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"INFLUENCE OF THE REMNANTS OF SILICONE OIL ON THE PENETRATION OF AH PLUS SEALER INTO THE DENTINAL TUBULES AFTER FINAL IRRIGATION WITH 17% EDTA AND 10% MALEIC ACID: A CONFOCAL LASER SCANNING MICROSCOPY STUDY."

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Abstract

Aim: To evaluate the influence of the remnants of silicone oil on the penetration of AH plus sealer into the dentinal tubules after final irrigation with 17% EDTA and 10% Maleic acid.
Material and Methodology: Twenty single canal premolars were instrumented using Pro Taper Universal rotary system. Teeth were divided into two main groups (n=10) with and without Silicone oil. Subsequently, each main group was further subdivided into 2 subgroups according to the final irrigation. Obturation was done using lateral compaction technique using Rhodamine B dye labelled sealer. The penetration depth of the sealer was evaluated by using a confocal laser microscope.
Results: The highest depth of sealer penetration into the dentinal tubules was achieved in specimens when final irrigation was done with 10% maleic acid when silicone oil was not used the lowest depth was obtained in specimens when final irrigation was done with 17% EDTA after placement of silicone oil.
Conclusion: Within the limitations of the study, none of the chelating agents were able to totally remove the silicone oil. 10% maleic acid showed better AH Plus sealer penetration into the dentinal tubules than 17% EDTA either with or without using silicone oil.
Keywords: AH Plus sealer, Confocal laser scanning microscopy, Silicone oil, Maleic acid, Ethelene diamino acetic acid.

Introduction

Proper cleaning, shaping, and three-dimensional filling of the root canal system are critical components of successful root canal therapy (RCT). In order to achieve an efficient RCT, root canal sealers are essential because they close the gaps between the gutta percha and the root canal walls [1]. Nevertheless, microscopic gaps that are present between sealer and dentine as well as between sealer and gutta percha may threaten the outcome of RCT. Because marginal

leakage might occur through these gaps leading to failure [2]. Sealers have a greater ability to reach obscure locations than gutta percha, including lateral canals, fins, isthmuses, and dentinal tubules. Many parameters, such as the permeability of the substrate (dentine), the method used to remove the smear layer, the filling procedure, and other aspects connected to the sealer, such as its mechanical and physiochemical qualities, affect the penetration depth of sealers [1].

AH Plus is an epoxy resin-based sealer, it is the gold standard sealer, and it displays acceptable physicochemical properties that have been broadly examined such as flowability, low solubility, biocompatibility, radiopacity, antibacterial action and sealing ability. Moreover, it shows a high bond strength to the canal wall and acceptable long term dimensional stability [1,3]. AH Plus sealer is available as two paste system, in that base paste contains Epoxy resin, Calcium tungstate, Zirconium oxide, Aerosil, Iron oxide and catalyst paste contains Adamantane amine, N, N-Dibenzyl-5-oxanonane, TCD-Diamine, Calcium tungstate, Zirconium oxide, Aerosil [3].

Due to the increasing need towards using NiTi rotary systems, clinicians often face instrument separation. Hence, searching for an aid to remove the separated instrument is the main concern. Recently, Terauchi and Renton recommended using silicone oil to facilitate the retrieval of the separated instrument [4].

A silicone oil is a liquid polymerized siloxane with chains of organic sides. Silicone oil is one of the constituents in intracanal medicaments such as Metapex, Vitapex, and Tegapex [5,6].

Maleic acid is a dicarboxylic acid found to possess the smear layer-removing ability. Ferrer-Luque et al showed the antimicrobial activity of Maleic acid against E. faecalis alone or in association with other irrigating agents [7].

EDTA is a chelating solution which aids in the elimination of smear layer by facilitating the eradication of microorganisms present in the canal space, thereby improving the anti-microbial efficiency of disinfecting agents in further deeper layers of dentin. Several previous studies resolved that irrigation in the endodontic treatment with EDTA appears to be a promising endodontic tool [8].

Calcium hydroxide combined with silicone oil, such as Metapex can be removed using maleic acid and EDTA. Thus, these irrigants are utilized in this study to remove the silicone oil due to this reason [9].

Using silicone oil may hamper the penetration of sealer into the dentinal tubules so the current study was conducted to evaluate the influence of the remnants of the silicone oil on the penetration of AH plus sealer into the dentinal tubules after Final irrigation with 17%EDTA and 10% Maleic acid using a Confocal Laser Scanning Microscope.

Material and Methodology

Specimen's Preparation

20 single rooted premolars were selected in the study. Teeth were cleaned of any debris or calculus by an ultrasonic scaler. The teeth were stored in saline until use. Decoronation of the teeth was completed using a diamond disc to ensure that root canal length was standardized at 15 mm.

