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Effect of Three Irrigating Solutions on Removal of Smear Layer: A Sem Study

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INTRODUCTION

The success of endodontic treatment depends on the eradication of microbes from the root canal system and prevention of re-infection. The root canal is shaped with hand and rotary instruments under constant irrigation to remove the necrotic tissue ,microbes/ bio films , and other debris from the root-canal space[1].It is impossible to create a sterile space in infected root canals with mechanical preparation alone because of complexity of root canal system[2-4].Pulpal tissue remnants and inorganic debris remain even in well- shaped canals, especially in those areas in which the instruments do not come in contact with the canal wall[5].

The amount of residual tissues is much more in canals that are treated without irrigation than those in which root canal irrigants are used[6].The main goal of instrumentation is to facilitate effective irrigation, disinfection and fillings. The irrigants facilitate removal of microorganisms, tissue remnants, and dentin chips from the root canal though a flushing mechanism.

All contemporary methods of root canal instrumentation produce a layer of organic and inorganic material called the smear layer. The smear layer produced during root canal instrumentation consists of dentin debris, pulpal remnants, microorganisms and fragments of odontoblastic processes[8].This layer covers the instrumented wall and prevents the penetration of intracanal medicaments into the dentinal tubules and interferes with the close adaptation of root fillings. The smear layer is potentially infected, and its removal allows more efficient penetration of intracanal medications into the dentinal tubules and a better interface between the filling material and the root canal walls[9].

The removal of debris and smear layer from the root canal system prior to obturation is one of the primary aims of endodontic treatment[10].The quantity of smear layer removed by an irrigant is related to its pH and time of exposure (Morgan and Baumgartner, 1997). A number of chemicals have been investigated as irrigants to remove the smear layer. The gold standard irrigant is still sodium hypochlorite. Different concentrations of sodium hypochlorite have been used as root canal irrigant for the past several decades because of its well-known antimicrobial action and its ability to dissolve tissue. However, its capacity to remove smear layer from the instrumented canal is lacking

as it does not affect the inorganic part of the smear layer. Smear layer removal requires a combination of sodium hypochlorite (an organic solvent) and substances active on inorganic compounds, including chelating agents (EDTA or REDTA) or acids (orthophosphoric, polyacrylic, tannic, maleic or citric acid) to remove both organic and inorganic components.

Baumgartner and Mader found that alternating solutions of EDTA with sodium hypochlorite was the most effective combination to produce clean root canal walls. Their study demonstrated the importance of using a chelating agent such as EDTA in combination with sodium hypochlorite, to effectively remove the inorganic and organic component of smear layer.[11] Yamada et al found that a final rinse with 10ml of 17% EDTA followed by 10ml of 5.25% of sodium hypochlorite was the most effective method to remove smear layer.

An aqueous solution of citric acid (a weak organic acid) has been advocated for smear layer removal. Citric acid effectively dissolves inorganic material including hydroxyapatite but it has little or no effect on organic tissue. Thus it has to be used in combination with sodium hypochlorite for effective removal of smear layer; Citric acid is marketed in various concentrations ranging from 1% to 50% with 10% solution being the most common.

An experimental antimicrobial root canal irrigant QMiX containing a mixture of a bisbiguanide antimicrobial agent, a poly amino carboxylic acid calcium–chelating agent, saline, and a surfactants[12] have been found to be more effective irrigant than BioPure MTAD against bacterial biofilms[13].

Introduction of the scanning electron microscope (SEM) has proved to be a valuable method for assessment of the ability of the endodontic procedures and irrigants to remove debris and smear layer from the root canals, thus enabling scientific basis for comparison of activity of different irrigating solutions[14].

As none of the previous studies have evaluated the ability of QMiX, Citric acid and EDTA in removing canal wall debris and smear layer, the present study will be conducted to evaluate the effect of three irrigating solutions, on removal of canal wall debris and smear layer using scanning electron microscope.

AIM

To evaluate the effect of three irrigating solutions on the removal of smear layer from the coronal third, middle third and apical third of the root canals.

OBJECTIVES

1. To evaluate the effectiveness of QMix (Dentsply Tulsa Dental Specialities) in removing smear layer.
2. To evaluate the effectiveness of freshly prepared 17% EDTA in removing smear layer.
3. To evaluate the effectiveness of freshly prepared 10% Citric acid in removing smear layer.
4. To compare the effectiveness of QMiX, freshly prepared10% EDTA and freshly prepared 10% Citric acid in removing smear layer.

MATERIALS

This study was conducted in the Department of Conservative Dentistry and Endodontics at I.T.S. Centre for Dental Studies and Research, Muradnagar, Ghaziabad in collaboration with Jawaharlal Nehru University, New Delhi to study the effect of three irrigating solutions on removal of smear layer.

