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Evaluation Of Three Root Canal Irrigants In Their Ability To Remove Smear Layer With Significantly Least Erosio – Ansem Analysis.

Smear Layer Removal

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Abstract:
Aim: To find a viable alternative to the existing benchmark root canal irrigants with less erosion and clinically acceptable smear layer removal.
Methods: Forty single rooted mandibular premolars were selected and decoronated to a standard size. Cleaning and shaping was done with Protaper sequentially till size F3 with 2.5 % sodium hypochlorite as working solution. Based on the final irrigating solution used, samples were divided randomly into four groups; group I: 17% EDTA+ 2.5% NaOCl, group II:Oxum +2.5% NaOCl, group III: 10% Triphala +2.5% NaOCl and group IV: 0.9% saline. After final irrigation with the above mentioned irrigants, teethwere prepared for SEM analysis to evaluate smear layer and presence or absence of erosion in the coronal, middle and apical thirds of radicular dentin. The data was statistically analyzed using the Kruskall- Wallis test.
Results: Atcoronal, middle and apical thirds, EDTA showed statistically significant smear layer removal accompanied by significantly severe erosion as compared to Oxum and Triphala. Oxum showed statistically significant smear layer removal in coronal and middle regions as compared to Triphala. In apical thirds, Triphala showed better smear layer removal as compared to Oxum but with significant erosion.
Conclusion: When compared to the benchmark irrigating solutions, Oxum (oxidative potential water - OPW) proved to be superior in smear layer removal with less significant erosion.

Keywords:-Oxum, Triphala, Smear layer, Erosion, sodium hypochlorite

1. INTRODUCTION

inliterature have recognized and endorsed a strong correlation between the basic science of microbiology and the clinical science of successful endodontic practice. Even with the increase in numerous irrigants and irrigation techniques, the ever controversial and perplexing problem of smear layer remains unsolved.

The effect of smear layer, its clinical implications due to bacterial contamination is enormously debated and always in disagreement amongst the researchers in Endodontics. Literature shows evidence that the bacteria and its byproducts present in the smear layer does contribute to the ultimate outcome of the endodontic treatment either directly or indirectly.

The most widely used combination of irrigants for debridement and removal of smear layer are namely EDTA and Sodium hypochlorite. They serve as a benchmark reference despite their tissue toxicity and erosive effects on dentine. Baumgartneret al reported that many a times the erosion can be severe enough to expose the globular surface of the calcospherites[1]

According to Chetan et al, it seems prudent to cause progressive dissolution of the dentine at the expense of peritubular and intertubular dentine due to sodium hypochlorite presumably being sucked into the dentinal tubule by capillary action and fluid dynamics which may ultimately compromise the structural integrity of dentine[2]

Hence, numerous newer root canal irrigants have been constantly tried and investigated for its ability in effective debridement and removal of smear layer. They have also been studied in detail with reference to their response to the exposed tissues. One such widely investigated root canal irrigant by Hata et al in Japan is Oxidative Potential Water (OPW- Oxum).[3] They report that it exerts rapid antimicrobial effect, decomposes to plain water instantly and does not get adsorbed to dentine hence, they substantiate their safety as a root canal irrigant.

The renewed interest among researchers to look for herbal alternatives is on the rise bearing in mind the safety concern, antibiotic resistant strains, and no or least potential side effects. According to Prabhakar et al, Triphala owing to its antimicrobial efficiency particularly against *Enterococcus faecalis* is being widely investigated as a root canal irrigant in most of the in vitro experiments.[4] There is adequate literature in Indian Ayurvedic Herbal medicine to prove its anti-inflammatory, antimicrobial, and curative properties.[5] Hence, in our study a comparative evaluation of a nonsynthetic irrigant namely Oxum and an herbal irrigant Triphala have been evaluated as compared to the conventional endodontic irrigant EDTA for smear layer removal and erosion.

