

Current Concepts

Lateral Ankle Instability: Review of the Diagnosis & Treatment

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Ankle sprains are common injuries that can progress into chronic lateral ankle instability (CLAI). Definitive diagnosis and optimal treatment of CLAI are still controversial. Multiple studies have been conducted to better understand the anatomy and underlying pathophysiology of CLAI. History and physical examination are essential tools in the diagnosis of CLAI. Further imaging studies, including stress views, magnetic resonance imaging (MRI), and ultrasound, can aid in diagnosis if the physical examination findings are vague. Conservative treatment is often successful in the acute setting and can also be considered the first line of treatment in CLAI. Anatomic and nonanatomic procedures are described in the treatment of CLAI. Open anatomic repair with the Broström-Gould procedure seems to be the gold standard technique. Arthroscopic intervention emerged in the last decade, but there is still not enough evidence to support this procedure over the open Broström-Gould procedure. This review article aimed to summarize the diagnostic methodology and treatment options for CLAI.

INTRODUCTION

Lateral ankle sprains are common musculoskeletal injuries, and about 2 million ankle sprains occur annually in the United States. They are frequently sports related and may end up missing training and competition in addition to high reinjury rates.¹ If they are undertreated, they can cause residual symptoms, weakness, chronic pain, and instability. Lateral ligament instability can also lead to debilitating post-traumatic arthritis in the long term.²

Approximately 80% to 90% of acute ankle sprains can be treated with nonsurgical management. However, about 20% of the patients with acute lateral ligament ruptures may develop chronic lateral ankle instability (CLAI) after one year from the index injury.³ Diagnosing and treating acute and chronic ankle sprains requires understanding the anatomy that provides stability to the lateral ankle. Clinicians should be able to perform a focused physical examination and obtain appropriate imaging studies to provide optimal treatment.⁴

Various surgical procedures have been described to treat CLAI, including open anatomic ligament repair,⁵ anatomic ligament reconstruction with allograft or autograft,⁶ nonanatomic reconstruction,⁷ and arthroscopic reconstruction.⁸ Although there are plenty of surgical treatment options, the ideal treatment of CLAI is still controversial. In

this review article, we aim to provide condensed knowledge of the diagnosis and treatment of CLAI.

REVIEW

ANATOMY

Bony structures contribute up to 30% of ankle stability in rotational forces. The talus has a unique morphology with a broader anterior surface than the posterior. The anatomy of the talus bone increases ankle joint stability in a neutral position but predisposes instability for supination-eversion injuries. Hindfoot varus alignment has also been shown to predispose lateral ankle instability.⁹

Ligamentous structures play an essential role in ankle joint stability. The lateral ligamentous complex is the primary stabilizer of the lateral side of the ankle joint. The lateral ligamentous complex is composed of anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligament (PTFL) [Figure 1]. Disruption of this lateral ligamentous complex can lead to ankle instability.¹⁰

The ATFL is located adjacent to the lateral joint capsule. The ATFL has different compositions of bundles and fascicles, including single (23-38%), double (50-70%), or triple bundles (6-18%). The ATFL's superior fascicle is considered

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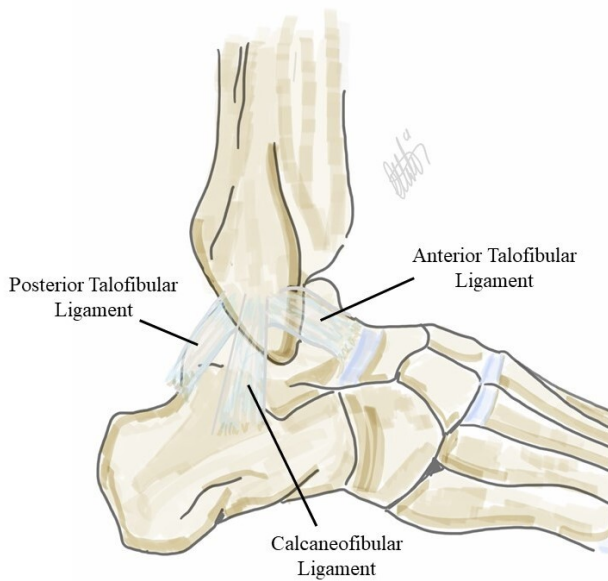


