Efficacy of calcium hydroxide dressing in endodontic infection treatment: a systematic review

Eficácia da pasta de hidróxido de cálcio no tratamento de infecção endodôntica: uma revisão sistemática

Abstract

Pupose: To perform a systematic review of the efficacy of calcium hydroxide (CH) dressing prepared with different vehicles on the treatment of teeth with endodontic infection.

Methods: Search strategies included electronic search in databases (MEDLINE, EMBASE, CENTRAL) from 1966 to January 2007 and manual search in endodontic journals and references of previously selected studies. The following terms were used: calcium hydroxide, chlorhexidine, root canal infection, faecalis, intracanal dressing, endodontic infection, intracanal medicament, paramonochlorophenol, para monochlorophenol, and p-monochlorophenol.

Results: From the 71 in vivo studies retrieved, five clinical studies met the inclusion criteria. Saline solution was the vehicle of CH dressing in all five included studies, and only one study compared saline *versus* chlorhexidine as vehicles of CH dressing. From a total of 130 teeth with endodontic infection, 39 teeth (30%) had remaining microorganisms after sanitation and CH dressing with saline.

Conclusion: Adequate sanitation and CH dressing with saline vehicle reduce microorganisms in teeth with endodontic infection.

Key words: Calcium hydroxide; intracanal dressing; endodontic infection; apical periodontitis; systematic review

Resumo

Objetivo: Realizar uma revisão sistemática sobre a eficácia de pastas de hidróxido de cálcio preparadas com diferentes veículos no tratamento de dentes com infecções endodônticas.

Metodologia: As estratégias de busca incluíram buscas eletrônicas em bases de dados (MEDLINE, EMBASE, CENTRAL) de 1966 a janeiro de 2007 e busca manual em periódicos especializados e referências de estudos selecionados. Os seguintes unitermos foram utilizados: calcium hydroxide (CH), chlorhexidine, root canal infection, faecalis, intracanal dressing, endodontic infection, intracanal medicament, paramonochlorophenol, para monochlorophenol e p-monochlorophenol.

Resultados: Dos 71 trabalhos in vivo obtidos, cinco estudos clínicos satisfizeram os critérios de inclusão. Solução salina foi o veículo na pasta de hidróxido de cálcio em todos os cinco estudos incluídos na revisão, e apenas um estudo comparou solução salina *versus* clorexidina como veículo da pasta de hidróxido de cálcio. De um total de 130 dentes com infecção endodôntica, 39 dentes (30%) apresentaram microrganismos após o procedimento de sanificação combinado com pasta de hidróxido de cálcio associada à solução fisiológica.

Conclusão: O adequado procedimento de sanificação do canala associado à pasta de hidróxido de cálcio com veículo de solução fisiológica reduzem a quantidade de microrganismos em dentes com infecção endodôntica.

Palavras-chave: Hidróxido de cálcio; medicação intracanal; infecção endodôntica; periodontite apical; revisão sistemática

Carlos Estrela[a]
Daniel de Almeida Decurcio[a]
Ana Helena Gonçalves de Alencar[a]
Gilson Blitzkow Sydney[b]
Julio Almeida Silva[a]

[a] Department of Endodontics, Federal University of Goiás, Goiânia, GO, Brazil
[b] Department of Endodontics, Federal University of Paraná, Curitiba, PR, Brazil

Correspondence:
Carlos Estrela
Centro de Ensino e Pesquisa Odontológica do Brasil (CEPOBRAS)
Av. C-198, Quadra 487, Lote 9, Jardim América
Goiânia, GO – Brazil
74270-040
E-mail: estrela3@terra.com.br

Recebido: 20 de novembro, 2007
Aceito: 07 de janeiro, 2008

Introduction

Intracanal dressing was regarded as a fundamental step of endodontic treatment for many years. At present, the real effect of intracanal dressing on teeth with apical periodontitis is controversial. The chemical-mechanical preparation of root canals has been considered the clinical procedure mainly responsible for microbial control due to intracanal sanitation, including canal emptying, enlargement, and irrigation.

