Technical Note

ACL Reconstruction and Modified Lemaire Tenodesis Utilizing Common Suspensory Femoral Fixation

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Abstract: Persistent rotatory instability after anterior cruciate ligament (ACL) reconstruction has been well studied and recognized as the cause of unsatisfactory clinical results. Various anterolateral techniques have been described as an adjunct to the ACL reconstruction to improve clinical outcomes. Modified deep Lemaire lateral extra-articular tenodesis has been tested both biomechanically and clinically and proved an efficient solution in controlling tibia internal rotation, when performed in conjunction with ACL reconstruction. We describe a simple, versatile, effective, and reproducible technique of lateral extra-articular tenodesis, using common suspensory femoral fixation, with no additional cost and surgical risk.

Despite the evolution in anterior cruciate ligament (ACL) reconstruction techniques, the clinical results remain unsatisfactory. Graft failure rates vary between studies and can reach up to 20% in young athletes.[1] Moreover, the rate of return to preinjury level of activity is low, ranging from 44% to 72%.[2,3]

Those disappointing results have been attributed to the failure of the ACL reconstruction techniques to restore normal knee biomechanics.[4] Positive pivot-shift test is present in 25% of patients with ACL reconstruction,[5] and this persistent rotatory instability leads to poorer clinical results and to the progression of osteoarthritis.[6]

Based on the aforementioned data, several techniques for lateral augmentation of ACL reconstruction have been proposed as the solution to improve the clinical outcomes of ACL reconstruction. These techniques differ in terms of the surgical approach, the graft used, and the point and method of fixation of the graft. Recent biomechanical studies[7] confirm that combined ACL reconstruction and modified deep Lemaire lateral extra-articular tenodesis (LET) can restore normal knee biomechanics. Moreover, clinical studies confirm the reduction in graft failure and persistent rotatory laxity rate.[8]

The purpose of this article is to describe a simple, versatile, effective, and reproducible technique of LET, using common suspensory femoral fixation, with no additional cost and surgical risk (Video 1).

Surgical Technique

Patient Positioning

The patient is positioned in the supine position and a well-padded tourniquet is placed as proximal as possible. A side support is placed at the level of the tourniquet and a foot bar is used to hold the knee stable at 90° of flexion.

Standard Arthroscopy

The procedure starts with standard diagnostic arthroscopy. The ACL tear is confirmed, and concomitant pathology is thoroughly evaluated and addressed accordingly. Special attention is taken to recognize and repair any meniscal tears (ramp and root tears included).

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Graft Harvesting and Preparation

This technique can be applied with all types of grafts. We favor the quadriceps tendon (QT) graft in almost all our ACL cases. We harvest a full-thickness QT graft with a bone block in revision cases and without bone block in primary ACL reconstruction and especially in children and adolescents with open physes.[9]

For QT graft harvesting, the knee is placed in 90° of flexion and the superior pole and medial and lateral borders of the patella are marked (Fig 1). The graft is harvested through a 2- to 3-cm longitudinal incision starting 1 cm proximal and in line with the center of the superior border of the patella.

The incision is taken through the subcutaneous tissue and the QT is exposed. It is very important to obtain clear visualization of the QT, vastus medialis, and vastus lateralis. The arthroscope can be used as an aid in identifying the proximal, medial, and lateral borders of the QT (Fig 2). We use a 9-, 10-, or 11-mm double-bladed knife (Arthrex) depending on the size of the patient, and we aim at a 6- to 7-cm graft length. The concept of a "moveable window" is used to accomplish that goal, and the graft is released with a No. 15 blade from the patella and freed from its attachments along its length. Once the desired length is obtained, the QT graft is amputated proximally. If needed, a traction suture at the distal part of the QT graft, along with a long Langenbeck retractor, may give access to the most proximal part of the QT graft.

We advocate the "all-inside" ACL reconstruction technique because of the proposed benefits of decreased bone removal, diminished surgical trauma, decreased postoperative pain, and improved cosmesis.[10,11]

In order to prepare the QT graft, each end is whip-stiched with a fiber loop and secured to an adjustable loop suspensory fixation[12] (Arthrex) (Fig 3). The graft length and thickness are measured for tunnel preparation.

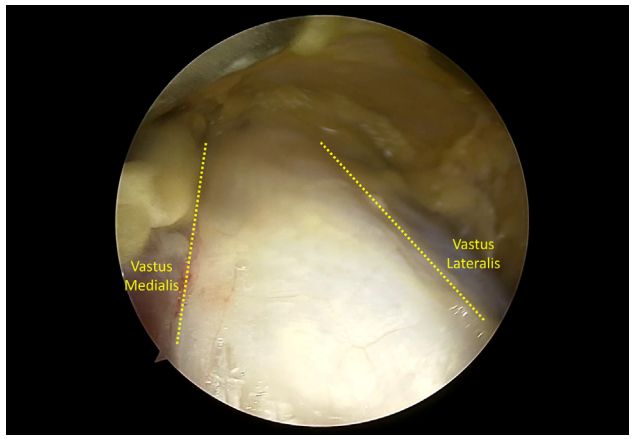

Fig 2. Left knee. Supine position with the knee flexed at 90°. Endoscopic view of the quadriceps tendon. For quadriceps tendon harvesting, the proximal, medial, and lateral borders of the tendon should be identified. The yellow dotted lines represent the endoscopic view of the quadriceps tendon borders with the vastus medialis and vastus lateralis.

