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In Vitro comparative Study of Sealing Ability of the Root End Filling Materials

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ABSTRACT

Aim: This *in vitro* study evaluated and compared sealing ability of four different root end filling materials i.e. Glass Ionomer cement, Amalgam, Mineral trioxide aggregate and Bio dentine as a new root-end filling material.

Materials and Methods: sixty extracted human maxillary central incisors were selected. All the roots were instrumented and obturated with gutta-percha and resin sealer. Obturated roots were divided randomly into 6 experimental groups of 10 samples each. In the negative control group (group I), roots were kept without any further preparation. In the positive and experimental groups, roots were apically resected and root-end cavities were prepared and filled with: (a) gutta-percha (group 2-positive control group); (b) amalgam (group 3); (c) IRM (group 4);(d) MTA (group 5); (e) Biodentine (group 6). Apical leakage was assessed using dye penetration technique. Data were submitted to statistical analysis by the one-way analysis of variance (ANOVA) and Tukey's test.

Results: Significant difference of sealing ability was found among 4 tested groups. Biodentine followed by MTA showed the highest sealing ability, amalgam showing the maximum leakage.

Conclusion: Biodentine with its high sealing ability can be considered a possible root end sealing material.

Keywords: Biodentine, root canal sealer, MTA.

INTRODUCTION

The primary aim of root canal treatment is the elimination and exclusion of micro-organisms from the root canal system.[1] Failure occurs as there are root canal complexities that cannot be cleaned and or obturated specially in apical third region. When nonsurgical root canal treatment fails to treat periradicular lesions of endodontic origin or retreatment is not feasible, endodontic surgery may be indicated.[2] Therefore; infection can persist or quickly re-establish itself. In rare cases, factors located outside the tooth within the inflamed periapical areas can impede healing of apical periodontitis after a tooth has been treated endodontically.[1] The objective of periradicular surgery is to access the affected area, remove the diseased tissue, evaluate the root circumference of

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root canal system and place a biocompatible seal in the form of root end filling that can stimulate regeneration of the periodontium.[3] Gartner and Dorn4 proposed the ideal properties of a root end filling material. The material should be easy to manipulate, radiopaque, dimensionally stable, nonabsorbable, insensitive to moisture, adhesive to dentine, nontoxic and biocompatible. [5, 6]

For providing an adequate seal there should be a proper root end preparation. Multiple techniques and instruments have been advocated for root end preparation.7 Various materials used as root end fillings include Gutta-percha, Silver Amalgam, Intermediate Restorative Material (IRM), Super EBA, Diaket, Glass Ionomers, Composite resins, Zinc Oxide Eugenol cements, MTA, & recently discovered Bio dentine. The quality of apical sealing obtained by different root end filling materials can be assessed in different ways such as dye penetration, bacterial penetration, electromechanical ways, fluid filtration technique etc.[2, 4, 8] The aim of this in-vitro study was to compare and evaluate the best sealing ability of four different root end filling materials i.e. Glass Ionomer cement, Amalgam, Mineral trioxide aggregate and Bio dentine.

MATERIALS AND METHODOLOGY

The study was conducted in the department of Conservative Dentistry and Endodontics in NIMS Dental College.

Specimen Preparation

Sixty extracted maxillary permanent central incisors were collected and stored in normal saline. The external surfaces of teeth were cleaned with scalers to remove any gross debris and calculus deposits, after which they were decoronated from the level of cementoenamel junction using a diamond disc (DFS, Germany) before root canal preparation. The pulp tissue was extirpated with a barbed broach. A size 10 K- File (Dentsply Maillefer, USA) was used to confirm canal patency. The working length was determined with the help of radiographs.

