Technical Note

Single Femoral Tunnel for Anterior Cruciate Ligament Reconstruction With Bone-Patellar Tendon-Bone Graft and Lemaire's Extra-Articular Tenodesis as a Good Alternative for Combined Anterior Cruciate Ligament and Anterolateral Ligament Revision Surgeries

Rodrigo Araújo Goes, M.D., M.Sc., Rafael Pereira, M.D., Frederico Lage de Oliveira, M.D., Pedro Castelhanito, M.D., M.Sc., Raphael Serra Cruz, M.D., M.Sc., and José Leonardo Rocha de Faria, M.D., M.Sc.

Abstract: The literature has shown a significant decrease in failure rates when the anterior cruciate ligament (ACL) reconstruction was associated with an extra-articular reinforcement technique such as the anterolateral ligament (ALL) or the iliotibial band tenodesis (ITBT) using the modified Lemaire technique. As much as there is a progressive decrease in the failure rates of ACL reconstructions when the ALL reconstruction technique is associated, there are still and will be cases that will result in graft rupture. These cases will require more alternatives for revision, which are always challenging for the surgeon, where the lateral approaches represent complicating factors, especially because of the distortion of the lateral anatomy (by the previous approach for ALL reconstruction), previous reconstruction tunnels, and the presence of fixation materials. We present here a safe technique that offers great stability to the fixation of the graft and is easy to perform, using a single tunnel for the passage of the ACL and ITBT grafts, allowing a single fixation for both. In this way, we performed a lower-cost surgery, with a lower risk of lateral condyle fracture and tunnel confluence. This technique is indicated to be used in cases of revision after failure of combined ACL reconstruction with ALL.

Approximately 64% of all knee injuries are anterior cruciate ligament (ACL) tears and occur during sports participation involving pivoting and change of direction.[1] The graft tear after an ACL reconstruction surgery is a major concern.[2] About 37% of reconstruction failures have multiple causes, especially the combination of technical errors, traumatic injuries, and biological factors.[3]

The literature has shown a significant decrease in failure rates when the ACL reconstruction was associated with an extra-articular reinforcement technique such as the anterolateral ligament (ALL) or the iliotibial band tenodesis (ITBT) using the modified Lemaire technique.[2,4-8] DePhillipo et al.[4] observed only 1.1% of graft rupture when ACL reconstruction was associated with ALL reconstruction, versus 16.3% of failures in isolated ACL reconstructions.

Similarly, with 2 years of follow-up, Delaloye et al.[5] reported a graft rupture rate of 10.8% in isolated ACL reconstructions when using a quadruple hamstring graft and 6.8% when using a patellar tendon graft. In the combined

From the North Lisbon University Hospital Centre (CHULN) - Santa Maria Hospital (R.A.G., R.P., F.L.dL. P.C.), Lisbon, Portugal; the The Division of Traumatology and Ortopedics (DITRO) of National Institute of Traumatology and Orthopedics of Brazil (INTO) (R.A.G., R.S.C., J.L.R.dF.), Rio de Janeiro, Brazil; Free Assistant of the Chair of Orthopedics at the Faculty of Medicine of Lisbon - FMUL (R.A.G.), Lisbon, Portugal; and the School of Medicine from University of São Paulo, USP Riberão Preto (J.L.R.dF.), SP, Brazil.

The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received November 6, 2022; accepted February 12, 2023.

Address correspondence to José Leonardo Rocha de Faria, Instituto Nacional de Traumatologia e Ortopedia, Centro de Cirurgia do Joelho, Av Brasil, 500, Sao Cristovao, Rio de Janeiro, Rio de Janeiro 20940-070, Brazil. E-mail: drjoseleonardorocha@gmail.com

© 2023 THE AUTHORS. Published by Elsevier Inc. on behalf of the Arthroscopy Association of North America. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

2212-6287/221466
https://doi.org/10.1016/j.eats.2023.02.026

cases of ACL reconstruction and ALL, this rate was only 4.1%, regardless of the graft used in the ACL reconstruction with a reduction in the reoperation rate to 8.7% when associated with ALL reconstruction compared to isolated ACL reconstruction.[5] With a longer follow-up, Sonnery-Cottet et al.,[2] in a study involving a young population at high risk for participating in pivotal sports, found the graft failure rate in combined ACL and ALL reconstructions to be 2.5 times lower than with patellar tendon grafts alone and 3.1 times smaller than with quadruple hamstring grafts, in addition to being associated with greater chances of returning to pre-injury sporting levels.

Several techniques have recently been described for the anatomical reconstruction of ALL based on currently recognized fixation points, which confirms the popularization of the procedure.[9-12] There are few studies comparing revision surgery techniques. Retrospectively, Alm et al.[13] found substantially superior results in functional scores and lower failure rates (5% and 21%, respectively) when associated with ITBT. In a systematic review involving 851 patients who underwent revision techniques associated with lateral reinforcement, Grassi et al. found 8% of complications and 3.6% of failures.[14] About 74% of patients returned to their previous sport, and it was concluded that, despite being frequently associated with good results in the medium term, there are no high-level studies supporting this technique.[14]

Batailler et al.[15] presented and compared 2 safe techniques, with patellar tendon graft associated with ITBT or gracilis, with slightly better results for the first combination. Performance of more than 1 bone tunnel for fixation (ACL + Lemaire tenodesis) may be associated with the convergence of these tunnels in up to 70% of cases.[16]

As much as there is a progressive decrease in the failure rates of ACL reconstructions when the ALL reconstruction technique is associated, there are still and will be cases that will result in graft rupture, which, consequently, will require more alternatives for revision. This is always challenging for the surgeon, where lateral approaches represent complicating factors, especially because of the distortion of the lateral anatomy (by the previous approach for ALL reconstruction), previous reconstruction tunnels, and the presence of fixation materials. So far, there is no consensus on the best way to perform the revision surgery; however, the authors present a safe technique that offers great stability to the fixation of the graft and is easy to perform and is to be used in cases of revision after failure of combined ACL reconstruction with ALL.

Operative Technique

Positioning and Evaluation of the Patient Under Anesthesia and Surgical Preparation

The patient under spinal anesthesia associated with selective blockade in the adductor canal is placed in a supine position on a conventional table, with a pneumatic cuff tourniquet positioned at the root of the thigh. A support for knee arthroscopy (leg holder) is fixed to the operating table to facilitate the opening of the medial compartment during valgus and varus stresses. A complete comparative physical examination is performed for diagnostic confirmation, with the Lachman and pivot shift tests for anterior instability; rear drawer for posterior instability; valgus and anterior drawer stress with external rotation of the foot for medial and posteromedial instabilities; varus and anterior drawer stress with internal rotation for lateral and posterolateral instability. Asepsis and antisepsis of the injured limb are started, and sterile surgical drapes are installed.

Arthroscopy, Joint Assessment, and Diagnostic Confirmation

After exsanguination of the limb and with a tourniquet inflated 150 mm Hg above the patient's systolic pressure, the anterolateral portal is made, and then, under direct arthroscopic view, the anteromedial portal is created. With the aid of the probe, joint assessment is carried out, with special attention paid to diagnostic confirmation of the lesion of the anterior cruciate ligament graft, medial and lateral menisci, and articular cartilage, which must be repaired when identified. Preoperative x-ray films show the previous tunnels (Fig 1).

