Comparative evaluation of debris removal from root canal wall by using EndoVac and conventional needle irrigation: An in vitro study

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Abstract

Context: Microbial control is of paramount importance in Clinical Endodontics. Therefore, cleaning and disinfection of root canals are essential to achieve endodontic success. Aims: The purpose of this study is to compare the efficacy of EndoVac irrigation system and conventional needle (30 gauges side venting needle) irrigation for removal of debris from the root canal walls at coronal, middle and apical third by using the scanning electron microscopy (SEM). Settings and Design: An in vitro randomized control trial study. Materials and Methods: A total of 20 mandibular premolars with completely formed roots were selected and randomly divided into two groups - Group 1: Irrigation with the Conventional system and Group 2: EndoVac irrigation. After access opening and working length determination biomechanical preparation completed up to a rotary protaper F4 file. Groupwise irrigation with sodium hypochlorite and ethylenediaminetetraacetic acid was done with each canal in between instrumentation. Then, the teeth were sectioned in buccolingual direction and the halves were sputter-coated with gold palladium and coronal, middle and apical third were examined by SEM at x2000 magnification. Statistical Analysis: Mann-Whitney test for comparison between methods, Kruskal-Wallis test for comparison among thirds and Miller test for individual comparisons. Results: The apical, middle and cervical root canal thirds were evaluated and the results were analyzed statistically by the Mann-Whitney test for comparison between methods, Kruskal-Wallis test for comparison among thirds and Miller test for individual comparisons. Conclusions: EndoVac group resulted in significantly less debris at apical third compared with the conventional needle irrigation group. There was no statistical significant difference found in debris removal at coronal and middle third of root canal wall between the EndoVac group and conventional needle irrigation group.

Keywords: Conventional irrigation, EndoVac irrigation system, negative apical pressure, positive apical pressure, root canal irrigation, vapor lock

Introduction

Irrigation is the vital part of root canal debridement. About 35% of root canal surfaces remained un-instrumented, regardless of instrumentation technique used. In conventional needle irrigation, replenishment and exchange of irrigant in the apical third and the effectiveness of chemical debridement depends upon the depth of needle penetration. Exchange of irrigant does not extend much beyond the tip of the irrigating needle i.e., only 1-1.5 mm past a side vented needle and the irrigant beyond that point remains stagnant. Vapor lock that results in trapped air in the apical third of root canals might also hinder the exchange of irrigants and also affect the debridement efficacy of irrigants. Past studies have shown that conventional irrigation methods are effective in cleaning root canals coronally, but less effective apically. So for effective irrigation, an improved delivery system is highly desirable.

The EndoVac, apical negative pressure irrigation system (Discus Dental, Smart Endodontics, Culver City, CA) has three components: Micro cannula, the macro cannula and the master delivery tip (MDT). The MDT simultaneously delivers and evacuates the irrigant. The macro cannula is used to suction irrigant from the chamber to the coronal and middle segments of the canal. The micro cannula contains 12 microscopic holes and is capable of evacuating debris to full working length (WL). Nielsen and Craig Baumgartner concluded that EndoVac was significantly better for root canal debridement at the apical termination than positive pressure needle irrigation. Shin et al. also showed that the EndoVac left significantly less debris behind than conventional needle irrigation. The inability of the different irrigation regimens to clear the debris from canal wall has led to research specifically aimed at this challenge; hence, this study was conducted to know the efficacy of debris removal of positive apical pressure (conventional needle irrigation) and negative apical pressure (EndoVac system).
Materials and Methods

The study was conducted on 20 mandibular premolars with completely formed roots and a single root canal extracted due to orthodontic reasons. The teeth had similar canal diameters as shown by previous periapical radiographic examination. After access opening, a #15 K file (Dentsply) with a rubber stop was introduced in the canal until its tip could be seen through the apical foramen under the operating microscope (Seiler,) at ×12 magnifications. The tooth length was then checked and 1 mm was subtracted to determine the WL. The teeth were randomly divided into two groups of 10 teeth each, according to the irrigation method employed.

Group I, the root canals were irrigated with conventional method using a 30 guage side-vented needle (ammdent). Before instrumentation tooth irrigated with 2 ml of 2.5% sodium hypochlorite (NaOCl) followed by instrumentation with Protaper Rotary files and rinsed by 2 ml of 2.5% NaOCl. Tooth was instrumented up to Protaper F4 and further rinsed with 2 ml of 2.5% NaOCl. The solution was then allowed to remain undisturbed in the canal for 60 s and final irrigation procedure was performed as rinsing canal with 2.5 ml of 2.5% NaOCl followed by 2.5 ml of 2.5% NaOCl as last irrigant.

In Group II - Before instrumentation, irrigation with 6 ml of 2.5% NaOCl was carried out by EndoVac MDT, at each change of instrument canal was rinsed with 6 ml NaOCl by MDT followed by instrumentation with F4 and rinsed with 6 ml NaOCl by MDT. Macro irrigation was performed in which macro cannula is continuously moved up and down for 30 s half the length the canal. NaOCl left undisturbed in the canal for 60 s and then three cycles of micro irrigation (30 s) were performed. In 1\(^{st}\) cycle, canal rinsed with 6 ml NaOCl by MDT and active micro irrigation at apex performed for 18 s. 2\(^{nd}\) cycle was performed with same steps using 5 ml 17% EDTA and the 3\(^{rd}\) cycle again by using 6 ml of 2.5% NaOCl.

