

Field Evaluation and Management of Non-Battle Related Knee and Ankle Injuries by the Advanced Tactical Practitioner in an Austere Environment

Part One

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Editor's Note: The following article will be published in three parts due to its size and amount of pictures.

Part One will consist of evaluation of knee injuries;

Part Two will be in the Spring 09 edition and will consist of taping procedures for the various knee injuries;

Part Three will be in the Summer 09 edition and will consist of ankle injury evaluation and taping.

What are the options that you, as an advanced tactical practitioner (ATP), have when you're in an austere situation in the field carrying out a mission, and one of your teammates comes to you complaining of either a twisted ankle, a twisted knee, a locked knee, or some type of non-battlefield related lower extremity injury? These types of injuries are going to compromise the mission because of that Soldier's inability to bear weight and remain functional. Basically, you're in the middle of nowhere, your teammate can no longer walk, and your team leader wants to know if this person needs to be evacuated, thereby compromising the mission and any other follow-on missions. Is there anything that can be done to make him at least marginally functional?

The diagnoses pertinent to the knee that will be discussed are collateral and cruciate ligament injuries of the knee, patellar dislocation, and locked knee due to a torn meniscus. In addition, the importance of being able to distinguish between a bursitis and an effusion, and why this is important, will be addressed. Finally, the evaluation and treatment of an ankle sprain will be discussed.

There are several assumptions that need to be made: The treating ATP:

- has the knowledge of the anatomy of the joint.
- knows enough to ask the questions necessary to define the mechanism of injury. In other words, was this a twisting injury? Was there a blow to the lateral aspect

of the knee? Did the ankle go into a position of plantar flexion and inversion? Were there pops associated with this injury? Did the symptoms come on gradually or suddenly? Was this a result of a fall or a compressive injury? Did the knee buckle, and if so, in which direction?

- understands the different types of pathology that may occur given the history of injury and pertinent physical findings.

In addition, assume that you are in an austere environment situation with no diagnostic equipment, no additional or higher medical authority, and basically, your treatment supplies are limited to what you are carrying. This series of three articles will discuss how to evaluate and treat these injuries with taping techniques using any type of adhesive tape you have handy, even duct tape.

The goals of these procedures are to return the injured teammate to an ambulatory status or enough of an ambulatory status to continue the mission. At the very least you need to be able to give your team leader increased options for continuing the mission. Please note that everything in this article reflects temporary measures only — not definitive treatment. No matter what the patient says or how good the patient feels, additional medical care will be required once the mission is completed and the patient is returned to base.

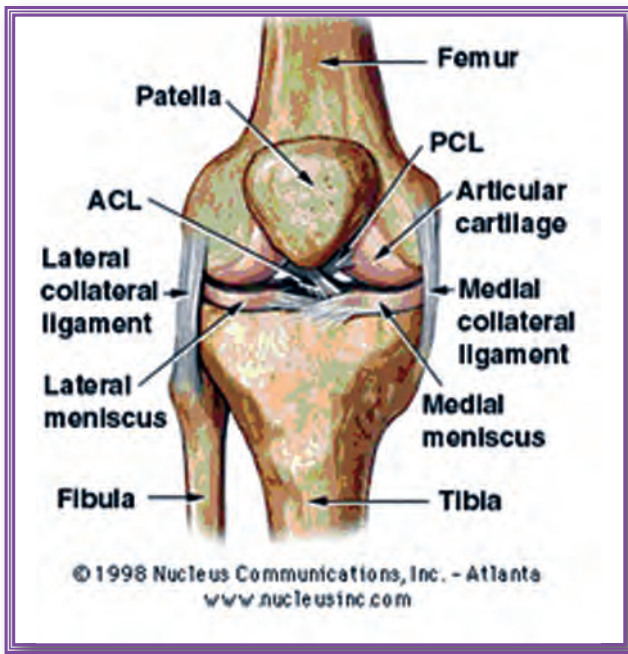


Figure 1: Knee anatomy, right knee (ACL=anterior cruciate ligament; PCL=posterior cruciate ligament)

KNEE

Anatomy

The knee is made up of four bones: the femur, the tibia, the fibula, and the patella.

The medial collateral ligament and the lateral collateral ligament are the ligaments on the medial and lateral sides of the knee. The medial collateral ligament (MCL) connects the femur to the tibia while the lateral collateral ligament (LCL) connects the femur and fibula (Figures 1 and 2).¹ They provide stability for the knee in a medial to lateral (sideways) direction.

