



ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2023; 9(4): 130-133
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www.oraljournal.com
Received: 02-10-2023
Accepted: 05-11-2023

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Role of antiseptics and disinfectants in the control of periodontitis: An overview

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DOI: <https://doi.org/10.22271/oral.2023.v9.i4c.1859>

Abstract

Periodontitis is an inflammation of supporting tissues of teeth caused by bacterial plaque. Bacterial aggregates get attached and are entangled in a self-produced matrix called biofilm. Causative agents are *Porphyromonas gingivalis*, *Tannerella forsythia*. These are controlled by chemical disinfectants like Povidone iodine, Chlorhexidine, Listerine and by using natural /herbal products such as Tulsi, Neem, Guava, Propolis and Sanguinarine etc.

Chlorhexidine was initially known for its antiseptic properties for skin and later it was introduced as disinfectant in Dentistry for plaque control. Povidone Iodine has microbicidal action against gram-positive & gram-negative bacteria, fungi, mycobacteria, viruses and protozoans. There are nine varieties of listerine which are used for the control of plaque accumulation and gingivitis. Tulsi has anti-inflammatory and anti-infectious properties which is used to cure oral diseases. Neem is a powerful antiseptic agent for treating skin diseases and to reduce the bacterial colonization on the tooth surfaces. Guava is available in the form of chewing stick which is used for cleaning the tooth surface. Propolis and Sanguinarine have anti-plaque action which control periodontal disease.

Keywords: Plaque, biofilm, *Porphyromonas gingivalis*, chlorhexidine, povidone iodine

Introduction

Periodontitis can be defined as inflammatory disease of supporting tissues of the teeth caused by specific or group of microorganisms resulting in progressive destruction of the periodontal ligament and alveolar bone with pocket formation, recession, or both [1]. The most important etiological factor is the accumulation of bacterial plaque [2] which results in tissue destruction [3]. *Treponema bacteroides*, *Porphyromonas*, *Prevotella*, *Capnocytophaga*, *Peptostreptococcus* & *Actinobacillus* are all the gram negative bacteria present in the oral cavity. Causative agents in periodontal disease include *Porphyromonas gingivalis*, *Actinobacillus actinomycetemcomitans* and *Tannerella forsythia* [4]. Bacterial aggregates attached to a substance that are entangled in a self-produced matrix of extracellular polymer substance is called as biofilm. There are various stages in the formation of biofilm which includes formation of an acquired pellicle, primary colonization of bacteria, secondary colonization of bacteria & biofilm maturation. These can be controlled by certain disinfectants and antiseptics [5]. Mostly the effective treatment measures are using the curettes and ultrasonic device, which is a manual removal of plaque, but by using the chemical disinfectant can control the plaque. Thus, chemical substitutes alter & prevent pathogenic growth. Most commonly used agent is Chlorhexidine & various concentrations of povidone iodine solution. Povidone iodine is used which is an effective antibacterial agent even at low concentration when directly used in the periodontal pocket [6]. This agent kills the microorganism within 15 seconds *in-vitro*. Its efficiency found to be increased when combined with Hydrogen peroxide [7]. Chlorhexidine is the first introduced antiseptic which is a broad spectrum bis-biguanide in clinical medicine. Chlorhexidine mouth rinse is mostly available in concentrations of 0.1%, 0.12% or 0.2% (Chlorhexidine digluconate). Also it is available in low concentration ($\leq 0.006\%$) rinse. On biofilm the effect of chlorhexidine is dose dependent [8]. Propolis contains natural ingredients such as volatile oils, plant balsams, phenolic acids, flavonoids, aromatic alcohols, fatty acids, mineral salts and vitamins. Propolis plays a vital role in prevention of periodontal diseases [9].

Neem is an herbal antiseptic which helps in removal of many oral pathogens (aerobic or anaerobic). Neem mouthwash helps in preventing tooth decay, it also prevents bleeding and sore gums, and prevents oral infections, its frequent use will lessen all the gingival problems and also it treats halitosis.

