The Knee: Anatomy, Pathology
and Evaluation

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Before we can discuss knee pathology and the evaluation of a knee injury it is important to have a firm grasp of the anatomy of the knee joint and the surrounding structures.

**Anatomy**

The knee joint consists of three bones: The femur, the superior bone, the tibia, the inferior bone, and the patella, the anterior bone of the knee. The fibula is another bone that is in close proximity to the knee on the lateral side (1, 4, 7, 11, 12, 14, 18).

The knee joint is not simply a hinge joint, it is a gliding hinge joint (14). A point on the patella and a point on the femur will not stay in the same place relative to each other during the range of motion, due to the gliding motion. The knee actually consists of three articulations: Two condyloid articulations, the articulation between the condyles of the femur and the respective tuberosity of the tibia, and the articulation between the patella and the femur (14).

The ligaments of the knee can be divided into two categories, external, those outside the knee joint, and internal, those inside the knee joint. The external ligaments are the ligamentum patellae or anterior ligament, ligamentum Posticum Winslowii or posterior ligament, internal lateral, long and short external lateral, and capsular (14). The anterior ligament is the central portion of the extensor mechanism (14). This ligament originates at the apex of the patella and inserts on the inferior portion of the tibial tuberosity (14). The fibers of the anterior ligament run continuously with the fibers of the extensor mechanism. The posterior ligament helps to form the popliteal floor (14). The posterior ligament originates on the superior margin of the intercondyloid notch of the femur and inserts on the posterior margin of the fibular head (14). The internal lateral or medial colateral ligament
originates at the inner tuberosity of the femur and inserts on the tibial shaft (14). This ligament contains a few common fibers with the semimembranous tendon and is also connected to the medial semilunar fibro-cartilages (14). The purpose of this ligament is to reinforce the medial side of the knee so that the knee can not hinge in a medial direction.

The external lateral or lateral colateral ligaments are designated by length. The long lateral colateral ligament runs from its origin at the posterior margin of the outer tuberosity of the femur to its attachment on the head of the fibula (14). The short lateral colateral ligament originates at the same place as the long lateral colateral ligament and attaches on the styloid process of the fibula (14). Unlike the medial colateral ligament, the lateral colateral ligament does not have any attachments to the lateral semilunar fibro-cartilage (11,14). This ligament, lateral colateral, has the job of keeping the knee from hinging in a lateral direction. The capsular ligament is the last of the external ligaments. The capsular ligament may be a very thin band of tissue but it remains very strong. It fills in the gaps between the other external ligaments that have already been described (14).

Within the knee there are eight internal ligaments: external crucial, internal crucial, transverse, coronary, two semilunar fibro-cartilages, ligamentum mucosum and the ligaments arelia (14). The crucial or cruciate ligaments are two ligaments that cross inside the knee forming an anterior cruciate and a posterior cruciate ligament (11,12,14,18). The anterior cruciate ligament originates at the spine of the tibia and simultaneously runs in a upward, lateral, and posterior direction to insert on to the inner posterior portion of the outer condyle of the femur (14). This ligament serves to keep the tibia from translating anteriorly out from under the femur (11,12,18). On the other hand, the posterior cruciate ligament passes in a
upward, anterior, and medial direction from an origin at the popliteal notch to an insertion at the outer anterior portion of the inner condyle of the femur (11,12,18). The purpose of this ligament is to keep the tibia from translating posteriorly out from under the femur (11,12,18). The transverse ligament, as it suggests, runs transversely across the anterior portion of the knee immediately in front of the fibro-cartilages. The transverse ligament serves to connect the two fibro-cartilages at their anterior insertions (12). The coronary ligaments have a similar purpose, they connect the fibro-cartilages to the margins of the tibia (14,18). The coronary ligaments are actually extensions of the capsular ligament (14).

The semilunar fibro-cartilages fore mentioned are more commonly known as the meniscus of the knee. These two structures have a flat inferior surface and a concave superior surface (14). The meniscus function to deepen the articulating surface of the knee (9,14), stabilize the knee, and act as a shock absorbing mechanism within the knee (4,9,14). The internal or medial meniscus is "C" shaped or semi-circular (11,12,14,18). On the other hand, the lateral meniscus is nearly circular in shape (11,12,14,18). The extremities of the lateral menisci are interposed between attachments of the medial menisci. The ligament of Wrisberg rises from the lateral menisci and passes upward and outward to its insertion at the inner condyle of the femur (14).

