6 Retention

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This article describes the mechanisms for retaining RPDs and considers the different types of direct retainer. The factors influencing the effectiveness of retentive clasps and governing the choice of clasp are discussed.

In this part, we will discuss
- Mechanisms of RPD retention
- Clasp types, efficiency and selection
- Attachments
- RPI system
- Other retentive devices

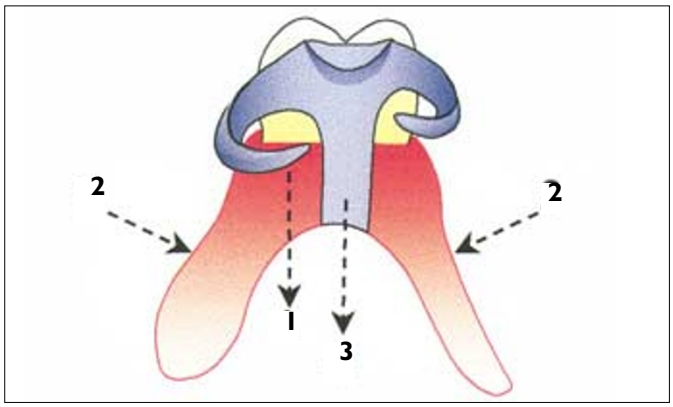

Fig. 1 — Retention
Retention of an RPD can be achieved by:
- Using mechanical means such as clasps (1) which engage undercuts on the tooth surface.
- Harnessing the patient's muscular control (2) acting through the polished surface of the denture.
- Using the inherent physical forces (3) which arise from coverage of the mucosa by the denture.

Whether reliance is placed on all, or mainly on one of these methods, depends on clinical circumstances. Retention by mechanical means can also be obtained by selecting a path of insertion which permits rigid components to enter undercut areas on teeth or on ridges (Figs 23 and 26 of Part 4).

Fig. 2 — Retention
In this particular case there are sufficient teeth with suitable undercut areas to allow the RPD to be retained by clasps. Successful clasp retention allows the palatal coverage to be reduced to a minimum. Not only does the patient appreciate this limited coverage but also it reduces the risk of damage to the oral tissues.

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REFEREED PAPER

New publications:
All the parts which comprise this series (which will be published in the BDJ) have been included (together with a number of unpublished parts) in the books *A Clinical Guide to Removable Partial Dentures* (ISBN 0-904588-599) and *A Clinical Guide to Removable Partial Denture Design* (ISBN 0-904588-637). Available from Macmillan on 01256 302699

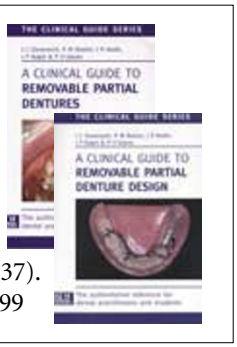
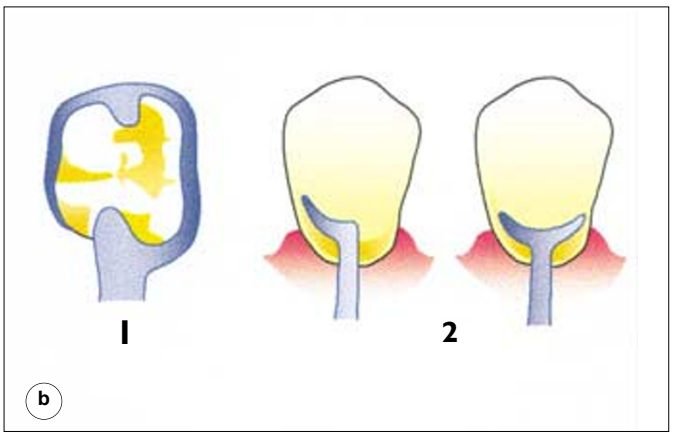


Fig. 3 — Retention
In contrast to the previous case, this patient's remaining teeth offer less opportunity for clasp retention. It is necessary, therefore, to cover more of the palate in order to harness the physical forces of retention. The broad palatal plate connector also provides a surface that the patient's tongue can press against to achieve muscular control of the prosthesis.

Fig. 4 — Retention
Muscular control is of particular importance for the success of an extensive mandibular bilateral distal extension saddle denture. Although this denture achieves some retention from clasps its success will depend primarily on the muscles of the tongue and cheeks acting on the correctly designed polished surfaces of the saddles.

As will be seen later in this section, there are circumstances where there is a tendency for retentive clasps to lose some of their efficiency with the passage of time. Thus, in the long term, successful retention may become more dependent upon the physical forces and muscular control. However, it is generally accepted that retentive clasps are particularly beneficial during the early stages of denture wearing as they ensure effective mechanical retention while the patient learns the appropriate muscular skills that will either augment or replace the contribution of the clasps.

The remainder of this section is devoted to a consideration of components which provide mechanical retention, namely clasps, precision attachments and other devices.



Clasps

Fig. 5a and b — Clasps
Although many designs of retentive clasps have been described, they can be considered in one of two broad categories: the occlusally approaching clasp on UL7 (27) and the gingivally approaching 'I' bar clasp on UL3 (23) (Fig. 5a). Common variations in the design of clasps (Fig. 5b) that may be selected primarily according to the distribution of tooth undercuts include:

1 the ring clasp (which is occlusally approaching).
2 the 'L'- or 'T'-shaped gingivally approaching clasp.

