

Isolated posterior cruciate ligament reconstruction

Long-term results

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ABSTRACT

From 1973 to 1987, 28 patients seen at our institution sustained isolated posterior cruciate ligament tears. Of these 28 patients, 25 were reevaluated at an average followup of 7 years and 1 month after secondary reconstruction of the posterior cruciate ligament using the semitendinosus and gracilis tendons alone or with an extraarticular procedure.

Subjectively, 22 of 25 patients related no restrictions regarding activities of daily living, with 14 of 25 patients being able to return to their previous competitive level in sports. Objective evaluation after reconstruction revealed no change in the preoperative and postoperative posterior drawer examination in 13 of 25 patients, a finding confirmed by KT-1000 arthrometer measurements. Radiographic evaluation revealed degenerative changes predominantly involving the medial and patellofemoral compartments in 15 of 25 patients.

Despite optimistic subjective reporting, this long-term retrospective study reveals that this procedure inconsistently limits posterior instability and therefore cannot be recommended.

“Rupture or stretching of the posterior cruciate ligament (PCL) of the knee-joint is an injury which, until recently, has baffled all efforts to bring about satisfactory repair.” This statement by Gallie and LeMesurier⁶ in 1927 is as pertinent today as it was then. Diagnosis and the appropriate treatment of PCL injuries continues to be a difficult problem. In the 1930s and 1940s, Palmer¹⁴ and Brantigan and Voshell¹ rekindled interest in knee ligament injuries, in

particular the anterior and posterior cruciate ligaments. Helfet⁷ further emphasized the importance of the cruciate ligaments as “guide-ropes” of the knee joint during the knee’s range of motion, and advocated their repair.

After reports by O’Donoghue¹³ on the repair of ligamentous injuries, Kennedy et al.¹⁰ focused increased attention on the anatomy and biomechanical properties of the PCL. In addition, they noted the relative rarity of isolated PCL injuries and found that most PCL injuries occurred with other ligamentous injuries.

The article by Hughston et al.⁸ on the classification of knee ligament instabilities further emphasized the importance of the PCL as the basic stabilizer of the knee joint, thereby renewing interest in primary and secondary reconstructive methods to restore its function in combined ligamentous injuries.

Hughston and Degenhardt⁹ advocated a dynamic secondary reconstruction using the medial tendon of the gastrocnemius. However, their results were mixed, with only 33% objective good results. Clancy et al.,² in 1983, reported their PCL secondary reconstruction results of using the medial one third of the patellar tendon with attached bone blocks. Sixteen of 33 patients had isolated chronic PCL tears, with the majority of the results being excellent or good.

Conversely, recent authors^{3,5,15} have advocated conservative treatment of isolated PCL tears. Their series indicate that patients relate doing well, although objective testing confirms moderate to significant posterior instability.

The purpose of this paper is to report our experience with the operative treatment of acute and chronic “isolated” midsubstance tears of the PCL using the semitendinosus and gracilis tendons as an intraarticular reconstruction alone or with a lateral extraarticular repair.

MATERIALS AND METHODS

From 1973 to 1987, 28 patients at our institution underwent secondary reconstruction for isolated PCL tears. Twenty-

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TABLE 1
Results of repair of acute isolated PCL tears

Preoperative evaluation		Operation ^b	Length of followup (months)	Postoperative evaluation		Referred to neutral position (mm)
Activity associated with Injury	Posterior drawer test ^a			Posterior drawer test ^a	KT-1000 (89 N posterior force) quadriceps neutral angle (mm)	
Skating	3+	ST/G	144	3+	3.25	5.75
Football	2+	ST/G/LAT	58	2+	7.00	7.00
MVA ^c	3+	ST/G/LO	72 ^d	2+	6.50	7.00
Fall	2+	ST/G/LAT	47	2+	2.25	6.25
Motorcycle	2+	ST/G/LO	60 ^e	1+	3.00	3.25
Football	2+	ST/G/LO	106	1+	3.25	4.75
Football	3+	ST/G	101	3+	5.50	7.75
Baseball	2+	ST/G	62	3+	5.00	7.25
Basketball	2+	ST/G	100	2+	4.50	8.50
Motorcycle	3+	ST/G	106	2+	5.75	6.50
Football	2+	ST/G/LO	77	2+	6.50	7.00
Football	2+	ST/G	104	2+	6.75	8.50
Basketball	2+	ST/G/LO	81	1+	3.75	6.25
MVA	2+	ST/G/LO	78	1+	2.50	2.75

^a Neutral rotation. 1+ = 5 mm or more of posterior motion; 2+ = 10 mm or more of posterior motion; 3+ = 15 mm or more of posterior motion.

^b ST/G, semitendinosus, gracilis; ST/G/LAT, semitendinosus, gracilis, lateral compartment procedure; ST/G/LO, semitendinosus, gracilis, Losee procedure.

^c Motor vehicle accident.

^d Reinjury—repeat reconstruction.

^e Failure—repeat reconstruction.

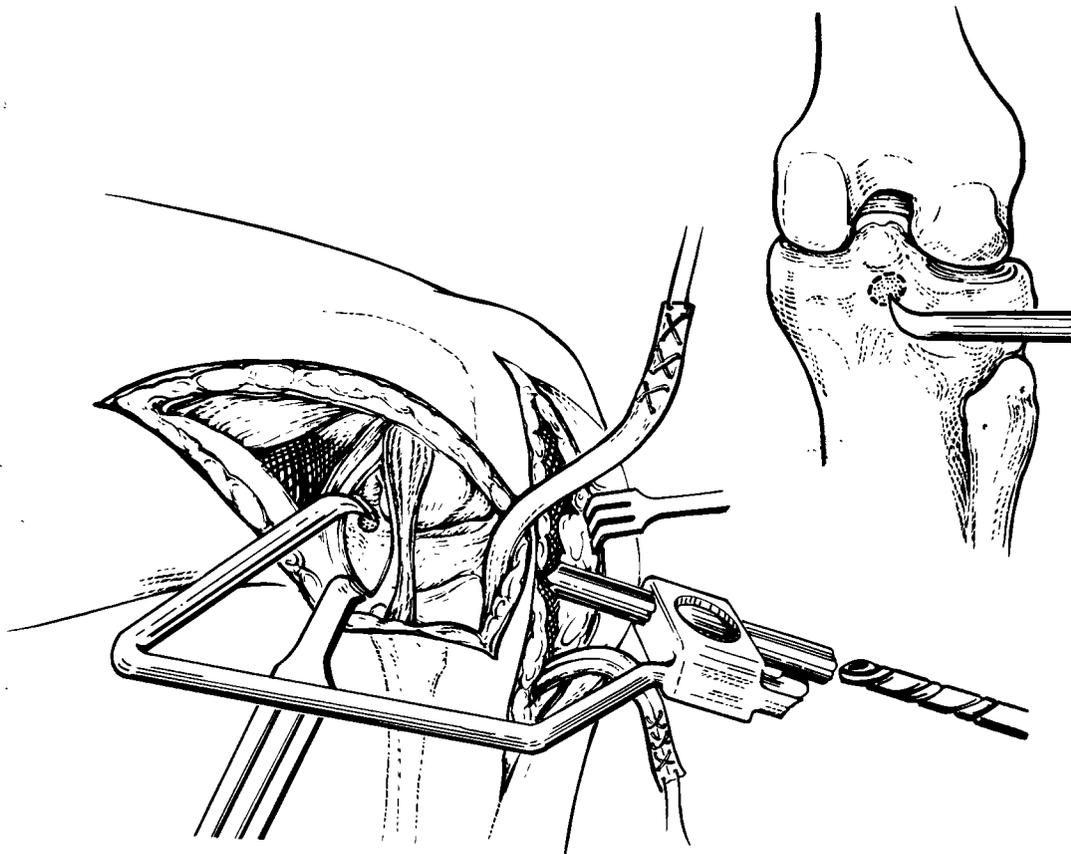


Figure 1. A vertical 2.5-cm incision is made through the posterolateral capsule and the point of the Lipscomb-Anderson drill guide is inserted through this incision (top right). This is secured in bone at the anatomic origin of the PCL and a 0.79-cm drill hole is made front to back through the anteromedial tibia.

