THE IMPACT OF DIFFERENT IRRIGANT SOLUTIONS AND ACTIVATION TECHNIQUES ON SMEAR LAYER REMOVAL: AN IN VITRO STUDY

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ABSTRACT

Background: Smear layer formed during root canal preparation that affects irrigation activity, which in turn affects the success of endodontic treatment. The aim of this study was to evaluate and compare the effectiveness of three irrigant solutions (ethylenediaminetetraacetic acid (EDTA), Triton and QMix) combined with three activation techniques (Sonic, Ultrasonic, Diode laser) on smear layer removal.

Materials and Methods: Ninety single-rooted extracted mandibular premolars were selected and decoronated to a length of 12 mm instrumented biomechanically with Pro Taper Next files up to size X3. The roots were then divided into three groups according to final irrigation (17%EDTA, Triton, QMix) each (number=30), then each group subdivided into three sub group according to activation method (Sonic, Ultrasonic, Diode laser) each (number=10). The samples were sectioned longitudinally and analyzed using a four-level scoring system in the coronal, middle, and apical thirds under a scanning electron microscope at 3000x magnification.

Result: In the apical third, Triton activated by diode laser demonstrated significant improvement in smear layer removal compared to sonic activation ($p<0.05$) and was also significantly more effective than the QMix group ($p<0.05$). There was no significant difference in activation methods between other groups ($p>0.05$). The coronal thirds observed significant cleaning ability compared to the apical third across most groups ($p<0.05$).

Conclusion: Diode laser-assisted Triton irrigation optimizes smear layer removal in the apical area, outperforming Sonic and QMix, which enhance cleaning performance. Overall, better cleaning in the coronal and middle third than the apical thirds.

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Keywords: Irrigation, Smear layer, Scanning electron microscope, Diode laser.

The three key components of root canal therapy are cleaning, shaping, and filling, these must be well integrated for successful treatment; chemical cleaning is essential for smear layer removal and disinfection[1].

The smear layer, created during canal shaping, contains pulp remnants, dentin debris, and bacteria; it covers dentinal tubules impedes irrigant and medication penetration and increases micro-leakage and treatment failure risk; hence, removal is recommended[2].

Irrigation plays a crucial role in cleaning and shaping root canals by removing necrotic tissue and dentine debris from prepared areas[3]. The Most commonly used irrigation is sodium hypochlorite (NaOCl) which efficiently eliminates organic substances and demonstrates antibacterial characteristics, also Ethylenediaminetetraacetic acid (EDTA), a chelating agent, effectively eliminates inorganic substances. The smear layer, composed of both organic and inorganic substances, necessitates the usage of a combination of NaOCl and EDTA for its

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removal[2]. Triton (Brasseler, Savannah, USA) is an innovative endodontic irrigation solution that integrates the benefits of NaOCl, EDTA, and chlorhexidine (CHX) into a single-step (all-in-one) formulation, Triton differs from standard irrigants and advanced solutions in that it is employed as a single irrigation during the procedure rather than a final irrigant[3].

The QMix is a premixed solution containing (CHX), (EDTA), saline, and a surfactant. This formulation provides both antimicrobial and smear layer elimination capabilities addressing the challenges posed by the complex anatomy of root canals where mechanical instrumentation often leaves areas untouched[4].

Advanced techniques, including ultrasonic, sonic and laser-activated irrigation, have been developed to enhance debridement. The action of sonic devices with sonically driven polymer tip generates hydrodynamic phenomena that facilitate the movement of irrigants within the canal, enhancing their cleaning ability[5].

Ultrasound devices produce sound waves characterized by minimal amplitudes and elevated frequencies (25-30 kilohertz), as they go laterally, their vibrations establish a network of nodes and antinodes, an oscillating tip conveys energy to the irrigant in the root canal by passive ultrasonic irrigation. The outcome is cavitation, which facilitates the elimination of dentin particles, along with sonic streaming[6]. Diode laser their primary application in the endodontic treatment process is photothermal disinfection and the activation of the chemical action of irrigants, such as sodium (NaOCl) and (EDTA)[7]. Laser-guided irrigation effectively removes the debris and smear layer from the root canal system by creating unstable vapor bubbles with a secondary cavitation effect[8].

Irrigation is a crucial component of root canal debridement; yet, the conventional irrigation solutions and techniques are insufficient for thorough root canal cleansing. Therefore, the present study compares a new irrigant, Triton, with QMix and EDTA using (sonic, ultrasonic, diode laser) activation to evaluate the impact of these irrigants and activations as a final irrigation protocol on smear layer removal under scanning electron microscope (SEM).

