



REVIEW ARTICLE

Importance of calcium hydroxide as intracanal medication

María Belén Muñoz-Padilla¹  , Camila Alejandra Villafuerte-Moya¹ , Verónica Alicia Vega-Martínez¹ 

¹Universidad Regional Autónoma de los Andes, Ibarra. Ecuador.

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ABSTRACT

Introduction: calcium hydroxide is widely used in endodontics for its antimicrobial, remineralizing, and anti-inflammatory properties, which promote healing and improve the prognosis of root canal treatments.

Objective: to describe the importance of calcium hydroxide as intracanal medication in endodontics.

Methods: a systematic review of the literature published between 2010 and 2024 was conducted, following the PRISMA methodology. The search was carried out in different databases, using related terms to develop the search algorithm, resorting to the application of inclusion and exclusion criteria to ensure methodological relevance and quality of the identified and selected sources for subsequent analysis.

Development: the reviewed evidence confirms that calcium hydroxide has a high pH that provides bactericidal action against resistant microorganisms, in addition to stimulating osteoblastic activity and apical repair. Efficacy in reducing postoperative pain is reported, although controversy persists due to limited clinical evidence. Its utility in cases of pulp necrosis, apical periodontitis, and teeth with incomplete root development is also highlighted, where it favors apical formation. Experimental studies show microbial reductions of over 90 %, while meta-analyses suggest additional benefits when combined with other therapies.

Conclusions: calcium hydroxide constitutes a versatile and effective material as intracanal medication. Its antimicrobial, remineralizing, and anti-inflammatory properties make it a key resource for optimizing endodontic treatments.

Keywords: Endodontics; Calcium Hydroxide; Root Canal Therapy.

INTRODUCTION

Calcium hydroxide is a medication widely used in conservative dental treatments, especially in the case of endodontics, for its bactericidal and antifungal action. In addition, calcium hydroxide stimulates the remineralization of dentin and the healing of tissues. This chemical substance also reduces the edema that forms during the intervention, allows sealing the canal system, and decreases dental sensitivity.⁽¹⁾

For this purpose, calcium hydroxide is administered directly inside the canals, which allows it to reach where the dentist's instruments cannot, such as lateral canals, dentinal tubules, or apical deltas. Its special properties make calcium hydroxide very useful in different dental treatments, especially considering the ease of handling and application:^(2,3)

- To cover deep caries without the pulp being exposed or when, for different reasons, the pulp protrudes outside the tooth. In both cases, this medication favors dentin regeneration.
- In the performance of pulpotomies (removal of diseased pulp), it favors the formation of a calcareous barrier and the dissolution of pulp tissue.
- When injected into the canals, it allows them to be cleaned perfectly, as it drags any dead tissue that may be in them.
- In the case of exudate, it causes its gelification and, consequently, a thrombolytic action.
- Reduces pulp sensitivity, thereby improving the action of anesthesia.
- As an anti - infective agent in any dental procedure that requires two or more visits to be completed.

Antisepsis procedures in endodontics take on special significance; the absence of germs is of paramount importance for the successful outcome of treatments in this specialty. Numerous medications have been employed for this purpose.⁽⁴⁾ Among this wide range of agents is calcium hydroxide (CaOH), whose use in dentistry has recently aroused considerable interest.

Calcium hydroxide is widely used in endodontics for its biocompatibility, disinfectant action, and ability to stimulate osteoblastic activity. It is used in occlusive dressings and temporary fillings, in irrigation of biopulpectomies, and in the control of hemorrhages and abscesses, thanks to its anti - inflammatory, hemostatic, and antibacterial properties. In addition, it reduces apical filtration by forming a tight seal with gutta - percha and sealer cement, and is fundamental in inducing root closure in teeth with incomplete development, favoring cell differentiation and the formation of osteocementum - like tissue.^(5,6,7) These applications underpin its clinical relevance and justify the need to systematically review the available evidence on its effectiveness, which motivated the development of the present study, which aimed to describe the importance of calcium hydroxide as intracanal medication in endodontics.

METHODS

A systematic review of the scientific literature was conducted following the PRISMA guidelines, with the aim of synthesizing the available evidence on the use of calcium hydroxide as intracanal medication in endodontics. The search period was delimited between January 2010 and December 2024, in order to cover recent and relevant publications that reflect the evolution of knowledge in this field.

The search was carried out in the main biomedical databases: PubMed, SciELO, ScienceDirect, Google Scholar, LILACS, and BVSALUD. Secondary references obtained from the bibliography of key articles were also consulted, and gray literature (theses, technical reports, and institutional documents) was included to minimize publication bias. This strategy allowed for an expanded spectrum of sources and ensured comprehensive coverage of the available evidence.

A search algorithm was designed combining keywords and Boolean operators. The main terms were: "calcium hydroxide", "endodontics", "intracanal medication", along with synonyms and DeCS/MeSH descriptors. Operators such as AND, OR, and NOT were applied to refine the results. For example: ("calcium hydroxide" AND "endodontics") OR ("intracanal medication" AND "calcium hydroxide"). Articles in Spanish, English, and Portuguese were considered, with no geographical restriction.

Studies published within the defined time range, with full - text access, and directly addressing the use of calcium hydroxide in endodontics were included. Experimental, clinical designs, and previous reviews were accepted. Duplicates, articles without full - text access, irrelevant studies or outside the search period, as well as isolated clinical case reports that did not provide systematic evidence were excluded.

The selection was carried out in several phases: first, title reading was performed, followed by abstract review and finally full - text reading. In the initial search, approximately 580 records were identified (180 in PubMed and 400 in Google Scholar). After eliminating 150 duplicates, 430 articles remained, of which 200 were considered relevant in the title phase. Subsequently, 45 were discarded after abstract reading for not meeting thematic criteria. Finally, 5 articles met the inclusion criteria and were selected for analysis. The entire process was represented by the PRISMA flow diagram, which illustrates the phases of identification, screening, eligibility, and inclusion.

