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Original Research Article

Comparison of Smear Layer Removal with Diode Laser, Canal Brush, 17% EDTA Solution - A Short Study

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ABSTRACT

Aim and objective: To evaluate the efficacy of canal brush, diode laser, 17% EDTA solution with NaoCl as irrigant during instrumentation on smear layer removal.
Materials and Methods: 36 freshly extracted single rooted mandibular premolars were collected, stored in distilled water, decoronated to 14mm length and instrumented up to F3 protaper. Irrigation was done with 1ml 3% NaoCl in all experimental groups while irrigated only with distilled water in control group & were assigned into groups: control, Laser, Canal brush, 17% EDTA groups, finally irrigated with distilled water, stored separately in labeled bottles. Now roots were split longitudinally in B-L plane, grooved at 4, 8,12mm length from root apices, dehydrated in series of ethanol, gold sputtered & photographed using SEM. Smear layer removal was evaluated.
Results: At apical third LASER, at middle third EDTA, at coronal third EDTA is best in smear layer removal. Canal brush good at apical third in smear layer removal next to laser
Conclusion: Based on this study, combined use of physical method & irrigant improves the efficacy of smear layer removal especially at apical third. Hence it is suggested to use 17% EDTA along with LASER.

Keywords: Canal brush, 17% EDTA, Laser, NaoCl, Smear layer, SEM.

INTRODUCTION

The success of the root canal therapy depends on the method and quality of instrumentation, method of irrigation, type of irrigant used, disinfection and 3-D obturation in root canal system. The aim of instrumentation and irrigation is for disinfection of root canal system, prior to obturation. It has been shown under SEM, that a layer of sludge material is always formed over the surface of dentinal walls; whenever dentine is cut (BOYDE and KNIGHT in the year 1970).This layer of debris has been called the "smear layer". Boyde et al. (1963) first described the presence of smear layer on the surface of cut enamel while Mc Comb and smith (1975) observed this layer on the walls of instrumented root canals and reported that it was similar in appearance to smear layer, formed on cut enamel. Instrumentation produces1-5µm thick smear layer on dentinal surface, [(1)] consisting of organic and inorganic components, such as vital or necrotic pulp tissue, microorganisms, saliva, blood cells and dentinal debris. [(2)] Bacteria harbor themselves deep into dentinal tubules and may survive for longer period and may cause reinfection later. For this reason, it becomes mandatory to remove smear layer from root canal for optimum success of treatment. [(3)] Sodium hypochlorite considered one of the most efficient endodontic irrigants, merely removes the

organic part of the smear layer. Therefore, Sodium hypochlorite has been used in association with 17% EDTA (Ethylene Diamine Tetra Acetic acid) solution, which acts on inorganic portion formed in instrumented root canal. To achieve the optimum results in clinical conditions, it is recommended to leave 17 % EDTA inside the root canal for 15 minutes [(4)] however; this longer exposure of EDTA can cause excessive removal of both peritubular and intratubular dentine. Most of the studies have demonstrated incomplete smear layer removal with these agents, especially in the apical third of the root canal. Researchers have proposed that improved irrigant activation methods to address this issue. [(5)] In the past, various activation techniques have claimed to be successful in smear layer removal such as manual, sonic and ultrasonic devices and all of them with conflicting results. Recently, activation of irrigating solutions with laser devices becomes popular. Diode laser have gained increasing importance in dentistry owing to their compactness and affordable cost .A combination of smear layer removal, bacterial reduction and reduced apical leakage are advantages of using this laser [(5)] and make it viable for endodontic treatment. Canal brush (coltene / Whaledent) is an endodontic microbrush recently introduced. This highly flexible micro brush is molded entirely from polypropylene and can be used with rotary action in a contra angle hand piece. It is considered that use of small and flexible canal brush with irrigation solutions remove debris from root canal extensions and irregularities. [(6)] But still there are very few studies about this. Therefore, present study is planned to evaluate the efficacy of Diode laser and Canal brush on removal of smear layer in coronal, middle and apical third of root canal.

MATERIALS AND METHODS

Selection and Preparation of Teeth Specimens:

A total of thirty six freshly extracted single rooted permanent human mandibular premolars, with a single root canal and complete root formation, extracted for orthodontic or periodontal reasons were used. All the teeth were non carious teeth. After extraction, intact apical root tips, presence of single root canal, were verified with the periapical radiographs. Inclusion criteria were permanent teeth with intact apices, no previous endodontic treatment and no restorations. Exclusion criteria were root length shorter than 15mm, extensive restorations, root caries, cracks and fractures. The teeth were cleaned from attachment debris and calculus and then stored in deionised water until used in the study. Standardized the length of roots to 14mm, by decoronation of all those selected teeth with diamond disc under water coolant. Working length was established by reducing 1mm from anatomical length.10K file was inserted into canal orifice until its tip became just visible through apical foramen. All root canals were instrumented with protaper Ni-Ti rotary instruments upto F3 size (0.3mm) to facilitate better irrigation, penetration and to allow tips of devices to reach appropriate working length. During the instrumentation, irrigation was done with of 3% NaoCl between each file in all experimental groups while irrigated only with distilled water in control group. Finally, after root canal preparation the canals were flushed with sterile distilled water to terminate any solvent action of the irrigants. All the root canals were dried with sterile paper points. After preparation, all specimens were enclosed with sticky wax to create closed end canal model and divided as following groups: 1.Control 2.Laser 3.Canal brush 4.17% EDTA solution.

Laser Group:

980nm wavelength GaAlAs diode laser device was used in this experiment. Power -3W, frequency -10 Hz is used, Diode laser used in pulsed mode, for 10 cycles of 10 sec/cycle. The delivery system consists of flexible fiber that had 200 µm diameter. 3%NaoCl was placed in the canals of specimens and then lased for 10secs. It must be stressed that the laser tip should be

in constant motion while in root canal during irradiation to avoid rise in temperature on root surface. Fiber tip was moving in clockwise direction combined with inward and outward movement (spiral motion). Between the each lasing cycle, 1ml of fresh irrigant was flushed through the canal to attenuate any thermal stress on external root surface. A final rinse of distilled water following the 10th cycle was used to remove residual irrigant (fig 1).

Fig (1): Laser Group

Canal Brush Group:

Recently, Canal brush (Coltene, Germany) specifically fabricated for root canal cleaning and it has been introduced which are available in three sizes (small, medium and large) to correspond for apical diameter of 25, 30, 40 respectively, according to ISO classification. This is used in conjunction with contra angle handpiece at speed of 450 rpm for 20s for 5times. 3%NaoCl was delivered into root canal with a 30 gauge needle, application of canal brush. Between each time of application of canal brush, 3ml of the same solution was flushed through the canal. At the end all specimens received, final rinse with distilled water to remove any remaining irrigants (fig 2).

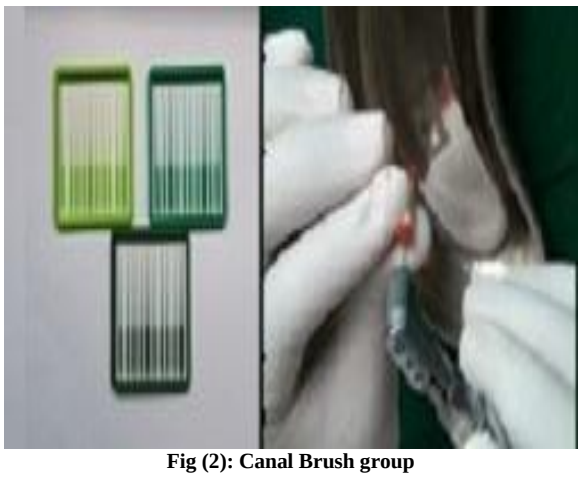


Fig (2): Canal Brush group

17%EDTA Group:

Here 17%EDTA solution was left in the canal for 50secs followed by flushing of 3%NaoCl solution and again 17%EDTA solution is left in the canal for 50 secs and finally rinsed with distilled water to remove residual irrigants if any.

Control Group:

Here no any specific irrigation protocol is followed to remove smear layer. Only instrumentation done under distilled water, to assess the maximum smear layer that can be formed after instrumentation.

Specimen Preparation for Sem Analysis

All The root canals were dried with paper points. A longitudinal groove in the buccolingual direction was made using a diamond disk. Colored gutta-percha cones were used to prevent the intrusion of the cutting disk into the canals. [7,8] Specimens were split by applying slight pressure to an enamel chisel into the longitudinal groove (fig 3), and one half of the specimen was randomly chosen for scanning electron microscope (SEM) evaluation.

Each specimen was dehydrated in ascending graded series of aqueous ethanol solutions (80%, 90%, 100% for 15mts per step) mounted on stubs, gold-sputtered and examined under Scanning electron microscope. SEM photomicrographs were

taken at apical third (4mm from apex), middle third (next 4mm) and coronal third (next 4mm) of all the specimens for analysis.

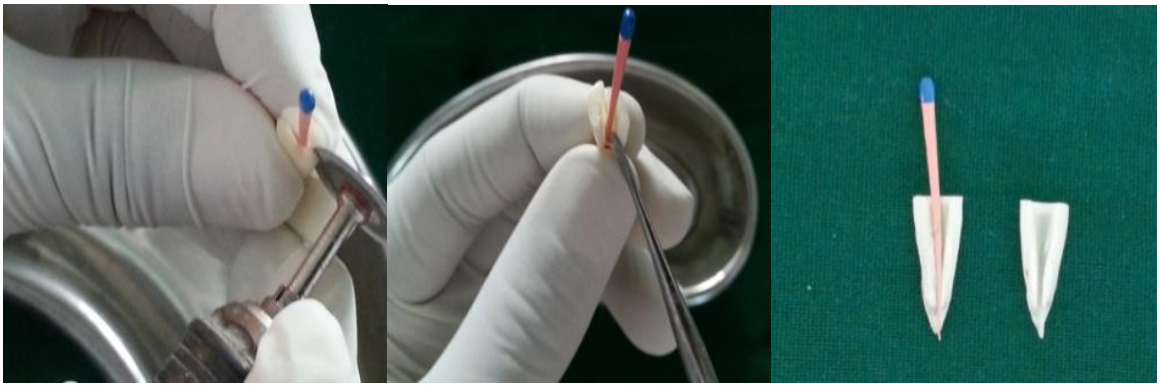


Fig (3): Splitting tooth specimen with enamel chisel

The amount of smear layer was assessed and recorded in accordance with the criteria proposed by Sadr- Lahijani et al. **(7,9)**

Score 1- Dentinal tubules completely open.
Score 2- >50% dentinal tubules open.
Score 3- <50% dentinal tubules open.
Score 4- Nearly all of the dentinal tubules covered with smear layer.

SEM figures representing the scores according to Sadr-Lahijani et al criteria:

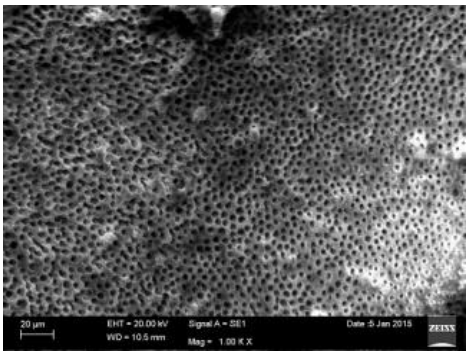


Fig (4): Score 1 Dentinal tubules completely open

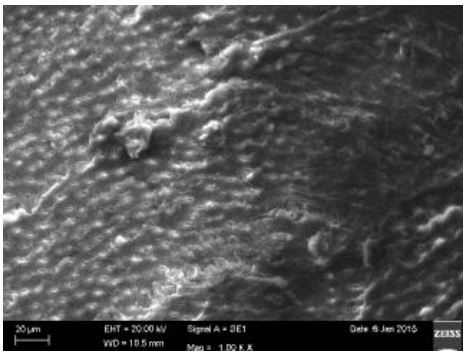


Fig (5): Score2 >50% dentinal tubules open

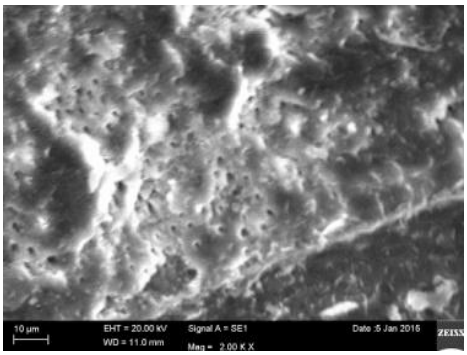


Fig (6): Score3 <50% dentinal tubules open

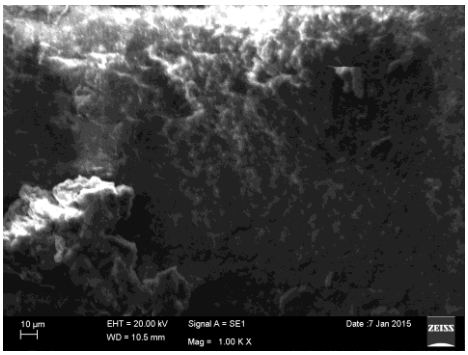


Fig (7): Score4 nearly all of the dentinal tubules covered with smear layer.

Note: The less the score, more will be the efficacy of smear layer removal

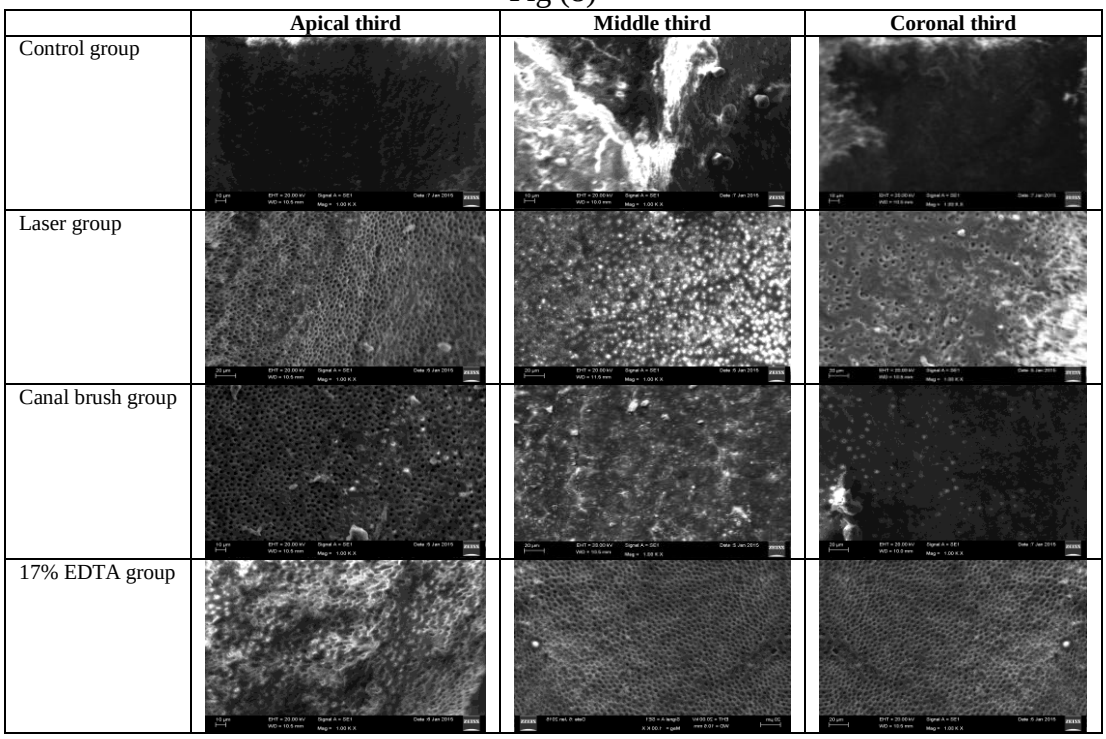
Statistical Analysis

Data was analyzed using SPSS software version by non-parametric Kruskal-Wallis test.

