Technical Note

Percutaneous Calcaneal Osteotomy Combined With Arthroscopic Lateral Ankle Ligament Reconstruction for Chronic Ankle Instability With Hindfoot Varus

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Abstract: Chronic ankle instability is the most frequent complication of lateral ankle sprain. Its reported incidence is approximately 40% after the first episode of instability. Although this rate varies depending on the type of activity, there are also certain risk factors associated with this condition, such as hyperlaxity, static or dynamic postural control deficits, and especially, hindfoot varus. If hindfoot varus is not managed when medical treatment fails and surgery is necessary, treatment may be unsuccessful, resulting in a poorer functional outcome and a higher rate of recurrent instability. Open hindfoot varus correction is often associated with poor wound healing and infectious complications. If ligament repair is also performed, the risk is increased by the numerous incisions. This article presents an arthroscopic lateral ankle ligament anatomic reconstruction technique with the gracilis tendon associated with percutaneous calcaneal osteotomy for the treatment of chronic ankle instability.

Chronic ankle instability (CAI) is the most frequent complication of lateral ankle sprain.[1] The reported incidence of this event is approximately 40% after the first episode of instability.[2] Although this rate varies depending on the type of activity, there are also certain risk factors associated with this condition, such as hyperlaxity, static or dynamic postural control deficits, and especially, hindfoot varus.[1-3] The latter is found to be associated with CAI in 8% to 28% of the cases in the literature.[2,4] Classic treatment involves lateral ankle ligament anatomic reconstruction (LALAR).[5-7] If hindfoot varus is not managed when medical treatment fails and surgery is necessary, treatment may be unsuccessful, resulting in a poorer functional outcome and a higher rate of recurrent instability.[4,8,9]

Several open surgical calcaneal osteotomy repair techniques have been described to correct these hindfoot varus deformities.[3,10] The most frequent risks of these techniques are poor wound healing and infectious complications.[11,12] If ligament repair is also performed, the risk is increased by the numerous incisions. A percutaneous calcaneal osteotomy (PCO) technique has been described to limit these risks.[11] This article presents an arthroscopic LALAR technique with the gracilis tendon associated with PCO for the treatment of CAI.

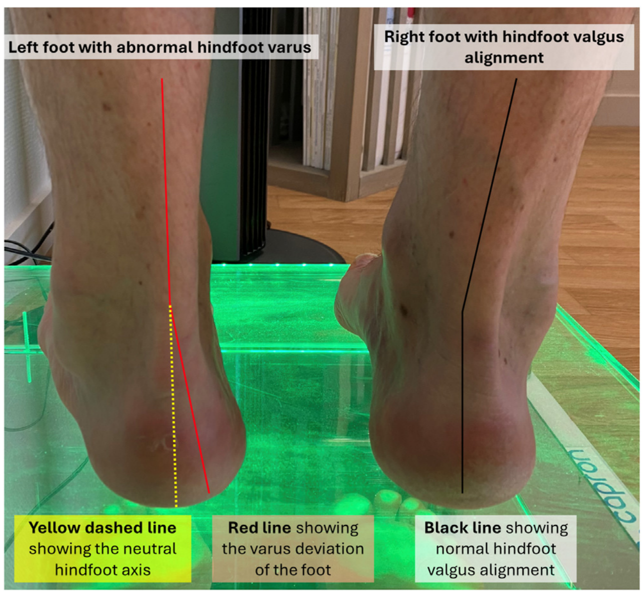

Fig 1. Photograph of patient's lower limbs: left foot with abnormal hindfoot varus (left) and right foot with hindfoot valgus alignment (right).

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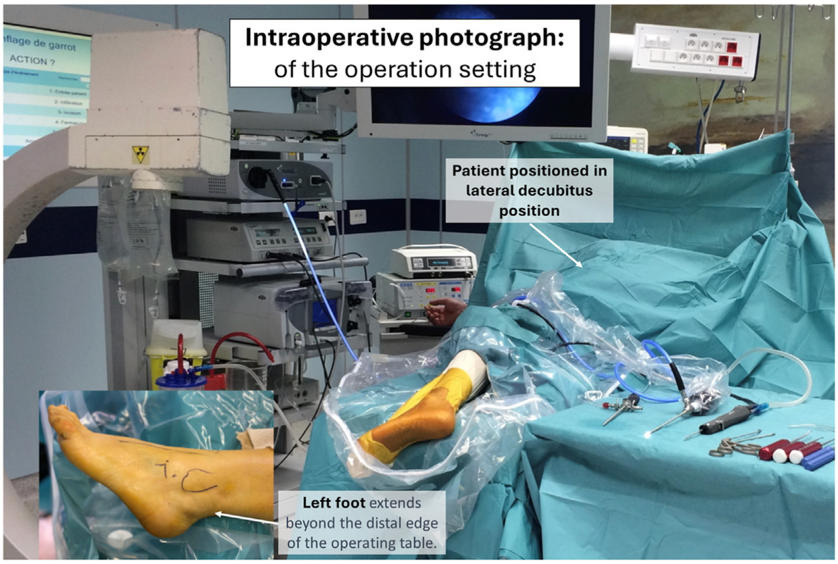

Fig 2. Intraoperative photograph of operating room setup. The patient is positioned in the lateral decubitus position. The left foot extends beyond the distal edge of the operating table.

Surgical Technique

This is a 2-step surgical technique. PCO is performed first, followed by LALAR. The procedure is presented in Video 1 in a patient with hindfoot varus (Fig 1).

Indications and Surgical Preparation

The indications for the described procedure are patients with CAI in whom conservative treatment has failed and who present with hindfoot varus. The patient is administered spinal or general anesthesia. A pneumatic tourniquet is placed on the thigh and inflated to 300 mm Hg. Prophylactic antibiotics are administered.

Percutaneous Calcaneal Osteotomy

Patient Positioning

The patient is installed in the lateral decubitus position. Sacral and pubic cushions are positioned under the patient to prevent compression. The operative foot extends beyond the operating table to facilitate perioperative arthroscopic control. The contralateral knee is flexed to avoid having one foot interfere with the other during these controls (Fig 2).

Equipment

Specific material for minimally invasive percutaneous foot surgery (MIS) is required: an MIS burr (e.g.,

Table 1. Pearls and Pitfalls of Percutaneous Calcaneal Osteotomy

Step	Pearls	Pitfalls
Creation of incision for calcaneal osteotomy	The incision should start at the intersection of a line bisecting the calcaneum in the proximal-to-distal direction and another line dividing the calcaneum into two-thirds and one-third in the anteroposterior direction.	The surgeon must make sure to protect the sural nerve during dissection.
Calcaneal osteotomy pattern	A chevron-pattern osteotomy aligned with the Achilles tendon and plantar fascia is performed for stability.	Misalignment can result in an unstable osteotomy or incomplete correction.
Calcaneal osteotomy in 4 steps	Because the drill is not as long as the width of the calcaneus, the osteotomy must be performed in 4 steps: The coronal section of the chevron is made first (superolateral then superomedial), followed by the axial section of the chevron (inferolateral then inferomedial).	The surgeon must not try to perform the osteotomy in a single step because it will be difficult and may result in osteotomy displacement.
Introduction of bone lever	The surgeon should carefully introduce the bone lever to maintain translation after the osteotomy.	Incorrect placement can lead to inadequate correction or damage to surrounding tissues.
Fixation with cannulated screws	Fluoroscopic guidance should be used for precise screw placement.	Poorly placed screws can compromise osteotomy stability and impact the union rate and quality (malunion).

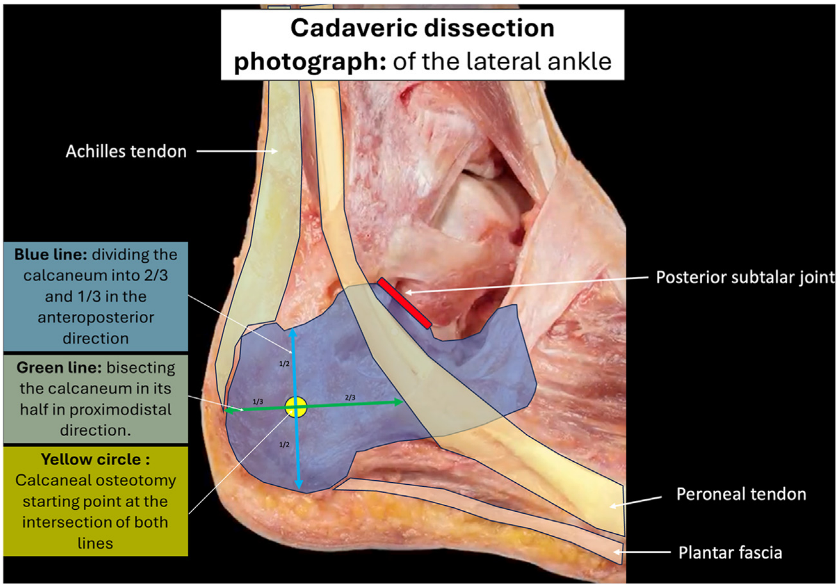

Fig 3. Calcaneal osteotomy landmarks. These are located at a point that divides the calcaneal tuberosity into two-thirds and one-third in the anteroposterior direction and in half in the proximal-distal direction.

3.1 mm diameter × 20 mm long; Arthrex, Naples, FL) and an MIS bone lever (MIS-II; FH Orthopedics, Heimsbrunn, France).

Osteotomy Steps

A 5-mm incision is made under fluoroscopic control to confirm the correct position of the osteotomy

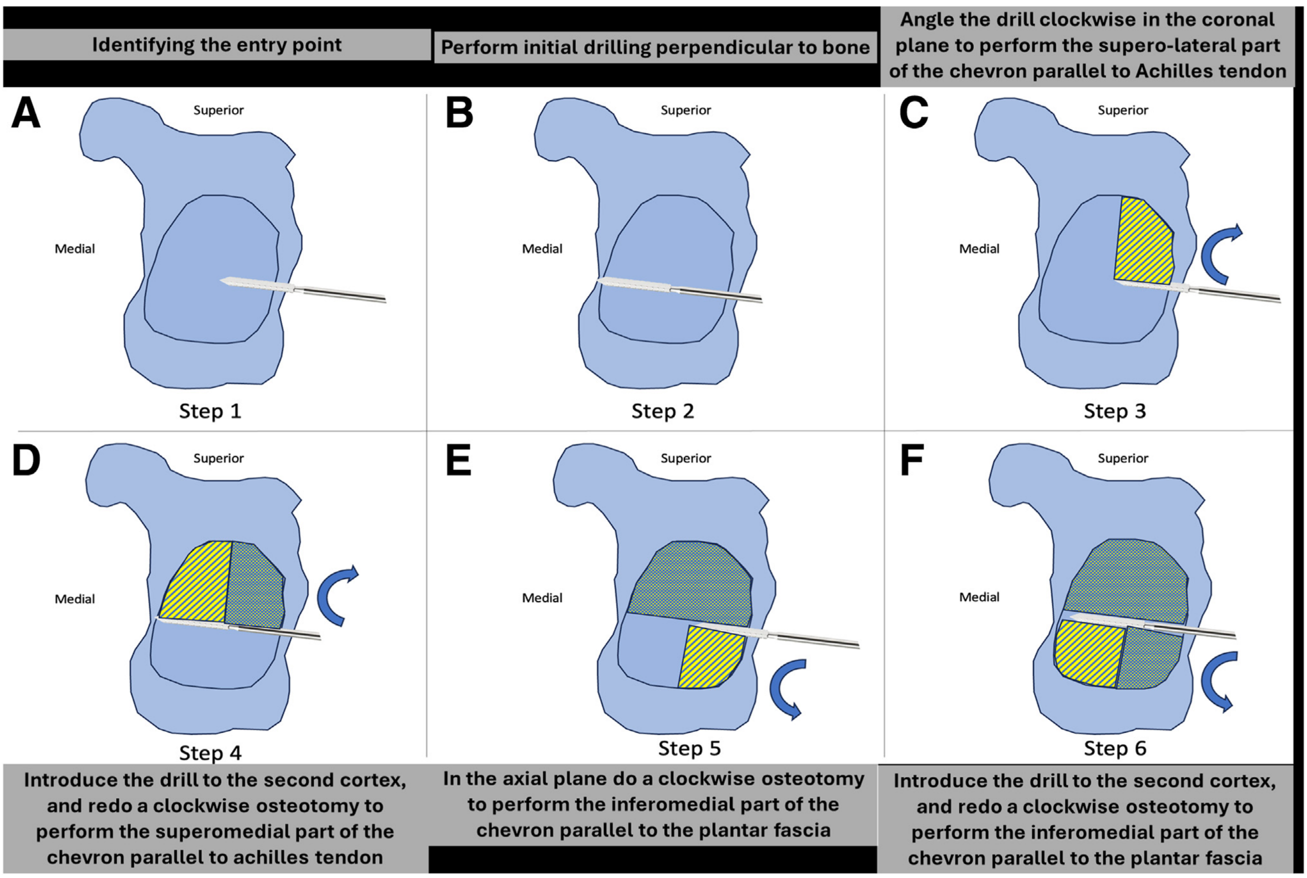

Fig 4. Step-by-step images illustrating calcaneal osteotomy process from incision to bone cutting and correction. (A-C) Initial drilling perpendicular to calcaneus and commencement of osteotomy, covering both superior lateral and medial quarters. (D-F) Remainder of osteotomy process, focusing on lower lateral and medial portions of calcaneus.

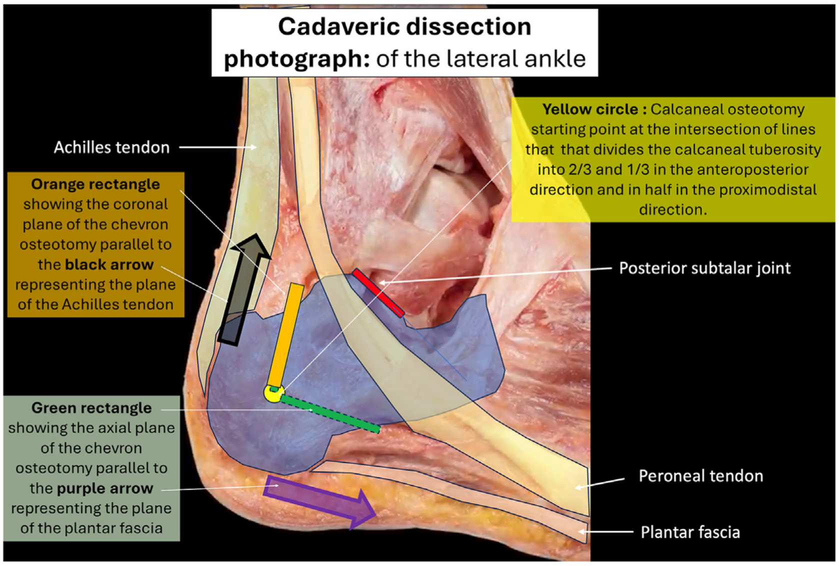

Fig 5. Cadaveric dissection photograph of lateral right ankle. The osteotomy direction creates a chevron pattern to improve stability. The superior half of the osteotomy is performed parallel to the Achilles tendon, and the inferior half is parallel to the plantar fascia.

(Table 1). This is located at a point that divides the calcaneal tuberosity into two-thirds and one-third in the anteroposterior direction and in half in the proximal-distal direction, as shown in Figure 3. The different steps of the PCO procedure are shown in Figure 4. A calcaneal tunnel is created by drilling perpendicular to the calcaneus (Fig 4 A and B). Because the drill is not as long as the width of the calcaneus, the osteotomy must be performed in 4 steps. For the osteotomy, the superior lateral quarter is treated first (Fig 4C), followed by the superior medial portion (Fig 4D), the lower lateral portion (Fig 4E), and finally, the lower medial portion (Fig 4F). Because the calcaneus tilts upward and forward, the superior half of the osteotomy is performed parallel to the Achilles tendon and the inferior half is parallel to the plantar fascia (Fig 5), creating a chevron osteotomy to improve stability.

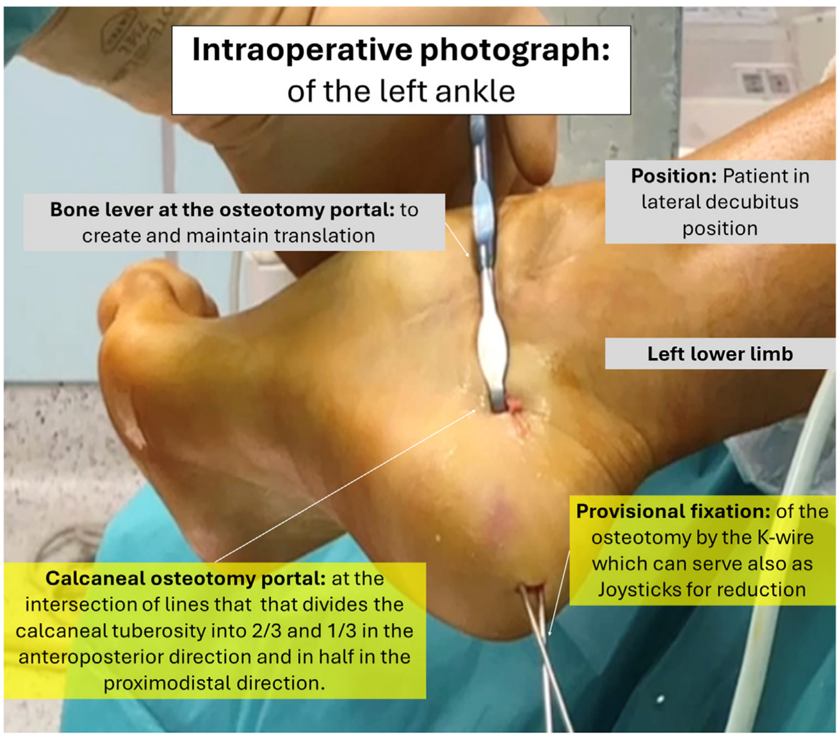

Fig 6. Intraoperative photograph of left ankle. A bone lever is introduced into the osteotomy portal to create and maintain translation. Provisional fixation of the osteotomy is achieved by a K-wire, which can also serve as a joystick for reduction.

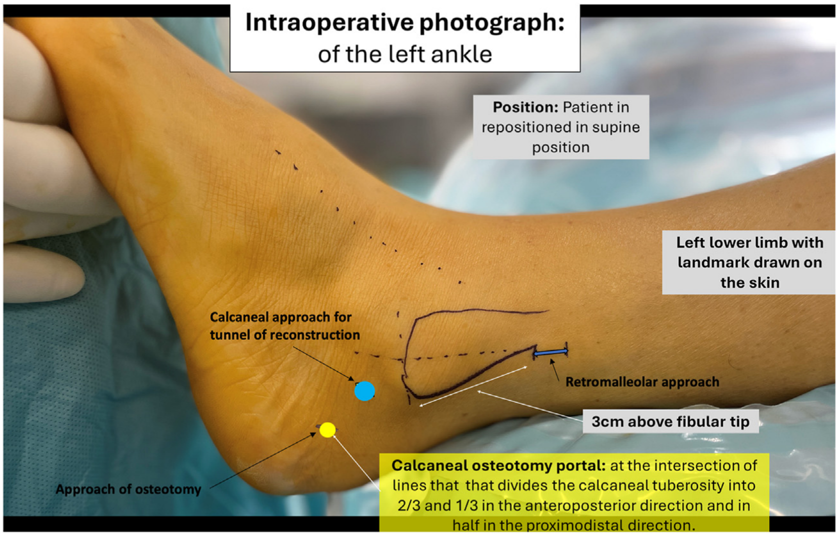

Fig 7. Intraoperative photograph of left ankle. A 1-cm retromalleolar portal is created 3 cm above the tip of the lateral malleolus directly behind the posterior cortex of the fibula.

The bone lever is introduced into the osteotomy portal to create and maintain translation (Fig 6). Fixation is obtained under arthroscopic control with two 6.5-mm-diameter tapered cannulated screws (SERF Extremity, Décines-Charpieu, France).

Lateral Ankle Ligament Anatomic Reconstruction

The LALAR technique has already been described.[13]

Patient Positioning

The patient is shifted backward into a supine position, which allows for the repositioning of the foot in medial rotation and facilitates access to the lateral gutter of the talus. During graft harvesting, the knee should be flexed at 90° and lateral counter-pressure is created on the lateral side of the thigh to prevent abduction.

Equipment

Standard arthroscopic material is used, including a 4.75 × 15—mm Bio-tenodesis screw (Arthrex). Also required is a 4-mm pin, specifically the RetroButton drill pin (Arthrex), along with a cortical fixation device (TightRope ACL-RT; Arthrex) with an EndoButton (Smith & Nephew Endoscopy, Andover, MA). Additionally, a PassPort Button Cannula (Arthrex) measuring 6 × 20 mm is used.

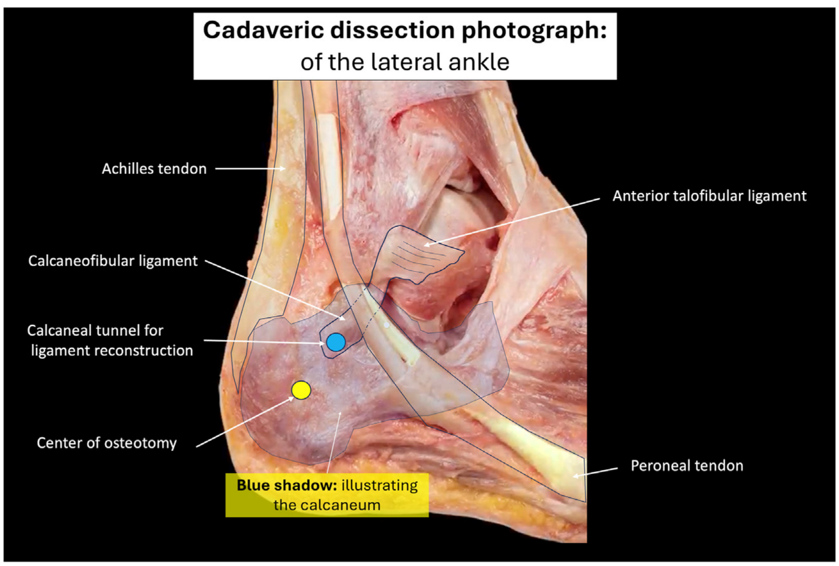

Fig 8. Cadaveric dissection photograph of lateral ankle. The difference between the center of the osteotomy and the calcaneal tunnel for ligament reconstruction is illustrated.

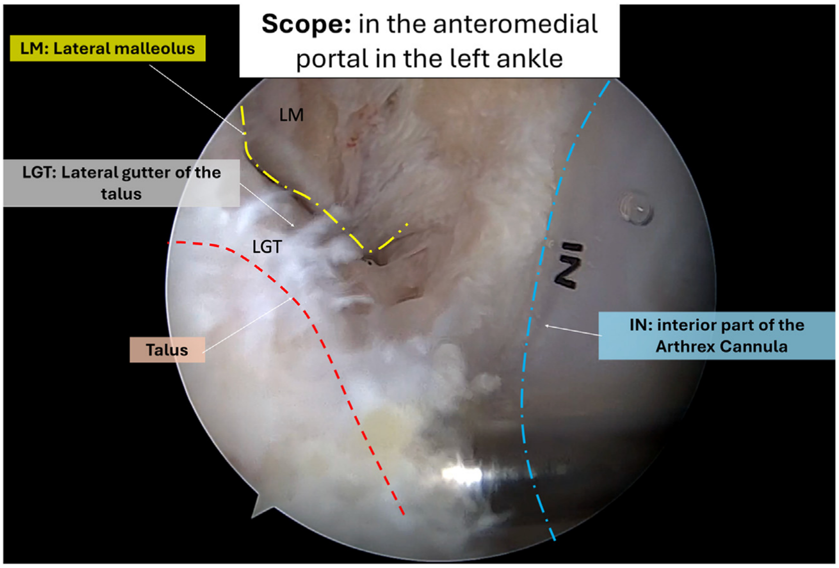

Fig 9. Arthroscopic view (with arthroscope in anteromedial portal in left ankle) showing exploration and preparation of talar tunnel drilling. (IN, inferior part of cannula; LGT, lateral gutter of talus; LM, lateral malleolus.)

Steps for Ligament Reconstruction

Graft Harvesting. The ipsilateral gracilis tendon is harvested. A 10-cm graft is sufficient. This graft is prepared by placing a 4.75 × 15—mm Bio-tenodesis screw at one end to be used for talar fixation. A 1-cm retromalleolar portal is created 3 cm above the tip of the lateral malleolus directly behind the posterior cortex of the fibula (Fig 7).