ARMAMENTARIUM

Selection of the samples

1. Endodontic microscope (Global Surgical Corporation, St. Louis, MO, USA)
2. Radio Visio Graphy (RVG)

Preparation of the sample

1. Diamond cutting disc (Microsaw; Dentsply Friadent, Mannheim, Germany)
2. Irrigation syringe 27- Navi tip needle (Prime dental PVT LTD)
3. Hammer
4. Chisel
5. Mandrel
6. Micro-motor (NSK) with contra-angle hand piece.
7. Digital Vernier calliper

Instrumentation of the canal

1. K files - # 10 to # 15 (Dentsply, Maillefer, Ballaigues, Switzerland)
2. ProTaper files (Dentsply, Maillefer, Ballaigues, Switzerland)

Evaluation of samples

- Scanning electron microscope
- Aluminium stubs

MATERIALS REQUIRED

Selection of samples

1. Chloramine-T (Halides chemical PVT.LTD)

Irrigating solutions

1. QMiX (Dentsply Tulsa Dental Specialities) solution.
2. 5 % NaOCl (Organo Biotech Laboratories PVT.LTD) solution.
3. Freshly prepared 17%EDTA solution.
4. Freshly prepared 10% Citric acid solution.
5. Distilled water.

Materials for evaluation

1. Ascending grades of alcohol (30%, 50%, 70%, 90%, and 100%).

Figure 1: Irrigant used

METHODOLOGY

For this study, forty freshly extracted human single rooted permanent teeth with straight single canals and fully developed apices, indicated for extraction due to periodontal reasons, prosthetic reasons or orthodontic treatment, were collected from the department of oral and maxillofacial surgery, I.T.S Centre for dental studies & research, Muradnagar, Ghaziabad.

Specimen selection

Teeth exhibiting only one canal which was confirmed by X-rays were taken for study. They were examined under operating microscope to rule out the presence of cracks or fractures. Teeth showing evidence of resorption, caries, and restorations and with dilacerated or calcified roots were excluded from the study. The teeth were then stored in Chloramine-T

Specimen preparation

The crown portion of all forty teeth was removed using a carborundum disc and the coronal part of the root was trimmed to 15mm in length (measured with Vernier calliper) from the root apex.

The working length was established by inserting a size 15k- file into the canal until the tip of the file was just visible at the apical foramen and then deducting 1mm from that length. The teeth with canals patent to size more than the size 15k- file were discarded. To resemble the clinical situation, a closed system was created by coating each root with soft modelling wax. The coating sealed the apical foramen and lateral canals. A shallow horizontal groove was made in the coronal 1/3rd of each root for mechanical retention and then placed in a plastic container filled with a rubber base impression material to mimic periodontal support.

Biomechanical preparation of root canal

Biomechanical preparation of the canal was done using hand protaper instruments starting with S1 instrument to prepare the coronal third of the canal, followed by S2 instrument for the middle third till the desired working length of 15mm. this was followed by use of finishing files F1and F2 and F3 sequentially to get desired apical preparation of no 30. Preparation was done under constant irrigation with 1 ml of 5 % NaOCl after each instrument used. Each canal was dried using size 30 paper points

Preparation of irrigating solutions

Preparation of freshly prepared 17% EDTA (pH=7.3)

17 g of disodium salt of EDTA (LR-GRADE ,CDH company) was dissolved in 100 ml of Aqua distilled water then 9.25 ml of 5M sodium hydroxide was added into the solution to make 17% EDTA.

Preparation of 10% citric acid

10g of citric acid (Fisher scientific, India) was dissolved in 100 ml of distilled water to make 10% citric acid

QMiX

QMiX solution supplied by manufacturer (QMiX (Dentsply Tulsa Dental Specialities) was used as such.

Grouping of samples

Forty samples were then randomly divided into three experimental groups and one control group and irrigation was done according to the following regimes

- Group 1 (n=10): Initial rinse with 5 ml of 5%NaOCl for 2 mins and final rinse with 5 ml QMiX for 2 mins.
- Group 2 (n=10) : Initial rinse with 5 ml of 5% NaOCl for 2 mins and final rinse with 5 ml of freshly prepared17% EDTA for 2 mins.
- Group 3 (n=10) : Initial rinse with 5 ml of 5% NaOCl for 2 mins and final rinse with 5 ml of freshly prepared 10% citric acid for 2 mins.

- Group 4 (n=10) : Initial rinse with 5 ml of NaOCl for 2 mins and final rinse with 5 ml of sterile distilled water for 2 mins.

Scanning Electron Microscopy

Samples were grooved longitudinally in bucco-lingual direction with the help of a safe-sided cutting disc under copious irrigation with distilled water and then split with the help of chisel. The samples were dried in various grades of alcohol (30%, 50%, 70%, 90% and 100%). The samples were mounted on aluminum stubs and sputter coated uniformly with a thin film of gold and viewed under scanning electron microscope. Samples were studied for smear layer and debris at apical (0-5mm), middle (5-10mm), and coronal (11-15mm) portions of the root halves derived from each fractured root.

PHOTOMICROGRAPHS

Four photomicrographs were taken at standardized magnification 2500 X at apical (0-5mm), middle (5-10mm), and coronal (11-15mm) portions of the root halves derived from each fractured root.

SCORING SYSTEM

A 4 category scale system was used for smear layer removed.

SCORE 1.presence of smear layer that cover 0-25% of the surface examined.