Root Canal Preparation

A K-file # 10 was introduced into each canal until it was visualized through the apical foramen and the length was determined. Working length (WL) was estimated by 0.5 mm from that length. Canal preparation was completed using the ProTaper Universal system (Dentsply-Maillefer, Bal laigues, Switzerland) up to F4. Between each file change, instrumentation was performed with intermittent irrigation with 3% NaOCl for 1 min. followed by sterile distilled water. Depending on whether silicone oil was used or not, teeth were divided into two groups.

Group A (n=10)- Without silicone oil

Group B (n=10)- With silicone oil

Again, each group was further divided into two subgroups based on the final irrigation solution used i.e., 10% Maleic acid, 17% EDTA.

Group A (n=10): Without silicone oil

In this group,10 teeth were prepared using the previously described technique, but silicone oil was not used. Again, the teeth were further divided into two subgroups.

Subgroup A1(n=5) - Final irrigation was done using 5 ml 10% maleic acid for 1 minute.

Subgroup A2(n=5) - Final irrigation was done using 5 ml of 17% EDTA for 1 minute.

Group B (n=10): With silicone oil

In this group,10 teeth were prepared using the previously described technique, where the canal was irrigated with 5 ml of silicone oil for 1 minute. Next, 5 ml of 3% sodium hypochlorite was used to irrigate the canals for one minute and then rinsed with 5 ml of sterile distilled water. Again, the teeth were further divided into two subgroups.

Subgroup B1(n=5) - Final irrigation was done using 5 ml 10% maleic acid for 1 minute.

Subgroup B2(n=5) - Final irrigation was done using 5ml of 17% EDTA for 1 minute.

Root Canal Filling

In all groups, the canals of the teeth were dried using paper points. The canals were coated with the AH Plus sealer that was mixed according to the manufacturer's instructions and mixed with 0.1% fluorescent Rhodamine B to allow visualization under the CLSM (Carl Zeiss, Germany). Master apical cone 40/0.02 was used in obturation and to apply the labelled sealer. Auxiliary cones # 25/0.02 were added and cold-compacted laterally using a finger spreader #25,1 mm shorter than the WL next to the master cones that were positioned. Accessory cones were coated with sealer and placed until no space was available for the spreader. Gutta-percha was severed and compacted vertically with an endodontic plugger. Mesiodistal and buccolingual radiographic examination was conducted to verify the quality of the obturation. The coronal seal was achieved by glass ionomer restorative material. Specimens were placed at 37°C and 100% humidity for 1 week to confirm complete setting of the sealers.

Sectioning of root

After 1 week, using a diamond disc the specimen was sectioned in a perpendicular direction to the long axis. The cross sections were taken at 2 mm from the root apex having a thickness of 2 mm. Specimens were investigated under a CLSM at 570 nm wavelength and 10X lens.

Images were transferred to the Image J software for measurement of the tested sealer penetration into dentine.

Statistical Analysis

Data was collected and analyzed using SPSS software version 21.0, where p-value <0.05 is considered to be statistically significant. Duncan's post hoc test was performed for the evaluation of statistical significance among the groups. Independent t-test was used to compare with and without silicone oil groups and to compare between final irrigation with 10% maleic acid and 17% EDTA.

Results

AH plus sealer penetration was higher in Group A (without silicone oil) when compared to Group B (silicone oil). Group A1 (without silicone oil - 10% Maleic acid) showed higher sealer penetration compared to Group A2 (without silicone oil - 17% EDTA). In Group B1(with silicone oil-10% Maleic acid) showed better sealer penetration compared to Group B2(with silicone oil - 17% EDTA) (Table 1) (Graph1).

When comparing all groups Group A1-10% Maleic acid without silicone oil showed higher sealer penetration followed by Group A2-17% EDTA without silicone oil, Group B1- 10% Maleic acid with silicone oil. Lower sealer penetration was observed in Group B2-17% EDTA with silicone oil (Table2) (Graph2). The same was depicted in figure 1.

TABLE 1: Intergroup comparison – Group A1 vs Group A2, Group B1 vs Group B2

		N	Mean	Std. Deviation	Std. Error Mean	t value	P value
(Group-A) WITHOUT SILICON OIL	**(Group-A1)** 10% MALEIC ACID GROUP	5	1034.8	99.84839	44.65356	-2.932	0.019*
	(Group-A 2) 17 % EDTA GROUP	5	867.80	79.03607	35.34600		
(Group-B) WITH SILICON OIL	**(Group-B1)** 10% MALEIC ACID GROUP	5	715.00	79.12648	35.38644	-3.484	0.008**
	(Group-B2) 17 % EDTA GROUP	5	567.00	52.51	23.48404		

* Statistically significant difference was found in the mean penetration depth of AH plus sealer in without silicon oil group (Group A) after final irrigation with 10% Maleic acid (Group A1) and 17% EDTA (Group A2).

