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Systematic Review

# Physical Examination of the Ankle: A Review of the Original Orthopedic Special Test Description and Scientific Validity of Common Tests for Ankle Examination

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**KEYWORDS**
Ligaments;
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**Abstract** *Objectives:* To review the literature, identify and describe commonly used special tests for diagnosing injury to the ligaments of the ankle complex, present the distinguishing characteristics and limitations of each test, and discuss the current evidence for the clinical use of each test.
*Data Sources:* Multiple PubMed (1920-2018) and CINAHL (1920-2018) searches were conducted and various musculoskeletal examination textbooks were reviewed to examine common orthopedic tests used to assess the ankle. The articles were reviewed for additional references and the search continued until the original description was found when possible.
*Study Selection:* All articles discussing the performance of the test or its validity (ie, sensitivity and specificity) were reviewed and summarized.
*Data Extraction:* Articles were reviewed for additional references and the search continued until the original description was found when possible.
*Data Synthesis:* The literature was reviewed, commonly used special tests for diagnosing ankle injuries were identified and described, distinguishing characteristics and limitations of each test were presented, and the current evidence for the clinical use of each test was discussed.
*Conclusions:* A complete physical examination is critical in the diagnosis of ankle injuries. The combination of available information such as mechanism of injury, all signs and symptoms, and changes in gait, is key to a conclusive and correct diagnosis. Clinicians should be aware of the severely limited evidence supporting the use of many commonly used special tests. Applying evidence from the literature will improve diagnostic accuracy. Further

*List of abbreviations:* ADL, anterior deltoid ligament; ATFL, anterior talofibular ligament; CFL, calcaneofibular ligament; PCNL, plantar calcaneonavicular ligament.
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research is needed to understand the performance ability of special tests, both individually and when grouped as part of a test battery.


The ankle complex comprises 3 distinct articulations: the talocrural joint, the subtalar joint, and the distal tibiofibular syndesmotic joint. During activity, these joints, along with the soft-tissue anatomy, primarily allow for multiplanar motion during functional movement. Too much stress or strain during movement, however, may lead to injury.[1] Ankle injuries are among the most prominent pathologies for patients to report to orthopedic emergency departments.[2] Ankle sprains are a common sports injury, accounting for 10% to 15% of sport-related injuries.[3]

Clinicians should carefully evaluate for injury with a patient interview, as well as clinical tests and measures, during the physical examination. After a thorough history, careful inspection and palpation should be performed. Special tests should then be performed, including range of motion, neurological examination, and orthopedic special tests.[1] Given the close relationship of the different anatomical structures, the variety of pathologies, and the numerous special tests designed to evaluate the ankle, a clinician must wisely choose the most appropriate special tests.

The purposes of this study were to review the literature, identify and describe commonly used special tests for diagnosing ankle injuries, present the distinguishing characteristics and limitations of each test, and discuss the current evidence for the clinical use of each test. Orthopedic special tests used to evaluate lateral ankle sprains, medial ankle sprains, and syndesmotic (high ankle) sprains were reviewed. The abundance of information in this area was clarified to provide a basic reference for using orthopedic special tests to diagnose common traumatic ankle sprain pathologies.

## Methods

Multiple PubMed (1920-2018) and CINAHL (1920-2018) searches were conducted and various musculoskeletal examination textbooks were reviewed to examine common orthopedic tests used to assess the ankle. The following search terms were used to search all databases: ankle special test, anterior talofibular ligament, calcaneofibular ligament, posterior talofibular ligament, deltoid ligament, anterior inferior tibiofibular ligament, posterior inferior tibiofibular ligament, interosseous membrane, transverse tibiofibular ligament, anterior drawer test, talar tilt, inversion stress test, eversion stress test, posterior drawer test, Cotton test, external rotation test, Kleiger's test, fibular translation test, squeeze test, compression test, crossed-leg test, and bump test. The reference lists for each identified article and textbook were cross-referenced and searched to identify additional articles for inclusion. Only those resources available in English were included. Initial searches elicited more than 12,000 results. Titles and abstracts were reviewed for content relating to human subjects, a focus on 1 or more special tests for ankle ligament stability, and discussion of the sensitivity and specificity of the special tests. One review author extracted the data from included studies and a second author checked the extracted data to ensure that it met eligibility criteria. Seventy-one total sources were selected as having met the inclusion criteria.

## Results

### Orthopedic tests for examining sprains of the lateral collateral ligaments of the ankle

The extent of soft tissue damage that occurs to the lateral collateral ankle ligaments after trauma may help determine the severity of the injury. After injury, patients may experience pain, swelling, weakness, instability, functional loss, or a combination of symptoms. Testing the lateral ankle after injury should include specific tests designed to examine the integrity of its structures. The following tests are intended to assess injury to the lateral ankle ligament complex: anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligament.

