Lateral Ligament Instability: Review of Pathology and Diagnosis

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Abstract

Purpose of Review Ankle sprains are a common injury that can lead to chronic lateral ankle instability resulting in pain, poor function, and decreased quality of life. The purpose of this review is to present information regarding injury mechanisms to the lateral ligaments of the ankle and the necessary steps to appropriately diagnose lateral ligament instability.

Recent Findings The literature demonstrates that history and physical examination is often a reliable method for diagnosis of lateral ankle instability. In addition, imaging modalities are often used as adjuncts for diagnosis, especially when physical exam findings are equivocal.

Summary In summary, chronic lateral ligament instability of the ankle occurs secondary to failure of the lateral ligamentous complex. A focused physical examination to evaluate the anterior talofibular ligament, calcaneofibular ligament, and posterior talofibular ligament is necessary for diagnosis. Imaging modalities including plain radiographs, stress radiographs, and MRI are helpful for definitive diagnosis and to rule out other pathology.

Keywords Ankle sprain · Lateral ligament instability · Anterior talofibular ligament · Calcaneofibular ligament

Introduction

Ankle sprains are common musculoskeletal injuries that can progress to chronic lateral ligament instability, a condition characterized by recurrent inversion ankle sprains, lateral ankle pain, and symptomatic instability. Lateral ligament instability is debilitating and can lead to even more severe disease in the form of post-traumatic arthritis [1–3, 4]. Appropriate diagnosis and management of this condition requires an understanding of the ligamentous complex that provides stability to the lateral ankle and how each structure can fail. In addition, the clinician must be able to perform a focused physical

examination and use appropriate imaging to reach a diagnosis prior to initiating treatment.

Anatomy

The ability to evaluate and diagnose lateral ligament instability of the ankle relies on a strong understanding of the anatomic structures that contribute to stability of the lateral ankle. While the bony anatomy of the ankle mortise provides some inherent stability to the joint, ligamentous structures play a significant role. The lateral ligamentous complex is composed of three main structures: the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligament (PTFL) (Fig. 1) [5–6, 7]. Pathology of this ligamentous complex is commonly a result of ankle inversion injuries and ultimately can result in joint instability.

The ATFL originates at the anterior aspect of the lateral malleolus. It courses anteromedially to insert on the anterolateral aspect of the talus at the junction of the body and neck. Most commonly, the ATFL has a bifurcate morphology with superior and inferior bands (50–70%). Single band (23–38%) and trifurcate (6–18%) anatomic variants also exist [5, 7]. The ATFL is an intra-articular structure and has an intimate relationship with the anterior joint capsule. With the ankle in

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Fig. 1 Lateral ligamentous complex of the ankle consisting of the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligament (PTFL)

plantar flexion, the ATFL is vertically oriented and becomes taut and begins to experience strain.

The CFL originates from the anterior-inferior aspect of the lateral malleolus at a point inferior to the origin of the ATFL. It courses posteroinferiorly and medially to insert on the lateral calcaneus. The CFL insertion is superior and posterior to the peroneal tubercle of the calcaneus. It spans both the tibiotalar and subtalar joints providing stability to both articulations. The CFL is an extra-articular structure and blends with the peroneal tendon sheath. Often, the CFL and ATFL have a connective fiber between them giving them a close relationship [7•].

The PTFL originates from the posteromedial aspect of the distal fibula and courses medially to insert onto the lateral aspect of the posterior talus. It travels almost directly horizontally to its insertion. Similar to the ATFL, the PTFL blends with the posterior joint capsule; however, it is extrasynovial.

Pathology

Ankle sprains are a common injury mechanism with an incidence of 2 to 7 acute ankle sprains per 1000 person-years resulting in approximately 2 million injuries per year [8•, 9]. The incidence of lateral ankle injury is more common in those involved in sports or in the military. Approximately 85% of all ankle sprains result in injury to the lateral ligamentous complex [10].

The ATFL is the most commonly injured structure with the lowest load to failure when compared to the other lateral ligaments. When the ankle is plantarflexed, the ATFL exhibits strain and becomes vulnerable to injury; additionally, in this position, the bony anatomy of the ankle provides less stability and constrain. As a result, in this position, the ATFL acts as a collateral ligament to the ankle [11•]. The ATFL primarily prevents internal rotation of the talus. It also prevents anterior

translation of the talus and is a restraint to plantarflexion. Inversion injury where a plantarflexed ankle undergoes supination and adduction is the most common mechanism of injury to the ATFL. Rupture of the ATFL typically occurs midsubstance; however, avulsion injuries are possible.

