

Comparison of Sealing Ability of MTA-based Root Canal Sealer with Silicone-Based GuttaFlow and Resin-Based AH Plus Root Canal Sealers - An In Vitro Study

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ABSTRACT

Introduction: Besides proper biomechanical preparation and obturation, microleakage of sealing materials is an important parameter that determines the success of endodontic treatment.

Objective: To compare the sealing ability of MTA-based root canal sealer, MTA Fillapex with resin-based AH Plus and silicone-based GuttaFlow.

Materials and Method: Ninety-five non-carious, single-rooted mandibular premolars were collected and immersed in sodium hypochlorite (5.25%, 24 hours). Selected teeth were decoronated to obtain 13 mm length. After decoronation, root canals of all teeth were prepared by Protaper with an apical preparation up to size F-3. The irrigant used was 5.25% sodium hypochlorite. After cleaning and shaping, samples were divided into three experimental groups of 30 each and five samples in positive control group. The experimental groups were obturated with MTA Fillapex, GuttaFlow, and AH Plus whereas fourth group served as control group which was instrumented but not obturated. Coronal cavities were then filled with glassionomer cement (3 mm). All samples were coated with two layers of nail varnish except 5 mm apically, immersed in 5% methylene blue dye for 48 hours, then washed under tap water and nail varnish removed. The samples were sectioned longitudinally and extent of apical dye penetration in all groups were measured.

Result: MTA Fillapex had minimum linear microleakage compared to both GuttaFlow and AH Plus but the difference was not significant with GuttaFlow. Whereas, AH Plus showed significantly more microleakage.

Conclusion: MTA Fillapex exhibited better sealing ability than GuttaFlow and AH Plus, though the mean leakage scores were statistically insignificant with GuttaFlow.

Keywords: Dye penetration; methylene blue; microleakage; mineral trioxide aggregate; resin-based sealer; silicone-based sealer.

INTRODUCTION

Clinical success of endodontic therapy depends on proper access, cleaning and shaping, disinfection, and sealing of root canals. Almost 60% of endodontic therapy failures occurs due to

incomplete and improper obturation of root canal system. The three-dimensional (3D) sealing ability of obturating material leads to decreased risk of apical microleakage and thus increased success rate of endodontic treatment.¹ Various methods have been used to assess the quality of root canal

seal like: dye penetration test, fluorometry, vacuum study, bacterial test, fluid-transport model, and electrochemical method.²

Ideally, root canal sealer should be capable of creating an effective bond between the core material and dentine of root canal, thus preventing microleakage. It should also be nontoxic and preferably have a positive effect on healing of periapical lesions. With this goal, different manufacturers have developed new endodontic sealers to improve root canal seal.³

As there are limited comparative studies among various root canal sealing materials,⁴ this study aimed to evaluate the sealing ability of recent MTA-based root canal sealer with other commonly used sealers like: resin-based AH Plus and silicone-based GuttaFlow by detecting microleakage with the help of 5% methylene blue dye penetration method to identify the better performing root canal sealer.

MATERIALS AND METHOD

Ninety-five freshly extracted non-carious, single-rooted, closed apex mandibular premolars were collected for this in vitro study. The study was done for three months from 2018 March 25 to May 24 in the Department of Conservative Dentistry and Endodontics, Kantipur Dental College, Kathmandu and Nepal Academy of Science and Technology (NAST), Lalitpur. The study proposal was approved by Institution's research committee (IRC-KDCH) on March 14, 2018.

The selected teeth were immersed in 5.25% sodium hypochlorite solution for 24 hours to remove adhered tissues. Calculus and surface deposits were removed by ultrasonic scaler. Then selected teeth were sectioned coronally (decorated) using a high speed diamond fissure bur (TC-11, Mani) with water spray to obtain 13 mm length to standardise study samples. After the decoronation, root canals of all teeth were prepared by rotary Universal Protaper (Dentsply) with apical preparation up to size F-3 using 17% EDTA (Glyde Prep, Dentsply) as lubricant and 5.25% sodium hypochlorite as the irrigant. Then, root canals of all teeth were dried with absorbent paper points. Master-cone gutta-percha was selected with corresponding master-file size F-3.