Lateral Extra-articular Tenodesis

The LET approach is then carried out. The lateral epicondyle, peroneal head, and Gerdy's tubercle are marked (Fig 1) and a 4-cm incision, under the lateral epicondyle and in line with the iliotibial band (ITB) fibers, is performed. The subcutaneous tissue is dissected down to the ITB, and the ITB is freed distally down to Gerdy's tubercle and proximally up to the point that would give a 9- to 10-cm length graft (Fig 4). Farabeuf retractors are used to give access to the desired length of the ITB.

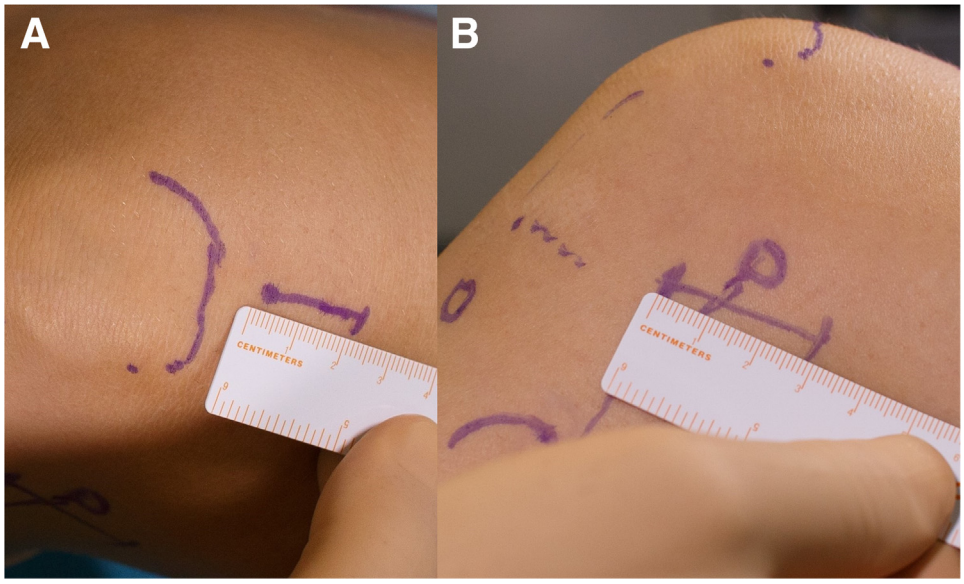

Fig 1. Left knee. Supine position with the knee flexed at 90°. (A) Anterior view. For the quadriceps tendon graft harvesting, the superior, medial, and lateral borders of the patella are marked. The skin incision is placed 1 cm proximal and in line with the center of the superior border of the patella. (B) Lateral view. For the lateral extra-articular tenodesis, the peroneal head, lateral femoral epicondyle, and Gedy's tubercle are marked. The skin incision is placed under the lateral femoral epicondyle and in line with the iliotibial band (ITB) fibers.

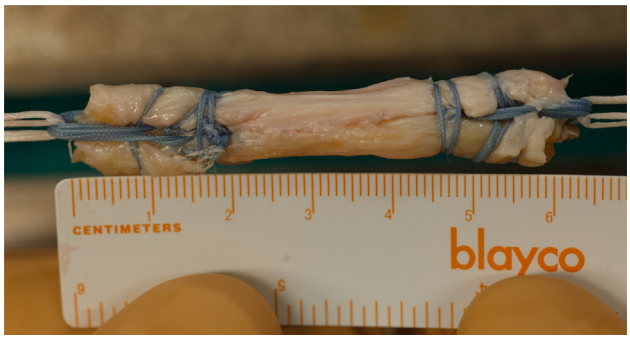

Fig 3. For the all-inside anterior cruciate ligament reconstruction technique, the quadriceps tendon graft is prepared with suspendory adjustable loop fixation implants at both ends. The length of the graft should be 6 to 7 cm.

A 9- or 10-mm double knife (Arthrex) is used to harvest a strip from the central one-third of the ITB. The ITB graft is left attached to Gerdy's tubercle distally, freed from the surrounding soft tissues, and cut proximal to give a graft of 9 to 10 cm. The graft is whipstiched with high-strength suture for manipulation and reinforcement.

The lateral collateral ligament (LCL) is then identified (Fig 5) and incised at its anterior and posterior borders, up to its origin at the lateral femoral epicondyle. Care is taken not to disrupt the ligament or the underlying capsule. A curved Kelly forceps or other grasping instrument is used to bring the ITB graft from distal to proximal, deep to the LCL. The point of femoral fixation of the graft is then identified. This point should be proximal and posterior to the origin of the LCL from the lateral epicondyle[13] (Fig 5). This point is marked with an electrocautery tip. This will be the exit of the femoral tunnel of the ACL reconstruction and thus the point of suspensory fixation arrest.

