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Effect of Varying Scaffold Architecture and Porosity of Calcium Alkali Orthophosphate Based-Scaffolds for Bone Tissue Engineering

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Abstract : The goal of this study was to develop 3D scaffolds from a silica containing calcium alkali orthophosphate utilizing two different fabrication processes, first a replica technique namely the Schwartzwalder Somers method (SSM), and second 3D printing, i.e. Rapid prototyping (RP). First, the mechanical and physical properties of the scaffolds (porosity, compressive strength, and solubility) was assessed and second their potential to facilitate homogenous colonization with osteogenic cells and extracellular bone matrix formation throughout the porous scaffold architecture. To this end murine and rat calavarie osteoblastic cells were dynamically seeded on both scaffold types under perfusion with concentrations of 3 million cells. The amount of cells and extracellular matrix as well as osteogenic marker expression was evaluated using hard tissue histology, immunohistochemistry, and histomorphometric analysis. Total porosities of both scaffolds were 86.9 % and 50% for SSM and RP respectively, Compressive strength values were 0.46 ± 0.2 MPa for SSM and 6.6± 0.8 MPa for RP. Regarding the cellular behavior, RP scaffolds displayed a higher cell and matrix percentage of 24.45%. Immunoscoring yielded strong osteocalcin expression of cells and matrix in RP scaffolds and a moderate expression in SSM scaffolds. 3D printed RP scaffolds displayed superior mechanical and biological properties compared to SSM. 3D printed scaffolds represent excellent candidates for bone tissue engineering.

Keywords : calcium alkali orthophosphate, extracellular matrix mineralization, osteoblast differentiation, rapid prototyping, scaffold
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