Bridge design, part two: fixed-movable bridgework

By Paul Tipton BDS, MSc, DGDP (UK)

In the second part of his series on bridge design, Paul Tipton looks at fixed-movable bridgework

There is much evidence in the literature to support the use of fixed-movable designs (Figure 1). As early as 1949 Chayes stated that rigid splinting of teeth was damaging, whilst Morrant (1956) concluded that fixed-fixed bridgework failed more often than fixed-movable bridges in posterior parts of the mouth. Reuter (1980), in a retrospective study, found that longer span bridgework failed more often than short span.

Figure 1: An example of successful crown and bridgework more than five years after placement

RATIONALE FOR USE

Physiological tooth movement, arch position of the abutments and the retentive capacity of the retainers often make a rigid, fixed-fixed bridge a less than ideal plan of treatment (Shillingburg, 1981). Studies in periodontometry have shown that bucco-lingual tooth movement ranges from 56 microns to 108 microns (Rudd, 1964) and intrusion by 29 microns (Parfitt, 1960) and in different directions (Chayes, 1949). This is obviously increased when teeth have lost bone support and have periodontal disease. The movement of an anterior tooth in a labio-lingual direction occurs at nearly 90° to the bucco-lingual movement of a molar tooth, due to the curvature of the arch (Figure 2). Because of these movements and the problems with cementation failure when secondary abutments are used, the use of some form of non-rigid connector has become the first choice of design in many types of bridge.

The non-rigid connector allows a stress breaking connection between retainer and pontic, instead of the usual rigid solder or cast joint. In spite of an apparently accurate fit, the movement of this type of connector is enough to permit individual movement between bridge abutments, thus allowing the stress of any flexing movement on the pontic to be taken up by the periodontal ligament and not the cement lute. The clinician must decide in each case how much movement is allowed between the male and female parts of the joint, and how much strain is therefore taken up by the periodontal ligament of the major retainer. This is accomplished by adjustment of the base of the male attachment (Figure 3). In effect, whilst the male is not contacting the base of the female the bridge is acting as a cantilever, but when the male moves further and contacts the base of the female it then starts to act as a fixed-fixed bridge.

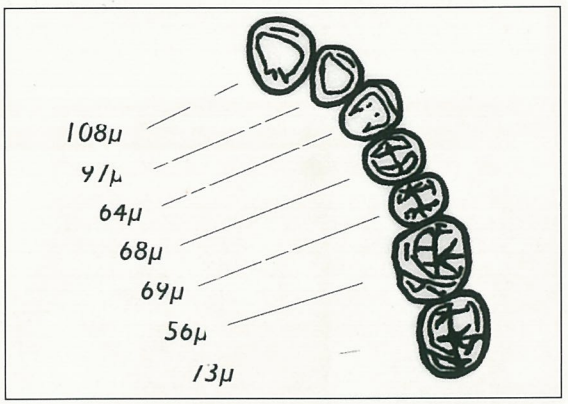

Figure 2: The movement of an anterior tooth in a labio-lingual direction occurs at nearly 90° to the bucco-lingual movement of a molar tooth, due to the curvature of the arch

The use of fixed-movable bridgework should usually be restricted to short span bridges (Markley, 1951), generally replacing one tooth (Figure 4), as the magnification of movement created by an increased span can be too destructive to the abutment tooth under a soldered retainer (Shillingburg, 1981). In certain situations when there are tilted abutments or when posts are incorporated into the bridgework the pontic span may be increased (Figure 5).

The fixed-movable bridge is the ideal bridge design for posterior bridgework except in situations where the abutments are mobile, or there is a long span when the choice is usually fixed-fixed. In cases where the posterior abutment

