Knee Orthopedic Tests

Adopted 12/12

A Strategic Approach to Assessing the Knee

The following is a strategy which may be used to guide 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 (*e.g., traumatic, overuse, postural*)*. 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** (most 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, pelvis, lumbar spine)?
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)?

Clinical Tip: An overarching element of the physical examination of the knee is observation. The process begins with observing the patient (beginning with their gait if they walk into the treatment room). Careful observation is a necessary part of all diagnostic procedures that follow. Focused observation and inspection of anatomy, bilateral symmetry, relationships, patterns of movement, and patient physical and emotional responses (e.g., pain coping behaviors) during the examination is an integral part of the assessment.

A Word on Joint/Ligamentous Causes of Knee Pain

Unlike the shoulder, in most knee cases the key pain generators are joint and ligamentous in origin (e.g., MCL, LCL, ACL, PCL, meniscus, capsule, proximal fibular joint, patella, and fracture). Consequently, the most useful exam procedures to answer the first three strategic questions listed above tend to be static palpation and passive loading/stress tests. This protocol focuses on the passive loading tests.

A Word on the Orthopedic Assessment

When performing joint orthopedic and palpation tests, compare the injured side to the opposite uninvolved side. It is recommended that the injury-free knee be assessed first, especially in the case of procedures that require assessment of characteristics other than strictly pain, such as instability, aberrant motion, or quality of end feel.

Acute cases presenting with painful, significant joint effusion offer an extra challenge. A thorough knee assessment may need to be delayed until some of the swelling has receded. Instability tests in particular may be falsely negative.

Test Validity

Many commonly performed orthopedic tests for the knee have not been subjected to well-designed clinical trials to establish their reliability and validity. Instead they are based primarily on biomechanical plausibility, expert opinion, and clinical experience. The studies that have been done are often small, flawed, and suffer from spectrum bias (i.e., performed on patients in specialty clinics as opposed to portal of entry clinics). Tests that initially look promising often lose their luster in subsequent studies; individual tests that have been relied upon for decades often do not perform as well as text books would lead one to believe. For this reason, the authors recommend that practitioners should rarely rely on single test results, that they keep up with the research literature in this arena, and that they should be ready to adopt new tests and abandon classic tests when good quality research moves toward a consensus on any one orthopedic test or test cluster.

A Word on the "Biomechanical" or Manual Therapy Assessment

Static palpation, length testing and muscle testing procedures are used to assess muscles and tendons and 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; other motion palpation procedures to assess joint glide are performed differently and are often interpreted differently. Besides static palpation for tissue tenderness and perhaps observing for misalignment, motion palpation assessment (as described below) for pain and restrictions is used. The joint glide maneuvers are usually done in an open 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 Manual Therapy Toolkit (for joints)**:

Tibiofemoral joint

- AP and PA glide
- Internal and external rotation
- Medial and lateral tilts of the tibiofemoral joint at both 0 and 10 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.

Clinical Tip: Similar assessments of the hip and ankle joint complex are recommended for patients whose chief complaint is knee pain.

A Word on Assessing the Acute Knee

When evaluating the acute knee, always first consider the Ottawa Knee Rules (see CSPE protocol) prior to moving or stressing the knee. The primary goal often does not involve assessment of all joint/end plays. Frequently, the initial treatment in acute cases does not involve manipulation, especially in traumatic knee injuries. However, some orthopedic procedures such as joint stability tests provide not only important data regarding what tissues are injured and the degree of injury, but may also provide valuable joint glide information that can later be used in determining appropriate manual therapy procedures. For example, a painful joint restriction may be discovered while performing the valgus instability test.

Orthopedic Tests in this Protocol

ACL Tests
- Anterior Drawer
- Lachman's
- Pivot Shift

Anatomical Comparison
- Standing observation
- Palpation and inspection
- Recurvatum test
- Other screening test
- Joint play maneuvers

Chondromalacia Patellae
- Clarke's test/sign
- Patellar facet pinch test
- Patellar grind
- Step up bench test
- Waldron's test

Collateral Ligament Instability
- Apley's distraction
- Valgus Stress Test
- Varus Stress Test
- Wobble Test

Functional Tests
- Hop
- Triple Hop
- Cross Over Hop

General Screening Tests
- Bounce home
- Hop
- Recurvatum
- Figure 4 position

ITB Syndrome
- Noble's
- Ober's
- Renne's

Intracapsular Effusion
- Ballottement
- Bulge sweep test
- Bounce Home

Meniscus Tears
- Apley Compression
- Ege's
- Hyperflexion
- Joint line tenderness
- McMurray's
- Payr's
- Steinman's
- Thessaly

Osteochondritis Dissecans
- Wilson's Test
- Varus stress test

PCL Tear
- Posterior Drawer Test
- Posterior Sag Sign

Patellofemoral Pain/Syndrome
- Waldron's test
- Step-up Bench test
- Chondromalacia tests
- Plica tests

Plica Tests
- Hughston's
- Plica Pinch
- Plica Stutter

Recurrent Subluxation (Instability)
- Patellar apprehension

Rotational Instability
- Slocum's tests
- Pivot Shift test (Anterolateral Instability)

Symptomatic Plica Tests
- Plica Stutter test
- Plica Pinch test
- Hughston's test

ANTERIOR DRAWER SIGN

ACL Tests
- ✓ **Anterior Drawer**
- **Lachman's**
- **Pivot Shift**

Click here for video

Indication: The patient often complains of trauma (e.g., hyperextension, sudden deceleration/change in direction) with an accompanying painful popping sensation, followed by swelling; or when chronic, the patient complains of apprehension, or giving way (i.e., recurrent shifting, or popping-out) when performing certain knee movements or with changes of direction.

Procedure: The patient is supine with the involved knee flexed 90° and the hip flexed 60° (foot on table). It is also acceptable, though more difficult for the smaller examiner, to flex both hip and knee 90° (foot off table). With the patient's foot flat on the table (and tibia approximately 0°rotated), gently sit on the lateral aspect of the patient's foot and grasp the patient's proximal leg with both hands, with thumbs resting in the joint lines. Look for the posterior sag sign and, if present, reposition the tibia back to normal translation neutral. From translation neutral, pull firmly on the upper calf (tibia) in an anterior direction. Option: If the knee is stabilized, slow low-amplitude tugs can be introduced initially, then with faster tugs to see if the ligament is sensitive to dynamic loading—faster tugs may also defeat a false sense of stability due to hamstring spasm.

Common Procedural Errors: Practitioner does not look for a sag sign and mistakes a PCL tear for an ACL tear. It is very important that the patient remain relaxed, especially the hamstrings, during this test. One method that helps to relax the hamstrings is pressing against their tendons with your index fingers during the test (Mullendore 2005). Not applying sufficient load to the ACL (it should be loaded with the practitioner's body weight). In the case of acute knee injuries, Lachman's is a better test choice.

Interpretation: Knee pain without instability is equivocal, but may indicate a mild **anterior cruciate sprain**; excessive anterior translation from neutral (more than 6mm) suggests **anterior cruciate tear**.

Reliability & Validity: The sensitivity of this test is questionable in the alert unanesthetized patient ranging from 22%-41%. However, the evidence suggests that the specificity is quite high (97%). (Malanga, 2003; Lubowitz, 2008; Ostrowski, 2006). A 2009 systematic review reported a positive test leads to a small to moderate increase in probability of an ACL tear: +LR 3.8 (95% CI, 0.65-22). A negative test has a small to moderate effect on ruling a tear out: -LR 0.3 (95% CI 0.05-1.5) (Simel 2009). Accuracy may be better in the anesthetized patient, with chronic injury, or with loss of secondary restraints to anterior translation (Lubowitz 2008, Donaldson 1985).

Follow-up Testing: Note that performing the anterior drawer test with the knee flexed 90° may actually interfere with anterior translation and is less sensitive than desired. A more accurate anterior translational stress test is performed with the knee flexed 15°-30° (Lachman's Test). The anterior drawer should also be followed up with the pivot shift test. Common sequelae to ACL tears include meniscus tears, chondromalacia, and premature osteoarthropathy. MRI or arthroscopy is necessary to confirm the diagnosis of an ACL tear.

APLEY'S COMPRESSION

Meniscus Tears

- ✓ **Apley compression**
- **Ege's**
- **Hyperflexion**
- **Joint line tenderness**
- **McMurray's**
- **Payr's**
- **Steinman's**
- **Thessaly**

Click here for video

Indication: The patient complains of localized joint line pain (or pain "inside" the knee), possibly associated with swelling, locking, catching or, infrequently, giving way (usually due to pain other than true instability). May be useful for suspected internal derangement (e.g., meniscus or osteoarthropathy) or coronary ligament sprain.

Procedure: The patient is prone with the involved knee flexed 90°. Stand at the side to be tested. During the compression test, grip the patient's dorsiflexed foot and ankle using both hands, apply a firm long axis compression on the patient's leg and foot, and internally and externally rotate the tibia to "grind" the meniscus (Chivers, MD and Howitti SD, 2004).

Interpretation: Increased knee pain on compression/rotation suggests a **meniscus tear** or **coronary ligament sprain**. Apley's distraction decreasing pain can help confirm a **meniscus tear,** but with *increased* pain it may indicate **capsular sprain** (Apley 1947, Chivers 2004).

Reliability & Validity:

- Different studies have shown different results with sensitivity ranging from 13%-41% and specificity ranging from 80-93% (Malanga 2003, Chivers 2009).
- A 2007 meta-analysis reported a +LR of 2.0 and -LR 0.57 (Hegedus 2007).
- As an isolated test, a positive Apley's has a minimal effect on making a meniscus tear diagnosis (+LR 1.8) and no ability to rule out (-LR 0.89). However, it may be of value in combination with other meniscus tests (Cleland 2008 meta-analysis). See the following bullet.
- A +LR of 7.5 and -LR of 0.03 was reported when any two of the following 6 tests were positive (based on a small study on athletes): Tenderness to palpation of joint line + Bohler test + Steinmann test + **Apley's grinding test** + Payr test + McMurray's test[7] (Muellner, 1997).

Follow-up Testing: Correlate with other meniscus tests. In the case of trauma, rule out "unhappy triad" (i.e., ACL and MCL/LCL tears). Confirmation of a meniscus diagnosis can be made by MRI or referral for arthroscopic assessment. Perform ligament stress tests to confirm capsular involvement.

APLEY'S DISTRACTION

Collateral Ligament Tests

- ✓ **Apley's distraction**
- **Valgus stress test**
- **Varus stress test**
- **Wobble test**

Click here for video

Indication: The patient presents with medial or lateral knee pain suggesting a collateral ligament injury, infrequently associated with giving way. May also be used in suspected meniscus cases (i.e., the patient complains of localized joint line pain, possibly associated with swelling, locking, or catching).

Procedure: The patient is prone with the involved knee flexed 90°. Stand at the side to be tested. Gently apply stabilizing pressure with your shin over the patient's posterior thigh, while pulling upwards on the patient's distal leg with both hands and rotating the tibia internally and externally. A small cushion or rolled up towel can be used to pad your shin against the patient's leg.

Common Procedural Errors: Too much shin pressure placed on the hamstrings or misinterpreting ankle/foot joint motion as knee motion.

Interpretation: Increased lateral or medial joint pain not isolated to the joint line suggests a **collateral ligament sprain**. Increased pain felt inside the knee or at the joint line suggests a **coronary ligament sprain**. Decreased symptoms may be associated with a **meniscus tear**.

Reliability & Validity: Unknown

Follow-up Testing: Correlate with other collateral ligament tests. If symptoms are reduced, perform other meniscus tests.

Comment: Some authors describe Apley's compression and distraction tests as a two part Apley's Grind test (see Apley's Compression Test).

BALLOTTEMENT

Intracapsular effusion
- ✓ **Ballottement**
- • **Bulge sweep test**
- • **Bounce home**

Click here for video

Indication: The patient complains of knee swelling, stiffness, or fullness. Suspected knee joint effusion, internal derangement.

Procedure: The patient is supine with knees fully extended and relaxed. The fingers of both hands grip the posterior knee while both thumbs contact the anterior patella as pictured above. Now briskly press (squeeze) the patella against the femur with your thumbs while supporting the posterior knee to prevent any accessory motion. Another option is to apply pressure with the palm of one hand on the anterior aspect of the patient's patella while the other hand supports the popliteal fossa to prevent knee extension.

Common Procedural Errors: Examiner does not support the back of the knee. When knee extension occurs it interferes with the examiners ability to feel the subtle increase in patellar movement.

Interpretation: A positive test is a sense of "squishy" or "springy" resistance, movement of >3 mm, or an audible click. Normally, the patella moves imperceptibly (approximately 1mm) posterior before contacting the patellar surface of the femur. Greater than normal A-P movement of the patella (compared to the other side) when pressure is applied indicates intra-articular fluid accumulation. *Intracapsular* **effusion** increases the probability of articular damage, meniscus, or cruciate tears. Usually the examiner is unable to perceive excessive movement unless there is a large amount of swelling, which may be noted on observation. Observation alone may not be helpful in large or obese patients. A variation is the "patellar tap test" (sometimes mistakenly called the ballottement test). This variation is performed by tapping or rapidly pressing down and *releasing* the patella. A positive finding is described as a "floating" or "dancing" patella (Magee 2002).

