Lateral Ankle and Subtalar Instability

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Ankle sprains, the precursor to lateral ankle instability, are the most common specific injury in sports, comprising approximately 25% of all sports injuries. In general, these injuries are responsible for anywhere from 7% to 10% of emergency room visits. Studies have documented that ankle sprains account for 45% of all basketball injuries and 31% of soccer injuries. More recently, it has been appreciated that injuries to the lateral ligamentous complex of the subtalar joint are closely related to ankle sprains.

Anatomy

The articulations of the ankle and subtalar joint are supported by a complex network of ligaments and tendons. The anterior talofibular ligament (ATFL) is the most well known. It is nearly 20 mm in length and courses at an angle of about 75° to the floor from the anterior aspect of the distal fibula. It inserts onto the body of the talus, just anterior to the articular facet. The ATFL does not insert onto the neck of the talus, which is a common misconception, but is confluent with the anterior capsule of the ankle.

The calcaneofibular ligament (CFL) originates on the anterior border of the distal fibula just below the origin of the ATFL. It courses in a medial, posterior, and inferior direction toward the calcaneus. The ligament is confluent with the peroneal tendon sheath and inserts onto a small tubercle posterior and superior to the peroneal tubercle of the calcaneus. The CFL is 2 to 3 cm long and subtends an angle of approximately 104° with the ATFL.

The posterior talofibular ligament (PTFL) originates on the medial surface of the lateral malleolus and travels medially and horizontally to the posterior talus. It is roughly 3 cm long and has a broad insertion across nearly the entire posterior lip of the talus; it is confluent with the joint capsule of the ankle.

The peroneal tendons, peroneus longus and brevis, run in a sheath posterior to the lateral malleolus coursing beneath the superior and inferior retinacula. These tendons act as dynamic stabilizers of the ankle. The peroneal brevis is anterior to the longus and is useful in tendon transfers about the ankle.

With respect to the subtalar joint, the lateral ligamentous complex is best thought of as being composed of three layers. The superficial layer is comprised of three structures. The lateral root of the inferior extensor retinaculum originates superficial to the peroneal tendons and inserts on the lateral aspect of the anterior process of the talus. The lateral talocalcaneal ligament originates on the lateral wall of the calcaneus just anterior to the origin of the CFL and inserts onto the body of the talus just inferior to the ATFL. It is often part of an arcuate complex blending with the CFL and ATFL.

The intermediate layer has two components: the intermediate root of the inferior extensor retinaculum and the cervical ligament. The cervical ligament lies in the sinus tarsi and is a strong band of collagen that connects the neck of the talus with the superior surface of the calcaneus.

Finally, the deep layer of the lateral ligamentous complex contains the medial root of the inferior extensor retinaculum, which courses more deeply in the sinus tarsi.
and sends attachments to both the talus and the calcaneus adjacent to the interosseous talocalcaneal ligament (IOL). The IOL is not a true lateral structure. It extends from the most medial aspect of the sinus tarsi and courses downward and lateral to the sinus calcii, blending with the most medial fibers of the cervical ligament. It then terminates by blending with the deep portion of the deltoid ligament. Some authors are now attempting to reconstruct this ligament in cases of subtalar instability, as will be described later.

**Biomechanics**

The biomechanics of the ankle and hindfoot and ankle are complex. Many studies have been performed, including serial sectioning studies,4-6 to delineate it more clearly. The contribution of each of the aforementioned ligaments is not constant, but instead is based upon the position of the ankle and foot in space. The joint stabilizing function of the ligaments is most critical in the unloaded ankle joint since in the loaded ankle the bony configuration of the mortise contributes to its stability. It follows that ligamentous disruptions occur while the extremity is being loaded or unloaded such as during initial ground contact in the gait cycle.

The ATFL has a load to failure that is 2 to 3.5 times lower than that of the CFL. Its prime function is to restrict internal rotation of the talus in the mortise and adduction in plantar flexion. Therefore, the ATFL is taught in plantar flexion and loose in dorsiflexion.

