Physical Examination for Meniscus Tears

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Kevin J. McHale, Min Jung Park, and Fotios Paul Tjoumakaris

Abbreviations

ACL	Anterior cruciate ligament
ER	External rotation
IR	Internal rotation
PCL	Posterior cruciate ligament
LCL	Lateral collateral ligament
MCL	Medial collateral ligament
PLC	Posterolateral corner

Introduction

Meniscus injuries, both from athletic activities and activities of daily living, are a common reason of referral for orthopedic evaluation. With an annual incidence of approximately 61 per 100,000 individuals in the general population, meniscus tears are one of the most common injuries to the knee and should often be included at the top of the differential diagnosis for patients presenting with knee pain [1]. While imaging techniques are playing an increasingly important role in confirming the diagnosis of meniscus injury, physicians must be capable of performing a thorough history and physical examination as it relates to the meniscus to determine when obtaining advanced imaging will be advantageous. This chapter will provide a review of the basic approach to the physical examination of the knee with a particular focus on the evaluation for meniscus tears.

History

Prior to performing the physical examination, it is essential that the physician obtain a focused history to facilitate the identification of a meniscus tear. The history is critical to determining optimal treatment for patients and determining the type of meniscus tear (acute versus chronic/degenerative). In the words of esteemed physician, Sir William Osler, "Listen to your patient, he is telling you the diagnosis," patients with sudden onset of pain in the setting of a twisting injury to the knee are more likely to require further diagnostic testing and, perhaps, surgical intervention. Patients with an insidious onset of pain without preceding injury may have underlying articular cartilage degeneration and joint wear that will more than likely dictate the treatment strategy. Several valuable features of the history include location and character of pain (medial versus lateral joint line), mechanism of injury, ability to bear weight, locking or instability sensations, appreciation of a "pop" at the time of injury, and

K.J. McHale, M.D. (✉) • M.J. Park, M.D., M.M.Sc.
Department of Orthopaedic Surgery, Hospital of the University of Pennsylvania, 3400 Spruce Street, Silverstein 2, Philadelphia, PA 19104, USA
e-mail: Kevin.mchale@uphs.upenn.edu

F.P. Tjoumakaris, M.D.
Department of Orthopaedic Surgery, Jefferson Medical College, Rothman Institute Orthopaedics, Egg Harbor Township, NJ, USA

J.D. Kelly IV (ed.), *Meniscal Injuries: Management and Surgical Techniques*,
DOI 10.1007/978-1-4614-8486-8_2, © Springer Science+Business Media New York 2014

history of previous knee injury. Patients may report pain with directional change during walking, difficulty squatting, as well as pain with ascending or descending stairs. Patients with medial meniscal tears may relate a history of pain when crossing their legs. Similarly, sudden pain localized to the joint-line when catching one's foot on an irregular surface is also indicative of meniscal pathology. While meniscus tears are often associated with mechanical symptoms such as "clicking" or "catching," these symptoms may also be caused by intra-articular loose bodies from chondral injuries or from abnormal patellofemoral mechanics. Patella maltracking is commonly referred to as "pseudolocking" because sudden patella displacement can indeed mimic meniscal symptoms subjectively. A complaint of "locking" with a mechanical block to extension may be associated with a displaced bucket-handle meniscus tear. Degenerative meniscus tears tend to occur in the absence of antecedent trauma in patients older than 40 years of age and are often associated with a history of joint-line pain and swelling with or without mechanical symptoms.

The clinical history also assists with the development of a comprehensive differential diagnosis that includes alternative or additional causes of knee pain. For example, anterior cruciate ligament (ACL) tears are often a result of a noncontact pivoting injury associated with an audible "pop" and immediate onset of pain and swelling. Posterior cruciate ligament (PCL) injuries can be caused by a direct blow to the proximal tibia, such as from a dashboard during a motor vehicle collision. A mechanism of injury that includes a varus or valgus stress to the knee with a resultant sensation of instability may be associated with lateral collateral ligament (LCL) or medial collateral ligament (MCL) injuries, respectively.

When evaluating patients with knee pain, physicians should keep a high clinical suspicion for meniscus injury even after an alternative source of pain has been identified. Meniscus tears often occur in combination with other knee injuries. Approximately one-third of all meniscus tears are associated with ACL injuries [1]. In the setting of an acute ACL tear, lateral meniscus tears occur more frequently than medial meniscus tears. In contrast, medial meniscus injuries are more common in knees with a chronic ACL deficiency due to the role of the posterior horn of the medial meniscus as a secondary restraint to anteroposterior translation. Injuries to the menisci are also common in the setting of multiligament knee injuries as well as tibial plateau and femoral shaft fractures [2]. Treatment of meniscus injuries in this setting is dependent upon the treatment of the ligament disruption or fracture and is typically delayed until the primary issues are addressed.

