Knee Pain in Children: Part I: Evaluation

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Practice Gap

Clinicians who evaluate knee pain must understand how the history and physical examination findings direct the diagnostic process and subsequent management.

Objectives

After reading this article, the reader should be able to:

1. Obtain an appropriate history and perform a thorough physical examination of a patient presenting with knee pain.
2. Employ an algorithm based on history and physical findings to direct further evaluation and management.

HISTORY

Obtaining a thorough patient history is crucial in identifying the cause of knee pain in a child (Table). For example, a history of significant swelling without trauma suggests bacterial infection, inflammatory conditions, or less likely, intra-articular derangement. A history of swelling after trauma is concerning for potential intra-articular derangement.

A report of warmth or erythema merits consideration of bacterial infection or inflammatory conditions, and mechanical symptoms (e.g., locking, catching, instability) should prompt consideration of intra-articular derangement.

Nighttime pain and systemic symptoms (e.g., fever, sweats, night sweats, anorexia, malaise, fatigue, weight loss) are associated with bacterial infections, inflammatory conditions, benign and malignant musculoskeletal tumors, and other systemic malignancies. A history of rash or known systemic inflammatory conditions, such as systemic lupus erythematosus or inflammatory bowel disease, should raise suspicion for inflammatory arthritis.

Ascertaining the location of the pain also can aid in determining the cause of knee pain. Anterior pain suggests patellofemoral syndrome or instability, quadriceps or patellar tendinopathy, prepatellar bursitis, or apophysitis (patellar or tibial tubercle). Medial pain points toward medial collateral sprain, meniscal pathology, osteochondritis dissecans, or pes anserine bursitis. Diagnostic possibilities associated with lateral pain include lateral collateral sprain, meniscal pathology, or iliotibial (IT) band tendinopathy. Posterior pain suggests the presence of effusion, Baker cyst, or hamstring tendinopathy.

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PHYSICAL EXAMINATION

Findings on the physical examination are key to establishing a working diagnosis and directing subsequent management. (1)

Observation

The first step in the knee examination is to observe the patient. Limp or inability to bear weight is concerning for serious pathology, including intra-articular derangement and bacterial infection. Redness about the knee raises the possibility of infection or inflammatory arthritis. Significant gross swelling is likely due to an effusion or prepatellar bursitis.

Palpation

Knee palpation is the most critical component of the physical examination. Joint warmth suggests potential infection or inflammation. Clinicians should palpate the distal femur, tibia, and fibula for tenderness or mass, which is concerning for fracture and tumor, respectively. The posterior fossa should be assessed for a mass consistent with a Baker cyst.

The next step in the physical examination is to determine whether an effusion is present. In addition to observation for gross swelling, the clinician has several options to assess effusion. In the ballottement test, the clinician “milks” excess fluid within the suprapatellar pouch distally toward the patella, then applies posterior pressure to the patella. The presence of bogginess compared to the other knee implies increased intra-articular fluid consistent with an effusion. In the swipe test, the clinician swipes one hand from beneath the medial joint line upward and toward the suprapatellar pouch in an attempt to move the effusion from the inside of the joint capsule to the lateral suprapatellar pouch. The clinician then swipes downward on the lateral aspect of the thigh, just superior to the suprapatellar pouch toward the lateral joint line. A small wave or bulge on the medial aspect of the knee just inferior to the patella suggests an effusion.

After assessing for warmth, bony tenderness, masses, and effusion, the clinician should palpate for areas of tenderness. Anteriorly, such palpation addresses the patella facets. To assess the patella, the clinician displaces the patella laterally and medially and palpates the facets on the undersurface of the patella. Tenderness at the inferior pole of the patella may suggest apophysitis. Further, the clinician should palpate the quadriceps and patellar tendon and the tibial tubercle. Medial palpation should address the medial collateral ligament, the medial joint line (femoral condyle, tibial condyle, and medial meniscus), and the pes anserine. Laterally, the clinician palpates for the lateral collateral ligament, the lateral joint line (femoral condyle, tibial condyle, and lateral meniscus), and the distal IT band. Posterior tenderness evaluation should encompass the distal hamstrings.
Range of Motion
Every patient should be able to flex the hip to 90 degrees and internally rotate the hip to 10 degrees without pain. Pain or inability to perform such hip motion is concerning for hip pathology.

