Cone Beam Computed Tomography Analysis of Three Method of Intracanal Calcium Hydroxide Placement

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Abstract

Aim: To compare and evaluate the quality of three different method of intracanal placement of calcium hydroxide paste through CBCT.

Methodology: Thirty single-rooted mandibular premolars were decoronated and cleaning and shaping was done using Protaper Rotary Files(till F4). The canals were divided into the following three groups which were filled with a radiopaque calcium hydroxide paste based on three insertion method (n = 10, each): using a Master Gutta-percha cone (MGP), Pastinject (PIT), and a technique combining conventional hand files with ultrasonic activation(UST). The quality of fillings was assessed using CBCT by examining the number of canal walls coated dividing the root into thirds. Statistical analysis was done using the Chi-square test of independence.

Results: The canals filled with combined technique (hand files with ultrasonic activation) had a better coating of canal walls followed by Master GP cone and Pastinject, with significant differences between them.

Conclusion: From the images obtained through CBCT analysis, calcium hydroxide placed utilizing hand files with ultrasonic activation (UST) produced better coating of canal walls over Master GP and Pastinject techniques.

Keywords: *Calcium Hydroxide; Intracanal medicament; Placement method.*

Introduction

The reduction or elimination of bacteria is one of the important objectives adding to the success of an endodontic treatment. Cleaning and shaping or chemomechanical preparation of the root canal is a vital phase of endodontic intervention and it has been found even after cleaning and shaping, bacteria may still be viable.[1,2] Therefore, intracanal medication may be a valuable adjunct to such cleaning and shaping procedures in the disinfection of the root canal system, reducing the endodontic microbiota.[3-8] Calcium hydroxide [$Ca(OH)_2$] is acknowledged as the most effective intra-canal medicaments used in endodontic intervention due to its bactericidal properties.[9] It has been effective in killing microorganisms through direct contact and hence advised to be close to the appropriate tissues as well as to be used with maximal density and depth till the working length of the root canal to permit its biological effects.[10] Several method have been employed for intra-canal $Ca(OH)_2$ placement, however, none of the studies have assessed method of placement three-dimensionally.[11-20] Hence, this study aimed to compare and evaluate the quality of three different method of intracanal placement of calcium hydroxide paste through CBCT.

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Materials and Method

Thirty single-rooted mandibular premolars extracted for orthodontic reasons were selected. The teeth were examined for fracture, cracks, or any other defect after which they were stored in a normal saline solution that was changed daily. Samples were radiographically examined for the presence of a single canal. The crowns were decoronated at 15 mm from the apex to standardize the root length. The working length was determined by subtracting 1mm from the length at which #10 K file tip extruded apically. Cleaning and shaping of the root canals were done with Protaper Rotary Files (Dentsply Maillefer, Ballaigues, Switzerland) using the crown-down technique up to size #40(F4). During the preparation, the root canal was irrigated with 2 ml of 5.25% Sodium Hypochlorite solution after each instrumentation and the final rinse was carried out using 5 ml of 17% ethylenediaminetetraacetic acid (EDTA) for 1 min followed by a final flush of saline. After cleaning and shaping, the canals were dried with paper points (Dentsply Maillefer, Ballaigues, Switzerland). Three U-shaped wax rims were prepared and ten teeth were randomly embedded in each rim in such a way that there was 3 mm of modeling wax all around the teeth to simulate the soft tissue around teeth and increase image contrast. All the teeth were numbered from 1 to 30. In this way, the position of each sample remained constant.

The teeth were grouped based on three insertion techniques of a ready-mix paste of Calcium hydroxide (AvueCal, Dental avenue) which was dispensed on a glass slab.