Harvest and Preparation of the Patellar Tendon Graft and Preparation of the Tenodesis of The Ilio-Tibial Band (Lemaire)

An anterior longitudinal incision is made over the patellar tendon. The central third of the patellar tendon is removed using a standard technique, with the aid of a saw osteotome and 2.5 mm drill, including two bone plugs, the patellar with 20 × 9 mm and the tibial with 20 × 10 mm (length × width) to be used as an ACL graft (Fig 2A). For graft preparation, a 2.5 mm drill is used to make 2 holes in each bone plug (patellar and tibial), through which no. 2 Ethibond sutures (Ethicon, Somerville, NJ) will be passed (Fig 2B).

A 6 cm incision, proximal to the joint line, is made on the lateral side of the knee, in line with the iliotibial band (ITB), toward the Gerdy's tubercle. A central strip, 9 mm wide and 8 to 10 cm long in the proximal direction, is removed, keeping the distal fixation (Gerdy) intact (Fig 3). A baseball-type suture is applied to the proximal end of the graft, using a no. 2 Vicryl suture, which allows it to be pulled further through the femoral tunnel and anteromedial portal.

Revision ACL Reconstruction Surgery

The femoral tunnel is then performed, with the aid of an outside-in guide (Smith & Nephew, Andover, MA), through the anterolateral portal (the camera through the anteromedial portal), with the proper angulation

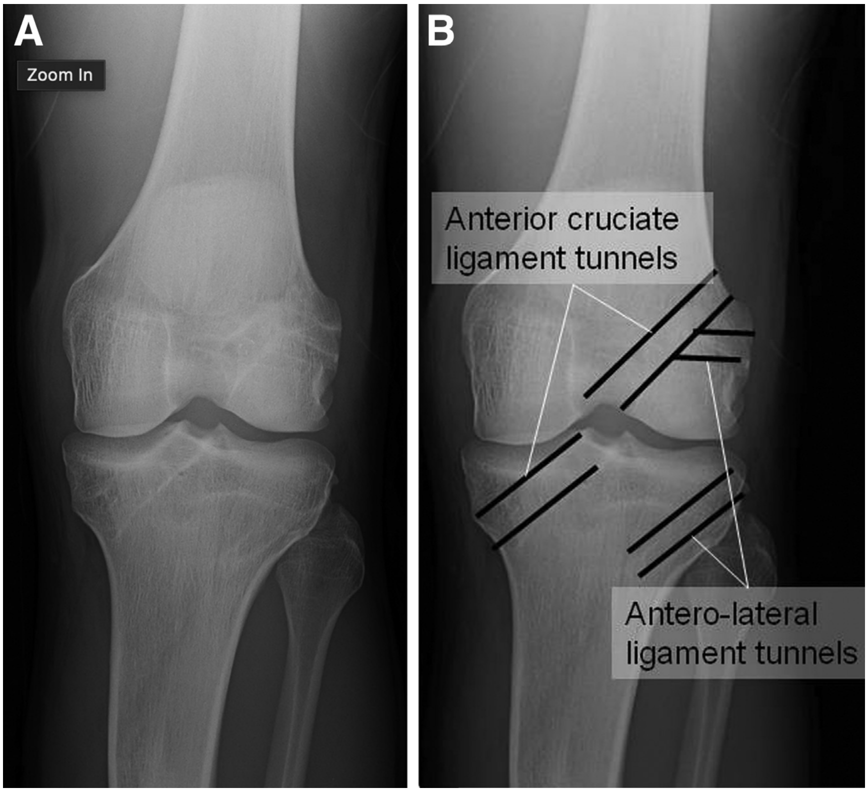

Fig 1. A 25-year-old male patient underwent a combined reconstruction of the anterior cruciate ligament and the anterolateral ligament and presented graft failure with a recurrence of instability. (A) Preoperative radiograph. (B) Preoperative radiograph with the previous reconstruction tunnels highlighted

adjustment, with the guidewire starting from the point of origin of the anterolateral ligament (3 mm proximal and posterior to the lateral femoral epicondyle) in the lateral cortex of the lateral femoral condyle (this point is marked with an electric scalpel and confirmed with the aid of fluoroscopy), towards the wall medial-lateral femoral condyle, in the footprint of the native ACL, with a 10 mm diameter drill (through this the 9 mm ACL graft and the ITBT will pass) (Fig 4).

The tibial tunnel is made using a standard ACL tibial guide (Smith & Nephew), with an angulation of 55°, from the medial cortex of the proximal tibia towards the native footprint of the ACL in the intraarticular region of the tibia, initially, a guidewire is inserted and

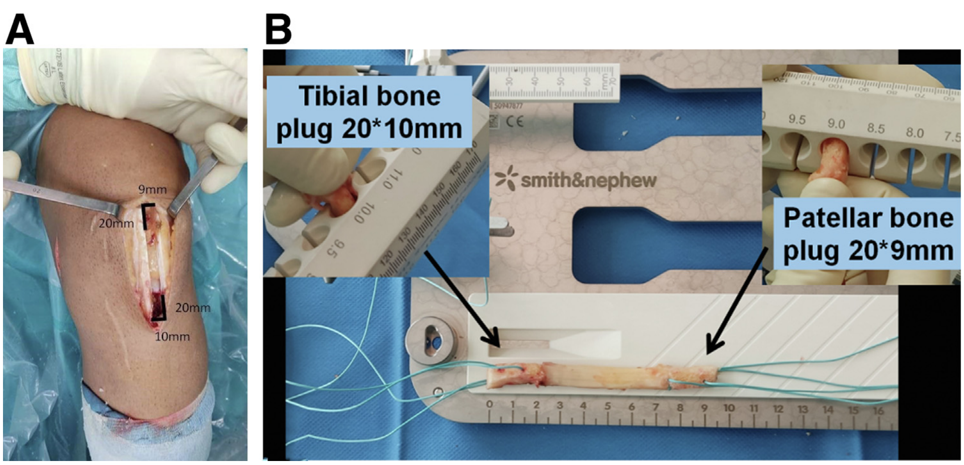

Fig 2. Removal of the central 1/3 of the patellar tendon (A), obtaining a bone-tendon-bone graft, with a 20 × 10 mm tibial plug and a 20 × 9 mm patellar plug (B).

