DOI: https://doi.org/10.30795/jfootankle.2024.v18.1817

Special Article

Lateral ankle instability

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Abstract

Ankle sprains are frequent injuries among athletes and the general population, making them one of the most prevalent sports-related injuries. While most lateral ankle ligament injuries typically respond well to conservative treatment, a significant portion evolves into chronic lateral ankle instability, which may require surgical intervention. Recently, new anatomical insights regarding the lateral ankle ligaments have emerged, enhancing the advancement of innovative diagnostic and treatment approaches. The objective of this article was to discuss the latest trends in lateral ankle instability.

Level of evidence V; Expert opinion.

Keywords: Ankle arthroscopy; Ankle instability; Ligament repair; All-inside repair.

Introduction

Ankle sprains with lateral ankle ligament (LAL) injuries are among the most common causes of orthopedic consultations. They account for around 25% of all musculoskeletal system injuries, affecting general and young patients engaged in physical activities[1]. Most (80%) LAL injuries involve the anterior talofibular ligament (ATFL), with the remaining cases resulting from combined damage to the ATFL and calcaneofibular ligament (CFL)[1,2].

Beyond the impact on the individual's quality of life, ankle sprains with LAL can develop a high recurrence rate and chronic ankle instability (CAI), which has long-term consequences that may impact patient outcomes[3,4]. It is estimated that approximately 40 % of the patients will suffer at least one more ankle sprain following an acute lateral ankle sprain at one year. After a new ankle sprain beyond the ligament reinjury, there is an increased risk of associated injuries such as an ankle fracture, cartilage injury of the talus, or syndesmotic injuries[3,5].

Due to the importance of this pathology, several anatomical and biomechanical studies on the lateral ligaments have been conducted in recent years. These studies have provided a better understanding of this pathology and the evolution of new methods of diagnosis and treatment[6-9]. The purpose of this article is to review the current trends in the anatomy, diagnosis, and treatment of patients with lateral ankle instability.

Anatomy

The ankle's lateral ligament complex consists of the ATFL superior fascicle (ATFLsup), the ATFL inferior fascicle (ATFLinf), the CFL, and the posterior talofibular ligament (PTFL). These ligaments are crucial for the ankle joint's lateral stability, maintaining stability by limiting the talus's anterior translation and internal rotation[1].

The ATFL is the primary restraint for anterior talar translation and is often injured in lateral ankle sprains. It typically consists of two bundles (superior and inferior) divided by a gap that

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How to cite this article: Nunes GA, Mann TS, Guelfi M, Dalmau-Pastor M, Cordier G, Veja J. Lateral ankle instability. J Foot Ankle. 2024;18(2):134-45.

permits vascular branches to enter from the perforating peroneal artery, which connects with the lateral malleolar artery[10].

The ATFLsup is an intraarticular structure with a fibular insertion placed under the distal insertion of the anterior inferior tibiofibular ligament (AITFL). The ATFLsup runs anteriorly and horizontally to be inserted on the talar neck, close to the talar dome's articular surface. It becomes lax in ankle dorsal flexion and taut in plantar flexion[7].

The ATFLinf is an extraarticular structure with a common fibular origin at the inferior tip of the fibula with CFL. From the fibular origin, the ATFLinf runs anteriorly, parallel to the ATFLsup, to attach to the talar neck just below the talar insertion of ATFLsup. Furthermore, the ATFLinf and the CFL are connected through arciform fibers and were observed as isometric structures. Considering these anatomical correlations, the ATFLinf, CFL, and their connections are described as a single functional anatomical structure named the lateral fibulotalocalcaneal ligament complex (LFTCL)[6,7]. A biomechanical study has shown the connecting fibers between the ATFLinf and CFL are robust enough to transmit tension between both structures[11].

The CFL has a distinct function because it is the only ligament connecting the talocrural and subtalar joints. It is a cordlike or flat and fanning band extraarticular structure, and most of the ligament is covered by the peroneal tendons sheath. This ligament has a common fibular origin with the ATFLinf. It runs in a posterior-inferior direction under the peroneal tendons sheath to insert into the small tubercle at the posterior aspect of the lateral calcaneus surface[12-14]. The CFL is a critical stabilizer of the lateral ankle, contributing significantly to ankle stability by preventing excessive inversion and providing resistance to the talar tilt. The insertion of the CFL on the calcaneus is approximately 13 mm from the subtalar joint[6,12,13,15].

The PTFL is the strongest ligament of the LAL. This ligament demonstrates different states of tension during ankle movements, being relaxed during plantar flexion and tensioned during dorsiflexion. Anatomically, the PTFL is a multifascicular ligament originating from the lateral malleolus's malleolar fossa on the medial surface. It runs nearly horizontally to insert in the posterolateral aspect of the talus[10,16]. An anatomical study with a tridimensional analysis of the LAL showed that the ATFLif, CFL, and PTFL have a continuous fibular footprint at the medial side of the fibula. Considering this data, the PTFL was suggested as part of the LFTCL[7,17] (Figure 1).

Concepts

Chronic ankle instability is traditionally defined as recurrent ankle sprain in patients with objective instability. This laxity can be clinically demonstrated in specific clinical maneuvers[3,18]. Individuals with this condition often suffer from significant instability accompanied by functional limitations, decreased levels of activity, and recurrent instances of ankle sprains, which can eventually result in the onset of ankle osteoarthritis[19].

According to the modern anatomical description of the LAL, depending on the ligament affected, the patient can develop ankle micro- or macro-instability[19].