Figure 1. Lateral ligamentous complex showing the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligament (PTFL) (Original work of the authors)

an intra-articular structure in the ankle that probably makes it unable to heal after a rupture. The ATFL's inferior fascicle is an extra-articular structure in close relationship with the lateral part of the subtalar joint capsule.¹¹ Clanton et al. reported that the single bundle ATFL originates a mean of 13.8 mm (12.3 – 15.3 mm) from the inferior tip of the lateral malleolus and inserts a mean of 17.8 mm (16.3 – 19.3 mm) superior to the apex of lateral talar process.¹² When the ankle is plantarflexed, the ATFL becomes vertical to the ankle joint and acts as the primary stabilizer during inversion. The ATFL is the most anterior and weakest part of the lateral ligamentous complex; therefore, it is prone to injuries.¹¹

The CFL is described as a cordlike extracapsular structure. The CFL originates from below the insertion of the inferior bundle of the ATFL at the anterior border of the lateral malleolus and inserts to the posterior aspect of the lateral surface of the calcaneus, posteroinferiorly to the peroneal tendons. The insertion is superior and posterior to the peroneal tubercle. Most of the CFL is covered by the peroneal sheath. It has an oblique trajectory going to the posterior-inferior medial direction. Anatomic variations of the CFL are also reported; the single bundle is the most frequent morphology. The CFL crosses both tibiotalar and subtalar joints providing ligamentous stability for both joints. When the ankle is dorsiflexed, the oblique trajectory of the CFL becomes vertical to the ankle joint, which makes the CFL the primary lateral stabilizer of the ankle and secondary stabilizer of the subtalar joint.¹³

The inferior fascicle of the ATFL and the anterior border of the CFL have interconnections by the arciform fibers that pose an intrinsic reinforcement to the subtalar joint. The

PTFL is the strongest and least vulnerable lateral ankle ligament. Its isolated injury is highly infrequent.¹¹

PATHOPHYSIOLOGY

Excessive internal rotation of the hindfoot and external rotation of the tibia is the most common mechanism of injury for lateral ankle sprains. The ATFL is the most frequently injured ligament. The CFL is affected in 50-75% of the sprains, and the PTFL gets injured in less than 10%. Although ATFL injuries are the most frequent lateral ligament injuries, the exact location of the injury within the ATFL is poorly addressed. Pierre et al. conducted a cadaveric study that showed 50% of the injuries were avulsions from the talar insertion, and 44% were mid-substance ruptures; interestingly, no fibular side avulsions.¹⁴ On the other hand, Kim et al. evaluated in vivo rupture sites of the ATFL with magnetic resonance imaging (MRI). The authors reported that 40% of the ruptures are located at the fibular attachment, 27.1% at the talar insertion, 14.5% at the mid-substance level, and 18.2% at multiple locations within the ATFL.¹⁵

The CLAI can be classified into two forms: functional and mechanical. Patients with functional instability often report insecurity, feelings of instability, and giving way. During physical examinations of these patients, there may sometimes be no demonstrable instability, even with stress radiographs. The potential causes of functional instability include damage to proprioceptive nerves within the ligament and surrounding skin and delayed muscle activity at the peroneal muscles. Mechanical instability is actual insufficiency at the lateral ligamentous structures, with demonstrable laxity on physical examination and stress test. Under mechanical instability, microinstability is a recently proposed concept involving a partial tear of the ATFL only at the superior fascicle.¹⁶ The superior fascicle of the ATFL is reported to be an intra-articular ligament that decreases its healing potential.¹¹ In the presence of microinstability, recurrent sprains could progressively affect the inferior fascicle of the ATFL and the CFL and may end up with true mechanical CLAI.¹⁶

Lateral ankle sprains are classified into three grades based on the severity of the injury. Grade 1 accounts for microscopic tears within the ligament. Grade 2 includes partial tears, and Grade 3 is represented with complete tears of the ligaments. It is hard to diagnose the grade of the injury in acute settings. Van Dijk et al. suggested that a physical examination <48 hours had 71% sensitivity and 33% specificity, while a repeat examination within 4-5 days had 96% sensitivity and 84% specificity in detecting ankle ligamentous injuries.¹⁷

