CHAPTER **62**

RADIOGRAPHIC ANALYSIS OF ANKLE LIGAMENTOUS INJURIES

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It is estimated that 5-10 million ankle injuries occur every year in the United States accounting for between 10 – 16% of all sport injuries. In over 85% of these injuries, the lateral ligament complex is damaged to some degree leading to an annual cost of over 2 billion dollars.1 The ankle joint is a very complex region due to the number of structures that cross the joint to move and stabilize it. Ankle injuries can manifest subtly with minor swelling and discomfort or obviously with pronounced edema, ecchymosis and loss of function. Ankle ligaments are most commonly injured while the foot is in a plantarflexed position with supinatory forces crossing the ankle joint.[2]

It is imperative that the clinician be able to make the diagnosis as well as the correct initial assessment of the severity of the injury to avoid later undesirable sequelae. The determination of injury severity will influence the treatment course, including length and immobilization or even the need for surgical intervention. The combination of clinical assessment along with radiographic evaluation can aid the physician in achieving these goals.

ANATOMY

The lateral collateral ligaments are composed of 3 distinct ligaments: the anterior talofibular, the posterior talofibuluar and the calcaneofibular ligaments. The anterior talofibular ligament (ATFL) is a flat, fan-shaped , intra-articular ligament measuring 15-20mm x 6mm x 2 mm.[3] The ligament is relatively strong and deemed to be the primary stabilizer of the ankle joint. The ATFL originates from the inferior/anterior border of the lateral malleolus then courses anteromedially to insert on the talar body just anterior to the lateral malleolar articular surface.[3] The ATFL is intimately associated with the capsule of the talofibular joint and has been described as being a thickening of this capsule. The ATFL is the ligament most at risk for injury with inversion ankle injuries. The ATFL is taut with ankle plantarflexion and as the talus internally rotates or as the ankle mortise externally rotates in relation to the talus, increased tension is placed on the ATFL. The greatest strain on the ATFL occurs between neutral and 20 degrees of ankle plantarflexion when the CFL and PTFL are bearing the least load.[1,2]

The calcaneofibular ligament (CFL) is a strong, extra-articular, cordlike structure measuring approximately 30mm x 4mm x 3mm in dimension.[3] The CFL originates from the inferior segment of the anterior border of the lateral malleolus and then passes posteriorly and inferiorly to insert on a small tubercle on the posterior aspect of the lateral calcaneus. The CFL spans both the ankle and subtalar joints and is crossed superficially by the peroneal tendons. The CFL and ATFL make approximately a 105 degree angle with one another. The CFL is maximally taut with inversion and dorsiflexion of the ankle joint.

The posterior talofibular ligament (PTFL) is a strong, intracapsular ligament measuring approximately 30mm x 5mm x 8mm.[3] The ligament originates on the medial surface of the lateral malleolus from the inferior digital fossa. The PTFL courses posteromedially to insert on the posterior surface of the talus as it contributes to the formation of the tunnel for the flexor hallucis longus tendon. The PTFL is maximally stressed with dorsiflexion and inversion of the ankle joint. The PTFL is the strongest ligament of the lateral complex and the least likely to be injured in inversion ankle trauma.[3]

The medial deltoid ligamentous complex is a broad, strong complex composed of deep and superficial structures.[3] The superficial structures are the tibionavicular, the calcaneotibial and the superficial posterior talotibial ligaments. The deep deltoid structures are the deep anterior and posterior talotibial ligaments. The anterior talotibial ligament originates from the intercollicular groove on the medial malleolus and inserts onto the neck of the talus. The posterior talotibial ligament originates from the posterior colliculus and inserts on the posterior tubercle on the posterior process of the talus. The superficial portion of the deltoid ligament serves to prevent anterior translation of the talus when the lateral ankle ligaments rupture. The deep deltoid structures prevent lateral translation and valgus rotation of the talus in the ankle mortise. The deltoid complex is maximally stressed with eversion of the ankle joint but isolated rupture of the complex is rare. Oftentimes an avulsion fracture of the medial malleolus will occur before a rupture of the ligaments due to the inherent strength of the complex.

