The Saudi Dental Journal (2015) **27**, 187–193

King Saud University

The Saudi Dental Journal

www.ksu.edu.sa
www.sciencedirect.com

ORIGINAL ARTICLE

Incidence of postoperative pain after use of calcium hydroxide mixed with normal saline or 0.2% chlorhexidine digluconate as intracanal medicament in the treatment of apical periodontitis

Ifeoma Nkiruka Menakaya [a], **Olabisi Hajarat Oderinu** [b,*], **Ilemobade Cyril Adegbulugbe** [b], **Olufemi Peter Shaba** [b]

[a] *Department of Restorative Dentistry, Lagos University Teaching Hospital, Lagos, Nigeria*
[b] *Department of Restorative Dentistry, Faculty of Dental Sciences, College of Medicine, University of Lagos/Lagos University Teaching Hospital, Nigeria*

Received 19 March 2014; revised 23 November 2014; accepted 26 January 2015
Available online 10 July 2015

KEYWORDS

Apical periodontitis;
Calcium hydroxide;
Chlorhexidine;
Normal saline;
Postoperative pain;
Root canal treatment

Abstract *Objective:* To compare the incidence of postoperative pain after the use of calcium hydroxide powder mixed with normal saline or 0.2% chlorhexidine digluconate as intracanal medicament.

Participants: Fifty-five subjects aged 17–60 years with teeth diagnosed to have apical periodontitis.

Intervention: Two-visit conventional root canal treatment of seventy teeth. The teeth were divided by randomization (balloting) into two groups: control group and experimental group, each with thirty-five teeth treated with calcium hydroxide mixed with normal saline or with 0.2% chlorhexidine digluconate as intracanal medicament respectively. Incidence of postoperative pain was assessed using the universal pain assessment tool and whether or not analgesic was taken.

Main outcome measured: Incidence of post-operative pain.

Result: Postoperative pain occurred only at 1-day and 1-week reviews. In the control group, the overall incidence of pain was the same at both review periods (5.7%), while the experimental group showed a slight decrease in incidence between 1-day (17.2%) and 1-week (11.4%) reviews. Incidence

* Corresponding author at: Department of Restorative Dentistry, College of Medicine, University of Lagos, P.M.B. 12003, Nigeria.
E-mail addresses: i_menakaya@yahoo.com (I.N. Menakaya), bisioderinu@yahoo.co.uk (O.H. Oderinu), cyadegbulugbe@gmail.com (I.C. Adegbulugbe), olufemishaba@yahoo.com (O.P. Shaba).
Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.sdentj.2015.01.007

of flare-ups was more in the experimental group (11.4%) than in the control group (5.7%). No significant statistical differences between the two groups were observed ($p > 0.05$).

Conclusion: The incidence of postoperative pain was lower in the normal saline treatment group, but the difference was not statistically significant.

1. Introduction

Post-operative pain of root treated teeth is defined as pain of any degree after initiation of endodontic treatment (Walton and Fouad, 1992). Therefore, pain after endodontic treatment can occur during intra-appointment or post-obturation in multiple visits or single visit endodontic treatment. Postoperative pain also includes endodontic flare-ups which are defined as strong pain with or without swelling that occurs after initiation or continuation of root canal treatment (Tsesis et al., 2008). Occurrence of post-operative pain can be very unpleasant for both patients and clinicians. Varied postoperative pain incidences have been reported ranging from 1.9% to 48% (El Mubarak et al., 2010) from studies based on various factors including single visit (Ali et al., 2012) versus multiple visit endodontic treatment (El Mubarak et al., 2010; Oginni and Udoye, 2004). Other factors studied in association with post-operative pain include type of intracanal medicament (Siqueira et al., 2002), root canal instrumentation protocol (enlargement /non enlargement of apical foramen) (Silva et al., 2013) and status of the pulp (Gotler et al., 2012).

