NCC Pediatrics Continuity Clinic Curriculum: **Knee & Ankle Pain**

Goals & Objectives: *To perform a proper assessment of a child with knee and ankle injuries and guide appropriate management.*

- Describe common knee and ankle injuries in orthopedic terms.
- List appropriate initial steps in the evaluation of a child with knee and ankle pain.
- Describe circumstances in which pediatric orthopedic consultation is indicated.

Pre-Meeting Preparation:

Please read the following enclosures:

- "Knee and Ankle Injuries in Children *(Peds in Review 1992)*
- Ottawa Knee & Ankle Rules *(Excerpt from JAMA 1994, 1996)*
- Osgood-Schlatter Disease *(Excerpt from Nelson's Textbook of Pediatrics)*
- Patellofemoral Syndrome *(Excerpt from PIR 2009---see below)*

Conference Agenda:

- Complete Knee & Ankle Pain Cases
- **Hands-on Exercise: Pair up & perform a detailed knee & ankle exam on your partner** (or one of your preceptors).
  ⇨ ***Need help?*** "See one-Do one-Teach one," using the ***video links*** below.

Post-Conference: *Board Review Q&A*

Extra-Credit:

- **Knee Exam Video (from the Hospital for Special Surgery)**—*can access from home*
- **Knee & Ankle Exam Videos (from Hutch)**—*can access from work*
  - *Pediatrics Folder → Services →Adolescent →Cybersyllabus →acute sports*
- **Essentials of Musculoskeletal Care 4th edition** – *excerpt of Special Exam tests*
- "Injuries and Chronic Conditions of the Knee in Young Athletes" *(Peds In Review 2009)*
- "Acute Limb Pain" *(Peds in Review 2006)*

Knee and Ankle Injuries in Children

Dennis P. Grogan, MD* and John A. Ogden, MD†

FOCUS QUESTIONS

1. Why is the response to musculoskeletal trauma different in the skeletally immature child than in the adult?
2. Why is it difficult to judge the size of a fracture fragment in the knee of a child by radiography?
3. What is the patellofemoral pain syndrome?
4. What is the purpose of functional knee bracing?
5. How is the diagnosis of patellar instability made?
6. What is the cause of osteochondritis dissecans?

The response of the skeletally immature child to musculoskeletal trauma is often quite different from the adult response to the same pattern of injury. The open growth plate is the primary factor accounting for this difference. The energy-absorbing capability of the growth plate is lower than that of bone, ligament, or tendon, which explains why the open growth plate is the preferential site for failure when a joint is injured. Because the growth plate will fail before these other structures, a true "sprain" of a child's knee or ankle ligaments will be infrequent compared with the common nature of these injuries in adults.

Injuries About the Knee

Beware of the child with knee pain, and always consider the possibility of referred pain from the hip consequent to hip disorders of childhood or adolescence. Always fully examine the hip of a child who is complaining of knee pain. Also, examine the back to be certain the knee pain is not the result of pathology in the spine.

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ANATOMY

The knee is a hinge joint that primarily permits flexion and extension. Small amounts of rotation are allowed but are carefully controlled by the ligamentous structures. Children usually exhibit greater ligamentous laxity than do adults. If laxity seems excessive in one knee, the opposite knee should be examined for comparison (ie, the "control" knee).

The femur and tibia articulate through the medial and lateral femorotibial articulations (Fig 1). The patellofemoral articulation lies between the anterior surface of the distal femur and the articular surface of the patella. Important ligamentous structures include the medial and lateral collateral ligaments and the anterior and posterior cruciate ligaments. The medial and lateral menisci, the joint capsule, and several large tendons (including those of the quadriceps and the hamstrings) act as important secondary stabilizing structures in maintaining the integrity of the knee joint. The growth plates of the distal femur and the proximal tibia and fibula are in close proximity to all of these structures.

The patella is a large sesamoid bone that, with the exception of the articular surface, resides within the tendinous expansion of the quadriceps muscle. Initially the patella is completely cartilaginous and, thus, radiolucent. It is not visible on radiographs until ossification begins at approximately 5 to 6 years of age, although small bony foci may be evident as early as 2 to 3 years of age.

RADIOGRAPHIC VIEWS

The complexity of the knee and the variety of injuries to which it may be subjected require a complete radiographic examination before skeletal injury can be ruled out completely. The standard anterior-posterior and lateral views often must be supplemented by a "notch" view (which shows the notch of the distal femur on end and is helpful in visualizing osteochondritis dissecans of the femoral condyles) or the "sunrise" view (to see the patella and its relationship with the distal femur better). Oblique radiographs or stress views may be necessary following certain forms of trauma, and a comparison view of the opposite normal knee may be quite helpful if there is any question regarding what is "normal." Because a significant percentage of the child's knee consists of radiolucent epiphyseal or articular cartilage, care must be taken in interpreting radiographic findings, particularly the size of fracture fragments, which may appear to be only a small bony fragment but are associated with a much larger cartilaginous portion.

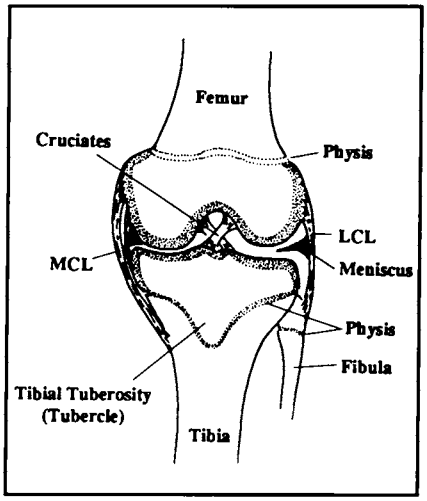


FIGURE 1. Anatomy of the knee joint. Bony and ligamentous structures are detailed. MCL = medial collateral ligament. LCL = lateral collateral ligament.

THE PATELLA

Patellofemoral Pain Syndrome

Normal functioning of the patellofemoral joint depends on the interaction and condition of at least four elements: normal alignment, stability, healthy articular cartilage, and strong muscles. The most common complaint referable to this area is pain. Most often the complaint is of nonspecific knee pain, but the areas medial to or behind the patella also

are mentioned frequently by patients. This condition, common in teenage girls, previously has been referred to as chondromalacia of the patella. Because most of these adolescents lack the true pathology of chondromalacia (with histologic changes or damage within the articular cartilage), this term is better replaced by patellofemoral pain syndrome, which more accurately describes the parapatellar or anterior knee symptoms frequently seen in this group. In many cases this is the result of malalignment problems and abnormal patellar tracking. When adolescents are active in sports, these slight biomechanical deviations from the norm may become magnified and symptomatic. The adolescent athlete is subject to many of the same overuse syndromes that the adult may experience.

