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Abstract (publication only)

Mechanical properties and disruption of dental biofilms

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Objectives: The aim of our research was to characterize and quantify the influence of a high velocity water microdrop impact on the structure and detachment of dental biofilms from the interproximal space of a typodont model using high speed imaging, and image analysis with focus on the viscoelastic parameters and cohesive and adhesive failure. **Methods:** General Bacterial Growth Conditions: *S. mutans* biofilms were grown on coupons, typodont teeth and human deciduous teeth and imaged with confocal and epifluorescent microscopy. High Speed Videography: A high-speed camera was used to record the impact of a high velocity water droplet of 114 μ L, burst from a Philips "AirFloss" device, on biofilm detachment from both model and human teeth. Compressive Testing: Uni-axial compression testing using a small scale mechanical tester was conducted on biofilms while submerged. Computational Fluid Dynamics CFD: CFD simulations based on the finite element method (FEM) were performed utilizing ANSYS Fluent software to calculate the shear distribution caused by the drop around a tooth geometry. **Results:** The water droplet had an exit velocity of 60 m/s leaving the "AirFloss" nozzle. We estimated that 90% of the water was ejected in the first 10 ms. At this time scale the water behaved initially as a continuous jet before breaking up into nanodrops. On impact there was initial cohesive failure as the water burst through the biofilm and subsequent adhesive failure as the shear caused the biofilm to flow over the tooth surfaces. 90 % of the biofilm was removed from the IP space and confocal microscopy showed that there were no biofilm at the device tip but small patches of biofilm remained on the prominences at the back of the teeth. Mechanical testing showed that the *S. mutans* biofilms were viscoelastic with an elastic modulus of 179 kPa and a relaxation time of 10 sec. The CFD simulations predicted lowest shear at posterior aspect of the teeth and were consistent with the experimental observations. **Conclusion:** Biofilms made from *S. mutans* were grown on different surfaces, including human teeth. The impact of the water drop was high enough to cause adhesive and cohesive viscoelastic failure contributing to the detachment process. High velocity water microdrops can effectively remove viscoelastic biofilms with minimal volume and time.