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THE EFFECT OF FOUR DIFFERENT IRRIGATING SOLUTIONS ON THE DEPTH OF PENETRATION OF VARIOUS SEALERS INTO DENTINAL TUBULES

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ABSTRACT

Introduction: Creation of a sterile space is impossible in infected root canals, using mechanical preparation alone due to the complication configuration of radicular canal systems. Nearly half of the radicular canal dentine were left unprepared during the mechanical preparation with traditional stainless steel hand instruments and endodontic instruments.

Aim; Evaluation of the outcome of numerous irrigating solutions used as final irrigation on the depth of sealer penetration into dentinal tubules.

Methods: Two different endodontic sealers Bioceramic sealer and Resin sealer were used with four different irrigating solutions (Sodium hypochlorite, Chlorhexidine digluconate, Chiostan nanoparticles, Bio pure MTAD). ***GROUP 1:*** 5 ML of 2 % of naocl were used as a final irrigant for 1 min. ***GROUP 2:*** 5 ML of 2% chlorhexidine were used as a final irrigant for 1min. ***GROUP 3:*** 5ML of 0.2% of chitosan nanoparticles were used as a final irrigant for 1 min. ***GROUP 4:*** 5ML of MTAD were used as a final irrigant for 1 min. Depth of sealer penetration into dentinal tubules was evaluated after samples preparation using confocal laser microscope analysis.

Results: Comparison between different sealers of all irrigants in the coronal section was performed by using Independent T-test which revealed that MTA fill apex was significantly higher than AH plus as $P < 0.05$ in NaoCl.

Conclusion: MTA Fill apex sealer exhibited a significantly greater dentinal penetration than AH plus sealer irrespective of the final irrigation protocol.

KEYWORDS: MTA fill apex, AH plus, Sodium hypochlorite, Chlorhexidine digluconate,

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INTRODUCTION

The establishment of a sterilized space is difficult in contaminated root canals, due to the complicated configuration of root canal systems. During the mechanical preparation with traditional St. St. hand devices, about half of the root canal walls were aborted unprepared. Endodontic therapy has two basic outcomes: first, it prepares and shapes the root canal, and second, it obturates the root canal system to various degrees to promote apical healing. (1)

Sealers were used to achieve a durable seal between the core material and root canal walls. The penetration of sealer into the dentinal tubules elevates the interface between the obturation material and the dentin. Which enhances the sealing capacity of the obturation. (2) A greater depth of penetration can increase the strength of endodontically treated teeth by allowing the sealer to come into touch with bacteria that haven't been eliminated, thereby improving its antimicrobial action.

This article was considered to estimate the outcome of many final irrigation protocols on the depth of sealer infiltration into dentinal tubules at the coronal, middle, and apical portions of the root canal.

MATERIALS AND METHODS:

1) Samples Selection

Fifty-six recently extracted human single-rooted teeth with mature apices (from the surgery department at the faculty of dentistry Ain Shams University) were used in this study.A lack of fissures or carious flaws proved the teeth's integrity. To understand the presence of calcifications, root curvatures, and multiple root canals, preoperative radiographs were taken in the mesiodistal and buccolingual directions.

Samples were submerged in normal saline for half an hour before being cleaned with an ultrasonic scaler to remove any soft deposits or hard tissue. All of the samples were decoronated at the cementoenamel junction with a high-speed diamond disc submerged coolant to a consistent length of 16mm. The samples were kept in water until they were needed.

2) Samples Classification

The teeth were biomechanically prepared in step-back technique reaching file number 50 as master apical file. According to the final irrigant used, the samples were arbitrarily divided into four groups.

- ***GROUP 1 (Naocl):*** consisted of fourteen samples that were irrigated using 5 ML of 2% sodium hypochloride.
- ***GROUP 2 (CHX):*** consisted of fourteen samples that were irrigated using 5 ML of 2% chlorhexidine.
- ***GROUP 3 (CHITOSAN):*** consisted of fourteen samples that were irrigated using 5ML of 0.2% of chitosan nanoparticles.
- ***GROUP 4 (MTAD):*** consisted of fourteen samples that were irrigated using 5ML of Biopure MTAD.

