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Use of Sodium Hypochlorite versus Chlorexidine Gluconate as an Irrigating Solution in Endodontic Treatment: A Literature Review of the Period from 2006 to 2016

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Abstract

Sodium hypochlorite is an irrigant solution widely used in chemotherapeutic treatment for a long time with great effectiveness. Gluconate chlorhexidine is a newer product but with excellent properties but there is still considerable controversy over which is the best product for the treatment of the canal. This study aims to identify through literature review using articles from 2006 to 1016 the use of sodium hypochlorite versus chlorhexidine gluconate as a solution Irrigator in endodontic treatment. Both gluconate chlorhexidine and sodium hypochlorite have great properties fundamental for endodontic treatment, neither of which can be disregarded. It is only necessary to analyze in detail when to use the hypochlorite or chlorhexidine that can be used alternately in the preparation of the endodontic canal, taking due care not to use them simultaneously because interaction between the two products provide a high toxicity. Hypochlorite may be used to initiate treatment and dissolution of pulp tissue and to terminate chlorhexidine treatment after pre-cleaning the hypochlorite removal canal, taking full advantage of the two products' qualities for best results.

Keywords: Chlorhexidine Gluconate; Sodium Hypochlorite; Root Canal Irrigation

Introduction

The success of endodontic treatment is directly related to the observance of all principles recommended for the treatment of root canals such as complete cleaning, disinfection and elimination of all and any residual channel system and modeling prior to restoration [1-3]. The preparation of the canal is highly influenced by the complexity and anatomical variability of the root canals that have recesses, side channels, accessories, secondary, isthmuses, oval channels, multiple foramina and apical deltas, making it difficult to clean and disinfect the endodontic system.

Residual remains, bacteria, remains of necrotic pulp tissue and dentin fragments are common, and may be a nutrient medium for resilient bacteria [4]. The biomechanical preparation of the root canals occurs by three means: mechanical, chemical and physical. In this way the cleaning and disinfection of the channels does not only depend on the instrumentation but also on the chemical action of irrigating solutions with chemical properties such as solvency, antimicrobial activity and physical action of irrigation and aspiration [3,4].

The instruments have a limited action, reaching only the main channel light, do not reach the complex channel system, and approximately 50.0 % of the channel walls remain uninsulated during the mechanical mechanical preparation, resulting in insufficient cleaning [4,5]. Due to the limited action of the instruments, it is necessary to associate chemical substances with the instrumentation process in order to facilitate the action of the instruments, reaching the entire channel system, sanitizing the endodontic complex [6].

Other authors recommend the addition of chemical substances to the mechanical preparation in order to intensify the disinfection, obtaining a greater emptying and widening of the canal through the combination of chemical substance and endodontic instrument [7,8]. The irrigating liquid through physical action promotes hydraulic circulation through the interior of the canal, eliminating organic matter as well as fragments of dentin. This results in the decomposition of organic and inorganic tissues and the sanification of the canal [8-10].

Sodium hypochlorite (NaOCl) has been widely used worldwide since 1792 in medicine. In endodontia sodium hypochlorite, then known as the Dakin solution, was introduced by Barret in 1917 as a root canal irrigation solution with proven efficacy and antiseptic efficacy [11]. Coolidge also used sodium hypochlorite as a method of cleaning and disinfecting root canals in order to improve the results [11]. Walker in 1936, began to use root canal treatment with necrotic pulps solution irrigator with 5.0% sodium hypochlorite [12].

However, Grossman in 1943 was the major disseminator of the sodium hypochlorite solution irrigator with the use of channel irrigation technique alternating sodium hypochlorite at 5.0% hydrogen peroxide 3.0%, the reaction of the two substances culminated in effervescence with release of oxygen, favoring the extinction of microorganisms and channel residues [13]. Sodium hypochlorite belongs to the group of halogen compounds available in concentrations of 0.5 to 5.3% and up to 10.0% for clinical use [14].

