Long-Span, Fixed-Movable, Resin-Bonded Fixed Partial Dentures: A Retrospective, Preliminary Clinical Investigation

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Purpose: Long-span, resin-bonded fixed partial dentures (FPDs) have been associated with higher debonding rates than short-span prostheses. The use of modified nonrigid connectors that allow movement between the abutments in long-span resin-bonded prostheses may reduce harmful interabutment forces that stress the metal framework and resin-bonded interface. This preliminary investigation aimed to evaluate the longevity of long-span resin-bonded FPDs of 4 or more units with a modified nonrigid connector and increased extension of the retainer framework around the major abutment. ***Materials and Methods:*** Thirty-eight patients attended a clinical examination; each had been provided with 1 or more resin-bonded FPD of 4 or more units (43 prostheses). For each patient, the following data were recorded: gender, age, cementation date, and endodontic treatment, if performed. Data regarding the occurrence of any debondings and patient expectations were also recorded. ***Results:*** The mean service life for the 43 prostheses was 46.9 months (SD 22.0), with a range of 12 days to 87 months. Three prostheses had debonded, resulting in a clinical retention rate of 92.2%. ***Conclusion:*** Long-span resin-bonded FPDs incorporating nonrigid connectors that allow independent movement between the major and minor retainer, combined with increased framework extension on the major abutment, appear successful in the short term. Further research is required to determine their long-term efficacy. *Int J Prosthodont 2005;18:371–376.*

Evidence-based information has shown that the clinical retention of resin-bonded fixed partial dentures (RBFPDs) is improved by a number of factors, including tooth preparation and resistance features,[1–3] increased extension of the retainer framework around the major abutment,[4,5] and 2-unit cantilevered designs.[6–12] Despite recent findings of better clinical retention for shorter span prostheses, the dental literature still supports the clinical observation that the greater the number of units in a RBFPD, the greater the chance of debonding.[6,9,13–15]

The longevity of 2-unit cantilevered RBFPDs is thought to be as good, if not superior, to 3-unit or greater fixed-fixed RBFPDs because of the freestanding nature of single retainer single pontic prostheses; there are no interabutment stressed to challenge the luting cement.[12,16,17] During function of a fixed, rigid prosthesis, interabutment forces will stress the retainer framework and luting interface, causing possible debonding. As the length of the RBFPDs increases, interabutment stresses will be greater as the result of fulcrum and loading effects. It is therefore likely that these factors will significantly contribute to the higher failure rates of longer span prostheses. As a result, the use of nonrigid connectors that allow independent

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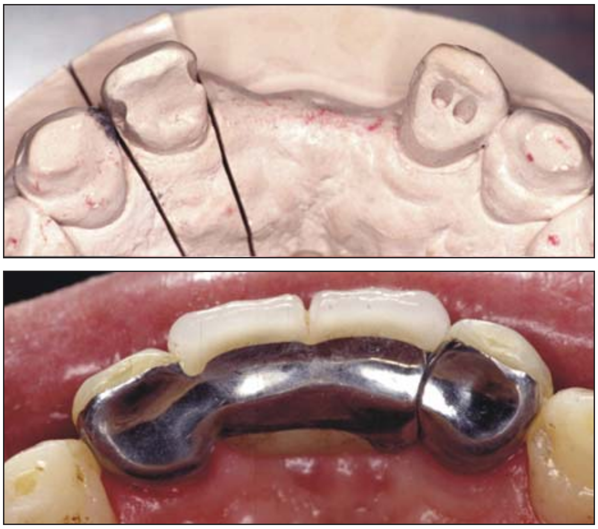

Fig 1 This anterior 4-unit RBFPD has the minor connector housed in the abutment at the maxillary left lateral incisor, which was endodontically treated; this allowed pin-hole preparation into the access cavity of the composite restoration. The major abutment, at the right lateral incisor, has tapered interproximal grooves placed for greater resistance form.

movement between the retainers of long-span RBFPDs during loading should reduce these harmful inter-abutment stresses and increase clinical retention (Fig 1). In addition, given the greater loading experienced by the major retainer during function, an increase in the abutment and retainer resistance form would also seem appropriate to ensure longevity.

