Technical Note

Arthroscopic Anatomic Lateral Ankle Reconstruction Using Allograft: A Simplified Approach

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Abstract: Ankle instability is a common medical condition that frequently necessitates surgical intervention to achieve ankle joint stability and enhance functional outcomes after failure of conservative treatment. Many surgical techniques have been described in the literature to restore joint stability, including repair or reconstruction of the anterior talofibular ligament and the calcaneofibular ligament. In this article, we describe a simplified arthroscopic technique for anatomic lateral ankle ligament reconstruction using an extensor hallucis longus allograft and involving percutaneous creation of the calcaneal tunnel after identification of the calcaneofibular ligament distal footprint insertion relative to the lateral malleolus.

Ankle sprains, particularly involving the anterior talofibular ligament (ATFL) and the calcaneofibular ligament (CFL), are quite common. For most individuals who sustain these injuries, conservative treatment is effective in promoting recovery; however, up to 30% of patients do not respond to this treatment, ultimately leading to the development of chronic ankle instability (CAI), subsequently increasing the negative impact on patient quality of life and physical function, as well as the economic burden.[1,2]

Over time, the Broström-Gould procedure, representing surgical repair of the injured ATFL and CFL associated with extensor retinaculum augmentation, has been considered the gold-standard procedure.[3,4] Nevertheless, it is crucial to recognize that there are myriad therapeutic options for CAI. Anatomic lateral ankle ligament reconstruction (ALALR) is steadily gaining popularity in cases in which severe ligament injury makes anatomic repair unfeasible,[5,6] reducing the long-term risk of tibiotalar and subtalar joint osteoarthritis—a risk that is typically observed with nonanatomic ankle ligament reconstruction.[7]

Despite positive outcomes achieved with open surgical approaches, there is growing interest in the use of arthroscopy to perform ankle stabilization procedures.[8] The primary objective of arthroscopy includes not only enhancing the diagnosis and management of concomitant intra-articular lesions but also ensuring precise graft placement into the footprint of the ATFL and CFL.[9]

The CFL plays a vital role in maintaining lateral ankle stability mainly in the neutral position and during ankle dorsiflexion,[10] and precise positioning of its anatomic distal insertion is crucial to restore ankle joint kinematics and to obtain satisfactory functional results. Although gracilis tendon autograft is commonly used for ALALR,[11] fresh-frozen and nonirradiated allograft, such as that used for anterior cruciate ligament reconstruction,[12] can be considered an alternative option for ALALR mainly to obtain optimal functional outcomes and mechanical strength.[13,14] Fresh-frozen allograft is indicated in revision cases, patients with hyperlaxity, or patients who have undergone another procedure using gracilis autograft.

In this article, we describe a simplified arthroscopic technique for ALALR using an extensor hallucis longus allograft and involving percutaneous creation of the calcaneal tunnel after identification of the CFL distal footprint insertion relative to the lateral malleolus (Video 1). Pearls and pitfalls are presented in Table 1. Advantages and disadvantages are listed in Table 2.

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Table 1. Surgical Steps, Pearls, and Pitfalls

