



Evaluation of the apical microleakage of MTA Fillapex, AH₂₆ and Endofill sealers

Avaliação da microinfiltração apical de cimentos MTA Fillapex, AH₂₆ e Endofill

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ABSTRACT

Objective: Proper apical seal plays an important role in the success of root canal treatment. The most common cause of failure of root canal therapy is known as the lack of adequate apical seal. The aim of this *in vitro* study was to compare the apical microleakage of MTA Fillapex, AH₂₆, and Endofill sealers using dye penetration method. **Material and Methods:** In this *in vitro* study, 72 single-rooted extracted human teeth were selected. The teeth were randomly divided into three experimental groups of 20 and two positive and negative control groups of 6. The canals were prepared by step-back technique and then filled with gutta-percha and one of the sealers mentioned. In the positive control group, the canals were filled with gutta-percha without sealer, and in the negative control group, the canals were prepared but not filled. The teeth were immersed in 2% methylene blue dye for 72 hours. The teeth were then cut longitudinally and the level of dye penetration was measured under a stereomicroscope. Data were analyzed by SPSS ver. 19 software, ANOVA and Bonferroni post-hoc tests. **Results:** The mean level of dye penetration in the Endofill test group was significantly higher than that in the AH₂₆ and MTA Fillapex test groups. While, the observed difference between AH₂₆ and MTA Fillapex groups was not statistically significant ($p < 0.05$). **Conclusion:** The results of this study showed that AH₂₆ and MTA Fillapex sealers did not show any significant difference in apical seal properties. However, their sealing strength was significantly greater than Endofill sealer.

KEYWORDS

AH₂₆ sealer; Endofill; MTA Fillapex; Microleakag.

RESUMO

Objetivo: O selamento apical adequado desempenha um papel importante no sucesso do tratamento do canal radicular. A causa mais comum de falha da terapia endodôntica é conhecida como falta de selamento apical adequado. O objetivo deste estudo *in vitro* foi comparar a microinfiltração apical dos cimentos MTA Fillapex, AH₂₆ e Endofill usando o método de penetração de corantes. **Materiais e métodos:** Neste estudo *in vitro*, 72 dentes humanos unirradiculares extraídos foram selecionados. Os dentes foram divididos aleatoriamente em três grupos experimentais de 20 e dois grupos controle, positivo e negativo, de 6. Os canais foram preparados pela técnica escalonada e preenchidos com gutta-percha e um dos cimentos mencionados. No grupo controle positivo, os canais foram preenchidos com gutta-percha sem cimento, e no grupo controle negativo, os canais foram preparados, mas não preenchidos. Os dentes foram imersos em corante azul de metileno a 2% por 72 horas. Os dentes foram então cortados longitudinalmente e o nível de penetração do corante foi medido sob um estereomicroscópio. Os dados foram analisados pelo software SPSS ver. 19 e pelos testes ANOVA e post-hoc de Bonferroni. **Resultados:** O nível médio de penetração do corante no grupo de teste Endofill foi significativamente maior do que nos grupos de teste AH₂₆ e MTA Fillapex. Enquanto, a diferença observada entre os grupos AH₂₆ e MTA Fillapex não foi estatisticamente significante ($p < 0,05$). **Conclusão:** Os resultados deste estudo mostraram que os cimentos AH₂₆ e MTA Fillapex não apresentaram diferença significativa nas propriedades do selamento apical. No entanto, suas forças de vedação foram significativamente maiores que a do cimento Endofill.

PALAVRAS-CHAVE

Cimento AH₂₆; Endofill; MTA Fillapex; Microinfiltração.

INTRODUCTION

The root canal treatment involves cleaning and shaping the canal and filling its three-dimensional space [1]. The complete sealing of the root canal after cleaning and shaping prevents the colonization of microorganisms in the root canal and re-infection of the periapical tissues inside the root canal [2].

The failure of endodontic treatment is associated with several factors, but mainly the permanence of bacteria in the root canal system [3]. Gutta-percha lonely cannot fill the root canal space, and the use of a sealer is necessary to fill the three-dimensional space of root canal [4]. An ideal sealer should be compatible with tissue, have antimicrobial properties, be non-toxic and radiopaque, and should also fully fill the root canal system and be dimensionally stable and have a proper adherent to the wall of the canal [5].

