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Observational Study

Comparative study of the clinical efficacy of all-inside and traditional techniques in anterior cruciate ligament reconstruction.

A comparative study of AIST and TBT

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Abstract

BACKGROUND

Many studies have focused on the femoral tunnel technique and fixation method, but few studies have involved the tibial tunnel technique and fixation method. The all-inside technique is one of the new techniques that has been described in recent years. All-inside ACL reconstruction is based on a tibial socket instead of a full tunnel. This method has many potential advantages.

AIM

To compare clinical outcomes of knee anterior cruciate ligament (ACL) autograft reconstruction using all-inside quadruple semitendinosus (AIST) and traditional hamstring tendon (TBT) techniques

METHODS

From January 2017 to October 2019, the clinical data of 80 patients with anterior cruciate ligament reconstruction were retrospectively analyzed, including 67 males and 13 females. The patients had an average age of 24.3 ± 3.1 years (age range, 18-33 years). The AIST technique was used in 42 patients and the TBT technique was used in 38 patients. The time between operation and injury, operative duration, postoperative visual analogue scale (VAS) score and knee functional recovery were recorded and compared between the two groups. The International Knee Documentation Committee (IKDC) and Lysholm scoring system were used to comprehensively evaluate clinical efficacy.

RESULTS

Eighty patients were followed for 24-36 months, with an average of follow-up duration of 27.5 ± 1.8 mo. There were no significant

differences in the time between surgery and injury, operative duration, IKDC and Lysholm scores of the affected knee at the last follow-up evaluation between the two groups. There were significant differences in VAS scores 1 day, 3 days, 7 days, 2 weeks, and 1 month after surgery ($P < 0.05$). There was no significant difference in VAS score at 3 months, 6 months and 1 year after operation.

CONCLUSION

The efficacy of the AIST ACL reconstruction technique was comparable to the TBT technique, but the postoperative pain was less with the AIST technique. Thus, the AIST technique is an ideal treatment choice for ACL reconstruction.

Key Words: Anterior cruciate ligament reconstruction; All-inside quadrupled semitendinosus; Clinical curative effect

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Core Tip: This study retrospectively analyzed 80 patients with anterior cruciate ligament (ACL) injuries who underwent all-inside quadruple semitendinosus (AIST) or traditional hamstring tendon (TBT). we demonstrated that ¹there were no significant differences in the time between surgery and injury, operative duration, IKDC and Lysholm scores of the affected knee. However, there were significant differences in VAS scores 1 day, 3 days, 7 days, 2 wk, and 1 mo after surgery ($P < 0.05$). These results indicated the efficacy of the AIST ACL reconstruction technique was comparable to the TBT technique, but the postoperative pain was less with the AIST technique. Thus, the AIST technique is a better choice for ACL reconstruction.

INTRODUCTION

Anterior cruciate ligament (ACL) injuries are common sports injuries that often lead to knee instability and secondary traumatic osteoarthritis, meniscus injuries, and contralateral ACL injuries [1-2]. Arthroscopic reconstruction of the ACL is the main method of repair. The optimal ACL reconstruction technique has not been determined, with reported graft retear rates ranging from 10%-25% [3-5]. This is a significant clinical problem due to the increasing frequency of ACL injuries occurring in this group [6-9] and to the high rate of secondary injuries following ACL reconstruction in this particular cohort [10-15]. Many studies have focused on the femoral tunnel technique and fixation method, but few studies have involved the tibial tunnel technique and fixation method. The all-inside technique is one of the new techniques that has been described in recent years. All-inside ACL reconstruction is based on a tibial socket instead of a full tunnel [16]. This method has many potential advantages. Specifically, Lubowitz *et al* [17] reported less pain with all-inside allograft ACL reconstruction compared with a full tibial tunnel in a randomized controlled trial. Therefore, this all-inside approach improved graft integration and stability of a hamstring construct [18], in contrast to other described hamstring reconstruction techniques that have been compared with a bone-patellar-tendon-bone graft, along with the added benefit of less anterior knee pain. The purpose of this investigation was to compare knee ACL autograft reconstruction using all-inside quadrupled semitendinosus (AIST) and traditional hamstring tendon (TBT) techniques. In this study 80 patients with ACL injuries admitted to our hospital from January 2017 to October 2019 were retrospectively analyzed.

