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Review ARTICLE

Role Of Calcium Hydroxide In Root Canal Therapy

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ABSTRACT
Calcium hydroxide is a multipurpose agent, and there have been an increasing number of indications for its use. Some of its indications include direct and indirect pulp capping, apexogenesis, apexification, treatment of; root resorption, iatrogenic root perforations, root fractures, replanted teeth and interappointmentintracanal dressing. Hence; we planned the present review to highlight role oh calcium hydroxide in root canal therapy.

Key words: Calcium hydroxide, Root canal therapy

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INTRODUCTION
Calcium hydroxide is a material which has been used for a variety of purposes since its introduction into dentistry in the early part of the twentieth century. In its pure form, the substance has a high pH, and its dental use relates chiefly to its ability to stimulate mineralization, and also to its antibacterial properties. A range of products has been formulated with different therapeutic actions, the effects of which are partially dependent upon the tissue to which they are applied.[1, 2]

Calcium hydroxide

Calcium hydroxide was originally introduced to the field of endodontic by Herman in 1920 as a pulp-capping agent. It is a white odorless powder with the formula Ca(OH)2 (Fig. 1) and has a molecular weight of 74.08. Ca(OH)2 has low solubility in water (about 1.2 g·L-1 at 25), which decreases as the temperature rises. The dissociation coefficient of Ca(OH)2 (0.17) permits a slow, controlled release of both calcium and hydroxyl ions. The low solubility is a good clinical characteristic because a long period is necessary for Ca(OH)2 to become soluble in tissue fluids when in direct contact with vital tissues. Ca(OH)2 has a high pH (about 12.5-12.8), is insoluble in alcohol, and is chemically classified as a strong base. Its main actions result from the ionic dissociation of the Ca2+ and OH-ions and their effect on vital tissues, such as inducing hard tissue deposition and being antibacterial. Ca(OH)2 dissociates into calcium and hydroxyl ions on contact with aqueous fluids.

Calcium hydroxide for the purpose of pulp protection is available in various forms, such as in aqueous suspensions or as cements, liners, or filled risens.[3, 4]

Calcium hydroxide aqueous suspensions are suspensions of calcium hydroxide in water. After application, the solvent evaporates, leaving behind (as a liner) a layer of calcium hydroxide, for example, Pulpdent (Pulpdent, Brookline, MA, USA). Calcium hydroxide liners, however, are a combination of calcium hydroxide with a varnish to modify the viscosity and to improve handling, for example, Hydroxline (George Taub, Jersey City, NJ, USA). Calcium hydroxide cements are paste/paste systems. One paste contains calcium hydroxide and the other contains salicylate. Salicylate is a weak acid that is chemically similar to eugenol and reacts with the calcium hydroxide. The acid–base reaction between calcium hydroxide and a salicylate is responsible for setting, the reaction forms an amorphous calcium salicylate. This form of calcium hydroxide materials fit into what was previously described as low-strength bases, for example, Dycal (DENTSPLY, Milford, DE, USA) and Life (Kerr, Portland, OR, USA).[5, 6]

Calcium hydroxide as Intracanal medicament

Intracanal medication with calcium hydroxide (Ca(OH)2) pastes is commonly used to complement the root canal disinfection after chemo mechanical preparation. Studies have shown that this procedural step positively influences the outcomes of endodontic treatment in infected cases. However, a homogeneous filling up to working length (WL) is essential to ensure adequate effectiveness of Ca(OH)2 pastes. Several methods are used to deliver Ca(OH)2 pastes into the root canal, including a hand file, Lentulo spiral, and special devices such as syringes and compactors.[7]

Studies comparing different techniques to fill root canals with Ca(OH)2 show controversial results. One study found that the endodontic hand file is superior to McSpadden compactor and Lentulo spiral in root canals of dogs premolars, and the endodontic hand file produced the lowest number of empty spaces in the three thirds evaluated. However, another study reported that there were no differences in outcomes between using a Lentulo spiral or a hand file in human mandibular premolars.[8]

Alternative devices/techniques have been examined to improve the quality of Ca(OH)2 filling. For instance, one study compared different devices/instruments including K-file, ultrasonic file, and Lentulo spiral in single-rooted premolars, and showed comparable quality of fillings. Currently, ultrasound as well as sonic devices are very popular among endodontists, and their applications include activation of irrigation solutions and sealer placement. Sonic systems are suggested to improve the quality of Ca(OH)2 root canal filling; however, there is no scientific evidence that supports this statement, to date.[9]

Biological properties of calcium hydroxide

An important property of calcium hydroxide is the ability to activate alkaline phosphatase. The pH necessary forthe activation of this enzyme varies from 8.6 to 10.3according to the type and concentration of substratum,temperature and source of enzymes. It is reported that the action of calcium hydroxidewould explain how its high pH inhibits enzyme activitiesthat are essential to bacterial life, i.e., metabolism,growth and cellular division. The effect of pH on thetransport of nutrients and organic components throughthe cytoplasmic membrane determines its toxic action onbacteria. This also activates the hydrolytic enzyme alkaline phosphatase, which is closely related to the processof tissue mineralization. The mechanism of action of calcium hydroxide on tissues, inducing the deposition of mineralized tissue, is anextremely important aspect for the indication of calciumhydroxide, because it demonstrates biological compatibility of calcium hydroxide.[10, 11]

