10 Connectors

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This article describes the types and functions of connectors for RPDs. It also considers the relative merits and limitations of these connectors.

In this part, we will discuss
- Major and minor connectors
- Connectors for the upper jaw
- Connectors for the lower jaw
- Non-rigid connectors
- Connectors for acrylic dentures

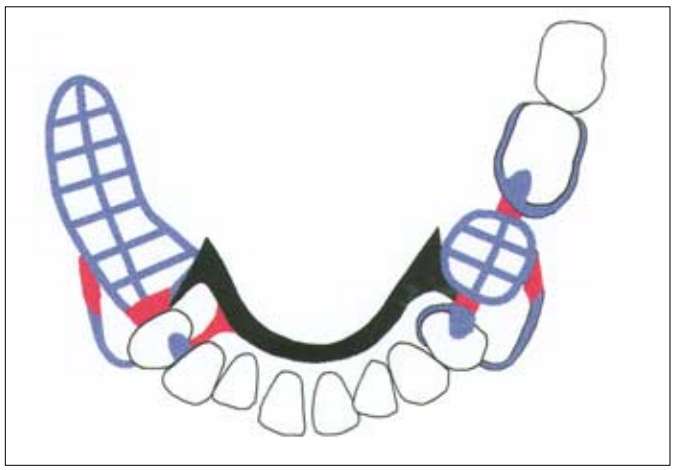

Fig 1 — Connectors

Connectors can be classified as either minor or major. The minor connectors (coloured red) join the small components, such as rests and clasps, to the saddles or to the major connector. In addition, they may contribute to the functions of bracing and reciprocation as in the RPI system (Figure 6.26*). The positioning of the minor connectors joining rests to a saddle will vary according to whether an 'open' or 'closed' design is to be used (Figure 4.9*). The number of minor connectors should be kept to a minimum to conform to the key design principle of simplicity.

The major connector (coloured black) links the saddles and thus unifies the structure of the denture. The remainder of this chapter is devoted to the major connector. The major connector may fulfil a variety of functions. In addition to its basic connecting role it contributes to the support and bracing of a denture by distributing functional loads widely to the teeth and, in appropriate maxillary cases, to the mucosa. It can help to retain the denture by providing indirect retention, by contacting guide surfaces and, in the upper jaw, by coverage of palatal mucosa.

**A Clinical Guide to Removable Partial Denture Design*

Designs of connector for the upper jaw

The choice of the shape and location of connectors is greater in the upper jaw because of the area available for coverage offered by the hard palate.

A decision on choice of connector type is based upon the requirements of:

- Function (eg connection of components, support, retention).
- Anatomical constraints.
- Hygiene.
- Rigidity.
- Patient acceptability.

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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the parts which comprise this series (which will be published in the BDJ) have been included (together with a number of unpublished parts) in the books *A Clinical Guide to Removable Partial Dentures* (ISBN 0-904588-599) and *A Clinical Guide to Removable Partial Denture Design* (ISBN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

Palatal Plate

Fig. 2 — Palatal plate

The basic functional requirement of a major connector is to link the various saddles and other RPD components. In this tooth-supported RPD a simple mid-palatal plate has been used. This is a very satisfactory connector for such situations as it:

- Leaves all gingival margins uncovered.
- Can be made rigid.
- Has a simple outline.
- Is well tolerated as it does not encroach unduly on the highly innervated mucosa of the anterior palate.

