ability to gain retention to the enamel and dentine allows their application where silicate would be impossible. Silicates, however, may still be used in Class III restorations where strength is not a prime requirement of the material, and the cariostatic properties of the fluoride containing silicate would be of value, for instance, in a caries prone mouth.

147 In pre-composite days, multiple Class V lesions were treated with unsightly amalgam, or silicate which soon became unsightly due to marginal staining.

147

148 & 149 Multiple Class V lesions such as these cervical abrasion defects may now be dealt with in a more aesthetically acceptable manner. No cavity preparation would be required if glass ionomer cements were to be used, merely cleansing of the dentine surface to allow good adhesion to take place. If composite is used, as shown here, light feather bevelling of the enamel margins is required, to provide a sufficient area of prepared enamel for retention by the acid-etch technique.

148

149

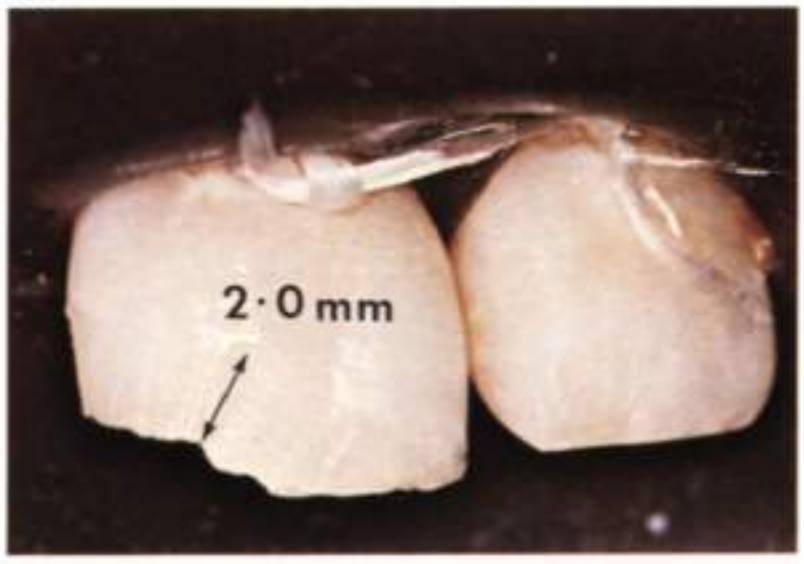
A composite tip restoration

150–158 The tip of this |1 has been fractured obliquely (**150**) and involves an area of dentine on the palatal aspect. The tooth is vital, and is deemed suitable for restoration with an acid-etched composite resin.

150

A light bevel is prepared all round the margin of the fractured surface extending over the enamel for approximately 2mm (**151**).

151



This is done, whenever possible, under rubber dam to prevent contamination of the freshly cut enamel with saliva, which might interfere with the union of composite to tooth.

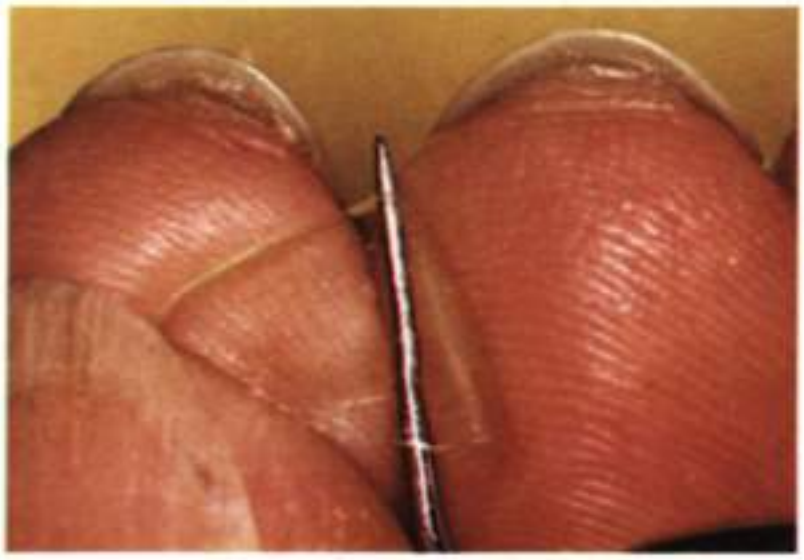
The area of exposed dentine is protected with a wash of a quick-setting calcium hydroxide (**152**) and a cellulose acetate crown form of appropriate shape is selected and trimmed to overlap the bevel and extend only minimally on to the surface enamel (**153**).

A small pinhole is placed in the incisal corner of the matrix (**154**) to allow trapped air to escape when the composite is inserted, and thus avoid a blow hole in the finished restoration.

152

153

154



The manufacturer's etchant is applied to the bevelled area with a small brush (**155**) or sponge pledget. For best results this should be kept on the move for the recommended time (30–60 seconds). The etchant should be washed off with a vigorous water spray and the surface well dried. This will present the composite with a very irregular surface (see **49**) for retention by mechanical interlocking between the resin and the enamel. The crown form filled with composite is seated over the etched surface.

A small extrusion of composite is evidence of the evacuation of any trapped air (**156**). Some operators first coat the etched surface with pure resin though a number of studies indicate this is not necessary (Pahlavan et al 1976, Barnes 1977). If the matrix has been correctly trimmed, it should be possible to reach any excess composite and remove it before it sets. This is difficult to do at a later stage, particularly from interproximal areas.

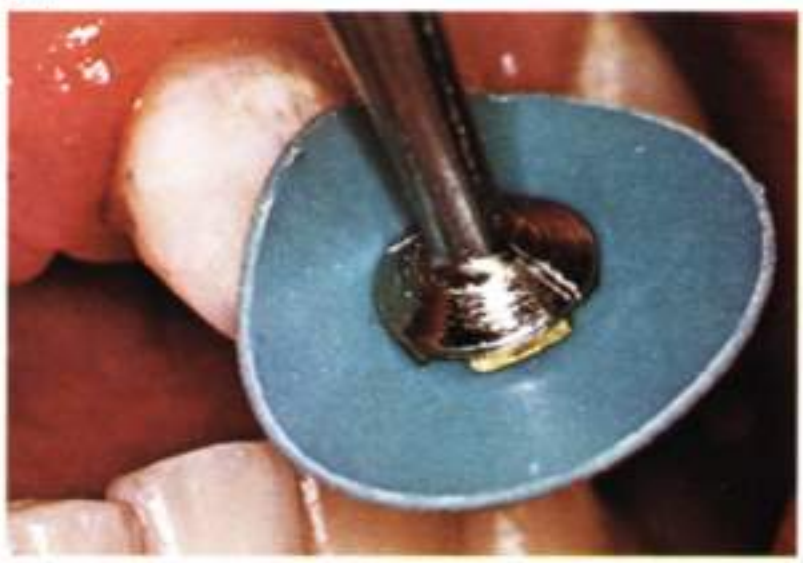
Any shaping or removal of positive edges can be accomplished with a flexible disc manufactured for the purpose (**157**). It is sometimes recommended to glaze the surface with clear resin but the glaze is often soon lost; further wear will remove more resin and leave the inorganic particles protruding from the surface. Eventually, these filler particles will be lost to leave a rough and pitted surface. Probably the best surface is achieved by using a fine particle composite and polishing this with Baker-Curson finishing burs or very fine polishing discs as appropriate.

The appearance of Class IV composite restorations can be very good with regards both to shade and to shape. However, if an accurate colour match is achieved, the shade should be chosen before the rubber dam is applied. This is because the composite needs to match the natural colour of the tooth, not the lighter colour that the crown will often assume when separated by the rubber dam from the moist oral environment. Comparing figures **150** and **158**, it can be seen that the teeth that had been placed through the dam have lightened considerably. In a short while, they will return to their normal colour when the composite will then be a good match.

155

156

157



158

159 & 160 This is an example of enamel hypoplasia (**159**) where the upper central incisors have been treated with acid-etched composite facings, which have been extended sub-gingivally (**160**). The appearance is improved by this extension, but care will be needed both in finishing the margins and plaque control if gingival inflammation is to be kept to a minimum.

159

160

161 & 162 The buccal enamel of 21|1 has been eroded (**161**). Although there is marked interproximal staining the teeth are caries-free. The appearance is improved with simple facings of composite retained by etching the eroded enamel (**162**). Any dentine exposed by the erosion should be protected with a thin wash of calcium hydroxide prior to the application of composite. The composite should be confined to the buccal surfaces of such teeth and should not run over the incisal margins, in view of the heavy incisal wear indicated by the attrition.

161

162

163 & 164 Early loss of the central incisors has resulted in mesial movement of the laterals (**163**) which will eventually require jacket crowns to simulate the original centrals. A temporary improvement in appearance has been achieved with acid-etched composite facings (**164**).

163

164

165 & 166 This young patient (**165**) has partial anodontia with missing lateral incisors and a retained ⌊C. The appearance of the retained primary tooth has been made to resemble a permanent lateral incisor with an acid-etched composite facing (**166**) which is shown here 12 months after application.

165

166

167 & 168 The acid-etch technique can be used to attach a temporary pontic to an adjacent tooth. Here a stock plastic tooth has been trimmed to fit in the ⌊3 space. It is attached with composite to the acid-etched distal surface of the ⌊2. Provided the pontic is not subjected to heavy occlusal force it will constitute a very convenient stop-gap for a patient who has lost a denture, or who is awaiting the construction of a spring cantilever bridge. (Kochavi et al, 1977).

167

168

A glass ionomer cement restoration

169–174 The cementum and dentine in the buccal cervical region of the upper left lateral incisor has been seriously abraded by the tooth brush (**169**). It is difficult to create a retentive cavity in such a situation because of the amount of tissue worn away mesially and distally.

As the only enamel adjacent to the abraded area is on its coronal margin, there is little opportunity for gaining retention for a composite through bevelling and etching the enamel.

This form of lesion therefore, presents the ideal situation for the glass ionomer cement restoration, which adheres directly to dentine. No cavity preparation is required but the dentine surface needs to be cleaned, usually with dilute citric acid, so that the filling material can come into direct contact with the dentine. The glass ionomer cement is mixed to a stiff consistency and is applied to the tooth, aided by a cervical foil which is adapted closely to the margins of the lesion to provide a good contour (**170**).

169

170

The excess cement can be removed before it sets, so that on removal of the foil there is very little trimming required (**171**).

The slight positive edge that exists can readily be reduced to a smooth finishing line with a flame-shaped Baker-Curson bur.

171

Whilst adjusting the cervical margin the gum can be retracted to a safe position with a flat plastic instrument (**172**).

172

The recreation of the original cervical convexity can best be appreciated in a profile view of the finished restoration (**173**).

173

Viewed from the buccal aspect the colour match is quite acceptable (**174**).

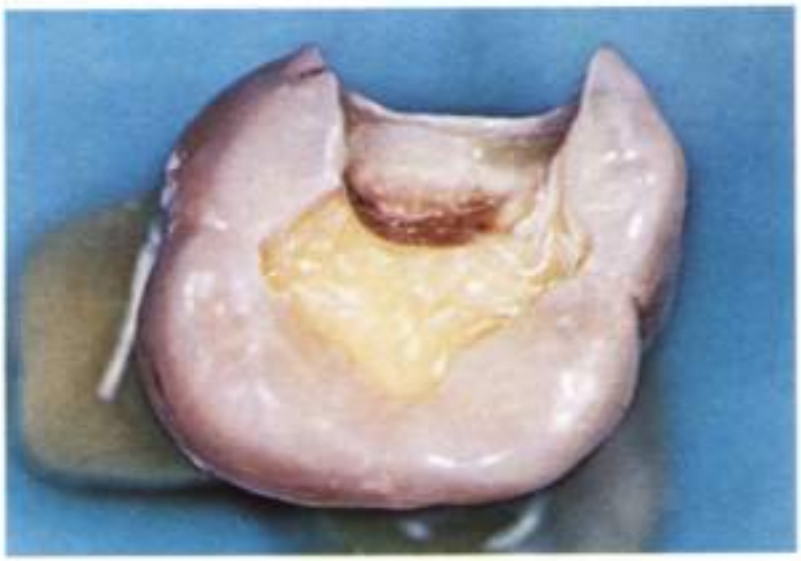
174

10 Aids to retention

When caries has destroyed or undermined tooth tissue extensively, there is the problem of gaining retention for a restoration from the sound tissue that remains. Where possible, retentive devices such as dovetails, should first be incorporated in the cavity form, but these may be inadequate. Retention may then be supplemented by the use of pins inserted into the dentine, round which a plastic restoration, usually amalgam or composite, is packed. Such a restoration may suffice on its own or be cut down for use as a core under a full coverage crown. The approach to the problem of retention can be demonstrated by consideration of a series of cavity preparations, dealing with carious lesions of increasing size.

175 In this molar, there has been a large interproximal carious lesion, resulting in a cavity with a deep and wide box. Occlusal extension into buccal and palatal fissures has, however, provided a satisfactory retentive dovetail and further retention from pins should not be required here.

175

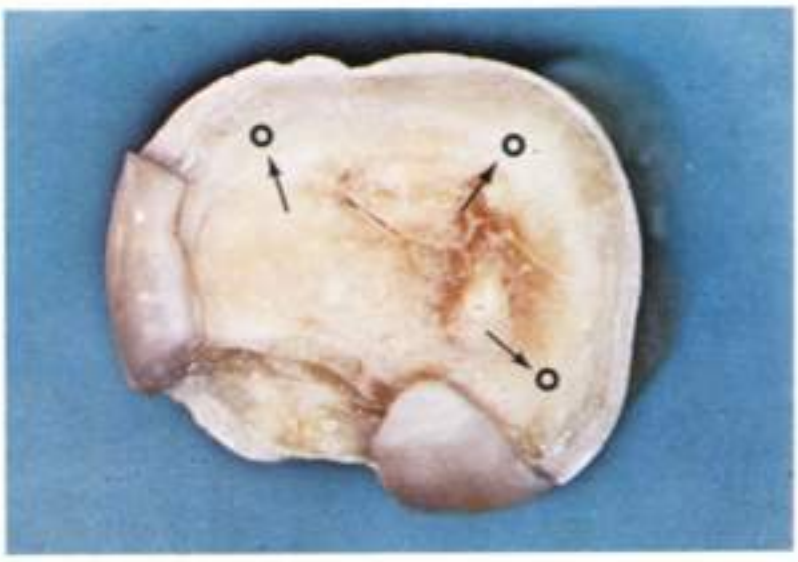


176 The caries in this lower first molar has been more extensive than in the previous example, and this has caused loss of the mesio-lingual cusp. Some retention form has been achieved from a dovetail cut into the distal end of the occlusal surface, but this is probably insufficient for successful retention. It should therefore be supplemented with a pin in the position marked by an arrow.

176

177 This very extensive preparation leaves little sound tissue to support the restoration. Some retention form has been created with a buccal box, which was required because of caries involving the buccal fissure. Applying the 'rule of thumb' that one pin should be used for every cusp missing, three pins will be needed here as indicated.

177



178 No retention form was feasible in this example. The buccal wall was sound, and therefore cutting of a buccal box for retention was not justified. Four pins would be required here.

178

179 This example, similar in extent to the previous figure, shows the four pins in position. A base has been inserted to reduce the size of the cavity to reasonable proportions. Care has been taken to keep the base clear of the pins, so that amalgam may be condensed all round them for maximum retention.

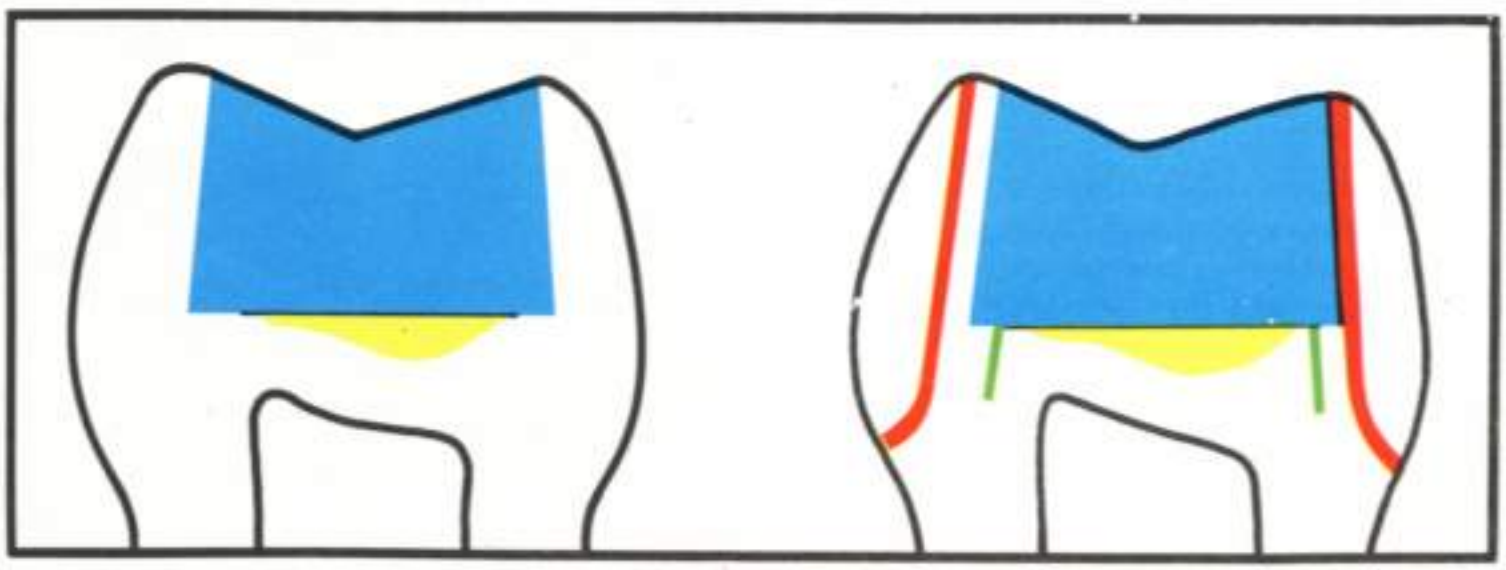
179

180 An amalgam restoration may be retained exclusively by pins and carved to restore fully the original crown form. In many mouths, a restoration such as this may well stand up to normal wear and tear. However, should it not, the amalgam may later be reduced to act as a core for a full veneer gold crown (see **228** and **229**).

180

181 Pin retention may be advisable whenever a tooth requiring a large amalgam restoration may also require a full coverage crown at a later date, even if pinning is not considered essential for the initial amalgam (**181** left). This is to anticipate the weakening of the remaining tooth tissue (**181** right) following the full crown preparation, which may remove much or all of the support for the amalgam core, which would then need to rely almost totally on the pins for its retention.

181

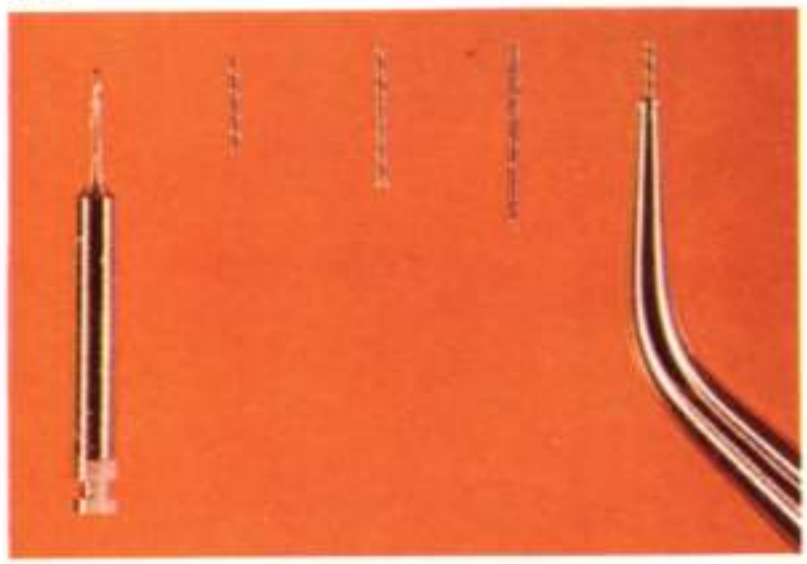


Types of pin for supplementary retention

The simplest form of extra retention is obtained by drilling a hole in the dentine with a narrow flat fissure bur, and cementing into this a short length of stainless steel wire of matching diameter. Retention of the amalgam to such pins can be increased by bending the protruding portion. A refinement of this technique is to use wire which has been threaded; such pins still require to be cemented into the dentine, but better retention for both cement and amalgam is gained from the thread. Cemented pins are of value when no other sort is available but they have been superceded by more precise pin systems, of which a considerable range has been developed by the manufacturers.

182 The friction-grip system provides a twist drill (left) of precise diameter for cutting the hole in dentine and pins (centre) of varying lengths. The diameter of the pins is fractionally greater than that of the twist drill, but the resilience of the dentine allows the pins to be forcibly inserted into the holes cut by the drill; the tightness of fit prevents their withdrawal. The pins are inserted with a special hand tool, the working end of which is seen on the right.

182



183 The latest development is in self-tapping pins which are screwed into slightly undersize holes, thus cutting their own thread into the dentine. One such system is the Thread-Mate-System (TMS) which has a choice of pin sizes ranging up from, left to right, Minikin, Minim, and Regular, with their matching twist drills. Some of these pins are supplied as '2-in-1' with a shearing point half way along the double length pin. The twist drills are shouldered for safety thus preventing too deep a hole being drilled. Sometimes the whole pin is inserted, when used for instance to retain gold-work, in which case a non-shouldered twist drill (centre) is used.

183

184 TMS pins are inserted in a number of ways, either manually by finger held driver (left) or by use of a handpiece with clutch chuck (middle) or bur adaptor (right). A system which allows insertion of the pin by the handpiece has a distinct advantage in that if access is possible to drill the pin hole, it will also be possible to insert the pin. This is not always the case when hand chucks or spanners are used. It is safe to bend the TMS pins after insertion and they are gold-plated to resist corrosion.

184

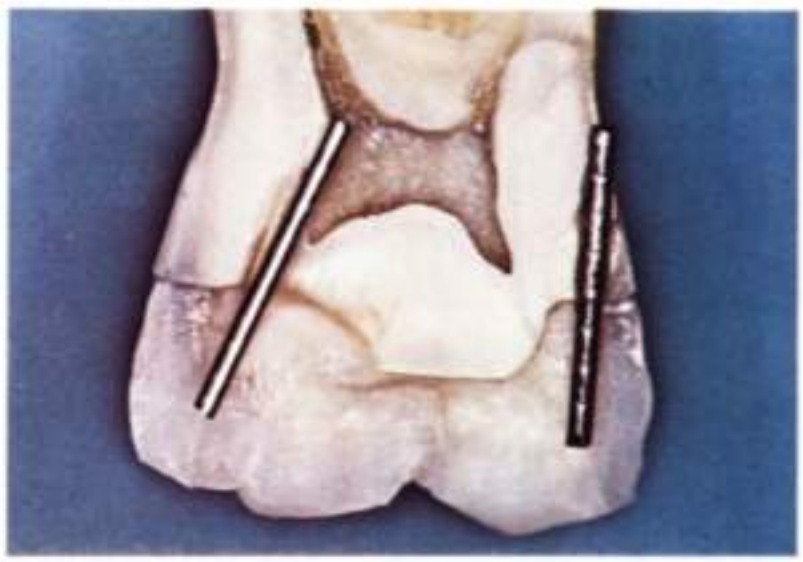
185 Other systems using the self-tapping pin, such as the Stabilok system, provide the pin and bur shank in one piece. A shouldered twist drill is used to make a hole in the dentine of a depth equal to half the pin length. The drill is then exchanged in the handpiece for the pin bur, which, driven into the hole, shears off automatically when it reaches the bottom. Care must be taken to ensure that the pin is being rotated in a forward direction, and it is an advantage to use a speed reduction head for this stage. The Stabilok pin is bendable and is supplied in two sizes of diameter.

185

Pin retention – posterior teeth

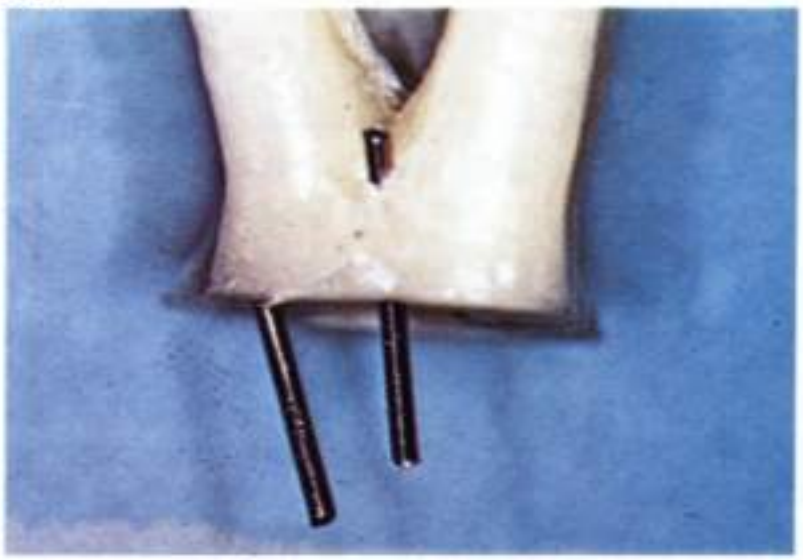
186–194 The cutting of pin holes 2mm into dentine is not without risk and should not be undertaken lightly. The main risk is that the pin-hole may penetrate into the periodontal ligament or the pulp chamber (**186**).