Tunnel Drilling

The next step of the procedure is the ACL reconstruction femoral tunnel creation. An outside-in ACL

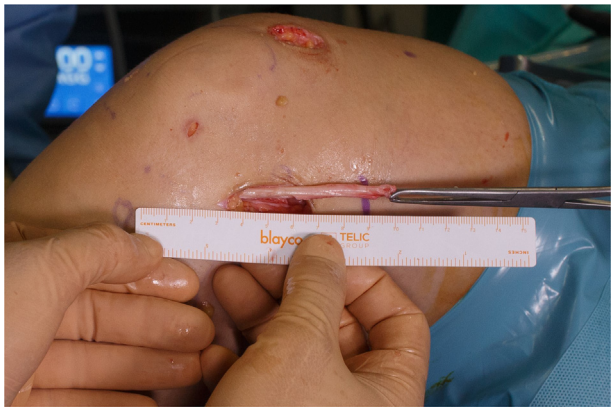

Fig 4. Left knee. Supine position with the knee flexed at 90°. Lateral view. The iliotibial band graft should be 9 to 10 cm in length and 9 to 10 mm thick.

Fig 5. Left knee. Supine position with the knee flexed at 90°. Lateral view. The lateral collateral ligament (LCL) is identified and the area proximal and posterior to the lateral femoral epicondyle is cleaned with the electrocautery tip (yellow arrow).

femoral guide (Arthrex) is introduced through the anterolateral portal (Fig 6), while the anteromedial portal serves as the viewing portal. The ACL femoral footprint can be easily identified through the anteromedial portal, and the femoral outside-in guide is positioned in the center of the footprint and slightly proximal (toward the center of the anteromedial bundle), which is our preferred femoral tunnel position. The angle of the femoral outside-in guide is then adjusted so that the drill sleeve placement is at the femoral fixation point of the ITB graft that was previously marked with the electrocautery tip. The FlipCutter (Arthrex) is then drilled and its position is checked both into the joint (ACL femoral tunnel) and outside the joint (ITB femoral fixation point) for correct placement. For a young patient with open physes, the FlipCutter position is also checked with fluoroscopy, to ensure that the route of the FlipCutter is fully epiphyseal. The femoral tunnel is then drilled in a retrograde fashion according to the diameter of the graft, allowing at least 15 to 20 mm of graft incorporation into the tunnel. A suture relay is passed through the drill sleeve into the joint and retrieved through the anteromedial portal for later use.

The tibial tunnel is drilled with the ACL outside-in tibial guide (Arthrex), aiming at the center of the ACL tibial footprint. The FlipCutter is introduced into the joint, and retrograde drilling of the tibial tunnel is performed aiming at 15 to 20 mm of graft incorporation. A second suture relay is introduced through the tibial tunnel into the joint and out of the anteromedial portal to aid in graft passage.

Graft Passage

The QT graft is loaded onto the relay sutures and passed through the anteromedial portal proximally into the femoral tunnel, where it is left partially seated until

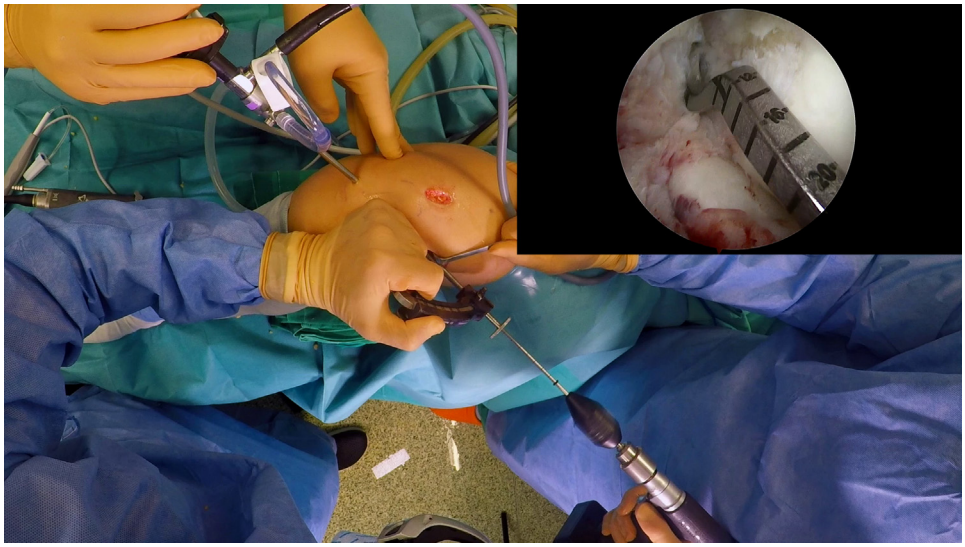

Fig 6. Left knee. Supine position with the knee flexed at 90°. Anterior view. The anterior cruciate ligament, outside-in femoral guide is introduced through the anterolateral portal and positioned in the desired position (arthroscopic view), while the drill sleeve is positioned proximal and posterior to lateral femoral epicondyle, at the area that was previously marked. The scope is in the anteromedial portal.

tibial passing is completed. The femoral button is now positioned at the ITB fixation point. With the ACL graft in place but not fixed, the femoral button is lifted off the bone (Fig 7). The ITB graft, the lateral collateral ligament, and the adjustable loop of the femoral button are identified (Fig 8), and the ITB graft is passed under the lateral collateral ligament (Fig 9) and through the adjustable loop of the femoral button (Fig 10).

