Knee Pain in Children, Part III: Stress Injuries, Benign Bone Tumors, Growing Pains

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Practice Gap

Clinicians who evaluate knee pain must be able to recognize stress injuries, benign bone tumors, or growing pains and pursue the appropriate management.

Objectives

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

1. Describe the presentation and treatment of stress injuries that may cause knee pain in children.
2. Delineate the presentation and treatment of benign bone tumors that may cause knee pain in children.
3. Describe the presentation of growing pains in children.

INTRODUCTION

According to the treatment algorithm cited in the first part of this three-part article on knee pain in children, the initial concerns that the clinician must address are limb- and life-threatening conditions, hip pathology, and effusion-related conditions. After eliminating these potential causes, clinicians can turn to their attention to stress injuries and benign bone tumors (Table). If none of these diagnoses is captured in the patient review, a final possibility is growing pains.

ACUTE AND CHRONIC STRESS INJURIES TO VULNERABLE KNEE STRUCTURES

Anterior Knee Pain

Patellofemoral Syndrome. Patellofemoral syndrome involves dysfunction of the patellofemoral joint that presents as anterior knee pain. With this syndrome, altered forces and tracking mechanics at the patellofemoral joint place excessive stress on the joint. Physical examination findings include patellar facet tenderness and a painful patellar grind test. Rarely, patellofemoral syndrome can present with a small effusion. The key to treatment is identification of the inappropriate biomechanical forces that are causing stress in the joint. In young patients, such abnormal forces are related to tight hamstrings or quadriceps, weak hip external rotators (gluteus medius and gluteus minimus), or a tight lateral retinaculum of
the patella. These conditions can be addressed with home exercises or physical therapy. In addition, open patellar bracing can be helpful. Postexertional ice and intermittent anti-inflammatory drugs can help with pain control. If symptoms do not improve after a course of physical therapy, radiographs with anteroposterior (AP), lateral, and sunrise views are indicated, and if radiographs are nondiagnostic, magnetic resonance imaging (MRI) is appropriate. Persistent pain despite improvement in the underlying abnormal biomechanics warrants diagnostic arthroscopy to evaluate for intra-articular derangement not demonstrated on imaging. Finally, surgical procedures, including a lateral soft-tissue release, may be needed. (1)(2)

**Quadriceps or Patellar Tendon Tendinopathy.** The quadriceps tendon inserts the quadriceps to the superior aspect of the patella. The patellar tendon originates from the inferior aspect of the patella and inserts onto the tibial tubercle. Abnormal biomechanical forces can cause stress injury of either tendon. Patients present with tenderness of the tendon. Treatment is similar to that for patellofemoral syndrome or apophysitis.

**Prepatellar Bursitis.** Bursae are fluid-filled sacs throughout the body that help alleviate areas of tension. One is the prepatellar bursa that reduces friction between skin and the patella. It can be acutely or chronically inflamed. Affected patients present with anterior knee pain and swelling (sometimes significant) that may be associated with erythema and warmth. Physical examination reveals discrete prepatellar swelling. The primary treatment is anti-inflammatory measures, including ice, compression, and anti-inflammatory medications. Rarely, the bursa must be aspirated. Of note, an inflamed bursa can become superinfected, necessitating oral antibiotic therapy.

**Posterior Knee Pain**

**Baker Cyst.** A Baker cyst is a popliteal fossa extension of the synovial lining or a distinct enlarged bursa that results in a focalized area of swelling and occasional pain. It is common in 4- to 8-year-old children and most often is developmental rather than related to intra-articular pathology. However, the cyst can also form after effusion. If there is no concern for intra-articular pathology, the patient can be observed because the cyst is usually self-limited. The diagnosis can be confirmed with soft-tissue ultrasonography. Acute worsening of pain and generalized swelling may signal cyst rupture. Any concern for intra-articular pathology should prompt an appropriate evaluation, as described previously. (4)(5)

