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Evaluation of Intracanal Calcium Hydroxide Removal with Different Techniques: A SEM Study

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ABSTRACT

Aim: This study aimed to evaluate the efficacy of Intracanal calcium hydroxide removal with different techniques.

Materials and methods: Seventy-five freshly extracted, non-carious, single canalled lower first premolars, having anatomic characteristics similar to each other, extracted for the orthodontic purpose were collected. After the root canal preparation, Calcium hydroxide was placed into the working length using lentulo spiral instrument till the medicament was visible at the apex. The specimens were segregated into three groups; Group 1: Rotary Files, Group 2: EndoVac system and Group 3: Ultrasonics. The evaluation was done with SEM in the coronal and apical third of the roots with a magnification of 1000x. The statistical analysis was done using statistical packages for social sciences (SPSS) software, version 20.0 for Windows (SPSS Inc., Chicago, IL). A p-value of less than 0.5 was considered significant statistically.

Results: Maximum removal of $Ca(OH)_2$ was analyzed in the EndoVac system (2.90 ± 0.12) followed by the rotary files (1.76 ± 0.26) and least was seen with Ultrasonics (1.32 ± 0.14). The p-value of 0.001 was seen between the coronal and apical third with the EndoVac system which is statistically significant. The significant difference statistically was observed between Rotary Files *vs*. Ultrasonics at apical third and with the EndoVac system *vs*. Ultrasonics at coronal third as well as at the apical third with p-value 0.001.

Conclusion: It can be concluded that the EndoVac technique was effective in removing $Ca(OH)_2$ medicament from the coronal and apical third of the root canal significantly.

Clinical significance: Calcium hydroxide removal before the obturation was of priority as the $Ca(OH)_2$ remnants have a negative impact of the ability for sealing the obturation material. Therefore, having a complete knowledge regarding the effective technique is much important.

Keywords: Calcium hydroxide, Different techniques, EndoVac system, Rotary Files, Ultrasonics.

INTRODUCTION

Microorganisms play the significant role in the pulp and periapical disease. The aim of the root canal treatment (RCT) is to eliminate the bacteria and to prevent the reinfection. The cleaning and shaping of the infected canals have been proved to be effective in

reducing the bacterial count, though the complete disinfection is challenging to achieve. Failure of the RCT may cause due to the survival of the left over bacteria.[1] Calcium hydroxide Intracanal medicament was used to reduce the further microbial growth in the canal as advocated by many authors.[2,3]

The bacterial endotoxin neutralization, apical stimulation, periapical repair, and proven antimicrobial activity makes calcium hydroxide to be used commonly as an intracanal medicament.[4] The calcium hydroxide remnants on the canal walls affect the bond strength of the dentine and also affects the root canal filling quality negatively. Therefore, the remnants have to be removed prior to the root canal obturation. The irregular residues on the walls of the root canal would be the main drawback.[5]

The efficient method to deliver the irrigant has considered being a conventional syringe irrigation method, using the syringe with a different combination of ethylenediaminetetraacetic acid (EDTA) and NaOCl. The practitioners still widely accept this technique. The stream action is weak, relatively with the use of conventional method due to the complex anatomy of the root canal.[6] The effectiveness of the irrigation doesn't depend on the volume of irrigation, but on the stream action, as supported. Hence, the present endodontic treatment techniques cannot achieve the goal of complete removal of calcium hydroxide dressing. The null hypothesis of the study was that there is no significant difference between the different techniques in the removal of Intracanal calcium hydroxide. Hence, this research aimed to evaluate the Intracanal calcium hydroxide removal using various techniques, considering the removal of dressing from Intracanal prior to the filling of the root canal to be important.

MATERIALS AND METHODS

Seventy-five freshly extracted, non-carious, single canalled lower first premolars, having anatomic characteristics similar to each other, extracted for the orthodontic purpose were taken for this study. This study was conducted in Department of Conservative Dentistry and Endodontics, Rama Dental College, Hopsital & Research Centre, Kanpur. The extracted teeth were immersed for 2 days under 5% NaOCl solution, to eliminate organic residues residual. The specimens were further kept in 1% thymol solution until the completion of the procedure. The inclusion of criterions for the study were; a single canal, freshly extracted, an absence of root resorption. The exclusion criterion was; fractured, carious, and surface loss of the teeth due to erosion, attrition, and abrasion.