MATERIALS AND METHODS

Clinical data

This study retrospectively analyzed the data of 80 patients with ACL injuries admitted to the Department of Orthopedics at the Third Medical Center of PLA General Hospital from January 2017 to October 2019. There were 67 males and 13 females, 18 -33 years of

age, with an average age of 24.3 ± 3.1 years. There were 42 patients in the AIST group and 38 patients in the TBT group. There was no significant differences in gender, age, injured side, and time between operation and injury between the two groups ($P > 0.05$). This study was conducted with the informed consent of the patients and according to the guidelines of the Declaration of Helsinki.

Eligibility criteria

Eligibility for the study was assessed before consent and conducted by a research coordinator at the study site. The inclusion criteria were patients with an ACL-deficient knee who agreed to ACL reconstructive surgery using autograft tissue. Patients with associated meniscal and chondral pathologic changes (except those meeting exclusion criteria) were included in the study; the pathologic changes treated at the time of ACL reconstruction at the discretion of the study surgeon. All pathologic changes and treatments were recorded. Patients who had previous ACL reconstructive surgery or underwent multi-ligament, medial collateral ligament, posterior cruciate ligament, lateral collateral ligament, posteromedial corner, or posterolateral corner repair or reconstruction surgery were excluded.

Surgical technique

AIST technique group: The ipsilateral semitendinosus muscle was passed through the respective TightRope loops, quadrupled, and the two free ends on the tibial side were sutured together with #0 FiberLoop (Arthrex,) in a SpeedWhip-type pattern leaving the suture ends intact (Figure 1). Using the remaining native ACL fibers as a reference and the over-the-top position with a guide (Arthrex), a pin was placed and the lateral femur was drilled out. In this way, the femoral socket was created as close as possible to the anatomic ACL center *via* anteromedial portal drilling using a low-profile reamer (Arthrex) matching the graft diameter. The minimal graft in socket depth was 25 mm. The pin was used to place a #2 FiberWire (Arthrex) shuttle suture. The intra-articular ACL graft distance was measured with an intra-articular ruler (Arthrex), and this distance was added to the length of the graft in the femoral socket to determine the

depth of graft in the tibial socket based on the total graft length. The tibial socket was created at the anatomic tibial site indexing off the anterior horn of the lateral meniscus using a FlipCutter aiming guide (Arthrex). A straight FlipCutter pin matching the graft diameter was then drilled into the joint and “unflipped” to become a reamer to retro-cut the tibial socket, which was also reamed 5 mm deeper than needed to allow for optimal graft tensioning with the all-inside technique. The FlipCutter pin was drilled back into the joint, “unflipped,” removed, and a #2 TigerStick suture (Arthrex) was passed through this FlipCutter pin hole up into the joint and retrieved as a tibial shuttle suture. The #2 FiberWire shuttle suture from the femoral socket was used to pull the graft through the anteromedial portal across the joint up into the femur, flipping the suspensory TightRope RT button on the lateral femoral cortex. The graft was then hoisted up into the socket to the appropriate depth with the TightRope shortening strands (Figure 2).

TBT technique group: A #2 FiberWire was used to suture 2 cm at each end of the ipsilateral semitendinosus and gracilistendons. The tibial insertion was located by point-to-point sight (Smith & Nephew), and the medial side of the femoral lateral condyle was located *via* the tibia, and the femoral side was fixed by an Endobutton (Smith & Nephew). The graft was tightened at 30° flexion of the knee and tibial fixation was achieved using an interference screw (Smith & Nephew).

Rehabilitation protocol

The rehabilitation protocol for the AIST and TBT technique cohorts were the same. The affected limbs of the two groups were fixed with braces after surgery. Quadriceps isometric exercises were started on the 2nd day after surgery, straight leg raising exercises were started on the 3rd day after surgery with gradual weight-bearing under brace protection, and complete weight-bearing was achieved 4 wk after surgery. Passive knee flexion and extension exercise were started the 2nd week after surgery, increasing by 30° every week, and reaching > 120° (close to normal) 6 wk after surgery. Activities of daily living were resumed the 4th month after surgery and physical exercises were gradually resumed 6 mo after surgery.

Outcome measures

All patients underwent an extensive clinical, subjective, and objective evaluation preoperatively. Visual analogue scale (VAS) scores were evaluated and recorded 1, 3, and 7 days, 2 wk, 1 and 6 mo, and 1 and 2 years postoperatively for each patient. The operative duration, and International Knee Documentation Committee (IKDC) and Lysholm scores of the affected knee at the last follow-up evaluation were recorded.

Statistical methods

To determine the difference between the two-sample means, normal distribution measurement

data are expressed as the mean \pm standard deviation. T-test and repeated measurement data analysis of variance were used.

