Anatomic Reconstruction of the Anterior Cruciate Ligament Using Double-Bundle Hamstring Tendons: Surgical Techniques, Clinical Outcomes, and Complications

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Purpose: The objective of the study was to retrospectively compare the clinical outcomes of anatomic double-bundle anterior cruciate ligament reconstruction via hamstring tendons with single-bundle reconstruction between April 2002 and March 2004. **Methods:** We retrospectively reviewed 123 consecutive patients, 71 of whom underwent double-bundle reconstruction and 52 of whom underwent single-bundle reconstruction. The same postoperative rehabilitation protocol was used for all patients. The patients were followed up for a mean of 33 months. We evaluated manual knee laxity, anterior knee laxity as measured with the KT1000 arthrometer (MEDmetric, San Diego, CA), range of knee motion, isokinetic peak torque of knee extension and flexion strength adjusted for body weight as determined by Cybex testing (Lumex, Ronkonkoma, NY), and Lysholm score. **Results:** The Lachman test was negative in 64 cases (90%) and the pivot-shift test was negative in 62 cases (87%) in the double-bundle group. The Lachman test was negative in 45 cases (86%) and the pivot-shift test was negative in 42 cases (81%) in the single-bundle group. There was an extension deficit of greater than 5° in 19 cases (26%) in the double-bundle group and 6 cases (10%) in the single-bundle group ($P < .05$). The side-to-side difference in anterior tibial translation measured with the KT1000 arthrometer was 1.7 ± 2.0 mm in the double-bundle group and 1.9 ± 2.2 mm in the single-bundle group. The isokinetic peak torque of knee extension and flexion strength was 90% and 89%, respectively, in the double-bundle group and 87% and 86%, respectively, in the single-bundle group. The Lysholm score averaged 96.8 ± 5.1 in the double-bundle group and 92.8 ± 6.9 in the single-bundle group postoperatively. **Conclusions:** No significant difference was found between the 2 procedures with regard to manual knee laxity, anterior knee laxity measured by the KT1000 arthrometer, knee extension and flexion strength, and Lysholm score. In contrast, there was a significant difference in the range of knee motion between the 2 groups. The findings of our study do not support the routine adoption of double-bundle reconstruction. **Level of Evidence:** Level III, retrospective comparative study. **Key Words:** Anterior cruciate ligament—Double bundle—Anatomic reconstruction—Posterolateral bundle—Complications.

Several authors have described double-bundle anterior cruciate ligament (ACL) reconstruction via hamstring tendons.[1-12] Although normal knee laxity after ACL reconstruction is gained by use of bone–patellar tendon–bone graft, as well as hamstring tendons, the procedure using bone–patellar tendon–bone has some disadvantages, such as anterior knee pain and slow recovery of quadriceps muscle strength.

There is concern regarding the current technique of ACL reconstruction in terms of residual laxity, especially in controlling rotation. To control rotatory instability, a number of authors have suggested reconstructing not just the anteromedial (AM) bundle but

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TABLE 1. *Demographic Data*

	Single-Bundle Group	Double-Bundle Group
Age (yr)	25.3	24.2
Sex (M/F)	21/31	33/38
Mean preoperative period (mo)	19	17
Mean follow-up period (mo) (range)	28 (24-39)	29 (24-36)
Accompanying meniscal injury	MM in 10 (repair in 4 and meniscectomy in 2) and LM in 18 (repair in 1 and meniscectomy in 4)	MM in 14 (repair in 7 and meniscectomy in 3) and LM in 35 (repair in 4 and meniscectomy in 7)

Abbreviations: MM, medial meniscus; LM, lateral meniscus.

also the posterolateral (PL) bundle.[1-11] Adachi et al.[5] and Hamada et al.[2] indicated that there were no advantages for a double-bundle reconstruction as opposed to a single-bundle reconstruction in terms of anterior laxity. On the contrary, Muneta et al.[11] and Yasuda et al.[10] reported that the side-to-side anterior laxity of their double-bundle ACL reconstructions was significantly better than that of the single-bundle reconstruction.

Since April 2000, we have performed double-bundle ACL reconstruction with the EndoButton device (Smith & Nephew Endoscopy, Andover, MA) for femoral-side fixation according to the method of Rosenberg and Graf[13] to improve the results of reconstruction via semitendinosus (gracilis). In this study we compared the clinical outcome of anatomic double-bundle ACL reconstruction with single-bundle reconstruction in terms of manual knee laxity, range of knee motion, knee extension and flexion strength as determined by Cybex testing (Lumex, Ronkonkoma, NY), anterior knee laxity as measured by use of the KT1000 arthrometer (MEDmetric, San Diego, CA), and Lysholm score. Our hypothesis is that the anatomic double-bundle reconstruction is superior to the single-bundle procedure in terms of knee stability, especially with regard to rotatory instability.

METHODS

We retrospectively reviewed 123 consecutive patients with ACL-deficient knees who had undergone single- or double-bundle reconstruction between April 2002 and March 2004. Patients who underwent ACL reconstruction of both knees and those with an open physis were excluded from evaluation. Those with other ligamentous instability and those with articular cartilage lesions exceeding grade III were also excluded. The final study population consisted of 54 men and 69 women.

Double-bundle ACL reconstructions were performed in 71 consecutive patients (Table 1). The mean patient age was 24 years 2 months. The mean follow-up period was 2 years 5 months (range, 24 to 36 months). Single-bundle ACL reconstructions were performed in 52 consecutive patients. The mean patient age was 25 years 3 months. The mean follow-up period was 2 years 4 months (range, 24 to 39 months).

At 1 year postoperatively, we performed second-look arthroscopy, examining the status of the reconstructed ACL, meniscus, and articular cartilage and removing the staples from the tibia in all patients. At 1 year and 2 years postoperatively and at the final follow-up, we examined manual knee laxity, anterior tibial translation measured with the KT1000 knee arthrometer, range of knee motion, Lysholm score, and knee extension and flexion strength. Anterior tibial translation was measured with the KT1000 arthrometer with the knee in 20° of flexion, with an anterior force of 89 N being applied to the tibia. The maximum extension and flexion strength (adjusted for body weight) of both knees were measured by Cybex testing at 60°/s and are expressed as the percentage of the uninjured knee.

Statistical analysis was performed with the unpaired t test, Mann-Whitney U test, and χ^2 test. The unpaired t test was used for anterior knee laxity measured with the KT1000 arthrometer and Lysholm score. The Mann-Whitney U test was used for manual knee laxity. The χ^2 test was used for range of knee motion, as well as knee extension and flexion strength. $P < .05$ was considered statistically significant.

Surgical Procedure

Double-Bundle Procedure: All surgeries were performed by use of the same procedure in each patient. After the knee was examined with the patient under general anesthesia, diagnostic arthroscopy was performed without an air tourniquet.