Among the intracanal dressings commonly used, calcium hydroxide (CH) paste has been shown to be biocompatible and effective in teeth with apical periodontitis (1). CH paste can be prepared with different vehicles, such as distilled water, saline, camphorated paramonochlorophenol, chlorhexidine, polyethylenoglicol, propilenoglicol, Otosporin, or glicerine (2-5), but it still is unclear if there is a synergistic antimicrobial effect between vehicle and CH. The antimicrobial mechanism of CH has been associated with ion availability, diffusion, and velocity of dissociation, as the dissociated ions calcium and hydroxide participate in enzymatic reactions in bacteria and tissues (6,7). The hydroxide ion can affect the viability of anaerobic bacteria present in apical periodontitis, such as *E. faecalis*, which is very resistant to canal disinfection (8-10). For example, CH dressing seems to be more effective than camphorated paramonochlorophenol or camphorated phenol in the treatment of infected root canals with apical lesions (2). However, lack of standardization of procedures and limited sample size often compromise the direct comparison of previous clinical reports.

Good scientific evidences are mandatory to elaborate clinical decisions, yet few systematic reviews or meta-analysis have been developed in Endodontics (12,13). Therefore, this study aimed to systematically review published prospective clinical research to investigate the efficacy of CH dressing in the treatment of teeth with endodontic infection. The specific aim was to assess the influence of the vehicle used for CH dressing preparation on reduction of microbial contamination in teeth with apical periodontitis in humans.

Methods

Prospective clinical studies were searched using electronic and manual search strategies. The following databases were searched on January 2, 2007: MEDLINE (with no filter, from 1966 to January 2, 2007), EMBASE (with no filter, from 1980 to January 2, 2007), Cochrane Oral Health Group Trials Register and Cochrane Central Register of Controlled Trials (CENTRAL). The mesh terms used were: 1. Calcium hydroxide and chlorhexidine OR, 2. Calcium hydroxide and root canal infection OR, 3. Calcium hydroxide and faecalis OR, 4. Calcium hydroxide and intracanal dressing OR, 5. Calcium hydroxide and endodontic infection OR, 6. Calcium hydroxide and intracanal medicament OR, 7. Calcium hydroxide and paramonochlorophenol OR, 8. Calcium hydroxide and para monochlorophenol OR, 9. Calcium hydroxide and p-monochlorophenol. The manual search was conducted by checking Endodontics journals and the references of previously selected studies for other potentially relevant clinical trials.

Studies were selected by analysis of their titles and abstracts according to predefined eligibility criteria (Table 1) by two independent reviewers. Full-text copies were obtained of all selected studies and those where the title and abstract were not sufficient to decide for or against the study inclusion. Table 2 displays the clinical studies in humans retrieved by the search strategies and excluded from the final analysis according to the inclusion/exclusion criteria.

Two reviewers independently assessed the methodological quality of the selected studies. For each study, the following data were collected for qualitative analysis: sample size, type of infection (primary or secondary), type of tooth and root canal, microbiological technique, microbial assessment in baseline samples, vehicle of CH dressing, substances used for canal sanitation, duration of the intracanal dressing previously to canal filling, and microbial assessment in final samples.

Table 1. Criteria for inclusion and exclusion of studies

a. Inclusion criteria
1. Related to the efficacy of CH dressing on the treatment of endodontic infection
2. Nonsurgical root canal treatment
3. Subjects with medical history that would not compromise the outcomes
4. Microbiological samples collected before and after sanitation
5. Treatment outcome stated as positive or negative microbial culture
b. Exclusion criteria
1. In vitro studies
2. Animal models
3. Literature reviews
4. Case reports
5. Absence of abstract
6. Non-English language
7. Studies on the efficacy of intracanal dressings other than CH
8. Studies in deciduous teeth
9. Studies where the vehicle associated with CH was not specified
10. No collection of microbiological samples before or after sanitation

