CONTINUING EDUCATION
for Physical Therapists

ORTHOPEDIC SPECIAL TESTS: LOWER EXTREMITY

4 CE HOURS

Course Abstract

This course provides learners with state-of-the-art literature on orthopedic special tests for the lower extremity, with attention to the statistics that support and/or dispute the continued relevance of each. It begins with an overview of relevant statistical terminology; touches on medical screening, toolbox questionnaires, and clearing the lumbosacral spine; and examines special tests and related statistics for the hip, knee, and ankle.

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Approvals

To view the states that approve and accept our courses, CLICK HERE.

Target Audience & Prerequisites

PT, PTA, ATC – no prerequisites

Learning Objectives

By the end of this course, learners will:

- ❑ Distinguish between the statistical concepts of sensitivity and specificity
- ❑ Recall elements of medical screening
- ❑ Identify toolbox questionnaires pertaining to the lower extremity
- ❑ Recall elements of clearing the lumbosacral spine
- ❑ Recognize special tests and related statistics for the hip, knee, and ankle
- ❑ Recognize the significance of statistics as they apply to special test scenarios

Timed Topic Outline

I. Statistics: Sensitivity and Specificity (20 minutes)

II. Medical Screening, Toolbox Questionnaires, Lumbosacral Spine and Deep Tendon Reflexes (40 minutes)

III. Special Tests: Hip (60 minutes)

IV. Special Tests: Knee (60 minutes)

V. Special Tests: Ankle (45 minutes)

VI. Conclusion, Additional Resources, References, and Exam (15 minutes)

Delivery Method

Correspondence/internet self-study with a provider-graded multiple choice final exam. *To earn continuing education credit for this course, you must achieve a passing score of 80% on the final exam.*

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Course Author Bio and Disclosure

Dawn T. Gulick, PT, PhD, ATC, CSCS, is a Professor of Physical Therapy at Widener University in Chester Pennsylvania. She has been teaching for over 20 years. Her areas of expertise are orthopedics, sports medicine, modalities, and medical screening. As a clinician, she has owned a private orthopedic/sports medicine practice. She also provides athletic training services from the middle school to elite Olympic/Paralympic level. As a member of the Olympic Sports Medicine Society, Dr. Gulick has provided medical coverage at numerous national and international events. As a scholar, Dr. Gulick is the author of 4 books (Ortho Notes, Screening Notes, Sport Notes, Mobilization Notes), 4 book chapters, and over 50 peer-reviewed publications, and has made over 100 professional and civic presentations. She is the developer of a mobile app called iOrtho+ (Apple, Android, & PC versions), and the owner of a provisional patent.

Dr. Gulick earned a Bachelor of Science in Athletic Training from Lock Haven University (Lock Haven, PA), a Master of Physical Therapy from Emory University (Atlanta, GA), and a Doctorate of Philosophy in Exercise Physiology from Temple University (Philadelphia, PA). She is an AMBUCS scholar and a member of Phi Kappa Phi Honor Society. As a licensed physical therapist, she has direct access authorization. She also is a certified strength and conditioning specialist.

DISCLOSURES: Financial – Dawn T. Gulick sells iOrtho+, a mobile app, through Therapeutic Articulations LLC; receives royalties as an author with F. A. Davis Publishing; and received a stipend as the author of this course. Nonfinancial – No relevant nonfinancial relationship exists.

Welcome to lower extremity examination tests, an evidence-based course designed to provide you with state of the art literature on how to perform and interpret orthopedic examination techniques for the lower extremity.

The physical examination is made up of many elements:

- Client history
- Visual inspection
- **Medical screening**
- Functional skills
- **Questionnaires**
- ROM, MMT, Sensation, DTR's
- Palpation
- **Special tests**

This course will emphasize medical screening, toolbox questionnaires, and special tests.

Client history and visual inspection are components you most likely already know very well. We will touch on them on occasion, with the idea that there may be some particular questions that you might want to ask – or some particular things you might want to look for – but we are not going to spend a great deal of time on them.

We will, however, discuss medical screening, because not everything that causes joint pain is always musculoskeletal. Consider, for example, an individual who presents with anterior hip pain. Pain with motion and tenderness to palpation may imply the problem is musculoskeletal. However, it is important to also consider the possibility that the signs and symptoms may be the result of appendicitis. It is essential to look at the viscera as a potential source of some of this pain, and make the appropriate referrals for the things that are outside our scope of practice.

Functional skills I'm going to leave to you as part of your exam.

We are also going to talk about toolbox questionnaires: they're a resource that's readily available to you that not only helps you discern how much pain someone's in (which is certainly important!), but really helps you focus on function as well. It's one thing if a person reports to you with a pain level

of 9 or 10 out of a scale of 0-10, but it's another if they're also laughing and joking and moving around rather quickly or freely: you look at a situation like that and you say "This doesn't make sense." That's where using toolbox questionnaires to put pain together with respect to function can be very helpful. They can also help you to do serial measurements: doing a test at the time of the examination, and then doing another questionnaire or the same questionnaire two weeks later (or three or four weeks later, or at discharge) helps you to see that serial level of improvement. Finally, they help you to take rote data like range of motion and manual muscle testing and put it into a functional context. By that, I mean if a person gains ten degrees of external rotation over the course of two or three treatments, it is certainly very promising. But the more important consideration is what they can *"do"* with those ten degrees of external rotation – and that's where the toolbox questionnaires come in: by taking that increased motion and telling us how that is related to function.

Range of motion, manual muscle testing, sensation, and palpation are certainly important components of an examination, but will not be a part of this course.

We will spend most of our time discussing the special tests.

All special tests have an inherent problem that I'd like to disclose right from the get-go: standardization of some of these tests can be problematic, because many authors have studied them, and some have proceeded to apply their own personal little tweaks to them. Why is that a problem? Well, particularly in the area of orthopedics, what tends to happen is someone names a test after him/herself, and then somebody else picks up that test, tweaks it slightly, and renames it… and we end up with seventeen tests for the glenoid labrum. That is reality! There are seventeen tests right now for the glenoid labrum…..some of them good, and some of them not so good. So which of those tests do you do? And what if you get a positive on one test and a negative on another – now what do you do? To that end, you have to be able to figure out for yourself which of these tests are good and which of these are not good. You'll want to make sure that you have *multiple* tests pointing in the same direction to give you confidence that a *particular* test is valuable to you.

Statistics

As we discuss special tests, we are going to talk about their clinical significance and clinical application: basically, "What do they mean to us?" In order to do that, we need to lead off with a brief tutorial on statistics, focusing on the concepts of *sensitivity* and *specificity*.

If you graduated from school more than ten years ago, these concepts were probably not in your curriculum. That's because we really didn't know a lot about the sensitivity and specificity of many of the orthopedic tests that we were utilizing. But since the early 2000s, this has evolved – and since we have coined the term "evidence-based practice" the use of statistics has basically exploded.

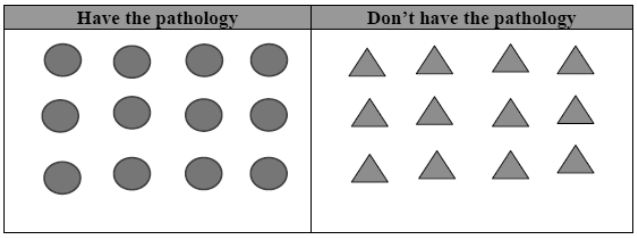
- **Sensitivity = Sen Neg OUT**
  - Test is Negative = Rule pathology OUT
- **Specificity = Sp Pos IN**
  - Test is Positive = Rule pathology IN

For the concept of *sensitivity*, use the acronym '**S-N-O-U-T**'…..**S**ensitivity – **N**egative – rule it **OUT**. When a test is highly sensitive and the results are negative, we can rule out the suspected pathology. In other words, if we have a test that has high sensitivity testing muscle 'A,' and that test is negative, then we can say with confidence that muscle 'A' is not injured. Thus, a test that is highly sensitive is used to rule out the pathology when the test result is negative.

For the concept of *specificity*, use the acronym '**S-P-I-N**'…. **S**pecificity – **P**ositive - rule it **IN**. So when a test that is highly specific is used on muscle 'B,' if that test is positive, then we can say that there's a good chance that muscle 'B' is injured. Now that is not the way you want to necessarily function in the clinic: you don't want to get the results of one test and go running off saying "I know what the problem is; let's start treating you." Ideally, you would like to see a couple of tests that are positive. So to that end, we will also look at clustering tests.

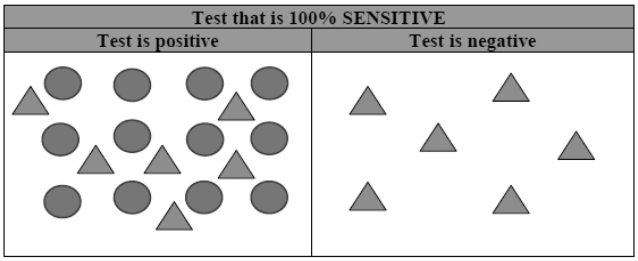
Let's consider this example, published by Cleveland (2007) to depict the application of the sensitivity and specificity.

Here is a situation where we have 12 people with a disease and 12 people without a disease: the ones on the left are red and they have the disease; the ones on the right are green and they do not have the disease.

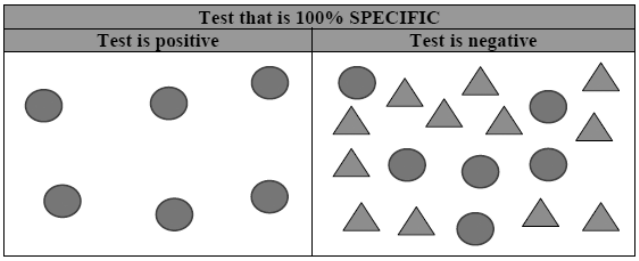


If we explore using a test that is 100% *sensitive*, then that would mean if a person tests negative for that disease, we can rule it out. In the image below, the people on the left tested positive and the people on the right tested negative. As you can see, every single person who tested negative does not have the disease, so it is 100% accurate for sensitivity. Now clearly there

are people on the left that tested positive that don't have the disease, and those would be false positives. But as we go forward in our examination and look at other tests – again, you're not ever going to want to just use one test – we will find things that will help to reassign or recapture those people in the right area.



At the other end of the spectrum, here we see a test that's 100% *specific*: all the people on the left tested positive, all the people on the right tested negative, and every single person who tested positive does in fact have the disease. Again, we have people on the right who tested negative that have the disease, and this test would be a false negative for those people. I'm going to keep stressing this point: as a clinician you will not be making a diagnosis based on one test alone. Instead, your examination process will seek to identify a cluster of signs and symptoms pointing to the correct diagnosis of a given pathology. Following this practice will help you ensure that another test or measure will recapture or reassign the individuals that were false negatives.



Likelihood ratios help to enhance our interpretation of test sensitivity and specificity. A test that has a good negative likelihood ratio would be one that tells us how much the odds of the disease decrease when the test is negative. Conversely, a test that has a solid positive likelihood ratio will tell us how much the odds of the disease increase when the test is positive.

Let's couple these factors together and see what they tell us. If a test for a particular disorder is highly sensitive (over 90%), and also has a negative likelihood ratio that's down around 0.1 or 0.2., this would be a good metric to rule out the disorder. In other words, if the test for muscle 'A' comes back negative on a highly sensitive test with a good negative likelihood ratio, we can pretty confidently say that muscle 'A' is not the problem here.

Likewise, if a test for a particular disorder is highly specific, with a likelihood ratio that's over 5 (it's even better yet when it's in double digits: 10, 11, 15), and the test for muscle 'B' comes back positive – you're in a good position to state that muscle 'B' it is in fact problematic.

Remember, in both instances, you will go on to look at other tests to confirm your initial results, and you'll also consider other tissues, in order to rule them out.

You want to make sure that the results of the tests you chose to implement are complementary, i.e. those tests with high sensitivity are complemented by those that have high specificity in your clinical examination.

The complementary nature of radiographs and the Ottawa Ankle Rules serve as a good example. The Ottawa Ankle Rules detail criteria to discern whether a radiograph is needed, so if a person injures his/her ankle, you would implement the Ottawa Ankle Rules to determine if an x-ray is needed.

Per the Ottawa Ankle Rules, if a person has bone tenderness at the posterior edge of the distal 6 cm of either the medial or the lateral malleolus, that would be positive. (Be sure to palpate the bone and not the joint or muscle. Remember you are looking for the potential of a fracture, not a sprain.) In addition, if the person has difficulty or is unable to weight bear immediately after the injury, and is unable to take four steps in the emergency room or shortly thereafter, then this would also be a positive test.

X-ray series of the ankle is only required if the client presents with any of the following criteria:

- Bone tenderness at posterior edge of the distal 6 cm of the medial or lateral malleolus
- Totally unable to bear weight both immediately after injury & (for 4 steps) in the emergency department

Ottawa Ankle Rules

- Adults:
  - Sensitivity = 95-100%
  - Specificity = 16%
- Children:
  - Sensitivity = 83-100%
  - Specificity = 21-50%

Radiograph

- Sensitivity = 57 - 62%
- Specificity = 88%

Ottawa Ankle Rules

Looking at the metrics, you can see that the Ottawa Ankle Rules are highly sensitive for both adults and for children, but the specificity is extremely poor. So while this test is very good at ruling out the need for a radiograph, it doesn't tell us that there's a fracture. It simply tells us that we need a radiograph if it's positive.

Conveniently, the metrics for a radiograph indicate that they are highly specific.

To recap: in your repertoire, you have the Ottawa Ankle Rules (highly sensitive) and a radiograph (highly specific). So when you couple these two types of tests together, you can arrive at a clinical decision that is strongly supported by the literature: one test rules a pathology out; the other test confirms the diagnosis of the pathology. This is just one of many examples of how you can use the literature to confidently implement clinical decision making.

A final thought: we want test metrics to optimally be > 90%. Greater than 75% may be helpful when clustered with other tests, but metrics around 50-60% are no better than a coin toss… and clearly we don't want to make clinical decisions with a coin toss!

Hopefully this has made the concept of statistics a little bit easier for you, and has helped you see their clinical relevance. Now, on to the meat of the course!

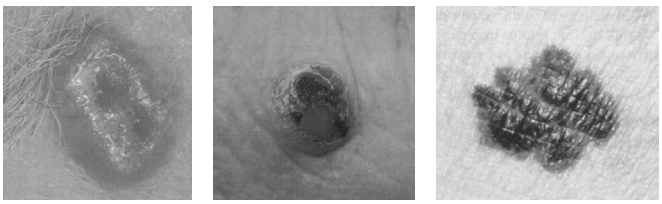
Medical Screening

Not all lower extremity pain comes from a lower extremity pathology. As clinicians we need to confirm the "driver" of the pain, and not be fooled into treating the "passenger." Herniated disks are not the only pathology that radiates into the hip or down the leg. There are numerous pathologies that produce lower extremity pain. Some of these pathologies may be specific to certain periods of time within the lifespan and others may occur at any time. We are going to begin with one of the most devastating of all pathologies: cancer. Whenever someone has a diagnosis of cancer in their history, you always have to be concerned about an exacerbation. A client may be in remission for a long period of time and then they present to you in the clinic with pain or some type of problem that might indicate that the cancer has come back. We need to remember: "once a cancer diagnosis, always a cancer diagnosis."

So what are the warning signs of cancer? We use of the word "caution" to help to describe these warning signs.

- **C** = Change in bowel & bladder
- **A** = A sore that fails to heal in 6 weeks
- **U** = Unusual bleeding or discharge
- **T** = Thickening/lump (breast or elsewhere)
- **I** = Indigestion or difficulty swallowing
- **O** = Obvious change in wart or mole
  - **A** = Asymmetrical shape
  - **B** = Border irregularities
  - **C** = Color – pigmentation is not uniform
  - **D** = Diameter > 6 mm
  - **E** = Evolution (change in status)
- **N** = Nagging cough, hoarseness, rust colored sputum

For each one of the warning signs, there are many other possible mechanisms for the stated sign or symptom. As a clinician, you need to look for cluster of signs and symptoms that point to a given diagnosis. For example, "C," a change in the bowel or bladder function may be the result of a spinal cord injury. A thorough low back examination would be appropriate to rule out mechanical mechanisms for the signs or symptoms before considering cancer. Likewise, when we look at "O," an obvious change in a wart or mole, there are five considerations: an asymmetrical shape, a border that's irregular, pigmentation that's not uniform (multiple color tones), or a diameter greater than six millimeters. As for the diameter, I am not suggesting that you measure all of the warts or moles on your clients. If I told you that six millimeters is the size of a pencil eraser, you get an idea in your head of the size of a lesion that should concern you. If the wart or mole is larger than six millimeters, it may be cause for concern. And then, "E" evolution refers to a change in status over time. If this is the first time you have seen this client, you are going to have to rely on his/her knowledge of the situation. You may have to ask the client if there has been a change in the wart or mole (size, shape, coloration) in the past few weeks or months. Here is an example of some of the things in the A, B, C, D, E's. When you look at these images, you can see the different criteria for concern: multiple pigmentations, irregular borders, asymmetrical shapes.



Now as a therapist, it doesn't really matter what the labels are on these lesions. You simply need to recognize that elements of the A,B,C,D,E's are present. You need to recognize this is outside of your scope of practice and see to it that the client is referred to the appropriate medical professional.

In addition, there are other cancers besides skin cancers. Maranhao, Maranhao-Filho, Lima, and Vincent (2010) conducted an interesting study that looked at 13 different clinical tests on the detection of unilateral brain tumors. They actually found that the specificity was quite high for a variety of the tests studied. These are the thirteen tests that were explored.

Clinical Tests

- Spasticity of conjugate gaze
- Platysma sign
- Forearm rolling test
- Finger rolling test
- Digit quinti sign
- Souques interosseous sign
- Pronator drifting test
- Mayer sign
- Finger tapping sign
- Digit quinti rolling sign
- Foot tapping test
- Babinski sign
- Chaddock sign

Below are the details for six of the 13 tests reviewed. As you can see from the statistics, all six of the tests have strong specificity and high (+) predictive values (PPV). These are simple maneuvers that could be performed in seconds to assess the likelihood of a unilateral brain tumor.

