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REVIEW PAPER

Dental Biofilm and periodontal disease

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Oral health is an essential aspect of general health and is considered an integral component of an individual's overall health and well-being. Various forms of oral diseases, including gingival and periodontal diseases, have affected the human population since prehistoric time. Several research studies have convincingly established the role of the dental biofilm in the initiation and progression of various forms of periodontal disease. Studies have also shown the link between poor periodontal health and the systemic health of an individual. In this article, an attempt has been made to highlight dental biofilm and its role in the initiation and progression of periodontal diseases. In the recent time, much importance to oral health has been given as studies have shown that periodontal diseases are associated with various systemic diseases like diabetes mellitus, preterm low birth weight babies, chronic obstructive pulmonary disease, heart attack and stroke.

Keywords: Dental biofilm; gingivitis; periodontitis; oral health; World Health Organization.

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INTRODUCTION

The most common oral diseases that affect the human population globally are dental caries and periodontal disease. These two diseases are responsible for a substantial number of teeth losses all over the world. The world health organization (WHO) has recognized oral diseases as a serious public health problem. The WHO stated that despite significant improvements in the oral health status of populations worldwide, oral health problems are still prevalent at a large scale, especially among the underprivileged groups in developed and developing countries.¹ India is a developing country, and various studies reported a high prevalence of oral diseases.^{2,3} The National Epidemiological Oral Health Survey and Fluoride Mapping of India report (2002-2003) stated a high prevalence of gingival and periodontal diseases. In its report, Gingival and Periodontal diseases are prevalent in 67.7% of 15-year-olds and 89.6% of (35-44) years old, which is relatively higher than dental caries in our country.

The most common form of the gingival disease is dental plaque-associated gingivitis. Dental plaque has been identified and recognized as a dental biofilm. The inflammation of the soft tissues around a tooth leads to the development of

gingivitis. Gingivitis is part of the broader classification of periodontal diseases, where gingivitis is included at the milder end, and periodontitis has been included at the more extreme end of periodontal disease. The cause of gingivitis and periodontitis is considered to be primarily bacterial substances in dental plaque.⁴ The association of dental plaque with the development of gingivitis is well established. Loe H. et al. had convincingly demonstrated the role of dental plaque in the initiation and progression of gingivitis in their classic human experimental gingivitis model.⁵ They had also shown that plaque-induced gingivitis is a reversible disease. With adequate supragingival plaque control, gingivitis cases can be reverted to a healthy state. It is also known that if not adequately treated, some cases of gingivitis may progress to periodontitis. Periodontitis is an advanced stage of periodontal disease that slowly destroys the tooth-supporting structures, leading to the loss of teeth at an early age. The pathogenesis of periodontitis is complex. Several critical factors, including host immunity and host-microbial interaction, are involved in determining the progression of a case of gingivitis to a more advanced form of periodontitis. It is challenging to differentiate between stable gingivitis from progressive gingivitis or the time at which progressive gingivitis will turn

into a destructive form of periodontal disease. Therefore, prevention of gingivitis, early diagnosis, and treatment of gingivitis is the most practical ways to prevent periodontitis, which is considered a significant global public health problem. A better understanding of the dental biofilm and its role in the etiopathogenesis of dental and periodontal diseases will help to control oral diseases.

DENTAL BIOFILM

Dr G V Black (1898) initially used the term plaque in dental caries to describe the felt like a mass of microorganisms over carious lesions. Dental plaque is a highly organized ecologic unit consisting of masses of bacteria embedded in an amorphous matrix of macromolecules synthesized by increasing bacteria and constituents of the crevicular fluid.⁶ In recent years, dental plaque has been identified as a biofilm, a complex, communal, three-dimensional arrangement of bacteria. Dental plaque biofilm is recognized as the organized soft deposit adhering tenaciously to the teeth surfaces or other hard surfaces in the oral cavity, including removable and fixed restorations. The moist environment, a relatively constant temperature of (34-36) degree centigrade, PH close to neutrality in most areas of the oral cavity, provides a favourable environment for the growth of a wide variety of microorganisms. However, all areas of the oral cavity are not precisely similar in their environment. Based on physical and morphologic criteria, six major ecosystems have been identified in the oral cavity. Each of the ecosystems in the oral cavity is characterized by different physicochemical factors and supports the growth of different microbial community types. Anatomical diversity and the interrelationships between the other anatomical structures play a determining role in microbial growth on the oral cavity structures. Teeth serve as non-shedding hard surfaces and provide many different sites for colonization by bacteria on the supragingival and the subgingival areas.

On the other hand, oral mucosa is characterized by continuous desquamation of its surface epithelial cells, which readily eliminates bacteria from the mucosal surfaces. The tongue with its papillary characters provides sites of colonization that are not easily reached by the regular mechanical oral hygiene devices. The gingival crevice also offers a unique colonization site that includes both the hard and soft tissues of the gingiva. Saliva and the gingival crevicular fluid (GCF) constantly baths the oral surfaces and are essential for maintaining the oral ecosystems by providing water, nutrients, adherence and antimicrobial factors.

