Original Article

Comparative study of the modified transtibial technique and the transportal technique in anterior cruciate ligament reconstruction

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Background: This study sought to compare the efficacy of the modified transtibial (TT) technique and the transportal (TP) technique in arthroscopic anterior cruciate ligament (ACL) reconstruction.

Methods: This study retrospectively analyzed the clinical data of 74 patients (74 knees) who underwent ACL reconstruction using a single bundle of autologous hamstring tendon graft from October 2013 to September 2017. Forty-one knees were reconstructed using the TT technique (the TT group), and 33 were reconstructed using the TP technique (the TP group). There was no statistically significant difference between the two groups (P>0.05) in terms of age, sex, follow-up time, time from injury to operation, left and right knees, body mass index, and preoperative International Knee Documentation Committee (IKDC) score, Tegner Activity score (Tegner score), Lysholm score, Lachman test results, and Pivot-Shift test results.

Results: The incisions in both groups were healed by first intention, and no early postoperative complications occurred. All patients attended follow-up appointments. The TT group had a follow-up period of 24–46 months (average follow-up time: 27.3 months). The TT group had a follow-up period of 24–38 months (average follow-up time: 26.3 months). Two years after surgery, the IKDC, Lysholm, and Tegner scores of the two groups were significantly improved compared to those before surgery (P<0.05), and there was no statistically significant difference between the two groups in relation to these scores (P>0.05). There was also no statistically significant difference in the Lachman and Pivot-Shift test results between the two groups (P>0.05).

Conclusions: Both the TT and TP techniques provide satisfactory efficacy in ACL reconstruction.

Keywords: Arthroscopy; ACL reconstruction; modified transtibial technique (TT technique); transportal technique (TP technique)

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Introduction

As an important static stable structure of the knee joint, the anterior cruciate ligament (ACL) plays an important role in the anterior-posterior and rotational stability of the knee joint (1). The ACL is also one of the most common ligaments to be injured (2). ACL rupture leads to the damage of knee joint function and increases the chance of developing knee osteoarthritis (3,4). Injuries to the ACL often result in knee pain, impaired function, and increase the risk of meniscus tear and early osteoarthritis (5). Given the poor efficacy of conservative treatments for ACL injury, ACL reconstruction is widely used in clinical settings (6). Despite previous study on ACL reconstruction, the increased risk of early osteoarthritis and the function

impairment of the knee joint have not yet been resolved (7).

Drilling the femoral tunnel through the tibial tunnel is the most widely used method in single-bundle anterior cruciate ligament reconstruction (8), but due to the drawback that femoral tunnel position is dictated by the tibia tunnel, it makes anatomic femoral tunnel formation difficult (9). Transportal (TP) technique can produce an anatomically positioned femoral tunnel more easily than the transtibial technique because femoral tunnel positioning is independent of the tibial tunnel. However, TP technique has the potential risk of posterior wall blowouts, short femoral tunnel length etc. (10).

A study has compared transtibial technique with transportal technique for SB ACL reconstruction (11), their efficacy remains controversial. A modified transtibial technique may overcome the drawback of transtibial technique, however, fewer studies focus on it. We adopted a modified transtibial technique and hypothesized that there would be no significant differences between the modified transtibial technique and transportal technique in clinical outcomes. We present the following article in accordance with the STROBE reporting checklist (available at https://apm.amegroups.com/article/view/10.21037/apm-21-2460/rc).

Methods

General information

Patients with an ACL rupture who underwent ACL reconstruction using an autologous hamstring tendon graft at the Shaoxing People's Hospital from October 2013 to September 2017 were selected as the research objects. Seventy-four patients with an ACL rupture underwent autologous hamstring tendon reconstruction. Among these patients, the TT technique (the TT group) was used in 41 cases, and the TP technique was used in 33 cases (the TP group). The TT group comprised 23 males and 18 females, aged 19 to 44 years (average age: 31.2±10.5 years). ACL reconstruction was performed on the left knee in 16 cases and the right knee in 25 cases in the TT group, and the time from injury to operation ranged from 3 days to 3 years (median time: 30 days). In the TT group, 5 patients had a meniscus injury, 5 had a cartilage injury, 3 had an Outerbridge Grade I, and 2 had an Outerbridge Grade II. Conversely, the TP group comprised 20 males and 13 females, aged 16 to 42 years old (average age: 29.7± 10.2 years). ACL reconstruction was performed on the left knee in 13 cases and the right knee in 20 cases in the TP group, and the time from injury to operation ranged from 5 days to 3 years and 2 months (median time: 32 days). In the TP group, 13 patients had a meniscus injury, 4 had a cartilage injury, 3 had an Outerbridge Grade I, and 1 had an Outerbridge Grade II. All the operations were performed by the same orthopedic surgeon. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Ethics Committee of the Shaoxing People's Hospital (No. 2021-84). Written informed consent was obtained from the patients or their parental/legal guardians.