186



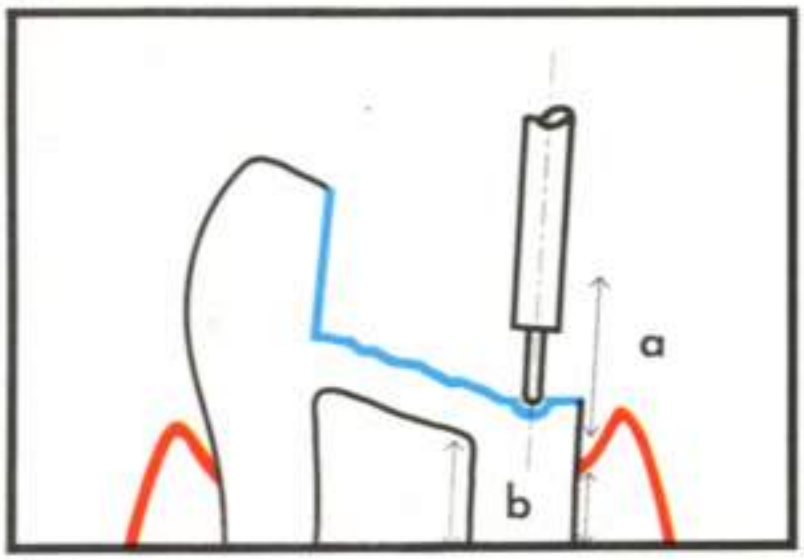
The periodontal ligament is particularly vulnerable if a pin hole is drilled immediately over a bifurcation or trifurcation (**187**). A further risk is that the enamel may fracture from the side of the pin hole if it is placed along the amelo-dentinal junction. It is therefore important to assess carefully the anatomical situation before preparing any pin holes, firstly to decide the starting point for the pin hole and secondly deciding on the direction in which it should be cut. It is helpful to create a small depression in the dentine with a round bur as a starting pit for each hole. Such a pit will keep the twist drill to its intended access point. It should be approximately 1mm inside the amelo-dentinal or dentino-cemental junction and away from furcation zones (see **211**).

187



The direction of the pin hole should be parallel to the inner and outer surfaces of the dentine into which it is placed (**188**). This direction can be assessed by placing a probe against the accessible root surface (**a**) and by studying a bitewing radiograph. The radiographic assessment, however, is of use only in the mesial and distal regions as indicated in (**b**).

188



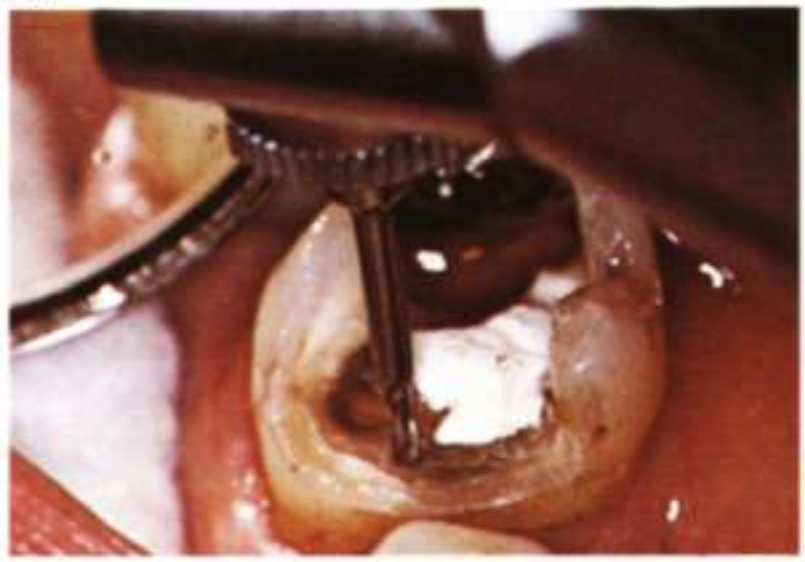
Pins placed buccally or lingually are superimposed on the pulp chamber and their angulation in a pulpal/periodontal direction cannot be seen radiographically (**189**).

189

To cut the pin hole, the twist drill is placed in the starting pit and carefully lined up in the predetermined direction (**190**).

The pinhole is cut to the depth of the shoulder, preferably in one go so as to lessen the risk of deviation from the chosen line. Use of a speed reduction head should keep heat production to a minimum. If more than one attempt is required to complete the cutting, great care should be exercised to maintain a uniform angulation of the drill. It must be accepted, however, that there is the risk of over-enlarging the pin hole each time the drill is re-inserted.

190



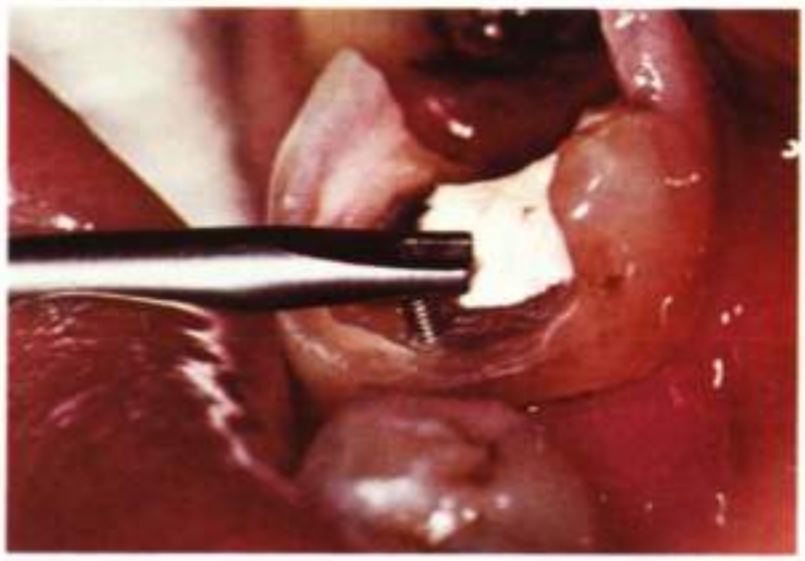
To insert a self-shearing pin of the Stabilok type, it should first be correctly lined up to match the post hole direction and poised slightly above the post hole. The speed-reduction head should then be allowed to reach maximum speed before the pin is pushed into the pin hole orifice. The pin will tap itself into the dentine and come to a sudden stop at the bottom of the hole when the momentum of the dental motor will cause the pin to shear from its shank (**191**).

191

If it proves necessary, the pin may then be bent. This can be done most safely with a special tool which can bend the outer end of the pin (**192**) without putting heavy stress on the retaining dentine.

The length and direction of the external half of each pin should be checked for adequate clearance between the pin and the matrix band, and between the pin and the opposing teeth (**193**). If it is intended to cover the pinned amalgam with a gold crown, it is necessary to bend the pins well inwards (**194**) to avoid them being laid bare during the full veneer crown preparation.

192



193

194

195–201 If the tooth to be restored has been root filled, it may be preferable to gain retention via the root canal, rather than further weaken the remaining tooth tissue with a series of pin holes. This example is of a single rooted upper first premolar, root filled and with extensive caries which has left only the palatal cusp standing (**195**).

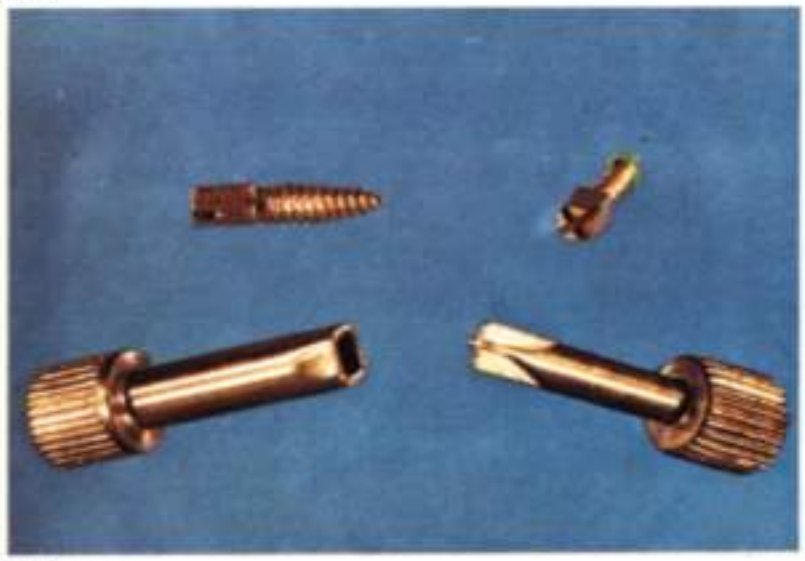
After caries and unsupported enamel have been removed, the single gutta-percha point root filling can be seen in cross-section (**196**).

195

196

Retention can be obtained by removal of the coronal half of the root filling and shaping the canal to receive a threaded screw post, such as the Dentatus shown here (**197**) with driver and box spanner which are used for insertion. It will be noted that the Dentatus post is tapered and there is, therefore, a risk of splitting the root during its insertion unless the root canal is shaped accurately to a slightly undersize, though similar, taper. Shaping is best accomplished by using the appropriate engine reamer chosen from the set of six supplied by the manufacturer (**198**) to match the range of Dentatus posts.

197



198

After the Dentatus screw post has cut its own thread into the root dentine, it should be removed to allow the application of phosphate cement before re-insertion. It will be noted here that the matrix band holder has been applied palatally, so that the gap in the matrix is in an area remote from the amalgam (**199**). After removal of the matrix, the amalgam carving is completed (**200**) taking care to reduce the occlusal surface in areas of possible heavy contact with the opposing teeth.

An immediate radiograph will confirm the sound placing of the dentatus post and will also indicate feathers of cervical excess, as seen mesially here (**201**) which may be removed before the amalgam is fully set.

199

200

201

202–205 In a two-rooted premolar, it is possible to increase retention by the insertion of two screw posts, one into each canal (**202**).

202

203

Where no crown tissue remains, a copper band may be preferred for a matrix (**203**). This is easily packed with composite material, and is ready for reduction to a full crown preparation as soon as it has set (**204**). This technique overcomes the problems associated with the provision of a post crown for a two-rooted premolar, and here has provided the core for a bonded porcelain crown (**205**).

204

205

206 & 207 It is sometimes found that a tooth has lost its vitality after it has been restored with a full veneer crown, and root canal therapy has to be undertaken through an access hole cut through the occlusal surface of the gold crown. After successfully root filling the tooth it may be advisable to ensure the future retention of the crown by using supplementary retention, as it were, in retrospect. A dentatus screw post may be fitted to the root canal (**206**).

206

The access hole in the gold can then be packed with amalgam to complete the retention between the crown and the post (**207**).

207

208–210 Gum tissue may be found to have proliferated over the cervical margin of a broken down tooth (**208**) and before a pinned amalgam can conveniently be placed, this excess tissue needs to be removed. This can most-easily be accomplished with the fine right-angle probe of a surgical diathermy which makes a clean incision (**209**). The high speed suction nozzle is performing the dual task of soft tissue retraction and evacuation of the smell of burning tissue before it is detected by the patient.

208

209

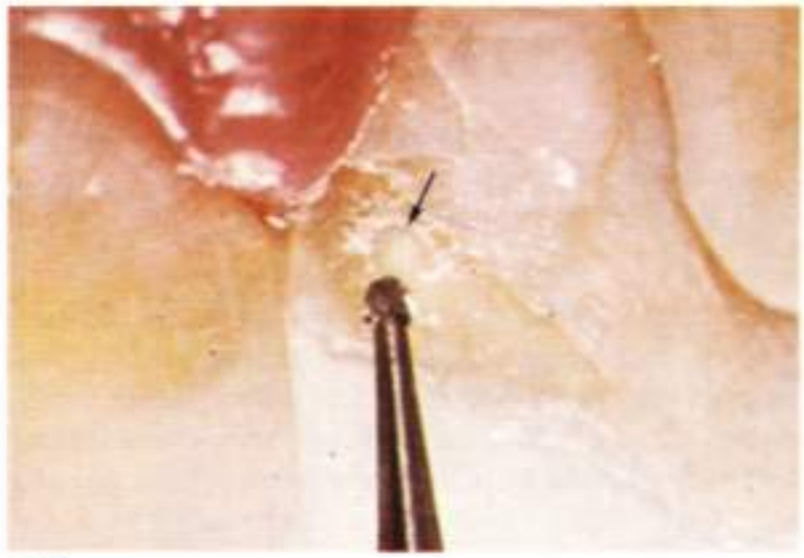
The resultant wound is a dry one (**210**) which allows work on the tooth preparation to proceed immediately. The superficial charring of the wound surface suggests that the diathermy output was set too high in this case, or alternatively that the output of the machine used was not fully rectified.

210

Pin retention – anterior teeth

211–215 It may be decided to supplement the retention of a composite tip restoration with pin retention. Because composite restorations are usually less bulky than amalgam restorations there may be the need to use a more delicate pin on these occasions. The Minikin pin, the smallest in the TMS range, is used in this series. The starting pit is placed with a small round bur (**211**) as for a posterior pin and the pin-hole is drilled with a twist drill (**212**) that matches the Minikin pin. The easy access to anterior teeth allows the use of a finger held driver to insert the pin (**213**). The Minikin pin has a small mushroom shaped head for extra retention (**214**) and its gold plating is a precaution against discolouration of the complete filling. In order to prevent the pin showing through the semi-translucent composite material, its buccal side should be painted with opaque composite (**215**) before the application of the main bulk of the composite.

211



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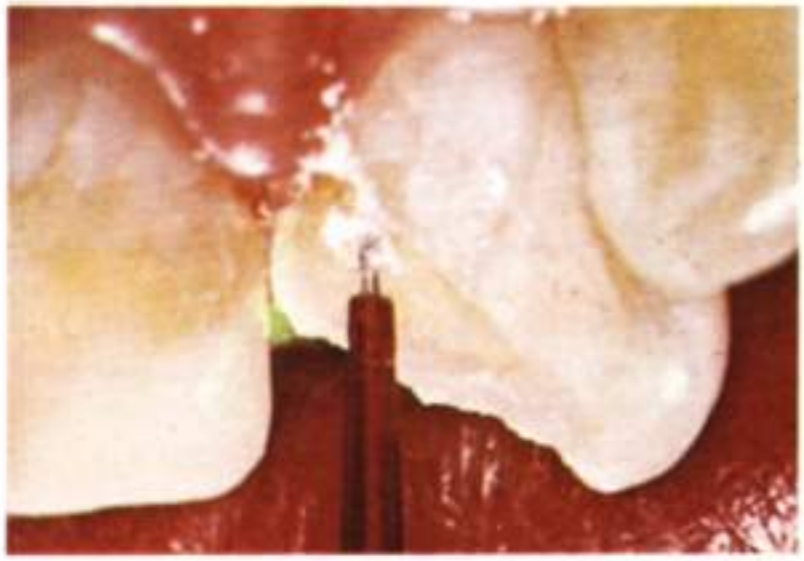

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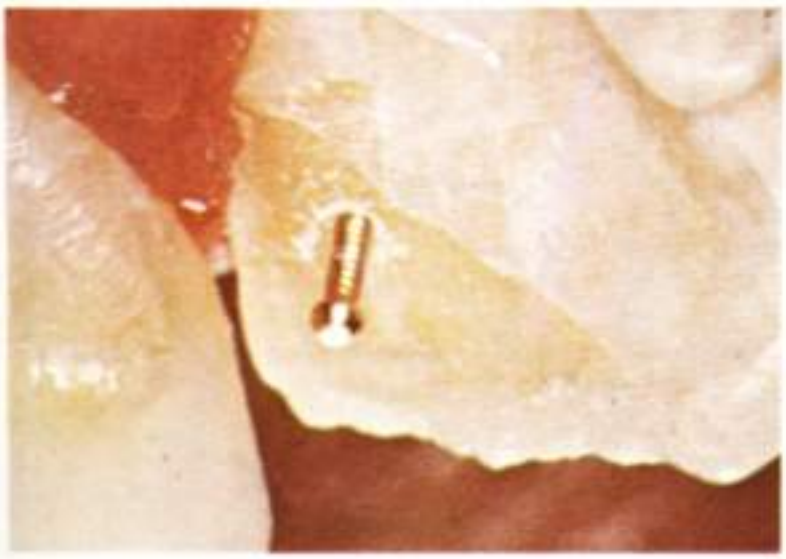


215

11 Gold restorations

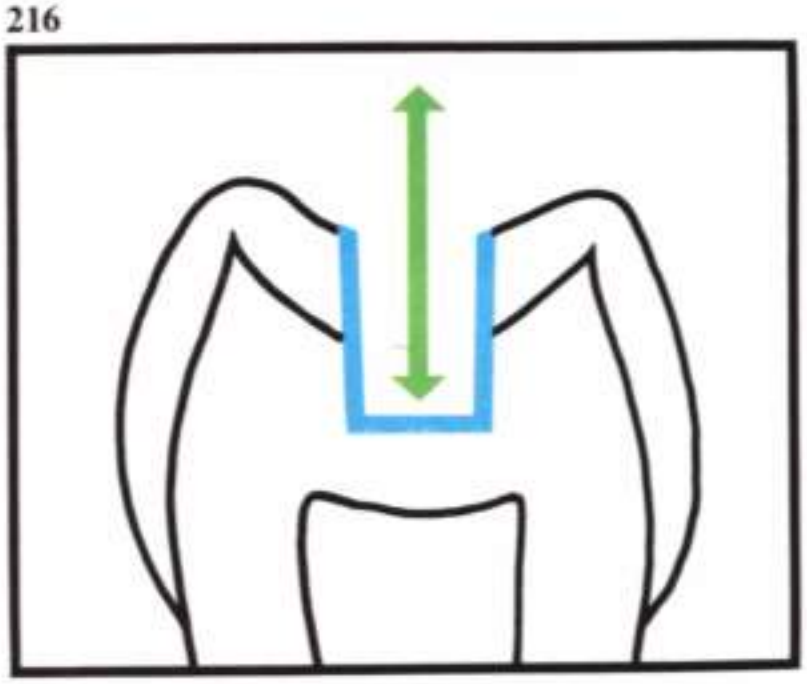
Intra-coronal restorations

Gold restorations which are placed into cavities cut into enamel and dentine, and which receive support and retention from the surrounding tooth tissue, are classed as inlays or intra-coronal restorations. Many of the principles which govern amalgam cavity preparation apply also to inlay cavity preparation, including outline form, resistance form and removal of carious dentine. Any differences are related to the facts that the inlay is constructed out of the mouth, and has thus to be capable of insertion into the cavity, and that the gold has to be capable of burnishing to cover over the cement lute. These differences resolve themselves into two aspects of cavity preparation – the cavity walls and the cavity margins.

In order that a wax pattern may be removed from the tooth or its replica – the die – the walls of the cavity must be free from undercuts. The same freedom from undercuts permits the insertion of the cast inlay into the tooth. Linked with this consideration, however, is the need to supply retention for the restoration which in the amalgam cavity was provided by undercuts. This is gained by so angling the walls of the cavity that they are as nearly parallel to the line of insertion of the inlay as convenience will allow. Retention is then a function of the length and near-parallelism of these walls.

216 & 217 In these drawings, the retention of the cavity indicated in blue is good, having near parallel walls and a long line of insertion. The retention for the cavity outlined in magenta is poor due to divergent walls and a shallow floor resulting in a short line of insertion.

216



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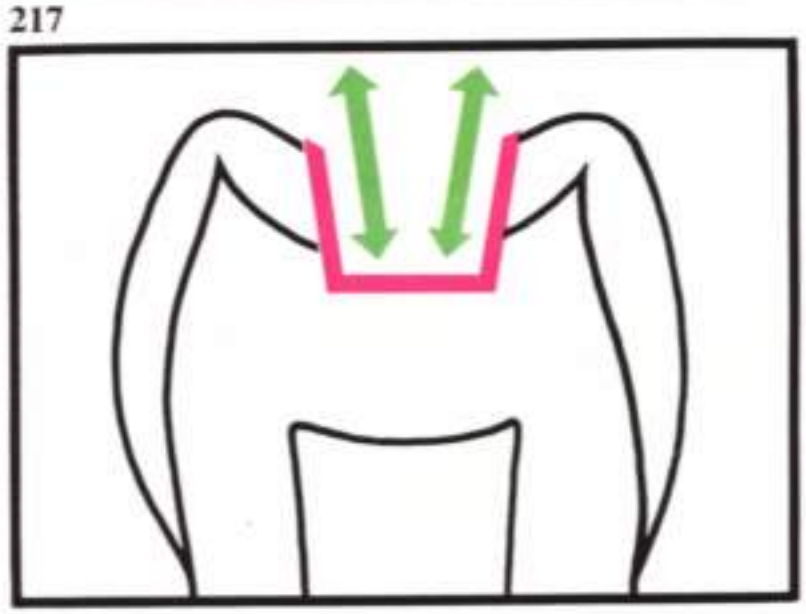
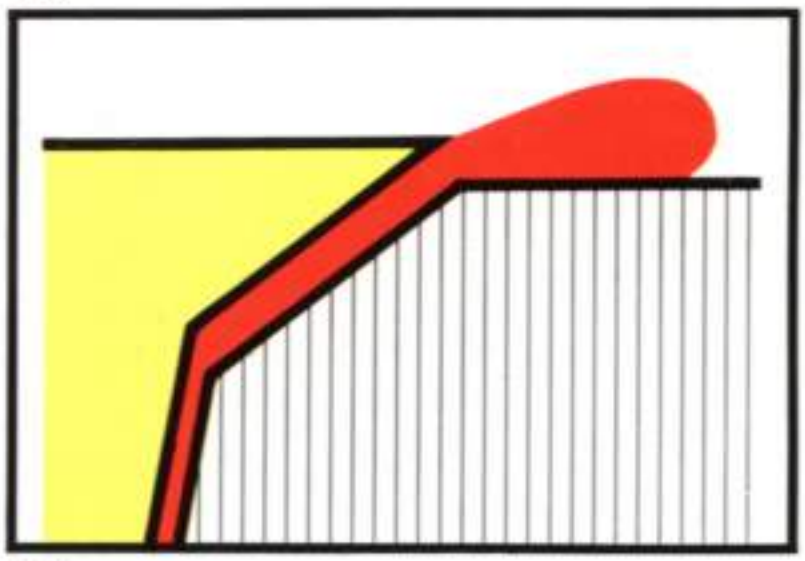


218–221 However good the retention of a gold inlay may be, it still requires to be cemented into place. This is to resist removal of the inlay in a direction opposite to its line of insertion. Between the inlay and cavity therefore is interposed a film of cement which, being soluble in mouth fluids, will wash out and leave a gap between the inlay and tooth margins. To prevent any serious consequences arising from this situation, advantage is taken of the strength and malleability of gold which will allow a thin margin to be bent (burnished) towards the enamel and thus cover over the cement lute.

To be thin enough to allow burnishing, the angle of the gold margin must be 45° or less. This implies a cavo-surface line angle of 135° or more. Immediately upon insertion, a sectional view of the inlay and cavity margins would show a marginal gap equivalent to the film thickness of the cement (**218**).

Preliminary burnishing before the cement has set will reduce the marginal film thickness of the cement to a minimum (**219**). At a later visit, when the superficial layer of cement has been leached out by the oral fluids (**220**), the burnishing can be completed to bring the gold margin into contact with the enamel (**221**). If this is done with a finishing bur, it is important that the direction of rotation of the bur should be from gold towards enamel and that the handpiece is also moved only in this same direction, as has been indicated by the arrows. Some slight thinning of the gold, as indicated in green, will accompany the burnishing process and the result should be a flush margin to the inlay, barely detectable to the probe.

