E-Poster #46
Increased Anterior Cruciate Ligament Graft Strain with Lateral Meniscus Posterior Root Tears

William J. Uffmann III, MD;¹Neal S. ElAttrache, MD;¹Trevor Nelson, BS;²Samuel Eberlein, BS;²Juntian Wang³, MD; Daniel Howard, MD;²Melodie Metzger, PhD²

Cedars-Sinai Kerlan-Jobe Institute
Disclosure Information

Grant/Research Support
• This study was funded by Arthrex, Inc.
• Dr. ElAttrache receives research support from Arthrex

Speaker’s Bureau
• Dr. ElAttrache, Arthrex

Consultant
• Dr. ElAttrache is a Consultant for Arthrex

Other
• Dr. Elattrache receives IP royalties from Arthrex
Objectives of the Study

- Determine whether LM posterior root tears lead to increased strain across reconstructed ACL grafts
- Determine if subsequent root repair effectively decreases graft strain to its pre-torn level

Hypotheses:
- Injuring the root complex will significantly destabilize the knee and significantly increase the strain across the reconstructed ACL graft
- Root repair would restore kinematics and strain to pre-torn levels.
Materials and Methods

- 12 fresh-frozen cadaveric knees tested in these states:
  - Intact
  - ACL Reconstruction with Intact Lateral Root and MFL
  - ACL Reconstruction with sectioned Root and MFL
  - ACL Reconstruction with Repair Lateral Root

- Each state tested as follows
  - Displacement and rotation of the tibia and ACL graft strain recorded at 0, 15, 30, 60, 90 degrees of flexion
    1. 88 N anterior drawer
    2. 5 N-m IR
    3. 5 N-m ER
    4. Simulated Pivot Shift (5 N-m IR and 7 N-m Valgus at 0, 15, 30)

- ACLR using BTB autograft (10x25 mm bone blocks 100 mm length)
  - Femur:
    - 10 x 30 mm tunnel
    - 7x20 metal interference
  - Tibia
    - 10 x 40 mm tunnel
    - 9x25 mm metal interference

- Open, hyper flexed drilling
- DVRT (strain gauge) placed in graft mid-substance
Testing Apparatus
Illustration of an ACL reconstructed right knee demonstrating: (A) sectioned lateral meniscal root and meniscofemoral ligament, (B) passing of repair sutures, (C) completed repair.
A repeated measures one-way ANOVA adjusted for multiple comparisons using Dunnett’s multiple comparison test was performed to compare each state. Individual variance was computed for each state.

IR, ER, Pivot Shift, AP translation were compared at each angle as follows:

- Intact vs. ACLR
- Intact vs. ACLR with root tear
- Intact vs. ACLR with root repair
- ACLR vs. root tear
- ACLR vs. ACLR with root repair
- ACLR with root tear vs. ACLR with root repair

Statistical significance set at $P = 0.05$. 
Results: Anterior Tibial Translation

Average anterior tibial translation (±SD) as a function of knee flexion angle. Note: * denotes a P < 0.05 when compared to the intact state, + denotes a P < 0.05 when compared to the ACLR state (Anterior cruciate ligament reconstruction).
Results: Internal Rotation

*Average (±SD) internal rotation as a function of knee flexion. Note: * denotes a P < 0.05 when compared to the intact state, + denotes a P < 0.05 when compared to the ACLR state (Anterior cruciate ligament reconstruction).
Results: Pivot Shift

Average (± SD) anterior tibial translation measured during simulated pivot shift at 0, 15, and 30° of flexion. Note: + denotes p < 0.05 when compared to ACLR (Anterior Cruciate Ligament Reconstruction).
Results:
Strain

Average (±SD) ACL graft strain measured during (A) anterior tibial loading, (B) internal torque, and (C) simulated pivot shift loading as a function of knee flexion. * indicates p < 0.05 and ** indicates p < 0.01, ACLR = Anterior cruciate ligament reconstruction.
Kinematics:
- Sectioning the MFL and PLMR significantly destabilized the knee at 30 degrees
  - Increased IR at 30 degrees ACLR vs. ACLR with root tear
  - Increased ATT at 30 degrees ACLR vs. ACLR with root tear
  - Increased combined ATT with pivot shift at 30 degrees ACLR vs ACLR with root tear
- Similar to prior studies
- Small kinematic gains with repair ~ 0.5mm

Strain:
- As expected ACL strain was increased at low flexion angles:
  - IR loading at 30 comparing ACLR vs. ACLR with root tear
  - Anterior loading at 15 and 30
  - With Pivot shift at 15 and trend toward 30 degrees
- Strain data/values in accordance with literature
  - Increases in strain near 2% (<Δ5%)
• Repair:
  • Able to restore kinematics to intact PLMR/MFL state
  • Able to restore strain to intact PLMR/MFL state with IR and simulated pivot at 15, 30
  • Unable to restore strain to intact PLMR/MFL state under simulated Lachman at 15 and 30 degrees
• Repair better modified excess strain 2/2 rotational load
  • Perhaps speaks to a stronger role in preventing internal rotation
• Repair:
  • Able to restore kinematics to intact PLMR/MFL state
  • Able to restore strain to intact PLMR/MFL state with IR and simulated pivot at 15, 30
  • Unable to restore strain to intact PLMR/MFL state under simulated Lachman at 15 and 30 degrees

• Repair better modified excess strain 2/2 rotational load
  • Perhaps speaks to a stronger role in preventing internal rotation
• Injury to the lateral meniscus posterior root complex places excess strain across the reconstructed ACL graft.
• Posterior root repair better normalizes strain secondary to rotational loading when compared to translational loading.
• This study provides further evidence to support transtibial pullout root repair given the protective role of the posterior root of the lateral meniscus and excess ACL graft strain.
- Injury to the lateral meniscus posterior root complex places excess strain across the reconstructed ACL graft.
- Posterior root repair better normalizes strain secondary to rotational loading when compared to translational loading.
- This study provides further evidence to support transtibial pullout root repair given the protective role of the posterior root of the lateral meniscus and excess ACL graft strain.

**Conclusion and Clinical Significance**