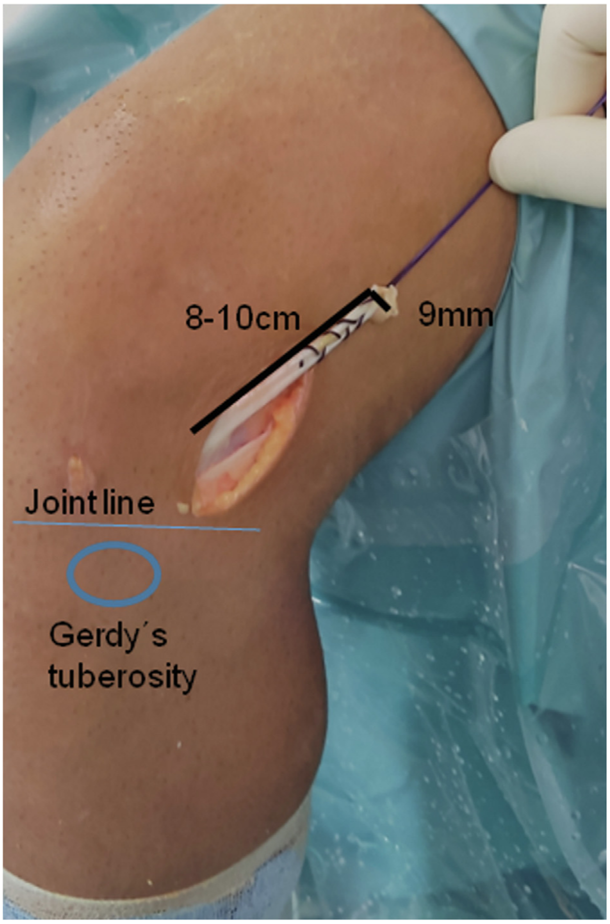

Fig 3. Preparation of the tenodesis of the iliotibial band (Lemaire procedure), obtaining a central strip of the band measuring 10 × 0.9 cm that maintains its distal insertion on Gerdy's tubercle.

later with a 10 mm diameter drill bit for drilling. (Fig 5). The length of the femoral and tibial tunnels is measured (Fig 6), for a proper definition of the length of the graft and screws to be used for fixation, in addition to the final definition of the positioning of the graft inside the tunnels (the ends of the graft must be visible inside the tunnels). A no. 2 Ethibond suture thread (Ethicon) is passed through the femoral tunnel and maintained, which will be used to transport the ACL graft through the tibial tunnel toward the femoral tunnel.

Passage of the Grafts and Fixation

After careful dissection, the ITB strip is passed under the fibular collateral ligament (Fig 7A) and is transported through the femoral tunnel in an intra-articular direction, with the suture threads captured with a grasper through the anteromedial portal. When this suture is pulled through the anteromedial portal, the ITBT is tensioned (Fig 7B).

The patellar tendon graft is passed from the tibia to the femur, with a single graft in the form of a ribbon, 10 mm thick, with the ends, the bone plugs, being inside the femoral and tibial tunnels (Fig 7C). Through the hole in the lateral cortex of the femur, there is a direct view of the grafts to be fixed, namely the ACL bone plug and the ITBT strip. A guidewire is then introduced so that it is located between these grafts (Fig 7D).

The femoral ACL fixation is initially performed from the outside-in, with an absorbable interference screw of poly-L-lactic acid/hydroxyapatite (Biosure HA; Smith & Nephew) with a diameter of 8 mm in the femur, with control of simultaneous traction of the grafts, in opposite directions (ACL for superior lateral and BIT for inferior medial), with the knee positioned at 30° of flexion, neutral rotation, and slight posteriorization of the tibia (Fig 8).

Then, the tibial fixation of the ACL graft is performed, with the knee in extension, the graft under traction, a tibial posteriorization maneuver, and with an absorbable interference screw one size smaller than the diameter of the tunnel (in this case, 9 mm) (Fig 9). The stability of the knee is tested with the Lachman maneuver and the tension of the graft within the joint is palpated with the probe.

The final appearance of the surgical procedure is shown in Figure 10, and the immediate postoperative radiographs are shown in Figure 11. A review of hemostasis is performed, wounds are sutured in layers to the skin, and occlusive dressing and an inguinal-malleolar knee immobilizer are used for protection.

Rehabilitation

The key point for the success of the rehabilitation from this surgery is to understand the final goals of the treatment: to achieve ligamentization (synovialization) of the ACL graft, to provide extra-articular stability with lateral tenodesis, and to heal the repairs performed in the meniscus or cartilage when needed. For this, we must keep in mind a series of restrictions throughout the process, especially not imposing a full load on the operated limb for a total of 6 weeks, but it mainly depends on the associated procedures that were performed.[17-19]

Thus we will describe below the other recommendations for rehabilitation.

Phase 1: Immediate postoperative period (first week – day 1 to day 7)[17,18]

Cryotherapy 6 times a day for 25 minutes

Care of the operative wound (always keep it clean, dry, and with an occlusive dressing)

Pain control with analgesic medication and edema with limb elevation

Use of prophylactic anticoagulation (enoxaparin at a dose of 40 mg once a day for 14 days)

Mobilization of the patella, patellar tendon, and quadriceps

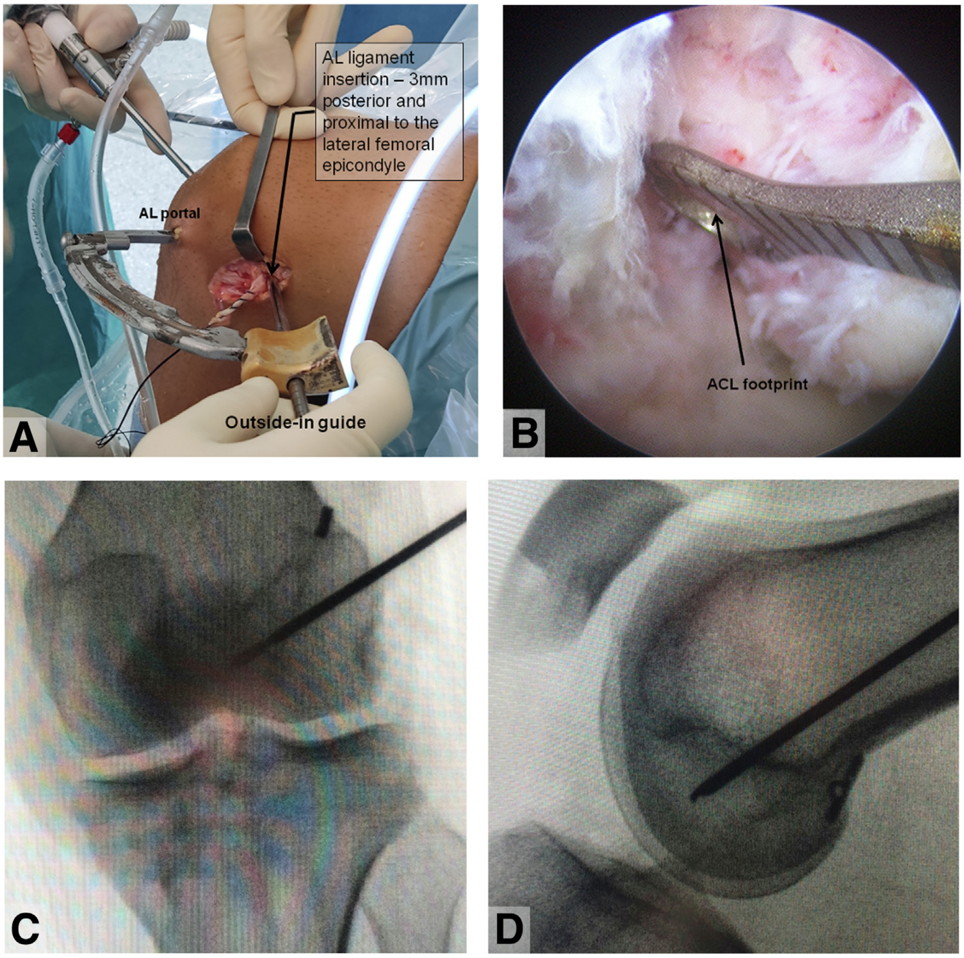

Fig 4. Preparation of the femoral tunnel using the Outside-in guide (Smith & Nephew) through the anterolateral portal, starting from the point of origin of the anterolateral ligament—3 mm posterior and proximal to the lateral epicondyle (A)—and in toward the medial wall of the lateral condyle, in the footprint of the native anterior cruciate ligament (ACL) (B). Fluoroscopic control of the tunnel path in the anteroposterior (C) and lateral (D) views.