MATERIALS AND METHODS

The present study was conducted in the Conservative Department/ College of Dentistry/ in Duhok City. The study was conducted from November 2024 to July 2025. The study design was an invitro experimental study on extracted lower mandibular premolar teeth that had been extracted for orthodontic reasons. patient age between 18 to 25 years old. The current study was approved by the research team ethics committee of Duhok Directorate of health and college of dentistry, University of Duhok (Reference number: (27112024-10-1).

Sample Selection and Preparation

Ninety straight, single-rooted mandibular premolars that had been extracted for orthodontic purposes were selected, teeth with cracks, resorption, root caries, canal obstructions, previous endodontic treatment were excluded, soft tissues debris was removed using periodontal scaler. the samples were stored in 0.1% thymol solution until use[9]. The samples were decoronated to a length of 12mm using a diamond disk and electronic caliper, the pulp extirpation and patency were checked using a 10 K file and the working length was determined by subtracting 1mm from whole root length, which had been fixed at12mm (9). Apical foramen was sealed with flowable resin composite to prevent extrusion of irrigation solution during preparation[10].

Mechanical preparation of samples was performed using Pro Taper Next rotary files (Dentsply, Switzerland) and an E-COM Cordless Endo Motor (Woodpecker, China) set to 300 rpm and 3.5 Ncm torque according to manufacturer instructions for Pro Taper next files. Three main files (X1, X2, X3), each with a unique tip size and taper, were used during the shaping process [11]. Between instrumentation, irrigation was performed to decrease the amount of packed dentin, 2 ml of 5.25% NaOCL was used after each file for all groups except for the Triton group for which it is recommended according to the manufacturer instructions to use only Triton along with the procedure, 2 ml of Triton was used between each file instead of NaOCL[3].

Sample grouping

Samples were divided into three main groups (Group A: 17% of EDTA, Group B: QMix, Group C: Triton) each n=30, according to the final irrigation solution, each group then subdivided into three subgroups according to the activation system (sonic, ultrasonic, diode laser) each n=10. A 30-gauge endodontic needle side vent and a disposable syringe were used with 3ml for each irrigation solution (EDTA, QMix, and Triton) as a final irrigating solution, 2 mm short of the working length, finally, 3 ml of distilled water were used to rinse the canals, and Pro Taper Next paper point was used to dry the canal after final irrigation[12].

Group (A, B, C) sonic irrigation activation: Sonic activator (UDG sonic irrigator pro. China), the tip of the medium-sized polymer (25/.04) was employed. The tip was passively inserted into the canal, 2 mm shorter than the working length, and run in three cycles at 10,000 cpm for 60 seconds (5).

Group (A, B, C) passive ultrasonic activation: Ultrasonic activation was performed using a silver tip with a length of 21mm, with tip size 25/0.02, using woodpecker ultrasonic device, allowing for 3 cycles of 20 seconds and 45 kHz, performed apical-coronal pumping movements while the tip was held 1 mm from the working length in the middle of the canal[13].

Group (A, B, C) diode laser activation: Diode laser 940 nm was use with eye glass for protection. Specimens were irradiated by endodontic fiberoptic tip, (E2) with 200 µm tip diameter (Biolase, CA, USA), with 1.08Watt panel setting in a speed of 1mm/s, CW mode; The fiber tip was inserted 2mm from the apex, helicoidal movement in apical to coronal direction this was performed in two cycles of 18 second each resulting in a total laser radiation time of 36 seconds[14].

Sample preparation for scanning electron microscopy (SEM)

A diamond disc was used at a reduced speed to create extended grooves on both the buccal and lingual root surfaces. Subsequently, the roots were bifurcated[11]. One half of the root was delineated into coronal, middle and apical thirds using an indelible marker and prepared for scanning electron microscopy (SEM) analysis[9]. Samples were dehydrated for 24 hours using ethyl alcohol at concentrations between 30% and 100%, then they were positioned on metallic stubs inside a vacuum chamber and then underwent gold sputtering[11]. A scanning electron microscope was used to analyze the samples at ×3000 magnification to identify any residual smear layers in the coronal, middle, and apical thirds[3]. The scoring evaluation of SEM images examination had been done blindly by two researchers for the same samples using score system established by Gutmann et al[15]. Score1: There is little or no smear layer, less than 25% of the specimen is covered with tubules that can be seen and are open. Score2: A moderate to light smear layer covers 25–50% of the specimen, exhibiting several open, visible tubules. Score3: Moderate smear layer covering 50–75% of the specimen, either scattered or aggregated, with little or no visible tubules. Score4: The specimen has a thick smear layer that covers more than 75% of it and there are no visible or open tubule orifices.

