Acute and Chronic Lateral Ankle Instability in the Athlete

Keith W. Chan, M.D., Bryan C. Ding, M.D., and Kenneth J. Mroczek, M.D.

Abstract
Ankle sprain injuries are the most common injury sustained during sporting activities. Three-quarters of ankle injuries involve the lateral ligamentous complex, comprised of the anterior talofibular ligament (ATFL), the calcaneofibular ligament (CFL), and the posterior talofibular ligament (PTFL). The most common mechanism of injury in lateral ankle sprains occurs with forced plantar flexion and inversion of the ankle as the body’s center of gravity rolls over the ankle. The ATFL followed by the CFL are the most commonly injured ligaments. Eighty percent of acute ankle sprains make a full recovery with conservative management, while 20% of acute ankle sprains develop mechanical or functional instability, resulting in chronic ankle instability. Treatment of acute ankle sprains generally can be successfully managed with a short period of immobilization that is followed by functional rehabilitation. Patients with chronic ankle instability who fail functional rehabilitation are best treated with a Brostrom-Gould anatomic repair or, in those patients with poor tissue quality or undergoing revision surgery, an anatomic reconstruction.

Ankle sprain injuries are the most common injury sustained during sporting activities. It accounts for up to 40% of all athletic injuries and is most commonly seen in athletes participating in basketball, soccer, running, and ballet/dance.1-2 Up to 53% of basketball injuries and 29% of soccer injuries can be attributed to ankle injuries and 12% of time lost in football is due to ankle injuries.3-4 Patients presenting with ankle sprains make a full recovery with conservative management, while 20% of acute ankle sprains develop mechanical or functional instability, resulting in chronic ankle instability. Recent epidemiological studies in high school athletes have found ankle sprains to be the most prevalent soccer injury amongst boys and girls (16% and 20%, respectively).6 Ankle ligament sprains were also the most common injury pattern in basketball, usually occurring from jumping and landing, being stepped on, and rotation around a planted foot.7 Three-quarters of ankle injuries involve the lateral ligamentous complex, with an equal incidence between males and females.8 Most ankle sprains do not develop lateral ligamentous instability and those that do are thought to be due to a loss of mechanoreceptors.2 Eighty percent of acute ankle sprains make a full recovery with conservative management, while 20% of acute ankle sprains develop mechanical or functional instability resulting in chronic ankle instability.2,5-9 Chronic ankle instability can lead to early degenerative changes in the ankle due to unbalanced loading on the medial side of the ankle.10

In a classic study by Harrington,10 36 ankles with 10 years of lateral ankle instability were studied. He found degenerative changes of the medial ankle joint that were worse with weightbearing films. Fourteen out of 22 ankles with mild to moderate arthritis showed symptomatic and radiographic improvement after lateral ankle ligament reconstruction. However, four out of five ankles with severe arthritis required eventual total ankle replacement.10 Numerous surgical procedures have been described for the treatment of chronic lateral ankle instability beginning with Elmslie, in 1934, who first reported using fascia lata graft to reconstruct the lateral ankle ligaments.11 Today, surgical treatment of lateral ankle instability can be divided into anatomic repair, nonanatomic reconstruction, and anatomic reconstruction.
Anatomy

The ankle joint is the most congruent in the body. Stability of the ankle is due to bony configuration of the ankle mortise and talar dome, ligamentous structures, capsule, syndesmosis, and the crossing tendons. The lateral ankle ligamentous complex comprises the anterior talofibular ligament (ATFL), the calcaneofibular ligament (CFL) and the posterior talofibular ligament (PTFL) (Fig. 1).

The ATFL is the weakest of the lateral ankle ligaments. It originates 1 cm proximal to the distal tip of the fibula and inserts on the lateral talar neck just beyond the articular surface about 18 mm proximal to the tibiotalar joint. It is contiguous to the ankle joint capsule and has been found to be a discrete capsular thickening. It measures 6 to 10 mm in width, 10 mm in length, and 2 mm in thickness.12,13

The CFL is the only extra-articular ligament within the lateral complex and originates on the distal tip of the fibula. It travels in an oblique direction plantarly and posteriorly towards its calcaneal insertion 13 mm distal to the subtalar joint. The CFL measures 20 to 25 mm in length and 6 to 8 mm in diameter and crosses both the tibiotalar and subtalar joints. The CFL also forms the floor of the peroneal tendon sheath and is larger and stronger than the ATFL.12,13