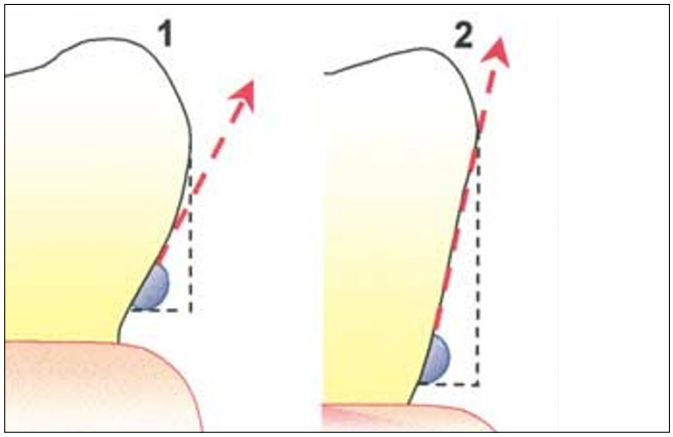


Fig. 6 — Clasps
Whatever type of clasp is used a denture will be retained successfully only as long as the force required to flex the clasps over the maximum bulbosities of the teeth is greater than the force which is attempting to dislodge the denture. The retentive force is dictated by tooth shape and by clasp design.

Tooth shape influences retention by determining the depth and steepness of undercut available for clasping. Clasps 1 and 2 are positioned in the same amount of undercut and therefore provide the same overall retentive force. However, for the same small vertical displacement, clasp 1 is deflected more than clasp 2 and therefore offers greater initial resistance to the displacing forces.

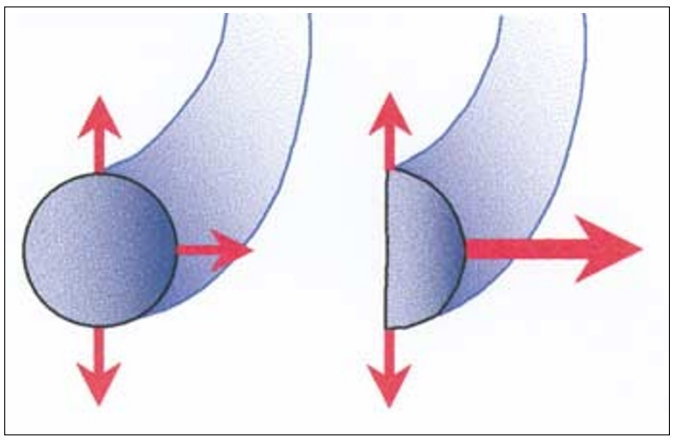
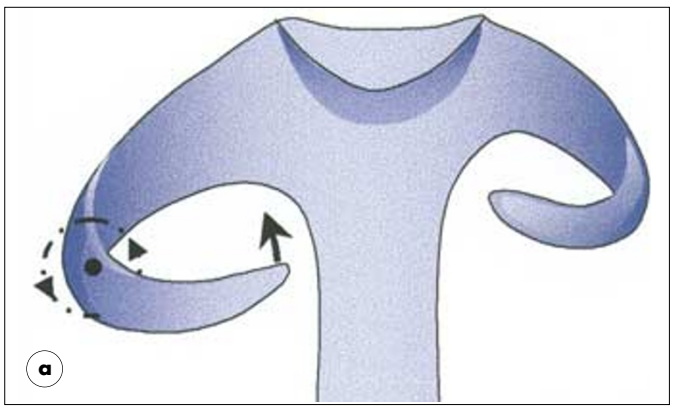


Fig. 7 — Clasps
The flexibility of a clasp is dependant on its design.

- ***Section***
  A round section clasp will flex equally in all directions, whereas a half round clasp will flex more readily in the horizontal than in the vertical plane.
- **Length**
  The longer the clasp arm the more flexible it is. Thus an occlusally approaching clasp on a molar tooth will be more flexible than one on a premolar.
- **Thickness**
  Thickness has a profound effect on flexibility. If the thickness is reduced by half the flexibility is increased by a factor of eight.
- **Curvature** (see Fig. 8)
- **Alloy** (see Fig. 9)



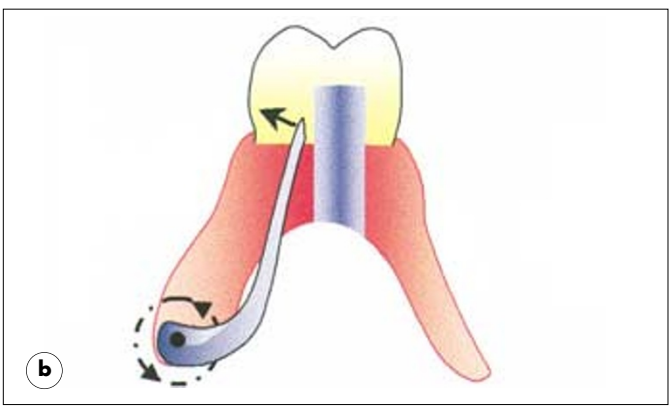


Fig. 8a and b — Clasps
A clasp which is curved in two planes can exhibit the so-called 'bucket handle' effect in which torsional movement of the clasp increases flexibility of the clasp arm.

