Assessment and Treatment of Knee Pain in the Child and Adolescent Athlete

Yi-Meng Yen, MD, PhD

INTRODUCTION

Knee pain is one of the most common musculoskeletal complaints seen in the pediatric and adolescent population. The complaint is most prevalent in physically active patients, with up to 54% of athletes having some degree of knee pain per year.1 The knee is a trocho-ginglymus joint allowing flexion and extension as well as slight internal and external rotation. The 2 joints within the knee consist of the patellofemoral articulation between the patella and femur and the tibiofemoral joint between the tibia and femur. A fairly extensive differential diagnosis exists for knee pain and can present a challenge to physicians. A detailed history, focused physical examination, and, when indicated, appropriate use of imaging modalities and laboratory tests can lead to accurate diagnosis and treatment.

Assessment

A patient’s description of knee pain is helpful in focusing the differential diagnosis. As with any patient evaluation, a history of the pain must be elicited and should include the characteristics of the pain, onset (acute or insidious), location, duration, severity,

Disclosure: None.

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KEYWORDS

- Patellofemoral • Injury • Ligament tear • Pediatrics

KEY POINTS

- A patient’s description of knee pain is helpful in focusing the differential diagnosis.
- A good history and physical examination, followed by appropriate imaging is paramount for the diagnosis. Always check and examine the hip joint as well.
- A history of locking episodes could suggest meniscal injury or plica.
- A sensation of popping at the time of injury suggests a ligamentous injury. Giving way of the knee may represent ligamentous injury, patellar subluxation or dislocation, or even quadriceps inhibition or malfunction.
quality, and radiation. Aggravating or alleviating factors should be identified, and if the knee pain was caused by acute injury, the ability to weight bear after the injury should be discerned. Mechanical symptoms, such as locking, popping, catching, or giving way of the knee, should be ascertained. A history of locking episodes could suggest meniscal injury or plica. A sensation of popping at the time of injury suggests a ligamentous injury. Giving way of the knee may represent ligamentous injury, patellar subluxation or dislocation, or even quadriceps inhibition or malfunction. A history of prior knee injury or surgery is important, as is a history of rheumatologic disease.

The presence of an effusion is important to note for knee pain. Rapid onset of effusion after an acute injury suggests a hemarthrosis and could represent fracture or cruciate ligament injury. A slow onset of effusion may represent meniscal injury or ligament sprain. An effusion in the absence of injury may indicate infection. If an acute injury occurred, the patient should be questioned about the specific mechanism of injury. It is important to determine if there was a direct blow, the direction of the blow, if the foot was planted at the time of injury, if the patient was accelerating or decelerating, a twisting component, or if landing from a jump. An anterior blow to the tibia with the knee in flexion can cause posterior cruciate ligament (PCL) injury. A valgus force produces a medial collateral ligament (MCL) injury whereas a varus force produces a lateral collateral ligament (LCL) injury. The anterior cruciate ligament (ACL) can be ruptured with a deceleration, hyperextension, and rotational injury. A rotational injury can also cause meniscal damage or patella subluxation. Any of these forces in children could produce fractures other than ligamentous injury due to the relative strength of the ligament compared with bone in this age group.

**Physical Examination**

The physician begins the examination of the knee by starting at the more proximal joint, the hip. Pain from the hip can be perceived as knee pain, likely due to the innervation of the anterior branch of the obturator nerve or articular branches of the femoral, common peroneal, or saphenous nerves. It is, therefore, mandatory that a complete examination of the hip accompany an examination of the knee. The knee evaluation is conducted by comparing the asymptomatic knee to the painful one. The injured knee is inspected for erythema, bruising, swelling, and discoloration. The musculature around the knee should be symmetric on both sides, and, in particular, the vastus medialis oblique should be noted for any signs of atrophy.