The most common cause of postoperative pain is micro-organisms while other causes include mechanical or chemical injury to pulpal or periapical tissues (Siqueira et al., 2002). Micro-organisms have also been implicated in the pathogenesis of the periradicular lesions such that success of endodontic treatment depends on their reduction or elimination (Suchitra et al., 2006; Carrotte, 2004; Athanassiadis et al., 2007; Bystrom et al., 1985). Reduction or elimination of micro-organisms from the root canal system is achieved by chemo-mechanical preparation. The chemical preparation involves the use of irrigating solutions and intracanal medicaments. Calcium hydroxide is one of the most widely used intracanal medications in patients undergoing multiple visit endodontics (Siqueira et al., 2007; Manzur et al., 2007; Lee et al., 2009; Law and Messer, 2004; Baker et al., 2004; Tanriverdi et al., 1997; Silveira et al., 2007). Its antibacterial action is via release of hydroxyl ions, which kill or inactivate bacteria (Manzur et al., 2007; Evans et al., 2003). It has also been observed that the vehicle used in mixing calcium hydroxide determines its working characteristics (De Moor, 2003; Siqueira and Lopes, 1999; Balto, 2007). Calcium hydroxide is reported to be ineffective against all bacteria species especially *Enterococcus faecalis* found in the root canal. It was suggested that calcium hydroxide should be used in combination with other medicaments so as to enhance its efficacy (De Moor, 2003; Siqueira and Lopes, 1999; Balto, 2007). Different vehicles that have been used to mix calcium hydroxide powder include distilled water, dental anaesthetic solution, normal saline solution, ringers' solution several others (Fava and Saunders, 1999; Estrelaa et al., 2008) and more recently, chlorhexidine (Estrelaa et al., 2008; Nageshwar et al., 2004). The efficacy of calcium hydroxide is affected by its dissociation capability which is determined by the type of vehicle used to mix it (Silveira et al., 2007; De Moor, 2003; Lacevic et al., 2003). While it has been observed that the mixture of calcium hydroxide and chlorhexidine showed synergistic action and greater efficacy than calcium hydroxide alone (Evans et al., 2003; Nageshwar et al., 2004; Valera et al., 2009). The purpose of this clinical study was to compare the incidence of postoperative pain after the use of calcium hydroxide powder mixed with normal saline or 0.2% chlorhexidine digluconate as intracanal medicament in the treatment of apical periodontitis.

2. Materials and method

This study was part of a larger study which was a randomized controlled clinical trial carried out at the Restorative Dental Clinic of the Lagos University Teaching Hospital, Lagos, Nigeria. Approval was obtained from the Hospital's Research and Ethics committee. The study was carried out on patients that were 17 years and above with teeth diagnosed as having apical periodontitis and required endodontic treatment. The patients included in the study gave written informed consent. Treated teeth included those with apical periodontitis with none or minimal (2.0×2.0 mm) periapical radiolucency and are restorable, have closed apex and favourable root morphology. Exclusion criteria included teeth with dento-alveolar abscess or swelling, re-treatment cases, periodontally compromised teeth, teeth that require surgical endodontics and those that required more than two endodontic treatment visits. Also, excluded are medically immune compromised patients.

The teeth were divided into two groups by randomization (balloting). Group A was the control group and comprised teeth treated with calcium hydroxide mixed with normal saline intracanal medicament. Group B was the experimental group and comprised teeth treated with calcium hydroxide mixed with 0.2% chlorhexidine digluconate intracanal medicament. Where a subject had more than one tooth for treatment, each tooth was assigned by balloting. Incisor, canine and premolar and molar teeth were treated. The subjects in each group were reviewed at one day, one week, one month, three months and six months. The sample size was calculated (Varkevisser et al., 1992) to be approximately 25 teeth per group based on the results of previous studies representing the control (Zerella et al., 2005) and experimental (Wang et al., 2007) groups respectively. To ensure validity and correctness for possible attrition, teeth treated in each group were increased to 35 giving a total of seventy teeth treated.

