

# Does This Patient Have a Torn Meniscus or Ligament of the Knee?

## Value of the Physical Examination

Daniel H. Solomon, MD, MPH

David L. Simel, MD, MHS

David W. Bates, MD, MSc

Jeffrey N. Katz, MD, MSc

Jonathan L. Schaffer, MD, MBA

### CLINICAL SCENARIOS

#### Case 1

A 20-year-old man presents to your office complaining of knee pain after playing basketball. During the game, as he came down after jumping for a rebound, another player fell on the back of his calf. He remembers hearing a “pop” and had pain upon standing, preventing him from playing in the remainder of the game. While on the bench, he noticed that the pain improved but his knee became swollen. He used ice on the knee and was able to put some weight on it later that day. Today he is concerned about putting all of his weight on the knee because it feels as if it may buckle.

#### Case 2

A 72-year-old woman notes that her left knee has recently begun to swell. She has had pain in the medial aspect of the knee for several years but only recently did she notice fullness around the knee. She fell several weeks ago and supposes that the fall may have caused the buildup of fluid. The knee hurts her all day long but feels worse going down stairs, especially early in the morning and late in the day. She finds acetaminophen helpful, but the pain relief is not adequate for her to be fully active.

**Context** While most meniscal or ligamentous knee injuries heal with nonoperative treatments, a subset should be treated with arthroscopic or open surgery.

**Objective** To analyze the accuracy of the clinical examination for meniscal or ligamentous knee injuries.

**Data Sources** MEDLINE (1966-December 31, 2000) and HealthSTAR (1975-December 31, 2000) databases were searched for English-language articles describing the diagnostic accuracy of individual examination items for the knee and a combination of physical examination items (composite examination). Other data sources included reference lists from relevant articles.

**Study Selection** Studies selected for data extraction were those that compared the performance of the physical examination of the knee with a reference standard, such as arthroscopy, arthrotomy, or magnetic resonance imaging. Eighty-eight articles were identified, of which 23 (26%) met inclusion criteria.

**Data Extraction** A rheumatologist and an orthopedic surgeon independently reviewed each article using a standardized rating scale that scored the assembly of the study, the relevance of the patients enrolled, the appropriateness of the reference standard, and the blinding of the examiner.

**Data Synthesis** Summary likelihood ratios (LRs) were estimated from random effects models. The summary LRs for physical examination for tears of the anterior cruciate ligament, using the anterior drawer test, were 3.8 (95% confidence interval [CI], 0.7-22.0) for a positive examination and 0.30 (95% CI, 0.05-1.50) for a negative examination; the Lachman test, 25.0 (95% CI, 2.7-651.0) and 0.1 (95% CI, 0.0-0.4); and the composite assessment, 25.0 (95% CI, 2.1-306.0) and 0.04 (95% CI, 0.01-0.48), respectively. The LRs could not be generated for any specific examination maneuver for a posterior cruciate ligament tear, but the composite assessment had an LR of 21.0 (95% CI, 2.1-205.0) for a positive examination and 0.05 (95% CI, 0.01-0.50) for a negative examination. Determination of meniscal lesions, using McMurray test, had an LR of 1.3 (95% CI, 0.9-1.7) for a positive examination and 0.8 (95% CI, 0.6-1.1) for a negative examination; joint line tenderness, 0.9 (95% CI, 0.8-1.0) and 1.1 (95% CI, 1.0-1.3); and the composite assessment, 2.7 (95% CI, 1.4-5.1) and 0.4 (95% CI, 0.2-0.7), respectively.

**Conclusion** The composite examination for specific meniscal or ligamentous injuries of the knee performed much better than specific maneuvers, suggesting that synthesis of a group of examination maneuvers and historical items may be required for adequate diagnosis.

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**Author Affiliations** are listed at the end of this article.  
**Corresponding Author and Reprints:** Jonathan L. Schaffer, MD, MBA, Department of Orthopedic Surgery, The Cleveland Clinic, 9500 Euclid Ave, Desk A41, Cleveland, OH 44195 (e-mail: schaffj@ccf.org).

**The Rational Clinical Examination Section Editors:** David L. Simel, MD, MHS, Durham Veterans Affairs Medical Center and Duke University Medical Center, Durham, NC; Drummond Rennie, MD, Deputy Editor, *JAMA*.

### Why Is the Diagnosis Important?

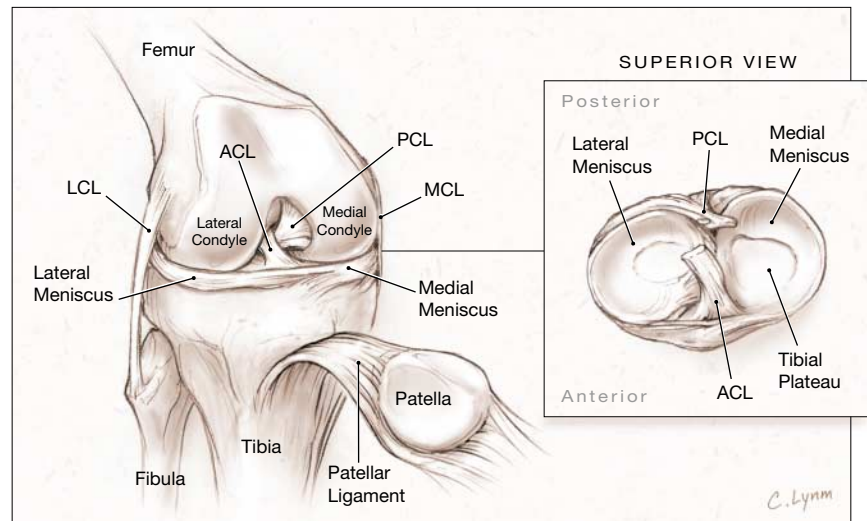
Ten percent to 15% of adults in the community report knee symptoms with over 3.3 million new visits made annually.<sup>1,2</sup> Overall, knee pain accounts for 3% to 5% of all visits to physicians and a substantial proportion result in referrals for diagnostic imaging and/or specialty care.<sup>3</sup> A careful history taking and physical examination can assist the examiner in determining whether the knee pain is part of a systemic condition or whether it represents a local musculoskeletal problem. If the knee pain is part of a local regional musculoskeletal disorder, the clinician must decide whether the pain represents a torn meniscal or ligamentous structure and then whether non-operative or operative intervention is indicated. Since torn meniscal or ligamentous structures can cause significant pain and disability, injuries to these structures may require expeditious repair. The physical examination can aid the primary care clinician in assessing the likelihood of a torn meniscal or ligamentous structure and whether a referral will be beneficial.

