Original Article

Efficacy Of The Rotary Instruments In The Removal Of Calcium Hydroxide Intracanal Medicament: An In Vitro CBCT Volumetric Analysis

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Abstract

BACKGROUND: The purpose of this study is to evaluate the efficacy of XP Endo Finisher & Master apical file X3 (Protaper Next) used to remove Calcium hydroxide paste from endodontically treated teeth by using CBCT volumetric analysis.

AIM & OBJECTIVE: The aim of the study is to evaluate the efficacy of two rotary instruments in the removal of Calcium hydroxide placed as an intracanal medicament.

MATERIALS AND METHOD: 60 extracted human mandibular single rooted premolar teeth was selected. All the teeth samples were measured 14 mm from apex &sectioned using diamond disc. Root Canals was prepared using crown-down technique with Protaper Next Rotary NiTi system. The preparation was done upto X3. Calcium hydroxide was inserted into the canals until it extruded through the apex. After storage for 7 days, the specimens were allocated into four groups. Group A: Positive control- In this group Calcium hydroxide was applied but not removed. Group B: Negative control-In this group Calcium hydroxide was not be applied. Group C: Master apical file X3was inserted in rotary motion up to the working length then root canals. Group D: XP Endo finisher was used in continuous motion with 800 rpm & 1 N/cm torque for 1 min with slow 7-8 mm up & down movement to entire length of canal. The CBCT imaging was done for the volumetric analysis of remaining Calcium hydroxide in the canal.

RESULT& STATISTICAL ANALYSIS: The efficacy of Calcium hydroxide removal from whole root canals after using Master apical file (Protaper next X3) &XP Endo Finisher showed significant difference. The statistical analysis showed that the mean percentage of oil-based Calcium hydroxide volume removed by XP Endo Finisher was more than Master apical file.

CONCLUSION: The XP Endo Finisher removed significantly more root filling material than Master apical file X3 (Protaper Next).

KEYWORDS: Calcium hydroxide, Retrieval, Protaper Next, XP Endo finisher, CBCT.

INTRODUCTION:

Endodontic treatment is essentially directed towards the prevention & control of pulpal and peri-radicular infection.[1] The primary aim of any root canal therapy is to maintain the canal space free from microorganisms and most importantly prevention of recontamination after the endodontic procedure.[2] However, total elimination of bacteria is difficult to accomplished even after thorough instrumentation & irrigation.

In post-treatment disease, the microflora is dominated by facultatively anaerobic gram positive cocci and rods such as Streptococcus, Enterococcus, Peptostreptococcus and Actinomyces species.[3] Sodium hypochlorite

(NaOCl) at 0.5 to 5.25% is gold standard for root canal irrigation due to its wide antimicrobial spectrum of action and ability to dissolve organic tissue.[4] Other antimicrobial irrigants such as Chlorhexidine, Potassium Iodine, MTAD (a mixture of tetracycline, citric acid and a detergent) and QMix (a mixture of Ethylenediaminotetraacetic acid, Chlorhexidine and Detergent) have been investigated, but still not proven to be more effective than NaOCl.[5] Calcium hydroxide was introduced to dentistry by Hermann in 1920. It is widely used as root canal disinfectant during root canal treatment due to its alkaline pH (12.5). Combination of its antimicrobial potential, tissue dissolution has all made it material of choice for intracanal medication of choice.[6]

Vehicle determines the velocity of ionic dissociation causing the paste to be solubilized and resorbed at various rates by the periapical tissues and from within the root canal. Three types of vehicles are used: aqueous, viscous or oily (Fava 1991, Holland 1994, Lopes et al. 1996). Aqueous vehicle - Causes rapid release of ions. Viscous vehicle - Slow release of ions for extended period. Oily vehicle - Promotes the lowest solubility & diffusion of paste within tissues.[6,7]

In vitro studies have shown that remnants of Ca(OH)2 can hinder the penetration of sealer into dentinal tubules which ultimately affects the adhesion of root canal sealer to the dentin that markedly increase the apical leakage of root canal treated teeth.[8]

According to Lambrianidis et al. they associated difficulty in retrieval with the type of vehicle used for mixing Ca(OH)2.[9] Several methods & devices has been proposed over the years for activation of intracanal solutions to improve the mechanical flushing action of irrigant. Sonic, Ultrasonic, Canal brush, Files etc. have been used for agitation of irrigating agents. Kenee et al. found rotary instrumentation & ultrasonic, better than hand instrumentation for removal of Calcium hydroxide. The mechanical agitation provided by ultrasonic/sonic instrumentation or a rotary file together with irrigant also enhance the removal of Calcium hydroxide.[10]

The most commonly used protocol for the removal of Ca(OH)2 is the mechanical instrumentation using a Master apical fileX3 (Protaper Next) combined with NaOCl irrigation.[11] XP Endo Finisher is a universal NiTi-based instrument which is highly flexible and can expand. During use, the file reaches 100-fold of an equivalent sized file or 6 mm in diameter. These features help in dentine preservation.[11]

The purpose of this study is to evaluate the efficacy of XP Endo Finisher & Master apical file X3 (Protaper Next) used to remove Calcium hydroxide paste from endodontically treated teeth by using CBCT volumetric analysis.

