ORIGINAL ARTICLE

Effect of Intracanal Medication with Calcium Hydroxide and 1% Chlorhexidine in Endodontic Retreatment Cases with Periapical Lesions: An *In Vivo* Study

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Background/Purpose: Calcium hydroxide ($Ca(OH)_2$) has been widely used as an intracanal medicament for endodontic retreatment, but very few studies used both $Ca(OH)_2$ and 1% chlorhexidine (CHX) as intracanal medicaments. The purpose of this study was to assess the *in vivo* effectiveness of a combination of $Ca(OH)_2$ and 1% CHX as intracanal medicaments in endodontic retreatment cases with periapical lesions.
Methods: Previous cases of endodontically treated teeth with periapical pathosis in 70 patients (36 men and 34 women, age range 18–60 years) were included. Of these teeth, 59 had received root canal treatment and 11 had been subjected to previous apical surgery, indicating endodontic failure. Following the routine procedures, including canal reshaping and irrigation with 2% CHX, a canal medication material containing $Ca(OH)_2$ powder and a 1% CHX solution was placed into the root canals. Over a 6-week period, the intracanal medication was periodically changed until the teeth became asymptomatic. Patients were recalled at 3-month intervals for radiographic and clinical examination.
Results: Our clinical and radiographic assessment of retreatment cases showed complete healing in 41 (64%) teeth, incomplete healing in 9 (14%) teeth, and failure in 14 (22%) teeth. For complete healing teeth, the healing time varied from 6 to 36 months. The size of the periapical lesions and previous surgical treatment had no influence on the prognosis.
Conclusion: Our results suggest that a combination of $Ca(OH)_2$ and 1% CHX can be successfully used as intracanal medicament for disinfection in endodontic retreatment cases with periapical lesions. [*J Formos Med Assoc* 2007;106(3):217–224]

Key Words: calcium hydroxide, chlorhexidine, medication, periapical diseases, root canal retreatment

Endodontic treatment is one of the most progressive aspects of modern dentistry. Success rates for conventional endodontic treatment are often reported at 80–85%.[1] However, the treatment is not routinely successful, and retreatment is necessary as a common clinical practice, reflecting an increased patient demand for teeth to be maintained in the dental arch. The main causes of failure are salivary microleakage, incomplete cleaning and obturation, previous unsuccessful endodontic therapy, the anatomy of the tooth, and occlusal trauma.[2–7] Teeth with failed endodontic treatment have considerable bacterial diversity, and the number of species isolated from a retreatment case probably depends on the quality of initial treatment and the filling material used.[8] Bacterial colonization

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and/or endotoxins in root canals generally play a vital role in the pathogenesis of periapical lesions.[9]

When unsuccessful endodontic therapy and surgical failures occur, endodontic retreatment is preferred over apical surgery or tooth extraction.[10–13] In deciding on retreatment, analysis of the clinical and radiographic signs and symptoms and patient cooperation should be carefully evaluated.[14]

Calcium hydroxide ($Ca(OH)_2$) has been widely used as an intracanal medicament for retreatment of such failed cases.[1,15] Retreatment requires the use of suitable intracanal medicaments that simultaneously eliminate bacteria, prevent their proliferation, act as a barrier against their ingress and cut off their nutrient supply.[16,17] Previous studies have shown good results when a tooth had formerly been retreated with nonsurgical treatments using a $Ca(OH)_2$ paste.[18–20] It has been shown in many previous studies that $Ca(OH)_2$ paste applied at intervals of at least 7 days is able to eliminate and/or reduce the total number of bacteria surviving even after biomechanical preparation.[15,21] Despite the fact that the antimicrobial activity of $Ca(OH)_2$ seems dependent upon direct contact with bacteria,[22] Ørstavik and Haapasalo[23] demonstrated that it is not effective in eliminating bacteria living in the deep part of the dentinal tubules. This poor activity of $Ca(OH)_2$ is, in part, related to its low solubility,[24,25] and research has focused on alternative substances. For two decades now, chlorhexidine (CHX) has been proposed both as an irrigant and an intracanal medicament in endodontics.[26–28] Chlorhexidine gluconate is recognized as an effective oral antimicrobial agent with a broad antibacterial spectrum, and is routinely used in periodontal therapy and for caries prevention.[29–31] CHX combined with $Ca(OH)_2$ has recently been advocated as a suitable medicament in insistent, endodontic periapical pathology, even though the clinical data available are limited.

The purpose of this study was to evaluate a mixture of $Ca(OH)_2$ and 1% CHX as a medicament in endodontic cases needing retreatment. Clinical results obtained from the period from March 2002 to May 2005 are presented.

