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ORIGINAL RESEARCH

Assessment of Marginal Adaptation and Sealing Ability of Root Canal Sealers: An *in vitro* Study

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ABSTRACT

Aim: This study aims to compare the marginal adaptation and sealing ability [mineral trioxide aggregate (MTA)-Fillapex, AH Plus, Endofill sealers] of root canal sealers.

Materials and methods: In the present study, the inclusion criteria include 45 single-rooted extracted mandibular premolar teeth, with single canal and complete root formation. The sectioning of the samples was done at the cementoenamel junction using a low-speed diamond disc. Step-back technique was used to prepare root canals manually. The MTA-Fillapex, AH Plus, and Endofill sealers were the three experimental sealer groups to which 45 teeth were distributed. Under scanning electron microscope (SEM), marginal gap at sealer and root dentin interface were examined at coronal and apical halves of root canal.

Results: Among the three maximum marginal adaptations were seen with AH Plus sealer (4.10 ± 0.10) which is followed by Endofill sealer (1.44 ± 0.18) and MTA-Fillapex sealer (0.80 ± 0.22). Between the coronal and apical marginal adaptation, significant statistical difference ($p = 0.001$) was seen in AH Plus sealer. When a Mann–Whitney U-test was done on MTA-Fillapex sealer *vs* AH Plus sealer and AH Plus sealer *vs* Endofill sealer, there was a statistically significant difference ($p < 0.05$) found between the above two groups at coronal and apical third.

Conclusion: The present study proves that AH Plus sealer has a better marginal adaptation when compared with other sealers used.

Clinical significance: For sealing space of crown wall and main cone in root canal treatment, sealers play an important role. The other advantages of sealers are that they are used to fill voids and irregularities in root channel, secondary, lateral channels, and space between applied gutta-percha cones and also act as tripper during filling.

Keywords: AH Plus, Endofill, Marginal adaptation, Mineral trioxide aggregate-fillapex, Scanning electron microscope.

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INTRODUCTION

Complete obturation of the root canal system is necessary for successful root canal therapy. There are few materials used for obturation that can prevent bacterial microleakage up to some extent, but it is unfortunate that till now, no obturation material or technique can prevent microleakage for an indefinite period of time; hence, the importance of maintaining a coronal seal comes into the picture to prevent microleakage into the canal space. However, it is still equivocal regarding the ability of different temporary restorative materials to establish and maintain a good coronal seal.[1]

Cavit, amalgam, gutta-percha, composite resins, super ethoxybenzoic acid, intermediate restorative material, zinc oxide and eugenol cement, biodentin, endosequence, and MTA are few root-end filling materials which are recently introduced.[2] A successful endodontic surgery

requires adequate marginal adaptation of retrograde materials, and this property determines their suitability for clinical use.[3]

When MTA is used it forms a new cementum with no inflammatory cells (after 6 months) and thus induces closure of main canal foramen. As a root canal sealer, it forms MTA interfacial layer in the presence of phosphate compacting against a dentin. When observed under X-ray diffraction and SEM analysis, this adherent interstitial layer is indistinguishable from hydroxylapatite in composition and structure.[4]

The physical properties of epoxy resin-based sealers are appreciable and also have a very good apical sealing ensuring adequate biological performance, but it has several disadvantages in clinical use, radiopacity, and retreat ability. Thus, there remains no perfect adhesive material designed solely for endodontic purposes and becomes important to develop one which is suitable to use in such procedures.[5] For permanent root canal filling, Endofill is one of the important radiopaque preparations in the category. It does not incite inflammation in the tissue environment but in fact provides an anti-inflammatory, antiseptic, and germicidal action. It has a unique property of penetrating the narrowest fissures before solidifying until completely set and it maintains the therapeutic effect throughout the treatment. The final obturation neither retracts nor resorbs.[6] This *in vitro* study compares marginal adaptation and sealing ability (MTA-Fillapex, AH Plus, Endofill sealers) of root canal sealers.

MATERIALS AND METHODS

This study includes 45 single-rooted extracted mandibular premolar teeth, with single canal and complete root formation.

The sectioning of the samples was done at the cementoenamel junction using a low-speed diamond disc. Step-back technique and stainless steel K-type files were used to prepare root canals manually. The master apical file taken in the study was a no. 30 K-file, and for coronal flaring, Gates Glidden drills no. 2 through 4 were used. About 5.25% sodium hypochlorite solution, 17% ethylenediaminetetraacetic acid was used to irrigate the canals in between the files, later rinsed with distilled water and sterile paper points for drying.

The formula used to calculate sample size was:

$$n = \frac{z_1^2 - \alpha/2}{d^2}$$

n is required sample size

$z_{1-\alpha/2}$ is a constant, its value for a two-sided test is 1.96 for 95%

d is absolute precision 20% = 0.2

Three experimental groups were divided, to which 45 teeth were allocated.

