Resin-Bonded Fixed Partial Dentures: What's New?

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Contexte et objectif : Les dentistes remettent souvent en question l'emploi des prothèses partielles fixes (PPF) liées à la résine pour la restauration fiable d'espaces édentés. Les tentatives initiales consistant à lier des PPF à des dents n'ont pas tardé à aboutir à des échecs en raison de la déliaison. Dans les années 1980 et 1990, l'amélioration des méthodes de préparation, des alliages métalliques et des techniques de liaison a fait des PPF liées à la résine une option plus prévisible. Dans le présent article, nous résumons les informations récemment recueillies sur leur succès et leur échec.

Méthodologie : Une recherche a été effectuée dans MEDLINE à l'aide de mots clés décrivant les PPF liées à la résine pour répertorier les articles pertinents en anglais parus dans des revues révisées par des pairs depuis 2000.

Résultats : La principale raison de l'échec des PPF liées à la résine reste la déliaison de l'armature à partir de la dent pilier. La sélection des dents piliers non mobiles, la préparation pour améliorer la rétention et la forme de résistance, le choix de l'alliage approprié et les techniques de liaison du métal et de la dent constituent les clés du succès. L'emploi d'attachements en porte-à-faux et non rigides peut diminuer les forces entre piliers et réduire la déliaison des éléments de rétention ou rétenteurs.

Conclusions : Le taux de survie des PPF liées à la résine est toujours considérablement inférieur à celui des PPF traditionnelles. Même si les PPF liées à la résine peuvent être utilisées dans les régions antérieure et postérieure de la bouche pour remplacer 1 ou 2 dents manquantes, la sélection prudente du pilier, la préparation de la dent, le choix de l'alliage et la technique de liaison sont essentielles au succès clinique.

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The prosthetic restoration of small edentulous spans poses a dilemma when the adjacent teeth do not require crowns. It is difficult to justify extensive reduction of the adjacent teeth to support a conventional fixed partial denture. A single-tooth implant is an alternative for patients with adequate bone dimensions and who are willing to undergo a minor surgical procedure. However, oral implants are not the treatment of choice for many patients and the resin-bonded fixed partial denture (RBFPD) offers a possible solution.

In the 1970s, Howe and Denehy[1] adapted the Rochette bonded cast-metal periodontal splint concept[2] to create the first RBFPD. The early procedures were conservative, but problems with debonding resulted in a survival rate of only 28% at 7.5 years.[3] To enhance retention and resistance form of posterior RBFPDs, Livaditis[4] recommended preparation of parallel

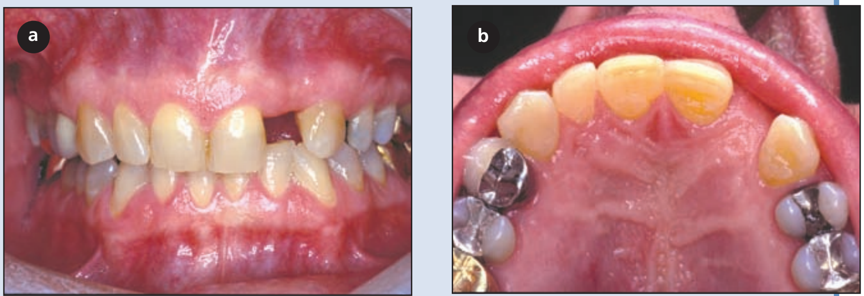

Figure 1: (a) Facial view of missing maxillary left lateral incisor. **(b)** Occlusal view of missing maxillary left lateral incisor.