Statistical analysis

Data were collected and analyzed with SPSS Inc.'s version 26, the Statistical Package for the Social Sciences. Descriptive statistics served as an initial step to interpret the nature of the data, given that the data consisted of ordinal measurements, non-parametric statistical tests were applied. The Kruskal–Wallis H test was used to compare independent groups, and for pairwise comparisons, the Mann–Whitney U-test was conducted with using the Bonferroni correction. To compared the three different levels of the root canal within the same group, the Friedman test was employed, in cases where the Friedman test indicates a statistically significant difference, the Wilcoxon Signed-Ranks test was employed for pairwise comparison using the Bonferroni correction. $P < 0.05$ was chosen as the significance level. Effect sizes were calculated For the Kruskal–Walli's test, Eta-squared (η^2) for the Wilcoxon Signed-Ranks and Mann–Whitney U tests, the effect size r will be calculated using standardized Z statistic. For the Friedman test, Kendall's W (coefficient of concordance) reported as a measure of effect size.

RESULTS

Descriptive statistical analysis shows median scores of smear layer removal in each group (EDTA, Triton, QMix), according to the activation techniques with Interquartile Range.

In the coronal third, EDTA, QMix, and Triton demonstrated comparable smear layer scores across diode laser, sonic, and ultrasonic activation. Middle thirds: EDTA high smear layer scores were found in ultrasonic and diode laser, while the lowest was in sonic; the QMix group the highest smear layer scores were in diode laser followed by sonic and lowest in ultrasonic. In the Triton group all three activations had the same smear layer scores. Apical third: EDTA represented the same smear scores in all activations, while in the QMix the highest smear score was found in ultrasonic and the lowest was found in both diode laser and sonic. In the Triton group the highest smear score was found in sonic and lowest was in ultrasonic and followed by the diode laser (Tabe 1).

Table1: Descriptive statistical analysis of smear layer scores of Activation Methods for different group in (Coronal, Middle, Apical).

Root Canal	Solution	Activation Method	Min	Max	Median	Interquartile Range
Coronal	EDTA	Diode Laser	1	2	1.000	1.000
		Sonic	1	4	1.000	0.250
		Ultrasonic	1	2	1.000	0.250
	QMix	Diode Laser	1	2	1.000	1.000
		Sonic	1	2	1.000	1.000
		Ultrasonic	1	2	1.000	1.000
	Triton	Diode Laser	1	2	1.000	0.250
		Sonic	1	2	1.000	1.000
		Ultrasonic	1	2	1.000	1.000
Middle	EDTA	Diode Laser	1	3	2.000	2.000
		Sonic	1	3	1.500	2.000
		Ultrasonic	1	3	2.000	1.000
	QMix	Diode Laser	1	3	2.000	1.250
		Sonic	1	3	1.500	1.250
		Ultrasonic	1	3	1.000	2.000
	Triton	Diode Laser	1	3	1.000	0.250
		Sonic	1	4	1.000	3.000
		Ultrasonic	1	2	1.000	1.000

Root Canal	Solution	Activation Method	Min	Max	Median	Interquartile Range
Apical	EDTA	Diode Laser	1	4	2.000	3.000
		Sonic	1	4	2.000	2.000
		Ultrasonic	1	3	2.000	2.000
	QMix	Diode Laser	2	3	2.000	1.000
		Sonic	1	4	2.000	3.000
		Ultrasonic	1	4	2.500	2.250
	Triton	Diode Laser	1	3	1.500	1.000
		Sonic	2	4	3.500	2.000
		Ultrasonic	1	4	1.000	2.000

Comparison of smear layer removal in the same group according to activation methods

There was no significant difference between activation methods in each group (EDTA, QMix, Triton) in the coronal and middle thirds ($p>0.05$), but there was a significant difference in the apical third in the Triton group ($p<0.05$), while EDTA and QMix showed no significant difference in the apical third ($p>0.05$). (Table2)

Table 2: Kruskal–Wallis H test for comparison of activation methods in the same group in the (coronal, middle, apical)

Root Canal	Solution	H statistic	p-value	Effect Size (η^2)
Coronal	EDTA	0.273	0.873	<0.001
	QMix	0.290	0.865	<0.001
	Triton	0.330	0.848	<0.001
Middle	EDTA	0.891	0.641	<0.001
	QMix	0.095	0.954	<0.001
	Triton	1.536	0.464	<0.001
Apical	EDTA	0.329	0.848	<0.001
	QMix	0.493	0.782	<0.001
	Triton	9.471	**0.009**	0.277

$\eta^2 < 0.01$ (negligible), $0.01 \leq \eta^2 < 0.06$ (small), $0.06 \leq \eta^2 < 0.14$ (medium), and $\eta^2 \geq 0.14$ (large)

In the apical third of the Triton group there was a significant difference between diode laser and sonic ($p<0.05$) while, no significant difference was observed between diode laser and ultrasonic ($P>0.05$). Additionally, no significant difference between sonic and ultrasonic ($P>0.05$). In Triton group diode laser was more effective on smear layer removal in the apical third followed by ultrasonic then sonic. (Table3)

Table 3: Comparison in the apical third using Mann–Whitney U-test (Apical- Triton)

Groups	Mean Rank	U-test	Z	p-value	Effect Size (r)
Diode Laser	6.75	12.500	-2.978	**0.009**	0.544
Sonic	14.25				
Diode Laser	10.15	46.500	-0.292	1.000	0.053
Ultrasonic	10.85				
Sonic	13.40	21.000	-2.270	0.069	0.414
Ultrasonic	7.60				

$r < 0.1$ (negligible), $0.1 \leq r < 0.3$ (small), $0.3 \leq r < 0.5$ (medium), and $r \geq 0.5$ (large)

* *Adjusted p-values using the Bonferroni correction*

Comparison of smear layer removal between the study groups according to activation methods

There was no significant difference in the activation methods between the groups in both the coronal and middle thirds, but in the apical third, there was a significant difference in diode laser between the groups ($p<0.05$), while no significant differences were found in sonic and ultrasonic in the apical third. (Table 4)

Table 4: Kruskal–Wallis H test for comparison between group according to activation methods in the (coronal, middle, apical)

Root Canal	Activation Method	H statistic	p-value	Effect Size (η^2)
Coronal	Diode Laser	0.921	0.631	<0.001
	Sonic	0.160	0.923	<0.001
	Ultrasonic	0.330	0.848	<0.001
Middle	Diode Laser	3.418	0.181	0.053
	Sonic	0.038	0.981	<0.001
	Ultrasonic	1.047	0.593	<0.001
Apical	Diode Laser	6.097	**0.047**	0.152
	Sonic	4.162	0.125	0.080
	Ultrasonic	0.696	0.706	<0.001

$\eta^2 < 0.01$ (negligible), $0.01 \leq \eta^2 < 0.06$ (small), $0.06 \leq \eta^2 < 0.14$ (medium), and $\eta^2 \geq 0.14$ (large)

There was no significant difference in diode laser effect between EDTA and QMix; no significant difference between EDTA and Triton was found. However, there was a significant difference between QMix and Triton ($p<0.05$), the diode laser in Triton group being more effective on smear layer removal than in the QMix group in the apical third. (Table 5).

Table 5: Comparison in the apical third using Mann–Whitney U-test (Apical- Diode Laser)

Groups	Mean Rank	U-test	Z	p-value*	Effect Size (r)
EDTA	10.30	48.000	-0.164	1.000	0.030
QMix	10.70				
EDTA	12.70	28.000	-1.762	0.234	0.322
Triton	8.30				
QMix	13.50	20.000	-2.466	**0.042**	0.450
Triton	7.50				

$r < 0.1$ (negligible), $0.1 \leq r < 0.3$ (small), $0.3 \leq r < 0.5$ (medium), and $r \geq 0.5$ (large)

** Adjusted p-values using the Bonferroni correction*

Comparison of smear layer removal among thirds in each group

In the EDTA group a significant difference was found in diode laser between root canal thirds ($p<0.05$), In the QMix group, both diode laser and sonic showed a significant difference among root canal thirds ($p<0.05$), In the Triton group sonic showed significant differences among thirds ($p<0.05$). (Table 6).

