ORIGINAL ARTICLE

Tubular Penetration Depth of AH26 and MTA Fillapex Root Canal Sealers in Human Single-Rooted Teeth: An Ex Vivo Study

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Abstract

Background and Aim: The purpose of this study was to compare dentinal tubular penetration of two root canal sealers namely AH26 and MTA Fillapex in single-rooted teeth by scanning electron microscopy.

Materials and Methods: Thirty-five mature human single-rooted teeth were selected. Cleaning and shaping was performed. The teeth were randomly divided into 2 groups. AH26 was delivered into the canals in group 1, and MTA Fillapex was delivered into the root canals in group 2 by lateral compaction technique. The roots were sectioned at 3 mm and 5 mm from the apex. The sections were evaluated by scanning electron microscopy, and the deepest penetration depth of sealers was recorded. Statistical analysis was performed by t-test using SPSS version 19.0.

Results: The deepest tubular penetration in group 1 at 3 mm from the apex was 808 µm while it was 717 µm in group 2 at 3 mm from the apex. The difference between the two groups was not significant (P=0.4). At 5 mm from the apex, the deepest tubular infiltration in group 1 was 995 µm while it was 915 µm in group 2. The difference between the 2 groups was not significant (P=0.4).

Conclusion: Both sealers can be predictively used in different clinical situations when indicated .

Key Words: Root Canal Preparation; Microscopy, Electron, Scanning; Root Canal Therapy

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Introduction

One of the main goals of root canal therapy is to eradicate the microorganisms from the root canal walls and prevent reinfection. Root canal sealers are applied to fill the gaps not occupied by the gutta-percha cones.[1] Furthermore, sealers penetrate into the dentinal tubules and may entrap the residual bacteria lodged in the tubules.[2] Therefore, sealer penetration improves the treatment outcome. Presence of smear layer on the root canal walls may block the tubules and prevent sealer penetration into them.[3] Thus, it may prevent optimal adaptation of filling materials to the root canal

walls.[4] Chemical bond between the root canal walls and sealers does not occur; thus, penetration of sealers into dentinal tubules may increase micromechanical bonding and resultantly improve the quality of sealing.[5] Tubular penetration might be affected by wettability, surface tension, and hydraulic properties of root canal sealers.[6] Depth of penetration of root canal sealers can be analyzed by light, confocal, or scanning electron microscopes.[7,8] The most important advantages of the aforementioned methods include high magnification and exact determination of specific details and sealer penetration margin.[9] AH26 (DeTrey, Gmbh, Konstanz, Germany) is an epoxy resin based sealer. Good sealing property of AH26 has been previously confirmed, although evidence shows that there is no chemical bonding to root canal walls.[10] MTA Fillapex (Angelus, Londrina, Brazil) is a bio-ceramic and biocompatible root canal sealer with questionable sealing properties.[11,12] The purpose of this study was to compare the tubular penetration of AH26 and MTA Fillapex in extracted teeth.

Materials and Methods

Thirty-five extracted sound human central incisors were collected with no root canal curvature and complete apices for this in vitro experimental study (ethical code: IR.IAU.Dental.REC1399/25). The patency of the apices was ensured by using a patency file (10#). The teeth were collected from the tooth bank of Islamic Azad University, Dental School, Tehran, Iran. Lack of root resorption and root curvature were confirmed by taking periapical radiographs. The teeth were randomly allocated to 3 groups. AH 26 was used in group 1 (n=15). MTA Fillapex was used in group 2 (n=15), and no sealer was used in the control group (n=5). Standard access cavity was prepared in all teeth using a high-speed handpiece under water spray to prevent temperature rise. Working length was determined by reduction of 1 mm of the patency file length (Dentsply Maillefer, Ballaigues, Switzerland), which passed through the apical foramen. The teeth with apical size larger than #20 K-file were excluded from this study. The root canals were shaped by the step-back technique until a master apical file size of #40; the remaining part of the canal was enlarged to #60 by reduction of working length by 0.5 mm for each file.

