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Review Article

Amelioration in the sodium hypochlorite as root canal irrigant – A review

Preety Sehrawat[1]*

[1]*Dental Surgeon, Armour Dental, Najafgarh, New Delhi, India*

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ABSTRACT

The objective of endodontic treatment is the eradication of microbiota from root canals. This is achieved by using an efficient irrigating solution along with the mechanical preparation done with the various file systems. Sodium hypochlorite is the earliest and most efficacious irrigant in the field of dentistry. It acts by confiscating the dentinal debris and pulpal remnants dependent on various factors such as the time and concentration of the solution, anatomy of root canal. There are certain factors which boost the efficiency and potency of sodium hypochlorite solution for instance warming the solution, use it in concurrence with few components, or actuating via varied mode of agitation. Regardless of its efficient and potent capabilities to act as an irrigant, there are few side effects of sodium hypochlorite on the soft and hard tissues of the oral cavity. Hence, this article focuses to analyze and review the advancement in the sodium hypochlorite solution in relation to its concentration, irrigation techniques and factors affecting its efficacy and efficiency.

1. Introduction

Endodontic treatment is an amalgamation of the mechanical and chemical prepartation.[1] Despite various instrumentation techniques have been introduced in the past, approximately 35% of the root canal surface remained unmarked, which makes it indispensable to employ the disinfecting solutions to irrigate the root canal system.[2] Irrigation kinetics carries out a decisive task in endodontic treatment.[2] The impact of irrigating solution counts upon its mechanism of the action and its capability to affect the microorganisms and dentinal debris within the root canal.[1]

A quintessential irrigant should be orally biocompatible, must deliver strong flushing action, be microbiocidal and able to dissolve remnants of organic tissues without being detrimental to the periradicular tissues on extrusion.[1] The classification of root canal irrigants is as follows:[3]

Table 1:

Endodontic Iirigants	
Chemical Agents	**Natural Agents**
i. Tissue dissolving agents – Sodium hypochlorite, ClO_2	i. Green tea
ii. Antibacterial agents	i. Triphala
Bacteriocidal – Chlorhexidine	
Bacteriostatic - MTAD	
iii. Chelating agent	
Mild pH – HEBP	
Strong pH - EDTA	

Sodium hypochlorite (NaOCl) is the most widely used irrigant in endodontics. It has a broad history in the field of medicine and dentistry. During World War I, Henry Drysdale Dakin and Alexis Carrel have used the buffered 0.5% NaOCl solution to irrigate the infected wounds.[3] It is bench mark in root canal irrigants because of the antibacterial and tissue-dissolving properties.[2,3]

* *Corresponding author*.
E-mail address: sehrawatpreety@yahoo.in (P. Sehrawat).

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Nevertheless, the role of NaOCl as endodontic irrigant has been well-established long back but it is crucial to discuss the factors that has a role in the effectiveness of NaOCl.[2]

Therefore, the aim of the present article is to discuss the advancement in sodium hypochlorite solution in relation to its concentration, irrigation techniques and factors affecting its efficacy and efficiency.

2. Mechanism of Action

Step 1: Hypochlorous acid, present in the sodium hypochlorite solution, when comes in contact with organic tissue, acts as a solvent and releases chlorine, which further combines with the protein amino group to form chloramines.[2,3]

Step 2: The chloramines inhibit cell metabolism. Chlorine has an antimicrobial action, preventing bacterial enzymes that results into an irreversible oxidation of sulphydryl group present in the bacteria.[2,3]

Step 3: Hypochlorous acid ($HOCl^-$) and hypochlorite ions (OCl^-) bring about amino acid degradation and hydrolysis.[2,3]

Pulpal remnants provide competent environment for the growth and propagation of microorganisms, hence the dissolution of pulpal remnant and organic tissue via sodium hypochlorite is inimitable in the success of endodontic treatment.[4–6]

The organic component when comes in contact with the free chlorine molecules account for amino acid degradation and hydrolysis, and also saponification of fats. It is believed that the dissolution effect of sodium hypochlorite on necrotic tissue is more than that on normal, healthy tissue.[7]

2.1. Consequential factors determining the strength of sodium hypochlorite are

1. Exposure Time - Increase in exposure time would necessitate better antibacterial effectiveness. The suggested exposure time varies from 1 – 3 mins.[8]
2. Potency - Sodium hypochlorite incurs its antibacterial and tissue-dissolving ability due to the presence of free chlorine molecules, though as the interaction ensues between free chlorine molecules and organic tissue, the potency of solution decreases. Therefore, renewal of sodium hypochlorite solution is advised to enhance the potency of the solution by reimbursing the free chlorine molecules.[9]
3. Concentration – It is used at differed concentrations ranging between 0.5% - 6%. Its concentration is analogous to the rate of collagen dissolution and penetration depth.[9,10]
4. pH - The decrease in pH value leads to a higher proportion of HOCl, which is a strong antiseptic, resulting in greater antibacterial efficacy of the irrigant, while its tissue-dissolving capacity would be reduced. Neutralizing or stabilizing the pH value of NaOCl irrigant has been proposed as strategy of achieving ideal chemical properties.[8–10]

