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# An Evidence Based Approach for the Provision of Resin-Bonded Bridgework

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**Abstract -** *Resin bonded bridgework (RBB) is a technique often overlooked by practitioners despite a large amount of evidence supporting the technique. In Cork University Dental School an evidence-based, standardised approach for the delivery of RBB by undergraduate students has been developed over the past 10 years. The aim of this study was to evaluate the success of this standardised approach on the delivery of RBB by students. 222 bridges were reviewed which had been delivered over a 6 year time period between 2002 and 2007. A success rate of 84.1% was achieved with a mean survival time of 41 months. This study illustrates that predictable and highly successful RBB can be delivered by inexperienced clinicians using an evidence-based, standardised approach.*

KEY WORDS: resin-bonded bridges, undergraduate students, evidence-based practice.

## INTRODUCTION

Resin bonded bridgework (RBB) can offer a simple yet effective option when considering the replacement of missing teeth. Evidence shows that it can provide a successful, predictable outcome with high levels of patient satisfaction[1-3]. However many practitioners appear to be reluctant to utilise RBB, instead often choosing conventional designs which are more destructive of tooth tissue. Reasons for this may include a lack of confidence in the technique supported by early studies which reported high failure rates[4,5]. A more recent systematic review also identified educational issues including a lack of knowledge and understanding of the technique as one of the key barriers to greater use of the RBB by clinicians[6].

Since RBB evolved from the Rochette Bridge described in 1973, there have been significant changes in bridge design, materials used and in abutment tooth preparation[1]. Current bridge designs use sandblasted, non precious metal cemented with chemically active resin[7]. A cantilever design is favoured to reduce the amount of tooth preparation and to produce a more retrievable restoration. Evidence illustrates that RBB placed using current techniques can achieve high success rates with survival of up to 87.7% reported after 5 years[8].

At the present time, there is limited information on the teaching of standardised treatment protocols for RBB to undergraduates. This study aims to show that by adopting a logical, simple and reproducible technique for providing RBB that a high degree of success can be achieved. A retrospective clinical study was conducted to review the clinical performance of RBB placed by undergraduate students in Cork University Dental School and Hospital, Ireland. All undergraduate students in the dental school are taught a standardised protocol for the preparation of RBB as part of a preclinical crown and bridge course which is then followed on the restorative clinic[9] (Table 1) (Figure 1,2 ).

The standardised protocol has been developed over a number of years and itself is based on available evidence. Whilst some authors argue that preparation of the abutment teeth is unnecessary, evidence shows that tooth preparation increases retention and resistance[10]. Preparations are used to produce retentive forms and to simply increase the surface area for bonding. Fundamentally, all preparations should remain within enamel to take advantage of better bonding conditions. Minimal preparations expose more reactive enamel, which improves the cement bond[11,12]. Preparing the palatal/lingual surfaces of the abutment teeth allows an adequate framework thickness to be incorporated into the RBB. The framework should be as rigid as possible, thus preventing flexure. It has been shown that an increase in thickness has a corresponding increase in resistance to dislodgement[13]. A thickness of a least 0.7mm metal work is now recommended by many authors[14].

Resistance form and retention are gained in the anterior dentition by the placement of a rest seat in the cingulum area. On the posterior teeth (premolars and molars) occlusal seats are placed on the mesial and distal marginal ridges. A seating groove is placed on the longest wall next to the pontic area on abutment teeth. Similar to the conventional bridge, reduction of the axial walls of the abutment teeth should allow for a single path of draw for the prosthesis[15]. No temporary restoration is required as the preparation is only in enamel. For occlusal considerations it is recommended that there is only one opposing contact on the abutment wing with light contacts on the pontic, especially in lateral excursions[16].

A clear laboratory prescription is written to provide the technician with information detailing the preparation features, prescribed metal extensions and pontic design for the bridge. The metal used for construction of the bridge

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**Table 1** *Standardised protocol followed in Cork University Dental School*

*Case Selection*
1. Cantilever designs are favoured over fixed-fixed.
2. Short spans replaced.
3. Only one opposing contact on the abutment wing.
4. No contacts on the pontic, especially in lateral excursions.

