Technical Note

Lateral Collateral Ligament and Proximal Tibiofibular Joint Reconstruction for Tibiofibular Instability

Justin J. Ernat, M.D., Annalise M. Peebles, B.A., and
CAPT. Matthew T. Provencher, M.D., M.B.A., M.C., U.S.N.R. (Ret.)

Abstract: Instability of the proximal tibiofibular joint (PTFJ) can be post-traumatic or due to accumulative injuries and may also be underdiagnosed pathology that can present with symptoms of lateral and/or medial knee pain. It can be associated with subtle instability and subluxation or frank dislocation of both the PTFJ and the native knee joint. Previously described techniques have been either nonanatomic, require secondary hardware removal, disrupt native anatomy, or fail to account for the inherent stabilizing effect of the lateral collateral ligament, which is likely additionally injured or lax in these patients. The purpose of this Technical Note is to present an open anatomic reconstruction of the PTFJ and lateral collateral ligament using a single semitendinosus allograft, thus restoring all anatomic constraints to the PTFJ and lateral knee.

Instability of the proximal tibiofibular joint (PTFJ) is a rare, yet likely underdiagnosed, pathology that can present with symptoms of lateral and/or medial knee pain.[1] It can be associated with subtle instability and subluxation or frank dislocation of both the PTFJ and the native knee joint.[1,2] Notably, PTFJ instability has been reported to occur in up to 9% of multiligamentous knee injuries.[2] The traditionally described instability pattern of an injured PTFJ is anterolateral due to the stronger anterior versus posterior ligaments of the joint.[3-5] Given the anatomic relationship of the lateral collateral ligament (LCL) to the PTFJ, we propose that the LCL provides an impactful role in anterolateral stability of the PTFJ and, thus, injuries to the PTFJ can inherently produce laxity in the LCL.

First-line treatment of PTFJ instability includes a period of activity modification, physical therapy, and bracing and/or taping.[1] Immobilization may be indicated in acute dislocations as well.[6] When patients do not respond to nonoperative treatment, surgical intervention may be warranted. Multiple approaches have been described, including temporary screw stabilization, allograft reconstruction, split biceps femoris reconstruction, dynamic suture button fixation, fibular head excision, arthrodesis, and direct repair.[2,5,7-14] However, these techniques are either nonanatomic, require secondary hardware removal, disrupt native anatomy, or fail to account for the inherent stabilizing effect of the LCL, which is likely additionally injured or lax in these patients. The purpose of this Technical Note is to present an open anatomic reconstruction of the PTFJ and LCL using a single semitendinosus allograft, thus restoring all anatomic constraints to the PTFJ and lateral knee.

Surgical Technique (With Video Illustration)

A narrated video with demonstration of the surgical technique described in the following may be reviewed (Video 1). The patient is positioned supine with a lateral post on the operating room table. We prefer to use regional anesthetics in additional to general anesthesia,

From the Steadman Clinic (J.J.E., M.T.P.); and The Steadman Philippon Research Institute (A.M.P., M.T.P.), Vail, Colorado, U.S.A.

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Address correspondence to CAPT. Matthew T. Provencher, M.D., M.B.A., M.C., U.S.N.R., Steadman Philippon Research Institute, The Steadman Clinic, 181 W Meadow Dr., Ste 400, Vail, CO 81657. E-mail: mprovencher@thesteadmanclinic.com

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including a sciatic indwelling catheter that is placed dry in the preoperative holding area. This allows adequate examination of the peroneal nerve in the postoperative recovery unit and then subsequent dosing thereafter. Prophylactic intravenous antibiotics are administered. Anatomical landmarks are identified including Gerdy's tubercle, the fibular head, the lateral joint line, lateral epicondyle of the femur, and the posterior apex of the lateral femoral condyle. The leg is exsanguinated, and a thigh tourniquet inflated. The knee is flexed to 90° (an assistant can manually hold the foot, the foot can be propped against the surgeon's leg, or a commercial foot holder can be used) and an incision is made from the lateral epicondyle of the femur in a trajectory that intersects Gerdy's tubercle and fibular head (FH). Skin flaps are elevated anteriorly, posteriorly, superiorly and inferiorly, taking care to note that the common peroneal nerve (CPN) that will be exiting from deep and posterior to the biceps femoris (BF) as it courses across the proximal fibular neck. We first identify the CPN as it crosses the fibular neck (Fig 1). A thorough neurolysis is performed including releasing the proximal-most aspect of overlying fascia of the lateral leg compartment distally, and then also more proximally on the undersurface of the BF. A vessel loop is placed around the nerve without instruments so that it can be readily identified but is not on traction at any point.

