Comparison Sealing Ability of MTA Sealer and Resin Epoxy Sealer

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Abstract

Despite the excellence properties of mineral trioxide aggregate sealer (MTAS), it may have some influence in its sealing ability. The purpose of this study was to analyze and compare sealing ability of MTAS and resin epoxy sealer (RES).

Thirty-two extracted human lower premolar teeth had their canals prepared with ProTaper Universal. This group divided into two groups, group 1, the root canals were filled using guttaperca with MTAS and Group 2 root canals were filled using guttaperca with RES. All samples were incubated at the temperature of 370C for 24 hours with 100% humidity. Then the whole sample were immersed in India ink for 7 days. Samples were washed and decalcified until became transparent. The penetration of India ink was evaluated by using a stereo microscope, and the scores are were given by criteria: score 1: 0-0.5 mm ink penetration; a score 2: ink penetration 0.51- 1mm; and a score 3: ink penetration > 1 mm.

Score 1 in the group RES 37.5%, and 21.9% MTAS group, score 2: RES (3.1%) and MTAS (12.5%), score 3: RES 9,4% and MTAS 15,6%. The data was analyzed using ANOVA SPSS 17 at 5% significance level. Statistical analysis between the two groups showed no significant difference.

As a conclusions the sealing ability of MTAS showed the same level with RES.

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Introduction

The function of root canals' sealer is to fill areas which are not covered by gutaperca and create adhesions between gutaperca and the canal walls. The sealer also creates a fluid tight seal state obturation according to monoblock concept.[1,2,3] The ideal sealer must be well tolerate by the tissue with a low degree of toxicity, stable and adhesive, form a bond between the dentine core materials to cover all the cavities.[2]

Tunga et al. (2006), Stratton et al. (2006), and Kim et al. (2009) stated that currently sealer resin has the best physical properties.[1,2,4] Torabinejad M (1993) of Loma Linda University introduced a mineral trioxide agregate (MTA) to be used to treat perforation (endodontic reparative cement).[5] Morever, the calcium silicate MTA sealer similar to calcium silicate cement. According to Weller et al. There is no difference of adhesive and sealing ability of MTA and epoxy-resin sealer.[6] Epoxy-resin sealer has a poor bond to dentin due to polymerization shrinkage. Zhang et al, (2009) in his research compared the sealing ability of calcium silicate cement (iRootSP) with resin cement (AH Plus) by using 3 different root canal filling technique. Continuous wave technique with Calcium silicate sealer was used in group A, single cone technique with calcium silicate sealer in group B, and Group C used continuous wave technique with resin sealer. The leakage was measured by the method of fluid filtration. The highest leakage was shown in group B which are filled with single cone technique with calcium silicate sealer, but when all three groups were compared, the results were not significantly different.[7] To overcome this problem, the ratio gutaperca and sealer shoul be higher.[1,2,6,8,9]

To increase the MTA sealing ability, Arruda et.al (2012) compared destilled water, chlorhexidine and doxycycline as the liquid to create the solution and the result are no

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significant difference on sealing ability.[10] Brito-Junior et.al (2010) concluded the improvement the sealing ability of MTA by adding propyleneglycol to seal perforated bifurcation.[11] Bernabė et.al (2013) compared the effect of using sonic and ultrasonic devices condensation during MTA aplication on retrogade filling , and the best result was shown in sonic.[12]

Koçak et,al (2011) compared MTA sealing ability on apical cavity which are prepared using low speed bur, ultra sonic and laser Er.Cr.YSGG, and the best result was shown in group which are prepared using laser.[13] But according to Jeevani E et.al (2014) compared the sealing ability between MTA, endosequense and biodentin, and found that statistically MTA had lower sealing ability compared with endosequence.[14]

In this study will be analyzed and compare the sealing ability of the MTAS and RES in a apical third root using dye penetration methods and techniques of transparency.

Materials and methods

32 samples of teeth soaked in 0.9% saline solution prior to treatment. The whole sample prepared with ProTaper Universal rotary instruments (Densply Mailefer. USA) and irrigated with 2.5% NaOCl 2 ml at each sequence. At the end of preparation, root canals are irrigated with 17% EDTA solution and allowed to stand for 1 minute, then rinsed with 2.5% NaOCl. Samples were randomized and divided into two groups, group 1 root canal is filled with main cone guttapercha coated with RES ((AH Plus, Dentsply) ; put spreader along 2 mm from the tip apex and gutaperca accessories were added. Group 2 used MTAS (MTA Fillapex, Angelus, Brazil).

