Ankle Injuries in Football

4

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Lateral Ankle Sprains

The seemingly benign "ankle sprain" has become commonplace is sports, especially in football. Players of all ages sustain these injuries and most parents, coaches, and players have some knowledge of "rolling" an ankle and sustaining a "sprain." Certainly, some of the general public's knowledge stems from the fact that ankle sprains are so common. At the high school level, ankle sprains are the most common injury during practice and competition and more likely to occur during practice than in games [1]. This may be due in part to the fact that there are more exposures during practices each season than in games. In 2006, the most common foot and ankle injuries among former collegiate football players participating in the Combine were lateral ankle sprains. Several epidemiological studies have been performed to characterize the incidence of ankle injuries in National Football League (NFL) players [2]. The foot and ankle are involved in roughly 17% of NFL injuries and occur most frequently in linemen [2]. Among foot and ankle injuries, lateral ankle sprains are increasingly common.

Lateral ankle sprains are important not only because of the frequency with which they occur but also because of their potential to cause long-term ankle instability. In fact, approximately 20–40% of lateral ankle sprains will lead to persistent symptoms, including pain and instability, if left untreated [3]. This chapter will focus on ways to minimize time lost from competition and how to prevent chronic instability.

The osseous anatomy of the ankle consists of the tibia medially, fibula laterally, and talus distally. It is a sickle-shaped joint with cartilage on both sides. While the tibial surface is commonly convex, it can be concave in approximately 16% of individuals. It is wider anteriorly than posteriorly.

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The lateral ankle complex is made up of the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligament (PTFL) [4]. The ATFL arises from the distal fibula and inserts onto the lateral aspect of the talar body (Fig. 4.1). The CFL connects the lateral fibula to the calcaneal tubercle. The PTFL runs from the posterior aspect of the lateral fibula to the posterior process of the talus.

The effect each ligament has on ankle mechanics depends on the position of the talus relative to the tibia. With the talus in neutral or dorsiflexion, the wider anterior border sits between the malleoli and imparts stability to the mortise. As the talus is plantarflexed, the mortise is no longer filled with bony anatomy and stability depends on ligamentous structures. The ATFL is taut with the ankle in plantarflexion, while the CFL is taut with subtalar inversion and the ankle in a neutral or dorsiflexed position. Perhaps the most well-known study on lateral ankle sprains was performed by Brostrom in 1965, who found that the ATFL was the most commonly injured lateral ankle ligament and, in fact, lateral ankle sprains occur most commonly when the ankle is in this plantarflexed and inverted position [5]. Oftentimes an injured player describes a “pop” or twisted ankle. While a player’s injury mechanism can be a clue to diagnosis, many times the injury is not observed and/or the athlete cannot recall exactly what happened.

In these cases, practitioners must rely more heavily on their physical exam. When examining a patient with a suspected lateral ankle sprain, approach the exam systematically. The first portion of the exam begins with an analysis of the athlete’s gait. This can be performed as they come off the field, and complete inability to bear weight may signify a more severe injury. Once sidelined, have the player sit and remove his cleats. After inspection and a brief assessment of neurovascular status,

Fig. 4.1 ATFL (**a**) and CFL (**b**) are the main structures of the lateral ligament complex. These ligaments provide the lateral ankle ligamentous stability. The ATFL and its broad insertion are well visualized. The CFL provides stability to both the tibiotalar and subtalar joints

assess the alignment of the hindfoot. A cavus foot can be a risk factor for ankle sprains. Test active and passive plantarflexion and dorsiflexion as well as subtalar inversion and eversion. Palpate the malleoli and ligamentous structures. Be sure to begin away from the area of tenderness to gain an athlete's trust and obtain a more precise exam.

After this is complete, move to dynamic tests of ankle stability. The anterior drawer test is a test of the ATFL and is performed with an anterior force placed on a dorsiflexed talus (Fig. 4.2a). While this can be compared to the contralateral foot for a baseline level of laxity, it is more helpful in anesthetized patients. Depending on the rules of participation, you can inject the tibiotalar joint with a local anesthetic to temporarily anesthetize the patient on the sidelines. This will allow you to perform these tests without causing pain and differentiate pain from instability.

The talar tilt test evaluates the function of the CFL. The examiner places one hand above the malleoli with the ankle slightly plantarflexed and holds the calcaneus in the other hand in order to use it to invert the foot (Fig. 4.2b).

These dynamic tests are difficult to objectively measure. Several grading systems have been used to characterize lateral ankle sprains. However, much of this relies on experience, with comparison to the athlete's contralateral side, and is largely subjective [6–8]. The most widely used classification system has three grades. The first is mild and involves little tenderness, no instability, and no loss of function. A grade 2, or moderate injury, consists of moderate swelling, tenderness, and instability, with a decrease in function. Grade 3 injuries are the most severe (Table 4.1). Grade 3 injury implies a complete ATFL rupture and has edema and ecchymosis that may be

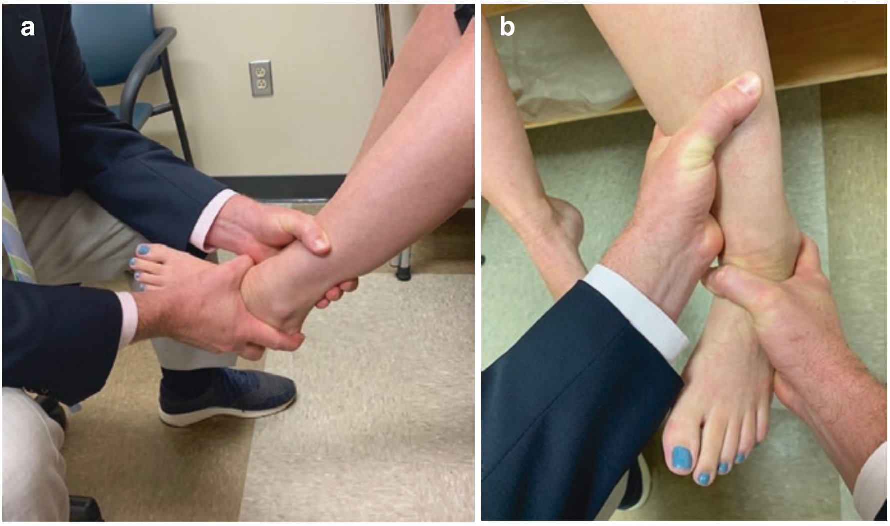

Fig. 4.2 (**a**) Anterior drawer test, using an anterior force on the calcaneus with the leg stabilized. (**b**) Varus Tilt test, a varus force is applied to the calcaneus and talus while stabilizing the subtalar joint