#### Anterior drawer test

The anterior subluxation of the talus, which later became known as the anterior drawer sign, was first described by Dehne,[4] Anderson et al,[5] and Landeros et al.[6] Anderson et al[5] noted that "strain on the ankle joint in the coronal plane with the foot in plantar flexion produced an anterior subluxation"[(p855)] and that the amount of translation was most increased with the ankle plantar flexed 20 degrees. Landeros et al[6] provided more detail, but a contrasting approach, writing that the anterior drawer sign "must be tested for with the knee flexed and the ankle held at a right ankle. With plantar flexion of the ankle, a positive anterior drawer sign usually becomes negative."[(p1028)]

Approximately 10 years later, Frost and Hanson[7] felt the test was still poorly understood, or simply performed improperly, and published an article describing the technique. According to Frost and Hanson, the patient would be positioned to promote relaxation, and could be either sitting or supine. The leg being examined would have the knee flexed to 90 degrees and the ankle positioned at 90 degrees, as it was believed that plantar flexion would make it nearly impossible to demonstrate the drawer sign. The clinician would then stabilize the anterior tibia with the heel of 1 hand just proximal to the ankle joint while extending the fingers around the medial tibia to serve as "sensors" to feel for displacement of the talus on the tibia. The other hand would be placed with the palm on the underside of the heel with the fingers wrapping around the posterior aspect of the heel. The clinician would then pull anteriorly with the hand grasping the calcaneus and push posteriorly with the hand stabilizing the tibia, looking and feeling for the anterior drawer sign.[7]

Since this account by Frost and Hanson, some have described the performance of the test almost identically,[8] whereas others performed the test with the addition of plantarflexion (table 1).[1,17,18] Still others have described performing the test with the patient supine, with no mention of knee position, and with the examiner grasping the forefoot to apply the force necessary to translate the talus anteriorly.[19]

Varying testing methods have led to differing results. Regarding translation of the talus on the tibia, the majority suggest that the greatest translation is achieved with the patient's ankle plantar flexed 10 to 20 degrees,[20-27] although dorsiflexed[28,29] and neutral positioning has also been suggested.[14] Anatomically, in plantarflexion the ATFL is maximally strained and the CFL is relaxed, whereas both are relaxed in the neutral position. In dorsiflexion, the CFL is strained and the ATFL is relaxed.[24,27,28,30-34] Kovaleski et al[23] reported that 90 degrees of knee flexion produced the greatest laxity during the test.

Universal diagnostic criteria using talar translation has not been established, but the normal ankle can be used as a diagnostic guide. An increase in translation of approximately 3 mm or more compared with the uninvolved side is associated with non-functionality of the ankle.[11,26-28,33,35] Injury to both the ATFL and CFL will result in even greater translation[20,22,33] across all joint angles compared with the normal ankle.[26,33] Cadaveric sectioning of the anterior deltoid ligament (ADL) or the syndesmotic ligaments did not produce significant change in translation.[36]

Sensitivity reports vary greatly based on the performance of the test, the timing of the examination, and the definition of a positive test result. Sensitivity of the test has been reported to be 80%,[9] 75%,[11] 32%,[12] 80%,[10] 74%, and 83%,[13] with specificity of 50%,[11] 38%, and 40%.[13] For isolated tears of ATFL, a sensitivity of 60% and specificity of 74% have been reported.[14] The test is more sensitive at low loads owing to muscular contraction produced to protect the joint from high forces; large magnitude forces are unnecessary.[20,27,37] Lähde et al[38] found that ATFL and combined ATFL/CFL tears were not detected 28% and 38% of the time, respectively, when using the anterior drawer test in patients with chronic instability.

The evidence indicates that the greatest stress can be placed on ATFL when the test is performed in 90 degrees of knee flexion, with 10 to 20 degrees of plantarflexion and low magnitude force. Similarly, the CFL can best be isolated when performing the test in dorsiflexion. These testing procedures do not guarantee that the clinician will have the ability to differentially diagnose between individual and combined ligament injury, although no significant difference has been established between outcomes of the manual anterior drawer test, stress diagnostic ultrasound, or stress radiography.[39] Further research is needed with clinicians performing the test as part of a complete physical examination and with others blinded to the physical examination on actual patients to determine the clinical accuracy of the test.

**Prone anterior drawer test**

Gungor[40] described the prone anterior drawer test in 1988 as an alternative to traditional methods of performing the anterior drawer test. Gungor reported:

"The patient lies prone with the foot and ankle extending beyond the end of the couch or table; usually the foot is in plantarflexion. With one hand the surgeon presses the heel forward steadily; if the anterior talofibular ligament is ruptured the talus moves forward in the ankle mortice further than on the uninjured side. At the same time the vacuum effect is seen, since the forward movement of the talus results in negative pressure which draws the skin inward on both sides of the calcaneal tendon."

A positive test was to be confirmed by taking lateral radiographs with the foot in the starting position and testing position. It was reported to be "much easier to perform with the patient prone, presumably because in that position he is more relaxed" (table 1).

No supporting evidence was found in the literature for Gungor's prone anterior drawer test, suggesting that further research is needed.

**Modified anterior drawer test**

Nyska et al[41] introduced the modified anterior drawer test in 1992 as a modification to the anterior drawer test. This test is performed as follows:

"Patient lies on his back with almost complete flexion of the knee. The foot is in the equinus position of 15°. The test itself is done by stabilizing the foot on the examination table with one hand, and forcefully pressing posteriorly the distal tibia with the other hand. The test is positive when the tibia moves posteriorly and proximally from the foot. The test results in one of three stages: at stage 0, there is no movement of the tibia from the talus; at stage 1, there is a slight posterior displacement of the tibia on the talus, but a firm end point is arrived at; and at stage 2, there is significant displacement of the tibia from the talus and no terminal resistance of the ligaments is arrived at."

The authors concluded that a stage 1 result indicates an injury mainly to the ATFL, whereas a stage 2 result may indicate injury to both the ATFL and CFL.

No supporting evidence was found in the literature for the modified anterior drawer test, suggesting that further research is needed.

**Anterolateral drawer test**

Phisitkul et al[11] introduced the anterolateral drawer test in 2009 because of a potential lack of sensitivity in previous methods not accounting for the anterolateral rotatory instability associated with lateral ankle sprains (see table 1). The test is performed as follows:

"One hand stabilizing the leg just above the ankle joint and the other hand providing a combination of the anterior directed force of the talus via the calcaneus, measurement of talar translation, and control of ankle plantarflexion. The index finger and long fingers are pressed firmly against the posterior aspect of the heel to provide a gentle anteriorly directed force. The palm supports against the sole of the foot to stabilize the ankle

**Table 1** Lateral ankle ligament tests

| Test | Description | Authors | Evidence (95% Confidence Interval) | Comments |
|---|---|---|---|---|
| Anterior drawer test | The patient is supine or seated, knee flexed to 90 degrees, ankle plantar flexed 10-20 degrees. Low magnitude force is utilized to translate the subtalar joint anteriorly. CFL is best isolated with dorsiflexion, although differential diagnosis is not guaranteed. | Lindstrand[9] | Sensitivity: 80% | Prospective study of 100 acutely injured patients. Examiner details were not included. |
| | | van Dijk et al[10] | Sensitivity: 80%<br>Specificity: not reported | Prospective blinded study of 160 patients injured within 48 hours of examination. Interrater reliability was good and not dependent on experience level. |
| | | Phisitkul et al[11] | Sensitivity: 75%<br>Specificity: 50% | Cadaveric study of 10 ankles evaluated by 1 of 2 examiners. |
| | | Blanshard et al[12] | Sensitivity: 32% | Prospective radiographic study of 142 patients examined within 5 days of injury, compared with 216 healthy controls |
| | | Croy et al[13] | Sensitivity: 74%-83%<br>Specificity: 38%-40% | Prospective study of 66 patients with history of lateral ankle sprain, evaluated by 1 examiner. |
| | | Fujii et al[14] | Sensitivity 60%<br>Specificity: 74% (Isolated tears of ATFL) | Cadaveric study of 6 ankles evaluated by 5 blinded examiners. |
| Prone anterior drawer | Patient is prone with foot/ankle beyond the end of the plinth. Foot in slight plantarflexion. Anterior force applied steadily and translation is compared bilaterally. | No studies were found that identified the accuracy of the specific test. | | |
| Modified anterior drawer | Patient is supine, almost full knee flexion, foot equinus 15 degrees. One hand stabilizes the foot on the table, 1 hand forcefully presses distal tibia posteriorly | No studies were found that identified the accuracy of the specific test. | | |
| Anterolateral drawer | Patient is short seated. One hand stabilizes the leg above the ankle joint, the other supports the sole of the foot and maintains 10-15 degrees of plantar flexion while providing anterior force while monitoring for talar translation and controlling plantarflexion. The thumb rests longitudinally anterior to the lateral malleolus. Anterior translation is applied and the foot is allowed to rotate internally and any step-off is palpable by the thumb. Translation of 3 mm or more indicated ligament disruption. | Phisitkul et al[11] | Sensitivity: 100%<br>Specificity: 100% | Cadaveric study of 10 ankles evaluated by 1 of 2 examiners. |

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|---|---|---|---|---|
| Inversion stress test | Patient is short seated with the ankle in neutral. Clinician stabilizes the distal leg with 1 hand. The other hand grasps the talus and calcaneus as a unit and provides an inversion force. | Blanshard et al[12] | Sensitivity: 52% Specificity: not reported | Prospective radiographic study of 142 patients examined within 5 days of injury, compared to 216 healthy controls. |
| | | Hertel et al[15] | Sensitivity: 52% Specificity: 88% (combined ATFL and CFL) | Prospective blinded study of 12 patients with history of lateral ankle sprain against 8 healthy controls, evaluated by 1 examiner. |
| | | Raatikainen et al[16] | Specificity: 68% (combined ATFL and CFL) | Prospective study of 188 patients with acute ankle sprain. Examiner details were not included. |
| Posterior drawer | | No studies were found that identified the accuracy of the specific test. | | |

in plantarflexion of 10 to 15 degrees. The thumb is placed along the relatively smooth plane formed by the lateral aspect of the anterior talar dome and anterior aspect of the lateral malleolus 1 cm proximal to its tip. Anterior translation is applied at the posterior aspect of the heel while the foot is allowed to rotate internally and any step-off is palpable by the thumb."