Canal Preparation& Root Resectioning

Canals were cleaned and shaped using step back technique. 5% sodium hypochlorite and 17% EDTA (Ammdent) were used as irrigants. All the canals were enlarged upto No. 50 K- file (master apical file) at the apical foramen. The specimens were stored in normal saline until obturation. Canals were dried using absorbent paper points and master cone selection was confirmed with radiographs. Canals were obturated with gutta percha by lateral compaction technique. Radiographs were taken to confirm the quality of obturation and the openings were sealed with glass ionomer cement. All samples were stored at 37 ± 1°C and 100% relative humidity for 7 days. The obturated samples were randomly divided into 2 control and 4 experimental groups of 10 roots each. In the negative control group (group 1), no further preparation was done and the entire specimen including the root canal orifice and the apical foramen was completely coated with three layers of nail varnish to prevent the dye leakage into the root canal system. Then the teeth in group 2-6 were resected apically at 90° angle to the long axis of the root using diamond disc (DFS, Germany) removing 3 mm of the apex. The cut surface was made without bevelling, to enhance measurement accuracy of the apical cavity depth. The 3 mm deep retrograde cavity was prepared using No. 2 round diamond bur (Mani, Japan) the cavities were irrigated with saline and dried. The teeth were randomly divided into 6 groups of 10 specimens each. Each sample was restored with different materials. Group 1 served as the negative control group coated with nail varnish. Group 2 Positive control group filled with gutta percha. Group 3 roots were retro filled with Glass Ionomer Cement (GC Fuji 9, GC Corporation, Tokyo, Japan). Group 4 roots were retro filled with Amalgam(DPI).Group 5 roots were retro filled with Mineral Trioxide Aggregate (Pro Root MTA, Dentsply).Group 6 roots were retro filled with Biodentine™ (Septodont, St. Maur-des-Fossés, France).

The samples were stored individually in screw capped vials in an incubator at 37° C for 48 hours. A water saturated cotton pellet was placed in each vial to assure 100% humidity. After removing the samples from the incubator the samples were covered with three layers of nail varnish leaving 1-2 mm around the retrograde filling area. The specimens were suspended in 2% methylene blue for 72 hours. Following this, the roots were rinsed for 15 minutes under tap water. The teeth were

split longitudinally with a diamond disc using a water coolant. The depth of dye penetration in each tooth was assessed under 10X magnification with a stereomicroscope and microleakage associated with different root end filling materials was evaluated. To determine statistically significant differences in leakage among four tested groups, data were analyzed using one-way Analysis of Variance test and an intergroup comparison was performed by post-hoc test. Statistical analyses were made using SPSS 19 software. Positive and negative control groups were considered to note the actual difference with the use of various root end filling materials.

(I) Descriptive statistics

It was carried out to know the mean standard deviation between different root end filling materials as shown in

Table 1: Descriptive Statistics showing the mean standard deviation of Biodentine, GIC, MTA & Amalgam.

Groups	N	Minimum	Maximum	Mean	Std. Deviation
Biodentine	9	.4	.7	.544	.1130
GIC	9	1.4	1.8	1.589	.1453
MTA	9	.7	.9	.789	.0782
Amalgam	9	1.8	2.2	1.978	.1394
Valid N (listwise)	9				

One Way Analysis of Variance

It was done to detect any significant difference in microleakage in all groups. The microleakage value estimated for different groups were:

Table 2: ANOVA showing the inter group comparison between Biodentine, GIC, MTA & Amalgam.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	11.495	3	3.832	262.751	.000
Within Groups	.452	31	.015		
Total	11.947	34			

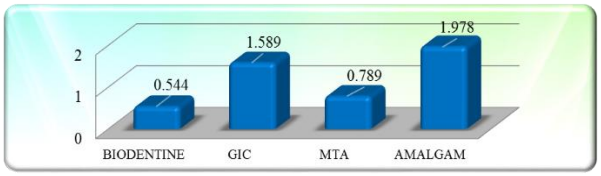
The result is found to be significant ($p < 0.05$), then to identify the differences between the groups post-hoc test is carried out as shown in **Table 3.**

(I) POST HOC TEST

Table3: Post hoc comparison between Biodentine, GIC, MTA, Amalgam.

Groups	Between groups	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Biodentine	GIC	-1.0264*	.0587	.000	-1.192	-.861
	MTA	-.2264*	.0587	.003	-.392	-.061
	Amalgam	-1.4153*	.0587	.000	-1.581	-1.250
GIC	Biodentine	1.0264*	.0587	.000	.861	1.192
	MTA	.8000*	.0569	.000	.640	.960
	Amalgam	-.3889*	.0569	.000	-.549	-.228
MTA	Biodentine	.2264*	.0587	.003	.061	.392
	GIC	-.8000*	.0569	.000	-.960	-.640

	Amalgam	-1.1889*	.0569	.000	-1.349	-1.028
Amalgam	Biodentine	1.4153*	.0587	.000	1.250	1.581
	GIC	.3889*	.0569	.000	.228	.549
	MTA	1.1889*	.0569	.000	1.028	1.349



Graph 1: Mean microleakage scores for the four experimental groups.

