SPER Publications and Solutions Pvt. Ltd.

Research Article

Antimicrobial efficacy of calcium hydroxide, propolis, and *Aloe vera* as intracanal medicament - A review

J. Sowjanyaa, C. S. Chandana

Department of Conservative Dentistry and Endodontics, Saveetha Dental College, Saveetha University, Chennai, Tamil Nadu, India

Correspondence: C. S. Chandana, Department of Conservative Dentistry and Endodontics, Saveetha Dental College, Saveetha University, No. 162, Poonamallee High Road, Chennai - 600 077, Tamil Nadu, India. Phone: +91-9600040740. E-mail: drchandanasubbarao@gmail.com

ABSTRACT

The goal of endodontic treatment is to remove the diseased pulp tissue and to provide an environment that is conducive to allow the healing of periapical tissues and maintain the roots of the tooth in a healthy periodontium. Various disadvantages have been associated with chemical medicaments such as antibiotic overuse and misuse, side effects, and cytotoxic reaction. To overcome these side effects, herbal and natural products have become popular. The aim of this review is to evaluate the antimicrobial efficacy of two natural intracanal medicaments, namely, propolis and *Aloe vera*, in comparison with calcium hydroxide in a root canal system. A web-based research on MEDLINE was done using keywords, published dental journals. Keywords used for a research were antimicrobial efficacy, propolis, *A. vera*, calcium hydroxide, and intracanal medicament. This review article screened about 23 articles, and then, the relevant information was compiled. Based on the evidence available, it can be concluded that propolis and *A. vera* can be used as effective alternate intracanal medicament in comparison with calcium hydroxide in a root canal system. Although *in vitro* studies show the significant antimicrobial efficacy of these natural medicaments in comparison with calcium hydroxide, clinical trials have to be conducted to extrapolate these results in a clinical scenario.

Keywords: Antimicrobial efficacy, propolis, Aloe vera, calcium hydroxide, intracanal medicament

Introduction

Effective disinfection and complete debridement of the root canal space are an important prerequisite for achieving long-term success of non-surgical endodontics,[1] as the treatment outcome for teeth with apical periodontitis depends on the effective disinfection of the root canal.[2,3] Chemomechanical cleaning and shaping of the root canal are of help to reduce the number of microorganisms but not completely eliminate them.[4]

Effective antimicrobial treatment protocol should be used to reduce the effect of bacterial endotoxins to a minimum allowing the defense system of the host to take over and provide a favorable environment for healing.[5,6] Applying an interappointment antimicrobial dressing in infected root canals is recommended, as instrumentation and irrigation do not reliably eradicate all of the bacteria.[7] Chemical medicaments are associated with several disadvantages such as antibiotic misuse and overuse, cytotoxic reaction, and side effects. Owing to these side effects, natural and herbal products have become popular.[8]

The purpose of this review is to evaluate the antimicrobial efficacy of two natural intracanal medicaments, namely, propolis and *Aloe vera*, in comparison with calcium hydroxide in a root canal system.

Materials and Methods

A web-based research on MEDLINE (www.pubmed.gov) was done. To limit our research to relevant articles, the search was filtered using keywords, published in the past 10 years and dental journals. Keywords used for research were antimicrobial efficacy, calcium hydroxide, propolis, *A. vera*, and intracanal medicament. Relevant articles were chosen to get the desired knowledge update. This review article screened about 23 articles comparing the antimicrobial efficacy of calcium hydroxide, propolis, and *A. vera*, and then, the relevant information was compiled.

Background on *Enterococcus faecalis*

E. faecalis is a Gram-positive bacterium, which is a facultative anaerobic bacterium, recovered from previously root-filled teeth with persistent periapical lesions.[9,10] The characteristics of this bacterium that makes it a persisting endodontic pathogen are its ability to invade dentinal tubules, withstand the ecologically demanding conditions of the root canal, and adapt to lethal challenges.[11] Numerous studies have

Access this article online

Website: www.japer.in | **E-ISSN:** 2249-3379

How to cite this article: Sowjanyaa J, Chandana CS. Antimicrobial efficacy of calcium hydroxide, propolis and *Aloe vera* as intracanal medicament - A review. J Adv Pharm Edu Res 2017;7(3):263-266.

