

# Comparison between Different Endodontic Irrigation in Smear Layer Removal from Radicular Dentin - A Systematic Review

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**Abstract:** *The purpose of this study was to measure the cleaning efficiency of irrigating solutions used during root canal treatment regarding smear layer removal from the root canal dentin walls by three different irrigation solution (Ethylenediaminetetraacetic acid (EDTA) 17%, citric acid 10% and sodium hypochlorite (NaOCl) 2, 5 %) were tested as final irrigating solutions. The study was done on forty extracted teeth, divided in four groups according to the irrigation protocol used. The samples were analyzed by scanning electron microscopy and the amount of smear layer present at apical, middle and coronal level was recorded, based on a scoring system. The data were statistically analyzed using Kruskal - Wallis and Friedman test and the level of significance was set at  $p < 0.05$ . In the coronal and middle segments of dental roots we noticed no statistically significant difference between EDTA and CA in smear layer removing capacity. Final irrigation with 17% EDTA proved to be more efficient than 10% CA and 2, 5% NaOCl in smear layer removal at apical level of the root canal, with  $p < 0.05$  ( $p = 0.042$ ), which is an important area for disinfection in endodontic treatment.*

**Keywords:** Chelating agents, smear layer, scanning electron microscope, radicular dentin

## 1. Introduction

The main goal in endodontic therapy is to remove infected dental pulp and debris by chemo - mechanical preparation, as the clinical success of root canal treatment is based on proper instrumentation, disinfection and hermetic filling of the root canal. During this process, a special complex of organic and inorganic debris is formed on the radicular dentin surface as a result of endodontic treatment, named smear layer (1, 2). The irrigating solutions used for Cleaning the root canal contain sodium hypochlorite (NaOCl) solution 2, 5 - 5, 25% combined with a chelating agent, but the best sequence of solutions is still a reason of debate and controversy in the scientific literature (3). The use of NaOCl 5, 25% and EDTA 17% had been proposed as an excellent irrigation protocol, which effectively removes debris and smear layer (4). Also, it is an artificial amino acid with a pH 7, biocompatible and with a reduced antibacterial effect, based on the inhibiting effect on bacterial growth by chelating with metallic ions used in their metabolisms (5, 6). EDTA can be used in combination with a surfactant to remove calcifications from the pulp chamber or obliterated root canals, allowing proper cleaning and shaping. Another chelating agent is citric acid 10% that has been proposed to be exert a good capacity of smear layer removal (6). The aim

of our study was to compare the effectiveness of EDTA, NaOCl and citric acid in smear layer removal from infected root canals after different endodontic irrigating protocols.

## 2. Material and methods

Forty humans freshly extracted necrotic teeth were used. All samples were stored informal in solution for 1 - 2 days and instrumented by using step – back technique with K files (Dentsply - Maillefer, Ballaigues, Switzerland) up to size #40 with NaOCl 5, 25% irrigation after each file, followed by 5 ml of saline solution. The samples were divided in 4 study groups: Group I: EDTA 17%, Group II: citric acid 10%, Group III: NaOCl 5, 25% and Group IV: saline solution (control group). For the scanning electron microscopy evaluation, longitudinal grooves were made on the surface of the crown and root using a low speed hand piece with diamond disk without penetrating the canal. The roots were split in half with a sharp blade and were coded according to the protocol used and the specimens were examined using a scanning electron microscopy at x1000 and x750 magnification at the coronal, middle and apical thirds, based on a graded scale from 1 - 3 which scale 1: complete removal of smear layer (open dentin tubules), scale 2: moderate smear layer (partially opened tubules) and scale 3:

dentin surface completely covered with smear layer, in order to assess the quality of smear layer removal. Photomicrographs of the examined areas were taken and evaluated by two independent observers in a double-blind Social Sciences (SPSS) version 16.0 for Windows. Non-parametric data of smear layer scores were presented as a percentage distribution and the mean ranks were calculated for each root section. The Kruskal-Wallis test was used to compare between final irrigation solutions at each section between study groups and Friedman test was used to compare between root canal thirds at each group. The significance level was set at  $p < 0.05$ .

### 3. Results

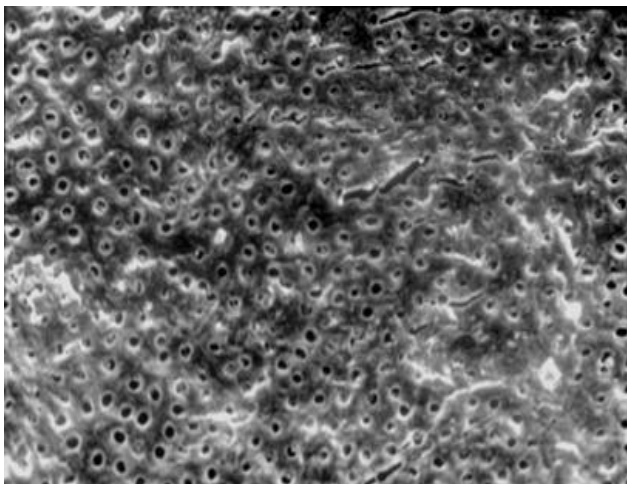
Based on Kruskal-Wallis test, there were no statistically significant differences between EDTA and citric acid except

for the apical thirds of the root canal which citric acid proved to be more efficient in removing the smear layer with  $p < 0.05$  ( $p = 0.042$ ). The mean scores of smear layer removal for all study groups and the control are presented in Fig. 1-2 and Table 1. These show the ability of chelating agents to remove debris efficiently in the coronal and middle thirds of the root canal.

