Original article

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Effect of Various Root Canal Irrigants on Removal of Smear Layer and Debris an in Vitro study: A Scanning Electron Microscopic (SEM) Study

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Abstract

Objective: To compare the effectiveness of different Root Canal irrigants. To evaluate comparative efficacy of different root canal irrigants when used singly or in combination for the removal of smear layer and debris.

Methods: One hundred fifty freshly extracted premolars, for orthodontic purposes were selected. Access cavities were prepared and working lengths were established. The teeth were divided into 6 groups of 25 teeth each. Six groups of teeth were irrigated with Saline, Sodium Hypochlorite (NaOCl) 5.2%, Chlorhexidine Gluconate (CHX) 0.2%, Hydrogen Peroxide (H_2O_2) 3%, Ethyldiamine Tetra Acetic Acid (EDTA) 17% and Sodium hypochlorite and EthylDiamine Tetra Acetic Acid respectively.
The teeth were sectioned longitudinally and examined under Scanning Electron Microscope for removal of smear layer and debris at different levels of root canal system.

Results: The best smear layer and debris removal was obtained with 5.2% Sodium Hypochlorite and 17% Ethyldiamine Tetra Acetic Acid combination followed by Ethyldiamine Tetra acetic Acid 17% when used alone.

Conclusion: The intracanal irrigation was found to be most effective with a combination of irrigation rather than when used alone.

Key words: Root Canal Irrigants; Efficacy; Smear Layer; Scanning Electron Microscope.

Introduction

In pediatric patients, Pulpectomy (root canal treatment) is the treatment of choice for maintaining structural integrity of grossly carious tooth. To ensure good long serving pulp treatment, the skill of dentist, chemo mechanical preparation of root canal and removal of smear layer and debris followed by obturation play a combined role[1]. The ideal properties of various root canal irrigants must be the removal of complete smear layer and debris. The aim of endodontic treatment is the disinfection and then obturation of root canal system in three dimensions to prevention reinfections.[2] Canal system, irrigation and disinfection and then obturation of root canal system in three dimensions to prevention reinfections.[3,11] Irrigation of root canal is probably the most underrated procedure in endodontic therapy[4]. The exact composition and clinical implication of smear layer is not completely understood. It plugs the orifices of dentinal tubules reducing the permeability of dentin thereby preventing bacterial penetration into the dentinal tubules[5]. However, on the other hand smear layer acts as a reservoir for potential irritants.[6, 26] Proponents state that removal of the smear layer allows for intimate contact of irrigants and medicaments with potentially infected dentinal tubules. They also state that the smear layer removal increases the bond strength of resin sealers which results in better apical seal whereas opponents of smear layer removal have found that the smear layer acts as a barrier, inhibiting bacterial colonization of the

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dentinal tubules.[7] Obturation in the presence of smear layer is considered as a weak union between canal walls and obturating material because smear layer can break away from underlying matrix resulting in microleakage.[8,24] So in view of this background, the current study was undertaken with the aim to assess and compare the efficacy of Sodium Hypochlorite (NaOCl) 5.2%, Hydrogen Peroxide (H_2O_2) 3%, Normal saline, Ethylenediamine Tetra Acetic Acid (EDTA) 17%, Chlorhexidine Gluconate (CHX) 0.2%, alone and in combination of Sodium Hypochlorite (NaOCl) 5.2% and Ethylenediamine Tetra Acetic Acid (EDTA) 17% in removal of the smear layer and debris from the root canal walls.

Materials and Methods

Total of 150 premolars were collected for the study from the Department of Pedodontics and Preventive Dentistry, Santosh Dental College and Hospital, Ghaziabad. Inclusion

Fig 1: Picture of Some Samples used in the study

Criteria for the selection of each tooth were : dried with paper points.

