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Review Article

Plaque Control-Review Article

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Abstract

This review article aims to establish a scientific foundation for dental professionals, allowing them to formulate a systematic strategy for plaque management. It will be grounded in contemporary understanding of how the oral microorganisms contribute to both oral health and disease. Dental plaque, a biofilm naturally occurring on exposed tooth surfaces and other oral areas, serves as the main causative agent for common oral conditions like dental caries and periodontal diseases. The specific, nonspecific, and ecological plaque hypotheses detail the origins of dental and related diseases. In a state of health, there's a harmonious equilibrium between the host and the resident microflora, but disease arises when this balance is disrupted. It's crucial to educate patients on effective plaque management methods that keep dental biofilms at levels conducive to oral health. This way, the advantageous aspects of the resident microflora can be preserved while minimizing the potential for dental diseases due to excessive plaque accumulation. Numerous techniques have been utilized for plaque management, broadly categorized into mechanical and chemical methods. Mechanical approaches encompass a range of methods, including manual and advanced toothbrushes such as power-driven, sonic, and ultrasonic variants, as well as innovative options like solar-powered and laser toothbrushes. Additionally, interdental cleaning aids fall under this category.

Keywords: Interdental Cleaning Aids; Plaque Control; Mechanical Plaque Control; Toothbrushes; Oral Irrigation Device; Chemical Plaque Control

Introduction

Dental plaque is the community of microorganisms found on a tooth surface as a biofilm, embedded in a matrix of polymers of host and bacterial origin [1]. The arrangement of plaque biofilm can limit the effectiveness of antimicrobial agents, and bacteria that grow slowly on surfaces exhibit unique characteristics, including reduced sensitivity to inhibitors [2]. The formation of dental plaque follows a structured series of steps, leading to the development of a diverse microbial community that is both structurally and functionally organized [3]. Plaque formation progresses through several distinct stages: initial formation of an acquired pellicle; reversible adhesion facilitated by weak physicochemical interactions between cell surfaces and the pellicle, potentially leading to stronger adhesion through adhesin-receptor interactions; co-adhesion, where secondary colonizers attach to already adhered cells, leading to multiplication and biofilm formation, including the production of exopolysaccharides; and occasionally, detachment [4].

Dental plaque, also known as “oral biofilm,” is a resilient substance found on teeth that cannot be easily removed by rinsing with water. It is primarily composed of a structured matrix originating

from salivary glycoproteins and microbial products, forming a biofilm on the hard, non-shedding surfaces within the oral cavity.

Plaque hypothesis

The three main hypotheses that explain the disease occurrence in oral cavity are as follows

- Specific plaque hypothesis: This statement implies that individual bacterial species within dental plaque play a significant role in causing disease, in contrast to the previous description.
- Nonspecific plaque hypothesis: When bacterial dental plaque gathers around teeth, it forms a fairly uniform mass. If this accumulation surpasses the host's defense mechanisms, it can lead to periodontal disease.
- Ecologic plaque hypothesis: According to the theory suggesting that the specific local environment shapes the composition of oral microorganisms, any disruption in this equilibrium could result in an upsurge of pathogenic microorganisms at the expense of benign normal oral flora.
- Keystone pathogen hypothesis: According to the KPH, specific microbial pathogens present in low numbers can induce inflammatory diseases by augmenting the normal microbiota's quantity and altering its composition.