The second most common injury type is a combination injury to both the CFL and ATFL. The CFL rarely exhibits isolated rupture, but it can occur with an inversion injury to a dorsiflexed ankle where the CFL acts as the collateral ligament and the ATFL is slack. The load to failure of the CFL is approximately 2 to 3.5 times greater than the load to failure of the ATFL [12]. The CFL is the primary constraint to talar inversion when the ankle is dorsiflexed, and in plantarflexion, it resists inversion in conjunction with the ATFL [13•]. Rupture most commonly occurs midsubstance, but again, avulsion injury is not uncommon.

The PTFL is rarely injured unless gross dislocation of the ankle joint is seen, and it is almost always injured in combination with the failure of the CFL and ATFL. The PTFL resists external rotation with the ankle dorsiflexed and assists the medial ligaments with restricting dorsiflexion of the ankle.

Finally, it is important to recognize that ankle sprains can result in injury to structures other than the lateral ligament complex. These associated injuries include, but are not limited to, peroneal tendon tears; chondral and osteochondral fractures of the talus; medial ligamentous injury; ankle syndesmosis injury; and fractures to the hindfoot, midfoot, and forefoot. Without complete evaluation of the aforementioned structures, injuries may be missed and patient outcomes can be adversely affected.

Classification

Multiple classification schemes for lateral ligament instability have been described, and no apparent consensus exists on the best classification system. Some methods grade injury by the number of ligaments ruptured, while others grade injury by the severity of clinical signs and symptoms. Other systems grade injury based on which anatomic structures have been injured. A commonly used classification scheme describes grade I injury as characterized by injury to the ATFL and/or CFL without complete rupture to either structure. A grade II injury is characterized by complete rupture of the ATFL, but the CFL remains. A grade III injury is typically a result of complete rupture to both the ATFL and CFL. Grade III injuries may or may not have injury to the PTFL [11•].

Another important distinction is the difference between mechanical instability and functional instability [14•]. Mechanical instability is defined as objective findings demonstrating increased laxity in the lateral ligamentous complex of the ankle. These findings can be seen on physical exam or radiographic stress testing, which is described later. Functional instability is defined by the subjective symptoms

that a patient experiences. They often describe apprehension of ankle motion with a sensation of giving way and weakness during athletic activities. The distinction between mechanical and functional instability can help guide potential treatment recommendations.

Chronic Lateral Ankle Instability

In addition to acute injuries, pathology of the lateral ligaments of the ankle can lead to chronic lateral ankle instability, which is defined by persistent symptoms 1 year after primary injury [14•, 15•]. Up to 70% of patients who sustain an acute lateral ankle sprain can go on to develop chronic ankle instability [8•]. Following initial injury to the lateral ligaments, mechanical impairments may develop as a result of laxity of the ankle joint. These impairments can lead to recurrent instability episodes and attenuation of the lateral ligamentous complex. In addition, sensory impairments can develop that lead to persistent pain, perceived instability, and fear of reinjury. These mechanical and sensory impairments lead to altered kinematics, weakness, impaired reflexes, and decreased neuromuscular control [15•]. This ultimately leads to a cycle of mechanical, sensory, and motor deficiencies that contribute to chronic lateral ankle instability.

Diagnosis

Clinical Evaluation

Patients often present with ankle pain following a traumatic incident where they describe a twisting injury to the ankle usually sustained during athletic activities such as running, cutting, or jumping. For those who can recall a specific mechanism, they often describe inversion or internal rotation injury to an ankle in the plantarflexed position. Some patients describe audible cracking or popping, which may be indicative of a ligamentous rupture or fracture. Patients often report development of pain, swelling, and ecchymosis following injury. In severe injuries, patients will be unable to bear weight on the affected extremity.