Phisitkul et al[11] performed a cadaveric study with the introduction of this test. The study was designed to compare the accuracy of the anterolateral drawer test versus the anterior drawer test in 1 of 3 conditions: (1) intact ligaments; (2) ATFL-cut; (3) ATFL-and-CFL-cut. The physical examinations were performed by a fellowship-trained foot and ankle surgeon and an in-training foot and ankle fellow who were blinded to the specimen preparations and each other's results. A specificity of 100% and a sensitivity of 100% were found when performing the anterolateral drawer test using 3 mm or more of translation as the threshold to diagnose ligament disruption.

Although the anterior lateral drawer test has not been further studied for validation, the work of Nigg et al,[34] which found the longest normalized elongation of the AFTL in internal rotation and maximal plantarflexion, created a foundation for the theoretical validity of the test. Further research is needed to build evidence of the test's performance.

**Inversion stress test (medial talar tilt stress test)**

The earliest reference of the Inversion stress test by Leonard[42] in 1949 reported that with "the foot at an angle of 90 degrees with the leg, the calcaneofibular ligament is perpendicular and the anterior talofibular ligament is parallel to the long axis of the talus. Therefore, inversion in this position results in strain on the calcaneofibular ligament." Early use of the test was with either a mechanical device[43] or by manual clinical application.[44] Ruth[44] performed the test with the ankle in 20 to 30 degrees of plantarflexion by stabilizing the right ankle with the left hand and using the right hand to grasp the calcaneus and apply an inversion force.

Slight variations in the test are common today, but consistent performance includes positioning the patient with a flexed knee and the ankle in neutral. The clinician, while grasping the talus and calcaneus as a unit, stabilizes the distal leg with one hand and provides an inversion force with the other hand (see table 1). The test performed in 10 to 20 degrees of plantarflexion primarily places force on the ATFL,[24,32-35,45] whereas the test performed in 10 degrees dorsiflexion primarily stresses the CFL.[24,29,30,32-34] An increase in motion compared bilaterally is considered a positive test[8,18,19]; an increase of 10 degrees or more likely indicates a combined rupture.[4,46] Clinicians should be aware that varying degrees of normal inversion exist at the ankle, reported to range from 0 to 5 degrees[35,47] and to 0 to 23 degrees[43] and that the addition of plantarflexion increases the amount of naturally occurring talar tilt.[14,35]

Sensitivity of the inversion talar tilt is reported to be 50% to 52%,[12,15] with a specificity for detecting combined ATFL and CFL sprains of 68%[16] and 88%.[15] The performance of the test may vary as a result of differing testing methods, duration of load, positioning of the ankle, or use of anesthesia.[48,49]

**Table 2** Distal tibiofibular syndesmosis tests

| Test | Description | Authors | Evidence (95% Confidence Interval) | Comments |
|---|---|---|---|---|
| Cotton test | The ankle is grasped just above the joint with 1 hand, the other hand is beneath the sole with the thumb on 1 side and the fingers on the other below the malleoli. The talus is shifted medially or laterally and abnormal mobility when compared bilaterally is noted. | Beumer et al[52] | Sensitivity: 25%<br>Specificity: not reported | Prospective blinded study of 3 patients with syndesmotic rupture and 9 healthy controls examined twice by 9 examiners. |
| External rotation test (when used to determine syndesmotic injury) | With the patient in a seated position, knee at 90 degrees and ankle in a neutral position, external rotation stress is applied to the involved foot and ankle. Positive test produces pain over the anterior and posterior tibiofibular ligaments and interosseous membrane. | de Cesar et al[55] | Sensitivity: 20%<br>Specificity: 84.8% | Prospective study of 56 patients with acute injury of the syndesmosis suspected. Examiner details were not reported. |
| | | Nussbaum et al[56] | Sensitivity: 75%<br>Specificity: not reported (when performing the test in dorsiflexion) | Prospective study of 60 athletes with history of "high" ankle symptoms examined by 1 of 5 clinicians and supported by radiographic findings. |
| Fibula translation test | Patient is short sitting. The tibia and fibula are grasped and the fibula is translated anteriorly and posteriorly on the tibia. Increased translation indicates a positive result. | Beumer et al[52] | Sensitivity: 75%<br>Specificity: 88% | Prospective blinded study of 3 patients with syndesmotic rupture and 9 healthy controls examined twice by 9 examiners. |
| Squeeze test | The fibula is compressed into the tibia above the midpoint of the calf. Pain in the area of the interosseous ligament and/or supporting structures indicates a positive test. | de Cesar et al[55] | Sensitivity: 30%<br>Specificity: 93.5% | Prospective study of 56 patients with acute injury of the syndesmosis suspected. Examiner details were not reported. |
| | | Nussbaum et al[56] | Sensitivity: 33% | Prospective study of 60 athletes with history of "high" ankle symptoms examined by 1 of 5 clinicians and supported by radiographic findings. |
| Crossed-leg test | The patient is seated in a chair and places the middle to distal one-third of leg to be tested across the knee of the opposite leg. The patient then applies a gentle downward force at the knee being tested. | No studies were found that identified the accuracy of the specific test. | | |

| | | |
|---|---|---|
| Stabilization test | Several layers of athletic tape are applied above the ankle to stabilize the distal syndesmosis. The test is positive if a series of weight bearing tasks are less painful with taping. | No studies were found that identified the accuracy of the specific test. |
| Heel-thump test | Patient is in a short-seated position, ankle in its natural resting position. One hand stabilizes the leg and the other fist is used to deliver firm thumps to the heel along the axis of the tibia. Positive test is indicated by pain in the areas of the interosseous membrane or tibiofibular ligaments. | No studies were found that identified the accuracy of the specific test. |

#### Posterior drawer test

Frost and Hanson[7] described the posterior drawer test using the same patient and clinician positioning as that used for the anterior drawer test. The patient is positioned to promote relaxation with the knee flexed to 90 degrees and the ankle positioned at 90 degrees. The clinician stabilizes the anterior tibia with the heel of one hand just proximal to the ankle, while extending the fingers around the medial tibia to serve as "sensors," feeling for displacement of the talus on the tibia. The other hand is placed with the palm on the underside of the heel with the fingers wrapped around the posterior aspect of the heel. The clinician would simply reverse the forces applied to the ankle during the anterior drawer test, providing a posteriorly directed force (see table 1).[7]

No supporting evidence was found in the literature for the posterior drawer test, suggesting that further research is needed.

### Orthopedic tests for examining sprains of the distal tibiofibular syndesmosis

Distal syndesmotic sprains can occur by several different mechanisms and, for this reason, can be difficult to differentiate. Patients may experience pain with external rotation or dorsiflexion of the ankle, as well as tenderness over the joint. The use of specific tests intended to assess injury to the distal tibiofibular joint may be helpful to determine the involvement of the structure.[50] The joint includes the anterior inferior tibiofibular ligament, posterior inferior tibiofibular ligament, interosseous membrane, and transverse tibiofibular ligament.[51]

Because displacement of the fibula on the tibia measured after cadaveric ankle ligament sectioning was within the normal physiological range, it is unlikely that syndesmotic injury can be accurately identified by increased displacement during the squeeze, Cotton, fibular translation, or external rotation tests.[36] These tests are not uniformly positive for translation, and clinicians should rely on pain as the primary diagnostic indicator.[36,52]

A battery of tests used to assess syndesmotic injury result in a correct diagnosis in 80% of cases.[52] Patients with multiple positive tests are significantly more likely to take longer ($\geq$7d) to walk 10 meters without pain.[53] Clinicians should repeat diagnostic evaluation until recovery, while noting other signs of syndesmotic injury: heel raise during gait to avoid dorsiflexion, shortened duration of stance phase of the involved side during gait, and less swelling compared with lateral collateral ankle ligament sprains.[50,53]

#### Cotton test

Frederic Cotton introduced the Cotton test in 1910. The test was originally a technique to diagnose Pott's fractures (ie, fractures of both malleoli). "The ankle is grasped with one hand just above the joint, while the other hand is placed beneath the sole, with the thumb on one side of the foot, the fingers on the other below the malleoli. If the foot is grasped firmly and pushed inward and outward, the presence of an abnormal lateral mobility is easily recognized."[54] Crepitus felt in the fibula and palpation of a fracture to the medial malleolus may also be felt while the foot is pushed outward.[54]

More recently the test has been used to assess distal tibiofibular sprain, with increased translation of the talus[1,19] or pain at the distal syndesmosis resulting in a positive test (table 2).[1] One study by Beumer et al[36] with cadaveric examination produced evidence that anterior displacement only occurred after sectioning of the anterior syndesmosis alone. In another study, by Beumer et al[52] in which 9 investigators examined 12 patients with suspected syndesmotic injury, researchers found the Cotton test to have a sensitivity of 25%, suggesting that clinical experience indicating a neutral ankle position is best to reduce the risk of false positives in plantarflexion.[36,52] In the same study, 2 of the 12 patients underwent arthroscopy and the relationship between a positive Cotton test and arthroscopically confirmed tibiofibular syndesmosis sprain was demonstrated. A modification of the test using a bone hook to produce traction of the tibia is commonly used to confirm diagnosis during surgery.[57] Conclusive quantitative data for the Cotton test does not exist in the literature, nor could we find evidence for its clinical use.[36]

### External rotation test

Boytim et al[58] introduced the external rotation test in 1991 and described the test as "applying an external rotation stress to the involved foot and ankle with the knee at 90 of flexion and the ankle in a neutral position. A positive test produces pain over the anterior and posterior tibiofibular ligament(s) and over the interosseous membrane." Further description of clinical performance of the test in written form was absent, but a figure was provided depicting how to perform the test (see table 2).

Cadaveric sectioning of the ADL did not increase external rotation achieved during the test, but sectioning of the anterior tibiofibular ligament alone did. However, motion was significantly greater when all syndesmotic ligaments were sectioned (approximately 1 mm).[36] Beumer et al[36] suggested that clinical observation of increased external rotation of the talus and foot is therefore not indicative of syndesmotic injury, even though the external rotation test produced more displacement than the squeeze, fibular translation, and Cotton tests.

In a study examining 10 cases of intra-articular debridement after syndesmotic sprain, the external rotation test was positive in all patients upon initial examination and negative after surgery. From these cases, it was concluded that the test might not assess syndesmotic instability, but instead give a positive indication "of irritation or mechanical disruption of the syndesmosis with the torn ligament and/or chondral lesion causing the pain."[59]

Some argue that a positive test in acute cases is not indicative of a true pathology because of acute pain and edema. False positives have also been in question in cases with concomitant lateral ankle sprain,[60,61] although the external rotation test was found to produce fewer false positives,[53] to be more reliable, and have the best intra-observer agreement when compared with the squeeze, fibula translation, and Cotton tests.[52,53] A sensitivity of 20% and specificity of 84.8% was reported by de Cesar et al[55] in a study of 56 subjects with some degree of lateral ankle sprain, when comparing the external rotation test to magnetic resonance imaging findings.[55] A 75% sensitivity has been reported by Nussbaum et al[56] when performing the test in dorsiflexion, not in neutral as originally described by Boytim.[58] In a study of 20 patients with chronic distal syndesmotic injury confirmed with arthroscopy, a mere 15% had a positive external rotation test during clinical examination.[62]

A possible concern to clinicians is the depiction of the test, specifically regarding hand positioning, which commonly appears incorrect in texts and in practice without report of purposeful modifications based on the depiction of test performance in the initial description.[58] The limitations of the external rotation test also include poor specificity in acute and chronic cases, as well as those with simultaneous lateral ankle sprain.

### Fibula translation test

Ogilvie-Harris and Reed[59] described the performance of the fibula translation test as "the tibia and fibula were grasped directly and an attempt was made to translate the fibula on the tibia in the anterior posterior plane." The test was considered positive if this maneuver produced pain by stressing the tibiofibular syndesmosis (see table 2). More recent descriptions of the test have included positioning the patient with the foot relaxed in plantar flexion and using increased translation as an additional indication of a positive result.[1,52]

In a cadaveric study, only after all syndesmotic ligaments were sectioned did the fibular translation test produce significant differences in translation, occurring in both the anterior and posterior directions, but smaller than what occurs naturally during normal dorsiflexion and plantarflexion of the ankle. Clinicians who performed the test on the same cadavers produced similar movements during examination, but did not agree on the amount of translation produced by the test, which may contribute to the test producing the highest number of false positives in asymptomatic ankles compared with other syndesmotic tests.[36,52]

The sensitivity and specificity of the test is 75% and 88%, respectively. Increased movement is unlikely to be noticed by clinicians and should not be relied on as indicative of a positive test. Provocation of pain during the fibular translation test should be used as the primary diagnostic indicator of a positive test.[36,52]

### Squeeze test

Hopkinson et al[63] described the squeeze test in 1990 as a method for diagnosing syndesmotic sprains after the exclusion of fractures, compartment syndrome of the leg, cellulitis, contusions, or abrasions. The test is performed by compressing the fibula to the tibia above the midpoint of the calf. The test is considered positive when proximal compression produces distal pain in the area of the interosseous ligament or its supporting structures. Although the authors did not instruct the clinician on a preferred method for applying the compressive force, the accompanying figure demonstrates the test being performed with only 1 hand (see table 2).

In cadaveric studies, significant displacement at the anterior syndesmosis of roughly 0.2 to 0.3 mm is produced with the squeeze test only after the anterior tibiofibular,

**Table 3** Medial collateral ligament tests

| Test | Description | Authors | Evidence (95% Confidence Interval) | Comments |
|---|---|---|---|---|
| Eversion stress test | Patient is supine, side lying, or seated with knee flexed to 90 degrees and the foot relaxed. The distal tibia is stabilized with 1 hand and the other grasps the calcaneus and applies an abduction force to tilt the talus. Increased talar tilt or pain over the deltoid ligament, when compared bilaterally, indicates a positive test. | No studies were found that identified the accuracy of the specific test. | | |
| External rotation test (Kleiger's test) | | No studies were found that identified the accuracy of the specific test to determine deltoid ligament injury. | | |

posterior tibiofibular, and anterior deltoid ligaments were all sectioned.[36,64] The test appears to stress the anterior inferior tibiofibular ligament the most as complete sectioning of the anterior tibiofibular ligament produces an increase in displacement of nearly 0.4 mm.[36,64] The test does not produce posterior displacement.[36]

A positive test indicates a more significant injury and longer return,[56,63] although the test rarely produces a positive, usually requiring significant force or the presence of a severe and sensitive injury.[53] It is important to note that severity of lateral ankle sprain does not have an association with the presence of syndesmotic injury.[55] Alonso et al[53] concluded that the test has moderate ($\kappa = 0.50$) inter-rater reliability but low overall reliability. The sensitivity of the test has been reported between 30% and 33%[57,58] and may lack sensitivity to minor or incomplete syndesmotic injuries.[53] In contrast, the specificity of the squeeze test is rather high. In a comparison with diagnostic magnetic resonance imaging, the squeeze test was specific to 93.5%.[55]

The usefulness of the squeeze test is limited. Results suggest that the test cannot accurately predict the degree of mechanical instability associated with syndesmotic injury[65] and does not stress the syndesmosis posteriorly.[36] The test does have a high specificity, indicating that patients who do test positive are very likely to have a syndesmosis injury.[55]

### Crossed-leg test

Kitner and Bozkurt[61]introduced the crossed-leg test in 2005, suggesting that it provided advantages compared with other syndesmosis tests because it was self-administered by the patient, did not rely on joint manipulation, accounted for leg size differences in patients, and removed issues associated with inter- and intraobserver reliability (see table 2). To perform the test, the patient is seated in a chair and the physician demonstrates the correct position. The patient places the leg to be tested across the kneecap of the other leg, with the pivot point at the junction of the middle and distal thirds of the tibia. When the patient applies a gentle force with his or her hand on the medial side of the knee, pain in the syndesmosis area is a positive result, indicating a syndesmosis injury.

The original authors examined 9 patients who experienced syndesmotic injuries without fractures and returned to full activity without functional restriction in an average of 31.7 days. In these patients, the crossed-leg test was positive in all patients at initial examination and at the 1-week follow-up examination. The external rotation test was positive in 7 patients and unclear in 2 at first examination but was positive in all cases at the 1-week follow-up examination. The squeeze test was negative in 2 patients on initial examination and negative in 3 patients at the 1-week follow-up examination.[61] The crossed-leg test lacks evidence for use other than that presented by the original authors, suggesting that further research is needed.

### Stabilization test

Williams et al[65] cited unpublished data from Amendola in 2001 for the description of the stabilization test. The test is to be performed after the acute phase of injury to confirm the diagnosis of a syndesmotic sprain. To perform the test, tightly apply "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 (Table 2). The test result is positive if these maneuvers are less painful after taping."[65(p1199)] The stabilization test lacks evidence in the literature, suggesting that further research is warranted.

### Heel-thump test

Lindenfeld and Parikh[60] described the heel-thump test in 2005 as a routinely used special test in their facility for differentiating syndesmotic sprains from lateral ankle sprains. To perform the test, the "patient is seated at the edge of table and the knee is held at about 90 degrees of flexion. The ankle is in gravity equinus, and the leg is stabilized by one hand. Using the fist of the other hand, the examiner delivers gentle but firm thumps to the heel of the injured leg" (see table 2). The clinician should direct the force through the calcaneus along the axis of the tibia without producing inversion or eversion stress to the talocrural joint. "A positive test produces pain over the anterior or posterior aspect of the ankle or in the distal leg, corresponding to the area of the anterior or posterior tibiofibular ligament and interosseous membrane, respectively." A positive test is believed to indicate a syndesmotic sprain, but only after an examination has ruled out fractures, contusions, and compartment syndrome in the leg and ankle. The heel-thump test lacks evidence in the literature, suggesting that further research is warranted.

## Orthopedic tests for examining sprains of the medial collateral ligaments of the ankle

Determining the severity of injury to the medial ligaments of the ankle is facilitated by understanding the mechanism of injury. The primary ligamentous restraint that provides stability to the medial aspect of the ankle is the deltoid ligament.[4,66] The deltoid ligament is comprised of a superficial layer (tibionavicular, tibiocalcaneal, and posterior tibiotalar fibers) and a deep layer (anterior tibiotalar fibers).[4,19] The deep fibers resist external rotation and the superficial fibers resist eversion of the talus. Certain mechanisms of injury can result in trauma to multiple fibers of the deltoid ligament, and complete rupture usually involves injury to other structures (ie, fibular fractures, distal syndesmosis separation).[66] For this reason, special tests designed to isolate each structure can be helpful in determining which may be affected.

### Eversion stress test

We could not locate the original description for the eversion stress test, but its performance appears consistent across many sources. The patient is supine, side lying, or seated with the knee flexed to 90 degrees and the foot relaxed. The clinician stabilizes the distal tibia with 1 hand and grasps the calcaneus with the other. While maintaining the ankle in a neutral position, the clinician applies an abduction force to the calcaneus to tilt the talus (table 3). An increased amount of talar tilt compared bilaterally or pain over the deltoid ligament is considered positive.[1,8,19]

Cadaveric studies indicated that a valgus tilt of the talus only occurs when the superficial and deep fibers of the deltoid ligaments are incised.[67] Neutral positioning of the ankle is suggested to test the superficial later,[19] while testing throughout available ankle range of motion may assess different deltoid fibers.[18] In the neutral position, a 2-degree or greater tilt during testing when compared bilaterally indicates a high probability of significant injury to the deltoid. Some have said that a 10-degree angle could be normal valgus tilt.[66]

The eversion stress test lacks evidence in the literature. Data regarding the specificity and sensitivity of the test could not be identified.

### External rotation test (Kleiger's test)

Sources described varying methods for performing the external rotation test and what it is intended to diagnose. Some sources listed this method as both the external rotation test and Kleiger's test, described it as being used to diagnose both syndesmotic sprains and deltoid ligament sprains, and performed it similarly to the external rotation test described by Boytim et al.[1,19,58] The test described by Boytim et al,[58] however, did not describe the test being used to assess the deltoid ligament. Other sources listed it only under the name of Kleiger's test and use it to assess primarily deltoid ligament sprains.[8,18] Another source separated it from the external rotation test as an entirely different test, with both being described individually.[19] Articles attributing Bernard Kleiger[68,69] as the original source of the test did not describe the performance of a manual test, but did indicate that lateral rotation of the talus might result in trauma to the deltoid ligament.

In performing the test, the patient position was similar across a variety of sources with the patient being seated with the knee flexed and the leg hanging off the table.[1,8,18,19,70] There was also agreement on the clinician stabilizing the patient's leg, although placement of the stabilizing hand varies from the distal lateral leg,[1] to distal medial leg,[18] to the tibiofemoral articulation.[19,70] The main difference in performing the test appears to revolve around the clinician's distal hand placement on the foot. Some sources described the clinician grasping the calcaneus and supporting the forefoot with their forearm,[1,70] whereas others perform the test by grasping the medial foot.[8,18,70] The examiner then applies a lateral rotary force to the ankle with the foot in neutral or slight plantarflexion,[1,50] looking for pain or increased motion when compared bilaterally to indicate a positive (see table 3).[1,8,18,70]

In cadaveric studies, sectioning only the ADL and performing the external rotation test did not increase the motion of the test. This suggests that clinical observation of increased external rotation of the talus and foot is not indicative of syndesmotic injury.[52] Determining appropriate testing for the ADL may be important as the anterior fibers of the deltoid ligament blend into the plantar calcaneonavicular ligament (PCNL) and, therefore, may lead to compromise of the PCNL. It may be useful for clinicians to always test the integrity of the PCNL when testing for integrity of the ADL is positive.

Because many perform this test as the external rotation test, inter-rater reliability would then carry over. However, the external rotation test lacks evidence in diagnosing deltoid ligament sprains. Based on the anatomy, review of the literature, and our clinical experience, we have a recommendation for performing this test to potentially improve its diagnostic accuracy: (1) the stabilization hand is either medial on the tibia or proximal on the posterior tibia to prevent compression of the ankle mortise and to ensure the fibula is able to move naturally; (2) to increase the fulcrum and isolate the ADL, we prefer to grasp the medial foot with our movement hand to apply the external rotation force; (3) the test is normally performed in 10 to 20 degrees of plantarflexion. We acknowledge that further testing is necessary to validate this recommendation.

## Study limitations

The results of this comprehensive review should be considered in light of some limitations. First, the lack of literature surrounding several of the ankle special tests did not allow the authors to provide evidence regarding their utility. Second, the authors did not include studies that were not published in English, which could have introduced selection bias and resulted in an under-reporting of evidence. Attempts were made to mitigate selection bias by having 2 researchers tasked with selecting evidence and using a third to manage conflicting decisions.

## Conclusions

A complete physical examination is critical in the diagnosis of ankle injuries. Considering and examining all signs and symptoms of the injury is key to a conclusive and accurate diagnosis. The mechanism of injury, as well as localized symptomology, provides the examining clinician with valuable diagnostic information.[4] Changes in gait should also be considered. For example, a heel-raise gait may be indicative of syndesmotic sprain, whereas a calcaneal gait may be indicative of a lateral ankle sprain.[50] Clinicians should also consider a combination of factors and clinical findings. Reliance on a single finding or special tests alone may result in misdiagnosis. In one study, 1 out of 5 clinicians misdiagnosed a syndesmotic sprain when relying on special tests alone.[52] In contrast, Van Djik[10] explored lateral ankle sprains and found that "the combination of tenderness at the level of the anterior talofibular ligament, lateral hematoma, discoloration and a positive drawer test indicated a ligament lesion in 95% of cases. A negative drawer test and the absence of discoloration always indicated an intact ligament, as did the absence of pain on palpation at the anterior talofibular ligament."

In addition to completing a comprehensive investigation, clinicians should be aware of the limited evidence supporting the use of many of the commonly applied orthopedic special tests. Clinicians must know the limitations of each special test, as well as the limitations of testing batteries or prediction rules. Further research is needed, as many tests currently lack evidence (eg, sensitivity, specificity, likelihood ratios) to guide clinical practice. Additionally, research is also needed to explore the performance of coupled tests as part of a purposeful testing battery or prediction rule.

The ability to critically review the literature and apply evidence to determine when and which tests to apply is imperative. To improve diagnostic accuracy, clinicians must utilize tests in an effective format and with the best patient and clinician positioning. Tests combined with patient history and signs and symptoms, compared with special tests alone, increase test sensitivity and, therefore, make them more useful. Utilization of the aforementioned steps is evidence-based practice in action, which can improve clinician effectiveness, efficiency, and accuracy.

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