- Group 1, Master apical GP (MGP, n=10): A Protaper Universal GP cone F4 (DentsplyMaillefer) coated with $Ca(OH)_2$paste was inserted into the canal till the apex and removed in a counterclockwise direction. This process was repeated three times for each tooth.
- Group 2, Pastinject (PIT, n=10): A Pastinject #35 paste carrier (MicroMega) coated with $Ca(OH)_2$ paste was inserted into the working length of the canal 2mm short from the apex, rotating at 500 rpm on a contra-angled handpiece, then withdrawn in a continuous movement while maintaining contact with the surface of the canal wall. Slight pumping motion was applied. This process was repeated thrice for each tooth.
- Group 3, Conventional hand files with ultrasonic activation (UST, n=10): A #40 hand K-file coated with $Ca(OH)_2$paste was inserted into the canal up to the root apex and removed with counterclockwise movement, after which the ultrasonic file was layered with the same paste and inserted into the canals, 2 mm short of the working length and activated at full power mode(with the water off), then withdrawn through the use of short, vertical pumping movements while maintaining contact with the canal wall. The process was repeated thrice for each tooth.

Outcome Assessment: Post $Ca(OH)_2$ placement CBCT imaging was done for all the samples, and the assessment of root canal filling of each specimen was estimated by two examiners using NNT viewer software version 7.2 by NewTom Cone beam 3D imaging in MPR view. The assessment of paste fillings was executed based on the number of canal walls (buccal, lingual, mesial and distal) coated dividing the root into thirds (cervical, middle and apical). Scoring was given as 0,1,2,3 and 4 depending on the number of walls coated in each third. Statistical analysis was done using the Chi-square test of independence for studying the association between Method/technique (Master GP, Pastinject & Conventional Hand file plus Ultrasonic Activation) and the number of walls coated. IBM SPSS Statistics 24, SPSS South Asia Pvt. Ltd. was used for data analysis.

Results

The association of wall coating with the type of technique used for the placement of Ca $(OH)_2$ in the coronal third is presented in Table 1 and the analysis did not find any significant difference (p=0.329) as a maximum number of the walls were coated with the paste in the coronal third with all the three techniques. However, analysis of the middle third revealed significant association of wall coating with the type of technique used (p=0.001) showing the highest number of wall coating with Conventional Hand file plus Ultrasonic Activation (UST) followed by Master GP (MGP) and the least with Pastinect (PIT) as presented in Table 2. Analysis of the Apical third showed a significant association of wall coating with the type of technique (p=0.014) with the UST technique having the highest number of wall coating followed by Master GP (Table 3).

Table 1. Association of wall coating with Type of technique for Coronal third

Coronal	Groups								χ^2, p
	Master GP Cone		Pastinject		Ultrasonic		Total		
	No.	%	No.	%	No.	%	No.	%	
No Wall Coated	0	0	0	0	0	0	0	0	$\chi^2 = 2.222$ p = 0.329
One Wall Coated	0	0	0	0	0	0	0	0	
Two Wall Coated	0	0	0	0	0	0	0	0	
Three Wall Coated	2	20	0	0	1	10	3	10	
Four Wall Coated	8	80	10	100	9	90	27	90	
Total	**10**	**100**	**10**	**100**	**10**	**100**	**30**	**100**	

Table 2. Association of wall coating with Type of technique for Middle third

Middle	Groups								χ^2, p
	Master GP Cone		Pastinject		Ultrasonic		Total		
	No.	%	No.	%	No.	%	No.	%	
No Wall Coated	1	10	8	80	0	0	9	30	$\chi^2 = 27.103$ p = 0.001
One Wall Coated	0	0	2	20	0	0	2	6.7	
Two Wall Coated	3	30	0	0	2	20	5	16.7	
Three Wall Coated	5	50	0	0	6	60	11	36.7	
Four Wall Coated	1	10	0	0	2	20	3	10	
Total	**10**	**100**	**10**	**100**	**10**	**100**	**30**	**100**	

Table 3. Association of wall coating with Type of technique for Apical third

Apical	Groups								χ^2, p
	Master GP Cone		Pastinject		Ultrasonic		Total		
	No.	%	No.	%	No.	%	No.	%	
No Wall Coated	6	60	10	100	2	20	18	60	$\chi^2 = 16.00$ p = 0.014
One Wall Coated	0	0	0	0	0	0	0	0	
Two Wall Coated	0	0	0	0	1	10	1	3.3	
Three Wall Coated	0	0	0	0	2	20	2	6.7	
Four Wall Coated	4	40	0	0	5	50	9	30	
Total	**10**	**100**	**10**	**100**	**10**	**100**	**30**	**100**	

