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ORIGINAL RESEARCH

Scanning Electron Microscopic Analysis to Compare the Cleaning Efficiency of Three Different Irrigation Systems at Different Root Canal Levels: An *in vitro* Study

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ABSTRACT

Aim: This study compared the efficacy of conventional, endovac and ultrasonic irrigation system for the removal of debris from root canal walls, using scanning electron microscopy (SEM) at cervical, middle and apical 3rd.

Materials and methods: A total of 30 freshly extracted human mandibular premolars with complete root formation were selected and divided into group 1 endovac, group 2 conventional and group 3 ultrasonic. After instrumentation and irrigation, the teeth were sectioned in buccolingual direction and analyzed by SEM and the results were analyzed statistically by students unpaired 't' test.

Results: There was significant difference between mean values of cervical (CV), middle (M), and apical (A) when endovac compared with conventional and conventional compared with ultrasonic group (i.e. < 0.05) and no significant difference between mean values at CV, M and A when endovac compared with ultrasonic group.

Conclusion: Among all groups ultrasonic and endovac group showed cleaner canal walls and less amount of debris than conventional group.

Clinical significance: Application of ultrasonic and endovac can be used effectively for irrigation of canals leading to least debris and better prognosis.

Keywords: Endovac, Ultrasonic, Cleaning efficiency, Scanning electron microscopy.

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INTRODUCTION

The success of endodontic treatment depends on some factors, such as correct indication, accurate diagnosis, adequate cleaning and root canal preparation, quality of root canal filling, and an adequate final restoration. All these factors are interdependent and equally important.[1] The persistence of pulp remnants, microorganisms and bacterial byproducts may lead to treatment failure.[2] Their elimination may be achieved by the mechanical action of instruments on the root canal walls and the chemical and physical action of irrigants.[3] Irrigants must be brought into direct contact with the entire canal area and especially with the apical portions of narrow root canals for optimal effectiveness. The penetration and flushing action of the irrigant depend not only on the anatomy of the root canal system but also on the system of delivery, the volume and fluid properties of the irrigant, and the size, type, and insertion depth of the irrigation needle.[4] Traditionally, irrigation has been performed with a plastic syringe and an open-ended needle into the canal space. An increasing number of novel needle-tip designs and equipment are emerging in an effort to better address the challenges of irrigation. Throughout the history of endodontic, endeavors have continuously been made to develop more effective irrigant delivery and agitation systems for root canal irrigation.[5]

Endovac system (Discus Dental, Culver City, CA, USA) is depending on the apical negative pressure for cleaning of the root canal with safely deliver irrigant to working length.

Ultrasonic is an useful adjunct in cleaning difficult and complex anatomical features. It has been demonstrated that an irrigant in conjunction with ultrasonic vibration, which generates a continuous movement of the irrigant, is directly associated with the effectiveness of the cleaning of the root canal space.[6]

Literature does not reveal any comparative study of conventional, endovac and ultrasonic irrigation system for canal cleanliness and smear layer removal.

Aim of our study was to compare conventional, endovac and ultrasonic irrigation system for canal cleanliness and smear layer removal using SEM.

MATERIALS AND METHODS

A total of 30 freshly extracted human mandibular premolars with complete root formation were selected. Standard access cavity preparation was done using diamond burs BR-13 and EX-24.

The working length was determining by inserting 10 K-file (Dentsply Maillefer Baillaigues, Switzerland) into the canal and digital radiograph was taken. Instrumentation was carried out with standard step back technique with K-flex file upto apical size #40.

The teeth were randomly divided into three groups of 10 teeth each, according to irrigation method employed.

Group I: Endovac Group

In this group after each instrument change the microcannula was used for initial flushing of the coronal portion of canal. This was replaced by microcannula which was used for irrigation at the apical portion of the canal to the working length.

Group II: Conventional Syringe

In this group, after each instruments change 1 ml of 3% sodium hypochlorite was used as irrigation. Each canal was syringe irrigated with a 30 gauge side vented irrigation needle.

Group III: Ultrasonic group

In this group ultrasonic irrigation was performed passively (PUI) the root canal was filled with NAOCI, and then the solution was activated with ultrasonic tip for 20 seconds at 1 mm short of the working length.

