A Retrospective Study of the Clinical Performance of Porcelain-Fused-to-Metal Resin-Bonded Fixed Partial Dentures

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Purpose: This study investigated the clinical performance of resin-bonded fixed partial dentures (RBFPDs) using minimally invasive, nonretentive abutment tooth preparation. ***Materials and Methods:*** Forty-four patients received 56 porcelain-fused-to-metal RBFPDs (52 three-unit RBFPDs, 4 four-unit RBFPDs). All RBFPDs were inserted between 1995 and 2010 according to a standardized protocol. Thirty-eight RBFPDs replaced anterior teeth in the maxilla, 18 RBFPDs replaced anterior teeth in the mandible, and 3 RBFPDs replaced premolars (1 maxillary, 2 mandibular). At annual recall appointments, RBFPDs were carefully inspected for technical and biologic failures or complications (eg, debonding, abutment tooth caries). ***Results:*** The mean observation period was 76 months, with a minimum of 4 months and a maximum of 198 months. Five RBFPDs debonded. Further complications comprised one instance of porcelain chipping and one caries lesion underneath a loose retainer. One patient was dissatisfied with the esthetic appearance of her RBFPD. The cumulative survival rate with the event "debonding" dropped to 90% after 23 months and then remained constant. Survival rate with the event "any restoration complication" dropped to 84% after 77 months and then remained constant. ***Conclusions:*** With regard to the high patient satisfaction and relatively low incidence of failures and complications, the clinical performance of nonretentive RBFPDs can be considered satisfactory. Hence, within the limitations of this study, the data justify nonretentive RBFPDs as long-term provisional restorations. *Int J Prosthodont 2012;25:265–269.*

Resin-bonded fixed partial dentures (RBFPDs) have become a popular alternative to conventional FPDs when abutments are intact or exhibit minimal caries lesions. Since their introduction by Rochette[1] in the early 1970s, there have been significant changes in technical as well as clinical procedures to improve the longevity of the prostheses. A systematic review[2] of studies published between 1992 and 2005 reported estimated RBFPD survival rates between 63.3% and 98.8% after 5 years.

The recommendations concerning tooth preparation design and its impact on longevity still appear somewhat contradictory. Although RBFPD stability depends primarily on adhesive bonding of resinous cements to a metal or ceramic framework and etched enamel, some authors regard retentive tooth preparation as essential to resist dislodgement and improve success.[3–7] Retentive tooth preparation was found to reduce the risk of failure to almost one-fourth[6] and one-twentieth.[4] Other studies could not confirm the benefit of a substantial tooth preparation and reported insignificant differences in survival probability of RBFPDs with or without retentive tooth preparation.[8–10] An earlier study revealed a survival rate of 86% after 3 years[11] without retentive preparation.

Preparation designs for RBFPDs are strictly limited to the enamel and may comprise palatal veneer preparations, proximal boxes, vertical grooves, guiding planes, or pinholes in the cingulum area.[4,6,12–16] Although considered minimally invasive, the sacrifice of enamel in retentive tooth preparations for RBFPDs is an undesirable side effect when RBFPDs are planned as provisional restorations for a few months after implant insertion or even for years in adolescents suffering from trauma or congenitally missing teeth. However, when omitting a retentive tooth preparation, the merits of preserving the enamel have to be weighed against the possibility of an increased risk

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Table 1 No. of Teeth Replaced in Each Arch (No. of RBFPDs)

	Central incisor	Lateral incisor	Canine	Premolar
Maxilla	10 (9*)	26 (26)	2 (2)	1 (1)
Mandible	14 (11†)	3 (3)	2 (2)	2 (2)

*One four-unit RBFPD replaced both central incisors.
†Three four-unit RBFPDs replaced both central incisors.

Fig 1 Nonretentive abutment preparation for RBFPDs replacing congenitally missing maxillary lateral incisors. The red lines indicate the retainer extension. Retainers ended 1 mm supragingivally.

of debonding and hence the chance of caries should a bond failure go undetected for some time.

