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Original Research Article

Ultrasonic Versus Sonic Activation of the Final Irrigant in Root Canals Instrumented With Rotary Files: An In-Vitro Stereomicroscopic Analysis

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ABSTRACT

Aims: To compare the efficiency of debris removal in root canals instrumented with three different agitation systems: UltraX (ultrasonic device), Endo activator (Sonic device) and manual dynamic agitation**.**
Methodology: One hundred and twenty freshly extracted teeth were selected for the study and access cavity is prepared. After determining the working length, instrumentation was done till ProTaper F2 with simultaneous irrigation with 5.25% NaOCl and 17% ethylenediaminetetraacetic acid. These samples were then divided into four groups of 40 samples each that is sonic activation (EndoActivator), ultrasonic activation (Ultra X), manual dynamic activation (MDA) and a control group. About 5.25% NaOCl was used for irrigation activation. Mesial roots were sectioned 4 mm from the apex and observed under a stereomicroscope at 20Xmagnification for the presence of debris.
Results: Endoactivator presented the least amount of debris followed by ultrasonic device and manual dynamic agitation.
Conclusion: In this study, none of the devices were able to remove the debris completely. EndoActivator and UltraX could be used as effective irrigation activation devices.

Keywords: Endo activator, Ultrasonic irrigation, debris removal, manual dynamic agitation

INTRODUCTION

The ultimate goal of endodontic surgery is the complete disinfection of the root canal with effective disinfection of the canals. [1] Instrumental formation of the canal walls shapes debris and smear surface composed of organic and inorganic materials together with different microorganisms and their by-products. [2] The debris and smear layer prevents the penetration of root canal irrigants and intracanal medicines into the dentinal tubules that do not provide adequate sealing of the root canals. [3] Therefore, it is essential to use a chemomechanical system that leads to the minimum amount of debris and smear layer leaving the canal walls. [4] Instrumentation alone is found to be highly ineffective to achieve complete removal of bacteria and debris in all streams. Effective supply of irrigant is now a prerequisite for the elimination of smear layers and debris from the root canal system. [2]

Various studies using advanced techniques have found that the instruments remain untouched by large areas of the main

root canal wall. Nonetheless, for effective action, it becomes important to put such irrigants in direct contact with the entire canal wall, as the conventional needle irrigation method offers solutions no more than 0–1.1 mm above the needle tip. [4,5]

To increase the flow and distribution of irrigating solutions within the root canal system multiple devices for irrigation has been proposed which depicts varying efficiency.

EndoActivator (Dentsply, Tulsa Dental) utilizes irrigant acoustic stimulation comprising of a compact handpiece and three forms of reusable elastic plastic tips in various sizes without slicing root dentin. The theory is focused on the method of cavitation and acoustic processing, which helps to significantly improve the decomposition and destruction of the smear surface and biofilm. [6]

Ultra X (Eighteenth, Orikam) is a cordless ultrasonic irrigation device that oscillates at 45,000 kHz ultrasonic frequencies using the acoustic microstreaming, agitation and cavitation principle that can reach difficult inaccessible areas (almost 35%) of the complex root canal system. It can be administered endodontically to 1) destroy the smear surface and biofilm and expand the blocked dentinal tubules; 2) eliminate gross dentinal tubules; 3) improve irrigant performance. Ultrasonic irrigation (Ultra X) uses energy from ultrasonic waves that is transmitted to the irrigant from a folder or smooth tube. A syringe needle delivers the irrigant to the root canal in intermittent flushed ultrasonic irrigation. Using an ultrasonically oscillating instrument, the irrigant is then triggered. [7] Manual dynamic activation (MDA) is a simple and cost-effective technique involving repeated insertion of a clever guttapercha cone that works by hydrodynamically performing vertical strokes to displace and agitate the irrigant by producing eddy currents. [8]

It is essential to identify the irrigant device which could efficiently eliminate the smear layer and debris from the larger area of root canal system. Hence, this in vitro study is aimed to evaluate the cleaning efficacy of EndoActivator, Ultra X, and MDA. The null hypothesis was that there is no significant difference in the debris removal efficacy among the three irrigant activation methods tested.

