Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 02, pp.12889-12893, February, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

REVIEW ARTICLE

FROM BASICS TO BEYOND FABRICATION OF RESIN-RETAINED FIXED PARTIAL DENTURES

*Poonam Malik and Manu Rathee

Department of Prosthodontics, Post Graduate Institute of Dental Sciences (PGIDS)
Pt. B.D.Sharma University of Health Sciences, Rohtak, Haryana-124001

ARTICLE INFO

Article History:
Received 27th December, 2014
Received in revised form
08th January, 2015
Accepted 20th January, 2015
Published online 28th February, 2015

Key words:
Resin-retained fixed partial denture,
Chemical etched enamel, Resin cement.

ABSTRACT

Resin-retained FPDs are particularly useful in treating younger patients because much less tooth reduction is required than for a conventional retainer design. Contrasted with conventional fixed prostheses, which depend on the geometric shape of a circumferential tooth preparation, these prostheses rely in part on adhesive bonding between etched enamel and the metal casting. Nevertheless, specific, conservative tooth preparations are necessary to achieve optimal retention. This review article provides a basic outline regarding the fabrication techniques in different tooth of resin retained fixed partial denture.

INTRODUCTION

Resin-retained fixed partial dentures have gained considerable popularity since the technique for splinting mandibular anterior teeth was described by Rochette in 1993. The restoration consists of one or more pontics supported by thin metal retainers placed lingually and proximally on the abutment teeth. However, problems with long-term retention and esthetic concerns related to darkening of the abutment teeth limit their application. They are held in place by resin, which locks mechanically in to chemically etched enamel and into microscopic undercuts in the casting, as contrasted with conventional fixed prostheses, which depend on the geometric shape of the prepared tooth for retention and resistance. The resin-bonded FPD originally consisted of either a natural tooth or acrylic resin pontic bonded with composite resin directly to the abutments. A supporting wire or stainless steel mesh framework was incorporated and adapted to the adjacent tooth contours for additional reinforcement. Later developments included custom cast metal retainers with numerous perforations. These afforded additional strength and improved esthetics. However, a common problem was early degradation of the composite resin-to-metal bonding technology, a retentive cast metal framework, and a metal-ceramic pontic. Three principles are fundamental to achieve predictable results: proper patient selection, correct enamel modification, and framework design. The treatment is not a panacea, and if any of the contraindications are present the patient is likely to be better treated with a conventional FPD or implant. Proper enamel modification is needed to ensure that the framework has only one path of insertion, resists all displacement forces except those along the path of insertion, and directs any loading parallel to the long axes of the abutments. Correct framework design proximal surface for sufficient resistance form, and it provides for optimum esthetics by minimizing visibility of the metal framework (**Schillingburg *et al.,* 1981; Kern, 2005; Creugers *et al.,* 1992**).

Corresponding author: Poonam Malik,
Department of Prosthodontics, Post Graduate Institute of Dental Sciences (PGIDS) Pt. B.D.Sharma University of Health Sciences, Rohtak, Haryana-124001

Steps in Fabrication

In the fabrication of resin-retained FPDs, attention to detail in all three phases is necessary for predictable success: Steps of fabrication**:** Preparation of the abutment teeth, Design of the restoration, and Bonding.

Preparation of the abutment teeth

Whether anterior or posterior teeth are prepared, common principles dictate tooth preparation design. A distinct path of insertion must be established, proximal undercuts must be removed, rest seats to provide resistance form and a definite and distinct margin must be prepared. On anterior teeth, the procedure is similar in many ways to the lingual reduction needed for a pinledge preparation, but the amount of reduction is less because the enamel must not be penetrated. If necessary, the opposing teeth can be recontoured to increase inter occlusal clearance. It is essential that there be sufficient enamel area for successful bonding and that the metal retainers encompass enough tooth structure to resist lateral displacement.

Bur selection primarily depends on operator preference. Gingival margins and circumferential preparation are easily accomplished with a chamfer or round tipped diamond. Occlusal and incisal rest seats can be prepared with a diamond or carbide inverted cone bur. Additional retentive features such as slots, grooves, or pinholes can be made with tapered fissure carbide (**Creugers *et al.*, 1992; Ibbetson, 2004**).

