Knee Pain in Children, Part II: Limb- and Life-threatening Conditions, Hip Pathology, and Effusion

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Practice Gap

Clinicians who evaluate knee pain must be able to recognize limb- and life-threatening conditions, hip pathology, or joint effusion and pursue the appropriate management.

Objectives

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

1. Describe the presentation and treatment of common limb- and life-threatening conditions that can cause knee pain in children.
2. Delineate how hip pathology can contribute to knee pain in children and how such conditions should be diagnosed and treated.
3. Explain the diagnosis and treatment of conditions that may cause effusion in conjunction with knee pain in children.

INTRODUCTION

As noted in the first part of this three-part review of knee pain in children, the clinician can use the information gained from the history and physical examination in an algorithm to establish a working diagnosis and direct subsequent evaluation and management. The initial priorities are to identify emergent limb- and life-threatening conditions, hip pathology, or effusion (Table).

LIMB- AND LIFE-THREATENING CONDITIONS

Bacterial Infections

Septic Arthritis. The knee is the most common site of septic arthritis in children. Usually, septic arthritis is characterized by the acute onset of steadily progressive knee pain with fever and a physical examination demonstrating effusion, warmth, erythema, and limited motion. Concern for septic bacterial arthritis in children warrants emergent evaluation, including knee radiographs (anteroposterior [AP] and lateral) and laboratory studies (complete blood cell [CBC] count with

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differential count, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), blood culture, and synovial fluid analysis that includes cell count and differential count, Gram stain, and culture. Magnetic resonance imaging (MRI) should be obtained to detect any adjacent osteomyelitis. Children with bacterial arthritis often require open surgical drainage followed by prolonged antibiotic therapy. (1)(2)(3)

**Musculoskeletal and Systemic Malignancies**

Although the overall incidence of malignancy is low, several malignant conditions can present as knee pain, including primary bone lesions (Ewing sarcoma, osteosarcoma, primary bone lymphoma), soft-tissue malignancies (rhabdomyosarcoma, fibrosarcoma, liposarcoma), and leukemia. (6)

Children who present with knee pain and systemic symptoms, nighttime pain, or a palpable mass should be evaluated immediately for malignancy. The evaluation begins with radiographs of the knee (AP and lateral) and possible AP and lateral radiographs of the femur or tibia and fibula. Ewing sarcoma is associated with layers of periosteal reaction called “onion skinning.” Osteosarcoma is characterized by the radiographic finding of “sun bursting,” which represents calcified blood vessels radiating out from the lesion. Leukemia frequently is associated with radiographic osseous abnormalities, including diffuse osteopenia, metaphysial bands, periosteal new bone formation, geographic lytic lesions, sclerosis, mixed sclerosis/lysis, and permeating destruction. (7)(8)(9)(10)

Depending on the degree of clinical concern, subsequent evaluation usually begins with an MRI and may include a CBC with manual differential count or computed tomography scan. Laboratory studies looking for evidence of active inflammation (ESR, CRP, antinuclear antibody [ANA] with reflexive titers) could also be considered. Any concern for malignancy should be directed to a pediatric oncologist for immediate evaluation.

**HIP PATHOLOGY**

Knee pain may be indicative of hip pathology, including slipped capital femoral epiphysis. Hip pathology must be considered if there is concurrent hip or thigh pain with medial knee pain or the patient is unable to flex the hip to 90 degrees or internally rotate the hip to 10 degrees without pain. The patient for whom the clinician has concern about hip pathology must remain strictly nonweight-bearing until pelvis radiographs (AP and frog-leg lateral) are obtained to ensure the absence of emergent hip pathology.
Slipped capital femoral epiphysis is pathology of the proximal femoral physis that results in displacement of the proximal femoral epiphysis from the metaphysis. It typically occurs in 10- to 16-year-old children. The patient with a slipped capital femoral epiphysis who initially can tolerate weight-bearing but progresses to the point where weight-bearing is intolerable has a significantly worse prognosis. Patients whose physical examination or radiographic findings are consistent with slipped capital femoral epiphysis should be made strictly nonweight-bearing and referred to the emergency department for further management. (11)(12)