Classification of mechanical plaque control aids

1. Tooth brushes	2. Interdental aids	3. Aids for gingival stimulation	4. Others	5. Aids for edentulous & partially edentulous patients
a) Manual tooth brush. b) Electric tooth brush.	a) Dental floss. b) Triangular tooth pics. -Hand-held triangular toothpics. -Proxapic. c) Interdental brushes. -Proxabrush system. -Bottle-brushes. -Single-tufted brushes (flat or tufted). d) Yarn. e) Superfloss. f) Perio-Aid.	a) Rubber tip Stimulator. b) Balsa wood edge.	a) Gauze strips. b) Pipe cleansers. c) Water irrigating device.	a) Denture & partial clasp brushes. b) Cleansing solutions. 10

Figure a

The toothbrush

Toothbrushes have been continuously improved to promote healthier teeth. Contemporary manual toothbrushes are more efficient in cleaning teeth compared to conventional tools like fingers, sticks, and twigs. Toothbrushes come in various sizes and designs, with differences in bristle length, hardness, and arrangement. Certain manufacturers assert the superiority of their designs based on minor adjustments in bristle placement, length, and stiffness.

Dentifrices

Dentifrices aid in cleaning and polishing tooth surfaces. Primarily, toothbrushes are used with pastes, although powders and gels are alternatives. Abrasives, which are insoluble inorganic salts, significantly boost the abrasive effects of brushing, sometimes by up to 40%, constituting around 20% to 40% of dentifrices [5].

Anticaries agents in toothpastes

- **Fluoride**: Different types of fluoride, including amine fluoride, stannous fluoride, sodium fluoride, and sodium monofluorophosphate, have been incorporated into toothpaste formulations. Dentifrices containing fluorides in concentrations >1500ppm are classed as prescription only medicines (POM) and should be used only above the age of 10 years and for the management of high caries risk individuals such as those with xerostomia or root surface caries.[6]
- **Non-fluoride:** Non-fluoride anti-caries agents within toothpaste formulations include agents containing calcium, phosphorus (phosphate, tri metaphosphates, pyrophosphates, glycerophosphates), metals (zinc, tin, aluminium, iron, manganese, molybdenum) and various antimicrobials. Although many agents have been identified in various models few have been taken forward to clinical trials in humans [6].

Abrasives	Surfactants	Humectants
Alumina	Amine fluorides	Glycerol
Aluminium trihydrate	Dioctyl sodium sulfosuccinate	PEG 8 (polyoxyethylene glycol esters)
Bentonite	Sodium lauryl sulfate (SLS)	Pentatol
Calcium carbonate	Sodium N lauryl sarcosinate	PPG (polypropylene glycol ethers)
Calcium pyrophosphate	Sodium stearyl fumarate	Sorbitol
Dicalcium phosphate	Sodium stearyl lactate	Water
Kaolin	Sodium lauryl sulfoacetate	Xylitol
Methacrylate		
Perlite (a natural volcanic glass)		
Polyethylene		
Pumice		
Silica		
Sodium bicarbonate		
Sodium metaphosphate		
Gelling or binding agents	**Flavours**	**Preservatives**
Carbopols	Aniseed	Alcohols
Carboxymethyl cellulose	Clove oil	Benzoic acid
Carrageenan	Eucalyptus	Ethyl parabens
Hydroxyethyl cellulose	Fennel	Formaldehyde
Plant extracts (alginate, guar gum,	Menthol	Methylparabens
gum arabic)	Peppermint	Phenolics (methyl, ethy, propyl)
Silica thickeners	Spearmint	Polyaminopropyl biguanide
Sodium alginate	Vanilla	
Sodium aluminum silicates Viscarine	Wintergreen	
Xanthan gum		
Colours	**Film agents**	**Sweeteners**
Chlorophyll	Cyclomethicone	Acesulfame
Titanium dioxide	Dimethicone	Aspartame
	Polydimethylsiloxane	Saccharine
	Siliglycol	Sorbitol

Figure b

Toothbrushing methods

Many methods for brushing the teeth have been described and promoted as being efficient and effective. These techniques are mainly classified based on the brushing motion pattern and are primarily of historical significance, as follows [7].

- **Roll:** Roll or modified Stillman technique
- **Vibratory:** Stillman, Charters, and Bass techniques
- **Circular:** Fones technique
- **Vertical:** Leonard technique
- **Horizontal:** Scrub technique

Bass method

- **Technique**: The brush head remains parallel to the occlusal plane, covering approximately 3-4 teeth starting from the furthest teeth in the arch. Bristles are positioned at a 45-degree angle to the tooth's long axis at the gum line. Gentle vibratory pressure is applied with short back-and-forth movements, dislodging the bristle tips.

