Resin-retained Bridges Re-visited Part 1. History and Indications

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Resin-retained bridges have been used clinically since the 1970s, and offer a more conservative approach to the restoration of edentulous spaces than conventional bridgework. They are easy to place, cheap to fabricate and have been shown to be cost effective. Despite this, they are not frequently used in general dental practice and they have an undeserved reputation for failure.

Since their initial introduction, they have undergone a number of changes to their method of retention, and the materials used in their construction. This has resulted in a predictable, aesthetic restoration which, barring the use of implants, is often the treatment of choice where teeth adjacent to an edentulous space are minimally or not restored.

This first article details the history, advantages, indications, and designs of resin-retained bridges.

**History**

Resin-retained bridges have been used clinically for nearly 25 years, and today are considered to be capable of producing long lasting, aesthetic results (Figure 1). Their success is partly due to the development of better retention methods, appropriate choice of metals for casting and adhesive cements.

**Retention**

In 1955, Buonocore introduced the concept of adhesion in dentistry when he etched enamel with 85% phosphoric acid and attached acrylic resin. This technique has been developed allowing restorative materials to be attached to teeth with little or no tooth preparation. The development of a composite resin containing bis GMA (bisphenol-A-glycidyl methacrylate) by Bowen, produced a filling material which could be bonded predictably to enamel without the problems associated with acrylic.

With these advances in dental technology came a number of techniques to restore edentulous spaces:

- Bonding of extracted natural teeth crowns to adjacent teeth using composite resin.
- Attaching acrylic resin denture teeth with composite to adjacent teeth.
- Attaching composite pontics to adjacent teeth.

Although some of these techniques were moderately successful, a common clinical finding was fracture of composite connectors.

In 1973, Rochette used a perforated type IV gold casting to splint periodontally involved teeth together using self-cured acrylic resin. The application of this appliance to replace missing teeth was quickly seen, spawning the first resin-retained bridge, the Rochette bridge (Figure 2). The main disadvantages of this type of bridge were the limited retention provided by the composite retained metal, the thickening of the metal retainers required to compensate for the weakening effect of the perforations, and the wear of the resin cement.

Other forms of retention have included:

- **Macro/mechanical retention.**
  - Mesh retention. This technique used a mesh within a solid retainer. The retentive area was less than the fit surface area, because the mesh was sealed at...
the margins. Poor castings were common with this technique.

- Acrylic beads. Acrylic beads (0.2-0.3 mm) were placed on the fit surface of the retainer wings, which were then duplicated in the casting to produce mechanical retention.

- Virginia salt technique. Salt crystals (0.15-0.25 mm) were incorporated into wax and removed in solution leaving cubic retentive pits. This was a time saving method compared to the technique of etching. The evaluation of the retentive surface was easier and a greater choice of non-etchable metals could be used. A commercial product, Crystal Bond, which was a combination of salt and acrylic beads used to produce pits and retentive beads on the fit surface of retainers, was produced.

All the above techniques required thickening of the retainers to incorporate the retentive system used, and were poorly retained at their margins due to the retentive feature stopping short of the retainer edges.

**Micro-mechanical retention**

- Etching. This has been carried out by electrochemical and chemical methods. The electrochemical etching technique, developed at the University of Maryland, gave rise to the name ‘Maryland Bridge’. The tiny etching pattern produced was verified by examination under a microscope to ensure it was adequate. Bond strengths were good, but difficulties in calculating times for electrochemical etching, the hazards of chemical etching, and producing uniform etch patterns, led to the use of other methods.

- Sandblasting. This technique used 50 µ alumina to produce a roughened oxide layer over the surface (Figure 3). Sandblasted base metals have been shown to give higher bond strengths than etching or using salt particles, especially when the metal used had an oxide coating and was used with a chemically active resin.

**Chemical bonding**

- Tin coating. The fit surfaces were tin coated electrochemically. Noble metals were mainly used rather than non-precious alloys. Little data was available to show success rates, and the technique when applied to sandblasted nickel-chrome failed to improve bond strengths when compared to sandblasting alone.

**Metals**

Metals used in the construction of resin-retained bridges should possess the following qualities:

- **Rigidity.** Base metal alloys have higher rigidity and hardness than noble metal alloys. This makes them ideally suited to being used in thin section resulting in less bulky retainers. Possible disadvantages include greater wear of opposing natural teeth, difficulty in adjusting the finished metal, and the inability to burnish margins to optimise retainer fit.

- **Accurate when cast.** Noble metal alloys melt at lower temperatures than base metal alloys and therefore shrink less on cooling.

- **Biocompatible.** Gold alloys are biocompatible, whereas base alloys such as nickel-chrome may cause hypersensitivity reactions. Beryllium was originally added to nickel-chrome as it produced a superior pattern when etching was employed. However it is no longer used due to its known carcinogenic potential, and the availability of alternatives to etching.

