BRITTLE TO BONE-LIKE BEHAVIOR IN POROUS HYDROXYAPATITE SCAFFOLDS

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Research on synthetic bone is driven by the need for alternatives to allograft and autograft for defect repair. Ideally, surgeons could provide tailor-made implants having the mechanical integrity to withstand loads such as those required for the head, spine, joints, and extremities. A logical choice is a ceramic like hydroxyapatite (HA) because its composition is similar to the mineral phase in natural bone. However, the brittle nature of HA limits its use for load bearing defects. The long term function of an implant depends on its integration into the host bone and on its bio-mimetic qualities. Complete integration necessitates a porous implant, which facilitates tissue ingrowth and vascularization, but also significantly decreases the mechanical strength.

In a recent study, porous HA samples exhibited an unusual change in mechanical behavior from brittle to bone-like. Furthermore, scaffolds used in this study that contain multi-scale porosity may be more osteoconductive *in vivo* than those with a single pore size. HA scaffolds, some containing multi-scale porosity and some with only macroporosity, were infiltrated with gelatin microspheres containing BMP-2 and implanted intramuscularly in Yorkshire pigs. After 8 weeks, the resulting composite consisted of the original scaffold with bone bridging between the rods/struts in scaffolds with multi-scale porosity, but not in scaffolds containing only macroporosity. Vasculature, loose connective tissues, osteoclasts, osteoblasts, and evidence of scaffold resorption and bone remodeling were also observed. Preliminary micro-ct imaging and histology of deformed samples show that the natural bone arrested crack propagation in the ceramic, thereby toughening the composite. This small quantity of bone and connective tissue likely contributes to the transition from brittle to bone-like behavior.

By appropriately tailoring the macro and microporous structures we predict that the improved osteoconductivity will compensate for the loss in strength that accompanies the additional porosity as healing progresses. Results from this study will determine the significance of multi-scale porosity for bone growth and scaffold mechanical properties, which to date has not been adequately described, and will allow the mechanical behavior and damage mechanisms of complex, porous, and potentially load-bearing, synthetic bone scaffolds to be better understood following implantation. The results obtained will also provide a framework for assessing the quality and function of an implant *in vivo*, which in turn will guide clinicians in prescribing rehabilitation strategies for recovering patients with a range of load bearing bone defects.

Keywords: scaffold, bone, composite