All groups were coronally sealed with RMGIC. The root canal filling were evaluated radiographically. All samples were incubated for 24 hours at a temperature of 37^0C with 100% humidity to permit setting of the sealer. The sample was then dried with an air spray and the outer surface of the tooth roots covered with nail polish as two layers except for the 1 mm from the tip apex. The first layers are dried at a temperature 37^0C for 1 hour, followed by a second layer aplication. The next day, all of the samples were immersed in India ink for 7 days at a temperature of 37^0C. Once the samples are removed from the ink solution, washed under running water and the nail polish are cleaned using scalpel. The decalcification process until all the samples become transparent was done according to the method of Robertson.[15] All of india ink penetration into the root canal of each sample was measured using a stereo microscope 20X magnification (Discovery V12, Carl Zeiss, AxioCam, Germany) with a millimeter grade. The level of ink penetration into the root canal grouped by using a scoring system: score 1 = leakage 0-0.5 mm, score 2 = 0.51 -1 mm and a score 3 =>1 mm.

Statistical Analysis

The data were examined by using Chi-Square test for the microleakage difference between RES and MTAS. The results were analyzed by using the Kolmogorov Smirnov in software (SPSS for Windows 17.0), at a significance level of $p \leq 0.05$.

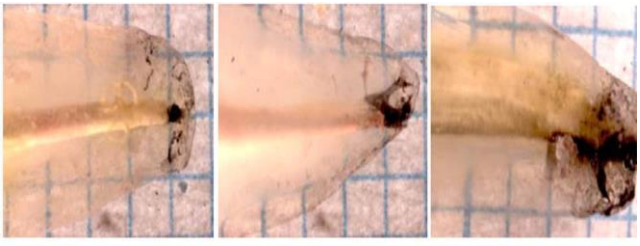
Results

In Table 1. 37.5% of total sample in RES group showed score 1 while MTAS group showed only 21.9% of total sample. The MTAS group showed 15.6% of total sample on a score 3 while group RES showed only 9.4% of total sample.

Test Group								
Leakage rate	1		2		3		Total	*P*
	n	%	n	%	n	%		0.415
ERS	12	37,5	1	3.1	3	9,4	16	
MTAS	7	21.9	4	12.5	5	15.6	16	
Total	19	59.4	5	15.6	8	25	32	

Table 1. Distribution of scores in each group.

Score distribution:
n = number of samples
1 = Leakage third apex of 0-0.5 mm
2 = Leakage third apex of 0.51 to 1 mm
3 = Leakage third apex of> 1 mm n



A B C

Figure1. Overview india ink penetration depth into the apical third with 20X magnification.
A. Scores 1. B. Scores 2. C. Score 3.

Statistically, there was not significant difference between the RES group and the MTAS group, although the RES group showed a lower leakage rate than MTAS group but the test was not statistically significant difference.

Discussion

Around the third of the apex has a very complex anatomy that can affect the quality of root canal filling.[16,17] The function of root canal sealer on the root canal filling is to fill the empty spaces that are not occupied by obturation material guttap. Good sealer should be able to well adapted to the root canal walls, and currently the best type of sealer type is epoxy resin.[1]

MTAS began to develop because the cement is first used and has proven biocompatible and has a good sealing ability. So in this study to test the sealing ability of the MTA sealer by analyzing a depth on the apical leakage after root canal filling.

The samples used in this study were mandibular first premolar with a single root and straight and extracted due to orthodontic treatment. To maintain moisture and create biological circumtances of teeth, the teeth are stored in saline solution.

Preparation of root canals using crown down technique to minimize extruded debris with rotary instruments Protaper Universal®.[18] Irigation solution that are used are combination of 5.25% NaOCl and 17% EDTA so that the organic material and smear layer is soluble.[19] Lentulo was used to sealer placement to root canal, so that the sealer could be well distributed throughout the root canal walls. According to Kahn et al. (1997), method of placement in the root canal sealer is a critical component in the root canal filling procedure.[20]

There are several methods for analyzing the method of microleakage of fluid filtration, polymicrobial penetration, and penetration of dyes with longitudinal cutting techniques. However, these methods have not been standardized materials and methods by default.[21,22] Hence, the method used in this study according to Robertson method that analyzes the penetration of dyes by using transparency.[23] This technique gives an overview of internal anatomy of the root canal in three dimensions without the loss of tooth substance, thus simplifying assessment leak area. Moreover, this method also facilitate the assessment of lateral root canals and accessories as well as can be clearly reflects the relationship between the filler and the foramen apex and apical leakage can visualize the size of a millimeter. The use of India ink in this study is more effective because India ink particles has the same diameter as bacteries molecules in the root canals approximally 3 µm.[24]

Data were analyzed by nonparametric statistical test Chi-Square as a categorical variable and not in pairs. But because it does not meet the requirements that the expected value of more than 5 up to 20% (in this study 4, amounting to 66.7%), then the test is used Kolmogorov-Smirnov.

