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ORIGINAL ARTICLE

Comparing the Sealing Ability of Different Intra Orifice Barriers using two Different Sealers

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ABSTRACT:

Objectives: The purpose of this study was to compare the sealing ability of Biodentine, Mineral Trioxide Aggregate (MTA) and Glass Ionomer Cement (GIC) when used over gutta-percha as intracanal sealing materials. The study also evaluated the sealing ability of Zinc oxide eugenol (ZOE) sealer and AH PLUS sealer. **Materials and Methods:** Ninety mandibular premolars were prepared using step-back technique and divided into experimental groups A, B (45 premolars each). Teeth were obturated with gutta-percha using sealer ZOE (group A) and AH PLUS (group B). The groups were further divided into 3 subgroups (15 premolars each) on the basis of intracanal sealing material used: GIC subgroups (A1, B1) MTA subgroups (A2, B2) and biodentine subgroups (A3, B3). The clearing technique was used in this study for leakage evaluation. Coronal microleakage was determined under stereomicroscope using 15X magnification. Data was statistically analyzed using one-way ANOVA followed by Post-Hoc Multiple comparison (Bonferroni). **Results:** Biodentine group leaked significantly less than GIC group ($P < 0.05$). AH Plus sealer exhibited better sealing ability than ZOE sealer. **Conclusions:** Biodentine or MTA may be preferred over GIC as an intracanal barrier.

Keywords: AH Plus sealer; Biodentine; GIC; Intracanal barrier; Intracanal sealing; MTA.

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INTRODUCTION:

The success of the root canal treatment mainly depends upon the three dimensional obturation of the root canal system with a complete coronal and apical seal.[1] Even though a proper apical seal is obtained there are chances that the treated tooth might get exposed to oral microbial flora. This can occur when 1) there has been a delay in the restoration of a tooth following root canal treatment; 2) the coronal temporary filling, placed immediately following root canal treatment, is compromised; 3) the tooth is fractured and the canal system is exposed prior to final restoration; 4) the final restoration, regardless of type or design, lacks ideal marginal integrity or cannot withstand the forces of occlusal function, and deteriorates; or 5) recurrent decay is present at the restoration margin(s).[2,3] So it is important to obtain to proper coronal seal.

The seal established by the present day restorative materials is questionable. Various permanent restorative materials like Amalgam, Composite resin, etc. have been used as intracanal plugs. However, an ideal intracanal barrier has not been identified yet, or perhaps not even developed. So thus it is the need of the hour to search for a material which would provide a proper coronal seal.

However glass ionomer cement has reported to be used as a intracanal sealing material because of its adhesive and anti cariogenic properties.[4] Mineral trioxide aggregate (MTA) due to its good sealing properties has also been used as a intracanal sealing material. Biodentine which is a newer calcium silicate based material, has very good biocompatibility. There have been minimal attempts where biodentine has been used as aintracanal plug. The purpose of this invitro study was to compare the intra canal sealing ability of glass ionomer cement, mineral trioxide aggregate and biodentine when used over guttapercha.

MATERIALS AND METHODS:

Ninety extracted human non-carious and non-restored mandibular premolars with single canal were taken for this study from individuals amongst 20-30 years of age. The teeth were radiographed from facial and proximal

views to confirm the presence of single canal. After removal of soft tissue and hard aggregations from the root surfaces, teeth were stored in saline until used. The teeth were decoronated with a tapered fissure carbide bur at high speed to a standardized length of 16 mm. Prior to sample selection, all teeth were inspected clinically under ×3.5 magnification using magnifying loupes for fractures or defects that would eliminate them from the study. Cleaning and shaping procedures were executed using step back technique described by Mullaney (1979).[5] In Phase I, the apical preparation was done upto file no. 35. In Phase II, rest of the canal was prepared in stepping back procedure in 1 mm increments, no. 35 through 50. The coronal and mid-root preparations were done in Refining phase IIa using Gates Glidden drills no. 2, 3, and 4. The no. 35 file was circumferentially filed to smoothen the preparation in Refining phase IIb.[6] All instrumentation was accompanied by copious irrigation with 5% sodium hypochlorite. Each instrument was coated with Glyde (DentsplyMaillefer, Ballaigus, Switzerland) before insertion, and 2 ml of 5% sodium hypochorite (NaOCl) was used after each file size. After instrumentation, final rinse was done with 2.5 ml of 17% Ethylene diamine-tetraacetic acid (EDTA) followed by 5 ml of 5% NaOCl and 5 ml saline. Teeth were randomly divided into experimental groups A and B (45 teeth each).