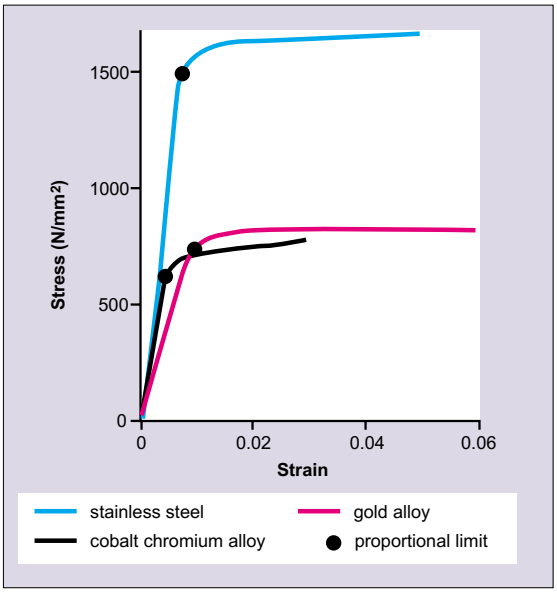
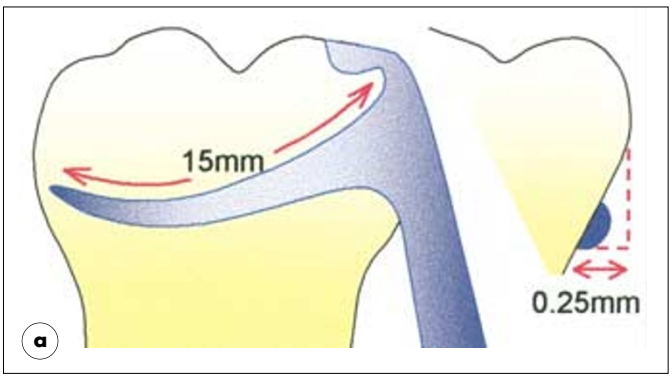


Fig. 9 — Clasps
Flexibility is also dependent upon the alloy used to construct the clasp. The most commonly used alloy, cobalt chromium, has a value for modulus of elasticity (stiffness) indicated by the steepness of the first part of the black curve, which is twice that of gold alloy (the red curve). Thus, under identical conditions the force required to deflect the cobalt chromium clasp over the bulbosity of the tooth will be twice that of a gold clasp.

Of particular importance is the proportional limit of the alloy indicated by the solid circles on the curves. If a clasp is stressed beyond the proportional limit it will be distorted permanently. Hard gold and cobalt chromium have similar proportional limits. Hardened stainless steel wire (blue curve) has a much higher value.

It will be appreciated that the factors mentioned above interact with each other. Thus the choice of an appropriate clasp which will retain a denture satisfactorily and yet not stress the tooth unduly, or be distorted permanently during service, might appear to be somewhat bewildering. In this book we feel it is appropriate to offer the following clinical guidelines which have been shown to work in practice.



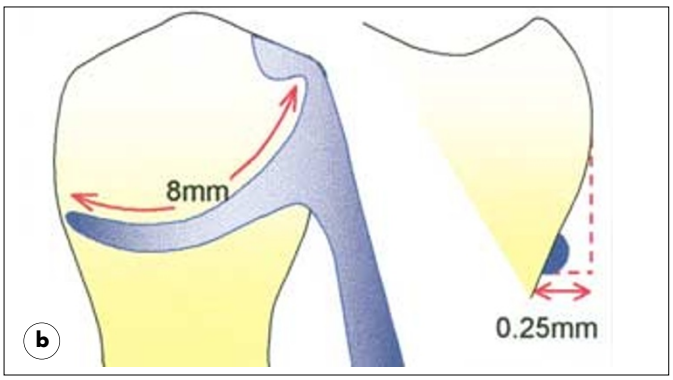
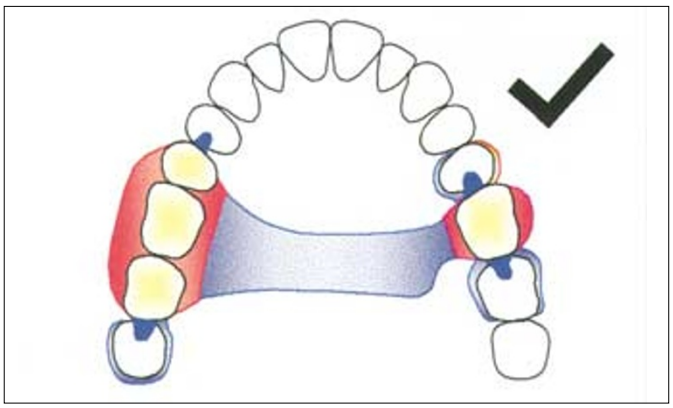


Fig. 10a and b — Clasps
As shown in (a), a cobalt chromium clasp arm, approximately 15 mm long, should be placed in a horizontal undercut of 0.25 mm. If the undercut is less the retention will be inadequate. If it is greater, the clasp arm will be distorted because the proportional limit is likely to be exceeded. A cobalt chromium occlusally-approaching clasp engaging the same amount of undercut on a premolar tooth (b) is likely to distort during function because it is too short. In such a situation a longer clasp arm can be achieved by using a gingivally-approaching design. Whether this choice is appropriate depends on certain clinical factors that will be highlighted later in this chapter. Alternatively, an alloy with a lower modulus of elasticity but similar proportional limit, such as a platinum–gold–palladium wire, can be used. Yet another possibility is to use a material with a higher proportional limit but similar modulus such as wrought stainless steel or cobalt chromium (Wiptam) wires.

Fig. 11 — Clasps
Whether a gold or stainless steel clasp arm can be provided depends on the configuration of the denture. In this example the gold clasp on UL5(25) can be held securely within the acrylic of the saddle.