After instrumentation and irrigation, the teeth were sectioned in buccolingual direction with carborundum disks at low speed. The most preservative halves of each tooth were selected and analyzed by SEM. Each specimen was photographed at cervical, middle and apical thirds, and 2 calibrated examiners assigned scores to the SEM micrographs according to amount of debris present on the root canal walls.

Score 1: Absence of debris, open dentinal tubules.

Score 2: Small amount of smear layer obliterating dentinal tubules.

Score 3: Homogenous smear layer covering the root canal wall, very few dentinal tubules open.

Score 4: Smear layer covering the dentinal wall, no open dentinal tubules.

The final results for each section of the canals were obtained by calculating the mean of the scores of each of the photographs.

Stastical analysis: Differences in the scores were analyzed by students unpaired 't' test.

RESULTS

The present *in vitro* study was conducted for comparative analysis of smear layer in coronal, middle and apical third of root canal by using endovac (group 1), conventional (group 2) and ultrasonic (group 3). Debris and smear layer were observed in all the three groups and at every root level using any irrigation technique. By applying Student's, unpaired 't' test there was significant difference between mean values of CV, M and A when endovac compared with conventional and conventional compared with ultrasonic group (i.e. < 0.05) and no significant difference between mean values at CV, M and A when Endovac compared with Ultrasonic group ($p > 0.05$). Table 1 demonstrates comparison between the groups.

Graph 1 (Bar graph no. 1) depicting the comparison of mean scores of smear layer at cervical, middle and apical 1/3 rd between three groups.

DISCUSSION

Debridement of the root canal system is a major concern for endodontic success and irrigation is an important part of root canal debridement. 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 are likely to harbor debris and bacteria, thereby making thorough canal debridement difficult[7] unfortunately many studies have reported that currently used methods of root canal preparation and irrigation do not effectively debride the entire root canal system.[8] For these reasons many devices and techniques were developed to overcome this weakness in cleaning of root canal. In our study three different irrigation systems were compared for their efficiency in removing of dentin debris, cleaning canals and removing smear layer; the conventional irrigation, the endovac and ultrasonic irrigation by SEM. SEM analysis is useful to evaluate the action of different instrumentation and irrigation system on root canal walls.

Table 1: Comparsion of mean and SD values in all groups

	Cervical Mean ± SD	*Middle Mean ± SD*	*Apical Mean ± SD*
Endovac	1.6 ± 0.51	2.6 ± 0.51	3.6 ± 0.51
Conventional	2.2 ± 0.42	3.6 ± 0.51	4 ± 0.0
Ultrasonic	1.4 ± 0.51	2.4 ± 0.51	3.4 ± 0.51

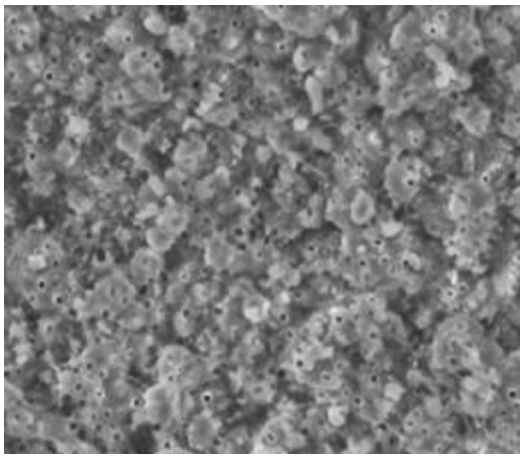


Fig. 1: Endovac group cervical level (score 2)

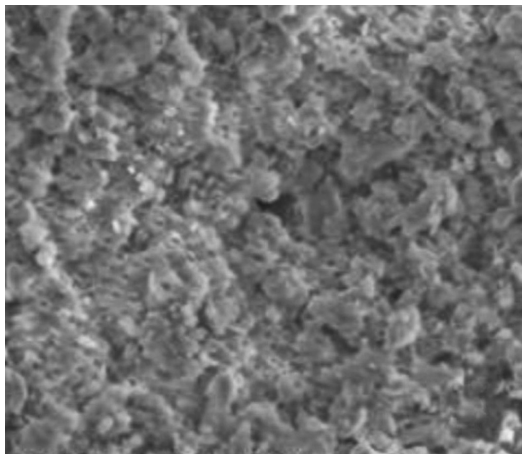


Fig. 2: Endovac group middle level (score 3)

