

*Dept. of Public Health Dentistry*

*Chemical Plaque  
Control*

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# INTRODUCTION

- PLAQUE
- PLAQUE CONTROL: It is the removal of microbial plaque and the prevention of its accumulation on teeth and adjacent gingival tissues.
- Primary level of prevention
- 1] Mechanical plaque control: Brush, Interdental aids
- 2] Chemical plaque control- **As adjuncts**  
→enhances the efficacy of mechanical plaque control methods.

Chemical plaque control **CANNOT** replace/  
substitute mechanical plaque control.

# DEFINITION

- Chemical plaque control refers to the topical application of antimicrobial agents in the oral cavity with respect to the depletion of supragingival plaque deposition on the tooth surface thereby affect the gingival inflammation.
- Ideal adjunct to mechanical plaque control procedures especially in individuals with a
  1. defective host defense mechanism
  2. mentally or physically handicapped
  3. in patients who have undergone surgical procedures postoperatively.

# Goals of Chemical Plaque Control

- To prevent & control plaque formation
- To reduce, disrupt or remove existing plaque
- To alter composition of plaque flora
- To exert bactericidal or bacteriostatic effects on microflora implicated in caries and periodontal disease
- To alter surface energy of the tooth, in turn, affecting the plaque adherence

## *Ideal Requisites of an antiplaque agent:*

- Should significantly reduce plaque and gingivitis.
- Should prevent the growth of pathogenic bacteria:  
selectivity
- Should prevent development of resistant bacteria.
- Should be compatible with the oral tissues
- Should not stain teeth / alter taste.
- Should exhibit good retentive properties (Substantivity)
- Should penetrate deeply into the formed plaque  
matrix: Penetrability
- Should not undergo chem. Breakdown or modification  
during storage: stability
- Should be inexpensive and easy to use.

# DELIVERY VEHICLES

- Mouth rinses
- Gels
- Toothpastes
- Chewing gums, lozenges
- irrigants
- Varnishes and controlled release devices

# Classification of chemical plaque control agents:

## 1. First generation antiplaque agents:

- Reduce plaque scores by 20-50%.
- poor retention within the mouth

E.g.. Antibiotics, phenols like Listerine, Triclosan, Quaternary ammonium compounds and sanguanarine.

## 2. Second generation antiplaque agents:

- Reduce plaque by 70-90%
- better retained by the oral tissues and exhibit **slow release** properties.

E.g.. Bisbiguanides (Chlorhexidine), Triclosan with co-polymer or zinc citrate.

## 3. Third generation antiplaque agents:

- They block binding of microorganisms to the tooth or to each other.
- As compared to Chlorhexidine, they **do not exhibit good retentive properties.**

# Phenol related Essential Oils

## 1] Listerine® ( Essential oil mouth wash)

combination of the phenol-related essential oils, thymol and eucalyptol, mixed with menthol and methylsalicylate in a 26.9% hydro alcoholic vehicle.

Mechanism of action : mainly by cell wall disruption and inhibition of bacterial enzymes.

There is some evidence that Listerine®, by nature of the phenolic and alcohol content, can also “extract” the lipopolysaccharide-derived endotoxin from Gram-negative bacteria.

They have anti-inflammatory and cyclo-oxygenase inhibitory activity which can occur at a concentration below that for antibacterial activity.

Some patients find an initial burning sensation and bitter taste.

Plaque reduction -20 to 34%

Gingivitis reduction -28 to 34% when Listerine® was used twice daily following tooth brushing.

# LISTERINE

- It is phenol related essential oils:
  - Thymol- 0.064%
  - Eucalyptol- .092%
  - Methanol: .042%
  - Methyl salicylate: 0.060% in HCl solution
  - Benzoic acid: 0.15%

# Listerine

- Advantages: better taste than CHX, no stains, less expensive; OTC mouthwash
- Disadvantages: High alcohol content (exacerbates Xerostomia); contraindicated in patients under treatment of alcoholism who take antabuse (disulfiram)

## 2] Triclosan :

- Both a bisphenol and a nonionic germicide
- **Broad spectrum of activity** against both gram positive and gram negative bacteria, also includes Mycobacterium spores and Candida species.
- *Mechanism:*