The Fisher test was used for enumeration data, and the Kruskal-Wallis test was used for multi-valued ordinal data. Statistical analyses were performed with commercially-available software (SPSS version 18.0). A $P < 0.05$ was considered statistically significant.

RESULTS

All patients had follow-up evaluations for 24-36 months (mean, 27.5 \pm 1.8 months). There was no significant difference in the operative duration between the two groups. One patient in each group had grade C knee function postoperatively. Two patients in the traditional group had numbness at the graft site postoperatively; the numbness was significantly relieved 1 year postoperatively. There was no significant difference in the IKDC score between the two groups (Table 1). The Lysholm scores of all patients were $> 90^\circ$. There was no significant difference in the mean scores between the two groups (Table 2). The VAS score of the internal group was lower than the traditional group ($P < 0.05$). All patients were pain-free 6 mo, and 1 and 2 years postoperatively (Table 3). No complications, such as ligament re-injuries and infections, occurred in the two groups during the follow-up period.

DISCUSSION

An ACL injury is one of the most common sports-related knee injuries. With the advances in arthroscopic technology, arthroscopic ACL reconstruction is a widely performed surgical procedure. Some studies [17,19]; however, have shown that the absence of the hamstring tendon of the knee will lead to a reduction in the flexion internal rotation force of the knee by 5%-10%. Yosmaoglu *et al* [20] have shown that preserving the gracilis muscle is crucial for postoperative rehabilitation training, especially for patients who participate in knee flexion exercises > 70°. Preservation of the gracilis muscle significantly accelerates recovery of knee function after ACL reconstruction. Volpi *et al* [21] believed that to restore joint motion and function, the clinical effect of the all-inside technique is similar to traditional single-beam reconstruction surgery. The bone tunnel of the tibia in the AIST group was drilled from outside-in, and the tunnel was thin outside and thick inside, which is conducive to reducing the leakage of joint fluid and thereby reducing the risk of infection. Based on a retrospective analysis, Connaughton *et al* [22] concluded that the operative time, Lysholm score, and IKDC score were not significantly different between the AIST and TBT groups, but the postoperative VAS score of the AIST group was significantly lower than the TBT group ($P<0.05$). Connaughton *et al* [22] believed that the efficacy of all-inside reconstruction was similar to the traditional group, but the postoperative pain of the all-inside group was less severe. Benea *et al* [23] also reported that the pain at the graft removal site was apparent in the short term after surgery, and only one tendon could be removed to alleviate postoperative pain. Within 1 mo after surgery, the pain among patients in the all-inside group was significantly lower than the traditional group. This study also confirmed that the VAS score of the all-inside group was significantly lower than the traditional reconstruction group, and the patients felt well. In our study, the VAS score for postoperative pain in the all-inside group was lower than the traditional group. The reasons for this finding were as follows: the diameter of the cortical tibial tunnel in the all-inside group was 3.5 mm and

7 or 8 mm in the traditional group; and only semitendinosus muscle was taken as the graft in the all-inside group, which caused less injury to the surrounding soft tissues.

Kouloumentas et al. [24] showed that fixed and adjustable loop buttons of the femoral end fixation greatly exceed the mechanical strength required for early knee exercises in the maximum load biomechanical test, which met the needs of patients for early functional exercises. In a randomized controlled study involving 188 patients, Boyle *et al* [25] showed that there was no statistical difference in the test results of KT-1000, the graft failure rate, and the graft failure time between adjustable and fixed loops at the femoral end. The tibial lateral fixation method was changed from the traditional interfacial screw extrusion fixation to suspension fixation. Biomechanical tests confirmed that extrusion screw fixation had a lower relaxation rate of graft elongation and ideal anti-pull-out performance, while suspension fixation had a higher load limit and did not show increased graft displacement compared with screw fixation [26]. A meta-analysis concluded that there was no significant difference between suspension fixation and tunnel extrusion screw fixation in terms of normal knee relaxation, the graft failure rate, patient satisfaction, and recovery to the pre-injury activity rate. Therefore, it can be concluded that both the all-inside suspension fixation technique and the traditional total tibial tunnel interface extrusion screw fixation technique achieve excellent results in anterior cruciate ligament reconstruction [27,28]. Our study also showed that the tension of the all-inside reconstruction graft and the stability of the knee postoperatively were ideal, and there was no graft relaxation or failure. There was no significant difference in the treatment effect and postoperative knee function recovery between the two groups. The two groups achieved satisfactory treatment effects in pain improvement and recovery of knee motor function.

