The child or adolescent who presents with a painful knee is a routine challenge for most primary care providers. Knee pain is one of the most common reasons for referral from our local primary care providers to the orthopedic and sports medicine specialist. Complaints may be acute or long-standing, and making a diagnosis that responds to treatment for the patient with long-standing knee pain may be elusive. Careful consideration of the history, physical exam findings, and imaging study results can help sort through which patients can be managed in the primary care provider’s office and which ones should be referred to a pediatric and adolescent sports medicine specialist.

Injuries to the knee occurred with an incidence of nearly one per player per year in a survey of English teenage soccer players, and the prevalence of diffuse anterior knee pain has been reported in up to 40% of adolescents participating in sports. Common acute knee injuries and chronic knee conditions that present in youth can be found in Table 1 (see page 123).

**IMPORTANCE OF HISTORY IN MEDICAL EXAM**

Complaints of knee pain are typically either acute or chronic. A patient with a recent injury may be particularly difficult to work-up: the history of the event may be fresh in the patient’s mind and the pain that resulted may still linger, leading to a nervous, tense, and difficult-to-examine patient, depending on the level of their discomfort.

A history of swelling suggests injury within the joint. In the acute setting, swelling likely represents a hemarthrosis, or blood in the joint from trauma. An anterior cruciate ligament (ACL) tear, physeal or osteochondral fracture, patella dislocation, or meniscus tear

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can all produce a hemarthrosis. In patients with chronic swelling, the effusion may be indicative of an inflammatory arthritis.

Most people have joints that “pop,” likely reflecting soft tissues snapping benignly over bony prominences. The “cracking of knuckles” type of joint popping is believed to be a benign process, resulting from a cavitation phenomenon where sudden volumetric changes in the joint space are accompanied by popping as carbon dioxide moves out of solution from the dissolved state. Joints that “clunk” or “snap,” with a jump of the patella or the tibia during knee flexion or extension, suggest a mechanical problem (see Table 2, page 124).

Joints that lock or catch suggest a meniscal pathology or a loose body in the knee. The notion of “giving way” is a difficult symptom to interpret. Quadriceps inhibition, or the cessation of quadriceps contraction when a patient experiences pain can produce “giving way”; so too does a subluxating or dislocating patella, or a knee with major ligament injury. Distinguishing between these different causes can be difficult. Recreating the apprehensive feeling in the patient during the exam by using specific maneuvers can help confirm a diagnosis.

STAGES OF FULL PHYSICAL EXAM

For patients who are uncomfortable and/or apprehensive, I recommend limiting the exam of the injured knee. However, I do try to gain as much information as possible from the visit. Are there crutches in the room? Even if there are crutches present, I’ll ask the patient to try to take a few steps without them, if they think they can. Watching the patient walk may help in identification of the source of their discomfort, potentially suggesting hip as opposed to knee pathology.

Examining the uninjured side first establishes a baseline for comparison and can potentially reassure the patient of the examiner’s gentle approach. On the other hand, starting on the uninjured side with an aggressive, forceful, and rapid exam may only heighten the patient’s apprehension. A complaint of knee pain may reflect irritation of the obturator nerve from a hip pathology, so examination of the hips should be included when the patient is supine. Log rolling the limb on the unaffected side, followed by gentle hip flexion to 90 degrees, then internal and external rotation of the hip in flexion will establish the norm for comparison. On the injured side, pain with log rolling while holding the knee still may suggest a hip pathology. If flexing the hip results in obligate external rotation and abduction, that suggests hip pathology such as slipped capital femoral epiphysis (SCFE).

LIMITED EXAM OF THE ACUTELY INJURED KNEE

After examining the hips, the uninjured knee is observed palpated, gently ranged, and provoked to establish a baseline. Comparing the two knees with regards to size, resting position, and coloration can be done without touching the injured knee. Gently palpating the joint line and the physes, the tibial tubercle and the inferior border of the patella helps identify the location and normal prominences of these landmarks. Flexing the knee somewhat may help the examiner locate the joint line, as it lies both medial and lateral to the inferior border of the patella when the knee is flexed. Tests of stability (described below), and gentle provocation of the uninjured knee will give the examiner a sense of baseline tightness or laxity of the knee.

