



Minimally Invasive Ultrasound-Guided Anterolateral Ligament Reconstruction With Autologous 2-Strand Gracilis Graft

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Abstract: We describe an ultrasound-guided anterolateral ligament (ALL) reconstruction technique that uses the gracilis tendon and can be added to any anterior cruciate ligament reconstruction technique. Preoperative ultrasound imaging is used to view the ruptured ALL and confirm the location of bony landmarks. Two minimally invasive incisions are made: one posterior to the lateral epicondyle and one posterior to the Gerdy tubercle. After anterior cruciate ligament graft fixation, the 2-strand gracilis tendon is introduced from the tibial incision, under the fascia lata, toward the femoral incision. The ALL graft is secured to the femur with a 5.5-mm anchor, positioned posteriorly and proximally to the lateral epicondyle. The distal end of the graft is tightened in full extension and fixed to the tibia with a ligament staple posterior to the Gerdy tubercle. This ALL technique requires no graft preparation.

Anterolateral ligament (ALL) reconstruction is not yet a standard procedure.¹ An increasing number of studies are reporting improved clinical results when ALL reconstruction is added to anterior cruciate ligament (ACL) reconstruction.²⁻⁴ With the recent expert consensus obtained about the ALL,⁵ the number of ALL reconstructions is bound to increase in years to come.

Several techniques have been described for anatomic reconstruction of the ALL.⁶ Most require additional tunnels. Drilling several adjacent tunnels for ACL and ALL reconstruction can be a challenging procedure with a high risk of convergence.⁷

Graft positioning is crucial.^{8,9} Ultrasonography (US) can be used as a guide for locating the bony landmarks and positioning the graft. US is a dynamic, low-cost, non-irradiating, widely available examination method.¹⁰ The accuracy of US has already been shown for the diagnosis of ALL deficiency, thanks to high-performance spatial resolution and the possibility of dynamic testing.^{11,12}

The technique described in this article is our first-line technique for lateral extra-articular tenodesis. It is an anatomic ALL reconstruction method that uses the gracilis tendon folded in 2 strands, without additional tunnels, after US is used to locate the bony landmarks.

Surgical Technique

Surgical Setup and Preoperative Examination

The patient is placed supine on the operating table in the standard arthroscopy position, with a lateral post proximal to the knee at the level of the tourniquet, as well as 2 foot rolls at 90° and 120° of flexion. Bony landmarks are drawn after anesthesia and setup and before draping (Fig 1). The Gerdy tubercle, the head of the fibula, and the lateral epicondyle are first located by palpation. A US machine with a 12-MHz superficial probe (Sonosite; GE Healthcare, Milwaukee, WI) is then used to confirm the position of the bony landmarks and explore the ALL.^{11,12} This US analysis allows for short percutaneous incisions to be made exactly at the desired location.

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Fig 1. Preoperative marking of bony landmarks for anterolateral ligament reconstruction, that is, lateral epicondyle (LE), Gerdy tubercle (GT), and fibular head (F), as well as marking of minimally invasive femoral incision (white arrow) and tibial incision (black arrow).

Graft Harvesting and Preparation

A standard vertical 2-cm incision is made medially to the anterior tibial tuberosity. The semitendinosus and gracilis tendons are harvested with an open tendon stripper and are then cleaned and cut close to their tibial insertion. Hyperflexion provides better access to the most proximal vincula.¹³ The semitendinosus tendon, used as the ACL graft, is prepared in 4 strands on a TightRope device (Arthrex, Naples, FL) with a Fiber-Wire suture (No. 2; Arthrex) at the distal end.¹⁴ The gracilis tendon is not prepared. Both tendons are soaked in vancomycin solution before implantation.¹⁵

ACL Reconstruction

ACL reconstruction is performed first, with the 4-strand semitendinosus graft. The tibial tunnel is drilled completely from the hamstring incision with an outside-in guide. An inside-out guide is used to drill a 10-mm-long femoral tunnel.¹⁴ The graft is passed from

distal to proximal, the TightRope fixation system (Arthrex) is secured on the femoral cortex, and the graft is tightened with a BioComposite interference screw (Arthrex) on the tibial side in 30° of flexion.