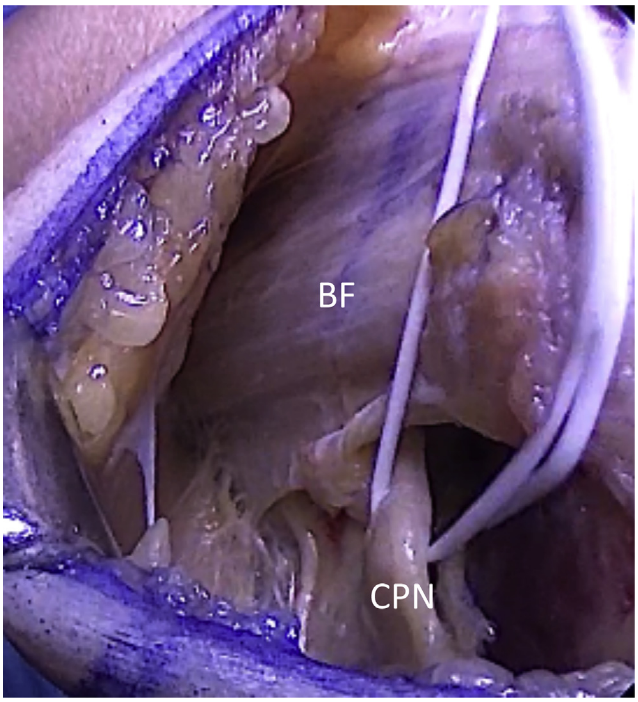

Fig 1. In a right knee via a lateral incision in the supine position with the knee flexed to 90°, the common peroneal nerve (CPN) is identified posterior to the fibular neck and deep/posterior to the biceps femoris (BF).

Table 1. Pearls and Pitfalls of Combined Proximal Tibiofibular Joint (PTFJ) and Lateral Collateral Ligament (LCL) Reconstruction

Pearls	Pitfalls
Identify and perform a neurolysis of the peroneal nerve to prevent injury during the procedure.	There is risk of injury to the peroneal nerve while working near the fibular head or with retraction.
Identifying and tagging the LCL at the biceps femoris—iliotibial band interval first allows for easier identification of the LCL origin and insertion.	Addition of the LCL component requires extra dissection and steps versus isolated reconstruction of the PTFJ.
Check PTFJ stability before dissection, after LCL reconstruction, and after PTFJ reconstruction to confirm stabilization effect of each step of the procedure.	Avoid injuries to the posterior neurovascular structures and soft tissues of the knee.
Avoid overconstraining or a nonanatomic reduction of the joint by reducing with light manual pressure.	Dissection/work on the lateral metaphyseal flare of the tibia is often by feel due to poor visualization of this area.
Perform a diagnostic knee arthroscopy after to assess for countercoup lesions in the medial compartment.	

Next, we identify the native LCL in the interval anterior to the BF insertion and posterior to the iliotibial band (ITB) (Table 1). It is isolated and tagged with a #2 nonabsorbable stitch (FiberWire; Arthrex, Naples, FL). Pulling tension on the stitch will demonstrate the laxity in the LCL and/or the mobility in the FH (Fig 2). Using manual pressure or a clamp on the FH will demonstrate this LCL laxity in the lateral plane, in addition to the anteroposterior instability of the PTFJ. Next, the LCL origin is identified at the lateral epicondyle of the femur (Fig 3). Pulling and releasing tension repeatedly on the LCL tag stitch assists in identification, and a 2-cm split can be established in the ITB at the origin. The origin is marked and a Beath pin is passed from lateral in an anteromedial trajectory out the medial femoral skin. A 6-mm reamer is used over the pin and drilled to a depth of 30 mm. A passing suture is shuttled through the tunnel with the Beath pin and it is snapped and set aside. The LCL insertion on the anterolateral FH is identified through palpation of its anatomic bony ridge as well as with assistance of pulling and releasing the LCL tag stitch (Fig 4). The site is marked. Next, the lateral head of the gastrocnemius is elevated of the posterolateral FH using a combination of Bovie and a Freer elevator, with care taken to note the location of the CPN. A window is created with blunt finger dissection across the posterior FH until the posterior PTFJ and lateral tibial metaphyseal flare are readily palpable. A threaded 2.4-mm guide pin is next drilled

