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RESEARCH ARTICLE

Resin-bonded fixed partial dentures with metal framework a report of 49 cases followed for 2 years

*[1]EL Mesbahi, N., [2]Hamza, M. and [3]Bennani, A.

[1]Rue Saoussane 19 B. BP:20200 Beausejour by Private practice, Casablanca, Morocco
[2]Department of Epidemiology and Biostatistics, Faculty of dentistry, Hassan IIUniversity, Casablanca, Morocco
[3]Department of Fixed Prosthodontics, Faculty of dentistry, Hassan II University, Casablanca, Morocco

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ABSTRACT

Purpose: The survival rates of 49 cast metal resin-bonded fixed partial denture (RBFPD) were evaluated in this clinical study for a period up to 30 months. **Method and materials**: Forty-four patients with a total of 49resin-bonded fixed partial denture (RBFPD) placed between 2010 and 2012were examined after 6-month periods for up to 30 month. Originally, there were 50 patients (the drop-out rate was12%). Partial or complete total debonding of the RBFPD was considered a treatment failure. The data were analyzed with Kaplan-Meier survival test (α=.05). The probability of survival was calculatedfor location anterior/posterior and maxilla/mandible. **Result:** Eight frameworks were debonded. The survival rate calculated using the Kaplan-Meier method (α=.05)at 30 months was 76 %. Only slight but not statistically significant differences between the covariates maxilla/mandible, anterior/ posterior were observed. Six of the failed RBFPDs were rebonded. **Conclusion:** Within the limitations of this study, RBFPDs with cast metal framework seem to be a reliable restorative alternative during a short-term period.

INTRODUCTION

Resin-bonded fixed partial dentures (RBFPDs) with metal framework are an established and conservative methodfor treating single missing teeth mainly in juvenile patients or caries-free dentitions.It is an inexpensive alternative to conventional fixed partial dentures and implant-supported prostheses. Unlike with conventional denture, the basic principle of a resin-bonded fixed partial denture is minimal invasiveness. However, a restoration in an abutment tooth requires a certain occlusal space which is realized by tooth preparation. The longevity is limited, but when the construction fails the negative consequences for the abutments are generally limited, which leaves open several types of other treatment (Kreulen and Creugers, 2013). The main reason for failure of the metal-supported RFPDs was failure of debonding (Ketabi, 2004). Debondingmight be minimized by using retentive preparation forms with slots and boxes (Behr, 1998). The purpose of this clinical study was to collect survival data of RBFPDswith a minimally invasive preparation design placed under controlled clinical conditionsand evaluate the clinical outcomes of RBFPDs over a short period. It also investigated the influence of location on the survival rate of the bonded restorations.

****Corresponding author: EL Mesbahi, N.,***
Rue Saoussane 19B BP : 20200 Beausejour, Casablanca, Morocco

MATERIALS AND METHODS

A total of 55 RBFPDs was inserted into 50 patients between 2010 and 2012 (the starting time of the investigation was April 2010 and the end of the patient intake was July 2012).The follow-up examination stopped at the end of January 2013. The 55 RBPDs were inserted by post-graduate prosthodontists working at the fixed prosthodontics department, Faculty of Dentistry of The University Hassan II of Casablanca in Morocco. Forty-four patients attended the follow-up examination. The drop-out rate was 12%. The six patients who dropped out of the study could not be reached by telephone. The patients were examined by the same clinicianat six-monthly intervals during which the restorations were checked for caries, retention, and occlusion. The patientswere also instructed to notify us if they suspected or detected a failure themselves. Forty-four of 50 patients came to the recall examination. So, the follow-up was done for 49 RBFPDs inserted into 44 patients.

