ORIGINAL REPORT

Press-fit Femoral Fixation in ACL Reconstruction using Bone-Patellar Tendon-Bone Graft

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Abstract- Bone-patellar tendon auto graft is probably the most widely used graft for ACL reconstruction. Several methods for graft fixation have been described. To avoid intra-articular hardware we adopt biological fixation with a femoral trapezoidal press-fit fixation. A prospective study was performed on 30 consecutive active people who underwent ACL reconstruction with this technique by two surgeons between september2004 and march2007 (mean follow-up 15.2 months). Results were evaluated by an independent examiner using radiography, subjective and objective evaluation. Assessment using the IKDC knee scoring revealed 92% of the patients with a normal or nearly normal knee joint. Lysholm's score was 63.6(40- 86) preoperatively and 91.88(73-100) at the latest follow up ($P < 0.005$). No patient complained of instability at latest follow up. The quadriceps muscle showed mild atrophy at 3 and 6 months and at final follow-up. Five Patients complained of anterior knee pain and had a positive kneeling test. We found no graft displacement on follow up radiographs. All cases showed radiological evidence of graft osteointegration at last follow up. Our results show that press-fit fixation of trapezoidal bone graft in femoral tunnel is a simple, reliable, and cost-effective alternative for ACL reconstruction using bone-patellar tendon-bone graft.

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Key words: Anterior cruciate ligament reconstruction, patellar tendon, press fit-fixation

Introduction

Arthroscopically assisted anterior cruciate ligament (ACL) reconstruction is a common procedure performed by many orthopedic surgeons. Many different grafts have been used, but the bone-patellar tendon graft has been considered the gold standard for many years (1-7). The main advantage of patellar tendon graft include high load to failure, adequate stiffness, and rapid bone to bone healing. The importance of secure graft fixation in ligament reconstruction has changed dramatically in the past 20 years. Current rehabilitation protocols after knee ligament surgery stress immediate full range of motion, return of neuromuscular function, proprioception, and early weight bearing. In the early postoperative period graft fixation is the weak link in the system; fixation methods must be rigid and stiff to allow current rehabilitation principles (8). Various techniques have been applied for femoral fixation of the graft, among which, interference screws have been the most widely used, although various complications have been reported, including divergent screw placement, possible impingement, and abrasion. Furthermore, it is difficult to remove the hardware in the case of revision surgery (9-15). Metal interference screws may also produce disturbance in postoperative magnetic resonance imaging. Press-fit fixation offers an alternative method which provides a biological fixation, and this has been shown to have similar pull-out strength (4,9,11-17).

We present the results of a prospective study on reconstruction of the ACL with a central third patellar-tendon autograft fixed to the femur by press-fit technique without interference screw

Patients and Methods

Between September 2004 and March 2006, a prospective study was performed on 30 consecutive active people who underwent ACL reconstruction using a central one-third bone-patellar tendon-bone auto graft by two

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surgeons. Patients with isolated ACL injury reported within 5 months, a normal contralateral knee, consent for participation in the study group, and availability for follow-up at 3, 6, and at least 12 months or when asked for and willingness to follow a specific rehabilitation program at the same institute. Patients who had previous knee surgery (excluding meniscus surgery), associated ligament injury, grade III or IV chondral damage, and abnormal radiographs were excluded from this study.

Patients were operated on by two surgeons and followed an aggressive rehabilitation program. All subjects were examined separately by third independent examiner after 3, 6, and 12 months. Final evaluations were performed by an independent examiner at an average follow-up time of 15.2 months (range 9-27 months). Radiography was carried out on the first day after surgery3, 6 and12month after surgery and at final follow up. All patients underwent radiography of both knees at final evaluation.

For the subjective evaluation the patients were asked about their assessment of function and symptoms, including the presence of kneeling pain, satisfaction with the treatment (i.e., if their expectations were met), and if they felt that they were able to return to their pre-injury sport and level. A clinical examination was performed by an independent examiner, which included assessment of thigh circumference and presence of kneeling pain. Knee range-of-motion was also recorded. Extension lag was measured with the patient prone and flexion loss was measured in the supine position, comparing the operated knee with the contralateral. The medial, lateral, and patellofemoral joints were examined for crepitus. The patellofemoral joint was assessed also for tightness in the retinaculum and patellar harvest site pain.

All patients underwent the Lysholm's score tests at the beginning, 6 months and at final evaluation. The standard IKDC knee score was also used for final evaluation.

Statistical analysis

For continuous data, we used both parametric and nonparametric tests. In the parametric data analysis, t test and pair t test was performed. We set statistical significance at a P value less than 0.05.

