Scanning Electron Microscopic Evaluation for the Ability of Endovac and EnoActivator in Cleaning Root Canal Space Using EDTA and QMix™

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Abstract

Evolution of a highly qualified materials and techniques were recently innovated to ensure adequate cleaning and total disinfection of the root canal space during endodontic treatment. The exact aim of this study is to compare and contrast the ability of two irrigating systems, namely; EndoActivator system and EndoVac system in cleaning and debridement of the root canal space using either EDTA or QMixTM irrigation in conjunction with the basically used sodium hypochlorite solution.

All the teeth under investigation were evaluated using scanning electron microscope with a magnification of X1500 and the collected data were scored then statistically analyzed using Paired, Student's t and Chi-square test.

Regarding the irrigating and debridement quality, a significant difference was found to exist between both solutions with more tendency to clean and debride the canal walls when using the QMixTM for irrigation. However, no significant difference exists between EndoActivator and EndoVac systems when used with both irrigating solutions.

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Introduction

It is well known that cleaning and shaping of the root canal space have both biological and mechanical objectives. Concerning the mechanical objectives, they mainly deal with the final shape and anatomy of the canals which have to be conservative as much as possible and in the same time should be adequate enough to carve away any restrictive dentin and sculpt a preparation that is thoroughly cleaned and prepared to receive a proper three dimensional obturation for the best sealing results. On the other hand, biological objectives meant to "free" the root canal system from any remaining pulp tissues, bacteria and their endotoxins as well as any other infected tissues inside the canals or around their periapical area. "just as Michelangelo was said, to have 'freed' his statues from the stone" [1].

It also seems worthy to know that, failure to respect and appreciate the previously mentioned biological and mechanical objectives of cleaning and shaping will properly increase frustrations and predisposes the endodontically treated patients to unneeded complications and further possibilities of treatment failure. Consequently, a great innovation in the materials and methods of root canal debridement were discovered and fabricated by manufacturers to decrease the percentage of canals contamination during their preparation with more possibility for long term successful endodontic treatment [1-4].

Some of those recently introduced trials are those concerning with manufacturing of a highly technical equipment for ideal canal debridement and irrigating solutions distribution throughout the canal irregularities as well as lateral canals, isthmus and apical delta as well to ensure adequate cleaning and total disinfection of the canal space during preparation. These innovations start from using rotary filing systems till the use of much more advanced equipment that was designed specifically for precise canal debridement, including the use of ultrasonic tips

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and the Endo-activators [5,6]. On the other hand, a continuous and prompt modifications was achieved regarding the materials and components used for the same purpose, starting from the usual use of sodium hypochlorite irrigation, till the most advanced chemically chelating agents used for further cleaning and superior debridement quality.

In the current study, a comparative evaluation for the effect of ultrasonic tip, namely: EndoVac (Sybron Endo, Orange, CA, USA)) and Endo-Activator (DENTSPLY Tulsa Dental Specialties, Tulsa, OK, USA), was done to measure the degree of cleanliness throughout the canal during preparation by rotary files and the amount of remaining attached debris to the canal walls with the aid of both NaOCl (sodium hypochlorite) together with either EDTA (ethylenediaminetetraacetic acid) or otherwise with QMix™ 2in1(a polyamino carboxylic acid chelating agent, a bisbiguanide antimicrobial agent, a surfactant and deionized water) using scanning electron microscope for maximum precise evaluation [7,8].

Materials and methods

Sample preparation

Total number of forty-eight (48) freshly extracted mandibular permanent human premolar teeth with single canals were selected for this study. Teeth were checked to be free from any obvious defects or abnormal morphology. Crowns were removed at the level of the cervical edge using safe-sided disc mounted on a high-speed handpiece. Teeth were then checked for canal patency using # 10 or # 15K-files. All specimens were prepared using Protaper Next System (Dentsply Maillefer, Ballaigues, Switzerland) till reaching size X3: 30/0.06 taper, this was done by the aid of an X-Smart endodontic rotary contra-angle motor (Dentsply, Sirona, Canada) mainly designed for rotary Nickel Titanium files with a speed range of 250-300 rpm and under a torque of 2.5 Ncm using the Crown-down pressurless technique and following the manufacturer instructions for preparation.