RESULTS

SEM figures at canal thirds of all groups are given below:

Fig (8)

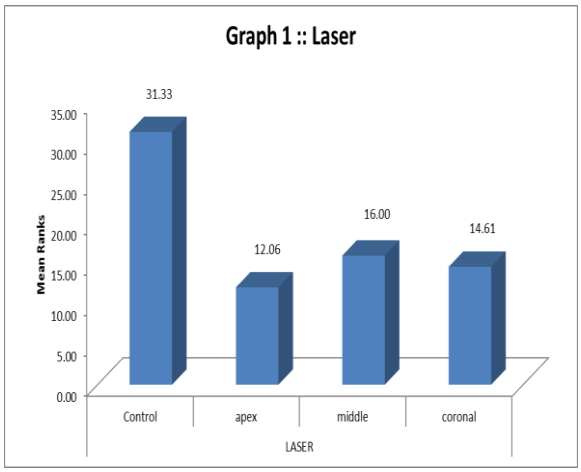


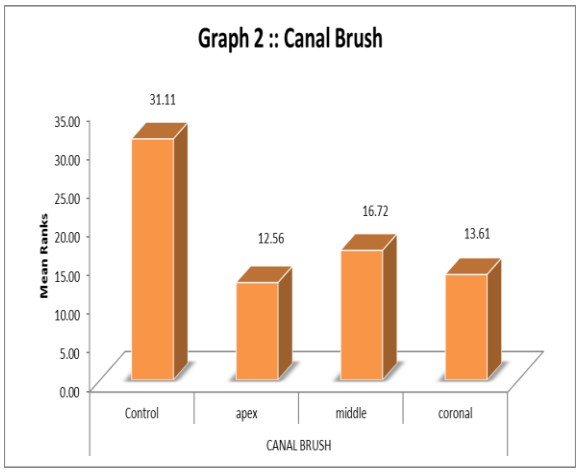
	GROUP	N	Mean Rank	Chisquare	p value	Sig
LASER	Control	9	31.33	21.074	0.000	**
	apex	9	12.06			
	middle	9	16.00			
	coronal	9	14.61			
	Total	36				
CANAL BRUSH	Control	9	31.11	21.202	0.000	**
	apex	9	12.56			
	middle	9	16.72			
	coronal	9	13.61			
	Total	36				
EDTA	Control	9	31.44	25.930	0.000	**
	apex	9	18.78			
	middle	9	14.44			
	coronal	9	9.33			
	Total	36				

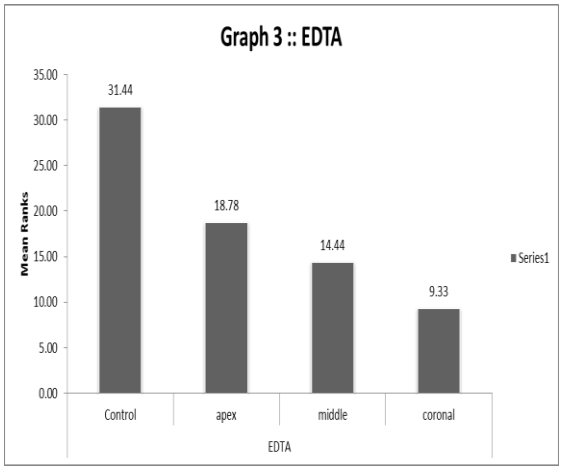
Table 1: Inter Group Comparison

	groups	N	Mean Rank	Chisquare	p value	sig
apex	Control	9	31.22	22.101	0.000	**
	Laser	9	11.22			
	Canal Brush	9	13.78			
	EDTA	9	17.78			
	Total	36				
middle	Control	9	31.11	21.350	0.000	**
	Laser	9	14.11			
	Canal Brush	9	16.72			
	EDTA	9	12.06			
	Total	36				
coronal	Control	9	31.56	24.302	0.000	**
	Laser	9	15.50			
	Canal Brush	9	16.78			
	EDTA	9	10.17			
	Total	36				