The PTFL is the strongest of the lateral ankle ligaments and is rarely injured in ankle inversion sprains. It originates 10 mm proximal to the distal tip of the fibula and inserts onto nearly the entire nonarticular portion of the posterior talus up to the flexor hallucis longus groove. The PTFL is usually not involved in chronic ankle instability.12

Biomechanics

The ATFL forms a 47° angle to the sagittal plane and 25° angle to the horizontal plane and is the primary restraint against plantar flexion and internal rotation of the foot.12,14,15 The CFL forms a 133° angle with the fibula and a 104° angle with the ATFL. The CFL is relaxed in plantar flexion and taut in dorsiflexion and thus stabilizes the ankle and prevents talar tilt as the ankle moves from neutral into dorsiflexion.12,14,15

The most common mechanism of injury in lateral ankle sprains occurs with forced plantar flexion and inversion of the ankle as the body’s center of gravity rolls over the ankle. The ATFL followed by the CFL are the most commonly injured ligaments. Many investigators have confirmed this in biomechanical and clinical studies. Attarian and colleagues17 found in a cadaveric study that the maximum load to failure for the CFL was two to three-and-a-half times greater than the ATFL.16 Brostrom17 surgically explored 105 sprained ankles and found that two-thirds of the ankles had an ATFL tear, while a quarter of the ankles had a combined ATFL and CFL rupture.

Acute Ankle Sprains

Clinical Presentation

A careful history and physical examination is crucial when evaluating a patient with an acute ankle sprain, as it can elicit the severity of the injury. A patient usually describes “rolling over” his or her ankle due to a combination of inversion, plantar flexion, or internal rotation of the ankle. The patient will likely report acute lateral ankle pain and, the physician may elicit the extent of ligament injury by inquiring about swelling, ability to bear weight and subsequent ecchymosis.

On physical examination, patients can localize the lateral ankle tenderness in the acute setting but the pain and swelling becomes more diffuse over the next few days. Careful palpation can confirm the structures involved in the injury—localized ATFL tenderness is exhibited at 4 to 7 days post injury, while CFL injury can be diagnosed with tenderness at the calcaneal insertion. Funder and coworkers18 found that 52% of patients with ATFL tenderness indeed had a ruptured ATFL, while 72% of patients with CFL insertional tenderness had a ruptured CFL.

There are two provocative tests that can assess ankle instability—the anterior drawer test and the talar tilt test. The anterior drawer test assesses the integrity of the ATFL as the ATFL prevents anterior translation of the talus with respect to the tibia. The test is performed after positioning the ankle in neutral to 10° of plantar flexion with the patient seated and the knee flexed (Fig. 2). The examiner holds the calcaneus in one hand while stabilizing the distal tibia and subtalar joints. The examiner then translates the talus forward. Increased translation of 3 mm compared to the uninjured side or an absolute value of 10 mm of displacement correlates to ATFL incompetence.19

The talar tilt test is described as the angle formed by the talar dome and the tibial plafond during forced hindfoot inversion with the tibiotalar joint held in neutral (Fig. 3). The test is not a useful physical examination tool as it is hard to distinguish ankle motion from subtalar motion, but it can be as useful as a stress radiograph. The normal range of

---

Figure 1 The lateral ankle ligamentous complex.
talar tilt is variable and can range from five to 23°. However, 10° of absolute talar tilt or 5° difference compared to the contralateral side is generally considered a positive talar tilt test. The Telos Stress Device (Telos, Marburg, Germany) can be utilized to perform more consistent stress measurements for talar tilt and anterior talar translation by placing the lower extremity in the apparatus.

**Diagnostic Studies**

Standard ankle radiographs can be performed after an acute ankle injury to rule out fracture. The Ottawa Ankle Rules were established by Stiell and Greenberg as a guideline to determine when to obtain radiographs for ankle injuries. 