Syndesmotic sprains occur in approximately 10% of all ankle sprains and can be a chronic source of pain and arthritis if undiagnosed.[4] The distal tibiofibular ligament complex consists of 5 structures: the anterior, posterior, interosseous and transverse tibiofibular ligaments and distal aponeurotic fibers. Under static conditions, minimal tension is applied to the tibiofibular ligaments but with dorsiflexion of the talus, the syndesmosis widens by an average of 1.22mm and the fibula externally rotates 2 degrees.[5] Injury to the syndesmosis is produced by forced eversion of the talus in the ankle mortise while the foot is dorsiflexed attitude thus forcing the wider anterior portion of the talus into the ankle mortise.[5]

ANTERIOR DRAWER RADIOGRAPH

The primary restraint to anterior displacement of the talus in the ankle mortise is the anterior talofibular ligament. However when the ATFL is completely disrupted, the superficial portion of the deltoid complex can limit anterior displacement of the talus as well. The anterior drawer test, originally described by Dehne in 1934,[6] evaluates the integrity of the ATFL by measuring talar displacement in the ankle mortise utilizing push-pull stress. A major disadvantage of this exam is manual symmetric reproducibility of ankle position and load forces.[7] Mechanical devices such as the TELOS machine (Austin and Associates, Fallston, Maryland) are expensive and not readily available at all facilities. This device utilizes a standard 150-N force to apply stress to the ankle to evaluate the degree of injury present. Karlsson reported an anterior translation of the talus of 10mm along with a talar tilt of 9 degrees or more indicated ankle instability.[8]

The anterior drawer exam can be performed manually with the patient in a prone, supine or sitting position. With the patient in a sitting position, one stabilizes the heel of the injured ankle in one hand and pushes anterior-to-posterior with the other hand on the distal tibia (Figure 1A). A lateral radiograph is then obtained in this position. If the patient is in a supine position, one can elevate the heel of the injured foot on a sandbag or firm radiolucent block. The foot is held stable distally with one of the examiner's hands and the other hand is used to apply anterior-to-posterior pressure on the distal tibia (Figure 1B). With the patient in the prone position, the knee is flexed to 90 degrees, the distal tibia is stabilized with one hand and the foot is displaced from posterior to anterior with pressure applied to the posterior heel. The deltoid ligament may act as a point of rotation when the lateral ligaments have been disrupted and actually to some degree prevent the anterior displacement of the talus from the mortise. Slight internal rotation of the ankle joint before anterior translation of the talus may help to take these medial ligaments off stretch and obtain a pure measurement of ATFL integrity. A modified method described by Nyska et al. is performed with the patient supine on the table with knees flexed fully and the plantar foot in full contact with the table.[10] The foot is stabilized on the table with one hand and forceful posterior pressure is applied to the distal tibia with the other hand. The test is considered positive when the tibia moves posteriorly and proximally from the foot.[11] Dimpling over the skin of the anterolateral ankle may signify a defect in the ATFL. This may or may not be present due to edema. The examiner should also pay attention to the quality of the end-point of the excursion of the talus as a soft feel to the end range of motion may indicate complete ATFL rupture.[11]

Many different methods have been proposed for

Figure 1A. Foot is slightly inverted and talus is pulled anteriorly out of ankle mortise while anterior to posterior pressure is applied to the distal tibia.

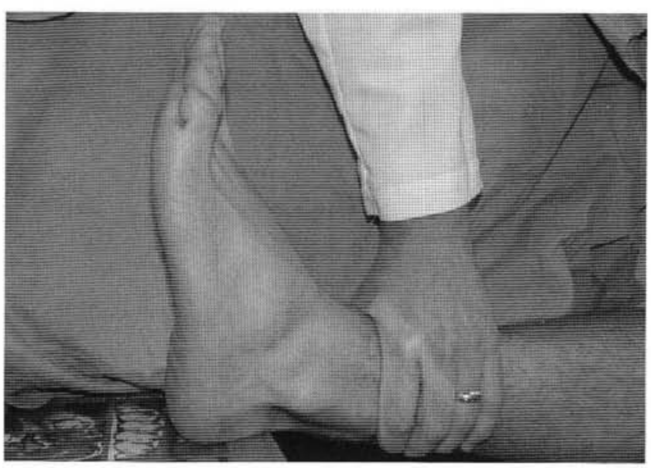

Figure 1B. The heel is placed on a stable surface elevating it off the exam table and anterior to posterior pressure is applied to the distal tibia.