After instrumentation, the teeth were sectioned by giving vertical groove in buccolingual direction with carborundum discs at low speed under continuous water irrigation. Then each tooth was vertically split by applying slight pressure by enamel chisel into longitudinal groove. The most representative halves of each tooth were selected, sputter-coated and analyzed by scanning electron microscopy (SEM) Each specimen was photographed at the apical, middle and cervical thirds for the amount of remaining debris.

Results

Scoring criteria: Three calibrated examiners assigned scores to the SEM micrographs according to the amount of debris present on the root canal walls as follows:

Score 1: Absence debris; Score 2: Smear layer obliterating the dentin tubules; Score 3: Smear layer covering the dentin walls; Score 4: Debris covering the dentin walls [Figure 1].

The study had a double-blind design. Coincident scores between two or more examiners were assigned to the specimen. In case of disagreement among the three examiners, the specimen was reevaluated.

Statistical analysis

The scores were analyzed statistically by the Mann-Whitney U-test for comparison between techniques at each third, Kruskal Wallis test for overall comparison between thirds and Miller test for individual comparisons, at a significance level of \(P < 0.05\). The Kendall test was also applied for analysis of inter-examiner agreement [Tables 1 and 2 Graph 1].

Discussion

Past studies have shown that current irrigation methods may be effective at cleaning the coronal portions of root canals, but much less effective in the apical portions of canals. The mechanical flushing action created by conventional hand-held syringe needle irrigation is relatively weak. After conventional syringe needle irrigation, inaccessible canal extensions and irregularities...
study, two different irrigation techniques were compared for their efficiency in removing of dentin debris; the conventional irrigation (positive pressure irrigation) and the EndoVac system (negative pressure irrigation). In the present study focused on evaluating the effectiveness of EndoVac irrigation system in removing the debris from root canal wall at coronal, middle and apical third after rotary instrumentation of root canals, using SEM. The results of comparison of EndoVac group with conventional group at apical third are in agreement with the previous study by, Siu and Baumgartner;[13] and Shin et al.[11] The explanations for these results might be related to the depth of penetration of the irrigation needles; in the conventional needle irrigation group, the depth of needle penetration were limited to 2 mm from WL, to avoid NaOCl accidents. 2 mm represents a distance from the WL that is likely the closest that most practitioners place an ordinary needle during irrigation. Thus, this distance is a best-case scenario for needle irrigation to compare with the EndoVac system. EndoVac pulls the irrigant into the canal and remove it by negative pressure at WL thus avoiding entrapment of air and also safely deliver irrigant to WL. Because of the inherent differences between these two irrigating techniques, the variable of cannula or needle compared with WL was not held constant and represents the possible advantage of the EndoVac system, namely, safe irrigation at WL. With the EndoVac, irrigant is pulled into the canal and removed by negative pressure at WL; the microcannula was inserted to WL,[15] Desai and Himel[16] found that the EndoVac was able to be used to the WL very safely, without extrusion of irrigating solution beyond the apical constriction of the canal. The volume of irrigant delivered to the canal apically by the EndoVac system was significantly higher than the volume delivered by conventional syringe needle irrigation during the same time period.[10]
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There are a number of studies that have compared the microbial reduction efficacy of the EndoVac system with other irrigation techniques with conflicting results. Brito et al. (Brio PR, Souza LC,) compared the effectiveness of three irrigation techniques on the reduction of intra-canal Enterococcus Faecalis and found that there were no significant difference among conventional irrigation, endoactivator and EndoVac irrigation technique.\[17\] Miller and Baumgartner\[18\] exposed the dentinal tubules in the apical 5 mm by crushing the root end, there was no statistically significant difference in the bacterial reduction between the EndoVac and conventional needle irrigation. When Hockett et al.\[19\] used paper points to sample canal contents, they concluded that irrigation with the EndoVac resulted in significant microbial reduction compared with using a traditional irrigation delivery system.

NaOCl has the ability to dissolve organic debris, kill microbes and destroy microbial byproducts.\[3\] EDTA is a chelating agent used to remove the smear layer.\[9,20\] This combination of irrigants has been shown to be effective in debriding and disinfecting root canals as well as other irrigants.\[7,9,20-22\] With the EndoVac system, more irrigant can be delivered through the delivery/evacuation tip. While the cannulas are in the canal, a constant flow of fresh irrigant is being delivered by negative pressure to WL. Studies have shown increased efficacy of canal debridement with increased apical size preparations and increased taper of instruments.\[8,16,23-25\] EndoVac irrigation system with its apical negative pressure is able to remove more debris at apical third when compared with conventional needle irrigation but, unable to remove debris completely. [Figures 2 and 3]

**Conclusion**

Effective irrigant delivery is pre-requited for successful endodontic treatment. In this study, EndoVac group resulted in significantly less debris at apical third level compared with the conventional needle irrigation group. No significant difference was found at middle and coronal third. Future studies should look at the effect of taper, apical size, safety and effect on apical seal when the EndoVac is used for irrigation. The result also demands need for better irrigant protocols to completely remove debris from the apical third of the canal.

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