Bursae are small fibrous sacs of fluid that serve to reduce friction around the joint (4). There are thirteen major bursae around the knee. The bursae are distributed as follows: four bursae are around the patella on the anterior portion of the knee, four bursae are on the lateral portion of the knee, and five bursae are on the medial portion of the knee (4).
The retinacula is the fused insertion of the quadriceps femoris muscle and the fascia lata which functions to strengthen the anterior lateral surface of the joint (18). Similar to the retinacula is the Pes anserinus. This is the fused insertion of the semitendinosus, sartorius, and gracilis tendons (11). The pes anserinus serves to stabilize the anterior medial portion of the knee (4).

The patellar tendon is the common extensor tendon that is associated with the knee. This tendon originates from the vastus lateralis, vastus intermedius, vastus medialis, and rectus femoris muscles (12, 18). As the patellar tendon passes inferiorly it encompasses the patella and inserts on the tibial tuberosity (12, 18).

A dermatome is the area of skin supplied by a specific dorsal root (18). The dorsal roots effecting the knee are L2, L3, and S2 (18). The area supplied by the L2 root is the medial superior portion of the knee (18). The L3 root supplies the majority of the knee. The L3 root supplies the anterior, lateral, and the lateral portion of the posterior surface of the knee (18). The posterior surface of the knee is supplied by the S2 dorsal root (18).

The myotome is the muscle that is supplied by a nerve. The knee is affected by three nerves: the femoral, the tibial, and the obturator (18). The femoral nerve supplies the quadriceps group (18). The hamstring group and the gastrocnemius muscles are supplied by the tibial nerve (18). The obturator nerve is also involved because it supplies the gracilis nerve (18).

**Pathology**

Because of the complexity of the knee joint, there is a wide variety of pathology associated with the knee. A sprain can occur to any of the ligaments of the knee. A sprain
is simply the tearing of ligamentous fibers (7). The athlete may indicate that he/she felt or
heard a pop or snap at the time of injury (4). There are four sprains that are of crucial
importance in the knee because of their structural properties. The ligaments involved in
these injuries are the anterior cruciate, posterior cruciate, medial collateral, and lateral
colateral ligament. The anterior cruciate ligament sprain occurs due to a rotational force
applied to the knee while the foot is planted (4,11). Because the anterior cruciate is an
internal structure the edema will remain inside the capsular ligament. Other symptoms
include varying degrees of laxity and inability to ambulate according to the severity of the
injury.

The mechanism of injury for a posterior cruciate ligament sprain involves a blow to
the anterior surface of the tibia, forcing the tibia directly backwards (4,11). Once again the
ensuing edema will increase rapidly but will remain inside of the capsular ligament. The
symptoms are the same as they were for the anterior cruciate sprain except that the laxity
will be in the opposite direction.

The medial collateral ligament is relatively easy to sprain because of the mechanism.
This injury occurs due to a force applied to the lateral side of the knee, a valgus force, such
as clipping (1,4,11). The medial collateral ligament is an exterior structure, unlike the
cruciate ligaments, the ensuing edema will exist primarily outside of the capsular ligament.
The athlete may report that the knee feels "wobbly" or unstable. Other symptoms include
point tenderness over the ligament, laxity, difficulty in ambulation, and loss of full ROM
(4,11).
The symptoms will be the same for a lateral collateral ligament sprain. The mechanism for a lateral collateral ligament sprain is a force directed through the knee from the medial side of the knee (4,11). This injury is less common then the medial collateral ligament sprain because it is harder to receive a varus force then it is to receive a valgus force.

Strain refers to the disruption of muscular or tendinous fibers (7). This disruption may be stretching or tearing of the fibers (7). A strain may occur to any of the muscles associated with the knee, the quadriceps group, the hamstring group, or the gastrocnemius. The mechanisms for this injury are explosive contraction, fatigue, or a muscular imbalance (11). The athlete will indicate that there is pain during some part of the ROM and possibly that he/she felt a pop or pull at the time of injury. This injury may produce edema and/or a palpable divot at the point of injury, depending on the severity. There will be point tenderness, a loss of strength, and possibly a loss of function depending on severity.

Rotatory instabilities are combined movements involving both an anterior or posterior component and a rotational component (4). In order for this pathology to exist, the arcuate complex must be torn (4). The most instabilities are posterio-lateral and antero-medical rotatory instabilities (4). The rotatory instabilities produce the same symptoms as those associated with the individual components of the arcuate complex: pain, swelling, loss of function, and loss of ROM (4).