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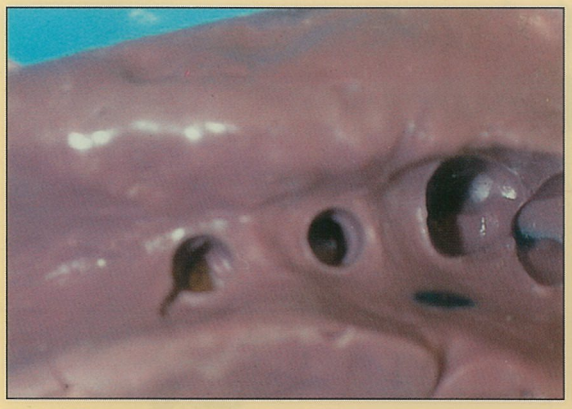
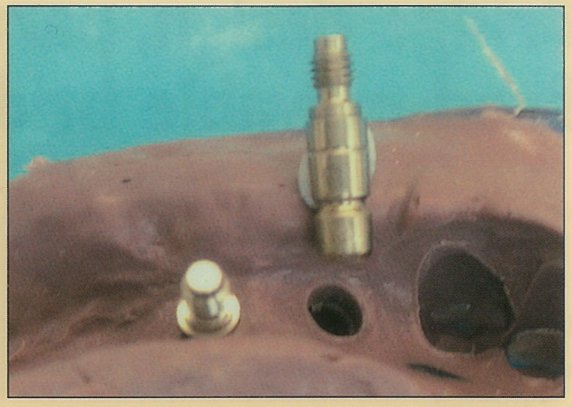
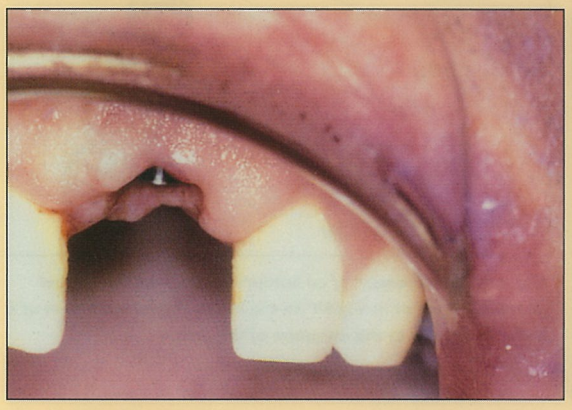
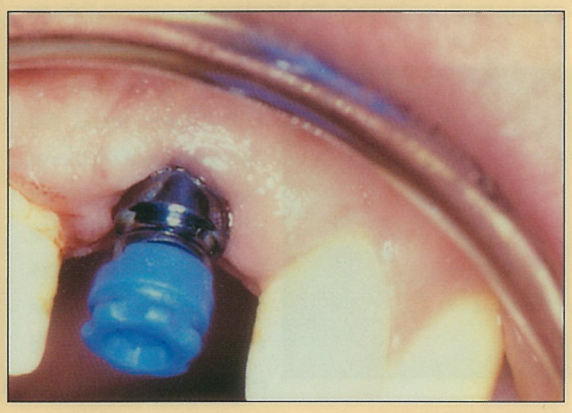




Figures 4a and 4b: Repositioning impression: Short impression posts are removed from the mouth and re-seated into the impression





Figures 5a and 5b: Hybrid technique: A short impression post and a plastic cap are utilised in the Frialit-2 (FRIADENT) system

Special techniques:

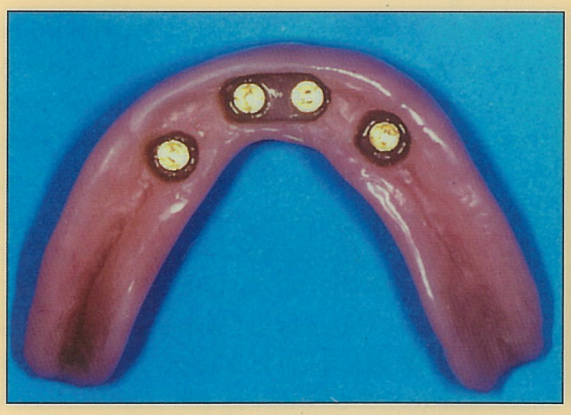
Situations may arise during the maintenance of existing implant-borne prostheses whereby replacement of existing components, or relining of mucosal-borne areas are required. Possibly the two most common scenarios (Figures 6a and 6b) are:

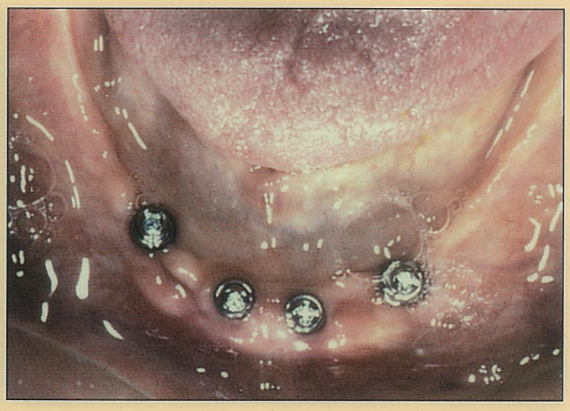
- Relining of a free end saddle overdenture
- Replacement of matrices (studs and clips).

