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Diversity of Oral Microflora in Oral and Systemic Diseases: A Brief Review

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ABSTRACT

The oral cavity contains rich and diverse microflora, known as oral microflora. Oral microflora usually presents within the biofilms attached to the various soft and hard tissue surfaces of the oral cavity. Oral microflora is beneficial to us and plays an important role in the normal development of the physiology. It also contributes to host defense; however, it can also have severe adverse effects for overall health. The present article aims to review the information regarding oral microflora in health and diseases. Recent updates regarding the oral microflora contribution in several common oral and systemic diseases are also briefly discussed.

Keywords: Oral microbiota, Oral microflora, Oral cavity, Periodontal disease, Dental plaque, Oral microbiome, Dental caries

INTRODUCTION

The microorganism present in the oral cavity of human has been known as oral microflora or oral microbiota. The first description of oral microflora was given by Antonie van Leeuwenhoek [1]. Oral microflora is a complex and dynamic ecosystem in which several different species of microorganism has been identified and these species will change during the life of the individual [2]. After the birth or few months after birth comprises only mucosal surfaces for colonization of microorganism but soon after the eruption of teeth gives a platform of hard non-shedding surface which permits large area for accumulation of microorganisms [1].

The knowledge of oral microflora is very important for us because it is involved in both oral and systemic diseases. Approximately 700 species of bacteria are reported in the oral cavity, out of which only a small number of species of microflora is cultivated, still, a huge number is uncultivable and needs to be identified [2]. Oral health has a strong influence on the quality of life of an individual and is more than merely preserving the integrity of the teeth and their supporting tissues [3]. elationship between microflora and environment is known as a microbial ecosystem. Changes in environment due to metabolic activities can alter the oral microbial physiological activities, initiating a shift from healthy to pathological condition (disease) in microbial ecosystem (Figure 1).

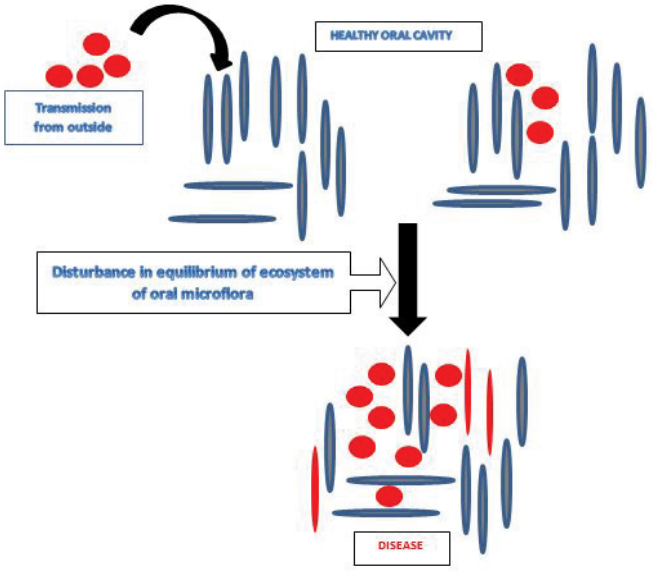

Figure 1 Schematic presentation of pathological microflora (red) and resident oral microflora (grey) in dental plaque during health and disease. Healthy oral cavity represents very few pathological microflora or pathogens may transmitted to dental plaque. In healthy conditions, there is an ecological equilibrium between pathological and resident microflora. Disturbance in equilibrium (xerostomia, drop in pH, high carbohydrate diet and poor oral hygiene) leads to disease

Classification

- Indigenous flora: It refers to organisms that are almost always present in high numbers (greater than 1%) in a particular site such as the surface of the tongue or supragingival plaque. Their numerical dominance implies that they are compatible with the host and have entered into a stable relationship with the host. They do not compromise the host's survival. The common indigenous organism present in the oral cavity is *Streptococcus*, *Actinomyces,* and *Neisseria* [4]
- Supplemental flora: It refers to microorganisms identified in a significant amount but low in numbers (less than 1%) in certain individuals. These organisms may be converted to indigenous if the condition changes. The most common supplemental organism present in the oral cavity is *Lactobacillus spp*. [4]
- Transient flora: This flora comprises of organisms that are present in the oral cavity for a very short time (only for hours and days). This flora may flourish and becomes opportunistic in conditions where the host is immunocompromised (Figure 2) [4-6]

Working Classification of Normal Oral Microflora

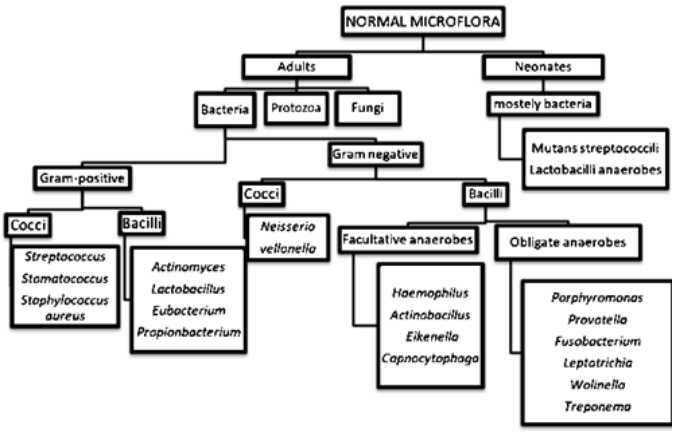

Figure 2 Classification of normal oral microflora [7]

Development of the resident oral microflora: The fetus in the mother's womb is normally sterile. During birth, microorganisms transfer from the mother to the child. The oral cavity is extremely selective for microbes during the first few days of life. The method of feeding can also affect the colonization of microbes. The oral cavity of children less than 3 years encompasses of microorganism which is passively transferred from mother, through milk, water, and saliva [7-9]. By the age of 3 years, children already have a complex and diverse oral microflora. The eruption of the tooth in the oral cavity will provide a platform for colonization of microorganism and play a major role in the ecological event. The first microorganism that colonized in the mouth is known as the pioneer microbial community. In the oral cavity, most common pioneer microorganisms are streptococci (*S. mitis, S. oralis,* and *S. salivarius*) [8,9].

Oral Microflora in Oral Diseases

1. **Dental plaque biofilms:** Bacteria colonize in the oral cavity soon after the birth and form organized, co-operating communities called biofilms within specific ecological niches. These biofilms permit the growth of microorganism and protect from environmental insults and frictional forces [1]. The important functions of biofilms are to prevent pathogenic colonization and educate the immune system to recognize 'friend and enemy'. In a state of health, equilibrium exists between biofilm antigens, toxins and the host immune response [10,11]. Many researches have been done to determine the composition of dental plaque microflora from diseased sites in order to find out those species which are involved in pathology.

2. **Oral microflora and dental caries:** Dental caries is generally considered as a polymicrobial disease. Microorganisms play a major role in the initiation and progression of dental caries. Many clinical researches have been revealed that the caries is linked with increase in production of acidogenic and aciduric bacteria, which are able to demineralizing the enamel. Most common microflora involved in dental caries are Lactobacilli, *Streptococcus mutans*, *Streptococcus sanguis* and *Actinomyces* [12,13]. Other than these microflora many other species also appear to be overexpressed in dental caries as compared to the normal healthy teeth such as *Selenomonas, Neisseria, Bifidobacterium* and *Propionibacteria* [14-16]. *Streptococcus mutans* not ubiquitously present in the mouth because the normal microflora in the oral cavity is commensal and work together to prevent the growth of the pathological bacteria. Therefore, dental caries occurs as a result of poor oral hygiene and high sugar-rich diet that leads to continuous recolonization of pathological microorganisms. Few studies reported that genera associated with dental caries in both primary and permanent dentitions are *Streptococcus* including *S. mutans, S. sanguinis,* and non *S. mutans streptococci, Veillonella, Actinomyces, Bifidobacterium, Lactobacillus, Propionibacterium* and *Atopobium* [17].

3. **Oral microflora and endodontic infections:** Normally the pulp and root canal systems are sterile. However, bacteria may enter through cracks around restorations, areas of exposed dentin and possibly microfracture, or through trauma to the tooth. Studies of the endodontic bacteria have relied heavily on anaerobic cultivation techniques to identify the components. The most prevalent cultivable taxa from root canals are *F. nucleatum, P. gingivalis, Pseudoramibacter alactolyticus, Parvimonas micra (Peptostreptococcus micros), S. mitis, S. intermedius*, other streptococci and *Candida* [18]. Microorganisms recovered from asymptomatic and symptomatic root canals are *Prevotella* and *Veillonella*. There is, however, some tentative data suggesting that the incidence of *Fusobacterium* and *Eubacterium* is higher in symptomatic conditions [19].

4. **Oral microflora and periodontal diseases:** After a few minutes of thorough cleaning of the tooth surface, microorganism gets colonized on the tooth mainly around the gingival margins and interdental areas. Many studies revealed that there are a high concentration of *P. gingivalis* and *Treponema denticola* in periodontal diseases. Microorganism present in mouth is essential for the development or progression of periodontal disease [20,21].

    a) Gingivitis: In gingivitis, initial colonization of microorganisms are facultative gram-positive microflora such as *S. sanguis, S. mitis, S. oralis, S. intermedius, A. viscosus, A. naeslundii*, and *Peptostreptococcus*. Later these species are switched by facultative gram-negative microflora such as *F. nucleatum, P. intermedia, V. Parvula, Hemophilus, Capnocytophaga* and *Campylobacter* [22,23].

    b) Chronic periodontitis: Most common cultivated microorganisms seen in chronic periodontitis are *P. gingivalis, B. forsythus, P. intermedia, Eikenella corrodens, F. nucleatum, A. actinomycetemcomitans, Treponema and Eubacterium. C. rectus, P. gingivalis, P. intermedia, F. nucleatum,* and *B. forsythus* are commonly seen at the active sites. A higher concentration of *P. gingivalis, P. intermedia, B. forsythus, C. rectus,* and *A. actinomycetemcomitans* are commonly noted with disease progression [24]. Recent literature has revealed the role of viral microorganisms such as herpes viruses, Epstein Barr virus-1 and human cytomegalovirus with chronic periodontitis [20,25].

c) Localized aggressive periodontitis (LAP): Most of the studies confirm the most cultivable microflora (90%) in LAP is *A. actinomycetemcomitans. P. gingivalis, C. rectus, F. nucleatum, B. capillus, Eubacterium brachy, Capnocytophaga*, and Spirochetes. Association of herpes viruses is also documented in LAP [24].

Oral Microflora and Systemic Diseases

The oral cavity is the entrance to the human body, thus microorganisms from the oral cavity are capable to spread into other parts of the body and leads to a variety of localized systemic diseases. Oral microflora can enter into the bloodstream through oral mucous membrane or periodontal pockets and alter host defense and produce inflammatory mediators, thus causes disease at different sites of the body [24].

Bacterial endocarditis (infective endocarditis): The viridans streptococci (most commonly *S. sanguinis*), and unidentified oral streptococci are accounted for about 50% of infective endocarditis cases in the developing world. Approximately another 30% of cases are due to *S. aureus*, and develop more rapidly as *S. aureus* is more virulent than oral streptococci [25].

Respiratory infections: Pneumonia is a common infection of lungs mainly caused by bacteria, virus, and mycoplasma. As the oral cavity has a continuation with the trachea and lower airways, microflora from the oral cavity can easily enter into the lower airway and leads to respiratory tract infection [26], most common microflora species that colonized into oropharynx are *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Mycoplasma Pneumoniae* [27].

Osteomyelitis: Most common oral microflora associated with osteomyelitis are *A. actinomycetemcomitans, P. micros* and *E. corrodens*. In a few cases, Fusobacteria and *Candida albicans* are also reported. It has been proved by culture and PCR that *A. israelii* is the most common species reported in chronic osteomyelitis [21].

Diabetes: Diabetes is characterized by hyperglycemia. The link between periodontal diseases and diabetes are reported in a few cases. Microflora plays an important role in the pathological process of diabetes. Casarin, et al., reported a significant difference in subgingival microflora between diabetes type 2 and non-diabetic subjects, with a higher concentration of *Neisseria, Gemella, Eikenella, Selenomonas, Actinomyces, Capnocytophaga, Fusobacterium, Veillonella* and *Streptococcus* [27-29].

Cancer: Microorganism may play an important role in carcinogenesis. The general concept of human microflora is changing when molecular techniques have revealed its vast diversity of etiopathogenesis, however, *Helicobacter pylori* frequently reported on the skin and gastrointestinal tract mucosa is linked with carcinogenesis. Most commonly linked human viruses with cancer are Epstein-Barr virus (EBV), Hepatitis B virus (HBV), Hepatitis C virus (HCV), Human papillomavirus (HPV), Human T-cell lymphotropic virus (HTLV-1) and Kaposi's associated sarcoma virus (KSHV) [28-30].

CONCLUSION

Oral microflora is beneficial to the host and contributes for normal development of the physiology and host defenses. Oral microflora ecosystem is essential to maintain oral as well as systemic equilibrium. Disturbance in the equilibrium of oral microflora in oral cavity promotes the growth of the pathogenic microorganism which leads to oral diseases. As the oral cavity provides a primary gateway to the body, pathogenic microorganism from oral cavity gets easy accesses to another part of the body, producing systemic diseases. The dental and medical practitioner needs to be aware of the valuable effects of normal oral microflora and their treatment plan should be targeted on control rather than eradication of oral microflora. Maintaining good oral hygiene plays an important role to keep our body healthy and prevent the spread of infection to other parts of the body.

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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