Materials and Methods

The study was carried out at the Department of Endodontics, School of Dentistry, Dicle University. Although not a criterion for inclusion or exclusion, the reason for retreatment was determined from the material on the basis of combined radiographic signs and clinical symptoms. Patients reporting any kind of systemic disorder and/or medication, teeth without periapical radiolucencies, or mobile teeth with advanced periodontitis were excluded from the study.

Seventy patients (70 teeth) attending the university endodontic clinic between 2002 and 2005 were included. All teeth were retreatment, endodontic cases, and periapical pathosis was observed at radiographic examination. Of the 70 teeth, 59 had a failed root filling, and 11 had previously been subjected to apical surgery. The age range of the patients was 18–60 in both sexes.

Before implementing the clinical procedures, all subjects were informed of the aim of treatment and the clinical results expected, as well as the advantages and disadvantages of the treatment, and informed consent was obtained. The patients were interviewed and examined by two operators, and the clinical characteristics of the 70 teeth studied were categorized as follows: acute pain (28/70), previous pain (40/70), tenderness to percussion (32/70), swelling (8/70), tooth mobility (6/70), and fistula (7/70). Of the teeth, 23 had acute pain/tenderness to percussion and swelling; 17 had previous pain and tooth mobility; four had tooth mobility and fistula, and three had tooth mobility and swelling. There were no swellings of the alveolar ridge or any other abnormalities.

At radiographic examination, an experienced radiographer took all the radiographs, using the long-cone paralleling technique with a setting of 70 kV, 10 mA and a film focus distance of 28 cm with Ultra Speed film (Eastman Kodak, Rochester, NY, USA). To standardize the evaluation of the radiographs, all films were examined using an illuminated view box and a magnifying lens in the dark room. The status of the periapical tissues was evaluated according to the "periapical index" (PI), by two of the authors using the periapical radiographs. This index is a simplified version of the radiographic method of interpretation used by Ørstavik et al,[32] and consists of five categories, numbered 1–5.

All cases were treated by a single operator in order to reduce the effect of interpersonal disparity. After isolation with a rubber dam, coronal restorations were removed using a high-speed hand piece and a sterilized round bur. The removal of previous root canal fillings was performed using Gates Glidden drills, hand files, heated pluggers, and Ni-Ti rotary instruments without chemical solvents. After this procedure, the working lengths were determined using an apex locator and periapical radiographs, withdrawing 1 mm from the apexes. With irrigation by 2% CHX, step-back preparation was performed on each canal using hand files.

The canal was then dried with paper points, and a canal dressing containing $Ca(OH)_2$ and 1% CHX paste was applied. To prepare the dressing material, 0.48 mL of CHX at 1% was added to 4.8 g of $Ca(OH)_2$ paste (Calen; composition: 2.5 g $Ca(OH)_2$, 0.5 g zinc oxide p.a., 0.05 g colophony, 1.75 mL polyethylene glycol 400; SS White) in a laminar air flow, and the material homogenized and kept in sterile tubettes, using a Lentulo spiral filler. A sterilized cotton pellet was placed in the canal orifice and the tooth sealed with zinc oxide-eugenol cement (Cavex, Haarlem, The Netherlands).

At the next appointment, the tooth was reopened, the $Ca(OH)_2$ paste was removed and a patency file (size 08 Flexofile; Dentsply-Maillefer) was pushed through the foramen. The root canal was again irrigated with 2% chlorhexidine gluconate hypochlorite, and dried and redressed with the same paste. The intracanal medication was changed periodically over 6 weeks, by which time the teeth were asymptomatic and the canals could be dried. All teeth with clinical symptoms were treated two or three times until they became symptom-free.

Treatment was considered successful (complete healing) when the tooth was determined to be clinically free of symptoms and radiographs showed the complete disappearance of the preexisting radiolucency. Depending on the degree of radiographic appearance, all periapical pathosis was classified according to the following criteria modified from Strindberg[33] and Rud et al[34]: (1) complete healing; (2) incomplete healing; and (3) failure. Cases exhibiting a decrease in size of periapical radiolucency in the final observation period were placed in the incomplete healing category. If expansion or no change in the size of the preexisting lesion was observed, the treatment was recorded as a failure. At all follow-up examinations, clinical and radiographic examinations were performed in order to evaluate the success and/or failure of the treatment.

All teeth categorized as complete and/or incomplete healing were reopened, and any remnants of $Ca(OH)_2$ were removed using a patency file (size 08 Flexofile; Dentsply-Maillefer). The teeth were symptomless and the root canal was obturated with gutta-percha points and a $Ca(OH)_2$-based root canal sealer (Sealapex; Sybron/Kerr, Romulus, MI, USA) using the lateral condensation technique. Access cavities were sealed with a light-cure composite resin (Charisma, Kulzer, Germany) after proper etching, priming, and bonding.