2. MATERIALS AND METHODS

Ethical clearance was obtained from the Ethical Committee (IEC SBDCECM104/12/19) of Bharath University, Chennai,Tamil Nadu, India. Forty extracted human lower second premolar teeth with straight roots and type I canal anatomy were selected. All the teeth were radiographed to verify the presence of a single canal with mature apex and the absence of any resorption or endodontic obturation. Superficial soft tissues were removed with a brush, and the teeth were stored in 0.2% Sodium Azide (Sigma Chemical Co, St Louis,MO) at 4 ^{0}C. The teeth were decoronated to standardize the root length to 15 mm and the samples were divided randomly into four experimental groups. The working length was established by inserting a no.10 K file (Mani Inc, Tochigi Ken, Japan) into each root canal until it was just visible at the apical foramen (observed under magnifying loupes) and by subtracting 1 mm from this point. A Gates Glidden drill (Mani Inc, Tochigi Ken, Japan) no. 1-2 was used to enlarge the root canal orifice. Apically, the canals were enlarged up to ISO size no 20.Irrigation was performed with 1 ml of 2.5% of NaOCl (Ups Hygenies, Mumbai,India) solution after each instrument change. The root canals were cleaned and shaped using Universal Protaper rotary system (Dentsply-maillefer,Switzerland) as per manufacturer's protocol up to F3 .

The final irrigation sequence was as follows: Group I- 17% EDTA(Pulpdent-Pulpdent Corporation, MA, USA); Group II – OXUM (Sun Pharma, Mumbai, India); Group III - 10 % Triphala (Impcops, Chennai, India)– 5ml of the above irrigants was irrigated for 1 minute, rinsed with distilled water, followed by 5 ml of 2.5% NaOCl for 1 minute; Group IV - 0.9% Saline (Nirlife, Nirma limited, Gujarat, India) for 1 minute.

All the irrigating solutions were introduced into the canal using stainless steel 27-G beveled needle. The needle was placed within 1 to 2 mm of the working length in each canal. Then, the root canals were finally irrigated with 5 ml of distilled water to remove any precipitate that might have been formed. The canals were blot dried with sterile paper points and a sterile cotton pellet was placed in the access cavity followed by a temporary filling. The teeth were stored in a plastic bag placed in a humidor. Then, longitudinal grooves were prepared on the buccal and lingual surfaces of each root by using a diamond disc at a slow speed without penetrating the canal. The roots were then gently split into two halves using a chisel and stored in deionized water at 37^0C until SEM analysis. The specimens were dehydrated using 100% ethyl alcohol and placed in a furnace at 60^0C for 24 hours. The samples were then mounted on metallic stubs, gold sputtered using an ion sputter, and examined under scanning electron microscope (LEO 440i, Carl Zeiss, Tokyo, Japan) for the presence or absence of the smear layer. Several photomicrographs were taken to observe the surface morphology at 2,000 X magnification of the canal walls at the coronal (10-12 mm from apex), middle (6-7 mm from apex), and apical (1-2 mm from apex) thirds of each specimen. The images were scored according tothe following criteria given by Torabinejad et al[6]

- 1 = No smear layer .No smear layer on the surface of the root canal; all tubules were clean and open,
- 2 = Moderate smear layer .No smear layer on the surface of the root canal, but tubules contained debris,
- 3 = Heavy smear layer. Smear layer covered root canal surfaces and tubules.

In addition the same investigators scored the degree of erosion of dentinal tubules as follows:

- 1 = No erosion. All tubules looked normal in appearance and size,
- 2 = Moderate erosion. The peritubular dentin was eroded,
- 3 = Severe erosion. The intertubular dentin was eroded and tubules were connected with each other.

These areas were evaluated by two independent evaluators who were unaware of the experimental groups to which the samples belonged.

3. RESULTS

The SEM analysis images taken at the coronal, middle and apical third for all the experimental groups are shown in Figures 1 - 4. Mann Whitney results showed that there was no statistical significant difference between the two examiners' values for scoring the smear layer and erosion in the coronal, middle, and apical thirds for the EDTA,Oxum and Triphala groups. When levels of smear layer and erosion are compared between 3 areas and 4 groups Kruskal Wallis non parametric tests were used. Statistical analysis is indicates that there is significant difference between coronal, middle and apical third with P value <0.05, among all the groups (Table I). In Group IV (Saline) heavy smear layer was found in all 3 regions with no erosion. The graph showing the mean values for smear layer is represented in Figure 5.

For erosion in Group I (EDTA) no Statistical significant difference was found in Coronal and Middle third but statistically significant difference is found between apical third as compared to middle and coronal (p value <0.05). Statistically significant difference is there between coronal, middle and apical thirds of group II and III (p value <0.001). The graph showing the mean values for erosion is represented in Figure 6.

