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Azza Abdelkader Salim Osman
Dental Specialist, El-Galaa Teaching Hospital, Cairo, Egypt

Manal Ibrahim Attalla bekhit
Dental Specialist, El Sahel Teaching Hospital, Cairo, Egypt

Marwa Medhat Ahmed Naiem
Dental Specialist, El Sahel Teaching Hospital, Cairo, Egypt

Corresponding Author:
Azza Abdelkader Salim Osman
Dental Specialist, El-Galaa Teaching Hospital, Cairo, Egypt

Interactions between sodium hypochlorite, chlorohexidine and citric acid

Azza Abdelkader Salim Osman, Manal Ibrahim Attalla Bekhit and Marwa Medhat Ahmed Naiem

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Abstract
When sodium hypochlorite (NaOCl) came into contact with chelators, antagonistic interactions included the loss of free accessible chlorine, which decreased the substance's capacity to dissolve tissue and, to a lesser extent, its antibacterial properties. A precipitate that can have negative effects on endodontic therapy, such as discolouration and possible chemical leaching into the periradicular tissues, is created when chlorohexidine (CHX) and NaOCl are combined. Citric acid and NaOCl interactions demineralise the intertubular dentin, which causes the dentinal tubules to open. E. faecalis was eliminated from the main canals of each root by CACHX eighteen hours after irrigation.

Keywords: Interaction, sodium hypochlorite, chlorohexidine, citric acid

Introduction

Endodontic therapy's main goal is to rid the root canal system of all live and dead tissues, as well as microbes and their byproducts. This objective is achieved through a combination of chemical and mechanical cleaning methods [1].

During the shaping of root canals, continuous irrigation is typically employed. The irrigation solutions are intended to facilitate the removal of the smear layer. Since no single solution possesses all the necessary characteristics, it is essential to utilize a combination of two or more solutions to ensure safe and effective irrigation [2].

Consequently, a range of irrigating solutions is employed alongside mechanical instrumentation, including sodium hypochlorite (NaOCl), chlorhexidine digluconate (CHX), 17% ethylenediaminetetraacetic acid (EDTA), and citric acid (CA) [3].

It is important to note that endodontic irrigation solutions may undergo chemical interactions when used in an alternating irrigation technique, potentially leading to the formation of undesirable by-products that could be toxic or provoke allergic reactions. The most well-known and, in recent years, most often suggested irrigating treatments for eliminating any remaining germs after chemo-mechanical root canal therapy are sodium hypochlorite and chlorhexidine [4].

Irrigation

The process of providing water to the root canal is called irrigation. In endodontic therapy, root canal irrigation is crucial and serves two purposes. (A) Physical goal: to promote the flow of irrigant throughout the root canal system while making sufficient physical contact with the canal walls to enable efficient debridement. (B) Chemical goal: To break up bacterial biofilms, render endotoxins inactive, then remove the smear layer and tissue pieces from the canal walls. These two objectives may be used to categorise root canal irrigants into two groups: Both active and inactive (inert) irrigants [5].

Inert Irrigants

These are only meant to be used as rinsing solutions. However, it is crucial to understand that the mechanical action of irrigation (flow and backflow) alone reduces intracanal microbial burdens, independent of the irrigant's chemical properties [6].

Distilled water

Although it works well for rinsing, water is not a good endodontic disinfectant. Bacteria without cell walls can be lysed by water by hypotonic action. Cell walls, however, are frequently present in bacteria found in root canals. Precipitates do not develop when distilled water is combined with the majority of the chemicals used in root canal therapy, such as sodium hypochlorite (NaOCl) in varying quantities and 2% chlorhexidine (CHX) solution/gel [7].

Saline solution

Because saline lacks antibacterial and tissue-dissolving qualities, it is not advised to use it as the primary irrigating solution, even if it is highly biocompatible. When mixed with 2% CHX in both gel and solution forms, saline solution precipitates with salt but not with NaOCl when used as an irrigant. The salting-out procedure, which precipitated the CHX salts and increased the salt concentration by administering saline solution, is responsible for the precipitate that developed between CHX and saline solution [7].

Active Irrigants

They fall into two categories: natural and chemical agents. Chemical agents exhibited a variety of characteristics, including moderate (HEBP) and strong chelating activity (EDTA), bactericidal (CHX, NaOCl), bacteriostatic (MTAD), and tissue solvent action (NaOCl and ClO_2). Because of their antibacterial properties, natural remedies including green tea and triphala have been taken into consideration [8].

Sodium hypochlorite (NaOCl)

The alkaline, potent oxidant aqueous solution is used as home bleach and as a disinfectant. NaOCl is the most widely used chemical for root canal irrigation due to its unique ability to breakdown organic tissue and its antibacterial qualities. Three processes enable NaOCl to dissolve organic materials: neutralisation reactions, which neutralise amino acids to produce salt and water; saponification, which converts fatty acids into fatty acid salts and glycerol; and chloramination of chlorine and amino groups, which disrupts microbial cell metabolism [9].