Table 2. Studies in humans excluded from the present systematic review

Excluded studies	Reason for exclusion	Excluded studies	Reason for exclusion
1. Ghoddusi et al., 2006	10	19. Siqueira Jr et al., 2002	10
2. Al-Omari et al., 2006	7	20. Peciuliene et al., 2001	9
3. Oncaag et al., 2006	8	21. Shuping et al., 2000	9
4. Silva et al., 2006	10	22. Walia et al., 2000	10
5. Gesi et al., 2006	10	23. Waterhouse et al., 2000	8
6. Waltimo et al., 2005	9	24. Weiger et al., 2000	10
7. Caliskan, 2005	9	25. Reit et al., 1999	7
8. Rocha & Cardoso, 2004	8	26. Molander et al., 1999	9
9. Nakajo et al., 2004	10	27. Trope et al., 1999	10
10. Yoldas et al., 2004	10	28. Fava, 1998	10
11. Pacios et al., 2004	10	29. Barbosa et al., 1997	10
12. Caliskan, 2004	10	30. Caliskan & Sen., 1996	10
13. Molander & Dahlen, 2003	10	31. Fava, 1992	10
14. Ehrmann et al., 2003	10	32. Sjögren et al., 1991	9
15. Zamany et al., 2003	10	33. Molander et al., 1990	7
16. Chávez de Paz et al., 2003	10	34. Lundin et al., 1990	7
17. Rodd et al., 2002	7	35. Eronat & Eronat, 1989	6
18. Cheung, 2002	10	36. Klinger et al., 1975	6

Results

The search strategies yielded 303 published papers: 22 literature reviews, 71 in vivo studies (clinical studies in humans or animal models), 34 cases reports, and 178 in vitro studies (25 studies with agar diffusion test, 31 with direct contact test, 11 with cell culture, 75 with contaminated dentine specimens, 20 with microbial colonization – cfu, and 16 with others methodologies) (Figure 1). Regarding clinical studies in humans, most retrieved studies did not meet the inclusion criteria for data analysis and were excluded (Table 2). Five *in vivo* studies in humans were considered for analysis of the outcome variables (Table 3).

Qualitative analysis of the five included studies was performed for a total of 130 teeth with primary or secondary infection and baseline microbial assessment. After intracanal sanitation (root canal preparation, use of irrigant solutions – saline, sodium hypochlorite 0.5 to 5.25%) and CH dressing for 7 to 28 days, 39 teeth (30%) showed remaining microorganisms. Saline solution was the vehicle of CH dressing in all five included studies, and one study compared saline *versus* saline plus chlorhexidine as vehicles of CH dressing.

