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RESEARCH ARTICLE

EFFICACY OF IRRIGANT ACTIVATION TECHNIQUE OF Q-MIX 2 IN 1 IN REMOVING INTRACANAL SMEAR LAYER: AN IN-VITRO SCANNING ELECTRON MICROSCOPIC STUDY

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ABSTRACT

Context: The success of endodontic treatment depends upon through debridement of the root canal system. Q-mix is a novel irrigant which shows smear layer removal as well as antibacterial action. The irrigant can go 0.1 – 1mm beyond the tip of the needle which prevents apical penetration of the solution. The irrigant needs to be activated to allow penetration of the irrigant till the apical third of the root canals.

Aim: To evaluate the smear layer removal efficacy of Q-mix 2 in 1 using different activation regimens.

Settings and Design: An in vitro randomized control trial study.

Methods and Material: 30 sound premolars were decoronated at cement enamel junction. Biomechanical preparation was done till size #F3. For final irrigation regimen teeth were randomly divided into 2 groups as Conventional Needle irrigation (CI), Mannual Dynamic activation technique (MDA). The teeth were then sectioned vertically and examined under scanning electron microscope for smear layer removal at coronal, middle and apical third.

Statistical analysis: Kruskal-Wallis test was used for comparison across irrigation techniques. Pair wise comparison of ratings was performed using Wilcoxon rank sum test.

Result: Manual Dynamic activation of the irrigant Q mix 2 in 1 significantly improved the smear layer removal ability as compared to Conventional irrigation technique. There was statistically significant difference at middle third between CI and MDA.

Conclusion: MDA resulted in significantly less smear layer as compared to conventional needle irrigation group.

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INTRODUCTION

The smear layer has been shown to prevent the penetration of intracanal disinfectants and sealers into the dentinal tubules, which may result in compromising the seal of the root filling (White*et al.,* 1987; Orstavik and Haapasalo, 1990).Smear layer acts as a barrier and prevents bacterial invasion of the dentinal tubules. However, bacteria might survive and multiply in the smear layer and can also penetrate into dentinal tubules. In addition smear layer might decrease antimicrobial effectiveness of medicaments or sealing ability of root canal filling. Therefore, it becomes mandatory to remove smear layer

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from root canal for optimum success of treatment (Singh *et al.,* 2014).Various chelating agentslike EDTA, Citric Acid, Phytic acid and various herbal irrigants are usedfor smear layer removal from root canal. Q-Mix 2in1 (Dentsply Tulsa Dental, Tulsa, OK, USA) a novel endodontic irrigant was introduced in conjunction with Dr. Markus Haapasalo, chair of the Division of Endodontics at the University of British Columbia, Vancouver, Canada. It is a clear solution, ready to use with no chair side mixing. It comprises EDTA, Chlorhexidine (CHX) and a detergent(Triclosan). It has been designed to be used as a final rinse for 60-90 seconds in place of 17% EDTA, as it causes less demineralization of intact dentin collagen than EDTA.

This one step final rinse is supposed to combine the antimicrobial and substantivity properties of CHX with smear layer removing properties of EDTA (Morgental*et al.,* 2013). Moreover, QMix 2in1 contains a detergent that decreases surface tension and increases wettability in solution to potentially allow better intracanal delivery (Wang*et al.,* 2012). Previous studies reported that Q-Mix was as effective as 17% EDTA in smear layer removal and has improved push-out bond strength of Epoxy Resin based sealer (Uzunoglu*et al.,* 2015). EDTA has been tried with different agitation protocol and is found to be more effective in removing the smear layer than conventional irrigation technique without agitation (Gu*et al.,* 2009). Studies have shown that the irrigant has only a limited effect beyond the tip of the needle i.e. 0.1-1mm because of the dead-water zone or sometimes air bubbles in the apical root canal, which prevent apical penetration of the solution (Boutsioukis*et al.,* 2010).

An irrigant must be in direct contact with the canal walls for effective action. However, it is often difficult for the irrigant to reach the apical portion of the canal because of the so-called vapor lock effect. Researchers have shown that gently moving a well-fitting gutta-percha master cone up and down in short 2- to 3-mm strokes (manual dynamic irrigation) within an instrumented canal can produce an effective hydrodynamic effect and significantly improve the displacement and exchange of any given reagent (Gu*et al.,* 2009). Hence this study was conducted with the aim to evaluate the effect of manual dynamic activation of Q-mix 2 in 1 on smear layer removal ability. Null Hypothesis of this present study was that there will be no difference of activation systems on efficacy of smear layer removal of Q-mix 2 in 1 solution.

