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Fabrication of Bioresorbable Flow-diverting Stents by 3D printing

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Introduction:

Flow-diverting stent (or flow diverter) is a promising medical device to treat aneurysms. Most of the stents are fabricated by braiding technology. However, it is not easy to tune the structure (pore size and pore density) of the stent and braid it with fine fiber diameters. In this context, a flow-diverting stent is proposed to be printed by an advanced 3D printing technology, termed melt electrowriting (MEW), enabling scientists to print fiber-based scaffolds with fiber diameters in ranges of 3 to 50 μm. In this report, a rotating collector for a MEW device was designed and set up to produce the stents, and the printability was also investigated.

Experimental:

A home-built MEW device is applied to print stents (Fig.1). Medical-grade polycaprolactone (PCL) (PC-12, Corbion, Netherlands) is used for the printing process. The printing parameters include a mandrel with 3 mm in diameter, 25G nozzle, 5.3 kV applied voltage, 88 °C print temperature, 0.15 MPa air pressure, and 4 mm/s print speed. The room temperature was controlled at 22 ~ 24 °C, and the relative humidity was controlled at 34 ~ 36%.

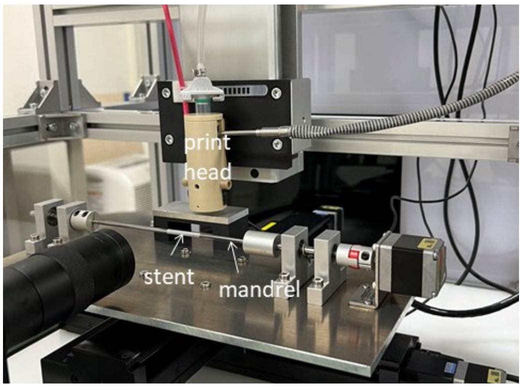

Fig.1 A home-made electrowriting device.

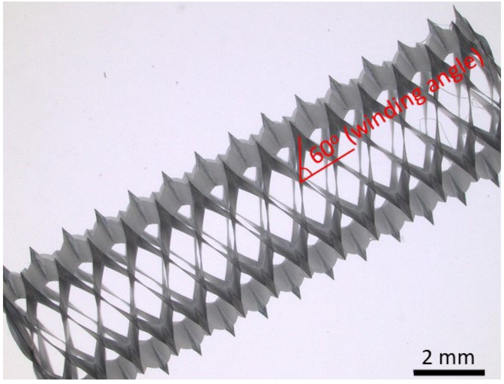

Fig.2 A PCL stent made by melt electrowriting.

Results and Discussion:

PCL stents have been successfully printed out by the home-made electrowriting device. For example, Fig.2 shows a stent with a winding angle of 60°, and the number of pivot points of 10. The pivot point is the cross point at the ends of the stent, which is related to the diameter of the mandrel, the length of the stent, and the winding angle. The winding angle is determined by the rotational speed and the translational speed of the mandrel. As a result, stents with various winding angles (30°, 45°, 60°) and the number of pivot points (6, 8, 10) were fabricated. These two parameters further determine the pore size and the porosities of the stent, which are the crucial indexes of evaluating the flow-diverting stents.

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