Calcaneal Tunnel. A percutaneous calcaneal tunnel is created through a calcaneal portal according to precise skin markings.[14] Generally, this tunnel is located above and in front of the osteotomy (Fig 8).

Talar Tunnel. A standard anteromedial portal is created. The anterolateral instrumental portal is identified arthroscopically with a needle. The cannula

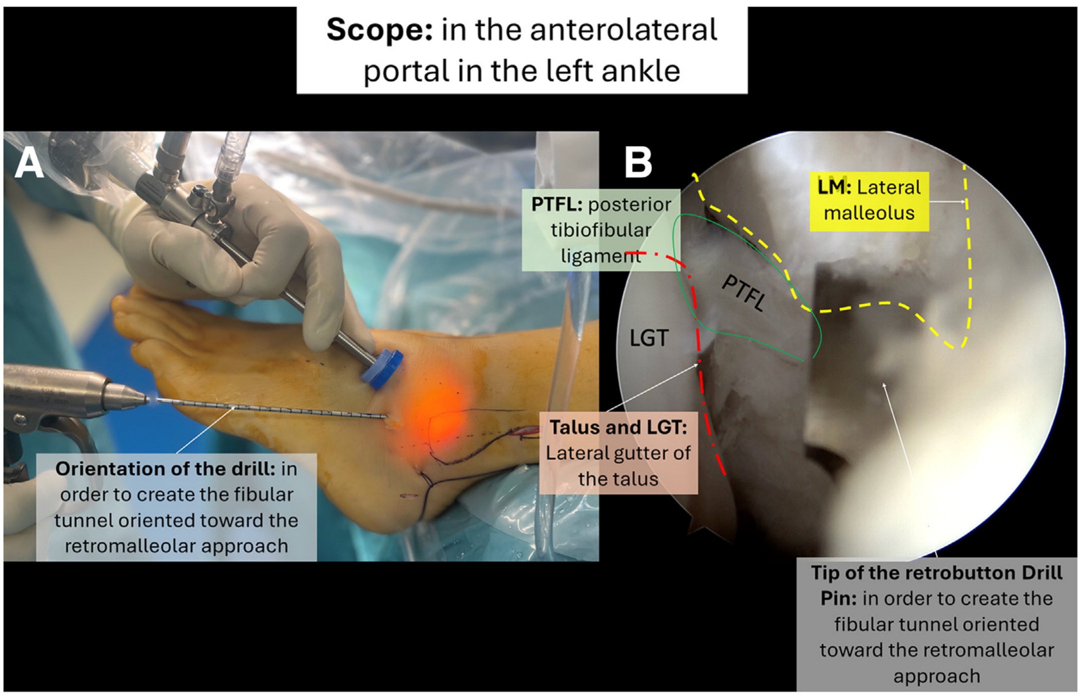

Fig 10. Fibular tunnel creation. (A) Intraoperative photograph of lateral ankle. (B) Arthroscopic view (with arthroscope in anterolateral portal in left ankle) showing exploration and preparation of fibular tunnel creation using RetroButton drill pin. (LGT, lateral gutter of talus; LM, lateral malleolus; PTFL, posterior tibiofibular ligament.)

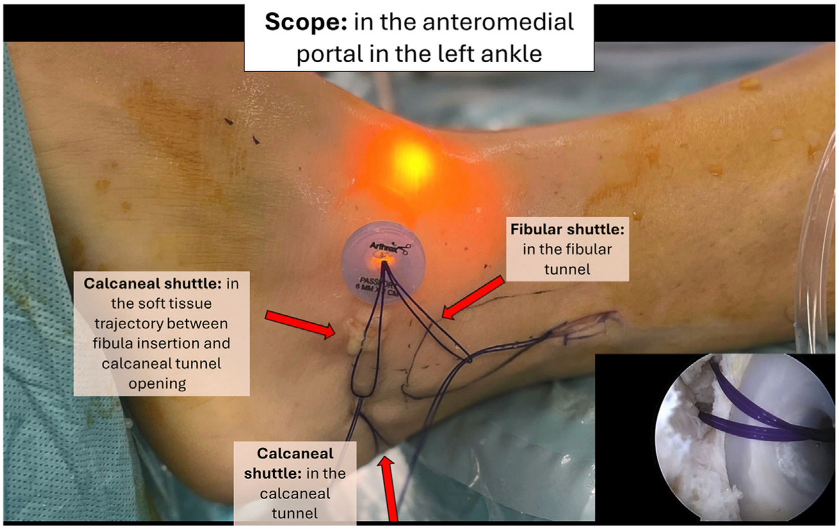

Fig 11. Passage of 3 shuttle relay sutures in fibular and calcaneal tunnels: (1) fibular shuttle in fibular tunnel, (2) calcaneal shuttle in soft-tissue trajectory between fibular insertion and calcaneal tunnel opening, and (3) calcaneal shuttle in calcaneal tunnel. The inset image is the intraarticular view from the anteromedial portal showing the prepared shuttle.

