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Review Article

Role of calcium hydroxide in root canal therapy: A comprehensive review

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ABSTRACT
Calcium hydroxide is classified chemically as a strong base with a high pH (approximately 12.5–12.8). Its main properties come from the ionic dissociation of Ca2+ and OH ions and their effect on vital tissues, generating the induction of hard-tissue deposition and being antibacterial. It is widely used in endodontics as an intracanal medicament to eliminate the remaining microorganisms after chemomechanical preparation. Hence; in the present review, we aim to highlight role of calcium hydroxide in root canal therapy.
Key words: Calcium hydroxide, Root canal therapy

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INTRODUCTION

The main etiologic factors responsible for apical inflammatory pathologies are microorganisms. The goal of endodontic treatment is the prevention and control of pulpal and periradicular infections. Numerous measures have been introduced to reduce the number of microorganisms from the root canal system, including various mechanical instrumentation techniques, irrigation regimes, and intracanal medicaments. Since Hermann introduced it in 1920 as a pulp-capping agent, calcium hydroxide (Ca(OH)2) has been widely used in endodontics. Various biological properties of Ca(OH)2, such as antimicrobial activity, tissue-dissolving ability, inhibition of tooth resorption, and hard tissue formation, have been investigated, and its wide use in root canal treatment has been associated with periradicular healing and few adverse reactions. Currently, Ca(OH)2 is considered the first choice of root canal dressing materials.[1-3]

CHEMICAL PROPERTIES

Calcium hydroxide is a white odourless powder with the chemical formula Ca(OH)2 and a molecular weight of 7.08. Chemically, it is classified as a strong base in contact with aqueous fluids (its pH is about 12.5 - 12.8), and dissociate into calcium and hydroxyl ions. Calcium hydroxide is used and supplied in various forms. It is used like a varnish when supplied as a liquid containing calcium hydroxide suspended in a solvent or when supplied as a paste in which calcium hydroxide is suspended in methylcellulose. Another form of calcium hydroxide is marketed as a base and a catalyst. By using the catalyst, calcium hydroxide reacts faster and forms a hard, amorphous compound within matter of minute in the oral environment. Finally, calcium hydroxide supplied as a paste contains a polymer resin that can be hardened when exposed to illumination from a handheld blue light source.[4, 5]

ADVANTAGES OF CALCIUM HYDROXIDE:

- 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.[6, 7]

DISADVANTAGES OF CALCIUM HYDROXIDE:

- 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[8-10]

ANTI-MICROBIAL ACTIVITY

The antimicrobial activity of $Ca(OH)_2$ is dependent on the release of hydroxyl ions in an aqueous environment. Hydroxyl ions are highly oxidant free radicals that show extreme reactivity with several biomolecules. This reactivity is indiscriminate; thus, this free radical rarely diffuses away from sites of generation. The lethal effects of hydroxyl ions on bacterial cells are probably due to damage to the bacterial cytoplasmic membrane, denaturation of proteins, or damage to the DNA. Although these three mechanisms may occur, it is difficult to establish, in a chronological sense, which is the main mechanism involved in the death of bacterial cells after exposure to a strong base. Hydroxyl ions from $Ca(OH)_2$ exert their mechanism of action in the cytoplasmic membrane because that is where enzymatic sites are located. Extracellular enzymes act on nutrients, carbohydrates, proteins, and lipids that, through hydrolysis, favor digestion. Intracellular enzymes located in the cell favor the respiratory activity of the cellular wall structure. The pH gradient of the cytoplasmic membrane is altered by the high concentration of hydroxyl ions from calcium hydroxide acting on the proteins of the membrane (protein denaturation). The high pH of $Ca(OH)_2$ alters the integrity of the cytoplasmic membrane by means of chemical injury to the organic components and transport of nutrients or by means of the destruction of phospholipids or unsaturated fatty acids of the cytoplasmic membrane during the peroxidation process, which is a saponification reaction.[11-14]

MINERALIZATION ACTIVITY

Ca(OH)2 in direct contact with connective tissue gives rise to a zone of necrosis, altering the physicochemical state of inter-cellular substance which, through rupture of glycoproteins, determines protein denaturation. The formation of mineralized tissue following contact between Ca(OH)2 and connective tissue has been observed from the 7th to the 10th day following application. The mineralizing action of Ca(OH)2 is directly influenced by its high pH. The alkaline pH not only neutralizes lactic acid from osteoclasts, but could also activate alkaline phosphatases, which play an important role in hard-tissue formation.[15, 16]

ANTI-ENDOTOXIN ACTIVITY

Endotoxin, a part of the cell wall of all Gram-negative bacteria, is composed of polysaccharides, lipids and proteins and is referred to as lipopolysaccharide (LPS), emphasizing its chemical structure. Endotoxin (LPS) is released during multiplication or bacterial death causing a series of biological effects, which lead to an inflammatory reaction and periapical bone resorption. In teeth with chronic periapical lesions, there is a greater prevalence of Gram-negative anaerobic bacteria disseminated throughout the root canal system (dentinal tubules, apical resorptive defects and cementum lacunae), including apical bacterial biofilm. endotoxin, a component of the cell wall of Gram-negative bacteria, plays a fundamental role in the genesis and maintenance of periapical lesions because of the induction of inflammation and bone resorption. Ca(OH)2 inactivates endotoxin, in vitro and in vivo, and appears currently the only clinically effective medicament for inactivation of endotoxin.[14-16]

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.

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