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AMINOCOAT

Population aging in developed countries will further increase bone deficiencies due to pathologies such as osteoporosis. Thus, the need of bioactive implants with the capacity to integrate inside osteoporotic bone will raise significantly. Surface chemistry and topography modifications have been shown to improve bone implants tissue integration. In a recent common work using microfabricated surfaces, we demonstrated the predominance of chemistry versus topography in influencing bone cell response. Amine functionalization of geometrically grooved titanium substrates with poly(allylamine) plasma polymer was able to abrogate cell contact guidance along the microgrooves.

This was the first demonstration of the possibility to overcome a strong topographical signal by changing the surface chemistry.

Several hypotheses have been proposed to explain this effect: (a) the high electrostatic interactions that must occur between a negatively-charged cell membrane and the positivelycharged amino residues; (b) the increased adsorption of cell-adhesive proteins from the serum with more efficient conformation for interaction with integrin receptors; (c) the capacity of polyamines residues released in medium to promote cell protrusion formation.

However, this original result obtained by our two groups with poly(allylamine) plasma polymer coatings needs now to be analyzed more deeply to determine the role of physico-chemical surface properties on this cell behavior and the biological mechanisms involved.

With the objective of determining the role of surface and/or volume density of amino groups in this cell response, we propose to develop controlled amino-rich nano-layers using three different techniques allowing increasing levels of control of chemical composition : (a) plasma polymerization of allylamine, (b) covalent grafting of polymer-based amino-rich nano-coatings with varying content in amino groups, and (c) self-assembled monolayers with amino terminal groups.

On these perfectly characterized amino-rich organic surfaces, we will explore in depth which proteins from the serum are adsorbed on the surface, in which quantity and how they are conformed.

To verify the adhesion and abrogation potential of these different surfaces in relationship with the density and organization of amino groups, the morphology of human bone cells will be evaluated in living and fixed cells on coated grooved substrates. The organization and dynamics of the cytoskeleton and focal adhesions will be quantified to implement an in silico cell model and determine the adhesion force and mechanical properties of cells adhering on amino-rich nano-layers. To go deeper into the analysis of the cellular mechanisms involved in cell response, both the signalling and the gene expression of the cells will be analyzed.

The understanding of the mechanism of action of these amino-rich nano-layers shall bring basic knowledge essential for improving bioactive implants for deficient aged bone.