Eugenol Zinc Oxide Sealers have long been used successfully. Zinc oxide eugenol-based sealers like Tubli Seal and Fill Canal showed cytotoxic response [6,7]. Zinc oxide eugenol sealers, such as Endofill, have long been used successfully. If these sealers expand into periradicular tissue, they will absorb. These materials have a slow setting time, shrinkage during setting and solubility and can change the color of the tooth structure. An advantage of these sealers is their antimicrobial activity [8].

Epoxy resin-based sealers now have good physical and chemical properties and have high biocompatibility. AH₂₆ is an epoxy resin whose desirable properties include antimicrobial action, adhesion, long service life, ease of mixing and ability to seal. Very good. Its disadvantages include discoloration, relative insolubility in solvents, relative toxicity until hardened, and some solubility in oral fluids [9].

MTA Fillapex is a type of MTA-based sealer consisting of resin salicylic, calcium silicate and bismuth trioxide compounds, which according to the manufacturer claims, it has the same MTA composition after being mixed [10-12]. This sealer has proper flow, solubility, water absorption, proper working time and setting time [13].

Various methods have been used to investigate the apical seal of root canal sealers. However, due to the high sensitivity and consistency, the most common method used to evaluate the apical seal is the method of evaluating the dye penetration. The depth of penetration shows the distance between the filling material and the canal walls [14,15].

As the sealing ability is one of the ideal apical sealer requirements, this study aimed to compare the apical microleakage of three widely used sealers MTA Fillapex, AH₂₆ and Endofill using dye penetration method. The null hypothesis was that MTA Fillapex has better apical seal because of its structure. The result of this study may contribute to the provision of documented information based on academic research to examine the results.

MATERIAL AND METHODS

In this *in vitro* study, 72 extracted human teeth with single root and single canal were used. The teeth were disinfected with 5.25% sodium hypochlorite for one hour to control the infection. Their outer surfaces were cleaned of any kind of soft and hard tissue and calculus.

The crowns of all teeth were cut to standardize the samples, so the same length from each root remains (14 mm). This was done under a water spray with a diamond disc (Teeskavan Iran). After the access cavity was prepared, the working length was measured using a K-File#15 (MANI, INC. Japan) by removing 1 mm from the length when the

tip of the file is out and seen from the apical foramen. To standardize the diameter of canals and the apical foramen, the preparation of the canals up to #60 file in the apical region was done by Step Back technique.

The irrigation was done during the instrumentation with 5 ml of 5.25% NaOCl and 5 ml of distilled water. The smear layer was then removed by the method suggested by Yamada et al [16]. This procedure was performed intermittently in three steps using sodium hypochlorite. In the first stage of sodium hypochlorite, in the second stage of EDTA and in the third stage again of Sodium hypochlorite was used and finally irrigated with normal saline to remove sodium hypochlorite and EDTA. Then the root canals of teeth were completely dried with a paper cone (Meta, Korea). At this stage, the teeth were randomly divided into 3 test groups of A, B and C (each group included 20 teeth) All teeth in the test group were obturate using lateral compaction technique with the sealers related to each group and gutta-percha (Mani, Utsunomiya, Japan). The MTA Fillapex sealer (Angelus, Londrina, Brazil) with gutta-percha were used in the group A, AH₂₆ sealer (Dentsply, Dentry Germany) with gutta-percha were used in group B, and Endofill sealer (PD, Switzerland, Swiss) with gutta-percha were used in group C. After cutting the gutta-percha cones, the final condensation was performed by a manual plugger. At the end, the canal filling was evaluated by radiography for existence of voids or incomplete filling (Figure 1). In this study, 12 teeth were selected as positive and negative controls. In 6 teeth in the positive control group, canal filling was done using gutta-percha and without a sealer. The purpose of this work is to have samples that microleakage easily takes place in them. Then, the access cavities were sealed with CAVISOL temporary filling material (Golchay_Iran) for coronal sealing.