While musculoskeletal conditions are common and costly, physicians in training receive little instruction in musculoskeletal medicine.<sup>4,5</sup> This educational deficit potentially leads to sub-optimal treatment. Several studies have suggested that the musculoskeletal examination can be effectively taught through the use of small-group teaching and trained actors playing the role of the patient-educators.<sup>6,7</sup> The purpose of this review is to analyze the diagnostic accuracy of the physical examination for meniscal and ligamentous injuries.

### Anatomy of Meniscal and Ligamentous Knee Injuries and Their Relationship to Symptoms

The knee joint is the largest articulation in the body. It is a modified hinge with an extensive range of motion. The stability of the joint is provided by the soft tissue structures: the anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL), the medial col-

**Figure 1.** Anatomy of the Knee



Right knee shown. LCL indicates lateral collateral ligament; ACL, anterior cruciate ligament; PCL, posterior cruciate ligament; and MCL, medial collateral ligament.

lateral ligament (MCL) and the lateral collateral ligament (LCL), the menisci, the capsule, and the muscles (FIGURE 1). The ACL and PCL add stability to the joint and aid in proprioception. The subcutaneous location in a weight-bearing extremity combined with the relatively long lever arms exerting forces on the joint render the knee susceptible to injury. All of the structures that comprise the knee joint synchronously function through a normal, physiologic range of motion. Knee symptoms occur when any of these structures are altered, potentially creating interference with normal knee function.

An anatomic description of the knee provides a basis for understanding the various injury patterns that are typically seen by clinicians. The ligaments passively limit the motion of the joint, thus providing stabilization. The ACL and PCL limit the anterior and posterior displacement of the tibia on the femur, respectively. Since the intact ACL prevents anterior motion of the tibia on the femur, an ACL injury leads to abnormal forward movement of the tibial plateau. This abnormal motion leads to relative internal rotation of the tibia during the terminal part of extension. Absence of a functioning ACL and the related anterolateral rotatory instability can

result in the sensation that the knee is buckling or “giving out.” These symptoms occur with normal walking, but may be most prominent during pivoting movements, such as those that occur with quick changes in direction. In the absence of knee buckling, patients with ACL disruption may express a loss of confidence in the stability of their knee, possibly because of the ACL’s role in proprioception.<sup>8</sup>

The PCL provides stability to most forces regardless of knee position. Isolated disruption of the PCL permits the tibia to displace posteriorly, decreasing the forces on the posterior horns of the menisci and increasing the forces directly on the articular surfaces of the medial compartment and patello-femoral joint. While absence of the PCL may have no associated symptoms, it may result in hyperextension of the knee, posterior displacement of the tibia during knee flexion, and varus (bowlegged) and valgus (knock-kneed) angulation with the knee extended. Knee buckling may occur, especially during pivoting motions or when descending stairs. Symptomatic PCL lesions are more common in patients with chronic tears or with acute tears associated with other ligament injuries.

The meniscal fibrocartilages are semi-lunar, crescentic-shaped structures that

are attached to the tibial plateau at the edge of the articulating surfaces of the femur and tibia. The menisci are wedge-shaped with a thin free edge at the inner margin and a wide base attaching to the tibia by the coronary ligaments. The surface is flat inferiorly and concave superiorly, providing a congruous surface for the transmission of 50% of the axial forces across the knee joint.<sup>9</sup> The menisci increase joint stability, facilitate nutrition, and provide lubrication and shock absorption for the articular cartilage.<sup>10</sup> The lateral meniscus is larger than the medial meniscus and less firmly attached to the tibia resulting in a more mobile structure.<sup>10</sup> The medial meniscus, firmly attached to the capsule and MCL, is relatively immobile. Because of its fixed nature combined with the greater force transmission across the medial aspect of the knee, the medial meniscus is more susceptible to injury.<sup>10</sup> Knee flexion forces the menisci posteriorly. In extreme flexion, the posterior portion of the meniscus is firmly compressed between the posterior portion of the tibial plateau and femoral condyle.

### **Mechanism of Meniscal and Ligamentous Knee Injuries**

The position of the joint at the time of the traumatic force dictates which anatomic structures are at risk for injury; hence, an important aspect of obtaining the patient's history for acute injuries is to allow him/her to describe the position of the knee and direction of forces at the time it was injured. In full knee extension, the ACL and PCL limit the antero-posterior motion of the tibia on the femur. The ACL is often injured during traumatic twisting injuries in which the tibia moves forward with respect to the femur, often accompanied by valgus stress. No direct blow to the knee or leg is required, but the foot is usually planted and the patient may remember a "popping" sensation at the time of the injury. Similar to the ACL, PCL injuries often occur during twisting with a planted foot in which the force of the injury is directed posteriorly against the tibia with the knee flexed.

The most common collateral ligament injury results from an abduction and external rotation force applied on a knee in an extended or slightly flexed position. An intact MCL helps the ACL prevent posterior motion of the femur. An injury to the MCL may allow for anterior subluxation of the tibial plateau during flexion, especially in an ACL-deficient patient.

Meniscal injuries typically occur through application of specific forces while the knee joint is in certain positions. During flexion, if the tibia is rotated internally, the posterior horn of the medial meniscus is pulled toward the center of the joint. This movement can produce a traction injury of the medial meniscus, tearing it from its peripheral attachment and producing a longitudinal tear of the substance of the meniscus. With aging, the meniscal tissue degenerates and can delaminate, thus making it more susceptible to splitting from shear stress, resulting in horizontal cleavage tears. Without the menisci, the loads on the articular surfaces are increased significantly leading to a greater potential for degenerative arthritis. Since the menisci are without pain fibers, it is the tearing and bleeding into the peripheral attachments as well as traction on the capsule that most likely produce a patient's symptoms of pain. In fact, 16% of asymptomatic patients have meniscal tears demonstrated on magnetic resonance imaging (MRI) with the incidence increasing to 36% for patients older than 45 years.<sup>11</sup> With posterior horn tears, the meniscus can return to its anatomic position with extension. If the tear extends anteriorly beyond the MCL creating a bucket-handle tear, then the unstable meniscus fragment cannot always move back into an anatomic position. Such a meniscal tear can result in locking of the knee in a flexed position. The lateral meniscus, being more mobile, is less likely to be associated with locking when torn. The patient may also note a "clicking" sensation while walking due to traction against a torn medial or lateral meniscus. Locking of the knee is more common in younger patients with meniscal

tears. Older patients are more likely to have degenerative meniscal tears with less mechanical symptoms and an insidious onset.