Ankle micro-instability is characterized by subtle or minor ankle joint instability caused by an inversion ankle sprain with an isolated ATFLsup injury. Patients with this condition usually report a subjective sensation of the ankle giving way associated or not with pain in the lateral gutter. This type of instability is distinct from gross clinical laxity and major ligamentous disruptions. Since the injury occurs only of ATFLsup and the LFTC is intact, the lateral ankle instability is subtle and may not be demonstrated by the classical objective clinical and radiological examinations[19,20].

Before the anatomical understanding of the lateral ligament complex, this condition was either neglected or treated only as an anterolateral soft tissue impingement. The physiopathology of ankle micro-instability is understood as the knee's anterior cruciate ligament (ACL) injuries. In the same way as the ACL, the ATFLsup cannot heal after an injury because they are an intraarticular structure. Synovial fluid prevents collagen synthesis, thus explaining why intraarticular ligaments do not heal adequately[19].

Figure 1. Anatomic dissection showing the lateral ankle ligaments: (1) Anterior inferior tibiofibular; (2) Anterior talofibular superior fascicle; (3) Anterior talofibular inferior fascicle; (4) Arciform connecting fibers; (5) Calcaneofibular.

Micro-instability may be a key factor in developing associated intraarticular injuries, emphasizing the need to address subtle ligamentous issues to prevent further joint degeneration. With an ATFLsup injury, the talus biomechanic changes work with increased internal rotation. Consequently, associated deltoid injuries can occur, developing rotational ankle instability. The natural progression occurs with chondral and osteochondral injuries, anterior tibia osteophytes, and finally, ankle arthrosis[20,21].

Diagnosis

Clinical exam

The clinical exam typically involves a comprehensive review of the patient's history, symptoms, functional limitations, and physical findings related to the ankle joint[22,23]. Patients commonly experience sensations of the ankle "giving way," frequent sprains, persistent ankle pain, swelling, episodes of locking, mechanical symptoms, and restricted range of motion (ROM)[18].

It is essential to examine both ankles for comparison during the physical exam. Significant variations of joint laxity exist among individuals, depending on genetics, age, and gender. The traditional and specific tests for lateral ankle instability include the anterior drawer test and the talar tilt test. To ensure reliable results, it is essential to position the patient correctly, allowing the gastrocnemius complex to relax. Incorporating an internal rotation force during the anterior drawer test enhances the test's specificity by minimizing the effects of the deltoid ligament on the interpretation of results[24].

A novel maneuver, known as the tibiotalar posterior drawer test, has been developed to evaluate patients suspected of ankle micro-instability, mainly focusing on the tightness of the ATFLsup during plantar flexion and its role in limiting talar internal rotation. During this test, the patient lies on the examination table with a flexed hip and knee to allow full ankle plantar flexion and the foot resting on the table. By internally rotating the foot slightly and pushing the tibia posteriorly, any posterior tibia and fibula translation indicates potential injury to the ATFLsup[19].

Radiography

Radiography is crucial for evaluating associated injuries, such as impingements, syndesmosis injuries, osteochondral injuries, and ankle fractures, on the base of the fifth metatarsal, on the anterior process of the calcaneus and the lateral process of the talus. It can also detect ankle alignment and morphological changes that could contribute to instability[5].

Stress radiography to evaluate lateral ankle instability is no longer used. The subjective application of force during this procedure may not accurately reflect the necessary level of stress required to provoke instability[25].

Ultrasonography

The ultradound (US) is a valuable diagnostic tool to evaluate the LAL. Its real-time imaging capacity allows for dynamic evaluation, capturing nuances of ligament integrity and ankle stability during movement. Moreover, the US is an important tool for diagnosing micro-instability since it can identify the ATFL fascicles separately. The main disadvantage of this exam is that it is a dependent operator and requires a radiologist's expertise to interpret the findings correctly[26-28].

Magnetic resonance image

Magnetic resonance imaging (MRI) helps detect ligament injuries and associated pathologies, such as osteochondral injuries of the talus, impingements, bone bruises, occult fractures, tendon injuries, and related syndesmosis and deltoid ligament injuries, that may be present in patients with CAI[29-32].

MRI findings that indicate chronic injury to the lateral ligaments consist of heterogeneous fiber signals, irregular contours, elongation, ligament attenuation, or ligament absence. Another possibility is to analyze the ATFL fascicles. A recent study has shown that a three-dimensional volumetric MRI modality can identify the ATFL fascicles and the ligament connections, providing detailed information on their anatomy, structure, and integrity[33,34]. Therefore, the MRI can be an essential tool to diagnose micro-instability (Figures 2 and 3).

Some authors have found preoperative MRI reliable and valid for surgical decision-making in CAI. In a study involving 22 patients with CAI submitted to ankle arthroscopy following preoperative MRI, the authors determined that MRI is sensitive in identifying abnormality in the ATFL. However, the agreement between MRI findings and arthroscopic assessment was moderately substantial (k = 0.70). The study reinforces that MRI can detect intrinsic ligament defects or deficiencies but cannot evaluate ligament function[35]. One of the primary limitations of MRI is that it is typically conducted

Figure 2. Tridimensional volumetric sagittal magnetic resonance image showing the anterior talofibular ligament (ATFL) fascicles with the superior ATFL fascicle (red arrow) and inferior ATFL fascicle (blue arrow).

without physiologic weight-bearing, and although MRI-compatible stress devices exist, they have yet to be widely available. Therefore, it is crucial to correlate MRI findings with the clinical examination. Since MRI is not a dynamic exam, only morphological abnormalities can be reported, which may not always correlate with clinical findings[35].

Conservative treatment

Conservative approach should be the first line of treatment for LAL[3]. Although conservative methods cannot restore ankle stability, they are important for treating symptoms and strengthening secondary ankle stabilizers. The protocols emphasize early mobilization, functional rehabilitation, and patient education, which have been shown to enhance outcomes and reduce the risk of chronic instability post-ankle injuries.

The most modern protocol to treat acute and chronic LAL injuries is based on the acronym PEACE and LOVE[36]. The PEACE protocol focuses on the acute phase of injury management. Key components of this protocol include "P" protecting the injured area, "E" elevating the ankle to reduce swelling, "A" avoiding anti-inflammatory medications, "C" compression to manage edema, and "E" educating the patient on early intervention and proper care. The LOVE protocol becomes relevant as the acute phase transitions into the subacute and chronic stages, emphasizing Load, Optimism, Vascularization, and Exercise. Central tenets of the LOVE protocol include progressively loading the ankle for strength and stability, fostering a positive mindset through optimism, promoting vascularization for improved blood flow and tissue healing, and engaging in targeted exercises for function restoration and injury prevention[36].

Surgical treatment

Surgical treatment is indicated in cases where the conservative approach has failed. The definition and time of failure of conservative treatment in these cases have changed in recent years. The surgical indications have increased with the advancement of fully arthroscopic techniques, low morbidity, and the possibility of early rehabilitation. Several surgeons consider that if conservative treatment fails for three months, surgery may already be indicated[37,38]. The risk of persisting with conservative treatment is that repetitive ankle sprains can develop associated intra-articular injuries. The presence of these associated injuries tends to have a worse prognosis[39]. Therefore, early surgical intervention for CAI is recommended before the onset of associated injuries[38,40]. The authors of this study corroborate this approach but emphasize that treatment should always be individualized, and the peculiarities of each patient, such as comorbidities, age, level of physical activity, and associated injuries, must be considered in this decision-making.

The open Brostrom Gould surgery has traditionally been considered the gold standard for CAI treatment[41]. With the evolution of anatomical knowledge and the development of arthroscopic techniques, this scenario has changed in recent years. In addition to allowing the evaluation and treatment of injuries associated with the modern arthroscopic approach, it allows evaluating the quality of ligament remnant, performing fully anatomical all-inside ligament repair techniques, and increasing biological or synthetic reinforcements when necessary[20,42,43]. Recently, several comparative studies and meta-analyses have shown that the arthroscopic treatment of LAL has provided results that achieved similar or even superior clinical scores and faster rates of motion recovery. Additionally, it may facilitate an accelerated postoperative rehabilitation process[43,44].

Arthroscopic assessment

The ability to evaluate ligaments and related intra-articular ankle injuries has established arthroscopy as a crucial tool in managing CAI. The arthroscopic evaluation of CAI may include additional procedures, such as medial ligament repair, syndesmosis stabilization, or treatment of cartilage injuries[43].

Figure 3. Arthroscopic lateral ligament quality assessment. (A) Partial ligament detachmen; (B)Total ligament detachment; (C) Hook palpation.

The management of CAI encompasses various arthroscopic treatment options, such as lateral ligament repair, repair with augmentation, and ligament reconstruction. The appropriate procedure selection depends on factors like the quality of the ligament-tissue remnant, age, hyperlaxity, body weight, sports involvement, and competition level[18]. The best way to evaluate the quality of ligament remanent is during the arthroscopic intervention. It is possible to visualize and evaluate the ligament tension by hook palpation[45,46] (Figure 3). This analysis is subjective and depends on the surgeon's experience. Some surgeons proposed an arthroscopic classification of the quality of the ligament remnant tissue[45] (Table 1).

When the remaining ligament quality is moderate or poor, biological or non-biological augmentation may be necessary, particularly for patients with hyperlaxity, high body mass index (BMI), or high-level athletic demands. In cases with no native ligament remnant for repair or revision, anatomic reconstruction using a tendon graft may be necessary[18].

Arthroscopic all-inside repair

The arthroscopic all-inside repair (AIR) is a fully arthroscopic and anatomical technique described by Vega et al.[47]. This procedure involves directly repairing the LAL into their footprints. This technique is indicated for patients with micro- and macro-instability with good-quality ligament remnant [9].

The literature indicates that arthroscopic AIR is an anatomical, safe, and reproducible method that can effectively repair the LAL with minimal risk to the nearby anatomical structures.[9,47] Because the suturing and reinsertion of the ligaments are conducted exclusively within the joint under direct arthroscopic visualization, the likelihood of entrapment of the superficial fibular nerve is lower compared to other arthroscopic techniques[48,49]. Vega et al. presented a case series involving 24 patients with CAI who were treated through AIR of the ATFL and CFL, increasing the American Orthopaedic Foot and Ankle Society (AOFAS) scores from 65 to 97 points, with no recurrences and only one case (4.2%) of superficial peroneal nerve neurapraxia[8]. Pellegrini et al. reported superficial peroneal nerve neurapraxia in 15% of patients submitted to the Artrobrostrom procedure, [41] while Acevedo et al.[42] and Corte-Real et al.[50] documented rates of 6.8% and 10.7%, respectively.

