Common Acute Sports-Related Lower Extremity Injuries in Children and Adolescents

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Most acute sports-related injuries in children and adolescents involve the lower extremities. Emergency department physicians are often the first to evaluate and treat these injuries and are commonly asked for advice regarding return to sports and activities. This article will review the most common acute lower extremity injuries seen in young athletes, including contusions, muscle strains, fractures, ankle and knee sprains, and patellar dislocations. Diagnosis, initial treatment, prognosis, and time frame for return to sports will be discussed.
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KEYWORDS sports injuries, lower extremity injuries, quadriceps contusion, hamstring strain, avulsion fracture, ankle sprain, anterior cruciate ligament sprain, medial collateral ligament sprain, patellar dislocation, fifth metatarsal fracture, tibial eminence fracture

Most acute sports-related injuries in children and adolescents involve the lower extremities. Emergency department physicians are often the first to evaluate and treat these injuries and are commonly asked for advice regarding return to sports and activities. This article will review the most common acute lower extremity injuries seen in young athletes, including contusions, muscle strains, fractures, ankle and knee sprains, and patellar dislocations. Diagnosis, initial treatment, prognosis, and the time frame for return to sports will be discussed.

Contusions

Contusions result from a direct blow to the muscle or soft tissue and are most common in collision sports such as football and hockey. Most are mild injuries that resolve with ice and a short period of rest. Quadriceps contusions tend to be the most disabling. Physical examination reveals diffuse anterior thigh tenderness, often associated with swelling and ecchymosis. Pain is worse with passive knee flexion and hip extension. Injury severity is classified based on knee range of motion 12 to 24 hours after injury (mild, >90°; moderate, 45°-90°; severe, <45°) [1]. A sympathetic knee effusion is common 2 to 3 days after a moderate to severe contusion.

A contusion with a large intramuscular hematoma may be complicated by myositis ossificans, a benign proliferation of bone and cartilage that occurs in a muscle 3 to 4 weeks after trauma. Myositis ossificans can limit muscle flexibility and function and significantly prolong recovery. In a study of 117 quadriceps contusions in military cadets, myositis ossificans developed in 9% and was associated with 5 risk factors (knee motion less than 120°, injury occurring during football, previous quadriceps injury, delay in treatment greater than 3 days, and ipsilateral knee effusion) [2].

Initial treatment of a quadriceps contusion includes rest, ice, compression, elevation (RICE), and weight-bearing as tolerated. As pain subsides, gentle range of motion is encouraged. Reevaluation should occur in 7 to 10 days. For moderate and severe contusions, a 6-in compression wrap should be applied around the thigh and lower leg to hold the knee in as much flexion as tolerable for the first 24 to 48 hours to limit hematoma formation and prevent extension contracture

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[2]. Use of nonsteroidal anti-inflammatory medications (NSAIDs) is controversial. Studies demonstrate that NSAIDs can reduce inflammation in the short-term but may impair muscle repair process in the long-term, resulting in decreased muscle tensile strength and force production [3,4]. A rehabilitation program of progressive stretching and strengthening is necessary to restore muscle strength and flexibility and helps to speed recovery. Return to sports is allowed when tenderness is resolved and knee range of motion is full and pain-free. A protective thigh pad is recommended to prevent reinjury. Return to sports averages 13 days for mild contusions, 19 days for moderate contusions, and 21 days for severe contusions [2].

Muscle Strains

Muscle strains are caused by a sudden forceful change in the length of the muscle-tendon unit, resulting in a stretch or tear of the muscle fibers. They occur most commonly at the musculotendinous junction. Muscle strains are classified as mild, moderate, or severe. A mild strain is a stretch injury to the muscle, with no loss of strength or motion. A moderate strain is a partial tear of the muscle, with some loss of strength and/or motion and some degree of ecchymosis or swelling. A severe strain is a complete muscle tear with major hemorrhage and complete loss of function. The hamstrings are the most frequently strained muscle in the lower extremity and can lead to significant disability. Athletes who sprint, jump, leap, or kick are most susceptible. Injured athletes report a sudden, painful "pop" and are unable to bear weight comfortably. Physical examination reveals posterior thigh tenderness and pain with contraction or passive stretch of

the hamstrings. Initial treatment includes RICE and weight-bearing as tolerated. Heat should be avoided. Use of NSAIDs is controversial for the reasons mentioned previously. A supervised rehabilitation program of progressive stretching and strengthening exercises should be initiated as soon as pain begins to subside. Return to play ranges from 2 to 3 days for mild strains to 3 to 12 weeks for severe strains. Hamstring strains have a high rate of recurrence (12%-31%) and can lead to prolonged disability if rehabilitation is inadequate or return to play is rushed [5,6].

Ankle Sprains

Ankle sprains account for up to 28% of all sports-related injuries. Athletes between 15 and 19 years of age are most frequently affected, with basketball, soccer, football, and volleyball being the most common sports [7]. Eighty-five percent of ankle sprains are lateral, 10% are syndesmotic, and 5% are medial.

