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Original article

Revision single-bundle anterior cruciate ligament reconstruction with over-the-top route procedure

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ABSTRACT

Purpose: In revision anterior cruciate ligament reconstruction (ACLR), the single-stage technique and the over-the-top route (OTTR) procedure were usually selected for cases where the bone tunnel cannot be created at an anatomical position due to tunnel enlargement and overlap with the mal-positioned tunnel of primary reconstruction. The purpose of this study was to evaluate the clinical results of revision single-bundle ACL reconstruction using OTTR procedure and to compare the clinical results of OTTR procedure with those of anatomical single-bundle revision reconstruction (SBR).
Hypothesis: The results of OTTR procedure are equivalent to that of SBR.
Methods: Seventy-six revision ACL reconstruction knees from April 2002 to December 2012 were involved in our study. We focused on 21 knees which underwent surgery with SBR and 22 knees with OTTR using hamstring tendon. The clinical results were evaluated by means of the Lysholm score and the knee stability was assessed by the Lachman test, pivot-shift test and side-to-side difference by KT-2000 pre-operatively and after 1 year post-operatively. AP translation and rotational laxity using a navigation system were evaluated before and after revision ACL reconstruction under anesthesia in 8 cases of OTTR and in 6 cases of SBR.
Results: There was no statistically significant difference between the OTTR and SBR regarding Lysholm score, Lachman test, pivot-shift test, ATT by KT-2000, and AP translation and rotational laxity with a navigation system.
Conclusions: The clinical results of OTTR are almost equivalent to those of SBR. For the cases in which it is impossible to create the femoral tunnel in an anatomical position, OTTR is a valuable revision ACL reconstruction method.
Level of evidence: Case-control study. Level III.

1. Introduction

The revision anterior cruciate ligament reconstruction (ACLR) procedures are more complex than those of primary reconstruction, because the pre-operation status differs from case to case, with the most demanding cases being those where the femoral tunnel cannot be created due to bone tunnel enlargement. As a general rule, second-stage revision surgery using bone grafting has been performed for such cases. However, they require a long therapeutic period which may cause mental distress to a patient and jeopardize an athlete's career. Therefore, the single-stage technique for revision ACLR has been recommended and the over-the-top route (OTTR) procedure has been selected for cases where the bone tunnel could not be created in an anatomical position due to tunnel enlargement and overlap with the mal-positioned tunnel of primary reconstruction. OTTR procedure had been regarded as the last ACLR revision option and salvage procedure for skeletally immature patients [1,2]. Previous clinical reports showed that OTTR procedure restore antero-posterior (AP) stability, but it is unknown whether rotational stability is restored or not [3,4]. Recent studies have reported that OTTR restores intact knee kinematics, and that the antero-posterior stability and rotation stability of OTTR are comparable to that of anatomical single-bundle reconstruction [5,6]. However, no report has evaluated the clinical results relating to knee stability of OTTR procedure in revision ACLR.

The purpose of this study is to evaluate the clinical results of revision single-bundle ACL reconstruction using OTTR procedure and to compare the clinical results of OTTR procedure with those

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of single-bundle revision reconstruction (SBR). Our hypothesis is that the results of OTTR procedure are equivalent to that of SBR.

2. Material and methods

Seventy-six revision ACL reconstruction knees from April 2002 to December 2012 were involved in our study. Twenty-one knees which underwent surgery with SBR and 22 knees with OTTR procedure using hamstring tendon retrospectively. There was no statistically significant difference between the OTTR group and SBR group regarding gender, age, interval from primary ACLR to reconstructed ACL failure and interval reconstructed ACL failure to revision surgery (Table 1). At the time of revision ACLR, meniscal and chondral injury was observed in 7 patients of SBR and 8 patients of OTTR procedure. There was no statistically significant difference in the presence of meniscus and cartilage lesions.

All surgery were performed and directed by senior author (M.O), using autologous quadrupled semitendinosus tendon. The ipsilateral semitendinosus tendon was harvested if it had not been used for primary reconstruction, but the contralateral semitendinosus tendon was harvested if it had been used for primary ACL reconstruction. In SBR, femoral graft fixation was achieved with EndoButton-CL (Smith&Nephew, Andover, Massachusetts) (Fig. 1). The distal ends of the graft were sutured with Endobutton tape (Smith&Nephew) and tibial fixation was achieved with two staples with the tension of 50 N. In OTTR procedure group (Figs. 2 and 3), the both ends (proximal and distal) were sutured with Endobutton tape. A 4-cm longitudinal skin incision was made proximal to the lateral femoral condyle. After incising the fascia lata, the vastus lateralis was reflected upwards. The periosteal was divided longitudinally. OTTR was made with curved Kelly's forceps, inserted through the medial infra-patellar portal into the intercondylar space. The tip of the forceps was passed between ACL remnant and PCL to break the postero lateral capsule. After breaking the joint capsule, the tip of the forceps emerged at the lateral aspect of the femur, and the graft was passed through the same way. Finally, the graft was fixed to the distal femur with two staple and then tibial fixation was achieved with two staples with the tension of 50 N (Fig. 4).