** Statistically significant difference was found in the mean penetration depth of AH plus sealer in with silicon oil group (Group B) after final irrigation with 10% Maleic acid (Group B1) and 17% EDTA (Group B2).

Graph 1: Mean penetration depth of AH plus sealer in with and without silicone oil groups (Group A, Group B) after final irrigation with 10% Maleic acid (Group A1, B1) and 17% EDTA (Group A2, B2) groups.

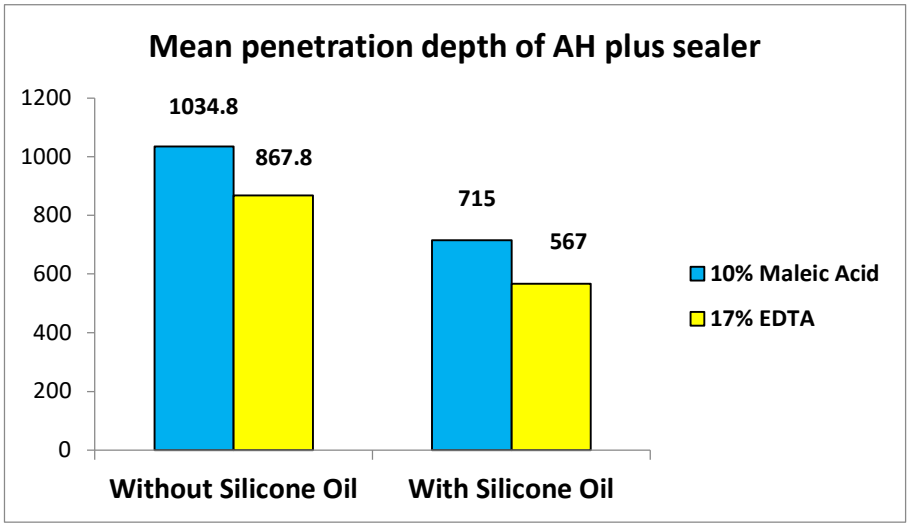


TABLE 2: Overall comparison of all groups (A1, A2, B1, B2)-Post hoc test

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	F value	P value
						Lower Bound	Upper Bound				
G-A1	**10% MALEIC ACID WITHOUT SILICON OIL**	5	1034.80	99.848	44.654	910.82	1158.78	919	1158	32.01	**0.000***
G-A2	**17% EDTA WITHOUT SILICON OIL**	5	867.80	79.036	35.346	769.66	965.94	789	985		
G-B1	**10% MALEIC ACID WITH SILICON OIL**	5	715.00	79.126	35.386	616.75	813.25	598	804		
G-B2	**17% EDTA WITH SILICON OIL**	5	567.00	52.512	23.484	501.80	632.20	490	610		
Total		20	796.15	192.880	43.129	705.88	886.42	490	1158		

*Statistically significant difference was found in the mean penetration depth of AH plus sealer in all groups ($p<0.05$).

Graph 2: Mean penetration depth of AH plus sealer with and without silicone oil (Group A, Group B) after final irrigation with 10% Maleic acid (Group A1, Group B1) and 17% EDTA (Group A2, Group B2).

