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Calcium Release And Ph-Characteristics of Calcium Hydroxide When Placed In Pulp Chamber And Root Apex – An- In Vitro Study

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Abstract

Background: The value of calcium hydroxide in endodontic treatment of necrotic infected teeth is well documented.

Aim: Evaluate and compare in vitro effects on pH changes and calcium release when calcium hydroxide is placed in pulp chamber and root apex at an interval of 2 days, 1 week and 2 weeks.

Materials and methods: 90 extracted human single rooted teeth were collected. Teeth were instrumented till the apex upto the size 45 K file and divided in to two groups. In Group 1-$Ca(OH)_2$ was placed in pulp chamber and in group 2-$Ca(OH)_2$was placed upto root apex and all samples were then placed in NS solution. Ca concentration and Ph were measured at intervals of 2 days, 1 week, and 2 weeks by pH meter and ICPOES, respectively. Findings were assessed using student's t-test.

Results: At end of 2 days calcium ion concentration had significantly increased in pulp chamber group from baseline**.** At end of 1and 2 weeks, calcium concentration had increased significantly in both root canal and pulp chamber groups. pH values had also increased but only non-significantly when placed in either pulp chamber or the root canal group.

Conclusion: Placing Ca $(OH)_2$in pulp chamberis as effective as placing it in root canal.

Keywords: Calcium Release, Ph Changes, Pulp Chamber, Root Apex.

Introduction

The value of calcium hydroxide in endodontic treatment of necrotic infected teeth is well documented in the literature[1.]Its various biological properties, such as antimicrobial activity[2], inhibition of tooth resorption[3], induction of repair by hard tissue formation[4] have been attributed to this substance and because of such effects, calcium hydroxide has been recommended for use in several clinical situations for almost a century[5,6].The success of calcium hydroxide as an intracanal dressing is primarily due to the liberation of hydroxyl ions in an aqueous environment that in turns attain the high pH, and hence effective microbial destruction and stimulation of undifferentiated mesenchymal cells[7].

In a case of a necrotic pulp with a periapical lesion, it is important to clean the canal and place the calcium hydroxide paste homogeneously up to its entire working length, but sometimes after the root canal and periapical repair ,the removal of calcium hydroxide is frequently incomplete, resulting in a $CaOH_2$ residue covering 20% to 45% of the canal wall surfaces, hence it may interfere with the seal of the root canal filling and compromise the quality of treatment.So if calcium hydroxide in pulp chamber could have the same result as calcium hydroxide in the root canal we can use it without those concerns and it could be washout from the pulp chamber easily[8].

Method

In this experimental in vitro study 90 extracted human single rooted teeth were usedwhich were soaked in 2.5% sodium hypochlorite solution for 30 minutes to remove organic debris. Subsequently they were scaled with ultrasonics, washed with distilled water for the removal of any calculus or soft tissue debris and then stored immediately in 10% buffered formalin solution until use.

The selected teeth were divided into 2 groups: group 1 and 2 of 45 teeth each on the basis of placement of calcium hydroxide. In both the groups standard access cavity preparation was done using high speed air rotor with water spray and #2 round bur and straight bur. The entire canal contents were grossly debrided with broaches and irrigated with normal saline and sodium hypochlorite. The canal length was established with #10 endodontic K file just visible through the apical foramen and working length was established at 1 mm short of this point. The root canals were serially enlarged at the apical foramen to size 45 K file.A standard flare was produced by instrumentation up to file No. 70.

Irrigation during cleaning and shaping was performed using 10 ml of 2.5% of sodium hypochlorite solution and normal saline. After instrumentation, root canals were again irrigated with 10 ml of 2.5% sodium hypochlorite, then 3 ml of 17% EDTA, followed by a final flush of 3 ml sodium hypochlorite and 10 ml normal saline.

In group 1 the access cavity was dried with cotton pellet and the root canal remained wet after root canal preparation in order to allow hydroxyl and calcium ions to be released and the calcium hydroxide paste was inserted into the pulp chamber by spatula.