On the injured side, gently palpating the landmarks described above may help establish the point of maximal tenderness (PMT), though patient discomfort may make identification of the PMT impossible. The PMT is a valuable landmark in identifying the site of injury or pathology in the child and adolescent’s knee. Mild flexion, if tolerated, followed by stability testing can be useful. However, I am quick to wrap-up the exam of the acutely injured knee and order orthogonal radiographs (AP and lateral, supine) if there is marked swelling, ecchymosis, gross instability,

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**TABLE 1.**

Common Causes of Knee Pain in Youth

<table>
<thead>
<tr>
<th>Acute Injuries</th>
<th>Semi-Acute Conditions</th>
<th>Chronic Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture (femur/tibia/patella)</td>
<td>Osteochondritis dissecans</td>
<td>Inflammatory arthritis</td>
</tr>
<tr>
<td>Dislocation (patella)</td>
<td>Slipped capital femoral epiphysis</td>
<td>Apophysitis: Osgood-Schlatter Sinding-Larsen-Johansson</td>
</tr>
<tr>
<td>Meniscus tear (torn discoid meniscus)</td>
<td>Loose body</td>
<td>Anterior knee pain: Patello-femoral syndrome Impinging Hoffa’s fat pad</td>
</tr>
<tr>
<td>Anterior cruciate ligament (ACL) tear</td>
<td>Tumor</td>
<td>Tendonitis: Quadriceps Patellar tendon</td>
</tr>
<tr>
<td>Medial collateral ligament (MCL) tear</td>
<td>Infection</td>
<td></td>
</tr>
<tr>
<td>Soft tissue contusion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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or refusal to ambulate. Worth noting, the Ottawa knee rules have been validated in children, having a 100% sensitivity for identification of fracture in patients ages 2 to 16 years. The Ottawa criteria for radiographs of the acutely injured knee include: 1) tenderness at head of fibula; 2) isolated tenderness of patella (no bone tenderness of knee other than patella); 3) inability to flex to 90 degrees; and 4) inability to bear weight immediately and in the emergency department (defined as an inability to transfer weight twice onto each lower limb, regardless of limping).7

Prescribing a hinged knee brace that is left open enough to allow a tolerable range of motion and crutches as needed for comfort, along with the encouragement to remove the brace and gently move the knee when resting is often the best approach to the patient with a painful and acutely injured knee. Rest, ice, compression, and elevation (RICE) is a good rule of thumb. Acetaminophen or nonsteroidal anti-inflammatory medications may help with pain relief. The patient can then be re-examined in about a week’s time.

**COMPLETE EXAM OF THE KNEE**

Again, an approach that works well for the order of the complete knee exam includes observing gait, examining hips, followed by the knee examination, focusing on the uninjured side before going to the side of complaint. Observing, palpating gently, ranging, then performing tests for knee stability followed by provocative tests is the typical recommended order to proceed through the exam, though I like to do my basic tests of stability before looking for a point of maximal tenderness, so the patient is most relaxed for stability testing.

**Tests of Stability**

**Lachman’s Testing**

Once the knee has been evaluated for swelling and patella dislocation, a Lachman’s test in about 20 degrees of knee flexion will help determine any anterior instability. If present, this suggests a tear of the ACL.

An effective Lachman’s exam requires a relaxed patient, so performing this, with a gentle touch, prior to any other manipulation or palpation increases the chances the patient will be relaxed during the maneuver. Laxity on Lachman’s testing suggests an ACL injury. A pivot shift test typically is not possible in the acutely injured patient, as full extension and relaxation are prerequisites to a successful test. When full knee extension is possible, the pivot shift can reveal rotatory instability, as the lateral femoral condyle may flick past the iliotibial band, also indicative of an ACL tear.

While the patient is supine with the knee flexed to 90 degrees and the patient’s heel on the table, posterior directed pressure or a posterior drawer test can reveal a posterior cruciate ligament (PCL) deficiency. Excursion that is palpably greater than the uninjured side with a soft end-point would suggest a tear of the PCL. An anterior drawer test at 90 degrees of knee flexion may test the integrity of the ACL, although the ACL is under greatest tension at only 20 degrees of knee flexion. Therefore, there is a greater sensitivity for ACL deficiency with Lachman’s exam than there is with the anterior drawer test.

