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Review Article

Resin-Bonded Fixed Partial Denture

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Abstract

Introduction: Resin-bonded fixed partial dentures (RBFPDs) have been known and used clinically from the past three decades. It was first introduced in the 1970s, but initially, the resin-bonded fixed partial denture was questioned about being used in short span edentulous spaces because of the bonding technique and often had failed as a result of debonding. With the advancement of bonding techniques, design principles, the metal alloys, and the treatment of the fitting surface, the resin-bonded fixed partial denture became one of the treatment modalities. Initially, the restoration was retained by adhesion, but at present, the minimal tooth preparation of abutment teeth not only increased retention but resistance form as well. With the emergence of materials like ceramic, fiber-reinforced composite, and zirconia, the longevity of restoration has increased. Hence resin-bonded fixed partial denture shows promising results.

Aim of the Study: The aim of the study is to have an overview of resin bonded partial denture, the design principles, and technique.

Methodology: The review article is a comprehensive research of PUBMED from 1955 to 2012.

Conclusion: Resin-bonded fixed partial dentures can be used for short span edentulous spaces in both anterior and posterior regions and are proven to be successful with careful selection of case, abutment teeth, the choice of alloy, and bonding technique used. The minimal abutment tooth preparation and various modifications should also be considered whenever necessary since the retention and resistance form majorly depends on it. Resin-bonded restoration mostly relies on adhesive retention, so occlusal forces should be considered, and nightguards can be given in patients with parafunctional habits. Despite all these advancements, the survival rate of resin-bonded fixed partial denture remains lower than conventional fixed partial denture; hence all the factors should be considered thoroughly before treatment initiation.

Keywords: *Design Principles for RBFPD; Tooth Preparation of Abutment Teeth; Patient Selection; Bonding Technique*

Background

The prosthetic restoration for small edentulous spaces by a conventional fixed partial denture remains in question since it does not justify an unnecessary reduction of adjacent teeth and restoring them with a crown. The alternative to this is a single-tooth implant, but implants are successful when the patient has adequate bone dimension and for those who are willing to proceed with minor surgical procedures involved in implant placement. This often leads the patient to choose resin-bonded fixed partial denture [1].

Buonocore introduced the bonding in 1955, which led to advancement in adhesive technology, and more conservative tooth preparation of abutment teeth became possible. Rochette first introduced the concept of bonding enamel with metal retainer using adhesive resin in 1973. He splinted the periodontally weak mandibular anterior teeth with cast bar bonded to the lingual surface of teeth. This splint had perforations to provide interlocking between cement and metal. It was further modified by Howe and Denehy, which formed the first RBFPD. The abutment preparation in RBFPD was first proposed by Livaditis, which included a proximal and lingual surface reduction to create an easy path of insertion, which increased the resistance and retention form of the metal retainer to the tooth [2-5].

Figure 1: *Showing RBFPD using Rochette design with perforated retainers [7].*

Later on, the resin-to-metal bond system came into consideration, which lead to the discovery of surface treatment of the fitting surface of the retainer. The concept of electrolytically etching a non-precious metal to roughen the surface microscopically was first introduced by Livaditis and Thompson. This is known as the Maryland Bridge technique using etching of non-precious alloys such as Ni-Cr. While this discovery led to a step forward in RBFPD, it was almost impractical to apply clinically since the etching process was very technique sensitive and required special laboratory equipment and microscopic detection to verify the quality of etching [6]. In 1978, (4-META) 4-methacryloxyethyl trimellite acid anhydride was used as a reactive functional monomer for adhesives to enamel, dentin, ceramic and dental alloy. With the advent of functional monomers for noble metal, alloys containing sulfur such as VBATDT, MTU-6, and MDDT made excellent progress in resin-bonded restoration practice. Later on, noble metal alloys such as Ag-Pd-Cu-Au alloy developed, which adhered directly to resin materials. With all these advancements, RBFPDs are accepted as an alternative option to a conventional partial denture [8].

Patient selection

Those with small edentulous span bounded with sound teeth are good candidates for a resin-bonded fixed partial denture. The requirement of potential abutment teeth is to be healthy, caries-free, unrestored, or minimally restored as well as have adequate crown height and width. The teeth should be free of periodontal disease and non-mobile that will provide a sufficient surface area of enamel, thus acts as an ideal abutment. The age of patients should also be considered; the young patients tend to have more sound teeth, debond rate is more among people under 30 years of age [9].

