

# Pediatrics<sup>in</sup>Review<sup>®</sup>

**Injuries and Chronic Conditions of the Knee in Young Athletes**  
Alfred Atanda, Jr, Deepak Reddy, Jaime A. Rice and Michael A. Terry  
*Pediatrics in Review* 2009;30;419  
DOI: 10.1542/pir.30-11-419

The online version of this article, along with updated information and services, is  
located on the World Wide Web at:  
<http://pedsinreview.aappublications.org/content/30/11/419>

Pediatrics in Review is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1979. Pediatrics in Review is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2009 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0191-9601.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



# Injuries and Chronic Conditions of the Knee in Young Athletes

Alfred Atanda, Jr, MD,\*  
Deepak Reddy, MD,<sup>†</sup>  
Jaime A. Rice, MD,<sup>†</sup>  
Michael A. Terry, MD<sup>†</sup>

Author Disclosure  
Drs Atanda, Reddy,  
Rice, and Terry have  
disclosed no financial  
relationships relevant  
to this article. This  
commentary does not  
contain a discussion  
of an unapproved/  
investigative use of a  
commercial product/  
device.

**Objectives** After completing this article, readers should be able to:

1. Recognize the physical findings that are consistent with internal derangement of the knee.
2. Differentiate among bony, ligamentous, and cartilaginous injuries of the knee based on physical findings.
3. Discuss the criteria for orthopedic consultation for a knee injury.
4. Know which types of knee injuries require magnetic resonance imaging for evaluation.

## Introduction

Pediatric and adolescent athletes who have sustained knee injuries often present initially to their primary care doctors. Damage to the bone, ligaments, or cartilaginous structures of the knee may occur, depending on the particular mechanism of injury. A history, physical examination, and radiographic studies can narrow the differential diagnosis. The purpose of this article is to provide a case-based review of common knee injuries and chronic knee conditions that affect pediatric and adolescent athletes. We review history and physical findings, epidemiology, appropriate imaging studies, when to refer to a specialist, and treatment options.

## Case #1

*A 13-year-old boy comes to your office complaining of left knee pain after being injured during a basketball game yesterday. He describes a sudden deceleration with his left foot planted. He had immediate pain and was unable to ambulate. On physical examination, he has moderate joint effusion, with tenderness over his tibial tubercle and an inability to extend his knee actively. His knee is otherwise stable. Neurovascular examination results are normal. Plain lateral radiographs of the knee demonstrate widening and partial detachment of the tibial tubercle (Fig. 1). You diagnose tibial tubercle avulsion fracture.*

## The Condition

Tibial tubercle fractures usually result from an indirect force on the knee, such as from sudden deceleration or contraction of the quadriceps muscle. During skeletal growth, the tibial tubercle ossification center undergoes architectural changes as the composition of the cartilage changes. The tubercle growth plate is weakened during this transition and is particularly susceptible to fracture when the patellar tendon exerts tensile forces on it.

## Classification

Classification of these injuries is based on the extent of the fracture line and its proximity to the articular surface of the knee. Type I is a simple avulsion fracture of the tuberosity. Type II injuries involve fractures at the level of the horizontal portion of the tibial physis. Type III fractures extend up into the articular surface.

## Clinical Picture

Affected patients generally are male athletes between the ages of 14 and 16 years. The knee typically is held in flexion, with tenderness directly over the fracture site. With type I

## Abbreviations

**ACL:** anterior cruciate ligament  
**MCL:** medial collateral ligament  
**MRI:** magnetic resonance imaging  
**OCD:** osteochondritis dissecans  
**OSD:** Osgood-Schlatter disease  
**PFS:** patellofemoral syndrome

\*Department of Orthopaedic Surgery, A.I. DuPont Children's Hospital, Wilmington, De.

<sup>†</sup>Section of Orthopaedic Surgery, The University of Chicago Hospitals, Chicago, Ill.



Figure 1. Lateral radiograph showing partial elevation of the tibial tubercle.

injuries, patients may have minimal swelling and still be able to extend the knee. With type II and III injuries, a large effusion often is present, and knee extension usually is not possible.

### Diagnosis

Diagnosis can be made on the basis of plain radiographs. Because the tibial tubercle is just lateral to the midline, a lateral radiograph in slight internal rotation gives the best profile of the tibial tubercle (Fig. 1). A lateral view of the contralateral knee can detect asymmetry. In type I injuries or equivocal cases, magnetic resonance imaging (MRI) also may help to detect bony edema consistent with an occult fracture. This injury should be differentiated from Osgood-Schlatter disease (OSD) because the latter tends to be associated with less severe symptoms that are more chronic and not related to an isolated traumatic event.

### Treatment

All tibial tubercle avulsion fractures should be referred to an orthopedic surgeon. In the immediate setting, the patient should be made nonweightbearing and placed into a straight-leg knee immobilizer. Type I injuries are treated nonoperatively with a long leg cast or a knee brace locked in extension. Type II and III injuries are treated with open reduction of the tibial tubercle fracture fragment.