Clinicians are advised to be aware of the inevitable requirement for such procedures following provision of implant-borne overdentures. The patient must of course be informed of the need for ongoing maintenance prior to consenting to treatment.

Readers are recommended to read standard prosthodontic textbooks for details of these particular techniques. ■

Figures 6a and 6b: Maintenance of implant retained prostheses. Saddle areas may require relining and matrices within the denture need to be replaced





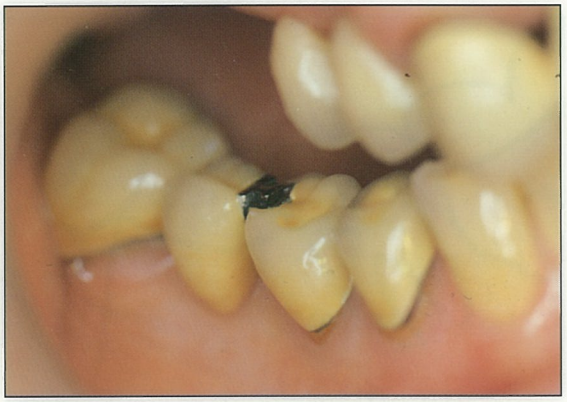


Figure 3 (top left): Adjustment of the base of the male attachment

Figure 4 (top right): The use of fixed-movable bridgework should usually be restricted to short span bridges, generally replacing just one tooth

Figure 5 (bottom left): When posts are incorporated into the bridgework the pontic span may be increased in order to take the stress off the cement lute of the post

Figure 6 (bottom right): In cases where the posterior abutment and pontic are unopposed the fixed-movable should not be used as the posterior section can over-erupt

and pontic are unopposed the fixed-movable should not be used as the posterior section can over-erupt (Figure 6).

JOINT LOCATION

The location of the stress-breaking device is also very important. It should always be placed in the normal distal contours of the anterior or minor abutment (Figures 7 and 8) whilst the pontic should always be attached to the posterior, or major abutment (Figure 9). The long axes of the posterior teeth usually incline slightly in a mesial direction so that vertically applied occlusal forces produce further mesial movement. Picton (1962) showed that 98% of posterior teeth tilt mesially when subjected to occlusal forces. If the female part of the connector is therefore placed on the distal side of the anterior abutment, mesial movement seats the male more completely into the female (Figure 10). This in turn leads to increased stability, less wear of the joint and less chance of the male pulling out of the female attachment.

OCCLUSION

In general an intercuspal holding contact should be incorporated into all units of the bridge including a lighter one on the pontic. The pontic, however, should have no lateral or protrusive guidance placed on it. Should the guidance have to be placed on the bridgework it should be taken up by the abutment teeth, otherwise there will be increased torsional forces

Figures 7 and 8: A stress-breaking device should always be placed in the normal distal contours of the anterior or minor abutment

Figure 9 (left): The pontic should always be attached to the posterior, or major abutment

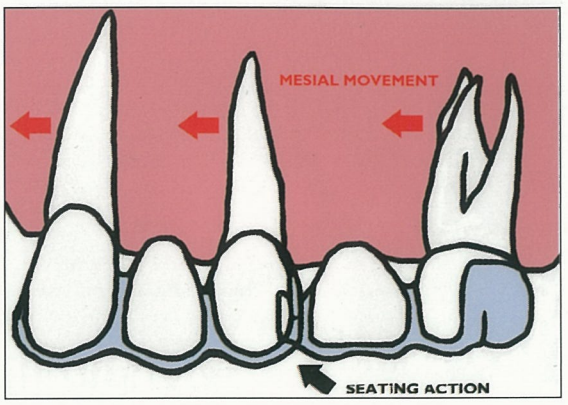


Figure 10 (right): If the female part of the connector is placed on the distal side of the anterior abutment, mesial movement seats the male more completely into the female