RBFPD is mostly known to be used in single unit edentulous space surrounded by healthy teeth. Still, many case studies prove its use for provisional treatment prosthesis and an alternative to acrylic resin removable partial denture. RBFPDs are also used as an immediate prosthesis following extraction in many patients [10].

A B

Figure 2: *Showing A) facial view and B) Occlusal of missing maxillary left lateral incisor [1].*

Design principle for anterior teeth

Rochette first reported the splinting system, but it was limited to mandibular anterior teeth because it was adapted as a temporary procedure with no teeth reduction. Howe., *et al*. used the perforated retainers for missing anterior teeth without tooth preparation by selecting a situation with open bites or where the occlusal load is minimum, but the retainer frequently fractured due to lack of sufficient strength. Maryland Bridge was the first transition from perforated to non-perforated retainer design in which base metal alloy retainer of RBFPD covers most of the proximal and lingual areas of the anterior abutment tooth minimal tooth preparation [11].

The restoration shows the supragingival margins, which is one of the common features of RBFPD. Sufficient occlusal clearance must be provided for retainers even if the abutment tooth is intact. At present, the tooth preparation design of anterior RBFPDs usually includes grooves and pinhole as an extra retentive structure. The systematic preparation design for anterior abutment teeth helps in the preservation of patient occlusal guidance. The reduction in a design should extend to the part of occlusal wear facets, thus making it possible to preserve patients' innate occlusal function and holds the retainer firmly. The functional force from the antagonist's teeth should load the retainer and enamel equally. Such a force should appropriately press the retainers to abutment and should not debond the retainer from bonded enamel. One of the significant problems of maxillary anterior RBFPDs is difficulty in thickening the retainers due to anterior-guided occlusion. No design yet has resolved this problem [8].

Splinting with partial veneer restoration is considered to be useful in a mobile tooth due to periodontal disease. But the long-term prognosis of resin-bonded fixed partial denture depends on a long term follow up and condition of abutment teeth involved. RBFPDDs are known to fail at higher rates when a significant retentive preparation is not applied. Therefore, pinholes and grooves are given in the anterior region, along with enamel etching, and the use of unfilled resin adhesive is suggested for the long-term success of prosthesis [12].

Design principle for posterior teeth

The Maryland Bridge used earlier for posterior teeth included only axial coverage and occlusal rest without any proximal or lingual enamel reduction. Earlier it was known that the success of posterior RBFPDs requires a 180 degree plus circumferential tooth prepara-

