

Monitoring of Cell Migration on Structured Surfaces

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INTRODUCTION: Cell migration is crucial to technological applications such as tissue engineering and implant surfaces [1]. Regarding bone related implants, like the hip prosthesis and dental implants, the correct interaction between bone marrow cells and implant materials is crucial for their clinical success. An optimal interaction consists in the colonization of the implant surface by the correct cell types and is among others determined by attachment and migration of latter cells. The observation of the cell migration and its analysis may be of key importance in order to understand the mechanisms [2]. In order to monitor cell behaviour over periods of several days, cells had been labelled with a fluorescent dye (DiI) [3]. The monitoring was done with a confocal laser scanning microscope combined with a computer-assisted image analysis software.

METHODS: For the observation of the mobility of the cells on the scaffolds, the cells were stained with a fluorescent lipophilic dye (DiI). For observing the movement of the cells on the scaffolds, the scaffold with the labelled cells was transferred in an incubation chamber, with a cover glass lid, which allowed the on-line observation of the cells on the scaffold. The monitoring was done with a confocal laser scanning microscope. With a heating chamber, which was installed around the microscope, it was possible to maintain a constant temperature of 36.7° C. The movement of the cells was monitored by using a Zeiss Axioplan 2 microscope with a LSM 510 scanning module. For the observation of the cell movement on the scaffolds the Zeiss LSM software Release 2.8 (12/2000) was used. During several days each 15 min. a picture was taken from several previously selected areas of interest. From the obtained pictures the migration pathway (trajectory), cell shape, migration direction and the migration velocity were estimated by special image analysis software developed by Visiometrics (Konstanz, D). Data were further analysed using MS Excel-macros.

RESULTS and DISCUSSION: Cells were seeded on a titanium scaffold with eleven different structures. By that consisting of grooves, and ridges of different width, depth and inter

groove/ridge distances the observation of the cell migration could be monitored on all types of surfaces at the same time. On a plane, non-structured surface no guided migration was observed. The covered trails (trajectories) of the moving cells on the plane surface were random (Fig. 1a). The movement on the structured surfaces was different. The angles of the trajectories on grooved surfaces were quite well orientated along the axes of the grooves (Fig. 1b).

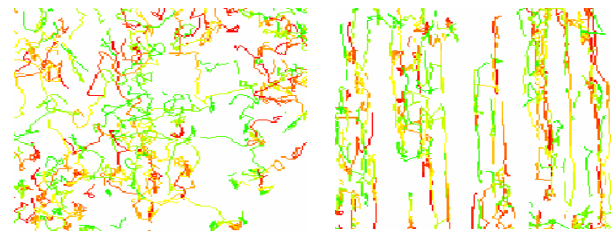


Fig. 1a: The covered trails of moving cells on a plane surface were randomly distributed.

Fig. 1b: The covered trails of migrating cells on a structured surface with deep grooves were following the direction of the grooves.

The analysis of the cell shape revealed that the cells on the non-structured surface were randomly orientated. On grooved surfaces cells were better orientated. Depending from the depths of the grooves around 37 % to 53 % of the cells were orientated parallel to the axes of the grooves, within a variation in the latitude of ± 15 %. It was obvious that the topography on the scaffold surfaces influenced not only cell orientation and the direction of migration, but also the average velocity of the migrating cells in x and y direction. Even the cells on the structured surfaces migrated well orientated in the direction of the grooves, no significant differences in the frequency of the velocities were found between cells plated on the plane and cells plated on the structured surfaces.

REFERENCES: ¹D.A. Lauffenburger and A. Horwitz (1996) *Cell* **84**:359-369. ²K. Webb, V. Hlady and P.A. Tresco (2000) *J. Biomed. Mat. Res.* **49**:362-368. ³J.-P. Kaiser and A. Bruinink (2004) *J. Mater. Sci.: Mater. Med.* **15** 429-435.