Treatment for the majority of patients who have patellofemoral pain syndrome is symptomatic. Muscle strengthening exercises, especially for the quadriceps and the hamstrings, is a major emphasis of any rehabilitation program. If the pain is sport- or activity-related, then modifications in the activity can be considered (such as decreasing time spent in training) as well as pre- and postactivity icing and the use of nonsteroidal anti-inflammatory medications and orthotic support. Knee bracing may be either parapatellar or infrapatellar. Orthotic devices inserted into running shoes also may be successful. Although functional knee braces may provide symptomatic relief, there is no evidence that they can alter the biomechanics of the knee or decrease the incidence of sports-related knee injuries.

Patellar Subluxation and Dislocation

Patients who have symptoms of patellar instability are considered separately from those who have the more common patellofemoral pain syndrome. Stability of the patella on the femur is provided by a combination of bone and ligamentous restraints. A diagnosis of instability depends on the demonstration of an abnormal displacement of the patella on the femur, not on nonspecific and subjective criteria, such as swelling, "giving way," difficulty climbing stairs, positive "theater sign" (the inability to sit comfortably for a few hours with the knee flexed), or apprehension with stress. These should be taken as suggestive only and not pathognomonic of patellar instability. Sunrise radiographic views of the patella may help document a suspected lack of congruence of the patellofemoral joint.

Acute patellar dislocation is treated with immediate reduction and immobilization, with the knee extended, for 3 to 6 weeks. Radiographic evaluation must include inspection for osteochondral fracture fragments, particularly from the medial margin of the patella. Following the immobilization period, and for those patients who have subluxation or recurrent dislocation, management should focus on nonsurgical rehabilitation and strengthening before surgical intervention is considered. Results of surgical treatment are not uniformly successful, particularly in patients who are anatomically predisposed to dislocation because of generalized ligamentous laxity, increased Q angle, or flattened lateral femoral condyle. The Q angle is defined as the angle formed at the center of the patella by the line of pull of the quadriceps tendon and that of the patellar tendon. Normally this measures 15 degrees or less; a larger angle is considered abnormal and indicates an increased tendency for lateral subluxation of the patella. Children who have Down syndrome or neuromuscular disorders also are prone to patellar instability, and management of these individuals is complicated.

Fractures of the Patella

Patellar fractures may result from a direct blow to the patella or through avulsion forces applied proximally or distally or, less commonly, from the medial or lateral edges. Displaced, transverse fractures require open reduction and internal fixation, just as for an adult. The more common avulsion or "sleeve" fracture will appear radiographically to include only a small, often insignificant appearing fragment of bone (Fig 2). However, an extensive sleeve of radiolucent cartilage also is pulled from the patella, making this a significant injury despite its seemingly benign radiographic appearance. For this

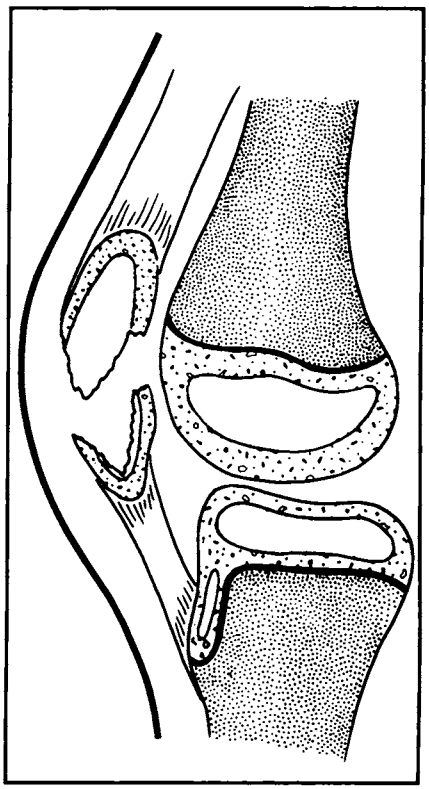


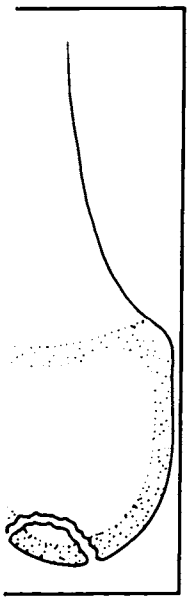
FIGURE 2. Lateral schematic view of sleeve fracture of inferior pole of patella. Stippled cartilage would appear radiolucent on a radiograph, causing the large inferior fragment to appear smaller.

reason, there is often a delay in the diagnosis of these fractures or they are undertreated based on their radiographic presentation. Most can be treated with a long leg cast with the knee extended for 4 to 6 weeks, but those with displacement should be reapproximated surgically, with repair of any associated quadriceps mechanism tear.

Radiographs of patients who have cerebral palsy often will appear to demonstrate an acute fracture of the patella, even though the patient is asymptomatic. This is the result of chronic stress (avulsion forces) from the spastic quadriceps and will require no specific treatment because the continuity of the articular cartilage is maintained, again despite the appearance of the radiographs.

OSTEOCHONDRITIS DISSECANS

Osteochondritis dissecans is caused by a combination of trauma and ischemic disease of bone and is seen more commonly in rapidly growing



r schematic view of distal femur showing typical appearance of osteochondritis dissecans. Treatment will depend on size of lesion and whether fragment becomes displaced from its bed.

children (Fig 3). An area of subchondral bone and the contiguous trabecular bone dies (for unknown reasons), yet the attached articular cartilage remains healthy because of its synovial nutrition. Most often this fragment undergoes resorption and gradual replacement with healthy bone. If the traumatic injury causes the cartilage to be disrupted, however, the fragment may become displaced from its bed and become a loose body within the knee joint.

Affected children usually complain of knee pain and swelling. Those who have a displaced fragment have the classic complaints of an internal derangement of the knee, with swelling, popping, locking, catching, a feeling of instability, "giving way," or other similar problems. Treatment of the nondisplaced lesions is nonoperative, with activity modification and immobilization for a period of time sufficient to allow the lesion to heal. Displaced fragments are treated best by arthroscopy or arthrotomy and by excision of the fragment if the nonweight-bearing surface is involved, or by replacement and the fixing of the fragment into its bed when the weight-bearing area of the joint is involved.