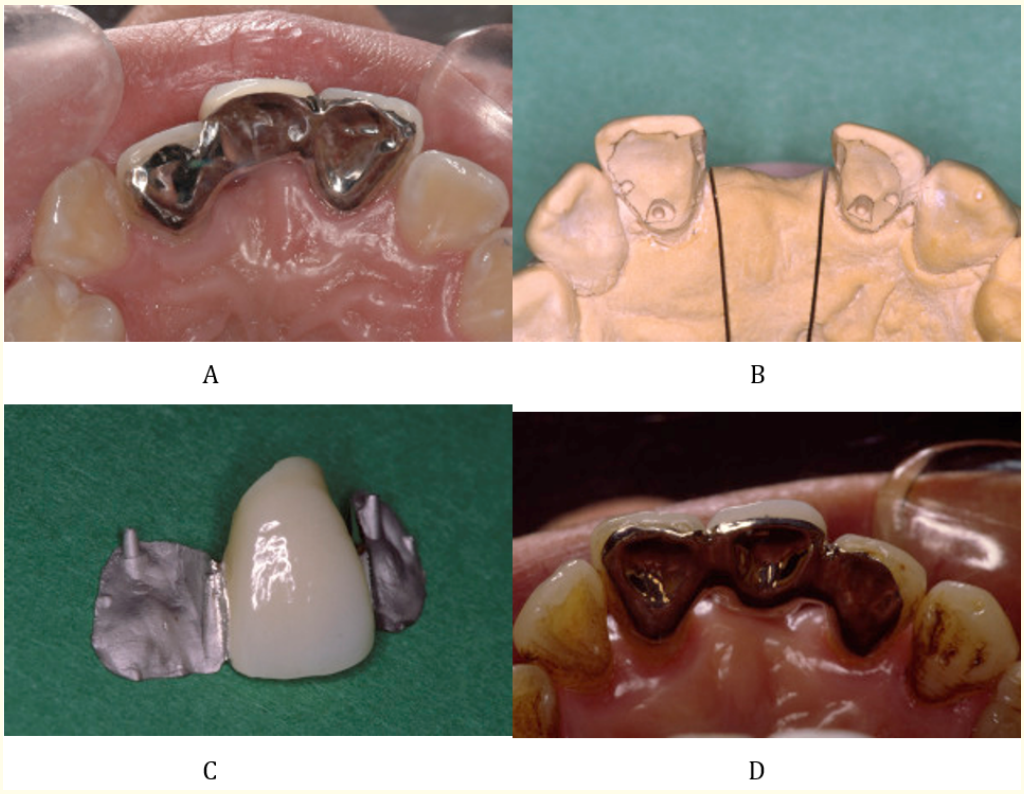

Figure 3: *Showing A) Early Maryland Bridge uses in anterior region. B) Definitive cast with grooves and pinholes preparation on central and lateral incisor. C) Intaglio view of anterior RBFPD with retentive pin. D) Placement of RBFPD after completion [8].*

tion. Later on, preparation designed evolved to improve and included mechanical retention by providing grooves for resistance. The L-shaped design of the retainer covers ½ of the lingual cusp with a groove at the far side of the buccal line angle and placement of groove at the opposite side of the lingual line angle to hold abutment teeth firmly in place. The D-shape design became popular later. An approach using groove, plate, and strut with minimal preparation of abutment teeth is made to receive an RBFPD made of base metal alloy.

Botelho advises a design with a major retainer having a wraparound configuration on a minimum three surfaces abutment, or axial grooves or slots placed opposite; this can be used for edentulous space where two or more teeth are missing [13,14].

Another design includes preparation for posterior partial veneered restoration, which provides sound occlusal function and isolates the occlusal contact area in the enamel region to maintain the vertical dimension of occlusion. This design is recommended when a prosthesis is not provided in a long time to replace the missing teeth and the mesial and distal teeth incline towards the edentulous space [15].