### Lessons for the Clinician

Tibial tubercle avulsion fractures can be diagnosed easily with a lateral radiograph of the knee. Patients should be immobilized for comfort and referred to an orthopedic surgeon. The prognosis is very good, and significant complications are rare. Patients who sustain such injuries tend to be older and near skeletal maturity, so premature growth arrest and angular deformities are of little concern. If a patient develops significant leg or calf pain that is unresponsive to narcotic therapy, compartment syndrome should be considered. Although rare, it has been reported and warrants an emergent orthopedic consultation if suspected.

OSD is a common cause of chronic anterior knee pain and should be considered in a patient who presents with tibial tubercle pain. The exact cause of this condition is unknown, but excessive force exerted on the tibial tubercle by the patellar tendon is a major factor. Rapidly growing adolescents involved in jumping and squatting sports are most susceptible to OSD. Although OSD is not associated with trauma, patients often experience significant tenderness and swelling over the tibial tubercle, as would be expected with a fracture. Lateral knee radiographs show soft-tissue swelling and fragmentation of the tibial tubercle (Fig. 2). OSD is a self-limiting condition that resolves once the growth plates have closed. Nonoperative treatment consisting of rest, ice, and anti-inflammatory medication is the mainstay of treatment.

Another common disorder that can cause anterior knee pain is prepatellar bursitis. A bursa is a fluid-filled sac between a bony prominence and the overlying skin that reduces friction and skin irritation. The prepatellar bursa primarily reduces pressure exerted on the skin overlying the patella when a person is kneeling on hard surfaces. The bursa can become irritated and inflamed in young athletes who spend a lot of time on their knees, such as wrestlers and baseball catchers. The bursa also can fill with blood, which may result in significant swelling. Affected patients present with tenderness, redness, and pain with knee flexion. Swelling generally is located superficial to the patella (Fig. 3). Swelling at the medial and lateral joint lines is more consistent with an effusion or swelling in the knee joint itself. Imaging studies generally are not useful in diagnosis. Symptoms usually resolve with rest, ice, and compressive dressings. Large fluid collections may be aspirated for comfort. The aspirate should be sent for crystal analysis and Gram stain to rule out infection or gout. Patients who have septic bursitis or those who fail conservative management should be referred to an orthopedic surgeon.



Figure 2. Lateral radiograph of the knee shows soft-tissue swelling and fragmentation of the tibial tubercle.

### Case #2

A 16-year-old girl presents to the clinic complaining of right knee pain after an injury during a soccer game 1 month ago. She does not recall exactly what happened, but she is sure that she did not come into contact with another player. She remembers that her right leg was planted on the ground and that her knee made a “twisting motion.” She had immediate onset of pain with significant swelling, but she still could ambulate. Over the next 2 weeks, the pain and swelling gradually subsided, but she states that her knee has “given out” several times when she has tried to play soccer again. On physical examination, she has full range of motion of the knee without an appreciable effusion. She is able to perform a straight leg raise and has 5/5 quadriceps and hamstring strength. She has a positive Lachman maneuver (Fig. 4). The remainder of the knee examination findings are within normal limits. Plain radiographs are unremarkable. You suspect an anterior cruciate ligament

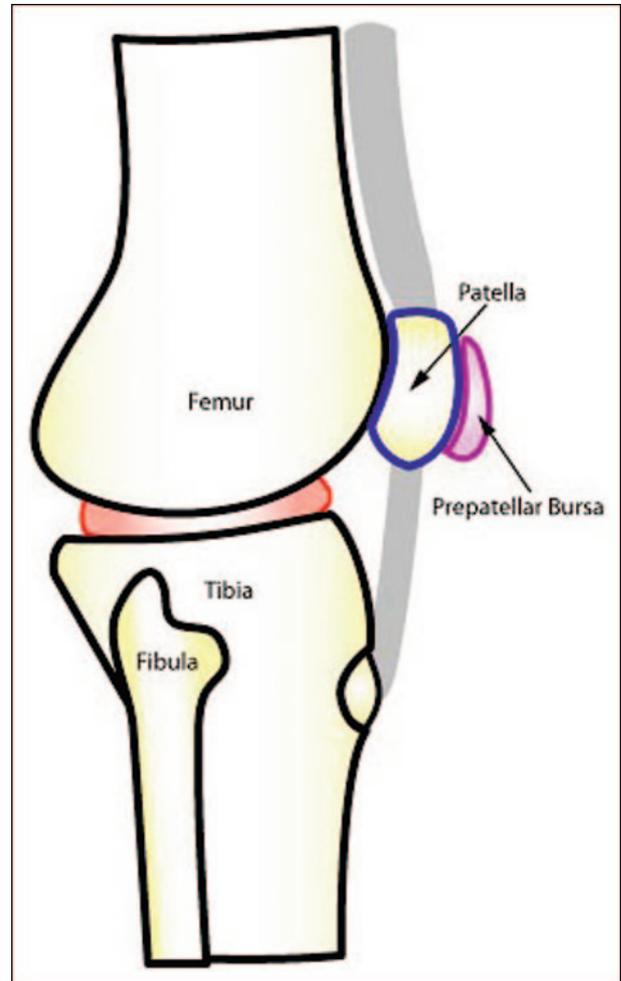


Figure 3. Prepatellar bursitis causes swelling superficial to the knee cap. Swelling located at the knee joint line is more consistent with an effusion or intra-articular fluid collection.