218



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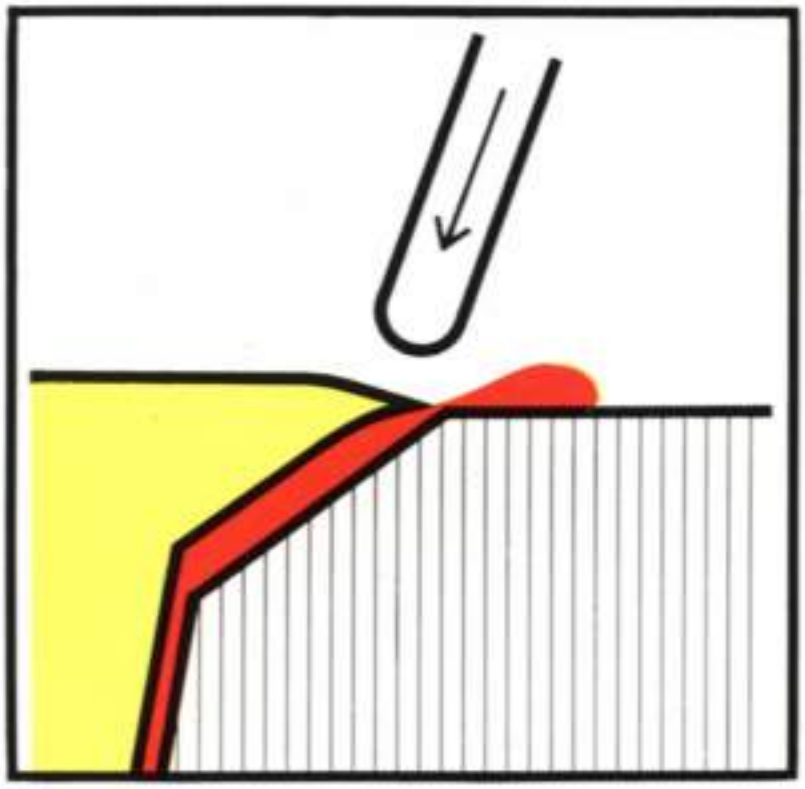

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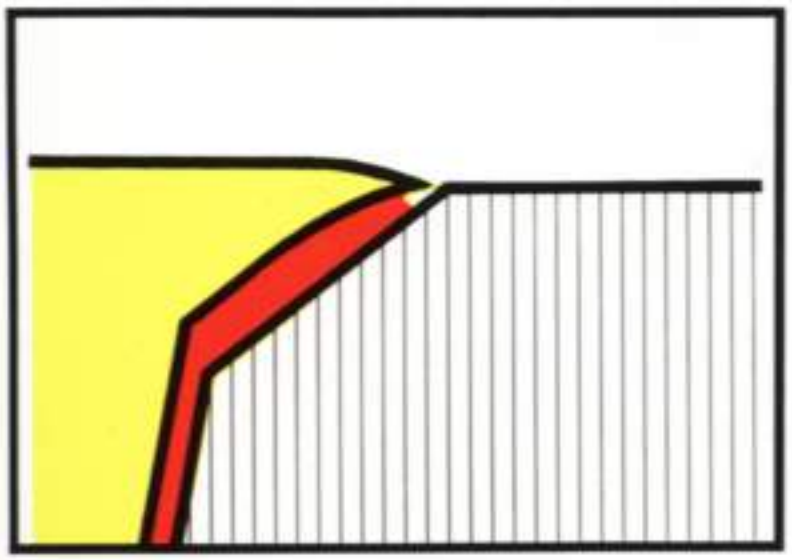

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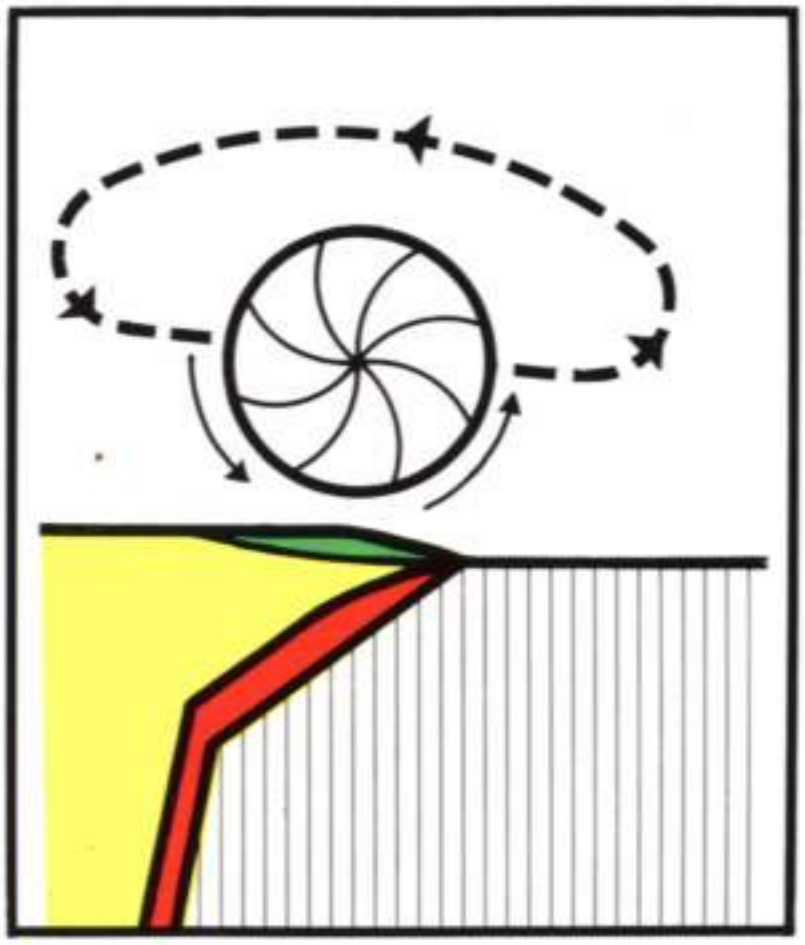
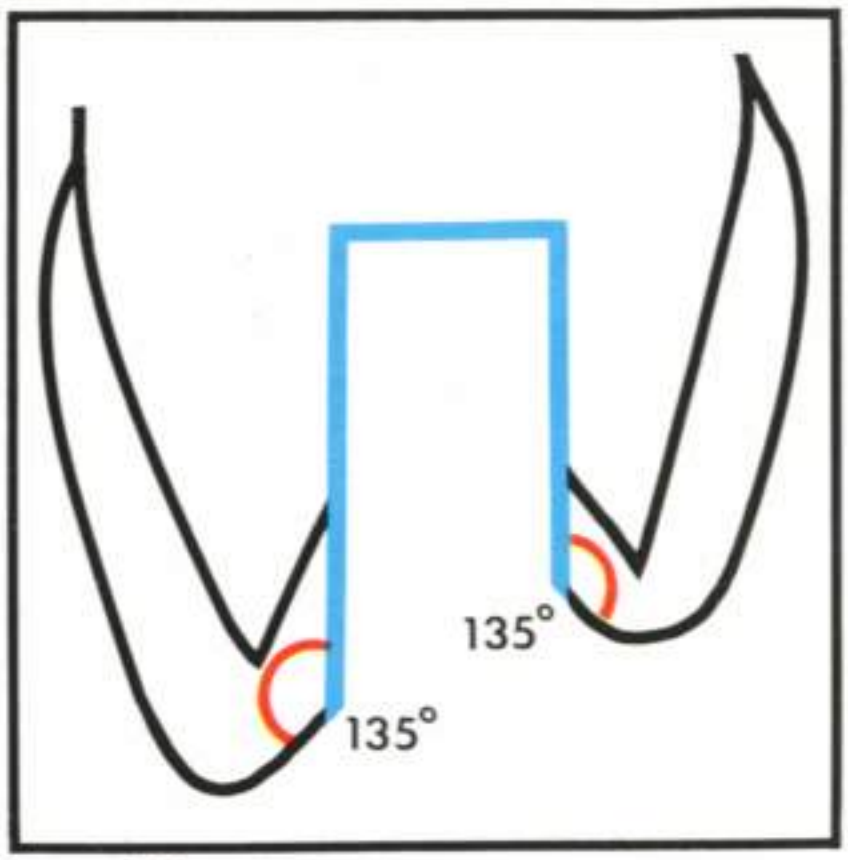


222 Where the cusps are steep, the required 135° cavo-surface line angle already exists as shown here. With flatter cusps, and at cervical margins and marginal ridges, a bevel needs to be added to create the correct angle. This can be done smoothly and delicately with Baker-Curson burs (**118**) of appropriate shape.

222



223 This proximal view of a single box Class II gold inlay cavity shows in green the retentive form achieved occlusally and, in yellow, the retentive form in the box. The bevelling is depicted in blue.

223

224 An occlusal view of the previous figure emphasises the withdrawal/insertion form. All the surfaces of the cavity walls can be seen from a single viewing point above the cavity indicating absence of undercuts. However, these surfaces are only just visible demonstrating their near-parallelism.

224

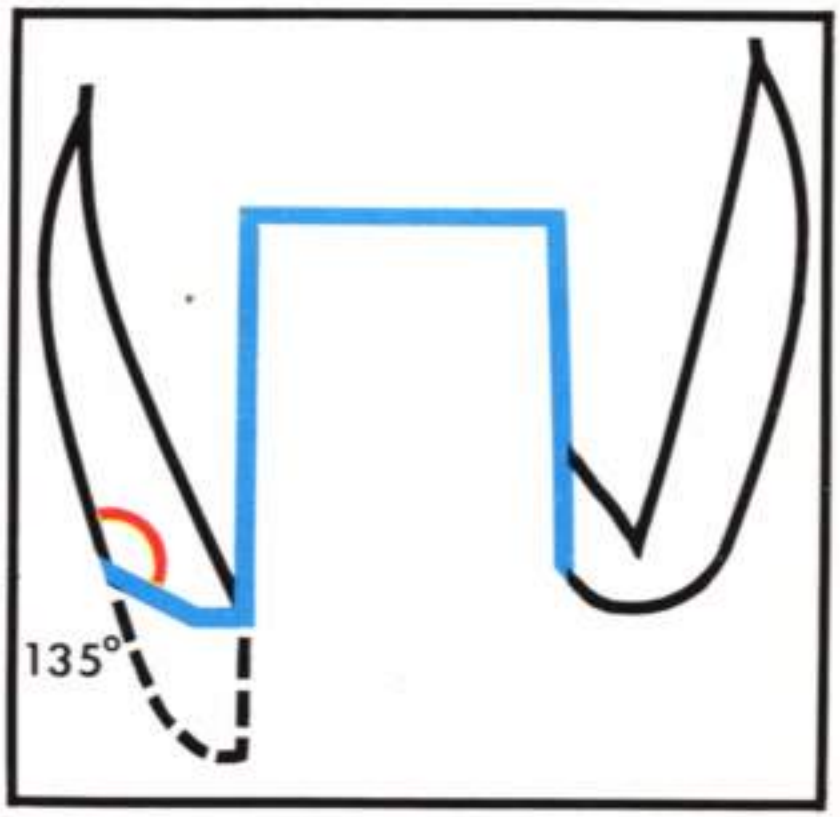
225

225 Minimal interproximal enamel caries may be dealt with by cutting a channel-slice preparation shown in blue and red. The shallow slice is cut with a disc and removes only a little enamel. The channel, cut with a tapered fissure bur, is to give some resistance form, but also provides a strengthening spine to the wax pattern to resist distortion during its handling and investment. Because the resistance form in a channel-slice preparation is minimal, it is not recommended for use on its own but in an MOD restoration where the opposite interproximal lesion has been prepared to a box design.

226

226 The occlusal view of the channel-slice preparation stresses its minimal resistance-form, compared with the box preparation, but does indicate the fine margin that will be produced in the gold which will greatly facilitate burnishing. If the interproximal caries involves much dentine, the 'channel' may have to be widened to allow caries removal. Although the channel-slice preparation can be shallow, the external contours of the tooth may make it much wider than the corresponding box design, and for mesial preparations in particular this may affect the aesthetics adversely.

227



227 An extra-coronal extension may be required for an inlay cavity where one or more of the cusps is weak. This 'capping' of the cusp is achieved by reduction of the cusp height by approximately 1.0mm, and the addition of a 'reverse' bevel to achieve a cavo-surface line angle of 135°. The finished inlay will thus cover the cusp and protect it from occlusal stress.

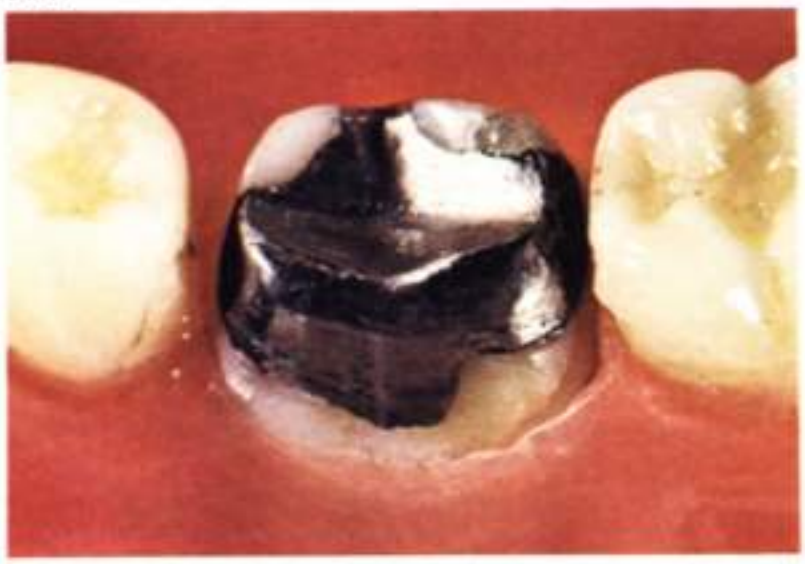
Extra-coronal restorations

By virtue of its strength, gold can be used entirely extra-coronally, and thus completely protect what remains of the crown of the tooth. Such crowns are known as full coverage or full veneer crowns and can be made in yellow gold, or platinised gold faced with a layer of porcelain bonded directly to the metal. A variation of the full veneer yellow gold crown is the three-quarter crown, which involves the preparation of all but one surface of the tooth. Often this is the buccal surface where aesthetic considerations make full coverage with gold inadvisable (see **420 & 421**).

228 & 229 Teeth requiring full veneer crowns usually do so because of extensive caries. An exception to this could be the abutment tooth intended as a support for a bridge, which might be minimally carious or even caries-free. Following removal of the carious tissue and weakened enamel, the crown should be restored in a plastic material, preferably amalgam, which is retained with pins.

The re-built crown is then prepared to allow room for coverage with gold, taking note of the need for near-parallelism, freedom from undercuts and correct marginal finish (**228**). The full veneer crown can then replicate the external dimensions of the original crown, as seen here (**229**).

228

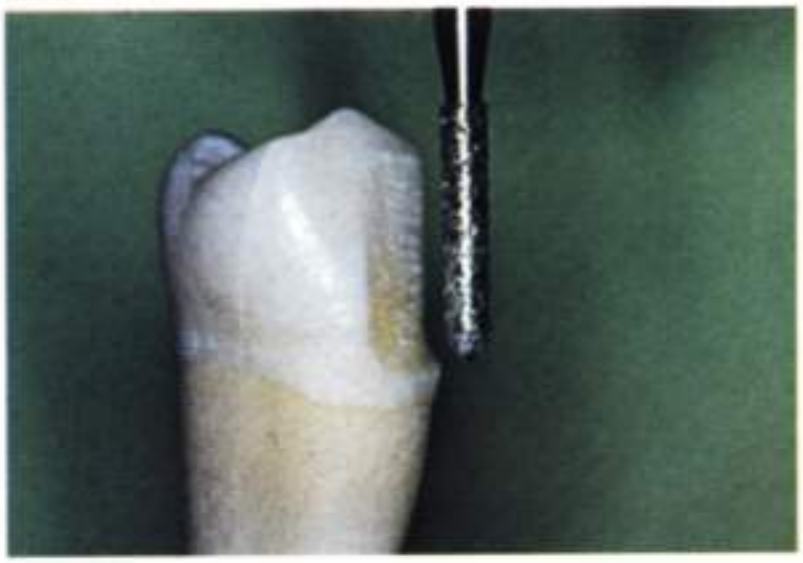


229

230–236 The appropriate marginal finish for a full veneer crown preparation is what is termed a '135° chamfer'. The advantages of this are that only a minimal amount of tooth tissue is removed, compared with a shouldered preparation, yet a more readily recognisable margin on the die is created, compared with a knife-edge preparation.

The 135° chamfer is readily prepared using a torpedo-shaped diamond (**230**) or tungsten bur.

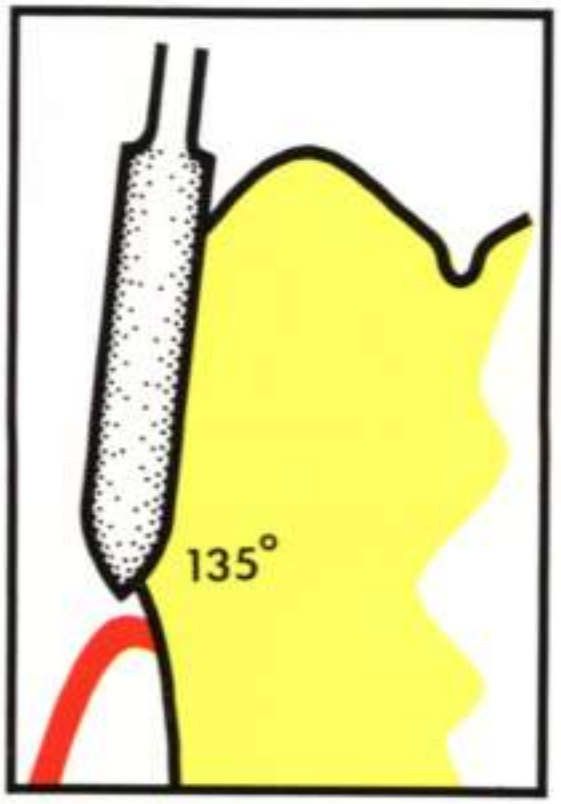
230



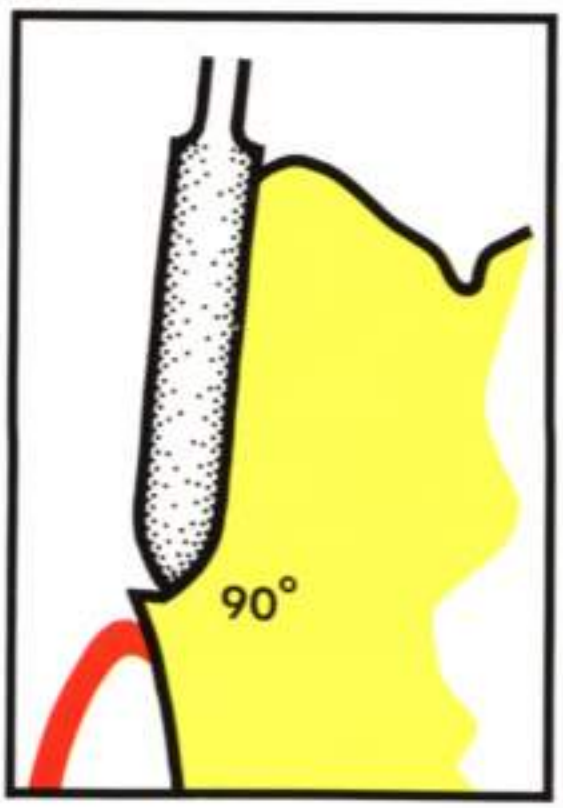
The shape and dimensions of such a bur ensure that adequate reduction and near-parallelism are achieved at the same time that the correct margin is being created, so long as the tip of the bur remains outside the tooth (**231**).

If this bur progresses too far, an unacceptable marginal angle of approximately 90° will result (**232**). When full veneer crowns are required on adjacent teeth, the touching proximal surfaces may be prepared simultaneously (**233**).

231



232



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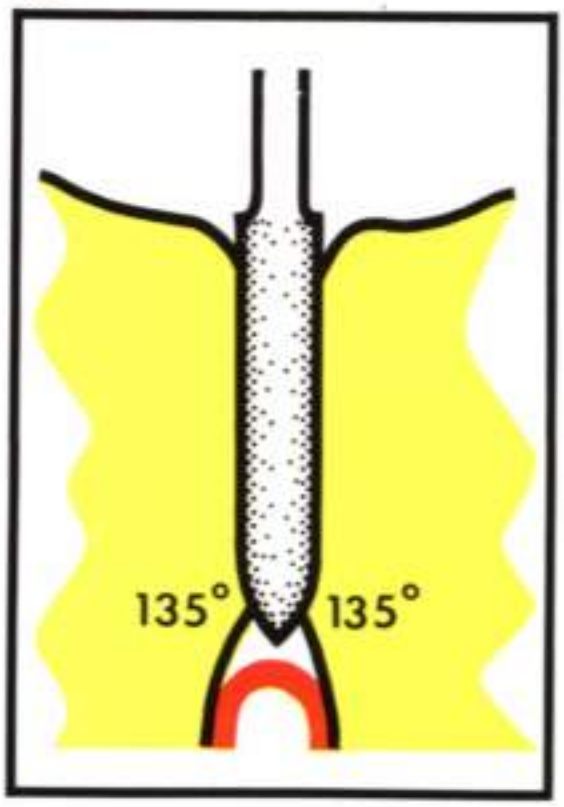

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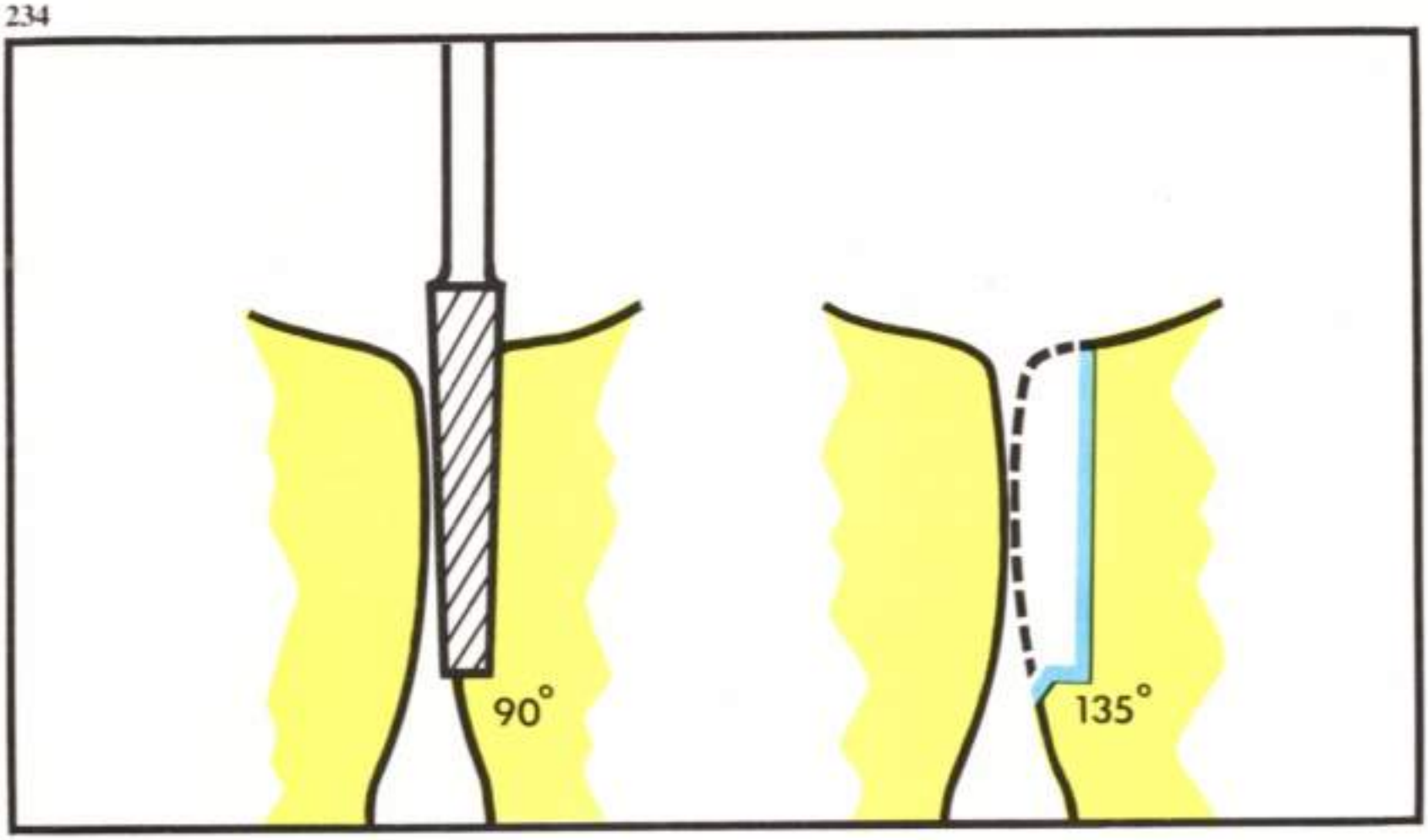
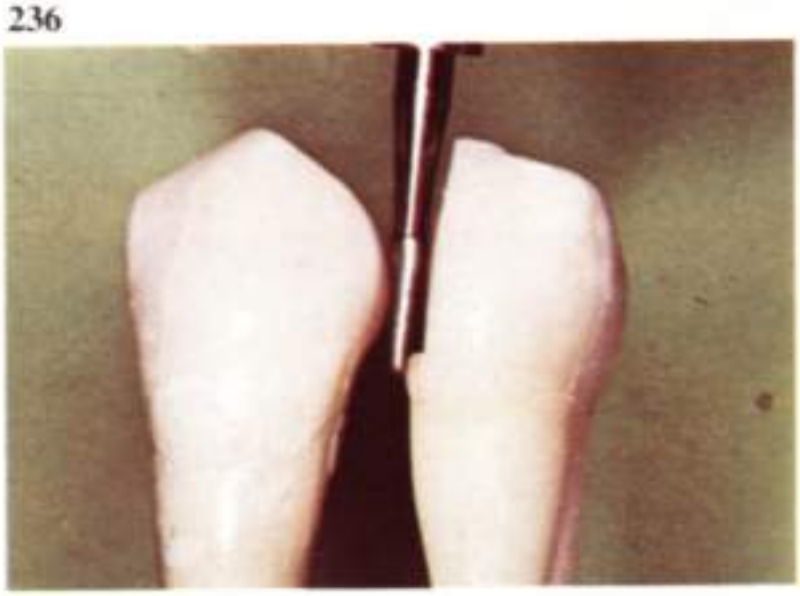


When only a single veneer crown is required, however, the torpedo-shaped diamond bur cannot usually be used interproximally without damaging the adjacent tooth, unless, of course, there is interproximal spacing. To avoid such damage, a delicate tapered tungsten bur may be used for the interproximal reduction (**234** left and **235**). The shoulder resulting from the use of a tapered fissure bur will require bevelling, if a burnishable margin is to be produced on the finished crown (**234**, right). This can be applied with a Baker-Curson bur slightly angled to the line of withdrawal (**236**).