In Table 5.1 the apical third microleakage occurred in both groups, these results are consistent with the statement Hammad et al. (2009), which states that no root canal filling is perfectly sealed the canals. The higher ratio of the gutapperca and sealer, the lower gap formation occured.[25] The occurrence of leakage in root canal filling can also be caused by NaOCl, because it release a number of ammonia and carbon dioxide, which will be stuck at the apex and form a gas column called vapor lock. So the effectiveness of NaOCl in cleaning smear layer on root canal walls at the apex is reduced which causes sealer adaptation to the canal walls disturbed.[26]

RES group had a lower rate of leakage from the group MTAS. But when both groups were compared statistically between the two groups then there is no significant difference (p=0.415). These results are consistent with studies conducted by Zhang et al. (2009) comparing the ability of the closure of MTAS (iRootSP) with RES (AH Plus), and the result is the ability of the MTAS and RES was almost the same.[7] In previous studies have also proven that the epoxy resin sealer (AH Plus) has the lowest level of solubility than other root canal cement. This is because the epoxy resin sealer has a long-term dimensional stability, low solubility, good apical closure, microretention with dentine in root canals, and low toxicity.[27,28] Epoxy resin sealer contains diepoxyde and poliamine when manipulae will form a covalent bond and produce polymers that bonded strong and rigid so the more stable and low solubility sealing are achived.[29,30] When polymerized, Epoxy resin also experience shrinkage so that the microleakage could occur.[6,8,9] According to Hammad et al. in

2008, RES has the highest value when the polymerization shrinkage, that is equal to 1.46 to 1.76%.[25]

MTAS on contact with fluid from tissues apex major cations (Ca + 2, Mg + 2) will be dissolved. Cations Calcium ions released from MTA will diffuse through dentinal tubules and react with phosphate ions in the tissue fluid which will produce calcium phosphate. Calcium phosphate then joined by other ions and become carbonated apatite which will provide chemical bonding between the MTA and the dentin. This adhesion layer resembles hydroxyapatite both of composition and structure when viewed in the SEM analysis. This interfacial layer edge MTA showed superior adaptation.[31]

It is also supported by a previous study also showed that the results of SEM analysis found the porosity and crack in the resin matrix after the dissolution test. This may be due to the content of bismuth trioxide is associated with reduction of molecular stability in the cement-based MTA.[32]

Conclusions

Sealing ability of MTAS did not statistically significantly different with the RES, but in substance the sealing ability of MTAS was lower than RES.

