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ABILITY OF SONIC ACTIVATION, ULTRASONIC ACTIVATION AND XP-FINISHING ROTARY FILE IN THE REMOVAL OF CALCIUM HYDROXIDE-IODOFORM INTRACANAL MEDICATION

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ABSTRACT

This research compared the efficiency of calcium hydroxide Ca(OH)2-iodoform removal from a simulated groove using sonic endo activator (EQ-S), Ultrasonic activator (Ultra smart) and XP-endo finishers (XP) thirty maxillary central incisors with a single canal were divided lengthwise and prepared to size 40/0.04. In the apical third, an artificial groove was created and filled with Ca(OH)2-iodoform paste. According to the techniques used for removal, the root halves were put back together and split into three experimental groups (n = 10). A four-grade score was used to assess the residual Ca(OH)2-iodoform. The Kruskal-Wallis test was used to assess the differences between the categories (P 0.05). There were no notable variations among them (P = 0.209), but Ultra smart, XP, removed more Ca(OH)2 than(EQ-S). None of the techniques that were tried could remove all of the Ca(OH)2-iodoform paste.

KEYWORDS: Sonic activation; Ultrasonic activation; XP-finishing rotary file, removing intracanal medication

INTRODUCTION

Microorganisms are crucial in the development of the pulp and periapical diseases [(1)]. The main goal of root canal therapy was to rid the root canals of microbes, microbial poisons, and remnants of vital and necrotic tissue through chemo-mechanical preparation or chemical decontamination using topical medications [(2)]. sadly, none of the modern techniques enable for the full cleaning of the root canal system [(3)].

Since it has been used in dentistry for almost a century, calcium hydroxide dressing has both benefits and drawbacks that are well known [(4)]. The inability to completely remove this dressing material from the root canal system is one of the main issues[(5)].

Before filling the root canal, all interappointment dressings must be removed [(6)]. This is done to prevent harmful interaction between the medication and the filling substance [(7)], which might lead to an apical leakage [(8)]. Alternatively, it might lead to a possible decline in sealant adaptation [(9)], or both.

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EQ-S (Meta Systems, Seongnam, Korea) is passive sonic activator uses non-cutting plastic points that oscillate at much lower frequencies (150–200 Hz). To further boost productivity in comparison to traditional sonic irrigation and PUI, low electric current-assisted sonic irrigation has been developed. These sonic devices made an effort to minimize fluid disturbance and cavitation while still removing the smear layer and displacing intraradicular biofilm [10].

A wireless ultrasonic irrigation device called COXO Ultra smart (COXO Medical instrument Co, China) was created to clear the challenging and challenging regions of a complicated root canal system. It operates at a 38 kHz frequency with activation sequences of 20 sec. It can access blocked dentinal tubules, clear biofilms and smear layers, and improve drainage effectiveness. When the irrigation is activated, this device generates sound micro-streaming and cavitation (https://www.coxotec.com).

The XP-endo finisher (XP) (FKG Dentaire, La Chaux de Fonds, Switzerland) is a file with a small core size 25 and no taper that is based on the shape-memory properties of NiTi alloy. It was created to be used after any root canal preparation of size 25 or more in order to clean highly complex morphologies and challenging-to-reach areas ((http://www.fkg.ch/).

Well-pex is an oil-based calcium hydroxide Paste with Iodoform. Primarily contains calcium oxide and iodoform, which has excellent radiopacity and antimicrobial properties. Highly flowable slurry that is premixed and extremely stable without any solidification or partition. Well-pex contains an oily vehicle, i.e., silicon oil, which might have restricted its dissolution and removal from the root canal

The current research assessed how well the root canal cleaning tools EQ-S, COXO Ultra Smart and XP-endo finisher removed calcium hydroxide. Our baseline hypothesis is that there is no difference between the three methods in terms of their calcium hydroxide removal efficiency.

