Resin bonded bridgework in a public health service

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Abstract

Objectives: To investigate some of the clinical variables that may affect the longevity of the resin bonded fixed partial denture [RBFPD] in a public health care facility.
Method: A retro-prospective clinical review of patients and records to evaluate the clinical factors that may predispose to failure of RBFPDs placed in the Assir Dental Center based on certain selection criteria was carried out. The variables included patient's age and gender, location and function of pontic in the mouth and the luting cement used. The results were subjected to Chi square and Bivariate regression analyses.
Results: Out of the 133 RBFPDs analyzed, 27 [20.30%] failed. Fifteen per cent of these were debonded prostheses, others failed due to dental caries [3.01%], pain and periodontal disease [2.26%] over a 5-year observation period.
Conclusion: The choice of luting cement was a critical clinical contributing factor to the failure of the RBFPDs.

Keywords: Resin-bonded bridges, public dental health, fixed dental prosthesis.

Introduction

Rochette introduced the use of composite resin technology in the 1970s, when he bonded cast gold retainers to the lingual surfaces of abutment teeth[1]. Retention of his splint/fixed partial denture [FPD] design relied on the undercuts present on the perforated retainer and on the acid etched enamel. Livaditis and Thompson, and then Wood described improvements in this technique which included the use of bonding non-precious alloys and porcelain pontics, the 'Maryland Bridge' [2,3]. This new bridge design had the advantage of ensuring a true mechanical bond at the metal/resin interface without exposing the resin cement to the oral cavity.
The clinical fascination with the Maryland Bridge is that a minimal preparation of the abutment teeth is required. It also has additional advantages of shorter treatment time, reduced patient discomfort otherwise associated with conventional bridge abutment tooth preparation, simpler impression procedures and less demanding technical expertise for laboratory production. The Maryland Bridge is considered a conservative, reversible and cost-effective tooth replacement technique. However, they have exhibited lower retention rates than conventional bridgework. They have been unpopular because of the unpredictability of treatment outcome. Earlier on, the high failure rate was attributed to a weak link in the adhesive interface between the metal and the cement. Many methods were developed to overcome this problem. They included macro-retentive and micro-retentive features on the metallic fitting surfaces and later on, the development of the chemically active resin cements.
Concurrent investigations into the biomechanical principles relating to framework design resulted in recommendations that designs should include features that improve retention and resistance while reducing stresses from functional and parafunctional tooth contacts. The principle is to reduce the effect of dislodging forces on the cement. Recent studies continue to show that with improved prosthesis design, the resin bonded bridges are lasting longer [4-10].
The objectives of this study are to investigate the possibility of prescribing resin bonded bridges in a public health service as a cheap and cost-effective tooth replacement technique and some of the clinical variables that may affect the longevity of the resin bonded FPD.

Materials and Method

The records of all patients who had resin-bonded FPDs [RBFPDs] in the Assir Dental Center between the year 1994 and year 2003 in Saudi Arabia, were reviewed. Those that met the selection criteria were recalled for evaluation by direct telephone contact. Those who were still visiting the Dental Center and met the selection criteria had appointments arranged, when the FPDs were evaluated. Relevant information including the patient's age and gender, date of FPD insertion, type of cement used, number of FPD pontics and retainers were obtained.

Selection Criteria:
The following criteria were used in selecting the FPDs included in this investigation:

1. They were prepared and managed clinically by the author
2. The abutment teeth were vital at the time of tooth preparation
3. They were fabricated by the same technician