The usual mechanism for a lateral ankle sprain is excessive inversion of a plantar flexed ankle. The anterior talofibular is the weakest of the 3 lateral ligaments and is the most frequently injured, followed by the calcaneofibular ligament. The posterior talofibular ligament is least frequently injured [8]. At the time of injury, athletes usually experience a pop or "snap." Those with more severe sprains will be unable to bear weight. On physical examination, swelling and bruising are localized to the lateral ankle, and the injured ligament is tender to palpation. Stress tests such as the anterior drawer and talar tilt can be performed to confirm the diagnosis of a lateral ankle sprain and grade injury severity (Figures 1 and 2) [9]. A grade I sprain represents a stretch injury of
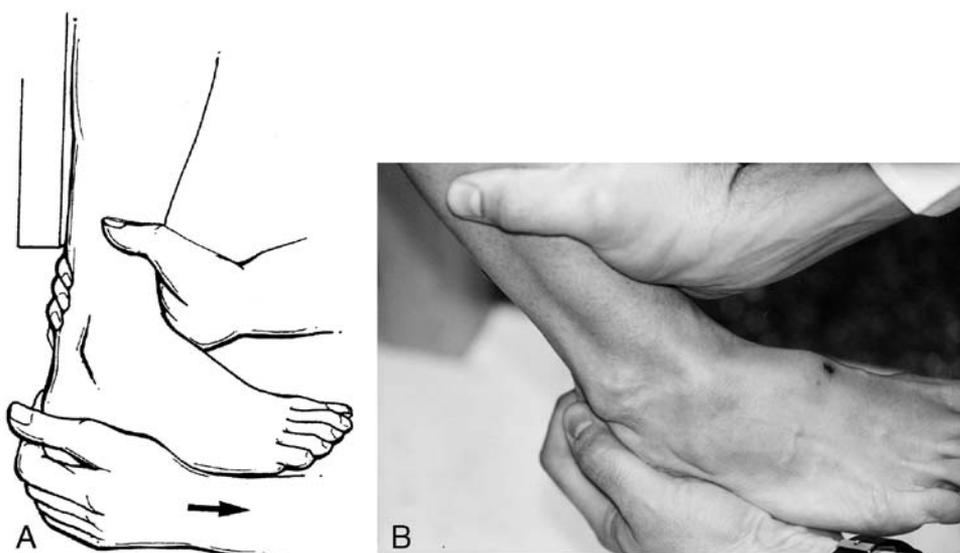
Figure 1 Anterior drawer test assesses integrity of the anterior talofibular ligament: With the ankle relaxed in 10° of plantar flexion, stabilize the distal lower leg with the nondominant hand, then use a brisk motion to pull the heel forward. Test is positive if there is more anterior displacement compared with the uninjured ankle.
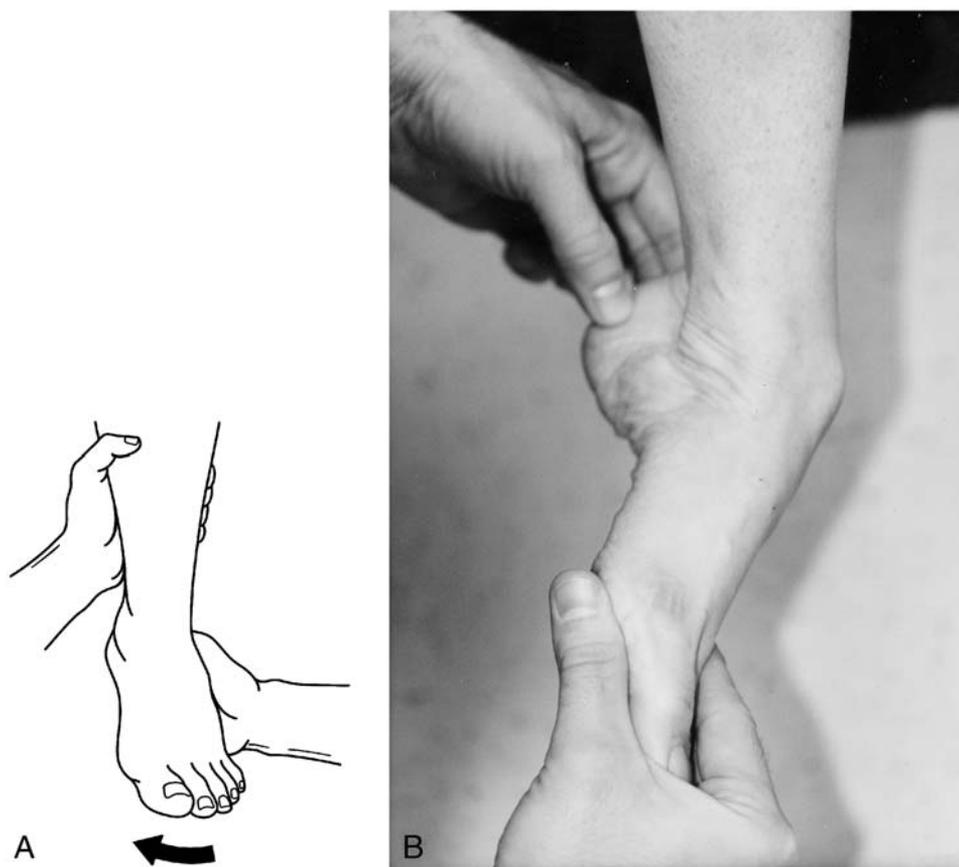
Figure 2 Talar tilt test assesses the integrity of the calcaneofibular ligament: With the ankle in neutral or slight dorsiflexion, stabilize the distal lower leg with the nondominant hand, then use a brisk motion to invert the calcaneus (and talus) on the fibula. Test is positive if there is more inversion compared to the uninjured ankle.