MATERIALS AND METHODS

Teeth selection

G*Power 3.0.10 programme (v 3.0.10: Kial University, Germany) was used to calculate the sample size. Thirty periodontally diseased upper central incisors with straight roots that had recently been extracted were selected for this study. After extraction, the teeth were stored in distilled water. The research included intact teeth with tight apices. Carious, fractured, cracked, resorbed or calcified teeth were excluded from this research.

Specimen preparation

To standardize the length of the canal, the teeth were decoronized under water cooling by measuring 18 mms from the root apex. An endodontist (RW) prepared all root canals. A 40/0.4 taper RaCe (FKG Dentaire, La Chaux de Fonds, Switzerland) file system was used to prepare the samples. Using 5 mL of 4% NaOCl, irrigation was done between each file (Clorox, Egypt). When the mechanical preparation completed, a final flush was given using 5 mL of 17% EDTA followed by 5 mL 4% NaOCl, and the channel was desiccated with paper points.

The Specimens were put into silicone impression substance and then numbered. Each Specimen had a unique identifier. The Specimens were taken out of the impression substance, and the buccal and lingual sides were grooved with a diamond disc (Horico, Germany) under water cooling. The chisel blade was then used to divide the roots in half by being hammered into the grooves that had been made fig. 1-a.

By the aid of a cavitron tip connected to an ultrasonic system (Woodpecker, China), standard grooves (4 mm length, 0.2 mm width, and 0.5 mm depth) were made in the root apical region fig. 1-b. A toothbrush was used to clear debris from the root halves and artificial grooves. After washing the teeth with 2 mL each of 4% NaOCl and 17% EDTA, they were dried with an air mist. A creamy mix of Well-pex paste was injected into the grooves to simulate $Ca(OH)_2$ remnants in an uninstrumented natural canal recess.

After that, the root halves were then put back together by the aid of glue. Wax was applied to the separated lines and apical region of the samples to prevent fluid leaks and to enable closed-system irrigation, and then the roots were mounted again in the silicone moulds. To mimic an inter-appointment dressing, the access cavities were temporarily sealed with a temporary filling (Orafil-G, PREVEST, India) and kept at 37°C and 100% humidity for a week in an oven. The samples were then split into three categories at random.

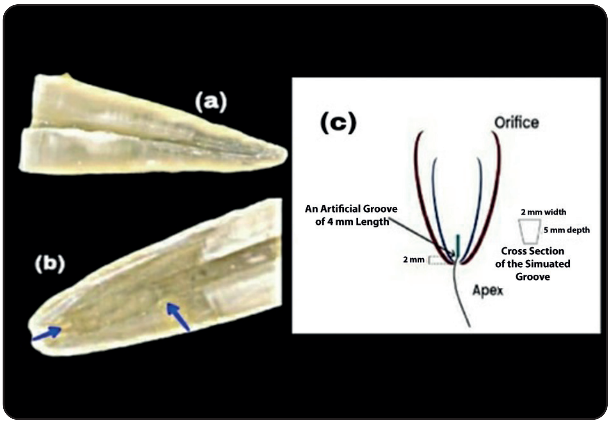

Fig. (1): (a) sectioned root-(b) blue arrows refer to groove position-(c) schematic drawing of the mannered groove.

Standardization and operator accuracy

The original training for the standardization of the research procedure was provided by a seasoned endodontist.

Irrigating procedures

Irrigation was done in the following ways: Fanta irrigation needls (FANTA, China) was used to apply 3 mL of 17% EDTA to the root canals for 30 seconds. This was followed by activation for another 30 seconds. This pattern was doubled. 2 minutes of irrigation were needed, along with 6 mL of 17% EDTA.

GROUPING

The following tools were utilized to activate irrigation (n = 10):

EQ-S sonic activator: The wireless handpiece of the sonic activator device is connected to a polymer tip (#15/0.2) worked at 217 Hz.

Ultra smart: Tip (#25/0.2) connected to COXO Ultra Smart handpiece worked at 38 kHz.

