Pediatric Ankle Sprains and Their Imitators

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Abstract

Ankle injuries are common in sports, and the ankle sprain is the most common of ankle injuries, but there are many injuries that can mimic a sprain. In the skeletally immature athlete, bone injuries, particularly those that affect the physis, are more likely to occur than a ligamentous injury. Knowledge of relevant anatomy, physical exam, and appropriate imaging can assist the primary care provider in accurately diagnosing the majority of ankle injuries in the young athlete. [Pediatr Ann. 2014;43(12):e291-e296.]

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Ankle injuries are common and are second in incidence only to hand and wrist injuries in the young athlete. Ankle sprains comprise the majority of these injuries. In the skeletally immature athlete, however, injuries that affect the physes occur more frequently than a sprain. Careful consideration of all diagnostic possibilities is important to determine the correct treatment plan.

**Epidemiology**

Almost 50% of all ankle sprains are sports related, with the majority occurring in basketball (41%), football (9%), and soccer (8%). In youth soccer, foot and ankle issues account for 18% of all injuries.\(^1\) The peak age for all ankle sprains is between 15 and 19 years, with a rate of 7.2 sprains per 1,000 person-years.\(^2\) The mean peak ankle sprain incidence for males occurs between ages 15 and 19 years and for females occurs between ages 10 and 14 years.\(^2\)

**Anatomy**

The ankle is a hinge joint, with most motion occurring primarily in the dorsiflexion and plantar flexion positions. Side-to-side movement is achieved through the subtalar joint. Three bones comprise the main ankle joint—the distal tibia, distal fibula, and talus (Figure 1). Three ligaments provide stability to the lateral ankle—the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligaments (PTFL). The deltoid ligament complex provides stability to the medial ankle. The distal tibiofibular ligaments, along with the syndesmosis (the membrane that connects the tibia and fibula), provide additional stability, and when these are injured, the diagnosis is a “high” ankle sprain.

**Physical Examination**

The same general physical examination principles that are applied to other joints can also be applied to the ankle. First, one should inspect the ankle for swelling, bruising, deformities, and skin integrity, and then ask if the patient has been using any assistive devices such as a brace or crutches to ambulate. Second, range of motion should be evaluated both actively and passively. In an acute injury, passive motion by the examiner may elicit significant pain and should not be forcefully conducted. Strength should be assessed with resisted dorsiflexion, plantar flexion, inversion, and eversion. Strength may be diminished in an acute injury secondary to pain.

Palpation should be conducted over all bones, ligaments, and tendons around the ankle and midfoot in an acute ankle injury. Particular note should be made regarding tenderness over either the lateral or medial malleolus, base of the fifth metatarsal, and navicular bone because tenderness in these areas warrants further evaluation with X-rays.

Special tests for the ankle include the anterior drawer test, talar tilt test, external rotation stress test, and squeeze test. The anterior drawer test is to determine laxity of the ankle joint secondary to an ATFL rupture. The test is performed with the foot and ankle at a 90-degree angle or a “neutral” position. The examiner uses one hand cupped around the heel while the other hand stabilizes the tibia. The hand holding the heel is used to try to anteriorly translate the foot relative to the ankle. A test is considered positive when there is increased laxity and a visible gap laterally while performing this test. Pain does not need to be provoked to consider this a positive test. The talar tilt test is performed to assess for potential rupture of the ATFL and CFL. While keeping the ankle in a position similar to the anterior drawer test, the examiner will invert the ankle. If both the ATFL and CFL have been injured, there will be an increased angle between the tibia and talar dome compared with the uninjured side. This test may be difficult to conduct in the setting of an acute injury as this motion may be limited due to pain and patient guarding.

