Decalcifying Effect of Three Chelating Agents

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ABSTRACT

Background and Objectives: The objective of my study is to determine the efficacy of 17% EDTA plus 1.25 % sodium lauryl ether sulfate (EDTA-T), 10% Citric acid and 17% EDTA with respect to calcium ion extraction from the root canal dentin.

Method: The study sample comprises of 90 freshly extracted permanent human maxillary incisors. Access cavity is prepared in all the teeth. A step back method of biomechanical preparation is done. The last instrument to be used in the apical third is K-file no. 40 and in the middle and coronal third K-file no. 80 is used. At the change of each instrument, 2 ml of sodium hypochlorite irrigating solution is used for irrigation. The final irrigation is done by dividing the samples into nine groups. Final irrigation is done for 3 minutes, 10 minutes and 15 minutes with 20 ml of the irrigation solutions, EDTA-T, 10% Citric acid and 17% EDTA. The solution is collected in a container after the required time periods for each group and calcium concentration in the solution used for final irrigation is determined by using atomic absorption spectroscope. The values are recorded and the data is statistically analyzed using one-way ANOVA for multiple group comparisons followed by Newman-Keul’s range test for pairwise comparisons, with level of significance as 5%.

Results: 10% citric acid showed maximum amount of calcium extracted. 17% EDTA also showed calcium extraction similar to citric acid but comparatively less. EDTA-T showed least amount of calcium extraction, though it had the best penetrability of 17% EDTA because of the presence of surfactant 1.25% sodium lauryl ether sulfate.

Interpretation and Conclusion: Overall, the maximum decalcification of the root canal with respect to calcium ion extraction was seen with 10% citric acid.

Key words: biomechanical preparation, final irrigation, decalcification, calcium extraction, chelation.

INTRODUCTION

The success of endodontic treatment is mainly dependant on thorough cleaning and shaping of root canal system. A clean root canal system along with a three dimensional seal is the clinician’s road to success. In endodontics smear layer results directly from instrumentation used to prepare the canal wall. Because the tooth structure is cut, instead of being uniformly sheared, the mineralized matrix shatters and forms smear layer, which is scattered over the dentinal surface. McComb and Smith were the first to report the presence of smear layer on root canal walls. The smear layer is an amorphous structure composed of an organic portion, that is coagulated proteins, necrotic and normal pulpal tissue, saliva, microorganisms, etc. and an inorganic portion that is minerals from the dentinal structure. Thus, adequate removal is not possible only by sodium hypochlorite but a chelating agent is required for removal of inorganic dentin. Ostby, found that EDTA reduced the time necessary for debridement, aided in enlarging narrow or obstructed canals. The
solution is neither bactericidal nor bacteriostatic, but it inhibits the growth of eventually destroyed bacteria by the process of starvation. EDTA is generally effective at pH of 7.2. In endodontics, citric acid is widely accepted as an irrigant, showing its biocompatibility compared to EDTA and effective smear layer removal. Yamaguchi et al, proposed citric acid as an endodontic irrigant. Goldman et al, reported the effects of removal of smear layer obtained with citric acid were similar to those by EDTA. Citric acid is less cytotoxically irritable to tissue than EDTA. Smith and Wayman concluded that the smaller the concentration of citric acid solution, the smaller the antimicrobial effect of citric acid is related to its low pH, which promotes the denaturation of proteins. Citric acid has also been shown to be effective on anaerobic microorganisms. Pavia and Antoniazzi first recommended the association of Tergentol (sodium lauryl ether sulfato) with Furacin later with EDTA. It is believed that addition of a surface-active agent, Tergentol could stimulate a reduction in its surface tension and wettability and improve its penetration into the uninstrumented areas of root canal system. Although 1.25% sodium lauryl ether sulfate with 17% EDTA did not allow calcium removal with same intensity as EDTA, but further research is still being carried out in respect to EDTA-T. The purpose of my study is to determine the efficacy of EDTA-T, 10% Citric acid and 17% EDTA with respect to calcium ion extraction from the root canal dentin.

METHODOLOGY

The experimental method consisted of ninety freshly extracted maxillary incisors collected. After extraction, the teeth were rinsed in tap water to remove the attached soft tissue and stored in deionized water (pH7), till the time of experimental study. All experimental teeth are cleaned and dried in a desiccator for 1 hour. Access opening was done for all the selected teeth. A high-speed handpiece was used with a no.4 round bur on the lingual side, at the middle third of the tooth. Biomechanical preparation was done using step back technique of instrumentation in all ninety teeth. The last instrument to be used in the apical third is K-file no. 40 and in the middle/coronal third is K-file no. 80. At each instrument change, 2ml of NaOCl is used for irrigation. For final irrigation, the groups were divided as follows,

Group 1 : 20 ml of EDTA-T for 3 minutes.
Group 2 : 20 ml of 17% EDTA for 3 minutes.
Group 3 : 20 ml of 10% citric acid for 3 minutes.
Group 4 : 20 ml of EDTA-T for 10 minutes.
Group 5 : 20 ml of 17% EDTA for 10 minutes.
Group 6 : 20 ml of 10% EDTA for 10 minutes.
Group 7 : 20 ml of EDTA-T for 15 minutes.
Group 8 : 20 ml of 17% EDTA for 15 minutes.
Group 9 : 20 ml of 10% citric acid for 15 minutes.

