ORIGINAL RESEARCH

Qualitative and Quantitative Analysis of Intracanal Delivery Systems of Calcium Hydroxide -An In-Vitro Study

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ABSTRACT: *Aim :*This study compared the weight & radiographic appearance of ca(oh)2 delivered into standardized , minimally & fully prepared canals . *Materials & Methods:*An injection system, an endodontic flex o file rotated counterclock wise direction ,Lentulo spiral(maillefer, Ballalgues, Switzerland) & .04 Rotary niti files (Protaper,Dentsply,Maillefer,Switzerland) in an anticlock wise direction were used in this study . Two extracted human second mandibular premolars with single canals were prepared to an MAF # 25 and the other till #40. *Results:*The results of our study showed that lenulospiral achieved the maximum fills in the minimal & maximum prepared canals followed by injection system, rotary & k flex. *Conclusion:*All delivery techniques deliver near optimal weight of ca(oh)2 in the completely prepared canal. Complete instrumentation is needed to obtain optimal delivery of ca(oh)2.

Keywords: calcium hydroxide, intracanal delivery systems, root canal

Calcium hydroxide is used extensively as an intracanal medicament. It inhibits the growth of bacteria between appointment[1]. To achieve periapical healing with endodontic treatment, the root canal system must be thoroughly cleaned, shaped, and obturated. The main goal of cleaning is to remove necrotic debris and reduce the bacterial flora. This may be accomplished by the combination of (a) mechanical cleansing using files and reamers, (b) irrigation of the canal with various chemical agents, and (c) placement of antibacterial dressings in the canal[2]

Intracanal medications, because of their antimicrobial properties, minimize reinfection and / or regrowth of bacteria in the canal. Calcium hydroxide has also been widely used to treat the open apex permanent tooth, internal root resorbtion, iatrogenic root perforation, furcation perforation, root fracture, avulsed teeth, and inflammatory root resorbtion. Ca $(OH)_2$ is reportedly bactericidal and is retained in the canals for extended periods of time, longer than other suggested intracanal medications. To maximize the antibacterial properties of Ca $(OH)_2$,it is important to have a dense homogenous filling to the root apex [2].Delivering the largest amount of Ca $(OH)_2$ into the root canal should enhance the elimination of bacteria.

If the clinician uses calcium hydroxide as an inter appointment medication, a technique should be selected that will deliver the maximum amount of

material for a given preparation. When the diagnosis indicates calcium hydroxide therapy accurate placement of the paste is desirable[3]. If the time is limited, which is common in an emergency appointment, instrumentation procedures must be chosen that will permit an adequate amount of Ca $(OH)_2$ to be placed in the canal.

The aim of this study was to compare the weights of Ca $(OH)_2$ delivered by four different techniques into minimally and fully prepared canals in a standardized split-tooth model.

The main objective of the study was to find which technique will deliver maximum amount of calcium hydroxide. In addition, the radiographic appearance was evaluated to determine if a correlation exists between the weights of Ca $(OH)_2$ delivered and the radiographic appearance.

MATERIALS & METHODS

Two mandibular second premolars with single canals were used in this study.

Access opening done with round bur & working length determined by visualizing #15 K File through the apical foramen and subtracting 1mm. Biomechanical preparation done with crown down technique using .02 hand K-files, #2 and # 3 gates glidden drills. Canals irrigated with 2ml of 17% EDTA followed by a 5ml of 5.25% NaOCl between files. A # 15 K- file maintained canal patency thoroughout instrumentation. One tooth was prepared to a master apical file (MAF) # 25 (minimally prepared canal) to simulate an emergency appointment and the other to a (MAF) # 40 (fully prepared) to simulate a completed preparation(fig-1). After final irrigation, the canals were dried.