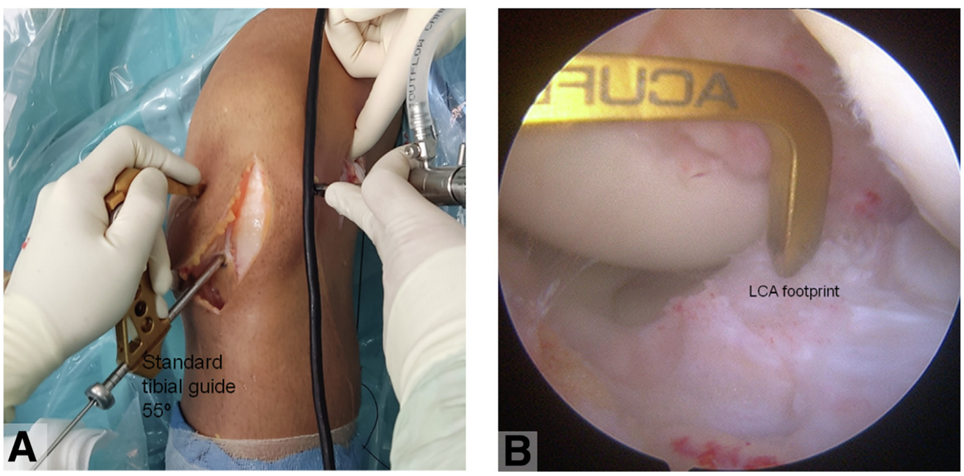

Fig 5. Preparation of the tibial tunnel using the standard anterior cruciate ligament (ACL) tibial guide (Smith & Nephew) at 55°, between the medial cortex of the tibia (A) and the native footprint (B).

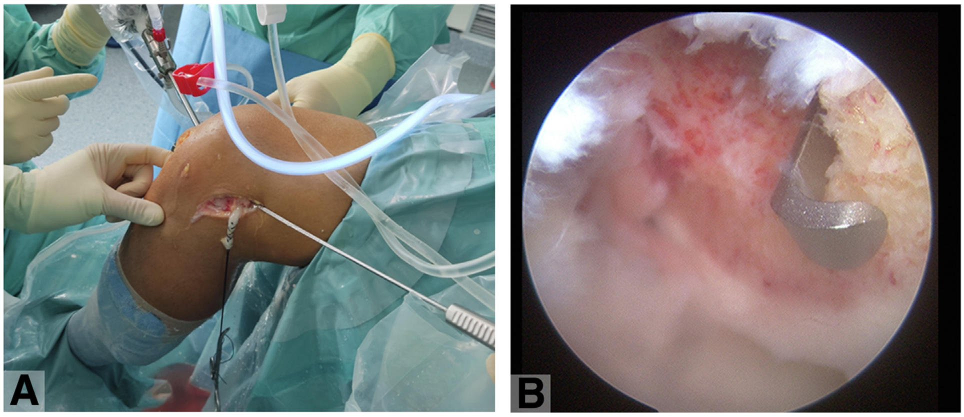

Fig 6. Measurement of the femoral tunnel (A) with arthroscopic control (B). The surgeon can make the femoral and tibial tunnels with the desired angle to achieve the correct footprints; no special equipment is needed to perform this technique.

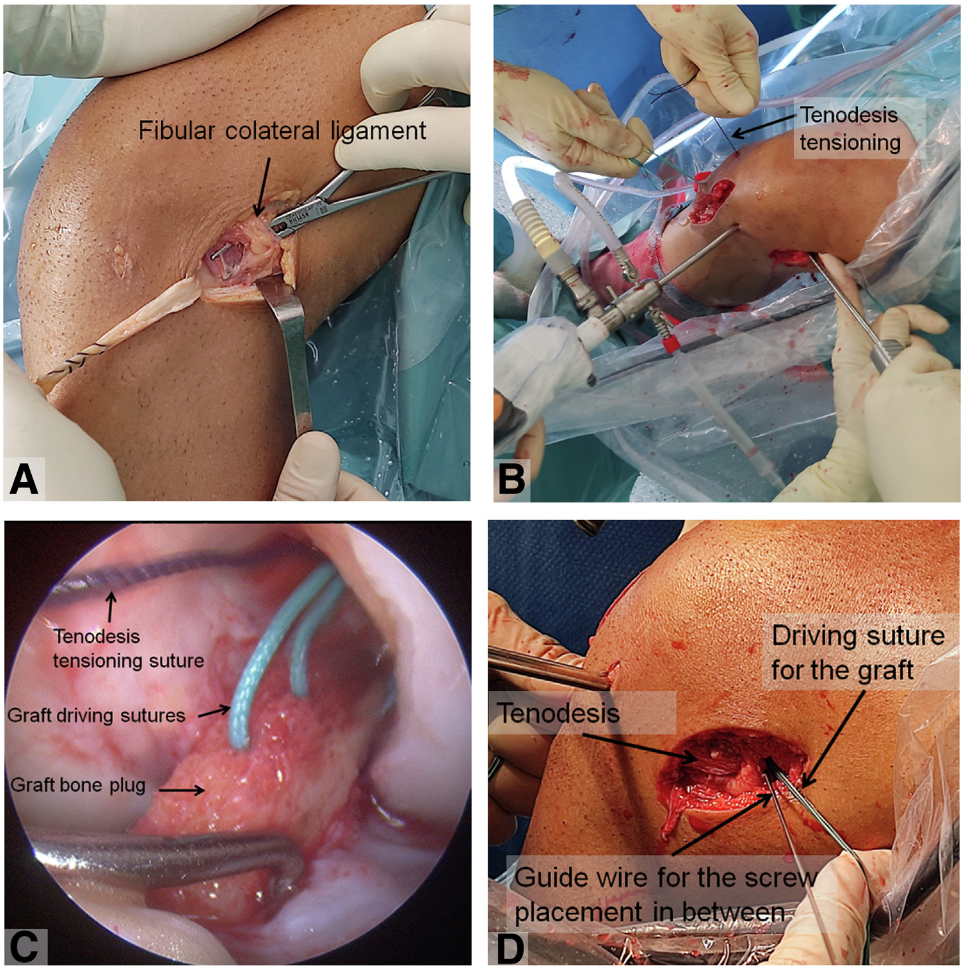

Fig 7. The iliotibial (IT) band is passed under the fibular collateral ligament (A) and transported through the lateral femoral tunnel, in an intra-articular direction, with the help of grasper-type forceps through the anteromedial portal. When pulling the suture through the anteromedial portal, the tenodesis is tensioned (B). Then, the bone-tendon-bone graft is passed using the conductive sutures on the bone plugs and grasper-type forceps, under arthroscopic control (C). The guidewire of the interferential screw is placed in the lateral orifice of the femoral tunnel in a position posterior to the tenodesis of the IT band and anterior to the bone plug of the graft (D).

