Technical Note

# Combined Anterior Cruciate Ligament Reconstruction and Lateral Extra-Articular Tenodesis

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**Abstract:** Anterolateral rotational instability may persist after anterior cruciate ligament (ACL) reconstruction for a variety of reasons including damage to lateral or posterolateral structures, injury to the meniscus, disruption of anterolateral soft tissue structures, or increased tibial slope. In the setting of revision or primary ACL reconstruction with persistent anterolateral laxity, despite repair or reconstruction of other injured structures or in the setting of increased tibial slope, a lateral extra-articular tenodesis procedure can be used to augment an ACL reconstruction to aid in restoring anterolateral rotational stability and to upload the ACL reconstruction graft. This article details our technique for performing a modified Lemaire lateral extra-articular tenodesis using iliotibial band autograft as an adjunct to ACL reconstruction.

The lateral extra-articular tenodesis (LET) procedure was initially developed as a treatment for anterior cruciate ligament (ACL) insufficiency prior to the advent of modern ACL reconstruction techniques.[1] There are a multitude of various LET procedure variants that have been introduced following the initial technique described by Lemaire in 1967. All of these procedures attempt to reduce tibial internal rotation and anterior translation by way of an extra-articular graft between the tibia and femur on the lateral side of the knee. While the procedure no longer is indicated as a standalone procedure for ACL insufficiency, its role as an adjunct to arthroscopic ACL reconstruction has received greater attention as has the anatomy[2] and reconstruction procedures of the anterolateral ligament (ALL).[3] The anterolateral soft tissue structures of the knee have been shown to contribute to anterolateral rotary stability of the knee,[4] leading to increased interest in the use of LET and ALL procedures to aid in preventing residual anterolateral instability after ACL reconstruction.

Persistent anterolateral rotary instability of the knee as measured by pivot-shift testing is associated with worse functional outcomes in patients who have undergone ACL reconstruction surgery. Persistent anterolateral rotary instability after ACL reconstruction can occur for a variety of reasons. Meniscal root tears and total/subtotal meniscectomies,[5,6] sectioning of the ALL and distal Kaplan's fibers (anterolateral soft tissue structures),[7] and injury to collateral ligaments or posterolateral or posteromedial corner structures have all been shown to increase rotational instability.[8] Additionally, increased posterior slope >12° has been associated with increased graft failure and can result in insufficiency of the ACL graft over time in cases where overt failure does not occur.[9,10] In certain cases, these contributors to rotational instability can be addressed, but in other cases, either a discrete additional cause of instability may not be able to be identified or rotational instability may still be present despite treatment. In such cases, augmentation of an ACL reconstruction with a LET procedure can be a good option. This article details our technique for performing a modified Lemaire LET using iliotibial band (ITB) autograft as an adjunct to ACL reconstruction.

## Surgical Technique

A detailed video of the technique is shown in Video 1. Pearls and pitfalls of this technique and a step-by-step approach are described in Tables 1 and 2, respectively.

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**Table 1.** Pearls and Pitfalls

| Pearls | Pitfalls |
|---|---|
| In the setting of high-grade pivot shift, thoroughly assess with examination under anesthesia and diagnostic arthroscopy for other injured structures that could be contributing to instability. | Taking iliotibial band graft too posteriorly could disrupt Kaplan's fibers. |
| Dissect and clean the iliotibial band autograft prior to detaching proximally. It is more difficult to clean the graft when the proximal end is free. | Not ensuring that the foot is in neutral rotation during tensioning and fixation of the lateral extra-articular tenodesis graft may result in excessive overconstraint of knee internal rotation or prevent adequate protective effect of lateral extra-articular tenodesis. |
| Assess knee rotation and graft tension after fixation. Graft should become taut with internal rotation. | |
| Tunnel graft under the fibular collateral ligament to prevent excessive lateral movement of the graft. | |
| In pediatric patients with open physes, consider the use of fluoroscopy if using staple fixation to ensure fixation is not across the physis. | |

## Patient Positioning and Anesthesia

The patient is placed in the supine position on the operating table. After the induction of general anesthesia, a bilateral knee examination is performed to evaluate for any concurrent ligamentous instability and to assess knee range of motion. A well-padded high-thigh tourniquet is subsequently placed on the operative leg, which is then placed into a leg holder (Mizuho OSI, Union City, CA) while the contralateral knee is placed into an abduction stirrup (Birkova Product LLC, Gothenburg, NE). The foot of the operating table is then lowered, allowing the surgeon to freely manipulate the knee as needed. An explosive grade 3 pivot shift in the face of intact menisci and other ligaments should alert one to the risk of increased stress on an ACL reconstruction graft.

## Surgical Approach

Prior to beginning the surgical approach for the LET procedure, the surgical approach for ACL reconstruction surgery should first be carried out with graft harvest followed by a complete diagnostic arthroscopy with careful assessment of other injuries, which could be contributing to increased rotational or translational instability such as meniscus tears, particularly meniscal root tears. Any meniscus tears should be addressed and repaired when possible. Prior to proceeding with ACL reconstruction, the surgical approach for the LET procedure should be performed to prevent excess fluid extravasation, which can make lateral dissection more difficult.

