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Original Article

Dentistry Section

Effectiveness of Two Techniques in Removal of Calcium Hydroxide Medicament from Root Canals: An in-vitro Assessment

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ABSTRACT

Introduction: Calcium Hydroxide {$Ca(OH)_2$} is widely used as intracanal medicament. However, complete removal of $Ca(OH)_2$ is very difficult from canal walls resulting in its residues on canal wall which interfere with bonding of sealers and reduce success of root canal treatment.

Aim: To compare the effectiveness of two techniques, i.e., wave one and wave one with EndoActivator in removing $Ca(OH)_2$ from the root canals.

Materials and Methods: This was an in-vitro study involving 30 extracted single-rooted mandibular premolar bicuspid teeth. Access opening was done followed by biomechanical preparation with ProTaper universal rotary file system (Dentsply, Tulsa Dental Specialities) till F2. Canals were filled with injectable $Ca(OH)_2$ (UltraCal XS, Ultradent Products, INC). The tooth was stored in saline for one week. Then samples were divided into two main groups T1 and T2 (n=15) according to the method of $Ca(OH)_2$ removal. Group 1 (T1): $Ca(OH)_2$ was removed using wave one file alone. Group 2 (T2): $Ca(OH)_2$ was removed using wave one file followed by EndoActivator.

Teeth were sectioned buccolingually. The amount of residual $Ca(OH)_2$ was observed and under a stereo microscope (30X magnification) for coronal, middle and apical third. The data were analysed using Mann-Whitney U test to compare between the two techniques, i.e., T1 and T2, taking into consideration $p<0.05$ as statistically significant.

Results: In the coronal third, there was no difference between the two groups ($p>0.05$). The most efficient $Ca(OH)_2$ removal in apical and middle third was recorded in Group 2 (T2), i.e., Wave one with EndoActivator ($p<0.05$) as compared to Group 1 (T1) wave one file alone.

Conclusion: EndoActivator results in better debridement of root canals when used in combination with different rotary file systems.

Keywords: Bicuspid, Endodontics, Equipment design, Root canal preparation, Root canal therapy, Sodium hypochlorite

INTRODUCTION

It is well known that oral cavity exhibits a complex microbial ecosystem. Infected root canal shares this complex microbial system and exhibits a unique niche for the development and multiplication of selective species of microorganism, playing a unique role in the development of apical periodontitis [1]. Various chemical and herbal intracanal medicament and irrigants are used to disinfect these root canals [2]. $Ca(OH)_2$ is most commonly used intracanal medicament [3]. $Ca(OH)_2$ act as a potential aids in the elimination of harmful bacterias from the root canal and accelerates repair in periapical region [3]. Incomplete removal of $Ca(OH)_2$ from root canal may adversely affect the prognosis of the entire root canal treatment procedure [4].

Improper or partial debridement of $Ca(OH)_2$ medicament, leaves residues on the root canal walls and thus effecting the sealing ability and bonding of endodontic sealers to the canal walls [5]. Numerous methods have been suggested in the past to remove the $Ca(OH)_2$ from the root canal such as hand files, sonic activation, passive ultrasonic irrigation, the canal brush and rotary files [6-8]. Most commonly used method in clinical practice is hand instrumentation with master apical file and copious irrigation with sodium hypochlorite [6,9].

This study aimed to evaluate the effectiveness of two technique i.e., T1 (Wave one without EndoActivator) and T2 (Wave one with EndoActivator) in the removal of $Ca(OH)_2$ medicament from root canals in an in-vitro setting.

MATERIALS AND METHODS

Root canal preparation: The present study was designed as an in-vitro study, where single rooted 30 mandibular premolar bicuspid teeth were used for the study. Teeth with caries, curved canals, calcified canals, fracture and open apex were excluded. Preoperative X-ray was taken to confirm canal morphology and curvature of the root canal. After partial decoration, the roots were adjusted to a standard length of 14 mm. A 10 size K-hand file was used to measure working length.