In our study the all-inside technique was used to reconstruct the ACL. Only the semitendinosus tendon was used as a graft, which reduced loss of the internal rotation force in flexion of the affected knee after surgery and was beneficial to postoperative rehabilitation. One patient in the traditional group had numbness at the graft site after surgery, which may have been caused by injury of the inferior patellar branch of the

saphenous nerve during tendon extraction, leading to numbness on the medial aspect of the proximal knee. In the all-inside group, one patient had a postoperative knee extension limitation of 8°. This patient underwent ACL reconstruction on the 19th day after the injury. The reason for this finding may be that the operation was too close to the injury time, thus resulting in knee stiffness. Andernord et al. [29] showed that ACL reconstruction in the early stage after injury increased the incidence of knee stiffness, and the mechanism may be related to the influence of operation timing on postoperative joint fibrosis.

In addition, the femoral tunnel is independently drilled through the foot location area of the anterolateral entrance of the positioning hook, which does not require excessive flexion of the affected knee and is in agreement with the concept of anatomic reconstruction [30,31], which effectively avoids pain caused by the impact of the non-anatomic reconstruction graft on the intercondylar fossa or posterior cruciate ligament during knee activity [23]. Lubowitz *et al* [17] also reached the same conclusion in a prospective randomized controlled study. The bone tunnel of the whole inner group of the tibia was drilled from inside-to-outside, which effectively preserved the cortical bone of the proximal tibia and avoided a burst fracture. In addition, the tunnel is thin outside and thick inside, and the tunnel communicating with the outside world is very small, so the joint fluid will not leak, thus reducing the risk of infection [21]. The tibia and femur sides of the all-inside group were suspended and fixed by a TightRope locking loop bone plate, which not only makes full use of the tendon-bone interface and promotes tendon-bone healing, but also effectively avoids the cutting effect of squeeze nails on the graft [32]. Compared with an Endobutton, the TightRope has an adjustable locking wire loop [31], so there is no need to reserve the loop turning distance when making the bone tunnel, which reduces bone loss and keeps the graft close to the bottom of the bone tunnel, thus effectively avoiding the "bungee effect" of suspensory fixation [33].

CONCLUSION

In conclusion, the all-inside technique has the same efficacy as the traditional technique with respect to knee function and exercise level, but has less postoperative pain, higher tendon utilization, and less injury. In addition, the all-inside technique has little damage to the proximal tibial cortex and only uses one hamstring muscle, which is of great value in simultaneous ACL reconstruction with high tibial osteotomy, multiple knee ligament reconstruction, and revision surgery for ACL re-tears.

ARTICLE HIGHLIGHTS

Research background

Arthroscopic reconstruction of the ACL is the main method of repair, the optimal ACL reconstruction technique has not been determined.

Research motivation

⁴ To compare clinical outcomes of knee anterior cruciate ligament (ACL) autograft reconstruction using all-inside quadruple semitendinosus (AIST) and traditional hamstring tendon (TBT) techniques.

⁵

Research objectives

To seek a good fixation method to reconstruct the ACL and reduce the failure rate.

¹

Research methods

From January 2017 to

October 2019, the clinical data of 80 patients with anterior cruciate ligament reconstruction were retrospectively analyzed, including 67 males and 13 females. The patients had an average age of 24.3 ± 3.1 years (age range, 18-33 years). The AIST technique was used in 42 patients and the TBT technique was used in 38 patients. The time between operation and injury, operative duration, postoperative visual analogue scale (VAS) score and knee functional recovery were recorded and

compared between the two groups. ¹ The International Knee Documentation Committee (IKDC) and Lysholm scoring system were used to comprehensively evaluate clinical efficacy.

Research results

Eighty patients were followed for 24-36 months, with an average of follow-up duration of 27.5±1.8 mo. ¹ There were no significant differences in the time between surgery and injury, operative duration, IKDC and Lysholm scores of the affected knee at the last follow-up evaluation between the two groups. There were significant differences in VAS scores 1 day, 3 days, 7 days, 2 weeks, and 1 month after surgery ($P < 0.05$). There was no significant difference in VAS score at 3 months, 6 months and 1 year after operation.

Research conclusions

The efficacy of the AIST ACL reconstruction technique was comparable to the TBT technique, but the postoperative pain was less with the AIST technique. Thus, the AIST technique is an ideal treatment choice for ACL reconstruction.

Research perspectives

⁴ We compare clinical outcomes of knee anterior cruciate ligament (ACL) autograft reconstruction using all-inside quadruple semitendinosus (AIST) and traditional hamstring tendon (TBT) techniques.

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SIMILARITY INDEX

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