AIM AND OBJECTIVE: The aim of the study is to evaluate the efficacy of two rotary instruments in the removal of Calcium hydroxide placed as an intracanal medicament.

MATERIALS AND METHOD: Sixty extracted human mandibular single rooted premolar teeth were selected. Inclusion criteria was single rooted teeth with patent root canals & fully developed root apices. Exclusion criteria: Teeth with any signs of resorption, Teeth with curvature defect or cracks, Immature apex, Previous restorations & Endodontically treated teeth. Teeth were cleaned of extraneous tissue and calculus by using ultrasonic scaler. They were subsequently rinsed under running tap water and immersed in 5.25% sodium hypochloride solution for 30 minutes to remove soft tissue from the root surface. To ensure that the teeth had non-calcified canals, buccolingual and mesiodistal periapical radiographs were taken.

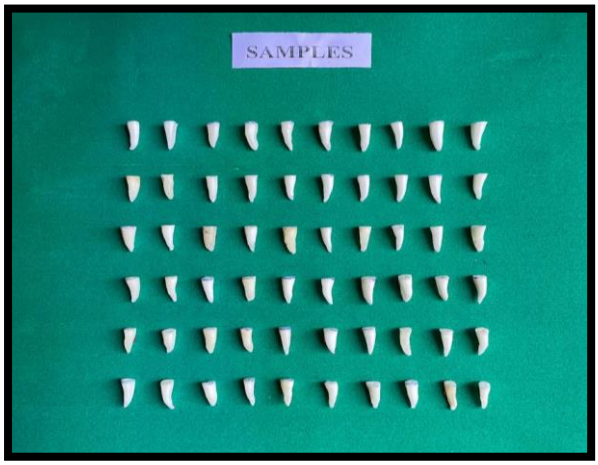


Fig. no.1 Decoronated samples

All the teeth samples were measured 14 mm from apex with the help of digital vernier calliper & sectioned using diamond disc, perpendicular to the long axis of the teeth under water cooling to standardized the root length (fig no. 1). Root Canals was prepared using crown-down technique with Protaper Next Rotary NiTi system. The preparation was done upto X3 with speed of 300 rpm & 2 N/cm torque. Standardized protocol was followed to irrigate all canals. The protocol included using 3 ml of 5% Sodium hypochlorite (NaOCl) solution was used to irrigate the canal between each filing. Once the preparation was complete the root canals were irrigated with 5 ml of 17% Ethylenediaminetetraacetic acid (EDTA) applied for 1 min and 5ml of Sodium hypochlorite (NaOCl) for 1 min. Finally, 10 ml of distilled water was applied for irrigation.

Fig. no.2 Placement of Metapex

All canals were dried using absorbent paper points and Calcium hydroxide (Metapex) was inserted into the canals until it extruded through the apex (fig no. 2). Radiographs were taken in two angulations, mesiodistal and buccolingual, to ensure complete filling of canals with Calcium hydroxide and to check for the voids. Then these samples were store at 37°C and 100% relative humidity for 7 days.