- **Good bonding to porcelain and resin.** Gold alloys have been shown to bond to porcelain well, but the greater thickness of oxides present following the heating of base metal alloys can be more prone to fail cohesively, resulting in porcelain fracture.

- **Aesthetics.** Base metal alloys may cause greying of anterior teeth due to metal shine-through, although this has been reduced to some degree by the use of opaque cements.

- **Low cost.** Base metal alloys are cheaper than noble metal alloys, hence their widespread use.

The original Rochette bridge was constructed from type IV gold, but the majority of resin-retained bridges made today use a beryllium-free nickel-chrome alloy as a superior material for frameworks.

**Cements**

Resin cements have been used for the cementation of resin-retained bridges to etched enamel since Rochette cemented his periodontal splint using Sevriton (self-cured acrylic resin).

Acrylic resin had the following problems:

- Low compressive and tensile strength.
- High solubility.
- Polymerisation shrinkage.
- Thermal expansion.

These problems were largely overcome by the introduction of bis GMA type composite resins, used to cement the original Rochette bridges.
With new methods of increasing retention of frameworks came better composite resins with smaller filler particles, and better flow properties. The first true breakthrough was the development of the adhesive 4-META (4-methacryloyloxyethyl trimellitate anhydride), which was incorporated into the dental cement Super Bond C & B. Although initially successful, it was found that the high bond strengths obtained decreased over time when immersed in water and following thermal cycling.\(^{22}\)

The development of Panavia-Ex, which contained phosphate monomers, led to predictable bonding, which overcame the problems of Super Bond C & B. Adhesion occurred between the phosphate group in the monomer and the oxide coating of the nickel-chrome, and also via mechanical bonding.\(^{23}\) A study\(^{24}\) carried out with this cement showed that it may be possible to bond strongly to nickel chromium with little or no preparation of metal surfaces. This led to the introduction of sandblasting in combination with adhesive resin cements to retain bridges. This has since been validated in other studies,\(^{15,16}\) and has brought reliable bonding to resin-bonded bridges.

Panavia-Ex has since been superseded by Panavia 21 which is supplied as a two-paste system, unlike Panavia-Ex, which was a powder and liquid. It contains 10-methacryloyloxydecyl di-hydrogen phosphate which produces a strong bond to metal. Both types of Panavia are chemical-cured materials.

### Advantages and Disadvantages of Resin-retained Bridges

#### Advantages
- Conservative. Retention does not rely on conventional retentive features, so little if any tooth preparation is necessary. When preparation is required, this should be restricted to enamel.
- Reversible. Providing there is little or no tooth preparation, the bridges can be removed with minimal damage to the abutments. This feature is helpful when this type of bridge is used as an interim restoration in the young, eg prior to implant therapy.
- Cheap and quick. Laboratory bills are reduced, as well as chair-time.
- Easy to do. Impressions, a jaw registration, and a shade are often all that is needed.
- Patient preference, due to reduced chair-time, cost, and lack of tooth preparation.
- Cost-effective. A recent study has shown the median survival of resin-retained bridges to be seven years and ten months.\(^{25}\) Creugers and Kayser (1992)\(^{26}\) considered resin-retained bridges to be cost-effective if their median survival was greater than 6.5 years.

#### Potential disadvantages
- More frequent de-bond when compared to conventional bridges.
- Resin-retained bridges have an undeserved reputation for failure, partly brought about by poor bridge design and cementation technique. If de-cementation occurs, it is often easy to re-cementation using rubber dam application.
- Aesthetics. Problems can occur with incisal shine-through of metal if an opaque cement is not used. An opaque cement lute may also be more visible. Retainers, if extending onto occlusal or incisal surfaces may also be visible. These can be masked by abrading the retainer surfaces with glass beads. The matt finish produced and lack of reflection makes the metal surfaces disappear into the darkness of the mouth.
- Redistribution of space. When diastemas are present, or pontic space is too large or small, it is often difficult to distribute the space between pontic and abutment teeth. Cantilever or spring cantilever designs may be considered in these cases.
- Limited tooth replacement. Small spans tend to be more successful than larger ones.
- Temporisation/trial prosthesis is not usually possible. This prevents evaluation of aesthetics, guidance, and speech. When bridges are temporarily cemented, re-preparation of both tooth and retainer fit surfaces is necessary.
- Dramatic failure. A partial denture can be made simultaneously to restore function if there is dramatic failure of the resin-retained bridge.
- Poor remuneration. This treatment can be well rewarded in the private sector, but remuneration is poor under the National Health Service. This, combined with scepticism about success from many practitioners, has led to their limited use in general dental practice.

### Indications and Contra-indications

#### Indications
- Un-restored/minimally restored teeth. The highest bond strengths are obtained when metal is bonded to enamel. Minimal exposure of dentine or the presence of fillings, are not absolute contra-indications. Restorations
on abutment teeth should be composite resin, and require replacement prior to taking the impressions for bridge construction.

- Sufficient, good quality enamel. Toothwear (Figure 5a), diminutive teeth (Figure 5b) and certain abnormalities of enamel eg amelogenesis imperfecta, may reduce the quantity/quality of enamel for bonding and therefore the strength of the adhesive bond.

- Sufficient inter-occlusal space for retainers exists. Lack of inter-occlusal space can be overcome by cementing restorations 'high' at an increased occlusal vertical dimension, similar to the appliance developed by Dahl.27 Occusal contacts between the remaining teeth are usually restored in a few months in a young patient and slightly longer, 9-12 months, in an older patient. Bridges cemented this way spare enamel, have been shown to be well tolerated, and have good retention rates.25 This is the preferred method of the authors, and is indicated in most clinical situations apart from:
  - Teeth with little periodontal support or increased mobility. Splaying of abutment teeth may occur, rather than intrusion and compensatory eruption of the remaining teeth. Rotation of abutments may occur when cantilever bridges are cemented high on these teeth.
  - Patients with a large horizontal slide from their retruded contact position, to their intercuspal position. Posterior re-positioning of the mandible may occur in these patients resulting in anterior guidance being lost. Luckily, these cases are rare in clinical practice.
  - 'Occlusally-aware' patients. The harmony in some patients' mouths can be upset by the placement of high retainers. Again, these patients are rare. Patients should be warned that chewing food may be difficult until tooth contacts are restored.
  - Where a resin-retained bridge is an intermediate prosthesis (prior to implants). This is very useful during growth years when implants are contra-indicated.
  - Patient wishes. Some patients are reluctant to have minimally restored teeth prepared.

Contra-indications
- Heavily restored teeth. This reduces the area of enamel bonding.
- Little enamel to bond to. Despite the recent advances in dentine bonding, one still prefers to bond mainly to enamel.
- Poor quality enamel/frequent de-bonds.
- Translucent incisal edges of abutment teeth. These allow shine-through of metal retainers (Figure 6). This may be minimised by the use of opaque cements.
- Excessive occlusal loading. Debonding may occur when occlusal contacts are present on the pontics in excursive movements.
- Difficulty in isolation for cementation to achieve a dry field.

Bridge Design

There are three possible designs based on retainer type and connectors:

- Cantilever (Figure 7)
  Using a single retainer eliminates the problems of partial de-cementation as the patient/dentist is instantly aware of bond failure! This may be seen as a disadvantage because of the dramatic failure. A careful occlusal analysis is required to avoid heavy contact on the pontic, especially on excursive movements, which could precipitate an early failure.

  A cantilever bridge is less expensive than a fixed-fixed resin-retained bridge, but limited to replacing one missing tooth. A diagnostic wax-up should reveal any contacts in excursive movements, which may cause either bond failure or tooth rotation. If orthodontic stability of teeth adjacent to the space is required, this design may be inappropriate.

- Fixed-fixed (Figure 8)
  With fixed-fixed bridges, one or more retainers are placed on either side of the pontic. Differential movement of abutments can result in bond failure, but this can be reduced by making sure opposing teeth only contact retainer wings and not tooth tissue in excursive
contacts, thereby biting the abutments out of the retainer. Double abutments offer no advantages in terms of retention as the weaker abutment retainers are often put under shear forces causing debonding. This can make maintenance difficult. Long spans, e.g. replacing 2312 using 34 as terminal abutments, have been shown to be successful. This design of bridge is indicated where excursive movements on pontics cannot be avoided, tooth stability is required following orthodontic movement, and lack of periodontal support could produce abutment movement.

Hybrid bridges (Figure 9)

This design has both resin-retained and conventional retainers. They are indicated where one of the abutments is minimally restored, and a resin-bonded retainer is used at this site to conserve tooth tissue. Laboratory bills are increased and care should be taken in the location of the connectors to ensure that drifting apart of the joint does not occur. The male part of the joint is often attached to the resin-bonded retainer to simplify maintenance when de-bonds occur, as the resin-retained part of the bridge invariably fails before the conventional retainer. It also enables optimal seating.

References


Proprietary names


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New CDO Appointed

The Department of Health announced the appointment of Professor Raman Bedi to the post of Chief Dental Officer for England on 17th May 2002. Professor Bedi is presently Head, Department of Transcultural Oral Health, Eastman Dental Institute, Professor of Transcultural Oral Health, University College London, Co-Director, WHO Collaborating Centre for Disability, Culture and Oral Health. He qualified at the University of Bristol in 1976. He has held academic posts at the Universities of Manchester, Hong Kong, Edinburgh and Birmingham. He is a specialist in both dental public health and paediatric dentistry. The Faculty welcomes Professor Bedi’s appointment at a crucial time for the profession. Professor Bedi has worked closely with the Faculty in the past and we share his views on oral health equality issues.