Concurrent arthroscopic bicruciate ligament reconstruction using Achilles tendon-bone allografts: experience with 15 cases

SHI De-hai 史德海, CAI Dao-zhang 蔡道章*, WANG Kun 王昆, RONG Li-min 戎利民 and XU Yi-chun 徐义春

Objective: To evaluate the clinical outcome of arthroscopically assisted combined anterior and posterior cruciate ligament (ACL/PCL) reconstructions using Achilles tendon-bone allografts.

Methods: Associated meniscus injuries were treated according to established methods prior to ligament reconstructions during arthroscopic surgery. Thirty Achilles tendon-bone allografts were used to reconstruct torn ACL and PCL in 15 knees. At postoperative follow-up, all knees were graded using the modified IKDC and the Lysholm scoring systems just as done preoperatively. Results were analyzed compared with the contralateral healthy knees.

Results: Eleven men and 4 women with a minimum of 3-year follow-up (mean 38 months) were included in the study. Preoperatively, the group ratings by the modified IKDC standards were all severely abnormal. Twelve bicruciate reconstructions were performed in subacute or chronic stage (>3-8 weeks), 3 for acute ligamentous deficiencies (≤ 3 weeks). The noticeable early complication was transitory local fever combined with joint effusion in one case. At postoperative follow-up, 9 knees were normal, 5 nearly normal and 1 abnormal. On Lysholm score the difference was statistically significant (t-test, P<0.001) before and after operation.

Conclusions: Achilles tendon-bone allograft offers an alternative for simultaneous arthroscopic ACL/PCL reconstructions. However, further investigation is needed to eradicate its potential immunogenicity for better use.

Key words: Anterior cruciate ligament; Posterior cruciate ligament; Arthroscopy; Achilles tendon

A new era began in the treatment of intracapsular ligament deficiencies in the early 1980’s, when arthroscopic anterior cruciate ligament (ACL) reconstructions were introduced. Experience was firstly accumulated from isolated ACL or posterior cruciate ligament (PCL) replacements. Then with advancement in arthroscopic technique, a great success was achieved in combined ACL/PCL reconstructions. Though use of autogenous bone-patella tendon-bone (BPTB) graft was thought to be gold standard for ligament reconstructions, orthopedists continue to look for new material to prevent autografting complications.1, 2 In recent years, various allografts have been used in combination with autografts for arthroscopic bicruciate reconstructions, and good results have been obtained.3-5 Yet no literature, to our knowledge, has ever referred to simultaneous arthroscopic ACL/PCL reconstructions using the same allograft. The purpose of this study is to present our experience in 15 cases of one-stage ACL/PCL reconstruction using Achilles tendon-bone allograft.

METHODS

Patients

Between July 2000 and February 2005, 15 of 48 simultaneous ACL/PCL reconstructions met the selection criteria and were included in the study. The inclusion criteria were unilateral simultaneously broken ACL and PCL of knees. Bicruciate rupture cases complicated with collateral ligament and/or posterolateral corner injuries were excluded from the study. Comprehensive knee examination was performed routinely to identify ligamentous ruptures and coupled intracapsular injuries. Diagnostic MRI data were used as supportive evidence. The time from injury to surgery was from 2 to 3 weeks (mean 18 days) in the acute group, and 3 weeks to 18 years (mean 1.5 years) in the subacute and chronic groups. The patients’ age was 24 years old on average at the time of surgery (range: 17 to 44 years).
Affected knees with limited range of motion (ROM) were placed on continuous passive motion (CPM) machine preoperatively until the swelling subsided and the joints had obtained a nearly normal ROM (0°-10° to 130°-145°). All knees were graded using the modified International Knee Documentation Committee (IKDC) standard, and the Lysholm scoring system prior to surgery. The irradiated, fresh-frozen Achilles tendon-bone allografts were obtained from the Shanxi Medical Tissue Bank, China (Fig. 1).

