

Aids in chemical plaque control: A review

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Abstract

The most common disease-causing factor in the oral cavity is the dental biofilm. It leads to caries and well as disease of periodontium that is periodontitis. Biofilm formation is a complex process that takes place following a series of events. Two widely accepted method of plaque control include chemical and mechanical methods. Where mechanical methods are of utmost importance. Chemical plaque control has also gained popularity. Various agents are available for effective plaque control. However, these agents are always used as an adjunct to mechanical plaque control. Following paper discusses various agents used for chemical plaque control.

Keywords: Plaque, Bisbiguanides, Herbal, Listerine, Generations.

Introduction

Dental plaque is a biofilm that forms naturally on the surfaces of exposed teeth. It is a complex organized microbial community which is the primary etiological factor for the most frequently occurring oral diseases, such as dental caries and periodontal diseases.¹ The classic experiments of Loe demonstrated that the accumulation of microbial plaque for 3 weeks predictably resulted in the development of generalized gingivitis.² The plaque formation is a progressive, dynamic process which if permitted to continue unhindered results in gingivitis.³ Early human dental plaque formation is initiated by the deposition of a thin biofilm mainly derived from salivary glycoproteins onto the tooth surface.⁴ Proliferation of bacteria accounts for the major part of the microbial mass increase with time rather than being a continuous

apposition of salivary microbes during early plaque formation.⁵

Plaque control normally means preventive measure aimed at removing dental plaque and preventing it from reoccurring. This can be accomplished either mechanically or chemically: sometimes the two procedures are combined.⁶ To date, mechanical plaque elimination with assorted devices remain the primary and most widely accepted means of controlling plaque and maintaining good oral hygiene.⁷

Most patients do not achieve effective plaque removal from interdental areas with tooth brushing. The effectiveness of plaque removal is, among other aspects, dependent on the dexterity and thoroughness of the individuals as well as their compliance.⁸ Such extensive and time-consuming efforts have provided the basis for implementing preventive concepts and suggest the need for developing agents for chemical plaque control.²

History

In tombs of the Sumerians during 3000 B.C., archaeologists have uncovered toilet sets of gold that included tooth picks. Evidence of oral hygiene maintenance has been elicited in Chinese literature in 1600 BC using chewing sticks.⁹ The first mouthwash advocated was urine from a child. Vinegar was also propagated as a mouthrinse.⁴ **Davis et al**, 1945 did a study on compounds and found that certain bisbiguanides have a broad antimicrobial spectrum. By structural variation they arrived at an agent with greatest bacteriostatic and bactericidal features, which was 1,6 bis-4 chloro, phenyldiguanidohexane a synthetic cationic detergent usually referred as Chlorhexidine. Use of chlorhexidine in dentistry was for surgical disinfection of mouth and in Endodontics.¹⁰ **Loe and Rindom Schiott** in 1970 demonstrated the antiplaque action of chlorhexidine.¹¹

Chemical Plaque Agents

Three main group of chemical agents are:

1. Enzymes
2. Antibiotics
3. Antiseptics¹²

Enzymes

Enzymes preparations have been investigated in an attempt to break down the plaque matrix. **Stewart** studied the effect of mucinase used in compatible dentifrice in a total of six subjects. Beneficial results were obtained. He found that the amount of calculus that did form was much softer. Similar results were obtained by **Allece and Forscher**.¹³

Antibiotics

Dental plaque consists mainly of bacteria and it is reasonable to assume that antibiotics may have a role in the prevention and control of plaque formation. Thus, various antibiotics were assessed for their effect on dental plaque. Effective results were seen but due to development of drug resistance to various antibiotics and also their harmful effect on the normal microflora of the gut and the oral cavity also limited their use.

Antiseptics

Antiseptics are defined as antimicrobial substances that are nondamaging to living tissue/skin while reducing the possibility of infection, sepsis, or putrefaction. Many substances have been tested. The compounds used as antiseptics have been divided according to their substantivity, that is prolonged association between a material and a substrate. The agents on the basis of their substantivity have been divided into 4 generations.⁴

Generations of Mouthwash

First generation: The agents that do not exhibit any significant substantivity (only minutes). Generally, consist of quaternary ammonium compounds cetylpyridinium chloride), essential oil phenolic compounds, fluorides

including monofluorophosphate and sodium fluoride, oxidizing agents, plant alkaloids and iodine including povidone iodine.⁴

Second generation: They are characterized by high substantivity, that is, retention of 25-30% after each 1-minute mouthrinse.¹⁴ Such compounds remain active in situ for hours and include bisbiguanides (such as chlorhexidine), amine fluoride and stannous fluoride mouthrinse, and triclosan when associated with a copolymer of polyvinyl methyl ether and maleic acid copolymer.