4. They had only two retainers - one mesial and one distal in a Maryland bridge design irrespective of number of pontics. All the abutments were prepared to receive retainers. The design followed the recommended guidelines by Barrack[6].
5. They were made from the same non-precious bonding alloy-Wiron 99 [Bego, Bremen, Germany]. A nickel-chromium bonding alloy containing Nickel (Ni 65%), Chromium (Cr22.5%), Molybdenum (Mo9.5%), Niobium (Nb 1%), Iron (Fe 0.5%), Cerium (Ce0.5%).
6. The metal fitting surfaces of the retainers were pre-treated for bonding by grit-blasting with 50μ aluminum oxide particles [Korox 50 Bego, Bremen, Germany].
7. The bridge was bonded with one of the following cements; PanaviaEx21 [Kuraray, Japan], PanaviaEx [Kuraray, Japan] or ABC Cement [Vivadent, Liechtenstein]. These are chemically active resin cements used in combination with macro-retentive features on a nickel-chromium bonding alloy for the bridges under study.
8. Patients were regular attendees at review appointments over the initial 24-month post-cementation period and were available for the annual review or could be invited by telephone.
9. The patient's records revealed a potential five-year post-insertion history.

Data Analysis:
Whenever a debond occurred before the 60th month anniversary of insertion it was recorded as a failure. A debond is decementation or cement failure leading to loosening and removal of the bridge. A decementation detected by probing of retainer margins at a review appointment which results in bridge removal is recorded as a failure. If a bridge is removed for other reasons such as occurrence of secondary dental caries, it is also regarded as a failure. If such a bridge is repaired and recemented, it is regarded as a new bridge and reckoning starts from the new date of insertion. This implies, the bonding procedure rather than the patient was the event used as the unit of analysis. Patients lost to follow-up and missing data were censored from the evaluation.
Patients' ages were pooled into three groups - 15-29 years, 30-49 years and 50-69 years. The pontics were also pooled into three groups for analysis based on their physiologic functions namely; anterior teeth, premolars and molars. They were also analysed based on location in the mandible or maxilla. Bivariate regression analysis of the data was done to compare the worse case scenario of a clinical factor judging by published trends. The results of the variables of the particular clinical factor were then compared statistically with the known supposedly unfavourable group. Statistical analysis was done with the SPSS for Windows 9.0.0 computer program [SPSS Inc, 1998].

Results

One hundred and thirty-three prostheses involving 108 patients; 43 males and 65 females with an age range of 15-62 years met the selection criteria. Forty-six [34.59%] of the bridges were placed in male patients while 87 [65.41%] were placed in females. One hundred and six bridges [79.70%] were successful beyond the 5-year period (Table 1). Twenty-seven bridges [20.30%] failed out of which 4 [3.01%] were lost to dental caries, 3 [2.26%] to periodontal diseases and 20 [15.04%] debonded due to cement failure (Table 2). Failure rate by cement was P_{21}-14.58%, P_{ex}-26.92% and ABC-54.55%. Statistical analysis of the factors namely the effect of patient's age and gender, location of pontic and function are detailed in Table 3.
All the clinical factors demonstrated no significant difference among the variables except for the type of resin cement used. The failure rate of ABC was significantly high compared to the Panavia cements.

Discussion

Resin bonded bridges have been recommended as tooth replacement options under certain conditions. The learning curve for the proper design and clinical management for these prosthesis keeps flattening as understanding of design parameters improve [7-10]. This study establishes the fact that resin bonded bridges can safely be prescribed and used in the public health service for a larger patient population base than those recommended by earlier studies. This is because catchment area of the population studied is different from those of previous reports which were commonly University Teaching Hospital attending patients. Our patients came for treatment in a public service institution as a state sponsored social service. The doctor is their first point of contact for fixed prosthodontic management.