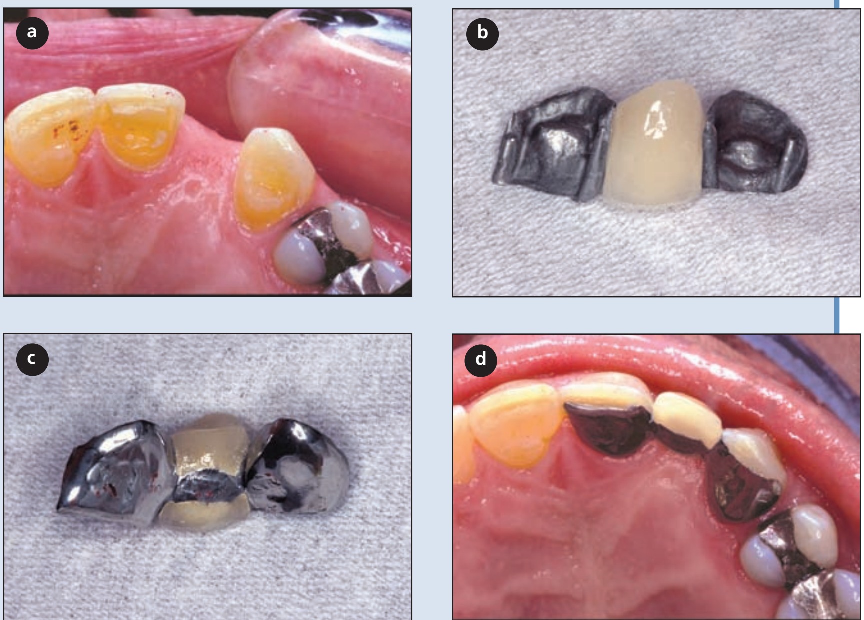

Figure 2: (a) Tooth preparation finish lines for anterior resin-bonded fixed partial denture (RBFPD). **(b)** Facial view of anterior RBFPD. **(c)** Palatal view. **(d)** Occlusal view.

guide surfaces on the interproximal and lingual aspects of the adjacent teeth along with rests on the occlusal aspect to counteract dislodging forces. Resin bonding was further enhanced by using solid electrolytically etched base-metal-alloy casting.[5] The result was a doubling of the survival rate to 64% at 7.5 years.[3] In the 1980s and 1990s, significant advances in metal surface treatment, dentin bonding and resin cements potentially improved the clinical success rate of RBFPDs. A meta-analysis[6] identified 60 papers published in the 1980s reporting success rates for various designs; Kaplan-Meier statistical analysis determined an overall survival of 74% ± 2% at 4 years for 1,598 RBFPDs compared with 74% ± 2% at 15 years for 4,118 conventional fixed partial dentures.

In this paper, we summarize outcomes of RBFPDs published in English-language, peer-reviewed journals since 2000. In addition, new information concerning preparation, material selection and bonding of RBFPDs is explored. Articles were identified by a MEDLINE search using key words describing RBFPDs.

Patient Selection

Patients with small edentulous spans bounded by sound teeth are good candidates for RBFPDs (**Fig. 1**). The potential abutment teeth should be healthy, unrestored or minimally restored, free of caries and periodontal disease, and have an adequate crown height and width. A nonmobile tooth with an adequate surface area of enamel provides an ideal abutment. Although the young are more likely to have sound teeth, debond rates are higher among people under 30 years of age.[7]

Although the RBFPD is considered a definitive solution for single-unit edentulous spaces bounded by healthy teeth, case reports on the use of this procedure as a provisional treatment continue to be published. Poyser and others[8] recommend the Rochette bridge as an alternative to an acrylic resin removable partial denture. Al-Wahadni and Al-Omari[9] calculated a 90.5% success rate over the short term (35 months) for 21 RBFPDs used as provisional prostheses immediately following tooth extraction. Two mandibular posterior devices failed after 3 and 4 months due to trauma, but were successfully rebonded.

Tooth Preparation

Since 2000, modification of the tooth preparation process has been advocated to enhance retention and resistance form of RBFPDs. The goal is to create a defined path of insertion for the framework while minimizing the display of metal. Frameworks have been extended maximally on the lingual aspect of teeth to improve resistance form and prevent dislodgment of the restoration. The use of defined rest preparations (cingulum and occlusal) has been advocated to provide support or prevent dislodgement toward the gingival aspect. The use of proximal grooves on molars in preparation for RBFPDs has resulted in significant improvements in retention and resistance as measured by dislodgement forces on maxillary ivorine teeth; however, no significant improvement has been noted for mandibular molars.[10] Although tooth preparation is required, less than half the amount of coronal tooth structure by weight is removed compared with that removed for complete coverage crowns.[11] According to studies of debonding, the mean debonding rate for RBFPDs placed without retentive tooth preparation was 47% compared with only 11% for those with retentive preparation.[7]

El-Mowafy and Rubo[12] recommend an anterior design involving a 0.5-mm lingual reduction of enamel and a 1-mm supragingival reduction extending to the centre of the interproximal contact, with an incisal finish line 2 mm short of the incisal edge for optimal esthetics (**Fig. 2**). Adequate and parallel axial reduction of the proximal surface adjacent to the edentulous area and extending lingual to the planned interproximal contact is required for a path of insertion and retention. Maximum extension onto the proximal surfaces with proximal grooves will enhance resistance for the RBFPD and prevent mesiodistal and faciolingual dislodgement. A cingulum rest with a flat floor will provide support, preventing movement toward the gingival aspect.

