In Anterior Cruciate Ligament Reconstruction using Quadriceps Tendons, Simply Fixing the Graft to the Suspensory Button Does Not Provide Adequate Strength

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INTRODUCTION:

Although the hamstring tendon and bone-patellar tendon are most commonly used in anterior cruciate ligament reconstruction (ACLR), the quadriceps tendon (QT) graft has recently gained considerable interest as an autograft for ACLR. We previously reported that the hamstring tendon is immature, whereas the QT is mechanically strong in skeletally immature children. A systematic review demonstrated that soft-tissue QT grafts showed less postoperative rotatory instability and fewer complication profiles than QT grafts with bone blocks.

In ACLR using soft-tissue QT graft, the graft preparation strategy is important. The graft rupture rates in ACLR and ACLR with QT are 5.3–7%, and 2.1–7.3%, respectively. Various methods have been used; however, no method has yet been established. The graft rupture rate may differ depending on the suturing technique used. A recent biomechanical study investigated the effects of different suturing techniques and suture diameters on the fixation of soft-tissue QT grafts. Kamada et al. compared the biomechanical strengths of fixation configurations using suspensory buttons and fixed soft-tissue QT grafts directly sutured to a continuous loop with a suspension button using simple sutures. They reported that the configuration with the smallest elongation had the highest maximum load to failure. However, there are no reports comparing methods with only adjustable loops.

Therefore, this study aimed to compare the biomechanical strengths of various QT-fixation configurations with adjustable loops in ACLR using soft-tissue QT grafts. We hypothesized that one manufacturer's technique would exhibit the lowest elongation and the highest maximum load to failure. More faithful to the clinical situation than previous reports, the results of this study may provide surgeons with new insights into femoral fixation of soft-tissue QT grafts in ACLR.

METHODS:

Thirty freshly frozen bovine 10-mm wide, 50-mm long, and 4-mm thick Achilles tendons were used. Tendons were assigned to three groups (n = 10 per group) with different suture configurations using adjustable loops with a suspensory button (Fig. 1): Group A, fixation using the method of Hughes et al.; Group B, continuous loops with hanging buttons directly sutured to the tendon with eight simple sutures and 15 mm of the 30-mm loop sutured to the tendon; and Group C, fixation using the one manufacturer's technique. One experienced surgeon fixed Groups A and B using No. 2 FiberWire and Group C using FiberTag, respectively. All knots were tied five times and fixed.

Tensile tests were performed using a material-testing machine. The sutured tight rope on the femoral side was threaded between the thread graspers and the button was secured by hanging it over a frame that mimicked the bone cortex. The tibial side was clamped 1.5 cm distally with gauze sewn on to prevent the tendon from slipping. Five cycles of preloading at 50 N for 1 min were performed. Finally, load-to-failure tests were conducted at a rate of 5 mm/min until rupture. The difference in the total length (elongation) of the tendon before and after preloading and the maximum test force at rupture were measured using material-analysis software.

One-way analysis of variance was used to explore differences in graft elongation and the maximum load to failure between the three groups. Data are presented as means and standard deviations. Statistical significance was set at $P<0.05$.

RESULTS:

The average elongation was 10.3±2.4 mm, 16.6±2.2 mm, and 10.0±1.0 mm in Groups A, B, and C, respectively. The average elongation was significantly larger in Group B than in Groups A and C (both $p<0.001$) (Fig. 2). The average maximum test force in Groups A, B, and C was 157.5±33.4 N, 253.4±45.5 N, and 337.7±21.0 N, respectively, with significant differences between the groups (all $p <0.001$) (Fig. 3).

DISCUSSION AND CONCLUSION:

Fixation of the soft-tissue transplanted tendon using one manufacturer's technique to fix with a suspensory button resulted in minimal elongation and higher fixation strength. Simple devices that use this method have already been developed. Because it can be fixed using a relatively simple method, it is advantageous for femoral fixation in ACLR using soft-tissue QT.

Fig.1 Schema of suturing method for each group

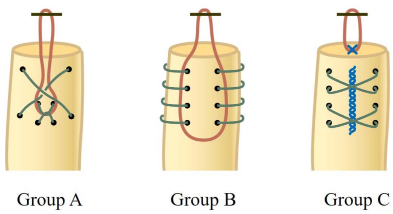

Fig.2 Comparison of elongation for each group

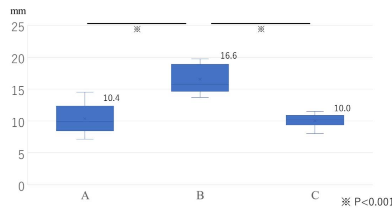

Fig.3 Comparison of failure load for each group