Clinical Test	Maneuver	Positive Sign
Forearm rolling	Make fists, hold forearms horizontal & roll arms	1 arm orbits around other
Finger rolling	Index fingers pointing towards each other ~ 1 finger length apart; roll fingers	1 finger orbits around other
Souques interosseous sign	Pt raises both UE to 180° of shoulder flexion	Involved fingers ext & abd
Finger tapping	Index finger to thumb IP quickly x 10 sec	> 5 rep difference
Foot tapping	Sit, knee & ankle @ 90°, keep heel on floor & tap foot x 10 sec	> 5 rep difference
Babinski sign	Stimulate lateral plantar surface with blunt object	Extension of great toe

Clinical Test	Sens	Spec	PPV	NPV
Forearm rolling	16%	100%	100%	37%
Finger rolling	41%	93%	92%	44%
Souques interosseous sign	23%	80%	70%	34%
Finger tapping	18%	90%	78%	35%
Foot tapping	23%	93%	87%	37%
Babinski sign	8%	100%	100%	35%

For the forearm rolling test, you make a fist, hold your forearms out in front of you in a horizontal position, and roll the forearms around each other. If one arm orbits around the other in an asymmetrical movement, the test would be positive. Finger rolling is similar. The index fingers are held out in front in a horizontal position about one finger length apart. The client is asked to roll the fingers around each other. Again, a positive test is an asymmetrical motion of one finger orbiting around the other. For finger tapping, the client is asked to take the index finger to thumb and doing a quick tapping motion as many times as possible for ten seconds. A greater than five-rep difference between the right and left hands is a positive test. Foot tapping involves tapping your foot on the floor for ten seconds and looking to see if there is a five-rep difference between the right and left feet. The Babinski is a plantar surface stimulation of the foot. The clinician uses the blunt side of a reflex hammer to stroke the foot. A positive sign would be extension of the great toe.

These are just a few examples, really simple things that can be done to screen for a brain tumor. With that being said, it is important to remember that "when you hear hoof beats, think horses, not zebras." There are a large number of possible diagnoses that are more likely than a brain tumor. The brain tumor is the "zebra" but there are grave consequences to missing this diagnosis. It is critical to rule this possibility out before moving forward with other possibilities.

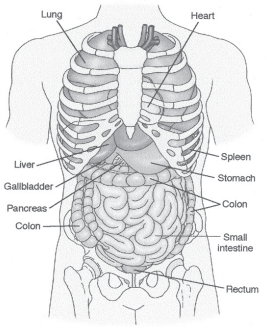
When you look at the statistics of these tests, you can see that although the sensitivity is not high, specificity is excellent. Likewise, positive predictive values coupled with the high specificity make these superb diagnostic tests. Should one or more of these tests be positive, a dialogue with the primary care physician would be in order.

In addition to cancer, there are several other medical conditions that should be ruled out before proceeding with a lower extremity examination. When we speak about 'red flags' in medical screening, we will define a 'red flag' as a sign or symptom that is a strong predictor of pathology. And red flags are going to differ based on the person with who you are working. For example, let's take the symptom of a headache. If you are a middle-aged adult, chances are you have had many headaches over the course of your life span. However, if you are a three year old child, a headache is not typical at all. So a headache may not be a big concern for an adult but it may be a red flag for a three or four year old child. So we have to put signs and symptoms into perspective. The interpretation of red flags has to be client-specific.

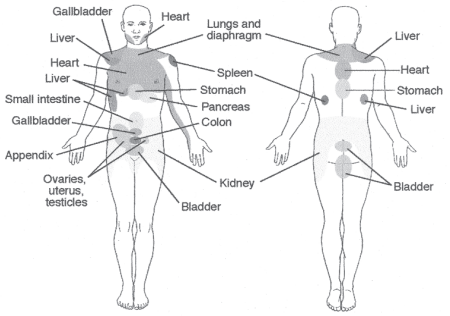
VISCERAL SCREENING

When we talk about red flags, some of them include the visceral system and their referral patterns. The diagrams below show the anatomic location of the visceral structures and the referral pattern of each struc-

ture. Some of the issues that could include the lower extremity could originate from the kidney which refers to the flank. The bladder and colon, as well as the ovaries, uterus, and testicles, refer to the groin. Ruling out an ovarian cyst when an individual presents with groin pain would be important. In addition, the appendix can produce pain in the right lower quadrant. So we really need to know where these structures are and recognize where they refer to so that we can also rule out visceral issues as part of our initial data gathering.



Gulick, OrthoNotes, FA Davis Publishing, 2013



Gulick, OrthoNotes, FA Davis Publishing, 2013

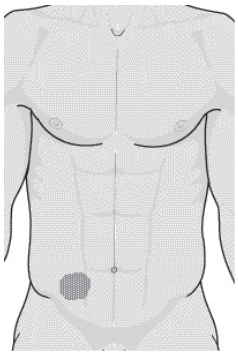
Blumberg's sign, known as rebound tenderness, is a generic abdominal test which tells you if there is a problem with inflammation in the abdominal cavity. The technique involves pushing down vertically into the gut very slowly, and then releasing quickly. If the client reports discomfort upon release, that would be a positive test. A positive test does not tell you anything about what kind of problem may be present, just that there is a concern. So that may be a piece of information that you store, and then you look further into other areas. Potentially this may result in a conversation with the client's physician.

Blumberg's Sign

Gulick, iOrtho+ Mobile App, 2016

Three additional tests can be used to assess potential problems of the appendix: McBurney's point, psoas sign, and obturator sign.

McBurney's Point



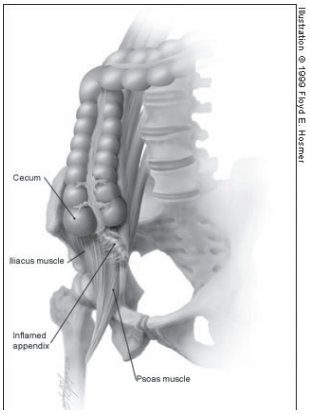
Gulick, OrthoNotes, FA Davis, 2013

Let's begin by reviewing the function of the appendix. Many see the appendix as a structure of little value. However, the appendix is a reservoir for good bacteria. If you've ever had Montezuma's Revenge, food poisoning, or taken a broad spectrum antibiotic that wiped out the good bacteria in your gut, the appendix is responsible for repopulating the good bacteria.

Sometimes the appendix can become inflamed, and palpation of McBurney's point can be helpful in pinpointing that condition. McBurney's point is a location that is 1/3 of the distance between the anterior superior iliac spine (ASIS) and the umbilicus. If that spot is tender to palpation, it would be a positive test.

The psoas sign capitalizes in the proximity of the psoas muscle to the appendix. By incriminating the psoas muscle, an inflamed appendix will reproduce the pain. The test involves positioning the client in left sidelying and extending the right hip while stabilizing the lumbar spine. By taking the right hip back into extension, the psoas - a hip flexor - will tug on the adjacent appendix and reproduce the symptoms. That would be a positive test. Given that the specificity for this test is 95%, it can serve as a strong diagnostic tool.

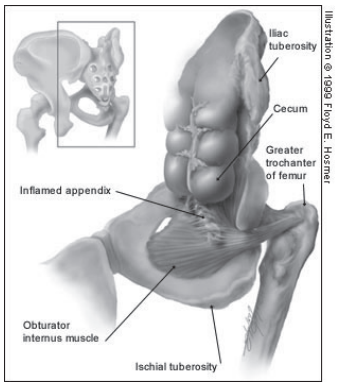
However, the clinician still must be certain that the client does not have any mechanisms for a psoas injury before suspecting an appendix problem. If there is any concern about the psoas test being a false positive, the obturator sign could be performed.



Psoas Sign

Gulick, iOrtho+ Mobile App, 2016

The obturator sign is similar to the psoas sign in that it uses the proximity of the obturator internus to the appendix. The test position is supine with the right hip and knee in 90° of flexion. The hip is then passively taken into internal rotation. Since the obturator internus is a hip external rotator, this position will put the muscle on a stretch and incriminate the appendix. Although the testing process parallels that of the psoas sign, there is not any statistical data to support its use.



Obturator Sign

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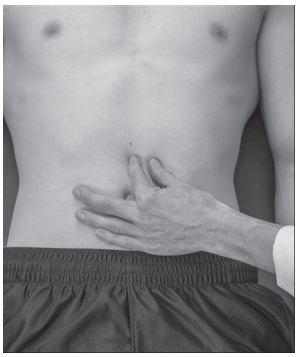
Given the catastrophic nature of a ruptured abdominal aorta (AAA), palpation of the abdominal aorta width may be helpful. In supine with the hips/knees flexed, the clinician palpates the upper abdomen. First identify the xiphoid process and then the umbilicus. Go half way between these two structures just left of midline. Press firm and deep into the abdominal region to palpate the pulsation of the aorta. Place a thumb on one-side and an index/middle finger on the other side and measure this distance. This corresponds to the width of the abdominal aorta. A normal aortic pulse width is less than 2 cm (some clinicians say 3 cm). When accompanied by back pain with palpation and/or bruits on auscultation, is reason for significant concern. This concern is evidenced by the statistics for this test. However, it is important to note sensitivity decreases significantly when abdominal girth exceeds 100cm (39.4 inches). The charts below reveal the recommended course of action when an AAA is suspected.

Abdominal Aorta Palpation



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Palpation of Abdominal Aorta

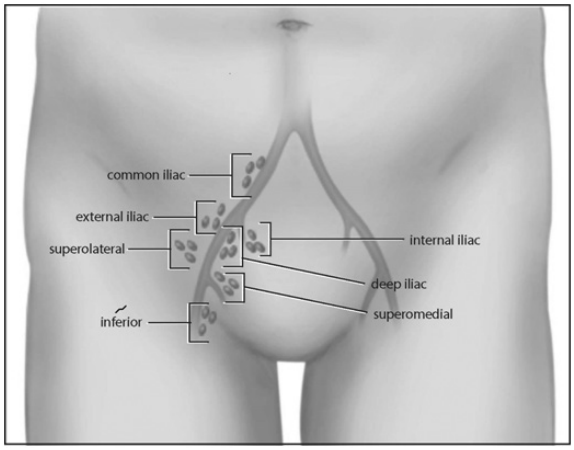
Sensitivity = 31-77%
Specificity = 75-96%
(+) LR = 2.7-12.0
(-) LR = 0.43-0.72

Aneurysm Width	Surveillance
< 3.0 cm	None
3.0 - 3.9 cm	US every 2-3 year
4.0 – 5.4 cm	US or CT every 6-12 months
> 5.4m cm	Surgical consult

Aneurysm Width	Lifetime Risk of Rupture
5 cm	20%
6 cm	40%
7 cm	50%

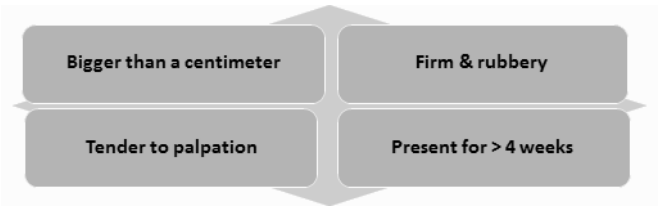
In addition to the standardized tests for the viscera, there are other "red flags."

A number of indicators known as constitutional symptoms can be warnings of systemic pathology. Signs and symptoms such as weight loss, fever, chills, pallor, bowel and bladder changes are all known as constitutional symptoms. If your client presents with any of these, you need to be considering systemic issues. None of these indicators happen with a musculoskeletal pathology: these are systemic and suggest that we need to look deeper.



Gulick, iOrtho+ Mobile App, 2016

Furthermore, any time we see enlarged lymph nodes, we need to consider systemic issues. The location of the inguinal lymph nodes is displayed above; they should be palpated if constitutional symptoms are present. Upon palpation, if the lymph nodes are bigger than a centimeter, firm and rubbery, tender to palpation, and present for more the four weeks, the primary physician should be consulted.



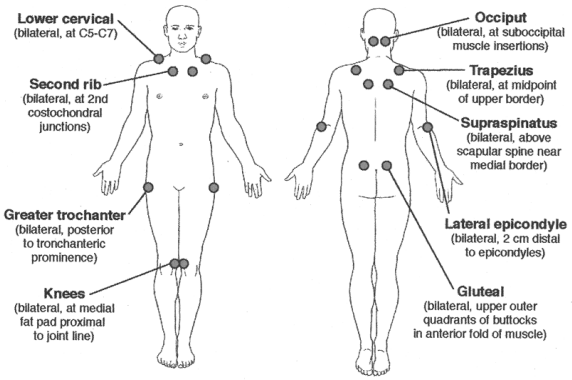
Other systemic syndromes that may present as musculoskeletal problems include Lyme disease and fibromyalgia.

Bull's-Eye Rash

The hallmark of Lyme disease is a bull's-eye rash that occurs within 7-14 days of a tick bite. The rash may be five to six inches in diameter, and may or may not be warm to palpation, but it is usually not painful or itchy. Sometimes tick bites occur on areas of the body that may be difficult to see. Ticks tend to bite where natural barriers impede their forward motion, i.e. popliteal fossa, axillary fold, gluteal fold, hairline, areas near elastic bands in bra straps or underwear. If the bullseye rash dissipates without being noticed, the remaining signs and symptoms can be a challenge to diagnose as Lyme disease. Muscle aches, joint pain, fever, malaise, and headache are very common to many pathologies and diseases, thus making a differential diagnosis challenging.

MANIFESTATION	PREVALENCE (%)
Tender points (11 of 18)	100
Arthralgia, myalgia	80
Nonrestorative sleep	80
Fatigue	70
Tension headache	53
Functional bowel disease	40
Numbness, burning	35
"Brain fog"	20
Psychopathology	20
Limb mov't syndrome	15

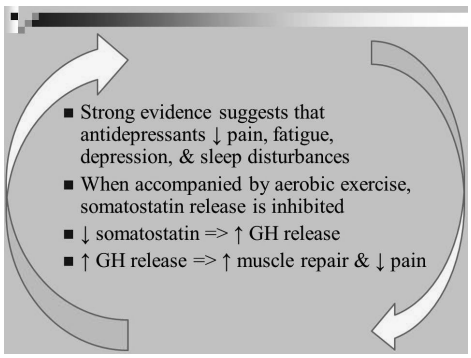
Fibromyalgia is a disorder characterized by widespread musculoskeletal pain. Fibromyalgia is a complex syndrome that presents with chronic muscle pain, fatigue, sleep dysfunction, memory and mood issues, and pain tender points. The chart to the right displays the likelihood of the symptoms in fibromyalgia. Tender points have the highest prevalence of all signs and symptoms. When an individual has at least 11 of 18 tender points, displayed below, fibromyalgia must be explored further. Some of the tender points are pretty common. For example, many people have tenderness in the lower cervical region, the base of the occiput, and upper trapezius muscle; however, areas such as the greater trochanter and the medial aspect of the knees are not as common. One must be careful not to confuse tender points with trigger points. Most clients present with some type of joint or muscle aches, making it challenging to distinguish some of the pathologies.



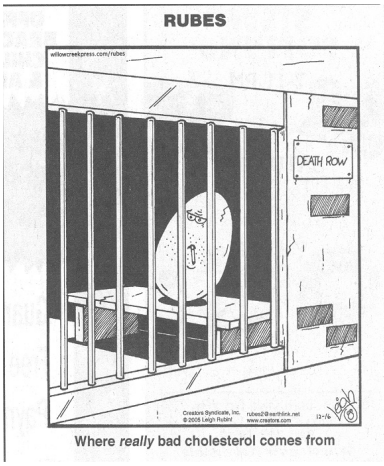
Gulick, OrthoNotes, FA Davis Publishing, 2013

There are a few entities worthy of discussion about fibromyalgia.

First, it is important to manage this diagnosis with a team approach. What we know about fibromyalgia has increased exponentially in the past 20 years. We know growth hormone is secreted predominantly at night. We need growth hormone to be secreted in order to repair our muscles. If a person is not getting adequate sleep, he/she is not secreting a sufficient amount of growth hormone (GH). Thus, muscles are not being repaired at night and a cycle of pain and discomfort begins. Consequently, part of the team approach to the treatment of fibromyalgia is some type of sleep medication and perhaps even a type of anti-depressant.



Furthermore, we know as clinicians in physical medicine that an increase in somatostatin will limit growth hormone release. Yet, exercise inhibits somatostatin, so we've got a negative feedback loop that we can use to our advantage. If we increase exercise, we will inhibit somatostatin release which in turn allows an increase in growth hormone to occur. If we increase growth hormone, then we increase the ability for muscles to repair themselves, and decrease pain. This basically creates a cyclic response that is positive. So in addition to sleep medication and anti-depressants, a multidisciplinary approach includes aerobic exercise. More specifically, an aquatic aerobic exercise program has been deemed successful. Using the buoyancy of the water to support body weight, reduce joint stress, and facilitate pain-free motion is very valuable.



Where *really* bad cholesterol comes from

MEDICATIONS

Finally, as you know, identifying the medications a client is taking is very important. In addition, ascertaining any recent change in medications can yield information about toxicity and/or side effects. Although it is beyond the scope of this course to explore pharmacology is great depth, there are three medications that are both common and can present troublesome side effects. As you know, identifying the medications a client is taking is very important. In addition, ascertaining any recent change in medications can yield information about toxicity and/or side effects.

One such common medication with side effects is a statin. Frequency prescribed for individuals with high cholesterol, statins are drugs that block an enzyme (HMG-CoA reductase) linked to the production of cholesterol in the liver. This inhibits the liver's ability to produce low density lipoproteins (LDL) and results in an increase in the of LDL receptors on the surface of the liver cells. Hence, more cholesterol is removed from the bloodstream in an attempt to reduce a significant cardiovascular risk factor. However, the range of LDL reduction is highly variable (18-55%).

Since cholesterol is not just found in the bloodstream - it is also in cell walls throughout the body - removal of too much cholesterol can impact other systems of the body and produce some adverse responses. The list below represents some of the side effects of statins.

- Loss of muscular coordination
- Trouble talking & enunciating words
- Loss of balance
- Loss of fine motor skills (difficulty writing)
- Trouble swallowing
- Constant fatigue
- Joint & muscle aches & stiffness
- Vertigo & disorientation
- Blinding headaches

In reviewing this list, it is not hard to see that these effects appear in a large number of clients who present for treatment of physical limitations. Onset of these effects after the recent prescription of statins or an increase in the dosage of a statin may warrant a conversation with the prescribing physician.

In spite of the potential concern over side effects, research has also demonstrated some very positive influences of statins on other systems. Statin use has been associated with a 22-55% reduction in various cancer deaths in women and when combined with the anti-diabetes medication, metformin, found a 40% reduction in prostate cancer mortality.

The other two medications are frequently seen in combination: aspirin (ASA) and non-steroidal anti-inflammatories (NSAID). The FDA has issued a "black box warning" for the combination of these two medications.

Many individuals take a daily dose of 81 mg aspirin to reduce the risk of platelet aggregation. Many also take NSAIDs for joint pain, inflammation, osteoarthritis, etc. Given that these two medications compete for the same binding site on a platelet, the timing is ingestion is critical.

ASA works via an irreversible binding of the COX-1 enzyme rendering the platelet permanently unable to aggregate. NSAIDs do the same on a reversible basis with inhibition related to the half-life of the specific medication - this half-life can range from two to twelve hours. Thus, it is imperative for ASA to be taken at least 30-minutes before or more than eight hours after an NSAID to avoid attenuation of the aggregation effect.

