

# Prospective clinical comparisons of semitendinosus versus semitendinosus and gracilis tendon autografts for anatomic double-bundle anterior cruciate ligament reconstruction

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## Abstract

**Background** The data available from the previously reported clinical studies remains insufficient concerning the hamstring graft preparation in double-bundle anterior cruciate ligament (ACL) reconstruction.

**Objective** To test the hypothesis that there are no significant differences between the semitendinosus tendon alone and the semitendinosus and gracilis tendon graft fashioning techniques concerning knee stability and clinical outcome after anatomic double-bundle ACL reconstruction.

**Methods** A prospective study was performed on 120 patients who underwent anatomic double-bundle ACL reconstruction according to the graft fashioning technique. The authors developed the protocol to use hamstring tendon autografts. When the harvested doubled semitendinosus tendon is thicker than 6 mm, each half of the semitendinosus tendon is doubled and used for the anteromedial (AM) and posterolateral (PL) bundle grafts (Group I). On the other hand, when the harvested semitendinosus

tendon is under 6 mm in thickness, the gracilis tendon is harvested additionally. The distal half of the semitendinosus and gracilis tendons are doubled and used for the AM bundle graft, and the remaining proximal half of the semitendinosus tendon is doubled and used for the PL bundle grafts (Group II). Sixty-one patients were included in Group I, and 59 patients in Group II. The two groups were compared concerning knee stability and clinical outcome 2 years after surgery.

**Results** The postoperative side-to-side anterior laxity averaged 1.3 mm in both groups, showing no statistical difference. There were also no significant differences between the two groups concerning the peak isokinetic torque of the quadriceps and the hamstrings, the Lysholm knee score, and the International Knee Documentation Committee evaluation.

**Conclusion** There were no significant differences between the two graft fashioning techniques after anatomic double-bundle ACL reconstruction concerning knee stability and postoperative outcome. The present study provided orthopedic surgeons with important information on double-bundle ACL reconstruction with hamstring tendons.  
**Level of evidence** Level II; prospective comparative study.

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## Introduction

The normal anterior cruciate ligament (ACL) consists of the anteromedial (AM) and posterolateral (PL) bundles, which have different functions [1, 2]. The idea of reconstructing both bundles was proposed in the 1980s [3]. In the early 2000s, since Yasuda et al. [4] reported a new concept of anatomic reconstruction of the AM and PL bundles of the ACL with 2-year clinical results superior to conventional

single-bundle ACL reconstruction, a number of anatomic, biomechanical, and clinical studies on the anatomic double-bundle reconstruction procedures have been conducted in the field of ACL reconstruction, and several clinical trials have found that postoperative knee stability is superior in the anatomic double-bundle reconstruction compared with conventional single-bundle reconstruction [5–13].

The essence of ACL reconstruction is grafting tendon bundles across the knee joint. Therefore, graft selection, preparation, and fixation are critical factors to ensure ACL reconstruction leads to clinical success [14]. However, it has been well established that the weak points of the hamstring tendon graft fixed with sutures to bone are (1) low stiffness of the graft-suture-bone complex, (2) rapid relaxation of the graft tension after surgery, and (3) difficulty in tension control during graft fixation [15, 16]. Therefore, the authors have developed hamstring tendon ‘hybrid’ autografts which consist of hamstring tendon connected in series with commercially available polyester tape (Leeds-Keio Artificial Ligament, Neo Ligament, Leeds, England, United Kingdom) [10, 15, 16]. The hybrid graft was used to address the above described weak points based on biomechanical studies [17–19]. In anatomic double-bundle ACL reconstruction, the authors developed the protocol described below to fully utilize the limited amount of hamstring tendon. Concerning the graft preparation in double-bundle ACL reconstruction, a few clinical comparisons between different fashioning techniques have been reported [20, 21]. On the basis of clinical results [8, 9, 13], the authors hypothesized that there are no significant differences between the semitendinosus tendon alone and semitendinosus and gracilis tendon graft fashioning methods concerning knee stability and clinical outcome after anatomic double-bundle ACL reconstruction. The purpose of this study was to test this hypothesis.

## Materials and methods

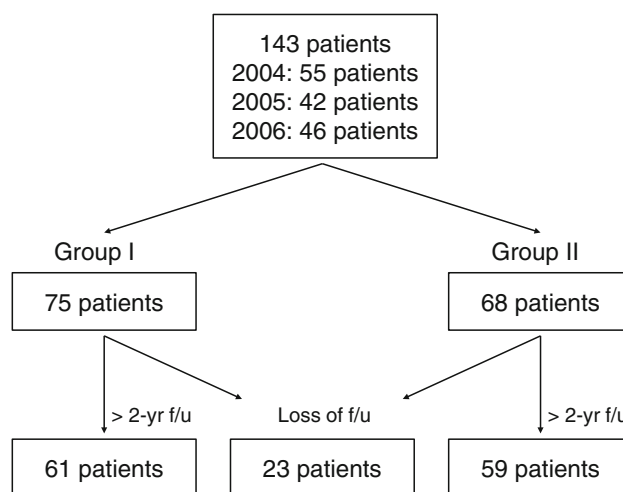
### Study design

A prospective, comparative, cohort study was conducted in 143 patients who underwent anatomic double-bundle ACL reconstruction using hamstring tendon autografts in one of the author’s affiliate hospitals between 2004 and 2006. Based on the graft fashioning protocol described below, the authors performed anatomic double-bundle reconstruction using semitendinosus tendon autograft or semitendinosus and gracilis tendon autografts for all patients. Each patient showed an ACL deficiency in the unilateral knee at the time of surgery. The diagnosis of injured ligaments was made based on a detailed history of the knee injury, physical examinations on pathologic status and abnormal laxity,

routinely performed computed digital radiographs and MRI scans, and the findings at surgery. Patients with a combined ligament injury in the posterior cruciate ligament, the lateral collateral ligament, the PL corner structures of the knee, and medial collateral ligament (grade 3) were excluded from this study. In addition, patients with any previous operations for ligament injuries, a concurrent fracture, or severe osteoarthritis were excluded. The time from onset of injury to surgery was 1 month or more. This clinical study design had been accepted by the institutional review board clearance in this hospital before commencement, based on the described study design and informed consent.

In 2004, 2005 and 2006, 55, 42, and 46 patients, respectively, were enrolled in this study. Patients were informed that they were going to be in a study, and that they could choose another graft type if they did not wish to participate in this study. Other surgical options in this hospital included single-bundle reconstruction with hamstring tendon autografts, or a bone-patella tendon-bone autograft. The patients who did not wish to take part in this study were not enrolled.

Two years after surgery, each patient was examined with the standard clinical evaluation methods. One hundred and twenty patients (83.9 %) underwent the same follow-up examinations, while 23 patients were lost (Fig. 1); 16 patients were excluded from the evaluation because there were no muscle torque data taken at the final follow-up. Two patients were excluded for contralateral ACL injury and ipsilateral revision ACL surgery, respectively. Finally, three patients did not attend the regular follow-up after ACL reconstruction up to 2 years postoperatively. There were 68 men and 52 women with an average age of 27 years at the time of surgery. In Group I, 61 patients underwent anatomic double-bundle ACL reconstruction using the semitendinosus tendon alone. In Group II, 59 patients underwent anatomic double-bundle ACL



**Fig. 1** Flowchart demonstrating patient movement through the study

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