Two tests for syndesmotic injuries (ie, “high” ankle sprains) include the squeeze test and the external rotation stress test. The squeeze test is conducted with the patient sitting on an exam table with the leg hanging over the table with the knee at 90 degrees of flexion. The fibula and tibia are compressed near the mid-calf. A positive test produces pain at the syndesmosis. The external rotation stress test is also performed with a patient sitting with the leg hanging with the knee flexed to 90 degrees. Passive external rotation of the foot and ankle are performed while keeping the ankle in a neutral position at 90 degrees of flexion. A positive test is indicated by pain at the syndesmosis.

**Imaging**

When ordering radiographs of the ankle, the standard series includes an anterior-posterior (AP) view, lateral view, and mortise view (AP view with foot internally rotated about 20 degrees). In some cases, further evaluation with a computed tomography (CT) scan may be warranted, particularly in cases in which fractures are noted to extend intra-articularly and further determination of displacement may be needed for surgical planning. Magnetic resonance imaging (MRI) is typically not indicated for most acute ankle injuries in the young athlete.\(^3\)

Clinical decision rules have been devised (initially for adults and then validated in children older than age 5 years)
and are named the Ottawa Ankle Rules (OAR) \(^4\) (Table 1). A meta-analysis evaluating the accuracy of the OAR in children revealed a pooled sensitivity of 98.5% and specificity of 7.9%-50%.\(^5\) The pooled negative likelihood ratio is 0.11, which would make use of the OAR acceptable for ruling out a fracture of the ankle.\(^5\) The estimated missed fracture rate was 1.22%.\(^5\) These studies also estimated a reduction in ankle radiographs performed by 5.4%-43.8% if the OAR are applied.\(^5\) Other radiograph decision rules, including the Low-Risk Exam and Malleolar Zone Algorithm, were found to be inferior to OAR in a head-to-head comparison study.\(^6\)

**PHYSEAL FRACTURES**

**Salter Harris Type I Fractures of Distal Fibula**

One of the most common ankle injuries in the young athlete, which is often misdiagnosed as an ankle sprain, is a Salter Harris type I fracture of the distal fibula. The mechanism is identical to that for an ankle sprain—inversion of the ankle. Given the relative weakness of the physis compared with the lateral ligaments, the physis is the structure that often fails first, resulting in this fracture. Careful examination for the area of maximal tenderness will help distinguish between a ligament sprain and a physeal fracture. For a lateral ankle sprain, maximal tenderness will be over the ligaments themselves, whereas the Salter Harris type I fracture will have maximal tenderness over the physis of the lateral malleolus. Often, soft tissue swelling is noticeably more pronounced directly over the lateral malleolus and the area around the ATFL, as in a lateral ankle sprain. Radiographs are often normal, although some may demonstrate slight widening of the physis and/or soft tissue swelling adjacent to the physis. Treatment is often with a walking boot or short leg walking cast for 3-4 weeks followed by another 1 or 2 weeks to transition back to normal sporting activities. Consideration should be made to follow up any physeal fractures for growth arrest up to 1 year following the injury.

**Juvenile Tillaux Fracture**

The juvenile Tillaux fracture is a fracture unique to the adolescent population that occurs as the adolescent is nearing skeletal maturity, usually between the ages of 12 and 15 years. The injury is a Salter Harris type III fracture that extends from the anterior lateral distal tibial physis and exits intra-articularly through the epiphysis.\(^3\) (Figure 2). The mechanism is typically through an eversion mechanism. Management is dictated by the amount of displacement. Traditionally, >2 mm of displacement is thought to be the criteria for the need of open reduction and internal fixation of the fracture.\(^7,8\) A CT scan may be used to more accurately determine the degree of fracture displacement (Figure 3). Non-displaced fractures can be treated with a nonweight-bearing cast followed by a walking boot for a total of 6 to 8 weeks.\(^7\) With prolonged immobilization, there likely will be a need for physical therapy. Time to return to sports is variable but should be based on the athlete’s return to normal range of motion, strength, and function.