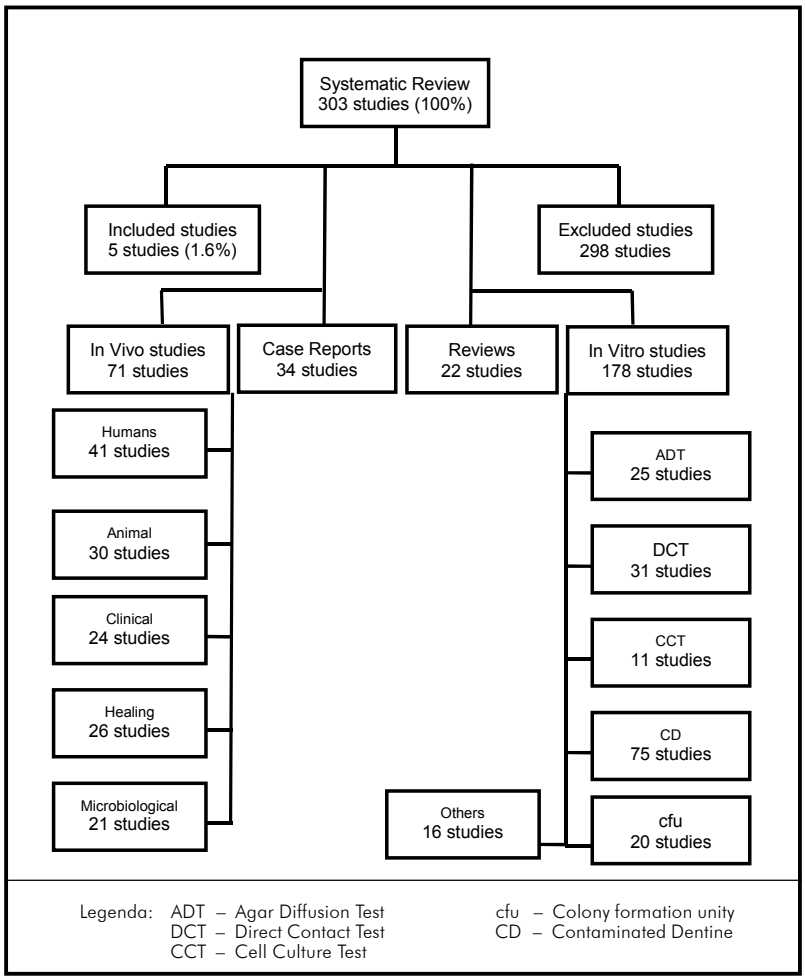

Fig.1. Distribution of the studies retrieved for the present systematic review.

Table 3. Studies included in the present systematic review on the efficacy of CH dressing in the treatment of teeth with endodontic infection

Reference	n	TI	Tooth	Technique	Vehicle	IS	Intervention	Med	Outcome
Chu et al. (21)	35	1	18 uni 14 bi 3 tri	Culture	Saline	35	0.5% SH + CH	7 d	11
Ørstavik et al. (22)	23	1	23 uni	Culture	Saline	22	Saline + CH	7 d	8
Peters et al. (23)	21	1	DNI	Culture	Saline	21	2% SH + CH	28 d	2
Souza et al. (24)	12	1	12 uni	Checkerboard DNA	Saline	12	5.25% SH + CH	14 d	6
Zerella et al. (25)	Group 1: 20 Group 2: 20	2	40 uni	Culture PCR	G1: Saline G2: 2% CHX	G1: 20 G2: 20	1% SH + CH	14 to 21 d	G1: 8 G2: 4

n – sample size; TI – Type of infection (1 – primary, 2 – secondary); Tooth – uniradicular / biradicular / triradicular; DNI – data not identified; Technique – Identification procedure; Vehicle (CHX – chlorhexidine); IS – Initial microbiological sample; Intervention (SH – sodium hypochlorite, CH – calcium hydroxide dressing); Med – duration of intracanal dressing; Outcome – number of teeth with remaining microorganisms.

Discussion

Previous studies questioned the mandatory indication of intracanal dressing in the clinical treatment of infected root canals (2,14-18). Also, most experiments in the literature were developed in vitro or in animal models, and care should be taken to extrapolate those results to the clinics. Systematic reviews use a strict methodological approach to search, select, evaluate, and analyze original data from primary sources. Established criteria for inclusion and exclusion of papers, hierarchy of the selected studies (level A: randomized controlled trials/meta-analysis, level B: non-randomized clinical study, and level C: consensus/personal opinion) (19), and combined data analysis allow a more scientific evaluation of the literature to provide evidence-based clinical directions. However, an assessment of the quality of published systematic reviews related to dental interventions revealed that only 19% studies properly identified relevant papers (20).

In the present study, from the 71 in vivo studies retrieved using the search strategies, only five (21-25) met the inclusion criteria and were analyzed. Comparison of results was compromised to some extent due to the lack of experimental standardization in relation to the limits of canal instrumentation, technique of root canal preparation, type and size of teeth, materials and endodontic technique, criteria to identify periapical lesion, etc. The limited sample size and heterogeneity of studies in relation to clinical protocols precluded this review from a meta-analysis. However, the results of the present review corroborate previous studies on the antibacterial effect of intracanal dressing (12,13).

Initially the objective of this study was to review clinical studies on CH dressings prepared with different vehicles as in vitro results showed that the vehicle may influence the chemical characteristics and antimicrobial potential of CH dressing (3,4). However, only one out of five papers selected in the present systematic review addressed this issue, and 20% of the teeth treated with CH dressing with chlorhexidine still were contaminated after 14 to 21 days (25).