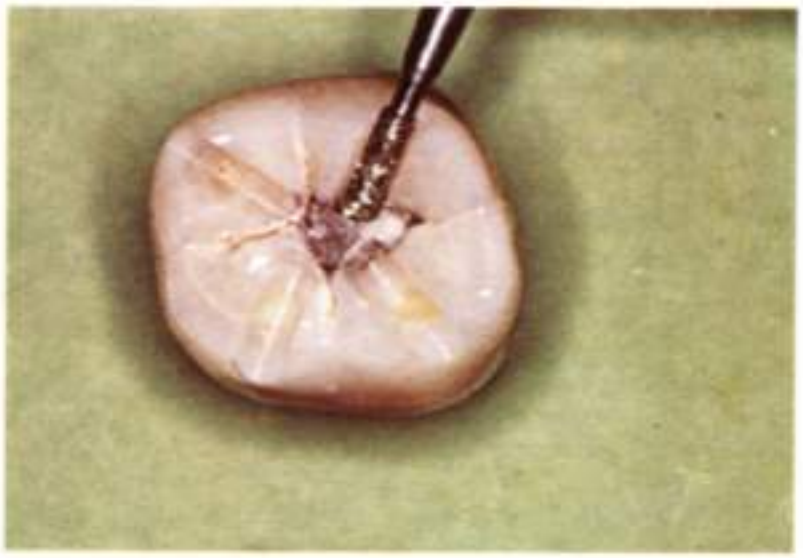
235

236



237 & 238 If yellow gold is to be used, the occlusal surface of the full veneer crown preparation should be reduced by 1.0mm. In order to achieve this reduction evenly over the whole occlusal surface, it is helpful to start by cutting 1.0mm channels in several places with a flat fissure bur of 1.0mm diameter (**237**). These channels will act as depth markers during occlusal reduction, and will assist in ensuring that the surface is neither over nor under reduced. The effectiveness of these channels can be appreciated by this buccal view (**238**).

237



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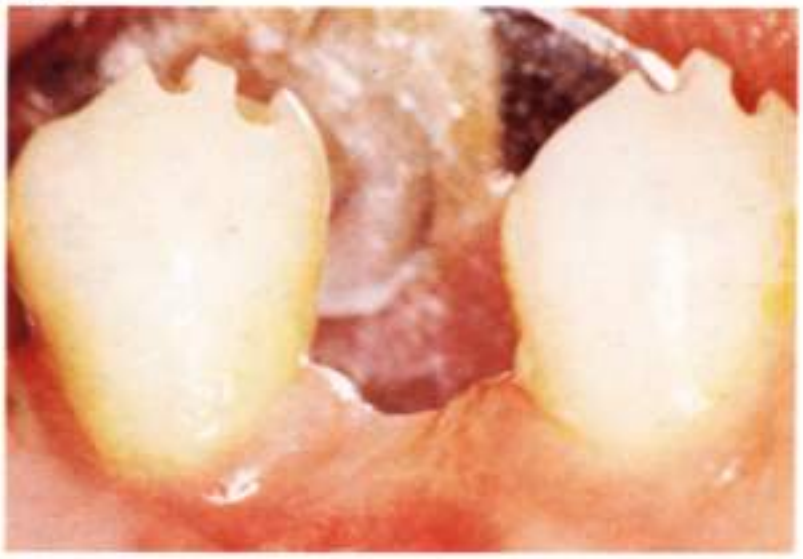
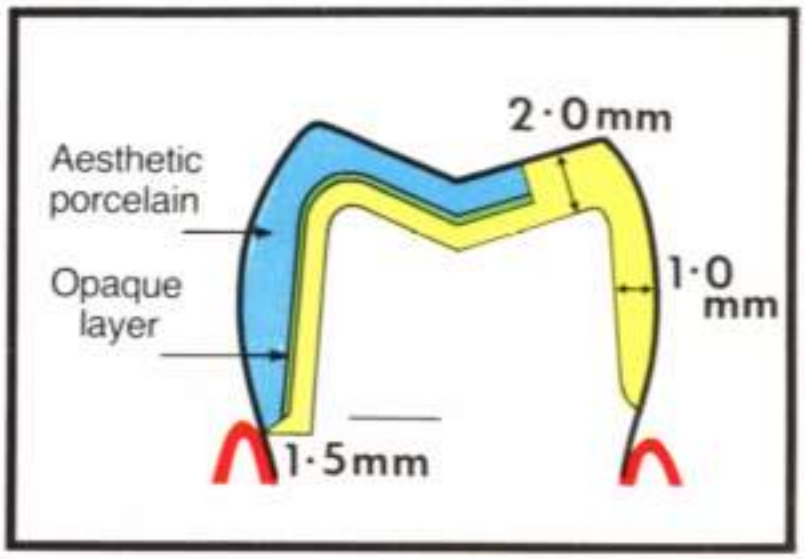


239 If a bonded-porcelain crown is to be used, tooth reduction has to be increased to make room for both metal and porcelain. A minimum thickness of 0.5mm is required in the gold substructure. If the gold is used in thinner sections than this, it may flex in use and cause the porcelain to crack. Also, the gold may sag whilst being heated during the addition of porcelain and thus distort. A minimum thickness of 1.0mm has to be allowed for the porcelain, if it is to achieve adequate translucency yet mask the gold. These requirements demand, therefore, a shoulder with a minimum width of 1.5mm in all regions to be covered by porcelain and gold. The marginal finish may be a butt-joint as shown here (left). Some operators prefer to bevel this margin slightly. However, this has either the aesthetic disadvantage of showing more gold or the periodontal disadvantage of having to hide the gold margin sub-gingivally. As the platinised gold is too hard to burnish, it is arguable that a butt-joint is acceptable, as indeed it is for a porcelain jacket crown.

Where porcelain coverage is not needed, that is palatally and lingually in many cases, reduction is required only to accommodate the gold, as in a standard full veneer crown, and a 135° chamfer margin can be used (right).

239



12 Anterior crowns

Although many aesthetic defects in anterior teeth can be remedied by acid-etch composite techniques, these have not been in use long enough for an opinion to be given on the long term prognosis of the resulting restorations. It seems likely that crowns, particularly of porcelain fused to metal, will still have an important part to play.

The use of jacket crowns

240 & 241 A jacket crown may be the permanent restoration of choice for a fractured incisor, but when the tooth is fractured at an early age, it may be inappropriate to restore this immediately with a jacket crown, due to the risk of an exposure of the large pulp and to the lack of gingival maturity. Such a fracture is usually treated with an acid-etched composite, a shoulderless acrylic crown or a basket crown (**240**) which require minimal tooth preparation. At a later age, when the pulp is smaller and the gingival margin is in a stable position, it is appropriate to provide a porcelain jacket crown (**241**).

240

241

242 & 243 Extensive recurrent caries round large restorations (**242**) is an indication for protection against further caries by full coverage with jacket crowns (**243**) which can also be the most aesthetically acceptable form of restoration.

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243

244 & 245 The disfigurement resulting from the large discoloured restorations in the upper left central and lateral incisors (**244**) can be remedied with jacket crowns. In this case, however, the jacket crown for the left central incisor was combined with a jacket crown for the right central to produce an all-porcelain bridge, which replaced the missing right lateral incisor, whilst the left lateral was restored separately with a porcelain jacket crown (**245**).

244

245

246–248 In this typical example of Amelogenesis Imperfecta, the enamel is hypocalcified, the teeth are unsightly and the rough surface has contributed to the heavy plaque and calculus deposits, especially around the lower incisors (**246**). After cleaning the teeth and establishing good plaque control, the upper and lower incisor teeth are prepared for shoulderless jacket crowns, with only minimal tooth preparation being required (**247**).

246

247

The transformation in appearance following the fitting of eight jacket crowns (**248**) is likely to have a marked effect on the personality of the patient and his attitude to dental care, which fully justified the use of advanced restorative work in one so young. It will of course be necessary to remake the crowns with normal shouldered preparations when it is safe to do so.

248

249 Enamel hypoplasia which has seriously affected the appearance of 21|12 can readily be improved by the provision of jacket crowns.

250 & 251 Mottled enamel affecting most obviously the upper central and right lateral incisors (**250**) can be treated effectively with jacket crowns (**251**).

250

252–254 Abrasion facets have been worn incisally on the left incisors and canines by this patient's pipe (**252 & 253**). Note the 'characterisation' of the 1|12 jacket crowns by cervical staining to make them blend in with the natural teeth (**254**).

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255–256 In this example of erosion, buccal enamel has been lost from the upper incisors (**255**) due to the acid environment in which this patient worked. A good aesthetic result has been obtained with four jacket crowns (**256**).

255

256

257 A dramatic improvement in appearance in this example of tetracycline staining can be achieved by multiple jacket crowns, as can be seen at this halfway stage of the treatment.

258 & 259 The space left by the early loss of the upper right lateral incisor has partially closed (**258**) leaving little room for a partial denture which would not therefore give a very pleasing result.

The space and the rather noticeable canine can both be dealt with by crowning the canine to simulate a lateral (**259**). The 'lateral' shown here has had to be made with a tilted long axis, and is inevitably rather wider than the contralateral tooth, but in social terms the improvement in appearance is very acceptable.

257

259

258

260 & 261 The appearance resulting from missing upper laterals and a retained c| (**260**) can be improved by four jacket crowns. An attempt has been made to disguise the width of the central crowns by making the buccal contour more convex than would normally be the case (**261**). The crowning of a primary tooth can be justified if there is no root resorption and the tooth is firm. However, the disparity in shape between the original primary tooth, and that of the tooth being simulated makes it difficult to achieve a perfect cervical adaptation for the crown, with consequent problems of plaque control. The marginal gingivitis evident here will need careful home treatment by the patient.

260

261

262 & 263 The unsightly appearance of these upper front teeth (**262**) is due to a number of circumstances, including a missing lateral incisor, drift of a canine, fracture of a central incisor and presence of a 'peg' lateral incisor.

Jacket crowns have been placed on |12 and a simple cantilever bridge on 31| which fills the distal space with a simulated canine, whilst the natural canine is converted to look like a lateral (**263**). The aluminous core to the crown on |1 is visible, and this should have been masked by covering with a thicker layer of dentine porcelain.

262

263

264 & 265 Early loss of the upper right central incisor has allowed the lateral incisor to move into the space (**264**). Other teeth in the quadrant have also moved forward. An acceptable appearance is created by crowning the lateral to simulate a central incisor, and by grinding the tip of the canine to make it look more like a lateral incisor (**265**).

264

265

266–268 At first sight, the tilting of the lateral incisors into the space from which the centrals have been lost (**266**) suggests that jacket crown preparations would risk exposing the pulps.

However, preparations were possible without resorting to post crowns (**267**). It is debateable whether the resulting jacket crowns (**268**) should have been made fractionally wider to avoid the diastema.

266

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269–271 The space due to the missing 3| is only the width of half a tooth (**269**), making it impossible to fill it with a natural size canine. It has therefore been partially filled with a jacket crown on the lateral, built out distally. From the side, with lips retracted, it can be seen that the space has not been filled fully (**270**). However, from the front the illusion is effective (**271**).

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272–274 The |1 of this patient has erupted with its palatal surface facing buccally (**272**). A standard jacket crown preparation is carried out according to tooth morphology and ignoring the rotation (**273**). The porcelain crown however is orientated to disguise the rotation (**274**). To improve the appearance further, the upper left canine requires some incisal grinding, and possibly the addition of acid-etched composite mesio-incisally to make it look like a lateral incisor.

272

273

274

275 Gingival recession poses problems for anterior crown work, whether following the fitting of crowns as shown here, or in the natural dentition before crowns are contemplated. The narrowing of the root makes the establishment of 1mm gingival shoulders in the preparations difficult, if pulp exposure is to be avoided. There is also the aesthetic problem of not making the patient look 'long in the tooth'.

275

276 & 277 The aesthetic problem mentioned above can sometimes be solved by the use of pink porcelain to simulate gum, as in the upper right lateral incisor.

276

277

278 & 279 The unsightly loss of alveolar bone due to the removal of a supernumerary tooth between the upper left incisors (**278**) can be made good by a projection of pink porcelain from the jacket crown made for the lateral incisor (**279**). The underside of the projection will need careful cleaning with dental floss.

278

279

280 Not all disfigured teeth should be recommended for crowning however. Apart from slight incisal notches and a small chip fractured from the mesial corner of 1| these geminated upper centrals are perfectly healthy, as are their supporting structures. The best dental advice should be to persuade the patient to accept the excessive crown width. Correction is difficult due to the wide cervical dimension. Some improvement could be obtained by making jacket crowns for 1|1, that are smaller than the present crowns. This would create diastemata between all incisors which would not look natural. The distal spaces could be closed by crowning 2|2 but this would mean involving a further two sound teeth.

281 & 282 This condition of relative generalised microdontia (**281**) is due to slightly larger than normal jaws. The teeth and supporting structures are completely healthy and the problem is simply one of aesthetics.

To show the patient what can be done, four acrylic jacket crowns can be made on a model of the upper jaws (**282**). These can be used as temporary crowns if the patient wishes to proceed with porcelain jacket crowns. However, rather than put the teeth and gums at risk, it would be better not to interfere but to persuade the patient to accept her appearance.

283 This diastema due to the position of the frenum could readily be closed by two jacket crowns but, as the upper centrals are quite sound, an attempt could be made to dissect out the attachment of the frenum and move the teeth orthodontically into an acceptable position – thus avoiding crowns altogether.

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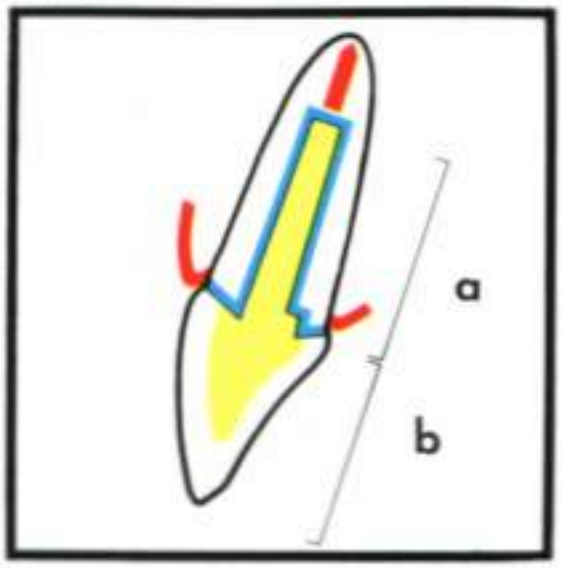
The use of post crowns

Sometimes it is not advisable to attempt a jacket preparation when a crown is to be provided. This might be because the amount of tooth tissue lost, due to caries or a fracture, would create problems with retention. It is also considered by many to be unwise to place a jacket crown on a non-vital tooth, because the increase in brittleness of non-vital dentine might cause it to fracture. A further contra-indication to attempting jacket crown preparations would be when this might cause a traumatic exposure of the pulp, as for instance, when an excessive amount of tooth tissue has to be removed in order to re-align the crown.

In these and similar situations, a post crown is the treatment of choice after a suitable root filling has been placed.

284–285 Ideally, a post-cum-core design is used (**284**). The post gains retention from the root of the tooth and the core simulates a jacket crown preparation. If the post/core is to be cast, the post hole must be cut with a slight taper for reasons of convenience form, as in the case of any gold restoration. However, the post taper should be kept to a minimum if good retention is to be obtained, and the length of the post should be at least the same length as the crown that it is to support i.e. (a) = (b), and preferably the post should be longer. When the root of a tooth requiring a post crown is shorter than normal, as for instance following apicectomy, it is possible to retain an adequate length of post hole by not reducing the crown portion to gum level. Thus the core is formed partly of dentine and partly of gold, and the a/b ratio is maintained (**285**). With both these designs it is possible to replace the standard jacket crown, should this be necessary, without removal of the post and core. If a remake should become necessary because of gingival recession, only the buccal cervical dentine need be adjusted, in order to place the crown margin sub-gingivally. The post and core remain untouched and a new jacket crown is constructed.

284



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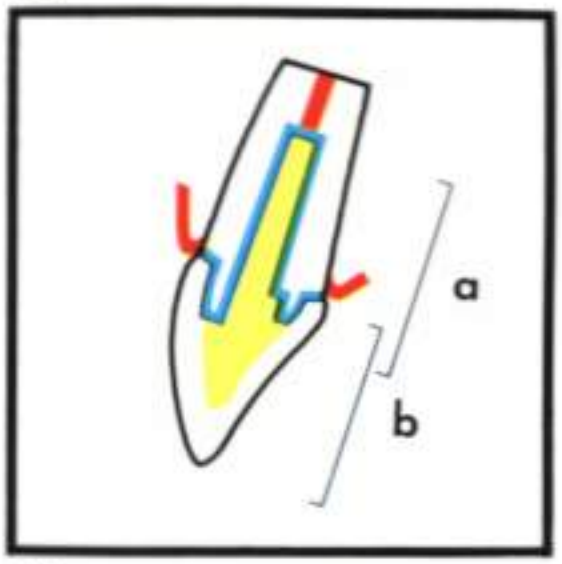

286 & 287 The cast post/core shown here has a slight protruberance at the coronal end of the post (**286** arrowed) which fits into a matching groove cut into the dentine thus resisting dislodgement of the post and core by rotatory forces.

286

When the post is cemented in place, the combination of the protruding gold core and the cervical shoulder of dentine resembles a jacket crown preparation (**287**) and is treated as such from then on. The cast post/core technique is particularly suitable for elliptical canals, and also for wide canals, as this makes for easy impression taking and waxing up and the resulting cast post is strong.

287

288 & 289 An alternative to a cast post and core is the pre-formed blank. One such is the Kurer Anchor System (Kurer 1967). The Kurer post (**288a**) is threaded and achieves great retention from being screwed into the dentine of the pulp canal. An engine reamer (b) prepares a post hole of the correct diameter to allow a tap (c) to cut a thread in the dentine. The face of the preparation is made flat, with a special instrument (d), ready to receive the core when the Kurer post is inserted with the screwdriver provided (e). After any necessary adjustment to the length of the post to allow full seating of the core, cement is introduced into the post hole and the Kurer post is screwed in, When the cement has set, the protruding core is shaped up (**289**), impressions are taken and a jacket crown is made (see also **453–458**).

288

289

290 The Charlton system provides a blank with a parallel-sided post, which is cemented into a non-tapered post hole of matching size. It is claimed that better retention is obtained than with a comparable tapered post (Charlton 1965). The post hole is cut with the appropriate sized flat fissure bur, and rotation of the post is resisted by a slot cut in the face of the preparation with the matching diamond wheel provided. The mesial and distal 'flats' of the core fit into this slot. As with the Kurer system, after cementation the core is prepared to receive a jacket crown. The range of post diameters in both the Kurer and Charlton systems is limited, and they may only be used where it is possible to prepare a non-tapered post hole.

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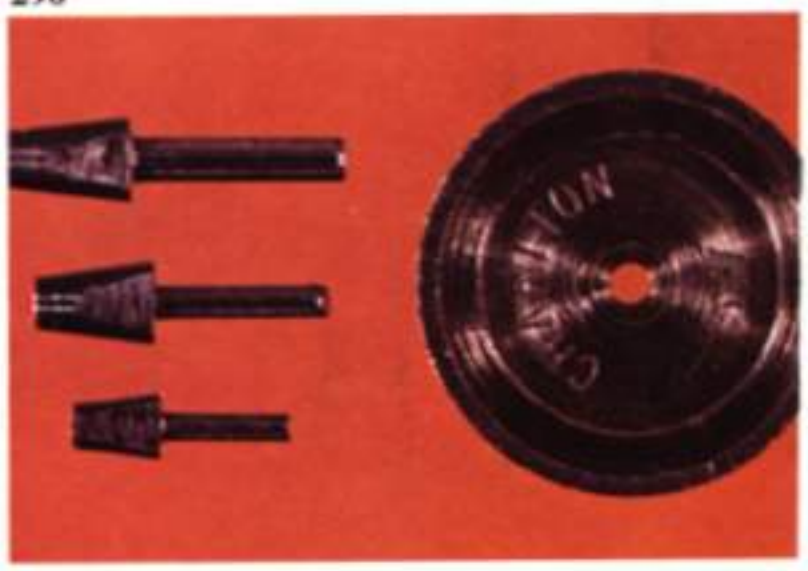
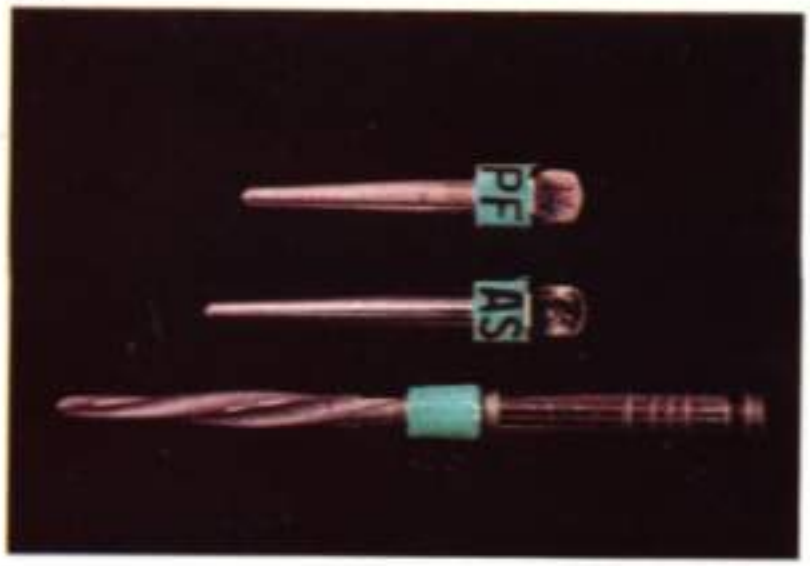


291–293 Another approach to post crown design combines a pre-formed post with a cast core. One system is based on the technique described by Mooser, (1970 and 1973). Matching posts and reamers are provided in a range of sizes (Métaux Précieux S.A.). From these are chosen the appropriate size base metal post (AS) precious metal post (PF) and engine reamer, which are colour-coded to prevent error in selection (**291**).

291



The post hole is precisely cut with the engine reamer, and this hole is made slightly eliptical at the coronal end to provide an anti-rotational groove. The base metal post is next inserted and an overall impression taken which combines with the post (**292**). In the laboratory the model is cast and the precious metal post substituted for the one of base metal.

292

A core is waxed up around the precious metal post and cast onto it (**293**). Note how the core of yellow gold extends into the anti-rotational groove. A variant of this technique is the Wiptam technique (Harty and Leggett, 1972). This uses a wrought wire for the post made of nickel, chrome, and cobalt which is strong in thin section. The wire ranges in diameter from 1.0 to 1.5mm, and is a useful alternative to the cast post when the canal is narrow.

293

294 In certain situations, such as marked attrition, loss of space palatally may be so severe, as to make it impossible to find room for the standard design of core and porcelain jacket crown. It may then be necessary to cast the post and core in platinised gold, and to bond porcelain to this on the buccal side only. However, if replacement becomes necessary this will involve removal of the whole post crown.

