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Microbial Interactions with Dental Biomaterials: From Biofilm Formation to Antimicrobial Strategies—A Narrative Review

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Abstract

The oral cavity harbors a complex microbial ecosystem in which microorganisms continuously interact with natural tooth structures and dental biomaterials used in restorative and prosthodontic treatments. These interactions promote the formation of biofilms on restorations, removable prostheses, and implant surfaces. Biofilms are structured microbial communities embedded within an extracellular polymeric matrix that protects microorganisms from host defenses and antimicrobial agents. Persistent biofilm accumulation is associated with secondary caries, peri-implant diseases, denture stomatitis, and the premature failure of prosthodontic restorations. The adhesion and maturation of biofilms are strongly influenced by the physicochemical properties of dental materials, including surface roughness, surface free energy, hydrophobicity, surface charge, and chemical composition. In addition, microbial activity can induce biodegradation and biocorrosion of dental materials, compromising their structural integrity, esthetics, and long-term clinical performance. Recent advances in dental biomaterials have focused on developing antimicrobial and bioactive surfaces through the incorporation of nanoparticles, antimicrobial agents, and surface modifications designed to reduce microbial adhesion and inhibit biofilm formation. This review summarizes the mechanisms of microbial adhesion to dental materials, the effects of oral biofilms on material degradation and prosthodontic outcomes, and current strategies aimed at minimizing microbial colonization and improving the longevity of dental restorations and implant-supported prostheses.

Keywords: Oral biofilm; dental materials; microbial adhesion; prosthodontics; biomaterials; antimicrobial surfaces; peri-implantitis.

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