Technical Note

Combined Open-Anterolateral Ligament and Anterior Cruciate Ligament Reconstruction of the Knee: The "Open-ALL"

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Abstract: The addition of an extra-articular reinforcement, such as the anterolateral ligament (ALL) or a Lemaire's procedure, in anterior cruciate ligament reconstructions has shown good clinical results, with greater graft protection and a lower rerupture rate. Despite being a reproducible procedure, its application in cases of large, muscled knees or in obese patients can be challenging. This Technical Note describes the "Open-ALL" technique, using a mini-open approach for a combined anterior cruciate ligament and ALL reconstruction.

Combined reconstruction of the anterolateral ligament (ALL) and anterior cruciate ligament (ACL) of the knee has increasingly demonstrated its advantages, achieving a better clinical result with a lower failure rate than isolated ACL reconstruction.[1,2] Recent literature further reinforces this superiority in cases at higher risk for rerupture, such as revisions, small flexor grafts, and female patients.[3-5] Several techniques have been presented for extra-articular reconstruction of the knee, whether reconstructing the ALL or performing iliotibial band (ITB) tenodesis, such as Lemaire.[6,7]

Despite presenting equivalent clinical results, each one has its advantages.[8,9] Although ALL reconstruction restores the anatomic attachment points of the native ligament, in patients with a large, muscled knee or in obese patients, finding these points can be challenging. On the other hand, the modified Lemaire technique has limitations concerning anatomic points, but it has an easier surgical exposure, in addition to having superior stability when passing under the lateral collateral ligament (LCL).

The aim of this Technical Note is to present the "Open-ALL" reconstruction using a mini-open approach, being seen as a mix between the original ALL reconstruction and the modified Lemaire tenodesis.

Surgical Technique

The surgical technique is presented in Video 1.

Patient Setup

The patient is placed supine on the operating table in the standard arthroscopy position with a lateral post just proximal to the knee, at the level of the padded tourniquet, and a foot roll to prevent the hip from externally rotating and to maintain 90° of knee flexion. In this way, the knee can be moved freely through full range of motion. Appropriate landmarks are palpated and marked, including the joint line, Gerdy tubercle, head of the fibula, and lateral epicondyle (Fig 1).

Preparation for the Open-ALL Reconstruction

Three stab incisions are made in preparation for the Open-ALL reconstruction. The first longitudinal incision is made approximately 2 cm proximal to Gerdy's tubercle, extending 6 cm proximally in a curve passing over the lateral femoral epicondyle. The second incision is made at the posterior aspect of the Gerdy tubercle, perpendicular and 1 cm distal to the joint line. The third

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Fig 1. Right knee, lateral view. Skin landmarks. (GT, Gerdy's tubercule; LE, lateral epicondyle.)

Fig 3. Right knee, lateral view. Tibial incisions: ALL tibial guide (Arthrex) to pass the suture loop (*) through the tibial tunnel. (ALL, anterolateral ligament.)

incision is made 2 cm posterior to this, anterior to the head of the fibula (Fig 2).

Then, two 15-mm sockets are created in the tibial incisions using a 4.5-mm drill. These sockets are connected using an ALL tibial guide (Arthrex). A suture loop is then passed through the tunnel using a No. 2 suture (Mersilene; Ethicon), which is used to facilitate ALL graft passage later in the procedure (Fig 3).

Definition of the ALL Landmarks

Exposure is achieved with a Farabeuf retractor (Landanger), and then, using a No. 11 scalpel blade, an incision is made splitting the ITB at the level of the lateral femoral epicondyle. Then, by retracting the ITB, a fat pad can be easily identified just posterior to the epicondyle. To define the femoral attachment for the ALL, this fat pad should be carefully removed. This point is located 5 mm proximal and posterior to the lateral epicondyle, at the lateral collateral ligament insertion, just under genicular vessels (Fig 4). The landmark can be marked with an electric cautery. At this point, the LCL should be identified, visually or by palpation, and 2 small capsular incisions anterior and posterior to the proximal portion of the LCL are performed (Fig 5).

Graft Harvesting

The hamstrings tendons are harvested with an open-ended tendon stripper using the surgeon's preferred method. The free end of the gracilis tendon is whip-stitched using a No. 0 suture (Mersilene). The tibial insertion is preserved to improve fixation, and the tendons are then wrapped in vancomycin-soaked swabs to reduce the risk of septic arthritis.[10]

Fig 2. Right knee, lateral view. Skin incisions: 1. First proximal longitudinal incision. 2. Second incision. 3. Third incision.

