Preparation of multifuctional nanofibrous scaffold for tissue engineering

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Statement of Purpose: In tissue regeneration, nutrient, oxygen and biomolecule distribution in the microenvironment surrounding cells is important to convey proper cues for cells to maintain the phenotypic function. Local release of multiple or specific biomolecules to selected cell types are desirable approach in regulating tissue formation [1]. Nanofibrous scaffold fabricated by electrospinning is demonstrated favorable for cell function due to the geometrical similarity as extracellular matrix fibrils [2]. This study was aimed to incorporate multiple bioactive molecules into nanofibers and fabricate multifunctional scaffolds for tissue engineering.

Methods: Poly (epsilon-caprolactone) (PCL, Mw=80,000, Sigma) with biocompatibility and degradability [3] was used as the base materials for nanofibers. Bovine serum albumin (BSA) labeled with fluorescein isothiocyanate (FITC) and calf skin collagen I were used as biomolecule models. PCL (8 wt%) mixture solutions containing different collagen, and/or BSA were prepared and electrospun into nanofibers (power= 10 kv, 10 cm for the distance between spinneret and collecting plate, flow rate=10 μL/min). The distribution of BSA in PCL nanofibers was examined with fluorescence microscope, and the BSA release profile was monitored by measuring BSA amount in the supernatant of extraction. Human dermal fibroblasts (passage 6 to 7) were used to test the function of formed scaffolds.

Results/Discussion:

PCL solution containing different amount of BSA (BSA/PCL,1:60 to 1:600) and different amount collagen I (Coll/PCL, 1:1 to 1:3) were successfully electrospun into fibers. The inclusion of BSA or collagen resulted in a reduction of fiber diameter compared to pure PCL fibers. Homogeneous distribution of BSA in the electrospun fibers was confirmed by using FITC-labeled BSA (inset of Fig1). Rapid release of BSA from PCL nanofibers was observed but continuous release retained even after 24 hours (Fig 1). Rapid released BSA is most likely those located on the surface of nanofibers and continuously released BSA is from the inside of the nanofibers. Accumulative release of BSA reached its plateau at about 8 hours and remained the same for rest of the experimental time. By designating the solution used and electrospinning sequence, scaffolds with multi-functionality and varied distribution of bioactive molecules was formed (Fig 2). Cell culture study showed that human dermal fibroblasts had a preferential attachment to collagen-containing nanofibers. This indicates selective cell adhesion targeting release to specific cell type can be achieved by proper scaffold functionality.

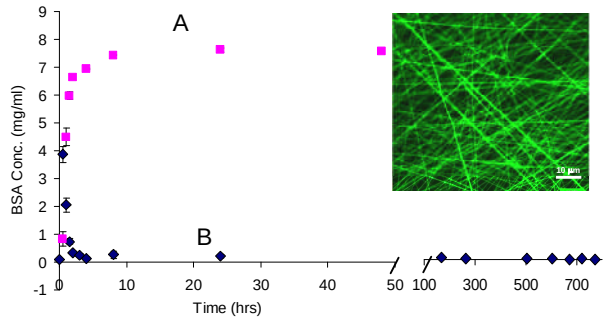

Figure 1. Release profile of BSA from BSA/PCL nanofibers. A, acculative release; B, continuous release. Inset, fluorescence image of electrospun BSA/PCL fibers.

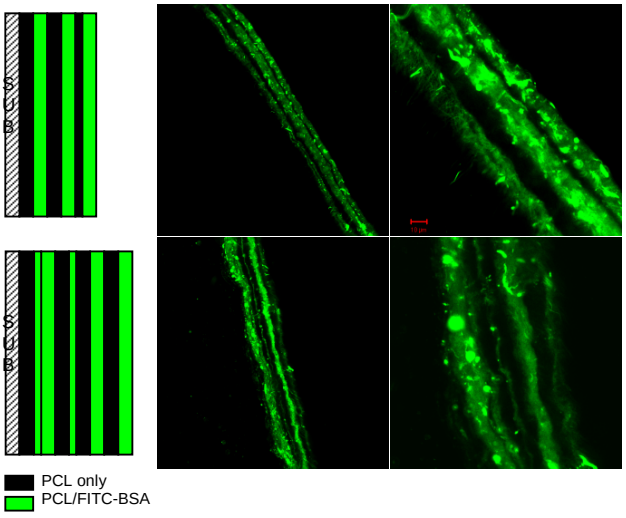

Figure 2. Fluorescence images of multifunctional scaffolds preparation by electrospinning followed the designed deposition sequence. Right panel is high magnification (63x) of middle one (10x). BSA as amodel protein.

Conclusions: Obtained results clearly indicate the feasibility of producing scaffolds with diverse functionality and distribution across the scaffold using electrospinning approach. Ongoing studies are focus on the incorporation of different growth factors and programmed release.

References:

[1]. Wei G, et al. J Control Release. 2006;112:103-10.
[2]. Wei G and Ma PX J Biomed Mater Res A. 2006; 78: 306-15.
[3]. Jiang G, et al. Biomaterials. 2005; 26:2281-8.