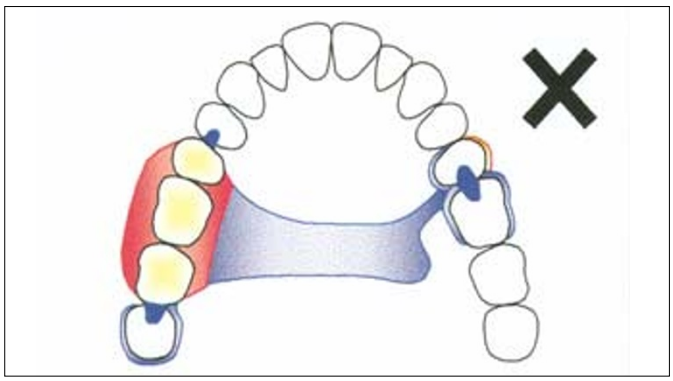
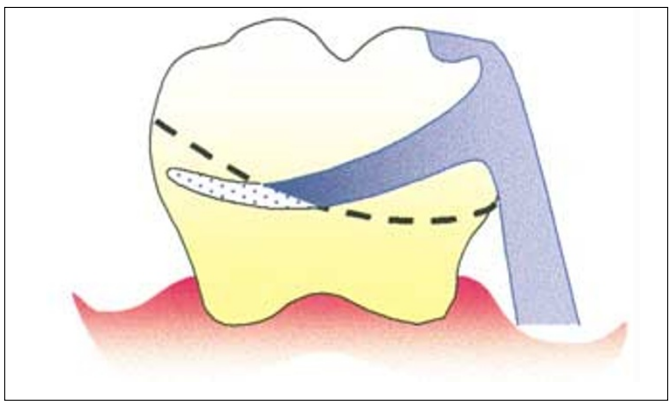


Fig. 12 — Clasps
If a gold clasp were to be provided for UL5(25) in this case, its only means of attachment to the remainder of the denture would be by soldering it to the cobalt chromium framework. Such a union is possible but relatively weak and thus is prone to fracture during use. The metal frame of an RPD ideally consists of a single alloy. However, if different metals or alloys are present in the same oral environment, as in the examples described above, interactions frequently occur between these materials that reduce their individual properties. Corrosion is the most common reaction and it begins as soon as different metals or alloys are in contact with each other.

Fig. 13 — Clasps
A cobalt chromium 'Wiptam' round wire clasp can be attached to the framework using a 'cast-on' technique.

Where it is necessary to add clasp retention to an acrylic transitional denture, stainless steel wire is a relatively inexpensive solution to the problem. Wire of 0.75 mm diameter is appropriate for premolar teeth while 1 mm diameter wire is suitable for molar teeth.

Two final points are worth making before we leave the subject of clasp construction and progress to further consideration of design and clinical use. First, the efficiency of a retentive clasp is also influenced by the support of the denture (Fig. 17, Chapter 5 of our BDJ publication *'A clinical guide to removable partial denture design'*) and by reciprocation (Figs 12 and 13 of Part 7). Second, the variables of clasp construction have been simplified by certain manufacturers producing preformed wax patterns with dimensions that are appropriate for the properties of the alloy to be used and the tooth to be clasped.



Comparison of occlusally and gingivally approaching clasps

Retention

Fig. 14 — Retention
Only the terminal third of an occlusally-approaching clasp (stippled section) should cross the survey line and enter the undercut area. If, in error, too much of the clasp arm engages the undercut, the high force required to move it over the maximum bulbosity will put a considerable strain on the fibres of the periodontal ligament and is likely to exceed the proportional limit of the alloy, thus distorting the clasp.

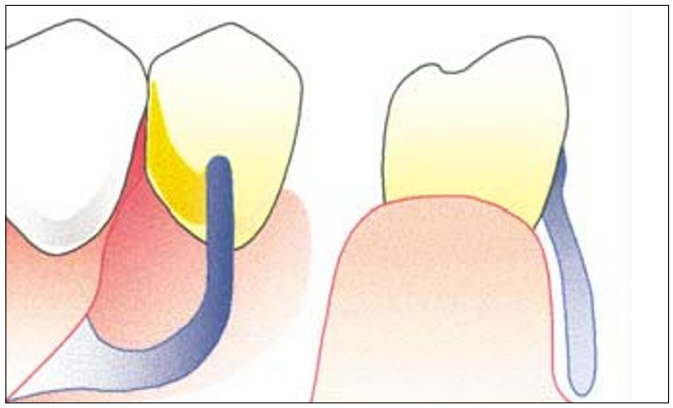


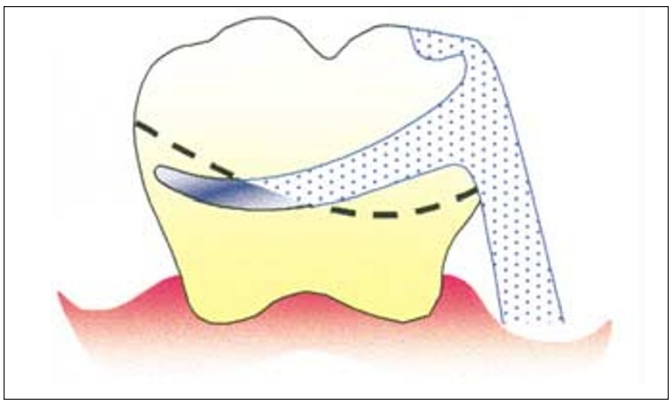
Fig. 15 — Retention
A gingivally approaching clasp contacts the tooth surface only at its tip. The remainder of the clasp arm is free of contact with the mucosa of the sulcus and the gingival margin.