(ACL) tear and order a confirmatory MRI, which demonstrates a mid-substance rupture of the ACL (Fig. 5).

### The Condition

ACL tears are common in adolescent athletes, with an overall incidence of 16 per 1,000 high school students. The injuries usually occur when a sudden deceleration and twisting force is applied to the knee. The injury can result from noncontact trauma during cutting and pivoting sports such as soccer and basketball or when a valgus force is applied to the knee with the foot planted during a collision. Females have a higher incidence of ACL ruptures than do males because of many extrinsic (body movement, level of skill, and coordination) and intrinsic (joint laxity, body alignment, ligament size, notch width) factors.



Figure 4. Lachman maneuver to assess for an anterior cruciate ligament (ACL) tear. With the knee flexed 15 to 30 degrees, the proximal tibia is pulled anteriorly, while the femur is stabilized. Excessive anterior translation signifies an ACL injury.

### Clinical Picture

Patients often present acutely with inability to bear weight, effusion of the knee, and decreased range of motion. After several weeks, the effusion and pain gradually subside. As a result, range of motion and the ability to bear weight return. However, most patients still report “giving way” or instability episodes when they engage in cutting and pivoting activities.

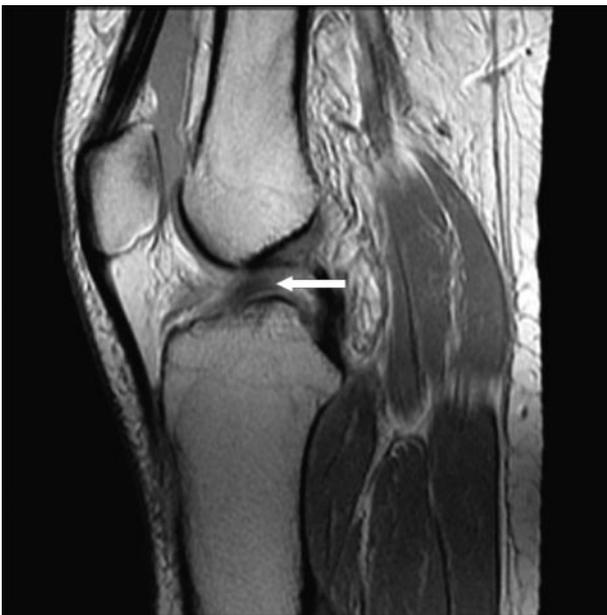


Figure 5. T1-weighted sagittal magnetic resonance imaging shows complete mid-substance rupture of the anterior cruciate ligament.

### Diagnosis

Assessment of the ACL on physical examination employs the anterior drawer and Lachman tests. The anterior drawer test involves grasping the proximal tibia and pulling the leg forward with the knee flexed to 90 degrees and foot stabilized. The Lachman test is performed by flexing the knee 15 to 30 degrees, followed by attempting to pull the tibia forward with one hand while holding the femur stationary (Fig. 4). Excessive anterior tibial translation (forward motion) with either test signifies an ACL injury. Although the Lachman test is more sensitive, (1) both tests have decreased sensitivity immediately after an injury due to significant pain and swelling. Weight-bearing radiographs (anteroposterior, lateral, notch/tunnel, skier’s views) should be obtained. Although often appearing normal, radiographs may demonstrate an avulsion fracture of the lateral tibial plateau (Segond fracture), which is highly suggestive of an ACL injury (Fig. 5). MRI shows disruption of the mid-substance of the ACL in older patients and possibly associated injuries such as meniscal tears, chondral defects, and bone bruising (Fig. 6). Children younger than age 14 years are more likely to sustain avulsions of the tibial spine than an intrasubstance tear of the ACL.

### Treatment

In the immediate setting, patients suspected of having an ACL tear should be placed into a knee brace or immobilizer and given crutches for protective weightbearing. An elective outpatient referral to an orthopedic surgeon should be made within 7 to 14 days. For low-demand patients who have no desire to return to competitive cutting sports, nonoperative treatment consisting of aggressive physical therapy, quadriceps strengthening, and neuromuscular rehabilitation may be a reasonable option. Patients who want to return to sports are treated with surgical reconstruction.

### Lessons for the Clinician

Clinicians who treat adolescent athletes commonly encounter ACL injuries. The diagnosis often can be based on physical examination findings and supported by MRI. Without operative management, inability to play sports and recurrent knee instability may develop. Furthermore, damage to menisci and articular surfaces may result from chronic knee instability and may hasten the development of osteoarthritis. Despite these potential consequences, nonoperative treatment may be considered in certain situations. Regardless of treatment, young patients who sustain ACL tears should be made nonweightbearing,



Figure 6. A Second fracture results from a bony avulsion of the lateral tibial plateau by the iliotibial band or fibular collateral ligament and is associated with an anterior cruciate ligament tear in up to 100% of cases.

placed into a straight-leg knee immobilizer, and referred to an orthopedic surgeon for definitive management.

