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Evaluating the Sealing Ability of MTA as a Root Canal Sealing Material

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Key words
Sealing ability , MTA, root canal sealer.

Abstract

This study was to evaluate the potential of using mineral trioxide aggregate (MTA) as a root canal sealing material via comparing its apical sealing ability with that of the most commonly used root canal sealer (Dorifill) zinc oxide based sealer , twenty-eight extracted human single rooted teeth were selected for use in this study . All teeth were prepared in standard manner using hand instruments, randomly divided into two groups of twelve teeth each and a control group of four teeth. Root canals in the two experimental groups were filled laterally condensed gutta percha and either MTA or zinc oxide based (Dorifill) sealer. After sealers had set, the root surfaces were coated with nail varnish except 1 mm at the apex of the root . Positive controls had no root filling and were coated with nail varnish in the same manner, while the negative controls were sealed only entirely with nail varnish. The teeth were immersed into 1% methylene blue dye for 72 hours. The teeth were cleared and the linear extent of dye penetration was measured with a stereomicroscope. Group (MTA) showed significantly less apical dye penetration than group 2 . Positive controls had total leakage and negative controls had no leakage. The study demonstrate that MTA provide an apical seal that is superior to that of zinc oxide based root canal sealer (Dorifill).

Introduction

Successful root canal therapy require complete filling of the root canal system with nonirritating biomaterials. It is common knowledge that most endodontic failure are caused by incomplete sealing of the root canals.[1] This emphasized the need for using materials that are able to create a hermitic seal between the root canal system and the periapical tissues. Therefore, microleakage studies on the sealing properties of endodontic materials are currently available and standard practice in endodontic therapy has restored to a combination of gutta perch point and root canal sealer.[2-4] The concept of three-dimensional cleaning, disinfecting & shaping of the root canal system has become the major aim of modern root canal treatment. In endodontic practice, 60% of all failure in root canal treatment[3-5] are due to the incompletes unsuitable root canal obliteration.[6] Sealing the root canal, three dimensionally without any leakage from the apical foramen may increase the clinical success to a rate as high as 96.5%.[7] . MTA is a biocompatible material, & has reported to have superior biocompatibility & less cytotoxic than other materials currently used in endodontic therapy[31]. As a retro filling material, MTA fulfill many of the requirements of the ideal material such as: biocompatible with the

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periradicular tissue, non toxic, non resorbable and minimal or no leakage around the margin.[32] Mineral trioxide aggregate (MTA) has been developed to seal off pathways of communication between the root canal system & the external surface of the tooth. It was introduced to endodontic by Torabinejad et al (1993) & has been successful in the repair of lateral root perforations & furcal perforation, as vital pulp capping agent & as an apical pulg in one visit apixification & as a root_end filling material. MTA is a powder that consist of fine hydrophilic particles that harden when they come in contact with water. Hydration of the powder results in colloidal gel that solidifies to a hard structure. The characteristic of hardened MTA depend on the size of the particles, the water/powder ratio, the temperature & humidity at the application site, & the amount of air trapped in the mixture.[13]
According to its manufacture, the chemical composition of ProRoot MTA (Tulsa Dental, OK, USA) is basically a mixture of oxide, quite similar to those of Portland cement, Bismuth oxide powder which is particularly insoluble in water & chemical inert, has been added to the ProRoot MTA formula to make the aggregate radio opaque & radiographically identifiable.[14]

Materials and Method

Twenty-eight single rooted human teeth with a single root canal were selected for use in this study. Each specimen was examined with stereomicroscope(X20 magnification)and excluded from the study if there were any previously undetected root fractures or evidence of previous apical surgery. Pre_operation radiographs were taken from both mesiodistsl and faciolingual directions and any tooth with previous root canal fillings. Open apices, bifurcations or ribbon shaped canals, root curvatures greater than five degrees were also excluded from the study. The selected teeth were stored in 1% sodium hypochlorite(NaOCl) solution for tow days to remove any organic debris and then after they were stored in normal saline solution at room temperature prior to the study.(The teeth were cleaned, polished with a slurry of pumice and water in rubber prophylaxis cup at low speed.
For each tooth access preparation was performed, working lengthwas determined by inserting size 15 file and just seen by the necked eye from the apex then withdrawn 1.5 mm.Root canals were cleaned and shaped using K-file,K-flex file and headstrom files(Ballaigues European Mandatory CH-1338 Swiss made)combined with 2.5% sodium hypochlorite(NaOCl)irrigation solution, all teeth were instrumented to size 40 flex file. After instrumentation had been completed, a size 10 file was passed one millimeter through the apical foramen to ensure that it was patent to allow dye penetration. The instrumented canals were dried with paper points(North Hamlia Avenue,Lincoh Wood,USA)and the teeth were randomly divided into two experimental groups of 12 teeth each and a control group of four teeth. The root canals of the control groups were left empty and the experimental teeth had the root canals filled with a sealer and gutta percha points(Dia Dent International CHO NGJU City, Korea) using lateral condensation technique, while the specimens were held in saline_moisted guase.The sealers used were:
Group:
1:Mineral trioxide aggregate(MTA)(proR-oot ,Tulsa Dental, ok USA).
Group:
2:Zinc oxide based root canal sealer (Dorifill,Gmblt, Vienna, Austria).
In the negative control group, the entire root surface was covered with two nail varnish to demonstrate a leakage free state. In the positive control group, no nail varnish was applied to any of the teeth surfaces.
The root canals of the teeth in group 1 and 2 were dried with paper points and standardized size 40 gutta percha points were selected as a master points. Each point were tested visually and radiographically in the root canal to ensure placement to the full working length .The experimental materials were mixed according to the manufacturers directions and were introduced into the canals using a spiral root filler.

The master gutta percha point was then coated with a sealer and inserted into the canal to within the working length and lateral condensation utilizing
non_ standarized small size accessory points was performed until the entire canal was filled. Excess gutta percha was removed with a heated instrument. The access opening were sealed with composite resin. Then teeth from group 1 and 2 were then kept in 100% humidity for 72 hours to allow complete setting of the materials[18]. The teeth were coated with two layers of nail varnish except for approximately 1mm of the tooth structure beyond the apical foramen.
The teeth allowed to dry for 30 minutes. The specimens maintained in distilled water for 1 week at 37C.Then the teeth immersed in buffered 1% methylene blue solution at 37C for 72 hours[19],after which the samples were rinsed under tap water, and nail varnish was removed by using a sharp hand instrument.
For evaluation, each tooth root were grooved buccally and lingually with adiamond disc, and then were split into two halves by a plaster knife. The liner extent of the dye penetration from the apical root ends was measured using stereomicroscope(Hamilton by Altaly International, Italy)at magnification level of X20.Two independent examiners evaluated and scored the dye leakage.
The results were analyzed statistically using t-test to determine whether there were any statistically significant differences between and among the experimental groups at 5% level of significance ($p<0.05$).

Results

The two positive control specimens demonstrated total dye penetration of the root canal systems, whilst the two negative control specimens showed no dye penetration into the roots. Measurements of the apical dye penetration for each of the experimental groups are summarized in table(1).The t-test was used to determined whether there was significant differences in the apical leakage values between group 1 and group 2,group 1 and group 3,and between group 2 and group 3.The difference was highly significant experimental group($p<0.0001$).

Discussion

There was a wide variation in the sealing capacity of different endodontic materials and achieving an adequate apical seal is an important goal in endodontic. When evaluating root canal filling materials, analysis of its sealing ability is therefore very important[20]. Several methods have been used to investigate the sealing ability of root-canalsealers[21]
Dye penetration is often used for leakage studies, because dyes are relatively easy to be stored, applied and have their penetration assessed quantitively.[22,23] Moreover, if a filling material does not allow penetration of small molecules such as dyes, it is likely that it has a potential to prevent leakage of larger molecules, such as bacteria and their byproducts[24] ,several types of dyes i.e., ethylene blue[15],India ink[23],fuchsine and rhodamine[24]have been used.
In their studies, Torabinejad et al.[24]and Aqrabawi[25] used 72 hours immersion in 1%methylene blue dye to penetrate MTA root end fillings. These authors observed mean dye penetration of only 0.28-0.31 mm and no leakage respectively.
Wu et al.[26] reported that the seal produced by MTA leaked after 24 hours. However, MTA sealing was greatly improved during the first 3 months and was maintained until the end of the experiment.[26]This may probably be attributed to further hydration of MTA powder by moisture ,which can result in an increase in compressive strength and decrease in leakage. In the present study, MTA sealing was assessed 72 hours after root canal filling. This may possibly explain why dye penetration of MTA was zero mm in most of the specimens.
Several studies using different methodologies have been carried out to assess the marginal sealing of MTA and have shown its effectiveness in preventing or reducing leakage, as well as .its good adaptation and less amount of marginal cracks[24,27].However, in this investigation ,MTA showed less leakage than zinc oxide

based root canal sealer(Dorifill).Also, MTA did not resist leakage completely, potentially due to being subjected to leakage by a water-soluble dye of small molecular size, shortly after placement .It is likely that exposure to fluids before achieving full set contributed to greater degree of leakage. Existing materials for root canal obliteration meet most of the requirement for successful endodontic, as listed by Grossman [28] and Cohen and Burns[29] .However, the use of traditional gutta percha products with zinc oxide based sealers does not ensure a hermetic seal. There is no adhesion between core and sealers or between sealers and dentin. Thus, canal obliteration is not necessarily impervious to moisture. This explain the higher rate of apical leakage demonstrated in this study for group 2 in which zinc oxide based sealer was used.

Comparison of the data obtained from various leakage studies shows considerable variations in the results of these investigations, and examination of clinical studies shows that there are many variables in these investigations. The main variables include: the number of cases, materials tested, different procedures, techniques, different kinds of dyes and lack of standardization or evaluation criteria for quantitive results obtained in these studies. Because of these variables, it is difficult to compare the results with one another[12,16].The majority of leakage studies have been performed in vitro with little or no similarities to in vivo conditions. one of their major limitations is the amount of fluid exchange between the apical root canal walls and the root canal filling materials. on the other hand, the purpose of placing a root canal filling material is to prevent penetration of Irritants from the root canal system in to periradicular tissues. Thus coronal seal of root canal filling material is probably more important than the apical seal. As a result ,despite their popularity and ease of use the results and clinical significance of leakage studies have been questioned[16,28].

MTA was used with gutta percha because gutta percha is the root canal filling material most commonly used today. The present study demonstrated a highly significant statistical difference in the apical seal produced by MTA and gutta percha with lateral condensation technique when compared with zinc oxide based sealer with gutta percha in group 2.This result was not surprising as numerous studies reported that MTA is an effective root canal filling material[16,24].In the present study, the MTA was mixed according to the manufacturer's directions and allowed to set in 100% humidity for 72 hours, and because the material is not usually used in bulk, we did place a size 40 gutta percha points to with in 1mm of the working length to reduce the thickness of the material and facilitate its setting hydration reaction. Clinical support for the use of MTA as an obturating material was presented in a case reported by O'Sullivan et al,[30] in which MTA was used as the obturating material for the root canal system of a retained primary second molar.

Conclusions

Under the conditions of this study, the apical seal produced by MTA was superior to that produced by zinc oxide based sealer (Dorifill).As MTA proven success in numerous other clinical applications, further investigations should be conducted to determine whether MTA itself or the technique for its placement could be modified for the use as a root canal filling material in perforated roots.

Table (1) :- Mean linear dye penetration for experimental groups.

Group	Sealer		No Of teeth	Apical dye application	T-value		
				Mean ± SD (mm)	Group 1 vs. Group 2	Group 1 vs. Group 3	Group 2 vs. Group 3
1	MTA		12	0.700± 0.675	4.43* (p=0.0004)	10.79* (p=0.0000)	5.27* (0.0001)
2	Zinc oxide		12	2.100± 0.738			
3	Controls	+ve	2	3.600± 0.516			
		_ve	2	0.000			

Significant difference P< 0.05.*

References

1-Ingel JI. Tainer JF. Endodontic. 3rd edition. LEA edition. Lea & Febiger Philadelphia. 1985.

2-White RR, Goldman M, Lin PS. The influence of the smeared layer upon dentinal tubule penetration by plastic filling materials. J.Endod. 1984;20:18-21.

3-Alacam T. Endodontic. Ankara. Baris Press; 2000.Pp. 454-483.

4-Sen BH, Piskin B, Baran N. The effect of tubular penetration of root canal sealers on dye microleakage. Int. Endod. J. 1996;29:23-28.

5-Anic I. Matsumato K. comparison of the sealing ability of laser – softened ,laterally condensed & low temperature thermoplasticized gutta percha. J.Endod. 1995;21(9);464-469 .

6-Hata G, Kawazoe S, Toda T, et al. Sealing ability bof therma fill with & without sealers. J. Endod. 1992;18(7);322-326.

7-Davalous S, Guttamann JL, Nunn MH. Assessment of apical & coronal root canal sealers using contemporary endodontic obturation and restorative materials and techniques. Int Endod. J.1999; 32(5):388-396

8-Torabinejad M, Watson TF, Pitt Ford TR. Sealing ability of a mineral trioxide aggregate when used as a root end filling material. J.Endod. 1993; 19:591-595.