Biofilm

- Red complex, which is composed of chiefly gram negative anaerobic species present in the plaque biofilm causes chronic inflammation of the supporting periodontal tissues.
- In the patients with periodontal pocket *Porphyromonas gingivalis*, *Treponema denticola*, *Tannerella forsythia* are the most predominantly found red- complex bacteria [10].
- Fimbriae which are thin filament surface appendages that protrude from outer membrane of *Porphyromonas gingivalis* enhance the attachment of this microorganism and its invasion to host cells. Its fimbriae which include proline-rich proteins, glycoproteins, fibrinogen, fibronectin and lactoferrin helps in binding to host tissues and cells through wide range of host molecules and oral substrate [11]. *Porphyromonas gingivalis* contains the host pro-inflammatory response and the production of pro-inflammatory cytokines.
- *Tannerella forsythia* which is a non-motile, anaerobic gram negative bacteria with various proteinase as virulence factors that degrade host proteins for the growth of *Tannerella forsythia* which provides essential amino acids, peptides and heme. It also degrades the periodontal tissue by modifying the host cell proteins for bacterial colonization.

Relationship between biofilm and saliva

Protective biofilms evolving from oral microorganism persist in varying environment. Dental plaque can do two roles that is it catch in and block the proliferation of a pathogen that is currently present or offers a refuge for pathogen to conceal from the salivary flow and host safe system.

Biofilm remains healthy and stable when there is a healthy status of the homeostasis & microbial activity [12].

Role of biofilm in gingival health

The early part of plaque formation is predominated by the gram positive bacteria such as *Actinomyces viscosus*, *Streptococcus* species and the later part is predominated by gram- negative species like *Fusobacterium nucleatum*, *Prevotella intermedia*, *Campylobacter gracilis*.

Organisms capable to cope with high oxygen condensations and to forebear from the different elimination mechanisms of oral cavity like swallowing, chewing, salivary, nose-blowing are the first colonizers.

Thus rapid growth allows the subsequent adhesion of other bacterial strains incapable to attach to the previously existed microorganism. This is called as secondary colonization.

Chemical plaque control

The process of regular removal and prevention of accumulation of the dental plaque on the teeth and adjacent gingival surfaces is known as plaque control [13]. Chemical plaque control agents are classified into first, second and third generation anti-plaque agents which includes antibiotics, phenol, bisbiguanides (chlorhexidine), delmopinol and so on [14].

Chlorhexidine (CHX)

Chlorhexidine was developed in England in the 1940s and it was used as an antiseptic for skin wounds in 1954. From 1970s it is used in Dentistry as mouthwash and as disinfectant that is capable of inhibiting the formation of plaque [15]. It is a cationic polybiguanide (bisbiguanide). Its chemical formula is $C_{22}H_{30}Cl_2N_{10}$ [16]. Chlorhexidine binds with bacterial cell wall thereby forming strong absorption to phosphate containing molecule and penetrates through the bacterial cell wall resulting in bacteriostatic and bactericidal action [17, 18, 19, 20]. Rinsing 0.2% chlorhexidine twice daily and 2% solution of chlorhexidine once daily prevents plaque formation. On single application, it has an antiplaque action existing for 24 hours [21]. During orthodontic treatments and InterMaxillary Fixation (IMF), the use chlorhexidine mouth rinse will reduce the plaque load [22, 23]. Chlorhexidine is also useful in physically and mentally handicapped persons for plaque control [24].

Side effects of Chlorhexidine

1. Alteration in taste perception.
2. Its bitter taste cause discomfort.
3. Burning sensation of the oral mucosa.
4. Dryness & soreness of the mucosa.
5. Epithelial desquamation [25].

Povidone Iodine (PVP-I)

A chemist named Bernad Courtis, discovered Iodine in 1811 and Devaine described its bactericidal efficacy in 1880. In late 1960s, Povidone iodine was introduced [26]. Chemical formula of povidone iodine is $(C_6H_9NO)_{n.xI}$. Polyvinyl pyrrolidone is heated with elemental iodine (10%) which actually contains (1%) Iodine [27]. Its mechanism of action is microbicidal against gram-positive & gram-negative bacteria, fungi, mycobacteria, viruses and protozoans [28]. Though at low concentration, when used directly into the periodontal pocket, it remains as an effective antibacterial agent.

