567a Electrospun Degradable Segmented Polyurethane Elastomers for Ligament Tissue Engineering

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Roughly 100,000 surgeries are performed annually in the US to repair ruptured or torn anterior cruciate ligaments. Although the patellar tendon and hamstring tendon are considered the gold standard for tissue reconstruction, they create a second injury site with its associated pain and risk of donor site morbidity and tissue atrophy. Concurrently, synthetic fibrous materials – designed to permit tissue ingrowth – suffer from stress shielding, which inhibits formation of oriented collagen fibrils and ultimately fails under cyclic load. An ex vivo tissue engineering approach to develop a material suitable for ACL replacement involves the seeding of ligament progenitor cells on an oriented fiber mesh. Through control of culture conditions and application of uniaxial stretch, the cells can be directed to proliferate, differentiate, and deposit an oriented extracellular matrix rich in type I and III collagens which, when implanted, will stimulate integration with adjacent bone, recruitment of host progenitor cells, and normal tissue remodeling.

We are currently developing high modulus, degradable, segmented polyurethanes that are composed of hexamethylene diisocyanate (HDI), para-aminobenzoate (PABA), propanediol (PDO), and polyester macrodiol soft segments. By control of the macrodiol content we can regulate microphase separation and hard segment percolation and produce a family of materials with different mechanical properties. Concurrently, we are electrospinning these polymers to form fused fiber meshes with micron-diameter fibers. This fiber diameter is ideal for regulating cell adhesion and spreading through a contact guidance mechanism. Finally, we are culturing bone marrow stromal (ligament progenitor) cells on the electrospun meshes and characterizing the effects of fiber diameter and orientation on cell morphology, proliferation, and matrix deposition.

We present preliminary results demonstrating that we can control the diameter and degree of orientation of electrospun polyurethane fibers, and that electrospun substrates alter cell spreading, orientation, and the expression of extracellular matrix proteins.