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Research Article

COMPARATIVE EVALUATION OF SMEAR LAYER REMOVAL USING DIODE LASER, PASSIVE ULTRASONIC IRRIGATION AND SONIC IRRIGATION WITH 17% EDTA UNDER SCANNING ELECTRON MICROSCOPE.

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ABSTRACT

Aim- To evaluate and compare the effect of diode laser, ultrasonic and sonic irrigation with EDTA on smear layer removal from root canals.
Materials And Methods-A total number of 45 single rooted mandibular human premolars were decoronated to working length of 12 mm and prepared with Protaper (Densply) rotary files upto size F_3 (0.30mm,4%). Recapitulation and copious irrigation were done for each tooth during the procedure using 3% Naocl. Then sample were randomly divided into 3 groups (n=15) for final irrigation protocol. Group A-Each root sample of the group was agitated with Diode laser filled with 1ml of 17% EDTA for 1 min. Group B-Each sample of the group was treated with Passive ultrasonic irrigation filled with 1 ml of 17% EDTA for 1 min. Group C –Each sample of the group was treated with Sonic irrigation using Endoactivator + 1 ml of 17% EDTA for 1 min. After final irrigation with 5 ml distilled water, Each sample was groove along buccal and lingual planes by using diamond disc and splited longitudinally with beveled chisel and mallet to observe under scanning electron microscope for remaining smear layer at coronal, middle and apical third. Data was noted and analysed by ANNOVA test and Post HOC Tukey's test of each sample for all three group.
Results- It was observed that there was a greater discrepancy between group with respect to apical third .Ultrasonic with EDTA had the least smear layer scores at apical third
Conclusion- At the coronal third and middle third, diode laser irrigation showed maximum smear layer removal, followed by ultrasonic irrigation and sonic irrigation with EDTA . At the apical third, ultrasonic with EDTA irrigation showed maximum smear layer removal and sonic with EDTA irrigation showed least smear layer removal.

INTRODUCTION

During the chemomechanical preparation process of the root canal system, an amorphous and irregular layer is produced on the root canal wall (Torabinejad *et al*., 2002). The mineralized tissue is not shredded or cleaved but shattered to produce considerable quantities of debris (1). Smear layer which is composed of inorganic debris, dentin particles and organic materials including pulp tissue remnants, bacteria and bacterial products prevents the penetration of intracanal medicaments into dentinal tubules and close adaptation of obturation material to root canal walls (2). Shahravan *et al* concluded that removal of smear layer improves the seal of root canal system (3).Irrigation is defined as washing out a body cavity or wound with water and medicated fluid. Endodontic Irrigation is the process of delivery of endodontic irrigants within the root canal.

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Irrigation is complementary to instrumentation in facilitating removal of bacteria, debris and necrotic tissue, especially from areas of the root canal that remain unprepared by mechanical instruments (4)

Effective irrigation depends on various irrigants and irrigation devices and techniques. Various solutions used for removing the smear layer include phosphoric acid, citric acid, maleic acid, ethylenediaminetetraacetic acid (EDTA), and MTAD (a mixture of tetracycline isomer, an acid, and a detergent). Sodium hypochlorite (NaOCl), 1–5.25% concentration as an irrigant is widely used in root canal treatment as it is bactericidal and has the ability to dissolve organic tissues but non effective in removing the smear layer. [5] Traditional needle irrigation has been proved to be insufficient for a complete cleaning of the complex anatomy of root canal system (especially the lateral canals, isthmuses and the apical third), therefore endeavors are being made to develop new irrigants and irrigating devices to improve the root canal disinfection in everyday endodontic practice.[6]

With regard to laser application to endodontics, laser systems such as neodymium:yttrium-aluminum-garnet (Nd:YAG) and carbon dioxide (CO2) lasers have proved effective in cleaning and disinfecting the root canal and lateral dentinal tubules.[7,8] Following development of the laser technique and device, the diode laser has gained increasing importance due to its compactness and low cost. The diode laser is recommended for endodontic treatment because its wavelength is within the infrared range, and thin and flexible fibers can be used. Previous reports demonstrated the bactericidal effects of 810-nm wavelength [9,10] and 980-nm wavelength diode lasers.[11] However, to date, the potential application of 980-nm wavelength diode laser in endodontics has seldom been addressed.