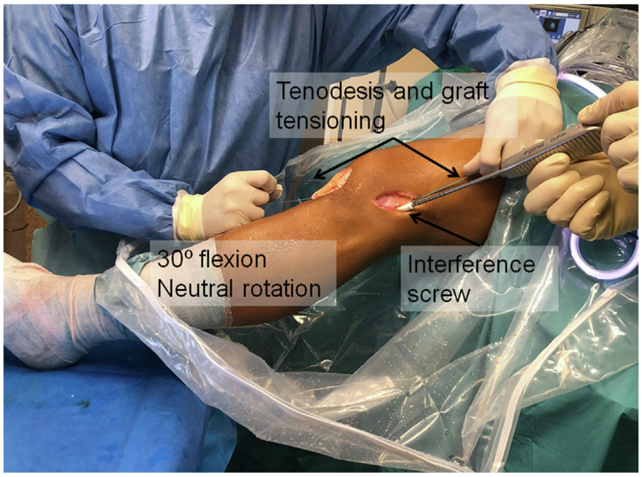

Fig 8. Fixation of the graft and tenodesis in the lateral femoral tunnel with an interference screw, simultaneously tensioning the tenodesis of the iliotibial (IT) band through the anteromedial portal and the graft through the femoral tunnel, keeping the knee at 30° of flexion, in neutral rotation and with slight posteriorization of the tibia.

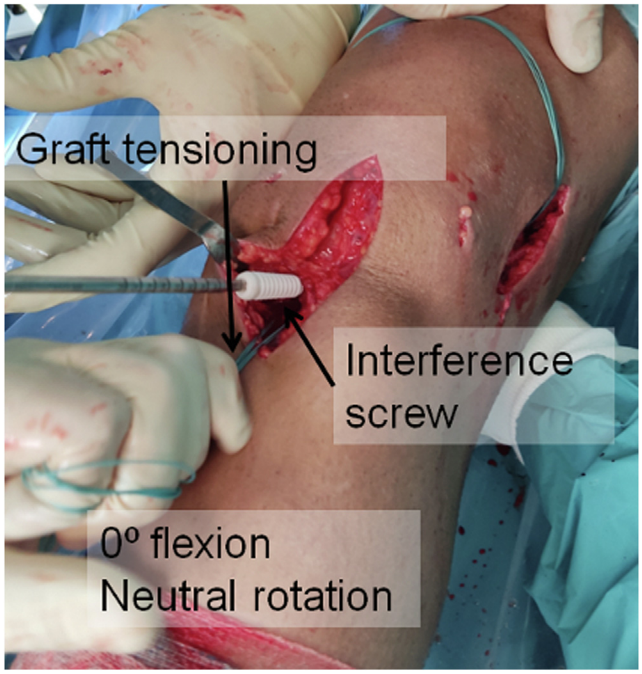

Fig 9. Fixation of the graft in the tibial tunnel with an interference screw, keeping the knee in extension.

Mobilization of the tibiotarsal joint (ankle)

Use of knee immobilizer (especially for sleeping and walking)

Control of the load of the operated member (depending on the associated procedures)

Exercises to force passive and active extension gain

Passive flexion allowed up to 90° and must be stimulated to avoid joint stiffness

Activation of the quadriceps (with isometric exercise)

Phase 2: Second and Third Weeks (Day 7 to Day 21)[17,18]

All recommendations from the previous phase

Removal of stitches or staples around the third week

Start and associate isometric exercises for abductor and adductor muscles

Phase 3: Third to Sixth Weeks (D 21 to Day 42)[17,18]

The recommendations and load restrictions on the operated member are maintained (depending on the associated procedures)

The knee immobilizer no longer needed

Use of articulated knee pad for protection

Force passive and active extension gain

Passive flexion up to 100° allowed as tolerated by the patient

Isometric exercises of quadriceps, abductors, and adductors

Phase 4: Sixth to Eighth Weeks (Day 42 to Day 60)[17,18]

Stimulate gait with progressive load

Proprioception training on a stable surface

Start active flexion gain and goal of total passive joint gain

Phase 5: Eighth to Twelfth Weeks (Day 60 to Day 90)[17,18]

Progression of gait with support until complete removal of the crutch

Focus on gaining full active joint range

Phase 6: Twelfth to Sixteenth Weeks (Day 90 to Day 120)[17,18]

Use of a stationary bicycle with an elevated seat, without resistance, started to gain joint mobility

Closed kinetic chain exercises maintained with an increase in knee joint amplitude to 0° to 90°

Start the leg exercises, bilaterally

Freestyle swimming, elliptical, and treadmill walking allowed to increase aerobic fitness

Note: Running is not allowed at this stage

Phase 7: Sixteenth Week to Sixth Month (Day 120 to Day 180)[17,18]

Activities included in phase 6

Start proprioception training with support and resistance in exercise bike training

Evolve in leg exercises (LL), from bilateral to unilateral

Start closed kinetic chain exercises with knee flexion at a restriction angle between 0° and 30°, always bilateral at the same time (leg press and squats)

Open and closed kinetic chain exercises are maintained by increasing the angular range of the knee to 0° to 90°

