ORAL BIOFILMS AND GUM DISEASES

“We Live in a Microbial World: Head to Toe”

“The distinction between dental and medical microbiology is a man-made fabrication via our simplistic attitude of a very complex total body ecosystem that is just now being uncovered”

There is no such thing as dental microbiology

by

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ORAL BIOFILMS AND GUM DISEASES

After reading the heading the very 1st question that arises in our minds is .....WHAT EXACTLY A BIOFILM IS...???

Biofilm is any group of microorganisms in which cells stick to each other on a surface and these adherent cells are embedded in a self produced matrix of extracellular polymeric substance (EPS). They were for the very 1st time reported by Black in 1898.

This EPS also called as SLIME is a polymeric conglomeration composing extracellular DNA, proteins and polysaccharides. They prevents the colony from Antibiotics, Antimicrobials, and most importantly from the host defence mechanisms.

- Now the next question arises is that HOW THEY ARE FORMED..??

1. Begins with attachment of free floating microorganisms on surface and they get clustered.
2. Signals one another to form gooey matrix.
3. Adheres weekly through VANDERWAAL FORCES and Forms the MICROCOLONY
4. Adheres permanently using CELL ADHESIONS.
5. DISPERSION-(Enables to spread and colonize the new surface).

- What exactly a biofilm contains..??
- **Bacterial micro-colonies**
- **Extracellular slime layer**
- **Fluid channels**
- **Primitive communication systems.**

- Biofilms are not only present in the oral cavity as dental plaque. They are Ubiquitous and are present on both living and nonliving structures. Some common e.g. are:
  - In ponds and rivers, sometimes they form a very important component of the food chain.
  - Inside water and sewage pipes and causes corrosion and clogging
  - Over the contact lenses (as shown in fig below)

- Biofilms a THREAT....
The micro-organisms present in biofilms causes a lot of infections. To name a few -

- GINGIVITIS
- PERIODONTITIS
- Urinary tract infections
- Middle ear infections and many more.

**DENTAL PLAQUE - A HEAVEN FOR ORAL MICROBES**

- It is a three dimensional yellowish oral biofilm, develops naturally on the teeth.
- It is a PRIMARY cause of DENTAL CARIES and other ORAL INFECTIONS like GINGIVITIS and PERIODONTITIS.
- It consists of 1000’s of bacterial species that take part in complex ecosystem of mouth.
- It normally exists in Dynamic equilibrium with host defenses and it’s also speculated that it forms a part of Defense system of host by helping to prevent colonization of micro-organisms that may be pathogenic.
- Initially it is soft enough such that it come off using just a fingernail, after 48 hours if it’s not removed it start hardening and finally in about 10 days it becomes DENTAL CALCULUS (TARTA).
- Plaque develops when foods containing carbohydrates (sugars and starches), such as milk, soft drinks, raisins, cakes, or candy are frequently left on the teeth. Bacteria that live in the mouth thrive on these foods, producing acids as a result.
- The moment a baby passes through the birth canal and takes it’s first breath, microbes begin to reside in its mouth. And later as the teeth erupts ,additional bacteria establishes colonies on the tooth surface and finally forms the Dental plaque.
- Bacteria present in dental plaque exhibits an entirely different set of genes than the free floating bacteria. They have a mutualistic symbiotic relationship in the oral cavity.

**PEEPING IN THE DENTAL PLAQUE**
✓ **Adsorption of Host and Bacterial Molecules to the Tooth Surface**

Within minutes of tooth eruption or a cleaning, pellicle formation begins, which can be defined as a thin coat of salivary proteins. The pellicle acts like an adhesive by sticking to the tooth surface and encouraging a conditioning film of bacteria to attach to the pellicle. This conditioning film directly resulting in a scattered pattern of bacterial deposits composed of initial colonizers like Actinomyces sp., Streptococcus sp., Lactobacillus sp. and Candida sp., and continues to adsorb bacteria to the tooth surface.

✓ **Passive Transport of Oral Bacteria to the Tooth Surface**

Following pellicle formation, there is passive transport of oral bacteria to the tooth surface, which involves a reversible adhesion process. An area of weak attraction is formed that encourages the microbes to reverse their previous adhesion to the pellicle and come off the tooth surface. This leads to a much stronger, irreversible attachment.

