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Effect of Medial-Lateral Position of the Tibial Anteromedial Bundle Tunnel on Knee Biomechanics

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Summary:
The medial-location of the AM bundle on the tiba in ACL double bundle reconstruction has an effect on knee biomechanics.

Abstract:
Introduction:
Anatomic placement is important to anterior cruciate ligament (ACL) reconstruction when using either the single-bundle or double-bundle (DB) technique. Although there are several studies showing the superiority of the anatomic placement on the femur over the non-anatomic placement in terms of knee biomechanics, the impact of the tibial placement has been rarely studied especially in a coronal plane. The native tibial ACL footprints of the anteromedial (AM) and posterolateral (PL) bundles are varied in both sagittal and coronal planes, and the AM position is sometimes observed on the lateral side relative to PL position. Moreover, AM bundle can be divided into AM medial part (AMM) and lateral part (AML). The two bundles play different roles which the AMM bundle is the primary stabilizer to tibial anterior drawer through wide range of motion, while the AML bundle is the secondary stabilizer in deep flexion angles. The purpose of this study was to evaluate knee biomechanics after two different tibial AM bundle placements of medio-lateral (ML) alignment in DB ACL reconstructions.

Methods:
Nine fresh frozen human cadaveric knees were used in this study. A robotic system was used to measure the 6 degree-of-freedom knee kinematics. Two external loadings were applied to the tibia while measuring the knee kinematics: 1) an anterior tibial load of 89 N at 0º, 30º, 60º and 90º of knee flexion and 2) a combined rotatory load (7 N-m valgus and 5 N-m internal tibial torque) at 0º, 15º, 30º and 45º of knee flexion. The testing was done in the ACL intact, ACL deficient and two types of ACL reconstructed knees.
Two different types of DB ACL reconstructions were performed. In the medial AM reconstruction group the 6 mm tibial AM tunnel was located at the medial part of the AM footprint, while the 6 mm tibial PL tunnel was created on the center of the PL footprint. The 6 mm femoral tunnels for both bundles were then placed in anatomic positions. In the lateral AM reconstruction the same specimen was used after filling the tibial AM tunnel by an epoxy compound. The 6 mm tibial lateral AM tunnel was located at the lateral part of the AM footprint, while the same tibial PL tunnel was used as medial AM reconstructed knee.
The 6 mm diameter hamstrings grafts were passed through both AM and PL tunnels. On the femoral side, the grafts were fixed with an extra-cortical buttons, while on the tibial side with a screw and washer. The AM graft was fixed at 30º of knee flexion and the PL graft was fixed at 0º of knee flexion while applying a 20 N tension on each graft.

Results:

Paper #159

Kinematics under anterior tibial load: The anterior tibial translation (ATT) of the ACL-deficient knee was greater than that of the intact knee at 0º and 30º of knee flexion. Both DB reconstructions reduced the ATT from the ACL-deficient condition. After medial AM reconstruction, the ATT was closely restored to the intact level at 0º of knee flexion. After lateral AM reconstruction, the ATT was less than the intact level at 0º of knee flexion.
Kinematics under a combined rotatory load: The coupled ATT of the ACL-deficient knee was greater than that of the intact knee at 0º of knee flexion. Both DB reconstructions reduced the ATT from the ACL-deficient condition. There was no difference between medial and lateral AM reconstruction at all selected flexion angles.

Conclusion:
The finding of this study was that the different coronal location of the AM bundle on the tibia in the DB ACL reconstruction resulted in different knee kinematics, and that the medially placed AM bundle better restored intact knee biomechanics.
For anatomic DB ACL reconstruction, placement of the tibial AM tunnel is important to restore knee kinematics. The tibial ACL footprint has many variations. Therefore, placement of the tibial tunnel should be carefully determined according to individual anatomic variation. Lateral AM placement might cause an overconstraint, i.e. posteriorly shifted and externally rotated at low knee flexion angle. This over constraint might be due to impingement between laterally placed AM graft and lateral condyle or PL graft

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