Reducing bacterial adhesion on surface modified titanium

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Statement of Purpose: Implant associated infections are one of the main causes for implant failures associated with medical devices. Bacterial localization and biofilm formation may lead to acute and chronic infection. [1] Biofilm formation on the implant surface protects the bacteria from the immune system and antibiotic therapy. This needs aggressive treatment of antibiotics. The high doses of antibiotic treatment prevent healthy tissue formation at the implant site and triggers antibiotic resistance. [2] Thus, to prevent implant infections, various strategies have been developed besides conventional systemic and local antibiotic treatment. Recently, there is an increasing interest for coating of the implants to improve osseointegration and prevent infection. The current in vitro study aimed to modify the surface of titanium by coating it with nanoscale hydroxyapatite, in a range of sizes, using electrophoretic deposition with a DC current to impart anti- bacterial properties.

Methods: All of the tests in this study were performed on titanium, which was cut into small squares with dimensions of 1cm X 1 cm. Nanophase hydroxyapatite (HA) was prepared by wet chemical synthesis using Ca $(NO_3)24H_2O$, KH_2PO_4, distilled water, ammonia and acetone by stirring for 1 hour and aging for 24 hours followed by filtering using Whatman's grade:1 filter paper and then sintering at 900° C. The HA was then coated onto the alloy using electrophoretic deposition (EPD) For comparison with a popular conventional coating technique, plasma sprayed samples with micron sized HA were obtained from the firm HIMED. Different material characterization studies were performed in order to determine the nature of the samples. TEM was used to determine the size of the nanoparticles. SEM was used to visualize the surface after coating and AFM helped determine the surface roughness. Contact angle analysis was used to determine surface hydrophilicity/ hydrophobicity of the samples. A bacterial assay was performed for 24 hours using *Staphylococcus aureus* (ATCC® 25923) and *Pseudomonas aeruginosa* (ATCC® 39324TM) strains of bacteria to determine anti-bacterial properties. All experiments were conducted in triplicate and repeated three times each.

Results: The reduction in the size of the hydroxyapatite particles on the surface of titanium led to increased roughness of the surface. Also, the surfaces coated with nano HA by EPD were highly hydrophilic in nature as compared to the plasma sprayed surface. Moreover, the smaller the size of the HA particles on these surfaces, the lesser was the adhesion of bacteria (Figure 1).

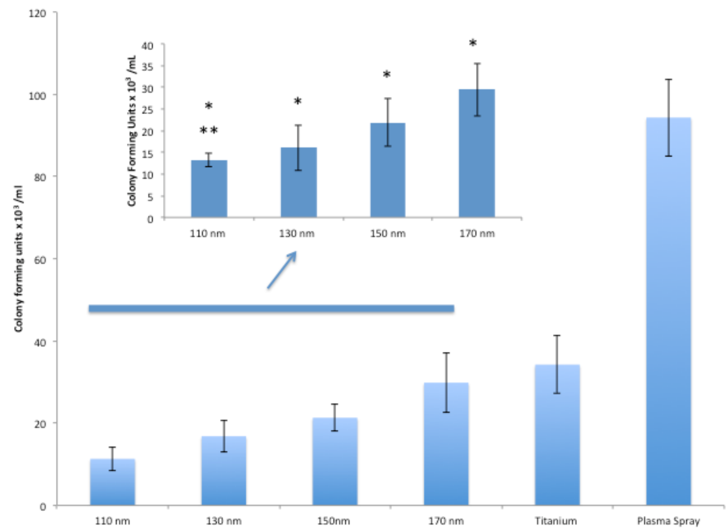

Figure 1: *P. aureginosa* colony forming units/ml on nano-sized HA samples (110, 130, 150, and 170 nm), plain titanium and plasma sprayed samples after 16 hours of incubation. Data are expressed as the mean ± standard error of the mean; N=3; *P<0.01 compared with plasma-sprayed-deposited hydroxyapatite on Ti and ** P<0.01 compared with Ti (control).

Conclusions: A reduction in size of HA nanoparticles on the surfaces coated with EPD led to reduced bacterial adhesion on these surfaces as compared to the more popular and conventional plasma sprayed method and, hence, this technique should be further explored.

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