Physical examination is a reliable tool to evaluate lateral ligamentous injury following an ankle sprain. Routine physical exam protocols should be followed. Inspection for swelling, ecchymosis, deformity, and open injuries should be performed. Purposeful palpation to elicit tenderness can guide the diagnosis. The ATFL, CFL, peroneal tendons, base of the fifth metatarsal, and lateral malleolus are some of the important structures to isolate with point palpation during the examination of the lateral ankle. Range of motion is often limited secondary to pain. Stress tests including anterior drawer and talar tilt testing can be performed to assist in the diagnosis of lateral ligament instability. These maneuvers will be described

below. Finally, assessment for intrinsic risk factors of lateral ankle instability including hindfoot varus, midfoot cavus, and overall systemic ligamentous laxity can be performed to further guide clinical evaluation and potential treatment options.

A comprehensive physical exam has demonstrated a sensitivity of 96% for detecting lateral ligament pathology at 5 days after injury and is particularly useful in diagnosis of grade III injuries [16, 17]. However, physical exam can be less reliable if performed within 48 h of injury due to swelling, pain, and inherent guarding. Repeat examination at a later date may need to be performed in such instances [16].

Stress Tests

To evaluate the integrity of the ATFL, the examiner evaluates for increased anterior translation of the lateral aspect of the talus (internal rotation of the talus). The exam should be performed with the foot hanging free. One hand stabilizes the tibia. The other hand cups the calcaneal tuberosity with the lesser fingers, while the thumb palpates and is placed in the interval between the fibula and talus (Fig. 2). An anteriorly directed force on the hindfoot is introduced through the lesser fingers, causing internal rotation of the talus with respect to the tibia/fibula that can be detected by the thumb (Fig. 3). Translation of 5 mm or greater is considered abnormal and indicative of ATFL injury [6, 18]. A sulcus or dimple sign can occasionally be seen. A positive test has been shown to have

Fig. 2 Demonstration of anterior talofibular ligament (ATFL) stress test. Examiner's right hand used to stabilize lower leg. Lesser fingers of left hand used to cup calcaneal tuberosity posteriorly and thumb on lateral malleolus

Fig. 3 Stress test of the anterior talofibular ligament (ATFL) using skeletal model. **a** Anterior view of ankle without stress. **b** Anteriorly directed force placed on hindfoot resulting in internal rotation of talus. Positive test representing ATFL disruption. **c** Lateral view without stress. **d** Lateral view of positive ATFL stress test with internal rotation of talus

reasonable sensitivity (73–96%) and specificity (84–97%) for ATFL injury [19, 20].

The talar tilt stress test is a method to evaluate for increased laxity with inversion of the talus (Fig. 4). The exam is typically performed under fluoroscopy. This test can be poorly tolerated by patients and may require local or general anesthesia to be performed reliably. The tibia is stabilized while inversion force is applied to the hindfoot. There is considerable variability in the normal talar tilt angle, and variable cutoffs have been used [21]. Most commonly, a talar tilt greater than

10–15° is often used to indicate ligamentous injury. Comparison to the contralateral ankle may help determine normal for specific patients, and greater than a 5° difference can indicate a positive test [22], depending on whether the test is performed under ankle dorsiflexion or plantarflexion dictates which ligamentous structure is primarily stressed. Ankle dorsiflexion typically isolates the CFL and ankle plantarflexion test contributions of the ATFL. Alternatively, the talar tilt stress test can be performed without fluoroscopy during a standard physical exam to assess stability and reproduction of patient symptoms. Both stress test maneuvers should always be performed bilaterally to assess differences from side to side.

Radiologic Examination

Radiographic evaluation is often necessary to evaluate lateral ligament instability and rule out other pathology. The Ottawa Ankle Rules are often used by emergency department and primary care providers to assess the need for radiographs in a patient presenting with an acute ankle sprain. Radiographs are indicated in patients who describe pain in the malleolar region and one of the following physical exam findings: bone tenderness over the inferior 6 cm of the medial or lateral malleolus or inability to bear weight or take 4 steps at the time examination. Following this protocol has nearly 100% sensitivity of identifying ankle fractures if performed within the first 48 h following injury; however, specificity of the Ottawa Ankle Rules is suboptimal and often falls below 50% [23–25].

Complete radiographic evaluation includes an AP, lateral, and oblique (mortise) radiographs of the ankle. These radiographs should be inspected to look for fractures of the malleoli and ensure that the ankle mortise is intact. In addition, fractures of the lateral process of the talus, anterior process of the calcaneus, osteochondral lesions of the talus, and ligamentous avulsion injuries can be missed. Radiographs can be used during stress testing to assist with diagnosis of ligamentous injury. There should be a low threshold to obtain radiographs of the foot to evaluate for associated injuries.