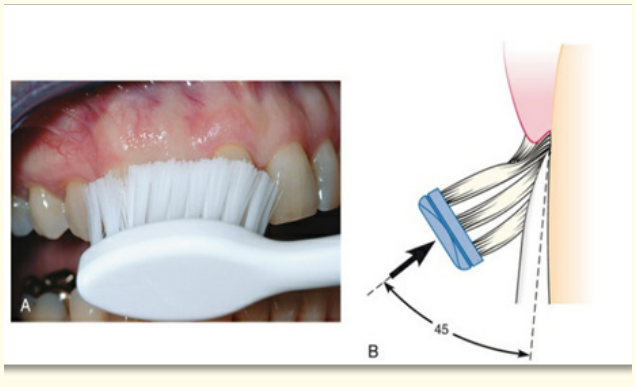

Figure 1: Bass method. (A) Proper positioning of the brush in the mouth aims the bristle tips toward the gingival margin. (B) Diagram shows the ideal placement, which permits slight subgingival penetration of the bristle tips.

- **Indication**
  - Adaptable for open interproximal & cervical areas
  - Contour of the enamel & exposed root surfaces.
  - Recommended for routine patients with or without periodontal involvement.

Modified bass methods

The modified Bass technique stands out as one of the most highly recommended brushing methods, supported by research indicating improved plaque control and a notable decrease in gingival inflammation.

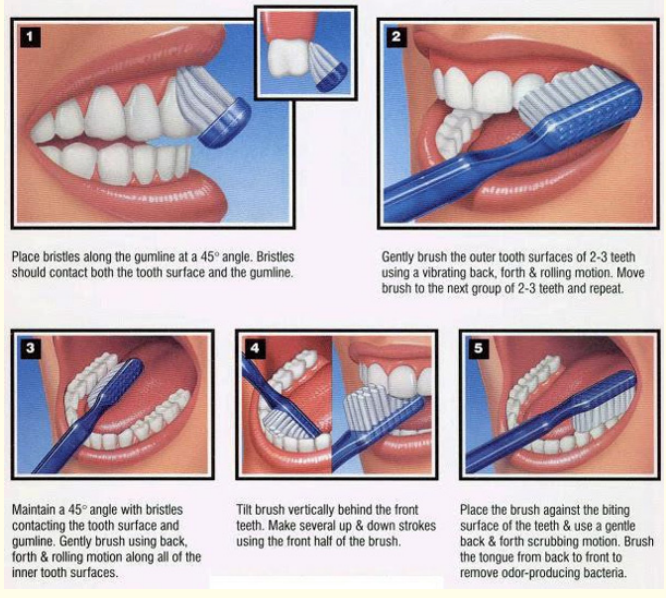

Figure 2: Modified bass method.

Brushing with powered toothbrushes

The various mechanical motions built into powered toothbrushes means they do not require special techniques. This area is the focal point for maintaining oral hygiene and is systematically addressed around the dental arch. Similar to the manual brushing method described earlier, it is the standard technique used with a powered toothbrush [8].

Dental Floss

Floss, a thin cord, should be delicately inserted beneath the point where teeth touch and employed in a back-and-forth or up-and-down motion to eliminate plaque. It proves advantageous in teeth with tight spaces and densely packed areas. Numerous dental floss varieties are presently accessible, ranging from those with and without handles to flavored and unflavored types, and both waxed and unwaxed options.

Figure 3: Positioning the powered toothbrush head and bristle tips so that they reach the gingival margin is critical to achieving the most effective cleaning results. (A) Straight-head placement. (B) Round-head placement.

