Microporous biopolymer cell carriers prepared by microfluidic device for tissue engineering

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Statement of Purpose: Microspheres have been regarded as a promising carrier of cells because of their injectability and large surface area. In our previous works, porous poly(caprolactone) (PCL) microsphere was developed using camphene as a pore generating material [1, 2]. Microfludic system is a versatile technology that can be used as platforms for microfabrication [3]. In this study, size-controllable microporous PCL spheres were fabricated using the microfluidic device.

Methods: Polydimethylsiloxane (PDMS) chip was prepared by soft-lithography method. In the PDMS chip a mixture solution of PCL and camphene and the aqueous PVA solution were introduced as sample and sheath flows, respectively. The pore size and diameter of the microsphere were tuned by controlling the camphene content and sheath flow rate, while the concentration of PCL and the sample flow rate were fixed. The synthesized microspheres were then solidified, washed with distilled water and freeze-dried, successively. The pore size and diameter distribution of the microspheres were evaluated by optical or electron microscopy images. Preliminary study of cell culture onto the microspheres was also conducted.

Results: The relationship between the microsphere size and the sheath flow rate was examined using pure PCL composition. The pure PCL microspheres generated using microfluidic system showed spherical shapes and excellent uniformity in diameter. The size of the pure PCL microsphere decreased with increasing sheath flow rate. After solidifying the microsphere, the size of the microspheres decreased by 45%, while maintaining the uniformity in diameter. The microstructure of the PCL microsphere was significantly influenced by camphene content in the initial mixture solution. The average size of the solidified microspheres increased with increasing the camphene content. It was notable that the size distribution of PCL microsphere was still monodisperse, regardless of camphene content. Furthermore the micropore channels were formed on the microspheres when the camphene was incorporated, and the size of the micropores also increased with increasing camphene content. The initial cell growth study on the microporous spheres showed good cell viability and the possible use as cell carriers.

Conclusion: Porous PCL microspheres with monodisperse size distribution were fabricated by using camphene and microfluidic system. The microstructures of the PCL microsphere, such as sphere size and the pore structure were easily tuned by adjusting the camphene content or sheath flow rate. This porous microsphere system would be potentially applicable as cell carriers for tissue engineering.

References:

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