

ASSESSMENT OF THE EFFECT OF EDTA AS A CHELATING AGENT ON INTRACANAL TOPOGRAPHY: AN IN VITRO STUDY

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KEYWORDS

Chelator, Dentin, Erosion, Saline, Sodium Hypochlorite

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ABSTRACT

Aim: this study aimed to evaluate the effect of final rinse with sodium chloride (normal saline) versus Ethylenediaminetetraacetic acid (EDTA) on dentin erosion. **Material & methods:** twenty lower second premolars were selected and prepared Under Dental loupes with 6X magnification, the selected teeth will be cleaned of calculus and soft tissue remnants using a hand curette. The teeth were disinfected using 5.25% NaOCl for 10 minutes and was rinsed with distilled water. Then teeth were decapitated. All crowns were cut by a diamond stone to establishing a unified length of 14 mm for all roots. After shaping the selected premolars by rotary file till 40.04 by 5.25% NaOCl the final rinse was sodium chloride group A1. (Normal saline), sodium hypochlorite and Ethylenediaminetetraacetic acid (EDTA) group A2. **Results & Conclusion:** EDTA scored high dentin erosion in comparison with sodium chloride.

INTRODUCTION

Irrigating solutions are essential for cleaning and disinfecting root canals. The removal of necrotic tissue, microorganisms, bacterial products and the smear layer created during instrumentation is a major goal in the success of endodontic treatment. The use of NaOCl and EDTA have been recommended during chemo-mechanical preparation. It was observed that these irrigants induce dentin changes. Including its physical, chemical and structural properties. NaOCl decreases the dentin micro hardness, changes its flexural strength and modulus of elasticity. It results in erosion of the dentin microstructure. It also oxidizes the organic matrix denaturing the collagen components of the dentin surface. Relating these facts to, the possibility of clinical occurrences, degradation of collagen matrix in mineralized tissues results in a less resistant and more brittle substrate, which can make the endodontically treated teeth more susceptible to crown or root fracture. EDTA may negatively alter the microstructure of dentin. It can also change the original ratio of organic and inorganic components, resulting in undesirable changes in the properties of hardness and roughness, as well as causing dentin erosion⁽¹⁾.

MATERIALS AND METHODS

This in vitro study was conducted on 40 extracted human mandibular first premolars teeth extracted for orthodontics reason. It was approved by Research ethics committee (REC) 288/2020, at the Faculty of Dentistry, Suez Canal University.

Preparation of samples

Root canal Preparation:

Started with manual stainless file size #10 K. The tooth length measured in millimeters and 1 mm was subtracted from tooth length to establish the working length by mean of file 15K. Thereafter, the teeth prepared with ProTaper next (PTN) rotary files used in a torque control, rotary motor at speed of 300 RPM with light apical pressure. For optimal usage, torque control devices are recommended at 200 Ncm on E-connect pro rotary devices. Starting from X1 File 17/04 to the working length and then X2 25/06 and then X3 30/07 and then 40/06 this was the last file and consider as master apical file. Each file was placed into the canal for three strokes. Between each rotary file patency by mean of file #10K to keep the canal patent and to avoid the blockage may occur by rotary file.

During the whole shaping procedure, the 1ml of 5.25% NaOCl solution was used as an irrigant between each file.

Inclusion criteria :

- Single root with Vertucci type I root canal.
- Straight root.
- Teeth with no caries.
- Teeth with no cracks.
- Teeth with no attritions.
- Teeth with no fractures.
- Teeth with no restorations.

Samples Grouping:

Roots were divided into two equal groups of 20 teeth according to the type of final irrigation protocol.

Group A₁: final rinse with Normal saline

The total volume of the irrigant was 10ml of normal saline delivered along 5 minutes.

Group A_2 : final rinse with NaOCl 5.25% and EDTA 17%.

The total volume of the irrigant was 10ml6.6ml of NaOCl along 4 minutes and 3.4 ml EDTA for 1 minute.

Analysis of Samples:

Teeth were sectioned longitudinally to be viewed under a scanning electron microscope (SEM) (**Figure1**). Diamond disc was used to create two grooves on the buccal and lingual surfaces of the roots. This was followed by sectioning of the roots using chisel and mallet into two halves. The best half was chosen for SEM examination to evaluate dentin erosion via scoring system $^{(2,3,4)}$.

The specimens were mounted on a metallic stub and sputter-coated with a 20nm layer of gold. A magnification of 3000X was used to evaluate the coronal, middle, apical third of the root canal.