Oral Irrigators

These irrigation tools deliver a pulsating fluid flow between teeth, effectively reaching the spaces between them. Moreover, they have the capability to administer medications such as chlorhexidine, antibiotics, and 5% tetracycline. Oral irrigation devices are available in different forms, including both powered and manual models, designed for use at home or in professional settings, with options for interchangeable tips or without.

Musical toothbrush

As implied by its name, this toothbrush features an integrated musical component that activates when brushing begins and stops when the brushing process is complete. This toothbrush is specifically recommended for children to enhance the enjoyment and excitement of brushing [9]. (Example – PossiTM, Kyocera and Lion Corporation, Japan.

Laser toothbrushes

Dentinal hypersensitivity continues to be a prevalent concern in the field of dentistry. Laser therapy works by interrupting impulse transmission through dentinal tubules, effectively reducing dentinal hypersensitivity. Laser toothbrushes, a variation of powered toothbrushes, emit laser energy to tackle hypersensitivity.

Chemical plaque control is one of the aspects of non- surgical periodontal therapy that as an adjunct to mechanical therapy has many benefits. Ominous morphology of the periodontal pockets makes it difficult for mechanical instrumentation which leads to inadequate removal of plaque and calculus, incomplete eradication

of all periodontal pathogens. Microorganisms within the oral cavity have the capacity to migrate and infiltrate tissues. These factors collectively contribute to the immediate impact of scaling and root planing. Such persistence of action, sometimes termed substantivity, appears dependent on several factors

- Adsorption and prolonged retention on oral surfaces including importantly, pellicle coated teeth.
- Sustaining antimicrobial efficacy after absorption is mainly achieved through a bacteriostatic mechanism targeting predominantly the bacteria responsible for plaque formation.
- There is minimal or gradual neutralization of antimicrobial effectiveness within the oral environment, or slow release from surfaces.

First generation antiplaque agents	Second generation antiplaque agents	Third generation antiplaque agents
This may reduce the plaque to 20-50%. They have low mouth retention.	The plaque decrease is about 70-90% overall and is better preserved than the first generation. They demonstrate improved oral tissue retention and slow release characteristics	They block microorganisms' binding on or against the tooth. In contrast to second generation chlorhexidine, they have low retention capability.
E.g., Antibiotics, phenols, quaternary ammonium compounds and sanguanarine.	E.g,. Bisbiguanides (chlorhexidine).	E.g., Delmopinol.

Figure c

CLASS OF INHIBITOR	EXAMPLE	MECHANISM OF ACTION
Bisbiguanide	Chlorhexidine.	Inhibits sugar transport, acid production, amino acid uptake, polysaccharide synthesis, bacterial membrane functions, protease activity.
Enzymes	Mutanase, dextranase, amyloglucosidase-glucose oxidase.	Inhibit plaque biofilm matrix formation by degradation of bacterial polysaccharides, bacterial glycolysis, by boosting salivary peroxidase system.
Essential oil extracts	Menthol, thymol, eucalyptol, methyl salicylate.	Inhibit acid production, bacterial growth reduces lipopolysaccharide.
Metal salts	Zinc, copper, stannous ions.	Inhibit sugar transport, acid production, protease activity.
Quaternary ammonium compounds	Cetylpyridinium chloride	Damage cell membrane, inhibit bacterial enzymes.
Phenols	Triclosan	Inhibit sugar production, acid production, protease activity.
Natural molecules	Plant extracts (eg., apigenin, tt-farnesol)	Inhibit acid production, polysaccharide synthesis.
Surfactants	Sodium lauryl sulfate, delmopinol	Damage cell membrane, inhibit bacterial enzymes.

Figure d

Natural products

Sanguinarine

Sanguinarine, an anti-plaque/anti-gingivitis agent, is presently utilized in both mouthwashes and toothpastes. Rinsing with the active solution seems to inhibit both plaque buildup and gingivitis, with a more noticeable impact on the cheek and tongue surfaces [10].