General Examination

The physical examination always begins with an assessment of height and weight. The patient's body mass index should be calculated as load bearing across the knee joint is affected by body weight and characteristic tears occur in larger framed individuals. For example, degenerative meniscal tears occur in the setting of obesity. Furthermore, women with a high body mass index have a proclivity for meniscal root avulsion. Patients should be offered examination shorts so that assessment of both knees can be performed. These garments should be comfortable and rest above the knee for easy inspection during the examination.

Inspection of the knee begins with evaluation of gait. The knee should smoothly transition through a sequence of motions during the normal gait cycle. During swing phase, the quadriceps contracts to extend the knee and to begin accelerating the lower limb from a flexed position. At midpoint of swing phase, the hamstrings begin to contract to decelerate the lower limb in preparation for heel strike. The knee reaches full extension at heel strike and then remains flexed through the foot flat and midstance portion of the stance phase. Push off then marks the end of stance phase and the start of the next swing phase [3]. Patients with meniscus tears or degenerative changes in the knee often experience pain during the stance phase of gait. Push off can be particularly troublesome for patients with

advanced chondrosis, since the gait phase is where tibiofemoral joint reactive forces peak [4]. These patients tend to ambulate with an antalgic gait, shortening the amount of time spent on the affected extremity during stance phase. Patients with an associated ligamentous injury may also widen their gait to accommodate knee instability [3]. The physician should next evaluate the alignment of the knee joint. The normal knee has a slight valgus alignment with a tibiofemoral angle of approximately 6°. Varus or valgus malalignment of the knee should be noted as it alters normal knee kinematics by shifting the load bearing axis medially or laterally, respectively. Varus malalignment increases stress applied to the medial meniscus while valgus malalignment heightens contact pressure across the lateral meniscus. As a result, medial and lateral meniscus tears have been correlated with varus and valgus malalignment, respectively [5]. Furthermore, alignment promotes meniscal "dependency": that is, a varus knee will have more inherent dependence on the medial meniscus to dissipate load.

When examining the alignment of the knee, the clinician should also assess the quadriceps (Q) angle. The Q angle is the angle between the axis of the extensor mechanism (anterosuperior iliac spine to the mid-patella) and the axis of the patellar tendon (mid-patella to the tibial tubercle) with the knee in extension. The average Q angle is 10° in men and 15° in women. Abnormalities in the Q angle may result in patellar maltracking [6]. Similarly, a "J" sign should be noted, whereupon a quadriceps contraction leads to lateral excursion of the patella in extension. This indicates maltracking due to an excessive Q angle and/or trochlear dysplasia.

Inspection of the knee joint should also include assessment of the skin and muscle tone. Skin abnormalities such as abrasions, lacerations, ecchymosis, and erythema can provide important information regarding the etiology of knee pain. Asymmetry of muscle contours above the knee, particularly atrophy of the quadriceps, may indicate disuse after injury and can help the clinician to determine chronicity.

Palpation of the Knee Joint

The physician should thoroughly palpate the bony and soft tissue structures of the affected and unaffected knees, paying particular attention to areas of focal tenderness and swelling. Palpation of the knee is best performed with the patient lying supine on the examination table to allow for full unrestricted range of motion. The clinician can begin with palpation of the anterior structures of the knee including the quadriceps tendon, patella, and infrapatellar tendon. Any focal tenderness or palpable defects noted during the examination could indicate an injury to the extensor mechanism. When evaluating the anterior structures, the clinician should also note any warmth, erythema, or tenderness overlying the regions of the suprapatellar, prepatellar, or infrapatellar bursas, as they can be significant sources of pain when inflamed secondary to infection or overuse.

After assessment of the anterior knee structures, the physician can address the medial aspect of the knee joint. Careful attention should be paid to the palpation of the medial meniscus at the upper edge of the medial tibial plateau (Fig. 2.1a) and the MCL extending from the medial femoral epicondyle to the medial proximal tibia. Tenderness to palpation along the posterior medial joint line can indicate a medial meniscus tear, MCL injury, or medial compartment osteoarthritis. On the posteromedial aspect of the knee, the sartorius, gracilis, and semitendinosus tendons can be palpated as they cross the knee joint prior to inserting on the anteromedial proximal tibia at the pes anserine bursa, which may become inflamed and cause pain with knee motion [3]. Palpation of the anteromedial joint line relative to the distal femur can also indicate any subtle posterior subluxation of the tibia. Normal tibiofemoral step-off is approximately 10 mm with the tibia being anterior to the femur with the knee at 90° of flexion. Decreased step-off can indicate injury to the posterior cruciate ligament and posterior capsular structures [7]. Anteromedial tenderness may also be present when patella