METHODOLOGY

One hundred and twenty extracted human mandibular molars were selected for the study. Access cavity was prepared in these teeth and patency was established. Working length (WL) was obtained by#10 K‑file from the apex. The initial filing was done with hand files #15 and #20 K. Followed by hand filing the ProTaper rotary system was used for endodontic preparation. Each canal was prepared apically till F2 size for adequate cleaning and penetration of the solution upto apical one‑third area. Thorough Irrigation was done with 5.25% NaOCl in between each successive file using 30 gauge side‑vented needle.

After complete biomechanical preparation, final irrigation of each sample was done with 17% ethylenediaminetetra-acetic acid (EDTA-1 ml) and 5.25% NaOCl (3 ml) followed by cleaning with normal saline (3 ml). These samples were then divided randomly into 4 groups containing 30 samples each. Irrigation using each method was performed for 1 minute in all the samples except the control group.

Group 1: EndoActivator (Sonic device) – The canals and pulp chambers were filled with 5.25% NaOCl. The EndoActivator sonic handpiece was set at 10,000 cycles per minute and a size no. 25/0.04taper activator tip was passively inserted in the canal within 2 mm of the working length. The tip was moved in short2–3 mm vertical strokes

Group 2: UltraX (UI) – Final rinse with 5.25% NaOCl by side vented needle. Acivato tip was selected that fits passively when placed 2-3 mm short of working length. The solution was agitated using short vertical strokes for around 30 seconds. The irrigant is replenished using suction to

remove loose debris. This cycle is repeated 4-5 times.

Group 3: Manual dynamic agitation (MDA) – The canals and pulp chambers were filled with 5.25% NaOCl. Repeated insertion of a snugly fitting guttapercha cone to working length. The recommended rate for performing activation was set at 100 strokes per minute.

Group 4 (Control): No activation of the irrigants was done in this group.

After the irrigation activation, distal and mesial roots were separated, and mesial roots were dissected and sectioned longitudinally 4 mm from the apex. Isthmus cleanliness and residual debris was checked with stereomicroscope at 20X magnification. These images were analyzed under ImageJ Software (National Institutes of Health, Bethesda,Maryland, USA).

The scoring criterion proposed by Paque and his co-workers [9] described as follows:

• Score 1 – Clean root canal walls with only small debris particles

• Score 2 – Few small agglomerates of debris on the root canal walls

• Score 3 – Many agglomerates of debris covering <50%of the root canal wall

• Score 4 – More than 50% of the root canal wall clogged and covered with debris

• Score 5 – Complete or nearly complete root canal walls covered with debris.

Statistical analysis:

Data were tabulated and examined using the Statistical Package for Social Sciences Version 20.0 (IBM SPSS Statistics for Mac, Armonk, NY: IBM Corp, USA). Descriptive statistical analysis had been carried out in the present study. Results on continuous measurements are presented as Mean±SD. The statistical power calculation was based on the assumption that the data were normally distributed. The data were subjected to one way ANOVA followed by Tukey's *post hoc* test which enabled us to determine whether the inhibition by the test drugs is significant in comparison to the control group. A $P < 0.05$ was considered as significant.