All samples were stored in an incubator at 37 °C for 72 hours at 100% humidity. The external surface of all teeth in the test group and positive control group except for 2 mm of the apical end (except for the negative control group) were completely covered by two layers of nail polish. In 6 teeth of the negative control group, after canal preparation the canals, the entire surface of the roots was covered with nail polish. The purpose of this was to investigate the sealing ability of nail polish against dye penetration in the experimental conditions of this study. The most common substance used in dye penetration studies is methylene blue. Afterwards, the teeth were immersed for 72 hours in methylene blue (2%, PH=7), which was freshly prepared (Figure 2). After this time, the teeth were removed from the dye, and washed under running water for 15 minutes. The samples were cut by a diamond disk (Teeskavan, Iran), and divided into two buccal and lingual halves (Figure 3). In the healthier halves of the tooth, the level of dye penetration (in millimeters) from apex towards the crown were observed under a stereomicroscope (Stemi 508 Zeiss, Germany) with a 30X magnification, and measured by a caliber with a precision of 0.02 millimeters (Figure 4). Data were analyzed by SPSS ver. 19 software and ANOVA test. Bonferroni post-hoc test was used for pairwise comparison of sealers. In all tests, the significance level was considered as less than 0.05.

RESULTS

The complete dye penetration had taken place in the sample of the positive control group (Figure 5), however it did not completely pass through the cavit. In the negative control group, no dye penetration was observed (Figure 6).

The mean dye penetration in the MTA Fillapex test group was 2.391 mm and in the AH₂₆ test group was 1.948 mm, and in the

Endofill test group was 3.899 mm (Figure 7).

The highest categorical frequency in the test groups of AH₂₆ and MTA Fillapex was in the range of 0-3 mm, and in the Endofill group was in the range of 9-12 mm (Table I).

ANOVA statistical test showed that there is a significant difference between the three test groups in terms of dye penetration (Table II).

In the pairwise comparison of groups, Bonferroni post-hoc test showed that there are statistically significant differences between the test groups of A (MTA Fillapex) and C (Endofill), as well as test groups of B (AH₂₆) and C (Endofill). However, there was no significant difference between the groups of A (MTA Fillapex) and B (AH₂₆).

Table I - The categorical frequency distribution of studied teeth based on the level of dye penetration in the test groups in millimeters.

Color penetration rate	Group		
	MTA Fillapex	AH ₂₆	Endofill
16 (80)	16 (80)	0 (5)	0-3
4 (20)	4 (20)	6 (30)	3-6
0 (0)	0 (0)	6 (30)	6-9
0 (0)	0 (0)	7 (35)	9-12
20 (100)	20 (100)	20 (100)	Total

Table II - Color values of color penetration in test groups in millimeters.

Group	Number	Minimum penetration of paint	Maximum penetration of the paint	Mean	Standard deviation	ANOVA test result
MTA Fillapex	20	0.54	4.92	2.3910	1.11543	F = 55.541
AH ₂₆	20	0.36	3.90	1.9480	1.09091	
Endofill	20	2.48	10.78	7.3590	2.70488	
Total		0.36	10.78	3.8993	3.04292	

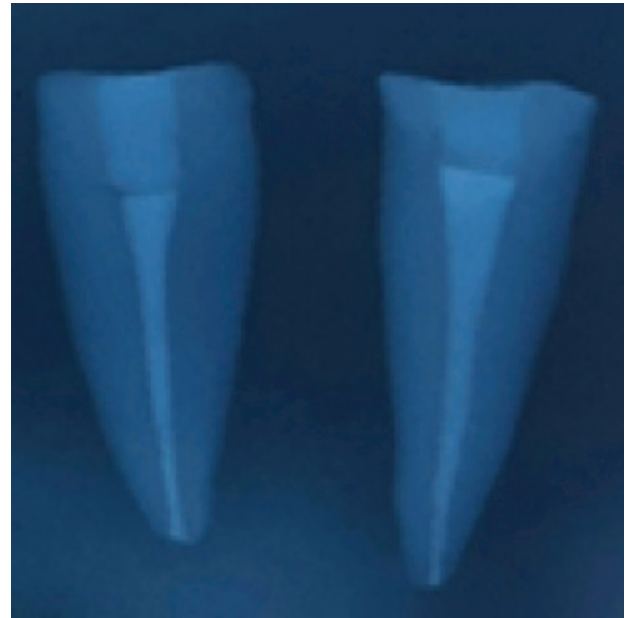


Figure 1 - Some test samples.