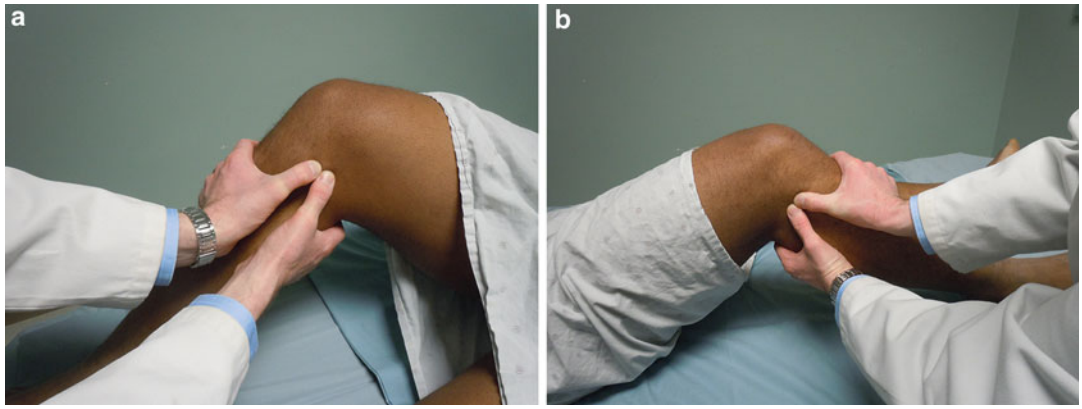


Fig. 2.1 Palpation of the meniscus. (**a**) Palpation of medial meniscus. (**b**) Palpation of lateral meniscus

maltracking is present and may represent fat pad irritation, synovitis, or tension on medial patellofemoral ligaments.

The lateral knee must also be evaluated carefully with palpation. Analogous to the medial aspect of the knee, the lateral meniscus can be palpated at the upper edge of the lateral tibial plateau (Fig. 2.1b) and the LCL can be palpated as it extends from the lateral femoral epicondyle to the fibular head. Tenderness to palpation along the lateral joint line can indicate a lateral meniscus tear, LCL injury, or lateral compartment osteoarthritis. The biceps femoris and iliotibial tract can also be palpated as they cross the knee joint to insert on the fibular head and lateral tibial tubercle, respectively. Palpation of the lateral joint line can be facilitated by placing the knee in a crossed position, or the "figure of four" position. This places a varus moment on the knee, opening up the lateral compartment. The LCL can easily be palpated running from the lateral epicondyle to the fibular head, and posterior to this structure on the joint line is the lateral meniscus body and posterior horn segment. Care must be taken to differentiate joint-line tenderness from popliteus tendonitis (more proximal) or iliotibial friction band syndrome (more proximal).

The final step in the palpation of the knee joint is the assessment for intra-articular effusions. While the absence of indentations adjacent to the infrapatellar tendon implies the presence of a large intra-articular effusion, specific physical examination maneuvers can assist with the detection of more subtle effusions. The first maneuver involves the creation of a fluid wave to detect an effusion. With the knee extended, intra-articular fluid can be milked into the suprapatellar pouch by sliding the hand proximally along the medial aspect of the patella. Next, this fluid can be compressed out of the suprapatellar pouch by sliding the hand distally along the lateral aspect of the patella. A fluid bulge can be seen medial to the patella with this lateral compression in the presence of an intra-articular effusion. Another maneuver to detect an effusion involves the ballottement of the patella in the presence of an effusion. One hand is used to compress fluid from the suprapatellar pouch to beneath the patella while the second hand squeezes fluid from the inferior aspect of the joint to beneath the patella. A finger can then be used to depress the patella, which will feel as if it is bouncing on the underlying effusion [8].

Range of Motion

The physician should evaluate both active and passive range of motion of the knee joint. Normal knee extension ranges from 0° to -10°, and normal knee flexion ranges from 130° to 150°. The patella should be observed for appropriate tracking with active and passive knee range of motion. Patellofemoral crepitus can often be observed with range of motion in the presence of patellofemoral osteoarthritis. Crepitus and/or pain in early flexion

indicates more distal patella disease. Joint pain that is present during both active and passive range of motion is often associated with intra-articular pathology while pain that is present only with active range of motion has a higher likelihood of being related to an extra-articular soft tissue disorder [8].