Fixation

With both grafts now in place, the knee is brought to near full extension (10°) and neutral rotation. The assistant holds the ITB graft in the desired tension (20 N), while the surgeon tensions and fixes the ACL graft as usual, thus securing the ITB graft as well (Fig 11). The tension of the grafts is checked and adjusted if needed. The ITB graft is then folded over the button (Fig 12) and sutured to itself (Fig 13) with a No. 2 nonabsorbable suture for additional security. Both ITB graft (Figs 14 and 16) and ACL graft (Figs 15 and 16) are checked and the surgical wounds are closed in a standard fashion.

Rehabilitation

No modifications of the standard ACL reconstruction regimen are needed.

Discussion

Simple Technique

The main advantage of this technique is its simplicity. It has no steep learning curve and can be easily

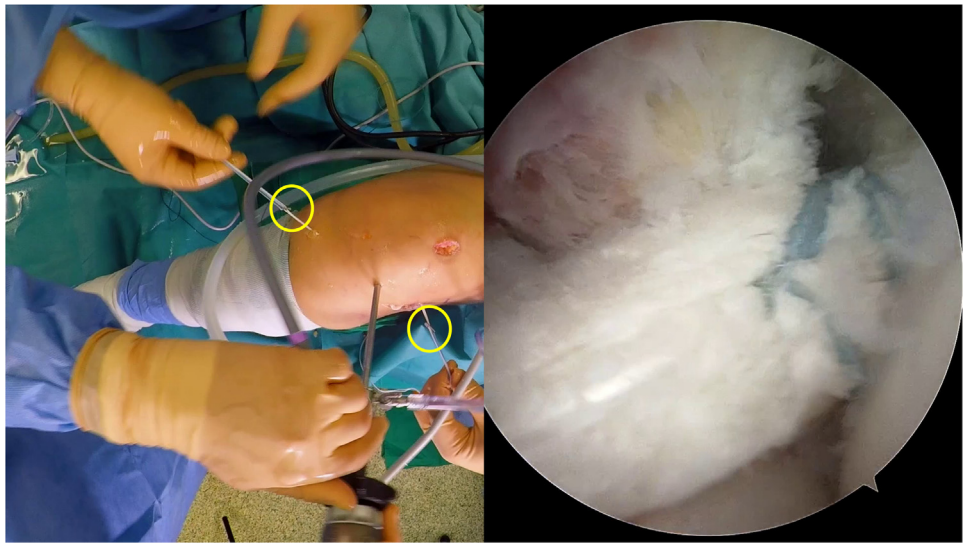

Fig 7. Left knee. Supine position with the knee flexed at 90°. Anterior view. The anterior cruciate ligament graft passage has been completed, and the graft is in place (arthroscopic view) but not fixed. The yellow circles point to the tibial and femoral adjustable loop suspensory implants with both loops loose.

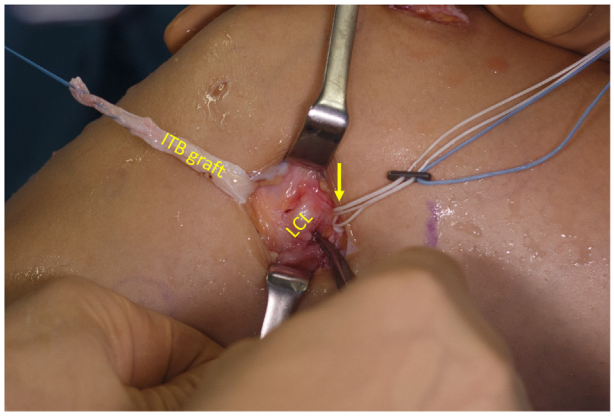

Fig 8. Left knee. Supine position with the knee flexed at 90°. Lateral view. The iliotibial band (ITB) graft, lateral collateral ligament (LCL), and the loop (yellow arrow) of the suspensory fixation implant are identified.

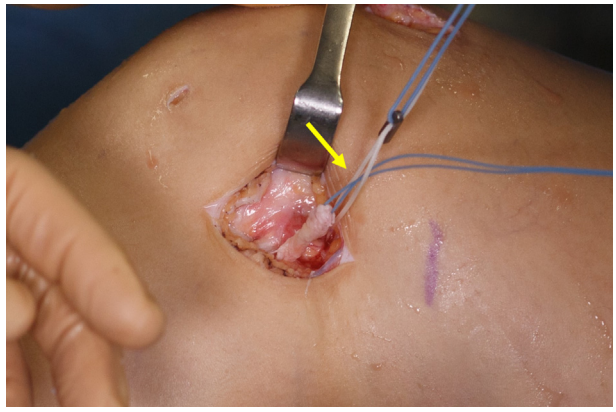

Fig 10. Left knee. Supine position with the knee flexed at 90°. Lateral view. The iliotibial band is passed (yellow arrow) through the adjustable loop of the suspensory fixation implant.

performed by all surgeons who already perform ACL reconstruction and LET. No extra surgical steps or implants that could raise the complexity of the combined ACL reconstruction and LET are used.

