Enhanced Bone Integration of Cortical Segmental Bone Defects Using Metallic Metabiomaterials Coated with Sol-Gel Hydroxyappetite

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Metallic metamaterials are a are promising class of biomaterials for grafting large bone defects particularly in restoring the performance of cyclic load mechanism of hip and knee by rationalizing the size and geometry of porous structure that resulting in sufficient mechanical support and good osseointegration. To reinforce metallic metamaterials with biological cues that enhance and continue bone regeneration, metamaterials can be incorporated with bioactive gels such as hydroxyappetite (HAP). In this study metamaterials meant as scaffolds for femoral bone defects were designed with controlled unit cell types and geometries and were fabricated by selective laser melting (SLM) process. HAP-based coating using sol-gel deposition technique has been studied to deliberate the surface morphologies and chemical composition, mechanical performance and biological responses of the coating when applied on the metallic biomaterials. It has been observed that uniform and homogenous coating thickness and high adherent biocompatible coating even on complex shape can be obtained. Cobalt chrome molybdenum (CoCrMo) metamaterials were evaluated using in vitro MTT Assay, compression test and observed under scanning electron microscope (SEM). All SLM-ed CoCrMo metamaterials are justified not harmful to the cells and no proof to cells death, whilst the stiffness and compression strength of metamaterials satisfy those range of cortical and cancellous femoral bone. Interestingly, formation of cell matrix can be observed on the metamaterials after 21 days of cartilage cell culture. In conclusion, metallic metamaterials can improve the design of current load bearing implant for cortical bone defects and incorporation of sol-gel dip coating is a promising strategy to enhance and continue bone regeneration of large bone defects.