The knee should extend fully and symmetrically compared to the opposite knee. Inability to extend the knee fully suggests the possibility of meniscal tear or a loose body causing a mechanical block. The knee should be able to flex to at least 110 degrees. Inability to flex the knee has a broad differential diagnosis, including mechanical block from meniscal tear, loose body, or effusion; quadriceps tightness or contracture; or anterior knee pathology (quadriceps or patellar tendinopathy, patellofemoral syndrome, or apophysitis) that inhibits knee movement due to pain.

Patellar mobility can be assessed by displacing the patella laterally and medially from a midline neutral position. Any restriction in motion may indicate patellofemoral syndrome, and excessive mobility could indicate instability.

Hamstring, quadriceps, and IT band flexibility must be assessed. Hamstring flexibility is measured by the popliteal angle. The supine patient’s hip is flexed to 90 degrees and the knee is extended until resistance is appreciated. Quadriceps flexibility is measured while the patient is prone with knee flexing. IT flexibility is measured by the Ober test in which the patient lies on the opposite side with the knee flexed to 90 degrees and hip extended 10 degrees. The clinician allows the force of gravity to adduct the extremity.

Strength
Hip flexor, quadriceps, and hamstring strength can be assessed while the patient is in a sitting position. Importantly, the clinician must assess the strength of the hip abductors and external rotators; weakness of these muscles is associated with anterior knee pain. Gluteus minimus strength is assessed with the patient lying on his or her side and adducting the upper hip while it is in a slight amount of extension. Gluteus medius strength is assessed with the patient lying on his or her side and adducting the upper hip while it is in a slight amount of extension and maximally externally rotated.

Figure 1. Diagnosis and management algorithm.

- ANA=antinuclear antibody, CBC=complete blood cell count, CRP=C-reactive protein, CT=computed tomography, ESR=erythrocyte sedimentation rate, MRI=magnetic resonance imaging
Special Tests

The clinician should approach special testing with potential diagnoses in mind. Patellar instability is assessed via the patellar apprehension test. When the patella is laterally displaced, pain or apprehension is considered a positive apprehension test and indicative of patellar subluxation, dislocation, or chronic instability. The patellar grind test assesses for potential patellofemoral syndrome. The patient is asked to contract the quadriceps while supine and fully extend the knee. The patient then relaxes the quadriceps, and as the clinician pinches the quadriceps tendon, effectively shortening the extensor mechanism, the patient is asked to contract the quadriceps again. Shortening the extensor mechanism places stress on the patellofemoral joint and can exacerbate underlying patellofemoral syndrome.

Ligamentous instability is assessed through stress testing, with pain or excessive motion with stress testing considered a positive test result. Valgus and varus stress testing assesses the medial collateral ligament and lateral collateral ligament, respectively. Valgus and varus stress testing should be performed with the knee in slight flexion to prevent false-negative results from the inherent bony stability of an extended knee. Anterior and posterior drawer testing evaluates the anterior cruciate ligament and posterior cruciate ligament, respectively. The Lachman test also assesses anterior cruciate ligament incompetency. With the quadriceps relaxed and the knee flexed to 20 degrees, the clinician tries to displace the tibia anteriorly upon the femur beyond the stability demonstrated on the unaffected knee.

DIAGNOSIS AND MANAGEMENT ALGORITHM

Using the information gained from the history and physical examination, the clinician can establish a working diagnosis and direct subsequent evaluation and management (Fig 1).

The initial priority in evaluation of a patient presenting with knee pain is identification of any potentially limb- or life-threatening conditions. These conditions include septic arthritis, osteomyelitis, primary musculoskeletal malignancies, and other systemic malignancies (especially leukemia). A history of unexplained systemic symptoms (eg, fever, sweats, night sweats, anorexia, fatigue, malaise, weight loss), pain that awakens the patient from sleep, mass, erythema, or warmth should raise substantial concern.

Any concern for bacterial infection merits referral of the patient to an emergency department for radiographs, laboratory studies, possible knee aspiration with synovial fluid analysis, advanced imaging with magnetic resonance imaging (MRI), and orthopedic consultation. Concern for malignancy should prompt immediate radiographs as well as possible laboratory studies, advanced imaging with MRI or computed tomography scan, and orthopedic or oncologic consultation.

If the clinician has no concern for limb- or life-threatening conditions, he or she should evaluate the hip as a potential source of pain that is referred to the knee. Concern for hip pathology, especially slipped capital femoral epiphysis, warrants an emergency evaluation. A history of hip, thigh, or medial knee pain coupled with limited hip motion on physical examination should raise suspicion for hip
If hip pathology is a true diagnostic possibility, the patient should be made strictly nonweight-bearing and radiographs of the pelvis obtained emergently. The presence of a slipped capital femoral epiphysis necessitates immediate referral to an emergency department.