Reliability & Validity: Unknown

Follow-up Testing: Orthopedic tests for meniscus and cruciate tears. MRI or ultrasound can confirm the presence of swelling and internal derangement. In older patients, plain films to detect OA. It is sometimes useful to quantify the swelling by measuring the circumference of the knee at the patella. Tests to evaluate chondromalacia and patellofemoral pain should be performed when pressure on the patella creates pain deep to the patella.

BOUNCE HOME

Click here for video

General screening tests
- ✓ **Bounce home**
- **Hop**
- **Recurvatum**
- **Figure 4 position**

Part 1

Part 2

Indication: This is a good screening procedure for knee pathology/injury to do early in the physical exam. This test should not be performed on a patient with suspected acute ligamentous sprain unless minor and/or the examiner is attempting to ascertain the patient's ability to return to play or work.

Procedure: It is performed with the patient supine and the examiner standing along the side to be tested. Support the knee with one hand under the patient's popliteal fossa and the other hand cup the patient's heel. The patient's knee is passively flexed to approximately 5- 20° (initially perform test @ 5°). Then allow the knee to rapidly "free fall" to the endpoint of extension.

Common Procedural Errors: It is important for the examiner to never completely remove either hand from the patient. The knee should not be allowed to fall uncontrollably into extension without the examiner's hand positioned to cushion the drop.

Interpretation: Depending on pain location, free range of motion and quality of end feel, a variety of lesions can be suggested with the exception of a patellofemoral syndrome.

Exam Finding	Interpretation
Sharp joint line pain	**Meniscus lesion**
Pain inside the joint	**Joint surface lesion, meniscus tear (localized), cruciate tear**
Medial or lateral knee pain	**Collateral ligament sprain**
Cannot fully extend	**intra-articular fragment (i.e.,osteochondral fracture, meniscus tear, or osteochondritis dissecans)**
Cannot fully extend with spongy end feel	**Swelling**
Cannot fully extend with rubbery end feel	**Bucket handle meniscus tear**
Recurvatum and/or empty end feel	**Ligamentous laxity or instability.**
Posterior knee pain	**Baker's cyst, popliteus strain**

Reliability & Validity: The lead author was unable to find any studies regarding the reliability or validity of this test.

Follow-up Testing: Depending on the bounce home results, any or all of the following may be appropriate: tests for capsular/ligamentous lesions (MCL/LCL), meniscus tears or cruciate tears, chondromalacia patellae, plicae, and/or Wilsons test for OCD in adolescents.

BULGE/SWEEP TEST

Joint Effusion
- **Ballottement**
- ✓ **Bulge Sweep**
- **Bounce Home**

Click here for video

Indication: The patient complains of knee swelling, stiffness or a sense of fullness. Suspected intra-articular or suprapatellar effusion.

Procedure: The maneuver is usually done on a supine patient with knees extended; however, it may sometimes be more effective if performed when the patient is standing. Palpate just lateral and medial to the infrapatellar tendon with the thumb and index of one hand. Then firmly contact the quadriceps above the suprapatellar bursa (about 4"above patella), and attempt to milk the fluid from the suprapatellar pouch in firm sweeping motions towards the patella. Palpate with the other hand below the patella. Finally, squeeze the bulge inferior to the patella and sweep upward. The excess fluid will be forced proximally and may be felt superior to the patella. This is repeated 2-3 times in each direction. Another option is to reverse the order: first milk the fluid in a superior-direction, starting from below the patella and complete the procedure by milking the effusion back down out of the suprapatellar bursa.

Common Procedural Errors: Applying pressure directly to the patella may be unnecessarily painful for the patient.

Interpretation: Bulging at the sides of the tendon below the patella is noted and indicates **excess fluid in the synovial cavity** of the knee. This, in turn, suggests possible **internal derangement** (e.g., meniscus or cruciate injury). This test may be more useful in the larger or obese patient where the effusion is difficult to see on visual inspection. (Comment: This is not usually a pain provoking test when the effusion is due to internal derangement unless there is trauma directly to the region above the patella).

Reliability & Validity: Reliability has been reported to be moderately good (k=0.61) (Logerstedt 2010). The lead author could find no reports on test validity.

Follow-up Testing: Orthopedic tests for meniscus and cruciate tears. MRI or diagnostic ultrasound can confirm the presence of swelling and internal derangement. In older patients, plain films to detect OA. It is sometimes useful to quantify the swelling by measuring the circumference of the knee at the patella and comparing bilaterally.

CABOT'S TEST

Meniscus Tears

- **Apley compression**
- ✓ **Cabot's Test**
- **Ege's**
- **Hyperflexion**
- **Joint line tenderness**
- **McMurray's**
- **Payr's**
- **Steinman's**
- **Thessaly**

Click here for video

Indication: The patient complains of localized joint line pain, possibly associated with swelling, locking, crepitus or occasionally giving way. Suspected internal derangement (e.g., meniscus/coronary ligament sprain or cruciate lesion). The patient may complain of knee pain when sitting cross legged or in the figure 4 position.

Procedure: This test begins with the patient supine and the involved lower limb in a figure 4 position. The patient then extends the lower leg against your resistance while your free hand palpates the joint line.

Common Procedural Errors: Failure to identify the exact location of pain by palpating joint lines and ligaments (e.g., the lateral collateral ligament is stressed in this position).

Interpretation: This test is described as mainly a test for **lateral meniscus** pathology (Mariani 1996). However, if joint line pain is exacerbated in this position, it is positive for meniscus tear consistent with the medial or lateral joint line involvement. Note that localized joint line pain may indicate a meniscus tear, but the figure 4 set up of this procedure may also aggravate pathologies involving ligaments especially the LCL (Rossi 2011), tendons, and **internal derangement** other than meniscus lesions. Abnormal translation or rotation of the tibia during this test indicates **cruciate tear**.

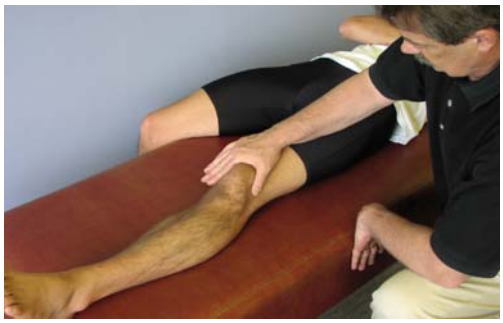
Reliability & Validity: This is a well-known test in Europe as a test for LCL and lateral meniscus pathology (Mariani 1996); however, validity and reliability studies were not found by the lead author.

Follow-up Testing: Can be performed in conjunction with Payr's test. Correlate with other meniscus or cruciate tests. In the case of trauma, rule out "unhappy triad" (i.e., ACL + MCL/LCL + medial meniscus). Confirmation of a meniscus diagnosis can be made by MRI or referral for arthroscopic assessment. Perform Wilson's test to rule out osteochondritis dissecans in adolescent patients.

CLARKE'S TEST/SIGN

Click here for video

Chondromalacia patellae
- ✓ **Clarke's test/sign**
- **Patellar facet pinch test**
- **Patellar grind**
- **Step up bench test**
- **Waldron's test**



Indication: The patient complains of patellar or anterior knee pain and crepitus. Suspected chondromalacia patellae, degenerative arthropathy involving patellofemoral articulation (OA), or other patellar surface injury.

Procedure: The patient is supine with knees extended and relaxed. With one hand at the superior pole of the patella, traction the patella toward the foot. Then instruct the patient to contract the quadriceps ("press the back of your knee against the table by tightening your thigh muscles"). Alternatively, "trap" the superior pole of the patella and press downward into the table (instead of distally) while the patient contracts the quadriceps.

Modified Clarke's Test (MC)* – Instead of making contact at the superior pole of the patella, begin the traction about ½ - 1" (1-2 cm) above the patella and press posteriorly on the upper part of the quadriceps tendon. Resist movement of the patella while the patient contracts the quadriceps. This method is less likely to produce false positive signs in normal patients compared with the traditional Clarke's Test described above.

Common Procedural Errors: Performing the Clarke's instead of the modified version, thereby increasing the potential for false positives which can be quite painful to the patient.

Interpretation: Retropatellar pain, crepitus, or the inability to hold the contraction due to pain for several seconds is recorded as positive signs of **chondromalacia patellae**.

Reliability & Validity: Unfortunately, this test is positive in a large percentage of asymptomatic knees. Although commonly performed and required learning, it is probably of little value as an isolated finding (Doberstein 2008, Pihlajmäki 2010).

Follow-up Testing: Screen for common contributing factors to poor patellar tracking (e.g., tight ITB, weak medial quadriceps, pronation syndrome, inhibited hip adductors). Also screen for symptomatic plica. Radiographs are of little diagnostic value, but MRI is accurate with severe chondromalacia and can be performed in the rare cases where surgical referral is warranted (75% PPV and 72% NPV, Pihlajamäki 2010). Arthroscopy, however, is considered to be the "gold standard" (Doberstein 2008).

Other References: Malanga (2003), Nijs (2006), DeHaven (1980), Doberstein (2005)

* This test, modified by the senior author (MC), is unique to UWS. Although it appears to decrease false positives, its validity is unknown.

EGE'S TEST (AKA Weightbearing McMurray's)

Ege's with internal rotation

Meniscus Tears

- **Apley compression**
- ✓ **Ege's**
- **Hyperflexion**
- **Joint line tenderness**
- **McMurray's**
- **Payr's**
- **Steinman's**
- **Thessaly**

Click here for video

Indication: The patient complains of localized joint line pain, possibly associated with swelling, locking, crepitus, or occasionally giving way. Suspected internal derangement (e.g., meniscus or osteoarthropathy).

Procedure: There are 2 parts to this test. Offer a hand to stabilize the patient during the procedure. During the first part the patient stands with both thighs fully externally rotated and the feet separated at least 6-12" then performs a squat (~90˚) with the feet pointing laterally. During the second part the patient stands with the feet separated ~12-24" with the thighs internally rotated and then performs a ½ squat with the feet pointing medially (Akseki 2004, Chivers 2009).If genu valgum causes the knees to contact each other before the squat is completed, have them repeat with a wider stance.

Common Procedural Errors: Failure to support patient. The patient's feet are not separated enough to complete the 1/2 squat while internally rotated without avoiding knee contact.

Interpretation: With tibia laterally rotated, medial joint line pain is positive for a **medial meniscus tear**. With tibia rotated medially, lateral joint line tenderness is positive for a **lateral meniscus tear**. Note that the joint pain may occur on either side in either of the testing positions. A study that compared McMurray's test and joint line tenderness to Ege's test concluded that Ege's test was superior except for negative predictive value (NPV) when compared with joint line tenderness for medial meniscus tears (Akseki 2004).

Reliability & Validity: Ege's test for medial meniscus has a +LR 3.5 and -LR 0.4 (sensitivity 67%, specificity 81%, overall accuracy 71%); for lateral meniscus the LRs are +LR 6.4 and -LR 0.4 (sensitivity 64%, specificity 90%, overall accuracy 84%) [based on one high quality study, Akseki 2004].

Follow-up Testing: Correlate with other meniscus tests. In the case of trauma, rule out "unhappy triad" (i.e., ACL and MCL tears). Confirmation of a meniscus diagnosis can be made by MRI or referral for arthroscopic assessment. Tests for capsular involvement and symptomatic plicae are also suggested. In the case of on adolescent patients perform Wilson's test to rule out osteochondritis dissecans.

HOP (vertical)

General Screening Test

- **Bounce Home**
- ✓ **Hop**
- **Recurvatum**
- **Figure 4 Position**

No video available

Indication: This procedure is usually not part of an initial routine examination of a patient in pain. Indications include patients who are asymptomatic at the time of the physical; knee pain that is not reproduced during a routine knee exam; knee pain exacerbated by patient jumping; or knee/lower extremity pain that is poorly localized.

Procedure: Patient stands on one foot and hops vertically. The forefoot should contact the ground first followed by the heel. The patient holds a hand rail or your hand to maintain their balance. Another option is to first screen patients by instructing them to stand on their toes (bilaterally) with knees extended and then instantaneously drop onto the heels, thus producing a shock to both lower limbs.

Common Procedural Errors: Not screening the patient adequately to determine if the test is safe. Failure to stabilize the patient during the single leg hop. The patient either lands directly on the heel during the hop or does not roll on to the heel at all.

Mechanism: This is a general screening provocation test that creates a vertical compression force intended to provoke and localize the pain to the injury site. This involves a similar mechanism as the anvil test. This test is especially helpful in cases where the symptoms and signs are very subtle, inconclusive or mild.

Interpretation: The localization of the pain indicates the injured region (i.e., it may discriminate **tibial, femoral, hip joint, from knee joint pathology**) and may produce pain precisely at the specific site of the injured structure. Other incidental observations include whether the foot has a tendency to pronate (possible **pronation syndrome**), the knee to collapse into varus direction (possible **inhibited hip abductors**), knee to collapse in a valgus direction (**genu valgum** and **weak hip external rotators**) or the pelvis to drop prematurely (possible **inhibited hip abductors**).

Reliability & Validity: Unknown

Follow-up Testing: Knee pain should be followed up by further palpation of the knee and appropriate orthopedic tests.

HOP (single leg hop for distance)

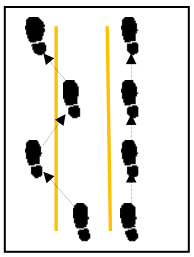
Click here for video

Functional Tests
- ✓ **Hop**
- **Triple Hop**
- **Cross Over Hop**



Indication: This is a not a test leading to a diagnosis of the patient's pain generator. It is a functional test of strength and coordination and is done only after the patient is out of the acute phase and transitioning into the rehabilitation and recovery phases of treatment.