Joint Stability

The assessment of joint stability is an essential part of every orthopedic knee examination. When evaluating joint stability, the physician should perform a series of maneuvers to both the affected and unaffected knee to test the collateral and cruciate ligaments for laxity. The MCL is best evaluated with the patient supine by applying a valgus stress to the knee joint both with the knee in 30° of flexion and in full extension. The LCL can be assessed in a similar manner by applying a varus stress to the knee joint in 30° of flexion and full extension. By stressing the knee in flexion and extension, the clinician can test the collateral ligaments both in isolation and in combination with the secondary stabilizers of the knee. Laxity to valgus or varus stress with the knee in 30° of flexion indicates an isolated injury to the MCL or LCL, respectively. When laxity is also noted to varus or valgus stress with the knee in full extension, one or both cruciate ligaments are likely injured in addition to a collateral ligament [9]. The physical examination maneuvers utilized for the evaluation of the collateral ligaments are summarized in Table 2.1.

Table 2.1 Physical examination of the collateral ligaments

Physical exam test	Technique	Significance
Valgus stress	Valgus stress applied to knee in 30° flexion and full extension	Laxity in 30° flexion indicates isolated MCL injury. Laxity in full extension indicates MCL injury with associated cruciate ligament injury
Varus stress	Varus stress applied to knee in 30° flexion and full extension	Laxity in 30° flexion indicates isolated LCL injury. Laxity in full extension indicates LCL injury with associated cruciate ligament injury

The examiner should also consider meniscal pathology when evaluating the stability of the collateral ligaments. When performing isolated varus or valgus stress, pain on the side of compression suggests meniscal injury while pain on the side of distraction implicates ligamentous pathology. As a result, medial knee pain with varus stress and lateral knee pain with valgus stress are concerning for medial and lateral meniscus tears, respectively [10].

The posteromedial and posterolateral complexes of the knee are also important collateral stabilizers of the knee joint. The posterior oblique ligament and posteromedial joint capsule of the posteromedial complex prevent excessive anteromedial rotation, while the posterolateral complex (popliteus, fibular collateral ligament, popliteofibular ligament, fabellofibular ligament, arcuate complex, and lateral head of the gastrocnemius) prevents excessive posterolateral rotation. The anterior rotation drawer test and dial test are important maneuvers to determine whether pathology in these structures may exist.

The anterior rotation drawer test can be used to assess for both posteromedial and posterolateral instability. This maneuver is performed by applying an anterior drawer force to the tibia with the knee flexed at 90°. The anterior force is first applied in the neutral position, then with 15° of tibial internal rotation, and finally with 30° of tibial external rotation. Increased subluxation of the tibial plateau in reference to the femoral condyles in neutral position that is accentuated by external rotation and decreased by internal rotation is indicative of anteromedial instability. Anterior tibial subluxation in neutral position that is increased with internal rotation and decreased by external rotation is indicative of posterolateral instability [11].

The dial test can also be used to assess for posterolateral instability. This maneuver can be performed both with the patient supine and prone. With either position, the examiner should use one hand to grasp each of the patient's feet and externally rotate the lower legs simultaneously first at 30° of knee flexion and then at 90° of knee flexion.

Table 2.2 Physical examination of the anterior cruciate ligament

Physical exam test	Technique	Significance	Reliability
Lachman test	Anterior proximal tibial translation with knee in 30° flexion	Soft end point or increased translation compared to contralateral knee is concerning for ACL injury	Sensitivity: 80–99 % [12–17] Specificity: 95 % [14]
Anterior drawer	Anterior proximal tibial translation with knee in 90° flexion	Soft end point or increased translation compared to contralateral knee is concerning for ACL injury	Sensitivity: 22.2–95.24 % [12–14, 16, 17] Specificity: >97 % [14]
Pivot shift	Knee passively flexed with lower extremity in slight internal rotation (IR) while valgus stress applied	An appreciable "clunk" at 30° knee flexion from spontaneous reduction of displaced tibial plateau is suggestive of ACL injury	Sensitivity: 35–98.4 % [13, 14] Specificity: >98 % [13, 14]

A positive dial test is indicated by asymmetric external rotation (>15°) of the symptomatic extremity when compared to the asymptomatic extremity. A positive dial test performed at 30° of knee flexion is concerning for an isolated PLC injury. A positive dial test both at 30 and 90° of knee flexion is concerning for a PCL injury in addition to a PLC injury [6]. The prone position may be more favorable since it safeguards against excessive anteromedial tibial subluxation.

After the collateral ligaments are evaluated, attention should then be turned to examination of the cruciate ligaments. The physical examination tests used during the evaluation for ACL injury, including the Lachman test, anterior drawer, and pivot shift test, are summarized in Table 2.2. The Lachman test is the most sensitive and specific physical examination maneuver for the detection of an ACL injury with reported sensitivity ranging from 80 % to 99 % [12–17] and a specificity of 95 % [14]. This test is performed with the patient placed in the supine position with the knee flexed at approximately 20–30°. With one hand stabilizing the femur, the examiner's second hand is used to briskly anteriorly translate the proximal tibia with respect to the femur. A soft end point to anterior translation or greater translation when compared to the unaffected knee is considered a positive Lachman test and is concerning for a possible ACL injury [17].