Surgical technique

All operations were carried out under general or spinal anesthesia and tourniquet. A diagnostic arthroscopy was performed using anterolateral and anteromedial portals; the notch was cleared and the stump of the old ACL removed. An incisions about 7-8 cm were used for taking the graft. A trapezoidal bone block of 25×11 mm

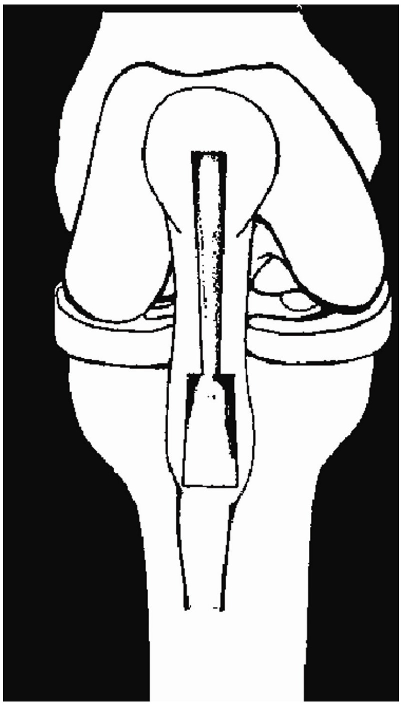

Figure 1. Trapezoidal graft is removed from tibia.

was removed from the tibia. The patellar tendon was incised and a patellar bone block of 25 × 9 mm was removed. The tibial bone block must be sized so that its tip can pass through a tunnel of 9 mm diameter and the rest of the bone block 11 mm diameter (Figure 1).

The scope was then reinserted through the lateral portal, and the tibial tunnel was created using a drill guide inserted through the anteromedial portal. The tip of the guide was placed within the remnants of the stump of the ACL at a position 7 mm anterior to the posterior cruciate ligament, and drill number 9 was used creating the tibial tunnel. The length of the tibial tunnel was usually 45-50 mm. Debris including any remaining stump of the ACL at the aperture of the tibial tunnel was removed to avoid impingement when the knee was fully extended). Then femoral drill guide was inserted which allows the insertion of the guide wire 7 mm anterior to the true posterior capsular insertion, and at the 11 o'clock (right) or 1 o'clock (left) position with respect to the apex of the notch. The femoral tunnel must be 2 mm less than the thickness of the largest portion of the trapezoidal bone block to allow press fitting; as the bone block was 11 mm in its largest diameter, a 9 mm diameter reamer was used. A 5cm incision was done in lateral aspect of thigh and the patellar tendon auto graft was then passed into the knee using a pull-through suture and the bone block positioned in its tunnel by pulling and assisted with light hammering using impactor inserted through thigh incision (Figure 2). The tibial bone block in the tibial tunnel was placed with the cancellous, side facing anteroinferiorly. Firm traction was then applied to the tibial bone block while the knee was taken through a full range of movement to pretension the graft and to observe full extension without impingement and to test the fixation of the plug in the femoral tunnel. If by firm traction the graft pulled out, we inserted interference screw for rigid fixation. This occurred in three patients at the beginning of the study due to poor graft preparation, and these patients were excluded from the study. Then we put the knee in full extension to start fixation of the tibial bone plug using interference screw. Stability was checked by the Lachman and anterior drawer tests.

Patients began weight bearing on crutches immediately for a median of 10 days (7-21 days). They were given simple analgesics for pain control and daily physiotherapy to reduce postoperative swelling and to allow active exercises aiming for full extension by 14 days, and the range of motion was limited to 0°–90° to avoid pull-out of the plug from the femur. Wound inspection and suture removal took place at 10–14 days. The intensive rehabilitation program began immediately. At 12 weeks postoperatively general strengthening exercises were continued with agility work, and sporting activities were encouraged. Return to competitive sport involving jumping, pivoting, and sidestepping was prohibited until 9 months after the reconstruction, but with variable patient compliance.

Follow-up

All patients were assessed preoperatively and 6 months, and at final evaluation using Lysholm's score and only at the last follow up using the evaluation of the International Knee Documentation Committee (IKDC) to document subjective symptoms.