Different substances have been proposed as adjuvant components of CH dressing or sole intracanal medication, but their antimicrobial efficacy and safety is controversial. For example, phenol compounds should not be used as intracanal medication due to high-toxicity and limited clinical effectiveness (26). Haenni et al. (27) evaluated the antimicrobial and chemical effects of CH dressing with saline plus chlorhexidine, sodium hypochlorite, or iodine potassium, and reported no improvement of antimicrobial effect with addition of any substance. Likewise, the use of chlorhexidine as irrigant solution before CH dressing was as effective as 2.5% sodium hypochlorite irrigation plus CH dressing in the treatment of apical periodontitis in dogs (15). When chlorhexidine is associated with CH, the pH is approximately 10 and the surface tension increases to 55dinas/cm, which does not improve the properties of CH with saline (28). Also, chlorhexidine does not promote degradation of the microbial lypopolysaccharides as CH with saline does (11). On the other hand, chlorhexidine was reported to increase the antimicrobial potential of CH, compared to other vehicles such as saline, camphorated paramonochlorophenol, and propylenoglycol (29). Further investigation is necessary to clarify whether addition of chlorhexidine or other substance to CH dressing significantly impacts clinical treatment.

Successful endodontic treatment of teeth with apical periodontitis also may be related to other variables not assessed in this review. For example, Kvist et al. (30) found that microbial content significantly decreases after root canal preparation, and reported intracanal recontamination in 29% of teeth treated in one clinical session in comparison with 36% of teeth treated in two sessions. Therefore, prospective controlled clinical trials on the efficacy of endodontic treatment of teeth with apical periodontitis should balance the combined effect of materials, technique, and procedures to provide good scientific information to develop clinical guidelines.

Conclusions

Within the limitations of this study, the results suggest that adequate sanitation procedure and CH paste with saline vehicle reduce microbial contamination in teeth with apical periodontitis.

