Evaluation of the Effect of Different Concentrations of Citric Acid Irrigation on Smear Layer Removal and Dentin Structure.

(An in vitro study)

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DEDICATION

To all my family, and my friends who helped me to accomplish this work

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Introduction

Endodontic success depends mainly on effective chemomechanical debridment of the root canal through the use of proper instruments and irrigating solutions. The inherent complexity and irregularity of the root canals make the mechanical instrumentation inadequate to plane all the walls and produce a clean canal. These irregularities in dentin provide the temples in which bacteria live, and the tags of the pulp tissue provide the feasts on which they thrive. Therefore, reliance is placed upon irrigation to chemically clean the ramifications and flush debris away.

Recently the importance of irrigation is stressed upon with the advent of the new mechanized instrumentation techniques that always recommend working in wet canals. However, as a concept, irrigation is the maneuver that not only mechanically washes out debris but also simultaneously exerts an antiseptic action on the canal walls and a dissolving action on the retained debris.

After mechanical instrumentation of the root canal surface, a smear layer is present. It is characterized by its amorphous structure that obscure the underlying dentin surface. Smear layer harbors bacteria. Its removal exposes the dentinal tubules and provides a network for adhesive resin tag formation within the dentinal tubules and the anastomosing of lateral canals, which may be fundamental to the development of a stronger adaptation, adhesion and dentin/resin bond ***(Chappell et al,. 1994).***

Sodium hypochlorite NaOCl irrigation used during root canal therapy does not remove the smear layer alone. The challenge is to remove the smear layer, without significantly changing the structure of dentinal walls. Chelating agents as Ethylenamine tetra acetic acid EDTA or demineralyzing agents as citric acid are used to remove the smear layer.

The recommended regimen to remove the smear layer is a final flush with EDTA followed by NaOCl. EDTA is, however, not antibacterial and erodes the dentin if the exposure time exceeds one minute ***(Çalt and Serper, 2002 a).***

Citric acid has been shown to remove the smear layer after cavity preparation, it demineralizes the treated surface, and elutes bacterial endotoxins from pathologically altered cementum surfaces ***(Labahn et al,. 1992).***

The usefulness of citric acid solution has provided the motivation to conduct this study to evaluate its effectiveness at different concentrations in removing the smear layer. Also the effect of citric acid on dentin structure was observed.

Aim of the study

The aim of the present investigation was to:

1-Evaluate and compare the ability of different concentrations of citric acid solution and EDTA to remove debris and smear layer.

2- Evaluate and compare the effect of different concentrations of citric acid solution and EDTA on dentin structure.

Review of literature

Without root canal irrigation, instruments become quickly ineffective due to debris accumulation. Currently, there is no single irrigant that can fulfill all the ideal requirements and, at best, we need to rely on a combination.

Ideally, an irrigant should be a tissue or debris solvent, have a low toxicity level, low surface tension (in order to flow into inaccessible areas), be an effective lubricant, be able to effectively sterilize the root canals (or at least disinfect them), and be able to remove the smear layer. It should be easily used, convenient, have adequate shelf life, and easily stored.

Effect of different irrigants on smear layer removal and dentin structure:

Frithjof et al., (1963) compared the demineralizing effect of ethylene diamine tetraacetic acid + Cetavlon (EDTAC) and 50% sulfuric acid (H_2SO_4) after their application to dentin for different periods of time. They found that EDTAC was very effective at removing the inorganic portion after 5 minutes, while H_2SO_4 was inefficient.

Seidberg and Schilder (1974), made an investigation to quantitate the chemical process of chelation of dentin by ethylene diamine tetraacetic acid (EDTA). Extracted human teeth were collected at random from various age groups, and the root portion were crashed and powdered. The dentin was dried overnight in an electric oven. One tenth gram of powdered dentin was subjected to the chemical action of fresh

solutions of 0.5M EDTA, four consecutive times over a 7-hour period. The result showed that 73% of the inorganic portion of dentin could be chelated.

McComb et al., (1976) instrumented vital and non vital teeth using distilled water, 1% and 2% sodium hypochlorite NaOCl, 5% and 10% polyacrylic acid, and 6% EDTAC, during and after instrumentation. Scanning Electron Microscopic SEM results confirmed the inability of NaOCl to remove the smear layer, while EDTA produced the cleanest canals in cervical and middle regions; however, this was not always consistent apically, with gross debris occasionally present.

Ram (1977) compared with the SEM the cleaning effect of three chelating agents (EDTAC, RC-Prep, Salvizol) when applied in large amounts to instrumented and noninstrumented canal walls. It was found that reaming with 15% EDTAC with immersion for 24 hours resulted in smooth clean walls, free of smear layer and superficial debris, and that RC-Prep or Salvizol groups were covered with large quantities of debris.

Kaufman et al., (1978) compared the cleaning ability of 0.5% Salvizol or EDATC after each instrument. Following mechanical preparation up to #40, the root canals were rinsed with 5 ml of the tested solution. SEM results of teeth prepared with EDTAC revealed clean and smooth walls in coronal and middle thirds with some scattered debris and no smear layer. While in the apical third a cluster of debris and organic material were seen. Salvizol proved to be a superior cleaning agent.

Pashley et al., (1981) examined the SEM appearance of dentin before and after sequentially removing successive layers of the smear layer with brief time of application (5, 15, 30, 45 and 60 sec) of 6% citric acid and correlated the effects of these maneuvers on dentin permeability

in vitro. Twenty dentin disks were cut from extracted human third molars. The disks were treated with the test solution for the different time intervals followed by immediate rinsing off. They concluded that the use of dilute (6%) citric acid for very short time as little as seconds interval permitted sequential removal of the smear layer on human dentin and exposed the orifices of the dentinal tubules. They also concluded that dentin permeability increased rapidly during acid etching with 6% citric acid, reaching a maximum value only after 15 sec of etching.

Yamada et al., (1983) tested the efficacy of instrumenting the root canal with 1 ml of 5.25% NaOCl solution between each instrument and final flushing with 20 ml of various solutions or combinations of solutions: physiologic saline solution, 5.25%NaOCl, 8.5% EDTA, 17 % EDTA, and 25% citric acid. Forty recently extracted, human teeth with relatively straight canals were used.The SEM showed that a final flush with 10 ml of 17% EDTA buffered to pH 7.7 followed by 10 ml of 5.25% NaOCl solution was the most effective in smear layer removal.

Baumgartner JC., (1984) used a scanning electron microscope and a rank-ordered scoring system to evaluate statistically the amount of superficial debris and the smeared layer that remained on the canal wall following root canal preparation with six different debridement regimens. Regimens which used citric acid or a combination of NaOCl and citric acid for irrigation were more effective than NaOCl alone in removing the smear layer from the surface of the prepared root canal walls.

Baumgartner and Cuenin (1992) evaluated the debridement capabilities of several concentrations of NaOCl (5.25%, 2.5%, 1.0%, and 0.5%) using SEM. Two pairs of teeth were used as controls. NaOCl was delivered with either an endodontic irrigation needle or an ultra-sonic