Versatile Technique

Besides simple, this technique is also versatile and can be easily adjusted to the surgeon's preferences and the patient's needs. The only part of the technique that cannot be changed is the creation of the femoral tunnel, with an outside-in guide aiming at the anatomic points described and the use of an adjustable button as the common femoral fixation method for the 2 grafts.

The described technique can be applied with all types of grafts since all QT, bone-patella-tendon-bone, and hamstring grafts can be fixed with an adjustable loop button. It can also be combined with all fixation methods of the ACL graft in the tibia since tibia fixation is irrelevant with ITB graft fixation.

It can be performed with the minimally invasive philosophy without full-length femoral tunnels (all-inside) and long incisions as described. Nevertheless, someone can apply this technique using full-length tunnels[14] with the utilization of the appropriate length button or an extension button (XTENDO-BUTTON [Smith and Nephew]; Tightrope Button Extender [Arthrex]).

Our technique can also be used in children and adolescents, as long as fully epiphyseal position of the drill guide is confirmed intraoperatively with fluoroscopy.

A similar technique for patients with open physes was described by Leyes-Vence et al.[15] They used quadrupled semitendinosus tendon as a graft for the ACL reconstruction, and they fixed the ITB graft by suturing it on the button. Apart from patient population and type of graft used, the main difference of our technique is the

Fig 9. Left knee. Supine position with the knee flexed at 90°. Lateral view. The iliotibial band (ITB) graft is passed under the lateral collateral ligament (LCL).

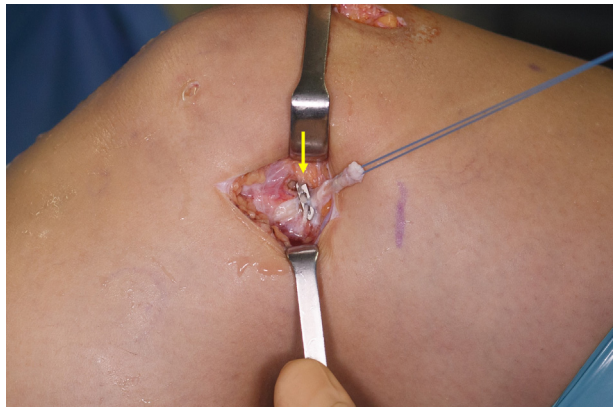

Fig 11. Left knee. Supine position. Lateral view. The iliotibial band graft is fixed with the suspensory fixation implant (yellow arrow) with the knee in 10° of flexion, thus fixating the anterior cruciate ligament graft as well. The picture is taken in 90° of knee flexion (after the fixation has been completed) for demonstration purposes.

Fig 12. Left knee. Supine position with the knee flexed at 90°. Lateral view. After the graft fixation, the free end of the iliotibial band graft is brought over the suspensory fixation implant.

method of ITB graft fixation. The interposition of the button between the ITB graft and the bone surface may play a negative role in the healing process, and as a result, the stability of the graft relies mainly on suture of the button.

Durable Fixation for Both Grafts

The fact is that the fixation method we used for both ACL and ITB grafts is new and has not been tested in the laboratory. In theory, that could be an issue in terms of graft healing.

Nevertheless, adjustable suspensory femoral fixation has been long used in ACL reconstruction, with great biomechanical and clinical results using the QT graft,[16] hamstring graft,[17,18] and bone-patella-tendon-bone graft.[19]

For the femoral fixation of the ITB graft, a variety of methods have been used like screw,[20] staple,[21] suture anchor,[22] or even no implants at all.[23] Our method of fixation (adjustable button) mimics the function of the staple, as it compresses the ITB graft against the femur, while suturing of the graft to itself also mimics the technique without implants. The advantage of our technique, compared to the staple fixation method, is the presence of the femoral tunnel that provides healing factors through the bleeding, while the loop of the button partially pulls the ITB graft into the femoral tunnel. Therefore, our technique provides excellent biomechanical and biological conditions for graft healing to the femoral bone tunnel entrance.

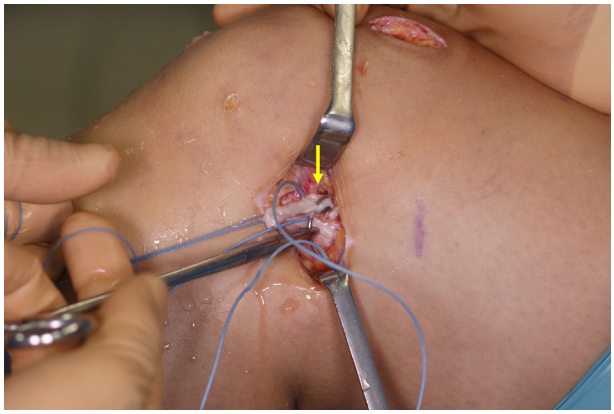

Fig 13. Left knee. Supine position with the knee flexed at 90°. Lateral view. The free end of the iliotibial graft is sutured to itself for additional security.

