Original article

Influence of calcium hydroxide as an intracanal medicament on apical leakage following obturation using three different sealers

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Abstract

Background and objectives**:* The aim of this invitro study was to study the effect of calcium hydroxide when used as an intracanal medicament on apical leakage following obturation using zincoxide eugenol (Tubliseal), calcium hydroxide (Apexit) and glass ionomer (Ketac-Endo) based sealers. ***Methods: Sixty seven recently extracted human permanent teeth with single roots were selected for the study. To facilitate instrumentation, the crown portion of each tooth was removed at the level of CEJ with a thin diamond disk using slow speed straight hand piece. The canals were prepared using a step back technique and divided into two equal groups of 33 each into group A and group B. One root was used as a positive control group. Group A was medicated with calcium hydroxide for 7 days and Group B was not medicated. Group A and Group B were randomly divided into three subgroups (A1, A2 and A3, B1, B2 and B3) containing 11 roots each, for obturation using three different sealers. A1and B1 was obturated using Tubliseal, A2 and B2 was obturated using Apexit and A3 and B3 was obturated using Ketac-endo. One root in each sub-group was selected and completely coated with nail varnish and used as a negative control. One unfilled root was used as positive control. All the roots were subjected to dye penetration using methylene blue for one week. The roots were longitudinally sectioned and observed under stereomicroscope. ***Results:*** The Tubliseal medicated group showed statistically less leakage compared to the non-medicated group. The Apexit and Ketac-endo group also showed less leakage but were not statistically significant. ***Interpretation and conclusion:*** All the medicated groups showed less leakage when compared with the non-medicated group. When calcium hydroxide used as a medicament, there was less leakage. This may be due to effect of residual calcium hydroxide, which was left on the canal walls.

Keywords: Medicated, non-medicated, Tubliseal, Apexit, Ketac-Endo.

Introduction

A long standing endodontic infection allows bacteria to propagate the entire root canal system including the ramifications, isthumuses, apical deltas and dentinal tubules. In these locations, bacteria may remain even after complete chemo-mechanical preparation of the root canal[1,2]. These remaining bacteria grow and multiply inside the root canal system if no intracanal dressing is used between the appointments. Thus intracanal medications may be a valuable adjunct to chemo-mechanical preparation in the disinfection of the root canal system, reducing the endodontic microbiota and therefore favoring periapical tissue repair[3].

Porkaew et al and Kontakiotis et al found that residual calcium hydroxide did not affect the apical sealing of root fillings. In contrast others have observed variations in apical sealing ability and attributed them too remaining calcium hydroxide. Such conflicting results suggest that calcium hydroxide may have an effect on the sealing ability when used as an intracanal medicament.

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Endodontic sealers based on zinc-oxide and eugenol has been used for several decades because they have satisfactory physico-chemical properties[4]. It would be beneficial if the sealer has some therapeutic effect on the periradicular tissues to create an environment conducive to healing and for this reason calcium hydroxide containing sealers have been introduced.[5]

One of the characteristics of an ideal sealer is the ability to bond to root canal walls. Glass ionomer sealers can accomplish this property and they are biocompatible[5].

In this invitro study the purpose was to determine the effect of residual calcium hydroxide when used as an intracanal medicament on apical leakage following obturation using three different sealers.

Methodology

Method of collection of data: Recently extracted human permanent teeth with single roots were selected for the study. The teeth were stored in 0.9% isotonic saline at room temperature at all times. Specimens were soaked in 5.25% sodium hypochlorite for 30 minutes and the remaining periodontal tissue and calculus were removed. The teeth were radio-graphed from both bucco-lingual and mesio-distal aspects and the teeth possessing calcified canals, extra canals, curved canals or external or internal resorptions were not used in this study.

Specimen preparation: A total of 67 teeth were selected for the study, to facilitate instrumentation, the crown portion of each tooth was removed at the level of CEJ with a thin diamond disk using slow speed straight hand piece. To eliminate root length as a variable, only teeth with roots 12 to 18mm long were used and these were placed in individually numbered vials filled with 0.9% isotonic saline. After determining the working length the canals were prepared using a step-back technique with K-Files to a size 50K file.

