BIOMATERIAL MODIFICATIONS AND CELLULAR BEHAVIOR

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Introduction

The first critical course for assessing the suitability of a new biomaterial in medicine is - in addition to the biofunctionality - the compatibility of the biosystem at the site of its effect. Knowledge of the molecular interactions of biomaterial surface modifications – topography and chemistry - with the biosystem is of specific importance. Osteoblasts, important cell type in orthopedic and dental applications, are known to sense the biomaterial surface characteristics [1]. The most central initial process in this cell-material interaction is the mechanical anchoring of the cell to the biomaterial interface – the cellular adhesion (FIG. 1) [2]. The "race for the surface" is decisive for the integration and acceptance of biomaterials [3]. The contacts via adhesion molecules like the integrins lead to modulated cell functions such as signaling events [4]. External signals from physico-chemical environments finally affect the cell physiology [5,6]. Therefore, it is important to study *in vitro* effects of biomaterials on cellular adhesion, the expression and location of the actin cytoskeleton, the expression of signaling molecules and finally cell function markers [5,6]. The understanding and interpretation of the cellular behavior via biophysical *in vitro*-studies is critical for the acceptance of new biomaterial surfaces in medicine.

Materials and Methods

In our field of research, we conducted the *in vitro*-studies on the acceptance and functionality of newly developed biomaterials. In addition to biomaterial tests, we also specifically investigated the influence of a defined topography or chemistry to provide insights in cellular behavior [5,6]. To analyze the cell morphology we used microscopy – scanning electron microscopy (FE-SEM) or confocal laser scanning microscopy (LSM). The flow cytometry was applied for the expression of cellular components or cell cycle regulation. To determine further specific cellular markers and reactions, many techniques are used such as rtPCR, Western-Blot, ELISA or Bio-Plex. The biological characteristics of a range of materials (titanium, silicon, polymers or ceramics) are studied *in vitro* with relevant osteoblast-like cells as well as primary cells in the appropriate media under physiological conditions: 37°C, 5% CO_2 [4-6]. To validate the data we used GraphPad Prism with the corresponding test of significance.

Results and Discussion

Established on our basic research, we were able to demonstrate that a defined surface topography influences the osteoblast behavior: changes in cell morphology, the organization and expression of cellular structures, signaling events and finally also the expression of bone-specific markers. Morphological analyses with FE-SEM as an important parameter revealed the cellular behaviour on biomaterials (FIG. 2). Using LSM we were able to recognize the influence of nano- and microstructures and chemical modifications on the spatial organization of cellular components, e.g. the actin cytoskeleton (FIG. 3). These studies of the cell architecture and physiology are first important steps for assessing cellular behavior at the interface of a biomaterial.

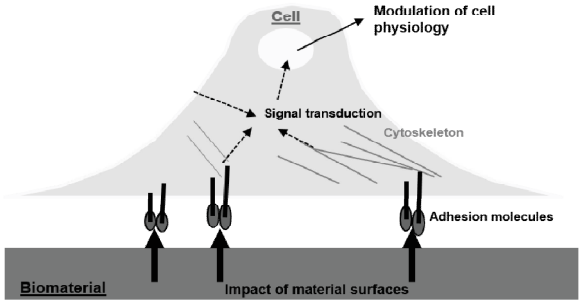

FIG. 1. Scheme of cell-material interaction.

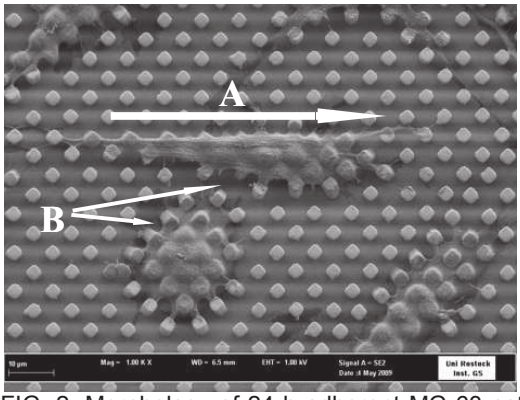

FIG. 2. Morphology of 24 h adherent MG-63 osteoblasts on defined micro pillars (Si-Ti, 3x3x5 µm, W x L x H by RIE; Prof. Kern/Tubingen) (FE-SEM, magnification 1kx, bar 10 µm, Lange/Rostock). Note that cells are elongated and oriented along the structures (A). The cells are able to pull the pillars due to their adhesion strength (B).

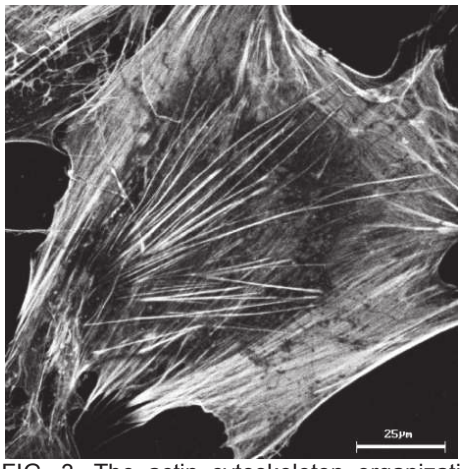

FIG. 3. The actin cytoskeleton organization of primary osteoblasts on the planar surface Si-Ti (LSM410, bar 25 µm). Note the well-defined stress fibers spanning across the entire cell body.

Conclusions

Cell biologic *in vitro*-studies are necessary for a better understanding and assessment of innovative medical materials and their interplay with the surrounding biosystem.

Acknowledgments

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References

[1] J. Rychly & J.B. Nebe, BioNanoMat 14 (2013) 153-60.
[2] K. Anselme, Biomaterials 21 (2000) 667-81.
[3] A. Gristina, Science 237 (1987) 1588-95.
[4] F. Luethen *et al.,* Biomaterials 26 (2005) 2423-40.
[5] C. Moerke *et al.,* Biomaterials 76 (2016) 102-14.
[6] S. Staehlke *et al.,* Biomaterials 46 (2015) 48-57.