Building Blood Vessel-like Structures using Stem Cell Derived Endothelial Cells

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Cardiovascular diseases are leading cause of morbidity worldwide and a better understanding of their nature is crucially needed. Modelling disease with human blood vessel-like structures would be a more efficient way for drug development than those with animal testing. The aim of my projects was to create three dimensional blood vessel-like structures, by using stem cell-derived endothelial cells and human arterial extracellular matrix (ECM). I have cultured and differentiated human embryonic (hESC) and induced pluripotent stem cells (hIPSC) into endothelial cells (EC). In order to validate efficiency in vitro, I have assessed their markers with immunocytochemistry and gene profiling. Compared to adult cells, they expressed similar pattern for several endothelial markers. HESC-ECs and hiPSC-ECs formed capillary-like tubes on Matrigel. Real-time PCR suggested high expression of endothelial genes in both cell types. In order to build vessel-like structures, I have produced a vascular ECM from slices of vessel walls with an optimised decellularisation. For this, I have used human aortic samples from our clinical Biobank. To recellularise the ECM, cells were cultured in bioreactor under controlled conditions for 18 days. I showed that cells adhered to ECM in vitro. Generated vessel-like constructs were further analyzed by PCR and immunohistochemistry. In summary, hESC- and hIPSC-EC have similar structure as native endothelial cells. My further aims are investigating the function of 3D vascular structures and demonstrate the feasibility of vascular tissue engineering with specific imaging. Tissue engineered vascular grafts would replace in the future some of the old techniques in personalised medicine and in vascular surgery.