INTRODUCTION

Tooth replacement is a common dental need warranting special considerations. Teeth may be missing due to a number of factors which include trauma, congenital conditions, caries, periodontal disease, restoration requirements and failed dental treatments. The common options available for management of missing teeth include conventional fixed partial dentures, dental implants, removable dentures, no replacement and resin bonded fixed partial dentures.

Conventional fixed partial dentures are irreversible options of tooth replacement and require tooth preparation. Preparation sequence when followed requires extensive reduction of the abutments which compromises the vitality of the pulp tissue. Plaque accumulation, inflammation and gingivitis are also reported to occur in teeth restored with conventional crowns & bridges. Removable partial dentures (RPD) restore function and aesthetics to an extent and are cost effective, however problems of poor retention & stability along with plaque retention remain with them and they may not be the treatment of choice for most individuals. Whilst removable prosthesis becomes loose and unstable with time, dental implants can provide support for both removable and fixed prosthesis which are both aesthetic and durable. However, implants require clinical expertise, circumferential bone, long-term maintenance, increased expense and cannot be placed in growing individuals and patients with medical contraindications.

Dentists may hesitate to provide resin bonded metal restorations because of the fear that the restorations might fail. However, dental literature has a number of studies outlining the improved clinical performance of resin bonded bridges. These restorations have shown survival rates that are acceptable in view of minimally invasive techniques. Creugers et. al., 1991 reported 75% survival rates for the anterior RBBs over a period of 7.5 years. Long term median survival rates of 7 years and 10 months were reported by Djemal et.al. and similar success rates were also reported by Hussey & Linden. Boyer et. al. also demonstrated that resin bonded bridges can provide predictable long term clinical service. RBBs are considered useful alternatives to conventional crowns and bridges but debonding has been considered as main disadvantage of these restorations. However if sufficient coverage over the abutment teeth is provided, proper case selection is done and the occlusal considerations are understood during their fabrication, these restorations offer good clinical performance whilst being conservative.
There is no standard registered body to give a number of RBB’s fabricated or fitted in Pakistan. After an online search of journal database in Pakistan (www.pakmedinet.com), we were unable to find published statistical facts related to the percentage of usage of RBB’s in teaching institutes or private practices in Pakistan. This makes it impossible to factually comment on the clinical use of these restorations and in some way reflects the inferior understanding and under usage of these indirect restorations. This paper will present the factors vital in clinical success of RBBs and two cases to demonstrate their clinical application and treatment sequence.

FACTORS VITAL FOR CLINICAL SUCCESS OF RESIN BONDED BRIDGES

The clinical success in the provision of resin bonded bridges is multifactorial and these are discussed as follows.

a) Case Selection

Patients with para-functional habits can cause excessive occlusal loading and increased demands on the cement lute. Similarly, short clinical crowns in patients with tooth surface loss, microdontia and hypodontia, teeth which are heavily restored, and with abnormalities of enamel or with exposed dentine surface reduce the amount of enamel for adhesive bonding. Due to rapid developments in bonding to enamel and dentine, techniques and materials, the above mentioned conditions are although not absolute contraindications for Resin Bonded Bridges but extra precautions should be taken in the design of connectors and retainers, and bonding techniques. Patients should also be consented and those with parafunctional habits provided with an hard acrylic splint for night time wear.

b) Bridge and Connector design

There are three possible designs of a bridge based on retainer type and connectors.

- Cantilever RBB
- Fixed-fixed RBB
- Hybrid bridge

Tay and Shaw\(^1\) in the year 1982 suggested that where single missing anterior teeth were being replaced with adhesive (Rochette) bridges then single unit cantilever worked best. However in a study\(^2\) of 832 resin retained bridges and splints, the median survival for fixed-fixed designs was 7.8yrs whereas the median survival for cantilever designs was 9.8yrs.

The movement allowed within the periodontal ligament space of the abutment tooth together with the attached bridge is responsible for the improved performance of cantilever resin bonded bridges compared to fixed-fixed RBB. In a fixed-fixed resin bonded design the opportunity for such free movement is lost as the abutment teeth are splinted together by the rigid framework. As a result of this differential abutment movement, if one retainer debonds, the bridge will still remain in situ and the carious destruction of tooth tissue may go undetected for some time. However, using a single retainer eliminates the problem of partial decementation as the bond failure is instantaneously obvious. This may also be seen as a disadvantage because of dramatic failure.

However, it is suggested\(^3\) that it is too simplistic to assume that longevity is automatically associated with cantilever design. It was proposed\(^4\) that the increased success associated with cantilever bridges is related to their selection in relatively ‘safe’ situations i.e. where occlusal demands are modest and the stability of the abutment is predictable. However the ambitious use of cantilevers simply to avoid a fixed-fixed alternative is cautioned. In situations where the span is of such a length that an abutment is needed at each end, or where the occlusion is more complicated and excursive movements on pontics cannot be avoided, or where tooth stability following orthodontic movement is required then a fixed-fixed design is indicated. A vital factor in decreasing the risk failure is also to eliminate sliding contacts across the tooth-retainer junction as this could result in tensile forces between the tooth and retainer, increasing the risk of failure.

A conventional fixed movable-bridge has a rigid connector usually at the distal end of the pontic, and a movable connector on the mesial abutment tooth. It is thought that the fixed-movable design exerts a ‘stress-breaking’ effect, reducing the demands on the minor retainer and allowing the abutments to retain a degree of independent axial mobility. In reality whether this happens or not has yet to be proven and there are no studies that demonstrate increased longevity when utilising a fixed-moveable design. With regard to resin bonded bridgework the use of fixed-movable designs should be limited to hybrid bridges.

c) Retainer design & coverage

Resin bonding a cast framework was originally described by Rochette\(^5\) and employed as a periodontal splint. This was based on macro mechanical retention. Howe and Denehy\(^6\) adapted this concept for a resin bonded bridge with perforated retaining wings. Such restorations have become known as Rochette bridges. Livaditis and Thompson\(^7\) superseded this design with an improved
renders the process irreversible. The very concept of resin temporization, makes removal of bridges difficult and caries with undetected de-bonding, difficulty in enamel have increased. Preparation results in sensitivity, bonding, preparation of teeth with slots and grooves in preparation. However due to perceptions of increased de-bonding, relative axial tooth movement, adjustments of the antagonists, preparation of the abutment.

d) Framework alloy:
The Ideal Properties for metals alloys in case of resin bonded bridges are optimum modulus of elasticity, casting, bonding to ceramic, bonding to resin cements, biocompatibility and acceptable aesthetics. Nickel chromium is preferred over type IV gold as it shows greater bond to resin cements, is less expensive and increased in rigidity. Nickel chromium is preferred over type IV gold as it shows greater bond to resin cements, is less expensive and increased in rigidity.

e) Occlusal management
Management of the occlusion is important in the success of cantilever bridges. A careful occlusal analysis is required to avoid heavy contact on the pontic especially in excursive movements which could cause bond failure or tooth rotation. In situations where occlusion is more complicated and excursive movements on pontics cannot be avoided then a fixed-fixed design is indicated.

Adhesive retainers generally require at least 0.7mm of space between abutment teeth and their antagonists, if resistance of the framework to flexure is to be adequate. Often it is necessary to create space for the framework. There are a number of ways of creating space:

- Preparation of the abutment
- Adjustments of the antagonists
- Relative axial tooth movement

f) Tooth preparation
Initial trends in resin bonded bridges were of non-preparation. However due to perceptions of increased de-bonding, preparation of teeth with slots and grooves in enamel have increased. Preparation results in sensitivity, caries with undetected de-bonding, difficulty in temporization, makes removal of bridges difficult and renders the process irreversible. The very concept of resin bonded bridges is conservation of tooth structure, which is lost with tooth preparation. It is established that interfacial bond strength of resin cements to enamel is far greater than dentine, as a result dentine exposure needs to be avoided during tooth preparation. Use of proximal grooves (1 to 3 mm), is becoming come practice for better retention and resistance form of preparations. Other preparation features include rest seats for a seating stop and resistance to displacement, parallel proximal surface preparation or guide planes to increase connector height and develop path of insertion, palatal or lingual reduction for space of metal retainer and axial reduction supragingival margins allowing for 180° wrap around of the retainer to abutment tooth. However, there is no evidence to suggest that tooth preparation provides greater success rates and to date no comparable data is available. Therefore, a balance needs to be established between decreased risk of de-bonding and caries development in case of undetected partial failure.

g) Pontic design
Initially, investigators thought that the pontic material may have been an important factor in the aetiology of inflammatory changes beneath bridge pontics. In a further investigation the plaque retaining capacity of four dental materials was assessed. They found that the plaque retaining capacity of porcelain and acrylic was significantly different to type III gold and ceramo-metal. Therefore, porcelain and acrylic were easier to clean though all could be cleaned in time. In addition to that, pontic surfaces should be a smooth as possible to prevent them from being plaque retentive.

The most important features of pontic design are therefore related to its cleansability. Poor cleansability around pontics can lead to plaque accumulation and hence soft tissue inflammation. Proper oral hygiene instruction to the patient and the cleansability of pontics is more important than the choice of material. Therefore, pontics should have passive tissue contact with a convex, smooth fit surface and adequate embrasure space to facilitate cleaning.

h) Periodontal considerations
The periodontal health of the remaining teeth should always be optimum before bridgework is commenced and this should be maintained after the bridge is constructed. Aspects of bridge design that have implications for the periodontium need to be considered, which include overcontouring, undercontouring, surface finish, cleansable embrasures, optimum marginal fit, adequate cement lute finish and polish, a favourable pontic-soft tissue contact and ideal proximal contact points. An over contoured
restoration may cause plaque accumulation and gingival inflammation and the margins should be placed supragingivally\(^1,20\).

Good periodontal health is dependent on the patient’s ability to control plaque, and restorations should provide optimum access for oral hygiene. Overcontoured restorations in the embrasure region leave insufficient room to accommodate an oral hygiene aid. In case of teeth with poor periodontal support when using relative axial tooth movement, splaying of abutment teeth may occur rather than intrusion or compensatory eruption of the remaining teeth. Teeth with active periodontal inflammation (gingivitis, periodontitis) render the prosthodontic treatment almost impossible due to presence of increased fluids and bleeding during tooth preparation, impression taking and restoration fit.

i) Aetiology Of Tooth Loss

The cause of tooth loss or absence can be an important factor in successful function of resin bonded bridges. The causes resulting in a need of RBB can be hypodontia, extraction due to orthodontic reasons, trauma, caries and its sequelae and periodontal disease. Patients with hypodontia have deficient enamel for adhesive bonding. Garnett et al\(^2\) (2006) in a follow up study of 79 RBB’s over a period of eleven years reported 41.1% debonding rate. Increase failure rates have been reported\(^3\) for trauma patients due to increased dentine exposure and short clinical crowns of abutment teeth. Saddles with increased bone loss due to periodontal disease result in taller and longer pontics. This could present the potential for greater non-axial forces on the restoration, however, taller abutments also allow for increased dimensions of connectors. Teeth lost due to and dentition affected by periodontal disease show differential micr-movement. This could further result in partial de-bonding at one or more abutments with greater individual tooth mobility.

j) Fit of framework

A poorly fitting restoration results in plaque accumulation which creates the potential for gingivitis, periodontitis, marginal leakage, secondary caries, partial debond of bridge and complete decementation. Therefore it is pivotal that the framework is as accurate a fit to the abutment tooth surface as possible. As the thickness of the cement lute increases above the optimum, the bond strength decreases\(^2\). In a further study, Chana et al\(^1\) showed that bridges constructed using a refractory die technique produce more accurate castings than those where the pattern was lifted off the cast prior to investing.

k) Cementsations procedure

Preparation of the retainer surface should be carried out immediately before cementation using 50um alumina in a sandblaster. Sandblasting helps to increase surface area, form micromechanical undercut and remove the oxide layer from the metal surface. Following this, the metal should be steam cleaned to ensure it is free from alumina or metal deposits. Resin cements are the material of choice and the cementation protocol for each product should be strictly adhered. Metal alloy resin primers are also used in some cement systems (Panavia- Ex, Kuraray Co., Ltd., Osaka, Japan) to couple the adhesion of resin cement to metal. Isolation with a rubber dam is essential for the success of all enamel and dentine bonding procedures.

**CLINICAL CASES**

Both the cases presented below were initially screened by a senior clinician and referred to the prosthetic department clinic for restoration of spaces with fixed prosthesis. The patients were treated within four clinical appointments involving Initial assessment and treatment planning, tooth preparation and final impression, try-in and cementation and lastly follow-up. Initial assessment involved history taking, intra and extra oral examination, radiographic records, alginate impressions, facebow and interocclusal record. In the laboratory, casts were prepared and articulated on a semi-adjustable articulator (Denar) and assessed for abutment position, angulation, mesiodistal and inter-occlusal saddle space, tissue loss at the saddle (bucco-lingual and vertical) and verification of intra-oral findings (Occlusion). Following which a diagnostic wax-up was performed in order to assess and plan for the type, design and contours of the planned restoration. Also custom trays were requested to be ready at the next clinical visit. Second clinical appointment involved treatment plan discussion, mouth preparation, final impression ( Dual phase, single stage polyvinylsilocone; PVS in custom tray), inter-occlusal record and shade and mould discussion and decision. Third clinical visit included prior to sand-blasting try-in and adjustments, sandblasting and cementation. In both cases cementation was carried out using; Panavia-Ex, dual polymerized resin based cement under rubber dam. Follow-up appointment involved patient’s feedback, assessment of occlusion, function, aesthetics and patient adherence to plaque control.

**Clinical case A:** (Figures 1 & 2) was a 15 year old female with missing bilateral mandibular premolars due...
to hypodontia. The history revealed that the patient had orthodontic treatment and was at the stage of wearing a full-time retainer. The patient was medically fit and well with no known allergies and abnormalities. On intra-oral assessment, the mesio-distal saddle space was for a single unit premolar tooth bilaterally. There was no active disease in relation to soft and hard oral tissues and the direct restoration present (class V composite on tooth number 36 and 46) were deemed as optimum on clinical and radiographic evaluation. The occlusion was class-I with canine guidance bilaterally and absence of posterior interference. The spaces were restored with contemporary resin bonded bridges to preserve the sound abutment teeth as implants were contraindicated due to continued growth. After completion of diagnostics the only tooth preparation carried out was at the proximal surfaces of abutment teeth for guide planes. No tooth preparation was deemed essential for occlusal surface of molars and lingual of the canines (abutment teeth) due to presence of space after orthodontic treatment. The design involved coverage of lingual surfaces of canine and molar including 1/4th of the lingual-occlusal surface as a seating lug. The cementation was done under rubber dam with Panavia-Ex (Kuraray Co., Ltd., Osaka, Japan). The cement lute margins were finished and polished using shofu rubber wheels followed by diamond polishing paste on rubber cups using a slow speed motor.

**Clinical case B:** (Figures 3, 4 and 5) illustrates the provision of resin bonded bridge for replacement of lost maxillary left first premolar. Tooth was lost due to refractory infection and bone loss as a consequence of an endo-perio lesion. The mesial abutment (canine) was un-restored and vital and the distal abutment (second premolar) was also vital with an adequate, moderate sized class I occlusal amalgam. Resin bonded bridge with palatal and partial occlusal coverage retainers was the treatment of choice and was chosen with mutual consent. To obtain a minimum of 4mm of connector height the distal proximal surface of canine and mesial of premolar received minimal preparation for guide planes. The interocclusal space on the palatal canine surface was created by using relative axial tooth movement as described by Dahl24. The inter-occlusal space created was 0.7mm (the thickness of the retainer) and space closure was complete in 16 weeks with full arch contacts.