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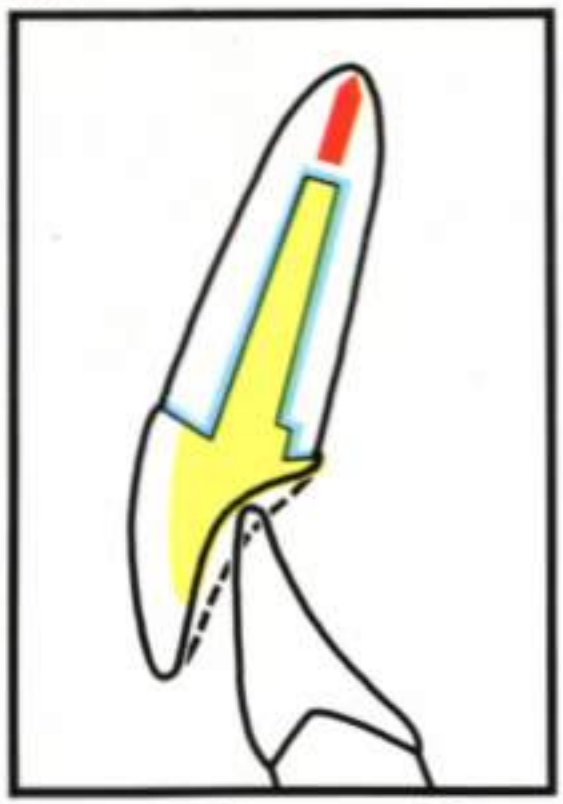


295–297 A problem sometimes encountered in a post crown preparation is the establishment of a good length post hole, without deviating from the direction of the pulp canal causing an unwelcome undercut, or accidental root perforation. It can be particularly difficult to keep on track if the root canal has been filled, for instance, with well condensed gutta percha. The initial penetration of such a root filling can safely be achieved with the Gates-Glidden reamer (**295**) which has a blunt tip. The design of this reamer is such that it will readily cut its way through gutta-percha, whilst its blunt tip will guide it up the root canal without risk of lateral deviation.

The post hole can be further widened with an engine reamer, and if this is used with an adjustable stop (**296**) a predetermined length post hole can be cut safely. If a cast post is to be made, the final shaping of the post hole can well be accomplished using a diamond fissure bur, of a size and taper corresponding to that of the intended post (**297**).

295 296 297

298 & 299 Post crowns are the inevitable choice for this patient, because the gross caries in the upper lateral incisors has destroyed too much crown tissue for jacket preparation to be considered (**298**).

298

After placing suitable root fillings, preferably apical-third silver points, the canals are prepared for cast posts and cores. Jacket crowns are then fitted (**299**). Note that it has been possible to restore the large mesial cavities on the central incisors with composite fillings.

299

300 The usual restorative approach to the aesthetic improvement of discoloured non-vital teeth is post crowns, following root filling. Jacket crowns are not recommended because of the brittleness of dentine associated with non-vital teeth, and the weakening of the crown dentine caused by the access hole required for root canal therapy. On otherwise sound crowns such as these, however, bleaching could be attempted, but this is time-consuming and not often fully successful (see **330–332**).

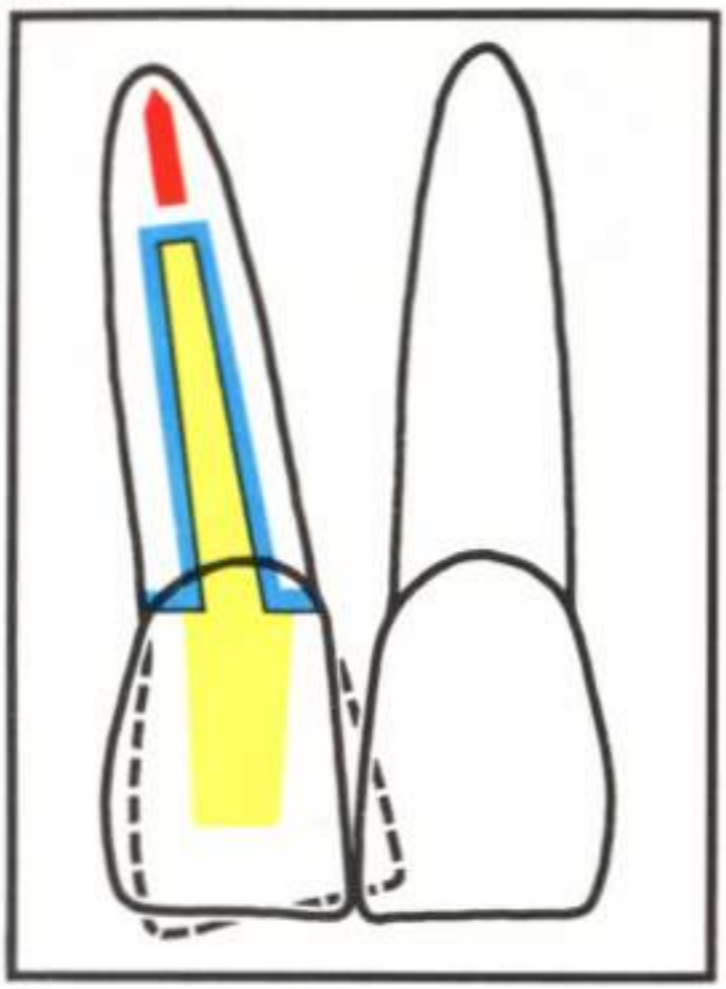
300

301 & 302 A multiple traumatic exposure such as this (**301**) may be difficult to avoid, if an attempt is being made to re-align a proclined tooth into the arch by crowning. Often the exposure can be predicted, and an early decision made to perform a vital extirpation and root filling followed by a post crown. Re-alignment of crowns is possible using post crowns, because it is not essential for the post and core to have a common long axis.

301

In this example of a tilted central incisor (**302**) advantage is taken therefore of the cast post/core technique, whereby the core can be waxed up in a position quite independently of the axis of the post. Thus an overlapping natural crown can be replaced with a jacket crown that is positioned regularly in the arch.

302



303–306 In this example of Angles Class II, division 2, malocclusion (**303 & 304**) any attempt to reposition the upper incisors with jacket crowns would entail so much tissue removal that the teeth would be weakened and the pulps exposed.

303

304

Post crowns have therefore been placed, with the cores so arranged as to allow the subsequent crowns to be brought into an aesthetically acceptable position (**305 & 306**). Before such a procedure is undertaken, it is important to analyse the occlusal relationships with the lower incisors, to ensure that there is going to be enough room to accommodate the retracted upper lateral crowns.

305

306

307–309 This patient has lost one of his protruding upper central incisors in an accident, and the closeness of the lower incisors to the palatal mucosa leaves little room for a denture (**307**).

Elective extirpation of the pulps in $\underline{1|2}$ allows cores to be well positioned in the arch (**308**) and both the incisal protrusion and the missing tooth are successfully remedied with an all-porcelain bridge (**309**) based on jacket crown retainers.

307

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309

310–313 The fracture of the lower right lateral incisor goes deeply subgingivally on the lingual side (**310**) making it difficult to achieve the necessary shoulder for a porcelain crown. This problem is overcome by constructing a cast post/core with diaphragm (**311**).

The cervical margin of the diaphragm has been burnished into close approximation to the root, whilst its coronal surface provides the required shoulder for porcelain (**312**). In this example, the diaphragm is carried cervically round the whole circumference of the root face to protect it and aid retention.

If the appearance of gold buccally (**313**) is unacceptable, the diaphragm may be finished short of the buccal margin to allow porcelain to contact tooth, but the resulting restoration will not be as sound. In upper teeth an added advantage of a diaphragm is that its palatal extension supplements the resistance to buccal displacement of the crown by the lower teeth, and thus reduces the risk of splitting the root.

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313

314–316 Here the lower incisors occlude so closely to the palatal aspect of the 1|, which has been prepared for a post crown (**314**) that there is not room for an adequate thickness of porcelain in the cervical region to resist fracture. A half-diaphragm is included therefore on the cast post/core to cover the cingulum area, and to provide a shoulder where there is room to accommodate the porcelain (**315**). The margin of the porcelain crown is placed where it will not be subjected to occlusal stress (**316**).

314

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318

317 & 318 It may sometimes be found, when remaking the porcelain jacket for a post crown, that the core is lacking in retentive shape (**317**) or that it may even have sheared off from the post. Ideally, the post should be removed and the post and core remade. This may not always be possible or advisable and an alternative solution can be to cast a new core (**318**) and fit this to the tooth face over what remains of the post. Retention for the new casting is obtained via a number of parallel pin holes cut into the dentine, into which fit corresponding projections from the casting.

Porcelain crown characterisation

Aesthetics in relation to porcelain crowns is an art and whole books have been written on the subject, (Goldstein 1976). Suffice it to say here that a crown should blend imperceptibly with the adjacent teeth, rather than represent the technician's concept of the ideal. Sometimes this involves the use of stains which, when judged on models in the laboratory, seems to disfigure the crown but when it is placed in the mouth it looks just right.

319 & 320 The porcelain crown for the upper right central incisor is perfectly sound from a technical and biological point of view, but it has been made without consideration for the appearance of the natural teeth which surround it (**319**). The shade is wrong and lacks any graduations in colour, such as are displayed by the contralateral tooth. The shape is that of a stylised central incisor rather than mimicking its partner. The contact points have been closed and although this might be correct for the majority of patients, it is wrong for this one.

The remade crown results in a pleasing natural appearance (**320**).

319

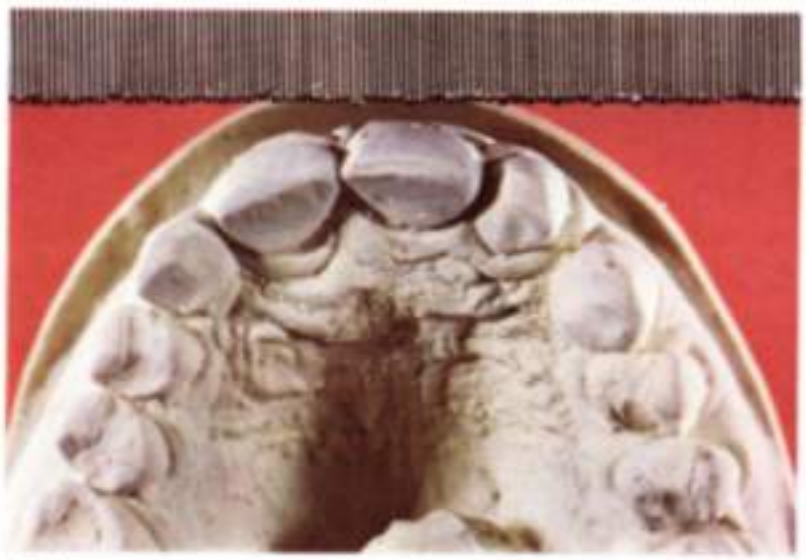
320

321 In contrast to figure **319**, the characterisation in the shape of the porcelain crowns for 12 completely matches that of the natural contralateral teeth. Perhaps a touch more white and orange stain delicately applied would have made the illusion complete.

321

322–324 An aid to reproducing the original buccal contours of crown when multiple crowns are being undertaken is the Mimic Instant Shape Tracer (Copydex British Patent No. 931463). The shape tracer can be placed against the buccal surfaces of a study model of the teeth to be crowned (**322**) and when pushed into close contact (**323**) will record the buccal profile of the patient's natural teeth. If this is the shape required to be simulated in the crowns, then the information can be transferred to the working models (**324**) and will thus guide the correct build up of porcelain. This is particularly helpful when multiple crowns are being made and guidance in buccal profile by adjacent teeth is not available.

322



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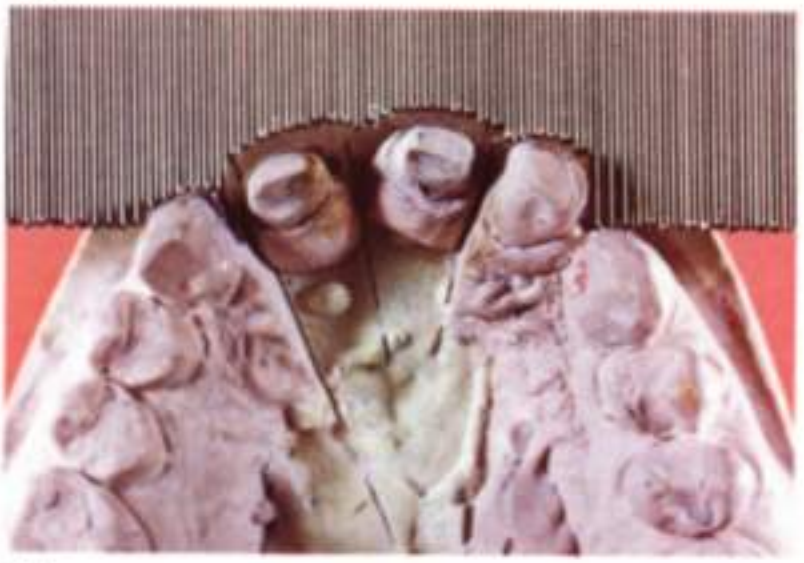


Some errors in post crowns

325 & 326 The post crown on this upper right central incisor has become protruded (**325**) and after its removal, inspection of the cast post/core shows that the post was too thin (**326**) in proportion to the crown it had to support. The heavy attrition of the lower teeth should warn the operator that heavy forces are likely to be applied to such a crown. If it is inadvisable to widen the canal to increase the strength of a cast post, the greater strength may be obtained through using a wrought metal post, as in the Wiptam technique.

325

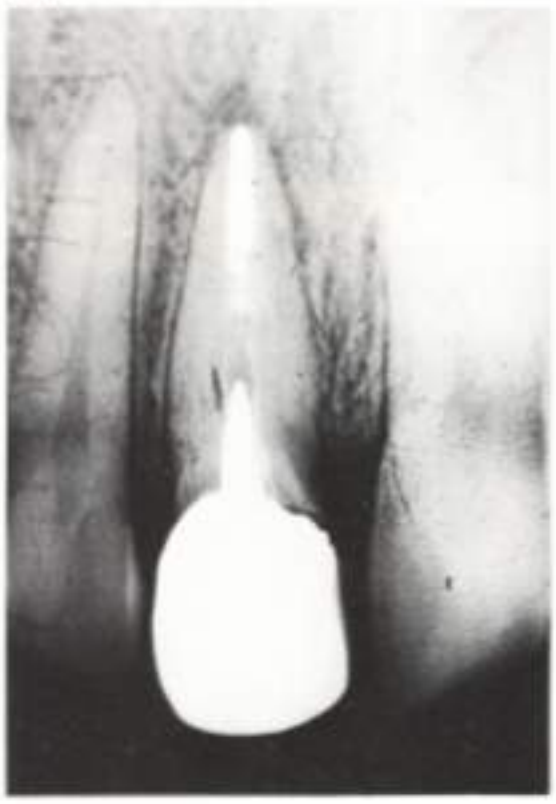
326

327 A stout Charlton post will certainly resist the sort of displacement shown in **325**. However, in this case, poor judgement has resulted in too wide a post being chosen for this slender lateral incisor. Incorrect angulation of the post hole has caused a perforation, but even if this had been avoided, the root would have been weakened unnecessarily.

327

328 & 329 The post crown in **328** has become loose. It is a cast post/core design. The original post hole was not long enough, and furthermore was not fully filled by the casting. The remade crown (**329**) has a good length near parallel post hole, well filled by the casting.

328



329

Bleaching

330–332 The discoloured upper left central incisor (**330**) is to be bleached to restore it to its natural colour, by gaining access through the cingulum to the pulp chamber and introducing 30% w/v hydrogen peroxide in distilled water. This powerful bleach oxidises the breakdown products of haemoglobin that have entered the dentinal tubules and caused the discolouration.

330

Rubber dam should be used to confine this powerful solution to the tooth under treatment. Oxidation is assisted by heat and light from a photo-flood bulb, from which the patient is protected by a surgical towel (**331**).

331

Several visits, of up to 30 minutes each, may be required to achieve the successful result shown here (**332**). Discolouration may recur, and the patient should be warned of this possibility.

332

13 Impression techniques

Introduction

It is possible, though often time-consuming, to fabricate gold inlay wax patterns in the mouth. This is known as the direct technique; however, more complex gold work and all porcelain work has to be made in the laboratory, where the technician works to a replica of the patient's dentition in what is thus known as the indirect technique. In order to replicate the patient's dentition, impressions are taken of the upper and lower arches, and from these models are made, either by copper plating or by using special die-stones.

Over many years materials used for impression taking have included composition in copper rings, hydrocolloids and alginates. These have now been largely superceded by a range of elastomeric impression materials of synthetic rubber. The variety available is very wide and is being added to regularly as new materials are developed.

The techniques by which impressions are taken, however, are clearly defined (Appendix 5) and these will be illustrated here, whilst leaving the choice of material to the personal preference of the operator.

The special tray technique is used in conjunction with polysulphide rubbers, because their properties of dimensional stability and elasticity are optimal if the material is kept to an even thickness of between 2–4mm (Skinner and Phillips 1973). Polysulphide rubber is supplied in various viscosities, light bodied, regular, and heavy bodied. In the single stage technique, the light bodied or regular material is injected by syringe into and around the teeth to be restored, whilst heavy bodied material is placed in the special tray. The tray is then seated in the mouth and both materials set simultaneously. In the two stage technique, the special tray is pre-lined with heavy bodied polysulphide by taking an impression of a study model that has been protected with a layer of foil. This provides a very accurate special tray and simplifies the chairside technique. The light bodied material is injected as before and a wash is also smeared

over the lined special tray before it is seated.

The stock tray technique is used with silicone rubbers. These are also supplied in varying viscosities, light bodied, regular and heavy bodied (putty). In the two stage or putty/wash technique, the stock tray is filled with the high viscosity putty and an impression is taken. Low viscosity material is applied as a wash to the putty impression which is then re-inserted. A syringe is not necessary, as the putty impression will push the wash material into place and this will record all the fine detail required. The single-stage stock tray technique may also be used without a syringe or adrenalin string, and this is applicable to simple preparations where the cervical margin is supra-gingival. The putty and wash material are mixed at the same time. The tray is filled with the putty which is then thinly coated with the light bodied material. The tray is inserted and the two materials set simultaneously. The single-stage technique is also appropriate for the impressions of post crown preparations, but with slight variations (**359–362**). Here a syringe is required, firstly to inject low viscosity material into the post hole and then into the gingival crevice. The wash coated putty is then inserted and again the two materials set at the same time.

Gingival retraction

For periodontal health, the gingival margins of all preparations should finish in a supra-gingival position. This results in the added chairside advantages of being able to see the margins easily, in order to finish them without gingival trauma, and of being able to take impressions without interference from gingival tissue or blood. Often, however, caries extends sub-gingivally so that after tooth preparation, the cervical margin is sub-gingival. Sub-gingival extension may also have been necessary to gain length of preparation, to provide sufficient retention, especially on a tooth with a short clinical crown. In either case, the advantages outlined may be regained by local gingival surgery to remove the gum tissue, and establish the cervical margin of the preparation once more in a supra-gingival position (see **115 & 209**).

It is not always appropriate, however, to remove the gingival tissue, as for instance where the cervical margin is intentionally placed sub-gingivally for aesthetic reasons. In such cases it is necessary to retract the gingival tissue temporarily, to reveal the margin of the preparation whilst an impression is taken of it. This is usually accomplished with cotton string, often impregnated with adrenalin, and sometimes assisted with an alum/adrenalin solution to help gain a dry field (see **102**). Other methods include pressure packs of various materials, placed a few days before the impression stage, or the use of a diathermy electrode to remove a little gingival tissue from within the gingival crevice.

Special tray – one stage technique

333–342 The special tray may be made of self-curing acrylic (**333**). It is important to incorporate into such a tray two or more stops (arrowed) which will rest on teeth remote from those being restored, during the taking of the impression. These stops are to maintain a 2mm space between the tray and the other teeth in order to ensure an optimal thickness of polysulphide rubber. The tray is shown here coated with adhesive. It is important for good retention to apply the adhesive several minutes (according to manufacturer's instructions) before the impression material is inserted, and to carry the adhesive well over the margin of the tray. Adrenalin string is inserted into the gingival crevices of all teeth with cervical margins which extend sub-gingivally.

333

The gingival retraction achieved by the adrenalin string has brought all the prepared cervical margins into view (**334**). The adrenalin string has been stained dark for reasons of photographic contrast. Notice the precautions taken to maintain a dry field.

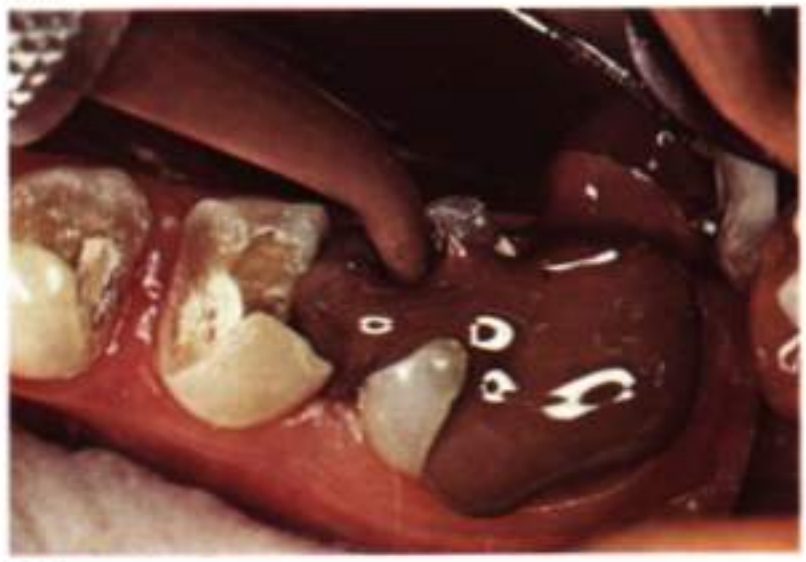
334

Just before the operator receives the syringe loaded with polysulphide rubber, he removes the string. The effectiveness of the gingival compression can be seen (**335**) and this should last long enough to allow time for the injection of the elastomer into the gingival crevices.

335

Care is needed to avoid trapping air in the polysulphide rubber during both mixing and injection. Mixing is best achieved using the tip of the spatula in a stirring action. Injection should be continuous, starting at the most distal part of the preparations, and advancing forwards displacing the air from the cavities instead of trapping it. Note how the nozzle of the syringe remains well submerged in the polysulphide material (**336**) to lower the risk of air inclusions. When injection of the light bodied material is completed, the special tray, loaded with heavy bodied polysulphide, is firmly inserted until the stops engage the occlusal surfaces of the teeth. The tray is held steady for the recommended time, and then removed quickly with a snap action in the correct line of withdrawal.

336



After washing and drying, the impression is examined for completeness, especially of cervical detail and for freedom from air blows (**337**).

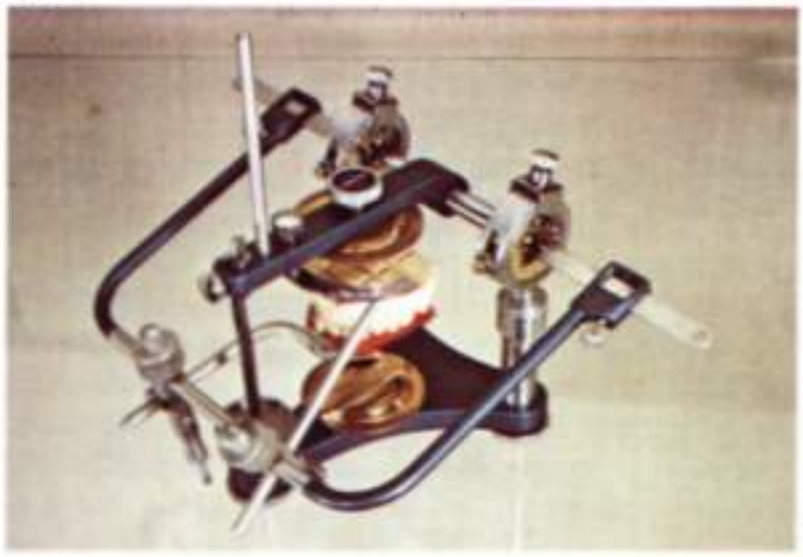
337

If in occlusion the cusps interlock positively, a simple wax bite registration (**338**) may be sufficient to allow the setting up of the models on a simple hinge articulator, capable of limited movement.

338

In situations where the occlusal relationships are not self-evident, mutually occluding teeth are to be restored at the same time, or particular problems exist related to cuspal contour, then face bow recordings are recommended (**339**).

339



This enables the models to be set up on an articulator that can reproduce protrusive and lateral movements (**340**).

340

The temporary dressing used should hold the teeth in the position recorded by the impression, and thus prevent over-eruption or mesial drift. If the dentine is adequately protected with a base, a temporary dressing of gutta percha can be used as seen here (**341**). It has the advantages of being tough and strong yet easily and cleanly removed when required. It is important to get the patient to move into occlusion quickly so that high spots may be pressed down before the gutta percha cools.

341

If the temporary dressing had done its job, the inlays should fit the teeth well without the need for occlusal or contact point adjustment (**342**). Correct occlusal relationships should be confirmed with thin articulating paper, preferably in different colours for centric and protrusive closures. High spots, should they exist, can be more readily identified as burnished marks if the inlay occlusal surfaces have been sandblasted to dull them. This permits very accurate easement. The important effects of the occlusion upon restorations should be taken into account at this stage (Wise 1977).

