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In-situ Deposition of Nanohydroxyapatite within N,O-Carboxymethylchitosan/Polyvinylpyrrolidone Hydrogels: Characterization and Bioactivity Evaluation

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Background: Bone is a natural composite; its primary purpose is to provide mechanical support for soft tissues and serves as an anchor for muscles that generate motion. Although, bone has a remarkable ability to regenerate when damaged, treatment of bone defects caused by various reasons still a clinically confusing problem. Of possible choices, autogenous bone transplantation is the optimum choice. Unfortunately, the limited donor source, the damage and complications that may happen to the donor site are the worse limitations. Currently, bone tissue engineering strategies offer promising alternatives for autografts and allografts using scaffolds for guided tissue regeneration. Scaffolds are synthetic grafts, have the ability to promote bone regeneration within the defect site. Scaffolds should be porous to ensure nutrient and waste transport, tissue in-growth, and biological fixation with surrounding tissue. Also, they should be osteoconductive to facilitate bone formation on its surface. Scaffold should have adequate mechanical strength to support bone in-growth at the site of implantation, maintain structural integrity during in vivo tissue remodeling and it should degrade over time in concert with bone formation. Recently, polymeric composite scaffolds are gaining increased attention as synthetic alternatives for bone grafting materials. They improve the bioactivity and mechanical properties so as to meet the basic requirements for bone repair. The development of bone-like composites with enhanced biocompatibility calls for a biomimetic approach using hydroxyapatite [Ca10(PO4)6(OH)2]as a guide.
Methodology: Hydrogel matrices based on N,O carboxymethylchitosan and polyvinylpyrolidone (NOCMCs/PVP) were synthesized using ☒-radiation as clean initiator. Alternate soaking method was used to obtain (NOCMCs/PVP)–nanohydroxyapatite composite scaffolds. In vitro bioactivity and biocompatibility evaluation was investigated before and after immersion in simulated body fluids (SBF) to follow the formation of bone like carbonated hydroxyapatite (HCA) layers.
Results: After alternate soaking process; the deposition of guided nHA layers onto (NOCMCs/PVP) hydrogels were confirmed using FTIR, EDX, XRD and SEM techniques. EDX analysis confirmed that Ca/P molar ratio (1.62) was very close to the theoretical value of Ca/P molar ratio in human bone (1.67). The development of nHA crystals was confirmed from XRD measurements and the average grain size was found to be in the range of 12-37 nm. The compressive strength for the tested composites recorded comparable values compared to the cancellous bone.
Post immersion in SBF, the growth of carbonated apatite (HCA) particles increased by time and the surface appears smooth after 28 days of immersion as it is clear in Figure (1).By increasing HA content, the weight of blood clot formed and the percent heamolysis decreases and tends to zero. Conclusion: synthesis of guided nano-hydroxyapatite layer within (NOCMCs/PVP) hydrogels using alternate soaking is a simple and efficient method. biomineralization process in SBF contributes to the formation of bone like carbonated hydroxyapatite (HCA) layers. In vitro bioactivity and blood compatibility evaluation indicated that nHA-(NOCMCs/PVP) scaffold was bioactive and biocompatible and may be promising for bone repair.

Country/Organization invited to participate

Egypt

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