MATERIALS AND METHODS

30 single rooted single canaled sound human premolars without any cracks were selected for this study. Teeth were then sectioned with diamond disc and water coolant at cementoenamel junction, leaving a coronal surface perpendicular to long axis of the roots and to achieve a standard root length of 13mm. Root canal patency till apical foramen was determined with a size 10 K file (MANI, INC, Japan). Working length was established by subtracting 1mm, from the length of inserted #10 K file. Root canal was then prepared with the ProTaper Universal Nickel-Titanium rotary system (Dentsply-Maillefer Switzerland) till size #F3. Between each file size, irrigation was performed with 1ml of 5% Sodium Hypochlorite (Neelkanth Health Care(P,)LTD, India). After that 5ml flush of distilled water was used.

Final irrigation regime

The specimens were then randomly divided into 4 groups with 15 specimen in each group (n=15)

Group 1 (Control): Teeth irrigated with Q-mix 2 in 1 without activation

Group 2: Teeth irrigated with Q-mix 2 in 1 with manual dynamic irrigation

For Group 1 after instrumentation, the canals were irrigated with 1ml of distilled water, and then 1ml of Q-mix was flushed into the canal with an in-and-out motion using the 30-gauge conventional needle and syringe and left in place for 1min per canal (Figure 1). For Group 2 after suctioning away the intra-canal surplus of distilled water, 1 mL of the Q-mix was flushed into root canal. This solution was activated by pumping with a F3 gutta-percha point, with short vertical strokes for 1 min. The frequency of activation used was 100 push-pull strokes per minute (Figure 2).

Scanning electron microscopy

After dentin surface treatment, all specimen of each group were prepared for scanning electron microscope (SEM). After the removal of the smear layer, two parallel longitudinal grooves were prepared with a diamond disc in low-speed rotation on the buccal and lingual surfaces of each root without penetrating the canal. The roots were then split into two halves using hammer and chisel. After that, the samples were gold-sputtered, and examined with a scanning electron microscope (Leica S-440) at 1000X magnification. The images were performed without the knowledge of the group tested.

SEM evaluation

The images magnified at 1000X magnification were evaluated for the presence of a smear layer for both conventional needle irrigation (Figure 3) and Manual Dynamic Activation (Figure 4). The scoring system described by Hulsmann *et al.* (1997) was used (Hulsmann *et al.,* 1997). The degree of evaluation was scored in a blind manner by three independent observers.

RESULTS

Descriptive statistics like mean, range were obtained for each technique and for each tooth section. Kruskal-Wallis test was used to determine the statistical significance of ratings across irrigation techniques for each section. Pair wise comparison of ratings was performed using Wilcoxon rank sum test. Further, the analysis was also performed for each tooth section across irrigation techniques using Kruskal-Wallis test, followed by pair wise comparison using Wilcoxon rank sum test. All the analyses were performed using SPSS ver 20.0 (IBM Corp.) software and statistical significance was evaluated.Paired differences at coronal and apical sections, showed statistically insignificant results. In Pairwise comparison for middle section using Wilcoxon rank sum test, when conventional irrigation technique was compared with Manual Dynamic irrigation (P value 0.0263), it has been found that activation of the irrigant Q mix 2 in 1 significantly improved the smear layer removal ability as compared to Conventional irrigation technique as shown in Table 2.

Figure 1. Conventional Needle Irrigation

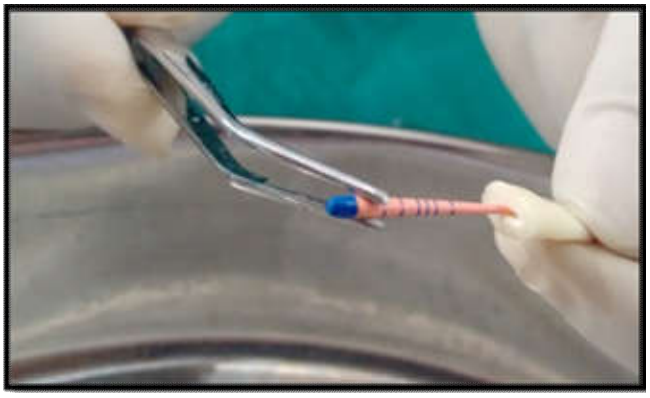

Figure 2. Manual Dynamic Activation

Table 1. Comparison of smear layers across sections for each technique

Technique	Sections						P-value*
	Coronal		Middle		Apical		
	Mean	Median	Mean	Median	Mean	Median	
Conventional irrigation technique	2.80	3	3.33	3	3.40	3	0.0041 (S)
Manual dynamic irrigation technique	2.67	2	2.73	3	3.27	3	0.1379 (NS)