After removing the smear layer by 17% e thylenediaminetetraacetic acid (EDTA) and 5.25% sodium hypochlorite each for 1 minute, distilled water was used for final irrigation. Paper points were used to dry the root canals. E9 ultrasonic tip (Woodpecker, Guangxi, China) was used for 10 seconds to deliver AH26 or MTA Fillapex sealer into the root canal system in the experimental groups by a circumferential motion, and obturation was performed by the lateral compaction technique (master apical cone: #40, spreader: #25 and lateral cones: #20). The teeth were stored in an incubator for 2 weeks. To prepare the sections, the teeth were embedded in self-cure acrylic resin (AcroPars, Tehran, Iran). A CNC machine (Delta Electronics, Taoyuan, Taiwan) was used to prepare sections with 1 mm thickness perpendicular to the longitudinal axis of the tooth samples at 3 and 5 mm distance from the anatomical apex. To remove the superficial debris from the prepared sections, 17% EDTA was used (Fig. 1). After coating the prepared samples with gold, they underwent scanning electron microscopy (S-4160; Hitachi, Tokyo, Japan) to assess the maximum penetration of sealers into dentinal tubules. The highest infiltration of sealers was determined under low magnification (x20). The exact sealer penetration was ascertained under high magnification .

(x500) image (Fig. 2). T-test was used to compare the deepest point of penetration among the study groups at different levels (3

and 5 mm from the apex) by SPSS version 19.0 software (Chicago, IL, USA)

Fig 1. Prepared sections at 3&5 mm levels using CNC machine [Delta Electronic s, Taoyuan, Taiwan

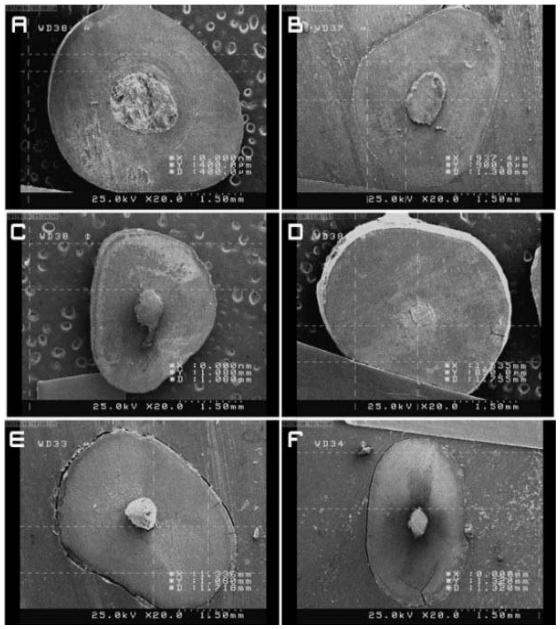

Fig 2. Tubular penetration of MTA Fillapex [A, B, C] and AH26 [D, E, F] sealers in 3&5 mm levels

Results

In group 1, the maximum penetration of sealers into dentinal tubules at 3 mm from the apex was 808 µm while this value was 717 µm at 3 mm in group 2, and this difference was not significant (P= 0.4). In group 1, the maximum penetration into tubules at 5 mm from the apex was 995 µm while this value was 915 µm in group 2, and this difference was not significant (P= 0.4). In group 1, the maximum mean penetration into tubules at 3 mm from the apex (808 µm) was much lower (23%) than the penetration depth at 5 mm (995 µm), and this difference was not significant (P= 0.4). In group 2, the maximum mean penetration into tubules at 3 mm (717 µm) was much lower (27.6%) than the value at 5 mm level (915 µm), and this difference was not significant (P= 0.08) (Table 1).