Procedure: Mark a starting position on the floor. The patient stands on one leg and hops forward as far as possible. Start with the uninjured extremity. The patient gets 2 practice hops followed by 2 test hops. Measure the distance of each test hop and average. If the initial hop is painful, consider waiting to do this assessment. A brace is recommended when performing the test post injury and up to 1 year post-surgical. Variations include the cross over hop and triple hop.



Interpretation: This is a dynamic test for **quadriceps strength** and **motor control**. An abnormal finding is the injured side hopping < 85% of the distance of the uninjured extremity. A target for rehabilitation in an active patient would be 92-96%. (Logerstedt 2010)

Reliability & Validity: The ICC for test-retest reliability is reported to be an excellent 0.92 in both healthy individuals and patients with post ACL reconstruction. (Logerstedt 2010)

Follow-up Testing: Resisted testing of the quadriceps, hamstrings, hip extensors, hip abductors, hip external rotators, extensors of the spine and abdominal muscles. Proprioceptive tests (i.e. one legged stand - eyes open and eyes closed); flexibility tests involving knee flexion and extension; hip flexion, extension, abduction and adduction; and spinal flexion, extension, and lateral bending.

HUGHSTON'S PLICA TEST

Plica Tests
- ✓ **Hughston's**
- **Plica Pinch**
- **Plica Stutter**

Click here for video

Indication: The patient complains of reoccurring anterior knee pain proportional to activity levels (usually running), clicking that worsens with increasing pain and swelling. Sometimes a noticeable patellar catch or "stutter" is described by the patient (Amatuzzi 1990). The patient may have a history of twisting or blunt trauma to the knee (Calvo 1990) and sometimes a tender slender band is palpable along the medial border of the patella (Hardaker 1980).

Procedure: The patient is supine (sitting is an acceptable alternative) with the knees relaxed and extended. Stand at the side to be tested while grasping the heel or ankle with one hand, as the other hand is cupped over the patella (the finger pads hooked around the medial aspect and the heel of the hand against the lateral side of the patella). With the distal hand, passively flex and extend the knee, while holding the tibia internally rotated [Note: internal rotation not shown in video]. The test can also be performed actively. Simultaneously, the upper hand applies moderate force on the lateral side of the patella in a medial direction with the heel of the hand to pinch the patella against the finger pads and medial lip of the patellar groove of the femur. This procedure is essentially the same as the Plica Pinch Test with a dynamic component added.

Interpretation: If the patient complains of localized medial knee pain, it suggests a **symptomatic plica** (usually medial). If the examiner palpates localized snapping or tenderness with the fingertips or there is a noticeable "stutter" of the patella, the test is positive for synovial plica syndrome. When a child or adolescent presents with this finding, be especially suspicious of a symptomatic plica (Johnson 1993).

Reliability & Validity: The lead author was unable to find any evidence regarding the validity or reliability of this test.

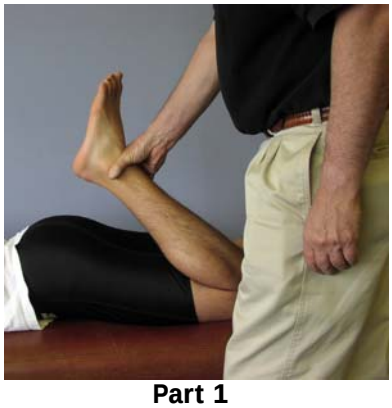
Follow-up Testing: Other plica tests. Also meniscus tests to rule out meniscus lesions may present with pain and clicking. Chondromalacia tests to identify patellar chondropathy that may be caused or aggravated by a symptomatic plica. Arthroscopy is the diagnostic "gold standard" yet MRI and/or dynamic ultrasound are often performed to confirm the presence of a plica prior to arthroscopy.

Note: There are no signs or symptoms that are pathognomonic of a symptomatic synovial plica (Reid 1992).

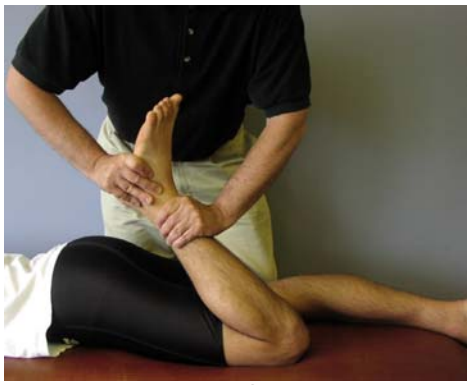
HYPERFLEXION

Click here for video

Meniscus Tears
- Apley compression
- Ege's
- ✓ Hyperflexion
- Joint line tenderness
- McMurray's
- Payr's
- Steinman's
- Thessaly



Part 1



Part 2

Indication: The patient complains of localized joint line or popliteal pain with kneeling or deep knee bends. May be associated with swelling, locking, crepitus or sometimes giving way. Suspected internal derangement, (especially a meniscus tear involving posterior horn).

Procedure: This is a modification of Apley's Compression Test and consists of 2 parts. The 1st part involves fully flexing the knee (heel to buttock) with the patient in a prone position (normal = 130°-150°). Then perform the 2nd part by compressing and grinding/rotation as in Apley's compression test but with the knee fully flexed (back off about 5° if the patient has pain other than localized to the joint line when fully flexed). Some authors include this test as an extension of Apley's compression test (Malanga 2003).

Common Procedural Errors: Do not perform the 2nd part if the 1st part produces significant knee pain.

Interpretation: Pain suggests subtle **posterior horn tears of the meniscus**. The test may be positive even when Apley's compression is negative. The patient may complain of knee pain only during a deep squat or when fully flexing the knee. Medial joint line pain during either part of this test (often accompanied by decrease ROM) can indicate a posterior horn tear of the medial meniscus, whereas lateral joint line pain can indicate a posterior horn tear of the lateral meniscus.

Reliability & Validity: Unknown

Follow-up Testing: Correlate with other meniscus tests. In the case of trauma, rule out "unhappy triad" (i.e., ACL and MCL/LCL tears). Confirmation of a meniscus diagnosis can be made by MRI or referral for arthroscopic assessment. Tests for capsular or plicae involvement are also suggested. Perform Wilson's test to rule out osteochondritis dissecans in adolescent patients.

JOINT LINE TENDERNESS

Meniscus Tears

- **Apley compression**
- **Ege's**
- **Hyperflexion**
- ✓ **Joint line tenderness**
- **McMurray's**
- **Payr's**
- **Steinman's**
- **Thessaly**

Click here for video

Indication: The patient complains of localized joint line pain, possibly associated with swelling, locking, crepitus or sometimes giving way. Suspected internal derangement (e.g., meniscus or cruciate lesion).

Procedure: Palpate along the medial and lateral joint lines between the femur and tibia. Option: Palpate the menisci for abnormal crepitus, bulges and movement while the patient (or doctor) rotates the tibia internally and externally.

Common Procedural Errors: Failing to compare sides.

Interpretation: Isolated localized tenderness or lack of meniscus movement with rotation suggests a **meniscus tear**, **sprain of the coronary ligament**, **adhesion**, or **joint motion restriction**. A meniscus tear is more likely if palpation findings are confirmed by palpation performed under load (e.g., during Ege's and Thessaly tests). In the experience of the senior author (MC), isolated localized joint line tenderness is very useful in cases of *uncomplicated* meniscus tears, especially when combined with joint line pain provoked by meniscus tests. Joint line tenderness is less indicative of meniscus pathology when the patient presents with effusion or in the case of complex or severe knee injuries (Fowler 1989, Shelbourne 1995, Scholten 2006). On the other hand, complex or serious injury seldom presents with *isolated* localized joint line pain and tenderness. When tenderness extends beyond the joint line other conditions should also be suspected (i.e. ligament sprain, DJD, patellofemoral pain syndrome).

Reliability & Validity: Malanga et al. (2003) state that "joint line palpation is one of the most basic maneuvers, yet it often provides more useful information than the provocative maneuvers designed to detect meniscal tears." Hing et al. (2009) cite a recent evidence-based guideline that "joint line tenderness is the only reliable clinical indicator of meniscal pathology." Yet the validity of joint line tenderness is still considered controversial. The procedure has not been studied in a primary care setting and further study is necessary. Test validity ranges from a high of +LR 3.3, -LR .31 (Cleland 2008 meta-analysis) to +LR 3.0, -LR 0.2 (single study, Konin 2009), to +LR 2.7, -LR 0.48 (Hegedus 2007 meta-analysis) to a much poorer +LR 0.9 (0.8-1.0), - LR 1.1 (95% CI 1.0-1.3) based on two studies (Simel 2009). This discrepancy may be based on the heterogeneity of the studies and the lack of distinction between isolated joint line tenderness and joint line tenderness as part of a more widespread distribution of pain.

Follow-up Testing: Correlate with other meniscus tests. In the case of trauma, rule out "unhappy triad" (i.e., meniscus tear combined with ACL, LCL and MCL tears). Confirmation of a meniscus diagnosis can be made by MRI or referral for arthroscopic assessment. Apley's distraction test for coronary ligament involvement is also suggested as well as Wilson's test to rule out osteochondritis dissecans.

LACHMAN'S TEST

Click here for video

ACL Tests
- **Anterior Drawer**
- ✓ **Lachman's**
- **Pivot Shift**

Classic

Modified

Stable

Prone

Indication: The patient often reports a history of trauma with an accompanying popping sensation, followed by swelling; or when chronic, the patient complains of apprehension or giving way (i.e., recurrent shifting, or popping-out) when performing certain knee movements or with changes of direction.

Procedure: In the classic Lachman's test the patient is supine with the knee flexed 15°-30°. Evidence indicates that anterior laxity in the ACL deficient knee is greatest when the knee is flexed 20° (Markolf, 1984). Firmly grasp the patient's anterolateral thigh with one hand (thumb over distal quadriceps), while grasping the upper leg with the other hand (thumb over tibial tuberosity). Do not contact the patella during the test. After finding translation neutral, firmly push posterior on the thigh and pull forward on the leg. The patient must remain relaxed, especially their hamstrings, throughout the test. When the patient is large the classic Lachman's test may be quite difficult. For this reason, many other versions of this important test have been described in the literature. See photos above and videos for alternative methods. Mulligan et al. (2011) also described a prone version of the test.

Common Procedural Errors: Positioning the knee too flexed or too extended. Applying pressure on the patella. Not producing motion parallel with the joint plane. Failure to compare sides in determining the starting position or comparing motion. Relying on just Lachman's test without more comprehensive history and examination.

LACHMAN'S Test (Continued)

Interpretation: Lachman's test is considered to be the "gold standard" maneuver to diagnose anterior translational instability. With the leg more extended than in the anterior drawer test, the hamstrings and menisci are less able to block translational motion. An intact ACL will limit anterior translation to about ¼" (½ cm) with a firm end feel. Excessive anterior translation or a soft/mushy end feel is positive for an anterior cruciate tear. Pain with normal translation suggests an **ACL sprain or partial tear**. Note that excessive swelling (hemarthrosis) may develop soon after a cruciate tear and interfere with anterior translation. For this reason, Lachman's test may only be reliable shortly following the injury ("golden period") or later when the swelling has subsided. False-negatives can occur if there is significant hamstring spasm (Hammer 2007) or if blocked by a bucket-handle tear of the meniscus (Torg 1976, Malanga, 2003, Hammer 2007). However, Donaldson et al. (1985) notes an overall 99% test sensitivity and found that the test was relatively unaffected by associated hamstring or meniscal injuries. Hammer (2007) suggests that if both the Lachman and drawer tests are positive, the ACL is probably completely ruptured. If Lachman's alone is positive, then only the posterolateral band of the ACL is usually ruptured.

Reliability & Validity: A positive Lachman test with non-discrete end feel or increased anterior tibial translation has a **+LR 42** (95% CI, 2.7-651) and **-LR 0.1** (95% CI, 0.0-0.4) (Simel 2009). Logerstedt (2010) reported lower estimates (but still quite useful): +LR 10, -LR 0.2. Scholten et al. (2003) in their meta-analysis conclude that the Lachman test is the most sensitive test in the diagnosis of ACL tears. Few studies have been done on alternative variations of the classic Lachman's Test (Malanga 2003). Intra-examiner judgment of a positive vs negative test has a reported *k*= 0.46 (range 0.38-0.60) and inter-examiner agreement has a reported *kappa* ranging from 0.19 -0.42 (Logerstedt 2010). Mulligan, et al. (2011) state that the diagnostic accuracy and reliability of the prone Lachman (based on one small study) was an excellent +LR 20.0, -LR 0.32, and *kappa* 0.81, but should not be the sole criterion to rule out the presence of an ACL tear.

Follow-up Testing: Other ACL tests (anterior drawer test, Pivot shift), posterior sag sign to rule out PCL. In the case of trauma, rule out "unhappy triad" (i.e., ACL combined with meniscus and MCL/LCL tears). Confirmation of an ACL tear can be made by MRI or referral for arthroscopic assessment.