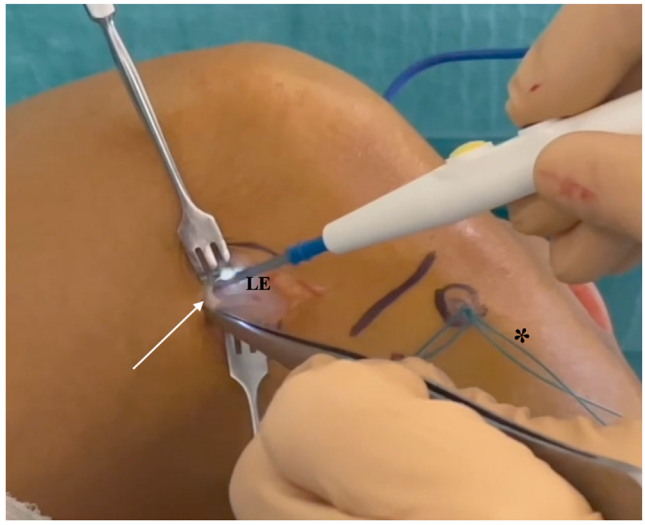

Fig 4. Right knee, lateral view. Fat pad removal. Fat pad (white arrow) removal 5 mm proximal and posterior to the LE. (LE, lateral epicondyle.)

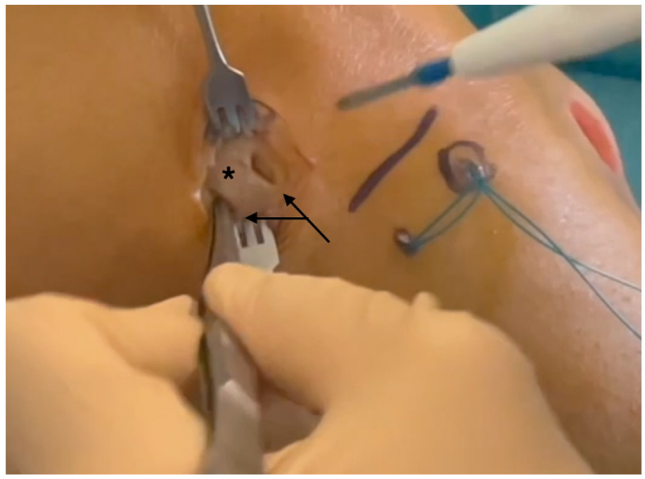

Fig 5. Right knee, lateral view. Lateral collateral ligament identification. Lateral collateral ligament (*), capsular incisions (black arrows).

Femoral Tunnel

The femoral ACL tunnel (Femoral ACL Hook for Outside-In Technique; Arthrex) is established with arthroscopic assistance by an outside-in approach. The drill guide is placed intra-articularly at the femoral origin of the ACL, between 10- and 11-o'clock on the right knee and between 1- and 2-o'clock on the left knee. The drill guide is then placed on the lateral femoral cortex at the femoral attachment for the ALL, which was previously marked with the cautery. A guidewire is placed in an outside-in manner, and subsequent drilling of the appropriate ACL size is performed.

Tibial Tunnel

The tibial ACL guide (Arthrex) is set at 65°, positioned over the ACL remnant, and a guidewire is inserted just above the hamstring insertion. A 6-mm reamer is initially used to allow any adjustments with the appropriately sized reamer based on graft size.

Preparation of the Graft

A No. 2 passing suture (Polysorb; Covidien) is delivered from the femoral tunnel through the tibial tunnel. The tunnel length is identified by measuring the distance from the hamstring insertion to the lateral cortex of the femur and marking it with a pen. The distance from the hamstring insertion to the tibial aperture is then measured using a depth gauge. The semitendinosus tendon is marked at these distances, allowing for 2 cm of the graft within the tibial tunnel. The gracilis is then detached from its tibial insertion and sutured to the semitendinosus at the markings with a No. 0 suture (Mersilene). A No. 2 suture (Mersilene) is then positioned at the distal mark, and the semitendinosus is folded back on itself and sutured with a further No. 0 suture. Finally, the semitendinosus is tripled, and several No. 0 sutures are used to tubularize the graft. As a result, this creates an ACL graft that is 3 parts semitendinosus and 1 part gracilis, with an additional continuation of the gracilis for the ALL graft[6] (Fig 6).