Then all teeth were decoronated with diamond disc (Dentaurum) mounted on a low-speed handpiece (NSK). (Fig 2). Then longitudinal and transverse grooves, which did not penetrate into the canal, were prepared along the buccal and lingual surfaces of each root. Then the roots were carefully sectioned with the help of surgical chisel and mallet (API), thereby providing two sections from each root (Fig 3). The two halves were dehydrated in alcohol, coated with gold palladium and viewed with a Scanning Electron Microscope (Fig 4). The apical, middle and cervical portion of root was scanned and representative areas

Fig 2: Decoronation of crown

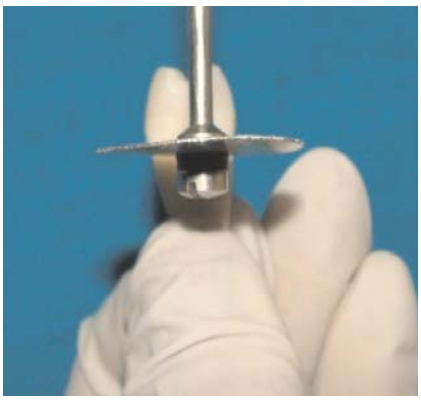


Fig 3: Longitudinally Sectioned Samples

0–Heavy smear layer seen with indistinguishable tubular outline.

were photographed at x2000 - x5000 magnification, for assessing the presence of debris, soft tissue or smear layer.

Criteria for evaluation of smear layer removal as by Rome et al [3] –3

No smear layer seen with all the dentinal tubules opened. (100% distinguishable tubular outline free of debris). 2- Little smear layer seen with more than 50% distinguishable tubular outline. 1– Moderate smear layer seen with less than 50% distinguishable tubular outline or with more than 50% indistinguishable tubular outline.In group 2,

moderate smear layer was seen in 65 % of samples with 50% distinguishable tubular outline (mean score 2) and only mild amount of smear layer (mean score 1) was removed in 30% of samples. In group 3, in about 80% of samples mild amount of smear layer was removed with more than 50% indistinguishable tubular outline (mean score 1) and 20% of samples showed moderate smear layer removal (mean score 2) In group 4, about 88% of samples little amount of smear layer was removed with more than 50% indistinguishable tubular outline (mean score 1) and 12% of samplese moderate amount of smear layer was removed (mean score 2). In Group 5, about 68% showed little smear layer with more than 50% distinguishable tubular outline (mean score 2) and in 32% of samples no smear layer was seen with all the dentinal tubules opened. (100% distinguishable tubular outline free of debris) (Mean score 3).In Group 6, about 92% of samples no smear layer was seen with all the dentinal tubules opened. (100% distinguishable tubular outline free of debris) (Mean score 3) and 8% of samples showed little smear layer with more than 50% distinguishable tubular outline (mean score 2). The observed scores, total sum and mean of smear layer and debris removal are presented in (Table 1)**.** The percentage of smear layer and debris removal is presented in (Table 2)**.** The graphic bar **(**Graph 1**)** represents mean grading for smear layer removal. The irrigants which showed maximum mean grading was efficient in removing the smear layer whereas irrigants with minimum mean grading failed to remove the smear layer completely. The graphic bar **(**Graph 2**)** represents percentage value for complete removal of smear layer.

To achieve this objective, root canals are cleaned thoroughly before the root filling using mechanical instrumentation, supplemented with irrigants and intracanal medications. Instrumentation leads to formation of an amorphous, irregular layer known as the smear layer on root canal walls. The smear layer contains remnants of ground dentine, pulp tissue, odontoblastic processes and bacteria Success of root canal therapy depends on the accurate diagnosis, quality of instrumentation, cleaning and shaping of 1.Freshly extracted premolars for the purpose of orthodontic treatment. (Fig 1)

All intact teethExclusion Criteria for teeth were

1. Fractured Premolar

2. Previously root canal treated teeth The teeth were divided into 6 groups of 25 teeth each on the basis of respective irrigating solutions being used.

First group-Normal Saline- control group Second group-Sodium Hypochlorite – 5.2% (NOVO)

Third group - Hydrogen Peroxide – 3% (Sandika pharmaceutical)

Fourth group Chlorhexidine Gluconate – 0.2%

Fifth group EDTA-17% (Dentsply).

