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Fabrication of Tube-Typed Scaffold Using 3D Bioprinting and Electrospinning

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Extended Abstract

3D bioprinting is known widely for tissue engineering and regenerative medicine as implantable scaffold. Especially, it is a highly contested area of technological innovation. Fabricating biological constructs using 3D bioprinting technology can attach cells onto a biocompatible scaffold through interconnected pores of layer-by-layer process to generate tissue-like three-dimensional structures. Nanofibers by electrospinning can obtain large volume area for cell attachment. To fabricate a scaffold architecture mimicking morphological and mechanically that of a blood vessel, tube-typed scaffold was performed using a rotating drum of 3D printing with 4-axes and a collector of electrospinning. Recently, some researchers demonstrated the merits of artificial blood vessel composed of chitosan blended with synthetic polycaprolactone (PCL). In this study, we fabricated tube-typed scaffold for artificial vascular systems using 3D printing and electrospinning. Printed PCL can enhance the physical strength of the artificial vessel made by electrospun chitosan.

We divided into 3 groups; chitosan nanofiber with PCL strand, chitosan/PCL blended nanofiber with PCL strand, and PCL nanofiber with PCL strand. Surface chemical properties of tube-typed scaffold were characterized by Fourier transform infrared spectroscopy (FT-IR). The structural and mechanical properties of the scaffolds were examined using scanning electron microscopy (SEM) and tensile testing. Hydrophilicity of tube-typed scaffold was measured by contact angle and water absorption. In PCL nanofiber, C-H and ester carbonyl group peaks were represented at 2938 cm^{-1} and 1724 cm^{-1}, respectively. The chitosan blended with PCL (9:1) nanofiber showed a peak both amide bond I of chitosan and ester carbonyl group of PCL. These results indicate that chitosan and PCL were well blended in the chitosan/PCL nanofiber. In SEM results, 3D PCL strand was plotted layer-by-layer onto nanofiber. PCL strand size and space of strand to strand showed 300 um and 1200 um, respectively. We confirmed that chitosan nanofiber has good hydrophilicity through contact angle measurement. The contact angle is closely related to an amount of water uptake. The ultimate tensile stress of pure chitosan nanofiber was considerably lower than chitosan nanofiber covered with PCL strand, and chitosan/PCL nanofiber was also much lower compared with chitosan nanofiber covered with PCL strand.

The findings suggest the feasibility of printing and electrospinning to design scaffolds with a hierarchical organization through a layer-by-layer process and control of nanofiber. The tube-typed conduit presents appropriate characteristics to be considered a candidate scaffold for blood vessel tissue engineering.

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