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ORIGINAL ARTICLE

Comparing the Sealing Ability of Contemporary Restorative Materials

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ABSTRACT

Aim: The success of the root canal treatment mainly depends upon the three-dimensional obturation of the root canal system. The purpose of this study is to compare the sealing ability of biodentine, mineral trioxide aggregate (MTA), and glass ionomer cement (GIC).

Materials and methods: Teeth were obturated with gutta-percha using AH PLUS sealer in all groups. The intracanal sealing material used in group I was GIC, group II was MTA, and group III was biodentine. The specimens were longitudinally sectioned. Coronal microleakage was determined under a stereomicroscope using 15× magnification. Data were statistically analyzed using one-way analysis of variance followed by *post hoc* multiple comparisons (Bonferroni).

Results: Biodentine group leaked significantly less than the GIC group ($p < 0.05$). The sealing ability of biodentine was better than that of MTA, but the difference was not statistically significant.

Conclusion: Biodentine or MTA may be preferred over GIC as an intracanal barrier.

Clinical significance: Biodentine or MTA can be used in areas where an impervious seal has to be obtained. They can also be used to seal the perforations in the coronal middle and apical thirds of the root canal. These materials have an ability to form a barrier during apexification procedures.

Keywords: AH PLUS sealer, Biodentine, Glass ionomer cement, Intracanal sealing, Mineral trioxide aggregate.

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INTRODUCTION

The success of the root canal treatment mainly depends on 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 exposure of the canal system due to fracture of tooth prior to final restoration; (4) lack of ideal marginal integrity of the final restoration; or (5) recurrent decay is present at the restoration margin(s).[2,3] Thus, it is important to obtain a proper coronal seal.

The seal established by the present-day restorative materials is questionable. Various permanent restorative materials like Amalgam, Composite resin, etc., are being used as intracanal plugs. However, the search for an ideal intracanal barrier still continues. Thus, it is the need of the hour to search for a material that would provide a proper coronal seal.

However, glass ionomer cement (GIC) has been reported to be used as an intracanal sealing material because of its adhesive and anticariogenic properties.[4] Mineral trioxide aggregate (MTA) due to its good sealing properties has also been used as an 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 an intracanal plug. Thus, comparing the intracanal sealing ability of GIC, MTA, and biodentine when they are placed over gutta-percha is the aim of this *in vitro* study.

MATERIALS AND METHODS

Forty-five extracted human noncarious and nonrestored mandibular premolars with single canal were taken for this study from individuals among 20 to 30 years of age. To check for the presence of single canal, the teeth were radiographed from facial and proximal views. Soft tissue and hard aggregations were removed from the root surfaces followed by which teeth were stored in saline until used. The decoronation of all teeth was done to standardize the root length up to 16 mm. All samples were examined under 3.5× magnification loupes to eliminate the teeth that have fractures. The biomechanical preparation was done using stepback technique described by Mullaney,[5] which involves two phases. In phase I, the apical part of the canal was prepared till file no. 35. In phase II, the remaining part of the canal was prepared

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in stepping back procedure in 1 mm increments, no. 35 through 50. Gates Glidden drills no. 2, 3, and 4 were used for coronal and midroot preparations during refining phase IIa. The smoothening of the preparation was done using file no. 35 in a circumferential filing motion.[6] Glyde (Dentsply Maillefer, Ballaigus, Switzerland) was coated on each instrument and sodium hypochlorite was used after every file; 17% ethylenediaminetetraacetic acid was used as a final rinse. Teeth were randomly divided into experimental groups IA, IB, and IC (15 teeth each). Obturation of the teeth was done using gutta-percha and AH PLUS (Dentsply-Maillefer Ballaigues, Switzerland), a resin-based sealer.

Heated spoon excavator was used to shear and vertically condense the gutta-percha right at the orifice opening of the canals.[7] Cotton pellets were used to close the access openings. An UNC 15 probe was used to verify the depth of gutta-percha removed.[7] Examination of gutta-percha and sealer remnants was done using radiographs. Group A was further divided into three subgroups (IA, IB, and IC) depending on the sealing material to be used for the coronal seal.

Group IA

A conventional chemical cured GIC (Fuji II, GC Corporation, Tokyo, Japan) was used as an intracanal barrier. Manipulation of GIC was done 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 IB

Mineral trioxide aggregate was used as an 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). Using a spoon excavator and a small plastic instrument, MTA was placed into the canal and then condensed using endodontic plugger.[8] The access was covered with cotton pellet moistened with water.

Group IC

Manipulation of biodentine (Septodont, Saint-Maur, France) was done 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]

The adaptation, length, and consistency of the material over gutta-percha filling were confirmed with radiographs. If voids were present, a new mixture was prepared and condensed into the canal. Teeth were incubated at 37°C for 48 hours to ensure that the material was properly set.