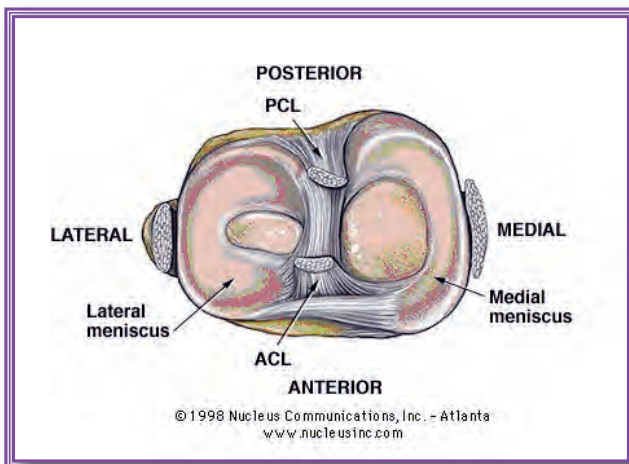


Figure 2: Right knee, cross sectional anatomy (ACL=anterior cruciate ligament; PCL=posterior cruciate ligament)

The medial and lateral menisci cartilage are c-shaped pieces of tissue that sit inside the joint. They are located on the peripheral aspect of the joint and act as a buffer between the tibia and femur (Figures 1 and 2).¹

Two cruciate ligaments pass through in the center of the knee joint: the anterior cruciate (ACL) and the posterior cruciate (PCL) ligaments. These are the major stabilizing ligaments of the knee. In Figure 3,¹ in the lateral view, the posterior cruciate ligament prevents the femur from sliding forward on the tibia (or the tibia from sliding backward on the femur). In the medial view, the anterior cruciate ligament prevents the femur from sliding backward on the tibia (or the tibia sliding forward on the femur). Most importantly, both of these ligaments stabilize the knee against rotation in the horizontal plane (OR: around the vertical axis). Thus, if one of these ligaments is significantly damaged, the knee will be unstable when planting the foot of the injured extremity and pivoting, causing the knee to buckle and give way.

Overlaying the anterior aspect of the patella, between the patella and the skin is a potential sack called the bursa. At times this will become inflamed and swollen. When evaluating the knee, the examining ATP must be able to accurately determine the presence of a swollen bursa (bursitis) as opposed to localized soft tissue swelling or an effusion.

Effusion

An effusion represents a collection of an abnormal amount of fluid inside the joint. This fluid may be due to sepsis and be pus; it may be due to a fracture and be a lipohemarthrosis or hemarthrosis; it may be

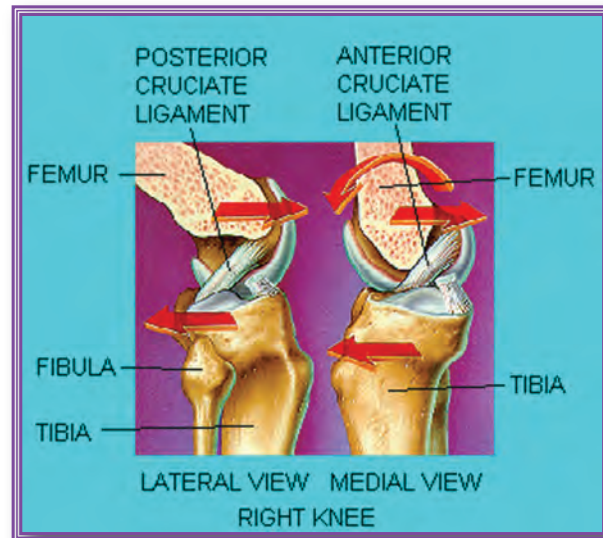


Figure 3: Cruciate ligament function



Figure 4: Normal appearance of a knee. The knee skin depressions adjacent to the patella are the “knee dimples” which disappear with the development of intra-articular swelling (effusion).



Figure 5: Above - Left knee with effusion
Red line: Approximate extent of superior aspect of knee joint. **Black circle:** Patella

due to a torn anterior cruciate ligament and be a hemarthrosis; or it may be due to a torn meniscus or a loose body and be a collection of serous fluid.

The importance of distinguishing the effusion from the bursitis is that an effusion represents a significant intra-articular disorder, requiring a more thorough examination and treatment regimen.

