International Journal Of Health, Engineering And Technology (IJHET) *E-ISSN 2829 - 8683*
Volume 5, Number 1, May 2026, *Page. 1273 - 1278*
Email : editorijhess@gmail.com

The Role Of Chlorhexidine In Dentistry: Mechanisms Of Action And Clinical Applications

Anindia Nazla Kusumaputri[1)], Shahnaz Fitri Rahmadhanna[2)], Gema Gempita[3)]
[1,2)] Undergraduate Dentistry Program, Faculty of Dentistry, Universitas Padjadjaran
[3)] Departement of Dental Material Science and Technology, Faculty of Dentistry, Universitas Padjadjaran

*Corresponding Author
Email : anindia22001@mail.unpad.ac.id

Abstract

This literature review discusses the role of chlorhexidine as an antiseptic in dentistry, where it is still regarded as the gold standard for use. Chlorhexidine is a cationic bisbiguanide compound with broad-spectrum antimicrobial activity against Gram-positive and Gram-negative bacteria. It acts by interacting with the microbial cell membrane, producing a bacteriostatic effect at low concentrations and a bactericidal effect at higher concentrations. In clinical practice, chlorhexidine is available in various formulations, including mouthwash (0,12-0,2%), gel (0,12-1%), 2% irrigating solution, and higher-concentration varnish, which are selected according to therapeutic needs. Its applications include caries control through the reduction of Streptococcus mutans, periodontal therapy as an adjunct to scaling and root planing, support in endodontic treatment as an alternative irrigant, and post-surgical care to reduce the risk of complications such as alveolar osteitis. Chlorhexidine has been proven effective, its use should be limited due to potential side effects, including tooth staining, taste alteration, and xerostomia; therefore, it is recommended as an adjunctive therapy based on specific clinical indications.

Keywords: ***Chlorhexidine, Dentistry, Antimicrobial Agent.***

INTRODUCTION

Chlorhexidine is a bisbiguanide compound that was developed in England in 1950, when a group of researchers from Imperial Chemical Industries Limited, Biological and Research Laboratories conducted studies on the biological properties of polydiguanide compounds. Initially, this compound was known as “Hibitane” before it was officially named chlorhexidine. The compound was commercialized in England in 1954 as a topical antiseptic, marking the beginning of its widespread use in the medical field. Subsequently, in the 1970s, chlorhexidine was found to possess significant antiplaque activity. This discovery encouraged its development as an oral healthcare preparation, and by 1976 chlorhexidine had become available in the form of mouthwash.

Entering the 1980s, chlorhexidine combined with alcohol began to be widely utilized, establishing chlorhexidine as a standard agent for skin disinfection prior to invasive procedures. In the 1990s, the Food and Drug Administration (FDA) approved the use of chlorhexidine-impregnated sponges for temporary medical devices as an infection prevention strategy. During the same period, chlorhexidine-impregnated catheters were also developed. These innovations further expanded the applications of chlorhexidine in healthcare practice.

In the field of dentistry, chlorhexidine is widely used as an oral antiseptic and is available in various formulations, including mouthwashes, gels, creams, and toothpastes, allowing its use to be tailored to specific clinical needs. Its effectiveness in controlling biofilm formation and plaque accumulation is supported by its broad antimicrobial spectrum against both Gram-positive and Gram-negative bacteria. These characteristics have established chlorhexidine as the gold standard in dentistry to this day. The use of chlorhexidine is particularly important considering that microbial biofilms in the oral cavity constitute a major factor in the pathogenesis of various oral and dental diseases, including halitosis, dental caries, gingivitis, periodontitis, and post-surgical infection.

This article aims to comprehensively discuss the role and development of chlorhexidine use in dentistry, including its mechanism of action and various clinical applications in controlling oral diseases caused by microorganisms.

RESEARCH METHODS

The literature search was conducted through Google Scholar, PubMed, and ScienceDirect to identify relevant studies for the literature analysis. The journal search was performed using the keywords “chlorhexidine,” “dentistry,” and “antimicrobial agent” within the publication period of 2015–2025. The retrieved articles were subsequently screened based on their relevance to the focus of the discussion, namely the role of chlorhexidine in dentistry, including its mechanism of action and clinical applications. A total of 20 articles were selected and further analyzed according to topic relevance and publication quality.

