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TITLE: COMPARATIVE EVALUATION OF INTRACANAL CALCIUM HYDROXIDE REMOVAL WITH HAND FILE, ROTARY FILE AND ULTRASONIC IRRIGATION: AN IN-VITRO STUDY

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ABSTRACT

Aim: This study evaluated the efficacy of three techniques of removal of calcium hydroxide [$Ca(OH)_2$)] from the root canals, i.e. hand filing, rotary instrumentation, & ultrasonic irrigation (UI). **Materials and Method:** Sixty freshly extracted single rooted human permanent teeth with intact apices were selected. All the tooth samples were decoronated to obtain a length of 14 mm from apex. After BMP, an artificial groove, 3 mm in length, 0.2 mm in width and 0.5 mm in depth was then cut in the root canal dentine of one half of each specimen at a distance of 2 mm from the apex. Grooves were filled with $Ca(OH)_2$. The root halves were then re-assembled and access cavities were temporarily sealed with a cotton pellet and temporary restorative material. Samples were randomly divided in three groups for $Ca(OH)_2$ removal using three different techniques. Each sample was examined under a stereomicroscope and photograph was taken with the help of a digital camera. The photographs were evaluated as per the following scores, Score (1) = Absence of remnants, Score (2) = Scattered remnants, Score (3) = Densely packed remnants. The evaluation of differences in the $Ca(OH)_2$ score amongst the different groups were analysed using the KRUSKAL-WALLIS TEST. **Results and Conclusion:** None of the tested methods could completely clean the $Ca(OH)_2$ from the artificial standardized groove in the apical third of the root canals. Rotary and UI removed significantly more $Ca(OH)_2$ than HAND files, with no significant difference among them.

Keywords: Calcium Hydroxide, ProTaper gold, Ultrasonic irrigation

INTRODUCTION

The presence of microorganisms in the root canal plays a major role in the pathogenesis and progression of pulp and periapical diseases. The primary aim of endodontic treatment is to remove as many bacteria as possible from the root canal system and then to create an environment in which any remaining organisms cannot survive. Root canal treatment aims to eliminate bacteria from the root canal system and prevent reinfection. Although cleaning and shaping have been shown to greatly reduce the number of bacteria in infected canals, complete disinfection of canals is difficult to achieve. Bacteria left in the root canals may survive, resulting in the failure of root canal treatment.[1]

Mechanical instrumentation and irrigation with antibacterial solutions have been considered essential for the elimination of microorganisms during endodontic treatment. However, half of the treated root canals still harbour bacteria even after careful mechanical instrumentation and the use of an antimicrobial irrigating solution.[2] The use of intracanal dressing to disinfect the root canal system has been advocated to enhance the success of root canal treatment. An ideal root canal dressing must have antimicrobial efficacy causing no harm to the periapical tissues.[3]

Calcium hydroxide has been used in dentistry since several decades and has become a main-stay therapeutic agent owing to its numerous advantages. It has been used in a number of applications such as vital pulp therapy, pulp revascularization, root canal sealers, prevention and treatment of root resorption, and even leads to hard tissue formation, repair of perforations, treatment of root fracture, pulpotomy procedures, apexogenesis, apexification.[4]

Calcium hydroxide $Ca(OH)_2$ medicament should be completely removed from the canal walls before root canal fillings because any residues in the canal walls will negatively affect the quality of root canal filling and produce a negative impact on the prognosis of treated tooth. Furthermore, remnants of calcium hydroxide may influence the dentine bond strength by interfering with the sealing abilities of the root canal sealers, resulting in potential reduction of sealer adaptation. The removal of calcium hydroxide $Ca(OH)_2$ residue from

irregular canal walls is difficult. The most common method for removing calcium hydroxide $Ca(OH)_2$ is the use of "master apical file" (MAF) at working length combined with copious sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) solution for irrigating the canals.[5]

Several other techniques have been proposed to remove the $Ca(OH)_2$ dressing from the root canal system including chemical cleaning solutions irrigated with NaOCl, EDTA, citric acid, lactic acid or other chemicals and mechanical cleaning with endodontic hand files, sonic activation, ultrasonic irrigation and canal brush system. NiTi rotary instruments has been advocated among the latter, a wide variety of multiple rotary file system such as ProTaper Gold, Profile, HERO shaper and ProTaper have been employed.[6]

Thus the purpose of the present study is to compare and evaluate the quantitative amount of removal of $Ca(OH)_2$ from the middle and apical third of root canals and canal walls using hand files (K file), rotary files, and ultrasonic irrigation. Stereomicroscope was used for evaluation of efficacy among these methods.

