Introduction

- Previous research has failed to analyze in vivo kinematics of isolated anterior cruciate ligament reconstruction (ACLR) versus ACLR plus meniscus injury\(^1,2\).
- Aim: assess the effect of concomitant meniscus injury on knee kinematics in patients undergoing ACLR.
- Hypothesis: (1) Anatomic ACLR in the absence of meniscus injury restores native knee kinematics, and (2) Anatomic ACLR in the presence of medial meniscus injury results in altered knee kinematics.

Methods

**Kinematics Testing 24 months post-ACLR Groups**

- ACLR +/- meniscus pathology (49 Subjects)
- Isolated ACLR (24 Subjects)
- ACLR + medial meniscus tear (11 Subjects)
- ACLR + lateral meniscus tear (9 Subjects)
- ACLR + bilateral meniscus tears (5 Subjects)

**Data Acquisition**

- Dynamic biplane radiography (150 frames/s, 1 ms pulse duration)
- 6-degree-of-freedom tibiofemoral kinematics during downhill running at 2.5 m/s on a 10° downhill slope
- Volumetric model-based tracking process (previously validated in vivo\(^2\)) used to determine bone motion (Figure 1)
- Bilateral high resolution (0.31 x 0.31 x 0.6 mm voxels) computed tomography (CT) scans used to create anatomic coordinate systems and 3D models
- Average kinematics (3 trials) of footstrike through push-off collected for each knee
- Initial single-support phase of the gait cycle (0-10%) analyzed

**Figure 1**

- Left: Subject performing downhill running within the DSX system
- Middle: The volumetric model-based tracking process used to determine bone motion
- Right: Anatomic tibiofemoral coordinate systems to assess translation and rotation

**Statistics**

- Kruskal-Wallis tests (non-parametric ANOVA) + post-hoc exact Wilcoxon rank-sum test with Benjamini Hochberg P value adjustments for multiple comparisons
- Side-to-side knee differences in kinematics
  - Wilcoxon signed rank test for paired non-normal data for each meniscus group
  - Cohen’s D effect sizes for each difference
  - Effect size thresholds: 0.2, 0.5, and 0.8 :: small, medium, and large magnitude, respectively\(^4\)

Results

<table>
<thead>
<tr>
<th>Meniscal Tear Characteristics and Management</th>
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<tr>
<td><strong>Meniscus Status</strong></td>
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<td>Isolated Lateral Meniscal Tear</td>
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<th>Kruskal-Wallis Results Assessing Interactions Among Meniscus Status Groups</th>
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<td><strong>Kinematics Measurement</strong></td>
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<td>P Value</td>
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**Figure 2**

Anterior tibial translation in ACLR and contralateral knees. Shaded zone indicates SEM for each group either above (ACLR knee group) or below (contralateral knee group) the mean.

- Significant Kinematics Interaction: Anterior tibial translation (ATT) (p = 0.007)
- Significant Between Groups Differences in ATT:
  - Intact menisci vs medial meniscus tears (p = 0.036)
  - Medial meniscus vs lateral meniscus tears (p = 0.025)
- Within Group ACLR vs Contralateral Knee ATT Differences:
  - Intact menisci: (mean ± Standard Error of the Mean (SEM)): 13.1 ± 0.7 mm vs 12.6 ± 0.5 mm; p = 0.15; Cohen’s D: 0.147; n = 24 (Figure 2A)
  - Medial meniscus tears: (15.4 ± 1.0 mm versus 13.2 ± 1.0 mm; p = 0.024; Cohen’s D: 0.658; n = 11) (Figure 2B)

Discussion

- Isolated ACLR in the absence of meniscal injury demonstrated no significant difference from native knee kinematics 24 months after surgery
- Associated medial meniscus injury in the setting of ACLR leads to increased ATT

References and Acknowledgement

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