### **Epidemiology of Meniscal and Ligamentous Knee Injuries**

Injuries to the collateral or cruciate ligaments or to menisci are difficult to account for entirely since many are diagnosed without imaging or arthroscopic confirmation and many go undiagnosed. Data collected through surveys of athletes participating in organized sports or information collected at sports medicine clinics provide the most reliable data, but do not represent the true spectrum of meniscal and ligamentous knee injuries. In a 7-year study of trainees at the US Naval Academy, women who had an injury to their ACL had a relative risk (RR) of 2.44 compared with men.<sup>12</sup> A similar increased risk for ACL injuries was also noted among female competitive alpine skiers.<sup>13</sup> A Norwegian study of soccer players with verified ACL injuries suggested that there were 0.063 injuries per 1000 game hours; women had an almost 2-fold greater incidence of ACL injuries than did men.<sup>14</sup> While a number of other studies exist, there are few epidemiologic data regarding other meniscal and ligamentous knee injuries.<sup>15,16</sup>

### **Clinical Examination for Internal Derangement of the Knee**

The purpose of the examination is to make a correct anatomic diagnosis. Most experts recommend initiating the examination of the patient by focusing first on the leg that is healthy while the patient assumes a position that makes him/her most comfortable.<sup>17</sup> The patient should be allowed to recite the history of his/her knee discomfort without interruption. After the history has been taken, the examiner inspects, palpates, and assesses function of the unaffected (or less affected) knee. Examining the healthy knee first creates trust that the examiner is not trying to cause pain and distracts the patient somewhat from the actual maneuvers, allowing greater re-

laxation. Missing items in the history can be obtained later. The healthy knee must be examined because an essential component of interpreting the findings in the affected knee is the comparison. The following sections describe the cardinal features of a knee examination for a meniscal or ligamentous injury.

**Inspection.** A patient's gait should be observed. Patients will usually assume a position that provides them the most comfort. If seated on the examination table, the affected knee will be flexed and hanging off the edge. The quadriceps and calves should be evaluated for atrophy, often present following ligamentous injuries. The knees should be inspected for asymmetry that may indicate swelling. An early sign of effusion is the loss of the peripatellar groove on either side of the patella, seen best with the patient supine. Also, swelling over the medial or lateral aspect of the joint should be recorded and may indicate local inflammation over the collateral ligaments.

**Palpation.** Differences in temperature between the knees suggest inflammation. With the patient supine, the knees should be examined for an effusion and discomfort with patellar motion. An effusion can be detected by noticing the loss of the peripatellar groove and by palpation of the fluid. Smaller effusions may be detected by compressing the medial and superior aspects of the knee, then pressing or tapping the lateral aspect to create a fluid wave. A perceptible bulge on the medial aspect suggests a small effusion; this sign may not be present with larger effusions. Ballottement of the patella may also be a useful technique for detecting an effusion. The examiner quickly pushes down on the patella. In the normal knee joint with minimal free fluid, the patella moves directly into the femoral condyle and there is no tapping sensation underneath the examiner's fingertips. However, in the knee with excess fluid, the patella is "floating"; thus, ballottement causes the patella to tap against the femoral condyle. This sensation is transmitted to the examiner's fingertips. Localized swelling over specific knee structures, such as the

MCL or LCL, can also be noted. Crepitus, a palpable grating sensation, may be produced during certain motions in joints with cartilage disruption.<sup>18</sup> The maneuvers producing crepitus, the location of the crepitus, and any pain elicited should be recorded. Joint line tenderness can also be detected by palpating medial and lateral to the patella in the groove between the femoral condyle and the tibia.

**Function.** The Lachman test, anterior drawer test, and lateral pivot shift test are the 3 physical examination maneuvers commonly used to assess the integrity of the ACL (FIGURE 2). Although the patient may be fearful, these functional tests should not cause pain with isolated ACL injuries in the subacute setting.

Lachman test is typically performed while the patient lies supine with the knee flexed to 20° to 30°.<sup>19</sup> The examiner stands to the side of the patient's leg with the patient's heel on the examination table. The femur is grasped with one hand just above the knee. While the examiner grasps the femur firmly to prohibit motion of the upper leg and to relax the hamstrings, the other hand grasps the proximal tibia. The lower leg is then given a brisk forward tug and a discrete end point should be felt. A positive test is one in which the end point is not discrete or there is increased anterior translation of the tibia. The test is more difficult to perform when the examiner has small hands or the patient has large legs, both situations making it more difficult to completely grasp the legs. In this situation, the patient may be placed prone with the knee at the same degree of flexion while the examiner attempts the same motion of the tibia.

The anterior drawer test is also typically performed with the patient supine and the knee in 90° of flexion. The examiner quickly pulls the upper portion of the calf forward using both hands. The tibia must not be rotated and the hamstrings must be relaxed to properly assess the ACL. An intact ACL abruptly stops the tibia's forward motion as the ACL reaches its maximum length. If the tibia can be moved ante-

riorly without an abrupt stop, referred to as a discrete end point, this is considered a positive anterior drawer sign. It is often useful to perform this test on the uninjured knee to determine whether the amount of anterior translation differs between knees.

The lateral pivot shift test combines a valgus stress (pushing the outside of the knee medially) with a twisting force while the knee is being flexed. In Losee's<sup>20</sup> version of the test, the patient rests on his/her back with the knee at 45° flexion. The examiner places a hand on the lateral aspect of the knee and pushes medially creating a valgus strain. At the same time, the examiner's other hand supports and pulls the foot laterally. As the examiner slowly extends the knee, the tibia and foot begin to twist internally. A positive test consists of an obvious "thud" or "jerk" at 10° to 20° flexion in the ACL-deficient knee, representing anterior subluxation of the tibia on the femur.