Each group was subdivided according to the type of sealer used into

-***Subgroup A***: consisted of seven samples that were obturated using a Bioceramic sealer.

-***Subgroup B***: consisted of seven samples that were obturated using a Resin sealer.

3) Samples Preparation

Distilled water was used to irrigate the root canals, which were then dried with paper points. Each group will be further classified based on the type of sealer used for obturation. For fluorescence under confocal laser microscopy, about 0.02 % fluorescent dye (Rhodamine B) was added to MTA fillapex and AH plus. Obturation was performed using the lateral compaction technique with gutta-

percha and MTA fillapex in subgroup A, and gutta-percha and AH plus in subgroup B. Excess gutta-percha was removed, and access cavities were temporarily sealed with a filling.

After final obturation, samples were held at 37°C and 100 percent relative humidity to allow the sealer to settle in the dentinal tubules. Samples were imbedded in resin blocks before being sectioned transversely into three thirds (coronal, middle, and apical) with a cutting machine (ISOMET 400011, Buehler, 41 Waukegan Road Lake Bluff, IL) under coolant water at 2, 5, and 8 mm from the root apex. The specimens were placed onto a glass coverslip 22 X 50 mm and inspected with a confocal laser microscope (CLSM). The penetration levels in the root sections were scanned .

4) Method of Evaluation

A ZEISS confocal laser microscope LSM 710 (Carl Zeiss, Jena, Germany) was set at the excitation wavelength 543 nm and emission wavelengths of 546 – 735 nm and to inspect the tooth samples (EC Plan-Neofluar 10x/0.30 M27), digital zoom 1.2. The whole teeth have been scanned using tile scan mode to acquire the representative image for the teeth. The acquisition of images was acquired by the ZEN 2.3 software (Carl Zeiss) at a resolution of 512 x 512 pixels, 16-bit depth. A confocal laser scanning microscope was used to visualize the different penetration abilities of sealers inside the dentinal tubules.

Analysis of images acquired by confocal laser microscope was done by three equations:

% of penetration

$$= \frac{\text{(Area of root canal (outlined violet)- Area of sealer (outlined green)}}{\text{(whole area (outlined yellow)- Area of root canal (outlined violet)}}$$

1- The percentage of penetration:

2- The maximum length of sealer penetration has measured randomly in each tooth and the average maximum depth was calculated from 3 measurements of each tooth.

3- The amount of sealer penetrated in the canal perimeter:

Canal perimeter % =

$$\frac{\text{length of sealer penetrated in canal perimeter}}{\text{Whole perimeter of canal}} \text{ X } 100$$

Statistical analysis was performed using an Independent t test for revealed data as mean ± standard deviation with probability level at $P \leq 0.05$ which is considered as significant.

RESULTS

For different irrigating preparations regarding coronal, middle, and apical sections, it was estimated that MTA fill apex showed higher values than AH plus concerning overall sections, in the table (1) and figure (1).

The level of significance revealed that there was a significant difference between MTA and AH in all sections as P value < 0.05 except for MTAD in the middle section which was insignificant different as P value > 0.05, listed in the table (1).

TABLE (1): Comparison between different sealers of all irrigants in different sections:

Section	Irrigants	MTA		AH Plus		P value
		M	SD	M	SD	
Coronal	NaOCL	54.7	8.0	20.1	7.6	0.0001*
	CHX	63.6	8.5	46.8	6.2	0.0012*
	CHITOSAN	55.3	7.4	33	4.3	0.0001*
	MTAD	55.6	3.8	36.9	13.2	0.0036*
Middle	NaOCL	51.7	8.4	41	6.8	0.0224*
	CHX	60.6	5.7	33	2.5	0.0001*
	CHITOSAN	67.7	3.8	21.8	4.8	0.0001*
	MTAD	48.4	8.3	47.7	10.5	0.8922 (ns)
Apical	NaOCL	58.9	7.9	31.7	15.5	0.0014*
	CHX	51.6	11.4	24	7.1	0.0002*
	Chitosan	53	10.5	36.6	9.9	0.0109*
	MTAD	38.9	2.0	12.3	4.4	0.0001*
Overall	NAOCL	55.10	8.10	30.93	9.97	0.0003*
	CHX	58.60	8.53	34.60	5.27	0.0001*
	Chitosan	58.67	7.23	30.47	6.33	0.0001*
	MTAD	47.63	4.70	32.30	9.37	0.0022*