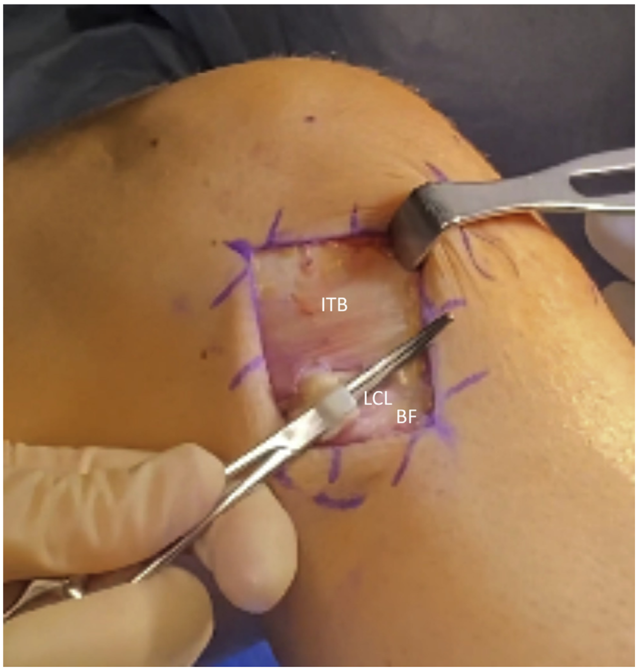

Fig 2. In a right knee via a lateral incision in the supine position with the knee flexed to 90°, the lateral collateral ligament (LCL) is identified in the interval between the iliotibial band (ITB) and biceps femoris (BF). A tag/traction suture is placed in the native LCL.

from the LCL insertion that was previously marked, in a posteromedial trajectory through the FH taking care to protect the posterior soft tissues of the knee. A 6-mm reamer is used over the pin through the FH, and a wire suture passing device is used to shuttle a passing stitch through the FH so that passing of the future graft can occur from anterolateral to posteromedial. The passing stitch is snapped and set aside. Hemostats are used to fashion a tunnel under the BF and ITB in the trajectory of the native LCL for lateral anatomic graft passage.

The PTFJ tibial tunnel is prepared next. Gerdy's tubercle is marked, and a 2.4-mm threaded pin is passed from anterior to posterior, in a trajectory matching the posterior slope of the tibia, to the position of the posterior PTFJ on the lateral metaphyseal flare of the tibia (Fig 5). This can be done using a commercial guide (Arthrex), or by hand with finger palpation. Care is taken to protect the posterior soft tissues of the knee. A 6-mm reamer is used over the wire to complete the tunnel. A wire suture passing device is used to shuttle a passing stitch through the FH so that passing of the future graft can occur from posterior to anterior through the tibia. The passing stitch is snapped and set aside.

A semitendinosus allograft is prepared on the back table during tunnel preparation with nonabsorbable #2 high strength Krakow suture in each end. For implantation, one limb is shuttled and docked into the LCL origin tunnel on the femur. Pulling medial tension on the sutures, and a gentle downward tension on the graft in the trajectory of the native LCL, a 7 × 23-mm PEEK (polyether ether ketone) interference screw is inserted securing the graft in the femur (Fig 6). Hemostats are used to shuttle the graft under the previously established tunnel deep to the ITB and BF. The graft is next shuttled through the FH from anterior to posterior. The knee is positioned in 70° of flexion, with internal rotation of the tibia, and a valgus stress applied to the knee, and a 7 × 23-mm PEEK interference screw is placed from anterior to posterior securing the graft in the FH and completing the LCL stabilization component of the procedure. Manual manipulation of the FH will demonstrate increased instability even before reconstruction of the PTFJ.