the ligament(s). There is minimal to no swelling, and stress tests demonstrate pain but no laxity. A grade II sprain represents a partial tear of the ligament(s). There is moderate pain and swelling, with some laxity on stress test. A grade III sprain represents a complete tear of the ligament(s). There is significant pain, swelling and bruising, an inability to ambulate, and gross laxity on stress test. Stress tests can be unreliable in the acute period after injury, with a large number of false-negatives due to pain and guarding. Their sensitivity (96%) and specificity (84%) for detection of a ligament rupture are best at 5 days after injury [10].

The Ottawa ankle rules can be used to determine the need for radiographs (anteroposterior, lateral, and mortise views) in older adolescents who are skeletally mature. Reported to be 100% sensitive for ankle fractures in adults, the Ottawa ankle rules' use the following criteria for obtaining radiographs: (1) age 55 or greater; (2) inability to bear weight immediately and for 4 steps in the emergency department; or (3) bony tenderness at the posterior edge or tip of either malleolus [11]. The Ottawa ankle rules have been evaluated in children and were found to be 83% sensitive and 50% specific for predicting ankle fractures in children [12]. Thus, it is recommended

that all skeletally immature athletes who report an inversion ankle injury have radiographs. Because the distal fibular physis is weaker than the surrounding ligaments, children are more likely to have a physeal fracture than a ligament sprain.

Initial treatment of a lateral ankle sprain includes RICE and weight-bearing as tolerated. Ice should be applied for 15 to 20 minutes every 2 to 4 hours. Heat should be avoided. An air stirrup is preferred over a compression wrap because it provides not only compression but also protection and support, which is helpful in promoting early weight-bearing. Athletes with more severe sprains may require use of crutches until weight-bearing is more comfortable. Nonsteroidal anti-inflammatory medications are recommended during the first week after injury. Animal studies demonstrate NSAIDs have no adverse effects on ligament healing and may even increase early ligament strength when given for the first 6 days after acute injury [13,14]. In clinical studies, NSAIDs have been shown reduce pain and inflammation in the first few days after an ankle sprain, which may shorten recovery time and speed return to sports by allowing rehabilitation to progress more quickly [15].

Reevaluation should occur 5 to 7 days after the injury. Studies show that prolonged immobilization weakens the mechanical and structural properties of healing ligaments, whereas early mobilization decreases adhesions and increases ligament strength [16,17]. Rehabilitation to restore range of motion, flexibility, strength, and proprioception speeds recovery and should be initiated as early as tolerated by the athlete [18]. Return to sports averages 8 days for grade I, 15 days for grade II, and 28 days for grade III lateral ankle sprains [19].

After an initial ankle sprain, the risk for reinjury is up to 5 times higher, with an estimated 20% to 40% of athletes having chronic instability [20,21]. Completing a supervised rehabilitation program that includes proprioception training and using a semirigid ankle brace or athletic tape during athletic activities have each been shown to be effective in reducing the risk for recurrent ankle sprains [22].

The syndesmosis complex consists of the anterior and posterior tibiofibular ligaments and the interosseous membrane. Syndesmosis sprains are often referred to as "high" ankle sprains because the injury is superior to the ankle joint. The usual mechanism is excessive external rotation of the ankle, usually in dorsiflexion. There is tenderness over the anterior tibiofibular ligament and interosseous membrane, pain with passive dorsiflexion and external rotation of the ankle, and a positive squeeze test (compression of the tibia and fibula together at midcalf causes pain at the ankle). Severe sprains will have widening of the ankle mortise on radiographs (>5 mm). Initial treatment is the same as for lateral ankle sprains; however, a longer period of non–weight-bearing is often necessary. Syndesmosis sprains are associated with prolonged disability, with studies showing an average of 51 days before return to sports [19,23]. Grade III syndesmosis sprains may require surgical stabilization.

The mechanism of injury for a medial ankle sprain is excessive eversion, usually from a fall, causing injury to the deltoid ligament. A reverse talar tilt test (talar tilt test using eversion instead of inversion stress) will be painful, and with severe sprains may reveal some laxity. Initial treatment is the same as for lateral ankle sprains; however, return to sports may take slightly longer.