Irrigation with 5.25% sodium hypochlorite solution was performed using a 22-guage needle during the instrumentation process. Frequent recapitulation was done using a 15k file to maintain the patency of the apical foramen and the roots were kept in moist gauze during instrumentation.

A total of 67 roots were randomly divided into two equal groups of 33 each into Group-A and Group-B. One root was used a positive control. Group-A is to be medicated with calcium hydroxide and Group-B should not be medicated. After completion of instrumentation, the canals were dried with paper points .Roots in group-B had cotton pellets placed in the access openings and were sealed with 3mm of cavit and placed in individual numbered vials.

Calcium hydroxide medication: Calcium hydroxide powder was mixed with saline in the ratio of 0.9gmL-1 and all the roots in group-A was condensed and compacted using a plugger with calcium paste.

The access cavities of the root canals of Group-A were finally sealed with 3mm of cavit. Buccolingual and mesiodistal radiographs were taken to determine that the calcium hydroxide fillings were dense and without voids.

All 66 roots were wrapped in water saturated 2x2-inch gauze, sealed in its vial and placed in an incubator at 37 for one week.

Control groups: one root was instrumented and prepared in the same way as the other experimental groups and no obturation was done and this root was used as a positive control. Only cotton pellet was placed in the access cavity and sealed with 3mm of cavit and placed in the vial.

Group-A and Group-B were randomly

divided into three subgroups containing 11 roots each for obturation using three different sealers and named as A1, A2, A3, B1, B2, and B3.Sub-group A1 and B1 were obturated using zinc oxide based sealer (Tubliseal).Sub-group A2 and B2 were obturated using calcium hydroxide based sealer (Apexit) and sub-group A3 and B3 were obturated using glass-ionomer based sealer (Ketac-Endo).

All the 66 roots were obturated using lateral condensation technique as the method of obturation. The roots were dried with nail varnish except for an area approximately 2mm surrounding the apical foramen. No nail varnish was coated on the positive control to show that the dye was capable of penetrating the entire length of the canal. Six filled teeth one from each group was randomly selected and completely coated with nail varnish to prevent dye penetrating through the canal and used as a negative control.

All the 67 roots were placed in vials, which contained 2.5ml of 2% methylene blue solution. All the roots were suspended in a vial and the apical 3mm of each root was immersed in methylene blue dye and incubated at 37 for 7 days.

Linear leakage evaluation: The roots were rinsed in tap water after removal from the dye, two grooves were placed one on lingual and one on the buccal without penetrating into the gutta-percha filling using a thin diamond disk and split longitudinally using a chisel and the sectioned roots were placed in individually numbered vials, linear leakage was evaluated under a stereomicroscope at 20x magnification.

Results

Method of statistical analysis

Mann Whitney U test (Table II) was applied to find out the significant difference between two independent groups. The formula used is follows:

$$U = n_1 n_2 + \frac{n_1(n_1 - 1)}{n_2(n_2 - 1)} - \sum R_i \quad \text{Where}$$

R=Rank order assigned to each value

Kruskal Wallis test was applied to find out significant difference between the sealers within the study groups. The formula used is as follows:

$$H = \frac{12}{N(N-1)} \sum_{j=1}^{k} \left\lfloor \frac{\sum R_i^2}{n_j} \right\rfloor - 3(N-1)$$

In the above equation $\sum_{j=1}^{k} \left\lfloor \frac{\sum R_i^2}{n_j} \right\rfloor$ indicates that for each of the K groups, the sum of the ranks is squared and then divided by the number of subjects in the group.

In all above test P value less than 0.05 was taken to be statistically significant.

Tables and graphs

The mean values in the medicated groups are 11.62mm, 9.25mm and 5.91mm for Tubliseal (A1), Apexit (A2) and Ketac-endo (A3) respectively. In the non-medicated groups the mean values are 7.42mm for B1, 6.43mm for B2 and 3.98mm for B3 sub-groups. Tubliseal (A1) medicated sub-group showed less leakage values when compared to the non-medicated (B1) sub-group and was statistically significant. Both the Apexit (A2) and Ketac-Endo (A3) medicated groups showed less leakage when compared to the non-medicated groups (B2) and B3 but they were not statistically significant.