<table>
<thead>
<tr>
<th>Ottawa Ankle Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtain radiographs if ankle pain and one of the following:</td>
</tr>
<tr>
<td>1. Bony tenderness at the base of the 5th metatarsal</td>
</tr>
<tr>
<td>2. Inability to bear weight immediately after the injury and for four steps in the emergency department</td>
</tr>
<tr>
<td>3. Bony tenderness at the tip or posterior edge of the malleolus</td>
</tr>
</tbody>
</table>

In their study, they were able to reduce the cost to the emergency department by three million dollars annually by following their guidelines yet still accurately detecting ankle fractures.

Ultrasound has been advocated for the evaluation of acute ankle ligament injuries because it allows for noninvasive and dynamic assessment of the ankle. However, ultrasound is highly dependent upon equipment and operator skill level. Ligament tears are usually seen at insertional sites or in the central third. Acute tears are visualized as ligament swelling, discontinuity, hypoechogenicity, and nonvisualization. The diagnostic accuracy for ATFL tears by ultrasound is 95% and for CFL tears is 90%. 

CT and MRI scans are not typically indicated for acute ankle sprains. However, if there are other suspected injuries, MRI can be useful to elucidate associated conditions. The differential diagnosis of ankle injuries is varied, ranging from fractures to other ligamentous injuries (Table 2). Frey and associates correlated MRI with clinical findings and found a high percentage of peroneal tendon pathology. Posterior tibial tendon and deltoid ligament injury was also common.
The classification of lateral ankle sprains is divided into three grades with increasing severity and ligamentous damage (Table 3). The classification scheme aids the clinician in diagnosis and assessing the correct treatment plan for the patient.

### Classification

The treatment of functional rehabilitation is based upon four stages of biologic healing. In the first stage, the RICE (rest, ice, compression, elevation) protocol is used to decrease inflammation and swelling in order to promote and improve conditions for healing. In the second stage, ligaments are protected for one to three weeks during the healing or proliferation phase. Fibroblasts invade the injured area and form collagen fibers. Bracing or taping is recommended as it can decrease radiographic talar tilt. Approximately 3 weeks after injury, collagen fibers mature and become scar tissue in the maturation phase. By performing controlled stretching, the collagen fibers are able to be reoriented and help prevent stiffness. At 6 to 8 weeks post-injury, the fourth and final stage of healing brings the patient near full strength and able to return to full activity. However, patients should be counseled to allow six to 12 months for full maturation and remodeling of the injured ligaments.

### Treatment

As with most diseases, prevention of injury can be the best treatment. Various investigators have examined the use of footwear and bracing to prevent ankle sprains. However, it remains controversial as to what is the best method for prevention. Some have described the use of low-top shoes combined with lace-up bracing in order to decrease the number of ankle sprains, while others have used high-top shoes with taping. The use of taping itself is time-consuming and has been shown to only reduce range of motion for 2 to 3 hours, as well as potentially irritating.

The treatment of grade I and II ankle sprains is straightforward, and conservative management remains the norm. Balduini and colleagues advocated a short period of rest, ice, compression, and elevation (RICE) followed by protective taping or bracing and functional rehabilitation. The average disability is approximately 8 days and 15 days for grade I ankle sprains and grade II ankle sprains, respectively.

### Table 2 Differential Diagnosis of Ankle Injury

<table>
<thead>
<tr>
<th>Fractures of the ankle and foot</th>
<th>Lateral, medial, posterior malleoli</th>
<th>Proximal fibula</th>
<th>Posterolateral process of talus</th>
<th>Lateral process talus</th>
<th>Anterior process calcaneus</th>
<th>Base of fifth metatarsal</th>
<th>Navicular or midtarsal bones</th>
<th>Growth plate injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteochondral fractures</td>
<td>Anterolateral talus</td>
<td>Posteromedial talus</td>
<td>Distal tibia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other ligamentous injuries</td>
<td>Hindfoot and midfoot sprains</td>
<td>Peroneal tendons</td>
<td>Peroneal retinaculum</td>
<td>Medial ankle tendons</td>
<td>Posterior tibial</td>
<td>Flexor digitorum longus</td>
<td>Flexor hallucis longus</td>
<td></td>
</tr>
<tr>
<td>Tendon injuries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nerve injury</td>
<td>Superficial peroneal nerve</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3 Classification of Injury and Clinical Presentation