Knee Sprains

Sprains of the anterior cruciate ligament (ACL) occur most commonly in basketball, soccer, football, and volleyball. Over 70% of ACL injuries occur without any contact with another player, typically while landing from a jump, decelerating quickly, or changing direction suddenly [24,25]. The mechanism of injury is most often a combination of excessive femoral internal rotation and valgus stress with the foot fixed. Hyperextension is also a common mechanism. Anterior cruciate ligament injuries

are rare before the age of 11, after which the incidence increases steadily with age throughout adolescence. An increased frequency of ACL injury has been noted over the past decade, which correlates with the growth in sports participation among children during the same period [26]. Overall incidence is about 1 in 100 high school-aged athletes, with girls 2 to 8 times more likely to injure their ACL than boys in similar sports [27-30]. The reasons for this sex disparity are not yet completely understood but are believed to be multifactorial and include the effect of estrogen on ACL laxity and the tendency for females to have less stable lower extremity alignment and jump-landing mechanics, smaller intercondylar notch, higher incidence of generalized ligamentous laxity, and greater strength imbalances in the lower extremities [31]. A growing body of evidence suggests that the key risk factor for females is poor neuromuscular control of knee motion during athletic tasks such as landing and cutting. Compared with males, females demonstrate reduced activation of the hamstring muscles, less knee and hip flexion, and greater knee valgus when landing from a jump or performing a cutting maneuver [32-37]. Neuromuscular training programs that teach safe landing mechanics have been shown to reduce the risk for ACL injury among female athletes by up to 88% [32,38-41].

Athletes with ACL injury typically report a twisting injury to the knee associated with a painful pop, immediate swelling, feeling of instability, and an inability to bear weight. Physical examination usually reveals a significant hemarthrosis and limited range of motion. There may not be much tenderness unless associated
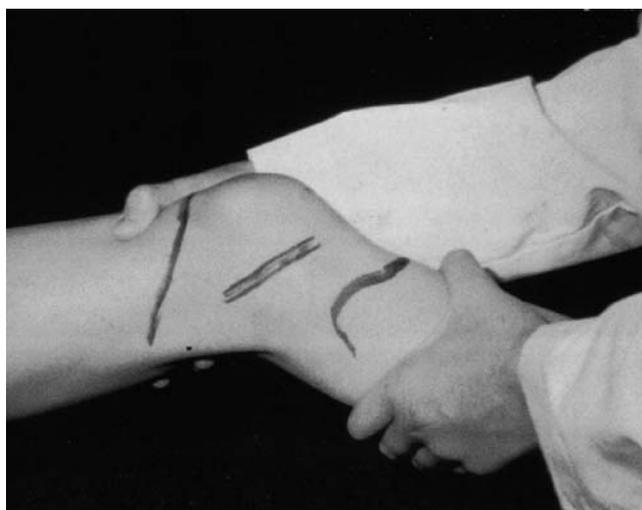
Figure 3 Lachman test for ACL sprain. With the patient supine, stabilize distal thigh with the nondominant hand. With the knee in 20° of flexion, use a brisk motion to pull the tibia anteriorly. Test is positive if there is more anterior displacement compared with the uninjured knee.

injuries are present. The Lachman test (Figure 3) [42] has been shown to be the most accurate physical examination test for evaluation of ACL injury [43]. Radiographs (anteroposterior, lateral, and tunnel views) should be performed to evaluate for fracture and are especially important for the skeletally immature athlete, in whom a tibial eminence fracture may clinically mimic an ACL sprain. Radiographs may also reveal a Segond fracture (Figure 4), which is pathognomonic for intra-articular injury.

Initial treatment for an ACL injury consists of RICE and weight-bearing as tolerated. If there is a large hemarthrosis, aspiration can improve patient comfort and facilitate early rehabilitation. NSAIDs are helpful for control of pain and swelling. Reevaluation should occur within 5 to 7 days after an ACL injury. A comprehensive rehabilitation program, starting with early weight-bearing and range of motion exercises, is initiated as soon as possible. Activities are restricted for a minimum of 4 to 6 weeks. Return to sports varies from 6 to 12 weeks for those treated nonoperatively to 6 to 8 months for those who undergo surgical reconstruction. After nonoperative treatment, a functional knee brace can subjectively improve knee stability during high-risk sports and activities [44].

Sprains of the medial collateral ligament (MCL) can occur in isolation or in conjunction with ACL injuries. The mechanism is a valgus stress and/or external rotation
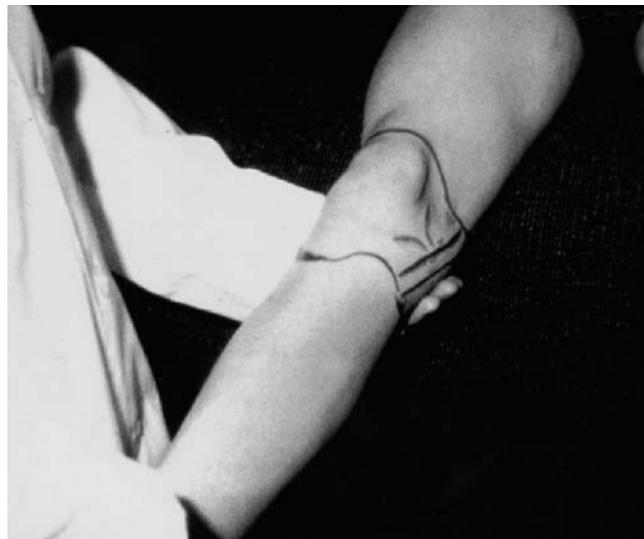
Figure 5 Valgus stress test for MCL sprain. With patient supine, knee in extension, stabilize the lower leg and apply a valgus stress (medially directed force) to the knee. Repeat at 30° of knee flexion, which isolates the MCL. Compare degree of laxity to the uninjured knee. Laxity at full knee extension suggests an MCL sprain with associated injuries, most commonly an ACL sprain.

of the tibia on a fixed foot and is often associated with contact with another player. Athletes report sharp medial knee pain, immediate swelling, a feeling of instability, and inability to bear weight. Physical examination reveals limited range of motion, with localized swelling and significant tenderness along the medial aspect of the knee. A valgus stress test (Figure 5) confirms the diagnosis and determines injury severity [42]. Injury severity is graded based upon joint pain and laxity (grade I, pain without laxity; grade II, pain with some laxity; grade III, significant laxity with or without pain). The valgus stress test should be performed first with the knee in full extension and then at 30° of flexion, which isolates the MCL. Laxity with the knee in full extension suggests a grade III injury or an associated ACL tear. Because an injury mechanism that involves valgus stress to the knee is more likely to injure the distal femoral physis than the MCL, the valgus stress test should not be performed on a skeletally immature athlete until after radiographs have ruled out a physeal fracture.

Initial treatment of an MCL sprain consists of RICE and weight-bearing as tolerated. Reevaluation should occur 3 to 5 days after the injury. If clinical improvement is demonstrated, early mobilization and progressive rehabilitation are initiated. Time to return to sports varies depending on the severity of injury: 2 to 4 weeks for grade I and II injuries and 6 to 12 weeks for grade III injuries. A functional hinged knee brace may reduce the risk for reinjury and is recommended for those
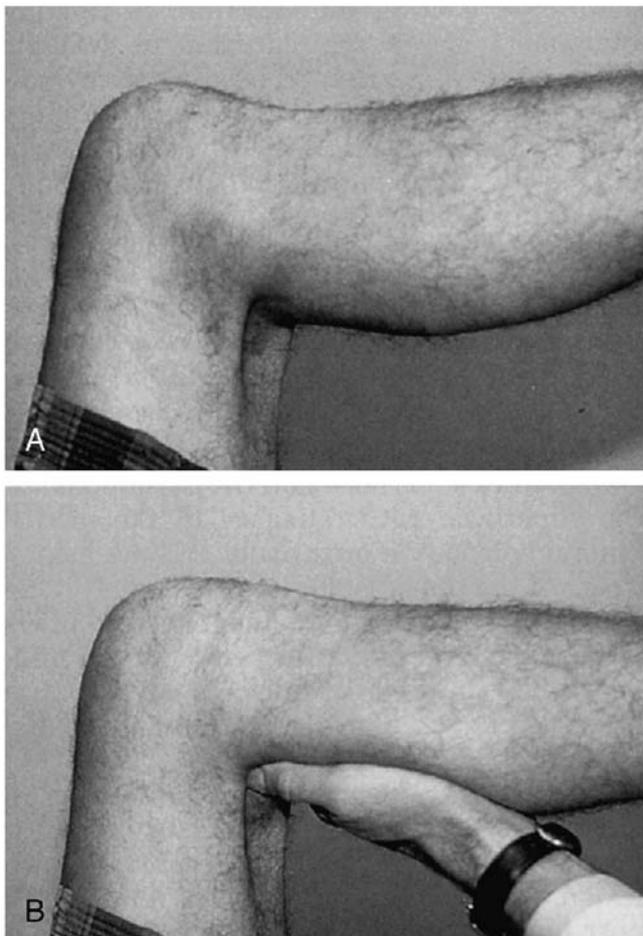

Figure 4 Segond fracture, also called a lateral capsular sign, is a small flake-like avulsion fracture from the lateral aspect of the proximal tibia. Segond fracture is pathognomonic for an intra-articular injury. Over 70% are associated with an ACL tear.