*Tooth Preparation*
1. 0.7mm preparations carried out on the lingual or palatal surfaces of the teeth.
2. The preparation is confined entirely to enamel and includes a chamfered finishing line.
3. The margins should finish at least 1mm above the gingival margin, short of the proximal contact area and fade out towards the incisal edge.
4. Occlusal support is gained in the anterior dentition by the placement of an occlusal seat in the cingulum area.
5. On the posterior teeth (premolars and molars) occlusal seats are placed on the mesial and distal marginal ridges.
6. A seating groove is placed on the longest wall next to the pontic area on abutment teeth.
7. Reduction of the axial walls of the abutment teeth should allow for a single path of draw for the prosthesis.
8. No temporary restoration is required as the preparation is only in enamel.
9. Full arch impressions are taken using an addition silicone impression material.
10. Retraction cord is usually not necessary as preparations finish supragingivally.

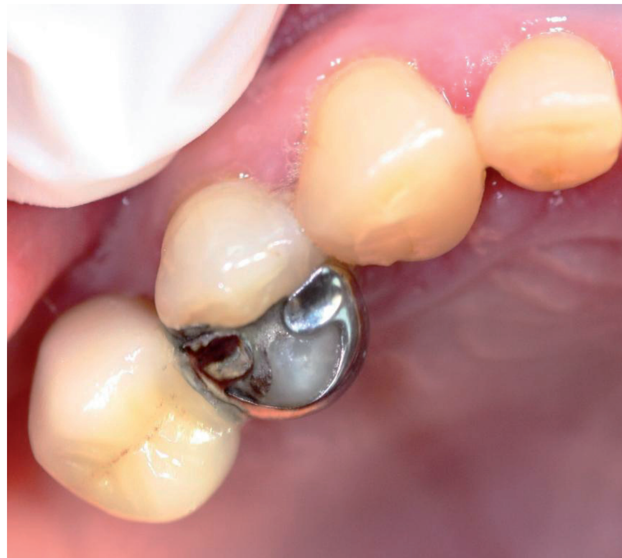

**Figure 1.** *Cantilever RBB replacing 25 placed by a final year undergraduate student. The preparation on the 24 includes mesial and distal rests.*

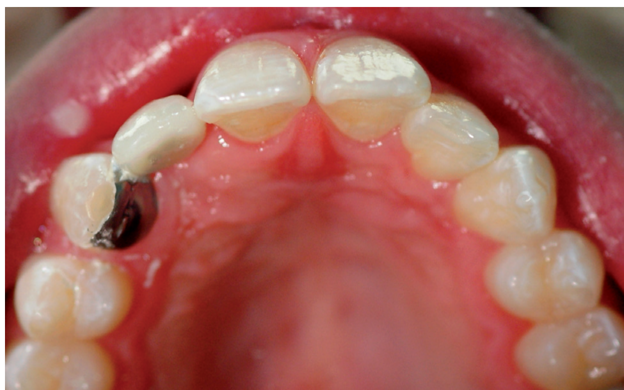

**Figure 2a.** *RBB replacing 12 placed by a final year undergraduate student*

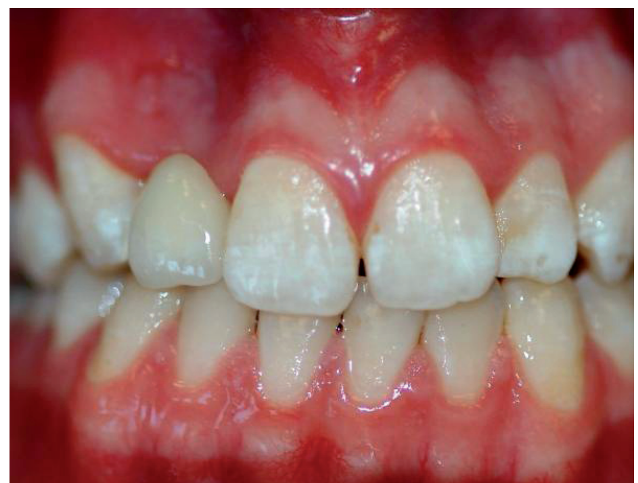

**Figure 2b.** *Anterior view of RBB placed by undergraduate student*

is Nickel-Chromium (NiCr), which is sandblasted with 50µm alumina on the fitting surface by the laboratory. Non-precious alloys are preferred as they are more rigid in thin section, having a modulus of elasticity twice that of type 4 gold[17]. Sandblasting is advocated as it increases surface roughness and the potential bonding area[18]. Bridgework is tried in the patient's mouth to check fit prior to cementation. After fit has been deemed satisfactory the fitting surface is again sandblasted chairside. Following sandblasting, care is taken to avoid contamination and the prosthesis is never retried on the stone model[19]. Panavia™ 21 (Kuraray Co. Ltd, Kita-Ku, Osaka, Japan.) and Panavia™ F (Kuraray Co. Ltd, Kita-Ku, Osaka, Japan.) are the cements of choice for bridge cementation and these are used strictly according to manufacturer's instructions[20]. Panavia is a chemically active resin cement which bonds to the oxidised surface of non-precious alloys. The use of rubber dam is advocated where feasible to provide optimal moisture control[14].