Table 2. Paired comparison of smear layers at different section

Technique	Middle	Coronal	Apical
Conventional irrigation technique vs. Manual dynamic irrigation technique	0.0263 (S)	0.3515 (NS)	0.648 (NS)

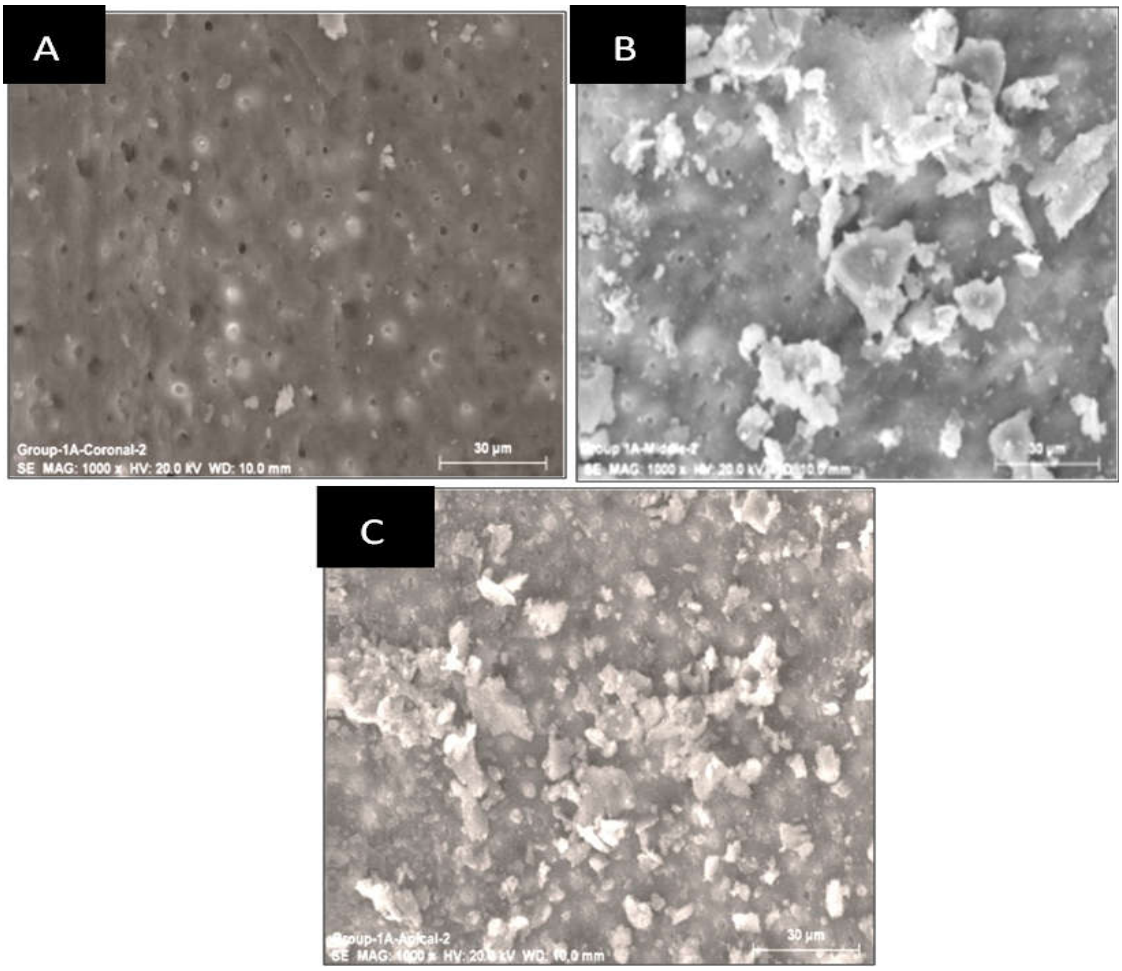

Figure 3. Scanning electron Microscopic images of Conventional irrigation group, A- Coronal, B- Middle, C- Apical