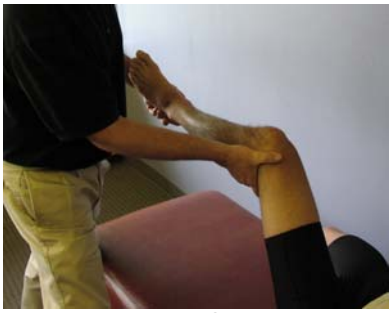
McMURRAY'S TEST

Click here for video

Meniscus Tears

- **Apley compression**
- **Ege's**
- **Hyperflexion**
- **Joint line tenderness**
- ✓ **McMurray's**
- **Payr's**
- **Steinman's**
- **Thessaly**

Part 1



Part 2

Part 3

Indication: The patient complains of localized joint line pain, possibly associated with swelling, locking, crepitus or giving way. Suspected internal derangement (e.g., meniscus or cruciate lesion) or coronary ligament sprain.

Procedure: The patient is supine. Part 1: Grip the patient's foot or heel (or just proximal to the ankle) with the inferior hand while the stabilizing hand is placed on the anterior distal thigh above the knee. Fully flex the knee and then rotate the tibia with the inferior hand while applying compression with both hands to grind the menisci (a mechanism similar to Apley's compression test). Part 2: The superior hand is placed on the lateral aspect of the knee, fingers wrapped around the upper calf for support. The tibia is maintained in an externally rotated position as a valgus force is applied while extending the leg. Part 3: The superior hand is placed on the medial side of the knee with fingers supporting on the posterior side of the calf. The tibia is maintained in an medially rotated position as varus force is applied while extending the leg. Parts 2 and 3 should be repeated several times.

Common Procedural Errors: Failure to fully flex knee to start each of the 3 maneuvers shown above. Pressure on the patella that may provoke patellar pain. Failure to ascertain exactly whether the pain is actually in the medial or lateral joint lines (as opposed to a collateral ligament or patellofemoral). Failure to support the upper calf during the part 2 and 3 maneuvers resulting in the upper calf experiencing a jarring drop into the extension. Failure to stabilize the ankle while performing the internal and external maneuvers. Failure to compare sides. Conclusions based only on McMurray's test results without a comprehensive history and examination.

Mechanism: Sometimes the patient with a bucket handle tear is unable to fully extend the knee due to articular block (joint locking). McMurray's maneuvers may manipulate the folded fragment (i.e. bucket handle tear) back into its normal position (often with an audible snap) thus unlocking the knee and providing temporary pain relief. Unfortunately, this is often only a transient reduction of the offending fragment.

Interpretation: Joint line pain (a soft positive) or a painful snap/click/catch (a stronger positive) during the maneuvers suggests a **meniscus tear.** However, a painful snap when the tibia is maintained in medial rotation may be due to a **symptomatic synovial plica**. The location of the pain implicates which meniscus may be involved (medial or lateral). A larger "thud" (Evans 1993) or clunking should evoke suspicion of instability but may also accompany large medial meniscus tears. A click or snap without pain is not necessarily significant. Flexion-extension clicks can be caused by a synovial fold (plica), patellar lesions, osteochondral loose bodies, or reduction from a subluxation position as a result of an anterior cruciate tear (Hammer 2007). In chronic meniscus problems, the orthopedic tests may be negative, and the examiner may have to rely on history and joint line tenderness. (Hammer 2007).

McMURRAY'S TEST (Continued)

Reliability & Validity: The accuracy of this commonly used test is controversial possibly because there are several variations of the McMurray's test that are described in the literature and used in validity studies (Hing 2009). Furthermore, Hing (2009) cites evidence that modifications of McMurray's test may have better validity and diagnostic accuracy than the original test. Overall, there seems to be a wide variation in reported sensitivities and specificities of this test in detecting meniscus tears (Malanga 2003).

- A 2007 meta-analysis reported a +LR of 2.4 and –LR 0.42 (Hegedus 2007); in a 2008 meta-analysis pain, catch or both had a reported +LR 2.4 and -LR .58 (Cleland 2008)]; a 2009 analysis of 3 studies reported a lower overall rating: +LR 1.3 (95% CI, 0.9-1.7) and -LR 0.8 (95% CI, 0.6-1.1) (Simel 2009); a 2009 small cohort reported +LR 2 and –LR 0.6 (Konan 2009)
- A +LR of 7.5 and -LR of 0.03 was reported when any two of the following 6 tests were positive (based on a small study on athletes): Tenderness to palpation of joint line + Bohler test + Steinmann test + Apley's grinding test + Payr test + **McMurray's test** (Muellner 1997).
- A study by Akseki, et al. (2004) indicates that the Weight Bearing McMurray's Test (Ege's) seems to be more accurate than McMurray's in detecting both lateral and medial meniscus tears (see Ege's Test).

Follow-up Testing: Correlate with other meniscus tests. Care should be taken to perform tests to rule out a plica as it may cause a snap during McMurray's test (Reid 1992). In the case of trauma, rule out "unhappy triad" (i.e., Meniscus in combination with ACL, LCL, and MCL tears). Confirmation of a meniscus diagnosis can be made by MRI or referral for arthroscopic assessment.

When the pain produced in this test is not localized to the medial or lateral joint line, it is important to investigate other possible causes of the patient's signs and symptoms (such as patellofemoral, plica, ligament, or tendon problems.) Perform Wilson's test to rule out osteochondritis dissecans in adolescent patients.

NOBLE'S TEST

Click here for video

ITB Syndrome
- ✓ **Noble's**
- **Ober's**
- **Renne's**

Part 1

Part 2

Indication: The patient complains of lateral knee pain and sometimes crepitus during knee flexion-extension that is aggravated while running. Suspected iliotibial band (ITB) syndrome.

Procedure: The patient is supine or side-lying with the injured side up. Grasp just above the ankle and slowly bend the knee back and forth several times from 0-90° while palpating the lateral epicondyle of the femur for crepitus with the other hand. This is repeated in part 2 while applying firm pressure with the thumb over the ITB just above the lateral epicondyle (Magee 2002).

Common Procedural Errors: Applying pressure in part 2 too distally and directly on the lateral femoral epicondyle rather than just proximal to epicondyle. Avoid applying pressure on the patella as this may provoke patellar symptoms.

Interpretation: Palpable snapping, rubbing or "squeaky hinge-like" crepitus or localized pain that increases with pressure at or above the epicondyle (often at 30° of flexion) indicates **ITB syndrome**.

Reliability & Validity: Unknown

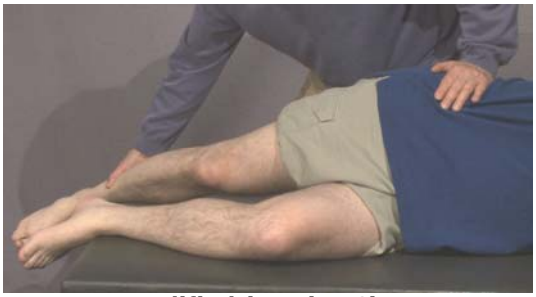
Follow-up Testing: May correlate with the weight bearing version of the test (Renne's test). Perform Ober's or modified Ober's test to assess for ITB tightness. If there is joint line pain or suspicion of lateral meniscus lesion, perform meniscus tests.

OBER'S TEST

Click here for video

ITB Syndrome
- **Nobel's**
- ✓ **Ober's**
- **Rinne's**

Classic (Version 1)



Modified (Version 2)

Indication: The patient complains of low back pain, lateral knee pain (especially overuse) or anterior knee pain suggesting patellofemoral pain syndrome (PFPS).

Procedure: The patient lies on their side along the back edge of the table. The downside limb is flexed approximately 30˚for more stability, but the foot should not extend beyond the back edge of the table. Stand behind the patient and firmly stabilize the pelvis to prevent movement in any direction by using your body and one hand on the ilium. Grasp the distal end of the patient's leg with your inferior hand. The test can be performed two ways. Version 1 (Classic): the patient's knee is flexed to 90˚. Then, while maintaining the pelvis in the starting position, extend the hip, and slowly allow the lower extremity to drop towards the table behind the opposite knee. Version 2 (Modified): with the knee fully extended, the entire limb is slowly lowered toward the floor (clearing the back edge of the table). In both versions overpressure can be applied to assess end feel. Finally, you can follow up both versions by gradually releasing the stabilizing pressure on the pelvis to determine the effect of ITB and hip abductor tightness on the lateral flexion of the spine and pelvis. During Version 1, an inclinometer placed on the lateral side of the thigh is used to quantify the adduction angle at the end of passive ROM (Reese 2003). The quantitative measurement is seldom necessary in clinical practice.

Common Procedural Errors: Failure to compare sides. Dropping the tested limb too rapidly or repeatedly "bouncing" the limb to assess end feel. Version 1: Failure to maintain the thigh/hip in a neutral rotated position (leg should remain horizontal, parallel to the ground) throughout the test. Allowing the thigh to internally rotate as the limb is lowered to the table. Version 2: Failure to prevent the pelvis from rolling back toward the practitioner. The lower foot or the edge of the table interferes with the tested limb from achieving full range of motion. The practitioner pressing their anterior pelvis against the patient while trying to stabilize the patient's pelvis (boundary issue).

Mechanism: The test assesses isolated tension on the ITB, hip abductors, and possibly the vastus lateralis and rectus femoris if the trunk and pelvis are properly stabilized. The tension on the ITB across the hip is greater when the knee is at 90˚ compared to 0˚ and thus adduction is more limited when the knee is flexed (Gajdosik 2003).

Interpretation: Normal hip adduction flexibility allows the upper (tested) knee to fall behind the knee of the lower limb in version 1. The foot of the tested side should reach below the plane of the table-top in version 2. Mean adduction ROM in asymptomatic female adults is less than in males in both versions of the test (Gajdosik 2003). Hudson and Darthuy found less mean adduction ROM in version 2 of the test in males and females with patellofemoral pain compared to asymptomatic controls (20-21˚from horizontal), and decreased ROM when comparing symptomatic to asymptomatic sides in those with unilateral PFPS. In patients with low back pain, asymmetrical **tightness of the ITB** may be a factor in biomechanical faults of the lumbar spine and pelvis. Pain at the hip during the procedure suggests hip pathology that may refer to the knee.

Reliability & Validity: Unknown

Follow-up Testing: Nobel and/or Rene test with suspected ITB Syndrome; Patellofemoral and plica tests with suspected PFPS, and lumbar and pelvic orthopedic tests in patients with low back pain.

Ober test was first described (Ober 1936) with the knee flexed 90˚, yet subsequent descriptions of the test with the knee flexed and also with the knee extended (and other slight variations of both versions) have been described (Evans 1994, Hertling 1996, Hoppenfeld 1976, Kendall 2005, Magee 2002). Consequently, this has led to confusion on how the test is performed and how it is interpreted.

PATELLAR APPREHENSION

Recurrent subluxation (instability)
✓ **Patellar apprehension**

Click here for video

Apprehension 1

Apprehension 2

Indication: Suspected patellar instability or recent patellar dislocation/subluxation. Patients with an unreduced patellar dislocation usually present to the ER. Usually the dislocation has already reduced in patients who present to a chiropractor. The patient may be unable to ambulate and, when chronic, may complain of knee giving away.

Procedure: The test should be performed with the patient relaxed in 2 positions: first fully extended and then flexed approximately 30°. The patient is supine with knees relaxed. Instruct the patient to remain relaxed while carefully and slowly attempting to translate the patella laterally with one hand. The test is positive if the patient is unable to relax the thigh, contracts his/her quadriceps during the maneuver, demonstrates any verbal or nonverbal signs of apprehension, or the patella seems about to dislocate. **Note:** As with many orthopedic tests, there are several variations on the manner in which this test is described. Some describe the test as a 2 part test as in this document; others describe the test while actively or passively flexing and extending the knee, whereas some describe the test while only in a 30° flexed position.

Common Procedural Errors: Care should be taken not to dislocate the patella, especially when the knee is fully extended! Leaving out one of the two parts may miss a positive test.

Interpretation: Positive signs may indicate a **reduced patella following dislocation in an acute knee**, or an **unstable patella** in the patient with a history of the "knee cap popping out" or recurrent patellofemoral symptoms. Bruising medial to the patella and in the VMO due to tearing as the patella dislocates laterally should be documented. Apprehension at 30° represents more serious instability and should be referred for further assessment. Mild pain without apprehension could be due to a lateral symptomatic patella or a rare lateral symptomatic plica.

Reliability & Validity: The available evidence suggests that the "apprehension test" described above as well as other variations may have limited diagnostic value as stand-alone tests in the unanesthetized patient (Malanga 2003, Sallay 1996, Nijs 2006, Smith 2008, Smith 2012). Of some interest is the Moving Apprehension test performed on anesthetized patients proposed by Ahmad CS et al. (2009) with a reported positive predictive value (PPV) of 89% and negative predictive value (NPV) of 100%.

Follow-up Testing: Three view knee radiographic evaluation (AP, lateral, sunrise) is necessary following a suspected patellar dislocation to rule out articular fracture. MRI may be necessary when significant cartilaginous damage is suspected.

PATELLAR FACET PALPATION* (AKA Patellar Facet Pinch Test)

Chondromalacia patellae

- **Clarke's test**
- ✓ **Patellar facet pinch test**
- **Patellar grind test**
- **Step-up bench test**
- **Waldron's test**

Click here for video

Indication: Anterior knee pain may be associated with overuse. Patient may complain of pain and/or grinding under the patella, aggravated by ambulation (especially up or down inclines), and periodic knee swelling.