Source of Support: Nil, **Conflict of Interest:** None declared.

shown that calcium hydroxide [$Ca(OH)_2$] cannot eliminate *E. faecalis* completely, though currently it is the most common endodontic disinfectant in use.[12-14] On the other hand, disinfectants such as iodine potassium iodide, chlorhexidine, or their combinations with $Ca(OH)_2$ have been found to be superior to $Ca(OH)_2$ alone in reducing the number of viable cells of *E. faecalis*.[14-16] Complete elimination of the bacteria is not guaranteed with the use of these agents.

Calcium hydroxide as intracanal medicament

Calcium hydroxide is one of the most commonly used intracanal medicaments. Its high pH (about 12.5) alters the biological properties in the cell walls of Gram-negative species, namely, the bacterial lipopolysaccharides, thus inactivating the membrane transport mechanisms. However, the buffering action of dentin neutralizes the action of calcium hydroxide at deeper layers of dentinal tubules, resulting in the survival of microorganisms.[17,18] Several studies have reported the failure of $Ca(OH)_2$ to eliminate enterococci effectively as they tolerate high pH values, varying from 9 to 11.[19]

Propolis as intracanal medicament

Propolis is a natural product wherein it is a resin-like substance, rich in flavonoid, which is produced from poplar and coniferous trees or Clusia flowers by bees. This substance can be used as an intracanal medicament as it has antibacterial, antifungal, and antivirus properties.[20] Flavonoids constitute the major components of propolis resin, which is the active ingredient with most of its properties.[21,22] Its phenolic combinations, terpene, aromatic acids, and esters have antibacterial activities.[21] Recent studies have indicated that propolis is effective against microorganisms and yet more compatible with periapical tissues than existing intracanal medicaments.[23]

A. vera as intracanal medicament

A. vera (*Aloe barbadensis* miller) belongs to the Liliaceae family and is a cactus-like plant.[24] It is a natural medicament with a long history of usage in medicine and nutrition. The antimicrobial properties of *A. vera* against various species of microorganisms, including *E. faecalis*, have also been reported as *A. vera* has potent antibacterial, antiviral, and antifungal activities.[25,26] The possible reason for antimicrobial action of *A. vera* could be the presence of 75 potentially active constituents: vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids, and amino acids.[27] The antimicrobial activity of *A. vera* might be attributed to the presence of carvacrol and thymol, and they are natural monoterpenes that act on the cell membrane of the organisms causing cellular death.[28]

Comparison of antimicrobial efficacy

In the *in vitro* study done by Bhardwaj *et al.,* in 2012, antimicrobial activity of *A. vera* gel and calcium hydroxide was compared against *E. faecalis* at the days 1, 3, and 5. The overall percentage inhibition at 200 and 400 µm depths and different time intervals were 78.9% with *A. vera* gel and 64.3% with calcium hydroxide. The inhibition of growth of *E. faecalis* at 200 and 400µm was uniform with no statistically significant difference for calcium hydroxide and *A. vera* gel.[27]

In the *in vitro* study done by Abbaszadegan *et al.,* in 2014, the bacterial load reduction from 7 to 14 days of incubation was significant for *A. vera* but not significant for calcium hydroxide. A statistically significant difference was observed between the medicaments after 1 and 7 days of incubation, and no significant difference was present between them after 14 days. The results of the study revealed that calcium hydroxide could not completely eradicate *E. faecalis*, even after 14 days of intracanal medication. *A. vera* had slow antimicrobial activity against *E. faecalis*, which was enhanced significantly from the day 1 to 7 and 14 days of contact time.[28]

In an *in vitro* study done by Bazvand *et al.*, in 2014, the percentage reduction in CFU/ml was 2933.3 ± 2880.1 and 9200 ± 4601.2 for propolis and *A. vera,* respectively. It showed that propolis and *A. vera* were relatively effective against *E. faecalis*.[29]