When evaluating a knee for the presence or absence of an effusion, examine the front of the knee joint. Since an effusion represents an accumulation of fluid inside the joint, as the joint becomes swollen (distended), the dimples on each side of the kneecap will disappear.

By comparing the effusion photograph (Figure 5) to the normal photograph (Figures 6), one can see that there’s been a loss of the dimples in the knee with an effusion. This indicates an accumulation of an effusion (fluid inside the joint space) which displaces the overlaying skin in an outwards direction, causing the “knee dimples” to disappear.

In addition, since the joint also extends about four inches above the knee, any collection of fluid inside the joint will give a bulging above the kneecap (Figure 5). This is most noticeable at the superior lateral aspect of the patella. By pushing on the lateral as-

Figure 6: Below - Normal knee



pect of the knee, the examiner may actually detect a transient bulging sensation on the medial aspect of the knee if there is a significant accumulation of fluid. This is known as a fluid wave.

The field evaluation and treatment of an effusion is to initially determine the origin of the effusion and begin appropriate treatment for the underlying disorder. Temporarily, after addressing the causative injury, NSAID (non-steroidal anti-inflammatory drug) medication should be started. Upon return to base, further evaluation is absolutely required.

With respect to evacuation possibilities, and mission continuation possibilities, this depends on the injury. Typically an effusion does not require evacuation unless sepsis occurs, a fracture occurs, or there is complete loss of function which prevents further ambulation.

In trying to distinguish between these diagnostic possibilities, sepsis will almost always require some sort of penetrating injury to the knee joint. There will be the typical signs that are associated with infection including erythema, exquisite increasing pain which is not responsive to pain medication, progressive increase in effusion and loss of motion, possible lymphangitis, and swollen, tender groin nodes. The presence of a septic knee constitutes a surgical emergency requiring evacuation.

In trying to determine the differential diagnosis of a fracture, without having any diagnostic equipment, the mechanism of injury comes into play. If a significant compressive force occurred across the joint, then the probability of a fracture to the proximal tibia or distal femur is increased. The very rapid accumulation of an effusion should also make the examiner worry about the presence of a fracture.

Finally, percussion or palpation of the bones of the proximal tibia or distal femur is normally not tender. If the examination shows an angular deformity at the joint, exquisite pain on attempted manipulation of the joint, or pain on percussion or palpation of the bones around the joint, then a presumptive diagnosis of a fracture must be considered.

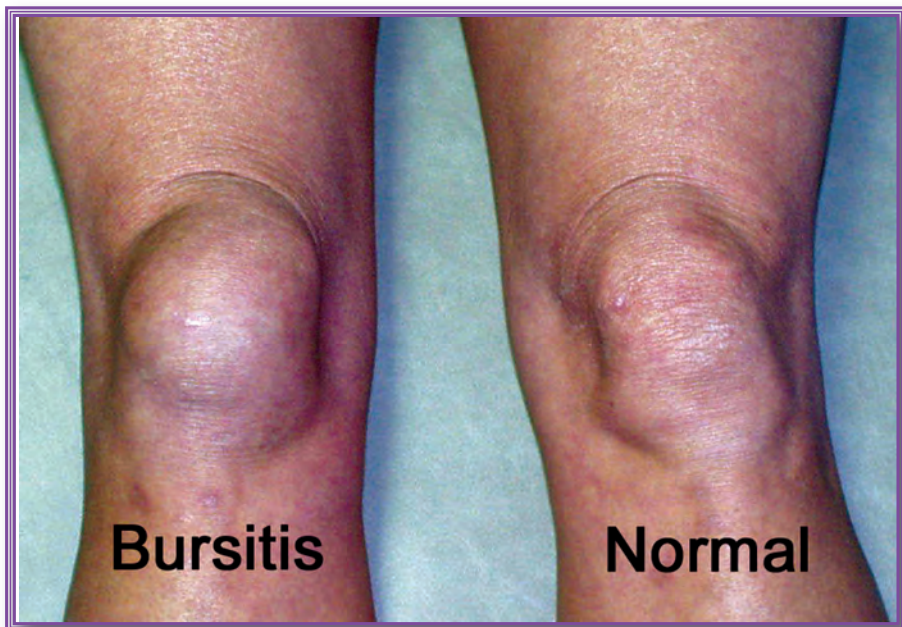


Figure 7: Notice the taut skin on the anterior surface of the knee with bursitis, as opposed to the presence of flexion creases on the anterior aspect of the normal knee. Both knees have “knee dimples” present.

