Lateral Extra-articular Tenodesis Increasingly Protects ACL Graft at Higher Posterior Tibial Slopes in a Laxity-Calibrated Knee Model

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ISAKOS CONGRESS 2025 | MUNICH GERMANY June 8–11

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Disclosures

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- Kyle Borque
  - Paid Consultant for Xiros
    Support received from Xiros

- Walter Lowe
  - Arthrex, Inc: Paid consultant; Paid presenter or speaker
    DJ Orthopaedics: Paid consultant

Background and Purpose

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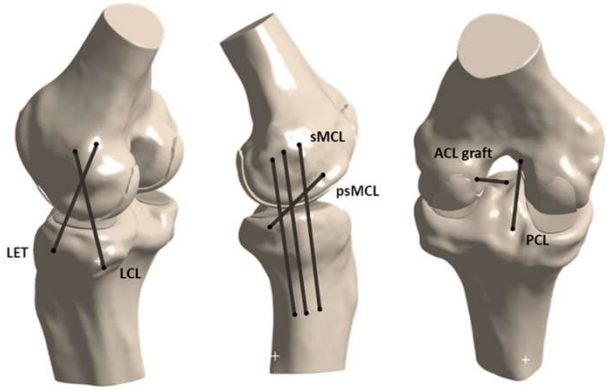
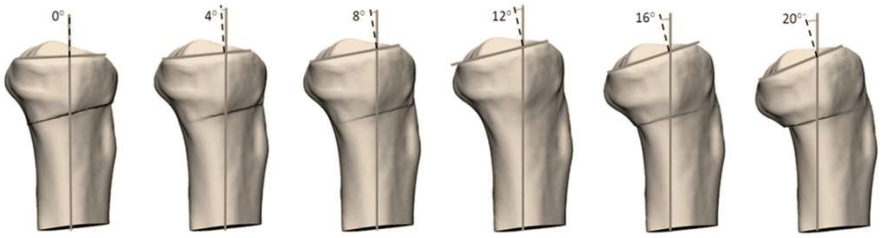
- The addition of a lateral extra-articular tenodesis (LET) at the time of anterior cruciate ligament reconstruction (ACLR) reduces ACL graft forces.
- LET has been shown to lower the risk of ACL graft rupture in patients who are at high risk due to
  - young age, elevated tibial slope, high grade laxity, participation in pivoting sports
- However, it is unknown whether the effectiveness of LET in patients with increasing posterior tibial slope (PTS) may plateau or drop-off at a threshold slope value.

The purpose of this study was to evaluate how increasing posterior tibial slope alters the protective effect of a LET on ACL graft force during pivot shift and anterior drawer tests.

Methods

- 18 finite element knee models derived from cadaveric specimen
  - Intact ACL
  - ACL reconstruction
  - ACL reconstruction with LET
  - All conditions modeled at 6 levels of PTS from 0° to 20°





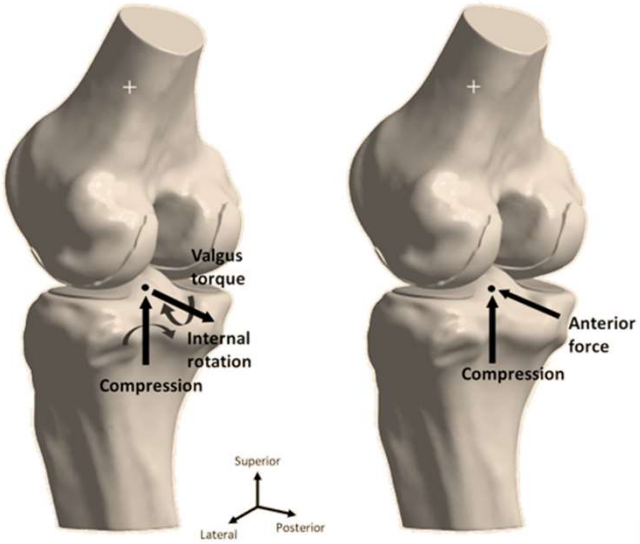
- CT scans, motion envelope, soft-tissue attachments collected to personalize models
- Rotational knee laxity equalized across models (< 3 deg)
- Ligament and graft materials modeled as nonlinear springs

Methods

- Simulated modified Lemaire LET surgery
  - LET attached 5 mm posterior and proximal to LCL origin and to Gerdy's tubercle
  - Knee flexed to 30 degrees
  - ACLR was tensioned to 20 N, then LET was tensioned to 20 N

PTS	ACLR pretension	LET pretension
0	12.7	20.5
4	14.3	20.3
8	11.7	20.2
12	13.3	19.8
16	9.0	19,8
20	12.9	19.9