In the *in vitro* study done by Madhubala *et al.,* in 2011, they determined the antibacterial efficacy of propolis and calcium hydroxide as intracanal medicaments against *E. faecalis*. The percentage reduction in colony count was highest for propolis showing 100% reduction on the day 2 and 92.2% on the day 3. Calcium hydroxide showed a gradual increase in antibacterial activity with a maximum of 59.4% on the day 7. It can be concluded that propolis can be used as a short-term intracanal medicament as it was effective against *E. faecalis* in the root canal space.[20]

In the *in vitro* study done by Saha *et al.,* in 2015, a significant difference was observed between the test groups when compared to control group. With increase in time of application, the antibacterial efficacy also increased with its greatest on the 5th day. The least value of optical density (0.33 ± 0.62) was exhibited by propolis indicating it as the best antibacterial medicament.[30]

In the *in vitro* study done by Ahangari *et al.,* in 2012, the number of colonies was $43,333.33 \pm 48,027.077$ and $55,000 \pm 46,368.09$ after incubation for 72 h and using calcium hydroxide and 30% propolis extract, respectively. After 1-week incubation, the number of colonies was 166.67 ± 408.25 in the propolis group and 0 in the calcium hydroxide group. No colonies were observed after 1-month incubation in both groups. No significant differences were noted between two medicaments at different time intervals.[31]

In the *in vitro* study done by Bhandari *et al.,* in 2014, the number of colony-forming units in all the experimental groups was significantly lower in comparison with saline on the day 1, 3, and 5 ($P < 0.05$). Intergroup comparison between groups showed a significant difference between propolis (66.37%) and calcium hydroxide (50.89%) on the day 1 ($P = 0.002$), i.e., propolis was more effective than calcium hydroxide on day 1, but there was no significant difference in their effectiveness on the day 3 and 5.[32]

In the *in vitro* study done by Carbajal Mejía in 2014, log CFU/ml after 14 days against *E. faecalis* at 200 and 400 m depth was 0.86 and 1.29 for propolis, respectively, and 3.68 and 1.01 for calcium hydroxide, respectively. Log CFU/ml after 14 days against *Candida albicans* at 200 and 400 m depth was 2.82 and 2.59 for propolis, respectively,

and 3.39 and 3.65 for calcium hydroxide, respectively. Propolis was effective against *E. faecalis*, but *C. albicans* exhibited resistance after 14 days of placement.[33]

In the *in vitro* study done by Kayaoglu and Ørstavik in 2011, the experimental agents significantly reduced the number of the cultivable bacteria. No significant reduction in the number of colonies was found for the propolis extracts at the day 1; however, there was a significant reduction at the day 7. The 2 samples of propolis were statistically similar to each other and to calcium hydroxide at day 7. The antimicrobial activity of the propolis samples tested in this study was better than calcium hydroxide.[21]

In the laboratory study done by Awawdeh *et al.,* in 2009, a significant difference was found between propolis and calcium hydroxide groups ($P < 0.05$) with the later being ineffective against *E. faecalis* after such short duration as calcium hydroxide has to be applied for a longer duration for antimicrobial efficacy.[34]

In an *in vitro* study done by Sinha *et al.,* in 2015, the overall percentage inhibition of fungal growth (at 200 μm and 400 μm depth) was 0.2 ± 0.42 and 0.4 ± 0.52 at day 1, 0.5 ± 0.53 0.6 ± 0.52 at day 3, and 3.5 ± 0.71 and 4.4 ± 0.52 at day 5 for propolis. The overall percentage inhibition of fungal growth (at 200 μm and 400 μm depth) was 28.4 ± 0.52 and 42.8 ± 0.42 at day 1, 55.5 ± 0.53 and 69.4 ± 0.52 at day 3, and 82.6 ± 0.52 and 87.4 ± 0.52 at day 5 for calcium hydroxide. Propolis performed better than calcium hydroxide against *E. faecalis*.[35]

In an *in vitro* study done by Zare Johromi *et al.,* in 2012, minimum inhibitory concentrations of $Ca(OH)_2$ were 2500 and of propolis were 340. Propolis displayed more potency than $Ca(OH)_2$ and required a much lower concentration of propolis for inhibitory activity against *E. faecalis*. Propolis is an effective agent against *E. faecalis,* and it showed superiority over calcium hydroxide.[36]

Result

Based on the evidence available, it can be concluded that propolis and *A. vera* can be used as effective alternate intracanal medicament in comparison with calcium hydroxide in a root canal system.