**Surgical technique**

A patient was in a supine position on the operating table following the establishment of spinal anesthesia. The operation was performed under tourniquet. A separate inflow for knee distention was established via superomedial portal and standard anterolateral and anteromedial portals were made for arthroscopic instruments. A routine arthroscopic examination of knee was performed with adequate soft tissue debridement. An invaded U-shaped notchplasty was performed only when needed by enlarging the notch superiority and laterally. Repair was done to injured meniscus as indicated. The stumps of both cruciate ligaments were identified and marked.

**Graft preparation**

Graft was prepared by an assistant once the diagnosis of bi-cruciate ruptures was ascertained under arthroscopy. The frozen Achilles tendon-bone allograft was thawed in warm normal saline for 10 minutes. After it was taken out and towed off, the tendon section was trimmed into a 10-11 mm wide strip. The calcaneal bone block was tapered in order to pass through a trial mold (diameter: 10 mm). Two holes were drilled close to the free end of the bone plug and each threaded with two 1/0 Dexon sutures. The tendinous end was stitched in a whip fashion and the free end was attached to two 1/0 Dexon sutures. Then the graft was carefully wrapped in a moist saline compress, ready for passage. Two Achilles tendon-bone allografts were used for each bicruciate reconstruction.

**Tunnel preparation for PCL reconstruction**

An intersection 4 cm inferior to the joint line and 1.5 cm medial to the tibial tuberosity was established as the entrance of the tibial channel. With the tibial guide set at 60°, the intended tibial insertion of the PCL was determined by placing the guide tip 10 mm below the cartilage surface. A tibial tunnel was created by firstly driving a guide pin through the guide and then by tapping a 10-mm reamer over the guide pin. The femoral reconstruction site, about 8 mm posterior to the margin of the articular cartilage of the medial femoral condyle, was placed at the 2-o'clock mark for a right knee or the 10-o'clock mark for a left knee. With the femoral guide positioned at 60°, the femoral tunnel was drilled and reamed to 10 mm in diameter.

**Graft passage and fixation**

The PCL graft was passed firstly. With the Dexon sutures and a grasper, the graft was pulled up into the joint and then up into the femoral tunnel with the cancellous portion of the bone graft facing anteriorly in the femoral tunnel. A titanium interference screw was used to fix the graft in the femoral tunnel. Similarly, the ACL graft was passed and its femoral ends were fixed. Then with the knee flexed at 70° and 30° respectively, the grafts were held tight, then the tibial ends of the PCL and ACL were fixed with interference screws. After reconstruction was completed (Fig. 2), Lachman test was performed to test if the knee was stable, and the knee was moved to confirm that there was no impingement.

As soon as the surgery was finished, the knee was placed in a protective hinged brace (Tehlin Prosthetic & Orthopaedic, Inc, China) (Fig.3). Each reconstructed knee was radiographed postoperatively to evaluate the internal fixation by interference screws (Fig. 4).
Postoperative rehabilitation

Postoperatively, a 3-stage rehabilitation protocol was prescribed for all the patients. The first stage (0-2 weeks) program included immediate continuous passive exercises of the knee (ROM: 5° to 90°) on a CPM machine for 2 hours per day, isometric exercises of quadriceps muscle, patellar mobilization, straight-leg raising in prone position, and 30% weightbearing with crutches. During this stage, the patients kept wearing braces unless they did CPM activities. The second stage (3-5 weeks) consisted of achieving full range-of-motion exercises of the knee in supine position on bed, 60% weightbearing with crutches, active closed-chain quadriceps and hamstring muscles exercises. From the postoperative 4th week on, the brace was removed at night. In the third stage (6-12 weeks), full weightbearing activities were permitted with the brace on at weeks 6 to 9. Stationary bicycling and jogging were allowed at weeks 10-12. Hyperextension and hyperflexion were discouraged during this stage. The patients were able to return to sports and daily activities 6 months after surgery. Athletic sports and heavy physical activities were forbidden in the first year.