(PassPort Button Cannula, 6 × 20 mm) is positioned in the anterolateral portal, and the lesion is carefully evaluated. A 5-mm-diameter and 20-mm-deep talar tunnel is created above the subtalar joint behind the junction of the talar neck and body, aiming at the tip of the medial malleolus[13,14] (Fig 9).

Fibular Tunnel. The arthroscope is inserted through the anterolateral portal to obtain a full view of the lateral gutter of the talus and to create the subtalar portal. A 4-mm pin (RetroButton drill pin) is inserted through this portal and positioned at the center of the footprint of the insertion of the anterior talofibular ligament and calcaneofibular ligament.[13,14] It is drilled toward and exits the retromalleolar portal (Fig 10). A 6-mm-wide and 15-mm-long blind fibular tunnel is drilled on this pin.

Graft Passage and Fixation. The arthroscope is now inserted into the anteromedial portal, and 3 shuttle relay sutures are put in place (Fig 11). The graft is screwed into the talus through the anterolateral portal under arthroscopic control. The cortical fixation device (TightRope ACL-RT) with EndoButton is placed at the distal end of the free graft outside the cannula (Fig 12). The distal end of the graft is inserted into the calcaneal tunnel, and the EndoButton is pulled into the fibular tunnel. The distal end is pulled into the calcaneal tunnel

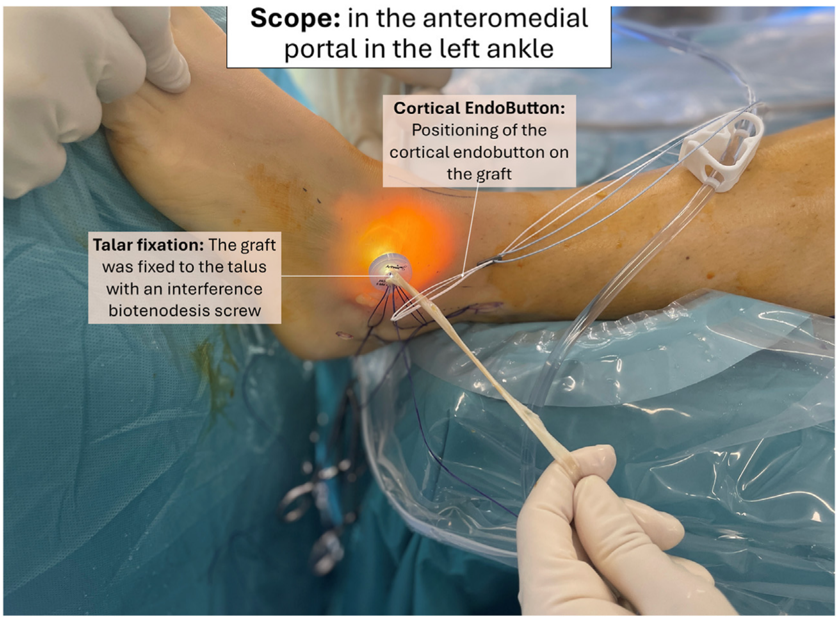

Fig 12. Positioning of cortical EndoButton on graft that is fixed to talus by Bio-tenodesis screw.

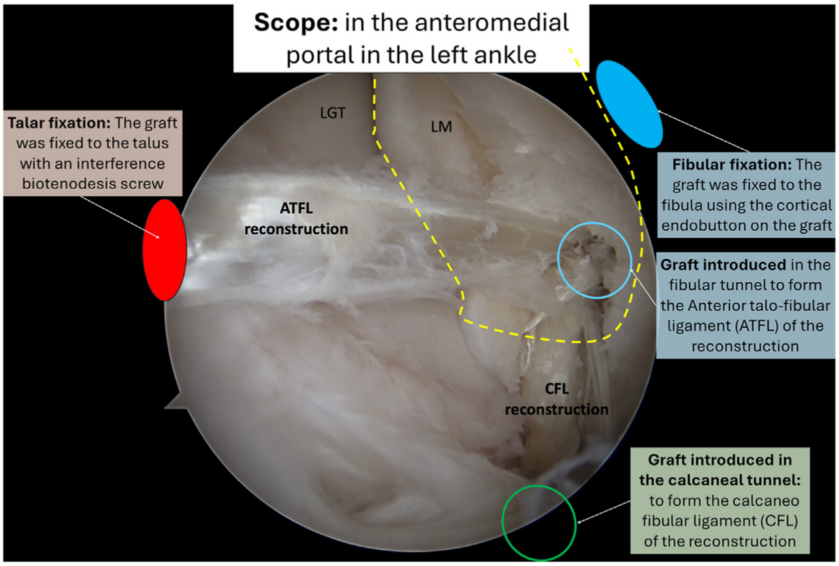

Fig 13. Arthroscopic view (with arthroscope in anteromedial portal in left ankle) showing tightening of graft under arthroscopic guidance after passage of both ends in fibular and calcaneal tunnels. (ATFL, anterior talofibular ligament; CFL, calcaneofibular ligament; LGT, lateral gutter of talus; LM, lateral malleolus.)

by relay suture and attached with a 6 × 15—mm Biotenodesis screw inserted from outside to inside along a guidewire. The cortical EndoButton is permanently tightened under arthroscopic control (Fig 13).

Postoperative Protocol

The described procedure is performed on an outpatient basis, and a postoperative radiograph is obtained immediately after the procedure (Fig 14). Weight bearing is not allowed for the first month. The ankle is kept at a 90° angle with a walking boot for 2 weeks, even at night. Anticoagulants are prescribed for 1 month. Analgesics are prescribed depending on the level of pain, and nonsteroidal anti-inflammatories are systematically prescribed for the first 2 days to prevent postoperative pain. Physical therapy is begun 2 weeks

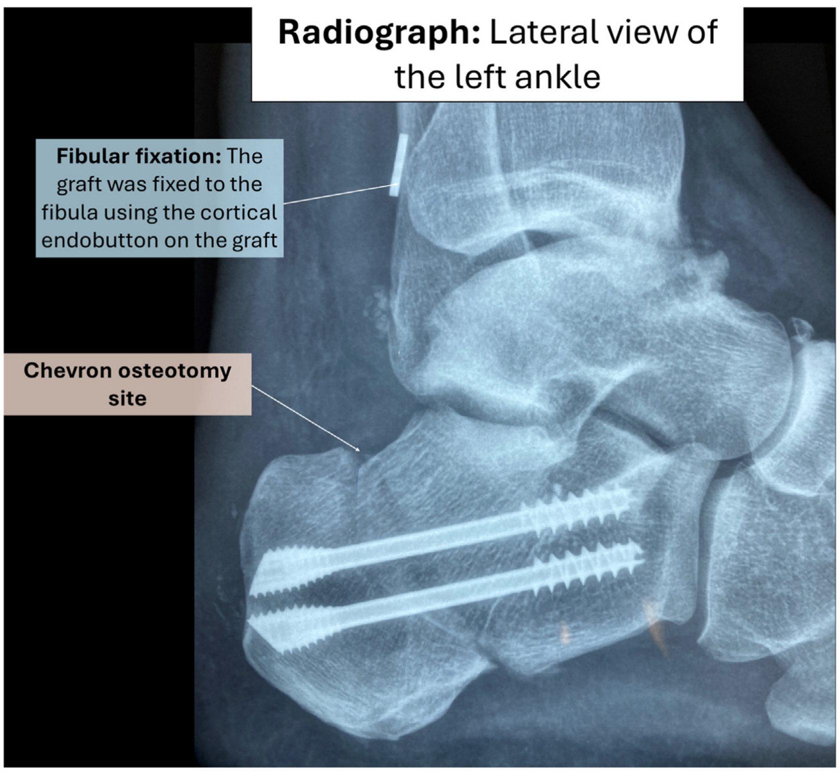

Fig 14. Postoperative lateral radiograph of left ankle showing end result of osteotomy and fixation.

Table 2. Advantages and Disadvantages of Percutaneous Calcaneal Osteotomy With Arthroscopic Lateral Ankle Ligament Reconstruction

Advantages	Disadvantages
Minimally invasive, with reduced surgical trauma and scarring, as well as lower risk of infection	Risk of inaccurate reduction especially for surgeons inexperienced in percutaneous surgery, leading to poor alignment
Shorter recovery time, with quicker return to daily activities and sports, owing to avoidance of 2-stage technique	Risk of nonunion as potential complication due to inadequate reduction or fixation
Lower risk of infection owing to smaller incisions and less tissue disruption	Risk of hematoma and nerve injury
Better cosmetic outcomes, with smaller incisions than open osteotomy technique	Inadequate for severe varus deformity

after surgery to drain and mobilize the ankle and to limit stiffness. Running is allowed 4 to 6 months after surgery.

Discussion

This article describes a technique associating PCO and LALAR to manage chronic lateral ankle instability associated with hindfoot varus. The minimally invasive nature of PCO combined with LALAR presents clear advantages, such as reduced trauma, lower infection risk, quicker recovery, and better cosmetic outcomes. However, these benefits come with considerations such as the potential for inaccurate reduction, especially in less experienced hands, and the possibility of nonunion, hematoma, or nerve injury. Moreover, PCO may not be suitable for severe varus deformities, necessitating alternative approaches in such cases (Table 2).[12]

The indications for this type of surgery are patients with CAI presenting with hindfoot varus in whom conservative treatment has failed. In case of surgery owing to a retear of the lateral ligament reconstruction, this procedure can be added. In conclusion, PCO and LALAR can be effectively and reliably performed during the same surgical procedure.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: R.L. is a board member of the Francophone Arthroscopy Society; is a consultant for Arthrex, Serf Extremity, and Implant Service Orthopédie; and is a developer for Serf Extremity and Implant Service Orthopédie. A.H. is a consultant for Arthrex and DePuy. The other author (M.K.M.) declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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