ANKLE ligament sprains account for approximately 25% of all injuries sustained by male and female collegiate basketball players and approximately 15% of all injuries documented for a wide variety of collegiate sports. Ankle sprain is often considered to be a trivial injury, but residual symptoms of weakness, instability, crepitus, and stiffness are common among athletes who have sustained recurrent ankle sprains. The ankle is far more susceptible to arthritic changes after ligamentous trauma than is generally recognized. As many as 89% of ankle sprain cases involving rupture of the anterior talo-fibular ligament (ATFL) may be associated with the existence of a medial articular cartilage lesion. If ecchymosis is present and palpation of the ATFL elicits pain, the estimated likelihood of ATFL rupture is 90%. Thus, failure to recognize the potential serious nature of this exceedingly common sports injury presents the potential for long-term adverse effects on an athlete’s functional capabilities.

Laxity of the ATFL is associated with anterior translation of the talus from beneath the tibio-fibular mortise. Stress radiography is often used to assess the extent of this instability. With the leg fixated and the foot in a neutral position, the application of manual stress to the foot in a posterior-to-anterior direction will produce an “anterior drawer” effect that can be documented on a lateral radiograph. Laxity of the ATFL is also associated with lateral tilt of the talus within the mortise, which is induced by the application of a varus stress to the foot in a plantar flexed position. The extent to which the superior articular surface of the talus tilts laterally in relation to the articular surface of the tibia is often documented on an antero-posterior radiograph or a mortise-view radiograph. Because the anterior drawer and talar tilt tests do not impose an axial load on the articular surfaces of the talo-crural joint (TCJ), the nature of the injury mechanism that disrupts the ATFL during weight-bearing activity does not necessarily correspond to the manually induced open-chain displacements that are typically used by clinicians to assess laxity. Numerous researchers have emphasized the importance of ATFL integrity for restraint of internal rotary displacement of the talus within the transverse plane as well as restraint of external rotation of the tibia.
and fibula in relation to the talus (Figure 1). Because the antero-lateral portion of the talus is displaced by simultaneous internal rotation and anterior translation (Figures 2-5), the displacement pattern associated with ATFL laxity has been designated as antero-lateral rotary instability (ALRI). If the foot segment is firmly fixed on the ground, external rotation of the leg segment will produce the same relative displacement pattern of the TCJ articular surfaces (Figure 6). Because the foot segment is not fixed to the ground during the performance of functional activities, combined motions within the STJ and TCJ are associated with simultaneous internal rotation of the foot segment (often designated as “adduction” of the foot) and external rotation of the leg segment.

The antero-medial articular surfaces of the TCJ may be damaged by impaction and shear forces associated with an acute inversion ankle sprain, and progressive posttraumatic degeneration has been shown to result from ALRI. Arthroscopic evidence of medial articular cartilage damage was reported by van Dijk et al. for 67% of patients who had sustained a severe inversion sprain (20 of 30). The anterior margin or distal tip of the tibial malleolus and the opposing medial articular facet of the talus were the primary locations of the acute chondral lesions. Taga et al. reported that

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**Figure 1** Inversion of the subtalar joint induces simultaneous internal rotation of talus and external rotation of the tibia and fibula, which is primarily restrained by the ATFL. Reprinted with permission from Wilkerson GB. Biomechanical and neuromuscular effects of ankle taping and bracing. *J Athl Train.* 2002;37:436-445.

**Figure 2** Superior view of the talus in a neutral position within the transverse plane.

**Figure 3** Anterior translation of the talus (and the entire foot segment) in relation to the tibio-fibular mortise.

**Figure 4** Internal rotation of the talus in relation to the tibio-fibular mortise, which is limited by contact of the head of the talus against the antero-medial aspect of the tibial malleolus.

**Figure 5** Combined anterior translation and internal rotation of the talus in relation to the tibio-fibular mortise, which displaces the antero-lateral portion of the talus (ALRI).

**Figure 6** Combined external rotation and posterior translation of the tibia and fibula upon a fixed foot.
reported arthroscopic evidence of chondral lesions in 89% of patients who had experienced an acute lateral ankle ligament rupture (8 of 9) and 95% of patients with chronic lateral ankle instability (21 of 22). Okuda et al.15 reported the existence of focal chondral lesions in 63% of patients who received lateral ankle ligament reconstruction surgery (19 of 30). Chronic articular surface degeneration has been reported to be most commonly located on the medial half of the talar dome and tibial plafond.4,15 Among patients with chronic ankle instability, Hintermann et al.14 found arthroscopic evidence of articular cartilage degeneration in 66% of those who had an elongated or ruptured lateral ligament damage (81 of 123). Among those who had both lateral ligament damage and an elongated or ruptured deltoid ligament, 98% were found to have articular cartilage degeneration (58 of 59). The researchers suggested that the coexistence of ligament lesions on the lateral and medial aspects of the TCJ is an indication of rotational instability, which plays an important role in development of articular cartilage damage.

