REVIEW ARTICLE

SODIUM HYPOCHLORITE: A LITERATURE REVIEW

Amrit Pal Singh[1]

ABSTRACT

The goal of the endodontic treatment is to disinfect the entire root canal system. This requires the removal of infected pulp. This is achieved by the combination of mechanical instrumentation along with chemical irrigation. Chemical irrigation is necessary as it may reach the areas where the mechanical instrumentation cannot reach. Many such irrigants are available in the market. Sodium Hypochlorite is an excellent antimicrobial agent and is used widely during root canal treatments. This paper reviews properties of sodium hypochlorite as used in Endodontics.

Keywords: *Sodium hypochlorite, root canal irrigant, NaOCl*

INTRODUCTION

Sodium hypochlorite is a sodium salt of Hypochlorous acid. It has high broad antimicrobial and tissue dissolution capacities. It encompasses many desirable properties of an ideal root canal irrigant. It also has a broad spectrum of antimicrobial activity against endodontic microorganisms, by its ability to oxidize and hydrolyze cell proteins. Its tissue solvent capacity, low surface tension and its lubricating action in the canal increases its value as an endodontic irrigantsolution.[1] It is used in endodontic procedures in concentration ranging from 5.25% to 7.0%.[2]

Although, sodium hypochlorite solution is relatively cheap and has broad antimicrobial activity, but also has disadvantages of beingcorrosive to metals, hypertonic, strongly alkaline and it also has a very bad taste.[3] The paper reviews properties of sodium hypochlorite as used in Endodontics.

Mechanism of Action of Sodium Hypochlorite

In Water:

$NaOCl + H_2O \leftrightarrow NaOH + HOCl \leftrightarrow Na^+ + OH^- + H^+ + OCl^-$

1. Zonal Operation Manager, Clove Dental, Amritsar

Corresponding Author
Amrit Pal Singh
Zonal Operation Manager, Clove Dental, Amritsar
Email: dramrit3@gmail.com

Tissue Dissolving:

Sodium hypochlorite reduces the Surface tension of the solution by dissolving organic fatty acids and converting them into fatty acid salts and glycerol. Sodium hypochlorite also neutralizes amino acids, thus forming water and salt. As the Hydroxyl ions exits, there pH is reduced.[4]

The Chlorine released from Hypochlorous acid acts as solvent for organic tissues and interferes with their cell metabolism.[4]

Antibacterial activity: Sodium hypochlorite is a strong base. The high pH of sodium hypochlorite causesirreversible inhibition of enzymes, alteration in cellular metabolism (Chloramination) and phospholipid degradation.[5]

Properties of Sodium Hypochlorite

The basic properties of Sodium hypochlorite are:

1. Ability to dissolve organic tissues
2. Antimicrobial action
3. Alkaline pH
4. Deodorant action
5. Low surface tension
6. Effectiveness time

1. Ability to dissolve organic tissues:

Sodium hypochlorite degrades fatty acids and lipids resulting in soap and glycerol. The ability of NaOCl to dissolve organic tissues depends on its concentration

Spano et al (2001) studied the effect of solvent, the level of residual chlorine, pH and surface tension before and after dissolution of tissues, of four different concentrations of NaOCl (0.5%, 1.0%, 2.5%, and 5.0%) on bovine pulp tissue. The higher concentrations of NaOCl were more rapid on dissolution of the pulp tissue.[6]

2. Antimicrobial action:

The effective antimicrobial action of sodium hypochlorite is due to the hypochlorous acid ($HOCl^-$) and hypochlorite ions (OCl^-) present in the solution. They release chlorine, which is a strong oxidant, and inhibits bacterial enzymes which leads to an irreversible oxidation of SH groups (sulphydryl group) of essential bacterial enzymes.

Ludin N et al (2013) studied antimicrobial activity of sodium hypochlorite against E.faecalis, and concluded that Sodium hypochlorite possess an effective antibacterial action against E. faecalis and their level of effectiveness depended mainly upon their concentration, with high concentrations (4-5%) being most effective.[7]

Dioguardi M et al (2018) studied different methods to improve efficacy of Endodontic irrigants and found that the Sodium Hypochlorite was the only irrigant that could dissolve the necrotic pulp residues ans dental collagen, but it was not effective against the smear layer.[8]

3. Alkaline pH:

Sodium hypochlorite has a highly alkaline pH (pH = 11-13), that has harmful biological effects on bacterial cells, contributing to its high bactericidal action.

