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RESEARCH ARTICLE

An *in vivo* study on the effect of scaffold geometry and growth factor release on the healing of bone defects

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Abstract

The hypothesis of this study was that the extent of bone regeneration could be enhanced by using scaffolds with appropriate geometry, and that such an effect could be further increased by mimicking the natural timing of appearance of bone morphogenetic proteins BMP-2 and BMP-7 after fracture. Bioplotted poly(ε-caprolactone) (PCL) disks with four different fibre organizations were used to study the effect of 3D scaffold architecture on the healing of bone defects in a rat pelvis model. Moreover, one PCL construct was further modified by introducing a nanoparticulate sequential BMP-2/BMP-7 delivery system into this scaffold. Scaffolds and functionalized construct along with free nanocapsules were implanted using a rat iliac crest defect model. Six weeks post-implantation, the defects were evaluated by CT scan and histology. Analysis revealed that the basic architecture, having the highest pore volume for tissue ingrowth, presented the highest bone formation as determined by the bone mineral density (BMD) within the defect (144.2 ± 7.1); about four-fold higher than that of the empty defect (34.9 ± 10.7). It also showed the highest histological analysis scores with a high amount of bone formation within the defect, within the scaffold pores and along the outer surfaces of the scaffold. The basic scaffold carrying the BMP-2/BMP-7 delivery system showed significantly higher bone formation than the growth factor-free basic scaffold at 6 weeks (BMD 206.8 ± 15.7). Histological analysis also revealed new bone formation in close to or in direct contact with the construct interface. This study indicates the importance of open and interconnecting pore geometry on the better healing of bone defects, and that this effect could be further increased by supplying growth factors, as is the case in nature. Copyright © 2012 John Wiley & Sons, Ltd.

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1. Introduction

Impaired healings and non-unions account for 5–10% of all fractures on an annual basis (Navarro *et al*., 2008) and necessitate development of proper bone fillers that induce regeneration while providing structural and mechanical support. Tissue engineering is considered to be a promising field for the production of such artificial bone substitutes that would eventually replace bone grafting. It involves the use of cells together with biodegradable scaffolds that structurally and mechanically mimic the defect structure and composition. Therefore, scaffolds play a central role in tissue engineering applications because

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