**EFFUSION AFTER TRAUMA**

If significant swelling develops after an acute traumatic injury and there is evidence of effusion on physical examination, the clinician must consider intra-articular derangement of the knee until proven otherwise. Intra-articular derangement includes fractures (tibia, femur, fibula or patella), cartilage injury, cruciate ligament rupture, meniscal tear, and patellar subluxation or dislocation. Any concern for intra-articular derangement necessitates MRI of the knee without contrast. (13)(14)(15)

**Intra-articular Fractures**

Intra-articular fractures are uncommon. They can occur to the femur, tibia, fibula, or patella. Any patient presenting with traumatic knee pain, effusion, and bony tenderness needs radiographs (AP and lateral of knee) to assess for possible intra-articular fracture. If fracture is present, the patient should be made nonweight-bearing, the knee immobilized, and the patient referred for emergent surgical evaluation. (16)

**Cartilage Injury**

Cartilage injuries can also cause posttraumatic effusion. Affected patients often present with pain and effusion and may complain of mechanical symptoms. Cartilage lesions are identified by MRI. Small lesions without significant underlying bone injury can often be managed nonoperatively with rest and rehabilitation. Larger lesions or those associated with significant subchondral bone injury that results in an unstable defect often must be treated surgically with debridement, stabilization, or cartilage grafting techniques. (17)(18)

**Cruciate Ligament Rupture**

The anterior cruciate ligament (ACL) prevents anterior translation of the tibia upon the femur and is crucial for knee stability. Patients who have ACL rupture present with varying degrees of pain but typically all have an effusion. The ACL can be ruptured in isolation or with concurrent injuries to other ligaments or the meniscus. If there are concurrent injuries, the patient should be urgently referred for surgical evaluation. If the ACL rupture is isolated, the primary care physician may initiate physical therapy. A period of physical therapy before surgical reconstruction improves outcomes in patients with isolated ACL ruptures who undergo surgical reconstruction, although isolated ACL ruptures do not necessarily require surgical reconstruction. However, because only approximately 10% of patients with an incompetent ACL are capable of competing in athletics without further episodes of instability (and risk of further intra-articular derangement), most young athletes pursue immediate surgical reconstruction. A total of 6 to 9 months of rehabilitation is required after reconstruction before a return to sports can be considered. Studies of return to athletics after ACL reconstruction show mixed outcomes but generally positive results. After ACL rupture, the incidence of osteoarthritis increases significantly, regardless of subsequent management. (19)(20)(21)

The posterior cruciate ligament (PCL) prevents posterior translation of the tibia upon the femur. In most individuals, the PCL is not crucial for knee stability. Patients with isolated PCL ruptures can be referred for rehabilitation and can usually return to a high level of athletics within a few months. (22)

**Meniscal Injury**

The menisci are specialized thickened cartilage tissues that stabilize and cushion the tibial-femoral joint. Each knee has a lateral and medial meniscus. Patients with a meniscus injury present with pain, effusion, and often limited motion and mechanical symptoms. Physical examination can reveal limited range of motion and joint-line tenderness. Depending on the location and size of the tear in the meniscus, patients may undergo meniscal repair, partial meniscectomy, and rarely complete meniscectomy. (23)(24)

**Patellar Subluxation and Dislocation**

The patella is stabilized by multiple ligamentous and soft-tissue supports. Direct trauma to the patella or a violent contraction of the quadriceps with the knee flexed can cause subluxation or dislocation of the patella, usually laterally. This injury results in a sprain or rupture of the medial patellofemoral ligament (MPFL). Concurrent injury to the cartilage or subchondral bone can occur during dislocation or relocation of the patella, usually to the lateral femur or medial patella. Patients present with pain and effusion. If the patella is still dislocated, deformity is obvious, with the patella resting lateral to its anatomic position. Physical examination reveals an effusion (often small in a subluxation and large in a dislocation), significant medial patellar tenderness, and a positive patellar apprehension sign.
As many as 50% of patients have been reported to experience repeat episodes of patellar instability. Accordingly, some surgeons advocate for surgical reconstruction of the MPFL after an initial dislocation. However, most clinicians obtain MRI after an episode of instability, and if there is concurrent significant cartilage or subchondral damage, refer the patient for surgical evaluation. If there is no evidence of concurrent injury, the patient is immobilized for 3 weeks, with weight-bearing as tolerated. Immobilization allows for healing without distracting stress that may result in increased mobility of the MPFL. After 3 weeks, the patient is referred for rehabilitation. Most patients can return to athletic activity in 2 to 4 months. (23)(26)

Effusion Without Trauma

In addition to trauma, an effusion can be caused by inflammatory conditions or nonseptic infectious arthritis. (13)

Juvenile Idiopathic Arthritis

The juvenile idiopathic arthritides are a collection of idiopathic autoimmune diseases that result in inflammatory arthritis. The current classification system describes five categories, but each category probably encompasses more than one disease and a patient may not fit into only one category. (27)(28)

Systemic-onset juvenile idiopathic arthritis (formerly known as Still disease) is characterized by intermittent fever, rash, and arthritis. The fever classically peaks one or two times per day and can be intermittent. The rash is salmon pink, macular, and migratory and frequently occurs with the fever. The arthritis may not be present early in the course but can become destructive. The patient may also develop lymphadenopathy and hepatosplenomegaly. Patients frequently have significant leukocytosis and thrombocytosis, anemia, and elevated ESR. Results of tests for ANA and rheumatoid factor are usually negative. Based on findings from the history, physical examination, and laboratory studies, the differential diagnosis for systemic-onset juvenile idiopathic arthritis is broad and includes viral arthritis, leukemia, lymphoma, malaria, and other rheumatologic conditions (eg, systemic lupus erythematosus, dermatomyositis). Treatment begins with nonsteroidal anti-inflammatory medications and progresses to corticosteroids, methotrexate, and other disease-modifying biologic drugs. The most common complications of systemic-onset juvenile idiopathic arthritis are macrophage activation syndrome, growth retardation, and osteoporosis. (29)

Pauciarticular-onset juvenile idiopathic arthritis is characterized by large joint asymmetric arthritis in four or fewer joints, usually in a 2- to 5-year-old girl. The presentation generally is characterized by a limp and swollen joint but no complaint of pain or systemic symptoms. Pauciarticular-onset juvenile idiopathic arthritis is associated with uveitis, especially if ANA antibodies are present. Treatment is typically limited to nonsteroidal anti-inflammatory medications and intra-articular corticosteroids. Leg length discrepancy and short stature are well-known complications.

Polyarticular-onset juvenile idiopathic arthritis is characterized by symmetric small joint arthritis in five or more joints. The course is often complicated by dactylitis, uveitis (especially if ANA-positive), and destructive arthritis.

Psoriatic arthritis and enthesitis-related arthritis are the two final categories of juvenile idiopathic arthritides.

Infectious Arthritis

Lyme Disease. Lyme disease is an infection associated with the spirochete Borrelia burgdorferi. Infection occurs through a tick bite. Lyme disease is endemic in the northeastern United States, Virginia, Minnesota, and Wisconsin. Early localized disease is characterized by the bull’s-eye erythema migrans rash, which can be accompanied by fever, fatigue, or arthralgia. Untreated Lyme disease progresses to early disseminated disease (which may cause multiple erythema migrans, cranial nerve palsy, meningitis, and carditis) and finally late disseminated disease (which most commonly results in arthritis). Lyme arthritis typically presents with a large effusion. Pain is variable but is usually not severe, and most often patients can bear weight. Untreated Lyme arthritis generally resolves spontaneously but returns in the same or a different joint. Patients with suspected Lyme arthritis should undergo Lyme antibody enzyme-linked immunosorbent assay screening with reflexive Western blot confirmation drawn from the blood. Treatment is 28 days of oral antibiotics. If pain or swelling persists 6 weeks after the initiation of therapy, an alternative diagnosis should be pursued. (30)(31)(32)(33)