Table 1: Summary of the patients and factors evaluated

Factors	Successful		Failed		Total		Statistics
Gender	**No**	**%**	**No**	**%**	**No**	**%**	**x^2; df**
Total	106	79.70	27	20.30	133	100	**P**
Male	34	73.91	12	26.09	46	34.59	1.88; 1
Female	72	82.76	15	17.24	87	65.41	0.162
Age	106	79.70	27	20.30	133	100	
15-29	47	79.66	12	20.34	59	44.36	0.0909; 2
30-49	48	77.42	14	22.58	62	46.62	0.34
50-69	11	91.67	1	8.33	12	9.02	
Pontic location [arch]	106	79.70	27	20.30	133	100	
Maxilla	71	82.56	15	17.44	86	64.66	0.90; 1
Mandible	35	74.47	12	25.53	47	35.44	0.343
Pontic location [function]	106	79.70	27	20.30	133	100	
Anterior	38	82.61	8	17.39	46	34.59	3.58; 2
Premolar	17	68.00	8	32.00	25	18.80	0.167
Molar	51	82.26	11	17.74	62	46.62	
Type of Cement used	106	79.70	27	20.30	133	100	
P_{21}	82	85.42	14	14.58	96	72.18	12.77; 2
Pex	19	73.08	26.92	26.92	26	19.55	0.0016*
ABC	5	45.45	6	54.54	11	8.27	

***Statistically Significant**

Table 2: Analysis of the causes of failure

Cause of failure	Failures n=27	Percentage of failures [%]	Percentage of all FPDs [%] n = 133
Decementation	18	66.67	13.53
Dental caries	4	14.82	3.00
Periodontal disease	3	11.11	2.26
Patient's wish	1	3.70	0.75
Pain of unexplained origin	1	3.70	0.75

Table 3: Bivariate Logistic Regression Analysis of the clinical variables

Dichotomized factor	B	S.E.	Wald	df	P	AOR	95% C.I. for OR Lower	Upper
Age	-0.884	1.081	0.668	1	0.414	0.413	0.050	3.441
Sex	0.392	0.468	0.702	1	0.402	1.480	0.592	3.700
Jaw	-0.952	0.551	2.981	1	0.084	0.386	0.131	1.137
Cement	1.681	0.673	6.237	1	**0.013**	5.369	1.436	20.078
Pontic	-0.721	0.547	1.737	1	0.187	0.486	0.166	1.421
Constant	-0.753	0.570	1.747	1	0.186	0.471		

df = degrees of freedom p = probability **AOR** = Adjusted Odds Ratio **OR** = Odds Ratio

Variables dichotomized: Age group 50-69 against the younger groups; Males vs. Females; Mandible vs. Maxilla; ABC vs. Pex & P21; Molars vs. Premolars & Anterior teeth.

The traditional selection criteria for the prescription of resin bonded bridges suggest extra caution on grounds of age, pontic location and function [11-15]. This report shows that patients of all ages can have and use resin bonded bridges successfully. The study also confirms that resin bonded bridges can be used successfully in the replacement of molar teeth irrespective of the jaw, whether mandibular or maxillary. This is a major departure from earlier reports which tended to suggest extreme caution or outright contraindication in this segment of the mouth [7, 8, 13-15]. The molar pontics were not only the modal functional group, they displayed as high a success rate as any other segment of the mouth. Success rates were generally high and demonstrated little clinical significance among many parameters evaluated except for the choice of the cementing medium. Bivariate regression analysis as used in this study allows both only inter-factor analysis and intra-factor non-parametric analysis on a pair-wise case by case basis. For example, it examines the results of the elderly age group against the results of very young and compares them for statistically significant differences. Clinical data of this nature is collected on a nominal scale that encourages only non-parametric statistical evaluation making measures of association and directions difficult. Studies on the ordinal scale should now be designed to identify the specific factors that directly affect the treatment outcome.

Clinical evaluations of resin bonded bridges have reported failure rates ranging from 10.5% to 34.9% over five or more years study periods [3, 5-8, 16-18]. The result of a failure rate of 20.3% appears on the high side if one considers the private practitioner's confidence level of prescribing resin bonded bridges for patients in any practice setting. The choice of the resin luting cement contributed significantly to the outcome of treatment. However, clinical studies continue to show that a learning curve exists with the use of resin bonded bridges [9 10, 12, 14, 19, 20]. This implies that an initially high failure rate usually declines with time and operator familiarity with the technique.

