Original Research Paper

Volume - 11 | Issue - 12 | December - 2021 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Paediatric Dentistry

"A COMPARATIVE EVALUATION OF DIFFERENT ROOT CANAL IRRIGANTS ON REMOVAL OF SMEAR LAYER FROM INSTRUMENTED ROOT CANAL SYSTEM: A SCANNING ELECTRON MICROSCOPY STUDY"

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ABSTRACT **Introduction:** The aim of this study was to evaluate the influence of various endodontic root canal irrigants on the removal of smear layer from root canal system of human teeth by calculating percentage of open dentinal tubules using Scanning Electron Microscope. **Materials and Methods:** Thirty single rooted were selected for the study. Chemo-mechanical preparation was done using crown down technique with irrigation of normal saline after every instrument use. Depending on the final irrigation solution, the samples were divided randomly into three experimental groups and one control group:(1)Normal Saline(n = 10), (2)1% Peracetic Acid with sonic activation (n = 10) and (3)TweenKleen(9% HEBP) + 3% Sodium Hypochlorite with Sonic activation(n = 10). These teeth were then evaluated using SEM analysis for the absence or presence of smear layer, thereby analyzing their cleaning effectiveness in the coronal, middle, and apical thirds of the root canal system. Bivariate analyses was performed using Kruskal wallis test followed by Mann whitney U test for post hoc pairwise comparison. The inter examiner's reliability was verified with the use of Kappa test. **Results:** Tweenkleen along with sonic activation is more effective in smear layer removal followed by 1% PAA with sonic activation whereas Normal Saline was completely ineffective in removing smear layer from coronal, middle and apical thirds of the root canal system. **Conclusion:** A final irrigation with TweenKleen along with sonic activation is more efficacious than 1% PAA.

KEYWORDS : HEBP, PAA, Endoactivator

INTRODUCTION:

Cleaning and shaping of infected root canals is the most important phase of endodontic treatment in achieving a successful clinical outcome. Endodontic hand files or rotary instruments used for these procedures, produce considerable quantities of debris which is made up of very small particles of mineralized collagen matrix, that is spread over the surface to form the smear layer.

For the complete debridement of root canal, literature emphasizes mandatory removal of smear layer which can be achieved by copious irrigation along with mechanical instrumentation. Numerous irrigants are available in market but no single irrigant is potent of eliminating the organic and inorganic content of smear layer.[1]

Etidronic acid (also known as 1-hydroxyethylidene-1,1-bisphosphonate or HEBP) is a substance that prevents bone resorption and is used systemically in treating patients suffering from osteoporosis or Paget's disease. [2] A single-step irrigation material-Tween Kleen under the name of HEBP is a weak chelator with short term biocompatibility with Sodium Hypochlorite, known to have the ability of removing the inorganic phase of smear layer.

Another irrigant that has been researched with the purpose of improving the cleaning and disinfection of root canal system is Peracetic acid(PAA). It has been used as a single endodontic irrigant having antibacterial, sporicidal, antifungal, and antiviral effects.[3]

To enhance the efficacy of root canal irrigants within the complex root canal systems, especially in the apical third, adjunctive activation methods have been proposed. EndoActivator(Dentsply, Tulsa Dental) uses sonic activation of irrigants by vigorous activation of intracanal fluids. The debridement and disruption of the smear layer and biofilm is significantly improved by cavitation and acoustic streaming. It not only removes the smear layer in the apical region but is distributed uniformly in the whole root canal length.[4]

Therefore, this study aimed to compare and evaluate the influence of various endodontic root canal irrigants on the removal of smear layer from root canal system of human teeth.

AIM & OBJECTIVE:

The aim of the present in vitro study was to compare and evaluate different types of irrigants namely, 0.9%Saline, 9% HEBP+3% Sodium Hypochlorite (TweenKleen) with sonic activation and 1% Peracetic acid with sonic activation on the removal of smear layer using a Scanning Electron Microscope(SEM).

MATERIALS AND METHODS:

Thirty anterior teeth with type I canal anatomy and straight roots were selected for the study Teeth were rinsed with distilled water and air dried. A standardized root length of 12mm was achieved by decoronation of the samples at the cementoenamel junction by using a slow speed, water-cooled diamond disc bur to obtain uniform working length. Following this, the samples were randomly divided into two experimental groups and one control group. An ISO hand K-file no.10 K file was used to assess the working length. The working length was checked with a size 10 K-file introduced into the root canal of each tooth up to the point until it became visible at the apex and then pulled back 1 mm. The canals were prepared using hand K-files up to size 80 in a step-down technique. Throughout the preparation, canals were irrigated using a 30 gauge side vented needle with 0.9% saline solution for 1 min after every instrument change. The final irrigation sequence in each group was as follows:

Group I: 5ml 0.9% of saline for 1min.
Group II: 5ml of 1% PAA with Sonic activation for 1min with Endoactivator.
Group III: 5ml of TweenKleen(9% HEBP) + 3% Sodium Hypochlorite with Sonic activation for 1min with Endoactivator.