Results

Of the selected study population ($n = 70$), 36 (53.8%) were male and 34 (46.2%) female (Table 1). Six patients did not attend recall visits, and were excluded from the study. Table 2 shows the distribution of the causes of failure and tooth types in the endodontic retreatment cases according to clinical and radiographic examinations.

All patients were followed-up clinically and radiographically at months 3, 6, and 12. Generally, at month 3, clinical symptoms subsided, and apical lesions exhibited significant opaque trabeculation radiographically. After month 12, apical radiolucency was absent, and bone trabeculation was clearly visible on radiographic examination.

Table 1. Patient sex, age, and tooth-type distribution

Tooth type	Gender		Age (yr)			
	Male	Female	18–28	29–39	40–50	51–60
Incisor	14	13	11	4	7	5
Canine	10	8	9	4	3	2
Premolar	6	8	3	6	3	2
Molar	6	5	8	2	1	0
Total	36	34	31	16	14	9

Table 2. Distribution of causes of root canal treatment failure according to tooth type

	Tooth type					After completion of retreatment		
	Incisor	Canine	Premolar	Molar	Total	Complete healing	Incomplete healing	Failure
Inadequate coronal restoration	7	5	5	2	19	13	4	2
Poorly condensed filling	8	8	3	4	23	15	2	3
Underfilling	10	5	3	4	22	13	0	6
Overfilling	2	0	1	0	3	0	2	1
Broken instrument	0	0	2	1	3	0	1	2
Total	27	18	14	11	70	41	9	14

The results are shown in Table 3. Forty-one teeth were categorized as having complete healing (64.1%), nine as incomplete healing (14.1%), and 14 as failures (21.9%).

As seen in Table 3, when we observed the 41 complete-healing teeth according to "previous treatment group", 35 teeth were included in the previously inadequate root-canal therapy group. Of these teeth, seven, 11, nine, five, and three healed within 0–6, 7–13, 14–20, 21–27, and 28–36 months, respectively. In the complete-healing-group, of the six teeth in the previous surgical failure category, three, two, and one healed within 7–13, 14–20, and 28–36 months, respectively (Table 3).

Discussion

The aim of this *in vivo* study was to evaluate the effect of a $Ca(OH)_2$-CHX mixture as an intracanal medicament in endodontically retreated teeth with periapical lesions. At the end of 12 months, many of the cases exhibited radiographic and clinical healing except for six cases that showed no radiographic changes.

The reasons for root canal treatment failure were inadequate control of infection, poor design of the access cavity, inadequate instrumentation and obturation, missed canals, and coronal leakage.[35] There are three treatment options in such cases: conventional nonsurgical root canal retreatment, periradicular surgery, or extraction.[36] Generally, retreatment is regarded as the therapy of choice,[11,12,19] and in a recent study, it was reported that endodontic retreatment success rates vary from 60% to 98%.[1]

Generally, bacteria in the root canal system are known to be the cause of endodontic periapical lesions, and they cause endodontic failure.[19,37] Some clinical studies have confirmed that simple nonsurgical treatment with proper infection control

Table 3. Size of lesions in failures and complete healing in previous treatment groups

Previous treatment groups	Initial size of lesions	Follow-up period of healing groups after completion of retreatment															Total (*n*)
		Complete healing					Incomplete healing					Failure					
		n (%)					*n* (%)					*n* (%)					
Root canal therapy		28 (70.0%)					5 (12.5%)					7 (17 5%)					40
	<2 mm	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	
		6	8	7	4	3	–	2	2	–	1	1	2	2	–	2	
		7 (46.7%)					2 (13.3%)					6 (40.0%)					15
	2–6 mm	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	
		1	3	2	1	–	–	–	1	1	–	2	–	3	–	1	
Apical surgery		4 (100%)					0					0					4
	<2 mm	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	
		–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	
		2 (40.0%)					2 (40.0%)					1 (20.0%)					5
	2–6 mm	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	
		1	–	1	–	–	1	–	1	–	–	–	–	1	–	–	
Total		32 (72.7%)					5 (11.4%)					7 (15.9%)					44
	<2 mm	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	
		6	10	9	4	3	–	2	2	–	1	1	2	2	–	2	
		9 (45.0%)					4 (20.0%)					7 (35.0%)					20
	2–6 mm	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	0–6 mo	7–13 mo	14–20 mo	21–27 mo	28–36 mo	
		2	3	3	1	–	1	–	2	1	–	2	–	4	–	1	
		41 (64.1%)					9 (14.1%)					14 (21.9%)					

can promote the healing of large lesions.[11,13] Therefore, intracanal medicaments are thought to be useful in preventing periapical lesions caused by intracanal microorganisms or microbial invaders.[22]