The most common area for osteochondritis dissecans of the knee is the lateral portion of the medial femoral condyle. The notch view is the best radiographic view when this lesion is suspected.

FRACTURES OF THE DISTAL FEMUR

Although fractures of the femoral shaft are the most common type of fracture involving the femur, fractures of the distal femoral growth plate also are relatively common, especially in the adolescent (Fig 4). The fracture pattern (or type of growth mechanism injury) will determine the most appropriate treatment.

Type 1 physeal fractures are seen as infrequent obstetric injuries to the newborn. A strong backward force on the extended knee may rupture the anterior periosteum and cause posterior displacement of the epiphysis. The infant usually is irritable, particularly when this extremity is manipulated, and may exhibit pseudoparalysis (not voluntarily moving the involved lower extremity). The diagnosis may be difficult unless the radiograph is carefully examined. This injury can and has been mistaken for septic arthritis, osteomyelitis, or dislocation. Treatment is relatively simple, involving immobilization in a plaster splint or cast for 2 to 3 weeks. Significant displacement should be reduced gently prior to immobilization. These injuries heal rapidly. As with any injury involving the growth plate, long-term follow-up is necessary to evaluate the continued functional integrity of the physis.

Type 2 fractures traverse the growth plate and extend into the metaphysis. This is the most common pattern of distal femoral fractures. They require reduction (usually closed) and cast immobilization.

Type 3 and type 4 fractures are more problematic because the frac-

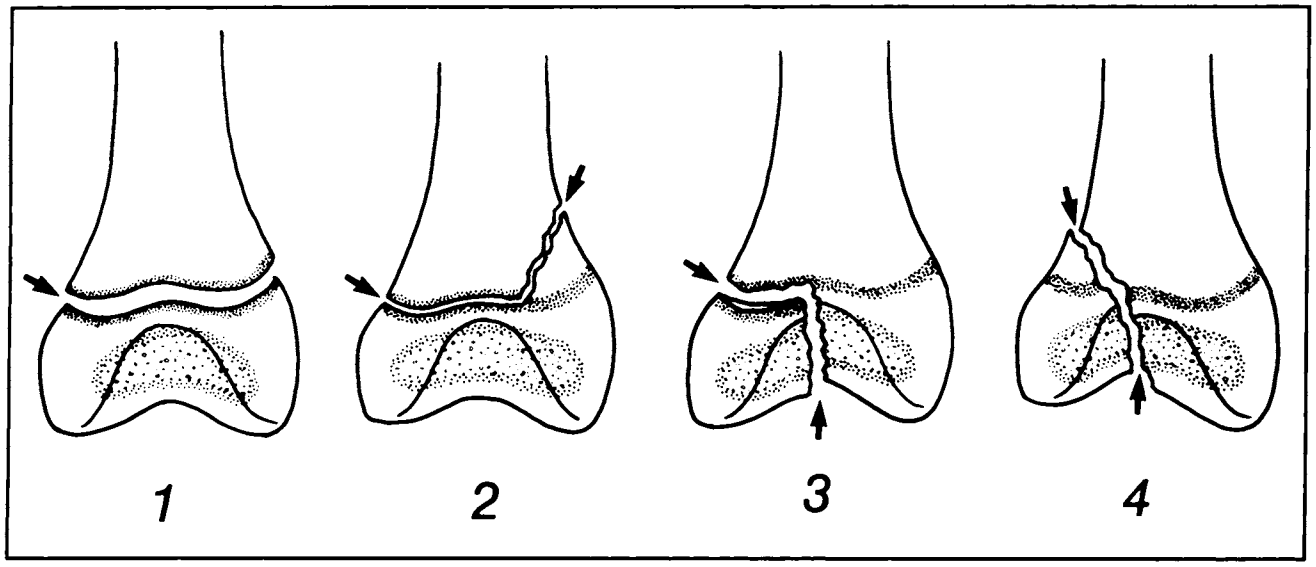


FIGURE 4. Growth plate fractures involving distal femur. Type 1 injuries involve fracture through growth plate. Type 2 fractures traverse growth plate and extend into metaphysis. Type 3 fractures extend from growth plate through articular surface of joint. Type 4 fractures extend from metaphysis, across growth plate, and through articular surface of joint. These patterns of injury apply to any fracture involving growth plate of any growing bone.

ture crosses into the epiphysis and also disrupts the articular surface. Anatomic realignment of both the growth plate and the articular surface is mandatory to minimize possible future sequelae. Growth plate dysfunction is highly likely following any of these patterns, with growth slowdown or formation of an osseous bridge. The formation of an osseous bridge across the growth plate can have serious consequences in a young child with many years of anticipated future growth, particularly considering that the distal femoral growth plate is responsible for 40% of the growth of the entire lower extremity.

FRACTURES OF THE PROXIMAL TIBIA

Epiphyseal fractures of the proximal tibia are much less common than are similar fractures of the distal femur due to a combination of anatomic and biomechanical factors.

TIBIAL SPINE AVULSION FRACTURES

Avulsion of the anterior tibial spine usually occurs in children involved in bicycle and athletic injuries. The anterior cruciate ligament attaches to the base of the anterior spine and,

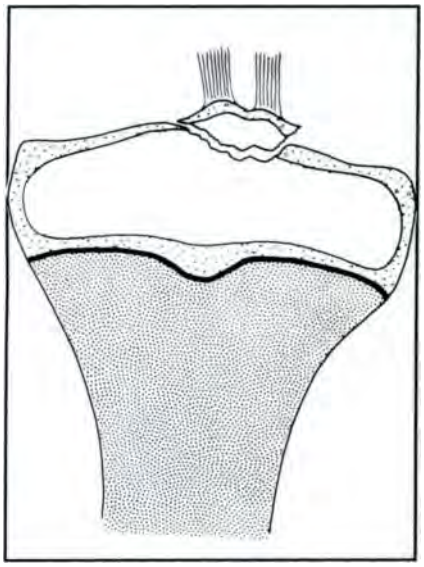


FIGURE 5. Anteroposterior view of proximal tibia, demonstrating avulsion fracture of tibial spine. Attached anterior cruciate ligament (top of drawing) is responsible for avulsing this chondro-osseous fragment from its bed in the proximal tibia. Treatment is determined by amount of displacement of fragment.