Posterior or PCL stability is generally assessed using the posterior drawer test. This is performed with the patient supine and the knee flexed to 90°. The alignment of the knees is inspected: if the tibia of the affected knee is subluxed posteriorly (a posterior "sag"), then applying anterior pressure will correct the sag. If the subluxation can be corrected, it is considered a positive posterior drawer sign. Others consider a posterior drawer test to be positive if a posterior force on the tibia encounters no discrete end point, the reverse of the anterior drawer test. A method of assessing whether a PCL injury is present in combination with an MCL injury is to perform the abduction (or valgus) stress test with the knee in 2 positions. First, with the knee in 30° of flexion, the examiner supports the foot or ankle of the leg being examined and places the other hand along the lateral aspect of the knee. An inward or medial force is then applied to the knee while an opposite force is applied to the lower leg. The examiner grades the "opening" of the medial compartment of the knee. If the opening is larger on the injured side than on the opposite side, an



MCL injury is suggested. The same test is then carried out with the knee held in full extension. Normally, the abduction stress test produces no opening of the medial compartment when the knee is fully extended in a patient with an intact PCL and MCL. If the opening of the medial compartment is similar with the knee in full extension, a combined PCL and MCL injury is suspected.

Finally, meniscal integrity is assessed using several specific examination maneuvers, including McMurray test, the Apley compression test, and the medial-lateral grind test (Figure 2). McMurray test is performed with the patient supine. The examiner stands on the

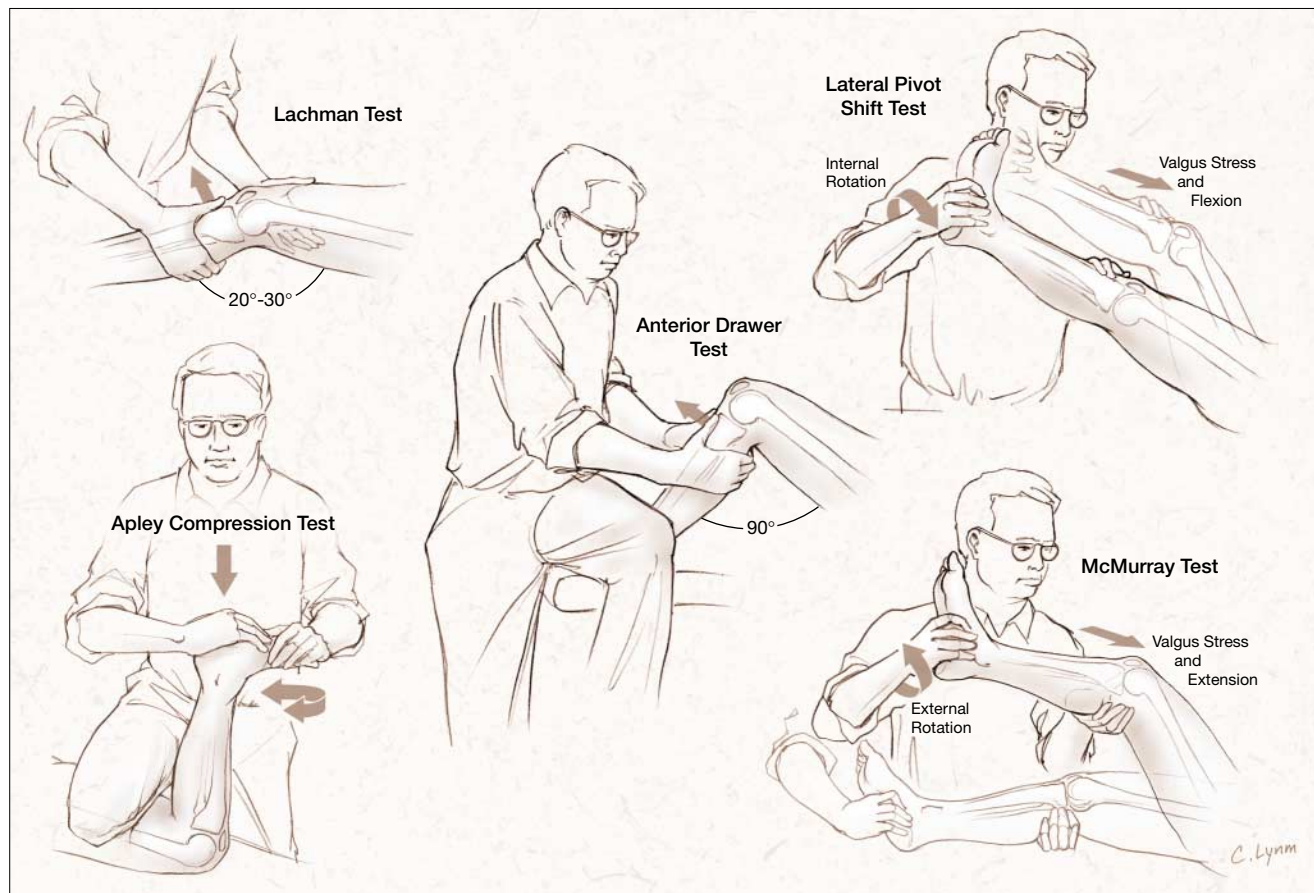
side of the affected knee and places one hand on the heel and another along the medial aspect of the knee, providing a valgus force. The knee is extended from a fully flexed position while internally rotating the tibia. The test is repeated while externally rotating the tibia. A positive sign is indicated by a “popping” and sensation of symptoms along the joint line, often accompanied by an inability to fully extend the knee.

The Apley compression test is performed with the patient laying in a prone position on a low examination table. The examiner applies his/her knee into the posterior thigh of the leg to be examined, then flexes and externally ro-

tates the tibia while gripping the ankle. The examiner then compresses the tibia downward. If this compression produces an increase in pain, the test is considered positive.

The medial-lateral grind test is performed with the patient supine on the examination table. The examiner cradles the affected leg's calf in one hand and places the index finger and thumb of the opposite hand over the joint line. Valgus and varus stresses are applied to the tibia during flexion and extension. If a grinding sensation is palpated by the hand placed over the joint line, the medial-lateral grind test is deemed positive.