## MATERIALS AND METHODS

Treatment provided by undergraduate students was evaluated with a retrospective clinical study. Patients were eligible for inclusion in the study if they had been treated for tooth/teeth replacement using RBB constructed by an undergraduate student. Patients were excluded if treated by members of hospital staff. All patients treated between 2002 and 2007 were eligible for inclusion in the survey as computer records were available for patients attending during that time period. A protocol and study design were prepared and submitted for ethical approval by the Cork Teaching and Clinical Ethical Committee. Full ethical approval was granted.

The records of all patients provided with RBB on the student clinic at Cork University Dental School and Hospital between 2002 and 2007 were evaluated. In total 259 patients had RBB placed during this study period. All eligible patients were initially contacted by post and invited to participate in the study. Each patient received a letter explaining the purpose of the study and assuring them that future care at Cork University Dental School and Hospital would be unaffected by their decision to participate. The letter also guaranteed that any information collected would remain confidential. Participation involved completion of a questionnaire and consent to the review of clinical records. A pre-addressed envelope was enclosed with the study documents.

A simple questionnaire was devised for the purposes of the study and piloted. After some minor modifications the questionnaire was widely distributed. The questionnaire recorded: reason for treatment, complications during and after treatment, and treatment satisfaction. Satisfaction with treatment was assessed using a visual analogue scale (VAS) completed by the patient. A separate questionnaire was provided for each individual bridge received by the patient. The degree of patient satisfaction and their perceptions of the function of the restorations were assessed using the following parameters: 'function', 'appearance', 'avoidance of loading', and 'recommendation to other patients'.

After the initial response rate from the postal questionnaires proved to be low the study protocol was modified so that non responders were contacted by telephone. Each patient received a telephone call from a research nurse and was invited to participate in the study with the same assurances regarding confidentiality and future treatment. Participants completed the questionnaire over the telephone with their answers transcribed by the research nurse. For these patients, satisfaction was scored on a scale from 0-10 instead of a VAS.

A standardised proforma was developed for reviewing patients' records. A bridge was considered to have been unsuccessful if it had debonded on more than one occasion and/or if it required replacement. Information recorded included: age and gender of patient, reason for treatment, date of cementation of bridge, bridge design, location of the bridge in the arch and any post-operative problems including debonding. Data was collated and entered using Microsoft Excel (Microsoft® Office Excel 2003, Microsoft Corporation, Redmond, USA.). Data was analysed using SPSS® and statistical significance was determined at $p<0.05$.

## RESULTS

A review of clinical records revealed that 326 units of RBB were fitted for 259 patients during the period from January 2002 until December 2007. 116 patients returned the questionnaires but six patients completed the questionnaire incorrectly and were removed from the survey. This gave an initial response rate of 44.8%. When patients were contacted by telephone, a further 51 participated in the study giving a total of 167 participants. This gave an overall response rate of 64.5%.

In total, 222 items of RBB were delivered to the study participants. This made up 68.1% of the total RBB delivered during the investigation period. The study group included 104 females (62.2%) and 63 males (37.7%). 151 items (68.0%) of RBB were delivered to the female participants with 71 items (32.0%) delivered to the males. The mean age of the study participants was 47.8 years (range 16-79 years). For the non-responders, the mean age of the patients was 53.2 years (range 16-82 years) with 55.4% females and 44.6% males.

The majority of the bridgework (47.7%) was placed exclusively in the anterior portion of the mouth, replacing incisors or canines. 24.3% of the bridgework was placed posteriorly, replacing premolars or molars with 27.9% replacing a combination of anterior and posterior teeth. More than two thirds of the bridgework (68.5%) was placed in the maxillary arch with approximately one third (31.5%) placed in the mandible.