The length of the gingivally approaching clasp, unlike the occlusally approaching clasp, is not restricted by the dimensions of the clasped tooth. The length of the gingivally approaching clasp arm can therefore be increased to give greater flexibility which can be a positive advantage when it is necessary to clasp a premolar tooth or a tooth whose periodontal attachment has been reduced by periodontal disease.

Bracing

Fig. 16 — Bracing

The occlusally approaching clasp is more rigid, and more of it (stippled section) is in contact with the tooth surface above the survey line. It is therefore capable of transmitting more horizontal force to the tooth and is a more efficient bracing component as a result (Part 7). Whether such a measure is appropriate depends upon the health of the periodontal tissues and the functional requirements of the RPD.



Appearance

Fig. 17 — Appearance

Either type of clasp can detract from appearance when placed on a tooth that is toward the front of the mouth. However, the gingivally approaching clasp has more potential for being hidden in the distobuccal aspect of a tooth provided that there is a suitable undercut area for the clasp.

Fig. 18 — Appearance

Tooth-coloured occlusally approaching polyoxymethylene clasps are an alternative to metal clasps where the colour of the clasp is a key factor. However, these clasps are bulkier than metal clasps and require a deeper undercut. Other disadvantages include lack of adjustability and increased cost.

Hygiene

The gingivally approaching clasp can be criticized on the grounds that it crosses a gingival margin. There does not appear to be any evidence to indicate that one clasp encourages more plaque than the other. However, it is not unreasonable to assume that if the patient does not practise good oral hygiene the gingivally approaching clasp could pose a greater threat to periodontal health.

The gingivally approaching clasp might also increase the risk of root caries. It should be remembered that this lesion is strongly associated with gingival recession, which itself is age-related.

Occlusion

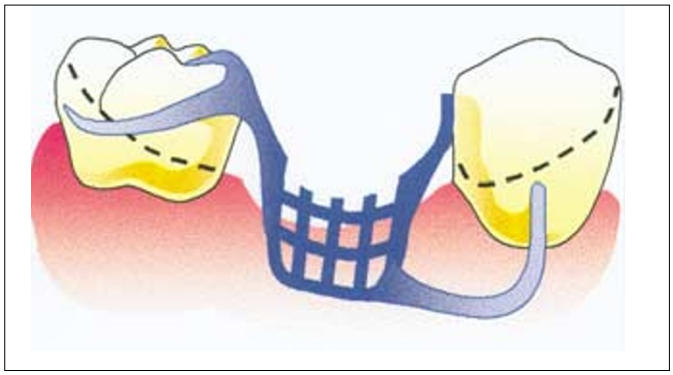
An occlusally approaching clasp must begin, and have two-thirds of its length, in the area bounded by the occlusal contacts of the opposing teeth and the survey line on the tooth to be clasped. Provision of an adequate space for the clasp may require tooth preparation (see Figs 7, 8, 21–22 of Part 12). Occlusal contacts, however, have no influence on gingivally approaching clasps.

Factors governing the choice of retentive clasp

The choice of retentive clasp for an individual tooth depends upon the:

- Position of the undercut.
- Health of the periodontal ligament.
- Shape of the sulcus.
- Length of clasp.
- Appearance.
- Occlusion.

As we have already discussed the significance of the length of clasp, appearance and occlusion, particular attention will be focused on the first three factors.



The position of the undercut

Fig. 19 — The position of the undercut

The diagonal survey lines on the molar and premolar teeth shown here indicate that there is a larger undercut on that part of the tooth which is furthest away from the edentulous area. Typical designs of retentive clasp are the occlusally approaching clasp on the molar and the gingivally approaching 'I' bar on the premolar tooth.

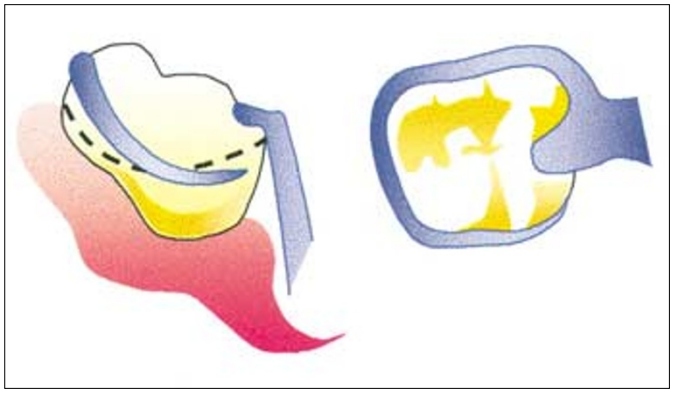


Fig. 20 — The position of the undercut

The orientation of the diagonal survey line on this molar creates the larger undercut area nearer to the saddle. The design of the occlusally approaching clasp used on the molar in Fig. 19 would be quite inappropriate because it would prove difficult to keep the non-retentive two-thirds of the clasp out of the undercut whilst, at the same time, offering very little undercut for the retentive portion. An alternative design is the ring clasp that commences on the opposite side of the tooth and attacks the diagonal survey line from a more appropriate direction. An 'I' bar would be suitable for a premolar tooth with a survey line of similar orientation.

