# A Comparative Evaluation of Removal of Intracanal Calcium Hydroxide with Endoactivator System and Mechanical Instrumentation with K File, Using Two Irrigating Solutions: an in Vitro Study

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## ABSTRACT

**Background**

Calcium Hydroxide [$Ca(OH)_2$] is widely used intracanal medicament in endodontics due to its antimicrobial activity against persistent microorganisms. Although routine use of calcium hydroxide is highly recommended, its removal at the time of canal obturation is equally important and challenging because its remnant might prevent the sealer penetration into dentinal tubules, potentially interact with zinc oxide eugenol sealers making them brittle and granular, and adversely affect the bonding of resin sealer adhesion thus significantly increasing the apical leakage of root canal treated teeth. Removal of intracanal calcium hydroxide is performed usually with different irrigants in combinations with ultrasonic, sonic, hand or rotary instruments.

**Objective**

The objective of this study is to evaluate the efficacy of Endoactivator system and mechanical instrumentation with K files using two irrigants for removal of intracanal $Ca(OH)_2$.

**Method**

Forty extracted single rooted human mandibular premolars were collected and divided into two groups of 20 samples each (N=40; Group A: 1-20; Group B: 21-40). All samples were decoronated, instrumented, irrigated, dried and filled with $Ca(OH)_2$ paste. Samples were stored in a humidor for a week and were instrumented with conventional k-file (Group A) and Endoactivator system (Group B). A radiograph was taken to evaluate the remnants of intracanal medicament.

**Result**

Overall there is not any statistically significant difference on any method of intracanal calcium hydroxide removal (p=0.45). However, on section wise comparison of efficacy of $Ca(OH)_2$ removal, Endoactivator seems to be more effective than hand files on apical section (p=0.047). There is no statistically significant difference on coronal and middle segments between two methods (p=0.99).

**Conclusion**

The efficacy of removal of calcium hydroxide medicament from overall canal by conventional method and endoactivator system is similar though endoactivator system seems to be relatively more efficient on apical portion of root.

## KEY WORDS

*Calcium hydroxide, Endoactivator, Intracanal, Sonic*

## INTRODUCTION

Calcium hydroxide, introduced by Herman in 1920 has highly alkaline PH and it disassociates into hydroxyl ions and calcium ions, which exerts antimicrobial properties.[1] In endodontics, calcium hydroxide [$Ca(OH)_2$] paste is most commonly used intracanal medicament due to its antibacterial efficacy against the majority of endodontic pathogens and biocompatibility.[1,2]

Prior to root canal obturation, the intracanal dressing of $Ca(OH)_2$ paste has to be removed completely from the canals to minimize a negative influence of $Ca(OH)_2$ dressing on root filling materials. Residual $Ca(OH)_2$ on canal walls not only interact with some sealers changing its physical properties, reducing the flow and setting time but also prevents the penetration of sealer into the dentinal tubules and might increase apical leakage of gutta-percha root fillings especially with zinc oxide-eugenol sealer.[3] Therefore, different methods have been introduced over the years to improve removal of calcium hydroxide intracanal dressing which includes use of patency files, rotary instruments, and different sonic and ultrasonic devices for activation of an intracanal irrigants to improve the flushing action of the solution.[3] Mechanical instrumentation with hand K file (Master apical file) with copious irrigation with sodium hypochlorite (NaOCl) and EDTA is the most frequently used method.[4] Though Sonic and ultrasonic devices are claimed to be more effective however, till now there is no general consensus regarding the best method for the removal of intracanal $Ca(OH)_2$.[3,5,6]

Recently, a sonically driven root canal irrigating system known as the Endoactivator (Dentsply Tulsa Dental Specialties, Tulsa, OK, USA) has been introduced in order to improve the effects of irrigation in endodontics. However it is still not clear whether this system is superior on removal of intracanal medicament than conventional method. Hence, in order to evaluate the effectiveness of Endoactivator system and conventional method on removal of intracanal $Ca(OH)_2$ this study was performed.

## METHODS

The ethical approval for this experimental study was taken from the Kathmandu University Ethical review Committee. The study was conducted from January 2017 to March 2017, in 40 single rooted extracted human mandibular first premolars from the patients of similar age group of both male and female, extracted for orthodontic treatment, from the department of orthodontics of Dhulikhel Hospital. Samples that meet the inclusion criteria were selected and immersed in 3.0% sodium hypochlorite solution (NaOCl) for 5 minutes to remove organic debris. Subsequently, to remove any calculus or soft tissue from the root surface, the external root surfaces were scaled with ultrasonic instruments and washed with distilled water. Then the samples were stored in 10% buffered formalin solution until use.

The samples were then blindly divided into two groups: Group A (conventional syringe irrigation and mechanical instrumentation with hand k-files: Dentsply, Maillefer) and Group B (Endoactivator system: Dentsply, Maillefer) consisting of 20 samples each. All the samples were decoronated to obtain a standardized root length of 15 ± 2 mm by using a diamond disk. The external surface of all the teeth was coated with nail polish to prevent extrusion of irrigants through apical foramen.

