Global Journal of Medicine and Public Health
www.gjmedph.org

Role of Calcium Hydroxide in Endodontics : A Review

Mohammed Mustafa[1], Saujanya KP[2], Deepak Jain[3]. Sangameshwar Sajjanshetty[4],Arun A[5]. Laxmi Uppin[6],Mahnoor Kadri[7]

[1]Faculty of Dentistry & Course Director, Division of Endodontics, Department of Conservative Dental Sciences, College of Dentistry, Salman Bin Abdulaziz University, Al-Kharj, Kingdom of Saudi Arabia. , [2]Department of SMBT Dental College, Sangamner Taluka, [3] Dept of Conservative Dentistry & Endodontic. Karad, Senior Lecturer, [4]Dept of Pedodontics. MIDSR Dental College, Latur. Maharashtra. [5] Dept of Conservative Dentistry & Endodontic.Siddharth Dental College. Tumkur. [6] Dept of Pedodontics. DY Patil Dental College, Pune,[7]ITS Dental College Greater Noida , UP.

A B S T R A C T

Calcium hydroxide is a multipurpose agent, and there have been an increasing number of indications for its use in endodontics. Some of its indications include inter-appointment intracanal medicaments, endodontic sealers, pulp capping agents, apexification, pulpotomy and weeping canals. The purpose of this article is to review the properties, advantages, disadvantages and various indications for the use of calcium hydroxide in endodontics.

Keywords: Calcium hydroxide , Pulp Capping , Apexifacation, Pulpotomy.

Corresponding Author: Saujanya KP,Senior lecturer, Dept of Conservative Dentistry & Endodontic.SMBT Dental College.Sangamner Taluka. Ahmednagar Dist. Maharashtra.

Funding: None Conflict of interest: None to Declare

Introduction

Calcium hydroxide has been used in dentistry for almost a century,[24] it was originally introduced to the field of endodontics by Hermann in 1920 as a pulp-capping agent,[10, 11] but its uses today are widespread in endodontic therapy.

Pure calcium hydroxide paste has a high pH (approximately 12.5-12.8).[27] It is a basic compound, as such it is mildly irritating to vital pulp tissue. It has bacteriostatic properties which mean it keeps bacteria from actively spreading. Both of these qualities make it a good lining material for restoration in close proximity to pulp.

Although calcium hydroxide does not bond to dentin, it does have antibacterial property.[3,16,17,21] Its mechanism of actions[13, 24] are achieved through the ionic dissociation of Ca(2+) and OH(-) ions and their effect on vital tissues, the induction of hard-tissue deposition[1] and the antibacterial properties. The lethal effects of calcium hydroxide on bacterial cells are probably due to protein denaturation and damage to DNA and cytoplasmic membranes. It has a wide range of antimicrobial activity against common endodontic pathogens. It continues to have a high pH after setting because material dissolves readily in aqueous solution, liberating hydroxyl ions. This high pH provides a stimulus for tooth to repair itself in absence of bacterial infection.

It is supplied in several forms, available as a liquid containing calcium hydroxide suspended in a solvent, also it is supplied as a paste in which calcium hydroxide is suspended in methylcellulose. In these first two forms material is used like a varnish. In its third common form calcium hydroxide is supplied as a 02-paste system in tubes marketed as a catalyst and a base.

A catalyst is present to cause calcium hydroxide to react and form a hard, amorphous compound within matter of minute under oral condition. Finally a fourth calcium hydroxide paste formulation contains a polymer resin that can be hardened by illumination from a handheld blue light source.

Properties of Calcium hydroxide: [14]

STRUCTURE:

1. Arrangement= amorphous matrix, crystalline fillers.
2. Bonding= covalent; ionic.
3. Defects=pores, cracks.
4. Setting reaction= acid base reaction.

PHYSICAL PROPERTIES:

1. L.C.T.E= low.
2. Thermal conductivity= insulator.
3. Electrical conductivity= insulator.

CHEMICAL PROPERTIES:

1. Solubility- 0.3-0.5

MECHANICAL PROPERTIES:

1. Elastic mod=588
2. Compressive strength >24 hr=138

BIOLOGIC PROPERTIES:

1. Biocompatible.

Advantages of Calcium hydroxide: [8]

Initially bactericidal then bacteriostatic.
Promotes healing and repair.
High pH stimulates fibroblasts.
Neutralizes low pH of acids.
Stops internal resorption.
Inexpensive and easy to use.