The endodontic motor (Rooter, FKG Dentaire, La Chaux de Fonds, Switzerland) was used with the XP files at 800 rpm and 1 Ncm. The elastic stopper was adjusted on the plastic tube to correct the WL, and the file was straightened by cooling it with an Endo Ice cold spray (Mahwah, NJ, USA). The access cavity was filled with irrigant after the file was inserted into the WL, and the file was then handled for 60 seconds using slow, gentle, 5-6 mm lengthwise in-and-out motions.

In all groups, irrigation initiation was done 2 millimetres below the working length. During the process, oscillations with amplitude of 2-4 millimetres were carried out in the sonicActivator group. Short, vertical strokes were used to finish irrigation in the Ultra smart group. Then the roots were divided, dried with paper points, and the calcium hydroxide residue was examined.

Analysis of cleaning ability

Karl Kaps microscope at a 24x magnification and a digital camera were used to capture digital pictures of the grooves both before and after the Well-pex was applied. (Sony alpha A6000, Sony Inc., New York, USA). To stop the assessors from identifying the specimen, the images were coded. Two calibrated endodontists scored the quantity of Well-pex that remained in the grooves. The Lee et al. 22-described four-grade scoring method was applied. Score 0: the groove is empty; Score 1: less than 50% of the groove area is covered by Ca(OH); Score 2: more than 50% of the groove area is covered by Ca(OH); and Score 3: the groove is entirely covered by Ca(OH). Any differences of opinion among the witnesses were discussed and resolved.

Statistic evaluation

In order to assess intra- and inter-observer agreement, kappa values were computed. The Kruskal-Wallis test was used to assess the variations in Ca(OH)2 scores between the various groups at a 95% confidence level (P 0.05). The spss 20.0 programme was used to conduct all statistical studies. (SPSS, Chicago, IL, USA).

RESULTS

The intra- and inter-observer differences in scoring were never greater than one score throughout the full scoring process. The first and second viewers' intra-observer kappa values were 0.944 and 0.957, respectively, and the kappa value between the observers was 0.947. The spread of the scores for $Ca(OH)_2$ removal is shown in Figures 2&3. None of the evaluated techniques was able to remove all of the $Ca(OH)_2$-iodoform from the synthetic standard grooves. There were no significant differences between the three groups (P = 0.206). sonicActivator group was the least effective at removing Ca(OH)-iodoform past