RESULTS AND DISCUSSION

Chlorhexidine is composed of two biguanide groups linked by a hexamethylene bridge, forming a symmetrical molecule with two nonpolar benzene groups at both ends. Chlorhexidine exists in several forms, including chloride, acetate, and digluconate. The form most commonly used in the medical and dental fields is chlorhexidine digluconate due to its superior water solubility, particularly at neutral pH, with soluble concentrations ranging from 0.5%–2.0%.

Chemically, chlorhexidine is stable in aqueous solutions at neutral pH; however, it may undergo degradation under highly acidic or highly alkaline conditions. Its predominantly nonpolar molecular nature limits its solubility in water and less polar organic solvents such as dichloromethane. Nevertheless, its solubility increases in alcohol-containing formulations. This enhanced solubility broadens its range of applications, making it suitable for disinfectant preparations and antiseptic gels.

As a cationic bisbiguanide compound, the activity of chlorhexidine may also be reduced through interactions with other ionic compounds, particularly anionic substances such as sodium lauryl sulfate (SLS) and triclosan, which are commonly found in toothpaste. Therefore, the use of chlorhexidine-containing products is not recommended simultaneously with toothbrushing, and an interval of approximately 30 minutes after brushing is advised.

Mechanism of Action

The mechanism of action of chlorhexidine begins with the interaction between positively charged chlorhexidine molecules and negatively charged bacterial cell walls, particularly the phosphate and sulfate groups within membrane phospholipids and lipopolysaccharides (LPS) in Gram-negative bacteria. The cationic of chlorhexidine also enables interaction with the biofilm matrix containing extracellular polysaccharides and glycoproteins. Following initial contact, chlorhexidine undergoes strong and specific adsorption to phosphate-containing molecules on the bacterial cell wall, thereby reinforcing its initial binding to microbial cell structures.

The subsequent stage involves the penetration of chlorhexidine through the cell wall toward the cytoplasmic membrane. This process disrupts membrane integrity and increases membrane permeability. Consequently, leakage of small intracellular components such as potassium and phosphate ions occurs, along with disturbances in membrane-associated enzymatic activity. At low concentrations (0.02%–0.06%), these effects are bacteriostatic because chlorhexidine interferes with osmoregulation and metabolic activity without directly causing cell lysis. Under these conditions, the damage remains reversible if exposure is discontinued.

When the concentration of chlorhexidine remains stable or increases, particularly at concentrations above 0.12%, its effect shifts to bactericidal. Under these conditions, cell membrane damage becomes irreversible due to increased permeability. Chlorhexidine subsequently enters the cytoplasm and forms complexes with phosphorylated compounds, such as adenosine triphosphate (ATP) and nucleic acids, leading to cytoplasmic coagulation and precipitation. This process permanently inhibits cellular metabolism and DNA/RNA synthesis, ultimately resulting in cell lysis and death.

Concentration and Formulation in Dentistry

Chlorhexidine is available in various dosage forms, including mouthwashes, gels, toothpastes, and varnishes, with concentration variations adjusted according to therapeutic purposes and clinical indications. Solution-based preparations such as mouthwashes, concentrations commonly used range from 0.12%–0.2%, which have been shown to effectively reduce plaque formation when used daily for two weeks.[3] Meanwhile, gel formulations generally contain chlorhexidine concentrations ranging from 0.12%–1% for topical applications in plaque control and caries management, whereas dental varnishes are available at higher concentrations of 1%, 10%, and even 40%, depending on their clinical indications. These differences in concentration and formulation play an important role in determining the clinical effectiveness of chlorhexidine in controlling plaque and oral microorganisms.

Clinical Applications in Dentistry

In dental practice, chlorhexidine plays an important role as an antimicrobial agent in various clinical procedures. Its use is not limited to plaque control but also includes periodontal therapy, adjunctive use in endodontic treatment, and postoperative care to suppress the growth of pathogenic microorganisms and optimize tissue healing processes. The following sections describe the applications of chlorhexidine in various fields of dentistry.

Conservative Dentistry

Among the various formulations available, chlorhexidine-containing mouthwash is considered the most effective in providing comprehensive plaque control. Comparisons between chlorhexidine mouthwash formulations at concentrations of 0.12% and 0.2% and gel formulations at concentrations of 1% and 0.12% have shown that mouthwash provides superior effectiveness in inhibiting plaque when used daily for two weeks. After six weeks of use, chlorhexidine significantly reduced Gram-positive bacteria, Gram-negative bacteria, and *Capnocytophaga* within dental plaque. Although chlorhexidine gel was still capable of inhibiting plaque growth, its effectiveness was lower, particularly in situations where mechanical cleaning was not feasible.

