Adopted 10/13

Knee Diagnosis: An Aid to Pattern Recognition

Each of the conditions in this compilation is followed by a list of findings that, when taken together, form a pattern that would support a particular diagnosis. The signs and symptoms listed in this document are not intended to be comprehensive. Companion CSPE protocols exist (e.g., Knee Orthopedic Tests, Knee Pain: DDX by Location) as well as standard texts and other supporting literature should also be consulted. Note that some knee presentations may not fit neatly into any of these patterns and will require further investigation by the practitioner. This document is based on the opinions of the authors in the context of the cited references located at the end of the document. It is not the result of a systematic review of the literature.

This protocol is divided into two sections. The first section contains a list of knee conditions arranged in alphabetical order. Test validity numbers are cited when known; those that appear to be clinically important are in bold. Because the accuracy of orthopedic tests for the knee is an ever changing landscape, readers are cautioned that it is incumbent upon them to keep up with the literature in this arena and that some of the statistics in this protocol will likely go out of date. The second section organizes the same conditions into various patient presentations.

Additional, pertinent information is available in the peer reviewed literature, in standard texts and in the following companion CSPE protocols:

Imaging Decision Making: Acute Knee Injury
Knee Pain & Tenderness: Differential Diagnoses by Location
Knee Orthopedic Tests: A Strategic Approach to Assessing the Knee
Knee Orthopedic Tests 2012 https://media.uws.edu/kneetests/

A number of orthopedic tests are listed in this protocol. These are described in detail in the CSPE Knee Orthopedic Tests protocol and in the video demonstrations in Knee Orthopedic Tests.

A Word on Assessing Knee Complaints

Research evidence suggests that the clinical examination and/or combinations of findings generally seem to be very good at identifying and ruling out various knee pathologies, including meniscal tears, ACL tears, and symptomatic plica.[1]

A Strategic Approach to Assessing the Knee

The following is one strategy guiding a typical knee assessment. If there are no red flags for disease (i.e., infection, inflammatory arthritis, tumors) in the presentation, the practitioner can usually assume that the knee problem falls into the broad category of *injury*. In these cases, the practitioner sets out to answer 5 basic questions:

1. Is there internal derangement (e.g., meniscus or cruciate tear)?
2. Is the knee stable (important in trauma and osteoarthritis cases)?
3. What is the primary pain generator (if not due to internal derangement, what knee structure(s) is the pain coming from? Is it referred from the hip?)?
4. What is the biomechanical or "manual therapy" assessment (is there joint dysfunction of the knee complex? Myofascial trigger points)?
5. Are there contributing/predisposing factors in the kinetic chain (e.g., pronation syndrome, muscle imbalance, hip issues)?

Taking a History

Taking the chief complaint history for a patient with a knee problem is essentially the same as taking the history of a patient with any other musculoskeletal presentation. A few lines of questioning bear special attention.

Location of pain: Initially this can be very useful in helping to generate a reasonable differential (see p. 56). Later in the examination palpatory tenderness may be useful in localizing the site of injury as well as differentiating referred pain from the site of injury.

Mechanism of injury: Patients will generally quickly fall into one of 3 possibilities: a single traumatic event, an obvious overuse injury, or no obvious cause. Single traumatic events and overuse syndromes trigger different sets of possible diagnoses (see p 56). When a single traumatic event is implicated, a detailed account of the mechanism including the activity, estimated force and force vectors can be useful.

Aggravating and relieving factors: Besides asking the usual open questions, it is useful to specifically ask about pain with going up or down stairs (e.g., cruciate tears, patellofemoral syndromes, infrapatellar tendinosis), pain going into a squat (e.g., patellofemoral syndrome) as opposed to the bottom of a squat (e.g., meniscus tear), pain with the knee held in sustained flexion at acute angles (e.g., patellofemoral syndrome), and pain with pivoting/twisting on the injured knee (e.g., meniscus tears, collateral ligament sprains, cruciate tears). Aside from pain, a sense of apprehension or a sense that the knee "pops out or out and in" during certain activities may lead the examiner to suspect patellofemoral or tibiofemoral instability (e.g., subluxating patella, ACL tear, PCL tear).

Associated symptoms: Associated symptoms can be roughly organized into 1) knee symptoms, 2) symptoms in related joints, 3) red flags for disease, and 4) neurological symptoms. There are 4 important local knee symptoms to routinely ask about: catching or locking, buckling/giving way, swelling or stiffness, and crepitus (e.g., popping, snapping, grinding). (See p. 54.) In addition, routinely inquire about related joints, especially the hip, ankle and low back. In cases where there is reason to suspect a systemic or local disease process, the usual constitutional symptoms can be useful (i.e., fever, malaise, fatigue, weight loss). Neurological symptoms are *not* commonly associated with isolated knee pain. However, the presence of neurological symptoms (weakness, pain, paresthesia, concomitant back pain) distal to the knee suggests a radicular or peripheral nerve injury either causing the knee pain or associated with it.

A Word on Referred Pain

The examining clinician should be aware that symptoms may be referred from a distant site and should be considered in the differential diagnosis when a patient presents with pain in an extremity. Referred pain may be the sole cause of knee discomfort or a contributing factor. Note that referred pain usually, but not always, projects from proximal to distal. Referred pain may be neurogenic (e.g. radicular and peripheral neuropathy) or arise from muscles, ligaments, joints, bones, and other soft tissues of the back, pelvic, hip, and upper thigh regions. For this reason the practitioner should take a moment to explore the above mentioned regions. Note that it is not unusual that chronic hip pathology (e.g. arthritis, Perthes, slipped femoral capital epiphysis, neoplasms, and femoral stress fractures) in all age groups, especially pediatric and geriatric patients, may have knee pain as their main complaint. Trigger points in the thigh and hip may also be the source of knee pain. Furthermore, the knee pathology itself may be a source of referral, referring pain to the leg and sometimes the foot. Patients suffering from knee arthritis may complain of leg pain similar to shin splints that may even extend to the dorsum of the foot.[2,3,4,5,6,7,8]

The Physical Examination

Clinical Tip: An overarching part of the physical examination of the knee is observation. You begin with observing the patient (including their gait if they walk into the treatment room). It is a necessary part of all diagnostic procedures that follow. Careful and focused observation and inspection of anatomy, bilateral symmetry, relationships, patterns of movement, and patient physical and emotional responses during the examination is an integral part of the assessment.

Musculotendinous Causes of Knee Pain

When assessing the muscles of the knee as potential pain generators, the assessment starts with observation and active range of motion. Observation and inspection including symmetry, size, shape, contours, texture, tone, color, location, changes that occur with changes in body position and between contracted and relaxed, involuntary movements, facial expression and vocal responses. Active range of motion includes flexion and extension as well as internal and external rotation and may indicate which muscle is injured. The practitioner tests to see whether there is reduced range, strength and/or pain. The "hands on" physical examination procedures generally boil down to just 3 types of procedures:

The Muscle Assessment Toolkit

- Palpation (including palpation with the muscle or tendon under load)
- Stretching (both active & passive)
- Contraction (may include any of the following: an isometric manual muscle test, resisted range of motion, or repetitive weight bearing loads)

The Key Differentials

Once identifying a painful muscle, the practitioner must then decide whether the problem is primarily with the muscle itself or secondary to another cause. The differential diagnoses of muscle or tendon tissue damage/disease include:

- **tendinopathy/tendinosis** (formerly called tendinitis)
- **strains:** grade 1 (mild), 2 (moderate), or 3 (severe/complete rupture) strains
- **contusion**
- **muscle spasm**
- **myofascial trigger point** (AKA myofascial pain syndrome)
- **myopathy:** a rare primary disease of muscle tissue.

Other Differentials

If the muscle itself is not the site of the lesion, other possibilities are neurological (in which case the pain is referred to the muscle in question and may even result in increased sensitivity to deep palpation), vascular, or joint related. Injured joints can refer pain to a muscle or result in painful muscle splinting/spasm. Sometimes an uninjured muscle will cause pain when contracted against resistance because it creates a compressive load to an inflamed joint or irritates another adjacent injured tissue.

Muscle weakness

Muscle weakness may be due to a number of factors that can present a challenge to the practitioner. It is convenient to separate painful muscle weakness from painless weakness.

Painful Muscle Weakness

When muscle weakness is associated with pain, the first differential would be a traumatic or repetitive use strain (signaling possibly a grade I-III strain) or other condition originating from chronic muscle or tendon pathology (e.g. degenerative tendinopathy, myofibrosis or myofascitis). Even a grade I strain may test weak because a muscle in acute spasm (like the hamstrings) may be too painful for the patient to voluntarily maintain the contraction. A differentiating feature is that the weakness associated with a myospasm would be far more temporary than when associated with a muscle tear. The weakness, however, may also be due to a pain response associated with internal derangement of the knee joint. For example, isometric contraction of the quadriceps creates a mild compression load, and if joint effusion is present, this may be painful enough to inhibit the muscle either reflexively or voluntarily by the patient.

Painless Muscle Weakness

Painless weakness can be associated with a complete muscle or tendon tear, nerve damage to that muscle from a distant lesion (e.g., in the spine), reflex inhibition (from a myofascial trigger point or perhaps from a short tight antagonist muscle), or from disuse and atrophy. Note: local muscle pain and tenderness is not unusual at the location of the MFTP, thus resulting in weakness of the muscle where the MFTP is located as well as symptom referral.

A Word on Joint/Ligamentous Causes of Knee Pain

Unlike the shoulder, in most knee cases (except patellofemoral pain) the key pain generators are joint and ligamentous in origin (e.g., MCL, LCL, ACL, PCL, meniscus, capsule, and proximal fibular joint capsule) and fracture. Consequently, the most useful exam procedures tend to be static palpation and passive loading/stress tests.

A Word on Fractures

Fractures in the knee region are not commonly seen in a chiropractor's office. Yet when a patient presents with an acute traumatic injury, it is important to carefully and thoroughly evaluate the patient with the expectation that a fracture may have occurred. Therefore, the examination should begin with the "first 3 first" rule whereby the practitioner 1) observes and inspects, 2) asks the patient to actively flex and extend the knee as much as tolerable, and 3) screens for fracture. **It is very important to rule out a fracture at the beginning of the physical evaluation prior to passively moving the knee and especially prior to stress testing, muscle testing, joint plays or any other procedure that could harm the patient.** If it is decided that radiographs are needed because of a significant probability of fracture, the physical examination should cease until the results of the radiograph are known. If the radiographs are negative, the examination can continue. If there is evidence of a fracture and there is any reason to believe that there may also be nerve damage (e.g., a peroneal nerve lesion associated with a fibular fracture), vascular tests (e.g., pulses in the ankle) and sensory testing in the peripheral nerve territory (e.g., light touch, sharp dull) is recommended prior to treatment or referral. Vascular compromise would warrant an urgent referral.

Historical clues that should alert one to the possibility of fracture include **age (>55)**, mechanism of injury (excessive twisting or bending), high energy traumatic force, inability to bear weight, marked loss of ROM **(< 90˚ of flexion)**, extreme pain, visible displacement at the time of injury, extreme or rapid swelling or bruising, and/or patient describes a "crack" or "crunch" at the time of injury. Observe for displacement or anatomical irregularity, and determine if the patient can **bear weight for at least 4 successive steps**. During active ROM an **inability to bend the knee to 90˚** would indicate a serious injury including fracture. Local **boney tenderness especially on the patella or proximal fibula** indicates a possible fracture (see CSPE protocol Imaging Decision Making: Acute Knee).

A Word on Imaging

Plain radiographs are useful with a history of trauma to show fractures or other bone abnormalities (see CSPE protocol Imaging Decision making: Acute Knee). They may also be useful in identifying osseous lesions and joint disease. Diagnostic ultrasound (US) may be of value in assessing for muscle/tendon abnormalities, joint effusion and popliteal cysts. MRI (with or without contrast) is best for the evaluation of tendon and ligament injury about the knee, intra-articular derangement, and occult fractures. Computed tomography is useful when trying to better delineate fractures of the knee.

A Word on the "Biomechanical" or Manual Therapy Assessment

The exam procedures used to assess muscles and tendons outlined above are adequate for identifying muscle spasm, myofascial pain syndromes, and myofibrotic changes that are amenable to manual therapy interventions. Some procedures used to assess joint dysfunction may be similar to classic orthopedic tests, others are different, and they are often interpreted differently. Besides static palpation for tissue tenderness and observing for misalignment, motion palpation (as described below) for pain and restrictions is used. The joint play maneuvers are usually done in an open/loose packed position (e.g., A-P glide is performed with the tibiofemoral joint at around 90 degrees and is done in place of end range flexion and extension).

The Motion Palpation Toolkit

Tibiofemoral joint
- AP and PA glide
- Internal and external rotation
- Medial and lateral tilts of the tibiofemoral joint at both 0 and 20-30 degrees of flexion.

Patella
- Patellar glide in multiple directions around the face of a clock.

Tibiofibular glide
- AP and PA glide
- Superior → inferior and inferior → superior glide.

Similar assessments of the hip and ankle joint complex can also be helpful to identify biomechanical lesions in the kinetic chain which may be increasing loads on the knee.

References for Introduction

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CONTENTS

CONDITIONS

BAKER'S CYST (AKA popliteal cyst) ICD 9 – 727.51

Snapshot: Patient complains of posterior fullness, stiffness or knee pain and swelling.[1]

History and physical

- Visible or palpable swelling in the popliteal fossa, usually medial side between the tendons of the semi-membranosus and medial gastrocnemius muscles.[1,4,8]
- Flexion and extension may be limited

Etiology

- May be associated with inflammatory arthropathy[8] (e.g., RA) or secondary to joint effusion from degeneration (e.g. OA) or from a prior knee injury *even after the joint has recovered* (e.g., meniscus tear, ACL or PCL tear, fracture, chondromalacia, plica).[1,2,6,7]
- Occasionally a popliteus bursa Baker's cyst develops due to internal derangement and will present with tightness and deep calf pain; some may be asymptomatic.
- In young people with a Baker's cyst it may be due to a one way valve mechanism rather than internal derangement.[7]
- May cause arterial or venous obstruction of popliteal vessels.

Imaging

- Radiography and/or MRI [5,6,9] should be ordered in the case of a persistent Baker's cyst to differentiate it from a solid mass and to determine what, if any, internal derangement may be related.
- Diagnostic ultrasound may also play a role in detecting cysts, especially in rheumatoid arthritis.[7]

Lab

Lab studies should be considered when there is no identifiable injury, mechanical or degenerative etiology: ESR/CRP and CBC; if an inflammatory arthropathy is suspected such as RA, include anti-CCP and RF. In some cases arthrocentesis may be necessary.

DDX

- <u>DVT</u>, <u>popliteal aneurysm</u>, <u>soft tissue tumor</u>, <u>excessive popliteal adipose</u>

BURSITIS

ICD 9
Prepatellar (AKA housemaid's knee) 726.65
Pes Anserine 726.61
Unspecified 726.60
Joint Swelling 719.0

Snapshot: Patient complains of persistent knee pain, stiffness &/or fullness with an area of visible swelling.

History and physical[1,2,3,4]

- Knee bursitis often mimics or may be secondary to other pathologies.
- Pain and visible swelling in the location of one of the knee's bursa.
- The most common are **pre-patellar** (swelling over the front of the patella), **pes anserine** (swelling at the insertion of sartorius, gracilis and semitendinosus on anterior superior tibia), **Baker's cyst** (posterior knee), or **suprapatellar** (directly superior to the patellar, may swell proximally as much as 10cm above the patella).
- Patellar ballottement or the bulge/sweep tests may be useful in identifying intracapsular and suprapatellar bursal effusions that may also be accompanied by a Baker's cyst.
- In the case of Baker's cyst, the patient complains of stiffness and a feeling of fullness behind knee that affect both flexion & extension (fluid motion).

Etiology & contributing factors[1,2,3,4,5]

Recent history of trauma, chronic condition (i.e. OA), internal derangement, or another infection site (local or systemic), surgery or immunocompromised.

- **Prepatellar Bursitis (AKA Housemaid's Knee):** sustained rocking forward onto knee cap while kneeling, trauma to anterior patella, infection, or inflammatory arthritis.
- **Pes Anserine Bursitis:** lesions in the kinetic chain such as anteromedial rotational instability, over pronation, foot flare, genu valgum; direct pressure or trauma; infection/arthritis; or accompanied by medial hamstring or pes anserine tendinopathy (see Pes Anserine Tendinopathy for more details).
- **Baker's Cyst:** secondary swelling from lesions inside the joint capsule such as OA, meniscus tear, ACL or PCL tear, fracture, chondromalacia, plica (see Baker's cyst for more details).
- **Infrapatellar Bursitis (AKA Carpet Layers Knee):** sustained or repetitive pressure on the infrapatellar tendon and underlying bursa; most often due to kneeling; may also be associated with Osgood Schlatter's Disease.[2]

Imaging [5,6,7,8,9]

- Imaging is not usually required, except in the cases of a Baker's cyst where an MRI or diagnostic ultrasound may be necessary to identify the source of the swelling. (Hyde 2007)

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BURSITIS (continued)

Lab

Laboratory studies should be considered when there is an unconfirmed suspicion of inflammatory arthritis, infection (e.g. staphylococcus, Lyme, fungal), or other systemic disease. Tests to consider include ESR/CRP and CBC; if an inflammatory arthropathy is suspected such as RA, include anti-CCP and RF. In some cases arthrocentesis may be necessary. If Lyme is suspected, ELISA and Western Blot testing is suggested (accuracy is controversial).

DDX

- PFPS, tendinitis, chondromalacia, symptomatic plica, Osgood Schlatter, OCD

CHONDROMALACIA PATELLAE (Patellar Chondropathy) ICD 9 – 717.7

Snapshot: Patient reports insidious onset of anterior knee pain with prolonged knee flexion, during squats, and while going up and down stairs.[1]

Background: This common condition, often related to overuse,[3,4] is very similar to patellofemoral pain syndrome (PFPS) and jumpers knee except it is more likely to present with painful crepitus and pain and tenderness deep to the patella; to be in older patients; to be aggravated by a greater number of the orthopedic tests listed below; to be more painful even between activities; to present with early stages of osteoarthropathy. It is this author's opinion that "Chondromalacia patellae" should be reserved for lesions of articular cartilage that can be confirmed by special imaging or arthroscopy.[5]

History[2,3,4,7,8,10,11]

- Usually gradual onset of vague patellar pain relieved by rest in the early stages (common cause of anterior knee pain), but can be caused by blunt trauma patellar instability or dislocation.[10,11]
- Aggravating factors include running, jumping, going up and down hills/stairs, knee extension exercises, prolonged sitting with knee acutely flexed ("theater sign"), while squatting up and down.
- Associated symptoms: painful crepitus, stiffness or grinding sensation; but visible swelling, locking/catching, and giving way is not usually expected.[2]

Physical[3,8,913,14,15]

- Chondromalacia cannot be diagnosed with certainty based on signs and symptoms alone[3,8,9]
- AROM and passive ROM usually complete and painless (terminal flexion and flexion end feel *may* aggravate)
- Palpation: tender facets, palpable crepitus, soft mushy VMO when contracted; effusion is uncommon in PFPS including chondromalacia (occasionally a bakers cyst accompanies chondromalacia patellae)[2,3]
- Orthopedic tests
  - Clarke's test this well know and often performed test may be painful in chondromalacia patella (but test often painful in asymptomatic knees; it is been suggested to have very little diagnostic value, and that this test be abandoned)[5,6]
  - Patellar grinding test or repetitive step up test may be create pain or crepitus
  - Positive Waldron's test
  - Motion palpation test involves flexion-extension of the knee while the examiner applies slight A→P pressure on the patella; a positive is painful grinding (sensitivity 87%, specificity 33%, PPV 97%, NPV 10%)[15]
- Active resisted knee extension may produce retropatellar pain
- Pain and grinding while performing a squat (NOTE: may be used as an *outcome measure*)[3]

Etiology & contributing factors[2,3,4,17,18,19,20]

- Overuse and high impact activities (common), direct trauma (less common), aging, iatrogenic (e.g., post-surgical, aggressive bracing), and over training.
- May be the result of long standing patellofemoral pain syndrome
- Key potential reversible contributing factors (check muscle balance, hip and ankle pronation)

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CHONDROMALACIA PATELLAE (continued)

- Abnormal movements during step down test or single leg squat may occur (i.e. contralateral pelvis drop, hip adduction and internal rotation, knee abduction, tibial external rotation, over-pronation);[2,3] weak hip flexors[18]; tight hamstrings and calves; IT Band tightness[19, 20]
- Muscle imbalances: weak or delayed timing in hip abductors;[17] weak knee extension (systematic review)[15]; weak or delayed timing of medial quads vs. lateral quads; short tight quads
- VMO weakness and loss of tone;[4] atrophy is more likely related to a meniscus lesion[3]
- Femoral anteversion
- Over-pronation[4] may be associated with < 10 degrees ankle flexion; poor shoe support

- Additional contributors
  - Patella anomalies: size, shape, and position (e.g., squinting patella,[3] patella alta or baja)
  - Q-angle (>13-18 degrees, genu valgum favors lateral patellar tracking; note: the importance of the Q-angle is controversial)[2]
  - Instability: patellofemoral or at tibiofemoral joint (e.g., medial collateral laxity, ACL laxity, meniscectomy, anteromedial & anterolateral instability). [12]

DDX

Isolating the exact cause of anterior knee pain is very challenging with many different soft tissue pathologies presenting with similar symptoms and signs, especially in their early stages. Also, other pathologies may coexist in the patient with chondromalacia. This explains why these many different pathologies are commonly grouped under the umbrella heading of "Patello-femoral Pain Syndrome." It is likely that a patient presenting with anterior knee pain at onset and during the early stages will usually be diagnosed and treated as PFPS. However, in more chronic presentations or where treatment has failed after 6 months further investigation (lab, imaging, and arthroscopic surgery) is necessary to reach a more precise pathological cause and treatment specific to the cause.

- Other common causes of anterior knee pain similar to chondromalacia patellae are:
  - symptomatic plica or loose body (clicking, grinding & swelling)
  - meniscus lesion (localized joint line tenderness and swelling more likely)
  - infrapatellar tendinopathy (tenderness more localized to inferior pole of patella and tendon)
  - Osgood Schlatter & Sinding –Larsen-Johansson diseases (usually under age 16 with pain and tenderness inferior to patella)
  - patellar stress fracture (locally tender on the anterior patella and to percussion/vibration)
  - osteoarthritis (may coexist or be the end stage of chondromalacia, often seen in the elderly and may also involve the tibiofemoral joint)
  - Fat pad inflammation (Hoffa's disease)

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CHONDROMALACIA PATELLAE (continued)

Imaging

- X-ray not usually necessary and usually normal in early stages; may be useful in ruling out osseous pathology.
- MRI is often used to rule in cartilage damage or rule out other soft tissue pathology (i.e. tendinopathy or synovial plica). However, as of 2010 the evidence is still unclear whether MRI can unequivocally confirm the correct diagnosis of chondromalacia with sensitivity ranging from 26-100%, specificity ranging from 50-94% and diagnostic accuracy ranging from 73-90%.[9]

CONTUSION & MYOSITIS OSSIFICANS

ICD 9 – 924.00
(Myositis ossificans 728.12)

Snapshot: Patient presents with knee, lower thigh or upper calf pain, swelling and/or bruising produced by forceful impact from a blunt non-penetrating object. When the patient has persistent swelling or increased pain and stiffness (loss of knee flexion) beyond what is expected (especially involving the deep quadriceps) suspect myositis ossificans.[1]

History and physical[1-11]

- Blunt trauma due to contact from an external source: collision sport (contact with helmet, shoulder, elbow, knee, foot), motor vehicle accident or being struck by a moving vehicle, struck by a flying object (baseball), fall onto a blunt object, striking a stationary object (running into a table corner or a hand rail), being stuck by a moving object at work, crushing injury (i.e. stepped on by a horse or rolled over by a car)
- Patient may present with an antalgic gait and in severe cases may have difficulty ambulating
- Pain, tenderness, swelling, and decreased knee flexion are common; bruising and ecchymosis may or may not be visible
- Pain and weakness of the involved muscle group; occasionally knee joint swelling and stiffness
- Thigh contusion grades of severity (12-24 hours post injury) based on Jackson-Faegin Criteria (1973)[1,2,3,11]
    - Grade 1 (mild) – patient able to flex knee greater than 90˚
    - Grade 2 (moderate) – patient able to flex knee 45-90˚
    - Grade 3 (severe) – patient unable to flex knee to 45˚

DDX

- Suspect acute compartment syndrome with massive swelling, severe pain and/or neurovascular signs and symptoms.[7,8] Immediate referral when suspected.
- Suspect myositis ossificans (MO) with persistent palpable mass, pain, swelling and/or warmth especially involving the anterior or lateral thigh. Approximately 10-20 % of anterior thigh contusions develop myositis ossificans;[4] repetitive contusions and severe contusions have the greatest risk of myositis ossificans;[4,5] the majority of MO cases are post-traumatic, however about 40% have no history of trauma.[6]
- Suspect neoplasm with increasing symptoms over time especially when non-traumatic.
- Suspect bone bruise or fracture with direct contact on a bone surface; blunt trauma to the patella may also result in prepatellar bursitis or chondral damage to the patellofemoral surfaces

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CONTUSION & MYOSITIS OSSIFICANS (continued)

Etiology & contributing factors [1,3,4,5,6,9,11]

- The anterior or lateral thigh, anterolateral leg and posterior calf are vulnerable to contusive injury.
- Deep bruises in the anterior compartment of the thigh are the most common site in the body for the development of myositis ossificans.
- Inadequate padding in contact sports such as hockey and football.
- Early aggressive painful stretching and or massage, therapeutic ultrasound, and /or heat may be risk factors in the progression of a contusion and myositis ossificans.