To complete anatomic reconstruction of the PTFJ, the residual posterior allograft is shuttled from posterior to anterior through the tibial tunnel. A bump is placed under the knee holding it at approximately 20 to 30° of

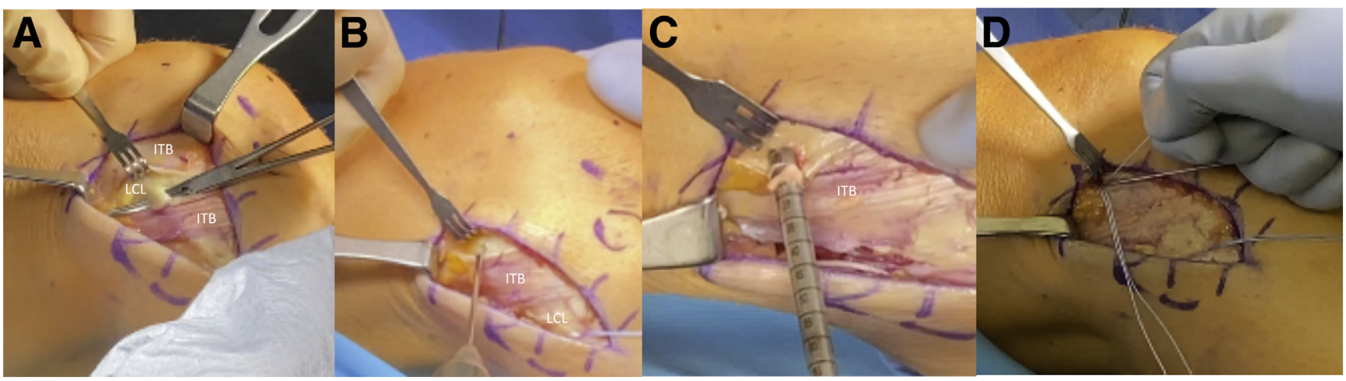

Fig 3. In a right knee via a lateral incision in the supine position with the knee flexed to 90°, the femoral origin of the lateral collateral ligament (LCL) is identified by splitting the iliotibial band (ITB) and pulling on the LCL traction stitch (A). A guide pin is passed lateral to medial through the origin (B). A reamer is used over the guide pin to a depth of 30 mm (C). A passing suture is shuttle through the femur for later graft passage (D).