Discussion

Infiltration of root canal sealers into dentinal tubules can provide a barrier against bacterial invasion into the tubules. Better infiltration provides better sealing ability.[13] Sealers do not interact chemically with the dentinal walls; thus, better infiltration of sealers can help preserve the core filling material in the root canal space.[14] Based on the results of this study, tubular infiltration of AH26 was comparable to that of MTA Fillapex at 3 and 5 mm from the apex, and infiltration of AH26 at 5 mm was higher than that at 3 mm. Higher infiltration of AH26 was due to its lower film thickness and more hydrophobic nature. The higher infiltration of sealers at 5 mm was due to density of the tubules at the middle and coronal thirds of the root.[15,16] Ultrasonic technique was used to apply the sealers into the root canals because of the optimal efficacy of this method compared with other techniques such as the use of Lentulo and master file.[17] Scanning electron microscopy can provide better images of sealer infiltration compared with confocal microscopes and stereomicroscopes.[7] Smear layer can inhibit sealer infiltration; thus, irrigating the canal with 17% EDTA and 5.25% NaOCl can increase the penetration depth of sealers.[18,19] However, the irrigation technique has no effect on infiltration of sealers.[20] Based on a study

Table 1. The deepest tubular penetration [Mean ± Standard deviation] of AH26 and MTA Fillapex sealers at 3&5 mm levels

Groups \ Levels	Tubular penetration at 3mm level [µ]	Tubular penetration at 5mm level [µ]	P Value
Group 1: AH 26	808 ± 201	995 ± 202	P= 0.04
Group 2: MTA Fillapex	717 ± 245	915 ± 353	P= 0.08
P Value	P= 0.4	P= 0.4	

by De-Deus et al,[19] higher penetration of sealer was observed in vertical condensation technique compared with lateral compaction or single-cone techniques. They also observed chewing gum. Studies examining the effect of xylitol with zero plaque at the beginning of the study are short-lived because other oral hygiene methods are omitted during the study period.[7]

Makinen and colleagues showed that although the intrinsic anti-plaque activity of xylitol-containing chewing gum is lower than other plaque control agents, it can have a positive effect on plaque reduction.[15] In the present study, the O'Leary plaque Index was lower in the case group than in the control group, indicating the effect of chewing gum consumption on the reduction of plaque at smooth levels, although this difference was not statistically significant. Also, Bleeding Index was compared in the case and control groups. The results showed that the Bleeding Index in the case group was higher than the control group and chewing gum cause the increase of BOP in participants and this shows that chewing gum did not reduce inflammation and did not have a positive effect on plaque accumulation, which could be due to the short period of study design. Although omitted of oral hygienic practices within 48 hours causes the initial signs of inflammation, but bleeding after probing may require more time,[17] while the results of Poureslami et al. study on the evaluation of the effects of two kinds of chewing gums containing xylitol and sucrose on the accumulation of bacterial plaque showed that the amount of plaque was significantly lower in the xylitol chewing gum group compared to the sucrose chewing gum group.[8] Evaluation of both chemical and mechanical effects of chewing gum on plaque reduction and more samples size in Poureslami study than the present study were the power of their study. In the study of Borhan Mojabi et al., the O'Leary plaque index was used to investigate the effect of chewing xylitol gum on plaque formation on smooth and occlusal surfaces of teeth similar to the present study. The results of Borhan Mojabi study showed that chewing xylitol gum can significantly reduce plaque accumulation at the occlusal, buccal and lingual levels but has no significant effect on proximal surfaces, which can be due to Minimal contact of chewing gum with proximal surfaces. In this study, unlike the present study, the occlusal surface was also examined and according to the results of their study, the lowest plaque accumulation was observed on the occlusal surface, which is quite reasonable considering the maximum contact of chewing gum with the occlusal surface.[7] The results of Hanham et al.'s study on 11 oral health students showed that the changes in plaque formation at smooth surfaces were not statistically significant, [13] which is consistent with the results of the present study, which

could be due to differences in the number of samples in the study. Although in Hanham's study, unlike the present study, proximal levels were not examined but plaque accumulation at the occlusal surface was evaluated and demonstrated significantly less plaque accumulation on this surface in gum chewing. Also, in the study of Pizzo et al. the results showed that chewing sucrose-free gum containing lactoperoxidase or silicon dioxide or zinc gluconate had no inhibitory effect on plaque accumulation on smooth surfaces.[11]

