Evaluation of Sealing Ability of Three Root-end Filling Materials

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ABSTRACT

Introduction: Reinfection of root canal treated tooth leads to endodontic failure. In such case surgical endodontic therapy is the treatment of choice which provides obturation of radicular space with 3-dimensional sealing.

Objective: To evaluate and compare the sealing ability of Mineral trioxide aggregate (MTA) with Glass ionomer cement (GIC) and Super EBA (Epoxybenzoic acid) root-end filling materials.

Materials & Method: 94 extracted single rooted upper anterior teeth were selected for root canal preparation and obturation. Root were apically resected 3 mm; and 3 mm deep Class-I root-end cavities were prepared. Teeth were randomly distributed into 3 groups comprising 30 teeth in each group. Group-1 was retrofilled with MTA, Group-2 with GIC and Group-3 with Super EBA. 2 positive and 2 negative control teeth were instrumented and obturated but not filled on root-end cavity. In experimental groups and positive control group the whole surface of teeth except 3 mm adjacent to resected area were covered with two coats of nail polish but in negative control group whole surface of teeth were covered, dried, immersed in 1% methylene blue for 72 hours. Each root was sectioned labio-lingually to the long axis of root. Depth of dye penetration was evaluated by 10x stereo-microscope.

Result: MTA retrograde filling showed the best hermetic seal property whereas, few GIC and Super EBA samples showed microleakage in retrograde filling. GIC showed better sealing ability than Super EBA.

Conclusion: MTA has potential to provide better hermetic-seal than GIC and Super EBA as root-end filling material.

Keywords: GIC, microleakage, MTA, retrograde, Super EBA

INTRODUCTION

The ideal treatment of pulpally infected tooth is root canal system. However, reinfection of the tooth leads to endodontic failure. The preferred treatment of failing endodontic cases is nonsurgical retreatment. Though most of the retreatment have successful outcome; complexity of root canal system, inadequate instrumentation, improper filling and presence of physical barriers lead to the failure of nonsurgical treatment. In these cases surgical endodontic therapy becomes the gold standard.[1,2] Surgical endodontic therapy provides three-dimensional obturation of radicular space which seals root canal system apically, coronally and laterally and alternatively we achieve tight seal which is most essential for long-term success of endodontic treatment.[2]

To achieve successful surgical endodontic treatment apical 3 mm should be resected and followed by retrograde root-end filling that provides hermetic seal between apical portion of root canal and periapical tissues and prevents infiltration of microbacteria and its byproducts.[3] The angle of bevel increases due to the permeability of dentinal tubules[4] so root should be resected perpendicular to the long axis of the root with an ideal material and root-end cavity preparation is a crucial step in the thickness establishment of apical seal in periradicular surgery.[5] After surgical exposure and resection of involved apex, the ideal preparation is a Class-I cavity prepared along the long axis of the tooth to a depth of atleast 3 mm.[4,6] The efficient retrograde sealing of root canal following apicoectomy is a major factor in surgical endodontic failure and search for ideal material that seals the root canal foramen is still being researched. However, the success also depends on operator's skill.[7,8]

The ideal material for retrograde sealing should be nontoxic, noncarcinogenic, biocompatible and should prevent leakage of microorganisms and its byproducts to the apical tissue. Sealing ability of material should not change due to tissue fluids or the moisture in the environment. Also material

should be easy to manipulate and radiopaque.[9] Besides, they may be well tolerated by periapical tissue, long shelf life, nonabsorbable, dimensionally stable and easily removable if required.[10]

Various materials like guttapercha, siver amalgam, poly-carboxylate, zinc phosphate, zinc oxide eugenol, IRM cement, Super EBA, Glass ionomer, composite resins and other materials such as gold foil, silver points, polyhema and hydron, diaket root canal sealer, titanium screws and teflons have been suggested as root-end filling materials.[9,11]

Mineral trioxide aggregate (MTA) is a remarkable material for use in endodontics.[12] MTA was developed by Torabinejad at Loma Linda University. It is a compound mixture of hydrophilic tricalcium silicate, tricalcium aluminate with other oxides. MTA was specially developed as a root-end filling material, which has undergone numerous *in vitro* and *in vivo* investigations.[5,13] However, the comparison of sealing ability of MTA with other two known retrograde filling materials GIC and Super EBA has not been well documented. Thus, the aim of this study was to compare MTA with GIC and Super EBA by dye leakage method.

MATERIALS AND METHOD

The *in vitro* study was carried out in the Department of Conservative Dentistry & Endodontics, Kantipur Dental College Teaching Hospital & Research Center, Kathmandu from September 2 to October 23, 2015. Ninety four maxillary anterior human permanent teeth having radiographically single root canal (Type-I) with no evidence of previous root canal treatment were selected for the study.

The extracted teeth were immersed in 1% sodium hypochlorite (Safe plus) in a screw capped glass vial for 24 hours to remove any organic debris from the surface followed by manual cleaning and ultrasonic scaling to remove calculus, stain and remaining tissue debris. Then the teeth were immersed in distilled water for 24 hours prior to the tooth preparation. The pulp chambers were accessed and pulp were removed with No. 2 and 4 round burs and canal were negotiated by No.15 k-file (Diadent), canal orifices was enlarged with Sx ProTaper (Dentsply). The working length was determined by substracting 0.5 mm from the length at which No. 15 k-file appeared at the apical foramen. The canal preparation was done sequentially with ProTaper rotatory files and apical preparation was done upto No. F-3 finishing file. 5.25% sodium hypochloride was used as irrigation. Canal was cleaned and dried with paper point and was then obturated with single cone technique using ProTaper guttapercha with zinc oxide eugenol paste sealer. The access opening was sealed with temporary restoration (Cavit). All teeth were left in humid air for 72 hours allowing the sealer to set completely.

Roots were apically resected 3 mm from apex 90o to the long axis of tooth with No. 701 fissure bur (Mani) using high speed handpiece. A 3 mm deep root-end cavity was prepared by round diamond bur using high speed handpiece. During retrograde cavity preparation, surface of cavity was smoothen to avoid micro slits in the dentinal walls of root tip.

Teeth were randomly distributed in three groups comprising 30 teeth in each group. Group-1 was retrofilled with MTA (Dentsply); which was mixed with water to putty consistency in 3:1 ratio then inserted into the cavity using MTA carrier gun. Group-2 was retrofilled with GIC (Fuji IX) using bulk pack technique and coated with Fuji varnish. Group-3 was retrofilled with super EBA (Dentsply). After setting, excess materials were removed and margins were finished with composite finishing burs. Two positive and two negative control teeth were instrumented and obturated but root-end cavity were not filled with retrograde filling material.

In experimental groups and positive control group the whole surfaces of teeth except 3 mm adjacent to resected area were covered with two coats of nail polish. In negative control groups, the whole surface of the teeth was covered with two coats of nail-polish. Teeth were dried then immersed in 1% aqueous solution of methylene blue (HUMAN). All the specimen of different groups were left suspended for 72 hours to check the apical seal. After removal of the teeth from dye jar, teeth were washed under running tap water for 10 minutes and were dried. Each root were sectioned to the long axis of root in labio-lingual direction by using a diamond disc in a high speed handpiece. The depth of dye penetration was evaluated by 10x stereo-microscope. The roots were evaluated and scored as either acceptable or unacceptable. Acceptable samples were scored as no leakage or leakage according to the extent beyond the retrofilling material into the root canal space. Statistical analysis was performed with SPSS and chi-squared test was done.

RESULT

The apical dye penetration on experimental root-end filling materials of 3 mm thickness is shown in Table 1. In Group-1, MTA scored as acceptable because all 30 samples did not show any leakage beyond retrofilling material, whereas, in Group-2, GIC showed 5 (6.66%) out of 30 samples were unacceptable because of dye penetration beyond retrofilling material. In Group-3 Super EBA showed 12 (40%) out of 30 samples were scored as unacceptable. Positive control sample showed dye leakage throughout the length of canals, while negative control samples had no any dye penetration.