A 10 to 12 cm long skin incision is made laterally centered over the posterior aspect of the ITB and extending from Gerdy's tubercle to the just above the lateral epicondyle (shown in Fig 1), as fixation of the LET graft will require exposure of the distal insertion of Kaplan's fibers, which occurs 31.4 mm proximal to the lateral epicondyle.[11] Dissection should be carried down to the ITB, and the central third of the ITB should be prepared for harvest (shown in Fig 2).

## Graft Preparation

The ITB graft will be left attached to Gerdy's tubercle distally and should measure at least 8 mm wide and be 10 to 12 cm in length to have sufficient length to reach the graft fixation point at the distal Kaplan fiber attachment site. Cleaning of the tendon of overlying fat and soft tissue should be performed before detaching the tendon proximally. A scalpel is used to cut the ITB graft along its anterior, posterior, and proximal margins, and Metzenbaum scissors can be used to dissect away soft tissue from the deep aspect of the graft after the graft is elevated. The proximal end of the graft should be whipstitched with high-strength suture to aid in passing and fixation of the graft.

After the LET graft has been prepared, the ACL reconstruction should be resumed and fixation of the ACL should be completed prior to proceeding with LET.

## LET

The prepared ITB graft should be first passed under the fibular collateral ligament (FCL) prior to fixation to the distal femur (shown in Fig 3). A Metzenbaum scissors can be used to dissect a soft tissue tunnel deep to the FCL with care taken not to disrupt the ligament or underlying capsule. A tonsil or other grasping instrument can then be used to pass the graft from distal to proximal, deep to the FCL ligament. The site of

**Table 2.** Advantages and Disadvantages

| Advantages | Disadvantages |
|---|---|
| Offers additional anterolateral rotary instability when used in conjunction with anterior cruciate ligament reconstruction. | Potentially overconstrains knee internal rotation. |
| Does not use soft tissue autografts that are commonly used for other knee ligament reconstructions. | Requires additional lateral incision and dissection. |

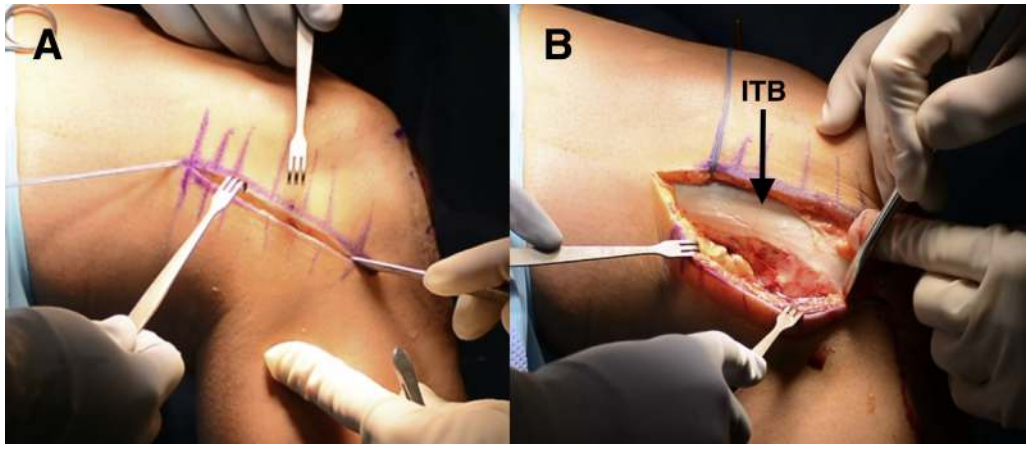


**Fig 1.** From a lateral view, the procedure is begun with a posterolateral hockey stick incision on a right knee (A) and exposure of the iliotibial band (ITB) (B) is performed prior to harvest of the graft.

fixation of the ITB graft must then be identified and prepared. The ITB graft should be fixed to the point of insertion of the distal insertion site of Kaplan's fibers of the ITB into the femur. There is a bony prominence on the supracondylar flare of the distal femur at this location, called the distal ridge of Kaplan's fibers, which is located on average 31.4 mm proximal to the lateral epicondyle. Soft tissue should be dissected away from this bony landmark, and an osteotome or curette can be used to roughen up the bone surface in preparation for fixation of the ITB graft to the femur.

Our preferred method of fixation is with a small Richards staple (Smith & Nephew, London, UK; shown in Fig 4). The knee is kept in neutral rotation and flexed to 20° with tension pulled on the graft proximally at the time of fixation. After fixation, ensure that the knee can obtain full extension and flexion. The graft should become taut with internal rotation.