Patellar tendonitis is a chronic irritation of the patellar tendon (7). Tendonitis will have a gradual onset with non-specific tenderness and generalized swelling in the area of the tendon (4,11). Patellar tendonitis is usually brought on by repetitive jumping activities and

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aggravated by any motion that reproduces those forces such as squatting, climbing stairs, or full arc extensions (16). It has been hypothesized that chronic patellar tendonitis may cause structural weaknesses which can lead to mid-tendon ruptures of the patellar tendon (16). Because of the mechanics of jumping, Rosenberg and Whitaker feel that a unilateral rupture is more common, but the bilateral ruptures can also occur (16).

Bursitis is a common problem which is relatively easy to take care of. Bursitis is the inflammation of a bursa sac (7). The prepatellar bursa is one of the most commonly injured bursa because of its position between the patella and the skin (4). This condition usually occurs from a direct blow to the area over the bursa. However, this condition may also arise from excessive friction, normally between a bone and a tendon (4). The common symptoms of bursitis are a prominent localized swelling, increased skin temperature over the area of swelling, and tenderness over the bursae (4).

Pre-patellar bursitis is a common problem involving the patella, but there are other types of pathology associated with the patella. The patella may sublux or become dislocated. Subluxation is the more common injury (4,11). In a subluxation, the patella moves laterally out of the patellofemoral groove and then spontaneously reduces itself (4,11). A dislocation differs in that there is no spontaneous reduction. The knee cap can usually be reduced by straightening the knee (1,4,11). Rarely will the patella move medially because the medial condyle is larger and offers a greater mechanical block (4,11). Subluxations and dislocations can occur for two reasons: 1. There can be a direct blow mechanism to the medial side of the patella, or 2. There may be a congenital/developmental condition (4). Congenital conditions such as knock knees, shallow patellar groove, abnormal patella, abnormal extensor
tendon placement, or Q angle, especially in women, may cause a chronic problem (4). The major developmental problem is the deterioration or atrophy of the vastus medialis obliquus, a portion of the vastus medialis in which the muscle fibers run in an oblique manner (11,14). The atrophy of this portion allows the patella to be pulled laterally since the medial structures are no longer able to counteract the stronger lateral structures (4).

The dislocation or subluxation of the tibio-fibular joint is a rare injury, but this is an injury which is easily missed during an examination. There are four defined injuries affecting this joint. An antero-lateral dislocation is the most common injury, but there are also reported cases of subluxations, posteromedial dislocations, and superior dislocations (13). These injuries have been reported in sports ranging from extreme risk, parachuting, to moderate risk sports like soccer and gymnastics. There have even been cases reported of professional dancers suffering from this type of injury. The common mechanism for this injury requires the athlete to twist the knee while landing with the knee flexed near eighty degrees (13). The symptoms associated with this injury are pain and tenderness over the head of the fibula, drop foot and loss of the dermatomes (13) of the distal third of the anterior and lateral leg and foot (18). The loss of sensation and drop foot phenomenon is due to the damage to the peroneal nerve. Nerve palsy is due to the repositioning of the fibular head. If the head has only subluxed, there is a good chance for complete recovery; however, damage to the nerve due to a dislocation will typically not recover very well (13).

Chondromalacia patellae is a degenerative process where the posterior surface of the patella becomes softened and irregular (1,4,11). Chondromalacia patellae will have a gradual onset and is usually caused by either direct trauma or internal derangement whether
it be congenital or developmental (4). This condition will usually be associated with swelling and crepitus (4). Tenderness will be centered around the margin of the patella, especially under the medial facet of the patella (4). The athlete will also convey that he/she experience pain while sitting for long periods of time.

Though the meniscus are not involved in knee stability, meniscus can be involved with knee pathology. A meniscal lesion is the tearing of meniscal tissue (1,4,7). The medial meniscus is more frequently injured then the lateral meniscus (4). The reason for the disproportion of meniscal lesions is that the medial menisci is more securely held in place by the coronary ligaments and is directly attached to the capsular ligament (1). The most common mechanism for a transverse lesion is a rotary torque while weight baring with a bent knee (4). A longitudinal lesion is usually sustained from a internal torque with a forced extension of the knee (4). When the lateral menisci is injured the mechanism will usually be caused by the tibia being forcefully extended while being externally rotated (1). The symptoms of a meniscal lesion are intracapsular swelling, pain, loss of motion, the athlete may also describe a locking effect which is due to the meniscus becoming lodged between the articulating surfaces (1). Remember that not all meniscal injuries require surgery; one should try conservative treatment for minor symptoms (9).