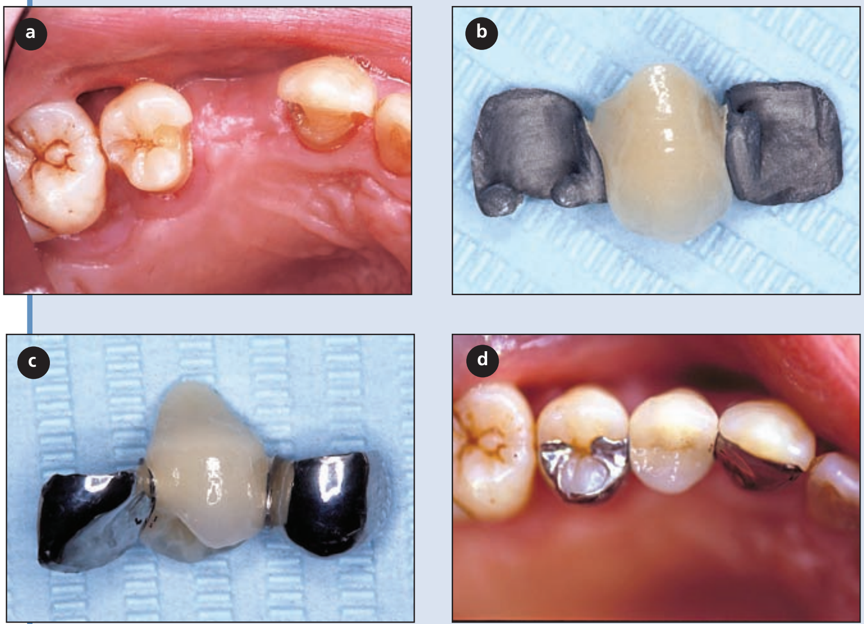

Figure 3: (a) Tooth preparation finish lines for posterior resin-bonded fixed partial denture (RBFPD). **(b)** Facial view of posterior RBFPD. **(c)** Palatal view. **(d)** Occlusal view.

A posterior design that creates parallelism between the proximal surfaces of the teeth adjacent to the edentulous space creates an optimal insertion path.[12,13] The supragingival preparation, 0.5 mm within enamel, should extend from the facial line angle lingual to just short of the interproximal contact area on each of the adjacent teeth. Occlusal rests and the base of the lingual grooves provide support, preventing movement toward the gingival aspect (**Fig. 3**). Alternatively, slot or box preparations replacing existing restorations may be used for framework support. Creating a box with a slight convergence toward the occlusal aspect to lock in the composite resin cement can enhance retention.[12] A similar posterior design has been recommended by Chow and others[14] with the addition of a palatal groove and an occlusal strut (mesial-distal groove) to enhance resistance form. Shimizu and Takahashi[15] describe a posterior design that involves preparation extending from a mid-buccal to a mid-lingual groove and incorporating an occlusal rest on each abutment tooth. However, this display of metal on the buccal surface may not be acceptable where esthetics are a concern.

Alternative Designs

The use of a single abutment to support a single pontic may be a viable alternative RBFPD design, at least for anterior regions. The design principles are the same as for the conventional RBFPD, with conservative tooth preparation, but optimizing resistance form.[16] The preparation should be confined to enamel as much as possible and maximize the surface area to enhance bonding of a rigid framework. Occlusion on the pontic should be kept to a minimum and molar-sized pontics should be avoided.