A small number of case reports have demonstrated the clinical use of nonrigid connectors for RBFPDs with the rationale for their use cited as accommodating abutments with different mobility.[18–21] Botelho previously described case reports of long-span RBFPDs with the proposed modified nonrigid connectors and improved resistance form for the major retainer to improve clinical retention.[22]

The aim of this study was to perform a clinical audit on the clinical retention of long-span RBFPDs with modified nonrigid connectors and increased resistance form of the major retainer.

Materials and Methods

The sample population was identified from the computer records of patients who had RBFPDs of 4 or more units placed between August 1997 and November 2003 at the Prince Philip Dental Hospital, University of Hong Kong. A total of 43 patients were identified, 5 of whom were unable to attend because they either had emigrated or could not be contacted. Thirty-eight patients were clinically examined; 13 were men and 25 were women, with an age range of 23 to 80 years.

According to the usual practice at the Prince Philip Dental Hospital, patients would have been selected based on the need to replace 2 or more adjacent teeth, with abutments being sound or minimally restored, with sufficient enamel for bonding, adequate crown height (> 3.0 mm), healthy periodontal tissues, and a specific patient request for a FPD. For most of the prostheses placed during the earliest phase of the study period, these would have been supervised or performed by a limited number of staff, since it has only recently been adopted for clinical practice as part of the undergraduate teaching program.

Nine of the prostheses replaced anterior teeth (ie, incisors) and 34 RBFPDs replaced posterior teeth (ie, premolars and molars). Because this study was retrospective, it was not possible to describe certain design characteristics of the prostheses, such as thickness of the retainer, framework extension, and tooth preparation. However, these would have conformed to recommended guidelines.[22]

Design and Fabrication of Long-Span RBFPDs

Since 1999, the clinical practice, as taught in the undergraduate curriculum, has been that all long-span RBFPDs provided at the Prince Philip Dental Hospital have been designed with a modified nonrigid connector which allows independent movement between the abutments to reduce interabutment stress, and a metalwork design that optimizes both abutment and framework resistance form. The stress-breaking nonrigid connector was created either by a custom-made pattern in wax or by adjusting the metalwork formed by a cast, prefabricated plastic pattern. The aim of the modified nonrigid connectors was to allow independent movement between the abutments both vertically and horizontally. For the replacement of all posterior teeth, the minor retainer was placed on the anterior abutment; for anterior prostheses, the location of the major retainer was determined on a case-by-case basis, the abutment with the greater resistance form or bone support carrying the pontics.

Increasing abutment resistance form was achieved by maximizing the surface area for bonding by lowering the survey line on the tooth and increasing wrap-around of the framework on the abutment. On posterior major retainers, each framework was extended onto at least 3 axial surfaces of the abutment, which involved breaking the distal contact point on the major abutment if necessary. Increased framework resistance form for posterior retainers had been achieved by additional occlusal coverage of the occlusal surface, either by covering the lingual cusp, by use of an occlusal bar joining the ends of the retainer (Fig 2), or by encircling the abutment with an "O"-shaped retainer to provide 360-degree "wrap-around" (Fig 2). Auxiliary resistance features such as grooves, slots, or pin holes were also used when required, particularly on anterior abutments where extensive wraparound would not be esthetically acceptable (Fig 1). The use of such auxiliary retention features has been shown to improve retention of RBFPDs both in vitro[23,24] and in vivo,[1,2] and may be considered to have greater importance in prostheses that receive heavy occlusal loading.

All RBFPDs were fabricated by dental technicians at the Dental Technology Unit of the Prince Philip Dental Hospital according to a standard procedure. Wax patterns were laid down on a DVP investment model (Whip Mix) using preformed wax sheets (approximately 0.9 mm thick) to ensure adequate rigidity of the retainer. Optimum nickel-chrome alloy (Matech) was used to cast the frameworks. The movable connector was either custom made or cast using a Mini Rest (Ney Dental) preformed plastic pattern. After casting, both the patrix and matrix connectors were trimmed using a tapered No. 170 tungsten carbide bur in an air-turbine handpiece to allow horizontal and vertical movement between the major and minor connector of approximately 0.5 to 1.0 mm. The fitting surfaces of the retainers were airborne particle abraded using 50-μm aluminium oxide before fitting. All RBFPDs were cemented with Panavia 21 or Panavia F cement (Kuraray).

