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Solvent-free polymer/bioceramic scaffolds for bone tissue engineering: fabrication, analysis, and cell growth

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Abstract

This study examines the potential use of porous polycaprolactone (PCL) and polycaprolactone/hydroxyapatite (PCL/HA) scaffolds fabricated through melt molding and porogen leaching for bone tissue engineering. While eliminating organic solvents is desirable, the process steps proposed in this study for uniformly dispersing HA particles ($\sim 5 \mu\text{m}$ in size) within the scaffold can also contribute to homogeneous properties for these porous composites. Poly(ethylene oxide) (PEO) was chosen as a porogen due to its similar density and melting point as PCL. Pore size of the scaffold was controlled by limiting the size of PCL and PEO particles used in fabrication. The percent of HA in the fabricated scaffolds was quantified by thermogravimetric analysis (TGA). Mechanical

testing was used to compare the modulus of the scaffolds to that of bone, and the pore size distribution was examined with microcomputed tomography (μ CT). Scanning electron microscopy (SEM) was used to examine the effect on scaffold morphology caused by the addition of HA particles. Both μ CT and SEM results showed that HA could be incorporated into PCL scaffolds without negatively affecting scaffold morphology or pore formation. Energy-dispersive X-ray spectroscopy (EDS) and elemental mapping demonstrated a uniform distribution of HA within PCL/HA scaffolds. Murine calvaria-derived MC3T3-E1 cells were used to determine whether cells could attach on scaffolds and grow for up to 21 days. SEM images revealed an increase in cell attachment with the incorporation of HA into the scaffolds. Similarly, DNA content analysis showed a higher cell adhesion to PCL/HA scaffolds.

Keywords:

bone

polycaprolactone

hydroxyapatite

scaffolds

tissue engineering

cell culture

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