535b A New Paradigm in Tendon Tissue Engineering

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Tendons are inelastic collagenous anatomical tissues that connect muscles to bone. They possess high tensile strength but have poor intrinsic healing capabilities. Most tendon injuries result in the degeneration and morphological alteration of collagen fibers. The exact causes of collagen degeneration are still not very well understood. Tendon injuries affect several individuals yearly and in many cases prevent participation in daily activities and work capabilities. According to a recent study done by Achilles tendon.com, in the year 2002 there were an estimated 232,000 Achilles tendon sports injuries in the U.S. for individuals aged six and over. Out of the total injuries 109,000 prevented sports participation for up to one month, and 57,000 prevented participation for at least one month. The Bureau of Labor Statistics documented 44,504 injuries from tendinosis and/or carpal tunnel syndrome in the private industry in 1999. According to the same source, 57,420 total workers in the US suffered from repetitive motion disorders in 2003, out of which 7,730 were tendonitis. Workers suffering from tendonitis lost, on an average, 11 days of work. In an effort to understand the behavior of tendons under stress conditions, extensive research has been conducted on the effect of dynamic mechanical loading on the morphological and mechanical properties of collagen fibrils and collagen seeded scaffolds. It has been shown that dynamic mechanical loading increases the cellularity of collagen scaffolds and enhances their mechanical and morphological properties. In our study, we attempted to develop a tissue engineered tendon model using decellularized veins as scaffolds. We hypothesized that culturing the seeded veins under cyclic mechanical loading conditions would enhance the fibroblasts to assume a tendon-like morphology and mechanical characteristics. Veins extracted from umbilical cords were used as scaffolds for seeding fibroblastic cells. The veins were initially decellularized in 1% sodium dodecyl sulfate (SDS) and then dehydrated in 75% ethanol. Thus, the vein-model scaffold used was primarily composed of type I collagen, the most abundant protein in tendons. Decellularized veins were then flipped inside out so that the smooth basement membrane was on the outside, and the type I collagen matrix on the inside. The rough surface composed of type I collagen would be more appealing for fibroblastic cells to attach to and migrate within, rather than the smooth endothelial basement membrane composed primarily of types IV and XVIII collagen. The vein scaffolds were then injected with type I collagen along with fibroblastic cells under sterile conditions and cultured for periods of one and two weeks. A bioreactor was designed to apply cyclic loading on seeded vein scaffolds under sterile conditions. Statically cultured samples were used as controls. Samples from two time frames, 1 week and 2 weeks, were tested for tensile strength and cellularity. In addition morphology of collagen fibers and fibroblasts was studied in regards to the collagen gel itself, and the walls of the decellularized vein. Results were compared to the statically cultured controls.