Chlorhexidine: a novel perspective in Endodontics

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ABSTRACT

Introduction: Chlorhexidine demonstrates effective results in endodontics as an irrigation substance, or as an intra-canal medication. **Aim:** The aim of this study is to review the literature about the properties of chlorhexidine, emphasizing new findings about the use of this substance as an intra-canal medication, and as an irrigation substance. **Methods:** Thus, a search was performed on the online databases Bireme and Google Scholar using the keywords irrigation substances, chlorhexidine, and sodium hypochlorite, restricting the search to the period from the year of 2000 to August of 2015. Results: It was found that Chlorhexidine presents a wide range of properties that enhance its potential as an irrigation substance when compared to sodium hypochlorite, such as antimicrobial effect, substantivity, and low toxicity. Due to all the before mentioned characteristics, chlorhexidine has been considered a novel perspective in the treatment of endodontic infections, even though sodium hypochlorite is still the irrigation substance of choice among clinicians. **Conclusion:** Therefore, this study demonstrated that chlorhexidine is an effective alternative to the disinfection and treatment of the root canals.

Keywords: Root canal irrigants. Chlorhexidine. Sodium Hypochlorite

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Introduction

Complete disinfection of the root canal system is achieved when an efficient biomechanical instrumentation is associated with the use of irrigation substances with antimicrobial properties compatible with the periapical tissues. The success of the endodontic therapy is strictly associated with the control and elimination of microorganisms from within the root canals, which makes the use of irrigation substances an important aspect of the treatment of teeth undergoing endodontic infections.[1] Sodium hypochlorite is the most used and studied irrigation substance in endodontics, however, chlorhexidine has also been considered an alternative irrigation solution and intra-canal medication.[2] Such substance has both gram-negative and gram-positive spectrums of antimicrobial action. It also demonstrates antiseptics properties due to its bacteriostatic effects, which are empowered by the substantivity and biocompatibility of the chlorhexidine.[2] All the before mentioned characteristics make chlorhexidine an effective product, and promotes its potential for the success of the endodontic treatment.

Microorganisms and bacterial products are involved in the etiology of diseases of the pulp and periapical tissues. When they are present within the root canals, their removal is performed through the combination of mechanical instrumentation aided with antimicrobial irrigation solutions.[3] Since the aim of the endodontic treatment is to eliminate the bacteria present within the root canals,[1] which diminish the risk of reinfection, only the right combination of mechanical techniques and chemical cleaning is capable of guaranteeing the healing of the periapical tissues.[4]

Even knowing that the mechanical instrumentation and modeling of the root canals is responsible for reducing the number of microorganisms significantly, these procedures do not penetrate the dentin tubules, a fact that makes the complete removal of bacterial impossible. From this perspective, the importance of using irrigation solutions to clean the root canal system arises.[5]

Since remains of pulp tissue can still be present within the dental tubules of the root canal system after the instrumentation, an ideal irrigation solution has been searched.[6] Among the currently used substances, sodium hypochlorite is the solution of choice. However, when it is used at high concentrations, caution must be reinforced. Mainly, when irrigating tooth with wide apex foramen or necrotic pulp, cases when the solution might extrude from the root canal.[7] Pretel et al.[8] explains the preference for sodium hypochlorite based on the antimicrobial effects of the solution, and on its capacity of dissolving organic tissue.

Other chemical agents, such as chlorhexidine, have been on focus of investigations due to properties, such as broad antimicrobial spectrum, high substantivity and biocompatibility.[9] Chlorhexidine is a cationic agent that binds the anionic surface of the microorganisms, affecting the anatomical integrity of the cytoplasmic membrane. This alteration changes the cellular osmotic equilibrium, interfering in the biological metabolism, growing, cell division, and in the anaerobic respiratory processes of the bacteria.[10,11]

Moreover, chlorhexidine can interact with oral tissues, which prolongs its liberation. Other advantage of the chlorhexidine is its capacity of maintaining disinfectant activity after the contact with organic materials. This characteristic reduces the risk of reinfections.[3]

Investigations have highlighted the potential of chlorhexidine as an alternative intra-canal medication due to its broad antimicrobial spectrum, and to its capacity of adhering to the dentin tubules walls.[12] Reinforcing this potential, Khademi el al.[13] demonstrated that a five-minute application of 2% chlorhexidine induces substantivity for at least 4 weeks.

