https://doi.org/10.3329/cbmj.v12i2.68342

An Evaluation of the Effectiveness of Calcium Hydroxide as A Root Canal Sealer Constituent

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Abstract

A descriptive, comparative study was conducted in the Department of Conservative Dentistry and Endodontics, Dhaka Dental College Hospital, Bangladesh, from December 2014 to November 2015, to evaluate the effectiveness of calcium hydroxide as a root canal sealer constituent. A total of 60 patients were selected by purposive sampling technique. Patients were divided into two equal groups of 30: group-I had zinc-oxide eugenol [ZOE] cement as a root canal sealer, while group-II had calcium hydroxideor sealapex [$Ca(OH)_2$] cement as a root canal sealer. Total number of teeth treated by single-visit root canal therapy. Out of 60 patients, 37(61.7%) patients were male. In ZOE group, the highest incidence was in age group 21-30 years, where as in $Ca(OH)_2$ group, it was in 11-20 years. The mean age of the patients was 27.62±6.20 years in ZOE group and 25.0±6.14 years in $Ca(OH)_2$ group. 21(70.0%) mentioned trauma as an etiological factor followed by caries 4(13.33%) in ZOE group, while 18(60.0%) patients mentioned trauma followed by caries 6(20.0%) in $Ca(OH)_2$ group. In ZOE group, the incidence of pain was 23(76.67%), and in $Ca(OH)_2$ group, 22(73.33%) reported pain. Periapical radiolucency follow-up findings were significantly better at 3-month and 6-month follow-ups in the $Ca(OH)_2$ group. The difference inthe final outcome of effectiveness in both ZOE and $Ca(OH)_2$ group in the management of periradicular pathosis was statistically not significant (P>0.05). The present study findings revealed that single-visit root canal therapy was equally effective in the management of endodontically involved teeth with periradicular pathosis. After 12 months, in follow-up with post-operative clinical and radiological evaluations, $Ca(OH)_2$ sealer group showed better results than ZOE sealer group. However, in shorter follow-ups, $Ca(OH)_2$ sealer group showed significantly better findings as compared to ZOE sealer groups.

CBMJ 2023 July: vol. 12 no. 02 P: 141-149

Keywords: Endodontics, root canal treatment, sealer, calcium hydroxide, zinc oxide

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Introduction

Dental pulp infection typically occurs as a result of bacteria entering the pulpal space as a result of dental caries, trauma, or surgical procedures. Pulpal infections frequently progress to pulp necrosis and apical periodontitis. These lesions are visible on radiographs as radiolucent areas around the main canal, lateral, and/or accessory canals. Effective removal of the root canal contents is required for successful treatment, followed by the formation of a fluid-tight seal at the apical foramen and total obliteration of the root canal system to allow for healing and repair.[1] Because of various advantages, single-visit endodontics is gaining popularity over traditional multi-visit endodontics for the treatment of such cases. Single-visit root canal treatment has been recommended for use in cases of the inflamed pulp of vital teeth, complicated fracture of anterior teeth where aesthetics are important, non-vital teeth with sinus tract, patients who require sedatives every time, and teeth with limited access.[2,3]

To prevent apical leakage, a solid core filling material such as gutta percha has been used to obturate the root canal in conjunction with a sealer.[4] A poor seal results in the presence of voids where tissue fluids can stagnate.[5] For several decades, the sealers most commonly used were those based on zinc oxide-eugenol. However, despite their satisfactory physical and chemical properties, these sealers do not exhibit favorable biological behavior.[2,6,7] As a result, sealers containing calcium hydroxide have been introduced in the ongoing search for better biological results after treatment. Since its introduction in 1930 by Hermann *et al*., calcium hydroxide has been widely used in dentistry.[8] In endodontic therapy, calcium hydroxide has antibacterial properties, mediates the degradation of bacterial lipopolysaccharides, induces healing through hard tissue formation, and regulates inflammatory root resorption.[8,9] Sealapex, a commercial calcium hydroxide-based endodontic sealer, is relatively soluble after application but retains its sealing ability.[9,10] Several studies on the outcome and complications of single-visit root canal therapy are available. Several studies have found a link between pulpal and periapical status and endodontic treatment outcomes. Despite the fact that apical periodontitis with the periapical lesion is very common in endodontics, research on the healing of periapical lesions in necrosed teeth is limited. Hence, the purpose of this study was to compare and contrast the clinical and radiographic efficacy of zinc oxide-eugenol sealer and calcium hydroxide-containing root canal sealer (Sealapex) in the repair process of peri radicular pathosis by single-visit root canal treatment.

