The Effect of Arthroscopic Partial Meniscectomy on Tibiofemoral Stability

INTRODUCTION:
Irreparable tears of the posterior horn of the medial meniscus are the most common meniscal injury and arthroscopic partial meniscectomy is the current standard of care. However, despite the excellent results of partial meniscectomy, there is still little known regarding the effects of the size of a resection on tibiofemoral stability, as measured by laxity and anterior-posterior (AP) position. Therefore in this study, we sought to determine this by conducting three successive partial meniscectomies of the posterior horn of the medial meniscus (PMM) and measuring the laxity and AP position of the medial femoral condyle over a series of loading conditions following each resection. It was hypothesized that the second resection would result in significant changes in laxity and AP position compared to the intact knee; +compared to the 22% resection; #compared to the 46% resection.

METHODS:
Five cadaveric knees were dissected to the capsule, preserving all ligaments and the quadriceps tendon, and tested using a three step process: 1) Laxity testing, 2) MRI and 3) Partial medial meniscectomy.

1. Laxity Testing
Each specimen was first tested on a rig (Figure 1) with the tibia fixed vertically and the femur attached to a framework, such that the medial and lateral epicondyles were aligned with transverse rods. Three conical holes were made in the distal femoral cortex and the proximal tibial cortex, as fiducial reference points. A krackow locking suture was fastened through the preserved quadriceps tendon and a wire attached from the suture to the proximal end of the femoral framework to allow for control of the flexion angle.

The fiducial points were recorded with the knee at full extension under compression only (low: 50N and high: 500N) using a Microscribe G2LX digitizer (CNC Services, Inc., Amherst, VA), and then with compression combined with a 50N anterior shear, 50N posterior shear, 2Nm internal torque and a 2Nm external torque. This procedure was repeated for 15°, 30°, 60° and 90° of flexion. The loads were always applied in the same order.

2. MRI
Upon completion of the laxity testing, the knee was scanned at 15° of flexion using a Siemens MAGNETOM Verio 3 Tesla MRI machine with a 3D-PD-nfs SPACE sequence. Scans were repeated for each meniscal resection, producing a total of 4 scans per knee.

3. Partial Medial Meniscectomy
After the MRI of the intact knee, an arthroscopic partial medial meniscectomy was performed by one orthopaedic surgeon member of our team using standard arthroscopic instrumentation and technique. The linear width along the posterior third of the meniscus including the posterior horn was measured and recorded at 1cm intervals using a meniscal measuring guide (ReGen Biologics, Inc., Hackensack, New Jersey). At the first partial medial meniscectomy we aimed to remove 30% of the original width of the PMM, the second aimed to resect 60% and then a 100% removal of the PMM. Following each meniscectomy the laxity testing and MRI were repeated.

RESULTS:

A two-way Analysis of Variance (ANOVA) was used to determine if there was a significant difference in the average medial positions and average laxity under each loading condition after each partial meniscectomy was performed (i.e. first resection vs. second resection) as well as compared to the intact (i.e. first resection vs. intact). Statistical significance was determined for a p-value < 0.05.

MRI analysis demonstrated that 22% ± 9% of the original width of the posterior horn was removed at the first resection, 46% ± 11% at the second resection and full removal at the third resection (Figure 3). After 22% resection, there were no significant changes in AP position or laxity when compared to the intact knee. Following the 46% resection, significant changes in AP position were found when compared to the intact knee and the 22% resection. There was also a statistically significant increase in rotational laxity under 50N compression (p=0.014) and AP laxity under 500N compression (p=0.045). With a 100% resection of the PMM, the changes in AP position were found to be statistically significant when compared to the intact knee and the 22% resection, however there was no statistical difference when compared to the 46% resection. There was a statistically significant increase in AP laxity at 50N compression (Figure 4) when compared to the intact (p=0.024), 22% resection (p=0.005) and the 46% resection (p=0.004).

DISCUSSION:
Partial meniscectomy equal to or greater than 46% resection of the posterior horn of the medial meniscus significantly altered the AP position of the medial femoral condyle, and increased laxity, similar to a 100% removal.

SIGNIFICANCE:
Resections of the posterior horn of the medial meniscus exceeding 46% can lead to mechanical changes which may cause instability and contribute to early osteoarthritis.

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