**Varus and Valgus Testing**

Stability testing in full extension and mild flexion can give information on capsular integrity as well as integrity of the collateral ligaments; pain with either maneuver may suggest meniscal injury as well. As the medial meniscus has attachments to the MCL, valgus stress may result in medial pain from movement of a torn medial meniscus when the MCL comes under tension, whereas lateral pain may reflect pinching of a torn lateral meniscus. Medial-

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**TABLE 2.**

**Common symptoms and signs of various acute knee injuries**

<table>
<thead>
<tr>
<th>Injury</th>
<th>Symptoms</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft tissue contusion</td>
<td>Diffuse pain</td>
<td>Local swelling without effusion resolving ecchymosis</td>
</tr>
<tr>
<td></td>
<td>Painful walking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bruising</td>
<td></td>
</tr>
<tr>
<td>ACL/MCL sprain</td>
<td>Wobbly knee — instability</td>
<td>Unstable ligament exam</td>
</tr>
<tr>
<td></td>
<td>Swelling after activity</td>
<td>Palpable effusion</td>
</tr>
<tr>
<td>Meniscus tear</td>
<td>Sudden onset loss of motion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intermittent clunking or snapping</td>
<td></td>
</tr>
<tr>
<td>Patellar dislocation</td>
<td>Weakness</td>
<td>Tender medial knee</td>
</tr>
<tr>
<td></td>
<td>Intermittent “giving way”</td>
<td>Appreciation with lateral push to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>patella when gently flexing from</td>
</tr>
<tr>
<td></td>
<td></td>
<td>full extension</td>
</tr>
<tr>
<td>Loose body</td>
<td>Intermittent locking or pinching</td>
<td>Palpable mobile body</td>
</tr>
<tr>
<td></td>
<td>Feels like something may be loose</td>
<td>Variable range of motion</td>
</tr>
<tr>
<td></td>
<td>and “floating” around in the joint</td>
<td></td>
</tr>
<tr>
<td>Fracture</td>
<td>Inability to weight bear</td>
<td>Ecchymosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physeal tenderness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibial tubercle tenderness</td>
</tr>
</tbody>
</table>

ACL = anterior cruciate ligament; MCL = medial collateral ligament.
sided pain with varus stressing may be related to pinching of a torn medial meniscus. For skeletally immature patients, tenderness along the condyles 2 cm to 3 cm from the joint line may suggest a physeal fracture.

Gently grasping both of the patient’s heels and lifting the feet off the table will help indicate the magnitude of the loss of knee flexion of the injured limb. Avoid looking for the maximum tolerable knee flexion until later in the examination.

While flexing the knee gently, pay careful attention to the patient’s demeanor to determine at what point flexion becomes a bit uncomfortable. Ask where it hurts when this point is reached to determine if the pain is anterior, suggesting anterior injury or tightness, or posterior, suggesting posterior injury such as a torn meniscus.

**Palpitation for Effusion**

Follow the Lachman’s test with what might be described as thorough palpation — look for the PMT. Identifying the PMT is key to determining the pathology: joint line tenderness suggests meniscus injury, tenderness along the course of the medial collateral ligament (MCL) suggests MCL sprain, tenderness along the medial border of the patella or adductor tubercle suggests a patella dislocation, and tenderness on either femoral condyle in full knee flexion may suggest osteochondral fracture. Tenderness at the inferior border of the patella or tibial tubercle suggests an apophysitis or inflammation of a growth center at the attachment of a tendon (Sinding-Larsen-Johansson and Osgood-Schlatter, respectively). An effusion may be detected by milking the suprapatellar pouch from proximal to distal, looking for fluid accumulation medial and lateral to the patella. If posterior pressure on the patella (ballotment) produces a medial and lateral fluid wave, that suggests fluid in the joint.

At times, identifying the joint line can be difficult, particularly when there is an effusion or hemarthrosis. Palpat ing the inferior border of the patella with the knee mildly flexed, followed by sliding the examiner’s fingers off to either side may help establish the location of the joint lines.

The distal femoral physis lies at the level of the medial and lateral femoral epicondyles, whereas on the tibia the proximal physis extends from about 1 cm to 2 cm inferior to the joint line medially and laterally to just below to the tibial tubercle anteriorly.

**Meniscus Pathology**

With fingers on the joint line and a hand on the patient’s foot and ankle, rotate the ankle while flexing the knee and place gentle varus pressure on the knee, then gently repeat the process with a rotation in the opposite direction while placing upon it a gentle valgus stress. If during these maneuvers the patient experiences any pain, or if there is a clicking or clunking sound, or if there is a palpable flipping of tissues under the examiner’s fingers, a meniscal pathology is likely. Pain while bearing weight on the affected limb, with the knee flexed 20 degrees while twisting back and forth is an even more sensitive test for meniscus tear.