Clearly there is significant value to preventing platelet aggregation. More than two million deep vein thromboses occur in the USA per year. This is third only to coronary artery disease and cerebral vascular accidents. In addition, ASA has been found to have an influence on colon cancer risk. Individuals who have taken a daily aspirin for 20 year have shown a 50% reduction in the risk of colon cancer.

Finally, with regard to medications, the clinician must recognize the overall impact of any medication taken in combination with another. The cytochrome P450 enzymes are essential for the metabolism of numerous medications; this class has more than 50 enzymes, yet six of them are responsible for the metabolism of 90% of drugs. Drug-drug interactions can be serious. Interactions between beta-blockers and anti-depressants, Plavix and Tylenol, and many others can occur. In addition, interactions can occur with non-drug substances such as caffeine and alcohol.

Fortunately there are several resources available to clinicians to identify there interactions. Free mobile apps such as Medscape and Epocrates are available for mobile devices to render access to copious amounts of pharmaceutical information to aid your clients in the recognition and prevention of drug related side effects/interactions.

Questionnaires

As we discussed previously, toolbox questionnaires can be very helpful in clinical practice because they give you information about many parameters other than just pain. There are numerous questionnaires that can useful to us in terms of gathering information about a client's pain level as well as their function (or lack of function). It is critical that we are able to understand what a client can and can't do.

The questionnaires cited in this course have been studied for both validity and reliability. Data from these questionnaires may be collected on the initial examination, every week or two, and/or at discharge. They provide serial measures on how a client is improving or regressing over time.

The WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) can be used for both the hip and the knee (http://performanceptpc.com/paperwork/womac.pdf). It rates a client's abilities on a scale of 0 - 4. The higher the sum of the individual scores, the more sever the disability.

Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC)

Instructions: Please rate the activities in each category according to the following scale of difficulty:
0 = none; 1 = slight; 2 = moderate; 3 = very; 4 = extremely

Pain	■ Walking	
	■ Stair climbing	
	■ Nocturnal	
	■ Rest	
	■ Weight bearing	
Stiffness	■ Morning stiffness	
	■ Stiffness occurring later in the day	
Physical Function	■ Descending stairs	
	■ Ascending stairs	
	■ Rising from sitting	
	■ Standing	
	■ Bending to floor	
	■ Walking on flat surface	
	■ Getting in/out of car	
	■ Going shopping	
	■ Putting on socks	
	■ Lying in bed	
	■ Taking off socks	
	■ Rising from bed	
	■ Getting in/out of bath	
	■ Sitting	
	■ Getting on/off toilet	
	■ Heavy domestic duties	
	■ Light domestic duties	
Score:		

Scoring: Summate the scores of each item for the total score. The higher the score, the more severe the disability.
Source: From Bellamy, et al. Journal of Rheumatology, 15:1833–1840, 1988.

Gulick, OrthoNotes, FA Davis Publishing, 2013

The Harris hip score is useful for rating hips before and after surgery. The Harris hip score (https://feeds.orthopad.net/orthopad/elearning/forms/harris%20hip%20score.pdf) has a pain section as well as a function section of scoring. It addresses the distance the person can walk, whether they limp, whether they need an assistive device, how they negotiate stairs, etc. Once all of these areas are scored, the higher the sum of the components, the lower the level of disability. The following are the criteria for the scoring:

- < 70 = Poor
- 70 – 79 = Fair
- 80 – 89 = Good
- 90 – 100 = Excellent

Studies by Marchetti et al (2005) reported that when there is a post-operative increase in the Harris hip score of more than 20 points, radiographs demonstrate a stable implant, and there is no additional femoral reconstruction, the surgery is deemed successful.

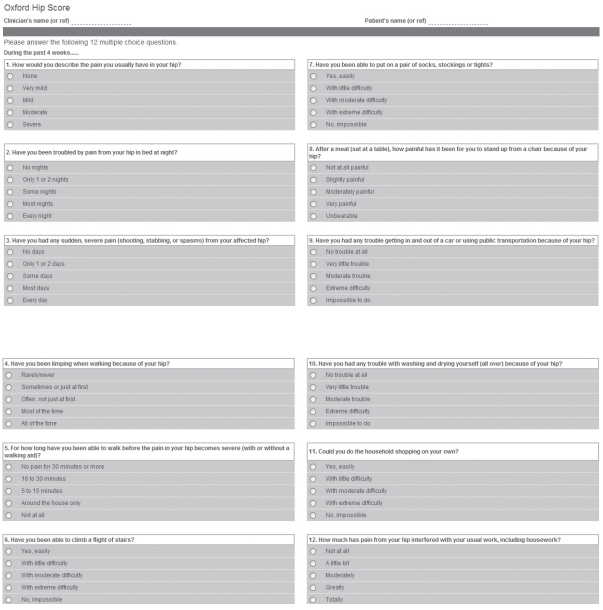
HARRIS Hip Score		
Select the descriptor for each section that best describes your current condition		
Pain—44 possible points		
None or ignores it		44
Slight, occasional, no compromise in activities		40
Mild pain, no effect on average activities, moderate pain with unusual activities, may take aspirin		30
Moderate pain, tolerable but makes concessions, some limitation of ordinary activity, occasional pain medicine stronger than aspirin		20
Marked pain, serious limitation of activity		10
Totally disabled, crippled, pain in bed, bedridden		0
Function/Gait—33 possible points		
Distance Walked	Unlimited	11
	4–6 blocks	8
	2–3 blocks	5
	Indoors only	2
	Unable to walk	0
Limp	None	11
	Slight	8
	Moderate	5
	Severe	0
Support	None	11
	Cane for long walks	7
	Cane most of the time	5
	One crutch	3
	Two canes	2
	Two crutches	0
	Not able to walk	0

HARRIS Hip Score—*cont'd*		
Select the descriptor for each section that best describes your current condition		
Function/Activities—14 possible points		
Stairs	Normally without rail	4
	Normally with rail	2
	In any manner	1
	Unable to do stairs	0
Shoes & Socks	With ease	4
	With difficulty	2
	Unable	0
Sitting	Comfortable in ordinary chair 1 hr	5
	On a high chair for ½ hr	3
	Unable to sit comfortably	0
Enter Public Transportation		1
Deformity—4 points for each of the following present		
<30° flexion contracture		
<10° adduction contracture		
<10° abduction contracture		
<3.2 cm leg-length discrepancy		
ROM		
Flexion	0–45° (1.0 point per degree)	
	+ 0.6 points/degree from 45°–90°	
	+ 0.3 points/degree from 90°–110°	
Abduction	0–15° (0.8 points per degree)	
	+ 0.3 points/degree from 15°–20°	
ER (in ext)	0–15° (0.4 points per degree)	
Addduction	0–15° (0.2 points per degree)	
Total Score		
Scoring: The higher the total score, the lower the level of disability.		

Gulick, OrthoNotes, FA Davis Publishing, 2013

The Oxford hip score (http://www.orthopaedicscore.com/scorepages/oxford_hip_score.html) involves 12 multiple choice questions. It is scored as follows:

- **0 – 19** = severe hip arthritis, surgical intervention is likely
- **20 – 29** = moderate to severe hip arthritis; see your family physician for an assessment and x-ray; consider an orthopedic consult
- **30 - 39** = mild to moderate hip arthritis; may benefit from non-surgical treatment
- **40 – 48** = satisfactory joint function; may not require any formal treatment


Oxford Hip Score

Clinician's name (or ref) ..... Patient's name (or ref) .....

Please answer the following 12 multiple choice questions.
During the past 4 weeks.....

1. How would you describe the pain you usually have in your hip?
- None
- Very mild
- Mild
- Moderate
- Severe

2. Have you been troubled by pain from your hip in bed at night?
- No nights
- Only 1 or 2 nights
- Some nights
- Most nights
- Every night

3. Have you had any sudden, severe pain (shooting, stabbing, or spasms) from your affected hip?
- No days
- Only 1 or 2 days
- Some days
- Most days
- Every day

4. Have you been limping when walking because of your hip?
- Rarely/never
- Sometimes or just at first
- Often, not just at first
- Most of the time
- All of the time

5. For how long have you been able to walk before the pain in your hip becomes severe (with or without a walking aid)?
- No pain for 30 minutes or more
- 16 to 30 minutes
- 5 to 15 minutes
- Around the house only
- Not at all

6. Have you been able to climb a flight of stairs?
- Yes, easily
- With little difficulty
- With moderate difficulty
- With extreme difficulty
- No, impossible

7. Have you been able to put on a pair of socks, stockings or tights?
- Yes, easily
- With little difficulty
- With moderate difficulty
- With extreme difficulty
- No, impossible

8. After a meal (sat at a table), how painful has it been for you to stand up from a chair because of your hip?
- Not at all painful
- Slightly painful
- Moderately painful
- Very painful
- Unbearable

9. Have you had any trouble getting in and out of a car or using public transportation because of your hip?
- No trouble at all
- Very little trouble
- Moderate trouble
- Extreme difficulty
- Impossible to do

10. Have you had any trouble with washing and drying yourself (all over) because of your hip?
- No trouble at all
- Very little trouble
- Moderate trouble
- Extreme difficulty
- Impossible to do

11. Could you do the household shopping on your own?
- Yes, easily
- With little difficulty
- With moderate difficulty
- With extreme difficulty
- No, impossible

12. How much has pain from your hip interfered with your usual work, including housework?
- Not at all
- A little bit
- Moderately
- Greatly
- Totally

The LEFS, the Lower Extremity Functional Scale, looks at the difficulty in performing 20 different activities of daily living (http://www.emoryhealthcare.org/physical-therapy/pdf/hip-lefs.pdf). The LEFS can be used for unilateral or bilateral LE impairments. Items are scored on a 0-4 scale and then the items are summated. This questionnaire has been examined regarding the "minimal detectable change" – this is the level at which the difference in scores are clinically significant. This value was determined to be 9 points. Thus, if a client's score changes two to three points in a given week, it would not be considered clinically important.

Activities	Extreme Difficulty or Unable to Perform Activity	Quite a Bit of Difficulty	Moderate Difficulty	A Little Bit of Difficulty	No Difficulty
a. Any of your usual work, housework, or school activities.	0	1	2	3	4
b. Your usual hobbies, recreational or sporting activities.	0	1	2	3	4
c. Getting into or out of the bath.	0	1	2	3	4
d. Walking between rooms.	0	1	2	3	4
e. Putting on your shoes or socks.	0	1	2	3	4
f. Squatting.	0	1	2	3	4
g. Lifting an object, like a bag of groceries from the floor.	0	1	2	3	4
h. Performing light activities around your home.	0	1	2	3	4
i. Performing heavy activities around your home.	0	1	2	3	4
j. Getting into or out of a car.	0	1	2	3	4
k. Walking 2 blocks.	0	1	2	3	4
l. Walking a mile.	0	1	2	3	4
m. Going up or down 10 stairs (about 1 flight of stairs).	0	1	2	3	4
n. Standing for 1 hour.	0	1	2	3	4
o. Sitting for 1 hour.	0	1	2	3	4
p. Running on even ground.	0	1	2	3	4
q. Running on uneven ground.	0	1	2	3	4
r. Making sharp turns while running fast.	0	1	2	3	4
s. Hopping.	0	1	2	3	4
t. Rolling over in bed.	0	1	2	3	4
Column Totals:					

The Lysholm knee rating system (http://middleburg-pt.com/pdfs/lkss.pdf) includes eight questions about gait, assistive devices, locking, instability, and swelling. For the Lysholm, the higher the questionnaire score, the greater the client's functional ability.

An ankle questionnaire known as the Performance test protocol and scoring scale for the evaluation of ankle injuries can be used to quantify the level of ankle dysfunction. Summating the scores of the nine questions can be classified as follows:

- 80 – 100 = Excellent
- 70 – 80 = Good
- 55 – 60 = Fair
- < 55 = Poor

Clearing the Lumbosacral Spine

Prior to exploring the status of the lower extremity, it is always important to rule out problems originating from the lumbosacral spine. We should assess range of motion of the spine: forward bending/backward bending, side-bending, and rotation. In addition, performance of the lower limb tension tests (also known as neural tension tests) involves assessment of the various branches of the sciatic nerve, as well as the femoral, obturator, and saphenous nerves.

Testing of the sciatic nerve can be done via combinations of four different positions to incriminate the sciatic, tibial, sural, and common peroneal nerves. All sciatic nerve tests begin in the supine position and a straight leg raise (SLR) is performed, i.e. hip flexion, knee extension.

Each of the tests would be deemed positive if the neurological symptoms are reproduced. The chart below distinguishes the defining characteristics of each the nerves:

Nerve	Test Position
Sciatic	hip flexion, adduction, IR with knee extended; ankle dorsiflexion
Tibial	hip flexion, adduction, IR with knee extended; ankle dorsiflexion, eversion & toes extended
Sural	hip flexion, adduction, IR with knee extended; ankle dorsiflexion & inversion
Common Peroneal	hip flexion, adduction, IR with knee extended; ankle plantarflexion & inversion

Straight Leg Raise Testing

Sensitivity = 40-98%, Specificity = 10-100%
(+) PV = 83%, (-) PV = 64%
(+) LR = 1.0-1.98, (-) LR = 0.05-0.86
Reliability (Kappa) = 0.32-0.86

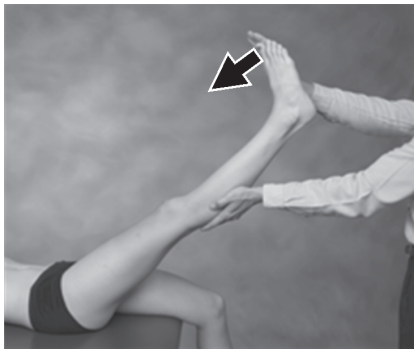
Sciatic Nerve Tension Test

Gulick, OrthoNotes, FA Davis Publishing, 2013

Tibial Nerve Tension Test

Gulick, OrthoNotes, FA Davis Publishing, 2013

Sural Nerve Tension Test



Gulick, OrthoNotes, FA Davis Publishing, 2013

Common Peroneal Nerve Tension Test

Gulick, OrthoNotes, FA Davis Publishing, 2013

Prone knee bend testing allows for the assessment of the femoral, lateral femoral cutaneous, obturator, and saphenous nerves. All tests begin in the prone position. The chart below differentiates the various positions for each nerve:

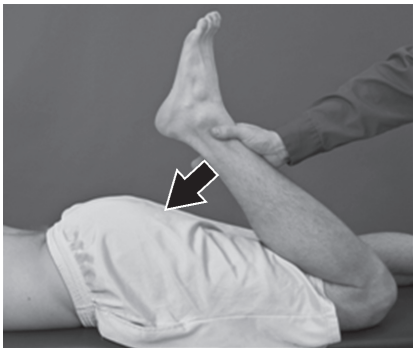
Nerve	Test Position
Femoral	Hip extension, knee flexion
Lateral femoral cutaneous	Hip extension, adduction & knee flexion
Obturator	Hip extension, abduction & knee extension is performed
Saphaneous	Hip extension, abduction, & ER with knee extension & ankle dorsiflexion with eversion

A positive test is a reproduction of the neurological symptoms. Unfortunately there is not any literature on sensitivity but specificity is very high and makes the prone knee bend tests strong diagnostic assessments.

Prone Knee Bend Tests

Sensitivity = NT, Specificity = 84%
Reliability (Kappa) = 0.21-0.26

Femoral Nerve Tension Test



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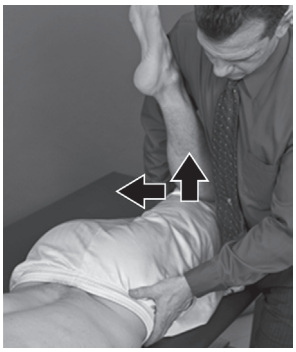
Lateral Femoral Cutaneous Nerve Tension Test



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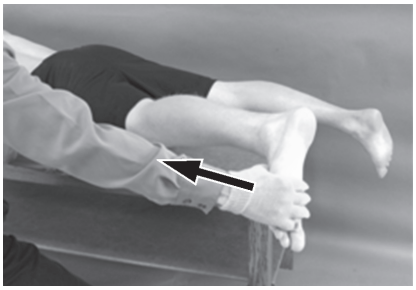
Obturator Nerve Tension Test

Gulick, iOrtho+ Mobile App, 2016

Saphenous Nerve Tension Test



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Deep Tendon Reflexes (DTR)

DTRs are a brisk muscle contraction in response to a sudden stretch generated by a reflex hammer tapping the tendon insertion. DTRs assess the central nervous system as well as the peripheral nervous system at the segmental level of innervation. Hyperactive reflexes may indicate pathology above the level of the reflex arc. Hypoactive reflexes may be the result of muscle, nerve, nerve root, or spinal cord damage.

The patella, tibialis posterior, medial hamstrings, lateral hamstrings, and Achilles assess L2 -4, L4 – 5, L5 – S1, S1 – 2, and S1 – 2, respectively. The performance of these reflexes is as follows:

Patella DTR

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Tibialis Posterior DTR

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Medial Hamstring DTR

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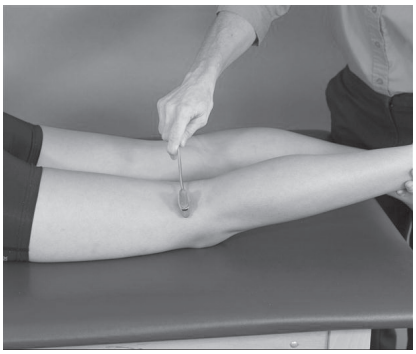
Lateral Hamstring DTR



Gulick, iOrtho+ Mobile App, 2016

Achilles DTR

Gulick, iOrtho+ Mobile App, 2016

The grading of the DTRs is displayed below. Data published by Teitelbaum et al (2002) reported the use of the patella, medial, and lateral hamstring reflexes to be good diagnostic tools for the detection of unilateral cerebral lesions. However, there is no statistical data on the tibialis posterior or Achilles reflex.

Grading DTRs

0 = areflexia/absent
1 = hyporeflexia/diminished
2 = average/normal
3 = hyperreflexia/exaggerated
4 = clonus

DTRs

Sensitivity = 68.9%, Specificity = 87.5%
(+) LR = 5.5; (-) LR = 0.36
(+) PV = 86.1%; (-) PV = 71.4%

Special Tests

Once the viscera, l-spine, and potential issues with neural tension tests and DTRs are ruled out, one can begin to examine the LE.

You are strongly encouraged to not only examine the involved joint but also the joint proximal and distal. The presence of numerous biarticulate muscles lend themselves to the potential for injury. A thorough evaluation includes posture, ROM (osteokinematics and arthrokinematics), strength, sensation, deep tendon reflexes, and functional activities.

