58 Clinical Tests for Assessment of Instability of the Ankle and Syndesmosis

Flávio Cruz, Gustavo Vinagre, and Pieter D'Hooghe

58.1 Introduction

The ankle sprain incidence in sports has been reported between 0.324 and 9 per 1000 h of activity [1, 2], with a variability that is most likely due to different definitions of injury and population. In football for example, increased ankle sprain rates have been reported in older players, dominant leg, during competition, and at the end of each half of a game [3]. Historically, the ankle used to be the most common location of injury in professional football players (around 30% of total injuries). However, more recent studies suggest a lower ankle injury rate, accounting for 10–15% of all injuries [4–6]. Approximately 60% of ankle sprains occur as a result of player contact [7, 8] and the overall ankle sprain recurrence rate is between 4% and 29% [3, 7, 8].

A major problem accompanying ankle injury is the high rate of recurrence associated with chronic ankle instability [9–12]. With an inversion trauma mechanism, the anterolateral ankle ligaments are strained and even ruptured in more severe cases. The anterior talofibular ligament (ATFL) is the most commonly ruptured, followed by the calcaneofibular ligament (CFL) and more rarely the posterior talofibular ligament (PTFL) [13, 14]. Post-traumatic osteoarthritis has been shown to be the resultant of abnormal loading and changes in contact stress and distribution [15].

Injury to the syndesmotic ligaments (often referred to as a high ankle sprain) occurs in 1–18% of patients with an ankle sprain, with reports of injury in football players of 3–6% [9, 16]. It is likely that this is an underestimate, as 20% of athletes suffering from an acute ankle sprain show evidence of a syndesmotic injury on MRI [17]. Male gender, higher level of competition, and a planovalgus foot alignment are known risk factors for syndesmotic injury in athletes [18].

Chronic ankle instability presents through symptoms like recurrent sprains, pain, swelling, and avoidance of provoking activities and can be classified as functional instability or mechanical instability resulting in proprioceptive deficit [19].

Previous history taking and clinical physical examination are essential in the diagnosis of ankle instability. Differentiation between functional and anatomical ankle instability is also important to guide the proper treatment [14]. Functional instability depends on the patient-generated reports or complaints that could be accompanied by clinical laxity, while mechanical instability can be identified by physical examination [20, 21]. It is cur-

F. Cruz · G. Vinagre · P. D'Hooghe (✉)
Department of Orthopaedic Surgery,
Aspetar Orthopaedic and Sports, Medicine Hospital,
Doha, Qatar
e-mail: flavio.cruz@aspetar.com;
gustavovinagre@gustavovinagre.com;
pieter.dhooghe@aspetar.com

J. G. Lane et al. (eds.), *The Art of the Musculoskeletal Physical Exam*,
https://doi.org/10.1007/978-3-031-24404-9_58

rently believed that the mechanical instability may be due to laxity imparted by the trauma, whereas the functional instability is a result of neuromuscular insufficiencies, muscular weakness, and proprioceptive insults [11, 13, 22]. Lateral ankle sprains are most commonly involved in the development of CAI [19].

Associated injuries that may accompany chronic ankle instability are chronic regional pain syndrome, neuropraxia, sinus tarsi syndrome, tendon disorders such as peroneal tendinopathy, dislocation or subluxation, impingement syndromes, fractures such as anterior calcaneal process, fibula and lateral talar process, loose bodies, and osteochondral lesion of talar dome or distal tibia [19].

Fact Box

- Ankle inversion injury is one of the most common injuries in the general as well as in the athletic population.
- Differentiation between functional and anatomical ankle instability is essential to guide proper treatment.
- Associated injuries can develop after a failed treatment for ligament injury in the ankle. They regularly present as talar osteochondral injuries, loose bodies, and anterior and posterior impingement syndromes.

58.2 Anatomy

The ankle joint can be regarded as a fork, in which the tibia plafond and both malleoli form a mortise to receive the talus. As a hinge joint, there is a single axis of movement that allows for dorsiflexion (20°) and plantar flexion (50°). As the superior surface of the talus is narrower posteriorly, there is a looser fit within the fork during plantar flexion and most stability is then provided by the ankle ligaments alone. This reduced intra-articular stability can potentially explain why most ligamentous injuries are sustained in plantar flexion [23].

The distal part of the tibia and fibula also articulates at the inferior tibiofibular level, supported by the syndesmotic ligaments (Fig. 58.1), thereby forming the inferior or distal tibiofibular joint ("distal tibiofibular syndesmosis"). This syndesmotic joint allows the tibiofibular complex (as a whole) to adapt to the varying width of the upper articular surface of the talus.

In addition, inferiorly to the talocrural joint, the subtalar joint is formed between the inferior surface of the talus and the superior surface of the calcaneus. The subtalar joints provide 35° of inversion and 15° of eversion.

Overall stability over the ankle joint is provided by passive and dynamic factors. Passive stability depends on the form of the articular surfaces, articular capsule, surrounding ligamentous complexes (Fig. 58.2), and retinacula. The

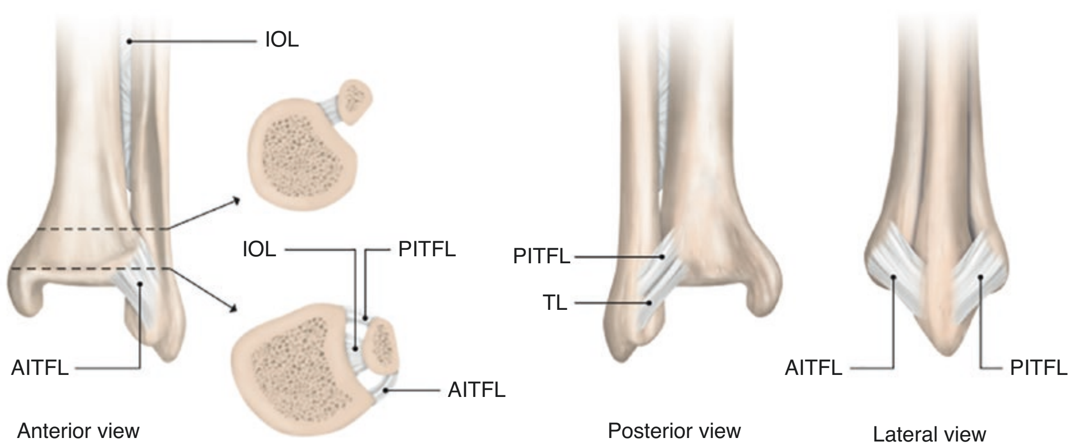

Fig. 58.1 The syndesmotic ankle ligaments presented. Copyright by Dr. Pieter D'Hooghe