Overall, the success rate was 84.1% with 187 bridges still in place at the time of the investigation. (Table 2) For bridgework placed in the maxilla the success rate was 88.8% with 135 bridges in place. In the mandible 37 bridges were still in service giving a success rate of 81.4%. There was not a statistically significant difference in the success rate for bridges placed in the upper versus the lower arch ($p=0.03$). A chi-squared test showed that there was a statistically significant difference between the success rates for bridges placed anteriorly compared with those placed posteriorly ($p<0.001$) and in combination ($p<0.001$). There was not a statistically significant difference between the success rates for posterior bridges compared with those

replacing a combination of anterior and posterior teeth (p=0.45). The mean duration of ongoing clinical service for the successful bridges was 41 months (range 6-75 months). (Figure 3) The majority of bridges replaced a single tooth (90.5%) with much fewer replacing two (8.6%) and three teeth (0.9%). (Table 3)

The RBB delivered was divided according to bridge design. The majority of the bridges placed were cantilever (61.7%), with smaller numbers of fixed-fixed (34.7%) and hybrid (3.6%) designs. The cantilevers achieved the highest success rates (90.3%), followed by fixed-fixed (75.7%) and hybrid bridges (57.1%). (Table 4) Using a chi-squared test there was a statistically significant difference between the success rates for cantilever and fixed-fixed designs ($p<0.001$). There was also a statistically significant difference between the success rates for hybrid bridges and the other designs but the small numbers recorded make interpretation difficult. ($p<0.001$) The most successful bridges were cantilever designs placed in the anterior maxilla with 92.3% still in position when surveyed.

In total 45 bridges debonded with 10 of these successfully recemented. 33 bridges debonded more than once and two others were replaced with conventional bridgework, all of which were considered to have failed. For the unsuccessful bridgework, the average length of survival was 38 months. Three of the bridges failed within the first 16 months with 7 bridges failing after 4 years. The overall failure rate was greater in the mandible (28.3%) than in the maxilla (12.3%) ($p<0.01$). The greatest number of failed bridges were those in the mandibular posterior region (3.2%).

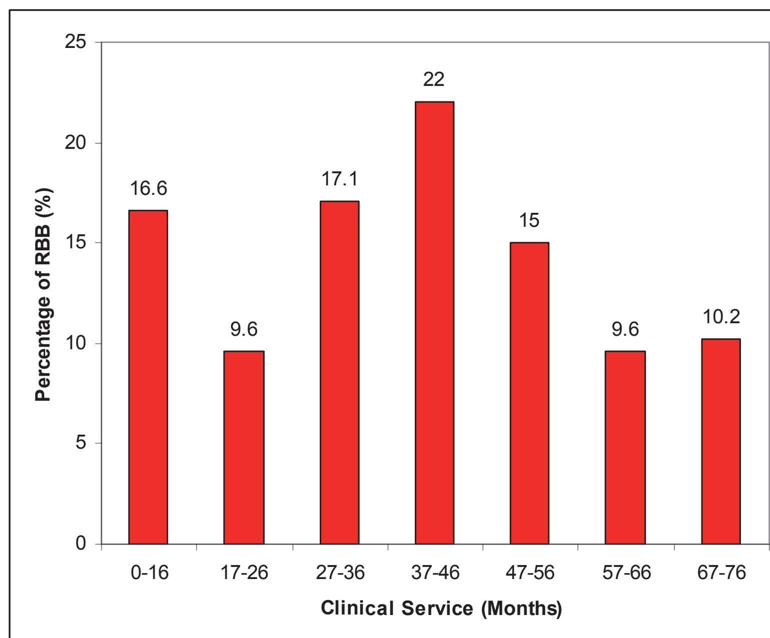


**Figure 3.** *Length of clinical service of successful bridges.*

**Table 2** *Success rates for RBB*

| *Outcome* | *Location of RBB* | | | *Total (n=222)* |
|---|---|---|---|---|
| | Anterior (n=106) | Posterior (n=54) | Combination (n=62) | |
| Successful (%) | 91.5 | 75.9 | 79.0 | 84.2 |
| Not Successful (%) | 8.5 | 24.1 | 21.0 | 15.8 |

**Table 3** *RBB categorised according to number of teeth replaced*

| *Number of teeth replaced* | *Number of bridges (N=222)* | *Percentage of total RBB (%)* |
|---|---|---|
| 1 | 201 | 90.5 |
| 2 | 19 | 8.6 |
| 3 | 2 | 0.9 |

**Table 4** *Success rate for RBB according to design and location*

| *Outcome* | *Bridge Design* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Cantilever (n=137)* | | | *Fixed-Fixed (n=77)* | | | *Hybrid (n=8)* | | |
| | *Mandible* | *Maxilla* | *Total* | *Mandible* | *Maxilla* | *Total* | *Mandible* | *Maxilla* | *Total* |
| Success (%) | 83.8 | 93.1 | 90.3 | 76.0 | 75.6 | 75.7 | 66.7 | 50.0 | 57.1 |
| Failure (%) | 16.2 | 6.9 | 9.7 | 24.0 | 24.4 | 24.3 | 33.3 | 50.0 | 42.9 |