Discussion

The mechanism that calcium hydroxide uses to eliminate bacteria may include damage to the bacterial cytoplasmic membrane by inducing lipid peroxidation, protein denaturation and damage to bacterial DNA and by serving as a physical barrier that withholds nutrients for bacterial growth and limits space for bacterial multiplication[6,7]. Although the exact mechanism of action is still

unknown, its antimicrobial activity is generally considered to be related to the release of hydroxyl ions in an aqueous environment producing a pH of approximately 12.5 even in dilute mixtures[8-10]. Metzler and Montgomery found that intracanal calcium hydroxide left for seven days with subsequent instrumentation cleaned the canal and isthumuses. Sjogren et al also suggested that a 7-day dressing with calcium hydroxide eliminated the bacteria that survived bio-mechanical preparation, because of these reports the experimental period of our study was 7 days.

Chemically hydro soluble vehicles (distilled water and saline) induce a higher speed of ionic dissociation than viscous and oily vehicles.[11] Hence a vehicle of hydro soluble nature (saline) was selected for this study. Complete removal of the calcium hydroxide medicament is difficult irrespective of the technique used, enlarging the canal to the next size has been recommended by porkaew et al. A combined approach of irrigation and instrumentation demonstrated no difference in the apical seal between K-Files one size larger than the MAF and K-files of the same size as the master apical file. (12)In any case complete removal of all the calcium hydroxide from the canal cannot be achieved. An improvement in the sealing quality of the root canal fillings was found when calcium hydroxide was uses as a temporary dressing. (Porkaew et al 1990, Holland 1995, Holland et al 1996). This might be due to two hypotheses: a) Residual calcium hydroxide incorporated in the sealer during obturation, which may cause a decrease in the permeability of the sealer itself and b)calcium hydroxide is transported or mechanically forced into the dentinal tubules, blocking them off and decreasing dentin permeability.[13,14]

The findings in our study between the zinc oxide eugenol medicated and non-medicated groups are in concurrence with previous study by Porkaew et al. Obuturating root canals with a calcium hydroxide sealer after medicating with calcium hydroxide paste may be beneficial in providing a hermetic sealing of the root canal. It is possible that residual calcium hydroxide might be incorporated into the calcium hydroxide containing sealer.[15] Caliskan et al found that the size of the calcium hydroxide crystals was larger and the distribution was more extensive in the group medicated with calcium hydroxide plus water. The larger and more intensively distributed crystals in the group medicated with calcium hydroxide plus water might be the reason for less leakage.[15] Glass ionomer has an inherent potential for providing a more stable apical seal due to bonding properties which may provide physical support for resisting tooth fracture.[16] Holland et al observed less leakage when a calcium hydroxide or camporated para monochloro phenol dressing was used before filling with ketac endo and it was statistically significant. It is possible that these medicaments could produce an expansion of the material or become a layer between the material and the root canal walls reducing leakage.[17] Although the results indicated that the application of calcium hydroxide prior to filling effectively reduced apical leakage this study was conducted using large and straight canals over a one week period of time. The long-term effects in teeth with small or curved canals should be evaluated.

Table-I: Mean values of sealers among medicated and non-medicated groups (in mm)

		Zinc oxide eugenol sealer (ZOE) Tubliseal		**Calcium hydroxide sealer $Ca(OH)_2$ Apexit**		**GLASS-IONOMER SEALER (GIC) Ketac-endo**	
		Mean ± S.D	***Range***	***Mean ± S.D***	***Range***	***Mean ± S.D***	***Range***
Medicated	10	7.42 ± 2.44	3.53-12.09	6.43 ± 2.81	4.34 - 11.16	3.98 ± 2.58	1.55-9.77
Non medicated	10	11.62 ± 4.09	5.89-17.67	9.25 ± 4.92	3.72 - 17.52	5.91 ± 3.08	2.33-10.85

Table-II: Mann Whitney test results to compare the sealer values between medicated and non-medicated groups (in mm)

	ZOE		**$Ca(OH)_2$**		**GIC**	
	Mean range	**p'value**	**Mean range**	**p'value**	**Mean range**	**p'value**
Medicated	13.30	0.035	12.05	0.247	12.40	0.165
Non medicated	7.70		8.95		8.60	

Table-III: Comparison of sealer mean values among medicated groups (in mm)

Sealers	**Mean ±S.D**	**Chi Sq Value**	**Significance**
ZOE	7.42 ± 2.44		
$Ca(OH)_2$	6.43 ± 2.81	8.085	0.018*
GIC	3.98 ± 2.58		