Sixth group EDTA 17% and NaOCl 5.2%

Method

Conventional access cavities were prepared on the occlusal surfaces of the teeth. Pulp was extirpated and working length determined 1mm short of the apex using 10 size K- file. A No.-10 K file (DENTSPLY) was inserted into each canal until tip of the file was visible at the apical foramen.1mm length was subtracted from this length in order to establish the working length for each root canal. Biomechanical preparation was done by crown-down technique. For each experimental group, a new ensemble of files was used.During the procedure all specimen were kept moist by holding them in moist gauze. All the teeth were stored in normal saline throughout the study. After each instrumentation canals were irrigated with 2ml of respective group irrigating solution. The apical foramen of each canal was sealed using sticky wax in order to prevent the escape of irrigating solution beyond the apical foramen. Final flush using distilled water was done in all the groups in order to remove any reaction of irrigants with root canal wall. After final irrigation, the root canals were Fig 2. Decoronation of crown Fig 3. Longitudinally

Sectioned Samples. 0 – Heavy smear layer seen with indistinguishable tubular outline.

Results

About 70% of samples were unable to remove the smear layer (mean score 0) and 20% of samples were able to remove mild amount of smear layer removal (mean score 1).Heavy smear layer with indistinguishable tubular outline was noted in all specimens Group 1. Samples irrigated with control group showed very little smear layer removal. (Fig 5). Group 1. Samples irrigated with EDTA 17% showed moderate smear layer removal. (Fig 7). Group 5.Samples irrigated with 5% NaOCl, 0.2% CHX and 3% H2O2 showed the presence of high amounts of smear layer but were well debrided. (Fig 6). Group 2, 3, 4. Samples irrigated with NaOCl-EDTA (Group 6) combination, the smear layer was removed very effectively when compared with other groups (Fig 8). The NaOCl and EDTA combination showed the ability to demineralize inorganic component of smear

Fig 4: Scanning Electron Microscope (SEM)

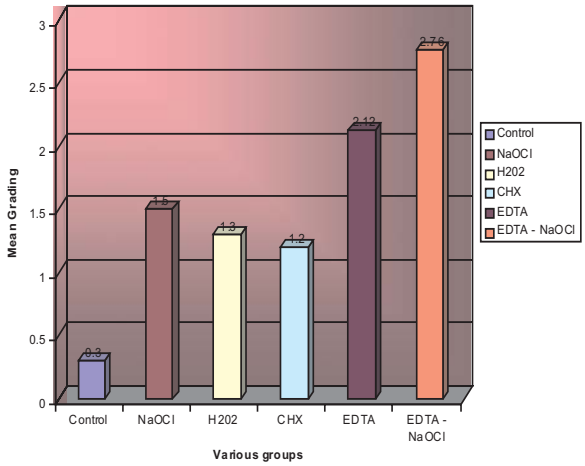
Table 1: Observed Scores, Total Sum and Mean of Smear Layer removal by various groups

S.No	Control Group	NaOCl	H_2O_2	CHX	EDTA	NaOCl-EDTA
1.	0	1	1	1	2	3
2.	0	1	1	1	2	3
3.	0	1.5	1.5	1.5	1.5	3
4.	1	1	1	1	2	2.5
5.	0	2	2	2	2	3
6.	0	2	1	1	2	3
7.	1	1.5	1.5	1.5	2.5	2.5
8.	1	1.5	1.5	1	2.5	2.5
9.	0	2	1	1	2	3
10.	0	2	1	1	2	3
11.	0.5	1	1	1.5	2	3
12.	0	1	1	1	2.5	2.5
13.	0	1	1	1.5	2	2.5
14.	1	1.5	1.5	1.5	2	3
15.	1.5	1.5	1.5	1	1.5	3
16.	0	2	1	1	2	2
17.	0	2	2	1	2.5	2.5
18.	0.5	1.5	1.5	1.5	2.5	2.5
19.	1	1	1	1	2.5	3
20.	0	1.5	1.5	1.5	2	3
21.	0.5	1.5	1.5	1	2	3
22.	0	2	2	1	2	2.5
23.	0	1	1	1	1.5	3
24.	0	2	1	1	3	3
25.	0	1.5	1.5	1.5	2.5	2
Total sum	9	37.5	32.5	30	53	69
Mean	0.3	1.50	1.30	1.20	2.12	2.76

Table 2: Overall mean grading and percentage of smear and debris removal of various groups