Fig. 3 — Palatal plate

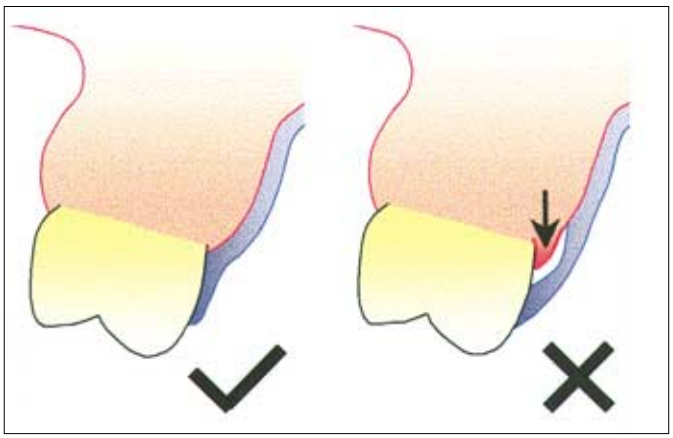
In contrast, the greater extent of the saddles in this tooth–mucosa supported RPD presents more of a support problem. The functional forces can be shared between teeth and mucosa by using a larger connector that extends posteriorly to the junction of hard and soft palates. It is still possible to leave the gingival margins of the majority of teeth uncovered.

Fig. 4 — Palatal plate

Where two or more teeth separate adjacent saddles it is possible to keep the border of the connector well away from the vulnerable gingival margins. Where only a single tooth intervenes between two saddles (eg UR4 (14)) it may not be possible to uncover the gingival margin widely enough to avoid problems of gingival irritation and patient tolerance. However, any opportunity to uncover the gingival margin around even a single tooth should normally be grasped (*A Clinical Guide to Removable Partial Denture Design,* Statement 15.10)

Fig. 5 — Palatal plate

If coverage of the gingival margin by the connector is unavoidable, close contact between the connector and gingival margin should be achieved whenever possible. If 'gingival relief' is created, the space is soon obliterated by proliferation of the gingival tissue; this change in shape increases the depth of the periodontal pocket and thus makes plaque control more difficult.



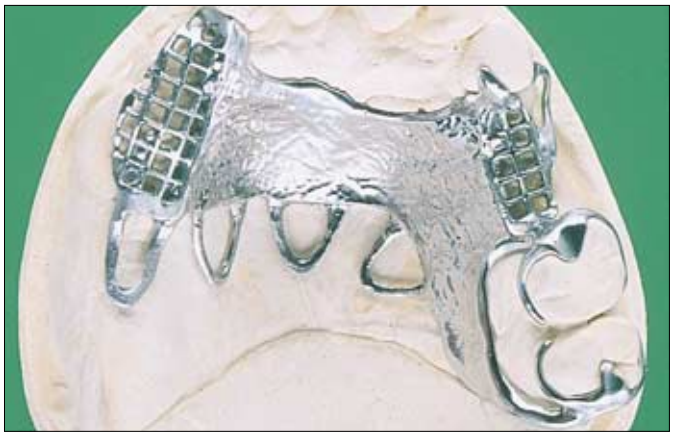
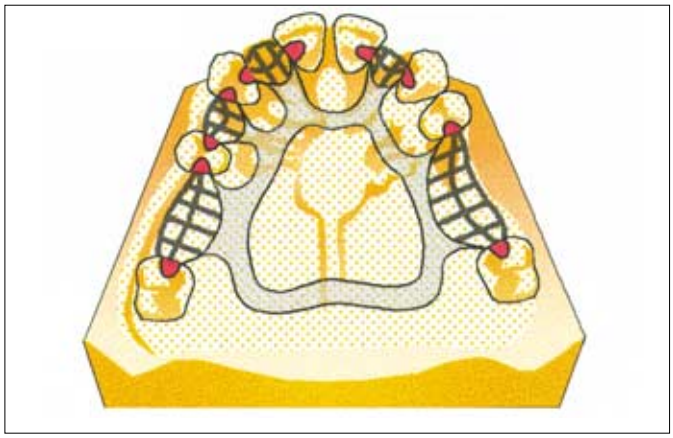


Fig. 6 — Palatal plate
Full palatal coverage with cobalt chromium has two disadvantages. First, the weight of a large metal connector can contribute to displacement of the prosthesis. Second, the position of the post-dam cannot be altered should it prove to be poorly tolerated by the patient. An alternative approach which may possibly be used to overcome these problems is illustrated. The posterior part of the casting has a retaining mesh to which an acrylic extension will be attached.



Ring connector
Fig. 7 — Ring connector
A ring connector, outlined here on a cast, may be used in cases where there are multiple saddles widely distributed around the arch, and where tooth support can be obtained. This connector may also be indicated where a prominent palatal torus would contraindicate a mid-palatal plate.