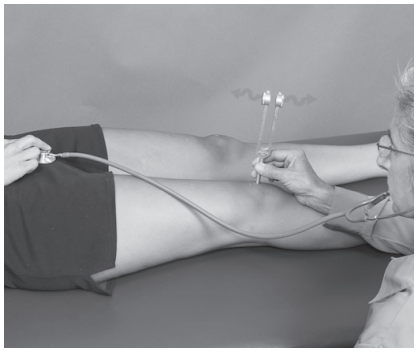
HIP

The categories of hip special tests included in this course are as follows: structural impairments, impingement, labral tests, and muscular tests. Structural impairments include screening for fractures, instability, and leg length discrepancy.

Structural Impairments

The Patella-Pubic Percussion test is used to assess for hip fractures or structural pathology. The test involves placing the stethoscope on the pubic bone. Out of respect for a client's privacy, handing the bell of the stethoscope to the client and allowing him/her to place the stethoscope on the proper landmark could avoid an awkward situation. With the stethoscope in your ears, vibrate a tuning fork and place it on the patella. You are listening for a disruption in the condition of the sound. Disruption may occur if there is some type of lesion (tumor) or a fracture. Comparing the involved to uninvolved side may be necessary to have an appreciation for subtle changes in the quality of the sound transmission. The statistics for this test are very unique. Both the sensitivity and specificity are excellent. The positive likelihood ratio is also huge, while the negative likelihood ratio is low. Thus, this test is an exceptional test for both screening and diagnostic purposes to pick up some type of structural pathology.

Patella-Pubic Percussion Test



Gulick, iOrtho+ Mobile App, 2016

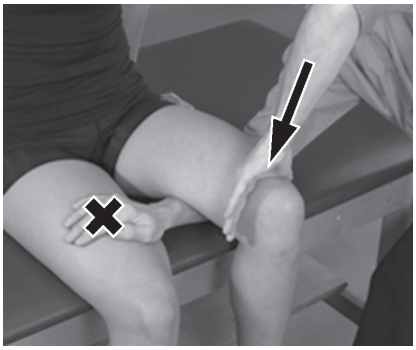
Patella-Pubic Percussion

Sensitivity = 94-96%, Specificity = 86-96%
(+) LR = 6.73-21.6, (-) LR = 0.14-0.7

The Hip Fulcrum test is used to identify femoral shaft stress fractures. The client sits on the edge of a plinth or a chair that is high enough to have his/her feet off the floor. The clinician weaves a hand underneath the suspected injured region of the femur to the contralateral thigh. Body weight through the

ischial tuberosity provides proximal stabilization. The clinician applies a vertical force at the distal femur to create a fulcrum of the femur. This test is excellent for ruling out femoral stress fractures and moderate for diagnostic purposes.

Hip Fulcrum Test



Gulick, iOrtho+ Mobile App, 2016

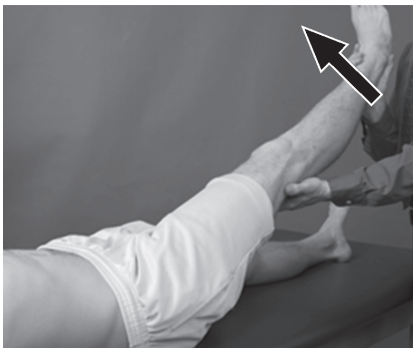
Hip Fulcrum Test

Sensitivity = 93%, Specificity = 75%

The Sign of the Buttock is a unique test used to identify a number of non-musculoskeletal pathologies. This term was coined by Cyriax and looks to a combination of findings to identify serious pathology. With the client in supine, the clinician passively performs a straight leg raise (SLR) and notes the degree of hip flexion before limitation or onset of symptoms occurs (image 1). The knee is then flexed and additional hip flexion is attempted (image 2). Under normal circumstances, one would expect hip flexion to increase when the knee is flexed. If this does not happen, one should question the origin of the buttock pain. Is it a local lesion or is it referred from the hip, sciatic nerve, or hamstrings? If the following seven signs/symptoms are present, this would be considered a "red flag" and a physician referral should occur (http://www.physio-pedia.com/Sign_of_the_Buttock).

- Buttock large and swollen and tender to touch
- Straight Leg Raise limited and painful
- Limited trunk flexion
- Hip flexion with knee flexion limited and painful
- Empty end feel on hip flexion
- Non capsular pattern of restriction at hip (flexion, abduction, IR)
- Resisted hip movements painful and weak, especially hip extension

Sign of the Buttock - 1



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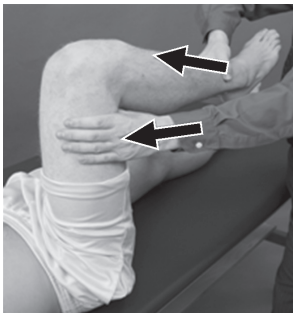
Sign of the Buttock - 2



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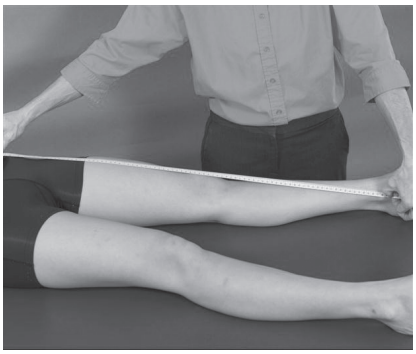
Although this test has been reported in several manuscripts and textbooks, there isn't any statistical data published. An example of how this test is used was described by VanWye (2009) with a 77 year old male with a diagnosis of lumbosacral and hip osteoarthritis. The client was referred to physical therapy. When the clinician identified a positive "sign of the buttock," empty end feels for all hip motions, and severe night pain, a referral was made. With the assistance of additional testing, a diagnosis of primary lung adenocarcinoma with widespread metastases (including the hip) was made. Hence, this cluster of signs/symptoms is a major "red flag."

Leg length assessment is something that classically performed as part of a LE examination. In supine, the clinician applies a bilateral traction force to the LE's to equilibrate the pelvis. In option #1, a measurement is made from the prominence of the anterior superior iliac spine (ASIS) to the distal medial malleolus of the ipsilateral leg. In option #2, a measurement is made from the prominence of ASIS to the distal lateral malleolus of the ipsilateral leg. Why would one choose option #1 vs option #2? The primary reason is a significant anomaly of one leg, i.e. quad atrophy, knee swelling, etc. Crossing over from the ASIS to the medial malleolus can result in abnormal measures if the quadriceps are atrophied or the knee is edematous. Thus, using option #2 would be advised.

Leg Length Assessment - 1



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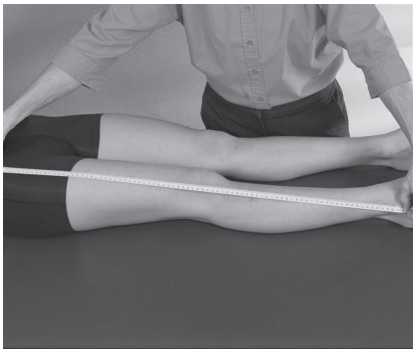
Leg Length Assessment - 2



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Looking for asymmetry is the goal. A limb length difference is not unusual: one study reported that 32% of 600 military recruits had a 1/5 inch (0.5 cm) to a 3/5 inch (1.5 cm) difference in their leg lengths. Although discrepancies may be common, it does not mean there are not residual effects: for example, differences of 3.5-4% of the total length of the leg (about 4 cm or 1 2/3 inches in an average adult) may cause gait abnormalities. However, a simple measure does not tell us whether the discrepancy is a structural (anatomic) or a functional (apparent) difference. Additional techniques need to be utilized to make that determination.

Impingement Tests

Impingement, first described by Smith-Petersen (1936), is caused by abnormal contact between the femur and the acetabulum. There are two types of femoral-acetabular impingement (FAI): cam and pincer. Cam impingement is an osseous abnormality (bone bump) at the femoral head-neck junction. It is an abnormality of the femur and the impact damages articular cartilage. Pincer impingement is an abnormality of the bony acetabulum leading to over-coverage of the femoral head, i.e. acting like tweezers or pincers around the femoral head. This damages the labrum.

There are a few different tests used to identify FAI.

The C-sign was described by Byrd (2005) and is a simplistic indication of FAI. The client makes a shape of a 'C' with his/her hand and places the hand right on the hip joint, i.e. the location of the pain. Many of the physical tests for FAI are very similar. There are slight deviations in the DEXRI, DIRI, impingement test, FABER test & FADIR test.

The DEXRI (Dynamic External Rotation Impingement) and DIRI (Dynamic Internal Rotation Impingement) tests involve scouring the hip through a defined arc of motion. The DEXRI is performed in supine with involved LE flexed to 90° at the hip and knee. The hip is passively taken through an arc of hip abduction and ER. Some clinicians recommend holding the contralateral limb in a flexed position beyond 90 degrees to stabilize the pelvis. The DIRI is also performed in supine with involved LE flexed to 90° at the hip and knee but the hip is passively taken through an arc of hip adduction and IR. Together, they scour the entire hip socket. Neither test has any statistical data reported.

DEXRI Test

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DIRI Test

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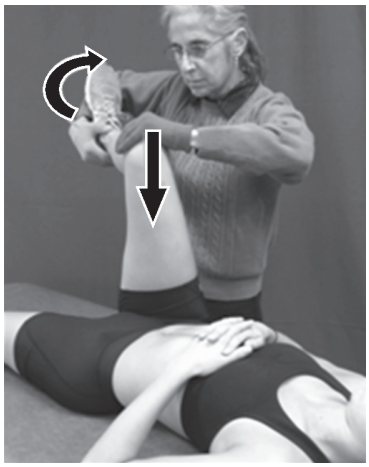
The impingement test attempts to reproduce pain into the groin. In supine, the client is passively taken into a position of hip/knee flexion to 90/90 and then into IR (no adduction). Some clinicians recommend adding axial compression and/or over-pressure into IR. However, these additional maneuvers do not appear to enhance the statistical values.

Impingement Test



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Impingement Test

Sensitivity = 20-100%, Specificity = 44-86%
(+) LR = 1.25-1.55, (-) LR = 0.68-0.93
(+) PV = 63-100%, (-) PV = 44-53%

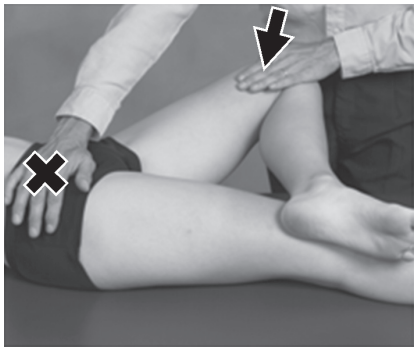
With axial compression & IR over-pressure

Sensitivity = 75-89%, Specificity = 15-43%
(+) LR = 1.05-1.32, (-) LR = 0.58-0.73
(+) PV = 19-27%, (-) PV = 86%

The FABER (Flexion, Abduction, External Rotation) and FADIR (Flexion, Adduction, Internal Rotation) tests are similar to the DEXRI and DIRI tests with regard to the combination of motions.

The FABER test, also known as the Patrick test, is used to assess a wide array of musculoskeletal problems: hip/SI pathology, labral damage, or FAI. The position is known as the "figure – 4" position. In supine, the client is passively taken into a position of hip flexion, abduction, and ER hip. The lateral malleolus is placed on the contralateral distal thigh. Overpressure is applied to the medial border of the flexed knee. Given the number of tissues challenged by the FABER test, a positive test can take many forms. Pain assuming the position may be due to a problem with the Sartorius. Pain once in the position may be due to hip impingement or SI/low back pathology. If the knee is more than 4 cm from the surface, the labrum may be the problem. Regardless of the tissue being tested, the FABER test, by itself, is not a good diagnostic tool.

FABER



Gulick, iOrtho+ Mobile App, 2016

FABER Test

Sensitivity = 69-97%, Specificity = 24%
(+) LR = 1.16, (-) LR = 0.5
(+) PV = 18-100%, (-) PV = 91%

The FADIR is performed in supine just like the DIRI. The hip and knee is passively flexed to 90/90 and the adducted with hip IR. As the femoral head comes in contact with the acetabular rim, a positive test for FAI would be pain in the groin region. The FADIR test only has statistics for sensitivity and the value is high, indicating it is an excellent screening tool. However, there are statistics for the combination of several tests including the FABER and FADIR.

FADIR

Gulick, iOrtho+ Mobile App, 2016

FADIR Test

Sensitivity = 88-100%, Specificity = Not tested
(+) LR = 0.64-1.00, (-) LR = Not tested
(+) PV = 100%, (-) PV = 13%

FABER + FADIR

Sensitivity = 90-100%

FABER + FADIR + resisted SLR + Thomas Test

Specificity = 90-100%

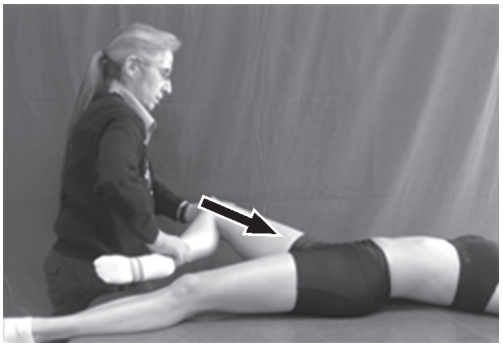
Labral Tests

The labrum is a band of tough cartilage and connective tissue that lines the acetabular rim to deepen the hip socket. It cushions the hip joint and prevents the femoral head from rubbing against the acetabulum. In addition to the FABER test discussed above, there are at least four tests known to incriminate the labrum:

Anterior and Posterior Labral Tests, the Log Roll, and the Scour.

The anterior and posterior labral tests are also known as the Fitzgerald Test. They use passive diagonal motions coupled with compression to capture the labrum. The anterior labral test begins in hip flexion, abduction, and ER and moves passively into extension, adduction, and IR. If you remember your PNF diagonals, it is very similar to a D2 extension pattern with the opposite rotation component. While moving through this diagonal, a longitudinal compressive force is applied through the femur to load the hip joint. A positive test could be a reproduction of pain or a clicking sensation.

Anterior Labral Test
Start Position



Gulick, iOrtho+ Mobile App, 2016

Posterior Labral Test
Start Position

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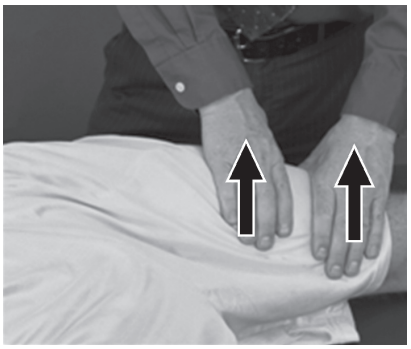
The posterior labral test begins in hip flexion, adduction, and IR and is passively taken into hip extension, abduction, and ER. Again, this resembles the PNF D1 extension pattern with the rotation component switched. The statistics for both these tests reveal they are good screening tests.

Anterior & Posterior Labral Test

Sensitivity = 75-100%, Specificity = 43%
(+) LR = 1.32, (-) LR = 0.58
(+) PV = 100%, (-) PV = 0%

The Log Roll Test is another rather nonspecific hip test. In addition to assessing labral lesions, it has been reported to be used to assess iliofemoral ligament laxity and hip impingement. The log roll test has also been used for a pediatric disorder of unknown etiology called phantom hip disease (AKA transient and toxic hip synovitis). Some literature has associated phantom hip disease with a prodromal upper respiratory infection. We tend to see phantom hip disease in pre-pubescent children: they wake up in the morning and don't want to move or put weight on their leg. Radiographs may be taken to rule out a slipped capital epiphysis. The log roll test is performed in supine with the LE's extended. The clinician simply applies a force from medial to lateral to roll the thigh into maximal ER. Excessive ER as compared to the contralateral side may indicate iliofemoral ligament laxity. Pain may indicate a labral tear, impingement, or phantom hip disease in a child. Sensitivity is 30% and specificity has not been reported.

Log Roll Test



Gulick, iOrtho+ Mobile App, 2016

The scour test mimics the technique of scrubbing a soiled pan. The repetitive, slow-amplitude, circular motions, combined with an axial load through the femur, incriminates the acetabular labrum. This motion is done in 90 degrees of hip and knee flexion to capture the labrum. If the labrum is captured, the client may experience a click, a grinding sensation, or pain. A false positive may be obtained if a client has osteoarthritis.

Scour Test

Gulick, OrthoNotes, FA Davis Publishing, 2013

Hip Scour Test

Sensitivity = 88-100%, Specificity = 43%
(+) LR = 1.54, (-) LR = 0.28
(+) PV = 23-100%, (-) PV = 95%

Muscular Tests

As we look at flexibility and muscle incrimination, there are ten tests to discuss: Hernia (athletic pubalgia), Phelps, Thomas, Ely, Ober, Noble, 90-90 SLR, Taking off the shoe, Piriformis, and Trendelenburg Test. Unfortunately, of all the tests identified, only the Taking off the shoe and the Trendelenburg tests has any statistical values to support their use. Clinical application comes down to a thorough understanding of anatomy and muscle actions.

These tests correspond with the following muscles:

Test	Muscle
Hernia	Rectus abdominus, hip adductors
Phelps	Gracilis
Thomas	Iliopsoas, rectus femoris
Ely	Rectus femoris
Ober	ITB, Tensor fascia latae
Noble	ITB, Tensor fascia latae
90-90 SLR	Hamstrings
Taking off the shoe	Hamstrings
Piriformis	Piriformis
Trendelenburg	Gluteus medius

A sport hernia, aka athletic pubalgia, is essentially a tug-of-war between the rectus abdominis and the adductor muscles. The distal rectus abdominis and the proximal adductor muscles share a common attachment in the pubis.

Sport Hernia Test

Gulick, iOrtho+ Mobile App, 2016

A common mechanism of injury is doing a leg press. The rectus abdominis is typically recruited to stabilize the core. If a client attempts to lift a weight heavier then he/she is capable of moving, the tendency may be to also recruit the hip adductors. This can result in a valgus moment and increased stress on the common muscular attachment. Thus, although there are different types of hernias, the test used to identify them aims to simultaneously recruit these muscles. The client stands with his/her buttock up against a plinth. A ball is placed between the knees. The adductors are isometrically engaged to squeeze the ball. The plinth is used as a fulcrum for the client to lean back and eccentrically recruit the rectus abdominis. Pain in the pubic region would be a positive sign.