Group A: Teeth were obturated with gutta-percha and ZOE sealer which was made by mixing zinc oxide powder with eugenol liquid (Deepak Enterprise, Mumbai, India) on a glass slab, with a weight ratio of 2.07 : 1.00 in order to have a thick creamy consistency using lateral compaction method.

Group B: Teeth were obturated with gutta-percha and AH PLUS (Dentsply-Maillefer Ballaigues, Switzerland), a resin-based sealer

Guttapercha was cut with a heated spoon excavator and vertically condensed right at the orifice opening of the canals.[7] Access openings were closed with cotton pellets. Teeth were then incubated at 37° c for 1 week to allow the sealer to set. Four millimeters of gutta-percha was removed from the coronal part of the teeth by using a hot plugger.[7] The depth was verified with a UNC-15 periodontal probe. Radiographs from facial and proximal views were taken using paralleling technique to verify the reduction of gutta-percha radiographically and also to examine if any gutta-percha or sealer remnants present. Experimental groups A and B were further divided into 3 subgroups each (A1, A2,A3, B1, B2,B3), depending on the sealing material to be used for the coronal seal.

Group A1 and B1: A conventional chemical cured GIC (Fuji II,GC Corporation, Tokyo, Japan), was used as intracanal barrier. Glass ionomer cement was mixed according to manufacturer's instructions. Four millimeters of the material was placed into the canal using a spoon excavator and a small plastic instrument; and then condensed using an endodontic plugger. The access was closed with a dry cotton pellet.

Group A2 and B2: Mineral trioxide aggregate was used as intracanal barrier. One sachet of MTA (White ProRoot,Dentsply-Maillefer, Ballaigues, Switzerland) was mixed with one drop of distilled water on a sterilized glass slab (according to manufacturer's instructions). MTA was placed into the canal, using a spoon excavator and a small plastic instrument, and then condensed using endodontic plugger.[8]Access was covered with cotton pellet moistened with water.

GROUP A3 and B3: Biodentine(Septodont, Saint-Maur, France) capsule was manipulated with the help of amalgamator (according to manufacturer's instructions) and the mix was condensed into the mold with the help of amalgam carrier and plastic filling instrument. [9]

All teeth were radiographed to ensure adaptation, length and consistency of the material over gutta-percha filling. In cases where voids were present or the length of material was not adequate, the material was removed and a new mixture was prepared and condensed into the canal. Teeth were incubated at 37°C for 48 hours to ensure that the material had properly set.

All root surfaces of experimental groups were covered with sticky wax leaving only the access opening uncovered. All teeth were immersed vertically in methylene blue for 5 days.

The sticky wax was removed following the dye exposure. Teeth were decalcified in 5% nitric and for 72 hours with fresh solution used daily. Teeth were then washed for 4 hours under running water and were dehydrated gradually in ascending percentages of ethanol. First teeth were immersed in 80% ethanol overnight; then in 90% ethanol in 2 one-hour washes and then in 100% ethanol in 3 one hour washes. All teeth were cleared in methyl salicylate overnight and further kept moist in it. The degree of coronal microleakage was determined by measuring the linear extent of dye penetration in millimeters from the coronal end of the preparation, using the calibrated stereomicroscope (C-DS Model, Nikon) under 15× magnification.[10]

Statistical analysis of the data was performed using SPSS (version 15.0; SPSS Inc., Chicago, IL, USA). Kolmogorov-Smirnov tests revealed that measurement of the amount of dye leakage was normally distributed. F-value was found to be significant between the groups. Therefore, One-Way ANOVA test followed by Post-Hoc Multiple comparison (Bonferroni) test at 95% confidence interval was used for intergroup comparison. A P-value of less than 0.05 was considered as statistically significant.

RESULTS:

The mean microleakage for all groups is given in Table 1.

Table 1: Mean Microleakage and Standard Deviation Of All The Groups

Groups	Mean	N	Std. Deviation (in mm)
GIC + ZOE(A1)	12.8267	15	1.58045
MTA + ZOE(A2)	8.8400	15	2.34758
Biodentine + ZOE(A3)	4.9400	15	1.56150
GIC +AH+(B1)	7.2867	15	1.53291
MTA + AH+(B2)	3.3600	15	1.60080
Biodentine + AH+(B3)	1.4400	15	.69877

Table 2: Intergroup Comparative Evaluation Of Microleakage Using Post-Hoc Test (Bonferroni)

(I) groups	(J) groups	Mean Difference (I-J)	Sig.
GIC + ZOE	MTA + ZOE	3.98667*	.000
	Biodentine + ZOE	7.88667*	.000
	GIC +AH+	5.54000*	.000
	MTA + AH+	9.46667*	.000
	Biodentine + AH+	11.38667*	.000
MTA + ZOE	GIC + ZOE	-3.98667*	.000
	Biodentine + ZOE	3.90000*	.000
	GIC +AH+	1.55333	.158
	MTA + AH+	5.48000*	.000
	Biodentine + AH+	7.40000*	.000
Biodentine + ZOE	GIC + ZOE	-7.88667*	.000
	MTA + ZOE	-3.90000*	.000
	GIC +AH+	-2.34667*	.002
	MTA + AH+	1.58000	.139
	Biodentine + AH+	3.50000*	.000
GIC +AH+	GIC + ZOE	-5.54000*	.000
	MTA + ZOE	-1.55333	.158
	Biodentine + ZOE	2.34667*	.002
	MTA + AH+	3.92667*	.000
	Biodentine + AH+	5.84667*	.000
MTA + AH+	GIC + ZOE	-9.46667*	.000
	MTA + ZOE	-5.48000*	.000
	Biodentine + ZOE	-1.58000	.139
	GIC +AH+	-3.92667*	.000
	Biodentine + AH+	1.92000*	.026
Biodentine + AH+	GIC + ZOE	-11.38667*	.000
	MTA + ZOE	-7.40000*	.000
	Biodentine + ZOE	-3.50000*	.000
	GIC +AH+	-5.84667*	.000
	MTA + AH+	-1.92000*	.026

*. The mean difference is significant at the 0.05 level.

DISCUSSION:

The concept of coronal leakage having an effect on the outcome of root canal treatment has been known for nearly 90 years. Contamination of the root canal system with saliva has been identified as a potential cause of endodontic failure.[11] Swanson and Madison reported that exposure of the coronal segments of obturated root canals to artificial saliva resulted in recontamination of 79 to 85% of the root canal system in as little as 3 days.[1] Torabinejad et al. demonstrated that over 50% of obturated root canals were contaminated after 19 days of exposure to *Staphylococcus epidermidi*s.[12]

The intracanal barriers provides a secondline of defence against the bacterial leakage in obturatedcanals offering enough bulk of material for sealingwithout compromising the retention of final restoration.[13]Numerous studies have shown that the use of intraorificebarriers in canals filled with gutta-percha significantlydecreases coronal microleakage.[7,14,15]

The purpose of this study was to compare the sealing ability of MTA, GIC and biodentine when placed over gutta-percha obturated root canals as intracanal plugs. Conventional glass ionomercement (Fuji II) was chosen as an intracanal plug in Groups A1 and B1 as it has been found to have better sealing ability than resin-modified glass ionomer cement.[16] The polymerization shrinkage on curing may have been the reason for inferior sealing ability of the resin ionomer.