Several studies aimed at evaluating the effects of sodium hypochlorite solutions on the decomposition of pulp tissue, on dentin permeability, on the cleaning of the canal and its bactericidal action, in its different concentrations emphasizing the superiority of sodium hypochlorite solutions compared to other auxiliary solutions of the channel preparation [15]. Since sodium hypochlorite has been used for a long time, its results are already widely proven, based and consolidated in the international literature.

On the other hand, chlorhexidine appeared through studies with the aim of finding a new antimalarial agent, being developed polyibisguanide compounds that had a significant antimicrobial potential called cationic detergent and later gluconate chlorhexidine. This compound was the basis for the production of a salt that reached the consumer market under the name of chlorhexidine gluconate in 1954 [15]. As chlorhexidine gluconate exhibits an excellent degree of skin affinity, it is the first international antiseptic indicated for skin asepsis due to its good antibacterial activity and low levels of toxicity. Chlorhexidine gluconate was introduced in dentistry around 1959 for the control of bacterial plaques and its use, in general, occurred around 1970 [15,16].

Among the main advantages of chlorhexidine gluconate are: enlargement and modeling of the canal system, elimination of microorganisms and their by-products, live or necrotic pulp tissue [15]. There are still many disagreements as to which chemical agent would have its most suitable qualities for the irrigation of the canal system provoking numerous discussions and controversies between the defenders of sodium hypochlorite and chlorhexidine gluconate, which justifies if we analyze in more detail the literature produced in the the last 10 years on the employment advantages and disadvantages of each product [16]. The present study aimed to identify through a review of the literature in the period from 2006 to 1016 the use of sodium hypochlorite versus chlorhexidine gluconate as an irrigating solution in endodontic treatment.

Methods

Experimental and clinical studies were included (case reports, retrospective, prospective and randomized trials) with qualitative and / or quantitative analysis. Initially, the key words were determined by searching the DeCS tool (Descriptors in Health Sciences, BIREME base) and later verified and validated by MeSh system (Medical Subject Headings, the US National Library of Medicine) in order to achieve consistent search.

Mesh Terms

The words were included Chlorhexidine gluconate, sodium hypochlorite, root canal irrigation. For further specification, the root canal irrigation description for refinement was added during searches. The literature search was conducted through online databases: Pubmed, Periodicos.com and Google Scholar. It was stipulated deadline, and the related search covering all available literature on virtual libraries.

Series of Articles and Eligibility

A total of 45 articles were found involving temporomandibular dysfunction. Initially, it was held the exclusion existing title and duplications in accordance with the interest described this work. After this process, the summaries were evaluated, and a new exclusion was held. A total of 27 articles were evaluated in full, and 19 were included and discussed in this study.

Literature Review

Main Considerations on the Sodium hypochlorite

Sodium hypochlorite belongs to the group of halogen compounds, it is an active chlorine solution with a high pH around 11 to 12, it is more stable promoting the release of chlorine in a slower way due to the action of hydroxyl ions [2]. In order for a sodium hypochlorite solution to be effective its properties must be preserved by suitable chemical standards as the shelf life and as close as possible to the date of manufacture, storage in amber glass away from the light and preferably in the refrigerator, and the same concentration as described on the label by the manufacturer, excess light and heat lead to loss of the chlorine content of hypochlorite [3,4].

It is essential that the dental surgeon obtain a good quality hypochlorite with adequate concentration, it is common to find some products outside the specifications described on the packaging label. Factors such as instability and climate in our country (high temperatures, sunlight) facilitate the loss of active chlorine concentration more rapidly over time making the solution ineffective [5,17].

Main Considerations for Chlorhexidine

Chlorhexidine gluconate is available on the market under liquid or gel at different concentrations, the most used in dentistry is 2.0% [17,6]. Chlorhexidine gluconate is used as a channel irrigant solution and intracanal medication (alone or in combination with other substances). Chlorhexidine has a mild acid character, with a more stable pH ranging from 5 to 8.0, but its higher antibacterial efficiency is concentrated in the pH range of 5.5 to 7 [7].