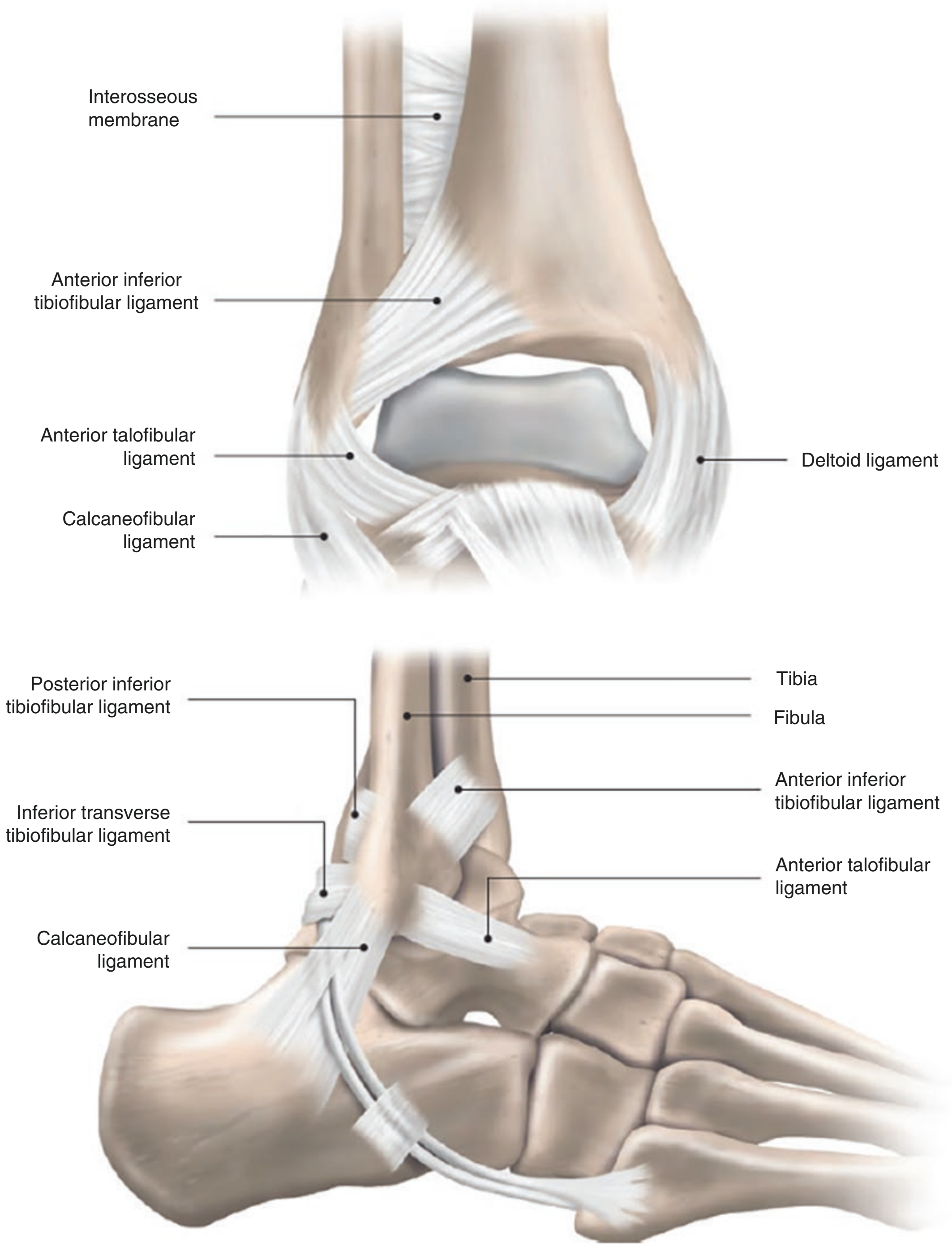

Fig. 58.2 Anteroposterior and lateral views to the lateral ankle joint ligaments. Copyright by Dr. Pieter D'Hooghe

dynamic stability is predominantly provided by muscle activation.

58.3 Mechanism of Injury

Lateral ankle sprains occur when the foot is in plantar flexion and inverted, causing damage to various structures most commonly involving the anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL). Between these two, damage to the ATFL is overwhelmingly more common, occurring in 66% of lateral ankle sprains with CFL sprains constituting about 20% of lateral ankle sprains [24]. Damage or disruption to the local soft tissue, nerves, and bony components of the lateral ankle, in addition to damaged ligamentous structures, can result in ankle pain [24]. Within the literature, chronic ankle instability (CAI) is most often described as chronic ankle pain (CAP) as a consequence of an acute or recurrent lateral ankle sprain. In a recent review, Miklovic et al. suggested that approximately 40% of individuals who sustain a lateral ankle sprain may end up in developing CAI and CAP [25].

Although medial ankle sprains are considered rare, recent studies have revealed that the deltoid ligament complex is injured more frequently than expected. This medial ankle injury sprain is thought to be due to a combination of eversion and external rotation of the hindfoot or a reverse inward body rotation on a fixed foot. With severe external rotation moments, the tibiofibular syndesmotic ligaments can join the mechanism of injury [26, 27]. Osteochondral lesions (OCLs) of the ankle typically present as a part of the acute medial ankle instability (AMAI) [28, 29].

The most accepted mechanism of injury for syndesmotic ankle sprains is a forceful external rotation of the foot and ankle with the ankle in dorsiflexion and the foot pronated [30]. This is most commonly experienced (1) when an athlete rapidly pivots internally off a foot planted in external rotation, (2) when contact with another player applies a valgus load to the leg while the foot is planted, or (3) when a direct blow to the lateral aspect of the heel forces the foot and ankle of a kneeling or fallen athlete into external rotation (toward the ground) [31]. As the talus rotates in the mortise, the fibula rotates externally and moves posteriorly and laterally, separating the distal tibia and fibula, sequentially tearing the anterior inferior talofibular ligament (AITFL) and deep medial ligament complex (MLC), or causing a malleolar fracture, involving the interosseous ligament (IOL) and finally the posterior inferior tibiofibular ligament (PITFL) [30, 32].

Severity of syndesmotic injury varies, ranging from a partially torn AITFL to a complete disruption of all ligaments with mortise widening. Combined deltoid and syndesmosis injury critically disrupts talar stability [33]. The amount of force and how long it is applied will determine how proximal the syndesmotic and interosseous injury extends [34], sometimes resulting in a Maisonneuve fracture. Another injury mechanism for syndesmotic ankle sprains is hyperdorsiflexion. Forced dorsiflexion of the ankle causes the wider anterior talus to act as a wedge that can cause injury to the syndesmotic ligaments.

Fact Box

- Lateral ankle sprains occur in plantar flexion—inversion and tearing the ATFL and CFL.
- Medially, the injury is a combination of eversion and external rotation of the hindfoot or a reverse inward body rotation on a fixed foot.
- Syndesmotic ankle sprains happen in a forceful external rotation of the foot and with the ankle in dorsiflexion and the foot pronated.

58.4 Clinical Presentation and Diagnosis

Patient history and video images are particularly useful in identifying the mechanism of injury, and it is important to distinguish a simple sprain from a ligament rupture, since adequate treatment is associated with a better prognosis [35, 36]. Ankle sprains may be accompanied by an audible snap or crack. All ligamentous and bony structures should be palpated for tenderness, including the whole length of the fibula and the base of the fifth metatarsal. Note that approximately 40% of the patients with a lateral ligament rupture have pain upon palpation over the medial malleolus, whereas 60% report tenderness over the anterior inferior tibiofibular ligament (AITFL)—without injury to the ligament, probably due to an anterior capsule tear [36, 37].

However, manual stress tests are less reliable in the acute phase, because of pain and swelling. Therefore, delayed physical examination (4–5 days) gives a better diagnostic timing and is considered the gold standard in the diagnosis of an acute lateral ligament injury. The sensitivity to diagnose an acute lateral ligament rupture during a delayed physical examination is 96%, with a specificity of 84% [36, 37].

In high ankle sprains, specific symptoms may be suggestive of syndesmotic injury; patients may have inability to bear weight, swelling, pain during the push-off phase of gait, and pain anteriorly between distal tibia and fibula, as well as postero-medially at the level of the ankle joint [38]. The presence of high ankle pain (proximally up the anterolateral leg) is suggestive of a more significant injury [17].

In acute injuries, inspection may reveal edema and ecchymosis around the lateral, medial, and/or anterior aspect of the ankle. In syndesmotic lesions, range of motion (ROM) is often limited with an empty or painful apprehension at terminal dorsiflexion [39]. There is a significant correlation between how far this anterolateral tenderness extends proximally in the leg and the injury severity. Local tenderness is, however, not specific in the acute setting, as 40% of the patients with an ATFL disruption report pain in the area of the AITFL, while arthroscopy shows no syndesmotic injury [36].