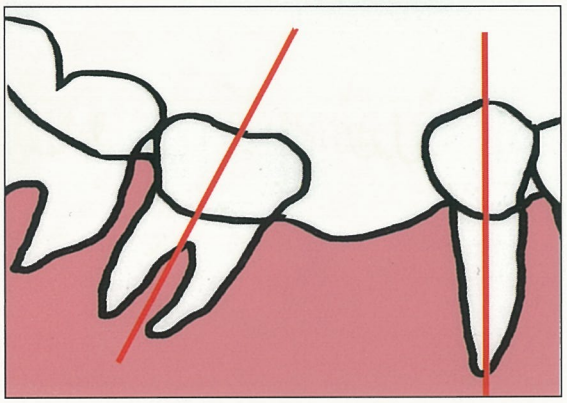


Figure 11: The most common problem is the mandibular second molar tooth abutment which has tilted mesially into the space formerly occupied by the first molar

on individual abutments. This would lead to an increased failure rate.

BENEFITS OF FIXED-MOVABLE BRIDGEWORK: INDIVIDUAL RETENTION

In addition to the stress-breaking element involved in fixed-movable designs, they can be used in situations where there is a problem with tooth alignment. The most common problem is the mandibular second molar tooth abutment which has tilted mesially into the space formerly occupied by the first molar (Figure 11). In such cases it is often impossible to prepare both abutment teeth along their long axes and expect to have a common line of withdrawal and insertion as well as maximum retention of the retainers. This can also be complicated by the presence of a third molar, the mesial surface of which will encroach upon the path of insertion of the bridge, as the path is dictated by the smaller anterior unit. The fixed-movable joint will allow each abutment tooth to be prepared to its maximum retention as the joint will be placed into the anterior abutment fabricated parallel to the distal abutment by the dental technician. Should the molar tooth be severely tilted then the attachment may end up partially extra coronal causing occlusal forces to be directed outside the long axis of the abutment tooth and also potential periodontal problems.

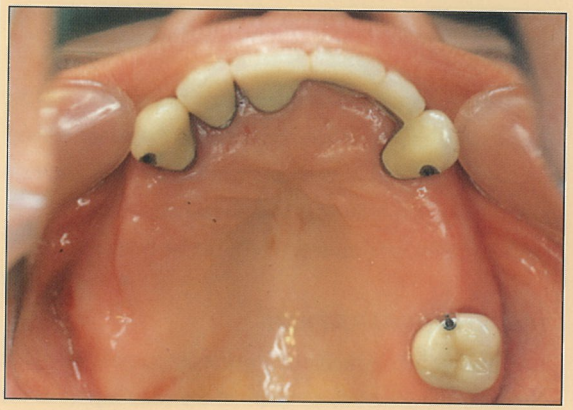
TOOTH CONSERVATION

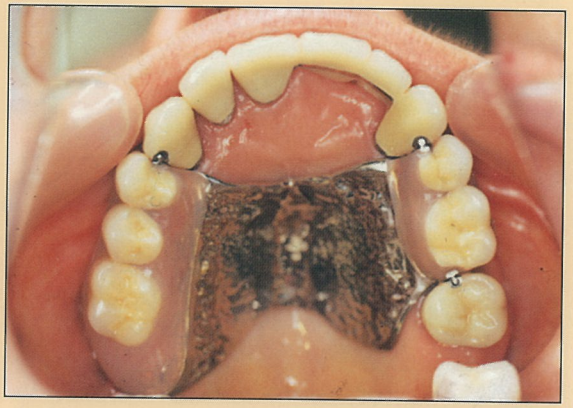
The fixed-movable design will also conserve tooth substance in the above case, since excess tooth need not be removed from the mesial part of the tilted second molar, with the possibility of pulpal exposure. Also, because each tooth is prepared to its maximum retention, a full crown preparation is often not required since the stress on the cement is less with this type of design. Partial veneer restorations (Figures 12 and 13) with all their benefits (Khan, 1960) can be used more often in these situations since each abutment does not have to be as retentive as would be necessary in fixed-fixed designs (Table 1). The partial veneer however is less retentive than the full crown, difficult for most practitioners to perfect and less aesthetic, especially in the lower jaw.