Obtaining biplanar orthogonal radiographs can be useful, as fractures and patellar subluxation may both be evident (see the discussion above under Limitations Exam of the Acutely Injured Knee); however, unless clinical suspicion is high, such as with isolated joint line tenderness that is unresponsive to therapy, pain with provocation, loose body symptoms, persistent effusions, and gross instability, ordering an MRI for acute or chronic knee complaints is generally not advised. Most pediatric orthopedic specialists prefer to first examine the patient before an MRI is ordered. Exam by the primary care practitioner has been shown to be quite sensitive for ACL tears, and obtaining repeat MRI prior to surgery for knee injuries (for improved study quality or a more timely study) occurs commonly, suggesting the disutility of the original MRI studies.

**REFERRALS TO SPECIALISTS**

The patient with persistent swelling and mechanical symptoms typically has an ACL deficiency, medial or lateral instability, fracture, meniscal tear, or patellar instability. Although patients with small meniscal tears and early patellar instability may respond to a physical therapy program, MCL and PCL instability and nondisplaced physeal fractures may be treated with a period of bracing followed by a guided rehabilitation program; whereas untreated ACL tears may lead to further giving-way, risking articular cartilage or meniscal injury. Patients with ACL tears should be referred to an orthopedist.

**Hoffa’s Fat Pad**

In those patients who have a history of having fallen directly on their knee, or having been struck on the front of their knee during a collision in sport may develop anterior scar tissue that can produce painful pinching with full knee extension. This is known as an impinging Hoffa’s fat pad — the exuberant tissue that grew in response to the anterior injury may cause the fat pad to be adherent to the ACL, and with knee extension, may cause a posterior pulling of this excessive tissue and fat pad into the knee joint. Patients with this condition often complain of discomfort when the knee is fully extended, made worse when the examiner applies pressure anteriorly at

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Exam by the primary care practitioner has been shown to be quite sensitive for ACL tears.
either the medial or lateral joint lines, adjacent to the patellar tendon.\textsuperscript{12}

Aggressive massage in the area of discomfort may stretch the underlying tissues and provide relief over time. Arthroscopic treatment of impinging tissue often brings relief, although recurrence of symptoms, likely due to the return of scar tissue within the joint capsule, may occur. Massage, stretching of anterior and posterior thigh musculature, and strengthening of core and hip abductors are the initial treatments of choice for this diagnosis.

**Osteochondritis Dissecans**

Tenderness directly over a femoral condyle with full flexion of the knee may suggest osteochondritis dissecans, a diagnosis that may be confirmed with radiographs of the knee.\textsuperscript{13} This diagnosis may benefit from an early MRI, as fluid deep to the lesion may suggest poor likelihood of resolution or healing with rest.

**‘Bad Actors’**

For patients with a chronically painful knee or a knee with the insidious onset of pain, keep in mind potential “bad actors” such as a tumor near the knee, inflammatory arthritis, hip pathology such as SCFE or an infection.

If the PMT is over the distal thigh or upper leg, or if there is a stiff knee, night pain, loss of energy and/or appetite, and any enlarged local lymph nodes, then there is the possibility of neoplasia or infection. Radiographs and serum inflammatory markers may help point toward such a diagnosis.

The pain-free swollen knee, worse with activity and accompanied by morning stiffness, should suggest the possibility of juvenile idiopathic arthritis. Elevated serum inflammatory markers and elevated anti-nuclear antibody titers would support such a diagnosis. A knee aspiration would reveal many white cells (> 1,000/mm\(^3\)) with no growth on culture. A trial of a nonsteroidal anti-inflammatory and referral to a pediatric rheumatologist would then be recommended.

The patient with SCFEs or other hip pathology may complain of medial knee or thigh pain, walk with a turned out foot, resist flexion, and display obligatory abduction and external rotation when the hip is flexed. Painful internal rotation is also a classic exam finding.

