Bridge design, part seven: adhesive bridgework

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Paul Tipton discusses the advantages and shortcomings of resin-bonded prostheses in bridgework

An analysis of the literature regarding resin-bonded prostheses is more straightforward than that concerning conventional fixed partial dentures. Most resin-bonded prostheses are single-tooth replacements, and reported results are not as influenced by large prostheses as they are with conventional replacements.

The same criteria of bridge design apply equally to adhesive bridgework as conventional bridgework, such as retentional requirements, occlusion, and hygiene etc.

FAILURE

Dislodgement is the overriding cause of failure of resin-bonded replacements (Al-Shammery, 1989; Hussey, 1991) and if double abutments are used this can lead to rapid caries (Figures 1 & 2). Results suggest that overall long-term retention may be unpredictable: failures ranged from 10% over 11 years (Barrack, 1993) to 54% over 11 months (Hansson, 1994). Creugers (1991) reported promising early results, but extended evaluations showed inconsistent success rates. Short-term data does not accurately predict actual long-term survival of these prostheses (Thompson, 1993).

Although combined long-term retention rates of resin-bonded prostheses appear problematic in many reports, certain selected variables show greatly improved success rates. Restorations placed on tooth preparations having definite guide planes, proximal grooves, and occlusal rests performed better than those with little or no preparation (Creugers, 1991). The original concept of reversible resin-bonded fixed prostheses must be reconsidered if predictable retention is to be achieved. Current design parameters require that retainers more closely resemble traditional partial coverage restorations retained by resin cement (Burgess, 1989). Luting agents and metal surface preparation techniques appear to have significant effects on retention rates. Panavia EX (Morita, Japan) coupled with aluminium oxide abraded retainers showed improved retention (Hussey, 1991; Barrack, 1993). Cement fatigue as noted by Wood and Thompson (1993) or cement washout as defined by Boyer (1993), might best explain unexpected long-term failure after short-term success.

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SUCCESS VARIABLES

Occlusal forces, enamel surface area, and isolation feasibility are factors that probably contribute to

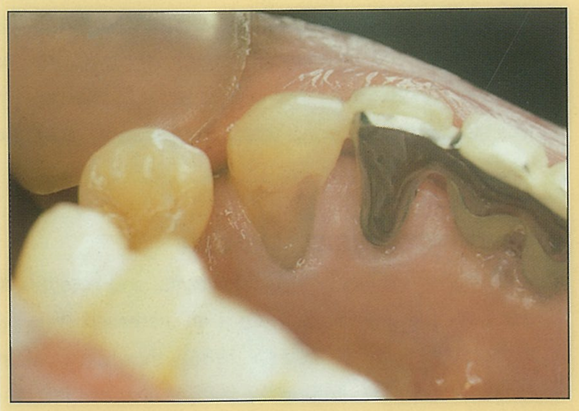


Figure 1: Rapid caries beneath the retainer

Figure 2: Carious exposures under the metal wings

Figure 3: Lingual tooth preparation

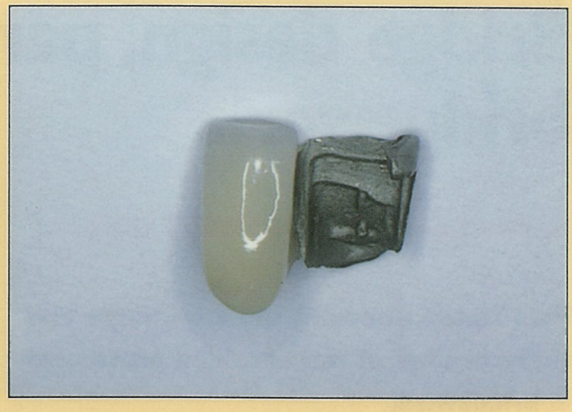


Figure 4: Metal wing design showing retention features

Figure 5: Cantilever bridge on the silver die showing seating strut over the incisal edge

Figure 6: Lingual view

Figure 7: Incisal view when cemented in the mouth

divergent success rates in specific locations in the arch. Maxillary anterior prostheses demonstrate the highest retention rates, (Verzijden, 1994). Prostheses placed later in experimental periods usually fared better than those initially seated, indicating that operator skill and experience are influential variables (Creugers, 1991). Proper patient selection and treatment planning can result in clinically acceptable retention rates, if the potential frailties of resin-bonded prostheses are realised and avoided.