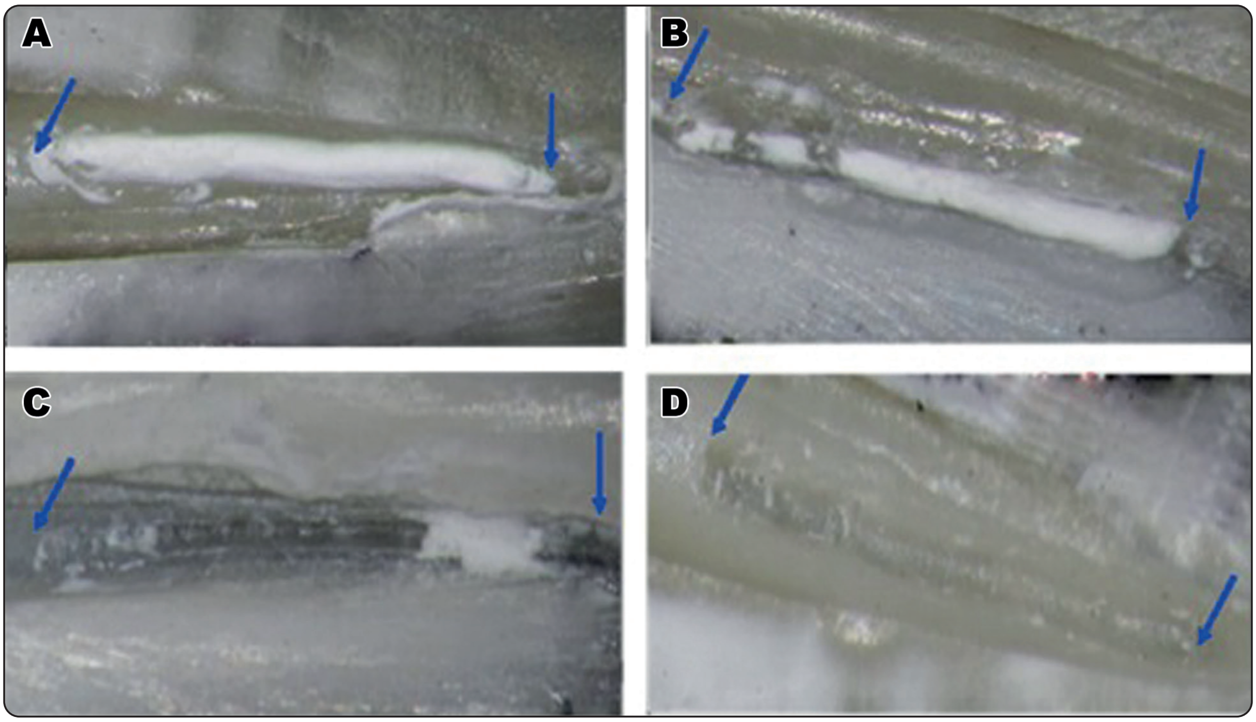

Fig. (2)

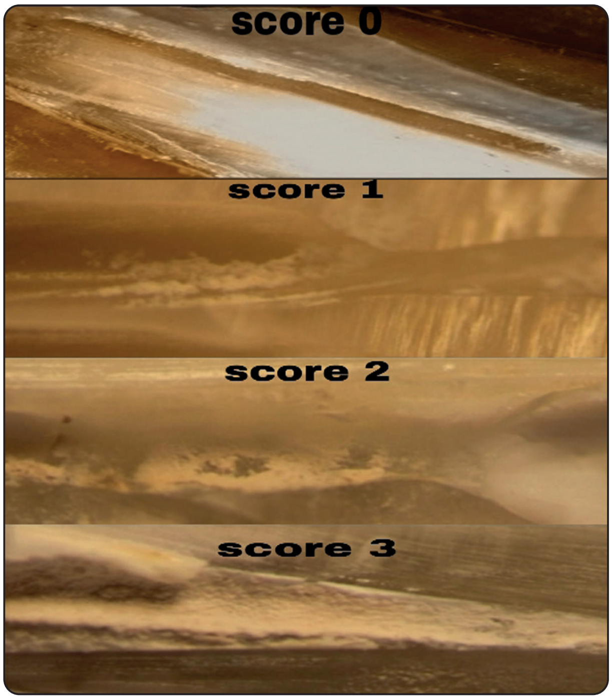

Fig. (3)

DISCUSSION

Even though mechanical cleaning can remove the majority of germs and their byproducts from the root canal system, irrigation and intracanal medications are advised to guarantee antimicrobial efficacy [11]. Calcium hydroxide is the most frequently used medication for this reason in endodontics [12].

The longest-lasting medication used to clean the root canal system is calcium hydroxide [12]. Despite its effectiveness against microbes, the use of this medication is still debatable because there is a chance of apical leaking because the obturation substance does not adhere well to the root canal and prevents root canal sealer from penetrating. While some studies claim that calcium hydroxide reduces or completely eliminates apical leaks, other studies claim that calcium hydroxide is ineffective as a sealant. Therefore, prior to root canal filling, calcium hydroxide must be entirely eliminated [13, 14].

Because NaOCl cannot decompose inorganic materials, it is not appropriate for eliminating calcium hydroxide from root canal walls. [15]. Rödig et al. discovered that chelating compounds, such as EDTA and citric acid, were more effective. However, adding NaOCl to EDTA did not improve elimination effectiveness [16]. In the current research, calcium hydroxide was eliminated using 17% EDTA as the chelating substance.