In a study, Zhan et al. examined the effect of xylitol-containing wipes on cariogenic bacteria and caries in children. In this study, 44 mothers with children aged 6 to 35 months with active caries were randomly divided into two groups: using xylitol-containing wipes and placebo-containing wipes. In this study, the rate of dental caries in children at the beginning and after one year and the amount of Streptococcus mutans and Lactobacillus in saliva were evaluated. The results of this study showed that the use of wipes containing xylitol reduces the incidence of caries in children and xylitol can be considered as a useful supplement to control caries [18]. This study, unlike the present study, examines only the chemical effect of chewing gum and one of its strengths is the study of bacteria involved in caries and the duration of the study. Also in a study that Aluckal et al. examined the effect of xylitol-containing chewing gum on salivary streptococcus mutans, they showed that these chewing gums could be used as an adjunct to regular home care preventive procedures in caries prevention.[19]

In the present study, the O'Leary plaque index was used to measure the amount of plaque, while in the Isotupa study, the plaque collection method and the dry weight of plaque were used.[20] This method can be a good way to measure the amount of plaque. The disadvantages of this method are that it does not specify the amount of plaque in different dental parts separately and also requires more conditions and facilities than the O'Leary index, which was not possible in the present study.

In addition to the mechanical effects of chewing gum, Keukenmeester et al. investigated the chemical effect of chewing gum. The two indices evaluated in this study, like the present study, were related to gingivitis and plaque levels. One of the strengths of this study is the longer duration of this study (3 weeks) and the larger number of samples (220 people). In this study, gingivitis was treated under both hygienic and not hygienic methods circumstance, so that participants did not brush their mandibular teeth during the study, but maintained maxillary oral health. The results of this study showed that chewing gum has no effect on BI and PI if oral hygienic practices are taken regularly, but in the absence of hygienic practices, chewing gum will have an inhibitory effect on gingival inflammation.[9] Barnes considered chewing gum as an effective oral hygiene device in the absence of brushing and it was effective in adjunct to brushing for increasing oral health. [21] In another study, the results showed that chewing gum containing sucrose along with oral hygiene methods can reduce dental plaque accumulation by 40%, while in the same condition, sugar-free gum reduces by 51%. [22] In the absence of oral health methods, these values were changed to 47 and 67%.[5] These results emphasize the greater effect of chewing on the removal of dental plaque, especially on the use of chewing gum, and in particular in situations where for some reason it is not possible to perform effective oral hygiene practices. Also, these results show that in the absence of routine oral hygiene practices compared to performing normal oral hygiene practices, chewing sugar-free gum is superior to sucrose-containing gum in reduction of dental plaque accumulation due to the inherent properties of substitute sugars such

as reducing mutans streptococci of saliva and plaque, reduced salivary and plaque acid production.[23] One of the ways to prevent caries in chewing gum is to increase the saliva secretion caused by chewing gum. A study by Stookey et al. Showed that increased saliva secretion from chewing gum after a meal was more effective in preventing caries than its compounds which can be recommended for subjects with low levels of saliva secretion, such as patients undergoing radiotherapy.[24]

In a study, Cosyn and Verelst stated that chewing gum significantly reduces dental plaque in the palatal and lingual areas, but has no effect on buccal aspect of tooth plaque,[25] which may be due to more contact of the chewing gum during chewing with Palatal and lingual surfaces, which indicate the mechanical effect of chewing gum on dental plaque reduction.

One of the limitations of this study is the lack of microbial examination and measurement of other indices involved in inflammation. One of the confounding factors of this study was the type of nutrition and cooperation of participants in the implementation of the project, which could affect the outcome of the study. It is noteworthy it was observed plaque formation on the participant's teeth due to not brushing for a few days during the study period after the completion of the polishing project was done for them and also some patients dissatisfied the taste of the disclosing tablet when measuring PI.

Conclusion

According to the results, chewing gum in the absence of other hygienic practices has little effect on plaque reduction in smooth tooth surfaces. Also, it is suggested that future research be conducted with a larger number of specimens and examination of patients over a longer period of time, as well as examination of bacteria in the salivary specimen.

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Conflict of interests

The authors declare that they have no conflict of interests.

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