An Investigation on Surface Topographies of Materials on Biological Behaviors of Cells

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Statement of Purpose: This study investigates the effect of Surface Topographies and structures of fabricated fibers on the biological behaviors of Human Umbilical Vein Endothelial cells (HUVEC) for better understanding of interactions of cells with nanodimensional materials. Such information would have important implications to create surface topographies and structures which have been found to have several applications in the tissue engineering.

Methods: Poly (glycolic acid) (PGA) and collagen. (PGA/collagen) fibers at different diameters of 10 μm, 3-5 μm and 500 nm at PGA/collagen weight mixing ratio of 7%, 18%, 40%, 67% and 86% were fabricated through the electrospinning technique to evaluate the effect of diameter of PGA/collagen fibers on the cell viability and adhesion. The amount of Intergrin α_v, Collagen I, vascular endothelial growth factor (VEGF) receptor, and CD44 were detected by two dimensions electrophoresis and electrophoresis of PCR.

Results/Discussion: Scanning electron microscopy (SEM) observation revealed that the PGA/collagen fibers exhibited homogenous long fibers, irrespective of the PGA/collagen weight mixing ratio. When HUVEC were seeded on the PGA/collagen fibers with different diameters and compositions, larger number of cells attached was observed in the fibers with smaller diameter compared with those fabricated with medium and bigger diameter. The morphology of the cells attached became more spread with a decrease in the fiber diameter. The highest affinity of cell adhesion was observed in the PGA/collagen fibers with diameter of 500 nm and PGA/collagen weight mixing ratio of 40%. Figure 1-A shows SEM observation of PGA/collagen fibers fabricated with eletrospinning device which operated at flow rate of 10ml/h, 23kV power supply and PGA concentration of 40 %. Distribution of HUVEC attached to and proliferated in PGA/collagen fibers 24h after cell seeding are shown in figure 1-B. The amount of Intergrin α_v, Collagen I, and vascular endothelial growth factor (VEGF) receptor were detected by two dimensions electrophoresis and electrophoresis of PCR. HUVEC attached and proliferated homogeneously on PGA/collagen nano-fibers 24h after cell seeding. Significantly increase in integrin α_v gene expression was observed in PGA/collagen fiber with diameter between 3 to 5 μm and PGA/collagen fibers with diameter smaller than 1 μm compared with PGA fiber/collagen fibers with the diameter bigger than 10 μm. After 3 days incubation of cells in PGA/collagen fibers, significantly increase in VEGF expression was observed for PGA/collagen fibers with diameter between 3 to 5 μm. VEGF expression increases slowly with incubation time in PGA/collagen fibers with diameter smaller than 1 μm.

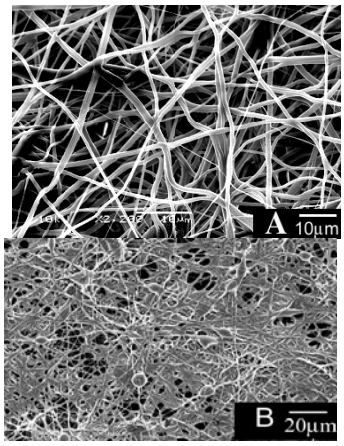

Figure 1. SEM of PGA/collagen nano-fiber with mean diameter of 500 nm (A) and HUVEC attached to PGA/collagen nano-fiber 24 hr after cell seeding (B).

Conclusions: We indicated that nano-structured fibers materials can increase the ECM protein and may control the growth factor, which are suitable for application in tissue engineering. These findings suggest that the nano-structured PGA/collagen fibers can be used as biomimetic nano-fibers toward achieving excellent integration between cells and scaffolds for tissue engineering applications.