Table 4.1 Classification systems of lateral ankle sprains

Classification system of lateral ankle sprains
Anatomic system
Grade I: ATF sprain
Grade II: ATF and CF sprain
Grade III: ATF, CF, and PTF sprains
AMA standard nomenclature system
Grade 1: ligament stretched/attenuated
Grade 2: ligament partially torn
Grade 3: ligament completely torn

AMA American Medical Association, *ATF* anterior talofibular, CF calcaneofibular, *PTF* posterior talofibular

visible on the skin, very limited motion, frank instability, and is unable to participate [8].

Remember that there can be numerous associated injuries with low ankle sprains. Be wary of syndesmosis injuries (discussed subsequently), deltoid ligament sprains, subtalar subluxations or dislocations, lateral process of the talus fractures, peroneal tendon subluxations, underlying subtalar coalitions, avulsion fractures, or osteochondral lesions. Adequate radiographs can help identify most of these.

Obtain AP, lateral, and oblique or mortise images of the ankle. It is prudent to obtain full-length images of the tibia and antero-posterior, lateral, and oblique images of the foot. If at all possible, have the player standing when these are taken because this will demonstrate limb alignment and foot position more accurately. These weight-bearing views can also show instability such as talar tilt if a player has had many ankle sprains and chronic instability. Contralateral comparison views may be useful. Stress x-rays themselves or those where the examiner is using their hand to perform the external rotation, anterior drawer, or talar tilt tests listed above are less helpful with decisions about treatment but serve as excellent documentation (Fig. 4.3).

MRI is usually reserved for those athletes with ankle sprains that do not progress through the rehabilitation process in a timely fashion. MRI can delineate reasons for an athlete's inability to return to play including intraarticular and soft-tissue pathology as well as bone edema. When ordering MRIs for ankle sprains, most orthopedists consider many factors such as the performance of the athlete, time since injury, resources of the institution, and position during the season. Remember that many of the causes of slow return to play can be evaluated intra-operatively by arthroscopy, and MRI may not always provide useful information. Perhaps more importantly, MRI findings may not correlate with instability findings on physical exam becuase MRI is a static test, not a dynamic exam.

After diagnosis, focus begins on returning the athlete safely to the field as quickly as possible. In some cases, the athlete can return to play during the same game or practice. Additional stability is imparted with a lace-up ankle brace or taping by an athletic trainer. After competition, he/she should be treated with "RICE therapy" or rest, ice, compression, and elevation [9]. Rest can consist of non-weight-bearing for a few days in a splint or boot, brace, or limiting high-impact activities like running and cutting. Remember that during recovery, supportive athletic shoes with laces are better than sandals and slip-on shoes. Anti-inflammatory medications are

Fig. 4.3 Stress fluoroscopy of right ankle demonstrating significant instability with talar tilt test. Incongruency of the lateral tibiotalar joint is noted

excellent for pain control during this time. When the athlete is able to bear weight without pain, begin active range of motion exercises and progress through a proprioception training. Many of these exercises include single-leg standing activities on uneven surfaces or balance boards. Single-leg hops can be a quick tool to assess their progress. In our experience, once the player can do 15 consecutive single-leg hops, they can usually return to play. Finally, the player can resume noncontact football-specific drills. Progression should be based on the player's progression, not strictly based on time.

Surgical treatment is usually reserved for chronic instability. Clinically, these players have more instability and less pain than acute ankle sprains. It is not advisable to operate during the season unless absolutely necessary, as this would most likely preclude the player from participating for the remainder of the season. There are several operative repair techniques, many are of only historical interest, as they have fallen out of favor. Most surgeons today prefer an anatomic repair; however, there are still surgeons employing non-anatomic repairs, such as Evans technique, which uses a portion of the peroneus brevis tendon to stabilize the lateral ankle and prevent inversion.

Today, the author's preferred technique is to anatomically repair both the ATFL and CFL (Brostrom-Gould procedure) while often employing a newer augment technique utilizing an internal brace (Arthrex, Naples, FL). This augmentation is valuable in high-level collegiate and NFL players, whose ankles see tremendous stress. It is also indicated for players who have had prior failed ankle instability surgery or those who have baseline hypermobility [10]. Salvage options include anatomic reconstruction of the ATFL and CFL with allograft tissue. However, these are reserved for refractory cases of chronic instability. During surgery, arthroscopy can assess instability, remove hematoma and debris from the joint, characterize the status of the articular cartilage, and allow for intervention if needed. Following surgical treatment, the player is placed in a splint and is non-weight-bearing for a short period of time (2–4 weeks). Subsequently, the rehabilitation is similar to that explained above for nonoperative treatment.

Surgical treatment is not without complication. Early complications most commonly include issues with wound healing and superficial peroneal nerve injury. Technical failures intraoperatively can present as immediate recurrent instability from inadequate fixation or failures in fixation. Poor range of motion postoperatively may represent over-constraint of the joint. Late complications include recurrent chronic lateral ankle instability. Be aware that athletes sometimes describe instability as pain.