Regarding *Streptococcus mutans*, the use of chlorhexidine mouthwash has been shown to significantly reduce its quantity. In contrast, chlorhexidine gel preparations at concentrations of 0.12% and 0.2% did not demonstrate a similar reduction when applied. However, the reduction in *S. mutans* populations achieved through chlorhexidine mouthwash use is not always directly associated with clinical benefits such as reduced caries incidence.

In endodontics, the primary objective of root canal treatment is to achieve hermetic sealing of the root canal system to prevent reinfection. Nevertheless, post-endodontic pain remains common and is multifactorial in nature. In this regard, chlorhexidine has the potential to reduce postoperative pain due to its strong antimicrobial activity, prolonged substantivity, and relatively low toxicity.

Chlorhexidine at a concentration of 2% has been proposed as an alternative irrigating solution capable of replacing sodium hypochlorite (NaOCl) in root canal treatment. Differences in pain intensity between these two solutions were observed during the first 6 hours after treatment, in which chlorhexidine was associated with lower pain levels compared with NaOCl, particularly when solution extrusion beyond the apex occurred. NaOCl is known to induce more severe inflammation in apical tissues, whereas 2% chlorhexidine demonstrates lower toxicity.

In addition to its clinical benefits, chlorhexidine also exhibits effective antimicrobial activity. Exposure to chlorhexidine may enhance the antimicrobial activity of endodontic sealers through increased inhibitory effects against microorganisms. However, this enhanced antimicrobial effect may also result in decreased cell viability and alterations in the physical properties of sealer materials. Therefore, the use of chlorhexidine in combination with endodontic sealers should be carefully considered.

Periodontics

Periodontal disease is a multifactorial inflammatory condition characterized by destruction of periodontal tissues and loss of connective tissue attachment. One of the primary contributing factors to this disease is the accumulation of biofilm along the gingival margin.[3] One therapeutic approach involves the use of antimicrobial agents to inhibit the growth of pathogenic microorganisms within

periodontal tissues. Among the various antimicrobial agents available, chlorhexidine is recognized as one of the most effective and has been widely used in the treatment of gingivitis and periodontitis.

Chlorhexidine mouthwash at concentrations of 0.1%–0.2% has demonstrated significant antiplaque and anti-inflammatory effects and is effective in reducing the clinical signs of gingivitis. Rashed et al. (2016) found that the use of 0.2% chlorhexidine mouthwash as an adjunct to scaling and root planing (SRP) produced better clinical outcomes in patients with chronic periodontitis, as indicated by greater reductions in gingival index scores and periodontal pocket depth compared with hydrogen peroxide and control groups. In addition to mouthwash formulations, chlorhexidine gel preparations are also available as antimicrobial agents for periodontal pockets and have been reported to contribute to pocket depth reduction, although the additional benefits remain relatively limited.

Dental scaling procedures as part of periodontal therapy may also generate aerosols containing microorganisms from biofilm and saliva, thereby increasing the risk of bacterial dissemination. Preprocedural rinsing with chlorhexidine has been reported to significantly reduce bacterial colony counts in aerosols, thus improving infection control during periodontal treatment.

Prosthodontics

Following implant placement procedures, the use of antiseptic mouthwash is generally recommended as adjunctive therapy for plaque control during the initial healing phase when mechanical cleaning cannot yet be optimally performed. Among the various antiseptics available, chlorhexidine has long been used and confirmed to be effective in controlling plaque accumulation and postoperative gingival inflammation.

The use of chlorhexidine at concentrations of 0.12% and 0.2% has been shown to be more effective than placebo in reducing plaque and inflammation, particularly during the first postoperative week following implant surgery. However, the long-term benefits did not demonstrate consistent superiority over placebo; therefore, chlorhexidine is recommended as a short-term adjunctive therapy during the early postoperative phase.

Another study comparing 0.2% chlorhexidine combined with an anti-discoloration system (ADS), and povidone iodine demonstrated that the effectiveness of 0.2% chlorhexidine in promoting wound healing and reducing plaque was comparable to that of povidone iodine. Interestingly, chlorhexidine formulations containing ADS showed greater advantages, including fewer side effects such as taste disturbances, burning sensations, and tooth discoloration. These findings further support the role of chlorhexidine as a postoperative antiseptic, particularly during the early healing phase while considering formulation selection to improve patient comfort.

