Anteromedial Ligament Contribution to Translational Knee Stability: A Cadaveric Biomechanical Pilot Study

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INTRODUCTION: The traditional understanding of translational knee stability has focused on the anterior and posterior cruciate ligaments as the major contributors to anterior and posterior translational stability. There is a developing body of evidence suggesting the importance of extra-capsular ligamentous structures such as the Anterolateral ligament (ALL) which may act as secondary stabilizers to translational knee stability. Anteromedial and anterolateral extracapsular ligamentous structures of the knee may play an important role in augmenting knee stability in revision cruciate ligament reconstruction or multi-ligamentous knee injuries. The Anteromedial Ligament (AML) as described by Massey et al, is an extracapsular ligamentous structure of the knee which originates deep, posterior, and inferior to the femoral origin of the superficial medial collateral ligament (sMCL) at the medial epicondyle of the femur, and inserts on the anteromedial tibial plateau rim. Biomechanical studies of the AML and its contribution to translational knee stability have not been conducted. The purpose of this biomechanical cadaveric pilot study is to test the contribution of the AML to anterior translational knee stiffness in varying degrees of knee flexion.

METHODS: The AML was identified deep and oblique to the superficial MCL after removal of the skin and subcutaneous tissues. Biomechanical testing was performed with a servohydraulic testing system (Instron 8874) with the femur and tibia potted in a custom jig. The knees were preconditioned with flexion and extension cycles, followed by application of an anterior translational load on the tibia at 20mm/min until reaching 134N. A posterior force of 134 N was applied at the start of each trial. Each knee was then loaded in tension at a rate of 20 mm/minute until 134 N to simulate an anterior drawer test. Knees were tested at 30-, 60-, and 90-degrees flexion and full extension with 3 trials at each degree flexion. The AML was then sectioned and the testing protocol was repeated. Load (N) vs displacement (mm) line graphs were constructed, and the tangents of 0-10N and 20-40N were used to calculate stiffness. Mean stiffness of the knees before and after AML sectioning at each flexion position were calculated and compared with a student's t-test.
RESULTS: Four fresh-frozen cadaver knees were tested. two right knees and two left knees were included. At 30 and 60 degrees, there were no differences in mean knee anterior translational stiffness when comparing intact and AML-deficient knees in both the 0-10N and 20-40N force ranges. At 30 degrees of knee flexion, the mean stiffness in anterior translation for the AML intact and sectioned specimens was 1.42 N/mm and 1.44 N/mm respectively for the 0-10N force range ($p=0.98$), and 15.57 N/mm and 15.06 N/mm respectively for the 20-40N force range ($p=0.82$). At 60 degrees of knee flexion the mean stiffness in anterior translation for the AML intact and sectioned specimens was 2.25 N/mm and 3.03 N/mm respectively for the 0-10N force range ($p=0.55$), and 16.69 N/mm and 14.73N/mm for the 20-40N force range ($p=0.24$). At 90 degrees, the mean stiffness of the intact and AML deficient knee in the 0-10N force range was 1.88 N/mm ± 0.22 and 1.22 N/mm ± 0.27 respectively, which was significant ($p=0.03$).

DISCUSSION AND CONCLUSION:
Our study demonstrates that sectioning of the AML decreases anterior translational knee stiffness in 90 degrees of knee flexion. Our results suggest that the AML may contribute to secondary stabilization of anterior translational knee stiffness in higher flexion angles.The results of this pilot study suggest that further research into the role of the AML in knee biomechanics is warranted. Our results also suggest that injury to the AML may lead to increased forces placed on the other stabilizers of anterior translational stability such as the anterior cruciate ligament and posterior meniscus. Reconstruction or repair of the AML may prove to be a useful adjunct in restoring anterior translational stability of the knee after injury. Further research into the utility of repair or reconstruction of this ligament in the surgical treatment of translational knee instability is needed.