M; [1]mean *SD; standard deviation* **significant difference* *NS; Insignificant Difference*

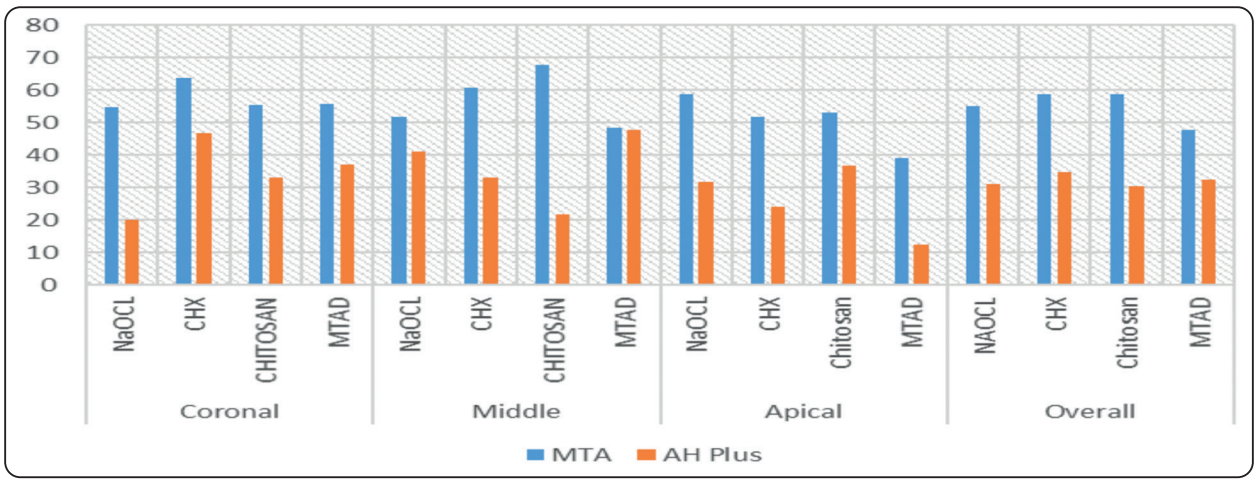

Fig. (1): Bar Chart revealing comparison between different sealers of all irrigants in different sections

DISCUSSION

Sealer penetration into dentinal tubules is thought to be advantageous in terms of inhibiting bacterial repopulation or inactivation as a blocking agent within the tubules [3]. The mechanical interaction of the sealer and the root dentin improves the retention of filling material within the root canal [4]. Furthermore, encase any residual germs in dentinal tubules. As a result, sealer penetration into dentinal tubules is regarded clinically important, and its physicochemical qualities are more important. [5]

The highest penetration values into dentinal tubules can be associated with an increase in debris elimination and better penetration of the endodontic cement. The mechanical interlocking of the sealer plug in the dentinal tubules has been suggested to improve retention of the root canal filling material. [6, 7].

In this study, we used AH Plus sealer with a pseudoplastic behavior. When the shearing rate increases during the filling procedure, the viscosity decreases and the flow increases [9]. Because of this physical feature, the sealer is able to cling to the root canal wall, fill uninstrumented auxiliary root canals, and penetrate dentinal tubules.

MTA fillapex is MTA-based root canal sealer. Although it shows good physicochemical properties, MTA fillapex appears to be even more cytotoxic than epoxy resin-based sealer [10].

To eradicate bacteria, many forms of irrigations have been used to irrigate root canals [11]. The most common kind of irrigation is NaoCl, which dissolves necrotic and less vital pulp remnants, as well as dentinal collagen and dentinal collagen collagen, but not the smear layer.