The CFL restricts adduction almost exclusively in dorsiflexion and neutral. During plantar flexion, it resists adduction in combination with the ATFL. It also acts as a stabilizer of the subtalar joint.

The PTFL prevents external rotation in dorsiflexion and resists ankle dorsiflexion along with the medial ligaments, which are primarily responsible for these constraints. Following sectioning, or rupture of the ATFL, it restricts internal rotation. Finally, it can resist adduction when the ankle is in dorsiflexion after rupture of the CFL.

Motion of the subtalar joint is in flexion-supination-adduction/extension-pronation-abduction. Stability of the joint, as in the ankle, relies upon the ligaments as well as the bony configuration of the talus and calcaneus and their articular surfaces. Besides the IOL and the cervical ligament, both of which help to limit rotation of the calcaneus on the talus, the CFL strongly resists adduction in the subtalar joint with an increase of 77% observed after sectioning of the CFL. There has been some discrepancy in the past with respect to the contributions of the CFL to subtalar instability. This may have been due to its variability in anatomic orientation, as the lateral talocalcaneal ligament may blend with the CFL, be nonexistent, or be a separate structure.

As a result of the fact that the ATFL has a lower load to failure than the other ligaments of the ankle, combined with the common mechanism of injury of plantar flexion and inversion, the ATFL is the ligament most commonly injured. Typically, it tends to tear in its midsubstance along with the CFL. Avulsions may occur and some authors have surmised that nonunion of these avulsions may be the source of os fibulare. Calcaneofibular ligament tears are second to those of the ATFL and most commonly occur in combination with ATFL injuries; they are rarely seen as isolated injuries. Finally, the PTFL is seldom observed to be injured alone, but is, instead, part of a constellation of injuries to the lateral ligaments. It can also be injured in forced dorsiflexion injuries along with the medial ligaments. As mentioned, subtalar injuries probably occur in combination with lateral ankle injuries, but also can occur as isolated injuries. The most severe subtalar injury is a dislocation with disruption of the talonavicular and subtalar joints.

Associated injuries of varying degree are common in the acute setting. These may include: partial or complete tears of the peroneal tendons, peroneal synovitis, fractures of the talus, medial ligament injuries, injuries to the syndesmosis, fifth metatarsal fractures, calcaneocuboid crunches, “snowboarder’s” fractures, and post-sprain neuritis of the sural nerve, superficial peroneal nerve, deep peroneal nerve, and posterior tibial nerve.

Chronic injuries present several different problems. Rarely are cases of lateral instability seen that are isolated findings. The most common associated finding in chronic injuries is peroneal synovitis. Some other associated injuries are anterolateral impingement, ankle synovitis, intra-articular loose bodies, and osteochondral defects of the talus.

**Clinical Evaluation**

Clinical evaluation of a patient with an ankle injury begins with the examiner eliciting a thorough history. The patient’s description can be enlightening and may include hearing a “pop” at the time of injury. Not uncommonly, an athlete will describe stepping on someone else’s foot. Many times the patient will describe inversion of the foot with resultant difficulty ambulating. Most importantly, one should try to elicit from this is a recurrent problem. More likely than not, if it is a recurrent problem, the patient will tell you that early in the interview. It then becomes a matter of deciding if the patient has symptoms consistent with chronic ankle instability. Additionally, if the patient has subtalar instability, they may describe difficulty walking on uneven surfaces. Runners may state that they cannot run at night, or that when they do, they have to constantly look at the surface on which they are running.

The evaluation proceeds with a thorough examination of the foot and ankle. There is usually a large amount
of acute swelling and ecchymosis, mostly laterally. It is important to carefully palpate each of the structures about the ankle. This is especially helpful in the acute setting. Unfortunately, the specificity of point tenderness decreases as the time from injury increases.