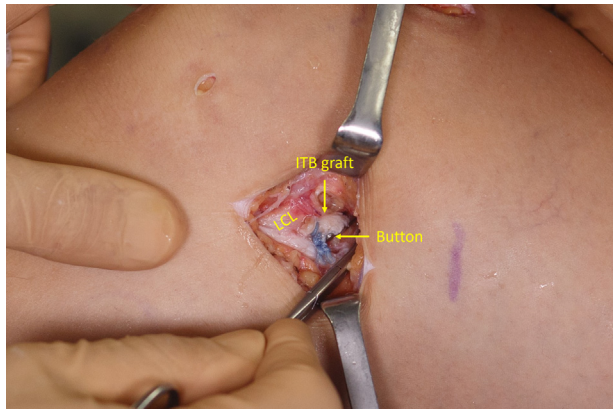

Fig 14. Left knee. Supine position with the knee flexed at 90°. Lateral view. Final result of the modified Lemaire tenodesis with the iliotibial band (ITB) graft passing under the lateral collateral ligament (LCL), fixed by the suspensory femoral fixation of the anterior cruciate ligament graft (button, yellow arrow) and tied to itself.

Synergistic Effect

The fact that ACL and ITB grafts are interconnected through the common femoral fixation button potentially allows them to work synergistically, especially in the early postoperative period, where the grafts have not healed yet. In other words, we could hypothesize that when the ACL graft is loaded, the tension is transferred through the loop of the button to the ITB graft, thus efficiently protecting the knee.

No Extra Implants

One more advantage of this technique is the fact that no additional implant is required, and as a result, the cost of the procedure remains unaffected.

No Extra Tunnel and Risk of Convergence

Tunnel convergence in combined ACL reconstruction and LET has been reported as a concern that would potentially cause iatrogenic ACL graft damage or compromise fixation and thus affect the outcome of the procedure.[24] Recently, the use of an anchor for the ITB femoral fixation was proposed as a solution to this risk.[25,26] The fact that no extra tunnel (for screw fixation) or drill hole (for anchor or staple fixation) is used in the described technique makes the technique

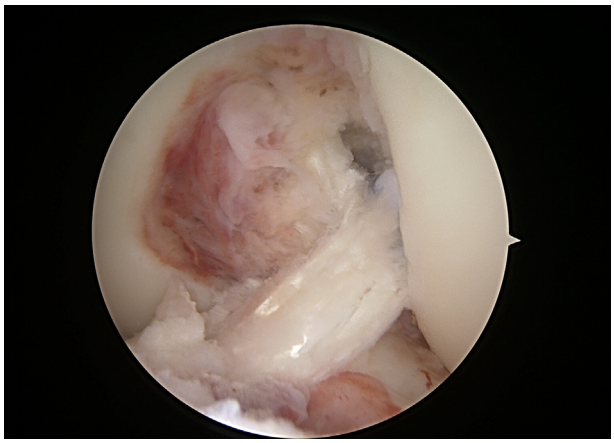

Fig 15. Left knee. Arthroscopic view of the anterior cruciate ligament graft through the anterolateral portal.

completely safe and simplifies the procedure since it does not add any additional risk.

The advantages of our technique are outlined in Table 1.

Limitations and Risks

On the other hand, we recognize that the outside-in femoral drilling technique is the least popular one in ACL reconstruction. As a result, a learning curve may be associated with this technique for most orthopaedic surgeons.

Table 1. Advantages and Limitations

Advantages	Limitations
Simple and easy to perform without steep learning curve	The biomechanical properties of this fixation technique have not been studied, and as a result, graft healing could be an issue in theory.
Applicable with all types of ACL grafts	Outside-in femoral tunnel drilling is the least popular drilling technique and therefore it is probably associated with a learning curve for most orthopaedic surgeons.
Applicable with all methods of tibial ACL graft fixation	Combined fixation of both grafts requires precise leg positioning and concomitant graft tensioning. Failure to adequately tension the ITB graft while securing the femoral button may lead to a less protective effect of the LET.
Durable fixation for both grafts	
Can be used in children and adolescents with open physes	
No extra implants required	
No additional cost	
No risk of tunnel convergence in the femur	
Potential synergistic protective effect of the 2 grafts in the early postoperative period	

ACL, anterior cruciate ligament; ITB, iliotibial band; LET, lateral extra-articular tenodesis.