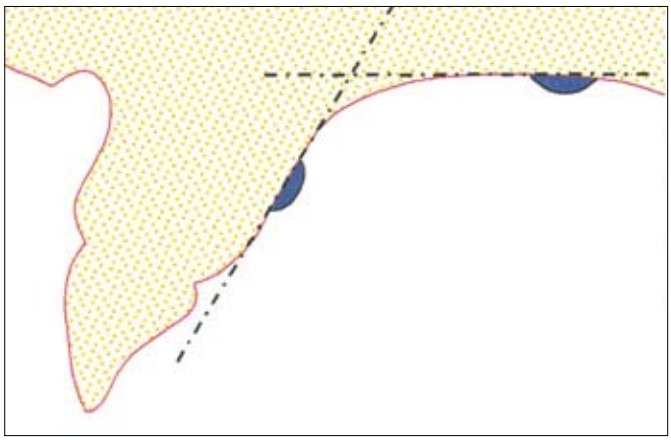


Fig. 8 — Ring connector
The ring connector exhibits good rigidity for a relatively low bulk of metal. This is because the anterior and posterior bars can be positioned in different planes so that an 'L'-shaped girder effect is created.

Although this connector leaves a large area of the palate uncovered, it does have the potential disadvantage that the anterior bar crosses mucosa that is richly innervated and is contacted frequently by the tongue during swallowing and speech. The anterior bar may interfere with these functions and be poorly tolerated as a result. If this design is selected the anterior bar must be carefully positioned and shaped to blend with the contours of the palatal rugae.

Designs of connector for the lower jaw

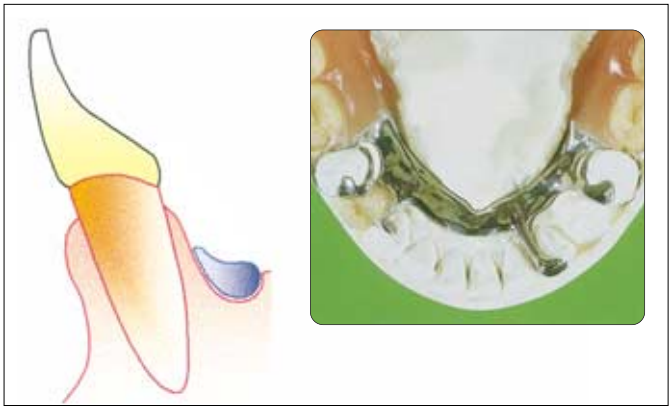
The main anatomical constraint for connector design in the lower jaw is the relatively small distance between the lingual gingival margin and the functional depth of the floor of the mouth. In terms of functional requirements the mandibular connector does not contribute to support by distributing loads directly to the mucosa. It connects the RPD components and can provide indirect retention and guide surfaces.

With gingival recession there is even less room to manoeuvre and it may be difficult to design a connector that satisfies two of the main requirements: maintenance of oral hygiene and rigidity.

Five of the common connectors are illustrated diagrammatically and clinically.

Sublingual bar

Fig. 9 — Sublingual bar



The sublingual bar differs from the lingual bar (see below) in that its dimensions are determined by a specialized master impression technique that accurately records the functional depth and width of the lingual sulcus (*A Clinical Guide to Removable Partial Dentures*, Figs 16.23–16.25). These sulcus dimensions are retained on the master cast so that the technician waxes up the connector to fill the available sulcus width at its maximum functional depth. This results in a bar whose maximum cross-sectional dimension is oriented horizontally.

The rigidity of a lingual bar increases by a square factor when its height is increased and by a cube factor when its width is increased. The increased width of the sublingual bar connector therefore ensures that the important requirement of rigidity is satisfied. This is not invariably the case with a conventional lingual bar.

As the vertical height of a sublingual bar is less than a lingual bar it can be used in shallower lingual sulci and be kept further away from the gingival margins.

