THE INFLUENCE OF THE SURFACE TOPOGRAPHY ON THE CELL-DIFFERENTIATION EFFECT

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[ENGINEERING OF BIOMATERIALS 148 (2018) 22]

Introduction

The plasticity of non-embryonic stem cells and their potential to de-differentiate provides new therapeutic strategies in regenerative medicine. Derived from human endothelial cells, differentiated progenitor cells provide reliable, reproducible and physiologically appropriate source of cells for the treatment of vascular disease, atherosclerosis, coronary heart disease, hypertension and inflammatory diseases. The aim of the work was to explore and characterize the influence of defined surface topography of thin haemocompatible thin films (a-C:H) for effective capturing progenitor cells from whole human blood for differentiation into vascular endothelium.

Materials and Methods

200 nm thin a-C:H films (amorphous hydrogenated "diamond-like" carbon) were deposited by magnetron sputtering of a pyrolytic carbon target in ($Ar+C_2H_2$) atmosphere on soft, 1 mm thin thermoplastic polyurethane foil substrates. Homogenous surface topography of the films with uniaxial wave structure was achieved by pre-straining of the foils before deposition and release of the strain afterwards, which leads due to different elastic moduli (E) of substrate and film to the formation of "wrinkles" [1-4].
The interaction of endothelium progenitor cells (i-Cells) with the defined topography, mimicking tissue niches of the ECM was investigated by a VascuLife VEGF Medium Complete Kit (LifeLineCell Technologies, US).

Results and Discussion

The degree of differentiation was tested using anti-CD62E (E-selectin) and anti-CD31 (PECAM-1) antibodies. The results are presented in FIG. 2: PECAM-1 positive cells (yellow) indicate diversification into endothelial cells, E-Selectin (red) leukocyte-endothelial cell adhesion molecules, ZO-1 staining (green) tight intercellular junctions, and blue staining the cell nuclei (FIG. 1).

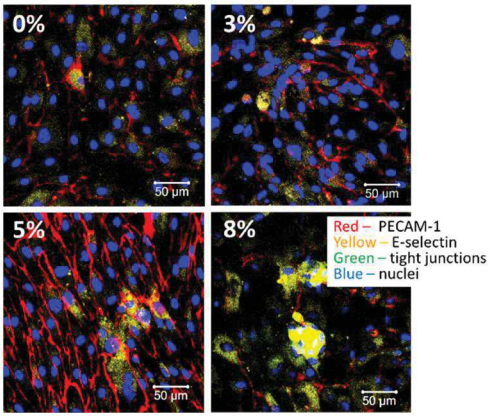

FIG. 1. Degree of differentiation by expression of PECAM1 (red), Selectin-E (yellow), ZO-1 (green) and DAPI (blue, indicating cell nuclei).

As visible, especially the 5% pre-straining result in a very regular network of PECAM-1 expression (leukocyte-endothelial cell adhesion molecules). There is a probability that deformation limit exists between 5% and 8% strain. In the case of the 8% deformation, the degree of cell differentiation and the likelihood of the appropriate cell-cell interactions formation that indicate the cell monolayer creation is weakened.

Conclusions

Summing up, the influence of the surface tomography on the cell-material interaction was observed. The surface tomography could influence on the cell differentiation effect as well as the monolayer formation. Both phenomena could have the significant meaning on potential use of biomaterial in cardiovascular regeneration. At the work, the biomaterial should not come into direct contact with blood. Biomaterial should create an appropriate environment for the self-formation of the endothelium. Endothelium is the natural layer that is able to self-regulate the clotting process. Therefore, the appropriate differentiation of progenitor cells into endothelium and the generation of appropriate cell-cell interactions is crucial. The paper shows the influence of surface topography, adequately formed on the degree of differentiation.

Acknowledgments

The research was financially supported by the Project no. DZP/M-ERA.NET-2014/291/2015 "Nonthrombogenic metal-polymer composites with adaptable micro and macro flexibility for the next generation heart valves in artificial heart devices", funded by FFG and NCBR. Part of this publication was prepared under the project no. 2014/13/B/ST8/04287 "Bio-inspired thin film materials with the controlled contribution of the residual stress in terms of the restoration of stem cells microenvironment" of the Polish National Centre of Science.

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