After cleaning and shaping of root canal system, samples were divided into three experimental

groups of 30 each and five samples in positive control group (G-4). The experimental groups were obturated with MTA-based sealer (MTA Fillapex) and gutta-percha point (G-1), silicone-based sealer (GuttaFlow) with gutta-percha point (G-2) and resin-based sealer (AH Plus) with gutta-percha point (G-3) up to established full working length whereas teeth in fourth group (G-4) were instrumented but not obturated.

After obturation of root canals with the respective materials, coronal cavities were filled with glassionomer cement (GC Fuji IX) of 3 mm in thickness to achieve adequate coronal seal. All the teeth were stored at 37 degree Celsius for 48 hours at 100% humidity to allow root canal sealer to set. All samples were coated with two layers of nail varnish except in apical 5 mm. The samples were immersed in 5% methylene blue dye for 48 hours. Then, samples were washed under tap water for half an hour to remove dye. Then acetone was used to remove nail varnish from sample. After this, the samples were sectioned longitudinally using high speed disc bur under copious water spray. Then, extent of apical dye penetration in all the four groups were measured from anatomical apex in millimeters using (10X magnification) stereo microscope.

The data recorded in terms of the extent of apical dye penetration in all four groups was analysed by Kruskal Wallis and Mann Whitney test at 95% CI, $P \leq 0.05$.

RESULT

The results obtained using the dye leakage method showed that, MTA-based sealer (MTA Fillapex) and silicone-based sealer (GuttaFlow) had minimum linear microleakage (Table 1, 2). The microleakage of MTA Fillapex was not significantly different from GuttaFlow (Table 3). The resin-based sealer (AH Plus) showed more microleakage in comparison to MTA Fillapex and GuttaFlow (Table 1, 2). The difference was statically significant with both of MTA Fillapex and GuttaFlow (Table 4, 5).

Table 1: Average linear microleakage in millimeters of methylene blue dye in different root canal sealers.

Group	Mean±SD
MTA Fillapex (G-1)	0.3913±1.36
GuttaFlow (G-2)	0.3683±0.59
AH Plus (G-3)	1.3497±1.48

Table 2: Comparison between Group 1, 2 and 3 (Kruskal Wallis Test).

Group	Mean rank	P value
MTA Fillapex	33.43	<0.001
GuttaFlow	40.13	
AH Plus	62.93	

Table 4: Comparison between MTA Fillapex and AH Plus (Mann Whitney).

Group	Mean rank	P value
AH Plus	40.0	<0.001
MTA Fillapex	21.0	

DISCUSSION

Successful endodontic therapy is dependent on a 3D obturation of root canal which minimises microleakage which means it prevents passage of bacteria and its byproducts, fluids and chemical substances between the root structure and various filling materials.^{5,6} Microleakage mainly occurs because of the microscopic gaps which are present at the interface of the filling material and tooth.⁷ Microleakage in between filling material and tooth surface can be minimised by using sealer. But different sealers have different physicochemical properties and sealing capacity. So, for a successful endodontic treatment one needs to select sealer with properties like: non-resorbable, dimensionally stable, and with no or minimal microleakage.

Prior studies have used various methods to assess the quality of root canal seal such as: dye penetration test, fluorometry, vacuum study, bacterial leakage test, radio tracer penetration test, fluid-transport model, and electrochemical methods.⁸ In current study, methylene blue was used as the dye to assess sealing ability on three types of sealers because particle size of methylene blue is similar to the size of bacteria and its byproducts present in oral flora.⁹

The use of single-cone filling technique is often considered inferior to the more sophisticated 3D compaction techniques because the volume of sealer is highly relative to the volume of the core, which promotes void formation and reduces the quality of the seal.¹⁰ However, in majority of endodontic treatment scenario, it is not always feasible to use sophisticated 3D compaction techniques. Hence in the current study, single cone technique was selected to evaluate the sealing ability of sealer

Table 3: Comparison between GuttaFlow and MTA Fillapex (Mann Whitney).

Group	Mean rank	P value
GuttaFlow	33.07	0.168
MTA Fillapex	27.93	

Table 5: Comparison between GuttaFlow and AH Plus (Mann Whitney).

Group	Mean rank	P value
AH Plus	38.43	<0.005
GuttaFlow	22.57	

with minimal microleakage in endodontically treated teeth that may increase the success rate of endodontic treatment.