Osteochondritis disseicans refers to a fracture of the articular cartilage and the bone lying immediately under the cartilage at a point where there are no load baring attachments (6). The area is usually avascular and necrotic prior to the fracture. The fact that there may be no load baring attachments rules out avulsion fractures which will be discussed in greater depth later. This condition may occur to the patella or the tibia, but the most common spot
for a Osteochondritis dissecans to occur is the lateral surface of the medial femoral condyle (6). The mechanism for this pathology is related to the avascularity of the tissue caused by recurrent trauma to the area set off by an acute blow (6). This condition will reveal medial joint line tenderness, pain, edema, and stiffness possibly due to loose bodies within the joint (4).

Fractures about the knee are rather unusual, the only sport where these fractures are somewhat common is auto racing (7,11). Osteochondral fractures include osteochondritis dissecans and chondral fractures. It is common to find co-existing abnormalities with osteochondral fractures (6). It has been estimated that approximately five-percent of all dislocated patellas have osteochondral fractures that occur simultaneously (6). The mechanism of injury may be from either inside the knee, endogenous, or outside the knee, exogenous. Endogenous forces are forces such as muscle contractions or weight baring (6). Exogenous forces are those involving a blow or fall (6). According to Cohn et al.(6), adolescents are most affected by this injury because of the relative instability of the chondral structure (2,6). The patient will report a "pop" or "snap" and edema will develop within a few hours (4). If the fracture becomes displaced, forming a loose body in the joint, it may hinder weight baring, and the joint may lock if the displaced bone becomes lodged between the articular surfaces (6).

Though still not common, patellar fractures are frequent enough to be described in more detail. Patellar fractures can be divided into transverse, stellate, longitudinal, and avulsion fractures (6). Transverse fractures are typically produced by a direct blow to the patella with a force that would not typically produce a fracture combined with a muscle
contraction acting on the patella (6). Fifty to eighty percent of all patellar fractures will be transverse fractures with the majority producing one large piece and one small piece (6).

Stellate fractures are the second most frequent patellar fracture, but it is rarely seen in athletics because of the excessive force needed to produce a fracture of this nature (6).

Longitudinal fractures account for approximately twenty-percent of patellar fractures (6). The mechanism for this fracture is either a direct blow or this fracture may be caused by a dislocation of the patella.

An avulsion fracture may occur at any point where a tendon or ligament attaches to bone(4,6). This fracture is produced by a sudden violent contraction of force(4). The athlete will usually report having hear a pop at the time of injury(11).

Knee dislocations that are tibial femoral dislocations are highly traumatic and very rare (19). Most dislocations occur due to auto accidents, but dislocations have also been reported in high collision sports such as football (19). This condition will have obvious deformations and may require surgical intervention because of vascular and nerve damage (19).

Osgood-Schlatter's syndrome is another pathology associated with the knee. This syndrome mostly affects young children around the age of puberty and is usually bilateral (3,4,7,11). With this condition, repeated trauma due to the fact that the bones are growing faster than the muscle causes a micro avulsion fracture of the tibial tuberosity. This syndrome is evident by localized swelling, tenderness over a prominent tibial tuberosity, and restricted passive knee flexion (11). Usually bounding activities such as running and jumping
will aggravate this condition. If undetected this condition may weaken the bone allowing an acute avulsion of the tuberosity (2).

Sinding-Larsen-Johansson disease is not as common as Osgood-Schlatter's syndrome, but it is still a problem with skeletally immature athletes (3). This condition is a calcification of the inferior pole of the patella at the point where the patellar tendon attaches (1,4). The athlete will indicate that pain increases during activity. Examination will indicate point tenderness and bone disfiguration over the inferior pole of the patella (3).

There are also special acute concerns when dealing with younger children. Because the ligaments in young children are at full strength and the bone is still in a maturation process, a situation develops in which a force that would normally affect the ligaments of an adult, now affect the bone, the weak link (2). The epiphyseal plate is the area of bone growth. An injury to this area can potentially be a serious condition. If the damage to the epiphyseal plate is significant enough, the injury may impede further bone growth (12). A fracture through the epiphyseal plate will mimic a ligament injury upon initial evaluation, palpation may however indicate a false joint space. The only way to definitely diagnose this condition is to have x-rays taken (2). The force that will usually affect the anterior cruciate ligament, in a young person, may instead cause the tibial eminence to fracture. This fracture will develop the same symptoms as an cruciate ligament sprain (3). The twisting mechanism for this injury is identical to an anterior cruciate ligament tear.

Bipartite patella is a congenital condition which under initial examination will mimic a fractured patella, but this condition can easily be diagnosed with the use of x-rays. A
Bipartite patella will not have sharp edges like a fracture. The edges will be rounded and smooth (6,11). This condition may cause pain if the athlete receives a direct blow (2).