In group 2 the access cavity was dried with cotton pellet and root canals were dried with paper point and calcium

hydroxide paste was filled in the root canals with the help of reamer and plugger until the calcium hydroxide paste was visible at the apical foramen. All the access cavities were then filled with cavit to a depth of 3mm. All the root surfaces except for the apical 2mm were covered by two layers of nail polish. The samples were then immersed in capped containers containing normal saline individually.

The samples were then stored in an incubator at 37ºc and 100% humidity which were then further subdivided into subgroup A,B and C of 15 teeth each according to the different time intervals i.e 2 days, 1 week and 2 weeks.Calcium ion concentration andnormal saline pH were measured by atomic absorption spectrometer system and pH meter, respectively.

Statistical analysis: The results were assessed using Student's t test.

Results

Group 1 Pulp Chamber I Intragroup comparison of calcium in Pulp Chamber at 2days , I week, and 2 weeks

The difference between the mean of calcium between 2 days and one week was 2.054 which was highly statistically significant (t(44)= 43.36, p = 0.000). Similarly, difference between the mean of calcium obtained at one week and two weeks was also highly statistically significant (t(44)= 17.99, p = 0.000). The mean difference of calcium level at 2 days and two weeks was 4.494 was also highly significant (t(44)= 35.71, p = 0.000). (fig I)

Intragroup comparison of pH in Pulp Chamber

The difference between the mean of pH between 2 days and one week was 0.04 which was not statistically significant (t(44)= 0.82, p = 0.417). Similarly, difference between the mean of pH obtained at one week and two weeks (mean = 0.05) was also not statistically significant (t(44)= 1.03, p = 0.307). The mean difference of calcium level at 2 days and two weeks was 0.096 was also non significant (t(44)= 1.84p = 0.07). (fig II)

Group 2 ROOT CANALIntragroup comparison of calcium in Root Canal

The difference between the mean of calcium between 2 days and one week was 2.429 and this difference was highly statistically significant (t(44)= 56.99, p = 0.000). The mean difference of calcium level at one week and two weeks (4.36) was also highly statistically significant (t(44)= 23.68, p = 0.000). The mean difference of calcium level at 2 days and two weeks (6.792) was also highly significant (t(44)= 41.17, p = 0.000). (fig III)

Intragroup comparison of pH in Root Canal

The mean difference between 2 days and one week was 0.06(t(44))= 1.20, p = 0.238).and the mean difference between 1 week and 2 week was 0.01,which was not statistically significant (t(44) = 0.214, p = 0.831). The mean difference of calcium level at 2 days and two weeks was 0.06,which was also not statistically significant (t(44)= 1.85 , p = 0.071). (fig IV)

Intergroup comparison for Calcium at different time intervals

At 2 days, the mean of calcium at pulp chamber was 2.85 ± 0.28, which was higher than root canal 2.64 ± 0.37 and this difference appeared to be highly statistically significant, (t= 2.97, p = 0.000). At 1st week, the calcium level in both categories did not show any statistically significant differences. However, at 2nd week, mean calcium at root canal was 9.4 ±1.24, which was higher than the mean calcium level in pulp chamber (7.34 ± 0.63) and this was found to be highly statistically significant (t = 10.06, p = 0.000). (table I, fig V)

Intergroup comparison for pH values at different time intervals

The root canal pH is somewhat higher than pulp chamber for all the time intervals. At 2 days, the mean pH at root

canal was 8.65 ±0.14 which was somewhat higher as compared to pH in pulp chamber (mean 8.59 ± 0.22). At 1 week, the mean pH at root canal was 8.71± 0.21as compared to a lower pH in pulp chamber (mean 8.64± 0.20). Finally, at two weeks, the pH in root canal was 8.72 ± 0.145, which was also higher as compared to the mean pH for pulp chamber (8.69 ±0.32). However, none of these differences appeared to be statistically significant.(table II, Fig VI)