Bio pure MTAD is an ideal irrigant as final flush, it was found to be a highly effective intracanal irrigant compared to other commonly used irrigants with excellent disinfection of the root canal system. [13]

Chlorhexidine digluconate (CHX) is widely used in disinfection because of its excellent antimicrobial activity. However, it completely lacks tissue-dissolving capability. [15]

Recently chitosan has been widely used. As it has chelation ability; therefore, it can dissolve the in-organic parts of smear layers. Chitosan also has an antibacterial effect so it is considered as a final irrigation solution [16].

Single-rooted teeth (anterior and premolars) were chosen for this investigation because they have a straight and circular canal system, which allows for more consistent canal preparations and optical sectioning. [17]

For uniformity, root canal instrumentation and irrigation were performed on 16mm root segments using the crown down approach to allow for improved irrigation penetration into the apical third [18]. The depth of penetration into dentinal tubules was measured using the Rhodamine B isothiocyanate dye. CLSM can identify the fluorescence signal given by the sealer that has penetrated the canal. The coronal, middle, and apical thirds were scanned. CLSM was utilized in this investigation because it has various advantages over SEM. CLSM does not necessitate any extra specimen preparation, and observations can be conducted in near-normal settings. Sample preparation for CLSM likewise produces fewer artifacts than sample preparation for SEM. [19].

There was no significant difference between the use of different irrigation solutions on the depth of penetration of the sealer. As Sealer, penetration cannot be reputed as an absolute index of smear layer removal. The presence of the smear layer limits but does not completely prevent sealer penetration into tubules. Therefore, sealer penetration into dentinal

According to the findings of this investigation, lesser irrigant penetration was reported in all experimental groups at the apical 2-mm level than at

5 mm, as has been observed in prior studies [21]. Many factors can influence the depth of irrigant penetration into dentinal tubules. One of these elements is the root canal system's anatomical structure. Because of tubular sclerosis, smaller diameter, and a lower number of dentinal tubules in this region, tubules in the coronal and middle thirds of the roots are substantially more permeable than those in the apical thirds [22]. Furthermore, the narrowing of the root canal at the apical third impedes the flow and backflow of irrigating solutions, affecting their cleansing [20].

According to the results of this study, we found that CHX irrigation showed the highest percentage of penetration in coronal sections as compared to others irrigants in both types of sealers (MTA fillapex - AH plus). Recently Zandi et al. have shown that CHX can be used as a main irrigant, with similar success rates to those obtained with NaoCL [23]. Since, Rhodamine B dye was added to CHX to evaluate their penetration depth into dentinal tubules under confocal laser microscope, by mixing CHX with Rhodamine B the surface tension of CHX could be altered. In our study, just like Vadhana et al. [24] were evaluated previously, the results were confirmed to be similar, this was probably due to the small quantity of the dye mixed with the irrigant.

Our results showed that MTA fillapex has a higher penetration depth in dentinal tubules than AH plus, this was in disagreement with ***Zandi*** et al.[26] who reported that their penetration into the dentinal tubules was statistically similar.

MTA fillapex showed the highest percentage of penetration than AH plus at coronal followed by middle and apical which is in an argument with ***Vadhana*** et al.[27] . The properties of MTA Fillapex and AH Plus, such as flow, working time, initial and final setting time, also Consistency, particles size, and shear rate of a sealer determine its flow. These all are the main factors that affect the penetrability of a sealer.

The penetration depth of MTA-Fillapex was significantly greater in all other groups. This result is following the findings of Nikhil et al and is consistent with the studies by Silva et al. which showed MTA-Fillapex to possess greater flow and smaller particle size than AH Plus. [28]

Sealers can be pulled into tubules by capillary action rather than hydraulic forces generated during root canal filling. MTA fillapex sealer appeared to have the best tubular penetration and adaptability to the root canal wall of the sealers evaluated. To see the penetration using a confocal laser scanning microscope, the sealer must be labelled with Rhodamine B. The flow of the sealer labelled with 0.2 percent Rhodamine B did not vary according to American Dental Association requirements. These findings support the hypothesis that the chemical and physical properties of the sealer's components influence the sealer's depth of dentinal tubule penetration. [29] None of the sealers were able to permeate the entire structure.

CONCLUSION

Regardless of the final irrigation strategy, MTA Fill apex sealer had much better dentinal penetration than AH plus sealer.

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