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Hydroxyapatite Nanorods as Novel Fillers for Improving the Properties of PBSu

Authors : M. Nerantzaki, I. Koliakou, D. Bikiaris

Abstract : This study evaluates the hypothesis that the incorporation of fibrous hydroxyapatite nanoparticles (nHA) with high crystallinity and high aspect ratio, synthesized by hydrothermal method, into Poly(butylene succinate) (PBSu), improves the bioactivity of the aliphatic polyester and affects new bone growth inhibiting resorption and enhancing bone formation. Hydroxyapatite nanorods were synthesized using a simple hydrothermal procedure. First, the HPO42- -containing solution was added drop-wise into the Ca2+-containing solution, while the molar ratio of Ca/P was adjusted at 1.67. The HA precursor was then treated hydrothermally at 200°C for 72 h. The resulting powder was characterized using XRD, FT-IR, TEM, and EDXA. Afterwards, PBSu nanocomposites containing 2.5wt% (nHA) were prepared by in situ polymerization technique for the first time and were examined as potential scaffolds for bone engineering applications. For comparison purposes composites containing either 2.5wt% micro-Bioglass (mBG) or 2.5wt% mBG-nHA were prepared and studied, too. The composite scaffolds were characterized using SEM, FTIR, and XRD. Mechanical testing (Instron 3344) and Contact Angle measurements were also carried out. Enzymatic degradation was studied in an aqueous solution containing a mixture of R. Oryzae and P. Cepacia lipases at 37°C and pH=7.2. In vitro biomineralization test was performed by immersing all samples in simulated body fluid (SBF) for 21 days. Biocompatibility was assessed using rat Adipose Stem Cells (rASCs), genetically modified by nucleofection with DNA encoding SB100x transposase and pT2-Venus-neo transposon expression plasmids in order to attain fluorescence images. Cell proliferation and viability of cells on the scaffolds were evaluated using fluoresce microscopy and MTT (3-(4,5-dimethylthiazol-2-yl)-2,5 diphenyltetrazolium bromide) assay. Finally, osteogenic differentiation was assessed by staining rASCs with alizarine red using cetylpyridinium chloride (CPC) method. TEM image of the fibrous HAp nanoparticles, synthesized in the present study clearly showed the fibrous morphology of the synthesized powder. The addition of nHA decreased significantly the contact angle of the samples, indicating that the materials become more hydrophilic and hence they absorb more water and subsequently degrade more rapidly. In vitro biomineralization test confirmed that all samples were bioactive as mineral deposits were detected by X-ray diffractometry after incubation in SBF. Metabolic activity of rASCs on all PBSu composites was high and increased from day 1 of culture to day 14. On day 28 metabolic activity of rASCs cultured on samples enriched with bioceramics was significantly decreased due to possible differentiation of rASCs to osteoblasts. Staining rASCs with alizarin red after 28 days in culture confirmed our initial hypothesis as the presence of calcium was detected, suggesting osteogenic differentiation of rACS on PBSu/nHAp/mBG 2.5% and PBSu/mBG 2.5% composite scaffolds.

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