Several other studies have used the experimental model that was used in this research [16, 17, 18], which is similar to that outlined by Lee et al. [19]. The groove model's benefit is that the grooves contain similar quantities of medication before irrigation and are of standardized size and location. Previous studies examined the amount of calcium hydroxide after irrigation while presuming an equivalent baseline quantity of calcium hydroxide, which could lead to an inaccurate assessment of the efficacy of various irrigation methods [20, 21]. The main flaw in this model is that the standardised channels don't accurately depict the complicated nature of root canal anatomy. Microcomputed tomography (CT), which enables a more accurate measurement of medication remanent in the root canal system, can be used to get around these constraints [22].

In this study, apical preparation was carried out to size 60, 0.02 taper to simulate an average size of chemomechanical instrumentation before placing the interappointment dressing because large final preparation sizes for single-rooted teeth of size 50–90 have been suggested [23]. Larger sized apical preparations have been shown to enhance irrigant replenishment and the mechanical effectiveness of root canal irrigation in several studies [24, 25, 26]. Therefore, it is possible to hypothesise that root canal preparation to a reduced apical size may affect hydrodynamics and lessen irrigation's efficacy, leaving more medication behind. The scoring method used in this research have been used by Van der Sluis [17].

During irrigation, the Ultra smart ultrasonic triggering device produces sound streaming in the liquid using a 38 kHz oscillation frequency. This audio streaming causes the fluid surrounding the vibrating file to travel quickly in a circular or vortex-like pattern. Acoustic microstreaming is the name for this phenomenon that occurs during ultrasound treatment in the root canal [27]. The incidence of acoustic microstreaming and fast fluid movement can be used to explain why Ultra smart is more effective than EQ-S Endosonic.

Donnermeyer et al. discovered no statistically significant difference between EDDY and ultrasonic irrigation for removing calcium hydroxide from root canals in a prior research [28]. This discovery is congruent with what i found. The fracture-resistant, bendable polyamide ends of EDDY may generate acoustic currents that result in spiral eddies along the point. Although EQ-S has bendable polymer tips, they are less efficient than Ultra smart tips. The higher working vibration frequency (38 kHz) of ultrasonic than other sonic devices may help to explain its better effectiveness in removing calcium hydroxide.

It is stated that XP's flexibility and ability to extend its reach to 6 millimetres in diameter, or 100 times more than an equivalent-sized file, will enable mechanical cleaning of the waterway in previously inaccessible regions (FKG). The architecture of the file is based on the shape-memory properties of the NiTi alloy, which is straight in its M-phase when chilled and transforms to the A-phase when subjected to canal temperature.

The theory is that the A-phase shape will enable the file to compress and enlarge in rotation mode in accordance with the root canal anatomy, providing access to and cleaning of regions that are otherwise difficult to reach with conventional tools (FKG). Regarding $Ca(OH)_2$ paste, the current research XP-endofinsher files meet this assumption.

One potential drawback is that the operator has little control over how long the file will truly interact with an irregular region because the operator only has control over the working time. Longer operation times should be tried to address this problem before drawing definitive, more thorough conclusions because the 1-min operation time recommended by the maker was insufficient for the effective elimination of $Ca(OH)_2$ from the artificial groove in this research.

No significant differences in the cleaning effectiveness of these tools were found. This finding may be related to the fact that root canal irrigation's efficacy depends on a number of variables, including the size of the apical preparation [29], taper[30], The chemical capacity of the irrigant to dissolve tissue[9], penetration depth of the irrigation needle [31], irrigant volume [32]. intracanal medications [16] and flow velocity [26] are other factors to consider.

Due to the fact that EQ-S sonic activator, Ultra smart and XP all removed considerably more $Ca(OH)_2$, the study's null hypothesis was denied. However, none of these techniques was able to remove $Ca(OH)_2$ completely from the channels. To find an irrigation method that can successfully remove the remains of $Ca(OH)_2$ paste, more research should be done.

CONCLUSIONS

No tried technique could successfully eliminate all the Ca(OH)2-iodoform from the simulated standardized groove in the apical third of root canals within the constraints of this research. EQ-S sonic activator, Ultra smart and XP were all effictive, but they were all equally capable of removing Ca(OH)2-iodoform completely.

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