A review[17] of 11 clinical studies using cantilevered RBFPDs concluded that this prosthetic design was reliable and predictable and had greater longevity than conventional RBFPDs with 2 abutments. Compared with conventional RBFPDs, this restoration is claimed to have better esthetics, to involve less tissue damage, to be easier to clean, to be less expensive and to have no chance of undetected debond due to its single retainer.[17] When 269 2-unit cantilevered RBFPDs were followed for at least 2 years, debonding occurred in 14 (94.8% success rate); no changes in occlusion occurred in relation to drifting of abutment teeth.[18]

The integration of a nonrigid connector between the abutment and the pontics of long-span, RBFPDs with 2 or more pontics may reduce debond failure by allowing independent movement of the abutment teeth.[19] This design reduces the interabutment stresses that tend to cause debonding. The nonrigid connector is designed to allow movement in the vertical and horizontal planes, such that the least mobile retainer contains the matrix.[19] A clinical success rate of 92.2% was noted for 43 RBFPDs with 2 or more pontics that were followed up to 87 months.[20] All failed prostheses replaced posterior teeth, and adverse occlusal contacts on the abutment teeth were speculated to be the cause of this failure.

Bonding

The preparation of abutment teeth for RBFPDs using the previously described 0.5-mm axial reduction with further reduction for grooves, boxes and rest seats likely exposes dentin. An in vitro study of 20 extracted premolars after RBFPD preparation noted dentin exposure on all specimens; the mean area of exposure was 11.06 mm^2 (16.15%).[21] Preparation of 1-mm deep interproximal grooves exposed dentin in all teeth. Axial reduction resulted in variable dentin exposure at the gingival margin. Reliance on dentin bonding in modern RBFPD preparation designs seems a reality.

Base metal alloys, typically nickel–chromium–beryllium, are preferred over gold alloys due to their enhanced bond to resin cements. In vitro testing using aqueous aging and cyclic loading of Panavia-F (Kuraray Co., Ltd., Osaka, Japan) cemented RBFPDs determined that debonding was a result of cohesive failure within the cement at the filler–resin interface.[22] No difference in debond rates over 6 and 12 months was noted between nickel–chromium based RBFPDs cemented with Panavia 21 Opaque (Kuraray Co., Ltd.) and Scotchbond Multi-Purpose with Scotchbond Resin Cement (3M Dental Products, St. Paul, Minn.); however, the latter (a clear cement) was associated with graying of the abutment teeth.[23]

In vitro testing of combinations of chrome–cobalt metal surface treatments and resin cements found the use of Unifix (Cavex Holland BV, Haarlem, Holland) and airborne-particle abrasion (50 micron aluminium oxide) provided the firmest physical bond.[24] Similar research using nickel–chromium alloy also resulted in good bond strengths.[25] Airborne-particle abrasion of the alloy significantly improved bond strength; further enhancement was achieved by using 96% isopropanol for 3 minutes in an ultrasonic cleaner-than-air dryer for an additional 3 minutes.[25]

Use of tin-plating gold alloys to enhance bonding has not been predictable and led researchers to explore other surface treatments. The use of a metal primer (Alloy Primer, Kuraray Co., Ltd.) significantly improved the tensile bond strength between gold–palladium alloys and human enamel compared with airborne-particle abrading and tin plating.[26] This primer is based on acetone, 10-methacryloyloxydecyl dihydrogen phosphate and 6-vinylbenzyl-n-propyl amino triazine dithione. The use of a vinyl-thiol primer (a solution of acetone containing 0.5% 6-[4-vinylbenzyl-n-propyl] amino-1,3,5-triazine-2,4-dithiol) to bond gold alloy based RBFPDs resulted in a clinical success rate (76.9% at 10 years) similar to that for conventional base-metal alloys.[27] The use of silica coating to enhance bonding of RBFPD frameworks resulted in a similar survival rate.[28]

El-Mowafy and Rubo[12] recommend rubber dam isolation to enhance bonding of the RBFPD to tooth structure. A retrospective study of 100 RBFPDs placed between 1993 and 2003 found that various preparation designs, metal alloys, metal preparations, number of abutments and pontics were not predictive of debonding.[29] However, the use of rubber dam during cementation significantly reduced the risk of debonding.