Using a standardized clinical report form, 2 clinicians collected the following data for each patient: gender, age, cementation date, and endodontic status. Patients were also asked a series of questions about their satisfaction with the prosthesis (a 10-point scale was used), any concerns about the appearance of the metal of the RBFPD, any chewing modifications they made to protect the prosthesis, and whether the prosthesis had previously debonded.

Fig 2 These posterior 4-unit RBFPDs show major retainers on the molars with 360-degree and 3-surface wraparounds (D-shaped) on the abutments to give greater resistance form. The minor abutments also have increased wraparound; when this is not possible, the use of grooves or pin-holes on the abutment is recommended.

Results

A total of 45 long-span fixed-movable RBFPDs in 38 patients were clinically assessed, 2 of which did not meet the assessment criteria. Twenty-two prostheses were present in the maxilla and 21 in the mandible. Nine RBFPDs replaced missing anterior teeth (ie, canines and incisors), and 22 replaced posterior teeth between the first premolar and second molar. Twelve prostheses extended distally from the canine. The prostheses ranged from 4 to 6 units in length, with 37 having 4 units, 4 prostheses with 5 units, and 2 prostheses with 6 units (Fig 3). The prostheses were bound at each end by a single abutment. One patient had 3 long-span RBFPDs, 4 patients had 2 prostheses, and the remainder had 1 prosthesis each. Thirteen patients were men (34%) and 25 were women (66%), with an age range of 23 to 80 years (mean 50.9 years).

At the time of examination, the average service life of the 43 RBFPDs placed was 46.9 months (SD 22 months; median 43.2 months) with a range from 12 days to 87 months. A frequency distribution table of prosthesis age is given in Table 1. No survival analysis was performed because of the small sample size and number of failures. Of the 25 major retainers on posterior abutments, 14 had 360-degree wraparound; 9 had D-shaped retainers (Fig 2) with wraparound extending on the mesial, distal, and lingual axial surfaces; and for 2 retainers, the extent of coverage was not recorded. Two abutments were root filled. Patients gave a mean satisfaction with the prostheses of 8.5 (range, 1 to 10), 5 patients reported being concerned with the appearance of the metal, and 9 patients said they avoided chewing on the prosthesis to protect it. The patients reported that they expected the prosthesis to last a range of 5 to "over 10 years" (mean 7.3 years). Seventeen of the cases were prepared and cemented by 1 experienced clinician, and the remainder were completed by undergraduate students.

In total, 5 prostheses had debonded, although 2 of these did not meet the assessment criteria and were not included in the retention data. The first of the excluded prostheses (replacing the maxillary first and second premolars) had debonded twice: 56 days after cementation and again 152 days after recementation. On clinical examination, the debonded major retainer

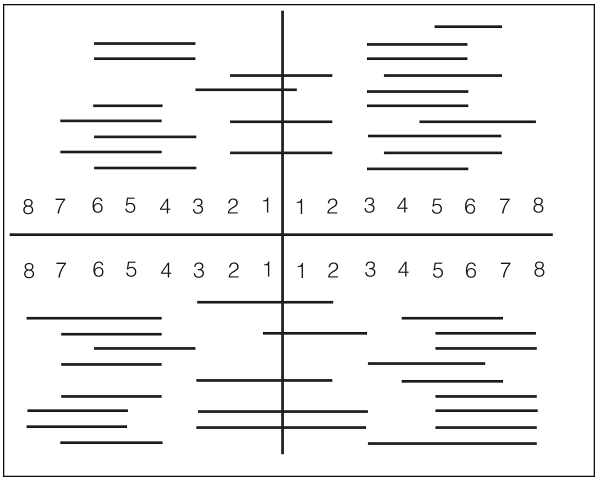

Fig 3 Distribution of the 43 RBFPDs. The horizontal bar shows the extension of the long-span fixed-movable prostheses in the maxillary and mandibular arches (from 1 = central incisors to 8 = third molars).