Procedure: The patient is supine with knees extended and relaxed. Apply gentle pressure to displace the patella laterally and expose the lateral patellar facet. Then apply firm pressure and rub your finger pads along the lateral facet. Firmly palpate the medial facet with the patella carefully displaced medially. Facet tenderness is positive for chondromalacia patellae.

Common Procedural Errors: Be careful not to dislocate patella laterally, especially with patellar instability or history of patellar dislocation or orthopedic subluxation.

Interpretation: Facet tenderness is positive for **chondromalacia patellae**.

Reliability & Validity: Unknown

Follow-up Testing: Other tests for chondromalacia. Tests to rule out symptomatic plicae. Special imaging is recommended in cases that are severe, chronic, or where conservative treatment fails. Physical examination is not sufficient to conclusively reach a diagnosis of chondromalacia patellae. Definitive confirmation requires imaging or arthroscopy. This test and others fail to unequivocally distinguish chondromalacia from other causes of patellofemoral pain.

---

*This is a test unique to UWS and modified by the senior author (MC) who recommends this version over the classic Clarke's test.

Note: this test is demonstrated on the Knee Orthopedic videos with the Apprehension Test and is referred to as facet palpation.

PATELLAR GRIND

Chondromalacia patellae

- **Clarke's test**
- **Patellar facet pinch test**
- ✓ **Patellar grind test**
- **Step up bench test**
- **Waldron's test**

Click here for video

Indication: **The p**atient complains of anterior or poorly localized knee pain and/or crepitus. Suspected chondromalacia patellae, patellofemoral arthropathy, or other patellar articular pathology. (Note: Sometimes Clarke's Test is referred to as the "Grind Test")

Procedure: The patient is supine with knees relaxed and extended. Either using fingertip pressure or by cupping your hand over the patient's patella, compress the patella against the patellofemoral surfaces while moving and "grinding" it in a circular fashion.

Common Procedural Errors: Be careful not to cause posterior tilting of the superior or inferior poles as this may cause a false positive due to painful grinding crepitus between non-articular inferior/superior poles of the patella against the articular surface on the femur. Failure to do follow-up testing (see below).

Interpretation: Normally, there is no pain or crepitus as the patella is mobilized in this fashion. Pain and crepitus are recorded as positive signs **for chondromalacia patellae or other patellar pathology.**

Reliability & Validity: Unknown

Follow-up Testing: Other tests to confirm chondromalacia patellae (Clarke's test, patellar facet pinch test, step up bench test). Tests to rule out symptomatic plicae (plica stutter test, plica pinch test, Hughston's test). In addition, screen for contributing factors related to poor patellar tracking (e.g. tight ITB, weak VMO, pronation syndrome, inhibited hip abductors). Imaging (e.g., AP, lateral sunrise radiographic views and/or MRI) may be necessary to evaluate the extent of articular damage in severe or chronic cases or when conservative therapy fails.

PAYR'S TEST

Meniscus Tears

- **Apley compression**
- **Cabot's test**
- **Ege's**
- **Hyperflexion**
- **Joint line tenderness**
- **McMurray's**
- ✓ **Payr's**
- **Steinman's**
- **Thessaly**

Click here for video

Indication: The patient complains of localized joint line pain, possibly associated with swelling, locking, crepitus or sometimes giving way. Suspected internal derangement (e.g., meniscus/coronary ligament sprain or cruciate lesion). The patient may complain of knee pain when sitting cross legged or in the figure 4 position.

Procedure: This simple test is performed with the patient supine and the involved lower limb in a figure 4 position. You then follow up by carefully palpating the joint lines (front to back) for isolated localized tenderness.

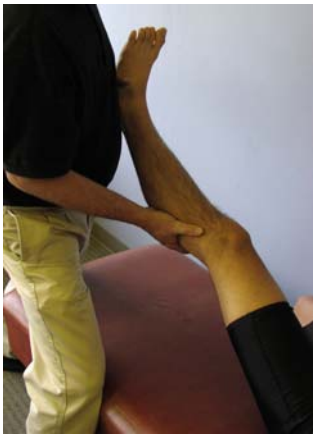
Common Procedural Errors: Failure to identify exact location of pain by palpating joint lines and ligaments (e.g., the lateral collateral ligament is stressed in this position).

Interpretation: If isolated localized joint line pain and tenderness is exacerbated in this position, it is positive for **meniscus tear** consistent with the medial or lateral joint line involvement. Note that the figure 4 position may also aggravate pathologies involving the c**oronary and collateral ligaments, tendons,** and **internal derangement**.

Reliability & Validity: Two of the following 6 tests had a +LR of 7.5 and -LR 0.03 (based on a small study on athletes): Tenderness on palpation of joint line + Böhler test + Steinmann test + Apley's grinding test + **Payr test** + McMurray's test (Muellner 1997).

Follow-up Testing: Correlate with other meniscus tests (note that Cabot's test is performed in the same patient position). In the case of trauma, rule out "unhappy triad" (i.e., ACL, and MCL or LCL tears). Confirmation of a meniscus diagnosis can be made by MRI or referral for arthroscopic assessment. Perform Wilson's test to rule out osteochondritis dissecans in adolescent patients.

PIVOT SHIFT



ACL Tests
- **Anterior Drawer**
- **Lachman's**
- ✓ **Pivot Shift**

Click here for video

Indication: The patient often complains of a history of trauma with an accompanying popping sensation, followed by swelling; or when chronic, the patient complains of apprehension, locking, or giving way (i.e., recurrent shifting or popping-out) when performing certain knee movements or with changes of direction.

Procedure: Macintosh's Pivot Shift Test – The patient is supine, relaxed, with the knee extended. Stand at the side to be tested with one hand grasping the ankle or heel, while the other hand holds the posterolateral calf at the head of the fibula. The upper hand internally rotates and applies anterior translation. The hand grasping the ankle holds the tibia in internal rotation throughout the test while both hands passively flex the knee. After approximately 10° of flexion, a valgus stress is applied.

External Rotated Pivot Shift Test Some authors suggest that if the pivot shift test is performed with the foot/leg maintained in an *externally* rotated position (rather than internally), the procedure may be more accurate (Bach 1988, Noyes 1991, Lubowitz 2008); therefore, the pivot shift test should be performed both with the tibia internally rotated and externally rotated.

Common Procedural Errors: Not getting the patient to relax during the procedure. Patient must be relaxed. Sometimes the patient is unable to relax without anesthesia. You perform the test with tibia internally rotated when the hip is abducted. If Lachman' s test or anterior drawer sign is positive, it is best to refrain from doing the pivot shift because it is creates a more aggressive load on the injured ACL.

Mechanism: The ITB must be intact for the pivot shift to be effective in an ACL deficient knee. As the knee moves through 20-40°, the ITB switches between being a knee extensor to flexor and provides the changing tension that creates the relocation action resulting in the clunk or thud detected during the test (Bach 1988, Lubowitz 2008). Meniscus tears and swelling may interfere with the pivot shift test.

Interpretation: A positive "pivot shift" is when the tibia shifts, thuds, or clunks posteriorly (and medially rotates) at approximately 20°- 40° of flexion. The tibia may clunk again when the knee is moved back into extension. A positive test indicates a **torn ACL** and may also indicate additional structures are damaged resulting in **anterolateral rotational instability**. The test may not become positive until 6 weeks after the injury, although it is consistently positive in acute injuries under anesthesia. Crepitation in the lateral joint line during the flexion phase may represent a tear of the lateral meniscus. The pivot-shift test can be graded as 0 (absent), 1+ (slight slip), 2+ (moderate slip) or 3+ (momentary locking) (Hammer 2007). Test result variability in different studies may be related to different methods of preforming the maneuver (Noyes 1991).

Reliability & Validity:
- Positive pivot shift test with nearly normal ("glide"), abnormal ("clunk"), or severely abnormal ("gross") shift has a reported **+LR 8.5** (95% CI, 4.7-15.5) and -LR .9 (95% .8-1.0).
- The anterior drawer and the pivot shift test are good at identifying anterior cruciate ligament (ACL) tears (+ LR = 2.9 to 8.5). Lachman test is best at ruling them out (– LR = .10 to .20). (Cleland 2011)
- Scholten et al. (2003), in their meta-analysis conclude that the pivot shift had favorable +predictive value, but because of the difficulty of the test and the inexperience of the examiner makes it less accurate in a primary care setting.

Follow-up Testing: Other pivot shift tests for anterolateral rotational instability including some not discussed in this document (i.e. Losee T.,Hughston's Jerk T.); posterior sag sign to rule out PCL; other ACL tests.

PLICA PINCH (Mediopatellar Plica Test)

Symptomatic Plica Tests
- **Plica Stutter test**
- ✓ **Plica Pinch test**
- **Hughston's test**

Click here for video

Indication: The patient complains of reoccurring anterior knee pain proportional to activity levels (usually running or up & down stairs) and in 50% clicking (Reid 1992) that worsens with increasing pain and swelling (visible swelling is rare). Sometimes a noticeable patellar catch or "stutter" is described by the patient (Amatuzzi 1990). The patient may have a history of twisting or blunt trauma to the knee (Calvo 1990) and sometimes a tender slender band is palpable along the medial border of the patella (Hardaker 1980).

Procedure: The patient is supine with knees relaxed and extended. Support the knee by placing your hand in the popliteal fossa. (Alternatively, you can place your forearm behind the patient's ipsilateral knee while gently gripping the opposite thigh for support). The patient's knee is supported by your hand or forearm under the popliteal fossa, while the other hand is free to position the affected knee at 30° flexion. Then apply pressure on the lateral side of the patella displacing it medially and the fingertips scoop the tissue medially against the medial patellar facet as the leg remains stationary at 30° (Magee 2002, Mital1979).

Common Procedural Errors: N/A

Mechanism: In this test, a medial synovial plica may be pinched between the patella and medial lip of the patellar groove of the femur or the patella.

Interpretation: If the patient complains of localized medial knee pain and tenderness during the test (often 1 finger breadth medial to the inferior 1/3 of the patella), it suggests a **symptomatic medial plica**. If the examiner palpates localized snapping or tenderness with the fingertips or there is a noticeable "stutter" of the patella, the test is positive for synovial plica syndrome. The examiner should be especially suspicious of a symptomatic plica when a child or adolescent presents with this stutter (Johnson 1993).

Reliability & Validity: The lead author was unable to find any evidence of the validity or reliability of this test.

Follow-up Testing: Perform other plica**, c**hondromalacia and meniscus tests. Note that a symptomatic plica may mimic a meniscus tear and may be a contributing factor in patients with chondromalacia patellae. Arthroscopy is the diagnostic "gold standard" yet MRI or dynamic ultrasound are often performed to confirm the presence of a plica prior to arthroscopy.

Note: There are no signs or symptoms that are pathognomonic of a symptomatic synovial plica (Reid 1992).

PLICA STUTTER (AKA KNEE EXTENSION TEST)

Symptomatic Plica Tests
- **Plica Pinch test**
- **Hughston's test**
- ✓ **Plica Stutter test**

Click here for video

Indication: The patient often complains of recurring anterior (usually anteromedial and occasionally anterolateral) knee pain proportional to activity levels (usually running or going up & down stairs) and there can be clicking that worsens with increasing pain and swelling (Reid 1992). Sometimes there is a noticeable patellar catch or "stutter" described by the patient (Amatuzzi 1990). The patient may have a history of twisting or blunt trauma to the knee (Calvo 1990) and sometimes a tender slender band is palpable along the medial border of the patella (Hardaker 1980).

Procedure: The patient is seated at the end/edge of the examination table, and the examiner stands or sits to the side being tested while gently palpating the patella. The patient is instructed to slowly flex and extend the knee. (Magee 2002).

Common Procedural Errors: Applying too much pressure on the patella; it should only be lightly palpated and carefully observed.

Interpretation: Localized medial knee pain and tenderness during the test (often 1 finger breadth medial to the inferior 1/3 of the patella) and an observable/palpable catch or "jump" of the patella as the patient moves the knee suggests a **symptomatic synovial plica** (AKA medial shelf syndrome, synovial shelf syndrome, synovial plica syndrome, or plica synovialis patellaris). Localized pain at the moment the patella "stutters" is strongly suggestive of a symptomatic plica. However, if there is noticeable swelling, positive findings during this test are inconclusive. Note that synovial plica syndrome often presents with recurrent exercise induced pain, snapping and swelling of the knee similar to a meniscus lesion. Be careful not to confuse a patellar stutter with the jump sign where the tibia "jumps" due to a detached meniscus or a tibial clunk or shift due to tibiofemoral instability related to a torn ACL.

Reliability & Validity: The lead author was unable to find any evidence regarding the validity or reliability of this test.

Follow-up Testing: Other plica tests. Pain and clicking may also be associated with meniscus lesions which should be ruled out. Chondromalacia patellae tests should be performed and may reveal patellar chondropathy caused or aggravated by a symptomatic plica. Arthroscopy is the diagnostic "gold standard" yet MRI or dynamic ultrasound is often performed to confirm the presence of a plica prior to arthroscopy.

Note: There are no signs or symptoms that are pathognomonic of a symptomatic synovial plica (Reid 1992).

POSTERIOR DRAWER (NEUTRAL)

PCL Tear
- ✓ **Posterior Drawer Test**
- • **Posterior Sag Sign**

Click here for video

Indication: The patient presents with a history of knee trauma followed by apprehension, knee pain, swelling, giving way when performing certain knee movements *especially* when ambulating on uneven surfaces or during changes of direction. Common sequelae include meniscus tears, chondromalacia and premature osteoarthropathy.