Passive ultrasonic irrigation (PUI) of the root canal involves activation of the irrigant without simultaneous instrumentation by an ultrasonically activated file in the canal.[12,13] Increased ultrasonic-device intensity leads the irrigation solution around the file, within the canal, to move rapidly.[14] De Moor *et al*.[15] compared the effects of PUI and laser-activated irrigation (LAI) on dentin debris, and concluded that the laser technique gives results comparable to those of the ultrasonic technique, with longer irrigation times. Recent studies have shown that ultrasonic activation of irrigants improves debridement compared with conventional syringe irrigation.[16] An ultrasonically oscillating file transmits energy, causing acoustic microstreaming and mixing of the irrigant; it enables the irrigant to reach inaccessible regions, and enhances shear stress on the root canal surfaces at a distance from the file.[17,18]

EndoActivator (EA) ((Dentsply, Tulsa Dental Specialties, Tulsa, OK), the sonically driven irrigant activation system, works on the principle of sonic activation of files (1-6 kHz) to produce hydrodynamic intracanal fluid agitation [19-20]

The purpose of study, *There* have been very *few studies* conducted on diode laser, passive ultrasonic irrigation and sonic irrigation.

This study was conducted for an in vitro comparative evaluation of the smear layer removing efficacy of these three irrigation system (diode laser, Passive ultrasonic irrigation and sonic) at apical, middle and coronal third of root canal under scanning electron microscope.

METHOD AND MATERIALS

A total no of 45 adult human non-carious mandibular premolar teeth were taken for the study. Inclusion criteria were single rooted teeth with straight, patent root and fully formed apices.

Sample preparation

The teeth were stored in 10% formalin solution till they were used for the study. The tooth were cleaned and then decoronated using a dimond disc under water irrigation to obtain a standard root length of 12 mm. After standardization, the working length of each specimen was determined by deducting 1 mm from the actual length. Apex of each root was sealed with sticky wax to stimulate the clinical condition and root canal instrumentation was completed with ISO hand file #20 followed by Protaper (densply) rotary file upto size F_3 . A constant total volume of 15 ml NaOCl was used as irrigant for each root canal during study . Then specimens were randomly divided into 3 groups (n=15) for final irrigation protocol

Group A (Diode Laser + EDTA)- Each specimen was initially irrigated with 0.8 ml EDTA for 40 sec ; The remaining 0.2 ml was used to fill the root canals and diode laser application was done. A 200 micro m, 970+ -15 nm, power max 7 watts fiber optic tip was introduced into the each root canal up to the working length. The laser was activated and gently withdrawn from root canal to the coronal region with a helicoids movements and reintroduced to the apex for total laser irradiation cycle of 20 sec.

Group B (Passive ultrasonic irrigation + EDTA)- The root canals were irrigated with a final flush of 1 ml EDTA with passive ultrasonic activation for 1 min. The activation was performed by using stainless steel ultrasonic tip at 1 mm short of working length during activation. The tip was operated by an ultrasonic system at power setting ½.

Group C (Endoactivator /Sonic Activation+EDTA)

Each canal was irrigated with 1 ml, 17% EDTA using 30 gauge needle. The red endoactivator tip (25/04) was used to activate intracanal solution at speed of 10KHN for 1min.

Each specimen of each group was irrigated with 5 ml distilled water .The teeth were grooved along buccal and lingual planes using a diamond disc at low speed. Each root specimen was then splited longitudinally with bi beveled chisel and a mallet .One half of each root was selected depicting the entire root canal length and prepared for scanning electron microscope examination. The selected root specimens were progressively dehydrated using graded concentration of aqueous ethanol for 24hr. After dehydration, samples were placed in a vacuum chamber and sputter coated with a 30 nm gold layer. The dentinal wall of the each specimen was examined at coronal, middle and apical third at a magnification of ×1000 for smear layer evaluation and patency of dentinal tubules. Photomicrographs of each specimen was taken at coronal, middle and apical level for scoring in a calibrated single blind manner according to rating system developed by Hulsmann *et al*.