Lingual bar

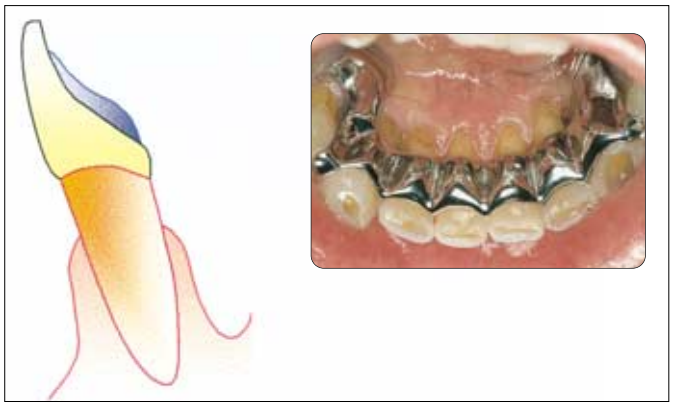
Fig. 10 — Lingual bar

The lingual bar, like the sublingual bar, should be placed as low as the functional depth of the lingual sulcus will allow. The cross-section of the lingual bar is determined by the shape of a prefabricated wax pattern, either prescribed by the dentist or selected by the dental technician. The maximum cross-sectional dimension of this connector is oriented vertically.

Fig. 11 — Lingual bar

If either a lingual or sublingual bar is to be used and additional bracing and indirect retention are required, bracing arms and rests can be incorporated in the design.

There are anatomical constraints in the lower jaw that may prevent the use of sublingual or lingual bars. Mention has already been made of lack of space between the gingival margin and the floor of the mouth. A prominent lingual fraenum may compound the problem and make it impossible to use either of these connectors. A mandibular torus may be of such a size that a sublingual or lingual bar, sitting on top of the bony protuberance, would be excessively prominent, creating major difficulties for the patient in tolerating the prosthesis.



Dental bar

Fig. 12 — Dental bar

On occasions, there is insufficient room between gingival margin and floor of the mouth for either a sublingual or lingual bar. A lingual plate should be avoided wherever possible because it might well tip the delicate balance between health and disease in favour of the latter. An alternative connector, where the clinical crowns are long enough, is the dental bar. Patient tolerance inevitably places some restriction on the cross-sectional area of this connector and thus some reduction in rigidity may have to be accepted.

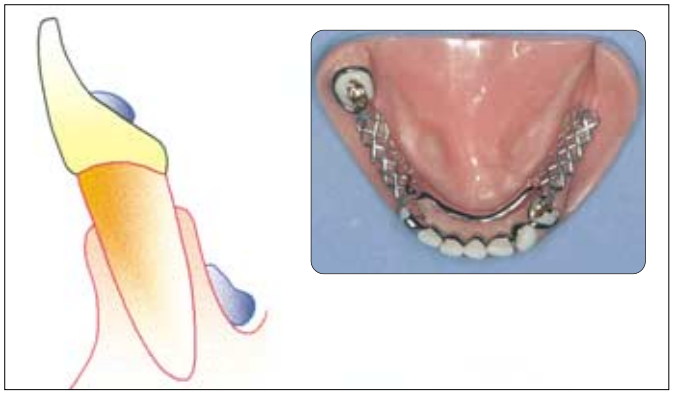


Fig. 13 — Dental bar

Another connector (sometimes referred to as a 'Kennedy Bar' or continuous clasp) consists of a dental bar, combined with a lingual bar. This combination allows the dimensions of each component to be reduced to a limited extent without compromising the overall rigidity of the connector. However, this is a relatively complex design and is best avoided if any of the simpler alternatives are feasible. Tolerance of the patient must be assessed carefully before prescribing either a dental bar or a lingual bar and continuous clasp.