If there is no concern for a limb- or life-threatening condition or hip pathology, the clinician must determine if an effusion is present. An effusion is suggested by gross swelling, painful or limited flexion, and positive ballottement or swipe testing results. The presence of an effusion implies intra-articular pathology that requires urgent evaluation.

Among the multiple causes of intra-articular derangement causing posttraumatic effusion are fracture, cartilage injury, cruciate ligament rupture, meniscal tear, and patellar subluxation or dislocation. If the effusion is posttraumatic, the clinician should immobilize the knee, make the patient nonweight-bearing, initiate pain control, and obtain urgent radiographs. If the radiographs are nondiagnostic, urgent MRI without contrast is indicated. If imaging confirms intra-articular derangement, the patient should be urgently referred to an orthopedic surgeon. If the presence of an effusion is confirmed without any specific findings of intra-articular pathology.
derangement, the clinician should consider pursuing the evaluation of an effusion without a history of trauma (described later in this article) or referral to an orthopedic surgeon for possible diagnostic arthroscopy. If imaging does not reveal any pathology, the clinician should pursue evaluation of conditions due to acute or chronic stress on vulnerable knee structures (described later in this article).

The differential diagnosis of an effusion without a history of trauma includes the previously mentioned intra-articular derangement, the juvenile idiopathic arthritides, other systemic inflammatory conditions that are associated with arthritis (eg, systemic lupus erythematosus, inflammatory bowel disease), and nonseptic joint infection (eg, Lyme disease, gonococcal, viral). If the effusion is atraumatic, the patient can be allowed to bear weight as tolerated. In addition, the clinician should initiate pain control, obtain knee radiographs, and order appropriate laboratory studies (complete blood cell count with differential count, erythrocyte sedimentation rate, C-reactive protein, anti-nuclear antibody with reflexive titters, Lyme titters with reflexive Western blot if in an endemic area, and viral titters or gonococcal cultures if appropriate). Any concern for inflammatory arthritis should prompt referral to a rheumatologist for further management. Four weeks of appropriate antibiotics should be administered for Lyme arthritis. Gonococcal arthritis is treated with at least 7 days of parenteral antibiotics with concurrent chlamydial treatment. Viral-associated arthritis can be treated with pain control and close observation.

If the clinician eliminates potential limb- or life-threatening conditions, hip pathology, and effusion from the differential diagnosis, he or she should use the pain location and degree of tenderness to guide diagnosis and management. Most often, knee pain is related to acute or chronic stress on vulnerable knee structures. Anterior pathology includes patellofemoral syndrome, apophysitis of the patella and tibial tubercle, quadriceps and patellar tendinopathy, and prepatellar bursitis (Fig 2). Posterior pathology comprises Baker cyst and hamstring tendinopathy. Lateral pathology can encompass lateral collateral ligament sprain, IT band tendinopathy, and meniscal pathology (including tears and discoid meniscus) (Fig 3). The primary sources of medial pathology are collateral ligament sprain, pes anserine tendinopathy, meniscal pathology, and osteochondritis dissecans (Fig 4).

Once a vulnerable structure has been identified as the likely source of pain, the clinician should use other findings of the physical examination to evaluate for biomechanical factors contributing to stress on the vulnerable structure. Such biomechanical factors commonly include inflexibility (hamstrings, quadriceps, or IT band) and weakness (gluteus medius, gluteus minimus, or quadriceps). The clinician should initiate a home exercise program or physical therapy to address any deficiencies. In addition, anti-inflammatory medications, frequent brief periods of icing, and bracing should be considered. If there is no improvement in 4 to 6 weeks with these interventions, radiographs plus MRI or referral to orthopedics, sports medicine, or rheumatology should be considered.

During the previously described evaluation, clinicians commonly identify a benign bone tumor. This frequently incidental and asymptomatic finding may be the source of the patient’s knee pain. Large lesions (nonossifying fibromas, aneurysmal bone cysts, unicameral bone cysts, osteochondromas) can weaken the bone and lead to pathologic fractures. Further, some benign bone tumors can be inherently painful (osteoid osteoma, osteochondroma). Other lesions (aneurysmal bone cysts) are locally aggressive. Nonossifying fibromas and osteochondromas can be monitored by the clinician, but large lesions, pathologic fractures, locally aggressive lesions, and inherently painful lesions should be referred to an orthopedic surgeon for surgical evaluation.