Third generation: Substances with mild antibacterial effect but that interfere with bacterial adhesion are referred to as third-generation antimicrobial agents: the amino alcohols (octapinol, decapinol).¹⁴

Fourth generation: A fourth generation could be envisaged. The mouth flora will be individually characterized. Thus, in the laboratory a cocktail of nonadherent bacteria would be prepared and this mixture given to a particular individual at more or less frequent intervals, until such time as he or she acquires a personal flora mainly comprising handicapped bacteria. The technical knowledge is already available. However, whether this approach is feasible or even desirable remains to be seen and the strategy must be described at present as being rather futuristic.⁴

Various Chemical Plaque Agents Used In Dentistry

Quaternary Ammonium Compound: The agents are anionic in nature. Since they are strongly positively charged, they bind easily to oral tissues. Their substantivity is approximately 30 minutes. The best-known agent of this category is **Cetylpyridinium chloride** (CPC). It can interact with the bacterial cell membrane, resulting in leakage of cellular components, disruption of cellular metabolism, inhibition of cell growth and cell death. Recommended dosage is rinse for 30

seconds with 20mL (4 teaspoonfuls) twice a day for 2 weeks.

Side effects seen with CPC include, staining and enhanced calculus formation, especially when used at higher concentrations. Burning sensation and transient desquamation of the oral mucosa have also been reported¹⁵

Essential Oil Phenolic Compounds: These include **Listerine®**. EOs generally show antimicrobial activity against Gram-positive bacteria. They can interfere with enzymes involved in the production of energy, and at higher concentrations, they can denature proteins. They are neutral in charge. It is available in either a 26.9 per cent or 21.6 per cent alcohol vehicle with a pH of 5.0 or 4.4.¹⁶

Povidone-Iodine Mouthwashes: Povidone-iodine (PVP-iodine) is an antiseptic with a broad antibacterial spectrum. They act by interrupting the metabolic processes by binding of iodine. This mechanism of action was given by **Gottardi** in 1985. The side effects associated with povidone iodine include local mucosal irritation and sensitivity reactions, allergic reaction, thyroid function impairment, metabolic acidosis and impaired renal function. The substantivity of betadine is 1hr and the recommended dosage is dilute 2 to 4 caps in approximately 125 mL of water. Wash or gargle for at least 30 seconds every 1 - 4 hours.¹⁷

Plant Alkaloids – Sanguinarine: It is extracted from the blood root plant *Sanguinaria canadensis* which provides an alkaloid extract which bears the name sanguinarine. Sanguinarine is a benzophenanthridine alkaloid.¹⁵ Sanguinarine has broad antimicrobial activity as well as anti-inflammatory properties. It has been incorporated into dentifrices and mouthwash Viadent (USA) Perioguard (UK).¹⁸ The only adverse effect reported with this agent has been burning sensation when used initially.¹⁹

Oxidizing Agents: Gram-negative anaerobes are involved in the pathogenesis of gingivitis and periodontitis. These organisms are highly sensitive to active oxygen. Therefore, oxygenating agents have been used to suppress or control the oral infections caused by Gram-negative anaerobes. The most commonly used agents have been hydrogen peroxide, urea peroxide, and the oxygen releasing enzyme glucose oxidase.¹¹

Fluorides: Sodium fluoride has been classified as first generation mouthwash whereas amine and stannous fluoride have been classified as second generation mouthwashes that has shown some effectiveness as an antiplaque agent. It is due to the binding of the stannous ion to the bacterial cell surface, displacing calcium ions and the alteration of enzyme function. However, the shelf life of these mouthwashes is very limited because of rapid oxidation and hydrolysis of stannous ion which can inactivate stannous fluoride. Sodium fluoride is also one of the most commonly used mouthwash 0.05% and 0.2% sodium fluoride mouthwashes are currently available. The only adverse effect is small amount of staining.¹⁹

Chlorhexidine: Chlorhexidine has a wide variety spectrum of activity encompassing gram negative and positive bacteria, viruses, yeast, fungi, dermatophytes. It shows different effects at different concentrations, at low concentration, bacteriostatic whereas at higher concentration is bactericidal. The mode of action is that bacterial cells is characteristically negatively charged. The cationic chlorhexidine is rapidly attracted towards negatively charged bacterial cell surface, with specific and strong adsorption to phosphate containing compounds.

This alters the integrity of bacterial cell membrane and chlorhexidine is attracted toward the inner cell membrane. Chlorhexidine leads to increased permeability of the inner membrane and leakage of low molecular weights

compounds such as potassium ions. At this bacteriostatic stage the effects of chlorhexidine are reversible.

Increasing the concentration causes progressively greater damage to the membrane. The bactericidal stage is irreversible.²⁰The superior antiplaque effect of Chlorhexidine which makes it gold standard can be attributed to its substantivity.