Provocative tests can be helpful, although they may be difficult in the acute setting because of pain. In contrast, patients with chronic instability may tolerate these maneuvers well. The first of these performed is typically the anterior drawer sign. It can be done with the patient sitting on the edge of the bed while his leg dangles or while lying supine. With the patient sitting, one hand is used to stabilize the tibia while the other hand cups the heel and applies an anteriorly-directed force. With the foot in plantar flexion, this maneuver primarily tests the integrity of the ATFL. If the foot is in dorsiflexion or neutral, the same maneuver can also be used to assess the integrity of the CFL. With complete disruptions of the lateral ligaments, including the anterolateral joint capsule, one may see a “suction sign.” This dimple develops just anterior to the distal fibula when an anterior drawer is applied. When the anterior drawer is performed with the patient supine, the foot is stabilized on the table and a posteriorly-directed force is applied to the tibia.

An attempt to evaluate the subtalar joint can be performed by applying an inversion stress to the hindfoot. This may induce pain or instability in the presence of a CFL rupture. Unfortunately, it is often difficult to assess subtalar versus tibiotalar instability. The former results in increased internal rotation and inversion of the hindfoot.

Further evaluation should proceed with evaluation of the syndesmosis by use of the squeeze test. This test is performed by squeezing the tibia and fibula, which may elicit tenderness at the ankle if a syndesmotic injury is present. Palpation anterolaterally over the syndesmosis may also elicit tenderness. Finally, one may notice increased external rotation of the foot when compared to the uninjured side.

Finally, the peroneal and posterior tibial tendons should be evaluated, and one should be alert for any predisposing factors like a varus hindfoot, hypermobile joints, and tarsal coalitions.

**Radiologic Evaluation**

When evaluating ankle problems, a routine three-view ankle series is appropriate: AP, internal rotation, and lateral radiographs. Tibia and fibula films may be added if there is an indication of proximal fibula tenderness. Foot films may be appropriate if there is any tenderness during the foot exam. When evaluating these radiographs, one should be alert for avulsions, osteochondral fractures, occult fractures, or other lesions.

In the past, stress views were advocated for all ankles suspected of having instability problems; however, this practice is no longer followed. Studies have shown that these views add little to the management and ultimate outcome of these patients. If stress views are performed, which can be uncomfortable for the patient, it is wise to offer the patient some form of anesthesia. An ankle block works best in this situation.

A lateral anterior drawer view can be used to assess integrity of the ATFL. Once again, a jig may be used, or the foot can be held manually in gentle plantar flexion and adduction. In the past, 15° was used as a guide for complete CFL ruptures; however, in some studies, as many as 5% of normal ankles had greater than 20° of inversion at the subtalar joint.

The use of MRI is largely advocated as an adjunct for those patients that have been indicated for surgery and in those for whom the exact etiology of pain may be unrelated to their ankle instability. MRI allows superior visualization of ligaments, tendons, and bony injuries with a single study and has also been found to correlate well with clinical and surgical diagnoses.

**Classification**

Many classification schemes have been designed. However, they are largely confusing in the sense that some offer grade schemes based on clinical signs and symptoms, while others grade on the degree of ligamentous injury, and still others on the number of ligaments injured.

The most useful of these schemes is a system devised by Clanton and Schon that is relatively simple to learn and provides therapeutic recommendations; it divides injuries into stable (Type I) and unstable (Type II) groups. Type I injuries are stable by clinical examination and should be treated symptomatically. Type II injuries demonstrate an anterior drawer or talar tilt on examination. They are further subdivided into two groups. Group I is comprised of non-athletes or older individuals who should be treated functionally. Functional treatment consists of 2 to 3 weeks of immobilization after which the patient may be placed in an ankle stirrup-type brace. This coincides with the start of the rehabilitation phase that includes Achilles tendon stretching, peroneal strengthening, and proprioceptive re-
education, something that will be discussed further later. Group 2 is comprised of young athletes who are for the most part treated functionally, except for those with grossly unstable injuries for which surgical repair may be recommended.

**Prevention**

The best way to avoid these injuries is with prevention. Many methods are used to prevent acute ankle injuries in athletes, and most importantly to prevent recurrent injuries. The most popular methods are taping and bracing. A retrospective study of a large cohort of college football players found that the use of lace-up ankle braces and high-top shoes was better than taping. Other preventative measures include muscle strengthening, Achilles tendon stretching, and proprioceptive training.