Antimicrobial Activities

Sodium hypochlorite: Sodium hypochlorite presents different concentrations and has great advantages as: tissue solvent, its high alkaline pH neutralizes the acidity of the medium, making it unsuitable for bacterial development, forming as a powerful bactericide and also the formation of hypochlorous acid and release of chlorine leads to the saponification of fats, destruction of the membrane phospholipid layer of bacteria [8-10].

The high pH of sodium hypochlorite interferes in the integrity of the cytoplasmic membrane, inhibiting the enzymes irreversibly, causing biosynthetic changes in the cellular metabolism leading to irreversible inactivation of bacterial enzymes, forming as an excellent effective antimicrobial agent and organic solvent [11].

The concentration of sodium hypochlorite is proportional to its antimicrobial and solvent activity, that is, the more concentrated the sodium hypochlorite solution, the greater its antimicrobial activity [12]. Sodium hypochlorite solutions with chlorine concentrations below 0.3% have no effect on microorganisms such as Candida albicans and Streptococcus faecalis [2,3].

In their study Chandra et al. [6] found that 5.3% sodium hypochlorite had superior antimicrobial efficacy compared to chlorhexidine gluconate 2.0% and EDTA 17.0% when used alone. Already in association with 1% clotrimazole, 5.3% sodium hypochlorite and 2.0% chlorhexidine gluconate also showed significantly higher antifungal properties than EDTA at 17.0%, proving that clotrimazole associated with gluconate of chlorhexidene 2.0% or sodium hypochlorite 5.3% were effective in combating *C. albicans* in the final irrigation of the root canals.

The study by Ferraz et al. [8] compared the action of the antimicrobial activity of chlorhexidine gluconate 0.2% gel; 1.0% and 2.0%, liquid chlorhexidine gluconate and sodium hypochlorite at various concentrations as an irrigating solution. It was found that the chlorhexidine gluconate at 2.0% gel presented a statistically significant difference when compared to sodium hypochlorite and liquid chlorhexidine gluconate, proving its great antimicrobial potential.

Some studies recommend the use of 2.5% sodium hypochlorite as the first choice to obtain quality sanitation, but emphasize the importance of controlling the volume of solution used and the contact time in the channel system during the mechanical chemical preparation [12-15]. Ribeiro et al. [14] warns that the higher the concentration of sodium hypochlorite solutions, the greater the loss of collagen; in the case of solutions at 5.3% there are negative effects on tooth properties, reducing their flexural strength and dentin elasticity.

On the other hand, Pretel et al. [13] recommends sodium hypochlorite in the concentration of 2.5% to 5.3%, as the most indicated in the necroses because it presents a better antimicrobial effect against resistant microorganisms like Enterococos faecalis and Candida albicans, but smaller concentrations as 0.5% and 1% can be used in biopulpectomies. One of the main disadvantages of sodium hypochlorite is the high irritability of the periapical tissues, high concentrations [16]. When analyzing the antimicrobial action of 2% chlorhexidine gluconate, 1% sodium hypochlorite and paramurochlorophenol combined with furacin against strains of S. aureus, C. albicans, E. faecalis and P. aureginosa, Semenoff et al. (2010) and found that both 2.0% chlorhexidine gluconate and 1.0% hypochlorite had higher inhibition factors in that the PMC paramnonchlorophene combined with furacin was not effective against the tested microorganisms. In this way, the supremacy of both chlorhexidine gluconate and hypochlorite was proved to be bacteriostatic.

