SEVEN publicações acadêmicas

Use of calcium hydroxide as an intracanal medication in permanent teeth: A brief review of the literature

Crossref doi
https://doi.org/10.56238/sevened2023.005-010

Cibelly Mara Pereira Araújo
Highest degree of training: Specialist in Endodontics
Academic institution: Institute of Health Studies – IES

Ana Carolina Duarte Corlaitti Duarte
Highest degree of training: Specialist in Endodontics
Academic institution: Institute of Health Studies – IES

Thais Martins Jajah Carlos
Highest degree of education: Bachelor of Dentistry
Academic institution: Federal University of Uberlândia-UFU

Mariana Alves Rossi Faleiros
Highest degree of education: Bachelor of Dentistry
Academic institution: Centro Universitário do Triângulo-UNITRI

Glaciele Maria de Souza
Highest degree of education: Doctorate in Dentistry/Dental Clinic
Academic institution: Federal University of the Jequitinhonha and Mucuri Valleys-UFVJM (Post-Doctoral Fellow PPGOdontoto-UFVJM)

Warley Silva de Oliveira
Highest degree of training: Doctor of Clinical and Experimental Dentistry
Academic institution: University of Grande Rio-UNIGRANRIO

Túlio Bruno Cavalhero de Oliveira
Highest degree of training: Specialist in Endodontics
Academic institution: Institute of Health Studies – IES

Renata Pereira Georjutti
Highest degree of education: Doctorate in Dentistry/Dental Clinic
Academic institution: Federal University of Uberlândia-UFU and University Center of Triângulo-UNITRI (Coordinator of the Dentistry course).

Débora Souto-Souza
Highest degree of education: Doctorate in Dentistry/Pediatric Dentistry
Academic institution: Federal University of the Jequitinhonha and Mucuri Valleys-UFVJM and University Center of the Triangle-UNITRI (Professor of Dentistry)

ABSTRACT
Endodontic treatment aims to reduce bacterial contamination in permanent teeth with pulp necrosis. The success of root canal treatment is directly related to the neutralization and reduction of pathogenic microorganisms, so it is essential to carry out an adequate chemical-mechanical preparation and employ the use of auxiliary medications, in order to combat the maximum of resistant microorganisms. Among these medications, calcium hydroxide stands out for its breadth of beneficial properties to the canal and adjacent tissues, being the drug of first choice, as it has antimicrobial and repair-inducing characteristics.

Keywords: Endodontic treatment, Intracanal medication, Calcium hydroxide.

1 INTRODUCTION

Endodontics is a specialty of Dentistry popularly known as root canal treatment, responsible for treating pathologies that affect the dental pulp and periapical tissues. Endodontic treatment consists of different phases, including modeling, cleaning and filling of root canals, which aims to restore the function of the dental element (ZAIA, 2008).

Successful endodontic therapy comprises the chemical-mechanical preparation of root canals, using instruments and irrigation solutions, with the aim of promoting the cleaning and modeling of root canal systems. The treatment aims to eliminate microorganisms through the removal of the pulp tissue and the use of intracanal medication will complement this process, since in order to obtain the repair and cure of the pathologies, the elimination of the infection is indispensable (ESTRELA; ESTRELA PÉCORA, 2003; SINGH et al., 2013).

The ideal intracanal medication has the function of assisting in the reduction of microorganisms, acting as a physicochemical barrier, reducing the inflammatory process, neutralizing toxic products, preventing periapical reinfection, reducing periapical symptomatology and providing repair of the tissues involved (SOARES; GOLDBERG, 2011).

The most commonly used medications to remove bacteria inside root canals are: phenolic compounds, camphor paramonochlorophenol, formalin tricresol, formocresol, glutaraldehyde, iodoform, calcium hydroxide, corticosteroids and antibiotics (NERY et al., 2012).