**Triplane Fracture**

A triplane fracture is a Salter Harris type IV fracture of the distal tibia. Similar to the Tillaux fracture, these often occur as the athlete is nearing skeletal maturity, usually between the ages of 12 and 15 years. These typically occur from an external rotation force to the foot. Several variants of this fracture have been described. The fracture, when viewed from the AP radiograph, may appear similar to a juvenile Tillaux fracture. The lateral view will usually demonstrate a Salter Harris type IV fracture affecting primarily the posterior aspect of the tibia. A CT scan is often used to determine the significance of the fracture and displacement. Surgical reduc-
tion may be necessary, and referral to an orthopedist is warranted if this fracture is identified.9

LIGAMENTOUS INJURIES

Injuries to the ankle ligaments are more likely to occur in the skeletally mature young athlete than in the skeletally immature athlete. Once the physis has closed, the bone no longer acts as the “weak link,” allowing the ligaments to take more of the force. Injuries can occur to any of the three lateral ankle ligaments—the deltoid ligament complex, or the distal tibio-fibular ligaments and syndesmosis.

Lateral Ankle Sprain

The lateral ankle sprain, which constitutes the majority of all ligamentous injuries of the ankle, occurs through an inversion mechanism. A common cause is landing from a jump on an opponents’ foot and rolling off the foot. Pain and swelling is usually localized over the anterior lateral ankle. The degree of swelling and bruising can vary dramatically. Tenderness is most commonly localized over the ATFL, but may be present in other areas depending on when the patient is evaluated. Immediately following the injury, stiffness and additional swelling may produce tenderness to palpation in other areas.

Initial treatment may consist of the use of crutches or a walking boot in cases where normal weight bearing is too painful. The RICE (rest, ice, compression, and elevation) treatment method should be encouraged immediately after the injury. Early range of motion may help reduce swelling and hasten recovery. Weight bearing can be allowed, and should be encouraged as soon as the patient has a normal heel-to-toe gait. Pain control may be achieved through use of acetaminophen or nonsteroidal anti-inflammatory drugs. A randomized study comparing acetaminophen and naproxen showed they were equally effective in reducing pain and disability when taken regularly for 5 days following an acute ankle sprain.10 Physical therapy is recommended to help restore normal function and to reduce repeat injuries.

Ankle sprains may be graded based on the severity of the injury. In a grade I injury, the ligament has a mild stretch with no gross tearing. The anterior drawer test may be painful but does not demonstrate any significant laxity. Grade II injuries involve partial tearing of the ligament. The anterior drawer test demonstrates moderate laxity but with a firm end point. In a grade III injury, the ligament is completely torn. Anterior drawer test shows significant laxity and no firm end point. Return to play can be variable following an ankle sprain. Some athletes may have a mild enough injury to be able to return in a few days and others may take months to fully recover. Generally, the higher the grade of sprain, the longer the recovery. Typically, once an athlete can demonstrate a normal heel-to-toe gait without pain or a limp and can progress through functional testing relevant for the sport they are returning to, such as running, cutting side-to-side, or jumping without limitations, the athlete can be considered able to return to play. In a study of high school athletes, no difference was found in the time to return to play in a new versus a recurrent ankle sprain.11

A variant of a sprain is the avulsion fracture of the lateral malleolus. An avulsion fracture may be a common finding on an ankle radiograph following an inversion injury. These injuries are often equivalent to a sprain, and in this author’s experience may be treated the same as a lateral ankle sprain rather than as a fracture.