Because clinicians generally associate medial ankle ligament pathology with an inversion injury mechanism, the existence of deltoid ligament damage in athletes who have sustained multiple inversion injuries may seem counterintuitive. The posterior tibio-talar ligament (PTTL) corresponds to the deep posterior portion of the talus than a purely linear application of tensile load. The fibers of the PTTL that have a tranverse medio-lateral orientation are subjected to tensile loading when the ATFL ruptures and the talus is forced into further internal rotation (or the tibia is forced into external rotation upon a relatively fixed foot). The inversion sprain mechanism, which many clinicians primarily associate with varus tilt of the talus within the frontal plane, induces motion within the transverse plane that can result in ALRI. If the ATFL and PTTL are disrupted, the rotation ultimately results in impaction of the opposing articular surfaces of the talus and tibia on the antero-medial aspect of the TCJ.

**Clinical Evaluation and Management**

Accurate clinical assessment of subtle biomechanical alterations that may result from ankle ligament pathology requires a high degree of familiarity with the normal structure and integrated function of the TCJ and the STJ.9,21 Torque is transferred between the STJ and the TCJ in either a proximal-to-distal direction or a distal-to-proximal direction. The talus and calcaneus are tightly bound to one another by the interosseus talo-calcaneal ligament (ITCL), which is often damaged by an inversion injury mechanism.9,21 When assessing displacement of the foot segment in relation to the stationary leg segment, the clinical should be aware that the possible existence of instability in both the TCJ and the STJ.

Despite the high incidence of inversion ankle sprains, there is no standard clinical assessment for determination of injury severity. The anterior drawer test is widely utilized to assess ankle ligament laxity, but a variety of techniques are used to perform the test and different criteria are used to define a positive test result.22-24 An anterior drawer test performance technique developed by van Dijk et al.25 emphasizes the application of a force that simultaneously induces anterior translation and internal rotation. Cadaver studies have demonstrated that this technique produces substantially greater displacement of the antero-lateral portion of the talus than a purely linear application of a manual force in an anterior direction.22,24 The anterior drawer test with internal rotation will often elicit perceptible displacement when the ATFL is completely torn, but the abnormal motion may be extremely subtle or imperceptible in many cases. Pain, muscle spilling, edema, and examiner skill are factors that greatly influence the response to manual force application, and the examiner’s interpretation of the test result is highly subjective. Stress radiography provides an objective method for quantification of anterior translation of the talus, but ALRI is not effectively assessed through measurement of linear displacement.15

Within 48 hours of injury, the combination of a positive ALRI drawer test, point tenderness over the ATFL, and lateral discoloration has been reported to have 95% sensitivity for the existence of an ATFL rupture.25 If the result of manual drawer testing for ALRI is inconclusive, locations of point tenderness and discoloration are extremely important clinical indicators of injury severity. Localized tenderness over both the ATFL and PTTL strongly suggests that internal rotary subluxation of the talus was responsible for damage to both ligaments,18 and ALRI is associated with symptoms on both the lateral and medial sides of the ankle.14 The presence of discoloration below the tibial malleolus on the medial aspect of the ankle may result from damage
to the PTTL, or it could originate from hemorrhage within the STJ that is associated with ITCL damage. Substantial medial discoloration suggests that at least one of these secondary ligamentous restraints was damaged in addition to disruption of the ATFL. Tenderness along the antero-medial aspect of the TCJ may be an indication of a significant chondral lesion that has resulted from excessive internal rotation of the talus (i.e., high-energy bone-to-bone impact between the talus and the tibial malleolus). Three-dimensional analysis of TCJ kinematics under progressively increased weight-bearing load (from 25% to 100% of body weight) has demonstrated significantly greater internal rotation of the talus in the injured extremity of patients with unilateral ankle instability. This finding suggests that early weight-bearing activity during the acute phase of healing may impose loads that elongate the ATFL. The results of a dynamic analysis of three-dimensional TCJ kinematics and articular surface pressure distribution demonstrated that a widely-utilized stirrup-type brace provided restraint to lateral displacement within the frontal plane, but it did not provide any substantial resistance to displacement within the transverse plane. Thus, such a brace design is not likely to protect a damaged ATFL from tensile loading during weight-bearing activity. If ATFL laxity develops, the medial articular surfaces of the TCJ will be subjected to greater compressive and shear loading, and susceptibility to a subsequent inversion sprain will be increased. Reconstructive surgery can restore lateral ankle stability, but tenodesis procedures can alter the kinematic coupling of the TCJ and STJ in a manner that leads to accelerated joint degeneration. Because chondral lesions found in chronically unstable ankles are worse than those associated with acute injuries, prevention of recurrent inversion sprains is crucial for avoidance of progressive degeneration of chondral lesions. Jump landing, pivoting, and cutting maneuvers can impose extremely large loads on the TCJ, which may exacerbate ATFL laxity and articular damage. To date, no functional ankle brace has been shown to effectively restrict anterior translation and internal rotary displacement of the talus. An ankle taping procedure for stabilization of the STJ has been shown to effectively restrain anterior translation of the foot, and the same taping procedure has been shown to restrain external rotation of the leg during weight-bearing inversion of the STJ. These findings suggest that the “subtalar sling” ankle taping procedure can control ALRI during performance of sports activities.

Summary
Failure to recognize and properly manage ALRI of the TCJ can have serious functional consequences. Unfortunately, ALRI can be extremely subtle and difficult to diagnose. When ATFL rupture is suspected, the potential for chronic ankle dysfunction and progressive chondral degeneration should not be underestimated.

References


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