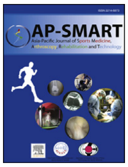
Available online at www.sciencedirect.com

ScienceDirect

Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology 3 (2016) 6–12
www.ap-smart.com



Original article

Graft quality and clinical outcomes of intraoperative bone tunnel communication in anatomic double-bundle anterior cruciate ligament reconstruction

Atsushi Ichiba*, Fumihito Tokuyama, Kaoru Makuya, Kosaku Oda

Department of Orthopedic Surgery, Takatsuki Red Cross Hospital 1-1-1, Abuno, Takatsuki, Osaka, 569-1096, Japan

Received 11 August 2015; revised 18 October 2015; accepted 30 October 2015
Available online 11 January 2016

Abstract

Background/objective: In anatomic double-bundle anterior cruciate ligament reconstruction, it is crucial to create two separate bone tunnels within the footprints of the anterior cruciate ligament at the femur and tibia. This can occasionally be difficult to accomplish and the adverse effects of bone tunnel communication are unclear. The purpose of this study was to examine the effects of intraoperative bone tunnel communication on graft quality and clinical outcome.

Methods: Fifty-two patients (52 knees) who underwent anatomic double-bundle anterior cruciate ligament reconstruction with hamstring tendons were included. The mean age of the patients was 30.7 years. Clinical assessments were performed 1 year after surgery. Bone tunnel communication was evaluated using computed tomography 10 days after surgery. Graft quality was evaluated using magnetic resonance imaging 6 months after surgery and the signal/noise quotient was calculated using the region of interest technique.

Results: Bone tunnel communication was observed in the femur of one knee (1.9%) and the tibias of 10 knees (30.8%). The knees with tibial bone communication were classified into Group C ($N = 16$), and the knees without tibial bone tunnel communication were classified into Group N ($N = 36$). No significant differences were observed between Groups C and N in terms of clinical outcome. The signal/noise quotient of the distal portion of the posterolateral graft in Group C was significantly higher than that of Group N.

Conclusion: Bone tunnel communication in anatomic double-bundle anterior cruciate ligament reconstruction did not affect clinical outcome, but it did affect posterolateral graft quality.

Level of evidence: Level 4, case series, therapeutic studies.

Keywords: bone tunnel communication; clinical outcome; double-bundle anterior cruciate ligament reconstruction; magnetic resonance imaging

Introduction

Endoscopic anterior cruciate ligament (ACL) reconstruction is one of the most commonly performed orthopaedic surgeries, and the concepts and techniques of this surgery have changed drastically over the past 10 years. In particular, the concept of anatomic reconstruction, creating bone tunnels within the anatomic centre of the native footprint, was introduced and is now considered important for both the single-bundle and double-bundle (DB) procedures.[1–3]

In DB ACL reconstruction, it is crucial to create two separate bone tunnels within the ligament's footprints in the femur and tibia, preserving a bony bridge between the tunnels. This can be difficult because of the lack of definite arthroscopic surgical landmarks, small patient body

---

* Corresponding author. Department of Orthopedic Surgery, Takatsuki Red Cross Hospital 1-1-1, Abuno, Takatsuki, Osaka, 569-1096, Japan.
E-mail address: adriasea7264@yahoo.co.jp (A. Ichiba).

http://dx.doi.org/10.1016/j.asmart.2015.10.001

constitution,[4,5] and technical errors during surgery. Bone tunnel communication results in excessive graft movement and adverse effects on the remodelling processes of the graft and bone-tendon healing in the bone tunnels. Lehmann et al[6] indicated that a 1-mm bony bridge between the tunnels in the femur results in a reduction of biomechanical strength and that a 2-mm bony bridge is necessary. Peterson et al[7] compared the biomechanical properties of the knees that were reconstructed via one or two tibial tunnels in anatomic DB ACL reconstruction. The results indicated that the knees with two tibial tunnels exhibited better biomechanical outcomes. The cadaveric knees that were reconstructed with one tibial tunnel and two femoral tunnels were equivalent to the cases in which two tibial tunnels completely communicated.

Revision surgery is difficult after DB ACL reconstruction cases of bone tunnel communication. Bone tunnel communication is one of the weak points of DB ACL reconstruction, and surgeons should pay special attention to this issue. There are some reports of bone tunnel communication in DB ACL reconstruction,[6,8–10] but studies on the adverse effects of bone tunnel communication are currently ongoing.