**Evaluation**

Evaluation of the knee can be a very delicate matter. To obtain an accurate evaluation, the evaluator must have a lot of experience and sensitive hands. Because of the complexity of the knee evaluation, it is important for the beginner to develop a system that he/she will use every time so that nothing is overlooked.

As with any evaluation, the examiner should begin with the history. When dealing with the knee questions such as: have you injured this or the other knee before, were you hit or was no one around you, was your foot planted, as well are the usual questions about sounds, feelings, and exact mechanisms. A careful listener will be able to pick out clues as to what type of injury the athlete has developed.

**Observation**

Observation is also an important part of the knee evaluation, especially when dealing with chronic injuries. Some visible abnormalities can lead to specific abnormalities. Genu valgus is a condition in which the knees, in a normal standing posture are closer together then the feet, also known as knocked knees (1,4). This condition will affect patellar alignment by increasing the Q angle (1,4). The Q angle is the angle between a line from the anterior superior iliac spine to the mid-point of the patella and a line from the tibial tuberosity and the mid-point of the patella (4). Normal Q angles for men range from five to ten degrees and for women from ten to fifteen degrees (1).
Genu varum, bow legs, is the condition where the knees, in normal standing posture, are further apart than the feet (1,4). This condition may affect patellar alignment, but in a different way than genu valgus. While genu valgus alters the pull of the quadriceps (4), genu varum may cause the patella to rotate.

Genu recurvation is the hyperextension of the knee (4). This condition will cause the weakening and stretching of the posterior structures (4). Especially in younger children at the age of puberty, the growth spurts may produce undue stress on musculotendinous junctions. A common indicator of this problem at the knee is the enlargement of the tibial tuberosity. Whatever condition the athlete may have, the evaluator's observations should pick up possible condition such as these which the athlete may already have.

**Palpation**

Palpation is the art form in which the finger tips are used to find abnormalities in the tissues of the body (7). The examiner should develop a systematic approach to evaluating the knee. The examiner should begin by palpating the patella. In this area, the examiner is feeling for bony abnormalities, fractures, or swelling. Fractures can be identified by a noticeable crevice in the bone or by a false joint, a joint where there should not be an articulation. Swelling will be noted by observation and by the feel of gel instead of a water like substance in the knee. If the fluid around the knee is viscous enough there may also be pitting edema, a sign of advanced swelling where a visible pit will develop when the examiner removes his finger and the skin will slowly return to its pseudo-normal state (11). If the leg musculature is relaxed enough, it may be possible for the examiner to palpate the underside of the patella. To do so apply pressure to either the medial or lateral anterior
border. The pressure will cause a slight rotation in which the postero-lateral margins of the patella may palpate. Any muscle spasm or guarding by the athlete may make this test impossible.

Next, the examiner should move distally onto the patellar tendon at its insertion and origin. When palpating the patellar tendon, the examiner should be looking for point tenderness or possible a divot or tear in the fibers (11). The examiner should begin to think patellar tendonitis if there is generalized tenderness over the whole tendon or significant part of the tendon. Point tenderness over the insertion or origin may be strains or tendonitis, but an avulsion fracture must also be considered, especially at the insertion of adolescents where the condition, Osgood-Schlatter's syndrome is common (7).

Continuing with the palpation, the examiner should move to the joint line opposite to the area the athlete is complaining. With the knee in a flexed position, the examiner may palpate the anterior surface of the meniscus as well as the bony margins. The examiner should progress around the joint line attempting to feel the meniscus, as much as possible. This may be easier on some people then on others because of the size of the joint space. Once the examiner reaches the collateral ligaments, the respective ligament should be palpated along the entire length of the ligament. Once again, point tenderness at the origin or insertion may indicate a avulsion fracture (11). Point tenderness in the body of a collateral ligament may indicate the presence of a collateral ligament sprain (11).

The examiner should finish by palpating the posterior portion of the joint space. The examiner will attempt to feel the posterior portion of the meniscus, the popliteal space, for nerve impairment, and the insertions of the hamstring group and gastrocnemius origin (11).
Tenderness over one of the muscle insertions may indicate tendonitis, muscle strain, or in traumatic cases an avulsion fracture (11). In general, joint line pain not directly over another structure will indicate a meniscal injury. Because the cruciate ligaments are internal structures, they can not be palpated. The cruciate ligaments have to be evaluated by stress techniques presented later in this paper.

**Special Tests**

In the case of the knee, there are some special tests that will afford the examiner a better indication as to the type of pathology from which the athlete is suffering. The ballotable patella test is used with an athlete suspected of having a good deal of effusion outside of the capsule (4). The examiner will have the athlete relax the leg, then apply a gentle force in an anterior to posterior direction and then quickly release the patella. If the test is positive, the patella will spring up and appear to be floating on top of the fluid (4).