Methods

This was a descriptive type of comparative study conducted in the Department of Conservative Dentistry and Endodontics of Dhaka Dental College Hospital, Bangladesh, from December 2014 to November 2015. A total of 60 patients participated in this study who attended the Department of Conservative Dentistry and Endodontics for endodontic treatment; they were selected through by purposive sampling technique. Patient having chronic periapical periodontitis with or without sinus tract, endodontically involved tooth with periapical radiolucency up to 5mm, acute exacerbation of periradicular pathosis and radio graphically shows evidence of periradicular pathosis in non-

vital discolored tooth were included in the study.

Inclusion Criteria:

- Patient having chronic periapical periodontitis with or without sinus tract.
- Endodontically involved tooth with periapical radiolucency upto 5mm.
- Acute exacerbation of periradicular pathosis.
- Radio graphically shows evidence of periradicular pathosis in the non-vital discolored tooth.

Exclusion Criteria:

- Periapical radiolucency greater than 5mm.
- Patient with calcified teeth.
- Incomplete root formation.
- Tooth mobility.
- Fractured teeth.
- Deep periodontal pocket.
- Diabetic patient.
- Patients with immune suppression of immune compromise.
- Debilitating patient.
- Handicapped patient

The patients of the present study were equally divided into two groups: 30 patients had Zinc-oxide eugenol cement as a root canal sealer introduced into the canal by lentulo spiral filler or reamer, and the other 30 patients had calcium hydroxide or Sealapex $Ca(OH)_2$ cement as a root canal sealer introduced into the canal by lentulo spiral filler or reamer. The clinical outcome of the patients was measured based on the following variables: pain, swelling, tenderness on percussion, and discharging sinus. Radiological evaluation was measured based on periapical radiolucency and Root resorption.

All data were analyzed through standard statistical methods by using SPSS 26 software as well as the Microsoft package Excel. Continuous parameters were expressed as mean±SD and categorical parameters as frequency and percentage. Comparisons between groups (continuous parameters) were done by unpaired t-test. Categorical parameters were compared by the Chi-Square test or Fisher exact test. A P value <0.05 was considered significant. This study was approved by the Ethical Review Committee of Dhaka Dental College and Hospital, Dhaka, Bangladesh.

Results

The study involved a total of 60 patients of endodontically involved teeth with peri-radicular pathosis. Among these, 30 teeth were treated by single-visit root canal therapy using zinc oxide-eugenol-containing root canal sealer [ZOE group], and 30 were treated by single-visit root canal therapy with calcium hydroxide-containing root canal sealer [$Ca(OH)_2$ group]. Figure 1 shows the distribution of patients by age. In ZOE group (group-I), the highest incidence of age was 21-30 years - 14(46.67%), the next highest age group was 11-22 years - 8(26.67%), and the lowest incidence of age group was 41-50 years - 3(10.0%). In $Ca(OH)_2$ group (group-II), the highest incidence of age group was 11-22 years - 12(40.0%), the next highest age group was 21-30 years - 11(36.67%) and the lowest incidence of age group was 51-60 years - 1(3.33%). The mean age of the patients was 27.62±6.20 years in ZOE group, and 25.0±6.14 years in $Ca(OH)_2$ group. The mean age difference between the two groups was not statistically significant. Figure 2 shows sex distribution of the patients. Males were more in both ZOE 20(66.67%) and $Ca(OH)_2$ 17(56.67%) groups than females 10(33.33%) and 13(43.33%) respectively. However, the difference

between the groups was not statistically significant.

