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# Comparison of bracket retention of a resin modified glass ionomer cement and a resin based adhesive

Adeel Tahir[a], Ulfat Bashir[b], Arsalan Hamid Khan[c]

## Abstract

**Introduction:** For many years composite resins have been used for bonding orthodontic brackets to the enamel tooth surface. Unfortunately due to the absence of an equal counterpart, the drawbacks of the resin adhesive needed to be endured. Over the past decade, resin modified glass ionomer cements have emerged as adhesives for bonding brackets to tooth surface with very fruitful results.

**Material and Methods:** This study was conducted at Islamic International Dental Hospital, in the department of orthodontics. The study design was a randomized control trial using a split mouth technique. A sample of 40 patients were selected according to the inclusion and exclusion criteria and randomly distributed into two groups. Brackets bonded with composite resin and RMGIC adhesive were compared for bracket retention over a period of one year.

**Results:** The obtained data was analyzed by using SPSS version 20. No statistically significant results were obtained. Statistically composite resin was not better than RMGIC in retaining orthodontic brackets.

**Conclusions:** RMGIC is as good as retaining brackets as composite and a great way to overcome the technique sensitive procedure, cytotoxicity and deleterious effects of composite resins in clinical use.

**Keywords:** Composite; white spots; cytotoxicity

## Introduction

Brackets used in fixed orthodontic treatment have to be bonded to the tooth surface. Direct bonding of attachments revolutionized the placement of orthodontic appliances in the late 1970s and 1980s.(1) Buonocore, Bowen, Wilson, and Tavas pioneered in the technique of direct bonding of brackets. Acid etching, composite resins, glass ionomer cements (GICs), and visible light-curing adhesives have evolved from these early efforts.

Early GICs consisted of glass powder, a concentrated solution of polyacrylic acid, or a glass powder blended with polyacrylic powder, which was mixed with diluted tartaric acid or water.(2) In response to the demand for improvement of the original product, Antonucci et al introduced resin-modified glass ionomer cements (RMGICs) in 1988.(3) Light-activated RMGICs were formulated to overcome the problems of moisture sensitivity of composites and low early mechanical strength of glass ionomers while maintaining the clinical advantages of conventional glass ionomers.(4)

However there are many problems of using a resin based adhesive system for bracket cementation. These include formation of white spot lesions and loss of enamel surface through etching and adhesive removal after bracket de-bonding. These problems can be overcome by using a glass ionomer cement. The GIC has the advantage of leaching out fluoride which prevents formation of the white spot lesions and ease of cement removal.(5) Bond strengths of GIC previously used for bracket cementation were low and had high rate of bond failures.(6) However the newer Resin Modified Glass Ionomer

[a] Corresponding Author: BDS; Post graduate resident, Islamic International Dental College, Islamabad, Riphah International University.
Email: dr.adeeltahir@hotmail.com
[b] BDS, MCPS, FCPS, MHPE; Professor, Department of Orthodontics, Islamic International Dental College, Islamabad, Riphah International University.
[c] BDS; Post graduate resident, Islamic International Dental College, Islamabad, Riphah International University.

Cements show promising results of orthodontic bonding.[3] Etching with 15 % phosphoric acid for 15 seconds without moisture contamination resulted in optimal bond strength.[7]

The importance of evaluating bracket retaining properties of RMGIC was so that the adverse effects of composite resins can be avoided.[8] Composite resins have been considered the gold standard of bonding orthodontic brackets to tooth surfaces but because of the absence of an effective counterpart, the cytotoxic effects of unreacted monomer, leaching of ions causing cell alterations and retention of plaque precipitates needed to be barred with.

## Material and Methods

A randomized control trial using split mouth technique was conducted in the department of orthodontics, Islamic International Dental Hospital, Islamabad. A sample size consisting of 40 patients were included in this study. Informed consent was taken from all the patients. The inclusion criteria was male or female, completely erupted permanent dentition, enamel with absence of buccal enamel defects, restorations, veneer or crowns and normal to mild skeletal discrepancy. The exclusion criteria was **s**ystemic disease, trauma, moderate to severe skeletal discrepancy, mentally handicapped patients, severe periodontal disease, craniofacial anomalies, patients with para-functional habits and patients requiring growth modification or surgery.