**Acute Injuries**

The treatment of acute injuries is largely conservative. Non-surgical treatment has provided good to excellent results in the vast majority of patients across numerous studies, and is divided into three phases of rehabilitation. The first few days after injury are the acute phase. Treatment during this time consists of rest, ice, compression, and elevation (RICE). If the injury is very painful, the patient may be kept non-weightbearing in a short leg splint with the ankle in neutral or slight dorsiflexion. Cryotherapy, applied with ice packs or circulating cold water systems, is important during this time; compression may be used to control swelling and support the ankle. Pneumatic braces such as the Aircast® (Aircast Incorporation, Summit, New Jersey) are commonly used during this phase. Although these braces have been found to limit talar tilt, their real utility is probably in their ability to increase proprioception.

The second phase is comprised of mobilization, typically in some sort of brace or with taping. The patient should be encouraged to bear weight as tolerated based on the amount of swelling and discomfort. Crutches should be discontinued as soon as the patient is able to tolerate full weightbearing. The patient should avoid plantar flexion and elevate the extremity frequently. The goals of this phase are the ability to bear weight without tenderness and to increase range of motion (ROM). The third phase continues to address range of motion, but more aggressively, and adds strengthening by isotonic, isometric, and isokinetic means. Once pain and swelling allow, proprioceptive training with a wobble board, tilt board, or mini-trampoline is begun. Proprioceptive reeducation is probably the most important aspect of rehabilitation, particularly in chronic cases. This is related to the fact that neurosensory elements have been identified within the ATFL that may be disrupted during injury. The resultant proprioceptive defect may be improved with the use of these devices. Athletes can begin to run figure eight’s in tighter and tighter circles, then advance to cutting drills and finally sports specific drills. Stable ankles should be supported for at least three to four weeks. Unstable ankles should be braced during athletic activities indefinitely since ankles with prior ankle sprains remain at increased risk of re-injury. For non-athletes, immobilization for more than one to two weeks should be avoided. Placing the patient in a stirrup-brace will avoid stiffness, swelling, disability, and muscular atrophy.

Some guidelines for return to sport include: full active and passive ROM, the ability to walk and run without a limp, attaining over 90% strength in the uninjured ankle, and reaching maximum speed during running and cutting drills.

Although some authors have recommended surgical repair for young athletes with grossly unstable ankles, this remains controversial and is rarely performed in the absence of a fracture. If acute surgical management is undertaken, then the appropriate procedure is a modified Brüstrom repair. An incision is made from the level of the plafond, about 5 to 10 mm anterior to the fibula, parallel to its anterior border, and ends distally at the distal edge of the peroneal tendon sheath beneath the tip of the fibula. Caution must be used to spare the lateral branch of the superficial peroneal and sural nerves. An inversion stress or anterior drawer may be used to identify the injured tissues. A formal arthrotomy is often unnecessary as the capsule is torn at the time of injury. Sometimes, the CFL is found to be flipped superficial to the peroneal tendons, appearing analogous to a Stener lesion of the hand. As noted previously, the PTFL is usually uninvolved and does not need to be addressed. Heavy absorbable or nonabsorbable sutures are placed in the remnants of all injured structures but are not tied. Avulsions may be secured through bony tunnels or with suture anchors. Sutures may be used to close the traumatic arthrotomy; all sutures are then tied sequentially starting from posterior to anterior while the foot is everted and dorsiflexed. Gould’s modification calls for advancing the edge of the inferior extensor retinaculum as reinforcement of the ATFL repair. The peroneal tendon sheath is then closed. The repair can be further reinforced with a portion of the peroneus brevis tendon in higher demand patients (i.e., overweight patients), patients with soft tissue laxity, or those involved in strenuous work or athletic activity.

Postoperatively, patients are placed in a short leg splint or walking boot and allowed to bear weight as tolerated for 4 weeks. At that time, the splint is discontinued and the patient is placed in an ankle stirrup and dorsiflexion and eversion movements encouraged. Gentle active inversion and Achilles stretching is begun at around 8 weeks, at which time proprioceptive and resistive exercises are also started. Rehabilitation then progresses from
straight line walking and running to figure eight’s, and ultimately sport specific drills. If any undue swelling or discomfort occurs during rehabilitation, the program is slowed until they resolve. Once all aspects can be performed comfortably, the athlete may return to sports activity.

Complications are not uncommon with these surgical procedures. The most commonly reported complication is nerve injury. Hypersensitivity or hyposensitivity, with or without dysesthesias, has been reported in 7% to 19% of cases.1 Infection, stiffness, deep venous thrombosis, and wound necrosis have all been reported to occur to a lesser degree.

**Chronic Injuries and Instability**

Chronic injuries typically present after an acute injury. The patient typically describes a recurrent problem. The chief complaint is usually that of functional instability and not pain. Functional instability is a subjective complaint without objective findings and is quite amenable to rehabilitation. The theory underlying functional instability is that the ATFL is a highly innervated structure, as mentioned previously, and chronic injury results in a proprioceptive defect. This can be demonstrated by a modified Romberg test where the patient is asked to stand on the affected extremity and close his eyes.2 The test is considered positive if he has difficulty maintaining balance.

Rarely do chronic problems present as painful conditions. If they do, then further examination should be performed to elucidate another possible etiology of the pain. It is the physician’s responsibility to rule out all other causes of chronic pain. General categories of other problems that may cause chronic ankle pain include articular cartilage injury, nerve injury, tendon injury, other ligamentous injuries, impingement, and other miscellaneous conditions such as tarsal coalitions and proprioceptive deficits. One should always be aware of unrelated pathology that may be masked by a traumatic event, such as a rheumatologic condition or tumor.

Once again, treatment is largely conservative. The first step is always a period of intense rehabilitation. During this time, repeated examinations may more clearly elucidate the source of the patient’s problems if they are unrelated to instability. Other conservative measures include shoe modification, the use of an ankle-foot orthosis, or lateral heel wedges. Unfortunately, these are rarely successful in athletes.

At this time, there are no clear-cut indications for surgery, as functional and mechanical instability may be mutually exclusive. Surgery should be reserved for those that have failed appropriate rehabilitation and a bracing trial. Furthermore, instability has not been consistently shown to significantly increase the incidence of symptomatic arthrosis in these patients, although there may be radiographic evidence.

More than 50 procedures have been described in the literature and most of them have not withstood the test of time. If one needs to proceed with surgical intervention, the objective is to choose a procedure that avoids excessively restricting ankle and subtalar motion. These procedures can largely be divided into anatomic repair versus reconstruction procedures. The most commonly used procedures have all shown greater than 80% good to excellent results.1

The role of arthroscopy is still being delineated in lateral ankle and subtalar instability settings. When the source of chronic pain remains unclear, arthroscopy can be performed prior to open reconstruction without affecting the quality of the tissues for repair.12,29 Arthroscopy also allows intra-articular visualization for those cases that have intra-articular pathology that might be contributing to the pain. A recent preliminary study of arthroscopic monopolar thermal stabilization showed a decrease in anterior drawer and varus tilt and a high degree of patient satisfaction, with all 10 patients returning to full activities at three months.30 Long-term follow-up is needed to determine if this will prove to be a viable option in these cases.

The Watson-Jones31 and Evans32 procedures are examples of nonanatomic reconstructions that have recently fallen out of favor, as they radically alter the biomechanics of the hindfoot.

The Watson-Jones procedure was first described in 1952 by Sir Reginald Watson-Jones. It is an attempt to reproduce the function of the ATFL by tunneling the peroneus brevis through the fibula and talar neck. As such, it does not limit external rotation.33 Patients may have persistent instability in up to 90% of cases,1 and there is no control of subtalar instability. However, one recent study reported good to excellent results in 88% of cases with a 12 year follow-up.34 Interestingly, although there was radiographic evidence of arthrosis (progressive exostosis with joint space narrowing), there was no correlation with clinical outcome.

The Evans procedure was originally described as transferring the peroneus brevis through a drill hole in the tip of the fibula and then tenodesis it to itself proximally. It has subsequently been modified over the years to a split transfer through the fibula from posterior to anterior and tenodesis to itself, distally.35 Patients complain of subjective instability in 20% to 33% of cases.1 It has been shown to limit adduction and inversion but not anterior translation.36 Concern has been expressed37 over the altered mechanics of the hindfoot resulting from this procedure, and reports of greater than 80% good to excellent results have been challenged.38 More recently, it has been suggested that the Evans procedure be used only as a last resort when anatomic reconstruction cannot be performed.39
On the other hand, there are the anatomic repairs and reconstructions. The most popular of which is the Bröstrom repair that was described earlier. It is a primary or secondary repair of the patient’s native ligaments. It can also be augmented with a strip of peroneus brevis, similar to that done in the Evans procedure. Another advantage of this procedure, which is now becoming more widely appreciated, is that it can be used in cases of subtalar instability.

Finally, there is the Chrisman-Snook procedure, which is a modification of the Elmslie procedure. The Elmslie procedure was originally described in 1934 as using a strip of fascia lata in an attempt to reconstruct the lateral ankle ligaments in nearly anatomic fashion. The Chrisman-Snook procedure does this by using a split peroneus brevis transfer. The split portion is tunneled through the neck of the talus, from anterior to posterior through the distal fibula, and then down through the tip of the fibula to the calcaneus. In a prospective, randomized study of 40 patients who underwent either a Bröstrom or Chrisman-Snook procedure, both procedures resulted in good to excellent results in greater than 80% of cases. However, there was a significantly higher rate of complications in those that had the Chrisman-Snook procedure. This procedure has been further modified to address subtalar instability by incorporating a limb that is tunneled through the anterior process of the calcaneus to the neck of the talus. It is important to avoid over tightening this limb because as many as 30% of patients will describe a feeling of tightness in their ankles postoperatively. Interestingly, in 13% to 30% of cases, patients have reported a feeling of persistent instability postoperatively. Unlike the non-anatomic procedures, objective instability has not been an issue.

Other anatomic reconstructions have been described in the literature, but little long-term follow-up is available. In revision cases, anatomic repairs with augmentation should be attempted. In experienced hands, these revisions may have the same level as success as primary procedures.

Subtalar Instability

Subtalar instability has become more widely appreciated in recent years. It appears to occur in about 10% of those patients with chronic ankle instability, and is probably the result of an ankle injury, although in the past it was theorized to be due to trauma and degeneration of the interosseous ligament (IOL). Injury to the subtalar joint proceeds along a spectrum, with subtalar dislocation being the most severe injury. Clinical evaluation can be difficult. Stress radiographs have been shown to correlate poorly with clinical symptoms. Furthermore, the problem with subtalar instability is not so much in recognizing it, but in treating it appropriately. Conservative management, with measures similar to those mentioned previously, is the rule. For those that have failed a supervised rehabilitation program and bracing, surgery may be indicated. Secondary anatomic repairs of the lateral ankle and subtalar ligaments like the Bröstrom or tri-ligamentous reconstructions like the Chrisman-Snook are recommended. Recently, Kato and Pisani have described procedures that reconstruct the IOL and have had excellent short-term success with good to excellent results in 90% of cases.

Conclusions

Chronic ankle and subtalar instability may be troubling for both the patient and surgeon. Fortunately, the majority of patients will do well with non-operative management. Stress radiographs have proven to add little to the diagnosis and ultimate outcome of these injuries. Surgical intervention should only be considered in patients whose functional instability is refractory to an appropriate rehabilitation program. Anatomic repairs and reconstructions, like the Bröstrom and Chrisman-Snook procedures, are the most appropriate procedures in both acute and chronic cases.

References