Figure 2 - Samples after immersion in methylene blue.



Figure 3 - Samples after cutting.

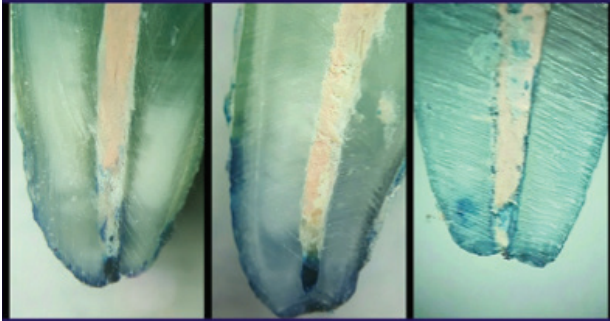


Figure 4 - Treated samples under stereomicroscope, from right to left: MTA Fillapex, AH₂₆, and Endofill.

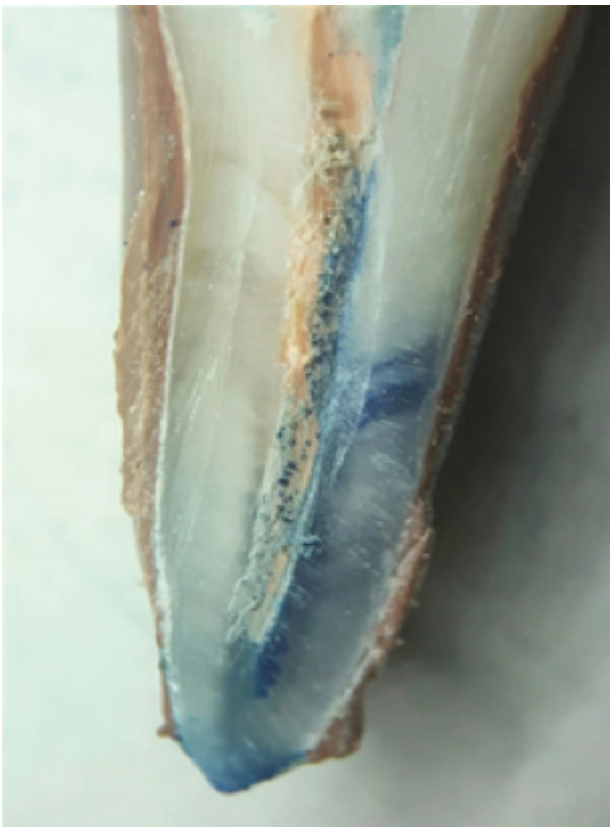


Figure 5 - Positive control group.



Figure 6 - Negative control group.

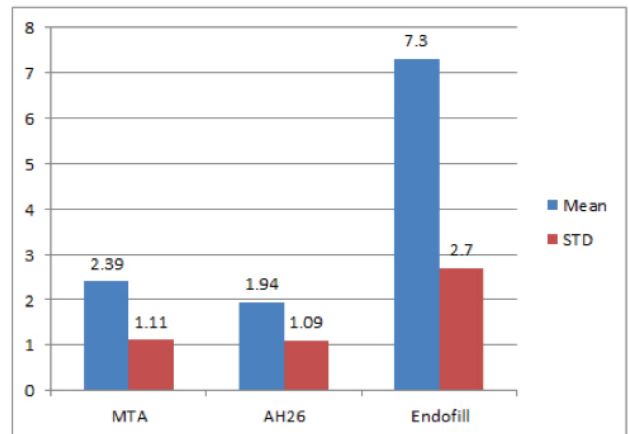


Figure 7 - The mean dye penetration in the test groups.

DISCUSSION

The adhesion between the root canal surface and filling materials is important in order to prevent microleakage, which can be achieved through the use of different sealers. Filling the root canal with gutta-percha or a sealer alone does not create a long-term sealing [17,18].