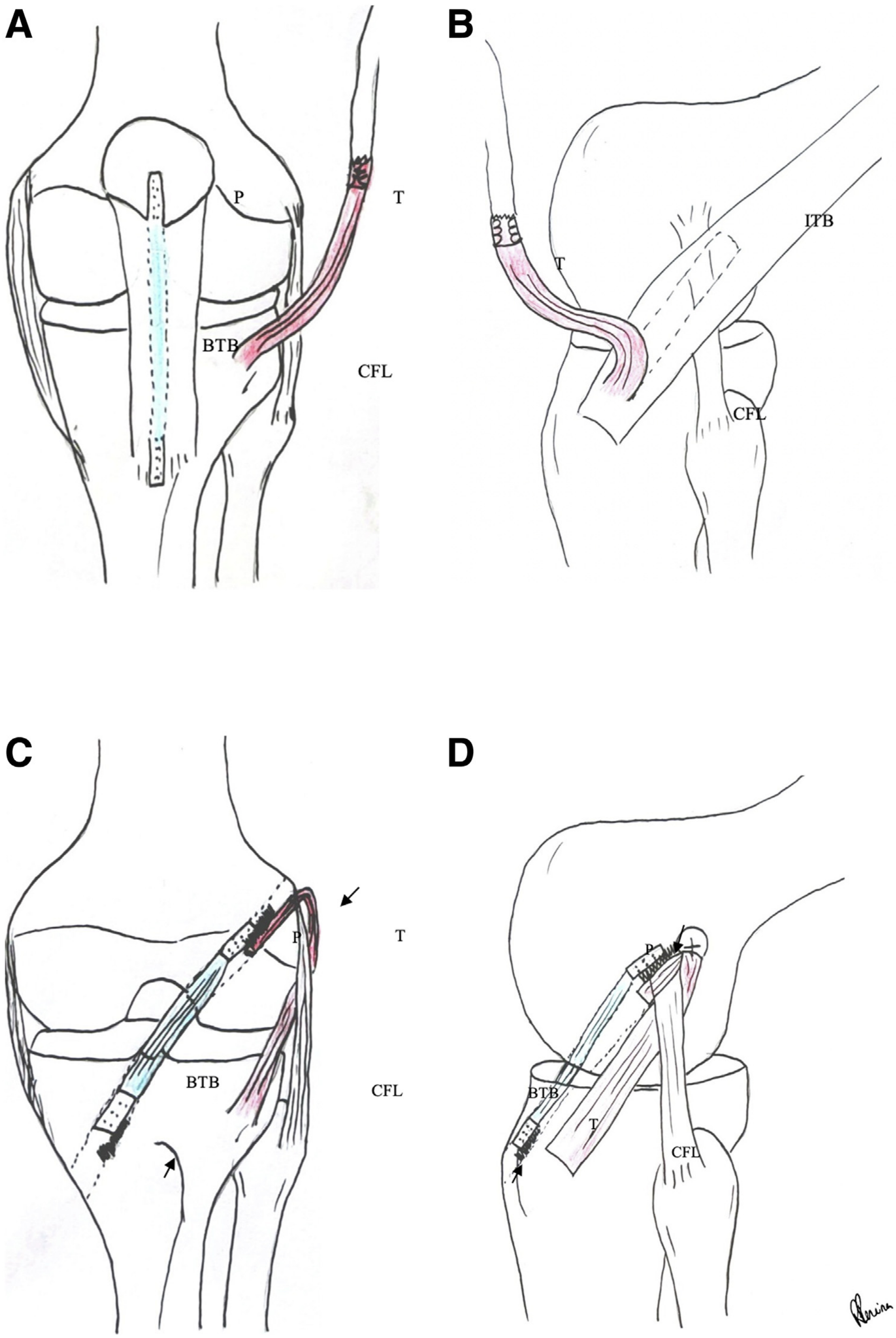

Fig 10. Schematic of the revision technique of anterior cruciate ligamentoplasty with bone-tendon-bone graft and Lemaire's extra-articular tenodesis with a single femoral tunnel. The tenodesis (T) measuring 9 mm × 8-10 cm obtained from the iliotibial band (ITB) is passed under the peroneal collateral ligament (CFL) and fixed in a single femoral tunnel (+) together with the bone plug (P) 9 × 20 mm of the graft. The bone-tendon-bone graft is fixed using an interference screw (arrow). In the tibial tunnel, the graft is also fixed with an interference screw (arrow).

Focus on quadriceps muscle strengthening and unilateral exercises, including hip abductors and external rotators

Freestyle swimming, elliptical, and walking on sand, grass, and treadmill allowed to increase fitness

Assessment of the quadriceps index with a dynamometer (manual or isokinetic), and, at this stage, the quadriceps strength of the operated limb must be above 80% of the unaffected limb

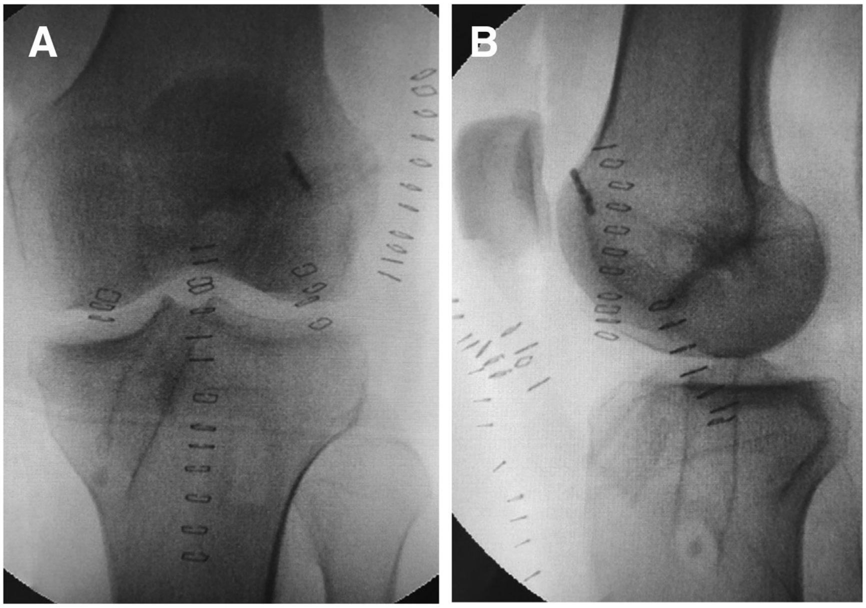

Fig 11. Immediate postoperative radiographs, anteroposterior (A) and lateral (B) of the revision technique of anterior cruciate ligamentoplasty with the bone-tendon-bone graft and Lemaire's extra-articular tendon with a single femoral tunnel.

Phase 8: After the Sixth Month (Day 120 to Day 180)[17,18]

Maintain muscle strengthening

Start running training, with alternating floors (sand, grass, treadmill, and track)

The quadriceps index evaluated with a dynamometer (manual or isokinetic), and, in this phase, the quadriceps strength of the operated limb must be above 90% of the unaffected limb

Assessment of return to the sports activity of choice

Discussion

The main advantage of this technique is the use of a single femoral tunnel for the passage of the ACL and

Table 1. Step-by-Step Revision ACL Technique

1. Patient is anesthetized and positioned with thigh support and an inflated pneumatic cuff tourniquet
2. Anterolateral and anteromedial arthroscopy portals for joint assessment, diagnostic confirmation, and repair of intra-articular meniscal and chondral injuries
3. Incision anterior to the knee and removal and preparation of the patellar tendon graft with plugs 9 × 20 mm from the patella and 10 × 20 mm from the tibia
4. A 6 cm lateral incision, visualization, and preparation of the tenodesis of the Ileo-tibial Band, 9 mm wide and 10 cm long
5. Passage of the prepared tenodesis under the lateral collateral ligament
6. Construction of a 10 mm femoral tunnel from the outside to the inside, with arthroscopic control and at the native points of the ALL footprint (3 mm proximal and posterior to the lateral epicondyle) and the intra-articular ACL, with a Smith & Nephew ACL pin-point guide.
7. Construction of a 10mm tibial tunnel, with arthroscopic control of the intra-articular ACL footprint, with a Smith & Nephew conventional ACL tibial guide.
8. Passage of the tenodesis through the femoral tunnel from the outside to the inside and traction through the Anteromedial portal.
9. Measurement of the femoral and tibial tunnels.
10. Ascent of the ACL graft through the tibial and femoral tunnels.
11. Femoral fixation with a bioabsorbable screw 8 mm in diameter, taking care to enter between the ACL bone plug and the ITB tenodesis and control the traction of the ACL grafts and tenodesis and with the knee angulated at 30° of flexion, rotation neutral and discreet posteriorization of the tibia to tension the tenodesis.
12. Tibial fixation of the ACL graft with a 9 mm diameter bioabsorbable screw, with full extension, neutral rotation, and posteriorization of the tibia.
13. Test the stability of grafts and reconstructions.
14. Review of hemostasis, suture of surgical wounds, occlusive dressing, and knee immobilizer as protection.