measuring the anterior displacement of the talus. One method originally described by Landeros is to measure the distance between the posterior most aspect of the tibial plafond and the nearest point on the dome of the talus (Figure 2A). A posterior opening of the tibiotalar joint of less than 5mm is considered normal. However, an opening greater than 6-10mm is considered indicative of ATFL rupture.[12] Another method is to superimpose stressed and unstressed ankle views on one another and measuring the excursion of the distal fibula or the distance between 2 centers of curvature for the talus. The drawback to the x-ray superimposition methods that the radiographs may be shot at slightly different angles or by separate technicians leading to asymmetric views. Another method termed the concentric circle method involves drawing a concentric circle utilizing a radius guide for both the tibial plafond and the talar dome.[13] The direct centers of both the circles are identified and the distance between them are measured on a plane parallel to a line formed by connecting the anterior and posterior aspects of the tibial plafond (Figure 2B). The talar displacement is divided by the tibial plafond width (both in mm) and multiplied by 100 to determine the percentage of displacement.[13] The advantage of this method is it negates the necessity to take both unstressed and stressed views.

TALAR TILT

The inversion stress test is utilized to evaluate the integrity of the both the ATFL and the CFL in a combination injury. The test is performed with one hand grasping the foot at the calcaneo-cuboid joint and forcing it into inversion with the other hand stabilizing the distal medial tibia while the foot is in zero degrees of dorsiflexion (Figure 3A). A standard AP radiograph is obtained and the degree of talar tilt is determined (Figure 3B). The angle formed between the tibial plafond and the talar dome is then measured. Rubin and Witten reported a range of 0 – 23 degrees in normal ankles while Cox and Hewes believe that a talar tilt of more than 5 degrees compared with the uninjured side signifies that there is

Figure 2A. Talar Dome to Tibial Plafond Method

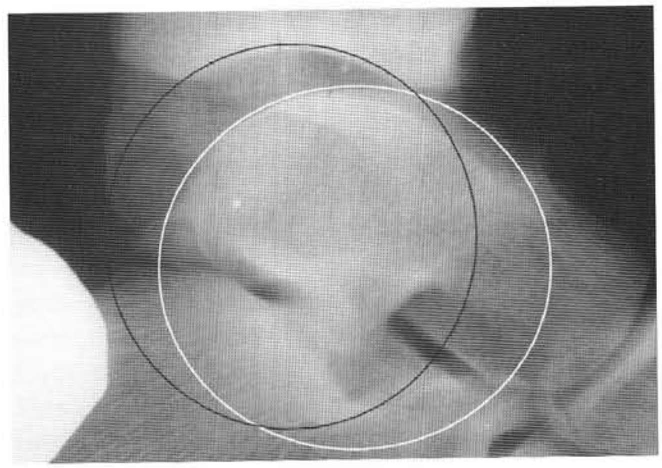

Figure 2B. Concentric Circle Method

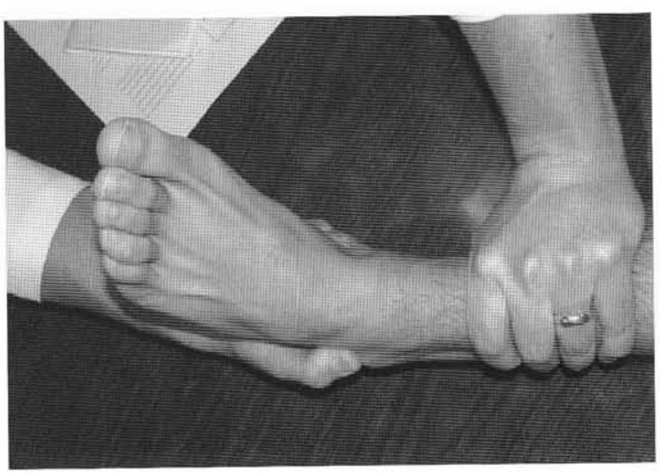

Figure 3A. Talar Tilt Exam. Foot is inverted while the tibia is held stable.