Selection criteria for restorations

The reason for the treatment with RBFPDs, when a single tooth is missing, in most cases was the need of a low-priced fixed prosthesis or a contra-indication for surgical procedure like implants. RBFPDs were made on two immobile and intact abutments for replacement of a missing tooth.So, selection of RBFPDs as the treatment of choice required the presence of

abutment teeth that needed a very small restoration and had sufficient intact, or nearly intact, enamel for bonding. Indication included the need for replacement of single missing tooth and a stable intercuspal position with normal vertical and horizontal overlap. Exclusion criteria included mobility or difference in tooth mobility and parafunctional habits such as bruxism. RBFPDs were made by the same dental laboratory.The RBFPDs were considered to have survived when no loss of retention was detected by the observer or by the patients themselves. Ifa bridge was dislodged from one or from both abutment teeth, it was considered to be a failure.
The characteristics of the treated dentitions and RBFPDs are presented in Table I.

A detailed diagnostic document were prepared for each patient. The pre-restorative documentation included measurements of mobility, detecting caries on abutment teeth and registration of occlusal contacts in static and dynamic occlusion with articulating paper.The clinical procedures were standardized. Any small old restoration in abutments were removed and replaced by new composite fillings. Study casts was also done to determine the most appropriate path of insertion. The abutment tooth preparationswere made with diamond burs.

The design for the preparation was as follows: a lingual or palatal reduction between 0,3 and 0,5 mm creating a minimal interocclusal clearance. It is also advantageous to have a large area of enamel to aid in bonding the plate (palatal or lingual framework) to the abutment tooth. The proximal extension of the plate is limited by esthetics and the proximal contact. In our preparation, we never remove the proximal contact between the abutment and its adjacent tooth and slots were placed on the proximal surfaces of anterior abutment.The margins of the preparations were placed 2 mm gingival from the incisal edge in the anterior anda palatal hole of 1 mm depth on the cingulum was placed on each anterior abutment (Figure1). One proximal box adjacent to the ponticwas placedon proximal surfaces of posterior abutment to provide retention and resistance form to the retainer against the dislodging forces acting on the pontic (Emara et al., 2004). Occlusal strut were prepared to provide rigidity to the resin-bond retainer. The strut is in the deepest part of the tooth and not in occlusal contact with the opposing dentition (Figure 2).

All the preparations were 1-2 mm from the free margin of the gingival. Afterthe abutment tooth preparations, impressions were made with silicone elastomeric impression material.Cavities were protected with provisional filling material free from eugenol for the period of the laboratory procedure. The metal framework was cast with a nonprecious Nickel-Chromiumalloy, pontics were veneered using a glass ceramic (Vita; Bad Säckingen, Germany). During the visits, the bridge was tried in the mounth and all necessary adjustments were made. Prior to luting, the finished RBFPDs were sandblast with 50 μm Al_2O_3 particles and cleaned in ultrasonic cleaner. During the bonding procedure, enamel was etched with 37% phosphoric acid gel for 30 seconds and dentin for 15 seconds. Then, the surfaces were washed thoroughly with the dental unit's air/water spray and air dried until the etched enamel appeared to be frosted and white. The restorations were seated under relatively dry conditions using cotton rolls. No rubber dam was applied.RBFPDs was bonded withSuperbond ® (SunMedical)a self-cure dental adhesive system containing 4-META/MMA-TBBin accordance with manufacturer's instructions.

Bonding agent was appliedquickly to both the preparation and internal surface of the restorationwith a disposable brush. The restoration was seatedwith moderate pressure before the mixture began threading, and excess bonding agent was carefully removed with an explorer. Occlusion was adjusted, and the patients were examined after 6-months periods. Patients were asked to call or visit immediately the dentist examinator if it is any suspicion of debonding. The dentist verified the assumption of failure expressed by the patient. The precise time of the failure was used in the analysis of the results. Follow-up photographs were made for selected patients. The presence of secondary caries was clinically evaluated in recall examinations. Radiographs were no systematically made. If an incident resulted in the loss of the prosthesis, it was defined as a catastrophic failure, eg, caries or loss of retention without the possibility to re-bond. Before rebonding, we proceeded at the removal of the bonding agent remained attached to the tooth and an ultrasonic cleaning and sandblasting of the metal framework.

The parameters evaluated were as follows: anterior versus posterior location and maxillary versus mandibular location. The survival estimation method of Kaplan-Meier was used with SPSS 16.0 statistical software (Statistical Package for Social Science, SPSS Inc, Chicago, III.) at the level of significance of α= 0,05. Survival rates of different groups were compared using Mantel log-rank test.