Substantivity of Chlorhexidine is 12hr.²⁰ However, prolonged use of chlorhexidine leads to local side effects. The main adverse effect is extrinsic staining. Occasionally reported are cases of burning sensation and painful desquamative lesion on oral mucosa which appears to be idiosyncratic reaction and concentration dependent.²²

Triclosan: Triclosan is a bisphenol as well as a non-ionic germicide with low toxicity and a broad spectrum of antibacterial activity. The antibacterial action seems to be associated with the cytoplasmic membrane disruption of the bacterial cell, whereas its anti-inflammatory action lies on the inhibition of the oxygenase/lipoxygenase pathway in the arachidonic acid metabolism.¹⁴ Since it does not bind well to oral sites due to its lack of a strong positive charge, formulations have been developed to enhance its ability to bind to plaque and teeth. These formulations include:

1. Combination with zinc to take advantage of its potential antiplaque and anticalculus properties;
2. Incorporation of triclosan in a copolymer of methoxyethylene and maleic acid to increase its retention time;
3. Combination with pyrophosphates to enhance its calculus-reducing properties.¹⁹

Herbal Mouthwash: Herbal mouthwash contains a natural ingredient called phytochemical that contains desired anti-microbial and anti-inflammatory effect. It contains natural herbs that have natural cleansing and healing property to teeth and gums.²³

Neem (Azadirachta Indica): The leaves, twigs, and seeds of neem have been used in India and South Asia for thousands of years. Neem has been shown to have significant effects on both gram-positive and gram-negative organisms. The possible mechanism of anti-inflammatory action of neem is by inhibiting prostaglandin E and 5 HT and thus reducing the inflammation.²⁴

Tulsi (Ocimum sanctum): It contains Eugenol, Carvacrol, Eugenol methyl ether, Caryophyllin, linalool, Aneole, Chavicol, nerol, terpinin, decylaldehyde, r-selinene, champhor sesquiterpenes. Besides the volatile oil, the plant is reported to contain alkaloids, glycosides, saponins and tannins. Its leaves, dried in the sun and powdered, can be used for brushing teeth. It can also be mixed with mustered oil to make a paste and used as toothpaste. This is very good for maintaining dental health counteracting bad breath and for massaging the gums. The anti-inflammatory and anti-infectious properties of tulsi make it a powerful treatment for gum disease.²⁴

Green Tea (Camellia sinensis): Its remedial effects are associated with the polyphenol contents comprising catechin, epicatechin, gallic acid, epigallocatechin, epigallocatechin gallate, and epigallocatechin gallate (EGCG). The two latter are mainly found in green tea rather than the black tea and are among most potential contents to be reviewed for periodontal adjunct therapies in terms of their special anti-collagenase activity. In addition, it is suggested that EGCG inhibits the growth and cellular adherence of periodontal pathogens.²³

Lemon Grass Oil (Cymbopogon citrates): It is made up of myrcene, citronellal, geranyl acetate, nerol, geraniol, neral and traces of limonene and citra. Lemongrass oil has antibacterial, anti-inflammatory, and also superoxide scavenging property. Reduction in the bacterial load, decrease in inflammation and reduction of the oxidative

stress will bring about the overall health of the tissues. Based on above property, studies have been done to prove lemongrass oil mouthwash can be used as an adjunct along with the nonsurgical therapy.²⁴

TURMERIC (Curcuma longa)

It is an excellent natural antibiotic, and one of the best detoxifying herbs by virtue of its beneficial effect on the liver, a powerful antioxidant with health-promoting effects on the cardiovascular, skeletal and digestive systems. It has now been confirmed that turmeric is a first-rate anti-inflammatory herb. It contains at least two chemicals, curcumin and curcuminoids, that act to decrease inflammation much like NSAID COX-2 that inhibit the production of prostaglandins.²⁴

Other herbal mouthwash available are:

1. Propolis
2. Aloe Vera
3. Tea Tree Oil (Melaleuca Alternifolia)
4. Miswak (Salvadora Persica)
5. Guava (Psidium Guajava)
6. Pomegranate (Punica granatum)

Conclusion

Periodontitis and periodontal diseases are true infections of the oral cavity. Pathogens of the subgingival microbiota can interact with host tissues even without direct tissue penetration, and the subgingival microbiota accumulate on the oral cavity to form an adherent layer of plaque with the characteristics of a biofilm. Chlorhexidine, to date is the most potent anti-plaque agent. It is considered gold standard anti-plaque agent, against which efficacy of other anti-plaque and anti-gingivitis agents are measured. The antimicrobial properties of Chlorhexidine are attributed to its bi-cationic molecule, and this same property is the

basis of its most common side effect, extrinsic tooth staining.

Given the increasing trend of Ayurveda use in day today's life and the enormous power to two contemporary approaches evidence-based clinical practice and modern dentistry the time is ripe to reformulate our approach to the practice, research and training in Ayurveda and holistic dentistry. Natural compounds can again become central players in the treatment of disease and in the understanding of disease mechanisms.

The adjunctive use of chemical plaque control, together with mechanical control, offers advantages in terms of prevention of gingival inflammation development and in plaque levels control.

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