Professionals find it difficult to choose the ideal medication due to the great diversity of products found in the dental market (LOPES and SIQUEIRA, 2015). Based on the literature, the most widely used drug in endodontics has been calcium hydroxide due to its antimicrobial action and induction of repair by the formation of mineralized tissue (NERY *et al.*, 2012).

The purpose of this study is to conduct a brief review of the literature on the use of calcium hydroxide as an intracanal medication in the endodontic treatment of permanent teeth.

2 METHODOLOGY

- ➢ A literature search was performed using the following keywords in Portuguese: "Endodontic treatment" AND "Intracanal medication" AND "Calcium hydroxide"; and in English: "Endodontic treatment" AND "Intracanal medication" AND "Calcium hydroxide intracanal", in the following databases: Scielo and PubMed, between the years 1999 to 2022.
- ➢ A total of 34 articles were found, of which 23 were selected according to their relevance to the present study.

It was selected as a reference book: Endodontics, Biology and Technique, 4th edition, by the authors Lopes and Siqueira.

3 LITERATURE REVIEW

When the bacteria reach the dental pulp, an acute inflammatory process begins. The purpose of this response is to find and eliminate the antigen, remove the degenerated tissues, and prepare the affected area for tissue repair. A series of vascular events must be initiated for this to occur, aiming at the arrival of defense cells to the compromised region. This acute infectious process is accelerated, lasting from minutes to three days and, depending on the amplitude of the aggression, the antigen will be eliminated and the tissues will be repaired. If this does not occur, the microorganisms invade the root canal system and chronic inflammation is installed (LACERDA *et al.*, 2016).

When pulp necrosis occurs due to trauma or caries infection, the presence of chronic lesions in the periapex due to the microbial and toxic content of the necrotic pulp cavity is frequently observed. Therefore, endodontics is recommended with emphasis on the disinfection phases (LACERDA *et al.*, 2016).

In the chemical-mechanical preparation phase, sanitation is responsible for reducing root canal contamination. Although a significant reduction in microorganisms is observed soon after the end of the cleaning, disinfection and modeling process, it is necessary, in some cases, to use medication between sessions in order to enhance the process (ESTRELA; FIGUEIREDO, 1999).

3.1 MICROBIOTA

The dentin tubules, open cavity, periodontal membrane, bloodstream, caries and defective restorations are used as access routes by microorganisms. The tooth reacts in various ways to the presence of microorganisms, which can trigger reversible and irreversible inflammatory processes. If reversible reactions are not treated, irreversible inflammations will occur and, consequently, more severe inflammation will settle reaching the periradicular tissues, leading to the formation of periapical lesions (LOPES and SIQUEIRA, 2015).

As bacterial density and the number of species increase because of pulp exposure, this tissue is affected by higher concentrations of toxic bacterial products. Thus, the tissue portion in direct contact with the offending agent undergoes severe inflammatory changes, culminating in necrosis (LOPES and SIQUEIRA, 2015). The main ecological factors that influence the composition of the microbiota, within this system, are oxygen tension, type and amount of available nutrients. In addition, pH, temperature and host resistance are also important influences in this process (LEMOS, 2001).

Knowledge about the microorganisms present and predominant in root canal infections and periapical tissues is essential for the adoption of a conduct aimed at microbial control, for the choice of intracanal medication and for subsequent stimulation of tissue repair (LACERDA *et al.*, 2016).

In the oral cavity, the amphibiontic microbiota (a varied set of microorganisms commonly found colonizing a certain site of the organism, coexisting harmoniously with the host) is composed of about 800 species of bacteria. Strict anaerobic bacteria predominate in the contaminated channels, accompanied by some facultative anaerobic bacteria and, infrequently, aerobic bacteria (LACERDA *et al.*, 2016)

3.2 ENDODONTIC INFECTIONS

The bacteria use the dentin tubules, pulp exposure and periodontium as access routes to the root canals, thus causing pathologies involving the pulp and periradicular tissues. (LOPES; SIQUEIRA, 2015).