✓ **Co-Adhesion of later colonizers to already attached early colonizers**

The co-adhesion of the later colonizers to the already present biofilm continues to involve many specific interactions between bacterial receptors and adhesions. These interactions build up the biofilm to create a more diverse environment, and the presence of either Streptococcus sp. or bacteria from the CFB-cluster may reflect a crucial transition in supragingival plaque from a predominantly gram-positive saccharolytic plaque to a gram-negative proteolytic plaque and also leads to development of unusual morphological structures like corn-cobs and rosettes.

![Figure 7: SEM of mature human dental plaque demonstrating corn cob formation. Bar = 10 microns at an original magnification of 2,020.](image)

*Courtesy of Dr. Charles Cobb, University of Missouri-Kansas City.*

✓ **Multiplication of the Attached Microorganisms**

Eventually, the bacterial cells continue to divide until a three-dimensional mixed-culture biofilm forms that is specially and functionally organized.
Oral Cavity – Haven for Bacterial Growth

✓ Main ecological factors needed for their growth are – pH, Saliva, Temperature, and Redox
  reactios.

✓ pH preferred is neutral.

✓ Saliva- acts as a BUFFER and along with gingival cervicular fluid It provides nutrients to bacteria.

COMMUNICATION BETWEEN BROTHER BACTERIA
Bacteria follows the principle that

**Biofilm Principle**

**Being Attached Rather than Suspended, Makes a World of Difference**

*Given a choice, 99.9% of bacteria will form a BIOFILM*

**“INTELLECTUAL DESIGN”**

- Communication can occur in a variety of ways, including gene expression, cell-cell signaling (ex. quorum sensing).
- These virtually helps bacteria to benefit from one another and allows them to feel the presence of each other which helps in exhibiting HOMEOSTASIS.
- Quorum sensing, is a mechanism that bacteria employ to control gene expression in response to the population size, it is a decision-making process.

**TYPES OF PLAQUE**

- **SUBGINGIVAL**
  - Inferior to the gingival margin.
  - May or may not be attached to the epithelium or tooth.
  - Calcify with minerals from the lamina propria's blood vessels and become subgingival calculus.
  - Mainly gram-ve bacteria.

- **SUPRAGINGIVAL**
  - Superior to the gingival margin.
  - May appear on any surface in the oral cavity.
  - Calcify from salivary minerals and become supragingival calculus.
  - Mainly gram +ve bacteria.
RELATION BETWEEN PLAQUE AND GUM DISEASES

If you have been told you have gum disease, you’re not alone. Periodontal diseases range from simple gum inflammation to serious diseases that result in major damage to the soft tissue and bone that support the teeth. In the worst cases, teeth are lost.

WHAT ACTUALLY GUM DISEASES ARE...

Gum disease is an inflammation of the gums that can progress to affect the bone that surrounds and supports your teeth. It is caused by the germs in plaque. If plaque is not removed through daily brushing and flossing, gingival margins becomes inflamed and swollen resulting in creation of a deepend gingival sulcus. This biofilm extends into this sub gingival region and flourishes in this protected environment resulting in mature subgingival plaque formation.

Stages of gum diseases

1. **GINGIVITIS**: This is the earliest stage of gum disease, an inflammation of the gums caused by plaque buildup at the gum line. Plaque produces toxins (poisons) that can irritate the gum tissue, causing gingivitis. Bleeding is the first sign for Gingivitis. At this early stage in gum disease, damage can be improved, since the bone and connective tissue that hold the teeth in place are not yet affected

- As defined by the 1999 World Workshop in Clinical Periodontics, there are two primary categories of gingival diseases, each with numerous subgroups:
  
  a) Dental plaque-induced gingival diseases.
     
     i. Gingivitis associated with plaque only
     
     ii. Gingival diseases modified by systemic factors
     
     iii. Gingival diseases modified by medications
     
     iv. Gingival diseases modified by malnutrition
  
  b) Non-plaque-induced gingival lesions
     
     i. Gingival diseases of specific bacterial origin
     
     ii. Gingival diseases of viral origin
     
     iii. Gingival diseases of fungal origin
     
     iv. Gingival diseases of genetic origin
     
     v. Gingival manifestations of systemic conditions
     
     vi. Traumatic lesions

- The symptoms of gingivitis are somewhat non-specific and manifest in the gum tissue as the classic signs of inflammation:
Bad breath (halitosis)

Swollen gums

Bright red or purple gums

Gums that are tender or painful to the touch

Bleeding gums or bleeding after brushing

Additionally, the stippling that normally exists on the gum tissue of some individuals will often disappear and the gums may appear shiny.