Methods

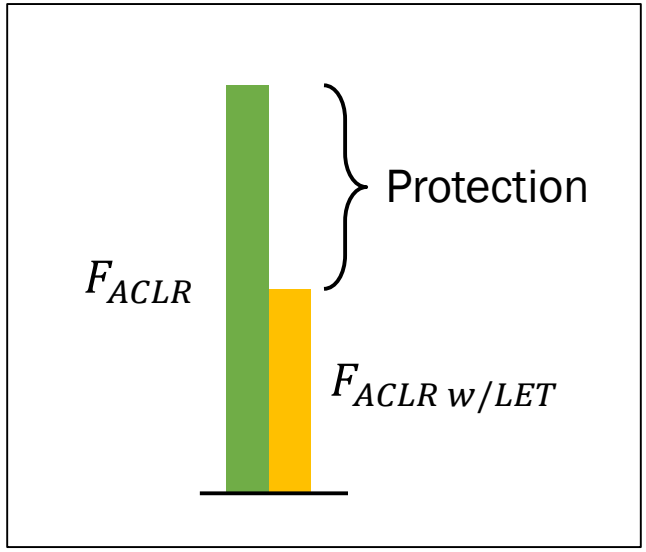


- Pivot shift
  - Simulated by applying 5 N·m valgus and 3 N·m internal rotation moments to the proximal tibia at 30° flexion.
- Modified anterior drawer
  - Simulated by 710 N compressive force and an anterior force on the tibia, loading the ACL graft to 75% of its tensile failure limit
- Force measurement
  - ACL, ACLR, and ACLR with LET forces at each tibial slope condition
  - Medial and lateral contact forces
- Statistics
  - Wilcoxon signed-rank test ($p<0.05$)

Methods

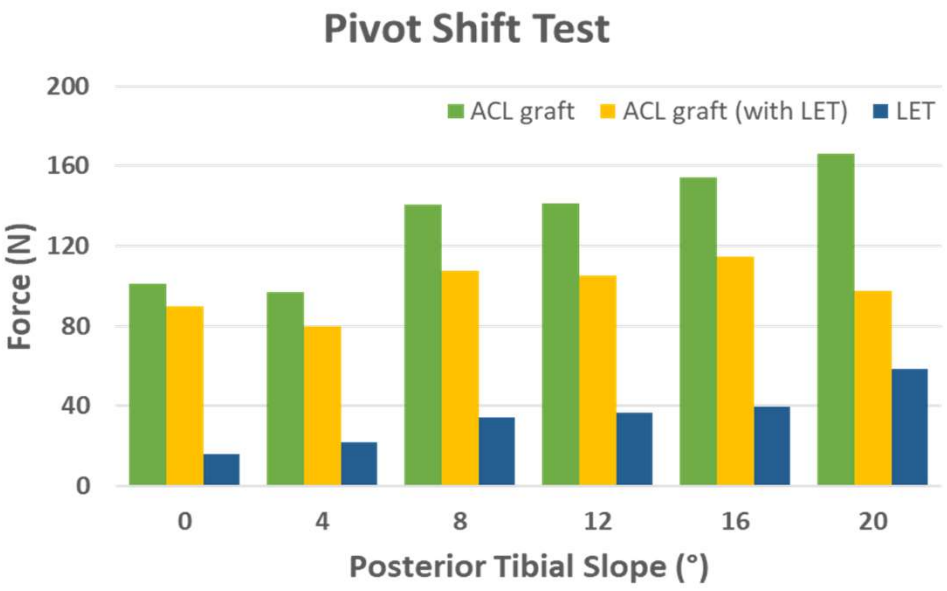
- Graft protection
  - Change in graft force after LET relative to graft force without LET

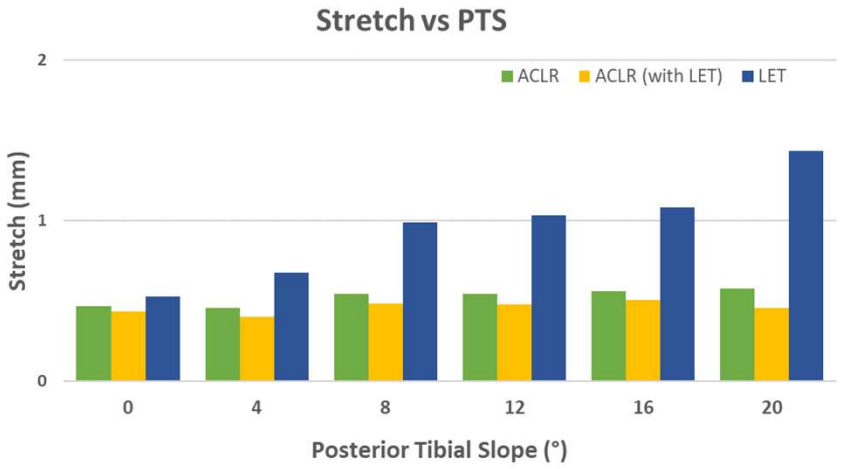
$$\text{Protection (\%)} = \frac{F_{ACLR\ w/LET} - F_{ACLR}}{F_{ACLR}} \times 100$$