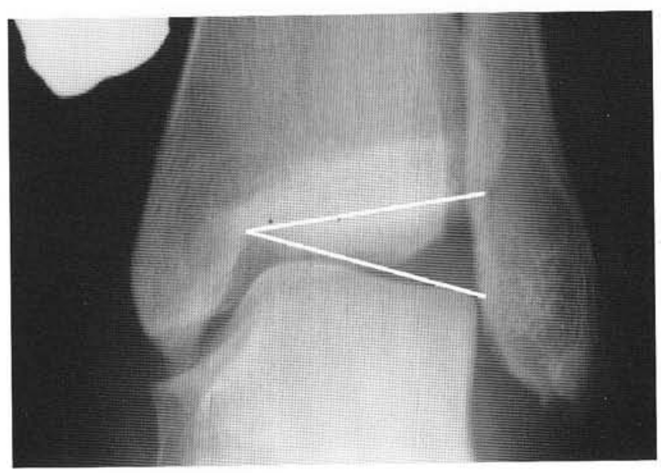

Figure 3B. Talar Tilt Exam

probably ligament rupture.[14] The variability in testing is most likely due to force that is manually applied, the position of the foot during stress and radiography and the usage of anesthesia.

MEDIAL CLEAR SPACE

The clear space between the lateral aspect of the medial malleolus and the medial aspect of the talus should not be greater than the distance between talar dome and the tibial plafond. If the medial clears space exceeds 6mm on the AP and mortise views, there may be damage to the syndesmotic ligaments present.

AP Radiography of the Ankle Syndesmosis

Even minor widening of the ankle syndesmosis secondary to injury can result in chronic pain and arthrosis unrecognized and untreated. Anatomic alignment of the ankle mortise is required for good joint congruency and painfree range of motion. Measurements of the tibiofibular overlap (TFO) and tibiofibular clear space (TCS) can be made on an AP radiograph to determine the presence and severity of syndesmotic injury. The TFO is determined by measuring the overlap of the anterior portion on the lateral tibia on the fibula. This is done simply by determining the distance between the lateral border of the tibia and the medial border of the fibula at a point 1 cm proximal to the ankle joint.[15] The tibiofibular clear space (TCS) is the area between the medial border of the fibula and the incisura fibularis on the tibia. The value that is historically supported by the literature for TFO is greater than or equal to10mm and less than 5mm for TCS both on AP radiographs. Harper and Heller determined that a TFO of greater than 6mm or 42% of the width of the fibula and less than or equal to 6mm for TCS was sufficient to rule out syndismotic injury.[16] A gender-based study by Ostrum et al determined that the TFO should be reported as normal when greater that 2.1mm for females and 5.7mm for males or greater than 24% of the fibular width. TCS should be less than 5.2mm for females and 6.5mm for men.[15]

ARTHROGRAPHY

Arthrography was first popularized by Brostrom and is useful for the detection of injury to the lateral, medial and syndesmotic ligaments of the ankle. Arthrography should be performed within 5 days of the original injury for accurated assessment. Contrast medium is injected into the ankle joint alone or in combination with local anesthetic. An anteromedial approach to the ankle is commonly used with the needle entering between the tibialis anterior and the extensor hallucis longus tendons injecting a total of 10cc of contrast medium.[17] Radiographs are then obtained to view the pattern of dispersion of the contrast material. The ATFL closely associated with the anterior portion of the ankle capsule and leakage of contrast to the anterolateral aspect of the joint indicates damage to this ligament. Leakage of the contrast into the peroneal tendon sheath can show injury to the CFL however sometimes this communication fails to occur.[17]

SUMMARY

There are various methods proposed for determination of radiographic values to assess the presence and degree of ankle ligamentous injury. Although a gold standard for ankle injury evaluation is not agreed upon, almost any of the methods described above can be used if individual variability is considered. If these radiographic values cause the examiner to elect surgical versus conservative care for the patients, then they can be a valuable tool. Consistent and reproducible exam methods in combination with proper radiology skills and positioning can influence the validity of these tests.

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