Surgical Steps	Pearls	Pitfalls
Calcaneal portal and calcaneal tunnel creation	Skin landmarks should be drawn to obtain accurate positioning of the skin incision relative to the lateral malleolus. The guidewire should be directed posteriorly and inferiorly toward the medial calcaneal cortex before tunnel creation.	Careful dissection of the subcutaneous tissues using the nick-and-spread technique should be performed to avoid sural nerve injury. The drilling direction of the calcaneal tunnel should be posterior and inferior to avoid subtalar joint penetration.
Retromalleolar portal creation	The skin incision should be made posterior to the fibula and 3 cm proximal to the lateral malleolus tip.	Careful dissection is required to avoid injury to the fibular tendons.
Talar tunnel creation	The ATFL remnants are used as a landmark for talar tunnel footprint identification. The guidewire should be directed posteriorly and upward toward the medial malleolus tip.	Identification of the subtalar joint is crucial for creation of the talar tunnel as low as possible to reconstruct the lowest and most important fibers of the lateral talo-fibulo-calcaneal ligament. Sinus tarsi penetration should be avoided when drilling the talar tunnel.
Subtalar portal and fibular tunnel creation	The subtalar portal should be identified using an 18-gauge needle under direct AL portal arthroscopic visualization. Through the subtalar portal, the guidewire is inserted in the fibula, starting from the lateral malleolus tip and directed toward the retromalleolar portal.	The fibular tendons should be protected when drilling the fibular tunnel. The surgeon should slide the mosquito clamp on the lateral talar and calcaneal wall to avoid sural nerve injury when retrieving the No. 3 loop suture.
Talar tunnel transplant fixation	Fixation of the transplant in the talar tunnel should be performed with a Bio-Tenodesis Screw.	The surgeon should avoid screw penetration into the sinus tarsi by precisely verifying the position of the talar tunnel using a shaver just before inserting the screw.
Fibular tunnel filling with transplant	The surgeon should perform suspensory fixation device retrieval from the fibular tunnel using the No. 2 loop suture and progressively pulling the graft to fill the fibular tunnel.	Direct visualization of the suspensory fixation device positioning on the posterior fibular cortex should be performed through the retromalleolar approach to avoid malpositioning in the soft tissue.
Passage and fixation of transplant to calcaneus and adjustment of final tension	The loop suture number 3 is used to retrieve the extremity of the graft from the calcaneal portal. The No. 1 loop suture is used to pass the graft in the calcaneal tunnel, exiting from the medial side.	Arthroscopic visualization of the graft before final tensioning and fixation should be performed to ensure anatomic position without soft-tissue interposition between the CFL and the fibula. Tensioning and fixation of the transplant in the calcaneal tunnel should be performed in a position of slight ankle valgus and dorsiflexion to avoid residual varus laxity.

AL, anterolateral; ATFL, anterior talofibular ligament; CFL, calcaneofibular ligament.

Surgical Technique

Patient Setup

Under general anesthesia, the patient is placed in the supine position and a tourniquet is applied on the operative thigh. To improve access to the lateral malleolus, a sandbag is placed under the buttock on the same side, which helps in rotating the foot inward. Ankle instability is confirmed preoperatively by performing the anterior drawer test and the talar tilt test (Video 1).

Transplant Preparation

An extensor hallucis longus allograft is soaked in rifampicin antibiotics for 20 minutes before use as a precautionary measure to minimize the risk of infection (Fig 1). The graft is subsequently prepared by passing a No. 2-0 FiberLoop (Arthrex, Naples, FL) with a straight needle through both ends of the graft. To secure it to the talus, a Bio-Tenodesis Screw System (4.75 mm × 15 mm; Arthrex) is placed at 1 end of the graft (Fig 2). The recommended graft length is usually between 10 and 15 cm (Fig 2).

Calcaneal Portal, Calcaneal Tunnel, and Retromalleolar Portal Creation

The creation of the calcaneal tunnel is achieved percutaneously, guided by a method developed from a preliminary cadaveric study.[15] This study revealed a clear anatomic relation between the lateral malleolus and the distal attachment point of the CFL.

Table 2. Advantages and Disadvantages

Advantages	
	Patient setup with supine position: no need to change position during surgery
	Percutaneous calcaneal tunnel creation
	CFL remnant preservation: better proprioception preservation and graft healing
	Anatomic lateral ankle ligament reconstruction: restoration of ankle joint biomechanics
	Use of allograft instead of autograft: avoidance of comorbidities of autograft harvesting, allowing better and faster patient rehabilitation
	Easy graft preparation and better tension control
Disadvantages	
	Risk of sural nerve injury when creating calcaneal portal
	Risk of subtalar joint penetration when drilling talar tunnel
	Risk of fibular tendon injury when drilling fibular tunnel

CFL, calcaneofibular ligament.

