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Treatment of multiple knee-ligament injury with calcaneal tendon allograft using arthroscopy.

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Abstract

The aims to evaluate the effectiveness of dislocated and unstable knee joint reconstruction using calcanei combined with an Achilles tendon allograft using one-stage arthroscopy. From January 2008 to January 2010, we treated 11 patients with knee-joint dislocation using calcanei combined with an Achilles tendon allograft using one-stage arthroscopy. A total of 9 males and 2 females aged 17 years to 45 years (average age of 22.3 years) were included in this study. All patients were treated with calcanei combined with an Achilles tendon allograft. The posterior cruciate, medial collateral, anterior cruciate and lateral collateral ligaments were reconstructed. All incisions healed at the first follow-up two weeks after operation. Ten of the patients were monitored for 24 months to 36 months (average of 30 months). Knee-joint function was evaluated using Lysholm and International Knee Documentation Committee scores. Significant differences were found between the pre- and post-operation Lysholm and IKDC scores (P<0.05), as well as between the pre- and post-operation movement ranges (P<0.05). The application of calcanei combined with an Achilles tendon allograft for the treatment of dislocated knee joints using one-stage arthroscopy recovered the stability and movement range of the knee joint. Therefore, the proposed method leads to satisfactory clinical effects.

Keywords: Arthroscopy, Knee joint, Joint dislocation, Tendon allograft, Calcanei combined achilles tendon.

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Introduction

The Anterior Cruciate Ligament (ACL), Posterior Cruciate Ligament (PCL), Medial Collateral Ligament (MCL), and Lateral Collateral Ligament (LCL) are the main ligaments that stabilize the knee. Knee performance becomes unstable and knee dislocation occurs when two cruciate ligaments and at least one composite or strip ligament tear [1]. Merged multiple-ligament knee injuries are rare. This type of injury causes serious wounds of the lower limbs, lead to severe dysfunction, and is associated with blood vessel and nerve damage, secondary compartment pressure, and limb necrosis. Moreover, improper handling may cause extinction [2]. Dislocation therapy relieves pain and maintains good knee motor function and stability. Nonsurgical treatments such as early resetting and cast immobilization are the optimal treatments options [3,4]. Patients treated by this method experience greater activity and stability of the knee compared with patients who underwent nonsurgical treatments. However, the pain, swelling, and degeneration of the knee joints are similar in the two groups. From January 2008 to January 2010, 11 cases of knee ligament injury (combined ACL, PCL, MCL and LCL) were treated with allogeneic calcaneal tendon allograft reconstruction and arthroscopic surgery. The internal structure of the knee was repaired. Follow up examinations were performed on 10 patients for more than two years. The proposed method was effective in treating the injury.

Clinical Data

From January 2008 to January 2010, 35 cases of knee dislocations were treated in Entire army Orthopaedic Center of No.309 hospital of PLA; 11 patients met the inclusion criteria. The inclusion criteria include (1) combined knee ACL, PCL, MCL, and LCL injury were diagnosed using MRI and arthroscopy; (2) no valgus deformities and other developmental abnormalities were found; (3) no severe osteoarthritis, rheumatoid arthritis, and osteoporosis or other diseases were observed. Exclusion criteria: blood vessel and nerve injuries were excluded. The damaged ligaments of all 11 patients were treated with allogeneic calcaneal tendon graft reconstruction. The No.309 Hospital of PLA Medical Ethics Committee approved this study and patients signed informed consent.

General Information

The 11 patients consisted of 9 males and 2 females aged 17 years to 45 years (mean age of 22.3 years). Six of the patients presented with right-knee injuries, whereas five had left-knee injuries. The causes of injury were as follows: 8 cases of traffic accidents, 2 cases of sports injuries, and 1 case of fall injury. Injury-to-operation time was 7 days to 21 days (average of 10 days). All 11 cases showed positive results in the Lachman test, as well as in the posterior drawer and sagging tests. Back-

and-forth tibia movement exceeded 12 mm. A total of 9 cases were positive in the knee varus stress test, whereas 11 cases were positive for the valgus stress test. Rotatory instability was observed in 11 cases. Merged meniscus was noted in 9 cases, synovial plica was found in 3 cases, and inter-condylar notch stenosis was observed in 2 cases. The preoperative Lysholm score [3] was 42.2 ± 3.5 min, and the International Knee Documentation Committee (IKDC) score [4] was 41.7 ± 6.5 points. The preoperative range of motion was 83.4º ± 7.0º.