There are three types of infections – primary, secondary, and persistent. Primary infection occurs in teeth without endodontic treatment and with pulp necrosis, with a predominance of Gram-negative bacteria. Secondary infection, on the other hand, occurs after the failure of endodontic treatment, with root canal contamination during or after treatment. And the persistent infection is the one that has been maintained after the disinfection procedures have been carried out and consists of the resistance of microorganisms to endodontic treatment, as is the case of *Enterococcus. faecalis.* Its cause is associated with both the microorganisms of the primary infection and those of the secondary infection. (LACERDA *et al.*, 2016).

3.3 *ENTEROCOCCUS FAECALIS*

The bacterium *E. faecalis* is a Gram-positive facultative anaerobic disease found in cases of endodontic failure. This microorganism has some properties, such as great capacity to adapt to adverse conditions, growth aptitude in the form of a biofilm or single colony, the ability to penetrate the dentin tubules, characterizing its high predominance in persistent infections. In addition, *E. faecalis* also has the ability to maintain itself in a viable but non-cultivable state, which is a mechanism of adaptation to the adverse conditions of the microenvironment, such as low concentration of nutrients, high salinity and extreme pH, in which the bacterium loses the ability to grow in culture, but maintains its virulence and possibility of dividing again at the moment when the place becomes once again beneficiated. (LACERDA *et al.*, 2016).

3.4 CALCIUM HYDROXIDE

Since the 1970s, histological studies have shown that better repair results after endodontic treatment occur after the use of intracanal medication with calcium hydroxide. Among the options available on the market, calcium hydroxide stands out due to its expressive antimicrobial properties and repair induction. (HOLLAND; OTOBONI; SOUZA; et al., 2003).

Calcium hydroxide in its pure form is a white, alkaline powder (pH 12.8), poorly soluble in water. This strong base is obtained from the calcination (heating) of calcium carbonate. With the hydration of calcium oxide, calcium hydroxide is obtained and the reaction between this and carbon dioxide leads to the formation of calcium carbonate (LOPES; SIQUEIRA, 2015). This powder can be mixed with aqueous or viscous vehicles, thus producing an alkaline paste. Due to its high pH, calcium hydroxide has a broad antibacterial effect. Its dissociation is slow and steady, thus having a controlled and long-lasting therapeutic action. (SIRÉN et al., 2014).

Widely used in endodontics, calcium hydroxide has excellent bacteriostatic and bactericidal action, thus exerting its antimicrobial effect. This drug is considered a reference in clinical practice due to its biological properties, such as antimicrobial effect combined with the ability to favor the tissue repair process. (NERY *et al*., 2012). Calcium hydroxide dissociates into calcium and hydroxyl ions and the action of these ions explains its biological and antimicrobial characteristics, which are manifested by enzymatic actions both on bacteria and on bacteria. the Tissues. Your employment in Endodontics by its Antimicrobial property, it enhances the disinfection of the root canal system, also acting in the periapical repair process. (STAR; FLOWERS 1999).

The antimicrobial activity of calcium hydroxide is due to the release of hydroxyl ions from its dissociation in an aqueous medium. Hydroxyl ions are highly oxidizing free radicals, being extremely reactive, binding to biomolecules close to their site of formation, i.e., where calcium hydroxide was applied. Its lethal effect occurs through the following mechanisms: loss of bacterial cytoplasmic membrane integrity, enzymatic inactivation, and DNA damage (LOPES; SIQUEIRA, 2015). However, before using calcium hydroxide as an intracanal medication, it is necessary for the professional to have scientific knowledge about the inflammatory process of the pulp and the infections involved. (SOUZA FILHO, *et al* , 2010).

Endodontic infections are classified as: primary, secondary, or persistent infection. Primary infection includes anaerobes, bacilli, and Gram-negative infections. This bacterial load can be partially eliminated after adequate instrumentation of the root canals. (SOUZA FILHO *et al.*, 2015).

