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Short Communication

Current Strategies for The Disruption and Inhibition of Oral Biofilm Formation

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Abbreviations: EPS: Extracellular Polysaccharides; MSNs: Mesoporous Silica Nanoparticles; CAT-NP: Catalytic Nanoparticles; QAS: Quaternary Ammonium Salts

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Oral biofilm, an organized community comprises of extensive variety of microbes rooted with extracellular polysaccharides (EPS) matrix. It is recognized as a virulence factor to numerous oral infectious diseases including dental caries, gingivitis, periodontitis, periapical periodontitis and peri-implantitis [1]. Biofilm formation on medical devices such as mechanical heart valves, catheters, contact lenses and prosthetic joints pose a critical medical problem. Both gram positive and negative bacteria can form biofilms on medical devices. Medical device infections are accountable for almost 60% of hospital acquired infections. In the United States, the anticipated expense of caring for healthcare-associated infections is nearly between $28 billion and $45 billion each year [2]. The lifecycle of a conventional biofilm comprises of bacterial attachment, biofilm growth/maturation, and biofilm dispersion. Biofilm cycle can be disrupted at any stage by taking measure. Oral cavity is continuously bathed with saliva, this rapid clearance and the complexity of the oral cavity hinders the effect of topically applied antibacterial agents at the suitable concentrations for an adequate duration [3]. To overcome antibiotic-resistant bacteria several attempts have been made to develop ideal antimicrobial agents. Drug laden nanoparticles could overpower the shortcomings of conventional antibiotic treatments coupled with toxicity, improper delivery, or enzymatic degradation. Furthermore, titanium dioxide, hydroxyapatite, collagen, and silica, are used as nano matrices to assimilate antimicrobials because of their nonimmunogenic characteristics, bioactivities, biocompatibilities, and low toxicities.

Mesoporous silica nanoparticles (MSNs) have the distinctive traits of mesoporous structure, large surface area and stable physicochemical property. MSNs have multiple usage such as biocatalysts, biosensors, drug delivery system, as well as imaging modality for diagnosis and therapy [4]. Silica nanoparticles could also inhibit adherence of bacteria. Catalytic nanoparticles (CAT-NP) also termed as nanozymes can disrupt the matrix through its inherent enzyme mimic activity (e.g., peroxidase) when at acidic pH levels (greater catalytic efficiency at pH4.5-5.5). CAT-NP are biocompatible and possesses enhanced and versatile catalytic activities. No side effects to the oral mucosa tissue have been reported when CAT-NP is used in vivo with H2O2 and can also reduce apatite demineralization under thus reducing the severity of carious lesions [5]. Quaternary ammonium salts (QAS) possess broad-spectrum of antimicrobial activity and low level of toxicity. Changing the functional group position of QAS may alter its anti-caries effects when incorporated into dental resin. 12-methacryloyloxydodecyl-pyridinium bromide (MDPB), a QAS exhibits strong antibacterial and antibiofilm effects against S. mutans, F. nucleatum, and Prevotella nigrescens [6]. MDPB and methacryloxylethyl cetyl dimethyl ammonium chloride (DMAE-CB) when incorporated into composites, inhibits the growth and adherence of oral pathogens. Natural product inspired group of small molecules such as garlic, ursine triterpenes, ginseng, etc. have good antibacterial activity and antibiofilm activity and prompt low drug resistance. Diazaspiro-decane structural analogs

specifically target C. albicans by inhibiting biofilm formation without influencing the growth of planktonic cells, making it a great contender for the control of oral candidiasis [7].

Arginine, as a base-generation substrate of oral bacteria, can act as an eco- modulator of oral biofilm and therefore prevent formation of dental caries. Furthermore, a group of natural products which contain polyphenols possess antimicrobial and antibiofilm activity with low drug tolerance towards oral biofilm. Polyphenol is a constituent that comprises of at least one aromatic ring with one or more hydroxyl groups and other substituents. They have been recognized as dynamic compounds in many natural products such as tea, propolis, cranberry, grapes, and cacao polyphenols [8]. Lately, new physical approaches like near-infra red light (NIR) or alternating magnetic fields (AMFs) have been employed with nanoparticles to cause irreversible thermal damage to cell surfaces and bacterial biofilm eradication [9]. Hence, bacterial colonization in the form of biofilms on surfaces triggers perpetual infections and is a matter of significant interest to healthcare providers. Recent developments in the material science and continuous progress in the nanotechnology field have created prospects to develop novel antibiofilm surfaces and biomedical devices. This can shield against biofilm formation and planktonic pathogens, including antibiotic resistant strains. These promising developments could possibly be tailored to treat biofilm infections in a noninvasive, on-demand manner.

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