Plaque biofilms, residual pulp tissue, and dentin are primarily composed of organic materials, making sodium hypochlorite (NaOCl) an effective agent for tissue dissolution in these contexts. This property enhances the debridement of areas that have not been adequately prepared. Furthermore, NaOCl possesses a wide-ranging antibacterial capability, which facilitates the elimination of infections within the root canal system [10].

The principal mechanism by which NaOCl operates involves hydrolysis, leading to the formation of hypochlorous acid. This compound subsequently decomposes into ecological oxygen, this has a broad-spectrum bactericidal impact by breaking down bacterial proteins, interfering with the oxidative phosphorylation mechanisms of bacterial biofilms, and preventing the creation of bacterial DNA. NaOCl is used in clinical settings at concentrations between 0.5% to 8.25%. Organic tissues dissolve best at concentrations over 2.5 percent, and the bactericidal activity and tissue dissolution capacity both improve with increasing concentration, temperature, volume, and exposure duration [11].

However, it is important to note that higher concentrations of NaOCl also increase the risk of cytotoxicity, causticity, and irritation to nearby tissues. NaOCl is typically utilised as the last irrigant after instrumentation and for root canal irrigation after mechanical preparation. A rubber dam should be used to protect the oral mucosa and gingiva while therapy is being administered. NaOCl solution extrusion from the apical foramen must be avoided as this may cause harm to the periapical tissues [11].

Chlorhexidine (CHX)

The gluconate salt derivative of chlorhexidine, a biguanide chemical known for its antiseptic qualities and topical antibacterial effectiveness, is chlorhexidine digluconate (CHX).

This compound carries a positive charge, allowing it to interact with the negatively charged surfaces of microbial cells, which ultimately compromises the integrity of their membranes. Following this interaction, chlorhexidine gluconate infiltrates the cell, resulting in the leakage of intracellular substances and subsequent cell death [12].

Due to their higher negative charge, gram-positive bacteria exhibit increased susceptibility to this agent. Chlorhexidine digluconate can serve as an adjunct to enhance the antibacterial effects of sodium hypochlorite (NaOCl) solutions during root canal procedures. *In vitro* studies indicate that CHX demonstrates antimicrobial properties comparable to those of sodium hypochlorite while exhibiting lower toxicity. However, a notable limitation of CHX in comparison to NaOCl is its inability to effectively dissolve both vital and necrotic tissues [13].

The antimicrobial efficacy of CHX is influenced by pH, with optimal activity observed within the range of 5.5 to 7.0, which corresponds to the pH levels found in various body surfaces and tissues. At physiological pH, CHX dissociates, releasing the positively charged chlorhexidine component. CHX may more easily enter bacterial cells and carry out its harmful effects because of the interaction between this positively charged molecule and the negatively charged phosphate groups on bacterial cell walls. Therefore, CHX's antibacterial action is still effective in the pH range of 5.5 to 7.0 [14].

Chlorhexidine digluconate is a broad-spectrum antibacterial drug that binds to the hydroxyapatite of dentin and enamel or to the anionic groups of glycoproteins. This property is known as substantivity to tooth structures. It is delivered gradually and has long-lasting antibacterial properties due to a mild drop in concentration. 0.2% is used to prevent plagues. 2% is applied as an irrigant during root canal therapy. It works better against germs that are gram-positive [14].

Citric acid

Because it dissolves the smear layer and the inorganic components of root dentine with little to no impact on organic components, citric acid, a weak organic acid, is utilised in endodontic treatment. Citric acid is less cytotoxic to preapical tissues than ethylenediamine tetra-acetic acid (EDTA), although it still has a chelating effect [15].

Chemical Interaction between NaOCl and CHX

When sodium hypochlorite and CHX are combined, a reddish-brown precipitate containing parachlororaniline (PCA) is produced. Human methemoglobinemia has been linked to the well-known carcinogen parachlororaniline. This precipitate, which obstructs the dentinal walls with a thickness of 139–639 µm, is the result of an acid–base interaction.7. According to reports, the amount of precipitate that forms increases with the concentration of chlorides in the NaOCL. The concentration of NaOCL used in conjunction with CHX determines the colour of the precipitate form [16].

Clinical Significance

The precipitate that has formed is known to obstruct the dentinal tubules, It might result in a weakened root canal filling material seal and insufficient penetration of intracanal medications. Furthermore, this precipitate may result in an undesired discolouration of the tooth's crown [17].

The amount of sodium hypochlorite (NaOCl) used has a direct impact on the amount of PCA produced in the previously stated precipitate. Studies have shown that the precipitate has a lower PCA concentration when the canal is first irrigated with NaOCl, then an intermediate irrigant, and finally rinsed with chlorhexidine (CHX). It has been demonstrated that applying an interim irrigant after NaOCl irrigation but before CHX efficiently lowers the precipitate's PCA levels. Additionally, it has been shown that irrigating the canal with large amounts of saline before to the final CHX rinse and following NaOCl treatment greatly reduces the production of precipitate [17].

Chemical Interaction between Sodim Hypochlorite and Citric Acid

The pH is significantly lower when NaOCl and citric acid are combined than when NaOCl and EDTA are combined. A 1:1 combination of 2.5% NaOCl and 10% citric acid has been shown to have a pH of 3. The generation of chlorine gas is encouraged by the low pH values [18].