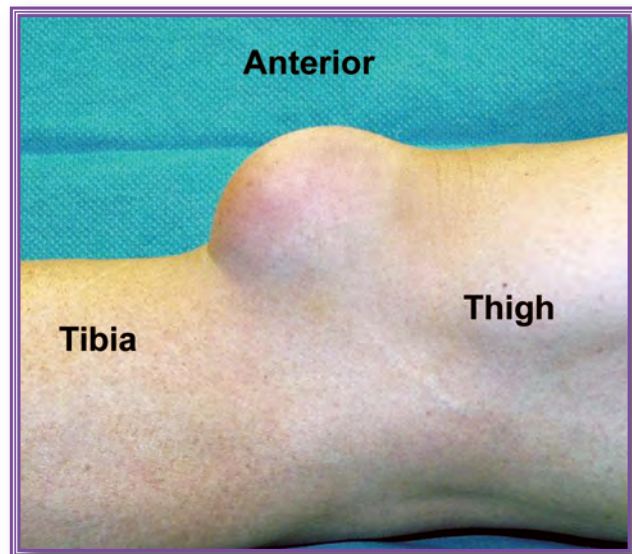


Figure 8: Lateral view of prepatellar bursitis

A torn anterior cruciate ligament is often associated with a pop and the rapid onset of swelling. Typically this injury does not prevent a patient from being ambulatory. However, it does make the knee somewhat unstable, especially with pivoting activities, while carrying heavy loads, and on uneven ground.



Figure 9: Anterior view of prepatellar bursitis. Note the taut anterior skin with loss of anterior knee creases.

In essence, anything that leads to complete loss of function of the joint with an inability to achieve an ambulatory status will require evacuation.

Bursitis

It is important to distinguish the potential mission-ending development of an effusion from the relatively benign pre-patellar bursitis. The bursa is essentially a flat sac that sits between the skin and the anterior aspect of the kneecap. When this sac becomes traumatized, it develops bleeding inside the sac, but extra-articular, which then causes a swollen, tender area on the anterior aspect of the knee joint. However, there is no development of an effusion. Typically the patient remains fairly functional although they do have some tenderness when attempting to kneel.

It is important to distinguish between the development of bursitis and the development of an effusion, because bursitis rarely interferes with the completion of a mission. With bursitis, the dimples on each side of the kneecap remain present (Figure 7). However, a tense swollen area is present that looks a little like a golf ball sitting on the anterior aspect of the kneecap (Figures 8 and 9). In the photos of the bursal swelling, close examination of the knee reveals that the flexion creases at the anterior aspect of the patella have disappeared due to the bursal swelling (Figures 7 and 9), as opposed to the normal knee. However, when examining the knee laterally, the swollen bursa becomes obvious (Figure 8).

In contradistinction to this, with the development of an effusion, the skin is not elevated off of the patella. However, the dimples around the kneecap are lost secondary to the outward pressure of the fluid that develops inside the knee joint.

In summary, with an effusion, both dimples will disappear; and with bursal swelling, the dimples remain, but the swelling is localized to the anterior aspect of the joint over the patella.

The treatment for bursitis is NSAID medication, kneepads, and limited kneeling and crawling. Once the person returns to base, further medical evaluation is required.

With respect to mission completion and evacuation, typically bursitis does not require evacuation unless infected. However, a septic pre-patellar bursitis is usually associated with some sort of penetrating injury to the anterior aspect of the joint. It will have the typical signs of infection including erythema, warmth lymphangitis, and tender swollen groin nodes. If septic, the person will most likely need to be evacuated.

It is important that the ATP understand that an acute, non-septic bursitis will often have the clinical presentation of swelling, warmth, and tenderness also. The major distinctions are that the septic bursitis has a penetrating injury and tender, swollen groin nodes whereas a non-septic bursitis (traumatic bursitis) has intact skin, and no tender, swollen groin nodes.

Motion

During evaluation of a knee, it is necessary to check for motion. Typically, loss of extension is secondary to an intra-articular block such as a torn meniscus or loose body. A swollen knee (secondary to an effusion) will normally have loss of flexion and occasionally loss of extension.