ProTaper universal rotary file system (Dentsply, Tulsa Dental Specialities) file was used to instrument all the teeth till size F2. Every instrument was followed thorough irrigation of root canal with 2 mL of 5.25% NaOCl (Sodium Hypochlorite). Final irrigation of root canal was done using 5 mL of 5.25 % NaOCl and 5 mL 17% ethylenediamine tetraacetic acid. Canals were then thoroughly dried using paper points. Injectable $Ca(OH)_2$ (UltraCal XS, Ultradent Products, INC.) was injected into each canal up to the working length. Prepared access was sealed with a loose cotton and temporary filling material (3M ESPE, CAVIT-G). The teeth were stored at 37°C in saline for one week. The teeth were then randomly distributed into two experimental groups, i.e., T1 and T2 (n=15). After one week, the temporary filling was removed, and $Ca(OH)_2$ medicament was removed from the root canals using two different techniques.

Group T1

Calcium hydroxide medicament was removed from root canal walls by using wave one primary file 8% 25 size (Wave One Endodontic system from DENTSPLY), which was used in the reciprocating motor (X-Smart plus, Dentsply) in a preset mode and advanced to the working length. About 5 mL of 5.25% NaOCl was used as a final rinse.

Group T2

Calcium hydroxide medicament was removed from root canal walls by using wave one primary file 8% 25 size (Wave One Endodontic system from DENTSPLY), which was used in the reciprocating motor

(X-Smart plus, Dentsply) in a preset mode and advanced to the working length which was followed by the use of the EndoActivator system with 25/0.02 EndoActivator polymer tips (ENDOACTIVATOR from DENTSPLY) for 30 seconds at 10,000 cycles per minute. About 5 mL of 5.25% NaOCl was used as a final rinse.

After the preparation, all the sample teeth were sectioned buccolingually using a carborundum disc preceded by fabrication of a groove on buccolingual direction with a diamond bur. Sectioning of the teeth was followed by observation of individual teeth under a stereo microscope (30X magnification). The $Ca(OH)_2$ residues were calculated for each sample in three parts of the root canal (coronal, middle, and apical) by using a four-grade scoring system:

0=Surface area is devoid of calcium hydroxide.

1=Calcium hydroxide is covering one-third of the surface.

2=Calcium hydroxide is covering two-third of the surface.

3=Complete coverage of the surface by calcium hydroxide.

To prevent observer bias, three independently trained observers's recorded the scores and mean of all the three observers were subjected to final analysis.

STATISTICAL ANALYSIS

The data thus obtained was arranged in Microsoft excel sheet 2013 and was subjected to analysis using SPSS version 23.0 (IBM, Chicago). Kolmogorov-Smirnov normality test were used to check the distribution of data. Following the conformation of non-parametric distribution of data, the data were analysed using Mann-Whitney U test to compare between the two techniques, i.e., T1 and T2, taking into consideration $p<0.05$ as statistically significant.

RESULTS

The study was aimed to assess the effectiveness of two technique in removing $Ca(OH)_2$ medicament from the canal, i.e., T1=Wave one without EndoActivator and T2=Wave one with EndoActivator. The study was carried out on 30 single-rooted extracted teeth prepared by using a similar technique. The present study revealed that both the techniques proved to be equally effective in removing $Ca(OH)_2$ from canal walls at coronal third with the similar median score. Hence, no statistically significant difference was observed in removing $Ca(OH)_2$ in the two groups ($p>0.05$) [Table/Fig-1].

Group	Median	25th percentile (Q1)	75th percentile (Q3)	Minimum Score	Maximum Score	p-value
Group 1 (T1)	0	0	1	0	1	p=0.242
Group 2 (T2)	0	0	1	0	1	

[Table/Fig-1]: Median score of residual calcium hydroxide in the coronal one third of root canal.
Test applied: Mann-Whitney U test, $p<0.05$ (statistically significant)

When comparing the middle third and apical third, technique T1 proved to be less effective as compared to technique T2 which was observed as higher values of median scores in comparison to T2, i.e., 2 and 1 for middle third and 3 and 1 for apical third respectively. Hence, in middle and apical third technique, T2 was statistically superior in removing calcium hydroxide from canal walls as compared to technique T1 ($p=0.001$ and $p=0.002$ respectively) [Table/Fig-2,3].

