Biomimetic Treatments on Dental Implants for Immediate Loading Applications

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Commercially pure titanium (cp Ti) dental implants have been widely and successfully used with high rates of clinical success in normal situations. However, there is still a lack of reliable synthetic materials to be used either a) when immediate loading of the implant is desired or b) when bone presents compromised conditions due to trauma, infection, systemic disease and/or lack of significant bone volume. Our group has aimed the development of biomimetic strategies of surface modification to obtain metallic implants with osteostimulative capabilities. These surface modifications will provide implants with a rapid rate of newly-formed bone growth and with ossecoalescence, i.e., direct chemical contact with the surrounding tissues. Consequently, the biomimetically-modified implants will be reliably used on those more demanding clinical situations. cp Ti surfaces treated to obtain a combination of an optimal random surface topography (in the micro and nanolevels) with a chemical modification of the naturally-formed titania layer have been proved bioactive. These rough and bioactive surfaces nucleate and grow a homogeneous hydroxyapatite layer both in vitro and in vivo. They stimulate the osteoblasts differentiation and trigger a rapid bone formation that mechanically fixes implants under immediate-loading conditions. A simple process using silane chemistry has been proved specific, rapid, and reliable to covalently immobilize biomolecules on c.p. Ti surfaces. This methodology can be used to develop biofunctionalized implant surfaces with different or combined bioactivities. The biofunctional molecules can be biopolymers, proteins, growth factors, and synthetic peptides specifically designed to be attached to the surface. The bioactive properties of the molecules designed and used can be mineral growing and nucleation, osteoblast differentiation (bone regeneration), fibroblasts differentiation (biological sealing), antibiotic,… Specifically, we have obtained mechanically and thermochemically stable coatings made of recombinant elastin-like biopolymers. The biopolymers bear either a) the RGDS peptide, which is a highly-specific cell-adhesion motif present in proteins of the extracellular matrix for different tissues including bone, or b) an acidic peptide sequence derived from statherin, a protein present in saliva with high affinity for calcium-phosphates and with a leading role in the remineralization processes of the hard tissues forming our teeth. Two different biomimetic strategies have been successfully developed combining topographical modification, inorganic treatments and/or biofunctionalization for improving bioactive integrative properties of c.p. Ti implants.

