Dual-layer Scaffolds for Small-caliber Blood Vessel Tissue Engineering


Introduction
Currently, there are no successful artificial small blood vessels for medical use. Methods and materials that have been useful in the surgical repair of large vessels (e.g. synthetic grafts) are non-effective in small vessels, because blood coagulation leads to rapid occlusion of these vessels. This project aims to use a tissue engineering approach to construct a more advanced artificial vessel, that is mechanically similar to a natural blood vessel, and that supports both smooth muscle cells within their natural extracellular matrix and an intact lining of endothelial cells. To this end a novel elastic material will be synthesized and evaluated for the controlled culture of smooth muscle cells and endothelial cells on a porous tubular scaffold in a pulsed bioreactor.

Mechanical Properties
Two thermoplastic elastomers (TPEs) based on the strongly dimerizing UPy moiety were evaluated, consisting of an amorphous polyester chain extended with an UPy bisisocyanate containing a bulky IPDI or a linear HDI spacer. The HDI material shows superior mechanical properties, presumably due to lateral stacking of dimerized UPy moieties, leading to higher stiffness and less plastic deformation on cyclic loading. The AFM data, showing hard blocks in a soft matrix, supports the assumption of lateral stacking (edge is 1 μm).

Cell Compatibility
3T3 mouse fibroblasts were seeded on a cast of the HDI derivative on a glass cover slip. No discernible difference was observed in cell proliferation and adhesion between the polymer film and the glass surface.

Conclusions
These data show that UPy-based thermoplastic elastomers are cell-compatible, can be tailored to a specific (tissue engineering) application, and that it is possible to process them into a porous material. This material can then be employed to construct a functioning dual-layer vascular tissue engineering scaffold. The use of this advanced scaffold, in combination with mechanical and biochemical stimuli, may eventually lead to a significant improvement in the surgical applicability and specifically the in vivo patency of artificial small blood vessels.

References

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