Jungbluth H et al (2011) studied the stabilization of sodium hypochlorite at high pH and their effects on soft tissue and dentin andconcluded that NaOH-stabilized NaOCl solutionshave a higher alkaline capacity and are thus more proteolytic than standard counterparts.[9]

4. Deodorant action:

The NaOCl solution also acts as a deodorant substance by acting on fatty acids and lipids (saponification), releasing soap and glycerol.

According to Gomes, Drucker and Liley (1996), infections caused by anaerobic bacteria often produce strong odor due to the production of short-chain fatty acids, sulfur compounds, ammonia and polyamines. Chlorine through its oxidative action, eliminates the fetid odor produced by necrosis.[10]

According to Estrela et al (2002), NaOCl neutralizes the amino acids forming water and salt. With the output of hydroxyl ions, a reduction in the pH occurs.[11]

5. Low surface tension:

Another factor to be mentioned on the NaOCl solutions is its low surface tension, which allows it to penetrate deep inside the dentinal tubules. Sodium hypochlorite 1% solution presents a surface tension equal to 75 dynes/cm. The reduction in the surface tension of these substances was investigated by Pecora, Guimaraes and Savioli (1991); Lopes, Siqueira Jr. and Elias (2004).[12]

6. Effectiveness time:

Milano et al (1991) observed in vitro that the pulp dissolution time with different NaOCl concentrations. A 0.5% solution of NaOCl took 2 hrs to eliminate all the colonies of E.faecalis, 1% solution took 1 hr, 2.5% solution took 30 mins, whereas a 5.25% solution took 20 mins. took eliminate all the colonies of E.faecalis.[13]

Radcliffe et al (2004) compared the effectiveness time of different concentrations of NaOCl on Actinomyces naeslundii, Candida albicans and Enterococcus faecalis. All concentrations proved effective against Candida albicans and Actinomyces naeslundii in less than 10 second.[14]

Interactions of sodium hypochlorite with other irrigants

Reaction with chlorhexidine:

Mixing sodium hypochlorite with liquid chlorhexidine results in the instant formation of a flocculate or precipitate. Several investigations have been undertaken to elucidate the chemical composition of the flocculate produced by the association of NaOCl with CHX. Different proportions and concentrations of NaOCl (0.5%, 2.5%, and 5%) and CHX (0.2%-2%) have been mixed, which results in the formation of a brownish flocculate evident when the solutions make contact with each other; atomic absorption spectrophotometry showed the presence of *Ca, Fe, and Mg.*

An ex vivo investigation compared the effects of combining 1% NaOCl and 2% CHX on dentinal permeability as measured by Rhodamine leakage in percentage. When compared against a ‘‘no irrigation’’ control, the mixture of NaOCl and CHX caused a reduction of permeability only in the apical third. This was explained by the formation of a brown mass suspended in the liquid that becomes a flocculate precipitate, which actedas a ‘‘chemical smear layer.’’ Therefore it is evident that interaction between NaOCl and CHX has a negative effect on the performance of NaOCl.[15]

Interactions of sodium hypochlorite with chelating agents

When EDTA is added to NaOCl, the consequences of chemical interactions between chelating agents and NaOCl result in a loss in the free available chlorine. The degradation of EDTA after its interaction with NaOCl is extremely slow, and, therefore, it does not compromise its clinical performance.[16]

Drawbacks of Sodium Hypochlorite

Sodium hypochlorite (NaOCl) is the most commonly usedirrigating solution, as it has a low-cost and is very effective against the microbiota present in the root canals. The concentration of NaOCl as a solutionmay vary from 0.5% to 7.0% and its biocompatibility is inversely proportional to its concentration. Its drawbacks include its inability to remove the inorganic component of the smear layer, unpleasant taste and cytotoxicity at higher concentrations.

Sodium hypochlorite accidents

Effect on eyes: Sodium hypochlorite may also be accidentally splashed into the operator's eyes. Loss of epithelial cells in the outer layer of the cornea may occur. Thorough irrigation with continuous stream of saline should be done in order to avoid further damage. An Ophthalmologist should be consulted immediately.[17]

Effect on periapical tissues: When NaOCl is accidentally injected into periapical tissues, the initial swelling is painful and may spread to adjacent tissues. It may also reach the periorbital area, the cheek and can be accompanied by profuse interstitial bleeding with haemorrhage of the skin and mucosa. Necrosis and secondary infection may become evident and other severe complications like anesthesia or paresthesia may be diagnosed.[17]

Accidental injection of sodium hypochlorite instead of local anaesthesia: Sometimes operator may accidentally inject sodium hypochlorite instead of local anesthesia. In these cases, severe palatal tissue necrosis or edema in the pterygomandibular space and pharyngeal areas may occur. In this condition, treatment includes injection of saline at the same site to dilute the hypochlorite injected and an injection of dexamethasone around the wound. Hospitalization for further treatment should be done immediately.[18]

Damage to clothing: As sodium hypochlorite is a common household bleaching agent, even small amounts may cause severe damage. These mishaps should be prevented by proper protection of the patient's clothing.[18]

CONCLUSION

This review discusses the advantages of sodium hypochlorite as an endodontic irrigant, as well as the potential complications that can occur with sodium hypochlorite in endodontic dental practice. Although rare, the recognition and subsequent primary management by the dental practitioner of these complications is essential to ensure best clinical practice.