Group I—MTA-Fillapex Sealer

A self-mixing tip attached to a syringe was used to combine the components. Then, the root canal space is filled with sealer and gutta-percha point coated with sealer was inserted up to the predetermined working length. At the orifice level, cone is then seared off.

Group II—AH Plus Sealer

This sealer had a mixture of components in equal portions of pastes A and B. Then, the root canal space is filled with sealer and gutta-percha point coated with sealer was inserted up to the predetermined working length. At the orifice level, cone is then seared off.

Group III—Endofill Sealer

The components of the sealer were combined by mixing the powder into liquid. Then, the root canal space is filled with sealer and gutta-percha point coated with sealer was inserted up to the predetermined working length. At the orifice level, cone is then seared off.

Marginal Adaptation Analysis

The obturated material was stored for 10 days in a humidifier with relative humidity more than 95% and temperature at 37°C. A hard tissue microtome was used to section the samples vertically and this reduces the chances of crack formation in the tooth structure and also in the material. Under SEM at coronal and apical halves of root canal, marginal gap at sealer and root dentin interface was evaluated.

Statistical Analysis

The analysis was done using Statistical Package for the Social Sciences version 17. Kruskal–Wallis analysis of variance was used to compare the marginal adaptation between the three different groups and for individual comparisons Mann–Whitney U-test was used; $p < 0.05$ was considered as statistically significant.

RESULTS

Table 1 depicts the mean and standard deviation of all the three sealers. The maximum marginal adaptation was

Table 1: Mean and standard deviation of three sealers

Type of sealer	*n*	*Mean ± SD*
MTA-Fillapex sealer	15	0.80 ± 0.22
AH Plus sealer	15	4.10 ± 0.10
Endofill sealer	15	1.44 ± 0.18

SD: Standard deviation

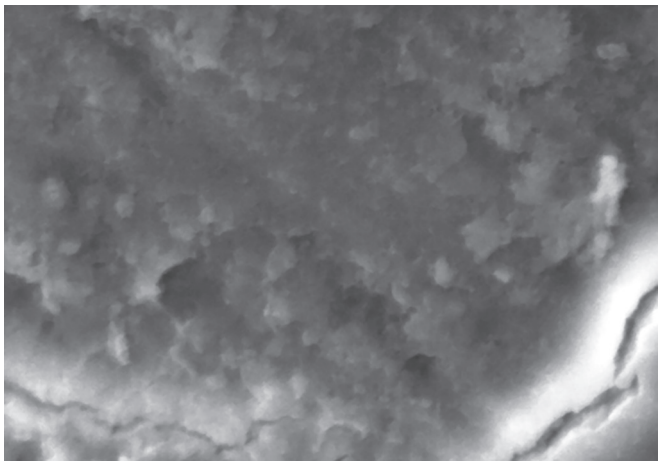

Fig. 1: Marginal adaptation of sealer at coronal third

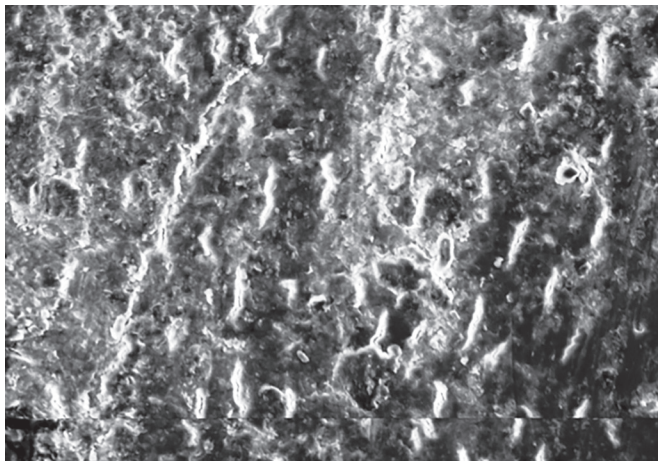

Fig. 2: Marginal adaptation of sealer at apical third

Table 2: Marginal adaptation of different sealers at coronal and apical levels

Type of sealer	*Coronal (mean ± SD)*	*Apical (mean ± SD)*	*K ANOVA value*	*p-value*
MTA-Fillapex sealer	0.38 ± 0.10	0.42 ± 0.12	21.00	0.08
AH Plus sealer	1.80 ± 0.04	2.30 ± 0.06	25.80	0.001**
Endofill sealer	0.42 ± 0.09	1.02 ± 0.09	21.44	0.06