To check for intracapsular edema, the examiner should place one hand approximately one-third of the way up the thigh from the knee and attempt to push the fluid towards the knee by squeezing the leg and running the hand down to the superior portion of the knee, milking the leg (4). The examiner should then place the thumb and index finger of opposite sides of the knee, apply a light pressure to the sides of the knee alternating between fingers. If the test is positive, the examiner will be able to feel the fluid moving against his/her fingers (4).

To test for patellofemoral pathology, the patellar grind test works well. To perform this test the athlete should be placed in the supine position with a towel roll under the knee, keeping the knee at approximately twenty degrees of flexion and the athlete should be relaxed
The examiner should place the thumb and index finger of one hand on the anterior superior margin of the patella, and then apply a force directed in the posterior and inferior directions (1). The athlete is then instructed to contract the quadriceps group, forcing the patella to be "raked" across the articulating surface of the femur. The test is positive if the athlete experiences pain or the examiner either feels or hears a grating sensation (1). In severe cases of patella femoral pathology, simply applying the force without the contraction may cause pain (1).

To test for a subluxation or self-reduced dislocation, the examiner should preform the apprehension test. To begin this test, the knee should be in full extension and the athlete must be relaxed. If the athlete is not relaxed at the beginning of the test, the test can not be performed (1,4). The examiner should then place both thumbs on the medial border of the patella and grasp above and below the knee with both hands respectively. A lateral force is applied to the patella. The test is positive if the athlete expresses a great deal or reluctance to allowing you to apply this force or begins to guard against this action (1,4). The reason for this reluctance is that you are effectively reproducing the force that caused the subluxation or dislocation (1,4).

The Ober test is designed to test for iliotibial band syndrome which may cause problems at or around the knee (4). To perform the test, the athlete should be placed on their opposite side and on the edge of the table. The examiner must reassure the athlete that they will keep the athlete from falling off in order for the athlete to allow the test to proceed. The examiner used his/her top hand to stabilize the hips and keep the hips from rotating. With the other hand the examiner grasps the lower leg immediately inferior to the knee. The
examiner then positions the athlete's leg in hip extension and abduction (4). Once in this position, the examiner allows the leg to fall towards the table. If the leg does not fall or only falls a minimal distance, try applying a gentle pressure to assist the motion. If the leg still does not reach the level of the table or lower the test is considered to be positive for tensor fasciae latae tightness and iliotibial bandy syndrome might be a possibility (4).

**Manual Stress Testing**

Perhaps the most important portion of a knee evaluation is manual stress testing; however, this portion also requires the most proficiency. Stress testing is used to evaluate the major ligaments of the knee. For all ligament stress tests in the knee, the following scale should be used as a baseline. No movement indicates that the ligament has not been damaged (4). If there is less than one-half centimeter of laxity, the injury should be considered to be first degree (4). Laxity between one-half and one centimeter should indicate a second degree injury (4). An injury with more than one centimeter of laxity and having no end point should be considered to be a third degree injury (4). Some people have knees that are naturally looser than other peoples so this scale should be adjusted for people with loose knees, not due to previous injuries.

The drawer test is used to evaluate the integrity of both the anterior and posterior cruciate ligaments (1,4,11). The drawer test is performed with the athlete in the supine position. The leg to be tested is flexed to approximately ninety-degrees while the other leg remains in extension (1,4,11). The examiner should sit on the forefoot of the leg being tested, place both thumbs over the anterior joint line, one on each side of the patellar tendon and wrap the rest of the hand around the lower leg just inferior to the knee. In order the
perform this test the examiner will attempt to pull or push the tibia put from its position under the femur (1,4,11). If the lower leg moves anteriorly, the anterior cruciate ligament has been damaged. On the other hand, if the tibia translates posteriorly from under the femur, then the posterior cruciate ligament has been damaged. There are two major shortcomings for this test. First, an athlete may not be able to achieve ninety degrees flexion due to pain; therefore, the test may loose some of its effectiveness (10). Second, the ninety degrees angle at the knee makes it very easy for the athlete to guard and give a false, negative test. This is where an experienced evaluator is required. The evaluator must get the athlete to relax the hamstrings in order to get an accurate test (10).

