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In Vitro Biocompatibility of a Compliant, Blood Compatible, and Biodegradable Nanofibrous Scaffold for Vascular Tissue Engineering

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ABSTRACT

A vascular scaffold must not only support appropriate structural integrity until neotissue can form, but also closely mimic the strength and compliance of native blood vessels. Hemocompatibility is also clearly a crucial factor to raise success of the engineered construct since the vascular scaffold comes in contact with blood. The degradation profile of the scaffold is another important criterion to consider for successful applications in tissue engineering of load-bearing structures like blood vessel tissues. A tissue-engineered vascular graft requires complete scaffold degradation with well-defined cellular organization and tissue remodeling.

To cover all these required features, we carried out the blend electrospinning to fabricate nanofibers of poly(L-lactide acid-co-poly ε-caprolactone) (PLCL), a biodegradable and compliant polymer, gelatin (Gel), a biodegradable and commercially available natural biopolymer possessing many integrin binding sites (such as RGD) for cell adhesion, and Tecophilic (TP), a hydrophilic, elastic and hemocompatible polyether-based thermoplastic aliphatic polyurethane, with a weight ratio of 60:20:20 (PGT;60/20/20) resulted in creation of a compliant, hemocompatible and biodegradable scaffold. The nanofibrous structure of the scaffold was visualized using a scanning electron microscope (SEM). The surface characterization of scaffold was carried out using ATR-FTIR spectroscopic analysis. For evaluating the potential of electrospun PGT;60/20/20 scaffold as a substrate for vascular regeneration, we cultured human aortic smooth muscle cells (SMCs) on the scaffold and studied the biocompatibility of the structure by performing the proliferation assay and cell morphology assessment.

SEM images demonstrated that electrospun PGT;60/20/20 nanofibers were successfully produced with a fiber diameter of 459±198 nm which revealed a significant reduction compared to fiber diameter of electrospun pure PLCL and pure TP. ATR-FTIR analysis confirms the presence of all components within the fibers. Comparing the behavior of SMCs on PGT;60/20/20 scaffolds with that on electrospun PLCL and TP scaffolds confirmed the potential use of PGT;60/20/20 nanofibers in blood vessel tissue engineering.

Keywords: vascular tissue engineering, electrospinning, nanofibers, smooth muscle cells

1. INTRODUCTION

The rational design of a scaffold depends on its ability to mimic the native extracellular matrix (ECM) as much as possible in terms of physical, chemical, and mechanical features. Development of an optimal scaffold plays a significant role in vascular tissue engineering. Bioengineered scaffolds serve as the temporary matrix and provide structural, mechanical, and biological support throughout the tissue formation assisting the process of tissue remodeling [1]. Among the numerous techniques used to fabricate scaffolds, electrospinning has been widely used because of the high porosity, large surface area, and nanofibrous structure of electrospun scaffolds mimicking the physical nano features of native ECM [2].