### Postoperative Protocol

After the procedure, the patient is weight bearing as tolerated with the use of crutches for a minimum of 2 weeks and may discontinue crutches once the patient can walk without a limp. The patient is placed into a functional hinge brace (CTi, Ossur Americas, Foothill Ranch, CA) as soon as weight bearing begins and remains in this brace with all activities until 3 months postoperatively. Physical therapy begins on postoperative day 1 with a focus on pain control, reducing edema, and knee motion. There are no restrictions for knee range of motion, with a focus on gradual progression. Stationary cycling begins around 3 to 4 weeks postoperatively, and a generalized strengthening progression is initiated at this time. Running and straight-line functional activities may begin at 4 to 5 months postoperatively once sufficient core strength is obtained and the patient can demonstrate a single leg squat without valgus collapse. At 6 months postoperatively, a clinical exam is performed to ensure adequate stability and patients may begin a gradual return to sport progression at this time. Clearance for full activities with no restrictions is allowed following the passing of a functional sports test between 7 and 9 months postoperatively.

## Discussion

When performed in addition to an ACL reconstruction, LET procedures have been demonstrated to significantly reduce anterior tibial translation and anterolateral rotary instability in addition to reducing the force experienced by the graft when an anteriorly directed load was applied.[7,12,13] This does come at the cost of overconstraint of the knee, with decreased tibial internal rotation across various flexion angles from 0° to 90°.[7] However, persistent anterolateral rotary instability occurring after ACL reconstruction leads to poor patient outcomes and increased risk of graft failure; thus, LET procedures may be able to help improve patient outcomes when used as an adjunct to ACL reconstruction by helping to restore normal rotational stability.

**Fig 2.** From a lateral view, harvest of the lateral extra-articular tenodesis (LET) graft from the iliotibial band (ITB) is performed on the operative leg (right knee).

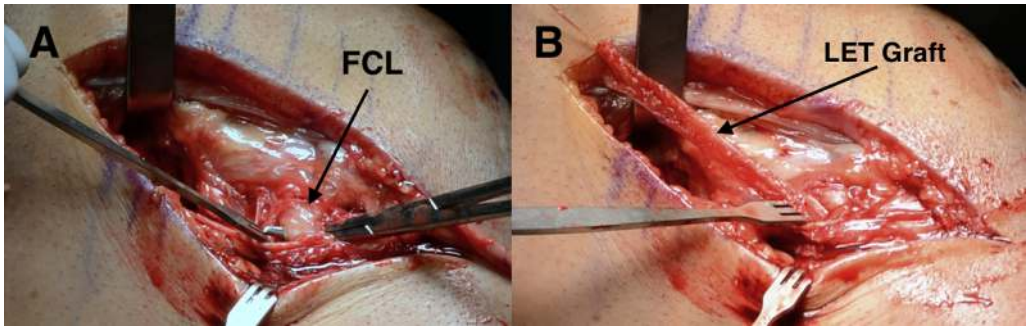


**Fig 3.** From the lateral view on a right knee, the fibular collateral ligament (FCL) must first be identified (A) and the iliotibial band (ITB) graft should be passed beneath it (B), to replicate the relative orientation of the native ligaments.

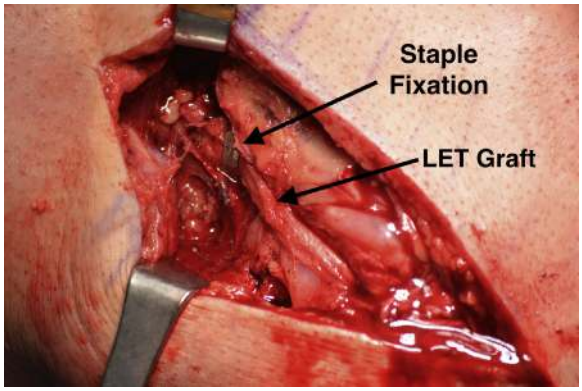


**Fig 4.** From the lateral view on a right knee, proximal fixation of the iliotibial band (ITB) graft is performed with a Richard staple with knee kept in neutral rotation and flexed to 20° and tension pulled on the graft, completing the lateral extra-articular tenodesis (LET) procedure.

To date, there are limited clinical outcome data for patients undergoing combined LET with ACL reconstruction, and there are no studies in the literature that compare outcomes of these patients to those undergoing ACL alone. As such, there is no consensus within the field for indications for LET augmentation of ACL reconstruction at this time. Suggested indications include patients with ACL tears with a grade III pivot shift without concomitant collateral or posterolateral corner injury (or after treatment of these injuries), meniscal deficiency, presence of a Segond fracture or identified ALL tear, a chronic ACL tear in which secondary stabilizers may also be insufficient, revision ACL tears, and desire to return to cutting/pivoting sports.[3] An additional indication to be considered is in the setting of a primary ACL tear with a tibial slope >12°. Based on the demonstrated biomechanical contribution to anterolateral stability of LET combined with ACL, LET procedures may substantially help reduce rotational instability and unload an ACL graft at risk for attenuation in those with increased tibial slopes in these at-risk patients.

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