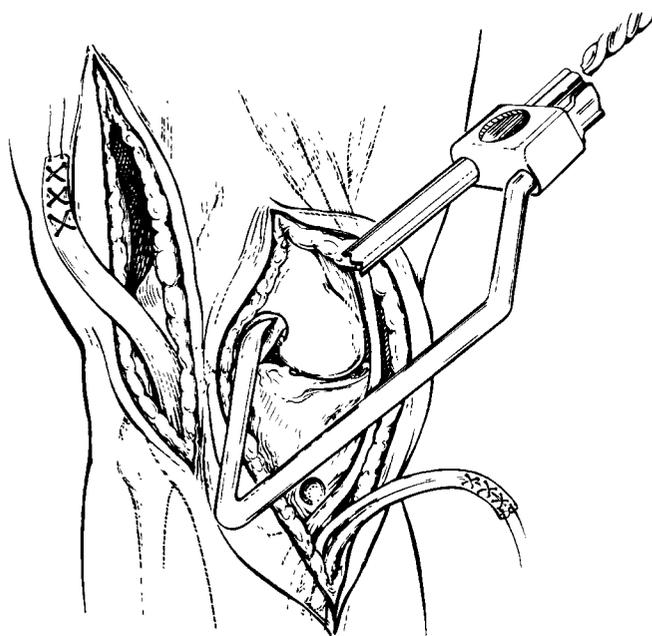


Figure 2. The drill guide is used to make a 0.79-cm hole through the medial femoral condyle, entering the joint at the anatomic insertion of the PCL.

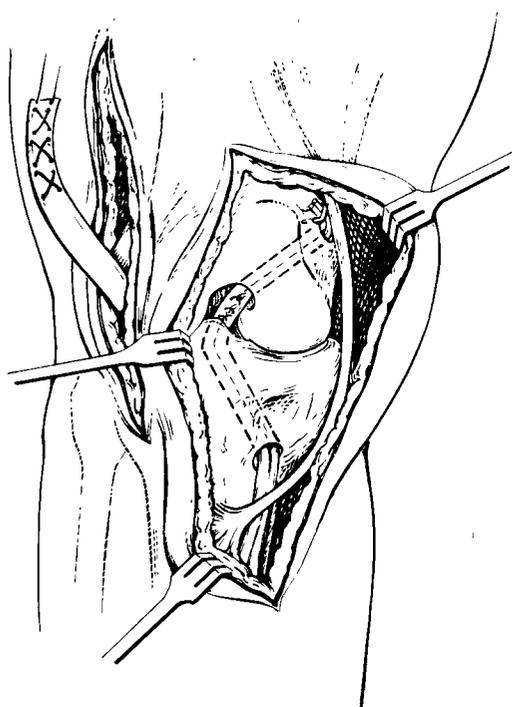


Figure 3. The semitendinosus and gracilis tendons are passed from front to back through the tibial drill hole, up through the notch, and out the hole in the medial femoral condyle. They are secured to the medial femoral condyle with a small barbed staple.