The Ottawa Ankle Rules (OAR) have been developed to help clinicians indicate X-ray imaging after acute ankle injury. It is an accurate instrument to rule out fractures over the ankle, with a sensitivity of almost 100% [40]. The OAR are recommended as a primary physical examination tool to rule out the likelihood of foot/ankle fractures by emergency physicians, general practitioners, or physiotherapists [41]. If a patient presents with negative findings following the OAR, there is less than a 2% chance of false negativity [42]. If grossly swollen ankle prevents proper palpation of bony structures, radiographs should be obtained [43, 44].

To apply the OAR, the physician might palpate the entire distal 6 cm of the fibula and the tibia/medial malleolus; palpate the entirety of the navicular bone (with special attention to the relatively avascular nickel-sized area at the central region of the proximal dorsal surface termed the "N" spot); palpate the base of fifth metatarsal bone; and observe the patient ambulate for at least four steps. Tenderness at these four locations is considered an indication for sending to radiography. Adequate imaging request should include AP, lateral, and ankle mortise views. Standard ankle radiographs (weight-bearing, if possible) are useful in acute cases to exclude widening of the medial ankle clear space, deltoid avulsion fragments, syndesmotic lesions, and ankle fractures. In chronic cases, the following weight-bearing radiographs are suggested: ankle mortise view, foot dorsoplantar view, foot lateral view, and hindfoot alignment (Saltzman) view [45].

If there is a clinical or radiographical suspicion of a Maisonneuve fracture (i.e., pain in the region of the proximal fibula, painful swelling on the medial side without a fracture, and isolated fractures of the medial malleolus or malleus tertius), radiographs with full-length views of the lower leg are required.

Several radiographic parameters have been developed to help identify ankle injuries. In cases of syndesmosis injury, the tibiofibular clear space (defined as the distance between the medial border of the fibula and the lateral border of the posterior tibia) provides the most reliable indicator of diastasis. This distance is measured at 1 cm proximal to the tibial plafond and should not exceed 6 mm in both the AP and mortise views.

Cross-sectional imaging such as magnetic resonance imaging (MRI) is fundamental to confirm clinical suspicion. Absence of tibiofibular diastasis no longer rules out the diagnosis. Computed tomography (CT) and comparative weight-bearing CT are helpful diagnostic tools, especially to evaluate potential avulsions or bony diastasis. Exhaustive osteo-ligamentous ankle assessment is necessary, as syndesmosis lesions may be just one component in more complex rotational instability [46].

Ultrasonography and MRI can be useful in diagnosing associated injury (bone, chondral, or tendon). Ultrasonography has been demonstrated to be an accurate investigation for ligamentous injury, but images may be difficult to interpret on retrospective review by other physicians. The sensitivity and specificity of ultrasonography for a lateral ligament rupture are 92% and 64%, respectively. However, if ultrasonography is performed after an inconclusive delayed physical examination, sensitivity increases to 100% and specificity to 72% [36]. A more recent study in ATFL injury comparing ultrasonography in the emergency room with MR images found no overall differences in diagnostic accuracy [47]. Ultrasonography can therefore be considered a valid alternative diagnostic method. It is less expensive and allows for a faster examination without radiation exposure, although it remains investigator dependent.

MRI is a reliable tool in the diagnosis of lateral ligamentous ruptures and other associated injuries such as tendinous and syndesmotic tears, occult fractures, and osteochondral lesions. The sensitivity and specificity of MRI for ATFL injuries are 92–100% and 100%, respectively [48, 49]. In comparison with arthroscopy, MR images can correctly locate the injured portion of the ATFL in 93%, whereas ultrasonography in 63% [49].

Ankle arthroscopy can also be helpful in the diagnosis of ankle instability. In AITFL injuries, the syndesmosis can be assessed by introducing an arthroscopic palpation hook into the tibiofibular joint line, also showing good correlation with MRI [46].

58.4.1 Physical Exam and Clinical Tests

Ankle instability can be defined as the inability to keep the normal relation between the bones in the ankle joint. The ankle that suffers from an acute high-grade sprain, when not properly treated, can be at risk for developing chronic instability (CAI) [50]. Some reports show that up to 20% of ankle sprains evolve to a CAI [19]. Therefore, physical examination of any ankle sprain should include clinical tests as well as inspection of the hindfoot (varus misalignment), and assessment of the ligamentous laxity and midfoot cavus alignment, which is considered a high arch foot condition [51], peroneal muscle strength, and hindfoot motion.

Two new concepts have recently been introduced (although there is no consensus currently between experts): micro-instability and rotational instability.

Micro-instability is a concept that can be presented as a lower grade of mechanical instability (due to a partial tear of the superior fascicle of the ATFL). This could relate to as why there is remaining pain and ankle discomfort after certain ankle sprains.

Rotational instability is defined as the increase of abnormal rotation of the talar bone into the mortise. This instability is explained as the result of chronic insufficiency over the lateral ligament complex, creating an excessive and continued internal rotation and anterior translation of the talus. Over the long term, it can lead to an injury of the most anterior component of the deltoid ligament, described as “open book tear” [50].

Ankle proprioception is commonly disturbed in patients with chronic ankle instability and therefore the Romberg’s maneuver can be carried out [52]. Reduced ankle dorsiflexion and muscle strength should also be assessed since both are known to be directly related to chronic ankle instability [53].

Over the medial side, the clinical examination of medial ankle instability (MAI) starts with a careful bilateral inspection over the ankle in standing, walking, and sitting positions with a hanging leg over the examination table. It is essential to look for swelling, hematoma, malalignment, deformity, and potential scars. When a patient bears weight, asymmetrical planovalgus and abductus of the affected ankle and foot may indicate MAI. Palpation should include medial and lateral ligaments in addition to palpating the syndesmosis and posterior tibial, peroneal, and Achilles tendon. Typically, patients with MAI will present with tenderness, mostly over the medial gutter, over the deltoid ligament and the spring ligament. Some patients may have tenderness along the posterior tibial tendon, because of the common relation of MAI with posterior tibial tendon insufficiency (PTTI). In advanced cases, tenderness over the lateral ankle ligament (in rotational ankle instability) and subfibular area (due to hindfoot valgus) can be elicited [45].

In combined medial and syndesmotic injuries, the clinical presentation is very similar to the classic lateral ankle sprain one. Medial symptoms can occur if the deltoid ligament is injured in combination as well. Pain, swelling, ecchymosis, weight-bearing inability, and soreness around the ankle joint are some symptoms that can be noted. Numerous clinical tests are described to detect additional syndesmotic injury. The external rotation test and the squeeze test are the most commonly used, but the Cotton test, the fibular-translation test, and the cross-legged test have also been described.

58.4.1.1 Lateral Instability

Lateral ankle sprains typically result from supination and inversion over the foot in plantar flexion position usually during athletic activity or running on uneven surfaces. Initially, significant soft-tissue swelling and ecchymosis can be present following the acute injury. Sufficiency of the ATFL can be assessed by the anterior drawer test, while the integrity of the CFL can be assessed by the talar tilt test. During the physical examination, two hands of the examiner are used to manipulate the ankle—one hand stabilizing the distal tibia and the other hand measuring the displacement of the unfixed talus. Both the ADT and talar tilt test are based on the perception of the talar displacement in the joint, which is likely to be disturbed when compared to the normal noninjured side.

If a hematoma is present, accompanied by soreness at palpation or a positive stress test or both, it is most likely that a (partial) lateral ligamentous rupture exists [35, 36]. The integrity of the ATFL can be assessed directly via a manual anterior drawer test [54]. Similarly, the talar tilt test is performed to assess for integrity of the CFL [55]. The anterior drawer test has been reported to be a reliable test, with sensitivity and specificity as high as 96% and 86%, respectively, for the detection of a ligament injury [36].

