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Fibroblast Compatibility of Core-Shell Coaxially Electrospun Hybrid Poly(ε-Caprolactone)/Chitosan Scaffolds

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Abstract : Tissue engineering is the field of treating defects caused by injuries, trauma or acute/chronic diseases by using artificial scaffolds that mimic the extracellular matrix (ECM), the natural biological support for the tissues and cells within the body. The main aspects of a successful artificial scaffold are (i) large surface area in order to provide multiple anchorage points for cells to attach, (ii) suitable porosity in order to achieve 3 dimensional growth of the cells within the scaffold as well as proper transport of nutrition, biosignals and waste and (iii) physical, chemical and biological compatibility of the material in order to obtain viability throughout the healing process. By hybrid scaffolds where two or more different materials were combined with advanced fabrication techniques into complex structures, it is possible to combine the advantages of individual materials into one single structure while eliminating the disadvantages of each. Adding this to the complex structure provided by advanced fabrication techniques enables obtaining the desired aspects of a successful artificial tissue scaffold. In this study, fibroblast compatibility of poly(ε-caprolactone) (PCL)/chitosan core-shell electrospun hybrid scaffolds with proper mechanical, chemical and physical properties successfully developed in our previous study was investigated. Standard 7-day cell culture was carried out with L929 fibroblast cell line. The viability of the cells cultured with the scaffolds was monitored with 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) viability assay for every 48 h starting with 24 h after the initial seeding. In this assay, blank commercial tissue culture polystyrene (TCPS) Petri dishes, single electrospun PCL and single electrospun chitosan mats were used as control in order to compare and contrast the performance of the hybrid scaffolds. The adhesion, proliferation, spread and growth of the cells on/within the scaffolds were observed visually on the 3rd and the 7th days of the culture period with confocal laser scanning microscopy (CSLM) and scanning electron microscopy (SEM). The viability assay showed that the hybrid scaffolds caused no toxicity for fibroblast cells and provided a steady increase in cell viability, effectively doubling the cell density for every 48 h for the course of 7 days, as compared to TCPS, single electrospun PCL or chitosan mats. The cell viability on the hybrid scaffold was ~2 fold better compared to TCPS because of its 3D ECM-like structure compared to 2D flat surface of commercially cell compatible TCPS, and the performance was ~2 fold and ~10 fold better compared to single PCL and single chitosan mats, respectively, even though both fabricated similarly with electrospinning as non-woven fibrous structures, because single PCL and chitosan mats were either too hydrophobic or too hydrophilic to maintain cell attachment points. The viability results were verified with visual images obtained with CSLM and SEM, in which cells found to achieve characteristic spindle-like fibroblast shape and spread on the surface as well within the pores successfully at high densities.

Keywords : chitosan, core-shell, fibroblast, electrospinning, PCL
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