**Figure 2.** Examination Maneuvers



Right knee shown. Examination maneuvers include the Lachman, anterior drawer, lateral pivot shift, Apley compression, and McMurray tests. Lachman test, performed to detect anterior cruciate ligament (ACL) injuries, is conducted with the patient supine and the knee flexed to 20° to 30°. The anterior drawer test detects ACL injuries and is performed with the patient supine and the knee in 90° of flexion. The lateral pivot shift test is performed with the patient supine, the hip flexed 45°, and the knee in full extension. Internal rotation is applied to the tibia while the knee is flexed to 40° under a valgus stress (pushing the outside of the knee medially). The Apley compression test, used to assess meniscal integrity, is performed with the patient prone and the examiner's knee over the patient's posterior thigh. The tibia is externally rotated while a downward compressive force is applied over the tibia. The McMurray test, used to assess meniscal integrity, is performed with the patient supine and the examiner standing on the side of the affected knee. See "Function" section of text for full explanation of all examinations.

## METHODS

### Search Strategy

We conducted MEDLINE and HealthSTAR searches to retrieve articles pertaining to the physical examination of patients with suspected meniscal or ligamentous injury of the knee. The search of MEDLINE and HealthSTAR included all years from 1966 and 1975, respectively; both searches were extended through December 31, 2000. Keywords for searching included: *knee, physical examination, internal derangement, anterior cruciate ligament, posterior cruciate ligament, medial collateral ligament, lateral collateral ligament, and meniscus*. Reference lists from relevant articles were also manually searched. Searching was limited to English-language articles describing human studies.

A total of 88 articles were retrieved. We included 26 articles that compared the performance of the physical examination of the knee with a reference standard, such as arthroscopy, arthrotomy, or MRI. Three articles were subsequently excluded because no primary data were reported, only aggregated sensitivities and specificities. Several different categories of physical examination findings were included: from widely available maneuvers; from maneuvers requiring specialized equipment; and general knee examination without specific maneuvers. We did not include data examining the accuracy of arthrometry or examination under anesthesia, since both of these examination techniques are not widely available. Two of the authors, a rheumatologist (D.H.S.) and an orthopedic surgeon (J.L.S.), graded each article for its methodological quality using a standardized scoring system.<sup>21</sup> The scoring system included assembly of the study (consecutive or otherwise), the relevance of the patient enrolled, the appropriateness and completeness of the reference standard, and the blinding of the examiner.

Articles contained level 1 evidence if they used an independent, blind comparison of the examination with the reference standard among at least 50 con-

secutive and relevant patients. Level 2 articles were similar in their methods but contained fewer than 50 patients. If patients were not recruited consecutively but otherwise the authors conducted an independent and blind comparison with the reference standard, then the article was considered level 3. Level 4 evidence came from articles that compared the examination with a reference standard but patients were not collected consecutively nor was the comparison independent.

We noted whether the patients included in each study had acute or chronic knee symptoms and whether the examiner was a specialist in musculoskeletal care. However, no studies reported data separately for nonspecialist examiners. Data were abstracted from each article to allow for calculation of the sensitivity and specificity of each physical examination finding. Several articles commented on the composite examination for meniscal or ligamentous injuries. These articles did not include data for specific examination maneuvers; rather all aspects of the physical examination were combined in an unspecified manner.

### Analysis

Sensitivity was calculated as the percentage of patients with a given lesion on the reference standard (usually arthroscopy or arthrotomy) who had an abnormal physical examination result; specificity was the percentage of patients without a given lesion who had normal results on the physical examination maneuver.<sup>22</sup> When sensitivity and specificity were available, likelihood ratios (LRs) with 95% confidence intervals (CIs) were calculated according to the method of Simel et al<sup>23</sup> and Hasselblad and Hedges.<sup>24</sup> The LR for a positive test was calculated as the sensitivity divided by 1 minus specificity; for a negative test, the LR equaled 1 minus sensitivity divided by specificity. When several studies provided data to calculate the LRs for the same examination maneuver, a summary LR was estimated from a random-effects model to provide conservative values.<sup>25</sup>

## RESULTS

No articles could be identified that adequately examined the diagnostic accuracy of the physical examination for MCL or LCL lesions. Hence, these structures will not be discussed further.

### ACL Examination

Three researchers reported on the composite examination for ACL injuries without giving data for specific examination maneuvers (TABLE 1).<sup>26-28</sup> These investigators found that the sensitivity of the examination for ACL injuries was more than 82% and the specificity was more than 94%. The summary LRs for these studies was 25.0 (95% CI, 2.1-306.0) for a positive examination and 0.04 (95% CI, 0.01-0.48) for a negative examination. Twelve other studies<sup>29-40</sup> were included that examined the anterior drawer, lateral pivot shift, and the Lachman maneuver tests. The methodologic quality of these studies was inconsistent; patients primarily had known ruptured ACLs and underwent subsequent arthroscopy or arthrotomy. The fact that only patients with known lesions were included precluded calculation of specificity and LRs in all but 4 studies.

The specificity of the anterior drawer test for ACL ruptures ranged from 23% to 100% with a mean (SD) of 67% (42%).<sup>29,36,38</sup> Likewise, the sensitivity of the anterior drawer test varied from 9% to 93% with a mean (SD) of 62% (23%).<sup>29,31,32,35-40</sup> Several of these studies were small; this may explain the variability in results. The summary LR (TABLE 2) for a positive anterior drawer test was 3.8 (95% CI, 0.7-22.0) and for a negative test was 0.30 (95% CI, 0.05-1.50). Only 1 study<sup>38</sup> reported on the specificity of Lachman test and it found 100% specificity; however, the authors reported on a population of patients who underwent MRI and subsequent arthroscopy, thus limiting the generalizability of these findings. The sensitivity of Lachman test ranged from 60% to 100% and the mean (SD) was 84% (15%) (Table 1).<sup>32,34,35,37-40</sup> Based on the 1 study<sup>38</sup> that reported both the specificity and sensitivity of Lachman test, the

LR for a positive test was 42.0 (95% CI, 2.7-651.0) and for a negative test was 0.1 (95% CI, 0.0-0.4) (Table 2). The specificity of the lateral pivot shift test has not been reported. The sensitivity of this maneuver varied from 27% to 95% with a mean (SD) of 38% (28%).<sup>30-32,35,39</sup>

### PCL Examination

Two studies of the composite examination for PCL injuries reported a mean sensitivity of 91% and specificity of 98%

(TABLE 3).<sup>26,27</sup> The summary LRs for a positive general examination was 21.0 (95% CI, 2.1-205.0) and for a negative general examination 0.05 (95% CI, 0.01-0.50). Three studies<sup>36,41,42</sup> analyzed the diagnostic accuracy of specific examination maneuvers. The specificity of the posterior drawer test was not reported in any study. Two studies<sup>41,42</sup> reported its sensitivity, which ranged from 51% to 86% with a mean of 55%. The only other examination

maneuver tested for PCL lesions was the abduction stress test, examined by the 1 investigator who originally described the test.<sup>36</sup> This test had a sensitivity of 94% and a specificity of 100%. The resulting LR for a positive test was 94 (95% CI, 6-1487) and for a negative test 0.1 (95% CI, 0.0-0.4).