Criteria for inclusion and exclusion

To be eligible to participate in the study, patients had to meet the following inclusion criteria: (I) be aged 16–45 years; (II) have undergone magnetic resonance imaging (MRI) and a physical examination that confirmed an ACL injury (meniscus injury or mild cartilage injury with Outerbridge Grade I or II); (III) require single-bundle four-strand hamstring reconstruction; (IV) have no serious postoperative complications, such as an infection or fracture; and (V) have been followed-up with for a period of more than 2 years and have complete clinical data. Patients were excluded from the study if they met any of the following exclusion criteria: (I) had multiple ligament injuries of the knee joint; (II) had serious articular cartilage damage (Outerbridge Grade III or IV); and/or (III) had undergone revision surgery.

Methods of operation

All operations were performed under general anesthesia or continuous epidural anesthesia, and a pneumatic tourniquet was applied on the thigh root. The patients were placed in a supine position, with the affected limbs of patients in the TT group bent at 90 degrees and suspended beside the bed, and with the baffles placed on the outside of the affected limbs of patients in the TP group. The conventional anterolateral and transportal incision were adopted for both groups. The meniscus and cartilage were observed under an arthroscope, and the ACL rupture was identified. Patients with a meniscus tear were treated with meniscus repair (2 cases in the TT group and 4 cases in the TP group) or meniscectomy (3 cases in the TT group and 9 cases in the TP group). The injured cartilage was treated by routine conventional radio frequency (RF) vaporization gasification.

First, a longitudinal incision of the proximal medial side of the leg was made with reference to the narrowing point, and the gracilis and semitendinosus tendons were carefully separated, braided, and pretensioned for later use.

The following procedure was adopted for the TT group: (I) creation of tibial tunnel: the tibial point-to-point guide (Smith & Nephew) was set at 50 degrees, the knee was flexed at 90 degrees, and the intra-articular tip of the tibial guide was placed in a slight anterior and medial position relative to the conventional position. (II) Creation of femoral tunnel: a femoral guide was inserted through the tibial tunnel when the knee flexed at about 80 degrees, and the femoral guide insert through the tibial tunnel and stuck with posterolateral cortex of the intercondylar fossa of femur, and the tibia was turned varus and internal rotation. The guide pin was pointed between the anteromedial bundle and the posterolateral bundle. After inserting the guide pin, the femoral bone tunnel was drilled along the guide pin with a 4.5-mm hollow drill. After measuring the total length of the femoral bone tunnel, the thick femoral bone tunnel was drilled according to the graft diameter.

The following procedure was adopted for the TP group: creation of femoral tunnel: The guide pin was placed using an anterior-medial approach, and the guide pin was placed at the center of the ACL anatomical footprint point, with extreme knee flexion to about 120 degrees, and the posterior wall of the femoral bone tunnel was about 2 mm away from the posterior wall of the femoral condyle. After the guide pin was inserted, the femoral bone tunnel was drilled along the guide pin with a 4.5-mm hollow drill. The total length of the femoral bone tunnel was then measured, and the thick femoral bone tunnel was drilled according to the graft diameter. The central point of the tibial tunnel was at the intersection of the longitudinal line across the lateral slope of the medial intercondylar ridge and the horizontal line parallel to the free edge of lateral meniscus. The creation method was the same as that used in the TT group.

The graft was pulled into the tunnel through the tibial-femoral tunnel. The ACL was reconstructed with 4-strand autologous gracilis and semitendinosus tendon bundles with a diameter of 7–8 mm in both groups. Endobutton (Smith & Nephew, UK) with appropriate specifications was selected for the femoral side fixation according to the length of the tunnel, and Intrafix (Smith & Nephew, UK) was selected for the tibial side fixation according to the diameter of the tunnel. At the end of the operation, the existence of intercondylar notch impingement and graft tension were examined, and the wound was sutured layer by layer after irrigation.

