

# Evaluation Of The Amount Of Calcium Hydroxide Intracanal Medicament Extrusion During Its Removal With Combination Of Master Apical File And Different Agitation Techniques

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## Abstract

**Aim:** The study's objective was to determine the quantity of calcium hydroxide (Ca(OH)<sub>2</sub>) extrusions during its removals using a master apical file with two agitation techniques, sonic and ultrasonic, set 1 mm short of the apex or at working length.

**Materials & Methods:** ProTaper Next rotary system up to X3 was used to prepare 120 straight root canals of human incisors. The Ca(OH)<sub>2</sub> mixed with methylene blue were then added to the canals to assist display. By considering the master apical file (X3), the Ca(OH)<sub>2</sub> was cleaned. Next, the teeth were separated into 2 groups—sonic and ultrasonic—and 2 subgroups—at working length and 1 mm short of working length—according to the agitation system and the root length level at which they were utilized, respectively. The apically extruded material was gathered in Eppendorf tubes throughout processing. The mass of the empty tubes was then subtracted from the weight of the tubes carrying the material to calculate the related amount of extruded Ca(OH)<sub>2</sub>. The results were statistically analyzed by considering the one-way ANOVA and Tukey's post hoc test. (P<0.05)

**Results:** The highest extrusion seen with ultrasonic agitation technique used at working length (0.04±0.02)g while least extrusion seen with sonic agitation technique used at working length (0.02±0.02) with statistical significant difference(P=0.001) between them.

**Conclusion:** The ultrasonic agitation technique at working length cause more Ca(OH)<sub>2</sub> intracanal medicament extrusion during its removal than sonic agitation. At 1mm short of the apex both sonic and ultrasonic device showed almost same amount of extrusion.

**Keywords:** straight canals, irrigation, ultrasonic irrigation, sonic irrigation

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## Introduction:

The intracanal drug calcium hydroxide is frequently utilised during interim appointments for root canal therapy since it has antibacterial properties. To allow the obturation materials to adapt to the dentinal wall of the root

canal, the  $\text{Ca}(\text{OH})_2$  medicament must be entirely eliminated before root canal obturation. Endodontic sealer reactivity with  $\text{Ca}(\text{OH})_2$  remains on walls of the root canal can change the sealer's viscosity, flow, and setting time, which hinders sealer deposition and binding to the dentinal tubules[1]. Furthermore, gaps on the dentine-filling interface brought on by the solvability of  $\text{Ca}(\text{OH})_2$  into the root canal may encourage bacterial growth. Therefore, it is essential to eliminate  $\text{Ca}(\text{OH})_2$  medication entirely and predictably before root canal obturation. This is probably connected to successful therapy and a good prognosis[2].

Numerous tools and mechanisms are considered to study the elimination of  $\text{Ca}(\text{OH})_2$ . The method that is most usually described is root canal instrumentation using a master apical file and sufficient irrigation. However, canal imperfections might be unavailable for standard irrigational techniques, and  $\text{Ca}(\text{OH})_2$  might still be present in these extensions[3]. The EndoActivator (Dentsply Tulsa Dental, Tulsa, OK) work on sonic waves that fluctuate between 2 and 5 KHz—along with longitudinal movements to safely activate the irrigating substance, causing the irrigants to be vigorously stirred up[4]. It has been demonstrated that the EndoActivator technology irrigates simulated lateral canals more effectively than simple needle irrigation[3].

Weller et al. provided the initial description of passive ultrasonic irrigation (PUI). These have a system of files that are driven at frequencies between 20 and 50 kHz with a transverse movement pattern, resulting in acoustic streaming[5]. This streaming causes fluid to travel in a narrow, erratic circle around the instrument. When the flow is abruptly guided towards the tip, eddying appears near to the tip than the file's coronal ending. As a result of the root canal's existing enlargement, the file can easily oscillate such that it allows acoustic streaming and sending power to the irrigant inside the canal[6].

Wiseman demonstrated that  $\text{Ca}(\text{OH})_2$  couldn't be removed from the mandibular molars' mesial root canals by sonic or ultrasonic irrigation. The combined approach of rotational action and PUI of 20 seconds for 3 sessions absolutely decreasing the deposits of  $\text{Ca}(\text{OH})_2$  with comparison to sonic irrigation [7].