MATERIALS AND METHOD

Sixty single rooted mandibular premolars were selected. Decoronation was performed to obtain a flat coronal reference point to standardize the length of all samples. Access cavity was prepared and patency of the apical foramina was standardized by inserting a size 10 k-file so that the tip is just visible under surgical operating microscope.

Working length determination was done 1mm short of that position. Cleaning and shaping was done using crown down technique using rotary files (Protaper Gold no. 25, 6% taper). 3% sodium hypochlorite was used as irrigant. Penultimate rinse was carried out with 17% ethylenediaminetetraacetic acid for 1 min and distilled water was used as final rinse.

Two longitudinal grooves were made in the buccal and lingual aspect of each root, with a diamond disk and split into two halves by a chisel.

Creating artificial groove: A longitudinal groove at the apical third, 3mm in length 2 mm in width and 0.5 mm in depth was created in all specimens.

Placement of calcium hydroxide: $Ca(OH)_2$ was mixed with saline solution to obtain a creamy consistency and grooves were filled using paper points. The root halves were assembled and specimens were remounted in the plexi glass tube mould. The access cavities were temporarrily sealed with cotton Pellet and temporary restorative material. After storage for 1 week in humidified chamber the specimens were randomly divided into three groups according to the file system used.

Group I: Hand instrument group, Group II: Rotary instrument and Group III: Ultrasonic irrigation group.

After 7 days, temporary filling was removed with the help of spoon excavator, and $Ca(OH)_2$ was removed in each group using hand, rotary and ultrasonic irrigation.

Group I (Mani K file, Japan): Hand file (no.25, 2% K file) the file was placed through the working length and moved up and down for 1 minute using 2 mL of 3% NaOCL. Finally, the root canals were irrigated using 3 mL of 17% EDTA for 3 minutes. Canals were then dried with paper points.

Group II (Rotary instrument, ProTaper Gold: Dentsply, USA): Under consistent irrigation using 2 ml of 3% NaOCL, the same file system that was used for cleaning and shaping was placed through the working length and moved up and down for 1 minute. Finally, the root canals were irrigated using 3ml of 17% EDTA for 3 minutes and were dried with paper points.

Group III (Ultrasonic irrigation): Ultrasonic irrigation was performed using an endo-ultra ultrasonic system and an IrriSafe size 20, .00 taper file (Acteon, France) in an endo power setting using 30% power.

- The specimens were rinsed with 2.5 mL 3% NaOCl using a syringe and 30G needle placed 1 mm from the WL with a flow rate of approximately 5 mL/min.
- The file was inserted into the canal 1 mm short of the WL
- The irrigants were ultrasonically activated for 20 s.
- This sequence was repeated two more times, followed by a final flush with 2.5 mL 3% NaOCl at a flow rate of approximately 5 mL/min.
- A total irrigants volume of 10 mL was used and was activated for a total of 1 min.

Then the samples were disassembled to evaluate the removal of calcium hydroxide paste from the grooves. Each sample was examined under a stereomicroscope and photograph was taken with the help of a digital camera. Photographs were evaluated by a person, un-associated with the study. The marked middle and apical portion was evaluated as per the following scores (Figure 1)

- Score (1) = Absence of remnants
- Score (2) = Scattered remnants
- Score (3) = Densely packed remnants.