2.1. Treatment protocol

A detailed history, clinical examination, investigations, diagnosis and treatment planning were done for each patient. Root

canal treatment was performed by the same endodontist. Carious cavities were restored as required with the use of either amalgam, composite or glass ionomer cement. All operative procedures were undertaken under local anaesthesia and rubber dam isolation. Standard infection protocol was observed. Irrigation of the canals was done using 2% sodium hypochlorite solution (Milton). The orifices of the root canals were located with the aid of loupes (Stardent, France). The working length was determined by the use of the paralleling radiographic method with the use of XCP kit (Dentsply) and was estimated at 0.5 mm short of the radiographic apex, using K-files with stoppers. The apical stop was prepared 2–3 file sizes larger than the first file that bound snugly at the apex. The last file used to work the apex was the master apical file. The step-back biomechanical preparation technique was performed on each canal using manually operated files. The last irrigating solution used in each tooth was normal saline. The canals were then dried with paper point before canal dressings were placed in the canals. Mixtures of calcium hydroxide/normal saline were placed into the canals of teeth in Group A using lentulo spiral fillers (Henry Schein) and calcium hydroxide/0.2% chlorhexidine digluconate (Corsodyl^{R}) mixture was placed in teeth of Group B.

A sterile cotton wool pellet was placed on the pulp chamber floor to cover the pulp canal orifices and the access cavity packed with zinc phosphate cement. The dressing was left in-situ for seven days (Barbosa et al., 1997; Sjogren et al., 1991). At the second visit, teeth were examined to note if the zinc phosphate dressing was intact, the tooth symptom free i.e. no pain, tenderness or associated swelling. The dressing was then removed and the following assessments made: the cotton pellet for wetness, the canal for foul smell or exudate discharge from the canal. All the teeth that were symptom free were then obturated.

The master cone was selected based on the size of the last file that was used to work the apex. A master cone radiograph was then taken to confirm this. Sealing of the canal was done with appropriate sizes of gutter-percha, AH26 as the sealant, and adequate number of accessory cones using the cold lateral compaction technique. The access cavities were filled appropriately using composite (20/20 Composite, Henry Schein) for the anterior teeth and amalgam (Ivoclar vivadent) for the posterior teeth.

2.2. Evaluation of teeth at recall visits

Assessment for incidence of post-operative pain was done at one day, one week, one month, three months and six months post-obturation. The patients were reminded of their appointment by telephone calls. At each follow up visit, clinical assessment of the treated teeth was carried out by two experienced endodontists who were blinded to the treatment received by the teeth. Assessment for incidence of post-operative pain was part of the evaluation done in a larger study using the Quality guidelines for endodontic treatment: Consensus Report of the European Society of Endodontology 2006 (European Society of Endodontic treatment, 2006). Pain assessment was done using the universal pain assessment tool and also whether or not analgesic was used (Wong et al., 2001).

2.3. Data analysis

Data were analysed using Epi info 2000 (window version) and presented using tables and bar and pie charts. Association between age, sex, pain score and other symptoms using chi squared test or Fisher exact test was determined (significance level set at $p < 0.05$). Comparison of pain score between the two groups was done using Mann–Whitney Rank-Sum.

3. Results

3.1. Sample demography

Seventy teeth in fifty-five patients were treated and reviewed. In forty-three patients a single tooth was treated and reviewed, while in eleven others two teeth were treated and reviewed. In one patient five teeth were treated and reviewed. The study population comprised of 27 males and 28 females with an age range of 17–60 years (mean 34.8, SD ± 9.91). The two treatment groups were similar with respect to age, gender and teeth treated ($p > 0.05$) Table 1.

3.2. Pre-operative signs and symptoms

There was no statistical significant difference in the distribution of signs and symptoms of pain at the onset of this study between the two treatment groups (Table 1).

Table 1 Tooth distribution by age and gender.

Variable	Group A ($n = 35$)		Group B ($n = 35$)		X^2	p
	Frequency	%	Frequency	%		
Age (years)						
⩾17–20	1	2.9	1	2.9		0.75ŧ
21–30	19	54.3	20	57.3	0.06	0.80
31–40	8	17.1	7	19.8	0.08	0.77
41–50	2	5.7	4	11.4		0.33ŧ
51–60	5	8.6	3	2.9		0.35ŧ
Total	**35**	**100**	**35**	**100**		
Gender						
Male	16	45.7	15	42.9	0.06	0.80
Female	19	54.3	20	57.1	0.06	0.80
Total	**35**	**100**	**35**	**100**		

ŧ Fisher exact p.