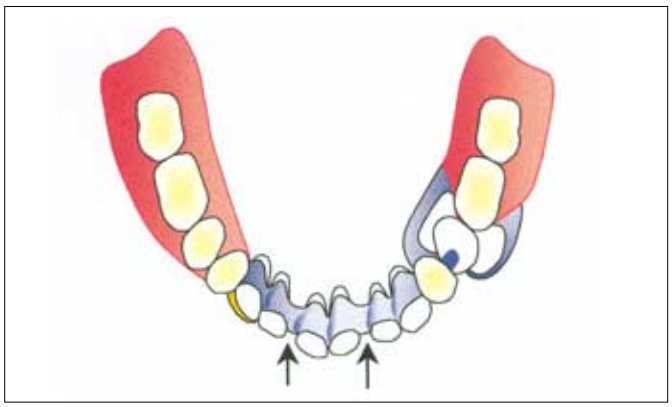
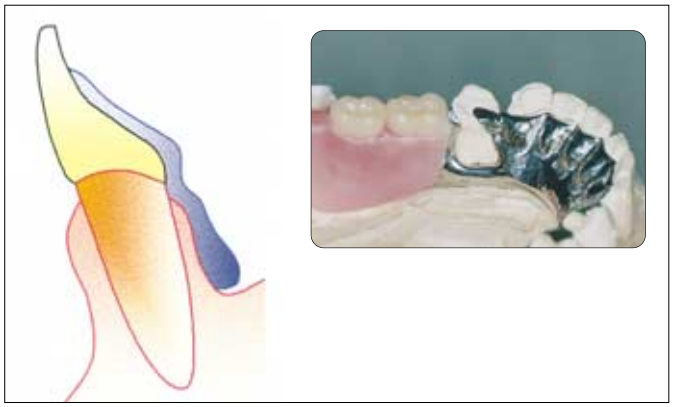


Fig. 14 — Dental bar

Spaces between the incisors are likely to preclude the use of the dental bar or continuous clasp on aesthetic grounds as the metal will show through the gaps (arrows). A sublingual or lingual bar would avoid this problem, although a lingual plate with its superior border notched where it passes behind the spaces is an alternative solution.
If the space is small, composite may be added to the adjacent teeth to close it and allow a dental bar to be used.



Lingual plate

Fig. 15 — Lingual plate

The lingual plate covers most of the lingual aspects of the teeth, the gingival margins and the lingual aspect of the ridge. The plate terminates inferiorly at the functional depth of the sulcus. Rigidity is achieved by thickening the lower border to a bar-like section. One of the major drawbacks of the lingual plate is its tendency to encourage plaque formation. Plaque control should therefore be impeccable before a lingual plate can be prescribed with any confidence.

Labial (or buccal) bar

Fig. 16 — Labial (or buccal) bar

Mention has already been made of lingually inclined teeth creating an obstruction to the insertion of an RPD, and how a change in path of insertion can sometimes avoid this obstruction (*A Clinical Guide to Removable Partial Denture Design,* Figs 3.23 and 3.24). However, on rare occasions the lingual tilt is so severe that it is impossible to use any of the lingual connectors. Under such circumstances a labial (or buccal) bar can be used. The cross-sectional area of the bar is severely restricted by the limited space available and also by patient tolerance.

The combination of limited space for the bar and its increased length as it travels around the outer circumference of the dental arch makes it difficult to achieve rigidity although, in this example, the short spans minimize this problem.

A summary of the functions and essential qualities of the mandibular connectors is presented in Table 1:

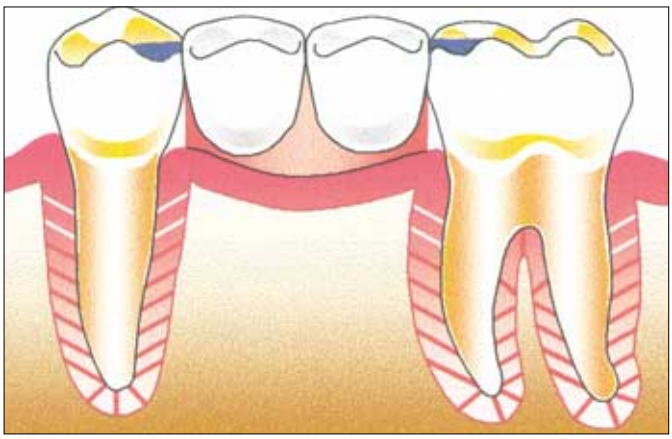
√ Present
? Uncertain
× Absent

Table 1 Summary of functions and essential qualities of connectors

Connector	Connect	Bracing	Indirect retention	Rigidity	Hygiene	Tolerance
Sublingual bar	✓	✗	✗	✓✓	✓	✓
Lingual bar	✓	✗	✗	?	✓	✓
Dental bar	✓	✓	✓	?	✓	?
Lingual plate	✓	✓	✓	✓	✗	✓
Labial bar	✓	✗	✗	?	✓	?