While most lateral ankle sprains are relatively benign injuries that allow players to return to play quickly, remember to rule out other causes of pain in these athletes. In addition, begin considering these associated injuries when a player is unable to return to the field in a reasonable timeframe. These may signal associated injuries that require surgical treatment to preserve their long-term function.

Syndesmosis Injuries

Syndesmosis sprains of the ankle in the athlete often result in a significant amount of lost playing time. This injury has garnered significant attention in the sports medicine realm over the past decade as the frequency of these injuries has increased and the treatment algorithms have changed. Colloquially referred to as *high ankle sprains*, syndesmotic injuries can result in a greater level of impairment than isolated injuries to the lateral ligamentous complex. The reported incidence of syndesmosis sprains ranges from 1% to 16% of ankle injuries [11–15]. These injuries are often missed or undiagnosed, and occur less frequently than isolated lateral ankle sprains [16].

The ankle syndesmosis contains a bony congruence between the distal tibia and fibula with ligament reinforcement. This ligamentous complex provides the majority of stability to the syndesmosis and consists of three distinct entities: the anterior inferior tibiofibular ligament (AITFL), the posterior inferior tibiofibular ligament (PITFL), and the interosseous tibiofibular ligament or membrane (ITFL) [17].

The AITFL has a broad fanlike origin on the anterolateral tubercle of the tibia that travels obliquely, tapering off as it travels toward its insertion on the longitudinal tubercle of the lateral malleolus. This gives the AITFL a triangular or trapezoidal appearance [18]. The AITFL often consists of several bands, and some consider the most inferior band a separate entity entirely: the accessory AITFL. These fibers can be seen during ankle arthroscopy [19].

The PITFL consists of the deeper transverse tibiofibular ligament and a superficial PITFL. The superficial PITFL originates on the posterior aspect of the tibia at the posterolateral tubercle and travels obliquely down the posterior fibula. The deep portion originates distally on the posterior tibia and has a more transverse course, inserting anterior to its superficial counterpart. Some consider this portion its own entity, the transverse ligament (Fig. 4.4). The PITFL is the strongest ligament of the syndesmotic complex and therefore is usually the last to tear. Given its inherent strength, injuries to PITFL commonly result in an avulsion, rather than mid-substance tear [17, 20]. The ITFL originates approximately 1–1.5 cm proximal to the tibiotalar joint and runs the majority of the course of the tibia and fibula [17].

The syndesmosis is best thought of as a dynamic structure that moves in three dimensions. Several cadaveric studies have illustrated the importance of the syndesmosis complex to ankle stability. When the AITFL is sectioned, there is an additional 4–12 mm of sagittal translation between the tibia and fibula [12, 21, 22]. Xenos et al. described a 2.3 mm increase in translation with isolated AITFL transection. When both the distal most 8 cm of the ITFL and 8 cm of PITFL were transected, a total of 7.3 mm of translation between the tibia and fibula occurred [23]. Rotational instability also occurs with disruption of the syndesmosis. With isolated AITFL resection, there is an average increase of 2.7 deg. of rotation. With complete disruption of the complex, this number increased to 10.2 deg. of rotation [24, 25].

Several classification systems exist when describing syndesmosis injuries. In the acute setting, the practitioner must differentiate between stable and unstable syndesmoses. Furthermore, an ankle may possess latent versus frank instability. The ankle

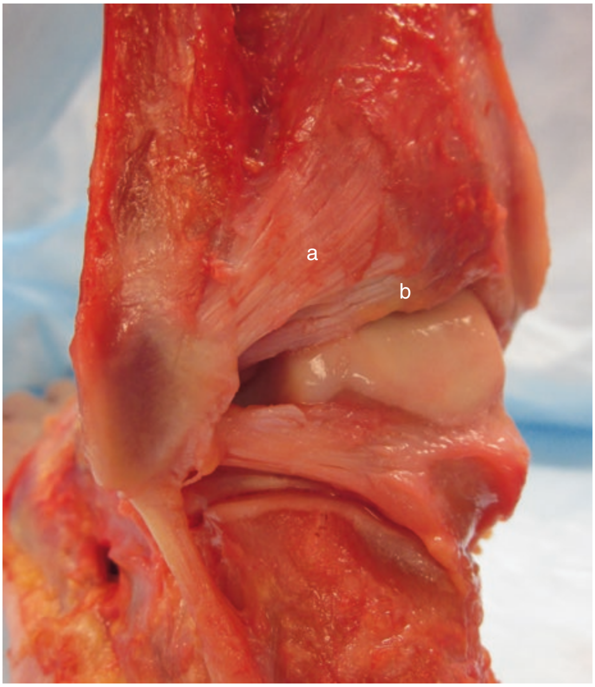

Fig. 4.4 Posterior tibiofibular ligament (**a**) is a large, strong ligament connecting the posterior tibia and fibula. The most inferior band of this ligament, often a separate band itself, is often called the transverse ligament (**b**). These bands both contribute to the significant overall strength of the posterior ligamentous complex

with latent instability will have normal-appearing radiographs but will reveal instability with stress views or dynamic image evaluation. Frank diastasis occurs when widening is present on routine ankle imaging [26]. The graded ankle sprain classification is also commonly used. A grade I injury describes a stable ankle with mild distal tibiofibular joint tenderness. A grade II injury results in a partial tear to the syndesmosis complex with a positive squeeze test and external rotation test. A grade III injury is a complete disruption of the syndesmosis plus or minus deltoid injury [27].

An isolated acute ligamentous syndesmotic injury oftentimes goes undiagnosed; therefore the practitioner must maintain a high level of suspicion, employ a detailed physical exam, and obtain appropriate imaging. High ankle sprain injuries range from a mild injury to the syndesmotic complex to a complete diastasis of the distal tib-fib joint. Diastasis is defined as “any loosening in the attachment of the fibula to the tibia at the inferior tibiofibular joint, and is not confined to a wide separation of the bones” [28].