Studies show that psychological factors of the examiners can influence the perception of a stimulus [56]; therefore, a new test is described to diagnose ATFL injuries, decreasing the sensation of relative hand movements. The new physical examination test, supplemented with more technical requirements, is named the "reverse anterolateral drawer test (RALDT)." This new clinical test can optimize the examination, avoid the contextual effects introduced by the clinician's hands, and provide a more sensitive and accurate measurement for diagnosing chronic ATFL injuries [57].

Anterior Drawer Test

With the ankle in 10–15° of plantar flexion and the examiner's hand stabilizing the distal tibia, the calcaneus is translated anteriorly, and the degree of laxity or subluxation is assessed. Anterior displacement of the talus creates a negative pressure, resulting in a "sulcus sign" whereby the skin dimples at the lateral side where the ATFL has ruptured [55] (Figs. 58.3, 58.4, and 58.5).

The test can be performed lying or in a seated position with the calf hanging over the edge of the examination bed. The examiner stabilizes the distal tibia of the participant with one hand and applies an anteriorly orientated force to the

Fig. 58.3 Anterior drawer test: ankle in 10–15° of plantar flexion and the examiner's left hand stabilizing the distal tibia

Fig. 58.4 The distal tibia is stabilized, the calcaneus is translated anteriorly, and the degree of laxity or subluxation is assessed

Fig. 58.5 Anterior displacement of the talus creates a negative pressure, resulting in a "sulcus sign" (circle) whereby the skin dimples at the lateral side where the ATFL has ruptured

calcaneus with the other hand as described by van Dijk et al. [36]. The examiner grades the amount of talus anterior-posterior displacement according to a 0–4 ordinal scale, with a grade of 0 as hypomobile, 1 as normal, 2 as mildly increased laxity, 3 as moderately increased laxity, and 4 as severely increased laxity. Grades 3 and above are considered "positive" for excessive laxity, whereas grades 0, 1, and 2 are considered "negative" or normal [58].

The sensitivity (84%) and specificity (96%) of a physical examination using the anterior drawer test are optimal if the clinical assessment is delayed for 4–5 days post-injury [35, 36, 59, 60]. In case of a suspected fracture, the OAR should be applied and sent to imaging where required [41]. In the anterior drawer test, when the ATFL is injured, the medial deltoid ligament can remain intact, leading to false-negative results. Lahde et al. reported that 28% of ATFL tears and 38% of combined ATFL and CFL (calcaneofibular ligament) tears were not detected by the anterior drawer test [61].

Anterolateral Drawer Test

The test is performed with one hand stabilizing the leg just above the ankle joint and the other hand providing a combination of an anterior orientated force, measuring the talus displacement, and control of ankle plantar flexion simultaneously with the other hand, as described by Phisitkul et al. More specifically, the index and middle fingers press firmly against the posterior aspect of the heel to provide the anteriorly directed force. The palm supports the sole of the foot to maintain a 10–15° plantar flexion and tighten the lateral ligaments. The thumb is placed along the relatively smooth plane of the lateral aspect of the anterior talar dome and the anterior aspect of the lateral malleolus 1 cm proximal to the tip. Anterior translation is applied at the posterior aspect of the heel, while the foot is allowed to rotate internally while a potential step-off is then palpable by the thumb [62].

The differences between the traditional ADT and ALDT are (1) 10–15° of controlled plantar flexion (which puts the ATFL in a tightened state) and (2) palpation at the smooth plane of the lateral aspect of the anterior talar dome and the anterior aspect of the lateral malleolus (which makes it easy to feel the displacement of the talus). Some techniques, such as unconstrained internal rotation of the forefoot (which puts the ATFL in a tightened state and relaxes the medial ligaments at the same time), can be applied in the diagnosis of ATFL injuries (to maximize the accuracy of the ALDT). This test has been modified and applied to diagnose ATFL injuries with or without CFL injuries with a higher accuracy [62].

Reverse Anterolateral Drawer Test

The exam is performed with the patient lying on the bed with the knee flexed and the angle of the knee adjusted to facilitate plantar flexion. The heel is completely pressed on the bed by the examiner with one hand after adjusting the ankle to a 10–15° of plantar flexion and unconstrained internal rotation. The index and middle fingers are placed along the relatively smooth plane of the lateral aspect of the anterior talus dome and the anterior aspect of the lateral malleolus (1 cm proximal to the tip). The other hand holds the distal tibia, and the base of the palm pushes against the tibia to induce a posteriorly oriented displacement of the tibia with a force parallel with that of the articular surface arch of the talus. The grading standard is similar to that of the ADT. Both sensitivity and specificity of the RALDT are higher than 85%. The RALDT (with both a relatively high specificity and sensitivity) shows a good ability to diagnose chronic ATFL ankle injuries [57].

Talar Tilt Test

The talar tilt test, or inversion stress maneuver, is performed with the patient supine or on the side, with the foot relaxed. The gastrocnemius muscle must also be relaxed by flexion of the knee. The talus is then tilted from side to side into adduction and abduction. The findings should be compared with the contralateral side. A sensitivity of 52% has been reported in one study for the talar tilt test [63]. If a firm end point cannot be felt when compared with the opposite ankle by abducting and inverting the heel, damage to the CFL can be apparent. (Note that the degree of tilt ranges from 0 to 23°.) Pain in the area of the ligament or a sensation of clunk would indicate a positive test. An outward translation in excess of 5° on the injured side compared to the uninjured side, or a spongy or indefinite end feel, may indicate a complete tear of CFL. In many cases, this test is difficult, if not impossible, to perform secondary to post-traumatic patient pain and swelling [64] (Fig. 58.6a, b).

58.4.1.2 Medial Instability

An acute injury to the deltoid ligament complex following a pronation (eversion) trauma usually presents with symptoms ranging from discomfort to a severely painful and swollen medial ankle with the inability to bear weight. The mechanism of trauma, level of daily activity, level of athletic activity, and any history of previous ankle sprain should be clarified. Chronically, a deltoid ligament injury presents as a medial giving way, especially when walking on uneven ground. The patient usually complains of anteromedial pain, and sometimes the pain emanates laterally due to the hindfoot valgus (subfibular impingement). Mechanical symptoms like catching or locking may be present with the development of intra-articular impingement (hypertrophic synovium, anteromedial osteophytes, OCLs). Any associated foot deformity or disease, history of ankle sprains, and the patient's activity level should also be evaluated [45].

Severe ankle sprains may affect the medial ligament complex, whose deterioration and suboptimal treatment can result in chronic rotational ankle instability (i.e., combination of medial and lateral ankle instability). In a prospective study, an arthroscopic exploration of the deltoid ligament done during the treatment of chronic lateral ankle instability revealed that 20% of patients had a concomitant lesion of the deltoid [26]. Therefore, small alterations in the deltoid ligament complex lead to secondary lateral ankle instability, respective rotational ankle instability, and increased risk for ankle osteoarthritis (OA) [45].

