THE INFLUENCE OF TEMPERATURE AND PORE SIZE ON CELL GROWTH AND PROLIFERATION ON HYDROXYAPATITE SCAFFOLDS

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Abstract

Porous biomaterials, especially synthetic porous ceramics, are of significant importance in bone tissue engineering, and there has been rapid growth in the medical use of these biomaterials over the last 50 years. The reason is that they are relatively easy to prepare and are available in unlimited supply, unlike the allografts and autografts that are used in clinical practice. Various hydroxyapatite (HAp) scaffolds can be prepared, using various pore-forming techniques and firing temperatures. The firing temperature significantly affects microstructural parameters such as total porosity, pore size, the interconnected pore network, and also the chemical and phase composition. Last but not least, it also affects the mechanical properties of the samples. Knowledge about these factors is therefore essential for designing a sample with the desired controlled microstructure and properties.

In this work, uniaxial pressing has been used for preparing HAp disks from nanocrystalline HAp powder, using saccharose as a pore-forming agent. The highest porosity achieved (after partial sintering at 800°C) was in the range of 64.7-70.6%. The firing temperature significantly affects porosity, pore size, grain size and mechanical strength, whereas the dwell time has only a minor effect on these parameters. After firing, XRD confirmed more than 98.4% HAp in all cases. Mercury porosimetry confirmed the presence of nanosized interstitial voids for partially sintered materials and pore throat sizes of approximately 100μm (much smaller than the pore cavities), which is adequate for bone cell penetration and further ingrowth. After firing at 1200°C, the matrix is more or less fully sintered, and nanosized pores are absent or closed.

The biological part of the paper summarizes the results from cell-seeding and cultivation experiments to determine the cell adhesion, proliferation, viability, mitochondrial activity and osteogenic cell differentiation on the scaffolds, and thus the biocompatibility and bioactivity of the scaffolds. The highest values for all these parameters, particularly the number of cells, were on HAp fired at 1200°C. The samples fired at 1200°C were prepared with various pore sizes (in the range of 100 – 800μm). We found that pore size has a non-significant effect on cell colonization, whereas the firing temperature has a major influence. All tested HAp samples showed a remarkable ability to adsorb proteins on their surfaces, namely albumin and fibronectin, and to promote cell adhesion. Some cytotoxic activity was observed on the samples fired at 800 and 1000°C. Possible reasons for this cytotoxicity have been discussed. However, it can be concluded that the HAp samples created in this study and fired at 1200°C hold great promise for bone tissue engineering.

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POLYLACTIDE NANOFIBERS IN SKIN TISSUE ENGINEERING

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Abstract

Various artificial or natural biomaterials can be used for constructing a scaffold suitable for treating skin injuries. Artificial skin replacements are made from polyhema, polybutylene terephthalate, nylon, polylactic acid and polyglycolic acid or their copolymers. The most widely applied natural biomaterials are collagen, chitin, hyaluronic acid and chondroitin sulfate [1]. In recent tissue engineering, nanofibrous scaffolds have been very attractive because they better simulate the architecture of natural extracellular matrix. In skin tissue engineering, nanofibrous membranes can be used for constructing a bilayer of fibroblasts and keratinocytes [2]. These membranes will separate the two cell types, ensuring their physical and humoral communication; thus the layer of fibroblasts will serve as a feeder for keratinocytes. For our study, we chose nanofibers made of polylactide (PLA), prepared in external collaboration with Elmarco Ltd. (Liberec, Czech Republic). The main advantage of PLA is its biodegradability; it is slowly resorbed in the organism, and is finally replaced by regenerate tissue.