The anterior drawer test may also be used to assist with the identification of an ACL injury. In this test, the patient is positioned supine with the hip flexed at 45° and the knee flexed at 90°. The examiner places both hands on the proximal tibia with thumbs on the anterior tibial plateau and remaining fingers wrapped posteriorly. The lower extremity can be stabilized by sitting on the patient's foot. An anterior translational force is then applied to the proximal tibia in relation to the femur. Analogous to the Lachman test, the anterior drawer test is positive for injury to the ACL injury when it results in a soft end point or increased anterior translation of the proximal tibia when compared to the unaffected side [9]. Reported sensitivity of this test is much more variable, ranging from 22.2 % to 95.24 % [12–17]. The specificity of the anterior drawer has been reported as greater than 97 % [14].

The pivot shift test is another effective maneuver for the detection of an ACL tear. This test is based on the anterior subluxation of the lateral tibial plateau relative to the femoral condyle that occurs with full knee extension in the presence of an ACL injury. A positive pivot shift test detects the spontaneous reduction of the tibial plateau with flexion of an ACL deficient knee. To perform the pivot shift test, the examiner uses one hand on the patient's ankle to raise the lower extremity with the knee in full extension and slight internal rotation. The examiner then applies a valgus stress to the knee joint while passively flexing the knee. A positive test will result in a profound clunk at approximately 30° of flexion when the displaced tibial plateau spontaneously reduces beneath the femoral condyle [18]. The sensitivity of the pivot shift test has also been reported to have variable results (35 % to 98.4 %) [13, 14]. The specificity

Table 2.3 Physical examination of the posterior cruciate ligament

Posterior sag sign	Inspection of bilateral proximal tibias with 90° knee flexion and patient supine	Loss of 1 cm anterior step-off of medial proximal tibial plateau in relation to femoral condyle is concerning for PCL injury	Sensitivity: 79 % [19] Specificity: 100 % [19]
Posterior drawer	Posterior proximal tibial translation with knee in 90° flexion	Soft end point or increased translation compared to contralateral knee is concerning for PCL injury	Sensitivity: 51–100 % [5, 18, 19] Specificity: 99 % [19]
Quadriceps active test	Attempted active knee extension from 90° flexion against resistance	Anterior shift of proximal tibial plateau >2 mm suggestive of PCL injury	Sensitivity: 54–98 % [19, 20] Specificity: 97–100 % [19, 20]
Dial test	Simultaneous external rotation (ER) of bilateral lower legs with 30° and 90° knee flexion	Asymmetric ER (>15°) at 30° is suggestive of an isolated PLC injury. Asymmetric ER at 30° and 90° is suggestive of a PCL injury in addition to a PLC injury	

of this test has been reported as 98 % or greater [13, 14].

The PCL can also be evaluated by a variety of clinical examination maneuvers, which are summarized in Table 2.3. The knee should first be inspected for a posterior sag sign, which is indicative of a PCL tear. To test for this sign, the patient is positioned supine with 45° of hip flexion and 90° of knee flexion. In this position, the medial tibial plateau should sit approximately 1 cm anterior to the medial femoral condyle in a knee with an intact PCL. In the presence of a torn PCL, the tibial plateau will sag posteriorly resulting in a loss of this visible step-off and a positive posterior sag sign [7]. The posterior sag sign has been reported to have a sensitivity of 79 % and specificity of 100 % [19].

While maintaining 45° of hip flexion and 90° of knee flexion, a posterior drawer test can then be performed by applying a posterior translational force to the proximal tibia in relation to the femur. The examiner should apply this force using both hands on the proximal tibia with thumbs on the anterior tibial plateau and remaining fingers wrapped posteriorly. The lower extremity can be stabilized during this maneuver by sitting on the patient's foot. A positive posterior drawer test results in increased posterior tibial translation when compared to the unaffected knee and is concerning for PCL injury [9]. The reported sensitivity of the posterior drawer has ranged from 51 % to 100 % [5, 18, 19] while its specificity has been reported as 99 % [19].

The quadriceps active test may also help confirm the posterior tibial displacement of a PCL deficient knee. The patient is maintained in the supine position with 45° of hip flexion and 90° of knee flexion. The foot is again stabilized by the examiner. The patient is then asked to extend the knee against the examiner's resistance. In the presence of a torn PCL, the contraction of the quadriceps muscle results in greater than 2 mm of an anterior shift of the tibial plateau [20]. The quadriceps active test has been shown to have a range of sensitivities from 54 % to 98 % and specificities from 97 % to 100 % [19, 20].

It is essential to look for a posterior sag sign prior to performing cruciate ligament testing to ensure that the tests begin with the normal relationship between the tibial plateau and femoral condyles. An undetected posterior sag of the tibial plateau can lead to a falsely negative posterior drawer test secondary to the lack of additional posterior translation of an already posteriorly subluxed tibia. Additionally, the examiner may falsely diagnose an ACL injury based on an inaccurate Lachman test that resulted in excessive anterior translation due to the initial posterior displacement of the tibial plateau. For this reason, the examiner must be aware of the starting location of the tibial plateau prior to performing cruciate ligament testing.

Evaluation of the Meniscus

After completion of the exam for joint stability, the physician can evaluate the knee for evidence of meniscus injury. As previously described, the examiner can begin by evaluating for medial or lateral joint-line tenderness to palpation. Although joint-line tenderness may result from alternative knee pathology, focal tenderness over the medial or lateral menisci is often present in those with meniscus tears. Joint-line tenderness has been reported to have a sensitivity for detecting meniscal pathology ranging from 55 % to 85 % and a specificity ranging from 29.4 % to 67 % [21–23].

In addition to joint-line tenderness, several provocative maneuvers, summarized in Table 2.4, can be performed to aid in the diagnosis of meniscus injury. The McMurray test is one of the most widely utilized clinical exam maneuvers to evaluate for meniscus tears. This test is performed with the patient supine (Fig. 2.2). The examiner first brings the knee into full flexion while grasping the patient's foot with one hand and stabilizing the knee with a second hand. The knee is then brought from full flexion to 90° of flexion first with full internal rotation of the tibia and then with full external tibial rotation. A positive test produces an appreciable click in association with a torn meniscus that reproduces the patient's previous painful sensations. Pain or clicking with internal rotation suggests the presence of a lateral meniscus injury while a positive test with external rotation is indicative of medial meniscus injury [26]. This maneuver has been shown to

Table 2.4 Physical examination tests for the detection of meniscus injury

Physical exam test	Technique	Significance	Reliability
Joint-line tenderness	Direct palpation over medial and lateral joint line	Tenderness can indicate a meniscus tear, collateral ligament injury, or DJD	Sensitivity: 55–85 % [21–23] Specificity: 29.4–67 % [21–23]
McMurray test	Range knee from full flexion to 90° of flexion first with full tibial IR and then with full tibial ER	Positive test produces "click" in association with torn meniscus and reproduces patient's painful sensation	Sensitivity: 16–58 % [21–24] Specificity: 77–98 % [22–24]
Apley grind test	Strong ER force applied to knee flexed at 90° at rest, with distraction, and with compression	Joint-line pain with distraction is concerning for ligamentous injury. Joint-line pain with compression is concerning for meniscal pathology	Sensitivity: 13–16 % Specificity: 80–90 % [22, 23]
Bounce home test	Passive full knee extension from flexed position	Loss of terminal extension indicates mechanical block, such as a meniscus tear	
Finochietto test (jump sign)	Anterior proximal tibial translation with knee in 130°–140° flexion	Positive test produces "jump" of torn posterior horn of meniscus with anterior displacement	
Boehler test	Varus and valgus stress applied to knee in almost complete extension	Pain on side of compression is suggestive of meniscus injury	
Thessaly test	Patient internally and externally rotates his or her knee and body while keeping one foot planted with the knee flexed at 5° and then 20°	Joint-line pain with maneuver indicates possible meniscus tear	20° Thessaly test Sensitivity: 89–92 % [25] Specificity: 96–97 % [25]
Childress test	Patient "duck walks" by moving forward with maximal knee flexion	Joint-line pain with maneuver indicates possible meniscus tear	



Fig. 2.2 Positioning for McMurray test



Fig. 2.3 Positioning for Apley grind test

have a modest sensitivity for the detection of meniscus tears with reported values ranging from 16 to 58 % [21–24]. However, the McMurray test is highly specific for meniscus tears, particularly tears of the posterior horn, with specificity values ranging from 77 to 98 % [22–24]. Consequently, this provocative test has continued utility in combination with other physical examination maneuvers for the diagnosis of meniscus injury [26].

The Apley grind test involves a series of provocative maneuvers that also may be used to diagnose a meniscus injury. For this test, the patient is positioned prone (Fig. 2.3). The injured knee is flexed to 90° and a powerful external rotation force is applied to the tibia. This maneuver determines if external rotation of the knee elicits pain. With the thigh stabilized against the examining table, a distraction force is then applied to the lower leg with the knee flexed at a right angle and an external rotation force is again applied. During this test, the physician should note if pain is elicited with distraction and external rotation and if this pain is greater than without distraction. Increased pain with this maneuver indicates a positive distraction test and is concerning for a ligamentous sprain. Pain with distraction also decreases the likelihood that the meniscus is the etiology of knee pain since distraction decreases the compressive force on the meniscus. The examiner next applies a compression force to the knee while applying an external rotation force in 90° of knee flexion. Increased pain with this maneuver indicates a positive compression test and is concerning for a medial meniscus injury. This series of provocative maneuvers can then be repeated with internal rotation to examine the lateral meniscus [27]. Similar to the McMurray test, the Apley grind test also has been shown to have a relatively low sensitivity (13–16 %) and high specificity (80–90 %) [22, 23].