Post-operative rehabilitation followed the same program as that of primary ACLR. Active quadriceps exercises were carried out as soon as possible. The knee was immobilized at 30° flexion for two days. Range of motion exercise was encouraged using continuous passive motion. The extension was limited at –30 degrees in a brace for three months to prevent the loosening of ACL graft. Partial weight-bearing was allowed at 10 days, full weight-bearing at 3 weeks and jogging at 4 months after surgery. Return to sports activity was permitted at 12 months after surgery.

The clinical results were evaluated by means of the Lysholm score pre-operatively and at 1 year post-operatively. The post-operative stability was assessed by the Lachman test, pivot-shift test and side-to-side difference of anterior-posterior translation of the tibia (ATT), as measured by the knee arthrometer (KT-2000, Medtronic) at 30 lbs pre-operatively and at 1 year post-operatively. The Lachman test and the pivot-shift test were simply classified as positive or negative.

AP translation and rotational laxity using a navigation system (Orthopilot ACL reconstruction V 2.0, B. Braun Aesculap, Tuttlingen, Germany) were evaluated before and after revision ACL reconstruction under anesthesia in 8 cases of OTTR group and in 6 cases of SBR group. ATT was measured under the anterior tibial loads of 100 N, and then the total range of tibial rotation (TTR) was measured under the rotational torque of 1.5 Nm using our original device with the knee at 30°of flexion [7,8].

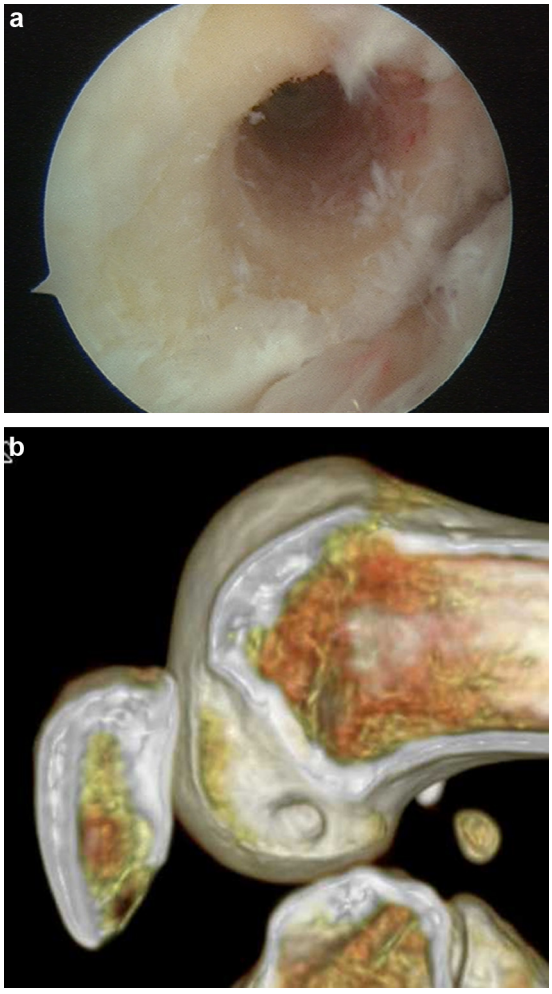

Fig. 1. Single-bundle revision reconstruction case. The primary femoral bone tunnel is in an anatomical position and not enlarged. a: arthroscopic view; b: 3D-CT.

Table 1
Gender, age, interval from primary ACLR to ACL failure and interval from reconstructed ACL failure to revision surgery in both groups.

	OTTR	SBR	*P* value
Gender	M: 10 F: 12	M: 7 F: 14	NS
Age	32.3 (16–62)	30.9 (5–20)	NS
Interval from primary ACLR to ACL failure	7.9 y (5m–25 y)	10.2 y (5m–20 y)	NS
Interval from reconstructed ACL failure to revision surgery	2.8 y (2m–15 y)	2.9 y (2m–17 y)	NS

OTTR: over-the-top route; SBR: single-bundle revision; ACLR: anterior cruciate ligament reconstruction.

3. Statistical analysis

The Chi^2 test was used to evaluate gender, the Lachman test and pivot-shift test. The Mann-Whitney U test was used to evaluate age, the Lysholm score, the interval from primary ACLR to reconstructed ACL failure, the interval from reconstructed ACL failure to revision surgery, the side-to-side difference of ATT was calculated by the knee arthrometer, and ATT and TTR was evaluated using a navigation system.

A *P* value of less than 0.05 was considered to indicate a statistically significant difference.