Clinical Significance

The primary clinical effect of this chlorine generation and reduction of free available chlorine is the loss of the ability of NaOCl and citric acid mixtures to dissolve organic tissue. Citric acid and NaOCl combine to demineralise the intertubular dentin and cause the dentinal tubules to open. As a result, it is not recommended to employ citric acid and sodium hypochlorite together in root canal therapy, either in a sequential manner or as an admixture, even if they do retain their chelation and antibacterial effect due to the decreased tissue dissolving potential [18].

Chemical Interaction between CHX and Citric Acid

10% citric acid and 1% chlorhexidine combined to create a cytocompatible irrigant that might eradicate E. faecalis from infected tooth samples. Additionally, 18 hours after irrigation, CACHX was able to eradicate E. faecalis from the major canals of every root, indicating that it is a viable option for endodontic therapies [19].

Conflict of Interest

Not available

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References

1. Kaur P. Role of irrigants in endodontics. Journal of Dental Problems and Solutions. 2020;7:100-4.
2. Malhan S, Bansal C, Johar S. Root canal irrigants: A review. International Journal of Health Sciences. 2021;20:134-42.
3. Boutsioukis C, Arias-Moliz MT. Irrigating Solutions, Devices, and Techniques. Endodontic Materials in Clinical Practice. 2021. p. 133-80.
4. Drews D-J, Nguyen AD, Diederich A, Gernhardt CR. The interaction of two widely used endodontic irrigants, chlorhexidine and sodium hypochlorite, and its impact on the disinfection protocol during root canal treatment. Antibiotics. 2023;12:589.
5. Kim SW, Shin DH. Antibacterial effect of urushiol on *Enterococcus faecalis* as a root canal irrigant. Restorative Dentistry and Endodontics. 2017;42:54-9.
6. Boutsioukis C, Arias-Moliz MT. Present status and future directions–irrigants and irrigation methods. International Endodontic Journal. 2022;55:588-612.
7. Gomes BP, Aveiro E, Kishen A. Irrigants and irrigation activation systems in endodontics. Brazilian Dental Journal. 2023;34:1-33.
8. Ali A, Bhosale A, Pawar S, Kakti A, Bichpuriya A, Agwan MA. Current trends in root canal irrigation. Cureus. 2022;14:150.
9. Achaw O-W, Danso-Boateng E. Chemical and process industries: Springer; 2021.
10. Ruksakiet K, Hanák L, Farkas N, Hegyi P, Sadaeng W, Czumbel LM, et al. Antimicrobial efficacy of chlorhexidine and sodium hypochlorite in root canal disinfection: A systematic review and meta-analysis of randomized controlled trials. Journal of Endodontics. 2020;46:1032-41.
11. Zou X, Zheng X, Liang Y, Zhang C, Fan B, Liang J, et al. Expert consensus on irrigation and intracanal medication in root canal therapy. International Journal of Oral Sciences. 2024;16:23.
12. Brookes ZL, Bescos R, Belfield LA, Ali K, Roberts A. Current uses of chlorhexidine for management of oral disease: A narrative review. Journal of Dentistry. 2020;103:103.
13. El Sayed M, Ghanerad N, Rahimi F, Shabanpoor M, Shabanpour Z. Antibacterial activity of sodium hypochlorite gel versus different types of root canal medicaments using agar diffusion test: An *in vitro* comparative study. International Journal of Dentistry. 2020;20:648.
14. Khoury RD, de Carvalho LS, do Nascimento MFR, Alhussain F, Abu Hasna A. Endodontic irrigants from a comprehensive perspective. World Journal of Clinical Cases. 2024;12:4460-8.
15. Elasas AM, Barakat IF, Ibrahim A, Bastawy A. Comparative evaluation of 6% citric acid and chitosan as irrigants on root canals of pulpectomized primary teeth: A clinical, radiographical, and microbiological study. Al-Azhar Dental Journal for Girls. 2022;25:517-23.
16. Siddique R, Sureshbabu NM, Somasundaram J, Jacob B, Selvam D. Qualitative and quantitative analysis of precipitate formation following interaction of chlorhexidine with sodium hypochlorite, neem, and tulsi. Journal of Conservative Dentistry. 2019;22:40-7.
17. Balamurali N, Piriyanga R, Deepika G, Abirami A, Sherwood A. Sodium hypochlorite interaction with other root canal irrigants: A systematic review. Restorative Dentistry and Endodontics. 2023;8:12.
18. Hardhitari R, Sumawinata N, editors. Effects of 2.625% NaOCl-20% citric acid and 2.625% NaOCl-17% EDTA on cleanliness of smear layer on apical one third. Journal of Physics: Conference Series; 2018: IOP Publishing.
19. Scelza MZ, Iorio NLPP, Scelza P, Póvoa HCC, Adeodato CSR, Souza ACN, et al. Cytocompatibility and antimicrobial activity of a novel endodontic irrigant combining citric acid and chlorhexidine. Journal of Dentistry. 2022;125:104-278.

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