<table>
<thead>
<tr>
<th>Ligaments Injured</th>
<th>Clinical Presentation</th>
</tr>
</thead>
</table>
| Grade I ATFL stretched | Mild swelling and tenderness
|                    | Minimal difficulty with ROM and WB       |
| Grade II ATFL torn ± CFL tear | Moderate swelling, ecchymosis
|                    | Anterolateral ankle tenderness           |
|                     | Restricted ROM, increasing difficulty WB |
| Grade III ATFL, CFL torn ± Capsular tear ± PTFL tear | Diffuse swelling, ecchymosis
|                     | Tenderness over anterolateral capsule, ATFL, CFL |
|                     | Inability to bear weight                 |

ATFL, anterior talofibular ligament; CFL, calcaneofibular ligament; ROM, range of motion; PTFL, posterior talofibular ligament; WB, weightbearing.
patients that had undergone surgery had less range of motion at final follow-up.\textsuperscript{34}

Although rarely performed, some investigators have promoted acute repair for lateral ankle sprains. Leach and Schepsis advocated primary repair in young athletes with Grade III sprains.\textsuperscript{35} A similar report found better objective scores in surgically managed patients but concluded that in most circumstances surgery was not worth the additional cost, risks, or complications.\textsuperscript{36} Given that the results of secondary repair are similar to primary repair and that functional treatment has yielded similar outcomes, surgery is rarely indicated in the acute setting.

**Chronic Ankle Instability**

**Clinical Presentation**

When elicting the history from a patient with chronic ankle instability, the main complaint usually includes intermittent “giving out of the ankle” with a past history of at least two or three severe lateral ankle sprains. The patient often complains of difficulty and apprehension on uneven surfaces. Even a mild exacerbation can lead to short-term dysfunction; however, these patients are normally without pain or dysfunction between episodes. Bracing or taping may provide only partial relief or improvement.

On physical examination, the lower extremity is inspected and palpated while noting any existing hindfoot varus. The hindfoot motion should be recorded and peroneal muscle strength should be tested. Signs of generalized ligamentous laxity should be elicited. Stability testing consisting of the anterior drawer and talar tilt test should be performed. Proprioception is often abnormal in these patients as grade III ankle sprains have been noted to have up to 86% and 83% of peroneal nerve and tibial nerve stretch injury, respectively.\textsuperscript{37} The modified Romberg test is used to examine proprioception as the patient stands on the normal ankle with their eyes open and then closed and is repeated for the injured ankle.

**Diagnostic Studies**

Plain radiographs should be taken and can be useful to rule out bony injury or degenerative changes. Stress radiographs are sometimes useful; however, there is a lack of universally accepted criteria for talar tilt and anterior talar translation. Ultrasound, as mentioned previously, can be used to assess the ankle but is highly user dependent.

MRI is more useful in the setting of chronic ankle instability than in the acute setting. Ligament injury can be seen on MRI as swelling, discontinuity of fibers, a lax or wavy ligament, or non-visualization. As well, associated causes of ankle pain can be visualized including chondral injury, subchondral edema, radiographically occult fractures, sinus tarsi injury, peri-articular tendon tears, and impingement syndrome. The study should be performed with the ankle in neutral or slight plantar flexion in order to help align the ATFL and CFL. Limitations of MRI include cost, time, availability, motion artifact, and being unable to accurately predict chronic sequelae following acute injury.\textsuperscript{38}

**Arthroscopy**

The role of arthroscopy in chronic ankle instability has not been well defined. More investigators are advocating arthroscopy because several intra-articular conditions associated with chronic ankle instability can contribute to pain and dysfunction. These include osteochondral (OCD) lesions of the talus, impingement, loose bodies, painful ossicles, adhesions, chondromalacia, and osteophytes. The incidence of talar OCD lesions with chronic ankle instability reported by Bosien and coworkers\textsuperscript{39} was 6.5%, but subsequent investigators have found a much higher rate of pathology. Van Dijk and associates\textsuperscript{40} found that two-thirds of patients with chronic ankle instability had articular injuries. The majority were located on the medial aspect of the ankle, and they hypothesized that medial ankle impingement occurred during the lateral ankle sprain. As well, Komenda and Ferkel\textsuperscript{41} arthroscopically examined 54 patients with lateral ankle instability and found 25% with articular chondral injury, while 51 ankles had intra-articular pathology. They recommended ankle arthroscopy prior to all lateral ligament reconstructions.