Mechanism of action of Povidone iodine

Its antibacterial activity is due to oxidation of amino (NH-), thiol (SH-) and phenolic hydroxy (OH-) groups in amino acids and nucleotides. It reacts strongly with double bonds of unsaturated fatty acids in cell walls and organelle membranes [29].

Listerine

A chemist named Joseph Lawrence in St-Louis, Missouri developed Listerine in 1879. It is a surgical antiseptic that includes Eucalyptol, menthol, methyl salicylate and thymol. In remembrance of Joseph lister Lawrence named his antiseptic as Listerine [30]. For treatment of oral conditions, Listerine was promoted to Dentists in 1895 [31]. Its chemical formula is $C_{30}H_{52}O_3$. Active Ingredients include 0.02% menthol, thymol 0.064%, methyl salicylate 0.06%, eucalyptol 0.002%, sorbitol alcohol and so on. The mechanism of action of Listerine includes bacterial cell wall destruction, enzymatic inhibition of bacteria lipopolysaccharide [32]. Research indicates that at 6 months of duration, it can reduce plaque by 22.2% and gingivitis by 28.2% [33, 34].

Natural and herbal products

Mouth rinses are widely used in oral hygiene and in the delivery of active agents to the teeth and gums. Natural and

herbal products have anti-microbial, anti-inflammatory and cytostatic effects^[35].

Herbal mouthwash

- **Use of guava (*Psidium guajava*) as a mouthwash:** In southern Nigeria the twigs are used as chew sticks and their bioactive compounds such as flavonoids, tannins and alkaloids are responsible for their effectiveness. Chewing sticks used without toothpaste are very effective, reliable and efficient for cleaning teeth^[36].
- **Use of Neem as a mouth wash:** Neem is used as an antiseptic substance against endo and ectoparasites. Its extracts are used to treat various skin diseases. It is commonly used as an herbal mouthwash^[37].
- Wolinsky *et al* have examined the inhibitory effects of neem such as bacterial aggregation, growth adhesion to hydroxyapatite aggregation, growth adhesion to hydroxyapatite and production of glucan which may affect *in-vitro* plaque formation.
- The neem stick extract inhibit insoluble glucan synthesis. Incubation of oral streptococci with the neem stick extract result in bacterial aggregation. These data suggest that neem stick extract can reduce streptococci to colonize tooth surface^[38].
- **Use of Tulsi (*Ocimum Sanctum*) as a mouthwash:** Tulsi a small plant, sub-shrub which has multiple uses, its leaves are quite effective for the treatment of ulcer and infections in mouth. The herb is useful and powdered can be used for brushing teeth. It can also mixed with mustard oil to make a paste and used as toothpaste. This is very good for maintain dental health contracting bad breath and for massaging the gums. It is also useful in pyorrhea and other germ diseases. The anti-inflammatory and anti infectious properties of tulsi make it a powerful treatment^[39].

Natural mouthwash

- **Use of Propolis as mouthwash:** Propolis added to toothpaste prevent periodontal diseases and it has anti-plaque/ anti-inflammatory effect^[40].
- **Sanguinarine as mouthwash:** Sanguinarine has anti-plaque/ anti-gingivitis agent effect currently used as both mouth rinses and toothpastes. It has antimicrobial activity against gram-positive and oral isolates.
- The cationic sanguinaria molecule chemically combine with plaque and remains detectable in the plaque for upto 4 hours of after use.
- Rinsing this solution prevent plaque formation and gingivitis. This mouth rinse is more effective in buccal and lingual surface^[41].

Conclusion

Periodontitis, an inflammation of supporting tissue of teeth caused by bacterial plaque which can be controlled by chemical antiseptics and disinfectants. Chemical substitutes like Povidone iodine and Chlorhexidine plays a role in controlling plaque and also, the use of Propolis and Sanguinarine, a natural product along with herbal products like Neem, Tulasi and guava have been used in plaque control.

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How to Cite This Article

Yuvashree M, Sushmi CB, Yogasri A, Sujitha VB, Hemalatha R. Role of antiseptics and disinfectants in the control of periodontitis: An overview. International Journal of Applied Dental Sciences. 2023;9(4):130-133.

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