Table 1 Frequency Distribution Table of Life Spans of Prostheses

Months in Situ	No. of prostheses
< 12	3
12–24	3
24–36	12
36–48	5
48–60	8
60–72	7
72+	7

did not have 3-surface wraparound and the distal contact point was still intact. In addition, the framework of the occlusal bar was only 0.3 mm thick and had become distorted. To deal with this problem, the major retainer was remade, with increased wraparound extending through the distal contact point and increased framework thickness. The new RBFPD had been functioning for 27.5 months at the time of review without any episodes of debonding. The second excluded prosthesis had debonded after 53.9 months and used the second premolar for the major retainer and the third molar as the minor retainer. Thus this prosthesis did not meet the desired design criteria. After removal of the minor retainer, the FPD was replaced with a fixed-movable RBFPD with the major retainer on the posterior abutment and was in situ for just over 2 months.

The 3 remaining debonded prostheses that did meet the inclusion criteria were also replaced with fixed-movable RBFPD prostheses with improved design. One of the debonded prostheses had been lost by the patient, and therefore it was not possible to comment on the framework design. However, there was an intercuspal contact on the mesiobuccal cusp that was not covered by the framework, and this was the only contact point on the abutment. The debonded major retainer was remade again as a fixed-movable design, but with increased wraparound (360 degrees) and extension of the framework to cover the intercuspal contact point on the mesiobuccal cusp tip.

The second fixed-movable RBFPD replaced the mandibular second premolar and first molar and had debonded 3 times. The first debond was at 12 days. This was attributed to an “occlusal interference,” which was “adjusted” and recemented. The prosthesis again debonded after 22.8 months and was recemented, with no comment made about occlusal interferences. After 5.3 months, it again debonded, at which time the likely cause was judged (by MB) to be a nonworking-side interference, as indicated by a wear facet on the posterior abutment. Because the framework was considered to be satisfactory in design, the prosthesis was recemented after occlusal adjustment of the wear facet on the second molar.

The last debonded prosthesis replaced the mandibular second premolar and first molar and had debonded on the minor retainer after 87 months of service. The major retainer was cut off and the movable joint was judged to have minimal stress-breaking effect, with little or no apparent trimming of the matrix and patrix to allow independent movement between the abutments (Fig 3). This prosthesis was actually one of the first long-span RBFPDs placed, and the importance of a loose, nonrigid connector was not realized at that time. There was no caries under the minor retainer; in this instance, the prosthesis was remade again as a fixed-movable RBFPD with increased wraparound on the premolar abutment, and a movable joint was created that allowed movement between the major and minor retainers.

For completeness of the review, the clinical records of the few patients who could not attend for examination were reviewed for any evidence of failure that might have been observed at previous clinical examinations. One patient who was overseas at the time of the review had a 7-unit RBFPD that replaced a span from the mandibular left canine to the right lateral incisor; this had been clinically reviewed at a recall appointment and was noted as being clinically retentive up to 41 months. Another patient had the RBFPD in place for 6 weeks but did not return for further treatment, and no failure had been recorded. The remaining patients had received hybrid FPDs (ie, a conventional and resin-bonded retainer) and therefore did not meet the examination criteria.

Discussion

The aim of this study was to clinically evaluate long-span RBFPDs that had been designed on principles aimed at meeting the demands of increased loading. These included: selection of an abutment with the larger surface area/resistance form; appropriate tooth preparation to increase resistance form, particularly on the major abutment; increased framework resistance of the major retainer by way of at least 3-surface wrap-around; an occlusal bar; and a modified movable joint to allow movement between the abutments to reduce interabutment stresses.

There are no equivalent data suggesting improved success of RBFPDs with a fixed-movable joint for comparison; however, there are some relevant data on conventional FPDs that have incorporated nonrigid connectors. In a clinical review of 515 FPDs, Walton[25] found that the use of 1 or more nonrigid connectors in a FPD had a significant decrease in retreatment rates when compared to fixed rigid prostheses. This was attributed to individual and differential tooth movement allowed by nonrigid connectors, which was suggested to reduce harmful flexural forces on the prosthesis.