Fig. 4 Talar tilt stress test. **a** Oblique radiograph of right ankle demonstrating intact ankle mortise. **b** Positive talar tilt test with increased inversion of talus as a result of CFL injury. Avulsion fragment from talus noted

Fig. 5 Magnetic resonance imaging of the anterior talofibular ligament (ATFL) on fat-saturated proton-density-weighted axial cuts. **a** Normal appearance of the ATFL (arrow) as a thick black line spanning from its fibular origin (f) to its talar insertion (t). **b** Appearance of a complete and chronically ruptured ATFL, with the absence of a ligament spanning the interval between the normal fibular origin (f) and talar insertion (t)

While physical examination can lead a physician to the diagnosis of lateral ligament instability, the use of MRI is helpful to reach a definitive diagnosis and rule out associated injuries. MRI is able to assess the individual lateral ligaments,

surrounding tendons, articular cartilage, and bony structures. Generally, uninjured lateral ligaments appear uniform in thickness with low T1 and T2 signal intensity (Fig. 5a). Partial tears of the ligamentous structures can result in a thickened ligament

Fig. 6 Clinical vignette. Fifteen-year-old male presents with concerns of left ankle instability. The patient reports two previous severe ankle inversion injuries. He has been treated with activity modification, bracing, and physical therapy. However, his symptoms of instability and pain have persisted for over 1 year. Physical exam demonstrates full range of motion without signs of acute injury. Ligamentous testing notable for increased laxity with stressing of the ATFL. Neurovascular examination is intact without any deficits. Three weight-bearing views of the left ankle

are overall unremarkable (a). Axial MRI of the left ankle demonstrates incompetence of the ATFL (b). Patient proceeded with lateral ligament reconstruction using a modified Broström-Gould procedure (c) with identification of the inferior extensor retinacular (white) to supplement the repair of the joint capsule and remnant ligaments (blue) to the attachment of the ATFL and CFL on the fibula (black). Patient is doing well without recurrence of symptoms at his most recent follow-up

with irregular contour and increased internal signal. Complete rupture of the ligament will result in discontinuity with retracted wavy fibers [26] (Fig. 5b). Acute ATFL rupture is associated with capsular injury resulting in leakage of joint fluid and increased signal seen in the surrounding soft tissues [27]. Injury to CFL is associated with irregular appearance of the superior peroneal retinaculum and peroneal tendon effusion due to the close relationship with these structures. Finally, periarticular edema and hemorrhage are seen primarily in the acute setting and resolve at approximately 7 weeks post-injury. At that point, chronic changes become more prevalent including heterogeneous intrasubstance signal, ligament thickening with fibrosis, ligament elongation with wavy contour, or complete absence of the ligament [28•] (Fig. 6).

Ultrasound evaluation of the lateral ligaments has also been advocated. Using arthroscopy as a gold standard, ultrasound was 100% sensitive at diagnosing acute ATFL injury; however, it had low specificity and was less accurate than MRI evaluation [29]. Despite MRI being a superior imaging modality and ultrasound being highly operator dependent, ultrasound evaluation may be useful as it can be done routinely at bedside and at less cost than MRI. Arthrography has also been used to diagnose lateral ligamentous injury with a sensitivity of 96% and a specificity of 71%, although it has become less common with availability of MRI [30]. It is most useful in the acute setting within 24–48 h of injury and when MRI is unavailable. Lastly, arthroscopic evaluation may be indicated in patients with persistent symptoms consistent with lateral ligament instability and negative MRI findings [31, 32].

Conclusions

Proper evaluation of lateral ligament instability requires the clinician to have an understanding of the ligamentous complex that provides stability to the lateral ankle. Pathology of these ligamentous structures can often be diagnosed with physical examination, especially in high grade injuries. Imaging modalities including plain radiographs, stress test imaging, and MRI are useful modalities to assist in the diagnosis and will help guide subsequent management.

Compliance with Ethical Standards

Conflict of Interest Edward Hur has no conflicts of interest to declare.

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Overview of the different imaging modalities used to evaluate ankle injuries including use of radiographs, MRI, and ultrasound.

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