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Effect of the Polymer Modification on the Cytocompatibility of Human and Rat Cells

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Abstract : Tissue engineering includes combination of materials and techniques used for the improvement, repair or replacement of the tissue. Scaffolds, permanent or temporally material, are used as support for the creation of the "new cell structures". For this important component (scaffold), a variety of materials can be used. The advantage of some polymeric materials is their cytocompatibility and possibility of biodegradation. Poly(L-lactic acid) (PLLA) is a biodegradable, semi-crystalline thermoplastic polymer. PLLA can be fully degraded into H₂O and CO₂. In this experiment, the effect of the surface modification of biodegradable polymer (performed by plasma treatment) on the various cell types was studied. The surface parameters and changes of the physicochemical properties of modified PLLA substrates were studied by different methods. Surface wettability was determined by goniometry, surface morphology and roughness study were performed with atomic force microscopy and chemical composition was determined using photoelectron spectroscopy. The physicochemical properties were studied in relation to cytocompatibility of human osteoblast (MG 63 cells), rat vascular smooth muscle cells (VSMC), and human stem cells (ASC) of the adipose tissue in vitro. A fluorescence microscopy was chosen to study and compare cell-material interaction. Important parameters of the cytocompatibility like adhesion, proliferation, viability, shape, spreading of the cells were evaluated. It was found that the modification leads to the change of the surface wettability depending on the time of modification. Short time of exposition (10-120 s) can reduce the wettability of the aged samples, exposition longer than 150 s causes to increase of contact angle of the aged PLLA. The surface morphology is significantly influenced by duration of modification, too. The plasma treatment involves the formation of the crystallites, whose number increases with increasing time of modification. On the basis of physicochemical properties evaluation, the cells were cultivated on the selected samples. Cell-material interactions are strongly affected by material chemical structure and surface morphology. It was proved that the plasma treatment of PLLA has a positive effect on the adhesion, spreading, homogeneity of distribution and viability of all cultivated cells. This effect was even more apparent for the VSMCs and ASCs which homogeneously covered almost the whole surface of the substrate after 7 days of cultivation. The viability of these cells was high (more than 98% for VSMCs, 89-96% for ASCs). This experiment is one part of the basic research, which aims to easily create scaffolds for tissue engineering with subsequent use of stem cells and their subsequent "reorientation" towards the bone cells or smooth muscle cells.

Keywords : poly(L-lactic acid), plasma treatment, surface characterization, cytocompatibility, human osteoblast, rat vascular smooth muscle cells, human stem cells
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