DIAGNOSIS

Patients often present with ankle pain and instability following traumatic ankle sprains sustained commonly during athletic activities. The patient's history should include the mechanism of injury, the ability to bear weight immediately after injury, the frequency of instability episodes, and previous treatments. The physical examination starts with

evaluating the alignment of the foot and hindfoot, as well as the gait examination. Varus alignment of the hindfoot is associated with lateral ankle instability and can easily be missed during the initial evaluations. Attention should be given to detecting any underlying varus deformity. In addition, ligamentous laxity should be examined carefully. If undiagnosed, it can end up with recurrent instability after surgery. Furthermore, tender points should be noted. Provocative stress tests can be performed, including anterior drawer (AD) test, talar tilt (TT) test, external rotation test, and Squeeze test.⁴ The AD test has 12-80% sensitivity and 67-100% specificity, and the TT test has 17-66% sensitivity and 82-100% specificity in diagnosing lateral ligament ruptures.¹⁸

Physical examination of the lateral ankle instability is challenging, given that ligamentous tensions change depending on the ankle's position. AD and TT tests are the most frequent tests used in clinical practice. The ATFL is maximally tensioned during ankle plantar flexion, and the CFL has maximum tension at the ankle dorsiflexion position.¹⁹ True sagittal translation of the ankle during the AD test may not be applicable due to intact medial ligamentous support. For that reason, the anterolateral drawer test involves the hindfoot being stabilized with the thumb located on the lateral ankle joint line, and the ankle is plantar flexed 10-15° while the other hand stabilizes the tibia. As the foot translates anteriorly, the foot internally rotates, and the physician can feel a step-off between the anterior fibula and lateral talus. The anterolateral drawer has been reported to be more accurate and detects more subtle instability than the AD test in diagnosing the ATFL injury.^{20,21} Examination of the CFL with TT test may cause clinicians to struggle to differentiate the tibiotalar tilt from the subtalar tilt because the CFL crosses both the tibiotalar and subtalar joints. A talar tilt of more than 10-15° degrees commonly indicates ligamentous injury. Comparative examination with the contralateral extremity is helpful, and any difference greater than 5° can also indicate a positive test.²²

Plain weight-bearing anteroposterior and lateral foot and ankle radiographs are often obtained. These images provide information about the joint space and alignment of the foot. Stress radiographs are also postulated as objective supplements to the physical examination. The threshold values for the AD test were 10 mm of anterior translation or 5 mm difference compared to the uninjured ankle; for the TT test, more than 10° of tilt or greater than 5° compared to the uninjured side.²³

MRI is also a useful diagnostic tool in the diagnosis of CLAI. It can provide information about associated foot and ankle pathologies such as tendon tears, cartilage injuries, and bone bruises.²⁴ The characteristic signs of CLAI on MRI scans include ligamentous swelling, discontinuity, undulating ligament, and nonvisualization of the ligament. Partial tears can be visualized as thickened ligaments with irregular contours. Although MRI is frequently used to diagnose CLAI, its biomechanical diagnostic ability is limited. A torn ligament may not be clinically symptomatic. Physical examination with patient history is still the major diagnostic

hallmark in CLAI.²³ However, MRI is useful in diagnosing concomitant injuries such as tendon tears and cartilage injuries.

Ultrasound (US) has been reported to be 100% specific and 94% sensitive in diagnosing ATFL tears compared to MRI.²⁵ Dynamic US has rapidly evolved in the past years in musculoskeletal injuries, providing a dynamic evaluation of both ligaments and the ankle joint. Choe et al. suggested a threshold greater than 20% stretch in ATFL length with dynamic ultrasound could predict CLAI.²⁶ However, the US is highly operator-dependent, and an experienced operator is required to obtain reliable results.