For precise tunnel location, a vertical line is drawn along the posterior border of the fibular shaft. Another line is drawn perpendicular to the first line and passing through the tip of the lateral malleolus. The calcaneal portal is located 1 cm distal and posterior to the intersection of these 2 lines (Fig 3). A small skin incision is created at the marked calcaneal portal, and meticulous subcutaneous dissection is carried out using a Kelley instrument until reaching the bone to avoid iatrogenic injury to nervous structures. Subsequently, a guidewire is inserted into the calcaneum directed to the posterior and inferior medial edge of the calcaneal tuberosity[16] (Fig 4); then, it is over-drilled using a 6-mm cannulated drill bit. A No. 1 loop suture is positioned in the canal.

A retromalleolar portal, measuring around 1 cm in length, is created 3 cm proximal to the tip of the lateral malleolus and just behind the posterior fibular cortex (Fig 3). This portal provides protection for the fibular tendons during the drilling of the fibular tunnel and ensures precise positioning of the cortical suspensory fixation device.

Anteromedial and Anterolateral Portal Creation and Joint Exploration

A standard ankle anteromedial portal is created medial to the anterior tibialis tendon (Fig 5). Subsequently, under arthroscopic guidance, an 18-gauge needle is introduced to ensure the accurate position of the anterolateral (AL) portal, which should be placed 1 cm distal to the joint line, enabling direct visualization of the lateral talar groove (Fig 5). A systemic exploration of the joint line is conducted to identify additional intra-articular cartilage or ligamentous lesions (Video 1).

Talar Tunnel Creation

The remnants of the ATFL are typically used as a landmark to identify its distal talar insertion. However, if they are absent, the "bare area" of the talus, which is consistently found between the lateral articular surface of the talus and the talar neck just below the anterior cartilaginous part of the talar dome, can serve as a landmark for ATFL distal insertion (Fig 6).

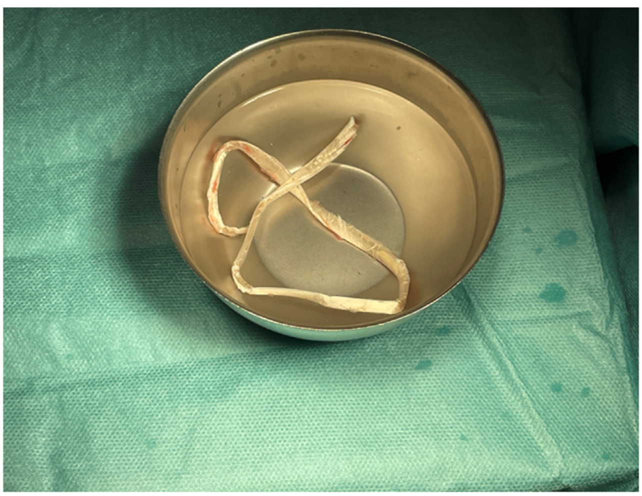

Fig 1. Intraoperative photograph showing extensor hallucis longus allograft soaked in rifampicin antibiotics.

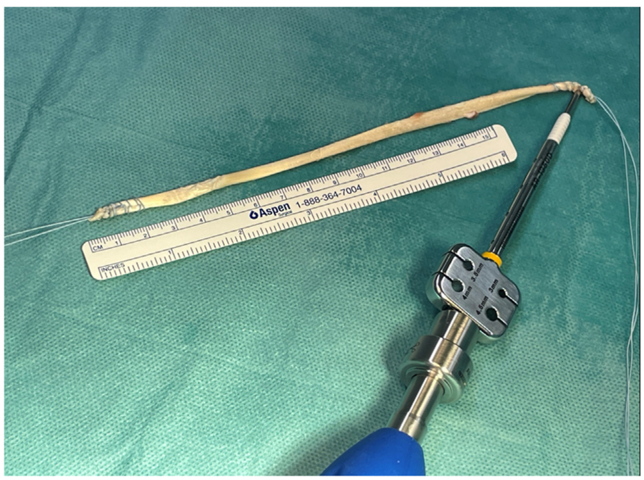

Fig 2. Intraoperative photograph showing both ends of allograft prepared using No. 2-0 FiberLoop. A Bio-Tenodesis Screw is placed at 1 end of the graft. The recommended graft length is typically between 10 and 15 cm.

