International Journal of Enhanced Research in Medicines & Dental Care (IJERMDC),
ISSN: 2349-1590, Vol. 9 Issue 12, December 2022, Impact Factor: 7.125

# Comparative Evaluation of Smear Layer Removal at Apical Third of Root Canal using Various Irrigation Devices-An an Vitro Study

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## INTRODUCTION

The aim of root canal treatment is to clean root canal by considering biological, chemical and mechanical objectives. Bacteria are the main causative factors in pulpal and periapical pathosis. The ultimate goal in cleaning and shaping of root canal system would be canal debridement and to promote apical healing. Though chemomechanical preparation of the root canals is able to reduce the number of bacteria, complete canal disinfection is difficult because of the complexity of the internal root canal anatomy.

It has been shown that both current nickle-titanium instrumentation system and traditional stainless steel hand instruments, leave almost half of root canal walls unprepared. Due to the complex anatomy of the root canal system, an effective disinfection in endodontics is only achieved by augmenting mechanical preparation with antimicrobial irrigants. Complete removal of debris and smear layer removal is not possible alone by means of mechanical instrumentation.

Irrigation has played a main role in endodontic treatment. During and after instrumentation, the irrigants accomodate removal of microorganisms, dentin chips from the root canal through a flushing mechanism of tissue remnants.Optimal irrigation is based on the combined use of two or several irrigating solutions in a specific sequence, to predictably attain the goals of safe and effective irrigation.

In a quest to minimize the smear layer, several irrigants and irrigant activation techniques were accomplished. Effective smear layer removal has been accomplished using chemical means and methods such as ultrasound, laser and hydrodynamic disinfection for its disruption. But there is no established evidence to suggest which material or technique of irrigation is best and reliable the research is still going.

The purpose of the present study was to evaluate the removal of smear layer after treating the root canal with sodium hypochlorite then activating the irrigant with three different irrigation activation devices i.e Laser, Endoactivator, Ultra X

The diode laser (FONA) is recommended for endodontic treatment because its wavelength is within the infrared range where thin and flexible fibers can be used. Studies have shown the bactericidal effects of 810-nm wavelength and 980-nm wavelength diode lasers.

EndoActivator (EA) ((Dentsply, Tulsa Dental Specialties, Tulsa, OK), is a sonically driven irrigant activation system that works on the principle of sonic activation of files this helps to produce hydrodynamic intracanal fluid agitation and smear layer removal.

The ultrasonic activation (ULTRA X EIGHTEEN) is the activation of an endodontic instrument by an ultrasonic device placed inside the root canal. This promotes mechanical agitation of a chemical substance without instrument contact with the root canal wall.

Aim of this study is electron microscopic evaluation of smear layer removal at the apical third of root canal using diode laser, end activator and ultrasonic with sodium hypochlorite.

## MATERIAL & METHODS

The crown of each tooth was sectioned at the cemento-enamel junction with a diamond disk to gain unrestricted access to the root canal system and to obtain a standardized root length of 12 mm. A #8 or #10 K-file was inserted into the root canals until the tip of the instrument was just visible at the major apical foramen to verify patency of the canal space and the apical foramen. The stopper was adjusted to correspond to the flat reference surface. Apices of the roots were sealed with sticky wax to simulate the clinical conditions. The root canal instrumentation was done till size 20 k file after that Coronal third was preflared using the Sx files of ProTaper gold rotary (Denstply Maillefer) then followed by S1,S2,F1,F2,F3 instruments. Each canal was irrigated with total 10mL of 5.25% sodium hypochlorite (NaOCl) solution followed by10 ml of 17 %EDTA after each change of file. Saline was used to flush after the use of each irrigant to terminate its action. Patency was constantly checked.

All the specimens were divided into three groups of 15 each.Final irrigation was done using 3ml of 5.25% NaOCl .

## GROUPING OF SAMPLES

Group A -Laser: Agitation was done with a 200µm fiber optic tip.It was introduced into the root canal up to the working length . Diode laser of 970 nm, 7 watts power, pulsed mode was used. The Laser was activated and withdrawn gently from the root canal to the coronal region with a helicoid movement and reintroduced to the apex for a laser irradiation cycle of 30 sec each for 2 cycle.