These injuries most commonly occur secondary to an external rotation force but can also result from a hyper-abduction force if the deltoid ligament is compromised. Hyper-dorsiflexion injuries can lead to diastasis as the anterior talus drives into the mortise [29, 30].

Upon examination, an individual with a syndesmotic injury will typically complain of anterolateral ankle tenderness, oftentimes with minimal tenderness over the ATFL or CFL. Tenderness over the deltoid ligament may indicate an abduction component to the injury mechanism. Palpation of the entire length of the fibula must occur to identify a proximal fibula fracture, and the severe swelling and ecchymosis common to a lateral ankle sprain are often less severe.

The *squeeze test* is a common clinical exam maneuver indicative of a high ankle sprain. A positive result occurs when the examiner squeezes between the fibula and tibia at the level of the mid-calf, eliciting pain at the level of the ankle. Miller et al. proposed that the height of anterolateral tenderness relative to the tibiofibular joint correlates with the severity of a syndesmotic injury [31].

The *external rotation test* is the most reliable to diagnostic test for syndesmotic injuries. With the knee flexed 90 degrees, one hand stabilizes the distal leg while an external rotation force is applied to the foot. Pain at the syndesmosis indicates a positive result. If able to bear weight, this test is dynamically reproducible by having the patient stand on the affected extremity alone while externally rotating the body.

AP, lateral, and oblique views of the ankle should be obtained in the suspected syndesmotic injury. Up to 50% of patients may have a bony avulsion off the anterior tibia or posterior malleolus, making radiographic evaluation an essential part of the diagnostic workup [11, 28, 32]. If tender at the proximal tibia, AP and lateral radiographs of the knee should be obtained to rule out a spiral fracture of the proximal fibula or *Maisonneuve* fracture.

Diagnosis of tibiofibular diastasis can be made by measuring several radiographic parameters. Widening of the medial clear space >4 mm may indicate diastasis, but there is often significant variability with this measurement, putting to question its reliability [28]. Several studies have advocated the use of tibiofibular overlap, with 5 mm on the AP and 1 mm on the mortise view representing normal findings [33]. The tibiofibular clear space is another parameter used, with a normal value ranging from 3 mm to 6 mm on an AP radiograph [34–37]. There is no single radiographic parameter that best identifies diastasis on routine radiographic imaging. Therefore, stress radiographs are an important part of the high ankle sprain workup (Fig. 4.5). An external rotation and abduction force are applied to the ankle to potentially reveal diastasis. When stress radiographs are inconclusive, advanced imaging in the form of a weight-bearing CT or MRI should be performed.

MRI is an excellent test for the diagnosis of syndesmotic injuries. Kazunori et al. showed that an MRI containing syndesmotic ligament discontinuity, a curved or wavy appearance of the ligament, or ligamentous non-visualization resulted in 100% sensitivity, 93% specificity, and 97% accuracy (Fig. 4.6) [38]. Although MRI is quite accurate with regard to syndesmotic injury identification, it is a static test. Thus, one might argue that weight-bearing CT has the advantage over MRI in that it can identify dynamic instability. CT scans, however, are often used to evaluate the syndesmosis in the chronic setting, not in the acute injury phase.

Arthroscopic evaluation of the distal tibiofibular joint has become the gold standard for diagnosing a syndesmosis injury. Calder et al. proposed that syndesmotic instability is present when a 2.9 mm shaver can fit within the distal tibiofibular joint [39]. The arthroscopic "drive-through sign" is another method to identify instability arthroscopically. If a 2.9 mm shaver can easily fit through the medial gutter during arthroscopy, one must have a high suspicion for syndesmotic and deltoid injury [40].

Syndesmotic sprains without diastasis are nonoperative and may be treated with proprioceptive rehabilitation, functional brace wear, and short-term activity modification. West Point cadets that suffered a stable sprain returned to full activity at an average of 43 days [14]. In the elite athlete, platelet-rich plasma or "PRP" is a

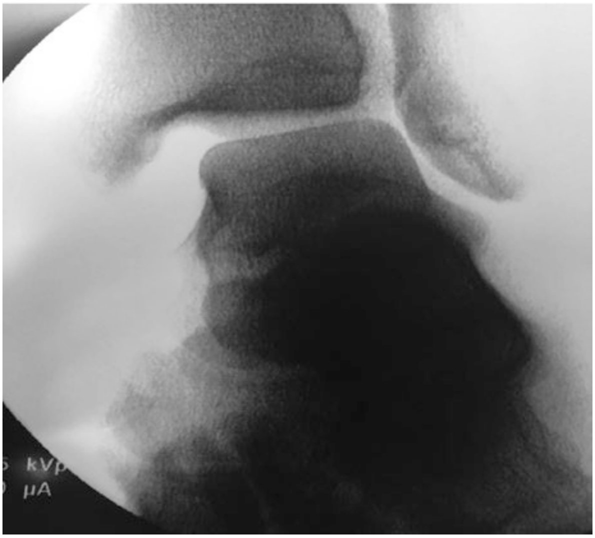

Fig. 4.5 Stress fluoroscopic image of syndesmosis injury indicating widened medial tibial clear space and loss of normal tibiofibular overlap