3.3. Incidence of post-operative pain

A post-operative review of the incidence of pain showed a marked decrease from the pre-operative pain in the two treatment groups. The incidence of pain in the two treatment groups occurred only at 1-day and 1-week post-operative review periods. In the normal saline treatment group, the overall incidence was the same at both 1-day and 1-week post-operative reviews (5.7%). The overall pain incidence at 1-day postoperative review for the chlorhexidine treatment group was 17.2% while there was a slight decrease in pain incidence (11.4%) by 1-week post-operative review. There were no significant statistical differences in incidence between the two treatment groups ($p > 0.05$) (Table 2).

On the intensity of pain, at both 1-day and 1-week post-operative reviews 2(5.7%) patients in the normal saline treatment group reported the pain as being the worst possible pain for which they took analgesics. On the other hand, 6(17.2%) patients in the chlorhexidine treatment group reported pain at 1-day post-operative review. Of the 6 patients, 2(5.7%) had mild pain, 2(5.7%) had severe pain and 2(5.7%) had the worst possible pain. Therefore, endodontic flare-ups (severe and worst possible pain) for the normal saline group were 5.7% while it was 11.4% for the chlorhexidine group at 1-day postoperative review, (Table 3).

At the 1-week post-operative review 4(11.4%) patients in the chlorhexidine treatment group took analgesics for the relief of pain, of these, 2(5.7%) of them reported the pain as severe and 2(5.7%) reported it as the worst possible pain. The incidence of worst possible pain was the same 2(5.7%) in both groups. A comparison of the pain score between the two groups at both 1-day and 1-week post-operative reviews showed that the difference was not statistically significant ($p > 0.05$) (Tables 3).

Incidence of post-operative pain at 1-day and 1-week post-operative reviews for matched tooth types and age group and gender in the normal saline treatment group showed no statistically significant difference ($p > 0.05$) Table 4. However, the association between age, gender, tooth type and incidence of pain at both 1-day and 1-week post-operative reviews showed that incidence of post-operative pain was more in females than in males. This difference was statistically significant in the chlorhexidine treatment group at 1-day post-operative review ($p = 0.02$) (Table 5). Also showing statistically significant difference in the chlorhexidine but not in the normal saline treatment group was the incidence of post-operative pain in the tooth types at both 1-day and 1-week post-operative reviews ($p = 0.02$ and $p = 0.003$ respectively). The highest incidence of post-operative pain was recorded in the molars followed by the premolars. No incidence of pain was recorded in the anteriors (Table 5).

Table 2 Comparison of incidence of pain and use of analgesics in the treatment groups.

	Group A ($n = 35$) Frequency (%)	Group B ($n = 35$) Frequency (%)	X^2	p
Pre-operative				
Clinical findings				
No signs/ symptoms	10 (28.6)	10 (28.6)	0.00	1.00
Symptoms of pain	25(71.4)	25 (71.4)	0.00	1.00
Review periods				
Incidence of pain				
1 day	2 (5.7)	6 (17.2)		0.12ŧ
1 week	2 (5.7)	4 (11.4)		0.33ŧ
Use of analgesics				
1 day	2 (5.7)	4 (11.4)		0.33ŧ
1 week	2 (5.7)	4 (11.4)		0.33ŧ

ŧ Fisher exact p.

Table 3 Comparison of pain intensity between the two treatment groups at 1-day and 1-week post-operative review using Mann–Whitney Rank-Sum.

Pain score	Group A ($n = 35$) Frequency	Group B ($n = 35$) Frequency	Mann–Whitney	
			z	p
1-Day				
None	33	29	1.39	0.16
Mild	0	2		
Moderate	0	0		
Severe	0	2		
Worst possible	2	2		
1-Week				
None	33	31	0.79	0.43
Mild	0	0		
Moderate	0	0		
Severe	0	2		
Worst possible	2	2		

4. Discussion

In this study, both incidence of pain and pain intensity were recorded. Pain intensity was rated with the standardized validated universal pain assessment tool (Wong et al., 2001), a verbal descriptor pain scale. This allowed for pain to be rated as none, mild (can be ignored), moderate (interferes with tasks or interferes with concentration), severe (interferes with basic needs), worst (bed rest required). Endodontic flare-ups were

Table 4 Association between age, gender, tooth type and incidence of pain in the normal saline treatment group at both 1-day and 1-week post-operative review.