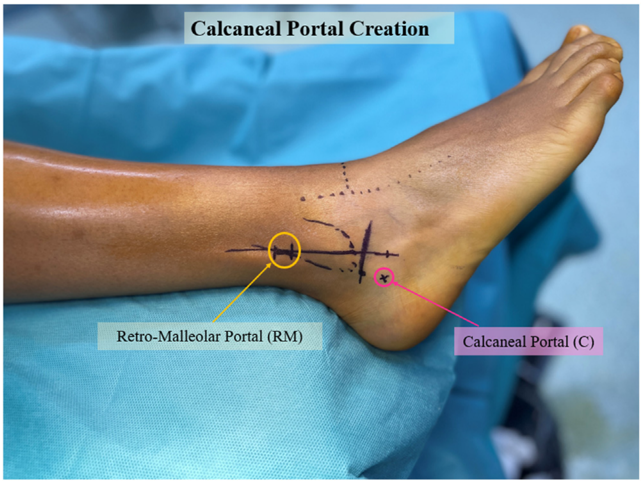

Fig 3. Intraoperative photograph of right ankle showing preoperative drawing of calcaneal portal (C) and retro-malleolar portal (RM). The patient is in the supine position. The calcaneal portal is located 1 cm distal and posterior to the intersection of 2 lines: The first line is a vertical line drawn along the posterior border of the fibular shaft, and the second line is drawn perpendicular to the first line, passing through the tip of the lateral malleolus.

A 6-mm × 20-mm PassPort Button Cannula (Arthrex) is introduced through the AL portal, and a guidewire is inserted through the previously identified ATFL footprint, directed posteriorly and slightly upward toward the tip of the medial malleolus while care is taken to avoid sinus tarsi penetration (Fig 6). The guidewire is over-drilled using a 5-mm drill bit to create a 20-mm-long talar tunnel.

Subtalar Portal and Fibular Tunnel Creation

The lateral gutter is completely visualized by the arthroscope through the AL portal, allowing the creation of the subtalar portal by using an 18-gauge needle targeting the fibular obscure tubercle (Fig 7). Subsequently, a guidewire is inserted through the fibula in a posterior oblique direction to obtain a long oblique fibular tunnel[17] exiting through the retromalleolar portal. A 6-mm drill bit is used to create a 15-mm-deep oblique fibular tunnel; then, a No. 2 loop suture is placed within the canal (Fig 7). A curved mosquito clamp is inserted through the AL portal and slid along the lateral talar and calcaneal wall until reaching the calcaneal portal; then, the No. 3 loop suture is retrieved and drawn up from the cannula. Additionally, the loop of the No. 2 lead suture is retrieved and drawn up from the cannula under direct arthroscopic visualization (Fig 8).

Talar Tunnel Transplant Fixation

Under direct anteromedial portal arthroscopic visualization, the allograft is passed through the cannula from the AL portal and fixed in the talar tunnel using a Bio-Tenodesis Screw (Fig 9).

Fibular Tunnel Filling With Transplant

The cortical suspensory fixation device (ACL Tight-Rope RT; Arthrex) is placed on the allograft, which is pulled from its end through the calcaneal portal using the loop of the No. 3 lead suture. Subsequently, the No. 2 loop suture is used to pull the suspensory fixation device into the fibular tunnel, and the graft is gradually pulled up to fill the fibular tunnel. The suspensory fixation device is positioned on the lateral fibular cortex without tightening (Fig 10).