Gonococcal Arthritis. Untreated infection with Neisseria gonorrhoea progresses to disseminated gonococcal infection, which can result in arthritis. The arthritis in disseminated gonococcal infection can occur as part of a classic triad of dermatitis, tenosynovitis, and migratory polyarthritis or as an isolated purulent arthritis, usually in the knee. Patients with gonococcal purulent arthritis present with a warm, swollen, red knee. The clinician who is considering the diagnosis of gonococcal arthritis should obtain synovial fluid for culture. However, synovial cultures can be false-negative, so cultures or polymerase chain reaction testing of the blood or cervix, rectum, urethra, and pharynx specimens should be considered. Testing for additional sexually transmitted infections should
also be considered. Patients with gonococcal arthritis must be treated with parenteral antibiotics initially, changing to oral antibiotics as symptoms improve. Presumptive treatment for concurrent chlamydial infection should be strongly considered. (34)(35)

Viral Arthritis. Several viruses can directly cause arthritis and arthralgia. Those most commonly causing arthritis are parvovirus, hepatitis B and C, and rubella. Arthritis and arthralgia typically occur during the viral prodrome. Serologic testing for specific viruses as well as general laboratory studies (CBC count with differential count, ESR, CRP, comprehensive metabolic panel) can be obtained if the diagnosis cannot be determined clinically. Treatment of viral arthritis is supportive with ice and anti-inflammatory medications. (36)(37)

Summary

- On the basis of primarily consensus due to lack of relevant clinical studies, the most important evaluative step for knee pain is to identify any emergent conditions, including limb- and life-threatening disorders (septic arthritis, osteomyelitis, and malignancy), hip pathology, or conditions associated with effusions. (2)(3)(6)(8)(11)(13)(14)

CME quiz and references for this article are at http://pedsinreview.aappublications.org/content/37/2/72.

Parent Resources from the AAP at HealthyChildren.org

- 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
- English only
- 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
- English only
- 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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This journal-based CME activity is available through Dec. 31, 2018, however, credit will be recorded in the year in which the learner completes the quiz.

1. A 9-year-old boy presents with 48 hours of increasingly severe left knee pain, inability to bear weight, and temperature to 103°F (39.4°C). On physical examination, he is distressed and unable to tolerate your attempt to evaluate range of motion of the knee. The knee is warm and red, and effusion is present. The most likely diagnosis is:
   A. Intra-articular fracture.
   B. Pauciarticular juvenile idiopathic arthritis.
   C. Psoriatic arthritis.
   D. Septic (bacterial) arthritis.
   E. Viral arthritis.

2. A 7-year-old girl complains of right knee pain that is worse at night. Radiography of the right femur reveals layers of periosteal reaction of the distal diaphysis. The radiographic finding of “onion skinning” is associated with a diagnosis of:
   A. Ewing sarcoma.
   B. Leukemia.
   C. Osteoid osteoma.
   D. Osteomyelitis.
   E. Osteosarcoma.

3. A 15-year-old boy presents with medial knee pain and a limp that has progressively worsened over the last 2 weeks. He has no fever, weight loss, fatigue, or nighttime pain. There is no history of trauma. On physical examination, he has pain with flexion and internal rotation of the left hip. Another finding likely to be present is:
   A. Displacement of the proximal femoral head from the metaphysis on radiograph.
   B. Knee effusion.
   C. Meniscal tear on magnetic resonance imaging.
   D. Medial collateral ligament disruption on magnetic resonance imaging.
   E. Palpable mass in the proximal tibia.

4. A previously healthy 3-year-old girl presents with a limp and swollen right knee of several days’ duration. Laboratory studies show an erythrocyte sedimentation rate of 84 mm/hr and a positive antinuclear antibody titer at 1:320. Ophthalmologic consultation reveals an additional finding of uveitis. The most likely diagnosis is:
   A. Juvenile idiopathic arthritis.
   B. Lyme arthritis.
   C. Psoriatic arthritis.
   D. Rheumatic fever.
   E. Systemic lupus erythematosus.

5. A 3-year-old boy presents with a large right knee effusion. He is able to walk with discomfort. His history includes a 7-cm bull’s-eye rash in the right groin that appeared 3 months ago and was associated with malaise and low-grade fever. The suspected diagnosis is confirmed by a laboratory test. The most appropriate treatment for this condition is:
   A. Amoxicillin administered orally for 2 weeks.
   B. Amoxicillin administered orally for 4 weeks.
   C. Corticosteroids administered orally.
   D. Corticosteroids administered intravenously.
   E. Nafcillin administered intravenously for 6 weeks.
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