The knee is then palpated, and areas of tenderness should be noted, particularly at the tibial tubercle, patella, joint line, and femoral condyle in flexion. The patella should be checked to see if it is ballotable, indicating effusion of the joint, and any warmth of the knee noted. Range of motion should be examined by flexing and extending the knee as far as possible. During the range-of-motion examination, patellofemoral tracking should be noted and the presence of crepitus detected. The Q-angle can be determined by drawing a line from the anterior superior iliac crest through the center of the patella and a second line from the center of the patella to the tibial tuberosity. A Q-angle greater than 15° may be a predisposing factor for patella maltracking. A J-sign is noted, which is the movement of the patella laterally on terminal extension of the knee. Patella mobility can be assessed both laterally and medially, in which one quadrant of motion is considered normal, and a patellar apprehension test can be performed. With a laterally directed force on the medial aspect of the patella, the physician attempts to subluxate the patella from 0° to 90°. If this reproduces a patient’s pain or feeling of giving way, this test is positive.

Assessment of the cruciate ligaments begins with the knee flexed at 90° (Table 1). Normally, the medial tibial plateau extends 1 cm anteriorly beyond the femoral condyle
### Table 1
#### Physical examination maneuvers

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>ACL tests</strong></td>
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<tr>
<td>Anterior drawer test</td>
<td>Patient is supine, hip flexed to 45° and knee flexed to 90°. Examiner sits on patient’s foot with hands behind proximal tibia and thumbs on tibial plateau. Anterior force is applied, increased tibial translation compared with other sides is indicative of tear.</td>
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<tr>
<td>Lachman test</td>
<td>Patient is supine, knee at 15° of flexion. Femur is stabilized with one hand while other hand stabilizes tibia. Femur is pushed posterior and tibia is pulled anteriorly. Increased translation and soft endpoint are indicative of a positive test.</td>
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<tr>
<td><strong>PCL tests</strong></td>
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<tr>
<td>Posterior drawer test</td>
<td>Patient is supine, hip flexed to 45° and knee flexed to 90°. Examiner sits on patient’s foot with hands behind proximal tibia and thumbs on tibial plateau. Posterior force is applied, increased tibial translation compared with other sides is indicative of tear.</td>
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<tr>
<td><strong>MCL and LCL tests</strong></td>
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<tr>
<td>Valgus stress test</td>
<td>Patient supine, knee flexed to 30°, hands on both sides of tibia, fingers used to stabilize femur. Application of valgus stress, if increased translation, indicative of MCL injury.</td>
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(continued on next page)
when the knee is flexed to 90°. Posterior displacement of the tibia indicates a torn PCL. Next, the examiner sits on the foot and positions a hand behind the proximal tibia with the thumbs on the tibial plateau. A posterior directed force assesses for the posterior displacement of the tibia; increased posterior displacement compared with the contralateral side is indicative of a partial or complete tear of the PCL. An anterior drawer test can also be performed, which can compare anterior displacement of the tibia with the uninjured side. Increased anterior displacement suggests ACL disruption. Chronic injuries tend to be more sensitive to the anterior drawer test than acute injuries. In general, the Lachman and pivot shift tests are both more sensitive and specific to ACL injuries and are the preferred tests to the anterior drawer. The Lachman test is performed with a patient in the supine position and the knee flexed to 30°. The examiner stabilizes the distal femur with one hand and the proximal tibia with the other. The tibia is then attempted to be subluxated anteriorly; lack of a clear endpoint to translation or increased translation compared with the uninjured side is indicative of a positive test.

The collateral ligaments are tested with a patient’s leg in slight adduction. The examiner places one hand on the lateral aspect of the knee joint and the other hand on the medial aspect of the proximal tibia. Valgus stress is applied at the knee at both full extension and at 30°. Laxity of the tibia or absence of an endpoint on examination indicates disruption of the MCL at 30°; at full extension, it indicates disruption of the MCL and one of the cruciate ligaments. Varus stress testing is similar to valgus stress testing except the examiner’s one hand is placed on the medial aspect of the knee joint and the other hand on the lateral aspect of the proximal fibula.