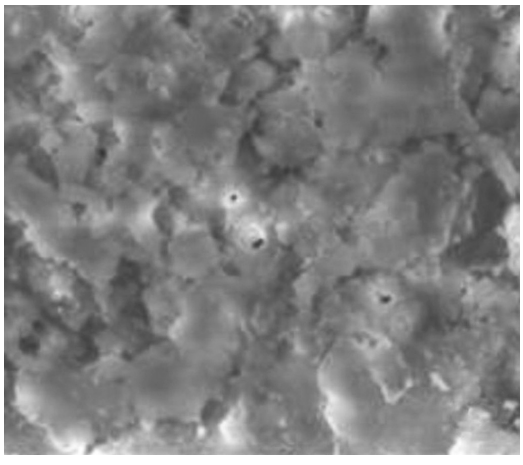


Fig 3: Endovac group apical level (score 4)

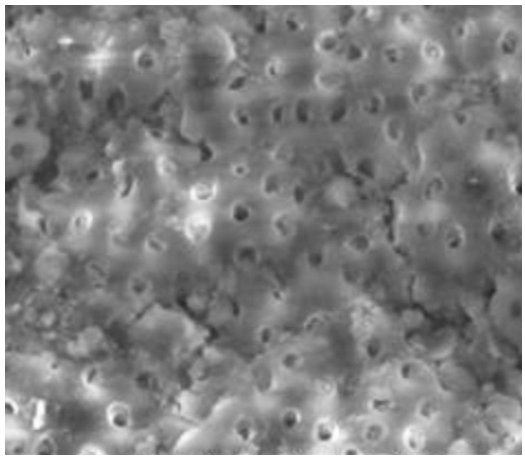


Fig. 4: Ultrasonic group cervical level (score 1)

Results of our study demonstrated that endovac and ultrasonic system were more effective than conventional irrigation. Similar study done by Nielsen and Baumgartner compared the endovac system and the conventional needle for smear layer removal, both acting at 1 to 3 mm from the WL, and reported significant difference between thirds only at 1 mm from the WL, with better results for endovac.[9]

Both endovac (Figs 1 to 3) and Ultrasonic (Figs 4 to 6) left significantly less debris behind when compared with conventional irrigation (Figs 7 to 9). The efficiency of endovac could be due to the macrocanula design, which act like Manual–Dynamic irrigant system and negative pressure system at the same time, the open end acted to sucking of irrigation solution with debris. The push-pull motion of a plastic macrocanula in the canal might generate higher intracanal pressure changes during pushing movements, leading to more effective delivery of irrigant to the untouched canal surfaces.[10] Use of ultrasonic energy for cleaning of the root canal and to facilitate disinfection has a long history of endodontics. Cunningham concluded that ultrasonic together with an irrigant, contributed to a better cleaning of root canal system than irrigation and hand instrumentation alone.[11] Cavitation and acoustic streaming of the irrigant contribute to the abiologic chemical activity for maximum effectiveness.[12] Analysis of the mechanisms of the hydrodynamic response of an oscillating ultrasonic file suggested that stable and transient cavitation of a file, steady streaming and cavitation microstreaming all contribute to the cleaning of the root canal.[13] Amount of debris remaining at cervical and middle levels were less than that of apical third for all the three groups so the possible reason may be related to the type of instrumentation and internal canal morphology. The apical instrumented space is narrowest than the middle and coronal region so less amount of irrigation delivered to these area.

Ultrasonic group showed least amount of debris among all the groups but stastically, no significant difference found between the endovac and ultrasonic group.

CONCLUSION

Within the limitations of this *in vitro* study following conclusions can be made:

1. There was significant difference between conventional irrigation and endovac in cleaning ability of root canal walls.
2. There was significant difference between conventional irrigation and ultrasonic irrigation in cleaning ability of root canal walls.

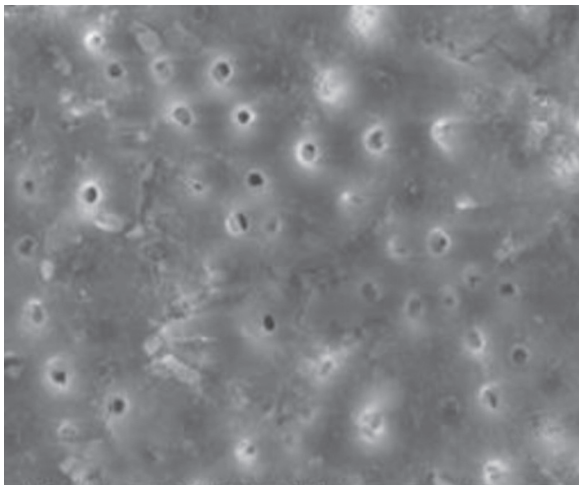


Fig. 5: Ultrasonic group middle level (score 2)

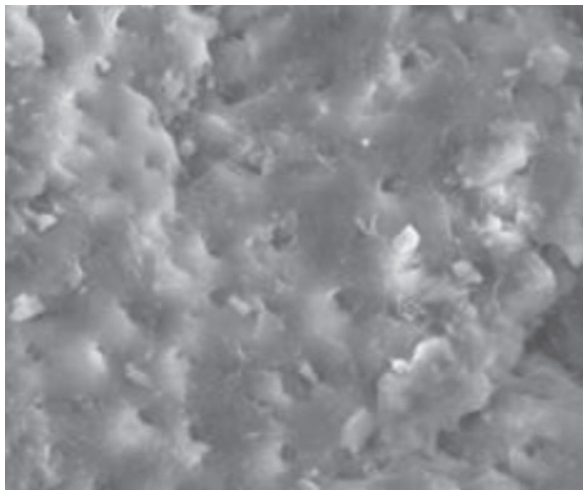


Fig. 6: Ultrasonic group apical level (score 3)

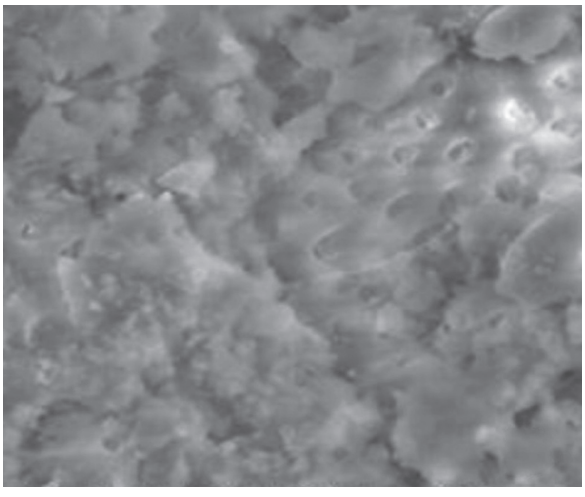


Fig. 7: Conventional group cervical level (score 3)

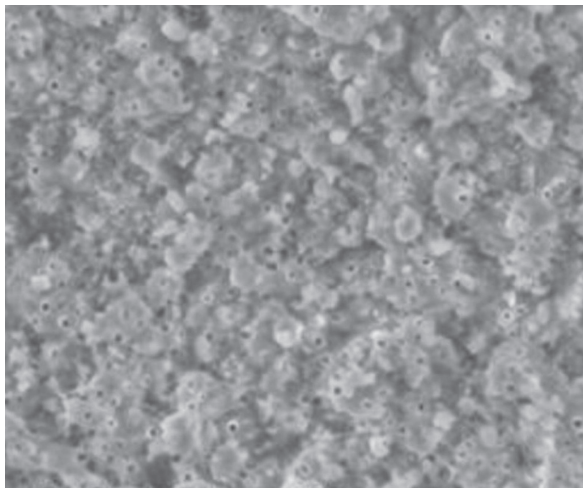


Fig. 8: Conventional group middle level (score 3)