Passage and Fixation of Transplant to Calcaneus and Adjustment of Final Tension

The distal end of the allograft is pulled through the calcaneal tunnel using the loop of the No. 1 lead suture. Subsequently, the allograft is fixed into the tunnel using a 6-mm × 15-mm Bio-Tenodesis Screw while the

Fig 4. Intraoperative photograph of right ankle showing percutaneous creation of calcaneal tunnel. The patient is in the supine position. A small skin incision and meticulous subcutaneous dissection are performed at the marked calcaneal portal. A guidewire is inserted into the calcaneum directed to the posterior and inferior medial edge of the calcaneal tuberosity and is subsequently over-drilled using a 6-mm cannulated drill bit.

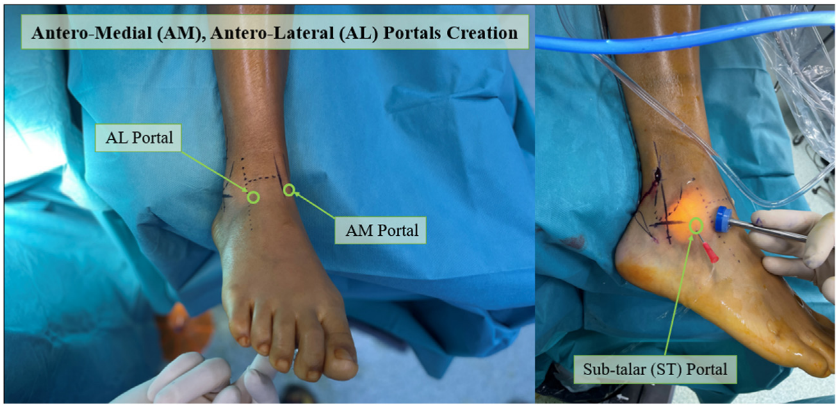

Fig 5. Intraoperative photograph of right ankle showing standard anteromedial (AM), anterolateral (AL), and subtalar (ST) portal creation. The patient is in the supine position, The AM portal is located medial to the anterior tibialis tendon at the level of the joint line. The AL portal is created under arthroscopic guidance using an 18-gauge needle 1 cm distal to the joint line. The ST portal is created under arthroscopic visualization (with the arthroscope in the AL portal) by using an 18-gauge needle targeting the fibular tip.

ankle and foot are maintained in neutral position (Fig 11). The cortical suspensory fixation device is finally tightened on the lateral fibular cortex, and the transplant is assessed to ensure accurate tension across the entire ankle range of motion.

Postoperative Protocol

The postoperative protocol includes 6 weeks of ankle walking boot immobilization. Ankle rehabilitation exercises are started 3 weeks after the surgical procedure to restore passive and active full ankle range of motion. Total weight bearing is allowed 4 weeks after the operation. The Ankle-GO score[18] is regularly obtained 3 months after the intervention to help in decision making regarding the return to sport. The patient is allowed to gradually return to sport, starting with nonpivoting sports at 10 weeks, followed by pivoting sports at 5 to 6 months based on the Ankle-GO score.[18]

Discussion

CAI is commonly seen after a lateral ankle sprain. Surgical lateral ankle ligament reconstruction is