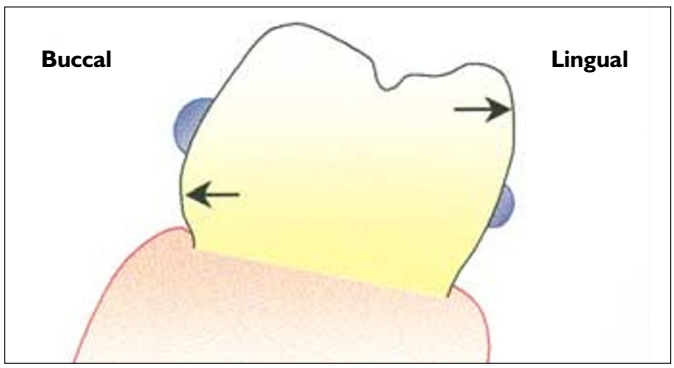


Fig. 21 — The position of the undercut

A low survey line (on the buccal side of the tooth) is present because the tooth is tilted; thus there is a high survey line on the lingual side of the tooth. Again, a ring clasp is a solution to the problem: the bracing portion of the clasp is on the left side of the tooth and the retentive portion on the right side.

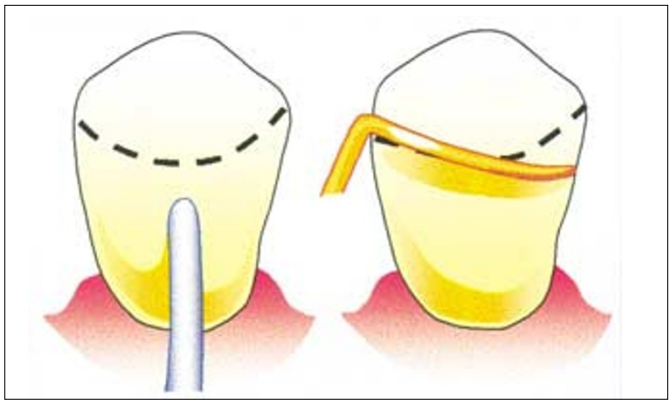


Fig. 22 — The position of the undercut

A high survey line poses particular difficulties on a premolar tooth. If it is not appropriate or practical to lower the survey line by altering the crown shape, it may be possible to position a flexible gingivally approaching clasp higher up the crown or, if an occlusally approaching clasp is preferred, to use a more flexible platinum–gold–palladium wrought wire clasp.

Even if the survey line is not high enough to create difficulties in clasping there will be potential advantages in using one of these more flexible types of clasp on a premolar tooth (Fig. 10).

The health of the periodontal ligament

If a retentive clasp is placed on a tooth, it is inevitable that extra force will be transmitted to the supporting tissues of that tooth. Whether or not these tissues are able to absorb the extra force without suffering damage depends upon their health, the area of attachment and the magnitude of the force.

Fig. 23 — The health of the periodontal ligament

This canine tooth has already lost approximately half its periodontal attachment as a result of previous periodontal disease. Although the disease process has been arrested, there is the possibility that further damage will occur if a relatively inflexible retentive clasp system, such as a cast cobalt chromium occlusally approaching clasp, is provided. If it is considered essential to rely on mechanical retention, a possible solution is to prescribe a more flexible gingivally approaching clasp. However, this option should be used with caution if the gingival recession is associated with root caries in which case a wrought wire occlusally approaching clasp might then be more suitable.

The shape of the sulcus

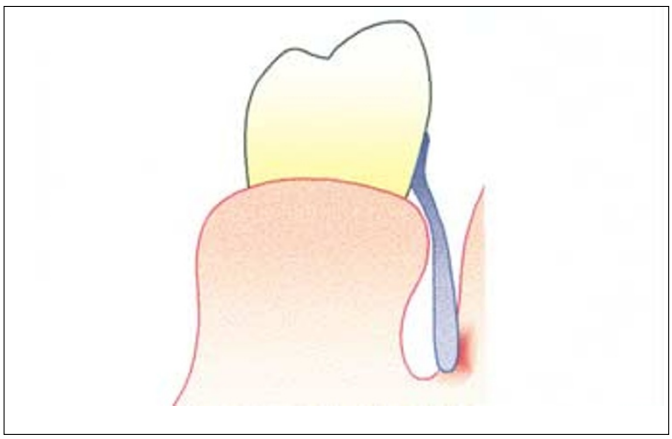
Fig. 24 — The shape of the sulcus

If a gingivally approaching clasp is envisaged, the shape of the sulcus must be checked carefully to ensure that there are no anatomical obstacles. In this example the prominent fraenal attachment would be traumatised by a gingivally approaching clasp of correct proportions and position. If there is no reasonable alternative to this clasp, and mechanical retention is thought to be essential, serious consideration must be given to surgical excision of the fraenal attachment.

Fig. 25 — The shape of the sulcus

If there is an undercut in the sulcus, the arm of a gingivally approaching clasp would have to be spaced from the mucosa of the ridge to allow the denture to be inserted and removed without the clasp traumatising the bulbous part of the ridge. If the undercut is deep, the resulting prominence of the clasp arm is likely to irritate the buccal mucosa and trap food debris, becoming an intolerable nuisance to the patient.

The German slang prosthodontic term for a gingivally approaching clasp, 'Sauerkrautfänger' ('cabbage catcher'), graphically describes the situation.



The RPI system

Fig. 26 — The RPI system

The RPI system is a combination of occlusal rest (R) distal guide plate (P) and gingivally approaching I bar clasp (I) used primarily with mandibular distal extension saddles.