Despite the fact that  $\text{Ca}(\text{OH})_2$  has been regarded as a safe agent [8], a few reports discussed the unfavourable effects of extrusion of  $\text{Ca}(\text{OH})_2$ , such as necrosis of the bone and inflammatory response in repaired mechanical perforations[16]. In animal models,  $\text{Ca}(\text{OH})_2$  paste can induce severe inflammatory reactions that lead to necrosis and degenerative alterations[9].

The frequency and volume of apical extrusion may be influenced by the root canal irrigation system type, the apical architecture, the irrigation needle type and size, the depth of penetration, and the instrumentation technique[10]. The root canal cleansing operation related on a variable factors, including, the needle's diameter, insertion depth, and the root canal's final size and taper[11].

The research that has been done so far has examined calcium hydroxide intracanal medication removal [12, 13]; irrigant and debris extrusion for root canal formulation [14, 15] using a variety of agitation systems or file systems. As far as we are aware, no research has been done on how much calcium hydroxide is extruded during removal with two different agitation systems. We expected that some calcium hydroxide extrusion would be seen during its removal using various agitation systems, and that the extrusion would be influenced by the location of the agitation system at different root lengths. Hence this study was conducted to evaluate the amount of extrusion of  $\text{Ca}(\text{OH})_2$  from the apical foramen during the  $\text{Ca}(\text{OH})_2$  intracanal removal with master apical file and its combination with two agitation techniques, ultrasonic and sonic at two different depth of its placement in the root canal.

## Material and methods:

In this investigation, 120 removed human maxillary incisors with straight canals and mature apices were used. The selection criteria for teeth included that they had fully formed roots and were devoid of obvious root caries, fissures, or fractures. Before being employed in the study, all of the teeth were stored in sodium hypochlorite ( $\text{NaOCl}$ ) with concentration of 5.25% at room temperature.



**Figure: 1 Ultrasonic and sonic agitation in straight canals (left to right)**



**Figure: 2 Apical extrusion of irrigant and  $\text{Ca(OH)}_2$  after agitation and collected  $\text{Ca(OH)}_2$  at bottom and tube wall (left to right)**



**Figure: 3 Measurement of apical  $\text{Ca(OH)}_2$  extrusion with microbalance**

### Teeth Preparation

For the purpose of standardizing the length of grooved teeth, each sample was decoronated, leaving 19 mm of root length. Each sample's buccal and proximal radiographic views were exposed, and the root canal morphology

was verified using these images (type I). High-speed carbide burs and water spray were used to complete the standard access preparation. Round and tapered carbide burs were used to prepare the access cavity. The size of 15 K-file was entered in to the canal until it was seen from apical foramen, 1 mm was removed from this length to get the working length.

After creating the glide path using a size 15 K-file to its maximum working length, the canal was prepared with a ProTaper Next system (DentsplySirona, Ballaigues, Switzerland) as instructed by manufacturer. An electric motor (Endo-Mate TC2, NSK, Japan) driving the files had a torque of 2.4 Ncm and a manufacturer-suggested speed of 300 rpm rotations. By considering the working length of 0.30 mm, a minimal apical formulation was created by employing the Master Apical File (MAF) (X3). Each file was thoroughly cleansed of contaminants after root canal preparation.

### Standard Irrigation Protocol

All canals were irrigated according to a standardised methodology. After each instrument, the canal was to be irrigated with two ml of 5.25% NaOCl. A side-vented needle (30-gauge, Ultradent, South Jordan, UT, USA) was used to irrigate the canals with 10 mL of 5.25% NaOCl after the instrumentation was complete. Next, 3 mL of 17% EDTA (PrevestDenPro, Jammu, India) was applied for 1 minute. A 30-gauge endodontic needle was used at two mm from the working length for the 3 mL of 5.25% NaOCl final rinse.

### Placement of Ca(OH)<sub>2</sub>

Ca(OH)<sub>2</sub> (Prime, Maharashtra, India) was introduced inside the canals by considering a manually guided lentulo-spiral carrier (size 25, Mani, Tochigi, Japan), adapted to 3 mm from the WL, after all canals were dried with absorbent paper points (Diadent, Chungcheongbuk-do, Korea). Radiographs were collected in the buccolingual and mesiodistal angulations to confirm that Ca(OH)<sub>2</sub> was available in the canals. Cotton swabs and orafil-G (PrevestDenPro, Jammu, India) were used to temporarily seal the access cavities. After that, samples were kept at 37 °C for a week in vials with gauze that had been wet with saline.

