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RESEARCH ARTICLE

Poly(ester-urethane) scaffolds: effect of structure on properties and osteogenic activity of stem cells

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Abstract

The present study aimed to investigate the effect of structure (design and porosity) on the matrix stiffness and osteogenic activity of stem cells cultured on poly(ester-urethane) (PEU) scaffolds. Different three-dimensional (3D) forms of scaffold were prepared from lysine-based PEU using traditional salt-leaching and advanced bioplotting techniques. The resulting scaffolds were characterized by differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), scanning electron microscopy (SEM), mercury porosimetry and mechanical testing. The scaffolds had various pore sizes with different designs, and all were thermally stable up to 300 °C. *In vitro* tests, carried out using rat bone marrow stem cells (BMSCs) for bone tissue engineering, demonstrated better viability and higher cell proliferation on bioplotted scaffolds compared to salt-leached ones, most probably due to their larger and interconnected pores and stiffer nature, as shown by higher compressive moduli, which were measured by compression testing. Similarly, SEM, von Kossa staining and EDX analyses indicated higher amounts of calcium deposition on bioplotted scaffolds during cell culture. It was concluded that the design with larger interconnected porosity and stiffness has an effect on the osteogenic activity of the stem cells.

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Keywords poly(ester-urethane); scaffold; stiffness; porosity; bone marrow stem cells; osteogenic activity

1. Introduction

Bone tissue engineering (BTE) is a promising alternative strategy for healing severe bone defects, utilizing cell-loaded scaffolds with engineering principles. A proper interaction between the loaded cells and the porous scaffold is important for the success of the implantable device. Various synthetic or natural materials, such as ceramics or polymers, are tested for their ability to support cell adhesion, proliferation and differentiation. Generally, natural polymers have better compatibility but may not have the desired strength, while the synthetic ones offer some advantages, such as controllable physical, chemical, surface and degradation properties. They can be easily designed to form porous three-dimensional (3D) complex structures with high porosity and a high surface area, which are essential for anchorage-dependent cells, such as bone cells, to attach, survive and differentiate (Rada *et al*., 2012). The role of a scaffold is to act as a temporary extracellular matrix (ECM) for the regenerating cells. Thus, the success of tissue engineering is greatly determined by the properties of the scaffolds and their *in vitro* and *in vivo* behaviours. Many parameters, such as shape, chemistry, surface roughness and surface energy, as well as pore size and mechanical strength, affect the cell response. Cells can sense and respond to external forces

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