Variable	Incidence			X^2 p
	Yes (%)	No (%)	Total (%)	
Age (years)				
⩾17–20	0 (0)	1 (100)	1 (100)	0.16ŧ
21–30	0 (0)	19 (100)	19 (100)	
31–40	2 (25)	6 (75)	8 (100)	
41–50	0 (0)	2 (100)	2 (100)	
51–60	0 (0)	5 (100)	5 (100)	
Gender				
Male	1 (6.25)	15 (93.75)	16 (100)	0.71ŧ
Female	1 (5.26)	18 (94.74)	19 (100)	
Tooth type				
Maxillary anteriors	0 (0)	12 (100)	12 (100)	0.32ŧ
Maxillary premolars	1 (10)	9 (90)	10 (100)	
Maxillary molars	1 (33.33)	2 (66.67)	3 (100)	
Mandibular anteriors	0 (0)	3 (100)	3 (100)	
Mandibular premolars	0 (0)	2 (100)	2 (100)	
Mandibular molars	0 (0)	5 (100)	5 (100)	

ŧ Fisher's exact p.

Table 5 Association between age, gender, tooth type and incidence of pain in the chlorhexidene treatment group.

Variable	Incidence			X^2 p
	Yes (%)	No (%)	Total (%)	
1-Day post-operative review				
Age (years)				
⩾17–20	0 (0)	1 (100)	1 (100)	0.29ŧ
21–30	2 (10)	18 (90)	20 (100)	
31–40	3 (42.85)	4 (57.15)	7 (100)	
41–50	1 (25)	3 (75)	4 (100)	
51–60	0 (0)	3 (100)	3 (100)	
Gender				
Male	0 (0)	15 (100)	15 (100)	0.02 * ŧ
Female	6 (30)	14 (70)	20 (100)	
Tooth type				
Maxillary anteriors	0 (0)	9 (100)	9 (100)	0.02 * ŧ
Maxillary premolars	1 (10)	9 (90)	10 (100)	
Maxillary molars	3 (75)	1 (25)	4 (100)	
Mandibular anteriors	0 (0)	2 (100)	2 (100)	
Mandibular premolars	0 (0)	4 (100)	4 (100)	
Mandibular molars	2 (33.33)	4 (66.67)	6 (100)	
1-Week post-operative review				
Age (years)				
⩾17–20	0 (0)	1 (100)	1 (100)	0.57ŧ
21–30	2 (10)	18 (90)	20 (100)	
31–40	2 (28.57)	5 (71.43)	7(100)	
41–50	0 (0)	4(100)	4(100)	
51–60	0 (0)	3(100)	3(100)	
Gender				
Male	0 (0)	15 (100)	15 (100)	0.09ŧ
Female	4 (20)	16 (80)	20 (100)	
Tooth type				
Maxillary anteriors	0 (0)	9 (100)	9 (100)	0.003 * ŧ
Maxillary premolars	0 (0)	10 (100)	10 (100)	
Maxillary molars	3 (75)	1 (25)	4 (100)	
Mandibular anteriors	0 (0)	2 (100)	2(100)	
Mandibular premolars	0 (0)	4 (100)	4 (100)	
Mandibular molars	1 (20)	4 (80)	5 (100)	

ŧ Fisher's exact p.

regarded as strong pain (severe and worst possible) (Tsesis et al., 2008).

Findings in this study revealed that the overall incidence of pain was 5.7% at both 1-day and 1-week post-operative reviews in the normal saline treatment group and although the incidence was higher in the chlorhexidine treatment group (17.2% and 11.4% at 1-day and 1-week post-operative reviews respectively), the difference was not statistically significant. Postoperative pain incidences recorded were more of flare-ups in terms of intensity of pain. The incidence of pain from this study may have been affected by the non-removal of the smear layer using 17% EDTA and Sodium Hypochlorite combination. The smear layer is of varying thickness and may have limited the optimum penetration of the disinfecting agents used in this study.