Collateral Ligaments

In looking at the medial collateral ligament and lateral collateral ligament injuries of the knee, these two ligaments stabilize the tibia relative to the femur in a side-to-side, medial-to-lateral direction. Typically, these ligaments are torn because there is a blow to the side of the knee or the patient jumps and lands on an uneven surface causing a buckling of the knee. The typical history is that of a tearing sensation, onset of pain, which is localized to the involved collateral ligament, onset of soft tissue swelling over the involved ligament, and then decreased motion secondary to the soft tissue swelling.

For example, if the patient receives a blow to the lateral aspect of the knee, they may have pain at the lateral aspect of the knee, but the deforming force will result in a tearing of the medial collateral ligament which then results in additional pain and swelling over the medial collateral ligament (Figure 10).

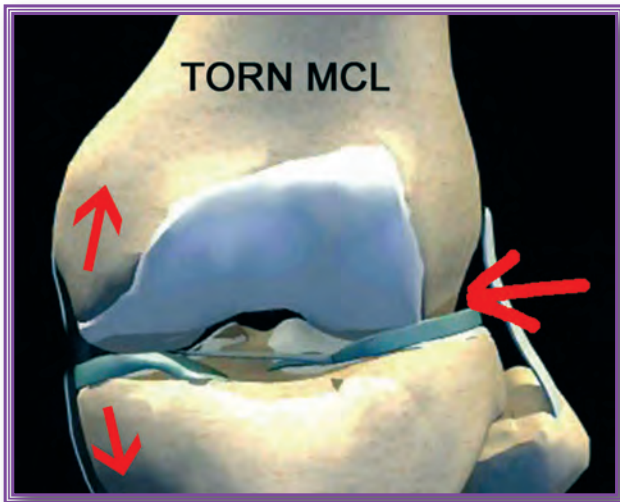


Figure 10: Lateral deforming blow resulting in a torn medial collateral ligament: When examining collateral ligaments, it is necessary to perform stress testing of the involved ligament. The stress testing for the medial collateral ligament is performed by stabilizing the distal femur and then applying a valgus or outward force to the knee joint (Figures 11 and 12).

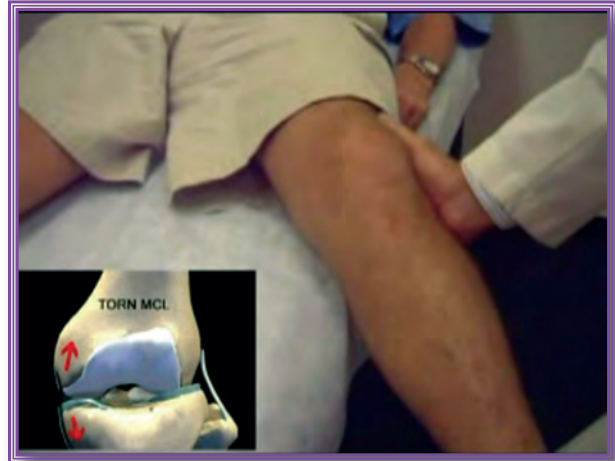


Figure 12: When the MCL is torn. The valgus force at the ankle allows the tibia and femur to separate. Compare the angle of the tibia relative to the femur in Figure 11. The inset diagrams the tibia and femoral separation in the presence of a torn medial collateral ligament.



Figure 11: Stabilize the distal femur with one hand and apply a valgus force to the ankle to stress the medial collateral ligament. The inset shows the effect of the stress test on the tibia and femur if the medial collateral ligament is intact.



Figure 13: Stabilize the distal femur with one hand and apply a varus force to the ankle to stress the lateral collateral ligament. The inset shows the effect of the stress test on the tibia and femur if the lateral collateral ligament is intact.



Figure 14: When the LCL is torn, the varus force at the ankle allows the tibia and femur to separate. Compare the angle of the tibia relative to the femur in Figure 13. The inset diagrams the tibia and femoral separation in the presence of a torn lateral collateral ligament.

If there is ever any question as to whether or not the patient has stability or instability, the opposite knee may always be tested. In looking for the presence or absence of swelling, there is usually swelling over the associated damaged ligament. If the swelling is significant enough, the dimple on the injured side of the knee will be lost due to soft tissue swelling, whereas the dimple on the uninjured side of the same knee will remain.

This action stretches the medial collateral ligament and if the medial collateral ligament is torn, instability will be appreciated as the tibia separates from the femur (Figure 12).

In a similar fashion, in testing the lateral collateral ligament, the distal femur is stabilized (Figure 13) and a varus-producing force (inwards) is applied to the distal tibia (Figure 14). If the lateral collateral ligament is torn, the tibia and femur will separate (Figure 14).