9-Saidon J ,He J, Zhu Q, Safavi K, Spangberge LS. Cell and tissue reactions to mineral trioxide aggregate and Portland cement. Oral Surge. Oral Med. Oral Pathol. Oral Radio. Endodon. 2003; 95(4):483-489.

10-Dammaschke T, Gerth HU, Zuchner H, Schafer E. chemical and physical surfaces and bulk material characterization of white ProRoot MTA and two Portland cement. Dent. Mater. 2005;21(8):731-738.

11-Danish G, Dammaschke T, Gerth HU, Zandbiglari T, Schafer E. A comparative study of selected properties of ProRoot mineral trioxide aggregate and two Portland cement. Int, Endodont. J. 2006; 39(3):213-219.

12-Torabinejad M, Chivian N. Clinical applications of mineral trioxide aggregate. J.Endodon. 1999; 25: 197-205.

13-Torabinejad M, Hong CU, McDonald F, Pitt Ford TR. Physical and chemical properties of a new root-end filling material. J. Endodon. 1995; 21:349-353.

14-Torabinejad M, Hong CU, Lee SJ, Monsef M, Pitt ford TR. Investigation of mineral trioxide aggregate for root end filling in dogs. J.Endodon. 1995; 21;603-608.

15-Torabinejad M, Higa RK, McKendry DJ, Pitt ford TR. Dye leakage of four root-end filling

materials: effect of blood contamination. J.Endodon. 1994; 20:159-163.

16-Torabinejad M, Rastegar AF, Kettering JD, Pitt ford TR. Bacterial leakage of mineral trioxide aggregate as a root end filling materials. J.Endodon. 1995; 21: 109-112.

17.Rhode TR, Bramwell JD, Hunter JW, Roahen JO. An in vitro evaluation of microleakage of a new root canal sealer. J.Endodon .1996; 22:365-368.

18- Abbott PV, Heijkoop PS, Caradaci SC , Hume WR, Heithersay GS. ASEM study of the effects of different irrigation sequences and ultrasonic . Int.Endodon. J. 1991; 24:308-316.

19-Adamo HL, Buruina R, schertzer L, Boylan RJ. A composition of MTA, super-EBA, composite and amalgam as root-end filling materials using a bacterial microleakage model. Int. Endodon. J.1999; 32;197-203.

20-Zmener O. et al. Sealing properties of a new epoxy resin based root canal sealer. Int, Endodont. J. 1997; 30 :332-334.

21-Wu MK, De Gee AJ, Wesselink PR, Moorer WR. Fluid transport and bacterial penetration along root canal fillings. Int, Endodont. J.1993; 28: 185-189.

22-Sen BH, Wesselink PR, Türkün M. The sm-ear layer : a phenomenon in root canal therapy . Int, Endodont. J. 1995; 31:980-99.

23-Youngson CC, Glyn Jones JC, Mangue M, Smith IS. In vitro dentinal penetration by traces used in microleakage studies. Int, Endodont. J.1998; 31:980-99.

24-Torabinejad M, Watson TF, Pitt ford TR. Sealing ability of a mineral trioxide aggregate when used as a root end filling material. J.Endodon. 1993; 19: 591-595.

25-Aqrabawi J .Sealing of amalgam, super-EBA , cement and MTA when used as a retrograde filling materials. Br.Dent. J. 2000;188:266-268.

26-Wu MK, Kontakiotis EG, Wesselink PR. Long-term seal provided by some root-end filling materials. J.Endodon. 1998; 24: 557-560.

27-Torabinejad M, Wilder Smith P, Pitt ford TR. Comparative investigation of marginal adaptation of MTA and other commonly used root end filling materials. J . Endodon. 1995: 21:295-299.

28-Grossman LI.ENDODONTIC PRACTICE . 10th edition .Lea & Febiger, Philadelphia. 1981:279.

29-Cohen S, Burns RC, eds. PATHWAYS OF THE PULP. 6th edition St. Louis :' CV Mosby. 1994:223-225.

30-O'Sullivan S, Hartwell GR. Obturation of a retained primary mandibular second molar using mineral trioxide aggregate : a case report . J.Endodon. 2001; 27: 703-705.

31-Holan G, Eidelman E & Fuks A(2005): Long – term evaluation of palpotomy in primary molars using MTA or formocresol. Pediat Dent, 27(2) :129-130

32-Hdeer A, Nieveen Sand David R(2004) : Comparison of the marginal adaptation of root – end filling materials in root end cavities prepared with ultrasonic tips. Int, Endodont J : 491-493.