Using a low-speed handpiece with a double-sided diamond disk (Fig. 1), the specimens were de-crowned, and root canal length was standardized to 14 mm.

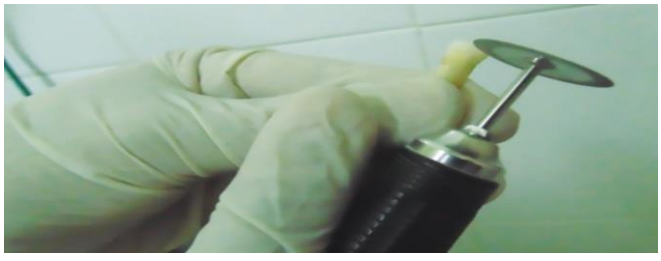

Fig. 1: Decoronation of tooth using diamond disc

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The apical patency was obtained with the help of K-files#10 firstly, then with #15 of Sybron Endo, Kerr, USA. The files were inserted until the tip was visible at the apex. Minus 1 mm of the length of the root was determined to be working length. The instrumentation was done using size F3 Protaper and irrigated in between with 2mL of 5% NaOCl (totally 6 mL). Electric engine with 300 rpm speed is used for canal preparation and dried using paper points. Lentulo spiral was used to carry the $Ca(OH)_2$ and placed into the canal until the medicament is seen at the apex of the working length. A cotton pellet is kept inside the access cavity and covered with temporary filling material. All specimens were kept for 7 days at 37 ± 1°C with a relative humidity of 100%.

The specimens were categorized into three groups (25 each) as per the $Ca(OH)_2$ dressing removal protocol used:

- Group 1: Rotary Files: Root canals were cleaned with a circumferential motion of K-file size 15 and 20, followed by using Protaper shaping was done. Simultaneously irrigation of the canal was done using 5mL of 5% NaOCl along with the equally carried out recapitulation.
- Group 2: EndoVac system (Fig. 2): The irrigation system used was Apical Negative Pressure Irrigation (EndoVac, Discus Dental, Culver City, CA). The irrigant was carried using macro cannula tip till 1mm down the canal, followed by microcannula irrigation of three cycles. During each microcannula irrigation cycle, the tip is placed for 6s at full WL and then taken out for about 2 mm from full WL for about 6s. During a period of 30s, this cycle was repeated. Five percent NaOCl of 10ml was used totally.

  Group 3 : Ultrasonics (Fig 3): Using ultrasonic technique, the $Ca(OH)_2$ was removed. Root canal irrigation was done with 5 mL of 5% NaOCl. The ultrasonic irrigation system (Electro Medical Systems. Switzerland) was used followed by using 5% NaOCl. The delivery of the solution was done using the master delivery tip, located at the orifice of the root canal. Continuous irrigant supply till 60 seconds were ensured. Root canals were finally irrigated using 5 mL of 5% NaOCl.

After completion of the calcium hydroxide removal process, using a diamond disc, grooves were made both on buccal as well as on lingual surfaces. Along the long axis of the teeth in a buccolingual direction, the teeth were split using a surgical chisel. For scanning electron microscope analysis purpose, examined at a 1000x magnification, the specimens were dehydrated followed by fixing on aluminum stubs and finally sputter-coated using gold was done before the examination.

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Fig. 2: EndoVac system

Fig.3: Ultrasonics system

SEM Evaluation

The root canal wall's cleanliness was evaluated using 1000x magnification at the coronal and apical third (Figs 4 and 5). Based on the below-mentioned scoring system, evaluation was performed as described previously by Kuga et al,[7] to access the remnants quantity on the root canal walls.

The scores are as follows:

- Score 0: Absence of residues,
- Score 1: Small amount of residues (up to 20% of thesurface covered),
- Score 2: Moderate amount of residues (20–60% of thesurface covered),
- Score 3: Large amount of residues (more than 60%of the surface covered).