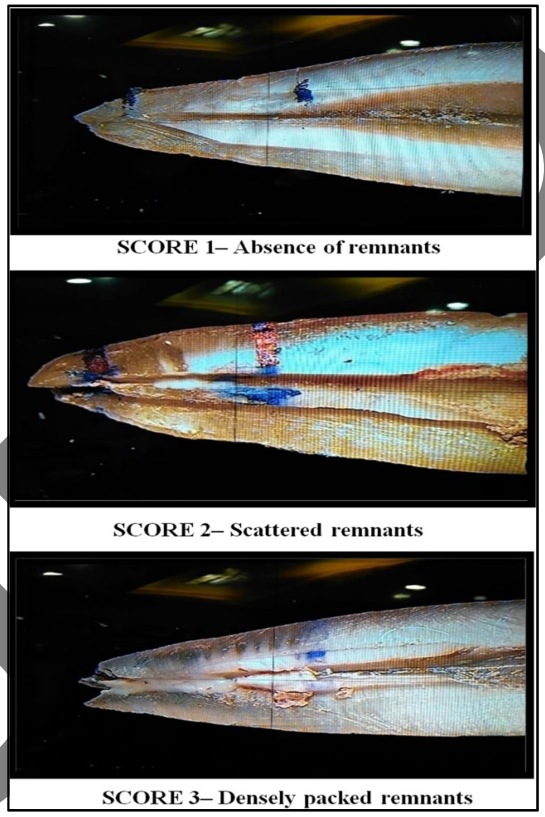


Figure 1: Scoring Criteria

The values were calculated by one observer. The evaluation of differences in the $Ca(OH)_2$ score amongst the different groups were analysed using the KRUSKAL- WALLIS TEST.

RESULTS

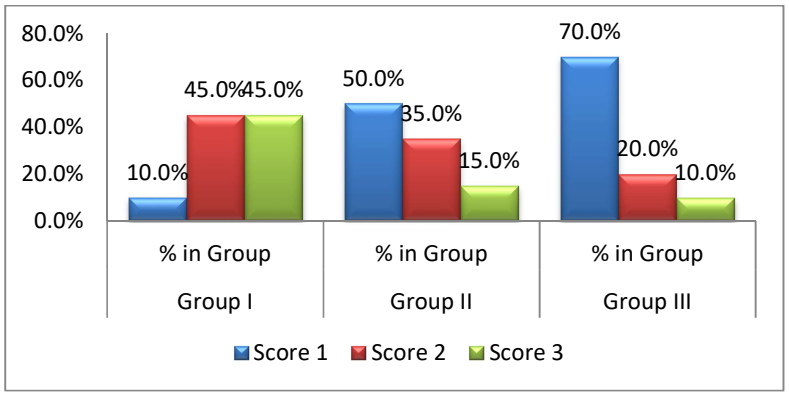
Group-wise score counts and percentages obtained of each score is tabulated in Table 1. It can be seen that highest percentage of Score 1 is obtained in samples of Group III and highest percentage of Score 3 is obtained in Group I samples. (Table 1)

Sample Group * Samples Score Crosstabulation

			Samples Score			Total
			Score 1	Score 2	Score 3	
Sample Group	Group I	Count	2	9	9	20
		% within Samples Score	7.7%	45.0%	64.3%	33.3%
	Group II	Count	10	7	3	20
		% within Samples Score	38.5%	35.0%	21.4%	33.3%
	Group III	Count	14	4	2	20
		% within Samples Score	53.8%	20.0%	14.3%	33.3%
Total		Count	26	20	14	60
		% within Samples Score	100.0%	100.0%	100.0%	100.0%

Table 1: Sample Group and Samples Score Crosstabulation

Graph 1, shows that only 10 percent of samples in Group-I had complete removal of $Ca(OH)_2$ rest had either partial or no removal of $Ca(OH)_2$, in Group-II most samples (50%) had complete removal of $Ca(OH)_2$ and in Group-III maximum samples (70%) had complete removal of $Ca(OH)_2$



Graph 1: Percentage of individual score in each Group.

