Bio-airway Research Offering New Concepts in Health (BRONCH) Partnership – Developing Novel Scaffolds for Airway Engineering

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RATIONALE. In the future, functional copies of human organs may be grown using tissue engineering techniques. Organ replicas would benefit *in vitro* experiments as they would have increased human physiological relevance compared to cell monocultures or animals. Electrospinning uses a high electrical potential difference to generate nanofibres of biocompatible materials such as gelatin, collagen or polyethylene oxide (PEO). Electrospun tissue scaffolds have been shown to support cell survival and can be remodeled by resident cells into a close approximation of human tissue. However, fibroblasts seeded onto such scaffolds typically do not migrate deeper than 50 microns, which places considerable limits on the variety and complexity of the resulting tissue replicas. We examined a potential method to increase the size and number of inter-fibre pores in electrospun scaffolds to increase fibroblast migration depth. We hypothesized that for a thin layer of scaffold, a mesh-like patterned collecting surface used in the electrospinning process would alter the deposition pattern of the electrospun nanofibres, increasing pore size.
METHODS. A variety of different copper meshes were used as collector surfaces during electrospinning of 20% gelatin scaffolds. Glutaraldehyde-fixed tissue scaffolds were stained with eosin, and imaged using 3-dimensional laser-scanning confocal, multi-photon, and transmission electron microscopy (TEM) techniques. Mean fibre diameter and inter-fibre distance (pore size) were calculated using all three imaging modalities.
RESULTS. A correlation between collector mesh-size and scaffold inter-fibre distance was observed away from the conducting surfaces of the collector mesh. A mesh size of 60x60 holes/inch^2 produced a scaffold with mean fibre diameter of 0.55 microns (SD ±0.43) and a mean inter-fibre distance of 1.1 microns (SD ±0.40). A larger mesh size of 12x12 holes/inch^2 produced a scaffold with mean fibre diameter of 0.50 microns (SD ±0.45) and mean inter-fibre distance of 3.0 microns (SD ±2.6). Intermediate mesh sizes produced scaffolds with intermediate inter-fibre distances.
CONCLUSIONS. Solid-surface collectors for electrospinning produce biocompatible and biomodifiable scaffolds, but a small inter-fibre distance prevents fibroblast penetration into the scaffold. We show that electrospinning onto mesh-like collecting surfaces results in a scaffold with varied pore size and increased inter-fibre distance at areas away from the conducting surfaces of the wire grid. Mesh-like collectors may thus improve the performance of 3-D electrospun scaffolds by allowing increased fibroblast penetration.