Figure 6 Posterior sag sign for posterior cruciate injury. Position hips and knees flexed to 90°. A positive sag sign is indicated in the upper photo (A), as posterior subluxation of the tibia on the femur is noted. To reduce the subluxation, apply force anteriorly (B).

with grade II and III sprains [45]. Injuries to the posterior collateral ligament (PCL) can occur alone or in conjunction with injuries to the posterolateral corner of the knee. Tears of the PCL are rarely seen in skeletally immature children, in whom avulsion fractures are more likely [42]. Posterior collateral ligament disruption mechanisms include hyperextension, posteriorly directed torsion, and (car) dashboard-type flexed knee injuries [42]. Physical examination findings include the posterior sag sign: the patient is positioned on their back with their hips and knees flexed to 90°. The profile of the knee on the affected side shows a posterior subluxation (Figure 6) [42]. Another finding is a positive posterior drawer test in 90° of knee flexion. In cases of PCL rupture, there may be no firm end point [42]. If there is concern about transient knee dislocation, vascular injury must be excluded. Mild, isolated PCL injuries may be treated with early

aggressive physiotherapy, but if radiographs reveal an avulsion fracture, operative fixation is required. Operative repair is also required for PCL tears and disruption [42].

Patellar Dislocations

Acute traumatic patellar dislocations are most common in high-level adolescent athletes between 10 and 17 years of age. The incidence is estimated at approximately 43 children per 100,000 and is similar for boys and girls [46-48]. The usual mechanism of injury is a sudden internal rotation of the femur and/or valgus stress on the knee while the foot is fixed, causing the patella to be displaced laterally. Most athletes report a popping or tearing sensation and a feeling that the patella has shifted out of place. Most (90%) patellar dislocations reduce spontaneously as the athlete extends the knee. A hemarthrosis usually develops within a few hours after injury. Physical examination reveals effusion, limited range of motion, and difficulty in bearing weight. There is tenderness around the patella, especially over the medial facet, medial retinaculum, and adductor tubercle of the medial femoral epicondyle. A patellar apprehension test, wherein the athlete expresses fear that the patella may dislocate as the examiner applies gentle laterally directed pressure, is almost always positive. Because the mechanism and presenting symptoms of acute patellar dislocation are very similar to those of an ACL tear, a Lachman test should always be performed. Radiographs (anteroposterior, lateral, oblique, and sunrise view at 20° to 30° of knee flexion) should be obtained but are not very sensitive for detecting associated injuries. Up to 72% of acute patellar dislocations result in osteochondral or chondral fracture of the patella and/or femur; however, only 32% of these injuries are seen on plain radiographs [49,50].

Patellar dislocations that do not reduce spontaneously will present to the emergency department with visible lateral displacement of the patella and prominent femoral condyles. Prompt reduction should be performed using adequate analgesia and/or sedation. With the athlete supine and the knee extended to relax the hamstrings, reduction is performed by gently applying a medial force to the lateral side of the patella. If reduction is difficult because the patella is locked on the lateral femoral condyle, a downward force should be applied first, followed by a medial force. Radiographs should be performed before and after reduction. Any loose bodies will eventually require arthroscopy for removal.

After reduction, a compression wrap is applied, and the knee is immobilized in extension using a commercial knee immobilizer. If there is a large hemarthrosis, aspiration can reduce patient discomfort and facilitate early rehabilitation. Initial treatment consists of RICE and
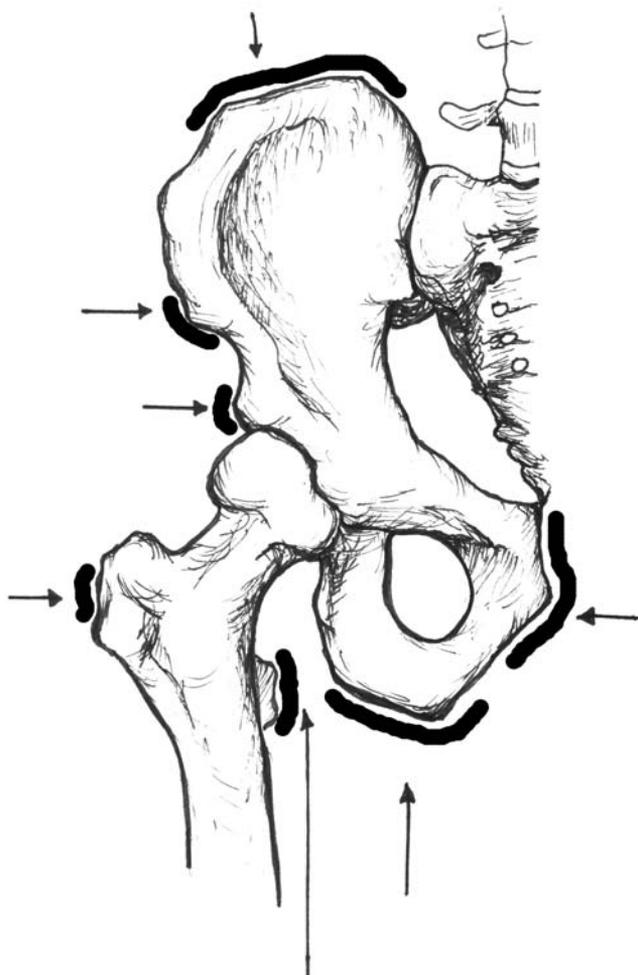
Figure 7 Apophyses of the pelvis are sites of attachment for several muscle groups.

weight-bearing as tolerated. Reevaluation should occur 3 to 5 days after the injury. If clinical improvement is demonstrated, early mobilization and progressive rehabilitation are initiated as soon as possible. Return to sports typically takes 8 to 12 weeks. Prognosis is fair. Recurrence rates range from 15% to 44% [51,52], and 30% to 50% of athletes will experience chronic patellofemoral pain [51-53]. Risk factors for recurrence include younger age and inadequate rehabilitation [48,53]. A functional patellar stabilizing brace may help to reduce symptoms of pain and instability during activity [54].