The bounce home test assesses passive knee range of motion to aid in the diagnosis of meniscus tears. This test begins with the patient positioned supine with full knee flexion. The examiner cups the foot of the affected extremity and allows the knee to passively fall into full extension. When performing this maneuver, the knee should "bounce home" into full extension with a sharp end point. A loss of terminal extension or a rubbery end point to extension indicates a positive bounce home test and is concerning for a meniscus tear or some other intra-articular pathology that provides a mechanical block to extension [3].

The Finochietto test or jump sign can be used to aid in the detection of tears of the posterior horn of the meniscus. To perform this test, an anterior translational force is applied to the proximal tibia, similar to the anterior drawer and Lachman tests, while the knee is held in 130–140° of flexion. This test is positive when the examiner



Fig. 2.4 Positioning for Thessaly test. (**a**) Thessaly test with external rotation of body. (**b**) Thessaly test with internal rotation of body

feels a "jump" when a torn posterior horn of the meniscus is displaced anterior to the tibiofemoral contact point [2].

The Boehler and Payr tests utilize the meniscal compression caused by varus and valgus stress testing to diagnose meniscus injuries. To perform the Boehler test, the examiner applies a varus force to compress the medial meniscus or a valgus force to compress the lateral meniscus with the knee in almost full extension. A positive test results from pain on the side of compression with this maneuver and is suggestive of meniscus injury, particularly in the anterior to middle section of the meniscus. The Payr test is similarly used to evaluate for medial meniscus tears by applying a varus force to compress the medial meniscus with the knee held in 90° of flexion [10].

The Thessaly and Childress tests are standing physical exam maneuvers that can aid in the detection of meniscus injury. These tests utilize the combination of axial load applied to the knee from standing to the rotational forces from designated maneuvers during the tests to elicit pain due to a meniscus tear. To perform the Thessaly test, the patient is asked to stand flat-footed with all weight on one extremity. While holding the examiner's hands for support, the patient is then asked to internally and externally rotate his or her knee and body three times while keeping the foot planted with the knee flexed at 5° and then with 20° of knee flexion (Fig. 2.4). The maneuver should first be performed on the patient's uninjured extremity prior to the symptomatic extremity to educate the patient on the physical exam technique. A positive result is indicated by medial or lateral joint-line pain with this maneuver and is concerning for meniscus injury [25]. When the Thessaly test is performed at 20° of knee flexion, it has been shown to have a high sensitivity for the detection of both medial and lateral meniscus tears (89 % and 92 %, respectively) [25]. The 20° Thessaly test also has been reported to have high specificity rates, 97 % and 96 %, for the detection of medial and lateral meniscus tears, respectively [25]. This test has a lower sensitivity and specificity when performed at 5° of knee flexion.



Fig. 2.5 Positioning for Childress test

The Childress test is performed by asking the patient to perform a "duck walk" by moving forward while maintaining full knee flexion (Fig. 2.5). Similar to the Thessaly test, this test is also positive for meniscal injury when the maneuver reproduces medial or lateral joint-line pain [10]. The Childress maneuver applies considerable compressive forces to the menisci and should not be performed in patients with a known positive McMurray test.

Conclusion

Due to the common occurrence of meniscus injuries, physicians should often consider the menisci as a potential source of knee pain and must be capable of performing a focused examination to aid in the diagnosis of a meniscus tear. While imaging techniques play an important role in confirming the diagnosis of meniscus injury, clinicians must utilize their physical examination skills to determine when obtaining advanced imaging is necessary. Understanding the physical examination of the knee, particularly relating to the meniscus, is essential for all practitioners responsible for caring for patients with knee pain. While the exhaustive use of all maneuvers is likely unnecessary to arrive at an accurate diagnosis, clinicians should be encouraged to become facile with 2 or 3 tests that are easily reproducible and can be applied to all patients presenting with knee pain. In this way, an individual examiner's sensitivity and specificity for detecting meniscal pathology will be optimized.

