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RESEARCH ARTICLE

SEALING ABILITY OF GLASS IONOMER CEMENT, BIODENTINE, MINERAL TRIOXIDE AGGREGATE & BONE CEMENT WHEN USED AS RETROGRADE FILLING MATERIALS IN ENDODONTIC SURGERY

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ABSTRACT

A***im***: The purpose of this present study was to evaluate the sealing ability of Glass Ionomer Cement (GIC), Biodentine, Mineral Trioxide Aggregate (MTA) and Bone Cement when used as a retrograde filling material.

Materials and Methods: Eighty extracted human maxillary anterior incisor teeth were obturated and stored in normal saline, and after the period of one week all the samples were resected apically at an angle of 90° and root end cavities were prepared. Teeth were divided into four groups of twenty specimens each, in Group I –Biodentine, Group II – Bone Cement, Group III - MTA, Group IV – GIC were used as a retrograde filling materials. The teeth were stored in humidifier and later coated with nail varnish except at the apical 1 mm. After drying the specimens were immersed in 0.2% Rhodamine-B dye for 72 hours. The teeth were rinsed under water for 15 minutes and sectioned longitudinally. All the samples were evaluated under stereomicroscope for determining the dye penetration in millimeters.

Statistical analysis used: All statistical analysis was done using SPSS version 17 using ANOVA with post-hoc test.

Results: The mean microleakage was significantly higher in GIC followed by MTA, Bone cement and least with Biodentine.

Conclusion: Biodentine has better sealing ability as root end filling material in comparison to MTA, Bone Cement and GIC.

INTRODUCTION

For successful endodontic therapy it is essential to have complete 3-Dimensional obturation of root canal system with fluid tight seal.[1] In cases, where conventional endodontic therapy is not possible, surgical endodontic therapy is attempted to save the tooth.[2] Surgical endodontics includes exposure of the involved apex, root end resection, root end cavity preparation and insertion of a retrograde filling material.[3]

Root end resection and its techniques plays an important role in surgical endodontics to significantly reduce the number of bacteria and an apical cavity of 3 mm is sufficient to produce a safe and an effective seal.[4] To seal these root end cavities an inert non-toxic retrograde filling material is required.[5]

An ideal retrograde filling material should provide fluid tight seal in root canal system. It should also have properties like biocompatibility, induce periapical healing, non absorbable, radiopaque, dimensionally stable, easy to use and it should not be affected by moisture.[6]

Different materials are available for use as retrograde fillings, including guttapercha, amalgam, cavit, intermediate restorative material (IRM), super EBA, bone cement, glass ionomer cement, composite resins, Biodentine and Mineral trioxide aggregate (MTA). But none of these materials fulfill the requirement of an ideal material.[7]

GIC also known as dentin substitute bonds chemically to tooth structure and have properties like excellent marginal adaptation and long term antibacterial action due to slow releases of fluoride.[8]

Principal ions of hard tissue are calcium and phosphorous which are also the main ions present in MTA making it to be biocompatible with cells and tissues. So interaction between material and host tissues is minimal.[9] These properties, favor its use as a root end filling material.

Another material that is Poly methyl methacrylate (PMMA) bone cement which is commonly used for fixation of prosthesis, filling bone defects and stabilization of compressive vertebral fractures in orthopedics surgery shows excellent adaptation to the cavity margins. This is because during polymerization, the cement increases to a maximum volume before shrinking slightly, although not to its initial volume. And also the properties like unaffected by moist environment and blood contamination makes it favorable for use as a retrograde filling material.[10]

The newer material such as Biodentine is now used as retrograde filling material, having the same composition like MTA. However, the disadvantages of MTA like the poor handling characteristics and prolong setting is overcome by adding setting accelerators and softeners to the powder which makes it more user-friendly.[11]

The aim of this invitro study was to compare microleakage of Mineral Trioxide Aggregate, Glass Ionomer Cement, Bone Cement and Biodentine when used as root end filling materials using dye penetration method under a stereomicroscope.

MATERIALS AND METHODS

In this study eighty freshly extracted human maxillary anteriors with fully formed apex teeth are selected. Diagnostic radiograph were taken to confirm straight canals and then teeth were kept in normal saline. After cleaning, the teeth were decoronated at CEJ with diamond disk before the preparation.

Working length was determined using No. 15 K-flex file (*Dentsply Maillefer, Tulsa, OK*) after pulp extirpation while maintaining the canal patency. Instrumentation was done using the hybrid technique with standard irrigation protocol upto 50 K-flex file at apical foramen. Cold lateral compaction obturation technique was done using AH-26 sealer (*Dentsply Maillefer, Tulsa, OK*). To check the quality of obturation radiographs were taken and coronal orifice were sealed using composite resin (3M ESPE, St. paul, MN, USA)

After obturation all the samples were kept in moist environment, thereafter, they were resected 3mm from apex at right angle to the long axis of teeth using diamond disc. Then 3mm deep retrograde cavity were prepared using ultrasonic surgical tip S12 (Satelec/Acteon, Merignac, France).