The filling microleakage occurs through the distance between the gutta-percha and the sealer, the porosity in the sealer, or through the distance between the sealer and the dentin. Therefore, microleakage of sealers has a great effect on the sealing of the canal and the success of treatment [19]. The level of microleakage is measured in laboratory conditions to assess the sealing ability of materials. Several methods have been designed and used for this purpose, including: bacterial penetration, fluid filtration, dye penetration, penetration of radioisotopes and gas chromatography. Some of these methods, such as dye penetration, are simple and some other, such as bacterial penetration, are more complex. However, in general, a standard technique has not been introduced yet, and even in the use of a particular method, differences in detail may be seen, which lead to contradictory results [20]. Among the available methods, the most commonly used method is dye penetration, which does not require sophisticated and advanced facilities [21,22]. On the other hand, given the diameter of the methylene blue particles, it seems unlikely that the bacteria penetrate somewhere inside the canal, which methylene blue cannot penetrate [23]. According to the results of the study, the mean color penetration in the Endofill sealer was significantly higher than that in the MTA Fillapex and AH_{26} sealers, while the observed difference between the groups of MTA Fillapex and AH_{26} (mean dye penetration in each group) was not statistically significant.

This indicates the same impact of two sealers in the apical seal.

Limkangwalmongkol et al. examined the apical microleakage of root canal following the application of Apexit, Sealapex, Tubliseal and AH_{26} sealers, and showed that the sealing capability of AH_{26} was much better than other sealers [24], which is consistent with the results of this study. However, in the study by Naulakha et al. (2011) on the four sealers of AH_{26} , Endomethacin, Sealapex, and ZOE, similar to this study, the leakage rate AH_{26} was lower than other studied sealers, but this difference was not significant [25]. This difference may be due to the type of sealers used in their study. The result of this study was consistent with the studies by Jafari et al. [19], and Razvian et al. [26]. ZOE-based sealers are highly degradable, soluble and permeable in culture media containing moisture. They also have a little ability to attach to the dental structure [27,28]. According to this information, the cause of the most apical microleakage in the present study can be justified, which is related to Endofill.

Remy et al. studied the marginal adaptation and sealing ability of AH Plus, Endofill and MTA Fillapex sealers. In this in vitro study, the sealing ability of MTA Fillapex did not have a statistically significant difference with Endofill, although both sealers had a significant difference with the AH Plus sealer [18], while in the present study, the difference in apical seal between Endofill and MTA Fillapex sealers was statistically significant. The reason for this statistical difference may be related to the method of studying the sealing ability. The study method of Remy et al. was direct observation of the interface between filling material and dentin wall by Scanning electron microscopy.

Jafari et al., examined the sealing ability of MTA Fillapex, Apatite and AH_{26} sealers by

bacterial microleakage technique [20]. In this in vitro study, the lowest microleakage was related to AH₂₆, MTA Fillapex and Apatite, respectively. The mean microleakage in AH₂₆ sealer had no statistically significant difference with MTA Fillapex sealer, which is consistent with the result of present study. In the study by Razvian et al., the microleakage rate in MTA Fillapex was higher than AH₂₆. This difference was statistically significant, which is inconsistent with present study. The reason for this contradiction may be attributed to the technique used to evaluate microleakage. Razvian et al. used bacterial penetration technique in their study.

In general, the reasons for the difference in the results of various studies are not clear, but it can be attributed to several factors, including: differences in the sample size, differences in different stages of treatment (cleaning, shaping, irrigation, placing the sealer, gutta-percha condensation, the cutting method of teeth, etc.). It should be noted that the results of the in vitro studies of dye penetration in a laboratory environment merely compares the sealing ability of sealers. Therefore, before accepting a new substance for clinical use, different studies must be performed to evaluate the physical, biological, biocompatibility, solubility, radiopacity, dimensional stability properties, and so on [24].

CONCLUSION

The results of present study showed that the sealing ability of AH₂₆ and MTA Fillapex sealers is similar in terms of apical seal, however, their leakage is lower in comparison to the Endofill sealer.

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