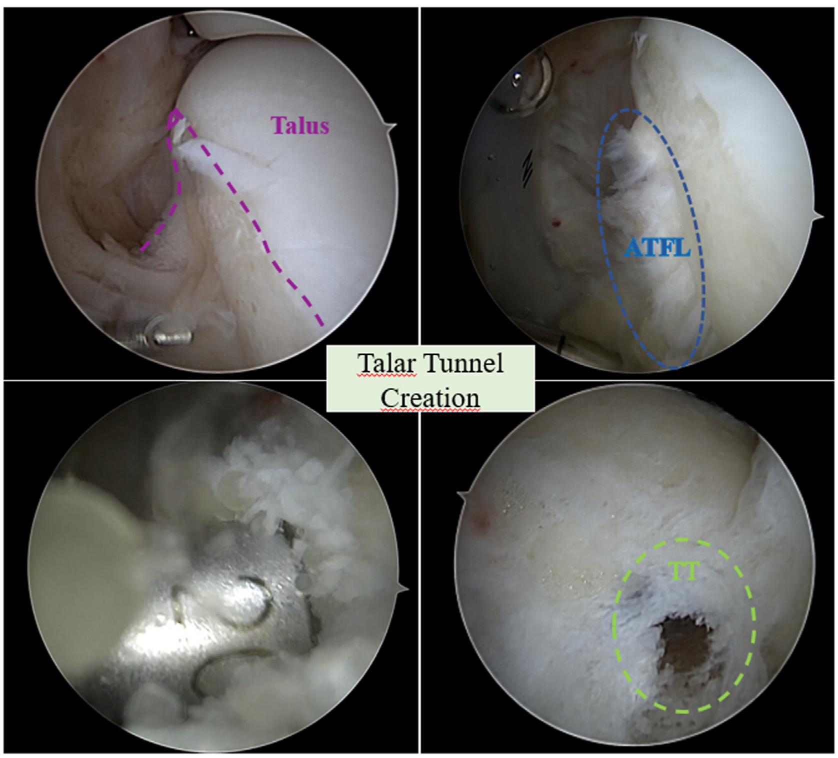

Fig 6. Arthroscopic view of right ankle, with arthroscope in anteromedial portal, showing lateral talar anterior talofibular ligament (ATFL) remnants in lateral gutter. A guidewire is introduced into the talus at the ATFL remnants through the anterolateral portal and directed to the medial malleolus tip. It is then over-drilled using a 5-mm drill bit to create 20-mm-long talar tunnel (TT).

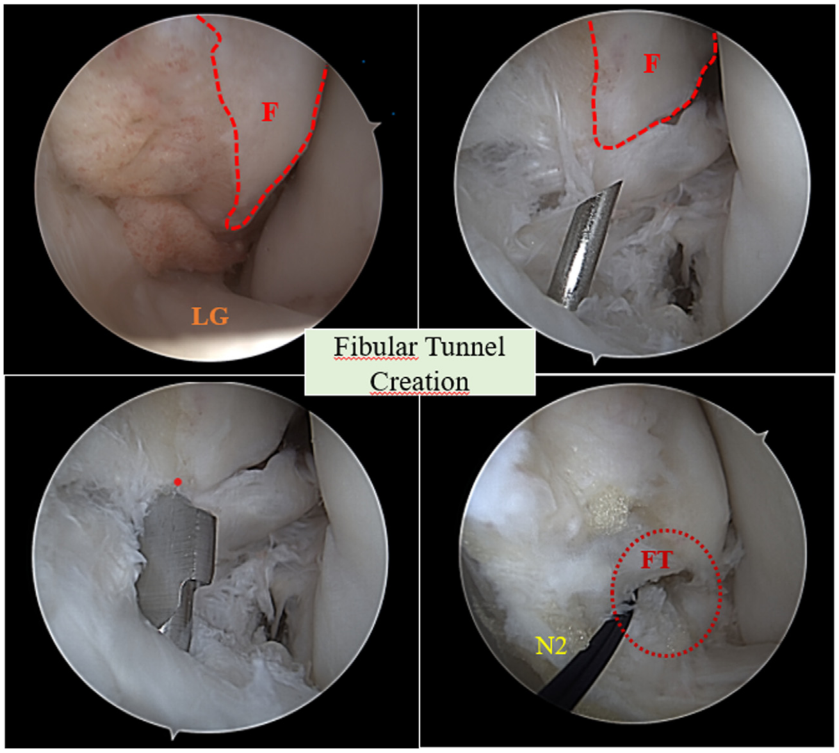

Fig 7. Arthroscopic exploration of lateral gutter (LG), with arthroscope in anterolateral portal, and creation of subtalar portal using 18-gauge needle directed to fibular tip. A guidewire is introduced through the subtalar portal and inserted in an oblique and posterior direction, exciting through the retromalleolar portal. A 6-mm drill bit is used to create a 15-mm-deep oblique fibular tunnel. Red dot: fibular tunnel entry point. (F, fibula; FT, fibular tunnel; N2, No. 2 loop suture.)