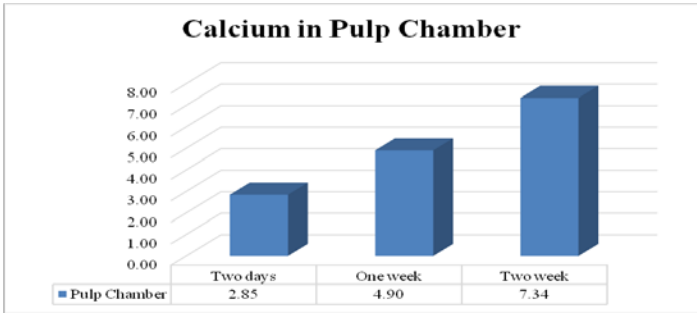

Fig- I: Intragroup representation of calcium level in pulp camber at different time interval

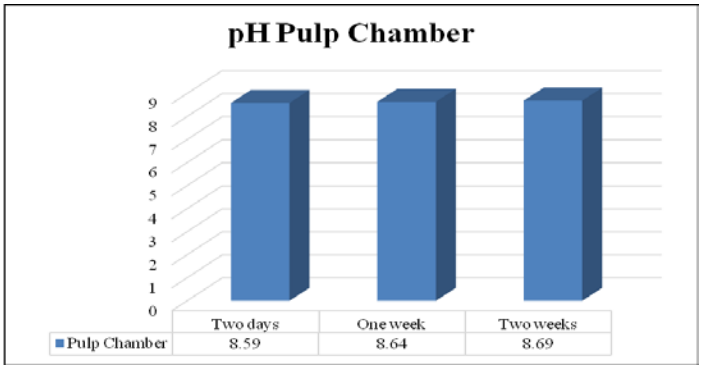

Fig II: Intragroup representation of pH in pulp chamber at different time interval

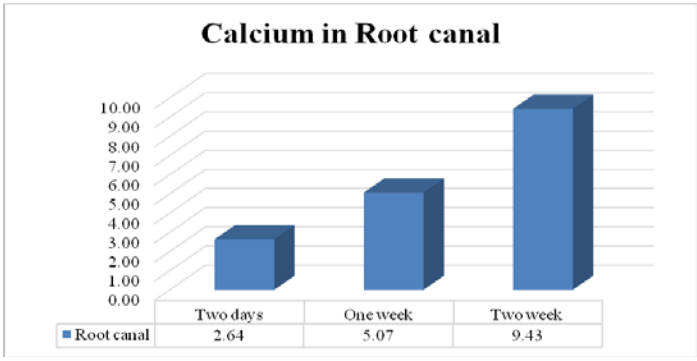

Fig III: Intragroup representation of calcium level in root canal at different time interval

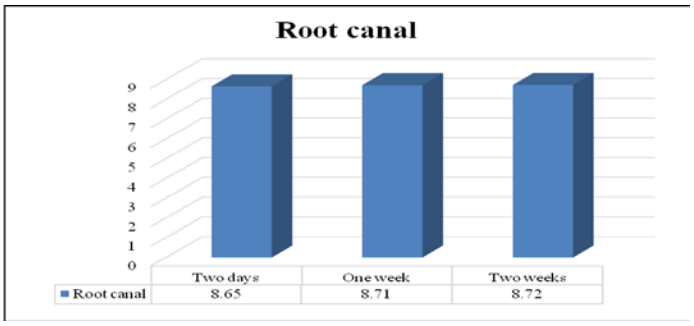

Fig IV: Intragroup representation of pH in root canal at different time interval

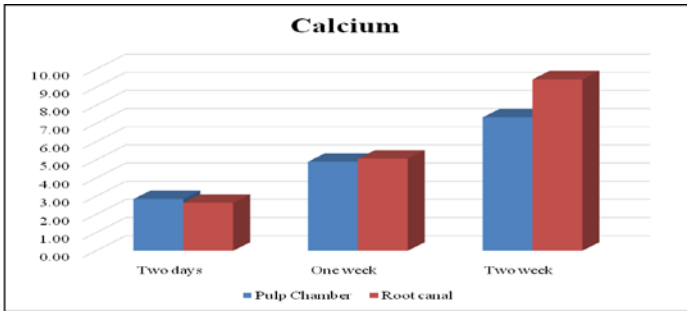

Fig V: Bar chart of calcium levels in pulp chamber and root canal at different interval