Groups	Irrigants	Mean Grading Value	% of Smear Removal
1st	Control group	0.3	10.6%
2nd	NaOCl	1.50	50%
3rd	H_2O_2	1.30	43.3%
4th	CHX	1.20	40%
5th	EDTA	2.12	70.6%
6th	NaOCl-EDTA	2.76	92%

Graph 1: Overall mean grading of smear layer removal in various groups



Graph 2: Overall percentage of smear layer removal by various groups

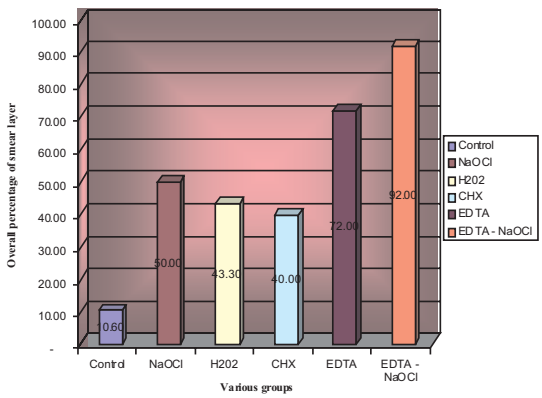
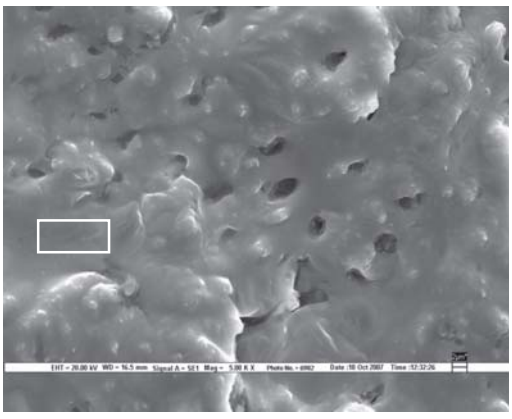
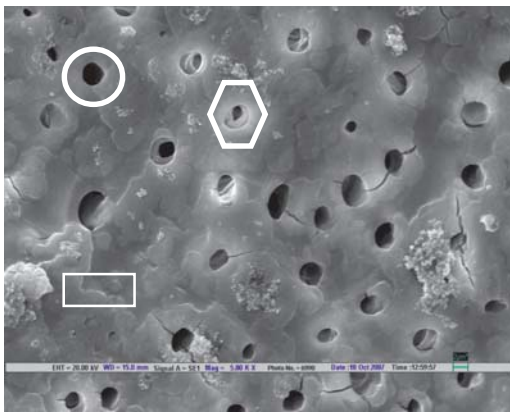


Fig 5: SEM photograph of sample treated with Saline



Smear layer

Fig 6: SEM photograph of sample treated with NaOCl



Completely Opened dentinal tubules

Partially opened dentinal tubules

Smear layer

Fig 7: SEM photograph of sample treated with EDTA

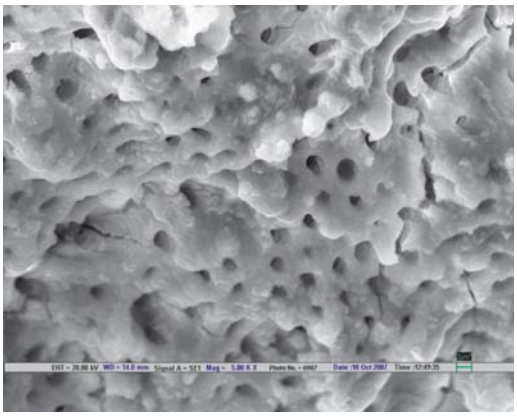
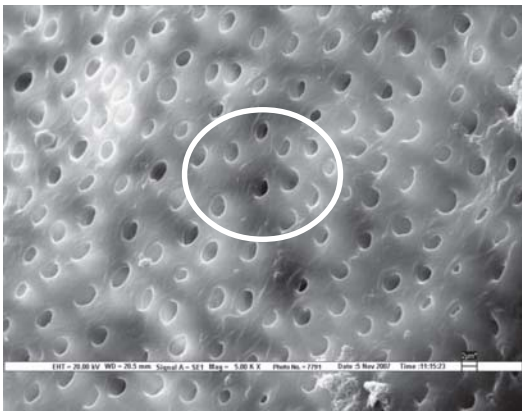


Fig 8: SEM photograph of sample treated with NaOCl & EDTA combination



O Completely Opened dentinal tubules free of debris

layer and dissolve organic component of the smear layer. The solution also has the capability of preventing the smear layer from becoming packed into the dentinal tubules.