indicated when conservative treatment is unsuccessful.[5] Numerous surgical techniques have been described in the literature for CAI treatment[4,5,19]; however, anatomic reconstruction of the ATFL and CFL is crucial to restore ankle biomechanics, preventing long-term degenerative complications.[20] Arthroscopic lateral ankle stabilization is increasingly gaining popularity, providing a safe and minimally invasive procedure for lateral ankle stabilization. This procedure allows for an earlier return to full weight bearing and participation in recreational sports compared with the open lateral ankle reconstruction technique.[21]

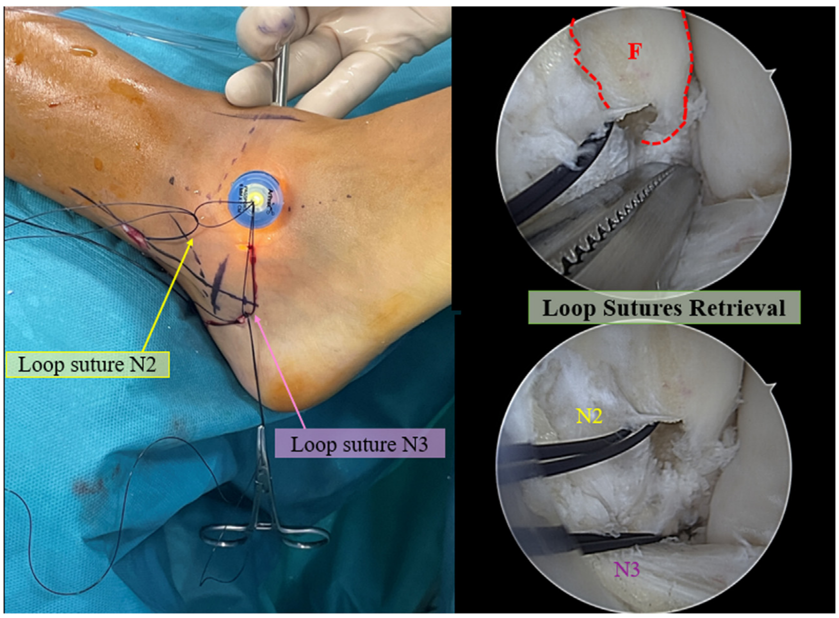

Fig 8. Intraoperative photograph and arthroscopic view of right ankle showing retrieval of No. 2 (N2) loop suture and No. 3 (N3) loop suture from cannula in anterolateral portal. The patient is in the supine position. The curved mosquito clamp is slid through the cannula in the anterolateral portal along the lateral talar and calcaneal wall to retrieve the loop suture No. 3 from the calcaneal portal under direct arthroscopic visualization (with the arthroscope in the anteromedial portal). (F, fibula.)

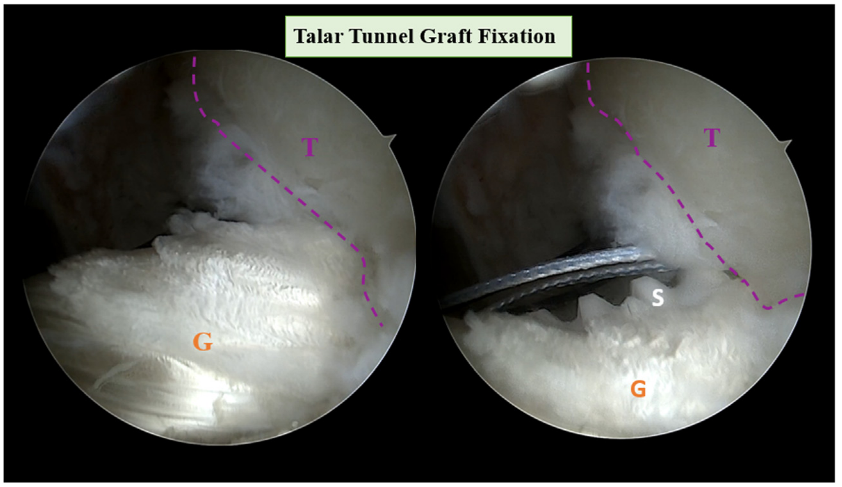

Fig 9. Arthroscopic view of right ankle, with arthroscope in anteromedial portal, showing allograft (G) fixation in talar tunnel (through anterolateral portal) using Bio-Tenodesis Screw (S). (T, talus.)