Evaluation at follow-up

As done preoperatively, the modified IKDC and the Lysholm scoring scales were used to assess the outcomes. All testing results of the involved knee were compared with the patient’s intact contralateral knee for analysis. The data were expressed as mean±SD. Statistical analysis of t-test was performed with SPSS software package (Version 11.0 for Windows). P<0.05 was considered as significant difference.

RESULTS

Among all patients, there were 11 males and 4 females. Nine left knees and 6 right knees were affected. Ten cases of the knee dislocations occurred in vehicle accidents, 3 in sports, and 2 in falling. Preoperatively, all the knees were graded as D (severely abnormal) according to the modified IKDC evaluation system and the mean Lysholm score was 56 (range: 48 to 64). Three patients were treated in acute stage (<3 weeks), the other 12 for subacute or chronic ligamentous deficiency (>3 weeks). One patient had avulsion fracture of the fibula head and partial common nerve palsy. At surgery, the nerve was decompressed and recovered completely within 16 weeks postoperatively. Patients with a history
over one year presented with obvious signs of degenerative arthritis under arthroscopy. Two lateral meniscus underwent plasty; two medial meniscus received arthroscopic suture.

The noticeable early complication in this series was localized fever combined with joint effusion in one knee. Negative blood and joint aspiration tests did not suggest infection. Mild rejection was considered yet we failed to perform further investigations to establish the diagnosis. Without intervention, fever abated after 6 days, and the joint effusion resolved 14 days postoperatively.

At 6 months follow-up, this patient showed a remarkable anterior dislocation of 10 mm by the KT-1000 arthrometer (MEDmetric, San Diego, California, USA). However, the patient had no marked giving-way symptom with daily activities and declined arthroscopic exploration.

All 15 patients were available for a minimum of 3-year follow-up, with an average of 38 months (range: 36 to 40 months). The results were tabulated based on subjective questionnaires and objective assessments on the operated knee (Table 1).

### Table 1. Examination findings and functional grades in 15 patients at 3-year follow-up

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<th>Extension loss (degree)</th>
<th>Flexion loss (degree)</th>
<th>Posterior drawer</th>
<th>Varus laxity</th>
<th>Valgus laxity</th>
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*N, normal; NN, nearly normal; A, abnormal; SA, severely abnormal.

By the KT-1000 arthrometer, the average side-to-side total anteroposterior displacement at 25° and 70° of knee flexion were 4.8 mm (range: -2 to 10) and 4.2 mm (range: -3.5 to 9), respectively. The average postoperative ROM of the affected knees was 144° (range: 128° to 150°). The average loss of extension was 1.5° (range: 0° to 4°), and the average loss of flexion was 3.9° (range: 0° to 10°). Stability improved in all patients postoperatively though two developed prominent anterior laxity (8 mm and 10 mm, respectively).

None of the patients had giving way with daily activities at follow-up, however, one athlete complained occasional partial giving way in professional sports. All patients were free of pain in activities of daily living, but one experienced pain episodes in recreational sports or athletic activities. Two of the collegiate athletes, one male judoman and one female wrestler, chose to give up their previous intensive sports career. The other 13 patients were able to remain in the same occupation or return to school.

For final evaluation, all the 15 knees showed remarkable increase in Lysholm scoring. The mean postoperative Lysholm score was 90±4 (range: 78 to 98), and the difference was significant compared with pre-
operative 56±5 (range: 48 to 64, P<0.001). According to modified IKDC standards, 9 patients received a final normal rating, 5 nearly normal. The one knee suspected of rejection was evaluated as abnormal due to significant anterior laxity.