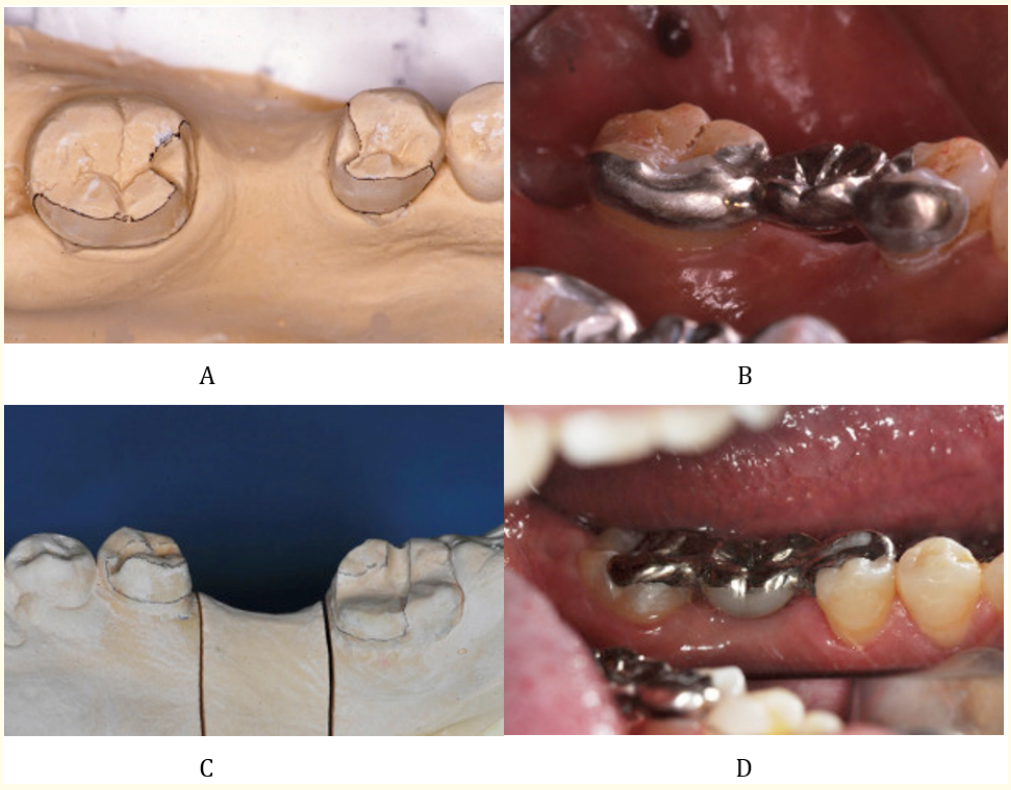

Figure 4: *Showing A) Occlusal view of the definitive cast for Maryland Bridge. B) Lingual view of early Maryland bridge. C) and D) Definitive cast of D-shaped preparation in 2nd premolar and enamel island preparation in 2nd molar [8].*

Tooth preparation

Many modifications have been made in tooth preparation of RBFPD since 2000; this includes an increase in retention and resistance form, creating a defined path for inserting the framework, and improving aesthetics by minimizing display metal. Therefore, the framework is extended more lingually, improving resistance form as well as preventing dislodgment of the prosthesis. The cingulum and occlusal rest also provide support and prevent dislodgement towards the gingival aspect, while the proximal grooves in molars significantly improve retention and resistance form [7].

Anterior Abutment tooth preparation

Aesthetics is one of the main concerns in the anterior region; hence the incisal finish line is usually 2 mm short of the incisal edge to avoid any impairment of incisal edge translucency. This varies from patient to patient; therefore, it should be assessed clinically from cervical to incisal of the tooth. Calcium hydroxide paste is used to try in retainer since it produces an opaque white shade of resins used to cement RBFPDs [16].

A 0.5 mm palatal reduction will suffice to allow adequate bulk of metal for the strength of the retainer; this keeps preparation confined to the enamel. The gingival finish line is placed 1 mm supragingival to ensure optimum hygiene and maintaining healthy tissues. It also aids in rubber dam placement for cementation of restoration. Proximally the finish lines end at the center of the contact area to maximize wraparound design and minimize the visibility of metal from the facial aspect. The proximal surface should be parallel to avoid space in between (black triangles) [16].

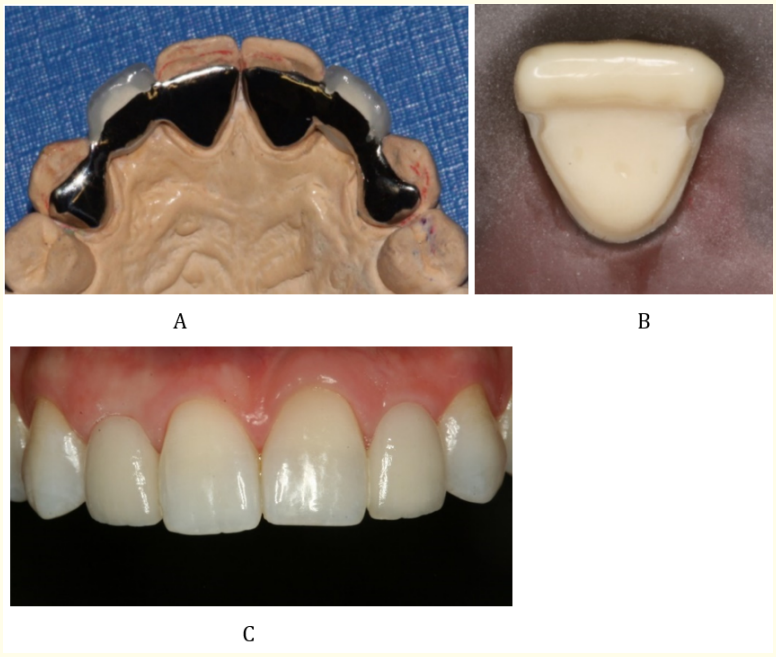

Figure 5: *Showing A. Occlusal aspect. B. Tooth preparation of abutment tooth in anterior RBFPD. C. Facial aspect of two anterior three-unit RBFPDs placed following orthodontic treatment [7].*

