April 2014 Case Study

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Chief Complaint: Right knee pain

HPI:
An 18-year-old male soccer goalie presents with right knee pain following two reported patellar dislocation events. The first event occurred six weeks ago when he kicked the ball awkwardly and fell to the ground during a game. He experienced immediate pain and was helped off the field. On the sideline he was unable to flex or extend his right knee. With assistance from friends on the sidelines, his patella, which had appeared dislocated laterally, was returned to its normal position. He then was able to flex and extend his knee. He did not seek evaluation at that time, and returned to soccer after one week. Two weeks after the initial event, he was kicked in the right knee from behind and felt his patella pop out laterally. Again, friends helped him off the field and returned the patella to its normal alignment. He noted significant swelling of his knee for approximately 4 weeks. Since then, he reports continued anterior knee pain and feelings of instability. Range of motion is now limited, such that he is unable to fully flex or extend his knee secondary to pain. Symptoms are worse with activity and weight-bearing and better with rest and ibuprofen. Sensation was initially affected, with diffuse feelings of “hundreds of cold needles,” which resolved over 4 weeks as swelling improved.

Physical Exam:
In general, he is alert, in no acute distress.
Musculoskeletal: Right knee:
--Inspection – tense effusion present with no fluid wave. No redness or erythema. Antalgic gait.
--Palpation - significant tenderness over the medial joint line and just distal to the anteromedial joint line over the pes anserine area. He also has tenderness over the distal patella.
--Range of motion – End range of motion for both flexion and extension is limited due to pain, with a flexion/extension arc of approximately 20-120 degrees.
--Strength - 5/5 in flexion and extension without significant pain.
--Special tests - significant involuntary guarding during the Lachman and anterior drawer tests, thus limiting the ability to fully test ACL. Significant laxity with valgus stress, but with appreciable endpoint. Negative varus stress test and negative posterior drawer test. He has significant patellar apprehension. Negative McMurray's; however, limited evaluation since he was unable to fully flex his knee during this part of the exam. Unable to fully squat secondary to pain.

Left knee was examined for comparison and was normal.
Neurovascular: Distal sensation intact. Feet were warm and well perfused.
Skin: No rashes.

Differential Diagnosis:
Causes of knee pain in this 18 year-old soccer goalie with 2 events of possible patellar dislocation:

(1) Patellar Instability
(2) Contusion (bone and soft tissue)
(3) Patellar Fracture
(4) Anterior Cruciate Ligament (ACL) injury
(5) Medial Collateral Ligament (MCL) injury
(6) Medial Meniscus injury
(7) “Unhappy Triad”: concurrent ACL, MCL, medial meniscus injuries
(8) Tibial Eminence/Spine Fracture
(9) Tibial Plateau Fracture  
(10) Osteochondritis Dissecans (OCD) of medial femoral condyle  
(11) Osteochondral fracture  
(12) Prepatellar bursitis  

Imaging:

X-ray: AP and tunnel views of right knee show no obvious fracture or dislocation; however there is a small calcific density just above the fibular head that may represent a Segond fracture.
X-ray: lateral view of right knee shows no obvious fracture or dislocation.

X-ray: sunrise view: show no fracture or dislocation.

Right Knee MRI – Sagittal Proton Density. The anterior cruciate ligament appears thin with attenuated fibers and ill-defined fatty soft tissue in its mid portion.
Right Knee MRI – Sagittal T2 Fat Saturation. There is punctuate high T2 signal within the proximal fibers of ACL.

Right knee MRI – Coronal STIR. There is some fluid surrounding the medial collateral ligament.

Right knee MRI – Coronal T1. There is some fluid surrounding the medial collateral ligament.
Final/Working Diagnosis:
1. Anterior Cruciate Ligament (ACL) tear with Second Fracture
2. Medial Collateral Ligament (MCL) Sprain
3. Patellar Dislocation

Treatment:
The patient was placed in a double upright hinged knee brace for MCL sprain. Pre-operative physical therapy was initiated for ACL rehabilitation program, with plan for ACL reconstruction and arthroscopy after adequate healing of the MCL.