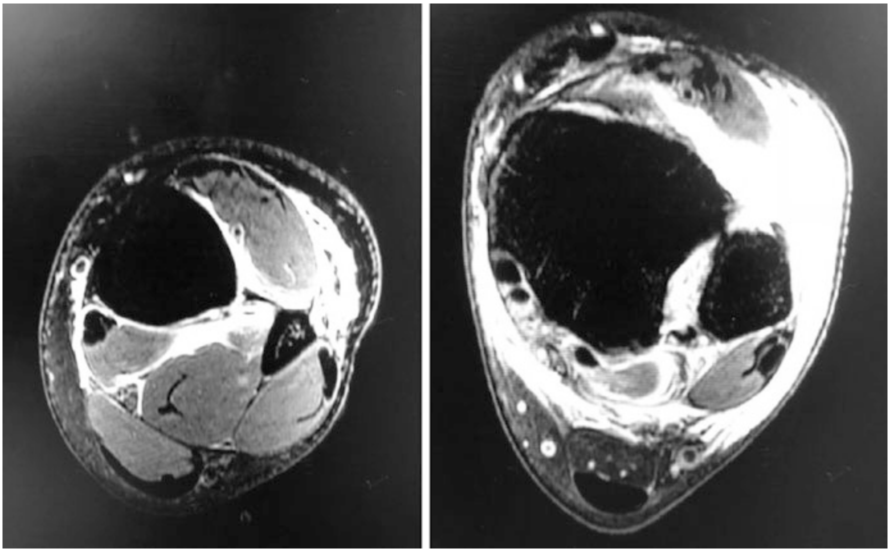

Fig. 4.6 Axial T2-weighted MR images indicating a significant syndesmosis injury with incongruence of the fibula and tearing of the interosseous membrane on the proximal axial cut and both the AITFL and the PITFL near the ankle

common adjunct to conservative management. Laver et al. performed an RCT comparing PRP to controls in elite athletes with AITFL injuries. Those receiving PRP had a significantly shorter ($p = 0.0006$) return to play time ($n = 41$ days) than the control group ($n = 60$ days) [41].

In patients with latent or dynamic instability, conservative treatment is an option if advanced imaging confirms anatomic reduction in the incisura fibularis. These patients typically require cast and boot immobilization for 8 weeks, with 4 weeks of non-weight-bearing.

Surgical fixation of high ankle sprains focuses on restoration of the normal anatomic relationship of the tibiofibular ligament to allow for early and full motion while increasing stability. Typically, fixation techniques are broken down into rigid screw versus dynamic suture button stabilization.

Suture button fixation has recently gained popularity because there is a lower risk for malreduction of the syndesmosis, preserved physiologic micromotion at the distal tibiofibular joint, and a significantly lower reoperation rate without failure [14, 26, 42–44]. Colcuc et al. performed a randomized controlled trial comparing rigid and dynamic fixation with 1-year follow-up. Those treated with dynamic suture button fixation experienced a significantly lower complication rate and a faster return to sport (14 vs. 19 weeks, $p = 0.0006$). There was no difference with regard to pain or clinical outcomes [45]. A meta-analysis of three RCTs and seven cohort studies performed by Gan et al. revealed no difference in clinical outcome, syndesmosis malreduction rate, and complication rate. There was a significantly lower need for hardware removal in the suture button fixation group. Ultimately, insufficient definitive evidence exists to consider either technique superior [46].

In our experience, surgical intervention is reserved for the athlete who cannot bear weight and has a positive squeeze test and significant pain with external rotation exam. Those with tenderness greater than 5 cm proximal to the ankle joint may have a more severe injury, likely warranting surgical intervention. In athletes with this subset of symptoms, we routinely order an MRI to evaluate the integrity of the syndesmotic complex. The MRI is obtained primarily to evaluate for the integrity of the AITFL and PITFL. If more than one ligament is compromised, it is considered a potentially unstable joint. In the face of positive MRI findings, a stress exam should be performed to correlate the static MRI test and confer the presence of dynamic instability. If multiple ligaments are involved, intraoperative fluoroscopic evaluation is performed and often confirms any latent instability. Arthroscopic evaluation is then performed. Any hematoma within the ankle joint is evacuated, and the distal tibiofibular joint is debrided to allow for anatomic reduction of the syndesmosis. Any additional cartilage injury is addressed at this time.

After arthroscopic evaluation, a small incision is made over the fibula, and a two-hole plate is used in conjunction with two suture button fixation devices. The plate assists with force dissipation of the construct. The tight ropes are placed in a divergent manner to maximize the pullout strength of our fixation (Fig. 4.7).

Immediately postoperatively the patient is placed in a boot with cold compression and IV NSAIDs. During the first 72 hours postop, treatment focuses on a range

Fig. 4.7 AP and lateral radiographic views of an offensive lineman treated with dual suture button stabilization for a high-grade syndesmotic injury

of motion exercises, swelling control, and non-weight-bearing of the involved extremity. Weight-bearing begins POD 4 in a CAM walker. At POD 7–9, the patient is transitioned to Alter-G treadmill or pool work. Subjects then progress to land exercises when able, usually between POD 10 and POD 15. Return to play is allowed when the athlete can pass return to sport testing.

In summary, syndesmotic injuries must be diagnosed early to avoid a prolonged treatment course. Anatomic reduction and stability must be confirmed to manage these injuries appropriately. If instability exists, surgical intervention focuses on anatomic restoration of the distal tibiotalar joint and allows for faster return to play in the elite athlete. Postoperative management focuses on early range of motion with a brief period of non-weight-bearing, followed by gradual resumption of weight-bearing activity and eventual return to sport when strength and agility are restored.

Ankle Fractures

While less common than ankle sprains, ankle fractures are frequent injuries that lead to significant time loss for athletes. When this type of injury occurs, ankle fractures sideline most athletes immediately. The injuries that cause these fractures are usually associated with higher energy than those that cause avulsion fractures and sprains. Because players are exposed to higher amounts of energy when they sustain ankle fractures, these injuries are more traumatic and can cause significant morbidity. Some authors report that return to play at a competitive level can be staggeringly low. In one study, 88% of recreational athletes had returned to sports, while only 11.6% of competitive athletes had returned to sports 1 year after an ankle fracture [47]. This chapter focuses on ways to improve in-season and long-term outcomes.
The ankle mortise consists of the tibia medially, fibula laterally, and talus distally. It is a sickle-shaped joint with cartilage on both sides. Approximately 10–15% of body weight is transmitted through the fibula during the normal gait cycle. Athletes commonly subject their ankles to higher stresses during the run of play. The tibia ends distally as the medial malleolus while the fibula extends further distally and comprises the lateral malleolus. This relationship is important in assessing the length of the fibula while identifying fractures during diagnosis and evaluating the quality of a reduction during treatment. The ligaments that attach to these malleoli provide the ankle with their primary soft tissue stability. Specifically, the deltoid ligament arises on the medial malleolus and inserts on the talus, navicular, and calcaneus. It is an important stabilizer of the mortise and knowledge of its anatomy and function is important during treatment decisions for ankle fractures.