Table 6: Comparison between thirds of each group according to the activation methods use Fridman test

Root Canal	Activation Method	Chi-Square statistic	p-value	Effect Size (W)
EDTA	Diode Laser	9.250	**0.010**	0.154
	Sonic	3.562	0.168	0.059
	Ultrasonic	5.419	0.067	0.090
QMix	Diode Laser	11.214	**0.004**	0.187
	Sonic	7.300	**0.026**	0.122
	Ultrasonic	3.909	0.142	0.065
Triton	Diode Laser	3.600	0.165	0.060
	Sonic	10.516	**0.005**	0.175
	Ultrasonic	1.810	0.405	0.030

$W < 0.1$ (negligible), $0.1 \leq W < 0.3$ (small), $0.3 \leq W < 0.5$ (medium), and $W \geq 0.5$ (large)

There were no significant differences between coronal and middle or middle and apical thirds in EDTA with diode laser activation, QMix with sonic and diode laser activation, and Triton with sonic activation ($p>0.05$). No significant difference was observed between thirds in the QMix group with sonic activation ($p>0.05$), while significant differences were observed between coronal and apical thirds in EDTA diode, QMix diode laser activation, and Triton sonic activation ($p<0.05$), which indicated better cleaning performance in coronal than in the apical thirds (Table 7)

Table 7: Wilcoxon signed rank test with for comparison between root canal third in the same group

	Groups	Mean Rank	Z	p-value	Effect Size (r)
EDTA-Diode Laser	Coronal	8.70	-1.633	0.189	0.298
	Middle	12.30			
	Coronal	7.40	-2.428	**0.045**	0.443
	Apical	13.60			
	Middle	8.90	-1.730	0.252	0.316
	Apical	12.10			
QMix-Diode Laser	Coronal	8.10	-2.000	0.138	0.365
	Middle	12.90			
	Coronal	6.70	-2.640	**0.024**	0.482
	Apical	14.30			
	Middle	8.30	-1.897	0.174	0.346
	Apical	12.70			
QMix-Sonic	Coronal	9.20	-2.000	0.138	0.365
	Middle	11.80			
	Coronal	8.55	-2.041	0.123	0.373
	Apical	12.45			
	Middle	9.55	-1.518	0.387	0.277
	Apical	11.45			
Triton-Sonic	Coronal	9.35	-1.633	0.306	0.298
	Middle	11.55			
	Coronal	6.10	-2.558	**0.033**	0.467
	Apical	14.90			
	Middle	8.95	-1.852	0.192	0.338
	Apical	12.05			

$r < 0.1$ (negligible), $0.1 \leq r < 0.3$ (small), $0.3 \leq r < 0.5$ (medium), and $r \geq 0.5$ (large)