Special tray – two stage technique

343 & 344 The two stage technique starts with the construction of a special tray in the usual way, with stops and a 2mm wax spacer adapted to the jaw model (**343**). In the laboratory, an impression is then taken in heavy bodied polysulphide of the model protected with a thin foil, but without the wax spacer (**344**). This provides a special tray accurately lined with a 2mm thick layer of heavy bodied polysulphide rubber. In the mouth the final impression is taken by syringing light bodied material into the preparations, as for the single-stage technique, followed by insertion of the special tray which has been coated sparingly with light-bodied material.

Stock tray – two stage technique

345–357 The chosen stock tray must be thoroughly dried and the correct adhesive carefully applied (**345**) at the recommended time before insertion of the putty, if the impression is to be retained in the tray without distortion or partial separation.

342

343

344

345

Adrenalin string is inserted where necessary so that all parts of the preparation are revealed (**346**). This is left in place during the first stage of the impression, and if it comes out with the impression, it should be re-inserted until the start of the second stage.

346

The heavy bodied material can be mixed with a fork if the catalyst is in liquid form (**347**). This will help to ensure even dispersion of the catalyst before final kneading of the putty. If a two paste system is used, this is mixed entirely by kneading in the hands.

347

Removal from the mouth of any elastomeric impression should be accomplished quickly, and in a straight line which matches that of the line of withdrawal for the preparations. It is therefore recommended that the tray should be grasped firmly at both sides in the premolar areas (**348**) and a snap withdrawal achieved. Distortion in the important areas will thus be kept to a minimum and the elastic recovery of the material should ensure an accurate impression. Use of the tray handle for removal should be avoided, as it is likely to result in leverage and distortion in excess of that capable of correction by the material.

348

The putty impression is examined for completeness, especially in regard to marginal detail and freedom from air-blows (**349**).

349

Excess material in the retro-molar and peripheral areas is removed with a sharp carving instrument or scalpel (**350**). This will reduce the suction-like retention of the second-stage impression and make its removal easier.

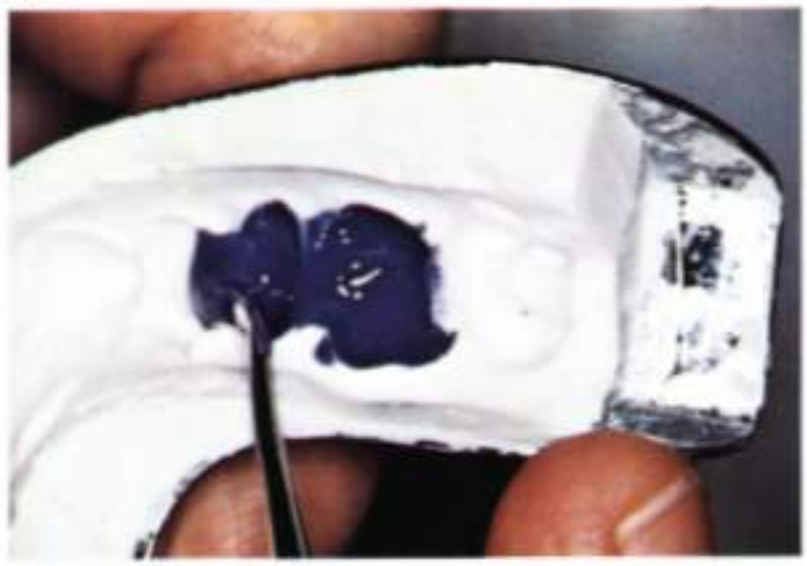
350

The interdental tags of the putty should also be removed (**351**) in order to facilitate re-insertion of the putty during the second stage. The putty surface must be washed and dried so as to present an uncontaminated surface to the wash, if this is not to peel off at a later stage. If the free ends of the adrenalin string have not already created escape channels for the wash material, these must now be cut into the putty.

351

The light-bodied material is introduced first into the areas recording the prepared teeth. This can be done with a small plastic instrument, and the material should be flowed across the impression in a steady stream to avoid trapping air (**352**).

352



The remaining areas of the putty are coated quickly using a spatula (**353**).

353

Just before re-insertion of the putty impression with its light-bodied wash, the adrenalin string is removed. As can be seen, the gingivae are well retracted (**354**). Care must be taken to ensure that the putty impression is fully seated home by the use of firm pressure. This will 'inject' the wash material into the remotest parts and eject any excess along the escape channels. However, pressure must be released quickly to allow any compression of the putty to recover before the wash material begins to set. If this point is not observed, recovery will take place on removal of the impression and distortion will result.

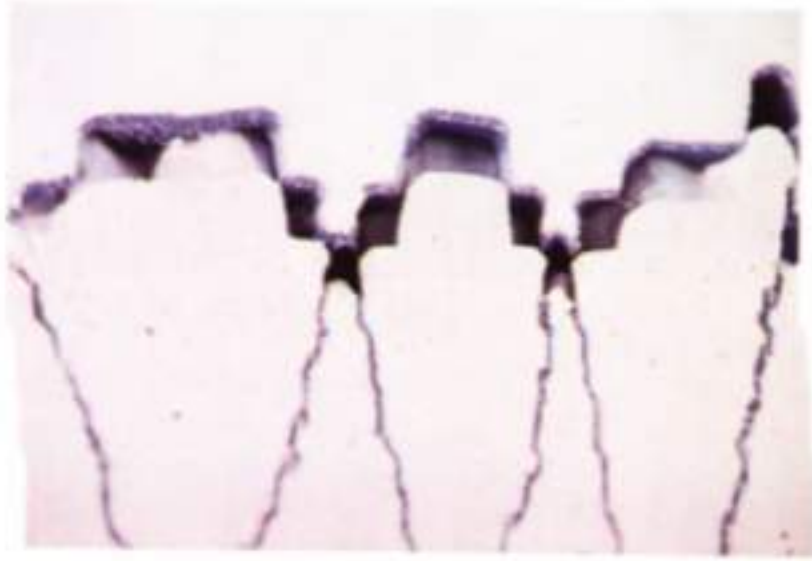
354

The final impression is examined to confirm that all essential information has been recorded. The white areas of putty visible through the light bodied rubber confirm that the wash is very thin, and the putty was therefore fully inserted (**355**).

355

A sectional view of the poured model, with the impression slightly withdrawn and with approximate root outlines pencilled in, demonstrates the successful retraction of the gingivae, the recording of the cervical bevels, and the thinness of the wash material (**356**).

356



One of the dies separated from the model shows the clarity of marginal definition that can be achieved with careful tooth preparation and impression technique (**357**).

357

358 Some silicone rubber putties are quite hard when set and present some difficulty in the removal of the interdental tags. This can be facilitated by the use of bone forceps as demonstrated here.

358

Stock tray – single stage technique for post crowns

359–362 There are difficulties in re-inserting the primary impression of a two-stage technique into the post hole of a post crown preparation. For this reason it is usual to opt for the single stage technique for post crown impressions, with slight variations because of the need to use retraction cord and an injection syringe.

The post crown preparation for 2| has been taken sub-gingivally in the buccal region, as is usually the case, and retraction cord has therefore been necessary to reveal the margin of the preparation (**359**).

Light bodied silicone rubber is first introduced into the post hole, taking care to avoid trapping air by injecting from the bottom of the post hole outwards (**360**).

359

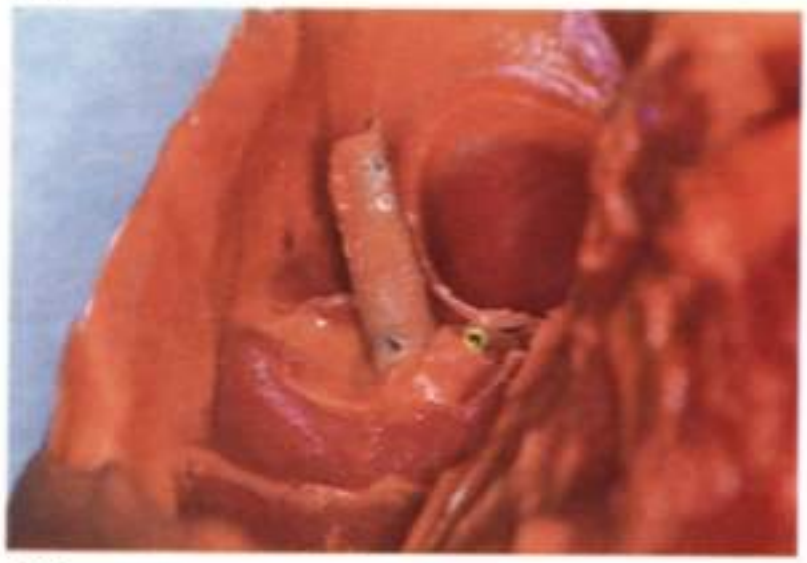
360

361

A metal post, previously coated with adhesive, is introduced next into the post hole, to act as strengthening re-inforcement to prevent flexure when the models are cast. The retraction cord is then removed slowly just ahead of the syringe nozzle (**361**) which injects impression material into the gingival crevice before the tissues have time to recover.

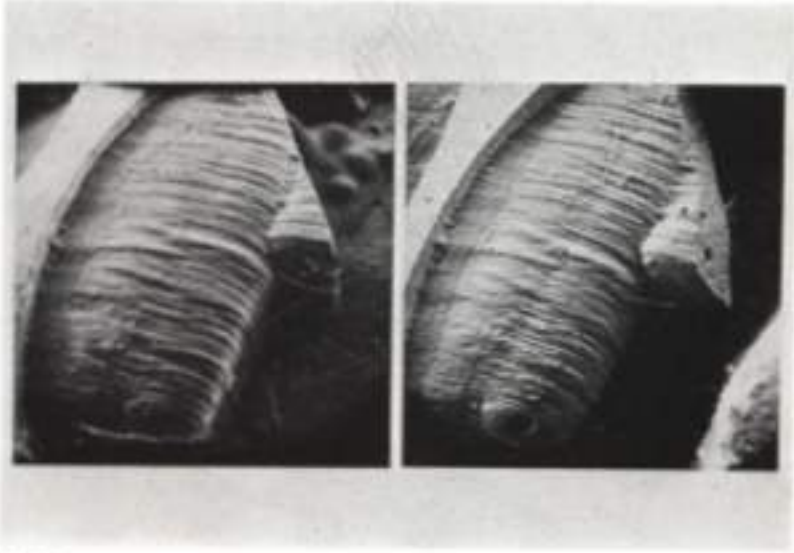
Care should be taken in the removal of the impression to withdraw in the same direction as the post hole, so as not to distort this delicate projection (**362**). The small air-blow, at the end of the post hole, could perhaps have been avoided if a Lentulo spiral had been used, instead of the syringe, as some recommend.

362



363 A critical factor in the accurate recording of detail is the proper control of moisture, as is demonstrated by these SEM pictures of the surface of two impressions of the same tooth preparation, both taken in polysulphide rubber. The left-hand example was taken under conditions of ideal moisture control, and shows clarity in the recording of the tooth surface which is covered with scratches from a diamond bur. The right-hand example shows an impression taken of the same surface which was not completely dry, and close scrutiny of comparable areas shows that in this case the detail is not as sharply recorded.

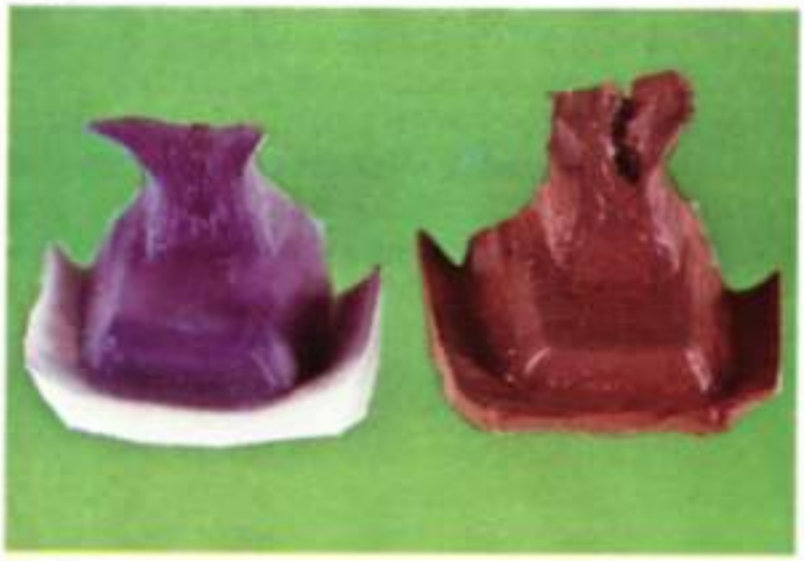
363



Choice of elastomer

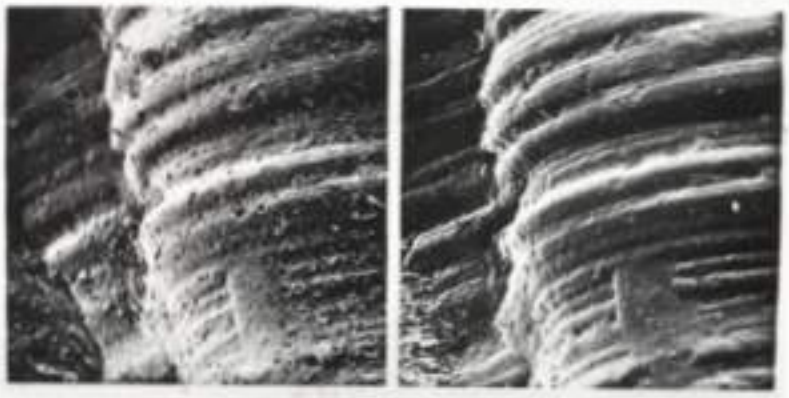
364 & 365 One factor affecting the choice of elastomer can be colour, and its effect on the ease with which an impression can be assessed. Parts of two impressions of the same box preparation are compared here (**364**). The detail can be seen more readily on the brown polysulphide than the blue silicone.

364



However, a comparison of SEM pictures of two impressions of the same prepared surface, shows slightly better reproduction of detail in the silicone material, on the right, when compared with the polysulphide material on the left (**365**). There are also minute air inclusions in the polysulphide material and these are very difficult to exclude even with the most careful mixing technique. In the range of silicone elastomers, the recently developed addition – cured materials have the advantages of longer working times and superior dimensional stability, compared with conventional silicone materials (McCabe & Wilson 1978).

365



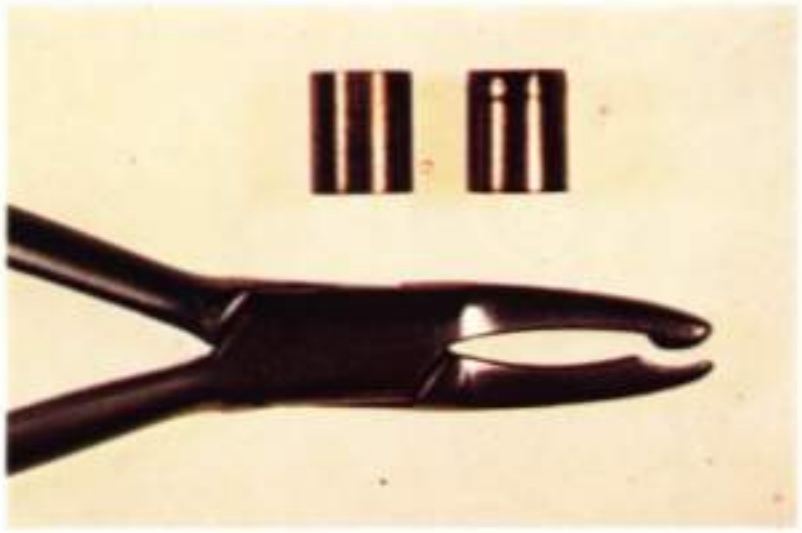
Copper ring impressions

366 Although largely superceded by elastomeric impressions, the copper ring technique still has a part to play. In very deep cavities, for instance, it may prove impossible to get adequate gingival retraction to obtain a complete rubber impression. In such cases, the solution can often be found in using a copper ring and impression compound, which can be pushed more readily into deep cervical areas. If a stock size copper ring does not fit the circumference of the prepared tooth accurately, then a slightly oversize ring can be chosen and its circumference reduced with orthodontic pliers.

367–372 In this series, a post crown is to be made for 1| which has a deep oblique fracture extending subgingivally on the palatal side (**367**).

An impression of the post hole is first obtained using greenstick composition, adapted and supported by a prefabricated metal post (**368**). After filling a copper ring with greenstick composition (**369**) this is inserted to record the detail of the face of the preparation. The post and copper ring components of the impression unite when chilled with cold water, and an individual impression of the prepared tooth is obtained (**370**).

366



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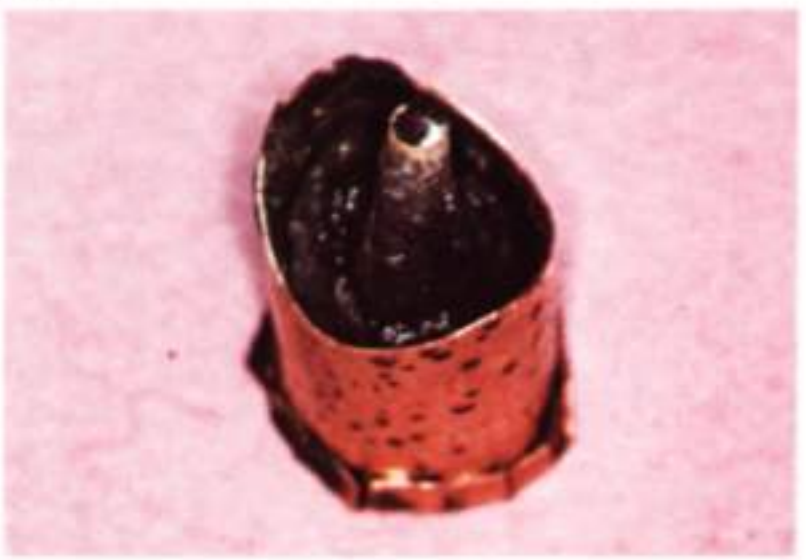


This will subsequently be copper plated to form a working die. The problem in this technique is one of locating the individual die in the overall impression of the dental arch, so that occlusal and contact point relationships can be reproduced. One technique for doing this is to record as much of the face of the preparation and post hole as possible, with a large piece of inlay wax (**371**).

371

An impression in alginate or silicone is taken over this (**372**). The copper plated individual die is inserted onto the inlay wax impression, and the complete arch model is then poured.

372

14 Temporary coverage

If for any reason it is not possible to insert the restoration immediately following tooth preparation, it is necessary to dress the tooth temporarily. The delay is usually due to the time required to construct an inlay, crown or bridge. Sometimes, however, it may be that time does not permit the insertion of an amalgam or composite restoration, and a temporary dressing is therefore necessary.

There are several reasons why temporary coverage of prepared teeth is required:

(i) Protection of the dentine from toxic irritation
(ii) Thermal insulation
(iii) Prevention of tooth movement
(iv) Avoidance of food stagnation
(v) Appearance

In a retentive intra-coronal cavity, the simplest form of temporary dressing is provided by a stiffly mixed paste of zinc oxide powder and eugenol (ZOE) as is the case in stabilisation (see **55**). This will, however, take up to several hours to set hard, and an accelerated proprietary version of ZOE cement may be preferred. If there is the danger that parts of such a dressing may break away, because it is inadequately retained by what is left of the tooth, wisps of cotton wool may be incorporated in the mix to give added strength to the dressing. Gutta percha, which can be heat softened, may be used as an alternative to ZOE (see **341**). However, an inflammatory response is likely to develop in teeth where gutta percha is applied directly onto dentine, so its use should be confined to non-vital teeth or those where the dentine is already protected with a base.

Extra-coronal preparations may be protected with a variety of pre-formed temporary crowns, or copper rings. It is also possible to fabricate a custom-made temporary crown or bridge at the chairside.

Anterior temporary crowns

These are constructed by combining a self-polymerising tooth coloured resin with a pre-formed crown shell. These resins are of two types, acrylic resins and epimine resins. The acrylic resins can be irritant to pulpal and gingival tissue, because of their monomer content and exothermic setting reaction. These disadvantages have been overcome with the development of resins using higher polymer powders, and higher methacrylate monomers. The epimine resins are commonly used because of their lower setting temperature and shrinkage. They are also less irritant to the dentine and pulp, as there is no free monomer in the mixed material (Braden et al, 1971).

The crown forms used with such resins are made of transparent cellulose acetate or tooth coloured polycarbonate. The cellulose acetate crown forms are peeled off after the resin has set. The polycarbonate crowns remain in the mouth as an integral part of the temporary restoration; though the fact that they do not bond with epimine resins will sometimes give rise to problems of separation of the two materials.

A temporary jacket crown

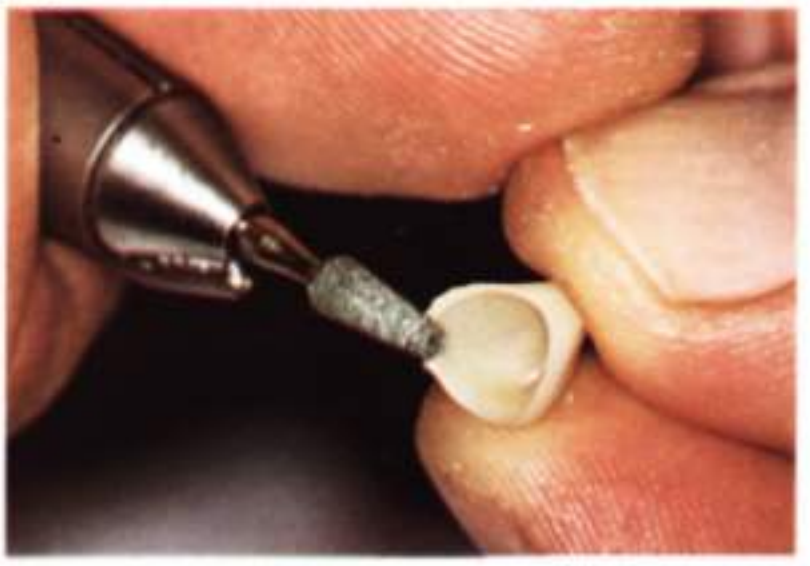
373–384 A polycarbonate crown form is chosen, of as near matching size and shape to the contralateral tooth as possible. It has a small tag attached to the incisal margin, which acts as a convenient handle (**373**).

373

374

It will be noted, however, that the crown is about 2mm too long. The cervical margin is therefore shortened with crown scissors (**374**) and smoothed with a carborundum stone (**375**).

375



The crown form is then filled with an epimine resin (**376**) and positioned over the prepared tooth (**377**). It is advisable to coat the preparation with a very thin film of lubricant to facilitate removal.

376

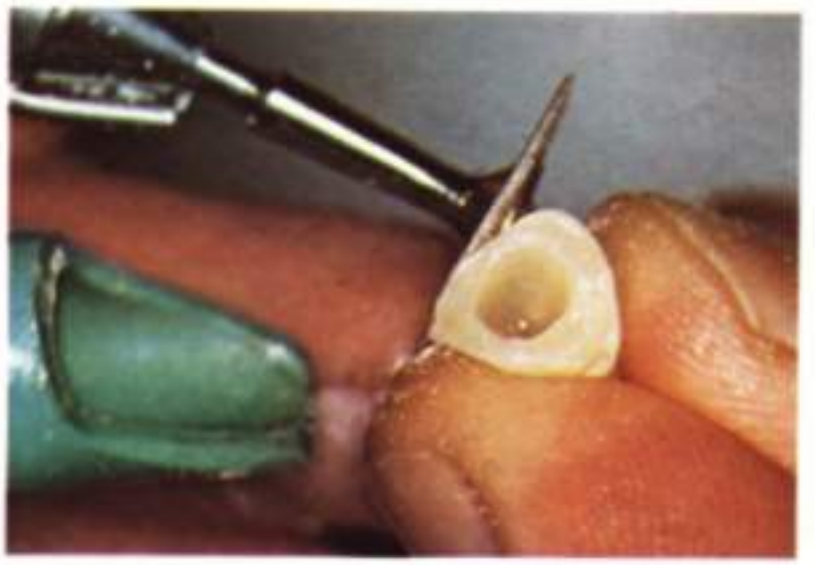
377

When the resin has set sufficiently, the crown is removed together with considerable resin excess (**378**). A good impression of the cervical margin of the preparation should be evident in the resin. The crown should then be placed in hot water to accelerate the completion of polymerisation.

378

The excess is trimmed away. This can be done very readily with a sandpaper disc, whilst the chair-side assistant evacuates the resultant resin dust and debris with high speed suction (**379**).

379



The temporary crown should now be an accurate fit cervically without positive or negative edges. This can be tested at try-in with a probe. At the same time, premature occlusal contacts can be identified with articulating paper (**380 & 381**) and adjusted.

