In Vivo Kinematics of Anterior Cruciate Ligament Reconstruction with Lateral Extra Articular Tenodesis During Downhill Running

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Introduction

Background
- Rotatory instability after ACL reconstruction (ACLR) can impair clinical outcomes1,2.
- The anterolateral complex provides rotary stability, and extra articular surgery in combination with ACLR has been proposed3,4.
- However, the extra articular surgery may over-constrain the knee joint5 and induce lateral compartment osteoarthritis6. Adding this surgery remains controversial.

Aim
- To compare tibiofemoral kinematics after ACLR alone versus ACLR plus lateral extra articular tenodesis (ACLR+LET) during dynamic activities.

Hypothesis
- The side-to-side-difference (SSD) of tibial rotation and anterior translation relative to the femur will be less after ACLR+LET in comparison to ACLR-alone.

Methods

Subjects: 20 patients provided informed consent in this IRB-approved study and were randomized during surgery to receive ACLR or ACLR+LET.
- 10 patients (5 subjects in each group) have completed 6-month post-surgical kinematic testing (average age: 20.5 ± 7.4 years, 4F/6M).
- Kinematics of contralateral unaffected knee served as the control.
- Inclusion: a quantitative pivot-shift > 6 mm lateral translation or > 10 m/sec² tibial acceleration.
- Surgery: ACLR: anatomical single bundle; LET: Modified Lameire’s technique.

Data Collection

- Participants performed three trials of downhill running (self-selected speed: average 2.0 m/s) on an instrumented treadmill while synchronized biplane radiographs were collected at 150 images/s over the first 40% of the gait cycle. (B) Bilateral knee CT scans were collected and used to create 3D bone models. (D) Patient-specific 3D bone models were created. (E) 3D knee kinematics were determined using a validated CT model-based tracking process7. (F) Knee translations were calculated from femur origin to tibia origin and knee rotations were calculated using standard methods8.

Data Analysis
- The primary outcome variables were anterior tibial translation (ATT) and tibial rotation (TR) over the initial 40% of the gait cycle.
- Non-paired t-test compared the SSD of kinematic values between ACLR and ACLR+LET at each 10% of the gait cycle.
- Changes in the SSD among each 10% gait cycle were identified by using repeated measured ANOVA (post-hoc test: Tukey test).
- P-value ≤ 0.05 was defined as statistically significant.

Results

- The SSD in ATT was greater in ACLR+LET patients compared with ACLR patients. This difference was significant at 0% of the gait cycle (p = 0.029, Figure 2A).
- No differences in TR were found between ACLR and ACLR+LET (Figure 2B).
- SSD in ATT and TR did not change over the first 40% of gait cycle.

Discussion

Main Finding
- ACLR+LET reduced the ATT, compared with ACLR, only at foot strike.
- The SDD of 3 to 4 mm in ATT was not statistically significant, but potentially clinically significant.
- This finding agrees with a previous in vivo study which showed LET reduced anteroposterior tibial translation9.
- On the contrary, our result disagrees with a previous cadaveric study which showed LET was not associated with the ATT5, and a clinical study using Lachman test that showed LET restored normal ATT10.
- Strength of the Study: This randomized study measured in vivo knee kinematics during a dynamic functional activity.
- Limitations: The relatively small sample size and evaluation at only 6-months post-surgery. These will be addressed by testing the remainder of the enrolled patients at 6-months post-surgery and all patients at 1-year follow-up.

Clinical Significance
- At six months post-surgery, concomitant extra articular surgery with ACLR appears to restrict the anterior tibial translation in comparison to ACLR.
- Decreased anterior tibial translation after LET may affect graft healing during early rehabilitation.

References