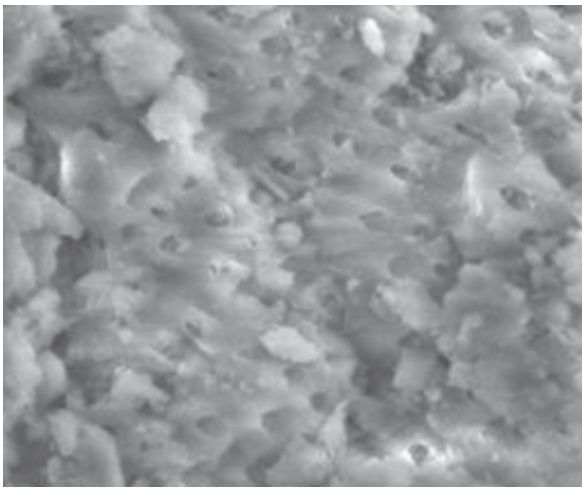
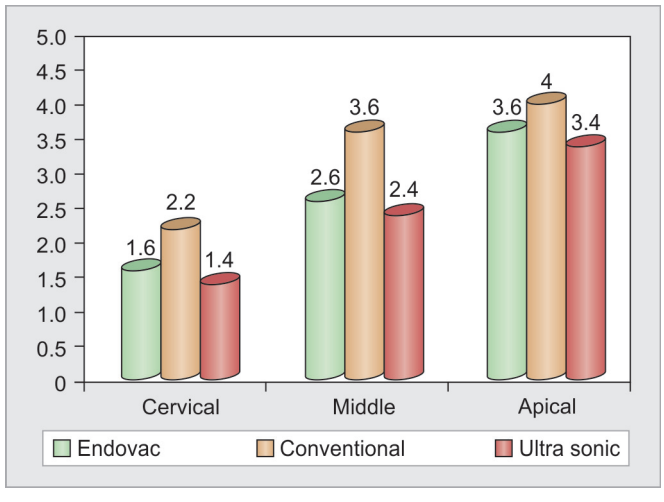


Fig. 9: Conventional group apical level (score 4)



Graph 1: Depicting comparison of mean values of endovac, conventional and ultrasonic groups

3. Ultrasonic irrigation allowed cleaner canal walls among all the groups but stastically, no significant difference found between the endovac and ultrasonic group.
4. The cervical and middle 1/3 of the canal walls were cleaner than apical 1/3 in all the groups.

CLINICAL SIGNIFICANCE

Application of ultrasonic and endovac can be used effectively for irrigation of canals. This will aid proper cleaning and debridement of canals which will decrease chances of reinfection.

REFERENCES

1. Vivan RR, Bortolo MV, Duarte MAH, de Moraes IG, Tanomaru-Filho M, Bramante VM. Scanning electron microscopy analysis of rins endo system and conventional irrigation for debris removal. Braz Dent J 2010;21:305-309.
2. Gutmann JL. Clinical, radiographic and histologic perspectives on success and failure in endodontics. Dent Clin North Am 1992; 36:379-392.
3. Schilder H. Cleaning and shaping the root canal. Dent Clin North Am 1974;18:269-296.
4. Shen Y, Gao Y, Qian W, Ruse ND, Zhou X, Wu H, Haapasalo M. Effect of needle tip design on irrigant flow pattern. J Endod 2010; 36:884-889.
5. Gu LS, Kim JR, Ling J, Choi KK, Pashley DH, Tay FR. Review of contemporary irrigant agitation techniques and devices. J Endod 2009;35:791-804.
6. Ahmad M, Pitt Ford TR, Crum LA. Ultrasonic debridement of root canals: an insight into the mechanisms involved. J Endod 1987; 13:93-101.
7. Wu MK, Dummer PM, Wesselink PR. Consequences of and strategies to deal with residual post-treatment root canal infection. Int Endod J 2006;39:343-356.
8. Torabinejad M, Handisides R, Khamedi AA, et al. Clinical implictions of smear layer in endodontics: a review. Oral Surg Oral Med Oral Path Oral Radiol Endod 2002;94:658-666.
9. Nielsen BA, Baumgartner JC. Comparison of the endovac system to needle irrigation of root canals. J Endod 2007;33:611-615.
10. Mc Gill S, Gulabi Vala K, Mordan N, Ng YL. The efficacy of dynamic irrigation using a commercially available system (Rinseendo) determined by removal of collagen' biomolecular film' from an ex vivo model. Int Endod J 2008;41:602-608.
11. Cunningham W, Martin H, Forrest W. Evaluation of root canal debridement by the endosonic ultrasonic synergistic system. Oral Surg Oral Med Oral Pathol 1982;53:401-404.
12. Martin H, Cunningham W, et al. Endosonics-the ultrasonic synergistic system of endodontic. Endod Traumatol 1985;1:201-206.
13. Roy RA, Ahmad M, Crum LA. Physical mechanisms governing the hydrodynamic response of an oscillating ultrasonic file. Int Endod J 1994;27:197-207.