Apical dye penetration of MTA, GIC, Super EBA observed by stereo-microscope is presented in Figure 1, 2 and 3 respectively. Data was analyzed statistically using Chi-square

test which revealed a statistically non-significant difference between Group-1 (MTA) and Group -2 (GIC) (p=0.062), which means that both root-end filling materials MTA and GIC have no significant difference in sealing ability. However, significant difference was observed between Group-1 (MTA) and Group-3 (Super EBA) (P=0.001) and between Group-2 (GIC) and Group-3 (Super EBA) (P=0.045); which mean that, Super EBA has low sealing ability.

Table 1: Dye leakage of experimental root-end filling materials

Groups	Materials	No. of samples	Acceptable	Unacceptable
Group-1	MTA	30	30 (100%)	0 (0%)
Group-2	GIC	30	25 (83.33%)	5 (16.66%)
Group-3	Super EBA	30	18 (60%)	12 (40%)

Table 2: Test significance for dye leakage among the groups

Inter-group	*p*-Value	Significance
Group-1 & Group-2	0.062	Not significant
Group-1 & Group-3	0.001*	Significant
Group-2 & Group-3	0.045*	Significant

*Statistically significant at p<0.05

Figure 1: Root-end seal with MTA

Figure 2: Root-end seal with GIC

Figure 3: Root-end seal with Super EBA

DISCUSSION

One of the ideal endodontic approach in pulpally infected tooth is root canal treatment, with the aim of providing proper bacterial tight seal; so that there is no communication between root canal and periapical tissue. However, conventional root canal treatment and retreatment sometimes fails to eradicate the persistant periapical lesions due to complexity of root canal systems, presence of numerous lateral canals at apical third of root. In such cases, surgical intervention is one of the alternative approach which entails resection of few millimeter of apical third and retrograde root-end filling which provides hermetic apical seal to prevent passage of microorganisms and their biproducts into periapical tissues.

For hermetic apical seal numerous retrograde filling materials have been investigated and suggested by many leakage studies and among them dye leakage test is the one. Varieties of dye used are: Indian ink, Erythrosine B solution, aqueous solution of Fuchsin, Fluorescent solution, Methylene blue solution etc. Shrestha and Mala used Rhodamine-B dye for dye penetration method to evaluate sealing ability of root canal sealers.[14] Kersten and Moorer found that the leakage of commonly used dye methylene blue was comparable with that of a small bacterial metabolic product of similar molecular size.[15] So, we also used 1% methylene blue as dye to analyze the sealing ability of experimental retrograde filling materials.

Tidmarsh *et al* has suggested that, with the increased angle of bevel subsequently, apical leakage also increase due to greater apical surface and greater number of dentinal tubules and its permeability.[16] So, in the present study, we resected all root-ends perpendicular to the long axis of root and prepared 3 mm depth of apical cavities.

Szeremata-Browar *et al* reported that; due to the number of disadvantages of amalgam as root-end filling material; EBA has been considered as alternative material. Leakage studies on the use of EBA cement as retrograde filling material show conflicting results.[17] Wu *et al* found glass ionomer cements and MTA had less leakage compared to amalgam and EBA cement.[18] Fischer *et al* stated that; 3 mm thickness of MTA was the most effective root-end filling material against penetration of Serratiamarcescens than 3 mm thickness of amalgam, IRM and EBA cements.[19] Therefore, it can be interpreted that the result of above studies are almost similar to the present study as our data revealed MTA had less dye leakage compared to GIC and EBA cements. However, further clinically-based *in vivo* studies with proper data are necessary.

CONCLUSION

MTA has potential to provide a better hermetic seal than GIC and EBA cement as root-end filling materials of 3 mm thickness. GIC had better sealing ability than Super EBA.

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