The solution was collected in a container after the required time periods for each groups and the calcium concentration in the solution used for final irrigation was determined by using atomic absorption spectroscope. Descriptive data are presented as mean, standard deviation, standard error and range values. One-way ANOVA is used for multiple group comparisons followed by Newman-Keul’s range test for pairwise comparisons. A P-value of 0.05 or less was considered statistically significant.

RESULTS

In all the solutions the calcium extraction is
seen to be highest in the first 10 minutes. At fifteen minutes the calcium ion extract readings are less, showing that the maximum effect is at early time periods, showing the time dependant effects. Overall, citric acid has maximum efficacy in terms of calcium extraction. EDTA-T solution has the least efficacy in terms of calcium ion extraction at the three different time intervals, when compared with 10% citric acid and with 17% EDTA. At 3 minutes there is a significant statistical difference between EDTA-T and 10% citric acid and between EDTA-T and 17% EDTA. All recording done has a P-value less than 0.01.

**DISCUSSION**

10% citric acid has shown to have the highest amount of calcium extraction in comparison to 17% EDTA and EDTA-T at all three time intervals. Citric acid compared to EDTA is as good a chelating agent. The 10% solutions with a pH of 1.8 are effective in removal of smear layer. The maximum decalcifying effect was seen between 3 and 10 minutes. The probable reasons for this could be as it forms complex with calcium of tooth which is greater than that of EDTA. It is biocompatible to the tissues, helps in cementum formation and periodontal tissue regeneration. It is also economical compared to EDTA and at concentrations used in dentistry it has antimicrobial effect. Though citric acid has proved itself by my study to be the most effective in terms of calcium ion extraction out of the three solutions, yet it is not preferred to be used in dental clinics because it precipitates in the canal to form crystals, which may harbor microorganisms and hamper the effective three dimensional seal. It has a disagreeable odor and sour taste. EDTA-T extracted the least amount of calcium from root dentin compared to 10% citric acid and 17% EDTA at the three times it has shown an increase in permeability at the apical level and association of 1.25% sodium lauryl ether sulfate with 17% EDTA did not allow the chelation of calcium ions with same intensity as EDTA used alone. EDTA-T has been used for better penetration of 17% EDTA into the dentinal tubules by use of
the surfactant Tergentol (1.25% sodium lauryl ether sulfate) which reduces the surface tension and increases wettability of the uninstrumented areas and helps remove smear layer. 17% EDTA though an efficient chelating agent, but according to my study, supported by various authors it should be placed second in line of use after 10% citric acid. It showed similar effects to citric acid. At 3 minutes there was a slightly more decalcification of 17% EDTA than 10% citric acid, abut at 10 and 15 minutes citric acid showed more decalcification than EDTA. This could be as EDTA causes necrosis of pulp remnants, inflammatory reaction of periapical tissues, toxicity has been shown at 17% concentrations, its leakage to periapical tissues inhibits macrophage function, it has also shown time dependant effect, causing erosion of peritubular and intertubular dentin. Ostby proposed the use of EDTA because, it has certain dentin dissolving effects, reduces time necessary for debridement, aids in enlarging narrow or obstructed canals, helps make possible the bypassing of broken instruments in canals, it is self-limiting and shows no corrosive effect on instruments. Overall, if we think in terms of calcium extraction, 10% citric acid is an ideal solution. But thinking in terms of an efficient smear layer removal and patient comfort, out of the three solutions EDTA is the most ideal.

CONCLUSION

The following conclusions have been drawn from my study,

1) Least amount of calcium ion extraction at the three time intervals is seen with EDTA-T.

2) EDTA-T shows most efficient penetration into the root canal dentin, because of the surfactant, sodium lauryl ether sulfate present which decreases surface energy thus increasing the wettability of EDTA and its better penetrability.

3) Calcium extraction with 10% citric acid and 17% EDTA was statistically similar with respect to efficacy. Thus, both can be recommended as good decalcifying agents.

4) In dental clinics because of its crystal precipitation in the root canal that harbors microorganisms and prevents an effective three dimensional seal, sour taste and disagreeable odor, citric acid is not preferred as a final irrigant. EDTA is generally used as it has a decalcification action, though comparatively less than citric acid but efficient in final irrigation.

BIBLIOGRAPHY