Imaging

- Most contusions (except when severe) do not require diagnostic imaging and radiographs have little diagnostic value during the first 2 weeks post injury aside from ruling out bone pathology (i.e. due to direct contact with a bony surface). Radiographic evidence of myositis ossificans is not visible until 3-6 weeks post injury. Note that the periosteal reaction associated with early stages of myositis ossificans may be confused with the with sarcomas (40% of sarcomas have trauma history but usually involve metaphysis rather than the diaphysis)
- Diagnostic ultrasound[1, 4, 6,12,13,14] and MRI[6, 14] are valuable in determining the extent of bleeding and soft tissue damage in severe contusions, severe pain, excessive swelling, or when signs/symptoms persist. Scintigraphy (bone scan) studies may be recommended[1, 6,15,16,17] when ultrasound or MRI is unavailable or contraindicated.

Referral with suspected:

- Emergent referral with suspected acute compartment syndrome
- Orthopedic consultation with myositis ossificans

DEEP VEIN THROMBOSIS (DVT)

ICD 9 Lower Extremity 453.40
Popliteal 453.41
Leg 453.42

Snapshot: Patient presents with posterior knee and leg discomfort and swelling of the leg and foot (DVT may present with swelling, but without pain).

History & Physical (based on Wells prediction rule)

- Posterior knee pain and/or swelling (if popliteal vein involved)
- Swelling of calf or entire leg; pitting edema in leg and/or foot
- Erythema of posterior knee or leg
- Tenderness over involved vein(s)
- Superficial veins may feel engorged and firm (not varicose)
- Back of knee and/or leg may feel warmer or cooler than normal side
- Warning: Homan's sign not considered diagnostic and may increase the risk of pulmonary embolism

Etiology & Risk Factors

- Previous history or family history of DVT
- Virchow's triad: hypercoagulability, venous stasis, vascular damage.
- Chronic diseases: cardiovascular, diabetes, cancer
- Following major surgery or arteriography in patients over 50
- Oral contraceptives
- Pregnancy – especially 3rd trimester to 4 weeks postpartum; leading cause of maternal fatality in US and UK.[1]
- Following prolonged periods of sitting (i.e. more than 6 hour airplane flight) being bed ridden, or prolonged lower extremity immobilization
- Post traumatic (e.g., severe knee injury, leg injuries ranging from mild to severe, following knee surgery especially knee replacement)
- Repetitive stress in younger age group (i.e., long distance running)
- Obesity
- Tight bandage, cast, tight wrap of lower limb

Differential Diagnosis

- Baker's cyst
- Bacterial cellulitis, osteomyelitis, or septic joint
- Posterior thigh or calf strains, contusions or severe cramps

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DEEP VEIN THROMBOSIS (continued)

Prompt Referral (for imaging or Emergency Department)

- Urgent (within 24 hours) if DVT suspected although only approximately 1 out of 4 referrals will result in a DVT diagnosis[10] for Duplex US, Doppler compression US, and d-dimer are tests.

- Emergent referral (911) with suspected pulmonary embolism (i.e., chest pain, shortness of breath, drop attack).

***NOTE:** See also CSPE protocol Deep Vein Thrombosis (DVT)/Thrombophlebitis Assessment & CSPE Urgent Referral protocols.

ILIOTIBIAL BAND SYNDROME (AKA ITBS)

ICD 9 – 726.60
(Unspecified knee enthesopathy)

Snapshot: Patient presents with lateral knee pain and sometimes crepitus secondary to overuse with no associated symptoms.

Background: Most common cause of lateral knee pain (may be burning pain, over and proximal to lateral femoral epicondyle) in overuse syndromes. ITBS accounts for approximately 12% of knee injuries in runners).[1] Current evidence indicates that symptoms of ITBS are linked to fat pad compression beneath the ITB rather than friction and that it does not involve bursitis as once thought.[6,7,8]

History[1,2,3,4,5]

- Onset: at first worse when running, relieved with rest; later constant; initially runners often describe pain just after heel strike (when the knee is approximately 20-30˚flexed) while running and later becoming constant; others describe pain during the swing phase.
- Aggravating factors: running or biking worse on hills (especially downhill)[4, 21] and stairs.
- Associated symptoms: sometimes crepitus; swelling, locking/catching, giving way not expected.
- Onset often follows a recent increase in training.[19]

Physical[1-9]

- Tenderness along the distal ITB (not at the insertion on the tibia) over & just proximal to lateral femoral epicondyle.[3,4,9,10]
- Orthopedic tests
  - Nobel/Rene's tests usually the most provocative; expect provocation to be greatest when the knee is about 20-30˚flexed.[3,11]
  - Ober's (flexed & extended knee) positive for tightness, only occasionally painful.[4,12,13,22]
- Some may demonstrate weakness on isometric hip abductor muscle tests.
- Diagnosis is usually made from history & physical findings and does not require imaging.

Etiology & contributing factors

- Check for knee instability,[4,15] leg length, pronation, and over training (recent increase).
- Improper rearfoot varus post/wedge (over correction), or decreased rear foot eversion.[3]
- Improper bicycle seat adjustment (too high or too far back); improper foot/cleat position with tibia too internally rotated.[16,17]
- Tight ITB; evidence suggests that increased strain or strain rate related to increased eversion, hip adduction or poor hip stabilization may be key etiological factors in ITBS.[10]

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ILIOTIBIAL BAND SYNDROME (continued)

- Hip abductor weakness has been commonly cited as a factor;[1,2,18] other studies have not found a difference when compared to non-symptomatic controls;[18] however symptom improvement with hip abductor strengthening exercises has been demonstrated.[1,2] (Hyde 2007)

DDX - Lateral collateral ligament sprain, popliteal tendinopathy, proximal tibiofibular subluxation, and lateral meniscus lesion.

INFRAPATELLAR TENDINOPATHY (aka JUMPER'S KNEE) ICD 9 – 726.64

Snapshot: Patient presents with anterior knee pain and localized tenderness involving mainly the infrapatellar tendon without associated symptoms, aggravated by running or jumping; and sometimes aggravated by a single leg squat, resisted knee extension and/or quadriceps stretching.

History

- Poorly localized anterior knee pain (infrapatellar tendon, retinaculum, inferior pole of patella)
- Pain during and after activity, hills & stairs (worse going down); progressive worsening
- \+ movie or theater sign (sitting for extended periods, especially if the knee is flexed usually at 90° or more)
- Grading system
  1. Pain only after sports activity
  2. Pain at beginning of sport activity, disappears after warm-up, and reappears with fatigue
  3. Constant pain at rest and during activity; unable to continue sport at previous level
  4. Tendon rupture (usually over age 40) (see Strains, Ruptures, and Tendinopathy)

Physical

- Tender infrapatellar tendon and inferior patellar pole; sometimes also superior pole
- No visible swelling or bruising
- Sometimes pain with stretch (i.e. squat or heel to buttock)
- Sometimes pain with isometric muscle testing in extension or resisted ROM
- A single leg squat performed on a 20° decline may be the most provocative PE procedure.

Etiology & contributing factors

- High impact/overuse activity, rarely due to direct trauma
- Tight iliotibial band (Ober's test), weak quadriceps (sometimes atrophy), weak hip abductors (strengthening hip abductors may improve signs and symptoms); weak external tibial rotation, and increased Q angle[1,2]
- Other factors include over pronation, underlying instability, structural faults (i.e. patella alta, genu valgum/varum, leg length asymmetry), muscle imbalance (lower X syndrome), tight hip flexors, knee extensors, hamstrings, ITB & gastrocnemius; weak abdominals, gluteals, quadriceps (especially VMO), & tibialis anterior.
- Training faults include over training or sudden training increase; cycling with toe clips (especially up hills) and improperly adjusted bicycle seat, crank or gears; running on hard surfaces or cambered/canted surface or hills; improper or worn out shoes; repetitive jumping, deep squats, stop & go or kicking.
- Can be secondary to patellar tracking dysfunction (due to lateral translation and lateral tilting) and so sometimes + chondromalacia tests.

Imaging

- X-rays usually not indicated (and negative); MRI and RTUS (+) but usually not necessary.

LYME ARTHRITIS (PART OF LYME DISEASE SYNDROME)

ICD-9: 088.81

Snapshot: Patient presents with knee pain and swelling. Lyme disease produces intermittent inflammatory arthritis in about 60% of untreated Lyme patients within 6 months of exposure. One or both knees are the most commonly affected joints; and the ankle, wrist, elbow, shoulder and hip are occasionally involved.

Background: A history of outdoor activities in high risk regions: the northeastern states extending from Maryland to Maine (~90% of US cases), followed by Wisconsin and Minnesota (~ 8% of cases), and Northwestern California (~1% of US cases). Lyme disease is rare in Oregon, Washington, and Western Canada; however exposure to this disease does occur along the Columbia Gorge and in southwestern Oregon. Episodes last approximately one week, may recur at 2-3 month intervals and may also involve multiple joints. Chronic and destructive knee arthritis develops in some patients. Chronic destructive arthritis rarely involves other joints.

History

- Pain involving one or both knees, often accompanied by swelling, develops within 6 months of a rash in untreated patients.
- The onset is characteristically independent of traumatic or other mechanical causes.
- Only about 25-30% of patients[25] recall seeing a small tick or remember being bitten.
- Associated symptoms: malaise, fatigue, headache, fever, myalgia, and joint achiness often described as flu-like accompany or follow the rash.

Physical

- 70-80%[12] of patients experience one or several large raised macular lesions (erythema migrans) in 3-32 days following exposure; the slowly expanding lesion often resembles a "bullseye" or target
- Joint swelling
- Lymphadenopathy

Lab (Controversial)

- The CDC and Infectious Diseases Society of America (IDSA) recommend a 2-tiered approach.
    1. antibody titer (ELISA) – either total Lyme titer or separate IgG and IgM titers
    2. confirm titers with Western blot for IgG and/or IgM
- The International Lyme and Associated Diseases Society (ILADS) position paper states that the 2 tiered approach misses the diagnosis in more than 40% of patients in the early stages of the disease

Imaging

- Not useful in reaching the diagnosis, but may be helpful in ruling out other diagnoses, and in determining the degree of joint destruction associated with chronic Lyme arthritis.

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LYME ARTHRITIS (continued)

Differential Diagnosis

- Rheumatoid arthritis, other infectious arthritides (especially those that are transmitted by tick bites), gout, SLE, radiculopathy.
- In cases where Lyme disease is associated with neurologic and myocardial symptoms, the differential includes meningitis, encephalitis, and AV node block.