For example, if the medial collateral ligament is torn, in examining the dimples, the lateral dimple will remain because there is no effusion since the medial collateral ligament and associated soft tissue swelling is extra-articular. Hence, the medial dimple will disappear due to the accumulation of soft tissue swelling medially.

In a similar fashion, if the lateral collateral ligament is damaged, the lateral dimple adjacent to the patella may disappear whereas the medial one will not. In addition, there will be no accumulation of fluid above the kneecap in the suprapatellar pouch of the kneecap.

The treatment of a collateral ligament sprain is protective splinting or taping. Anti-inflammatory medication is also prescribed. Even though the taping may aid in making the knee stable and restoring function to

the injured Soldier, it will be necessary to do protected weight bearing. This means that the Soldier's ruck and other weight will need to be re-distributed among the remaining members of the team so the weight of the ruck becomes minimal. It may be necessary to find a tree limb, if possible, to use not as a crutch, but as a walking stick much as hikers use poles when hiking. This gives the patient a little more stability with walking and redistributes the weight bearing load. A walking stick reduces the joint reactive forces of the hip and knee. By reducing the weight of the ruck and using the walking stick, the stress load across the injured ligament is also further significantly decreased. By doing these things and by taping the joint, it is usually possible to keep the patient at least semi-functional.

The ATP should recognize that it may be necessary to re-tape the knee as the tape will loosen with time. As the tape loosens, symptoms will gradually increase and this is a good indicator that taping needs to be reapplied. Once the patient returns to base, they absolutely will need further evaluation regardless of how they feels.

With respect to evacuation and mission completion, the ATP certainly needs to speak with the team leader and determine the demands of the terrain and the mission ahead and then give the team leader a realistic expectation and appraisal of how functional the patient will be. Most likely, the patient will be able to continue the mission although this depends in large part on the terrain requirements and the amount of medial and lateral stresses or twisting stresses that will be applied to the joint.

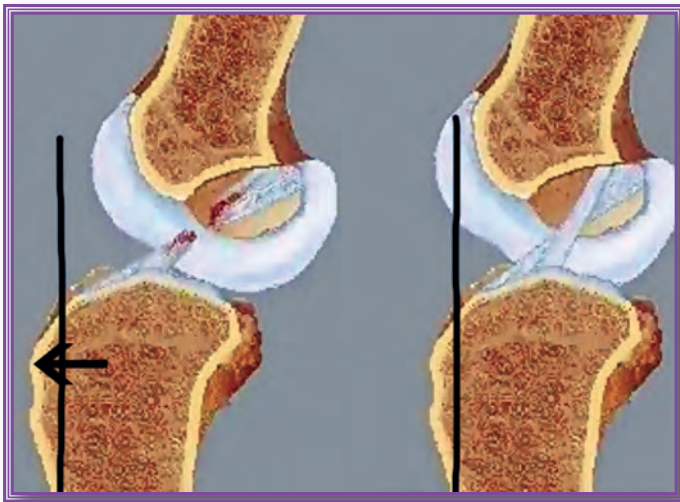
Anterior Cruciate Ligament

The anterior cruciate ligament is an intra-articular ligament of the knee. It stabilizes the tibia relative to the femur in an anterior to posterior direction (Figure 15). When torn, an (intra-articular) effusion rapidly develops; this is unlike tears to the extra-articular collateral ligaments, which do not result in the development of an effusion, but do cause soft tissue swelling.

The mechanism of injury is usually some sort of twisting or pivoting force to the knee that is accompanied by a popping sensation, a buckling sensation, the rapid development of an effusion and occasionally decreased flexion secondary to the effusion.

When performing the exam, the most reliable tests for this injury are to determine the presence or absence of an effusion (presence or absence of dimples), and then to perform the Lachman and anterior drawer tests.

When performing a Lachman test, the knee should be flexed to approximately 20 degrees and the



Torn ACL

Intact ACL

Figure 15: Comparison of tibia position in the knee with an intact ACL and one with a torn ACL. Notice how the anterior aspect of the tibia lines up with the anterior aspect of the femur on lateral examination when the ACL is intact.

femur stabilized. An anterior force is then applied to the proximal tibia. If the ACL is torn, then the tibia will sublux anteriorly relative to the femur as depicted in the drawing (Figures 16 to 18).