Figures 12 and 13: Partial veneer restorations

TABLE 1:
BENEFITS OF PARTIAL VENEER RESTORATIONS

More conservative
Less pulpal problems
Easier cementation
Reparable margins (supragingival)
Pulp testing is possible
Can be more aesthetic
Technician-friendly





Figures 14 and 15: Where the distal abutment has a dubious prognosis, a slot in the distal aspect of the anterior abutment can be used in the future as an attachment for a stable base denture

CEMENTATION

Cementation can be difficult with long span bridgework involving several abutments. The use of fixed-movable designs can reduce the difficulty, as each part of the bridge can be cemented separately, with different cement mixes, if required.

SERVICEABILITY

Fixed-movable bridgework also allows a certain amount of serviceability. Where the distal abutment has a dubious prognosis a slot in the distal aspect of the anterior abutment can be used in the future as an attachment for a stable base denture (Figures 14 and 15) if the distal abutment tooth has to be extracted. Alternatively, placing an attachment into the distal aspect of a crown allows it to serve as a bridge abutment at some stage in the future should the tooth or teeth directly behind it fail.

USE IN THE ANTERIOR REGIONS

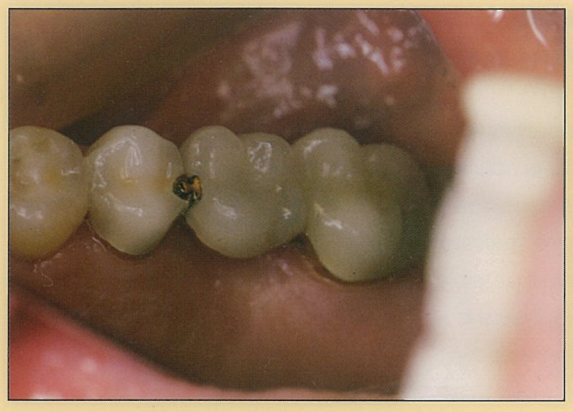
There are few advantages in using fixed-movable connectors as stress breakers in the anterior region because the joint is often not long enough and the forces act laterally, not down the long axis of the teeth. For this reason anterior bridgework is usually a fixed-fixed or single cantilever design. If, however, teeth are tilted and a single path of insertion cannot be prepared for both teeth than the attachment can be used to join both abutments and pontic together.

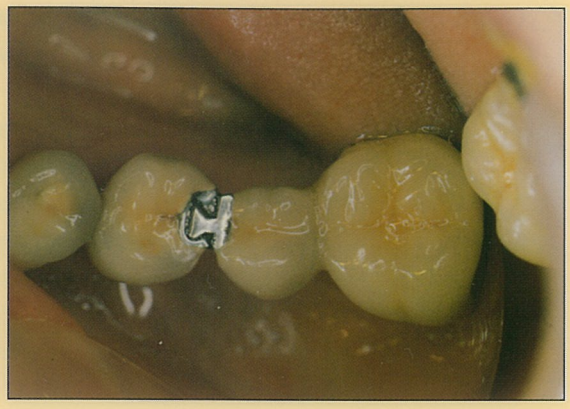
TYPE OF ATTACHMENT

The most commonly used non-rigid design have a T-shaped, rounded or triangular male portion (Figures 16 and 17), attached to the pontic and a dovetail keyway (female) placed within the retainer. This is usually available in the form of semi-precision plastic attachment (Figures 18) which the technician waxes into the contours of the crown and pontic before casting. These slots can also be hand cut or milled. They are usually parallel in design (as opposed to tapered) to offer more retention and rigidity as any vertical unseating movement of the male from the female in a tapered slot means immediate loss of retention and rigidity.