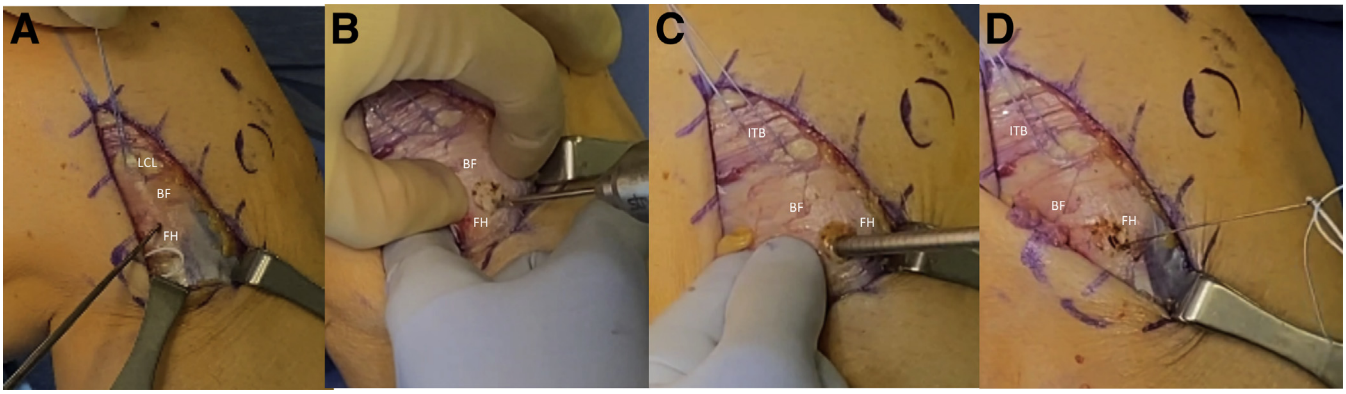

Fig 4. In a right knee via a lateral incision in the supine position with the knee flexed to 90°, the lateral collateral ligament (LCL) insertion on the fibular head (FH) as it traverses under the biceps femoris (BF) is identified by pulling on the traction suture (A). A guide pin is passed from anterolateral to posteromedial through the FH (B). A reamer is drilled bicortially through the FH (C). A passing wire is used to shuttle a passing suture through the FH for later graft passage (D).

flexion. While pulling anterior tension on the graft, an 8 × 30-mm biocomposite interference screw is placed over a Nitinol wire securing the graft and completing the PTFJ stabilization component of the procedure (Fig 6).

At this juncture, we recommend performing a diagnostic knee arthroscopy as it is not uncommon to encounter countercoup lesions of the medial meniscus and medial compartment chondral surface. For closure, the defect in the ITB and ITB-BF interval are closed with 0-VICRYL (Ethicon, Somerville, NJ) figure of 8 suture. Layered closure of preference is then performed.

Postoperatively, the patient is made toe-touch weight-bearing for 4 to 6 weeks with a range of motion knee brace that allows 0 to 90° of flexion. They transition to a functional brace thereafter with light strengthening and mobility exercises through the first 12 weeks to allow for graft incorporation. This is followed by progressive strengthening and eventually agility and sport-specific exercises with expected return to play at 8 to 9 months.

Discussion

PTFJ anatomic reconstruction can result in improved patient outcomes with low complications rates[1]; however, it is critical to acknowledge the additional injuries to the lateral stabilizing structures (i.e., LCL) of the knee. This proposed technique provides a complete anteroposterior and medial-lateral stabilization of the PTFJ by adding the LCL component and using a single allograft semitendinosus tendon. It is anatomic in principle and does not require any secondary surgeries for hardware removal unlike other previously described techniques (Table 2).

In 2017, Kruckeberg et al.[1] performed a systematic review of treatment and approach to the PTFJ. They identified 44 studies with 96 patients who were eligible to be included in the study. The treatments included nonoperative (18 studies, 35 patients), open reduction

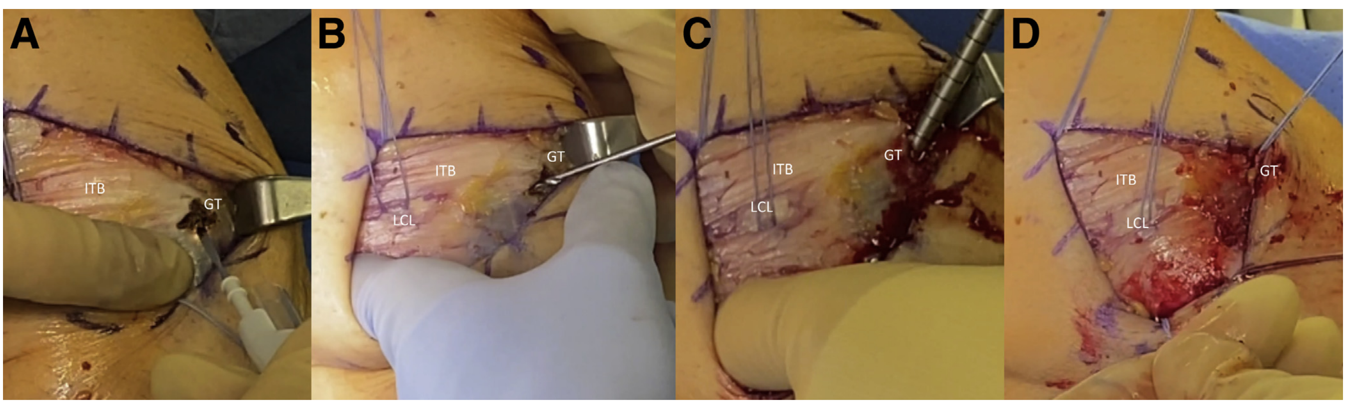

Fig 5. In a right knee via a lateral incision in the supine position with the knee flexed to 90°, Gerdy's tubercle (GT) is identified and marked (A). A guide pin is passed parallel to the tibial slope from GT to the tibial aspect of the proximal tibiofibular joint posteriorly using a window behind the fibular head (B). This is reamed bicortically over the wire (C). A passing wire is used to shuttle a passing suture through the tibial tunnel for later graft passage (D).