ALL Reconstruction

The ALL reconstruction technique is detailed in Table 1 and illustrated in Figures 2 and 3. Video 1 describes the technique. Tips and tricks for the technique are reported in Table 2. After fixation of the ACL graft, 2 incisions are made: 1 just posterior and proximal to the lateral epicondyle and another midway between the Gerdy tubercle and the fibular head. The fascia lata is incised starting at the proximal incision. A 5.5-mm suture anchor with 2 No. 2 Hi-Fi sutures (CrossFT; ConMed, Utica, NY) is screwed to the femoral cortex. A Kelly clamp is introduced through the proximal incision, under the fascia lata and above the lateral collateral ligament, toward the distal incision. The gracilis tendon is folded in 2 strands and pulled with the clamp from distal to proximal, with the 2 free ends hanging distally. The proximal end of the graft is sutured on the femoral anchor by passing a strand of each suture in the fold. With the knee in full extension, the distal part of the graft is tightened and secured with a 6 × 20-mm Spiked Ligament Staple (Arthrex), which is impacted posterior to the Gerdy tubercle. The free end of the graft is cut flush with the ligament staple.

Postoperative Rehabilitation

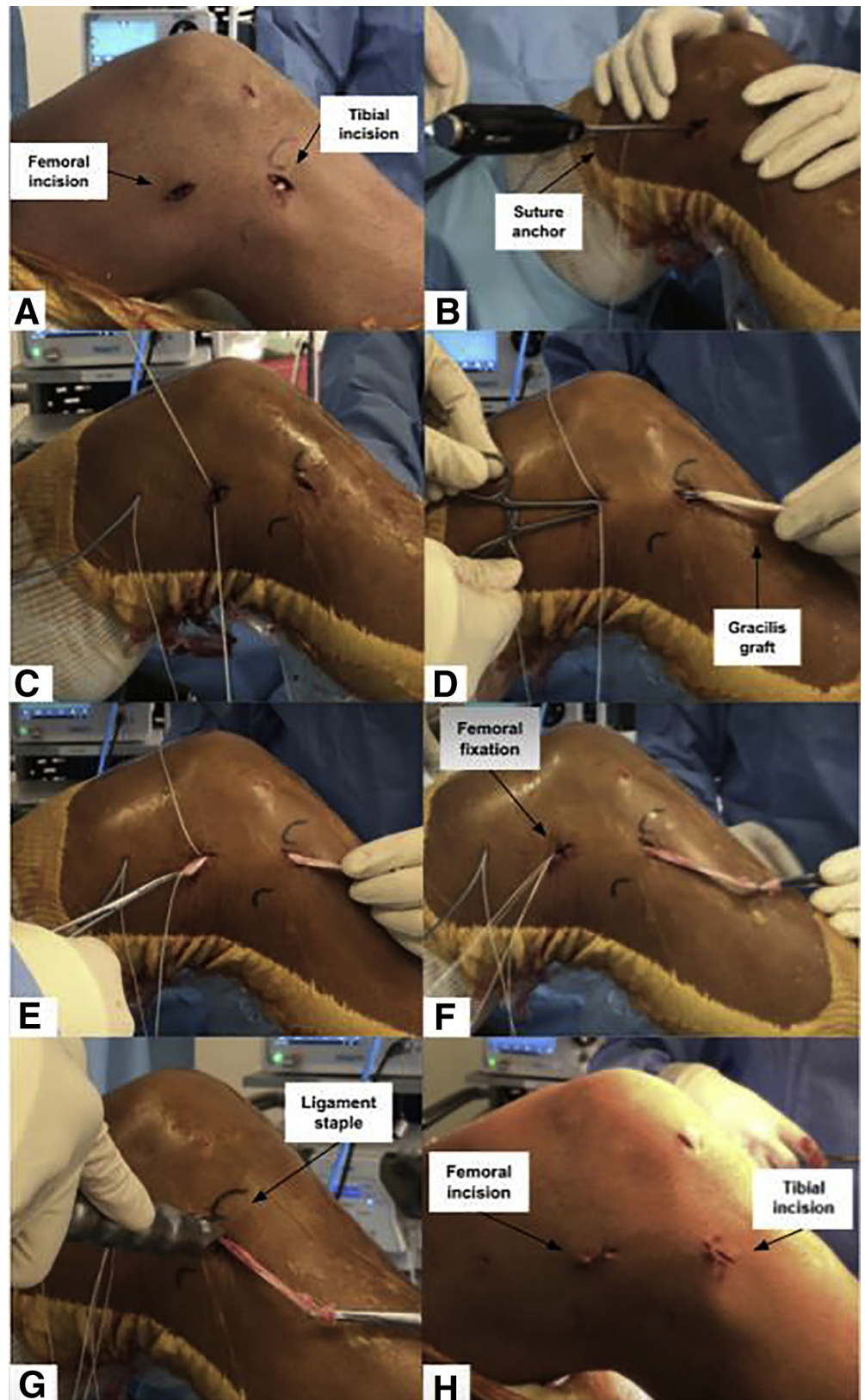
The knee is not immobilized with a brace, except in the case of radial or complete meniscal root tears. All patients are operated on an outpatient basis. The routine ACL rehabilitation program is started on the first postoperative day, entailing full weight bearing and progressive exercises to regain range of motion and quadriceps function. A gradual return to sports is generally allowed starting at 4 months for nonpivoting sports, at 6 months for noncontact pivoting sports, and at 8 to 9 months for contact pivoting sports, after isokinetic tests and functional evaluation.