Group II – Bone Cement (DePuy, Johnson and Johnson, California, USA)

Group III - Mineral trioxide aggregate (Pro Root MTA, Dentsply Tulsa Dental, Tulsa, OK, USA)

Group IV – Glass ionomer cement (GC Fuji II, GC Corporation, Tokyo, Japan).

Standard protocol is followed for retrograde filling.

Teeth were stored in humidifier until complete set of retro filling materials, this is followed by coating the teeth entirely with 3 layers of nail varnish except for 1mm of the apex and kept dry. Teeth were then suspended in 0.2% Rhodamine B dye for the next 72 hrs. Later, the teeth were cleaned under tap water for 15 minutes, and then teeth were sectioned longitudinally with a diamond disk under coolant. Samples were observed under stereomicroscope (30x) for evaluating the microleakage of different root end filling materials in millimeters using image analysis software (Magnum, Florida, USA) (Figure 1).

Statistical analysis was done using SPSS version 17. *P*-value of <0.05 was considered statistically significant. Comparison of mean microleakage among the study groups was done using ANOVA with post-hoc test.

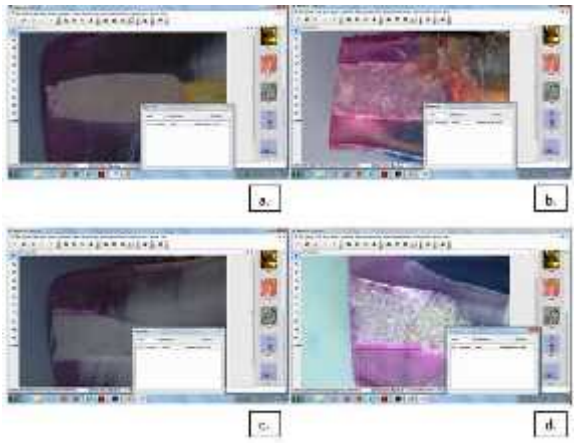


Figure 1 Illustrate microleakage evaluated in millimeters using image analysis software (Magnum, Florida,USA) in a. Biodentine, b. Bone Cement, c. MTA, d. GIC

Table 1 Comparison of mean micro-leakage in millimeter

	Groups								*P*-value
	Biodentine (1)		Bone cement (2)		MTA (3)		GIC (4)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Mean micro leakage in mm	.145	.080	.331	.102	.736	.137	1.250	.131	<0.001Sig

Table 2 Illustrate that there is significant difference between the all four Groups

Inter-group comparison	p-value
Group 1 vs 2	<0.001 sig
Group 1 vs 3	<0.001 sig
Group 1 vs 4	<0.001 sig
Group 2 vs 3	<0.001 sig
Group 2 vs 4	<0.001 sig
Group 3 vs 4	<0.001 sig

Then samples were divided into 4 groups of 20 specimens each for retrograde filling, using:

Group I – Biodentine (Septodont, St. Maur-des-Fossés, France)

RESULTS

The sealing ability of the root end filling materials was compared using dye penetration technique. The evaluation of microleakage was performed with the help of Image Analyser Software. All measurements were made in mm at 30X magnification. (Table 1) illustrates the mean microleakage measured in mm. There was significant difference in the mean micro-leakage among the 4 groups was statistically significant (*P*<0.001). Hence post-hoc test was done to evaluate significant inter-group comparison (Table 2). The result obtained revealed that the mean microleakage was significantly higher in GIC followed by MTA, Bone cement with least in Biodentine.

DISCUSSION

This study was to compare microleakage of various root end filling materials and can be carried out by both in vivo and in vitro methods. But, due to limitations with in vivo studies like large number of specimens, time consumption, in vitro study was done.

Various methods can be used to assess the microleakage of root end-filling materials like degree of dye penetration, radioisotope penetration, bacterial penetration, and electrochemical means and fluid filtration techniques.[12] Among these the most popular method is dye penetration method as it is easy to perform and gives reliable results.[13]

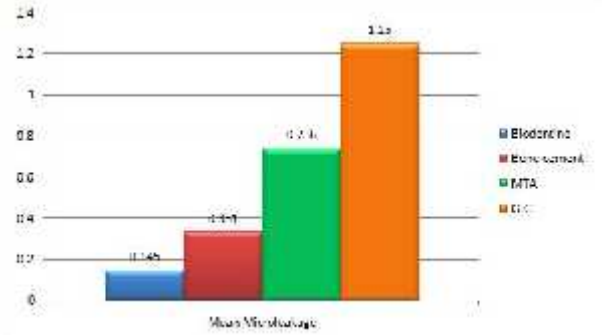
According to Azoubel, Veeck (1998), rhodamine B can be applied in studies of dye penetration because it has smaller particles, presenting a great diffusibility in dentinal tubules, which is easily visualized under stereomicroscope.[14]