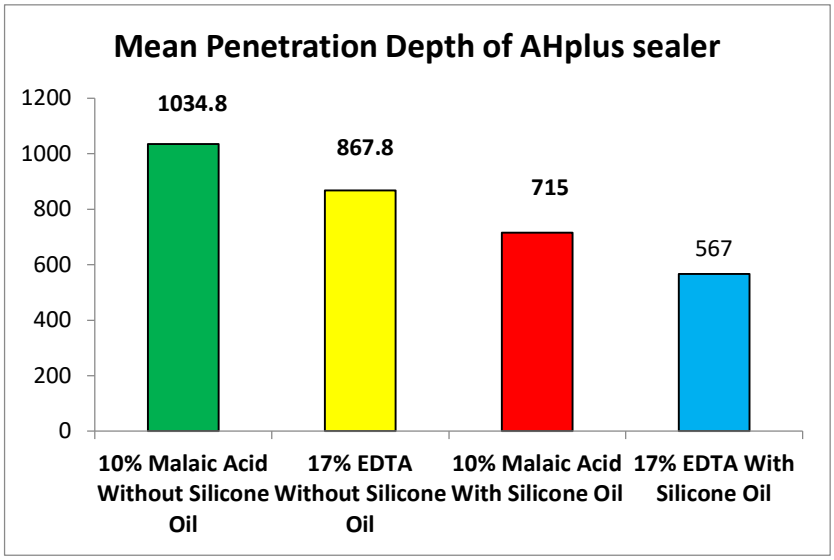
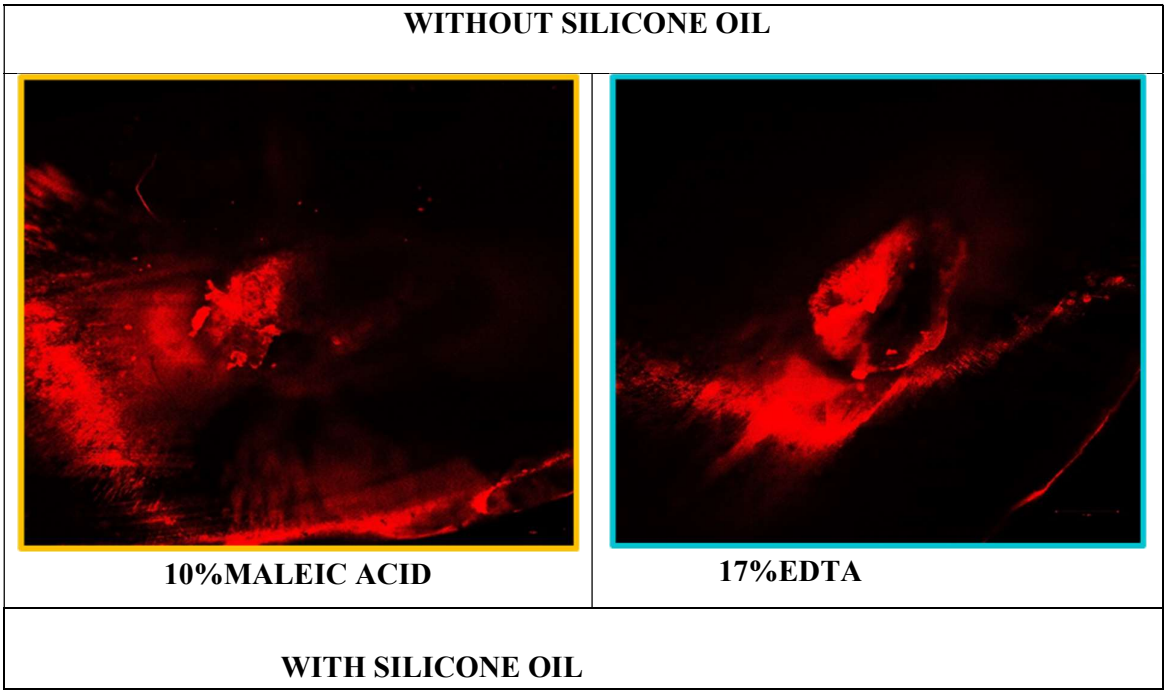
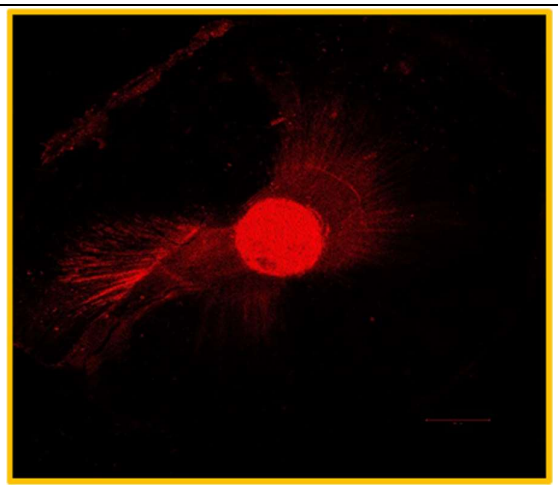
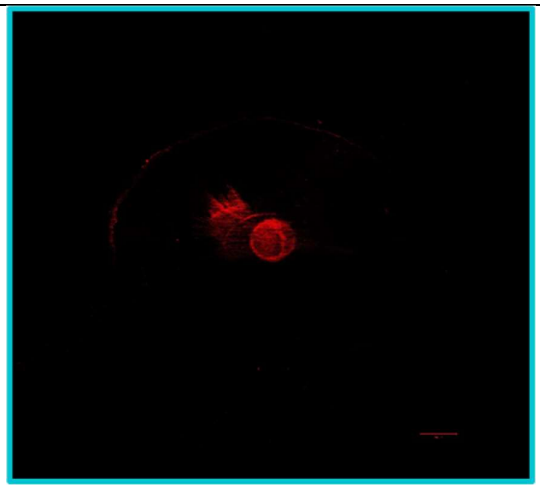


Figure 1. Representative Confocal Laser Scanning Microscopy images displaying AH plus sealer penetration into the dentinal tubules with and without using silicone oil after final irrigation with 10% Maleic acid and 17% EDTA.