Data Extraction and Analysis

Key variables were collected from each article: author, year of publication, methodological design, sample size and characteristics, as well as main results. The synthesis was carried out qualitatively, integrating relevant findings on the effectiveness and applications of calcium hydroxide as intracanal medication. No meta - analysis was performed due to the heterogeneity of designs and results, although a comparative approach was maintained to identify trends and consensus in recent literature.

DEVELOPMENT

Although the earliest reference to CaOH dates back to Nygren in 1838, its development in current dental practice began in 1930 when BW Hermann introduced it as an agent for pulpotomy and named it Calxyl. In the last two decades, it has become more popular in endodontics and has been successful in various clinical situations. It currently constitutes an effective endodontic medication. A review of the most up - to - date literature was carried out with the aim of describing the effects of CaOH and exposing the different clinical procedures in which it is used, as well as the results of its application in endodontic therapy.^(5,6)

The main attributes of the calcium ion and the hydroxyl ion explain much of the effectiveness of calcium hydroxide as intracanal medication. Calcium has a hygroscopic action that reduces capillary extravasation and, consequently, the accumulation of intercellular fluid, contributing to the control of exudate and the reduction of pain in inflammatory processes. In addition, it raises the threshold of nerve excitability, as it has been demonstrated that the application of calcium chloride on freshly cut dentin can abolish nerve impulse conduction. Added to this is its ability to stimulate the immune system and activate complement, as well as its mitogenic action, evidenced in the increase in cell divisions in teeth restored with CaOH. On the other hand, the hydroxyl ion exerts a marked antimicrobial action thanks to the high pH that alters the cytoplasmic membrane gradient, interfering with bacterial metabolism and division, giving it a broad spectrum against various microorganisms. It also promotes a mineralizing effect by activating enzymes such as alkaline phosphatase, adenosine triphosphatase, and calcium - dependent pyrophosphatase, favoring both apical repair and tissue mineralization processes^(7,8,9)

It can be seen in Table 1 that calcium hydroxide has great properties that make it an optimal material for intracanal medication in various endodontic procedures since it allows the elimination of bacteria that persist even after instrumentation, allows the remineralization of dental tissues, and contributes to reducing postoperative pain, giving better results in endodontic treatment for patients.

Table 1. Description of the selected articles.

Source	Design	Methods	Results
Fernández Menendez ⁽¹⁾	Bibliographic review	60 scientific articles, 2 endodontic books, and one postgraduate thesis	Its antibacterial action is largely provided by hydroxyl ions since they act on the bacterial membrane, causing a rupture of it and consequently the elimination of the bacteria
Argüello Ramos et al. ⁽²⁾	Experimental	27 ex - vivo monoradicular teeth	It has been demonstrated that calcium hydroxide, as an intracanal medication that maintains a high alkaline pH, is highly efficient in completely eradicating the proliferation of bacteria within the root canal, so this type of material is used especially in cases of severe dental damage such as pulp necrosis and periradicular pathologies
Ahmad et al. ⁽⁴⁾	Bibliographic review	18 studies with 1192 participants	Calcium hydroxide (HC) can be an effective intracanal medication to control pain between appointments. Combined therapies seem to be more effective than HC alone
Ibrahim et al. ⁽⁷⁾	Systematic review with meta - analysis	16 articles, including 1643 participants with 1699 teeth	It is beneficial for reducing the risk of pain by approximately 12% within the following 2 days and 87% afterwards
Barbosa-Ribeiro et al. ⁽⁸⁾	Experimental	Twenty infected root canals of monoradicular teeth	A microbial reduction of 99.5% was observed

Calcium hydroxide has been widely used in dentistry and, in particular, in endodontics, due to its properties that favor treatment effectiveness and improve clinical prognosis. As Fernández Menéndez,⁽¹⁾ points out, its use as intracanal medication further enhances the results of the endodontic procedure, thanks to its biocompatibility, ability to stimulate tissue repair, and disinfectant action. These characteristics have established it as a reference material in clinical practice, especially in cases of pulp necrosis and periradicular pathologies, where its high alkaline pH contributes to eradicating bacterial proliferation and creating a favorable environment for tissue regeneration.

Among its most outstanding properties is its antimicrobial action, which makes it a valuable option for controlling infections in dental pulp and root canals. In addition, various studies have explored its possible effect on reducing postoperative pain. Ahmad et al.,⁽⁴⁾ through a systematic review and meta - analysis of randomized clinical trials, reported that the application of calcium hydroxide as intracanal medication can reduce pain intensity after primary endodontic therapy. Similarly, Ibrahim et al.,⁽⁷⁾ confirmed in their meta - analysis that this material can reduce the incidence of pain and complications such as flare - ups, although they noted that the magnitude of the benefit varies among studies and that the evidence is still not conclusive.

While there is still some controversy regarding the solidity of the results in terms of pain control, most authors agree that the other properties of calcium hydroxide, its antimicrobial, anti - inflammatory, mineralizing actions, and its ability to promote apical repair, make it an excellent choice as intracanal medication. In this regard, its continued use is recommended in clinical practice, both for its proven effectiveness in disinfecting the canal system and for its potential to improve healing and the prognosis of endodontic treatments.

CONCLUSIONS

The extensive and beneficial properties that calcium hydroxide possesses make it an excellent material for use as intracanal medication, as it helps with the elimination of bacteria that persist in the root canals, aids in the remineralization of dental tissues, and reduces postoperative pain, thereby ensuring an adequate root canal treatment.

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