** Adjusted p-values using the Bonferroni correction*

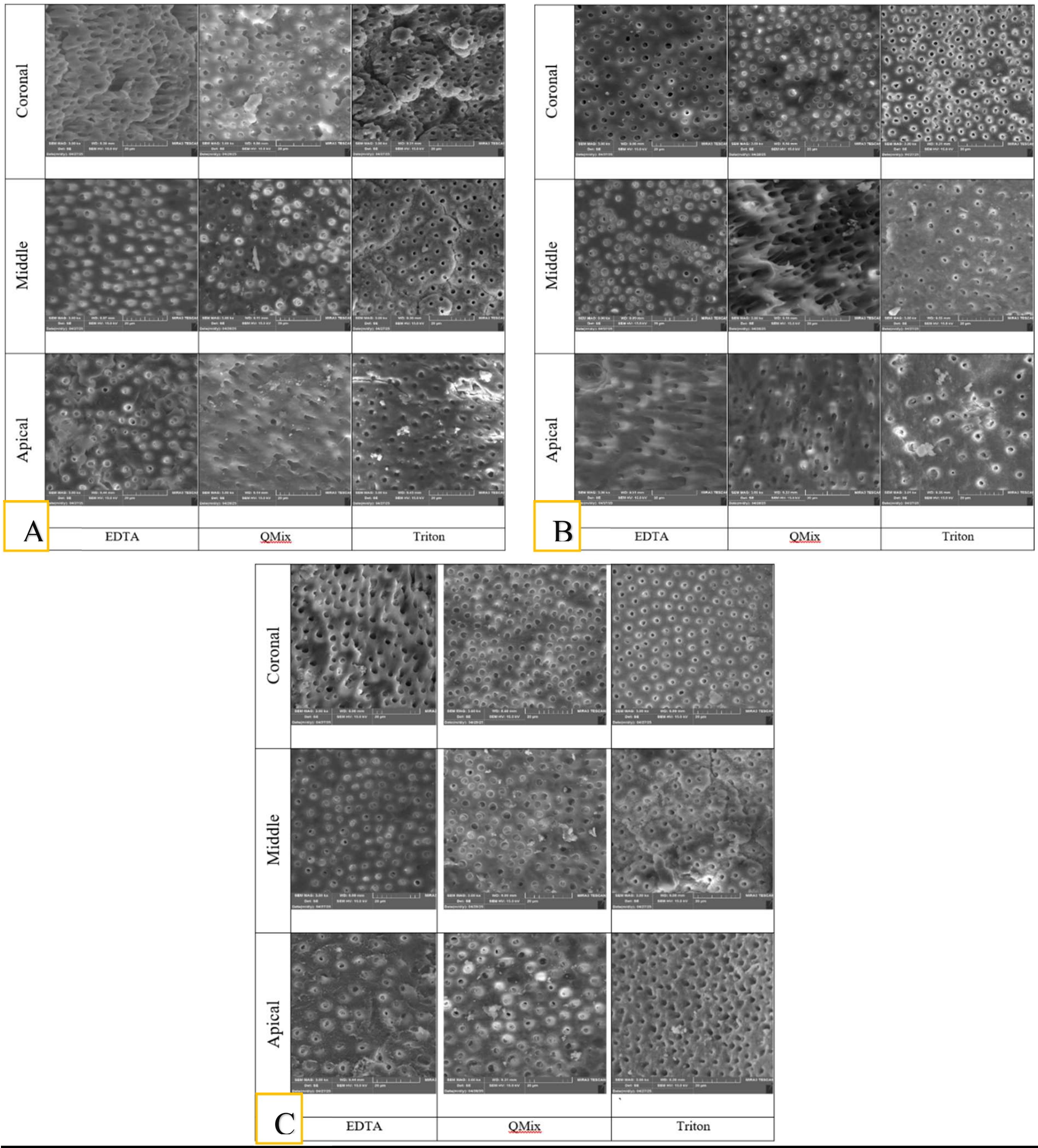

Figure 1: SEM images of smear layer removal from the root canal walls in each group and root third (magnification x3000) (A. Diode laser B. Sonic, C. Ultrasonic).

DISCUSSION

In dentistry, mechanical instruments, chemical irrigants, and intra-canal medicaments are often used for disinfection procedures. Mechanical preparation has many obstacles; one of these was the elimination of the smear layer from the canal lumen[16].

Smear layer covering the root canal wall obstructing dentinal tubules and reducing the efficiency of root canal therapy by preventing the filling material from making adequate contact with the root canal wall[17].

In this study, different irrigation solutions (EDTA, QMix, Triton) with different activation methods (diode laser, sonic, ultrasonic) were compared to determine their effectiveness in removing the smear layer from the root canal system.

Comparison of activation techniques within the EDTA group demonstrated no significant differences, consistent with the findings of Gültekin and Çobankara[18]. who also observed no variation in EDTA activation methods concerning the removal of smear layers and apical debris. Conversely, in the same study, the QMix group demonstrated notable variations in activation techniques; however, our study observed no differences. The amount of QMix used, and the duration of application in our study may contribute no differences in activation. Additionally, there is a study indicating that QMix was more effective when used for 3 minutes compared to 1 minute[19].

The superiority of diode laser over sonic activation on smear layer removal in the apical third in Triton agreed with Kaur et al.[11], who reported that laser activation enhances smear layer removal by effectively agitating irrigation, particularly in cases where ultrasonic or sonic tips have limited oscillation. Triton group in the apical third showed better performance with diode lasers than ultrasonics on smear layer removal but without significant difference between them, suggesting performance may depend on specific parameters, power setting, exposure time, canal anatomy, this comes in agreed with Elkhodary and Morsy[20]. There was no significant difference in the apical Triton group between sonic and ultrasonic activation in smear layer removal similar results obtained by Urban et al[21], who reported a similar effectiveness regarding removal of smear layer.

The variability in results among different solutions and thirds highlights the complexity of smear layer removal and suggests that no single activation method is universally superior under all conditions.

Triton demonstrated superior effectiveness in removing smear layers in the apical third with a diode laser compared to QMix; there was no direct comparison between the two solutions in the literature but there was a study by Castagnola et al[22]. found that Triton was more effective than Dual Rinse in eliminating smear layers in the apical and middle thirds. This study used Triton without activation, while in present study we used activation. Laser activation results in acoustic streaming and cavitation, which may improve the flushing of irrigation in inaccessible canal areas thus enhancing canal debridement[23].