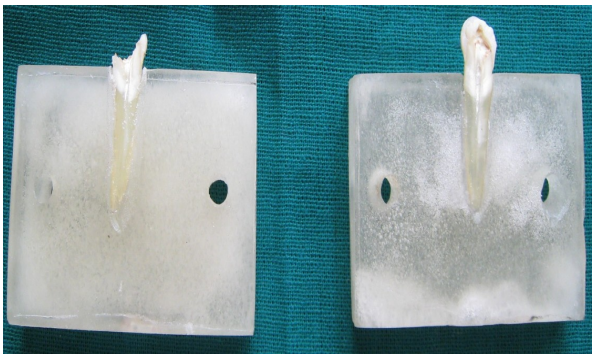
Two custom boxes were fabricated. Resin blocks with teeth embedded in it was prepared. Each resin block was then longitudinally sectioned throughout the center of the root canal (fig-2). Two halves of the block was reassembled with screws (fig-3).

RC Cal (prime dent) was used for each delivery technique tested : a) K- flex file (#25 & # 40 size files) system in an counterclock wise direction b) syringe system by using 30 gauge needle c) Lentulo spiral(maillefer, Ballalgues, Switzerland) d)Rotaryniti files (Protaper, Dentsply, Maillefer, Switzerland) in an anticlock wise direction at a constant 250 rpm. Each technique was repeated ten times and an average weight determined[1].

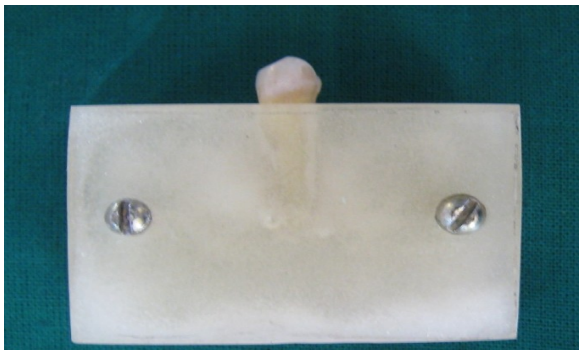
K flex file (fig-4) : The paste was applied to the entire length and introduced to the working length using a counter clockwise rotation. This is repeated until the material was visible at the canal orifice.

Syringe system (fig-5) : The paste was applied slowly and continuously from the apical to the most coronal part of the root canal using slight up and down movement. This is continued until the

Fig-1: Completed root canal preparation



Fig– 2: Sectioned tooth in resin block



Fig– 3: Reassembled tooth in resin block

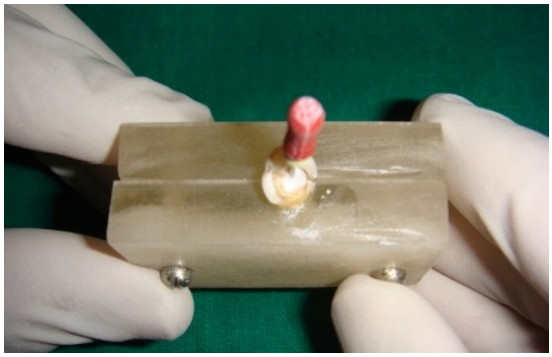
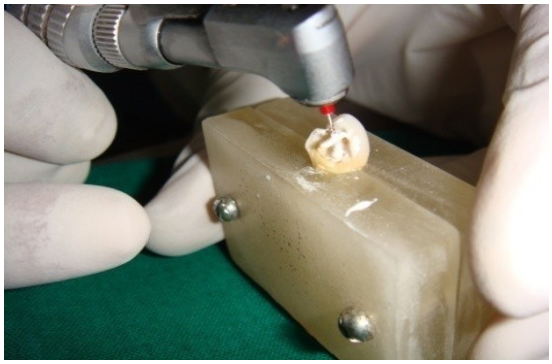


Fig-4: Paste application with K flex file

Fig– 5: Paste application with syringe system



Fig– 6: Paste application with lentulo sprial

Fig– 7: Paste application with Rotary Ni Ti

material was visible at the canal orifice.