Antibacterial Activity

Calcium hydroxide exerts antibacterial effects in the root canal system as long as a high pH is maintained. An in vivo study showed that root canals treated with Ca(OH)2 had fewer bacteria than did those dressed with camphorated phenol or camphorated monochlorophenol. Another study reported Ca(OH)2 to be effective in preventing the growth of microorganisms but to a limited extent when compared to camphorated chlorophenol, stressing the necessity of direct contact to achieve the optimum antibacterial effect. It was shown that a 7-day application of a Ca(OH)2 medicament was sufficient to reduce canal bacteria to a level that gave a negative culture. It has also been shown that an aqueous Ca(OH)2 paste and a silicone oil-based Ca(OH)2 paste are effective in the elimination of Enterococcus faecalis in dentinal tubules.[12]

Literature

Sharma et al. described two severe cases of iatrogenic extrusion of $CaOH_2$ (QED $CaOH_2$, Nordiska Dental, Angelholm, Sweden) on upper and lower molar tooth causing extensive necrosis in the scalp, skin, and mucosa in the first case and infraorbital nerve paraesthesia and palatal mucosal necrosis in second case. Both patients reported severe pain immediately after $CaOH_2$ injection. A computerized tomography (CT) scan with 3-dimensional (3-D) reconstruction in second case confirmed the intravascular distribution of the material. Authors explained that an exposure of $CaOH_2$ to blood resulted in crystalline precipitation and the consequent ischemic tissue necrosis. Their patient underwent thrombolytic, steroid and antibiotic therapies to maintain tissue reperfusion, limit inflammatory responses, and prevent infections, respectively. Lindgren et al. reported a case of $CaOH_2$ (Calasepts, Nordiska Dental, Angelholm, Sweden) injection into the root of a lower second molar, the inferior alveolar and farther maxillary and external carotid artery, causing necrosis of the ear lobe and superficial necrosis of the cheek skin. When the paste was applied with a syringe in the distal canal, the patient experienced severe local pain. Angiogram showed a number of vascular occlusions in the right external carotid artery branches.[8, 9]

Bramante et al. reported a case of $CaOH_2$ therapy for root resorption control in a maxillary lateral incisor. Three days after $CaOH_2$ placement (Biodinâmica, Ibiporã, PR, Brazil), an irregular zone of necrosis was observed on buccal mucosa. Careful curettage was performed around the region for removal of necrotic tissue and extruded $CaOH_2$; healing was observed at a 15-day follow-up.[10]

Several studies indicated that the treatment with intracanal medicaments could markedly affect the diversity and quantity of cultivable microorganisms in infected canals, with some groups of microorganisms being more resistant to treatment than others. Peters et al. evaluated microorganism in root canals with or without $Ca(OH)_2$ medication. They said that although $Ca(OH)_2$ was placed in the prepared canals, the number of positive canals had increased in the period between visits. $Ca(OH)_2$ could not totally prevent regrowth of bacteria. Zerella et al. said that complete disinfection was not achieved but all cases that initially harbored *Enterococcus* species were successfully disinfected. Chu et al. found that Gram-positive facultive anaerobic cocci tend to predominate than Gram-negative obligate anaerobic rods after treatment. Oncag et al. said that CHX was more effective than $Ca(OH)_2$ alone against *E. faecalis*. In the study of Sinha et al., $Ca(OH)_2$ showed limited efficacy against facultative anaerobes and *Candida*species, but was effective against obligate anaerobes. Molander et al. treated teeth with $Ca(OH)_2$ for 2 months and found that there was no increased antimicrobial effect of $Ca(OH)_2$ even if it was left for longer periods in the root canal.[11- 16]

Kazemipoor *et al*, have stated that the difficulties which are more challenging in the retreated canals are the openings of dentinal tubules which may be blocked with residual sealer and gutta-percha. This phenomenon can have an influence on the diffusion and penetration of hydroxyl ions into the dentinal tubules.Pashley and Livingston had suggested that hydrogen and hydroxyl ions like water should diffuse readily through dentine since permeability was in general inversely related to molecular size, and in this study where molecular charge was examined as a variable it did not appear to influence the rate of diffusion.[17, 18]

Yücel *et al*, stated that for proper wetting of the canal wall, $Ca(OH)_2$ powder has been used as a mixture for root canal dressing and can be mixed with vehicles such as olive oil, glycerin, propylene glycol, iodoform plus saline solution, camphorated parachlorophenol plus glycerin, camphorated parachlorophenol, methylcellulose, metacresylacetate, saline, distilled water, anesthetic solutions, Ringer's solution, and camphorated monochlorophenolcresatin.Besides permitting diffusion of the $Ca(OH)_2$, the vehicle can enhance the antimicrobial capacity of the paste. According to Gomes *et al*, chlorhexidine can be used as a vehicle for attempting an increase in the antimicrobial property to be effective against aerobic and facultative anaerobic microorganisms, Gram-positive and Gram-negative microorganisms, yeasts, and viruses.[19- 21]

CONCLUSION

The antimicrobial activity of $Ca(OH)_2$ is related to the release of highly reactive hydroxyl ions in an aqueous environment, which mainly affects cytoplasmic membranes, proteins, and DNA. Hence; calcium hydroxide a vital role in the success of root canal therapy.

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