Table 1

<table>
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<tr>
<th>Test</th>
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<tr>
<td>Varus stress test</td>
<td>Patient supine, knee flexed to 30°; hands on both sides of tibia, fingers used to stabilize femur. Application of valgus stress, if increased translation, indicative of LCL injury.</td>
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<tr>
<td>Meniscal tests</td>
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<tr>
<td>McMurray test</td>
<td>Patient is supine, the knee is fully flexed. Foot is held by the heel. The leg is rotated on the thigh with the knee in full flexion by internally and externally rotating. Altering the degree of flexion allows the whole segment of meniscus to be examined. If a click occurs, the test is considered positive.</td>
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Patients with injury to the meniscus usually demonstrate tenderness at the medial or lateral joint line.\textsuperscript{12,13} Flexion of the knee enhances the palpation of the anterior portion of both menisci. The McMurray test as originally described involves the patient supine with the knee fully flexed.\textsuperscript{14} With the knee in flexion, the tibia is rotated internally to test for the posterior horn of the lateral meniscus and externally rotated to test for the medial meniscus. An appreciable snap is considered positive and indicative of a torn meniscus. By altering the position of flexion, the whole of the posterior segment of meniscus can be examined (see Table 1).

Protocols have been developed to try to reduce the number of radiographs used in the evaluation of extremity injuries. The two best-known guidelines are the Ottawa knee rules and the Pittsburgh rules.\textsuperscript{15–18} In a prospective study, the Pittsburgh rules were more specific and sensitive than the Ottawa rules.\textsuperscript{19} If using the Pittsburgh rules, the inability to bear weight, effusion, or ecchymosis is an indication to obtain anteroposterior, sunrise, and lateral radiographs of the knee (Box 1). In patients with chronic knee pain and recurrent effusions, a notch or tunnel view (posteroanterior view of the knee flexed to 40°–50°) should be obtained. Clinical judgment should always be used, however, for the determination if radiographs are necessary. If radiographs are inconclusive, advanced imaging, such as MRI, may be necessary.

The presence of warmth, nontraumatic effusion, or significant pain with slight range of motion may be consistent with septic arthritis or an acute inflammatory arthropathy. In these cases, the use of laboratory studies is indicated. A complete blood cell count, sedimentation rate, and C-reactive protein should be obtained. Additionally, in endemic regions, a Lyme disease titer should be sent. An arthrocentesis may be required to differentiate the diagnosis (Table 2). The presence of a hemarthrosis indicates a fracture or ligamentous injury. Clear fluid suggests a sprain or possible chronic injury, whereas purulent fluid indicates infection. The joint fluid should be sent to a laboratory for a cell count with differential, glucose, and protein measurements; bacterial culture and sensitivity; and, in certain instances, the testing for crystals.

### OVERUSE INJURY

**Osteochondrosis**

Osgood-Schlatter

Osgood-Schlatter disease is a common cause of anterior knee pain in children and adolescents. It is caused by repetitive traction of the patellar tendon on the tibial

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**Box 1**

**Decision rules for knee radiographs**

<table>
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<th>Ottawa knee rules</th>
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<tr>
<td>Age greater than 55 years</td>
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<tr>
<td>Isolated tenderness of the patella</td>
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<tr>
<td>Tenderness at the head of the fibula</td>
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<tr>
<td>Inability to flex knee to 90°</td>
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<tr>
<td>Inability to bear weight immediately after injury AND in an emergency department for 4 steps</td>
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<table>
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<tr>
<th>Pittsburgh knee rules</th>
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<tbody>
<tr>
<td>Blunt trauma or fall as mechanism of injury AND</td>
</tr>
<tr>
<td>Age less than 12 or greater than 50 years</td>
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<tr>
<td>Inability to walk 4 full weight-bearing steps in the ED</td>
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<tr>
<td>Classification</td>
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<tr>
<td>Normal</td>
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<td>Noninflammatory</td>
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<td>Infectious</td>
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Abbreviation: WBC, white blood cell.
tubercle ossification center. Symptomatic patients are typically between the ages of 8 and 14, and 30% of patients have bilateral knee involvement.\textsuperscript{23,24} Symptoms are typically exacerbated with activities that involve jumping (basketball, volleyball, and running) or with direct contact of the tubercle (kneeling).\textsuperscript{25} Radiographic evaluation of early Osgood-Schlatter demonstrates irregularity of the apophysis with separation from the tibial tubercle, whereas late disease shows fragmentation of the apophysis (Fig. 1).