The integrity of the superficial deltoid ligament can be evaluated on a relaxed sitting patient with hanging legs using the "external rotation test," whereas the deep deltoid can be assessed by the "eversion stress test." A combined eversion and external rotation stress test addresses both

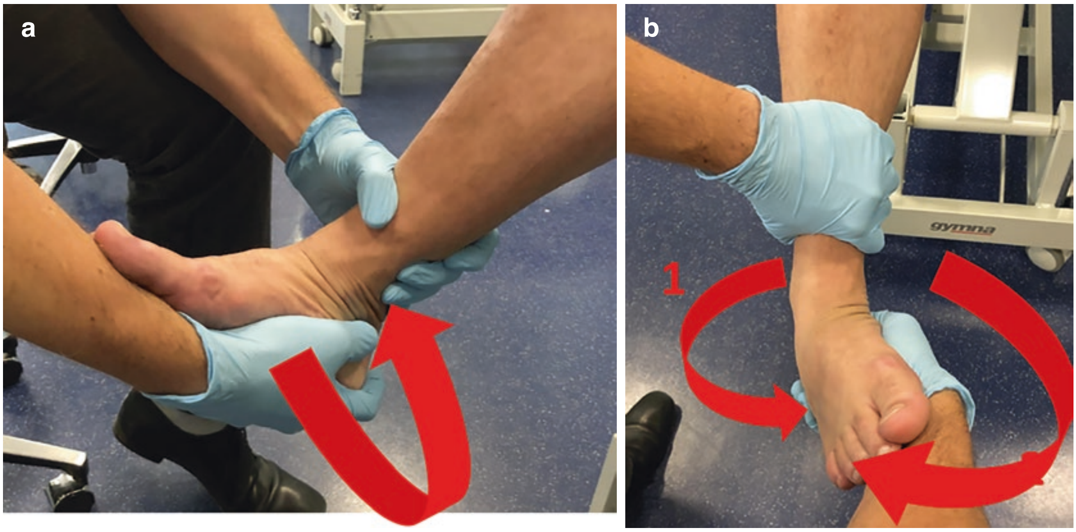

Fig. 58.6 (**a**) The talar tilt test, or inversion stress maneuver. (**b**) The talar tilt test. The talus is tilted from side to side into adduction (movement 1) and abduction (movement 2)

Fig. 58.7 (**a**) External rotation test: The foot is gently grasped and rotated laterally with the ankle locked in neutral. (**b**) External rotation test: The foot is gently grasped and rotated laterally with the ankle locked in neutral

the deep and the superficial deltoid ligament. The anterior drawer test is also a valuable tool for diagnosing anteromedial subluxation in deltoid ligament insufficiency [26, 27, 65].

External Rotation Stress Test

The external rotation test can demonstrate the integrity of the syndesmotic ligaments. The patient sits with the knee flexed to 90°. The foot is gently grasped and rotated laterally with the ankle locked in neutral. A positive test result occurs when the patient has pain over the syndesmosis. The external rotation test has a sensitivity of 20% and a specificity of 84.8% [66] (Fig. 58.7a, b).

Kleiger Test

This is also named the dorsiflexion external rotation stress test and seen as a variation of the external rotation test. The talus may displace from the medial malleolus, indicating a tear of the deltoid ligament. With the patient seated and the knee flexed approximately 90° and the ankle relaxed, use one hand to grasp and stabilize the leg from behind, making sure not to compress the fibula and tibia together. Use your other hand to fully dorsiflex the ankle and then externally rotate the foot (Fig. 58.8a–e). Pain over the location of the anterior inferior tibiofibular ligament is indicative of a syndesmosis sprain. A positive test

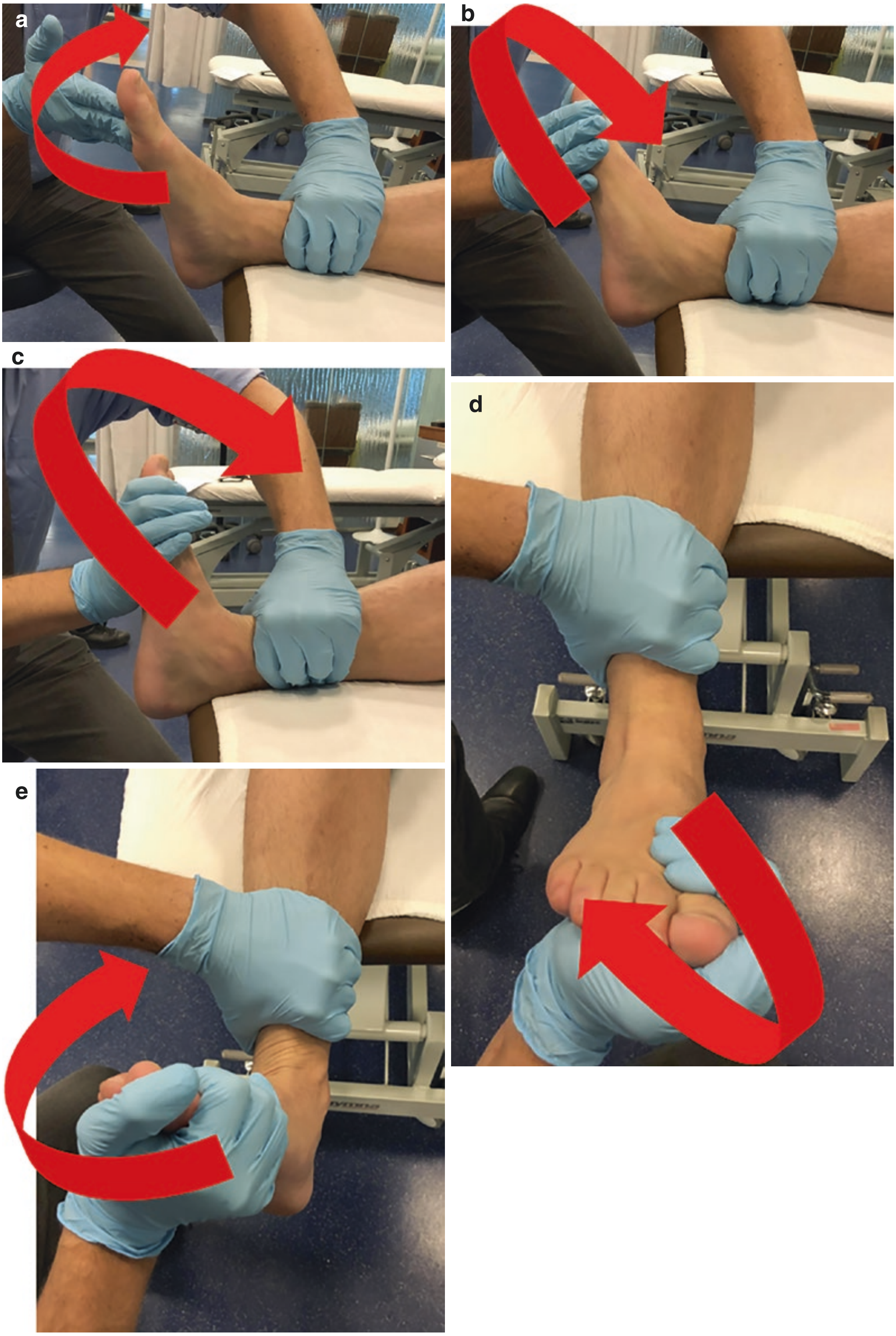

Fig. 58.8 (**a**–**c**) Kleiger test: one hand to grasp and stabilize the leg from behind, making sure not to compress the fibula and tibia together. Use your other hand to fully dorsiflex the ankle and then externally rotate the foot. (**d**) Upper view of the Kleiger test. External rotation. (**e**) Upper view of the Kleiger test. Hyperdorsiflexion

occurs when the patient has pain medially and laterally. Depending on the severity, the interosseous membrane may be involved, and pain can be radiated further up between the distal fibula and tibia. This test is also sensitive for fractures of the fibula [67].

Eversion Stress Test

The eversion stress test evaluates the integrity of the deltoid ligament. Patient is seated with knee flexed at approximately 90°, and ankle in neutral. One hand is used to stabilize the lateral aspect of the leg above the lateral malleolus. The other hand of the examiner is placed inferomedial on the calcaneus, and the hindfoot is everted. Pain over the deltoid ligament and increased eversion indicate possible injury to the midportion of the deltoid or a possible avulsion fracture of the medial malleolus. This test should be repeated while holding the ankle in full dorsiflexion to evaluate the posterior aspect of the deltoid and then repeated again in plantar flexion to evaluate the anterior aspect of the deltoid ligament [68].