Step-by-step procedure

1. Leave the margins about 1mm from the incisal or occlusal edge and 1mm supragingival if possible. Definite lingual ledges will provide resistance form for the retainers and assist in positive seating during cementation. Wherever possible, to enhance resistance, more than half the circumference of the tooth should be prepared.
2. Make an accurate impression. Marginal fit is a critical for a resin-retained restoration as for a conventional FPD.
3. Fabricate a provisional restoration with autopolymerizing acrylic resin. This step can be problematic, for retention is difficult to achieve. On occasion, a removable appliance may suffice, but the provisional must stabilize the abutments properly. Significant tilting or supraocclusion of the abutment teeth can occur rapidly, particularly in younger patients.

Anterior tooth preparation and framework design

In designing an anterior prosthesis the largest possible surface area of enamel should be used that will not result in compromise of the esthetics of the abutment teeth. The retentive retainers (wings) should extend one tooth mesially and distally if a single tooth is replaced. If two teeth are replaced double abutments on either side are appropriate. If a combination of tooth replacement and splinting is used, the framework may cover a larger number of teeth. The gingival margin should be designed so that a slight supragingival chamfer exists that delineates the gingival extension of the preparation. Any undercut enamel is removed at this time the chamfer finish line may also extend incisally through the distal marginal ridge area.

The finish line on the proximal surface adjacent to the edentulous space should be placed as far facially as is practical. Abutments should have parallel proximal surfaces. An optional slot, 0.5 mm in depth, prepared with a tapered carbide bur, may be placed slightly lingual to the labial termination of the proximal reduction. The occlusion is assessed to ensure at least 0.5 mm of interocclusal clearance for the metal retainers in the intercuspal position and throughout the lateral and protrusive excursive pathways. If inadequate clearance exists selective enameloplasty is performed. Occasionally additional clearance can be obtained through reduction of the opposing teeth. In the presence of wear or attrition on the incisal edges, however, this is ill-advised.

A distinct rest seat is then placed in the cingulum area of the abutment tooth. This may consist of ledges similar to those incorporated in a pinledge preparation, or it can be a notch or flat plane perpendicular to the long axis of the tooth. The objective is to provide resistance to gingival displacement and to add rigidly to the casting. Rest seats are easily prepared with an inverted cone bur to facilitate internal refinement. The frame work is extended labially past the proximal contact point to prevent torquing forces from dislodging the prosthesis to the lingual. To optimize esthetics the proximal wrap in the anterior region may be achieved in part through using the metal-ceramic pontic.

Preparation of mandibular anterior teeth is similar to that for the maxillary incisors. Lingual enamel thickness is 11 to 50 percent less than for maxillary teeth, and consequently tooth preparation must be more conservative. Combinations of periodontal splinting and tooth replacement are commonly used in the mandibular anterior region (**Ibbetson, 2004**).

Posterior tooth preparation and framework design

The basic framework for the posterior resin-retained FPD consists of three major components. The occlusal rest (for resistance to gingival displacement), the retentive surface (for resistance to occlusal displacement), and the proximal wrap (for resistance to torquing forces). A spoon-shaped occlusal rest seat, similar to that described for a removable partial denture (RPD), is placed in the proximal marginal ridge area of the abutments adjacent to the edentulous space. An additional rest seat may be placed on the opposite side of the tooth. To resist occlusal displacement the restoration is designed to maximize the bonding area without unnecessarily compromising periodontal health or esthetics. Proximal and lingual axial walls are reduced to lower their height of contour to approximately 1mm from the crest of the free gingiva. The proximal walls are prepared so that parallelism results without undercuts. The bonding area can be increased through extension onto the occlusal surface provided it does not interfere with the occlusion. Generally a knife-edge type of margin is recommended.

Resistance to lingual displacement is more easily managed in the posterior region of the mouth. A single path of insertion should exist. The alloy framework should be designed to engage at least 180 degrees of tooth structure when viewed from the occlusal. This proximal wrap allows the restoration to resist lateral loading by engaging the underlying tooth structure. It should not be possible to remove a properly designed resin-bonded FPD in any direction but parallel to its path of insertion. In general, the preparation differs between maxillary and mandibular molar teeth on the lingual surfaces only. The lingual wall of the mandibular tooth may be prepared in a single plane, and the lingual surface of the maxillary molars dictates a tow-plane reduction due to the taper of these centric cusps in the occlusal two thirds and occlusal function. Occasionally combination prosthesis can be used. This type of FPD includes a resin-bonded retainer on one of the abutment teeth and a conventional cast restoration on the other (**Howe and Denehy, 1977; Ibrahim *et al.*, 1997; Saad *et al.*, 1995; Livaditis, 1980; Buonocore, 1955, Rochette, 1973**).

Resin-to-metal bonding

In the original design Rochette made six perforations with a waxing instrument, thus providing mechanical undercuts for the resin cement.1 A perforated design has the disadvantage of exposing the resin to oral fluids, which may lead to problems of abrasion of the resin or micro leakage at the resin-metal interface. A nonperforated design avoids this potential problem and can be highly polished, resulting in improved oral hygiene. Presently nonperforated retainers are recommended.

Metal resin bonding can be classified as either mechanical or chemical. Primarily, mechanical bonding is subdivided into micromechanical retention, which uses etching to create microscopic porosities, and macromechanical retention, which relies on visible undercuts, usually with a mesh or pitted metal. Chemical bonding generally employs tin-plating of the metal framework and specific resin adhesives for metal and enamel.

Electrolytic etching

In this procedure microscopic porosity is created in the fitting surface of a nickel-chromium framework by differential electrolytic etching. The fabrication technique was developed at the University Of Maryland School Of Dentistry, and the prosthesis is sometimes referred to as the "Maryland bridge" (**Livaditis and Thompson, 1982; Livaditis, 1983; Botelho *et al.*, 2006**)

Step-by-step procedure

1. Wax the framework and cast it in a nickel-chromium metal-ceramic alloy. Different alloys require different etching regimens; it is important to use an alloy that has been well tested.
2. Build up the pontic in porcelain, fire it, and contour it.
3. Try the restoration in and, when the fit is satisfactory, stain and glaze it. After this has been done, the restoration can be polished. Regular finishing compound is suitable.
4. Clean the fitting surface with an air-abrasion unit and aluminum oxide.
5. Cover the polished surfaces with wax and attach the prosthesis to an electrolytic etching unit, following the manufacturer's instructions. A typical etching cycle will be 3 minutes 10% H_2SO_4 with a current of 300 milliamps per square centimeter of casting surface. As stated, different alloys require different etching regimens (with differing times, acid solutions, and currents).
6. Clean the etched surface ultrasonically in 18% HCl and then wash and air-dry it.

The etched surface must not be handled after this stage.

Chemical etching

Some operators prefer to substitute chemical etching for electrolytic etching. A gel consisting of nitric and hydrochloric acids is applied to the internal surface of the metal framework for approximately 25 minutes. As electrolytic etching is extremely technique sensitive, many believe that chemical etching provides more reliable results due to procedural simplicity. One significant disadvantage of the etched metal technique is the need to use only nonnoble metals, as noble metals do not etch. The suitable alloys contain nickel, which is a potential allergen. Patients should be questioned as to possible nickel allergies prior to use of alloys containing nickel.

Microscopic retention

In the second type of non perforated retainer, porosity is cast in the pattern itself rather than subsequently obtained by etching. This is done in a variety of ways. One technique uses a special pattern to form a meshwork on the fitting surface and the external lingual surface is waxed to give a smooth finish that can be highly polished. The principle is similar to that used for gaining retention in direct bonding of orthodontic brackets, the bonding resin flowing into undercuts created by the meshwork. An alternative technique21 uses water-soluble salt crystals sprinkled onto the die and incorporated into the wax pattern. The crystals are dissolved away before investing. An advantage of both these techniques is that any alloy can be selected, whereas with electrolytic or chemical etching the alloy usually must be nickel-chromium. Additionally, try-in and bonding of the prosthesis can be accomplished at the same appointment. These surfaces are not likely to be damaged during handling, as are the very fragile etched metal surfaces. Disadvantages of the technique include difficulty for the laboratory technician on adapting the mesh to create a closely fitting metal framework and potentially thicker metal framework than can be obtained with an etched metal retainer. Also, the rate of micro leakage along the cast mesh-composite resin interface is significantly greater than along an etched metal-resin interface (**van Heumen *et al.*, 2009; van Heumen *et al.*, 2010; Jokstad *et al.*, 2005; Attia and Kern, 2011**).

Step-by-step procedure

1. Outline the mesh framework, trim it to the preparation margins, and adapt it to the master cast.
2. Develop the lingual contour, wax the pontic, and cut back and sprue the finished pattern as usual.
3. Soak the cast in cold water to help release the pattern. Invest it normally. A Surfactant is not needed. Instead, attention is directed to brushing the investment into fine-grid mesh.
4. Cast the framework and prepare the veneering surface in the conventional way.
5. Build up the porcelain, polish the casting, and clean the fitting surface with an air-abrasion unit.
6. The restoration is ready at this time for try-in prior to bonding.

Tin-Plate

Tin-plating is recently introduced procedure that can improve the bond strength of specific adhesive resin cements to most metals. Precious alloys can be plated with tin and used as frameworks for resin retained FPDs. Tin forms organic complexes with several specific adhesive resin cements that result in significantly greater bond strengths.

Comparison of bond strengths

Comparison of resin to metal bond strengths using various methods of metal surfaces treatments adapted from a variety of sources. It should be noted that similar bond strengths are obtained. All are clinically acceptable. Personal preference and familiarity with a specific technique often become the deciding factor in making a choice.

Cements (bonding agents)

Composite resins play an important role in the bonding of the metal framework to etched enamel. A variety of resin adhesives have been introduced specifically for this purpose. Conventional Bis-GMA type resins, originally used for luting resin-bonded FPDs, are in the process of being replaced by these more recently developed resin-metal adhesives that continue to undergo improvements. One such product* is a filled Bis-GMA composite resin. A phosphate ester has been added to the monomer, and this allows chemical bonding to both the metal alloy and the etched tooth enamel. The powder contains approximately 75% quartz filler and is almost insoluble in oral fluids. The material shows excellent bond strengths to nonnoble metals and tin-plated noble metals. It will not set in the presence of oxygen. To ensure a complete cure, the manufacturer provides a polyethylene glycol gel, = which should be placed over the restoration margins. This creates an oxygen barrier, and it can be washed away after the material has completely set. It has been demonstrated for this material that the technique generally results in improved retentive force and retention rates. Other resin metal adhesives employ 4-META (4-methacryloxyethyl trimellitate anhydride). These cements are relatively recent developments and only limited clinical data are available.

Occasionally it is necessary to mask the unesthetic metallic gray retainer from showing through translucent enamel. An opaque composite resin can be incorporated in the resin cement to minimize this graying effect. Resin bonding kits generally contain an opaquing agent for this purpose (**Bottino *et al.*, 2005; O'Sullivan, 2005; El-Guindy *et al.*, 2010; Flood, 1989**).

Step-by-step procedure

1. Clean the teeth with pumice and water. Isolate then with the rubber dam and chemically prepare them. Currently 37% phosphoric acid is used to etch the enamel and is applied for 30 to 60 seconds.
2. Choose a composite resin that is specially formulated for the technique. Manufacturer's instructions must be closely followed to maximize resulting physical properties.
3. Place the cement on the internal surface of the prosthesis and completely seat the restoration. Proper seating should be verified visually and by running an explorer over the margins.
4. Firm pressure should be exerted on the restoration while excess uncured resin is removed prior to the material completely setting. A brush saturated with unfilled bonding resin monomer and dental floss work quite well for this purpose.
5. The restoration should be held in place until the resin has polymerized. Any residual excess can be removed with a sharp hand instrument, before checking the occlusion.

It is recommended that finishing, polishing and occlusal adjustments all be accomplished prior to bonding the restoration. The tensile strength of the bonded prosthesis can be adversely affected by the heat or vibrations produced with rotary instruments.

Summary

One of the basic principles of tooth preparation for fixed prosthodontics is conservation of tooth structure. That is the primary advantage of resin-retained fixed partial dentures. Precision and attention to detail are as important here as they are for conventional prosthesis. The successful practitioner will therefore carefully plan treatment and fabricate a resin-retained restoration with the same diligence as used for conventional restorations. The techniques can be very rewarding but must be approached with care. Careful patient selection is an important factor in predetermination of clinical success.