Al-Negrish and Habahbeh (2006) reported a 24.1% incidence at 2-day and a 5.3% incidence at 7-day post-operative review. Their finding at 7-day post-operative review is similar to that of this study even though the intracanal medicament used by the authors was a proprietary calcium hydroxide paste. Ghoddusi et al. (2006) using a modified version of the 10-degree form of Visual Analogue Scale to measure the severity of pain 6 hourly for up to 72 h reported a 15% incidence of post-operative pain. This differs from the figures for this study possibly due to differences in the timing of post-operative review and the vehicle for mixing calcium hydroxide (aqua in the case of that study). Using similar rating criteria for pain as with this study, Udoye and Aguwa (2010) reported a 10% incidence of post-operative pain. This figure is also significantly higher than the incidence rate for the normal saline treatment group but comparable to that of chlorhexidine treatment group in this study. However, the specific period at which post-operative pain was assessed, as well as the vehicle used for mixing calcium hydroxide was not stated in that study. In a study by Yoldas et al. (2004) using calcium hydroxide mixed with 0.2% chlorhexidine as intracanal medicament, the authors examined the incidence of post-operative pain after endodontic retreatment comparing single-versus two-visit treatment protocols. They categorized each group into two on the basis of pain rating as asymptomatic and symptomatic. The authors rated pain as none, mild, moderate and severe. In the two treatment groups in the Yoldas et al. (2004) study, the authors observed a 19% incidence of pain in the pre-treatment asymptomatic group and 51.5% incidence from the pre-treatment symptomatic group. The observed combined incidence of post-operative pain at one week period in that study was 28.6%. This was significantly higher than the incidence of post-operative pain in the chlorhexidine treatment group in this study. The reason for this difference might be because their study was re-treatment based. Incidence of endodontic flare-ups defined as strong pain was reported to be 8.4% in a meta-analysis by Tsesis et al. (2008) while a similar incidence of 8.1% for multiple visit endodontic treatment was also reported by Oginni and Udoye (2004). These incidences for endodontic flare-ups are different from the result of this study being 5.7% for the normal saline group and 11.4% for the chlorhexidine group at 1-day postoperative review. Generally, differences in frequency levels of flare-ups in studies could be due to various study populations, different treatment protocols and various numbers and experience of operators (Tsesis et al., 2008).

It was observed in the present study that female patients experienced more pain than male patients. This difference was statistically significant in the chlorhexidine treatment group but not in the normal saline group at 1-day post-operative review. This higher incidence in pain for females was also noted at 2-day post-operative review in a study by Al-Negrish and Habahbeh (2006) although they used a proprietary brand of calcium hydroxide paste. These authors considered two possible explanations for this observation: First, that difference in pelvic and reproductive organs may provide an additional portal of entry of infection in females leading to possible local and distant hyperalgesia. Second, that fluctuating female hormonal levels may be associated with changing levels of serotonin and nor-adrenaline leading to increased pain prevalence during the menstrual period and in women receiving hormonal replacement therapy or oral

contraceptives. Although these aspects of gynaecological history were not taken in this study among the female subjects, a study to evaluate the association between post-operative pain and menstrual history or oral contraceptive use might be indicated in our local environment.

The incidence of pain in the different teeth types was statistically significant in the chlorhexidine treatment group at both the 1-day and 1-week post-operative review. This was consistent with the findings in the study by Imura et al. (2007) and also in the two-visit treatment arm in the study by Ince et al. (2009). In the study by Ince et al. (2009), the incisors showed greater post-operative pain whereas the molars demonstrated a greater incidence of post-operative pain in this present study. However the results in this present study align with those of Imura et al. (2007) which also demonstrated greater incidence of post-operative pain in the molar teeth. The reasons for this could be because the molar has more than one root canal and it is the least accessible of all the tooth types. These make elimination of the root canal infection a greater challenge (Imura et al., 2007).

5. Conclusion

The incidence of pain in the early post-operative recall period (1st week) was lower in the normal saline treatment group, but the difference was not statistically significant. The occurrence of pain is uncommon after 1 week of treatment either with normal saline or 0.2% chlorhexidine digluconate as treatment vehicles.

The hypothesis that the incidence of postoperative pain after endodontic treatment will be reduced by the mixture of calcium hydroxide and 0.2% chlorhexidine digluconate as intracanal medicament can therefore not be accepted.

Conflict of interest

The authors declare no conflict of interest.

References

Ali, S.G., Mulay, S., Palekar, A., Sejpal, D., Joshi, A., Gufran, H., 2012. Prevalence of and factors affecting post-obturation pain following single visit root canal treatment in Indian population: a prospective, randomized clinical trial. Contemp. Clin. Dent. 3, 459–463.