Esthetics

Multiple questionnaires completed by 358 patients during regular recalls revealed that the degree of satisfaction with RBFPDs was high and did not seem to be influenced by the occurrence of failure.[30] However, satisfaction was correlated with complaints about colour and shape of the pontics. The metal framework of resin-bonded bridges may also darken thin or translucent abutment teeth; 5 studies identified this problem, with an overall occurrence of 18%.[7] The fracture of porcelain on the pontics is an esthetic complication that was identified in 15 studies with a mean incidence of 3%.[7]

Clinical Success and Failure

An extensive literature review[7] to identify the incidence of complications in fixed prosthodontics included RBFPDs. This study reviewed 56 publications, although when multiple reports on the same patient groups were eliminated, only 8 papers published between 1984 and 1998 remained. A total of 1,823 complications occurred in 7,029 RBFPDs in service for 1 month to 15 years. The overall debond rate of 21% affected 1,481 prostheses. The debond rate during the first 2 years was 10%, between 2–5 years the rate was 20%, and at > 5 years the rate was 24%. The debond rate for RBFPDs with more than 1 pontic (52%) was double that for frameworks supporting a single pontic.

Individual studies reporting on success of current design principles and bonding techniques show promise. The mean survival rate, based on bond retention, was 85% after 5 years for 100 RBFPDs placed between 1993 and 2003 at the University of Turin.[29] The annual debond rate over 3 years was 4.6% for 59 RBFPDs placed by predoctoral dental students.[31] The debond rate was 3 times higher in the mandible than the maxilla, with the poorest survival (debond rate 13.4%) in the anterior mandible. No differences in periodontal health (bleeding on probing and pocket depth) were noted between abutment teeth and controls.

Using Kaplan-Meier analysis, Zalkind and others[32] determined that 51 conventional base-metal alloy RBFPDs placed under controlled clinical conditions and followed over 13 years had a mean life expectancy of 85 months (7 years) ± 13%. Cox's proportional hazard analysis revealed that abutment teeth that were periodontally involved (relative risk [RR] 9.40) and were treated following orthodontics (RR 7.88) were significantly associated with failure of RBFPDs. Tooth mobility was the likely cause of failure in both these situations.

The use of supragingival margins should allow for adequate oral hygiene to control dental plaque and prevent gingivitis, periodontitis and dental caries. A lack of clinical impact on gingival and periodontal conditions has been reported; however, 22 studies of RBFPDs reporting on caries revealed a mean occurrence of 7%.[7] The complicating factor may be debonded frameworks; 7 studies reported on caries in conjunction with debonded retainers.

The use of cantilevered RBFPDs may be a viable alternative to 2 abutment RBFPDs. Kaplan-Meier survival estimates showed no significant difference between the survival rate for 77 RBFPDs (63%) and 25 cantilevered RBFPDs (81%) after 4 years.[33] A review of 2-unit cantilevered RBFPDs at the Prince Philip Dental Hospital (Hong Kong) revealed that 82 prostheses had a survival rate of 95.1% over the short term (mean service life 36.7 ± 15.4 months; range 4.3–95.4 months).[34] This high success rate may be due to minimal function or occlusal load.

Patient Satisfaction

Mandibular bilateral distal extension cantilevered RBFPDs were found to be equivalent or superior to removable partial dentures for 60 patients who completed satisfaction questionnaires.[35] No difference in quality of life was noted between patients provided with implant crowns and those receiving RBFPDs.[36] This study compared 11 patients with implant crowns and 33 with RBFPDs; the 2 groups were matched for gender, age, edentulous span and location of prostheses within the mouth. The self-administered quality-of-life questionnaire contained 2 subscales related to oral condition (mastication, pronunciation, swallowing, oral cleaning and esthetics) and general condition (physical function and psychological state). No differences were noted between treatment types. Patient satisfaction with cantilevered RBFPDs was also high; however, 10% were concerned about the metal appearance of the prostheses.[34]

Conclusions

RBFPDs can be used successfully in both the anterior and posterior regions of the mouth to replace 1 or 2 missing teeth. However, the survival rate of RBFPDs is still considerably less than that of conventional fixed partial dentures. The principle reason for failure is debonding of the framework from the abutment teeth. The use of cantilevered and nonrigid attachments may decrease interabutment forces and reduce debonding of retainers. The selection of nonmobile abutment teeth, preparation designs that enhance retention and resistance form, appropriate alloy selection and metal and tooth bonding technique are critical for success. ❖

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