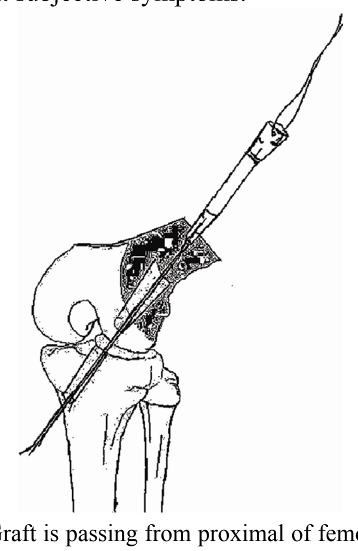

Figure 2. Graft is passing from proximal of femoral tunnel to distal

Ligament stability was measured by the Lachman and pivot-shift tests. The Lachman test was graded as 0(<3 mm laxity), 1 (3–5 mm laxity), 2 (5–10 mm laxity) and 3 (>10 mm laxity) the pivot-shift test as 0 (negative), 1 (glide), 2 (clunk), and 3 (gross). Thigh atrophy was determined by measuring the difference in thigh circumference 10 cm above the superior pole of the patella and the degree and location of pain on kneeling were determined. The placement of femoral and tibial tunnels was assessed radiographically at 6 and 12 months postoperatively

Results

25 patients returned for follow up evaluation; the average operation time was 95 min (75-125); harvesting of the grafts required 10 min and graft preparation 5 min. Twenty percent of these patients were discharged from the hospital within the first 48 h on oral analgesics, while the other patients left the hospital within 72 h. There were no perioperative complications.

Knee scores

Assessment using the IKDC knee scoring system was carried out at final follow-up and revealed that 92% of the patients had "normal" or "nearly normal" knee joints following surgery.19 patients was rated as group A, four as group B and two as group D (Figure 3). Moderate patellofemoral problems were present in four patients. Kneeling pain were present in five patients. One patient had 10° of extension lag and the other patient lost 15° of flexion; they were unsatisfied with their surgery and were rated as group D. The final Lysholm's score was rated at 91.88(range 73-100) which shows significant improvement regarding to pre-injury scores (63.6, range: 40-86) Table 1.

More than 50% of the patients returned to their previous sport at the pre-injury level, even in high-risk sports such as soccer, skiing, and motocross. The remaining patients changed their level of activity because of a lifestyle change or due to fear of a new injury.

Final evaluation showed less than 1 cm of difference in thigh circumference in 80% of our patients. Preoperatively all of the knees had a full range of motion, and at final follow-up all except one of patients regained full range of motion.

Table 1. Lysholm's knee scores at different time

Time	Lysholm's Knee score
Pre-operative	63.6, range: 40-86
At 6months	85.92(range 70-98)
At 1 year	91.88(range 73-100)

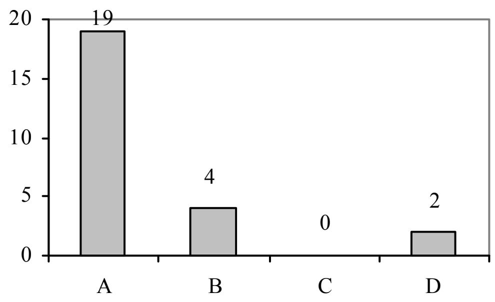

Figure 3. IKDC test result at final follow up. A: Normal, B: Near normal, C: Abnormal, D: Sever abnormal.

Preoperatively the Lachman test was positive in all our patients. Postoperatively the Lachman test was negative in 23 patients and in the two other patients it was positive with less than 5 mm laxity and a firm end point. In addition, we observed marked reduction in the degree of pivot shift test after the reconstruction; 22 knees (88%) had a value of 0 or 1 and 3 a value of 2 at the latest follow-up examination.

At final follow-up no patient in our group had medial or lateral compartment crepitus, but we found moderate patellofemoral crepitation in four patients. One patient considered pain and swelling after strenuous activity.

No medial joint space narrowing or patellofemoral joint space narrowing was observed and radiographies after 6 months showed complete integration of the bone plug in the femoral tunnel (Figure 4). However, when we compared the immediately postoperative radiograph with the final follow-up radiograph of our patients, we found no significant differences in tunnel width (<2 mm maximum difference). Furthermore, we had no patellar fractures. Three patients of our series at the beginning suffered a pull out of femoral bone block during aggressive assessment intra-operatively; the bone plug was repositioned and fixed with a 9-mm metal interference screw.

After careful rehabilitation the patients went back to sport and heavy work activities, and at final IKDC evaluations were classified as "nearly normal", but we exclude them from final evaluation. The improper preparation of trapezoidal portion of the graft seemed to be the main cause of failure of press fit fixation in these three cases.