Al-Negrish, A.R., Habahbeh, R., 2006. Flare up rate related to root canal treatment of asymptomatic pulpally necrotic central incisor teeth in patients attending a military hospital. J. Dentistry 34, 635–640.

Athanassiadis, B., Abbott, P.V., Walsh, L.J., 2007. The use of calcium hydroxide, antibiotics, biocides as antimicrobial medicament in endodontics. Aust. Dent. J. 52, 64–82.

Baker, N.E., Liewehr, F.R., Buxton, T.B., Joyce, A.P., 2004. Antibacterial efficacy of calcium hydroxide, iodine potassium iodide, betadine, and betadine scrub with and without surfactant against *Enterococcus faecalis* s in vitro. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod. 98, 359–364.

Balto, K.A., 2007. Calcium hydroxide has limited effectiveness in eliminating bacteria from human root canal. Evid. Based Dent. 8, 15–16.

Bystrom, A., Claesson, R., Sundqvist, G., 1985. The antibacterial effect of camphorated paramonochlorophenol, camphorated phenol and calcium hydroxide in the treatment of infected root canals. Endod. Dent. Traumatol. 1, 170–175.

Carrotte, P., 2004. The modern concept of root canal treatment. BDJ 197, 181–183.

De Moor, R., 2003. Calcium Hydroxide based paste used in endodontics. Rev. Belge. Med. Dent. 58, 34–48.

El Mubarak, A.H., Abu-bakr, N.H., Ibrahim, Y.E., 2010. Post-operative pain in multiple-visit and single-visit root canal treatment. J. Endod. 36, 36–39.

Estrelaa, C., Decurcioa, D.A., Gonçalves de Alencara, A.H., Sydney, G.B., Silva, J.A., 2008. Efficacy of calcium hydroxide dressing in endodontic infection treatment: a systematic review. Rev. Odonto. Ciênc. 23, 82–86.

European Society of Endodontic treatment, 2006. Quality guidelines for endodontic treatment: Consensus report of the European Society of Endodontology. Int. Endod. J. 39, 921–930.

Evans, M.D., Baumgartner, J.C., Khemaleelakul, S., Xia, T., 2003. Efficacy of calcium hydroxide: chlorhexidene paste as an intracanal medication in bovine dentin. J. Endod. 29, 338–339.

Fava, L.R.G., Saunders, W.P., 1999. Calcium hydroxide paste: classification and clinical implication. Int. Endod. J. 32, 257–282.

Ghoddusi, J., Javidi, M., Zarrabi, M.H., Bagheri, H., 2006. Flare-ups incidence and severity after using calcium hydroxide as intracanal dressing. NYSDJ 26, 24–28.

Gotler, M., Bar-Gil, B., Ashkenazi, M., 2012. Postoperative pain after root canal treatment: a prospective cohort study. Int. J. Dent., 5 http://dx.doi.org/10.1155/2012/310467. Article ID: 310467.

Imura, N., Pinheiro, E.T., Gomes, B.P.F.A., Zaia, A.A., Ferraz, C.C.R., Souza-Filho, F.J., 2007. The outcome of endodontic treatment: a retrospective study of 2000 cases performed by a specialist. J. Endod. 33, 1278–1282.

Ince, B., Ecran, E., Dalli, M., Dulgergil, C.T., Zorba, Y.A., Colak, H., 2009. Incidence of post-operative pain after single- and multi-visit endodontic treatment in teeth vital and non-vital pulp. Eur. J. Dent. 3, 273–279.

Lacevic, A., Vranic, A., Zulic, I., 2003. Clinical application of calcium hydroxide in dental pathology and endodontics. Bosn. J. Basic Med. Sci. 3, 26–29.

Law, A., Messer, H., 2004. An evidence based analysis of the antibacterial effectiveness of intracanal medicaments. J. Endod. 30, 689–694.

Lee, M., Winkler, J., Hartwell, G., Stewart, J., Caine, R., 2009. Current trends in endodontic practice: emergency treatments and technological armamentarium. J. Endod. 35, 35–39.