**Highly significant; SD: Standard deviation; ANOVA: Analysis of variance

Table 3: Mann–Whitney U-test for intergroup comparison at coronal third

Comparison between	*Mean rank*	*Mann–Whitney-U*	*p-value*
MTA-Fillapex sealer *vs* AH Plus sealer	22.70–8.30	30.20	0.001**
MTA-Fillapex sealer *vs* Endofill sealer	18.80–8.20	15.00	0.42
AH Plus sealer *vs* Endofill sealer	23.63–14.37	40.40	0.001**

**Highly significant

Table 4: Mann–Whitney U-test for intergroup comparison at apical third

Comparison between	*Mean rank*	*Mann–Whitney-U*	*p-value*
MTA-Fillapex sealer *vs* AH Plus sealer	24.60–12.40	28.70	0.001**
MTA-Fillapex sealer *vs* Endofill sealer	21.80–10.10	20.00	0.04
AH Plus sealer *vs* Endofill sealer	31.23–15.47	38.60	0.001**

**Highly significant

shown by AH Plus sealer (4.10 ± 0.10; Figs 1 and 2), next being the Endofill sealer (1.44 ± 0.18) and MTA-Fillapex sealer (0.80 ± 0.22).

There is statistically significant difference ($p = 0.001$) between the coronal and apical marginal adaptation with AH Plus sealer. However, MTA-Fillapex sealer and Endofill sealer failed to show any significant difference between the coronal and apical marginal adaptation (Table 2).

Table 3 compares the coronal third using a Mann–Whitney U-test. The MTA-Fillapex sealer *vs* AH Plus sealer and AH Plus sealer *vs* Endofill sealer showed statistically significant difference ($p < 0.05$).

Table 4 compares the apical third intergroup. The MTA-Fillapex sealer *vs* AH Plus sealer and AH Plus sealer *vs* Endofill sealer showed statistically significant difference ($p < 0.05$).

DISCUSSION

Prevention from microleakage and penetration bakeries into preapical are the two main important things for sealing the tooth channel and also to know the prediagnosis of root treatment it is very crucial. The vital factor in the failure of root canal treatments is coronal microleakage. By elimination of smear layer and applying sealers, microleakage can be avoided. Hence, it is important to know the physical working properties of different kinds of sealers and its capability to prevent coronal penetration of bacteria.[7] There are two positive consequences in using sealers with appropriate features, such as connection, matchless, and tubule penetration. First, due to higher interface of sealer with crown wall, it helps to create seal in channel; second is the antibacterial effect of sealers.[8] To prevent the reinfection of root canal and to preserve the health

of periapical tissues, obturation aims to provide a three-dimensional seal.[5,9]

Gurgel-Filho et al[6] showed that the lowest bond strength to root dentin was MTA-Fillapex which is similar to the present study where Fillapex sealer has the lowest mean marginal and apical adaptation at coronal as well as in the apical third among the three sealers used in the study. When the sealers come into contact with phosphate-containing fluids, the set material releases calcium and hydroxyl ions and forms apatite; this theory was put forth by Sarkar et al.[10] Reyes-Carmona et al,[11] in their study done in 2009, observed that the formation of an interface layer by apatite with tag-like structures plays a crucial role, this apatite is formed by MTA and phosphate-buffered saline which gets deposited within collagen fibrils, and it promotes controlled mineral nucleation on dentin formed. Sagsen et al[12] reported that the low-adhesion capacity of these tag-like structures is considered as the reason for the low bond strength of MTA.

AH Plus sealer turns out to be better among the three in marginal adaptation and sealing capacity in the present study, the reasons being radiopacity, biocompatibility, easy to use, and availability. Composition of AH Plus is an epoxy bisphenol resin-based sealer and contains adamantine to bond to root canal.[13]

Ruddle,[14] in his study, has said that even though AH Plus sets faster, it tends to shrink and cause early debonding from the root canal wall. As AH Plus is an epoxy resin-based sealer, it penetrates better into the microirregularities than others and also increases the mechanical interlocking between the sealer and root dentin because of its creep capacity and long setting time. Pawar et al[15] concluded that AH Plus has greater adhesion to root dentin than other sealers.

Torabinejad et al,[16] Xavier et al,[17] and Bidar et al[18] showed results contradicting to the present study where MTA presented as the best adaptation than eugenol-based sealer, but in this study, the Endofill had better marginal adaptability than MTA-Fillapex that failed to show any significant difference but was close to the critical value of significance for the coronal as well as in apical third.

The gold standard in root canal therapy is obturation with gutta-percha along with sealer. It also has few disadvantages; it cannot bond with root canal dentin and also sealer tends to pull away from the gutta-percha on setting because of its hydrophobic nature.[19]

Progressive factors are the lateral and additional channels and other anatomic differences along with periapical pressure which prevents total leakage from treated root channels; there are few areas where viscous material like sealer cannot reach and its untouched during root canal preparation and thus these spaces remain as the culprit for leakage and reduce the chances of success.[8]

Under optimal conditions, single-rooted teeth that have been obturated *in vitro* were used in this study. Thin sealer layer formed by an obturation is difficult to reproduce clinically. Comparative clinical studies with verified adhesion properties are needed to establish the relevance of adaptation to canal walls as a requirement for root canal sealer.