SCORE 2.presence of smear layer that cover 25-50% of the surface examined.

SCORE 3.presence of smear layer that cover 50-75% of the surface examined.

SCORE 4.presence of smear layer that cover 75-100% of the surface examined.

The mean score of the four photographs was taken as the score for a particular level of that sample. Similarly scoring was done for all the ten samples and mean smear layer score of ten samples of each group was calculated at each level.

The data collected was subjected to statistical analysis

Table 3: Multiple comparison of smear scores at coronal third in groups

Groups	Z	'p' value
10%Citricacid vs 10%EDTA	-2.238	0.025
10%Citric acid vs QMiX	-2.238	0.025
10%Citric acid vs Control	-4.110	0.000
17%EDTA vs QMiX	-0.000	1.000
17%EDTA vs Control	-3.990	0.000
QMiX vs Control	-3.990	0.000

To compare the smear score at coronal third level between two groups we have applied Mann-Whitney U test. By Mann Whitney U test the value of Z 10 % citric acid and 17% EDTA is – 2.238 is significant, p= 0.025 ($p<0.05$), the value of Z 10 % citric acid and QMiX is – 2.238 is significant, p= 0.025 ($p<0.05$) and the value of Z 10 % citric acid and Control is – 4.110 is significant, p= 0.000 ($p<0.05$).So, we found the smear score of 10% citric acid is significantly smaller in coronal third than the other groups.

The value of Z 17%EDTAand control – 3.990 is significant, p= 0.0000 ($p<0.05$). The value of Z QMiX and control – 3.990 is also significant, p= 0.0000 ($p<0.05$), while the value of Z 17%EDTAand QMiX– 0.000 is not significant, p= 1.0000 ($p>0.05$).

Table 4: Multiple comparison of smear scores at Middle third in groups

Groups	Z	'p' value
10%Citric acid vs10%EDTA	-2.260	0.024
10%Citric acid vs Qmix	-2.711	0.007
10%Citric acid vs Control	-4.065	0.000
17%EDTA vs Qmix	-0.449	0.654
17%EDTA vs Control	-4.021	0.000
Qmix vs Control	-4.069	0.000

By Mann Whitney U test the value of Z 10 % citric acid and 17% EDTA is – 2.260 is significant, p= 0.024 ($p<0.05$), the value of Z 10 % citric acid and QMiX is – 2.711 is significant, p= 0.007 ($p<0.05$) and the value of Z 10 % citric acid and Control is – 4.065 is significant, p= 0.000 ($p<0.05$).So, we found the smear score of 10% citric acid is significantly smaller in middle third than the other groups.

The value of Z 17%EDTAand control – 3.990 is significant, p= 0.0000 (p<0.05). The value of Z QMiX and control – 3.990 is also significant, p= 0.0000 (p<0.05), while it was found that the value of Z 17%EDTA and QMiX is – 0.449 is non significant, p= 0.654 (p>0.05)

Table 5: Multiple comparison of smear scores at apical third in three groups

Groups	Z	'P' value
10%Citric acid vs10%EDTA	-3.259	0.001
10%Citric acid vs QMiX	-3.502	0.021
10%Citric acid vs Control	-4.104	0.000
17%EDTA vs QMiX	-0.702	0.483
17%EDTA vs Control	-3.162	0.002
QMiX vs Control	-2.854	0.004

By Mann Whitney U test the value of Z 10 % citric acid and 17% EDTA is – 3.259 is significant, p= 0.001 (p<0.05), the value of Z 10 % citric acid and QMiX is – 3.502 is significant, p= 0.021 (p<0.05) and the value of Z 10 % citric acid and Control is – 4.104 is significant, p= 0.000 (p<0.05).So, we found the smear score of 10% citric acid is significantly smaller in Apical third than the other groups,

The value of Z 17%EDTAand control – 3.162is significant, p= 0.002 (p<0.05). The value of Z QMiX and control – 32.854 is also significant, p= 0.004 (p<0.05), while it was found that the value of Z 17% EDTA and QMiX is -0.702 non significant=0.483(p>0.05)

Data was tabulated and subjected to statistical analysis.

The results of present study were as follows:

- The mean of smear score in 10% Citric acid group are 1.2, 1.3, and 1.6 at coronal, middle and apical third respectively.
- The mean of smear score in 17% EDTA group are 1.8, 1.9, and 3.2 at coronal, middle and apical third respectively.
- The mean of smear score in QMiX group are 1.8, 2and 3.4 at coronal, middle and apical third respectively.
- The mean of smear score in control group are 3.9, 3.9 and 4 at coronal, middle and apical third respectively.

The order of smear layer removal efficacy was citric acid> EDTA=QMiX> control group.

Within the limitation of this in-vitro study the following conclusion can be drawn from the results of this study.

1. All the irrigants showed statistical significant better smear layer removal then control (distilled water) group.
2. Citric acid (group 3) showed statistical significant best smear layer removal followed by QMiX and EDTA with no statistical significant difference between EDTA and QMiX.

No single irrigant has been demonstrated to be capable of dissolving organic pulpal material and predentin as well as demineralizing the inorganic calcified portion of the canal wall.

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