In the period during which axial tooth movement took place, patient was reviewed every two weeks for carrying occlusal adjustments.

Both patients were delighted with the outcome of treatment and are reviewed every six months for detection of prosthesis related issues specifically, partial de-bonding.

**DISCUSSION**

The intention of this article is to present the vital factors in success of resin bonded bridges along with a couple of clinical cases to elaborate on some clinical issues encountered during treatment. In both the cases the spaces were restored with RBB’s primarily due to conservation of dentition and tooth structure. Also the relative contraindications for this treatment modality (parafuntional activity, high caries risk, heavily restored abutments, long span or heavy occlusal loads) were within physiologic limits. In case B, the presence of class I amalgam restoration did not compromise the adhesive bonding of retainer, as there was enough enamel at the mesial marginal ridge and beyond.

A fixed–fixed RBB was the design of choice, reason
being multifactorial. Firstly, cantilever RRB’s, although reported to have higher success rates are mostly in case of anterior saddle areas. Secondly, minimal preparation results in reduced tooth reduction than anticipated in cases of two abutment retained fixed-fixed design. RRB’s are retained primarily by adhesive bond strength along with the mechanical guide planes. Bond strength is directly proportional to the amount of surface area available for enamel bonding. In both cases the complete lingual surface of posterior teeth along with the lingual proximal surfaces were bonding substrates, resulting in 180° enwrapment. In addition, a mesial occlusal marginal ridge rest seat was also utilized to act as a seating stop. Furthermore, complete lingual surfaces of canines in both cases were also bonding substrates. This not just increased the retention, but also resistance form of the metal framework.

Preparation of teeth is not always necessary to create space for retainers, as space in occlusion may be present as shown in clinical case A (lingual surface of canine). As metal can be finished knife edge, no distinct preparation margins were prepared. The metal framework was designed to be 1mm short of lingual and proximal gingival margins for ease of cementation and cleansability for the patient. Space creation at the palatal surface of maxillary canine abutment was done using relative axial tooth movement. Relative axial tooth movement occurs when a localised appliance or restoration is placed in supra-occlusion, the occlusion re-establishes full arch contacts over a period of time. This method has been used for creation of interocclusal space in cases of tooth wear in combination with dento-alveolar compensation resulting in loss of prosthesis space. In a retrospective evaluation of the outcome and factors relating to the creation of localised inter-occlusal space, space was created with the use of an interim prosthesis that was generally a cemented cobalt chromium appliance. 50 appliances were reviewed in the study and the success rate was 96%.

Adhesive bond of a cemented RRB involves two substrates (metal and tooth enamel) resulting in two interface. On one side, resin cement interacts with the conditioned tooth enamel, resulting in a highly predictable bond. On the other side the metal retainer is surface treated, mechanically by the use of sandblasting with alumina particles and chemically using bi-functional metal primers (Panavia- Ex, Kuraray Co., Ltd., Osaka, Japan) enhancing bond strength and increasing survival rates of bonded metal restoration. Significantly higher bond strengths have been reported for silicoating procedures, which involves sandblasting metal retainers with silica coated alumina particles resulting in enhanced bond strengths.

CONCLUSION

Resin Retained bridge is a viable treatment option for replacement of one to two missing teeth in anterior or posterior regions of the mouth and should always be included in the treatment options for indirect restorations. These restorations have lower survival rates in comparison to conventional restorations, however they are, conservative of tooth structure, cost-effective, not needing local anaesthesia administration and reversible in nature with minimal or no tooth damage on debond. Its longevity is supported by increased enamel for adhesive resin bonding, non mobile abutments, lack of parafunction, rational bridge design, appropriate alloy selection, maximum enamel retainer coverage, adequate connector height and meticulous clinical technique.

REFERENCES