The standard of treatment of Osgood-Schlatter is nonoperative and includes icing, limitation of activities, oral antiinflammatory medication, physical therapy, and knee bracing.\textsuperscript{24,26–29} Generally, Osgood-Schlatter runs a self-limiting course with complete recovery expected with closure of the tibial growth plate. In rare recalcitrant cases, surgical excision of the ossicle can give good pain relief in skeletally mature patients.\textsuperscript{30,31}

\textit{Sinding-Larsen-Johansson}

Another common cause of anterior knee pain may be Sinding-Larsen-Johansson disease, which results from persistent traction at the inferior pole of the patella, leading to calcification and ossification at that junction.\textsuperscript{32} Symptomatic patients are usually between the ages of 10 and 12 who complain of activity-related pain, particularly with jumping, running, and kneeling. The pain and swelling are localized to the inferior pole of the patella. Radiographic evaluation can show variable amount of calcification or ossification at the inferior pole of the patella (Fig. 2).

Treatment is similar to that of Osgood-Schlatter, with icing, limitation of activity, nonsteroidal antiinflammatory drugs, or knee sleeve as the standard of treatment. This condition is benign and self-limiting and almost always resolves without sequelae and surgery is rarely needed.

\textbf{Fig. 1.} Fragmentation of the tibial tubercle apophysis indicative of late stage Osgood-Shlatter disease. Arrow shows ossicle of bone at tibial tuberosity.
Synovial Plicae of the Knee

Synovial plicae may cause anterior knee pain in children and adolescents. Plica syndrome can present with anterior knee pain and clicking, catching, locking, or pseudo-locking of the knee. An acute injury to the plica may cause inflammation and exacerbate symptoms. It is believed that the symptoms are caused by the bowing of the plica across the femoral condyle on flexion of the knee.33,34 During embryonic development, the knee is compartmentalized by suprapatellar, medial, and lateral synovial septae. With further development, depending on the degree of septal recession, persistence of the infrapatellar, suprapatellar, lateral, or medial plica can remain. The infrapatellar and suprapatellar plicae likely do not cause significant symptoms, and the lateral plica is exceedingly rare.35,36

The medial plica is the one that most frequently produces the symptoms of chronic anterior knee pain. Often there is a history of striking the anteromedial aspect of the knee followed by a chronic aching of the knee made worse with activity. Tenderness around the medial plica, which is commonly 1 fingerbreadth proximal and medial to the inferior pole of the patella, can suggest plica syndrome. Typically there is minimal effusion and the plica causes pain when palpated and rolled over the medial femoral condyle. Occasionally, there can be popping at approximately 30° to 40° of knee flexion.37 Radiographs are negative, but MRI can demonstrate the presence of a plica. Routine use of MRI to detect a plica is not, however, recommended.

Treatment of synovial plica should be conservative. Modification of activity to reduce repetitive flexion and extension, physical therapy, and nonsteroidal
antiinflammatory drugs should be used. Conservative management often leads to sufficient reduction in the synovitis and edema so that the plica resumes a more normal resiliency and no longer produces symptoms. Surgery should be reserved for those patients in whom other diagnoses have been ruled out and who have failed all modes of conservative management. Arthroscopic management of symptomatic plicae of the knee has been shown successful.38,39

**Osteochondritis Dissecans**

Osteochondritis dissecans (OCD) has been described as an acquired, potentially reversible, idiopathic lesion of subchondral bone resulting in the delamination and sequestration with or without corresponding articular cartilage involvement and instability.40–43 The cause of OCD remains unknown, although multiple theories have been entertained. The juvenile form most commonly affects the lateral aspect of the medial femoral condyle, although lesions can occur on the lateral femoral condyle and the patellofemoral joint. Patients often report a vague, poorly localized knee pain, with recurrent effusion. If the articular cartilage becomes unstable and breaks off, the corresponding loose body can create mechanical symptoms of locking or catching of the knee.