Metal salts

For numerous years, the antimicrobial effects of metal salts, particularly copper, tin, and zinc, have been recognized, garnering significant research attention. Stannous fluoride stands out as an exception but presents challenges in formulating oral hygiene products due to stability issues, including hydrolysis in the presence of water. However, zinc salts may still hold promise in reduc-

ing volatile sulfur compounds linked to oral malodor [11].

Povidone iodine

Povidone iodine exhibits an attraction to the cell membrane, enabling the direct delivery of free iodine to the surface of bacterial cells. With a wide range of effectiveness against bacteria, fungi, protozoa, and viruses, this mouthwash has demonstrated efficacy in decreasing plaque and gingivitis, potentially serving as a beneficial addition to regular oral care practices [12].

Chlorhexidine (CHX)

Schroeder proposed the use of CHX as an anti-calculus or antiplaque agent in 1969. CHX consists of two identical chlorophenyl rings and two biguanide groups connected by a central hydrophobic hexamethylene chain (1,6-di(4-chlorophenyl biguanido). Containing both hydrophilic and hydrophobic components, it serves as a cationic polybiguanide (bisbiguanide) primarily utilized in the form of its salts, including dihydrochloride, diacetate, and digluconate.

Chlorhexidine is particularly effective against Gram-positive bacteria in concentrations ≥ 1 µg/l. Significantly higher concentrations (10 to more than 73 µg/ml) are required for Gram negative bacteria and fungi [13].

Rolla and Melsen illustrated that, chlorhexidine attached to the oral mucosa show plaque-inhibitory action which can be explained with three processes [14]

- Preventing pellicle formation: by blocking the acidic groups on the salivary glycoproteins, thus reducing the protein adsorption to the tooth surface.
- Reducing adsorption of plaque onto the tooth surface: by binding to the bacterial surface in sub-lethal amounts.
- Preventing formation of plaque: by displacing calcium from the plaque matrix and precipitating the agglutination factors in saliva.

Antibiotics

These are compounds generated by certain microorganism species, capable of inhibiting the growth or exterminating other microorganisms even at minimal concentrations. The conditions outlined by regulatory agencies for the topical oral administration of antibiotics are [10].

- Actually not in life and death circumstances for medical reasons.
- There are no cross sensitive.
- Low dosage and active.
- Non-sensitive, allergic to oral tissue or distracting.
- Is not immune to oral ecology changed.

Recent advances

Xylihex

This formulation comprises chlorhexidine, sodium fluoride, and xylitol in tablet form, offering portability for convenient use anywhere. While ready-to-use mouthwash solutions are not feasible, users have reported that XYLIHEX tastes notably worse compared to chlorhexidine and sodium fluoride [10].

Delmophenol hydrochloride

This product has been created for plaque control purposes, although its precise mechanism of action remains unclear. Delmophenol, a surface-active agent within it, is believed to potentially disrupt the adhesion force between microbes and their environment [10].

Plax (Prebrushing rinse)

The mouthwash consists of a blend of anionic and ionic surfactants, which includes sodium lauryl sulfate and polysorbate. Plax performance (Colgate, UK) is significantly enhanced when the prebrush rinse contains 0.3% triclosan and 0.125% copolymer of methoxyethylene and malic acid. Additionally, no adverse effects have been reported with these commercial products [15].

Conclusion

A central focus of dentistry practice revolves around managing plaque effectively. Dentists advocate for patients to assume daily responsibility for their oral health. Periodontal therapy is indispensable for achieving and sustaining optimal oral health. In all dental procedures, it is essential to instruct and motivate every patient to maintain consistent plaque control. While mechanical plaque control forms the foundation for preventing oral diseases, it necessitates significant patient cooperation and motivation. Consequently, chemical plaque control agents serve as valuable supplements in achieving the desired outcomes. Antimicrobial and antiplaque agents in dentifrices and oral rinses act in several ways to reduce or remove dental biofilms and inhibit bacterial growth.

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