Finally, if no other diagnosis can be established, a finding of growing pains may be considered. Growing pains typically occur in a 2- to 10-year-old child who experiences pain in the evening or during sleep in both legs (but may be only one leg at a time). The pain resolves by the morning and does not affect the patient during the day. Physical examination findings are normal. Growing pains can be managed with pain control and parental reassurance.

### Summary

- On the basis of primarily consensus, due to lack of relevant clinical studies, the information obtained from the history and physical examination is the key to establishing a diagnosis and directing initial management of knee pain. (1)
- By applying history and physical examination findings to a diagnosis and management algorithm, clinicians can efficiently and effectively determine the potential cause of the knee pain.
- On the basis of primarily consensus, due to lack of relevant clinical studies, the most important step of the evaluation of knee pain is to identify emergent conditions, including limb- and life-threatening conditions (eg, septic arthritis, osteomyelitis, and malignancy), hip pathology, or conditions associated with effusions. (2)(3)(4)(5)(6)(7)(8)

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1. A 13-year-old boy began competitive running several months ago. He now complains of intermittent burning pain in his lateral left knee. Which of the following findings suggests iliotibial band tendinopathy as the cause of his pain?
   A. Nighttime pain that wakes the boy from sleep.
   B. Positive Ober test.
   C. Positive patellar apprehension test.
   D. Swelling behind the knee.
   E. Swollen knee upon awakening in the morning that improves with activity.

2. Your 14-year-old patient complains of several weeks of left knee pain that is worse when walking to school. She has mild persistent asthma and moderate obesity. She has no history of sports participation or trauma. On physical examination, the only finding is decreased internal rotation of the hip with mild pain. The most appropriate next step is to:
   A. Collect a urine specimen to test for gonococcal DNA.
   B. Immediately make the patient nonweight-bearing and obtain an urgent radiograph of the pelvis.
   C. Prescribe ibuprofen to treat her groin strain.
   D. Tell her to reduce time spent in sitting position and help her set a goal to increase her physical activity.
   E. Suggest rest and reassure her.

3. A 16-year-old boy presents with a painful knee after being hit from the side in football. On physical examination, you perceive a joint effusion and bruising over the lateral aspect of the knee. The most appropriate next step in caring for this patient is to:
   A. Advise rest and return to play when swelling subsides.
   B. Apply an elastic wrap to the knee to minimize swelling and provide support.
   C. Apply ice to the knee for 15 minutes at hourly intervals for 24 hours.
   D. Immobilize the knee and refer to the emergency department for urgent radiographs.
   E. Place the patient in a knee immobilizer and follow up in 1 week.

4. A 12-year-old girl complains of right anterior knee pain during gym and when climbing stairs. She has no history of trauma and denies that the knee locks or gives way. For which of the following findings would radiographs of the knee be most appropriate?
   A. Pain with compression of the quadriceps tendon while contracting the quadriceps.
   B. Presence of knee effusion with ballottement test.
   C. Tenderness over the lateral femoral condyle.
   D. Tenderness over the tibial tubercle.
   E. Tenderness over the inferior pole of the patella.

5. Your 7-year-old patient complains of intermittent pain in both legs when trying to fall asleep. The pain is relieved by massage. He plays soccer and has no pain during the day. Physical examination results are normal. Which of the following is a true statement about this scenario?
   A. Because the pain occurs at night, the child should be referred to an orthopedist.
   B. Fever, fatigue, and weight loss may occur with this condition.
   C. Reassuring the parents that their child has a harmless condition is appropriate.
   D. Radiographs of the legs are indicated to eliminate the possibility of a bone tumor.
   E. This child should discontinue participation in soccer.

Parent Resources from the AAP at HealthyChildren.org

- Knee Pain and Osgood-Schlatter Disease: https://www.healthychildren.org/English/health-issues/injuries-emergencies/sports-injuries/Pages/Knee-Pain-and-Osgood-Schlatter-Disease.aspx
- Knee Pain: How to Choose the Right Knee Brace for Your Child: https://www.healthychildren.org/English/health-issues/injuries-emergencies/sports-injuries/Pages/Knee-Pain-and-braces.aspx
- Knee Pain and Patellofemoral Pain Syndrome: https://www.healthychildren.org/English/health-issues/injuries-emergencies/sports-injuries/Pages/Knee-Pain-and-Patellofemoral-Pain-Syndrome.aspx
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