2.2. Modus operandi for amelioration in chemical efficacy and potency of sodium hypochlorite

1. Surfactant- High surface tension of sodium hypochlorite solution restricts its usefulness as an irrigant by decreasing its penetration into lateral canals and dentinal tubules. Thus, surfactants e.g. Benzalkonium chloride etc. were launched as supplement with NaOCl. It helps in strengthening the penetration depth along with the tissue dissolution capacity of sodium hypochlorite.[11–14]
2. Constant Chelation - It is a prolific root canal irrigation practice where NaOCl is mixed with a chelating agent such as EDTA and HEDP.
   Sodium hypochlorite with EDTA – EDTA is a strong chelating agent which helps in removal of dental smear layer which sodium hypochlorite is unable to dissolve. Although, EDTA reduces the tissue-dissolving capability of NaOCl due to the dramatic depletion of free chlorine molecules. Therefore, constant replenishment of sodium hypochlorite is required. Few studies suggest not to use EDTA and sodium hypochlorite together due to the same reason.[11–14]
   Sodium hypochlorite with HEDP - It is a weak chelating agent comparatively to EDTA but highly cooperative to sodium hypochlorite. Many authors have endorsed this combination as preferred choice than the NaOCl and EDTA method. This combination is found to be more potent as bactericidal and in dissolution of pulp. Nevertheless, there is no study that have suggested disparity in disposition of smear layer and dentinal debris.[15]
3. Increase temperature - The temperature of the solution can be raised via heating of the sodium hypochlorite solution in varied ways. This will ameliorate the efficiency and efficacy of sodium hypochlorite by accelerating the reaction. Heating of the solution can be achieved either by using preheated solution or heating it within the root canal by using agitation techniques such as sonic or ultrasonic devices. The rise in temperature also helps in improving the dissolution and antibacterial capabilities of the solution.[16]

2.3. Diverse agitation approaches to expand the efficiency of sodium hypochlorite

Agitation is an arbitrating protocol that expand the efficiency and potency of sodium hypochlorite irrigating solution. Primarily it is suggested that the sonic activation is apparently less potent than that of ultrasonic activation

because of its high-speed fluid flow. Additionally, size and taper of instrument, tip diameter, circumscription of the instrument within the reach of the canal and the type of irrigant, all do have a collective impact on the efficiency of the irrigating solution.[3,17]

1. Sonic activation approach – EDDY, a sonically activated device armed by noncutting plastic tips that possibly diminish the risk of hampering the anatomy of root canal when comes in contact with them.[17] The device has a circular motion in over-all along with the added motion in the most apical part of the tip.[18]
2. EndoActivator (Ultrasonic activation approach) - It is ultrasonic activated device, encompassed of a handpiece along with wide-range sized polymer tips. The tip of this device stream dynamic intracanal fluid agitation by means of ultrasonic wave and high pressure and build up a swarm of dentinal debris. This physicochemical activation boosts the penetration, circulation and flow of sodium hypochlorite solution into the lateral or curved canals.[17,18]
3. Vibringe – It is an innovative sonic irrigation approach that works in conjunction with perforated irrigation needle and sonic activation. It is battery enabled and produces vibrations when attached with the irrigating needle. It permits activation of the irrigation solution and high-pressure streaming at once within the root canal resulting in flushing out of dentinal debris.[18–20]
4. XP-endo Finisher – It is non tapered rotary tool, 25 nm in size made up of NiTi wire which enables it to have good handling and manipulation properties. It has dual shape feature which means a straight shape at room temperature while spoon-like shape at high temperature. This exclusive feature upsurges the probability to come into contact of canal walls and stir the irrigant once in motion.[3,18]
5. Gentle Wave System – It is designed to work by applying negative pressure to flush out the debris during initial stages of biomechanical preparation because the tip is placed only in the pulp chamber. This approach helps to avoid sodium hypochlorite accident in the patient's oral cavity.[17,18]

2.4. Shortcomings of sodium hypochlorite irrigant

1. Hypochlorite accident – It is also acknowledged as apical extrusion occurs when sodium hypochlorite irrigant draw out beyond apex mostly seen in cases with open apex, root resorption, and malposition of irrigating needle. NaOCl is considered cytotoxic to periapical tissues so results into exuberant inflammatory response, discoloration and damage to localized tissue.[21,22]
2. Cytotoxic – Sodium hypochlorite is a strong oxidizing agent which makes it cytotoxic to the periapical tissue and stem cells present in dentin.[23–25]
3. Post endo discomfort – The concentration of sodium hypochlorite plays an important role in the incidence rate of discomfort post biomechanical preparation. High concentration has high chances of cytotoxic effects on soft tissue which may last up to 24 hours. The intensity and duration of pain is directly proportional to the concentration of the irrigating solution.[26–28]
4. Catastrophic effect on dentin – This irrigant has a catastrophic effect on the mechanical properties of the dentin. It is in proportion to the concentration and frequency of the sodium hypochlorite irrigant resulting into the decrease in microhardness and modulus of elasticity of dentin by the development of a hydroxy appetite rich and collagen-scant dentin layer stated as Ghost layer.[29,30]

3. Conclusion

Sodium hypochlorite irrigant has a requisite part in the accomplishment of biomechanical preparation during root canal treatment. Numerous consequential factors such as the exposure time, potency, concentration, and pH of the sodium hypochlorite solution helps in determining its strength. There are many factors which ameliorate the chemical efficacy and potency of sodium hypochlorite such as surfactant e.g. Benzonium chloride, constant chelation by using EDTA and HEDP, and increase in temperature. The literature has suggested varied modes of agitation to increase the temperature likewise sonic and ultrasonic activation using EDDY, Endoactivator etc., vibringe, gentle wave system. Nonetheless, many studies are need to be done to establish the clinical efficacy and efficiency of these methods. In spite of numerous aids of sodium hypochlorite as an effective irrigant there are few limitations as well because of its cytotoxic nature and catastrophic effect on the mechanical properties of dentin which need to be taken care of.

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None.

5. Conflict of Interest

None.

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Author biography

Preety Sehrawat, Consultant Dental Surgeon https://orcid.org/0000-0003-0618-1773

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