

## A Study on Invitro to Measure the Shear Bond Strength of Glass Ionomer Cement Bound to Mineral Trioxide Aggregate

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### Abstract

**Aim:** To measure the shear bond strength of 2 conventional GICs to white mineral trioxide aggregate (WMTA) allowed to set for 3 different times, 45 minutes, 2 hours 45 minutes & 72 hours.

**Materials And Methods:** Forty eight W MTA specimens were prepared by using cylindrical acrylic blocks which were divided into 3 groups, first group was stored for 45 minutes, second for 2 hours 45 minutes and the last group for 72 hours at room temperature and 100% humidity. Then each group was divided into 2 sub-groups of 8 specimens, GIC was layered on each of 3 MTA preparations. 24 were bonded with MTA using Ketac molar glass ionomer cement while the remaining 24 were bonded using Fuji IX glass ionomer cement. Universal testing machine was used to measure GIC-MTA shear bond strengths and the findings were analyzed using One-way analysis of variance.

**Results:** It was observed that the mean difference was maximum between 45 min and 72 min intervals while it was minimum between 45 min and 165 min intervals.

**Conclusion:** GIC can be layered over MTA after 45 minutes to allow single visit procedure.

### Introduction

In Endodontic practice, procedural accidents such as perforations may occur. Ingle has reported that perforations were the major cause of endodontic failure and account for 9.6% of the unsuccessful cases. Different materials are used to repair these defects, but none fulfill the criteria of an ideal repair material that includes sealability, compatibility and ability to induce osteogenesis & cementogenesis.<sup>1,2</sup>

Mineral Trioxide Aggregate (MTA) was introduced by Mahmoud in 1993 as a root end filling material and with many ideal properties.<sup>3,4,5</sup>

MTA has multiple indications in dentistry like pulp capping, pulpotomy, root end filling materials and any of these above mentioned treatment should be covered with a moist cotton pellet & closed with a temporary restoration for minimum of 2 hours 45 minutes, or 24 hours and maximum of 72 hours.<sup>6,7</sup>

The main disadvantage of material is its prolonged setting time, approximately for 2 hours & 45 minutes. The mean initial setting time is 45 minutes, thus another visit to the dental clinic becomes mandatory for patient. A study by Nandini et al (2007) suggested that GIC could be layered 45 minutes after placing MTA for single visit procedure.<sup>6</sup>

Thus, the present study was undertaken with the aim to measure the shear bond strength of Glass Ionomer Cement bound to Mineral Trioxide Aggregate under three different intervals, 45 minutes, 2 hours 45 minutes and 72 hours.

### Materials and Methods

48 MTA specimens were prepared by using cylindrical acrylic blocks. Each block had a central hole measuring 4 mm in diameter and 2 mm in depth. MTA was mixed according to the manufacturer's instructions, poured into the holes in the acrylic blocks. The samples to be tested after 45 minutes and 2 hours 45 minutes were covered with moist cotton pellet and

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the rest of the samples were covered with moist cotton pellet with temporary filling material. 48 specimens were divided into 3 groups of 16 samples each. First group was stored for 45 minutes, second for 2 hours 45 minutes and the last group for 72 hours at room temperature. Each group was further divided into 2 sub-groups of 8 samples each on the basis of the types of GICs used. After removing the moist cotton pellet, the MTA surface was not rinsed or polished. The liquid was applied to the MTA surface with an applicator before the GIC was bonded to the MTA. Then, the GIC was placed at the center of the MTA surface by packing the material into cylindrical plastic tubes with an internal diameter of 3 mm and height of 4 mm. The specimens were allowed to set for 10 minutes within the plastic tubes and then removed carefully. All the samples were prepared by the same operator.

The specimens were mounted in a universal testing machine. A crosshead speed of 0.5mm/min was applied to each specimen by using a knife-edge blade until the bond between the MTA and GIC failed. The values were calculated in newtons and converted into megapascals (Mpa). The means & standard deviations were calculated. The mean bond strengths of the groups were analyzed using one way analysis of variance (ANOVA TEST).

**Results**

A total of 48 specimens were taken. Out of 48 specimens, 24 were bonded with MTA using Ketac molar glass ionomer cement while the remaining 24 were bonded using Fuji IX glass ionomer cement. The assessments were done under three simulations at three different time intervals. Analysis of specimens according to different simulation times were done.

In ketacmolar Easymix the mean Bond strength ranged from 7.73±0.87 to 9.30±0.73 Mpa at different time intervals. Minimum Bond strength was observed to be 6.10 MPa in a sample at 45 minutes while maximum Bond strength was observed as 10.5 MPa in a sample at 72 hrs.