Triclosan acts on the **microbial cytoplasmic membrane, inducing leakage of cellular constituents and thereby causing bacteriolysis.**

Three strategies have been developed to enhance the clinical effectiveness of oral Triclosan products:

- 1) Combine it with Zinc citrate ( Pepsodent) to take advantage of its potential anti-plaque and anti-calculus properties
- 2) Incorporate Triclosan in a copolymer of methoxyethylene and maleic acid (Gantrez) to increase its retention time- Colgate TOTAL ( here, the concentration of Triclosan is 0.2% and 2% of co-polymer)
- 3) Combine it with Pyrophosphates to enhance its calculus reducing properties.

# Chlorhexidine Gluconate(0.2%)

- Chlorhexidine Gluconate(0.2%) is a cationic bisbiguanide which is effective against an array of microorganisms, including gram positive and gram negative organisms, fungi, yeast and viruses.
- Gram positive bacteria are more susceptible than Gram negative, esp. Strep. Mutans
- Chlorhexidine exhibits both anti plaque and antibacterial properties.
- Plaque reduction of 45 to 61%
- Gingivitis reduction of 27 to 67%

## ***Mechanism of Action:***

### A. Antiplaque action:

The superior antiplaque activity of Chlorhexidine is due to its property of sustained availability- "**Substantivity**". This involves a reservoir of Chlorhexidine, slowly dissolving from all oral surfaces, resulting in the 'Bacterio static milieu' in the oral cavity. Chlorhexidine desorbed from the oral mucosa has 3 mechanisms of plaque inhibition:

- **Prevents pellicle formation** by blocking acidic groups on salivary glycoproteins, thereby reducing glycoprotein adsorption onto the tooth surface.
- **Prevents adsorption of bacterial cell wall** onto the tooth surface by binding to the bacteria.
- **Prevents binding of mature plaque** by precipitating agglutination factors in the saliva and displacing calcium from the plaque matrix.

## B. Antibacterial action of Chlorhexidine:

Chlorhexidine is a dicationic bisbiguanide with broad antibacterial activity.

It exhibits a wide spectrum of activity:

- gram positive and gram negative bacteria
- yeasts
- dermatophytes
- lipophilic viruses.

Chlorhexidine has strong affinity for binding to skin and mucous membrane

Chlorhexidine shows different effects at different concentrations i.e.

- Bacteriostatic at low concentrations.
- Bacteriocidal at high concentrations.

These concentrations vary between different bacterial species.

After a single rinse with Chlorhexidine, saliva itself exhibits **antibacterial activity for about 5 hours, and suppresses salivary bacterial counts for over 12 hours.** Following several rinses of CHX, number of aerobic and anaerobic species in saliva can be reduced by **80-90%.**

- Chlorhexidine has also been found to be a potent **antifungal** agent in the oral cavity.

# Pin Cushion effect

- One charged end of the cationic molecule of CHX binds to the tooth surface and other end remains available to initiate the interaction with bacterial membrane as the microorganism approaches the tooth surface.

# Mechanism of Antibacterial Action

At Bacteriostatic (sublethal) stage:

**Bacterial cell wall (negatively charged)**

- $\text{SO}_4^{4-} + \text{PO}_4^{4-}$  (Sulphates + Phosphates)

↓  
**Positively-charged CHX cation** is rapidly attracted to negatively charged bacterial cell wall with strong **adsorption** to phosphate compounds.

↓  
This alters integrity of **bacterial** cell membrane and Chlorhexidine is attracted towards the **inner cell membrane**.

↓  
CHX binds to the phospholipids in the inner membrane and **increase the permeability of the inner membrane** → leakage of low molecular weight compounds e.g.. Potassium compounds.

↓  
Vital cell elements **leak out and harmful substances gain entry into the cell**. At this bacteriostatic stage the effect of Chlorhexidine is **reversible**.