CANTILEVER DESIGN

Chang (1991) has reported increased failure rates when the number of pontics or retainers in an adhesive bridge were increased. This would suggest that adhesive bridgework is ideally suited to cantilevered bridges where there are small spans and only one pontic and abutment. Designs for adhesive anterior cantilevered bridgework are broadly the same as for conventional anterior cantilevers, the contraindications being abutment teeth that present a reduced enamel surface available for bonding (Tay, 1988). The retentional demands on the adhesive wing in a cantilever situation are not as great as in a fixed-fixed situation. Therefore, tooth preparation may not be as critical in the upper jaw where the cement is under compression as opposed to the lower jaw where, because the cement lute is under tension, tooth preparation may be required (Figures 3 to 7).

POSTERIOR BRIDGEWORK

In posterior bridgework the functional and retentional demands are greater as there is an increased chewing force posteriorly (Lundgren 1986), thus preparation techniques for maximising the surface area are increasingly important. This can lead to an increase in the amount of metal shown and decrease in the degree of

Figure 8: Failing composite bridge

Figure 9: Porcelain inlay preparations

Figure 10: Final porcelain adhesive bridge

acceptance by patients because of poor aesthetics. This has lead to the use of the all-ceramic adhesive bridge (Figures 8 to 10). There are no long-term studies on this style of bridge, only anecdotal case studies and so their use can only be considered experimental at this stage.

A further problem with posterior cantilevers is the amount of tooth intrusion that occurs during function. In the situation of a fixed-fixed adhesive bridge where there is no occlusal coverage, the opposing tooth can contact the tooth structure of the abutment tooth. This can lead to functional loading of the tooth encompassed by the adhesive retainer which, in turn, can lead to excess tensile stress on the bond as the tooth wants to intrude during this loading. Fatigue failure of the resin bonded cement lute can lead to debonding in this situation. Full occlusal coverage is therefore recommended for posterior fixed-fixed adhesive bridges in order to stop this intrusion.

FRAMEWORK DESIGN

Northanson (1980) stated that the metal framework should be thick enough to prevent flexing of the metal wings but no thinner than 0.3mm. Al-Shammery (1983) found that nickel-chromium beryllium alloys had a higher bond strength to composite than purely nickel-chromium alloys but that there were problems with the carcinogenic nature of beryllium. Ideally for a definitive restoration the metal framework should not be perforated for retention, but the retention should come from sandblasting the framework with aluminium oxide. However, a perforated framework is an ideal restoration for provisional adhesive bridgework, where the definitive plan may be implants in the future. The perforated framework allows easier removal and recementation when required (Figures 11 to 15). The size of the aluminium oxide also appears to play a part with, 110 micron and 250 micron grit size being better than 50 microns (Wiltshire, 1986).

PREPARATION

Tooth preparation is often required for adhesive retainers especially when the bridge will have a fixed-fixed design with the accompanying increased retentional demands this brings to the abutment teeth. This is usually in the form of intra-enamel guide planes, finish lines, grooves and steps (Figure 16). The goal is to produce a retentive preparation with resistance form so that as much stress as possible is removed from the cement lute. One groove placed palatally into dentine also increases resistance form and rigidity by increasing macro-retention (Flood, 1989) whilst a pin preparation has often been advocated. Tooth preparation also exposes a subsurface layer of enamel that is more reactive and allows better bonding (Schnieder, 1981). The incorporation of two proximal grooves (in dentine), wrap around and occlusal rest seat can give the same retention to the adhesive wing as a three-quarter crown (Burgess 1989).