Hulsmann rating system for remaining smear layer score

Statstical Analysis and Method

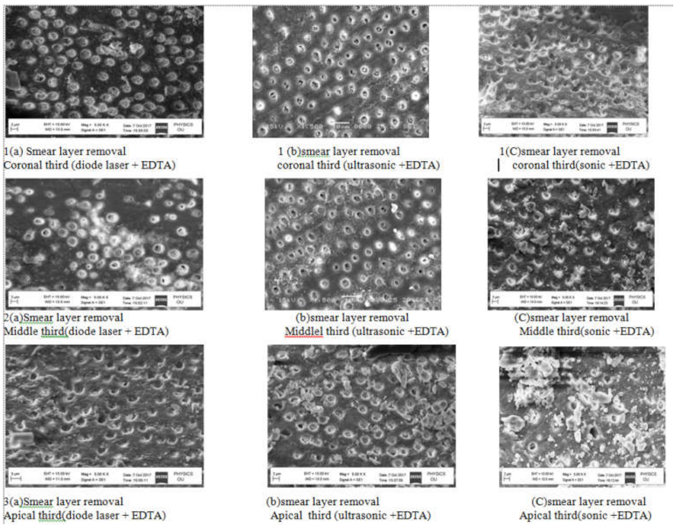
Data was collected by using a structure Performa. Data was analyzed by using SPSS 19.0 version IBM USA.Quantitative data was expressed in terms of Mean and Standard deviation Comparison of mean and SD between all groups were done by using One way ANOVA test. If ANOVA was significant (p value of <0.05), Post Hoc Tukey's HSD test was carried out to assess whether the mean difference between a pair of group is significant or not

A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant.

RESULT

If group A compared with Group B there is no significant (p value> 0.05) difference at coronal , middle and apical third .

If Group A and Group B compared with Group C, There is significant (p value of <0.05) difference at coronal, middle and apical third.



Intergroup comparison at coronal third (Table 1)-ANNOVA test

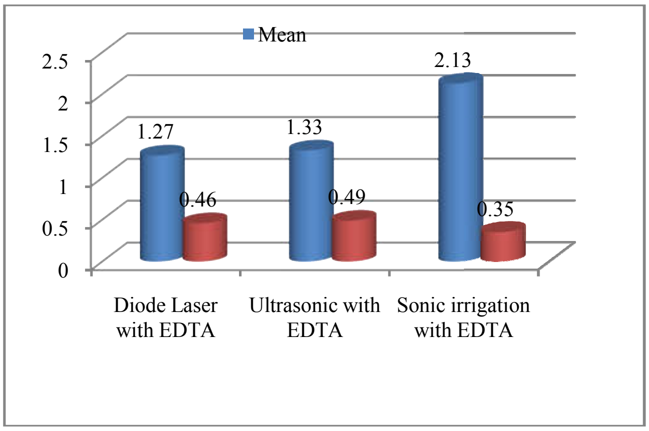
		N	Mean	Std. Deviation	F	df	p	Inference
CORONAL	Diode Laser	15	1.27	.46	18.32	2	0.0001 (<0.001)	Highly significant
	Ultrasonic	15	1.33	.49				
	Sonic irrigation	15	2.13	.35				
	Total	45	1.58	.58				

Post Hoc Tukey's HSD test to see whether the mean difference between individual group is significant or not

Post Hoc Tukey's HSD test at coronal third (Table 2)

	Ultrasonic	Sonic irrigation
Diode Laser	-0.06	-0.86*
Ultrasonic		-0.80*

*Indicates that the difference in the mean is significant at 0.05 level.