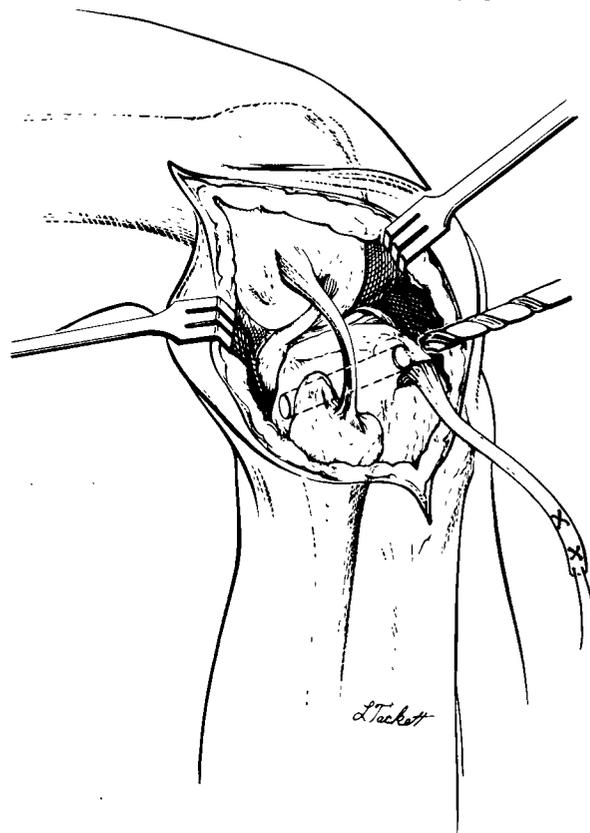


Figure 4. A 0.79-cm drill hole is made through Gerdy's tubercle from anterior to posterior, exiting inferior to the articular surface, just medial to the fibula.

five patients, were available for subjective and objective testing. At a mean followup of 7 years, the average age of these patients was 27 years. Fourteen patients were operated on within 2 weeks after their injuries and constitute an acute group (Group I); the remaining 11 patients constituted a chronic group (Group II).

Early in this series, secondary reconstruction of the PCL using the semitendinosus and gracilis tendons alone was performed in 8 patients. To augment this repair, a lateral reconstructive procedure, as described by Losee et al.,¹¹ was added in 11 patients. Later, a modification of the Müller¹² lateral reconstructive procedure was performed in 6 patients. This modification was developed to improve posterior stability as it became recognized that the Losee procedure appeared to be more effective in preventing anterior rather than posterior translation of the tibia.

To clarify the distinction between subjective and objective results, collective evaluation into categories of excellent, good, fair, and poor results will not be used to formulate the results.

Group I

Fourteen patients (11 men and 3 women) at an average age of 21 years (range, 22 to 49) at time of injury sustained acute tears of the PCL (Table 1). The injuries affected 7 right and 7 left knees. Most of these injuries occurred in competitive

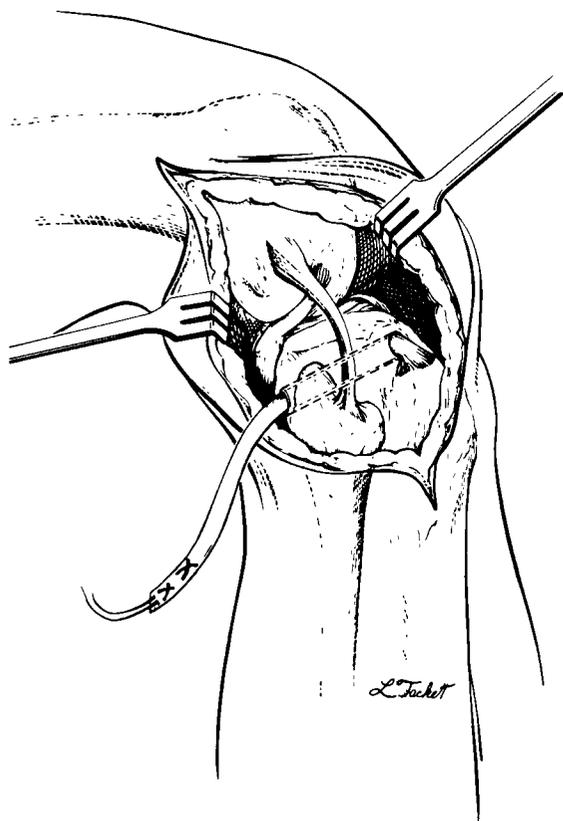


Figure 5. The strip of iliotibial tract is passed from front to back through the tibia.

sports and resulted from hyperextension, rotation forces, or from a fall on a flexed knee. Of these 14 patients, 1 had previously had an arthroscopic medial meniscectomy for an injury sustained 7 months before his acute PCL injury.