4. DISCUSSION

The outcome of root canal therapy depends on the method and quality of instrumentation, copious irrigation, nature of the irrigants and its techniques to provide sterile root canal space for a three dimensional obturation. Literature has shown evidence that a layer of sludge material, smear layer routinely forms over the surface of the dentinal walls after instrumentation. Smear layer is composed of dentine, remnants of pulp tissue, odontoblastic process, and bacteria. It slowly disintegrates and dissolves around the leaking obturating materials and may also interfere with adhesion and penetration of root canal sealer. Despite a variety of irrigating solutions available today, the search for an ideal root canal irrigant is a never-ending problem because of the dentine substrate, smear layer, and the micro-biota within are so complex and resist complete eradication.

In this study, a comparison of the efficacy of smear layer removal of 17% EDTA,OPW namely Oxum and 10 % Triphala as a final irrigant was done and evaluated the degree of erosion from the coronal, middle, and apical thirds of the root canal. It is evident from the figures obtained and results tabulated that EDTA inthe coronal third showed 70 % samples with no smear layer whereas Oxum(OPW)and Triphala uniformly had moderate smear layer (Oxum 55% and Triphala 50 %). In the middle third EDTA had 58 % no smear layer as compared to Oxum and Triphala which had moderate smear layer of 60 % and 70.5 % respectively.In apical third 45 % had no smear layer in EDTA group whereas Oxum showed least of 5 % and Triphala 12.5%. Several studies have supported the complimentary action of EDTA (as a chelate) with sodium hypochlorite.[7-9] Sodium hypochlorite when used as an irrigant alone removed the organic content of smear layer leaving behind mineralized smear layer, further preventing dissolution of the dentine. Hence they suggested EDTA due to its chelating action on the inorganic components could effectively remove the smear layer formed due to instrumentation from the root canal walls when used along with sodium hypochlorite.Michael O Connell and Baumgartner et al compared the EDTA of various concentrations and ph 7.3 and 11.3 and concluded that at high ph, the excess number of hydroxyl group prevented the dissolution of hydroxyapatite crystals thus limiting the number of calcium ions for chelation.[10]At neutral or low ph the calcium ions from dentine becomes more readily available for chelation due to dissociation of hydroxyapatite crystals. The ideal concentration concluded by them was from 15 – 17 % EDTA with neutral or low ph. Vasilenini and Papque et al in their study reported that dentine in the apical third is sclerosed and supported the view that EDTA may not have such a pronounced effect on the apical third as compared to middle and coronal third of dentine.[11,12]They have demonstrated that neutral EDTA solutions reduce the mineral and noncollagenous proteins of the dentine.Hulsmann proposed that EDTA not only removes the calcium ions but the calcium bonded to the noncollagenous proteins (NCP) because the content of NCPs decreases in the apical third.[13]The degree of decalcification of EDTA in this part is low. In the present study, we opted for a dwell time of 1-minute which is in accordance with various other studies conducted by Ballal et al.[14] Also, studies have reported that EDTA when used for more than1 minute causes erosion of dentinal tubules, thus reducing the dentin micro hardness and consequently causing root fragility. Saline, which is used as an irrigant in the control group, was found to have no effect on smear layer. The final rinse of 5 ml was used in this study as proposed by Mello[15]

It is evident from the figures obtained and results tabulated that in coronal third EDTA has a maximum erosion of 57 .5% as compared to Oxum (OPW) 42.5 % and Triphala 20%.In the middle third, EDTA exhibited severe erosion 55%as compared to Oxum (OPW) where 20 % severe erosion is present .In the apical third EDTA did produce severe erosion in 17.5 % samples as compared to other two groups where no severe erosion is seen. The combination of sodium hypochlorite and EDTA offered potential clinical advantages but also produced additional side effects like erosion on the exposed surfaces of the calcospherites. Sometimes the erosion may be so severe to deplete calcospherites completely from the dentine[1] The erosion of the exposed globular surface of calcospherites and the enlargement of orifices of dentinal tubules result in dissolution of the organic and in organic components of dentine.[10]