Group B Endoactivator: Agitation was done with 3 ml of sodium hypochloride using 27 guage needle for 30 sec followed which endoactivator device was activated for 30 sec at 10000 cycle per minute (167Hz) using a #25/04 polymer tip placed 1mm short of working length in a cyclic axial movement as described in the manufacturer's instruction for use same procedure was repeated once more so total irrigation time with 5.25% sodium hypochloride and activation time was 1minute.

Group C Ultra X: Agitation was done with 5.25% sodium hypochlorite and was activated using the ultra x for 60 sec at 30 khz using #15/02 metal activator tip. In up and down motion as described in the manufacturer's instructions for use The root canals were finally flushed using 5 ml of saline to terminate the action of irrigating solutions.

Specimens were dried and longitudinally cut for Scanning electron microscope examination.

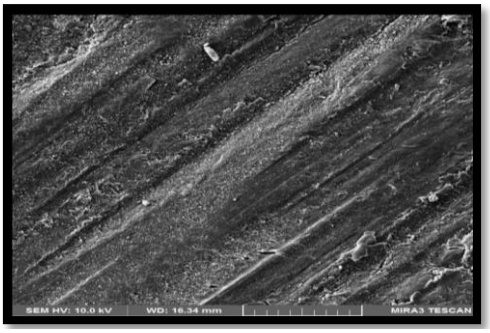


**FIG 1. Showing apical third of group A (Diode laser group) at 1000x magnification**

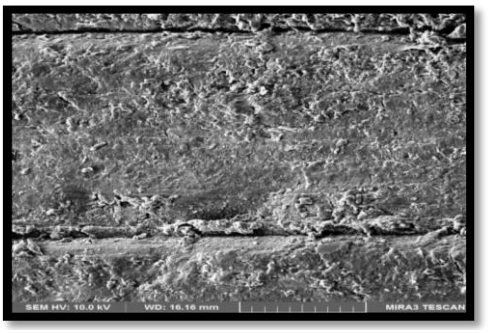


**Fig 2: showing apical third of group B (endo activator) at 1000x magnification**

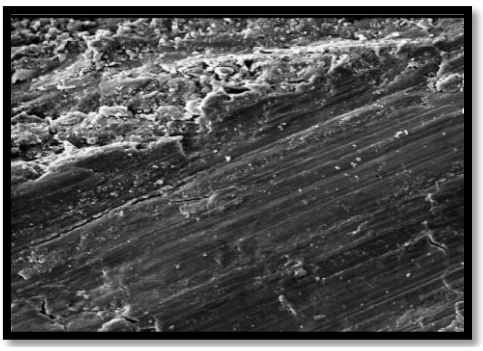

**Fig 3: Showing apical third of group c (Ultra X) at 1000x Magnification**

## RESULTS

The data for the present study was entered in the Microsoft Excel 2007 and analyzed using the SPSS statistical software 23.0 Version.

The intergroup comparison for the difference of mean scores between independent groups was done using the One Way ANOVA followed by Post Hoc Analysis.

**Table 1: Descriptive statistics of mean scores ± standard deviation comparing the remaining smear layer scores in the apical third amongthe three final irrigant activation Devices.**

| Groups | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | |
| **DIODE LASER GROUP(A)** | 2.1667 | .55635 | .14365 | 1.8586 | 2.4748 | 1.50 | 3.00 |
| **ENDOACTIVATOR GROUP(B)** | 2.5000 | .88641 | .22887 | 2.0091 | 2.9909 | 1.00 | 4.00 |
| **ULTRA X GROUP(C)** | 2.6333 | .69351 | .17906 | 2.2493 | 3.0174 | 1.50 | 3.50 |

**Table 2: Inter group comparison of smear layer removal among various studied groups**

| Source | Sum of Squares (SS) | Degree of Freedom (df) | Mean Square (MS) | F Value (ANOVA value) | P Value |
|---|---|---|---|---|---|
| Between Groups | 1.733 | 2 | .867 | 1.650 | 0.204 (NS) |
| Within Groups | 22.067 | 42 | .525 | | |
| Total | 23.800 | 44 | | | |