It is extremely important to fully identify the microbiota, and the degree of severity of an endodontic infection is related not only to the presence of microorganisms, but also to the amount found in the infected site. (SAINTS *et al*., 2015).

The secondary infection originates from a professional intervention, involving microorganisms that were not initially present in the endodontic treatment. It occurs from the moment when the micro-organisms are able to adapt or proliferate in the root canal. These pathogens can access the root canal and adjacent tissues through dressing changes or after filling, due to the breakdown of the aseptic chain, lack or inappropriate use of absolute isolation, contaminated instruments, teeth kept open due to loss of filling material (SOUZA FILHO; 2015). Only one species of microorganism will be present, most often being facultative Gram-positive, involving *Pseudomonas aeruginosas, Staphylococcus species, Escherichia coli, Candida species and Enterococcus faecalis.* (LACERDA *et al*., 2016).

Research reports that the most common microorganism in cases of endodontic reinfection is *Enterococcus faecalis*. This microorganism has a high prevalence in cases of endodontic failure, where calcium hydroxide has shown limited effects against this type of species because it is resistant to environments with high pH. (ZANDONÁ, J.; SOUZA, 2015).

A large load of aerobic bacteria is installed at the beginning of the infection of pulp pathologies and in more advanced cases gram-negative anaerobic bacteria will predominate. Endodontic treatment should not be postponed, and biomechanical preparation, irrigation, and intracanal medication should be performed. This approach aims to combat or eliminate as much as possible the microbial load existing in the infection. (SIQUEIRA JUNIOR *et al.*, 2012).

The chemical characteristics of calcium hydroxide have made it the drug of choice in endodontic treatments, such as: antibacterial action (bactericidal and bacteriostatic), anti-inflammatory action, promoting mineralizing effect, biocompatibility, dissolution of organic remains, neutralizing of toxic substances, inhibition of inflammatory resorptions and function of physical barriers. (RODRIGUES *et al.*, 2013).

In endodontics, in addition to being used as an intracanal medication, calcium hydroxide can be used as a lime water solution, helping in the irrigation of root canals, having a neutralizing action of toxic products and hemostatic. In some situations, it can also be used as a shutter paste. (SOARES AND GOLBERG, 2011). In deciduous teeth, calcium hydroxide can be used as an intracanal medication and obturator paste, while in permanent dentition its effects stood out as an intracanal medication. (MASSARA *et al.*; 2012)

In order for root canal decontamination to be carried out, it is necessary that the calcium hydroxide remains in the medium for some time and the ideal time is controversial. However, its antimicrobial action can be clinically evaluated by the absence of exudate in the root canal system and the absence of painful symptoms. However, it is known that in order to exert its antimicrobial activity inside the dentin tubules, calcium hydroxide needs a long time of action. (LOPES; SIQUEIRA JR, 2004)

In a study to evaluate the susceptibility of microorganisms to calcium hydroxide, its combination with some vehicles was carried out. Stainless steel cylinders were placed on the inoculated agar plates. The tested drugs and their controls were placed inside the cylinders. Growth inhibition zones were measured for each cylinder and recorded after the incubation period. *Enterococcus faecalis* was the most resistant microorganism to calcium hydroxide, while *Porphyromonas endodontalis was more susceptible to all drugs, followed by* Porphyromonas gingivalis *and* Prevotella intermedia. The association between calcium hydroxide and paramonochlorophenol and glycerin showed greater inhibition zones when compared to the other drugs tested. Through this study it was concluded that Gram-negative anaerobic bacteria are more susceptible to calcium hydroxide pastes than Gram-negative ones. (GOMES *et al.*, 2002).

The use of intracanal medication can interfere with the nutritional interrelationships already established, and some microorganisms that could be essential for the growth of others can be eliminated or maintained. The optimal time for calcium hydroxide to exert its antimicrobial action effectively in the root canal system has not yet been determined. The presence or absence of exudate in the root canal, presence or absence of *smear layer*, type of microorganism involved and its location in the root canal system will influence this time (GOMES *et al*., 2002). However, an in *vitro* study demonstrated that many microorganisms that are commonly found in the microbiota of the root canal system were rapidly eliminated when exposed to calcium hydroxide in a 7-day application. (ROSENBERG *et al*., 2007).