Hence, a constant search for an alternative irrigant is never ending. One such substitute is oxidative potential water due to its safety, bactericidal effectiveness and not getting adsorbed into the dentine.[16]It is rich in reactive oxygen with a neutral pH. It is stable and has a longer shelf life. It mainly contains oxidized solution (H_2O), sodium hypochlorite, hypochlorous acid, hydrogen peroxide, ozone, chlorine dioxide, sodium hydroxide, sodium carbonate and sodium chloride [17] The solution molecules are broken into ions and free radicals which rapidly react and denature protein of bacterial cell wall. It produces an environment of unbalanced osmolality that damages the cell wall of single cell organisms.Generally host tissues are multi cellular and hence they don’t react and not toxic.The low ph in Oxum (OPW)may sensitize the outer membrane of bacterial cell,thereby enabling oxygen anion radicals to attack the bacterial cellmore efficiently.It is reported that when Oxum was used as an irrigant,it cleans the root canal surfaces in a clinically significant manner as compared to NaOCl and removed the smear layer in large areas leaving the collagen fibers intact and completely exposed.Oxum (OPW) is having neutral ph lower free active chlorine (51-85ppm)and longer shelf life .The damage is direct result of osmolarity between the concentration of ions in solution vs the concentration of same ions in the cell. Multicellular organisms are not prone to such changes so host tissues are spared.Once single cell membrane is damaged the ions denatures bacterial protein as well.For these reasons it is referred to as a well suited irrigating agent. Its efficiency as a potential disinfectant has been endorsed by British department of health (HTM 2030) and its effect on smear layer is yet to be researched[18]

According to Neeraj Verma and Jagetia et al Triphala proved to be safe containing active constituents that have beneficial physiological effects apart from its curative property,[19,20]Its radical scavenging activity has encouraged endodontists to put to use as a root canal irrigant. Triphala has been reported to have very good chelating action. Triphala in particular contain fruits that are rich in citric acids that may aid in removal of smear layer.[4] Apart from citric acid it also contains gallic acid, ellagic acid, chebullic acid, chebullinic acid, tannic acid and ascorbic acid. All these weak organic acids have an anti-oxidant, immune-modulatory, regenerative, anti-mutagenic, antimicrobial and good scavenging ability. From the results obtained it is interesting to note that Triphala exhibited improved smear layer removal with moderate erosion in apical thirds as compared to Oxum.

All the irrigants were less effective in apical third due to the stagnation plane of the residual fluid at the apical third as explained by Gulabivala in the fluid mechanics of root canal irrigation [21]The existence of stagnation plane beyond which irrigant cannot pass has been observed in many studies but never has been well defined. The flow of irrigant with low Reynolds number is viscous and hence the interaction between fresh irrigant and root canal debris is reduced in the apical third. Many researchers have suggested a solution to overcome this problem by the use of a side opening needle than end opening needle because the Reynolds number is higher at the exit of side opening needle tip. So the use of side opening needle may lead to better removal of smear layer.

According to the results obtained in the present study, amongst the irrigants tested Oxum (Oxidative Potential Water - OPW) proved to be superior in smear layer removal with less significant erosion.Within the limitations of this study, it may be suggested that Oxum (OPW) may be used instead of EDTA for smear layer removal with less erosion. However it may be worthwhile to investigate further, the effect of Oxum (OPW) alone as a root canal irrigant to evaluate its effect on smear layer and on dentine.

CONFLICT OF INTEREST: Nil
SOURCE OF FUNDING: Nil
ETHICAL CLEARANCE:

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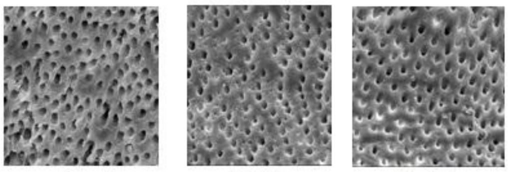
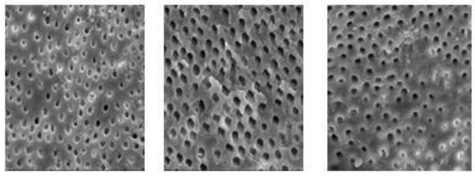