Disadvantages of Calcium hydroxide: [9]

Does not exclusively stimulate dentinogenesis.
Does exclusively stimulate reparative dentin.
Associated with primary tooth resorption.
May dissolve after one year with cavosurface dissolution.
May degrade during acid etching.
Degrades upon tooth flexure.
Marginal failure with amalgam condensation.
Does not adhere to dentin or resin restoration.

1. Calcium hydroxide as an Intracanal Medicament: [2,7,16,18,23]

It is the most commonly used dressing for treatment of the vital pulp. It also plays a major role as an inter-visit dressing in the disinfection of the root canal system.

Calcium hydroxide cannot be categorized as a conventional antiseptic, but it kills bacteria in root canal space. The value of calcium hydroxide in endodontic treatment of necrotic infected teeth is now well documented.

Calcium hydroxide is normally used as slurry of Calcium hydroxide in a water base. At body temperature less than 0.2% of Calcium hydroxide is dissolved into ca++ and OH- ions. Calcium hydroxide needs water to dissolve. Therefore it is most advantageous to use water as a vehicle for the Calcium hydroxide paste. In contact with air calcium hydroxide forms calcium carbonate.

Calcium hydroxide is a slowly working antiseptic. Direct contact experiments in vitro require a 24 hour contact period for complete kill of enterococci. Calcium hydroxide not only kills bacteria, but it also reduces the effect of the remaining cell wall material lipo-polysaccharide.

Calcium hydroxide may be mixed with sterile water or saline, but this formula is also available commercially from a number of manufacturers in a sterile single dose packages.

It should be mixed to a thick mixture to carry as much Calcium hydroxide particles as possible. This slurry is best applied with a lentulo-spiral. Saturated Calcium hydroxide solution mixed with a detergent is an effective antimicrobial agent suitable for irrigation.

It has a wide range of antimicrobial activity against common endodontic pathogens, but is less effective against Enterococcus faecalis and Candida albicans. Calcium hydroxide is also an effective anti-endotoxin agent. However, its effect on microbial biofilms is controversial.

2. Calcium hydroxide as an Endodontic Sealer: [5,6]

In the root canal obturation, sealer plays an important role, sealer basically fills the gap between the walls of the prepared dentine and the gutta-percha, all the space the gutta-percha is unable to fill because of gutta-percha physical's limitations.

To be therapeutically effective calcium hydroxide must be dissociated into Ca++ and OH-. Therefore to be effective, an endodontic sealer based on calcium hydroxide must dissolve and the solid consequently lose content.

Thus one major concern is that the calcium hydroxide content dissolve, leaving obturation voids. This would ruin the function of the sealer, because it would disintegrate in the tissue. Recently introduced several calcium hydroxide sealers are sealapex(kerr), apexkit(vivadent).

Calcium hydroxide-based root canal sealers have a variety of physical and biological properties. Comparative studies reveal their mild cytotoxicity, but their antibacterial effects are variable. Further research is required to establish the tissue healing properties of calcium hydroxide in root canal sealers.

3. Calcium hydroxide as a Pulp Capping Agent: [10,11]

Calcium hydroxide is generally accepted as the material of choice for pulp capping. Histologically there is a complete dentinal bridging with healthy radicular pulp under calcium hydroxide dressings.

When calcium hydroxide is applied directly to pulp tissue there is necrosis of adjacent pulp tissue and an inflammation of contiguous tissue. Dentinal bridge formation occurs at the junction of necrotic tissue and vital inflamed tissue. Beneath the region of necrosis, cells of underlying pulp tissue differentiate into odontoblasts and elaborate dentin matrix.

Three main calcium hydroxide products are: Pulpadent, Dycal, Hydrex(MPC).

Pulpadent paste is considered to be most capable of stimulating early bridge formation. Hydrex has been considered that fast capable of forming a bridge.

Commercially available compounds of calcium hydroxide in a modified form are known to be less alkanine and thus less caustic on the pulp. The action of calcium hydroxide to form a dentin bridge appears to be a result of the low grade irritation in the underlying pulp tissue after application.

