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In silico Statistical Prediction Models for Identifying the Microbial Diversity and Interactions Due to Fixed Periodontal Appliances

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Abstract : Like in the gut, the subgingival microbiota plays a crucial role in oral hygiene, health, and cariogenic diseases. Human activities like diet, antibiotics, and periodontal treatments alter the bacterial communities, metabolism, and functions in the oral cavity, leading to a dysbiotic state and changes in the plaques of orthodontic patients. Fixed periodontal appliances hinder oral hygiene and cause changes in the dental plaques influencing the subgingival microbiota. However, the microbial species' diversity and complexity pose a great challenge in understanding the taxa's community distribution patterns and their role in oral health. In this research, we analyze the subgingival microbial samples from individuals with fixed dental appliances (metal/clear) using an in silico approach. We employ exploratory hypothesis-driven multivariate and regression analysis to shed light on the microbial community and its functional fluctuations due to dental appliances used and identify risks associated with complex disease phenotypes. Our findings confirm the changes in oral microbiota composition due to the presence and type of fixed orthodontal devices. We identified seven main periodontic pathogens, including Bacteroidetes, Actinobacteria, Proteobacteria, Fusobacteria, and Firmicutes, whose abundances were significantly altered due to the presence and type of fixed appliances used. In the case of metal braces, the abundances of Bacteroidetes, Proteobacteria, Fusobacteria, Candidatus saccharibacteria, and Spirochaetes significantly increased, while the abundance of Firmicutes and Actinobacteria decreased. However, in individuals With clear braces, the abundance of Bacteroidetes and Candidatus saccharibacteria increased. The highest abundance value (P-value=0.004 < 0.05) was observed with Bacteroidetes in individuals with the metal appliance, which is associated with gingivitis, periodontitis, endodontic infections, and odontogenic abscesses. Overall, the bacterial abundances decrease with clear type and increase with metal type of braces. Regression analysis further validated the multivariate analysis of variance (MANOVA) results, supporting the hypothesis that the presence and type of the fixed oral appliances significantly alter the bacterial abundance and composition.

Keywords : oral microbiota, statistical analysis, fixed or-thodontal appliances, bacterial abundance, multivariate analysis, regression analysis
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