Chlorhexidine Gluconate

Chlorhexidine gluconate acts by adsorption on the cell wall of the microorganism attacking the cytoplasmic membrane of the bacterium, causes precipitation and coagulation of the cytoplasm, leading to osmotic imbalance, resulting in extravasation of the intracellular material [16,18]. Chlorhexidine gluconate can be both bacteriostatic at low concentration (0.2%) causing inhibition of ATP synthesis of bacteria and bactericide at high concentrations (2%) causing cytoplasmic membrane rupture, that is, it depends on the concentration used [13]. The action of chlorhexidine gluconate is broad spectrum acting against a large number of aerobic and anaerobic bacteria and against Gram-positive and Gram-negative species, with Gram-positive being highly susceptible to Gram-negative species [16].

Chlorhexidine gluconate has a long-lasting antibacterial and disinfectant effect that can be extended from day to week, with the ability to control the growth of Gram-positive and Gram-negative bacteria [18,19]. Although chlorhexidine gluconate does not exhibit the ability to dissolve organic tissues, it has other advantages that compensates for this deficiency, such as chlorhexidine gluconate gel that favors instrumentation, elimination of organic tissues, keeps the "active principle" in contact with the microorganisms for long periods and growth inhibitory effect [12].

Both liquid chlorhexidine gluconate and 2.0% gel are widely effective against various bacterial species but the 2.0% gel exhibits a high inhibitory growth power including Enterococcus faecalis and Staphylococcus aureus and yeast and fungi, in particular Candida albicans. Chlorhexidine gluconate does not have an effective efficacy in organic matter, mycobacteria, bacterial spores and viruses [12]. For Bonan, Batista, Hussne [17] sodium hypochlorite and chlorhexidine gluconate both exhibit antimicrobial action, a primordial and indispensable quality in an endodontic solution.

Biocompatibility

Sodium hypochlorite: Hypochlorite at lower concentrations (0.5% and 1.0%) is well tolerated by tissues, but at concentrations at 5.3% causes intense tissue injury. That is, the higher the concentration of sodium hypochlorite solutions, the greater the inflammation of the connective tissue. It has been observed that the extravasations of sodium hypochlorite to the periodontal tissues caused hematoma, edema, intense pain, haemorrhage, paraesthesia, hyperesthesia, emphysema and even tissue necrosis [18].

According to Ribeiro et al. [14] Sodium hypochlorite at low concentrations (0.5% and 1.0%) presented advantages over higher concentrations (5.25%) mainly with respect to biological compatibility, dentin effects and chemical stability, with satisfactory antimicrobial results. Sodium hypochlorite has a high pH (close to 11), but when in lower concentrations it expresses good tissue compatibility, but maintains its superior capacity for dissolution of organic tissue, besides presenting better chemical stability [14].

Chlorhexidine Gluconate

Bonan, Batista and Hussne [12] point out that chlorhexidine gluconate exhibits excellent biocompatibility, does not irritate periapical tissues and is indicated for allergic individuals and hypersensitivity to sodium hypochlorite and in cases of open apex teeth.

Chlorhexidine gluconate also exhibits the characteristic of the substantivity, or residual effect which is the ability to remain active and retained at the site of action for long periods with slow and continuous release after termination of its use permanence and may have the residual effect from hours to weeks [12], which is characterized by the fact that the bacterial cell wall of the bacterial cell membrane.

Marion et al., 2013 shows that the residual antibacterial effect of chlorhexidine gluconate is due to its ability to bind to hydroxyapatite, which promotes its gradual release by maintaining a constant level of molecules sufficient to create a bacteriostatic environment within the root canal long periods [12]. The substantivity of chlorhexidine gluconate is a feature of great relevance in cases of necrotic and infected pulp [14].

Dissolution of Pulpar fabric

Sodium hypochlorite: Several factors influence the degradation of tissues such as volume of hypochlorite present, frequency and intensity of the irrigant flow, the contact surface between the tissue and the solution, influence the degradation power of sodium hypochlorite. Several studies consider the rate of tissue degradation is proportional to the concentration, temperature and also pH of sodium hypochlorite solutions. The higher the concentration of the solution, the faster the tissue dissolution, and the higher temperature also provided a higher dissolution rate than the concentration variation (RIBEIRO et al, 2010).