58.4.1.3 Clinical Tests for Syndesmosis

Ruptures of the syndesmosis are rarely isolated injuries, but generally occur in association with other osteo-ligamentous injuries, especially fractures of either the fibula or the posterior and medial malleoli. It should be strongly suspected if there is an associated fracture of the proximal fibula (Maisonneuve fracture). Squeeze test, external rotation stress test, fibula translation test, Cotton test, and crossed-leg test are tests used to assess the integrity of the syndesmosis of the ankle. The external rotation test is specifically correlated with the presence of a syndesmosis sprain and is associated with a longer return to preinjury activities [69].

In a study comparing physical examination and MRI for lateral ankle sprain, sensitivity and specificity were 30% and 93.5% for the squeeze test, and 20% and 84.8% for the external rotation test, respectively. The sensitivity of the squeeze test and external rotation test was low, suggesting that physical examination often fails to diagnose syndesmotic injury. Conversely, the specificity was very high; nearly all patients with a positive test presented with a syndesmotic injury [66].

The classification of syndesmotic injury is divided into three grades: grade I represents a mild sprain to the AITFL without instability; grade II involves a tear of the AITFL and a partial tear of the IOL with some instability; and grade III represents definite instability with complete rupturing of all the syndesmotic ligaments [18].

Frick Test

This consists of forced dorsiflexion and external rotation of the ankle, with the knee in 90° flexion [16, 35, 70]. There is a variant of Frick test, performed under weight-bearing. Its sensitivity range is 30–71%, and it has a specificity of 85% [71–73].

Squeeze Test

It consists of proximal tibial and fibular compression (Fig. 58.9a, b), inducing a movement separating the two distally, which is possible, and painful, in case of syndesmosis ligament lesion [37, 40]. Pain at the level of the ankle joint indicates a positive test result. It has sensitivity of 30% and specificity ranging from 88 to 93.5% [36, 72, 74].

Cotton Test

The Cotton test is performed by translating the talus within the mortise from medial to lateral. Increased translation or pain may suggest syndesmosis involvement, as well as a deltoid (medial) ligament injury.

Single-Leg Jump Test

Exam consists of jumping with the injured leg; pain is alleviated when the same jumps are made with strapping at syndesmosis level, limiting abnormal motion of the distal tibiofibular mortise [47].

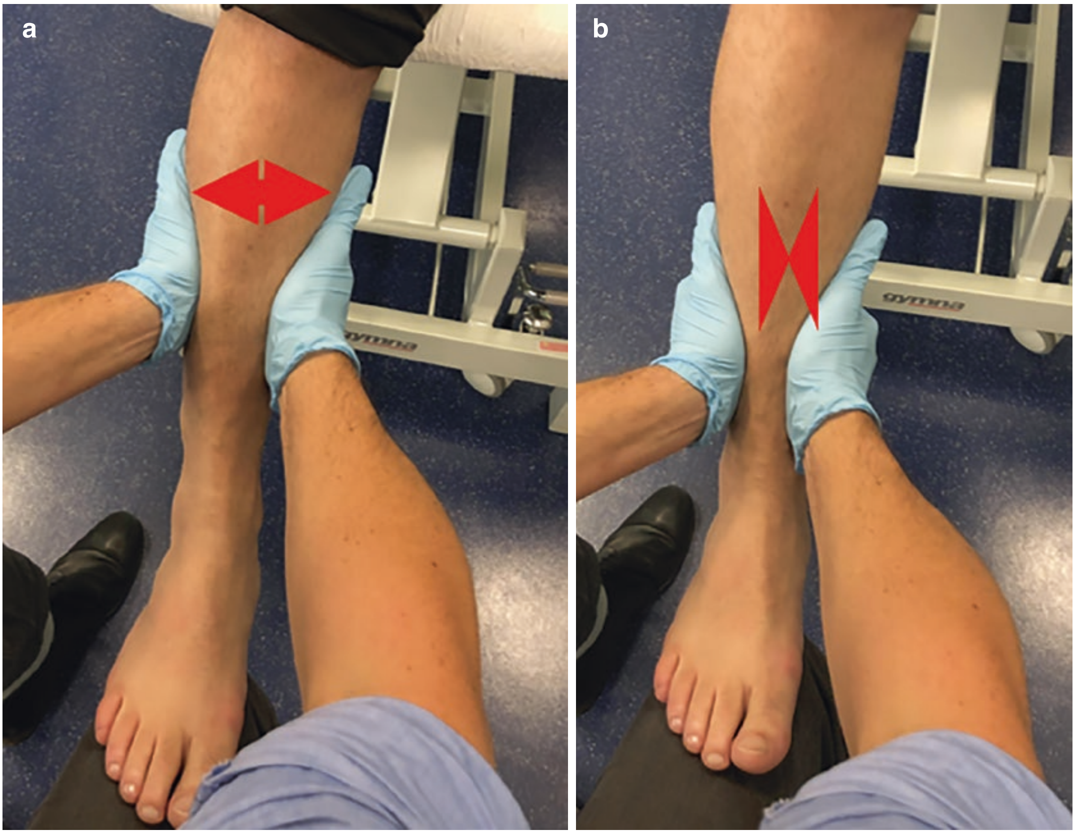

Fig. 58.9 (**a**, **b**) Squeeze test: proximal tibia and fibula compression

The External Rotation Stress Test

This is performed by placing the ankle in a dorsiflexion position and applying an external rotation force. Pain with this maneuver indicates a positive test result.

Fibula Translation Test

The examiner attempts to translate the fibula from anterior to posterior. In the normal ankle, there is a firm end point and little movement. Increased translation relative to the contralateral side and pain indicates a positive test result. The ligament tear causes abnormal motion revealing excessively anteroposterior fibular course compared to the tibia [70].

This test is performed by tightly applying several layers of 1.5 in. athletic tape just above the ankle joint to stabilize the distal syndesmosis. The patient is then asked to stand, walk, and perform a toe raise and jump. The test result is positive if these maneuvers are less painful after taping (Table 58.1).

Fact Box

- Syndesmotic injury generally occurs in high-grade ankle trauma.
- High number of syndesmotic injuries are missed during the initial clinical examination.
- Proper history taking and physical examination can lead to a fast diagnosis.

Table 58.1 Physical examination sequence on ankle instability and syndesmotic injury

Test	Description	Positive finding	Conditions associated with positive finding
Anterior drawer test	Patient supine, and the patient's foot in slight plantar flexion, brace the anterior shin with one hand and translate the heel anteriorly with the other hand. Comparison is made to the contralateral side	Laxity and absence of a firm end point laxity	ATFL rupture Possible CFL injury
Talar tilt test	With the patient seated or supine and the tibia and fibula stabilized, the ipsilateral foot is inverted and everted. Comparison is made to the contralateral side	Laxity and/or pain Pain	ATFL rupture CFL injury
Squeeze test	With the patient seated or supine, compress the patient's lower leg about midway up the test calf	Pain in the area of the distal tibiofibular and interosseous ligaments with proximal calf compression	Syndesmotic injury
External rotation test (syndesmotic stress test)	Patient seated on the examination table and the knee flexed over the edge of the table, the proximal lower leg is stabilized while the foot is grasped (plantar surface/heel) and dorsiflexed. The foot is then externally rotated	Pain in the area of the distal tibiofibular and interosseous ligaments	Syndesmotic injury
Kleiger test (dorsiflexion external rotation test)	With the patient seated and the knee flexed approximately 90° and the ankle relaxed, use one hand to grasp and stabilize the leg from behind, making sure not to compress the fibula and tibia together. Use your other hand to fully dorsiflex the ankle and then externally rotate the foot	Pain medially and laterally	Tear of the deltoid ligament Syndesmotic injury Interosseous membrane may be involved

58.5 Conclusion

Adequate history taking, clinical examination, and appropriate imaging are necessary to identify ankle ligament injuries, including potential associated pathology. Five to seven days of a delayed physical examination increases the sensitivity. Micro-instability and rotatory instability are new concepts that aim at fine-tuning a better understanding related to these injuries. Clinical examination of ankle ligament injuries is essential to avoid the ankle from developing instability and osteoarthrosis due to delayed diagnosis and rehabilitation.

References

1. Cloke DJ, Ansell P, Avery P, Deehan D. Ankle injuries in football academies: a three-Centre prospective study. Br J Sports Med. 2011;45(9):702–8.
2. Giza E, Fuller C, Junge A, Dvorak J. Mechanisms of foot and ankle injuries in soccer. Am J Sports Med. 2003;31(4):550–4.
3. Cloke DJ, Spencer S, Hodson A, Deehan D. The epidemiology of ankle injuries occurring in English football association academies. Br J Sports Med. 2009;43(14):1119–25.
4. Anderson RL, Engebretsen L, Kennedy N, LaPrade R, Wegner AM, Giza E. Epidemiology and mechanisms of ankle pathology in football. In: The ankle in football. Paris: Springer; 2014. p. 31–59.
5. Stubbe JH, van Beijsterveldt AM, van der Knaap S, Stege J, Verhagen EA, van Mechelen W, Backx FJ. Injuries in professional male soccer players in The Netherlands: a prospective cohort study. J Athl Train. 2015;50(2):211–6.
6. Ekstrand J, Hägglund M, Waldén M. Injury incidence and injury patterns in professional football: the UEFA injury study. Br J Sports Med. 2011;45(7):553–8.
7. Jain N, Murray D, Kemp S, Calder J. Frequency and trends in foot and ankle injuries within an English premier league football Club using a new impact factor of injury to identify a focus for injury prevention. Foot Ankle Surg. 2014;20(4):237–40.
8. Waldén M, Hägglund M, Ekstrand J. Time-trends and circumstances surrounding ankle injuries in men's professional football: an 11-year follow-up of the

UEFA champions league injury study. Br J Sports Med. 2013;47(12):748–53.
9. Woods C, Hawkins R, Hulse M, Hodson A. The football association medical research programme: an audit of injuries in professional football: an analysis of ankle sprains. Br J Sports Med. 2003;37(3):233–2388.
10. Waterman BR, Belmont PJ Jr, Cameron KL, De Berardino TM, Owens BD. Epidemiology of ankle sprain at the United States military academy. Am J Sports Med. 2010;38:797–803.
11. Al-Mohrej O, Al-Kenani NS. Acute ankle sprain: conservative or surgical approach? EFORT Open Rev. 2017;1:34–44.
12. Berson BL, Rolnick AM, Ramos CG, Thornton J. An epidemiologic study of squash injuries. Am J Sports Med. 1981;9:103–6.
13. Hertel J. Functional anatomy pathomechanics and pathophysiology of lateral instability. J Athl Train. 2002;37:364–75.
14. Hong C, Tan K. Concepts of ankle instability. OA Sports Med. 2014;2:3–11.
15. Blalock D, Miller A, Tilley M, Wang J. Joint instability and osteoarthritis. Clin Med Insights Arthritis Musculoskelet Disord. 2015;8:15–23.
16. Taylor DC, Englehardt DL, Bassett FH. Syndesmosis sprains of the ankle. The influence of heterotopic ossification. Am J Sports Med. 1992;20:146–50.
17. Roemer FW, Jomaah N, Niu J, Almusa E, Roger B, D'Hooghe P, Geertsema C, Tol JL, Khan K, Guermazi A. Ligamentous injuries and the risk of associated tissue damage in acute ankle sprains in athletes: a cross-sectional MRI study. Am J Sports Med. 2014;42(7):1549–57.
18. Williams GN, Jones MH, Amendola A. Syndesmotic ankle sprains in athletes. Am J Sports Med. 2007;35(7):1197–207.
19. Al-Mohrej O, Al-Kenani N. Chronic ankle instability: current perspectives. Avicenna J Med. 2016;6(4):103.
20. Ajis A, Maffulli N. Conservative management of chronic ankle instability. Foot Ankle Clin. 2006;11:531–7.
21. Rodriguez Merchan EC. Chronic ankle instability: diagnosis and treatment. Arch Orthop Trauma Surg. 2012;132(211):9.
22. Ortho Evidence. Approach to chronic ankle instability rehabilitation: does mobilization have a role? 2019. https://myorthoevidence.com/Blog/Show/28. This manuscript provides an approach to chronic ankle instability rehabilitation with a review of all the current literature
23. Giza E. Chronic footballer's ankle. In: Volpi P, editor. Football traumatology. Milan: Springer; 2006. p. 333–51.
24. Hamilton WG. Sprained ankles in ballet dancers. Foot Ankle. 1982;3(2):99–102.
25. Miklovic TM, Donovan L, Protzuk OA, Kang MS, Feger MA. Acute lateral ankle sprain to chronic ankle instability: a pathway of dysfunction. Phys Sportsmed. 2018;46:116–22.
26. Hintermann B, Boss A, Schäfer D. Arthroscopic findings in patients with chronic ankle instability. Am J Sports Med. 2002;30(3):402–9.
27. Hintermann B, Valderrabano V, Boss A, et al. Medial ankle instability an exploratory, prospective study of fifty-two cases. Am J Sports Med. 2004;32(1):183–90.
28. Valderrabano V, Hintermann B. Diagnostik und Therapie der medialen Sprunggelenkinstabilitat. Arthroskopie. 2005;18(2):112–8.
29. Taga I, Shino K, Inoue M, et al. Articular cartilage lesions in ankles with lateral ligament injury. An arthroscopic study. Am J Sports Med. 1993;21(1):120–6. [discussion: 126–7].
30. Calder JD, Bamford R, Petrie A, et al. Stable versus unstable grade II high ankle sprains: a prospective study predicting the need for surgical stabilization and time to return to sports. Arthroscopy. 2016;32(4):634–42.
31. Hunt KJ, Phisitkul P, Pirolo J, et al. High ankle sprains and syndesmotic injuries in athletes. J Am Acad Orthop Surg. 2015;23:661–73.
32. Taylor DC, Tenuta JJ, Uhorchak JM, et al. Aggressive surgical treatment and early return to sports in athletes with grade III syndesmosis sprains. Am J Sports Med. 2017;35:1833–8.
33. Van den Bekerom MP. Diagnosing syndesmotic instability in ankle fractures. World J Orthop. 2011;2:51–6.
34. Miller AN, Carroll EA, Parker RJ, Helfet DL, Lorich DG. Posterior malleolar stabilization of syndesmotic injuries is equivalent to screw fixation. Clin Orthop Relat Res. 2010;468(4):1129–35.
35. Van Dijk CN, Lim LS, Bossuyt PM, Marti RK. Physical examination is sufficient for the diagnosis of sprained ankles. J Bone Joint Surg (Br). 1996;78(6):958–62.
36. Van Dijk CN, Mol BW, Lim LS, Marti RK, Bossuyt PM. Diagnosis of ligament rupture of the ankle joint. Physical examination, arthrography, stress radiography and sonography compared in 160 patients after inversion trauma. Acta Orthop Scand. 1996;67(6):566–70.
37. van den Bekerom MP, Kerkhoffs GM, McCollum GA, Calder JD, van Dijk CN. Management of acute lateral ankle ligament injury in the athlete. Knee Surg Sports Traumatol Arthrosc. 2013;21(6):1390–5.
38. Verhage SM, Boot F, Schipper IB, Hoogendoorn JM. Open reduction and internal fixation of posterior malleolar fractures using the posterolateral approach. Bone Joint J. 2016;98(6):812–7.
39. Kent S, Yeo G, Marsland D, Randell M, Forster B, Lutz M, Okano S. Delayed stabilization of dynamically unstable syndesmotic injuries results in worse functional outcomes. Knee Surg Sports Traumatol Arthrosc. 2020;28(10):3347–53. https://doi.org/10.1007/s00167-020-05962-1).
40. Bachmann LM, Kolb E, Koller MT, Steurer J, ter Riet G. Accuracy of Ottawa ankle rules to exclude fractures of the ankle and mid-foot: systematic review. BMJ. 2003;326(7386):417.

41. Vuurberg G, Hoorntje A, Wink LM, Van Der Doelen BFW, Van Den Bekerom MP, Dekker R, et al. Diagnosis, treatment and prevention of ankle sprains: update of an evidence-based clinical guideline. Br J Sports Med. 2018;52(15):956.
42. Bachmann LM, Kolb E, Koller MT, et al. Accuracy of Ottawa ankle rules to exclude fractures of the ankle and mid-foot: systematic review. BMJ. 2003;326(7386):417.
43. Young CC, Niedfeldt MW, Morris GA, et al. Clinical examination of the foot and ankle. Prim Care. 2005;32(1):105–32.
44. Leddy JJ, Kesari A, Smolinski RJ. Implementation of the Ottawa ankle rule in a university sports medicine center. Med Sci Sports Exerc. 2002;34(1):57–62.
45. Alshalawi S, Galhoum AE, Alrashidi Y, Wiewiorski M, Herrera M, Barg A, et al. Medial ankle instability: the deltoid dilemma. Foot Ankle Clin. 2018;23(4):639–57.
46. Tourné Y, Molinier F, Andrieu M, Porta J, Barbier G. Diagnosis and treatment of tibiofibular syndesmosis lesions. Orthop Traumatol Surg Res. 2019;105(8):S275–86.
47. Gün C, Unlüer EE, Vandenberk N, Karagöz A, Sentürk GO, Oyar O. Bedside ultrasonography by emergency physicians for anterior talofibular ligament injury. J Emerg Trauma Shock. 2013;6(3):195–8.
48. Joshy S, Abdulkadir U, Chaganti S, Sullivan B, Hariharan K. Accuracy of MRI scan in the diagnosis of ligamentous and chondral pathology in the ankle. Foot Ankle Surg. 2010;16(2):78–80.
49. Oae K, Takao M, Uchio Y, Ochi M. Evaluation of anterior talofibular ligament injury with stress radiography, ultrasonography and MR imaging. Skelet Radiol. 2010;39(1):41–7.
50. Guerra-Pinto F, Corte-Real N, Vega J, Malagelada F, Guelfi M, Baduell A, Dalmau-Pastor M. Inestabilidad de tobillo: etiología, semiología y nuevos conceptos. Rev Esp Artrosc Cir Articul. 2020;27(1):52–60.
51. Chan KW, Ding BC, Mroczek KJ. Acute and chronic lateral ankle instability in the athlete. Bull NYU Hosp Jt Dis. 2011;69(17):26.
52. Nitz AJ, Dobner JJ, Kersey D. Nerve injury and grades II and III ankle sprains. Am J Sports Med. 1985;13(177):82.
53. Arnold BL, Linens SW, de la Motte SJ, Ross SE. Concentric evertor strength differences and functional ankle instability: a meta-analysis. J Athl Train. 2009;44:653–62.
54. Cho JH, Lee DH, Song HK, et al. Value of stress ultrasound for the diagnosis of chronic ankle instability compared to manual anterior drawer test, stress radiography, magnetic resonance imaging, and arthroscopy. Knee Surg Sports Traumatol Arthrosc. 2016;24:1022–8.
55. Gruskay JA, Brusalis CM, Heath MR, Fabricant PD. Pediatric and adolescent ankle instability: diagnosis and treatment options. Curr Opin Pediatr. 2019;31(1):69–78.
56. Meyers-Levy J, Zhu R, Jiang L. Context effects from bodily sensations: examining bodily sensations induced by flooring and the moderating role of product viewing distance. J Consum Res. 2010;37:1–14.
57. Li Q, Tu Y, Chen J, Shan J, Yung PSH, Ling SKK, et al. Reverse anterolateral drawer test is more sensitive and accurate for diagnosing chronic anterior talofibular ligament injury. Knee Surg Sports Traumatol Arthrosc. 2020;28(1):55–62.
58. Croy T, Koppenhaver S, Saliba S, Hertel J. Anterior talocrural joint laxity: diagnostic accuracy of the anterior drawer test of the ankle. J Orthop Sports Phys Ther. 2013;43:911–9.
59. Lin CW, Uegaki K, Coupé VM, et al. Economic evaluations of diagnostic tests, treatment and prevention for lateral ankle sprains: a systematic review. Br J Sports Med. 2013;47:1144–9.
60. Lin CY, Shau YW, Wang CL, et al. Quantitative evaluation of the viscoelastic properties of the ankle joint complex in patients suffering from ankle sprain by the anterior drawer test. Knee Surg Sports Traumatol Arthrosc. 2013;21:1396–403.
61. Lahde S, Putkonen M, Puranen J, Raatikainen T. Examination of the sprained ankle: anterior drawer test or arthrography? Eur J Radiol. 1988;8:255–7.
62. Phisitkul P, Chaichankul C, Sripongsai R, Prasitdamrong I, Tengtrakulcharoen P, Suarchawaratana S. Accuracy of anterolateral drawer test in lateral ankle instability: a cadaveric study. Foot Ankle Int. 2009;30:690–5.
63. Blanshard KS, Finaly DB, Scott DJ, Ley CC, Siggins D, Allen MJ. A radiological analysis of lateral ligament injuries of the ankle. Clin Radiol. 1986;37(3):247–51.
64. Lynch S. Assessment of the injured ankle in the athlete. J Athl Train. 2002;37(4):406–12.
65. Hintermann B, et al. Medial ankle instability. Foot Ankle Clin. 2003;8(4):723–38.
66. de César PC, Avila EM, de Abreu MR. Comparison of magnetic resonance imaging to physical examination for syndesmotic injury after lateral ankle sprain. Foot Ankle Int. 2011;32(12):111–4. (ISSN: 1071-1007).
67. https://www5.aaos.org/CustomTemplates/VideoGallery.aspx?id=4294972388&ssopc=1. Accessed 15 May 2020, 17h05.
68. https://www5.aaos.org/CustomTemplates/VideoGallery.aspx?id=42949723900&page=9&ssopc=1. Accessed 15 May 2020, 17h18].
69. Shore BJ, Kramer DE. Management of Syndesmotic ankle injuries in children and adolescents. J Pediatr Orthop. 2016;36(4):S11–4.
70. Khor YP, Tan KJ. The anatomic pattern of injuries in acute inversion ankle sprains: a magnetic resonance imaging study. Orthop J Sports Med. 2013;1(7):2325967113517078.
71. Andersen TE, Floerenes TW, Arnason A, Bahr R. Video analysis of the mechanisms for ankle injuries in football. Am J Sports Med. 2004;32(1 Suppl):69S–79S.

72. Krips R, de Vries J, van Dijk CN. Ankle instability. Foot Ankle Clin. 2006;11(2):311–29.
73. St Pierre RK, Rosen J, Whitesides TE, Szczukowski M, Fleming LL, Hutton WC. The tensile strength of the anterior talofibular ligament. Foot Ankle. 1983;4(2):83–5.
74. Hawkins RD, Hulse MA, Wilkinson C, Hodson A, Gibson M. The association football medical research programme: an audit of injuries in professional football. Br J Sports Med. 2001;35(1):43–7.