Physical examination of the knee often reveals quadriceps atrophy and tenderness along the surface of the affected chondral area with deep palpation. A small joint effusion may be present. Radiographs can be diagnostic and should include the anteroposterior, lateral, Merchant, and notch or tunnel views. MRI is highly sensitive in detecting these lesions and can help determine if the OCD is radiographically stable or unstable (Fig. 3).

Treatment of small stable juvenile OCD lesions begins with 6 to 8 weeks of limited weight bearing or even immobilization, followed by unloader bracing and activity restriction.44 Lesions that fail conservative treatment, large lesions, or unstable OCD

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**Fig. 3.** (A) Notch view of the knee showing OCD lesion of the lateral femoral condyle. Arrow denotes OCD lesion. (B) T2-weighted MRI of the same OCD lesion; arrow denotes fluid undercutting lesion indicating an unstable OCD.
can be treated with operative intervention. Antegrade or retrograde drilling of the lesion, screw fixation, curettage and bone graft, microfracture, autologous chondrocyte implantation, osteochondral autograft, and allograft have all been used as treatment options with varying degrees of success.45–52

TRAUMATIC INJURY

Fracture

**Sleeve fracture**

Avulsion fractures of the inferior or superior pole of the patella are rare and constitute approximately 1% of all children’s fractures.53 The low incidence of fractures may be a result of less stress loads and pressure on the patella due to the flexible soft tissue and mobile nature of the patella. Additionally, the thick layer of cartilage may act as a cushion to a direct blow. A superior avulsion fracture involves the superior pole of the patella is a more uncommon fracture pattern.54 An inferior avulsion injury involves the inferior pole of the patella and occurs due to an acute injury and must be differentiated from Sinding-Larsen-Johansson syndrome. The sleeve fracture includes an avulsion of a small bony fragment from the inferior pole of the patella with a large articular sleeve off of the bony patella. This injury occurs between the ages of 8 and 12.55 The mechanism of injury is usually from tensile load of the patella with forceful contraction of the quadriceps against resistance.

The clinical presentation is usually one of significant pain with a large hemarthrosis of the knee. Full extension and straight-leg raising are difficult and the patella is usually high-riding. Radiographs, in particular a lateral radiograph, show a small bony fragment that tears away from the inferior pole of the patella as well as patella alta (Fig. 4). Treatment of patella sleeve fractures is operative with careful reapproximation of the sleeve of cartilage. Modified tension-band wiring around screws or Kirschner wires helps centralize and reduce the fragment.55 Immobilization for a short time (3 to 4 weeks) followed by mobilization is required.

**Tibial tuberosity fracture**

Avulsion fractures of the tibial tuberosity are uncommon but tend occur in 13-to 16-year-old boys involved in a leaping activity. The male-to-female ratio is approximately 5:1 and bilateral fractures have been reported.56–59 Physical examination findings depend on...

Fig. 4. Patellar sleeve fracture on lateral radiograph; arrow denotes fracture.
the magnitude and severity of the injury. The joint is usually held at 20° to 40°, there is a hemarthrosis, and the amount of patella alta is dependent on the displacement of the tubercle. Plain radiographs, especially the lateral view, confirm the diagnosis (Fig. 5).

If the fracture is minimally or nondisplaced, a cylinder cast for 3 to 4 weeks can be used to allow for healing of the fracture. In cases of displaced fractures, open reduction and internal fixation of the fracture are necessary to achieve anatomic alignment and restore the quadriceps-patellar mechanism. As with other fractures, the tibial tuberosity fracture can extend into the physis of the proximal tibia and careful postoperative follow-up should monitor for signs of genu recurvatum or other angular deformities.

**Tibial spine (intercondylar eminence)**

Fractures of the tibial spine occur because of a chondroepiphyseal avulsion of the ACL insertion on the tibial eminence. Tibial spine fractures were once thought the pediatric equivalent of midsubstance ACL tears in adults, although recent evidence suggests that ACL tears in children are increasing and the tibial spine fracture in adults is more common than previously thought. Historically, the most common mechanism has been a fall from a bicycle, but an upsurge in participation in sports has led to an increase in tibial spine fractures.