**DISCUSSION**

Simultaneous ACL/PCL reconstruction can best restore knee stabilization in a dislocated knee. In 1995, Shapiro and colleagues first reviewed 7 open bicruciate reconstructions using fresh-frozen allograft. At follow-up, the functional grading was excellent in 3 patients, good in 3 patients, and fair in 1 patient. However, the authors noticed that arthrofibrosis was a common problem in the postoperative knees, and manipulation under anesthesia was frequently required. In 1996, Fanelli et al. first evaluated 20 patients with combined arthroscopic ACL/PCL reconstructions using a combination of allograft and autograft tissue. At 2 to 4 years' follow-up, their patients had a mean Lysholm score of 91.3 (range: 80 to 100). With functionally stable knees, all the patients returned to their desired activity level. In contrast to open procedures, Fanelli reported that no knees required arthroscopic lysis of adhesions or manipulation. Encouraged by Fanelli's success, several other investigators attempted arthroscopic ACL/PCL replacements using various implants and obtained similar results. These studies demonstrate that arthroscopic bicruciate reconstructions were reliable, efficient and superior to open surgical procedure.

Nowadays, while there is consensus among knee surgeons on the use of arthroscopic technique for cruciate restoration, new controversy exists as to ideal graft for reconstruction. It is easy to understand the advantages of an autogenous reconstruction, as it ensures fast biologic incorporation, avoids the danger of disease transmission and immune crisis. However, harvesting a graft in an already severely injured knee or from the contralateral healthy leg creates new damage to the patients. Additionally, obtaining sufficient graft material is difficult when reconstructing several ligaments. In contrast, an allograft reconstruction greatly reduces intraoperative time, improves cosmesis, and facilitates early postsurgical rehabilitation. Wainer et al. compared the outcomes of allograft with autograft reconstructions of the ACL, and concluded that viability, strength, and functional stability of allograft replacement were similar to that autograft tissue. Based on these previous practices, the authors preferred allograft tissue for the primary bicruciate reconstructions and reserved autograft tissue for possible future revision. Achilles tendon-bone allograft was chosen in this study because it was larger and stronger than other allografts, and probably more endurant to over-time stretching.

Previous investigations have identified a number of mechanisms that may influence the results of allograft-stabilized knees, including tissue procurement, type of cryo-sterilization, donor-host histocompatibility, processing, preservation, and shelf life. In our study, 14 reconstructions were uneventful, but one knee developed a suspicious rejection and subsequent knee laxity, which indicated that although allograft is a good ligament substitute, elimination of its immunogenicity needs further research.

Surgical timing of both ACL/PCL reconstructions varies, depending on the extent of the injury, the graft selection, specific surgical techniques, complications and the experience of the surgeon. Shelbourne et al. proposed an acute reconstruction of the PCL with nonoperative treatment of the ACL, or ACL could be performed later if instability is a problem. However, their rationale was based on the autogenous reconstruction rather than allogenic reconstruction, because harvesting enough autogenous tissue for bicruciate reconstruction might defer early postoperative rehabilitation. Lately, with proficiency in arthroscopic technique and allograft use for multiligament reconstruction, there seems to be a general trend for early multiple ligament reconstruction if only the patient's condition permits. Nonetheless, it is always reasonable that knees with multiple ligament injuries and limited ROM should be assessed on an individual basis with regards to timing and type of surgical procedures.

Postoperative instability or loss of ROM due to severe arthrofibrosis is the main complication that orthopedists are most concerned with knee surgery. Early investigators focused on achieving ligamentous stability by placing reconstructed knees in rigid casts or braces following surgery. As a result, this often induce loss of knee motion, which is especially true with those autograft reconstructions. Currently, researchers believe that a stiff knee is more inconvenient than an unstable knee, thus advocate early rehabilitation de-
spite the risk of recurrent ligamentous laxity that might require revision.²⁴,²⁶ We engaged our patients in early active rehabilitation with the use of protective hinged brace to fight against potential arthrofibrosis. The brace was proved effective in counteracting graft overstretching during exercise. In this study, though prominent laxity was observed in two knees, the group obtained an average of 144° (range: 128° to 150°) ROM, and all patients managed very well in daily activities without symptom of giving way.

REFERENCES


(Received August 11, 2008)