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Operative Techniques in

Sports Medicine

Adolescent Anterior Knee Pain

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A great many physicians believe that anterior knee pain cannot be broken down into its component pathologic processes. This is incorrect. If one knows the sites that are capable of generating pain and knows how to test those sites, localizing the involved sites is not difficult. It is more work to learn which pathologic processes occur in clusters and why each process evolves. Treatment begins to make sense and, perhaps even more important, the failure of certain treatments begins to make sense. A stepwise approach to obtaining the right history followed by an examination that identifies the sites of pain leads to appropriate diagnoses. Usually, adolescent anterior knee pain turns out to be Sinding-Larsen-Johansson, Osgood-Schlatter, patellofemoral, fat pad, or plica syndrome or a combination of these syndromes. Other syndromes are less common. Treatment frequently requires reducing or redistributing patellofemoral joint reactive forces by one or more of several techniques.

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Anterior knee pain in the adolescent continues to be one of the more difficult to treat problems in musculoskeletal medicine for 2 main reasons. The first is that the patient can experience pain, patellofemoral instability, or both. Patients and clinicians frequently have a difficult time discriminating between pain and instability, especially when instability leads to pain. The second reason is that the sources of pain are poorly understood and that frequently there are multiple painful sites. This kind of confusion leads to imprecise diagnoses and generic, "one size fits all" treatment interventions. The inevitable result is failed interventions, unhappy patients, frustrated physicians and therapists and wasted time. Success rests on understanding the pathophysiology of all possible sources of pain, accurate diagnosis, and selection of appropriate interventions for each pathologic process.

Pathophysiology

Anatomy

With the notable exception of articular cartilage, every structure in the knee contains noceceptive nerve endings.[1,2] Those that have been found to correlate to painful knee syndromes include nerves in patella subchondral bone, fat pad, synovium, retinaculae and joint capsule, plicae, patella tendon, patella tendon apophysis, iliotibial band, and femoral condyle bone.[3-6] After trauma, pain fibers in the menisci and ligaments may be activated and cause pain as well. Other sources of pain generation include the infrapatellar branch of the saphanous nerve and other more remote peripheral or central nerves referring pain to the knee.

Certain anatomic relationships are critical for normal knee homeostasis. Quadriceps strength, patella tracking, patella tendon length, size of medial plica, size of lateral and medial fat pads, and tightness in various structures around the knee all play roles in the various causes of anterior knee pain. A concept that frequently is overlooked with respect to anatomic variations and anterior knee pain is that of accommodation. Very few knees have perfect alignment or muscle and soft-tissue balance. Despite this, most knees accommodate to their anatomy and have no pain. Finding a lateral tracking patella, tight hamstrings, or weak quadriceps does not mean that that finding was necessarily the cause of the knee pain.

Mechanics

The mechanics of the knee refers to the mechanical functioning of the 3 chondral compartments of the joint and to the dynamic forces in the compartments and in the soft tissues around the knee. Excessively tight tendinous structures, such as the iliotibial band, can rub prominent bony areas, leading

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Table 1 Conditions Leading to Pain in the Anterior Knee

Condition	Anatomic site	Pathology
Sinding-Larsen-Johansson	Distal patella pole	Apophyseal traction
Osgood-Schlatter	Tibial tubercle	Apophyseal traction
Patellar tendinosis	Patella tendon	Microtears, degeneration
Patellofemoral syndrome	Patella bone	Pain, compression
Fat pad syndrome	Patella fat pad(s)	Hypertrophy, synovitis
Plica syndrome	Medial plica	Fibrosis, hypertrophy
Retinacular pain	Lateral retinaculum	Neuritis, degeneration
Iliotibial band friction	ITB at lateral knee	Bursitis, tendinosis
Juvenile rheumatoid arthritis	Synovial lining	Autoimmune synovitis
Infection	Bone or soft tissue	Infection of joint
Neoplasm	Anywhere in knee	Various processes
Osteochondritis dissecans	Medial condyle	Stress fracture
Meniscus tear	Medial or lateral	Tear from trauma
Neurogenic pain	Infrapatellar branch	Trauma or irritation
Complex regional pain	Sympathetic nerves	Minor trauma
Referred pain	Usually hip	SCFE, Perthes, infection

to bursitis or tendon damage. A tight quadriceps mechanism can lead to traction injuries such as Osgood-Schlatter Syndrome, Sinding-Larsen-Johansson syndrome, patellar tendinosis, or to patellofemoral overload pain. A lateral tracking patella may be an incidental finding or may indicate chronic lateral patella facet subchondral overload (sometimes called excessive lateral pressure syndrome) with or without medial plica impingement.

Of all the mechanical components to knee function, the most critical is patellofemoral joint reactive forces (JRFs). Patellofemoral JRFs have been measured as high as 8000 Newtons.[7] These forces are absorbed by the patella and knee extensor mechanism. It is no accident that the majority of painful areas in adolescent anterior knee pain arise in the extensor mechanism. Likewise, it is appropriate that altering extensor mechanics is a basic tenet for managing many types of anterior knee pain.

Pathologic Processes

Sixteen different pathologic processes can lead to complaints of knee pain in the young athlete. Of these, the first 8 listed in Table 1 are the most common. Many of these are technically not anterior, but because there is frequently pain at more than one site, they are included. Success in understanding this group of conditions requires the ability to identify all 16 processes and determine which ones are present in a given patient.

Sinding–Larsen–Johansson Syndrome (SLJ)

Pathophysiology

SLJ is classified as an apophysitis and an enthesitis. Unfortunately, it is not an inflammatory process and, therefore, the names are deceptive. Studies performed to determine the precise nature and etiology of the lesion have suffered from preconceptions and assumptions. What is known is that it occurs in mainly young boys aged 10 to 14 and is associated with excessive running and jumping, which is consistent with SLJ being an extensor mechanism traction injury. Whether the traction leads to tendon microtears and subsequent calcification or causes physeal cartilage stress fracture or both remain to be proven. Some recent studies have made the case for physeal stress fracture stronger[8,9] and it may well be that what tibial tubercle avulsion fracture is to Osgood-Schlatter, patella sleeve fracture is to SLJ.

Diagnosis

An active preadolescent boy with anterior knee pain is the typical patient, but active girls can have SLJ as well. Running, jumping, and climbing will exacerbate pain. The physical examination will show tenderness at the distal pole of the patella but not in the fat pads or with patella compression. Some boys also will have tenderness at the tibial tubercle. Frequently, the quadriceps is weak and tight and, almost always, the hamstrings are tight. Imaging studies are not mandatory, but plain films frequently are obtained. They can be normal or show ossification in the patella tendon just distal to the patella (Fig. 1). The ossification can be present in the initial radiographs or appear later as the condition matures, which has been interpreted to mean that the process is a calcific tendinitis[10] but could just as likely mean that a piece of unossified apophyseal cartilage had avulsed and later became ossified.

Treatment

Relative rest is the mainstay of treatment. It is felt that avoiding the running and jumping that are associated with the greatest pain will allow the injury to heal. Addressing the hamstring and quadriceps tightness and weakness that is usually found will help prevent recurrence. Physical therapists frequently are used to help with the strength and flexibility. Some of the children who develop SLJ are so active that relative rest is very difficult to achieve. They will stop their organized athletic activity but continue to stress the knee by bounding around the house. In these patients, a knee immobilizer or even a cylinder cast may be necessary to achieve relative rest. Four to 10 weeks of pain-free rest typically is