4. Calcium hydroxide in Apexification: [1,4,10,20]

In apexification technique canal is cleaned and disinfected, when tooth is free of signs and symptoms of infection, the canal is dried and filled with stiff mix of calcium hydroxide and CMCP. Commercial paste of calcium hydroxide (eg. Calasept, Pulpdent, Hypocal, Calyxl) may be used to fill the canals.

Histologically the formation of osteodentin after placement of calcium hydroxide paste immediately on conclusion of a vital pulpectomy has been reported. There appears to be a differentiation of adjacent connective tissue cells; there is also deposition of calcified tissue adjacent to the filling material. The calcified material is continuous with lateral root surfaces, the closure of apex may be partial or complete but consistently has minute communications with the periapical tissue.

5. Calcium hydroxide in Pulpotomy: [10,28]

It is the most recommended pulpotomy medicament for pulpally involved vital young permanent tooth with incomplete apices. It is acceptable because it promoted reparative dentin bridge formation and thus pulp vitality is maintained.

Histologically pulp tissue adjacent to calcium hydroxide was first necrotized by the high pH of calcium hydroxide. This necrosis was accompanied by the acute inflammatory changes in the underlying tissue. After 04 weeks a new odontoblastic layer and eventually a bridge of dentin developed.

Three histologic zones under calcium hydroxide in 4-9 days:

1. Coagulation necrosis.

2. Deep staining areas with varied osteodentin.

3. Relatively normal pulp tissue, slightly hyperemic, underlying an odontoblastic layer.

Internal resorption may result from overstimulation of the primary pulp by the highly alkaline calcium hydroxide. This alkaline induced overstimulation could cause metaplasia within the pulp tissue, leading to formation of odontoclasts. Also undetected microleakage could allow large numbers of bacteria to overwhelm the pulp and nullify the beneficial effects of calcium hydroxide.

Calcium hydroxide incorporated in a methylcellulose base such as pulpdent, showed earlier and more consistent bridging. At present calcium hydroxide pulpotomy technique cannot be generally recommended for primary teeth. But it is the recommended agent for carious and traumatic exposures in young permanent teeth, particularly with incomplete closure.

6. Calcium hydroxide in Weeping Canals: [3,19,25]

Sometimes a tooth undergoing root canal treatment shows constant clear or reddish exudate associated with periapical radiolucency. Tooth can be asymptomatic or tender on percussion. When opened in next appointment, exudates stops but it again reappear in next appointment, this is known as "weeping canal".

In these cases tooth with exudates is not ready for obturation, since culture reports normally show negative bacterial growth so, antibiotics are of no help. For such teeth dry the canals with sterile absorbent paper points and place calcium hydroxide in canal. It happens because pH of periapical tissues is acidic in weeping stage which gets converted into basic pH by calcium hydroxide.

Conclusion

Calcium hydroxide has been included within several materials and antimicrobial formulations that are used in a number of treatment modalities in endodontics. Calcium hydroxide is an amazing material which has a number of applications in dentistry and especially in endodontics, apart from being very economical and ease in handling properties compare to other material like MTA (mineral trioxide aggregate) which is also being used in endodontics recently. Calcium hydroxide is still a material of choice which is widely being used

for various reasons in endodontics, especially in rural practice.

References

1. Al Ansary MA, Day PF, Duggal MS, Brunton PA. Interventions for treating traumatized necrotic immature permanent anterior teeth: inducing a calcific barrier & root strengthening. Dental Traumatology 2009 Aug; 25(4): 367-79.

2. Barbosa CA, Goncalves RB, Siqueira Junior JF. Evaluation of the antibacterial activities of calcium hydroxide, chlorhexidine, and camphorated paramonochlorophenol as intracanal medicament. A clinical and laboratory study. Journal of Endodontics 1997; 23: 297–300.

3. Bystrom A, Claesson R, Sundqvist G. The antibacterial effect of camphorated paramonochlorophenol, camphorated phenol and calcium hydroxide in the treatment of infected root canals. Endodontics & Dental Traumatology 1985; 1: 170–5.

4. Cvek M, Hollender L, Nord CE. Treatment of non-vital permanent incisors with calcium hydroxide. A clinical, microbiological and radiological evaluation of treatment in one sitting of teeth with mature or immature root. Odontologisk Revy 1976; 27: 93–108.