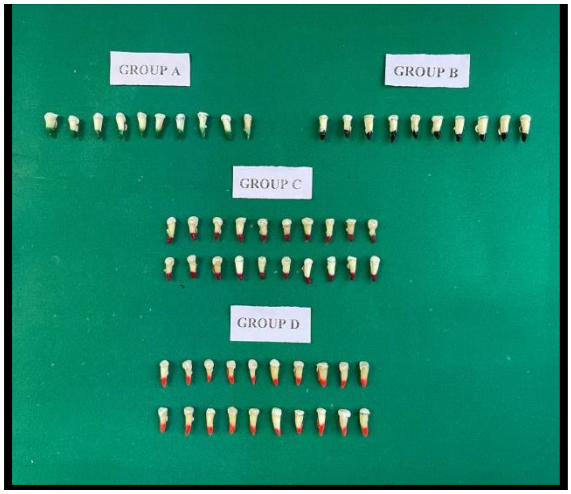


Fig. no. 3 Study Group

After storage for 7 days, the specimens (N=60) was allocated into four groups (fig no. 3):
Group A (n=10): Positive control- In this group Calcium hydroxide (Metapex) was applied but not removed.
Group B (n=10): Negative control-In this group Calcium hydroxide (Metapex) was not be applied.
Group C (n=20): Master apical file X3was inserted in rotary motion up to the working length then root canals were irrigated with 3ml of 5% Sodium hypochlorite (NaOCl). This procedure was repeated for 3 times. Then the canals were filled with 5ml of 17% EDTA for 1 minute and 5ml of Sodium hypochlorite (NaOCl) for 1 min. finally each specimen was rinse with 10 ml of distilled water (fig no. 4).

Group D (n=20): XP Endo finisher-The working length was fixed by using the plastic tube & rubber stopper. After removal of the plastic tube, the instrument will be inserted into the canal without rotation. Afterwards the instrument was used in continuous motion with 800 rpm & 1 N/cm torque for 1 min with slow 7-8 mm up & down movement to entire length of canal. Then same irrigation protocols were repeated (fig no. 4).

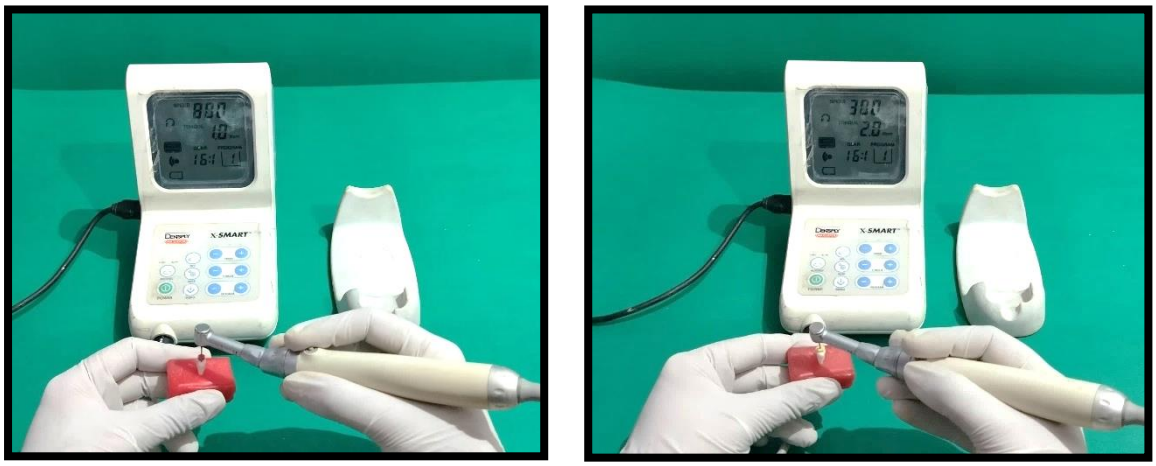


Fig. no.4 Removal of Metapex by Master apical file (X3) and XP Endo Finisher

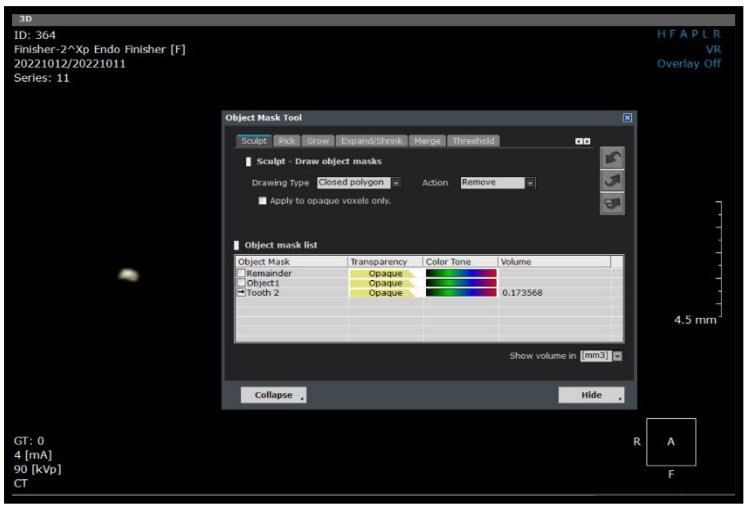


Fig. no.5: Volumetric analysis

The CBCT imaging was done for the volumetric analysis of remaining Calcium hydroxide in the canal. The calculation of Calcium hydroxide volume in each specimen was performed using OnDemand 3D software (Cybermedinc. korea) each dataset was also segmented using uniform greyscale threshold (OnDemand 3D software) to visualize and quantify the volume of residual Calcium hydroxide material (fig no. 5).