MENISCUS TEARS

ICD 9
Medial – 736.0
Lateral – 736.1

Snapshot: Patient presents with knee pain often localized to the medial or lateral joint line and occasionally with episodes of catching, locking, giving away, or limited ROM. Onset may follow an abrupt painful snap, traumatic event, or come on gradually.

Background: Pre-test probability unknown (based on mechanism of injury); 25% in an orthopedic practice.[1]

History

- Onset: trauma or single event, especially with hyperextension, twisting or rotational load
- Patient reports feeling a snap with sharp pain.
- Associated symptoms: recurrent swelling, catching, true locking, and/or buckling
- The absence of "weight bearing during trauma" slightly deceases the chances meniscal tear (-LRs 0.4).[2]
- **Chronic/degenerative presentation:** associated with older patients, may be more subtle than in trauma cases, either a single event or repetitive activity may precipitate symptoms, symptoms usually ebb and flow.

Physical

- Decreased active flexion and extension
- Joint effusion [**+LR 5.7** (95% CI, 0.4-86); -LR 0.7 (95% CI,0.5-0.9)**]**
- Localized joint line tenderness [**+LR 3.3**, **-LR .31**][3]
- VMO atrophy
- Pain aggravated at the bottom of a deep squat
- Orthopedic tests
  - Bounce home may be a good screening test (author's opinion MC)
  - Thessaly test at 20 degrees for medial meniscus **+LR 29.7**, **-LR 0.1**; for lateral **+LR 23, -LR 0.08** (one moderate quality study)[4]
  - Merke's sign (lateral or medial joint line pain during Thessaly/"disco test") **+LR 4.2**, **-LR 0.3** (one moderate quality study)[5]
  - Ege's test for medial meniscus [**+LR 3.5**, **-LR 0.4]**; for lateral meniscus **[+LR 6.4,-LR 0.4** (one high quality study)];[6] dynamic test for lateral meniscus [**+LR 8.5,-LR 0.2** (one moderate quality study)][7]
  - McMurray test: pain, catch or both [**+LR 2.4,** -LR .58];[3] [+LR 1.3 (95% CI, 0.9-1.7); -LR 0.8 (95% CI, 0.6-1.1)] (based on 3 studies)[1]
  - Medial lateral grind test [**+LR 4.8** (95% CI 0.8-30); **-LR 0.4** (95% CI, 0.2-0.6)]
  - Apley's tests +LR 1.8, -LR .89[3]
  - Hyperflexion (a variation of the Apley's compression test @ full knee flexion)
  - Wilson's test or pain with internal rotation
  - Bohler's test: joint line pain with valgus (lateral meniscus) or varus load (medial meniscus)
  - Steinmann Test: pain migrates with flexion and/or extension
  - Payr Test: joint line pain on "figure 4"

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MENISCUS TEARS (continued)

Test combinations

Two of the following 6 tests positive **[+LR 7.5; none positive -LR 0.03** (small, moderate quality study on athletes)]:[9]

1) Tenderness to palpation of joint line,
2) + Bohler test,
3) + Steinmann test,
4) + Apley's grinding test,
5) + Payr test,
6) + McMurray's test.

A combination of 5 diagnostic findings can suggest the presence of a meniscus test [**+LR 11.2**, -LR 0.9; 4 positives **+LR = 4.28;** -LR 0.87; 3 positives **+LR = 3.14**; -LR 0.77):[10]

1) history of catching/locking,
2) joint line tenderness,
3) pain with forced hyperextension,
4) positive hyperflexion test,
5) pain or audible click with McMurray's test.

Imaging/Arthroscopy

- X-rays are often performed initially to rule out bone pathology such as osteochondral fracture or osteochondritis dissecans prior to more costly special imaging
- MRI sensitivity 87% (medial meniscus); 46% (lateral)[11]
- Arthroscopy accuracy 93%-96%[11,9]

DDX

- Presenting with locking, swelling or giving way: ACL tear, loose body (perhaps secondary to OCD), subluxating patella, symptomatic plica, OA in older patient).
- With acute presentation rule out fracture and sprain.

Imaging vs. Clinical Exam

- Correct dx of lateral or medial meniscal lesion made by clinical exam alone was made in 89% of cases (n=83) and MRI was 89% (n=36).
- Accuracy, + predictive value, - predictive value, specificity, and sensitivity was high, nearly the same for exam vs. MRI.
- Other studies have also demonstrated that when an examination is performed by a skilled physician the accuracy in diagnosis of isolated meniscus lesions is quite good;[13] however, clinical diagnosis is not very accurate at correctly identifying all pathologies when multiple lesions are present.[14]
- MRI will be able to demonstrate type and grade of meniscus tear.

OSGOOD SCHLATTER'S DISEASE

ICD 9 – 732.4

Snapshot: Young active patient presents with anterior knee pain and a visibly enlarged tibial tubercle without associated symptoms (e.g., locking, giving way), aggravated by running or jumping, and by resisted knee extension and quadriceps stretching.

Background: Sometimes listed under the diagnosis of PFPS, but should not be.

History

- Common age of onset 10-15 years in males and 8-13 years in females [1,2]
- Pain localized to tibial tubercle and distal part of tendon[3]
- Often caused/ aggravated by vigorous activity (i.e. running, jumping, kicking, hills, or stairs)[1]
- 20-30% of all cases are bilateral;[1,2,3] when this occurs it is usually worse in the author's experience MC).
- Growth spurt may precipitate or exacerbate symptoms.[4]
- Three grades of severity[5]
  1. Pain after activity that resolves within 24 hours
  2. Pain during and after activity that does not limit activity and resolves within 24 hours
  3. Constant pain that limits sports and/or daily activity

Physical

- Tender, swollen, enlarged tibial tubercle; inferior infrapatellar tendon tenderness may also be noted
- Passive ROM pain at end range (heel to buttock)
- Local pain may be exacerbated by squat and rise
- Sometimes pain with quadriceps contraction

Imaging

- X-rays are not indicated unless there is a suspicion of tibial tubercle avulsion (very rare).[12] MRI and ultrasound are not usually necessary but both modalities are more sensitive and specific in identifying thickening of the distal patellar tendon, infrapatellar bursitis and soft tissue swelling anterior to the tibial apophysis/tubercle.[2,6,7]

DDX

- Tibial tubercle avulsion (precipitous onset of more severe pain and patellar displacement)[12]
- Sinding –Larsen-Johansson Disease (same ICD 9 but involves tendon attachment to inferior pole of patella); less common; knee pain and local tenderness at the inferior pole of the patella in an otherwise healthy physically active 10-14 year old;[1] once thought to be a traction epiphysitis/apophysitis, but now considered to be a pediatric calcific traction tendinitis; may require 3 months to a year to run its course; also may be erroneously listed as a type of PFPS.[8,9,10,11]
- Infrapatellar tendinopathy (Jumpers knee): age 16 and older

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OSGOOD SCHLATTER'S DISEASE (continued)

- Osteochondritis dissecans (pain is less likely to be localized to the tibial tuberosity, but more likely to be deep to the patella; radiates to the popliteal fossa and medial joint line; may be accompanied by joint locking and/or joint effusion
- Symptomatic plica (tender palpable threadlike ridge medial to patella recurring snapping and + plica tests)
- Patellar stress fracture or symptomatic bipartite patella

OSTEOARTHRITIS

ICD 9 – 715.96

Snapshot: Older patient with medial or generalized knee pain and stiffness and "grating sensation."

Background: Usually patients > 50, but may occur in younger patients as a result of trauma or heavy loads. OA is often associated with meniscus tears and/or degeneration of patellar, sharing characteristics with a chronic patellofemoral syndrome. It usually begins in the medial compartment and can lead to instability.

History

- Slowly progressive, recurrent knee pain (initially pain only after heavy use; then intermittent swelling; finally constant pain, swelling, and reduced ROM).
- Morning pain and stiffness that diminishes usually < 30 minutes,[1] although it may be as long as a few hours[2]
- Stiffness after rest; activity levels decline
- Worse with cold weather or when barometric pressure drops; better with warm weather
- Difficulty with stairs, squatting, getting out of cars, walking long distances and balance (may contribute to increased risk of falls in the geriatric population)
- Associated symptoms: Grinding, locking, grating sensation, giving way (especially going up stairs), may have meniscal and chondromalacia signs and symptoms.

Physical

- Antalgic limp
- General tenderness and swelling may be present; bony enlargement in advanced stage
- Severe or progressive unilateral genu valgum or varum (severe/advanced OA); however, note that genu varum and valgum are no longer viewed as predisposing factors
- Thigh muscle atrophy in severe or chronic
- Decreased active and passive flexion ROM (sometimes decreased extension ROM)
- Difficulty performing squat and rise and step up tests
- Palpable crepitus including patellofemoral
- Instability may be present

Diagnosis

Diagnosis of knee OA can be made without radiographic confirmation (even with normal x-rays) in adults > 40 years old when all of the following are present:[3]

- Knee pain with activity
- Short lived morning stiffness
- Functional limitations
- ≥ 1 typical sign on exam (crepitus, restricted movement, bony enlargement)

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OSTEOARTHRITIS (continued)

Imaging

- X-rays are adjunct and not central to diagnosis; however, imaging may be useful in establishing a baseline and later in determining the degree of progression of the disease
- Radiographic features:[3] focal joint space narrowing, osteophyte, subchondral bone sclerosis and subchondral cysts
- Imaging other than x-rays is not usually indicated except to rule out chondromalacia, meniscus tears, symptomatic plicae, or other soft tissue causes of pain that may mimic or complicate OA

Lab

If necessary to differentiate from inflammatory arthropathy, consider ordering ESR/CRP, RF, anti-CCP and in some cases referral for arthrocentesis.

OSTEOCHONDRITIS DISSECANS (AKA OCD)

ICD 9 – 732.7

Snapshot: Patient presents with medial knee pain and swelling, often proportional to activity. In more chronic cases mechanical signs of snapping, catching or locking as well as swelling. High suspicion of OCD if the patient is under 16 years of age with symptoms resembling a meniscus tear.

Background: Age of onset often early teens; some may be asymptomatic until late teens or twenties.

History

- Often no evidence of trauma
- Chronic knee pain often involving the medial joint line and radiating to the popliteal fossa
- Swelling/Bakers cyst
- Associated symptoms: possible locking &/or catching (due to joint mouse)
- Occasionally, it may occur bilaterally

Physical

- Joint line tenderness, often medial (85% involve the medial femoral condyle).
- + Wilson's: limited accuracy best used as adjunct[4]
- + Meniscus tests; + McMurray's test in 50%[4]
- Pain with resisted knee extension when the tibia is held internally rotated

Imaging

- X-rays AP, lateral & tunnel (the common lesion involving the lateral surface of the medial femoral condyle is best visualized on the tunnel view); MRI or CT when x-rays are equivocal

DDX

- Meniscus tear, discoid meniscus, neoplasm

PATELLA DISLOCATION & RECURRENT SUBLUXATION

ICD 9 – 836.3 (Closed)

Snapshot: Patient presents with a recent or repeated events of a very painful popping sensation on the anterior side of the knee. Sometimes the knee will pop a second time soon after the initial injury which may indicate a spontaneous reduction of the dislocation or subluxation. Some patellar dislocations remain visibly displaced in a lateral direction (this patient is unable to ambulate and most likely to initially seek attention at an emergency facility). Bruising medial to the patella, marked swelling, and painful ambulation often follows the injury.

Dislocation

Background: Dislocations are most common in teenagers and early 20's and most involve vigorous sporting activities.[1,2]

History

- A recent painful traumatic event followed by episodes of knee locking or giving away and extreme pain (the patella has usually relocated by the time of the visit)

Physical

- There may be observable displacement. Note that relocation may be spontaneous and that many authors suggest that complete patellar dislocation may be incorrectly diagnosed in 50-75% of patients.[3]
- Antalgic gait or inability to bear weight
- Patient very guarded
- Limited active flexion; inability to squat or kneel
- Weak knee extension (painful)
- Medial patellar, retinacular, and VMO tenderness
- Swelling and bruising are often present (usually medial to the patella and involving the VMO)
- Orthopedic tests
    - o + apprehension test
    - o + moving patellar apprehension test (+LR 8.3, -LR .00) (based on one study)[4]

Recurrent Subluxation

Background: More common in females.[1,5] There can be a familial predisposition.

History

- A history of repeated painful locking and/or giving way and weakness.[6]
- Chronic hypermobility of patella;[6] many times initiated by a traumatic event.
- May start with a single traumatic event (i.e. patellar dislocation),or a trivial event such as a careless step/externally rotated tibia/turning over in bed.[1,7]
- Previous history, biomechanical or structural fault are main contributing factors.

Physical

- Orthopedic tests
  - + apprehension test
  - + moving patellar apprehension test (+LR 8.3, -LR .00) (based on one study)[4]
  - Note that there is insufficient evidence supporting the utility of diagnostic tests for patellar instability, nor predictive of dislocation, and their usefulness in clinical practice has been challenged.[8]

Imaging

- Radiographs are recommended to rule out osteochondral fracture following dislocation
- MRI may be necessary to confirm chondral or other soft tissue lesions
- CT may be useful to evaluate suspected osteochondral fracture not visualized on radiographs.

PATELLOFEMORAL PAIN SYNDROME

ICD 9 – 717.7

Snapshot: Patient reports insidious onset of anterior knee pain with prolonged knee flexion, during squats, and while going up and down stairs;[1] no structural pathology is identifiable.

Background: Patellofemoral Pain Syndrome (PFPS) is considered a diagnosis by exclusion, after ruling out other causes of knee pain such as chondromalacia, symptomatic plica, osteoarthropathy, or other confirmable conditions.[2,3] Because of the confusion regarding the use of PFPS in discussions and studies in the literature, it is difficult to pool the results and interpret their applications.

History

- Usually gradual onset of vague peripatellar pain relieved by rest in the early stages (most common cause of anterior knee pain associated with overuse); may eventually lead to chondromalacia patellae or patellar osteoarthritis.
- Aggravating factors include running, jumping, going up and down hills/stairs, knee extension exercises, prolonged siting with knee acutely flexed ("theater sign"), going into a squat
- Associated symptoms: painful crepitus, stiffness or grinding sensation are less likely; and visible swelling, locking/catching, and giving way is unusual.[4]

Physical[5]

- Visible swelling is usually not present.
- AROM and passive ROM usually complete and painless (although terminal flexion and flexion end feel may aggravate).
- J-sign may be present during active extension (abrupt lateral shift as knee moves into terminal extension).
- Palpation: tender facets and occasionally palpable crepitus, similar to chondromalacia patellae, may be noted.
- Orthopedic tests
  - Patellar grinding test or repetitive step up test may be painful.
  - Positive Waldron's test, retinacular test
  - Clarke's test may be painful (but this test is undependable because it often produces pain in other asymptomatic knees); the evidence suggests that Clarke's test as part of a routine knee examination has poor diagnostic value and should be discontinued.[6]
- Active resisted knee extension may be painful or an isometric quadriceps muscle test (especially at 60 degrees).
- When patellofemoral tests are positive and imaging studies are negative diagnosis is PFPS.

Etiology & contributing factors (very similar to chondromalacia and jumpers knee)

- Overuse and high impact activities (common), direct trauma (uncommon), aging, iatrogenic
- Observation: VMO wasting (visible/palpable)
- Observation: abnormal movements during step down test or single leg squat may occur (i.e. contralateral pelvis drop, hip adduction and internal rotation, knee abduction, tibial external rotation, over-pronation)[4]

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PATELLOFEMORAL PAIN SYNDROME (continued)

Etiology & contributing factors (continued)

- Contributing anatomical and biomechanical factors
- Patella anomalies: size, shape, and position (e.g., squinting patella, patella alta or baja)[7]
- Q-angle (>13-18 degrees, genu valgum favors lateral patellar tracking, femoral anteversion); note: the importance of the Q-angle is controversial)[4]
- Over training
- Muscle imbalances: weak or delayed timing in hip abductors;[8] weak knee extension (systematic review);[9] weak or delayed timing of vastus medialis vs vastus lateralis; short tight quads;[10] weak hip flexors;[11] tight hamstrings and calves; IT Band tightness[11-13]
- Abnormal increased knee adduction ground reaction forces due to the hip being in an adducted position during stance increases lateral patellar tracking and fatigues VMO.[14]
- Over-pronation (may be associated with < 10 degrees ankle dorsiflexion ROM); poor shoe support
- Instability: patellofemoral or at tibiofemoral joint (e.g., medial collateral laxity, ACL laxity, meniscectomy, anteromedial & anterolateral instability)

Diagnosis

- According to Cook, et al.[3,15] diagnostic criteria for PFPS vary in the published reports in the literature and no single physical examination test or reported functional activity is helpful in the diagnosis of PFPS. Furthermore, they conclude that when any 2 of 3 of following: pain with squatting (may be used as outcome measure), quadriceps contraction, and/or tenderness on the posterolateral or posteromedial borders of the patella in the absence of other causes of anterior knee pain suggests PFPS.

DDX

- Differentiating from chondromalacia patella can be challenging: PFPS is more likely to be in younger patients; less likely to present with painful crepitus; more likely to be aggravated by fewer (or even no) orthopedic tests; less likely to be painful between activities; and will have no imaging evidence of pathological change in the posterior patella.
- Symptomatic plica or loose body (e.g., secondary to OCD) may mimic patellofemoral pain syndrome or be the result of PFPS.

Imaging

- Radiographic studies are usually normal and unnecessary when PFPS is the most likely diagnosis.
- If there is poor treatment response, x-rays may be ordered to rule out osseous pathology and MRI may be necessary to rule out cartilage damage or other soft tissue pathology (i.e. tendinopathy, symptomatic synovial plica).

PLICA (SYNOVIAL)

ICD 9 – 727.9
Plica Syndrome
719.0 Joint Effusion
727.0 Synovitis

Snapshot: Usually dull anteromedial pain and perhaps a sense of recurrent snapping/clicking (50% of patients[1]), locking, giving way and episodic swelling in a patient involved in repetitive activities, or has experienced a significant increase of activities, or suffered blunt trauma to the knee. When chronic, it may lead to OA and chondromalacia patellae.[1,3-5, 7-9, 13-17]

Background: Synovial plicae in the knee are commonly occurring normal asymptomatic structures, estimated at between 15-90% incidence in adults.[2,3,4,7] Yet some become symptomatic especially those occurring along the medial aspect of the patella.[1,3,4,5] Symptomatic plicae are found in young and old,[3] prevalent in adolescents[9,13] and some authors indicate that symptomatic plicae are rare in children.[2] There are 4 types: Superior and inferior are the most common but rarely symptomatic; lateral which rarely occurs and is rarely symptomatic; and medial which accounts for a large majority of symptomatic plica, frequently referred to as "medial plica syndrome".[3]

History[1-5,7-10,13-18]

- 64-85% of patients report anterior or medial knee pain above the joint line.[1,3,4,5,7,10,13,17]
- 55% of patients report anterior inferomedial tightness/swollen sensation.[1]
- Caused/aggravated by repetitive activities such as running or walking (85%);[1] may be aggravated by going up to down stairs, squatting or sitting for long periods.[1,3,4,7,15]
- Some may have experienced a twisting or blunt traumatic knee injury, in some onset is idiopathic and insidious.[3,16,17]
- Associated symptoms: recurrent episodes of swelling or swelling sensation (55%); recurrent snapping or clicking cracking, popping, or snapping during activity.[1,2,4,11,13,15,16,18]

Physical Exam

- Physical examination is often equivocal; symptomatic plicae have a reputation for mimicking other knee pathologies and are often diagnosed by exclusion following a period of unsuccessful treatment for something else (e.g. PFPS).
- Medial parapatellar tenderness (87%)[1]usually 1 fingerbreadth proximal to inferior pole of patella
- Tender and/or palpable band over medial femoral condyle medial to patella with knee flexed (73%)[1]
- Orthopedic tests: This author (MC) is not convinced that any single orthopedic test is accurate or reliable.
    - Magee (2002) describes 3 plica tests (+ <u>Stutter test</u>, <u>mediopatellar plica test</u>, <u>Hughston's test</u>).[18]
    - Irha & Vrdoliak[9] describe 2 other tests: one involves a <u>rapid</u> active extension kicking motion and another involves a rapid flexion movement that is stopped between 30-60˚. A positive test is knee pain.[3,9]

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PLICA (SYNOVIAL) (continued)

- o Kim, et al. describe the mediopatellar plica test (MPP), which is described differently in Magee's text,[18] whereby the test is performed on a supine patient starting with the knee fully extended and the examiner applying pressure to the inferomedial aspect of the patella. Then the knee is flexed to 90˚. The test is positive when tenderness along the medial patella when extended is reduced or eliminated when the kne is flexed 90˚ (reported test sensitivity is 89.7%, specificity 88.7, and accuracy is 89%).[4,6,8]
- o Although not designated as a plica test, McMurray's test may be positive.[1] This and the snapping may be reasons why a medial symptomatic plica is often diagnosed incorrectly as a medial meniscus lesion.

Imaging

- Reid[1] states that plica are 100% present on arthroscopy, CT or MRI.
- Arthroscopy is considered to be the reference gold standard, but is rarely the initial diagnostic study.[4]
- MRI is often recommended and has proven to be useful in identifying a synovial plica, and is recommended as a first imaging choice for suspected medial synovial plicae (sensitivity = 95%, specificity = 72%); however it has some disadvantages compared to diagnostic ultrasound.[5,20]
- Dynamic ultrasonography is also highly effective in detecting synovial plica; unlike MRI sonography shows changes in plical positioning and contact with other structures that occur with movement. Sensitivity ranges from 88-92% and specificity ranges from 73-83%. It has been suggested that sonography is more sensitive than MRI in the absence of joint effusion or when the plica is flat against the synovial lining.[5]
- X-rays are not usually needed except to rule out osseous pathology.[4]

DDX

- Medial patellar pain more likely to be related to abnormal patellofemoral tracking (PFPS) than to plica syndrome.[2]
- Anteromedial joint line tenderness more likely to be related to meniscal tear than to pathological plica.[2]
- Other differentials include chondromalacia and jumpers knee.

PROXIMAL TIBIOFIBULAR JOINT DYSFUNCTION

Snapshot: Patient presents with lateral knee pain without swelling, locking, catching or giving way.

Background: The fibula forms the lateral boarder of the ankle mortise and carries about 1/6 of axial load on the leg. Important functions of the proximal tibiofibular joint (PTFJ) include resisting superior-inferior shear between the leg bones, and reducing lateral bending and torsional forces on the tibia.[1] During plantar flexion-dorsiflexion and inversion-eversion, the fibular head glides distally and proximally at the PTFJ. There is also slight anterior-posterior motion in the PTFJ. Furthermore, a tight biceps femoris tendon may restrict normal inferior and superior glide of the fibula at the PTFJ. Repetitive motion during walking and running, ankle sprains and immobilization of the ankle/leg/knee are common contributing factors to this joint dysfunction.

History[1,2]

- Lateral knee pain
- Trauma to lateral knee, twisting injury, sudden dorsiflexion (or plantar flexion) injury to the ankle (the patient may not report a knee injury but instead an ankle sprain/strain).
- Running, especially sprinting, and directional changes may exacerbate symptoms.
- Associated symptoms: none expected.

Physical[1,2] (and author's observations ML)

- Sometimes tenderness on palpation of proximal tibiofibular joint.
- Single leg stand: difficulty bearing full weight at 30º of flexion without a sense of instability.
- When the patient supports the posterior fibular area with the foot of the healthy leg or the examiner's hand it may decrease or eliminate the sense of instability.
- Motion restriction and sometimes pain with motion palpation/joint play of proximal tibiofibular joint (especially P-A).
- Occasionally may be associated with irritation of peroneal nerve.

DDX

- Lateral collateral ligament sprain, popliteus tendinopathy, ITB syndrome, biceps femoris tendinopathy, peroneal neuropathy

COLLATERAL LIGAMENT SPRAIN

Lateral Collateral Sprain 844.0
Medial Collateral Sprain 844.1
Unspecified Sprain 844.9
Knee Instability 818.86
Hemarthrosis 719.1

Special note: For grading the severity of a sprain, see Appendix I. For the more complex diagnosis of rotational instability, see Appendix II.

Medial Collateral Ligament (MCL)

Snapshot: Patient reports medial knee pain and swelling after sustaining a blow to the lateral aspect of the knee; pain is aggravated by valgus stress test at 30˚ or 0˚. May be unstable.

Background: More common in males 2:1.[1] Most common knee sprain;[2] pre-test probability in trauma cases is about 25% in primary care setting;[3,4] a complete tear is only 0.7%.[4] The ICD diagnosis of a sprain of the medial (tibial) collateral ligament is made with a reasonable level of certainty based on clinical findings.[5]

History

- Traumatic force applied to the lateral aspect of the lower extremity above or below the knee, a twisting injury to the lower limb (e.g., dragging a ski with the lower extremity externally rotated), or any valgus force across the knee
- Feeling of side-to-side instability (grade III sprains)[1]
- Report of swelling, stiffness

Physical

- Normal active flexion and extension
- Usually localized swelling on medial aspect of knee; more generalized with severe MCL sprain
- Palpation of MCL reproduces familiar pain
- Valgus stress test
  - o Valgus testing is fairly good at ruling out medial collateral ligament (MCL) tears (– LR = 0.2 to 0.3). In one study post-test probability was 63%[4*]
  - o Pain with valgus stress test performed at 30º of knee flexion [+LR 2.3 (95%CI 1.7-3.3); -LR 0.3 (95% CI 0.2-0.6)][4*]
  - o Pain with valgus stress performed at full extension; note, joint laxity in this position suggests a complete rupture and additional structures involved (e.g., ACL, PCL, other capsular structures).
  - o Increased separation between femur and tibia (laxity) with a valgus stress test performed at 30º of knee flexion [+LR 1.8 (95%CI 1.4-2.2); **-LR 0.2** (95% CI 0.1-0.6)][4*]
- A positive modified stroke test or bulge sign
- Positive for medial knee pain with passive end range external rotation with the knee flexed to 90 degrees (Swain test)[6]

*Small prospective cohort study (n=134, 35 with MCL sprain), primary care setting, MRI gold standard.

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History and Physical Combinations

- A combination of trauma due to external force *or* rotational trauma and pain with valgus stress at 30 degrees [**+LR 4.8** (95%CI 2.2-10.4); **-LR 0.5** (95%CI 0.3-0.8)][4]
- Trauma due to external force *or* rotational trauma and both pain and laxity with valgus stress at 30 degrees [**+LR 6.4** 95%CI 2.7-15.2); **-LR 0.5** (95%CI 0.3-0.8)][4]

DDX

- Pes anserine tendinitis/bursitis, medial meniscus tear, medial femoral/tibial condylar fracture, patellar subluxation or dislocation, symptomatic synovial plica, and acute arthritic flare-up

Lateral Collateral Ligament (LCL)

Snapshot: Patient reports lateral knee pain and swelling after a traumatic event.

Background: diagnosis of a sprain of the lateral (fibular) collateral ligament and the associated diagnosis of knee stability and movement coordination impairments is made with a reasonable level of certainty based on clinical findings.[5]

History

- Excessive varus trauma
- Pain on lateral side of the knee, report of swelling

Physical

- Localized effusion over the LCL
- Palpatory provocation of LCL reproduces familiar pain
- Orthopedic tests
  - Pain with varus stress test performed at 0º and 30º of knee flexion
  - Increased separation between femur and tibia (laxity) with varus stress test applied at 0º and 30º of knee flexion
  - A positive modified stroke test or bulge sign

DDX

- ITB syndrome, lateral meniscus tear, proximal tibiofibular joint dysfunction, fracture (fibular head/lateral tibial/femoral condyle), popliteus tendinitis

Imaging for Collateral ligament Sprains

- X-ray not usually needed in mild cases; follow Ottawa rules (see CSPE Imaging Knee protocol).
- Stress films may be useful in acute suspected 2^{nd} / 3^{rd} degree sprains and in chronic sprains.
- MRI while not necessary in mild cases can demonstrate the extent of the tear and an associated structural damage.[7]
- MRI to demonstrate extent of tear, associated effusion, and associated structural damage.

SPRAINS & INSTABILITY (Cruciate Tears)

Anterior Cruciate Ligament (ACL)

Cruciate Sprain 844.2
Hemarthrosis 719.1

Snapshot: Patient reports feeling a painful pop while cutting, pivoting, twisting, hyperextending or as a result of being struck on the knee. The patient is apprehensive ("feels weird") with certain positions and movements, and the knee has swollen and occasionally gives way.

Background: Female athletes sustain ACL injuries at a 2.4 to 9.7 times greater rate when compared to male athletes.

Special note: For grading the severity of a sprain, see Appendix I. For the more complex diagnosis of rotational instability, see Appendix II.

History

- Mechanism of injury : non-contact--cutting and pivoting, deceleration and acceleration motions; contact -- valgus load at or near full knee extension or with rotation, or hyperextension
- Hearing or feeling a "pop" at time of injury
- Hemarthrosis within 0 to 2 hours following injury
- History of giving way (more common in chronic cases) or locking, occasional swelling
- May be unable to weight bear

Physical

- Loss of end range knee extension
- Orthoepdic tests
  - o Positive Lachman test with nondiscrete end feel or increased anterior tibial translation [**+LR 42** (95% CI, 2.7-651); **-LR 0.1** (95% CI, 0.0-0.4)][1]
  - o Positive pivot shift test with nearly normal ("glide"), abnormal ("clunk"), or severely abnormal ("gross") shift at 10° to 20° of knee flexion [**+LR 8.5** (95% CI, 4.7-15.5), -LR .9 (95% CI .8-1.0] (meta-analysis)[2]
  - o Positive anterior drawer test [3.8 +LR (95% CI, 0.65-22); -LR 0.3 (95% CI 0.05-1.5)[1]
  - o While the anterior drawer and the pivot shift test are good at identifying anterior cruciate ligament (ACL) tears (**+ LR = 2.9 to 8.5),** the Lachman test is best at ruling them out (**— LR = .10 to .20**).[2]
- Post-acute test: 6m single-limb timed hop test result that is less than 80% of the uninvolved limb

Imaging

- X-ray to rule out fracture
- MRI
- Exploratory arthroscopy when other imaging studies are equivocal

Posterior Cruciate Ligament (PCL)

Background: The diagnosis of a sprain of the posterior cruciate ligament and the associated diagnosis of knee stability and movement coordination impairments is made with a reasonable level of certainty when the patient presents with clinical findings.

History [2,3]

- Posterior directed force on the proximal tibia (dashboard/anterior tibial blow injury),[1] a fall on the flexed knees with the foot in plantar flexion or a sudden violent hyperextension of the knee joint
- Abrasions or ecchymosis on the anterior aspect of the proximal tibia
- Localized posterior knee pain with kneeling or decelerating
- Associated symptoms: Giving way, swelling is usually minimal

Physical[2,3]

- Loss of knee extension during gait observation or range of motion testing
- Orthopedic tests
    - Positive posterior drawer test at 90º with a non-discrete end feel or an increased posterior tibial translation
    - Posterior sag test with a subluxation or "sag" of the proximal tibia posteriorly relative to the anterior aspect of the femoral condyles. Note: not checking for the sag sign prior to performing an *anterior* drawer sign may yield a false positive for an ACL tear as the posterior sagging tibia is pulled back into neutral.
    - A positive modified stroke test or bulge sign

Imaging

- X-ray to rule out fracture
- MRI

STRAINS, RUPTURES and TENDINOPATHY

CALF MUSCLES (Gastrocnemius, Soleus, Plantaris)

Snapshot: Patient presents with posterior knee pain (medial or lateral side) either of gradual onset or sudden severe "pop" (in the case of a rupture).

History

- Posterior knee pain
- Usually due to a sudden eccentric load or repetitive eccentric loads over time
- Aggravated by walking or running
- Associated symptoms: none expected
- Increased risk with a history of anabolic steroid use or corticosteroid injection with tears of the Achilles tendon

Physical

- Patient may limp with the foot maintained in a plantar-flexed position to avoid painful stretching of the injured muscle.
- Bruising may indicate a grade 2 or 3 strain.
- Isometric contraction of ankle plantar flexors (knee flexed to test soleus; extended for gastrocnemius) or knee flexors reproduces pain.
- Palpation tender at tendon or, more commonly, at the tendinous muscular junction.
- Pain with stretching (ankle dorsiflexion); with gastrocnemius strains near end range dorsiflexion with the knee extended may be especially provocative.

Imaging

- Advanced imaging is not usually necessary, but an MRI can reveal inflammation or a tear.

STRAINS, RUPTURES and TENDINOPATHY (continued)

HAMSTRINGS

Snapshot: Patient presents with posterior knee pain (medial or lateral side) either of gradual onset or sudden severe “pop” (in the case of a rupture).

Background: Acute strains of the distal hamstrings in the proximity of the knee are uncommon. Tendinitis/tendinopathy is more likely to be the cause of hamstring pain in the knee region. Hamstrings strains occur most commonly at the proximal muscle-tendon junction of the biceps femoris, most often while running, jumping, kicking, and dancing.[1,2,3,7] Hamstring tendinitis/ tendinopathy also is more common proximally. Very few studies of distal hamstring tendon injuries were found in the literature by the lead author (MC). It has been suggested that concurrent or preexisting lumbopelvic pathology and/or pathomechanics may be related to hamstring injuries.[4,6] Note that referred pain from lumbopelvic and gluteal structures, radiculopathy, or sciatica may mimic a hamstring injury.[4]

History

- Location: Posterior knee pain when a tendon is involved and posterior thigh pain when a muscle belly is involved. Sometimes the patient may complain only of an uncomfortable tightness, dull ache or burning discomfort.[7]
- Strains are usually due to a sudden eccentric load or repetitive eccentric loads over time and are more likely related to ballistic flexion of the hip.[1,2,3,7 9]
- Tendinitis (proximal or distal) is more likely to occur gradually over time and is seen most frequently in endurance activities, or is secondary to other knee pathology (i.e. arthritis in the older patient).[8]
    - Biceps tendinitis at the knee will present with pain and tenderness near its insertion posterior to the LCL or near its attachment to the fibular head
    - Semimembranosus tendinitis will present with pain and tenderness at the posteromedial corner of the knee immediately distal to the joint line.[8]
    - Semitendinosus tendinitis usually involves the pes anserinus and may be accompanied by bursitis
- Sudden onset and a pop in the case of a rupture.
- Aggravated by walking, running or any other activity requiring hip flexion with the knee extended.
- Patient may have previous history or hamstring strain, posterior thigh pain, or back pain.

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STRAINS, RUPTURES and TENDINOPATHY (continued)

HAMSTRINGS (continued)

Physical

- Patient may limp with a shortened forward swing sometimes with a hand grasping the involved injury site.
- Acute strains usually present with palpatory tenderness at the proximal muscle-tendon junction (common in running injuries) or just inferior to ischial tuberosity (common in dancers).[1,2,3]
- A defect (depression or muscle retraction/bulge) and/or bruising suggests a grade 2 or 3 tear (most likely involving the proximal muscle-tendon junction or muscle belly).
- Isometric contraction of knee flexors reproduces pain.
- Pain is exacerbated by active/passive straight leg raising or other similar tests that involve hip flexion with the knee extended and stretches the injured muscle/tendon.

Imaging

Advanced imaging is not usually necessary unless a significant rupture is suspected, or when the patient fails to respond to treatment or suffers repetitive injuries. MRI and diagnostic ultrasound can reveal inflammation or a tear.

PES ANSERINE TENDINITOPATHY/ BURSITIS (PAT/B)

ICD – 726.61 (Pes Anserine bursitis

Snapshot: Medial knee pain and sometimes slight effusion in the region of the pes anserine tendon near its insertion inferior to the medial tibial condyle. (Note that tendinopathy and bursitis are very difficult to discriminate from one another and may coexist.)

History

- Onset is often insidious, usually at the medial tibial condyle, or 5-6 cm distal to the medial joint line.
- May be aggravated by ascending and descending stairs[1] or repeated flexion-extension.[2]
- Common to the breast stroke in swimming.[4]

Physical Exam

- Occasionally visible swelling of the bursa; best visualized with the patient in a seated position.[3]
- The tendon is tender as it crosses the posterior medial femoral epicondyle and tibial condyle, just distal to the medial tibial condyle and tibial tuberosity where it inserts.[3,4]
- Pain may be aggravated with resisted hamstring muscle testing and occasionally with valgus stress testing.[2]

Etiology and Contributing Factors: There are three factors which increase risk for PAT/B:

1) Repetitive running, swimming/breast stroke (breast strokers knee), cycling and jumping.[4,5,6,7]
2) Osteoarthropathy of the knee especially in obese females.[1,5,8,9]
3) Excessive genu valgum alone or in association with instability.[11]

Other contributing factors include a contusion, repetitive rubbing/pressure on the knee just distal to the medial tibial condyle, pronation syndrome, and genu valgum.[2,10,11]

Imaging

- Imaging is usually not necessary; however, bursitis may be confirmed with MRI [5] or diagnostic US.[9]
- Radiology may be necessary following trauma (see Ottawa Knee Rules) or to determine the severity of arthritic changes.
- Bone scan or MRI may be indicated when stress fracture is suspected.
- MRI may also be indicated when instability or meniscus lesion is suspected.

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PES ANSERINE TENDINITOPATHY/BURSITIS (PAT/B) (continued)

DDX

- Medial meniscus pathology usually presents with localized pain and tenderness proximal to the pes anserine tendon/bursa at the medial joint line.
- Sprain of the medial collateral ligament (just deep to the pes anserine tendon) usually involves an acute traumatic event and is more likely to have pain with valgus stress testing (PAT/B is rarely exacerbated with valgus stress @ 30˚flexed).
- Tibial stress fracture usually seen in physically active with a long history of shin splints and the pain and tenderness is more likely to be distal to the insertion of the PAT/B.
- Referred pain from knee osteoarthropathy; and in some cases may actually contribute to pes anserine bursitis.
- Tennis leg, DVT, and intermittent claudication may also produce pain in the upper medial calf but are usually more distal and posterior than the pes anserine tendon & bursa.

POPLITEUS TENOSYNOVITIS (TENDINITIS/STRAIN/PFL LESION)

Snapshot: Popliteus tenosynovitis/tendinitis, an uncommon condition, usually has a gradual onset of lateral knee pain without a history of recent trauma, and is often described as an overuse injury associated following repetitive activities involving deceleration walking or running down stairs/hills or changes of direction causing external tibial rotation.[1-4]

Background: The popliteus internally rotates the tibia to unlock the knee when moving from a from a fully extended position, resists external tibial rotation, aides the PCL and quadriceps in preventing excessive anterior translation of the femur (= posterior tibial translation) when going downhill. In some individuals it retracts the lateral meniscus during flexion.[1-3] It is at risk due to repetitive or acute injury from genu varus loads (e.g., due to weak/ inhibited abductors) and genu recurvatum/hyperextension (e.g., associated with weak hamstrings). A ligamentous expansion of the proximal popliteus tendon, the popliteofibular ligament (PFL), attaches distally to the head of the fibula is now considered an important stabilizing element of the posterolateral complex of the knee joint and may be ruptured with trauma involving varus stress, external rotation, and/or posterior tibial translation.[5-8] When this ligament is disrupted it may accompany injuries to the LCL, PCL, and popliteus; or when damaged may lead to a snapping popliteus tendon or fatigue injury of the before mentioned structures and quadriceps.[5-8]

History

- Onset
    - Tendinitis usually related to over training and sometimes osteoarthropathy (authors observation ML) and comes on gradually.[1,2]
    - Strains and PFL sprains are due to acute traumatic injury and may be difficult to DDX from tendinitis if symptoms persist; hypothetically tendinitis could develop secondarily to strain/sprain.[4-8]
- Lateral knee pain in the area of the proximal tibiofibular joint or just posterior to the fibular head.[1,2,5]
- Aggravated by downhill walking/running, rapid deceleration, & cutting maneuvers causing external tibial rotation.
- Associated symptoms: none expected in many cases; however, snapping or crepitus just proximal to the lateral femoral condyle has been reported;[5] and in some knees instability has been reported.

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POPLITEUS TENOSYNOVITIS (continued)

Physical

- Best palpated with the knee in a figure 4 position or prone with the knee flexed.[1]
- Tenderness posterior to the LCL[1] or proximal to the tibiofemoral joint[3] posterior to the LCL and fibular head.
- Isometric contraction of internal rotation may reproduce pain;[9] also aggravated by varus stress and extremes of external rotation. This may also reproduce crepitis if the patient has a snapping tendon.[5]
- With the patient in in a figure-four position, the examiner resists the patient's attempt at knee flexion while palpating behind the LCL. This maneuver should increase tenderness or create pain behind the LCL.[9]
- Finally, a weight-bearing test similar to that for the ITB syndrome is used. The patient performs the same maneuver as described earlier, but with internal rotation of the leg at 30º. The internal rotation supposedly distinguishes between popliteus and ITB involvement.[1]
- Instability tests should be performed to rule out LCL, PFL, and PCL damage; meniscus tests.

Imaging

- MRI or arthroscopic examination may reveal inflammation.[2] In the event of failed treatment arthroscopic exploration may also be required to formulate an accurate diagnosis[2] and ascertain the appropriate treatment.

DDX – Lateral meniscus tear, biceps tendinopathy, subluxating proximal tibiofibular joint, osteoarthropathy.

QUADRICEPS/PATELLAR TENDON TEARS

Snapshot: Painful snap above or below the patella while performing vigorous activity and followed by weakness during activities requiring knee extension. In the older patient or in those with chronic diseases this can occur during normal activities of daily living like walking and may occur bilaterally (~ 5% of tears).[1]

Background: A relatively rare injury in all age groups; very rare when bilateral. More common in men than women. Tears above the patella (quadriceps tendon ruptures) account for about 3/4 of all tears, usually occur in older patients (>40), especially those who are obese, sedentary, and suffering from chronic disease.[1,2] Tears below the patella (patellar tendon tears) usually occur in younger patients (<40), that are more physically active, previous knee surgery (ACL) or infrapatellar tendinitis/tendinopathy.[1-5]

History

- The patient often describes a popping or tearing sensation in the knee followed by anterior knee pain, swelling and weakness or giving away during activities requiring knee extension.[1,5,10,12,13,14]
- Mechanisms of injury include strong eccentric contraction, landing a jump, stopping and starting while sprinting, rapid changes of direction, squatting[1-8,11] and lifting, descending stairs (especially misjudging a step), kicking, forceful knee flexion while falling, or due to direct trauma. In the older patient the most common cause is a fall however this may occur during a low impact activity like walking or squatting without resistance.
- The patient may initially report to an E.R. and may be incorrectly diagnosed and released with a knee immobilizer and crutches.[1]

Physical

- Difficulty ambulating, sit to stand (especially if bilateral), squatting[1,4]
- Tenderness at site of injury; swelling and ecchymosis above or below patella[1,2,4,,12,13]
- A palpatory mushy defect may be palpated above or below the patella (called a "dimple sign" when infrapatellar) [1,2,4,5,10,12,13, 14]
- Patellar displacement (patella alta) is common in complete infrapatellar tears (inferior displacement is uncommon in suprapatellar tears)[1,4,5,12,14,]
- A large effusion or hemarthrosis may result in inconclusive interpretation of observational and palpatory findings
- Positive sitting extensor lag and weakness with resisted extension[1,5,12,13,14]

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QUADRICEPS/PATELLAR TENDON TEARS (continued)

Etiology and contributing factors

- Anabolic steroid use[4,10] (i. e. weight lifters) or corticosteroid injection(s) for PFPS or tendinopathy chronic conditions (PFPS or tendinopathy)[1-5] or diseases (i. e. diabetes, renal disease, lupus, gout, RA, obesity, hypertension, endocrine disorders)[1-4,7-13] are often cited as a contributing factor in all age groups.
- It has been proposed that some tears may result from recurrent microtearing of the tendon.[14]

Imaging

- Radiography is usually the initial imaging study and is useful in demonstrating patella alta (infrapatellar tear) or baja (suprapatellar tear); sometimes a small avulsion at the superior or inferior pole may be visible and in adolescents an avulsion of the tibial tuberosity may be seen; also useful in ruling out patellar fracture.
- MRI is the most sensitive, specific and accurate study for confirmation of quadriceps tendon injury[1] and may be useful in determining the exact site and nature of the soft tissue damage.[1]
- Diagnostic ultrasound may also be used to diagnose infrapatellar tears and are accurate in detecting degeneration and partial tears of the patellar tendon;[6] and is highly sensitive and specific for complete quadriceps rupture.[1]

Lab: may be useful in evaluating any metabolic factors that may be predisposing or contributing factors to the quadriceps tendon tears.

DDX – sprain, patellar dislocation, acute tendinitis, and patellar fracture; adolescent Sinding Larsson Johansson or Osgood Schlatter's Disease

NOTE: Quadriceps muscle belly strains rarely occur in the knee region and are most often due to contusions (see Contusions) and the vastus medialis may be injured with patellar dislocation (see Patellar Dislocation).

STRESS FRACTURES

Snapshot: Gradual insidious onset of vague mild knee pain following an increase in exercise. Localized pain increases with weight bearing activity (usually early in the activity) and is relieved by rest. Pain gradually increases over time.

Background: Highest frequency among those 15-30 years of age and post-menopausal. More common with college age athletes and military recruits.[1] In female athletes 1.5-3 times higher compared to male and 3-12 times higher in female military recruits[2]. 67% of all stress fractures in college athletics occur in freshman. Caucasians are at significantly higher risk than those of African descent.[3] There are 4 stress fractures that may cause knee pain.

- Patella: two types, both rare:[4, 5, 6, 7, 8]
  - o Transverse – more common; high risk; ddx bipartite patella; immobilize; prone to displacement **refer!**
  - o Longitudinal/vertical – very rare; stable; referral recommended
- Proximal tibia – rare compared to mid-shaft; local pain just distal to knee joint line; **referral recommended** especially when fracture involves anterior cortex.
- Femur – distal location rare, but subtrochanteric and neck are common and **may refer pain to knee;**[9] femoral neck fractures are unstable and prone to serious complications (displaced fx or AVN) therefore we recommend crutches and **immediate referral!** Some non-displaced fractures will be treated with supervised bed rest.
- Proximal fibular: although most involve distal to mid shaft, they occasionally occurs proximally; pain just distal to lateral knee; low risk/stable.[2]

History

- Chronic low-grade, localized pain and tenderness in the region of the lesion (i.e. patella or proximal tibia or fibular shaft). Note that many proximal femoral shaft fractures have poor localization of pain[10] and some may radiate to the knee in the region (authors personal experience); about 87% of femoral neck fractures present with groin pain,[11] but be prepared to explore the hip joint and proximal femur when knee pain is not accompanied by supporting or contradictory physical findings.
- Symptoms onset is frequently insidious and most often associated with strenuous repetitive exercise involving running or jumping (or recent increase in activity).

Physical

It is difficult to diagnose and differentiate from other pathological conditions based on physical exam findings alone. Vibration, percussion, and therapeutic ultrasound (US) may have diagnostic value but should **not be used as stand-alone tests.**[12]

- Some may present with a limp; hopping may be painful; anvil test may also provoke.
- Localized bony tenderness at the suspect site of the fracture may be a useful finding.
- The 128 and 256cps tuning fork test accuracy are controversial based on few high quality studies and inability to pool data. However, in one study the 256 tuning fork test on the tibia, fibula & foot bones had a high sensitivity value compared to reference radiographs, MRI and bone scans (92.3%, 90%, & 77% respectively), but a low relative specify (19.3%, 20%, & 25% respectively), and low +LR (1.04 – 1.14). In another more highly regarded study using the 128 cps tuning

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STRESS FRACTURES (continued)

fork on the tibia the sensitivity was 75%, specificity was 67%, and the +LR was 2.3%. There may be some diagnostic value in the early screening as part of a complete history and physical exam based on their moderate sensitivity in the presence of a stress fracture, but based on the low +LR they are of little value in ruling out other pathologies.[12]

- Therapeutic US has low to moderate pooled sensitivity and specificity (based on a systematic review and meta-analysis),[12] specificity is significantly higher than tuning fork and much lower than MRI and bone scan.

Etiology and contributing factors

- Repetitive high impact activity (i.e., running, jumping), prolonged or recurrent quadriceps contraction combined with knee flexion (i.e. sailboarding or dancing)[8]
- Recent rapid or abrupt increase in activity (distance, frequency, or intensity);[2] recent shoe change[13]
- Higher risk for female triad (oligomenorrhea or amenorrhea, eating disorder, & osteoporosis)
- Low bone density[2]
- Weight lifting→ transverse patellar fx ,i.e. repetitive high resistance squats[6]
- Leg length inequality[2]
- Increased foot flare can lead to tibial stress fractures; external hip rotation ROM > 58˚, (normal = 50-57˚ in military recruits).[14]
- Smaller tibial bone width[14], gynecoid pelvis, external tibial torsion, and pronation syndrome

Imaging

- MRI and scintigraphy (technetium bone scans) are both considered to be "gold standards' in the diagnosis of stress fractures,[12] however it is our opinion that there is a growing consensus[2] that **MRI has several significant advantages and is the preferred choice over scintigraphy**. MRI has higher specificity[3] than bone scans, provides a more reliable estimate of the degree of damage and recovery time, and is less invasive; however MRI is more costly, presents risks related to nearby metal implants, and may not be available to some patients. We have been trying to get away from recommending the use of scintigraphy in recent years; however when the use of MRI is not advisable a technetium bone scan is an appropriate alternative.[2]
- Plain films are frequently performed initially to rule out other osseous pathology; however, there is a low sensitivity in the presence of a stress fracture and when negative should not be trusted in ruling out stress fractures.[2]
- CT is not routinely used in the initial evaluation because of radiation dose and lower sensitivity compared to bone scan and MRI, however it is a viable option when MRI is not available or when metal implant/pace maker contraindicates MRI.[2,12]

Appendix 1: Grading Severity of a Sprain

Assess for laxity during "golden period" or may have to wait weeks or months after golden period to accurately evaluate stability.

Grade 1 – Treat conservatively!

- Localized pain & swelling
- No laxity on stress tests
- No hemarthrosis

Grade 2 – Treat MCL & LCL; refer ACL & PCL for 2nd opinion

- More pain & swelling (less localized)
- Slight laxity on stress tests
- Firm ligamentous end point
- More swelling/hemarthrosis rarely

Grade 3 – Best to refer

- Significant laxity on stress tests
- Soft or empty end point
- End point pain?
- Hemarthrosis common
- Dislocated knee – medical emergency!

Appendix II: Rotational Instability

Names describe damaged tissue not the direction of rotational instability. In rotational instability multiple structures are significantly damaged in two planes of motion.

- Anterolateral rotational instability
  - Damage to ACL & lateral complex (results in instability in an anterior & medial rotation direction): Pivot shift test, Slocum's; in addition a combination of the anterior drawer sign and lateral collateral stress tests may be positive for laxity.
- Anteromedial rotational instability
  - Damage to ACL & medial complex (results in instability in an anterior & lateral rotation direction): Slocum's; in addition a combination of the anterior drawer test and medial collateral stress tests may be positive for laxity.
- Posterolateral rotational instability
  - Damage to PCL & lateral complex (the instability is same direction as name implies): a combination of the sag sign, posterior drawer test and lateral collateral stress tests may be positive for laxity.
- Posteromedial rotational instability
  - Damage to PCL & medial complex (the instability direction is same as name implies): a combination of the sag sign, posterior drawer test and medial collateral stress tests.

KEY PRESENTATIONS

The following is a list of key patient presentations and appropriate differential diagnoses. Most of the diagnoses cited can be cross-referenced with the first part of this document.

Age

5-15 years (sometimes >15)
- "transient growing pains"
- discoid lateral meniscus

11-15 (sometimes older)
- onset of osteochondritis dissecans,
- Osgood Schlatter's
- Sinding, Larsen, Johansson

<16
- greatest risk of growth plate fractures and avulsions

>50
- increased incidence of DJD
- meniscus tears

15-35
- highest incidence of sports related traumatic injury

Note: tumors, both benign and malignant, infections and systemic diseases occur in all age groups.

Associated Symptoms

If the patient has knee pain plus any of the following:

Swelling (intracapsular)
- Internal derangement
- Infection
- Arthritis
- Cancer

Note: The lack of self-noticed swelling seems moderately helpful in ruling out knee joint effusion.[1]

[1] Cleland JA, Koppenhaver S. Netter's Orthopaedic Clinical Examination, An Evidence-Based Approach, 2nd Edition. Philadelphia PA:Saunders;2011:283-334.

Hemarthrosis (rapid or extensive swelling with discoloration)

Management Warning: Suspected hemarthrosis requires an urgent referral.

- ACL tear (most common)
- Osteochondral fx
- Patella dislocation
- Terrible/unhappy triad
- PCL tear
- Bleeding dyscrasia
- Medications with anti-coagulant properties

Swelling (extracapsular)

- Bursitis
- Sprain (collateral ligament)
- Tendinopathy

Locking/catching

- Mencius tear
- Cruciate tear
- Joint mouse (secondary to osteochondritis dissecans or OA)
- Subluxating patella

Buckling/giving way

- Mencius tear
- Cruciate tear
- Joint mouse (secondary to osteochondritis dissecans or OA)
- Subluxating patella

Creptius

- OA
- Plica

Stiffness

- Internal derangement
- OA
- Rheumatoid arthritis

Additional symptoms

- Common Associated Symptoms/Diseases
    - o Systemic(fever, malaise, etc.) – Lyme, other bacterial & fungal infections, inflammatory arthritides, multiple sclerosis & ALS (generalized weakness), malignancy, fibromyalgia
    - o Vascular – hemarthrosis, bleeding dyscrasia or clotting disorder, atherosclerosis, vascular anomaly, diabetes
    - o Neurologic – neuropathy, radiculopathy, ALS, MS, CNS pathology, diabetes, complex regional pain syndrome (AKA RSD)
    - o Dermatologic – infection, psoriasis
    - o Other joint involvement- inflammatory arthritids

Location of Pain & Mode of Onset

Location is based on subjective (have the patient point to the pain during the history) and objective findings (during both static palpation and orthopedic testing). Note: the specific anatomical location of pain and tenderness, and tissues involved are very important in reaching a correct diagnosis; anatomical alignment, size, shape, contours, textures, positions, relationships are also extremely important. A discrete knowledge of anatomy is critical.

Mode of onset includes a variety of possibilities:

General Mechanisms
- Fall
- Impact
- Twisting
- Abnormal movement
- Fatigue
- Repetitive activity

The patient interview should include specific activity that bring on the symptoms, and, in the case of single traumatic events, the direction and amount of force applied (see p.36).

Generalized or variable pain patterns

Arthritides including Lyme, other infections, joint effusions, hemarthrosis, fractures, tumors, radiculopathies & other referred pain from the back, sciatica, metastatic neoplasm, fibromyalgia (usually medial).

Intra-capsular pain

Knee trauma
- Meniscus
- Cruciate
- Fracture

Non-traumatic (overuse or insidious onset)
- Plica
- Meniscus
- Cruciate
- Osteoarthritis
- Joint mouse

Anterior knee pain

Knee trauma

- Above patella: tendon rupture, distal femoral fracture, quadriceps contusion
- Below patella: infrapatellar tendon tear, tibial fractures, fat pad inflammation
- Patella –patellar fracture, patellar dislocation or subluxation
- Medial or lateral to patella – symptomatic synovial plica

Non-traumatic (overuse or insidious onset)

- Above patella: quadriceps tendinopathy or suprapatellar effusions, osteoid osteoma, Ewing's, fibrosarcoma & osteosarcoma, and giant cell tumors (the distal femur is one of the most common sites for sarcomas in the body)
- Below patella – jumpers knee, Osgood Schlatter's, Sinding-Larsen-Johannson's, tibial fractures (stress), osteoid osteoma, Ewing's and osteosarcoma's, fat pad inflammation, infrapatellar bursitis, or entrapment
- Patella – patellar femoral syndrome, prepatellar bursitis, patellar fracture (stress), chondromalacia, patellar dislocation or subluxation (secondary to laxity)
- Medial or lateral to patella – symptomatic synovial plica; the hip joint, SI joint and proximal femur may refer pain superomedial to the patella; peripatellar neuritis (L2,3 or 4 radiculitis, femoral or saphenous neuritis, or post-surgical)
- Note: mid to proximal quadriceps and hamstring pathologies may refer pain to the anterior knee

Medial knee pain

Knee trauma

- Joint line (isolated) – Medial meniscus, medial joint surface trauma, coronary ligament sprain; MCL sprains present with pain that crosses the joint line but not usually isolated to it
- Above joint line – MCL sprain, patellar dislocation/medial retinacular tear, femoral fracture.
- Below joint line – pes anserine tendinopathy/bursitis, tibial fracture, tumor
- Superior (distal thigh)– hamstring or quadriceps strain including contusions & myositis ossificans, femoral fracture
- Inferior (proximal leg) – tennis leg (upper calf strain), fractures of the tibia or fibula; DVT, contusions

Non-traumatic (overuse or insidious onset)

- Joint line (isolated): Medial meniscus, osteochondritis dissecans, medial joint surface pathology, coronary ligament sprain; MCL sprains present with pain that crosses the joint line but not usually isolated to it
- Above joint line: MCL sprain, referred pain from the upper femur/hip joint/ SI joint (often involving the region of the VMO), saphenous neuritis (subsartorial canal with referred symptoms to the medial leg), tumor
- Below joint line: pes anserine tendinopathy/bursitis tumor
- Superior (distal thigh): hamstring or quadriceps strain, femoral fracture (stress), tumor
- Inferior (proximal leg): tennis leg (upper calf strain), fractures of the tibia or fibula (stress); DVT (deep posterior leg), tumor

Lateral knee pain

Knee trauma

- Joint line (isolated): lateral meniscus tear, lateral articular surface trauma, coronary ligament sprain; LCL sprains present with pain crossing the joint line but not isolated to it
- Above joint line: biceps tear, contusion
- Below joint line: fibular fracture, proximal tibiofibular sprain or joint dysfunction, peroneal neuritis (fibular tunnel), biceps or popliteus strain, contusion

Non-traumatic (overuse or insidious onset)

- Joint line (isolated): lateral meniscus tear, discoid meniscus in children, lateral articular surface pathology, coronary ligament sprain; LCL sprains present with pain crossing the joint line but not isolated to it
- Above joint line: ITB syndrome, biceps tendinopathy, tumor
- Below joint line – fibular stress fracture, radicular referred pain, proximal tibiofibular sprain or joint dysfunction, peroneal neuritis (fibular tunnel), biceps or popliteus strain or tendinopathy, tumor

Posterior knee pain

Knee Trauma

- Posterior –ACL or PCL tear, posterior capsular sprain, Baker's cyst with attendant internal derangement, tear posterior horn of medial or lateral meniscus, hamstring tear/rupture, gastrocnemius tear/rupture (upper calf)

Non-traumatic (overuse or insidious onset)

- Posterior –posterior capsular sprain, Baker's cyst with attendant internal derangement, tear posterior horn of medial or lateral meniscus, hamstring tendinopathy, popliteus strain, DVT, radicular referred pain, sciatica, gastrocnemius strain (upper calf), sarcoma's, infections, osteochondritis dissecans

Mechanism of Traumatic Injury

If the mechanism was twisting or rotational (especially with the foot planted)

- Meniscus

If the there was an impact to the lateral knee (valgus load)

- Medical meniscus
- MCL
- ACL
- All three (terrible/unhappy triad)
- LCL

If the there was an impact to the medial knee (varus load)

- Lateral meniscus
- LCL

If the there was an impact to the anterior knee (especially with knee flexed)

- PCL
- Patellar fracture
- Bone bruise (patella or tibia)

If the there was an impact to the posterior knee

- ACL

Pain at Rest

If the patient has significant pain at rest (and often greatly increased by any motion), consider…

- Joint infection
- RA
- Gout
- Cellulitis
- Malignancy

Note: If knee exam does not reproduce symptoms, consider hip pathology, referred pain from SI or lumbar spine.

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