References

1. Poehling GG, Ruch DS, Chabon SJ. The landscape of meniscal injuries. Clin Sports Med. 1990;9:539–49.
2. Finochietto R. Semilunar cartilages of the knee: the "Jump Sign". J Bone Joint Surg. 1935;17(4):916–21.
3. Hoppenfeld S. Physical examination of the spine & extremities. Upper Saddle River, NJ: Prentice Hall; 1976.
4. Worsley P, Stokes M, Taylor M. Predicted knee kinematics and kinetics during functional activities using motion capture and musculoskeletal modeling in healthy older people. Gait Posture. 2011;33:268–73.
5. Metcalf MH, Barrett GR. Prospective evaluation of 1485 meniscal tear patterns in patients with stable knees. Am J Sports Med. 2004;32:675–80.
6. Miller MD, Thompson SR, Hart JA. Review of orthopaedics. 6th ed. Philadelphia, PA: Elsevier; 2012.
7. Mayo Robson AW. Ruptured crucial ligaments and their repair by operation. Ann Surg. 1903;70:716–8.
8. Schraeder TL, Terek RM, Smith CC. Clinical evaluation of the knee. N Eng J Med. 2010;363(4):e5.
9. Malanga GA, Andrus S, Nadler SF, McLean J. Physical examination of the knee: A review of the original test description and scientific validity of common orthopedic tests. Arch Phys Med Rehabil. 2003;84:592–603.
10. Shrier I, Boudier-Reveret M, Fahmy K. Understanding the different physical examination tests for suspected meniscal tears. Curr Sports Med Rep. 2010;9(5):284–9.
11. Canale ST, Beaty JH. Acute traumatic lesions of ligaments in Campbell's Operative Orthopaedics. 11th ed. Philadelphia, PA: Elsevier; 2008.
12. Donaldson III WF, Warren RF, Wickiewicz T. A comparison of acute anterior cruciate ligament examinations. Initial versus examination under anesthesia. Am J Sports Med. 1985;13:5–10.
13. Jonsson T, Althoff B, Peterson L, Renstrom P. Clinical diagnosis of ruptures of the anterior drawer ligament: a comparative study of the Lachman test and the anterior drawer sign. Am J Sports Med. 1982;10:100–2.
14. Katz JW, Fingeroth RJ. The diagnostic accuracy of ruptures of the anterior cruciate ligament comparing the Lachman test, the anterior drawer sign, and the pivot shift test in acute and chronic knee injuries. Am J Sports Med. 1986;14:88–91.
15. Kim SJ, Kim HK. Reliability of the anterior drawer test, the pivot shift test, and the Lachman test. Clin Orthop. 1995;317:237–42.
16. Mitsou A, Vallianatos P. Clinical diagnosis of ruptures of the anterior cruciate ligament: comparison between

the Lachman test and the anterior drawer sign. Injury. 1988;18:427–8.
17. Torg JS, Conrad W, Kalen V. Clinical diagnosis of anterior cruciate ligament instability in the athlete. Am J Sports Med. 1976;4:84–93.
18. Galway HR, MacIntosh DL. The lateral pivot shift: a symptom and sign of anterior cruciate ligament insufficiency. Clin Orthop. 1980;147:45–50.
19. Rubinstein RA, Shelbourne KD, McCarroll JR, VanMeter CD, Rettig AC. The accuracy of the clinical examination in the setting of posterior cruciate ligament injuries. Am J Sports Med. 1994;22:550–7.
20. Daniel DM, Stone ML, Barnett P, Sachs R. Use of the quadriceps active test to diagnose posterior cruciate-ligament disruption and measure posterior laxity of the knee. J Bone Joint Surg Am. 1988;70:386–91.
21. Anderson AF, Lipscomb AB. Clinical diagnosis of meniscal tears. Description of a new manipulative test. Am J Sports Med. 1986;14:291–3.
22. Fowler PJ, Lubliner JA. The predictive value of five clinical signs in the evaluation of meniscal pathology. Arthroscopy. 1989;5:184–6.
23. Kurosaka M, Yagi M, Yoshiya S, Muratsu H, Mizuno K. Efficacy of the axially loaded pivot shift test for the diagnosis of a meniscal tear. Int Orthop. 1999;23:271–4.
24. Evans PJ, Bell GD, Frank C. Prospective evaluation of the McMurray test. Am J Sport Med. 1993;21:604–8.
25. Karachalios T, Hantes M, Zibis AH, Zachos V, Karantanas AH, Malizos KN. Diagnostic accuracy of a new clinical test (the Thessaly test) for early detection of meniscal tears. J Bone Joint Surg. 2005;87(5):955–62.
26. McMurray TP. The semilunar cartilages. Br J Surg. 1942;2(116):407–14.
27. Apley AG. The diagnosis of meniscus injuries: some new clinical methods. J Bone Joint Surg. 1947;29(1):78–84.

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Meniscal Injuries
Management and Surgical Techniques
Kelly IV, J.D. (Ed.)
2014, XIV, 129 p. 81 illus., 64 illus. in color., Hardcover
ISBN: 978-1-4614-8485-1