Table 1. Step-by-Step Description of ALL Reconstruction Technique

	Description
Step 1	After the landmarks are located by ultrasonography, 2-cm incisions are made, comprising a femoral incision posterior to the lateral epicondyle and a tibial incision posterior to the Gerdy tubercle.
Step 2	A 5.5-mm BioComposite CrossFT (ConMed) is screwed to the femoral cortex, posterior and proximal to the lateral epicondyle.
Step 3	Strands of both Hi-Fi sutures are separated.
Step 4	A Kelly clamp is inserted from proximal to distal, under the fascia lata and above the lateral collateral ligament.
Step 5	The gracilis tendon is folded in 2 strands of equal length and placed in the Kelly clamp.
Step 6	The graft is pulled toward the femoral incision.
Step 7	The graft is secured to the anchor on its femoral insertion with both Hi-Fi sutures.
Step 8	A 6 × 20-mm Spiked Ligament Staple is impacted over the distal end of the graft, posterior to the Gerdy tubercle, which is tightened in full extension.
Step 9	Closure of the minimally invasive incisions is performed with absorbable sutures.

ALL, anterolateral ligament.

Fig 2. Step-by-step intra-operative images of antero-lateral ligament reconstruction technique. The patient is lying supine under general or regional anesthesia. The lateral side of a right knee is represented as seen by the operator. (A) Minimally invasive femoral and tibial incisions after landmarks are located by ultrasonography. (B) Suture anchor placed at femoral insertion site, proximally and posteriorly to lateral epicondyle. (C) Separation of each suture into 2 strands. (D) Placement of folded 2-strand gracilis graft in Kelly clamp passed proximally to distally under fascia lata. (E) Gracilis graft pulled from tibial to femoral incision. (F) Femoral attachment of graft to suture anchor by passing 2 strands in fold, pulling graft distally, and tying sutures one by one. (G) Impaction of ligament staple over graft at tibial insertion site, lateral to Gerdy tubercle and perpendicular to tibial axis. (H) Minimally invasive incisions of antero-lateral ligament reconstruction after skin closure.



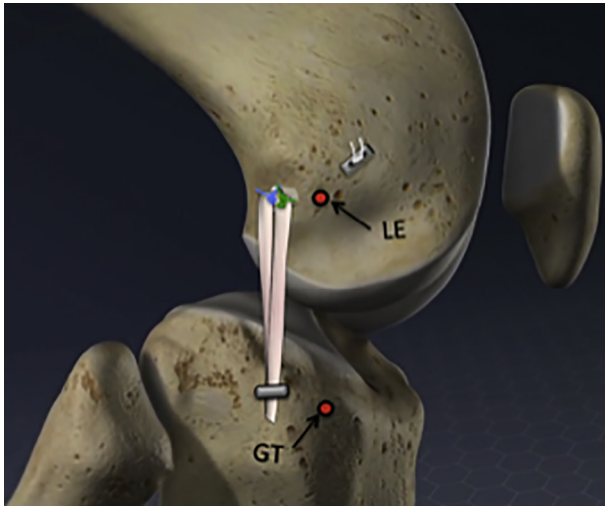


Fig 3. Anterolateral ligament reconstruction technique in a model of a right knee. The folded end of the 2-strand gracilis graft is attached proximally by 2 sutures on a suture anchor placed at the femoral insertion site, located just proximal and posterior to the lateral epicondyle (LE). The free strands of the graft are secured with a ligament staple to the tibial insertion site, located just posterior to the Gerdy tubercle (GT).