Ankle fractures typically occur in football players when the foot is rotated about the ankle. An inversion mechanism is the most common mechanism leading to fracture, although many different mechanisms can lead to fracture. Oftentimes, in the fast-paced nature of a football game, the athlete is unable to adequately describe the mechanism leading to the injury. They usually occur in a skilled-position player or lineman whose foot is planted on the field when he contacts the ground or an opponent. Players will endorse pain isolated to the ankle. Commonly, they will be unable to bear weight immediately after the injury, though it is not uncommon for the athlete to be able to bear weight, even with a fracture. The medical staff evaluating the player on the field or sideline after injury often get the most complete physical exam before the ankle becomes swollen.

Identification of an ankle fracture on the field may be obvious if the ankle is subluxated or dislocated. Gently reducing the ankle will help the athlete feel more comfortable and help the medical staff completely assess the players' neurovascular status. There is no value in obtaining x-rays prior to reduction. Trained personnel should reduce a dislocation as quickly as possible. Be sure to look for abrasions, tenting, and pallor. These skin changes can signal an open fracture and players with such injuries should be taken to an orthopedic surgeon for treatment immediately. Unfortunately, open fractures that are reduced on initial presentation may be more difficult to recognize.

To begin the exam, check for active ankle flexion, extension, inversion, and eversion. While most players will have some weakness due to pain, complete inability to perform these motions may signal a more serious injury. Next, check for sensation in all dermatomes of the foot. Most players will have some paresthesias from the injury that resolve quickly.

Finally, reserve palpation until the end of the exam as this helps build a player's trust in the medical staff. Palpate the medial and lateral malleoli, tibiotalar joint line, deltoid ligament, and fibular head. Pain at the fibular head, just distal to the proximal tibiofibular joint, can signal that the syndesmosis may be injured. Aside from obvious dislocations, point tenderness and inability to bear weight should signal practitioners to obtain radiographs.

Basic images consist of antero-posterior, lateral, and mortise radiographs of the ankle. Most fractures will be readily apparent on these views. If suspicion for a fracture is high and it is not evident on unilateral x-rays alone, bilateral weight-bearing views of the contralateral extremity can serve as a comparison. It is prudent to image the entire tibia and foot to rule out concomitant injuries. Image ankle injuries without any splinting material, braces, or boots as these can obscure osseous anatomy. Obtaining as much information as possible during an exam and with imaging can help facilitate treatment decisions.

If an ankle fracture is not readily apparent, scrutinize radiographs for small avulsion fractures. For example, fractures of the lateral process of the talus can mimic lateral ankle sprains and are often misdiagnosed. Avulsion fractures from the posterior tibia can signal a syndesmosis injury. Using dynamic imaging and/or stress x-rays is also a useful tool to assess stability and is discussed in greater detail below. After all necessary images have been performed, place the athlete in a well-padded splint or immobilizing boot. Remember that ankle fractures may swell quickly and pressure on tenuous skin can change a relatively benign fracture pattern with intact skin into a more serious open fracture.

There are several classification systems examiners use to characterize ankle fractures. Younger teenage players are subject to "transitional fractures" because their physes are still closing. Transitional fractures are also known as triplane and tillaux fractures. A triplane fracture involves disruption through the physes of the tibia in the sagittal, axial, and coronal planes. As these athletes age and their physes continue closing, injuries more often result in tillaux fractures. These tillaux fractures are avulsions of the anterolateral tibia distal to the physis, and they are most easily seen on antero-posterior x-rays. After players' physes close, they are subject to different fracture patterns. Consequently, there are also many adult fracture pattern classifications.

These adult-type ankle fractures in football players have been studied primarily in the NFL. By far the most common ankle fracture in the NFL is isolated distal fibula fractures. The predominant descriptive tool for these injuries is the Weber classification, and it describes a distal fibula fracture line based on its relationship to the syndesmosis. Weber A fractures are distal to the syndesmosis, Weber B fractures are at the level of the syndesmosis, and Weber C are all those above the syndesmosis.

Fibula fractures also occur in combination with other fracture patterns about the ankle (Table 4.2). A second classification system, called the Lauge-Hansen system, is based on injury mechanisms that cause fractures. Although its reliability has not been established, this system is useful to those on the field who witness the injury. It serves as a convention among providers to help communicate injury severity and

Table 4.2 Ankle fracture classification systems

Classification systems of ankle fractures			
Fibula fracture location	Danis-Weber classification	Lauge-Hansen classification	Stage description
Infrasyndesmotic	Type A	Supination adduction (SA)	Transverse fracture of the distal fibula Vertical fracture of the medial malleolus
Transsyndesmotic	Type B	Supination external rotation (SER)	Injury to the AITFL Oblique/spiral fracture of the distal fibula Injury to the PITFL or avulsion fracture of the posterior malleolus Medial malleolus fracture or sprain of the deltoid ligament
Suprasyndesmotic	Type C	Pronation external rotation (PER)	Medial malleolus fracture or sprain of the deltoid ligament AITFL injury Oblique fracture of the fibula proximal to the tibial plafond Injury to the PITFL or avulsion fracture of the posterior malleolus
		Pronation Adduction (PA)	Medial malleolus fracture or sprain of the deltoid ligament Injury to the AITFL Transverse/comminuted fracture of the fibula proximal to the tibial plafond

guide treatment plans. There are four main categories within the Lauge-Hansen classification: supination-adduction, supination-external rotation, pronation-abduction, and pronation-external rotation. The first word of these mechanisms describes the position of the foot, while the second word denotes the force that is applied to the extremity. Regardless of the classification systems used to characterize these injuries, they are useful because they help medical staff communicate clearly about an athlete's injury.