Manzur, A., González, A.M., Pozos, A., Silva-Herzog, D., Friedman, S., 2007. Bacterial quantification in teeth with apical periodontitis related to instrumentation and different intracanal medications: a randomized clinical trial. J. Endod. 33, 114–118.

Nageshwar, R., Kidiyoor, H.K., Hegde, C., 2004. Efficacy of calcium hydroxide-chlorhexidene paste against *Enterococcus faecalis* – An in vitro study. Endodontology 16, 61–64.

Oginni, A.O., Udoye, C.I., 2004. Endodontic flare-ups: comparison of incidence between single and multiple visit procedures in patients attending a Nigerian teaching hospital. Odontostomatol. Trop. Dec. 27 (108), 23–27.

Silva, E.J., Menaged, K., Ajuz, N., Monteiro, M.R., Coutinho-filho, T., 2013. Postoperative pain after foraminal enlargement in anterior teeth with necrosis and apical periodontitis: a prospective and randomized clinical trial. J. Endod. 39, 173–176.

Silveira, A.M.V., Lopes, H.P., Siqueira Jr, J.F.I.I., Macedo, S.B., Consolaro, A., 2007. Periradicular repair after two-visit endodontic treatment using two different intracanal medications compared to single-visit endodontic treatment. Braz. Dent. J. 18, 299–304.

Siqueira, J.F., Lopes, H.P., 1999. Mechanism of antimicrobial activity of calcium hydroxide: a critical review. Int. Endod. J. 32, 361–369.

Siqueira Jr., J.F., Rocas, I.N., Favieri, A., et al, 2002. Incidence of post-operative pain after intracanal procedures based on an antimicrobial strategy. J. Endod. 28, 457–460.

Siqueira Jr., J.F., Guimarães-Pinto, T., Rôças, I.N., 2007. Effects of chemo-mechanical preparation with 2.5% sodium hypochlorite and intracanal medication with calcium hydroxide on cultivable bacteria in infected root canals. J. Endod. 33, 800–805.

Suchitra, U., Kundabala, M., Shenoy, M.M., 2006. In search of endodontic pathogens. Kathmandu Univ. Med. J. 4, 525–529.

Tanriverdi, F., Esener, T., Ergani, O., Belli, S., 1997. An In vitro test model for investigation of disinfection of dentinal tubules infected with *Enterococcus faecalis*. Braz. Dent. J. 8, 67–72.

Tsesis, I., Faivishevsky, V., Fuss, Z., Zukermann, O., 2008. Flare-ups after endodontic treatment: a meta-analysis of literature. J. Endod. 34, 1177–1181.

Udoye, C., Aguwa, E., 2010. Flare-up incidence and related factors in adults. J. Dent. Oral Hyg. 2, 19–22.

Valera, M.C., Godinho da Silva, K.C., Maekawa, L.E., et al, 2009. Antimicrobial activity of sodium hypochlorite associated with intracanal medication for Candida albicans and *Enterococcus faecalis* inoculated in root canals. J. Appl. Oral Sci. 17, 555–559.

Varkevisser, C.M., Pathmanathan, I., Brownlee, A., 1992. Designing and Conducting Health System Research Projects, Vol. 2. International Development Center Ottawa and WHO Geneva, pp. 216.

Walton, R., Fouad, A., 1992. Endodontic interappointment flare-ups: a prospective study of incidence and related factors. J. Endod. 18 (4), 172–177.

Wang, C.S., Arnold, R.R., Trope, M., Teixeira, F.B., 2007. Clinical efficiency of 2% chlorhexidene gel in reducing intracanal bacteria. J. Endod. 33, 1283–1289.

Wong, D.L., Hockenberry-Easton, M., Wilson, D., Winkelstein, M.L., Schwartz, P., 2001. Wong's Essentials of Pediatric Nursing, sixth ed. Mosby, St Louis, 1301.

Yoldas, O., Topuz, A., Isci, A.S., Oztunc, H., 2004. Postoperative pain after endodontic retreatment: single-versus two visit treatment. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod. 98, 483–487.

Zerella, J.A., Fouad, A.F., Spangberg, L.S.W., 2005. Effectiveness of a calcium hydroxide and chlorhexidene digluconate mixture as disinfectant during retreatment of failed endodontic cases. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod. 100, 756–761.