### Meniscal Examination

Nine studies investigated the diagnostic accuracy of the examination for menis-

**Table 1.** Diagnostic Accuracy of the Physical Examination for Anterior Cruciate Ligament (ACL) Injuries\*

Source, y	Level of Evidence	No. of Subjects	Patient Population	Reference Standard	Examination Maneuver	Sensitivity, %	Specificity, %
Simonsen et al, <sup>26</sup> 1984	1	118	Consecutive patients with hemarthrosis; acute	Arthroscopy	General examination	62	56
O'Shea et al, <sup>27</sup> 1996	1	156	Consecutive patients with chronic knee pain; acute and chronic	Arthroscopy	General examination	97	100
Rose and Gold, <sup>28</sup> 1996	4	154	Nonconsecutive patients with knee pain; chronic	Arthroscopy	General examination	100	99
Braunstein, <sup>29</sup> 1982	4	29	Consecutive patients who underwent arthrography and then arthrotomy	Arthrotomy	ADT	91	89
Dahlstedt and Dalen, <sup>30</sup> 1989	2	41	Consecutive patients with hemarthrosis but no fracture on radiograph; acute	Arthrotomy	LPST	37	NA
DeHaven, <sup>31</sup> 1980	4	35	Consecutive athletes with knee injuries and hemarthrosis; acute	Arthroscopy	ADT LPST	9 27	NA NA
Donaldson et al, <sup>32</sup> 1985	4	101	Nonconsecutive patients from sports medicine clinic found at surgery to have ACL tears; acute	Arthroscopy/ arthrotomy	ADT LPST Lachman	70 35 99	NA NA NA
Fowler and Lubliner, <sup>33</sup> 1989	1	24	Consecutive patients with knee pain; chronic	Arthroscopy	JLT	75	NA
Gurtler et al, <sup>34</sup> 1987	1	75	Consecutive patients with ACL tears; acute and chronic	Arthroscopy	Lachman	100	NA
Hardaker et al, <sup>35</sup> 1990	1	101	Consecutive patients with knee injuries and hemarthrosis presenting to sports medicine clinic; acute	Arthroscopy	ADT LPST Lachman	18 29 74	NA
Hughston et al, <sup>36</sup> 1976	4	68	Consecutive patients with ruptures of the "medial compartment"; acute	Arthrotomy	ADT	65	23
Jonsson et al, <sup>37</sup> 1982	4	107	Nonconsecutive patients found at surgery to have a ruptured ACL; acute and chronic	Arthroscopy	ADT Lachman	93 60	NA NA
Lee et al, <sup>38</sup> 1988	4	41	Nonconsecutive patients who underwent MRI and then arthroscopy	Arthroscopy	ADT Lachman	78 89	100 100
Liu et al, <sup>39</sup> 1995	4	38	Nonconsecutive patients with proven ACL ruptures; acute	Arthroscopy	ADT LPST Lachman	63 95 72	NA NA NA
Mitsou and Vallianatos, <sup>40</sup> 1988	4	144	Nonconsecutive patients with proven ACL ruptures; acute and chronic	Arthroscopy/ arthrotomy	ADT Lachman	72 91	NA NA

\*Acute patients refers to those seen within 3 months of their injury and chronic refers to beyond 3 months. If no mention is made of acute or chronic, the authors did not specify. NA indicates not applicable since no patients without lesions were included; ADT, anterior drawer test; LPST, lateral pivot shift test; JLT, joint line tenderness; and MRI, magnetic resonance imaging. See "Methods" section for explanation of level of evidence.

cal injuries (TABLE 4); all used arthroscopy as the reference standard.<sup>27,28,33,43-48</sup> Five of these studies reported the accuracy of the composite examination; the mean (SD) sensitivity for the composite examination was 77% (7%) and the specificity was 91% (3%).<sup>27,28,43-45</sup> Four other studies examined specific examination maneuvers.<sup>33,46-48</sup> Joint line tenderness had a mean (SD) sensitivity of 79% (4%) and a specificity of 15% (22%).<sup>33,46-48</sup> The summary LR for a positive test was 0.9 (95% CI, 0.8-1.0) and for a negative test

**Table 2.** Selected Physical Examination Maneuvers for Ligamentous Knee Injuries\*

Source, y	Likelihood Ratio (95% Confidence Interval)	
	Positive	Negative
<b>Anterior Drawer Test</b>		
Hughston et al, <sup>36</sup> 1976	0.8 (0.6-1.2)	1.5 (0.6-3.8)
Braunstein, <sup>29</sup> 1982	8.2 (2.2-31.0)	0.1 (0.0-0.7)
Lee et al, <sup>38</sup> 1988	37.0 (2.3-576.0)	0.2 (0.1-0.5)
Summary†	3.8 (0.7-22.0)	0.30 (0.05-1.50)
<b>Lachman Test</b>		
Lee et al, <sup>38</sup> 1988	42.0 (2.7-651.0)	0.1 (0.0-0.4)

\*Includes all studies with data supplied to calculate both sensitivity and specificity.

†Calculated using a random-effects model.

**Table 3.** Diagnostic Accuracy of the Physical Examination for Posterior Cruciate Ligament (PCL) Injuries\*

Source, y	Level of Evidence	No. of Subjects	Patient Population	Reference Standard	Examination Maneuver	Sensitivity, %	Specificity, %
Simonsen et al, <sup>26</sup> 1984	4	118	Consecutive patients with hemarthrosis; acute	Arthroscopy	General examination	91	80
O'Shea et al, <sup>27</sup> 1996	1	156	Consecutive patients with chronic knee pain; acute and chronic	Arthroscopy	General examination	100	99
Hughston et al, <sup>36</sup> 1976	4	68	Consecutive patients with ruptures of the "medial compartment"; acute	Arthrotomy	AST	94	100
Baker et al, <sup>41</sup> 1984	4	40	Nonconsecutive patients with known PCL tear; acute	Arthroscopy	PDT	86	NA
Loos et al, <sup>42</sup> 1981	4	59	Nonconsecutive patients with PCL tear; acute	Arthroscopy/arthrotomy	PDT	51	NA

\*Acute patients refers to those seen within 3 months of their injury and chronic refers to beyond 3 months. If no mention is made of acute or chronic, the authors did not specify. NA indicates not applicable since no patients without lesions were included; AST, abduction stress test; and PDT, posterior drawer test. See "Methods" section for explanation of level of evidence.