Fig. 1: Distribution of patients by age groups (n=60)

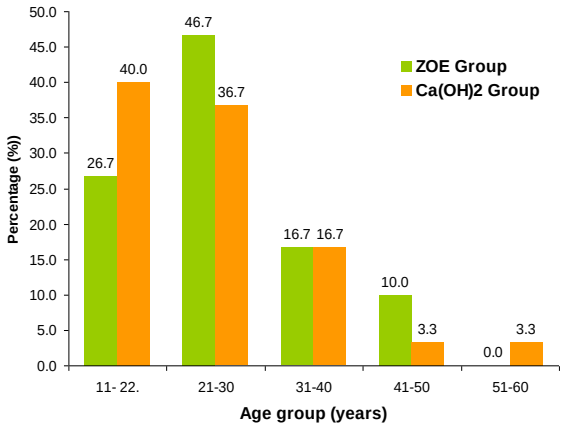

Fig. 2: Distribution of patients by sex (n=60)

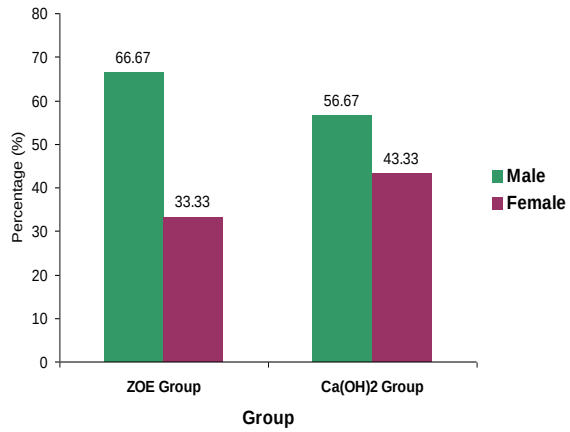

Table-I shows the etiological factors of patients, majority of the patient 21(70.0%) mentioned trauma as an etiological factor followed by caries 4(13.33%) in ZOE group and 18(60.0%) patients were mentioned trauma followed by caries 6(20.0%) in $Ca(OH)_2$ group. The association of etiological factors was not statistically significant. Table-II shows the type of treated teeth on both sides of the jaw. The highest number of infected teeth were maxillary central incisors in both ZOE group 12(40.0%) and $Ca(OH)_2$ group 14 (46.67) and the next most commonly infected teeth were lateral incisors in both the ZOE group 3(10.0%) and $Ca(OH)_2$ group 3(10.0%).

Table-I: Distribution of the patient according to the etiological factors (n=60)

Etiological factors	**ZOE Group (n=30)**	**$Ca(OH)_2$ (n=30)**	**P value**
Trauma	**n (%)**	**n (%)**	0.949^{ns}
	21 (70%)	18 (60%)	
Leaking restoration	3 (10%)	4 (13.33%)	
Caries	4(13.33%)	6(20%)	
Occlusal trauma	1(3.33%)	1(3.33%)	
Others	1(3.33%)	1(3.33%)	
Total	59.0001(100%)	61.0001(100%)	

*ns = Not significant

Table-II: Distribution of patients by the type of infected teeth (n=60)

Type of tooth	**ZOE Group (n=30)**		**$Ca(OH)_2$ Group (n=30)**	
	Maxillary	**Mandibular**	**Maxill-ary**	**Mandi-bular**
	n(%)	**n(%)**	**n(%)**	**n(%)**
Central incisor	12(40%)	6(20%)	14 (46.67%)	5 (16.67%)
Lateral incisor	3(10%)	1(3.33%)	3(10%)	00
Canine	1 (3.33%)	00	00(%)	2 (13.33%)
1^{st} premolar	1 (3.33%)	3(10%)	1 (3.33%)	1 (3.33%)
2^{nd} premolar	00	3(10%)	1 (3.33%)	1 (3.33%)
1^{st} molar	00	1(3.33%)	00	2 (6.67%)
2^{nd} molar	00	00	00	00(%)
Total	**17 (56.67%)**	**13 (43.33%)**	**19 (63.33%)**	**11 (36.67%)**

Table-III shows the distribution of the patients by preoperative signs and symptoms. In ZOE group, the incidence of pain was 22 (76.67%), swelling 4(13.33%), percussion tenderness was found in