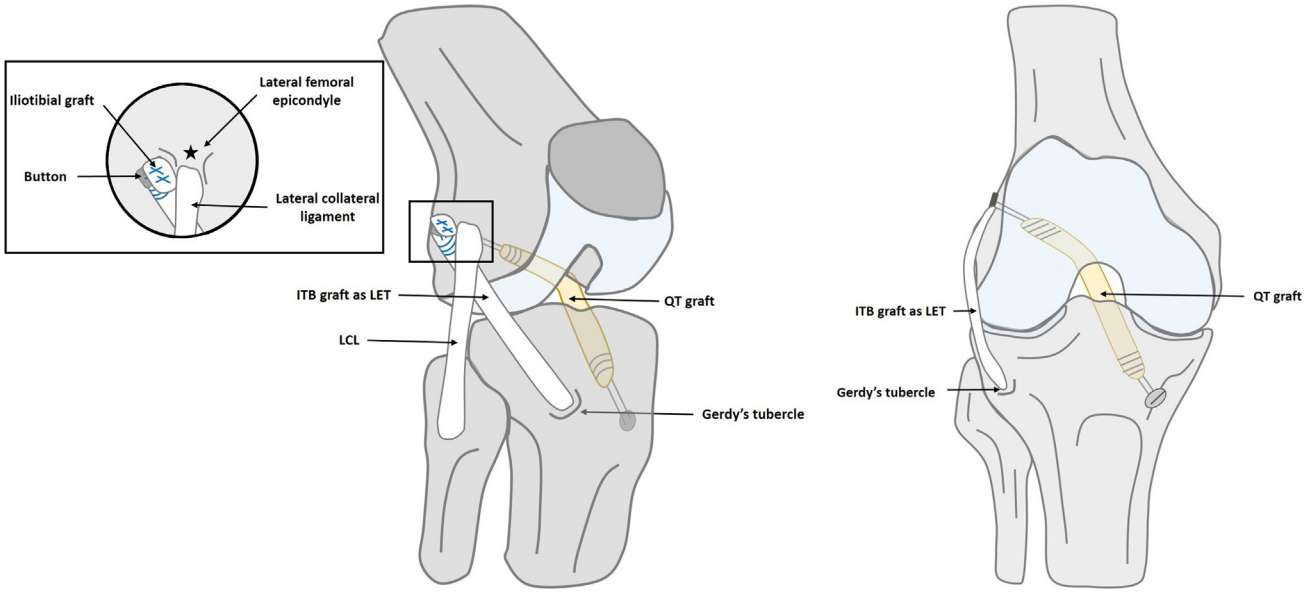

Fig 16. Drawing of the technique. Right knee. Lateral and anterior view. (ITB, iliotibial band; LCL, lateral collateral ligament; QT, quadriceps tendon.)

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Measure and mark the skin before QT and ITB graft harvesting to ensure adequate length of both grafts.	The all-inside ACL reconstruction technique requires accurate graft dimension measurements and socket drilling.
QT graft harvesting should be performed under direct visualization. Utilization of the scope and different knee flexion angles can help with this.	Medial, lateral, and proximal borders of the QT should not be violated during graft harvesting.
QT gap repair after graft harvesting prevents any fluid extravasation during the arthroscopy.	Iatrogenic injury to the LCL is possible.
Applying varus stress can aid in identification of the lateral collateral ligament.	The length of the ITB graft should be long enough to allow passage under and over the suspensory fixation implant.
Do not disrupt the knee capsule during ITB graft preparation and LCL identification.	

ACL, anterior cruciate ligament; ITB, iliotibial band; LCL, lateral collateral ligament; QT, quadriceps tendon.

Moreover, combined fixation of both grafts requires precise leg positioning and concomitant graft tensioning. Failure to adequately tension the ITB graft while securing the femoral button may lead to a less protective effect of the LET.

The limitations of our technique are outlined in Table 1.

We have also to underline that the existing risks of the all-inside ACL reconstruction and the LET techniques are still present with this technique. Risks for the all-inside ACL reconstruction technique include the short or inadequate graft, graft "bottoming out" during fixation, and soft tissue interposition during graft passage through the anteromedial portal. Proper graft harvesting technique, accurate measurement of graft dimensions and sockets, and single-bite shuttle suture retrieval through the anteromedial portal minimize those risks. The LET procedure puts in danger the LCL and the knee capsule. Figure-of-four knee position tensions the LCL, thus aiding in LCL identification and protection. Table 2 presents a comprehensive review of the common pearls and pitfalls of this technique.