Fig. (1) Scanning electron microscope (SEM)

Analysis of dentin erosion

The erosion in the coronal, middle, and apical thirds of the root canal was scored from SEM images using the scale suggested by **Torabinejad** *et al.*, ⁽⁵⁾ as follows (**Figure 2**).

- Score 1: no erosion, all tubules exhibited a normal appearance and size.
- Score 2: moderate erosion, the peritubular dentin was eroded.
- Score 3: severe erosion, the intertubular dentin was destroyed, and the tubules related to each other.



Fig. (2) A photomicrographic picture from SEM and the arrows on peri- and inter-tubuler dentin.

Statistical analysis

Statistical analysis for dentin erosion score distribution results were performed by Kruskal-Wallis and Mann-Whitney Test (p < 0.05).

RESULTS

In saline group

In the coronal third, 50% of samples recorded score 1 while 50% recorded score 2 and. In the

middle and apical thirds, 75% of samples recorded score 1, and 75% of the sample recorded score 2 (Figure 3, 4).

The score means ranks were 7.5, 6, and 6 for coronal, middle, and apical, respectively **Table** (1). According to Mann-Whitney test, there was no statistically significant difference between the three thirds.

Kruskal-Wallis test revealed that there was no statistically significant difference between the three thirds (p = 0.709).

Table (1) Comparison of erosion scores between the three-thirds of the canal for the Saline group without activation group

	Score 1	Score 2	Score 3	Mean Rank
Coronal	50%	50%	0%	7.5ª
Middle	75%	25%	0%	6ª
Apical	75%	25%	0%	6ª
	0.709 ^{NS}			



Fig. (3) Erosion score distribution (in %) in the coronal, middle and apical in the saline group



Fig. (4) A representative SEM photomicrographic showing dentin erosion with score 1 in coronal third in saline group.

In NaOCl + EDTA group :

In the coronal, 25% of samples recorded score 1, while 50% recorded score 2 and 25% of the sample recorded score 3. In the middle, 75% of samples recorded score 2, while 25% recorded score 3. In the apical, 25% of samples recorded score 1, and 25% of the sample recorded score 2, and 50% recorded score 3 (Figure 5, 6).

The score means ranks were 5.75, 6.75, and 7 for coronal, middle, and apical, respectively **Table (2)**. According to Mann-Whitney test, there was no statistically significant difference between the three thirds.

Kruskal-Wallis test revealed that there was no statistically significant difference between the three thirds (p = 0.852).

Table (2) Comparison of erosion scores between the three-thirds of the canal for the NaOCl + EDTA without activation group.

	Score 1	Score 2	Score 3	Mean Rank
Coronal	25%	50%	25%	5.75ª
Middle	0%	75%	25%	6.75ª
Apical	25%	25%	50%	7ª
	0.852 ^{NS}			



Fig. (5) Erosion score distribution (in %) in the coronal, middle and apical in the NaOCl + EDTA group.



 Fig. (6) A representative SEM photomicrographic showing dentin erosion with score 3 in apical third in NaOCl + EDTA group

Intergroup comparison

<u>Coronal third:</u> As displayed into Table (3) we can conclude the following:

In the Saline group, 50% of samples recorded score 1, while 50% recorded score 2.

In the NaOCl + EDTA group ,25% of samples recorded score 1, while 50% recorded score 2, and 25% of the sample recorded score 3.

There was a statistically significant difference between all groups in the erosion score distribution in the coronal third (P = 0.048).

Table (3) Comparison of erosion score distributionbetween the four groups in the Coronal third.

Coronal	Score 1	Score 2	Score 3	Mean Rank
Saline Group	50%	50%	0%	9.75
NaOCl + EDTA Group	25%	50%	25%	15.75
P	0.048 ^s			

Middle third: As displayed in **Table** (4):

In the Saline group without activation group, 75% of samples recorded score 1, while 25% recorded score 2.

In the NaOCl + EDTA without activation group, 75% of samples recorded score 2, while 25% recorded score 3.

There was no statistically significant difference between all groups in the erosion score distribution in the middle third (P = 0.455).

Table (4) Comparison of erosion score distributionbetween the four groups in the Middle third.

Middle	Score 1	Score 2	Score 3	Mean Rank
Saline Group	75%	25%	0%	8.75
NaOCl +EDTA Group	0%	75%	25%	21.75
P.	0.455 ^{NS}			

Apical third: As displayed in Table (5)

In the Saline group, 75% of samples recorded score 1, while 25% recorded score 2.

In the NaOCl + EDTA group, 25% of samples recorded score 2, while 25% recorded score 3, and 50% recorded score 3.

There was no statistically significant difference between all groups in the erosion score distribution in the Apical third (P = 0.455).