SPAN LENGTH

The length of the slot is determined by the height of the anterior abutment and also the degree of rigidity required in the bridge. The longer the slot, the more rigid the bridge joint (Figures 19 and 20). There are occasions when a more rigid connector may be required, as, for example, when increasing span length, by the incorporation of further pontics. A more rigid attachment at the anterior end will reduce the potential for overloading the distal abutment. In this case a reciprocal arm can also be attached to the lingual side, in order to





Figures 16 and 17: The most commonly used non-rigid designs have a T-shaped, rounded or triangular male portion

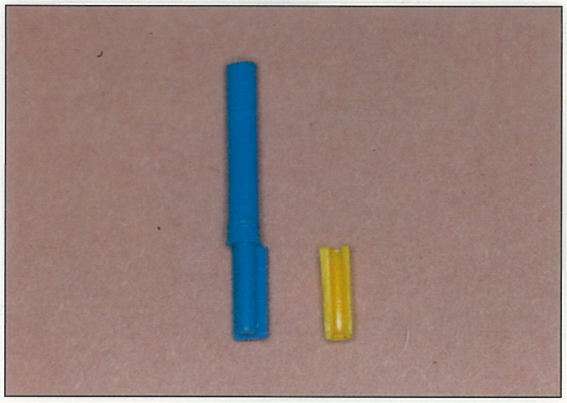


Figure 18: A semi-precision plastic attachment

increase the rigidity allowing it to act in a more fixed-fixed manner, by increasing the surface area of metal to metal contact (Figure 21).

LOADING CRITERIA

When excess loading is to be avoided on a particular tooth, the fixed-movable joint can be designed to limit the loading accordingly. When a root-filled, post-crowned tooth acts as the anterior or minor retainer for example, it is often advisable that the posterior or major retainer takes up more of the load, so that only when fully loaded does the minor retainer take up the progressive loading. In this way some of the problems of using post-crowns as bridge retainers with their inherent poor retention (Roberts, 1970) can be overcome.

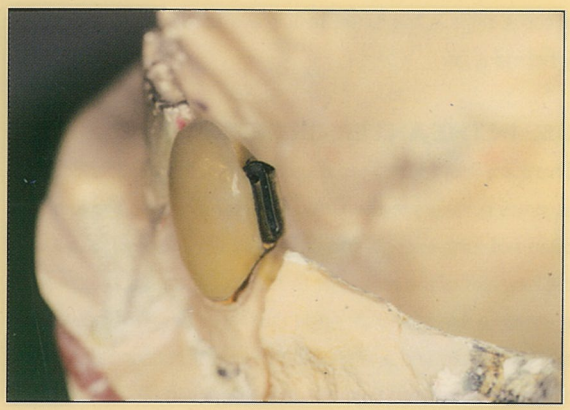
TOOTH PREPARATION

It has already been stated that - wherever possible - the joint should lie in the normal contours of the distal aspect of the anterior retainer. This requires the clinician to cut a box type preparation feature into the distal aspect of the anterior abutment tooth in order to house the female part of the slot (Figure 22). If this is not done then the attachment will be acting in part as an extra-coronal attachment and vertical forces will not be directed down the long axis of the tooth. Moreover the distal overcontouring resulting from this situation may produce a stagnation area which is difficult to keep clean.

CONCLUSIONS

One of the major failures of bridgework is because of cementation failure. The fixed-movable bridge design is the optimum

Figures 19 and 20: The longer the slot, the more rigid the bridge joint



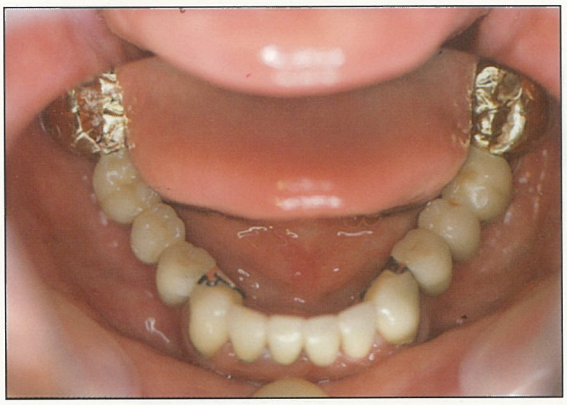


Figure 21: A reciprocal arm can also be attached to the lingual side in order to increase the rigidity, allowing it to act in a more fixed-fixed manner

Figure 22: The joint should lie in the normal contours of the distal aspect of the anterior retainer

choice of bridge design for the shorter span posterior bridge allows biting forces to be taken up by the periodontal ligament rather than the cement lute (Figures 23 and 24).

The next article in this series will concentrate on fixed-fixed bridgework designs. ■

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Figures 23 and 24: The fixed-movable bridge allows biting forces to be taken up by the periodontal ligament rather than the cement lute