Another test for the cruciate ligaments is the Lachman test. When performing the Lachman test the athlete should lie supine with both legs relaxed in extension (1,4,11). The evaluator will allow the heel of the leg to be tested to rest on the table while placing one hand above and one hand below the knee. The examiner should make sure that both hands are placed on the leg so that both thumbs are on the anterior surface. The knee should now be flexed to approximately thirty degrees for the test to be performed (1,4,11). The examiner should then attempt to translate the lower leg, tibia, out from under the femur. This test is more effective because the knee does not have to bend at a ninety-degree angle, and the position of the leg makes it easier to get the patient to relax and reduce the chance of hamstring guarding (10). Just like any other test, the Lachman test has its problems. This test can be especially difficult when the athlete has a very large leg, ie. football players (10). The problem can also be compounded if the evaluator has small hands. In this situation where the athlete has a large leg and the evaluator has small hands, some modifications to
One modification has been to involve a second person (10). In this version of the test, one person immobilizes the thigh while the second person manipulates the lower leg (10). Another modification of this test is to place the person in a device such as an Orthotron of Cybex where the thigh can be strapped down in order to immobilize the upper leg while the examiner manipulates the lower leg (10). This modification is not as effective; the athlete may not be able to lie in a supine position. Also, if the athlete has a great deal of hip flexion, the last modification increases the chance of hamstring guarding (10). A recent study has determined that, if performed by an experienced examiner, anterior cruciate ligament evaluations can be up to seventy-two percent accurate when compared with arthroscopy (8).

When testing for a cruciate deficient knee and a deficiency is found, it is necessary to pay attention to the starting position of the leg. Near full extension, the starting position will be near normal regardless of which ligament is injured. As the knee is flexed, a gravity sign sets in (17). The gravity sign is a phenomenon in which a deficient posterior cruciate sprain allows the tibia to translate posteriorly (17). Consequently, when the tests are performed, the examiner feels an anterior shift. However, this is not a positive anterior shift, the leg is simply being brought back to the neural position (17). If the examiner does not realize that this is occurring, the examiner will diagnose a false positive (17). In order to determine if the leg is in neutral, the athlete should be instructed to contract the quadriceps group (17). This contraction will pull the tibia into neutral if there is a gravity sign (17). Another way to determine if the starting position is translated posteriorly is the sag sign. This is an
observation test where the examiner looks to see if both tibias are equal prior to any other tests.

The valgus stress test is used to test the integrity of the medial collateral ligament (1,4,11). This test is also performed with the athlete in the supine position. The examiner's top hand is placed on the lateral side of the knee at the joint line. The other hand is placed over the medial malleolus and holds the lower leg. To perform this test, the examiner applies a valgus, inwardly oriented force to the knee while attempting to pull the lower leg laterally (1,4,11).

The varus stress test used to evaluate the lateral collateral ligament is very similar to the valgus stress test (1,4,11). With the varus stress test the examiner places his/her hands of the opposite side of the leg from the valgus test. The top hand is placed over the medial joint line and the bottom hand is placed over the lateral malleolus. This hand placement reverses the force on the knee to be an outwardly oriented force, varus force (1,4,11). Both the valgus and varus stress tests should be performed at zero and approximately thirty degrees of knee flexion. At thirty degrees the knee is usually a little looser than it is at zero degrees of flexion; therefore, more minor problems can be identified (1,4,11).

To test for anterio-lateral and anterio-medial instability, the examiner should perform a modified anterior drawer test. To modify the test, the foot and lower leg should be internally or externally rotated respectively (4). By rotating the tibia, stress is moved onto the structures that control the rotatory motion (4).

The lateral pivot shift, jerk test, and Slocum test will not be highly effective in an acutely injured knee. These three tests are most effective in the period of time over six
sensation in the knee. Several protocols have been developed to attempt to evaluate the meniscus. The McMurry test is performed with the athlete lying supine, with the leg to be tested flexed past ninety degrees (1,4,11). The top hand is placed over the anterior portion of the knee, with the thumb and index finger palpating the joint line. The other hand is used to support the foot and ankle. This lower hand will externally rotate the lower leg and foot while the top hand applies a valgus force. While the leg is in this position the knee is extended. This procedure should also be repeated with the lower leg internally rotated and a varus force applied to the knee (1,4,11). McMurry’s is a good test for the posterior portion of the meniscus because that is the portion of the meniscus that receives the greatest stress (4). The medial-lateral grind test is like grinding a tablet with a mortar and pestle (4). Hand placement, for this test, is the same as it is for the McMurry test, knee and ankle. For this test the knee is flexed to forty-five degrees a more feasible angle on an injured knee, except that it will miss a portion of the meniscus. During the grind test the leg is extended while a varus stress is applied and flexed while a valgus stress is applied (4).