25(83.33%) patients, and discharging sinus in 14(46.67%). In $Ca(OH)_2$ group, corresponding findings were found in 22(73.33%), 8(26.67%), 23(76.67%), and 16(53.33%) patients respectively. There was no statistically significant difference in signs and symptoms between ZOE and $Ca(OH)_2$ groups (P>0.05). Table-IV shows the postoperative clinical findings at 3 months and 12 months. In ZOE group, after 3 months follow-up, patients had no pain and swelling in both groups, percussion pain in 23(76.67%) and discharge sinus 3(10.0%) and 14 (46.67%) patients had percussion pain in ZOE group. Difference in percussion between the groups were statistically significant (P<0.05), while difference in discharge sinuses was not a statistically significant (P>0.05). After 12 months of follow-up, patients presented only percussion pain 4 (13.33%) in ZOE group. No statistically significant difference was observed in clinical complications after 12 months (P>0.05). Table-V shows the radiological evaluation of periapical pathosis periodically. After 3 months in ZOE group, 22 (73.33%) cases had no change in radiolucency, 8(26.67%) cases reduced radiolucency, and in $Ca(OH)_2$ group, 06(20.0) cases had no change in radiolucency, 24(80.0%) cases reduced radiolucency. No case in the group showed increased and disappeared radiolucency. The association of periapical radiolucency at 3 months between the two groups was statistically significant (P<0.001). After 6 months in ZOE group, 12(40.0%) cases no change in radiolucency, 18(60%) cases reduced radiolucency, but none of them had increased radiolucency. In $Ca(OH)_2$ group, 2(6.67%) cases had no change in radiolucency, 28(93.33%) cases of reduced radiolucency and none of them had increased radiolucency. The Association of periapical radiolucency at 6 months between the two groups were statistically significant (P<0.05). After 12 months, in ZOE group, 05(16.67%) cases had no change in radiolucency, 25(83.33%) cases of reduced radiolucency and none of them had increased radiolucency. In $Ca(OH)_2$ group, 1(3.33%) cases had no change in radiolucency, and 29(96.67%) cases reduced radiolucency. None of the cases had increased radiolucency. The Association of periapical radiolucency at 12 months between the groups was statistically not significant (P>0.05).

Table-III: Distribution of patients by pre-operative signs and symptoms (n=60)

Pre-operative Signs/symptoms	ZOE Group (n=30)	$Ca(OH)_2$ (n=30)	P value
	n(%)	n(%)	
Pain	23 (76.67%)	22(73.33%)	0.765^{ns}
Swelling	4(13.33%)	8(26.67%)	0.196^{ns}
Tenderness on percussion	25(83.33%)	23(76.67%)	0.518^{ns}
Discharging sinus	14(46.67%)	16(53.33%)	0.605^{ns}

*ns = Not significant

Table-IV: Distribution of patients by post-operative clinical findings at 3 months (n=60)

Clinical Findings	ZOE Group (n=30)		$Ca(OH)_2$ (n=30)		P value
	No	(%)	No	(%)	
At 3 month					
Pain	0	0	0	0	-
Percussion pain	23	76.67	14	46.67	0.016^{s}
Swelling	0	0	0	0	-
Discharge sinus	3	10.0	0	0	0.237^{ns}
At 12 month					
Pain	0	0	0	0	
Percussion pain	04	13.33	0	0	0.112^{ns}
Swelling	0	0	0	0	-
Discharging sinus	0	0	0	0	-

Table-V: Distribution of patients by radiological evaluation of periapical radiolucency (n=60)

Periapical radiolucency follow-up findings	ZOE Group (n=30)		$Ca(OH)_2$ (n=30)		P value
	No	(%)	No	(%)	
At 3 month					
Static	22	73.33	6	20.0	<0.001[s]
Reduced size	8	26.67	24	80.0	
Increased size	0	0	0	0	
Total	30	100.0	30	100.0	
At 6 month					
Static	12	40.0	2	6.67	0.002[s]
Reduced size	18	60.0	28	93.33	
Increased size	00	00	00	00	
Total	30	100	30	100	
At 12 month					
Static	05	16.67	01	3.33	0.194[ns]
Reduced size	25	83.33	29	96.67	
Increased size	00	00	00	00	
Total	**30**	**100**	**30**	**100**	

