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Pressure-wave assisted molecular delivery in oral biofilms

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Abstract:

Pressure waves are high amplitude transients generated by lasers. Pressure waves have been shown to enhance molecular delivery across biological membranes and skin. The ability to deliver methylene blue, a fluorescent probe and photosensitizer, into bacterial biofilms was demonstrated by applying pressure waves on saliva-derived multi-species biofilms. Pressure waves were generated with a Q-switched Nd:YAG laser and were directed into the biofilms in the presence of methylene blue. The biofilms were then irradiated with red light at 665 nm. After illumination, adherent bacteria were scraped and spread over the surface of blood agar plates. Survival fractions were calculated by counting bacterial colonies. Microbial analysis was performed via a colony lift method and a DNA checkerboard assay using whole genomic probes to 40 oral microorganisms. Visual analysis by confocal scanning laser microscopy demonstrated that the application of pressure waves enhanced the penetration depth of methylene blue in biofilms. Exposure to methylene blue, pressure waves and light led to a significant reduction of the mean levels of colonies. DNA probes revealed a trend towards a greater bacterial inactivation in 21, out of the 40, microorganisms of the treated groups. Elimination of individual groups of bacteria was increased while other types of bacteria remained unaffected. The reasons behind the different susceptibility of biofilm bacteria to light after the application of pressure waves may be related to the way that various bacterial species interact with pressure waves, the local environment and the position of the species within the biofilm.

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