The anterior and “frog leg” pelvis radiograph should confirm a diagnosis of SCFE. As the capital femoral epiphysis slips, it typically occurs in a slow yet irreversible fashion. Treatment includes halting the slipping with a surgery to fix the capital femoral physis on the neck where it lies, or “in-situ” fixation. The greater the slip, the more compromised the function of the limb, so early treatment may prevent a poor result. A fall in a patient who is walking on their slipped capital femoral epiphysis may lead to what is known as a “stable slip” becoming and “unstable slip”, with a much higher likelihood of a poor outcome. Sending the patient to the local emergency department in a wheelchair is the important next step in treatment of a SCFE.\textsuperscript{14}

**Patellofemoral Joint Pain**

Pain associated with abnormal loading at the patellofemoral joint is also common.\textsuperscript{15} Increased discomfort with a posterior-directed pressure or a lateral tilt of the patella during knee flexion may exacerbate symptoms. A wide pelvis or marked j-tracking of the patella may suggest increased lateral pressure at the patellofemoral joint, which also may be painful.

Strengthening the vastus medialis, the medial quadriceps, and the anterior thigh muscles may help reduce this lateral patellar pressure, resulting in reduced pain during activity. When knee pain is associated with patellar instability, the patient may present with a history of “giving way” or frank patellar dislocation events, usually with a history of a substantial initial trauma. Over time, as dislocations become more frequent, the patella may slip out — partially or completely — with less trauma, less of a twist, less drama with each event. On exam, a patient with patellar instability will typically flinch or show apprehension when laterally directed pressure is applied to the patella while the knee is gently flexed.

**BENIGN ANTERIOR KNEE PAIN**

The most common, and perhaps most challenging, variety of knee pain in the older child and adolescent is benign anterior knee pain. Patients tend to wave their hand over their knee when pointing to their site of greatest pain. It is often bilateral, but can be unilateral, perhaps brought on by a contusion to the knee through a collision. Patients might describe pain that follows activity, sometimes even pain that prevents further play, although swelling is rarely seen. Mechanical symptoms are also rare. They might also note pain that occurs after sitting for prolonged periods of time, pain when ascending or descending stairs, and tenderness over the tibial tubercle, inferior border of the patella, or the medial or lateral borders of the patella.

Anterior knee pain is often exacerbated by tight quadriceps muscles (indicated if the patient is unable to tolerate a hurdler’s stretch) and tight hamstrings (popliteal angles > 30 degrees to 40 degrees) through an increase in pressure at the patellofemoral joint, as the patella is caught within a tight extensor mechanism, whereas the tight quadriceps strain against the opposition of tight hamstrings.\textsuperscript{16} Hamstring and quadriceps stretching is the optimal treatment for this type of anterior knee pain. These stretches can be done at home; guidance from a physical therapist may help keep a patient on track in their quest to regain better flexibility.
CASES OF APOPHYSITIS

For cases of apophysitis (Osgood-Schlatter at the tibial tubercle, Sinding-Larson-Johansson at the inferior border of the patella), where cartilage growth centers may fail under tension, again, tight quadriceps and hamstring muscles are often seen. Neither radiographs nor MRI are useful in making the diagnosis, except to rule out other pathologies. Daily stretching over a matter of months is the preferred treatment for this condition.

This is a frustrating diagnosis for parents to manage because there are no tests of confirmation, only exam findings to support it; and there is no treatment that will cure it, only behaviors and exercises that will slowly reduce it. It does not respond well to narcotics, to surgery, or to intermittent physical therapy.

Heat before activity, followed by slow gentle stretching, then play, and ice at the conclusion may decrease symptoms, but does little to treat the cause. A regular dedicated program of daily prolonged stretching is the best treatment. After many months, the anterior knee pain should subside.

CONCLUSION

Separating acute injuries from chronic conditions may be helpful in making the diagnosis of knee pain in an adolescent. Mechanical symptoms and signs are key features of the history and exam, as patients with persistent or recurrent painful swelling, and mechanical symptoms such as locking, painful popping, catching, or “giving way” may have a cartilage injury or ligament tear that would benefit from referral to an orthopedist.

Identifying a point of maximum tenderness is especially important in diagnosing the adolescent knee, as it so often lies at the site of pathology. In the absence of any point tenderness, consider a process at the knee that may benefit from an aggressive stretching and strengthening program, keeping in mind the possibility of a hip or thigh pathology presenting as a knee complaint. Obtain orthogonal radiographs before any other imaging study, and consider referring to specialists before ordering MRIs.

REFERENCES