Key Major Factors Causing Dental Caries: A Review

Hira Hashim, Uzma Rafi, Roheela Yasmeen, Rasheda Jabeen, Aisha Waheed Qurashi and Syeda Shazia Bukhari

Department of Biology, Lahore Garrison University, Lahore, Pakistan
*Corresponding Author’s Email: shaziaabukhari@lgu.edu.pk

ABSTRACT: Oral cavity is the main part of the digestive system which is used for the uptake of nutrients/food while microbes can also enter through the oral cavity along the uptake of food. It is seen that the composition of host saliva is very important to build the environment of the oral cavity. When the pH of saliva became low then the chances of microbial attacks and their adherence to the surface of teeth to form lesion increases. A complete microbial ecosystem is present in oral cavity and biofilms are produced by the microbes of normal flora to protect host from pathogenic microbes. Most of the microbes that enter oral cavity have ability to cause disease, they incorporate themselves into the normal flora and alter the biofilm community and induce autoimmunity and inflammation into the host. The personnel and materials also play crucial role in activation and inhibition of caries and lesions. Phages are gaining interest in the field of microbiology as they are less toxic and host specific for their action. Dental caries are the indication of chronic infections inside the body. By examine the oral cavity of an individual we can analyze the health status of that individual. Diseases can be controlled through better living conditions and oral hygiene, as much of the developed countries has lower risk of getting caries where as in under-developed and developing countries have greater chance to get the risk.

Key words: dental caries, diet, oral infection, sugars.

INTRODUCTION

Among all age groups, dental caries is the most prevalent disease around the globe (Frencken et al., 2017). It is the public health issue all over the world especially this problem is most common in school children as reported by Dewhirst et al., (2010) however, female children were more effected from dental caries than male children. Health services surveillance can be carried out by estimating the number of dental carries cases (Hfnawy et al., 2016). The role of dental caries observed at high level in undeveloped countries (Wierzbicka, 2012).

Developed countries have less number of caries prevalence while in contrast to this in developing countries the rate of decline in the number of cases is comparatively slow (Bagramian et al., 2009; Marcenes et al., 2013, Nobile et al., 2014). Such issues can be addressed through epidemiological surveys that may assist to improve the poor Health conditions and can improve the basic life needs (Oulis et al., 2012; Tonello et al., 2016).
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It was observed that in industrialized countries small proportion of population is victim to such health issue.

In areas where resources are limited, a high risk to dental caries can be reduced by adopting appropriate preventive and restorative facilities for improving the efforts to address this problem (Natapov et al., 2010; Jiang and Wang et al., 2012; Cho et al., 2014).

Azizi (2014) reported the factors that contribute to caries risk in specific population groups from epidemiological socioeconomic perspective. It is also important to identify these important factors that modify this risk in different settings. Tooth decay is basically attributed to dental caries (Denbesten and Li, 2011). Holes in teeth are mostly taken as the main symptom of caries rather than taken as the main underlying cause of the dental decay disease. For over hundreds of years, it is an established fact that food fermenting bacteria and biofilm producing bacteria are the major causes of acid production as well as decaying the tooth material (Takahashi et al., 2011). In recent decades, better understanding regarding this disease has developed including microbiological studies, saliva composition analysis, tooth mineral estimation, tooth ultra-structure study, diffusion processes, and kinetics of demineralization and reversal of demineralization (Khalifa et al., 2014). Sabir et al., (2016) described dental caries as multifactorial disease and it does not occur due to a single factor.

Complex ecosystem and the dental caries:

The sites present in mouth are rich in microbial population such as tough teeth surfaces with gingival margin and various hollow and groves above and below the teeth, squamous epithelium covered with keratinized and non-keratinized epithelium and papillary texture of tongue (Dewhirst et al., 2010). A new environment emerges from the eruption of tooth subsequently due to caries (Abusleme et al., 2013). Environmental condition like salinity, temperature, pH conditions, assess to nutrients, assess to oxygen have an effect on each location of oral ecosystem and contribute to biofilm specie composition (Takahashi and Nyvad, 2011). Antibiotics have limited action on biofilms and these biofilm forming bacteria work silently without activating the immune system of host while treatment of the microbial community alters the microbial genus composition in oral cavity at various different stages (Hojo et al., 2009; Roberts and Mullanry 2010).