References

1. Barber-Westin S, Noyes FR. One in 5 athletes sustain reinjury upon return to high-risk sports after ACL reconstruction: A systematic review in 1239 athletes younger than 20 years. *Sports Health* 2020;12(6):587-597.
2. Brophy RH, Schmitz L, Wright RW, et al. Return to play and future ACL injury risk after ACL reconstruction in soccer athletes from the Multicenter Orthopaedic Outcomes Network (MOON) group. *Am J Sports Med* 2012;40(11):2517-2522.
3. Mascarenhas R, Tranovich MJ, Kropf EJ, Fu FH, Harner CD. Bone patellar tendon-bone autograft versus hamstring autograft anterior cruciate ligament reconstruction in the young athlete: A retrospective matched analysis with 2-10 year follow-up. *Knee Surg Sports Traumatol Arthrosc* 2012;20(8):1520-1527.
4. Georgoulis AD, Ristanis S, Chouliaras V, Moraiti C, Stergiou N. Tibial rotation is not restored after ACL reconstruction with a hamstring graft. *Clin Orthop Relat Res* 2007;454:89-94.
5. Chalmers PN, Mall NA, Moric M, et al. Does ACL reconstruction alter natural history? A systematic literature review of long-term outcomes. *J Bone Joint Surg Am* 2014;96:292-300.
6. Jonsson H, Riklund-Ahlstrom K, Lind J. Positive pivot shift after ACL reconstruction predicts later osteoarthrosis: 63 patients followed 5-9 years after surgery. *Acta Orthop Scand* 2004;75:594-599.
7. Inderhaug E, Stephen JM, Williams A, Amis AA. Biomechanical comparison of anterolateral procedures combined with anterior cruciate ligament reconstruction. *Am J Sports Med* 2017;45(2):347-354.
8. Getgood AMJ, Bryant DM, Litchfield R, et al. Lateral extra-articular tenodesis reduces failure of hamstring tendon autograft anterior cruciate ligament reconstruction: 2-Year outcomes from the STABILITY study randomized clinical trial. *Am J Sports Med* 2020;48(2):285-297.
9. Crum RJ, Kay J, Lesniak BP, Getgood A, Musahl V, de Sa D. Bone versus all soft tissue quadriceps tendon autografts for anterior cruciate ligament reconstruction: A systematic review. *Arthroscopy* 2021;37(3):1040-1052. https://doi.org/10.1016/j.arthro.2020.10.018.
10. Lubowitz JH, Ahmad CS, Anderson K. All-inside anterior cruciate ligament graft-link technique: Second-generation, no-incision anterior cruciate ligament reconstruction. *Arthroscopy* 2011;27(5):717-727. https://doi.org/10.1016/j.arthro.2011.02.008.
11. Lubowitz JH, Schwartzberg R, Smith P. Randomized controlled trial comparing all-inside anterior cruciate ligament reconstruction technique with anterior cruciate ligament reconstruction with a full tibial tunnel. *Arthroscopy* 2013;29:1195-1200.
12. Slone HS, Ashford WB, Xerogeanes JW. Minimally invasive quadriceps tendon harvest and graft preparation for all-inside anterior cruciate ligament reconstruction. *Arthrosc Tech* 2016;5(5):e1049-e1056.
13. Williams A. Editorial commentary: Lateral extra-articular tenodesis reduces anterior cruciate ligament graft rerupture rates: Proper anterior cruciate ligament and lateral extra-articular tenodesis technique is vital to prevent complications. *Arthroscopy* 2022;38(3):870-872.
14. Prado-Nóvoa M, Pérez-Blanca A, Espejo-Reina A, Lombardo-Torre M, Ezquerro-Juanco F, Espejo-Baena A. Assessment of fixation for anterior cruciate ligament reconstruction using oversized suspensory devices on full-length femoral tunnels. *Clin Biomech* 2020;76:105008.

15. Leyes-Vence M, Roca-Sanchez T, Flores-Lozano C, Villarreal-Villareal G. All-inside partial epiphyseal anterior cruciate ligament reconstruction plus an associated modified Lemaire procedure sutured to the femoral button. *Arthrosc Tech* 2019;8(5):e473-e480.
16. Crum RJ, de Sa D, Kanakamedala AC, Obioha OA, Lesniak BP, Musahl V. Aperture and suspensory fixation equally efficacious for quadriceps tendon graft fixation in primary ACL reconstruction: A systematic review. *J Knee Surg* 2020;33(7):704-721.
17. Sheth A, Salunke AA, Barve R, Nirkhe R. Arthroscopic ACL reconstruction using fixed suspensory device versus adjustable suspensory device for femoral side graft fixation: What are the outcomes? *J Clin Orthop Trauma* 2019;10(1):138-142.
18. Schützenberger S, Keller F, Grabner S, et al. ACL reconstruction with femoral and tibial adjustable versus fixed-loop suspensory fixation: A retrospective cohort study. *J Orthop Surg Res* 2022;17(1):244.
19. Taketomi S, Inui H, Nakamura K, et al. Secure fixation of femoral bone plug with a suspensory button in anatomical anterior cruciate ligament reconstruction with bone-patellar tendon-bone graft. *Joints* 2016;3(3):102-108.
20. Puzzitiello RN, Agarwalla A, Bush-Joseph CA, Forsythe B. Iliotibial band tenodesis with a tenodesis screw for augmentation of anterior cruciate ligament reconstruction. *Arthrosc Tech* 2019;8(4):e389-e393.
21. Kwapisz A, Mollison S, McRae S, MacDonald P. Lateral extra-articular tenodesis with proximal staple fixation. *Arthrosc Tech* 2019;8(8):e821-e825.
22. Muller B, Willinge GJA, Zijl JAC. Minimally invasive modified Lemaire tenodesis. *Arthrosc Tech* 2020;10(1):e29-e36.
23. Abusleme S, Strömbäck L, Caracciolo G, et al. Lateral extra-articular tenodesis: A technique with an iliotibial band strand without implants. *Arthrosc Tech* 2021;10(1):e85-e89.
24. Jaecker V, Ibe P, Endler CH, Pfeiffer TR, Herbort M, Shafizadeh S. High risk of tunnel convergence in combined anterior cruciate ligament reconstruction and lateral extra-articular tenodesis. *Am J Sports Med* 2019;47(9):2110-2115.
25. Mesnier T, Cavaignac M, Marot V, Reina N, Cavaignac E. Knee anterolateral ligament reconstruction with knotless soft anchor: Shallow fixation prevents tunnel convergence. *Arthrosc Tech* 2022;11(4):e511-e516. https://doi.org/10.1016/j.eats.2021.11.024.
26. Hopper GP, El Helou A, Philippe C, Campos JP, Vieira TD, Sonnery-Cottet B. How to avoid knee tunnel convergence when performing a modified Lemaire extra-articular tenodesis. *Arthrosc Tech* 2022;11(6):e1111-e1115. https://doi.org/10.1016/j.eats.2022.02.019.