# At Bactericidal stage

## Coagulations of cell contents:

Increased concentration of Chlorhexidine



Progressive greater damage to membrane



Large molecular weight compounds lost from the cell and this results in leakage of low molecular weight compounds



Coagulation and precipitation of cytoplasmic proteins → Free CHX molecules enter into the cell



Vital cell activity ceases → cell death (**Irreversible**)

# Use of Chlorhexidine

- 10 ml of Chlorhexidine gluconate soln. (0.2%) mixed with water in 1:1 ratio and then gargle for 2 minutes. After Chx use, one should not take any liquid or solid orally till half an hour. Chlorhexidine should NOT be used before or immediately after using a tooth paste as interaction with anionic surfactants (Sodium Lauryl Sulfate) found within the paste will reduce effective delivery of Chlorhexidine in an active form.

# Indications

1. Patients with compromised oral hygiene
2. Patients undergone periodontal, oral surgery, exodontia procedures
3. Patients with physical/mental/social handicap.
4. For treatment of Candidiasis, in combination with anti-fungal agents- it prevents recurrence
5. In high risk patients. Chx offers synergistic effect to fluorides
6. Management of recurrent aphthous ulceration due to bacterial contamination
7. Removal and fixed orthodontic appliance wearers
8. **For patient with tooth implants, it is a must**
9. To limit bacteremia and operator contamination by oral bacteria- **Pre-procedural mouth rinses**

# Adverse Effects

- Brownish staining of teeth, tongue, silicate and resin restorations which may be associated with precipitation of “melanoidins” from the saliva. This pption is enhanced by high lipid/carbohydrate diet. Reactions occur between Chlorhexidine molecules and elveomogens found within food stuff and beverages. The staining effect may be minimized by reducing intake of tea and coffee immediately after morning rinse with Chlorhexidine. Best to rinse at night before sleep.
- Loss of taste sensation
- Calculus formation
- Rarely hypersensitivity to Chlorhexidine has been reported
- Preparation contains 12% alcohol as a base. So it is not preferred by people who do not want to consume alcohol in any form and as alcohol increases risk of oral cancer.
- Alteration of normal oral microflora, development of resistant strains.

# Availability

- 0.2% IDA-BDA
- 0.12% ADA- Chlorhexidine digluconate

# QUARTEARNARY AMMONIUM COMPOUNDS

-They are cationic antiseptics and surface- active agents.  
-more active against gram positive than gram negative organisms; therefore effective against developing plaque which consists of predominantly **gram positive** organisms.

- *Mechanism of Action:*

The positively charged molecule reacts with the negatively charged cell membrane phosphates and thereby **disrupts the cell wall structure of microorganisms**. Their initial attachment is a strong one, but they are released from the binding sites at a much more rapid rate than Chlorhexidine.

e.g.. Benzathonium chloride, Benzalconium chloride and Cetylpyredinium chloride

# HERBAL EXTRACT- SANGUINARINE

- Sanguinarine is currently used in both a mouth rinse and toothpaste as an anti plaque/gingivitis agent.
- It is a benzophenathridine alkaloid extract from the root of plant *Sanguinaria canadensis*.
- They are effective against a wide variety of **gram negative organisms**.
- Sanguinarine exhibits good retentive properties with dental plaque when used as a mouth rinse.

# DELMOPINOL

-It is a morpholinoethanol derivative.

-inhibits plaque growth and reduces gingivitis.

-limited Substantivity as compared to Chlorhexidine.

- *Mechanism of Action:*

It basically interferes with plaque matrix formation and also reduces bacterial adherence. It causes **weak binding of plaque to the tooth surface**, thus aiding in easy removal of plaque by mechanical procedures. It is therefore indicated as a **pre-brushing mouth rinse**. Delmopinol has been effective in both rapid and slow plaque formers and also dissolves formed plaque in the absence of mechanical plaque control.

- *Adverse effects:*

Transient numbness of tongue, tooth and tongue staining, taste disturbance and sometimes mucosal soreness and erosion.

# POVIDONE IODINE

- This particular agent does not appear to have a significant plaque inhibitory activity when used as a 1% mouthwash, because it has **low substantivity**.
- However, certain studies have shown that Povidone iodine solution can reduce inflammation and progression of periodontal diseases.

# METALLIC IONS

- Some metal ions have a plaque inhibitory capacity.
- Salts of Zinc and Copper are the ones most commonly used.
- Metallic salts reduce the glycolytic activity in microorganisms and delay bacterial growth. These metallic salts are also incorporated with Triclosan to increase its retentive properties. It is available in tooth paste as 0.5% zinc citrate with Triclosan.