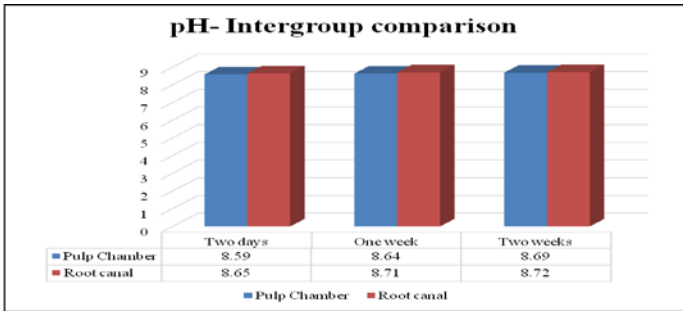

Fig VI: Bar chart of pH levels in pulp chamber and root canal at different interval

Table I

Parameter	Time Intervals	Pulp Chamber (N=45)		Root canal (N = 45)		Paired Comparison		
		Mean	SD	Mean	SD	Mean Difference	t	Sig. (2-tailed)
Calcium	Two days	2.85	0.28	2.64	0.37	0.206	2.98	0.00
	One week	4.90	0.51	5.07	0.28	0.168	1.95	0.06
	Two weeks	7.34	0.63	9.43	1.24	2.091	10.06	0.00

P < 0.001- Highly significant, p < 0.05- Significant, p > 0.05 Not significant (NS)

Table II

Parameter	Time Intervals	Pulp Chamber (N=45)		Root canal (N = 45)		Paired Comparison		
		Mean	SD	Mean	SD	Mean Difference	t	Sig. (2-tailed)
pH	Two days	8.59	0.22	8.65	0.14	0.059	1.54	0.13
	One week	8.64	0.20	8.71	0.21	0.072	1.64	0.11
	Two weeks	8.69	0.32	8.72	0.145	0.063	0.491	0.624

P < 0.001- Highly significant, p < 0.05- Significant, p > 0.05 Not significant (NS)

Discussion

Certain authors have recommended that the calcium hydroxide can be placed in coronal pulp chamber with an equal effect on periapical pH and calcium ion concentration.**Nerwich*et al.***in1993 demonstrated for the first time that that hydroxyl ions diffuse faster and reach higher levels when placed cervically than apically. In the cervical region, in proximity to the canal, the process occurs within hours[9]. **Gomes *et al.*** in 1996 investigated whether calcium ions from a paste of calcium hydroxide and saline introduced into root canals diffuse through the dentin to reach the surface of the root and found that calcium diffusion indeed was observed, in all situations in which there was calcium hydroxide paste inside the root canals[10]. **F. Pérez *et al.***in 2001did a study to determine whether dressings placed in the pulp chamber produced a pH more or less equal to that of root canal dressings and he found that aqueous calcium hydroxide paste placed in the pulp chamber provided the high pH values than the samples with calcium hydroxide placement in the root canals during the experiment[11].

When studying the effect on calcium ion concentration in periapical region when calcium hydroxide was placed in the pulp chamber it was found that calcium ion concentration increased with increase in time. As calcium ion concentration increased from 2 days to 1 week and it was found to be statistically significant. Calcium ion concentration further increased from 1 week to 2 weeks ad 2 days to 2 weeks and again it was found to be statistically significant.Similar results were shown by **Barekatain B *et al.*(2012)**who found significant rise in calcium ion concentration in periapical region from 2 days to 1 week and 1 week to 2 weeks and 2 days to 2 weeks[8].