The study by Só et al. (2011) tested the degradation effect of sodium hypochlorite and EDTA at various concentrations found that the 2.5% sodium hypochlorite solution is extremely efficient promoting a complete dissolution of the pulp tissue, while that EDTA was not completely effective in any of the samples. One of the main characteristics of sodium hypochlorite and its capacity for complete degradation of organic tissues is considered by many authors as their main advantage over chlorhexidine [17].

Chlorhexidine Gluconate

Chlorhexidine gluconate does not have the capacity for tissue degradation or the ability to inactivate lipopolysaccharides in the same way as sodium hypochlorite. The use of a calcium hydroxide based dressing in cases of necrotic and infected pulp where only chlorhexidine gluconate is used [17] is recommended.

It is not recommended to mix solution of sodium hypochlorite and chlorhexidine gluconate 2.0%, as this chemical interaction promotes color change, precipitation and forming a byproduct, Para Chloroaniline (PCA), resulting from the hydrolysis of chlorhexidine gluconate, an acid reaction -base. Para Cloroaniline, (PCA) is potentially toxic, carcinogenic and causes methemoglobinemia and cyanosis, in addition to being cytotoxic. Because of an acid-base reaction, this occurs when mixing sodium hypochlorite and chlorhexidine gluconate, the formation of highly toxic precipitate occurs [12].

Several authors, after research, advocate avoiding the association of chlorhexidine gluconate and sodium hypochlorite, as such chemical interaction produces a toxic precipitate [2-5]. Other byproducts that can present pathological action as free radicals.

The association of chlorhexidine with EDTA causes a chemical interaction producing a white-milky precipitate which, when combined with saline and ethanol, produces a precipitation of salt [12]. The use of sodium hypochlorite as an irrigating solution during the chemo mechanical preparation, and chlorhexidine gluconate as irrigator at the end of the procedure or as an intracanal medicine is recommended only after complete removal of sodium hypochlorite from the root canal, with the aim of chemical interactions between them. It can be used as a complementary irrigant solution, distilled water or abundant saline [12].

Or they indicate, in order to avoid PCA formation, irrigation with alcohol or EDTA after the use of sodium hypochlorite, if chlorhexidine gluconate is used sequentially [14].

Cytotoxicity

Chlorhexidine Gluconate: Chlorhexidine gluconate is a stable substance with absent cytotoxicity, minimally absolved by the skin and mucosa, with no cumulative effect, with excellent biocompatibility. There is no description in the literature of adverse effects following the use of chlorhexidine gluconate as a medicinal product or intracanal irrigant [15]. Gomes-Filho et al [11] confirmed in their experiment the high toxicity of sodium hypochlorite 5.3% in irrigation for subcutaneous connective tissue.

Rheological Action

Chlorhexidine Gluconate: The chlorhexidine gluconate gel has a viscosity that allows it to fill all the spaces of the pulp chamber and root canals during mechanical chemo preparation, facilitating the detachment of organic and inorganic debris and keeping them in suspension within the root canal in the amorphous mass of the gel, made easier to be removed by irrigation with serum or distilled water, in addition to leaving almost all the dentinal tubules open, facilitating the removal of the debris, preventing them from accumulating in the walls of the canals [12,15].

Conclusion

Both chlorhexidine gluconate and sodium hypochlorite have great fundamental properties for endodontic treatment and neither product can be disregarded. It is only necessary to analyze in detail when hypochlorite should be used and when chlorhexidine gluconate can be used that can be used alternately in the preparation of the endodontic canal and should not be used simultaneously, since the interaction between the two products provides a high toxicity. Hypochlorite may be used to initiate the treatment and dissolution of pulp tissue and to terminate treatment with chlorhexidine gluconate after precleaning the channel to remove sodium hypochlorite, taking maximum advantage of the qualities of the two products and obtaining better results.

Conflict of interests

There is no conflict of interest between authors.

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