All the samples were then instrumented 1 mm short of working length using ProTaper Next Rotary files (Dentsply, Maillefer) till X3, using full length technique. Irrigation was performed with 3% sodium hypochlorite (Pyrex, India) and 17% EDTA solution (MD-Cleanser, Metabiomed). In between, EDTA gel (Glyde, Dentsply; Maillefer) was used as a lubricant. All the canals were then dried with paper points and filled with barium sulphate containing $Ca(OH)_2$ paste ( AvueCal RC Protector, Dental Avenue India) till the working length using #25 lentulo spiral paste carrier and sealed with temporary filling material (Cavit, 3M ESPE). An Intra Oral periapical radiograph was taken in both mesiodistal and buccolingual direction to ensure complete 3 dimensional filling of canals (fig. 1) . Then the samples were stored for a week in a humidor at 37 degree centigrade at 100% humidity for a week. After a week, temporary filling material was removed using ¼ round bur and all the canals were initially instrumented with conventional # 10 k-file to loosen up the intracanal $Ca(OH)_2$.

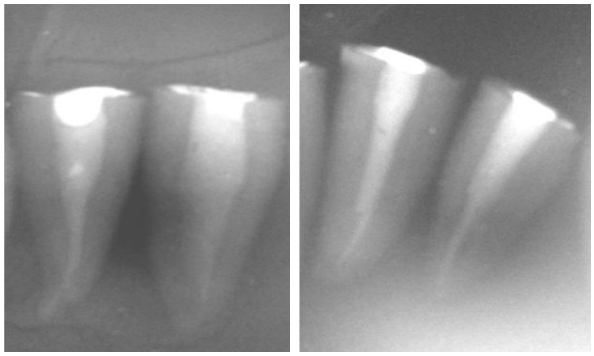

**Figure 1. Intra oral periapical images after intracanal dressing of radiopaque $Ca(OH)_2$ from Group A and group B respectively.**

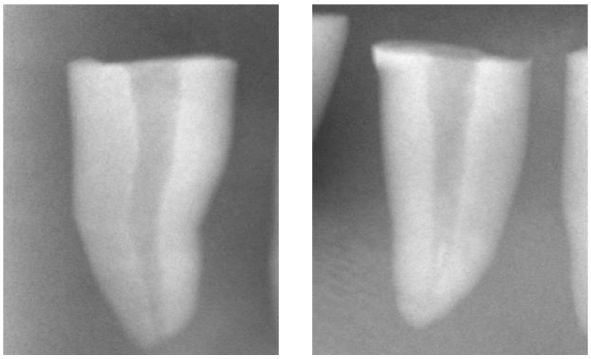

**Figure 2. Intra oral periapical images representative of complete and partial removal of $Ca(OH)_2$.**

**Table 1. Comparison of Removal of $Ca(OH)_2$ by Hand files and Endoactivator System**

| Removal Method | Removal of Medicament | Overall | Coronal | Middle | Apical |
|---|---|---|---|---|---|
| Hand File | Yes | 14 | 20 | 19 | 15 |
| | No | 6 | 0 | 1 | 5 |
| Endo Activator | Yes | 17 | 19 | 18 | 20 |
| | No | 3 | 1 | 2 | 0 |
| Intergroup comparison | P value | .45 | .99 | .99 | .047 |

Irrigation was performed with a side vented needles (Dentsply International, York, PA, USA) to 2 mm short of the working length using the following sequence: 5 ml 3% NaOCl was dispensed in the canal over a period of 1 minute with intermittent circumferential filing with #30 k-file (Group A) and intermittent use of the Endoactivator system with a size #30/02 polymer tip for 30 seconds (Group B), followed by irrigation with 3 ml of 17% EDTA. The sequence was repeated for both the groups. To eliminate any clogging and assure patency, #10 k-file was intermittently passed till the working length. Final rinse was performed with 5ml of 3% NaOCl for each sample and teeth were stored dry for 2 days. Then an intraoral periapical radiograph of the samples were taken in both mesiodistal and buccolingual dimensions (fig. 2). The radiographs were assessed by two calibrated evaluators to find out complete or partial removal of $Ca(OH)_2$ in coronal, middle and apical third of the samples. (fig. 3).