When studying the effect of rise in pH when calcium hydroxide was placed in pulp chamber it was found that pH did not rise significantly from 2 days to 1 week as it rose from the level of 8.59 at the end of 2 days to 8.64 at the end of 1 week, and further it did not rose significantly at the end of 2 weeks with level of 8.69 on pH meter. There was no significant rise even when we compared 2 days from 2 weeks for pH rise. Similar results were obtained by **F. Pérez *et al*. (2001)**and**Barekatain B *et al.* (2012)**who did not found any significant rise in pH at the end of 2 days and 2 weeks[8,11]. This could be explained by the fact that initially, ashydroxyl ions diffuse into the circumpulpal dentine, the permeability of dentine is high since there is insufficient bulk of dentine to significantly buffer or adsorb the ions. Asthe hydroxyl ions continue to traverse through dentine, the tubule diameter diminishes and buffering and related properties become more dominant asthe dentine bulk increases. The hydroxyl ions must overcome these latter effects before diffusing further through dentine. Finally, after **2-3** weeks, the whole thickness of dentine is saturated with hydroxyl ions asindicated by the detection of a raised pH at the outer dentine surface. It is then the tubule anatomy of dentine that dictates the final diffusion of the hydroxyl ion[9].

On studying the effect on calcium ion concentration in periapical region when calcium hydroxide was placed in

the root canal it was found that calcium ion concentration increased from 2 days to 1 week , 1 week to 2 weeks and 2 days to 2 weeks, it was found to be statistically significant. Similar results were shown by **Barekatain B *etal.* (2012)**who found significant rise in calcium ion concentration in periapical region[8].

When studying the effect of rise in pH when calcium hydroxide was placed in root canal it was found that pH did not rise significantly from 2 days to 1 week as it rose from the level of 8.65 at 2 days to 8.71 at the end of 1 week and again it did not rise significantly at the end of 2 weeks as well with a level of 8.72. There was no significant rise even when we compared 2 days from 2 weeks. Similar results were obtained by **F. Pérez *et al.* (2001)**and **Barekatain B *et al.* (2012)**who did not found any significant rise in pH at the end of 2 days and 2 weeks[8,11].

When comparing the two groups for calcium ion concentration at the end of 2 days it was found that calcium ion concentration was significantly higher in pulp chamber group than the root canal group. This could be probably because calcium hydroxide paste in the pulp chamber can quickly release calcium ions by absorbing the moisture from root canal. However, when calcium hydroxide is placed in the root canal, it needs more time to obtain moisture from periapical surrounding tissue, to enhance ions releasing. **Barekatain B *et al.* (2012)** also for the similar reason found significantly rise in calcium ion concentration in pulp chamber group than in the root canal group[8].

When comparing two groups at the end of 1 week for calcium ion concentration it was found that calcium ion concentration increased periapically in root canal group with time than in pulp chamber group but it did not reached statistically significant value at the end of 1 week. **Barekatain B *et al.*(2012)**also found that it is root canal group that shows higher calcium ion concentration in periapical region[8]. This could be probably due to calcium ion from calcium hydroxide remaining at the upper root canal migrates toward the apex, with calcium ion increases periapically with increase in time[12].

At the end of 2 weeks calcium ion concentration continued to increase in root canal group when compared to pulp chamber group in our study, and it became statistically significant. This is similar to the study done by **Grover C *et al.*(2014)**who found statistically significant rise in calcium ion concentration at the end of 2 weeks when compared to other group[13].

When studying the two groups for ph values at the end of 2 days,1 week and 2 weeks , it was found that ph value was higher in the root canal group than pulp chamber group and it was statistically non-significant. Similar results were found in the study done by **Barekatain B *et al.*(2012),Fulzele P *et al.* (2011) and Zmener*et al.*(2007) respectively**[8,14,15]**.** This could be due to hydroxyl ion from calcium hydroxide that had accumulated around the apex of the dental canal[12].

Conclusion

From our study we can conclude that placing calcium hydroxide in pulp chamber is as effective as placing it in the root canal.No significant differences in concentration of$Ca(OH)_2$ions and pH of $Ca(OH)_2$ was found when placed in the pulp chamber or in the root canal.

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