$Ca(OH)_2$ is a dressing material routinely used in endodontic therapy.[1,15] It has been recommended as an intracanal medicament because of its antibacterial, antiresorptive, and tissue-dissolving properties.[38,39] It has two main bioactive mechanisms: the killing of bacteria in inaccessible areas of the root canal system and the healing of periapical lesions.[15] When used as an intracanal medicament, it can be effective in eliminating bacteria from the root canal. Its high pH has a destructive effect on bacterial cell membranes and protein structures.[16] As the paste used in the present study is viscous, calcium and hydroxyl ions are released slowly, enabling them to persist in the periapical region for a considerable length of time, thus exerting a beneficial action.[14]

As stated above, $Ca(OH)_2$ effectiveness is highly pH-related.[40] Although direct clinical evidence is still elusive, it may be stated that bacteria and yeasts such as *Enterococci* and *Candida* species, with a high tolerance for basic pH levels, may not be effectively eliminated by conventional $Ca(OH)_2$ suspensions.[40,41] The combination of another bioactive material with $Ca(OH)_2$ therefore seems reasonable.

Our study evaluated the periapical healing process in terms of an intracanal medication with $Ca(OH)_2$-1% CHX paste in the recovery process of teeth with chronic periapical lesions and surgically failed cases. A scan of the literature revealed no *in vivo* studies concerning the effect of $Ca(OH)_2$-1% CHX used as an intracanal medicament for eliminating and/or reducing periapical pathosis. This is in agreement with de Rossi et al,[42] who used the same intracanal medicament in the endodontic treatment of dog teeth with chronic periapical lesions. In that study, a paste consisting of $Ca(OH)_2$-1% CHX resulted in a significant reduction in the size of periapical lesions at the end of 120 days.

As a general rule, our results suggest that "*the smaller the size of the pathosis the greater the chances of healing in retreatment cases.*" This is in line with a recent study by Çalişkan.[19] In that *in vivo* study, it was observed that previous surgical treatment and the size of the periapical lesion were factors that had a slightly negative influence on the outcome of nonsurgical retreatment. However, in our study, there was no statistically significant difference between healing frequency and the original size of the periapical lesion ($p = 0.955$). This is in contrast to various clinical studies that have reported that infection at the time of the root filling, the size of the periapical lesion, and the level of root filling at the radiographic apex can negatively affect prognosis in endodontic retreatment.[5,8,12] In agreement with these observations, Engström et al[43] and Sjögren et al[44] determined significant differences in healing frequency between lesions initially larger than 5 mm and those smaller than 5 mm. One possible explanation for our incompatible results, indicating nonsignificance between the size of periapical pathology and healing capacity, may be the high antibacterial activity of CHX, which was used as both an intracanal medicament and an irrigant in our study. This antibacterial agent has been found to be highly effective against both major bacteria—*Enterococcus faecalis* and *Candida albicans*—commonly found in necrotic pulp and responsible for periapical pathosis.[23] Moreover, because these two bacteria are resistant to $Ca(OH)_2$ only, in one clinical study, $Ca(OH)_2$ was mixed with CHX, which has been shown to be effective against *E. faecalis* and *C. albicans*.[45,46]

In our study, much of the complete healing at radiographic examination was seen in month 12. This period is relatively short when compared with other *in vivo* studies in the literature. For example, Engström et al [43] and Sjögren et al[44] stated that a follow-up period of at least 4–5 years was necessary for the complete healing of some of the largest lesions. However, according to other recent studies,[9,23,24] a 2-year follow-up period is sufficient to reach a conclusion concerning the treatment outcome of most lesions. Although it has not been achieved in any *in vivo* study, theoretically fast healing of periapical lesions can be attributed to the $Ca(OH)_2$-CHX mixture employed.

In an *in vitro* study by Sirén et al,[47] possible chemical reactions and antibacterial effectiveness in combinations of $Ca(OH)_2$ and CHX were investigated, using both fresh and 96-hour mixtures. Although 24-hour experiments showed somewhat slower disinfection by combinations of CHX and $Ca(OH)_2$, after 1 week the effect of the $Ca(OH)_2$-CHX mixture was the same as that observed with pure CHX. Additionally, the $Ca(OH)_2$-CHX mixture disinfected the tubules to a depth of 600 μm in 1 week and was able to kill all bacteria in one of the four test pieces. Finally, the authors maintained that $Ca(OH)_2$ does not impair the disinfecting effect of CHX, and that it provides an additional antibacterial activity, preserving its high alkalinity for longer periods of time.

In this clinical study, teeth with periapical lesions could be successfully retreated with $Ca(OH)_2$-CHX as a medicament, and the antibacterial effect of CHX in combination with $Ca(OH)_2$ may prove to be of benefit in the treatment of certain types of persistent infections in primary, and particularly in retreatment cases.

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