The supragingival environment is regularly exposed to saliva, and the subgingival environment, gingival crevice, are exposed to the gingival crevicular fluid. Saliva contains approximately 90 per cent water along with hormones, vitamins, urea and several ions. The diffusion of gingival crevicular fluid (GCF) in healthy gingiva is slow but increases in inflammatory conditions, and it contains proteins, albumins, leukocytes,

immunoglobulins and complements. The subgingival area, which is bathed by GCF, usually escapes from the salivary buffering activity. The PH of the gingival crevice may vary between 7.5 and 8.5 and provides an environment where selective periodontopathogens multiplies and results in the formation of dental plaque. Biofilm in supra and subgingival plaque is the etiological agent of various gingival and periodontal diseases.⁷

The first event in the formation of the supragingival dental biofilm is the deposition of salivary components on the tooth surfaces known as the acquired pellicle.⁶ The formation of this biological film is a prerequisite for the adhesion of bacteria over the tooth surface. The pellicle is a structureless, acellular film of glycoproteins, making the surface receptive to colonization by specific bacteria. Acquired pellicle formation begins within minutes after professional scaling and root planing, and microorganisms get attached to this pellicle as rapidly as within one hour. Gram-positive cocci and rods are the early colonizers on this pellicle. Gradually, a phenotypic change in bacteria occurs from planktonic to sessile type. As a result, genetic expression shifts and is followed by a short lag in bacterial growth.

Afterwards, a phase of rapid growth results, following the secretion of large amounts of water-insoluble extracellular polysaccharides to form the biofilm matrix, where the growth of microcolonies occurs. With the advancement of time, different varieties of bacteria adhere to the early colonizers, a phenomenon known as coaggregation resulting increase in bacterial complexity and structural stratification, which ultimately increases the thickness of the biofilm. Following this phase, bacteria in the interior of the plaque biofilm slow their growth and become static which is termed a steady-state phase. Bacteria lying deep in the biofilm show degenerative changes, but the bacteria lying near the surfaces remain intact. Surface detachment and sloughing of bacteria from the biofilm occurs, and they can form new colonies in different areas of the oral cavity. Bacterial communities living in a biofilm possess innovative survival strategies, including a broader habitat for growth, nutrition, waste elimination, new colonization, environmental niches for safety, barriers to thwart antimicrobial drug therapy, protection from the host's defence system including phagocytosis and enhanced pathogenicity.^{8,9} The bacterial mass produces several cytotoxic and chemotactic substances within the plaque. Products of metabolism and residual effects after lysis of bacterial cells and extracellular substances synthesized by bacteria like ammonia, sulfide, amines, indole, skatole, and organic acids can damage the gingival epithelium and connective tissue. The pathogenicity of the dental plaque biofilm is a matter of concern to clinicians. In the biofilm form, the component bacteria have increased resistance to antibiotics and other chemotherapeutic agents and are less susceptible to phagocytosis the host inflammatory cells. Practically dental biofilm cannot be eliminated, but it can be

adequately controlled with comprehensive mechanical and chemotherapeutic oral hygiene procedures, which are considered to be critical in the long term maintenance of oral health.^{10,11}

DISCUSSION

The mildest form of periodontal disease is dental biofilm induced gingivitis, an inflammatory condition of the gingiva. Various studies show that gingivitis affects more than 90 percent of the population regardless of age, sex or race. The classic experimental study of gingivitis on the human model by H Loe et al., convincingly demonstrated the causal relationship between the quantity of bacterial plaque and the degree of gingivitis.⁵ If adequate measures are not taken, some cases of gingivitis may progress to periodontitis, a condition where the supporting structures of the periodontium involve. A better understanding of the pathogenesis of periodontitis revealed that several factors, including host factors, determine the susceptibility of an individual to periodontitis. The host factors modulate the body's response to the accumulation of dental biofilm resulting in differences in the development of gingivitis and its progression to periodontitis. If not adequately treated at the early stages, constant stimuli from the dental biofilm will cause inflammation to continue for an extended time, resulting in chronic gingivitis. Epidemiological studies show that chronic gingivitis is the most prevalent type of inflammatory gingival lesion of our population. Most of our population ignores the condition. For a long time, gingivitis is not being treated, resulting in exposure of the body to continuous low-grade chronic bacteremia, which may affect systemic health. Several studies have shown that patients with periodontal diseases demonstrate elevated C-reactive protein levels (CRP), fibrinogen, and an increase in the number of white blood cells.^{12,13} An increased fibrinogen and C-reactive protein level has been suggested to be risk factors for cardiovascular disease and stroke by causing vascular injury and atherogenesis. Chronic obstructive pulmonary disease (COPD) has been associated with poor oral hygiene and poor oral health.¹⁴ Adverse pregnancy outcomes like preterm low birth weight babies are also being associated with periodontal inflammatory diseases.^{15,16}

Because of the local and systemic consequences of gingival and periodontal diseases, and because many of our population are suffering from this disease, it has become necessary to educate ordinary people regarding the etiological role of dental plaque in the initiation and progression of periodontal diseases. Plaque induced gingivitis is a reversible disease if appropriate measures are taken at the initial stage, which may prevent more destructive forms of periodontal disease.

CONCLUSION

Because of the widespread prevalence of periodontal diseases and the shortage of technical human resources, and the economic constraint of the common people of developing

nations like India, it has become necessary to concentrate on preventive and affordable treatment measures to control and treat gingival periodontal diseases at the community level. A better understanding of the role of dental biofilm in etiopathogenesis and the progression of dental caries and periodontal diseases have given us practical ways to control these two most widely prevalent diseases in our community. Therefore, dental health care providers have a great responsibility to educate the common people regarding controlling dental biofilm to prevent caries and periodontal diseases at the community level. This will help to achieve not only better oral health but will also help to improve the overall health of an individual.

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