The gracilis muscle also shares an attachment at the pubis. The Phelps test is used to isolate the gracilis. What makes this muscle different is that it is biarticulate, i.e. it crosses both the hip and the knee. The gracilis adducts, internally rotates, and flexes the hip, as well as participating in flexion of the knee. To perform the Phelps Test, the client is asked to assume a prone position and the clinician passively abducts the involved lower extremities to endrange. The knee is then flexed to 90 degrees and additional hip abduction is attempted. Since the gracilis is involved in knee flexion, this position is putting the gracilis muscle on slack and should allow for an increase in hip abduction motion. If motion does not increase, it may be due to gracilis tightness.

Phelps Test

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The Thomas test is used to assess the flexibility of the hip flexor musculature. This includes the iliopsoas and the rectus femoris. The technique involves a few steps to differentiate these muscles. First the client is positioned in supine on a plinth such that the knees are hanging over the edge. The client is asked to flex both hips/knees to the chest to stabilize spine. The client holds the uninvolved knee to the chest and allows the involved hip to extend. Inability of involved hip to achieve full extension is a positive test. However, this test has the potential to incriminate both the iliopsoas and rectus femoris. The iliopsoas is a hip flexor but the rectus femoris is biarticulate and serves to both flex the hip and extend the knee. Thus, reduced hip extension with full knee flexion suggests an iliopsoas restriction, whereas reduced hip extension

with knee flexion suggests a rectus femoris restriction (hip will extend if knee is extended). Movement of the hip into abduction suggests a tensor fascia latae restriction.

Thomas Test–Start position

Gulick, iOrtho+ Mobile App, 2016

Thomas Test–End position

Gulick, iOrtho+ Mobile App, 2016

Ely Test

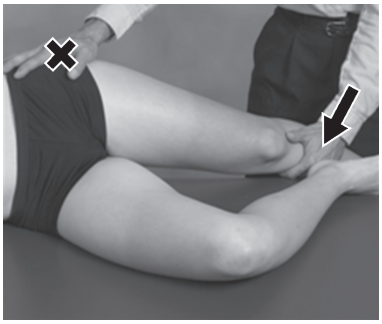
Gulick, iOrtho+ Mobile App, 2016

The Ely test is also used to assess the rectus femoris. However, this test can be performed in prone or sidelying. The prone position is preferred because it can achieve better lumbar stabilization than sidelying. Once in position, the knee of the involved LE is flexed to endrange. Limited knee flexion (< 135 degrees) or the production of hip flexion is a positive test. There are currently no metrics on sensitivity and specificity but the test has been deemed modestly reliable (ICC = 0.69).

There are at least two tests to gauge the tightness/irritation of the iliotibial band (ITB): the Ober and Noble Tests.

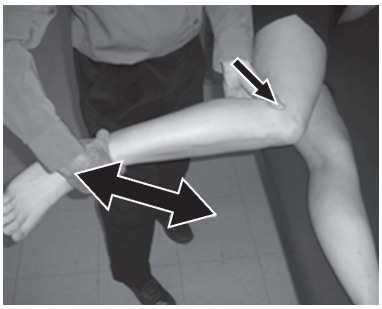
The Ober test is performed in sidelying with the involved hip superior and the pelvis stabilized. The superior LE is taken into hip extension with the knee extended and allowed to drop into adduction. Under normal circumstances, one would expect the involved LE to achieve sufficient adduction to cross midline. Failure to do so would be considered a positive test.

Ober Test



Gulick, OrthoNotes, FA Davis Publishing, 2013

Noble Test



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The Noble test is also used for the ITB but it is geared towards evaluating the degree of irritability (ITB syndrome) not tightness. To do so, the ITB is appraised distally. As you know, the ITB is involved in both flexion and extension of the knee. With the attachment at Gerdy's tubercle, the ITB is aligned in front of the knee axis of motion when the knee is in full extension, thus contributing to extension (0-30 degrees). When the knee is flexed beyond 30 degrees, the ITB is pulls posterior to the knee axis of motion and contributes to knee flexion (30-135 degrees). That being said, the testing process uses the 30 degree knee flexion point as the key to rating irritability. In sidelying on the uninvolved LE, the hip is placed in extension and the knee in flexion. The clinician places his/her thumb over the lateral femoral condyle. Pressure is applied while flexing and extending the knee over the 30 degree angle. As this motion occurs, the ITB will translate anterior over the femoral epicondyle with extension and posterior with flexion. If pain or clicking is reproduced with this translation, the test is considered positive.

In the neural tension test section, we discussed the use of a SLR to assess tension in the various neural tissues of the LE. A SLR can also be used to assess hamstring tension. This can be done in one of two ways. The

classic SLR is done with the knee in extension and the angle of the hip is goniometrically measured. The 90-90 SLR is carried out by placing the hip and knee at 90 degrees of flexion. The hip is stabilized in this position and the knee is extended. Popliteal angle (the angle of the shaft of the femur and the shaft of the tibia) is then measured with a goniometer. Children up to two years of age can typically achieve 180 degrees of knee extension (or 0 degrees if you read the alternative scale on the goniometer). By the age of six years, the range decreases to 155 degrees and for adults, a normal measure is 125 degrees. Sensitivity and specificity have not been established but interclass correlation (ICC) has been reported to be 0.86-0.98 and 0.90 when the 90-90 SLR is performed actively and passively, respectively.

Straight Leg Raise

Gulick, OrthoNotes, FA Davis Publishing, 2013

90-90 Straight Leg Raise

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The Taking off the Shoe Test was identified in 2006 by Zeren and Oztekin as a way of self-diagnosing biceps femoris muscle strains. The test involves executing a simple task. In standing, the client uses the contralateral foot to stabilize the ipsilateral shoe. The client uses the biceps femoris to pull the ipsilateral foot out of the shoe. The inability to remove the shoe without pain is a positive test. Although there is only one study on this technique, the statistics are interesting.

Taking off the Shoe Test

Sensitivity = 100%, Specificity = 100%

(+) LR = 280.0, (-) LR = 0

(+) PV = 100%, (-) PV = 100%

Taking off the Shoe Test -1

Gulick, iOrtho+ Mobile App, 2016

Taking off the Shoe Test -2

Gulick, iOrtho+ Mobile App, 2016

Given the biceps femoris is not the only muscle to flex the knee, additional techniques may need to be performed to achieve a differential diagnosis. The client may be able to provide information about the location of the pain to distinguish the biceps femoris from the semimembranosis and semitendinosis.

The target tissue of the Piriformis Test is self-explanatory. There has been some literature (Delp, 1999) that revealed that the piriformis functions as both an internal and external rotator depending on the amount of hip flexion that occurs. We actually see that with a number of muscles in the gluteal region: a variety of hip extensors change their angle of pull to the extent that they function as internal rotators versus external rotators as the quantity of hip flexion increases. So when testing the piriformis, angle of pull must be considered. In the supine position with hip flexed to 70-80 degrees and knee flexed to 90 degrees, the hip is maximally adducted. Taking the hip into IR stresses the superior fibers and taking the hip into ER stresses the inferior fibers of the piriformis. Pain in the buttock and sciatica is a positive test.

Piriformis Test: IR=Superior

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Piriformis Test: IR=Inferior

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The Trendelenburg Test is used to discover the presence of gluteus medius muscle weakness. As stated above, gluteal muscle are influenced by hip position. With the hip in neutral, the gluteus medius and minimus function together to abduct the thigh. With the hip flexed, the gluteus medius and minimus have been said to internally rotate the thigh. More specifically, the gluteus medius and minimus prevent ER (they don't actually pull the hip into IR). With the hip extended, the gluteus medius and minimus externally rotate the thigh. This action is important to mitigate the potential for valgus stress at the knee. During gait, these two muscles function to support the body in unilateral stance, and in conjunction with the tensor fasciae latae, prevent the pelvis from dropping to the opposite side.

To perform the Trendelenburg Test, the client stands on the involved LE, and the contralateral limb is flexed at the hip and knee to assume a position of unilateral stance. The level of the pelvis is assessed, i.e. the degree of pelvic drop. A positive test is when the contralateral pelvis drops. For example, if a client is standing on the left LE (weightbearing) and the right pelvis drops (non-weightbearing), this incriminates the left gluteus medius and minimus.

Piriformis Test: IR=Inferior

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Trendelenburg Test

Sensitivity = 73%, Specificity = 77%

(+) LR = 3.15, (-) LR = 0.335

Reliability (Kappa) = 0.67-0.83

KNEE

When evaluating injuries to the knee it is usually helpful to know something about the mechanism of injury, the environment, and the footwear. In addition, the timing/location of the pain and the timing/magnitude of the swelling can yield valuable information about the injury: we know that some structures are highly vascularized and will swell quickly, whereas others are poorly vascularized and will swell slowly, so the timing of the swelling can help us appreciate what type of tissue may be injured. As previously discussed, various questionnaires can be used to reveal information about pain and function.

The discussion of the orthopedic tests for the knee will proceed in the following manner: fractures, ligaments, meniscus, ITB, and patellofemoral.

Fractures

As with the examination of any joint, ruling out fractures is important. For the knee, osseous concerns can be assessed via any one of several "knee rules." These include the Ottawa, Pittsburgh, Weber, and Fagan and Davies Rules. These can all be used to identify the potential for a fracture.

In the interest of clarity, the two charts below summarize the criteria for the various "rules" and provide the statistics associated with each of the evaluative criteria. One key point when applying these rules is the precise palpation of bony structures. In order to determine if a radiograph is warranted, tenderness of bony landmarks are included in two of the four criteria. Furthermore, comparison of the criteria reveals several similarities. Thus, it should not be a surprise to see similar statistical values. All of these "rules" demonstrate much better sensitivity than

specificity. Consequently, these "rules" are very good at ruling out the possibility of a fracture but if the criteria are positive, they are not good at making the diagnosis of a fracture. So a radiograph is in order. As a strong screening tool, a study by Jackson (2003) found that the Ottawa Knee Rules would have reduced the use of radiographs by 25-28% if they'd been utilized in the emergency room.

Rule	Criteria
Pittsburgh Knee Rules	▪Inability to ambulate ▪Fall or trauma ▪<12 or >50 years
Weber Rules	▪Inability to ambulate without limping ▪Twist injury with effusion
Ottawa Rules	▪>55 years ▪Tenderness of fibula head OR patella ▪Flexion < 90° ▪Inability to WB 4 steps
Fagan & Davies Rules	▪>55 years ▪Inability to WB ▪Hemarthosis; effusion ▪Bony point tenderness

Rule	Sensitivity	Specificity
Pittsburgh Knee Rules	100%	79%
Weber Rules	100%	24 - 34%
Ottawa Rules*	85 - 100%	17 - 49
Fagan & Davies Rules	95%	62%

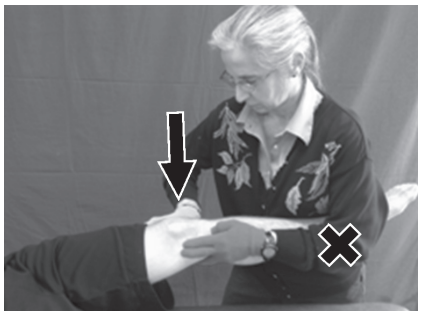
When the Ottawa Knee Rules are applied to children, the statistics are similar (sensitivity=100%, specificity=43%). A study by Bulloch et al (2003) examined children 2-16 years of age. Of 750 children enrolled, 670 radiographs were performed. If the Ottawa Knee Rules had been applied, only 460 would have required a radiograph. That value represents a 31.2% reduction in x-rays and demonstrates the usefulness of applying the criteria.

Ligaments

We will examine four main ligaments of the knee: collaterals (medial and lateral) and cruciates (anterior and posterior). The collateral ligaments control lateral stability of the knee. The medial collateral ligament (MCL) and lateral collateral ligament (LCL) check valgus and varus stress, respectively.

MCL testing is carried out in supine with the knee flexed to 15-30 degrees. The clinician applies a valgus stress. If the tibia is ER, maximal stress is on the MCL and cruciate stress decreases. Whereas, when the tibia is IR, stress is decreased on the MCL and increased on the ACL/PCL. If the clinician tucks the client's distal leg between the upper arm and rib cage, both hands are free to apply the joint stress and palpate the knee joint line. A positive test is pain with the valgus stress or laxity (as compared to the contralateral LE). The statistics vary based on the interpretation of the positive test.

MCL – Valgus Stress



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Valgus Stress: Pain

Sensitivity = 78%, Specificity = 67%

(+) LR = 2.3, (-) LR = 0.3

Reliability (Kappa) = 0.37

Valgus Stress: Laxity

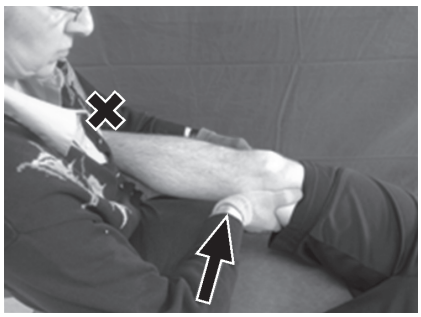
Sensitivity = 86-96% , Specificity = 49%

(+) LR = 1.8, (-) LR = 0.2

Reliability (Kappa) = 0.02-0.66

LCL stress testing is also performed in supine with the knee flexed to 15-30 degrees. A varus stress is applied. As with MCL stressing, tucking the client's distal LE between your proximal arm and rib cage frees up your hands to administer the test and palpate the knee joint line. A positive test is pain with the varus stress or laxity (as compared to the contralateral LE). The statistics reported are only for sensitivity = 25%, not for specificity. Likewise, reliability testing is poor for both pain (0.18) and laxity (0.24).

LCL – Varus Stress



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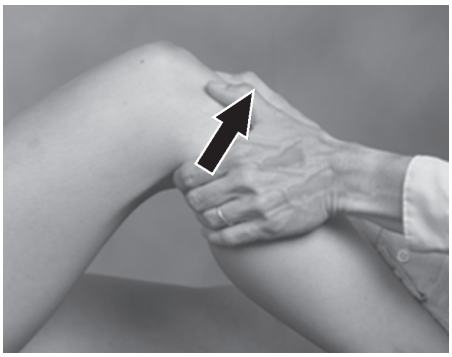
Anterior cruciate ligament (ACL) stress is applied through several mechanisms but they all have one thing in common: anterior translation of the tibia on the femur. This can be done in supine with knee flexion (anterior drawer test), supine with knee extension (Lachman), prone with knee extension (prone Lachman), supine with instrumentation (KT arthrometer), supine in 90/90 position (90/90 anterior drawer), or in supine with active quadriceps

contraction (active drawer). The first four have been studied extensively while the latter two have no statistical data.

Anterior Drawer



G Gulick, OrthoNotes, FA Davis Publishing, 2013

The anterior drawer test is performed in supine with the client's foot on table and the knee flexed to 60-90 degrees. A crisp anterior translation of the tibia is performed. Excessive anterior translation of the proximal tibia on the femur or a soft endfeel is a positive test. It is essential that the hamstrings be relaxed to avoid a false negative test. A torn posterior horn of the meniscus can wedge against the femoral condyle and result in a false negative result also. An audible snap with the anterior drawer indicates a meniscus tear. The statistics for the anterior drawer are very good as a diagnostic instrument. In addition, when combined with other symptoms (effusion, popping, or giving way), diagnostic ability improves.

Anterior Drawer Test

Sensitivity = 22-95%, Specificity = 78-100%

(+) LR = 5.4-8.2, (-) LR = 0.09-0.62

When combined with 2 of 3 symptoms (effusion, popping, or giving way):

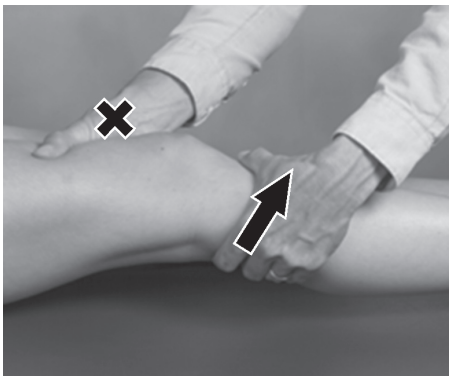
Sensitivity = 63%, Specificity = 85%

When combined with 3 of 3 symptoms:

Sensitivity = 16%, Specificity = 99%

The Lachman test is performed in supine but the knee is only flexed 0-30 degrees. With the hamstrings relaxed and the femur stabilized, the proximal tibia is translated anterior. A positive test is more than a 5 mm translation. Although this test is considered the gold standard for ACL assessment, not everyone can execute this technique. The challenge of this test is the potential mismatch between the size of the client's LE and the clinician's hands: when the client's LE is large or the clinician's hands are small, it is difficult to get a strong grip around the thigh or tibia to achieve a crisp translation.

Lachman Test



Gulick, iOrtho+ Mobile App, 2016

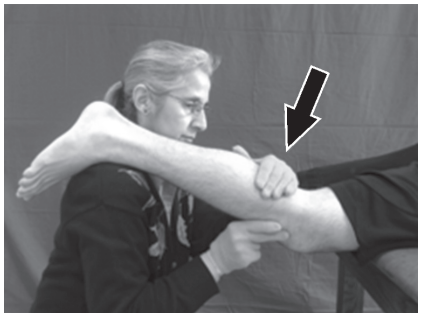
Lachman Test

Sensitivity = 63-99%, Specificity = 42-100%

(+) LR = 1.12-27.3, (-) LR = 0.04-0.83

Also, when gripping very forcefully, the ability to quantify the translation is often difficult. Hence, an alternative to the Lachman test is the prone Lachman. The alternative eliminates the need to grasp the client's limb. The client assumes a prone position and the clinician supports the LE over his/her shoulder with the knee in 0-30 degrees of flexion. The translation can be performed with both hands (image 1), one hand (image 2), or through the clinician's forearm (image 3).

Prone Lachman Test–2 hands



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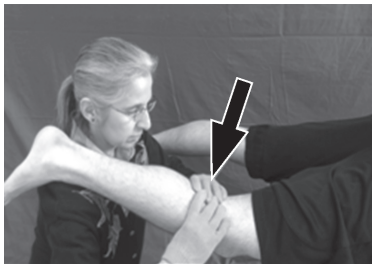
Prone Lachman Test–1 hand



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Prone Lachman Test–forearm

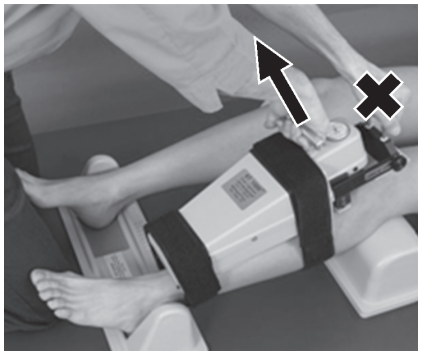
Gulick, iOrtho+ Mobile App, 2016

Prone Lachman Test

Sensitivity = 70-82%, Specificity = 88-97%
(+) LR = 6.83-20.17, (-) LR = 0.20-0.32
(+) PV = 94%, (-) PV = 80%
Reliability (Kappa) = 0.81

The arthrometer is a portable device which allows the tibial translation to be quantified, but it is expensive. Using an arthrometer renders the size of a client's LE or the clinician's hands irrelevant. In supine, the client is positioned with the knee between 20-35 degrees of flexion and the feet in spacer device. A thigh strap is secured to control hip ER. The arthrometer is lined up with the knee joint line and strapped onto the client's lower leg. Once the gauge is zeroed out, the handle is pulled to apply an anterior translation of the tibia on the femur. Audible beeps correspond to the amount of force applied (89N and 134N). The sensitivity of this technique is 92% at maximal manual force. Many orthopedic surgeons use this device in the clinic before they order an MRI.