Discussion

Calcium hydroxide is the most common inter-appointment dressing used as an adjunct to root canal disinfection after cleaning and shaping, especially in teeth with periapical lesions, and at least 1 week of its intracanal placement is recommended to reduce the number of residual bacterial load.[15] There are various therapeutic effects of a $Ca(OH)_2$ such as inhibition of osteoclastic activity, degradation of bacterial lipopolysaccharides, dissolving of soft tissues and apexification, etc. Even though the use of $Ca(OH)_2$ has now subsided with the use of other calcium silicate-based materials, it is still considered as the gold standard.

The maximum biological effects of $Ca(OH)_2$ is achieved when it is filled with the highest density along the entire canal working length which depends on the method in which calcium hydroxide is delivered into the root canal.[16,17] Various techniques have been employed

for intra-canal $Ca(OH)_2$ placement and it has been found that Lentulo-spiral provided better coating of canal walls.[14,15] However, results from another study showed Pastinject to be better than Lentulo-spiral.[21] Hence, in the present study Pastinject was used which gave the least result in coating the canal walls. This result contradicted the results of a study done by Deveaux et al. where Pastinject provided better root canal filling when compared with four other techniques which also included Lentulo-spiral and ultrasonic file.[11]

The use of ultrasonic files in the present study was derived from a study by La et al., where ultrasonic files were used for the placement of root canal sealers. However, the authors observed the ultrasonic vibrations to disrupt the sealer.[22] In the present study, a combined technique (UST) of K-file combined with Ultrasonic activation was employed which was found to be superior compared to the other two method, especially in coating the apical third of the root canal. This can be due to the ultrasonic vibration which enhanced the peripheral displacement of the medicament, even into the apical third, after the canal was adequately filled by manual K-file.

The use of Master Gutta-percha cone (MGP), which in the present study was found to be better after UST technique, was derived based on the results obtained from a study in which Master GP produced better coating of root canal sealer when compared to rotary and manual lentulo-spiral which was due to its better fitting to the prepared root canal as its size coincides with the last rotary file used during chemo-mechanical preparation.[23]

Calcium hydroxide that is oil-based although possessing an advantage of prolonged duration of action of the medicament also holds the disadvantage of difficulty in removing from the root canal. It has been found that residual calcium hydroxide on the canal walls obstruct sealer penetration into the dentinal tubules thereby affecting the bonding of resin sealer adhesion to dentin which markedly increases the chances of apical leakage of a root canal treated teeth.[24] Hence, in the present study a water-soluble Calcium hydroxide paste was used as it can be easily removed when compared with oil-based preparation.

A novel nondestructive technology in the dental-maxillofacial imaging, which has added to the ease in diagnosis and treatment plan, is the use of Cone Beam Computed Tomography (CBCT). Along with the 3D interpretation, it has various other advantages some of which are: lower radiation dose, shorter acquisition time, less space requirement, interactive display modes, etc.[25] Although CBCT has been used for the analysis of different techniques for calcium hydroxide removal, there is no literature available regarding its usage for intracanal placement of calcium hydroxide. Hence, CBCT imaging was done for the specimens in the present study.

The investigation done in the present study was limited to root canals with non-complicated anatomy. Hence, further study may be carried out in root canals with complicated internal anatomy along with the use of different types of vehicles and consistencies to ascertain the effectiveness of the technique in a clinical scenario, especially in the tooth with periapical lesion along with the use of CBCT.

Conclusion

Considering the limitations and assessing the images obtained through CBCT analysis, it can be stated that Calcium hydroxide paste placed using hand files with ultrasonic activation (UST) produced better coating of canal walls over Master GP and Pastinject techniques in single-rooted teeth.

Conflict of Interest: Nil

Funding: None

Ethical Permission: Approved

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