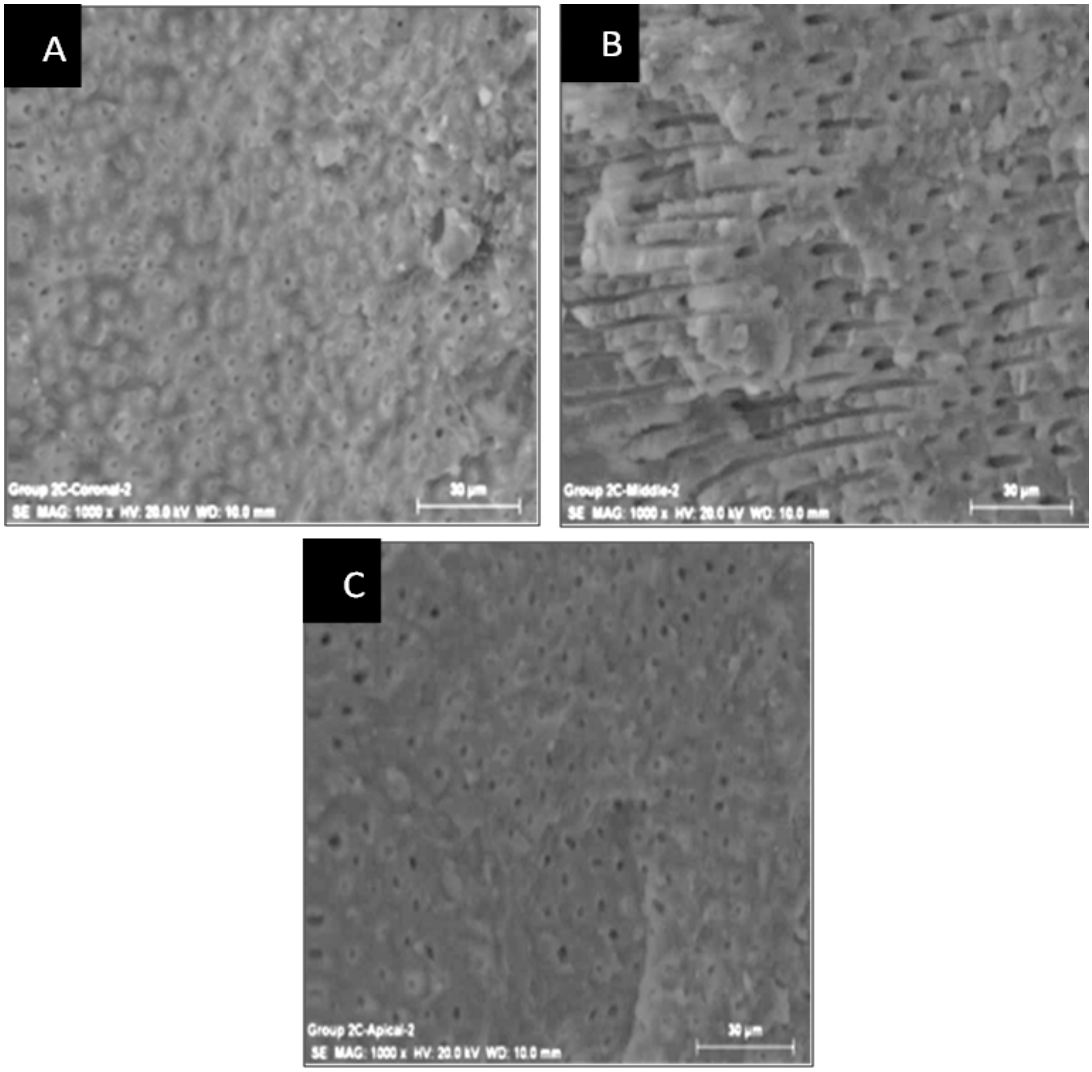

Figure 4. Scanning electron Microscopic images of annual Dynamic activation group, A- Coronal, B- Middle, C- Apical