Previous studies have observed that the material composition directly influences on its physicochemical behavior.¹¹⁻¹³ They have explained that the highest bond strength values obtained by epoxy resin-based cements are because of covalent bonding of an opened epoxy ring to any amine group exposed in collagen, giving long term dimensional stability and low polymerisation tension.¹¹⁻¹³ Whereas lower bonding capacity of MTA to dentinal tubules is because of formation of apatite by MTA. So, when exposed to scanning electron microscope, AH plus exhibited long and uniform tags and greater bonding capacity while MTA Fillapex displayed little or no formation of tags.¹⁴ Similarly, the GuttaFlow is known to expand slightly while setting but it showed gaps and voids after its setting. In contrast, the current study showed MTA Fillapex to have better sealing ability in comparison to GuttaFlow and AH Plus. The difference was however, not statistically significant with GuttaFlow.

CONCLUSION

MTA-based sealer (MTA Fillapex) exhibited better sealing ability than silicone-based sealer (GuttaFlow) and resin-based sealer (AH Plus), though the mean comparative leakage scores were found to be statistically insignificant with GuttaFlow. Thus, the results of study indicate that MTA-based sealer is good alternative to silicone-based sealer and resin-based sealer to obtain 3D bacterial tight root canal seal to increase rate of clinical success.

REFERENCES

1. Nicholls E. Endodontics. 3rd ed. Bristol: John Wright and Sons Ltd; 1984:221-45.
2. Dalat DM, Spanberg LS. Comparison of apical leakage in root canals obturated with various gutta percha techniques using a dye vacuum tracing method. *J Endod.* 1994 Jul;20(7):315-9.
3. Kumar SA, Shivanna V, Nainan MT, Shivamurthy GB. Comparative evaluation of the apical sealing ability and adaptation to dentine of three resin-based sealers: An in vitro study. *J Conserv Dent.* 2011;14(1):16-20.
4. Bouillaguet S, Shaw L, Barthelemy J, Krejci I, Wataha JC. Long term sealing ability of Pulp Canal Sealer, AH-Plus, GuttaFlow and Epiphany. *Int Endod J.* 2008 Mar;41(3):219-26.
5. Sagsen B, O Er, Kahraman Y, Orucoglu H. Evaluation of microleakage of roots filled with different techniques with a computerized fluid filtration technique. *J Endod.* 2006 Dec;32(12):1168-70.
6. Rajkumar B, Shukla P, Popli G, Gupta V, Bhatt A. Comparative evaluation of apical microleakage of three different obturating material using stereomicroscopy. *Int J Adv Multidiscip Res.* 2016;3(6):1-4.
7. Wu MK, Wesselink PR. Endodontic leakage studies reconsidered. Part I. Methodology, application and relevance. *Int Endod J.* 1993 Jan;26(1):37-43.
8. Ahlberg KM, Assavanop P, Tay WM. A comparison of the apical dye penetration patterns shown by methylene blue and india ink in root-filled teeth. *Int Endod J.* 1995 Jan;28(1):30-4.
9. Verissimo DM, do Vale MS. Methodologies for assessment of apical and coronal leakage of endodontic filling materials: a critical review. *J Oral Sci.* 2006 Sep;48(3):93-8.
10. Kontakiotis EG, Wu MK, Wesselink PR. Effect of sealer thickness on long term sealing ability: a 2-year follow-up study. *Int Endod J.* 1997 Sep;30(5):307-12.
11. Fisher MA, Berzins DW, Bahcall JK. An in vitro comparison of bond strength of various obturation materials to root canal dentin using a push-out test design. *J Endod.* 2007 Jul;33(7):856-8.
12. Koh ET, McDonald F, Pitt Ford TR, Torabinejad M. Cellular response to Mineral Trioxide Aggregate. *J Endod.* 1998 Aug;24(8):543-7.
13. Vilanova WV, Carvalho-Junior JR, Alfredo E, Sousa-Neto MD, Silva-Sousa YT. Effect of intracanal irrigants on the bond strength of epoxy resin-based and methacrylate resin-based sealers to root canal walls. *Int Endod J.* 2012 Jan;45(1):42-8.
14. Sagsen B, Ustun Y, Demirbuga S, Pala K. Push-out bond strength of two new calcium silicate-based endodontic sealers to root canal dentine. *Int Endod J.* 2011 Dec;44(12):1088-91.