Influence of Surface Roughness and Hydrophobicity on Bacterial Adhesion and Colonization

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Introduction: Bacterial adhesion and colonization are complicated processes that involve many factors, including surface chemistry, hydrophobicity, and surface roughness, but the roles of these factors are not clear. The objective of this study was to modify hydrophobicity and roughness on one polymeric surface, and measure the corresponding bacterial adhesion and colonization changes.

Methods: One- and two-dimensional mechanically-assembled (stretched) monolayer (MAM) methods were used to enhance hydrophobicity of fluoroalkylsilane (FAS) coatings on silicone. Surface roughness was varied with different abrasives. Surface hydrophobicity and roughness were determined by contact angle measurement and atomic force microscopy, respectively. Bacterial adhesion and colonization were quantified using scanning electron microscopy and direct colony-counting.

Results: Hydrophobicity increased as a function of stretched length or width (Δx); it reached a maximum at $\Delta x = 60\%$ with one- and two-dimensional MAM and decreased as Δx increased to 80% and 100%. After 12 hr incubation, all of FAS/silicone surfaces significantly reduced the adherence of *Staphylococcus epidermidis* from 42% to 88% compared to untreated silicone. Moreover, bacterial adhesion as function of Δx had an opposite trend, i.e. when hydrophobicity increased bacterial adhesion decreased and vice versa. Surface roughness had a significant effect on bacterial adhesion and colonization when the root-mean-square roughness was higher than 200nm.

Conclusion: On FAS/silicone surfaces, bacterial adhesion was reduced significantly, and was inversely related to surface hydrophobicity. Moreover, a rougher surface promoted bacterial adhesion and colonization; however, there is a certain threshold (below 200nm) below which there was no significant decrease in bacterial adhesion and colonization.