**Table 4.** Diagnostic Accuracy of the Physical Examination for Meniscal Injuries\*

Source, y	Level of Evidence	No. of Subjects	Patient Population	Reference Standard	Examination Maneuver	Sensitivity, %	Specificity, %
Daniel, <sup>43</sup> 1991	4	177	Nonconsecutive patients with suspected meniscal tears	Arthroscopy/arthrotomy	General examination	82	78
Gillies and Seligson, <sup>44</sup> 1979	4	50	Nonconsecutive patients with known meniscal tears	Arthrotomy	General examination	64	NA
Miller, <sup>45</sup> 1996	4	57	Nonconsecutive patients with known meniscal tears; acute and chronic	Arthroscopy	General examination	81	NA
O'Shea et al, <sup>27</sup> 1996	1	156	Consecutive patients with knee pain; acute and chronic	Arthroscopy	General examination	73	84
Rose and Gold, <sup>28</sup> 1996	4	154	Nonconsecutive patients with knee pain; chronic	Arthroscopy	General examination	79	79
Fowler and Lubliner, <sup>33</sup> 1989	1	80	Consecutive patients with knee pain; chronic	Arthroscopy	JLT McMurray Apley	85 29 16	NA NA NA
Anderson and Lipscomb, <sup>46</sup> 1986	4	100	Consecutive patients suspected of having meniscal tears presenting for arthroscopy; acute and chronic	Arthroscopy/arthrotomy	JLT McMurray MLGT	77 58 69	NA 29 86
Barry et al, <sup>47</sup> 1983	4	44	Nonconsecutive patients presenting for meniscectomy	Arthroscopy/arthrotomy	JLT McMurray Effusion	76 56 35	43 100 100
Noble and Erat, <sup>48</sup> 1980	4	200	Nonconsecutive patients presenting for meniscectomy; acute and chronic	Arthroscopy	JLT McMurray	79 63	11 57

\*Acute patients refers to those seen within 3 months of their injury and chronic refers to beyond 3 months. If no mention is made of acute or chronic, the authors did not specify. NA indicates not applicable since no patients without lesions were included; JLT, joint line tenderness; and MLGT, medial-lateral grind test. See "Methods" section for explanation of level of evidence.



**Table 5.** Selected Physical Examination Maneuvers for Meniscal Knee Injuries\*

Source, y	Likelihood Ratio (95% Confidence Interval)	
	Positive	Negative
<b>McMurray Test</b>		
Noble and Erat, <sup>48</sup> 1980	1.5 (1.1-2.1)	0.6 (0.5-0.9)
Barry et al, <sup>47</sup> 1983	8.9 (0.6-132.0)	0.5 (0.3-0.7)
Anderson and Lipscomb, <sup>46</sup> 1986	0.8 (0.5-1.3)	1.5 (0.4-4.9)
Summary†	1.3 (0.9-1.7)	0.8 (0.6-1.1)
<b>Joint Line Tenderness</b>		
Noble and Erat, <sup>48</sup> 1980	0.9 (0.8-1.0)	1.9 (0.8-4.3)
Barry et al, <sup>47</sup> 1983	1.3 (0.7-2.6)	0.6 (0.2-1.6)
Summary†	0.9 (0.8-1.0)	1.1 (1.0-1.3)
<b>Joint Effusion</b>		
Barry et al, <sup>47</sup> 1983	5.7 (0.4-86.0)	0.7 (0.5-0.9)
<b>Medial-Lateral Grind</b>		
Anderson and Lipscomb, <sup>46</sup> 1986	4.8 (0.8-30.0)	0.4 (0.2-0.6)

\*Includes all studies with data supplied to calculate both sensitivity and specificity.

†Calculated using a random-effects model.

1.1 (95% CI, 1.0-1.3) (TABLE 5). The mean (SD) sensitivity of the McMurray test was 53% (15%) and the specificity was 59% (36%).<sup>33,46-48</sup> The summary LR for a positive test was 1.3 (95% CI, 0.9-1.7) and for a negative test 0.8 (95% CI, 0.6-1.1). Other maneuvers were not formally examined in more than 1 study and included the Apley compression test, the medial-lateral grind test, and the presence of a joint effusion. The Apley compression test had a sensitivity of 16%; no patients without meniscal lesions were tested.<sup>33</sup> The medial-lateral grind test had a sensitivity of 69% and a specificity of 86%.<sup>46</sup> A joint effusion was found to have a sensitivity of 35% and specificity of 100%; however, this last study only included patients admitted for arthroscopy.<sup>47</sup>

### Limitations of Data

Given the relative frequency and economic consequences of meniscal or ligamentous knee injuries, data about the accuracy of the physical examination were relatively limited. While no specific examination maneuver has impressive test performance characteristics, the composite examination for ACL, PCL, and meniscal lesions are reported to be reasonably sensitive and specific. One possible explanation for this finding is that a constellation of examination findings may be more useful than any 1 finding. No data were available to judge the accuracy of the physical examination of the MCL and LCL.

The patient population examined in the studies reviewed was an important determinant of the accuracy of the examination. Some investigators only included acute injuries, others only chronic injuries, while some did not specify. The chronicity of the injury may affect the sensitivity and specificity of examination maneuvers. The examination for ACL injuries was less accurate if a hemarthrosis was present since the increased intra-articular volume causes pain that is increased with any examination maneuver. This is a good illustration of spectrum bias, where the "spectrum" of patients included in a study affects the diagnostic accuracy

### Box. Recommended Basic History and Physical Examination for Patients With Suspected Meniscal or Ligamentous Knee Injuries

#### Historical Items

1. Where exactly is the knee pain ("point to it with 1 finger")?
2. What is the duration of the pain?
3. Prior to the pain starting had there been a change in activities?
4. Was there an injury to the lower extremity and, if so, what was the direction of the forces?
5. Was there a "pop" at the time of injury?
6. Was the knee swollen at the time of the injury or anytime since?
7. Is there giving way or buckling of the knee?
8. Is the knee locking or catching in extension or flexion?
9. Is there pain in the hip, thigh, or back?