**Table 5** *Patient self reported satisfaction with successful RBB.*

| *Satisfaction (VAS)* | *100%* | *>90%* | *<90%* |
|---|---|---|---|
| Percentage of respondents (%) | 42% | 67% | 33% |

**Table 6** *Criteria and description of degrees for assessment of satisfaction*

| *Criterion* | *Degree of satisfaction* | *Result* |
|---|---|---|
| Appearance | Completely satisfied | 157 (84.0%) |
| | Reasonably satisfied | 23 (12.3%) |
| | Not satisfied | 7 (3.7%) |
| Function | Completely satisfied | 158 (84.5%) |
| | Reasonably satisfied | 25 (13.4%) |
| | Not satisfied | 4 (2.1%) |
| Avoidance of Loading | No | 99 (52.9%) |
| | Sometimes | 70 (37.4%) |
| | Always | 18 (9.6%) |
| Recommend this Treatment | Yes | 170 (90.9%) |
| | Do not know | 10 (5.3%) |
| | No | 7 (3.7%) |

Overall, the majority of participants indicated that were very satisfied with the RBB provided. In total 67% patients rated their overall satisfaction with treatment between 90% and 100%. 33% rated their satisfaction with treatment at less than 90%. (Table 5) The majority of patients with successful bridgework indicated that they were completely or reasonably satisfied with the appearance and the function of the RBB (95.4%) with only 4.6% not satisfied. 93.8% of participants with successful bridgework indicated that they would recommend this sort of restorative treatment to other patients. (Table 6)

## DISCUSSION

RBB is considered a successful and versatile option in the treatment of missing teeth. Predictable and user-friendly bonding systems have encouraged the development of adhesive alternatives to conventional bridgework. Compared with conventional designs, RBB is a more conservative approach to fixed prosthodontics with a much lower biological price. It can be used as a long lasting definitive restoration or as a provisional restoration following implant placement. RBB can be used successfully in the treatment of patients of all ages and can be utilised as a fixed retainer after orthodontic movement of teeth, although some authors report higher failure rates in these clinical situations[21].

Patients are generally accepting of RBB as the amount of operative time is often much less compared with conventional bridgework and financial costs are typically lower.

However, despite convincing evidence many practitioners working in general dental practice overlook RBB when considering fixed prosthodontic options for tooth replacement. This study aimed to enhance the evidence base supporting the use of RBB. It was hoped that by illustrating that the use of a standardised technique can be highly successful in the hands of inexperienced operators more experienced practitioners would consider the technique as part of their armamentarium. It was hoped that by teaching undergraduate students a standardised protocol that they would continue to use the techniques after graduation.

This study was based on a retrospective design which relied on interpretation of accurate case records. A relatively high number of patients were lost to follow up (n=92) as many attended the dental hospital for single items of treatment rather than remaining as long term patients. However, there was no evidence of any systematic differences between those patients who participated in the study and those who did not according to age and gender distribution. Despite these limitations the study illustrated that students using the standardised protocol achieved positive and successful results. The success rate of 84.1% achieved was comparable with previous survival data reported on resin-bonded bridges[22-25]. A recent meta-analysis reported an estimated survival of 87.7% for RBB after 5 years[8]. Compared to the outcomes of similar data collected for undergraduates the success rate is also very favourable [26,27]. The average debond rate recorded in this study (5.8% per year) is low and comparable to similar results in the literature[26].

Overall patient satisfaction with the RBB was very positive. 67% of the respondents with successful bridges reported an overall satisfaction of greater than 90%. The majority of patients indicated that they were satisfied with both the function and the appearance of the RBB. In addition, more than 90% of the participants would recommend this sort of treatment to others. Even for the patients for whom the RBB failed the degree of satisfaction recorded remained high.

The results of this study illustrate that by utilising a standardised treatment protocol the undergraduate students produced successful and predictable RBB which was deemed satisfactory by the patients treated. Practitioners should be encouraged to adopt an evidence based approach when treating patients and to include RBB as a viable option for the replacement of missing teeth when utilised according to evidence based protocols.

## CONCLUSION

RBB delivered according to a standardised and evidence-based protocol by undergraduate students provided successful restorations for patients. Only 15.8% of bridges provided failed after a mean service period of 41 months. The fact that these prostheses were delivered by students of limited experience further highlights the success. This study clearly illustrates that RBB is a suitable option for the replacement of missing teeth, with undergraduate students capable of delivering satisfactory restorations. Practitioners should be encouraged to include RBB within their armamentarium for replacement of teeth but should follow evidence based protocols during preparation, prescription and delivery.

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