Table-IV: Comparison of sealer mean values among non-medicated groups (in mm)

Sealers	**Mean ± S.D**	**Chi sq value**	**Significance**
ZOE	11.61 ± 4.09		
$Ca(OH)_2$	9.25 ± 4.92	8.583	0.014*
GIC	5.90 ± 3.08		

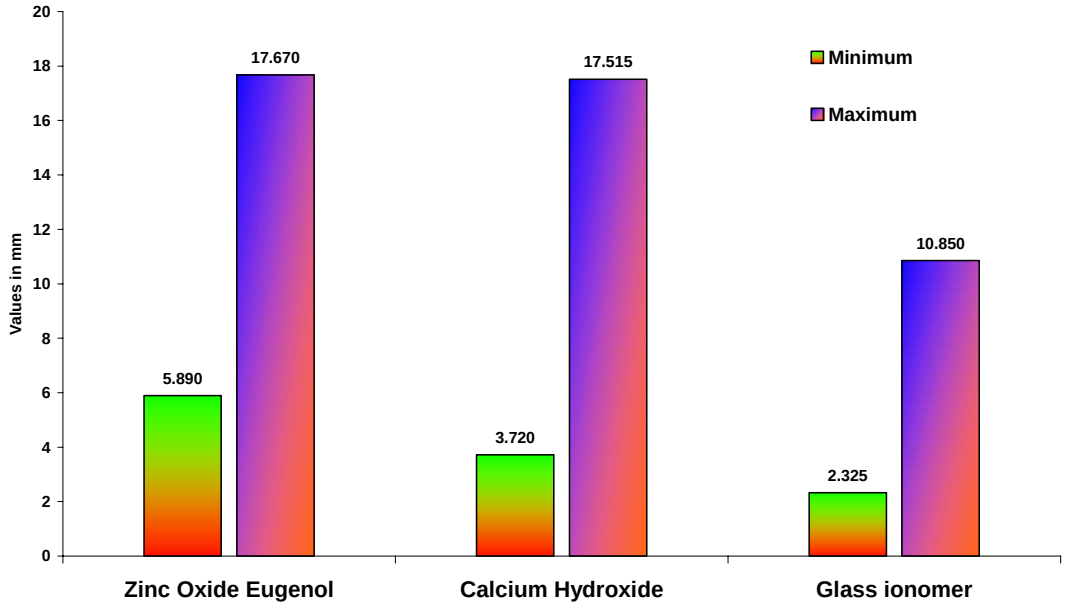

Figure 1: Minimum and Maximum leakage values among Non-medicated groups

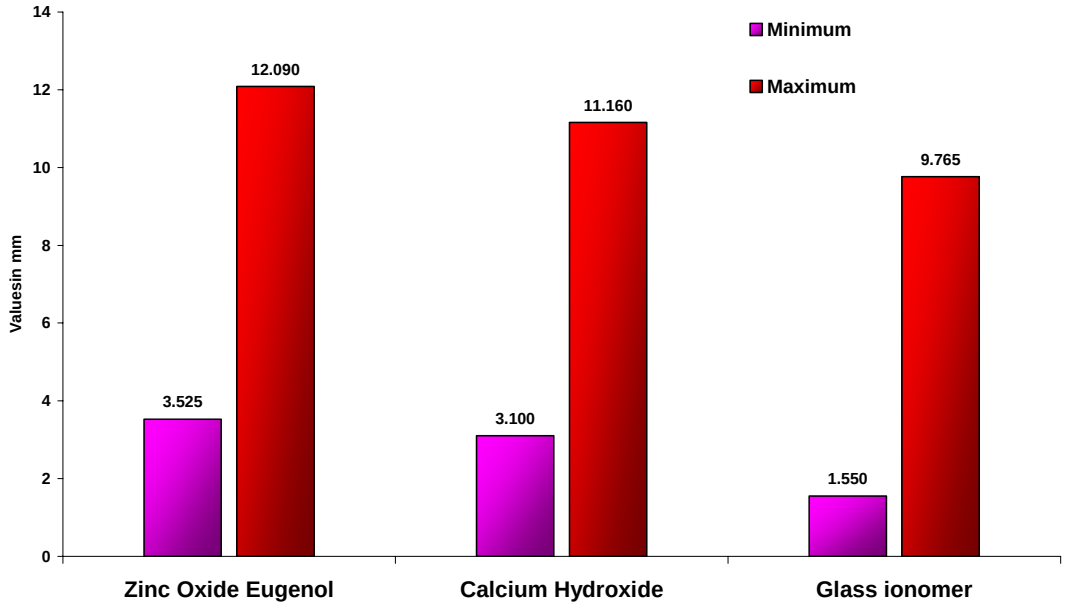

Figure 2: Minimum and Maximum leakage values among medicated groups

References

1. Carlos A.M.Barbosa Reginaldo B.Goncalves. Evaluation of the Antibacterial Activities of Calcium Hydroxide,Chlorohexidine and Camphorated paramonochlorophenol as intracanal medicament. A Clinical andLaboratory Study.J.Endod1997;23 (5):297-300. doi:10.1016/S0099-2399(97)80409-8.

2. Jose F.Siqueria.Milton de Uzeda. Influence of different vehicles on the antibacterial effects of calciumhydroxide.J.Endod1998;24(10):663-665. doi:10.1016/S0099-2399(98)80151-9.

3. Jose F.Siqueria.Milton de Uzeda.Intracanal Medicaments: Evaluation of the antibacterial effects of Chlorohexidine,Metronidazole and calcium hydroxide associated with three vehicles. J Endod1997; 23: 167-169. doi:10.1016/S0099-2399(97)80268-3.

4. W.A.De Almeida M.R.Leonardo. Evaluation of apical sealing of three Endodontic sealers.IEJ2000; 33:25-27.

5. Ferit Ozata,Banu Onal.A Comparative study of apical leakage of Apexit,Ketac-Endo and Diaket Root canal sealers.J.Endodon1999;25(9):603-604. doi:10.1016/S0099-2399(99)80317-3.

6. Micheal. J.Behen, Lesley A.West.Antimicrobial Activity of several Calcium hydroxide preparations in the root canal dentin.J.Endod2001; 27(12):765-767. doi:10.1097/00004770-200112000-00013. PMid:11771586.