The preoperative diagnosis of a PCL tear, as confirmed by a positive posterior drawer sign, was correct in 12 patients. An incorrect diagnosis of an acute ACL tear and an acute patellar dislocation was made in 2 patients.

At the time of operation, two patients had a medial meniscectomy. Another patient underwent medial meniscal repair with excision of a torn lateral meniscus.

Group II

Eleven patients (9 men and 2 women) with an average age of 20 years (range, 19 to 36) presented for secondary reconstruction an average of 8 months (range, 5 to 24) after injury. Injuries involved 8 left knees and 3 right knees and occurred either in athletic activities or in motor vehicle accidents. The primary complaint of these patients concerned the recurring episodes of instability, which they had either with activities of daily living or athletic endeavors that involved cutting maneuvers. Of these 11 patients, 3 had had previous operative procedures. Two had had primary PCL repairs at 7 and 16 months, respectively, before their

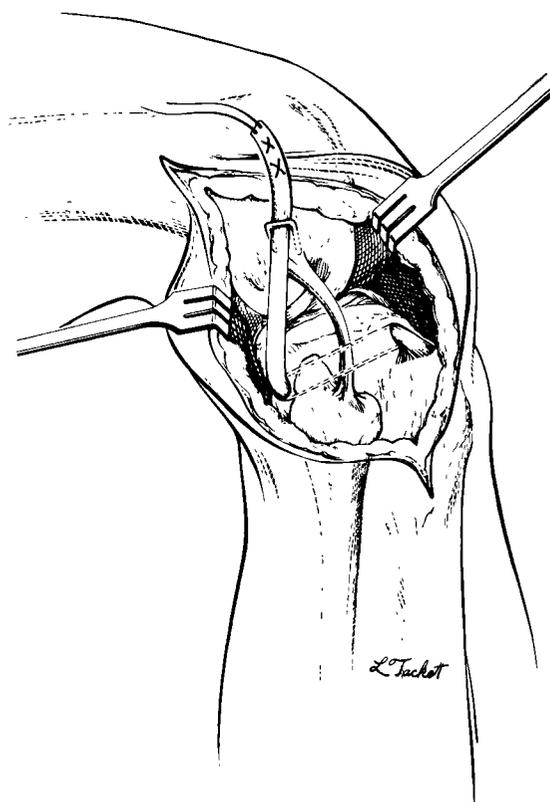


Figure 6. The strip is placed under tension and stapled to a groove in the lateral femoral condyle. The groove is angled at 45° to the long axis of the femur and located just superior to the origin of the fibular collateral ligament.

secondary reconstruction. The other patient had undergone an open medial meniscectomy 9 years before his PCL injury.

The correct diagnosis of chronic PCL tears was confirmed by a positive posterior drawer sign in 10 of 11 patients. An incorrect diagnosis of a chronic ACL tear was made in 1 patient. Interestingly, at the time of secondary reconstruction for chronic PCL tears, no medial or lateral meniscal tears could be identified. However, 3 of these 11 patients had significant changes involving the medial femoral condyle, a finding supporting those of the previous report by Clancy et al.²

TECHNIQUE

After adequate relaxation by anesthesia, a complete examination of the affected knee was performed to confirm the preoperative diagnosis. A long, medial parapatellar incision was made. The quadriceps tendon was split, and the patella dislocated laterally. With the knee flexed to 90°, the synovial sleeve of the PCL was incised longitudinally and carefully preserved for suture around the newly reconstructed ligament. The semitendinosus and gracilis tendons were dissected free in the distal thigh, divided at the musculotendinous junction, and sutured together using a Bunnell stitch

