DEVELOPMENT OF NOVEL SCAFFOLDS FOR BONE TISSUE ENGINEERING

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Text

Bone tissue regeneration to restore skeletal function remains a major challenge in modern medicine. Current procedures to repair critical size bone defects due to trauma, tumors, infections and development disorders include the use of autologous or allogeneic grafts. These approaches are limited by insufficient supply, donor site morbidity and potential disease transmission. In order to overcome the drawbacks of bone grafts, bone tissue engineering offers new therapeutic strategies for reconstructive orthopaedic surgery. Tissue engineering applies the principles of biology and engineering toward the development of synthetic graft substitutes that restore and maintain the function of human bone tissues. Biomaterials proposed as ideal scaffolds need to be biocompatible, ideally osteoinductive, osteoconductive, porous and mechanically compatible with native bone (1). Scaffolds should provide anchorage sites and structural guidance to osteogenic cells and, within an in vivo environment, should create an interface that responds to physiologic and mechanical changes in order to integrate with surrounding native tissue (2). In recent years, a number of synthetic bone-graft substitutes composed of diverse materials including natural and synthetic polymers, ceramics and composites of polymers and ceramics have been developed, with mixed success and surgical acceptance.

In the framework of this project, we propose the development of new polymeric, ceramic or composite scaffolds designed to mimic the three-dimensional characteristics of autograft tissue while allowing bone ingrowth. We will prepare biodegradable polymers with controlled pore size and structure, by means of supercritical fluid processing. In order to mimic the composition and structural properties of trabecular bone, macroporous ceramic scaffolds based on calcium phosphates will be generated using natural or synthetic foaming agents. Finally, we propose the generation of a three-dimensional, highly porous foam-like composite scaffold prepared by cryopolymerization with well-controlled internal and external architecture. Chemical composition, porosity and textural properties of novel scaffolds will be exhaustively characterized. Mechanical tests and finite element modeling will help to evaluate the mechanical performance of porous scaffolds. In vitro biocompatibility of materials will be studied using human mesenchymal stem cells derived from bone marrow or adipose tissue. Since mechanical strain regulates the structure and mechanical properties of bone tissue, we also aim to look at the effect of mechanical stimuli in cells cultured on three-dimensional scaffolds that will be studied using bioreactors. Specific biofunctionalization of scaffolds through incorporation of bioactive molecules will be considered. Finally, animal models will allow us to evaluate *in vivo* tissue integration as well as osteogenic and angiogenic effects achieved by candidate scaffolds.

References:

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