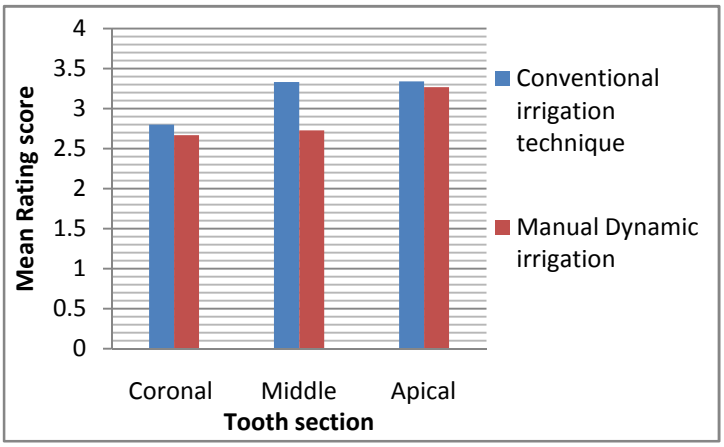

Figure 5. Column chart showing mean rating score on smear layer for each tooth section and irrigation technique used

DISCUSSION

To improve cleanliness, irrigants should be in contact with root canals (Zehnder, 2006). Previous studies have shown that when continuous needle irrigation was used, the irrigating solution was delivered only 1mm deeper than the tip of the needle (Munoz, 2012). This isinsufficient for complete cleaning of the complex anatomy of the root canal system because of lateral canals, isthmuses, fins, and accessory canals (Villas-Boas *et al.,* 2011). In addition vapor lock that results in trapped air in the apical third of root canals has also been considered because it might hinder the exchange of irrigants and affect their debridement efficacy (Tay*et al.,* 2010). The mean value for coronal third for group 1 is 2.80 whereas for group 2 is 2.67. The mean value for middle third for group 1 is 3.33 whereas for group 2 is 2.73. The mean value for apical third for group 1 is 3.40 whereas for group 2 is 3.27 (Table 1). The values suggest that activation of the irrigant Q-mix 2 in 1 with manual dynamic activation improved the smear layer removal ability as compared to conventional needle irrigation

technique in all the sections of the root canals. When conventional irrigation technique was compared with manual dynamic activation, P value for middle third of root canal is 0.0263 (<0.05). In the present study Manual dynamic activation showed significantly better smear layer removal property as compared to conventional irrigation technique in middle third region. The results are in agreement with Andrabi *et al.,*(2013) and Saber Sel *et al.,* (2011). The reason cited by above investigator is that MDA involves repeated up and down motion of a well tapered gutta-percha master cone in short gentle strokes to hydrodynamically displace and agitate a solution by producing eddy currents. This results in displacement of the apical air bubble which is responsible for the 'vapor lock effect'. The up and down motion of a well-fitting gutta-percha point in the canal generates higher intracanal pressure changes leading to more effective delivery of irrigant to the 'untouched' canal surfaces and also results in better mixing of the fresh unreacted solution with the spent, reacted irrigant (Caron *et al.,* 2010). MDA of the solution showed significantly cleaner root canal surfaces than those where no activation was done. This can be attributed to the fact that the vertical stroke pumping motion of a tapered gutta-percha cone produces an effective hydrodynamic activation of the solution and constant renewal of the spent irrigant. Whenever the gutta-percha tip moves towards working length, the reagent is displaced, and whenever the tip is partially withdrawn, there is an effective exchange of solution into the apical one-third of the canal. This hydrodynamic circuit produces better reach of the solution into the apical third area and also neutralises the vapour lock effect resulting in enhanced smear layer removal and cleaner root canal surfaces (Andrabi *et al.,* 2013). None of the techniques tested in this study completely removed the smear layer from the apical third of the root canal. This finding reflects the difficulty associated with cleaning the apical third of root canals, in agreement with the findings of previous studies. None of the protocols tested in this study showed 100% removal of the smear layer.But agitation technique like manual dynamic activation, seem to be superior over conventional needle irrigation technique.

Conclusion

Within the limitations of this study, it can be concluded that the irrigation of root canals by Q-mix 2 in 1 solution using manual dynamic activation appears to be more efficacious in the removal of the smear layer than that using conventional methods. Though various irrigantagitatation devices are available in the market. But most of them are expensive. But Manual Dynamic agitation technique is simple, not expensive and easily performed by clinicians seems to be very useful for removing smear layer from root canal which ultimately helps in success of the root canal treatment. Further investigations will be required to confirm this preliminary data, particularly in terms of biofilm removal and apical disinfection results.

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