An optimized procedure to develop a 3-dimensional microfluidic hydrogel with parallel transport networks

The development of microfluidic hydrogels is an attractive method to generate continuous perfusion, induce vascularization, increase solute delivery, and ultimately improve cell viability. However, the transport processes in many in vitro studies still have not been realized completely. To address this problem, we have developed a microchanneled hydrogel with different collagen type I concentrations of 1, 2, and 3 wt% and assessed its physical properties and obtained diffusion coefficient of nutrient within the hydrogel. It is well known that microchannel geometry has critical role in maintaining stable perfusion rate. Therefore, in this study, a computational modeling was applied to simulate the 3D microfluidic hydrogel and study the effect of geometric parameters such as microchannel diameters and their distance on the nutrient diffusion. The simulation results showed that the sample with 3 channels with a diameter of 300 μm has adequate diffusion rates and efficiency (56%). Moreover, this system provides easy control and continuous perfusion rate during 5 days of cell culturing. The simulation results were compared with experimental data, and a good correlation was observed for nutrient profiles and cell viability across the hydrogel.

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