Equilibrium between host and normal flora:

Dynamic equilibrium is maintained between micro flora of host and oral micro biota, if any disturbance occur it may lead to chronic disease with the imbalance of biofilm within oral cavity (Hojo et al., 2009; Hoiby et al., 2011; Marsh, 2012). At initial stage there is irreversible attachment of bacteria and Proline Rich Glycoprotein (PRG) with the surface, at this stage mainly two types of bacterial species are involved first one is Streptococci and the other is Actinomycetes. However, on later stages the attachment is irreversible with the hard surface of tooth but various species of bacteria are colonized 60-90% to form biofilm are Eikenella spp., Streptococcus spp., Haemophilus spp.,

Table 1. Biofilm forming bacterial species in oral cavity.

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<tr>
<td>Streptococcus spp.</td>
<td>Kreth et al., (2009)</td>
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<td>Actinomyces spp.</td>
<td>Huang et al., (2011)</td>
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<tr>
<td>Capnocytophaga spp.</td>
<td>Sain et al., (2011)</td>
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Role of saliva in oral cavity:

Saliva is the main component of oral cavity; it is the natural source of nutrient for oral microbes and contains biological active agents which determine the quality and quantity of oral micro biota. (Nasidze et al., 2009). The disease mechanism in all categories of dental caries is same and linked with demineralization (loss of minerals) and proteolytic breakage of tooth hard structure by acid producing bacteria (Marsh et al., 2012). Streptococcus mutans causes dental caries and reported as a pathogen in adult and children by Hoiby et al., (2011). Advance techniques like 16S rRNA gene analysis made possible to examine the difference between the healthy and diseased bacteria in oral community (Filoeche et al., 2010; Belda et al., 2012). Dental caries also occur due to use of anesthe-sia which is estimated in quality improvement program in china. Oral hygienic condition are very important to maintain oral health, local antibacterial agents used but these are not the substitute of professional oral hygiene (Struzycka, 2014).

Demineralization and remineralization:

Demineralization is due to the loss of minerals, a white area develops below the outer most layer of enamel and white spot in the form of lesion which are clinically noticed as demineralized area are termed as opaque (Robertson et al., 2011; Huang et al., 2013). The prevalence of white spot lesion in orthodontic patients is reported 2-96% (Tufekci et al., 2011; Sonesson et al., 2014). The demineralization in dental enamel may occur due to bacterial infection, saliva composition, poor oral hygiene, orthodontic brackets, bands and wires etc. The ideal way to assess dental caries lesions in early stage should be simple, valid, noninvasive and also reproducible (Robertson et al., 2011). The demineralization can be controlled by using remineralization procedure and these commercially available products have significant role in remineralization of tooth. These commercial creams contain honey and ginger which help in reminralization of tooth (Korkut et al., 2017).

Environmental influence on oral health:

Environment has a great impact on
oral health, if the individuals are living in healthy and hygienic environment then the risk of getting disease is less as compared to the persons who are living in unhealthy and unhygienic environment. Dental amalgam (for dental fillings alloy of mercury with other metals) is one of the most durable and coast effective material for dental restoration in this century. In most of the developing countries the peoples especially the dental staff remained exposed to mercury at different times such as for amalgam preparation, storage and placement and removal of amalgam in different patients. These people have higher mercury level in tissues and body fluids. These work practices may cause toxicological risk in dentist and chronic mercury exposure may also associated with the symptoms of allergies, behavior changes, severe stress, memory loss and renal failure. The world health organization discourage the use of mercury in oral treatment because it is not only dangerous for patient but also creating a problem in occupational groups. Alternative to amalgam have been introduced into well developed countries but they are not cost effective and durable as the amalgam is. In developing and under-developed countries alternative of amalgam should not be practiced because of limited resources while in Sweden, Norway and Denmark legislation is approved to stop the utilization of amalgam which contain high level of mercury.

