Surface Modification of titanium implants to reduce infection and inflammation

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Reducing bacterial density on titanium implant surfaces has been a major concern because of the increasing number of nosocomial infections. Controlling the inflammatory response post implantation has also been an important issue for medical devices due to the detrimental effects of chronic inflammation on device performance. It has recently been demonstrated that manipulating medical device surface properties including chemistry, roughness and wettability can control both infection and inflammation. Here, we synthesized nanophase (that is, materials with one dimension in the nanoscale) hydroxyapatite coatings on titanium to reduce bacterial adhesion and inflammatory responses (as measured by macrophage functions) and compared such results to bare titanium and plasma sprayed hydroxyapatite titanium coated surfaces used clinically today. This approach is a pharmaceutical-free approach to inhibit infection and inflammation due to the detrimental side effects of any drug released in the body. Here, nanophase hydroxyapatite was synthesized in size ranges from 110-170 nm and was subsequently coated onto titanium samples using electrophoretic deposition. Results indicated that smaller nanoscale hydroxyapatite features on titanium surfaces alone decreased bacterial attachment in the presence of gram negative (*P. aeruginosa*), gram positive (*S. aureus*) and ampicillin resistant gram-negative (*E.coli*) bacteria as well as were able to control inflammatory responses; properties which should lead to their further investigation for improved medical applications.

Future studies in this project will include investigation of the mechanism of bacterial adhesion to these samples and further understanding of the reason behind its reduction. The relationship between surface chemistry, structure, morphology and how it affects protein adsorption will also be explored and be associated with its effect on bacterial adhesion and macrophage adhesion and proliferation. The release of inflammatory cytokines shall be studied in detail using qPCR. Materials other than nanophase hydroxyapatite, like nanophase ceria, nanophase selenium and cellulose acetate and PET shall also be investigated as potential coatings on titanium surfaces. Composite coatings will be performed using these materials and their bacterial and inflammatory responses will be studied. Finally the best materials shall be chosen and an animal study shall be performed. The development of this surface modification technique shall be of great benefit to the medical industry as it shall help in the optimization of inflammatory response leading to faster wound healing and also significantly reduce post operative infections without the use of antibiotics. Overall this will increase the average lifetime of an orthopedic implant and offer more comfort and utility to the patients.