380

381

A quick setting temporary cementing medium is introduced to the crown (**382**) which is then seated firmly into position, so as to expel all excess cement and achieve the closest possible fit (**383**).

382

383

If the cement is left undisturbed to set fully, it will break away cleanly to leave a smooth cervical finish (**384**).

384

A temporary post crown

385–390 An appropriate shape of polycarbonate crown is chosen and tried in as before. Gingival pressure is indicated here by the blanching of the gum (**385**). The crown is seen to be too long and adjustments are made.

A small pledget of cotton wool is placed in the canal (**386**) to identify the end of the post hole as recorded on the impression. If this is not done, then the temporary cement will join with the existing root filling cement and the post hole depth would be uncertain at the try-in stage.

A preformed post is placed in the canal (**387**) and the resin filled polycarbonate crown is seated over it. When this has set, it is removed together with the post, and the excess is trimmed (**388**) to ensure a good fitting temporary crown (**389**). Final adjustments are required to the incisal length in this case, before cementing in place with a temporary cement.

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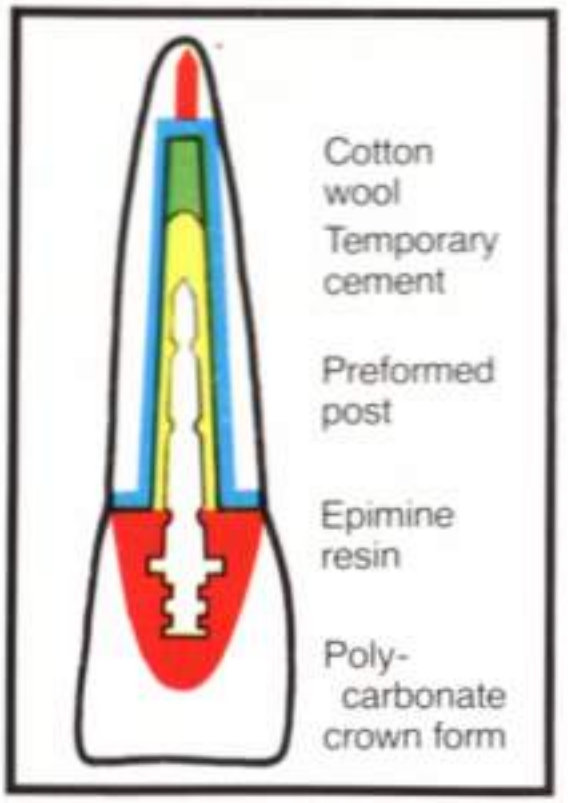
The line diagram (**390**) shows the component parts of the temporary post crown.

390



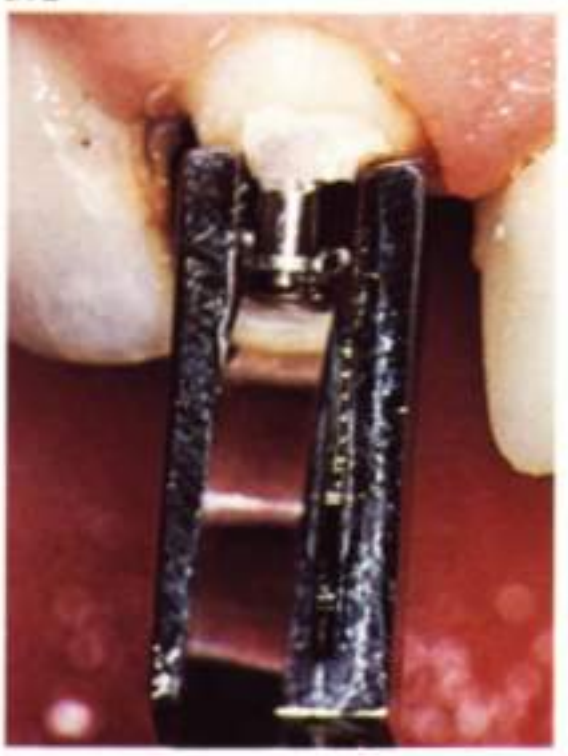
391 & 392 The post of the temporary crown may sometimes be well held by the temporary cement, in which case it may readily be drawn from the root by the Eggler post remover (**391**). This instrument is essential when a cast post and core is to be removed without endangering the root of the tooth.

In preparation for its removal, the protruding part of the post or core must be trimmed (a) mesio-distally, to allow the legs of the post remover access to the root face and (b) bucco-lingually, to provide a retentive shape for the jaws of the remover to grip.

391

The jaws are tightened onto the post by rotation of the capstan wheel. By turning the central screw the jaws draw out the post while the legs push against the root face (**392**).

392



393 & 394 Full crown preparations on posterior teeth (**393**) can be temporarily covered with preformed aluminium crowns (**394**) held in place with a proprietary temporary cement or ZOE. The range of shapes is somewhat limited, and it is often difficult to establish good contact points in order to avoid food stagnation.

393

394

395 Stainless steel crowns are available, and these can easily be trimmed and fitted to fractured incisors to hold a calcium hydroxide dressing in place, and restore the shape of the teeth. Some crowns have been produced with tooth coloured facings (see ⌊1 in figure 90) but these wear off in the mouth and look more unsightly than the stainless steel.

395

396 Polycarbonate crowns can be cemented directly into place with accelerated ZOE, as seen here for the lateral incisors. The technique using epimine resin however, produces crowns of a better fit and therefore better retention and less gingival irritation.

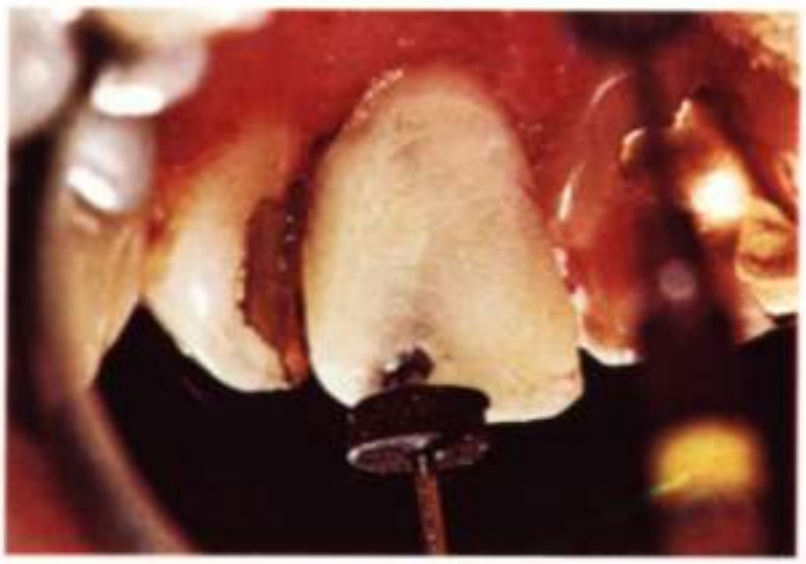
396

397–399 A temporary post crown may be required for a tooth which is undergoing root canal therapy. If the post used is a hollow one, root treatment can continue through it, obviating the need to remove and replace the crown at each visit. Orthodontic tubing will act as such a post. Its internal diameter should be greater than that of the biggest reamer likely to be used. An appropriate length of tubing is chosen and placed into a post hole (**397**) cut with a matching size flat fissure bur.

397

A cellulose-acetate crown form is trimmed to fit the root face, and a hole is cut in it to allow the end of the orthodontic tubing to protrude. The patency of the tubing is blocked with cotton wool before the crown form, filled with epimine resin, is seated. When the resin is set, the cervical excess is removed and the protruding portion of the tube is cut back. The finished temporary crown is then cemented in place (**398**) taking care not to block the apical end of the tube. Such a crown greatly assists in preventing contamination of the root canal during therapy, and enables rubber dam to be applied easily.

398



The incisal edge of the crown provides a definite reference point for length measurements, and the radiograph (**399**) demonstrates how instrumentation is possible with the crown in place.

399

15 Bridges

Assessment

Spaces in the dental arch do not automatically qualify for filling with a prosthesis – there must be a good reason for doing this. The reason might be a strong request by the patient for the space to be filled, for aesthetic or functional purposes. On the other hand, the dentist may recommend action to prevent tilting or over-eruption of the teeth (see **400**).

If it is decided to provide a prosthesis, a choice has to be made between denture and bridge. If the preference is for a bridge, several factors must be considered to see if a bridge is possible, and if so what form its design should take.

Abutment teeth

A suitable number of abutment teeth are required to which the bridge can be attached. A convenient way to decide this number is to count how many teeth are to be replaced by the bridge and add one to the total – there are, however, exceptions to this guide (see **427 & 435**).

The abutment teeth must have either vital healthy pulps or sound root fillings.

Attrition

Special note should be taken of any signs of attrition as this will give an indication of where masticatory stress is likely to be concentrated.

Pontic area

The pontic area must be free of retained roots or buried teeth. If this point is overlooked, a future surgical operation may be impeded by the presence of the bridge.

It will be evident, that such a comprehensive clinical assessment requires the additional evidence that can be provided by appropriate radiographs and suitably articulated study models.

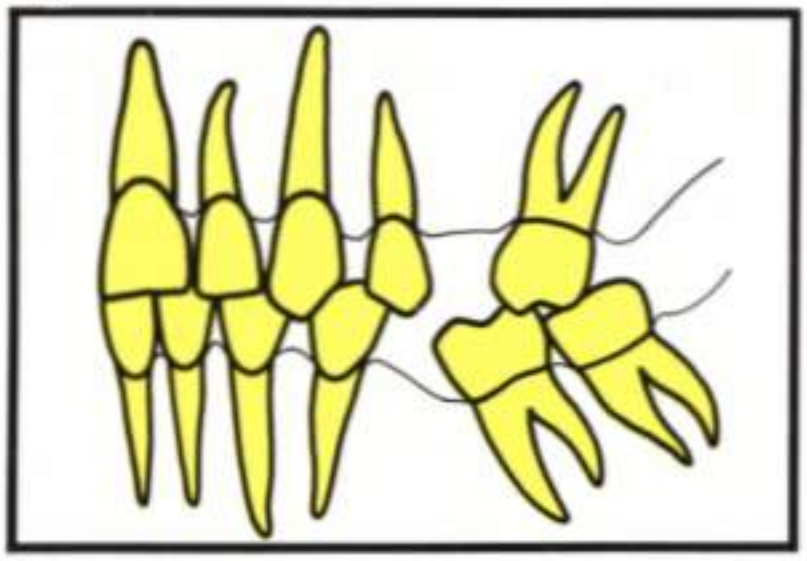
This atlas will confine itself to straightforward bridgework, within the scope of the general practitioner, where there is sufficient tooth contact between the natural teeth not concerned in the bridge design, to obviate the need for complicated bite analysis and the use of sophisticated articulators. The designs of such bridges fall into four basic categories, together with a fifth group, which combines two or more basic designs (Appendix 6).

Supporting structures

Bridges that are entirely tooth borne rely for their support on the roots of the abutment teeth and their supporting tissues. Experience, rather than rules, must be relied upon in determining whether these roots are long and strong enough, and the supporting tissues healthy enough, to support the extra load that will be imposed on them. Where some support for the bridge is provided by the soft tissues, a careful assessment must be made of the appropriate area of mucosa.

400 Failure to maintain the space resulting from tooth extraction can lead to movement of teeth, if intercuspal relationships do not prevent it. The teeth on either side of the gap may tilt and the opposing tooth may over-erupt as indicated here. This can result in interferences with occlusal excursions, and also in periodontal deterioration. Such consequences are better prevented, than treated after they have occurred, but prediction of which cases need preventive treatment is not always easy. In such instances, it is advisable to take impressions for study models soon after the extraction, and at reasonable intervals subsequently. Accurate measurements can then be made to see if slight tooth movement is taking place.

400



401 As an alternative to a series of periapical radiographs, a comprehensive radiographic assessment for a patient requiring bridges can be made by means of a single Orthopantomograph (O.P.G.). In particular, this will give information about the bone support for the abutment teeth, the presence of roots or unerupted teeth in the pontic area, and the direction of the long axes of the abutment teeth. It will also give an indication of periapical bone loss, but this would need to be confirmed with an intra-oral periapical film. Detailed information about the abutment crowns, such as extent of fillings or caries and mesio-distal dimension of the pulp chambers, would have to be obtained from bitewing radiographs.

401

Fixed/fixed bridges

402 One of the commonest bridges is that replacing a $\overline{6}$, to prevent, as in this case, further eruption of the $\underline{6}$ and tilting of the $\overline{7}$. If aesthetically acceptable, this is made most simply in yellow gold, and designed with a full veneer crown as the posterior retainer and a three-quarter crown anteriorly. The pontic is a simple gold bar, kept well clear of the mucosa to make it easy to clean the underside.

402

403 & 404 A bridge to replace an anterior tooth must be aesthetically pleasing. The design shown here uses yellow gold three-quarter crown pinlays for retainers attached to |13. Great care and skill is required to keep the incisal gold coverage to the minimum. The pontic facing for the |2 is made in porcelain, and is cemented to the gold bar connecting the retainers. The shade of the pontic is not very well matched to the adjacent teeth. The main weakness of this design is the method of attaching the pontic, and this has largely been superceded by the bonded porcelain technique.

403

404

405–407 With the introduction of aluminous porcelain, great strength has been added to the already attractive looking all-porcelain bridge. Here (**405**) the upper partial denture replacing |1 and the discoloured acrylic crown on |2 are to be replaced with an aluminous porcelain bridge attached to 1|2 prepared as for jacket crowns. The palatal view (**406**) shows the distribution of the opaque aluminous core which however is masked in the buccal view (**407**) by enamel and dentine porcelain.

405

406

407

408–410 One of the problems with fixed/fixed anterior bridgework is to disguise the fact that three teeth are actually joined together. In this example (**408**) the patient has a discoloured non-vital upper central and the adjacent lateral incisor is missing. Following root-filling of the 1] and fitting of a cast post and core, the 3[1] are prepared as for jacket crowns to take an all porcelain fixed/fixed bridge.

408

The illusion of interdental spaces is created in the bridge by staining (**409**) and this enables the tapered lateral of the opposite side to be simulated, without drawing attention to the connecting porcelain (**410**).

409

410

411 The advent of the technique for bonding porcelain to gold made possible the construction of stronger anterior bridges – sometimes at the expense of aesthetics. To blank off the underlying metal requires a layer of opaque porcelain. This in its turn requires to be blanked off with a considerable thickness of dentine and enamel porcelain, to give a natural look. A total thickness of 1.5 to 2.0mm is required for the gold substructure and two types of porcelain, and there is not always this amount of space available. Here the pontic replacing the 4] is attached to full crowns on 53]. The resulting bridge looks a bit dense and lifeless because of this problem of space. Note the blanching of the gum around 3] at the try-in stage. The cervical fullness of the 3] retainer needs reducing to relieve this.

411

412 & 413 Replacement of a lower incisor is difficult if the tongue space is not to be encroached upon. The adjacent incisors to be used for abutments have small crowns, which will not allow much tissue removal, and the preparations must be minimal ones. In order therefore to keep the lingual coverage of the bridge as thin as possible, a bonded bridge should be made (**412**).

412

The fullness of the bridge buccally (**413**) due to the covering of porcelain as well as gold, can usually be tolerated by the patient.

413

The problem of gingival recession

414 The bridge replacing ⌊3 is attached to ⌊24 by full-coverage crowns. The gingival recession seen buccally on the ⌊4 presents two problems, if an attempt is made to take the preparation sub-gingivally. Firstly, the ⌊4 crown will look excessively long. This can be disguised with porcelain chosen to match the cementum or even to match the gingivae (see **277**). However, this still leaves the problem of creating a 1.5mm shoulder in this narrow root area, without exposing the pulp or seriously weakening the remaining tooth tissue. A solution is to stop the preparation supra-gingivally as shown here. The slight cervical darkening due to the margin of the metal sub-structure is usually acceptable to the patient, and preferable to the risks already mentioned. If the aesthetic result is not acceptable, an alternative treatment would be to electively root fill and fit a post/core to the ⌊4, which would allow room for porcelain at the sub-gingival level.

414

Fixed/non-fixed bridges

415 & 416 This bridge to replace ⌈67 is attached to ⌈45 and the tilted ⌈8. Due to the difficulties in finding a common path of withdrawal for the retainers on ⌈458, the bridge has been constructed in two parts. A full veneer crown has been made for the ⌈8 with a dovetail mesial slot, which is parallel to the line of insertion of the full coverage crowns on ⌈45. The premolar crowns carry the pontic with a dovetail projection distally, which is shown partially inserted (**415**, arrowed).

An occlusal view of the completed bridge shows how the two parts of the bridge interlock (**416**). This design results in a bridge almost as rigid and stable as one that is fixed/fixed.

417–419 An alternative to the fixed/non-fixed solution to the tilted abutment problem is the 'telescopic' bridge. In this design no attempt is made to match the line of withdrawal of the two abutment preparations (**417**).

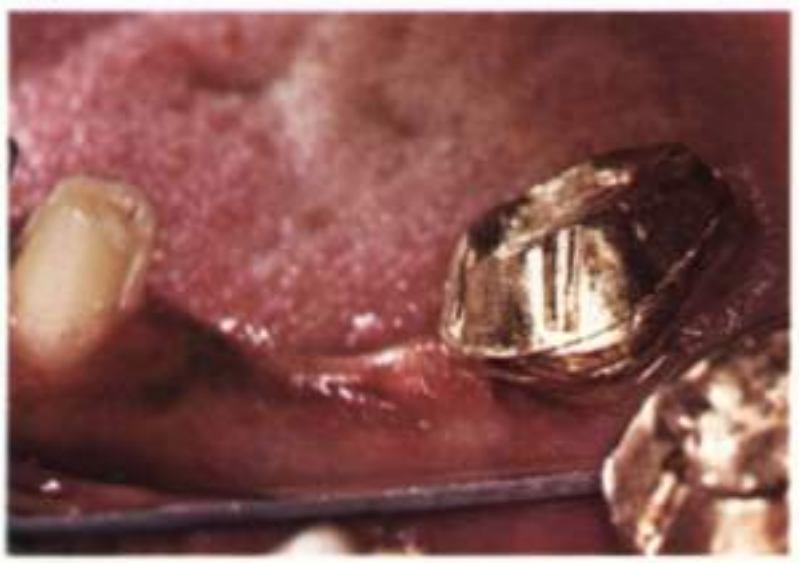
The problem of misalignment is solved by making the molar retainer in two parts. The first part (**418**) gives full coverage to the prepared molar crown, and is inserted in a line which suits the natural long axis of the tooth. The outer surface of this gold cap, however, has been created to simulate a full veneer crown preparation, which has a line of insertion that matches that of the mesial abutment tooth. The gold cap is cemented in place first, and the distal retainer of the straightforward fixed/fixed bridge is then cemented over it (**419**).

415

416

417

418



419

Simple cantilever bridges

420–422 This all gold bridge with a porcelain facing is based on three-quarter crown retainers on 56 and a box-pin pontic for 4, all three units being soldered together (**420 & 421**). A stock porcelain pinned tooth has been ground to shape, and this will be cemented into the gold box pontic which has been made to surround it (**422**). In this design, yellow gold is evident both buccally and occlusally.

420

421

422

423 & 424 The appearance of the pontic in **420** can be improved by the use of a porcelain bonded to gold unit, in place of the box-pin design. If full crown coverage in yellow gold is acceptable aesthetically for the posterior teeth, as would seem to be the case here (**423**), then yellow gold veneer crowns can be combined with a bonded porcelain pontic 4, by soldering together the three units to form a simple cantilever bridge (**424**).

423

424

425 & 426 A further improvement to aesthetics can be achieved by making the whole bridge in a metal substructure, faced where appropriate with bonded porcelain. Full coverage crowns on ⌊56 carry the cantilever pontic for ⌊4. Note that the buccal margin of the preparation on ⌊6 stops well short of the narrowing root (**425**). An occlusal view shows that porcelain coverage is omitted where particularly heavy stress from the opposing teeth occurs, or where it is not thought prudent to reduce the occlusal surface by the 2mm necessary to make room for metal plus porcelain (**426**). The narrow pontic simulates a canine rather than a premolar from an occlusal view, to lessen the likelihood of torque stresses being applied to the bridge. When the missing tooth is the second premolar, a similar pontic design will often permit a satisfactory bridge to be fitted to the molar, as the sole abutment tooth.

425

426

427

428

427 & 428 Here the space for the ⌊4 has partially closed and is not wide enough to admit a full size tooth. This situation can be disguised by placing the full width ⌊4 pontic slightly outside the arch over-lapping the slightly instanding ⌊5. The effect of slight irregularity of the teeth (**427**) is aesthetically more pleasing than an unnaturally small tooth fitted into the arch. The way this has been achieved can be seen in **428**. Because of the small span of the pontic, it was not thought necessary to involve more than one abutment tooth.

Spring cantilever bridges

429–431 In this example, the pontic for the 1 is attached to the premolars (**429**). The connecting bar is placed well clear of the intervening teeth, and is soldered to the centre of the palatal aspect of the three-quarter crown retainer of the 4. This is done so as not to obstruct the interdental space between 45, and thus allow floss to be passed under the soldered joint connecting the two retainers.

The gold portion of the pontic is shaped in jacket crown form (**430**) and a porcelain crown will be cemented to it. Should this porcelain crown ever need replacing, an impression as for a porcelain jacket crown can be taken, without removing the remainder of the bridge.

The buccal view (**431**) demonstrates the aesthetic advantages of the spring cantilever bridge, whereby the natural interdental spaces are maintained.

432 A patient, anxious to avoid a denture, may tolerate two spring cantilever bridges. In this example the design of the pontics is of the box-pin type. The palatal and incisal aspects of the pontic are in gold, the strength of which should withstand occlusal stress well. However, should a porcelain component require replacement, this may entail removal of the bridge.

429

430

431

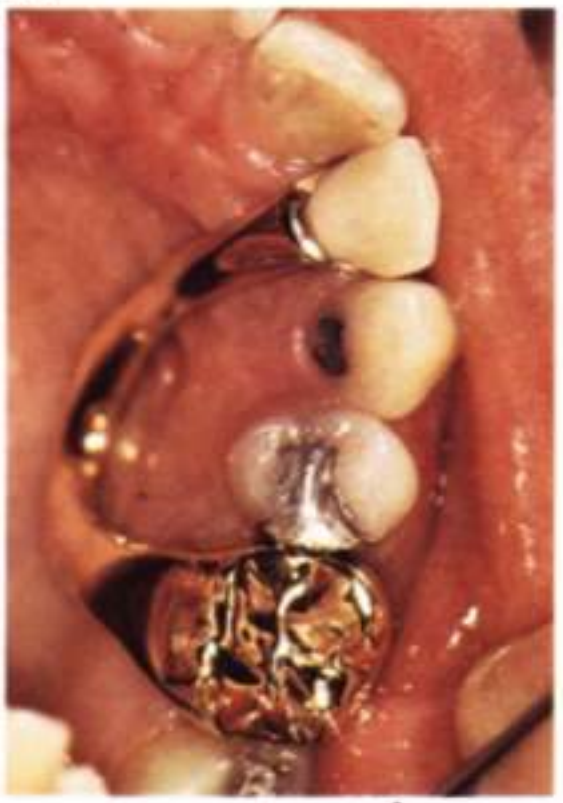
432

433–436 This patient requested a bridge in place of the partial denture that carried the upper lateral incisor (**433**). After full assessment of possible abutment teeth and an analysis of the occlusion, it was decided that the 2 could be carried on a single abutment spring cantilever bridge, using the 6 which was therefore prepared for a full veneer crown (**434**). The final bridge contrasts favourably with the partial denture in its avoidance of gingival coverage (**435**) and gives a pleasing appearance (**436**).

433

434

435



436

Compound bridges

437 The replacement of 1 and 5 is achieved by a combination of a spring cantilever design for 1, and a fixed/fixed design for the 5 with the 4 as a common abutment for both designs. The 5 units of yellow gold are soldered into one compound bridge.

437

438 & 439 The absent 2 and 4 (**438**) are replaced in a 5 unit bonded porcelain bridge, composed of a simple cantilever pontic for the 2, and a fixed/fixed pontic for the 4 based on 356 as abutments (**439**).

438

439

Temporary bridges

Once the final impression for a bridge has been taken, it is important to ensure that no tooth movement takes place while the bridge is being made. If any of the abutment teeth tilt, the parallelism achieved in the preparations will be disturbed, and it will be difficult to insert the bridge. If adjacent teeth move towards the prepared abutment teeth, the resulting tightness in the contact point areas will prevent the bridge from seating. Any over-eruption, either of the abutment teeth or the occluding teeth in the opposite jaw, will result in premature contact in the bridge area, which may be very difficult to adjust.

To prevent all these problems occurring, it is necessary to fit a carefully constructed temporary bridge which reproduces the original contours of the abutment teeth, and also locks them together so that their relative positions are maintained. The temporary bridge can be made at the chairside or in the laboratory.