10%MALEIC ACID



17%EDTA

Discussion

Penetration of the sealer into the dentinal tubules might emphasize its retention, which acts as a physical barrier, entombing the remaining microorganisms by depriving them from their nutrients. During obturation, the goal is to have a minimum thickness of sealer and a maximum body of gutta-percha [10,11].

CLSM was used in this study because it demonstrates the full extension of sealer into the dentinal tubules. High-contrast points were established when Rhodamine B dye was used. Penetration of the sealer into the dentinal tubules could be evaluated with CLSM [4]. To place the sealer inside the root canal, the master cone coating technique was used because it requires no extra equipment. A previous study revealed that sealer spreading within the root canal was not affected by the technique of sealer application [12].

In the present study, AH plus sealer was used because AH plus sealer has been shown best adaptability on dentine surface when compared with other sealers. This can be attributed to formation of the covalent bond between the dentine and sealer due to the action of epoxy resin that can combine with the amine group of collagen [13]. Additionally, good flow rate, reduced film thickness, small particle size, and its longer setting time encourage the mechanical interlocking between the sealer and dentine [14].

Delivery and rejuvenation of irrigants at the apical portions of the root is a challenging aspect of apical irrigation. The apical root dentin exhibits few or no tubular characteristics. Because of this reason, sealer penetration in the apical third is less comparing the coronal and middle third of the root. So, in this study sealer penetration in the apical third was evaluated [15].

Despite the invention of newly released Ni-Ti files, unfortunate separation of files might still occur hindering the completion of the root canal treatment. Terauchi and Renton recommended the use of silicone oil as a lubricant during the process of the instrument's retrieval [4].

Silicone oil may be effective in the removal of separated instruments but on the other hand, it may also hinder the penetration of sealer into the dentinal tubules during obturation which affects the success of root canal treatment by effecting the three-dimensional apical seal [4].

In the current study, using silicone oil lowered the mean values of the penetration depth of AH plus sealer into the dentinal tubules. To overcome this problem irrigation solutions like 10% maleic acid and 17%EDTA are used to remove the silicone oil to improve the penetration of the sealer into dentinal tubules.

In the present study, the 10% maleic acid solution performed better in comparison to the 17% EDTA solution in the removal of Silicone oil. The probable reasons could be that Maleic acid has a greater depth of demineralization in the apical third, caused due to its lower pH of 1.3, which results in a greater decalcifying effect in a shorter time. Since EDTA is a chelator, its role to decalcify the root canal dentin is free from the high concentration of hydrogen ions and is found to be effective at a neutral pH. The fall in the pH results from a trade by hydrogen ions for calcium from dentin. This decrease in pH over a period of time causes the ensuing reduction in the efficacy of EDTA. It has been shown that the dentinal tubules progressively get sclerosed in the apical third. Thus, the activity of EDTA may not be as effective in the apical third [16].

Sneha Pallepagu et al conducted a study on the removal of smear layer using 7%Maleic acid and 10% EDTA they have concluded that Maleic acid performed better than EDTA, the probable reason could be the ability of maleic acid to penetrate more in comparison to EDTA and chelate the calcium ions [9].

The low surface tension of the MA might have enhanced the efficacy of maleic acid in removal of silicone oil when compared with EDTA which has Higher surface tension [17]. Maleic acid also decreased the contact angle of AH plus sealer thereby improved the penetration of the sealer [18].

Goldberg et al. concluded that optimal results are obtained only after an application time of a minimum of 15 mins with EDTA, but in this study, the application time was only one minute hence EDTA was not as effective as Maleic acid in removing silicone oil at the apical third [8].

In this study, during initial root canal preparation, sodium hypochlorite was used to remove the smear layer. This might have enhanced the effect of maleic acid [4].

Ballal et al. conducted a study on smear layer removal from the apical third of the root canal using 7% maleic acid and EDTA. They have concluded that Maleic acid performed better than EDTA [8].

Conclusion

Within the limitations of the study, none of the chelating agents was able to totally remove the silicone oil. Under the limitations of this study,10% maleic acid showed better AH Plus sealer penetration into the dentinal tubules than 17% EDTA either with or without using silicone oil.

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