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Biofilm and Oral Health.

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ABSTRACT

Biofilms form when microbes adhere to surfaces in some form of watery environment and begin to excrete a slimy glue like substance that can stick to all kind of materials - metals,biological tissues,medical implant materials etc.Dental plaque is a stucturally organized biofilm that builds upon the teeth,which contains communities of disease causing germs and their uncontrolled accumulation has been assosiated with dental caries and gingival disease.Removal and reduction of biofilms can be mechanical and chemical means.Studying the nature of plaque biofilm is necessary to understand the microbial basis for the major infectious diseases and its overall effect on the oral health of the host. This review explains how biofilm is a perfect haven for the pathogens to thrive, resulting in serious oral health complications.

Keywords: Biofilm, Plaque, Dental bacteria, Oral health

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INTRODUCTION

Bacterial studies and the inventions followed are not an untried idea in the branch of microbial science.Infact it has been practicing for the past few decades. According to the separate experiments they conducted in bacteria those who survive in rich media and in isolation from the species, they found out that bacteria grown together in species are the ones which exist in oral biofilm.

Biofilms are the governing mode of microbial growth in the environment. Bacteria exists in sessile forms and free floating as well. Those bacteria which are free floating with single cell are known as planctonic cells.

It is only recently that plaque has been recognized as a biofilm .This recognition has given the dental community a better understanding of how dental biofilm forms, develops and how it can be the etiological factor of oral health diseases.

Dental plaque biofilm and oral infections -Then and now

The importance of plaque biofilm to the onset and progression of periodontal disease is well accepted. Beliefs about plaque have shifted over the years. Back in the 1960s there was the non specific plaque hypothesis which suggested that the greater the amount of plaque, more the disease should be present. This was a failure because clinicians could observe patients with heavy plaque, no disease and those with minimal disease, heavy plaque and pockets. Then came another drastic transformation regarding the concept of plaque which implied the idea of sticky matrix to a thriving dynamic microbial community called bacteria.

This concept of plaque as a biofilm has brought up information about the structure, habitat and survival of microbial species of plaque as well as its participation in disease virulence and microbial resistance.

Bacteria - The survival styles

Bacteria may be present as free floating or adhered to a surface. Biofilm is the name referred to bacteria which live in complex communities. A biofilm is a systematically arranged thin layer of micro organism that coats on various surfaces and is incorporated in an extracellular slime layer. Biofilm can be seen on medical and dental implants, intravenous and urinary catheters, contact lenses and prosthetic devices such as heart valves, pacemakers, artificial joints etc [1].

Advantages of microbial community life style

The universal existence of biofilm suggests that living this 'life style' carries some pretty significant benifits.Biofilms have been and remain as the dominant life forms on the planet.To have persisted in such abundance over such a lengthy period of time implies that this is an advantageous way of life.

A broader range of habitat available for colonization

Dental plaque bacteria are mostly obligate anaerobic despite the fact that they live in aerobic environment. The early microbes in the biofilm habitat absorb oxygen, which makes the conditions favorable even for obligate anaerobes to multiply. This happens due to the close physical contact between oxygen absorbing and oxygen sensitive bacteria.

Increased metabolic diversity and efficiency

The main source of nutrients for oral bacteria is achieved through endogenous substrates. Breaking down of these macro molecules by pure cultures of oral bacteria is generally not possible. These can be done only by the combined action of the consortia of oral bacteria.

Increased tolerance to inhibitory agents and host defenses

The community microbial life style makes a drug sensitive pathogen more resistive to antibiotics due to the action of neighboring commensal bacteria by the production of neutralizing or drug degrading enzymes. Oral biofilm bacteria are more fortunate because of the suitable conditions in the oral cavity. Beta lactamase enzyme contained in the gingival crevicular fluid has the capability of deactivating any penicillin delivered to the site.

Enhanced virulence

An organism requires a wide range of virulence traits to produce a disease, to adhere to a surface, to gain nutrients from the host and multiply, to escape surveillance by the host defenses etc.Many microbes are not capable to achieve all these conditions individually. By forming a virulent consortia of interacting organisms this will be possible due to the combined forces and within this consortia individual species can play many roles in a disease while different species could do identical functions.

Biofilm-the microstructure and formation

Biofilm are characterized by structural hetrogenicity, genetic diversity, complex community interactions and an extracellular matrix of polymeric substances. Biofilm development can be divided into several key steps including attachment,microcolony formation,biofilm maturation and dispersion and in each step bacteria may recruit different components and molecules including flagella,pili,DNA and exopolysaccharides.Formation of biofilm begins with the attachment of salivary pellicle.

Salivary proteins go and adhere on to the clean tooth surface that enables bacterial attachment to the tooth surface. Following adhesion, the bacteria divide grow and accumulate. Different types of adhesins are present in the bacteria which adhere with their receptors at the site of adhesion. Once the process of adhesion starts, the bacteria starts producing substances that stimulates other free floating bacteria to join the community. For a sub gingival biofilm to develop fimbria acts as the receptor and collagen residues do the same function when it comes to tissue surface.