Regarding the efficacy of the different pharmacological presentations, Ferraz et al.[14] showed that all the concentrations of chlorhexidine gel (0.2%, 1% e 2%), and solution (0.2%, 1% e 2%) tested against Staphylococcus aureus, Enterococcus faecalis, Streptococcus sanguis, S. sobrinus, Actinomyces naeslundii, Porphyromonas gingivalis, P. endodontalis, Prevotella intermedia and Prevotella denticol were somehow capable of reducing the bacterial count. The authors also highlight that sodium hypochlorite did not show similar results, mainly in lower concentrations.

Furthermore, studies have been showing the potential of chlorhexidine as an irrigation solution, since it can bind to hydroxyapatite, changing the dental surface electrical profile, hindering the micro-

bial adhesion.[5] Research has been done to improve the benefits of chlorhexidine, such as the association of it in the gel form with sodium hypochlorite solution. The viscosity of the resulting solution balances the incapacity of dissolving pulp tissues that the chlorhexidine presents. It also works as a lubricant, facilitating the mechanical instrumentation. Such improvement allows a more effective cleaning of the root canals, since it removes dentin debris, and organic tissue remains.[5]

Other combinations have also been tested as Souza-Filho et al.[2] show. These authors evaluated the effects of the association of chlorhexidine gel associated with calcium hydroxide, and with iodine. The better antimicrobial activity was shown by the chlorhexidine alone, followed by the association of it with calcium hydroxide, and iodine. These results allow the inference that chlorhexidine does not necessarily need an additive solution to work satisfactorily as an intra-canal medication.

Mechanical instrumentation promotes microbial disorganization, but eventually the canal is not completely sealed, and reinfection takes place. It is often caused by Enterococcus faecalis, a microorganism that can recolonize the root canals and form other biofilm.[15] Chlorhexidine has been proven to be more effective in the elimination of Enterococcus faecalis than calcium hydroxide.[6] Gomes et al.[16] also demonstrated that chlorhexidine was able to reduce bacteria and lipopolysaccharides from periapical and periodontal tissues, as well as endotoxin from the infected root canals.

Given the exposed, and knowing that there is a strong need of finding irrigation solutions with biocompatibility, the aim of this study is to review the literature about the properties of chlorhexidine as an intra-canal medication, and as an irrigation substance.

Material and methods

The electronic databases Bireme and Google Scholar were used in August 31 of 2015 to identify eligible studies using the descriptors: irrigation substances, chlorhexidine, and sodium hypochlorite combined. The time limit used for searching the articles was 2000-2015. The search resulted in the selection of 20 publications that had their full texts read.

Results

Table 1 presents a summary of the selected data. The selected publication showed that even though the use of chlorhexidine in endodontics is considered a novel perspective, this substance presents several important properties desired for an irrigation solution or intra-canal medication. According to the results, chlorhexidine also works as a lubricant due to its viscosity, a property that facilitates the insertion of instruments into the canal, aiding the mechanical instrumentation.

Discussion

Irrigation solutions are important to the chemical and mechanical preparation of the root canals, since they improve the cleaning, and act as a lubricant, which facilitates the use of endodontic files, and enhance the removal of debris. They also have antimicrobial effect, and dissolve organic material without causing damage to the periapical tissues.

According to Estrela et al,[24] the selection of an irrigation solution depends on the effect of the substance on the microorganisms. Even showing a number of advantages, chlorhexidine is still underused when compared to sodium hypochlorite. Pretel et al.[8] justifies this event based on the capacity of dissolving organic material that the hypochlorite possesses. However, evidences show that, at higher concentrations, the use of such solution must be handled carefully, mainly in necrotic teeth, or in those teeth with wide apex foramen.[7]

Chlorhexidine has been studied and used due to its substantivity, low toxicity, and antimicrobial effect. Gomes-Filho et al.[5] emphasizes that chlorhexidine is an alternative to the use of sodium hypochlorite, and that these two substances can be used together. However, when this combination is chosen, a dark precipitated is formed within the tooth, staining the dentin in a brown shade. Previous studies have suggested that this precipitate contained para-chloroaniline (PCA) in its composition[25,26]. However, for Orhan et al[27] the tests used for analysis showed different results, not containing free PCA. In the form of gel, chlorhexidine has been shown to be effective in reducing the microorganisms from the root canals, which allows a good performance as an intra-canal medication. Gomes-Filho et al.[5] and Gomes et al.[16] affirm that the use of this gel has been recom-

Table 1. Summary of the publications selected to compose the literature review.

