

MONITORING OF CELL MIGRATION ON STRUCTURED SURFACES

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INTRODUCTION: Cell migration plays a key role in normal physiological processes, such as embryogenesis and morphogenesis and disease. Examples are in wound healing migration of fibroblasts and vascular endothelial cells is essential and in bone healing the migration of mesenchymal stem cells and subsequent differentiation into active osteoblasts. Interaction between cells and implant materials contributes hereby or for certain implants is even a prerequisite for the clinical success (Lauffenburger and Horwitz, 1996¹). 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 object of this study was to investigate the migration behavior of cells on differently structured surfaces.

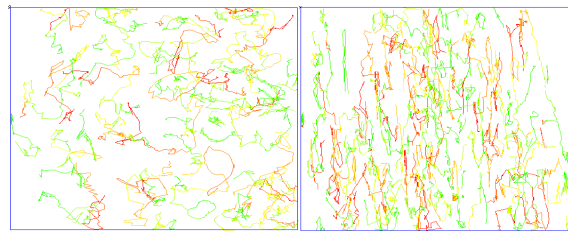
METHODS: For the present studies a fibroblastic cell line (3T3) was used. The movement of fluorescent vital dye (DiI) labeled 3T3 cells was monitored on various surfaces with a confocal laser scanning microscope for two days under cell culture conditions (5% CO₂, 37°C). Each 15 min a picture was taken from previously selected areas of interest. From the obtained pictures the migration pathway and the mean velocity was estimated by special software.

RESULTS: We could show that the vital dye used did not affect cell functionality. Also the CLSM monitoring strategy did not affect the cell migration indicating the correctness of the set-up used to study cell migration on non-transparent surfaces.

On plain surfaces no specific cell orientation in cell shape and migration could be found. On grooved (9.8 µm width, 1.1 µm depth) surfaces the cells oriented themselves along the axes of the grooves. Furthermore, most cells migrated along the grooves. No clearcut orientation of the cells was seen on plain surfaces (Fig. 1).

Computer analysis of each sequence of trajectories (connected line between centres of the same cell in two subsequent pictures) forming the migration pathway of each cell during two days of monitoring, revealed that about 70% of the trajectories were orientated in parallel to the grooves within a variation in the latitude of ±15. The trajectory angle distribution was nearly random on plain surfaces.

The topography on the scaffold surfaces influenced not only cell orientation and the direction of migration, but seem also to influence the average velocity of the migrating cells. On the grooved surface more fibroblast cells exhibited a higher migration velocity.



A

B

Fig. 1: The two pictures show the migration pathways of the cells cultured on a plain (A) and on a grooved surface (B) during the observation period of 2 days. The migration of the cells on the grooved surface was highly oriented in vertical direction along the axes of the grooves.

DISCUSSION & CONCLUSIONS: It is generally accepted that micro topography can influence cell shape, cell adhesion, cell orientation, and cell migration. The reactivity to surface structure and chemistry is known to be partly cell type specific (Duncan et al 2002²) and dependent on the groove depth as reported by Curtis and Wilkinson, 1997³. In our investigations the orientation and migration of the fibroblast cells was determined by the grooves. Beside the direction of migration also the velocity of the cell movement was influenced by the topography. Similar observations were reported by Dunn and Brown, (1986)⁴. The present study revealed that the software used represent a easy but powerful tool to analyze cell migration.

REFERENCES: ¹ Lauffenburger and Horwitz (1996) *Cell* **84**:359-369. ² Duncan et al (2002) *Biosensors and Bioelectronics* **17** 413-426. ³ Curtis and Wilkinson (1997) *Biomaterial* **18** 1573-1583. ⁴ Dunn and Brown (1986) *Journal of Cell Science* **83** 313-340.