# ANTIBIOTICS

- Antibiotics such as Vancomycin, Erythromycin, Clindamycin and Kanamycin have been used as agents for plaque control.
- However, due to potential problems of bacterial resistance and hypersensitivity reactions, the use of these agents has reduced considerably.

# ENZYMES

- Enzymes have been used as active agents in antiplaque preparations, due to the basic fact that they would be able to breakdown already formed matrix of plaque and calculus. Besides, certain proteolytic enzymes are bactericidal to microorganisms and would therefore be effective when applied topically in the mouth. E.g..  
Mucinase, dehydrated pancreas, Mutanase, Lactoperoxidase, Dextranase.

# ANTICALCULUS AGENTS

Dentifrices containing either soluble Pyrophosphates and zinc compounds have demonstrated **10-50% reduction in calculus.**

- *Mechanism of action:*

Pyrophosphates and zinc compounds have anticalculus effects by absorbing onto small hydroxyapatite crystals, thus **inhibiting growth of larger and more organized crystals.** They inhibit the mineralization of so called “petrified plaque”. **the calculus formed is soft and can be easily dislodged by brushing.**

e.g.. Pyrophosphates, zinc citrate, zinc chloride.

# PROFESSIONAL CHEMICAL PLAQUE CONTROL

- During initial intensive period to arrest initial caries and periodontal disease
- Accessibility is high as it is professionally applied
- Slow releasing agents extend the duration of effect.

# LOCAL DELIVERY OF ANTIBIOTICS

- TETRACYCLINE containing non-resorbable fibers (Actisite)
- Doxycycline: biodegradable mixture in syringe (Atridox)
- Sub gingival delivery system of 2% Minocycline (Dentamycin, PerioCline)
- Sub gingival delivery of Metronidazole (Elyzol)
- Resorbable delivery system of Chlorhexidine (Periochip)

# DENTIFRICES

- According to ADA “A dentifrice is a substance used with a toothbrush for the purpose of cleaning the accessible surfaces of the teeth”.

It may contain the following:

- A. The therapeutic agents such as fluoride (e.g.. Sodium monofluorophosphate) to inhibits dental caries or desensitizing agents e.g.. Strontium chloride, Potassium Nitrate.
- B. Antimicrobial agent such as Triclosan, Chlorhexidine etc. to reduce micro-organism count.
- C. An anticalculus agent such as zinc chloride, zinc citrate to dissolve calculus.

# Functions

The functions of toothpaste with tooth brushing:

- 1. Minimizing plaque build up
- 2. Anticaries action
- 3. Removal of stains
- 4. Mouth freshener

# INGREDIENTS

A dentifrice contains a number of ingredients that serve a definite purpose in providing adequate plaque control thus, preventing caries & periodontal diseases.

## ***A] Polishing/ abrasive agents (15-45%)***

- These agents have a mild abrasive action which aids in eliminating plaque from the tooth surface mechanically.
- They remove stained pellicle from the tooth surface, restores natural luster & also enhances whiteness.  
E.g. Calcium carbonate, Dicalcium phosphate, Aluminum oxide, Silica.

## ***B] Binding / Thickening agents (upto 2%):***

- These agents controls stability and consistency of a tooth paste.
- They affects ease of dispersion of the paste in the mouth.

E.g.. Water soluble agents :Alginates,  
Sodium carboxymethyl cellulose

Water insoluble agents: Colloidal silica,  
sodium magnesium silicate

### ***C] Detergents / Surfactants (1-5%):***

- They produce the foam → helps in removal of food debris and also dispersion of the product within the mouth
- also have antimicrobial property.
- E.g.. Sodium lauryl sulfate, sodium N-lauryl sarcosinate.

### ***D] Humectants (20-40%):***

- Maintain moisture in the toothpaste, thus binds the solids to form the homogenous pastes.
- e.g.. Sorbitol, Glycerin, Polyethylene glycol.

### ***E] Flavoring agents( upto 1%):***

- pleasant to use and leaves a fresh taste in the mouth after use.
- e.g.. Peppermint oil, spearmint oil, oil of wintergreen.