**Dental caries and sugar sweeten beverages (SSBs):**

High level import of sugar sweeten beverages (SSBs) effectively gain importance of sailing in most of the low and middle income countries, there is a link between disease and the consumption of SSBs, it is reported by that SSBs creating a problem like tooth decay, obesity and other non-communicable diseases. It is noticed that higher the consumption of sugars higher the rate of dental caries while lower the intake of these SSBs lower the risk to encounter the disease (World Health Organization, 2015). The sale of SSB is increasing day by day, data has been recorded from year 2000 to 2014 and it was estimated that there is remarkable increase in the consumption of SSB. The rate of intake of SSBs increases to 40% in fourteen years. The probiotic beverages like Yakult contain only one live bacteria that is *Lactobacillus casei* due to short term intake of Yakult oral biofilm acidogenicity and risk profile should be minimized in children.

**Relation between diet, nutrition, oral health and disease:**

The oral health determine the quality of life, your diet and working habits can be estimated from your dental condition. A multidimensional Oral Health-Related Quality of Life (OHRQoL) gives an idea about the health and disease of an individual. WHO model of health stated that there are five consequences such as functional limitation, disability, discomfort/pain, handicap and impairment involved in oral diseases. Dental conditions also describe the priorities of persons towards the prevention and treatment. The people who are suffering from malnutrition require supplements for their oral health as in old houses people are not provided with balance diet and these peoples encounter in disease very easily, so they needed oral nutritional supplements (Elia et al., 2017).
Oral biofilms are very common because moisture and nutrients are available for various microbes to inhabit the oral cavity and a combination of heterogeneous microbial community can be found in mouth. It is observed that 95% of bacteria form biofilm in their natural environment and these biofilm are not much effected by antibacterial substances as they contain extracellular layer to protect themselves (Saini et al., 2011). The matrix of biofilm consist of lipid, DNA, enzymes, polysaccharide, structural protein and water. This spatial organization of bacteria create environment to protect bacteria from phagocytosis and gives them reliable environment to flourish (Flemming et al., 2016). The biofilm forming bacteria communicate through quorum sensing by producing various chemical agent (Sztajer et al., 2014). The human health can be influenced positively and negatively by the interspecies interaction and balance is maintained between the host oral cavity and the associated biofilms (Sekirov et al., 2010; Ma et al., 2012; He et al., 2014). Certain environmental or genetic factors have ability to disrupt the microbial balance and induce dysbiosis which may leads to chronic inflammation (Lamont and Hajishengallis, 2015). Host immune defense is deregulated by opportunistic pathogens due to which virulence of whole community increases, and as a result of synergistic effect and autoimmunity the host tissues get damaged. This condition may also establish secondary infection in oral cavity. Alternative antibiotic therapy used for elimination of these pathogen and homeostasis of oral cavity restored. (Lemon et al., 2012; Guo et al., 2015).