5. Desai S, Chandler N. Calcium hydroxide-based root canal sealers: a review. Journal of Endodontics 2009 Apr; 35(4): 475-80.

6. De Moor R. Calcium hydroxide-based pastes used in endodontics. Rev Belge Med Dent (1984), 2003; 58(1): 34-48.

7. El Karim I, Kennedy J, Hussey D. The antimicrobial effects of root canal irrigation and medication. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007 Apr; 103(4): 560-9.

8. Farhad A, Mohammadi Z. Calcium hydroxide: a review. International Dental Journal 2005 Oct; 55(5): 293-301.

9. Foreman PC, Barnes IE. Review of calcium hydroxide. International Endodontic Journal 1990 Nov; 23(6): 283-97.

10. Fuks AB et al. Vital pulp therapy with new materials for primary teeth: new directions and treatment perspectives. Pediatr Dent. 2008 May-Jun; 30(3): 211-9.

11. Kakehashi S, Stanley H, Fitzgerald R. The effect of surgical exposures of dental pulps in germ-free and conventional laboratory rats. Oral Surgery, Oral Medicine, Oral Pathology 1965; 20: 340–9.

12. Law A, Messer H. An evidence based analysis of the antibacterial effectiveness of intracanal medicaments. Journal of Endodontics 2004; 30: 689–94.

13. Malagnino VA, Amori P, Gambarini G, De Marco M. Recent findings in the mechanism of action of calcium hydroxide in apexification. G Stomatol Ortognatodonzia. 1989 Jul-Dec; 8(4): 14-7.

14. Mohammadi Z, Dummer PM. Properties and applications of calcium hydroxide in endodontics and dental traumatology. International Endodontic Journal 2011 Aug; 44(8): 697-730.

15. Morfis AS, Sykaras S. Clinical use of Calcium hydroxide in dentistry – Review. Hell Stomatol Chron. 1987 Jul-Sep; 31(3): 169-75.

16. McGurkin-Smith R, Trope M, Caplan D, Sigurdsson A. Reduction of intracanal bacteria using GT rotary instrumentation, 5.25% NaOCl, EDTA, and Ca(OH)2. Journal of Endodontics 2005; 31: 359–63.

17. Molander A, Reit C, Dahle´n G. The antimicrobial effect of calcium hydroxide in root canals pretreated with 5% iodine potassium iodide. Endodontics and Dental Traumatology 1999; 15: 205–9.

18. 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. International Endodontic Journal 1991; 24: 1–7.

19. 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. International Endodontic Journal 2002; 35: 13–21.

20. Rafter M et al. Apexification - a review. Dental Traumatology 2005 Feb; 21(1): 1-8.

21. Safavi KE, Dowden WE, Introcaso JH, Langeland K. A comparison of antimicrobial effects of calcium hydroxide and iodine-potassium iodide. Journal of Endodontics 1985; 11: 454–6.

22. Sathorn C, Parashos P, Messer H. Antibacterial efficacy of calcium hydroxide intracanal dressing: a

systematic review & meta-analysis. International Endodontic Journal 2007; 40: 2-10.

23. Shuping GB, Orstavik D, Sigurdsson A. Reduction of intracanal bacteria using nickel-titanium rotary instrumentation & various medications. Journal of Endodontics 2000; 26: 751–5.

24. Siqueira JF Jr, Lopes HP. Mechanisms of antimicrobial activity of calcium hydroxide: a critical review. International Endodontic Journal 1999; 32: 361–9.

25. Sjogren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. Journal of Endodontics 1990; 16: 498–504.

Journal of Endodontics 2008 Jul; 34(7 Suppl): 25-8.

26. Sjogren U, Figdor D, Spangberg L, Sundqvist G. The antimicrobial effect of calcium hydroxide as a short-term intracanal dressing. International Endodontic Journal 1991; 24: 119–25.

27. Teixeira FB, Levin LG, Trope M. Investigation of pH at different dentinal sites after placement of calcium hydroxide dressing by two methods. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology 2005; 99: 511–6.

28. Witherspoon DE. Vital pulp therapy with new materials: new directions and treatment perspectives-permanent teeth.