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Polymer and protein surface coatings on silicone: effect on *Staphylococcus epidermidis* adhesion and colonization

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Background

Surface modifications of silicone have been attempted to reduce the incidence of shunt infections. However, the influence of surface hydrophobicity, roughness, and functional groups on bacterial adhesion has not been fully elucidated, and reports of protein effects are conflicting. Therefore, we have tested silicone coated with different biopolymers, silanes, and proteins to determine how these modifications influence *Staphylococcus epidermidis* adhesion and colonization.

Materials and methods

Silicone was coated with heparin, hyaluronan, octadecyltrichlorosilane (OTS), and perfluorodecyltrichlorosilane (FAS). Proteins, including bovine serum albumin (BSA), human serum albumin (HSA), γ-globulin, and fibrinogen were immobilized on the surface of silane-modified silicone. Comparisons were also made with physically adsorbed protein on silicone. The quality and stability of these coatings were examined by contact angle measurement, X-ray photoelectron spectroscopy, and atomic force microscopy. A colony-counting adhesion assay and scanning electron microscopy (SEM) were used to quantify bacterial adhesion and colonization.

Results

The contact angles of FAS, OTS, heparin, and hyaluronan coating on silicone were 112.2°, 102.3°, 55.3°, and 55.3°, respectively, and these coatings were stable for 30 days. After a 4 hr incubation with *S. epidermidis*, the pattern of least to greatest colony counts was: FAS – OTS – hyaluronan – silicone – heparin. After a 12 hr incubation, the size and number of colonies increased significantly, hyaluronan/OTS/silicone and heparin/OTS/silicone showed the least and greatest degree of bacterial adhesion, respectively. Immobilized protein on modified silicone surfaces was stable in saline for 30 days, while physically adsorbed protein showed instability within hours. The amount of nitrogen on all types of immobilized proteins was similar, but less on physically adsorbed protein. All protein immobilized on OTS/silicone surfaces significantly reduced bacterial adhesion by around 75% compared to untreated silicone, while physically adsorbed BSA on silicone reduced adhesion by only 30%.

Conclusion

While surface hydrophobicity and roughness did not appear to be determining factors on overall bacterial adhesion, the nature of surface functional group had a significant influence on the initial adhesion and subsequent colonization processes. FAS-coated silicone surfaces displayed the greatest inhibition of bacterial adhesion and

colony formation. Protein covalently immobilized on OTS/silicone reduced bacterial adhesion and colonization, with BSA having a greater effect than physically adsorbed BSA. However, different types of protein inhibited bacterial adhesion to a similar extent, possibly due to a comparable surface concentration of -NH_2 groups. These findings are helpful for devising novel strategies to reduce shunt infections.