RESULTS

The mean±SD of debris removal in isthmus area were lowest in case of Group 1; Endoactivator (2.8 ± 0.73) followed by Group 2; Ultra X (2.9± 1.12) and Group 3; MDA (3.3± 0.67) when compared to group 4: control group (3.5 ± 0.0.94). (Table 1)

When these all groups were compared using one way ANOVA followed the statistical significant association was found between all the groups (p value=0.002). When intergroup association was examined using post hoc tukey test Group 1 vs 2 (p value=0.424) and group3 vs 4 (p value=0.132) were not found to be statistically significant. Group 1 vs 3 (p value= 0.003), group 1vs 4 (p value= 0.001), group 2 vs 3 (p value = 0.002) and group 2 vs 4 (p value= 0.001) were found to be statistically significant. (Table 2)

Table 1: Descriptive analysis of all experimental groups

Groups	N	Mean±SD	F	P value
Group 1	30	2.8±0.73	5.234	0.002*
Group 2	30	2.9±1.12		
Group 3	30	3.3±0.67		
Group 4	30	3.5±0.94		

*Statistically significant
#statistically non significant
p value<0.05 is considered significant

Table 2: Inter group comparison of all experimental groups

Groups	Diff	P value
Group 1 vs 2	-0.1	0.424#
Group 1 vs 3	-0.5	0.003*
Group 1 vs 4	-0.7	0.001*
Group 2 vs 3	-0.4	0.002*
Group 2 vs 4	-0.6	0.001*
Group 3 vs 4	-0.2	0.132#

Statistically significant
#statistically non significant
p value<0.05 is considered significant

DISCUSSION

Penetration of irrigants into greater area of root canal system is desirable for successful endodontic treatment. The penetration of irrigants depends on multiple factors including coronal enlargement or flaring, diameter of the canals prepared, irrigant used and its volume and the mode of delivery of irrigants. [10] The use of ultrasonic devices, sonic devices and newer

techniques are found to be showing improvement in more meticulous irrigation of the root canal system favoring removing of smear layer and additional removal of bacteria. [1]

In the present study, three different modes of irrigation/agitation techniques were used to assess their efficiency in removing debris from the isthmus area in mandibular molars.

EndoActivator is a sonic irrigation device while UltraX is based upon ultrasonic technology. Manual dynamic agitation (MDA) is based on manually displacing, folding and cutting the fluid under "viscously dominated flow" in the root canal system.

The isthmus of mesial root of mandibular molars is selected for assessing the efficiency of irrigation system because in most of the mesial root of mandibular molars isthmus lies 3-4 mm from the apex which increases the difficulty of penetration of irrigant majorly and ultimately affecting the success of endodontic procedure. [11]

The present study revealed that sonic irrigation system (Endoactivator) was found to remove maximum debris followed by Utrasonic device (UltraX) and MDA. The comparison of efficiency between Endoactivator and MDA was found to be statistically significant. Including, the comparison of efficiency between UltraX and MDA was also found to be statistically significant. These results were in accordance with the study carried out by Kanter *et al*. [12] and Al‑Obaida *et al*. [13] which also revealed the higher efficiency of sonic irrigation significantly when compared to control group.

The present study stated the similar results as revealed by Khaord *et al*. [14] and Mozo *et al*. [15] who concluded that PUI is more effective than manual dynamic agitation method in eliminating pulp tissue and dentin debris. The ultrasonic device could be more effective because of higher flow and speed of the irrigants in the root canal system.

The present study stated that sonic device was found to be better in removing debris as compared to ultrasonic device but the comparison was not found to be statistically significant. These results were in accordance with the study carried out by Khalap *et al*. [16] which stated that sonic activation is more efficient than ultrasonic activation in smear layer and debris removal.

The reason for less efficiency of UltraX could be explained as UltraX creates acoustic microstreaming producing shear stresses for dislodging debris from instrumented canals. It possesses multiple nodes and antinodes all along the length of an activated ultrasonic file and creates undesirable dampening effect of its characteristic nodes and antinodes pattern when the instrument comes in contact of lateral walls of shaped canals especially. Contrastingly, sonic agitation is not influenced by lateral wall contact. [16]

CONCLUSION

Within the limitations of this *in vitro* study, it could be concluded that complete removal of debris was not achieved by any method. It was also resulted that Endoactivator was found to show superior debris removal followed by UltraX and MDA. Further comparative studies with larger sample size are required to assess the efficiency of this novel irrigant system with the other available irrigation systems.

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