

Evaluation of Graft Pretension Effects in Anterior Cruciate Ligament Reconstruction: A Series of In Vitro and In Vivo Experiments

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(ABSTRACT)

The purpose of this dissertation was to study the effects of graft pretension in anterior cruciate ligament (ACL) reconstruction through a series of experiments. First, an in vitro study of 5 human knees was conducted to determine if intact joint kinematics could be restored when using the ideal graft—the intrinsic ACL. The ACL tibial insertion site was freed, and pretensions of 0, 10, 20, 30, and 40 N were applied to the ligament using a custom designed load cell connection. Kinematics during a simulated active extension were compared to those of the intact knee. Intact knee kinematics were not restored. Pretensions that best restored tibial anterior/posterior translation and internal/external rotation ranged from 0-40 N. Furthermore, the pretensions that best restored these kinematic variables were widely disparate in two specimens. Second, the in vitro kinematics during a simulated active extension of human and porcine knees were compared and contrasted both prior to and following transection of the ACL. The ACL limited: (1) tibial anterior translation in both species, (2) tibial internal rotation in humans, and (3) tibial external rotation in pigs. Differences in kinematic patterns for tibial internal/external rotation and abduction/adduction between the species was explained by requirements for biped and quadruped stances. Third, the mechanical characteristics of porcine patellar tendon (PT) were investigated by uniaxial tensile testing at two strain rates. Patella-PT-tibia complexes from freshly sacrificed skeletally immature and mature animals were loaded to failure at elongation rates of 20 and 200 mm/min. Both strain rate and skeletal maturity significantly affected failure mode, tangent modulus, and ultimate stress of the tendons, and hence are important considerations in the mechanical evaluation of porcine PT. Fourth, ACL reconstructions were performed using pretensions of 10 or 20 N in an in vivo porcine model with a specially designed load cell/telemetry system to monitor graft load. Graft pretension was seen to increase during fixation with interference screws. Following sacrifice at 4 weeks, tissues were mechanically, histologically, and biochemically analyzed. A pretension of 20 N resulted in a tissue more similar to the intrinsic ACL.

Dedication

Connections slowly emerge. Like distant landmarks you are approaching, cause and effect begin to align themselves, draw closer together. Experiences too indefinite of outline in themselves to be recognized for themselves connect and are identified in larger shape. And suddenly a light is thrown back, as when your train makes a curve, showing that there has been a mountain of meaning rising behind you on the way you've come, is rising there still, proven now through retrospect.

—Eudora Welty in *One Writer's Beginnings*

This work is dedicated to my friends and family, past and present, as my connections emerge.

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