All root surfaces were covered with sticky wax leaving only the access opening uncovered. Immersion of teeth was done in methylene blue for 5 days. After the exposure of dye, the sticky wax was removed. Decalcification of teeth was done using 5% nitric acid for 72 hours with the fresh solution used daily. Running water was used to wash the teeth for 4 hours. Gradually ascending percentages of ethanol was used for dehydration. All teeth were sectioned longitudinally and 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 Statistical Package for Social Sciences software (version 15.0; SPSS Inc., Chicago, IN, USA). Kolmogorov–Smirnov tests revealed that measurement of the amount of dye leakage was normally distributed. The F-value was found to be significant between the groups. Therefore, the intergroup comparison was done using one-way analysis of variance test followed by *post hoc* multiple comparison (Bonferroni) test at 95% confidence interval. 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. The groups with biodentine and MTA plugs (Group IC, IB) exhibited lower leakage than groups with GIC plugs (Group IA). The intergroup comparison is given in Table 2 Among the groups, group IA with GIC plug exhibited the highest leakage. Group IC with biodentine plug exhibited the lowest leakage.

DISCUSSION

The concept of coronal leakage having an effect on the outcome of root canal treatment has been known for nearly 90 years. Saliva contamination of the root canal system has been identified as a potential cause of endodontic failure.[11] Swanson and Madison[1] 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. Torabinejad et al[12] demonstrated that over 50% of obturated root

Table 1: Mean microleakage and standard deviation of all groups

Group	*Mean*	*n*	*Standard deviation*
Glass ionomer cement	5.5400	15	0.18048
Mineral trioxide aggregate	1.3800	15	0.34888
Biodentine	1.3533	15	0.38334

Table 2: Intergroup comparative evaluation of microleakage using *post hoc* test (Bonferroni)

(I) Group	*(J) Group*	*Mean Difference (I − J)*	*Significnance*
Glass ionomer cement	Mineral trioxide aggregate	4.16000[a]	0
	Biodentine	4.18667[a]	0
Mineral trioxide aggregate	Glass ionomer cement	−4.16000[a]	0
	Biodentine	0.02667	1.000
Biodentine	Glass ionomer cement	−4.18667[a]	0
	Mineral trioxide aggregate	−0.02667	1.000

[a]The mean difference is significant at the 0.05 level

canals were contaminated after 19 days of exposure to *Staphylococcus epidermidis*.

The intracanal barriers besides providing a second line of defense against the bacterial leakage also provide enough bulk of material for sealing.[13] Many studies have shown that the coronal microleakage has been reduced when intraorifice barriers have been used.[7,14,15]

The purpose of this study is to compare the sealing ability of MTA, GIC, and biodentine, when placed over gutta-percha obturated root canals as intracanal plugs. Conventional GIC (Fuji II) was chosen as an intracanal plugin group IA as it has been found to have better sealing ability than resin-modified GIC.[16] The inferior sealing ability of resin ionomer may be attributed to the polymerization shrinkage that occurs on curing.

In the present study, white MTA (ProRoot MTA) was chosen as an intracanal barrier material in group IB due to its improved aesthetics and placement characteristics as compared with the original gray MTA.[17]

The reason for using 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 a most convenient, sensitive, and easy to accomplish method that does not require sophisticated materials or equipment[19] and produces results similar to bacterial leakage method.[20] The better penetrating ability due to low molecular weight was the reason for using methylene blue in the present study.[21]

The leakage in a group with GIC plug and AH PLUS sealer (IA) was highest among the experimental groups. 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.[22]

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

- When biodentine comes into contact with dentin, 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 dentin.[23]
- The sealing ability of biodentine is most likely through the formation of tags. Han and Okiji[24] showed that calcium and silicon ion uptake into dentin, leading to the formation of tag-like structures in biodentine, was higher than in MTA.
- Better seal with biodentine can also be attributed to its modified powder composition, i.e., the addition of setting accelerators and softeners, a new predosed capsule formulation for use in a mixing device, largely improves the physical properties including sealing ability of the material.
- Biodentine has an advantage of fast setting time (12 minutes), thereby sealing the interface earlier to avoid further leakage to take place so there is a lower risk of bacterial contamination.
- Due to its better handling properties, adaptation to the cavity walls is better, which can be responsible for the improved sealing ability of biodentine.
- Smaller particle size of biodentine adapts well to cavity surface sealing interface.
- Porosity and pore volume in set biodentine material are also less than in MTA, which could be a reason for better sealing ability.[25]

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 were seen with biodentine followed by MTA and highest marginal gaps with GIC.[26]

According to Torabinejad et al,[27] the hydrophilic nature and expansion of MTA when setting in a moist environment accounted for its superior marginal adaptation.[28] The property of GIC to shrink once it sets has led to gap formation, which resulted in poor sealing ability of the material.[29]

However, there was not much difference between MTA and biodentine. 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. 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 has to be done using larger sample size and also well-controlled *in vivo* studies and clinical trials have to be done to correlate the results.

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