Graph 1

2 Intergroup comparison at Middle third (Table 3)-ANNOVA test

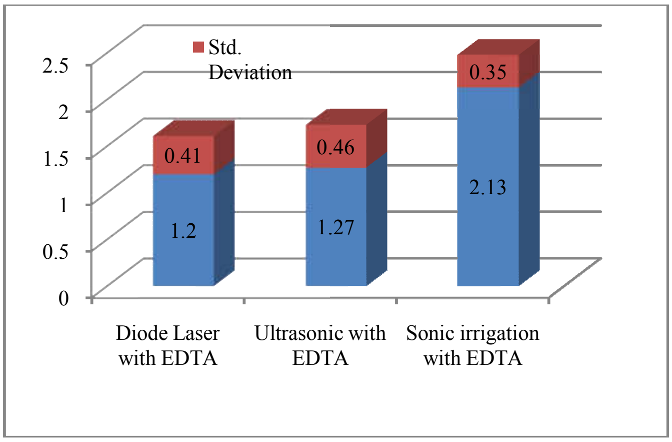
		N	Mean	Std. Deviation	F	df	P	Inference
MIDDLE	Diode Laser	15	1.20	.41	24.17	2	0.0001 (<0.001)	Highly significant
	Ultrasonic	15	1.27	.46				
	Sonic irrigation	15	2.13	.35				
	Total	45	1.53	.59				

Post Hoc Tukey's HSD test to see whether the mean difference between individual group is significant or not

Post Hoc Tukey's HSD test at Middle third (Table 4)

	Ultrasonic	Sonic irrigation
Diode Laser	-0.06	-0.93*
Ultrasonic		-0.86*

*Indicates that the difference in the mean is significant at 0.05 level.



Graph 2

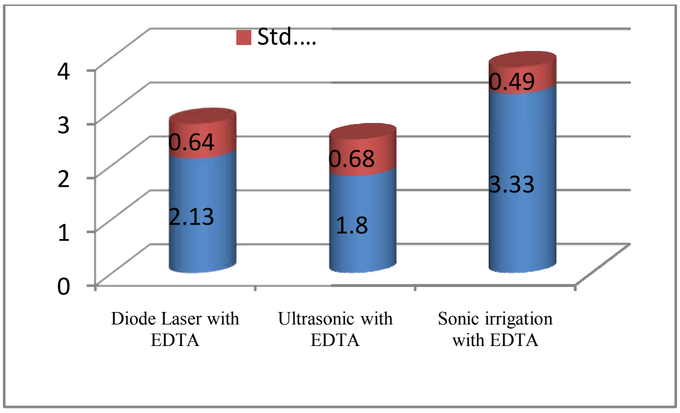
3Intergroup comparison at Apical third (Table 5) ANNOVA test

		N	Mean	Std. Deviation	F	df	p	Inference
APICAL	Diode Laser	15	2.13	.64	26.49	2	0.0001 (<0.001)	Highly significant
	Ultrasonic	15	1.80	.68				
	Sonic irrigation	15	3.33	.49				
	Total	45	2.42	.89				

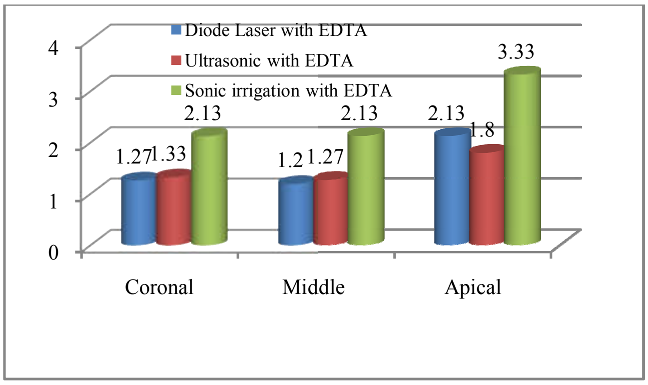
Post Hoc Tukey's HSD test at Middle third (Table 6)

	Ultrasonic	Sonic irrigation
Diode Laser	0.33	-1.20*
Ultrasonic		-1.53*

*Indicates that the difference in the mean is significant at 0.05 level.



Graph 3



Graph 4

Among all the 3 categories Diode laser at coronal third showed the minimum SEM score, average being 1.27. Statistically the score is not significantly (p value> 0.05) compared ultrasonic irrigation and significant (p value of <0.05) with sonic irrigation.

Among all the 3 categories Diode laser at middle third showed the minimum SEM score, average being 1.2. Statistically the score is not significantly (p value> 0.05) compared ultrasonic irrigation and significant (p value of <0.05) with sonic irrigation.

Among all the 3 categories passive ultrasonic irrigation at apical third showed the minimum SEM score, average being 1.8. Statistically the score is not significantly (p value> 0.05) compared diode laser irrigation and significant (p value of <0.05) with sonic irrigation.

DISCUSSION

During chemo-mechanical preparation of root canal either by hand or using rotary instruments, smear layer is created (Torabinejad *et al*., 2002)[21]. Smear layer is an amorphous layer containing inorganic as well as organic debris, micro-organisms and their byproducts (Abarajithan *et al*., 2011)[22]. Smear layer prevents irrigant, medicaments and sealer penetration into dentinal tubules and therefore prevents adequate disinfection of canal. Alternate use of 2.5% NaOCl and 17% EDTA with conventional needle and syringe is most commonly used method to disinfection of canal, but can not remove smear layer completely [23]. So different agitation Methods like ultrasonic, sonic, and laser have been tried.

Passive ultrasonic irrigation involves simultaneous irrigation with an ultrasonically activated file; which has been to be efficient in inaccessible region and apical region also. Ultrasonically activated files have the potential to prepare and debride rootcanals mechanically. The files are driven to oscillate at ultrasonic frequencies of 25–30 kHz that are beyond the limit of human hearing. The files operate in a transverse vibration, setting up a characteristic pattern of nodes and anti-nodes along their length (Walmsley 1987, Walmsley & Williams 1989). In PUI technique, Transient cavitation only occurs when the file can vibrate freely in the canal or when the file touches lightly the canal wall. When the root canal has already been shaped, the file or wire can move freely and the irrigant can penetrate more easily into the apical part of the root canal system and the cleaning effect will be more powerful [24, 25]

Diode laser has been used commonly in routine endodntic practice because of its Wavelength 810 nm, low cost, compactness and thin flexible fiber tube for delivery. Also the thermal side effects are minimum[26, 27, 28]

Sonic irrigation also gained popularity because of its low cost, easy availability and ease of operation. It is sonically driven canal irrigation system. It consist of portable handpiece and three type of disposable flexible polymer tips of different sizes and work on agitation of tips by sonic activation [29, 30, 31]. In present study diode laser activation and passive ultrasonic activation both found equally efficient in remaining smear layer at coronal, middle and apical third of root canal (Table 1,2,3 Graph 1,2,3). Our findings are in confirmation with findings obtained in study done by George *et al* Arslan *et al*.

Diode laser generates shockwaves form cavitation , results in shear stresses and hyrdraulic stresses on the root canal wall. To this physical agitation, laser activation of EDTA increases its temperature and also causes expansion of irrigant which further increases wettability and decreases surface tension of EDTA (32).

Similarly agitation with ultrasonic file induces acoustic streaming which directs jet of irrigant toward the root canal which produces shear stresson smear layer. In addition to shear stresses, it also removes debris 3mm beyond the file tip which makes the forceful elimination of smear layer, even in curved canals.[33]

In present study, sonic irrigation was found least efficient in remaining smear layer in coronal, middle and apical third region. The findings of our study are in confirmation with the findings obtained by David Uroz-torres *et al*

This might be due to sonic frequency which has range much lower than ultrasonic irrigation and laser irrigation and therefore the acoustic microstreaming would not be as efficient as them and so would be the smear layer, removing efficiency.[34]

CONCLUSION

At the coronal third and middle third , diode laser irrigation showed maximum smear layer removal, followed by ultrasonic irrigation and sonic irrigation with EDTA.

At apical third, ultrasonic with EDTA irrigation showed maximum smear layer removal and sonic with EDTA irrigation showed least smear layer removal

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