Several investigators have proposed an increasing role for arthroscopy as a definitive treatment. Maiotti and colleagues\textsuperscript{42} recommended using arthroscopic thermal capsular shrinkage for chronic ankle instability without ligamentous repair. Good-to-excellent results were reported in 86% of patients at 42-month follow-up. In addition, some authors have reported using a three portal arthroscopic approach to assist autogenous plantaris tendon reconstruction of the ATFL and CFL.\textsuperscript{43} No clinical results were reported and, as well, this technique is associated with a high level of technical difficulty.

**Nonoperative Treatment**

Functional rehabilitation has a high probability of success in functional ankle instability; however, the likelihood of success is decreased with mechanical instability, peroneal weakness, or proprioceptive deficits. Six weeks of aggressive physical therapy is recommended. Orthotics can be useful during the rehabilitation process, which can include a lateral heel wedge or a heel lift. Taping has been used with variable success but does not provide much support after 1 hour of exercise. Bracing may also provide additional support for the chronically unstable ankle.

**Operative Treatment**

Indications for lateral ligamentous reconstruction include persistent symptomatic mechanical instability and failed functional rehabilitation. Contraindications include pain without instability, peripheral vascular disease, peripheral neuropathy, and inability to comply with a postoperative regimen.

Over 80 surgical procedures have been described for chronic lateral ankle instability, and the procedures can be
divided into three categories: anatomic repair, nonanatomic, or check-rein, reconstruction, and anatomic reconstruction.

**Anatomic Repair**

Brostrom first described a mid-substance repair of the ATFL and CFL in 1966 after reporting on a series of 60 patients (Fig. 4A). Gould and coworkers further modified the Brostrom procedure by reinforcing the repair using the lateral talocalcaneal ligament, CFL, and inferior extensor retinaculum, which helped limit inversion and corrected subtalar instability (Fig. 4B). Karlsson and associates were the first to report on imbricating the damaged ligaments and reinserting the ligaments through drill holes in the fibula (Fig. 4C). They noted improved results using this bone tunnel repair of the ATFL and CFL.

Numerous studies have shown good-to-excellent results with anatomic repairs, with over 85% of patients achieving good outcomes. The longevity of anatomic repair is well established. Bell and colleagues followed 22 patients who underwent Brostrom repair for 26 years and reported over 90% good-to-excellent results.

A subset of patients, however, are subject to increased failure rates, including those with long-standing instability, poor tissue quality, history of previous repair, generalized ligamentous laxity, and cavovarus foot deformity. Different groups have tried to overcome these problems by augmenting the anatomic repair with local tissues, such as a periosteal flap or free tendon autograft or allograft. Nonanatomic and anatomic reconstructive tenodesis procedures are options to consider for these patients as well.

**Nonanatomic Reconstruction**

Nonanatomic reconstructions, or check-rein procedures, have been described for longer than anatomic repair. The

---

**Figure 4** A, Brostrom midsubstance repair of the ATFL and CFL. B, Gould and colleagues reinforced modification of Brostrom repair with lateral talocalcaneal ligament, CFL, and inferior extensor retinaculum. C, Karlsson and associates modification using bone tunnel repair of the ATFL and CFL.

**Figure 5** A, Watson-Jones nonanatomic reconstruction procedure using the peroneus brevis. B, Evans simplified version of the Watson-Jones procedure. C, Chrisman-Snook reconstruction, a variation on the original Elmslie procedure.
original Elmslie procedure was first described in 1934 using fascia lata as a means to reconstruct the lateral ankle ligaments. Watson-Jones popularized a procedure first reported in 1952 that used the peroneus brevis and rerouted the tendon in a posterior to anterior fashion through the fibula and securing it onto the talar neck (Fig. 5A). This procedure was successful at limiting internal rotation and anterior subluxation but fails to reconstruct the CFL, possibly leading to increased talar tilt and subtalar motion.

In 1953, Evans reported a simplified version of the Watson-Jones procedure by routing the peroneal brevis tendon obliquely through the distal fibula in an anterior-distal to posterior-proximal fashion (Fig. 5B). Although good subjective results were initially reported, residual anterior talar instability and reduced subtalar motion from this procedure led to poor long-term results. Biomechanical analysis showed a propensity for increased anterior displacement, internal rotation, talar tilt, and subtalar motion restriction.