KT Arthrometer



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The other two ACL tests are the 90-90 anterior drawer and the active ACL drawer test. Both tests are performed in supine. The 90-90 anterior drawer is similar to the anterior drawer with the LE in the air as opposed to fixed on the plinth. The active ACL drawer test recruits the quadriceps to create an active anterior translation. With the quadriceps attached to the tibial tuberosity, contraction results in anterior translation if the distal tibia is fixed. A problem with the latter test presents when a posterior cruciate is torn. This causes the tibia to drop (sag) posterior and can give a false impression of excessive anterior translation, when in reality the translation only appears excessive because the tibia is starting from a more posterior point. Neither of these tests have any statistical data.

90-90 Anterior Drawer

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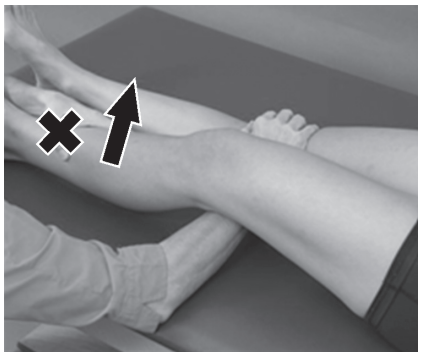
Active Drawer Test



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So far all of the ACL tests discussed have been diagnostic tests. There are five methods that can be used as screening tests with the hope of preventing ACL injuries from happening. All of the screening techniques are looking for knee valgus with flexion. We know individuals are at high risk for ACL injury when hip ER strength is less than or equal to 20.3% of body weight and hip abduction strength is less than or equal to 35.4% of body weight. Subsequently, if an individual has weak hip abductors and ER, they are more likely to go into knee valgus with flexion.

Dynamic Valgus Test - Start Position

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Dynamic Valgus Test - End Position

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The dynamic valgus test (AKA the drop/jump test) involves watching an individual drop off a box or step stool and watching how he/she lands. A dynamic knee valgus moment upon landing is a positive test. This motion can also be replicated with four other methods: a leg press machine, a forward lunge, a lateral step-up, or descending a flight of stairs. Identifying this risk factor can be valuable in preventing an ACL injury.

The other cruciate ligament is the posterior cruciate (PCL). This ligament is not as commonly injured as the ACL but it is responsible for posterior translation of the tibia on the femur in open kinetic chain and anterior translation of the femur on the tibia in closed kinetic chain. In addition to the use of an arthrometer, there are three tests used to assess the PCL: posterior drawer, sag test, and active PCL drawer test.

Posterior Drawer Test

Gulick, OrthoNotes, FA Davis Publishing, 2013

Posterior Drawer Test

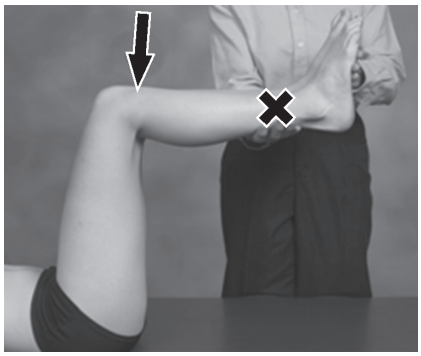
Sensitivity = 22-100%, Specificity = 99-100%

(+) LR = 90, (-) LR = 0.10

Reliability (Kappa) = 0.82

The posterior drawer test is simply the opposite of the anterior drawer: the clinician pushes the tibia posterior on the femur. Excessive posterior excursion, when compared to the contralateral limb, is a positive test. The test is easy and the statistics are strong, in isolation and in combination with the sag test.

Sag Test



Gulick, OrthoNotes, FA Davis Publishing, 2013

Sag Test

Sensitivity = 46-100%, Specificity = 100%

Posterior Drawer + Sag Test

Sensitivity = 90%, Specificity = 99%

The sag test places the client in supine with both the hips and knees flexed to 90 degrees. With the LEs supported distally, a comparison of the level of the tibial tuberosity is evaluated. When the PCL is torn, the ipsilateral tibial tuberosity will be lower (sag) than the contralateral side.

Finally, the active (PCL) drawer test includes a slightly different position than the active (ACL) drawer. This test is performed in 45 degrees of hip flexion and 90 degrees of knee flexion. The distal tibia is stabilized while the client is asked to contract the quadriceps muscle. A positive test is more anterior translation of the tibia on the ipsilateral side than the contralateral side. Although sensitivity is 54-98% and specificity is 97-100%, just like the active drawer for the ACL, this test needs to be coupled with other tests. The anterior translation with a quadriceps contraction cannot discern if the excessive motion is due to an ACL tear or a PCL tear. As previously stated, with a PCL tear the tibia will sag back and can result in the misperception that the ACL is torn. This is why endfeel is very important for this test. There may be more excursion but the endfeel will be an abrupt stop if the ACL is intact. Thus, as always, the clinician should look for multiple positive tests for a given structure to corroborate its damage.

Meniscus

With the meniscus, the mechanism of injury can be a rapid acceleration/deceleration, hyperflexion, a forced valgus with the tibia in external rotation, or cleats that get stuck on the playing surface to name a few. We know the vascular supply of the meniscus recedes as we age. As a child the mostly peripheral region is known as the “red zone” because it is vascular. As we move towards the central region of the meniscus, the area is known as the red-white zone and then the white zone. The white zone is definitely avascular. Identification of the zone of injury has a significant role in healing

potential.

There have been seven meniscal tests identified in the literature: some of the techniques for meniscal assessment are global and unable to distinguish the location of the tear, and others are more precise. Overall, the magnitude of knee flexion can be of assistance in incriminating the location of a meniscal tear.

For example, the Childress duck walking test is used to identify tears in the posterior horns of the meniscus because a deep squat compresses this region. However, there are other structures that could produce pain and limit the ability to perform a full squat. For these reasons, the statistical values of sensitivity (55-68%) and specificity (60-67%) are understandable.

Childress Duck Walking Test

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The Ege test adds internal and external rotation to the squat technique to increase the precision in the diagnostic parameters. Internal rotation is used to incriminate the lateral meniscus and external rotation the medial meniscus. The statistics support the addition of rotation to improve the specificity.

Ege Test – IR

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Ege Test – ER

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Lateral		Medial
64%	Sensitivity	67%
90%	Specificity	81%
6.4	(+) LR	3.5
0.4	(-) LR	0.4

The McMurray test uses a combination of several motions to systemically incriminate the meniscus. This test takes both coordination and practice to perform it correctly. The client is in a supine position. To assess the medial meniscus, the clinician uses one hand to grasp the distal tibia and places the other hand on the lateral aspect of the knee. Starting in full hip and knee flexion, the clinician passively extends the knee while imparting tibial ER and a valgus stress. To assess the lateral meniscus, the clinician uses one hand to grasp the distal tibia and the other places hand on the medial aspect of the knee. Starting in full hip and knee flexion, the clinician passively extends the knee while imparting tibial IR and a varus stress. Sometimes these maneuvers need to be performed a few times to "capture" the meniscus. A positive test would be clicking, snapping, or joint line pain. If the symptoms present with the knee in flexion, one might suspect a posterior meniscus injury, while symptoms in extension may be due to an anterior meniscus lesion. Statistics for this test are rather variable. This may be due to the interpretation of what one calls a positive test. Fortunately, when combined with the palpation of joint line tenderness, the metrics improve dramatically.

McMurray Test – Medial

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McMurray Test – Lateral

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McMurray		McMurray & Medial Joint Line Tenderness	McMurray & Lateral Joint Line Tenderness
16 - 95%	Sensitivity	91%	75%
25 - 98%	Specificity	91%	99%
0.39 - 8.0	(+) LR		
0.83 – 2.84	(-) LR		

The Thessaly test was first reported in the literature in 2005. Since that time, other studies have been published to validate the test for detecting meniscal tears (with and without ACL lesions). This test is performed in weight bearing. With the clinician standing in front of the client, hold on to the client's hands to assist balance. Ask the client to stand on the uninvolved LE and flex the knee 5 degrees. Now walk in an arc to one side of the client, go back to center, and repeat in the other direction. The goal is to have the client rotate on the knee while in a loaded/compressed status. Once the client understands the motion, perform the test on the involved LE. The test is performed in both 5 and 20 degrees of knee flexion. A positive test is clicking, locking, or catching of the meniscus.

Thessaly Test

Gulick, OrthoNotes, FA Davis Publishing, 2013

Thessaly Test – Alternative

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If the client performs too much upper body rotation and is not actually transmitting a rotatory force through the knee, an alternative is to have the client uses the clinician's shoulders for balance. The clinician places his/her hands on the client's hips and facilities rotation with a compressive force. The Thessaly alone has strong diagnostic parameters; it has also been combined with the palpation of joint line tenderness, just like the McMurray. The combined statistics are, in fact, very similar.

Thessaly at 5 degrees of knee flexion	Thessaly at 20 degrees of knee flexion		Thessaly & Medial Joint Line Tenderness	Thessaly & Lateral Joint Line Tenderness
66 – 81%	89 - 92%	Sensitivity	93%	78%
91 – 96%	96 - 97%	Specificity	92%	99%
6.8 – 16.5	23 – 39.3	(+) LR		
0.21 – 0.76	0.08 – 0.11	(-) LR		

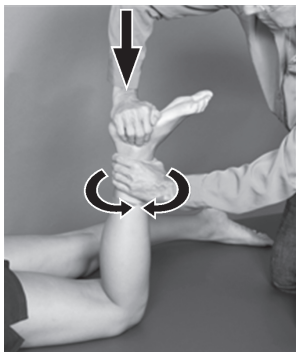
The Apley, Steinmann, and KKU Tests are all very similar in technique: they simulate weight bearing via a longitudinal compression force through the tibia.

The Apley is performed in prone with the knee flexed to 90 degrees and a vertical compression force to the knee through the heel. Once compressed, the tibia is rotated medial and lateral. The Steinmann is a multi-angled Apley test.

The Steinmann is performed in a supine position with the hip and knee in flexion. The knee is stabilized proximally and the thumb and index finger are used to palpate the knee joint line. The other hand grasps the tibia to apply an IR and ER force to the lower leg. This rotatory force is repeated in various knee positions.

The KKU (named after a university in Thailand) was revealed in 2007. It is also performed in supine. The only difference between it and the Steinmann is that the KKU includes a compression force while rotating the tibia at 120, 90, 60, 30, and 0 degrees. The statistics for these tests are summarized below. As an adaption, if a client has a current ankle problem or a history of ankle instability, the rotation forces could be applied through the tibia.

Apley Compression Test



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Steinmann Test

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KKU Test

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	Apley Test	Steinmann Test	KKU Test	McMurray + KKU Test
Sensitivity	16 - 61%	27.5 - 29%	86.27%	90%
Specificity	70 - 88%	100%	88.23%	76%
(+) LR	1.8 – 2.0			
(-) LR	0.56 – 0.89			

Iliotibial Band (ITB) Tests

The iliotibial band was covered in the hip section, in the context of our discussion of the Noble and Ober tests. Since the tensor fascia latae blends into the ITB to craft a biarticulate structure, the position of the hip will influence the tension on the structures of the knee.

Patellofemoral Tests

Although the patellofemoral joint is not a true articulation, there are several pathologies associated with it.

The patella is the largest sesamoid bone in the body and forms the least congruent joint in the body. The patella is stabilized by transverse & longitudinal restraints. The transverse restraints are the medial and lateral retinacula which joins the vastus medialis and lateralis. The longitudinal restraints are the quadriceps and patellar tendons. The patella lengthens the moment arm by increasing the distance of the quadriceps and patellar tendon from the axis of the knee. Acting as a pulley, the patella changes the line of pull of the muscle and reduces the friction between the quad tendon and the femoral condyles.

In knee extension, the patella is suspended over the femur-tibia articulation. In full extension, there is no contact between the patella and the femoral sulcus beneath it. This is because the quad tendon pulls from superior & the patellar tendon pulls from inferior. As the knee moves into flexion, contact of the patella with the femoral condyles begins inferiorly and shifts superior and lateral. This occurs as the pull of the quad/patellar tendons become oblique. At ~90 degrees, the patella is in contact with both condyles but beyond 90 degrees, the patella rotates (6-7 degrees) laterally so that only the medial condyle articulates with the patella. In full flexion the patella slides distally on the femoral condyles (7-8 cm of vertical movement) and sinks into the intercondylar notch. Failure of the patella to slide, tilt, and/or rotate will result in decreased ROM, pain, and/or destruction of the patellofemoral surfaces.

One of the measures frequently taken of the patella is the Q-angle: a measurement from the ASIS to mid-patella to tibial tubercle (measured in knee extension). A normal Q-angle is 17 ± 3 degrees in females and 14 ± 3 degrees in males. However, this is a static measure and cannot be changed.

Dynamic Q-angle is a much more functional measure and was addressed with ACL testing. Wilson and Davis (2008) and Philips (2006) looked at what happens with people who have patellofemoral pain when descending stairs. They found the Q-angle of a person without patella-femoral pain was 24 degrees versus 39 degrees in a person with patellofemoral syndrome. This significant increase in Q-angle is believed to be related to a very poor level of hip control. The femur was not being controlled eccentrically when going down the stairs. As previously stated, this theory was supported by literature that demonstrated the importance of hip strength for knee function. Predictive values have been reported to be hip ER strength is less than or equal to 20.3% of body weight and hip abduction strength is less than or equal to 35.4% of body weight (Khayambashi, Ghoddosi, Straub, & Powers, 2016).

	Sensitivity	Specificity
Superior-Inferior	63%	56%
Medial-Lateral	54%	69%
Inferior Pole Tilt	19%	83%

Assessing mobility of the patella is another technique to evaluate the patella-femoral joint. However, sitting with the knee in extension, quadriceps relaxed, and translating the patella superior/inferior, medial/lateral, and tilting has not been deemed very reliable. These maneuvers are difficult to quantify and normative data has not been established.

Superior-Inferior

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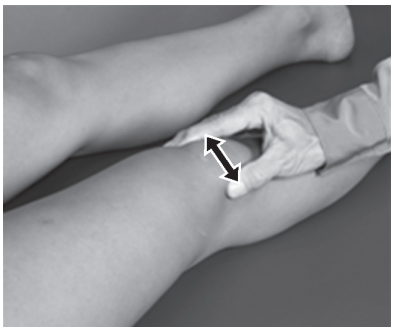
Medical-Lateral



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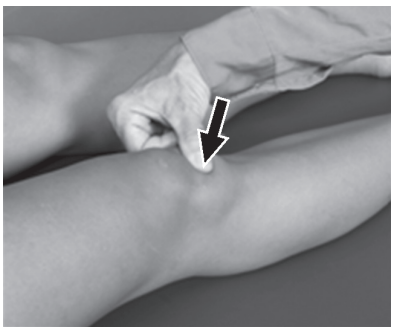
Inferior Pole Tilt



Gulick, iOrtho+ Mobile App, 2016

The Helfet test is used to assess patella alignment in the frontal plane. When sitting or supine with the knee flexed to 90 degrees, the tibial tuberosity should be in line with midline of the patella. When the knee is extended, the tibial tuberosity should be in line with the lateral border of the patella.

Helfet Test - Extension

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Helfet Test - Flexion

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Fairbank Apprehension Test

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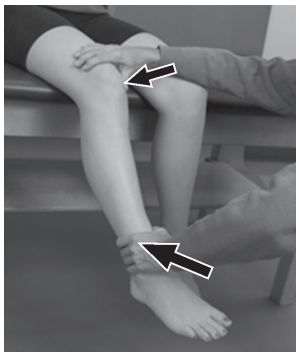
Fairbank apprehension and moving patella apprehension tests assess patella mobility for the tendency to subluxate/dislocate. Both tests are very similar but as the tests imply, one is static and the other dynamic. The Fairbank apprehension test (static) is performed in supine with the quadriceps relaxed and the knee flexed to 30 degrees. The clinician pushes the patella distal and lateral. For the moving patella apprehension test (dynamic) the client is sitting and the clinician uses his/her thumb to translate the patella laterally. This lateral pressure is maintained as the knee is flexed to 90 degrees and back to full extension. A positive test is apprehension of the client or contraction of quadriceps to prevent lateral displacement of patella. Hence the title of the tests: apprehension tests.

Moving Patella Apprehension Test



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Plica

The knee contains sleeves of synovial tissue called plicas. Normally, plica do not cause a problem but direct contact and overuse can result in inflammation or thickening, which can impair knee function and produce pain. The most common plica of the knee is on the medial aspect. X-rays of the knee are typically normal in a patient with plica syndrome. MRI has only been reported to detect 47.7 – 69.7% of plica problems. Tenderness, radiating heat, swelling, and snapping/clicking with knee flexion may occur.

Of course there are other pathologies such as meniscal tears that can also produce clicking. The Hughston plica and Stutter tests may be performed to assist in the clinical diagnosis.

Stutter Test

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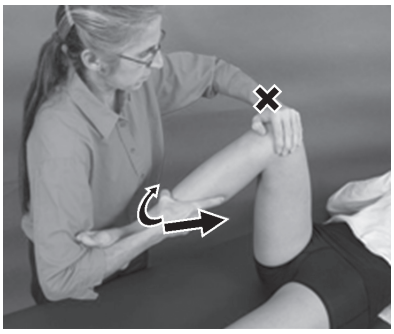
The Hughston plica test has the client in supine and the clinician uses one hand to flex the knee with medial rotation of the tibia. The heel of the clinician's other hand is placed on the lateral patella, while the fingers palpate the medial femoral condyle. A positive test is "popping" of plica band under the fingers with knee flexion/extension.

Hughston Plica Test



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The Stutter test is implemented in sitting with knee flexed over the edge of the table. The clinician places his/her finger on the center of patella and asks the client to slowly extend the knee. A positive test is a patella "stutter" between the arc of 60 to 45 degrees of motion of knee extension.

ANKLE

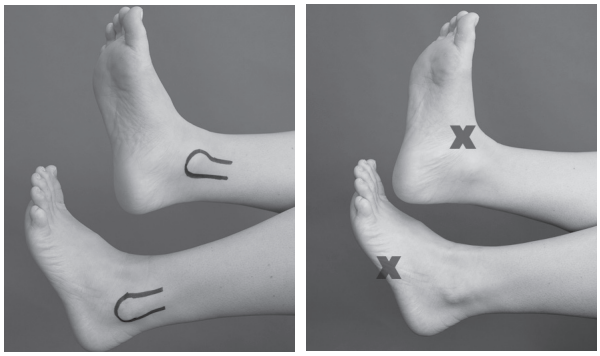
The tests used to evaluate the ankle will be discussed in the following categories: fractures, neural, mobility, ligament stability, tendons, and vascular.

Fractures and Structural Anomalies

There are several tests with very strong metrics available to screen for possible fractures and/ or structural anomalies of the ankle and foot. We addressed the value of the Ottawa Ankle Rules earlier when we attended to the statistical importance of various tests. Now we are going to look at the criteria for the Ottawa Ankle and Foot Rules.

Ottawa Ankle Rules Criteria	Ottawa Foot Rules Criteria
• Bone tenderness @ posterior edge of distal 6 cm of medial malleolus OR	• Bone tenderness @ navicular OR
• Bone tenderness @ posterior edge of distal 6 cm of lateral malleolus OR	• Bone tenderness @ base of 5th metatarsal OR
• Totally unable to bear weight both immediately after injury & (for 4 steps) in emergency department	• Totally unable to bear weight both immediately after injury & (for 4 steps) in emergency department

Ottawa Ankle Rules **Ottawa Foot Rules**



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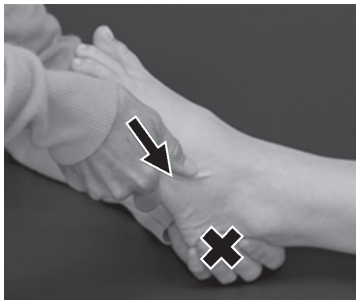
Ottawa Ankle Rules			Ottawa Foot Rules	
Children	Adult		Children	Adult
83 – 100%	95 – 100%	Sensitivity	100%	93 – 100%
21 – 50%	16%	Specificity	36%	12 – 21%

The 5th metatarsal (MT) is a common bone commonly fractured. This injury is known as a Jones fracture. The metatarsal load test is used to evaluate the potential of this injury. The clinician grasps the metatarsal distal aspect of the 5th metatarsal and applies a longitudinal load. A positive test is reproduction of pain along the shaft of the 5th MT.

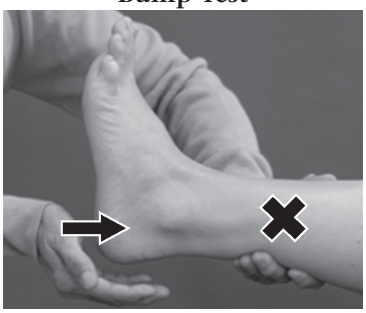
Metatarsal LoadTest



Gulick, iOrtho+ Mobile App, 2016

The bump test, tuning fork, and ultrasound are all techniques that could be used to assess for the presence of stress fractures. The Bump test is done in a non-weight bearing position. With the ankle in neutral and the distal LE stabilized, the clinician applies a firm, controlled, longitudinal force (bump) with the thenar eminence to the client's heel. If a fracture is present, the reverberating force will produce the pain.

Bump Test



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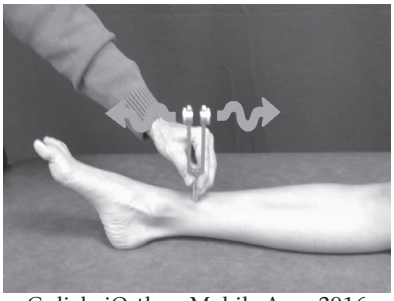
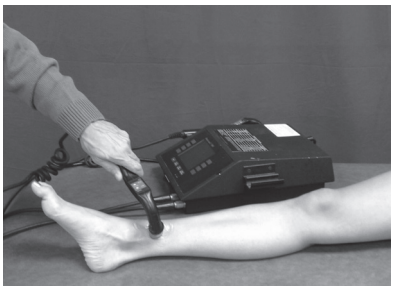
The use of a 256 Hz tuning fork and ultrasound function in a similar way for discerning the presence of a fracture. Stress fractures of the upper tibial diaphyseal or proximal metaphyseal regions are most common in volleyball and basketball, while the distal one-third of the tibia is more common in runners. The vibration over the periosteum of a fractured bone has been shown to produce pain in the region of the fracture (or stress fracture). If a clinician places the vibrating tuning fork or a 1 MHz frequency ultrasound transducer at 2.0 w/cm2 for 30 seconds over the region of the suspected stress fracture, reproduction of pain would be a positive test. In cases with normal radiographs but high clinical suspicion, diagnosis can be confirmed with MRI (correlated with edema) or bone scan (correlated with focal uptake). The clinician should also explore the risk factors associated with stress fractures: history of eating disorders, menstrual irregularities, prior stress fracture, LE malalignment, & recent changes in training techniques/intensities.

Tuning Fork Test



Gulick, iOrtho+ Mobile App, 2016

Ultrasound Test



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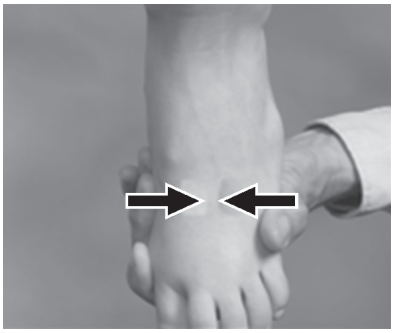
Morton Test



Gulick, OrthoNotes, FA Davis Publishing, 2013

Tuning Fork		Ultrasound
75%	Sensitivity	82%
67%	Specificity	67%
	(+) PV	99%
	(-) PV	13%

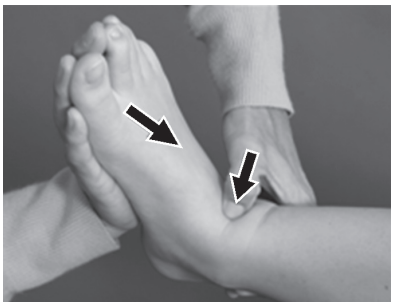
Neural

A Morton neuroma is a thickening of the medial or lateral plantar nerve in between the third and fourth metatarsals. This is often a result of friction or compression and results in sharp, burning pain into the distal toes. People often state a neuroma is like "standing on a pebble." To incriminate the neuroma, the clinician grasps around transverse metatarsal arch and squeezes the metatarsal heads together. Reproduction of pain is a positive test.

Talocrural joint impingement may be the result of a mechanical obstruction due to osteophytes and/or entrapment of soft tissue structures. When in supine or sitting with the knee flexed to 90 degrees, the clinician stabilizes the tibia with his/her thumb on the anterolateral aspect of the talus. Pressure is applied as the ankle is brought into forceful dorsiflexion. Reproduction of pain at the anterolateral aspect of the ankle is a positive test. Impingement is also suspected if five or more of the following criteria are present.

1. anterolateral tenderness
2. anterolateral edema
3. pain upon dorsiflexion & eversion
4. pain with single leg squat
5. pain with activity
6. ankle joint instability

Impingement Test



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Impingement Test

Sensitivity = 95%, Specificity = 88%

(+) LR = 7.9, (-) LR = 0.06

Mobility

There are at least three tests that can be used to assess varying types of mobility (or lack of mobility) of the ankle and foot. The navicular drop, Coleman block, and windlass test will be discussed.

The navicular drop test assesses midfoot mobility. The test has two steps: non-weight bearing and weight bearing. Step #1: Sitting with the foot on the floor, the clinician measures the distance from the navicular tuberosity to the floor. Step #2: Standing with weight equally distributed on both feet, the clinician measures the distance between the same anatomic structures. It is normal for the navicular to drop in weight bearing. A drop of six to eight millimeters is considered normal and 10 - 15 millimeters is abnormal. In addition, the navicular should drop the same amount in each foot. Excessive navicular drop has been associated with shin splints, medial tibial stress fractures, and patellofemoral tracking abnormalities. There is no published data on sensitivity or specificity but reliability of the measure has been reported to range from 0.57 to 0.78.

Navicular Drop Test

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The Coleman block test assesses hindfoot mobility as it relates to a plantarflexed first ray versus a tight tibialis posterior muscle. While standing (#1), the clinician measures the alignment of the hindfoot, i.e. how much rearfoot varus or valgus. Then, the client is asked to stand (#2) with on a 2 cm block under the lateral aspect of the foot (some suggest placing the block under the entire foot with the exception of the first ray- #3). The response of the hindfoot (varus/valgus) to standing on the block to observed. If the hindfoot has less varus (moves towards valgus) when standing on the block, the hindfoot has adequate flexible and the problem is a plantarflexed first ray. Whereas, if the hindfoot does not have less varus, the problem is limited hindfoot mobility attributed to tibialis posterior muscle tightness. There is no statistical data on this test.

Coleman Block Test – #1

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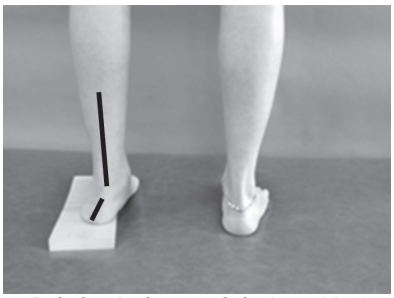
Coleman Block Test – #2



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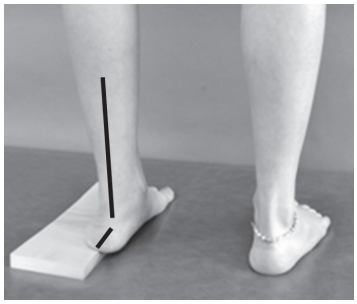
Coleman Block Test – #3



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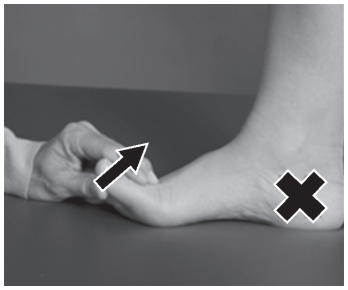
The Windlass test is used to assess the plantarfascia tension. There is a weight-bearing (WB) and non-weight-bearing (NWB) component to this test. In NWB, the ankle is stabilized in neutral and the great toe is dorsiflexed. In WB, with equal weight on both feet, the great toe is again dorsiflexed. Pain along medial longitudinal arch would be a positive test. The statistics for this test reveals it is an exceptional diagnostic tool.

Windlass WB



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Windlass NWB

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Windlass Test

Sensitivity = 13.6-31.8%, Specificity = 100%

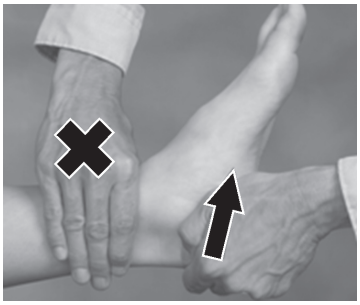
Reliability = 0.96-0.99

Ligamentous Stability

The primary ligaments of the ankle that tests are geared towards evaluating are the lateral ligaments (anterior talofibular, calcaneofibular, posterior talofibular) and the syndesmosis. The anterior drawer and talar tilt evaluate the lateral ligaments; the syndesmotic squeeze, external rotation, cotton, and fibular translation tests evaluate the syndesmosis. The mechanism of injury for a lateral ankle sprain is an excessive inversion force, whereas syndesmotic sprains are the result of forceful dorsiflexion and/or eversion.

The anterior drawer test stresses for anterior talofibular ligament (ATF) to determine laxity. The ATF is the most commonly sprained ligament of the ankle (60-70%). The ATF connects the tibia and the fibula so displacing the calcaneus anterior on the stabilized tibia-fibula will incriminate this ligament. The test may be performed in one of three ways: Method #1: Supine with the distal tibia/fibula stabilized, the posterior calcaneus/talus is translated anterior on tibia/fibula, i.e. distal moved on proximal. Method #2: Supine with the foot stabilized on plinth, the tibia is posteriorly translated on the talus, i.e. proximal moved on distal. Method #3: Prone with the lower leg over the edge of the plinth and the tibia/fibula stabilized, an anterior force as applied to the talus/calcaneus. For optimal technique, the clinician should keep his/her forearm parallel to the plantar surface of the client's foot.

Anterior Drawer Test



Gulick, OrthoNotes, FA Davis Publishing, 2013

Anterior Drawer Test

Sensitivity = 75-86%, Specificity = 50-88%

(+) LR = 3.1, (-) LR = 0.29

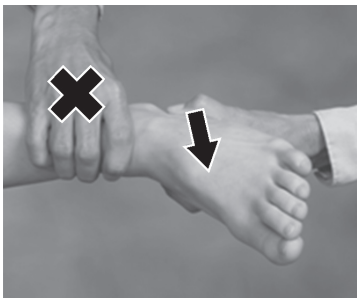
Intrarater reliability = 0.90-0.91

Furthermore, a study by Kovaleski et al (2008) examined the influence of knee and ankle position on anterior ankle laxity. Stiffness was determined to be greatest at 0 degrees of knee and ankle flexion. Laxity was maximal at 90 degrees of knee flexion with 10 degrees of plantarflexion. Therefore, if testing is performed in a position of maximal stiffness and laxity is determined to be present, it can be attributed to ankle capsuloligamentous structures. For any of

these methods, a positive test is pain and/or excessive gapping.

The talar tilt test also has three alternatives to enable the clinician to implicate any one of three ligaments: ATF, CF, PTF. In order to do this, the clinician stabilizes the lower leg and grasps the calcaneus to apply a varus stress. The position of the ankle determines the primary ligament stressed: plantarflexion = ATF, neutral = CF, and dorsiflexion = PTF. That is not to say the other ligaments are not stressed in the respective positions but it would not be the ligament of maximal stress. A positive test is pain and/or excessive gapping.

Talar Tilt Test



Gulick, OrthoNotes, FA Davis Publishing, 2013

Talar Tilt Test

Sensitivity = 67-100%, Specificity = 75-100%

(+) LR = 2.7, (-) LR = 0.44

Pearson r = 0.93, ICC = 0.945

A syndesmotic sprain is one in which the ankle mortise, the junction of the tibia and fibula, is separated. A syndesmotic sprain is also known as a "high ankle" sprain. The syndesmotic squeeze test can be performed in supine or sitting. It begins at the proximal tibia/fibula and the clinician begins squeezing the tibia/fibula together proximally and progresses distally towards ankle until pain is felt. The squeezing motion will gap the syndesmosis and the farther from the ankle that pain is elicited, the more severe the sprain. Care must be taking to be sure the squeeze is being applied to the tibia/fibula and not anterio/posterior or on the soft tissue.

Syndesmotic Squeeze

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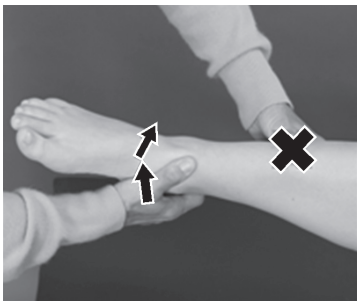
The external rotation test (AKA Kleiger test) is performed in supine with the knee flexed to 90 degrees. The clinician uses one hand to support the lower leg at the calf; the other hand supports the talocrural joint in neutral. The distal hand imparts an ER force to the ankle to displace the fibula laterally to open up the mortise. Specificity for this test has been reported to be 95%.

External Rotation Test



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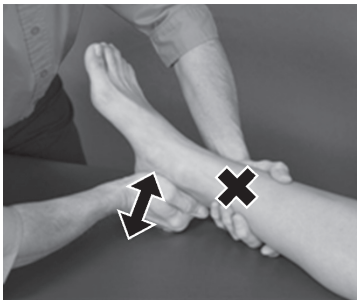
The Cotton (Shunk) test utilizes a lateral translation against the fibula to separate the mortise. Supine or sitting, the clinician stabilizes the distal tibia/fibula and grasps the foot with the other hand. The distal hand translates the rearfoot medial and lateral. This is not an inversion and eversion motion to incriminate the collateral ligaments. A positive test is translation in either direction of more than 3-5 mm or the presence of a "clunk."

Cotton Test



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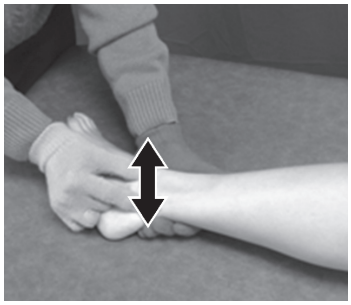
The fibular translation test places the client in contralateral sidelying for the clinician to apply an anterior-posterior force (sagittal plane) to the distal fibula. Increased translation as compared to the contralateral side would be a positive test.

Fibular Translation Test



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Aside from the external rotation test, there is no sensitivity or specificity reported for the syndesmotic tests. However, a study conducted by Beumer et al (2003) looked at the different tests for the syndesmotic

ankle instability, with the purpose of determining the best tests to identify laxity created by the sectioning of precise ligaments. They looked at the squeeze, the fibular translation, the cotton, the external rotation, and the anterior drawer under five different conditions. They tested ankle laxity on a control (no injury). Then they cut through the anterior deltoid ligament (ADL) for the second one. On the third condition the ATF ligament was cut. The fourth condition cut the ADL and ATF and for the fifth condition three ligaments were cut (ATF, ADL, PTF).

The charts below summarize the data. When attempting to separate the anterior syndesmosis, the external rotation test caused the greatest displacement, regardless of condition. When exploring posterior syndesmotic displacement, not only did the fibular translation test prove to be the best test but in opening the anterior syndesmosis, the external rotation test closed down the posterior syndesmosis.

	Displacement (mm) at the Anterior Syndesmosis				
Tests	Control	ADL	ATF	ADL + ATF	ATF, ADL, PTF
Squeeze	0.03	0.00	0.36	0.15	0.33
Fibula translation	0.28	0.24	0.59	0.42	0.66
Cotton	0.23	0.30	0.07	0.40	0.56
External Rotation	0.83	1.08	1.77	1.85	2.13
Anterior Drawer	0.50	0.50	0.91	0.73	0.80

	Displacement (mm) at the Posterior Syndesmosis				
Tests	Control	ADL	ATF	ADL + ATF	ATF, ADL, PTF
Squeeze	0.15	-0.14	-0.26	-0.33	-0.39
Fibula translation	0.20	0.27	0.28	0.29	0.52
Cotton	0.17	0.18	0.25	0.23	0.30
External Rotation	-0.61	-1.16	-1.14	-1.57	-1.54
Anterior Drawer	0.21	0.14	0.25	0.26	0.28

In summary, a positive test of all ankle ligamentous tests is pain and/or increased translation of the joint. It is always helpful to make a contralateral comparison if the other ankle is healthy.