ACL, anterior cruciate ligament; ITB, iliotibial band.

Table 2. Advantages and Disadvantages

Advantages
Provides anatomic reconstruction of the ACL, associated with extra-articular reinforcement of Lemaire's lateral tenodesis.
It does not depend on tissue bank grafting.
Reproducible with other forms of autologous graft (quadriceps or hamstrings) for ACL revision when a bone-patellar tendon-bone graft was used in the primary surgery.
Total control of graft size in contrast to reconstruction techniques with undersized autologous grafts (ST and GL).
Bone-patellar tendon-bone graft for the ACL and ITB for tenodesis with recommended thicknesses (ACL grafts < 8 mm increase the chance of failure).
Outside-in fixation on the femur ensures screw support in cortical bone and no tunnel confluence (when inside-out fixation).
More stable tenodesis fixation (with screw) when compared to anchors or press-fit.
Technical ease in the face of the anatomy distorted by previous surgeries.
A single femoral tunnel guarantees the technique without risk of confluence between the ACL and Tenodesis tunnels.
No need to approach the previous ALL tibial fixation site (between Gerdy's tubercle and fibula head).
Disadvantages
Additional lateral access and soft tissue injury.
Fixation of two structures in the same tunnel, with tensions in opposite directions.
Patients may experience lateral discomfort due to the iliotibial tract incision for an average of up to 6 weeks.

ACL, anterior cruciate ligament; ALL, anterolateral ligament; GL, gracilis; ITB, iliotibial band; ST, semitendinosus.

Table 3. Pearls, Pitfalls, Risks, and Limitations.

Physical and imaging examination (MRI and stress radiographs) identify possible associated injuries and causes of reconstruction failures.
Computed tomography performed, preferably with 3D reconstruction, assesses the positioning of the previous tunnels, the possibility of confluence with the new femoral tunnel, and possible enlargements.
Obtain an absolute side view to find the correct femoral radiographic anatomical reference point, because small inaccuracies can lead to totally incorrect points.
Always measure the length of the tunnels.
Pass the tenodesis graft under the fibular collateral ligament.
Direct view for insertion of the screw guidewire to fix the structures in the femoral tunnel.
Fix the femoral screw with the knee at 30° of flexion, with neutral rotation and slight posteriorization of the tibia to tension the tenodesis.
Risks
The screw in the lateral cortex of the femur, when protruding, can irritate the iliotibial band.
If the femoral fixation fails, we lose both ligaments.
Limitations
Patients with associated injuries to the posterolateral corner or to the lateral collateral ligament are contraindicated for performing this technique, due to the high risk of tunnel confluence.
Not recommended on immature skeletons.

3D, 3-dimensional; MRI, magnetic resonance imaging.

ITB grafts, allowing a single fixation for both. In this way, we performed a lower-cost surgery, with a lower risk of lateral condyle fracture and tunnel confluence.

Recently, ITBT has been gaining more supporters and more importance, especially for its contribution to the anterolateral rotational stability of the knee.[20,21] In addition, its reconstruction, when combined with ACL, was able to significantly reduce the forces that pass through the graft of the knee—with ACL up to 80% and anterior tibial translation in the anterior drawer test up to 70% in controlled biomechanical studies.[6]

Helito et al.[22] recently performed a study comparing patients who underwent revision ACL reconstructions without extra-articular reconstruction versus with extra-articular reconstruction. The authors retrospectively analyzed these patients and found that patients with the extra-articular reconstructions have a lower rate of failure and also less laxity analyzed in KT-2000 and pivot-shift physical examination.[22] Another recent study showed that patients who underwent revision ACL reconstruction associated with ITBT presented good clinical results at short-term follow-up, with no complications observed.[23]

There is a clear trend toward the association of extra-articular techniques in ACL revision surgeries, regardless of the cause of failure. Despite being a constant reason for debate, the list of indications for performing extra-articular techniques has been growing and includes the following: patients under 20 years of age, high-performance athletes, ligamentous hyperlaxity, explosive pivot shift (grade 3), Segond fracture, extensive medial meniscectomy, chronic ACL injury (>12 months), high level of sports activity, sports activities with pivot movements, a radiographic sign of lateral femoral condyle notch (lateral femoral notch), increased tibial slope (>12°), and recurvatum greater than 10°.[8,24-26]

The fact that we use an outside-in technique for construction of the femoral tunnel, taking advantage of the lateral incision necessary for the preparation of the ITBT graft, allows greater control of the entire tunnel path because both the entry points and the exit points are free, unlike when using the transportal technique, where the exit point in the lateral cortex will depend on the angulation and the entry point in the medial cortex of the femoral condyle.[27] In addition, when introducing the interference screw through the lateral cortex, the graft is fixed in an area further away from the medial opening of this tunnel, where the bone may be more fragile or even enlarged because of the existence of the tunnel performed in the first surgery.

A tomographic study, preferably with 3-dimensional reconstruction, may be necessary for planning the revision surgery to identify the paths of the tunnels and possible enlargements.[26] Because we use the interference screw as a fixation technique in case there is a widening of tunnels or because this is foreseen because of the proximity of the previous tunnel in the femur,

Table 4. Contraindications

Performance of this technique when the real known causes of anterior cruciate ligament failure are not identified
Tunnel widening or prediction of confluence with a previous tunnel at the femoral level that makes reconstruction impossible in a time with interference fixation

where the location of the new tunnel is fixed and corresponds to the anatomical positioning of the ALL,[16,28] a 2-step review should be considered, as already established in the literature.[29] Regarding the tibial tunnel, if it is well positioned and there is no significant enlargement, the same route as the primary surgery can be used. Otherwise, you must choose to create a new path to enable a new interference fixation.[30]

The steps of the technique are summarized in Table 1. Then, the advantages and disadvantages are described in Table 2, and in Table 3, the pearls, pitfalls, and risks are reported. Finally, in Table 4, we summarize the contraindications of the technique.

ACL reconstruction revision surgeries are always challenging and even more so when associated with ALL reconstruction. There is no defined standard in the literature to be used in revision surgeries with the association of the ACL and ALL. With the popularization of several ALL reconstruction techniques, more ALL revision surgeries will be necessary, and alternatives for joint revision of the structures are always useful. We hope that the technique presented can bring ease and safety during surgery, as well as advantages and benefits in the management of the postoperative period.