Table-VI shows the final outcome after long-term radiological evaluation of the study subjects. In ZOE group, 26 (86.67%) cases were successful and 4(13.33%) cases were doubtful. In $Ca(OH)_2$ group, 30(100%) cases were successful. Neither group had any failure. Though radiologically, the $Ca(OH)_2$ sealer group showed better results. The difference in the final outcome of effectiveness in both the ZOE and $Ca(OH)_2$ groups in the management of periradicular pathosis was statistically significant (P<0.05). Table-VII shows the final outcome after a long-term radiological evaluation of the study subjects. In ZOE group, 26(86.67%) cases were successful and 4(13.89) cases were doubtful. In $Ca(OH)_2$ group, 29(96.67%) cases were successful and 1(3.33%) cases were doubtful. Neither group had any failure. Although radiologically $Ca(OH)_2$ sealer group showed better results, the difference in the final outcome of effectiveness in both ZOE and $Ca(OH)_2$ group in management of periradicular pathosis was statistically not significant (P>0.05).

Table-VI: Distribution of patients by final clinical outcome (n=60)

Outcome	ZOE Group (n=30)		$Ca(OH)_2$ (n=30)		P value
	No	(%)	No	(%)	
Success	26	86.67	30	100	0.038[s]
Doubtful	04	13.33	00	00	
Failure	00	00	00	00	
Total	**30**	**100**	**30**	**100**	

Table-VII: Distribution of patients by final radiological outcome (n=60)

Outcome	ZOE Group (n=30)		$Ca(OH)_2$ (n=30)		P value
	No	(%)	No	(%)	
Success	26	86.67	29	96.67	0.353[ns]
Doubtful	04	13.89	01	3.33	
Failure	00	00	00	00	
Total	**30**	**100.0**	**30**	**100.0**	

Discussion

In this study, age and gender distribution of the participants were similar among both groups, with a majority of the participants being from the younger age groups. Male prevalence was observed in both ZOE and $Ca(OH)_2$ groups. Among the two groups, etiological factors did not have a significant difference. In group-I, i.e., ZOE group, trauma was the etiology for 70% of cases, and in group 2 it was 60%. Caries affected 13.33% of the ZOE group and 20% of the $Ca(OH)_2$ group. In this study, affected teeth were of both maxillary and mandibular groups, and the

maximum was maxillary central incisors. On presentation, the majority had pain and tenderness on percussion and some had swelling and discharging sinus. It was found that <5 mm diameter of preoperative periapical radiolucency was present. The study showed post-operative clinical findings at 12 months. After 12 months of follow-up, patients presented only percussion pain 4 (13.33%) in ZOE group, the ZOE group presents no statistically significant differences in clinical complication at 12 months in comparison to that of the $Ca(OH)_2$ group (P>0.05).

In a study by Bal *et al*, 100% of patients were asymptomatic in both zinc oxide eugenol and calcium hydroxide groups after 210 days. Zeliha *et al.* concluded that the results of their study were comparable to the healing of periapical radiolucency between teeth treated in a single visit and multiple visits with calcium hydroxide inclusion. If the cleaning and shaping procedures are carried out correctly, good results can be obtained in a single-visit treatment.[12] Peters & Wesselink studied the healing of periapical lesions in teeth with positive and negative canal cultures at the time of obturation, as well as the periapical healing of teeth treated with a calcium hydroxide interappointment dressing in one or two visits. In that study, thirty-nine patients were placed into two groups for root canal therapy. Group 1 only had one visit, whereas Group 2 had two. After 4.5 years of follow-up, the size of the periapical lesions in both groups decreased dramatically. Complete radiographic healing was observed in 81 percent of cases in the single-visit group and 71 percent of cases in the two-visit group.[13] Another study by Roane *et al.,* evaluated that in single appointment Endodontics, obturation of root canal is associated with fewer flare-ups and a decrease in pain. Furthermore, after obturation, the highest degree of pain occurs in the first 24 hours, and it diminishes substantially thereafter.[14] The change in the size of periapical radiolucency in the follow-up visits was taken as the criteria for success or failure of root canal treatment. The study showed post-operative radiological findings after 12 months, in ZOE group, 05(16.67%) cases with no change in radiolucency, 25(83.33%) cases reduced radiolucency and none of them had increased radiolucency. In $Ca(OH)_2$ group, 01 (3.33%) cases had no change in radiolucency, and 29(96.67%) cases reduced radiolucency. None of the cases had increased radiolucency. These findings were supported by the findings of another study by Grecca *et al*., where it was found that $Ca(OH)_2$ containing sealer (Sealapex) showed better results when compared with the zinc oxide-eugenol sealer (P<0.05).[5] However, contradictory findings were also observed in other studies, that observed a better efficacy in the usage of eugenol sealers compared to non-eugenol group sealers.[11]