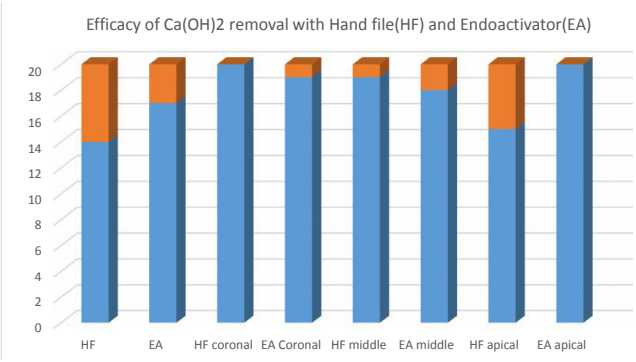


**Figure 3. Ca(OH)2 removal with different methods.**

The findings of the observation was fed into the excel sheet and was later transferred into SPSS software (version 20.0 for Windows; SPSS Inc., Chicago, IL, USA). Two sided Fischer's Exact test was performed to find out the difference on efficacy of Hand files and Endoactivator system. P value was kept 0.05 for the level of significance.

## RESULTS

The removal of $Ca(OH)_2$ from the overall canal as well as from cervical/middle/apical thirds are well shown in Table 1 and figure 3. Overall there was no statistically significant difference on any method of intracanal calcium hydroxide removal (p= 0.45). However, on section wise comparison of efficacy of $Ca(OH)_2$ removal, Endoactivator seems to be more effective than hand files on apical section (p= 0.047). However, there was no statistical significant difference on coronal and middle segments between two methods (p=0.99). In general, Endoactivator was able to remove $Ca(OH)_2$ in more number of teeth and more number of segments as compared with conventional method of removal though it was not of statistical significance.

## DISCUSSION

Calcium hydroxide paste is highly alkaline, inorganic intracanal root canal medicament. It is widely used due to its antimicrobial efficacy and favorable biological properties. However, failure to remove the remnants of $Ca(OH)_2$ results in the accumulation of its particles on the root canal wall, potentially leading to increase canal permeability that interferes with the sealing ability of endodontic sealer, ultimately leading to the failure of treatment.[7,8] It has also been reported that remnants of intracanal $Ca(OH)_2$ has chemical interaction with zinc oxide-eugenol sealers producing brittle calcium eugenolate and might also prevent sealer penetration, thus affecting the bonding of resin sealer adhesion to the dentin.[9] Hence, all intracanal inter-appointment medicaments should be removed thoroughly from the root canals before obturation.

This study aimed to evaluate the effectiveness of conventional needle irrigation in combination with hand k-files compared to Endoactivator system in removing intracanal $Ca(OH)_2$. In both the groups the irrigants used were combination of 3% NaOCl at room temperature, 3ml after each instrument and 5 ml of 17% EDTA.[10] In present study, we tried to equalize the type, volume and temperature of irrigating solution in both the groups to omit the biases. Furthermore to minimize the potential bias, all the specimens were single rooted with no apical curvature or double canal which was prepared till X3 ProTaper Next rotary files using recommended speed and torque setting. Radiopaque $Ca(OH)_2$ was used for better visibility in radiographs.

The findings of the present study indicated that conventional file system as well as Endoactivator system had no statistically significant difference on cal cium hydroxide removal. Moreover, in both groups, intracanal $Ca(OH)_2$ medicament was not completely removed from the root canal spaces in all the samples. This study further compared the efficacy of both the systems in different segments of the root. Result showed both group had no

statistically significant difference in coronal and middle section. However, Endoactivator system was able to remove $Ca(OH)_2$ more efficiently from apical section as compared to hand files group (p=0.047).

Sonically driven Endoactivator system that was developed as an adjunct to enhance the needle irrigation, is reported to produce acoustic streaming and cavitations, thus vigorously agitating the intracanal fluid.[11,12] This results in improved penetration, circulation, and flow of irrigant into inaccessible areas of the root canal system.[13] Hence, compared to conventional irrigation, sonic or ultrasonic agitation of the irrigants are reported to produce cleaner canals by improving the removal of smear layer even from the apical third of curved canals.[13] There are studies which have shown Endoactivator System to be more efficient than other techniques.[3,14] Similarly, in this study 85% of the sample from endoactivator group had complete removal of $Ca(OH)_2$ from the overall canal compared to 70% of samples in hand file group.

Most of the literature reported the difficultly in removal of $Ca(OH)_2$, smear layer and debris from apical third of the root canal walls.[11,15,16] This difficulty can be attributed to the volume of irrigation used. The greater volume of irrigant enhanced by ultrasonic agitation can efficiently remove smear layer and debris from apical third of root canals.[17] In this study 100% of samples from Endoactivator group had complete removal of calcium hydroxide from apical segment. However, Hand file group had only 75% of samples with complete removal of $Ca(OH)_2$ from apical segments, although it was not statistically significant probably because of the small sample size.

Although, the use of the scanning electron microscope (SEM) is considered to be standard method of evaluating the cleanliness of root canal walls surfaces, in this study we have used radiographic method. Use of SEM would have been more precise.

## CONCLUSION

The efficacy of removal of calcium hydroxide medicament from overall canal by conventional hand file and endoactivator system is similar though endoactivator system seems to be relatively more efficient on apical portion of root.

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