### Case #3

A 15-year-old boy presents to his pediatrician with a 2-day history of left knee pain stemming from an injury he sustained during his high school football game when he was tackled from the left side. He does not know exactly what happened but thinks that the other player's helmet hit the outside of his left knee and forced him into a "knock-kneed" position. He was able to continue playing but had significant pain while doing so. The pain, which is localized to the medial side of his knee, has improved only slightly with ice and anti-inflammatory medications. On physical examination, the boy walks with a slight limp. He has full range of motion of his left knee. He has no effusion but has ecchymosis and significant tenderness over the distal medial femoral condyle. In full extension, his knee is stable to valgus stress, but at 30 degrees of flexion, he has marked pain and his medial joint line appears to hinge open about 10 mm. The rest of his physical examination findings are



Figure 7. With the knee at 0 and 30 degrees of flexion, application of a valgus stress assesses the laxity of the medial collateral ligament. The amount of opening compared with the contralateral extremity indicates injury severity.

*normal. Plain radiographs are unremarkable. MRI of the left knee demonstrates significant edema of the soft tissues on the medial side of the knee as well as a complete tear of the midsubstance of the medial collateral ligament (MCL). No other abnormalities are noted. You diagnose an acute MCL tear of the knee.*

### The Condition

Rupture of the MCL occurs when a significant valgus force is applied to the knee with the foot planted on the ground. Such injuries typically result from a traumatic collision or during an awkward fall. A typical scenario is similar to the one described, in which the patient's knee is subjected to a valgus-producing ("knock-knee deformity") force from a lateral tackle or collision. The injuries are classified by the amount of medial joint line "opening" seen on valgus stress testing compared with the contralateral side. Grade I (mild tear) injuries have 0 to 5 mm of medial knee opening. Grade II (moderate tear) injuries have 6 to 10 mm of opening. Grade III (complete tear) injuries have more than 10 mm of opening.

### Clinical Picture

Patients present complaining of medial-sided knee pain. They have varying degrees of tenderness to palpation, depending on injury severity. An effusion and local ecchymosis may be present. Range of motion usually is normal.

### Diagnosis

Valgus stress testing in full extension and at 30 degrees of flexion is performed to test the integrity of the MCL (Fig. 7). In full extension, the MCL serves as a secondary

stabilizer, and the knee remains stable as long as the cruciate ligaments and posterior capsule are intact. In 30 degrees of flexion, cruciate ligaments and the posterior capsule are loose and do not resist valgus forces. The MCL is the primary stabilizer to valgus force at 30 degrees of flexion, and instability is present if the MCL is damaged. Although clinical findings are adequate to diagnose MCL injuries, MRI may be used as a confirmatory test in equivocal cases.

### Treatment

Treatment generally is nonoperative and consists of rest, anti-inflammatory medications, ice, and crutches for ambulatory assistance. A hinged knee brace can be used acutely, followed by early mobilization and physical therapy. Therapy should be directed at isometric quadriceps and hamstring strengthening. The patient may return to sports when sport-specific drills can be performed without pain and there is no residual laxity on examination. The duration of nonoperative treatment varies, based on the severity of the MCL injury. Average return to a sport for grade I injuries is 7 to 10 days, for grade II injuries is 2 to 4 weeks, and for grade III injuries is 8 to 12 weeks, although full ligament healing may take significantly longer. Failure of nonoperative treatment warrants referral to an orthopedic surgeon for consideration of operative repair.

### Lessons for the Clinician

MCL injuries result from a valgus force being applied to the knee. These injuries are rare in skeletally immature patients, and a physeal fracture should be ruled out before diagnosing MCL injury. Injury severity is determined by quantifying the amount of medial-sided laxity detected with valgus stress. Nonoperative treatment is the norm, with operative intervention rarely being indicated. Such injuries generally have a good prognosis, with infrequent long-term complications.

Athletes who sustain acute, traumatic knee injuries often are evaluated in emergency departments that are equipped with extensive imaging modalities and have orthopedic consultants readily available. Athletes who have chronic knee pain, however, often present to primary care physicians who do not have such services readily available. Although chronic knee pain has many causes, a history, physical examination, and imaging studies can narrow the differential diagnosis. Three common clinical disorders—osteochondritis dissecans, discoid meniscus, and patellofemoral syndrome—that cause chronic knee pain are discussed in detail in the following case examples.

### Case #4

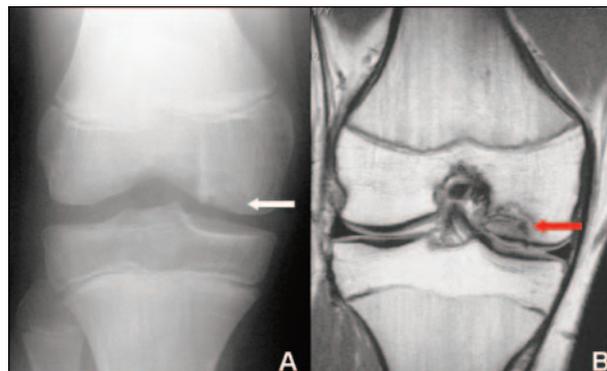
*A 13-year-old boy has a 6-month history of medial-sided right knee pain. He is the starting center fielder on his baseball team. The pain does not reduce his level of activity, but he is very sore after games. He denies swelling or “giving way” episodes. On physical examination, he has full range of motion of his knee and a small effusion. The knee is tender over the medial joint line, but no varus or valgus instability is present. Anterior drawer and Lachman testing results are normal. Distal neurovascular examination results also are normal. Standard anteroposterior and lateral radiographs of the knee are obtained. A radiolucent area is noted on the lateral surface of the medial femoral condyle (Fig. 8). An MRI later confirms an osteochondritis dissecans (OCD) lesion (Fig. 8).*