Table 1. Description of patients and the fixed partial dentures

Variable	n	Maxilla	mandible
Gender of the patient			
Male	13	9	5
Female	31	17	18
Location			
Anterior8		6	2
Posterior	41	20	21

RESULTS

Patients' age ranged from 18 to 71 years with a means of 39 years. The maximum observation period of the RBFPDs was 30 months and the minimum of 6 months. In total, 8 failures, 2 catastrophic and 6 relative, were observed. Four had a complete debond and four had a partial debond. The overall survival rate with respect to all failures was 76% after 30 months (95% CI: 22,25/28,25) (Fig 3). When comparing maxilla to mandible, 6 RBPDS placed in mandible and 2 placed in maxilla debonded.The difference was not statistically significant (Fig 4). Regarding jaw location, 6 RBPDs in the posterior region and 2 in the anterior region failed. No statistically significant difference could be detected in regard to failure rate dependent on jaw location (Fig 5). Five bridges failed within the first 6 months period. Two posterior failures occurred for the period 6-12 months. The recall period 18-24 months showed one failure of a mandibular posterior bridge.
In 2 of the failed RBFPDs, secondary caries were evident in the abutment tooth. After removal of decayed tooth substance, one RBFPD was rebonded (Fig 6). The other one could not be rebonded because the abutment needed endodontic treatment and the RBFPD didn't fit with the preparation geometry (Fig 7). The bonding agent remained attached to the teeth and not on the metal framework (Fig 8). This pattern suggested an adhesive failure as a result of debonding at the resin-metal interface.