This retrospective follow-up study recorded the long-term clinical outcome of porcelain-fused-to-metal (PFM) three-unit and four-unit RBFPDs in the anterior and premolar regions with nonretentive minimally invasive tooth preparations over up to 15 years in adolescent and adult patients. The primary aim of this study was to estimate the risk of debonding. Secondary parameters were failures because of other reasons as well as technical complications of the RBFPDs and biologic complications of the abutment teeth.

Materials and Methods

This retrospective study investigated the survival of 56 RBFPDs in 44 patients (22 females, 22 males) inserted between 1995 and 2010 at the Department of Prosthetic Dentistry at the Medical Faculty of the University of Technology Dresden, Dresden, Germany. The median patient age at the time of insertion was 22 years (minimum: 14 years, maximum: 68 years); 19 patients were 17 years of age or younger The study was approved by the ethics committee of the Medical Faculty of the University of Technology Dresden (protocol no. AK 165072007).

Inclusion criteria were intact abutment teeth or small fillings not interfering with bonding and abutment tooth mobility not exceeding grade 1 provided both abutments showed the same mobility. Contraindications were differences in tooth mobility,[17] bruxism, and inadequate width of tooth-bound spaces (ie, diastema mediale). The RBFPDs replaced 60 teeth in total (Table 1). Three patients received four-unit RBFPDs to replace both mandibular central incisors while one patient received a four-unit RBFPD to replace both maxillary central incisors. The reasons for missing teeth were aplasia (n = 36), trauma (n = 8), periodontal disease (n = 6), and caries or endodontic complications (n = 3). In seven cases, the reasons for tooth loss remained unclear.

Clinical Procedures

Tooth preparation with fine-grain diamond burs comprised a slight grinding of the entire surface for bonding to remove the fluoride-enriched superficial layer of enamel. A horizontal groove of 0.5-mm depth was prepared on the oral enamel surface of the height of the cingulum in anterior teeth to ensure correct positioning of the RBFPDs during bonding (Fig 1). Occlusal rests similar to those for removable partial dentures were then prepared on the marginal ridges of premolars.

Double-mix impressions were taken using addition-curing silicone materials (Provil Putty Soft/Light Body, Heraeus Kulzer) with metal stock trays; starting in 2004, Dimension Garant Heavy Body/Light Body (3M ESPE) was used instead. All RBFPD frameworks were cast in cobalt-chromium alloy (Remanium 2000, Dentaurum) and veneered with porcelain (Carat Ceramics, Dentsply DeTrey). The retainer thickness was 0.3 to 0.5 mm. Ridges in the metal retainers corresponding to the horizontally prepared grooves improved retainer rigidity.

Bonding was accomplished with composite resin cement Panavia EX (Kuraray); starting in 2005, Panavia 21 (Kuraray) was used instead. Prior to bonding, the metal surfaces were air abraded with 50-µm aluminum oxide at 2.4 bar pressure and carefully cleaned with pressurized air. The enamel surfaces were cleaned with pumice slurry and etched with 35% phosphoric acid for 60 seconds. After insertion, the RBFPDs were held in place by the operator for 5 minutes. Then, Oxyguard (Kuraray) was applied, and the material was allowed to set for an additional

Table 2 Failures (n = 6) and Consecutive Treatment with Respect to Location, Tooth Mobility, and Isolation Technique

Failure	Type of failure	Time until failure (mo)	Teeth replaced*	Rubber dam	Tooth mobility	Consecutive treatment
1	Dissatisfaction	77	22	No	0	Implant
2	Debonding	23	13	Yes	1	RBFPD rebonded
3	Debonding	4	32	Yes	0	New RBFPD
4†	Debonding	16	12	No	0	New RBFPD‡
5	Debonding	6	31, 41	Yes	1	New RBFPD
6	Debonding	22	41	Yes	1	Left as cantilevered RBFPD

*FDI tooth-numbering system.
†Caries under loose retainer at the maxillary right central incisor.
‡Designed with a retainer at the maxillary right canine and cantilevered pontic at the right lateral incisor.

10 minutes. After setting, excess material was carefully removed. In 18 of 44 patients, abutment teeth were isolated with rubber dam. In 26 patients, moisture control was accomplished with constant air flow and strategically placed cotton rolls. All RBFPDs were fabricated by the authors, who are senior dentists at the Department of Prosthetic Dentistry of the University Hospital Carl Gustav Carus in Dresden.