Table 1. Arthroscopic classification of the lateral ligament remnant tissue's quality

Quality	Description
Poor	Arthroscopic observation of a clearly hypoplastic ligament with poorly defined margins. The friability of the ligament makes it difficult to grasp
Moderate	Arthroscopic observation of fibrotic tissue or synovitis demonstrating a stretched hyperplastic or hypoplastic ligament. Initial good consistency of the ligament, but fragile when it is reiteratively grasped
Excellent	Arthroscopic observation of normal synovial tissue demonstrating a ligament with sharply defined margins. Solid consistency of the ligament when grasped

Despite the distrust of some surgeons in performing only a pure ligament repair, it is crucial to highlight that for effective restoration of ankle stability via a direct and isolated repair, the integrity of the remaining ligament must be sufficiently high to allow for proper grasping, tensioning, and reinsertion into its natural footprint[9]. In addition to the quality of ligament remnant, this technique is anchored in new anatomical ligament concepts that demonstrate that lateral ligaments have connections and work as a ligament complex described by Vega et al. as LFTC[17]. Nunes et al. reported a case series involving 18 patients with CAI who had well-preserved ligament remnants and underwent AIR of the ATFL. Based on the anatomical understanding of the relationships between the ATFL and CFL, ankle stability was restored in all cases, even when both ligaments were involved in the injuries[9].

The AIR is an anatomical procedure in which the ligaments are reinserted into the footprint. Consequently, this will generate a more physiological result with less stiffness[49]. After any arthroscopic repair or reconstruction of lateral ankle ligaments, a reduction in ankle ROM is anticipated. One comparative study found that this stiffness is more pronounced in percutaneous ligament repair methods assisted by arthroscopy, as these techniques involve suturing the capsule, retinaculum, and sural fascia together, which can lead to excessive fibrosis in the lateral ankle region[49].

It is essential to consider that despite the advantages of AIR, it also has some limitations. Firstly, it is a demanding technique that requires expertise in arthroscopy. The results of this procedure are influenced by the surgeon's progress through the learning curve, making it unsuitable for novice ankle arthroscopists. Secondly, the AIR is limited to patients with good quality remnant ligament without hyperlaxity and normal BMI. Patients with long-term CAI, poor ligament remnant, generalized ligament laxity, high BMI, or high-demand athletes may experience suboptimal outcomes with direct ligament repair[9,18].

Surgical technique

Arthroscopic portals are systematically established during the procedure. The anteromedial portal is created at the level of the ankle joint line, while the anterolateral portal is positioned approximately 0.5 cm below the joint line and medial to the superficial peroneal nerve. A cannula (PassPort Button cannula, Arthrex, Naples, FL) is introduced through the anterolateral portal to safeguard the superficial peroneal nerve and facilitate the insertion of arthroscopic instruments. Additionally, an accessory anterolateral portal is formed just anterior to the fibula, approximately 0.5 to 1 cm above the tip of the lateral malleolus (Figure 4A). A protocolized arthroscopic evaluation of the ankle joint is recommended to detect all possible intra-articular pathologies.

The ATFL's footprint is identified and debrided (Figure 4B). After identification of the ATFL remains, a suture passer with nitinol loop wire (Microsuture lasso curved 70 degrees, Arthrex, Naples, FL) and a 2.0 nonabsorbable suture (Fiberwire, Arthrex, Naples, FL) is prepared. The suture passer is introduced through the anterolateral portal, and under direct arthroscopic visualization, the ligament is penetrated from lateral to medial. Using Nitinol loop wire through the suture passer, the ligament is grasped and looped with a nonabsorbable suture (Figure 4C-G). Another option to grasp and loop the ligaments is using an automatic suture passer. The ATFL fibular footprint is drilled, and a knotless anchor (Pushlock 2.9 mm × 15 mm, Arthrex, Naples, FL) with the sutures is fixed, reinserting the ligament (Figure 4H).

The postoperative protocol includes full-time use of a removable walking boot with partial weight-bearing for three weeks, followed by three weeks using an ankle brace with full weight-bearing.

Arthroscopic all-inside repair with non-biological augmentation

In recent years, high-strength tapes (non-absorbable sutures) have become popular in orthopedics. Non-biological augmentation for LAL repair was initially described as an open technique using suture tapes after the classical open Brostrom-Gould repair. Later, Vega et al. developed this procedure for a fully arthroscopic technique[45].

Mackay and Ribbans first introduced the concept of suture tape augmentation for Broström or modified Broström repairs using high-strength, non-absorbable suture tape and knotless anchors. This technique enhances the repaired ligaments in a "scaffold-like" manner[51]. In a cadaveric study using 18 fresh specimens, suture tape augmentation of native ATFL increased up to 50% mean load to failure and stiffness compared with the intact ATFL[52]. The original Mackay and Ribbans case series described synthetic augmentation in 49 patients with CAI, which allowed for "early mobilization, reduced pain, and early restoration of function" in a primarily athletic patient population[51].

Vega et al. developed and popularized the arthroscopic AIR with non-biological augmentation. This procedure involves direct arthroscopic AIR, as described above, followed by suture tape augmentation fixed from the tip of the fibula to the talus. It is indicated in patients with CAI with poor-quality remnant ligament[45]. In addition, those CAI with good-quality ligament remnant and high-demand sports activities that demand fast recovery, high BMI, generalized hyperlaxity, combined ankle techniques as osteochondral defect treatment that need mobilization to ensure proper osteochondral healing or hindfoot endoscopy to avoid ankle dorsiflexion stiffness[18].

Using non-absorbable sutures (high-strength tapes) is not risk-free and can sometimes lead to chronic inflammation and a foreign body reaction. Nevertheless, the literature demonstrates some cases of series reinforcing this procedure's safety. Another concern is how tight the suture tape is fixed. Over-tightening the tape can lead to ankle plantar flexion limitation. To avoid this complication, fixing the second anchor on the talus with the ankle in neutral or slight plantar flexion is advised[45].

