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Design of Nanoreinforced Polyacrylamide-Based Hybrid Hydrogels for Bone Tissue Engineering

Authors : Anuj Kumar, Kummara M. Rao, Sung S. Han

Abstract : Bone tissue engineering has emerged as a potentially alternative method for localized bone defects or diseases, congenital deformation, and surgical reconstruction. The designing and the fabrication of the ideal scaffold is a great challenge, in restoring of the damaged bone tissues via cell attachment, proliferation, and differentiation under three-dimensional (3D) biological micro-/nano-environment. In this case, hydrogel system composed of high hydrophilic 3D polymeric-network that is able to mimic some of the functional physical and chemical properties of the extracellular matrix (ECM) and possibly may provide a suitable 3D micro-/nano-environment (i.e., resemblance of native bone tissues). Thus, this proposed hydrogel system is highly permeable and facilitates the transport of the nutrients and metabolites. However, the use of hydrogels in bone tissue engineering is limited because of their low mechanical properties (toughness and stiffness) that continue to posing challenges in designing and fabrication of tough and stiff hydrogels along with improved bioactive properties. For this purpose, in our lab, polyacrylamide-based hybrid hydrogels were synthesized by involving sodium alginate, cellulose nanocrystals and silica-based glass using one-step free-radical polymerization. The results showed good in vitro apatite-forming ability (biomineralization) and improved mechanical properties (under compression in the form of strength and stiffness in both wet and dry conditions), and in vitro osteoblastic (MC3T3-E1 cells) cytocompatibility. For in vitro cytocompatibility assessment, both qualitative (attachment and spreading of cells using FESEM) and quantitative (cell viability and proliferation using MTT assay) analyses were performed. The obtained hybrid hydrogels may potentially be used in bone tissue engineering applications after establishment of in vivo characterization.

Keywords : bone tissue engineering, cellulose nanocrystals, hydrogels, polyacrylamide, sodium alginate
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