Patients typically present with a painful swollen knee and are often unable to bear weight. Lateral radiographs are often diagnostic, although MRI can be useful to identify meniscal entrapment or tears (Fig. 6). Grading of a tibial spine fracture is based on the Meyers and McKeever classification: grade I—nondisplaced, grade II—posteriorly hinged, and grade III—completely displaced. Treatment is based on grading, with grade I, some grade II without laxity, and grade II or III fractures that are successfully reduced with closed maneuvers treated with cast immobilization. Grade II fractures with laxity and grade III fractures that are not reducible are treated surgically. Arthroscopic or open reduction with internal fixation of the tibial spine is performed using suture or cannulated screws. Patients are placed in a postoperative hinged knee brace and early initiation of physical therapy is done. Functional ACL bracing can be used if there is residual knee laxity.

**Cruciate Ligament Injury**

**Anterior cruciate**

ACL injuries are unfortunately seen with increasing frequency and severity. Stanitski and colleagues reported in 70 children and adolescents with acute traumatic hemarthrosis that 47% of those ages 7 to 12 and 65% of those ages 13 to 18 had suffered a torn ACL. The mechanism of injury is similar to that of adults, with a deceleration of the patient while planting a foot and turning in the opposite direction. The

![Fig. 5.](image-url) (A) Tibial tuberosity fracture (Salter-Harris IV). (B) After open reduction and internal fixation with 3 screws.)
resultant valgus stress causes anterior displacement of the tibia and injury to the ligament. Patients usually reported feeling or hearing a pop at the time and are usually unable to continue the activity. A large hemarthrosis usually develops, which limits range of motion. The Lachman test is most useful for clinical assessment, although an MRI is diagnostic (Fig. 7).

Fig. 6. (A) Displaced tibial spine fracture shown on lateral radiograph (B) Arthroscopic exposure of the tibial spine fracture with the fragment (asterisk) elevated off the tibial plateau. (C) Arthroscopic reduction of the tibial spine fracture with sutures around the ACL. (D) Anatomically reduced tibial spine fracture after fixation.

Fig. 7. MRI image of torn ACL; arrow denotes location of normal ACL.
The ligament may be fully or partially torn, and treatment options depend on the severity of the injury. Nonoperative management of partial tears may be successful in younger patients, those with a negative pivot shift test, and those with less than 50% of the ligament ruptured. Depending on age of the patient and the potential growth remaining in the distal femoral and proximal tibial physis, treatment of can consist of conservative or operative measures. Bracing and conservative management can be used as the primary treatment option, with a goal of stabilizing the patient until close to skeletal maturity. This may result, however, in decreased activity level, continued instability, or an increased rate of intra-articular damage, which may have long-term negative consequences in the development of degenerative joint disease.

Adolescents close to the end of growth or who are skeletally mature should undergo contemporary adult ACL reconstruction techniques. In those patients who are pre-pubescent, physeal-sparing techniques have been described that include the two most used techniques: an intra-articular extra-articular reconstruction using iliotibial band and an all-epiphyseal technique using bone tunnels. Patients are placed in a brace postoperatively and physical therapy is initiated quickly.

**Posterior cruciate**

PCL injuries are rare, with most cases case reports of a bony avulsion injury. The mechanism of injury is oftentimes an anterior blow to the tibia of a flexed knee. Clinical presentation is similar to the ACL with a large tense hemarthrosis and difficulty with range of motion. Lateral radiographs are often helpful to show bony avulsions, and MRI can be used to confirm the diagnosis. Treatment is usually nonoperative, unless there is significant displacement of the bony avulsion or gross instability due to a complete rupture. Kocher and colleagues recently described the largest series of PCL injuries in children and adolescents, in which 57% underwent operative intervention.

