Imaging of Ankle Sprain

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Introduction

Ankle sprain is among the most common musculoskeletal injuries. Most cases follow inversion trauma and involve the lateral ligament complex, but the apparently simple diagnosis of an “ankle sprain” encompasses a wide spectrum of injuries involving ligaments, tendons, cartilage, bone and the distal tibiofibular syndesmosis.

For the radiologist, the challenge is not simply to demonstrate a torn anterior talofibular ligament (ATFL). The clinically relevant questions are: Which ligament complex has been injured? Is the ankle mechanically stable? Is the syndesmosis involved? Is there an associated osteochondral, tendinous or osseous injury that could explain persistent symptoms?

Injury patterns

The mechanism of injury provides an anatomical roadmap. The classic lateral ankle sprain occurs with inversion, frequently combined with plantar flexion. The ATFL is usually the first ligament injured. With increasing trauma severity, the calcaneofibular ligament (CFL) and, less frequently, the posterior talofibular ligament (PTFL) may also be damaged.

External rotation and dorsiflexion should raise concern for injury to the distal tibiofibular syndesmosis—the so-called high ankle sprain.

Eversion trauma can damage the medial collateral or deltoid ligament complex and should also prompt careful assessment of the syndesmosis and proximal fibula.

Radiographs: fractures and alignment come first

Radiographs remain the initial imaging technique following significant acute ankle trauma when clinically indicated. Their primary role is to exclude fractures and assess joint alignment. Standard anteroposterior, mortise and lateral views are usually obtained.

Radiographs also provide indirect information about ligament injury.

Widening of the medial clear space may suggest deltoid ligament incompetence.

Abnormal tibiofibular relationships may indicate syndesmotic instability.

Small avulsion fragments are particularly important. A tiny fragment near a ligament insertion should not simply be described as a “small avulsion fracture.” It identifies the site at which a ligament or tendon has transmitted sufficient force to the bone to cause failure.

Weight-bearing or stress radiographs may provide additional information in selected patients with suspected instability. Stress radiographs shouldnot be obtained at the acute stage of the injury.

Ultrasound: the dynamic examination

High-resolution ultrasound is particularly well suited to ankle ligament assessment because most relevant structures are superficial. The ATFL can be visualized from the fibular malleolus to the talus. A normal ligament has a compact fibrillar appearance. Acute injury may produce thickening, hypoechogenicity, partial fiber disruption or complete discontinuity.

Ultrasound is also a dynamic assessment. Anterior drawer stress can demonstrate abnormal separation or translation associated with ATFL insufficiency. Similarly, the CFL can be evaluated during inversion and dorsiflexion.

Ultrasound also allows immediate evaluation of the peroneal tendons, retinacula and other superficial structures.

The ATFL

The ATFL is the most frequently injured ankle ligament. Because ATFL abnormalities are so common, particularly in patients with previous sprains, the radiologist must distinguish acute injury from chronic sequelae. An acute tear may demonstrate ligament thickening, increased signal or echogenicity changes, surrounding edema and discontinuity. Chronic injury may produce an attenuated, irregular or elongated ligament, sometimes with associated synovitis or ossicles.

MRI can demonstrate the ligament directly, but a visible ligament does not necessarily mean a functional ligament. A chronically elongated ATFL may remain continuous while providing inadequate mechanical stability. Clinical and dynamic assessment therefore remain important in patients with chronic ankle instability.

The CFL

The CFL extends from the fibular tip to the lateral calcaneus and crosses both the ankle and subtalar joints. It is frequently injured in more severe inversion trauma.Because of its oblique

course, the CFL may be difficult to assess completely on routine axial MRI. Multiplanar imaging or dedicated oblique reconstructions can improve evaluation.

Ultrasound is particularly useful because the ligament can be followed dynamically. The ligament can be set in tension by applying foot dorsiflexion. CFL injury is clinically important because combined ATFL and CFL disruption implies more extensive lateral ligament damage and may contribute to chronic instability.

The PTFL: rarely isolated

The PTFL is the strongest component of the lateral ligament complex and is rarely injured in isolation. Its disruption usually indicates severe trauma, frequently associated with ankle dislocation or extensive capsuloligamentous injury. An isolated abnormal PTFL signal on MRI should therefore be interpreted cautiously. The imaging findings should correspond to the expected severity and mechanism of injury.

Syndesmotic injury: the lesion not to miss

Syndesmotic injuries are less common than lateral ankle sprains but potentially more clinically significant because unrecognized instability may lead to chronic pain and premature osteoarthritis.