Highest mean score (Graph 2) is seen in Group I and lowest mean score is seen in Group III which suggests that highest $Ca(OH)_2$ removal efficacy is achieved by Ultrasonic file system (Group III) and lowest efficacy in Hand File system (Group-I)

Independent-Samples Kruskal-Wallis Test: To analyse the significance of difference in the distribution of individual scores obtained in each group Independent-Samples Kruskal-Wallis Test was performed keeping Scores as the dependent variable.

Independent-Samples Kruskal-Wallis Test Summary	
Total N	60
Test Statistic	15.700[a]
Degree Of Freedom	2
Asymptotic Sig.(2-sided test)	**0.000**
a. The test statistic is adjusted for ties.	

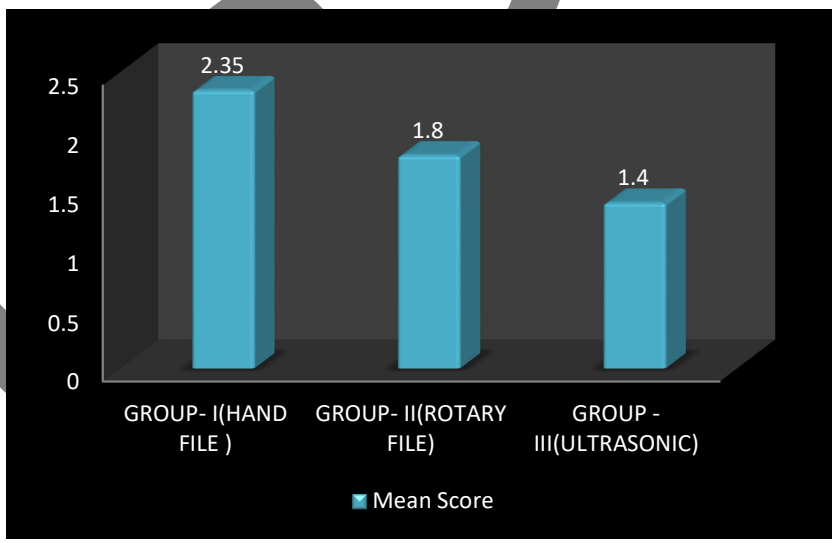
Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	**The distribution of Samples Score is same across categories of Sample Group.**	Independent-Samples Kruskal-Wallis Test	**0.000**	Reject the null hypothesis.
Asymptotic significances are displayed. The significance level is .05				

Table 2: Kruskal-Wallis Test Summary

Kruskal-Wallis Test was conducted on sample scores of all three groups (Table 2). P value is less than 0.05 which shows that result is significant. Hence, Null Hypothesis is rejected which concludes that there is a significant difference in the distribution of Sample Scores across categories of Sample Group.

Pairwise Comparisons of Sample Group					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Group III-Group II	5.450	5.149	1.059	.290	**0.869**
Group III-Group I	19.750	5.149	3.836	.000	**0.000**
Group II-Group I	14.300	5.149	2.777	.005	**0.016**
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.					

Table 3: Pairwise comparison of sample groups



Graph 2: Shows Mean score of each Group

Table 3, show significant difference between Group III and Group I ($p<0.05$) but no significant difference is seen in Group III and Group II ($p>0.05$). Also, between Group II and Group I ($p<0.05$), test shows significant difference among these Groups.

The result of the present study shows that there is highly significant difference ($p < 0.05$) exists between the $Ca(OH)_2$ removal efficacy of different file systems.

DISCUSSION

Mechanical instrumentation and irrigation with antibacterial solutions have been considered essential for the elimination of microorganism during endodontic treatment. The use of Calcium hydroxide as an intracanal medicament is an effective aid in addition to mechanical instrumentation because its tissue-dissolving effect allows remaining tissue to be flushed away after the Calcium hydroxide paste has been in situ for several weeks.[7] Several studies have shown the presence of calcium hydroxide on dentinal walls can affect end endodontic treatment results.[8],[9]

Calcium hydroxide medicament should be completely removed from the canal walls before root canal fillings because any residues in the canal walls will negatively affect the quality of root canal filling.