PREVENTION

Gingivitis can be prevented through regular oral hygiene that includes daily brushing and flossing. Hydrogen peroxide, saline, alcohol or chlorhexidine mouth washes may also be employed.

TREATMENT

The focus of treatment for gingivitis is removal of the etiologic (causative) agent, plaque. Therapy is aimed at the reduction of oral bacteria, and may take the form of regular periodic visits to a dental professional together with adequate oral hygiene home care. Thus, several of the methods used in the prevention of gingivitis can also be used for the treatment of manifest gingivitis, such as scaling, root planing, curettage, mouth washes containing chlorhexidine or hydrogen peroxide, and flossing. Interdental brushes also help remove any causative agents

COMPLICATIONS

Tooth loss, or decay.

Recurrence of gingivitis.

Periodontitis.

Infection or abscess of the gingiva or the jaw bones.

Trench mouth (bacterial infection and ulceration of the gums).

Swollen glands.

2. Periodontitis: It is a set of inflammatory diseases affecting the periodontium, i.e., the tissues that surround and support the teeth. Periodontitis involves progressive loss of the alveolar bone around the teeth, and if left untreated, can lead to the loosening and subsequent loss
of teeth. Periodontitis is caused by microorganisms that adhere to and grow on the tooth's surfaces, along with an overly aggressive immune response against these microorganisms.

**EXTENT**

The 'extent' of disease refers to the proportion of the dentition affected by the disease in terms of percentage of sites. Sites are defined as the positions at which probing measurements are taken around each tooth and, generally, six probing sites around each tooth are recorded, as follows:

i. mesiobuccal

ii. midbuccal

iii. distobuccal

iv. mesiolingual

v. midlingual

vi. distolingual

**SEVERITY**

The 'severity' of disease refers to the amount of periodontal ligament fibers that have been lost, termed 'clinical attachment loss'. According to the American Academy of Periodontology, the classification of severity is as follows:[3]

a) Mild: 1–2 mm (0.039–0.079 in) of attachment loss

b) Moderate: 3–4 mm (0.12–0.16 in) of attachment loss

c) Severe: ≥ 5 mm (0.20 in) of attachment loss

**SYMPTOMS**

Symptoms may include:

- Redness or bleeding of gums while brushing teeth, using dental floss or biting into hard food
- Gum swelling that recurs
- Spitting out blood after brushing teeth
- Halitosis, or bad breath, and a persistent metallic taste in the mouth
Gingival recession, resulting in apparent lengthening of teeth.

Deep pockets between the teeth and the gums (pockets are sites where the attachment has been gradually destroyed by collagen-destroying enzymes, known as collagenases)

Loose teeth, in the later stages

PREVENTION

- Brushing properly on a regular basis (at least twice daily), with the patient attempting to direct the toothbrush bristles underneath the gum-line, helps disrupt the bacterial-mycotic growth and formation of subgingival plaque.

- Flossing daily and using interdental brushes (if the space between teeth is large enough), as well as cleaning behind the last tooth, the third molar, in each quarter

- Using an antiseptic mouthwash: Chlorhexidine gluconate-based mouthwash in combination with careful oral hygiene may cure gingivitis, although they cannot reverse any attachment loss due to periodontitis.

- Using periodontal trays to maintain dentist-prescribed medications at the source of the disease: The use of trays allows the medication to stay in place long enough to penetrate the biofilms where the micro-organism are found.

- Regular dental check-ups and professional teeth cleaning as required.

3. Advanced Periodontitis: In this final stage, the fibers and bone supporting your teeth are destroyed, which can cause your teeth to shift or loosen. This can affect your bite and teeth may need to be removed.

For better understanding this picture shows how the gum diseases proceeds....
Progression of Gum Disease

Healthy Teeth and Gums
- Pink gums
- No bleeding gums with flossing and brushing
- Fresh breath

Gingivitis
- Red swollen gums
- Bleeding gums with flossing and brushing
- Possible bad breath or taste
- No bone loss
- No tooth mobility

Early Periodontitis
- Red swollen gums
- Bleeding gums flossing and brushing
- Persistent bad breath or taste
- Slight bone loss
- Possible tooth mobility

Moderate Periodontitis
- Red swollen gums
- Bleeding gums flossing and brushing
- Persistent bad breath or taste
- Moderate bone loss
- Tooth mobility and root exposure

Advanced Periodontitis
- Red swollen gums
- Bleeding gums flossing and brushing
- Persistent bad breath or taste
- Severe bone loss
- Severe tooth mobility and root exposure
- Possible tooth loss