In the present study, White MTA (ProRoot MTA) was chosen as an intracanal barrier material in Groups A2 and B2 due to its improved aesthetics and placement characteristics as compared to the original Gray MTA.[17] The reason for using a tricalcium based cement (Biodentine) in the present study is because of its antibacterial properties and a very good sealing ability.[18] In this study, linear dye penetration method was used as it is most convenient, sensitive, easy to accomplish method

that doesn't require sophisticated materials or equipments[19] and produces results similar to bacterial leakage method.[20] Methylene blue was used in the current study because it has a low molecular weight and penetrates more deeply than other dyes.[21] The Clearing technique recommended by Okumura in 1927 was used in this study for leakage evaluation. In this technique, the teeth become transparent after the process of demineralization, dehydration, and immersion in methyl salicylate. It permitted observation of dye along all the surfaces of the specimen without the loss of dental substance, which is not possible in the techniques in which a tooth is sectioned.[22] It is simple, fast, performed with substances low in toxins, and does not require complex equipment.[23]

The leakage in group with GIC plug and ZOE sealer (A1) was highest amongst the experimental groups. This may be due to poor sealing ability of both the ZOE sealer and GIC plug. The potential for air bubble formation which results in void incorporation and its property of dissolution in tissue fluids might have been the reason for inferior findings of GIC.[24]

The biodentine group had showed less leakage when compared to MTA group. This might be due to the following reasons:

1) When Biodentine comes in contact with dentine it leads to the formation of tag-like structures alongside an interfacial layer called the "mineral infiltration zone," where the alkaline caustic effect of calcium silicate cements hydration products degrades the collagenous component of interfacial dentine.[25]

2) The sealing ability of Biodentine is most likely through the formation of tags. Han and Okiji showed that calcium and silicon ion uptake into dentin leading the formation of tag-like structures in Biodentine was higher than MTA.[26]

3) Better seal with Biodentine can also be attributed to its modified powder composition i.e. the addition of setting accelerators and softeners, a new pre-dosed capsule formulation for use in a mixing device largely improve the physical properties including sealing ability of the material

4) Biodentine has an advantage of fast setting time (12 min) thereby sealing the interface earlier to avoid further leakage to take place so there is a lower risk of bacterial contamination

5) Due to its better handling properties adaptation to the cavity walls is better which can be responsible for improved sealing ability of Biodentine

6) Smaller particle size of Biodentine adapts well to cavity surface sealing interface

7) Porosity and pore volume in set Biodentine material is also less than MTA that could be a reason for better sealing ability.[27]

A study was done to check for marginal adaptation of three root-end filling materials GIC, MTA and Biodentine which concluded that lowest marginal gaps and good marginal adaptation was seen with Biodentine followed by MTA and highest marginal gaps with GIC.[28]

Torabinejad*et al*.[29] found superior marginal adaptation of MTA accounting for its ability to resist leakage. Its sealing ability has been attributed to its hydrophilic nature and expansion when it sets in moist environment.[30] Gap formation between GIC and dentin wall resulted in poor sealing ability of GIC, which may have been due to material shrinkage on setting. [31]

However, there was not much difference between MTA and Biodentine groups when AHPLUS sealer was used. This might be attributed to the better sealing property and low solubility of this sealer.[32]

The results of this study showed that biodentine when placed as an intracanal plug exhibited lower mean leakage than GIC and MTA irrespective of the sealer used. Also, AH Plus sealer exhibited better sealing ability than Zinc oxide sealer. Hence, Biodentine and MTA as an intracanal barrier and sealer with good sealing ability for obturation may be used to minimize microleakage in endodontically treated teeth. However, further research and clinical trials using larger sample size and well controlled *in vivo* studies need to be done to correlate the results.

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