Pelvic Apophyseal Avulsion Fractures

Apophyses are secondary ossification centers that develop with growth. They are subjected to tensile forces because they serve as attachment sites for muscle-tendon units. Because an apophysis is composed of cartilage cells, it is inherently weaker than its attached

muscle-tendon unit, which is composed of much stronger connective tissue. As a result, excessive traction stress in a skeletally immature athlete is more likely to cause an apophyseal avulsion fracture than a muscle strain or tendon injury. The pelvis is the most common anatomic location for apophyseal avulsion fractures, which can occur at any of the muscle insertion sites (Figure 7) but are most frequently reported at the ischial tuberosity, anterior superior iliac spine (ASIS), and anterior inferior iliac spine (AIIS) [55]. Peak incidence is in adolescents between 14 and 18 years of age; 80% are sports-related, and 90% occur in boys [55]. Avulsion fractures frequently occur in sports that involve kicking, sprinting, or leaping, such as soccer, football, track, or gymnastics. Mechanism of injury is a sudden forceful muscle contraction that causes acute separation of the apophysis. Some avulsion fractures are caused by direct trauma. The injured athlete reports sudden onset of sharp hip pain that may be associated with a pop. Most will have difficulty continuing activity or an inability to bear weight without pain. Physical examination reveals tenderness at the affected apophysis and pain with active contraction or passive stretch of the attached muscle group. An avulsion fracture can be misdiagnosed as a muscle strain if radiographs are not performed. An anteroposterior view of the pelvis will demonstrate most avulsions (Figures 8-11). Most can be treated non-operatively. Early callous formation is apparent between 2 and 4 weeks, and clinical healing occurs in 3 to 6 weeks. Acute treatment consists of ice and use of crutches until weight-bearing is pain-free, which usually takes about 2 to 4 weeks. Heat, massage, and vigorous stretching should be avoided during this period. Reevaluation should occur 2 to 3 weeks after the injury. A rehabilitation program of progressive stretching and strengthening exercises for the affected hip muscles is initiated when weight-bearing and range of motion

Figure 8 Avulsion fracture of the left iliac crest in a 15-year-old male softball athlete which occurred while rounding third base.

Figure 9 Avulsion fracture of the left AIIS in a 12-year-old male football athlete which occurred while sprinting.

are pain-free. Return to sports varies depending on the site and severity of injury, from 6 to 8 weeks for ASIS and AIIS fractures to 3 to 4 months for ischial tuberosity fractures. Surgical fixation may be required for ischial tuberosity avulsion fractures with more than 3 cm of displacement.

Tibial Eminence Avulsion Fractures

The tibial eminence is the area of the tibia within the intercondylar notch where the ACL inserts. Tibial eminence avulsion fractures are most common in children between 8 and 14 years of age [56]. In the past, these injuries were most commonly reported after a fall from a bike. However, as a result of the growing number of children participating in organized athletics, tibial eminence fractures are now being seen with increasing frequency in other sports. The usual mechanism is hyperextension of the knee with or without valgus or rotational stress. Injured athletes report a

Figure 10 Avulsion fracture of the right ASIS in a 16-year-old male soccer athlete which occurred while kicking a soccer ball.

Figure 11 Avulsion fracture of the left ischial tuberosity in a 14-year-old female track athlete which occurred while sprinting in a race.

sudden, painful pop followed by immediate swelling and inability to bear weight comfortably. Physical examination reveals significant effusion and limited range of motion. A Lachman test is usually positive and often painful. Radiographs (anteroposterior and lateral views) will demonstrate the fracture (Figure 12). Injury severity is graded based on the amount of displacement of the avulsed fragment on the lateral radiograph (type 1, minimal (<2 mm); type II, moderate; and type III, significant displacement) [57]. Type I fractures are treated with immobilization in a long-leg cast. The knee should be in about 20° to 30° of flexion, which

Figure 12 Tibial eminence fracture in a 13-year-old boy which occurred falling from a bicycle.

lack of consensus as to what constitutes successful closed reduction. Willis et al [58] compared surgical fixation versus closed reduction and found no differences in clinical healing. Regardless of reduction method, most patients (84%) were able to return to their previous level of activity.

Tibial eminence fractures have an excellent prognosis, despite the fact that 40% will demonstrate residual ACL laxity with Lachman test even after the fracture is healed. This laxity is thought to be due to an associated partial tear or elongation of the ACL at the time of injury. Short-term studies show no correlation between residual laxity and functional instability [59].