Results

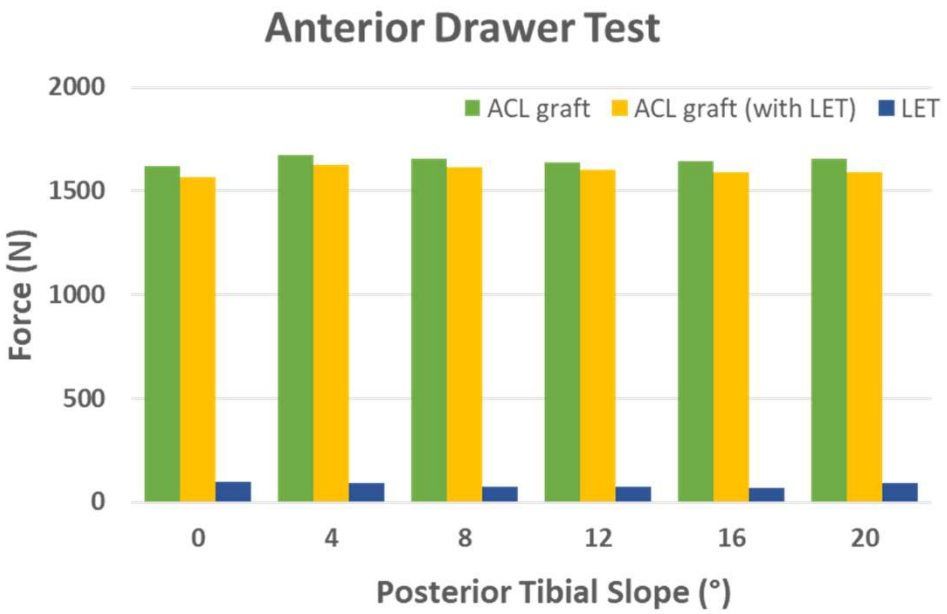
- Pivot shift
  - LET decreased forces on ACL graft at all slopes
  - Protective effect of LET increased with more PTS
  - LET force increased from 18.0% to 60.4% of ACLR graft force
  - LET stretch increased with PTS while ACL graft did not





Results

- Anterior drawer
  - LET marginally decreased forces on ACL graft at all slopes
  - Protective effect of LET not affected by PTS
  - LET force was 5.2% of ACLR graft force



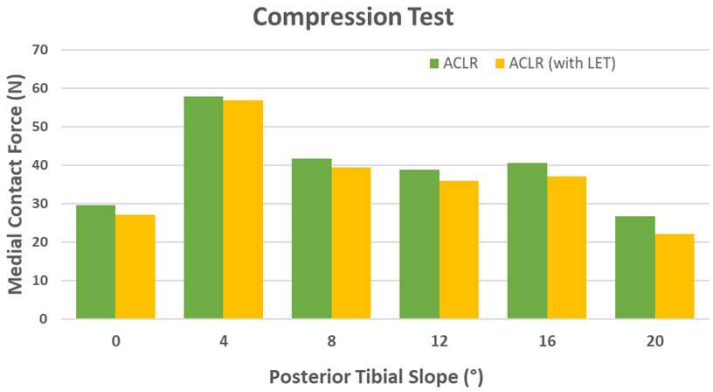
Results

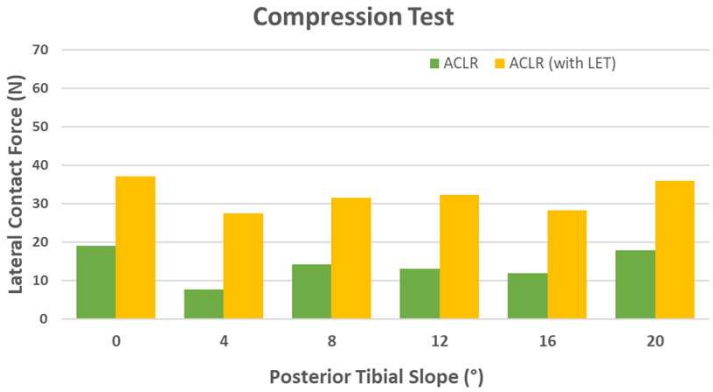
- The average protective effect of LET was greater during simulated pivoting.

	ACL Graft Protection (%)	
PTS	Pivot shift	Anterior drawer
0	11.2	3.5
4	17.9	2.8
8	23.4	2.5
12	25.4	2.3
16	25.6	3.1
20	41.3	3.8
Average	24.1 ± 10	3.0 ± 0.6

Results

- Average lateral contact force across all PTS were increased by 18.1 N after LET ($p < 0.03$); no difference in medial contact force
  - 20 N applied compression
  - ACLR and LET tensioned to 20 N
  - Ligament pretension





* Significantly different from ACLR condition

Conclusion

- Indications for when LET should be added are still being examined.
- One cadaveric investigation reported low effectiveness of LET
  - Pearce et al. reported 8.3% protection independent of PTS
- Clinical investigations report high effectiveness of LET in setting of increased PTS
  - Firth et al. reported risk reduction between 50% and 67% for graft failure
- <u>Findings from current study mirror the results from clinical study!</u>
  - Protective effect varies between 11% and 41% depending on PTS
  - Primary mechanism may be additional LET stretch at increasing PTS
  - Laxity-controlled investigations may be important when determining benefit

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