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Matrix-Dependent Adhesion of Vascular and Valvular Endothelial Cells in Microfluidic Channels

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Objectives:

Tissue-engineered (TE) valves are commonly endothelialized with vascular endothelial cells (ECs), primarily because of their availability. However, growing evidence suggests that vascular ECs are phenotypically different from valve ECs, particularly when exposed to shear. Therefore, choice of EC type is likely to impact proper endothelialisation, successful implantation and long-term viability of TE valves. Our objective was to characterize morphology and adhesion of two closely-related EC types to different extracellular matrix proteins of various coating concentrations.

Method:

Adhesion properties of primary porcine aortic ECs (PAECs) and valve ECs (PAVECs) were examined in a parallel microfluidic network. Cells were cultured for two hours in microchannels coated with fibronectin (FN) or Type I collagen (Col-I) over a range of coating concentrations. Adhesion properties were characterized by cell spreading area, and by number of cells attached after application of shear at 11, 110, and 220 dyn/cm².

Results:

PAVECs spread more and withstood shear significantly better ($P < 0.01$) on FN than on Col-I for coating concentrations of 100, 200, and 500 ug/mL. Beta1 integrin expression in PAVECs was higher on FN than on Col-I, consistent with the spreading and adhesion data. Between cell types, PAECs spread more ($P < 0.001$) on Col-I at 500 ug/mL compared to PAVECs, but did not display significantly better adhesion.

Conclusions:

Cell adhesion is both cell-type and matrix dependent, suggesting that endothelialization of TE valves and the mechanobiological responses of the ECs are likely influenced significantly by choice of cell type and composition of their underlying matrix.