Kinematic and Quantitative MR Evaluation of the Mini-Two Incision and Anteromedial Portal Femoral Tunnel Drilling for ACL Reconstruction - an In Vivo One-Year Study

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Disclosures:

Introduction: Abnormal knee kinematics have been hypothesized to lead to early progression of cartilage degeneration following ACL reconstructions. Recently, this has led to increased interest in methods of femoral tunnel drilling. Possible techniques include drilling through the anteromedial portal (AM) and the mini-two incision (MT) ACL reconstruction, which allows for complete independence of femoral tunnel drilling. The MT approach may allow improved visualization of the femoral tunnel, theoretically resulting in a more anatomic graft position and improved restoration of knee kinematics. The purpose of this study is to compare the knee kinematics between the reconstructed and contralateral normal knee for the MT and the AM reconstructions. A secondary purpose is to use T₁ρ MR imaging to evaluate the cartilage health of each group following reconstruction as compared to a control group of uninjured knees. We hypothesized that the AM and MT would result in similar kinematics as compared to the patient’s contralateral knee, as well as cartilage health that is similar to the control group.

Methods: Twenty patients were evaluated, including 10 patients (6 female) with MT and 10 patients (6 female) with AM, between 11 and 19 months after ACL reconstruction with a soft tissue graft. High-resolution CUBE MR images and T₁ρ maps were acquired from the reconstructed knee on a 3T scanner. Fat-suppressed T2 sagittal images were obtained of the reconstructed and uninjured knees in extension and 30° flexion with an applied load of 25% of total body weight. Image segmentation was performed with in-house Matlab software, and kinematics were calculated according to published procedures. Femoral, tibial, patellar and trochlear cartilage were manually segmented on sagittal CUBE images. T₁ρ values were calculated for overall compartments, as well as manually defined sub-compartments in the tibia and femur. Statistical analyses were performed with a paired t-test with alpha of 0.05 for comparisons of kinematic measurements of each patient to the contralateral knee. T₁ρ values were compared between the MT group, AM group and a Control group (20 knees; 10 subjects; 6 female) using an analysis of variance with Bonferroni correction and alpha of 0.05.

Results: Demographic information regarding the two reconstruction groups and control group were similar for all measures, including average age (MT 29.4 yrs, AM 33.1 yrs, Control 31.2 yrs; p=0.51), BMI (MT 26.2 kg/m^2, AM 23.6 kg/m^2, Control 24.3 kg/m^2; p=0.47), use of autograft (MT 7, AM 6; p=0.64), and meniscal debridments (all lateral; MT 2, AM 3; p=0.61). Time of imaging after surgery was significantly later for the MT group (13.7 vs 11.9 months; p=0.03). Anterior tibial translation and internal tibial rotation between flexion and extension was similar for both the MT reconstruction (ATT p=0.48; ITR p=0.44) and AM reconstruction (ATT p=0.90; ITR p=0.87). Tibial position was significantly more anterior in the MT group compared to the contralateral knee. T₁ρ values were compared between the MT group, AM group and a Control group (20 knees; 10 subjects; 6 female) using an analysis of variance with Bonferroni correction and alpha of 0.05.
The dynamic post-operative kinematics of the knee are restored in both groups, with no significant differences in tibial translation or rotation in moving from extension to flexion. However, the tibial position is significantly more anterior and...
externally rotated in the MT reconstruction relative to the uninjured knee. The anterior position of the tibia in the MT group resulted in the posterior shift in the medial contact centroid. Additionally, early cartilage degeneration, as indicated by elevated $T_1\rho$ values, is noted in the medial tibia of the MT group, specifically in the inter-meniscal contact region. Andriacchi proposed a framework for the development of post-traumatic arthritis, beginning as an alteration in the normal joint kinematics. This shift may lead to increased force distributed on cartilage not accustomed to high loads. Li reported that the ACL-deficient knee has a contact centroid that is 4 mm posterior to the normal knee. Despite the theoretical advantages offered by the MT reconstruction, further investigation of post-operative outcome measures are needed to clarify the effects of this technique on restoration of knee kinematics.

**Significance:** Within this cohort, the tibial position in the MT reconstruction is significantly more anterior than the contralateral knee. This difference is not present in the AM patients. Differences in tibial position can result in an alteration of cartilage loading and lead to the increased central-medial tibia cartilage changes seen in this group. Prospective studies evaluating the mini-two incision technique are warranted, as is a further investigation into the actual femoral tunnel position and its effect on kinematics and cartilage health.

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**References:**


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