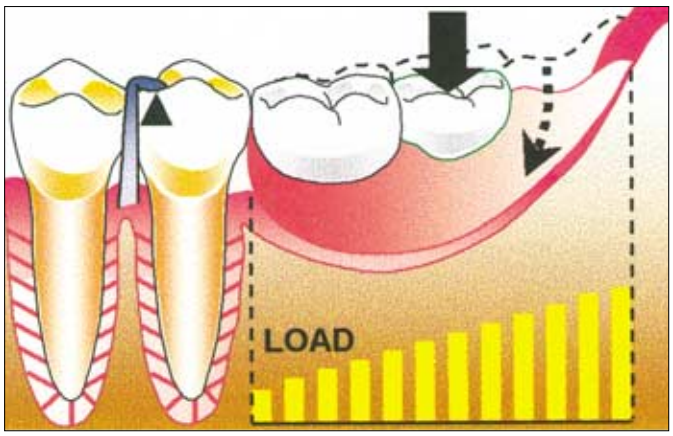
Non-rigid (stress breaking) connectors

Fig. 17 — Non-rigid (stress-breaking) connectors



During loading, a component resting on a tooth will be displaced very much less than one which rests on mucosa. If a denture is entirely tooth-supported, the displacement differential between teeth and mucosa is immaterial. The connector should be designed so that it is rigid and thus distributes the functional forces throughout the structure of the denture and thence to the supporting tissues.

Fig. 18 — Non-rigid (stress-breaking) connectors



A distal extension saddle gains some of its support from teeth and some from the tissues of the edentulous area. This support differential can result in tipping of the denture when it is loaded during function, causing an uneven distribution of load over the edentulous area. It will also result in a relatively greater share of the load being taken by the tooth. One way of minimising the problem is to refine the impression surface of the saddle by using the altered cast impression technique (*A Clinical Guide to Removable Partial Dentures*, Chapter 19).

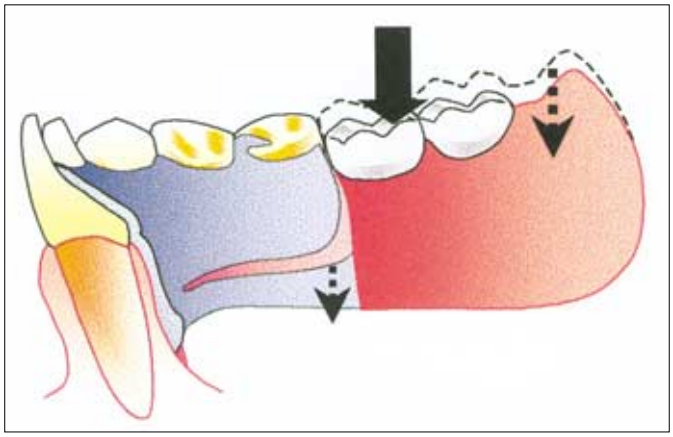


Fig. 19 — Non-rigid (stress-breaking) connectors.
An alternative approach is to create a design with 'independent rear suspension' by using a flexible connector such as this split lingual plate. If the saddle component is able to move more than the tooth-supported component, a greater proportion of the load will be transmitted to the tissues of the edentulous area and will be more evenly distributed. This is the principle on which the stress-broken denture is based and it has been suggested that perhaps it has its greatest application in the lower jaw. However, research evidence suggests that this desired result is not reliably achieved in practice.