Discussion

When root canals are instrumented during endodontic therapy, a layer of material composed of dentin, remnants of pulp tissue and odontoblastic processes and sometimes bacteria is also formed on the canal walls. This layer is called as the Smear Layer.[8,9,10,11] The exact composition of the endodontic smear layer has not been determined but SEM examination has revealed that it contains both organic and inorganic materials. The inorganic materials in the smear layer are made up of tooth structure. According to Mader et al (1984) the organic component may consist of heated coagulated proteins, necrotic or viable pulp tissue and odontoblastic processes plus saliva, blood cells and micro-organisms.[12] Smear layer has been the topic of concern for all the clinicians over the years and a lot of research has been done by various investigators. Controversy still remains about its clinical significance and influence on success of the treatment.[13].Under clinical conditions, especially during the treatment of infected teeth, viable bacteria andtheir products can be incorporated onto the smearlayer, forming a deposit of irritants.[14]EDTA is an inorganic solvent & demineralizes dentin and removes inorganic component of smear layer.[19, 20] It removes the calcium ions from the dentin and hence increases the diameter of exposed dentinal tubules. Sodium Hypochlorite is an organic solvent. Since smear layer contains both organic and inorganic components, addition of Sodium Hypochlorite solution with EDTA will remove organic component of the smear layer. The disodium salt of EDTA at 17% concentration and neutral pH is widely preferred to enlarge the root canal, removes the smear layer and prepares the dentinal walls for better adhesion of obturating materials [21, 22, 23].

Conclusion

This present in-vitro study was carried out to evaluate the effects of various root canal irrigants on removal of smear layer and debris by Scanning Electron Microscope.The best cleaning of the root canal walls was observed with Sodium Hypochlorite-5.2% and Ethylenediamine Tetra Acetic Acid-17% combination (Group 6). The use of EDTA -17% alone was capable of removing inorganic component of smear layer. Sodium Hypochlorite 5.2%, Hydrogen Peroxide 3% alone did not produce satisfactory results. The worst cleaning was observed in the groups in which Normal Saline (control Group) and CHX solution 0.2% were used as irrigants.

Therefore, its complete elimination would allow the most effective removal of the irritants from root canals, besides promoting an increase in the dentine permeability and increase in the ability of filling materials to penetrate into the dentinal tubules which contribute greatly to the success of endodontic therapy.[15] So the present study was therefore done with the purpose of evaluating the effects of various root canal irrigants on smear layer and debris removal.Greater discussions on the subject and various studies have been done to overcome this confusion. All of us, while doing SEM evaluation of various root canal irrigants for removal of smear layer and debris, would question the reliability and validity of the irrigants. A perusal of the literature reveals that there are various irrigant solutions for removing the smear layer and debris efficiently. Thorough research has documented that the NaOCl 5.2%-EDTA 17% combination has proven its superior effectiveness [16, 17, 18]. Therefore the combination of NaOCl 5.2%-EDTA 17% is the most reliable root canal irrigants for the removal of smear layer efficiently.

What this study adds

This study emphasizes the need to use root canal irrigants while doing biomechanical preparation in endodontic therapy from root canal walls. ·

This study highlights the combination of Sodium Hypochlorite 5.2% and Ethyl Diamine Tetra Acetic Acid 17% as the best irrigating solution.

Why this paper is important to pediatric dentists

Despite modern advances in the prevention of dental caries and an increased understanding of the importance of maintaining the natural dentition, many teeth are still lost prematurely. Maintaining the integrity and oral health is the primary objectives of the endodontic therapy. ·

In order to achieve successful root canal treatment, apart from the skills of dentist, chemo mechanical preparation of root canal, complete removal of smear layer and debris by an ideal irrigants play an important role.

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