According to Filho *et al.,* $Ca(OH)_2$ containing sealer (Sealapex) was significantly better in terms of histopathological repair when compared with ZOE sealer of the Grossman type.[3] Furthermore, partial sealing was more frequent in Sealapex (73.7%) than in the ZOE sealer group (92.9%). The irritating potential of the root canal filling materials had a significant influence on the results obtained. In cases of overfilling, Filho *et al.* found in a histopathological evaluation that ZOE in contact with periapical tissues promoted a severe inflammatory infiltrate, edema, congested capillaries, and scarce collagen fibers.[2] In contrast, when Sealapex was extruded into the periapical region, there was intense activity of macrophages and the formation of mineralized

areas close to the sealer. Hence, inflammatory infiltration in the periapical tissues was mild in the $Ca(OH)_2$ (Sealapex) Group (57.9%) when compared to the ZOE group (92.9%).

Although all these results were based on histopathologic findings, in the present study, the evaluation of the success rate of both ZOE and $Ca(OH)_2$ containing sealer (Sealapex) in the management of periradicular pathosis was assessed by postoperative clinical and radiological findings. After long-term (12 months) clinical evaluation showed in ZOE group, the favorable outcome was 86.67% and doubtful outcomes were 13.33%. In $Ca(OH)_2$ group, the clinical evaluation showed favorable outcomes were 100% without any doubtful outcomes. Radiological evaluation showed after 12 months, that favorable outcomes in the ZOE group were 86.67% and doubtful outcomes were 13.89% in $Ca(OH)_2$ group (96.67%) cases were successful and (3.33%) were doubtful. In both cases, there were a success, failures, and doubtful considered on the evaluation criteria.

The current investigation revealed that the questionable outcome could be attributed to a lack of sufficient biomechanical preparation of the root canal system or a failure to achieve a hermetic seal. This could also be attributed to the relatively short observation time. The 12 months follow-up may not have been enough for the large lesion to heal. Though in this study the performance of $Ca(OH)_2$ containing sealer (Sealapex) in the management of periapical pathosis was better than zinc oxide-eugenol sealer group but there was no statistically significant difference between the outcome of the two groups (P>0.05).

There were some limitations in this study. This study was conducted in a single hospital with a small sample size. Hence, the results may not represent the whole community. Endodontic treatment of necrotic teeth with (>5mm) periradicular lesion was not studied. The evaluation time was too short, long term follow-up could not be assessed. The outcome assessment was based on clinical and radiographic follow-up, histological analysis was not done.

Conclusion

The present study findings revealed that single-visit root canal therapy was equally effective in the management of endodontically involved teeth with periradicular pathosis. After 12 months of follow-up with post-operative clinical and radiological evaluations, calcium hydroxide sealer group showed better results than zinc oxide eugenol sealer group both clinically and radiologically. But in shorter follow-ups, calcium hydroxide sealer group showed significantly better findings compared to the zinc oxide eugenol sealer groups. Considerably large sample size should be taken up for a follow-up study. For a satisfactory result, long time follow-up is necessary. Histological analysis should be done for observation of the repair of the periapical structure.

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