The Summer Undergraduate Research Fellowship (SURF) Symposium
7 August 2014
Purdue University, West Lafayette, Indiana, USA

Design and Fabrication of a Novel Electrospinning System for Musculoskeletal Tissue Regeneration

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ABSTRACT

Disease and injury to human tissue, especially musculoskeletal tissue, is a prevalent concern to the public, affecting millions of people each year. Current treatment options involving autografts and allografts are hindered by limited availability and risk of immunogenicity, respectively. In order to overcome these limitations, a transdisiplinary regenerative engineering strategy has emerged with a focus on the development of biomimetic scaffolds that closely mimic the properties of the native tissues. For example, the structure of muscle tissue is characterized by oriented muscle fibers. However, fabrication of aligned nanofiber structures that mimic the anisotropic organization of muscle presents significant engineering challenges. The objective of this project is to engineer a novel precision fabrication system based on electrospinning for generation of highly aligned fiber scaffolds for muscle regeneration. Our system was based on a custom-made rotating collector made of parallel metal blades to combine the advantages of both the mechanical and electrical forces for fiber alignment. Solutions of widely investigated degradable polyesters were spun under optimized electrospinning conditions to produce aligned fibers in between the parallel blades. Fiber alignment and average fiber diameter were determined by microscopy in combination with ImageJ software. Our study demonstrated the potential of using this novel rotating collector to produce aligned polymeric scaffolds in an effective and controllable manner. Future in vitro and in vivo studies will be performed to optimize the scaffold properties and determine cellular response to these scaffolds for muscle regeneration.

KEYWORDS

Muscle regeneration, scaffolds, regenerative engineering, electrospinning, satellite cells