**Sample preparation :** The teeth were fixed with A-silicone cement and put within a rubber stopper. Glass bottles were filled with Eppendorf tubes, which were used to hold the teeth at the cement-enamel union point. Each tube's weight was measured three times using a microbalance scale (Sartorius, Göttingen, Germany) before each tooth was placed inside of it. The average of these measurements was then determined. To balance the pressures within and outside the bottle, a 26-gauge syringe was inserted through the rubber stopper. (Figure: 1)

The Eppendorf tubes were covered with aluminum foil during preparation to keep the operator from seeing the Ca(OH)<sub>2</sub> extrusion. In the Eppendorf tubes, the Ca(OH)<sub>2</sub> that was extruded from the apex during Ca(OH)<sub>2</sub> removal was collected. Using a microbalance, each tube was weighed three times in quick succession. The average results were then recorded. By deducting the tube's empty weight from the value obtained after the Ca(OH)<sub>2</sub> had been removed, the amount of extruded Ca(OH)<sub>2</sub> was determined. The apical extrusion was measured by a second independent operator, and the results of the two sets of measurements were compared.

### Removal of Ca(OH)<sub>2</sub>

After seven days, the sample was divided into 2 groups with 2 subgroups of each and the teeth (previously numbered and medicated) were randomly distributed. The groups were formed as follows:

Group 1: removal by manual instrumentation and sonic-activation agitation

Group 1a: removal by manual instrumentation and sonic-activation agitation at -1 mm working length

Group 1b: removal by manual instrumentation and sonic-activation agitation at working length

Group 2: removal by manual instrumentation and ultrasonic-activation agitation

Group 2a: removal by manual instrumentation and ultrasonic-activation agitation at -1 mm working length

Group 2b: removal by manual instrumentation and ultrasonic-activation agitation at working length

The root canals were irrigated with 5.25% NaOCl (10 mL) then the MAF was applied in a rotational movement up to the WL. The NaOCl solution was refilled as it was removed from the canal. The canal loaded with 17%

EDTA (3 mL) for initial 60 seconds, replacing it for each 15 seconds, and then final rinse with 5.25% NaOCl(3 mL). This technique was performed three times.

After using the MAF and performing routine irrigation, subgroup 1a received sonic activation using the Endoactivator (DentsplyMaillefer, Baillagues, Switzerland) (EA) set at power of 10 kHz and 25.04 tip two times during irrigation with NaOCl and once during irrigation with EDTA for a total of 20 seconds. The activation process took 60 seconds in total. Sonic activation was applied at working length to subgroup 1b.

The Eighteenth Ultra X (Eighteenth, Changzhou Sifary Medical Technology Co., Ltd, Changzhou City, China) was used for ultrasonic irrigation for one minute in subgroups 2a and 2b after the MAF and usual irrigation, respectively. Two times during NaOCl irrigation and one time during EDTA irrigation, ultrasonic activation was provided for 20 s each time. The activation period lasted 60 s in total. The soft and flexible X Silver tip (21mm, 2% taper) was used to adjust the gadget to its highest power setting of 45 kHz.

After that, absorbent paper (35/4%) was used to dry the canals.

### Assessment of apical Ca(OH)<sub>2</sub> extrusion

The Eppendorf tubes were rotated at 4400 rpm for 30 minutes in R-4C (REMI, Mumbai, India) centrifuge to cause the extruded material to settle at the bottom of the tube or stick to the tube walls, allowing us to collect and measure the extruded elements. (Figure: 2) Later, the liquid part was removed using single-use 1 mL syringes. To finish drying, the Eppendorf tubes were then kept in a 40 °C oven for 12 hours. Each Eppendorf tube was weighed three times on the same scale once drying was complete in order to determine its average weight. (Figure: 3)

Statistical analysis:

The amount of extruded Ca(OH)<sub>2</sub> data was generated in an Excel spreadsheet and using SPSS (version 20.0; SPSS Inc., Chicago, IL, USA) statistical analysis was performed. The means and associated standard deviation were determined using a descriptive statistical analysis. A one-way analysis of variance (one-way ANOVA) was carried out for numerical data (using the F distribution) to compare the means of two or more groups of samples. To identify whether the group is actually to blame for the substantial difference, a post hoc Tukey test was utilised. Additional data analysis using T-test was conducted, and the outcomes revealed statistically significant differences between each pair of groups being examined separately. At P < 0.05, statistics were considered to be significant.