Method of Operation

General handling

With the exclusion of surgery contraindications, all operations were performed under spinal and epidural anaesthesia by the same group of doctors. The patients were in the supine position, Tied a tourniquet to the thigh. For the limb fixed-knee flexion, the proximal femur fixation was used to prevent displacement. Preoperative Doppler ultrasound of the popliteal artery or dorsalis pedis pulse was performed. Pre-operative Doppler ultrasound popliteal artery and popliteal veins, if found vascular abnormalities, first need open surgical operation, to explore vessels and repair it. The patients were properly positioned after a comprehensive examination of all ligaments and joint activities under anaesthesia to identify the type of injury. Ligament, meniscal, and synovial damages were confirmed by conventional anterolateral and anteromedial arthroscopic examinations. The tibial plateau and femoral inter-condylar fossa ACL and PCL stubs were cut with a cutter. Angioplasty, suturing, and partial meniscectomy were performed depending on the type of meniscal tear. Plica was used in the device resection design. Accompanying inter-condylar fossa inter-condylar notch stenosis was subjected to angioplasty.

Access and weave tendon

All the tendon allografts, which were deep-frozen with calcaneal tendon, were provided by the First Affiliated Hospital of PLA General Hospital Library. The allografts were prepared as follows: an 11 mm trephine was used to drill along the Achilles' tendon to obtain the columnar unilateral Achilles' heel. The other end of the tendon was sutured using a Johnson and Johnson braided suture (suture tendon diameter, 8 mm). All grafts were prepared with the desired graft suture length and degree of tendon ministry.

Ligament reconstruction

Four ligament reconstructions were performed by following the PCL, MCL, ACL, and LCL order. A 3 cm subcutaneous incision was made in the anterolateral femoral condyle, medial, anterior medial tibial tuberosity, and fibular head lateral skin, in the PCL, MCL, ACL, and LCL reconstruction 2 mm positioning Kirschner 4. Approximately 7 mm hollow tunnels were then drilled into the bone. Tibia ACL and PCL tunnels with diameters of 11 mm were drilled to expand the bone through bone-tunnel penetration using an ACL-PCL reconstruction guide wire. A wire inserted into the Achilles tendon served as a guide in pulling the allograft through the tibial tunnel into the joint cavity and through the femoral tunnel piercing. The bone was plugged into the bottleneck-shaped tibial tunnel and then screwed into an absorbable squeeze screw. To complete the ligament reconstruction of the four groups, taut ligament reconstruction of PCL was performed using an 8 mm absorbable squeeze screw to a fixed bone tunnel at a flexion of 90°. The screw was flipped over to the tibial tendon allograft MCL attached to the ministry with 7 mm tunnels and then screwed into a absorbable squeeze screw for MCL reconstruction. At a knee flexion of 45°, taut ligament reconstruction of ACL was performed by an absorbable squeeze screw on the fixed stake bone tunnel. The allogeneic tendon was flipped over to the fibular head with 7 mm tunnels and then screwed to an absorbable squeeze screw and rebuild LCL. Microscopic examination was performed to determine the appropriate tension after ligament reconstruction, joint cavity cleaning, and wound closing.

Postoperative management and rehabilitation

One to three weeks after surgery, the reels in the flexion knee brace were limited to 30° at the neutral position brake. The patients started their day by being guided in isometric quadriceps and ankle plantar flexion dorsiflexion movements. After 4 weeks to 7 weeks, the knee angle was gradually increased at 30° increments. After the first seven weeks, the angle was increased from 0° to 135°. After the first 8 weeks to 22 weeks, the brace angle chuck was released, and daily activities were gradually restored. Active knee flexion and extension exercises were performed, but strenuous exercise and squatting were avoided. Quadricep and hamstring exercises were also performed. After 23 weeks to 30 weeks, sporting activities were gradually allowed, but strong opposition movements were avoided.

Postoperative efficacy evaluation

After 1, 3, 6, and 12 months of knee CT examination, the repair effect was evaluated. After two years the following tests were performed: (1) Lachman, posterior drawer, and sagging tests; (2) back and forth tibial movement, knee varus, and valgus stress tests; and (3) Lysholm and IKDC evaluations.

Statistical analyses

The SPSS14.0 statistical package was used for the statistical analyses. Score data are presented as the mean ± standard deviation before and after surgery. The data were compared using a paired t test. $P<0.50$ was considered statistically significant.

Results

All incisions healed without complication. A total of 10 cases were monitored for more than two years to obtain complete imaging and clinical follow-up data. Follow-up time was from 24 months to 36 months, with an average of 30 months. After

two years, the long-term follow-up results are as follows: negative Lachman test results for 10 cases (100%), negative posterior drawer test results for 9 cases (90%), negative knee varus and valgus stress test results for 10 cases (100%), and>5 mm back and forth tibial movement. After two years, the Lysholm knee score was 84.5 ± 6.2: 9 cases were graded A, 1 case was graded B, and no case was graded C (Table 1). The IKDC knee score was 82.3 ± 10.3 (Table 2). Preoperative and postoperative Lysholm and IKDC scores showed significant differences (P<0.05). The active range of motion was 126.3° ± 6.5°; this range is significantly different from the preoperative range of activities (P>0.05, Table 3).

Table 1. *Patients preoperative and postoperative knee function Lysholm score (Mean ± standard deviation).*

The number of cases	Preoperative	Postoperative 2 years
10	42.2 ± 3.5	84.5 ± 6.2
P<0.05		

Table 2. *Patients preoperative and postoperative knee function IKDC score (Mean ± standard deviation).*

The number of cases	Preoperative	Postoperative 2 years
10	41.7 ± 6.5	82.3 ± 10.3
P<0.05		

Table 3. *Patients preoperative and postoperative active joint range of motion (degrees, mean ± standard deviation).*

The number of cases	Preoperative	Postoperative 2 years
10	83.4 ± 7.0	126.3 ± 6.5
P<0.05		

Discussion

The incidence of knee injuries caused by traffic accidents is increasing; many of these cases involve ligament injury with acute knee instability and dislocation [5,6]. A stable knee structure mainly depends on the ACL, PCL, MCL, and PCL, as well as on four groups of ligaments. Knee-ligament damage caused by multidirectional instability is secondary to meniscal, articular cartilage, and neurovascular structural damages [7]. Knee-ligament injuries and damage to surrounding tissue, particularly due to improper disposal, can cause vascular injury, loss of function, limb compartment syndrome, and even necrosis [8]. Given that knee dislocation is not persistent, the treatment methods, timing of surgery, and reconstruction of knee dislocation, has considerable controversy [8,9].

For multi-ligament injury caused by knee dislocation, a long-brake conservative treatment is generally used. For injuries that have low demand on the joint function, particularly for the elderly and seriously ill patients who cannot tolerate surgery, conservative treatment has certain effects. However, some researchers believe that for patients that require physical recovery of limb functions, surgical treatment must still be performed [10]. Multiple knee-ligament rupture generally occurs after severe instability and may be secondary to injury or aggravated damage to the meniscus or to the articular cartilage. These injuries may induce severe traumatic arthritis and other diseases. In addition, longer-term fixed joints can also cause muscle atrophy around the knee, particularly the quadriceps, and thus affect the reconstruction and restoration of joint function [8,9]. Thus, surgical intervention is needed to restore joint function, and reconstruction of ligamentous structures is an ideal treatment method. From January 2008 to January 2010, our department treated 35 patients with knee instability and dislocation. Five cases were inoperable because of objective reasons. We performed a final surgery or two surgical treatments on the remaining 30 patients.

