Management of dental plaque to reduce disease

Dental hygienist Mhari Coxon gives an overview of dental biofilm

**Boxed area with Stages**

**Stage I** is the quiescent or least metabolically active state.

**Stage II** - Conversion or transformation from Stage I to Stage II requires significant genetic up-regulation.

**Stage III** involves maturity of the biomass, and total organism concentration increases. At this phase, new antigens may be expressed, genetic exchange enhanced and membrane transport maximized.

**Stage IV** (apoptosis or death) signals detachment, erosion or sloughing from the biofilm.

**Diagram One: Four Stages of Biofilm Cycle. With kind permission of Professor John Thomas, West Virginia University**

**Stage Three**

**Bacterial blooms are periods when individual species or groups of strains grow at a rapidly accelerated rate. More mesophilic, inorganic nutrients are utilized, and a second wave of bacterial co-aggregate with bacteria that are already locked to the pellicle.**

**Diagram Two: Biofilm Development Cycle. With kind permission of Philips Oral Healthcare**

**Stage Four**

**The bacterial colony will desquamate, sloughing off as a complete unit.** This amount varies from host to host depending on there predisposition to an inflammatory response.

**The subgingival dental biofilm is still formed mainly of gram-positive cocci and rods with some gram negative cocci and rods. The real change is the production of large numbers of gram negative rods and spirochetes which are either planktonic or attached to the epithelium.**

**Summary**

The first stage is predominately gram-positive cocci and is represented by the streptococcal species, the second stage is cross-linking via fusobacterial species, and the third stage is predominantly gram negative organisms. Mature oral biofilms are metabolically active, acting as reservoirs of antibiotic resistance and virulence in deep periodontal pockets. Their uncontrolled growth may lead to eventual periodontal disease.

**Diagram Three: Development of subgingival biofilm - With kind permission Profesor J Thomas University of West Virginia**

**Disruption of the biofilm**

The key weapon against this maturation is available to professionals and patients remains regular disruption, and where possible removal, of the biofilm and saliva pellicle causing a break in the cycle. This tends to inhibit the microbial growth. We know that, if left untouched for up to 12 weeks, pockets will be colonized and so the need for maintenance care remains as valid as it always has.

**Adjuncts**

Some adjuncts have proven to be helpful in slowing and reducing the cycle of biofilm.

**Mouthwashes**

Chlorhexidine, Cetyl pyridinium Chloride and Essential oil mix mouthwashes have all shown some penetration into a biofilm of varying percentage in research. These in conjunction with good toothbrushing and interdental cleaning can be useful in the reduction of incidence of the chronic diseases of periodontal disease and dental caries. No antimicrobial can disrupt the biofilm significantly without mechanical intervention.

**Photodisinfection**

Pert wave is a Photodisinfection system developed by Ondine that utilizes low-intensity lasers and wavelengths-specific, light-absorbing compounds to specif- ically target and destroy microbial pathogens and reduce the symp- toms of disease. The compounds are generally topically applied and one or more lasers are used to activate the compounds and comple- te the disinfection. Research is ongoing in this field.

**Probiotics**

There was a probiotic launched this year specifically aimed at supporting a healthy den- tal plaque. There is some early re- search available but more in- depth studies is needed.

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**Formation of the dental biofilm**

Microbial generally prefer to develop in an attachment (ses- site) formation. The microorgan- isms found to be pathogenic to humans can thrive as planktonic (free floating) phenotypes as well as sessile. Recent research shows there to be over 500 micro- bial strains present in oral biofilm.

**Diagram 4: Development of subgingival biofilm**

Formation of the biofilm can be separated into four stages.

**Stage Two**

Attachment can be defined as a slime layer forming around the colonizing pioneer bacteria, which consist mainly of gram-positive cocci and rods that divide and form microcolonies.

These initial colonising bac- teria connect to the pellicle and each other with the help of a network of fine, hair-like structures called fimbrines. Once they stick, the bacteria begin producing sub- stances that encourage other planktonic bacteria to join the community. This is the recruit- ment phase. It is thought that the act of attaching to the pellicle stimulates the bacteria to ex- crete an extracellular slime layer that helps to anchor them to the surface and provides protec- tion for the microbes already attached.

The biofilm then grows pri- marily through cell division of the already attached bacteria, rather than through the adher- ence of new bacteria. Next, the proliferating bacteria begin to grow away from the tooth. Plaque doubling times are rapid in this early stage of development.
Dental Practices nationwide are benefiting from the advantages of adding Periowave to their treatment regime.