Declaration of Interest

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References

1. Tunga U, Bodrumlu E. Assessment of the sealing ability of a new root canal obturation material. J Endod. 2006;32:876-878.
2. Stratton RK, Apicella MJ, Mines P. A fluid filtration comparison of gutta percha versus resilon, a new soft resin endodontic obturation system. J Endod. 2006;32:642-645.
3. De-Deus G, Brandao MC, Fidel RA, Fidel SR. The sealing ability of guttaflow in oval-shaped canals: an ex vivo study using a polymicrobial leakage model. International Endodontic Journal. 2007;40:794-799.
4. Kim YK, Grandini S, Ames JM, Gu L, Kim SK, Pashley DH, Gutmann JL, Tay FR. Critical review on methacrylate resin-based root canal sealers. Journal of Endodotics. 2009;9:1-17.
5. Torabinejad M. Physical and chemical properties of a new root-end filling material. J Endod.1995;21(7):349-353.
6. Weller RN, Tay KCY, Garrett LV, Mai S, Primus CM, Gutmann JL et al. Microscopic appereance and apical seal of root canals filled with guttaperca and proroot endo sealer after immersion in a phosphate-containing fluid. Int Endod J. 2008 Nov; 41(11): 977-86.
7. Zhang W, Li Zhi, Peng Bin. Assessment of a new root canal sealer's apical sealing ability. Oral Surg Oral Med Oral Path Oral Rad Endod J. 2009;107:e79-e82.
8. Bergmans L, Moisiadisb P, Munckc JD, Meerbeekd BV, Lambrechtsd P. Effect of polymerization shrinkage on the sealing capacity of resin fillers for endodontic use. J Adhes Dent. 2005;7:321–329.
9. Souza SFC, Bombana AC, Francci C, Goncalves C, Castellan C, Braga RR. Polymerization stress, flow and dentine bond strength of two resin- based root canal sealers. Int Endod J. 2009;42:867–873.
10. Arruda RAA, Cunha RS, Miguita KB, Silveira CFM, De Martin AS, Pinheiro SL, Rocha DGP, Bueno CES. Sealing ability of mineral trioxide aggregate (MTA) combined with distilled water; chlorhexidine, and doxycycline. J of oral Science. 2012;54(3):233-239.
11. Brito-Junior M, Viana FA, Pareira RD, Nobre SAM, Soares JA, Camilo CC, Faria-e-Silva AL. Sealing ability of MTA-Angelus with propyleneglycol in furcal perforation. Acta Odontal Latinoam. 2010;23(2):124-128.
12. Koçak MM, Koçak S, Aktuna S, Gorucu J, Yaman SD. Sealing ability of retrofilling materials following various root-end cavity preparation techniques. Lasers Med Sci. 2011;26:427-431.
13. Bernabė PFE, Gomes-Filho JE, Bernabė DG, Nery MJ, Otoboni-Filho JA, Dezan-Jr D, Cintra LTA. Sealing ability of MTA used as root end filling material: Effect of the sonic and ultrasonic condensation. Brazilian Dental Journal. 2013;24(2):107-110.
14. Jeevani E, Jayaprakash T, Bolla N, Vemuri S, Sunil CR, Kalluru S. Evaluation of sealing ability of MM-MTA, Endosequence, and biodentin as furcal spectrophotometric analysis. J Conserv Dent. 2014;17:340-343.
15. Verissimo DM, Vale MS. Methodologies for assessment of apical and coronal leakage of endodontic filling materials : A critical review. Journal of Oral Science. 2006;48(3):93-98.
16. Schmalz G. Root Canal Filling Materials. In: Bergenholtz G, Bindslev PH, Reit C (editor), Textbook of Endodontology. Victoria: Blackwell Publishing Company. 2003:261-285.
17. Gernhardt CR, Krüger T, Bekes K, Schaller HG. Apical sealing ability of 2 epoxy resin-based sealers used with root canal obturation techniques based on warm gutta-percha compared to cold lateral condensation. Quintessence International. 2007;38:229-234.
18. Beeson T, Hartwell G, Thornton J, Gunsolley J. Comparison of debris extruded apically in straight canals: Conventional filling versus profile .04 taper series 29. J Endodon. 1998;24:18-22.
19. http://www.dentsply.de/bausteine.net/file/showfile.asp. 16 May 2013.
20. Kahn FH, Rosenberg PA, Schertzer L, Korthals G, Nguyen PNT. An in vitro evaluation of sealer placement. Int Endod J. 1997;30(3):181-186.
21. Eldenize AU, Erdemir A, Belli S. Effect of EDTA and citric acid solution on the microhardness and the roughness of human root canal dentin. J Endod. 2005;31(2):107-108.
22. Pommel L, Camps J. Effects of pressure and measurement time on the fluid filtration method in endodontics. Journal of Endodontics. 2001;27(4):256-258.
23. Verissimo DM, Vale MS. Methodologies for assessment of apical and coronal leakage of endodontic filling materials: A critical review. Journal of Oral Science. 2006;48(3): 93-98.
24. Neelakantan P, Subbarao C, Subbarao CV. Comparative evaluation of modified canal staining and clearing technique, cone beam computed tomography, peripheral quantitative computed tomography, spiral computed tomography, and plain and contrast medium-enhanced digital radiography in studying root canal morphology. Journal of Endodontics. 2010:1-5.
25. Hammad M, Qualtrough A, Silikas N. Evaluation of root canal obturation: a three-dimensional in vitro study. Journal of Endodontics. 2009;34(4):541-544.
26. Glassman G. Safety and efficacy considerations in endodontic irrigation. Dental Economics. 2011;101(1):1-15.

27. Ørstavik D Materials used for root canal obturation: technical, biological and clinical testing. Endodontic Topics. 2005;12:25–38.

28. Garrido AD, Lia RC, Franca SC, da Silva JF, Astolfi-Filho S, Sousa-Neto MD Laboratory evaluation of the physicochemical properties of a new root canal sealer based on Copaifera multijuga oil-resin. International Endodontic Journal. 2010;43:283–91.

29. Case SL, O'Brien EP, Ward TC. Cure profiles, crosslink density, residual stresses, and adhesion in a model epoxy Polymer. 2005;46:10831–40.

30. Gençoglu N, Samani S, Günday M. Dentinal Wall Adaptation of thermoplasticized gutta-percha in the absence or presence of smear layer: a scanning electron microscopic study. J Endod. 1993;19(11):558- 562.

31. MTA Fillapex Endodontic Sealer. https://www.clinicalresearchdental.com/marketing/mta%20fillapex%20%20scientific%20profile_medium.pdf.

32. Coomaraswamy K, Lumley P, Hofmann M. Effect of bismuth oxide radiopacifier content on the material properties of an endodontic portland cement–based (MTA-like) system. Journal of Endodontics. 2007;33:295–8.