REFERENCES

Attia, A. and Kern, M. 2011. Long-term resin bonding to zirconia ceramic with a new universal primer. *J. Prosthet Dent*., 106 (5): 319-327.

Botelho, M. G., Leung, K. C., Ng, H. and Chan, K. 2006. A retrospective clinical evaluation of two-unit cantilevered resin-bonded fixed partial dentures. *J. Am. Dent. Assoc.,* 137 (6): 783-788.

Bottino, M. A., Valandro, L. F., Scotti, R. and Buso, L. 2005. Effect of surface treatments on the resin bond to zirconium-based ceramic. *Int. J. Prosthodont.,* 18: 60-65.

Buonocore, M. G. 1955. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces, *J. Dent. Res.,* 34: 849-853.

Creugers, N. H., Kayser, A. F. and Van't Hof, M. A.1992. A seven-and-a-half-year survival study of resin-bonded bridges, *J. Dent. Res.,* 71: 1822-1825.

El-Guindy, J., Selim, M. and El-Agroudi, M. 2010. Alternative pre-treatment modalities with a self-adhesive system to promote dentin/alloy shear bond strength. *J. Prosth.,* 19: 205-211.

Flood, A. M. 1989. Resin-bonded prostheses: clinical guidelines. *Aust Dent J.,* 34: 209-218..

Howe, D. F. and Denehy, G. E. 1977. Anterior fixed partial dentures utilising the acidetch technique and a cast metal framework. *J. Prosthet. Dent.,* 37: 28-31.

Ibbetson, R. 2004. Clinical considerations for adhesive bridgework. *Dental Update,* 31: 254-265.

Ibrahim, A. A., Byrne, D., Hussey, D. L. and Claffey, N. 1997. Bond strengths of maxillary anterior base metal resin-bonded retainers with different thicknesses. *J. Prosthet Dent*., 78: 281.

Jokstad, A., Göcke, M. and Hjortsjö, C. 2005. A systematic review of the scientific documentation of fixed partial dentures made from fibre-reinforced polymer to replace missing teeth. *Int. J. Prosthodont.,* 18: 489-496.

Kern, M. 2005. Clinical long-term survival of two-retainer and single-retainer all-ceramic resin-bonded fixed partial dentures. *Quintessence Int.,* 36: 141-147.

Livaditis, G. J. 1980. Cast metal resin-bonded retainers for posterior teeth. *J. Am. Dent. Assoc.,* 101: 926-929.

Livaditis, G. J. 1983. Etched metal resin-bonded restorations: principles in retainer design. *Int. J. Periodontics Restorative Dent.,* 3: 34-47.

Livaditis, G. J. and Thompson, V. P. 1982. Etched castings: an improved retentive mechanism for resin-bonded retainers. *J. Prosthet Dent.,* 47: 52-58.

O'Sullivan, M. 2005. Resin-bonded restorations. In: Fixed Prosthodontics in Dental Practice. Quintessence Publishing Co. Ltd; London.

Rochette, A. L. 1973. Attachment of a splint to enamel of lower anterior teeth*. J Prosthet Dent.,* 30: 418-423.

Saad, A. A., Claffey, N., Byrne, D. and Hussey, D. 1995. Effects of groove placement on retention/resistance of maxillary anterior resin-bonded retainers. *J. Prosthet Dent.,* 74: 133-139.

Schillingburg, H. T., Hobo, S. and Whitsett, L. W. 1981. Fundamentals of Fixed Prosthodontics (2nd ed.). Chicago: Quintessence Publishing Co. Inc, 79.

van Heumen, C. C., van Dijken, J. W., Tanner, J., Pikaar, R., Lassila, L. V. and Creugers, N. H. *et al.* 2009. Five-year survival of three-unit fibre-reinforced composite fixed partial dentures in the anterior area. *Dent. Mater.,* 25 (6): 820-827.

van Heumen, C. C., Van Dijken, J. W., Tanner, J., Pikaar, R., van Dijken, J. V. W. and Lassila, L. V. *et al.* 2010. Five-year survival of three-unit fibre-reinforced composite fixed partial dentures in the posterior area. *Dent Mater.,* 26 (6): 954-960.

****