Calcium hydroxide is a fine white powder, odorless, chemically strong and with an extremely alkaline pH. Its properties are released by the dissociation of calcium and hydroxyl ions. Its molecular weight (74.08g) should be highlighted, containing 45.89% hydroxyl ions and 54.11% calcium ions. When ionic dissociation occurs, its antimicrobial action is released, stimulating the formation of hard tissue and presenting good biocompatibility to the root canal and adjacent tissues. (ESTRELA, 2013).

In order for the ionic dissociation of calcium hydroxide to occur, it is necessary that it be associated with other substances in order to make it a paste, providing viscosity and greater radiopacity, improving its clinical properties. (SOARES; GOLDBERG, 2011).

A very important issue for the antimicrobial action of calcium hydroxide is the choice of the vehicle used in conjunction with the medication, as it will be decisive to maintain the properties of calcium hydroxide or potentiate it. Research has shown that the type of vehicle associated with calcium hydroxide is directly related to the concentration and release rate of hydroxyl ions, favoring the antimicrobial action of the paste and clinical handling. (SOARES; GOLDBERG, 2011) (NERY *et al*., 2012).

Vehicles can be classified under antibacterial effect or in relation to chemical properties. According to their physicochemical properties, they are classified as oily or water-soluble. As for their antibacterial effects, vehicles can be inert and biologically active. (LAUREL *et al*, 2018).

In the vast majority of situations, inert vehicles are characterized by being biocompatible and not influencing the antimicrobial properties of calcium hydroxide. Among them, the following stand out: distilled water, anesthetic solution, saline solution, methylcellulose solution, olive oil, polyethylene glycol, glycerin and propylene glycol. (LOPES; SIQUEIRA JR, 2004).

Aqueous inert vehicles promote rapid therapeutic action due to rapid ionic dissociation and rapid diffusion of hydroxyl ions and calcium ions. However, the loss of its effect occurs more quickly, requiring a more frequent change of medication. In the event of a breakdown of the aseptic chain or suspected infectious processes, active vehicles should be elected. (LAUREL *et al*, 2018).

Inert vehicles are biocompatible substances and do not influence the antimicrobial properties of calcium hydroxide, so its association with calcium hydroxide is indicated in cases of live pulp or biopulpectomy.

Additional effects Calcium hydroxide paste is provided by its association with biologically active vehicles, such as Paramonochloroconforate (PMCC), potassium iodide and chlorhexidine. (NERY *et al.*, 2012).

The aqueous vehicles provide an extremely fast ionic dissociation to the calcium hydroxide, resulting in greater diffusion and consequently greater action by contact of calcium and hydroxyl ions with microorganisms and tissues. When applied inside the root canal, the paste is quickly diluted, requiring successive changes so that the desired results are achieved. Distilled water, saline, anesthetic solutions, and methylcellulose solutions are examples of aqueous vehicles. Some examples of trademarks that employ watery vehicles are: Calxyl (Otto & Co. Frankfut, Germany), Pulpdent (Pulpdent Co. Brookline, MA, United States).

Viscous vehicles are soluble in water, but make the dissociation of calcium hydroxide slower due to their high molecular weight. Glycerin, polyethylene glycol, and propylene glycol are examples of viscous vehicles. Calen and Calen PMCC (SS White, RJ, Brazil) are trademarks that use polyethylene glycol as a vehicle. (LOPES; SIQUEIRA, 2015).