#### Physical Examination Tests

1. Alignment: Are the femur, tibia, and patella in normal alignment during standing and walking?
2. Range of motion: Can the patient actively and/or passively flex and extend the knee?
3. Effusion: Is there a fluid wave or does ballottement of the patella produce a tapping sensation?
4. Joint line tenderness: Is the patient tender along the medial and/or lateral joint lines?
5. Lachman test: Is there a discrete end point when the tibia is anteriorly subluxed on the femur?
6. Anterior drawer test: Is there anterior subluxation of the tibia on the femur?
7. Posterior drawer test: Is there posterior sag or translation of the tibia on the femur?
8. Lateral pivot shift: Does the tibia "jump" anteriorly when extended or flexed with a valgus stress?
9. McMurray test: Is there a "popping" at the joint line when the knee is extended and rotated?

of a given test.<sup>49</sup> This may have accounted for some of the variation in the results reported between articles.

Another potential source of variation in the literature was the experience of the examiner and the precise methods used for conducting the physical examination test. It is commonly believed that the examination for meniscal and ligamentous injuries is difficult to learn and that accuracy may therefore increase with experience. While all of the studies included in this literature review used orthopedic surgeons who are generally experienced in the knee examination, most articles did not quantify the examiners' number of years in practice. If experience is an important determinant of accuracy, the data presented in this review should represent an upper limit. The definitions of an "abnormal" or "positive" physical examination were not always clear from the articles. Also, the reproducibility of the physical examination was unclear and rarely reported. These sources of variation all contribute to heterogeneity between studies illustrated by broad 95% CIs in the summary LRs.

The physical examination should be preceded by a careful history taking. Historical findings that may substantially improve the accuracy of the physical examination include the angle and force of impact if an injury occurred; whether the patient heard a "pop" at the time of injury; whether the patient has been experiencing catching, locking, or giving way of the knee; and whether the patient had noticed swelling around the knee. The sensitivity and specificity of historical items deserve attention, but we were unable to find published data regarding the sensitivity and specificity of commonly asked questions. Our review suggests that a combination of historical and physical examination findings may be more useful than any 1 specific item. Future studies must pay careful attention to recruiting an appropriate patient population, including subjects without pathologic lesions. They should also be careful in describing the physical examination, explicitly documenting criteria for "abnormal"; in cal-

culating inter- and intra-observer reliability; and in testing the diagnostic accuracy of clinically relevant clusters of historical and examination items.

### How to Improve Your Physical Examination Skills

Improving your diagnostic skills for meniscal and ligamentous knee injuries takes practice. The physical examination can be practiced on healthy patients to develop an examination routine and gain a mental image of healthy anatomy. Patients with knee pain should be examined so that you can describe what you think is the anatomic lesion causing the pain. If you refer the patient, the referral letter should include your presumed anatomic diagnosis. This forces the examination to be more thorough and it will aid the consultant in his/her workup. If the patient goes for MRI or surgery, compare your assessment with the imaging or surgical findings.

### SCENARIO RESOLUTION

The first case describes a young man with a probable ACL rupture. The angle of injury, the presence of a "pop," the difficulty bearing weight, and the transient swelling all support this diagnosis. He should be counseled about his prognosis, encouraged to begin a program of quadriceps strengthening, and given the option of pursuing surgical reconstruction if the symptoms are functionally limiting. The second case characterized a common scenario in primary care practices, the older patient with degenerative joint disease and a probable superimposed degenerative meniscal tear. This patient's functional limitations need to be assessed carefully. If she is not too impaired, joint aspiration of the effusion, nonsteroidal anti-inflammatory drugs, quadriceps strengthening, and a cane may provide enough pain relief and mobility to make more invasive treatment unnecessary. If conservative management fails and her symptoms include locking or giving way, arthroscopic partial meniscectomy may be useful. Patients with substantial impairment and signifi-

cant degenerative changes on weight-bearing radiographs may be candidates for total knee replacement.

### THE BOTTOM LINE

Based on our review of the literature and clinical experience, we suggest the history and physical examination for patients with possible meniscal or ligamentous lesions outlined in the **BOX**. While there are scant specific data supporting each element of the history and physical examination we have outlined, these items are presumed to be part of the composite examination that was found to be useful in determining whether there is a possible meniscal or ligamentous injury. The composite examination for an ACL tear performed by orthopedic physicians is highly predictive (positive LR of 25.0; 95% CI, 2.1-306.0, negative LR of 0.04; 95% CI, 0.01-0.50), as is the composite examination for a PCL tear (positive LR of 21.0; 95% CI, 2.1-205.0, negative LR of 0.05; 95% CI, 0.01-0.50). The examination for meniscal tears is less efficient; the composite examination confers a positive LR of 2.7 (95% CI, 1.4-5.1) and a negative LR of 0.4 (95% CI, 0.2-0.7). If the history and physical examination do not allow the determination of a meniscal or ligamentous injury, consultation with a musculoskeletal specialist may obviate expensive and unnecessary diagnostic imaging.

**Author Affiliations:** Division of Rheumatology, Immunology, and Allergy, Robert B. Brigham Multipurpose Arthritis and Musculoskeletal Diseases Center (Drs Solomon and Katz), Division of Pharmacoepidemiology and Pharmacoeconomics (Dr Solomon), Division of General Medicine, Departments of Medicine (Dr Bates), and Orthopedic Surgery (Dr Schaffer), Brigham and Women's Hospital, Harvard Medical School, Boston, Mass; Durham Veterans Affairs Medical Center and Duke University Medical Center, Durham, NC (Dr Simel). Dr Schaffer is now with The Cleveland Clinic.  
**Author Contributions:** Study concept and design: Solomon, Simel, Bates, Katz, Schaffer.  
 Acquisition of data: Solomon, Schaffer.  
 Analysis and interpretation of data: Solomon, Simel, Schaffer.  
 Drafting of the manuscript: Solomon, Simel, Schaffer.  
 Critical revision of the manuscript for important intellectual content: Solomon, Simel, Bates, Katz, Schaffer.  
 Statistical expertise: Solomon, Simel.  
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