The patients were divided randomly using randomizing software into two equal groups. The dentition was divided into four quadrants, namely; upper right, upper left, lower right, lower left. Each quadrant consisted of a central incisor, lateral incisor, canine, 1st premolar, 2nd premolar and 1st molar. A total of six teeth per quadrant, 24 teeth were bonded on each patient. With a sample size of 40, a total of 960 teeth were bonded of which 480 teeth were bonded with composite resin and 480 teeth with RMGIC.

For both adhesives the teeth were cleaned with pumice slurry for five seconds followed by etching with 37% phosphoric acid for 30 seconds. The teeth were then rinsed and air-dried until a frosted enamel surface appeared. For the composite resin group the etched tooth surface was primed and cured with the help of curing light. For the RMGIC group the etched tooth surfaces were moistened with a cotton roll.

Bracket bonding procedure for the composite resin adhesive consisted of the following steps. Firstly, the stainless steel bracket was gripped with the help of reverse action tweezers, and a thin layer of the adhesive was applied to the bracket base. The adhesive was uniformly distributed over the meshed surface of the bracket base taking care not to leave any gaps between the adhesive and bracket base. If the adhesive is not evenly distributed over the bracket base there may be a bond failure because the formation of voids or spaces with absence of the adhesive. This may in turn cause a premature failure of the attachment. After loading the bracket, it was immediately placed on the tooth surface. Bracket holding tweezers were used to place the bracket on the tooth surface according to the occlusogingival, mesiodistal and correct angulation. The bracket was then firmly pressed onto the enamel surface, extruding any excess adhesive from the margins of the bracket base. Excess adhesive material which was squeezed out from the bracket base was removed with the help of a sharp scaler. Removal of the excess adhesive around the margins is vital to maintain good oral hygiene throughout the treatment. The bracket is placed at the desired place and cured with a curing light. Both mesial and distal aspects of the brackets were cured for 20 seconds of each bonded tooth. Residual adhesive is removed with the help of a handpiece to prevent unnecessary retention of plaque. This was also done so that the other operator attending

the patient at subsequent appointments is unable to differentiate which bonding adhesive was used for each tooth.

For bonding RMGIC, the adhesive was hand mixed according to the manufacturer's instructions. Each tooth was etched as in the composite adhesive group. After drying, the tooth surfaces were moistened by a cotton roll. RMGIC requires some moisture for good bond strength.(9) The adhesive was mixed for bonding 2 brackets at a time because of the short setting time. The brackets were placed similarly to that in the resin group, at the LA point determined by Andrews. The RMGI cement was light cured for 20 seconds on the mesial and distal aspect of each bonded bracket. All bonded brackets were carefully cleaned of any excess adhesive with the help of scaler and handpiece with a carbide bur to keep the operator from identifying which bracket is bonded with which type of adhesive during treatment. After bonding brackets with the RMGIC 10 minutes were given for adequate set of the material. In order to save time, RMGIC brackets were bonded first allowing the adhesive to gain enough strength for clinical application, followed by bonding with composite resin.

Each patient was recalled after one month. Any missing or loose brackets at each appointment were checked and failures were noted in the patient proforma sheet. The patient was asked to note down when the bracket had failed and report the failure at the subsequent appointment. A different operator attended the patients in the subsequent appointments. A patient proforma was used for each patient in order to record the date of bracket failure. Each failed brackets were replaced with new brackets with the same slot dimension and prescription. A total of 960 teeth were bonded, comprising of incisors, canines, premolars and 1st molars.

The brackets and tubes were bonded followed by ligating with a light archwire (0.012 inch NiTi). The patient was recalled every month. At each appointment the patient was checked for a debonded or missing bracket and an entry made on the patient's pro forma. The de-bonded bracket was checked for type of adhesive used. In case of missing brackets, it was considered as debonded.

Each bondup procedure was done by the same operator everytime. Each subsequent appointment was done by another operator who was unaware of which bonding adhesive was used. That operator also noted the results in the patient proforma sheets.

## Results

Table I gives the age profile and the type of malocclusion of the patients in the study. A sample of 40 patients was selected according to the inclusion and exclusion criteria. Of the 40 patients, 18 were male and 22 were female with a mean age of 15.8 and 13.4 respectively. Patients with normal to mild skeletal discrepancy were selected for the study which require only a fixed braces treatment and not growth modification or surgery.