In FUJI IX, the mean Bond strength ranged from 7.81±0.78 to 9.42± 0.97 MPa at different time intervals. Minimum Bond strength was observed to be 6.03 MPa in a sample at 45 minutes while maximum Bond strength was observed as 10.55 MPa in a sample at 72 hrs.

Table 1- Comparison between time intervals revealed a statistically significant difference between 45 min and 72 hr and 2 hr 45 min or 165 min and 72 hr intervals. It was observed that the mean difference was maximum between 45 min and 72 min intervals while it was

minimum between 45 min and 165 min intervals. The order of mean Bond strength at different time intervals in Group I was as follows:

$$45 \text{ min} \sim 2\text{hour}45 \text{ min} < 72 \text{ hr (165 mins)}$$

**Table 1: Between time interval comparison of mean Bond strength in Group I**

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. (p)	95% Confidence Interval	
					Lower	Upper
45 min	165 min	0.545	0.356	0.336	1.412	0.382
	72 hr	1.574	0.356	0.001	2.471	0.676
165 min	45 min	0.515	0.356	0.336	0.382	1.412
	72 hr	1.059	0.356	0.019	1.956	0.161
72 hr	45 min	1.574	0.356	0.001	0.676	2.471
	165 min	1.059	0.356	0.019	0.161	1.956

Table 2 - Comparison between time intervals revealed that the mean Bond strength at 72 hrs was significantly higher as compared to that at 45 minute and 2 hr 45 min time intervals. Statistically no significant difference in mean Bond strength was observed between 45 min and 165 min time intervals. Maximum difference was observed between 45 minute and 72 hr intervals while minimum difference was observed between 45 minute and 2 hr 45 minute intervals respectively. The order of mean Bond strength at three time intervals in FUJI IX was as follows:

$$45 \text{ min} \approx 2\text{hour}45 \text{ min} < 72 \text{ hrs (165 mins)}$$

**Table 2: Between time interval comparison of mean Bond strength in Group II**

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. (p)	95% Confidence Interval	
					Lower	Upper
45 min	165 min	-0.574	0.395	0.333	-1.568	0.421
	72 hr	-1.611	0.395	0.001	-2.606	0.617
165 min	45 min	0.574	0.395	0.333	-0.421	1.568
	72 hr	-1.038	0.395	0.040	-2.032	0.043
72 hr	45 min	1.611	0.395	0.001	0.617	2.606
	165 min	1.038	0.395	0.040	0.043	2.032

**Discussion**

Resin composites and GICs are popular in restorative dentistry because of their esthetic qualities. Resin composites cannot be placed directly over freshly mixed MTA because they can affect MTA setting and etching and rinsing of unset MTA can dislodge the material. Therefore placing GIC over partially set MTA should be considered as a part of permanent or provisional restoration.<sup>2</sup>

MTA is a powder which consists of fine hydrophilic particles. It also contains small amount of other Mineral Trioxides which modify its chemical and physical properties. When GIC is applied to MTA one of the two possible reactions can occur at the interface: the COO- of the polyacrylic acid could interact with the calcium of MTA to form calcium salts or the silicate hydrate gel of the MTA could condense with the silicate hydrate gel of the GIC to form by-products. Due to high percentage of mineral oxides in MTA, GIC would be expected to bond strongly to MTA. The adhesion of GIC to dental tissue relies primarily on the chemical interaction and to lesser extent on microchemical interlocking. The porous surface of MTA might increase the strength of MTA-GIC bond.<sup>2,8</sup>

The influence of glass ionomer cement on the interface and setting reaction of MTA when used as Furcal repair using Laser Raman spectroscopic analysis proved that placement of glass ionomer cement over MTA after 45 minutes did not affect its setting reaction and calcium salts may be formed in the interface of these two materials. Hence they suggested that GIC could be layered over partially set MTA after 45 minutes for a single visit procedure.<sup>6</sup>

This was in accordance to our present study in which maximum difference between bond strengths was observed between 45 minutes and 72 hours intervals while minimum difference was observed between 45 minute and 2 hr 45 minute intervals respectively. The order of mean Bond strength at three time intervals in KETACMOLAR EASYMIX & FUJI IX was as follows:

45 min ~ 2hour 45 min <72 hrs

In our study maximum Bond strength was observed as 10.5 MPa in a sample at 72 hr with both Ketacmolar easymix and Fuji IX. Similar findings were observed by Sluyk et al. (1998)<sup>9</sup>.

## Conclusion

On the basis of the results in the present study it can be concluded that though the shear bond strength increased when GIC was layered after 72 hours over MTA. But an optimum strength could be attained in 45 minutes and 2 hours 45 minutes to allow single visit procedure. Hence GIC can be layered over MTA after 45 minutes to allow single visit procedure.

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