EDITORIAL

Microbial Corrosion in Orthodontics

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Even with the exponential popularity of the contemporary clear aligners, the main stream of orthodontic practice still remains to be metal braces especially in adolescent age-group.[1] Along with the advantages of metal braces such as lower cost, reduced friction, etc., there goes the disadvantages such as corrosion possibility, reduced esthetics, etc. Corrosion of orthodontic appliances is a widely researched topic.[2–5] It is surprising to learn that microbially induced corrosion (MIC) has not been addressed in orthodontic literature till date. Microbial corrosion is an interesting arena which requires knowledge of both corrosion science and microbiology. The microorganisms capable of corrosion include various bacteria, fungi, and algae. The most common among them which has been widely indicated in MIC are the bacteria belonging to the sulfur cycle especially the sulfate-reducing bacteria (SRB). The connecting knot with orthodontics is the reported prevalence of these SRB in the oral cavity. SRB is prevalent in healthy individuals,[6,7] patients associated with periodontitis[6–11] and patients with gastrointestinal issues.[12–14] The prevalence of SRB in the oral cavity has a greater clinical implication since the SRB have been proven to cause corrosion of stainless steel.[15–24] There is literature attributing SRB as a potential cause in periodontal diseases[7–11] as well as gastrointestinal diseases such as ulcerative colitis, inflammatory bowel diseases, and Crohn's disease.[12] With its presence in the healthy oral environment already reported in the previous studies,[6,7,25,26] it further emphasizes the absolute need to be researching on its corrosion possibility in the intra oral environment. The genus generally found intraorally was *Desulfovibrio* and *Desulfobacter*[10] which is commonly regarded as the most "opportunistic" and ubiquitous group of sulfate reducers.[6,7] There is an interesting literature on the inhibition of *Desulfovibrio* spp. by human saliva, the reason being quoted as salivary nitrate and nitrite.[14] The mechanism behind the antimicrobial action of nitrate and nitrite is that they increase the oxidative stress on the bacteria.[27] However, concentrations of salivary nitrate vary depending on the food intake, endogenous production, and salivary flow rate.[28,29] Despite there exist natural inhibitors, the prevalence in oral cavity is high, 22% in healthy and 86% in patients associated with periodontitis.[7] There is a predilection for the bacteria to grow when favorable conditions exist. Biofilms is one such favorable medium for the growth of SRB. Paster et al.[26] identified SRB in biofilms of patients associated with refractory periodontitis, periodontitis, acute necrotizing ulcerative gingivitis (ANUG), and also in healthy subjects. Biofilm is a surface film composed of organic and inorganic saliva components that are colonized with microorganisms in extracellular polymeric substances adsorbed on all surfaces in the oral cavity.[30] The oral biofilm formation is a complex process involving interspecies aggregation, which is surrounded by a cohesive matrix, forms a complex structure which in turn facilitates anaerobic growth. It is the intrinsic nature of oral biofilms which make the survival of facultative anaerobes such as SRB in the oral cavity possible. Literatures[31–35] report that there are increased biofilm formations in orthodontic patients due to increased retentive areas caused by the brackets, ligatures, wires, mini implants, force components, and archwires. Bacteria in dental plaque function as a metabolically, functionally, and physically integrated community.[36] The study by Mystkowska et al.[37] mentioned that biofilm *per se* play a critical role in corrosion process by forming corrosive microcells. With time-dependent association, the microbes in the biofilm, along with saliva acting as an electrolyte and components from food, causes a decreased pH in the areas immediately under the biofilms. The decreased pH along with a change of oxygenation releases metal oxides and hydroxides from the metal surface ultimately leading to the corrosion of metallic structures.[37–41] The initial roughness also acts in a vicious form promoting more biofilm adherence and the process repeats causing more corrosion. With the biofilm itself serving to initiate and propagate corrosion, the increased prevalence of SRB in patients associated with orthodontics treatment all the more increases the possibility of MIC of orthodontic materials.

Availability of sulfate is the energy limiting source for the numerical prevalence of SRB in the oral cavity.[8] The sources of sulfate are the periodontal fluid where transudate from the serum is available. The mean concentration of free sulfate in serum is 0.3 mmol/L. In addition to this, sulfate from the dietary supplements such as the salts of sodium, calcium, iron, magnesium, manganese, zinc, copper, ammonium, and potassium should also be considered.[42] The higher range of sulfate consumption has been estimated to be 16.6 mmoL sulfate/day or even higher.[42] Beer, in particular, was found to be a rich source of sulfate in addition to other meat products. When the dietary supplements are low, the sulfate is obtained from oxidation of sulfur in proteins and amino acids.

Therefore, it seems possible that the prevalence of SRB in oral cavity can be influenced by the environmental factors such as availability of biofilm and sulfate. The prevalence chance is higher in orthodontic patients due to increased plaque and biofilm formation attributed to the retentive areas created by the brackets, wires, ligatures, and other force components. This will have greater clinical significance given the literature evidence of the corrosion capability of these sulfate-reducing organisms. With the availability of oral biofilm with a potential to create corrosive microcells and with the SRB's corrosive potential, intraoral corrosion possibility hypothetically increases. This should be experimentally tested. The future implications of this editorial will be to compare the prevalence of SRB in orthodontic vs non-orthodontic individuals and later to test the corrosion potential of this group of bacteria especially the species prevalent in the orthodontic patients on metallic orthodontic components including stainless steel and titanium materials through *in vitro* experiments and further to extend in finding compatible solutions to eliminate the corrosion caused by these organisms.

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