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Intra-canal Pressure Produced by Three Irrigation System: A Comparative Study

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ABSTRACT

Background: The aim of this study was to measure intra-canal pressure produced by different irrigation systems: Open end needle with syringe, open end needle attached to pressurized water device (Aqua-pick 300) and Sonic irrigation system (Endoactivator) and to evaluate the ability of pressurized water to be used as intra-canal irrigation technique.
Materials and methods: A special model was made to resemble a tooth (20 mm in length and 5 mm in diameter) embedded in a resin block then 3 sensors were connected directly to the model at 5 mm, 10 mm and 15 mm above the sample end, the sensors were then connected to a computer; Group A irrigation made 18 mm inside the model, Group B irrigation made 16 mm inside the model, each group divided into 3 subgroups: 1: Open end needle+syringe, 2: Open end needle+Aquapick, 3: Endoactivator. The data was read by Lab view program 2015 which analyzes pressure in millibar for 3 sensor areas the data then analyzed statistically by the ANOVA.
Results: Using ANOVA test there was intra-canal pressure produced by the irrigation systems used in this study but there were non-significant differences among the tested irrigation systems with high intra-canal pressure produced in the apical third in all tested groups.
Conclusions: Pressurized water technique can be used as an irrigation system during root canal treatment.

Key words: Endoactivator, Intra-canal pressure, Pressurized water irrigation system

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INTRODUCTION

Root canal debridement is very important for endodontic success, irrigation plays essential role in root canal debridement and it is impossible to shape and clean the root canal completely because of the nature of root canal anatomy, even with the use of rotary instrumentation, the nickel-titanium instruments only act on the central body of the canal, leaving canal fins and isthmi untouched after completion of the preparation and these places might harbor tissue debris, microbes, and there by-products which might prevent close adaptation of the obturation material and result in persistent periradicular inflammation [1].

Conventional irrigation with syringe still widely used and accepted method for irrigation around the world [2], as it easy to control depth of insertion and amount of irrigants during root canal treatment [3].

Increased pressure of irrigation leads to increase apical extrusion of irrigants [3]. Irrigation dynamics deals with the pattern of irrigant flow, penetration, exchange and the forces produced within the root canal space [4]. Current modes of endodontic irrigation include the traditional syringe needle irrigation or physical methods, such as apical negative-pressure irrigation or sonic/ultrasonically assisted irrigation. Since the nature of irrigation influences the flow of irrigant up to the working length (WL) and interaction of irrigant with the canal wall, it is mandatory to understand the irrigation dynamics associated with various irrigation techniques [5].

Endoactivator system (Dentsply Tulsa Dental Specialties, Tulsa, UK) is sonic canal irrigation system [6] and was reported to effectively clean debris from the lateral canals, remove the smear layer and dislodge clumps of simulated biofilm within the curved canals of molar teeth [7]. In general, 10,000 cycles per minute (CPM) can optimize debridement and lead to removal of the smear layer and biofilm [7].

Aquapick AQ-300 (Aquapick Co, Ltd, Korea) device is available in the market as an advanced oral irrigation device with 1800 pulsations per minute and maximum water pressure is 7 Kgf/cm [8].

The aim of this study was to compare the intra-canal pressure produced by pressurized water technique with two types of needle with the pressure produced by Endoactivator irrigation device.

MATERIAL AND METHODS

Preparation of the sample

A special model was made to resemble a tooth (20 mm in length & 5 mm in diameter) embedded in a resin block (Figure 1), then 3 sensors (The sensor type was ND Denso pressure transducer, 5 volt range, and it was calibrated for this range) were connected directly to the model the first one connected 5 mm above the foramen (apical third), the second one connected 10 mm above the apical foramen (middle third) and the third one connected 15 mm above the apical foramen area (coronal third) respectively.

The sensors were then connected to usb-4431 which was connected to a computer and the data was read by Lab view program 2015 which measured pressure in mm bar as shown in Figure 1. (The sensor type was ND Denso pressure transducer, 5 volt range, and it was calibrated for this range).

Three irrigation systems were used by this study:

1. Syringe with open end needle.
2. Pressurized water technique (Aquapick irrigation device). Some modification were made by adding open end needle gauge 23 mm to the device and fix them to the device by glue (Figure 2).