There are many classification systems; however, the most important characteristic of ankle fractures is stability. While some fracture patterns are inherently stable and may not require surgery, others are unstable and most likely will require surgery. Instability in the ankle mortise is defined as asymmetry in the articulation of the talus, tibia, and fibula. Most commonly this occurs from disruption of the syndesmosis. Identifying unstable ankle fracture patterns can be difficult. When used alone, plain x-rays have limited use in diagnosing associated syndesmosis injuries, especially when they occur with low fibula fractures. Dynamic or stress x-rays can aid in these scenarios. As previous described, the syndesmosis can be interrupted in association with a wide variety of ankle fractures. External rotation stress views help assess the syndesmosis and deltoid complex. However, there is much variation in the normal anatomic appearance of syndesmosis. Any views that are suspicious for a widened mortise or isolated medial malleolus fracture should have full-length tibia x-rays performed to assess the proximal fibula for a Maisonneuve injury. Advanced imaging is useful for some fractures, and an orthopedic surgeon can decide if they are needed. CT scans are useful to assess the size and fracture plane for posterior malleoli fractures, and MRI assesses the syndesmosis, other ligamentous injuries, and the state of the articular cartilage.

After a complete physical exam and imaging, treatment decisions are made. Some ankle fractures are treated conservatively without exposing an athlete to the risks of surgery while still allowing him to return to play quickly and safely. For example, an oblique fibula fracture with negative stress x-rays indicating stability can be treated without surgery and progress as symptoms allow. Most authors believe stable, nondisplaced Weber A and B lateral malleolus fractures can be treated conservatively [48].

Unfortunately, nearly half of ankle fractures are associated with disruptions of the syndesmosis and studies show they are being treated surgically with increasing frequency. From 2000 to 2014, nearly half of all distal fibula fractures were treated with surgery [49]. On the lateral side of the ankle, Tornetta et al. have used a more individualized algorithm for surgical decision making [48]. However, the authors believe fibula fractures associated with any instability of the mortise on the stress x-rays should be treated with open reduction and internal fixation. This includes all ligamentous supination external rotation type 4 injuries.

As described above, the deep deltoid ligament attaches to the colliculi of the medial malleoli and provides stability to the mortise. Therefore, supracollicular fractures are unstable and should be treated with surgery. Operative indications for medial malleolus fractures also extend to those with an articular component or vertical fracture pattern, which are most commonly associated with supination adduction injuries. The supination adduction fracture pattern should receive extra consideration as it is associated with plafond impaction which should be addressed with adequate visualization during surgery and may require bone grafting.

Avulsion fractures on the medial side of the ankle usually occur at the anterior colliculus. While commonly treated nonoperatively in recreational athletes, these superficial deltoid complex avulsions which occur during high-energy ankle fractures in athletes are a distinct injury pattern and should be recognized as such. Deltoid avulsion may benefit from primary open repair. The majority of NFL players treated surgically for deltoid avulsion injuries are able to return to play after surgery with no reported complications or persistent medial ankle pain or instability [35].

Some posterior avulsions can be treated conservatively. However, fractures of the posterior malleolus that are displaced, greater than one-third of the articular surface, and those with syndesmosis disruption require surgical intervention [50].

While many treatment algorithms are agreed upon in the literature, there is still debate about particular fracture patterns. For example, the management of nondisplaced, radiologically unstable fractures (i.e., nondisplaced bimalleolar fractures and nondisplaced Weber C fractures) is a topic of discussion [50]. Some advocate primary surgical fixation to facilitate early return to sport and others advocate attempted conservative management. Robertson et al. found that conservative management of nondisplaced bimalleolar fracture resulted in quicker return to play with fewer persistent symptoms. As such, current recommendations advise attempted conservative management of these fracture types, with close follow-up and surgical intervention if displacement occurs [50].

Once a decision has been made to proceed with surgery, there are several reduction and fixation options for osseous injuries. Reduction can be achieved with either open or percutaneous techniques. Open reduction internal fixation with lag screws and tubular plates is most commonly employed. The typical construct utilizes a lateral fibular plate to avoid peroneal irritation, though there are advocates of posterior fibular anti-glide fixation. Medial malleolus fixation typically utilizes a partially threaded cannulated screw.

Intramedullary fixation is gaining popularity in athletes because it can reduce an athlete's risk of symptomatic hardware [50]. It is best suited for unstable fibula fractures [51] but does not control length without adequate fracture opposition.

Repair of soft tissue injuries during initial operative intervention remains debatable in elite athletes, particularly in regard to management of the deltoid. Some clinicians only advise repair in settings when soft tissue blocks fracture reduction [52]. Athletes who received repair compared to those without repair did not show improvements in long-term follow-up. Short-term results are critical in the athletic population; therefore we advocate for deltoid ligament repair regardless of its effect on fracture reduction. For the syndesmosis, we prefer endobutton fixation through a well-contoured plate; a construct that has been studied in the NFL did not result in any residual pain or stiffness. Screw fixation for the syndesmosis has been the standard; however, emerging literature over recent years has supported the use of suture button constructs for syndesmosis stabilization [53].

Treating ankle fractures surgically can facilitate early return to football. However, it can also be associated with an increased rate of persistent symptoms, most frequently pain. Many causes of chronic pain after ankle injuries occur due to the injury itself and are recognized as pain generators after an athlete has not returned in a reasonable timeframe. For example, chondral injuries to the talar dome commonly cause chronic pain. Ankle arthroscopy, at the time of primary surgical intervention, can help treat chondral lesions and improve healing and long-term outcomes.