Root end resection can be done at different plans ie 30^0, 45^0, 90^0 . Among these the most accepted is 90^0 as it least affects the adaptability of root end materials, others have a disadvantage as they may lead to open dentinal tubules, more mechanical stresses, loss of dentine – cementum bone which may lead to compromised healing.[15]

Various root end anatomical variations can occur for example apical ramifications and lateral canals. Most accepted root end resection is 3 mm as it reduces 98% of apical ramifications and 93%lateral canals are eliminated.[16] In this study resection of root was performed at the depth of 3 mm to eliminate any lateral canals or apical ramifications.

The depth of penetration ideally should be 3 mm as more than that does not have any greater benefits whereas lesser depth may have negative effect on the long-term success of apical seal. Depth to an optimum of 3mm decreases the leakage. This is attributed to the occlusion of apical tubules by retro filling material. Hence the depth of retrograde cavities in this study was kept to an optimum of 3 mm.[17]

In this study the statistical analysis showed microleakage in all the samples but mean micro-leakage was significantly higher in GIC (1.25mm) followed by MTA (0.736mm), Bone cement (0.331mm) with least being in Biodentine (0.145mm) as shown in Graph 1. GIC showed high dye penetration in all specimens in this study. This result is in similar to studies of King, *et al*.[18] and D.Saini *et al*.[19]



Graph 1: Illustrate the Bar Graph which shows the mean microleakage of the four materials tested in millimeter

King, *et al*.[18] reported that a glass ionomer restorative material produced significantly less sealing compared to the other materials (amalgam and Super - EBA) and cannot be recommended for use as a root-end filling material.

D.Saini *et al*.[19] evaluated Mineral trioxide aggregate (MTA), Glass ionomer cement (GIC) and silver GIC (Miracle mix) as root end filling materials for microleakage using dye penetration technique under stereomicroscope. The obtained data revealed that MTA is a better material as root end filling material to prevent micro leakage, in comparison to GIC and Miracle Mix. This result is in congruence with our study.

With all the advantages of MTA, it has a few drawbacks namely difficulty in handling, slow setting, surface disintegration which may contribute to micro leakage, loss of marginal adaptation.[20]

While Bone Cement has many characteristics that make it well suitable for retrofilll. This cement exhibits low cytotoxity and excellent biocompatibility which allows for tissue reattachment. Bone exhibits long-term compatibility with bone cement that allows excellent interlocking of the cement with the soft and hard tissues of the bone without cell necrosis.[21]

In this study, MTA showed more microleakage when compared with Bone cement. This is in accordance with study by C Girish *et al*.[22]

In a study done by C Girish *et al*.[22] PMMA bone cement showed a mean microleakage, which was much less than MTA. They used confocal laser scanning microscope to measure the extent of dye penetration.

Biodentine showed the least microleakage in all the specimens of this study. These results are similar to studies by Kokate *et al*.[23], Prasanti Kumari Pradhan *et al*.[24] and Ankita Khandelwal *et al*.[25]

Biodentine is calcium silicate based cement. In addition to the chemical composition on the Ca_3SiO_5 and water chemistry which brings the high biocompatibility of already known endodontic repair cement like MTA, it has increased physico-chemical properties like short setting time, high mechanical strength which make it clinically easy to handle. These properties of Biodentine make it superior from MTA.[23]

Kokate *et al*.[23] study compared the microleakage using MTA, GIC & Biodentine using dye penetration method under stereomicroscope. The results of their study showed that there was significantly less leakage in Biodentine when compared to MTA & GIC. This result is in agreement with present study.
Prasanti Kumari Pradhan *et al*.[24] evaluated the microleakage using MTA, GIC, Biodentine and super-EBA using dye penetration method under 30x magnification. The results showed that biodentine produce less amount of microleakage compared to MTA, but results are not statistically significant and also both materials are superior to GIC, super-EBA.

Ankita Khandelwal *et al*.[25] compare the sealing ability of MTA and Biodentine as root end filling material using Rhodamine B dye. In this study also Biodentine showed significantly less microleakage than MTA.

The other probable reasons for Biodentine to show less microleakage are due to formation of tag like structures when it comes in contact with dentine,[26] also it adapt well to cavity surface due to smaller particle size,[25] and also set Biodentine has less porosity and pore volume when compared to MTA.[27]

CONCLUSION

GIC showed the maximum microleakage followed by MTA, Bonecement, and least microleakage was observed in Biodentine. Therefore Biodentine has better sealing ability as root end filling material in comparison to MTA, Bonecement and GIC

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