Consultation With the Specialist: Patellofemoral Conditions in Childhood
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Patellofemoral Conditions in Childhood

Theodore J. Ganley, MD,* Rebecca L. Gaugles,* Leslie A. Moroz*

Objectives  After completing this article, readers should be able to:
1. Describe the signs, symptoms, and risk factors related to patellofemoral instability and pain.
2. Discuss the elements of physical examination and the radiographic features that can help diagnose these conditions.
3. Assess the risk for recurrent instability and pain.
4. Provide patients with an overview of treatment options.

Introduction
Patellofemoral instability and patellofemoral pain are seen commonly in the outpatient setting. An understanding of knee anatomy and accurate interpretation of clinical findings are necessary to evaluate and manage patellofemoral pain and instability properly and to help young patients return safely to sports. In this article, we discuss how to distinguish patellofemoral instability from patellofemoral pain and offer our approach to managing these conditions.

Patellofemoral Pain
Patients who have increased hip internal rotation, lower leg external rotation, knock knee alignment, flat foot, tight hamstrings, tight heel cords, and poor quadriceps muscle tone are at increased risk for anterior knee pain. This condition is referred to as patellofemoral or anterior knee pain syndrome. The previous term, chondromalacia patella, has fallen out of favor because it refers only to the anatomic changes of the undersurface of the patella and not to the soft tissue or afferent and efferent pain fibers.

The physical examination for this condition follows the general protocol for assessment of knee pain. All patients should be evaluated to be sure that they have level shoulders and pelvis without evidence of spinal asymmetry. An observation of walking and running can help rule out quadriceps atrophy and identify painful or antalgic gait patterns as well as foot progression angles that show in-toeing or out-toeing. Patients are evaluated prone and supine to ensure that hip, knee, and ankle strength and range of motion are symmetric. A standing evaluation checks for evidence of malalignment, including genu valgum, calcaneovalgus, and pes planus. The knee is examined to rule out excess fluid, pathologic laxity, and tenderness over the medial and lateral joint lines. The most common locations of tenderness for patients who have anterior knee pain syndrome are in the medial and lateral parapatellar areas.

Diagnostic studies include anteroposterior, lateral, and merchant view radiographs. Such films sometimes show an asymmetrically shaped patella that has an elongated lateral portion and shortened medial portion, indicative of laterally directed vector forces on the patella through the years of growth and development.
Additional radiographic imaging, including bone scans and magnetic resonance imaging, can be used to rule out other pathologic conditions, but are not the primary modality for evaluating anterior knee pain.

Nonsurgical treatments are recommended for patellofemoral pain. Although regimens vary slightly, nearly all are based on the principles of activity restriction and exercising. Our treatment regimen consists of activity restriction to avoid high-impact running and jumping sports. A straight leg-raising program allows for toning and strengthening of the quadriceps without placing excessive forces on the patella that occur with activities such as deep squats. Water therapy, walking, elliptical trainers, and stationary bikes can be used to increase tone and aerobic fitness further while minimizing excessive patellofemoral stress. Additional treatment includes hamstring, quadriceps, and heel cord stretching (Fig. 1). Neoprene knee sleeves are sometimes but not always helpful for increasing warmth, and presumably blood flow, in the affected area. Orthotics can assist those who have excessive calcaneovalgus and pes planus to improve their lower extremity biomechanics. Bracing and orthotics, however, are secondary in importance to all other forms of treatment described.

**Patellofemoral Instability**

Patellofemoral instability in children may be due to inherent malalignment, overuse, trauma, or a combination of these factors. Patients generally fall into one of two categories: those who experience one episode of dislocation or those who have recurrent instability. Common presenting complaints are anterior knee pain and a sense of giving way. These are ubiquitous complaints among patients seen in general practice and orthopedic clinics. History, physical examination, and radiographic imaging can help differentiate patients who have patellofemoral instability from those who have patellofemoral pain syndrome or other causes of anterior knee pain (Table). Factors contributing to anterior knee pain include weak quadriceps or trunk muscles; tight hamstring, calf, or hip muscles; improper hip or ankle rotation; osteochondral lesions; patellar tendinitis; quadriceps tendonitis; arthritis; and other traumatic and overuse injuries.

**Acute Patellofemoral Instability**

Direct or indirect trauma is the cause of dislocation in most cases of acute patellofemoral instability. Direct trauma accounts for only 10% of all patients who have patellofemoral instability and usually is the result of a direct blow to the knee. More often, indirect trauma occurs during a twist on a “planted” foot. These injuries frequently occur in pivoting activities such as football, cheerleading, baseball, dancing, basketball, and hockey. Patients usually report feeling the knee “pop” or give way during a collision or change of direction. The patella also may have been visibly displaced. The patella reduces spontaneously in most cases, but some patients present with dislocation.

The physical examination usually reveals medial parapatellar tenderness, limited range of motion, and in some patients, a palpable defect along the medial border of the patella. The natural history of acute patellofemoral instability is such that without additional treatment, about 50% of patients experience no further problems, about 20% have another dislocation, and about 30% subsequently experience pain or intermittent instability. Acute direct trauma...
and indirect trauma, as well as the patient’s underlying biomechanical alignments, all contribute to intermittent recurrent instability.

Recurrent Patellar Instability
Patellar instability is seen most often in patients who have generalized ligamentous laxity. The first episode usually occurs during the teenage years and is more frequent among girls. Possible pathophysiologic mechanisms for recurrent instability include excessive femoral anteversion, hip internal rotation, a high-riding patella, knock knee alignment, tibial torsion, excessive pronation of the foot, a shallow-shaped femoral groove, or poor quadriceps muscle tone. Children who experience recurrent dislocations more frequently dislocate with indirect trauma and occasionally with the activities of daily living. Many patients report aching or occasional episodes of sharp pain, but some patients are pain-free. There often is little or no effusion around the joint in patients who experience frequent dislocations. Osteochondral fractures are rare in patients who have recurrent instability.

Clinical Evaluation
The goal of clinical examination is to evaluate anatomic structures via observation and direct palpation. When findings on the history suggest acute instability, it is important to rule out associated patella fractures or tears of the anterior cruciate or medial collateral ligaments. In cases of recurrent instability, patients should be examined while bearing weight to assess alignment and rotation in the back and lower extremities. Gait analysis can reveal a tendency toward internal hip rotation, tibial torsion, or foot pronation.

A thorough ligamentous examination should be performed to assess laxity. Knee and elbow hyperextension greater than 10 degrees or metacarpophalangeal hyperextension greater than 90 degrees (Fig. 2) indicates generalized laxity.

Specific evaluations of the knee

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Specific evaluations of the knee
relative to the opposite leg can provide a better indication of anatomic alignment. A positive patellar apprehension test is an indication of patellar malalignment or medial patellofemoral ligament disruption. While the patient lies supine, signs of apprehension or discomfort are monitored when an attempt is made to displace the patella. The degree of medial and lateral translation, normally between 25% and 50% of the width of the patella, provides an indication of stability. The Q angle is calculated by measuring the relative positions of the anterior superior iliac spine, midpoint of the patella, and the tibial tubercle. A normal Q angle is between 5 and 15 degrees for men and 10 and 20 degrees for women. A Q angle that exceeds normal values is indicative of malalignment.

**Imaging Studies**

Plain radiographs of anteroposterior, lateral, and merchant views of the knee should be evaluated for alignment and the presence of osteochondral fragments or osteochondral defects. On merchant views, the radiographic tube is placed at a 30-degree angle with the floor, and the patient’s knees are bent 45 degrees over the end of the table. The patella may appear laterally displaced with the knee in slight flexion, and the femoral condyle appears prominent medially.

Magnetic resonance imaging (MRI) is not used routinely but is helpful in evaluating selective cases. Bone bruises characteristic of trauma, hemarthrosis, and associated injuries, particularly disruption of the medial restraint, termed the retinaculum, are readily detected on MRI (Fig. 3). Computed tomography scans occasionally may be helpful for evaluating the bony anatomy of the knee.

**Management**

Although the dislocated patella may reduce spontaneously with leg extension, some patients present with a visibly displaced patella that requires manual closed reduction. In such cases, gentle medial force is applied to realign the patella. A mild sedative may be necessary in some patients to relieve pain. Operative reduction of a dislocated patella rarely is necessary. The initial focus in cases of acute dislocation should be on reducing pain and swelling, with ice packs applied for intervals of 20 minutes.

For patients who have experienced their first episode of patellar dislocation and have normal findings on plain radiography, physical therapy and a neoprene knee sleeve to provide support are the first line of treatment. If a large effusion is present, a knee immobilizer can be worn to keep stress off the extensor mechanism during ambulation until the swelling resolves. It also can be removed for range of motion exercises. Maintaining quadriceps and hamstring strength and flexibility is important to prevent additional dislocation. A knee sleeve that has lateral patellar supports can help maintain proper alignment as patients become more active. Bracing, however, is not a substitute for strengthening and stretching. Patients who have recurrent instability and report dislocation only during sports are advised to discontinue athletics for the duration of the season. Physical therapy and knee sleeves can promote more appropriate biomechanics and can help alleviate symptoms. If strength and motion have returned, activities are gradually increased.

For patients who have recurrent instability, are skeletally immature, and experience little or no effusion, physical therapy, a knee brace for physical activities, and occasionally the use of orthotics such as shoe inserts can help prevent additional episodes of instability. Surgery is recommended for patients who experi-

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Figure 3. Arrow A shows a subchondral contusion of the medial facet of the patella. Arrow B shows a contusion of the distal lateral trochlea.
ence episodes of dislocation with activities of daily living. For patients who have closed growth plates and severe alignment, bone surgery is performed. Only the soft tissue is treated in patients who have open growth plates and severe malalignment to preserve growth plates.

**Conclusion**

The key to diagnosing and treating patients who have patellofemoral instability is understanding that this is a multifactorial condition affected by factors and forces beyond the knee. History and physical examination and appropriate imaging studies are essential for differentiating patients who have patellofemoral instability from those who have patellofemoral pain syndrome and other causes of anterior knee pain.

The treatment of patellofemoral instability should be nonoperative in nearly all cases unless patients have “loose” bodies or recurrent dislocations with activities of daily living. Patellofemoral pain syndrome is essentially a nonoperative condition.

The most important form of management is the pediatric knee ABCs: activity modification, bracing (with a neoprene sleeve or foot orthosis, if needed), and continued rehabilitation. Bracing is considered secondary to activity modification and rehabilitation. The ultimate goal is to return patients to happy, healthy, and active lifestyles.

**Case Presentation**

A 17-year-old girl presented to the musculoskeletal center reporting that she had experienced several episodes of her left knee giving way over the previous 5 months. She reported that if she was running and twisted her knee awkwardly, she felt her kneecap shift to the outside. She could squeeze her knee with her hands from both sides to pop the kneecap back into position. She denied any other joint pain or swelling.

The patient enjoyed volleyball and participated in her school’s drill team among other extracurricular activities until she had a knee injury 1 year before her visit. She fell while ice-skating and was treated for a knee sprain with a brace. Her past medical history otherwise was noncontributory to her current symptoms.

On physical examination, her shoulders and pelvis appeared level, with no limb length discrepancy. Her hips rotated internally to 70 degrees and externally to 30 degrees. Hip rotation measurements were taken to determine the magnitude, if any, of excessive hip rotation, otherwise described as femoral anteversion. She had a 5-degree external rotation foot-thigh angle and was shy of full quadriceps flexion while lying prone. Her quadriceps tone was mildly diminished on her right relative to her left. She had Q angles of 20 degrees (Fig. 4). She also had infrapatellar fat pad hypertrophy, but no significant knee effusion. Her patella translated one quadrant medially and three quadrants laterally. She had mildly positive apprehension tests and trace palpable (but not audible) patellofemoral crepitation. She had no pathologic laxity with anterior or posterior drawer testing and varus or valgus stress testing.

Plain radiographs revealed a patella with an elongated lateral facet (Fig. 5) and well-preserved medial lateral hemijoint spaces. Otherwise, her physes were closed.

The patient was deemed to be at risk for repeated dislocations because of her femoral anteversion, demonstrated by a hip internal rotation greater than or equal to the amount of external rotation, a mildly dysplastic patellar shape, and a history of multiple prior dislocations.

Initially, a management strategy for preventing recurrent dislocation was discussed with the patient. She was restricted from contact, high-impact, and pivoting sports, and she was advised to wear a neoprene knee sleeve to provide lateral patellar support. She was permitted to swim, ride a stationary bike, and exercise on an elliptical trainer for aerobic activity. She was given a straight leg-raising strengthening program and a quadriceps, hamstring, and heel cord flexibility program.

The patient did well (no history of recurrences) for 4 months until she decided to return to volleyball and soccer. Her previously unaffected right knee gave way after she collided with an-
other player, and she experienced an episode of pain and swelling. She obtained an over-the-counter neoprene knee sleeve and performed the exercises that she previously had learned to strengthen both of her knees.

The patient subsequently presented with one more episode of patellofemoral instability, and she was instructed to change sports activities. She now only participates in such activities as swimming and biking and exercises on an elliptical trainer or stationary bike.

Suggested Reading
PIR Quiz
Quiz also available online at www.pedsinreview.org.

13. A previously healthy 12-year-old girl has had bilateral anterior knee pain for the past 3 months. Except for mild tenderness in the medial and lateral parapatellar area, findings on the physical examination are normal. Knee radiographs are unremarkable. You diagnose patellofemoral pain. Of the following, the best choice for initial management is:
   A. Ankle lifts.
   B. Bed rest.
   C. Deep squats.
   D. Stair climbing.
   E. Straight-leg raising.

14. A previously healthy 12-year-old girl has noted anterior knee pain for the past 3 months after playing volleyball. On physical examination, a diagnosis of patellofemoral instability is best supported by tenderness over the:
   A. Distal quadriceps.
   B. Inferior pole of the patella.
   C. Medial aspect of the patella.
   D. Prepatellar bursa.
   E. Tibial tubercle.

15. A 12-year-old girl who has anterior knee pain confronts the highest risk of patellofemoral instability with which of the following findings?
   A. Elbow hyperextension >10 degrees.
   B. Genu varum.
   C. Negative apprehension test.
   D. Q angle <15 degrees.
   E. Shortened lateral patellar facet.

16. A previously healthy 12-year-old girl experienced severe pain as she felt her left knee give way during soccer. On examination, the patella appears normally located. There is tenderness over the medial patella and a small effusion. Her Q angle is 20 degrees. Knee radiographs do not demonstrate fractures or bony fragments. Optimal management involves:
   A. Application of warm compresses.
   B. Knee immobilization for 8 weeks.
   C. Permanent discontinuation of all sports.
   D. Referral to physical therapy.
   E. Surgical repositioning of the medial patellofemoral ligament.
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