### Result:

The result showed that, ultrasonic agitation system caused the highest extrusion (0.04±0.02) at working length while the least extrusion was observed with the sonic agitation system (0.02±0.02), with a statistically significant difference between them (P=0.001). (Table: 1)

At 1mm short of the working length both sonic (0.03±0.02) and ultrasonic (0.03±0.01) agitation systems showed almost equal extrusion with no statistical significant difference between them (P=0.879). (Table: 1)

**Table 1: Independent t test to compare the various agitation groups for calcium hydroxide extrusion placed at two different root length levels**

Agitation level	Sonic (n=30)	Ultrasonic (n=30)	t	P value
	Mean ± sd	Mean ± sd		
At 1mm short of working length	0.03±0.02	0.03±0.01	0.153	0.879
At working length	0.02±0.02	0.04±0.02	3.507	0.001*

### Discussion:

Inflammatory substances to the periapical tissues, such as intracanal medications or irrigating solutions, might cause pain[16]. Syringe irrigation and mechanical instrumentation using MAF is the widely accepted protocol to

remove  $\text{Ca}(\text{OH})_2$ . However, it has been proven that irrigation is more efficient when paired with mechanical agitation, such as rotary file instrumentation or ultrasonic/sonic activation. Moreover, more effective way is sonic activation in removing  $\text{Ca}(\text{OH})_2$  from the root canal space than syringe irrigation[17].

The irrigation and removal of  $\text{Ca}(\text{OH})_2$  from the coronal third are made easier by the enlargement of the coronal third as compared to the middle and apical thirds[18]. Additionally, when apical anatomical differences are present,  $\text{Ca}(\text{OH})_2$  collected apically during its removal. And this area is not directly affected by ultrasonic activation due to the ultrasonic tip being placed 2 mm short of the working length, which also restricts the irrigation effect[19]. Therefore, in this study, we used agitation tips that were 1 mm short of the working length and at working length.

The presence of any apical anomalies or a lack of barrier to apical flow by the surrounding structure may also affect irrigant extrusion. We did not simulate periapical tissues in our model. It is acknowledged that a number of factors may reduce the degree of extrusion in therapeutic settings. Apical extrusion and non-patent canals are resisted by periapical tissues and bone [20].

Our research's findings demonstrated that, at working length, ultrasonic agitation results in the greatest quantity of extrusion. While sonic activation devices produce lesser oscillations between 1 to 6 KHz, ultrasonic irrigation (UI) produces larger oscillations between 25 to 40 KHz. When ultrasonic tips are engaged inside a root canal system, higher frequency ultrasonic energy allows for a steady flow to penetrate the entire length of the file [21]. According to research by Ahmad et al., greater amplitude at the file's tip enables more acoustic streaming to occur during ultrasonic activation, which may result in greater extrusion [22].

At working length, the sonic gadget displayed the least extrusion. A decrease in the canal lumen with a bigger tip 0.04 taper will result in a decrease in acoustic streaming since the EndoActivator operates at a low frequency and its capacity to generate acoustic streaming relies on the large displaced magnitude of its tip [23]. The absence of cavitation consequences is due to both the constant contact to walls of the dentine and taper of the tip [24]. These explanations lend credence to the findings of our investigation.

According to Merino et al. [25], even in curved canals, UI activated the irrigant more successfully than EA did at the operating length. These results may be influenced by the decreased intensity of 0.166 KHz produced by the EA compared to 30 KHz provided by the UI (180 times greater). With each technique used in this study, comparatively small amounts of extrusion occurred. The findings of this study are consistent with those of other investigations, which discovered that samples hydrated with the EA extruded a tiny amount of irrigant that was statistically irrelevant [26,27].

During the elimination of  $\text{Ca}(\text{OH})_2$ , some researchers assert that by using PUI or EA in conjunction with conventional syringe irrigation will lead to cleaner root canal systems [28]. According to the results of the current investigation, using PUI to improve  $\text{Ca}(\text{OH})_2$  removal seems reasonable, however doing so at working length can result in its extrusion.

The in vitro study's failure to replicate clinical situations, such as variations in root anatomy and periapical conditions of the tooth, is one of the study's drawbacks. Clinicians should consider all relevant factors in order to decrease apical extrusion. In-vitro research may act as a standard for future clinical studies in addition to providing better, more accurate conditions to make consistent comparisons between the tested groups.

## Conclusion:

In comparison to sonic agitation, at the working length the ultrasonic agitation approach causes higher  $\text{Ca}(\text{OH})_2$  intracanal medication extrusion following its removal. Both the ultrasonic and sonic devices displayed almost the same amount of extrusion at 1 mm short of the apex.

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