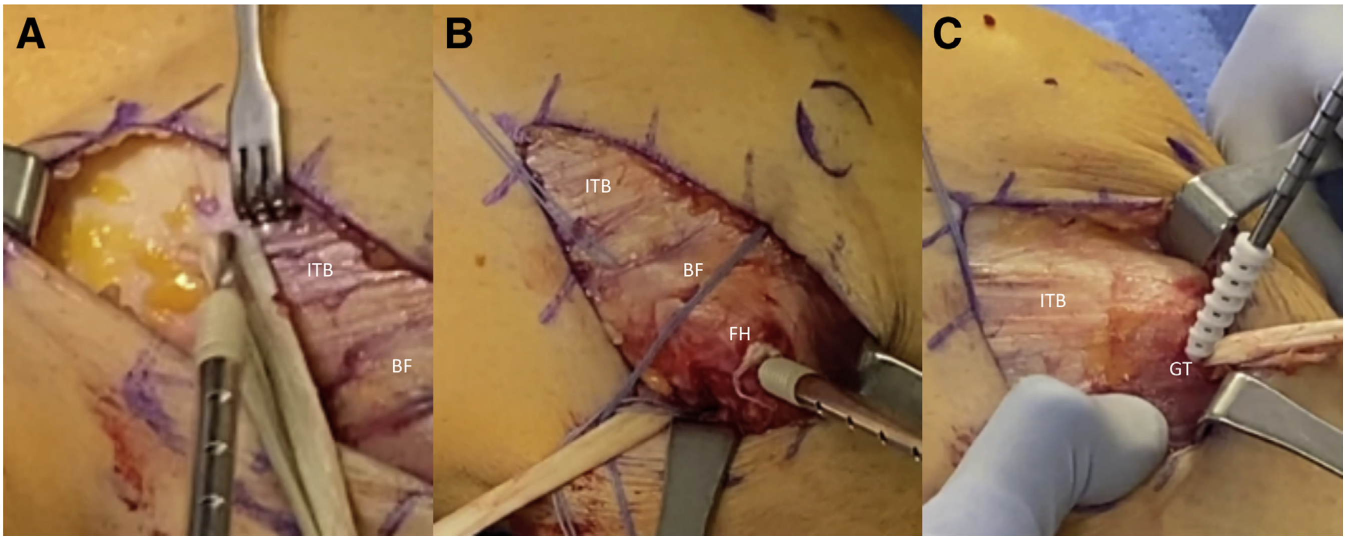

Fig 6. In a right knee via a lateral incision in the supine position with the knee flexed to 90°, a semitendinosus allograft is docked in the femoral tunnel and an interference screw is inserted while holding the graft in the trajectory of the native lateral collateral ligament (A). The graft is shuttled under the iliotibial band (ITB) and biceps femoris (BF) to the anterolateral fibular head (FH), and then through the FH from anterior to posterior. An interference screw is inserted in the FH to complete the lateral collateral ligament reconstruction (B). The graft is then shuttled from posterior to anterior through the tibial tunnel and fixated with an interference screw for the proximal tibiofibular joint reconstruction (C). (GT, Gerdy's tubercle.)

(3 studies, 4 patients), fixation (11 studies, 25 patients), proximal fibular resection (4 studies, 10 patients), adjustable cortical button fixation (3 studies, 11 patients), ligament reconstruction (2 studies, 3 patients), and biceps femoris tendon rerouting (5 studies, 8 patients). All studies reported improved outcomes; however, there were high complications rates associated with PTFJ fixation (28%) and FH resection (20%). Nonoperative treatment was associated with persistent symptoms despite improved outcomes, whereas biceps rerouting and anatomic reconstruction had the best outcomes, with low complications rates. However, it should be noted that all these findings were limited to level IV case series with very low patient numbers.