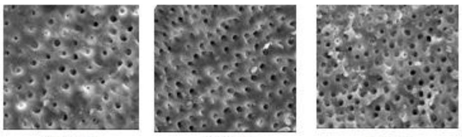
Coronal Middle Apical

Figure 1 - EDTA



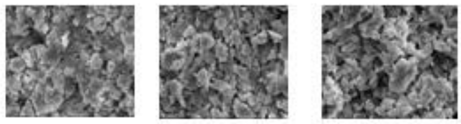
Coronal Middle Apical

Figure 2 - OXUM



Coronal Middle Apical

Figure 3 Triphala



Coronal Middle Apical

Figure 4 - Saline

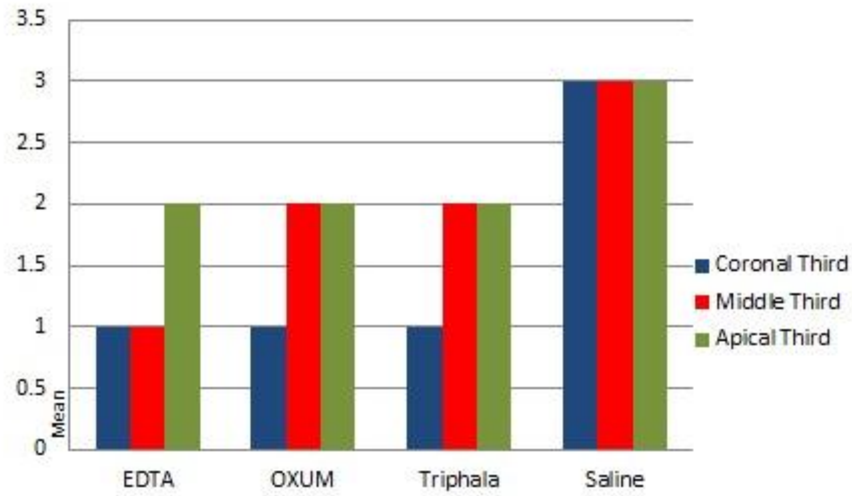


Figure 5 - Graph for Smear Layer

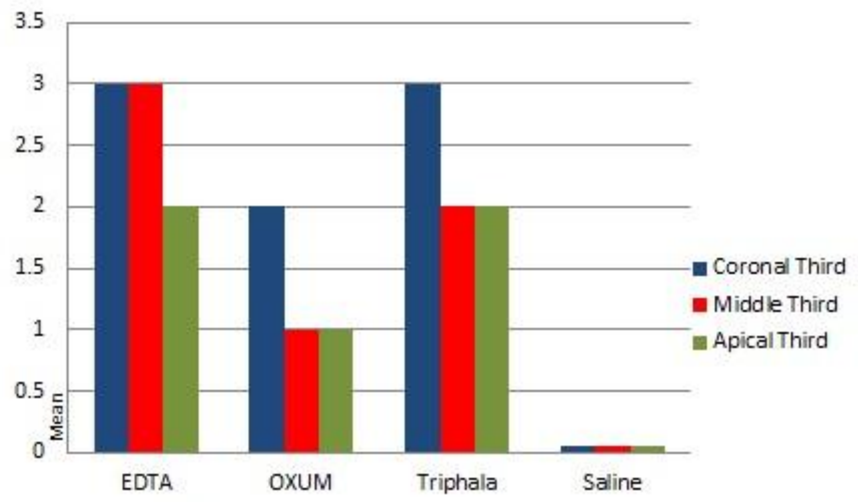


Figure 6 - Graph for Erosion

Table I – Percentile of smear layer and erosion

	GROUPS	Surface	No Smear Layer		Moderate Smear Layer		Heavy Smear Layer		Total	
			N	%	N	%	N	%	N	%
Smear Layer	Saline	Coronal	0	.0	0	.0	10	100.0	10	100.0
		Middle	0	.0	0	.0	10	100.0	10	100.0
		Apical	0	.0	0	.0	10	100.0	10	100.0
	17% EDTA	Coronal	7	70.0	3	30.0	0	.0	10	100.0
		Middle	5	50.0	5	50.0	0	.0	10	100.0
		Apical	2	20.0	8	80.0	0	.0	10	100.0
	Oxum	Coronal	6	60.0	4	40.0	0	.0	10	100.0
		Middle	1	10.0	8	80.0	1	10.0	10	100.0
		Apical	0	.0	7	70.0	3	30.0	10	100.0
	10% Triphala	Coronal	5	50.0	5	50.0	0	.0	10	100.0
		Middle	2	20.0	8	80.0	0	.0	10	100.0
		Apical	0	.0	6	60.0	4	40.0	10	100.0
Erosion	17% EDTA	Coronal	0	.0	3	30.0	7	70.0	10	100.0
		Middle	0	.0	4	40.0	6	60.0	10	100.0
		Apical	3	30.0	5	50.0	2	20.0	10	100.0

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	Oxum	Coronal	0	.0	5	50.0	5	50.0	10	100.0
		Middle	4	40.0	4	40.0	2	20.0	10	100.0
		Apical	10	100.0	0	.0	0	.0	10	100.0
	10% Triphala	Coronal	3	30.0	3	30.0	4	40.0	10	100.0
		Middle	3	30.0	7	70.0	0	.0	10	100.0
		Apical	3	30.0	5	50.0	2	20.0	10	100.0