Comparison of Clinical Outcomes After Anterior Cruciate Ligament Reconstruction Using a Hybrid Graft Versus a Hamstring Autograft

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Purpose: This study aimed to compare the clinical outcomes of patients who underwent anterior cruciate ligament (ACL) reconstruction with a hybrid graft versus an autograft after 3 years of follow-up. **Methods:** Among 57 patients with an ACL injury who underwent ACL reconstruction, 28 patients received a hybrid graft (gracilis and semitendinosus tendon autograft plus a soft tissue allograft) and 29 patients received an autograft (gracilis and semitendinosus tendon autograft). The 2 groups were compared after a minimum 3-year follow-up regarding International Knee Documentation Committee (IKDC) assessment of knee function and stability, pivot-shift test, Lachman test, and KT-1000 side-to-side differences. The patient-reported Tegner activity score, Lysholm score, and subjective IKDC score were also compared. Graft failures were identified by patient-reported outcomes, physical examinations, or magnetic resonance imaging, and were confirmed on second-look arthroscopy; failure rate was compared between groups. **Results:** At final follow-up, the 2 groups significantly differed in pivot-shift test result ($P = .013$) and Lachman test result ($P = .027$). The failure rate tended to be greater in the hybrid graft group (14.3%) than in the autograft group (3.4%) ($P = .148$). All 5 patients with failed graft reconstruction were revised after second-look arthroscopy. The KT-1000 side-to-side differences at final follow-up were significantly inferior in the hybrid graft group (3.5 ± 2.0) compared with the autograft group (2.5 ± 1.0, $P = .024$). The hybrid graft group also had a lower mean Lysholm score ($P = .000$) and subjective IKDC score ($P = .006$) than the autograft group. The mean Tegner activity score was 6.8 ± 0.8 in the hybrid graft group and 6.9 ± 0.6 in the autograft group ($P = .436$). **Conclusions:** The knee stability and patient-reported scores in the autograft-irradiated allograft hybrid graft ACL reconstruction group were significantly inferior compared with those in the autograft ACL reconstruction group. **Level of Evidence:** Level III, retrospective comparative study.

Anterior cruciate ligament (ACL) injury is one of the most common knee injuries,[1] and the most commonly used tissue for autograft ACL reconstruction is the hamstring tendon. Some previous studies reported that using a hamstring autograft of 8 mm diameter or less results in poorer clinical outcomes.[2-4] However, some patients have a small hamstring tendon diameter, which may compromise the mechanical properties of the autograft. Another common tissue used for primary ACL reconstruction is an allograft.[5] One of the major benefits of using allografts for ACL reconstruction is a predictable graft size with no donor site morbidity.[6] So the ideal solution to an inadequate graft diameter may be to augment the autograft with an allograft to create a hybrid graft. However, to date, only a few studies have compared the outcomes of ACL reconstruction using a hamstring autograft versus a hybrid graft,[7-10] and the reported outcomes still vary. Leo et al.[7] and Li et al.[10] reported that ACL reconstruction via a hybrid graft has a similar rupture rate and clinical outcomes to those achieved using a hamstring autograft, whereas Burrus et al.[8] and Darnley et al.[9] reported that hybrid grafts may have a higher failure rate and increased risk for revision ACL reconstruction. However, these previous studies have had several differences, such as the sterilization process of the allograft tissue used for hybridization, graft fixation device, and reconstruction technique, which may

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have induced this discrepancy and clinical outcome bias.

The purpose of the present study was to compare the outcomes of patients who underwent ACL reconstruction with an autograft versus a hybrid graft after a minimum 3-year follow-up. We hypothesized that hybrid graft ACL reconstruction would be associated with a higher failure rate, poorer knee assessment and stability, and poorer patient-reported outcomes than hamstring autograft ACL reconstruction.