It has been reported that residual calcium hydroxide interacts with zinc oxide-eugenol sealers to produce calcium eugenolate.[7] The residue could also influence the adhesion of sealers to the root canals,[10] compromising the quality of the sealer provided by the root filling.[11] The dressing can be removed by irrigating the canal by with NaOCl, EDTA or citric acid in conjunction with manual files,[12] passive ultrasonic irrigation,[13] sonic activation,[14] or rotary system.[15]

In this study, for simulating the irregularities, an artificial standardized groove was prepared at middle and apical third of the root canal. However, the limitation of this design is that the standardized groove does not exactly represent the natural morphology of the root canal system. Additionally, teeth with a single, straight root canal were used in this study. The efficacy of removal of Calcium hydroxide may be reduced in complex canal systems such as curved, oval-shaped, C-shaped, and type II root canals.

The present study investigated the effectiveness of Hand instrument, Rotary instruments and Ultrasonic Irrigation in removing calcium hydroxide from root canal walls. In the literature, calculation of the residual amount of calcium hydroxide remaining in the root canal were made by calculating the area of the remnant on dentin wall, by scoring, SEM analysis, volume analysis with spiral CT, by using a micro-CT, by using spectro microscope and CBCT.[16]

Ultrasonic irrigation relies on the transmission of acoustic energy from an oscillating file or smooth wire to an irrigant inside the root canal. It has been demonstrated that an irrigant solution in conjunction with ultrasonic vibration was directly associated with the removal of organic and inorganic debris from the root canal walls.[17]

The scoring method used in the study was described by van der Sluis, et al (2007) as it is a simple and easily accessible technique and used in many previous studies. The results of the current study show that the complete removal of Calcium hydroxide from artificial standardized grooves in the root canals was not obtained, and the null hypothesis that there is no difference between the various techniques was rejected because rotary file and Ultrasonic irrigation removed significantly more Calcium hydroxide than hand instruments, but among Rotary file system and Ultrasonic system there was no significant difference in the efficacy of removal of Calcium hydroxide.

- In the Hand file group, only 10% of samples had complete removal of calcium hydroxide, 45% samples had partial presence of calcium hydroxide and 45% samples were left completely filled/covered with $Ca(OH)_2$.
- In Rotary file group half of the samples had complete removal of $Ca(OH)_2$, 35% of the samples had partial remains of calcium hydroxide and only 15% samples were left completely filled/covered with $Ca(OH)_2$.
- In Ultrasonic group maximum samples (70%) had complete removal of $Ca(OH)_2$ and only 10% samples were found to be completely filled with calcium hydroxide while 20% samples had partial presence of $Ca(OH)_2$.

Mean score distribution is also indicative of efficacy of removal of Calcium hydroxide. Highest mean score is seen in Hand file group and lowest mean score is seen in Ultrasonic

group which suggests that highest calcium hydroxide removal efficacy is achieved by Ultrasonic file system and lowest efficacy in Hand file system.

Group-wise comparison of the means for test of significance shows significant difference in cleaning efficacy among three techniques. Ultrasonic and Rotary file system show better Calcium hydroxide removal efficacy than Hand file system. Although mean score value for Ultrasonic and Rotary file system suggests that Ultrasonic system is better but when tested for significance, the difference is not significant.

Although there have been significant advances in canal preparation and debridement, the fact remains that dentinal debris is still routinely found within canal preparations and that clinicians have been slow to adopt ultrasound as an addition to endodontic cleaning and shaping. The major reasons for this are the need for additional minutes per canal for adequate debridement, and file breakage at high level of ultrasound activation and unwillingness to incur the cost of equipment. Further during ultrasonic debridement, inadvertent canal contact with ultrasonic and sonic instruments can potentially damage the canal wall or finished canal preparation, forming longitudinal parallel grooves on the canal walls.

CONCLUSION

Within the limitations of the current study, it can be concluded that none of the tested methods could completely clean the $Ca(OH)_2$ from the artificial standardized groove in the apical third of the root canals. Rotary and UI removed significantly more $Ca(OH)_2$ than HAND file, with no significant difference among them.