When performing the anterior drawer test (Figure 19), the knee is flexed to 90 degrees. The examiner will usually sit on the foot and then with the thumbs on the joint line, an anterior directed force is applied to the tibia. If the anterior cruciate ligament is intact, there is no motion or translation of the tibia anterior relative to the femur (Figure 20). However, if it is torn, then the tibia will sublux anterior to the femur (Figure 21).

The treatment for this particular type of ligament injury is non-steroidal medication and taping. Again, the load of the rucksack needs to be re-distributed among the remaining members of the team so that the injured Soldier is carrying as little weight as possible. In addition, homemade equivalents of walking sticks are also helpful for decreasing the amount of stress across the joint.

Upon return to base, this condition will again require a medical evaluation. Mission completion with a team member having this injury, would depend on the mission requirements. However, the probability of the injured soldier being able to complete the mission although with some decrease in function is fairly high.



Figure 16: Lachman test. Insets show the anterior subluxation of the tibia, relative to the femur, when the ACL is torn.

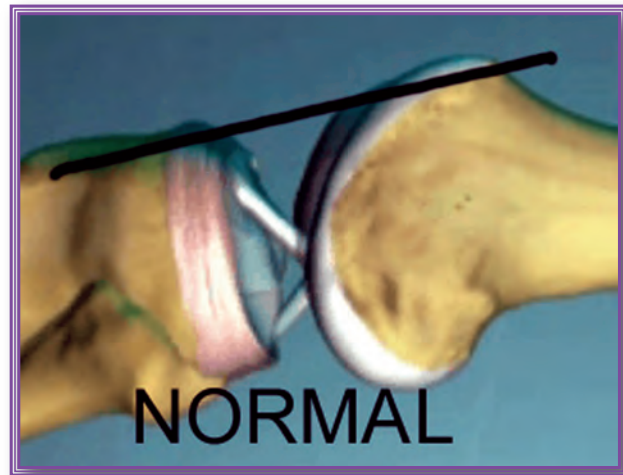


Figure 17: Above - Normal tibia-femoral relationship

Figure 18: Below - Anterior tibial subluxation

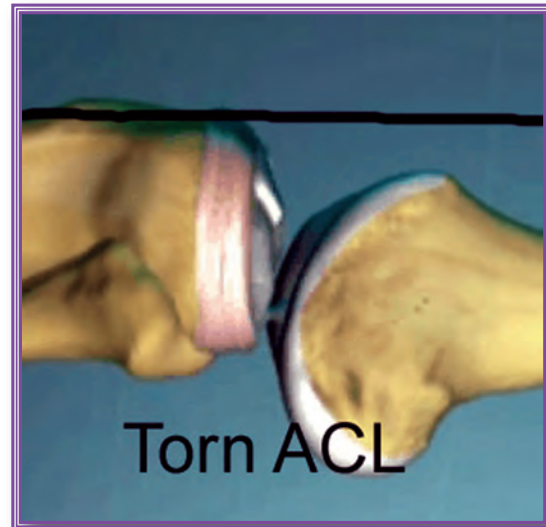




Figure 19: Anterior drawer test



Figure 20: Normal exam with the inset showing the relationship of the tibia to the femur.



Figure 21: Torn ACL with anterior tibial subluxation

REFERENCES

1. Figures 1 to 3 were obtained from <http://www.arthroscopy.com>.

This completes Part One of this article. Part Two of this article will appear in the Spring 2009 edition and will consist of taping procedures for the various injuries discussed in Part One.



JF Rick Hammesfahr, M.D. graduated from Colgate University in 1973 and the College of Medicine and Dentistry of New Jersey in 1977. He was Chief Resident in Orthopaedics at Emory University from 1980-1982. In addition to receiving numerous surgical awards, he has been on the speaking faculty of numerous medical and orthopaedic meetings serving as the co-director of several courses on knee surgery. His publications have focused on tactical medicine, arthroscopy, calcaneal fractures, abductor paralysis, wound healing, running injuries, meniscal repair, septic knees, and sports medicine. He has written two book chapters, one book, published 22 articles, serves on the editorial review board of multiple medical journals, is the editor of the "Ranger Medic Handbook", and has presented over 120 CME lectures and talks on orthopedics and sports injuries.

He has served as president of the largest regional orthopaedic association, the Southern Orthopaedic Association. Currently, Dr Hammesfahr is the Director of the Center for Orthopaedics and Sports Medicine and serves as the Chairman of the USSOCOM Curriculum and Examination Board.