No significant difference in diode laser between QMix and EDTA apically, this aligned with Koçak et al[24], finding that diode laser treatment reduced smear layer efficacy without significant difference. No significant difference between Triton and EDTA in the apical with diode laser this finding aligned with Zakaria and Khudair[25], that reported Triton effectively eradicates smear layer, as conventional root canal irrigating solutions (NaOCl/EDTA).

In a study by Oraim and Al-Zaka [3], they examined the performance of Triton, 0.5% chitosan nanoparticles (CNP), and 17% EDTA, and reported that smear layer removal was the least effective with Triton at all levels of the root canal. This disagreement may be due to the fact that they didn’t use activation with irrigation, in which laser activation enhances irrigants efficacy by generating cavitation bubbles and photoacoustic streaming, increasing penetration and smear layer disruption[14].

Comparison in thirds in each group showed no significant difference in smear layer removal between coronal and middle thirds, indicating better cleaning efficacy in this region due to easier irrigant access and larger canal diameter exposes the dentin to higher volume of irrigants allowing better follow of solution this similar result was obtained by Kaur et al[11].

Significant differences were observed between coronal and apical thirds, in which better smear layer removal was observed coronally, as demonstrated by EDTA diode laser and the QMix diode laser, and these findings aligned with Shakir and Bahnam[26]. Triton with sonic activation results in better removal of smear layer in the coronal than in the apical, with significant differences. The differences are due to several reasons: small diameter of the apical third which limits circulation action of irrigation solution. Additionally, the dentin in the apical region is sclerotic, translucent, and exhibits a more irregular architecture, leading to decreased permeability relative to the coronal or middle thirds. Furthermore, insufficient debridement in the apical region may result from the apical vapor lock phenomenon[27].

Ultrasonic activation showed uniform smear layer removal in all groups without significant differences observed between thirds; however, the coronal third appears cleaner, but the variation is not statistically significant. The use of acoustic streaming, cavitation, and proper technique during ultrasonic activation results in uniform smear layer removal in all thirds and increased streaming velocity of ultrasonic devices, which is typically unaffected by the curvature of the root canal, similar results were obtained by Haupt et al[28].

In EDTA and QMix with sonic activation there were no significant differences between thirds; this was agreed by Khateeb et al.[29], who found no significant difference in apical and coronal thirds of the root canal using sonic activation, the sound waves help to distribute the irrigant evenly, which can result in consistent cleaning across different sections of the canal.

The Triton group activated by diode laser showed no significant difference between thirds; however, better removal was observed in coronal and middle areas. The results disagreed with Al-baker and Al-Huwaizi[5]. Laser treatment is influenced by factors like operator technique, laser settings, and root canal system characteristics, potentially affecting smear layer removal[30].

CONCLUSION

Complete removal of the smear layer still challenging even with advanced solutions and techniques. Diode laser activation with Triton showed promising results when compared to sonic and QMix in the apical third. The apical third is the most difficult area to clean regardless of the method used.

Recommendation

Further studies must be conducted to evaluate the effectiveness of the new irrigation solutions Triton with different laser systems as well as its effect on dentin microhardness.

Conflict of interest:

The article authors declare that they have no conflicts of interest in the submitted manuscript.

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پوختە

کاریگەریا ماددێن جیاواز و تەکنیکین چالاکرنێ ین ئاڤدێریا ناڤا رها ددانی ل سەر راکرنا چینێ دامالی
ڤەکولینەکا تاقیگەهی

پێشەکی و ئارمانج: پێشەکی و ئارمانج: جینێ دامالی دروست دبیت دەمی پاقژ کرنا رها ددانی کو رێگری لچالاکرنا ماددداندا دکەت دبیتە ئەگەری نە سەرکفتنا پاقژکرنا رها ددانی، ئامانجا ئەڤێ ڤەکولینی ئەوە بو هەلسەنگاندن وبەراوردکرنا کاریگەریا (EDTA, Triton, QMix%17) دگەل چالاك کرنا ئەڤان ماددان ب سێ تەکنیکێن جودا (Diode laser, Sonic, Ultrasonic) ل سەر راکرنا چینێ دامالی دناڤا رها ددانی دا.