Procedure: The patient and examiner are in the same position as described for the anterior drawer test. After placing the tibia in translation-neutral, the posterior drawer test follows the anterior drawer test. Push firmly on the upper leg (tibia) in a posterior direction. Option: If the knee feels stable while pushing slowly, the practitioner can introduce faster push and pulls to see if the ligament is sensitive to dynamic loading.

Active Anterior and Posterior Drawer Test – The patient is supine or sitting with the knee flexed 90° and foot fixed to the table or ground. (The examiner can assist with foot fixation, if necessary). The patient is instructed to tighten the quadriceps isometrically (push heel forward into table/floor), then tighten the hamstrings (pull heel backwards into table/floor). This is repeated several times by alternating quadriceps and hamstring contractions with the foot remaining fixed and unmoving.

Common Procedural Errors – Failure to visualize sag sign and reposition the tibia to "translation neutral" prior to performing the test. "Translation-neutral" can be obtained by aligning the sagging tibia with the normal tibia (viewed from the side) before applying anterior and posterior translational stress. Failure to provide sufficient force on the knee (it should be loaded with the examiner's body weight). It is important that the patient remain relaxed during the procedure.

Interpretation: Pain with posterior translation of the tibia indicates a **posterior cruciate sprain**, whereas excessive posterior translation or empty end feel (lack of distinct ligamentous end point) suggests a complete tear of the PCL.

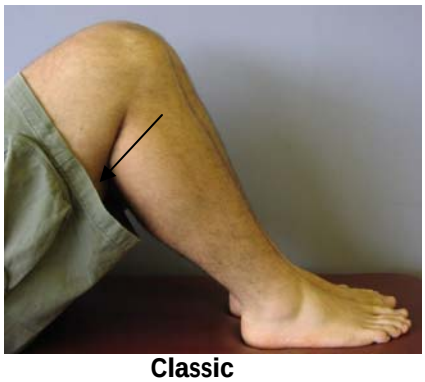
Reliability & Validity: This is a good, quick cruciate screening test when combined with the posterior sag sign. Numerous studies of the posterior drawer test have been done with sensitivity ranging from 51-100%. All but one are of low quality or flawed (Malanga, 2003). In a blinded RCT (Rubinstein 1994) of 18 patients with 19 chronic PCL tears (controls included 12 normals and 9 with ACL tears) the posterior drawer test was the most accurate of 8 tests with 90% sensitivity, 99 % specificity, +LR 90, -LR 0.1, and 96% accuracy and was more accurate than the KT-1000 arthrometer. Patients were examined by experienced orthopedic surgeons with fellowship training in sports medicine; however, the validity is unknown when less experienced examiners perform the test and also note that the accuracy of this test is questionable in acute PCL tears. The Rubinstein study also found that inter-examiner reliability regarding the severity/grade of PCL tear was high with 81% agreement among the 5 examiners, and concluded that a thorough clinical examination along with a patient history can be considered diagnostic of PCL injuries.

Follow-up Testing: Tests to rule out ACL tear as it presents with similar signs and symptoms. Confirmation of an ACL tear can be made by MRI or referral for arthroscopic assessment.

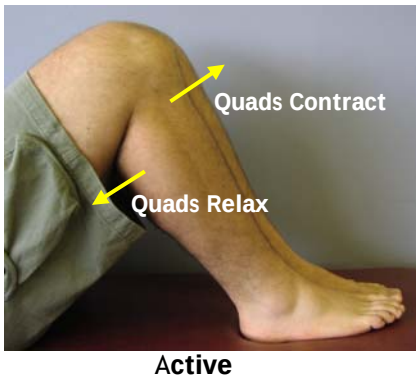
POSTERIOR SAG SIGN

PCL Tear
- **Posterior Drawer Test**
- ✓ **Posterior Sag Sign**

Click here for video



Classic



Active

NO video available.

Indication: The patient presents with a history of knee trauma (e.g., falling on a flexed knee, impact to anterior tibia) followed by knee pain, swelling, and symptoms of knee instability.

Procedure: When the patient is supine with the knee flexed, gravity will often cause the tibia to "sag" posterior when there is a complete tear of the posterior cruciate ligament. The posterior sag sign can best be observed from the side by comparing the involved leg to the normal side, while the patient is supine with both knees bent and feet side-by-side on the table (like Allis' Test/Sign). Active Sag Sign: The patient isometrically contracts and relaxes the quadriceps, causing visible movement as the tibia reduces back to neutral and sags posterior (similar to the active drawer).

Common Procedural Errors: Feet are not evenly aligned. Practitioner fails to check for a posterior sag sign before performing an anterior drawer sign and erroneously interprets excessive anterior translation as positive for an ACL tear rather than re-positioning a PCL tear.

Interpretation: The presence of the sag sign suggests a **posterior cruciate tear**. This may confuse the anterior/posterior drawers and Lachman's test results. For instance, this posterior sagging will produce excessive anterior translation on Lachman's and anterior drawer tests if the tibia is not first moved to translation-neutral before starting.

Reliability & Validity: In a double blind RCT involving the evaluation of 75 knees by Rubenstein, et al. (1994) the sensitivity of the posterior sag sign/test was 79% and specificity was 100%.

Follow-up Testing: Tests to rule out ACL tear as it presents with similar signs and symptoms.

RECURVATUM TEST

Anatomical Comparison

- **Standing observation**
- **Palpation and inspection**
- ✓ **Recurvatum test**
- **Other screening test**
- **Joint play maneuvers**

Click here for video

Indication: The patient presents with knee pain; this is a screening test that that should be performed early during orthopedic testing.

Procedure: The test starts with the patient supine, knees extended and the legs together. Stand at the foot of the table and lift both legs by the heels while holding the feet together. Observe the lower extremity for asymmetry.

Common Procedural Errors: Improper alignment of spine, lower limbs.

Interpretation: The test is intended to identify **excessive hyperextension** (i.e., recurvatum) of the knee(s). Back bending of the knees normally can reach 7˚and females typically have more extension ROM than males. Ideally, it is expected that the knees extend symmetrically. When the knee(s) hyperextend beyond 7˚or when one knee extends more than the other it should be documented. When unilateral excessive hyperextension of an injured knee is seen on this test it may indicate **capsular and ligamentous damage (e.g., posterior cruciate tear**), and **instability** should be suspected. When both knees demonstrate recurvatum in excess of 7˚in the absence of trauma it usually represents **hypermobility due to flexibility** and may be of no concern. Note that during this test other valuable anatomical information can be obtained through observation. This presents an excellent opportunity to compare the symmetry, shape, size and design of the feet (i.e., arches), ankles, legs (i.e., tibia varum), patella (i.e., lateral, alta, baja), genu varum/valgum, quadriceps (especially VMO development), femur and hip (i.e., anteversion & retroversion), leg length, less than normal extension, and any other notable anatomical abnormality.

Reliability & Validity: Unknown

Follow-up Testing: Tests for meniscus tears when knee fails to fully extend and/or joint like pain occurs at the end ROM of extension.

RENNE'S TEST

ITB Syndrome
- **Nobel's**
- **Ober's**
- ✓ **Renne's**

Part 1: Palpate

Click here for video

Part 2: Compress

Indication: This test can be performed instead of or in addition to the Noble Compression Test when the patient complains of lateral knee pain and sometimes crepitus when running.

Procedure: The patient is standing while weight bearing on the involved side. This can be performed with the non-involved side weight bearing or non-weight bearing knee flexed. Part 1: Patient sits or kneels while you palpate the iliotibial band (ITB) on or just above the lateral femoral epicondyle. The patient is instructed to place one hand on the examiner's shoulder for balance and slowly squat (one legged) to 60-90° flexion and then rise back up. First palpate the ITB just above the lateral femoral epicondyle, Part 2: Then have the patient squat and rise a second time while this time applying firm pressure (Renne 1975, Linenger 1992).

Common Procedural Errors: Examiner does not instruct patient to place hand on examiners shoulder to maintain balance. Those with balance problems or who are unable to perform a squat on one leg can perform the test with both lower limbs bearing weight - be careful to watch out for compensation where the patient shifts most of their weight to the opposite side.

Interpretation: Palpation in part 1 is intended to feel for crepitus. Palpatory crepitus, snapping &/or pain at the lateral epicondyle are positive signs of **ITB syndrome**. Firm pressure during part 2 is intended to provoke the lateral knee pain and increase crepitus.

Reliability & Validity: Unknown

Follow-up Testing: May correlate with the non-weight bearing version of the test (Noble's test). Perform Ober's or modified Ober's test to assess for ITB tightness. Palpate lateral joint line and perform other meniscus tests to rule out meniscus lesion.

SLOCUM'S TESTS (MODIFIED)

Click here for video

Rotational Instability
- ✓ **Slocum's tests**
- • **Pivot Shift test**
  (Anterolateral Instability)

Indication: The patient presents with history of trauma with an accompanying painful popping sensation followed by swelling; or, when chronic, the patient complains of apprehension, giving way, or locking when ambulatory on uneven ground, performing certain movements or changes of directions.

Procedure: These two procedures (Magee 2002) are the same as the anterior drawer test, but with the tibia almost fully externally rotated (~15˚) and almost fully internally rotated (~30˚). Note that the test was originally described with the patient in a side-lying position.

Common Procedural Errors: The two procedures are performed with the knee rotated at end ROM.

Interpretation: Excessive anterior translation of the medial tibial condyle when the tibia is *externally rotated* suggests **anteromedial rotational instability** due to **injury to the anterior cruciate (ACL)** and **medial capsular complex** (**medial capsule, medial collateral ligament**, **oblique popliteal ligament**, and **semimembranosus tendon**).

When the anterior drawer test is performed with the tibia *internally rotated*, it stresses the ACL and lateral capsular complex (**lateral capsule, lateral collateral ligament, ITB, arcuate ligament, biceps tendon,** and **popliteus**). Excessive anterior translation of the lateral tibial condyle when the tibia is internally rotated suggests **anterolateral rotational instability**.

Reliability & Validity: Unknown

Follow-up Testing: Other tests for ACL; posterior sag sign to rule out PCL tear. When anterolateral or anteromedial rotational instability is suspected, the MCL and LCL integrity should also be evaluated using valgus stress, varus stress, and wobble tests.

STEINMAN'S TEST

Click here for video

Meniscus Tears

- **Apley compression**
- **Ege's**
- **Hyperflexion**
- **Joint line tenderness**
- **McMurray's**
- **Payr's**
- ✓ **Steinman's**
- **Thessaly**

FLEXION (pain migrates posterior)

EXTENSION (pain migrates anterior)

Indication: The patient complains of localized joint line pain, possibly associated with swelling, locking, crepitus or sometimes giving way. Suspected internal derangement (e.g., meniscus or cruciate lesion).

Procedure: The patient is sitting. The knee is actively or passively flexed and extended. You can palpate the joint lines during the test. The patient reports the location of any pain provoked.

Interpretation: Pain will migrate anterior during extension or posterior during flexion depending on the location of the **meniscus lesion**. The examiner may also feel crepitus.

Reliability & Validity: A +LR of 7.5 and -LR of 0.03 was reported when any two of the following 6 tests were positive (based on a small study on athletes): Tenderness to palpation of joint line + Bohler test + **Steinmann test** + Apley's grinding test + Payr test + McMurray's test (Muellner 1997).

Follow-up Testing: Correlate with other meniscus tests. In the case of trauma, rule out "unhappy triad" (i.e., ACL and MCL/LCL tears). Confirmation of a meniscus diagnosis can be made by MRI or referral for arthroscopic assessment. Wilson's test should be performed on adolescent patients to rule out osteochondritis dissecans. Also perform plica tests to rule out symptomatic plica.

STEP-UP/ STEP-UP BENCH TEST

Chondromalacia patellae
- ✓ **Step-Up Bench Test**
- **Clarke's test**
- **Patellar pinch test**
- **Patellar grind test**
- **Waldron's test**

Click here for video

Indication: Patients with chondromalacia patellae often complain of pain and grinding while ascending and descending stairs. The step-up bench test is intended to reproduce these symptoms.

Procedure: The patient is instructed to stand facing a stable adjusting bench or stool that is approximately at the level of the patient's kneecaps (but at least 10 inches high). Sit or kneel at the side of the patient with one hand palpating the symptomatic knee cap. The patient is instructed to place his/her ipsilateral hand on your shoulder only for balance (the patient should not push off of your shoulder to help step up or step down), place his/her ipsilateral foot on the bench top, and then slowly step up and down from the table. This may be repeated several times on each side for comparison.

Common Procedural Errors: Examiner fails to stabilize patients to prevent loss of balance. The bench or stool is not high enough to provoke the symptoms.

Mechanism: The step-up test produces a large compressive load on the patellofemoral articular surfaces often exceeding 3 times the patient's body weight.

Interpretation: Retropatellar pain and crepitus, a painful grinding sensation, or a painful catch is recorded as a positive sign for **chondromalacia patellae or other patellar pathology**. Minor crepitus without pain is inconclusive and often occurs in normal asymptomatic knees. On the other hand, extreme grinding and grating should be further evaluated in patients with reoccurring chronic knee pain and/or swelling, even when non-painful at the time of testing. Pain located just inferior to the patellar may indicate **"jumper's knee."**

Reliability & Validity: Unknown

Follow-up Testing: Perform other tests to confirm chondromalacia patellae (Clarke's test, patellar facet pinch test, step up bench test and tests to rule out symptomatic plicae (plica stutter test, plica pinch test, Hughston's test). In addition, screen for contributing factors related to poor patellar tracking (e.g. tight ITB, weak VMO, pronation syndrome, inhibited hip abductors). Special imaging may be necessary to evaluate the extent of articular damage in severe or chronic cases or when conservative therapy fails.