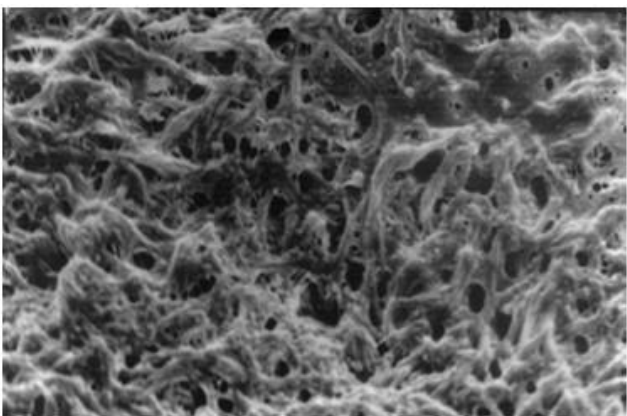
In the apical part, citric acid proved to have more better cleaning when compared to EDTA and CHX. The Friedman test had shown statistically significant differences within EDTA and citric acid groups regarding the degree of smear layer removal from canal with a  $p < 0.05$  ( $p = 0.008$  and  $p = 0.006$  respectively).

**Table 1:** Mean scores of smear layer removal from the radicular dentin wall.

Study group/ Root area	Coronal third Mean (+/- SD)	Middle third Mean (+/- SD)	Apical third Mean (+/- SD)	p - value
Control (saline)	3.0 +/- 0.0	3.0 +/- 0.0	3.0 +/- 0.0	P=1 ( $p > 0.05$ )
EDTA	1.3 +/- 0.68	1.4 +/- 0.56	2.6 +/- 0.48	P=0.008 ( $p < 0.01$ )
citric acid	1.2 +/- 0.80	1.1 +/- 0.88	1.78 +/- 0.24	P=0.006 ( $p < 0.01$ )
Chlorhexidine	3.0 +/- 0.0	3.0 +/- 0.0	3.0 +/- 0.0	P=1 ( $p > 0.05$ )



**Figure 1:** Photomicrograph showing complete removal of the smear layer from the radicular dentine, citric acid group, (score 1).



**Figure 2:** Image from CHX group, with smear layer present on the dentin wall (score 3).

### 4. Discussion

Instrumentation of root canal produces a layer of organic and inorganic material called smear layer that may contain bacteria and their by-products. In endodontic treatment it has many disadvantages as it prevents the penetration of intracanal medicaments into dentinal tubules and disrupts the seal between the dentin walls and root filling that may lead to treatment failure (7). Cleaning of root canal is extremely important and NaOCl 5, 25% solution is considered to be the gold standard in endodontic irrigating protocols because of its very good tissue dissolving effect and has been suggested to degrade micromechanical characteristics of root dentin. In addition, it is toxic to apical tissue and has no effect on the inorganic component of the smear layer during instrumentation and the use of a chelating agent facilitates the smear layer removal (8). Another important irrigant is CHX, a cationic polybiguanide which can be used due to the antimicrobial activity and its unique property called substantivity. Until now, using chelating agents was mostly by irrigation with EDTA, which has been tested in different concentrations and for different time periods (9). The disadvantages were lack efficiency in the apical area and dentinal erosion in the middle and coronal part of the root. Previous studies had shown that there is no significant difference between citric acid and EDTA regarding the capacity of smear layer removal, but both disclosed a limited antibacterial effect (10, 11, 12) examined smear layer removal with different solutions and found that EDTA and citric acid had comparable effectiveness. Our results showed that 5, 25% NaOCl and 2% CHX did not promote an adequate cleaning of root canal dentin with a great amount of smear layer present. Previous studies had demonstrated that CHX 2% solution could be an effective endodontic irrigant, it could maintain the canal free of microorganisms but few studies had shown its cleaning

capacity. The present study was carried out on extracted teeth and therefore the results do not allow a definite conclusion regarding the effects of chelating solutions used in situ. The presence of blood and tissue fragments, together with other variables may influence the action of these chemical agents under use in the root canal system. Therefore, more long - term clinical studies are necessary in order to confirm these results and to evaluate their relevance to dental endodontic practice.

## 5. Conclusion

The apical part of root canal takes a special attention during irrigation as the borderline between safety and effectiveness is important in this area. The final irrigation of the root canal with 10% citric acid is more efficient than 17% EDTA in smear layer removal at apical level. The chelating agents used especially EDTA exhibited an important decalcifying effect, therefore the risk of dentin erosion should be taken into consideration.

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