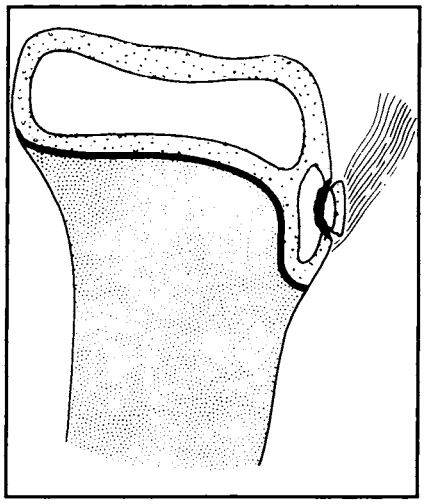


FIGURE 6. Lateral view of proximal tibia, showing Osgood-Schlatter lesion. Patellar tendon can be seen attached to this area of proximal tibia. Small fragments of chondro-osseous ossification center are avulsed from the tuberosity.

when stressed by a force that would probably lead to an isolated tear of the anterior cruciate ligament in an adult, causes the weaker cancellous bone at the base of its attachment to avulse in children (Fig 5). The ligament and its dense chondral attachments are stronger than the incompletely ossified tibial spine.

The radiographic appearance of this injury can be deceiving because of the incomplete ossification in this area. Most often, the ossified portion appears small. What must be appreciated is that there is a much larger piece of nonossified cartilage that also is avulsed and lifted from its cancellous bed. When this fragment displaces, it usually flips up and over a portion of the meniscus.

Minimally displaced injuries can be treated nonoperatively with cast immobilization. Displaced injuries are best treated with open reduction and fixation of the fragment.

KNEE LIGAMENTS

Fractures of the distal femur and the proximal tibia, including tibial spine avulsion fractures, can have associated ligamentous injuries. Although the growth plate absorbs most of the energy, a growth plate fracture does not preclude a concomitant injury to the ligamentous structures. This is particularly valid in the case of high-energy trauma. The anterior cruciate and the medial collateral ligaments are the most commonly injured. These ligamentous injuries should be sought at the time of the initial examination; most can be treated by the same immobilization being done for the fracture. Although evidence of ligamentous laxity can be found in up to 50% of some fracture patterns, it usually is discernible only by specific testing and is not clinically significant.

OSGOOD-SCHLATTER LESION

The lesion of the proximal tibia originally described by Osgood and Schlatter can be defined as an incomplete separation of fragments of the cartilaginous or chondro-osseous tuberosity of the tibia, along with a variable degree of patellar tendon disruption (Fig 6). Chronic, repetitive trauma to this area of the maturing proximal tibial growth plate is the most widely accepted cause of injury. Small portions of the ossification center of the tuberosity are avulsed away from the tuberosity. The cartilage or bone in these microscopic fragments may continue to grow and enlarge after having been avulsed and may develop into clinically significant ossicles visible on radiographs. Because of the chronic tensile stresses across this area, the intervening area may become fibrous and create a localized nonunion.

The typical patient is an active 12- to 14-year-old boy who has a painful knee and a tender prominence over the tibial tuberosity (just below the knee joint line, at the insertion of the patellar tendon). Active girls also are at risk for this growth-related problem. This lesion represents a healing fracture and should be treated accordingly. Modification of activities to the point of decreasing symptoms is a basic recommendation. All organized sports activities may need to be restricted for a period of time. Immobilization is required for those with persistent symptoms, but it does encourage further muscle weakening. The Osgood-Schlatter lesion is a self-limited condition; the majority of patients recover with nonoperative management. The patient and family should be forewarned that the prominence about the tibial tuberosity may persist into adulthood, even though the symptoms will resolve.

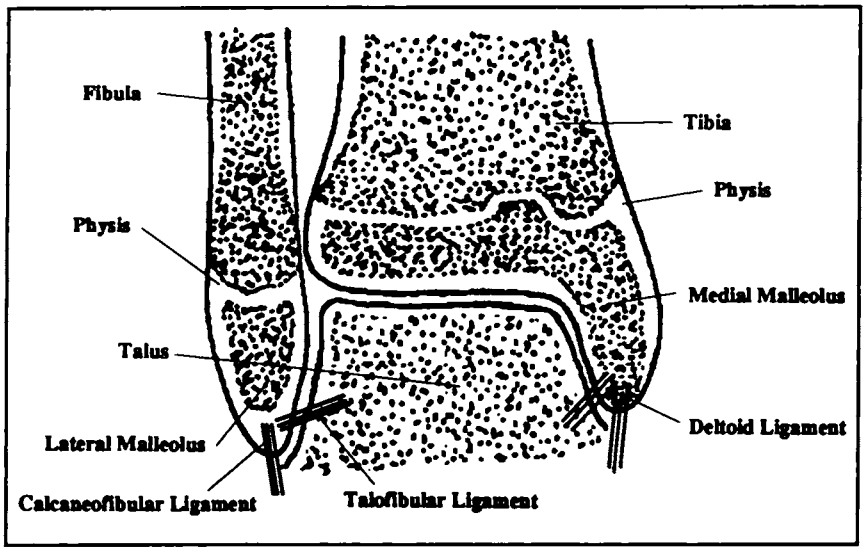


FIGURE 7. Anatomy of the ankle joint. Bony and ligamentous structures are detailed.

Injuries About the Ankle

ANATOMY

The ankle joint is also a hinge joint, allowing mainly dorsiflexion and plantar flexion. It is comprised of the distal tibia and fibula and the talus (Fig 7). The interrelationship between these three articular surfaces is called the ankle mortise because of the box-like shape formed by the distal tibia and fibula, into which the talus fits. The ankle joint relies on the strength and integrity of many ligaments, including the deltoid ligament medially and the anterior and posterior talofibular and calcaneofibular ligaments laterally. Although these ligaments are less well known than their counterparts about the knee, they are nonetheless important to the well-being of the ankle joint and are susceptible to similar injuries.

RADIOGRAPHIC VIEWS

The anterior-posterior and lateral views are considered the standard radiographic projections for evaluation of the ankle; however, they often must be supplemented by additional views, as is the case with the knee. A mortise view is a radiograph taken from the anterior-posterior view, with the ankle in about 20 degrees of internal rotation. This best demonstrates the interrelationship between the three bones making up the ankle joint, particularly following trauma, by correcting for the normal overlapping of the distal tibia and fibula seen from the anterior-posterior perspective (which is taken with the ankle in neutral). Oblique and stress views, as well as comparison views of the normal ankle, may be helpful when an injury is suspected but not well visualized from the routine anterior-posterior, lateral, and mortise views.