Fig. 1. Preparation geometry for anterior tooth

Fig. 2. Preparation geometry for posterior tooth

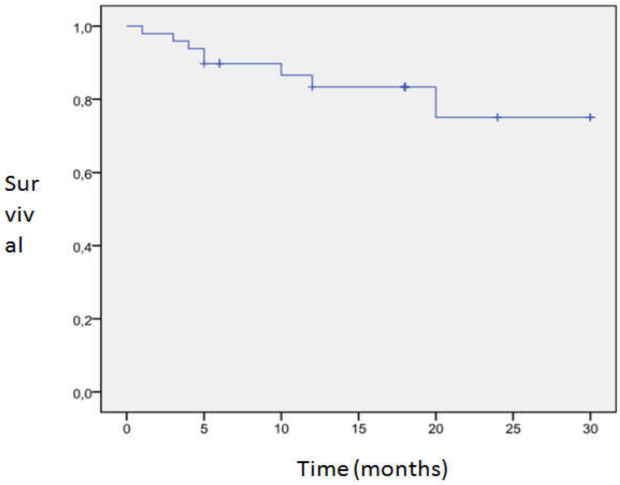

Fig. 3. Kaplan-Meier curve for all failures

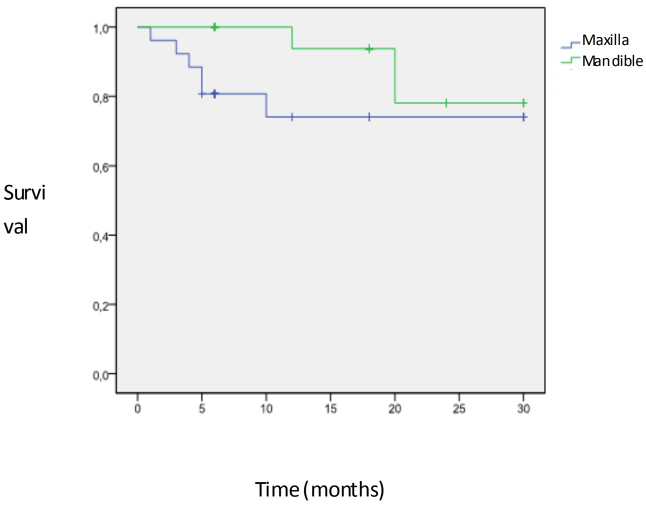

Fig. 4. Kaplan-Meier curve with covaiates maxilla, mandible for all failures

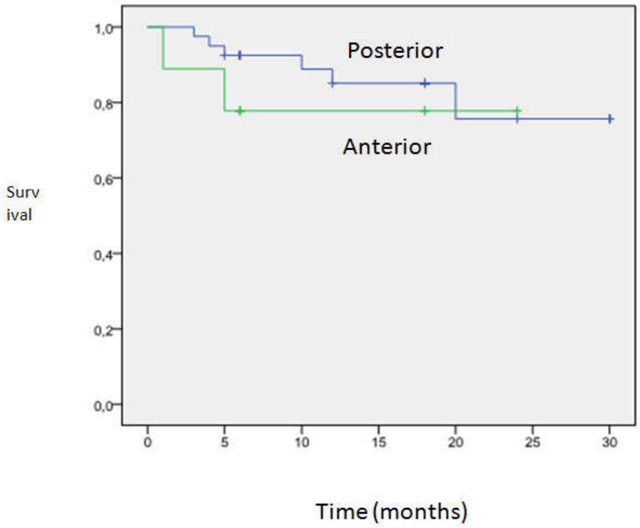

Fig. 5. Kaplan-Meier curve with covariates posterior/ anterior

Fig. 6. A partial debonding of RBFPD b posterior abutment with secondary cariecRBFPD rebonded after caries removal

7 a. Occlusal view after preparation

7 b. Palatal aspect of the RBFPD

7 c. Aspect of secondary caries in posterior abutment

Fig. 7. Catastrophic failure of RBFPD

Fig. 8. Occlusal view after debonding

DISCUSSION

A meta-analysis of 17 studies indicated an estimated survival of RBFPDs of 87,7% (95% confidence interval(CI): 81,6 91,9) after 5 years. The annual debondingrate for RBFPDs placed on posterior teeth (5,03%) tended to be higher than that for anterior-placed (3,05). The difference however, did not reach statistical significance (P=0,157). Also, the case for differences in failure rates between maxilla and mandible RBFPD (Pjetursson *et al*., 2008). The study of Barack (Barrack, 1993). showed that the success rate of 127 restorations has been 92.9%, with a mean longevity of 5 years and 8 months. Rammelsberg, Pospiech and Gernet (Rammelsberg, 1993), recorded an 82,9% survival rate for a 6-year period and they did not find a relation between the location (anterior or posterior) of the adhesive FPDs and the longitudinal success. Aggstalleret al (Aggstaller, 2008), showed an overall survival rate with respect to all failure of 77% after 10 years. Regarding jaw location, a survival rate of 57% in the anterior region and 82% in the posterior region but no statistically significant difference could be detected in regard to failure rate dependent on jaw location. A significant influence factor for RBFPDs was abutment tooth mobility (Paszyna, 1989). Probsteret al. (Probster, 1997), found that restorations on two immobile abutments had a significantly higher survival probability than restorations on mobile abutment. A different abutment mobility also was a very negative prognostic. The major advantage of the adhesive restoration technique is the preservation of dental hard tissues. Therefore, extensive preparations must be avoid. But, in spite of many encouraging advances in the field of material science, resin adhesive materials must not be relied on entirely for the retention of RBFPDs (Chow, 2002). To enhance retention and resistance form of posterior RBFPDs, Livaditis (Livditis, 1980) recommended preparation of parallel guide surfaces on the interproximal and lingual aspects of adjacent teeth with rests on the occlusal aspect to counteract dislodging forces. Chow et al. (Chow, 2002) described the groove, plate, and strut (GPS) design which is a conservative and esthetic approach to RBFPD preparation design. A minimum 180 degree encirclement of the tooth has been recommended (Creugers, 1989) but the occlusal strut contributes rigidity to the casting and eliminates the need for the 180-degree encirclement. Authors (El Salam Shakal, 1997 and Saad, 1995), stated that the surface area of the retainer must be maximized, and it is essential to maximize the resistance and retention form of the resin-bond retainer.