7. Christopher P.Mc Hugh,Ping Zhang.PH required to kill enterococcus feacalis in vitro.J.Endod2004;30(4):218-219.

8. Panagiotis G.Beltes.Eleftheria Pissiotis. Invitro release of hydroxyl ions from six types of calcium hydroxide non-setting pastes.J.Endodon1997; 23(7):413-415. doi:10.1016/S0099-2399(97)80292-0.

9. U.Signor,D.Figdor. The antimicrobial effect of calcium hydroxide as a short term intracanal dressing.IEJ1991; 24: 119-125.

10. Amanda Law,Harold Messer. An evidence based analysis of the antibacterial effectiveness of intracanal medicaments.J.Endod2004; 30(10):689-694. doi:10.1097/01.DON.0000129959.20011.EE PMid:15448460

11. Carlos Estrela,L.L.Baumann. Control of microorganisms invitro by calcium hydroxide pastes.IEJ; 2001:34:341-345.

12. S.K.Kim&Y.O.Kim.Influence of calcium hydroxide intracanal medication on apical seal.IEJ2002; 35:623-628.

13. Patcharin Porkaew,Hugo Retief. Effects of calcium hydroxide as an intracanal medicament on apical seal.J.Endod1990; 16: 369-374. doi:10.1016/S0099-2399(06)81908-4.

14. Holland R.Alexandre AC. Apical leakage following root canal dressing with calcium hydroxide. EndoDent Traumatol1995; 11:261-263. doi:10.1111/j.1600-9657.1995.tb00500.x.

15. M.K.Caliskan M.Turkun. Effect of calcium hydroxide as an intracanal dressing on apical leakage.IEJ1998; 31: 173-177.

16. Charles Q. Lee, Lyda Harandi. Evaluation of glass ionomer as an endodontic sealant. An invitro study.J.Endod1997; 23(4):209-212. doi:10.1016/S0099-2399(97)80047-7.

17. R .Holland, M. S. Sakashita. Effect of dentine surface treatment on leakage of root fillings with a glass ionomer sealer.IEJ1995; 28: 190-193.