A comparative study of shear bond strength of Fuji II and Ariadent glass Ionomer Cements to dentin of primary molar

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ABSTRACT

Background & Aim: More than 30 years has passed since introduction of glass-ionomer cement as a dental restorative material, luting cement and liner. Although they are sensitive to moisture and desiccation during the initial setting stages, relative poor physical properties because of chemical bonding to tooth substrate, and long-term esthetic quality, they are recommended for restoring anterior and posterior primary teeth, cervical lesions and root caries of permanent teeth. In this study, shear bond strength of Fuji II was compared with of ariadent glass-ionomer cements.

Materials & Methods: Thirty intact extracted primary molars were prepared for this study. Selected teeth were divided in two groups of 5. Sample were free of caries, fracture, crack, discoloration or any structural abnormality. The dentin of buccal surface of teeth were exposed by microtome apparatus. The surface was conditioned by polyacrylic acid (10%) for 20 seconds. Glass ionomer cements (Fuji II, and Ariadent) were prepared in a plastic cylinders (15 of each) and attached to the dentin of teeth horizontally. Shear bond stength of materials was measured by instron (Model 1159).

Results: Mean shear bond strength of Ariadent cement was 4.2 ± 1.9 Mpa while 7.4 ± 1.5 Mpa was of Fuji II cement (P=0.000). Failure mode was similar between two cements (P=ns). The most prevalent type of failure mode was cohesive failure leaving a firmly attached thin and homogenous layer of cement to dentin, in both groups.

Conclusion: It appears that shear bond strength of Ariadent cement to primary tooth is much lower than of Fuji II.

Keywords: Shear bond strength, Glass ionomer, Primary molar.

INTRODUCTION

Since introduction of glass ionomer cement (1972) as a restorative material, varieties of this material are marketed for purposes of luting and base of tooth filling.¹ The advantages of these cements are the ease of usage, chemical bond to tooth,²⁻⁵ longevity of fluoride ion release,⁶⁻⁹ low thermal expansion ratio¹⁰⁻¹¹ and acceptable esthetic appearance.¹² However, the disadvantages of these cements are: sensitivity to moisture in early setting and weak physical properties.¹,¹³,¹⁴

Despite the above disadvantages, the conventional glass ionomer cements provide acceptable restoration for posterior and anterior primary teeth,¹⁵ for cervical and root caries of permanent teeth.¹⁶ The early pattern of this cement had hybrid formulation of silicate and polycarboxylate cements. These particles are: alumino-silicate powder and polyacrylic acid. Currently, the improvement to different properties of GI cements has introduced new products like: metal-modified, resin-modified and compomers to the markets.¹⁷

Various researches are performed onto shear bond strength of GI cements. Thean and associates (2000) compared shear bond
strength of Fuji type IX GP with type II LC of GI cement to dentin of primary tooth. They found a cohesive type of fracture in all samples.

The other research by Fruits and his colleagues (1996) showed the Tetric composite has the highest shear bond strength in comparison to 3 other kinds of self and light cured GI. The GI samples fractured as of cohesive type. In their study, Almuammar and associates (2001) also concluded that among 2 types of Fuji GI cements, 3 compomers and a composite, Heliomolar showed the highest and the conventional GI showed the lowest shear bond strength. The fracture type whereas the previous studies was of adhesive kind.

It is obvious that the properties of a material change if formulation changes. This study is designed to compare domestic Glass ionomer cement (Ariadent) with an internationally marketed (Fuji II) product. To measure the adhesion rate of a material to tooth, shear bond strength is a routinely used test for this purpose. This test is performed on dentin of primary tooth.

MATERIALS & METHODS

This research is an in vitro, experimental, controlled and randomized trial. For this purpose, 30 primary lower molars were equally divided to 2 groups. The samples were selected if they were sound, free of any caries, fracture, crack or any discoloration. Primary teeth were cleaned of any debris. Then, they were disinfected in a 0.5% sodium hypochlorite solution for 10 minutes. Samples were then rinsed in a normal saline solution. Each container of a sample had the information regarding the date of extraction, child age and first or second molar. In this study, 2 types of the GI cements were used—Ariadent and Fuji II.

The buccal surface of teeth was abraded by a microtome apparatus till exposure of dentin. Samples were then stabled in acrylic resin. The dentin surfaces were conditioned with 10% acrylic acid for 20 seconds. Samples were afterward thoroughly rinsed and air dried. GI cement were mixed as instructed by manufacturer and placed in cylindrical plastic molds (3mm diameter and 2mm height). These cylinders were attached to dentin. After 5.5 minutes (setting time) plastic molds were removed. Teeth were painted over with GC Fuji II varnish. After air drying, they were placed in distilled water for 24 hours at 37 degree of centigrade.

Shear bond strength of the cement to dentin was measured by Instron apparatus (model 1195) at the crosshead speed of 0.5 mm/minute. Quality of fracture was observed by stereo-microscope after debonding of GI. Fracture types were classified in the following 3 categories: 1.Cohesive bulk fracture 2.Cohesive fracture with firmly attached, thin and homogenous layer, 3.Mainly adhesive fracture with islands of firmly attached materials.

Data were analyzed by SPSS statistical software. Levin's and T test was used to compare shear bond strength between 2 groups. Fracture mode was evaluated with Chi-square test. Correlation coefficient between shear bond strength and fracture mode was measured by Kendall's rank-order correlation coefficient test.

Table 1. Shear bond strength of 2 tested GI Cements (Mpa).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Min. of SBS</th>
<th>Max. of SBS</th>
<th>Mean</th>
<th>S-Error</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuji II</td>
<td>4.84</td>
<td>9.84</td>
<td>7.40</td>
<td>0.39</td>
<td>1.52</td>
</tr>
<tr>
<td>Ariadent</td>
<td>2.27</td>
<td>7.57</td>
<td>4.19</td>
<td>0.54</td>
<td>1.89</td>
</tr>
</tbody>
</table>

*SBS: Shear Bond Strength

RESULTS

Shear bond strength of Fuji II GI was 7.4±1.52Mpa and CI was 95%. The range was between 4.84-9.84Mpa. This measure for Ariadent cement was 4.19±1.89Mpa, and CI was 95%. Its value ranged between 2.27-7.57Mpa.

3 samples of Ariadent group were debonded before any mechanical test and discluded. There was a statistically significant difference between shear bond strength of Fuji II GI and Ariadent cement.
(F=1.101, P=0.34 in Leven's test and t=4.906, P=0.000 in T-test). Figure 1 shows frequency and type of fracture in two groups.

![Fig 1](image)

**Cohesive bulk fracture**
**Cohesive fracture with firmly attached thin and homogenous layer**
***Mainly adhesive fracture with islands of firmly attached materials***
****adhesive fracture

**Fig 1. Frequency bar chart of fracture modes of two sample groups.**

There was no statistically significant difference between two groups concerning frequency (X2=0.96, df=3 and P=0.851). This was also the same when shear bond strength of samples were compared based upon type of fracture (ANOVA test: P=0.932).

Considering the fact that there was only one sample in each fracture group of "a" and "d", no post hoc test was done. Only groups "b" and "c" was tested. Average bond strength of fracture in group "b" 7.21±1.22 Mpa and in group "c" 7.48±2.27Mpa was similar (F=6.192, P=0.03 in Leven's test and P=0.281 in t-test). Shear bond strength according to bond fracture was similar in all Ariadent samples (ANOVA: P=0.019). Post hoc test was done for fracture groups of a, b and c statistical significant difference (Pvalue=0.016) was found between shear bond strength of group "a" (7.42±0.21Mpa) and "b" (3.41±1.15Mpa), (F=2.502, P=0.165 in Leven's test and t=4.67, P=0.003 in t-test).

There was no difference between the shear bond strength of group "a" and "c" (4.13±1.63Mpa) (F=6.281, F=0.087 in Leven's test and t=2.686, P=0.075 in t-test). There was also no statistically difference between group "b" and "c" (F=0.705, P=0.429 in Leven's test and t=0.793, P=0.453 in t-test). According to Kendall's ratio, there was no correlation coefficient between shear bond strength of both GI groups to their regarded fracture type. This measurement for Fuji II cement group was 0.219 (P=0.336) and for Ariadent cement group 0.336 (P=0.174).

**DISCUSSION**

To select a restorative material a practitioner should consider a series of criteria. Acceptable shear bond strength is an invaluable factor that indicates the degree of adhesion of material to tooth structure. This is because of the fact that the higher bond strength provides lesser microleakage. The other benefit is the chemical bond diminishes the necessity of extra cavity preparation for mechanical retention.

To evaluate bond strength of a restorative material variety of a comparison method is recommended.(21) In this study Microtome was used for abrading tooth surface. The smear layer was eliminated by dentin conditioner. This will enhance the surface energy of dentin for better adhesion.(18)

Even though some studies have found no statistically significant difference in shear bond of GI cement where tooth conditioner was used or not,(8,23) researchers strongly recommend pretreatment dentin conditioning.(7,24,25)

Usage of a specified varnish or a resin bonding agent is emphasized due to moisture sensitiveness during early setting process of GI cement.(26,27)

Averagely, Fuji II cement showed much higher shear bond strength (7.4±1.52) than Ariadent cement (4.19±1.89), (Pvalue=0.00). Cohesion mode of fracture was the most frequent in both sample groups. This was concordance to the results of Thean,(18) Mount, (3,28) and Fruits. (20) This is indicative of low tensile strength of the GI cement.(18) Thus, this relates to the composition of the cement.(20) Accordingly, Fuji II has lower

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*Data extracted from the image*
intrinsic brittleness than the Ariadent cement. The ratio of powder to liquid for Fuji II cement was 2.7 and for Ariadent was 2.2, as manufacturers instructed.

The quality of bonding in this research is another factor that is to be considered. Anatomically and structurally, primary tooth dentin is different from permanent's. In that, presence of more frequent tubules and macrocanals (giant dentin tubules) all have positive effects on quality of bond strength of cement.\(^{(18,29)}\) Since the most prevalent cause of fracture was cohesive failure of the cement, the exact measurement for shear bond strength of was not feasible.

**CONCLUSION**

Collectively, it seems that Ariadent cement has a considerable low shear bond strength compared to Fuji II.

**REFERENCES**

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