References

1. Holland R, Otoboni Filho JA, de Souza V, Nery MJ, Bernabé PF, Dezan E Jr. A comparison of one versus two appointment endodontic therapy in dogs´ teeth with apical periodontitis. J Endod. 2003;29:121-4.
2. Byström A, Claesson R, Sundqvist G. The antibacterial effect of camphorated paramonochlorophenol, camphorated phenol and calcium hydroxide in the treatment of infected root canals. Endod Dent Traumato.l 1985;1:170-5.
3. Estrela C, Bammann LL, Pimenta FC, Pecora JD. Control of microorganisms in vitro by calcium hydroxide pastes. Int Endod J. 2001;34:341-5.
4. Safavi K, Nakayama TA. Influence of mixing vehicle on dissociation of calcium hydroxide in solution. J Endod. 2000; 26:649-51.
5. Siqueira JF Jr, Lopes HP, de Uzeda M. Recontamination of coronally unsealed root canals medicated with camphorated paramonochlorophenol or calcium hydroxide pastes after saliva challenge. J Endod. 1998;24:11-4.
6. Estrela C, Holland R. Calcium Hydroxide: study based on scientific evidences. J Appl Oral Sci. 2003;11:269-82.
7. Estrela C, Sydney GB, Bammann LL, Felippe Junior O. Mechanism of action of calcium and hydroxyl ions of calcium hydroxide on tissue and bacteria. Braz Dent J. 1995;6:85-90.
8. Chávez de Paz LE, Bergenholtz G, Dahlén G, Svensäter G. Response to alkaline stress by root canal bacteria in biofilms. Int Endod J. 2007;40:344-55.
9. Evans M, Davies JK, Sundqvist G, Figdor D. Mechanisms involved in the resistance of Enterococcus faecalis to calcium hydroxide. Int Endod J. 2002;35:221-8.
10. Love RM. *Enterococcus faecalis* – a mechanism for its role in endodontic failure. Int Endod J. 2001;34:399-405.
11. Buck RA, Cai J, Eleazer PD, Staat RH, Hurst HE. Detoxification of endotoxin by endodontic irrigants and calcium hydroxide. J Endod. 2001;27:325-7.
12. Law A, Messer H. An evidence-based analysis of the antibacterial effectiveness of intracanal medicaments. J Endod. 2004;30: 689-94.
13. Sathorn C, Parashos P, Messer H. Antibacterial efficacy of calcium hydroxide intracanal dressing: a systematic review and meta-analysis. Int Endod J. 2007;40:2-10.
14. Alencar AH, Leonardo MR, Silva LA, Silva RS, Ito IY. Determination of the p-monochlorophenol residue in the calcium hydroxide + P-monochlorophenol combination used as an intracanal dressing in pulpless teeth of dogs with induced chronic periapical lesion. J Endod. 1997;23:522-4.
15. Estrela C, Holland R, Bernabé PF, Souza V, Estrela CR. Anti-microbial potential of medicaments used in healing process in dogs' teeth with apical periodontitis. Braz Dent J. 2004;15:181-5.
16. Holland R, Valle GF, Taintor JF, Ingle JI. Influence of bony resorption on endodontic treatment. Oral Surg Oral Med Oral Pathol. 1983;55:191-203.
17. Sydney GB. Identificação da microflora endodôntica após o preparo do canal radicular de dentes portadores de periodontite apical assintomática e o emprego de medicação de hidróxido de cálcio em diferentes tempos [tese]. São Paulo (SP): Faculdade de Odontologia, Universidade de São Paulo; 1996.
18. Trope M, Delano EO, Orstavik D. Endodontic treatment of teeth with apical periodontitis: single vs. multivisit treatment. J Endod. 1999;25:345-50.
19. Siwek J, Gourlay ML, Slawson DC, Shaughnessy AF. How to write an evidence-based clinical review article. Am Fam Physician. 2002;65:251-8.
20. Glenny AM, Esposito M, Coulthard P, Worthington HV. The assessment of systematic reviews in dentistry. Eur J Oral Sci. 2003;111:85-92.
21. Chu FC, Leung WK, Tsang PC, Chow TW, Samaranayake LP. Identification of cultivable microorganisms from root canals with apical periodontitis following two-visit endodontic treatment with antibiotics/steroid or calcium hydroxide dressings. J Endod. 2006;32:17-23.
22. Orstavik D, Kerekes K, Molven O. Effects of extensive apical reaming and calcium hydroxide dressing on bacterial infection during treatment of apical periodontitis: a pilot study. Int Endod J. 1991;24:1-7.
23. Peters LB, van Winkelhoff AJ, Buijs JF, Wesselink PR. Effects of instrumentation, irrigation and dressing with calcium hydroxide on infection in pulpless teeth with periapical bone lesions. Int Endod J. 2002;35:13-21.
24. de Souza CA, Teles RP, Souto R, Chaves MA, Colombo AP. Endodontic therapy associated with calcium hydroxide as an intracanal dressing: microbiologic evaluation by the checkerboard DNA-DNA hybridization technique. J Endod. 2005;31:79-83.
25. Zerella JA, Fouad AF, Spangberg LS. Effectiveness of a calcium hydroxide and chlorhexidine digluconate mixture as disinfectant during retreatment of failed endodontic cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005;100:756-61.
26. Hauman CH, Love RM. Biocompatibility of dental materials used in contemporary endodontic therapy: a review. Part 1. Intracanal drugs and substances. Int Endod J. 2003;36:75-85.
27. Haenni S, Schmidlin PR, Mueller B, Sener B, Zehnder M. Chemical and antimicrobial properties of calcium hydroxide mixed with irrigating solutions. Int Endod J. 2003;36:100-5.
28. Estrela C, Estrela CRA, Guimarães LF, Silva RS, Pécora JD. Surface tension of calcium hydroxide associated with different substances. J Appl Oral Sci. 2005;13:152-6.
29. Estrela C, Rodrigues de Araújo Estrela C, Bammann LL, Pecora JD. Two methods to evaluate the antimicrobial action of calcium hydroxide paste. J Endod. 2001;27:720-3.
30. Kvist T, Molander A, Dahlén G, Reit C. Microbiological evaluation of one- and two-visit endodontic treatment of teeth with apical periodontitis: a randomized, clinical trial. J Endod. 2004;30: 572-6.