Soares and Goldberg (2011) report that calcium hydroxide expresses its antimicrobial effect in a safe way, and its time of action must be respected. The authors mention that if there is a need for the medication to be maintained for 30 days, changes should be made every 15 days, remembering that the clinical condition of the canal is a determining factor for changing the medication. The authors recommend the use of intracanal medication for a minimum period of 15 days, justifying that during this period of time, calcium hydroxide produces antibacterial action effectively and safely. However, in more severe cases, such as periapical lesions and apical resorptions, calcium hydroxide should remain for a period of 30 days. However, it is still unclear when the timing calcium hydroxide needs to develop antimicrobial action.

In order to improve the physicochemical properties, additional chemical substances have been added to calcium hydroxide to favor its clinical use, such as radiopacity itself. Usually, these substances are: bismuth carbonate, barium sulfate, iodoform, and zinc oxide. (LOPES; SIQUEIRA, 2015).

3.5 ROOT CANAL FILLING WITH CALCIUM HYDROXIDE PASTE

Several techniques for placing the calcium hydroxide paste inside the root canal have been used, especially endodontic instruments, amalgam holders, special syringes, paper or gutta-percha cones, EndoActivator (sonic appliance, Dentsply Tulsa Dental, Tulsa, OK, USA) and the Lentulo spiral.

In addition to the anatomy and chemical-mechanical preparation, the efficiency of inserting calcium hydroxide paste into the root canal depends on its chemical composition, the nature of the vehicle and its consistency at the time of use. Viscous and oily vehicles, because they act as lubricants, favor the placement of the paste inside the channel. Despite the various application techniques proposed, when the medication is prepared at the time of its use, the most recommended are those that use manual endodontic instruments or Lentulo aspirations. (LOPES; SIQUEIRA, 2015).

3.5.1 Manual endodontic instruments

A type K file with a diameter immediately below is used, and the last file used to make the apical preparation (memory file) must be selected for the insertion of the calcium hydroxide paste into the root canal. The instrument should be loaded with the paste into its spirals, slowly introduced to working length, brushed against the walls of the channel, and rotated counterclockwise for two or three times. Removal of the instrument should be performed slowly, without interrupting the counterclockwise rotation movement. This process should be repeated up to three times so that the entire channel is completely filled with the paste.

Subsequently, a radiographic examination should be performed. Once this is done, the paste is compacted with a sterile cotton wick of appropriate size, placed at the mouth of the canal and compressed with the tips of a clinical forceps or Paiva presser foot, to ensure the filling of the canal along its entire length. (LOPES; SIQUEIRA, 2015).

Figure 01: Representative image of a type K maual file that can be used for insertion of Calcium Hydroxide paste inside the root canal

SOURCE: https://www.dentalunic.com.br/produto/453/lima-k-file-n-10-25mm-dentsply-maillefer /

3.5.2 Lentulus Spiral

Lentulo coils are instruments that allow better application of calcium hydroxide paste inside the root canal. A study by Sigurdsson et al. He demonstrated the efficacy of the Lentulo spiral, endodontic files and syringe with needle in the placement of calcium hydroxide paste inside the mesiobuccal canals of maxillary first molars instrumented up to the K #25 file. It was concluded that the Lentulo spiral was more efficient in relation to the filling and compaction limit of the paste inside the root canals than to the filling and compaction limit of the paste inside the root canals. Lopes *et al*. In an in vitro study showed that the Lentulo spiral was more efficient than the McSpadden compactor in filling root canals with calcium hydroxide paste, probably due to the geometric shape of the instrument; McSpadden's compactor, has a larger straight section than the When the spiral of Lentulo is removed from the root canal, it shifts the paste to the side, thus leaving a higher percentage of voids.

To insert the calcium hydroxide paste into the root canal, the Lentulo spiral must have a diameter smaller than that at the end of the preparation, be placed to a depth of 2 to 3 mm below the working length and driven by a micromotor, at constant speed and with rotation to the right, for approximately 10 seconds.