Chairside made temporary bridges

440–445 This patient is to have the upper right canine (**440**) replaced with a fixed/fixed bridge. The first step in the manufacture of the temporary bridge is to record the unprepared surfaces of the abutment teeth in an impression, after the missing canine has been quickly reproduced in soft wax (**441**).

440

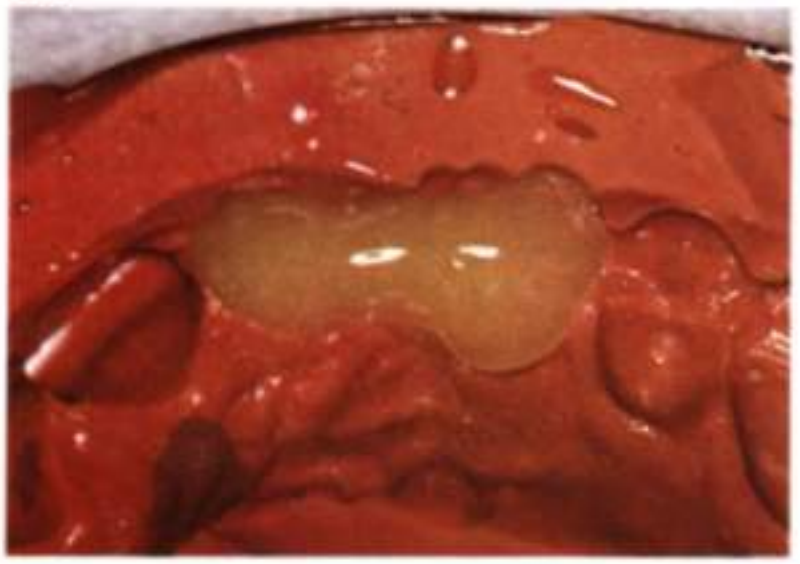
441

442

The abutment teeth are then prepared, in this instance for full coverage crowns (**442**). The abutment and pontic areas of the impression are now filled with a proprietary temporary bridge resin (**443**) taking care to avoid trapping bubbles of air. The impression is seated firmly back into the mouth when the resin will fill the spaces created by tooth preparation of the abutment teeth, and by the soft wax.

When the resin has set, the impression and temporary bridge are removed from the mouth and the excess resin trimmed from the bridge (**444**).

443



444

This is cemented in place with a temporary bonding material (**445**) and should be well tolerated by the patient without the creation of traumatic relationships with other teeth, because of the replication of the original teeth.

445

446 & 447 The temporary coverage for a cantilever bridge can be made with or without a pontic. If the space for the missing tooth is maintained by a partial denture, or if the situation has been stable for some time, then only the abutment teeth need be involved in the temporary bridge as in this case (**446 & 447**). The important thing is to reproduce the external contours of the abutments, so that this state of equilibrium will be maintained.

446

447

Laboratory made temporary bridge

The technician can fabricate the temporary bridge in plastic, heat or cold cured, or in cast metal, such as silver. The disadvantage of this approach is that the patient must make an extra visit for the final impression, after the temporary bridge has been made. However, there are a number of advantages to be considered. A bridge made in the laboratory can be stronger and better finished at the margins than one made at the chairside, especially if metal is used. The alignment of the preparations can be assessed in the laboratory, with a surveyor if desired, during the 'dummy run' of making the temporary bridge. Any adjustments to the abutment preparations deemed necessary can be made at the patient's next visit before the final impression is taken. The try-in of a cast metal temporary bridge very closely simulates that of a final bridge, and any problems of insertion or retention can be identified whilst there is still the opportunity to deal with them.

448 The silver temporary bridge is obviously not aesthetically attractive and it has a tendency to tarnish, as seen here, but these short-term disadvantages may be regarded as being well compensated by the long term advantages, and by the very positive way in which the position of the abutment teeth is maintained.

448

449

Bridge removal

449 & 450 A metal temporary bridge should be cemented only with a temporary bonding agent but even so, may be well retained. To remove it may require long and tedious cutting, but first it is worth trying to apply controlled force to dislodge it in the line of withdrawal. This can be done if soft wire is fed under the pontic or in the case of a cantilever bridge, between the retainers as seen here (**449**).

The remote ends of the wire are grasped with pliers, to which is applied a suitable impact force with the fist in the line of withdrawal (**450**). Such a technique can also be remarkably effective applied to an old bridge which needs replacement.

450

Adjustment for tight contacts

451 & 452 At try-in a bridge may not seat fully down because of tightness in the contact point area. A hit and miss approach to adjustment by the removal of gold or porcelain may well result in an open contact, and it is therefore important to define the area of tightness exactly. This can be done using very thin articulating paper which is wrapped around the adjacent standing tooth (**451**) whilst the bridge is inserted and withdrawn two or three times. The resultant mark will indicate accurately the area on the bridge that needs reduction (**452**).

451

452

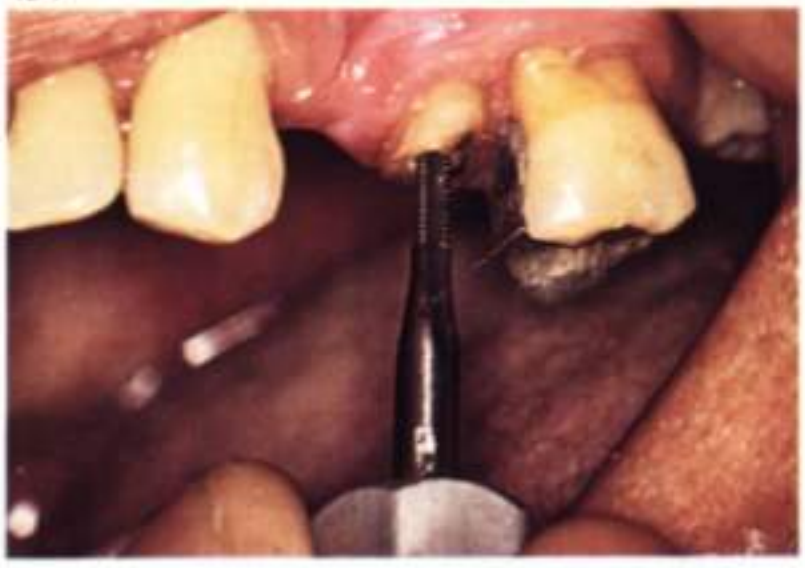
The broken down abutment tooth

453–458 There are numerous ways that missing tooth tissue may be replaced in order to give an abutment tooth sufficient bulk for strength, retention and resistance form. For vital teeth, this is usually done using pins with amalgam or composite (see **190–194**). In non-vital teeth, advantage is often taken of the excellent retention to be obtained from the pulp chamber and canal. This may take the form of a cast post and core, or one of the many designs of pre-fabricated post and core, which is cemented in place following satisfactory root filling.

The Kurer post and core is a pre-fabricated design that obtains additional retention from being screwed into the tooth (see **288 & 289**). In this example, a bridge is required to replace the upper left first premolar. It is intended to use the root filled ⌊5 as an abutment in a simple cantilever bridge, involving also the ⌊6. The grossly broken down crown of ⌊5 is reduced to gum level, and its single root canal enlarged with an engine reamer. The canal is then threaded using an engineers tap (**454**).

453

454



The Kurer post with matching thread is screwed fully into the tapped post hole (**455**).

455

After noting the amount of excess length, the post is removed and shortened appropriately. It is then screwed back into the cement filled post hole (**456**).

456

Both the protruding core of the ⌊5 and the crown of the ⌊6 are prepared for full crown coverage (**457**).

457

The fitted bridge is a combination of yellow gold and bonded porcelain units (**458**). Note the excellent characterisation that has been achieved in the buccal porcelain of ⌊5 and the pontic.

458

An implant abutment

459 & 460 An attempt to span with a bridge the space created by the loss of three or more teeth is likely to throw an insupportable load on the abutment teeth, as well as presenting problems of providing sufficient strength in the bridge material to avoid distortion. One solution to this problem is to change the usual bridge design to one that is partly tissue borne and removable. Alternatively, a partial denture may be considered. A third and somewhat rare variation is to supply an abutment in the centre of the span by means of an implant (**459**). In this example, the completed 5 unit bridge (**460**) is supported by full crown coverage on the 6, the implant and the 2, the anterior four units being of bonded porcelain and the posterior unit of yellow gold.

459

460

Some errors in bridgework

461 & 462 The usually acceptable retainers for bridgework are full crowns, three-quarter crowns or MOD inlays with capped cusps, in descending order of preference (Roberts 1970). In all of these there is complete occlusal coverage, to avoid the possibility of the tooth and its retainer being separated from each other by the stresses of occlusion. It is regarded as an error in design to rely on MOD inlays as retainers. In this exceptional case, however, a single MOD retainer (**461**) without cuspal coverage has successfully retained a cantilever pontic, replacing 3| for many years in a perfectly healthy condition (**462**).

461

462

463 Fracture in the cingulum region of an all porcelain bridge is likely to occur if allowance has not been made for occlusal relationships with the lower incisors. Space must be created, either during abutment preparation, or subsequent incisal reduction of the occluding teeth, to allow a sufficiently strong bulk of porcelain to be placed free from occlusal trauma.

463

464 This lateral incisor simple cantilever pontic has bent away from its retainer, due to a poorly designed or badly executed soldered joint.

464

465 Poor cementation has jeopardised the success of this bridge, which may well have been a perfect fit at try-in stage. Attention to such detail as glass slab temperature and cement consistency is critical if a bridge is to be properly inserted and burnished.

465

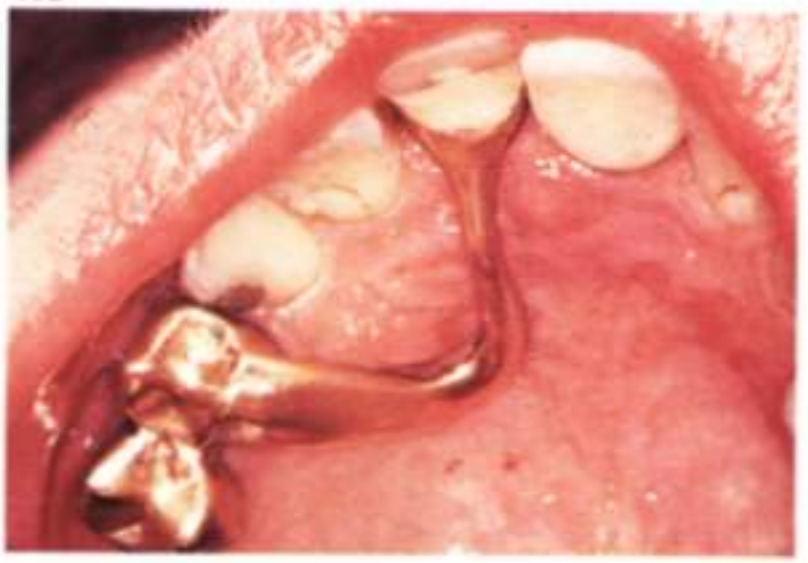
466 Poor design of the fitting surfaces of the pontics, aggravated by sub-standard plaque control, has resulted here in marked inflammation of the underlying mucosa. Where pontics are in contact with soft tissue, they should be designed to aid easy cleaning. Concavities should be avoided in the fitting surfaces which should make a line contact with the mucosa (all that is needed for aesthetic reasons) instead of an area contact. The patient should also be given explicit instruction in the effective use of dental floss.

466

467 & 468 The spring cantilever pontic replacing the 1| has sunk into the underlying mucosa (**467**).

467

468



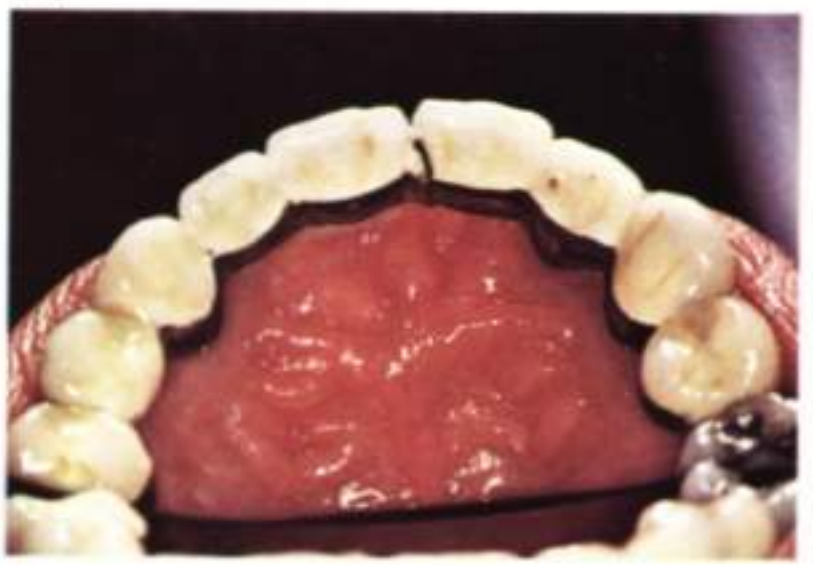
In this case movement has been allowed to occur due to the thinness of the connecting bar (**468**). Other factors may, however, have contributed to this movement, such as mobility of the abutment teeth, lack of palatal support for the bar and premature insertion of the bridge before the 1| socket had fully healed.

469 Bonded porcelain may shear off the metal substructure, resulting in the need for an expensive and time-consuming removal and remake of the bridge or crown. There are techniques for making good such deficiencies with self-tapping pins and composites, but prevention by proper design and application of the porcelain section is preferable (see **239**).

469

470 This ten-unit upper bridge has fractured between the central incisors. As it has been made in one piece it will be necessary to remove the whole bridge to repair the fault. The fracture may have been due to a weakness in the metal substructure, but it may also have been due to a slight sagging of such a long unit whilst in the porcelain furnace. The resulting slight distortion may not have been observed at cementation stage, and the lack of perfect fit may then have allowed the bridge to fatigue and crack in use.

470



471–473 Where it is intended to fit bridgework to the whole or nearly the whole arch (**471**), it is advisable to make the bridge in sections (**472**). Such shorter spans are less at risk in the porcelain furnace.

A locating impression can be taken of all three sections when these have been satisfactorily tried in (**473**), to enable them to be soldered together. If a suitable design can be devised, it is an advantage to avoid soldering altogether and to so interlock the three components, that any one section can be removed independently should it need to be repaired.

471

472

473

Appendix 1

Procedure for history and examination

History

1. Reason for Attendance
2. Details of Present Complaint (where applicable)
3. Dental History
4. Medical History
5. Family History
6. Personal History

Examination

1. General Assessment – appearance, build, etc.
2. Facial Examination
3. Oral Examination
   a. Area of present complaint (where applicable)
   b. General state of the mouth
   c. Soft tissues
   d. Periodontal tissues
   e. Occlusion
   f. Teeth
4. Special Tests (where applicable)
   a. Vitality tests
   b. Radiographs
   c. Transillumination
   d. Pulse and temperature
   e. Study models
   f. Pathological and biological tests

Appendix 2

Plaque index

The patient hygiene performance index Podshadley and Haley (1968)

1. A disclosing solution is applied to the labial surfaces of $\frac{61|6}{|1}$ and the lingual surfaces of $\overline{6}|\overline{6}$.

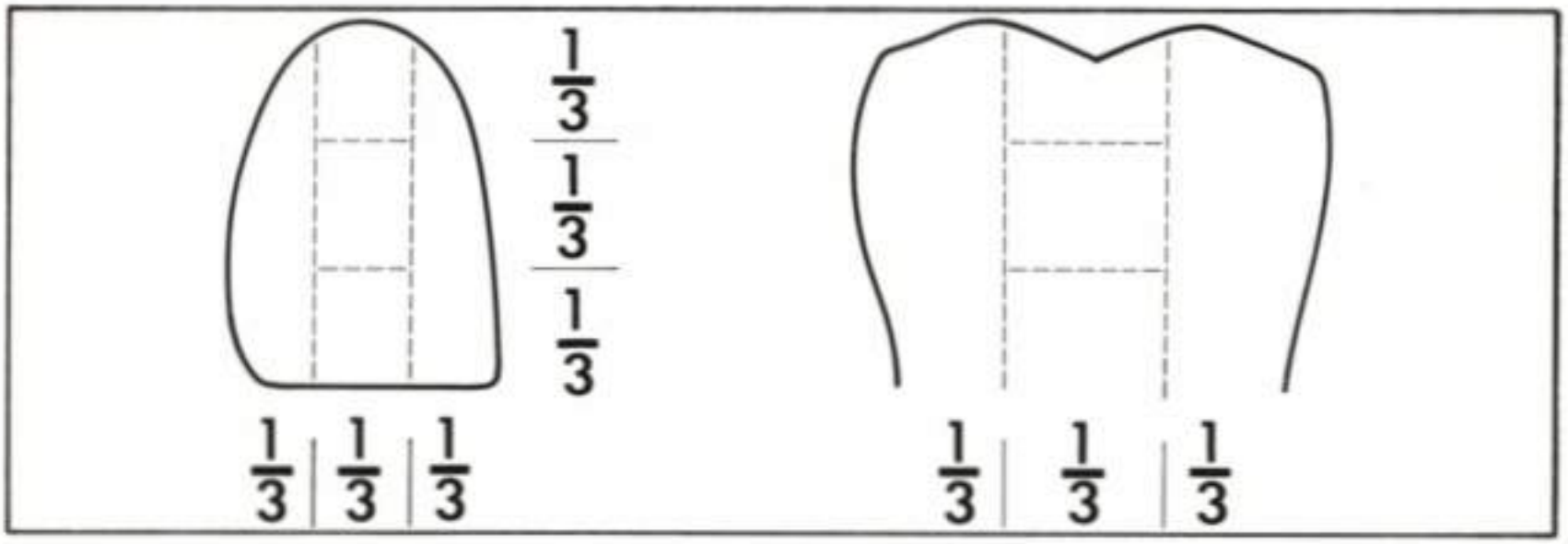
   (If the first molar is missing, broken down or crowned, the second molar is substituted. If the central incisor is missing or cannot be used, the adjacent central incisor is substituted.)

2. Each nominated surface is sub-divided mentally into five sections, as indicated below, and examined for stained oral debris or plaque. No stain scores 0, any stain scores 1, for each section. Any tooth surface will therefore have a total score of from 0 to 5.

3. The scores for all surfaces are added together and the sum is divided by the number of surfaces examined (usually 6). This gives the PHP Index.

e.g. 6|	3
|1	2
|6	4
$\overline{1}$|	3
6|	1
|6	3
	16

$$\text{PHP} = \frac{16}{6} = 2.66$$



Appendix 3

Alum solution

Alum solution as an adjunct to gingival retraction

Wilson and Tay (1977)

Adrenaline acid tartrate 1%

Sodium metabisulphite 0.1%

Potassium aluminium sulphate to 100%

Appendix 4

Bases and varnishes

Base materials

	These materials are used:
Modified zinc oxide/eugenol cements Calcium hydroxide Polycarboxylate cements Zinc phosphate cements (in association with a sub-base) Ethoxybenzoic acid cements* Glass ionomers*	(i) As protection for the dentine and pulp from chemical or physical irritation (ii) To reduce a deep cavity to appropriate depth for filling (iii) To support undermined enamel (iv) For the elimination of undercuts
*Protection would be required under these cements in deep cavities	

Sub-base

Calcium hydroxide in proprietary quick-setting form	Used as an 'indirect pulp cap' to induce pulpal calcification where the floor of a cavity is very close to the pulp. A sub-base may also be applied to the floor of a very deep cavity as protection against possible pulpal irritation from certain bases.

Varnishes

Copal ether varnish Proprietary varnishes often containing zinc oxide	Used to prevent marginal seepage between an amalgam restoration and the tooth

Appendix 5

Impression techniques

Information to be recorded at the chairside

1. The prepared teeth using an elastomeric impression
2. The opposing teeth using an alginate impression
3. Occlusal registration
4. Tooth shade (where appropriate)

Elastomeric materials available

Polysulphide rubber

Silicone rubber

Polyether rubber

Indirect techniques

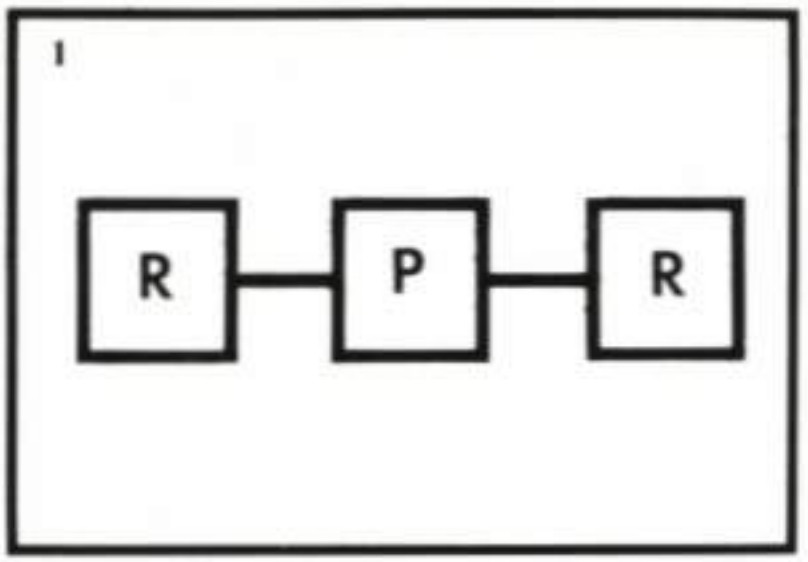
1. Special Tray (a) Single stage
   (b) Two stage
2. Stock Tray (a) Two stage
   (b) Single stage

Appendix 6

Bridge classification

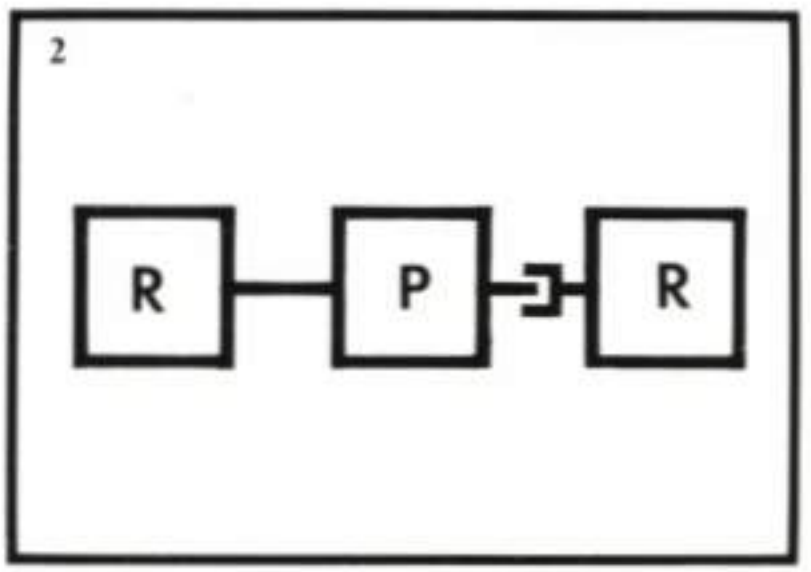
1 Fixed/fixed

A one-piece bridge with the retainers fixed at either end of the pontic



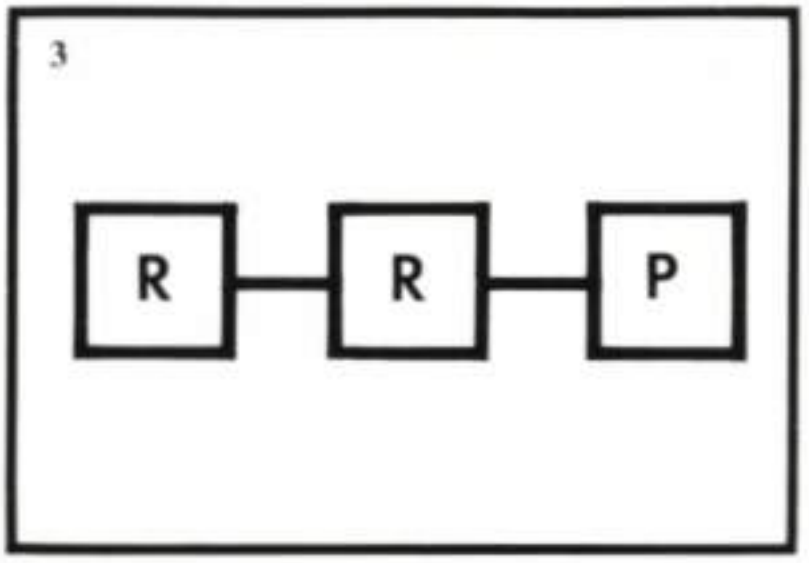
2 Fixed/non-fixed

A two-piece bridge comprising a pontic with a retainer fixed to one end and with a dovetail at the other. The dovetail fits into a slot in the second and independent retainer



3 Simple cantilever

A bridge where both retainers are adjacent to each other at one end of the pontic



4 Spring cantilever

A bridge where the retainers are adjacent to each other but separated from the pontic area by one tooth or more

5 Compound bridge

A bridge which combines two or more of the basic designs