Conclusion

Although *in vitro* studies show the significant antimicrobial efficacy of these natural medicaments in comparison with calcium hydroxide, clinical trials have to be conducted to extrapolate these results in a clinical scenario.

References

1. Lee Y, Han SH, Hong SH, Lee JK, Ji H, Kum KY. Antimicrobial efficacy of a polymeric chlorhexidine release device using *in vitro* model of *Enterococcus faecalis* dentinal tubule infection. J Endod 2008;34:855-8.
2. Sjögren U, Figdor D, Persson S, Sundqvist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. Int Endod J 1997;30:297-306.
3. Waltimo T, Trope M, Haapasalo M, Østravik D. Clinical efficacy of treatment procedures in endodontic infection control and 1 year follow-up of periapical healing. J Endod 2005;31:863-6.
4. 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.
5. Byström A, Claesson R, Sundqvist G. The antibacterial effect of camphorated paramonochlorophenol, cam-phorated phenol and calcium hydroxide in the treatment of infected root canals. Endod Dent Traumatol 1985;1:170-5.
6. Trope M, Bergenholtz G. Microbiological basis for endo-don tic treatment: Can a maximal outcome be achieved in one visit? Endo Topics 2002;1:40-53.
7. Athanassiadis B, Abbott PV, Walsh LJ. The use of calcium hydroxide, antibiotics and biocides as antimicrobial medicaments in endodontics. Aust Dent J 2007;52 1 Suppl: S64-82.
8. Pujar M, Mukandar S. Herbal usage in endodontics-a review. Int J Contemp Dent 2011;2:34-7.
9. Siqueira JF Jr, Rôças IN. Polymerase chain reaction-based analysis of microorganisms associated with failed endodontic treatment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;97:85-94.
10. Sedgley C, Nagel A, Dahlén G, Reit C, Molander A. Real-time quantitative polymerase chain reaction and culture analyses of *Enterococcus faecalis* in root canals. J Endod 2006;32:173-7.
11. Kayaoglu G, Ørstavik D. Virulence factors of *Enterococcus faecalis*: Relationship to endodontic disease. Crit Rev Oral Biol Med 2004;15:308-20.
12. Orstavik D, Haapasalo M. Disinfection by endodontic irrigants and dressings of experimentally infected dentinal tubules. Endod Dent Traumatol 1990;6:142-9.
13. Weiger R, de Lucena J, Decker HE, Lõst C. Vitality status of microorganisms in infected human root dentine. Int Endod J 2002;35:166-71.
14. Gomes BP, Souza SF, Ferraz CC, Teixeira FB, Zaia AA, Valdrighi L, *et al.* Effectiveness of 2% chlorhexidine gel and calcium hydroxide against *Enterococcus faecalis* in bovine root dentine *in vitro*. Int Endod J 2003;36:267-75.
15. Basrani B, Santos JM, Tjäderhane L, Grad H, Gorduysus O, Huang J, *et al.* Substantive antimicrobial activity in chlorhexidine-treated human root dentin. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;94:240-5.
16. Sirén EK, Haapasalo MP, Waltimo TM, Ørstavik D. *In vitro* antibacterial effect of calcium hydroxide combined with chlorhexidine or iodine potassium iodide on *Enterococcus faecalis*. Eur J Oral Sci 2004;112:326-31.
17. Cwikla SJ, Bélanger M, Giguère S, Progulske-Fox A, Vertucci FJ. Dentinal tubule disinfection using three calcium hydroxide formulations. J Endod 2005;31:50-2.
18. Mohammadi Z. Systemic, prophylactic and local applications of antimicrobials in endodontics: An update review. Int Dent J 2009;59:175-86.
19. Gomes BP, Vianna ME, Sena NT, Zaia AA, Ferraz CC, de Souza Filho FJ. *In vitro* evaluation of the antimicrobial activity of calcium hydroxide combined with chlorhexidine gel used as intracranial medicament. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;102:544-50.
20. Kayaoglu G, Ömürlü H, Akca G, Gürel M, Gençay Ö, Sorkun K, *et al.* Antibacterial activity of propolis versus conventional endodontic disinfectants against *Enterococcus faecalis* in infected dentinal tubules. J Endod 2011;37:376-81.
21. Almas K, Mahmoud A, Dahlan A. A comparative study of propolis and saline application on human dentin. A SEM study. Indian J Dent Res 2001;12:21-7.
22. Park YK, Alencar SM, Aguiar CL. Botanical origin and chemical composition of Brazilian propolis. J Agric Food Chem 2002;50:2502-6.
23. Madhubala MM, Srinivasan N, Ahamed S. Comparative evaluation of propolis and triantibiotic mixture as an intracanal medicament against *Enterococcus faecalis*. J Endod 2011;37:1287-9.
24. Newall CA, Anderson LA, Phillipson JD. Herbal Medicines. A Guide for Health-Care Professionals. London: The Pharmaceutical Press; 1996.