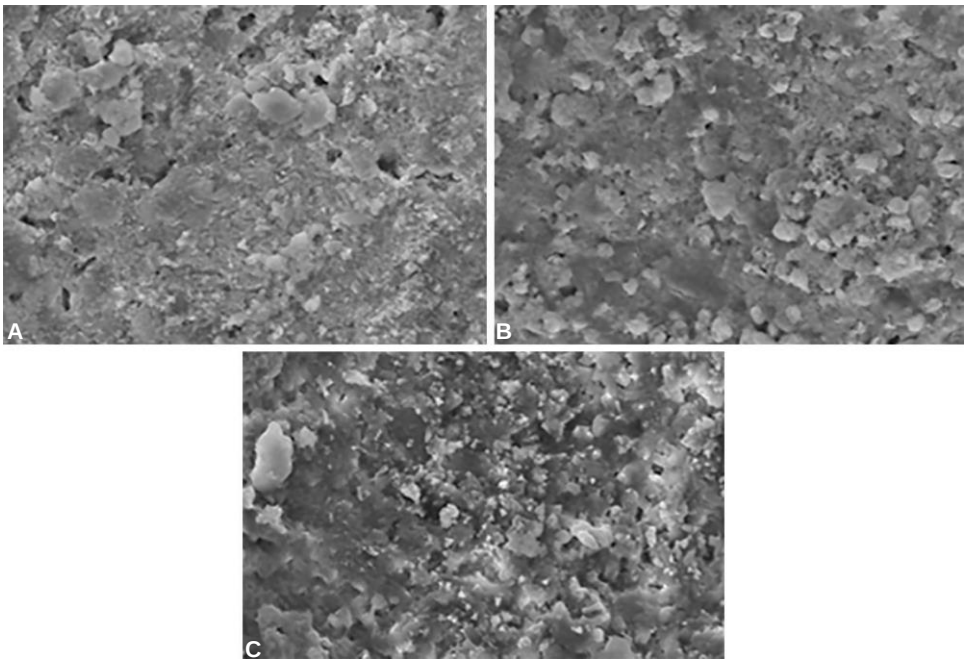
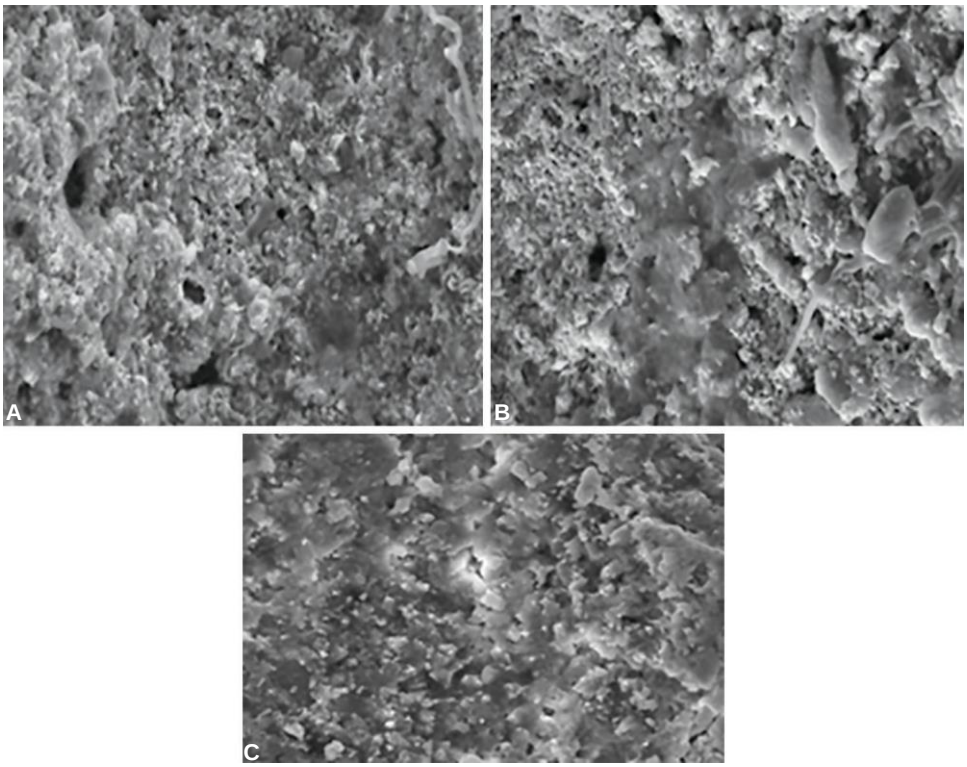


Fig. 4: SEM evaluation of (A) rotary Files; (B) endoVac system; (C) ultrasonic Activation at coronal third



Figs 5: SEM evaluation of (A) Rotary Files; (B) EndoVac system; (C) Ultrasonics actiavtion at apical third

STATISTICAL ANALYSIS

The statistical analysis was done using Kruskal-Wallis tests and Mann-Whitney U-test with the help of SPSS software, version 20.0 for Windows (SPSS Inc., Chicago, IL). The p-value of less than 0.05 was considered significantstatistically.

RESULTS

The mean and standard deviation of the three different techniques used to remove the $Ca(OH)_2$ Intracanal medicament is described in Table 1. EndoVac system (2.90 ± 0.12) showed the maximum removal of the medicament followed by Rotary Files (1.76 ± 0.26) and Ultrasonics (1.32 ± 0.14).

Table 1: Mean and standard deviation of three differenttechniques to remove Intracanal calcium hydroxide

Groups	*Techniques*	*n*	*Mean ± Std. Deviation*
Group-1	Rotary Files	25	1.76 ± 0.26
Group-2	EndoVac system	25	2.90 ± 0.12
Group-3	Ultrasonics	25	1.32± 0.14

A significant difference between the apical and coronal third of the root was observed in EndoVac system with a p-value of 0.001 statistically. There was no significant difference seen under Rotary Files and Ultrasonics at apical and coronal third as in Table 2.

Table 2: Intracanal calcium hydroxide removal of three different techniques at Coronal and Apical levels

Techniques	*Coronal (Mean ± SD)*	*Apical (Mean ± SD)*	*K ANOVA Value*	*p-value*
Rotary Files	0.70 ± 0.14	1.02 ± 0.12	22.00	0.06
EndoVac system	0.89 ± 0.03	2.01 ± 0.09	26.10	0.001**
Ultrasonics	0.47 ± 0.04	0.85 ± 0.09	21.87	0.42

Mann–Whitney U test was used to compare the coronal third remnants intergroup as shown in Table 3. There was a statistical difference between EndoVac system and ultrasonics with p-value 0.001.

Table 3: Inter group comparison at coronal third by using Mann Whitney U test

Comparison between	*Mean Rank*	*Mann–Whitney U*	*p-value*
Rotary Files vs EndoVac system	23.40-6.45	28.20	0.09
Rotary Files vsUltrasonics	20.70-9.12	30.00	0.82
EndoVac system vsUltrasonics	24.58-11.44	34.68	0.001**

Table 4 shows the apical third comparison results intergroup. Statistically, a significant difference was seen between EndoVac system and ultrasonics, and between rotary filesand ultrasonics with p-value 0.001.

Table 4: Inter group comparison at apical third by using Mann Whitney U test

Comparison between	*Mean Rank*	*Mann–Whitney U*	*p-value*
Rotary Files vs EndoVac system	24.30–11.20	32.10	0.06
Rotary Files vs Ultrasonics	22.86–10.24	30.10	0.04
EndoVac system *vs* Ultrasonics	34.95–16.27	42.30	0.001**

DISCUSSION

The widely used Intracanal medication between the sessions is $Ca(OH)_2$ due to its efficient anti-microbial property. Total removal of the medicament before to the obturation is of priority, as it may affect the sealing ability negatively.[8]

As per previous studies, $Ca(OH)_2$ remnants have been reported to penetrate the dentinal tubules, which reduces the bonding strength of the resin-based sealer and interfere with the silicon-based sealer during sealing.[9]

The main challenge to evaluate the effective and absolute calcium hydroxide removal from the canal is the permeability.[10] in this study; we have used SEM forevaluation.

EndoVac is used to deliver the irrigants safely till the apical portion using a negative pressure system, which optimally removes the smear layer and minimizes the seepage of the solution through the apical foramen. As recommended by the manufacturers, the microcannula is placed till the working length to suction the sufficient volume and to displace debris and

remove the smear layer.[11]

The present study showed the efficacy of the EndoVac system significantly better in calcium hydroxide removal compared to ultrasonics and rotary files at the apical and coronal third. These results were similar to the Turker et al.[5] study, which proved that the EndoVac has better flushing mechanism and vacuum aspiration effect during calcium hydroxide removal from the apical third. Furthermore, the microcannula orifices may help the $Ca(OH)_2$ to exit, which in turn helps in removal of the medicament form apical third.

Nielsen et al.[11] and Desai et al.[12] showed that the irrigation system with Negative pressure offers the possible effective and safe cleansing, especially at the root canal apical third. Ahmetoglu et al.[13] study showed the contrast results as the cleansing effectiveness is closely related to the irrigants volume used, increase in the volume, increases the effectiveness of the irrigation. The ultrasonics usage creates the cavitation and acoustic microstreaming resulting in the removal of more medication or debris from the remote locations and the root canal than achieved with standard irrigation. From the present study, the least intracanal $Ca(OH)_2$ was achieved by the ultrasonics. This result is a contrast to the study conducted by the Tasdemir et al.,[14] Kenee et al.,[15] Ricucci et al.,[16] showed the successful removal of the intra-canal medicament and has been efficient to improve dentinal wall cleanliness. The study by Jiang et al.[17] also showed that the efficient cleanliness is achieved using the ultrasonic device. In future, the success could be achieved possibly by increasing the ultrasonic activation output.

The irrigant used in this study was NaOCl. Without activation, the use of NaOCl was reported to be an inappropriate method to remove $Ca(OH)_2$ because of its minimal ability in dissolving organic materials. Margelos et al.[18] proved that using NaOCL or 15% EDTA alone cannot remove calcium hydroxide from the canal efficiently; however, hand instrumentation along with the combination of the two irrigants improves the efficiency for removal. Hence, the current research was conducted to evaluate the various irrigants agitation protocols for the removal of calcium hydroxide from the root canals using NaOCl.

In previous studies, the surface area left over on the canal walls measured in mm,[2] a scanning electron microscopy, scoring method, or a volumetric analysis by spiral computed tomography were used to measure the calcium hydroxide in canal.[19,20] Tooth were partitioned longitudinally, the canals were cleaned including tiny particle remnants and the two halves were reapproximated while measuring the surface area. A similar method was used in the current study. The longitudinal portioning was more accurate for the complete canal area measurement was showed in the study, Kenee et al.[21]

The present study proved that the efficiency of rotary files was higher than the ultrasonic's in the removal of calcium hydroxide. Other studies have proved the root instrument's influence on the removal of dressing from root canal. Kenee et al.[21] examined the amount of remaining calcium hydroxide on the molar's mesial canal after using EDTA and NaOCl irrigation, rotary instrumentation (size 35, profile system, instrument, 0.04 taper), ultrasonics (size 15 file), or hand files (size 35). The result showed that the rotary instruments were more efficient compared to that of the irrigation solution technique, and hand instrumentation, in removing the residues significantly. Kuga et al.[22] evaluated the three rotary instruments' efficacy (ProTaper, K3, and Twisted File systems) in eliminating the calcium hydroxide remnants in the root canal

and was notfound a significant difference between them.

The EndoVac system's effectiveness was attributed using "apical negative pressure irrigation" concept. Though the micro debridement, using the microcannulas at the apical end deliver more volume and flow at apical region compared to other techniques. While the irrigation only technique could not reach the apical third, therefore, better results were seen with the EndoVac system.

Entire emitting of $Ca(OH)_2$ was not possible in the apical third of the root canal even after using irrigant agitation in this study. The type of dentinal tubules that aren't regular and are less in number can be one of the reasons for this. A few dentinal tubules per unit area are present in the apical third of the root canal wall as per Whittaker and Kneale[23] did the study. However, in this study EndoVac technique showed significantly better in removing of the $Ca(OH)_2$ compared to other methods. Hence null hypothesis was rejected, and the alternative hypothesis was accepted.

The use of the split method is the limitation of the current study . Though this method has been identified in several studies for evaluation of root filling material on root canal walls, destructiveness, loss of remnants whileseparating the root is the major limitation. And in this study we have used only three-technique and SEM to assess the $Ca(OH)_2$ removal from the canal. Hence, other techniques of root canal preparation should be considered in further studies including irrigating and assessment method, both in ex vivo and in vivo conditions.

CONCLUSION

Within this study limitation, it is concluded that the EndoVac technique was significantly effective in removing the calcium hydroxide remnants from the coronal and apical third of the root canal.

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