RESULT& STATISTICAL ANALYSIS: Data was expressed as Mean ± Standard deviation. Paired t test was used to study significance of difference between the groups. ANOVA was done to assess the significance of difference, as the study contains more than two groups. P Value < 0.01 was considered to be statistically significant at 95% confidence interval (Table no. 1).

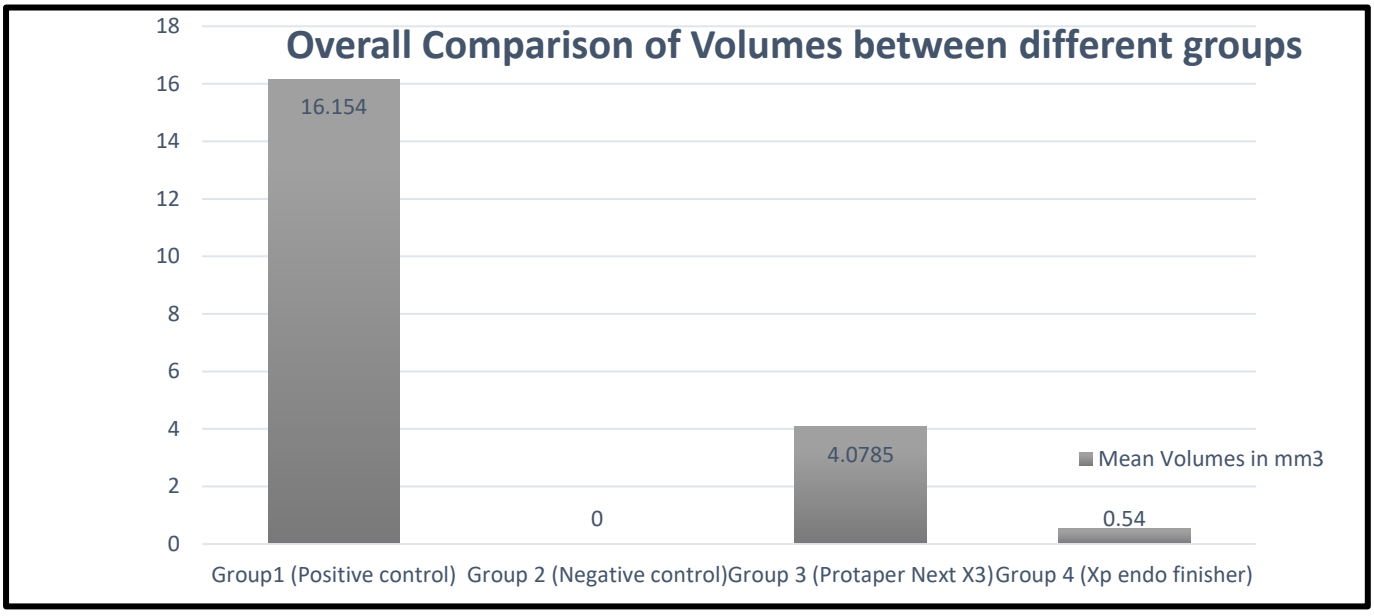
Table 1: Overall Comparison of Volumes between different groups

	N	Mean	Std. Deviation	F value	P value
Group1 (Positive Control)	10	16.1540	1.81726	158.200	<0.0001*

Group 2 (Negative Control)	10	.0000	.00000		
Group 3 (Master Apical File X3)	20	4.0785	3.07211		
Group 4 (XP Endo Finisher)	20	.5400	.79551		
Total	60	4.2318	5.95832		

Mean ± Standard deviation for Positive control group is 16.1540 ± 1.81726 which is higher than Negative control group. Mean ± Standard deviation for Positive control group is 16.1540 ± 1.81726 which is higher than Master apical file X3 having mean ± Standard deviation is 4.0785 ± 3.07211. Mean ± Standard deviation for Positive control group is 16.1540 ± 1.81726 which is higher than XP Endo Finisher having mean ± Standard deviation is 0.5400 ± 0.79551. Mean ± Standard deviation for Master apical file X3 is 4.0785 ± 3.07211 which is higher than Negative control group having mean ± Standard deviation is. 0.0000 ± 0.0000. Mean ± Standard deviation for XP Endo Finisher is 0.5400 ± 0.79551 which is higher than Negative control group having mean ± Standard deviation is 0.0000 ± 0.0000. Mean ± Standard deviation for Master apical file is 4.0785 ± 3.07211 which is higher than XP Endo Finisher group having mean ± Standard deviation is. 0.5400 ± 0.79551(Graph no. 1).

