

Topographical Surface Effects on Cell Fate of Adult Human Mesenchymal Stem Cells

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INTRODUCTION: Bone marrow derived mesenchymal stem cells (MSCs) have the potential of self-renewal and can differentiate into various cell types like osteoblasts, chondrocytes and adipocytes. Moreover, they are among the first cells contacting the bone implant surface. The surface topography influences the adhesion, motility, proliferation and differentiation of cells in a cell-type and -state dependent way. This study investigates the effect of defined surface topographies (i.e., hemispheres with a diameter of 30 or 50 μm) on the adhesion, the morphology and the migration and further the effect on cell fate determination of adult human MSCs (HMSC).

METHODS:

Adult HMSCs were isolated from patients obtaining a total hip prosthesis. After the first passage, the cells were either plated at a density of 5000 cells per cm^2 and stained on day 7 (Fig. 2) or directly DiI labeled and plated at a density of 20000 cells per cm^2 and live monitored the following day (Fig. 1). The cells were cultivated in α -MEM plus 10% FCS and 1% antibiotic mixture and investigated using the confocal laser scanning microscope (CLSM). The migration data analysis was done using visiometrics-iPS and -trace software (University of Konstanz, Germany). The structured cell culture dishes were fabricated by injection molding. The unit of the topographies consisted of either hemispheres of 50 μm in diameter and no spacing (50/0) or hemispheres of 30 μm with a spacing of 20 μm (30/20). The surface structures were characterized using scanning electron microscopy.

RESULTS: Adult HMSCs on (30/20) exhibited a significant increased migration velocity compared

to cells on reference (flat) surface (Fig. 1) and cells were predominantly located around and less often on the hemispheres (Fig. 2, B). The cells on (50/0) showed smaller migration capacity (Fig. 1) with cells spanning across the hemispheres (Fig. 2, C). On 50/0 the focal adhesion points were located on the top of the hemispheres and frequently observed in a radial arrangement (Fig. 2, D).

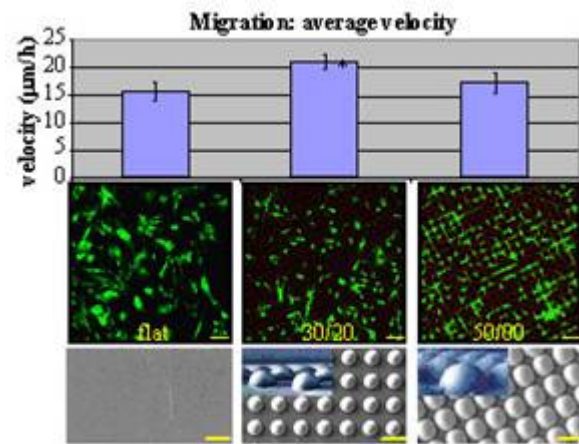


Fig. 1: Migration of adult HMSCs on the different topographies. Bar; 50 μm .

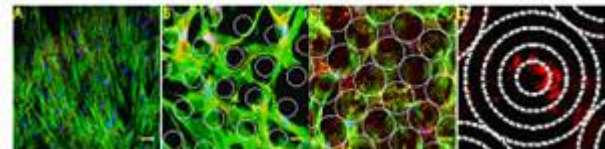


Fig. 2: Adult HMSCs were stained for F-actin (green), focal adhesion point; vinculin (red) and nuclei (blue). (A) flat, (B) 30/20, (C) 50/0. (D) single 50/0 hemisphere. Bar; 20 μm .

DISCUSSION & CONCLUSIONS:

The fact that HMSCs do not spontaneously differentiate [1] rises the possibility to guide this process *via* surface topography. The first results indicate that the surface topography influences the morphology and migration of HMSCs. In further experiments it has to be shown which effects the surface topography have on cell fate determination. The combination of the results may allow in the future the design of newly structured bone implant surfaces for medical applications.

REFERENCES: ¹ Pittenger M.F. et al. (1999). *Multilineage potential of adult human mesenchymal stem cells*, *Science* 284, 143-147.