Once the paste has been handled, spatulated presser feet will take small portions to the pulp chamber. Then the rotary instrument is loaded into its spirals with a small amount of paste and slowly introduced into the channel. Simultaneously, the Lentulo spiral is triggered to rotate to the right, with gentle and slow movements of penetration and removal, the root canal is filled. It is important that the instrument is removed from the channel while it is still rotating.

Next, the radiographic examination should be performed, and this procedure can be repeated until the canal is completely filled. As mentioned above, the paste must be compacted at the level of the inlet. (LOPES; SIQUEIRA, 2015).

Figure 02: Representative image of Lentulo

SOURCE: https://www.endovita.com.br/fabricante/tdk/).

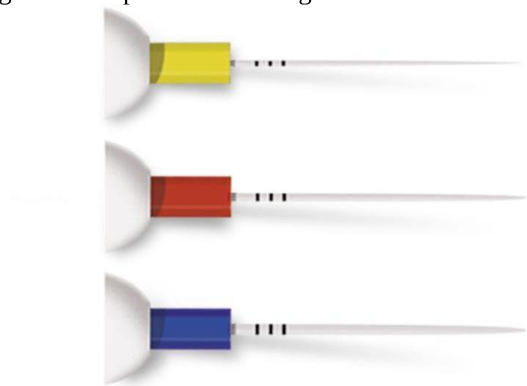
3.5.3 Endoactivator

The device uses subsonic vibration and can be used as an auxiliary resource for filling the canal with calcium hydroxide-based medication (RUDDLE, 2009). The author states that the oscillation of the plastic tip of the Endoactivator pushes the medication against all the walls of the root canal system. In this technique, using a steel file (conventional technique), the paste is taken into the canal, where the Endoactivator is used. This association aims to eliminate blisters by having the medication fill all the spaces in the root canal. This process can be repeated a few times, taking small amounts of the paste into the channel until it is completely filled.

Figure 03: Representative image of the Endoactivator instrument

SOURCE: http://endoactivator.com)

Figure 04: Representative image of Endoactivator Tips



SOURCE: http://endoactivator.com

4 CONCLUSION

One of the great challenges of endodontic treatment is to achieve asepsis of the root canal system through the elimination of pulp and periradicular pathogenic microorganisms.

Calcium hydroxide is the most widely used intracanal drug in the treatment of root canal infections, but it is not as efficient in eliminating *Enterecoccus faecalis*.

Although there are still divergences regarding the use of calcium hydroxide as an intracanal medication, studies point to its high efficacy in endodontic treatment, due to its high antimicrobial and antiseptic potential and in inducing periapical repair.

REFERENCES

CVEK, M.; HOLLENDER, L.; NORD, C. E. Treatment of non-vital permanenteincisors with calcium hydroxide.. VI. A clinical, microbiological and radiologicalevaluation of treatment in one sitting of teeth with mature or immature root. Odontol Revy, v.27, p.93-108, 1976.

ESTRELA, C. Endodontia Laboratorial e clínica. 1ª ed. São Paulo: Artes Médicas, 2013.

ESTRELA, C.; ESTRELA, C. R. D. A.; PÉCORA, J. D. A study of the time necessary for calcium hydroxide to eliminate microorganisms in infected canais. Journal of Applied Oral Science, v. 11, n. 2, p. 133-137, 2003.

Estrela, C.; Figueiredo, J. A. P. Patologia pulpar. In: Estrela, C., Figueiredo, J. A. P. Endodontia: princípios biológicos e mecânicos. São Paulo: ArtesMédicas, p. 137-166, 1999.

GOMES, B. P.; FERRAZ, C. C.; GARRIDO, F. D.; ROSALEN, P. L, et al. Microbial susceptibility to calcium hidroxide pastes and their vehicles. JEndod: v.28, p.758-761, 2002.

Holland R, Otoboni Filho JA, Souza V, Nery MJ, Bernabé PF, Dezan-Junior E. A comparison of one versus two appointment endodontic therapy in dogs' teeth with apical periodontitis. J Endod. 2003;29:121-4. http://dx.doi.org/10.1097/00004770-200302000-00009.

Lacerda, M. F. L. S. et al. Infecção secundária e persistente e sua relaçãocom o fracasso do tratamento endodôntico. Revistas Brasileira de odontologia. Rio de Janeiro, v. 73, n. 3, p. 212, 2016.

Lacerda, M. F. L. S. et al. Infecção secundária e persistente e sua relaçãocom o fracasso do tratamento endodôntico. Revistas Brasileira de odontologia. Rio de Janeiro, v. 73, n. 3, p. 212, 2016.

Lemos, E. M. Medicação Intracanal / MIC. Site Endo-e, 2005-2015.

LOPES, H. P.; SIQUEIRA, J. F. Endodontia: Biologia e Técnica 4ª. ed. Riode Janeiro: Ed. Medsi-Guanabara: Koogan S. A, 2015.

LOPES, Hélio Pereira ; SIQUEIRA Jr ., José Freitas. Medicação Intracanal.In: Endodontia: Biologia e Técnica. 2. ed . Rio de Janeiro: Guanabara Koogan,. v.19, p . 581 - 618 , c14 p 578 - 93,2004 .

LOUREIRO, M. A. Z.; BARBOSA. M. G.; CHAVES. G. S.; *et al*. Avaliação da composição química e radiopacidade de diferentes pastas de hidróxido de cálcio. Revista Odontológica Brasileira Central, v.80, n.27, p.19-23, 2018.

MASSARA, M. L. A.; TAVARES, W. L. F.; NORONHA, J. C, et al. A Eficácia do Hidróxido de Cálcio no Tratamento Endodôntico de Dentes Decíduos: Seis Anos de Avaliação. Pesquisa Brasileira de Odontopediatria de Clínica Integrada, v.12, n.2, p.155-159, 2012.

NERY, M. J. et al. Estudo longitudinal do sucesso clínico-radiográfico dedentes tratados com medicação intracanal de hidróxido de cálcio. Revista de Odontologia da UNESP. Araçatuba, p. 396-401, 2012.

RODRIGUES, M. C. M.; RANGEL, L. F.O.; PEREIRA, V. F. G. C.; et al. Avaliação do pH externo radicular do hidróxido de cálcio. Revista Odontológica de São Paulo, v.25, n.1, p.31-39, 2013.

ROSENBERG, B.; MURRAY, P. E.; NAMEROW, K. The effect of calcium hydroxide root filling on dentin fracture strength. Dent Traumatol, v.23, p. 26-29, 2007.

RUDDLE, J. Endodontic advancentsgame-changing Technologies. *Denttoday:*28: p.82-84, 2009.

SANTOS, E. L.; GAZONNI, A. F.; WGNER. CL. Análise da microbiota aeróbica endodôntica de dentes com e sem lesão periapical. Revista Ciênciae Saúde, v.17, n.1, p.33-39, 2015.

SIQUEIRA JUNIOR, J. F.; RÔÇAS, I. N.; LOPES, H. P. et al. Princípios biológicos do tratamento endodôntico de dentes com polpa necrosada e lesão perirradicular. Revista Brasileira de Odontologia, v.69, n.1, p.8-14, 2012.

SOARES, I. J.; GOLDBERG, F. Endodontia: Técnica e fundamentos. 2. ed.Porto Alegre: Artmed, 2011.

SOUZA FILHO, F. Endodontia Passo a Passo: Evidências clínicas. SãoPaulo: Artes Médicas, 2015.

ZAIA, A. A. Avanços atuais do tratamento endodôntico. Jornal da UNICAMP. São Paulo, 2008.

ZANDONÁ, J.; SOUZA, M. A. Características microbiológicas, patogenicidade e viabilidade do *Enterococcus faecalis* e seu cultivo in vitro em pesquisas microbiológicas na área da endodontia. Revista da Faculdadede Odontologia Universidade de Passo Fundo, v.22, n.2, p.255-260, 2017.