The three phases of plaque biofilm development are

- Attachment of bacteria to solid surface
- Formation of micro colonies on the surface
- Formation of mature sub gingival plaque Biofilms

Tooth surface is colonized predominantly by gram streptococci. An extracellular slime layer is formed that helps to anchor them to the solid surface and provides protection for attached bacteria.Microcolony formation begins once the surface of the tooth has been covered with attached bacteria. The proliferating bacteria begin to grow away from the tooth.

Bacteria colony has the ability to co aggregate which means they can adhere to the cells previously attached to the pellicle. This cluster formation and evolution leads to the development of mushroom shaped microcolonies that are attached to the tooth surfaces. They are known as sessiles. Thus a complex series forms with different bacteria chained to one another.

Once the biofilm is formed, it spreads into the subgingival region and proliferates and develops into a mature subgingival plaque biofilm. Gingival inflammation appears only after the biofilm composition changes from gram positive bacteria to gram negative anaerobes [2].

Conditioning the film: How does it form

The molecules which are derived from the saliva adhere on to the tooth surface and remain functional. In the sub gingival region these molecules emerges from gingival crevicular fluid. The conditioning film improves the surface properties and bacteria interact directly with the molecules.

Reversible adhesion

The combination of the charges produced on the microbial cell surface and that produced by the conditioning film fabricates a weak long range physio chemical interaction. This is known as reversible adhesion.

Irreversible adhesion

The strong adhesin-receptor interactions which operates over such a short distance targets to block colonization. The molecules here are the specific molecules on the microbial cell surface and complementary molecules in the acquired pellicle and these interactions are known as irreversible adhesion.

Co-adhesion

Co adhesion involves the attachment of secondary colonizers on already attached bacteria via adhesin receptor interaction. This increases the microbial diversity within the forming biofilm [2].

Multiplication of the attached cells

Increased biomass and synthesis of exo polymers leads to the formation of a biomatrix. The matrix helps in the structural integrity and general tolerance of biofilms against environmental factors and antimicrobial agents. The metabolism of microbes' produces gradients within the bioflm and bacteria alters their gene expressions to react to these sudden changes. All these processes lead to the formation of a mature biofilm.[2]

Oral cavity-a microbial habitat

More than 400 species of bacteria can be detected in the oral cavity, but only selective pathogenic species produce products harmful to gingival tissue. Oral cavity is warm and moist which facilitates the growth of an exclusive collection of micro organisms. Nutrients for the growth of micro organisms are obtained from endogenous sources such as amino acid proteins,glycoproteins in saliva and gingival crevicular fluid and thus the diet plays only a minor role in supplying nutrients for the resident microflora.Saliva plays a major role in maintaining the oral pH as almost natural ,which makes comfortable for the bacterial colonies to flourish.

Anaerobes can also grow in our oral cavity even though our mouth is aerobic .O2 is rapidly consumed by early bacterial colonies that are aerobic or facultatively anaerobic, other gases and reduced compounds are released which lower the redox potential mainly in dense biofilms such as dental plaque. This creates conditions favorable for the obligate anaerobes [2].

Prevention and management of biofilm

The plaque biofilm if not removed will trigger infections such as chronic gingivitis or periodontitis.The products of biofilm bacteria are known to initiate a chain of reactions in the tissue leading to host response as well as the destructive process. The formation of biofilm by sub gingival bacteria provides the bacteria with an advantage that it permits long term survival within the sulcus of pocket environment.

The extracellular protective slime layer is unusually resistant to antibiotics (systemic administration),anti-microbial (local administration) and the host defense system. Antibiotic doses that kill free floating bacteria need to be increased as much as 1500 times to kill the biofilm bacteria and at these high dose, the antibiotics would kill the patient before the biofilm bacteria.

The meticulous and regular removal biofilm is essential to keep the oral cavity healthy. Physical removal of bacterial plaque Biofilms is the most effective means of control. Plaque entrapped deep within the pockets cannot be reached by brushes, floss or oral rinse. Mechanical cleaning of the teeth and assosiated gingival tissue removes the bulk of biofilm that developed in the time since the last oral hygienic session.

The current therapeutic strategy to control biofilms involves mechanical removal of deposits both supra and sub gingival [3].

By removing the supragingival plaque in the early phase of biofilm maturation, the microbial load can be maintained at a relatively low level and the colonization by anaerobic species can be contained in the absence of adequate oral hygiene. The subgingival plaque will develop at which the point elimination and the effective control of the bacterial environment is considerably more difficult.

Control of biofilm or plaque begins with daily oral hygiene. Clinical procedures like scaling, rootplaning provides immediate benefits, whereas effective routine oral care can help to maintain a healthy oral environment and decreases the occurrence of oral disease. The education and motivation of patients to mechanically remove as much plaque as possible ,the use of soft bristled brushes, interdental brushes ,floss, tooth pick and rubber tips have all been recommended for the removal of plaque from the various surfaces of the tooth during home care [4].

CONCLUSION

A decade ago the key to oral health was thought to be total plaque removal, but today the key is maintaining a proper biofilm balence.Infact biofilm is necessary for oral health and low levels of pathogens are normal. Biofilm management aims to diminish the pathogenic nature of the dental plaque biofilm by reducing the bacterial overload and disrupting biofilm maturation.

The control of biofilm is a primal topic among peridontists and numerous researches are still being conducted to devise newer methods of reducing plaque biofilms and pathogenic micro organisms' assosiated.

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