The efficacy of Calcium hydroxide removal from whole root canals after using Master apical file (Protaper next X3) and XP Endo Finisher showed significant difference. The statistical analysis showed that the mean percentage of oil-based Calcium hydroxide (Metapex) volume removed by XP Endo Finisher was more (0.5400 ± 0.79551) than Master apical file (4.0785 ± 3.07211). Positive and Negative control group were found to be statistically different from experimental group (Master apical file & XP Endo Finisher). Group 2 (Negative control) was not filled with Calcium hydroxide, thus had lower Calcium hydroxide concentration. Significantly high Calcium hydroxide levels persisted in Group 1 (Positive control) as canals were filled with Calcium hydroxide but not removed.



Graph 1: Overall Comparison of Volumes between different groups

DISCUSSION: Antimicrobial activity of interappointment intracanal medications is an important consideration in endodontics. Intracanal medicaments have been recommended with goals of eliminating surviving bacteria in the root canal, which prevents bacterial proliferation between appointments.[12] Commonly used intracanal medicaments are Phenol, Eugenol, Formaldehyde, Chlorhexidine, Calcium hydroxide, Triple antibiotic paste (Metronidazole, Ciprofloxacin, Minocycline), Ledermix. [13]

Calcium hydroxide [Ca(OH)2] was chosen for the study because of its favourable alkalinizing effect.[14] It has high pH of 12.5 and is only slightly soluble in water with a solubility of 1.2 g/l, at a temperature of 25˚C.8 According to Komabayashi et al., the average size of Ca(OH)2 particles ranges between 0.5-2 μm, which is less than the dentinal tubule diameter. As a result, residual Ca(OH)2 particles can easily penetrate and block the dentinal tubules. [15] This may increase the chances of root canal treatment failure due to leakage. Metapex (MetaBiomed Dental Corp. Ltd., Elmburst, NY), a commercially available product which is composed of Ca(OH)2, Silicone oil and Iodoform was selected for this study. [16]Several methods for complete and predictable removal of Ca(OH)2 before obturation are : Ultrasonics, Sonic, Canal brush etc. and irrigating agents including Sodium hypochlorite (NaOCl), Ethylenediaminetetraacetic acid (EDTA) & their combination, Maleic acid, Chitosan, Hand files and Rotary files.[17]

Protaper Next rotary file is manufactured using M-Wire NiTi with a rectangular cross-section design had the highest results in cyclic fatigue resistance.[18] Protaper Next has positive rake angle improving its cutting efficiency, variable taper along its length, balanced pitch and helical angle to prevent screwing effect which may contribute to its improved effectiveness to remove oil-based Ca(OH)2 from canal.[19] Manufacturer's recommended rotational speed of Protaper Next is 300 rpm and 200 g/cm torque.[11]

The XP Endo Finisher (FKG Dentaire, La Chaux de Fonds, Switzerland) is a rotary root canal instrument ISO 30 was used in this study. It has also been reported that XP-endo Finisher curved bulb can expand its extent 6 mm in diameter when the file tip is squeezed or 100 times of a corresponding sized file.[20] The new technology behind XP Endo Finisher files manufacturing is based on the shape memory principles of the NiTi alloy. When the file is cooled, it becomes straight (M phase). It has been also claimed that the XP Endo Finisher can effectively remove hard tissue debris, smear layer & calcium hydroxide from root canal system because of its favourable flexibility, ability and shape memory effect.[21]

Damiano et. al stated that, the Protaper Next has off-centered rectangular cross section, gives the file a reduced pattern of contact between the instrument and canal wall significantly lower down the efficiency of removal of Calcium hydroxide.[22] Mustafa et. al (2020) stated that, with the fragile and elastic properties of the XP Endo Finisher with spinning force, it might originate a motion that constantly gives the operational part dissimilar routes which would allow it to come in touch with Calcium hydroxide.[23]

CONCLUSION:

Within the limitation of this study it was concluded that, removal of oil-based Calcium hydroxide paste (Metapex) was significantly less effective than water-based Calcium hydroxide. Master apical file X3 (Protaper Next) & XP Endo Finisher significantly reduced the volume of remaining root filling material from oval-shaped canals. Straight canals also demonstrate effective Calcium hydroxide elimination, which resulted in a lesser proportion of intracanal medicament volume.[24] The XP Endo Finisher removed significantly more root filling material than Master apical file X3 (Protaper Next) because of its transformation to A-phase, which causes the file to expand to adapt to the root canal anatomy.[25]

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