Figure 13 Avulsion fracture of base of the fifth metatarsal in a 12-year-old male basketball athlete which occurred as a result of inverting his ankle while landing from a jump.

minimizes tension upon the ACL. Isometric quadriceps exercises are initiated while in the cast. Reevaluation should occur in 2 to 3 weeks. Length of immobilization varies from 2 to 3 weeks for older children to 6 to 8 weeks for younger children. A progressive rehabilitation program follows. Return to play is usually possible after about 6 weeks of rehabilitation.

Controversy exists with regard to the treatment of type II and III fractures. Some recommend surgical fixation for all type II and III injuries, whereas others recommend surgical fixation only if immediate closed reduction with hyperextension is unsuccessful. Unfortunately, there is a

Figure 14 Normal appearance of the fifth metatarsal apophysis.

Salter-Harris I Fractures of the Distal Fibula

In the skeletally immature athlete, the most common acute injury of the foot and ankle is a Salter-Harris I fracture of the distal fibula. Because the physes are weaker than the surrounding ligaments, excessive inversion force to the ankle of a skeletally immature athlete is more likely to result in a fracture of the distal fibular physis than a sprain of one of the lateral ligaments. Injured athletes report lateral ankle pain and difficulty bearing weight. Physical examination reveals swelling and tenderness at the distal fibular physis, which can be palpated approximately 1 to 2 fingerbreadths proximal to the tip of the lateral malleolus. Radiographs may show soft tissue swelling adjacent to the physis and/or slight widening of the physis but are frequently normal. Regardless of radiographic findings, any skeletally immature athlete with tenderness at the distal fibula after an inversion injury to the ankle should be treated for a Salter-Harris I fracture. Most of these injuries can be treated in an air-stirrup or short-leg walking cast, as long as this allows the patient to bear weight without pain. Otherwise, crutches are required until weight-bearing is pain-free. Reevaluation should occur in 2 to 3 weeks. Athletes can return to play when there is no longer any tenderness at the physis, and weight-bearing is pain-free, which typically takes about 3 to 4 weeks. Rehabilitation is rarely necessary, and prognosis is excellent. Growth arrest of the fibula after a Salter-Harris I fracture is rare, and when it does occur, is typically inconsequential.

Fractures of the Fifth Metatarsal

The fifth metatarsal is commonly injured in young athletes. The same mechanism that causes an ankle sprain—excessive inversion on a plantar flexed ankle—can result in a fracture at the base of the fifth metatarsal. The 2 most common types of fifth metatarsal fractures in children and adolescents are tuberosity fractures and apophyseal avulsion fractures. Injured athletes report a sudden painful pop or snap on the outside of the foot and difficulty bearing weight. Physical examination reveals tenderness, swelling, and bruising along the lateral aspect of the foot. A tuberosity fracture is seen on radiographs (anteroposterior, lateral, and oblique views of the foot) as a transverse fracture through the tuberosity-oriented perpendicular to the long axis of the metatarsal (Figure 13). This fracture should not be confused with the normal apophysis (Figure 14), which is a fleck of bone parallel to the long axis of the fifth metatarsal. It is visible in girls 9 to 11 years of age and in boys 11 to 14 years of age [60]. The normal apophysis can be distinguished from an acute fracture by its lack of tenderness and its longitudinal orientation on radiographs. If there has been an apophyseal avulsion fracture, there will be tenderness at the fracture site and radiographs will demonstrate widening or separation of the apophysis from the base of the metatarsal. Comparison views of the opposite foot can confirm this diagnosis. Tenderness at the apophysis without a history of acute trauma suggests Iselin disease, an overuse traction apophysitis of the fifth metatarsal tuberosity. Iselin disease is a self-limiting condition in athletically active children. Treatment includes ice and activity modification [61].

Treatment of fractures of the base of the fifth metatarsal includes ice, elevation, immobilization in a short-leg walking cast, cast shoe, or walking boot with weight-bearing as tolerated. Reevaluation should occur in 2 to 3 weeks. Rehabilitation is rarely necessary. Return to sports is possible when there is no tenderness at the fracture site and weight-bearing is pain-free, which usually occurs at 3 to 4 weeks. Tuberosity fractures with more than 2 mm of displacement may require surgical fixation for optimal healing [62].

Nonsteroidal Anti-Inflammatory Medications and Fractures

Opinions differ with respect to the use of NSAIDs in the management of fractures. Some animal studies have shown that NSAIDs can delay and/or compromise fracture healing. This association has not been proved or disproved in human subjects. So although there are theoretical concerns about the adverse effects of NSAIDs on fracture healing, many experts feel there is not enough clinical evidence to warrant restricting their use for pain management in patients with simple fractures [63-65].

Summary

Emergency department physicians are often the first to evaluate and treat children and adolescents with sports-related injuries in the lower extremities. Knowledge of common injury mechanisms and comfort with musculoskeletal physical examination techniques is necessary for accurate diagnosis. Awareness of the current treatment principles and prognosis for recovery allows the emergency department physician to provide proper advice for safe and expeditious return to sports.

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