Implant Materials Affect Biofilm Formation

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Purpose: Bacterial surgical-site infections are a significant cause of morbidity and mortality globally, and lead to additional medical and surgical treatments, increased costs, and worse outcomes for orthopaedic patients. Bacteria-forming extracellular biofilms are particularly resistant to antibiotic and surgical treatments when surgical implants are present. We compared the ability of Staphylococcus aureus to form biofilms on common surgical implant materials.

Methods: Test coupons composed of hand-polished stainless steel (HPSS), titanium (Ti), titanium alloy Ti6Al4V (TiAlV), cobalt chrome alloy Co28Cr6Mo F1537 (CoCr), hydroxyapatite (HA), ultra-high molecular weight polyethylene (UHMWPE), polyether ether ketone (PEEK), and poly(methyl methacrylate) (PMMA) bone were coated with biofilms and quantified by colony-forming unit (CFU) count, confocal microscopy, and electron microscopy. Surface roughness and water contact angles were assessed with optical profilometer and optical zoom imaging.

Results: After 72 hours, biofilms grew more readily on non-polished 3D-printed metals and plastics, such as PMMA and UHMWPE compared to polished and machined metals. The materials with greater roughness and hydrophobicity developed more biofilm than smoother, hydrophilic materials.

Conclusion: Implant materials and characteristics have a strong correlation with biofilm formation, with hand-polishing of metals predicting resistance to biofilm formation. In addition to being mechanically weak and a poor antibiotic release profile, PMMA is also rougher and more hydrophobic than the metal implants, and thus provides an additional surface for bacteria to readily form biofilm. These results may inform implant designs and surgeons may choose materials with reduced biofilm affinity in both septic and aseptic procedures.