CONFLICTS OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Al-Garni S, Al-Shahrani S, Al-Nazhan S, Al-Maflehi N. Evaluation of calcium hydroxide removal using EndoActivator system: An in vitro study. Saudi Endodontic Journal. 2014 Jan 1;4(1):13.

2. Sjögren U, Figdor D, Spångberg L, Sundqvist G. The antimicrobial effect of calcium hydroxide as a short-term intracanal dressing. International endodontic journal. 1991 May;24(3):119-25.
3. Caliskan MK, Turkun MU, Turkun LS. Effect of calcium hydroxide as an intracanal dressing on apical leakage. International endodontic journal. 1998 May 1;31(3):173-7.
4. SM SC. Merits and demerits of calcium hydroxide as a therapeutic agent: a review. International Journal of Dental Sciences and Research. 2014 Dec 18;2(6B):1-4.
5. Tamil S, Andamuthu SA, Vaiyapuri R, Prasad AS, Jambai SS, Chittrarasu M. A comparative evaluation of intracanal calcium hydroxide removal with hand file, rotary file, and passive ultrasonic irrigation: an in vitro study. Journal of pharmacy & bioallied sciences. 2019 May;11(Suppl 2):S442.
6. Jain A, Patidar N, Nigam N, Bhadoria K, Choudhary B. An in vitro study: Evaluation of intracanal calcium hydroxide removal with different file systems. Indian Journal of Dental Sciences. 2017 Jan 1;9(1):26.
7. Meire M, De Moor R.Mineral trioxide aggregate repair of a perforating internal resorption in a mandibular molar. J Endod. 2008 Feb;34(2):220-3.
8. Ricucci D, Langeland K. Incomplete calcium hydroxide removal from the root canal: a case report. Int Endod J. 1997 Nov;30(6):418-21.
9. Windley W 3rd1, Ritter A, Trope M. The effect of short-term calcium hydroxide treatment on dentin bond strengths to composite resin. JOE 2003
10. Barbizam JV, Trope M, Teixeira EC, et al. Effect of calcium hydroxide intracanal dressing on the bond strength of a resin-based endodontic sealer. Braz Dent J .2008;19:224-7.
11. Estrela C1, Holland R, Bernabé PF, de Souza V, Estrela CR. Antimicrobial potential of medicaments used in healing process in dogs' teeth with apical periodontitis. Braz Dent J. 2004;15(3):181-5.
12. Lambrianidis T, Margelos J, Beltes P. Removal efficiency of calcium hydroxide dressing from the root canal. J Endod.1999;25:85–8.
13. Tasdemir T, Celik D, Er K, Yildirim T, Ceyhanli KT, Yesilyurt C. Efficacy of several techniques for the removal of calcium hydroxide medicament from root canals. Int Endod J.2011;44:505–9.
14. Wiseman A, Cox TC, Paranjpe A, Flake NM, Cohenca N, Johnson JD. Efficacy of sonic and ultrasonic activation for removal of calcium hydroxide from mesial canals

of mandibular molars: a microtomographic study. Journal of endodontics. 2011 Feb 1;37(2):235-8.

15. Kuga MC, Tanomaru-Filho M, Faria G, Só MV, Galletti T, Bavello JR. Calcium hydroxide intracanal dressing removal with different rotary instruments and irrigating solutions: a scanning electron microscopy study. Brazilian dental journal. 2010;21:310-4.
16. Salgado RJ, Moura-Netto C, Yamazaki AK, Cardoso LN, Moura AA, Prokopowitsch I. Comparison of different irrigants on calcium hydroxide medication removal: microscopic cleanliness evaluation. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009;107(4):580-4.
17. Van der Sluis LW, Wu MK, Wesselink PR. The evaluation of removal of calcium hydroxide paste from an artificial standardized groove in the apical root canal using different irrigation methodologies. International Endodontic Journal. 2007 Jan;40(1):52-7.