CONCLUSION

The present study shows that among the three sealers compared, AH Plus sealer shows a good marginal adaptation. Thus, the physical integrity of the sealer matrix may also be important in preventing leakages suggested by SEM observation.

REFERENCES

1. Malik G, Bogra P, Singh S, Samra RK. Comparative evaluation of intracanal sealing ability of mineral trioxide aggregate and glass ionomer cement: an *in vitro* study. J Conserv Dent 2013 Nov;16(6):540-545.
2. Oliveira HF, Alencar AH, Figueiredo JA, Guedes OA, de Almeida Decurcio D, Estrela C. Evaluation of marginal adaptation of root-end filling materials using scanning electron microscopy. Iran Endod J 2013 Autumn;8(4):182-186.
3. Nagesh B, Jeevani E, Sujana V, Damaraju B, Sreeha K, Ramesh P. Scanning electron microscopy (SEM) evaluation of sealing ability of MTA and EndoSequence as root-end filling materials with chitosan and carboxymethyl chitosan (CMC) as retrograde smear layer removing agents. J Conserv Dent 2016 Mar;19(2):143-146.
4. Rawtiya M, Verma K, Singh S, Munuga S, Khan S. MTA-based root canal sealers. J Orofac Res 2013 Jan-Mar;3(1):16-21.
5. Kumar NS, Palanivelu A, Narayanan LL. Evaluation of the apical sealing ability and adaptation to the dentin of two resin-based sealers: an *in vitro* study. J Conserv Dent 2013 Sep;16(6):449-453.
6. Gurgel-Filho ED, Leite FM, de Lima JB, Montenegro JP, Saavedra F, Silva EJ. Comparative evaluation of push-out bond strength of a MTA-based root canal sealer. Braz J Oral Sci 2014 Apr-Jun;13(2):114-117.
7. Farhad A, Havaie A, Barekatain B, Narimani T. Comparing the bacterial leakage in endodontic therapy following using EDTA as a irrigation and AH26 or tubliseal as sealers. J Mashhad Dent Sch 2007 Spring;31(1-2):83-92.
8. Mohammad TS, Samira S, Milad S. Experimental assessment of sealer bio ceramic wall matching in first and third apical areas by scanning electron microscope. Biosci Biotech Res Commun 2017 Mar;10(1):213-218.
9. Polineni S, Bolla N, Mandava P, Vemuri S, Mallela M, Gandham VM. Marginal adaptation of newer root canal sealers to dentin: a SEM study. J Conserv Dent 2016 Jul;19(4):360-363.
10. Sarkar NK, Caicedo R, Ritwik P, Moiseyeva R, Kawashima I. Physicochemical basis of the biologic properties of mineral trioxide aggregate. J Endod 2005 Feb;31(2):97-100.
11. Reyes-Carmona JF, Felippe MS, Felippe WT. Biomineralization ability and interaction of mineral trioxide aggregate and white Portland cement with dentin in a phosphate-containing fluid. J Endod 2009 May;35(5):731-736.

12. Sagsen B, Ustün 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(2):1088-1091.
13. Zhang W, Li Z, Peng B. *Ex vivo* cytotoxicity of a new calcium silicate-based canal filling material. Int Endod J 2010 Sep;43(9):769-774.
14. Ruddle, CJ. Advanced endodontics, gauging the terminus: a novel method. 2012. [cited 2012 May 25]. Available from: http://www.endoruddle.com/blogs/show/21.
15. Pawar SS, Pujar MA, Makandar SD. Evaluation of the apical sealing ability of bioceramic sealer, AH plus and epiphany: an *in vitro* study. J Conserv Dent 2014 Nov;17(6):579-582.
16. Torabinejad M, Smith PW, Kettering JD, Pitt Ford TR. Comparative investigation of marginal adaptation of mineral trioxide aggregate and other commonly used root-end filling materials. J Endod 1995 Jun;21(6):295-299.
17. Xavier CB, Weismann R, de Oliveira MG, Demarco FF, Pozza DH. Root-end filling materials: Apical microleakage and marginal adaptation. J Endod 2005 Jul;31(7):539-542.
18. Bidar M, Moradi S, Jafarzadeh H, Bidad S. Comparative SEM study of the marginal adaptation of white and grey MTA and Portland cement. Aust Endod J 2007 Apr;33(1):2-6.
19. Tyagi S, Mishra P, Tyagi P. Evolution of root canal sealers: an insight story. Eur J Gen Dent 2013 Aug;2(3):199-218.