

Biomechanical Evaluation of a Novel, All-Inside Posterior Medial Meniscal Root Repair via Fixation to the Posterior Cruciate Ligament

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Disclosures: None

INTRODUCTION: Biomechanical literature has aimed to understand the effect of posterior meniscal root tears on knee health and biomechanics. It has been concluded in recent studies that meniscal root tears significantly compromise the knee joint loading as a result of meniscal extrusion and the consequential increased tibiofemoral contact pressures [1]. To repair the meniscal root, the intact meniscus functionality must also be recreated. Repairing the root exclusively could minimize common adverse effects seen with traditional treatments including meniscectomy or non-operative management of meniscal root tear. The purpose of this study was to investigate a novel, all-inside posterior medial meniscal root repair technique via suture fixation to the posterior cruciate ligament (PCL) to determine this novel approach's ability to restore tibiofemoral contact mechanics. The restorative ability was assessed by comparing the tibiofemoral contact mechanics of an intact knee and a knee with a meniscal root tear with that of the repaired construct.

METHODS: Utilizing pressure sensors, tibiofemoral contact mechanics were evaluated in 8 human cadaveric knee specimens (4 male, 4 female, average age: 47.75±, range 44-49 years). Three testing conditions related to the posterior medial meniscal root were applied to each knee specimen: (1) intact knee; (2) root tear; and (3) novel repair method (Figure 1). The following three variables: contact area, mean contact pressure, and peak contact pressure, were measured and calculated by loading each knee with a 1000-N axial compressive force at 4 knee flexion angles (0°, 30°, 60°, 90°) for each testing condition. A linear model with a Tukey-Kramer Adjusted Least Square Means test was used to determine differences within all testing conditions.

RESULTS: Contact area: Knees under the root tear testing condition had reduced contact area compared to intact knees at all flexion angles. The overall mean was 26.3% reduction in contact area with root tear (vs. intact, p=0.0002). Contact area increased above intact values at all knee flexion angles, except for 0° when the repair condition was employed. The repair provided an overall mean of 3.2% reduction (vs. intact, p = 0.443). The 31.6% increase between overall mean contact area from root tear to repair was significant (p= 0.0297) (Table 1).

Contact pressure: Across all knee flexion angles with the root tear condition present, the contact pressure increased with an overall mean increase of 24.3% (vs. intact, p< 0.0001). The repair decreased contact pressure below intact values at all knee flexion angles except for 0°. The overall mean decreased with repair was 5.2% (vs. intact, p= 0.6960). Contact pressure decreases were demonstrated from root tear to repair at all knee flexion angles. The overall contact pressure mean decrease of 31.1% from root tear to repair was significant (p= 0.0037).

Peak contact pressure: Under the root tear condition, peak contact pressure was increased at all knee flexion angles except for 90°, resulting in an overall peak contact pressure mean increase of 10.6% (vs. intact, p< 0.0001). The novel repair condition restored or decreased peak contact pressure below intact values at 60° and 90°. The overall mean with repair decreased by 1.7% in peak contact pressure (vs. intact, p= 0.9833). Overall, decreases in peak contact pressure were accomplished from root tear to repair at all knee flexion angles except for 0°. The overall mean peak contact pressure from root tear to repair was 12.4% and was not statistically significant (p= 0.5310).

DISCUSSION: The novel, all-inside posterior medial meniscal root repair with suture fixation to the PCL restored tibiofemoral contact mechanics including improvements in contact area, contact pressures, and peak contact pressures at most knee flexion angles. All improvements were either comparable to the intact knee or better under most testing conditions. Future studies with greater sample sizes are required to conclude whether this repair technique is as effective or more effective than the traditional method of repair, tibial pull-out method.

SIGNIFICANCE/CLINICAL RELEVANCE: The significance of this study's findings includes an introduction to a new meniscal root repair method that can restore biomechanical function of the knee. The clinical relevance includes an alternative proposed method of repair which may lessen adverse effects on the knee joint's loading and improving long-term outcomes.

REFERENCES: [1] Allaire R, et. al. J Bone Jt Surg – Am Vol. 2008;90(9):1922-1931

Contact Area: Least Square Mean Difference Relative to Intact				
Flexion angle	Root Tear (mm ²)	P-value (Intact-Tear)†	Repair (mm ²)	P-value (Intact-Repair) †
0°	121.63 (31.69)	0.0069	90.25 (14.50)	<.0001
30°	87.375 (16.60)	<.0001	-2 (18.01)	0.99
60°	37.57 (10.66)	0.0004	-45 (13.43)	0.036
90°	54.62 (18.80)	0.1386	6.875 (9.76)	0.99
Contact Area: Percent Difference Relatives to Intact				
Flexion angle	Percent Difference	SE (+/-)	Percent Difference	SE (+/-)
0°	-30.0	8.1	-24.4	3.6
30°	-26.4	10.4	+1.3	9.0
60°	-15.5	7.9	+18.5	10.0
90°	-19.5	6.6	+2.4	4.4

Table 1. Percentage Difference (%Δ) in Medial Compartment Contact Area Between Intact and Root Tear or Repair at Each Knee Flexion Angle. NOTE: A negative percent difference indicates a smaller contact area than the intact meniscus. († = Tukey-Kramer adjusted for multiple comparisons; * = statistically significant [p < 0.05] from tear or repair compared to intact state; ^ = statistically significant [p < 0.05] from tear to repair).

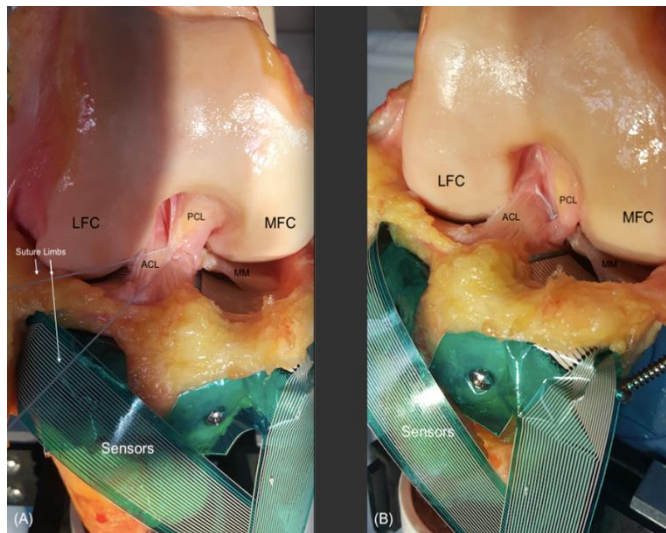


Figure 1. Image includes testing of the novel, all-inside repair of the posterior medial meniscal root tear via suture fixation to the nearby PCL, with the suture repair (A) prior to and (B) after tying of the suture limbs down. (LFC = lateral femoral condyle; MFC = medial femoral condyle; MM = medial meniscus; ACL = anterior cruciate ligament; PCL = posterior cruciate ligament)