**Collateral Ligament Injury**

Isolated injury to the MCL in children is uncommon, and injury to the LCL is even more rare. Collateral ligament injuries are graded as grades I to III. Grade I injuries are characterized by pain and tenderness along the course of the ligament without instability. Grade II injuries are associated with ligamentous laxity and represent partial tears, which present with increased laxity with varus or valgus force but a discrete endpoint. Grade II injuries are complete tears with no discernable endpoint to varus or valgus force.

Radiographs may demonstrate a distal cortical fleck fragment with either medial or LCL injuries; proximal or midsubstance injuries are uncommon. The injuries generally respond well to nonoperative treatment with a period of immobilization in a hinged knee brace for 6 weeks followed by physical therapy. Care must be taken to ensure that there is no concomitant cruciate ligament injury or multiplanar instability. In those settings, operative repair of the collateral ligaments should be considered. Sankar and colleagues reported on a small series of pediatric ACL/MCL injuries treated with nonoperative management of a grade II or grade III MCL with ACL reconstruction. At 5 years, all patients had stable knees and returned to sports similar to adult injury patterns.

**Meniscal Injury**

The meniscus can be torn acutely with a sudden twisting injury to the knee or can occur in association with a prolonged degenerative process, such as an ACL-deficient knee. Classic signs of meniscal injury include locking and giving way, although these, along with the McMurray sign, often are absent in children. It is,
therefore, not uncommon that meniscal injuries, in particular injuries to a discoid meniscus, often go undiagnosed for long periods of time. MRI may be useful in the diagnosis of these injuries.

The treatment of meniscal injuries is still somewhat controversial. Asymptomatic discoid meniscus is treated with observation. Partial and total meniscectomy have been performed in children, although an increase in the contact stresses of the knee and poor long-term outcomes have not made this a favorable procedure.\textsuperscript{20,22} Symptomatic meniscal tears are treated with meniscal repair using arthroscopic inside-out, outside-in, or all-inside techniques. Symptomatic discoid meniscus is treated with saucerization of the meniscus and repair to the capsule as indicated.

\textbf{Patellofemoral Injury}

Patellofemoral instability is one of the more common conditions seen around the knee in pediatric and adolescent patients.\textsuperscript{80,81} Most patella dislocations or subluxations occur in the lateral direction. Medial dislocations or subluxations are exceedingly rare and usually a result of a direct blow or iatrogenic surgical result.\textsuperscript{82} Patients usually report a feeling of the knee giving way, with the possibility of either a spontaneous or manual reduction. There may be a large effusion and usually significant pain medially around the patella. The Q-angle should be assessed and patellar apprehension test used if clinically indicated. Radiographs, if obtained, should include the anteroposterior, lateral, and Merchant views. The lateral view is important to assess for patella alta and trochlea dysplasia.\textsuperscript{83,84} If indicated, MRI can be useful to detect chondral injury, osteochondral fractures, or large medial patellar stabilizer defects.

Nonoperative treatment, with closed reduction and immobilization followed by rehabilitation, bracing, and strengthening, is the standard of treatment of the majority of first-time dislocations.\textsuperscript{85–88} Those dislocations that have a concomitant chondral injury, osteochondral fracture, or significant medial patellar stabilizer defect may be candidates for early operative intervention.\textsuperscript{81} Several studies have shown, however, that almost half of patients have recurrent instability or pain.\textsuperscript{81,89,90} The largest risk factor seems to be skeletally immature patients with trochlear dysplasia.\textsuperscript{91}

Operative intervention for patella instability in children and adolescents is constrained by the open physes and well over 100 procedures have been described for the treatment. The chondral injury of the knee is addressed first with the next goal re-establishing the balance of forces of the patella.\textsuperscript{92} Techniques include releasing tight lateral structures, restoring medial restraints by reefing or medial patellofemoral ligament reconstruction, and improving anatomic alignment.\textsuperscript{93} Distal realignment procedures are often reserved until skeletal maturity. Recently, the use of medial patellofemoral ligament reconstruction in skeletally immature patients has been gaining favor.\textsuperscript{94}

\textbf{REFERENCES}