**Table I: Patient characteristics**

| | Number of patients | Age (years) | Number of teeth bonded |
|---|---|---|---|
| Overall | 40 | 14.6 | 960 |
| Gender | | | |
| male | 18 | 15.8 | 432 |
| female | 22 | 13.4 | 528 |

Table II shows the total number of bond failures when composite resin and RMGIC was used as an adhesive for a period of 1 year. It was observed that a total number of 11 out of 480 brackets were debonded when resin modified glass ionomer was used and a total of 7 out of 480 brackets were debonded when a composite resin adhesive was used. The percentage of bond failure for RMGIC and Composite resin was 2.3% and 1.5 % respectively.

**Table II: Total number of bond failures (n=960)**

| | RMGIC | Resin |
|---|---|---|
| **Total number of bond failures** | 11/480 | 7/480 |
| **Percentage** | 2.3% | 1.5% |

Fig. 1 is a survivability curve of brackets debonded when RMGIC and composite resin was used. One can appreciate that half of the brackets bonded with RMGIC failed in the first two months of the treatment where as only 2 brackets failed when composite was used. The remaining duration of the study more brackets debonded in the composite group as compared to the RMGIC group.

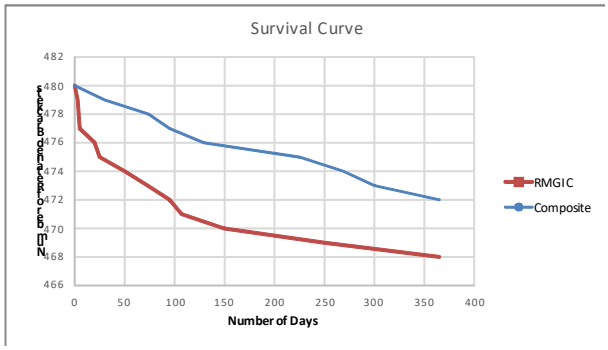


**Figure 1: Survivability Curve for Days of Retention of Brackets**

## Discussion

The aim of the study was to evaluate and compare the retention of brackets using RMGIC and composite resin as an adhesive over a period of one year of a patient undergoing fixed orthodontic treatment.

A randomized controlled trial of 960 teeth was carried out over a period of 12 months. All patients were selected according to inclusion and exclusion criteria. For universal use, the adhesive was tested by placing all brackets on Andrews FA point.

Studies carried out with previous generations of glass ionomer cements showed weak bond strengths, and high bracket failure rates.[10] Investigations have concluded that conventional glass ionomer cements were unsuitable for routine clinical orthodontic use. RMGIC have shown higher bond strengths and better mechanical properties.[11] In vitro studies have shown that even though modern RMGICs have a lower bond strength than that of a resin composite system but is still sufficient for orthodontic bracket bonding.[12][13][14]

The bracket failure rate in this study was insignificant when RMGIC was compared with the composite resin adhesives. Though 10% is considered clinically acceptable,[15] our study reported with a bracket failure rate of 2.3% in the RMGIC group and 1.5% in the composite resin group. In fig. 1 it can be observed that half of the brackets bonded with RMGIC failed in the first two months of the treatment where as only 2 brackets failed when composite was used. In the remaining duration of the study more brackets debonded in the composite group as compared to the RMGIC group. This data suggests that RMGIC have weaker bond strength initially but after two months the number of brackets debonded was smaller than that in composite resin group.

## Conclusions

After the 12 months randomized clinical trial, the following conclusions can be made:

1. The bracket failure rates when RMGIC and composite resins are used as adhesives for routine orthodontic cases observed were clinically acceptable.
2. The RMGIC adhesive showed a higher bracket failure rate which was 2.3%. This was within the acceptable bracket failure rate. Composite resin adhesive had a bracket failure rate of 1.5%. Both adhesives showed a statistically insignificant bracket failure rate when compared to each other over a period of one year.
6. Almost half of the bond failures occurred with the RMGIC in the first month but showed superior results later in the study.

From the present study it may be concluded that RMGIC, Fuji ortho LC has adequate bond

strength for use in orthodontic treatment, particularly in areas where moisture control is difficult to achieve. As the efficacy of the RMGI cement in retaining orthodontic brackets is as good as composite resins, the potential side effects of the resin composites can be avoided.

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