The role of arthroscopy is increasing in conjunction with ankle fractures. There are multiple factors associated with the use of arthroscopy as an adjunct to ankle fracture fixation. Some surgeons have advocated that you can better predict instability with arthroscopy. It allows better assessment of instability in multiple planes as well as reduction once the fixation is complete. Studies show that intra-articular lavage is beneficial to the patient. It significantly reduces the inflammatory cytokines in the joint, which may provide short-term pain relief as well as lower the risk of long-term posttraumatic arthritis. Visualization of the entire joint allows full assessment of associated injuries (Fig. 4.8). Arthroscopy allows the surgeon to fully assess the cartilage surfaces and address any acute cartilage damage. At the very least, it allows the surgeon to fully counsel the patient on the extent of their injury, which can help guide their postoperative course.

Proponents of ankle arthroscopy cite the ability to inspect the joint, educate the athlete, address intra-articular chondral lesions, or debride hematomas and debris as good reasons to routinely perform arthroscopy during the treatment of ankle fractures, although others argue that it does not change the acute management. Even if arthroscopy does not change the acute management of such injuries, we believe it is a valuable tool for documenting the severity of articular damage and as a prognostic tool. If a player returns to the office and has not progressed appropriately during rehabilitation, the status of the joint space during arthroscopy becomes valuable

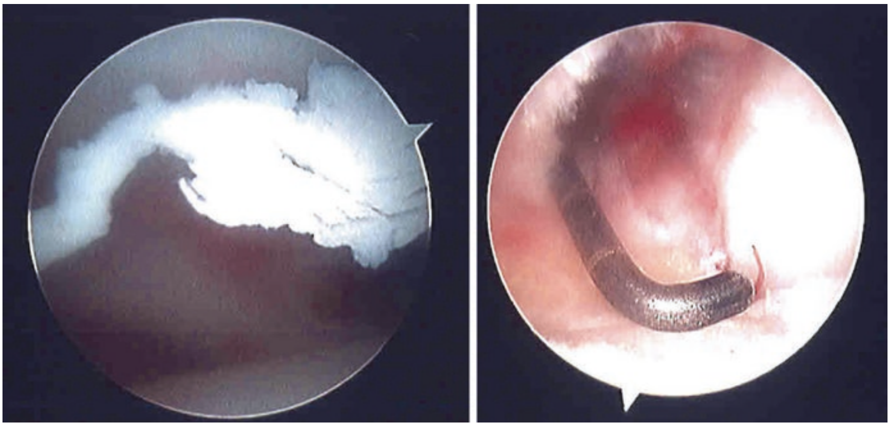

Fig. 4.8 Arthroscopic photos in a Weber C ankle fracture with cartilage debris and resultant 1 cm traumatic OCL on the lateral talar shoulder

information. Therefore, arthroscopy is a valuable tool in "identifying and treating intra-articular damage that would otherwise remain unrecognized and may provide prognostic information regarding the functional outcome of these injuries." [54]

The goal of all treatment decisions both surgical and nonsurgical is to safely and quickly return to football without compromising the longevity of an injured ankle. Naturally, more severe injuries usually require prolonged recovery times. Isolated fibula fractures result in fewer days missed than any other ankle fracture pattern. The mean time missed is approximately 90 days [49]. Predictors of return to sporting activities at 1 year include younger age, male gender, no or mild systemic disease, and a less severe ankle fracture [47]. The evaluation and management of ankle fractures discussed above can be very objective; in contrast, return to play criteria have been notoriously individual and subjective. There are, however, some general guidelines practitioners can use to collaborate with ATCs and PTs when deciding how quickly a player can return. For ankle fractures treated nonoperatively, we begin noncontact football including jogging, weightlifting, footwork, or "shadow" drills around 6–8 weeks post-injury. Return to contact football drills can usually begin around 12–16 weeks post-injury. Special consideration should be given to those treated surgically and who undergo syndesmotic fixation. In these cases, weight-bearing should not begin until 8 weeks after surgery and sport-specific drills adjusted accordingly.

While infrequent, complications do occur and can delay a full return to play. The medical team should be aware of several common complications. The skin of the ankle is thin, especially over the medial malleolus, and concerns about the healing of surgical incisions should be addressed in a timely fashion. In the early postoperative period, non-unions can be a source of pain. This is particularly true of medial malleolus non-unions. Non-union can continue to cause pain months after surgery, but it is more likely that they are found in the first 8 weeks. Complications from syndesmosis fixation are more likely to occur after 8 weeks. The most common of these is syndesmosis screw irritation or decreased range of motion [55]. Oftentimes players with these symptoms will ask that their hardware be removed. We recommend that only intact screws which have not broken be removed after 4–6 months after all other causes of persistent symptoms have been ruled out. A diagnostic and therapeutic injection at the site of the screw head can aid in this decision. CT scans are useful in the chronic setting to evaluate for malreduction of the fibula. Remember, the fibula can be malreduced in the transverse plane (most commonly shortened from its original length). Lastly, as mentioned above in regard to routine ankle arthroscopy, osteochondral lesions can be a source of prolonged pain. While ankle fractures are a common source of missed playing time for football players, most will return to play. It is important to recognize, examine, image, and treat each players with respect to their specific fracture. Some will return to play almost immediately, while others will make a more gradual return. In rare cases, players with the most severe fractures may only return to their baseline at 2–3 years after surgery [56].

Ankle injuries occur commonly in the football player. Systematic evaluation of the lateral ligamentous complex and syndesmosis should occur in each patient.

Radiographic evaluation should be performed to rule out fracture and to assess for possible dynamic instability. Surgery should address instability and obtain anatomic restoration of the ankle joint. Ankle arthroscopy is a useful adjunct to ligamentous repair or fracture fixation that identifies cartilage injury often missed with diagnostic imaging. Return to play should be tailored to each individual injury but should focus on early range of motion and graduated return to play.

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