### The Condition

OCD is a pathologic process of the knee that involves destruction of the subchondral bone on the undersurface of normal articular cartilage. Loss of the bony support leads to separation of the overlying cartilage. Further destruction may result in fragmentation of the affected bone, thereby producing a loose body within the joint. Juvenile OCD lesions affect children between ages 10 and 13 years who have open growth plates. Males are twice as likely to be affected as females.

### Cause

The exact cause of OCD lesions is unknown, but potential candidates include ischemia, repetitive microtrauma, genetic factors, and disorders of ossification. OCD lesions commonly affect the knee joint (80%), although they can occur in the elbow (distal humerus) and ankle



**Figure 8.** A. The most common location for osteochondritis dissecans lesions is the lateral surface of the medial femoral condyle, as seen on this plain radiograph. B. The T1-weighted coronal magnetic resonance image demonstrates the edema and inflammation surrounding the lesion.

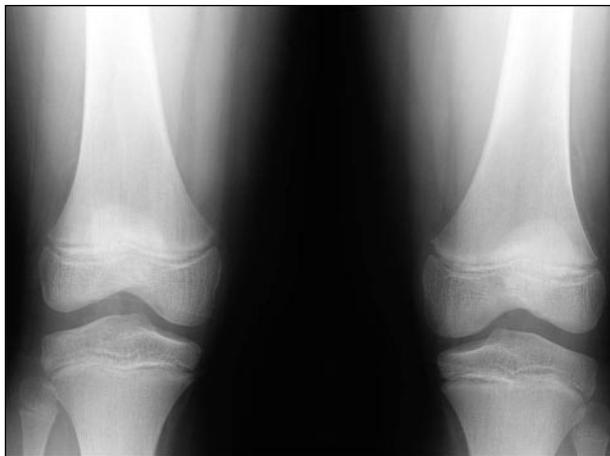


Figure 9. The tunnel or notch view is taken with the knee flexed 20 to 30 degrees and is useful for evaluating the posterior articular joint surface.

(talus) as well. The lateral surface of the medial femoral condyle is the most common site.

### Classification

OCD lesions are classified as stable or unstable based on the structural integrity of the lesion. Those that are continuous with the surrounding healthy bone are termed stable and those with disassociation between the bone and overlying cartilage are termed unstable. Stable lesions typically cause fewer clinical symptoms than unstable lesions.

### Clinical Presentation

Patients who have stable lesions may present with joint pain that is aggravated by physical activity. Unstable lesions often present with mechanical symptoms, swelling, or feelings of joint instability. Physical examination findings may be vague and nonspecific. Point tenderness may be appreciated directly over the lesion. An effusion may be present. The knee often feels stable because there is no damage to the major collateral and cruciate ligaments.

### Diagnosis

Anteroposterior and lateral radiographs should be obtained to help evaluate and characterize the lesion. A tunnel or notch view is helpful for evaluating the weight-bearing posterior surface of the joint (Fig. 9). If patellar involvement is suspected, a merchant or skyline view should be obtained (Fig. 10). MRI is the imaging modality of choice to assess the status of the articular cartilage, determine the size of the lesion, and estimate the extent of bony edema.

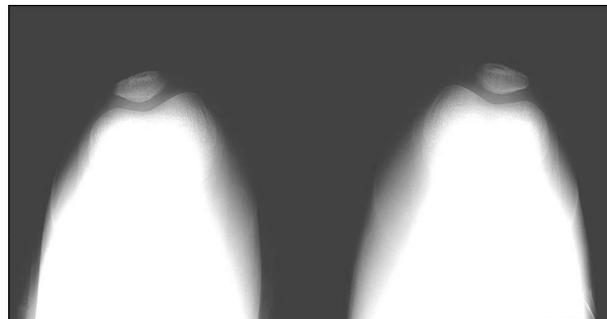


Figure 10. The skyline or merchant view evaluates the patellofemoral joint and can help detect patellar subluxation.

### Treatment

Nonoperative treatment consisting of observation, activity modification, and nonsteroidal anti-inflammatory drugs should be tried first. Most stable lesions eventually heal in children who have open growth plates, although such healing may take up to 18 months. Surgical treatment and orthopedic referral are warranted for patients who have unstable lesions and those who fail nonoperative treatment. Some centers advocate surgical management of stable lesions to allow for earlier return to sports. The goal of surgical management is to restore the normal contour of the articular surface. Operative treatment options include debridement, transarticular drilling, lesion reattachment/pinning, or bone grafting.