Posterior abutment tooth preparation

The gingival finish lines for posterior abutment also terminated 1mm supra-gingivally for the same reason as the anterior one. The enamel from the lingual side is removed to eliminate lingual bulge but also ensuring to keep the preparation confined to enamel only. The resistance form is enhanced by 180-degree wraparound preparation. The proximal finish lines end lingually to the facial line angles. The rest seats can be added to prevent movement of retainers towards the tissue. Ideally placed mesially, distally, or mid-lingual at disto-palatal groove to enhance axial loading of the abutment teeth [7].

The retainer, a cover of the occlusal surface of abutment teeth, increases retention and resistance forms of the prosthesis. The proximal part act as connectors as well as buccolingual bracing of the abutments. Proximal grooves also increase the retention of posterior RBFPD, but alternatively, slot or box preparation can also be used [7].

Figure 6: *Showing cemented three-unit FPD in the premolar-molar region [7].*

Choice of material

The following material can be used in resin-bonded fixed partial denture [7]:

- Gold alloy (earlier)
- Base metal alloy
- Cobalt chromium alloy
- Nickel-chromium alloy
- All ceramic
- Fiber-reinforced composite
- Zirconia.

Rochette used gold alloy in early RBFPDs. Since then, knowledge and material have evolved and lead to the use of nickel-chromium as a choice of material due to the high bond strength of these base metals. Retainer made of cobalt-chromium should be 0.5 mm thick since the increase in the thickness of the retainer increases the force to dislodge the retainer [3,16].

Figure 7: *Showing A. base metal framework prior to porcelain application. B. Try-in of Zirconia RBFPD [7].*

It is suggested to use alloys with a high modulus of elasticity with thickness more than or equal to 0.5 mm. Despite harness, good elastic modulus, and more sag resistance at high temperature, base metal alloys are challenging to casting procedure and solder. The clinician should ensure the sensitivity to nickel before selecting alloy. The aesthetic alternative to base metal alloys is All-ceramic RBFPD, which is mostly used in cantilever design. The disadvantage of All-ceramic material is the fracture of the prosthesis [17].

Fiber-reinforced composite is another material used with the advantage of better adhesion of composite resin luting agent to retainer, aesthetics, ease of repair. The glass fibers are most commonly used for this purpose because of their good strength as well as aesthetics. Framework fracture and delamination are some of the disadvantages with wear properties inferior to all ceramic material [18].

To eliminate the above mentioned disadvantages in material, zirconia becomes the choice of material when strength and aesthetics are a significant concern. The main disadvantage is the fracture of veneering porcelain. A better bond with zirconia can be achieved using a universal primer (Monoband) [19].

Bonding technique

The initial mechanical retention used a perforated retainer, which later changed to adhesives with more advancement in materials. The adhesion consists of three parts [7]:

- Enamel to resin bond
- Cohesive bond of composite resin
- Resin to framework bond.

In 1984, Panavia EX was first introduced based on bis-GMA and contained MDP (10-methacryloxydecyl dihydrogen phosphate), capable of bonding cobalt-chromium to the enamel. It was found in a study that 4-META applied to nickel-chromium is exceptionally durable. Thinner film thickness provides complete seating of the casting and minimizes internal flaws in the cement. Prior to bonding, the alloy surface is roughened using air abrasion of the alloy surface with 50μ alumina; alumina helps oxide bonding of phosphate-based adhesive systems such as Panavia. Moisture control is necessary for optimal bonding achieved using rubber dam during cementation. Cotton wool isolation is an alternative when rubber dam isolation is not feasible [20].

Conclusion

RBFPD can be used in both anterior and posterior edentulous spaces where 1 or 2 teeth are missing. Though the survival rate of RBFPDs is lower than other alternative options such as convention FBD and oral implants, it is still preferred in many cases. The most common failure is the debonding of the framework from abutment teeth. The ultimate success depends on case selection, condition of the abutment tooth, preparation design involving slots and grooves for retention, appropriate alloy selection, and bonding technique used for tooth-metal bonding with follow-ups.

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