Surgical technique

The arthroscopic AIR with a knotless anchor is performed as described in the section above. Once the knotless anchor (Pushlock 2.9 mm × 15 mm, Arthrex, Naples, FL) is introduced

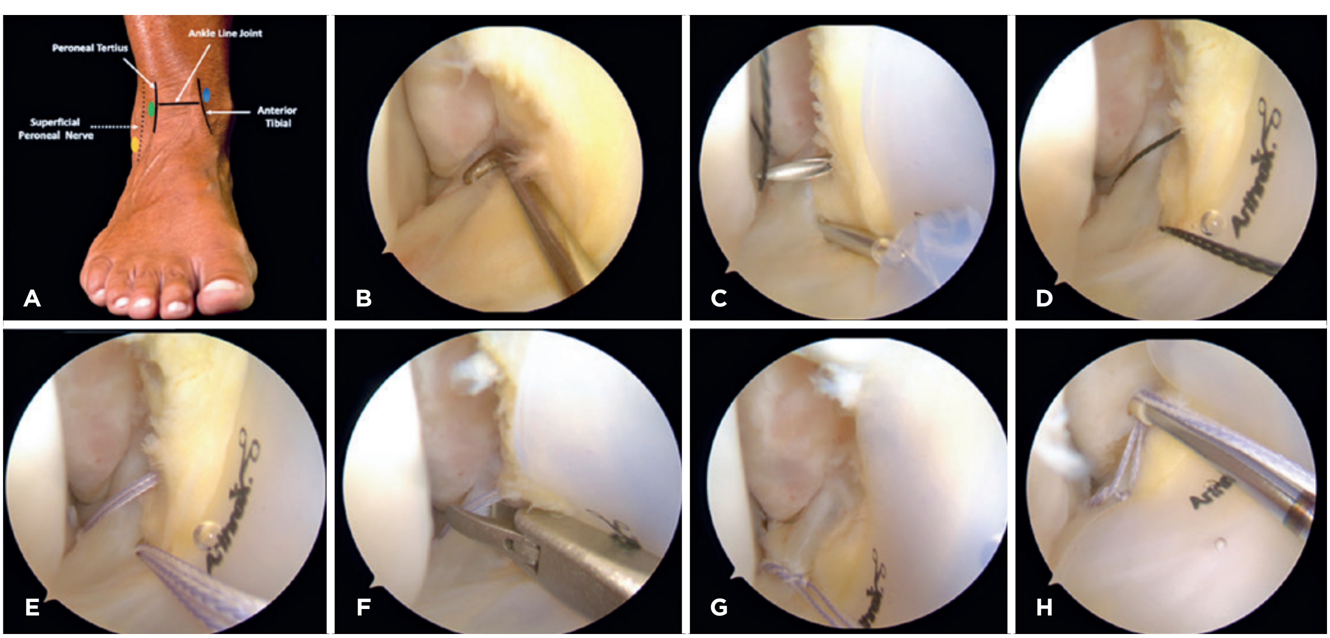

Figure 4. All steps of the arthroscopic all-inside repair.

and the ligament is repaired, the suture remnants (Fiberwire, Arthrex, Naples, FL), are not cut. Using an arthroscopic grasper, the limbs of the suture are pulled out through the accessory portal (Figure 5A). Then, both suture limbs are subcutaneously passed from the accessory portal to the anterolateral portal, returning to the joint (Figure 5B). Once in the anterior tibiotalar joint compartment, the sutures are pulled out through the cannula in the anterolateral portal (Figure 5C).

The talar attachment of the ATFL is identified arthroscopically near the talar neck. The drill guide is introduced through the anterolateral portal and placed at the center of the talar neck, just anterior to the ATFL talar attachment (Figure 5D).

Maintaining the ankle in a neutral or slight plantar flexion position, the Knotless anchor (Pushlock 2.9 mm × 15 mm, Arthrex, Naples, FL) with the sutures is introduced into the hole by impaction. This way, the suture augmentation will not be overtight and will protect the ligament repair. At the end of the procedure, the wires are cut, and the portals are sutured.

The postoperative protocol includes two weeks of partial weight-bearing in a removable walking boot, followed by physical therapy without protection in the third week.

Arthroscopic all-inside repair with biological augmentation

The literature already supports arthroscopic procedures to repair LAL; a recent systematic review demonstrated favorable clinical outcomes of arthroscopic LAL repair in the short term, with functional results like those of the Brostrom-Gould technique. ArtroBrostrom uses the same suture to grasp both ligaments' remnants and inferior extensor retinaculum (IER), while AIR with biological augmentation does it separately.

Cordier et al. presented a case series involving 55 ankles with CAI submitted to arthroscopic AIR supplemented with biological augmentation using the IER. With a mean follow-up period of 29 months, they observed good functional outcomes, as evidenced by improvements in AOFAS and Karlsson-Peterson scores. Complications occurred in five patients (9.1%), including one case of complex regional pain syndrome, two instances of deep venous thrombosis, and two patients who experienced neurological complications[21].

Surgical technique

The arthroscopic AIR repair with a knotless anchor is performed as described in the section above. The next step is biological augmentation using IER.

A second anchor is introduced and inserted proximal to the superior ATFL. A blind trocar is introduced through the anterolateral portal in the subcutaneous space and with a distal and anterior direction to create a working subcutaneous area just above IER.

