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Magnetic SF (Silk Fibroin) E-Gel Scaffolds Containing bFGF-Conjugated Fe3O4 Nanoparticles

Authors : Z. Karahaliloğlu, E. Yalçın, M. Demirbilek, E.B. Denkbaş

Abstract : Critical-sized bone defects caused by trauma, bone diseases, prosthetic implant revision or tumor excision cannot be repaired by physiological regenerative processes. Current orthopedic applications for critical-sized bone defects are to use autologous bone grafts, bone allografts, or synthetic graft materials. However, these strategies are unable to solve completely the problem, and motivate the development of novel effective biological scaffolds for tissue engineering applications and regenerative medicine applications. In particular, scaffolds combined with a variety of bio-agents as fundamental tools emerge to provide the regeneration of damaged bone tissues due to their ability to promote cell growth and function. In this study, a magnetic silk fibroin (SF) hydrogel scaffold was prepared by electrogelation process of the concentrated Bombxy mori silk fibroin (8 %wt) aqueous solution. For enhancement of osteoblast-like cells (SaOS-2) growth and adhesion, basal fibroblast growth factor (bFGF) were conjugated physically to the HSA-coated magnetic nanoparticles (Fe3O4) and magnetic SF e-gel scaffolds were prepared by incorporation of Fe3O4, HSA (human serum albumin)=Fe3O4 and HSA=Fe3O4-bFGF nanoparticles. HSA=Fe3O4, HSA=Fe3O4-bFGF loaded and bare SF e-gels scaffolds were characterized using scanning electron microscopy (SEM.) For cell studies, human osteoblast-like cell line (SaOS-2) was used and an MTT assay was used to assess the cytotoxicity of magnetic silk fibroin e-gel scaffolds and cell density on these surfaces. For the evaluation osteogenic activation, ALP (alkaline phosphatase), the amount of mineralized calcium, total protein and collagen were studied. Fe3O4 nanoparticles were successfully synthesized and bFGF was conjugated to HSA=Fe3O4 nanoparticles with %97.5 of binding yield which has a particle size of 71.52±2.3 nm. Electron microscopy images of the prepared HSA and bFGF incorporated SF e-gel scaffolds showed a 3D porous morphology. In terms of water uptake results, bFGF conjugated HSA=Fe3O4 nanoparticles has the best water absorbability behavior among all groups. In the in-vitro cell culture studies realized using SaOS-2 cell line, the coating of Fe3O4 nanoparticles surface with a protein enhance the cell viability and HSA coating and bFGF conjugation, the both have an inductive effect in the cell proliferation. One of the markers of bone formation and osteoblast differentiation, according to the ALP activity and total protein results, HSA=Fe3O4-bFGF loaded SF e-gels had significantly enhanced ALP activity. Osteoblast cultured HSA=Fe3O4-bFGF loaded SF e-gels deposited more calcium compared with SF e-gel. The proposed magnetic scaffolds seem to be promising for bone tissue regeneration and used in future work for various applications.

Keywords : basic fibroblast growth factor (bFGF), e-gel, iron oxide nanoparticles, silk fibroin
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