THESSALY TEST (Single Leg Twist)

Meniscus Tears

- **Apley compression**
- **Ege's**
- **Hyperflexion**
- **Joint line tenderness**
- **McMurray's**
- **Payr's**
- **Steinman's**
- ✓ **Thessaly**

Click here for video

Indication: The patient complains of localized joint line pain, possibly associated with swelling, locking or sometimes giving way. Suspected internal derangement (e.g., meniscus or cruciate lesion).

Procedure: The test can be performed in 2 positions starting with the uninjured knee. The patient stands on one leg with the other knee bent ~90° while holding your hands for balance. The 1st position is with the weight bearing knee flexed ~5°, and the 2nd position with the knee flexed ~20°. In both positions the patient is asked to twist back and forth on the weight bearing foot. NOTE: Though the accuracy of the test probably is higher @ 20°, there is a greater risk of further damage to the menisci; therefore the test should first be done with the knee 5° flexed and followed by the test at 20° only when the 1st test is equivocal.

Common Procedural Errors: Performing the test immediately at 20°without first performing it at 5°. The examiner does not help the patient balance through the test. The examiner does not clearly ascertain that the pain is felt in the *joint line* as opposed to another structure such as the fibula or a collateral ligmanet.

Mechanism: Twisting on a weightbearing lower limb grinds and stresses the menisci and articular surfaces.

Interpretation: The test is positive for **meniscus tear** with localized pain in either the lateral or medial joint lines. Pain occurring with just the flexion phase of the test may suggest a **patellofemoral problem**.

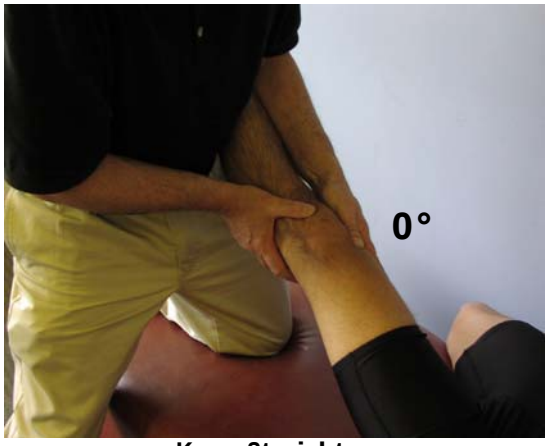
Reliability & Validity: At 5° the sensitivity/specificity for lateral meniscus tears has been reported to be 81%/91% and for medial meniscus tears 66%/96%. At 20° flexed the sensitivity/specificity for lateral meniscus tears was 92%/96%, and for medial meniscus tears 89%/97% (Karachalios 2005). The applicability of these findings are questionable because the validity of this test has not been assessed in a primary care setting and because a smaller study, without controls and few normal knees, reported a less favorable +LR 2 and -LR 0.6 - sensitivity 59% and specificity 67% (Konan 2009).

Follow-up Testing: Correlate with other meniscus tests. In the case of trauma, rule out "unhappy triad" (i.e., ACL and MCL tears). Confirmation of a meniscus diagnosis can be made by MRI or referral for arthroscopic assessment. Consider Wilson's test to rule out osteochondritis dissecans in adolescent patients. Also perform tests to rule out symptomatic plica.

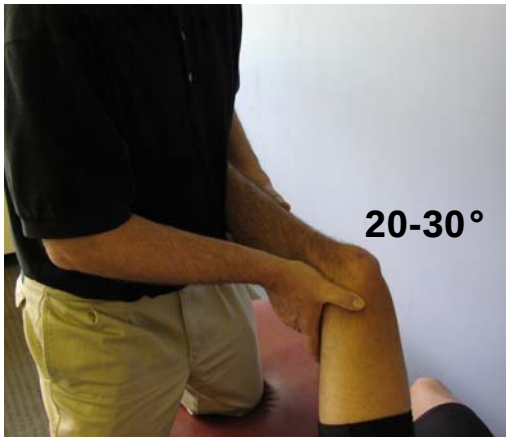
VALGUS STRESS TEST

Click here for video

Collateral Ligament Sprain
- Apley's distraction
- ✓ Valgus Stress Test
- Varus Stress Test
- Wobble Test



Knee Straight



Knee Bent

Indication: Acute knee trauma and medial knee pain and/or swelling.

Procedure: With the patient supine, stand at the same side to be tested and face cephalad. Grip the patient's ankle with one hand and place the other hand to the lateral aspect of the knee. With the patient's hip at 0-30° flexed and knee fully extended, apply a valgus force. Maintaining the hip at the same angle, repeat with the knee flexed 20°-30°. An option is to perform the test while maintaining the tibia is in an externally rotated position.

Common Procedural Errors: Not performing valgus stress in at least 2 positions.

Mechanism: Valgus or abduction stress gaps medial joint line and increases tension on MCL and medial joint capsule.

Interpretation: Pain over the ligament without excessive motion suggests a **grade 1 sprain.** Excessive valgus motion suggests a **grade 2-3 sprain**. Empty end feel (sometimes with less than expected pain) suggests a complete rupture of the lateral collateral ligament and other members of the lateral capsular complex.

Positive test at 0°: Excessive gapping of the medial joint line when the knee is fully extended indicates a grade 2 sprain and/or hypermobility (5-8mm gap) or a grade 3 sprain and/or instability (8mm gap). Significant gapping is rarely associated with an **isolated collateral ligament rupture** and more extensive tissue damage should be expected.

Positive test at 20-30°: Normally, there is more play (or "slop") in the joint when tested in this position. Excessive valgus joint play with a *ligamentous* endpoint when combined with normal valgus joint play when the knee is extended indicates a **mild (grade 1) to moderate (grade 2) medial capsular/collateral ligament sprain**. A complete rupture should be suspected when there is no firm capsular endpoint.

Knee pain may vary depending on the injured structure (Magee, 2002). For example, *lateral* knee pain during the valgus stress test may **indicate lateral meniscus pathology** (+ Bohler's Test), damage to the lateral articular surface, or fracture of the lateral tibial or femoral condyles.

Reliability & Validity: Though the accuracy of this test is not well defined in clinical studies, it is considered by many to be the best orthopedic test choice when performed at 30° with the tibia externally rotated (Lubowitz 2008). In two low quality studies sensitivity of the test at 30° ranged from 86-96% and specificity was not reported. Logerstedt (2010) reports a +LR 2.3 (95%CI 1.7-2.2) and -LR 0.3 (0.2-0.6) for pain; for laxity a lower +LR 1.8 (95% CI 1.4-2.2) but a similar -LR 0.2 (95% CI 01-0.6). In a single study by McClure, et al. (1989) inter-examiner reliability was reported as 68% when the knee was extended and 56% when the knee was at 30° (Malanga 2003).

Follow-up Testing: Accurate estimation of the grade/degree of valgus instability may be difficult to ascertain without stress radiography. Wobble test may provide more information.

VARUS STRESS TEST

Click here for video

Collateral Ligament Sprain
- **Apley's distraction**
- ✓ **Varus Stress Test**
- **Valgus Stress Test**
- **Wobble Test**


Knee Straight


Knee Bent

Indication: Acute knee trauma and medial knee pain and/or swelling.

Procedure: With the patient supine, stand on the opposite side to be tested. (It is also acceptable to perform the test while standing on the same side facing caudad). Grip the patient's ankle with one hand and with the other hand contact the medial aspect of the knee. With the patient's hip at 0-30° flexion and knee fully extended, apply a varus force at the knee. This is repeated with the knee flexed 20-30° (Magee 2002, Logerstedt 2010).

Common Procedural Errors: Not performing test in at least 2 positions.

Mechanism: Varus or abduction stress gaps lateral joint line and increases tension on the LCL and lateral joint capsule.

Interpretation: Findings are much the same as the valgus stress (See Valgus Stress Test), except that the varus stress test provokes/stretches the **lateral capsule** or **lateral collateral ligament** (thus causing lateral knee pain and/or gapping). If increased instability is noted with the knee flexed 30° suspect popliteofibular ligament involvement along with the LCL.

Note that medial joint line pain during varus stress testing suggests medial meniscus pathology (+ Bohler's test), O.C.D. of the medial femoral condyle, or fracture of the medial femoral or tibial condyles. Similar to Wilson's test, the varus stress of the flexed knee, when maintained in internal rotation, aggravates knee pain in O.C.D., whereas the same test with tibia externally rotated provides some relief of the knee pain. Furthermore, the valgus and varus stress tests may exacerbate pain associated with lesions of the articular surfaces.

Reliability & Validity: There is little evidence regarding the accuracy of this test in the literature; however, in one small study only 1 of 4 patients in an emergency room setting with LCL tears confirmed by arthroscopy were identified on the varus stress test performed with the knee flexed at 30° (Malanga 2003, Lubowitz 2008).

Follow-up Testing: Wobble test may provide more information.

WALDRON'S

Patellofemoral Pain/Syndrome

- ✓ **Waldron's test**
- **Step-up Bench test**
- **Chondromalacia tests**
- **Plica tests**

Click here for video

Indication: The patient presents with anterior knee pain, and/or difficulty walking or running up and down hills or stairs, and/or grinding sensation.

Procedure: The patient stands with feet separated approximately 12". While you palpate the patella they perform several slow deep squats (to about 90° if possible). If both knees are involved, perform the test on both sides; otherwise, use the opposite side for comparison (Magee 2002).

Common Procedural Errors: Failure to palpate the patella during the test. Failure to stabilize the patient to protect against loss of balance. Be sure to position the patient so that a table or other object does not impede the patient's ability to perform a full 90° squat.

Mechanism: Squatting produces a great deal of stress on the patella, patellofemoral articular surfaces, infrapatellar tendon, quadriceps tendon, and quadriceps muscle; this may produce knee pain or the patient may be unable to squat to 90° because of weakness. This may also provoke other conditions in addition to patellofemoral pain.

Interpretation: This is a general screening procedure much like the step-up test intended to identify **patellofemoral causes** of knee pain. Observation may reveal an inability or difficulty in completing a 90° squat, and abnormal compensatory movements or abnormal patellar tracking should be noted. Anterior knee pain and audible or palpable crepitus during the procedure is positive for **patellofemoral pain syndrome** including related conditions such as **jumpers knee, chondromalacia patella** and **symptomatic plica**. The test may also reveal quadriceps weakness and patellar tracking dysfunction.

Reliability & Validity: Unknown

Follow-up Testing: Step up bench test, resisted quadriceps muscle testing, plica tests, and chondromalacia tests to further evaluate the cause of the anterior knee symptoms. When clicking or crepitus is difficult to localize, meniscus and iliotibial band tests should be performed to rue in or rule out non-patellofemoral causes. When osteoarthropathy or chondromalacia is suspected, special imaging may be necessary to definitively support the diagnosis.

WILSON'S TEST/SIGN

Osteochondritis Dissecans

- ✓ **Wilson's Test**
- **Varus stress test (with tibia internally & externally rotated)**

Click here for video

Indication: An adolescent presents with a limp, medial and/or popliteal pain often without history of trauma. Joint effusion and/or joint locking may accompany the knee pain.

Procedure: The patient is supine or sitting with knees flexed 90° and dangling over the edge of the table. Instruct the patient to first extend his knee with the tibia in full *internal* rotation. Observe and/or gently palpate the popliteal fossa and medial joint line. Then instruct the patient to repeat the motion with the tibia in full *external* rotation.

Common Procedural Errors: Failure to repeat test with tibia rotated internally. Failure to palpate the medial joint line or popliteal fossa.

Mechanism: Flexing and extending knee with the tibia internally rotated increases pressure on the medial femoral condyle while moving the knee with the tibia externally rotated lessens the pressure.

Interpretation: Pain, catching and/or apprehension during extension (most often at approximately 30° flexion) suggests **osteochondritis dissecans.** The test is then repeated with the patient's tibia externally rotated. If the patient's pain, which is typically in the medial joint line or deep in the posteromedial popliteal fossa, is relieved, it suggests osteochondritis dissecans (OCD). In patients over 16 years old OCD or a **meniscus** may be present.

Reliability & Validity: This well-known test first described in 1967 (Wilson 1967) is frequently described as a test for OCD in the literature, but there is little evidence regarding its reliability and validity. The lead author was only able to find one study that reported that 75% of 32 patients with medial femoral condyle OCD had a negative test result (Conrad 2003).

Follow-up Testing: In the case of young patients (under age 16) with recurrent knee swelling, pain, or catching with a positive Wilson's Test, suggesting OCD, consider ordering radiographic evaluation or bone scan of the knee (A.P., lateral, and tunnel views). Tunnel or notch views are especially important because of the enhanced visibility of the intercondylar notch and its borders (the most common site in the body for OCD is the lateral aspect of the medial femoral condyle bordering the intercondylar notch). Finally, note that a symptomatic plica may mimic OCD and should be carefully evaluated for this possibility before ordering expensive and invasive tests that do not show soft tissue. Meniscus tests may also provoke the lesion on the medial femoral condyle. Therefore, MRI is now a routine part of the diagnostic evaluation in patients with suspected OCD (Kocher 2006).