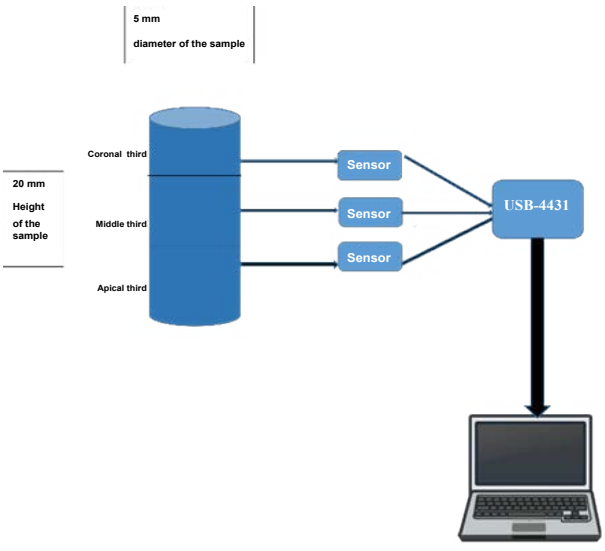

Figure 1: Schematic diagram to the pressure measuring method used in this study

3. Endoactivator irrigation device (Dentsply). It is a sonically powered irrigation device.

Figure 2: Aqua-pick irrigation device after modification

Irrigation was done by normal saline 4 ml for 30 seconds to mimic clinical steps with total irrigation time of 120 seconds for each system.

For Aqua-pick the device modified by the addition of apically vented needle gauge 23 (KDL, China) to its tip; irrigation was made by 4 ml of distilled water with duration of 30 seconds to mimic clinical steps with total irrigation time of 120 seconds for each system.

Grouping

Group A: Irrigation was made 2 mm shorter than the apical foramen

A1: irrigation made by open end needle with syringe.

A2: irrigation made by open end needle with Aqua-pick.

A3: irrigation made by Endoactivator.

Group B: Irrigation was made 4 mm shorter than the apical foramen

B1: irrigation made by open end needle with syringe.

B2: irrigation made by open end needle with Aqua-pick.

B3: irrigation made by Endoactivator.

Data obtained by the 3 sensors for each group then read by Lab-view soft word (2015) and then analyzed by one way ANOVA test and Tukey test.

RESULTS

Descriptive statistic, Means, Standard deviation for the intra-canal pressures produced for the tested group measured in mm bar were presented in Table 1 which presents that all the groups had least pressure in the coronal third followed by the middle third and the highest pressures were in the apical third.

The simulated canal system was an open system; the hole was 5 mm in diameter dimension.

One way ANOVA-test showed that there was non-significant differences ($p<0.05$) in the intra-canal pressure produced in the apical area or middle area for the tested systems but there was significant differences ($p>0.01$) in the coronal area pressure for the tested systems as presented in Table 2 and Figure 3.

Table 2: ANOVA test among apical, middle and coronal areas for the tested systems in both depth of insertion

ANOVA				
Areas Tested		**F**	**P-value**	**Sig**
Syringe	Apical third	0.124	0.734	NS
	Middle third	0.035	0.856	NS
	Coronal third	5.907	0.041	Sig
Aqua-pick	Apical third	0.149	0.71	NS
	Middle third	0.369	0.56	NS
	Coronal third	0.15	0.68	NS
Endoactivator	Apical third	0.213	0.657	NS
	Middle third	3.183	0.112	NS
	Coronal third	0.001	0.981	NS

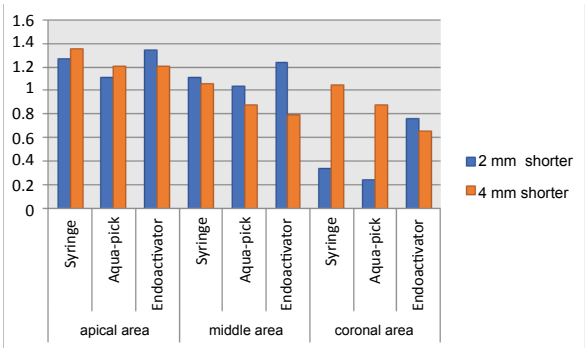

Figure 3: A histogram represent the apical, middle and coronal areas for the tested systems in both depth of insertion

ANOVA test showed that there was non-significant differences ($p<0.05$) in the intra-canal pressure produced in apical or middle area for the same group but with different depth of insertion of the needle inside the canal but there was significant differences ($p>0.01$) in the coronal area pressure as presented in Table 3 and Figure 4.

Table 3: ANOVA test among the tested systems in the apical, middle and coronal areas for each depth of insertion

ANOVA				
Areas Tested		**F**	**P-value**	**SIG**
2 mm Shorter than the Foramen	Apical third	0.472	0.635	NS
	Middle third	0.349	0.712	NS
	Coronal third	2.898	0.094	NS
4 mm Shorter than the Foramen	Apical third	0.192	0.828	NS
	Middle third	0.684	0.523	NS
	Coronal third	0.511	0.613	NS

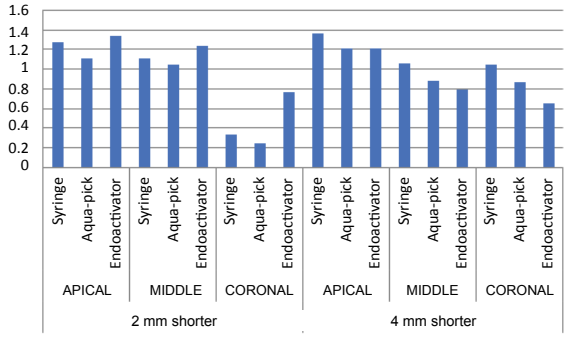

Figure 4: A histogram represent the tested systems in the apical, middle and coronal areas for each depth of insertion

DISCUSSION

The purpose of this study was to monitor amount of intra-canal pressure during irrigation with pressurized water technique with apically vented dental needle; compare it with the same needle attached to the disposable syringe and sonic irrigation system (Endoactivator irrigation device); also give an indications about the amount of apically extruded irrigation [3].

To investigate the safety of using pressurized water (liquid) technique as intra-canal irrigation technique by measuring the amount of intra-canal pressures produced by this technique in the 3 areas of root canal systems (apical, middle, cervical thirds) and comparing the results with the manual irrigation systems and Sonic irrigation systems, which supports the ability of using pressurized water technique as new root canal irrigation technique.

Pressurized water technique produce superior cleaning efficiency than the syringe irrigation and Sonic irrigation technique as we found in SEM study, with less amount of apically extruded irrigates when compared to syringe irrigation technique.

Penetration of the irrigant and the flushing action made by irrigation are dependent on the anatomy of the root canal system, the system of delivery, the depth of placement, the volume and fluid properties of the irrigant [4,9].

In this study a special model was constructed from resin block with (20 mm length and 5 mm diameter smallest diameter obtained by the resin block) also normal saline was used in this study to make sure that the results were due to irrigation systems.

Similar studies have been conducted in the field of neurosurgery to facilitate the design of improved injection equipment [10] and in dental anesthesia, to evaluate the risk of local tissue damage [11], cartridge failure [12] and needle clogging [13]. Also Measurement of pressure and flow rates during irrigation of a root canal [13] and air pressure developed beyond the apex from drying root canals with pressurized air [14].

According to the result of this study, all the tested groups produced a pressure in the apical, middle and coronal thirds of the sample as shown in Table 1, also all groups have low pressure in the coronal third and highest pressure in the apical third, No previous data concerning intra-canal pressure during root canal irrigation could be retrieved from the literature.

Pressurized water device (Aqua-pick device) had water pressure which is 7 Kgf/cm and 1800 pulsation per minute. This seems to produce vacuum inside the canal which lead to better cleaning efficiency. For Endoactivator, the oscillating patterns of the sonic instruments are different. They have one node near the attachment of the file and one antinode at the tip of the file [15].

According to this study, the pressure produced by pressurized water technique with apically vented needle inserted 2 mm or 4 mm shorter than the working length had non-significant differences from pressure produced by Endoactivator device inserted 2 mm or 4 mm shorter than the working length in apical third and middle third as shown in Table 2 but there was significant differences in coronal third pressure when both devices inserted 2 mm shorter than the working length as the pressure produced by Endoactivator was higher than the pressure produced by pressurized water device this may be because the Endoactivator produces lateral tip movement and not apical.

CONCLUSION

Within the limitation of this study, the pressurized water technique produce intra-canal pressure nearly the same as the sonic irrigation system (Endoactivator device) and could be used as new intra-canal irrigation system due to its low cost when compared to Endoactivator.

CONFLICT OF INTEREST

All authors declare that there is no conflict of interest.

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