### Lessons for the Clinician

It is important to consider the diagnosis of OCD in active adolescents who complain of vague knee pain. Prompt diagnosis and treatment may prevent stable lesions from progressing to unstable lesions. Nonoperative treatment is preferred for children who have open growth plates and stable lesions. (2) Treatment prior to growth plate closure has a better prognosis and is facilitated by early diagnosis and appropriate referral to an orthopedic specialist.

### Case #5

*An 8-year-old boy presents to the clinic complaining of snapping in his right knee that has been getting worse over the past 3 months. The snapping is mildly painful, is elicited by knee flexion and extension, and localizes to the lateral side of his knee. He denies any locking, swelling, or instability. He does not report a discrete traumatic event. On physical examination, pain and snapping are elicited when a valgus force with gradual extension and internal rotation (from a hyperflexed position) is applied to the knee. He otherwise has full range of motion. Anteroposterior and*



Figure 11. Discoid meniscus. Magnetic resonance images show continuity between the anterior and posterior horns of the meniscus on three successive sagittal cuts demonstrating the classic "bowtie" appearance.

*lateral radiographs of the right knee appear normal. An MRI of the knee demonstrates a thickened, disc-shaped meniscus (Fig. 11). Discoid meniscus is diagnosed.*

### The Condition

Discoid meniscus is a common cause of snapping or popping of the immature knee. The normal meniscus is C-shaped, is thicker peripherally, and serves as shock absorber between the femoral condyle and tibial plateau. Discoid menisci are abnormally disc-shaped, are thick throughout the substance, and have abnormal attachments. The abnormal shape often causes snapping, specifically with terminal extension. Lateral menisci are affected more commonly, and the condition can be bilateral in up to 20% of patients. The rates of discoid meniscus are significantly lower in the white population, with highest rates found in East Asian populations. (3) At this time, the exact cause of discoid meniscus is unknown.

### Clinical Picture

Children who have discoid menisci usually have no history of trauma and begin to experience symptoms at the age of 4 or 5 years. Pain associated with snapping typically does not present until age 8 or 9 years, however. A bump or bulge may be present over the affected joint line. Symptoms generally are exacerbated by physical activity. Effusions typically are not present.

### Diagnosis

The McMurray test often elicits positive results in patients who have meniscal abnormalities. To test for medial meniscal pathology, the patient is positioned supine, with the ipsilateral hip flexed to 90 degrees and affected knee maximally flexed. The knee is extended gradually while applying a valgus force and external rotation of the tibia (Fig. 12). The maneuver provides an axial load and rotational force to the meniscus and elicits pain. Plain radiographs usually appear normal but should be ordered

to rule out bony pathology. An MRI shows the continuity between the anterior and posterior horns of the meniscus on three consecutive sagittal images ("bowtie" appearance) and the thickened transverse diameter (Fig. 11). (4)

### Treatment

Treatment of discoid menisci is initially nonoperative. The snapping that patients experience is more of a

nuisance to the parents than an activity-limiting problem for the patient. Persistent pain, however, can represent a tear of the meniscus. Once pain prevents physical and daily activities, surgery is considered. Arthroscopic saucerization of the meniscus involves reshaping the meniscus back to its normal C-shaped configuration.

### Lessons for the Clinician

A child who has a snapping knee always should be evaluated for a discoid meniscus or possible meniscal tear. Physical examination may reveal a bulge or audible snapping near the lateral joint line. MRI should be obtained to evaluate the overall structure of the meniscus. Patients who have meniscal tears or persistent pain despite conservative treatment should be referred to an orthopedist. Undiagnosed meniscal tears may cause damage to the adjacent articular cartilage and hasten the development of arthritis later in life.

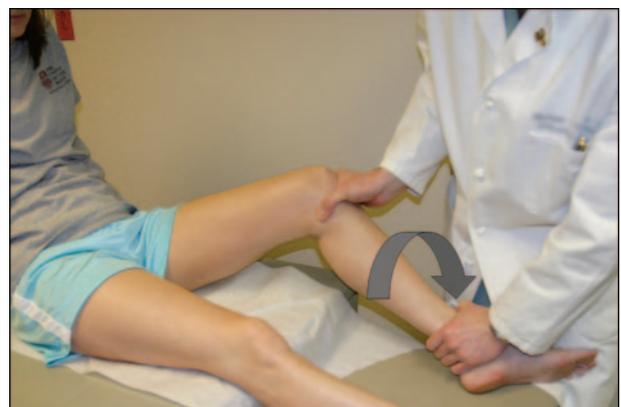


Figure 12. The McMurray test. To assess for meniscal pathology, the knee is hyperflexed and gradually extended. Simultaneously, a valgus force and external rotation are applied to the knee. Such axial loading and rotational force reproduce pain and popping when meniscal pathology is present.

