THE EFFECTS OF INITIAL GRAFT TENSION ON ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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INTRODUCTION:
Disruption of the anterior cruciate ligament (ACL) is a common injury that usually requires surgical reconstruction to restore function and prevent the progression of post-traumatic osteoarthritis. However, clinical studies suggest that the outcome of the procedure is highly variable, and that cartilage deterioration progresses in many of these patients (1). It has been hypothesized that the initial tension applied to the graft at the time of surgical fixation (the “initial graft tension”) affects knee joint kinematics and the distribution and magnitude of the articular contact stress, factors thought to promote osteoarthritis. However, the influence of initial graft tension on knee joint kinematics remains unclear (2, 3, 4).

The objective of this study was to determine if initial graft tension affects knee kinematics over time (during healing). Two commonly used “laxity-based” graft-tensioning techniques were evaluated: one in which the laxity of the tibiofemoral joint is over-constrained at the time of surgery in an effort to compensate for any graft stretching that may occur during healing, while the other was designed to restore normal knee laxity at the time of surgery in order to prevent the graft from stretching over time.

METHODS:
The data utilized in this post-hoc analysis were obtained from two prospective studies of ACL reconstruction: one comparing the outcome of patellar tendon grafts to hamstring tendon grafts (5), and the other evaluating post-operative rehabilitation (6). The Institutional Review Board approved the studies, and all subjects granted their informed consent. All patients included in the analysis underwent ACL reconstruction using an autogenous bone-patellar tendon-bone graft. In the former study, the patients who underwent ACL reconstruction using patellar tendon grafts were tensioned to produce anterior-posterior (A-P) knee laxity values that were less than the contra-lateral, normal knee.

These patients represented the “high-tension” treatment group in the current analysis. The initial graft tension was set with the knee at 30° of flexion, and the tensile load applied to the graft was adjusted such that the A-P laxity of the knee was less than the contra-lateral, ACL-intact knee. In the other patient set, those who underwent ACL reconstruction with patellar tendon grafts were tensioned such that the intra-tibial laxity matched that of the contra-lateral, ACL-intact knee. The tensioning procedure was performed with the knee at full extension. These patients comprised the “low-tension” treatment group. In both treatment groups, the operative techniques other than initial graft tension (i.e. surgeon, graft type, intra-articular graft placement, and fixation) were equivalent. A total of 28 subjects were included in the high-tension group (mean age = 29; 15 male/13 female; time between injury and surgery = 109 days), while 22 subjects (mean age = 32.6; 11 male/11 female; time between injury and surgery = 108 days) were included in the low-tension group.

The A-P laxity values of the injured and contra-lateral ACL-intact knees were measured using the KT-1000 (MedMetric Corp, San Diego CA). A-P laxity was defined as the A-P translation of the tibia relative to the femur between the A-P shear limits of +/- 90 N. The A-P laxity measurements were performed pre-operatively, intra-operatively, and at multiple follow-up periods for a minimum of 24-months. The A-P laxity data were analyzed as the difference between the injured and contra-lateral knee. A repeated measures analysis of variance was performed to compare the differences in A-P laxity between the two initial graft tension conditions across time. Pair-wise comparisons at each time point were performed using Fisher’s Least Significant Difference.

RESULTS:
Pre-operatively, the mean laxity differences (reconstructed – control knee) with respect to time.

DISCUSSION:
It was determined that the initial graft tension influenced knee kinematics following ACL reconstruction with patellar tendon grafts. This finding is contrary to two clinical studies that previously used a “tension-based” approach (i.e. 20 N versus 40 N; 25 N versus 50 N) to set the initial graft tension conditions using bone-patellar tendon-bone grafts (3, 4). However, none of the tension-based conditions that were evaluated produced a difference in knee laxity immediately following surgery. The limitations associated with the “tension-based” approach are that the initial graft tension required to restore normal A-P laxity varies across subjects, and that the force differential may be obscured due to frictional losses at the graft-bone tunnel interface, or lost during the graft fixation procedure. By utilizing a “laxity-based” approach, it is possible to produce a detectable difference in the initial tension conditions immediately following surgery, and therefore, the effect of initial graft tension after healing can be clinically evaluated. When using a “laxity-based” approach, it can be assumed that the tension applied to the graft in an effort to recreate normal A-P laxity is less than that required to over-constrain the joint for any knee under study, hence the terminology of “high versus low-tension".

Although patients were prospectively recruited within each of the treatment groups, the initial tension conditions were not randomized. Thus, a selection bias may have confounded our findings. Even though initial graft tension produced changes in A-P laxity during healing, it remains unknown whether or not an initial tension condition that restores normal knee kinematics or that over-constrains the tibiofemoral joint at the time of surgery will eliminate, or at least slow, the progression of post-traumatic osteoarthritis. Prospective randomized clinical trials are needed to assess these long-term effects.

REFERENCES:

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