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Outcomes following anatomic bular (lateral) collateral ligament reconstruction

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Abstract

Purpose The purpose of this study was to investigate clinical outcomes following anatomic fibular (lateral) collateral ligament (FCL) reconstruction. It was hypothesized that anatomic FCL reconstruction would result in improved subjective clinical outcomes and a high patient satisfaction with outcome.

Methods All patients 18 years or older who underwent FCL reconstruction from April 2010 to January 2013 with no other posterolateral corner pathology were included in this study. Patient subjective outcome scores were collected preoperatively and at a minimum of 2 years postoperatively.

Results There were 43 patients (22 males, 21 females, median age = 28.3 years, range 18.7–68.8) included in this study. The median time from injury to surgery was 22 days. Follow-up was obtained for 88 % of patients ($n = 36$) with a mean follow-up of 2.7 years. The mean Lysholm score significantly improved from 49 (range 11–100) to 84 (range 55–100) postoperatively ($p < 0.001$). The mean WOMAC score significantly improved from 37 (range 3–96) to 8 (range 0–46) postoperatively ($p < 0.001$). The median SF-12 physical component subscale score significantly improved from 35 (range 22–58) to 56 (range 24–62) postoperatively ($p < 0.001$). The median SF-12 mental component subscale score did not show significant change preoperatively 54 (range 29–69) to postoperatively 55 (range 25–62). The median preoperative Tegner activity scale improved from 2 (range 0–10) to 6 (range 2–10) postoperatively ($p < 0.001$). The median patient satisfaction with outcome was 8 (range 1–10). Postoperative patient-reported outcome scores were not significantly different for patients who underwent concomitant ACL reconstruction compared to patients without ACL reconstruction.

Conclusion An anatomic FCL reconstruction with a semitendinosus graft significantly improved patient function and yielded high patient satisfaction in the 43 patients. Additionally, there was no significant difference in patient-reported outcomes when accounting for concomitant ACL reconstruction.

Level of evidence Level IV.

Keywords Fibular collateral ligament · Lateral collateral ligament · Anatomic reconstruction · Outcomes

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Introduction

The fibular (lateral) collateral ligament (FCL) is an important stabilizer on the lateral side of the knee. The FCL attaches proximal and posterior to the lateral epicondyle on the femur and distally on the lateral downslope of the fibular head [14, 19]. The FCL functions as the primary restraint to varus forces at all knee flexion angles and resists external rotation near extension [11, 12, 22]. Injuries to this structure most commonly occur following a direct blow to the medial knee resulting in varus stress, a hyperextension injury, or a non-contact injury [2, 20, 23]. Additionally, FCL injuries often present in the context of multiligament injuries [4, 16, 26]. If left untreated, FCL injuries often result in chronic instability and the development of medial compartment articular cartilage lesions and medial meniscus tears [24].

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Following injury, treatment may consist of rehabilitation, repair, or reconstruction depending on the grade and time course of the injury. Non-operative treatment is reserved for acute grade I or II injuries [9]. Primary repair is indicated for acute bony avulsions of the femoral or fibular FCL attachment; however, a repair is not recommended for midsubstance tears [9]. Indications for reconstruction include all grade III midsubstance FCL tears and chronic lateral knee instability secondary to FCL injury.

Numerous FCL reconstruction techniques have been described. Techniques utilizing isometric principles include advancement of the proximal FCL attachment [30], augmentation using the biceps femoris tendon [34], quadriceps tendon–patellar bone reconstruction [5], biceps femoris tendon tenodesis [7], and bone–patellar tendon–bone reconstruction [25, 29]. Recently, as anatomic and biomechanical understanding has improved, other techniques utilizing anatomic principles have been developed [4, 6, 16, 21, 27]. The authors prefer an anatomic technique utilizing a semitendinosus allograft or autograft, which has been biomechanically validated to restore objective knee stability [6, 16]. Early clinical outcomes in sixteen patients demonstrated an improvement in subjective and objective outcome measures, but results across a larger cohort of patients have not been reported [16]. Therefore, the purpose of this study was to report subjective clinical outcomes following anatomic FCL reconstruction and investigate the impact of concomitant ACL reconstruction on patient outcomes. It was hypothesized that anatomic FCL reconstruction would result in improved subjective clinical outcomes and a high patient satisfaction with outcome.

Materials and methods

All patients 18 years or older who underwent isolated or combined fibular collateral ligament reconstruction from April 2010 to January 2013 by a single orthopaedic surgeon with no other posterolateral corner pathology were included in this study. Patients who were less than 18 years old were excluded. Detailed operative data and intraoperative findings were documented at the time of surgery. Patients completed a subjective questionnaire, including Lysholm score [3], Tegner activity scale [32], Western Ontario and McMaster Universities Arthritis Index (WOMAC) [1], short-form SF-12, and patient satisfaction with outcome, which were collected preoperatively and at a minimum of 2 years postoperatively. Patient satisfaction with outcome was rated on a 10-point scale, with 1 equal to highly unsatisfied and 10 equal to highly satisfied. For the purpose of this study, failure was defined as any patient who underwent revision FCL surgery.

Surgical technique

All patients included in this study underwent an anatomic FCL reconstruction [6, 16] with no other posterolateral corner repair or reconstruction procedures. Patients were excluded if they were younger than 18 years of age or if they required complete posterolateral corner reconstruction (FCL, popliteus, popliteofibular ligament), concomitant posterior cruciate ligament (PCL) reconstruction, medial collateral ligament (MCL) reconstruction, or revision FCL reconstruction. Indications for FCL reconstruction included acute grade III midsubstance FCL tears and patients with chronic lateral knee instability with preoperative varus stress radiographic lateral compartment gapping of 2.7–4.0 mm with the knee at 20° of flexion, which has been reported to have high intraobserver repeatability (0.99) and high interobserver reproducibility (0.97) [17].

Anatomic FCL reconstruction was performed using the following technique (Fig. 1). The patient was positioned with the surgical leg in 70° of knee flexion in a leg holder, while the non-surgical leg was abducted and secured in a leg holder. A lateral hockey stick incision was made starting proximally along the iliotibial band and extending distally between Gerdy's tubercle and the lateral fibular head [33]. A common peroneal nerve neurolysis was performed to retract the nerve from the surgical field and to minimize risk of peroneal nerve palsy postoperatively due to swelling. A small longitudinal incision was made in the distal aspect of the long head of the biceps femoris to access the biceps bursa, where the distal attachment of the FCL was found. A tag stitch was placed in the distal end of the attenuated or remnant ligament to facilitate the location of the proximal attachment using traction.

The anterior arm of the long head of the biceps femoris was incised longitudinally, and the FCL distal attachment was sharply dissected away, making room for the fibular head reconstruction tunnel. A guide pin was aimed from the FCL attachment on the lateral aspect of the fibular head to the posteromedial downslope of the fibular head, distal to the popliteofibular ligament attachment. A 7-mm reamer was used to create a 7-mm reconstruction tunnel. Finally, a passing stitch was passed through the newly created reconstruction tunnel. Next, a longitudinal incision was created through the mid-third of the iliotibial band over the lateral aspect of the distal femur. While placing tension on the traction stitch, the proximal FCL attachment was identified proximal and posterior to the lateral epicondyle and anterior and distal to the proximal anterolateral ligament (ALL) attachment [31]. The proximal FCL attachment was dissected from its attachment site, and an eyelet-tipped guide pin was aimed anteromedially across the femur to avoid collision with an ACL femoral tunnel [10]. A 6-mm reamer overreamed the eyelet pin to

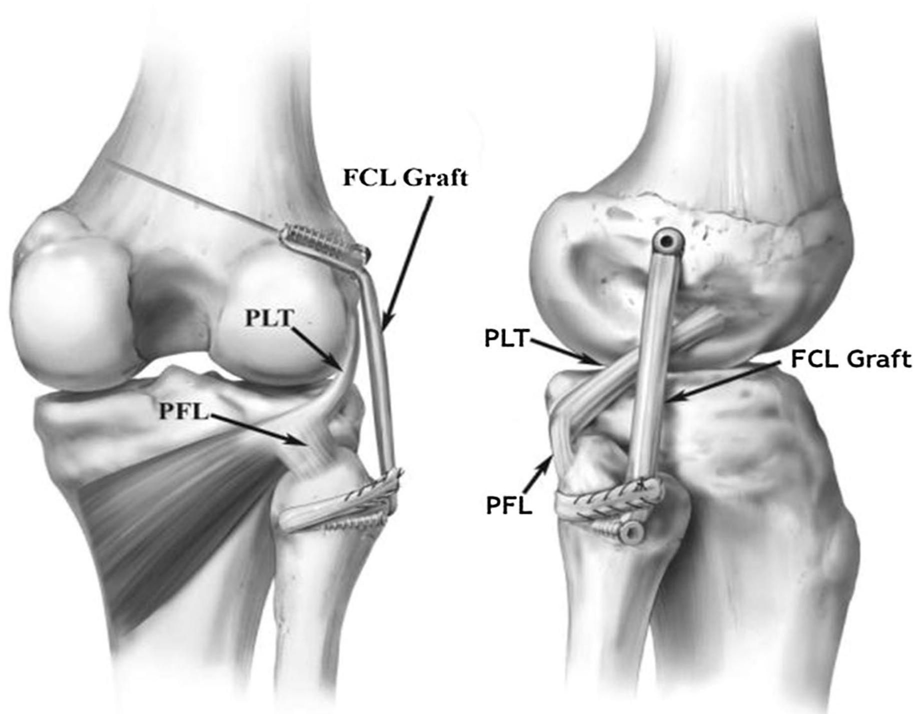

Fig. 1 Posterior–anterior and lateral views of an isolated anatomic fibular collateral ligament (*FCL*) reconstruction using a semitendinosus graft. *PLT* popliteus tendon, *PFL* popliteofibular ligament (reprinted with permission from Coobs et al. [6])

a depth of 30 mm, followed by a 7-mm tap to enlarge the femoral tunnel. A passing stich was pulled through the femoral tunnel.

With the proximal and distal FCL tunnels reamed, attention was turned to harvesting the semitendinosus tendon for patients receiving an autograft. The semitendinosus autograft was harvested in the standard fashion, and an assistant prepared the semitendinosus autograft while concomitant knee injuries were addressed. Anatomic ACL reconstruction was performed using a bone–patellar–bone autograft. An accessory anteromedial arthroscopic portal was utilized to form the femoral tunnel at the anatomic ACL insertion. Lateral and medial meniscal repairs involved inside-out vertical mattress sutures. Articular cartilage injuries were debrided or treated with a standard microfracture technique or a second-stage osteochondral allograft transplantation surgery (OATS) depending on size, severity, and location of the full thickness articular cartilage defect.

After intra-articular work was addressed, the FCL graft was passed into the femoral tunnel and fixed with a bioabsorbable screw (Fig. 2). The FCL graft was pulled laterally to verify secure femoral fixation. The FCL graft was now passed under the superficial layer of the iliotibial band and through the fibular head tunnel. A valgus force was placed with the knee in 20° of flexion and in neutral rotation, and the distal fibular FCL graft was fixed with a bioabsorbable screw. The knee was examined to confirm resolution of preoperative varus laxity.

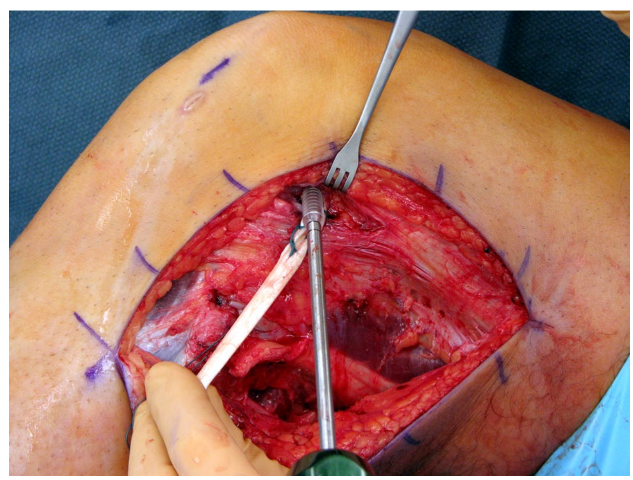

Fig. 2 Femoral fixation of the semitendinosus graft at the fibular collateral ligament attachment site

Rehabilitation

Patients were non-weight-bearing for the first 6 weeks after surgery and were restricted from tibial internal or external rotation and varus stress to allow adequate time for graft healing [8, 15, 28]. Range-of-motion exercises from 0° to 90° and quadriceps strength training exercises were initiated on postoperative day one [13]. Increased range of motion was allowed after 2 weeks. Patients returned to normal physical activities by 6 months postoperatively for isolated reconstructions and 6–9 months for concurrent ligament reconstructions. This study was approved (ID # 2002–2003) by the Vail Valley Medical Center (VVMC) institutional review board.

Statistical data analysis

Data were tested for normal distribution using the Kolomgorov–Smirnov test. The Lysholm score was normally distributed, and a paired *t* test was used to compare preoperative and postoperative scores. The WOMAC score, SF-12 physical and mental component subscales, and Tegner activity scale were not normally distributed; therefore, comparisons of preoperative and postoperative scores were performed using the Wilcoxon rank sum test. For comparisons between two independent groups, the Mann–Whitney *U* test was performed. Significance level was set at alpha less than 0.05.

Results

There were 43 patients (22 males, 21 females) with a median age at surgery of 28.3 years (range 18.7–68.8 years) who were included in this study (Fig. 3). The median time from injury to surgery was 22 days (range 1 day to 8.9 years). Concomitant surgical procedures performed during index surgery included anterior cruciate ligament (ACL) reconstruction, microfracture and osteochondral allograft transplantation (OATS) of femoral osteochondral lesions, and lateral and medial meniscal tears requiring partial meniscectomy or meniscal repair. Treatments for concomitant pathologies during the index FCL reconstruction are reported in Table 1. Fourteen patients (33 %) had previous surgery on the injured knee. Approximately 75 % of patients were participating in a sport when the FCL injury was incurred. Further details regarding the mechanism of injury are reported in Table 2. The most common sport patients were participating in when injured was alpine skiing/snowboarding (Fig. 4).

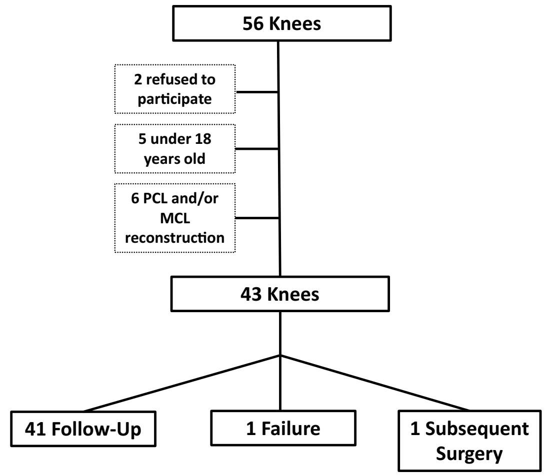

Fig. 3 Flow chart depicting fibular collateral ligament reconstruction patient population

Table 1 Concomitant surgeries at the time of FCL reconstruction for the total patient population

Surgery type	Number of patients (%)
ACL reconstruction	31 (72)
Partial meniscectomy–medial meniscus	3 (7)
Partial meniscectomy–lateral meniscus	10 (23)
Medial meniscal repair	10 (23)
Lateral meniscal repair	7 (16)
Microfracture	6 (14)
OATS	1 (2)

ACL anterior cruciate ligament, *OATS* osteochondral allograft transplantation surgery

Table 2 Mechanism of injury for all patients ($n = 43$)

Mechanism of injury	Number of patients (%)
Sports participation	32 (74)
Jumping	2 (5)
Twisted knee	2 (5)
Motor vehicle accident	2 (5)
Blow to the knee	1 (2)
Slip and fall	1 (2)
Other	3 (7)

Further surgical procedures

Two patients required subsequent surgery on the injured knee following the index FCL reconstruction. One patient, a 35-year-old female with a complex 7-year history of knee instability, required a third-time ACL revision, total posterolateral corner (PLC) reconstruction, and hardware removal 18 months after the index FCL operation due to continual instability and pain. This patient was considered a failure and therefore not included in outcome analysis (Fig. 3). The second patient, a 20-year-old male with a previous ACL reconstruction, suffered an oblique patellar fracture while slipping on ice, requiring an open reduction internal fixation of his patella 4 months after the index FCL operation. Although this case was not considered a failure, this patient was also excluded from outcome analysis in order to prevent bias in outcomes (Fig. 3).

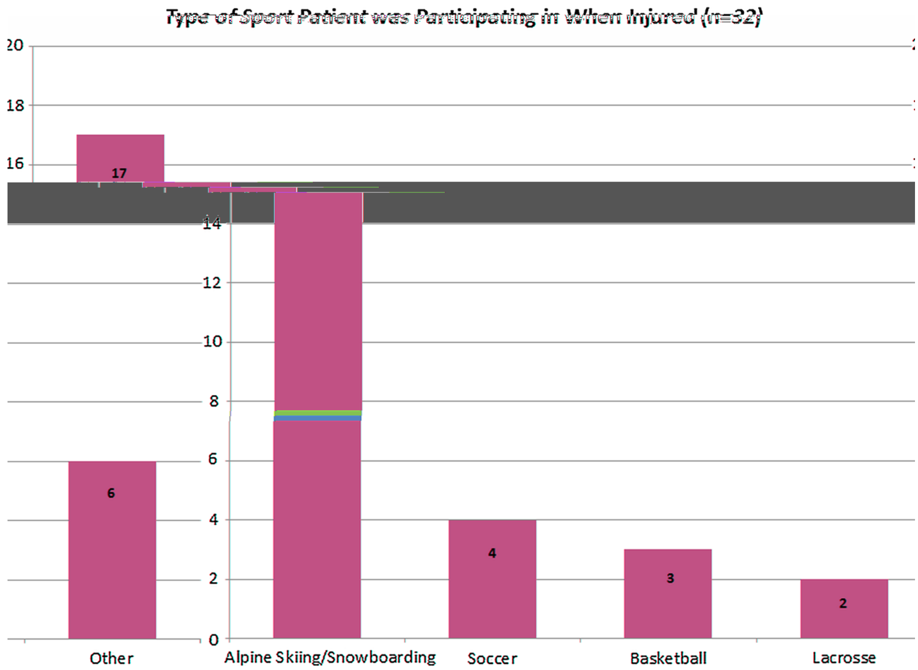

Fig. 4 Type of sport patient was participating in when injured. 'Other' included two flag football injuries, one competitive football injury, one hockey injury, one roller derby injury, and one volleyball injury

Table 3 ACL reconstruction subgroup analysis: postoperative subjective outcome scores

	No ACL recon	ACL recon	*p* value
Lysholm	87 (75–100)	83 (55–100)	0.43
Tegner activity scale	7 (3–10)	5 (2–10)	0.14
SF-12 PCS	57 (38–58)	55 (24–62)	0.70
SF-12 MCS	56 (42–61)	55 (25–62)	0.70
WOMAC total score	6 (1–17)	9 (0–46)	0.99

Outcome scores are reported as mean (range), except for Tegner activity scale, SF-12 PCS and SF-12 MCS reported as median (range). *ACL* anterior cruciate ligament, *SF-12 PCS* 12 item short-form survey physical component summary, *SF-12 MCS* 12 item short-form survey mental component summary

Outcomes

Follow-up was obtained for 88 % of patients ($n = 36$) with a mean follow-up of 2.7 years (range 2.0–4.2 years). The mean Lysholm score significantly improved from 49 (range 11–100) to 84 (range 55–100) postoperatively ($p < 0.001$). The mean WOMAC total score significantly improved from 37 (range 3–96) to 8 (range 0–46) postoperatively ($p < 0.001$). The WOMAC pain subscale improved from 8 (range 0–20) to 2 (range 0–12) postoperatively; the WOMAC stiffness subscale improved from 4 (range 0–8) to 2 (range 0–7) postoperatively; and the WOMAC function subscale improved from 25 (range 0–68) to 5 (range 0–27) postoperatively. The median SF-12 physical component subscale (PCS) score significantly improved from 35 (range 22–58) to 56 (range 24–62) postoperatively ($p < 0.001$), while the change in mean SF-12 mental component subscale (MCS) score was not significant (n.s.) ($p < 0.96$) preoperatively 54 (range 29–69) to postoperatively 55 (range 25–62). The median preoperative Tegner activity scale improved from 2 (range 0–10) to 6 (range 2–10) postoperatively ($p < 0.001$). The median patient satisfaction with outcome was 8 (range 1–10). Postoperative patient-reported outcome scores were not significantly different for patients who underwent concomitant ACL reconstruction compared to patients without ACL reconstruction (Table 3).

Discussion

The most important finding in the present study was that patient outcomes improved significantly, and patients were highly satisfied with their surgical results following anatomic FCL reconstruction with a semitendinosus graft. This included patients with acute grade III midsubstance FCL tears and patients with chronic lateral knee instability with preoperative varus stress radiographic lateral compartment gapping of 2.7–4.0 mm at 20° of flexion. There was a significant improvement in all subjective outcome scores, indicating that patients' function and activity levels increased following FCL reconstruction. Additionally, improvement in postoperative outcomes scores did not significantly differ when accounting for concurrent ACL reconstruction. Overall, patients who had an anatomic FCL reconstruction, regardless of concomitant ACL reconstruction, demonstrated an improvement in patient function, leaving patients satisfied with their surgical outcomes.

An anatomic FCL reconstruction technique has many advantages [35]. First, anatomic fixation results in physiologically normal forces on the graft during physical activity and has been validated to restore objective stability to an FCL-deficient knee allowing early range of motion during rehabilitation [6, 16]. Second, a hamstring graft more closely reapproximates the biomechanical properties of the native FCL [18] and the length of the native FCL [19]. Finally, the authors advocate that it is a simpler procedure than sling-type procedures, which ream fibular head tunnels anterior to posterior in the fibular head. An anatomic FCL reconstruction can be performed in 10–15 min of tourniquet time.

A variety of FCL reconstruction techniques have been reported in the literature. LaPrade et al. [16] reported 2-year outcomes in 20 patients following an anatomic FCL reconstruction with a semitendinosus autograft. They reported a significant improvement in Cincinnati (28.2–88.5) and International Knee Documentation Committee (IKDC) (34.7–88.1) scores at an average of 2 years. An anatomic FCL reconstruction technique with a semitendinosus graft was used in the present study as well. While different subjective outcome scores were collected, postoperative outcomes significantly improved in both studies. The improvement seen in knee function in the previous studies is similar to the results of the present study. In the present study, patients improved by 35 points on a 100-point scale as denoted by the Lysholm score.

In a clinical outcomes study, Latimer et al. reported the outcomes of a fibular collateral ligament reconstruction using a bone–patellar tendon–bone allograft reconstruction in 10 patients. They reported a mean postoperative Lysholm score of 76 (range 31–100) and a median postoperative Tegner activity scale of 4.5 (range 1–9), with five of 10 patients returning to preinjury level of activity [25]. The results of the present study on 43 patients were slightly higher, with a mean postoperative Lysholm score of 84 and a median postoperative Tegner activity scale of 6. Differences in outcomes may be related to variability in FCL reconstruction techniques utilized in the two studies; however, additional factors, such as varying concomitant pathologies, may also affect outcomes. All patients in the study by Latimer et al. required ACL and/or PCL reconstruction, while 72 % of patients in the present study required ACL reconstruction, and patients requiring PCL reconstruction were excluded.

Levy et al. [26] published 2-year outcomes for 28 patients with fibular collateral ligament and posterolateral corner injuries in multiligament injured knees. Outcomes following FCL/PLC repair versus FCL/PLC reconstruction using an Achilles tendon with bone allograft were documented. At a minimum of 2 years postoperatively, the mean Lysholm score was 85 (range 46–100) for the six of 10 patients in the repair group, with four failures, and 88 (range 59–100) in the 18 patients in the reconstruction group with one failure. In the present study, the mean Lysholm score was 84. Although graft types and concomitant pathologies varied between the previous study and the present study, both studies documented similar improvement in postoperative Lysholm scores at a minimum follow-up of 2 years after the index surgery.

There were some limitations to this study. First, this was a retrospective study; however, all data were prospectively collected. Additionally, the entire patient cohort was treated by a single surgeon at a tertiary referral surgery centre and may not accurately reflect the greater population. No objective data were available for this study. It is also important to note that the patient population included a variety of complex combined knee injuries requiring surgery, with approximately three-quarters of patients requiring concomitant ACL reconstruction. Additional studies with larger sample sizes are necessary to determine the exact influence of concurrent ACL reconstruction on patient-reported outcomes after anatomic FCL reconstruction. Further investigation is needed to elucidate differences in outcomes among patients with varying concomitant pathologies, to determine long-term patient outcomes and to define predictors of successful outcomes following anatomic FCL reconstruction.

An anatomic FCL reconstruction leads to improved clinical outcomes for patients with acute grade III midsubstance FCL tears or chronic lateral instability. Clinicians need to recognize the benefit of an anatomic FCL reconstruction for patients presenting with 2.7–4.0 mm of lateral compartment gapping on varus stress radiographs at 20° of flexion.

Conclusion

This study demonstrates that at an average follow-up of 2.7 years, an anatomic FCL reconstruction with a semitendinosus graft significantly improves patient function and yields high patient satisfaction. Additionally, FCL injuries requiring surgery often occur in the setting of additional knee pathology. The authors conclude that clinicians ought to perform an anatomic FCL reconstruction for isolated or combined acute or chronic FCL tears to improve patient function.

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