## 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 obliquus 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.

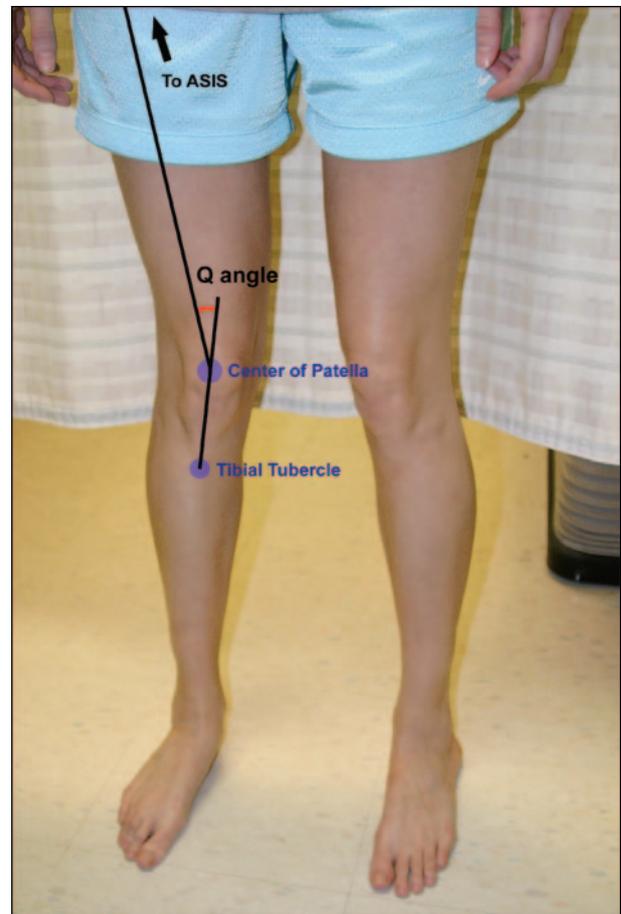


Figure 13. The Q-angle is defined as the angle between a line drawn from the anterior superior iliac spine (ASIS) to the center of the patella and a line from the center of the patella to the tibial tubercle. A Q-angle greater than 15 degrees may cause the patella to sublux laterally during quadriceps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

## Summary

- Pediatric knee pain can be difficult to manage in the outpatient setting. A thorough history is a vital part of the initial evaluation and should describe, quantify, characterize, and localize the pain.
- A focused, systematic physical examination should be performed and findings compared with the contralateral extremity.
- Plain radiographs should be ordered for all patients who have acute injuries and knee effusions to rule out a fracture. MRI is used to evaluate potential soft-tissue injuries that are undetected on standard radiographs.
- Nontraumatic causes of knee pain such as neoplasms and inflammatory arthritides (eg, septic arthritis, Lyme arthritis, juvenile idiopathic arthritis) can confuse the clinical picture and may have disastrous consequences if overlooked.
- A thorough history and physical examination should be performed for patients who do not have an obvious cause of their knee pain.
- Based on strong research evidence, (5) a Q-angle greater than 15 degrees is a predisposing factor for patellar subluxation.
- Based on strong research evidence, (2) stable OCD lesions in patients who have open growth plates are preferably treated nonoperatively.
- Based on strong research evidence, (1) the Lachman test has higher sensitivity than the anterior drawer test at detecting ACL tears.

## Lessons for the Clinician

An adolescent athlete who presents with prolonged anterior knee pain may have PFS. An increased Q-angle predisposes patients, particularly females, to this condition. (5) With rest, pain control, and extensive physical therapy, most patients can overcome the disorder without consequence. If nonoperative treatment fails, early surgical intervention is warranted to prevent early arthritis.

## Other Considerations

The clinician should be aware that hip disorders such as toxic synovitis, septic arthritis, Perthes disease, and slipped capital femoral epiphysis may present as medial thigh or knee pain because of dual innervation by the obturator nerve. Those patients who have no obvious cause of their knee pain deserve a thorough and systematic hip evaluation.

## References

1. Benjaminse A, Gokeler A, van der Schans CP. Clinical diagnosis of an anterior cruciate ligament rupture: a meta-analysis. *J Orthop Sports Phys Ther.* 2006;36:267–288
2. Schenck R, Goodnight J. Osteochondritis dissecans. *J Bone Joint Surg.* 1996;78:439–456
3. Ikeuchi H. Arthroscopic treatment of the discoid lateral meniscus: technique and long-term results. *Clin Orthop Relat Res.* 1982; 167:19–28
4. Zobel M, Borrelo J, Siegel M, et al. Pediatric knee MR imaging: pattern of injuries in the immature skeleton. *Radiology.* 1994;190: 397–401
5. Calmbach W, Hutchens M. Evaluation of patients presenting with knee pain: part I. history, physical examination, radiographs, and laboratory test. *Am Fam Physician.* 2003;68:907–912

## PIR Quiz

Quiz also available online at [pedsinreview.aappublications.org](http://pedsinreview.aappublications.org).

Match each of the following sets of histories and physical findings with the single clinical condition that *most* likely explains the symptoms and signs.

1. A 12-year-old boy has had left anterior knee pain for the past 2 months that is getting worse. He has no known injury and plays team basketball. You elicit tenderness over the tibial tubercle, but he has no limitation of motion and the knee is stable.
2. A 14-year-old boy experiences acute left anterior knee pain after sudden deceleration with the left knee planted. He holds the knee in flexion and has tenderness over the tibial tubercle.
3. A 15-year-old girl who is a marathon runner presents with bilateral anterior knee pain for the past 3 months that is worsening. The pain is made worse by sitting for long periods or climbing stairs at school. A Q-angle is 22 degrees, she has full range of motion, and the knee is stable.
4. A 15-year-old female soccer player has had pain in her left knee since she twisted the knee while running 3 weeks ago. She reports that the knee gives out. The Q-angle is 15 degrees, and results of the Lachman maneuver are positive.
5. A 15-year-old baseball player has had medial pain in his left knee for the past 6 months that is aggravated by physical activity. Results of his hip examination are normal, and he has no knee instability.
  - A. Anterior cruciate ligament tear.
  - B. Osgood-Schlatter disease.
  - C. Osteochondritis dissecans.
  - D. Patellofemoral syndrome.
  - E. Tibial tubercle fracture.

Injuries to the knee are bony, ligamentous, and cartilaginous in nature, and at times, more than one type of tissue is involved. Match each of the following types of injury/disorder with the clinical tests that are used *most* appropriately to diagnose it. Each clinical option may be used once, more than once, or not at all.

6. Anterior cruciate ligament tear.
7. Medial collateral ligament tear.
8. Medial meniscus tear.
9. Osgood-Schlatter disease.
10. Type II tibial tubercle fracture.
  - A. Direct palpation.
  - B. Inspection and range of motion.
  - C. Lachman test.
  - D. McMurray test.
  - E. Valgus stress testing.

Match each of the following sets of histories and physical findings with the *most* appropriate choice of imaging. Each imaging choice may be used once, more than once, or not at all.

11. A 12-year-old boy has had left anterior knee pain for the past 2 months that is getting worse. He has no known injury and plays team basketball. You elicit tenderness over the tibial tubercle, but he has no limitation of motion and the knee is stable.
12. A 14-year-old boy experiences acute left anterior knee pain after sudden deceleration with the left knee planted. He holds the knee in flexion and has tenderness over the tibial tubercle.
13. A 15-year-old girl who is a marathon runner presents with bilateral anterior knee pain for the past 3 months that is worsening. The pain is made worse by sitting for long periods or climbing stairs at school. A Q-angle is 22 degrees, she has full range of motion, and the knee is stable.
14. A 15-year-old female soccer player has had pain in her left knee since she twisted the knee while running 3 weeks ago. She reports that the knee gives out. The Q-angle is 15 degrees, and results of the Lachman maneuver are positive.
15. A 15-year-old baseball player has had medial pain in his left knee for the past 6 months that is aggravated by physical activity. Results of his hip examination are normal, and he has no knee instability.
  - A. Both plain radiographs and magnetic resonance imaging.
  - B. Magnetic resonance imaging alone.
  - C. No study generally required.
  - D. Plain radiographs alone.
  - E. Plain radiographs primarily; magnetic resonance imaging occasionally useful.

Match each of the following sets of histories and physical findings with the *most* appropriate choice of management for the condition. Each choice of management may be used once, more than once, or not at all.

16. A 12-year-old boy has had left anterior knee pain for the past 2 months that is getting worse. He has no known injury and plays team basketball. You elicit tenderness over the tibial tubercle, but he has no limitation of motion and the knee is stable.
17. A 14-year-old boy experiences acute left anterior knee pain after sudden deceleration with the left knee planted. He holds the knee in flexion and has tenderness over the tibial tubercle.
18. A 15-year-old girl who is a marathon runner presents with bilateral anterior knee pain for the past 3 months that is worsening. The pain is made worse by sitting for long periods or climbing stairs at school. A Q-angle is 22 degrees, she has full range of motion, and the knee is stable.
19. A 15-year-old female soccer player has had pain in her left knee since she twisted the knee while running 3 weeks ago. She reports that the knee gives out. The Q-angle is 15 degrees, and results of the Lachman maneuver are positive.
20. A 15-year-old baseball player has had medial pain in his left knee for the past 6 months that is aggravated by physical activity. Results of his hip examination are normal, and he has no knee instability.
  - A. Orthopedic surgeon required for immediate surgical repair.
  - B. Primary care pediatrician and physical therapist usually suffice.
  - C. Primary care pediatrician for initial care with planned referral to an orthopedic surgeon.
  - D. Primary care pediatrician generally capable of managing alone.
  - E. Primary care pediatrician; orthopedic surgeon only for unstable lesions.

**Injuries and Chronic Conditions of the Knee in Young Athletes**  
Alfred Atanda, Jr, Deepak Reddy, Jaime A. Rice and Michael A. Terry  
*Pediatrics in Review* 2009;30;419  
DOI: 10.1542/pir.30-11-419

**Updated Information & Services**

including high resolution figures, can be found at:  
<http://pedsinreview.aappublications.org/content/30/11/419>

**References**

This article cites 5 articles, 1 of which you can access for free at:

<http://pedsinreview.aappublications.org/content/30/11/419#BIBL>

**Subspecialty Collections**

This article, along with others on similar topics, appears in the following collection(s):

**Musculoskeletal Disorders**

[http://pedsinreview.aappublications.org/cgi/collection/musculoskeletal\\_disorders](http://pedsinreview.aappublications.org/cgi/collection/musculoskeletal_disorders)

**Permissions & Licensing**

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:  
</site/misc/Permissions.xhtml>

**Reprints**

Information about ordering reprints can be found online:  
</site/misc/reprints.xhtml>

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