Fig 1: Microlekage with Biodentine.

Fig 2: Microlekage with MTA.

Fig 3: Microleakage with Glass Ionomer Cement.

DISCUSSION

Surgical root canal therapy is often the indicated treatment when nonsurgical retreatment has failed or cannot be performed. Surgical root canal therapy usually involves resecting a portion of the root apex then preparing and filling a cavity in the root-end. The purpose of the retrograde filling is to seal the canal in order to prevent passage of bacteria or their toxins from the canal space into periradicular tissues.[9]

The quality of apical seal obtained by root end filling materials has been assessed by the degree of penetration. There are several methods by which it can be done such as chemical compounds (silver nitrate), bacterial penetration, fluid filtration techniques and radioisotope penetration.[10] But the most commonly used is dye penetration method (methylene blue, fuchsin, rhodamine B, fluorescent dyes). Using dyes is a simple and safe method for studying micro leakage, which is why we use it in current in-vitro study.[11]

In the current study methylene blue dye penetration was selected because it exhibits a high sensitivity, and its particles are of similar size of microorganism and their metabolite. This method allows for production of sections showing leakage in contrasting colours to both tooth and restoration without the need for further chemical reaction.[12, 13] The plane of sectioning also affects the degree of microleakage. 90° angulation has been proved to be most acceptable. The inclined plane sectioning of 30° or 45° angle could have disadvantages like open dentinal tubules, error in post-operative radiograph, mechanical stress, loss of dentin, cementum and bone which could result in compromised healing. So the root end resection angle of 90 degree was selected for this study.[14]

Apical ramification and lateral canals are very common near the root tip. Resection at the depth of 3mm reduces the apical ramification by 98% and lateral canals by 93%. In this study resection of root tip was performed at depth of

3mm to eliminate any lateral canals or apical ramification.[14, 15] For making cavity preparation in root end we can use various instruments like conventional slow speed handpiece, high speed airotor handpieces with burs, sonic and ultrasonic. According to previous studies ultrasonic root end preparation produces more conservative cavities when compared to conventional micromotor handpiece bur but we choose to prepare root end cavities using conventional slow speed handpieces as some studies have also shown that root end prepared by ultrasonic had a greater number of fractures.[16] Numerous substances have been used as root end filling materials. The choice of a root-end filling material could be governed by biocompatibility, apical seal ability, handling properties and long term clinical success (Johnson, 1999).[17] The clinical significance of microleakage in apical surgery has not been elucidated. However it seems logical that the lesser leakage would prevent migration of bacteria and toxins into the periradicular tissue (Johnson, 1999).[17]

Glass ionomer cement is a material with universal properties. It is a dentin substitute; its ability to exhibit chemical bond to tooth structure provides an excellent marginal seal. Studies have shown that glass ionomer cement possesses antibacterial activity due to slow releases of fluorides.[9, 18] The dental amalgam was the most commonly used retro grade filling material, as it is easy to manipulate seals cut apical orifice with acceptability due to slight expansion on complete setting. Moreover, amalgam is cost effective, least technique sensitivity, time tested.[19] MTA has been investigated and used as a root end filling material since its introduction. Despite its good physical, biological properties and it being hydrophilic in nature, MTA has some disadvantages such as long setting time and high cost. The search for alternative materials is aimed to reduce costs and to increase the feasibility to both professional and patient.[20, 21]

Biodentine is similar to MTA in basic composition. The manufacturers claim that it's modified powder composition i.e. the addition of setting accelerators and softeners, a new predosed capsule formulation for use in a mixing device largely improve the physical properties of the material making it more user-friendly. Biodentine proves superior to MTA as it does not require a two step obturation & as the setting is faster there is a lower risk of bacterial contamination.[22] All the samples in the negative control group did not show apical leakage and this indicates that nail varnish is effective in leakage prevention. In the positive control group, all samples showed full leakage along the gutta-percha indicating the need of a material that effectively seals the retrograde cavities.[23] The results of this study showed that all materials exhibited microleakage but there was significantly less leakage in Biodentine (0.544 mm) when compared to MTA (0.789 mm), GIC (1.589mm) and Amalgam (1.978). These results obtained were similar with previously done studies on Glass Ionomer Cement, MTA and Biodentine.[24,25]

CONCLUSION

Within the limitations of the study it was concluded that there was significantly less microleakage in Biodentine compared to MTA followed by GIC and maximum leakage was observed in amalgam.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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