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In vivo and in vitro biofilm formation on two different titanium implant surfaces.

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Abstract

OBJECTIVES: The aim of the present in vitro and human in vivo study was twofold: first, to evaluate the initial biofilm formation on different titanium implant surfaces by means of two highly sensitive fluorescent techniques and, second, to correlate these findings to different surface properties. MATERIALS AND METHODS: In vivo biofilm formation was induced on purely machined (Pt) and on sand-blasted and acid-etched titanium (Prom) specimens, which were mounted buccally on individual splints and worn by six study participants for 12 h. In vitro bacterial adhesion was also investigated after incubation with Streptococcus sanguinis suspension (37 degrees C, 2 h). Adherent bacteria were quantified by the following fluorescence techniques: Resazurin staining in combination with an automated fluorescence reader or live/dead cell labeling and fluorescence microscopy. Surface roughness (R(a)) was determined with a perthometer, and surface free energy (SFE) was measured with a goniometer. RESULTS: Prom showed a significantly higher median R(a) (0.95 microm) and a significantly lower median SFE (18.3 mJ/m(2)) than Pt (R(a)=0.15 microm; SFE=39.6 mJ/m(2)). The in vitro and in vivo tests showed a significantly higher bacterial adhesion to Prom than to Pt, and the initial biofilm formation on Pt corresponded to the circular surface modifications on the machined substratum. Both observations may be attributed to the predominant influence of surface roughness on bacterial adhesion. No significant differences in the percentage of dead cells among all adhering bacteria were found between Prom (23.7%) and Pt (29.1%). Ectopic solitary epithelial cells from the oral mucosa - strongly adhering to the substratum - were found on each Prom specimen, but not on any of the Pt surfaces. CONCLUSIONS: Initial bacterial adhesion to differently textured titanium surfaces is primarily influenced by R(a), whereas the influence of SFE seems to be of only minor importance. Therefore, the micro-structured parts of an implant that are exposed to the oral cavity should be highly polished to prevent plaque accumulation. Both tested fluorometric techniques proved to be highly sensitive and reproducible in the quantification of biofilm formation on titanium implant surfaces.