25. Arunkumar S, Muthuselvam M. Analysis of phytochemical constituents and antimicrobial activities of *Aloe vera* L. against clinical pathogens. World J Agric Sci 2009;5:572-6.
26. Thiruppathi S, Ramasubramanian V, Sivakumar T, Thirumalaiarasu V. Antimicrobial activity of *Aloe vera* (L.) Burm. f. against pathogenic microorganisms. J Biosci Res 2010;1:251-8.
27. Bhardwaj A, Ballal S, Velmurugan N. Comparative evaluation of the antimicrobial activity of natural extracts of *Morinda citrifolia*, papain and *Aloe vera* (all in gel formulation), 2% chlorhexidine gel and calcium hydroxide, against *Enterococcus faecalis*: An *in vitro* study. J Conserv Dent 2012;15:293-7.
28. Abbaszadegan A, Sahebi S, Gholami A, Delroba A, Kiani A, Iraji A, *et al.* Time-dependent antibacterial effects of *Aloe vera* and *Zataria multiflora* plant essential oils compared to calcium hydroxide in teeth infected with *Enterococcus faecalis*. J Investig Clin Dent 2016;7:93-101.
29. Zare Jahromi M, Toubayani H, Rezaei M. Propolis: A new alternative for root canal disinfection. Iran Endod J 2012;7:127-33.
30. Bazvand L, Aminozarbian MG, Farhad A, Noormohammadi H, Hasheminia SM, Mobasherizadeh S. Antibacterial effect of triantibiotic mixture, chlorhexidine gel, and two natural materials propolis and *Aloe vera* against *Enterococcus faecalis*: An *ex vivo* study. Dent Res J (Isfahan) 2014;11:469-74.
31. Awawdeh L, Al-Beitawi M, Hammad M. Effectiveness of propolis and calcium hydroxide as a short-term intracanal medicament against *Enterococcus faecalis*: A laboratory study. Aust Endod J 2009;35:52-8.
32. Ahangari Z, Eslami G, Ghannad S. *In vitro* antimicrobial activity of propolis in comparison with calcium hydroxide against *Enterococcus faecalis.* J Dent Sch 2012;1:9-17.
33. Joy Sinha D, Garg P, Verma A, Malik V, Maccune ER, Vasudeva A. Dentinal tubule disinfection with propolis and two extracts of *Azadirachta indica* against *Candida albicans* biofilm formed on tooth substrate. Open Dent J 2015;9:369-74.
34. Saha S, Nair R, Asrani H. Comparative evaluation of propolis, metronidazole with chlorhexidine, calcium hydroxide and curcuma longa extract as intracanal medicament against *E.faecalis* - An *in vitro* study. J Clin Diagn Res 2015;9:ZC19-21.
35. Bhandari S, T S A, Patil CR. An *in vitro* evaluation of antimicrobial efficacy of 2% chlorhexidine gel, propolis and calcium hydroxide against *Enterococcus faecalis* in human root dentin. J Clin Diagn Res 2014;8:ZC60-3.
36. Carbajal Mejía JB. Antimicrobial effects of calcium hydroxide, chlorhexidine, and propolis on *Enterococcus faecalis* and *Candida albicans*. J Investig Clin Dent 2014;5:194-200.