This is accomplished through the use of parallel grooves and occlusal rest seats in the preparation design of the bonded retainer. However, no relation was found between the preparation modifications (except gingival finishing line location) and long-term survival (Serdar, 1997). Boening and Ullmann (Boening, 2012), revealed a cumulative survival rate with the event "debonding" of 90% after 23 months and then remained constant. They concluded that the clinical performance of nonretentive RBFPDs can be considered satisfactory and within the limitations of their study, the data justify nonretentive RBFPDs as long-term provisional restorations. Rammelsberget al (Rammelsberg, 1993), reported that a retentive tooth preparation with parallel grooves and pins reduced the risk of failure to almost one twentieth. Anotherway to minimize debonding is to designRBFDPs as a two-unit cantilever. Several clinical studies ofthe last decade have demonstrated that two-unit cantileverRBFDPs performed as well as or even better than their threeunitfixed-fixed counterparts (Kern, 2011 and Botelho, 2002). The framework of RBFDPs is traditionally made of metal alloys, but their poor aesthetics and the growing awareness towards possible adverse health effects of dental alloys, such as Ni-, Cr-, Co-, Pd-, and Au-containing alloys (Schmalz, 2002 and Torgerson, 2007), stimulated the interest in metal-free restorations. Evidence has shown that all-ceramic RBBs (resin-bonded bridge) can be successful, and have relatively high success rates (Kern, 2005 and Sasse, 2012). Currently, however, they don'tappear to be as successful as traditionalmetal framed RBBs, as shown in a review by Miettinen and Millar (Miettinen, 2013). This review stated that all-ceramic RBBs had an estimated annual failure rate of 11.7% whilst metal framed RBBs had a failure rate of 4.6%. A literature review (Karl, 2016), to identify the outcome in fixed prosthodontics included RBFPDs for single tooth replacement. This study reviewed 258 publications. Metal-ceramic FDPs (fixed dental prosthesis) still show the highest survival rates of all tooth-supported restorations. Resin-bonded FDPs can be seen as long-term provisional restorations with the survival rate being higher in anterior locations and when a cantilever design is applied. Inlay-retained FDPs and the use of fiber-reinforced composites overall results in a compromised long-term prognosis. A study (Keulemans, 2015), evaluate the influence of different framework materials(direct fibre-reinforced composite (FRC-Z250), indirect fibre-reinforced composite (FRC-ES), gold alloy (M), glass ceramic (GC), and zirconia (ZI)) on biomechanical behavior of anterior two-unit cantilever RBFDPs.Finite element analysis revealed, that maximal principal stress showed a decreasing order: ZI>M>GC>FRC-ES>FRC-Z250. Advanced stress analyses suggest a possible difference in predominant failure mode: connector fracture forFRC- and glass ceramic-based RBFDPs and debondingfor metal- and zirconia-based RBFDPs. Kern (Kern, 2011) demonstrated a 10-years survival rate of 2-retainer alumina ceramic RBFPDs of 73,9 %, and for single-retainer FPDs 94,4%. He concluded that, cantilever all-ceramic resin-bonded fixed partial dentures made from high-strength oxide ceramics present a promising treatment alternative to two-retainer RBFPDs in the anterior region.

Conclusion

In this study, the clinical performance of 49 resin-bonded fixed partial dentures was reported. The calculation with the Kaplan-Meier method yielded a survival rate of 76% after 30 months. Within the limitations of this study, including a small sample size, the lack of randomization, and the lake of strict isolation with rubber dam, the following conclusions were made:

- The prosthetic replacement of asingle missing teeth using resin-bonded fixed partial dentures offered an acceptable survival rate.
- The resin-bonded fixed partial dentures' location (maxillary or mandibular, anterior or posterior region) had no influence on the survival rate.
- Despite the relatively high survival rate, debonding means that substantial amounts of extra chair time may by following the incorporation of RBFPDs.

A satisfactory outcome can be achieved by the appropriate selection of materials and bonding systems. So, rigorous planning, careful situation selection, and adherence to proper retentive tooth preparation and cementation protocols can provide for a high success rate.

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