Although surgery is generally believed to be necessary to achieve stable ligaments, no consensus has been established with regard to the timing of surgery and the need for phased restoration, which need to repair or rebuild ligament grafts [11]. A number of researchers believe that in addition to irreducible dislocation, emergency repair of ligaments must also be performed, and that the repair of other types of injuries can be postponed [12]. Even if vascular damage must be repaired, the treatment should be limited to repairing blood vessels. For open dislocations, we need to continuous flushing, debridement, soft tissue coverage, and intravenous antibiotic therapy, real ligament repair or reconstruction tends to take an additional month. Batch instalments have been proposed for knee dislocation and ligament repair or reconstruction [13]. Early reconstruction of PCL, a few months reconstruction of ACL, LCL and MCL was also proposed. Staging surgery theoretically reduces the risk of postoperative stiffness, requires complete follow-up activity, and does not result in valgus instability [2]. A number of scholars believe that in an emergency, the risk of fibrosis does not increase during cruciate ligament reconstruction, rehabilitation, or reconstruction [14]. Joint stability and functional recovery require full restoration of MCL, LCL, and PCL injuries; an insufficiently performed repair must be strengthened or rebuilt [15]. Studies have shown that approximately two weeks after injury is the optimal time to repair ligaments and recover joint function. A delay in surgery for more than one month can lead to fibrosis, intra-articular ligament and soft tissue adhesion, scarring, and other complications that can seriously affect the reconstruction results [9,16]. In the present study, the operation time from injury was 7 days to 21 days (average of 10 days). In all cases, the operation time was controlled within 1 month. Within that period, the PCL, MCL, ACL, and LCL were completely rebuilt, and satisfactory repair was achieved. The timing of surgery in this group was most delayed in one case, in which the operation was performed 21 days after the injury. In this case, ligament-tissue adhesion was more severe. Moreover, the Lysholm functional score was 68 points, which is the lowest among all patients. Therefore, ligament reconstruction should ideally be performed approximately 10 days after injury.

The repair of damaged ligaments can be classified into two types, namely, grafting and suturing, depending on the specific type of injury, time to repair, patient condition, surgical units, and several other factors [17]. Under normal circumstances, knee ligament injuries mostly involve dislocations with substantial tearing. In these cases, simple suturing cannot provide adequate mechanical support. In addition, for long-term injuries (generally two weeks or more), reconstruction should be performed because soft tissue scarring and contracture limit the success of ligament repair. For the patients that received graft repair methods, functional evaluation showed good general repair results compared with those that received suturing [18].

Autologous transplantation has been considered as the "gold standard" for ligament reconstruction; however, use of autograft patellar tendon, hamstring tendon, can cause muscle weakness, anterior knee pain on the donor, and other complications [19,20]. In addition, for severe knee-ligament injuries, autologous tissues are generally unsatisfactory. Therefore, transplantation using professionally processed allogeneic bone bank ligaments is more commonly performed. The use of allograft tissue grafts reduces the supply rate to the injured parts, decreases the knee incision number and scope, and reduces the intraoperative tourniquet time, postoperative pain, and knee stiffness [9]. For the present group of patients, a calcaneal tendon graft variant was rebuilt on the ligament because the commonly used bone-patellar tendon grafts retain a certain amount of the calcaneus compared with using a tendon at one end. The bone plug was prepared using a reserved calcaneus bone tissue according to the size of the tunnel structure. A structure can be established strong bony fixation between the bone tunnel and the calcaneus bone. The same material is also more conducive to the bone creeping substitution in the surrounding bone tissue. After one month, we found that only the bone plug components showed complete healing of the surrounding bone tissue. This phenomenon ensures the stability of the reconstructed ligament during the early functional recovery of the patient.

In this study, we have achieved satisfactory repaired knee-ligament dislocation using an arthroscopic allograft with calcaneal tendon graft. We believe that for patients with multiple ligament injuries, knee dislocation should be determined by eliminating the possibility of neurovascular injury, and that early repair should be performed. Repair should be performed approximately two weeks after the injury, and allogeneic tendon tissue should be used.

Conflict of Interest

All authors have no conflict of interest regarding this paper

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