COMPARISON OF ENDODONTIC SEALERS IN TERMS OF THEIR SHEAR STRENGTH

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ABSTRACT

The purpose of this in vitro study was to compare the shear bond strength of mineral trioxide aggregate and glass ionomer cement by Instron testing machine. It was carried out at Queen Mary and Westfield College, University of London during 2010-2011. Time duration was 6 months.

A total of 14 samples of elephant tusk dentine (ivory) were cut and prepared for shear bond strength test. MTA and GIC samples were randomly divided into 2 groups of 7 samples in each group. Then 10 mm of wires were cut, smoothened at one end and roughened at the surface. The endodontic sealers were mixed, applied on the wire and in the canal and then left overnight to set. Then samples with wire on the metal support were placed under Instron testing machine to test for shear bond strength. Shear strength was measured in megapascal (MPa). Student “T” test was done to evaluate the data. It was noted that shear bond strength of MTA GROUP A = 0.30714 MPa (mean value) was less than GIC GROUP B = 1.74 MPa (mean value). It was noted that there was poor adhesion of MTA with wire and dentin as well, that’s why the results showed very less values for MTA.

Key Words: Mineral trioxide aggregate, Glass ionomer cement, Instron testing machine, Elephant tusk dentine (ivory).

INTRODUCTION

The success of endodontic treatment depends on the tight apical seal and complete removal of microbes, necrotic debris and their by-products from the root canal. A very good endodontic treatment can fail because of microleakage. Microleakage occurs due to the movement of fluid with bacteria along the interface of the dentinal walls into the root canal. In the past apical microleakage was considered to be the main cause of failure of endodontic treatment. However, research has shown that coronal seal is also important as that of apical seal for the success of an endodontic treatment.

Different endodontic sealers like ethoxy benzoic acid (EBA), glass ionomer cement (GIC), AH 26 root canal sealer and zinc phosphate cement were used to determine their shear strength. Glass Ionomer cements (GICs) were initially introduced to dentistry by Wilson and Kent and to orthodontics by White. GICs possess many properties such as forming chemical bonds with enamel, dentin, metal and plastic through the affinity of calcium in tooth structure to carboxylate groups in the reacted GIC. Because of this unique ability, the GICs do not require a completely dry bonding field. GICs release fluoride within the period of at least 12 months and also have the ability of fluoride recharging from fluoride-containing materials such as toothpastes. This may protect enamel from decalcification. Among all the mentioned endodontic sealers mineral trioxide aggregate (MTA) has generated a lot of interest because of its good sealing ability. Over the last decade, MTA has gained great popularity, especially in endodontic and pediatric dentistry, because it possesses improved physical and regenerative characteristics: it supports cementum regrowth, has low solubility after setting, can set in a wet environment, facilitates the control of bleeding, provides a strong barrier for bacterial leakage, and can induce mineralized tissue formation.

The aim of the present in vitro study was to compare the shear strength of mineral trioxide aggregate and glass ionomer cement by Instron testing machine.
TABLE 1: SHOWING SHEAR BOND STRENGTH FOR MTA SAMPLES INDIVIDUALLY AND MEAN VALUE. (N = 07)

<table>
<thead>
<tr>
<th>No. of Sample</th>
<th>Endodontic Sealer</th>
<th>Shear bond strength MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MTA</td>
<td>0.05 MPa</td>
</tr>
<tr>
<td>2</td>
<td>MTA</td>
<td>0.40 MPa</td>
</tr>
<tr>
<td>3</td>
<td>MTA</td>
<td>0.31 MPa</td>
</tr>
<tr>
<td>4</td>
<td>MTA</td>
<td>0.43 MPa</td>
</tr>
<tr>
<td>5</td>
<td>MTA</td>
<td>0.12 MPa</td>
</tr>
<tr>
<td>6</td>
<td>MTA</td>
<td>0.46 MPa</td>
</tr>
<tr>
<td>7</td>
<td>MTA</td>
<td>0.38 MPa</td>
</tr>
</tbody>
</table>

Mean = 0.30714 MPa Standard Deviation = 0.15997
Standard Error = 0.06046, p = 0.00739

TABLE 2: SHEAR BOND STRENGTH FOR GIC SAMPLES INDIVIDUALLY & MEAN VALUE IN MPAGASCAL. (N = 07)

<table>
<thead>
<tr>
<th>No. of Sample</th>
<th>Endodontic Sealer</th>
<th>Shear bond strength MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GIC</td>
<td>2.07 MPa</td>
</tr>
<tr>
<td>2</td>
<td>GIC</td>
<td>4.62 MPa</td>
</tr>
<tr>
<td>3</td>
<td>GIC</td>
<td>1.05 MPa</td>
</tr>
<tr>
<td>4</td>
<td>GIC</td>
<td>1.03 MPa</td>
</tr>
<tr>
<td>5</td>
<td>GIC</td>
<td>1.01 MPa</td>
</tr>
<tr>
<td>6</td>
<td>GIC</td>
<td>1.25 MPa</td>
</tr>
<tr>
<td>7</td>
<td>GIC</td>
<td>1.15 MPa</td>
</tr>
</tbody>
</table>

Mean = 1.74 MPa Standard Deviation = 1.32317 Standard Error = 0.50011, p = 0.00739

METHODOLOGY

A fragment of elephant tusk from an elephant was used in this study. The bulk of this material is referred
as ivory and is composed of dentine. As compare to human dentine, the characteristic feature of elephant dentine is the tubule that sits in a matrix forming the mineralized collagen fibres. The elephant dentine is micro structurally similar to human dentine but there are some differences between them like in elephant dentine the tubules are more elliptical in shape and the peritubular cuff is small or non-existent as compared to human dentine, although the tubule density and mineral content appear to be similar to human dentine. We used ivory in our study because it consists mainly of dentine (inorganic formula \( \text{Ca}_{10}(\text{PO}_4)_6(\text{CO}_3)\cdot\text{H}_2\text{O}) \)), one of the physical structures of teeth. Ivory was provided by School of Engineering and Materials Science (SEMS), for research purpose only.

Total of 14 samples were cut and prepared for shear bond strength test as shown in Fig 1. The size of the samples was 2.4 mm in thickness with 1.6 mm of canal size. After cutting of samples fine finishing of the samples were done with sand paper for smoothness. The direction of dentinal tubules was considered such that it should be running horizontally for the endodontic sealer to penetrate for better adhesion. Samples were divided into two groups with 7 samples in each group as shown in Table 1.

Total 14 small pieces of wire (Stainless steel, Guage # 17) were cut to be inserted into the prepared canal with cement to evaluate its shear bond strength. The wire was marked with marker up to 10 mm and wire cutter was used for cutting purpose. Then one end of the wire was smoothened with finishing paper (water proof silicon carbide paper (FEPA) P # 320) by adjusting it on (Struers Kruth Rotor 3) machine as shown in Fig 2.

The preparation of the MTA (DENTSPLY Lot 05002015) was made by mixing MTA powder with the distilled water supplied by the manufacturer on a sterile glass slab. The powder and the water were incorporated to each other in small increments, in a proportion of 3:1, until a creamy consistency was reached. The obtained MTA creamy mixture was then used, immediately following its preparation. Then GIC was made by mixing GIC powder with the distilled liquid supplied by the manufacturer on a sterile glass slab. The powder and the liquid were incorporated to each other in small increments, in a proportion of 3:1, until a creamy consistency was reached. The obtained GIC creamy mixture was then used, immediately following its preparation. Then all 2 mixed sealers were carefully applied on the wire as well as some portion in the small prepared canal as well. Then wire was placed inside the canal. The excess MTA and GIC extruding from the specimens were removed. All of 14 samples were left overnight for the cement to set and gain its maximum strength. Next day sample with wire inside was placed on the metal support as shown in Fig 3 and checked for shear bond strength with the help of shear testing machine (Instron) as shown in Fig 4. Samples were placed under machine on metal support and jog speed was moved down until it just touches the wire. Then speed was adjusted at 0.5000 mm/minute. Then experiment was started by pushing the start button on the computer software and readings were noted.

The shear bond strength of MTA samples noted is given in Table 1 and of GIC samples is in Table 2. Then shear strength was measured by the formula stated below;

Shear bond strength = Force (max) / area.

Maximum Force = the peak value of the force applied on the wire noted.

Area = 2*3.14*0.8*2.4 = 12.05

RESULTS

In present study shear bond strength test was done to compare the shear strength of mineral trioxide aggregate with glass ionomer cement. Paired ‘T’ test was used for statistical analysis to calculate the mean, standard deviation and p values. The results for the shear bond strength in both Groups A and B are Group A = MTA = 0.30714 MPa (mean value) and Group B = GIC = 1.74 MPa (mean value). So it was noted that shear bond strength of MTA was less than GIC. It was noted that there was poor adhesion of MTA with wire and dentin as well, that’s why the results showed very less values for MTA.

DISCUSSION

In present study two endodontic sealers MTA and GIC were used to compare their shear bond strength. The results of the present study demonstrated that shear bond strength of GIC is more than MTA. Their was poor adhesion between sealer and wire. A similar study was done by Aggarwal et al and found less strength of MTA by push-out bond strength test. In another study done by Tagger et al also found less shear strength of MTA when compared with other endodontic sealers. However, several studies have indicated that MTA exhibits significantly lesser leakage than other materials. Due to difficult manipulation and insertion of MTA it is not routinely employed as a root canal filling material. However, MTA can be used as a root canal filling material, although clinicians should be aware of some of its limitations like difficulty in controlling the length of filling, chance of producing voids and the absence of a solvent for MTA removal. Hovaland et al also found that MTA showed more micro leakage than other sealers like sealapex and GIC. Glass ionomer cement showed less microleakage than mineral trioxide aggregate because of its chemical adhesion with dentine. Thus, mineral trioxide aggregate did not proved...
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to be the best material in terms of shear strength as compare to the glass ionomer cement. In contrast to present study Funteas et al found that GIC had the greatest dye penetration followed by calcium phosphate cement and MTA.\textsuperscript{12} Mineral trioxide aggregate and calcium phosphate cement had comparatively better sealing ability than glass ionomer cement.\textsuperscript{11} Some of the studies in which extracted teeth were used have also shown that MTA has poor shear strength but it can be used in furcation areas for repair purpose.

**CONCLUSION**

The results of the present study revealed that shear bond strength of GIC (1.74 MPa) is better than MTA (0.30714 MPa). However, further in vitro and in vivo investigations should be conducted to determine the suitability of GIC as a better sealing material than MTA.

**REFERENCES**


**CONTRIBUTIONS BY AUTHORS**

1. **Aamir Shahzad:** Main author, literature review, data collection, results and conclusion.
2. **Majid Zia:** Contributed in evaluating data by Student “T” test through email.
3. **Talib Hussain:** Contributed in writing discussion.
4. **Amnah Sibghat:** Contributed in writing references.