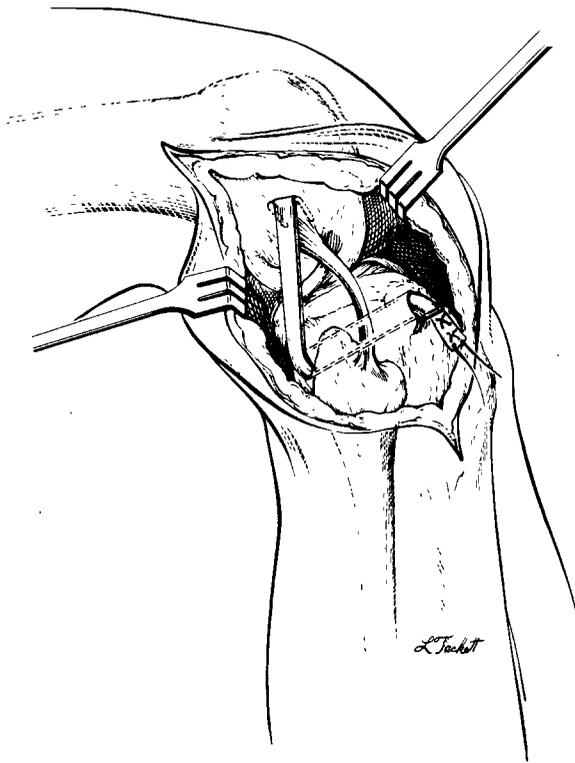


Figure 7. The remainder of the iliotibial tract is brought back on itself, passed through the tibial drill hole from posterior to anterior, and stapled to Gerdy's tubercle.

of no. 1 nonabsorbable material. The muscle bellies were allowed to retract.

A long, curved lateral incision was made, ending over Gerdy's tubercle. A strip of iliotibial band, 3.8 cm wide and 30 cm long, was mobilized from proximal to distal, leaving it attached to Gerdy's tubercle. A vertical 2.5-cm incision

was then made through the posterolateral capsule entering the joint. The point of the Lipscomb-Anderson drill guide (Richards Medical Co., Memphis, TN) was inserted through this incision. It was pushed inferiorly and secured in bone in the center of the posterior intercondylar fossa, about 1.9 cm below the level of the tibial plateau at the anatomic origin of the PCL. The position of the drill guide is confirmed by placing a right-angled clamp through the intercondylar notch and palpating the point of the drill guide. A 0.79-cm drill hole was made front to back through the anteromedial tibia, exiting at the tibial attachment origin of the PCL (Fig. 1). Using the drill guide, a 0.79-cm drill hole was made through the medial femoral condyle, entering the joint high in the intercondylar notch slightly posterior to the origin of the PCL, a point believed to be most consistently isometric (Fig. 2).

The semitendinosus and gracilis tendons were then passed from front to back through the tibial drill hole, up through the notch, and out the drill hole in the medial femoral condyle. They were fixed to the medial femoral condyle with a small barbed staple under moderate tension (approximately 89 N) with the knee at 45° of flexion and the tibia resting anteriorly on the femur (Fig. 3). If a substantial portion of the torn PCL was present, a gathering suture was placed in its end and it was also drawn through the drill hole and sutured to the periosteum. However, no attempt was made to do a primary repair of mop end intrasubstance tears. These fibers were sutured over the newly reconstructed PCL along with the synovium.

The medial parapatellar incision then was closed to maintain normal patellofemoral alignment. The vertical incision in the posterolateral capsule was closed by advancing the arcuate complex superiorly and distally.

Initially, the lateral compartment reconstruction procedure described by Losee et al.¹¹ was added to the intraarticular procedure with the expectation of reducing posterior