The Fox test, once again, is performed with the athlete supine (11). The knee is flexed to ninety degrees with one hand over the joint line and the other on the plantar surface of the os calcus. During the evaluation the leg is extended while the foot and lower leg repeatedly externally rotated, each time returning to neutral (11). The knee is once again flexed to ninety degrees and the test is repeated while the lower leg and foot are internally rotated. Once again the major problem with this test is that the knee must be able to achieve ninety degrees of flexion (11).
Appley's compression test is quite possibly the cruelest of all the meniscus tests used. To perform this test the athlete is in the prone position with the knee at ninety degrees of flexion (1,4,11). The examiner assumes a position over raised foot and places both hands on the plantar surface of the os calcus. The test is performed by applying a force on the knee through the lower leg. While this force is being applied the examiner internally and externally rotates the lower leg. This is quite possibly the least effective test that is widely used. This test may cause pain in a non-injured knee, giving a false positive sign (1,4,11). Appley has also developed a distraction test to delineate between a meniscus problem and a ligamentous problem (1,4,11). The test is performed with the athlete lying prone and the knee at ninety degrees of flexion. The examiner places one hand on the back of the leg just superior to the knee and the other hand grasps the ankle. To perform the test the examiner attempts to distract, or pull apart, the articular surfaces of the knee, while rotating the knee in both the internal and external directions. If compression elicits pain the injury is to a meniscus, but if distraction elicits pain then the injury is to a ligament (1,4,11). Several studies have been conducted to determine the accuracy of meniscal tests in comparison. Even with experienced examiners, the meniscal tests are highly variable. Medial meniscus evaluations are only seventeen percent accurate while lateral meniscus evaluations are as accurate as the cruciate tests (8).

**Manual Muscle Testing**

Manual muscle testing is a simple but highly effective method of assessing muscular problems affecting the knee. This procedure should be performed bilaterally. The opposite ligament is used as the baseline for management. The grading of muscle strength should be
based on a zero to five scale. A five rating is a normal contraction throughout the entire range of motion. A four rating is given to an athlete who can move through the whole range of motion but not with strength equal to the opposite side. A three rating is reserved for an athlete who can only move through the whole range of motion without any manual resistance. A two rating is based on the athlete's ability to move through the entire range of motion once the effects of gravity have been eliminated. A grade one rating is when the athlete shows evidence of a muscle contraction but can produce no joint movement. When an athlete can produce no evidence of a contraction, a rating of zero is given (4). Especially in athletes that one suspects of having little or no loss of muscle strength, it is important to have the athlete begin the contraction slowly and build up so that the examiner can react to the contraction.

The basic tests are administered in the following ways. The quadriceps group is evaluated by having the athlete sit at the end of the table so that their legs are hanging off the edge. From this position the examiner has leverage to control the extension of the knee (11). To evaluate the strength of the adductors and abductors there are two ways to position the athlete. In the sitting position, have the athlete spread their knees about one foot apart. The examiner then can place their hands on the medial or lateral side of the knee respectively to resist the contraction. The more accurate method is to position the athlete on their side. For adduction, the athlete lies on the side to be tested and lifts the leg towards the ceiling while the examiner provided resistance. To test abduction, test the opposite leg from the side the athlete is lying on. The athlete again pushes towards the ceiling against resistance. To test
the hamstring group, position the athlete in the prone position. From this position the examiner can control the flexion of the knee.
Technological Evaluation

Beyond what the athletic trainer can do to evaluate the knee is the domain of the doctor and technology. Even though an athletic trainer can not order these procedures to be performed, it is important to have a basic knowledge of what these procedure are. There are many types of imaging that serve different purposes: radiography, tomography, computed arthrotomography, and magnetic resonance. Radiographs are useful in detecting fractures and is more specific, as to type of fracture, then skeletal scintigraphy which has a slight edge in sensitivity (5). The tomography based imaging are best at showing displacement and depressions in isolated areas (5). Magnetic resonance imaging seems to be the way of the future because it does not require radiation (5,15) and this form is both very versatile and very accurate. Kelly et al (15) have reported accuracy from, ninety-four to ninety-eight percent in ruling out internal derangement and up to eighty-five percent accurate for positively diagnosis (15). At this time, the main reasons for not using magnetic resonance imaging more often is the high cost of performing the test (15).

Evaluating the knee can be a complex process. Hopefully this paper will put forth the basic information needed to begin a knee evaluation. As with any joint, the only way to become proficient in evaluation skills is practice. With experience will come accuracy and reliability. In order to become a highly experienced evaluator, put your hands on every knee you can, injured or not.
Reference