Postoperative treatment

The two groups received the same treatment. All patients were protected by a hinged knee brace, and ice packs were applied to the knee joint for 3 days after the operation. On the 1st day after the operation, the patients were trained to perform isometric contractions of the quadriceps femoris and ankle pump exercises, and walk with partial weight-bearing crutches. Patients undergoing meniscus repair should avoid weight-bearing for 3 weeks after the operation. The flexion angle of the knee joint was gradually increased after the operation, and was adjusted to 60 degrees at 1 week after the operation, 90 degrees at 2 weeks after the operation, and over 120 degrees at 6 weeks after the operation. 6 weeks later, patients were able to walk without weight-bearing crutches and their life gradually returned to normal; 12 weeks later, patients were able to engage in simple outdoor activities and light physical labor.

Evaluation index for efficacy

All the evaluations were conducted by another senior orthopedic surgeon who had no knowledge of the grouping. The patients were followed-up before and after surgery, and the anterior and lateral X-rays, three-dimensional (3D) reconstruction and MRI scans of the knee joint were taken. The Anterior Drawer Test (Lachman test), in which the patients were asked to flex the knee to 30°, and the Pivot-Shift test were used to evaluate the stability of the knee joint before and after surgery. In addition, the International Knee Documentation Committee (IKDC) score, Tegner Activity score (Tegner score) and Lysholm score were used to evaluate knee joint function before and after surgery.

Statistical analysis

SPSS21.0 statistical software was used for the analysis. The measurement data are expressed as mean ± standard deviation. Independent sample t tests were used for comparisons between the groups, and paired t tests were used for comparisons before and after surgery within the groups. The counting data were expressed by rate, and comparisons between the groups were carried out using the χ^2 test. The rank-sum test was used to compare grade data groups. The test level was set as α=0.05.

Table 1 General information of patients

	Number of cases	Male/female (case)	Age [year, ($\bar{x}$±s)]	Follow-up time [month, ($\bar{x}$±s)]	Operation time [week, ($\bar{x}$±s)]	Injured knee joint (left/right, cases)	BMI [kg/m^2, ($\bar{x}$±s)]
TT group	41	23/18	31.2±10.5	27.3±5.4	14.1±26.8	16/25	24.6±2.5
TP group	33	20/13	29.7±10.2	26.3±3.6	15.1±33.0	13/20	24.0±2.6
Statistical value	–	χ^2=0.153	t=0.610	t=0.928	t=–0.149	χ^2=0.001	t=1.061
P value	–	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

BMI, body mass index; TT, transtibial; TP, transportal.

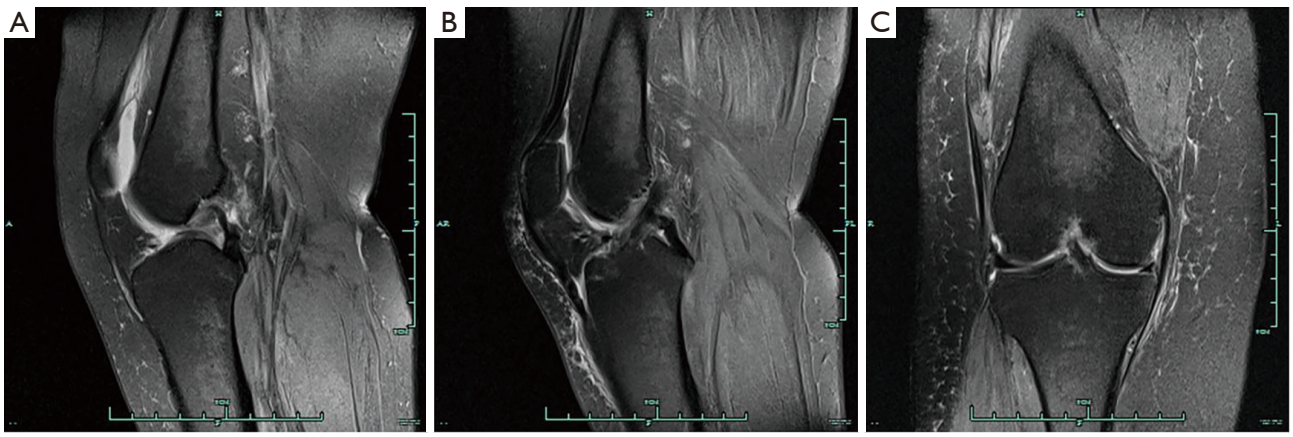

Figure 1 Diagram of the surgical procedure of TT technique. (A) Rupture of ACL; (B) sagittal view after ACL reconstruction through TT technique; (C) coronal view after ACL reconstruction through TT technique. TT, transtibial; ACL, anterior cruciate ligament.

