

Approach to the Active Patient with Chronic Anterior Knee Pain

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Abstract: The diagnosis and management of chronic anterior knee pain in the active individual can be frustrating for both the patient and physician. Pain may be a result of a single traumatic event or, more commonly, repetitive overuse. “Anterior knee pain,” “patellofemoral pain syndrome,” and “chondromalacia” are terms that are often used interchangeably to describe multiple conditions that occur in the same anatomic region but that can have significantly different etiologies. Potential pain sources include connective or soft tissue irritation, intra-articular cartilage damage, mechanical irritation, nerve-mediated abnormalities, systemic conditions, or psychosocial issues. Patients with anterior knee pain often report pain during weightbearing activities that involve significant knee flexion, such as squatting, running, jumping, and walking up stairs. A detailed history and thorough physical examination can improve the differential diagnosis. Plain radiographs (anteroposterior, anteroposterior flexion, lateral, and axial views) can be ordered in severe or recalcitrant cases. Treatment is typically nonoperative and includes activity modification, nonsteroidal anti-inflammatory drugs, supervised physical therapy, orthotics, and footwear adjustment. Patients should be informed that it may take several months for symptoms to resolve. It is important for patients to be aware of and avoid aggravating activities that can cause symptom recurrence. Patients who are unresponsive to conservative treatment, or those who have an underlying systemic condition, should be referred to an orthopedic surgeon or an appropriate medical specialist.

Keywords: patellofemoral pain syndrome; physical therapy; differential diagnosis

Introduction

“Anterior knee pain,” “patellofemoral pain syndrome” (PFPS), and “chondromalacia” are terms often used interchangeably to describe conditions that occur in the same anatomic region but that can have significantly different etiologies. Potential pain sources include connective or soft tissue irritation (quadriceps/patellar tendonitis), intra-articular cartilage damage, mechanical obstructions (loose bodies, unstable cartilage flaps), nerve-mediated abnormalities (referred pain from hip or spine pathology, complex regional pain syndrome), systemic conditions (inflammatory arthritis), or psychosocial issues. Although the differential diagnosis is broad, a detailed history and physical examination can narrow the diagnosis (Table 1). Appropriate treatment can begin only after correct diagnosis. The primary care sports medicine physician can manage most conditions that cause anterior knee pain in the active individual. However, there are occasions when the patient should be referred to an appropriate specialist (Table 2).

History

Although the exact etiology of chronic anterior knee pain may not be obvious, there are several key historical components that can help in formulating the differential diagnosis.

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It is important to determine whether the pain began abruptly with a specific event or if the pain occurred gradually and had no particular inciting event. If the pain began acutely, as with trauma or a fall, it is important for the patient to report the circumstances of the event (eg, knee buckling, twisting, or popping) to the physician. Using the center of the patella as a reference point, the anterior region of the knee can be divided into 5 locations for purposes of defining the source of the pain (Figure 1). The bony patella itself, the underlying cartilage, and the overlying skin comprise the first region. The superior structures, such as the superior pole of the patella and the quadriceps tendon, form the second region. The inferior structures, such as the inferior pole of the patella, patellar tendon, and tibial tubercle, form the third. The medial structures, including the medial retinaculum, plica band, pes anserinus (hamstring tendon insertion), and medial patellofemoral ligament, comprise the fourth. Lastly, the lateral structures, such as the lateral retinaculum, lateral patellar facet, and iliotibial band, form the fifth region. When asked to localize the pain, patients will often place their entire hand over the front of the knee.

In these cases, it may help to have the patient point to one area that bothers him or her most.

The patient should be asked to characterize the pain in simple terms. Constant, dull pain can be a sign of referred or sympathetic-mediated pain.¹ Referred pain from the hip may be suspected if there is decreased hip range of motion (ROM) and difficulty performing tasks such as putting on and taking off one's shoes. Referred pain from the lumbar spine should be suspected if there is back pain that radiates into the buttocks/posterior thigh region or is accompanied by lower-extremity numbness or weakness. Sharp, intermittent pain may be due to loose bodies or cartilage flaps in the joint, which can also be associated with locking and catching. Locking episodes may be associated with swelling and severe pain; however, patients may be entirely asymptomatic between episodes.² These episodes are frequently unpredictable and are not caused by any specific activity. Activity-related pain is usually caused by soft tissue/bone overload that is exacerbated with increased activity. Pain caused specifically by kneeling, crawling, going up and down stairs, and prolonged knee flexion can

Table 1. Summary of Etiology, Diagnosis, and Treatment of Anterior Knee Pain

Pain Source	Diagnosis	Signs and Symptoms	Diagnostic Tool	Treatment
Connective tissue	Soft tissue irritation (quadriceps/patellar tendonitis, plica syndrome, fat pad syndrome, ITB tendonitis), patellar stress fracture	Reproducible pain over the involved structure, pain with resisted motion	MRI to evaluate soft tissues, CT scan to evaluate for possible malalignment, bone scan evaluating for bony uptake	Physical therapy/activity modification; possible surgery for tendinopathy, plica band, or stress fracture
Cartilage	Articular cartilage irritation (DJD, posttraumatic, chondromalacia)	Swelling, crepitus with flexion/extension, pain with direct compression	Axial/sunrise patellar radiograph, MRI	Physical therapy, arthroscopy for cartilage resurfacing, patellar realignment to unload cartilage
Mechanical	Loose bodies, unstable cartilage flaps	Swelling, locking, catching	Radiographs, MRI	Arthroscopic loose body removal, cartilage resurfacing
Nerve	Referred pain	Abnormalities of lumbar spine or hip	Radiographs, MRI, bone scan	Dependent on underlying pathology
	Complex regional pain syndrome	Findings consistent with abnormal sympathetic function	Clinical diagnosis	Pain management referral
	Postoperative neuroma	Sensitivity and pain in the proximity of scars	Clinical diagnosis, diagnostic local anesthetic injection	Neuroma excision
Systemic condition	Inflammatory arthritis	Other joint involvement, morning stiffness, systemic symptoms	Laboratory work-up	Nonsteroidal anti-inflammatory drugs
	Medical condition causing weakness, muscle atrophy, laxity (cancer, endocrinopathies, pregnancy)	Past medical history and condition-specific physical examination findings		Treat underlying condition
Psychologic	Malingering/symptom exaggeration for secondary gain	Psychosocial issues	Psychiatric assessment	Therapy/counseling

Abbreviations: CT, computed tomography; DJD, degenerative joint disease; ITB, iliotibial band syndrome; MRI, magnetic resonance imaging.

Table 2. Summary of Specific Anterior Knee Pain Disorders

Disorder	Clinical Presentation	Radiographic Findings	Initial Treatment	Specialist Referral
Patellofemoral pain syndrome	Anterior or retropatellar pain with running, jumping, squatting, and stair climbing ^{21–24}	Often normal	PF joint load restriction, VMO strengthening, hamstring stretching, NSAIDs, McConnell taping, orthotics ^{10–12,20,25,31–33,40–43}	Orthopedic surgeon after 3–6 months of conservative treatment
Patellar tendinopathy	Pain at proximal patellar tendon/bone interface ^{45,46}	MRI findings of increased signal intensity and focal thickening of the proximal tendon ^{45,51,52}	Activity modification, quadriceps strengthening, NSAIDs, shoe wear adjustment ⁴⁶	Orthopedic surgeon after 3–6 months of conservative treatment
Patellar chondromalacia	Retropatellar pain, swelling, and grinding with deep knee flexion ^{55,56}	MRI findings of focal marrow edema and cartilage damage ⁵⁷	Activity modification, lubricant/steroid injections, NSAIDs, physical therapy ^{58,59}	Orthopedic surgeon after 2–3 months of conservative treatment
Prepatellar bursitis	Pain, swelling, and erythema just anterior to the patella (potential etiologies include trauma, infection, crystal deposition disease) ⁵¹	Radiographic findings of soft tissue shadow anterior to patella, MRI findings of fluid/edema overlying patella	RICE, avoidance of direct knee pressure, NSAIDs, aspiration/antibiotics if necessary ⁶⁰	Orthopedic surgeon if infection suspected or after 3 months of conservative treatment, primary care physician if gout suspected
Osteochondroses	Skeletally immature patient with activity-related pain at tibial tubercle (Osgood–Schlatter) or inferior patella (Sinding-Larsen-Johansson) ^{61,62}	Possible radiographic findings of soft tissue swelling and fragmentation	Activity modification, NSAIDs, hamstring stretching ^{61,63}	Orthopedic surgeon if patient skeletally mature with persistent symptoms

Abbreviations: MRI, magnetic resonance imaging; NSAID, nonsteroidal anti-inflammatory drug; PF, patellofemoral; RICE, rest, ice, compression, elevation; VMO, vastus medialis obliquus.

be a sign of patellofemoral overload or malalignment. This type of pain is generally relieved with periods of rest and inactivity.³ Pain that is worst at night or when the patient wakes can be a sign of infection, neoplasm, or prepatellar bursitis, and warrants further evaluation.

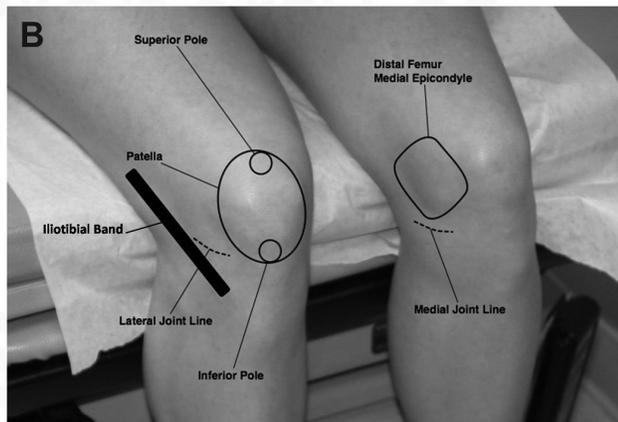
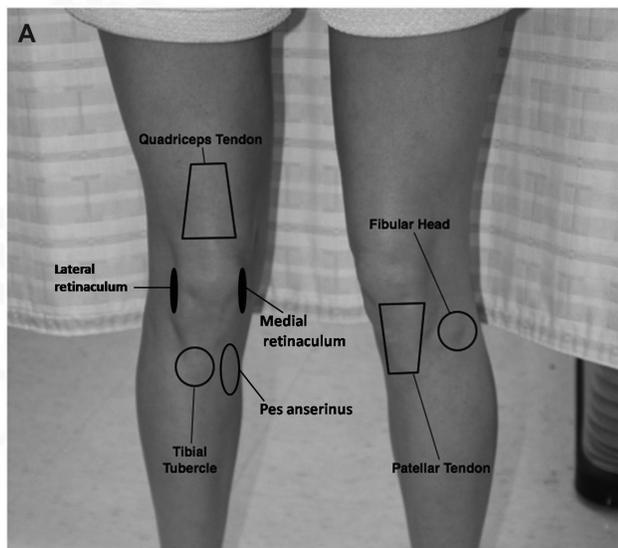
A brief medical and psychosocial history should be obtained to elucidate other systemic conditions that could produce knee pain. In certain areas of the country, Lyme disease can present with a knee effusion, particularly in young children.⁴ Pain in multiple joints or pain that is worst in the morning on waking and eases as the day progresses (ie, “start-up pain”) may be indicative of an inflammatory process, such as rheumatoid arthritis or lupus.⁵ Systemic conditions such as malignancy and endocrinopathies may result in generalized atrophy or muscle wasting, which can contribute to patellofemoral malalignment.¹ Prior treatment, such as previous courses of physical therapy, injections (cortisone or viscosupplementation), or surgical procedures, should also be documented.

Physical Examination

Physical examination of the patient with anterior knee pain should begin with a visual inspection of both knees during

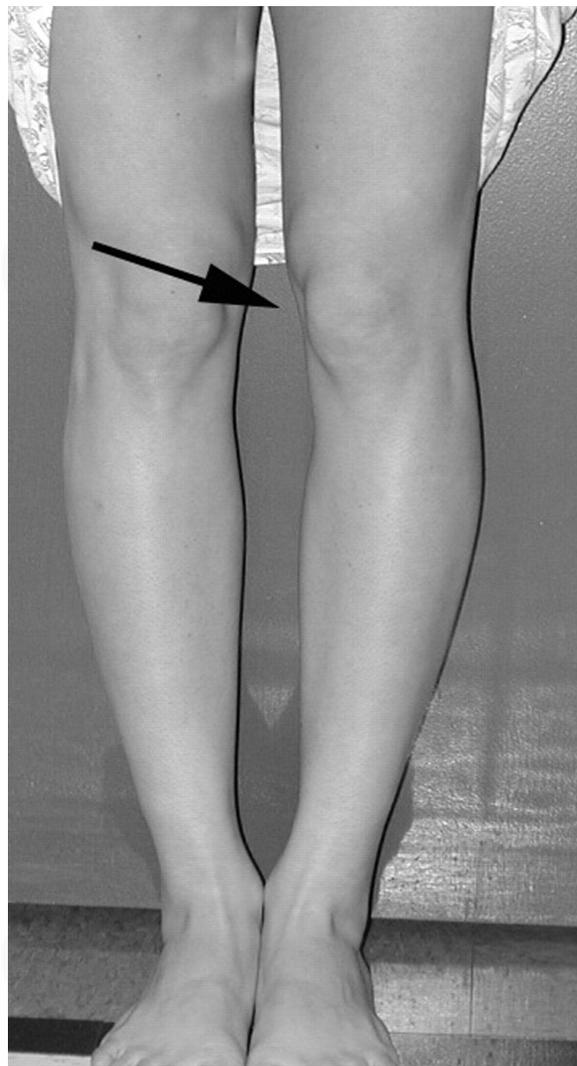
stance. The direction the patellas’ face in relation to the tibial tubercle should be noted. Inward-pointing patellas may suggest poor tracking due to externally rotated tibial tubercles or excessive femoral anteversion (Figure 2). A knock-knee appearance (genu valgum), bow-legged appearance (genu varum), or genu recurvatum should be documented. A posterior visual evaluation of stance should also be performed, with close attention to any alignment abnormalities (Figure 3). The patient should be instructed to walk barefoot and be observed from the front and back to check for a limp or other gait abnormality, as well as to inspect the posture of the foot for pathology (ie, pes planus). The involved knee should be inspected for quadriceps atrophy, erythema, bruising, calluses related to excessive kneeling, scars related to previous procedures, rashes, or color changes. The quadriceps angle (Q-angle), which is a measure of tibial tubercle external rotation, should be measured with a goniometer to assess potential malalignment. The Q-angle is the angle between a line drawn from the anterior-superior iliac spine to the center of the patella and a line drawn from the center of the patella to the tibial tubercle (Figure 4). In order to obtain a more accurate measurement, this should be done in 30° to 45° of knee flexion to ensure that the

Figure 1. Topographical anatomy of the anterior knee. **A)** Frontal anatomy; **B)** lateral and medial anatomy.



patella is engaged in the trochlea. In patients with patella subluxation, the angle when measured in extension will be falsely reduced. Q-angles of $\leq 10^\circ$ in males and $\leq 15^\circ$ in females are accepted normal values, although significant interobserver variation has been reported with this measure.⁶ After inspection, all bony prominences, including both poles of the patella, the tibial tubercle, and the fibular head, should be palpated. Tenderness in these areas may represent insertional tendonitis or growth overuse injuries (apophysitis) in skeletally immature patients (Osgood–Schlatter disease). Soft tissue structures such as the medial and lateral patellar retinaculum, patellar tendon, quadriceps tendon, and iliotibial band have extensive innervation with free nerve endings and should also be palpated.⁷ It is also important to test the patella for stability by translating it both medially and laterally to elicit any apprehension from the patient. It is also important to note warmth and/or erythema and to evaluate for a knee effusion versus soft tissue swell-

Figure 2. The patient's left patella is pointing inward, which can be associated with an externally rotated tibial tubercle or excessive femoral anteversion.



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ing. These findings help differentiate between traumatic injuries, inflammatory arthropathy, and septic arthritis. Hypersensitivity or sympathetic-mediated pain can be detected by lightly stroking the anterior aspect of each knee, which can be helpful in evaluating conditions such as chronic regional pain syndrome (formerly called reflex sympathetic dystrophy). Scars or arthroscopic portals from previous surgeries should be palpated to detect numbness, neuromas, or sensitive scar tissue.

Active and passive knee flexion and extension should be assessed for ROM. Any flexion contracture, extensor lag, and the ability to perform a straight-leg raise should be noted. Forceful loading of the patella in the trochlear groove (TG) that elicits pain can be a sign of articular cartilage damage. Crepitation of the patellofemoral joint during active knee

Figure 3. Posterior view of a patient with excessive hindfoot valgus and forefoot pronation. Posterior tibial tendon insufficiency.



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extension in a seated position can also signify articular cartilage damage.⁸ Observation of patella tracking during ROM can reveal subtle lateral subluxation. In cases where patellar instability is suspected, the examiner should attempt to laterally translate the patella to detect apprehension, assess patellar mobility, and detect laxity of the medial patellofemoral ligament (Figure 5). Patellar tilt should also be noted (Figure 6).

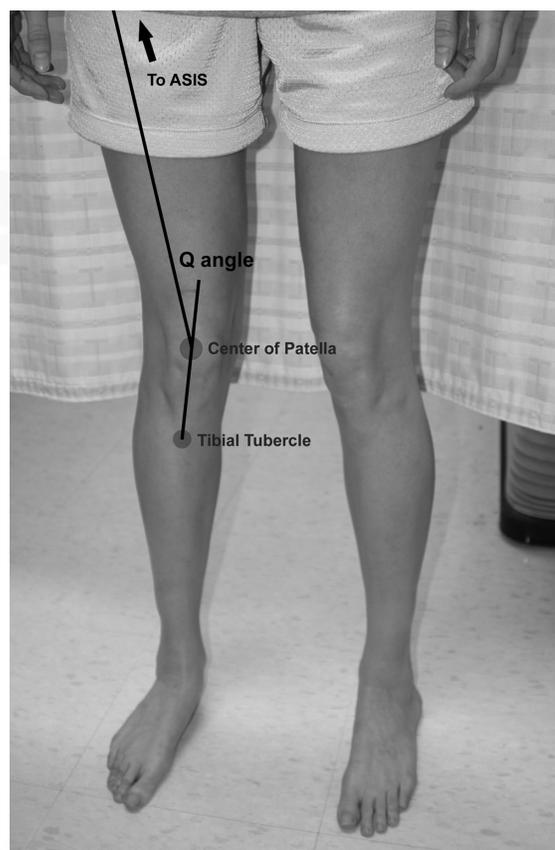
Evaluation of the hips and lower legs can reveal abnormalities that could contribute to anterior knee pain. The patient can be checked for hamstring tightness in the supine position, with the hips flexed 90° while trying to fully extend the knee. The patient can be checked for quadriceps muscle tightness and abnormal hip rotation in the prone position. Tibial torsion and foot deformities can also be identified in the prone position. While the patient is lying in the lateral decubitus position with the unaffected hip flexed, the examiner can evaluate the iliotibial band for tightness during attempted hip adduction. Hip abduction strength can also be tested in this position. While standing, the patient is asked to lift the opposite leg while bending the affected knee. Excessive hip internal rotation during this maneuver may signify decreased hip external rotator muscle strength. Weak hip external rotator muscles can accentuate lateral patellar tracking, thereby contributing to patellar instability and pain.^{9–12}

Diagnostic Studies

Plain Radiographs

Radiographic evaluation of any patient with chronic anterior knee pain should begin with a complete knee series, including standing anteroposterior (AP), posteroanterior (PA) flexion, lateral, and axial views. The AP view may show morpho-

Figure 4. The quadriceps (Q) angle is defined as the angle between a line drawn from the anterior superior iliac spine (ASIS) to the center of the patella and a line from the center of the patella to the tibial tubercle. A measurement > 10° in males and > 15° in females may contribute to lateral patellar subluxation.



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logic abnormalities of the patella that accompany patella fractures and bipartite patella. The lateral view allows for evaluation of patella height in relation to the distal femur. The Insall-Salvati ratio, which compares the length of the patella with the length of the patellar tendon, is a common radiographic measurement used to measure this relationship (Figure 7).^{13,14} The normal range for the ratio is 0.8 to 1.2. A ratio of < 0.8 is considered an elevated patella (patella alta), while a ratio of > 1.2 is considered a low-riding patella (patella baja). Patella baja may cause restricted ROM and retropatellar pain. Patella alta may contribute to patellar instability due to lack of patellar engagement in the trochlea at low angles of flexion, as well as overload of the inferior pole, which is more common in patients with patella alta.⁸ A precise lateral radiograph also helps identify trochlear dysplasia and rotational malalignment of the patella that may contribute to patellar instability.^{15,16} The axial (or Merchant) view, taken with the knee flexed between 30° and 45°, provides an excellent perspective of patellar congruence.¹³ Lateral patellar subluxation associated with instability is best

Figure 5. Patellar apprehension test. With the knee fully extended and the quadriceps relaxed, the examiner passively translates the patient's patella in a lateral direction. The test is positive if a feeling of apprehension or impending dislocation is experienced.

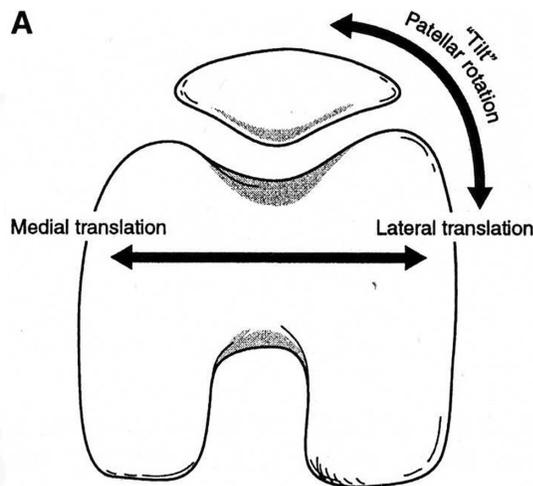


observed on the axial view. The axial view also allows for measurement of the patellar tilt angle, which is measured by drawing a line from the medial to the lateral edge of the patella and determining the relationship of this line to the horizontal plane.¹⁴

Magnetic Resonance Imaging

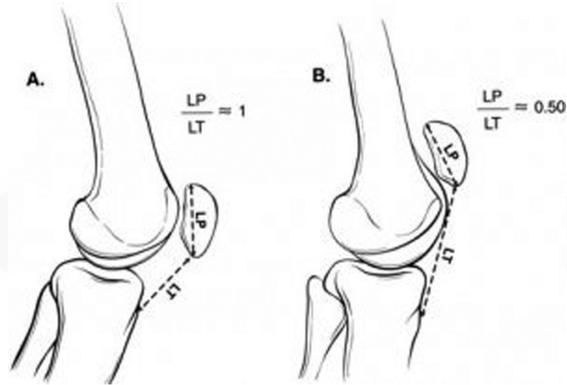
Magnetic resonance imaging (MRI) is useful when evaluating the cartilage structures of the patellofemoral joint and surrounding tissues. Articular cartilage damage and subchondral bone edema may be readily apparent on MRI. Specifically, bony edema and cartilage damage may be noted on the medial patellar facet and lateral femoral condyle in patients with a previous patellar dislocation.¹⁵ In patients with normal

Figure 6. Axial, or Merchant, view of patellar position relative to the femoral trochlea. Patellar malalignment may be present if there is significant lateral translation or tilt of the patella in relation to the femoral trochlea.



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Figure 7. The Insall-Salvati ratio compares the length of the patella with the length of the patellar tendon. **A)** The normal ratio is around 1. **B)** A ratio of < 0.8 is considered a high-riding patella or patella alta.



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radiographs who have equivocal physical examination findings, MRI may also detect degenerative joint disease, attenuation of the medial patellofemoral ligament, trochlear hypoplasia, loose bodies, and vastus medialis obliquus muscle atrophy.^{16,17}

Computed Tomography

Computed tomography (CT) scan has recently become popular in patellofemoral joint imaging because it allows for evaluation in various degrees of knee flexion. Typically, the patellofemoral joint is evaluated at 0°, 15°, 30°, and 45° of flexion.¹⁸ The distance between the tibial tuberosity (TT) and the TG, which may play a role in patellar instability, can be assessed. This measurement (ie, the TT-TG distance) typically ranges from 10 to 20 mm. Patients with instability and a TT-TG distance of > 20 mm may be candidates for medializing tibial tubercle osteotomy. Despite its usefulness for preoperative planning, however, it is worth noting that most of the previously cited figures can be derived from MRI. Because CT scans emit high levels of radiation, they should only be obtained when absolutely necessary. Radionuclide scanning may be helpful to evaluate anterior knee pain of unknown origin and pain associated with stress fractures, overuse, and traumatic injuries. Patellar or trochlear bone remodeling activity can be assessed to demonstrate healing with time after an injury.^{19,20} Nuclear imaging may also help provide objective documentation of bone injury in cases of pending litigation, workers compensation claims, and malingering.

Blood work and laboratory evaluation are necessary if medical and/or systemic processes are suspected. A C-reactive protein, erythrocyte sedimentation rate, and complete blood

count with differential may help in diagnosing infection, neoplasms, or rheumatologic conditions. A Lyme disease work-up (serum titers, enzyme-linked immunosorbent assay, and Western blot) should be performed in patients, specifically children, with potential tick exposures or who are from Lyme-endemic areas. In addition, blood chemistry and thyroid panels and urine human chorionic gonadotropin should be evaluated to identify systemic conditions, such as diabetes, thyroid dysfunction, and pregnancy.

Management of Specific Disorders

PFPS

Patellofemoral pain syndrome is a common orthopedic condition that can account for up to 25% of knee complaints in sports medicine clinics.^{21,22} It is characterized by anterior or retropatellar knee pain without evidence of other intra-articular pathology. It is more common in females than in males, and it particularly affects young, active individuals aged 12 to 40 years.²³ Patients may present with pain without any apparent cause or inciting event, which is exacerbated by activities such as squatting, stair climbing, hill walking, jumping, and kneeling. Physical examination may find swelling, grinding, catching, or a sense of giving way, but often, tenderness to palpation of the lateral facet and/or inferior pole may be the only positive finding aside from weakness. Symptoms vary greatly between individuals, ranging from pain with athletic activity to pain with simply rising from a chair.²⁴ Multiple causes of PFPS have been reported, including quadriceps muscle weakness and imbalance, soft tissue tightness, lower-extremity malalignment, hip musculature weakness, poor quality of movement, and abnormal foot alignment.^{12,25–28} Hip abductor and external rotator weakness, especially in females, has been reported to play a large role in PFPS.^{11,12} In addition to powering the hip, the hip abductor and external rotator muscles control femoral internal rotation and provide pelvic stability. Weakness of these muscles may accentuate knee valgus moments and femoral internal rotation, in addition to increasing compressive forces across the patellofemoral joint.²⁵ In light of these factors, it is widely accepted that the fundamental problem in PFPS is poor patellar tracking, which results in decreased patellofemoral contact area and increased patellofemoral joint reactive force.^{29,30} Initial PFPS treatment is nonoperative and focuses on inflammation reduction, load restriction across the patellofemoral joint, and an individualized rehabilitation program. Specifically, physical therapy regimens often focus on retraining the quadriceps and hip abductor and external rotator muscles with active weightbearing activities.³¹ These activities, com-

bined with patellar mobilization and bracing and/or taping, can reduce pain and enhance quadriceps muscle activation.³² It is important that patients have adequate pain control to ensure compliance with participation in therapy sessions. Pain from irritated soft tissues and other innervated structures often responds well to oral nonsteroidal anti-inflammatory drugs (NSAIDs).^{20,33} Patches can be very effective as well, particularly for tissues that are superficial. Either lidocaine patches or NSAID patches may be used to target specific areas of pain (ie, pes bursitis). A repetitive tissue-cooling program (icing for 15–20 minutes, 2–3 times/day) may also be helpful, particularly after increased activity.³⁴ Changing daily living and athletic activities can decrease repetitive, painful loading of the patellofemoral joint. Deep squatting, kneeling, excessive stair and hill climbing, and prolonged knee flexion should be avoided. Sitting on a higher chair and elevated toilet seat and changing the way a patient sits and stands from the seated position can decrease pain, especially in patients with patellar tendonitis. An effective rehabilitation program should combine painless muscle strengthening, soft tissue stretching, knee bracing (such as a patella-stabilizing sleeve), and patellofemoral taping. Quadriceps strengthening is very important because deficiency in this muscle group is hypothesized to play a fundamental role in PFPS.^{35–39} Hip external rotator and abductor muscle strengthening can also reduce pain and improve hip strength and patellar tracking, particularly in females.^{10,11} McConnell taping (patellofemoral joint taping) and bracing are commonly used with varying degrees of success.^{40–43} Foot orthotics may decrease patellofemoral pain in patients with hindfoot abnormalities and excessive foot pronation.⁴⁴

Patellar Tendinopathy

Patellar tendon abnormalities typically present as pain at the inferior pole of the patella or proximal aspect of the patellar tendon. Patellar tendonitis, often referred to as “jumper’s knee,” commonly affects individuals who engage in sports involving jumping, kicking, running, or repetitive forceful quadriceps contracture.⁴⁵ Skeletally mature patients are more commonly affected, and there does not seem to be a sex predilection.⁴⁶ There is some speculation that most cases of jumper’s knee are actually patellar tendinosis, which is characterized by fibroblast proliferation, cell hyperplasia, and intratendinous mucoid degeneration.^{46,47} The etiology of tendinopathy is multifactorial, likely due to a combination of extrinsic and intrinsic factors. Extrinsic factors are related to athletic activity, frequency and intensity of training, playing surfaces, shoe wear and equipment, and

training errors.⁴⁸ Intrinsic factors include malalignment, muscle weakness, hamstrings/quadriceps tightness, and limb-length inequalities.^{49,50} Diagnosis of tendinopathy is largely based on history and physical examination. Often, MRI shows increased signal intensity in the proximal tendon with focal thickening, and it can be used to confirm the diagnosis of patellar tendinopathy in equivocal cases.^{45,51,52} Conservative treatment, consisting of activity modification, NSAIDs, supervised physical therapy, shoe wear adjustment, and equipment modification, often yields good results in patients with mild-to-moderate symptoms; however, patients should be informed that full pain resolution may take several months.

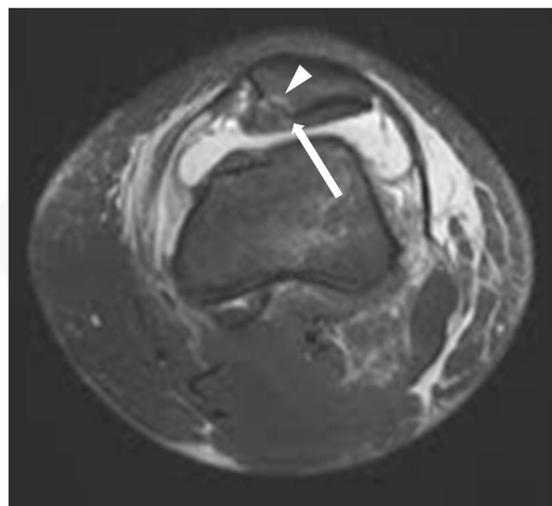
Patellar Chondromalacia

For the past several decades, the term patellar chondromalacia has been used indiscriminately as a diagnosis for nonspecific anterior knee pain.^{29,53,54} However, recent reports have shown that < 20% of patients with retropatellar or peripatellar pain actually have patellar degenerative changes at the time of arthroscopy.^{55,56} The true incidence of patellar chondromalacia is unknown, as these lesions are often discovered incidentally on MRI or arthroscopy when evaluating other intra-articular pathology. The diagnosis of patellar chondromalacia should be reserved for patients who have articular cartilage damage or defect on the undersurface of the patella. Patients with patellar chondromalacia often experience pain with activities that involve deep knee flexion, similar to those in PFPS. Swelling, grinding, and retropatellar crepitus may be observed on physical examination. The gold standard for diagnosis is articular cartilage evaluation with knee arthroscopy, although MRI is very sensitive at detecting moderate-to-severe lesions (Figure 8).⁵⁷ In addition, MRI may demonstrate focal marrow edema, compression, and cartilage damage of the lateral facet, consistent with lateral patellar compression syndrome. Conservative treatment with activity modification, lubricant and steroid injections, NSAIDs, and physical therapy may be effective for low-grade, superficial chondral defects.^{58,59}

Prepatellar Bursitis

The prepatellar bursa is a synovial fluid-filled sac that is located just anterior to the patella and beneath the skin.⁵¹ Prepatellar bursitis, often referred to as “housemaid’s knee,” is inflammation of this bursa resulting from trauma or repetitive friction (eg, kneeling), crystal deposition (gout or pseudogout), or infection (from hematogenous spread or direct inoculation). Symptoms include pain, swelling, and

Figure 8. Axial magnetic resonance image of the right knee demonstrating osteochondral defect of medial patellar facet with discontinuity of normal cartilage contour (arrow) and marrow edema (arrowhead).



erythema just anterior to the patella. In some cases of significant involvement, it may be hard to differentiate a frank joint effusion from bursa swelling. Traumatic bursitis can be treated with ice, compression, NSAIDs, and by avoiding kneeling and other exacerbating activities. Aspiration can provide relief in cases where significant swelling is present. It is sensible to obtain a fluid sample for Gram stain and crystal analysis if infection or gout/pseudogout is suspected. Gout/pseudogout is treated similarly to traumatic bursitis, although medications aimed at treating the systemic process should also be used. Septic bursitis should be treated with organism-specific antibiotic coverage and operative debridement in recalcitrant cases.⁶⁰

Considerations for Skeletally Immature Patients

Children and adolescents are susceptible to a group of disorders that affect the growing skeleton, termed osteochondroses. These disorders result from abnormal growth, injury, or overuse of the developing growth plate.⁶¹ Although the etiology is unknown, repetitive trauma, mechanical factors, hormonal imbalances, vascular abnormalities, and genetic causes may all play a role.⁶² When the tibial tubercle and inferior patellar pole are affected, the conditions are called Osgood–Schlatter disease and Sinding-Larsen-Johansson disease, respectively. Patellar tendon traction causes inflammation and pain during repetitive running and jumping activities. Patients often present with significant swelling and tenderness. Diagnosis is largely clinical, and radiographs are not routinely necessary. Both are self-limiting disorders that respond well

to brief immobilization, activity modification, NSAIDs, and physical therapy.⁶¹ Symptoms usually resolve within 10 to 12 months, and the condition is rare after skeletal maturity.⁶³

Referral to a Specialist

Most of the conditions discussed in this article can be successfully treated with nonoperative modalities, such as activity modification, physical therapy, and NSAIDs. The time required for symptom relief often depends on the duration of symptoms prior to treatment, the severity of the symptoms, and appropriate adherence to the treatment regimen. Patients should be told that it can take up to 6 months for symptoms to resolve. After this period, patients with PFPS, extensor tendonitis/tendinopathy, patellar chondromalacia, or an osteochondrosis should be referred to an orthopedic surgeon for possible surgical intervention (Table 2). Patients should be referred to an orthopedic surgeon at initial presentation if diagnosed with significant articular cartilage tears, mechanical loose bodies, referred pain from the hip or lumbar spine, or degenerative disease. Patients with inflammatory arthritis or an underlying medical condition should be referred to their primary care physician or appropriate medical specialist.

Summary

Treatment of chronic anterior knee pain can be quite frustrating for both the patient and physician. Although the differential diagnosis is broad, a detailed history and physical examination can aid in identifying the cause of the patient's discomfort. Once diagnosed, the patient should begin a nonoperative treatment regimen consisting of activity modification, physical therapy, and NSAIDs. Symptom resolution may take several months. Patients who fail conservative treatment or those with diagnoses not typically treated by the sports medicine physician should be referred to an orthopedic surgeon or other appropriate specialist.

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Conflict of Interest Statement

Alfred Atanda Jr, MD, Devin Ruiz, BSc, Christopher C. Dodson, MD, and Robert W. Frederick, MD disclose no conflicts of interest.

References

1. Post WR. Anterior knee pain: diagnosis and treatment. *J Am Acad Orthop Surg*. 2005;13(8):534–543.
2. Ozalay M, Tandoğan RN, Akpınar S, et al. Arthroscopic treatment of solitary benign intra-articular lesions of the knee that cause mechanical symptoms. *Arthroscopy*. 2005;21(1):12–18.
3. Grelsamer RP. Current concepts review: patellar malalignment. *J Bone Joint Surg Am*. 2000;82-A(11):1639–1650.
4. Milewski MD, Cruz AI Jr, Miller CP, Peterson AT, Smith BG. Lyme arthritis in children presenting with joint effusions. *J Bone Joint Surg Am*. 2011;93(3):252–260.
5. Grossman JM. Lupus arthritis. *Best Pract Res Clin Rheumatol*. 2009;23(4):495–506.
6. Post WR. Clinical evaluation of patients with patellofemoral disorders. *Arthroscopy*. 1999;15(8):841–851.
7. Biedert RM, Stauffer E, Friederich NF. Occurrence of free nerve endings in the soft tissue of the knee joint. A histologic investigation. *Am J Sports Med*. 1992;20(4):430–433.
8. Colvin AC, West RV. Patellar Instability. *J Bone Joint Surg Am*. 2008;90(12):2751–2762.
9. Fulkerson JP. Diagnosis and treatment of patients with patellofemoral pain. *Am J Sports Med*. 2002;30(3):447–456.
10. Nakagawa TH, Muniz TB, Baldon Rde M, Dias Maciel C, de Menezes Reiff RB, Serrão FV. The effect of additional strengthening of hip abductor and lateral rotator muscles in patellofemoral pain syndrome: a randomized controlled pilot study. *Clin Rehabil*. 2008;22(12):1051–1060.
11. Khayambashi K, Mohammadkhani Z, Ghaznavi K, Lyle MA, Powers CM. The effects of isolated hip abductor and external rotator muscle strengthening on pain, health status, and hip strength in females with patellofemoral pain: a randomized controlled trial. *J Orthop Sports Phys Ther*. 2012;42(1):22–29.
12. Prins MR, van der Wurff P. Females with patellofemoral pain syndrome have weak hip muscles: a systematic review. *Aust J Physiother*. 2009;55(1):9–15.
13. Merchant AC, Mercer RL, Jacobsen RH, Cool CR. Roentgenographic analysis of patellofemoral congruence. *J Bone Joint Surg Am*. 1974;56(7):1391–1396.
14. Grelsamer RP, Bazos AN, Proctor CS. Radiographic analysis of patellar tilt. *J Bone Joint Surg Br*. 1993;75(5):822–824.
15. Diederichs G, Issever AS, Scheffler S. MR imaging of patellar instability: injury patterns and assessment of risk factors. *Radiographics*. 2010;30(4):961–981.
16. Koskinen SK, Kujala UM. Patellofemoral relationships and distal insertion of the vastus medialis muscle: a magnetic resonance imaging study in nonsymptomatic subjects and in patients with patellar dislocation. *Arthroscopy*. 1992;8(4):465–468.
17. Thompson RC Jr, Vener MJ, Griffiths HJ, Lewis JL, Oegema TR Jr, Wallace L. Scanning electron-microscopic and magnetic resonance-imaging studies of injuries to the patellofemoral joint after acute transarticular loading. *J Bone Joint Surg Am*. 1993;75(5):704–713.
18. Schutzer SF, Ramsby GR, Fulkerson JP. Computed tomographic classification of patellofemoral pain patients. *Orthop Clin North Am*. 1986;17(2):235–248.
19. Dye SF, Chew MH. The use of scintigraphy to detect increased osseous metabolic activity about the knee. *Instr Course Lect*. 1994;43:453–469.
20. Dye SF, Staubli HU, Biedert RM, Vaupel GL. The mosaic of pathophysiology causing patellofemoral pain: therapeutic implications. *Oper Tech Sports Med*. 1999;7:46–54.
21. Sohl P, Bowling A. Injuries to dancers. Prevalence, treatment, and prevention. *Sports Med*. 1990;9(5):317–322.
22. Laprade J, Culham E, Brouwer B. Comparison of five isometric exercises in the recruitment of the vastus medialis oblique in persons with and without patellofemoral pain syndrome. *J Orthop Sports Phys Ther*. 1998;27(3):197–204.
23. Muller K, Snyder-Mackler L. Diagnosis of patellofemoral pain after arthroscopic meniscectomy. *J Orthop Sports Phys Ther*. 2000;30(3):138–142.

24. Welsh C, Hanney WJ, Podschun L, Kolber MJ. Rehabilitation of a female dancer with patellofemoral pain syndrome: applying concepts of regional interdependence in practice. *N Am J Sports Phys Ther.* 2010;5(2):85–97.
25. Piva SR, Fitzgerald GK, Irrgang JJ, et al. Associates of physical function and pain in patients with patellofemoral pain syndrome. *Arch Phys Med Rehabil.* 2009;90(2):285–295.
26. Draper CE, Fredericson M, Gold GE, et al. Patients with patellofemoral pain exhibit elevated bone metabolic activity at the patellofemoral joint. *J Orthop Res.* 2012;30(2):209–213.
27. Cowan SM, Crossley KM, Bennell KL. Altered hip and trunk muscle function in individuals with patellofemoral pain. *Br J Sports Med.* 2009;43(8):584–588.
28. Hudson Z, Darthuy E. Iliotibial band tightness and patellofemoral pain syndrome: a case-control study. *Man Ther.* 2009;14(2):147–151.
29. Fulkerson JP. *Disorders of the Patellofemoral Joint.* 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins; 1997.
30. Besier TF, Fredericson M, Gold GE, Beaupré GS, Delp SL. Knee muscle forces during walking and running in patellofemoral pain patients and pain-free controls. *J Biomech.* 2009;42(7):898–905.
31. McConnell J. The management of chondromalacia patellae: a long-term solution. *Aust J Physiother.* 1986;32:215–223.
32. Crossley K, Bennell K, Green S, Cowan S, McConnell J. Physical therapy for patellofemoral pain: a randomized, double-blinded, placebo-controlled trial. *Am J Sports Med.* 2002;30(6):857–865.
33. Dye SF, Vaupel GL. The pathophysiology of patellofemoral pain. *Sports Med Arth Rev.* 1994;2:203–210.
34. Dye SF. The pathophysiology of patellofemoral pain: a tissue homeostasis perspective. *Clin Orthop Relat Res.* 2005;436:100–110.
35. Natri A, Kannus P, Järvinen M. Which factors predict the long-term outcome in chronic patellofemoral pain syndrome? A 7-yr prospective follow-up study. *Med Sci Sports Exerc.* 1998;30(11):1572–1577.
36. Werner S. An evaluation of knee extensor and knee flexor torques and EMGs in patients with patellofemoral pain syndrome in comparison with matched controls. *Knee Surg Sports Traumatol Arthrosc.* 1995;3(2):89–94.
37. Collado H, Fredericson M. Patellofemoral pain syndrome. *Clin Sports Med.* 2010;29(3):379–398.
38. Kaya D, Citaker S, Kerimoglu U. Women with patellofemoral pain syndrome have quadriceps femoris volume and strength deficiency. *Knee Surg Sports Traumatol Arthrosc.* 2011;19(2):242–247.
39. Chiu JK, Wong YM, Yung PS, Ng GY. The effects of quadriceps strengthening on pain, function, and patellofemoral joint contact area in persons with patellofemoral pain. *Am J Phys Med Rehabil.* 2012;91(2):98–106.
40. Ernst GP, Kawaguchi J, Saliba E. Effect of patellar taping on knee kinetics of patients with patellofemoral pain syndrome. *J Orthop Sports Phys Ther.* 1999;29(11):661–667.
41. Gilleard W, McConnell J, Parsons D. The effect of patellar taping on the onset of vastus medialis obliquus and vastus lateralis muscle activity in persons with patellofemoral pain. *Phys Ther.* 1998;78(1):25–32.
42. Muhle C, Brinkmann G, Skaf A, Heller M, Resnick D. Effect of a patellar realignment brace on patients with patellar subluxation and dislocation. Evaluation with kinematic magnetic resonance imaging. *Am J Sports Med.* 1999;27(3):350–353.
43. Callaghan MJ, Selfe J, McHenry A, Oldham JA. Effects of patellar taping on knee joint proprioception in patients with patellofemoral pain syndrome. *Man Ther.* 2008;13(3):192–199.
44. Collins N, Crossley K, Beller E, Darnell R, McPoil T, Vicenzino B. Foot orthoses and physiotherapy in the treatment of patellofemoral pain syndrome: randomised clinical trial. *Br J Sports Med.* 2009;43(3):169–171.
45. Yu JS, Popp JE, Kaeding CC, Lucas J. Correlation of MR imaging and pathologic findings in athletes undergoing surgery for chronic patellar tendinitis. *AJR Am J Roentgenol.* 1995;165(1):115–118.
46. Witvrouw E, Bellemans J, Lysens R, Danneels L, Cambier D. Intrinsic risk factors for the development of patellar tendinitis in an athletic population. *Am J Sports Med.* 2001;29(2):190–195.
47. Dimitrios S, Pantelis M, Kalliopi S. Comparing the effects of eccentric training with eccentric training and static stretching exercises in the treatment of patellar tendinopathy. A controlled clinical trial [published online ahead of print August 19, 2011]. *Clin Rehabil.*
48. Lysens RJ, De Weerd W, Nieuwboer A. Factors associated with injury proneness. *Sports Med.* 1991;12(5):281–289.
49. Krivickas LS. Anatomical factors associated with overuse sports injuries. *Sports Med.* 1997;24(2):132–146.
50. Worrell TW, Perrin DH, Ganseder BM, Gieck JH. Comparison of isokinetic strength and flexibility measures between hamstring injured and noninjured athletes. *J Orthop Sports Phys Ther.* 1991;13(3):118–125.
51. Tuong B, White J, Louis L, Cairns R, Andrews G, Forster BB. Get a kick out of this: the spectrum of knee extensor mechanism injuries. *Br J Sports Med.* 2011;45(2):140–146.
52. Friederichs MG, Burks RT. Patellofemoral disorders. In: Garrick JG, ed. *Orthopaedic Knowledge Update: Sports Medicine 3.* Chicago, IL: American Academy of Orthopedic Surgeons; 2004:213–222.
53. Percy EC, Strother RT. Patellagia. *Phys Sportsmed.* 1985;13(7):43–59.
54. Garrick JB. Anterior knee pain (chondromalacia patellae). *Phys Sportsmed.* 1989;17(1):75–76, 81–84.
55. Casscells W. Chondromalacia of the patella. *J Pediatr Orthop.* 1982;2(5):560–564.
56. Abernethy PJ, Townsend PR, Rose RM, Radin EL. Is chondromalacia patellae a separate clinical entity? *J Bone Joint Surg Br.* 1978;60-B(2):205–210.
57. Pihlajamäki HK, Kuikka PI, Leppänen VV, Kiuru MJ, Mattila VM. Reliability of clinical findings and magnetic resonance imaging for the diagnosis of chondromalacia patellae. *J Bone Joint Surg Am.* 2010;92(4):927–934.
58. Mouzopoulos G, Borbon C, Siebold R. Patellar chondral defects: a review of a challenging entity. *Knee Surg Sports Traumatol Arthrosc.* 2011;19(12):1990–2001.
59. Kramer DE, Kocher MS. Management of patella and trochlear chondral injuries. *Oper Tech Orthop.* 2007;17(4):234–243.
60. Aaron DL, Patel A, Kayiaros S, Calfee R. Four common types of bursitis: diagnosis and management. *J Am Acad Orthop Surg.* 2011;19(6):359–367.
61. Atanda A Jr, Shah SA, O'Brien K. Osteochondrosis: common causes of pain in growing bones. *Am Fam Physician.* 2011;83(3):285–291.
62. Gholve PA, Scher DM, Khakharia S, Widmann RF, Green DW. Osgood Schlatter syndrome. *Curr Opin Pediatr.* 2007;19(1):44–50.
63. Hergenroeder AC. Approach to the young athlete with chronic knee pain or injury. UpToDate Online. http://www.uptodate.com/online/content/topic.do?topicKey=ped_trau/11489. Accessed December 17, 2011.
64. Grelsamer RP, Stein DA. Patellofemoral arthritis. *J Bone Joint Surg.* 2006;88:1849–1860.
65. Atanda A Jr, Reddy D, Rice JA, Terry MA. Injuries and chronic conditions of the knee in young athletes. *Pediatr Rev.* 2009;30(11):419–428.
66. Post WR. Anterior knee pain: diagnosis and treatment. *J Am Acad Orthop Surg.* 2005;13(8):534–543.
67. Rose PS, Frassica FJ. Atraumatic bilateral patellar tendon rupture: a case report and review of the literature. *J Bone Joint Surg.* 2001;83:1382–1386.
68. Deland J. Orthopaedia—Collaborative Orthopaedic Knowledgebase. Posterior tibial tendon insufficiency. <http://www.orthopaedia.com/x/CIOdAQ>. Published November 9, 2009. Updated October 25, 2010. Accessed March 15, 2012.