*Statistically non-significant

**Table 3: Multiple group comparison of smear layer removal among various studied groups**

**Post Hoc Analysis**

| (J) GP | Mean Difference (I-J) | Std. Error | Sig. | Significance |
|---|---|---|---|---|
| Group A vs Group B | -.33333 | .26468 | 0.215 | Non-Significant |
| Group A vs Group C | -.46667 | .26468 | 0.085 | Non-Significant |
| Group B vs Group C | -.13333 | .26468 | 0.617 | Non-Significant |

The mean score in the Diode laser group was 2.1667±0.556, in the Endo activator group it was 2.500±0.886 and in the Ultra X group it was 2.633 ± 0.693. The intergroup comparison between the three groups was statistically non-significant (p=0.204) when analyzed using One way ANOVA. When the post hoc analysis was done the intergroup comparison between Group A and Group B, Group A and Group C, Group B and Group C was statistically non-significant when analyzed using the post hoc LSD analysis and paired t test.

## DISCUSSION

It has been previously reported that more than 35% of the canal walls remain untouched by the endodontic instrumentation. These areas contain tissue remnants and biofilms that might lead to treatment failure as they provide the possibility for microorganisms to cause recolonization. Hence, irrigation plays a vital role during the debridement of the root canal.[1]

The effectiveness of an irrigating solution depends on the method of its delivery into the root canal system. Their action will be enhanced when acting in combination with activation techniques.

Therefore, the present study analyzed newer irrigation delivery systems such as Endoactivator, endoultra and diode laser devices for smear layer removal which are promising techniques that claim to improve the irrigant's effectiveness particularly at the apical third of the canal.

The results of this study showed that the apical third in group A had least smear layer score. This can be explained with a fact that the canal in the apical region is constricted, which can cause the close approximation of laser tip to the root canal walls and thus melting and evaporating the smear layer easily[2].These ultramorphological changes could be attributed to the photothermal, photochemical, photodisruption, photo dissociation, photoplasmolysis, and photoacoustic effect of the diode laser. Localized melting, fusion, and constriction of the dentinal tubule openings were found in many samples as similar to findings of Wang et al.

A study by Abraham, et al clearly shows the advantages of laser treatments over currently used conventional irrigation methods and techniques while using 0.2% chitosan as an irrigating solution.

The results of this study also showed that irrigation activation was effective removed smear layer from apical third. This finding is in agreement with the findings of Saber et al.'sstudy, who reported that in straight incisor, single-rooted premolar, the apical third had the highest amount of SL, regardless of the activation system used. A similar finding was reported by Abarajithan et al., who investigated the amount of SL remaining after irrigation activation in maxillary central incisors. They reported that the apical third contained significantly more SLs in the apical third than in the coronal and middle thirds. Rödig et al. reported similar findings in curved canals. These findings indicate that solution delivery and penetration to the apical third is always a challenge regardless of the needle insertion depth, mode activation.

In this study, the apical third of the canals were least influenced by the ultrasonic irrigation as compared to the other two groups. Ultrasonics is not able to effectively get through the apical vapor lock in the apical 3 mm of the canal. It has been shown that once an ultrasonically activated tip leaves the irrigant and enters the apical vapor lock, acoustic microstreaming and/or cavitation becomes physically impossible which is not the case with the apical negative pressure irrigation technique. This is because acoustic microstreaming or cavitation is only possible in fluids/ liquids, not in gases. The oscillation of the tips of passive ultrasonic irrigation ultrasonic instruments were decreased by constraining it in the root canal. Because the amplitude of the oscillation is largest at the instrument's tip, any attenuation affects the apical part most significantly where the diameter of the canal was smallest. This was

the same as reported by Cameron et al[3] .It was not same as the study results given by Huque et al[4] who reported that does not remove smear layer. This difference might be due to the irrigants and ultrasonic settings used in the study.

## CONCLUSION

Under the limitation of the study, it can be concluded that advanced irrigation devices are efficient in smear layer removal from the apical third of the root canals. Irrigation activation using Diode laser, endoactivator and ultra X did not show significant difference between degree of smear layer removal although diode laser has least smear layer score followed by endo activator and ultra x. Further investigations are warranted for their success.

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