Engineering Hydrogel Scaffolds for the Culture of Endothelial Cells: Application of Titanium Dioxide Nanoparticles Inhibits Proliferation

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Currently, endothelial cells are cultured in vitro on matrigels: expensive and difficult to synthesize protein mixtures derived from Engelbreth-Hoth-Swarm mouse sarcoma cells. Inexpensive viable alternatives to matrigels that can act as scaffolds and exhibit viscoelastic, biodegradable, and biocompatible properties, are sought. In our study, hydrogels were engineered by enzymatically cross-linking a gelatin matrix with microbial Transglutaminase (mTG), allowing the gelatin to be thermally stable and resistant at physiological temperatures. Through rheology, the shear stress resistance (i.e. elastic modulus) of the hydrogels was determined. Analysis of the elastic moduli of hydrogels of varying mTG to gelatin ratios revealed that the 1:25 ratio gel had the greatest and most stable elastic modulus. Using the hydrogels of 1:25 mTG to gelatin ratio as scaffold, the proliferation of endothelial cells was examined. Preliminary capillary formation suggested that the engineered hydrogels were biocompatible.The effects of rutile and anatase TiO2 nanoparticles on the proliferation of endothelial cells were examined and compared. Results showed that rutile weakened the actin fibers of the endothelial cells and consequently lessened cell to cell contact. In contrast, anatase lysed the endothelial cells and inhibited any cell function. This study shows that enzymatically cross-linked hydrogels can effectively promote proliferation of endothelial cells. Moreover, TiO2 nanoparticles can stifle development of these cells.