Outcome:
The patient is currently participating in physical therapy to prepare him for surgery with focus on increasing pain-free range of motion as well as pain-free strength and mobility. He continues to have pain in the medial knee, but much less so than before. He is able to extend his knee to 5 degrees, but has pain with any extension beyond 20 degrees. His ACL reconstruction surgery is scheduled to occur soon (5 months from original injury).

Discussion:
Tear of the anterior cruciate ligament (ACL) is relatively common among athletes. Over 100,000 ACL reconstructions are performed every year in the United States (1). Because of the relative weakness of the epiphyseal plates compared to the ACL, skeletally immature athletes are more likely to sustain avulsion injuries (2). ACL injuries typically occur in late adolescence or later. Nevertheless, increased participation in youth sports in recent years has caused higher rates of ACL injury in athletes with open physes. Females have up to a nine-fold higher risk of ACL injury. This is likely related to anatomic risk factors including increased anterior pelvic tilt, increased femoral anteversion, increased quadriceps angle, decreased intercondylar notch width, and increased posterior tibial slope (3). Extrinsic risk factors include harder playing surfaces, increased coefficient of friction between the shoe and the playing surface, and number, length, and placement of cleats on the shoe. The injury involves part or all of two major bundles (posterolateral, anteromedial) of the ACL, and may also include a tear of the middle one-third of lateral capsular ligament. The ACL is either torn from the femur or tibia, or torn in the mid-portion. Avulsion of the tibial spine can also be seen in skeletally immature athletes (4).

Injury occurs in situations that cause hyperextension, varus/internal rotation, as well as excessive valgus and external rotation about the knee (1). This often involves an abrupt landing, turn, or twist on a straight knee (5). Seventy percent of ACL injuries are non-contact, while the remaining 30% involve contact (2). Athletes often describe a “pop,” or “crack” that was either felt or heard. The injury is very painful immediately and athletes are unable to continue activity (1). Swelling results from hemarthrosis and usually occurs within 2 hours, although it can be minimal or delayed. If an athlete attempts return to activity (either acutely or after rest), he or she may report instability or giving way with twisting, pivoting, and cutting activities.

A proper knee exam is 82% sensitive and 96% specific for ACL tear (2). One of the most valuable findings is a hemarthrosis (fluid wave) or tense effusion. Up to 40-65% of acute hemarthroses in adolescents are from ACL tears (3, 6). This compares to 77-85% of acute hemarthroses in adults (2, 4). Other common causes for acute hemarthrosis in adolescents include patellar dislocation (28-36%), and isolated meniscus tears (13-15%) (6). In the absence of knee dislocation with multiple ligament injuries, simultaneous patellar dislocation and ACL tear is rare. Exam techniques directed at the ACL include the Lachman (more sensitive) and anterior drawer (less sensitive). In the less acute (and less painful) setting, the examiner may be able to appreciate positive pivot-shift or pivot-glide. Sensitivity of pivot-shift is 98% in anesthetized patients, compared to 35% in patients who are awake (3). The best time to examine an athlete is within 1 hour (before hemarthrosis), or several days after the injury. Range of motion testing often reveals an inability to
fully flex or extend the knee. Loss of flexion is usually due to swelling. Loss of hyperextension is more indicative of ACL tear and occurs for the following reasons: hemarthrosis, the torn ACL stump getting caught between the tibia and femur, a tibial eminence fracture, or a fragment from a concomitant meniscal tear causing mechanical symptoms (2). With a pediatric athlete, the examiner should also look for clinical malalignment and leg-length discrepancy, especially prior to surgery (3).