FRACTURES

During skeletal development, the physis (growth plate) is more likely to fail than the ligaments. For this reason, when a child sustains an inversion injury to his or her ankle that would cause a lateral ankle sprain in an adult, the point of failure is most often the physis of the distal fibula. The child experiences lateral ankle pain, but it is localized to the distal fibula and not to the anterior talofibular ligament, which is the site of injury in an adult's sprained ankle. Radiographs are not usually impressive because displacement at the fracture site is rare. Treatment consists of immobilization in a short leg cast for 3 to 4 weeks.

In the skeletally mature adolescent, an ankle sprain is seen more commonly, especially during sports activities. The mechanism of injury is usually one of inversion of the foot and ankle, stretching or tearing the ligamentous support of the lateral ankle. The diagnosis is supported by normal radiographs (other than soft-tissue swelling) and by tenderness and swelling at the site of the lateral talofibular ligament. Accompanying medial ligamentous injury may occur in the more severe patterns. The anatomic injury to the ligament is graded from I to III, depending on the degree of disruption of the fibers of the ligament.

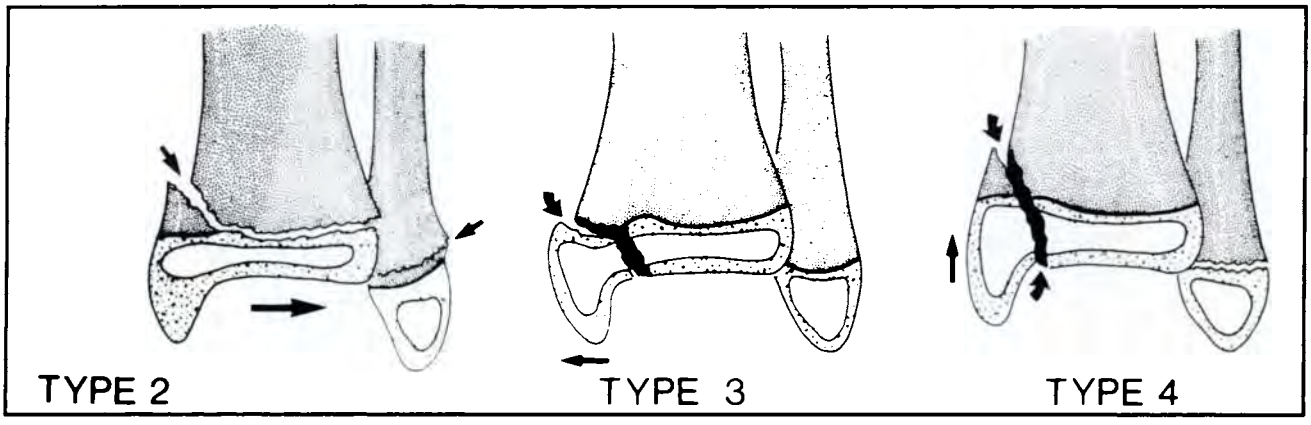


FIGURE 8. Schematic drawing of the more common injuries of the distal tibial and fibular growth plates. Types 2, 3, and 4 correspond to anatomic disruption noted in Fig 4 for distal femur. A type 1 fracture of the distal fibula is seen accompanying examples of both types 2 and 4.

Initial treatment includes rest, ice, compression, and elevation (easily remembered by the acronym RICE). Range-of-motion exercises should begin as soon as the symptoms allow. Specific muscle-strengthening exercises begin when the acute inflammation resolves. Rehabilitation of these injuries may prevent them from becoming a source of recurrent problems.

Fractures involving the distal tibial physis are common, constituting about 10% of all physeal injuries (Fig 8). They occur more frequently in boys, typically between the ages of 11 and 15 years. The pattern of fracture depends on the exact mechanism of injury (ie, the position of the foot at the time of the accident and the direction of the forces applied to the ankle). The most common pattern is the type 2 physeal injury, in which the fracture goes across the physis and out through the metaphysis (Fig 8). The fibula is most often fractured at the same time, usually through the metaphysis. Types 3 and 4 physeal injuries usually occur through the medial malleolus and enter the articular surface of the ankle, making them more severe.

Type 2 injuries require reduction of the growth plate displacement and cast immobilization. Type 3 and 4 injuries require the additional anatomic reduction of the disruption of the joint surface via operative reduction and internal fixation. Smooth pins are used to fix these and other fractures involving the growth plate. This form of operative treatment of type 3 and 4 injuries has been shown to yield significantly improved results compared with treatment by cast immobilization alone.

Complications relate to the extent and exact location of the damage done to the growth plate at the time of the injury. A growth plate injury can produce shortening (with resultant limb length discrepancy) or angular deformity (with resultant malalignment of the ankle joint). The significance of the growth plate injury will depend on the number of years of the child's remaining growth. The best way to avoid or to minimize these complications is to reduce all fractures accurately and to fix internally those fractures that require it, particularly those that enter the joint surface. Operative fixation of fractures involving the growth plates around the ankle is required more often than with other children's fractures.

SUGGESTED READING

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PIR QUIZ

20. What is the *primary* factor that accounts for the difference in response to musculoskeletal trauma in a skeletally immature child as compared with an adult?
    A. The child is not as well-coordinated as the adult.
    B. The child has thinner bones than the adult.
    C. The child has an open growth plate.
    D. Children weigh less than adults.
    E. Adults generate more momentum than do children.

21. The use of knee bracing in the treatment of patellofemoral pain syndrome:
    A. Provides symptomatic relief.
    B. Alters the biomechanics of the knee.
    C. Decreases the incidence of sports-related knee injuries.
    D. Allows full return of function.
    E. All of the above.

22. On which of the following should the diagnosis of patellar instability be based?
    A. Swelling of the knee.
    B. "Giving way."
    C. Difficulty climbing stairs.
    D. Demonstration of an abnormal displacement of the patella on the femur.
    E. A positive "theater sign."

23. A type 2 fracture is one in which:
    A. The fracture crosses into the epiphysis and disrupts the articular surface.
    B. The fracture does not traverse the growth plate.
    C. Reduction is not required.
    D. The fracture traverses the growth plate and extends into the metaphysis.

24. A *true* statement concerning the Osgood-Schlatter lesion is that:
    A. It occurs most frequently in 5- to 8-y-old boys.
    B. It should be treated by modifying activities to the point of decreasing symptoms.
    C. It almost always will necessitate a long-leg cast.
    D. The prominence of the tibial tuberosity will not persist into adulthood.

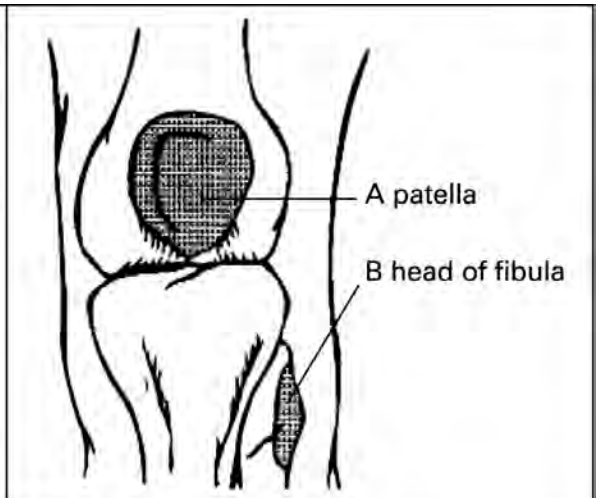
25. Which of the following is *not* an element of the usual treatment for ligamentous sprains?
    A. Rest
    B. Ice
    C. Compression
    D. Casting
    E. Elevation

Ottawa Knee & Ankle Rules

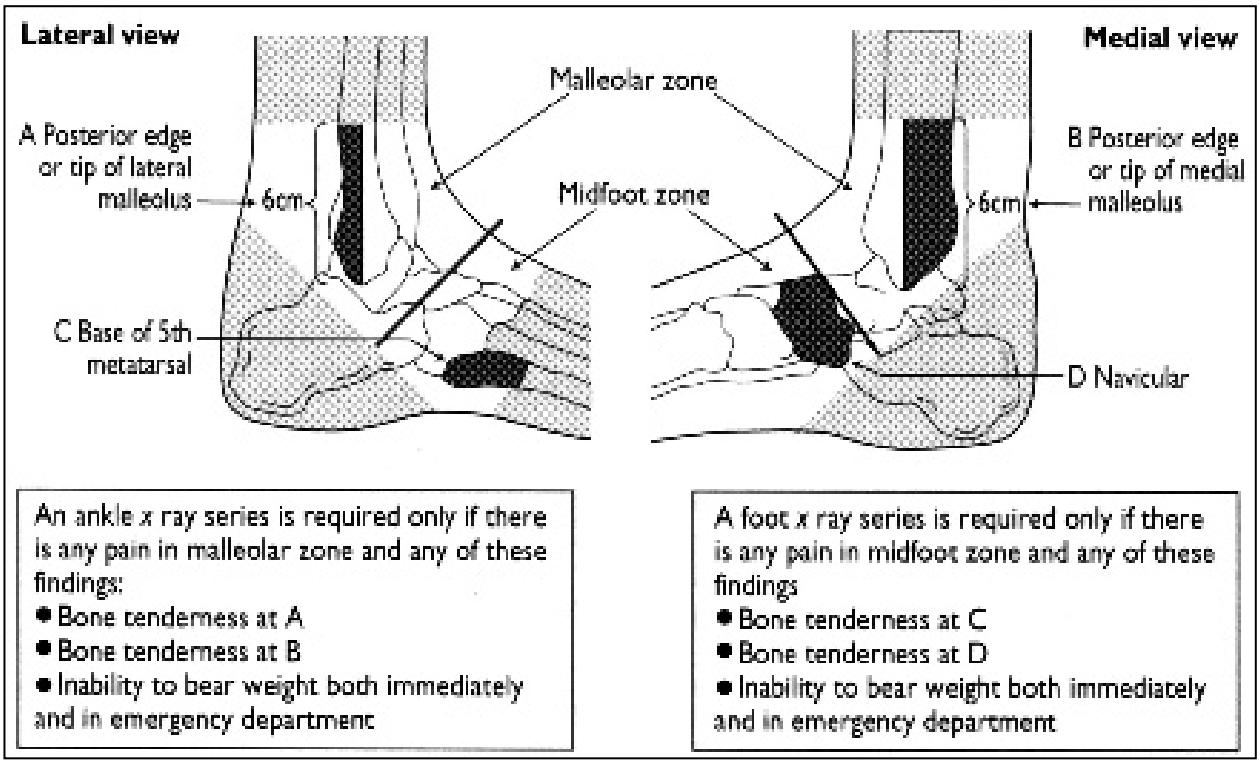
An x-ray is indicated if the patient has any of the following features:

Age > 55 years
Inability to bear weight both immediately and in the emergency department (4 steps) **
Isolated tenderness of the patella*
Tenderness at head of fibula
Inability to flex to 90°

*No bone tenderness of knee other than patella
**Unable to bear weight twice onto each limb regardless of limping[6]



* Meta-analysis suggests Knee Rules are sensitive & specific in children > 5yrs (*Emerg Med J*2009;**26**:250-253)



An ankle *x* ray series is required only if there is any pain in malleolar zone and any of these findings:
- Bone tenderness at A
- Bone tenderness at B
- Inability to bear weight both immediately and in emergency department

A foot *x* ray series is required only if there is any pain in midfoot zone and any of these findings
- Bone tenderness at C
- Bone tenderness at D
- Inability to bear weight both immediately and in emergency department

* Meta Analysis suggests Ankle Rules are sensitive in children >6 yrs (Acad Emerg Med 2009;16(4):277-287)

Osgood-Schlatter Disease

(Excerpt from Nelson's Textbook of Pediatrics—669.4)

Osgood-Schlatter manifests as **pain over the tibial tubercle** in a growing child. The patellar tendon inserts into the tibia tubercle, which is an extension of the proximal tibial epiphysis. Osgood-Schlatter disease is likely a **traction apophysitis** of the tibial tubercle growth plate and the adjacent patellar tendon.

It occurs during **late childhood or adolescence**, especially in athletes, and is likely due to repetitive tensile microtrauma. It occurs between the ages of 10 and 15 yr; the onset in girls is about 2 yr before that in boys. It is more common in boys.

This disorder is **self-limited** in most patients and resolves with skeletal maturity. Pain directly over the tibial tubercle is the usual complaint, and swelling over the tubercle is often of concern. The pain is aggravated by activities but often persists even at rest.

Physical examination reveals **point tenderness over the tibial tubercle** and the distal portion of the patellar tendon. There is often increased prominence of the tibia tubercle that is also firm. **Radiographs** are usually the only diagnostic studies necessary. Fragmentary ossification of the tibial tubercle is noted in some cases, which is often a normal variant. Some cases are associated with patella alta.

Rest, restriction of activities, and, occasionally, a knee immobilizer may be necessary, combined with an **isometric and flexibility exercise program**. Reassurance is important, because some patients and parents fear that the swollen tubercle may be a sign of malignancy.

Complete resolution of symptoms through physiologic healing (physeal closure) of the tibia tubercle can require **12-24 mo**. Removal of ossicles from the tubercle is rarely necessary in patients with persistent disabling symptoms. **Complications are rare** and include early closure of the tibial tubercle with recurvatum deformity and rarely patellar tendon rupture or avulsion of the tibial tubercle.

Case #6

A 15-year-old softball catcher presents to the athletic trainer complaining of diffuse bilateral knee pain over the past 4 months. She reports experiencing significant pain during the last 2 to 3 innings of each game. She localizes the pain to the front of her knee and says that it's "deep inside under her kneecap." She denies any symptoms of instability or any locking episodes. Of note, she reports that the pain is reproduced when she walks up and down stairs or sits with her knees bent for a long period of time. She denies any recent trauma or recent illness. On physical examination, she has painless knee range of motion bilaterally. She has moderate tenderness over both inferior patellar poles but no effusion or erythema. Prolonged hyperflexion of her knees reproduces her pain and is relieved with knee extension. Both of her lower extremities have a Q-angle of 20 degrees (Fig. 13). The rest of the physical examination findings are normal. Anteroposterior, lateral, notch, and sunrise radiograph views yield normal results. Given her activity level and reproducible anterior knee pain, you diagnose patellofemoral syndrome (PFS).

The Condition

PFS is a common cause of anterior knee pain that typically affects adolescent athletes who engage in running, jumping, and squatting sports. Females tend to have wider pelvises than do males and, therefore, have higher Q-angles that make them more susceptible to developing PFS. With deep knee flexion, several contact points between the patella and the femoral condyles experience increased pressure. A Q-angle greater than 15 degrees creates a laterally directed force on the patella and may result in maltracking of the patella during knee flexion, further increasing contact pressures. (4) During activities that require prolonged squatting, patellar maltracking can result in microtrauma to the articular cartilage. Common causes of patellar maltracking include vastus medialis obliqus weakness, lateral femoral condyle hypoplasia, lateral patellar facet hypoplasia, iliotibial band tightness, and miserable malalignment syndrome (excessive femoral anteversion combined with external tibial torsion).

Clinical Picture

Patients usually present with vague anterior knee pain with activities that require knee flexion with weightbearing, such as ascending/descending stairs and deep squatting. Crawling on hands and knees also can be troublesome. An effusion with exquisite point tenderness is usually not present, although crepitus may be present in severe cases.

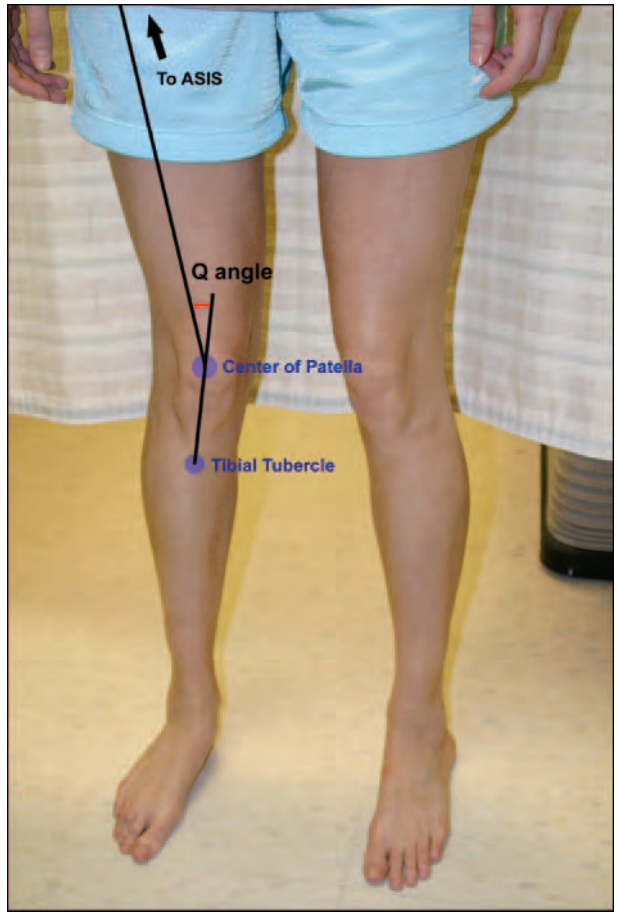


Figure 13. The Q-angle is defined as the angle between a line drawn from the anterior superior iliac spine (ASIS) to the center of the patella and a line from the center of the patella to the tibial tubercle. A Q-angle greater than 15 degrees may cause the patella to sublux laterally during quadriceps contraction.

Diagnosis

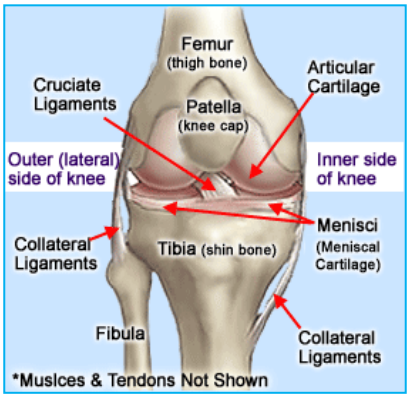
Diagnosis is based on history and physical examination. Plain radiographs generally are not helpful in making the diagnosis but may be useful in excluding other conditions such as an OCD lesion of the patella.

Treatment

Treatment focuses on pain relief and improving patellar tracking. Knee bracing, patellar taping, and antiinflammatories usually provide significant relief. Extensive physical therapy consisting of iliotibial band stretching and medial quadriceps strengthening helps to improve patellar tracking. Core strengthening to improve pelvic control and minimize medial knee deviation also may be beneficial. If 4 to 6 months of aggressive therapy and modalities fail to provide relief, patients should be referred to an orthopedic surgeon. Surgical treatment options include vastus medialis tightening, tibial tubercle realignment, and lateral retinacular release.

Knee & Ankle Pain Cases

Case 1: Philip is a 12 year-old soccer player who presents with a chief complaint of pain involving both knees. He reports a gradual onset of knee pain in the “front” of both of his knees that started about one year ago. The pain seems to be in the same spots and is worse after a hard practice or game and with running up and down hills. He noticed a "bump" on both of his knees recently that is tender if he falls or accidentally bangs them. The patient does not remember an initial history of trauma or injury. He is otherwise healthy with normal birth and development.



What other historical information would you like to know?

What is your differential diagnosis?

Examination is unremarkable with the exception of Philip’s knees. His right and left knee findings are identical. The patella is normally placed and there is no tenderness over the patella or the patellar tendon. No patellar grind is noted. A mild prominence over the tibial tuberosity is visible, with localized tenderness but no erythema or effusion. His knee range of motion is good, but he experiences pain over the tibial tuberosity when he is asked to extend his knee against force (such as against gravity, or against resistance from the examiner). Motor strength is good and neurologic exam of bilateral lower extremities is normal. Varus and valgus stress tests are negative. McMurray, anterior drawer, Lachman, and posterior drawer tests are all negative.

Demonstrate the following knee manipulations: anterior drawer, posterior drawer, Lachman, varus stress, valgus stress, and McMurray tests. What you might find if the test is “positive” and what would this indicate?

What is your diagnosis?

Would you order radiographs in this patient? Which ones?

Discuss the epidemiology of this disease. Whom does it affect more – boys or girls? What age range? What sports does it tend to be associated with?

How would you manage this patient? How would you counsel the patient and his family?

What is the prognosis for this patient?

Philip is instructed to rest and apply ice massages to the area, focus on stretching his hamstrings, and to take acetaminophen. He is permitted to ambulate normally and jog briefly, but he must stop if any pain occurs. After 5 weeks, the pain subsides and after about one year, he is symptom free. As he gets older, there remains snall, nontender prominences over both tibial tuberosities.

<u>Case 2:</u> Jessica is a 13-year-old who presents with a 1 day history of pain and tenderness over her right ankle. She states that she stepped on someone's foot at basketball practice and "landed funny". It is painful to bear weight on her ankle, but she can do so if asked. She has been applying ice to the area since incurring the injury, with some relief of the pain.

<u>Exam:</u> VS are normal.

- Her exam is unremarkable except for the right ankle, which is positive for moderate swelling and tenderness over the lateral malleolus. No ecchymosis or gross deformity is noted.
- Passive inversion and plantar flexion of the ankle produces pain. Anterior drawer test of the right anterior talofibular ligament is negative for laxity.

What is your differential diagnosis?

What is the name of the ligament she likely injured?

What is the purpose of the anterior drawer test? Demonstrate.

What is the purpose of the inversion stress test? Demonstrate.

Would you obtain X-rays on this child? Why? If so, which would you order?

You decide to order X-rays of her ankle, which do not reveal any fractures.

What is the mortise radiographic view? How does it help?

Jessica is advised to rest the affected joint for today and is instructed to elevate her ankle and wear a compression bandage around the ankle. She is also instructed on performing pain-free range of motion exercises and light activity as tolerated

Complete this statement: when a child or skeletally immature adolescent sustains an injury that would cause an ankle sprain in an adult, the most likely outcome is _____ _____ **Explain:**

Name 2 bad outcomes of improper management of an ankle fracture involving the physis:

What are indications for surgical referral in a patient with ankle pain?

Knee & Ankle Pain Board Review

1. A 15-year-old girl comes to your office complaining of knee pain. She is on the high school basketball team, and she began having knee pain after 4 weeks of preseason training. On examination, she has mild tenderness and swelling over her left anterior tibial tuberosity; the examination is otherwise normal.

Which of the following is the most appropriate management step?

A. Casting for suspected fracture.
B. Sunrise radiograph of the knee to confirm patellofemoral syndrome
C. Hip ultrasound for possible transient synovitis
D. Explanation to the patient that these are growing pains and do not require treatment
E. Temporary restriction from athletics, muscle stretching, and pain control

2. A 16-year-old girl comes to your office after sustaining an acute right knee injury 3 days ago during a soccer game. She reports that as she turned while running down field, an opposing player struck her right knee. She felt immediate pain and the sensation of knee instability. She was unable to continue playing. On physical examination, you note moderate swelling and tenderness over the medial aspect of her right knee. Valgus stress testing reveals a 5-mm opening at the joint line with associated pain. She has 4/5 strength for resisted straight leg raise. There is no evidence of anterior or posterior cruciate ligament instability. She has a mildly antalgic gait and feels as if the leg is going to give out when she turns to the right. She wants to know if she can play next weekend.

Of the following, the MOST appropriate criterion for her return to sports participation is

A. complete resolution of swelling.
B. Nearly Full strength in the knee
C. Normal findings on magnetic resonance imaging of the knee
D. Range of motion returned to 75% of normal
E. 3-mm opening at the joint line on valgus stress testing

3. You are seeing a 15-year-old soccer player who complains of intermittent knee pain. He reports frequent knee pain after practice and an episode of severe knee pain after a fall during a game 1 month ago. He recalls that his kneecap looked "out of place" at the time, but the deformity resolved after he was helped off the field. On physical examination, his knee is not swollen, red, or warm; he has no medial, lateral, or joint line tenderness; and there is no joint instability. He has a positive patellar apprehension test.

Of the following, the MOST appropriate initial treatment recommendation is

A. Corticosteroid injection
B. Knee immobilization for 6 weeks
C. Quadriceps strengthening exercises
D. Referral to an orthopedist for surgery
E. Use of a knee brace during practice

4. A 12-year-old boy presents with an itchy rash that you diagnose as scabies. As he leaves the examination room, you note that he is limping. He is overweight, and his mother states he has been playing football to get some exercise. She believes he is limping because he was injured during football practice several weeks ago and has been complaining of left knee pain. Findings on physical examination of the knee are normal, but he complains of pain with hip motion.

Of the following, the radiographic study MOST likely to yield a diagnosis is
A. anteroposterior, lateral, and sunrise radiographs of the knee
B. bilateral anteroposterior and frog leg radiographs of the hips
C. magnetic resonance imaging of the knee
D. ultrasonography of the hip
E. ultrasonography of the knee

5. A 12-year-old boy is brought to the emergency department by emergency medical services after sustaining a lower leg injury sliding into home plate during a baseball game. He tells you that the thinks his leg twisted when he slid. He reports that he had immediate pain in his right ankle and has been unable to walk since the injury occurred. Prior to transport, the paramedics splinted his right lower leg. On physical examination, he has significant swelling and ecchymosis around his distal tibia and fibula. Following the administration of analgesia, radiographs are obtained (*see radiographs on*).

Of the following, the MOST likely complication of this injury is
A. avascular necrosis of the distal tibia
B. osteochondritis desiccans
C. osteomyelitis
D. tibial growth arrest
E. unicameral bone cyst