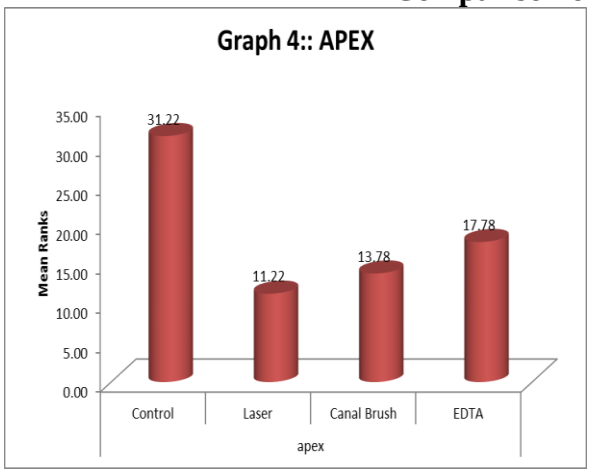
Table 2: Comparison of canal thirds

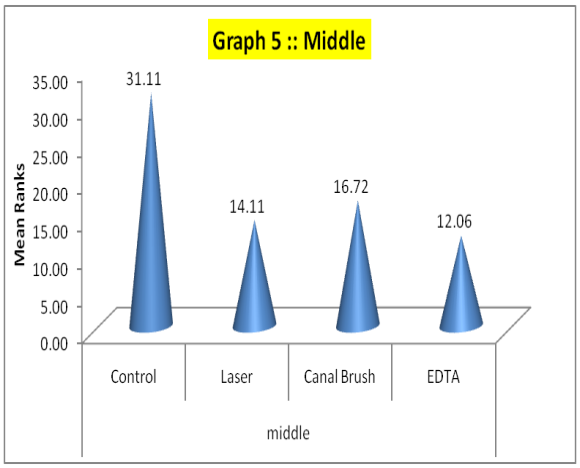


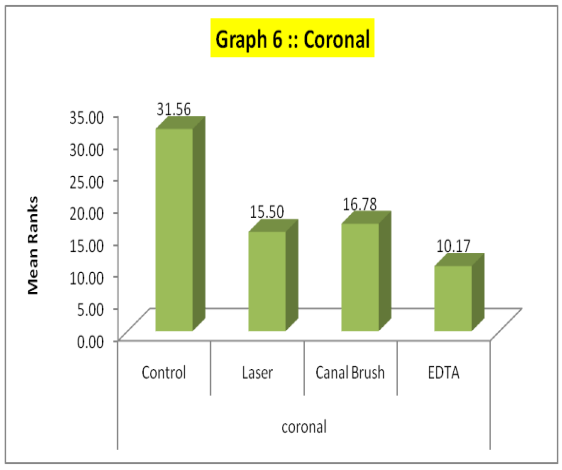




Comparison of Canal Thirds







Intergroup comparison shows that diode laser is the best at apical third in smear layer removal followed by canal brush and then by 17% EDTA solution. At middle third 17% EDTA is the best in smear layer removal followed by laser and canal brush. At coronal third 17% EDTA is the best followed by laser and canal brush.

Comparison between canal thirds with in laser group apical third shows highest smear layer removal efficacy, there was no statistically significant difference between coronal and middle thirds. Within canal brush group, apical third showed highest smear layer removal. However the efficacies of coronal and middle third were not significantly different from each other. While 17% EDTA shows best at coronal third followed by middle and was least at apical third.

DISCUSSION

The removal of any vital and necrotic pulp tissue, microbes and their toxins along with smear layer is essential for endodontic success. Studies have shown that currently used method of especially rotary instrumentation technique produces a smear layer that covers root canal walls and block opening of dentinal tubules. Therefore, this

study evaluated the efficacy of diode laser and canal brush on removal of smear layer and EDTA as it is one of the acceptable method that removes the smear layer.SEM is one of the most commonly used techniques to assess the removal of smear layer. [(7)]

To the authors knowledge this is the first study to compare the effectiveness of diode laser irradiation and canal brush as a means for activation or/ and agitating the irrigants to enhance the smear layer removal in apical third of the root canal system. Given the challenge of effective cleaning of root canal system, a technique which augments the effects of existing irrigants is of the potential clinical interest.