Inevitably, the stress-broken design is a more complex construction and thus more costly. It may also pose greater demands on plaque control and be less well tolerated by the patient. The use of a rigid connector may make it easier to design a simple shape. For these reasons it is our preference to design distal extension saddle RPDs that incorporate the following:

- A rigid connector.
- Control of the load distribution to the various tissues by:
  – reducing the area of the artificial occlusal table,
  – maximising coverage of the edentulous area,
  – employing the altered cast technique,
  – using one of the more flexible clasp systems,
  – instituting a regular maintenance programme.

Acrylic dentures

Although this book is primarily concerned with the design and construction of dentures with cast metal frameworks, there are occasions when it is appropriate to provide dentures made entirely in acrylic resin.

The main advantages of acrylic dentures are their relatively low cost and the ease with which they can be modified. They are therefore most commonly indicated where the life of the denture is expected to be short or where alterations such as additions or relines will be needed. Both these reasons may make the expense of a metal denture difficult to justify.

Indications for such treatment include the following:

1. When a denture is required during the phase of rapid bone resorption following tooth loss, for example an immediate denture replacing anterior teeth. In this case a reline followed by early replacement of the denture is to be expected.
2. When the remaining teeth have a poor prognosis and their extraction and subsequent addition to the denture is anticipated. A transitional denture may be fitted under such circumstances so that the few remaining teeth can stabilize the prosthesis for a limited period while the patient develops the neuromuscular skills necessary to successfully control a replacement complete denture.
3. When a diagnostic (or interim) denture is required before a definitive treatment plan can be formulated. Such an appliance may be required, for example, to determine whether the patient can tolerate an increase in occlusal vertical dimension required to allow effective restoration of the dentition.
4. When a denture must be provided for a young patient where growth of the jaws and development of the dentition are still proceeding.

In addition, acrylic dentures may also provide a more permanent solution; for example, where only a few isolated teeth remain an acrylic connector may function just as effectively as one in metal.

Fig. 20 — Acrylic dentures
Where an acrylic denture is provided as a long-term prosthesis it is particularly important that its potential for tissue damage is minimized by careful design. This is easier to achieve in the upper jaw where the palate allows extensive mucosal coverage for support and retention without the denture necessarily having to cover the gingival margins. A popular form of design for the replacement of one or two anterior teeth in young people is the 'spoon' denture. It reduces gingival margin coverage to a minimum, but a potential hazard is the risk of inhalation or ingestion.

Fig. 21 — Acrylic dentures

A more stable and therefore more widely applicable design is the modified spoon denture. Here one has the choice of relying on frictional contact between the connector and the palatal surfaces of some of the posterior teeth, or of adding wrought wire clasps.

Fig. 22 — Acrylic dentures.

Another acceptable design is the 'Every' denture which can be used for restoring multiple bounded edentulous areas in the maxillary jaw. Its characteristics are as follows:

- All connector borders are at least 3 mm from the gingival margins.
- The 'open' design of saddle/tooth junction is employed.
- Point contacts between the artificial teeth and abutment teeth are established to reduce lateral stress to a minimum.
- Posterior wire 'stops' are included to prevent distal drift of the posterior teeth with consequent opening of the contact points. These 'stops' can also contribute to the retention of the RPD posteriorly.
- Flanges are included to assist the bracing of the denture.
- Lateral stresses are reduced by achieving as much balanced occlusion and articulation as possible, or by relying on guidance from the remaining natural teeth to disclude the denture teeth on excursion.

When considering whether or not to provide an RPD in acrylic resin, the limitations of the material should be borne in mind. This material is weaker and less rigid than the metal alloys and therefore the denture is more likely to flex or fracture during function. To minimize these problems the acrylic connector has to be relatively bulky. This, in turn, can cause problems with tolerance and offers less scope for a design that allows the gingival margins to be left uncovered.

Another significant disadvantage of acrylic resin is that it is radiolucent so that location of the prosthesis can prove difficult if the denture is swallowed or inhaled.

Acrylic RPDs in the mandible often lack tooth-support making tissue damage highly probable. Such RPDs should therefore be avoided whenever possible.