Dr David Africa of Elm Dental Practice, Chessington, Surrey, has noted Periowave’s virtues. “The inclusion of the Periowave method in our armamentarium in the fight against periodontal disease has been a fantastic choice,” he says. “The ease of use and the acceptability by patients of the new technology, as well as the predictability of the results, makes everyone confident that we can significantly reduce the risk factors for periodontal disease.”

“In my experience with Periowave when combined with splinting,” Dr Africa continues, “I have seen amazing results, especially in the lower anterior region in patients of all ages. During their follow-up visit, patients immediately tell us about the significant improvement in the feel of their gums, and the disappearance of bleeding that was there before treatment.”

Philip S Burns & Associates Dental Practice, Sheffield, are happy with the results of Periowave. “There is considerably less bleeding after treatment and the pocket depths are reduced. Patients have noted that any bad taste has disappeared and there is far less tenderness in the gums. Patients have been delighted with the treatment.”

Tony and Lisa Appleton of Church Street Dental Practice appraise the commercial decision to take on board Periowave.

“We looked at each of the areas of dental care we were providing and highlighted and researched those areas we felt we could improve. Fortunately for us our research coincided with the UK launch of Periowave and we were lucky enough to secure one of the first Periowave machines in the country.”

“Patients appreciate the pro-active treatment Periowave offers and are happily paying for it. The ease of the treatment is a winner with both patients and practitioners alike! Initial data of pocket depth reductions suggest decreases of up to 3mm at the 6-week post-op review. We are currently looking to expand our periodontal team and firmly believe that Periowave has given us this welcome boost to the practice.”

Dental biofilm and caries

In dental caries, there is a shift toward community dominance by acidogenic and acid tolerating species such as mutants streptococci and lactobacilli, although other species with relevant traits may be involved. Strategies to control caries could include inhibition of biofilm development (for example, prevention of attachment of cariogenic bacteria, manipulation of cell signaling mechanisms, delivery of effective antimicrobials, etc.), or enhancement of the host defenses. Additionally, these more conventional approaches could be augmented by interference with the factors that enable the cariogenic bacteria to escape from the normal homeostatic mechanisms that restrict their growth in plaque and out compete the organisms associated with health. Evidence suggests that regular conditions of low pH in plaque select for mutants streptococci and lactobacilli. Therefore, the suppression of sugar catabolism and acid production by the use of metabolic inhibitors and non-fermentable artificial sweeteners in snacks, or the stimulation of saliva flow, could assist in the maintenance of homeostasis in plaque.

Summary Box

Reducing the carriers forming biofilm

Schematic representation of the relationship between the microbial composition of dental plaque in health and disease. Potential pathogens (grey) may be present in low numbers in plaque, or transmitted in low numbers to plaque; both situations may be compatible with health. A major ecological pressure will be necessary for such pathogens to out compete other members of the resident microflora (white) and achieve the levels (numerical dominance) needed for disease to occur. Possible ecological pressures for carriers include a sugar-rich diet, conditions of low pH, or low saliva flow. Disease could be prevented not only by targeting the pathogen directly (for example, with antimicrobial or anti-adhesion agents), but also indirectly by interfering with the ecological pressure responsible for the selection of the pathogen.

Conclusion

Dental biofilm is a complex group of communities which, when allowed, will create a suitable environment to thrive at the detriment of the host. Oral hygiene ensuring good plaque control still remains a major control element in maintaining a healthy dental biofilm. Diet and lifestyle are also important factors in determining the quality of dental plaque.

About the author

Mhari Coxon is a dental hygienist practising in Central London. She is chairman of the London British Society of Dental Hygiene and Therapy (BS-DHT) regional group and is on the publications committee of its journal, Dental Health. She is also clinical director of CPFDforDCP, which provides CPD courses for all DCps. To contact Mhari, email mhari.coxon@cpfdfordcp.co.uk.

Dental biofilms are complex microbial communities that form in oral cavities, contributing to various oral health conditions like tooth decay (caries) and gum disease (periodontitis). These biofilms consist of a matrix of extracellular polymeric substances (EPS) that bind bacterial cells together, creating a protective barrier against host defenses. Dental biofilms can be categorized into cariogenic and non-cariogenic species. Cariogenic species, like Streptococcus mutans, have the ability to produce acids that erode tooth enamel. Non-cariogenic species are more prevalent in the mouth, contributing to plaque formation and tooth discoloration. Understanding the mechanisms of biofilm formation and the role of various factors, such as diet, oral hygiene, and systemic factors, is crucial for effective prevention and management of oral biofilms.

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