The restorations were examined at recall appointments after 1 month and then at 1-year intervals. All patients were instructed to inform the dentist immediately if a retainer appeared loose. At recall appointments, the RBFPDs and abutment teeth were carefully inspected for technical and biologic failures or complications (eg, debonding, abutment tooth caries, porcelain defects).

Statistical Analysis

The WinSTAT software package (Kalmia) was used for statistical analysis. Survival rates of RBFPDs were assessed with the Kaplan-Meier method[18] for the events "debonding" and "any restoration complication." If patients stopped attending recall appointments with their intact RBFPD in situ, the date of the last recall appointment was defined as the point of censoring to analyze the event " any restoration complication." To analyze the event "debonding," failures not related to debonding were censored.

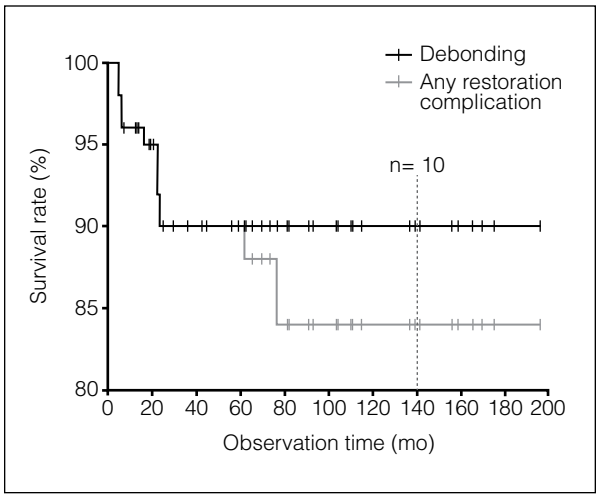

Fig 2 Survival curves of RBFPDs according to Kaplan-Meier[18] analysis (n = 56). After 140 months, the number of RBFPDs dropped below 10.

Results

From the 56 RBFPDs (52 three-unit RBFPDs, 4 four-unit RBFPDs) in 44 patients, 33 RBFPDs (28 patients) were free from complications and still "at risk." One RBFPD showed chipping of the ceramic veneering, which was corrected by grinding and polishing and remained "at risk." Nine patients stopped attending recall appointments with their intact RBFPDs in situ for reasons unknown (n = 5) or because they changed residences (n = 4) and had to be censored. One patient died. One patient decided to have her intact RBFPD removed for esthetic reasons in favor of an implant to replace the lateral incisor (Table 2).

Five RBFPDs in 5 patients showed failures resulting from debonding of one (n = 4) or both (n = 1) metal retainers (Table 2). All 5 patients reported to have noticed the incidence of debonding. Within these 5 cases, 1 restoration was left in situ as a cantilevered RBFPD, 1 RBFPD was rebonded, and a new RBFPD was inserted in 3 cases. One patient developed secondary caries underneath a retainer that appeared to be loose over several months. In abutment teeth with intact retainers, no caries or other biologic complications were detected.

The mean observation period in this study was 76 months, with a minimum of 4 months and maximum of 198 months. Figure 2 shows the survival probability according to Kaplan-Meier analysis. Survival with the event "debonding" dropped to 90% after 23 months and then remained constant. Survival with the event any restoration complication dropped to 84% after 77 months and then remained constant.

Discussion

With groups formed by past clinical decisions, treatment, and documentation, retrospective studies have inherent limitations. However, throughout this study's inclusion and exclusion criteria, clinical as well as laboratory procedures were not altered, with the exception of changes in impression materials and composite resin cement (from Panavia EX to Panavia 21). Both operators were also investigators. Hence, satisfactory data integrity may be considered. According to Johnston,[19] well-documented retrospective studies may be alternatives even to controlled trials when patient selection, unusual diligence over the course of treatment, and infeasibility of blinding limit data extrapolation into daily practice.