TREATMENT

Most lateral ankle sprains can be treated successfully with conservative treatment. Although the natural healing course after lateral ankle sprains is not clearly explained, complete acute isolated ATFL injuries have good outcomes with functional rehabilitation.²⁷ Early surgical treatment can provide a faster return to sports in selected patients such as elite athletes with high demand.²⁸

CONSERVATIVE TREATMENT

The optimal conservative treatment modality is not yet determined; the proposed methods are oral anti-inflammatory, temperature contrast baths, casting, elastic bandaging, therapeutic ultrasound, injections, ice, and a combination of these modalities.²⁷

Functional rehabilitation and bracing or taping are the most used conservative treatments. Grade 1 ankle sprains should receive functional rehabilitation and bracing as the initial treatment. Functional rehabilitation includes personal strengthening exercises and proprioception training. Ankle braces or tapes restrict the range of motion but decrease the reinjury rate and improve proprioception. Taping seems less bulky than braces, but braces have the advantage of being reusable. Functional rehabilitation and bracing or taping can provide approximately 80% functional improvement in CLAI patients.²⁹ Before surgical treatment, orthopedic surgeons should clarify if the conservative treatment has been done properly. If not, a repeat conservative treatment course is recommended.¹⁶ Although there is not enough evidence to support acute surgical repair after ankle sprains, patients requesting return to their pre-injury level in short-term and recurrent ankle sprains with functional instability can be considered candidates for acute surgical intervention.³⁰

SURGICAL TREATMENT

The surgical techniques for treating CLAI can be classified into two categories: anatomic procedures and nonanatomic (tenodesis) procedures. Non-anatomic procedures such as Watson-Jones [Figure 2A], Evans [Figure 2B], or Chrisman-Snook [Figure 2C] have been shown to alter the biomechanics of tibiotalar and subtalar joints, such as restriction in the range of motion of tibiotalar and subtalar joints. Krips et al. compared anatomical reconstruc-

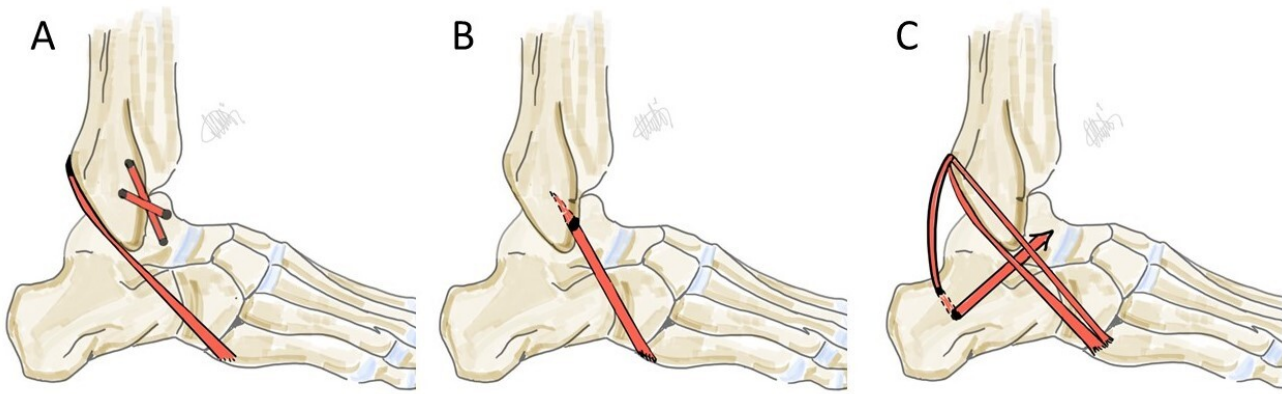


Figure 2. Nonanatomic reconstruction of lateral ankle instability with A) Watson-Jones procedure, B) Evans procedure, and C) Chrisman-Snook procedure. (Original work of the authors)

tion with tenodesis and reported tenodesis results in ankle stiffness, reduced long-term stability, and increased risk of medially located degeneration in 2 to 10 years.³¹ Therefore, anatomic repairs are recommended as the first line of surgical treatment.¹⁶

The first anatomic repair was described by Broström in 1966 and involves mid-substance imbrication and tightening of the ATFL and the CFL. Since then, several modifications have been proposed to the Broström technique. Gould et al. described the mobilization of the lateral portion of the extensor retinaculum and attaching it to the fibula on top of Broström repair.⁵ Karlsson et al. suggested the ATFL and CFL are not disrupted but elongated. The authors recommended tensioning the ligament by shortening and reattaching it to its anatomic origins through drill holes.³² A technique has been described recently that suggests augmentation of Broström repair with non-absorbable suture tape. The noted advantages of this technique are less immobilization and the allowance of early and aggressive physical therapy.³³

The success of open repairs is highly related to the soft tissue quality that allows effective repair. After open repairs with varying modifications, the functional outcomes have 87-95% success rates.^{5,32} The major risk factors for recurrence and worse outcomes are hyperlaxity, long-standing instability, and previous surgical repair attempts.