Table (5) *Comparison of erosion score distribution between the four groups in the apical third.*

Apical	Score 1	Score 2	Score 3	Mean Rank
Saline Group	75%	25%	0%	11.8
NaOCl + EDTA Group	0%	75%	25%	22.50
P-	0.451 ^{NS}			

DISCUSSION

Dentin erosion is defined as the chemical loss of tooth substance by the action of acids without bacteria⁽⁶⁾. Chemical erosion of the teeth occurs either by the hydrogen ion derived from strong or weak acids, or by anions which interact with calcium to form calcium chelate ⁽⁷⁾. Regarding the intra-group and inter-group analysis of dentin erosion there was no significant difference between all thirds in all groups.

In NaOCl +EDTA group recorded the highest score of dentin erosion. Results of the current study are in contrast with Yoshioka et al., (8) showed the effect of NaOCl 6% alone in 1,3 minutes as final rinse and EDTA 15% in 1,3 minutes and combination between both of 6% NaOCl and EDTA in 1,3 minutes. They found that in15% EDTA group the smooth and plane appearance of dentin, however dentinal tubule orifices were regular and separated and when they combined the NaOCl and EDTA, although dentin was eroded and dentinal tubules' orifices were irregular and rough. But NaOCl +EDTA were able to remove smear layer and debris. This is can be attributed to the dissolving effect of NaOCl on the organic matrix, while and EDTA demineralized inorganic component of dentin, by using NaOCl alone exposed inorganic matrix prevent dissolution of dentin. On the other hand using EDTA alone the organic matrix accumulation on canal surface preventing dentin dissolution.

The erosion scores of the current study are in agreement with **Wang** *et al.*, ⁽⁹⁾ study, which evaluated dentin erosion by two tests; by SEM and the second by energy dispersive X-ray Spectroscopy. They found no significant difference between all thirds regarding dentin erosion. This can be attributed to using NaOC1 and EDTA which cause dentin erosion.

One of the effects of NaOCl and chelating agents is the erosion of dentin. Dentin erosion will occur due to the exposure to the acidic chelating agents. Results of current study are in contrast with **Machado** *et al.*, ⁽¹⁰⁾ who compared the effect of conventional irrigation in all samples on dentin erosion after using NaOCl followed by EDTA in a group. Erosion was recorded in intertubuler and peri-tubular dentin without significant difference of all thirds.

CONCLUSIONS

- NaOCl is still the first choice during cleaning and shaping step and consider as the main irrigant during root canal treatment.
- EDTA have a high effect on dentin and the highest scored dentin erosion
- None of the used irrigant was capable to preserve ultrastructure of dentin.

REFERENCES

- Nogueira, Brenna Magdalena Lima .Effects of Different Irrigation Solutions and Protocols on Mineral Content and Ultrastructure of Root Canal Dentine. Iran Endod J 2018;13(2):209-215.
- Saber SED, Hashem AAR. Efficacy of different final irrigation activation techniques on smear layer removal. J Endod 2011;37(9):1272-1275.
- Vianna ME, Gomes BPFA, Berber VB, Zaia AA, Ferraz CCR, De Souza-Filho FJ. In vitro evaluation of the antimicrobial activity of chlorhexidine and sodium hypochlorite. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;97(1):79-84.
- Michelich VJ, Schuster GS, Pashley DH. Bacterial Penetration of Human Dentin in vitro. J Dent Res 1980;59(8):1398-1403.
- Qian W, Shen Y, Haapasalo M. Quantitative Analysis of the Effect of Irrigant Solution Sequences on Dentin Erosion. J Endod 2011;37(10):1437-1441.
- 6. American association of Endodontists. Glossary of Endodontic Terms Ninth Edition. Gloss Endod Terms 2015;1-50.
- Francis T&. Understanding the Chemistry of Food Carbohydrates. Food Carbohydrates 2005;20:2-21.
- Niu W, Yoshioka T, Kobayashi C, Suda H. A scanning electron microscopic study of dentinal erosion by final irrigation with EDTA and NaOCl solutions. Int Endod J 2002;35(11):934-939.
- Wang Z, Maezono H, Shen Y, Haapasalo M. Evaluation of Root Canal Dentin Erosion after Different Irrigation Methods Using Energy-dispersive X-ray Spectroscopy. J Endod 2016;42(12):1834-1839.
- Machado R, da Silva I, Comparin D, de Mattos BAM, Alberton LR, da Silva Neto UX. Smear layer removal by passive ultrasonic irrigation and 2 new mechanical methods for activation of the chelating solution. Restor Dent Endod 2021;46(1):1-11.