Results

The incisions in both groups were healed by first intention without wound infection, vascular or nerve injury, or other complications. All patients attended follow-up examinations. The 41 patients in the TT group had an average follow-up time of 27.3±5.4 months, and the 31 patients in the TP group had an average follow-up time of 26.3±3.6 months. There was no statistically significant difference in the general information of the patients (see *Table 1*). During the follow-up period, the knee joint movement of the two groups was satisfactory, and no restriction of knee joint flexion and extension was observed. At the writing of this paper, the patients recovered their daily life without symptoms of joint swelling, pain or joint instability. The MRI scans showed the good tibial and femoral tunnels, the well survived grafts and the normal ligament tension (see *Figures 1,2*). Compared to the last follow-up examination, the IKDC, Lysholm, and Tegner scores of the two groups were significantly improved (P<0.05), and there was no statistically significant difference between the two groups (P>0.05; see *Table 2*). The stability (as determined by the Lachman and Pivot-Shift test results) of the two groups after surgery was significantly improved compared to that before surgery (P<0.05), and there was no statistically significant difference between the two groups (P>0.05; see *Table 3*).

Discussion

ACL reconstruction can be divided into isometric ACL reconstruction and anatomical ACL reconstruction according to the positioning of the femoral tunnel. Kim *et al.* (12) were of the view that positioning at isometric points helps to maintain the stability of the knee joint by keeping ACL in continuous tension during flexion and extension. As a classic technique of isometric reconstruction, the TT technique has a number of advantages, including that it is an easy operation to perform and its reproducibility is high. During the joint

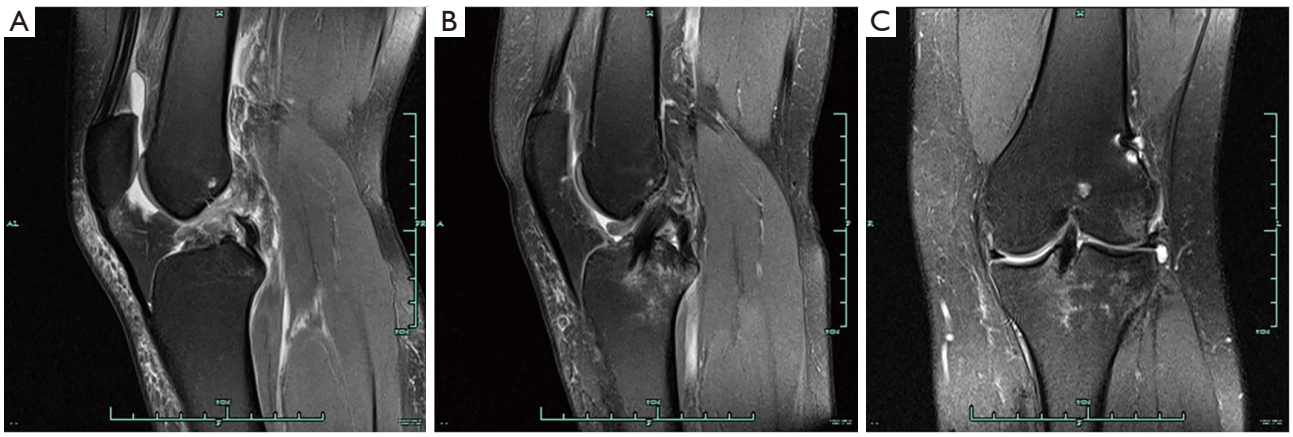

Figure 2 Diagram of the surgical procedure of TP technique. (A) Rupture of ACL; (B) sagittal view after ACL reconstruction through TP technique; (C) coronal view after ACL reconstruction through TP technique. TP, transportal; ACL, anterior cruciate ligament.

