Biomechanical Evaluation of New Fixation Techniques for Posterolateral Corner Reconstruction

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Disclosures: Richard L. Amendola (N), Alexander R. Garcia (N), Alex W. Brady (N), Amelia H. Drumm (N), A.F. Vidal: 3B: Vericel and Stryker; 5: Gemini Mountain Medical; 6: Bodycad Usa Corp, Smith & Nephew. M.T. Provencher: 1:Arthrex and Arthrosurface; 3B: Arthrex, Joint Research Foundation (JRF), and Arthrosurface; 5: Department of Defense (DoD) and National Institute of Health (NIH); 8: SLACK, Inc, AANA, AAOS, AOSSM, ASES, ISAKOS, The San Diego Shoulder Institute, and The Society of Military Orthopaedic Surgeons

INTRODUCTION: Posterolateral corner (PLC) injuries intricately damage vital knee stabilizers. Both fibular and tibial-based reconstruction techniques are used and are classically described with use of interference screw fixation of the graft at the femur. However, adjustable loop buttons may conserve more bone stock, reduce the risk of tunnel convergence in the setting of multiligament reconstruction, and provide more versatile and reproducible tensioning ability compared to interference screws. Further, tape-reinforced graft suturing has been shown to have favorable biomechanical properties over traditional graft suturing techniques. There is no study comparing interference screw fixation to adjustable-loop suspensory buttons in the context of PLC reconstruction. Therefore, the purpose of this study is to biomechanically compare adjustable loop button fixation with interference screws for fibular collateral ligament and popliteal tendon fixation to the femur for PLC reconstruction. We hypothesize there will be no difference in varus or external rotation laxity between the two methods of fixation.

METHODS: The biomechanical study was conducted on 10 cadaveric knee specimens in a non-destructive repeated measures sequence using a 6-degree of freedom robotic arm, under four conditions: (1) Native (2) PLC reconstruction with adjustable-loop suspensory button fixation, (3) PLC reconstruction interference screw fixation, and (4) PLC injured state. Reconstruction was performed using a fibular based technique as described by Arciero et al. FCL and popliteal tendon limbs were tensioned independently with 100N of force. The FCL was tensioned with the knee at 30 degrees of flexion and 3Nm of valgus torque in neutral rotation. The popliteal tendon limb was tensioned at 60 degrees of knee flexion with neutral rotation. Biomechanical evaluation consisted of a 5-Nm external rotation test and a 10-Nm varus test, performed at 0°, 30°, 60° and 90° of flexion.

RESULTS SECTION: All differences are presented in the order of 0°, 30°, 60° and 90° of flexion. Cutting the PLC significantly increased external rotation laxity (+3.8°, +9.7°, +9.9°, +7.6, all P<0.001) and varus laxity (+1.7°, +4.5°, +3.7°, all p<0.001, no significant difference at 90° of flexion) with respect to native. PLC reconstruction with suspensory fixation significantly over-constrained external rotation (-3.5° P=0.002, -4.3° P<0.001, -4.1° P=0.002, -3.1° P=0.039) and varus (-1.5°, -2.1°, -2.4°, -2.1°, all P<0.001). PLC Reconstruction with interference screws similarly over constrained external rotation (-4.3°, -5.5°, -5.4°, -4.5°, all P<0.001) and varus (-1.8°, -2.5°, -2.9°, -2.8°, all P<0.001). There was no significant difference found between the suspensory fixation and the interference screw fixation in any test.

DISCUSSION: Both reconstruction techniques restored the stability in external rotation and varus stress. No significant differences were found between the two fixation methods, validating both adjustable-loop suspensory buttons and interference screws as viable options for femoral fixation in the setting of PLC reconstruction. However, both methods over-constrained the knee in ER and Varus. This may be due to the increased stiffness of the tape-reinforced graft suturing, or over-tensioning of the grafts during fixation. The study tests a physiologic load but is limited since the specimen is not cyclically loaded or loaded to failure.

CLINICAL RELEVANCE: This study evaluates and compares two PLC reconstruction techniques and their impact on knee stability. These findings provide quantifiable data to aid surgeons in making evidence-based, patient-specific decisions regarding appropriate PLCR technique. Biomechanically, the adjustable-loop suspensory fixation and the interference screw behave very similarly at time zero. Given this, surgeons may select an implant based on their comfort, training and/or patient specific needs. Further research is necessary to determine which implant performs the best in a clinical setting.

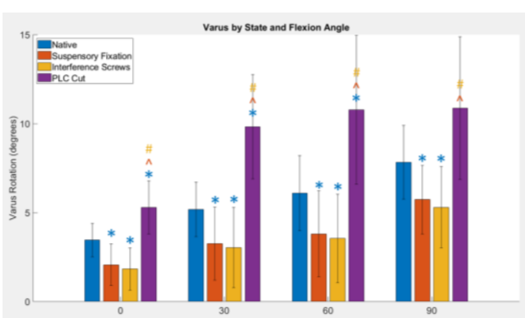

Figure 1. Knee external rotation range of motion as a function of flexion angle under a 5-Nm External Rotation Torque. *: Significantly different from Native, ^: Significantly Different from Suspensory Fixation, #: Significantly different from Interference Screws.

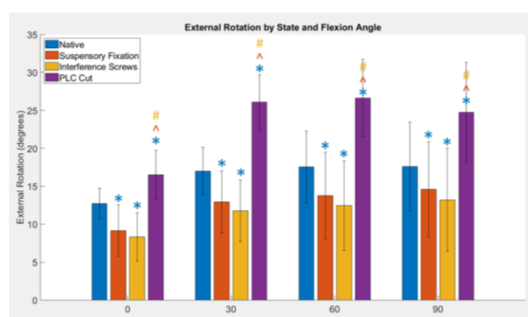

Figure 2. Knee Varus range of motion as a function of flexion angle under a 10-Nm Varus Torque. *: Significantly different from Native, ^: Significantly Different from Suspensory Fixation, #: Significantly different from Interference Screws.