BIOINSPIRED ANISOTROPIC NANOFIBRILLAR MATRICES FOR HEART VALVE ENGINEERING

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One great promise of heart valve tissue engineering, especially for children, is the production from autologous cells of an artificial tissue that can resume proper functionality and growth once implanted. In this context, an important goal is to devise a suitable biomimetic scaffold that supports proper cell-matrix interactions and cell growth by reproducing the specific anisotropic fibrillar structure of valves extracellular matrix (ECM).

The success of a tissue engineered heart valve is dependent on developing the right structure, the right interactions between the cells and the right matrix and mechanical force. Different materials have been used as scaffold to obtain the best result. However there are still problems in terms of long term durability.

Our objective is to evaluate a novel type of highly porous anitoropic nanobrillar matrices with regards to structure, mechanical properties and ability to support human adipose derived stem cell (ADSC) colonization, growth and ECM production in vitro.

Nanofibrillar structures were obtained by jet-spraying poly (ε-caprolactone) dissolved in chloroform on a variably rotating drum. Morphological evaluations of the structures were performed using scanning electron microscopy while porosity was calculated from polymer density, weight and volume.

Polymer spraying on rotating drum allowed the formation of nanofibrillar structures (600 nm in average diameter). While spraying on a static drum resulted in isotropic fibre orientation, increasing drum rotation speed up to 3000 rpm increased significantly fibres alignment. In correlation to fibres anisotropy, the scaffolds Young's modulus was simultaneously increased when measured respectively longitudinally and orthogonally to fibre alignment (figure 1). Interestingly, fibre alignment further increased scaffolds porosity. Rotary seeded matrices resulted initially in cells attached on both scaffold sides but anisotropic matrices allowed a more extensive cellular invasion than isotropic scaffolds, possibly linked to their higher porosity and therefore open structure. Over culture, cells proliferated extensively and bridged the entire scaffolds thicknesses over 10 days. After 18 days, an extensive cellular invasion in all scaffolds type, possibly linked to the high porosity, was evident. Proliferation was up to twice higher within nanofibrillar structures as compared to collagen scaffolds. This study indicates the potential of highly porous anisotropic nanofibrillar matrices as substrate for ADSC in view of tissue formation. In conjunction with their anisotropic mechanical properties, these structures could be of interest for heart valve engineering.