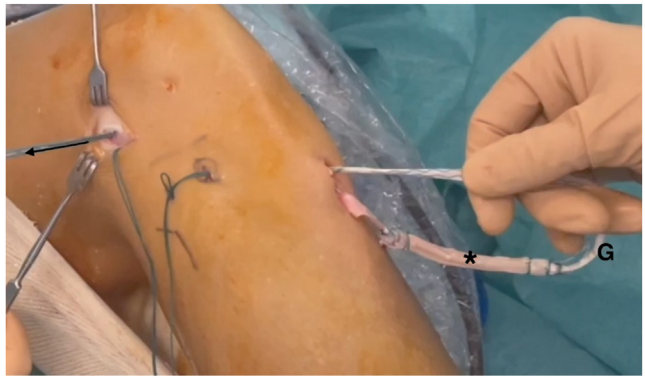

Fig 6. Right knee, anterolateral view. Graft prepared and passed through the tibial and femoral tunnels. Anterior cruciate ligament graft (*) composed of 3 parts of semitendinous and 1 part of gracilis, with an additional continuation of gracilis for the anterolateral ligament graft. The graft is pulled (black arrow) to pass through the tibial and femoral tunnels (black arrow). (G, gracilis.)

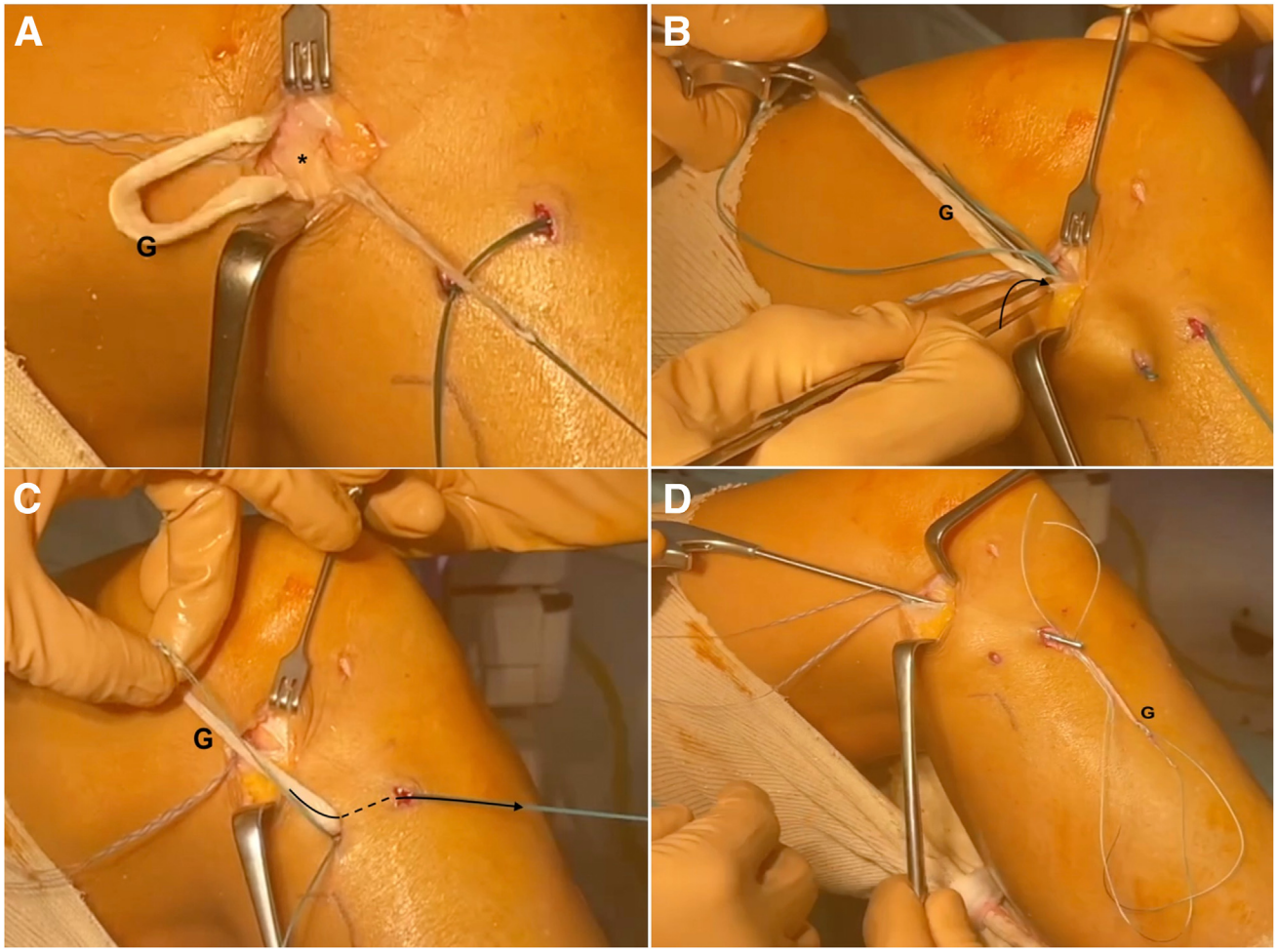

Fig 7. Right knee, lateral view. Anterolateral ligament passage and fixation. The anterolateral ligament graft is passed underneath the lateral collateral ligament (*) (A) and then shuttled to the posterior tibial tunnel deep to the iliotibial band (black arrow) (B). The graft is shuttled to the anterior tibial tunnel (C) and finally brought back out the proximal incision (D). (G, graft.)