Lentulo spiral (fig-6) : The paste is coated and introduced into the root canal and slowly rotated into the canal. The procedure is repeated until the material was visible at the canal orifice.

Rotary ni ti (fig-7) : The paste was applied to the entire file length and placed passively to the working length before running the files in reverse at `250rpm. The procedure continued until the material was visible at the canal orifice.

The reassembled blocks were individually weighed to the nearest 0.0005gms on a weighing scale (K-rey ind pvt limited). To establish a target weight for maximum capacity, both blocks were disassembled and Ca $(OH)_2$ firmly condensed into each half using a cement spatula. Blocks were then reassembled with screws and weighed independently three times to obtain the maximum (optimal) average weight.

Radiographic Evaluation

Three blinded independent examiners radiographically evaluated the completeness of filling. Radiographs were mounted in 35-mm slide format and examined by screen projection. A scale from 1 (empty canal) to 10 (full canal) was used to assign a grade of filling quality[1].

The quantitative data were analyzed using analysis of variance. The qualitative data of radiographic appearance were analyzed using Kruskal-Wallis and Pearson's χ^2 tests. Statistical significance was set at $p < 0.05$.

RESULTS

In this study, for the minimally prepared canal there were no statistical difference among the four experimental groups in the mean weights of Ca $(OH)_2$ delivered (table 1). When the mean weight of Ca $(OH)_2$ for each experimental group was compared with the optimal weight delivered into the same canal, the differences were highly significant ($p< 0.05$)(table 2).

In the completely prepared canal all four techniques delivered close to the optimal weight of Ca $(OH)_2$. The differences between the

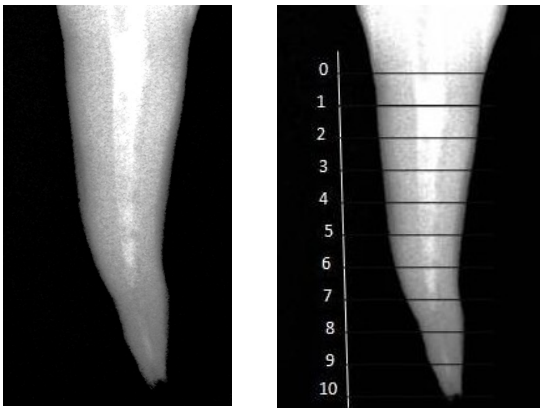


Fig-8: Minimally prepared tooth

Fig-9: Completely prepared tooth

experimental groups and the optimal weight were not significant (p >0.05)

Radiographically minimally prepared canal (fig-8) consistently contained multiple voids with quality of 1 to 6 on 10 scale whereas completely prepared canal (fig-9) had quality of 8 to 9 on 10 scale with few voids.

Table 1denotes: In all the four groups the mean weights and the radiographic values are statistically highly significant.

In comparison, the optimal weight values are more than any other experimental group both in minimally prepared and completely prepared canals. In fully prepared canals the weight values are relatively significant (p<0.143) between optimal weight and K-flex file method. In minimally prepared canals the mean weight values and radiographic values when compared among all the groups, are statistically significant (p<0.001).

DISCUSSION

The goal of cleaning the root canal system is to remove necrotic tissue and eliminate bacteria, calcium hydroxide has been recommended as an intra canal medication after cleaning and shaping the canal system[4].

Calcium hydroxide is a white odourless powder with the formula $Ca(OH)_2$ and a molecular weight of 74.08. Calcium ions play an important role in the initiation of the remineralisation process[5]. Two important properties of Calcium hydroxide are the inhibition of bacterial enzymes causing an antimicrobial effect and the activation of tissue enzymes, such as alkaline phosphatase, causing a mineralizing effect. Its high pH inhibits essential enzyme activities: metabolism, growth and cellular division[6].