In present study, minimum scores were observed in group I (980nm Diode laser) at apical third. It showed the efficacy of laser is more followed by canal brush and 17% EDTA at apical third. 17% EDTA showed minimum scores at middle third and at coronal third followed by diode laser and canal brush. This can be attributed to the narrower canal in the apical third. If the root canal is narrower, then the laser tip will be closer to canal wall, it is easy for melting and evaporating the smear layer. [(5)]

Canal brush is rotated at 450 rpm for 20 secs to agitate the irrigant solution inside the canal to remove debris and is more efficient at apical third next to laser than middle and coronal third. The probable reason could be because of canal brush disrupts vapor lock and hence enables more volume of irrigants to reach apical third of the root canal. A recent report by Weise et al showed that the use of the small and flexible canal brush with an irrigant removed the debris effectively from simulated canal extensions and irregularities. [(6)]

Nishi Singh et al. compared the smear layer removal efficacy of three different irrigant activation systems (canal brush, endo-activator and F-file) showed significant differences among the three groups. Concerning smear layer removal at apical third, canal brush presented the best results. [(10)]

The use of compact near infra-red diode laser of 980nm wavelength may offer benefits such as photo thermal disinfection and bio stimulation. Such effects rely on penetration of near infra-red laser energy through dentine, means that the microorganisms distant from root canal space could be inactivated which would add to antimicrobial effects from irrigants. Diode laser parameters used in this present study were based on the known threshold laser settings required to induce agitation in cavitation and shock waves using 980nm diode laser. [(11)]

Mohamed Helmy et.al, by his electron microscopic study, determined the effect of 980nmdiode laser and some irrigants (H_2O_2 and NaoCl) on surface morphology of root canal wall and concluded that SEM showed a smoother dentine surface with the removal of smear layer and debris when treated with laser irradiation compared to irrigation with NaoCl and H_2O_2. This improves adaptability of sealer to root canal wall. Thus, diode laser will be future therapy in endodontic treatment for cleaning the root canal of tooth. [(12)]

The results observed by Xiaogu Wang et al., in his study, Effect of diode laser on smear layer removal from root canal walls and apical leakage after obturation is in support with the results of this study as the diode laser 980nm removes the smear layer the best at apical third. Diode laser removes smear layer and debris as best at apical third and reducing apical leakage after obturation and would be useful for root canal treatment in clinic. [(5)]

Xiangjun Guo et. al, compared different irrigant activation techniques combined with 3% NaoCl and 17% EDTA in smear layer removal. The results showed that without any activation, combination of NaoCl used as irrigant during root canal preparation and 17% EDTA as final irrigant was effective for smear layer removal, but complete removal of smear layer was not

achieved particularly in apical third, probably because of the following reasons: (1) As the diameter of the root canal gradually decreased from the coronal to apical third, the volume of the irrigant decreased, which decreased the liquid backflow. Thus, less irrigant was flushed into the apical third than the middle and coronal thirds; (2) fewer dentinal tubules were found in the apical third compared with the middle and coronal thirds, and the extent of mineralization increases with age. [13]

Presence of apical vapor lock effect adversely affect debridement efficacy especially for needle irrigation technique. [7,14] probably because of this reason, 17%EDTA solution showed less efficient in smear layer removal at apical third of root canal, also in 17%EDTA group there is no any irrigant activation technique to disrupt apical vapor lock effect.

Findings of this present study demonstrate that compared with a conventionally instrumented root canal wall, a canal wall prepared by mechanical instrumentation combined with diode laser was significantly cleaner at apical third, 17% EDTA solution is significantly more efficient at coronal and middle third than at apical third compared to diode laser and canal brush. Canal brush also showed better smear layer removal at apical third but not more efficacy than diode laser. Further studies are needed to compare the efficacy of newer irrigant activation techniques in root canals.

CONCLUSION

Within the limitations of this study, it is concluded that laser is more efficient at apical third followed by canal brush, 17% EDTA is more efficient at middle and coronal third in removal of smear layer. Not even a single system is efficient in smear layer removal totally. Hence it is recommended that the combined use of physical methods and irritants to improve the effectiveness of smear layer removal especially at apical third. Hence, it is suggested to use the combination of 17% EDTA solution and Diode laser to remove smear layer. With the laser use, surface tension of EDTA can be reduced. Increasing the temperature results in increased wetting of the root canal surface. Thus, resulting in better way for removal of smear layer on root canal system.

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