The distal tibiofibular syndesmosis includes the anterior inferior tibiofibular ligament (AITFL), posterior inferior tibiofibular ligament, interosseous ligament and distal interosseous membrane.

MRI is highly sensitive for demonstrating ligament disruption and associated edema. However, morphology and mechanical instability are not synonymous. A torn AITFL does not necessarily imply an unstable syndesmosis, while subtle instability may be difficult to demonstrate on a non-weight-bearing static MRI.

Radiographs, weight-bearing imaging, stress examination and, increasingly, weight-bearing CT may provide complementary biomechanical information. The radiologist should therefore distinguish syndesmotic ligament injury from syndesmotic instability. This distinction has direct therapeutic implications.

The deltoid ligament

The medial collateral ligament complex is composed of superficial and deep components. The deep deltoid ligament plays an important role in stabilizing the talus within the ankle mortise. Injury may occur during eversion or external rotation trauma and can accompany syndesmotic lesions or fibular fractures.

MRI is useful for assessing the different components, although partial tears and post-traumatic signal abnormalities can be difficult to interpret. A major pitfall is diagnosing a clinically significant tear simply because the ligament appears heterogeneous. The deltoid complex has a naturally complex striated appearance. Again, morphology must be interpreted together with alignment, trauma mechanism and associated injuries.

Ultrasound enables to visualize the anterior (and superficial medial collateral ligament in neutral position whereas analysis of the posterior (deep) deltoid ligament can be assessed by using forced dorsiflexion of the foot.

Do not forget the tendons

Persistent symptoms following an apparently uncomplicated ankle sprain may originate from tendons rather than ligaments. Peroneal tendon injuries are particularly important after inversion trauma. The radiologist should evaluate the peroneus longus and brevis tendons, superior peroneal retinaculum and retromalleolar groove. Tendon splitting, tenosynovitis, subluxation and retinacular injury may accompany lateral ankle trauma. Dynamic ultrasound is particularly useful for detecting peroneal tendon instability because the tendons may be normally positioned on static MRI.

Medially, posterior tibial, flexor digitorum longus and flexor hallucis longus tendons should also be assessed when the mechanism or symptoms suggest involvement.

Osteochondral lesions: look at the talar dome

One of the most important causes of persistent pain after ankle sprain is an osteochondral injury of the talar dome. Radiographs and ultrasound may be normalmay be normal. MRI can demonstrate bone marrow edema, cartilage injury, subchondral fracture and unstable osteochondral fragments. CT provides superior characterization of subchondral bone and is particularly useful for preoperative assessment.

When interpreting MRI after ankle trauma, the talar dome should be inspected systematically even if a ligament tear has already been identified. The presence of an obvious ATFL tear should never become an excuse to stop searching.

Bone marrow edema tells the story of impact

Bone marrow edema is common after ankle trauma and is sometimes dismissed as nonspecific. However, its distribution can provide important biomechanical information. Contusions on opposing surfaces can reveal the direction of impact and help reconstruct the mechanism of injury. This can be particularly useful when the clinical history is vague. A marrow edema pattern inconsistent with a simple inversion injury should prompt

reconsideration of the mechanism and a search for additional ligamentous or osteochondral abnormalities.Thus, bone bruises should not simply be listed in the report. They can be used as footprints of trauma.

Persistent pain after a “simple sprain”

When symptoms persist several weeks or months after an ankle sprain, the imaging question changes. The objective is no longer simply to confirm that a ligament was injured. The radiologist should search systematically for complications and missed associated lesions: chronic lateral instability, syndesmotic injury, osteochondral lesion, peroneal tendon pathology, anterolateral impingement, occult fracture, loose body or post-traumatic synovitis. MRI provides an excellent overview in this situation, while ultrasound adds dynamic assessment of ligaments and tendons. Posttraumatic capsulitis is probably a frequently underdiagnosed condition

A practical reading strategy

A systematic approach is useful for both ultrasound and MRI.

- First, reconstruct the mechanism of trauma from the clinical history and bone contusion pattern.
- Second, evaluate the lateral ligament complex sequentially: **ATFL** → **CFL** → **PTFL**.
- Third, assess the distal tibiofibular syndesmosis.
- Fourth, examine the superficial and deep components of the deltoid ligament.
- Fifth, evaluate the peroneal and medial tendons and their retinacula.
- Sixth, inspect the talar dome and remaining articular surfaces for osteochondral injury.
- Finally, look for occult fractures, impingement lesions and other abnormalities that could explain symptoms.