Fig 8. Right knee, lateral view. Graft suture. Leg in full extension and neutral position.

Table 1. Pearls and Pitfalls

	Pearls	Pitfalls
Bony landmarks	After careful dissection of the fat pad, identification of the genicular veins and LCL assists in choosing the correct femoral point.	Incorrect placement of the ALL femoral attachment on the femur may compromise its biomechanical characteristics.
Passage of the ALL beneath the LCL	Although the LCL is usually easily palpable, applying a force in the varus or placing the knee in figure-of-4 position can help.	Placing Metzenbaum scissors deep to the LCL from anterior to posterior to bluntly dissect out a tract and using a right-angled clamp prevent the passage of the graft from being hampered by the soft tissues.
	Suturing the graft to the LCL helps increase stability.	
ALL fixation in full extension	Fixing the ALL with the knee in full extension ensures neutral rotation and ligament anisometry.	Despite having similarities with Lemaire's technique, ALL anisometry must be sought.

ALL, anterolateral ligament; LCL, lateral collateral ligament.

ACL Passage and Fixation

The graft is shuttled from the tibial tunnel through the femoral tunnel using the passing suture. A guidewire is inserted into the tibial tunnel; then, with tension applied to the graft where it exits the femoral tunnel, an interference screw (FastThread Bio-Composite Interference Screw; Arthrex) is inserted into the tibial tunnel. A guidewire is inserted into the femoral tunnel and an interference screw is inserted with the knee at 30° of flexion while tension is applied to the graft.

ALL Passage and Fixation

After fixation of the ACL, the suture connected to the gracilis, which is exiting through femoral attachment for the ALL, is grasped, passed underneath the LCL, and shuttled to the posterior tibial tunnel deep to the ITB. This is subsequently shuttled through the anterior tibial bone tunnel using the previously passed suture, brought back proximally once again out the proximal incision (Fig 7).

The bundle that passes underneath the LCL is sutured to it using a No. 0 suture (Mersilene). Proximally, the sutures holding the ACL graft are then circled around the ALL graft and tied once again in full extension and neutral rotation (Fig 8). Excess graft is incised, and ITB and skin closure are performed as usual.

Table 2. Advantages and Disadvantages

Advantages
Precise identification of the ALL femoral attachment
Good exposure in large knees and obese patients
Improved stability passing the ALL beneath the LCL
Direct visualization prevents a protruding screw in the femur
Single femoral tunnel for ACL and ALL
Disadvantages
Mini-open incision required

ALL, anterolateral ligament; LCL, lateral collateral ligament.

Postoperative Protocol

Immediate full weightbearing without a brace and progressive range-of-motion exercises are allowed. Subsequent progression is milestone based.

Discussion

The Open-ALL offers several advantages, such as a single tunnel for the ACL and ALL, and better exposure, which provides more precise identification of the structures, especially the femoral origin of the ALL. Additionally, direct visualization avoids a protruding screw in the femur. This may not be a problem when treating eutrophic patients, but those with large knees, such as obese patients, may have their ACL-ALL surgical procedure carried out easier.

In our opinion, the most important pitfall is the graft passage beneath the LCL, just like in Lemaire's technique. This step provides greater stability than traditional ALL reconstruction. Passing one of the bundles beneath the LCL causes the graft to act as a sling, generating dynamic stability in the same way as the subscapularis tendon in the Latarjet-Patte procedure in a shoulder stabilization. Therefore, we believe that this is a better technique for cases with greater instability, such as an explosive pivot shift, hypermobility, and in ACL revisions.

However, despite important advantages, a mini-open approach is necessary. Pearls and pitfalls of this procedure are described in Table 1. Advantages and disadvantages of the technique are summarized in Table 2.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: B.S-C. is a consultant or advisor for Arthrex. All other authors (F.G.A., J.C., M.B.U., S.C., A.B., L.K., T.D.V.) declare that they have no known competing financial interests or personal

relationships that could have appeared to influence the work reported in this paper.

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