While the proposed technique described here has the advantages of being a complete, multiplanar reconstruction of the PTFJ, it is not without disadvantages (Table 2). This technique is more technically demanding than previously described techniques and requires a more thorough understanding of the posterolateral anatomy of the knee. By using the aforementioned pearls where the peroneal nerve is isolated and the course of the native LCL is clearly defined, the anatomical reconstruction is easily reproducible and can be done so in an efficient manner. Second, this technique is more costly than others described with the addition of the LCL reconstruction and the use of allograft, however, we feel that achieving the multiplanar stability is necessary for eliminating symptoms and improving function and outcomes.

Table 2. Advantages and Disadvantages of Combined Proximal Tibiofibular Joint (PTFJ) and Lateral Collateral Ligament (LCL) Reconstruction

Advantages	Disadvantages
Adding the LCL reconstruction not only provides varus knee stability, but also adds inherent stability to the PTFJ.	Adding the LCL reconstruction requires additional surgical planning and tunnel drilling.
The technique provides anteroposterior and medial-lateral stability of the PTFJ.	It is more costly than using the biceps femoris split or only reconstructing the PTFJ (without LCL).
There is no disruption of native anatomy or need for hardware removal.	It is more technically demanding than a suture button technique.

In conclusion, this multiplanar reconstruction of with semitendinosus allograft provides reproducible, anatomic restoration of stability to the PTFJ. It provides lateral knee constraint through reconstruction of the LCL, which is often additionally injured or lax.

References

1. Kruckeberg BM, Cinque ME, Moatshe G, et al. Proximal tibiofibular joint instability and treatment approaches: A systematic review of the literature. *Arthroscopy* 2017;33: 1743-1751.
2. Jabara M, Bradley J, Merrick M. Is stability of the proximal tibiofibular joint important in the multiligament-injured knee? *Clin Orthop* 2014;472:2691-2697.
3. Ogden JA. Subluxation of the proximal tibiofibular joint. *Clin Orthop* 1974;(101):192-197.
4. Ogden JA. The anatomy and function of the proximal tibiofibular joint. *Clin Orthop* 1974;(101):186-191.

5. Ogden JA. Subluxation and dislocation of the proximal tibiofibular joint. *J Bone Joint Surg Am* 1974;56:145-154.
6. Ashraf MO, Jones HM, Kanvinde R. Acute traumatic fracture dislocation of proximal tibiofibular joint: Case report and literature review. *Injury* 2015;46:1400-1402.
7. Yaniv M, Koenig U, Imhoff AB. A technical solution for secondary arthritis due to chronic proximal tibiofibular joint instability. *Knee Surg Sports Traumatol Arthrosc* 1999;7:334-336.
8. McNamara WJ, Matson AP, Mickelson DT, Moorman CT. Surgical management of proximal tibiofibular joint instability using an adjustable loop, cortical fixation device. *Arthrosc Tech* 2018;7:e271-e277.
9. Oksum M, Randsborg P-H. Treatment of instability of the proximal tibiofibular joint by dynamic internal fixation with a suture button. *Arthrosc Tech* 2018;7:e1057-e1061.
10. Mena H, Brautigan B, Johnson DL. Split biceps femoris tendon reconstruction for proximal tibiofibular joint instability. *Arthroscopy* 2001;17:668-671.
11. Horst PK, LaPrade RF. Anatomic reconstruction of chronic symptomatic anterolateral proximal tibiofibular joint instability. *Knee Surg Sports Traumatol Arthrosc* 2010;18:1452-1455.
12. Kobbe P, Flohe S, Wellmann M, Russe K. Stabilization of chronic proximal tibiofibular joint instability with a semitendinosus graft. *Acta Orthop Belg* 2010;76:830-833.
13. van den Bekerom MPJ, Weir A, van der Flier RE. Anatomic reconstruction or temporary screw stabilization of chronic symptomatic anterolateral proximal tibiofibular joint instability. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1406-1407. author reply 1408.
14. Sekiya JK, Kuhn JE. Instability of the proximal tibiofibular joint. *J Am Acad Orthop Surg* 2003;11:120-128.