**TABLE. Specific Causes of Knee Pain in Children**

<table>
<thead>
<tr>
<th>ACUTE OR CHRONIC STRESS ON VULNERABLE STRUCTURE</th>
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<tr>
<td><strong>Anterior</strong></td>
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<tr>
<td>- Patellofemoral syndrome</td>
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<td>- Apophysitis of the patella or tibial tubercle</td>
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<tr>
<td>- Quadriceps or patellar tendinopathy</td>
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<td>- Prepatellar bursitis</td>
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<tr>
<td><strong>Posterior</strong></td>
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<tr>
<td>- Baker cyst</td>
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<tr>
<td>- Hamstring tendinopathy</td>
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<tr>
<td><strong>Lateral</strong></td>
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<tr>
<td>- Lateral collateral ligament sprain</td>
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<td>- Iliotibial band tendinopathy</td>
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<td>- Meniscal pathology</td>
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<tr>
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<tr>
<td>- Medial collateral ligament sprain</td>
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<td>- Pes anserine tendinopathy</td>
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<td>- Osteochondritis dissecans</td>
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<tr>
<th>SYMPTOMATIC BENIGN BONE TUMOR</th>
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<tr>
<td>- Osteochondroma</td>
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<td>- Osteoid osteoma</td>
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<tr>
<td>- Aneurysmal bone cyst</td>
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<td>- Nonossifying fibroma</td>
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<th>GROWING PAINS</th>
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An apophysis is a physis at the attachment site of a tendon or ligament. The apophysis helps to relieve stress at the insertion site and provides a painful warning of excessive stress on the joint. Osgood-Schlatter disease is an apophysitis of the tibial tubercle and Sinding-Larsen-Johansson disease is an apophysitis of the inferior pole of the patella. Affected patients present with anterior knee pain and bony tenderness in the area of the apophysis. Similar to patellofemoral syndrome, the key to treatment is to identify the inappropriate biomechanical forces that are causing stress on the apophysis and address them with home exercises or physical therapy. Ice, anti-inflammatory medications, and a counterforce strap worn between the patella and tibial tubercle also can alleviate some pain. Rarely, a brief period of immobilization is indicated for severe pain. (3)

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Hamstring Tendinopathy. The hamstrings are the flexors of the knee. They originate from the pelvis, cross the knee, and insert on the proximal tibia. Acute stress, usually during sprinting, can strain the hamstring. Such strains present with the acute onset of pain and limp and occasionally with bruising. Chronic stress, usually from inflexibility, can result in tendinopathy, which presents with acute or chronic pain with tenderness. Patients who have hamstring tendinopathy can be treated with icing, anti-inflammatory medications, and physical therapy.

Lateral Knee Pain

Lateral Collateral Ligament Injury. The lateral collateral ligament is an extra-articular structure that supports the knee from varus stress. The ligament is usually injured from a blow to the medial aspect of the knee, but injury can also occur with a noncontact varus stress or direct trauma to the lateral aspect of the knee. Patients present with pain and swelling to the lateral aspect of the knee. There is tenderness of the lateral knee as well as pain and possibly instability with varus stress testing. Treatment includes icing, pain control, and physical therapy. High-grade sprains or ruptures may benefit from an initial period of immobilization. Lateral collateral ligament injuries with concurrent injuries to other posteroslateral knee structures can result in knee instability and require surgical intervention. Injuries to the lateral collateral ligament generally heal more slowly than those to the medical collateral ligament. Most athletes can return to play in 1 to 2 months.

Iliotibial (IT) Band Tendinopathy. The IT band is a tendinous structure that acts to extend, abduct, and externally rotate the hip. In addition, the IT band contributes to lateral knee stabilization. During knee extension, the IT band moves anteriorly, while knee flexion moves the IT band posteriorly. It originates on the iliac crest and inserts at the lateral condyle of the tibia at Gerdy tubercle. Patients with IT band tendinopathy present with pain in the lateral aspect of the knee that often is worse with exertion. Physical examination shows lateral knee tenderness and IT band tightness. Treatment involves IT band stretching and physical therapy.

Meniscal Pathology. The menisci are specialized thickened cartilage tissues that stabilize and cushion the tibial-femoral joint. The lateral meniscus is less likely to be injured than the medial meniscus, but injury can occur via a twisting mechanism. Patients present with lateral knee pain. Larger tears may cause an effusion and/or mechanical symptoms. Physical examination findings typically are limited range of motion and lateral joint-line tenderness. Concern for meniscal tear should be investigated with MRI of the knee without contrast. Depending on the location and size of the tear, patients can undergo meniscal repair, partial meniscectomy, and rarely, complete meniscectomy. (6)(7)

A discoid meniscus is an anatomic abnormality of the lateral meniscus that results in a larger, thickened, disc-shaped meniscus. It is bilateral in 20% of patients. Often, a discoid meniscus is asymptomatic, but it may result in chronic pain, popping, or other mechanical symptoms. A discoid meniscus also is more susceptible to tearing and may present with acute pain and effusion. Physical examination reveals joint-line tenderness, and the meniscus may be able to be felt snapping laterally out of the joint. If there is concern for a discoid meniscus, MRI without contrast of the knee should be obtained. Patients with a painful discoid meniscus are treated with a “saucерization” procedure that shapes the meniscus into a more anatomic crescent configuration.

Medial Knee Pain

Medial Collateral Ligament Injury. The medial collateral ligament is an extra-articular structure that supports the knee from valgus stress. The ligament is usually injured from a blow to the lateral aspect of the knee, but injury can also occur with a noncontact valgus stress or direct trauma to the medial aspect of the knee. Patients present with pain and swelling of the medial aspect of the knee. The medial knee is tender, and pain and possibly instability may be elicited with valgus stress testing. Treatment includes icing, pain control, and physical therapy. High-grade sprains or ruptures may benefit from an initial period of immobilization. Most athletes can return to play in 1 to 2 months.

Pes Anserine Tendinopathy. The sartorius, gracilis, and semitendinosus muscles form a conjoined tendon that inserts superficial to the medial collateral ligament at the medial proximal tibia. Patients with pes anserine tendinopathy have medial knee pain that is often worse with exertion. The pes anserine is tender on physical examination. Treatment focuses on physical therapy addressing underlying predisposing mechanical factors, most often tight hamstrings.

Meniscal Pathology. The medial meniscus is more likely to be injured than the lateral meniscus, with injury occurring with a similar twisting mechanism. Patients present with medial knee pain; larger tears may cause an effusion and/or mechanical symptoms. Physical examination findings may include limited range of motion and lateral joint-line tenderness. Concern for meniscal tear should be investigated with MRI of the knee without contrast. Depending on the location and size of the tear, patients can undergo meniscal repair, partial meniscectomy, and rarely, complete meniscectomy. (6)(7)

Osteochondritis Dissecans. Osteochondritis dissecans describes injury to subchondral bone that progresses to
avascular necrosis and results in damage to the overlying cartilage. Osteochondritis dissecans usually occurs in the medial femoral condyle and can develop on the lateral femoral condyle, tibia, or patella. Patients present with medial knee pain that is usually worse with activity and possible intermittent swelling. Physical examination may reveal normal findings or medial femur tenderness and/or an effusion. The clinician who has concern for osteochondritis dissecans should obtain radiographs of the knee (AP, lateral, tunnel view). If a lesion is visible or if there is a strong clinical suspicion, MRI of the knee without contrast is appropriate.

The lesion can become unstable if the overlying cartilage is severely affected. If the lesion breaks through the cartilage, the bone component can separate from the surrounding bone, creating an osteochondral loose body that often results in an effusion and mechanical symptoms. Stable osteochondritis lesions in skeletally immature children can be treated nonoperatively with 1 month of nonweight-bearing, followed by 1 month of partial weight-bearing, followed by restricted activity and rehabilitation. Stable lesions that do not improve with nonoperative management, lesions in skeletally mature children, and unstable lesions require surgical intervention. (8)(9)

**BENIGN BONE TUMORS**

Most benign bone tumors are asymptomatic, incidental findings discovered during imaging for unrelated indications. Occasionally, benign bone tumors are found on imaging for specific indications such as mass, nighttime pain, or bony tenderness; in these cases, the benign tumor may be the primary cause of pain. Although benign bone tumors do not metastasize, some of the lesions can predispose to pathologic fracture, be inherently painful, or be locally aggressive.

Benign bone tumors have certain radiographic characteristics. In general, they have a well-defined or sclerotic border, a sharp zone of transition between lesion and normal bone, lack of cortical destruction, and no extension into the soft tissue. Certain lesions (nonossifying fibromas, osteochondromas) can be monitored by the clinician. Large lesions, pathologic fractures, locally aggressive lesions, and inherently painful lesions should be referred to an orthopedic surgeon for surgical evaluation and removal. (10)(11)

**Osteochondroma**

Osteochondromas (formerly known as exostoses) are cartilage-capped bony spurs arising from the cortex of the bone. They can be isolated or widespread, as in hereditary multiple osteochondromas. They usually present as a painless mass or a painful mass after trauma. The lesions are vulnerable to fracture. Radiographs reveal a well-defined bony spur that often points away from the joint. Osteochondromas generally grow throughout childhood, becoming stable in adulthood. A small incidence of malignant transformation suggests the need for yearly surveillance radiographs. Treatment is generally observation unless there is persistent pain or deformity. (12)(13)

**Osteoid Osteoma**

Osteoid osteomas are small bone-producing tumors with a central nidus that releases prostaglandins. Patients usually present with pain, especially at night. The pain is particularly responsive to anti-inflammatory medications. Daytime pain that is unrelated to exertion also may be reported. The physical examination usually reveals bony tenderness. Radiographs show a small round lucency (the nidus) surrounded by sclerosis. Lesions may be self-limited and can be observed, but often they cannot be managed with anti-inflammatory medications alone and require surgical resection of the nidus. (14)

**Aneurysmal Bone Cyst**

Aneurysmal bone cysts are vascular lesions that destroy bone, occasionally rapidly. Patients present with localized pain and swelling. Aneurysmal bone cysts often present after pathologic fractures. They can cause growth arrest. Radiographs reveal lytic lesions with a thinned “eggshell” sclerotic rim. Pathologic fractures are treated with immobilization to allow for healing. In general, aneurysmal bone cysts are treated surgically with curettage and bone grafting. The lesions tend to recur, especially in younger patients. (15)(16)

**Nonossifying Fibroma (Fibrous Cortical Defect)**

Nonossifying fibromas (also known as fibrous cortical defects) are developmental defects in which bone is replaced with fibrous connective tissue. The fibromas are usually incidental findings, but large lesions predispose to pathologic fractures. Radiographs reveal well-defined, eccentric lesions with sclerotic, scalloped borders. Small lesions need no further evaluation, but lesions can grow as the patient approaches adolescence. Large lesions sometimes are managed surgically with curettage and grafting to alleviate pain or in an effort to prevent fracture. (11)

**GROWING PAINS**

Growing pains are a common cause of knee pain in children and a diagnosis of exclusion. The cause is unknown but is believed to be a type of stress injury. Typical characteristics include preschool or school age; bilateral extremity pain;
intermittent pain; pain occurring during the evening; or pain that awakens the child from sleep, resolves by morning, and does not limit activity during the day. Frequently, growing pains occur after days of significant activity. Growing pains are associated with other chronic pain complaints (eg, headache or abdominal pain) or a family history of growing pains. The physical examination yields normal results.

If findings on the history and physical examination are consistent with typical growing pain, no further evaluation is needed. However, if the clinician has concern for another potential diagnosis, initial evaluation includes radiographs and laboratory studies (including complete blood cell count with differential count, erythrocyte sedimentation rate, C-reactive protein). Treatment involves ice, heat, massage, and anti-inflammatory medications. The parents must be reassured that the condition is benign and self-limited and should be instructed to minimize their response to the episodes, thereby diminishing nighttime disruption of the entire family. If the episodes are frequent, prophylactic anti-inflammatory medications can be given before bed. (17)(18)

Summary

On the basis of primarily consensus due to lack of relevant clinical studies, after eliminating emergent conditions as the cause of knee pain in children, clinicians can concentrate on stress injuries, benign bone tumors, and growing pains.

CME quiz and references for this article are at http://pedsinreview.aappublications.org/content/37/3/114.
1. A 15-year-old girl presents with a complaint of vague anterior knee pain 2 months after beginning a program of jogging 3 to 4 times weekly. You suspect patellofemoral syndrome. Another associated finding in patients with a correct diagnosis of patellofemoral syndrome is:
   A. Large knee effusion.
   B. Limited range of motion.
   C. Locking of the knee.
   D. Pain upon patellar grind test.
   E. Sensation of knee instability ("giving way").

2. An 11-year-old soccer player complains of mild but persistent right knee pain since the beginning of the soccer season. The only notable finding on physical examination is point tenderness over the right tibial tubercle. This clinical picture is most consistent with a diagnosis of:
   A. Iliotibial band tendinopathy.
   B. Osgood-Schlatter disease.
   C. Pes anserine tendinopathy.
   D. Pre-patellar bursitis.
   E. Sinding-Larsen-Johansson disease.

3. A 14-year-old boy presents with left medial knee pain occurring mainly during running and jumping as well as occasional locking of the knee. He plays basketball but does not recall any specific injury to the knee. On physical examination, he has a small knee effusion and minor decrease in extension of the knee. You suspect osteochondritis dissecans. Of the following, the best next step in management is to:
   A. Advise administration of ibuprofen and application of ice after exercise.
   B. Obtain anteroposterior, lateral, and tunnel view radiographs of the knee.
   C. Provide reassurance and recommend return to play.
   D. Recommend use of an open patellar brace.
   E. Refer for physical therapy.

4. A 15-year-old girl presents with a 2-week history of anterior pain and swelling below the left knee. There is no history of trauma. On physical examination, she has a palpable mass below the knee. Radiographs of the area demonstrate an expansile, osteolytic lesion of the proximal tibia with a "soap-bubble" appearance and a thinned "eggshell" sclerotic rim. Of the following, the most likely diagnosis is:
   A. Aneurysmal bone cyst.
   B. Osgood-Schlatter disease.
   C. Osteochondroma.
   D. Osteoid osteoma.
   E. Nonossifying fibroma.

5. A 7-year-old patient was previously diagnosed with growing pains after presenting with bilateral leg pain at night with no other findings. His parents return 2 weeks later with a concern that he is now complaining of pain during the day and has developed an intermittent limp. His physical examination yields normal results. Of the following, the most appropriate next step is to:
   A. Obtain radiographs and laboratories studies, including complete blood cell count with differential count, erythrocyte sedimentation rate, and C-reactive protein.
   B. Prescribe a knee brace to treat joint laxity.
   C. Provide reassurance and instruct the parents to minimize attention to the complaints.
   D. Refer for physical therapy.
   E. Refer to a psychologist.
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