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Attenuation of acute inflammatory responses by surface nanotopography

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ABSTRACT

The interaction between biology and non-viable surfaces is crucial for many organisms and cells. For example, bacterial cells need to adhere to mineral surfaces in the soil, plants climb and adhere to walls and marine organisms produce adhesives to cling to underwater rocks etc. In the human body, tissue needs to firmly adhere to the mineral surface of bone, but also to foreign materials when for example a biomaterial is implanted. The knowledge of how biology interacts with surfaces is hence important and interesting in many aspects.

Within seconds after implantation of a biomaterial, proteins from the immune complement and coagulation systems adsorb to the surface with possible adverse consequences for the patient. To overcome this, chemical surface modifications are readily employed. However, recently the significance of surface nanotopography for the adsorption of proteins, and attachment of cells have been acknowledged.

To facilitate research on the interactions between biology and nanostructured substrates novel experimental surfaces with defined nanotopography and surface chemistry were developed. The surfaces are fabricated by binding gold nanoparticles to a gold surface, using a non-lithographic method and standard laboratory equipment. The surface chemistry was evaluated using XPS and ToF-SIMS.

On these surfaces, the effect of surface nanotopography on the activation of the immune complement and activation of blood platelets was studied using QCM-D, SEM and fluorescence microscopy.

It was found that although nanostructured surfaces adsorbed greater amount of serum proteins, activation of the immune complement was attenuated by surface nanotopography. A suggested mechanism is that the curvature of the nanoparticles prevents interaction between complement proteins. It was also found that blood platelets were activated to a lower degree on nanostructured surfaces and were sensitive to changes in nanoparticle size and inter-particle distance. These nanostructured surfaces can hopefully facilitate research on protein/cell interactions on nanostructured surfaces.

Keywords: Gold nanoparticles, nanotopography, gradient nanotopography, immune complement, platelets