The purpose of this study was to examine the effects of intraoperative bone tunnel communication caused by drilling on the graft quality and clinical outcomes of patients undergoing anatomic DB ACL reconstruction. Three-dimensional computed tomography (CT) was used to investigate whether bone tunnel communication was present, and magnetic resonance imaging (MRI) was used to evaluate graft qualities. Our hypothesis was that bone tunnel communication would affect the graft quality but not the clinical outcome.

Materials and methods

Participants

All patients were operated on between January 2009 and December 2012. In this period, 78 isolated primary anatomic DB ACL reconstructions with hamstring tendons were performed in our institution. Inclusion criteria were: primary ACL reconstruction, closed growth plates, more than 1 year of follow-up after surgery, CT performed 10 days after surgery, and MRI performed 6 months after surgery with grafts clearly depicted on MRI. Exclusion criteria were also applied: previous knee surgery, additional knee ligament injury (posterior cruciate ligament injury or Grade 3 collateral ligament injury), and contralateral knee injury.

Clinical assessments

Clinical assessments were performed before surgery and 1 year after surgery by the same experienced orthopaedic doctor, and included the Lysholm knee scoring scale, the International Knee Document Committee objective scoring system, anterior laxity measured with a KT-1000 arthrometre (MEDmetric Corp., San Diego, CA, USA; a side-to-side difference at 134 N of stress was adopted), and a pivot-shift test.

Surgical technique

All operations were performed by the same experienced surgeon. Anatomic DB ACL reconstructions with hamstring tendons were performed in all patients. The footprint of the ACL on the femur was identified, and the ACL remnant was resected to observe the lateral intercondylar ridge on the lateral femoral condyle.[1] The ACL remnant of the tibial insertion was resected, which left a remnant of 1–2 cm. Femoral tunnels were created. Two 2.4-mm guide pins were inserted using the outside-in method with an anterolateral-entry femoral aimer (Smith & Nephew, Andover, MA, USA) at the centres of the footprints of the anteromedial (AM) and posterolateral (PL) bundles. Next, bone tunnels with diameters of 5.5–6.0 mm and 5.0–6.0 mm were created for the AM and PL grafts, respectively. After creating the femoral tunnels, tibial tunnels were created. Two 2.4-mm guide pins were inserted into the centres of the footprints of the AM and PL bundles. Then, bone tunnels with diameters of 5.5–6.5 mm and 5.0–6.0 mm were created for the AM graft and the PL graft, respectively. The grafts were fixed with two Endobutton CLs (Smith & Nephew) on the femoral side and two Double-Spike Plates (Smith & Nephew) on the tibia. The AM graft was set at 30 N and the PL graft at 20 N at 10° of knee flexion as determined with a ligament tensioner (Smith & Nephew).

Evaluation of bone tunnel communication on CT

Evaluations of bone tunnel communication were performed with a three-dimensional CT scanner (Aquilion 64, Toshiba Medical Systems, Tochigi, Japan) 10 days after surgery. In the femur and tibia, the presence of bone tunnel communication was determined based on coronal, sagittal, and axial sections. If bone tunnel communication was identified, the length of the communication was measured with CT, and the measurements were performed on the Digital Imaging and Communications in Medicine files using the manufacturer's software (Toshiba Medical Systems; Figure 1).

Evaluation of the reconstructed ACLs on MRI

Grafts were performed by MRI 6 months after surgery. Patients were scanned using a Vantage XGV with 1.5 T (Toshiba Medical Systems). All images were obtained with the patient in the supine position and affected knee extended. The standard sequences were sagittal proton density-weighted spin-echo (TR/TE, 1,300/12) sagittal and coronal T2-weighted gradient-echo (TR/TE 532/15) with a 25º flip angle, and axial proton-density spin-echo fat-suppressed (TR/TE 4,000/102). T2-weighted sagittal oblique images were used for evaluation. The slice thickness was 3 mm with a gap of 0.6 mm. The field of view was 16 cm, and the matrix size was 224 pixels × 352 pixels. The graft evaluations were performed by an experienced orthopaedic doctor. To analyse the graft quality, the signal/noise quotient (SNQ) was calculated using the region of interest (ROI) technique (with the diameter of a 3.0 mm^2 circle) with the following equation[11]: