ISAKOS

**International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine**

10th Biennial ISAKOS Congress • June 7-11, 2015 • Lyon, France

Paper #195

# The Evaluation of Intra- and Extra-Articular Tension of the Graft During the Graft Fixation in Anterior Cruciate Ligament Reconstruction

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**Summary**:
The intra-articular graft tension was quantitatively measured using an originally developed micro force sensor at the time of fixation in anterior cruciate ligament reconstruction, and the intra-articular graft tension was significantly smaller than the extra-articular tension.

**Abstract**:
INTRODUCTION
In anterior cruciate ligament (ACL) reconstructions, the initial tension of the graft at the fixation is considered as one of the most important factors for postoperative knee stability and function. However, most previous studies evaluated the extra-articular graft tension by pulling the graft from outside of the joint without knowing how much tension was actually transmitted to the intra-articular portion. The objective was thus to evaluate the intra- and extra-articular graft tension. The hypotheses were that intra-articular graft tension was smaller than extra-articular graft tension due to the friction between the graft and bone tunnels, and cyclic loading and pre-tensioning reduced the difference between intra- and extra-articular graft tension.

METHODS
Nine fresh-frozen human cadaveric knees (81.9 ± 9.5 y.o., 4 males, 5 females) were examined. After removing the native ACL, anatomical single bundle ACL reconstruction was performed. Femoral and tibial tunnels were created with a diameter of 6.5 mm and 7.0 mm respectively. The hamstring tendon graft was made with an originally developed micro force sensor inserted in the middle. The micro force sensor consists of an aluminum plate and two types of strain gauges. The graft was placed so that a micro force sensor was placed in the articular portion. The graft was fixed on femoral cortex using a suspensory button, and then fixed to a graft tensor with the suture connected with the graft. The graft tensor can fix the graft with an arbitrary tension and measure the extra-articular tension applied at the graft fixation by load cell. After applying graft tension by the graft tensor from outside of the joint, intra- and extra-articular graft tensions were simultaneously monitored. The simultaneous tension measurement was performed at the following three stages of the surgical tensioning simulation; Stage 1, applying 20 N of the initial tension to the graft at 20 ° of knee flexion; Stage 2, applying 20 N at 20 ° of knee flexion just after passive knee range of motion 5 times; Stage 3, applying 20 N at 20 ° of knee flexion just after the pre-tension with 20 N for 5 minutes. The knee flexion angles were confirmed using an electromagnetic measurement system. Statistical analyses were performed and P-value < 0.05 was considered statistically significant.

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RESULTS

After the graft placement, the intra- and extra-articular tension to the graft was 12.7 ± 5.3 N and 18.8 ± 1.1 N at Stage 1, 12.0 ± 4.8 N and 19.0 ± 1.0 N at Stage 2, and 13.5 ± 4.8 N and 20.2 ± 2.2 N at Stage 3, respectively. In all stages, the intra-articular tension was significantly smaller than the extra-articular tension (all, $P < 0.01$). Additionally, the intra-articular graft tension was not significantly different among the three stages.

CONCLUSION

The intra-articular graft tension was quantitatively measured using an originally developed micro force sensor. The intra-articular graft tension was significantly smaller than the extra-articular tension, even after the cyclic-loading and pre-tension, which might be due to the friction between the graft and bone tunnels.