The Chrisman-Snook reconstruction, which was a variation on the original Elmslie procedure, was subsequently reported (Fig. 5C). The peroneus brevis tendon is split and transferred through the fibula and into the calcaneus, thus providing a more anatomic reconstruction. The authors felt that this method did not sacrifice significant peroneal strength and effectively limited talar tilt by reproducing the restraints of the CFL in contrast to other nonanatomic tenodesis procedures. However, patients undergoing this procedure have been found to have subtalar stiffness and non-physiologic kinematics.

Results have been mixed for nonanatomic reconstructions as compared to anatomic repair. Problems observed in longer term follow-up include subjective instability, nonphysiologic kinematics, and diminishing clinical outcome scores. Van der Rijt and Evans reported on nine patients who underwent a Watson-Jones reconstruction with 22-year follow-up and found only one-third had complete relief of symptoms and that deterioration of results occurred at 7 to 10 years. Patients complained of residual instability and had radiographic evidence of degenerative disease. However, a similar study reported 88% good-to-excellent results following Watson-Jones reconstruction with no long term deterioration after 13 year follow-up.

Similar mixed results exist after reviewing the Evans procedure. In 91 ankles treated with the Evans procedure, only 57% were found to have a good-to-excellent result with findings of instability and radiographic degenerative changes despite a 92% satisfaction rate. However, Korkala and coworkers reported no deterioration of results after a 20-year follow-up in 24 ankles that had undergone the Evans procedure with 80% good-to-excellent results despite residual instability.

There have been few reports on the Chrisman-Snook procedure, but most have been positive. Snook and associates reported on 48 patients following a Chrisman-Snook operation with a mean 10-year follow-up. Ninety-three percent of patients had a good-to-excellent result, although three patients had recurrent instability from a severe reinjury.

Nonanatomic tenodeses are a powerful reconstructive option for chronic lateral ankle instability but, a permanent change in ankle kinematics occurs. Subtalar motion is permanently impaired with residual instability remaining. However, by increasing the anatomicity of the reconstruction, the tenodesis can be improved. Thus, a final category of procedures, anatomic reconstructions, has been advocated.

**Anatomic Reconstruction**

Anatomic tenodesis reconstructions are able to augment the anatomic repair without sacrificing lateral ankle anatomy or kinematics. Colville described a reconstruction using a split peroneus brevis tendon to augment a repaired ATFL and CFL (Fig. 6). The peroneus brevis is placed into the anatomic origins and insertions of the ligaments. As a result, normal ankle kinematics and subtalar motion are maintained.

Anatomic reconstruction can be achieved using free autograft or allograft tendon. The indications for this technique include poor tissue quality or revision surgery. The advantages for using free autograft or allograft are that a strong anatomic repair can be provided without sacrificing peroneal function or strength. The graft can be used to augment the anatomic repair and is placed into the anatomic origins and insertions of the ATFL and CFL. There are various sources of autograft that can be obtained from the patient including gracilis, semitendinosis, fascia lata, palmaris, plantaris, and patella tendons. The use of allograft may be preferable in certain circumstances, as there is no donor-site morbidity, but the patient should be counseled regarding the inherent risks with allograft tissue.

The early results for anatomic reconstructions are promising with excellent short term outcomes. Colville and Grondel reported on 12 patients with a three-and-a-half year follow-up and found good-to-excellent results in 83% of patients with no recurrence of instability while restoring...
ankle stability, strength, and normal subtalar motion. Another study reported similar outcomes with 94% good-to-excellent results in 31 patients at 2-year follow-up. The investigators concluded that anatomic reconstructions are excellent procedures for high demand ankles with chronic instability with or without subtalar instability or failed primary reconstruction.71

**Comparative Studies**

There have been several studies comparing the different categories of operative treatment. Krips and colleagues72 reported 20-year follow-up results on patients who had undergone a Karlsson anatomic repair versus an Evans nonanatomic tenodesis. The Evans tenodesis group had a much higher reoperation rate, increased laxity, pain, arthritis, and limited dorsiflexion. Eighty percent of the anatomic repair group had good-to-excellent results as compared to the 33% of the Evans tenodesis group. In addition, Hennikus and coworkers73 compared patients who had undergone a modified Brostrom anatomic repair to a Chrisman-Snook tenodesis procedure. Although over 80% of both groups reported good-to-excellent stability, outcome scores were higher in the anatomic repair group, and there were more complications in the tenodesis group.