The Kaplan-Meier method has achieved popularity to analyze survival. It has been used in numerous studies and thus allows easy data comparison. Survival rates of RBFPDs are still considerably lower compared to conventional FPDs.[20–22] Systematic reviews by Pjetursson et al[2] and Goodacre et al[23] confirmed that debonding was the most frequent complication in RBFPDs and occurred in 19.2% of cases after 5 years and 21% after 4 years, respectively. If retentive tooth preparation is ensured, survival rates of 96% after 6 years have been reported.[4,6]

Contrary to initial beliefs, the use of RBFPDs is not an easy clinical procedure. Careful treatment planning and clinical skills are required. Operator experience seems to have a significant impact on success.[8,10] Garnett et al[10] found RBFPD survival rates of 80% after 30 months when fabricated by senior staff but only 45% when fabricated by supervised students. This may explain the low incidence of debonding in this study, since only two experienced senior faculty dentists were involved in the treatment.

This study focused mainly on debonding to contribute to the risk estimation in nonretentive RBFPDs. Esthetic problems, caries, ingestion, or even aspiration may be adverse effects of debonding. Fortunately, the latter complication seems to be rare.[24] In this study, consequences of debonding were harmful in only one case of caries under a retainer that appeared to be loose for several months. The low incidence of caries lesions on abutment teeth is in accordance with other studies. Systematic reviews[2,23] confirmed a low incidence of biologic complications. Williams et al[25] found an occurance rate of 3% for caries lesions on abutment teeth over an observation period of 10 years.

Most clinical studies on RBFPDs accept more than one restoration per patient[2,4,6,15,17,20,26]; this study allowed two restorations per patient. A randomized selection of one restoration per patient might be a more stringent approach statistically. However, with a low number of events, the randomization process may affect the statistical analysis. In one patient of this study, one RBFPD debonded while the second was still intact. Depending on which RBFPD was included or excluded, survival switched between 90% and 87.5%.

Rubber dam application is strongly recommended as a standard procedure to reduce the risk of debonding.[9,27,28] However, its placement can be difficult in young patients with minimal undercuts because of immature gingival architecture and hinder cementation. Hence, the use of rubber dam should be judged on the merits of each case. This study did not statistically analyze the effect of rubber dam on survival because the patient groups (use/no use of rubber dam) differed substantially in age, conditions of abutment teeth, and occlusogingival height. For similar reasons, the effect of tooth mobility on survival was not analyzed.

With the advent of dental oxide ceramics, all-ceramic RBFPDs became possible, avoiding metal in the visible area of the oral cavity. While fractures occurred quite frequently in the traditional two-retainer design, single-retainer RBFPDs showed improved survival rates.[15,29,30] However, retentive tooth preparations comprising palatal veneer preparations and proximal grooves limit their suitability as long-term provisional restorations. Another metal-free alternative is fiber-reinforced RBFPDs. A systematic review revealed success rates of 45% and survival rates of 64% after 5 years.[26] Obviously material fatigue is still a major problem since framework fractures, wear, and delamination were reported to be the most prevalent reasons for failure. Framework and veneering failures are rare in PFM RBFPDs. In this study, one minor ceramic chipping occurred. Hence, PFM technology in RBFPDs is still the first choice with respect to technical safety and minimal invasiveness. The mechanical properties of cobalt-chromium-molybdenum alloys allow retainer thicknesses as small as 0.3 mm.[14]

Restoration location (anterior or posterior) may[11,31] or may not[2,7,14] have a significant effect on survival. This study did not include posterior RBFPDs because the demand for nonretentive RBFPDs to replace molars was rare. Some definitive posterior RBFPDs were manufactured but excluded from the study because they comprised distinct retentive tooth preparations.

Nonretentive RBFPDs were highly accepted by patients and parents since the treatment is pain free, hard tissue loss negligible, and the restoration convertible. This also has been documented in other studies.[8,32,33] Only one patient wanted her intact RBFPD to be removed in favor of an implant after 6 years. All other patients having reached adulthood decided to keep their RBFPDs.

Conclusions

Within the limits of this study, the clinical performance of nonretentive PFM RBFPDs can be considered satisfactory. With regard to the high patient satisfaction and relatively low incidence of debonding and other technical or biologic complications, RBFPDs are a valuable asset in the clinician's armamentarium to replace anterior teeth or premolars as long-term provisional restorations. However, debonding remains the most common mode of failure. Thus, patients should be instructed to attend the office immediately if a retainer appears to be loose.

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