Oral Surgery

A widely studied approach is the application of chlorhexidine to surgical wound areas. Chlorhexidine application has been reported to exert positive effects on wound healing by reducing the risk of complications and impaired healing. This benefit is associated with its ability to reduce the bacterial load within the wound area, thereby helping to prevent infections that may interfere with the early phases of tissue healing.

The use of 0.12% chlorhexidine mouthwash following tooth extraction has been shown to be more effective than placebo in reducing the incidence of alveolar osteitis in high-risk patients. These findings are consistent with the results of systematic reviews and meta-analyses demonstrating that chlorhexidine application after oral surgical procedures significantly improves wound healing and reduces postoperative complications. In addition to mouthwash formulations, chlorhexidine gel preparations have also been reported to reduce the incidence of dry socket following third molar extraction. Application of 0.2% chlorhexidine gel significantly improved clinical healing outcomes, with 7-day postoperative application resulting in more optimal wound closure and better healing scores.

Side Effects

In clinical practice, the use of chlorhexidine in its various formulations is not free from potential side effects. Evidence suggests that routine and frequent use of chlorhexidine may cause dry mouth (xerostomia) and taste disturbances (hypogeusia). Other less common side effects include

burning sensations in the oral cavity, desquamation of the oral mucosa, and swelling of the parotid glands. Among these adverse effects, tooth discoloration is one of the most frequently reported complaints, particularly with increasing chlorhexidine concentrations up to 0.1% after use for more than several weeks; therefore, its use is generally recommended for no longer than two weeks.

Under certain conditions, such as in patients with physical or mental limitations, prolonged chlorhexidine use may sometimes be unavoidable. To minimize tooth discoloration, formulations containing anti-discoloration systems (ADS) have been developed, incorporating agents such as polyvinyl pyrrolidone, perborate, sodium metabisulfite, or ascorbic acid. These formulations have been reported to reduce tooth staining, taste disturbances, and soft tissue irritation.

CONCLUSION

Chlorhexidine is a cationic bisbiguanide antiseptic with broad-spectrum antimicrobial activity, making it effective in controlling biofilm formation and reducing the bacterial load within the oral cavity. In dentistry, chlorhexidine digluconate is widely used for plaque control, periodontal therapy, and postoperative care. Numerous studies have demonstrated that the use of chlorhexidine, either in the form of mouthwash or gel, is effective in reducing bacterial counts, decreasing inflammation, supporting wound healing, and lowering the risk of complications such as alveolar osteitis, particularly at concentrations of 0.12–0.2%. Nevertheless, its use requires rational consideration due to the potential side effects, including taste disturbances, xerostomia, and tooth discoloration. Therefore, chlorhexidine is recommended as an adjunctive therapy for limited durations in accordance with clinical indications.

REFERENCES

Amaliya A, Ramadhanti R, Hadikrishna I, Maulina T. The Effectiveness of 0.2% Chlorhexidine Gel on Early Wound Healing after Tooth Extraction: A Randomized Controlled Trial. Eur J Dent. 2022 Jul;16(03):688–9. doi:10.1055/s-0041-1739544

Bashetty K, Hegde J. Comparison of 2% chlorhexidine and 5.25% sodium hypochlorite irrigating solutions on postoperative pain: A randomized clinical trial. Indian J Dent Res. 2010;21(4):523. doi:10.4103/0970-9290.74225

Brave DR, Langaliya AK, Rai JS, Buch A, Mahendra M, Patel S. The Impact of Chlorhexidine as an Endodontic Irrigant/Medicament on Post-Obturation Pain in Patients Following Endodontic Therapy: A Preliminary Bayesian Meta-Analysis. J Pharm Bioallied Sci. 2024 Jul;16(Suppl 3):S2935–7. doi:10.4103/jpbs.jpbs_284_24

Brookes ZLS, Bescos R, Belfield LA, Ali K, Roberts A. Current uses of chlorhexidine for management of oral disease: a narrative review. J Dent. 2020 Dec;103:103497. doi:10.1016/j.jdent.2020.103497 PubMed PMID: 33075450; PubMed Central PMCID: PMC7567658.