### ***F] Sweeteners ( 2%):***

- They provide pleasant sweet taste to the tooth paste. e.g.. sorbitol, manifold, saccharin.

### ***G] Antibacterial agents (upto 2%):***

- Inhibit the growth of bacteria
- e.g.. Triclosan, Delmopinol, Metallic ions like zinc citrate

### ***H] Anticaries Agents ( upto 2%):***

- e.g.. Sodium monofluorophosphate, sodium fluoride, stannous fluoride.

### ***I] Anticalculus agents( upto 2%):***

- Anticalculus agents are mostly designed to inhibit the mineralization of so called “petrified plaque”. They are also known as crystal growth inhibitors.
- e.g.. pyrophosphates, Zinc citrate, Zinc chloride, Gantrez (acid- copolymer- Methyl vinyl ether and maleic acid)

### ***J] Desensitizing agents( upto 5%):***

- They reduce the hypersensitivity reactions.
- e.g.. Sodium fluoride, potassium nitrate( blocks nerve conduction-used initially), strontium chloride (precipitates proteins- long term use).

***K] Water( 20-38%):***

As a vehicle

***L] preservatives (0.5%):***

Prevent microbial growth in the paste

***M] Coloring agents(0.5%):***

pleasant color

# DISCLOSING AGENTS

- A disclosing agent is a preparation in liquid, tablet or lozenge form containing a dye or other coloring agent used for the identification of bacterial plaque, which might otherwise be invisible to the naked eye.
- When applied to the teeth, the agent imparts its color to soft deposits but can be rinsed easily from clean tooth surfaces. Staining the deposits that can be distinctly seen provides a valuable visual aid in patient instruction. Thereby such a procedure can demonstrate dramatically to the patients the presence of deposits and the areas that need special attention during personal oral care.

## ***Uses of disclosing agents:***

- Personalized patient instruction & motivation
- Self evaluation by the patient
- To evaluate the effectiveness of oral hygiene maintenance.
- Preparation of plaque indices
- In research studies with regard to effectiveness of plaque control devices like toothpastes and dentifrices etc.

## ***Properties of Disclosing agents:***

- **1. *Intensity of color:***

Should have distinct staining of deposits and contrast color with normal colors of the oral cavity.

- **2. *Duration of intensity:***

The color should not get rinsed off with ordinary rinsing methods, or be removable by the saliva for the period of time required to complete clinical examination. It is desirable for the color to be removed from the gingival tissue and lips by the time of completion of the appointment.

- **3. *Taste:***

It should have highly pleasant taste.

- **4. *Irritation to the Mucous membrane:***

It should not produce any irritation or allergic reactions to the patient.

- **5. *Diffusibility:***

A solution should be thin enough so that it can be applied readily to the exposed tooth surface and yet thick enough to impart an intensive color to bacterial plaque.

- **6. *Astringent and antiseptic :***

It should inhibit the growth of microorganisms

# Agents used for disclosing plaque:

- a) Iodine preparations:
  - Skinner's iodine solution
  - Diluted tincture of iodine
- b) Mercurochrome preparations:
  - Mercurochrome solution 5%
- c) Bismarck Brown (Easlick's disclosing solution)
- d) Merbromin

- e) Erythrosine: FD & C no. 3 / No. 28
- f) Fast green: FD & C green no. 3
- g) Fluorescein: FD & C yellow no. 8 (Used with special ultraviolet source to make the agent visible)
- h) Two tone solutions:
  - FD & C green No.3, FD & c red no. 3
  - It mainly stains thicker (older) plaque blue and thinner (newer) plaque red.
- i) Basic fuschin

## ***Application of Disclosing Agents:***

The disclosing solution may be directly applied on to the tooth surface using cotton pellets or it may be rinsed after proper dilution.

The tablets & wafers may be crushed between the teeth and swished around the mouth from 30 to 60 seconds and rinsed.

# Questions asked

- Define plaque control. Enumerate qualities of an ideal chemical plaque control agent. Classify chemical plaque control agents. Describe Chlorhexidine & Triclosan in detail
- Short notes on:
  - Chlorhexidine & Triclosan
  - Disclosing agents
  - Dentifrices
  - Indications & Importance Of Chemical Plaque Control