REFERENCES

1. **Clarkson RM, Moule AJ.** Sodum hypochlorite and its use as an endodontic irrigant. Australian dental journal 1998;43:(4):000-000.
2. **Hu X, Peng Y, Sum CP and Ling J.** Effects of concentrations and exposure times of sodium hypochlorite on dentin deproteination: attenuated total reflection fourier transform infrared spectroscopy study. J Endod 2010; 36(12): 2008-11.
3. **Marion JJC, Manhaes FC, Bajo H and Duque TM.** Efficiency of different concentrations of sodium hypochlorite during endodontic treatment-Literature review. Dental Press Endod. 2012 Oct-Dec;2(4):32-7.
4. **Yazd ZM.** Sodium hypochlorite in endodontics: an update review.Int Dent J. 2008 Dec; 58(6):329-41.
5. **Fedele GR et al.** Antagonistic Interactions between Sodium Hypochlorite, Chlorhexidine, EDTA, and Citric Acid. JEndod Vol 38, No. 4, April 2012.
6. **Siqueira JF Jr, Batista MMD, Fraga RC, Uzeda M.** Antibacterial effects of endodontic irrigants on black-pigmented gram-negative anaerobes and facultative bacteria. *J Endod. 1998;24(6):414-6.*
7. **Ludin N and Ahmed HMA.** Antibacterial activity of sodium hypochlorite and chlorhexidine against Enterococcus faecalis.J Conserv Dent. 2013 Jan-Feb; 16(1): 9-16.
8. **Dioguardi M, Gioia GD, Illuzi G, Laneve E, Cocco A, Troiano G.** Endodontic irrigants: Different methods to improve efficacy and related problems. *European Journal of Dentistry 2018 Jul-Sept; 12(3): 459-66*
9. **Jungbluth H, Marending M, De-Deus G, Sener B, Zehnder M.** Stabilizing sodium hypochlorite at high pH: effects on soft tissue and dentin. J Endod. 2011 May;37(5):693-696.
10. **Gomes BPFA, Drucker DB, Liley J.D.** Association of endodontic symptoms and sings with particular combinations of specific bacteria. IntEndod J. 1996;29(4):69-75.
11. **Estrela C, Estrela CRA, Barbin EL, Spano JCE, Marchesan MA, Pecora JD.** Mechanism of action of sodium hypochlorite. *Braz Dent J. 2002;13(2):113-7*
12. **Spanó JC et al.** Solvent action of sodium hypochlorite on bovine pulp and physico-chemical properties of resulting liquid.Braz Dent J. 2001;12(3):154-7.
13. **Milano NF, Girardi V, Bergola AM, Chiapini IG.** Algunsaspectos do uso do NaOClemEndodontia. *Rev FacOdontol Porto Alegre. 1991;32(1):7-10.*
14. **Radcliffe CEL, Potouridou R, Qureshi N, Habahbeh A, Qualtrough H, Worthington DB.** Antimicrobial activity of varying concentrations of sodium hypochlorite on the endodontic microorganisms Actinomycesisraelii, A. naeslundii, Candida albicans and Enterococcus faecalis. IntEndod J. 2004;37(7):438-46.
15. **Rossi-Fedele G, Prichard JW, Steier L, De Figueiredo JA.** The effect of surface tension reduction on the clinical performance of sodium hypochlorite in endodontics. IntEdod J 2013 Jun;46(6):492-8.
16. **Siqueira JF Jr, Guimaraes- Pinto T, Rocas IN.** Effects of chemomechanical preparation with 2.5% sodium hypochlorite and intracanal medication with calcium hydroxide on cultivable bacteria in infected root canals. *J Endod2007; 33: 800-805*
17. **Yazd ZM.** Sodium hypochlorite in endodontics: an update review. *Int Dent J. 2008 Dec; 58(6):329-41.*
18. **Mehdipour O, Kleier DJ, Averbach RE.** Anatomy of sodium hypochlorite accidents.Compend Contin Educ Dent. 2007;28(10):544-50.