WOBBLE TEST (AKA Palmer's Test)

Photo and video pending

Collateral Ligament Instability
- **Apley's distraction**
- **Valgus Stress Test**
- **Varus Stress Test**
- ✓ **Wobble Test**

Indication: The patient presents with knee pain and suspected instability.

Procedure: The patient is supine with hip flexed 30-45°. Stand at the side of the patient while grasping the patient's knee with both hands and pin the patient's leg between your arm and side. If possible, with your thumbs or fingertips palpate medial and lateral joint lines for gapping and tenderness. Next rapidly alternate valgus and varus stress, starting with the knee flexed ~ 30°, and slowly extending. The procedure is repeated several times to better evaluate the stability of the joint and joint play unless there is significant pain or apprehension when initially performed.

Common Procedural Errors: Not moving the knee back and forth rapidly enough in valgus-varus directions. Applying too much pressure into varus and valgus---this involves rapid low force movements. This is primarily a provocative joint play maneuver rather than a stress test.

Interpretation: This is repeated several times flexing and extending the knee back and forth. This maneuver can often give the examiner a better sense of valgus-varus gapping in more subtle forms of hypermobility. Normally, there is no or very slight valgus-varus gapping ("slop") when the knee is fully extended, which increases as the knee is flexed. Normally slight "clunking" may be felt during this test as the knee is flexed. It is important to compare the involved knee to the normal knee for symmetry. Pain, apprehension and/or excessive gapping/clunking suggest **sprain and/or ligamentous laxity**.

Decreased valgus/varus gapping suggests capsular contracture or joint fixation.

Reliability & Validity: Studies of the reliability or validity of this test were not found by the lead author.

Follow-up Testing: Valgus or varus stress testing. Meniscus tests when meniscus pathology is suspected.

This test is unique to the lead author and UWS, but is patterned after a test ("Palmer's Test") described by I. Palmer in 1938 (Malanga 2003).

AUTHOR: Mike Carnes, MS, DC & Ron LeFebvre, MA,DC

Reviewed and Adopted by CSPE Committee

- Daniel DeLapp, DC, DABCO, LAc, ND
- Shawn Hatch, DC, DACBSP
- Lorraine Ginter, DC
- Owen T. Lynch, DC
- Aaron Montgomery, DC
- Ryan Ondick, DC
- Anita Roberts, DC
- James Strange, DC
- Laurel Yancey, DC

References

Ahmad CS, et al. The moving patellar apprehension test for lateral patellar instability. Am J Sports Med 2009;32(4):791-796.

Akseki D, et al. A new weight-bearing meniscal test and a comparison with McMurray's test and joint line tenderness. J Arth Rel Surg 2004;20(9):951-958.
Am J Sports Med 2008;26(3):577-594.

Amatuzzi MM, et al. Pathological synovial plica of the knee: Results of conservative treatment. Am J Sports Med 1990;18(5):466-469.

Apley A. The diagnosis of meniscus injuries: some new clinical methods. J Bone Jnt Surg 1947; 2Br:7-84.

Bach BR, et al. The pivot shift phenomenon: Results and description of a modified clinical test for anterior ligament insufficiency. Am J Sports Med 1988;16(6):571-576.

Calvo RD, et al. Managing plica syndrome of the knee. Phys & Sports Med 1990;18(7):64-74.

Chivers MD and Howitt SD. Anatomy and physical examination of the knee menisci: A narrative review of the orthopedic literature. J Can Chiro Assoc 2009;53(4):319-333.

Cleland JA, Koppenhaver S. Netter's orthopaedic clinical examination, an evidence-based approach, 2nd Edition. Philadelphia PA: Saunders;2011:283-334.

Conrad JM and Stanitski CL. Osteochondritis dissecans, Wilson's sign revisited. Am J Sports Med 2003; 31:777-778.

Cook C, et al. Best tests/clinical findings for screening of patellofemoral pain syndrome: A systematic review. Physiother 2012;98:93-100.

Cook C, et al. Diagnostic accuracy and association to disability of clinical test finding associated with patellofemoral pain syndrome. Physiother Canada 2010;62:17-24.

Daniel DM, et al. Use of the quadriceps active test to diagnose posterior cruciate-ligament disruption and measure posterior laxity of the knee. J Bone Jnt Surg 1988;70A(3):386-391.

DeHaven KE, et al. Chondromalacia patellae and the painful knee. Am Fam Physician 1980;21:117-124.

Doberstein ST, et al. Validity of Clarks sign in assessing anterior knee pain. Gunderson Lutheran Med Journal 2005;3(2):51-53.

Doberstein ST, Romeyn RL, Reineke DM. J Athletic Training 2008;43(2):190-196.

Donaldson WF, et al. SA comparison of acute anterior cruciate examinations. Initial versus examination under anesthesia. Am J Sports Med 1985;13(1):5-10.

Eren OT. The accuracy of joint line tenderness by physical examination in the diagnosis of meniscal tears. Arthroscopy (abstract) 2003;19(8):850-854.

Evans PJ, et al. Prospective evaluation of McMurray test. Am J. Sports Med 1993;21(4):604-608.

Evans RC. Illustrated Essentials in Orthopedic Physical Assessment Mosby-Year Book, Inc. 1994.

Fowler PD and Lubliner JA. The predictive value of fine clinical signs in evaluation of meniscal pathology. Arthroscopy 1989;5:184-186.

Gajdosik RL, et al. Influences of knee positions and gender on the Ober test for length of the iliotibial band. Clin Biomech 2003;18:77-79.

Haim A, et al. Patellofemoral pain syndrome: Validity of clinical and radiological features. Clin Orthop & Rel Res 2006;451:223-228.

Hardaker WT, et al. Diagnosis and treatment of the plica syndrome of the knee. J Bone Jnt Surg 1980; 62A(2):221-225.

Hededus EJ, Cook C, Hasselblad V, Goode A. McCrory DC. Physical examination tests for assessing a torn meniscus in the knee: a systematic review with meta-analysis. J Orthop Sports Phys Ther 2007;39(9):541-550.

Hertling D and Kessler RM. Management of Common Musculoskeletal Disorders: Physical Therapy Principles and Methods (2nd ed.) Lippincott, 1990.

Hing W, et al. Validity of the McMurray's Test and modified versions of the test: A systematic literature review. J Manual & Manip Therapy 2009;17(1):22-34.

Hoppenfeld S. Physical Examination of the Spine and Extremities. Appleton-Century-Crofts, 1976.

Hudson Z and Darthuy E. Iliotibial band tightness and patellofemoral pain syndromes: A case control study. Manual Ther 2009;14(20):147-151.
Hughston JC. The absent posterior drawer test in some acute posterior cruciate ligament tears of the knee. Am J Sports Med 1988;16(1):39-43.
Johnson DP, et al. Symptomatic synovial plicae of the knee. J Bone Jnt Surg 1993;75A(10):1485-1496.
Karachalios T, et al. Diagnostic accuracy of a new clinical test (The Thessaly Test) for early detection of meniscal tears. J Bone Jnt Surg 2005;87A(5):955-962.
Kendall FP, et al. Muscles Testing and Function with Posture and Pain (5th ed.) Lippincott Williams & Wilkins, 2005.
Kocher MS, et al. Management of Osteochondritis dissecans of the knee: Current concepts review. Am J Sports Med 2006;24(7):1181-1191.
Konan S, Rayan F, Haddad FS. Do physical diagnostic tests accurately detect meniscal tears? Surg Sports Traumatol Arthrosc 2009;17:806-811.
Lancaster AR, et al. The validity of the motion palpation test for determining patellofemoral joint articular damage. Phys Ther 2007.
Linenger JM and Christensen CP. Is Iliotibial Band Syndrome often overlooked? Phys Sports Med 1992, 20(2):98-108.
Logerstedt DS, Snyder-Mackler L, Ritter RC, Axe MJ, Godges JJ. Knee stability and movement coordination impairments: knee ligament sprain. J Orthop Sports Phys Ther 2010;40(4):A1-A37.
Lubowitz JH, et al. Comprehensive physical examination for instability of the knee. Am J Sports Med 2008;36(3):577-594.
Magee D. Orthopedic Physical Assessment (4th ed.) Saunders, 2002.
Malanga GA, et al. Physical examination of the knee: A review of the original test description and scientific validity of common orthopedic tests. Arch Phys Med and Rehab 2003;84(4):592-603.
Mariani PP, et al. A prospective evaluation of a test for lateral meniscus tears. Knee Surg Sports Traumatol Arthroscopy 1996;4:22-26.
Markolf KL et, al. Measurement of knee stiffness and laxity in patients with documented absence of anterior cruciate ligament. J Bone Jnt Surg 1984;66A(2):242-253.
McClure PW, et al. Intertester reliability of clinical judgments of medial knee ligament integrity. Phys Ther 1989;69:268-275.
Mital MA and Hayden J. Pain in the knee in children: The medial plica shelf syndrome. Orthop Clin N America 1979;10:718-722.
Muellner T, et al. The diagnosis of meniscal tears in athletes: A comparison of clinical and magnetic resonance imaging investigations. Am J Sports Med 1997;25(1):7-12.
Mullendore ST, et al. Better anterior drawer test. Phys Sports Med 2005;33(4):7.
Mulligan ED, et al. Reliability and diagnostic accuracy of the Lachman Test performed in a prone position. J Orthop & Spors Phys Therapy 2011;41(10):749-757.
Nijs J, et al. Diagnostic value of fine clinical tests in patellofemoral pain syndrome. Man Ther 2006;11:69-77.
Noble H, et al. Diagnosis and treatment of iliotibial band tightness in runners. The Phys Sports Med 1982;10(4):67-74.
Noyes FR, Cummings JF, et al. The diagnosis of knee motion limits, subluxations, and ligament injury. Am J Sports Med 1991;19(2):163-171.
Noyes FR, Grood ES, et al. Analysis of the pivot shift phenomenon: The knee motions and subluxations induced by different examiners. Am J Sports Med 1991;19(2):148-155.
O'Shea KJ, et al. The diagnostic accuracy of history, physical examination, and radiographs in the evaluation of traumatic knee disorders. Am J Sports Med 1996;24(2)2:164-167.
Ober FR. The role of the iliotibial band and fascia as a factor in the causation of low-back disabilities and sciatica. J Bone Int Surg;18:105-110.
Ogata K, et al. Pathomechanics of posterior sag sign of the tibia in posterior cruciate deficient knees: An experimental study. Am J Sports Med 1988;16(6):630-636.
Ostrowski JA. Accuracy of 3 diagnostic tests for anterior cruciate ligament tears. J Athletic Training 2006;4(1):120-121.

Pihlajamaki HK, et al. Reliability of clinical findings and magnetic resonance imaging for the diagnosis of chondromalacia patellae. J Bone Jnt Surg 2010;92A(4):927-934.
Reese NB, Bandy WD. Use of an inclinometer to measure flexibility of the iliotibial band using the Ober Test and the Modified Ober Test: Differences in magnitude and reliability of measurements. JOSPT 2003;33(6):326-30.
Reid D. Sports Injury Assessment and Rehabilitation. Churchill Livingston, 1992.
Renne J. The iliotibial band friction syndrome. J Bone Jnt Surg 1975;37A(8):1110-1111.
Rose REC. The accuracy of joint line tenderness in the diagnosis of meniscal tears. West Indian Med J 2006;55(5):1.
Rossi R, et al. Clinical examination of the knee: Know your tools for diagnosis of knee injuries. Sports Med Arthrosc, Rehab, Therapy & Tech 2011;3:25-34. (www.smartjournal.com/content/3/1/25).
Rubenstein RA Jr, et al. The accuracy of the clinical examination in the setting of posterior cruciate ligament injuries. Am J Sports Med 1994;22(4):550-557.
Sallay PI, et al. Acute dislocation of the patella. A correlative pathoanatomic study. Am J Sports Med 1996;24(1):52-60.
Scholten RJ, et al. Review: Physical diagnostic tests have low diagnostic accuracy for meniscal lesion of the knee. EBM 2002;7:93.
Scholten RJPM, et al. Accuracy of physical diagnostic tests for assessing ruptures of the anterior cruciate ligament: A meta-analysis. J Fam Practice 2003;52(9):689-694.
Shelbourne KD, et al. Correlation of joint line tenderness and meniscal lesions in patients with acute anterior cruciate ligament tears. Am J Sports Med 1995;23(2):166-169.
Simel DL, Rennie D. The Rational Clinical Examination, Evidence-Based Clinical Diagnosis. New York NY:The McGraw-Hill Companies;2009:369-70.
Smith TO, et al. An evaluation of the clinical tests and outcome measures used to assess patellar instability. The Knee 2008;15:255-262.
Smith TO, et al. The intra-and inter-observer reliability of the physical examination methods used to assess patients with patellofemoral joint instability. The Knee 2012;19:404-410.
Smith TO, et al. The reliability and validity of the Q-angle: A systematic review. Knee Surg Sports Traumatol Arthrosc 2008;16:1068-1079.
Tong JS, et al. Clinical diagnosis of anterior cruciate ligament instability in the athlete.
Wilson JN. A diagnostic sign in osteochondritis dissecans of the knee. J Bone Jnt Surg 1967;49A:477-80.
Yoon Y-S, et al. A prospective study of the accuracy of clinical examination evaluated by arthroscopy of the knee. Int'l Orthopaedics 1997;21:223-227.