Developments in minimally invasive surgery rendered arthroscopic CLAI surgery options possible. Early attempts started with thermal shrinkage of the ATFL³⁴ followed by arthroscopic assisted Broström procedure with anterocentral or accessory anterolateral portal.³⁵ These procedures required percutaneous steps and accompanying nerve injury risk; therefore, an all-inside arthroscopic technique was described to avoid nerve issues.⁸ In a recent meta-analysis comparing open and arthroscopic Broström surgery, the authors concluded that arthroscopic surgery is more technically demanding but provides superior postoperative American Orthopedic Foot and Ankle Society (AO-FAS) scores, visual analog scale (VAS) pain scores, and time to return to weight bearing. However, the operative time, complication rate, talar tilt, and anterior drawer tests were

excellent and statistically comparable with both techniques.³⁶

The first nonanatomic procedure was described by Watson-Jones and involved weaving the peroneus brevis tendon through a bone tunnel within the fibula to the calcaneus and talus.³⁷ Evans proposed a relatively simpler technique that passes the distally attached peroneus brevis tendon through an oblique posteriosuperior bone tunnel.⁷ Chrisman and Snook described a split peroneus brevis tendon to approximate the ATFL and the CFL through bone tunnels within the fibula and calcaneus.³⁸ Evans technique can also be used to augment open Broström repair. Kaikkonen et al. reported that only 52% of the patients treated with the Evans procedure could return to their preinjury activity level, and the noted complications were recalcitrant swelling, stiffness, and instability.⁷ A randomized controlled study by Hennrikus et al. showed that Broström repair had superior outcomes and fewer complications than Chrisman and Snook repair.³⁸

COMPLICATIONS

Although Broström repair has been reported to be a successful surgical option, it is not without complications. Nerve injuries to the superficial peroneal nerve and sural nerve have been reported. Delayed wound healing can also be encountered. The quality of the repair depends on the remnant soft tissue quality; thus, patients with poor soft tissue quality or ligamentous laxity are prone to recurrent instability.^{39,40} Ankle stiffness is another issue after Broström repair, but it is more common after nonanatomic procedures. Ankle stiffness can alter ankle joint mechanics and cause early ankle joint arthritis. Since nonanatomic procedures include tendon harvesting, donor-side morbidities are major drawbacks.⁷

CURRENT UPDATES IN ANKLE INSTABILITY

The arthroscopic Broström procedure gained popularity in the past decade. Wang et al. showed that arthroscopic Broström procedure has similar functional outcomes compared with open Broström. However, arthroscopic surgery

was superior in the six months follow-ups.⁴⁰ Furthermore, Hou et al. conducted a randomized study comparing arthroscopic versus open Broström repair. They concluded that arthroscopic surgery was superior in terms of healing period and return to sports rate. However, there was no clinical difference between 1-year and 2-year follow-ups.⁴¹

Recently, there has been a growing interest in using internal brace tape to augment the Broström repair. A biomechanical study by Schuh et al. showed that augmentation with a suture tape provides a stronger biomechanical repair than the Broström repair.⁴² Wittig et al. showed an early return to sports and low recurrence of instability and revision surgeries with internal brace augmentation technique.⁴³ However, a recent systematic review suggested that the outcomes were comparable between open Broström procedure only and internal brace augmentation + Broström repair. The authors also concluded that there is minimal evidence to favor internal brace augmentation over Broström repair regarding better functional outcomes and lower recurrence rates.⁴⁴

CONCLUSION

Ankle sprains are frequent injuries. Although most acute ankle sprains can be treated with conservative modalities, a portion of patients still develop CLAI if not treated appropriately. Appropriate diagnosis and treatment are significantly related to understanding pathology, anatomy, and biomechanics. Broström-Gould repair still seems to be the workhorse for surgical management of CLAI. Recent developments in arthroscopic techniques and fiber tape implants seem promising in treating CLAI; however, more evidence

is needed to replace the open Broström-Gould repair as a gold standard.

DECLARATION OF CONFLICT OF INTEREST

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No information (names, initials, hospital identification numbers, or photographs/images) in the submitted manuscript can be used to identify patients.

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