This article provides a simplified arthroscopic technique for ALALR. The patient is placed in the supine position without the need to change the position during the procedure. In addition, the use of an allograft prevents the associated comorbidities of gracilis tendon autograft harvesting and provides easier and faster patient rehabilitation. Furthermore, despite the similar results of calcaneal tunnel creation for the CFL between arthroscopic and open techniques,[22] percutaneous calcaneal tunnel creation, as shown in the cadaveric study conducted by Lopes et al.,[15] provides a minimally invasive anatomic reconstruction of the CFL and prevents the need for arthroscopic exploration of the CFL footprint insertion.[23] Consequently, this technique contributes to CFL remnant preservation, thereby improving proprioception and graft healing. Moreover, unlike the Y-shaped graft preparation technique described in the literature,[5,9] this technique provides the easiest method of graft preparation, allowing better graft tension control and avoiding any issues related to adjusting transplant tension or length (Table 2).

The main risk associated with this technique is sural nerve injury with calcaneal tunnel creation. This complication can be avoided by performing careful dissection until reaching the bone using the nick-and-spread technique described by Glazebrook et al.[24] (Table 2).

We believe that our technique offers a safe approach for arthroscopic ATFL and CFL reconstruction with a relatively quick learning curve. We encourage the creation of the calcaneal tunnel percutaneously, allowing biological ALALR.

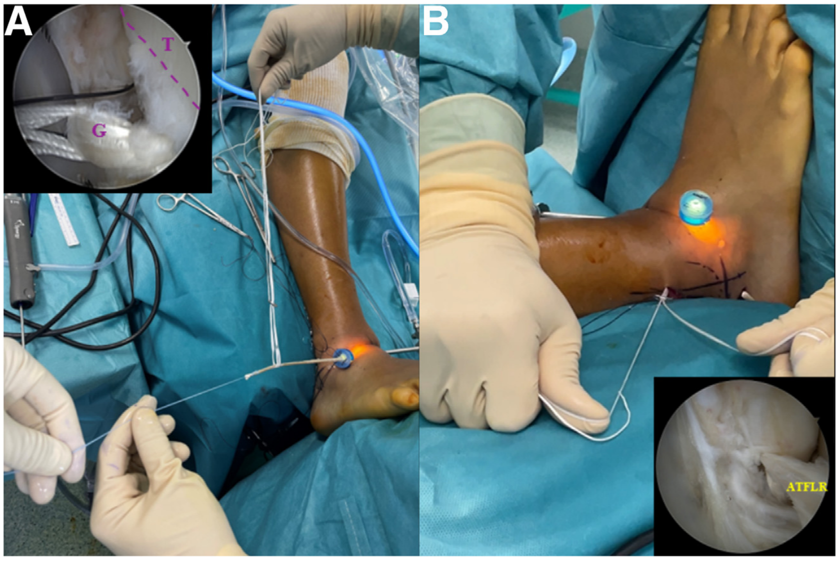

Fig 10. (A, B) Intraoperative photographs and arthroscopic view of right ankle showing cortical suspensory fixation device placed on allograft and pulled from its end through calcaneal portal using loop of No. 3 lead suture. The graft is gradually pulled up to fill the fibular tunnel, and the suspensory fixation device is positioned on the lateral fibular cortex without tightening. (ATFLR, anterior talofibular ligament reconstruction; G, graft; T, talus.)

Fig 11. Intraoperative photograph of right ankle showing calcaneal tunnel allograft fixation in neutral position using 15 mm Bio-Tenodesis screw.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: R.L. reports a consulting or advisory relationship with Arthrex. All other authors (A.A., M.K.M., 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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