**Postoperative Protocol**

The postoperative protocol following operative treatment for chronic ankle instability includes an initial splint holding the ankle neutral and the foot everted. The splint is removed at 2 weeks postoperatively and is switched to a removable ankle brace in order to begin gentle range of motion exercises. Passive inversion stretching is avoided for 6 weeks. Physical therapy is then commenced with active and passive range of motion, gait training, strengthening in ankle dorsiflexion, plantarflexion, eversion and inversion with a focus on the peroneals and balance and proprioceptive training. A return to full activity can be expected at 3 to 6 months. Ankle bracing should be continued full-time for the initial 3 months but should be continued indefinitely for high risk activities.

**Complications**

Fortunately, major complications, such as deep venous thrombosis, pulmonary embolism, reflex sympathetic dystrophy, septic arthritis, and osteomyelitis, are rare following operative treatment for chronic ankle instability. However, the more commonly occurring problems, such as wound and nerve problems, recurrent instability, stiffness, and subjective failure, can result in significant patient morbidity.74

Wound complications occur in approximately 1.6% of patients after anatomic repair and are slightly higher at 4% of patients after nonanatomic tenodesis. The wound issues tend to be superficial and treatable with local wound care and rarely require reoperation. Nerve problems can range in severity from mild temporary paresthesias to neuroma formation requiring operative excision. The approximate incidence of nerve problems range from 3.8% for anatomic repair to 1.9% for anatomic tenodesis to 9.7% for nonanatomic tenodesis.74

Early recurrent instability usually occurs after an acute reinjury, whereas late recurrent instability is likely due to chronic attritional injuries. Anatomic reconstruction or tenodesis offers the lowest rate of recurrent instability. Risk factors for failure and recurrent instability after operative procedure are ligamentous laxity, longstanding instability, high functional demand, and a cavovarus foot. Patients with ankle instability and hindfoot varus deformity should be treated with a concurrent calcaneal osteotomy with lateral ankle ligament reconstruction.74-76

Stiffness is common after both anatomic and nonanatomic reconstructions and is often well-tolerated by patients, as it may be a necessary trade-off for stability. However, overtightening of a nonanatomic tenodesis reconstruction is a recognized complication and can lead to loss of subtalar and tibiotalar motion and impingement. To avoid this from occurring, it is recommended to tension the reconstruction with the foot everted 5° to 8° to avoid over-tightening while maintaining an adequate repair.64,71,74,77

It is uncommon to have subjective failure with a structurally sound repair. Acutely, it may be due to poor patient selection or an inaccurate clinical diagnosis. Delayed subjective failure may be due to a single traumatic event or multiple subclinical events. Physical therapy remains the mainstay of treatment for subjective failure. Persistent functional instability in the face of a structurally sound repair is a difficult problem to treat. Proprioceptive-based therapy is often a preferable option to revision surgery, which is very unpredictable in these circumstances.74,78

**Conclusions**

Ankle sprains are the most common injury that occur during athletic events, with the lateral ligamentous complex most frequently injured. Approximately 20% of acute ankle sprains develop functional or mechanical instability resulting in chronic ankle instability. Over the years, an improved understanding of the biomechanics and pathoanatomy has expanded our treatment options for lateral ankle instability. However, the optimal means of prevention and treatment is still not fully ascertained. Functional rehabilitation remains the mainstay of treatment for acute ankle sprains. In chronic instability, the Brostrom-Gould anatomic repair provides the best functional results for correctly indicated patients. Anatomic tenodesis or reconstruction via autograft or allograft is an excellent option to primarily reconstruct or augment an anatomic repair, although long-term follow-up is lacking. The Chrisman-Snook procedure has the best results amongst the nonanatomic tenodesis reconstructions, which should be used primarily as salvage procedures given the high incidence of abnormal ankle kinematics and impaired subtalar motion with residual instability.
Disclosure Statement
None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

References
42. Maiotti M, Massoni C, Tarantini U. The use of arthroscopic