

# Comparison of Mechanical Property of Autograft Tendons used in Anterior Cruciate Ligament Reconstruction

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**Introduction:** Hamstring tendon (HT), bone-patellar tendon-bone (BTB), and quadriceps tendon (QT) are commonly used as transplanted grafts for anterior cruciate ligament (ACL) reconstruction. Recently, inferior postoperative anterior knee laxity after ACL reconstruction with a HT graft has been reported<sup>(1)(2)</sup>. Although the mechanical properties (stiffness or elastic modulus) have been compared among HT, BTB, and QT in the cadaveric knees<sup>(3)(4)(5)</sup>, the mechanical properties of the autografts actually used for ACL reconstruction have never been reported. In this study, we investigated the elastic (Young's) modulus of the autografts harvested during ACL reconstruction and compared the mechanical property among HT, BTB, and QT.

**Methods:** A total of 12 autografts harvested for ACL reconstruction intraoperatively were included in this study (HT, BTB, QT n=4 each). After the autograft was prepared for ACL reconstruction, one end of the graft was securely fixed, and the other end was pulled up to 50N with a tensiometer on the Smith & Nephew GRAFTMASTER II system (Fig. 1). From a video analysis while pulling the autograft, the strain (%) was measured from the displacement (mm) of randomly pointed markers onto the graft using a digital image correlation (DIC) method. The stress (MPa) acting on the graft was calculated by the cross-sectional area measured during the surgery. Finally, the longitudinal elastic (Young's) modulus (MPa) of the autograft was calculated from the stress (MPa) divided by the strain (%). The mean elastic (Young's) modulus was compared among HT, BTB, and QT. The Steel-Dwass test was utilized for statistical analysis with a significance level of 0.05.

**Results:** The elastic (Young's) modulus (MPa, mean  $\pm$  standard deviation) was  $243.5 \pm 217.3$  for the HT group,  $66.9 \pm 9.9$  for the BTB group, and  $72.7 \pm 24.1$  for the QT group. The mean modulus of the HT group was significantly higher than the other two groups ( $p < 0.05$ ).

**Discussion:** In this study, HT exhibited a higher elastic (Young's) modulus compared with those of BTB and QT. This tendency in the comparison of the autografts actually used for ACL reconstruction was consistent with the results of the previous reports in the cadaveric knees. Generally, the ligament has a lower elastic (Young's) modulus than the tendon because the ligament is directly connecting the adjacent bones and must adapt to the length change evoked by the joint motion or bone growth. Thus, the ACL is supposed to be able to generate restraining force over a wide range of motion of the knee joint. The higher elastic (Young's) modulus of HT, which means HT is stiffer but less compliant compared with BTB and QT, might prevent it from effective restraining of the knee joint motion when used as the ACL graft and lead to inferior postoperative anterior knee laxity after ACL reconstruction.

**Significance/Clinical Relevance:** This study indicates the mechanical properties of the autografts might affect the postoperative anterior knee laxity after ACL reconstruction and HT might not be suitable for the patients with a higher activity level as the ACL graft.

## References:

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## Figures:

Fig.1