Chye RML, Perrotti V, Piattelli A, Iaculli F, Quaranta A. Effectiveness of Different Commercial Chlorhexidine-Based Mouthwashes After Periodontal and Implant Surgery: A Systematic Review. Implant Dent. 2019 Feb;28(1):74–85. doi:10.1097/ID.0000000000000854

Deveci C, Tüzüner T, Cinar C, Odabas M, Buruk C. Short-term antibacterial activity and compressive strength of biodentine containing chlorhexidine/cetirimide mixtures. Niger J Clin Pract. 2019;22(2):227. doi:10.4103/njcp.njcp_436_18

Drugeon B, Rickard CM, Buetti N, Guenezan J, Mimoz O. Myths Glorify What Reality Neglects: Efficacy and Safety of Chlorhexidine Gluconate. Curr Infect Dis Rep. 2025 Dec;27(1):14. doi:10.1007/s11908-025-00865-z

Fiorillo L. Chlorhexidine Gel Use in the Oral District: A Systematic Review. Gels. 2019 Jun 11;5(2):31. doi:10.3390/gels5020031Halabi D, Escobar J, Alvarado C, Martinez N, Muñoz C. Chlorhexidine for prevention of alveolar osteitis: a randomised clinical trial. J Appl Oral Sci.

2018 May 7;26(0). doi:10.1590/1678-7757-2017-0245

Hoseyni S, Rostamzadeh M, Salimizand H, Azadnia A, Rahimi F, Khalifehzadeh S. Efficacy of preprocedural mouth rinses (Chlorhexidine, essential oil, and hydrogen peroxide) in reducing bacterial aerosols during dental scaling. BMC Oral Health. 2025 Jul 2;25(1):1004. doi:10.1186/s12903-025-06308-4Poppolo Deus F, Ouanounou A. Chlorhexidine in Dentistry: Pharmacology, Uses, and Adverse Effects. Int Dent J. 2022 Jun;72(3):269–77. doi:10.1016/j.identj.2022.01.005

Karpiński TM, Szkaradkiewicz AK. Chlorhexidine – pharmaco-biological activity and application. Eur Rev Med Pharmacol Sci [Internet]. 2015 Apr. Available from: https://pubmed.ncbi.nlm.nih.gov/25912596/

Kapralos V, Sunde PT, Camilleri J, Morisbak E, Koutroulis A, Ørstavik D, et al. Effect of chlorhexidine digluconate on antimicrobial activity, cell viability and physicochemical properties of three endodontic sealers. Dent Mater. 2022 Jun;38(6):1044–59. doi:10.1016/j.dental.2022.04.013

Pałka Ł, Nowakowska-Toporowska A, Dalewski B. Is Chlorhexidine in Dentistry an Ally or a Foe? A Narrative Review. Healthcare. 2022 Apr 20;10(5):764. doi:10.3390/healthcare10050764

Rashed H. Evaluation of the effect of hydrogen peroxide as a mouthwash in comparison with chlorhexidine in chronic periodontitis patients: A clinical study. J Int Soc Prev Community Dent. 2016;6(3):206. doi:10.4103/2231-0762.183114Sun H, Chen S, Yang C, Kuang H, Huang Y, He X, et al. Advances in the use of chlorhexidine for periodontitis treatment in diabetic patients: A review. Medicine (Baltimore). 2024 Sep 6;103(36):e39627. doi:10.1097/MD.0000000000039627

Romero-Olid MDN, Bucataru E, Ramos-García P, González-Moles MÁ. Efficacy of Chlorhexidine after Oral Surgery Procedures on Wound Healing: Systematic Review and Meta-Analysis. Antibiotics. 2023 Oct 20;12(10):1552. doi:10.3390/antibiotics12101552Zhao H, Hu J, Zhao L. Adjunctive subgingival application of Chlorhexidine gel in nonsurgical periodontal treatment for chronic periodontitis: a systematic review and meta-analysis. BMC Oral Health. 2020 Dec;20(1):34. doi:10.1186/s12903-020-1021-0

Solderer A, Kaufmann M, Hofer D, Wiedemeier D, Attin T, Schmidlin PR. Efficacy of chlorhexidine rinses after periodontal or implant surgery: a systematic review. Clin Oral Investig. 2019 Jan;23(1):21–32. doi:10.1007/s00784-018-2761-y

Strasding M, Eberhardt M, Hicklin SP, Schmidlin PR, Sahrmann P. Comparison of Chlorhexidine, Chlorhexidine with anti-discoloration system, and Polyvinylpyrrolidone-iodine on early wound healing after dental implant placement: A randomized clinical trial. Clin Oral Investig. 2025 Nov 28;29(12):589. doi:10.1007/s00784-025-06665-y