Deltoid (Medial) Sprain

The deltoid ligament complex is comprised of multiple bands.12 This ligament typically is injured through an eversion mechanism. Because the ankle has limited eversion ability compared with inversion ability, the deltoid ligament is less commonly injured than the lateral ankle ligaments. Careful physical examination of the entire ankle and lower leg should be conducted to evaluate for any lateral-sided pain or injury in association with the medial ankle injury. If both medial and lateral pain is present, one should suspect a more significant injury of the ankle, including an
injury to the syndesmosis, and ankle radiographs should be performed. These radiographs are used to determine if an unstable ankle exists from the injury. Evaluation for widening of the medial or tibiofibular clear space should be performed, and if widening is present a referral should be made to an orthopedist. If no widening is present, conservative management can be utilized. This often consists of a period of immobilization in a weight-bearing short leg cast or walking boot (usually for 3 weeks), coupled with physical therapy. Return to play often is prolonged following a deltoid sprain compared with a lateral sprain, and it often takes at least 4 weeks to return to full participation.

**High Ankle Sprain**

A less common but more severe injury to the ankle ligaments is what is often referred to as a high ankle sprain. This injury is caused by excessive external rotation of the ankle in relation to the foot, usually when the ankle is in dorsiflexion. Ligaments that can be affected include the anterior and/or posterior inferior tibiofibular ligament, the intersseous ligament, and syndesmosis. Standard ankle radiographs should be performed to assess for widening of the tibiofibular or medial clear space, as this indicates an unstable ankle and may require surgical management. Physical exam should include evaluation with the external rotation stress test and squeeze test and careful palpation of the entire length of the fibula, as a proximal fibula fracture may occur in association with a syndesmotic injury (Maisonneuve fracture). A rule of thumb in distinguishing the normal apophysis from a fracture is by the orientation of the lucency. The normal apophysis runs parallel to the long axis of the bone, whereas a typical avulsion fracture at the base of the fifth metatarsal has a lucency that is perpendicular to the long axis of the bone.

**OSTEOCHONDRAL DEFECTS OF THE TALUS**

Osteochondral defects of the talus can occur in either the medial or lateral aspect of the talus. Although often a result of trauma, this lesion can also occur without a history of trauma. Depending on the severity of the lesion, nonoperative or operative treatment may be appropriate. Cessation of activity and referral to an orthopedist or sports medicine specialist for further evaluation is warranted.

**AVULSION FRACTURE OF BASE OF FIFTH METATARSAL**

Avulsion fracture at the base of the fifth metatarsal is commonly seen with an inversion mechanism while the ankle is in plantar flexion (Figure 4). The forces of the peroneus brevis tendon and lateral band of the plantar fascia pulling at its attachment at the base of the fifth metatarsal have been implicated in producing this injury. A normal apophysis (a center of growth that a tendon attaches to but does not provide longitudinal growth) can exist at the base of fifth metatarsal and often is mistaken for a fracture. This apophysis can become painful, and this condition is known as Iselin’s apophysitis. A rule of thumb in distinguishing the normal apophysis from a fracture is by the orientation of the lucency. The normal apophysis runs parallel to the long axis of the bone, whereas a typical avulsion fracture at the base of the fifth metatarsal has a lucency that is perpendicular to the long axis of the bone (Figure 5). Treatment of the fifth metatarsal avulsion fracture often consists of the use of a walking boot or postoperative shoe for a period of 4-6 weeks. Return to sports typically occurs after the radiographs demonstrate evidence of healing, the bone is nontender, and the athlete has regained normal pain-free range of motion and function.

**PREVENTION**

Complete prevention of ankle injuries in sports is likely not possible. Proprioceptive training programs have been found to be an effective means of reduc-
ing the likelihood of a repeat ankle sprain in the athletic population but have not been conclusively demonstrated to help with primary prevention of sprains.\textsuperscript{16} External bracing with a lace-up ankle brace has been demonstrated to be effective in reducing the likelihood of primary and recurrent sprains in high school basketball and football players.\textsuperscript{17,18} Bracing has also been found to be more cost effective in prevention of secondary injury in comparison with both a neuromuscular training program and a combination program of bracing and neuromuscular training.\textsuperscript{19} An unsupervised, home-based proprioceptive program has also been found to be effective in reducing recurrent ankle sprains.\textsuperscript{20}

REFERENCES