Table 1: Comparison of Mean weights (gms) and Radiographic values of Ca $(OH)_2$ delivered into minimally and completely prepared canals within the same group

Technique (group)	Parameter	Size				p-value
		#25		#40		
		Mean	SD	Mean	SD	
K-flex	Weight*	.011	.001	.019	.001	**<0.05**
	Radiograph**	2.30	.95	7.80	1.23	**<0.05**
Ni-Ti rotary	Weight*	.012	.001	.021	.001	**<0.05**
	Radiograph**	3.20	1.32	7.90	1.37	**<0.05**
Injection	Weight*	.013	.001	.022	.001	**<0.05**
	Radiograph**	3.00	1.05	8.30	1.06	**<0.05**
Lentulospiral	Weight*	.015	.000	.023	.000	**<0.05**
	Radiograph**	4.00	.67	8.70	.48	**<0.05**

*t test ** Mann-Whitney U test p-values in bold are statistically significant

Table 2: Comparison of Ca (OH)2 delivery among different groups in both minimally and completely prepared canals

Size	Parameter	File										p-value
		K-flex [1]		Ni-Ti rotary [2]		Injection [3]		Lentulospiral [4]		Optimal [5]		
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
#25	Weight*	.011	.001	.012	.001	.013	.001	.015	.000	**.022**	**.003**	**<0.001**
	Radiograph**	2.30	.95	3.20	1.32	3.00	1.05	4.00	.67	**8**	**1**	**<0.001**
#40	Weight*	.019	.001	.021	.001	.022	.001	.023	.000	**.025**	**0.003**	**0.143**
	Radiograph**	7.80	1.23	7.90	1.37	8.30	1.06	8.70	.48	**8.8**	**1.64**	**0.150**

*ANOVA with post-hoc Scheffe test ** Kruskal-wallis ANOVA
p-values in bold are statistically significant.

Calcium hydroxide is the most commonly used intracanal dressing material due to its antimicrobial effect within the root canal[7]. To maximize the antibacterial properties of calcium hydroxide, it is important to have a dense, homogenous filling till the root apex. Delivering the largest amount of calcium hydroxide into the root canal should enhance the elimination of bacteria [1,7]

The results of this study indicate that to achieve optimal or near optimal placement of Ca $(OH)_2$, a complete preparation is needed. Regardless of the technique used, delivery of Ca $(OH)_2$ into the minimally prepared canal was ineffective. The experimental design of splitting the teeth longitudinally was chosen to establish a baseline for measurement. It was decided that longitudinal sectioning would more accurately allow for measurement of the complete canal area. The split tooth model enabled a comparison of the four delivery techniques in a standardized manner. In addition, two different canal conditions, minimal and complete preparation, were tested to determine the canal size needed to achieve optimal or near optimal delivery of Ca $(OH)_2$.

In this study delivery of calcium hydroxide was maximum with lentilo spiral technique and the values were near to that of optimal method which is similar to the study done by Sigurdsson et al, however Kflex technique showed minimal values.

In the minimally prepared canal, only 45% of the optimal amount of Ca $(OH)_2$ was delivered. In the completely prepared canal, the near optimal weight of Ca $(OH)_2$ delivered.

In all the experimental delivery systems, the weight mean value results order was almost similar to that of radiographic mean value order results both in minimally prepared and fully prepared canals.

CONCLUSION

Within the limitations of this study, among all the four intra canal calcium hydroxide delivery systems (excluding the optimal weight) when comparing weight values and radiographic values, lentilospiral system showed the best results followed by injection system, Ni Ti rotary system and finally K flex file system. To conclude, a complete preparation is needed to deliver a near optimal amount of Ca $(OH)_2$ into the root canal system. The four techniques tested can all achieve that desirable degree of filling.

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How to cite this article:
Ranga reddy D.S,Shankar narayan G,Venkatesan S M,Veniashok B,Duraivel D.Qualitative and quantitative analysis of intracanal delivery systems of calcium hydroxide -An in-vitro study. Journal of Scientific Dentistry 2013;3(1):8-14

Source of Support: Nil, **Conflict of Interest**: None declared