Discussion

We believe there are 2 types of indications for ALL reconstruction: preventive and curative (Table 3). It has been shown that adding lateral tenodesis to ACL reconstruction reduces the risk of ACL retear without increasing the complication rate.¹⁶ Thus, it appears this additional procedure is beneficial in populations with a high retear risk, regardless of the ALL status. Although this at-risk population has not yet been precisely defined, some candidates are high-level athletes, young adults, and individuals who participate in pivot or contact sports.¹⁰ We also believe there are curative indications related to damaged structures, that is, ALL reconstruction when this structure is visibly damaged.¹² On the basis of these indications, we perform ALL reconstruction in more than 80% of our primary ACL patients.

Our graft choice for ALL reconstruction is an autologous 2-strand gracilis tendon. This type of graft has biomechanical properties compatible with ALL reconstruction.¹⁷ We choose not to use the fascia lata to preserve its role in the control of rotational stability.^{18,19} Weakening it seems counterproductive to us. This technique does not require preoperative planning or preparation of the gracilis tendon. The tendon length is always sufficient for bipolar fixation; the distal tendon surplus is used to tighten the graft before it is cut flush with the ligament staple.

The preoperative US examination allows us to anchor the ALL graft very precisely on its femoral insertion, posteriorly and proximally to the lateral epicondyle.^{8,9} This is the non-isometric position that was shown to be the most favorable for graft behavior.

Being independent from the ACL graft and tunnels, this technique allows a surgeon to decide to perform an ALL reconstruction intraoperatively, even after the tunnels have been drilled. It can be added to any ACL technique that does not use the gracilis tendon, even with an inside-out femoral tunnel. For example, if a ramp lesion is discovered and repaired, it is possible to decide secondarily to perform an ALL reconstruction to protect the suture repair and the meniscus.²

This technique also minimally impacts the bone stock. No additional tunnels are drilled for the ALL reconstruction, contrary to other previously described techniques. It has been shown that convergence of both the ACL and ALL femoral tunnels can occur in 67% of cases.⁷ Tunnel convergence can become a major issue if the lack of a strong femoral attachment causes the reconstructed ACL to be inefficient. The femoral tunnel that we use for ACL reconstruction is a 10-mm-long blind tunnel, which has been shown to be sufficient for hamstring graft integration.¹⁴

We have performed over 200 ALL reconstructions with the described technique. We have not yet had to remove an ALL graft or 1 of the implants (anchor or staple) used for graft fixation. Zaffagnini et al.²⁰ recently published a 20-year follow-up study of ACL reconstruction combined with an extra-articular lateral

Table 2. Tips and Tricks

	Tips and Tricks
Hamstring tendon harvest	Hyperflexion during harvesting helps to view and cut the vincula, preventing tendon amputation and short graft.
Femoral ALL graft positioning	Immediate preoperative ultrasound examination helps to precisely locate the lateral epicondyle.
Graft passage under fascia lata in 1 step	The Kelly clamp must be fully inserted with the full clamp length outside the distal incision to secure at least 5 mm of the graft's folded end before pulling toward the proximal incision.
Tibial ALL graft fixation	The ligament staple is positioned at 90° of flexion, for a better view of the insertion site, before the knee is placed in full extension for impaction.

ALL, anterolateral ligament.

Table 3. Advantages, Disadvantages and Indications of Technique

Advantages
ALL graft technique independent from ACL graft technique
Precise location of insertion sites with ultrasonography
Use of gracilis tendon: tendon-sparing technique
No additional tunnels: no risk of tunnel convergence
Minimal scarring
Disadvantages
Cannot be combined with ACL graft technique in which both hamstring tendons are used
Additional implant cost
Indications
Curative indications: ALL deficiency detected on preoperative ultrasound
Preventive indications: high-level athlete and/or pivoting sports, chronic or repeated ACL rupture, and so on

ACL, anterior cruciate ligament; ALL, anterolateral ligament.

tenodesis using ligament staples for lateral fixation. No adverse effects were reported with the use of staples for fixation on the anterolateral side of the tibia.

This US-guided ALL reconstruction technique with an autologous gracilis tendon graft is simple and can be added to any ACL reconstruction technique that does not use the gracilis tendon. Ongoing comparative studies with sufficient power and follow-up will provide an evaluation of the efficacy and morbidity of this technique.

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