The minor connector carrying the mesial rest contacts the mesiolingual surface of the abutment tooth and, together with the distal plate, acts as a reciprocal for the tip of the retentive clasp which is positioned on or anterior to the midpoint of the buccal surface of the tooth.

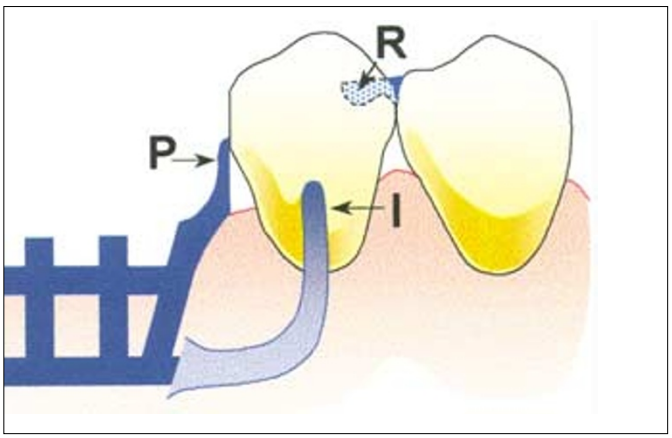


Fig. 27 — The RPI system
The distal guide plate is positioned at the gingival end of a guide surface prepared on the distal aspect of the tooth.

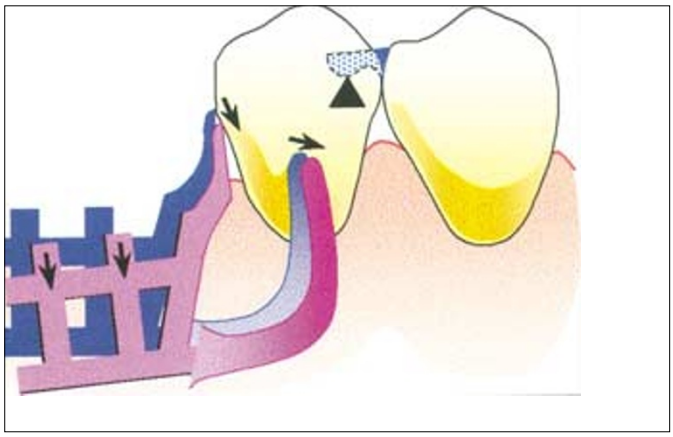


Fig. 28 — The RPI system
The RPI system is designed to allow vertical rotation of a distal extension saddle into the denture-bearing mucosa under occlusal loading without damaging the supporting structures of the abutment tooth. As the saddle is pressed into the denture-bearing mucosa, the denture rotates about a point close to the mesial rest. Both the distal guide plate and the I bar move in the directions indicated and disengage from the tooth surface. Potentially harmful torque is thus avoided.

When trying in the metal framework, it is advisable to check that it is able to rotate about the abutment tooth in the intended fashion. If this is found not to be the case, the framework should be carefully adjusted to allow this rotation.

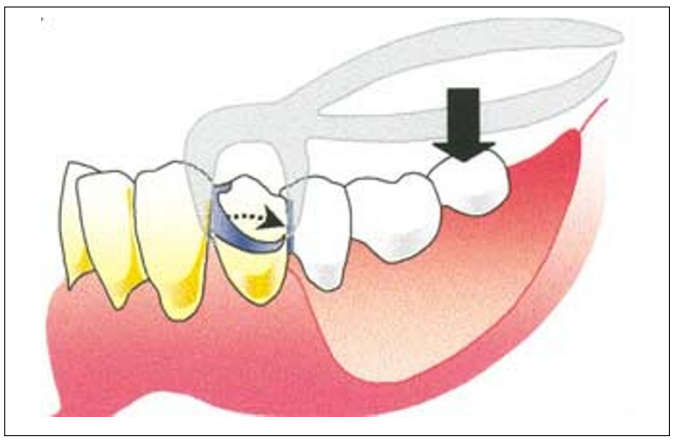


Fig. 29 — The RPI system
A distal extension saddle should not be rigidly attached to the abutment tooth by a combination of stiff clasp and long guide plates. If these are incorporated the occlusal loads falling on the saddle, which is in effect a long cantilever arm, are likely to result in the RPD acting like extraction forceps, with consequent damage to the supporting structures of the tooth.

Attachments

An attachment is made up of two components, one located in or on the abutment tooth and the other housed in the denture. When the two matched parts are linked together they produce very positive retention. Attachments are discussed further in our *BDJ* publication *A Clinical Guide to Removable Partial Dentures*, Figs 3.6 – 3.12. However, it is not the purpose of this book to provide detailed information on precision attachments but rather to note their existence and refer the reader to texts that deal with this topic.

Fig. 30 — Attachments
Tooth LR6 (46) has an example of an intracoronal micro-attachment. A slot is incorporated within the substance of a crown and is engaged by a matching component on the removable section.

Fig. 31 — Attachments
The extracoronal micro-attachment, such as the Dalbo on the right of the figure, is attached to the outside of the crown. The matched component on the left is held in the denture and is designed to allow rotatory movement as the distal extension saddle sinks into the denture-bearing mucosa, thus taking some of the stress off the abutment tooth.

