Influence of Ion Implantation on Physicochemical Processes at Titanium Surfaces

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There exists a clinical requirement for dental implants that will enhance the speed of achievement of osseointegration, its maintenance, and its biological and physical properties. While commercially pure titanium (cp Ti) remains the material of choice for implant fabrication, a promising approach to enhancing its performance is the surface incorporation of metallic ions.

Osteoblast behavior adjacent to the implant is a key factor in osseointegration and it is known that the response of these cells can be modified by the surface implantation of Ca ions. This process may modify cellular behavior via a number of physicochemical parameters, 3 of which were examined in this study using commercially pure titanium, into which Ca ions had been implanted: topography, calcium ion release, and molecular adsorption.

Surface topography can mediate cellular responses and may be modified by ion implantation. Laser profilometry and white-light interferometry were used to measure the roughness of cp Ti surfaces implanted with either biologically active Ca or chemically inert Ar, together with the effects of nitric acid treatment, which is routinely used in implant manufacture.

Ca-ion implantation may also influence cellular responses via accelerated precipitation of calcium phosphate, providing a surface with a chemical composition more similar to that of bone. This may be at least partially due to ion release from the implanted surface. Ion release into water was therefore investigated using ion chromatography and X-ray photoelectron spectroscopy (XPS).

The adsorption of organic molecules (eg, proteins and peptides) is also important in mediating cellular responses. The effects of Ca implantation on these processes were investigated using XPS to study the surface adsorption of small model biomolecules (amino acids) from an aqueous solution.

Ion implantation had little effect on surface topography; however, the implanted Ca ions were readily released into an aqueous solution and the surfaces became more receptive to the absorption of certain amino acids. It is concluded that aqueous solution and the surfaces became more receptive to the absorption of certain amino acids. It is concluded that Ca-ion implantation is a potentially valuable technique for the surface enhancement of titanium dental implants.

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