HYBRID DESIGNS

These designs incorporate a conventional retainer and

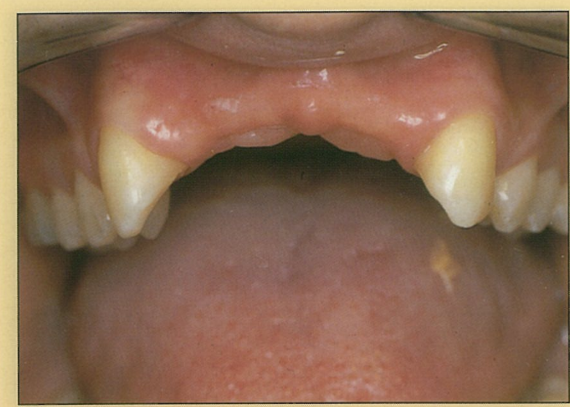


Figure 11: Loss of four anterior teeth

Figure 12: Rochette bridge on the model

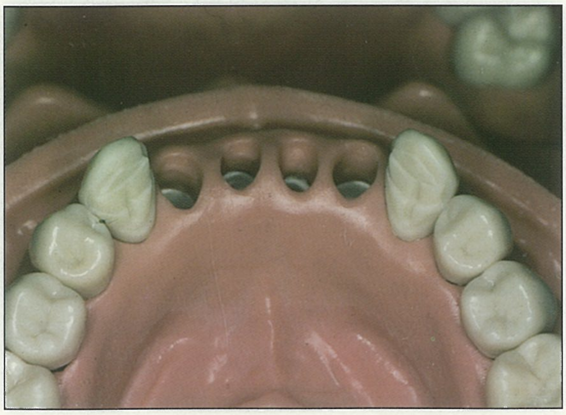
Figure 13: Close up of Rochette bridge with pink porcelain

Figure 14: Bridgework tried in the mouth

Figure 15: Bridgework cemented in place

so it is impossible for the male portion to touch the base of the female (bottom out) under any loading. Should this not be done and the weaker acid-etch retainer fail due to cement failure, it would not be able to drop off and be recemented as the male portion would hold the female in place, allowing caries to rapidly occur. This is an essential fail-safe for this type of design. In essence, then, the bridgework is held together by two parallel sided surfaces with a frictional element stopping excessive strain

Figure 16: Tooth preparation features on phantom head during teaching procedures



an acid-etch retainer in the same bridge design. These bridges should be used as fixed-movable not as fixed/fixed designs so that excess stress is not built up in the weaker, etch-retained cement lute, causing it to fail. There is however, a major difference in the design of the fixed-movable joint. The acid-etch retained wing is normally placed on the anterior abutment, and in order to keep the tooth preparation in enamel the traditional intra-coronal slot preparation for a fixed-movable bridge cannot be prepared (Figures 17 & 18). The wing should therefore carry an extra-coronal slot but this time the female slot must also be bottomless

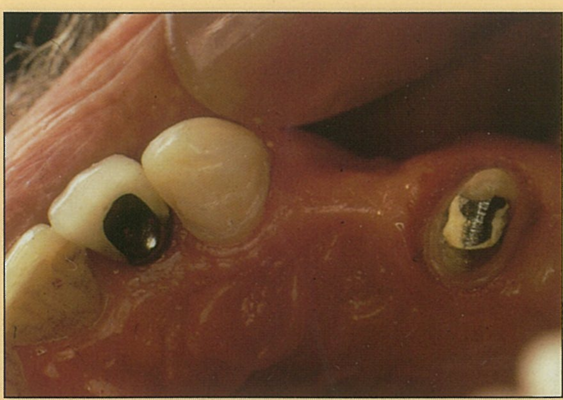


Figure 17: Tooth preparation with no intra-coronal slot for the fixed moveable joint

Figure 18: Impression showing retention features

from being transferred to the major retainer (Figure 19).

Figure 19: Hybrid fixed-moveable adhesive bridge in situ

It is important that the bridgework is first tried in the mouth to assess the fit and path of insertion, especially if there has been no tooth preparation as it can be very easy to slightly malposition the etched retainer. This would then prevent correct seating of the major retainer carrying the pontics and male portion of the attachment. Positioning can also be helped by the incorporation of a 'strut' over the incisal edge of the abutment tooth (Figure 5). Thus a further benefit of tooth preparation is the positive seating gained by the wing on the tooth. The two differing parts should be cemented independently, with the wing carrying the female slot cemented first. In a small study by Chang (1991), 100% success rates were recorded over a four-year period, using this style of bridgework.

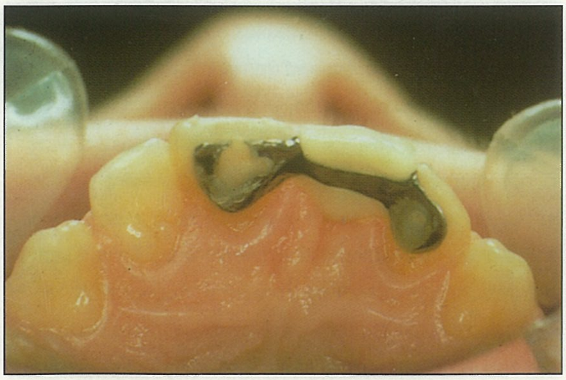
OCCLUSION

It has been shown previously that increasing the number of abutments in an adhesive bridge leads to an increased failure rate. In an attempt to make these types of adhesive bridges more aesthetic by eliminating the greying effect of the incisal edge, there has been the tendency to cut back the metal framework from the incisal edge. This has lead to a better aesthetic outcome but also a reduction in the retention of the retainer, as retention is proportional to the surface area available for bonding.

In upper anterior fixed-fixed adhesive bridgework during excursive movements the initial anterior guidance is usually taken by the metal wings and then onto the natural upper teeth in the incisal edge position. When the framework has been cut back for aesthetics, this movement from metal wing to tooth results in increased stress on the adhesion of the metal wing to the tooth and, in the long term, can lead to breakdown of the bond and the tooth 'walking out' of the bridge (Figure 20).

This is often the cause of failure of this style of bridgework and can be overcome by a change of design. If the bridgework is made of a cantilever design then the stress on the bond during lateral or protrusive movements would be taken up by the periodontal ligament of the tooth and the tooth would move accord-

Figure 20: Poor bridge design leads to the tooth walking out of the bridge



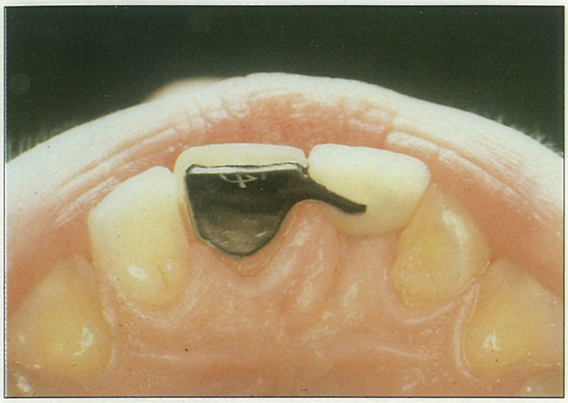


Figure 21: Ideal single cantilever design

ingly (Figure 21) thus dissipating the stress. Alternatively if a fixed-fixed design is required the metal framework should be taken up to the incisal edge not allowing any tooth to tooth contact in excursive movements. Shade matching becomes difficult in this instance and either an opaque resin cement should be used or shade taking should be completed whilst the metal framework is tried in the mouth. This allows the darker incisal edges of the abutment teeth to be reproduced on the pontic.

CONCLUSIONS

Adhesive bridgework has a very unpredictable success rate. If however attention is paid to case selection involving missing single anterior teeth, occlusion and tooth preparation, the success rates can be increased.

The next article in this series will concentrate on the use of gold copings in bridgework.

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