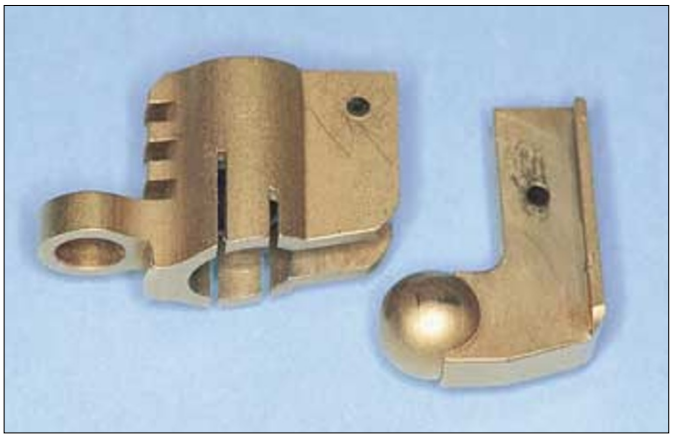


Fig. 32 — Attachments
With attachments like the Kurer system, the stud is fixed to the root face of a root-filled tooth and a retainer held in the acrylic of the denture base snaps over the stud.

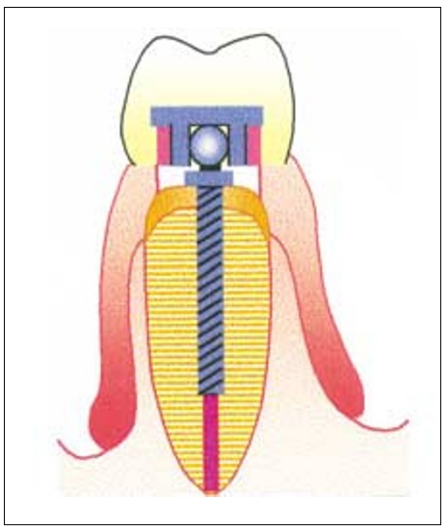


Fig. 33 — Attachments
In this example the stud attachment affords positive retention in the anterior region for the extensive saddles.

The advantages of attachments include positive retention in the absence of clasp arms. Their use necessitates extensive preparation of the abutment teeth and an inevitable increase in cost of treatment. The more rigid attachments require the abutment teeth to have particularly healthy periodontal tissues. As the attachments tend to encourage the formation of plaque, the standard of oral hygiene must be immaculate. Maintenance of the denture may be complicated by wear of the attachments, which may necessitate replacement of the component parts.

Other devices

Fig. 34 — Other devices
The ZA anchor is an example of a spring-loaded attachment. The spring-loaded nipple engages an undercut on the surface of an abutment tooth adjacent to the saddle. It is used for retaining bounded saddles and is of particular value for maxillary canine or premolar teeth where a conventional clasp arm would detract from appearance.

Fig. 35 — Other devices
In recent years there has been an increasing interest in the use of magnets. The modern alloys are powerful and retain their magnetism for a long time. Each magnetic unit has a force of attraction in the region of 200–300 g, which is maximal as soon as the denture starts to move. This force of attraction imparts a degree of security to the denture, without putting great demands on the periodontal tissues of the abutment teeth. In this example the bipolar magnet will be incorporated in the denture. The keeper is housed in a gold coping fitted to a root-filled tooth.

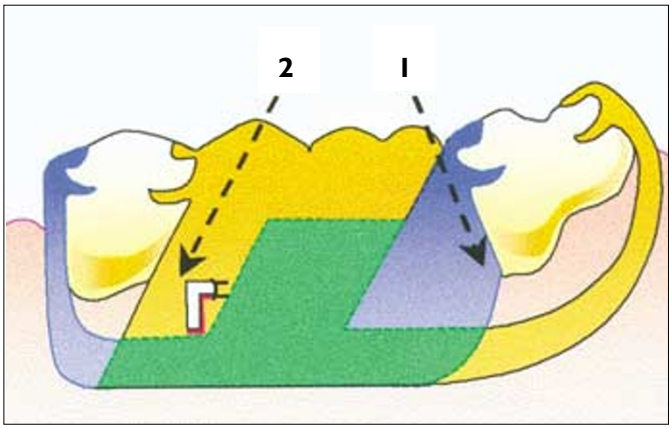


Fig. 36 — Other devices
The two-part denture makes use of opposing undercuts. Both parts are inserted separately using different paths of insertion. In this figure the portion coloured blue is inserted first from a mesial direction (1) to engage the mesial undercut on the molar. Then the yellow portion is inserted from a distal direction (2) to engage the distal undercut on the premolar. Once the components are fully seated they are locked together — in this instance with a bolt. This type of RPD is discussed further in our *BDJ* publication *A Clinical Guide to Removable Partial Denture Design*, Statement 11.2.

Fig. 37 — Other devices
A bolt retained sectional denture is shown *in situ*. The patient needs to be reasonably dextrous to successfully manage a denture of this type.

Fig. 38 — Other devices
The swing-lock denture has a hinged labial bar which has extensions into undercuts on the labial surfaces of the teeth. When the 'gate' is closed and locked into position, the denture is held securely by the 'gate' on the labial aspect and by the reciprocating components on the lingual aspects of the teeth. The denture can be particularly helpful where the remaining natural teeth offer very little undercut for conventional clasp retention. This patient, a trombone player, required a positively retained RPD. The swing-lock design allowed optimum use to be made of the incisors. As this type of denture covers a considerable amount of gingival margin, the standard of plaque control must be high.

Fig. 39a and b — Other devices
There is an added advantage of the swing-lock denture in that the 'gate' can carry a labial acrylic veneer. This veneer can be used to improve the appearance when a large amount of root surface has been exposed following periodontal surgery.