Unfavorable resin composite shrinkage stresses developing during the setting reaction were thought to contribute to the high rate of early failures. It is noted that such stresses developing over time may not be strong enough to cause immediate debonding, but substantial enough to introduce cracks in the cement and contribute to delayed failure [21,22]. Where the fit is not close enough, such stresses can actually be very detrimental as a thick layer of resin composite is present at the interface. This will increase polymerization shrinkage stresses and potential failure.

Some patient related factors specifically associated with public health service may have contributed to a high rate of failure. These include:

1. The characteristic compromised authority of the clinician over patient selection in a public health service, where the balance between potential allegation of negligence, based on discrimination and denial patient's right may not be clearly defensible by the clinical documentation of patient's presentation. Hence, more borderline cases receive treatment, thereby increasing the potential for failures. For example, poor selection of abutment teeth in questionable periodontal health or oral hygiene habits could potentiate dental caries or aggravate the periodontal disease. Yet, convincing the patient and the hospital administration that such conditions contraindicate fixed prosthesis is an uphill task in our social setting.
2. Patient's compliance with oral hygiene instructions depends on individual patient's motivation and may be difficult to enforce. For instance, many patients did not follow post-insertion instructions particularly, the use of superfloss or similar devices for supplementary cleaning. Typically, patients fail to obtain their own supplies once they run out of free hospital supplies.
3. The learning curve of training an inexperienced technician, operator understanding of essential manipulation techniques of individual cements and optimal design parameters in specific cases.
4. It is less significant but important to mention that not all the bridges classified as debonded did so due to cement failure. Some were debonded simply because the patients were not happy with the bridge design. Some others were debonded because patients felt uncomfortable with them or there was pain of unexplained origin.

It is interesting to note that nearly half of all the bridges were demands for lost molar replacements. This suggests that masticatory impairment was a major motivating factor for seeking prosthetic treatment. It is also interesting to note that the largest age group that sought treatment was the middle-aged adult group [30-49 years old]. We belong to a community where dental caries and periodontal disease are high and consequently tooth loss. The pattern of tooth loss also appears to worsen exponentially with age [23, 24]. A primary need for a sense of well-being may be responsible for this trend in demand for functional repair. It should also be noted that this is a social service provided absolutely free, suggesting a closing of the gap between need and demand.

Females and young adults [15-29 years old] also formed a sizeable group demanding treatment in this study. This was to be expected because of the esthetic concern in this age group. It is important to mention that a significant proportion of this age group were referred from the orthodontic clinics and may probably have rightly assumed that these replacements were part of the management for unesthetic malocclusions they presented with initially. The failure rates in these two groups remained comparatively low.

The premolars formed the highest unsuccessful pontic group The involvement of the premolars in occlusal guidance during the various mandibular excursions may predispose the adhesive interface to constant unfavorable stresses. Such stresses may be responsible for the very high failure rate observed. Minimal preparation bridges have been accused of contributing to occlusal interferences during lateral excursions [25]. Our results seem to indirectly corroborate such claims. This study also supports previous observations that maxillary molars are good for resin bonded bridge replacements [7, 10, 18, 19]. Reasons adduced for the higher success rates in the maxillary molar region compared to the mandibular region include; differences in abutment crown heights, different points of occlusal load impact, greater difficulty of moisture control in the mandibular region, more unfavorable deformation of the mandible during mastication and constant exposure of the mandibular prosthesis to the oral clearance pathway of saliva.

Clinicians should always bear this higher risk in mind when prescribing Maryland bridges. They are encouraged to carry out those clinical procedures that may reduce the incidence of bridge failures, such as crown lengthening, occlusal adjustments and optimal moisture control techniques. The technical expertise required to fabricate resin bonded bridges is certainly less demanding than that required for conventional bridges. This fact and the use of non-precious bonding alloy will ensure that a cheaper and cost effective tooth replacement is prescribed for the patient. It also makes it affordable for public dental care service providers and private dental practices. Further, with the development of improved designs and bonding technology, standardized procedures are just emerging, which means better results can be expected with time.

Conclusion

It can be concluded from this study that the choice of luting cement was a critical clinical contributing factor to the failure of the RBFPDs.

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