Final irrigation was done with 5ml of distilled water for each sample. Thereafter, drying of canals was carried out using sterile paper points. Longitudinal grooves were prepared on the buccal and lingual surfaces of each root by using a diamond disc at a slow speed. Care was be taken not to penetrate the root canal. A chisel was used to split the root into two halves. The samples were manually marked at the coronal (9-10 mm from apex), middle (6–7 mm from apex), and apical (2-3 mm from apex) of each specimen before the scanning electron microscopic analysis (SEM) analysis. Coded samples were mounted on metallic stubs, gold sputtered and viewed under a SEM (Hitachi *S-3400N*) in ×1500, 20 kV magnification at coronal, middle, and apical third. These were evaluated by two independent examiners unaware of the experimental groups to which the samples belonged. The images were scored according to the criteria given by Torabinejad *et al*(2003):
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 the root canal surface and the tubules).

Observations, Calculation & Statistical Analysis:
Descriptive statistics was performed using Statistical Package for Social Sciences(SPSS) version 23.0. The inter examiner's reliability was verified using the Kappa test. The data of the score for intragroup comparison and intergroup comparison to evaluate the presence or absence of smear layer were statistically analyzed by Pearson Chi-square test. The level of statistical significance was set at $P < 0.05$.

RESULTS:
The results obtained from this study are summarized in Graph 1 and Figures 1-3. They show the scanning electron photomicrographs of control and irrigated samples by 1% Peracetic acid with endoactivator and Tweenkleen with endoactivator.

According to this study, compared to 1% peracetic acid with Endoactivator, TweenKleen with Endoactivator removed the smear layer more effectively. The superiority of TweenKleen with Endoactivator over 1%Peracetic acid with Endoactivator was especially observed in apical region, although, in cervical and middle regions, these two solutions showed no significant differences. It was also noted that the cervical and middle third had the highest degree of cleanliness compared to other areas, while the apical third had the lowest.

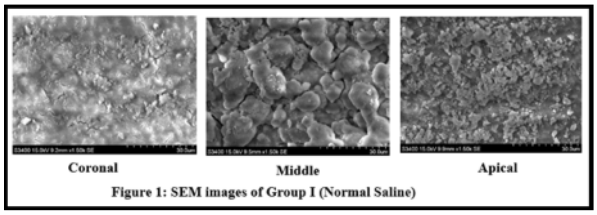


Figure 1: SEM images of Group I (Normal Saline)

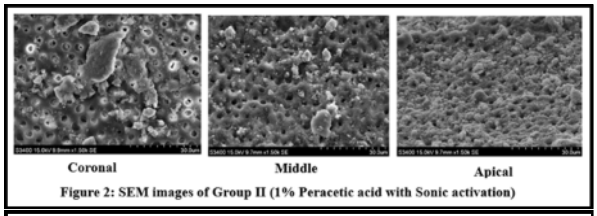


Figure 2: SEM images of Group II (1% Peracetic acid with Sonic activation)

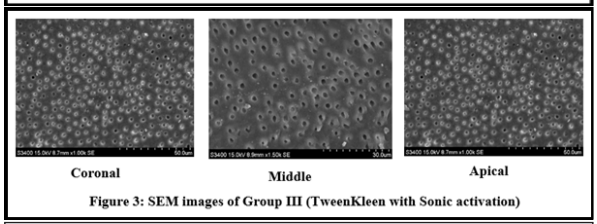
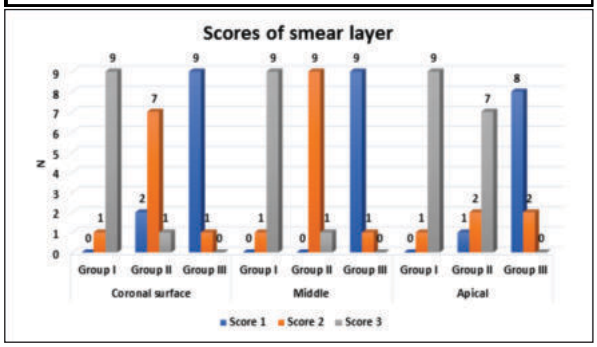


Figure 3: SEM images of Group III (TweenKleen with Sonic activation)



Graph 1: Comparison Of The Tested Irrigants At Coronal, Middle And Apical Third Regions Of The Instrumented Root Canal System.

DISCUSSION:
The most widely used irrigants in endodontic procedures are sodium hypochlorite NaOCl(proteolytic agent), ethylenediaminetetraacetic acid EDTA(demineralizing agent) and chlorhexidine(antiseptic). Evidence has shown that the physical and mechanical properties of the dentin are adversely affected by these irrgants. Sodium hypochlorite is the most potent and universally adopted irrigant because of its excellent tissue solvent and antimicrobial properties in concentrations ranging from 0.5 to 5.25%.[60]However, it is unable to remove the smear layer and hence for complete removal of inorganic phase of smear layer, NaOCl should be mixed with other chelating agents. Ethylenediaminetetraacetic acid (EDTA), a strong chelator, interacts with NaOCl decreasing its antimicrobial effect through reducing the free available chlorine. It also results in excessive erosion of peritubular and intertubular dentine that decreases microhardness of root dentine.[5]

Another irrigant that has been researched is peracetic acid. It is proven to be strongest disinfectant known with antibacterial, sporicidal, antifungal and antiviral properties and it has been used as single endodontic irrigant to disinfect the root canals. The acetic acid content seems to cause smear layer removal while also forming water soluble complexes with calcium.[6]

To overcome the drawbacks of sodium hypochlorite and EDTA, a novel irrigation regimen termed continuous chelation was introduced, in which, a weak chelator, 1-hydroxyethylidene-1,1-bisphosphonate or etidronic acid (HEBP) is mixed with NaOCl, to be used as an all-in-one irrigating solution.[7] It is a weak biocompatible chelator and can used as an all-in-one irrigating solution without influencing the desired properties of NaOCl. The novel TweenKleen solution is a mix of 9% HEBP and 3% sodium hypochlorite.

Conventional irrigation with needles is the standard procedure but unfortunately the cleaning of apical region is compromised. Different irrigation management techniques and devices have been suggested to overcome the shortcomings of conventional needle irrigation. Endoactivator is one such device which uses sonic energy, thus disrupting the smear layer and biofilm throughout the root canal.

Till date, there are no studies in the literature that evaluate the removal of smear layer provided by the use of 1% PAA with sonic activation or 9%HEBP+3%NaOCl with sonic activation.

Studies have revealed different results for 9% and 18% concentrations of HEBP in terms of smear layer elimination. In a study conducted by Ulusoy et al(2017) there was no significant difference in the smear layer removal between the two concentrations.[8] Therefore, to avoid deletorius effects of higher concentration on dentin, lower(9%) concentration of HEBP was used in our study.

In the present study, PAA was used in the concentration of 1% because 2.25% PAA causes dentin erosion.(Lottanti S,2009). 1% peracetic acid has similar antibacterial effect as that of 2.5% sodium hypochlorite and 2% chlorhexidine against E.faecalis.[9]

A 30gauge side vented needle was used in our study which can penetrate more deeply into the apical one third without binding to the canal (Gopikrishna 2016). The additional sideventing increases the contact of the irrigant to the canal walls and forceful passage of irrigants is prevented through the apical foramen.[10]

Group I where normal saline was used showed the presence of highest smear layer (Score – 3) in coronal, middle and apical third regions of root canal. This is due to the fact that Normal saline does not fulfil any of the requirements of an irrigant.

Another irrigant i.e. 1% PAA with sonic activation in Group II was used. It removed smear layer in coronal and middle third region of the root canal. However, it was not completely effective in the apical third. The result of this study were in contrast to the research done by Keine KC *et al* (2019) where 1% PAA as single root canal irrigant provided smear layer removal.[11] The difference in results could be attributed to the use of irrigant after every instrument change in their study whereas it was only used as final rinse for 1 minute in our study.

Group III where TweenKleen, a combination of 9% HEBP and 3% sodium hypochlorite with sonic activation was used, showed the least scores of smear layer removal(Score- 1) in all the coronal, middle and apical third regions of root canal equally. This could be due to the combined effect of sonic activation along with the irrigant. This was in agreement with the previous study reported by Bharathi S(2019) that revelaed 17% EDTA and 9% Etidronic acid were equally effective in the apical third without any much statistical difference in removing smear layer.[12]

The use of sonic activation with the use of Endoactivator(Dentsply) had superior quality of cleaning the root canals. The results of our study were in accordance with the study reported by Castagnola R et

al(2014) who found Endoactivator to be the best for cleaning of the root canal and could be used in addition to conventional irrigation.[13]

CONCLUSION:

Irrigation plays a key role in eradication of etiological factors of endodontic infection and the outcome of successful endodontic therapy. Tweenkleen along with endoactivator could be used for efficient removal of smear layer.

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