Table 2 Score of knee joint function ($\bar{x}$±s)

	Number of cases	Lysholm score		IKDC score		Tegner score	
		Before surgery	After surgery	Before surgery	After surgery	Before surgery	After surgery
TT group	41	44.1±7.0	90.2±6.1	37.8±6.3	86.4±7.4	4.7±1.0	6.1±1.0
TP group	33	42.6±6.4	92.1±6.2	40.0±6.5	88.8±7.9	5.2±1.0	6.4±0.9
t value	–	0.941	−1.375	−1.265	−1.358	−1.939	−1.063
P value	–	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

TT, transtibial; TP, transportal; IKDC score, International Knee Documentation Committee score.

Table 3 Evaluation of knee stability

	Number of cases	Lachman test				Pivot-Shift test			
		0	1+	2+	3+	0	1+	2+	3+
TT group	41	31	9	1	0	29	10	2	0
TP group	33	25	7	1	0	24	8	1	0
Z value	–	0.000				−0.007			
P value	–	>0.05				>0.05			

TT, transtibial; TP, transportal.

flexion and extension, the ligament is well protected, which can effectively control the anterior and posterior stability of the knee joint and minimize the tunnel enlargement caused by the "windshield-wiper effect" (13). Some scholars have reported that the TT technique is not good at controlling the rotational stability of the knee joint, and (14) the non-recovery of the normal knee kinematics may lead to knee degeneration (15).

With a better understanding of ACL anatomy and biomechanics, the kinematic changes of the knee joint after changing the position of the femoral tunnel in ACL reconstruction (16). Some scholars are of the view that positioning the femoral reconstruction point near the original ACL anatomical site helps to restore the normal function of ACL (17). TP is a classic technique of anatomical reconstruction, which can directly create a

femoral tunnel without a tibial tunnel, and the position of the intraarticular orifices of the tunnel is closer to the anatomical position. However, the TP technique also has its drawbacks, such as short tunnels and femoral condyle posterior wall blowouts (18). In addition, the extreme flexion of the knee joint during surgery may also result in a poor visual field and increase the risk of cartilage injury of the medial femoral condyle. In the animal model, it was found that the graft length in the tunnel significantly increased the pull-out strength of the tendon 6 weeks after surgery, and the pull-out strength of the graft increased by 153.7±78.6 newton (N) for every 1 cm increase in graft length (19).

After a 10-year follow-up period, the IKDC scores, Lysholm scores, and KT-2000 side-to-side difference (SSD) of the TT and TP groups were significantly improved compared with those before surgery (20), and there was no significant statistical difference in rotational stability, and the proportions of patients returning to preinjury level of activity were similar. The TP technique can reach the intraarticular orifices of femoral tunnel closer to the anatomical position, and the results of the Lachman and Pivot-Shift test results in the TP group were better than those in the TT group (21). A study has suggested that the anteromedial (AM) technique increases the risk of revision compared to the TT technique (22). A meta-analysis examined the different creation methods of the femoral tunnel, and found that each of the 4 methods has its own advantages and disadvantages, and none of them can be used as the gold standard at present (23).

By improving the traditional TT technique, the intraarticular orifices of the femoral tunnel can be located between the anteromedial bundle and the posterolateral bundle by turning the knee joint inward and rotating the knee joint inward during the creation of the femoral tunnel (12,24). After a follow-up period of more than 2 years, we found that the knee joint function scores and stability evaluations of the two groups were significantly improved compared with those before surgery, and there was no statistically significant difference between the two groups. Ro *et al.* found the clinical outcomes of ACL reconstruction were better with the TP than the TT technique, both on knee functional outcome scales and knee laxity tests, while our study found no difference between the two groups. It may result from improving the traditional TT technique (25). With the modified technique, the intraarticular orifices of femoral tunnel locate more anatomically, which may decrease stress. The modified TT technique is an easy operation to perform, is highly reproducible, and does not damage the medial condylar cartilage of the femur, and it may be an ideal method for ACL reconstruction.

Conclusions

The modified TT technique and TP technique both obtained satisfactory clinical results in ACL reconstruction using an autologous hamstring tendon graft. As this study was a retrospective study, and it had a limited sample size, thus, further multi-center prospective studies and long-term efficacy studies need to be conducted.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://apm.amegroups.com/article/view/10.21037/apm-21-2460/rc

Data Sharing Statement: Available at https://apm.amegroups.com/article/view/10.21037/apm-21-2460/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://apm.amegroups.com/article/view/10.21037/apm-21-2460/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Ethics Committee of the Shaoxing People's Hospital (No. 2021-84). Written informed consent was obtained from the patients or their parental/legal guardians.

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