Saliva flow normally control the oral microbes in biofilms, some factor like the daily oral hygiene, host immune defense, environmental factor such as carbohydrate rich diet, radiation treatment or chemotherapy and smoking etc involves in maintaining the tip between dysbiosis and host oral health. Peri-implantitis and peridontal diseases are the good example of acidogenic bacteria attached to enamel like streptococci metabolise food carbohydrates into organic acids. The predominant acidification allows demineralization of enamel and provide better habitat to thrive for aciduric specie for example Streptococcus mutans which further decrease the pH of oral cavity and the demineralization rate increases and the cavity is formed in dentine due to degradation of organic matrix (Bjorndal 2010; Takahashi 2011). In periodontal diseases some periodontal pathogens such as Porphyromonas gingivalis are opportunistic pathogens disturb the host defense and synergistically generates destructive inflammation of surrounding tooth tissue (Teles et al., 2013; Lamont et al., 2015). These inflamed tissues are rich source of peptides and proteins, dysbiotic biofilms and autoimmune reactions (Robitaille et al., 2015). Periodontal affects are 46 % while the dental caries are 91% in adults of western population (Dye et al., 2015; Eke et al., 2015). The prevalence rate of peri implant mucositis (surrounding of dental implant there is an inflammation of soft tissue) is 43% and peri-implantitis (defined by the failure of bone supporting the dental implant) is 22% respectively (Derks and Tomasi, 2015). Oral health and oral biofilm related disease are mainly associated with expenditure, systematic health and quality of life and the life style (Beikler and
Flemming, 2011; Hajishengallis, 2015). The commonly used method to treat oral disease are antibiotics but the antibiotic resistance is increasing day by day and due to this emerging problem therapeutic phages gaining interest in the role of human health (Vandenheuvel et al., 2015). These therapeutic phages are the fractional alternative of antibiotics (Czaplewski et al., 2016) and have limited host range so they are more specific than broad range antibiotics as it only kills the required host (Laanto et al., 2012).

**Use of phage in dentistry:**

To broaden the host range the phages are genetically engineered so that they can be used for broad range of hosts (Ando et al., 2015). These phages have ability to penetrate into the biofilm matrix of oral cavity where start to replicate with the host and will be responsible for lysis of the bacterial cell. The continuous death of bacterial cell may disrupt the biofilm matrix (Pires et al., 2016b; Uppuluri and Lopez Ribot et al., 2016). It is confirmed by clinical trials that the phages are harmless, nontoxic and body immune system can tolerate it (Sarker et al., 2016; Vandenheuvel et al., 2015). For commercial purpose some potential obstacles are included like social acceptance, quality control process, patenting problem, unmodified regulation, complex production and the absence of strict proof efficacy (Henein, 2013; Vandenheuvel et al., 2015; Debarbieuxet al., 2016). There is a need to overcome the limitation of these phages as they have vast applications in medical field (Brussow, 2014; Parason et al., 2014; Sillankorva and Azeredo, 2014; Abedon, 2015a, 2015b; Motlagh et al., 2016; Pires et al., 2016a&b).

**Oral hygeine, flouride, Saliva and other factors of caries risk:**

It was observed in Canada school children that the dental caries terminated due to fluoridation and the dental caries being more in primary teeth when the fluoridation stop (McLaren et al., 2017).

**Treatment for dental caries:**

The prevention of tooth decay can be a good approach in different ways but the most common way is through fluoridation, reduce sugar consumption, ozone therapy and also new technologies are emerging to replace or implant lost teeth. The tooth treatment through fabrication of customized root by utilizing additive manufacture technique is also one of important technique (Ramakrishnaiah et al., 2016). In recent technique restorage of orthopedic or maxillo-facial implant by fabrication using additive manufacturing (AM) technique (it’s a layer technique in which melted allow powder used with selective layer melting (SLM) and electron beam melting (EBM) or laser beam melting) are common (Jamshidinia et al., 2014 & 2015). SLM use 0.2kW Yb: YAG laser beam whereas EBM use electron beam which melts the alloy powder and these two technologies work on powder bed fusion technology (Syam et al., 2012).

**CONCLUSION**

Dental caries is a chronic disease which indicates poor health condition of an individual. Dental caries is a multifactorial disease and does not occur due to single reason. Although multiple advanced techniques are available to cure the disease
but it is better to avoid the multiple factors like nutrition deficiency, microbial flora, mouth cavity saliva and pH of saliva causing caries problem. And that can only be possible if ones takes good oral hygienic practices.

REFERENCES


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