In a study of 9 conventional fixed-movable posterior FPDs, Foster[26] observed greater longevity of these prostheses when compared to fixed rigid designs; however, the difference was not statistically significant. In an evaluation of 2,000 retainers, Roberts[27] showed that both posterior and anterior fixed-movable three-quarter-crown retainers had lower failure rates (5.8% and 13%, respectively) than their fixed rigid counterparts (23% and 24%, respectively). These differences may have been a result of reduced interabutment stresses with fixed-movable designs, or a result of the opportunity for more retentive tooth preparations along the long axis of the abutment that is permitted by a fixed-movable connector or a combination of the two.

The benefit of connectors that distribute stress between different components of prostheses is also supported by Studer et al,[28] who observed the success of abutment-supported partial dentures that had "rigid" and "semirigid" crown attachments. In these results, 45 of 50 failed reconstructions belonged to the rigidly attached group, which was significantly more than the semi-rigidly attached group.

While a number of studies have reported that increasing prosthesis length in RBFPDs was associated with lower retention rates,[6,9,15,29] most have not reported the actual service life for long-span RBFPDs to allow a comparison with the current findings. Djemal et al[9] demonstrated Kaplan-Meier survival plot data showing significant differences between RBFPDs with 4 or fewer units or less, versus those with 5 or more units. However, these data were pooled and included cantilever, fixed rigid, splinted, and hybrid designs of prostheses, so a comparison with the present data would not be appropriate.

The findings of this preliminary study have limitations, given the relatively small sample size, the wide age range of the prostheses placed, and the fact that 17 of the prostheses had been placed by an experienced operator and the remainder were placed by students or recent graduates with fewer than 4 years of clinical experience with FPDs. Some studies have shown differences in success of RBFPDs based on the experience of clinicians providing treatment. However, while some data show a positive relationship between experience and prosthesis success,[9] other studies show less success with experienced operators; this was attributed to the greater complexity of cases taken on by senior staff.[6] On the other hand, other studies have shown no effect of clinical experience on clinical outcome for RBFPDs.[30–32]

In the present patient sample, all of the failed prostheses replaced posterior teeth. This might be attributed to higher occlusal loading on posterior abutments or, as is suggested by the present study, that adverse occlusal contacts on the tooth tissue of the major retainer abutment and not the retainer itself may be a risk factor for premature failure. Adverse occlusal contacts on the abutment rather than the major retainer were observed in 2 of the 3 failed RBFPDs. The effects of occlusal contacts on abutments rather than retainers have been previously identified as potential risk factors for early failure of fixed rigid RBFPDs.[4,5,33] Based on these observations, it appears to be important to control adverse tooth contacts on the abutment by extending coverage of the framework of the major retainer or by performing an occlusal adjustment to remove the adverse contact.

The use of movable connectors for RBFPDs has other advantages, in that the loads on compromised minor abutments may be reduced, abutments with different paths of insertion may be prepared conservatively along their long axis, and also, minor retainers may be used with reduced occlusal coverage. However, fixed-movable designs would be expected to place greater loading on the major retainer, are technique sensitive, and have increased costs.

Despite the limitations of this preliminary study, the special design features incorporated into these long-span RBFPDs indicates a potential for greater service life over fixed rigid designs of RBFPDs. The independent movement that is allowed both horizontally and vertically between the abutments of long-span RBFPDs, along with increased resistance form of the major retainer and tooth preparation, appear to be important features for clinical success. While the short-term preliminary findings are promising, longer-term studies of larger samples are necessary to corroborate these results. Given the relatively short mean time in function of the prostheses, even if such prostheses are not accepted as long-term FPDs, there are many situations where they may be useful as longer-term provisional prostheses.

Conclusion

Long-span RBFPDs with increased resistance features, framework strength, and nonrigid connectors appear to have promising clinical success. Further studies evaluating longer term follow-up and larger sample size are required.

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