Achilles Tendon Allograft Reconstruction of the Fibular Collateral Ligament and Posterolateral Corner

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Purpose: The purpose of this study was to investigate the functional and clinical outcomes of a consecutive series of patients who underwent fibular collateral ligament (FCL) and posterolateral corner (PLC) reconstruction by use of a single Achilles tendon allograft construct. **Methods:** Patients were identified through prospective sports medicine databases at 2 academic institutions. Only patients who had undergone FCL and PLC reconstruction (as opposed to repair) were included. All patients followed a standard postoperative rehabilitation protocol. Various patterns of combined ligament injuries were included and divided into 2 groups (2 ligament *v* multiligament). Functional and clinical outcomes were assessed by clinical examination, Lysholm scores, and International Knee Documentation Committee subjective scores. Statistical analysis was performed by use of Wilcoxon paired rank-sum tests and multivariate regression. **Results:** We identified 16 knees in 16 patients, with a minimum of 2 years' follow-up. There were 13 men and 3 women. The mean age was 30 years (range, 19 to 61 years). The mean length of clinical follow-up was 30 months (range, 24 to 75 months). The mean International Knee Documentation Committee subjective scores were 80 points and 80 points ($P = .79$) in the 2-ligament and multiligament groups, respectively, and the mean Lysholm scores were 90 points and 89 points ($P = .96$), respectively. Age ($P = .41$), gender ($P = .84$), and interval between injury and surgery ($P = .72$) did not affect the clinical and functional outcomes between the 2 groups. Arthrofibrosis requiring manipulation developed in 1 patient. Residual varus laxity (1+) was noted in 4 patients, none of whom displayed functional instability. No patient has required revision reconstruction to date. **Conclusions:** We describe a novel technique that takes into account the main static PLC stabilizers (FCL, popliteofibular ligament, and posterolateral capsule) that has not been previously reported. Our series showed no significant differences in clinical and functional outcomes between 2-ligament and multiligament PLC-based reconstructions. However, given the heterogeneity and small sample size of our study group, it is difficult to draw qualitative conclusions. **Level of Evidence:** Level IV, therapeutic case series. **Key Words:** Posterolateral corner—Knee ligament reconstruction—Fibular collateral ligament.

Injuries to the posterolateral corner (PLC) are uncommon[1] but potentially devastating. The most common mechanism of injury for this area of the knee involves a combined hyperextension and varus force to the extremity that is often high energy.[2] Because of this, the injury is often associated with other ligamentous deficiencies, which make the diagnosis and surgical reconstruction of this region extremely challenging.[3]

The anatomy of the PLC is complex and, until recently, has been relatively poorly understood. This region of the knee is composed of static and dynamic stabilizers. The 3 primary static stabilizers are the fibular collateral ligament (FCL), the popliteofibular ligament (PFL), and the posterolateral capsule. The popliteus tendon regulates both dynamic and static posterolateral rotation of the knee.[4-6] The PFL, which branches from the popliteus tendon and assumes its

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course to the fibular styloid, is an important stabilizer of external rotation.[4-6] The FCL serves as the primary static restraint to varus opening of the knee. The posterolateral capsule also provides static stability to the knee with varus stress and supports the other structures of the PLC. It is the combined effect of these complex anatomic structures that provides the varus and external rotatory constraints necessary for a stable knee.

Anatomic reconstructions attempt to re-create the disrupted FCL, PFL, and popliteal tendon in each of their respective anatomic relations, insertions, and origins. These techniques vary between surgeons but essentially use a tunnel through the fibular head as well as a transtibial tunnel to facilitate graft passage and reconstruction of all 3 stabilizers.[7] The anatomic reconstruction, popularized by other authors, has strong biomechanical support but currently lacks clinical data.[3,7-9]

We developed a reconstructive technique that is less complex than some other anatomic techniques and does not require the creation of a tibial tunnel and additional graft passage. Our technique uses 1 Achilles tendon allograft to reconstruct the FCL, the popliteus tendon, and the PFL, followed by a posterolateral capsular shift. To our knowledge, an outcome study of this technique has not been previously reported.

The purpose of this report is to present the clinical and functional results of a consecutive series of patients who underwent this novel reconstruction technique with a minimum of 2 years' follow-up.

METHODS

Institutional review board approval was obtained, and patients were identified through the prospective sports medicine databases at 2 academic institutions. The inclusion criteria included a disruption of the PLC (diagnosed by physical examination, magnetic resonance imaging, and surgical findings), age of 18 years or older, minimum follow-up of 2 years, and primary PLC reconstruction (as opposed to PLC repair). Exclusion criteria included patients aged younger than 18 years, pregnant women, patients with bilateral knee injuries, patients with prior surgery of the PLC (open reduction–internal fixation and/or failed repair), and patients who were unable or unwilling to participate in rehabilitation of the knee.

All patients sustained injuries to other ligaments in addition to the PLC. The patients were divided into 2 groups based on injury pattern (2 ligament *v* multiligament). The timing of surgical intervention was defined as early for patients who underwent reconstruction within 14 days of the time of their injury and delayed for those who underwent reconstruction at greater than 14 days.[10,11]

All patients underwent an identical surgical technique by 2 surgeons and followed a standard postoperative multiligament rehabilitation protocol as described by Fanelli and Edson.[12] They were kept non–weight bearing for 6 weeks postoperatively, with the leg locked in full extension in a hinged knee brace for the first 3 weeks, and then allowed full range-of-motion (ROM) exercises and quadriceps strengthening with the brace unlocked. Hamstring exercises were restricted until 4 months postoperatively, and patients were allowed to return to full activities at 8 to 12 months, depending on the extent of their surgical reconstruction (i.e., number of ligaments reconstructed).

The functional and clinical outcomes were assessed by clinical examination, Lysholm scores,[13] and International Knee Documentation Committee (IKDC) subjective scores.[14]

Clinical examination consisted of side-to-side knee comparison and included several parameters. Gait was assessed for adductor thrust. Passive knee ROM was recorded. Anterior cruciate ligament (ACL) integrity was assessed by use of the Lachman examination (graded as 0, 1, 2, or 3).[15] Posterior cruciate ligament (PCL) integrity was assessed by use of the posterior drawer test at 90° of knee flexion (graded as 0, 1, 2, or 3).[16] Medial collateral ligament integrity was assessed by use of the valgus stress test at 0° and 30° of flexion (graded as 0, 1, 2, or 3).[17] FCL/PLC integrity was assessed by use of the varus stress test at 0° and 30° of flexion (graded as 0, 1, 2, or 3), the external rotation/posterior drawer test at 90° of flexion (graded as 0, 1, 2, or 3), and the dial test at 30° of flexion in a prone position (determined to be abnormal with a side-to-side difference $>15°$).[12,16]

Paired comparisons were performed by use of Wilcoxon signed rank tests. Multivariate regression was used to analyze the outcome effects of any independent variables showing a significant difference between groups. Significance was set at .05. Statistical analysis was performed with JMP Statistical Discovery Software, version 7.0 (SAS Institute, Cary, NC).

Surgical Technique

Our surgical technique is shown in Fig 1. The technique begins with an incision carried out over the

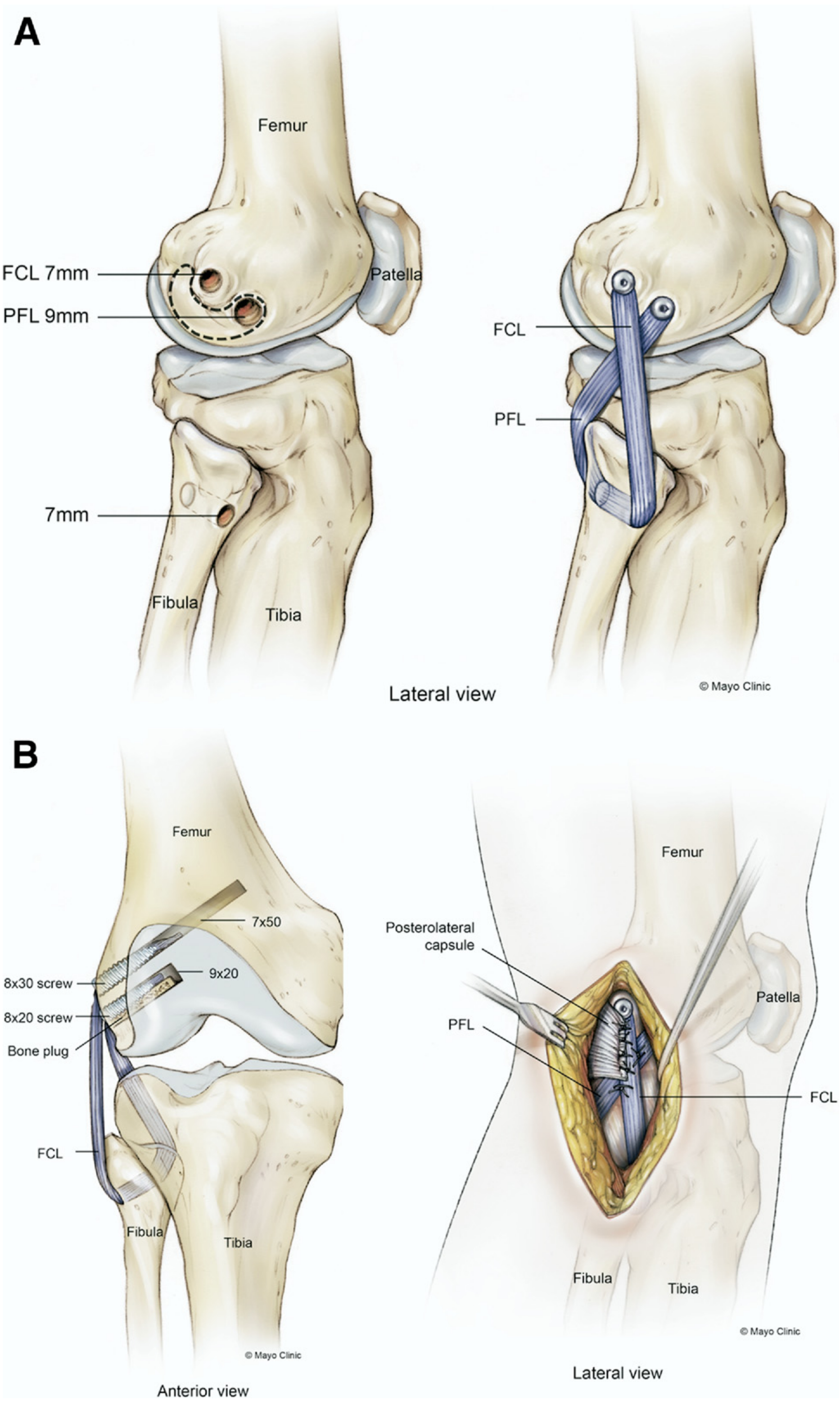

FIGURE 1. (A) Tunnel placement and graft construct. (B) Graft construct, followed by posterolateral capsular shift.

lateral epicondyle extending toward the anterior border of the fibula. Anterior and posterior full-thickness skin flaps are raised to expose the iliotibial band and the biceps femoris muscle complex. The peroneal nerve is identified posterior to the biceps femoris and followed proximally and distally to ensure that it is not tethered through its course and enabling its protection throughout the procedure with the aid of a vessel loop. The iliotibial band is then incised in line with the skin incision. The anterior and posterior borders of the fibula are identified, and subperiosteal dissection is performed, by use of a Bovey and small Cobb. After exposure of the fibular head, access to the anterior sulcus of the popliteus and insertion of the FCL is created with dissection over the lateral aspect of the femur. A tract is developed from the posterior border of the fibula, underneath the biceps femoris, and toward the popliteus sulcus for later passage of the graft. Under fluoroscopic control, a K-wire is passed through the anterior one fifth of the popliteal sulcus and then over-reamed with a 9-mm reamer to a depth of 20 mm (Fig 2). A nonirradiated fresh-frozen Achilles tendon allograft with a 9 × 20–mm bone plug on one end and 7-mm graft along its tendinous portion is prepared (Fig 3A). The bone plug of the allograft is then placed into the tunnel created at the popliteus sulcus and secured with an 8 × 20-mm metal interference screw allowing for bone-bone fixation (Fig 3B). After securing of the graft, the fibular tunnel is then prepared. Under fluoroscopic guidance, a K-wire is passed from the anterolateral fibula at the attachment site of the FCL to the posteromedial down-slope of the fibular styloid, where the PFL attaches to the posterior border of the fibula (Fig 3B). Once in the appropriate position, the K-wire is then over-reamed with a 7-mm reamer. The graft is passed underneath the biceps femoris through the tract that was previously developed, and a suture passer is passed anterior to posterior through the 7-mm hole in the fibula. At this point, the graft is passed posterior to anterior through the fibula, re-creating the popliteal fibular ligament. The graft is then looped back over to the lateral epicondyle at the insertion of the FCL, approximately 18.5 mm proximal and posterior to the popliteus tendon insertion, to re-create the FCL.[6] Once again, under fluoroscopic control, a Beath pin is passed at the FCL insertion to ensure that its path is not intruding on other reconstructed ligament tunnels (Fig 4A and B). With the Beath pin in place, the graft is checked for isometry in flexion and extension (Fig 4C and D).

Once isometry is attained, a 7-mm drill is passed over the Beath pin to a depth of approximately 40 mm (Fig 4E). The Beath pin technique is used to pass the graft from the lateral to the proximal and medial side of the knee. The Beath pin and sutures are pulled out of the medial side of the knee, to apply tension to the graft construct. The graft is tensioned with the leg at approximately 30° of flexion, 10° to 15° of internal rotation, and maximum valgus.[7] The graft is secured with an 8 × 30-mm bioabsorbable screw, completing the FCL reconstruction (Fig 5). The FCL and PFL limbs of the graft are now imbricated with No. 1 Ethibond suture (Ethicon, Somerville, NJ).

The posterolateral capsular shift is then performed in the following manner. The capsule is released off the distal femur, with subperiosteal dissection with a Bovey and Cobb. By use of 3 or 4 No. 1 Ethibond sutures, the sutures are passed from the posterolateral capsule, imbricated distally and anteriorly, and secured to the graft reconstruction complex, providing additional strength to the reconstruction (Fig 6).

All wounds are irrigated with normal saline solution, and the iliotibial band fascia is closed with interrupted No. 1 Ethibond suture, the subcutaneous layers are closed with No. 2-0 Vicryl (Ethicon), and the skin is closed by use of running No. 3-0 Monocryl (Ethicon) with Steri-Strips (3M, St Paul, MN). Postoperative radiographs are obtained (Fig 7).

The reconstruction is unloaded by placing the knee in a valgus-producing hinged knee brace locked in full extension. Any off-the-shelf hinged rehabilitation knee brace can be used, by applying a valgus bend to the brace. This brace is typically worn for the first 6 weeks postoperatively, until soft-tissue swelling subsides. Thereafter the patient's knee is placed in a custom valgus-producing unloader brace for approximately 8 to 12 months.

When indicated, our ACL reconstruction technique consisted of an arthroscopically assisted single-bundle, transtibial reconstruction, using soft-tissue allografts with cortical fixation on the femur and bioabsorbable screw fixation on the tibia.

When indicated, our PCL reconstruction technique consisted of an arthroscopically assisted anterolateral single-bundle, transtibial reconstruction, using Achilles tendon allografts with metal interference screw fixation on the femur and bioabsorbable screw fixation on the tibia.

RESULTS

Between January 2002 and March 2006, 20 knees in 20 patients were identified through our prospective

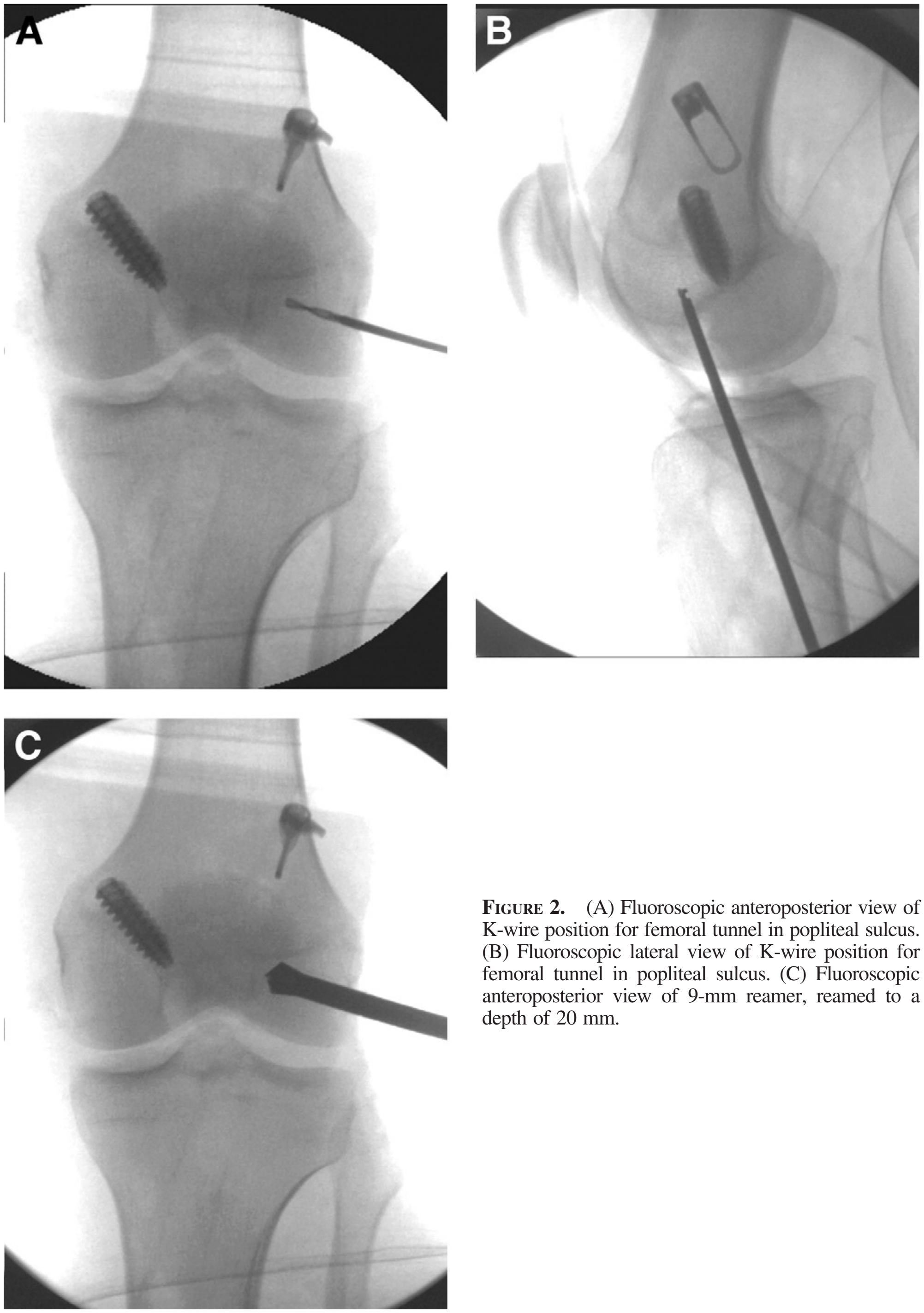

Figure 2. (A) Fluoroscopic anteroposterior view of K-wire position for femoral tunnel in popliteal sulcus. (B) Fluoroscopic lateral view of K-wire position for femoral tunnel in popliteal sulcus. (C) Fluoroscopic anteroposterior view of 9-mm reamer, reamed to a depth of 20 mm.

sports medicine databases as having undergone PLC reconstruction with the previously mentioned technique, with a minimum of 2 years' follow-up. On the basis of our inclusion and exclusion criteria, 2 patients were excluded because of contralateral knee injury and 2 patients because of prior surgery to the PLC. Thus our study comprised 16 knees in 16 patients: 13 men and 3 women. The mean age was 30 years (range, 19 to 61 years). The mean length of clinical follow-up was 30 months (range, 24 to 75 months). The mech-

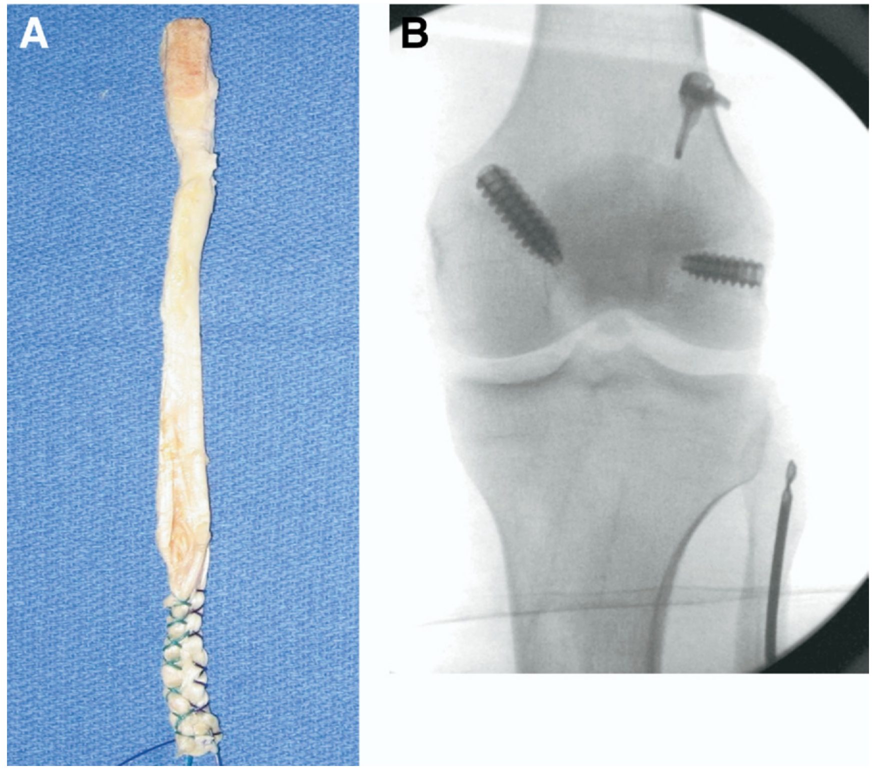

FIGURE 3. (A) Achilles tendon allograft with 9 × 20–mm bone plug and 7-mm graft. (B) Fluoroscopic anteroposterior view of bone block secured with metal interference screw at popliteal sulcus and K-wire placement for fibular tunnel.

anism of injury was considered high energy (i.e., motor vehicle accident) in 11 patients (69%) and low energy (i.e., sports trauma) in the remaining 5 (31%).

Various patterns of injury were noted in the study group and are outlined in Tables 1 and 2. The 2-ligament injury group consisted of 7 patients who had sustained either an ACL (5) or PCL (2) injury in combination with the PLC, and the multiligament group consisted of all other injury patterns (9 patients).

The timing of surgical intervention from injury date is detailed in Table 3. No patients underwent surgical reconstruction before 2 weeks from the time of their injury. Therefore all patients included in the study group underwent delayed reconstructions (>2 weeks). Overall, the mean time to reconstruction was 130 days (range, 17 to 731 days). The mean time from injury to reconstruction in the 2-ligament injury group was 109 days (range, 17 to 266 days), and that in the multiligament group was 207 days (range, 19 to 731 days). This difference was not statistically significant (P = .10). The wide variability in the timing of surgical intervention was a result of patients who were either unable to undergo surgical reconstruction because of associated injuries or those who presented with chronic instability. For example, 1 polytrauma patient had a fracture-dislocation of the ipsilateral hip, with a complex acetabular fracture, and did not regain full weight-bearing status until over 6 months from the injury, at which time an unrecognized multiligament knee injury became apparent. This patient underwent reconstruction at 393 days after injury. Another patient sustained a low-energy multiligament knee injury and was treated nonoperatively for almost 2 years before referral. This patient underwent reconstruction at 731 days after injury.

The mean IKDC subjective score in the 2-ligament injury group was 80 points (range, 50 to 92 points), and the mean Lysholm score was 90 points (range, 75 to 100 points). The mean IKDC subjective and Lysholm scores for the multiligament group were 80 points (range, 30 to 99 points) and 89 points (range, 60 to 99 points), respectively. Mean knee ROM was 132° (range, 100° to 150°) in the 2-ligament group and 118° (range, 80° to 145°) in the multiligament group. At final follow-up, clinical examination comparing the injured and contralateral knee in the 2-ligament group showed no side-to-side difference in lateral laxity (grade 0) at 0° or 30° in 5 patients and grade 1+ laxity (1 to 5 mm) at 30° in 2 patients, with varus stress testing. Clinical examination comparing the injured and contralat-

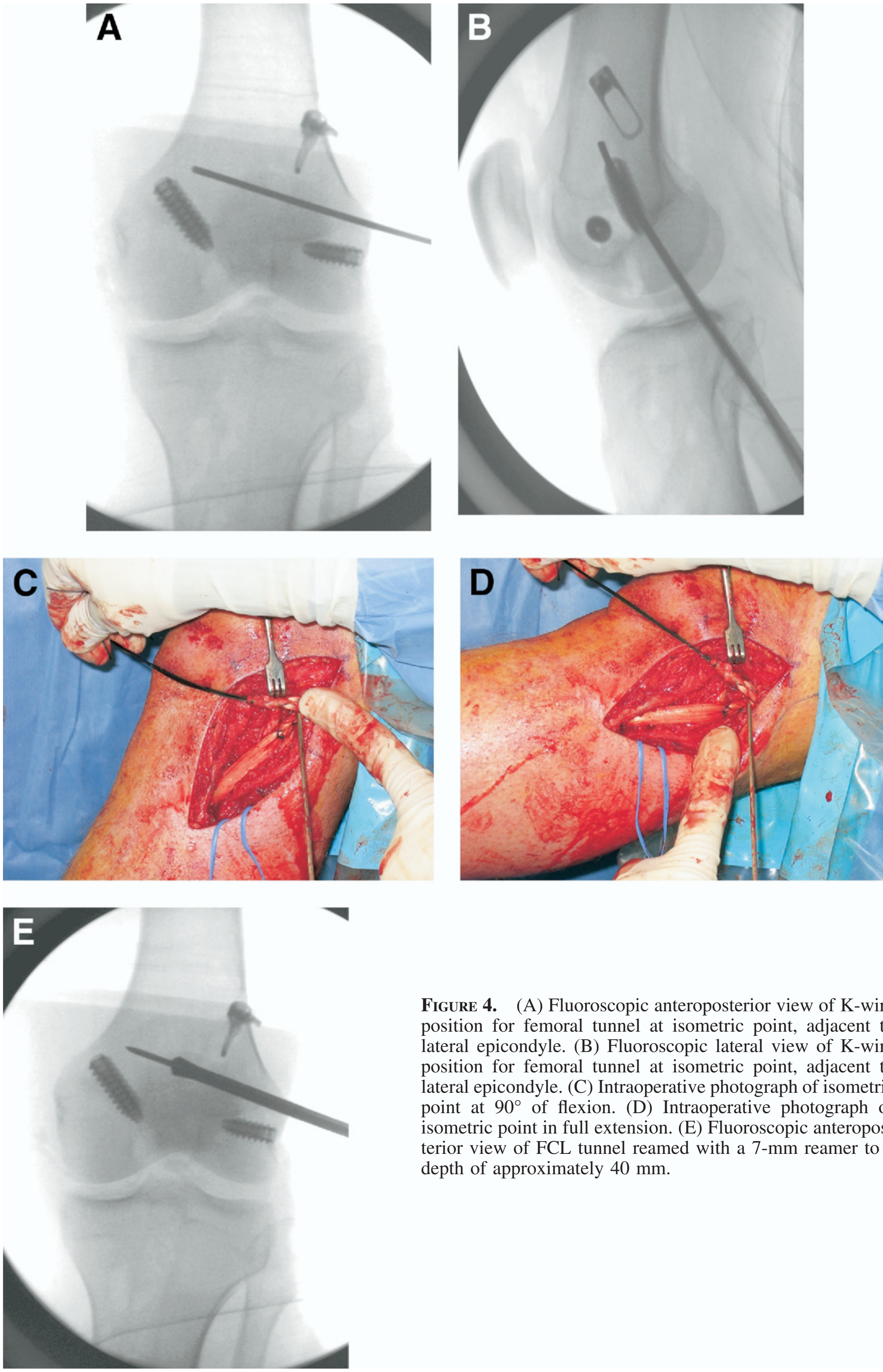

Figure 4. (A) Fluoroscopic anteroposterior view of K-wire position for femoral tunnel at isometric point, adjacent to lateral epicondyle. (B) Fluoroscopic lateral view of K-wire position for femoral tunnel at isometric point, adjacent to lateral epicondyle. (C) Intraoperative photograph of isometric point at 90° of flexion. (D) Intraoperative photograph of isometric point in full extension. (E) Fluoroscopic anteroposterior view of FCL tunnel reamed with a 7-mm reamer to a depth of approximately 40 mm.

Figure 5. Intraoperative photograph of FCL and PFL ligament reconstruction.

eral knee in the multiligament group showed no side-to-side difference in lateral laxity (grade 0) at 0° or 30° in 7 patients (78%) and grade 1+ laxity (1 to 5 mm) at 30° in 2 patients (22%), with varus stress testing. No patient in either group had varus laxity in full extension, varus laxity of grade 2+ or more at 30°, or adductor thrust with ambulation, and none had posterolateral rotatory instability upon dial and external rotation/posterior drawer testing.

Wilcoxon paired rank-sum tests showed no statistically significant differences between the 2 groups in terms of ROM ($P = .18$), IKDC subjective scores ($P = .79$), or Lysholm scores ($P = .96$). Multivariate regression showed no significant effect of age ($P = .41$), gender ($P = .84$), or interval between injury and surgery ($P = .72$) on the outcomes of the 2 groups.

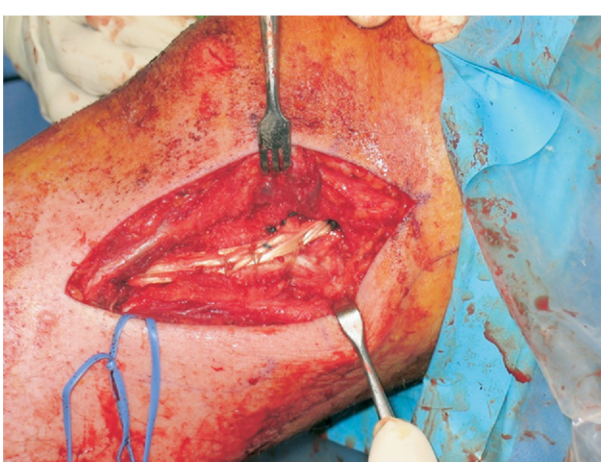

Figure 6. Intraoperative photograph of posterolateral capsular shift.

Figure 7. Postoperative anteroposterior view of 4-ligament reconstruction.

Complications included arthrofibrosis and a chronic regional pain syndrome in 1 patient in the multiligament group. No patient in either group has required revision reconstruction to date.

DISCUSSION

Numerous PLC techniques have been described in the literature with varying degrees of success.[8,12,18,19] Stannard et al.[18] described a technique for reconstruc-

Table 1. *Two-Ligament PLC-Based Injury Patterns*

	No. of Patients	Mean IKDC Score (Points)	Mean Lysholm Score (Points)
Injury Pattern			
ACL/PLC	5 (31%)	86	95
PCL/PLC	2 (13%)	63	77
Total	7 (44%)	80	90

TABLE 2. *Multiligament PLC-Based Injury Patterns*

	No. of Patients	Mean IKDC Score (Points)	Mean Lysholm Score (Points)
Injury Pattern			
ACL/PCL/PLC	5 (31%)	72	83
ACL/PCL/MCL/PLC	3 (19%)	87	96
ACL/MCL/PLC	1 (6%)	99	95
Total	9 (56%)	80	89

Abbreviation: MCL, medial collateral ligament.

tion of the PLC in 22 knees with minimum follow-up of 24 months. They used a modified 2-tailed technique that reconstructs the PFL and FCL through transtibial and transfibular bone tunnels and around a single screw on the lateral femoral condyle. Mean ROM was 133°. The mean Lysholm knee score was 90 points for the entire group, with scores of 92 points for the multiligamentous knees and 88 points for the isolated PLC reconstructions. There were 2 failures in the multiligamentous knee injury group (13%), as compared with no failures in the isolated PLC group.

Strobel et al.[19] evaluated clinical outcomes after single-stage ACL, PCL, and PLC reconstruction in 17 patients with chronic knee injuries at a minimum follow-up of 24 months. The PLC was reconstructed with a graft passed through the proximal fibula, with both graft limbs inserting at an isometric point on the femur. At final IKDC evaluation, the results were graded as nearly normal in 4 patients (29.4%), abnormal in 10 (58.8%), and grossly abnormal in 2 (11.8%). The mean postoperative subjective IKDC score was 71.8 ± 19.3 points.

Our series found ROM data and IKDC and Lysholm scores consistent with the previously described literature. Several patients in our series were involved in high-energy activities causing significant soft-tissue damage to their limbs, which ultimately had a negative impact on their clinical and functional outcomes. Two patients in particular had relatively lower ROM as well as IKDC and Lysholm scores compared with the rest of the study group. The first patient (Table 3, patient 10) sustained a 2-ligament knee injury (PCL/PLC), as well as a severe soft-tissue injury to the proximal tibia region, leading to an infected hematoma, which required several surgical interventions. At latest follow-up, this patient still had chronic pain and swelling in the lower leg. The second patient (Table 3, patient 10) sustained a multiligament knee injury with severe capsular disruption. In this patient arthrofibrosis developed, requiring manipulation under anesthesia and arthroscopic lysis of adhesions. She had subsequent development of a regional pain syndrome that is currently unresolved.

The reconstruction technique used in this series is similar to that described by Arciero[20] in that the PFL and FCL are reconstructed in a process that re-creates the femoral and fibular insertions of the 2 ligaments. However, our technique is unique in that the posterolateral capsule is then imbricated to our ligamentous reconstruction to further enhance varus and external rotatory stability.

TABLE 3. *Patient Data*

Patient No.	Age (yr)	Sex	Injury Pattern	Time to Surgery (d)	ROM (°)	IKDC Score (Points)	Lysholm Score (Points)
1	19	F	ACL/PLC	61	140	91	95
2	32	M	ACL/PLC	80	150	92	100
3	22	M	ACL/PLC	106	140	84	88
4	23	M	ACL/PLC	148	150	74	92
5	33	M	ACL/PLC	266	130	90	100
6	37	M	PCL/PLC	30	100	80	82
7	61	M	PCL/PLC	70	115	46	72
8	36	M	ACL/PCL/PLC	19	145	86	95
9	23	M	ACL/PCL/PLC	24	115	89	95
10	24	F	ACL/PCL/PLC	25	80	30	60
11	20	M	ACL/PCL/PLC	51	140	90	94
12	22	M	ACL/PCL/PLC	393	130	66	73
13	29	M	ACL/MCL/PLC	731	115	99	95
14	27	F	ACL/PCL/MCL/PLC	17	105	85	99
15	32	M	ACL/PCL/MCL/PLC	25	135	95	99
16	35	M	ACL/PCL/MCL/PLC	30	90	82	91

Abbreviation: MCL, medial collateral ligament.

Several biomechanical studies have shown restoration of varus and external rotational stability with anatomic PLC reconstruction techniques.[7,21] The reconstructive technique used in this series also has biomechanical support. Nau et al.[21] described a technique similar to ours with regard to the PFL and FCL graft placement in 10 cadaveric specimens and compared this with an anatomic reconstructive technique described by LaPrade et al.[7] The reconstructions were tested for varus and external rotatory stability. The results of this biomechanical analysis yielded similar outcomes for static ligamentous stability testing between both groups.

Our study has several limitations including a relatively small sample size, heterogeneity of the study group, variability in the timing of surgical intervention, and lack of objective testing of the FCL and PLC reconstruction.

The uncommon nature of isolated PLC injuries makes it difficult to obtain a completely homogeneous study group. In fact, no patients in our series had an isolated PLC injury. In an effort to minimize heterogeneity, we did the following. First, we reported only on those patients who underwent primary PLC reconstruction and excluded those who had any previous surgery to the PLC. Second, we excluded patients who had contralateral knee injuries. It is difficult to determine functional outcome scores in those patients because of the inability to perform side-to-side comparisons, as well as the patients' inability to participate in rehabilitation. Lastly, we divided our study group into 2 groups (2-ligament *v* multiligament injuries). The 2-ligament group (ACL/PLC, PCL/PLC) represents the more frequently encountered injury patterns associated with PLC injuries, whereas the multiligament group is less common. Although these efforts resulted in less heterogeneity, drawing valid conclusions from this study group remains difficult.

With regard to the timing of surgical intervention, the literature is unclear in the definition of early versus delayed reconstruction in the setting of combined ligament injuries of the knee.[11,12,22] Several authors define early as less than 2 weeks,[10,11] and others define it as less than 3 weeks.[22] On the basis of the outcomes in the current literature,[12] we typically perform early surgical management of all damaged ligamentous structures whenever possible. In this series, however, several patients presented with chronic instability whereas others presented with polytrauma and surgical intervention was delayed because of associated injuries. Multivariate regression analysis showed that the timing of surgery did not affect the clinical and functional outcomes between the 2 groups.

In our study stability was assessed through physical examination alone; thus there was a lack of objective testing of the FCL and PLC reconstruction. Recently, Noyes and Barber-Westin[22] reported on the use of postoperative comparison stress radiography to assess PLC stability. Although we recognize the benefits of stress radiography, we have found this technique difficult to perform in a reliable and reproducible fashion.

The main advantage of our reconstructive technique is that it does not require the creation of a tibial tunnel with additional graft passage and is therefore less complex than other previously described anatomic techniques. Another unique feature of this technique is the advancement of the posterolateral capsule, which is recognized as a static stabilizer.

The main disadvantage of this surgical technique is the necessity for an intact proximal tibiofibular joint because the reconstruction is tensioned through the fibula, not the tibia. Biomechanically, one would postulate that securing the grafts to the tibia should be advantageous. A biomechanical cadaveric study would need to be done comparing the "anatomic" technique with our technique (addressing the posterior capsule) to determine whether the posterolateral capsular shift offers a biomechanical advantage. Furthermore, clinical comparative studies would need to be performed to assess any differences among the techniques with regard to functional outcomes.

Although no patients have required revision reconstruction to date, 4 patients (25%) had subtle residual laxity (1+) to varus stress at 30°. Whether this residual laxity will result in functional instability in the future remains to be seen.

CONCLUSIONS

We describe a novel technique that takes into account the main static PLC stabilizers (PFL, FCL, and posterolateral capsule) that has not been previously reported. Our series showed no significant differences in clinical and functional outcomes between 2-ligament and multiligament PLC-based reconstructions. However, given the heterogeneity and small sample size of our study group, it is difficult to draw qualitative conclusions.

REFERENCES

1. LaPrade RF, Wentorf FA, Fritts H, Gundry C, Hightower CD. A prospective magnetic resonance imaging study of the inci-

dence of posterolateral and multiple ligament injuries in acute knee injuries presenting with a hemarthrosis. *Arthroscopy* 2007;23:1341-1347.
2. Baker CL Jr, Norwood LA, Hughston JC. Acute posterolateral rotatory instability of the knee. *J Bone Joint Surg Am* 1983; 65:614-618.
3. Lee MC, Park YK, Lee SH, Jo H, Seong SC. Posterolateral reconstruction using split Achilles tendon allograft. *Arthroscopy* 2003;19:1043-1049.
4. Maynard MJ, Deng XH, Wickiewicz TL, et al. The popliteofibular ligament: Rediscovery of a key element in posterolateral stability. *Am J Sports Med* 1996;24:311-316.
5. Sanchez AR II, Sugalski MT, LaPrade RF. Anatomy and biomechanics of the lateral side of the knee. *Sports Med Arthrosc* 2006;14:2-11.
6. LaPrade RF, Ly TV, Wentorf FA, Engebretsen I. The posterolateral attachments of the knee: A qualitative and quantitative morphologic analysis of the fibular collateral ligament, popliteus tendon, popliteofibular ligament, and lateral gastrocnemius tendon. *Am J Sports Med* 2003;31:854-860.
7. LaPrade RF, Johansen S, Wentorf FA, Engebretsen L, Esterberg JL, Tso A. An analysis of an anatomical posterolateral knee reconstruction: An in vitro biomechanical study and development of a surgical technique. *Am J Sports Med* 2004; 32:1405-1414.
8. Yoon KH, Bae DK, Ha JH, Park SW. Anatomic reconstructive surgery for posterolateral instability of the knee. *Arthroscopy* 2006;22:159-165.
9. Sekiya JK, Kurtz CA. Posterolateral corner reconstruction of the knee: Surgical technique utilizing a bifid Achilles tendon allograft and a double femoral tunnel. Arthroscopy 2005;21:1400.e1-1400.e5. Available online at www.arthroscopyjournal.org.
10. Fanelli GC, Giannotti BF, Edson CJ. Arthroscopically assisted combined posterior cruciate ligament/posterior lateral complex reconstruction. *Arthroscopy* 1996;12:521-530.
11. Liow RY, McNicholas MJ, Keating JF, Nutton RW. Ligament repair and reconstruction in traumatic dislocation of the knee. *J Bone Joint Surg Br* 2003;85:845-851.
12. Fanelli GC, Edson CJ. Combined posterior cruciate ligament-posterolateral reconstructions with Achilles tendon allograft and biceps femoris tenodesis: 2- to 10-year follow-up. *Arthroscopy* 2004;20:339-345.
13. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. *Am J Sports Med* 1982;10:150-154.
14. Anderson AF, Irrgang JJ, Kocher MS, Mann BJ, Harrast JJ. The International Knee Documentation Committee subjective knee evaluation form: Normative data. *Am J Sports Med* 2006;34:128-135.
15. Jonsson T, Althoff B, Peterson L, Renström P. Clinical diagnosis of ruptures of the anterior cruciate ligament: A comparative study of the Lachman test and the anterior drawer sign. *Am J Sports Med* 1982;10:100-102.
16. Veltri DM, Warren RF. Isolated and combined posterior cruciate ligament injuries. *J Am Acad Orthop Surg* 1993;1:67-75.
17. Hughston JC, Eilers AF. The role of the posterior oblique ligament in repairs of acute medial (collateral) ligament tears of the knee. *J Bone Joint Surg Am* 1973;55:923-940.
18. Stannard JP, Brown SL, Robinson JT, McGwin G Jr, Volgas DA. Reconstruction of the posterolateral corner of the knee. *Arthroscopy* 2005;21:1051-1059.
19. Strobel MJ, Schulz MS, Peterson WJ, Eichhorn HJ. Combined anterior cruciate ligament, posterior cruciate ligament, and posterolateral corner reconstruction with autogenous hamstring grafts in chronic instabilities. *Arthroscopy* 2006;22:182-192.
20. Arciero RA. Anatomic posterolateral corner knee reconstruction. Arthroscopy 2005;21:1147.e1-1147.e5. Available online at www.arthroscopyjournal.org.
21. Nau T, Chevalier Y, Hagemeister N, Deguise JA, Duval N. Comparison of 2 surgical techniques of posterolateral corner reconstruction of the knee. *Am J Sports Med* 2005;33:1838-1845.
22. Noyes FR, Barber-Westin SD. Posterolateral knee reconstruction with an anatomical bone-patellar tendon-bone reconstruction of the fibular collateral ligament. *Am J Sports Med* 2007; 35:259-273.