Tendons

The Achilles is a continuation of the gastrocnemius and soleus complex. Injuries to the Achilles can result from a direct trauma, forceful plantarflexion, excessive dorsiflexion, and chronic tendinosis.

Achilles tendon injuries can use two tests to identify damage: Thompson and Matles. Both tests position the client in prone with 90 degrees of knee flexion.

The Thompson test squeezes the middle third of the calf to elicit a plantarflexion response. If the Achilles is intact, the ankle should passively plantarflex. If it is damaged, plantarflexion will be diminished. Some clinicians perform this test in kneeling. In either case, care must be taken to squeeze the soft tissue and not perform a syndesmotic squeeze.

Thompson Test

Gulick, OrthoNotes, FA Davis Publishing, 2013

On the contrary, the Matles test observes the magnitude of dorsiflexion that results from a torn Achilles. This is called the "angle of dangle."

Matles Test

Gulick, OrthoNotes, FA Davis Publishing, 2013

In spite of the good statistics related to these two tests, one must remember that the Achilles (via the gastro/soleus) is not the only plantarflexors of the ankle. Even if the Achilles is torn, the peroneals (fibularis) and posterior tibialis muscles may still be capable of performing plantarflexion. Thus, comparison to the contralateral limb is important.

Thompson Test		Matles Test
40 – 96%	Sensitivity	88%
93%	Specificity	85%

Vascular

Edema is a frequently the sequelae of a foot or ankle injury. The use of a standard technique is important to obtain reliable measures. The ankle figure–8 measure does exactly that: it standardizes the technique to achieve a reliability of 0.98-0.99. The technique is based on the identification of precise anatomic landmarks. In supine with the knee extended, the clinician starts the tape measure on the distal aspect of the lateral malleolus, goes medial to the distal navicular, under the arch to the proximal head of the

5th metatarsal, across the anterior tibialis tendon to the distal aspect of the medial malleolus, and finally over the Achilles tendon back to the lateral malleolus.

Figure-8 Technique

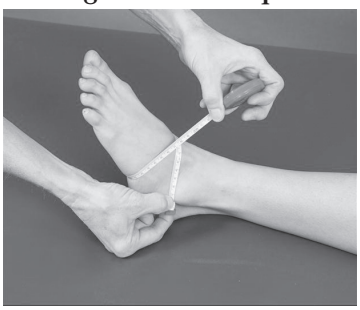

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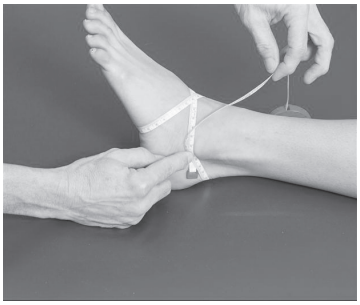
Figure-8 Technique



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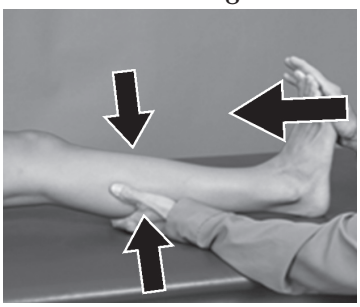
Deep vein thrombophlebitis (DVT) occurs in over two million people every year in the USA. DVTs are third only to coronary artery disease and strokes. DVTs account for 10% of all hospital deaths. The most common location of a DVT is the long saphenous vein. The Homan sign, first reported in the literature in 1934, is used to assess for DVTs in the LE. To perform the test, the client is in supine. The clinician passively dorsiflexes the foot and squeezes the calf. A positive test is extreme pain in the posterior leg or calf. Unfortunately, the Homan sign only predicts about 42% of DVTs. As you can see from the statistics, this is not a clinical test in which one can have confidence.

Homan Sign



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Homan Sign

Sensitivity = 35-48%, Specificity = 41%

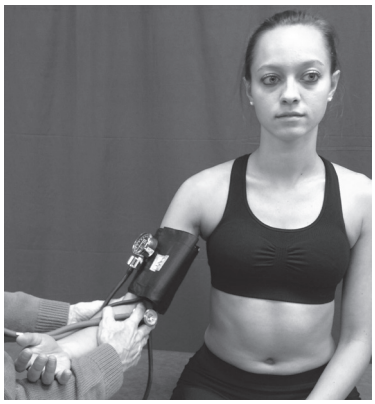
(+) LR = 0.81, (-) LR = 1.27

The alternative is the Wells Clinical Score. The Wells score for DVTs was developed in 1995 and includes a series of questions to assess a client's risk of a DVT. If the client has a score of three or higher, he/she has a 75% chance of a DVT. If the score is a one or a two, the client has a 17% chance of a DVT. DVTs are often accompanied by increased temperature and redness of the calf. Strong risk factors for a DVT include LE fractures, joint replacements, general surgery, major trauma, & spinal cord injuries. Moderate risk factors include arthroscopic surgery, central venous lines, chemotherapy/malignancy, congestive heart failure, oral contraception, stroke, pregnancy, and a previous DVT.

Wells Clinical Score for Deep Vein Thrombosis	
Clinical Parameter Score	**Score**
Active cancer (treatment ongoing or within 6 months)	+ 1
Paralysis or recent plaster immobilization of LE	+ 1
Recently bedridden for >3 days or major surgery < 4 weeks	+ 1
Localized tenderness along the distribution of the deep venous system	+ 1
Entire leg swelling	+ 1
Calf swelling > 3 cm compared to asymptomatic leg	+ 1
Pitting edema (>asymptomatic leg)	+ 1
Previous DVT documented	+ 1
Collateral superficial veins (nonvaricose)	+ 1
Alternative diagnosis (as likely or > that of DVT)	- 2

The final test of the LE is the ankle-brachial index (ABI). This is used to assess for peripheral artery disease and indirectly predict the likelihood of healing. The test requires being in supine for 5-10 minutes prior to taking UE blood pressure via the brachial artery. Ankle BP can be taken at the dorsalis pedis or posterior tibial artery (with higher value used).

Ankle-Brachial Index: Brachial Artery



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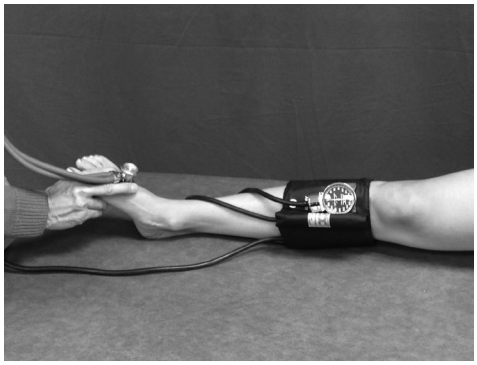
Ankle-Brachial Index: Dorsalis Pedis Artery



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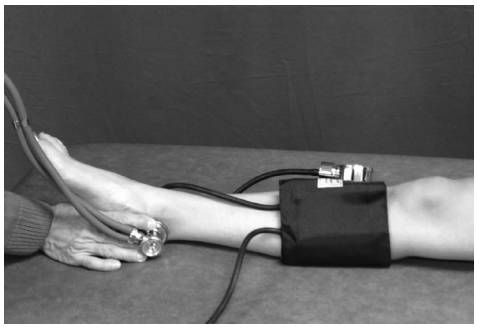
Ankle-Brachial Index: Posterior Tibial Artery



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Ankle-Brachial Index

Sensitivity = 79-95%, Specificity = >95%

The relationships and interpretations are as follow:

Right LE ABI = highest right ankle pressure / highest arm pressure

Left LE ABI = highest left ankle pressure / highest arm pressure

Ratio	Interpretation
> 1.30	non-compressible
1.00 – 1.30	normal
0.41 – 1.00	mild-moderate peripheral vascular disease
< 0.40	severe peripheral vascular disease

Conclusion

We have reviewed a plethora of clinical tests that can be very valuable in your clinical decision making. It is unfortunate that data does not exist for all clinical tests. However, that just reinforces the need for multiple signs, symptoms, and/or positive tests confirming or eliminating a given pathology.

With that thought in mind, you are challenged with the following self-reflective questions:

- What drew you to this course, and/or what needs does it address for you?
- Are you currently using statistics to determine which special tests you use?
- Do you anticipate that your practices will change as a result of information presented in this course?
- Are there additional tests you think are worthy of being included in your client examination?
- Is your decision to include other tests based on the literature or your personal experiences?
- Will you be incorporating additional special tests into your practice as a result of this course?

Space is provided for you to answer. (These answers need not be submitted - they are for your personal use.)

Additional Resources

As disclosed in the details of this course, the author of this home study course is the author of OrthoNotes (F.A. Davis Publishing, 2013) and the developer of iOrtho+ Mobile App.

In addition to the images, descriptions, and statistical data provided in this course, iOrtho+ has high quality videos for each of the more than 350 orthopedic tests.

iOrtho+ is available for all Apple and Android devices, including tablets. Imagine all this information with you at all times. In addition, iOrtho+ can be accessed on your computer (PC and MAC). So whatever device(s) you own, iOrtho+ is available for a one-time fee of only $14.99. There are no annual fees or membership dues, and iOrtho+ is updated several times a year to keep you current with the newest literature.

Simply go to www.iortho.xyz to enter your email, select a password, click register, and make your purchase. If you would like to see a video on iOrtho+ please go to https://www.youtube.com/watch?v=GuCD11B7giA.

Questions on course content or iOrtho+ may be sent to info@iortho.xyz.

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ORTHOPEDIC SPECIAL TESTS: LOWER EXTREMITY
(4 CE Hours)
FINAL EXAM

1. **If a test has high specificity, it would_____.**
   a. be a good test to rule out a pathology
   b. be a good test to confirm a diagnosis
   c. have few false negatives
   d. have many true positives

2. **The primary reason why the Ottawa Rules & Radiographs are an excellent association is because _____.**
   a. Both are highly sensitive
   b. Both are highly specific
   c. Ottawa rules are sensitive & radiographs are specific
   d. Ottawa rules are specific & radiographs are sensitive

3. **Cancer is among the pathologies that need to be ruled out in the process of medical screening. We use the word "_____" to help to describe cancer's warning signs.**
   a. CAUTION
   b. CHANGES
   c. DIAGNOSE
   d. WARNING

4. **All of the following are tests are used to screen for appendix pathology except _____.**
   a. McBurney's point
   b. Obturator sign
   c. Psoas sign
   d. Scour test

5. **The _____ questionnaire can be used for both the hip and the knee.**
   a. ANSI
   b. HHS
   c. LKRS
   d. WOMAC

6. **The defining characteristics of the test of the _____ nerve include hip flexion, adduction, IR with knee extended; ankle plantarflexion & inversion.**
   a. common peroneal
   b. sciatic
   c. sural
   d. tibial

7. **The _____ is excellent for ruling out femoral stress fractures (sensitivity = 93%) and moderate for diagnostic purposes (specificity = 75%).**
   a. leg length assessment
   b. hip fulcrum test
   c. sign of the buttock test
   d. tension test

8. **The _____ test was described by Byrd (2005) and is a simplistic indication of femoral-acetabular impingement (FAI): the client places his/her hand right on the location of the pain (in this case, the hip joint).**
   a. C-sign
   b. FADIR
   c. Fitzgerald
   d. Log Roll

9. **The _____ test (sensitivity = 20-100%, specificity = 44-86%) for femoral-acetabular impingement (FAI) attempts to reproduce pain into the groin.**
   a. DEXRI
   b. FABER
   c. impingement
   d. log roll

10. **The statistics for the anterior and posterior labral tests (sensitivity = 75-100%, specificity = 43%) reveal they are good _____ tests.**
    a. diagnostic
    b. diagnostic and screening
    c. screening
    d. none of the above

11. **Of the 10 muscular tests discussed, only the _____ tests have any statistical values to support their use.**
    a. Ely and Piriformis
    b. Noble and Ober
    c. Phelps and Hernia
    d. Taking off the shoe and Trendelenburg

12. **The Trendelenburg test corresponds with the _____.**
    a. gluteus medius
    b. gracilis
    c. iliotibial band
    d. rectus abdominus

13. **A study by Bulloch et al (2003) examined children 2-16 years of age. Of 750 children enrolled, 670 radiographs were performed. If the Ottawa Knee Rules had been applied, only _____ would have required a radiograph.**
   a. 250
   b. 390
   c. 460
   d. 520

14. **The statistics for the anterior drawer test of the ACL are very good as a diagnostic instrument (specificity = 78-100%). When combined with 2 of 3 symptoms (effusion, popping, or giving way), specificity = 85%; when combined with 3 of 3 symptoms, specificity = 99% – in other words, diagnostic ability _____.**
   a. decreases
   b. improves
   c. is variably impacted
   d. remains the same

15. **Of the six ACL tests discussed, _____ have no statistical data.**
   a. active drawer and 90/90 anterior drawer
   b. anterior drawer and Lachman
   c. KT arthrometer and anterior drawer
   d. Lachman and prone Lachman

16. **When the _____ test and the sag test are performed in combination, already-strong individual statistics improve to sensitivity = 90%, specificity = 100%.**
   a. dynamic valgus
   b. Ege
   c. KKU
   d. posterior drawer

17. **The _____ meniscal tests are all very similar in technique: they simulate weight bearing via a longitudinal compression force through the tibia.**
   a. Apley, Ege, and McMurray
   b. Apley, Steinmann, and KKU
   c. Ege, McMurray, and Thessaly
   d. KKU, McMurray, and Thessaly

18. **How should the following data used to assess the medial meniscus influence your interpretation?**

	Sensitivity	Specificity
McMurray	48%	94%
Thessally	66%	96%
Joint line tenderness	71%	87%
Joint line tenderness + McMurray	91%	91%
Joint line tenderness + Thessaly	93%	92%

   a. The use of 2 tests enhances the ability to making the proper diagnosis when positive
   b. The use of 2 tests enhances the ability to rule out the disorder when negative
   c. The use of 2 tests reduces the ability to making the proper diagnosis when positive
   d. The use of 2 tests reduces the ability to rule out the disorder when negative

19. **Reproduction of pain at the anterolateral aspect of the ankle is a positive test for _____; it is also suspected if five or more of the following criteria are present:**
   1. anterolateral tenderness
   2. anterolateral edema
   3. pain upon dorsiflexion & eversion
   4. pain with single leg squat
   5. pain with activity
   6. ankle joint instability
   a. LE malalignment
   b. Morton neuroma
   c. stress fracture
   d. talocrural joint impingement

20. **The statistics (sensitivity = 13.6-31.8%, specificity = 100%) for the Windlass test, used to assess the plantarfascia tension, reveals it is an exceptional _____ tool.**
   a. diagnostic
   b. diagnostic and screening
   c. screening
   d. none of the above

21. **Aside from the _____ test (specificity = 95%), there is no sensitivity or specificity reported for the syndesmotic tests.**
   a. cotton
   b. external rotation
   c. fibular translation
   d. syndesmotic squeeze

22. Based on the statistics (sensitivity = 35-48%; specificity = 41%), the Homan sign test - used to assess for DVTs in the LE - is _____.

a. a strong diagnostic test
b. a strong screening test
c. excellent for both screening and diagnosis
d. not a clinical test in which one can have confidence

23. Special tests for the hip include: _____.

a. FADIR, Taking off the shoe, and Log Roll
b. Sag, Lachman, and KKU
c. Trendelenberg, Matles, and Apley
d. Windlass, Tuning fork, and Cotton

24. Special tests for the knee include: _____.

a. FADIR, Taking off the shoe, and Log Roll
b. Sag, Lachman, and KKU
c. Trendelenberg, Matles, and Apley
d. Windlass, Tuning fork, and Cotton

25. Special tests for the ankle include: _____

a. FADIR, Taking off the shoe, and Log Roll
b. Sag, Lachman, and KKU
c. Trendelenberg, Matles, and Apley
d. Windlass, Tuning fork, and Cotton

ANSWER SHEET

First Name: _____ Last Name: _____ Date: _____

Address: _____ City: _____

State: _____ ZIP: _____ Country _____

Phone: _____ Email: _____

License/certification # and issuing state/organization _____

Clinical Fellow: Supervisor name and license/certification # _____

Graduate Student: University name and expected graduation date _____

** See instructions on the cover page to submit your exams and pay for your course.

By submitting this final exam for grading, I hereby certify that I have spent the required time to study this course material and that I have personally completed each module/session of instruction.

Orthopedic Special Tests: Lower Extremity
Final Exam

1. Ⓐ Ⓑ Ⓒ Ⓓ	6. Ⓐ Ⓑ Ⓒ Ⓓ	11. Ⓐ Ⓑ Ⓒ Ⓓ	16. Ⓐ Ⓑ Ⓒ Ⓓ	21. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓐ Ⓑ Ⓒ Ⓓ	7. Ⓐ Ⓑ Ⓒ Ⓓ	12. Ⓐ Ⓑ Ⓒ Ⓓ	17. Ⓐ Ⓑ Ⓒ Ⓓ	22. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ	8. Ⓐ Ⓑ Ⓒ Ⓓ	13. Ⓐ Ⓑ Ⓒ Ⓓ	18. Ⓐ Ⓑ Ⓒ Ⓓ	23. Ⓐ Ⓑ Ⓒ Ⓓ
4. Ⓐ Ⓑ Ⓒ Ⓓ	9. Ⓐ Ⓑ Ⓒ Ⓓ	14. Ⓐ Ⓑ Ⓒ Ⓓ	19. Ⓐ Ⓑ Ⓒ Ⓓ	24. Ⓐ Ⓑ Ⓒ Ⓓ
5. Ⓐ Ⓑ Ⓒ Ⓓ	10. Ⓐ Ⓑ Ⓒ Ⓓ	15. Ⓐ Ⓑ Ⓒ Ⓓ	20. Ⓐ Ⓑ Ⓒ Ⓓ	25. Ⓐ Ⓑ Ⓒ Ⓓ

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ORTHOPEDIC SPECIAL TESTS: LOWER EXTREMITY

(4 CE HOURS)

COURSE EVALUATION

Learner Name: _____

	Disagree				Agree	
Orientation was thorough and clear	1	2	3	4	5	
Instructional personnel disclosures were readily available and clearly stated	1	2	3	4	5	
Learning objectives were clearly stated	1	2	3	4	5	
Completion requirements were clearly stated	1	2	3	4	5	
Content was well-organized	1	2	3	4	5	
Content was informative	1	2	3	4	5	
Content reflected stated learning objectives	1	2	3	4	5	
Exam assessed stated learning objectives	1	2	3	4	5	
Exam was graded promptly	1	2	3	4	5	
Satisfied with learning experience	1	2	3	4	5	
Satisfied with customer service (if applicable)	1	2	3	4	5	n/a

What suggestions do you have to improve this program, if any?

_____

_____

What educational needs do you currently have?

_____

_____

What other courses or topics are of interest to you?

_____

_____