Authors	Properties of chlorhexidine
Torres et al.[9] (2000)	It is safe and effective, and presents high substantivity.
Estrela et al.[10] (2003)	It is a cationic agent with antimicrobial effects.
Amorim et al.[3] (2004)	It is capable of interacting with oral tissues, and continue to be released for long time periods. It maintains disinfectant effect even in contact with organic material.
Mônika et al.[12] (2006)	It is an antimicrobial agent of broad spectrum that can be used as an irrigation solution and as an intra-canal medication. It disinfects the dentin tubules and binds to the them.
Khademi et al.[13] (2006)	A five-minute application of 2%, chlorhexidine has a 4-week substantivity.
Ferraz et al.[14] (2007)	Higher antimicrobial inhibition is found when 2% chlorhexidine gel is used.
Gomes-Filho et al.[5] (2008)	It is capable of biding to hydroxyapatite, changing the electrical field of the tooth, which impedes microbial adhesion, and prolongers the residual effect of the substance. The gel consistency of the chlorhexidine positively balances its incapacity of dissolving pulp tissues because this property facilitates the mechanical instrumentation, and the cleaning of the root canals.
Souza-Filho et al.[2] (2008)	Compared to other intra-canal medications, 2% chlorhexidine gel showed the higher antimicrobial effect against all of the microorganisms tested.
Semenoff et al.[15] (2008)	It might be considered an alternative to the use of calcium hydroxide to eliminate E. feacalis, since evidences show that this last medication does not have enough effectiveness.
Maia Filho et al.[6] (2008)	It was more effective in eliminating E. feacalis than calcium hydroxide.
Basrani et al.[4] (2009)	As an irrigation solution, it showed excellent antibacterial effects. It has a lower toxicity level, and does not dissolve organic tissue.
Gomes et al.[16] (2009)	It is not capable of eliminating endotoxins from the infected canals. Sodium hypochlorite as is not as well.
Mohammadi et al.[11] (2009)	Comparative studies demonstrated confusing results regarding the effects of chlorhexidine and sodium hypochlorite. However, the studies show similar effects when the substances are used in the same concentrations.
Arias-Moliz et al.[17] (2010)	It is effective in the elimination of E. faecalis biofilm when associated with cetrimide, or when these two substances are used alternately.
Baca et al.[19] (2011)	Regardless of the chelator substance used, chlorhexidine was the most effective irrigation solution in the elimination of bacteria from the root canals.
Siqueira Júnior[18] (2011)	It is highly effect against fungus and bacteria due to its substantivity on the dentin, which ensures antimicrobial effects even after the irrigation.
Tavares et al.[20] (2013)	Chlorhexidine demonstrates effective results regarding the reduction of periapical inflammation 15 days after the clinical procedure.
Du et al.[21] (2014)	2% Chlorhexidine, and 2% sodium hypochlorite exhibited the same antimicrobial performance when used during the same time period.
Arslan et al.[22] (2014)	2% Chlorhexidine associated with 7% maleic acid, or 10% citric acid was more effective in removing calcium hypochlorite from the root canals than the other substances studied
Bötcher et al.[23] (2015)	2% chlorhexidine was found within the root canals 48 hours and 7 days after the first clinical application, which is beneficial in the reduction of E. faecalis biofilms.

mended because its viscosity balances the incapacity of dissolving organic tissues that the chlorhexidine has. The viscosity also aids the mechanical instrumentation, since the gel serve as a lubricant, which enhances the removal of debris from the canal.

In cases of retreatment, the prognosis is less favorable due to the composition of the infective biofilm. E. faecalis is the most prevalent microorganism in cases of reinfection, representing 38% to 70% of the microbiota of re-infected root canals. Chlorhexidine has been shown to be more effective against this kind of bacterium than calcium hydroxide.[6] Estrela et al,[24] however, showed that chlorhexidine and sodium hypochlorite have low capacity of eliminating E. faecalis.

The excellent antimicrobial property of chlorhexidine is also beneficial for patients allergic to sodium hypochlorite, and for those who have teeth with wide periapical lesions because, in these cases, sodium hy-

pochlorite can extrude from the canal to the apex.[7,18] Chlorhexidine is not capable of dissolving organic tissues, and it also presents low toxicity, which reduces the risks of harming the periapical and periodontal tissues

Conclusion

The success of endodontic procedures is a strong concern for clinicians. Although sodium hypochlorite is still the irrigation solution, chlorhexidine has also been considered a potential alternative for the treatment of the root canal system.

It shows antimicrobial activity similar to the sodium hypochlorite, and facilitates the mechanical instrumentation when a viscous form is used. It also binds to the dentin debris, facilitating their removal from the root canals. It is safer to be used, mainly when a complication occurs, such as extravasation of irrigation solution. However, since the use of chlorhexidine is a novel perspective in endodontics, further investigation is needed to prove the advantages of its use compared to the use of sodium hypochlorite.

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