Figure 4. Radiologic study at the latest follow-up shows complete integration of the femoral graft

Discussion

Few long-term studies have analyzed the results of biological fixation with patellar tendon graft. The main goal of our study was to determine whether ACL reconstruction performed with a patellar tendon graft and femoral trapezoidal press-fit fixation in general population guarantees good results in terms of stability and return to sports after a short follow-up. In the early weeks after ACL surgery the weakest links in the reconstruction are the fixation sites; if the reconstruction fails during this time, it is usually due to fixation failure rather than graft failure. Grafts with bone fragments attached can be effectively fixed using interference screw fixation, a Kirschner wire, or screw traversing the tunnel and bone plug, or heavy non-absorbable sutures tied to a screw, staple post, or button. The trapezoidal press-fit fixation is a simple technique that offers several advantages, including biological graft healing, the absence of any intra-articular hardware making easier revision surgery, and avoidance of the cost of femoral implants. Brand et al (18) reported no statistical difference in failure or stiffness comparing a press-fit bone plug with a patellar tendon bone plug with interference screw fixation, endobutton, or Mitek anchor. Malek (11) and Bozzotta (9) presented a technique with inside-out femoral press-fit with good long-term results. In this technique the stability of the graft during the first postoperative period depends on the knee position and flexion beyond 90° should be avoided. We adopted a trapezoidal press-fit femoral fixation to combine the advantages of biological anatomical healing with immediate knee stability at all degrees of flexion. The press-fit trapezoidal bone plug offers optimal stability and prevents any possible abrasion of the graft. Although all our patients followed an aggressive rehabilitation program (7), we found no cases of postoperative plug dislocation or loosening. Matthews and Soffer (19) described several potential pitfalls of the interference screw fixation technique: inadvertent graft advancement, screw laceration of the passing suture, and the screw thread can lacerate the tendon if the tip of the screw protrudes beyond the end of the bone plug. Interference screw fixation in osteopenic bone may need to be supplemented by tying the passing sutures around a screw for added security. It is also possible to "explode" a tunnel in soft bone (most often the tibia) if the tunnel begins too near the tibial articular surface, and the screw size is too large. In addition, metal implants can distort magnetic resonance imaging and release metal ions into the surrounding tissue. The advantage of our technique is avoiding the complications of the interference screws, and easier revision of ACL reconstruction without the problems of removal of the interference screw since the number of revisions has risen dramatically over the past few years. The main feature of press-fit technique is a stable bony fixation on the femoral site without interference screw. In reporting his experience with press-fit fixation Hertel[20] mentioned that the press-fit fixation is an anatomically oriented method with a high grade of tissue sparing and cost reduction. In our study evaluation used the IKDC score which revealed an overall improvement, as 92% had normal or nearly normal knee (grade A or B) at the latest follow-up. The Lachman test has proved to be the most accurate test for the assessment of ACL laxity. At the time of follow-up 23of the 25 knees (92%) had 2 mm or less laxity on the Lachman test. These results compare favorably with the findings in the published studies, using other methods for femoral fixation, in which 60 of 68 knees (88%) had a postoperative value of 2 mm or less (21,22). We believe that this stability contributed to the overall success of the reconstruction. The marked reduction in the degree of pivot shift after the reconstruction by press fit method in our patients was similar to results that have been noted in the literature (3,8). One of our patients had a loss of extension of more than 10° at last follow-up. Similar results were reported by Buss et al (22). The potential for arthrofibrosis, defined by many authors as 10° loss of motion in the involved knee postoperatively, is a real concern for a patient of any age who has ACL reconstruction (24,25). Giving way has been reported previously in association with lower knee-rating score. Our patients reported no giving-way postoperatively. Bozzotta (9) observed in his series that filling the patellar defect with cancellous bone reduces anterior knee pain. We adopted a similar technique, but 26% of our patients still had with patellofemoral pain after 6 months, while at final follow-up only five patients had a positive kneeling test; furthermore, none of these were found to have reduction in patellofemoral joint space. Similar incidence of patellofemoral problems has been reported by other authors using different fixation techniques (1,2,26-31). Enlargement of bone tunnels is a radiographic phenomenon that has been reported for both patellar tendon and hamstring tendon grafts (32). Although the cause of this phenomenon is still unknown, several studies have found no adverse effects of tunnel enlargement on clinical outcome after 1-2 years (32,33). In our study we found no significant increase in the size of the tibial and femoral tunnels, considering our short follow-up period. The coordination and strength of the leg are also important factors for good knee function (34,35). In our study, all patients showed some degrees of quadriceps atrophy in the latest follow up which indicate we should redeem our rehabilitation program. In conclusion, we conclude that bone-patellar tendon graft with trapezoidal press-fit fixation is an easy, reproducible technique for ACL reconstruction in young and active athletes. It provides a stable fixation at low cost, has low postoperative morbidity, and allows a rapid return to sports. The incidence of patellofemoral problems should be considered when using this technique especially in patients with preexisting patellofemoral pain.

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