References

1. Ellman M, Sherman S, Forsythe B, LaPrade R, Cole B Jr, JB. Return to play following anterior cruciate ligament reconstruction. *J Am Acad Orthop Surg* 2015;23:283-296.
2. Sonnery-Cottet B, Saithna A, Cavalier M, et al. Anterolateral ligament reconstruction is associated with significantly reduced ACL graft rupture rates at a minimum follow-up of 2 years. A prospective comparative study of 502 patients from the SANTI Study Group. *Am J Sports Med* 2017;45:1547-1557.
3. Group M, Wright R, Houston L, et al. Descriptive epidemiology of the Multicenter ACL Revision Study (MARS) Cohort. *Am J Sports Med* 2010;38:1979-1986.
4. DePhillipo N, Cinque M, Chahla J, Geeslin A, LaPrade R. Anterolateral ligament reconstruction techniques, biomechanics, and clinical outcomes: A systematic review. *Arthroscopy* 2017;33:1575-1583.
5. Delaloye J, Murar J, Gonzalez M, Amaral T, Kakatkar V, Sonnery-Cottet B. Clinical outcomes after combined anterior cruciate ligament and anterolateral ligament reconstruction. *Tech Orthop* 2018;33:225-231.
6. Marom N, Ouanezar H, Jahandar H, et al. Lateral extra-articular tenodesis reduces anterior cruciate ligament graft force and anterior tibial translation in response to applied pivoting and anterior drawer loads. *Am J Sports Med* 2020;48:3183-3193.
7. Ibrahim S, Shohdy E, Marwan Y, et al. Anatomic reconstruction of the anterior cruciate ligament of the knee with or without reconstruction of the anterolateral ligament. *Am J Sports Med* 2017;45:1558-1566.
8. Mathew M, Dhollander A, Getgood A. Anterolateral ligament reconstruction or extra-articular tenodesis: Why and when? *Clin Sports Med* 2018;37:75-86.
9. Chahla J, Menge TJ, Mitchell JJ, Dean CS, LaPrade RF. Anterolateral ligament reconstruction technique: An anatomic-based approach. *Arthrosc Tech* 2016;5(3):e453-e457.
10. Smith JO, Yasen SK, Lord B, Wilson AJ. Combined anterolateral ligament and anatomic anterior cruciate ligament reconstruction of the knee. *Knee Surg Sport Traumatol Arthrosc* 2015;23:3151-3156.
11. Helito CP, Bonadio MB, Gobbi RG, et al. Combined intra- and extra-articular reconstruction of the anterior cruciate ligament: The reconstruction of the knee anterolateral ligament. *Arthrosc Tech* 2015;4(3):e239-e244.
12. Sonnery-Cottet B, Thaunat M, Freychet B, Pupim BHB, Murphy CG, Claes S. Outcome of a combined anterior cruciate ligament and anterolateral ligament reconstruction technique with a minimum 2-year follow-up. *Am J Sports Med* 2015;43:1598-1605.
13. Alm L, Drenck TC, Frosch K-H, Akoto R. Lateral extra-articular tenodesis in patients with revision anterior cruciate ligament (ACL) reconstruction and high-grade anterior knee instability. *Knee* 2020;27:1451-1457.
14. Grassi A, Zicaro JP, Costa-Paz M, et al. Good mid-term outcomes and low rates of residual rotatory laxity, complications and failures after revision anterior cruciate ligament reconstruction (ACL) and lateral extra-articular tenodesis (LET). *Knee Surg Sport Traumatol Arthrosc* 2020;28:418-431.
15. Batailler C, Lustig S, Reynaud O, Neyret P, Servien E. Complications and revision surgeries in two extra-articular tenodesis techniques associated to anterior cruciate ligament reconstruction. A case-control study. *Orthop Traumatol Surg Res* 2018;104:197-201.
16. 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;47:2110-2115.
17. Lee JH, JinLim Y, BumKim K, Kim KH, Song JH. Arthroscopic pullout suture repair of posterior root tear of the medial meniscus: Radiographic and clinical results with a 2-year follow-up. *Arthroscopy* 2009;25:951-958.
18. Lee DW, Ha JK, Kim JG. Medial meniscus posterior root tear: A comprehensive review. *Knee Surg Relat Res* 2014;26:125-134.
19. Johannsen AM, Civitarese DM, Padaleck JR, Goldsmith MT, Wijdicks CA, LaPrade RF. Qualitative and quantitative anatomic analysis of the posterior root attachments of the medial and lateral menisci. *Am Orthop Soc Sport Med* 2012;40:2342-2347.
20. Kosy JD, Soni A, Venkatesh R, Mandalia VI. The anterolateral ligament of the knee: unwrapping the enigma.

Anatomical study and comparison to previous reports. *J Orthop Traumatol* 2016;17:303-308.
21. Pavão DM, Cruz RS, Faria JLR de, Sousa EB de, Barretto JM. Modified Lemaire lateral tenodesis associated with an intra-articular reconstruction technique with bone-tendon-bone graft using an adjustable fixation mechanism. *Arthrosc Tech* 2019;4(7):e733-e748.
22. Helito CP, Sobrado MF, Moreira da Silva AG, et al. The addition of either an anterolateral ligament reconstruction or an iliotibial band tenodesis is associated with a lower failure rate after revision anterior cruciate ligament reconstruction: A retrospective comparative trial. *Arthroscopy* 2023;39:308-319.
23. Pavão DM, Rocha de Faria JL, Albuquerque RP, Moreirão MC, Vivacqua TA, de Sousa EB. Modified Lemaire lateral tenodesis associated with revision anterior cruciate ligament reconstruction: A case series. *Braz J Case Rep* 2022;2:12-23.
24. Saithna A, Thaunat M, Delaloye JR, Ouanezar H, Fayard JM, Sonnery-Cottet B. Combined ACL and anterolateral ligament reconstruction. *JBJS Essent Surg Tech* 2018;10(8):e2.
25. Helito CP, Junior C do A, Camargo DB, Bonadio MB, Pecora JR, Demange MK. Extra-articular reconstruction associated with the anterior cruciate ligament in Brazil. *Acta Ortop Bras* 2019;27:202-206.
26. Vundelinckx B, Herman B, Getgood A, Litchfield R. Surgical indications and technique for anterior cruciate ligament reconstruction combined with lateral extra-articular tenodesis or anterolateral ligament reconstruction. *Clin Sports Med* 2017;36:135-153.
27. Sonnery-Cottet B, Ouanezar H, Vieira TD, et al. High risk of tunnel convergence in combined anterior cruciate ligament reconstruction and lateral extra-articular tenodesis: Letter to the editor. *Am J Sports Med* 2019;47(12):np67-np68.
28. Groves C, Chandramohan M, Chew C, Subedi N. Use of CT in the management of anterior cruciate ligament revision surgery. *Clin Radiol* 2013;68(10):e552-e559.
29. Erickson BJ, Cvetanovich G, Waliullah K, et al. Two-stage revision anterior cruciate ligament reconstruction. *Orthopedics* 2016;1(39):e456-e464.
30. Richter DL, Werner BC, Miller MD. Surgical pearls in revision anterior cruciate ligament surgery: When must I stage? *Clin Sports Med* 2017;36:173-187.