Group	Median	25th percentile (Q1)	75th percentile (Q3)	Minimum Score	Maximum Score	p-value
Group 1 (T1)	2	2	3	2	3	p=0.001
Group 2 (T2)	1	0	2	0	2	

[Table/Fig-2]: Median score of residual calcium hydroxide in the middle one third of root canal.
Test applied: Mann-Whitney U test, $p<0.05$ (statistically significant)

Group	Median	25th percentile (Q1)	75th percentile (Q3)	Minimum Score	Maximum Score	p-value
Group 1 (T1)	3	2	3	1	3	p=0.002
Group 2 (T2)	1	1	2	1	3	

[Table/Fig-3]: Median score of residual calcium hydroxide in the apical one third of root canal.
Test Applied: Mann-Whitney U test, $p<0.05$ (statistically significant).

DISCUSSION

The success of root canal treatment not only depends on instrumentation but also on irrigants and intracanal medicaments which are used during treatment to eradicate microorganisms from root canal system [10]. The commonly used intracanal medicament is $Ca(OH)_2$ because it is highly active against pathogenic microflora present in the infected root canal [11]. Before obturation of root canal, $Ca(OH)_2$ should be completely removed to allow maximum bonding between canal walls and root canal sealer [12]. Inadequate removal of $Ca(OH)_2$ medicament from root canal walls adversely effects the prognosis of root canal treatment. Previous studies reported that residual $Ca(OH)_2$ on the root canal wall could influence the penetration of sealer into dentinal tubules, reduce the bond strength of a resin-based sealer and interfere with the sealing ability of a silicon based sealer [13,14].

Various methods are used to determine the amount of $Ca(OH)_2$ residues present on the canal walls, such as digital imaging software, stereo microscopes, scanning electron microscopes, microtomography Computed Tomography (micro-CT) and spiral CT [15]. Recently Cone Beam Computed Tomography (CBCT) has been used in one of the studies for assessing residues left on canal walls, and it was found to be more superior as compared to another method [16]. In the present study, remnants of $Ca(OH)_2$ on root canal walls were evaluated using method similar to previous studies [17].

It was found out that statistically significant difference was seen between the two techniques in $Ca(OH)_2$ removal from the apical and middle one-third of the root canal ($p<0.05$). There was no difference between the two techniques ($p>0.05$) in the coronal third. The most efficient $Ca(OH)_2$ removal in apical and middle third was recorded by technique T2 (Wave one with EndoActivator) ($p<0.05$). The less effective $Ca(OH)_2$ removal in apical and middle third was recorded in technique T1 (wave one without EndoActivator).

In above two techniques, the coronal third demonstrated significantly better results in the removal of $Ca(OH)_2$ than apical third. It was suggested that it might be due to greater velocity and increase in volume of irrigant solution which reaches the coronal part of the root canal during an irrigation procedure [18]. This attributes to the difference in cleanliness which was observed between the coronal versus apical third.

The most efficient $Ca(OH)_2$ removal in the apical and middle one-third by wave one and EndoActivator is attributed due to its flexible polymer tips which on activation produces rapid fluid movement inside the root canal. It had been suggested that the EndoActivator stimulate increase flow of irrigant into lateral canals as well as apical portion compared with conventional needle irrigation [19,20]. In the present study, we find out that Wave one file, when used in combination with EndoActivator, showed the better removal of $Ca(OH)_2$ medicament from middle and apical third as compared to Wave one file alone. These results are similar to previous studies which concluded that the rotary endodontic files used along with EndoActivator were more efficient than the rotary endodontic files used with needle irrigation in removing $Ca(OH)_2$ from the root canal [21].

In the present study, $Ca(OH)_2$ medicament cannot be removed completely from the root canal walls. These results are similar to previous studies, which also showed the presence of $Ca(OH)_2$ remnant on the root canal walls irrespective of the technique of removal and file system used [22-24].

LIMITATION

There are inherent limitations in the study due to its study design i.e., in-vitro. In-vitro studies are preliminary studies to test the effectiveness in a well controlled environment of laboratories using test models and without the involvement of animals or humans for testing. The study was carried out with relatively small sample size utilising stereo microscope instead of using Scanning Electron Microscope (SEM) which could have given much more detailed accuracy to the study. Hence, further studies with an increased number of samples and use of SEM should be carried out.

CONCLUSION

Wave one file, when used along with EndoActivator, results in the better removal of calcium hydroxide medicament from middle and apical third as compared to Wave one files alone. Complete removal of calcium hydroxide medicament is not possible from root canal walls irrespective of the technique used.

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