Hybrid Materials Consisting of Hydroxyapatite and Bio-based Polymers Used as Scaffolds for Bone Tissue Engineering

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Large bone defects require fabricated bone constructs that consist of three main components: an artificial extracellular matrix scaffold, stem cells with the potential to differentiate into osteoblasts, and bioactive substances, such as osteoinductive growth factors to direct the growth and differentiation of cells toward osteogenic lineage within the scaffold. Scaffolds provide a 3D environment for cell seeding and proliferation as well as filling bone defects while affording mechanical competence during the process of bone regeneration. Today, scaffold development is focused on inorganic-organic composites (hybrids), mainly prepared using natural and synthetic polymers (i.e. collagen, polysaccharides), and inorganic hydroxylapatite (HA), tricalcium phosphate (TCP). In recent years, tissue engineers used various modifications such as addition of bioactive molecules or nanoparticles to enhance attachment and proliferation of stem cells on the scaffold. Thus, the application of so-called "smart scaffolds" enhances osteogenic differentiation of stem cells. [1] In particular, purinergic receptors, P_2X and P_2Y play a key role in osteogenic lineage commitment of human mesenchymal stem cells (MSCs). Via addition of corresponding P2X/Y receptor ligands (agonists, antagonists) the differentiation process can be triggered towards osteoblast formation. [2]

The main focus of this contribution is the correlations between scaffold structures, both bulk and surface and corresponding cell behavior, i.e. adhesion and differentiation. The human MSCs were gained through isolation of jar bone chip and liposuction material harvested during surgery intervention. Scaffold structure analysis to investigate scaffold hybrid materials (human, bovine, artificial) provides information on their chemical composition, 3D bulk and surface structure. Thus, FTIR spectroscopy, X-ray diffraction (XRD), small angle X-ray scattering (SAXS), scanning electron microscopy (SEM) and zeta potential measurements will be discussed to explain the hybrid structure-property relationships.

Three scaffold materials (collagen, bovine, artificial) were analyzed regarding their chemical composition, 3D bulk and surface structure. Administration of selective P2Y1 antagonists led to an enhanced matrix mineralization thus confirming the functional role of P2X7 during osteogenesis.

References

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