رێکێن ڤەکولینێ: نوت ددانێن هێرانێ تاکەرەهێن خوارێ ین دەرێختی کو هاتینە کورت کرن هەتا 12 ملم، بشێوازەکێ بایو میکانیکی هاتیە ئامادەکرن بـ(ProTaper Next files)هەتا قەبارێX3 لدیڤدا ب شێوازەکێ هەرمەکی هاتینە دابەش کرن بو سێ گروپان (EDTA, Triton, QMix%17) لدویڤ ئاڤدێریا دوماهیکێ بو ژمارە 30 بو هەر گروپەکی لدویڤدا هەرگروپەك هاتیە دابەشکرن بو گروپێن لاوەکی لدیڤ شێوازیا چالاککرنێ بوژمارە 10بو هەر ئێك, لدیفدا رەهێن ددانی هاتینە قەدکرن بدرێژاهی بو دوو کەران و رێژا چینێن دامالی یێن ماین ل سەر سێکا تاجی، ناڤەراست وسەرێ رەهان هاتیە تومارکرن لبن مایکروسکوپا پشکنینا ئەلیکترونی ب مەزناهیا x3000 ب بکارئینانا سیستەمێ خالکرنا چارئاست.

ئەنجام: (Triton) کو هاتیە چالاککرن بـ(Diode laser) کاریگەرترین رێك بو بو راکرنا چینێن دامالی ل سێکا سەری دا کو جوداهیەکا گرنگ هەبو ب بەراوردکرن دگەل(Sonic) و هەروەسا کاریگەرتر بو ژ (QMix). جوداهیەکا بەرچاڤ د شێوازێ چالاککرنێدا دناڤبەرا گروپێن دی تردا نەبو. راکرنا چینێ دامالی ل سێکا تاجی کاریگەرتربوو بەرامبە سێکا سەری کوجوداهیەکا گرنگ هەبو ل پرانیا گروپاندا.

دەرئەنجام: بکارئینانا (Diode laser) بتایبەتی دگەل ماددێ (Triton) باشتر و کاریگەر ترە بو راکرنا چینێ دامالی یێ سەری ب بەراوردکرن دگەل) (Sonic و(QMix) کو شیانێن پاقژکرنێ زێدەتردکەت ب بەراوردکرن دگەل گروپێن دی، راکرنا چینێن دامالی لسێکا تاجی و ناڤەراست کاریگە تربو ژ سێکا سەری.

الخلاصة

تأثير محاليل الري المختلفة وتقنيات التنشيط على إزالة طبقة اللطاخة: دراسة مخبرية

الخلفية والأهداف: طبقة التلطيخ التي تتشكل أثناء تحضير قناة الجذر والتي تؤثر على نشاط الري، مما يؤثر بدوره على نجاح علاج لب الأسنان. الهدف من هذه الدراسة هو تقييم ومقارنة فعالية ثلاثة محاليل ري (ethylenediaminetetraacetic acid (EDTA), Triton and QMix) مع ثلاث تقنيات تنشيط (Sonic, Ultrasonic, Diode laser) في إزالة الطبقة اللطاخة.

الطرق: تم ازالة تسعين من الضواحك للفك السفلي من أحادي الجذر بطول 12 مم، باستخدام جهاز ميكانيكي حيوي (Protaper Next files) حتى حجم X3. تم تقسيم الجذور عشوائيا إلى ثلاث مجموعات وفقا للري النهائي (EDTA%17، Triton، QMix) (العدد = 30) لكل مجموعة. تم تقسيم كل مجموعة إلى مجموعات فرعية وفقا لطريقة التنشيط (Sonic, Ultrasonic, Diode laser) (العدد = 10) لكل تنشيط. تم تقطيع العينات طوليا وفحصها تحت المجهر الإلكتروني الماسح عند تكبير x3000 في الثلث التاجي والوسطى والقمي باستخدام نظام تسجيل رباعي المستويات.

النتائج: كان (Triton) المنشط بـ(Diode laser) هو الطريقة الأكثر فعالية في إزالة طبقة اللطاخة في الثلث القمي مع وجود فرق كبير عند مقارنته بـ(Soni)، وكان أيضا اكثر فعالية من (QMix)، ولا يوجد فرق كبير في طريقة التنشيط بين المجموعات الأخرى. كانت إزالة طبقة اللطاخة أكثر فعالية في الثلث التاجي مقارنة في الثلث القمي مع فرق كبيرفي معظم المجموعات.

الاستنتاجات: يحسن تنشيط (Diode laser)، خاصة عند استخدامه مع مروي (Triton)، من إزالة طبقة اللطاخة في المنطقة القمية، متفوقا على الطرق (Sonic) و(QMix) ويحسن أداء التنظيف مقارنة بالمجموعات الأخرى. كانت إزالة طبقة اللطاخة أكثر فعالية في الثلثين التاجي والوسطي من الثلث القمي.