When ACL tear is suspected, X-rays (AP, lateral, tunnel, and sunrise views) should be performed initially to assess growth plates and identify any osteochondral lesions or avulsion of the tibial spine. If an avulsion of the tibial spine is detected, immediate referral to orthopedic surgery is recommended (5). Lateral capsular sign, described as a small fleck of bone adjacent to the lateral aspect of the lateral tibial plateau on AP knee radiographs, represents an avulsion of the middle one-third of the lateral capsular ligament, and implies an ACL tear. This is also known as a Segond Fracture (7). Diagnosis is most often confirmed on MRI, with a sensitivity and specificity of 95% and 88%, respectively, in children. MRI also aids in the diagnosis of concomitant meniscal tears and collateral ligament tears, which occur in 60-75% and 46% of cases, respectively. Complete collateral ligament tear is seen in 5-24% of cases. Chondral lesions occur in approximately 50% of high school athletes with an ACL tear, with female athletes at a higher risk, compared to their male counterparts (2).

After diagnosis, regardless of athlete age, early rehabilitation is often recommended to reduce swelling, improve range of motion, and to strengthen the quadriceps. Definitive treatment of the pediatric athlete represents unique challenges, as there is concern for physeal damage and resulting growth disturbances with surgery. Nevertheless, non-operative treatment has shown mixed results in partial tears, and poor results in complete tears. Approximately one third of pediatric athletes with partial ACL tears (representing 25-50% of all mid-substance ACL tears in youth) still required surgery for instability symptoms despite non-operative treatment with bracing and a rehabilitation protocol (3). Children with complete tears are at risk of progressive instability, leading to additional meniscal and articular cartilage damage. Furthermore, studies have shown that up to 50% of children treated non-operatively do not return to sport due to instability (3). If surgery is deferred, absolute avoidance of high-risk activities is critical, as this is superior to physical therapy and bracing in reducing future knee instability and further soft-tissue damage. Regardless of operative vs. non-operative treatment, athletes with ACL tears have a higher risk of early onset degenerative joint disease, often occurring within 20 years of injury (5).

In-depth discussion of surgical techniques is beyond the scope of this review. However, it is worth noting that extraphyseal, partial transphyseal, and all-epiphyseal techniques have been developed in recent years that yield superior results to non-operative management while preventing substantial growth disturbance. This highlights the importance of referral to a pediatric orthopedic surgeon when ACL injury occurs in athletes with open physes. Algorithms, such as the one by Fabricant et al, suggest various operative techniques based on physiologic age of the patient: prepubescent, young adolescent with growth remaining, and older adolescent (3). Athletes with concomitant collateral ligament injury, such as the patient above with MCL sprain, have better results when surgery is delayed until the MCL has healed. Sankar et al reported success with ACL repair in patients with combined ACL/MCL injury after an average delay of surgery by 33 days (8). Postoperative care involves immobilization in knee extension for several weeks to allow bone plug healing followed by physical therapy for at least several months. Return to sport usually takes place between 6 and 12 months after surgery (5).

Recent attention has been directed to neuromuscular training programs as a way to prevent ACL injury. Studies have shown mixed results; however, this may be related to athlete compliance. Hagglund et al demonstrated fewer ACL injuries and fewer acute knee injuries in female adolescent soccer players who complied with a neuromuscular training program. (9)
This case emphasizes the importance of considering ACL injury in the differential diagnosis of acute knee effusion – even in cases with reported patellar dislocation. This case is unusual in that there was no radiographic evidence of patellar dislocation, despite having two witnessed dislocation events. After discussing operative findings with the orthopedic surgeon who found excess laxity with patellar movement under anesthesia, it was theorized that this patient may have had an undiagnosed partial ACL injury which allowed for greater valgus displacement of the knee, making him more prone to patellar dislocation without tearing soft tissues or contusing bone. Overall, the persistence of effusion, continued pain, limited range of motion and feelings of instability should prompt further evaluation for ligamentous injury.

References:


