MONITORING OF CELL MIGRATION

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INTRODUCTION: Cells contacting an implant are affected by the implant surface. Latter interaction is an important key feature that determines the clinical success of implants. Beside the state of differentiation also the parameters cell shape, cell orientation, migration direction and migration velocity may be affected. Especially the latter two parameters (migration direction and migration velocity) may have consequences for the coverage of the implant by these cells. The monitoring of cell migration and its analysis are of key importance in order to elucidate the mechanisms on which (directed) cell migration is based.

METHODS: Cells (3T3 fibroblasts) were labelled before starting the migration experiments with a fluorescent dye (DiI). The structured surfaces with the labelled cells were placed in a special incubation chamber with a cover glass lid. This chamber allowed the online observations of the migrating cells with a confocal laser scanning microscope (CLSM) under cell culture conditions. Cell migration was monitored for several days by taking a picture each 15 minutes from the same previously selected areas of interest. Based on the obtained sequence of pictures of each cell, the migration pathway (trajectory), cell shape, migration direction and migration velocity were calculated by special image analysis software. Cell migration was analysed on a titanium alloy sample with a plane surface and 10 different micromaschined structures (grooves/ridges). The width of the ridges and grooves as well as the inter ridge/groove distance was in the range of 5 to 40 µm. The structured surfaces can be divided in V-shaped surfaces, U-shaped surfaces and ∩–shaped surfaces. Cell migration was monitored on all types of surfaces at the same time [1, 2].

RESULTS and DISCUSSION: The fibroblast cells were strongly affected by the surface structures and the extent was structure dimension dependently. The frequency of cells with a circular shape was higher on the plane surface, than the amount of cells with circular shape found on the structured surfaces. No significant difference in the frequencies of a certain type of cell shape was found among the different structured surfaces. On structured surfaces the fibroblasts significantly preferred orientating themselves parallel to the axis of the grooves/ridges within a sector ± 10°. Among all structured surfaces, structures with shallow grooves/ridges (5 µm width) and large plane sections between the grooves/ridges exhibited the lowest number of cells orientated parallel to the structures. Cells migrating on the plane surface showed a migration direction respectively migration angle, which was evenly distributed in all directions. Cells, which were seeded on the structured surfaces, migrated preferentially parallel to the grooves/ridges. Switching of tracks was depending on the dimensions of the grooves/ridges but also on the width of the tracks. On larger tracks the cells did not have the tendency to switch the tracks as often as they do, when they migrate on narrow tracks. On the various structured surfaces different mean migration velocities were observed. 3T3 fibroblasts cells migrating on the plane surface were by far not migrating with the lowest velocity. Cells migrating on structures with large plane tracks between the grooves, respectively large flat areas between the ridges exhibited the highest mean migration velocity. Structuring of the surface resulted in an increase in cell migration velocity parallel to the grooves/ridges compared to the overall mean velocity on that certain surface.

REFERENCES: [1] J.-P. Kaiser, A. Reinmann and A. Bruinink (2006) The effect of topographic characteristics on cell migration velocity, *Biomaterials* **27**: 5230-5241.

[2] J.-P. Kaiser and A. Bruinink (2004) Investigating cell – material interactions by monitoring and analysing cell migration, *Journal of Materials Science: Materials in Medicine **15**:* 429-435.