A third portal is located at the mead-distance of the line connecting the lateral malleolus tip and base of the fifth metatarsal and 1 cm proximal to this point. An automatic suture passer (Mini Scorpion DS Arthrex, Naples, FL) is introduced through the anterolateral portal, charged with one of the suture limbs from the second anchor. The suture passer is directed distally, and the IER is penetrated twice with each suture limb. Sutures are tensioned, and a slighting knot is made to finish the biological augmentation (Figure 6).

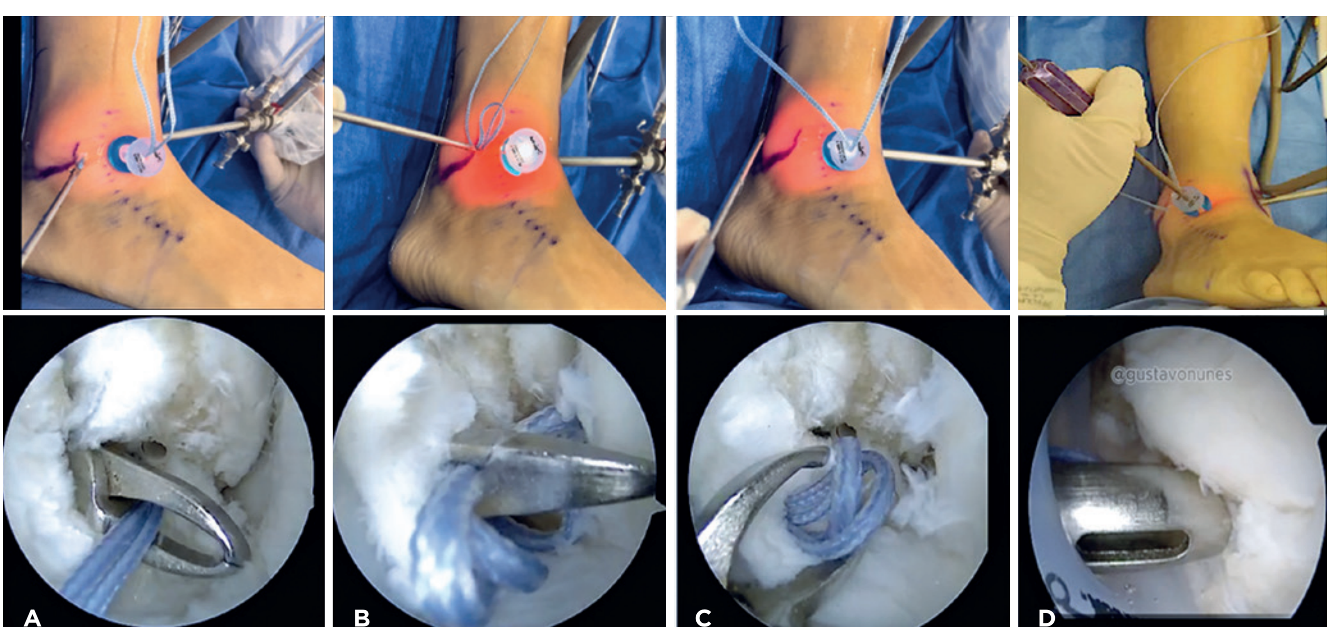

Figure 5. All steps of the arthroscopic all-inside repair with synthetic augmentation.

Endoscopic reconstruction

The ATFL and CFL endoscopic reconstruction is considered a suitable procedure in cases of severe CAI without ligament remnants. This procedure uses an autograft (gracilis tendon) to replace the ATFL and CFL in their native footprints[18]. As with all procedures, this technique was first described using an open approach and later developed using an endoscopic approach. According to the current anatomical description, this technique is not fully anatomical because it does not reconstruct both ATFL fascicles. Nonetheless, the literature has reported that LAL endoscopic reconstruction results in good clinical and functional outcomes[18].

The classical indications for endoscopic reconstruction are poor ligament remnant tissue, no remnant native ligaments, generalized hyperlaxity, high BMI, and revision of previous failed lateral ligament repair. Lateral ankle ligament reconstruction is technically demanding, more morbid, and requires longer patient recovery than arthroscopic repair[18]. With the advancement of lateral repair arthroscopic techniques with suture augmentation, the classical indications for reconstruction have been replaced[53]. The authors consider that the best indication for an endoscopic reconstruction using a graft tendon is to revise a previous failed lateral ligament repair.

Despite being technically demanding and more morbid than arthroscopic repair techniques, this procedure has good results and a low complication rate. Cordier et al. published a case series including 50 patients with a mean follow-up of 31 months. The patients returned to sports at the same level in 84% of the cases. The mean preoperative AOFAS score improved from 76 to 94 points, and the mean Karlsson–Peterson score increased from 73 to 93. There were only two significant complications with the reconstruction's failure (4%)[21].

Surgical technique

Under standardized anteromedial and anterolateral portals, a protocolized arthroscopic evaluation of the ankle joint is performed. A gracilis tendon graft with a minimum length of 11 cm is harvested and prepared. Sequentially, the ligamentous remnants of the ATFL and CFL are debrided, and the fibular footprints are prepared (Figure 7A).

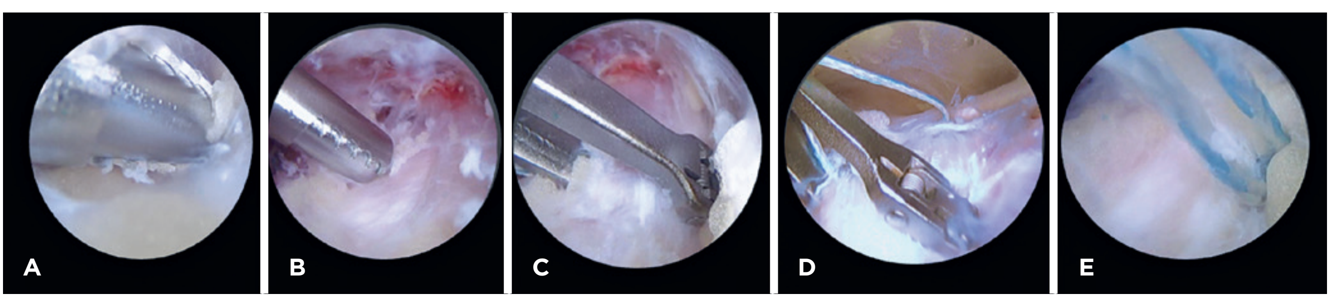

Figure 6. Biological augmentation. (A) Introduction of the shaver under visual control; (B) Creation of working space between inferior extensor retinaculum (IER) and subcutaneous tissue; (C–E) Grasping and suture of the IER.

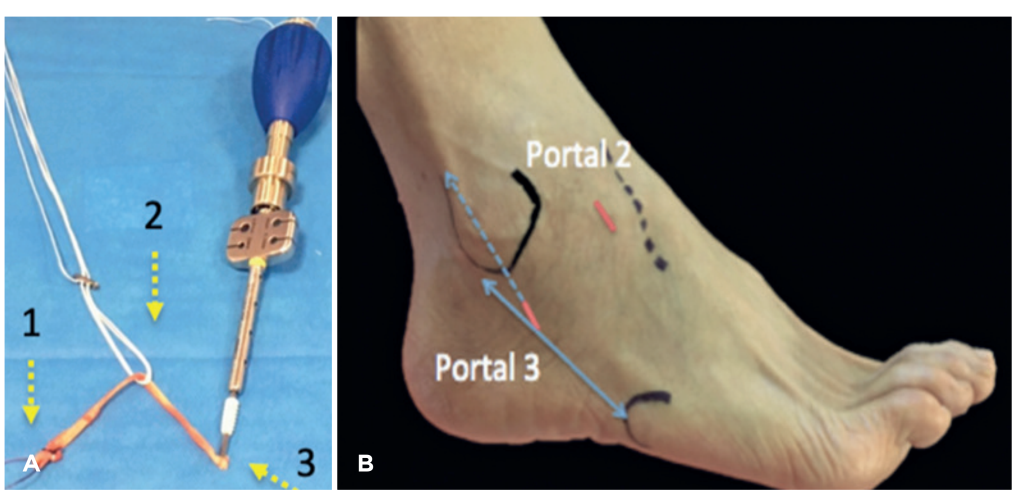

Figure 7. (A) Gracilis graft. (1) Calcaneal side with suture wire; (2) Fibular side with adjustable endobutton; (3) Talar side with tenodesis screw (B) Arthroscopic portals to lateral ligament reconstruction.

A third arthroscopic accessory portal is performed at the intersection of the axis of the fibular tunnel and the superior border of the peroneal tendons (Figure 7B). With the scope in the anterolateral portal and the shaver in the accessory third portal, the dissection is followed until the lateral talus is exposed and the CFL's calcaneal footprint can be visualized. A calcaneal tunnel from the calcaneal footprint to the anterior medial edge of the calcaneal tuberosity is performed (Figure 8). An oblique fibular tunnel (Figure 9) and a talar tunnel are performed by arthroscopic visualization.

The graft is introduced through the anterolateral portal and fixed in the talar tunnel using a 5.5 × 15 mm biotenodesis screw (Tenodesis Screw Biocomposite 5.5 15 mm, Arthrex, Naples, FL, USA) (Figure 10). The other end of the graft is retrieved through the accessory portal and passed through the loop of the adjustable endobutton (ACL Tightrope RT, Arthrex, Naples, FL, USA), which is introduced in the fibular tunnel. The other end of the graft is pulled inside the calcaneal tunnel and fixed with another biotenodesis screw. Holding the ankle in a valgus position at 90 degrees, the endobutton is tightened (Figure 11).

Postoperatively, a walking boot is indicated day and night for four weeks, followed by an ankle brace for two weeks during the day. Partial weight-bearing was allowed after

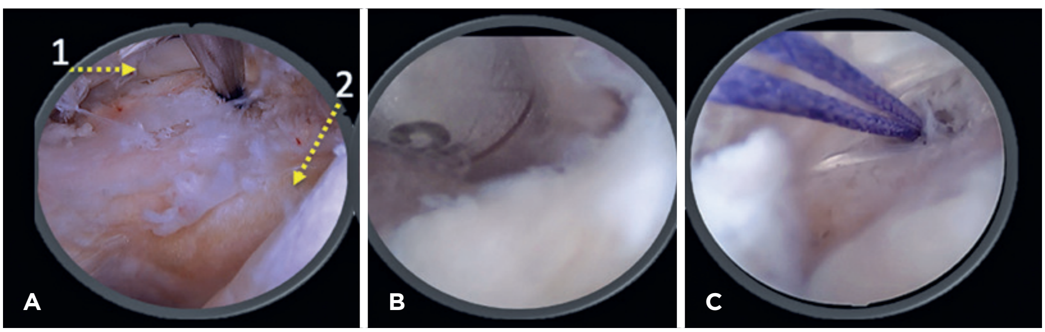

Figure 8. Calcaneal tunnel. (A) Insertion of the guide (1) Fibular tendons; (2) Posterior subtalar joint. (B) Drilling the tunnel (C) Insertion of the suture relay.

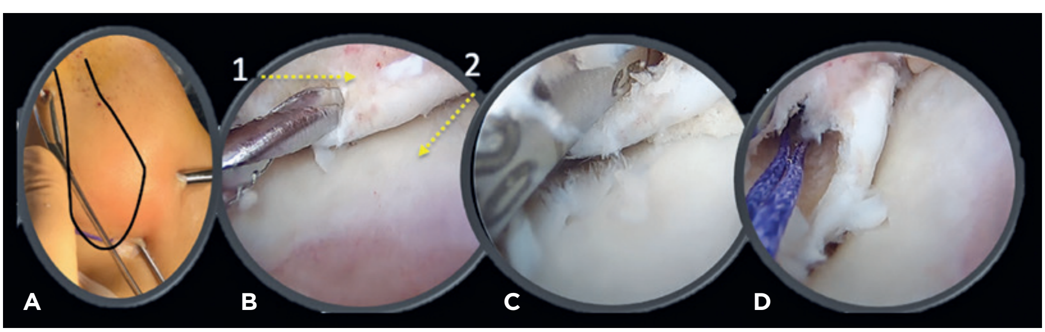

Figure 9. Fibular tunnel. (A) External view. (B) Insertion of the guide. (1) Lateral malleolar "obscure" tubercle; (2) Talar bone. (C) Drilling (D) Insertion of the suture relay.

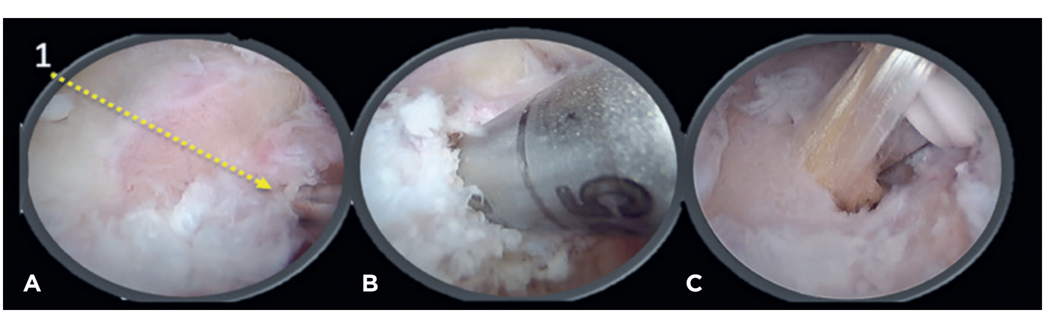

Figure 10. Talar tunnel. (A) Insertion of the guide. (1) Distal ATFL footprint. (B) Drilling over 2 cm (C) Fixation of the graft.

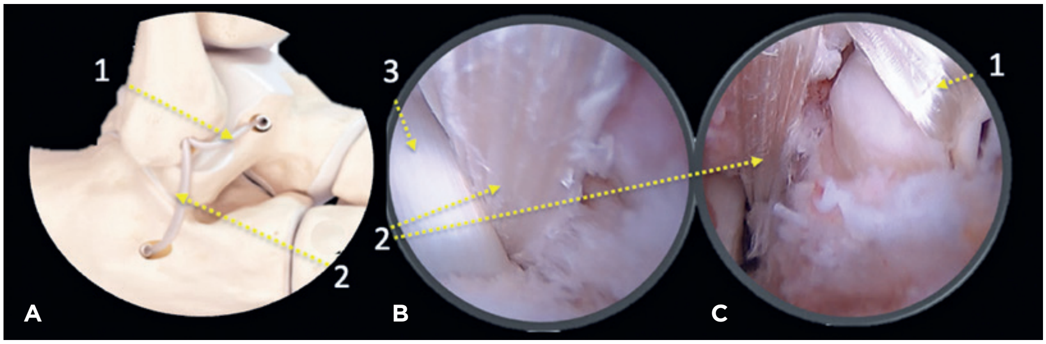

Figure 11. Final view. (A) Schematic view; (B) CFL graft; (C) Complete graft view. (1) ATFL graft; (2) CFL graft; (3) Fibular tendons.

four weeks and progressively to full weight-bearing at six weeks. Physiotherapy was started at four weeks with a strict protocol.

Conclusion

The ongoing developments in understanding the pathophysiology of lateral ankle instability and advancements in surgical techniques and rehabilitation strategies have changed the approach to lateral ankle instability. The low morbidity combined with the restoration of stability and accelerated rehabilitation has spotlighted anatomical arthroscopic techniques. With the growing literature evidence supporting its efficacy and safety, these procedures are becoming the preferred choice for treating lateral ankle instability.

Authors' contributions: Each author contributed individual and significantly to the development of this article: GAN *(https://orcid.org/0000-0003-4431-5576), and TSM *(https://orcid.org/0000-0003-4168-0981), and MG *(https://orcid.org/0000-0003-0671-4648), and MDP *(https://orcid.org/0000-0001-6043-698X), and GC *(https://orcid.org /0000-0002-7035-3931), and JV *(https://orcid.org/0000-0003-2762-8845) Conceived and planned the activity that led to the study, wrote the article, participated in the review process, data collection, bibliographic review. All authors read and approved the final manuscript.*ORCID (Open Researcher and Contributor ID iD.

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