Grouping

Samples were divided into two major groups consisting of twenty-four (24) teeth in each group. In the first group, EndoVac (Sybron Endo, Orange, CA, USA), was used for irrigation. On the other hand, EndoActivator (DENTSPLY, Tulsa Dental Specialties, Tulsa, OK, USA) was used for irrigation of the second group. Both groups were subdivided into two other subgroups. The first of which were irrigated using 6.15 %NaOCl (The Clorox Co., Oakland, CA, USA) that were delivered by means of a 27G syringe needle (NaviTip; Ultradent, South Jordan, UT) placed 1 mm short of the working length, with a final flush of 17% EDTA (PULPDENT™ Corporation, Oakland, Watertown, USA) using both activator systems, while the second subgroup were irrigated first by using 6.15 % NaOCl in the same way followed by a final flush of QMix™ 2in1 (DENTSPLY Tulsa Dental Specialties, Tulsa, OK, USA) by the aid of both activating systems too. Finally, the teeth were longitudinally split into two halves and only the intact halves were used for microscopic evaluation to detect the amount of dentin chips and surface debris under the stereomicroscope.

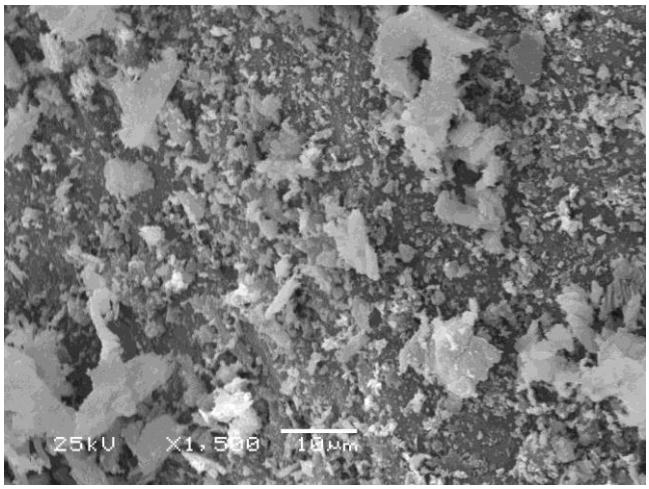

Figure 1. A photomicrograph showing a root section taken by SEM with magnification X1500 to evaluate the degree of canal debridement.

Microscopic evaluation

The evaluation of cleanliness in longitudinal sections was done using stereomicroscope with a magnification of X1500. Evaluation of the amount of superficial debris (dentine chips, pulp remnants, and particles loosely attached to the canal wall) in all of the instrumented root canals were done using a scale of A, B and C to rank the order of the amount of those debris. A score of (A) represented little or no superficial debris (conglomerations<25%) indicating good debridement, while the score of (B) represented

heavy amount of remaining debris (conglomerations>75%) indicating bad debridement. Finally, the score of (C) reflected gradation between the extremes indicating an average degree of debridement Figure 1.

Statistical analysis

All the data that were collected from the prepared samples were then statistically analyzed using Paired, Student's t and Chi-square test.

Results

A. The coronal and middle two thirds: Table 1, 2.

	Cronal & Middle NaOCl + EDTA		Cronal & Middle NaOCl + QMix™		Total	
	No.	%	No.	%	No.	%
A	1	8%	9	75%	10	42%
B	2	17%	0	0%	2	8%
C	9	75%	3	25%	12	50%
Total	12	100%	12	100%	24	100%

Table 1. The percentage of debridement and calculated P-value for the coronal and middle two thirds using NaOCl in conjunction with EDTA and with QMix™

Chi-square = 11.40 P = 0.0033**

** P<0.01; * P<0.05; ns = not significant (P>0.05)

	Cronal & Middle EndoActivator		Cronal & Middle EndoVac		Total	
	No.	%	No.	%	No.	%
A	6	50%	4	33%	10	42%
B	1	8%	1	8%	2	8%
C	5	42%	7	58%	12	50%
Total	12	100%	12	100%	24	100%

Table 2. The percentage of debridement and calculated P-value of the coronal and middle thirds using EndoActivator system and EndoVac system.

Chi-square = 0.73 P = 0.6930 ns

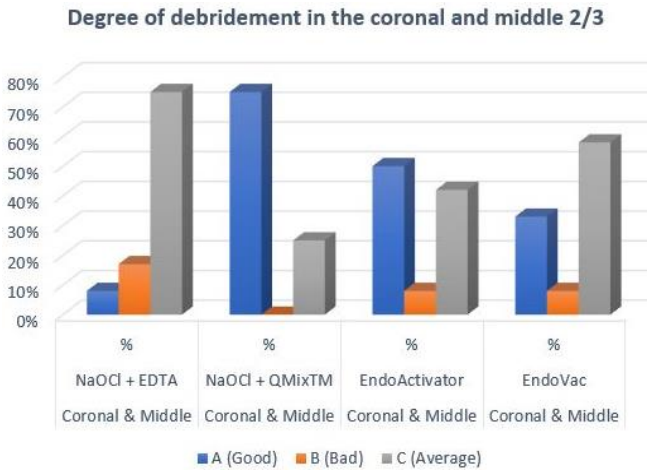

Figure 2. A graph showing the degree of debridement using EndoActivator and EndoVac with both EDTA and QMixTM irrigating solutions in the coronal and middle two thirds.

I. Using NaOCl irrigating solution in conjunction with EDTA in one group then with QMix™ in the other group. A significant difference exists between the two groups (P=0.0033) Figure 2.

II. Using EndoActivator system or the EndoVac system. No significant difference exists between both systems using either ways of irrigation (P=0.6930) Figure 2.

B. The apical third: Table 3, 4

	Apical Third NaOCl + EDTA		Apical Third NaOCl + QMix™		Total	
	No.	%	No.	%	No.	%
A	1	8%	9	75%	10	42%
B	4	33%	0	0%	4	17%
C	7	58%	3	25%	10	42%
Total	12	100%	12	100%	24	100%

Table 3. The percentage of debridement and calculated P-value for the apical third using NaOCl in conjunction with EDTA and with QMix™

Chi-square = 12.00 P = 0.0025**

	Apical Third EndoActivator		Apical Third EndoVac		Total	
	No.	%	No.	%	No.	%
A	4	33%	6	50%	10	42%
B	3	25%	1	8%	4	17%
C	5	42%	5	42%	10	42%
Total	12	100%	12	100%	24	100%

Table 4. The percentage of debridement and calculated P-value of the apical third using EndoActivator system and EndoVac system.

Chi-square = 0.40 P = 0.4966 ns

I. Using NaOCl irrigating solution in conjunction with EDTA in one group then with QMix™ in the other group. A significant difference exists between the two groups (P=0.0025) Figure 3.

II. Using EndoActivator system or the EndoVac system. No significant difference exists between both systems using either ways of irrigation (P=0.4966) Figure 3.

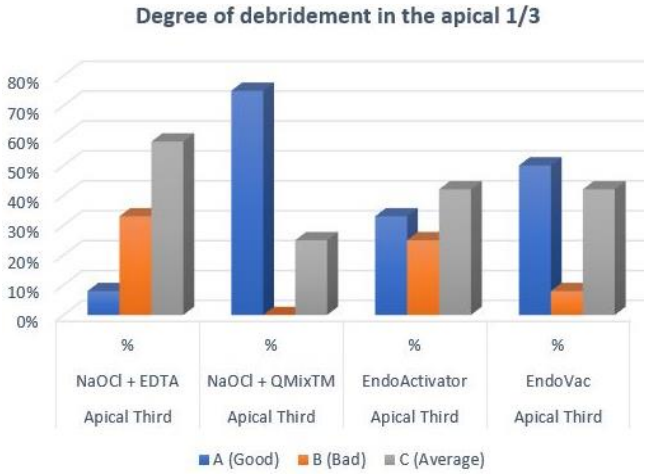

Figure 3. A graph showing the degree of debridement using EndoActivator and EndoVac with both EDTA and QMixTM irrigating solutions in the apical one third.

Discussion

It is now evident for all endodontic specialists that achieving the biological role of endodontic treatment is mainly dependent on the degree of canal debridement and total freedom from any remaining dentine chips, pulp remnants, and particles loosely attached to the canal walls, as well as bacterial products and their endotoxins. Failure to achieve such goal together with proper seal of the coronal and the apical entrance of the root canal space preventing any further contamination, will consequently lead to increasing possibilities of unneeded complications, failures and need for future retreatment or surgical interference in more complicated cases [9].

Applying NaOCl irrigating solution with its variable concentrations for these purposes, had been widely spreading long time ago due to its superior capabilities of maintaining the root canal space cleaned and freed from any source of bacterial infections or remaining pulp remnants [10]. Unfortunately, the organic matter including tissue residue, inflammatory exudates and microbial masses in root canals reduces the effect of NaOCl. However, it has been proved that tissue-dissolving ability of NaOCl solutions could be increased through increasing the solution temperature, by ultrasonic activation, and also by prolonged time of application [11]. An urgent need for much more effective debridement agents and methods of application appeared to reach the maximum goal of a totally clean and debride canal. These includes the use of EDTA (Ethylenediaminetetraacetic Acid) as an inorganic tissue-dissolving agent removing the smear layer and debris from the root canal system and have a major benefit as a chelating agent that aids in preparation of typically narrow and calcified canals as well [12-14].

Effect of EDTA also had been proved to be reinforced with the aid of much more advanced applicating equipment and also through increasing the total time of application [15,16]. Once again a new innovation in the irrigating solutions had came to the scene with the production of the QMix 2in1 irrigating combination (a polyamino carboxylic acid chelating agent, a bisbiguanide antimicrobial agent, a surfactant and deionized water) with its superior capability as a chelating agent as well as its excellent bacteria-killing properties in minimum time of application not exceeding 60-90 seconds [17-19]. On the other hand, and along with the recent irrigation's innovation, there has been a breakthrough in inventions concerning the methods of application of those irrigants, starting from the use of ultrasonics [20-22] till we reached a much more modified equipments that were designed mainly for this purpose including the use of the EndoVac system with its ability of initiating an apical negative pressure irrigation system using a suction system to pull the irrigant down the root canal, and then up and away into the Hi-Vac suction unit to deliver an ideal irrigation performance [23-26].

Further improvements had never stopped, and continuous modifications were always going through, which lead us to the newly fabricated irrigating device, namely; the EndoActivator, that seems to agitates irrigation solutions during endodontic treatment and designed to safely and vigorously energize the hydrodynamic phenomenon, promoting the irrigating solutions to enter further deeply into lateral canals and anastomoses for better cleaning and disinfection process [27-30]. The present study was done to compare the efficacy of two irrigating systems, namely; EndoActivator system and EndoVac system in cleaning the root canal system using either 17% EDTA or QMix 2in1 irrigation as a final rinsing after application of 6.15% NaOCl throughout the steps of canal preparation with the aid of rotary PTN filing system. Final evaluation was done using the electron scanning microscope as being proved to be an accurate

tool for evaluation of the root canal debridement and degree of cleanliness [31-35].

Regarding the degree of canal debridement, we considered the specimen to be badly debrided when most of the dentinal tubules are blocked and the dentin shavings are covering the canal. While the canal is considered to have good debridement when dentinal tubules are mostly opened with least amount of scattered dentin shavings and the canal is then almost clean. Average debridement will be lying in between the previous two categories. In the present study there was a significant difference between the group irrigated with NaOCl solution in conjunction with EDTA and that one which were finally rinsed with QMix 2in1 irrigation. This was actually might be due to the superior chelating properties of the QMix, which remove the smear layer and tend to retain the canals cleaner. Moreover, it has a great help in making the files more easily sliding inside the canal with least possibilities of breakage or distortion. Besides, it could reach its maximum effect in a minimal working time. On the other hand, it worthy stating that no significant difference was found to exist between the EndoActivator and the EndoVac systems concerning the degree of canal debridement with both irrigating solutions.

Conclusions

Regarding canal debridement; those canals which were irrigated with NaOCl solution in conjunction with QMix 2in1 irrigation as a final flush are significantly clearer and more debrided than those used NaOCl solution with EDTA. While no significant difference was found between the two irrigating devices, namely; EndoActivator and EndoVac systems regarding canal debridement.

Declaration of Interest

The author report no conflict of interest.

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