Methods

This was a retrospective study comparing ACL reconstruction with an autograft (gracilis and semitendinosus tendon) with ACL reconstruction with a hybrid graft (gracilis and semitendinosus tendon autograft plus a soft tissue allograft comprised of the tibialis anterior tendon). Patients provided written informed consent for study inclusion. The inclusion criteria were (1) diagnosis of unilateral isolated ACL rupture by magnetic resonance imaging and (2) age more than 18 years with radiographic evidence of skeletal maturity. The exclusion criteria were (1) injury to multiple knee ligaments, meniscal injury, and/or cartilage injury requiring surgery; (2) previous ACL surgery in the same knee; (3) contralateral knee ligament injury; (4) radiographically verified osteoarthritis; or (5) history of metabolic pathologies.

A total of 113 patients underwent ACL reconstruction in our hospital between July 2013 and July 2014. Of these 113 patients, 57 patients were included in the present study; 29 patients received autograft ACL reconstruction, and 28 received hybrid ACL reconstruction. All patients underwent arthroscopic primary ACL reconstruction by an experienced orthopaedic surgeon (S-J.G.). All autografts were composed of gracilis and semitendinosus tendons harvested from each patient intraoperatively. All allografts in the hybrid graft group were γ-irradiated (at a dose of 2.5 Mrad) and supplied by AoRui Tissue Bank, which had policies for serologic and microbiologic testing in accordance with guidelines set by the American Association of Tissue Banks and the US Food and Drug Administration. The protocol for graft choice was based on the size of the hamstring autograft, which was determined intraoperatively. If the combined diameter of the harvested hamstring autograft was less than 8 mm after being doubled once, an allograft was used as an augmentation to achieve a diameter equal to or larger than 8 mm.

Surgical Technique

Diagnostic arthroscopy was performed under general anesthesia to confirm ACL rupture. After confirmation, the gracilis and semitendinosus tendon autografts were harvested by a stripper through a standard oblique incision over the pes anserinus. The harvested autografts were cleaned of soft tissue on the graft preparation board. Once doubled over, if the combined diameter of the autograft was less than 8 mm, allograft tissue was used as augmentation to achieve a diameter equal to or larger than 8 mm. The graft tendons were sutured together at the top end. After the tendons were doubled over once, a hybrid graft with a combined diameter equal to or larger than 8 mm was created.

The remnant ACL fibers were clearly debrided to enable identification of the anatomic attachments on the tibia and femur. After the tibial pin was fixed at the tibial footprint of the ACL, the tibial tunnel was reamed. The femoral tunnel was then created independently on the anatomic ACL attachment on the femur through the anteromedial port from inside to outside. The tunnel diameter was equal to the graft tendon diameter. After reaming the tibial and femoral tunnels, the graft tendon was pulled into both tunnels from tibia to femur. The EndoButton (Smith & Nephew Endoscopy, Andover, MA) was flipped and fixed on the femoral cortical surface. The tibial tunnel was fixed with a biocomposite interference screw (Arthrex, Naples, FL). The length of the interference screw was 28 mm, and the diameter of the interference screw was equal to the bone tunnel in each case, ranging from 8 to 10 mm. Finally, the wound was closed in layers.

Rehabilitation

All patients followed the same rehabilitation protocol regardless of graft type or graft size. A brace was used immediately postoperatively for up to 6 weeks. Range-of-motion exercises and isometric quadriceps training were started 2 days postoperatively. The patients were permitted to conduct 50% weightbearing and full weightbearing at 6 and 12 weeks, respectively. Patients progressed back to jogging at 6 months postoperatively.

Clinical Outcome

After a minimum follow-up period of 3 years postoperatively, all patients were contacted and returned to our hospital for final follow-up evaluation. The Lachman test and pivot-shift test were used to examine knee laxity. Side-to-side differences were measured using a KT-1000 arthrometer (MEDmetric, San Diego, CA). The Lysholm score, Tegner activity score, and International Knee Documentation Committee (IKDC) evaluation were recorded before reconstruction and at final follow-up evaluation. Graft failure was defined as patient-reported knee instability that affected daily living or sport activities, pathologic laxity detected when the surgeon performed the physical examination (positive Lachman test, positive pivot-shift test, or a KT-1000 side-to-side difference greater than 3 mm), or magnetic resonance imaging (MRI) evidence. In all cases with suspected graft failure, second-look arthroscopy was performed to enable definitive confirmation of failed