TABLE 2
Results of chronic isolated PCL tears

Preoperative evaluation		Operation ^b	Length of followup (months)	Postoperative evaluation		Referenced to neutral position (mm)
Activity associated with injury	Posterior drawer test ^a			Posterior drawer test ^a	KT-1000 (89 N posterior force) Quadriceps neutral angle (mm)	
MVA ^c	3+	ST/G	67	1+	4.50	4.50
Motorcycle	2+	ST/G/LO	66	1+	4.50	8.25
Fall	2+	ST/G/LO	108	2+	5.00	5.75
Football	2+	ST/G/LAT	110	1+	5.75	6.25
Motorcycle	2+	ST/G/LO	64	2+	9.25	10.25
Fall	1+	ST/G	120	1+	2.50	7.00
MVA	3+	ST/G/LAT	138	2+	7.50	12.00
Softball	2+	ST/G/LO	58	1+	8.50	9.50
Football	2+	ST/G/LO	102	2+	6.50	7.00
Softball	1+	ST/G/LAT	54	1+	3.75	6.25
Motorcycle	2+	ST/G/LAT	60	1+	4.50	5.25

^a Neutral rotation.

^b ST/G, semitendinosus, gracilis; ST/G/LO, semitendinosus, gracilis, Losee; ST/G/LAT, semitendinosus, gracilis, lateral compartment procedure.

^c Motor vehicle accident.

instability and tightening the arcuate complex. When it became apparent that this procedure was more effective in reducing anterior rather than posterior tibial displacement, a modification of the lateral reconstructive extraarticular procedure described by Müller¹² was devised to reduce posterior displacement.

A strip of iliotibial tract that was approximately 30 cm long and 3.8 cm wide was mobilized from proximal to distal, remaining attached at Gerdy's tubercle. A 0.79-cm drill hole was then made through Gerdy's tubercle from anterior to posterior, exiting inferiorly to the articular surface, just medial to the fibula (Fig. 4). The strip of iliotibial tract was passed from front to back through the tibia (Fig. 5), placed under tension, and stapled to a groove in the lateral femoral condyle. The groove was angled at 45° to the long axis of the femur and located just superior to the origin of the fibular collateral ligament (Fig. 6). The remainder of the strip was then brought back on itself, passed through the tibial drill hole from posterior to anterior, and stapled to Gerdy's tubercle (Fig. 7). Care was taken not to trap the peroneal nerve.

Postoperatively, the knee was immobilized in 20° of flexion. Active range of motion exercises were begun at 3 weeks from 30° to 60° and advanced to a full range of motion at 8 weeks. Weightbearing was begun at 8 weeks, followed by swimming and bicycling at 4 months. Full activity was limited generally until 9 to 12 months postoperatively.

RESULTS

Group I

The 14 patients who had acute midsubstance isolated PCL tears (Table 1) returned for followup at an average of 7 years and 1 month after reconstruction. Unfortunately, 1 patient had to undergo a repeat reconstruction of the PCL, with a combined patellar autograft and allograft, 2 years after his initial reconstruction for residual disabling instability. Another patient underwent another reconstruction of the PCL with a peroneus longus allograft after a fall that disrupted his initial reconstruction.

Subjectively, 5 of these 14 patients related occasional discomfort after their reconstructions. Twelve patients reported no swelling, and 3 patients related occasional giving way of their knees. Twelve of these patients had no restrictions regarding activities of daily living and work. Seven patients were able to return to their previous sports, 4 patients returned to less strenuous sports activities, and 3 patients were unable to return to any sports activities.

Objective examination of these patients revealed no effusions. Half of these patients had audible patellofemoral crepitation during range of motion of the knee. Range of motion was decreased an average of 9°. Mild valgus instability at 30° of knee flexion was present in 2 of the 14 patients, and mild varus instability at 30° of knee flexion was present in 3 other patients. No varus or valgus instability was present at 0°.

At followup, the posterior drawer examination with the

knee in 90° of flexion and neutral rotation averaged 2+, a finding not appreciably different from the average preoperative examination. Posterior drawer examination at 90° of flexion with internal rotation averaged 1+. The KT-1000 arthrometer measurements (MEDmetric, San Diego, CA) were performed at 89 N, with the knee in the quadriceps neutral position. One technician performed all of the KT-1000 arthrometer tests. Separate tests were performed that determined trial-to-trial variability as being standard deviations of -0.4 ± -1.5 mm. The average corrected posterior drawer was 6.32 mm greater than the uninvolved limb, indicating minimal improvement in posterior restraint.

Quadriceps strength was tested with the Cybex II dynamometer using the 180 foot-pound, 150° scale at 60 and 240 deg/sec. The average quadriceps strength deficit, compared with the uninvolved limb, was 15% at 60 deg/sec and 7% at 240 deg/sec.

Postoperative radiographic evaluation revealed no degenerative changes in 8 of 14 knees. Six patients had significant medial femoral condyle flattening with intercondylar peaking. These findings were present in the 2 patients who had had a medial meniscectomy. In addition, 4 of these 6 patients had osteophytes present on the inferior patellar pole.

Group II

The average followup in the group of 11 patients who had chronic midsubstance isolated PCL tears (Table 2) was 7 years and 2 months. Four of these patients reported occasional discomfort along the medial aspect of their knees after reconstruction. In addition, of these 4 patients, 3 had occasional lateral joint discomfort. Ten of the 11 patients reported no swelling of their knees after activities, and 4 had only occasional episodes of giving way of their knees. Ten of the patients were able to return to their work and activities of daily living without restrictions. Seven patients were able to return to their previous sports activities and 4 patients returned to less strenuous sports.

Objective evaluation revealed no knee effusions in these 11 patients. Seven patients had audible patellofemoral crepitation during range of motion of the knee. Range of motion differences of the operated versus normal knees averaged 9°. Three patients had mild valgus instability at 30° of flexion and only 1 patient had mild varus instability at 30° of flexion. No patient exhibited varus or valgus instability at 0°.

Postoperative posterior drawer examination with a firm end point at 90° of flexion averaged slightly more than 1+ in these 11 patients, a measurement not appreciably different from the preoperative evaluation. Posterior drawer examination at 90° and internal rotation revealed little posterior translation of the tibia on the femur. The KT-1000 arthrometer measurements at 89 N, with the knee in the quadriceps neutral position, averaged more than 7 mm, a measurement comparable to a nonreconstructed chronic PCL rupture.³ Cybex II evaluation at 60 and 240 deg/sec revealed quadriceps deficits of only 6% and 8%, respectively.

Postoperative radiographic analysis revealed degenerative

changes in 7 of these 11 patients, with the majority of changes occurring in the medial compartment. In addition, 5 patients had evidence of inferior pole patellar osteophytes.

DISCUSSION

Because of its location, function, and strength, the PCL has been emphasized to be the primary stabilizer of the knee.¹ Logically, it would appear that secondary reconstruction of this ligament would be indicated to help maintain the normal biomechanical linkage of the knee. Unfortunately, reports of operative series regarding particular reconstructive methods for midsubstance isolated PCL tears have been small, and the overall results, with the exception of those by Clancy et al.,² have been only fair.

These poor operative results have led Parolie and Bergfeld,¹⁶ Dandy and Pusey,⁴ and Fowler and Messieh⁵ to advocate conservative treatment of isolated PCL midsubstance tears. Subjectively their patients do well, yet objectively there remains significant residual posterior instability. In addition, the study of Parolie and Bergfeld describes mild to moderate degenerative radiographic changes primarily involving the medial femoral condylar region, a finding corroborated in the study by Clancy et al.

Our retrospective study adds to the list of those that report that secondary reconstructive procedures do not effectively limit posterior translation of the tibia after isolated midsubstance PCL tears. Inadequate graft strength of the semitendinosus and gracilis tendons, compared with the strength of the PCL, appears to be the main factor in the failure of this procedure. In addition, despite the optimistic subjective reporting of our patients, significant posterior instability remains, as confirmed by manual and KT-1000 arthrometer testing. More importantly, significant degenerative radiographic changes were present in the majority of these knees that had intact menisci at 7 years of followup.

It appears that residual posterior instability is not totally benign. Despite adequate rehabilitation, the abnormal surface velocities leading to inefficient sliding of the knee after PCL disruption seem to predispose the knee to abnormal articular forces, resulting in degenerative changes. Whether these degenerative changes continue to progress in the future is unclear at this time.

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